Physical, Chemical, and Biological Characteristics of Least-Disturbed Reference Streams in Arkansas' Ecoregions



Yocum Creek
Ozark Highlands



Archey Creek
Boston Mountains



Dutch Creek
Arkansas River Valley



Little Missouri River
Ouachita Mountains





Moro Creek
Gulf Coastal Plain



Bayou DeView
Delta

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Volume I - Data Compilation

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Physical, Chemical and Biological Characteristics of Least-Disturbed Reference Streams in Arkansas' Ecoregions

Volume I - Data Compilation

I. INTRODUCTION

The goal of the Clean Water Act of 1972 (PL 92-500) is to assure that the Nation's waters are "fishable/swimmable." Such a simply stated goal could lead one to think that this would also be a simple task. Such might even have been the case in the early 1970's, when billions of tax dollars were spent in an effort to achieve this ambitious goal. Initially, the assumption was that cleaning up the nation's surface waters would automatically assure that they were "fishable/swimmable." One of the more important things learned during early efforts to control water quality was that minimal, subtle effects of man's activities can have dramatic effects on the beneficial uses of water.

Water uses are often adversely affected without degradation of water quality. Activities which alter the stream habitat may affect water uses as much as actual degradation of the water quality. This understanding has added significant complications to the task.

In the development of this project, it was realized that accurate measurements of relatively undisturbed stream habitat conditions as well as water quality must be obtained in order to evaluate the total impact of various land uses and other activities on streams. Measurement techniques have been standardized with the hope that the resulting information from various sites can be used on a more uniform basis and that valid comparisons can be made. This study attempts to transcend the narrow perspective regarding water quality standards and use a broader approach considering all aspects - chemical, physical and the resulting biological factors - of specific streams.

Purpose

This project was designed to provide a sound scientific basis for development, review, and adoption of water quality standards. At present, water quality standards are often nationwide values which do not recognize seasonal or regional variations in water quality. Many of the cleanest streams and lakes in Arkansas have naturally occurring water quality values that are substandard according to those national values. In numerous instances where the standard is incorrect, valuable resources have been spent to reach a goal which is not attainable.

The suspected disparity between the water quality standards and actual water quality values led to the conclusion that a study should be undertaken to identify water quality conditions in least-impaired streams within the different ecoregions of Arkansas. Least-impaired streams are those which have the least amount of disturbance (in terms of agriculture, silviculture, or other similar activities) and the fewest pollution sources in their watersheds. Such a study would provide valuable background information to measure the effects of dischargers and nonpoint pollution sources, and to provide the information necessary to derive appropriate water quality standards and designate realistic uses.

The very framework of any state water quality regulatory agency is the "standards" by which it regulates and manages the state's resources. By necessity, the standards must be correct in order to do an efficient and effective job.

Concept and Hypothesis of Study

Arkansas is a state with many diverse landforms which are distinctly divided into major ecoregions. This diversity in landforms significantly influences the biological, physical, and chemical nature of the streams draining these regions. The size of a watershed also influences a stream's characteristics. Therefore, the study was structured to evaluate streams with different watershed sizes within the different ecoregions. Seasonal variations within the streams were also evaluated.

To summarize, the basic concept for the study is to evaluate the physical, chemical, and biological characteristics of least-disturbed streams in watersheds of various sizes within each of the ecoregions. By determining the characteristics for regionally specific, least-disturbed

streams, the Department will have a much better idea of the characteristics of other streams within the region. This will help to develop realistic water quality standards and designated uses for all streams.

Planning of Study

To develop a workplan for the study it was necessary to:

1. Define the ecoregions;

2. Select a range of watershed sizes;

3. Select those seasons of the year which would be the most critical from a water quality standpoint, particularly regarding dissolved oxygen; and

4. Develop a method for selecting streams within each ecoregion which would have the least amount of disruption and fewest pollution sources in their watersheds, and whose watersheds would also be most typical for a given ecoregion.

Defining Ecoregions

The basic approach for selecting the regions and finally the specific sites to be investigated was taken from a paper entitled, "A Synoptic Approach For Regionalizing Aquatic Ecosystems" by J. M. Omernik, M. A. Shirazi, and R. M. Hughes (1981). In this paper, Omernik explains that the current approach to ecosystem classifications consider ecosystem components as a total entity, not as separate items such as energy, water, air, soil, biota and human culture. The authors are presently developing a framework for assessing the biological and chemical quality of surface waters for the nation. The immediate objective is to develop a better understanding of the geographical patterns of interrelationships involving surface water-related ecosystem components, using available data and rationales.

The approach utilizes topography, soils, potential natural vegetation and land use to characterize ecoregions based on: (1) determining the predominant general unifying characteristic of an ecoregion; (2) calculating and mapping the extent of combinations of these characteristics; (3) selecting areas that appear to be most typical, generally typical, and atypical of each ecoregion; and (4) identifying broad homogeneous areas that appear to have similar

characteristics. The regions defined herein were selected because each generally met the criteria described above. For the purpose of this study the regions are:

1. The Mississippi Alluvial Plain (hereinafter referred to as the Delta) occupying roughly the eastern one-third of the state;

2. The Gulf Coastal Plain, in the south central and southwestern part of the state;

3. The Arkansas River Valley, in the west central and central part of the state;

4. The Ouachita Mountains, in the west central part of the state;

5. The Ozark Highlands, in the northern part of the state; and

6. The Boston Mountains, in the north central part of the state.

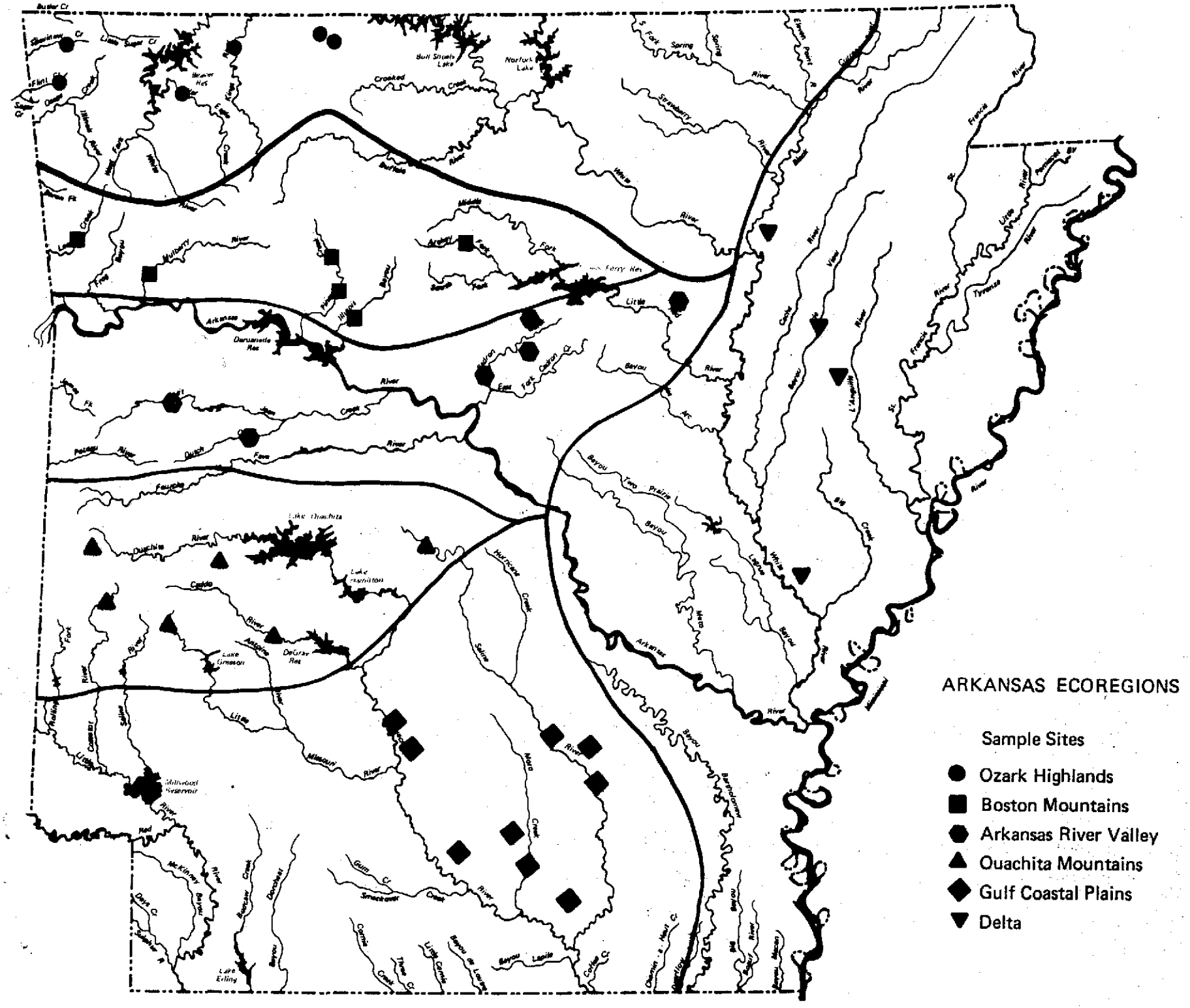
The six ecoregions and the reference stream sample sites are shown on the map on the following page. For the purposes of this study, Crowley's Ridge, which is usually regarded as a distinct region, was not included. The Ridge contains only a small number of minor streams which are unique to it. A full discussion of the ecoregions and their characteristics is presented in other sections of this report.

Watershed Size Selection

A range of watershed sizes, from about 20 square miles to approximately 500 square miles, was selected. This range of areas included all possible beneficial uses for the streams. The preliminary size groups of watersheds were: 20 to 50 square miles, 100 to 200 square miles, and 300 to 500 square miles. Plans were to collect data over a three-year period so that streams in each drainage area size group would be represented. The order of sampling was from the smallest to the largest watershed size within each specific ecoregion.

Climate

Arkansas has a moist, temperate climate with an average annual rainfall that varies from approximately 44 inches in the northwestern part of the state to 50-52 inches in the


ARKANSAS ECOREGIONS
Sample Sites
Ozark Highlands
Boston Mountains
Arkansas River Valley
Ouachita Mountains
Gulf Coastal Plains
Delta

central, southern, and southeastern portions of the state. During the summer, precipitation usually falls as scattered thundershowers. Most of the precipitation occurs as general rain and some snow during the late fall, winter and early spring.

Mean monthly rainfall is well distributed throughout the year. Winter and spring are the wettest times of the year and late summer and fall are the driest times of the year, although monthly totals during the summer and fall still average about three inches each month. Higher evapotranspiration rates and lower rainfall cause stream flows to be lowest during the late summer period.

Average air temperatures show little variation across the state. Maximum temperatures occasionally exceed 100°F (38°C) during July and August. Winters are short, but minimum temperatures, which usually occur in January or February, sometimes approach 0°F (-18°C).

Maximum stream temperatures usually occur in July and range from about 82°F (28°C) to 90°F (32°C) depending on the amount of solar radiation received, depth and other factors (NOAA, 1976).

Selection of Critical Survey Periods

Two sampling periods were selected. The first was late summer when water temperatures are normally at a maximum and flows are near minimum. At this time, dissolved oxygen should be the lowest. The second period was during the spring when fish spawning was occurring and dissolved oxygen requirements for fish reproduction would be critical. The late summer surveys were conducted in August and early September. The springtime period was chosen by monitoring stream temperature to determine when fish spawning began. This was usually in late March.

Site Selection Methodology

Least-disturbed streams within the state were selected by reviewing the location of known dischargers (ADPC&E 1984 305(b) report) and utilizing the extensive field experience of Department staff to exclude streams with known pollution sources. All potential "least-disturbed" watersheds were then outlined on a map. Additional review of these potential sites for nonpoint source pollution problems eliminated many sites. The scope of the project limited the

number of sites which could be investigated over a three-year period.

The initial goal of site selection was to confine sites to the "most typical" areas (Omernik, et al., 1981) of the previously described ecoregions. In the selection process, however, the staff discovered that sites in some regions would have to be located within "generally typical" sections, since too few least-disturbed streams could be found in the most typical region. Finally, extensive field evaluations of the potential sites were conducted to confirm their suitability for final selection as representative streams.

Initiating the Study

Once the plans and concepts were finalized, a workplan and grant request were submitted to Region 6 EPA for a grant to fund the study under the provisions of Section 205(j) of the Clean Water Act. The workplan and grant were approved and the study was initiated in the summer of 1983. Subsequent workplans and grants have allowed the Department to continue the necessary field work through 1984, 1985, and during the field efforts during the spring of 1986. This report includes the data from the various size watersheds from the six ecoregions of Arkansas for the entire project.

II. SAMPLING METHODOLOGY

Overview

Each stream survey consisted of a one-week work schedule in which physical, chemical and biological parameters were evaluated. Two sites per region were sampled during the same week. The spring and summer surveys varied slightly due to differing conditions, but the basic schedule was similar. Methods described in subsequent sections are currently accepted in stream-study research projects. The daily field schedule was as follows:

- o Monday - D.O. monitors were set up and calibrated at each stream.
- o Tuesday - D.O. monitors were checked and calibrated, and general conditions were recorded, including time, weather, D.O. readings and temperature.
    - The chemical grab samples were taken and stored on ice, then transported to the lab via car or plane.
    - Dye study was performed.
    - Flow measurements were taken and a staff gauge was installed.
    - A detailed physical evaluation was done.
    - The macroinvertebrate survey was conducted.
- o Wednesday - D.O. meters were checked and calibrated.
    - Fish collection was performed at one site.
    - Staff gauge measurements were taken.
- o Thursday - D.O. meters were checked and calibrated.
    - Fish collection was performed at the second site.
    - Staff gauge measurements were taken.
- o Friday - Flow was recorded and D.O. meters were checked and calibrated, then closed down.

Parameters Evaluated

Continuous Dissolved Oxygen (D.O.)

Dissolved oxygen (D.O.) was measured continuously during the survey using two (or more) Yellow Springs Instruments (YSI) Model 56 Dissolved Oxygen Monitors. These meters were placed on the streambank with the probe and stirrer in a pool (at mid-depth) and in a riffle. The meters were secured in place and camouflaged to prevent tampering or movement of the devices.

A typical D.O. meter installation would involve:

1. Measure the D.O. of the stream using the Azide Modification of the Winkler Method, perform duplicate titrations, record value;

2. Calibrate YSI Model 57 D.O. meter (portable), record;

3. Set YSI Model 56 D.O. monitors in place;

4. Calibrate using portable meter, record value;

5. Record D.O., temperature, time, date, location, meter I.D. number and calibrations;

6. Secure monitor with ropes and cover with garbage bags.

Subsequent calibrations of the continuous monitors included adjustment of the monitor to compensate for drift or changing the D.O. probe membrane due to damage. Continuous D.O. and temperature data were automatically recorded on a strip chart; times and dates were manually recorded on the strip chart by the survey crew. The time and date information was used to verify the clock (i.e., chart speed) of the D.O. monitor.

After the surveys on all six physiographic regions were completed, the data from the strip charts for each site were transcribed onto forms at fifteen-minute intervals. The data were then typed into computer files.

The computer was used to: (1) generate the percent saturation of dissolved oxygen based on temperature and measured D.O.; (2) correct the data to meet calibration adjustments; (3) calculate daily maximums, minimums and averages, and; (4) produce graphs of the data.

Chemical Parameters

Samples for chemical analyses were collected during the second day of the survey week. Three separate grab samples were secured at least 1 hour apart within an 8-hour period. Samples were taken just upstream of the reach used for physical evaluation (transects). Proper location was important because sediment stirred up from the streambed could greatly affect the chemical analyses. One such interference was noted and subsequently invalidated.

Two 1000-ml containers (one for chemical analyses and one which was lightproof for chlorophyll $\bar{a}$) were used to collect water at mid-depth from each sampling locale for each sampling time. A small volume from one container was filtered through a Gelman glass-fiber filter and stored in a 4-ml vial. The waste filtrate was discarded. One sterilized glass bottle (100 ml) was used to collect water for fecal coliform analysis.

At the time of collection, the following items were recorded: time, date, sample number, dissolved oxygen, pH, temperature, stream name and initials of sampler. This data was also recorded on field sheets for backup purposes. The pH was measured with an ORION RESEARCH digital pH meter, Model 211.

All sample containers were stored on ice and sent to the ADPC&E laboratory by automobile or airplane. Upon arrival at ADPC&E, the samples were prepared for analysis in accordance with STANDARD METHODS, 14th ed.

Laboratory personnel performed the following analyses:

- Coliform bottle - Fecal Coliform
- Filtrate - Ammonia-Nitrogen and Ortho-phosphate
- Dark Bottle - Chlorophyll $\bar{a}$
- Light Bottle - Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Biochemical Oxygen Demand-5-day and 20-day (BOD_5 and BOD_{20}), Total Phosphorus, Nitrate + Nitrite Nitrogen, Chloride, Sulfate, Total Iron, Specific Conductivity, Alkalinity, Hardness and Manganese

All analyses were performed in accordance with STANDARD METHODS, 14th ed., as specified in the Quality Assurance Project Plan for the Section 205(j) Project.

Physical Parameter Evaluation

Numerous measurements were made in completing a physical evaluation. These measurements were normally done on Tuesday of each week during the field survey. The drainage area of the test site was determined from 7½' USGS quadrangle maps prior to going to the field. The land use within the watershed was determined using the latest available information from the Soil Conservation Service (SCS).

Stream Flow Measurements - Stream flow is an important parameter in two ways:

(1) All other physical, chemical, and biological measurements are related to stream flow. The assumption is made that the combination of the lowest flow and highest instream temperature occur during late summer within a yearly cycle and, therefore, determine critical conditions.

(2) The actual site chosen to measure the flow determined the reach of stream to be used in making other physical measurements.

Stream flow was measured on the second day of the survey. A Marsh-McBirney Model 201 Portable Water Current Meter was used with a graduated rod which measured depth and held the flow probe at 60% depth. The width of the cross-section was measured with a Lufkin cloth tape (100 ft. or 50 ft.). At the time of the flow measurement, a staff gauge was set in place and readings were recorded daily. Flow data were recorded in field books and on field sheets. Calculations were performed after the survey using computer programs to calculate flow (in CFS) and sketch stream cross-sections.

The site selected for flow measurements was chosen on the basis of the most uniform streambed cross-section. This helped to assure the best measurements since non-uniform streambeds may cause errors in velocity and depth. Some man-made structures (bridges and culverts) were used as flow measurement sites while other flows were simply taken instream.

The location used as the flow measurement site was also the basis for the physical transect survey. The length of the transect reach to be studied was equal to 15 times the width of the stream at the flow measurement site.

Normally, ten transects were marked off within the stream reach. Sometimes, due to the uniform nature of the stream, fewer transects were sufficient to provide adequate physical information.

Stream Gradient - Stream gradient was determined by calculating the vertical drop in elevation per unit distance on a 7½' USGS quadrangle map which covered the area of the sample site.

Mean Channel Width - Mean channel width was determined by calculating the arithmetic mean of the transects measured between the normal high water marks.

Mean Stream Width - Mean stream width was determined by calculating the arithmetic mean of the transects measured from water's edge to water's edge.

Mean Stream Velocity (Dye Study) - Stream velocity was determined by putting fluorescent dye in the stream and timing its flow through a representative stream reach. From this information, an average velocity was calculated.

Estimated Mean Depth - Mean stream depth was determined by estimating the mean depth based on the observations made during the transect survey.

Stream Substrate - The composition of the stream substrate was determined along each transect line from streamside to streamside. A cloth tape is stretched across the stream channel and each 1-foot division of the measuring tape was projected by eye to the stream bottom. The predominant type of substrate found within these 1-foot divisions were recorded on the field survey form. The categories of substrate types include (EPA, 1982):

Bedrock	
Large Boulders	>45 cm
Boulders	25-45 cm
Rubble	6-25 cm
Gravel	6-60 mm
Sand	.06-6 mm
Mud/silt	<.06 mm

In addition to the substrate type, an estimation of the "percent embeddedness" was recorded for each transect. Embeddedness measures the degree to which the larger substrate particles are surrounded or covered by fine sediment. This measurement was given as a percent of the surface area of the larger particles that were covered by sediment.

In-stream Cover - Cover, relative to fishery needs, was measured much like the substrate type. While the tape was being used to measure the individual transect stream widths, the observer measured the cover types which predominated in each one-foot interval. Categories included: undercut bank, brush, logs, debris, overhanging vegetation and inundated vegetation. If inundated vegetation was present, a vegetation density code was utilized to account for surface, mid-depth and bottom coverage.

Pool/Riffle - Each transect was recorded as either a riffle or one of three categories of pools (deep, moderate and shallow).

Riparian Area - Data was generated concerning the riparian area outside the stream channel in order to make valid comparisons between sites. A ten-foot extension of each transect on either side of the channel was used to record the percentage of trees, shrubs, grasses and forbs, and rock or dirt.

Bank Stability - Both banks of each transect were classed according to the following:

S - stable, little evidence of new bank sluffing scars
M - moderately stable, new bank sluffing scars
U - unstable, extensive new bank sluffing conditions apparent

Percent Canopy - The amount of canopy along the tape measurements of each transect was recorded. The total amount of canopy was divided by the total width to record a percent measurement.

Macroinvertebrate Sampling

The benthic macroinvertebrate community of each site was used to further describe the total aquatic ecosystem within each study area. Qualitative samples of the benthos were collected over a pre-determined period of time using a Turtox Indestructible dip net and sampling all available microhabitats present within the stream reach.

After collection, samples were initially sorted using a #30 U. S. standard mesh seive. Benthos were then hand-picked from all material retained by the seive and preserved in 70% ethanol at streamside. Final separation, identification, and enumeration were completed in the lab. Identification was to the species level whenever possible. For each study site, a complete tabulation of taxa, numbers of individuals

and their percent composition is contained in Appendix A.

The qualitative samples were used to taxonomically characterize the aquatic community, identify indicator taxa and determine relative abundances of taxa and ecological types. The Dice Index (EPA, 1983), Qualitative Similarity Index and Common Taxa Index (ADPC&E, 1986), three qualitative similarity indices, were calculated to determine the similarity between samples. The Dice Index is the most applicable (Boesch, 1977) and is frequently utilized by stream investigators (Cairns and Dickson, 1971; Johnson and Brinkhurst, 1971; Kaesler and Cairns, 1972; and Foerster, 1974). The last two indices are variations of other qualitative indices that were developed for use with the Arkansas biomonitoring program (ADPC&E, 1986).

In addition, community parameters developed to indicate overall community "health" were calculated for all collections. These included Shannon-Wiener diversity index (Wihlm and Dorris, 1968) and indices of evenness, variety and dominance (ADPC&E, 1984).

During the summer 1983 surveys, the benthic collections were conducted over a one-hour time period. This included collection, sorting, picking and preserving of benthos. After analysis of the summer benthic collections, it was apparent that the 1-hour time period was not sufficient to collect a representative sample of the benthic community.

At the beginning of the spring 1984 surveys, the benthic collection was modified. The time of collecting was reduced to 30 minutes and included only collecting. The processes of sorting, picking and preserving were not timed, nor were they limited to a certain time period. Sorting and picking continued until all discernible organisms were collected from the sample. This generally exceeded 4 hours.

Fish Collection Procedures

A variety of fish-collecting techniques was necessary to overcome the wide range of physical and chemical conditions of the waters sampled. Major factors which influence collecting include flows, water depth, in-stream obstructions, water turbidity, temperature and conductivity.

Under conditions of warm water temperature and very low flows, the fish toxicant, rotenone, was used. Concentrations of active ingredient between 0.05 and 0.10 mg/l were dispersed into the sample area by first mixing powdered rotenone with water to a paste-like consistency,

then treating the sample area by throwing the mixture by hand or allowing the current to disperse it. Where substantial flows existed through the sample area, the rotenone was detoxified at the lower end of the sample area by treating with approximately 2 mg/l potassium permanganate. Fishes affected by the rotenone were dipped from the water by workers wading through the area. Normally, 4 to 6 people spent 3 to 4 hours picking up fish. Sample areas were checked for additional fish the following day, but significant numbers of fish were rarely found after the first day.

Electrofishing gear was used at sample sites where the majority of the water was wadable, the water was relatively clear and access from pool to pool was possible by flat-bottomed boat or canoe. A variety of shockers were used depending on availability of gear and physical characteristics of the sample stream. Gasoline-powered generators of the following types were utilized: (1) Homelite and Ag-tronic 3500-watt, 120/240 volt, single phase; (2) Dayton 2000-watt, 115-volt, single phase with a Powerstat variable voltage transformer (120 to 240 volts). This gear was transported through the sample area in a flat-bottomed boat or a canoe. The electrodes were hand-held by workers wading the shallow water. Fish collectors also waded while picking up stunned fish with dip nets.

Occasionally, shallow riffle areas were collected by placing a seine across the bottom of the riffle and shocking the area upstream. The gravel and rubble in the riffles were kicked and rolled by electrode-handlers to dislodge stunned fish from the bottom and allowing them to drift downstream into the net. In most cases the electrodes were connected directly to the generator output outlet. On one occasion, a boat-mounted shocker with the Ag-tronic generator and a Smith-Root variable voltage pulsator was used. Pulsed D.C. current up to 500 volts with 30 to 60 pulses per second was utilized during springtime sampling under conditions of high water and increased turbidity. Results were limited.

Backpack-mounted electrofishing gear was sometimes used in very small streams with flows too low to transport heavier gear from one pool to another. This equipment was composed of an Aqua Bug 300 gasoline-powered generator with an output capacity of 300 watts of 120-volt alternating current.

The techniques for electrofishing were intended to cover as much of the stream and as many micro-habitats as possible. Depth of water was normally the limiting factor. The

distance of stream covered varied from one-fourth to three-quarters of a mile depending on the extent of unworkable pools. When the fish species being collected and their abundance were obviously being duplicated with continuous sampling, shocking was terminated at that site. Trammel and hoop nets were used for springtime collections when flows were normally too high and water too deep for electrofishing. Monofilament trammel nets were used which had bar-mesh sizes of 1½, 2, 2½, 3 and 3½ inches. They were hobbled to four feet deep and the total length of each net was 100 feet. Also, hoop nets of 1 and 1½ inch mesh with hoops of two to three feet diameter were utilized. This gear was usually fished over a period of several days and was generally ineffective in collecting large numbers or numerous species of fish.

A complete list of scientific and common names of fishes (AFS, 1970) collected during this phase of the study is contained in Appendix B. Hereafter, text references to these fishes will be by common name only except in tables. The species considered to be most sensitive to environmental changes are designated in this appendix.

Due to collecting gear selectivity, the influence of physical conditions and natural occurrences of large numbers of individuals, the number of individuals collected was not used as a primary parameter in evaluating the population. Instead, each species collected was given a relative abundance number based on the observations of all collectors experienced and knowledgeable in fish identification and ecology. These numbers were either verified or modified after separation, identification and enumeration of the preserved specimens.

The observed relative abundance value was particularly useful for the electrofishing collections since often large numbers of fishes were stunned but could not be netted by the workers. Also, some species were so abundant and extremely vulnerable to electrofishing that continued collection of these individuals was unnecessary. The criteria for assigning relative abundance values to a species are given in Appendix C. Since these values are determined for three different size groups for each species, i.e., adults, intermediates and young, the maximum value for a species is 12 with a minimum of one.

The Shannon-Wiener dominance diversity index (Shannon and Weaver, 1963), the index of evenness (Pielou, 1975) and most of the other metrics were calculated using the relative abundance values.

III. REFERENCE STREAMS BY ECOREGIONS

DELTA ECOREGION

The Delta ecoregion occupies approximately the eastern one-third of the state. It is comprised of alluvial deposits of sand, gravel and clay deposited by the larger rivers and some wind-deposited loess. These deposits are of the Pleistocene to Holocene Epochs, dating from a million years ago to the present. Soils are deep and generally impermeable, making drainage poor.

The Delta is the flattest area in the state with maximum reliefs of only a few feet per mile. As a result, natural streams of this region are sluggish and meandering with very little gradient and low reaeration rates. Stream bottoms are usually silt or clay. Many of the natural streams have been channelized to facilitate drainage.

Native vegetation for this area is composed of bottomland hardwoods and wetland timber such as cypress and water tupelo but clearing for agricultural purposes has removed the majority of the timber. Land use is predominantly agricultural with cotton, soybeans and rice constituting the chief crops. Major streams or rivers draining this region are the Arkansas, White, St. Francis, Cache and L'Anguille.

Streams selected to represent the Delta Ecoregion and their respective watershed sizes are as follows:

Boat Gunwale Slash	23 mi^2
Second Creek	60 mi^2
Village Creek	194 mi^2
Bayou DeView	460 mi^2

BOAT GUNWALE SLASH

Boat Gunwale Slash, in the south central part of Monroe County, was selected as a small, least-disturbed stream in the Delta Region (Figure D-1). It was selected from other possible locations after an on-site visit confirmed its suitability as a least-disturbed stream. This stream has a limited amount of channel modifications. These are located in the upper watershed.

Boat Gunwale Slash starts in central Monroe County and flows in a southerly direction before joining Prairie Cypress Creek. Flow is eventually into the White River. The general area of the sampling site was above and below the Highway 146 bridge in Section 30, R 1 W, T 1 S.

General Site Discussion

Watershed Size - Drainage area above the Highway 146 bridge is 23 mi^2.

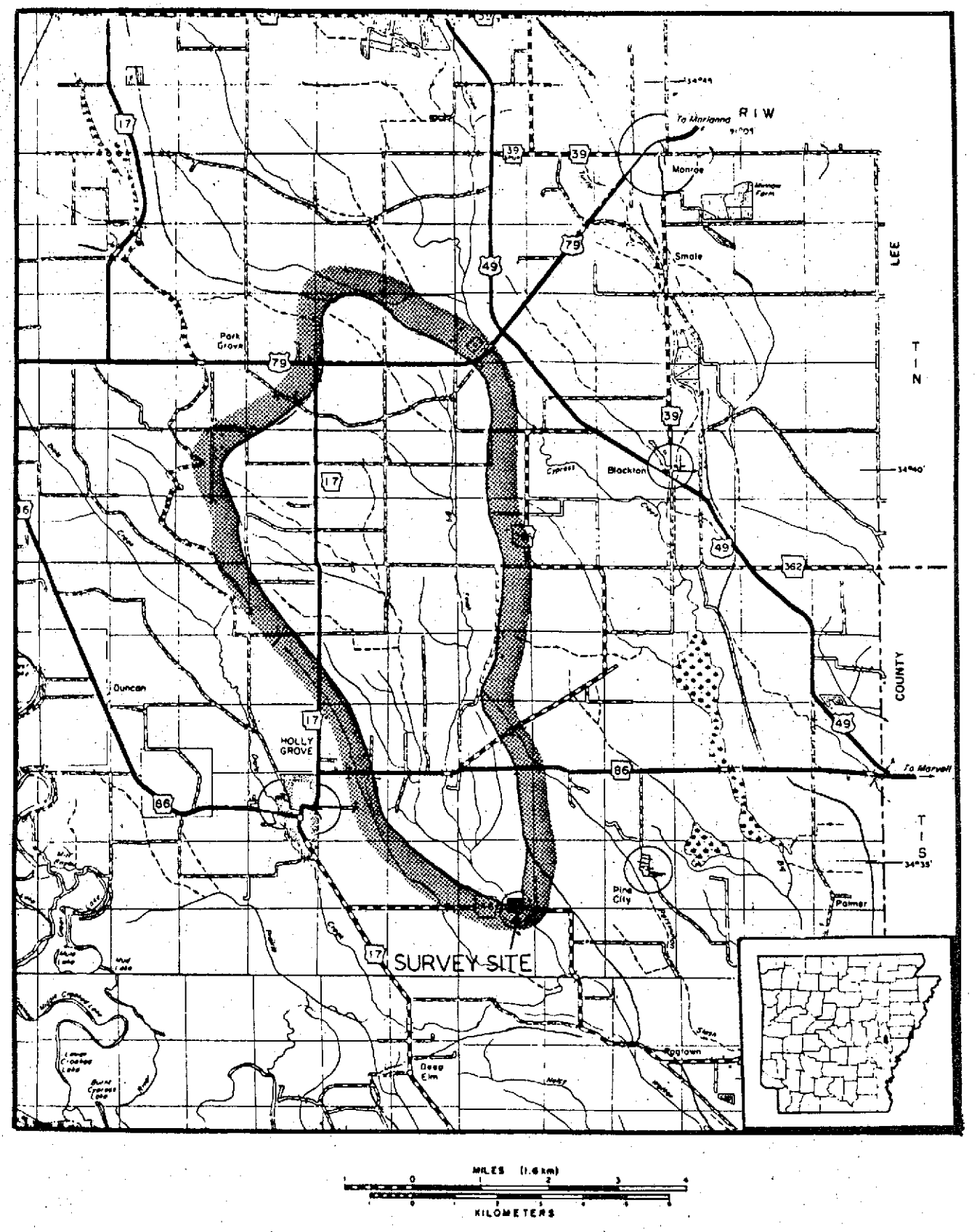
Geology - The watershed of Boat Gunwale Slash is in an area of unconsolidated loess and alluvial deposits of Pleistocene and Holocene age. These deposits are more than 200 feet thick (USDA, 1978).

Topography - Topography within the watershed is generally level with only minor differences in elevation. Elevation ranges from about 175 to 180 feet above mean sea level. Slopes are usually less than 1%.

Soil Type - Soils within the watershed are of alluvial and loess origin and are generally of the Jackport-Foley-Bonn and Dubbs-Bosket-Dundee associations. The predominant soil association is the Jackport-Foley-Bonn. It consists of poorly drained, level soils with a loamy surface layer and loamy and clayey subsoil located on broad upland flats. The soils of the Dubbs-Bosket-Dundee association are well-drained to somewhat poorly drained. These soils have a loamy surface layer and subsoil, and comprise most of the bottomlands.

Soils in both associations have only a "slight" erosion factor. The pH of these soils is neutral to very strongly acid, ranging from 4.5 to 7.3. Several of the soils within the watershed have high levels of magnesium and sodium (USDA, 1978). In some cases, this may be toxic to many plants (i.e., Lafe series of soils). This factor could be contributing to the higher total dissolved solids in Boat Gunwale Slash than are found in similarly-sized,

Figure D-1



BOAT GUNWALE SLASH: Drainage area 23 square miles ■ Survey site ▒ Survey area

least-disturbed streams in other regions.

Land Use and Flora - The watershed lies within the Southern Floodplain forest and the potential typical forest would consist of Oak-Tupelo-Cypress association (Bailey, 1976). However, due to the extensive clearing that has taken place in the Delta for agricultural reasons, only small portions of forest exist. Generally, these forests are in the floodplain of the streams. In the case of Boat Gunwale Slash, approximately 20% of the watershed is covered by forests including nearly all the floodplain of this small stream. The remainder of the area is agricultural land where soybeans, cotton and wheat are the main crops.

Stream Characteristics - Boat Gunwale Slash is a small, meandering stream with very little disruption of its immediate channel and riparian area. Stream gradient at the sample site was calculated to be 0.7 feet per mile. The stream channel has standing timber and understory vegetation in it. Boat Gunwale Slash is a typical, relatively undisturbed, sluggish, warmwater stream of this area.

Methodology and Sampling Results

The summer survey was conducted from August 1-4, 1983. Weather during this period was sunny to partly cloudy and hot. Rain during the week prior to the survey had increased flow in the creek; flow was still moderately elevated but falling.

The spring survey was conducted from April 9-12, 1984. Weather during this period was cloudy to partly cloudy. It had been raining prior to the survey period and flows were high but falling.

Continuous Dissolved Oxygen

Summer - Three continuous D.O. meters were set up 100 to 300 feet upstream of the bridge on the afternoon of August 1, 1983. They operated until the afternoon of August 4. Due to the decreasing flow in Boat Gunwale Slash and the lowering stream level, only one of the three meters was in a representative stream environment throughout the survey period. The meter at this site was about 300 feet above the bridge with the probe at mid-depth and in flowing water for the entire time.

Changes in dissolved oxygen at this site were very uniform over the period monitored. Dissolved oxygen ranged from a minimum of 2.5 mg/l (30% saturation) to a high of 3.2 mg/l

(38% saturation) on August 3. There was a small diel variation on August 2 which became more pronounced the next day. This small diel change may have been due to the complete canopy and fragile periphyton substrate. Plots of continuous dissolved oxygen, temperature and percent saturation are shown in Figure D-2.

Spring - Two meters were set up above the bridge. During the spring survey period, flow velocity was relatively uniform across the stream channel. Therefore, meters were placed on opposite sides of the stream about 20 feet above the bridge. One meter was off calibration by 1.2 mg/l the third day of the survey, but the other meter performed satisfactorily. Plots of continuous dissolved oxygen temperature and percent saturation are shown in Figures D-3 and D-4.

Dissolved oxygen showed a steady decline during the spring sampling period. Daily minimum D.O., which occurred around 0600 hours, was about 7 mg/l (68% sat.) on April 10 and fell to about 4.7 mg/l by April 12. Daily diel variations increased over the survey period from about 1.5 mg/l to 3 mg/l. The daily maximum D.O. was about 8.3 mg/l (85% sat.) which occurred around 1600 hours each day.

Chemical Parameters

Summer - Grab samples were taken during the summer survey about 300 feet above the bridge in flowing water, well above any areas disturbed by the other survey activity. Three separate samples were taken at mid-morning, near noon, and mid-afternoon on August 2, 1983.

Chemical results are shown in Table D-1. Turbidity values during this period were lower than had been expected. BOD, total and ortho-phosphorus, ammonia and total iron values were the highest of all the small, least-disturbed sites evaluated in the state. These high values could be related to the large amount of organic material (leaves, fallen trees, limbs, etc.) in the stream channel. The high phosphorus values but relatively low nitrate values would tend to indicate that agricultural contributions to the nutrient budget at this time of year are minimal. These higher amounts of phosphorus may also be due to the instream detritus. The total dissolved solids were also relatively high. Several of the soils in the stream's watershed are high in sodium and magnesium. These minerals may play a role in elevating the total dissolved solids.

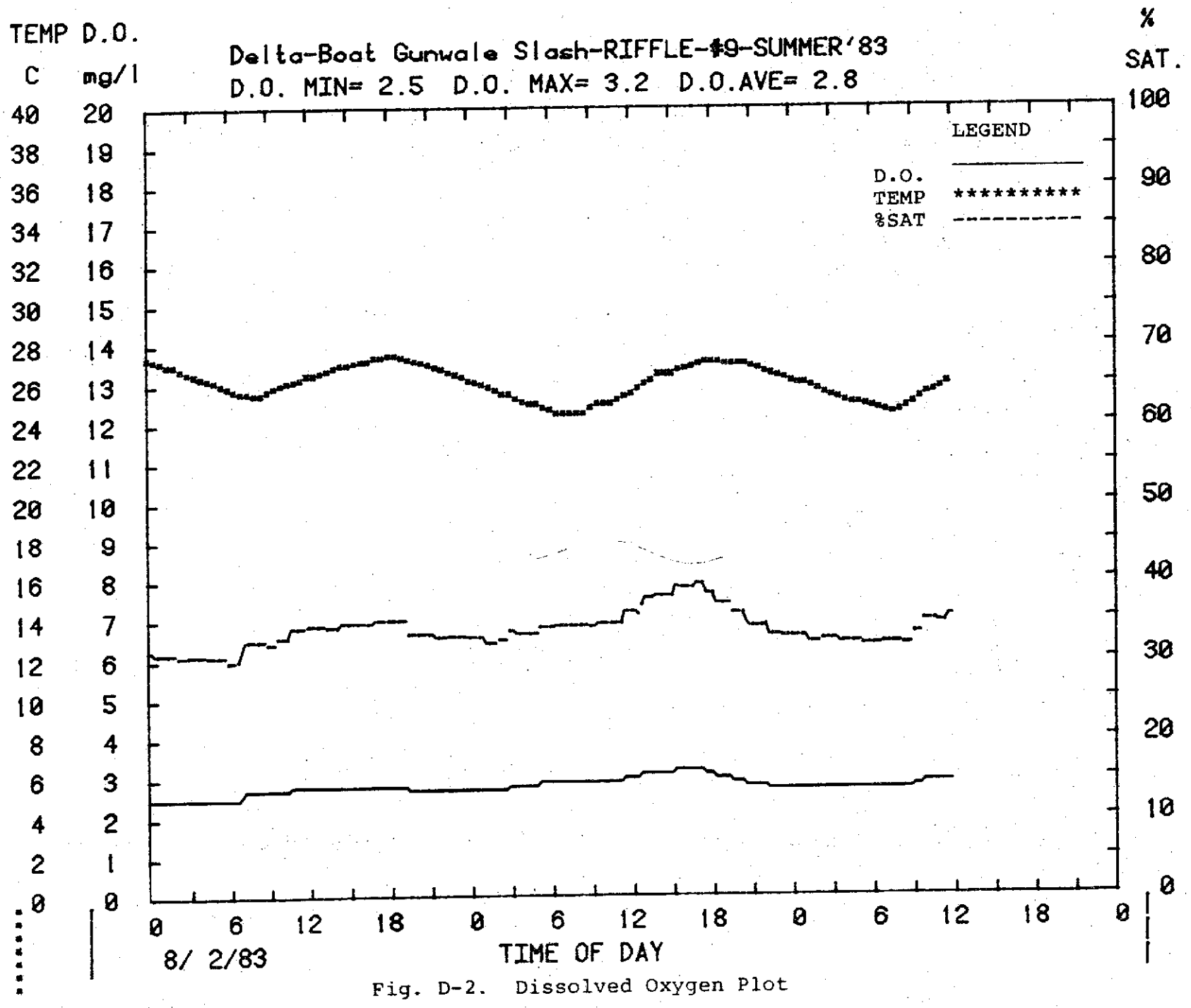


Fig. D-2. Dissolved Oxygen Plot

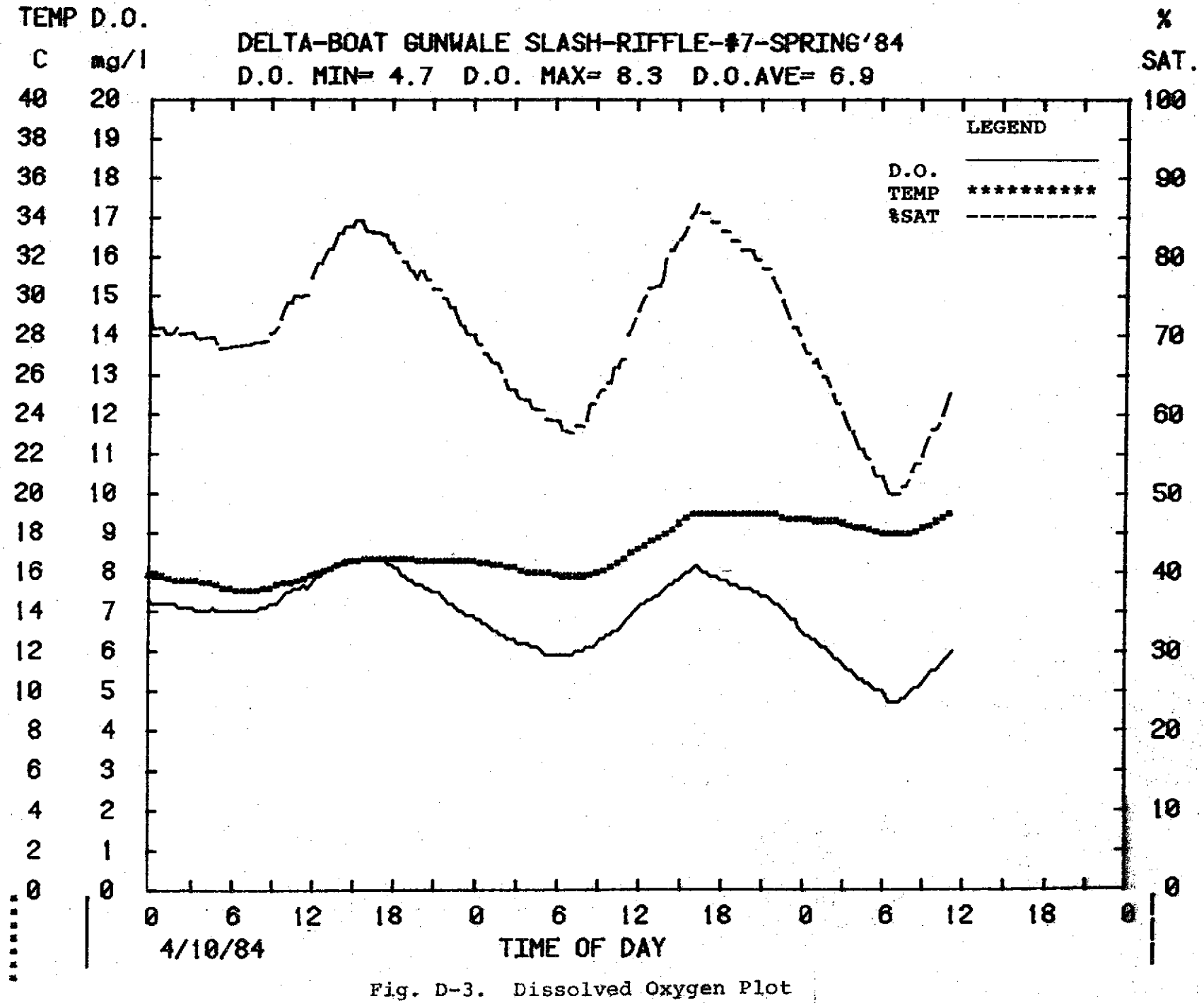


Fig. D-3. Dissolved Oxygen Plot

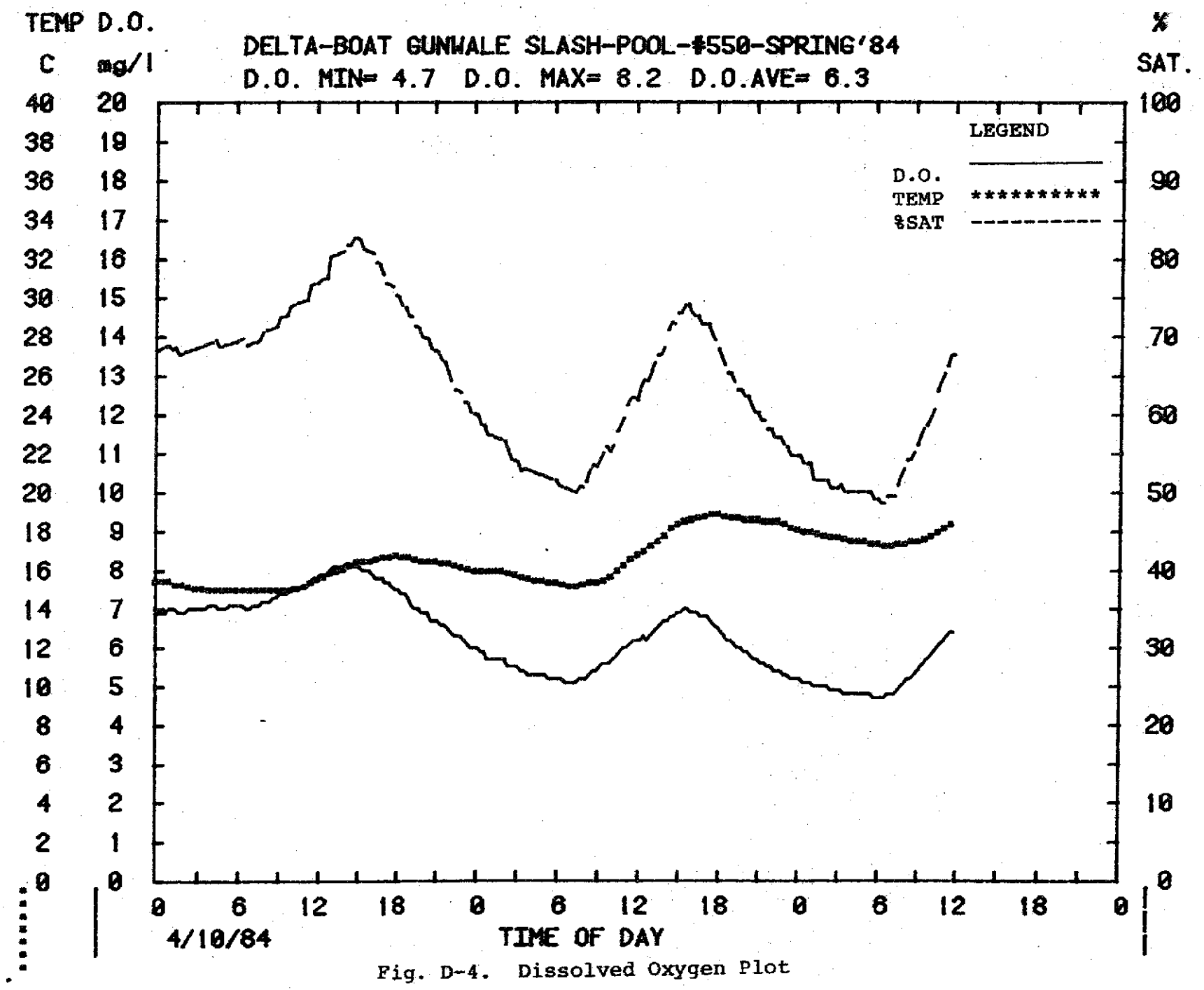


Fig. D-4. Dissolved Oxygen Plot

Table D-1

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Boat Gunwale Slash

Drainage Area: 23 Square Miles

Station Description: 100 yards above Highway 146 bridge, Section 30 T 1 S, R 1 W - Monroe County

Date: August 2, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	09:55	12:44	14:45	
Q, cfs	2.9	2.9	2.9	2.9
Temperature, °C	26	26	27	26.5
pH	6.5	-	6.5	6.5
Turbidity, ntu	6	5	6	6
TSS, mg/l	3	4	1	3
TDS, mg/l	92	93	93	93
BOD-5, mg/l	2.5	2.3	2.3	2.4
BOD-20, mg/l	7.2	6.5	8.3	7.3
T.Phos., mg/l	0.28	0.29	0.28	0.28
PO4-P, mg/l	0.21	0.22	0.22	0.22
NO2+NO3-N, mg/l	0.05	0.05	0.06	0.05
NH3-N, mg/l	0.30	0.30	0.30	0.30
Cl -, mg/l	5.5	4.5	4.5	5
SO4 =, mg/l	4	3	3	3
Fe, mg/l	1.23	1.34	1.40	1.32
Conductivity, μmho	118	118	118	118
Alkalinity, mg/l	44	43	44	44
T. Hardness, mg/l	52	50	50	51
Chlorophyll a, μg/l	-	-	-	-
Fecal Coliform	-	-	52	52

Dissolved Oxygen Data for 2 Aug 1983		
	Backwater	Riffle
Average	3.2	2.7
Minimum	2.7	2.5
Maximum	3.6	2.8

Spring - During the spring survey, grab samples were taken about 30 feet above the bridge in flowing water near the center of the channel. Three samples were taken on April 10, 1984, at 0945 hours, 1100 hours and 1300 hours.

Chemical results for the spring are shown in Table D-2. Turbidity values were highest in Boat Gunwale Slash compared to all similarly-sized, least-disturbed streams evaluated. As in the summer sample, BOD, total and ortho-phosphorus, ammonia and total iron were higher in this stream than any of the other comparably-sized sites in other regions. Nitrate-nitrite values were much higher than the values encountered during the summer survey. However, the total and ortho-phosphorus values were very similar for the spring and summer. The higher nitrate-nitrite values may be a result of runoff from agricultural operations. Total dissolved solids were slightly higher than the summertime values.

Physical Parameters

Physical evaluations were made during the summer survey on August 2, 1983. Flow, mean stream velocity and stream transects to assess width, depth, substrate, etc., were all conducted as outlined in the General Methodology of this report.

Summer - The results of the summer physical measurements are summarized in Table D-3.

Boat Gunwale Slash is a slow, wide stream with wetland-type timber growing in the stream channel. Large amounts of litter and leaves cover the streambed. The channel does not have steep banks so a slight increase in stream elevation results in the stream becoming much wider. This creates a dynamic relationship between the stream and the amount of inundated vegetation, leaf litter and cover for aquatic organisms. The stream bottom substrate is composed of a fine, silty clay and even though the turbidity of the water is low, the least disturbance or increase in stream velocity causes this mud to become resuspended in the water.

Flow during the summer was falling slightly throughout the survey period due to rain the previous week. Mean stream velocity was 0.17 fps, somewhat faster than expected. Stream canopy is nearly 100% which moderates stream temperature and may also minimize photosynthetic activity.

Spring - No additional physical evaluations were made during the spring survey other than channel and stream width, mean velocity, flow and mean depth.

Table D-2

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Boat Gunwale Slash

Drainage Area: 23 Square Miles

Station Description: At Highway 146 bridge, Section 30, T 1 S, R 1 W Monroe County

Date: April 10, 1984

PARAMETER	TIME COLLECTED 09:45	11:00	13:00	AVERAGE
Q, cfs *	~230	~230	~230	~230
Temperature, °C	16	16.5	16	16
pH	6.0	5.6	6.2	5.9
Turbidity, ntu	64	63	63	63
TSS, mg/l	20	25	20	22
TDS, mg/l	101	100	105	102
BOD-5, mg/l	2.0	2.0	2.0	2.0
BOD-20, mg/l	5.9	6.0	6.2	6.0
T.Phos., mg/l	0.26	0.25	0.23	0.24
PO4-P, mg/l	0.16	0.16	0.16	0.16
NO2+NO3-N, mg/l	0.23	0.22	0.22	0.22
NH3-N, mg/l	0.22	0.21	0.19	0.20
Cl -, mg/l	1	1	1	1
SO4 =, mg/l	2	3	2	2
Fe, mg/l	3.15	3.16	2.97	3.10
Conductivity,µmho	44	45	45	43
Alkalinity, mg/l	15	16	15	15
T. Hardness, mg/l	18	18	20	19
Chlorophyll a,µg/l	1.8	5.9	1.2	3.0
Fecal Coliform	-	-	90	90
MN mg/l	0.076	0.073	0.073	0.074
COD mg/l	25.8	25.8	23.8	25.1

Dissolved Oxygen Data for 10 Apr 1984		
	Pool	
Average	7.3	
Minimum	6.0	
Maximum	8.2	

* Flow decreased to 91 cfs on 4-11-84

Table D-3

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Boat Gunwale Slash
Date:	August 2, 1983
Drainage Area:	23 square miles
Watershed Land Use:	72% agriculture 28% forest
Stream Gradient:	0.7 ft/mile
Mean Channel Width:	182 feet
Mean Stream Width:	122 feet
Mean Stream Velocity:	0.17 ft/sec
Observed Flow:	2.9 cfs
Average Substrate Type:	100% mud/silt
Mean Instream Cover:	0% undercut bank 27% brush, logs, debris 0% overhanging vegetation 13% inundated vegetation
Riffle/Pool Ratio of Transects:	0% riffle 0% deep pool 0% moderate pool 100% shallow pool
Mean Bank Overstory Cover:	79% trees 13% shrubs
Mean Bank Ground Cover:	44% grass & forbs 56% dirt
Mean Bank Stability:	100% stable 0% moderate 0% unstable
Mean Stream Canopy:	94.4% stream canopy
Comments:	

Macroinvertebrate Populations

Fifty-nine (59) taxa representing 13 orders were identified from samples collected at this study site. Thirty-eight (38) and 40 taxa were identified from the summer and spring samples, respectively (Table A-1, Appendix A). The total number of organisms collected in the summer was 215; in the spring, 235 were collected. These totals were similar despite the increased sampling effort during the spring survey. Several taxa, which typically inhabit permanently wetted areas and are not outwardly mobile were absent from the spring sample. The high water conditions which existed during the spring may have reduced the sampling efficiency and hindered complete sampling of the main channel. The qualitative similarity indices indicated only a slight degree of similarity between the summer and spring samples.

Summer - Numerically, the dominant groups in the summer sample were mayflies, isopods and dipterans which comprised 17.7, 16.3 and 14.9% of the sample, respectively. Only Lirceus lineatus (an isopod) comprised greater than 10% of the total, an indication of the even distribution of taxa within this sample. Coleopterans and hemipterans were the orders containing the greatest number of taxa. These taxa utilize atmospheric oxygen and are not dependent upon dissolved oxygen concentrations.

Spring - The dominant orders of the spring sample were coleopterans and amphipods. Forty-seven (47%) percent of the taxa collected in the summer were also collected in the spring. Three of the five dominant taxa from the summer sample were also collected in the spring.

The community parameters calculated indicate a diverse, stable benthic community (Table D-4). A decrease in diversity values from summer to spring was noted despite the increase in total taxa. This phenomenon primarily resulted from the collection of large numbers of Gammarus fasciatus, an amphipod, during the spring collection. Another result was a reduction in the index of evenness. This difference does not reflect a reduction in water quality but resulted from the large amphipod populations which usually expand to massive numbers in the spring when habitat offers protection from predators.

Table D-4. Community Analysis of Benthic Samples from Boat Gunwale Slash - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	215	235	450
Total # Taxa	38	40	59
Diversity	4.4203	3.9979	4.2713
Index of Evenness	0.8423	0.7564	0.7743
Index of Dominance	0.5013	0.5148	0.5922
Index of Variety	4.7753	4.9574	6.3209
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.4615	
Common Taxa Index (range 0-1)		0.31	
Qualitative Similarity Index (range 0-100)		28.0	

Fish Populations

Summer - Approximately six pounds of 5% active ingredient, powdered rotenone was distributed over about 600 feet of the stream on August 3, 1983. A five- to six-man crew spent about 3 hours dipping fish from the water and preserving them in formalin. Almost all affected fish were picked up on the day of treatment; however, the following day, additional fish were recovered from the site and recorded.

A total of 1033 specimens were recorded representing 31 species (Table D-5). The total relative abundance value for these species was 188.5, with a relative abundance diversity index of 4.55 and an index of evenness of 0.92. Ten species of Centrarchidae made up 34.5% of the relative abundance value; six species of Cyprinidae, 14.3%; three species of Percidae, 9.0%; three species of Ictaluridae, 8.2%; and two species of Catostomidae comprised 5.8% of the total. The relative abundance value of the primary feeders was 10.1% of the total; secondary feeders, 74.5%; and top carnivores comprised 15.4% of the total (Table D-6). No sensitive species were collected. A list of species collected is included in Table D-5 in numerical order of relative abundance value. The atypical abundance of golden shiner in the sample was probably caused by escapees of this species from fish farms in the watershed where they are raised intensively for fish bait.

Table D-5. Fish Species Collected from Boat Gunwale Slash on August 3, 1983, with Relative Abundance Values

Species		R.A. VALUE
Gambusia affinis	Mosquitofish	12.0
Notemigonus crysoleucas	Golden shiner	12.0
Elassoma zonatum	Banded pygmy sunfish	12.0
Aphredoderus sayanus	Pirate perch	10.0
Amia calva	Bowfin	10.0
Erimyzon sucetta	Lake chubsucker	9.5
Esox americanus	Grass pickerel	9.0
Lepomis gulosus	Warmouth	9.0
Etheostoma gracile	Slough darter	9.0
Centrarchus macropterus	Flier	9.0
Fundulus olivaceus	Blackspotted topminnow	8.5
Ictalurus natalis	Yellow bullhead	8.5
Lepomis punctatus	Spotted sunfish	7.5
Micropterus salmoides	Largemouth bass	6.5
Lepomis macrochirus	Bluegill	6.5
Noturus gyrinus	Tadpole madtom	6.0
Lepomis cyanellus	Green sunfish	6.0
Etheostoma proeliare	Cypress darter	6.0
Notropis texanus	Weed shiner	6.0
Lepomis megalotis	Longear	6.0
Hybognathus hayi	Cypress minnow	5.5
Lepisosteus oculatus	Spotted gar	2.5
Etheostoma chlorosomum	Bluntnose darter	2.0
Lepomis symmetricus	Bantam sunfish	1.5
Hybognathus nuchalus	Silvery minnow	1.5
Minytrema melanops	Spotted sucker	1.5
Labidesthes sicculus	Brook silversides	1.0
Pomoxis nigromaculatus	Black crappie	1.0
Ictalurus melas	Black bullhead	1.0
Notropis maculatus	Taillight shiner	1.0
Notropis fumeus	Ribbon shiner	1.0

Table D-6. Summary of Fish Population Parameters from Boat Gunwale Slash

Total Species Collected	37.0
Total Number of Individuals	1033.0
Total Relative Abundance Value	188.5
Relative Abundance Diversity Index	4.55

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6.0	14.3
CATOSTOMIDAE	2.0	5.8
ICTALURIDAE	3.0	8.2
CENTRARCHIDAE	10.0	34.5
PERCIDAE	3.0	9.0
Primary Feeders	5.0	10.1
Macroinvertebrate Feeders	24.0	74.5
Carnivores	8.0	15.4
Sensitive Species	0.0	0.0

Spring - Springtime sampling on Boat Gunwale Slash was done April 9-11, 1984, using two monofilament 1½" square mesh trammel nets; one monofilament 2" square mesh trammel net and four small mesh hoop nets. All nets were set in the afternoon of April 9, 1984; fish were removed each of the two following days. The large-mesh trammel net, one of the small-mesh trammel nets and two hoop nets were set at a county road crossing approximately three miles downstream from the primary collecting site at the Highway 146 bridge. Attempts were also made to collect fish with the backpack shocker. Water conditions limited the effectiveness of this gear.

Almost all fish collected with nets were taken in the 1½" mesh trammel nets. Only three fish were taken in the 2" mesh trammel nets and two were taken in the four hoop nets. Listed below are the total numbers of fishes taken in the spring netting samples:

Amia calva - 26
Lepisosteus oculatus - 8
**Lepisosteus platostomus* - 1
**Esox niger* - 2
**Cyprinus carpio* - 1
**Ictiobus sp.* - 3 (1 *I. cyprinellus*)
Erimyzon sucetta - 1
Minytrema melanops - 4
Ictalurus natalis - 13
Centrarchus macropterus - 1

Lepomis cyanellus - 1
Lepomis moacrochirus - 3
*Lepomis microlophus - 2
Lepomis gulosus - 5
Micropterus salmoides - 3
*Pomoxis annularis - 1
Pomoxis nigromaculatus - 2

* Species not taken in previous summer samples

Several of the bowfin collected contained spent gonads indicating they had recently completed spawning. The bigmouth buffalo and spotted suckers were ripe and were either in the spawning process or were within only a few days of spawning.

Electrofishing produced only a few small individuals of the following species: carp, grass pickerel, largemouth bass, lake chubsucker, mosquitofish, longear and warmouth. Six species were collected in the spring sampling which were not collected the previous summer. This increased the total number of species collected from this site to 37.

SECOND CREEK

Second Creek, in the west central part of St. Francis County, was selected as a medium-sized, least-disturbed stream in the Delta Region (Figure D-5). It was selected from other possible locations after an on-site visit confirmed its suitability as a least-disturbed stream.

Second Creek starts in eastern Woodruff County and flows in a southeasterly direction before joining the L'Anguille River. The general area of the sampling site was below a county road bridge in the SW ¼, SE ¼ of Section 17, R 2 E, T 5 N, St. Francis County.

General Site Discussion

Watershed Size - Drainage area above the county road bridge is 60 mi^2.

Geology - The watershed of Second Creek is in an area of unconsolidated loess and loess-derived alluvial deposits of Pleistocene and Holocene age. These deposits are 2 to 20 feet thick and overlie alluvial deposits of sand and clay (USDA, 1966).

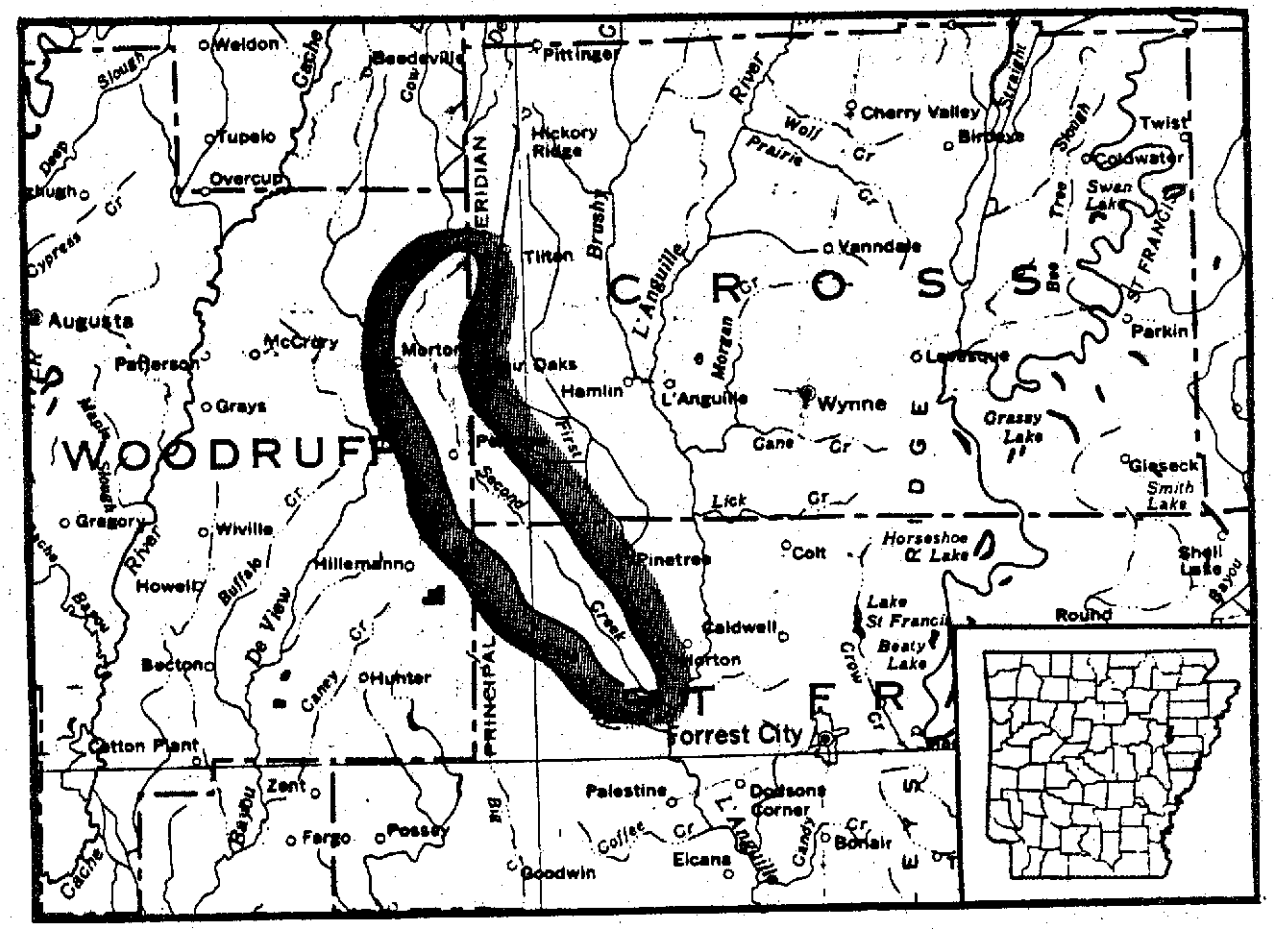
Topography - Topography within the watershed is generally level with only small differences in elevation. Elevation ranges from about 180 to 220 feet above msl. Slopes are usually less than 5%. Stream gradient at the sample site was calculated to be 0.75 ft/mile.

Soil Type - Soils within the watershed are loams of loessial origin deposited during the Pleistocene Epoch. Soil series consist of the Zachary along the floodplain and the Calloway, Loring and Henry series elsewhere. Zachary soils consist of poorly drained, level soils developed from sediments washed from the upland loess. They are strongly acid and, because of frequent flooding, are not suited for farming.

The upland soils of the Calloway-Loring-Henry association are moderately well drained to poorly drained and are underlain by a compact, brittle fragipan. The Loring series is easily eroded and comprises about 20% of the watershed.

Land Use and Flora - The watershed lies within the Southern Floodplain forest and the potential typical forest would consist of Oak-Tupelo-Cypress association in the bottomlands and Oak-Hickory forests mixed with prairie in the upland. However, due to the extensive clearing that has taken place in the area for agricultural reasons, only small portions of forest exist. Generally, these forests are in the

Figure D-5



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

SECOND CREEK: Drainage area 60 square miles ■ Survey site ▓ Survey area

floodplain of the streams. In the case of Second Creek, approximately 30% of the watershed is covered by forests including nearly all the floodplain of the stream. The remainder of the area is agricultural land where soybeans, rice, cotton and wheat are the main crops.

Stream Characteristics - Second Creek is a moderately-sized, meandering stream with very little disruption of its immediate channel, riparian area and floodplain. It is a typical, relatively undisturbed, sluggish, warmwater stream of this area.

Methodology and Sampling Results

The summer survey was conducted from July 30-August 3, 1984. Weather during this period was sunny to partly cloudy and hot. Stream flow was moderately elevated at the start of the survey and slowly decreased thereafter. Stage height decreased 5" from July 30-August 2, 1984. The spring survey was conducted from April 1-3, 1985. Weather during this period was clear and cool. Water level during this period was bank full.

Continuous Dissolved Oxygen

Summer - Two continuous D.O. meters were set up 150 and 200 feet upstream of the bridge near noon on July 30. They operated until the morning of August 3. Meter #6 performed satisfactorily throughout the survey period. Meter #8 malfunctioned shortly before 0600 hours on July 31, 1984, but was corrected and functioning properly by 12 noon of the same day. Both meter's probes were placed at mid-depth in flowing water on the south side of the stream.

Dissolved oxygen values between the two meter locations were very similar and uniform throughout the survey period. Dissolved oxygen for the period of the survey ranged from a minimum of 3.4 mg/l (39% saturation) to a high of 8.2 mg/l (100% saturation). These readings occurred on August 2, 1984, at Meter #8 and were typical. Minimum dissolved oxygen values occurred around 0600 hours each day and maximums at 1600 hours. Plots of continuous dissolved oxygen, temperature and percent saturation are shown in Figures D-6 and D-7.

Spring - Two meters were set up about 200 feet downstream of the bridge. During the spring survey period, flow conditions were relatively uniform throughout the stream channel. There were no pools and riffles. Therefore, meters were placed in the same stream section. Both meters were within 0.2 mg/l of calibration during the period.

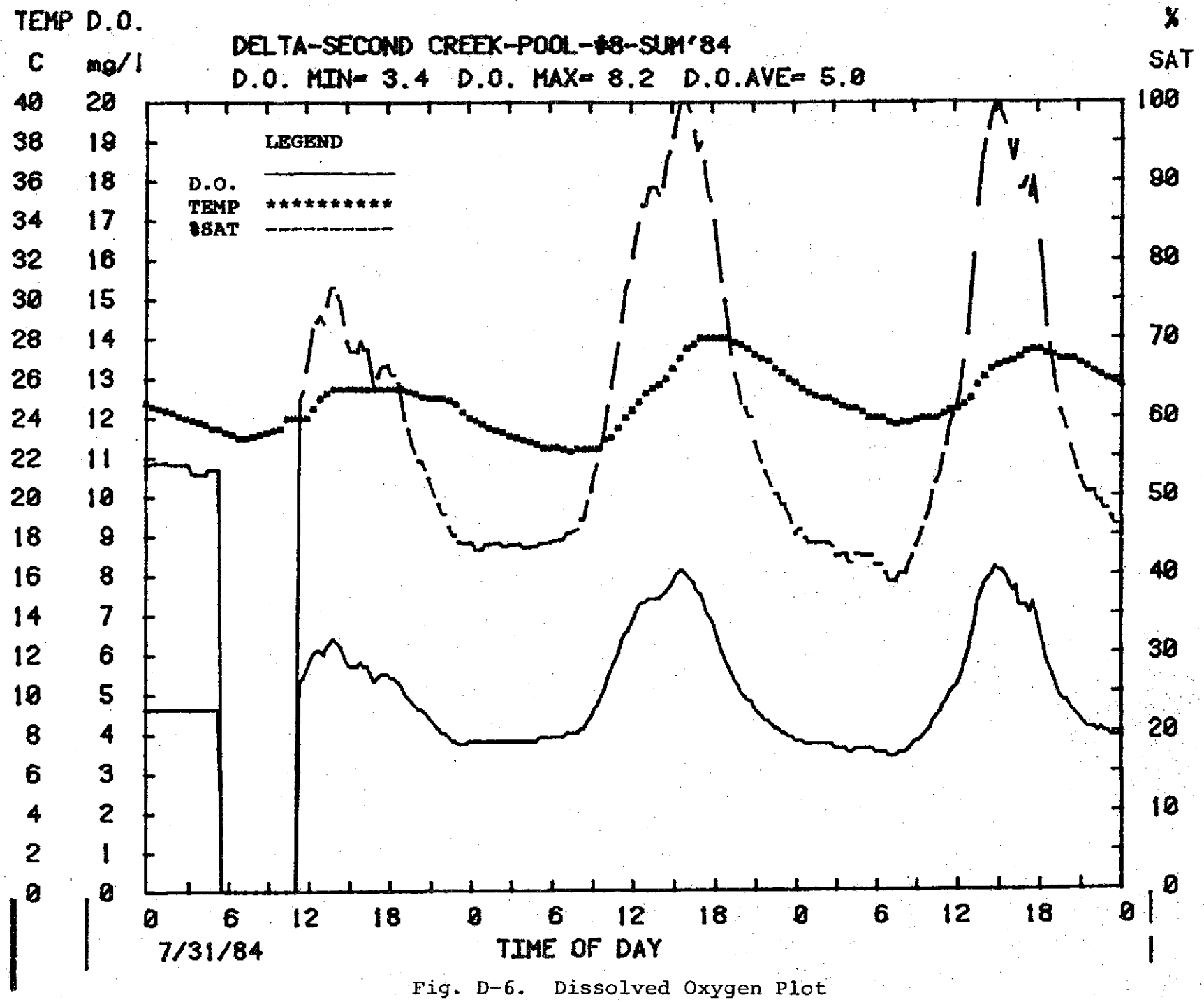


Fig. D-6. Dissolved Oxygen Plot

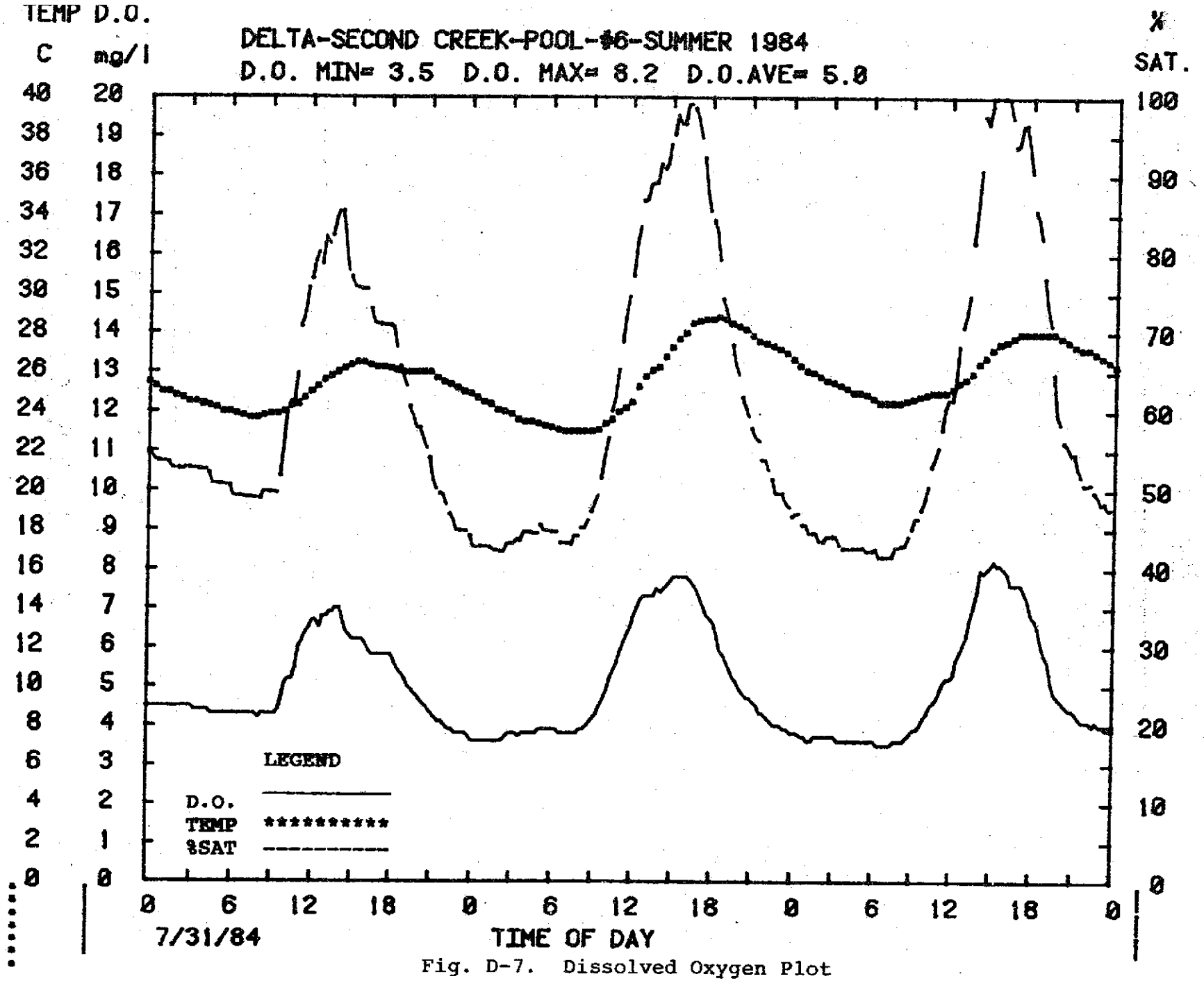


Fig. D-7. Dissolved Oxygen Plot

Plots of continuous dissolved oxygen, temperature and percent saturation are shown in Figures D-8 and D-9.

Dissolved oxygen showed a daily variation of slightly over 1 mg/l during the spring sampling period. Daily minimum D.O., which occurred around 0300 hours, was 6.4 mg/l (60% saturation) on April 2. The daily maximum D.O. was about 7.6 mg/l (78% saturation) which occurred around 1600 hours each day.

Chemical Parameters

Summer - Grab samples were taken during the summer survey just upstream of the bridge in flowing water, well above any areas disturbed by the other survey activity. Three separate samples were taken at 0908 hours, 1110 hours and 1210 hours on July 31, 1984.

Chemical results are shown in Table D-7. Turbidity values during this period were lower than what one normally expects in the Delta. In addition, BOD, total and ortho-phosphorus, ammonia and total iron values were also low.

Chlorides were higher than is normally found in non-polluted surface waters. Total dissolved solids, conductivity, alkalinity and total hardness were also slightly elevated. These higher values may be attributed to irrigation runoff which originally comes from groundwater.

Spring - During the spring survey, grab samples were taken about 10 feet above the bridge in flowing water near the center of the channel. Three samples were taken on April 2, 1985, at 0850 hours, 0940 hours and 1015 hours.

Chemical results for the spring are shown in Table D-8. Turbidity values were highest in Second Creek compared to all similarly-sized, least-disturbed streams from other regions. BOD, total and ortho-phosphorus, ammonia and total iron were higher in this stream than any of the other comparably-sized sites in other regions.

Nitrate-nitrite values were twice as high as the values encountered during the summer survey. Total phosphorus values were higher in the spring when compared to the summer and ortho-phosphorus values were six times higher. The higher values may be a result of runoff from agricultural operations. Total dissolved solids were slightly higher than the summertime values.

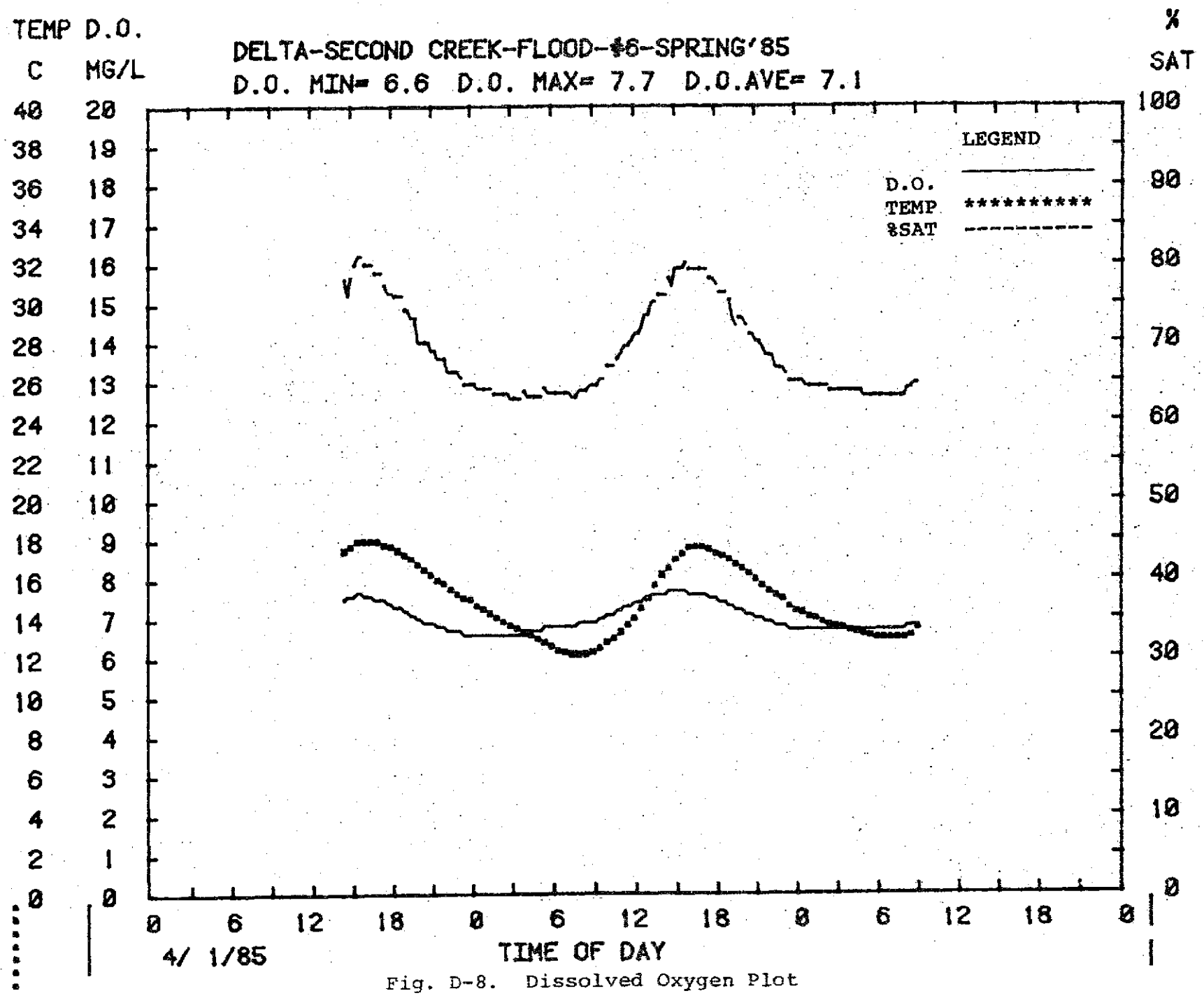


Fig. D-8. Dissolved Oxygen Plot

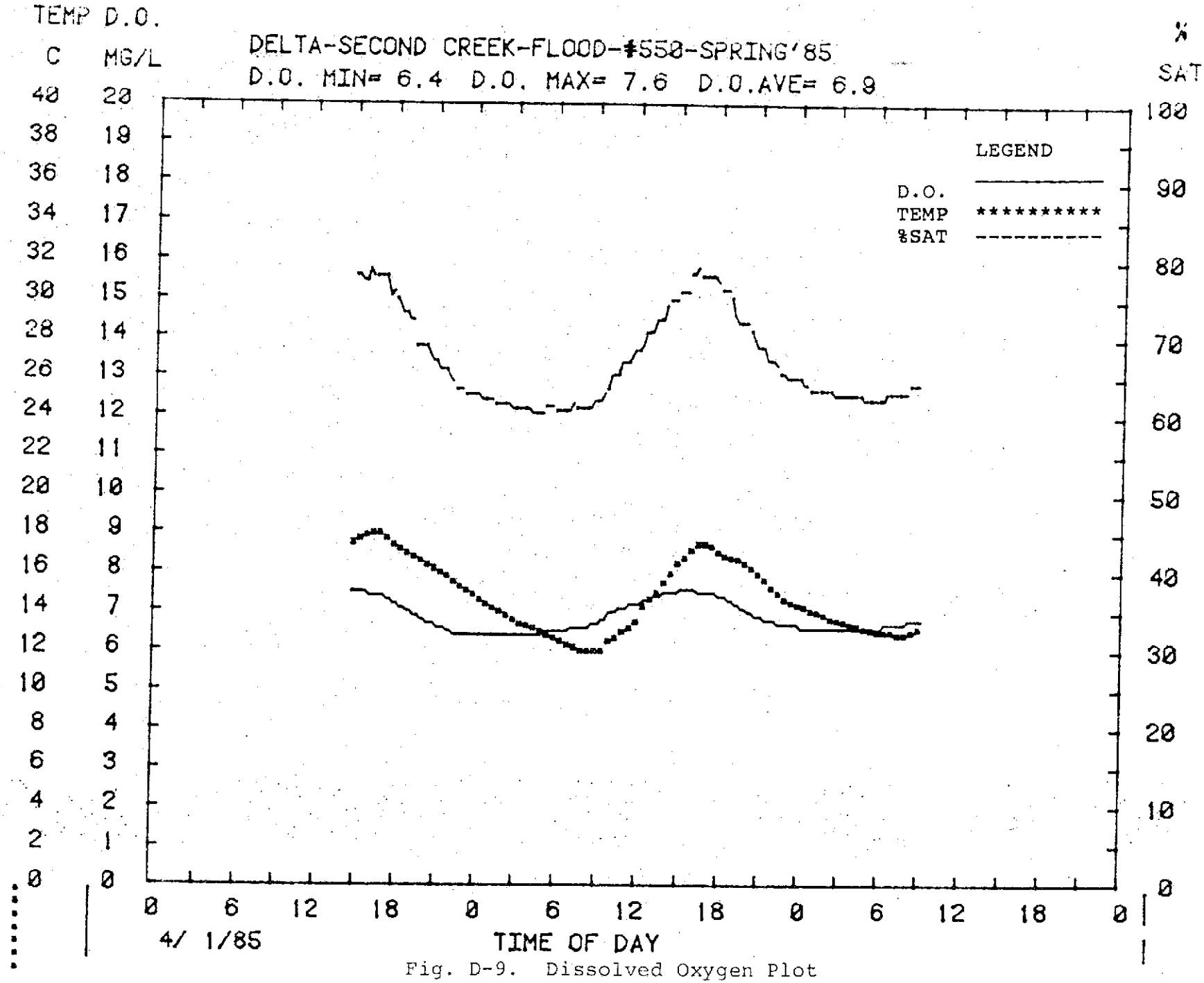


Fig. D-9. Dissolved Oxygen Plot

Table D-7

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Second Creek

Drainage Area: 60 square miles

Station Description: At new bridge site, county road between Palestine and Horton, SW 1/4, SE 1/4, Section 17, T 5 N, R 2 E - St. Francis County

Date: July 31, 1984

PARAMETER	TIME COLLECTED 09:08	11:25	12:10	AVERAGE
Q, cfs	7.5	7.5	7.5	7.5
Temperature, °C	24.0	25.0	25.0	25.0
pH	7.5	7.6	7.5	7.5
Turbidity, ntu	8	8	7	8
TSS, mg/l	14	10	10	11
TDS, mg/l	249	246	250	248
BOD-5, mg/l	1.5	1.1	1.1	1.2
BOD-20, mg/l	4.3	3.6	3.7	3.9
T.Phos., mg/l	.11	.09	.10	.10
PO4-P, mg/l	.03	.04	.04	.04
NO2+NO3-N, mg/l	.12	.12	.12	.12
NH3-N, mg/l	.07	.07	.07	.07
Cl -, mg/l	32	31	32	32
SO4 =, mg/l	9	8	7	8
Fe, mg/l	.32	.23	.21	.25
Conductivity umho	406	423	419	416
Alkalinity, mg/l	165	162	161	163
T. Hardness, mg/l	180	184	180	181
Chlorophyll a,ug/l	-	-	-	-
Fecal Coliform	-	-	24	24
Total Manganese	.45	.41	.41	.42

Dissolved Oxygen Data for July 31, 1984		
	Pool	
Average	5.0	
Minimum	3.7	
Maximum	7.0	

Table D-8

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Second Creek

Drainage Area: 60 Square Miles

Station Description: @ new bridge site; county rd. between Palestine and Horton, SW 1/4, SE 1/4, Section 17, R 2 E, T 5 N - St. Francis County

Date: April 2, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	08:50	09:40	10:15	
Q, cfs	165	165	165	165
Temperature, °C	13	13	14	13
pH	7.0	7.0	7.0	7.0
Turbidity, ntu	220	220	215	218
TSS, mg/l	142	139	136	139
TDS, mg/l	303	303	304	303
BOD-5, mg/l	3.3	3.5	3.6	3.5
BOD-20, mg/l	9.2	9.5	9.6	9.4
T.Phos., mg/l	0.26	0.26	0.26	0.26
PO4-P, mg/l	0.23	0.25	0.23	0.24
NO2+NO3-N, mg/l	0.24	0.24	0.24	0.24
NH3-N, mg/l	0.27	0.28	0.26	0.27
Cl -, mg/l	5.5	6	5.5	5.5
SO4 =, mg/l	12	14	14	13
Fe, mg/l	4.57	4.44	4.44	4.48
Conductivity,µmho	94	94	93	94
Alkalinity, mg/l	30	30	30	30
T. Hardness, mg/l	42	42	42	42
Chlorophyll a,µg/l	13.4	0.0	0.0	4.5
Fecal Coliform	-	-	680	680

Dissolved Oxygen Data for April 2, 1985 *		
	Meter 550	Meter 6
Average	6.9	7.1
Minimum	6.4	6.6
Maximum	7.6	7.7

* Water Level Bankfull

Physical Parameters

Physical evaluations were made during the summer survey on July 31, 1985. Flow, mean stream velocity and stream transects to assess width, depth, substrate, etc., were all conducted as outlined in the General Methodology of this report.

Summer - Second Creek is a moderate-sized, low gradient stream typical of the Delta region. The average stream width was 42 feet and estimated average depth was 2.5 feet for the segment evaluated (Table D-9). Stream gradient is 0.75 feet per mile. The stream bottom substrate is composed of a fine, silty clay and even though the turbidity of the water is low, the least disturbance or increase in stream velocity causes this mud to become resuspended in the water.

Instream cover is abundant, totaling 43% of the mean stream width for the section of the stream evaluated. Flow during the survey was falling slightly throughout the week. Mean stream velocity was 0.28 fps. Stream canopy is 55% which moderates stream temperature.

Spring - No additional physical evaluations were made during the spring survey other than stream width, mean velocity and flow. Stream flow was high, and the water level during the survey was bank full but relatively steady. Gauge height during the survey period only varied by 0.3 feet.

Macroinvertebrate Populations

Eighty-six (86) taxa representing 18 orders were identified from the summer and spring benthic samples of Second Creek. The dominant orders, Ephemeroptera, Amphipoda and Decapoda comprised 27.7%, 26.6% and 10.8% of the numerical total, respectively. The dominant taxa were Gammarus faciatus (20.7%), Caenis (18.7%), Palaemonetes kadiakensis (10.0%), Corbicula (3.4%) and Stenacron interpunctatum (7.8%). Other taxa which were not numerically dominant but considered as ecologically charactistic of delta streams include Hexagenia limbata, Peltodytes lengi and Sialis (Table A-2, Appendix A).

The qualitative similarity indices reflected the seasonal variation characteristic of macroinvertebrate populations. Several taxa were present in both samples but significant differences in the community structure of each sample were evident. Of the 86 taxa identified in the combined samples, 44 and 59 were identified from the summer and spring benthic samples, respectively. Eighteen (18) taxa were identified in both samples and 26 and 41 taxa were found to be unique to the summer and spring samples, respectively. The 18 taxa common to both samples comprised 81% of the total organisms collected. The 26 taxa unique to the summer sample

Table D-9

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Second Creek
Date:	July 31, 1984
Drainage Area:	60 square miles
Watershed Land Use:	64% agriculture 36% forest
Stream Gradient:	0.75 ft/mile
Mean Channel Width:	62.5 feet
Mean Stream Width:	42.2 feet
Mean Stream Velocity:	0.28 ft/sec
Observed Flow:	7.5 cfs
Average Substrate Type:	100% mud/silt
Mean Instream Cover:	0.4% undercut bank 35% brush, logs, debris 6.4% overhanging vegetation 0.9% inundated vegetation
Riffle/Pool Ratio of Transects:	0% riffle 0% deep pool 70% mod. pool 30% shallow pool
Mean Bank Overstory Cover:	72% trees 64% shrubs
Mean Bank Ground Cover:	24% grass & forbs 76% dirt
Mean Bank Stability:	80% stable 20% moderate
Mean Stream Canopy:	55% stream canopy
Comments:	water clear; flow dropping (0.5 inches/day)

accounted for only 9% of the numerical total of the summer community and the 41 taxa unique to the spring sample comprised only 25% of the spring benthic community.

Summer - The dominant groups of the summer benthic community were Amphipoda (38.1%), Decapoda (14.2%), Pelecypoda (13.3%) and Ephemeroptera (10.2%). The dominant taxa of the summer sample included Gammarus faciatus, Palaemonetes kadiakensis, Corbicula, Caenis and Corixidae. Other taxa, not numerically dominant, but considered as ecologically characteristic include Peltodytes lengi, Eptheic princeps, Sialis and Oecetis (Table A-2, Appendix A).

Spring - The spring benthic community was dominated by Ephemeropterans (43.4%) and Amphipoda (16.3%). Those two orders comprised 60% of all organisms collected. The dominant taxa included Caenis (26.9%), Stenacron interpunctatum (14.4%), Gammarus minus (8.3%), Palaemonetes kadiakensis (6.5%) and Corbicula flumenia (3.9%). Three of the five were dominant in the summer sample. Other taxa, not numerically dominant but considered as ecologically characteristic, include: Hexagenia limbata and Peltodytes lengi.

The community parameters indicated a balanced, healthy benthic population with a combined diversity well over 4.0 (Table D-10). There appears to be a significant difference between diversity values for the summer-spring benthic communities. The lowered diversity value of the summer samples were primarily due to the huge population of Gammarus fasciatus, which comprised 37% of that sample, numerically. Population "explosions" of the side-swimmer are a characteristic trait of the order and do not reflect a reduced water quality.

Table D-10. Community Analysis of Benthic Samples from Second Creek - 30 Minute Qualitative Samples, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	1368	1498	2866
Total # Taxa	44	59	86
Diversity	3.3473	4.4142	4.1540
Index of Evenness	0.6131	0.7061	0.6887
Index of Dominance	0.7045	0.7690	0.7370
Index of Variety	4.1275	5.4982	7.3140
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.60
Common Taxa Index (range 0-1)			0.31
Qualitative Similarity Index (range 0-100)			20.0

Fish Populations

Summer - Approximately one-half acre of the stream was treated with 5 pounds of 7% active ingredient rotenone on August 1, 1984. Block nets were placed at the upstream and downstream limits of the treated area. Potassium permanganate was used to detoxify the rotenone as it flowed out of the sample area. Six workers spent about three hours dipping the dying fish from the water. Additional fish were picked up the following day in the sample area. Total weight of the species collected was taken to estimate total standing crop.

Table D-11 lists the total species collected at this site. Thirty-five species were collected during the summer sampling and one additional species was taken during the spring sampling. The relative abundance value for the summer sample was 209.5 with a diversity index of 4.79. A total of 1837 individuals were collected which weighed 112.7 pounds, producing a standing crop of 234.8 pounds per acre. Table D-12 lists selected population parameters calculated from relative abundance values. This population was notably dominated by Centrarchidae. Only four species of Pericidae were collected, but the bluntnose darter was very abundant. The majority of the fish population occupied the macroinvertebrate trophic feeding level; however, carnivores made up a relatively large percentage of the population. No sensitive species were collected at this site.

Table D-11. Fish Species Collected from Second Creek with Relative Abundance Values

Species		R. A. VALUE
Aphredoderus sayanus	Pirate perch	12.0
Micropterus salmoides	Largemouth bass	12.0
Lepomis macrochirus	Bluegill	12.0
Etheostoma chlorosomum	Bluntnose darter	12.0
Gambusia affinis	Mosquitofish	10.5
Lepomis megalotis	Longear	10.5
Lepomis punctatus	Spotted sunfish	9.0
Ictalurus natalis	Yellow bullhead	9.0
Etheostoma asprigene	Mud darter	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
Lepomis gulosus	Warmouth	9.0
Pomoxis nigromaculatus	Black crappie	9.0
Etheostoma proeliare	Cypress darter	9.0
Fundulus notatus	Blackstripe topminnow	9.0
Notropis fumeus	Ribbon shiner	8.0
Notropis atherinoides	Emerald shiner	7.5
Notropis emiliae	Pugnose minnow	7.5
Lepisosteus oculatus	Spotted gar	7.0
Noturus gyrinus	Tadpole madtom	6.0
Aplodinotus grunniens	Freshwater drum	4.5
Lepomis cyanellus	Green sunfish	4.0
Dorosoma cepedianum	Gizzard shad	3.0

Table D-11, cont.

Species		R. A. VALUE
Ictalurus punctatus	Channel catfish	2.5
Ictiobus bubalus	Smallmouth buffalo	2.0
Notropis venustus	Blacktail shiner	2.0
Etheostoma gracile	Slough darter	2.0
Ictiobus niger	Black buffalo	2.0
Elassoma zonatum	Banded pygmy sunfish	2.0
Lepomis microlophus	Redear	1.5
Pomoxis annularis	White crappie	1.5
Cyprinus carpio	Carp	1.5
Micropterus punctulatus	Spotted bass	1.0
Hybognathus hayi	Cypress minnow	1.0
Notemigonus crysoleucas	Golden shiner	1.0
Lepomis symmetricus	Bantam sunfish	1.0
Amia calva	Bowfin	S

S - collected in spring sample only

Table D-12. Summary of Fish Population Parameters from Second Creek

Total Species Collected	36.0
Total Number of Individuals	1837.0
Total Relative Abundance Value	209.5
Relative Abundance Diversity Index	4.79

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	7.0	13.6
CATOSTOMIDAE	2.0	1.9
ICTALURIDAE	3.0	8.4
CENTRARCHIDAE	12.0	34.6
PERCIDAE	4.0	15.3
Primary Feeders	6.0	5.0
Macroinvertebrate Feeders	23.0	79.2
Carnivores	7.0	15.8
Sensitive Species	0.0	0.0

Spring - One-1½", one-2" and one 3½" mesh trammel nets were set at this sample site on April 1, 1985, and left overnight. The flow was more than 20 times greater than during the summer collection, turbidity was noticeably higher and water temperature was 14°C. These nets caught 14 fish weighing a total of 38.5 pounds. Carp, bowfin, spotted gar and smallmouth buffalo made up the majority of the sample weight. Bowfin was the only species netted that was not collected during the summer sampling. Examination of the gonads of these fishes indicated that the bowfin had completed spawning, carp and black crappie were in the spawning process and the smallmouth buffalo, spotted gar,

VILLAGE CREEK

Village Creek, located in the northeastern part of the state in Randolph, Lawrence and Jackson Counties was selected as one of the large-sized and relatively least-disturbed streams in the Delta Region (Figure D-10). Village Creek was selected from other possible locations after an on-site visit confirmed its suitability as a relatively least-disturbed stream. This stream has some channelized tributaries, but the major portion of the main stem of Village Creek is a natural channel.

Village Creek starts in the southeast corner of Randolph County and flows in a southwesterly direction before joining the White River. The survey site was at a county road bridge on the south section line between Sections 18 and 19, R 1 W, T 13 N, Jackson County.

General Site Discussion

Watershed Size - Drainage area above the county road bridge is 190 mi^2.

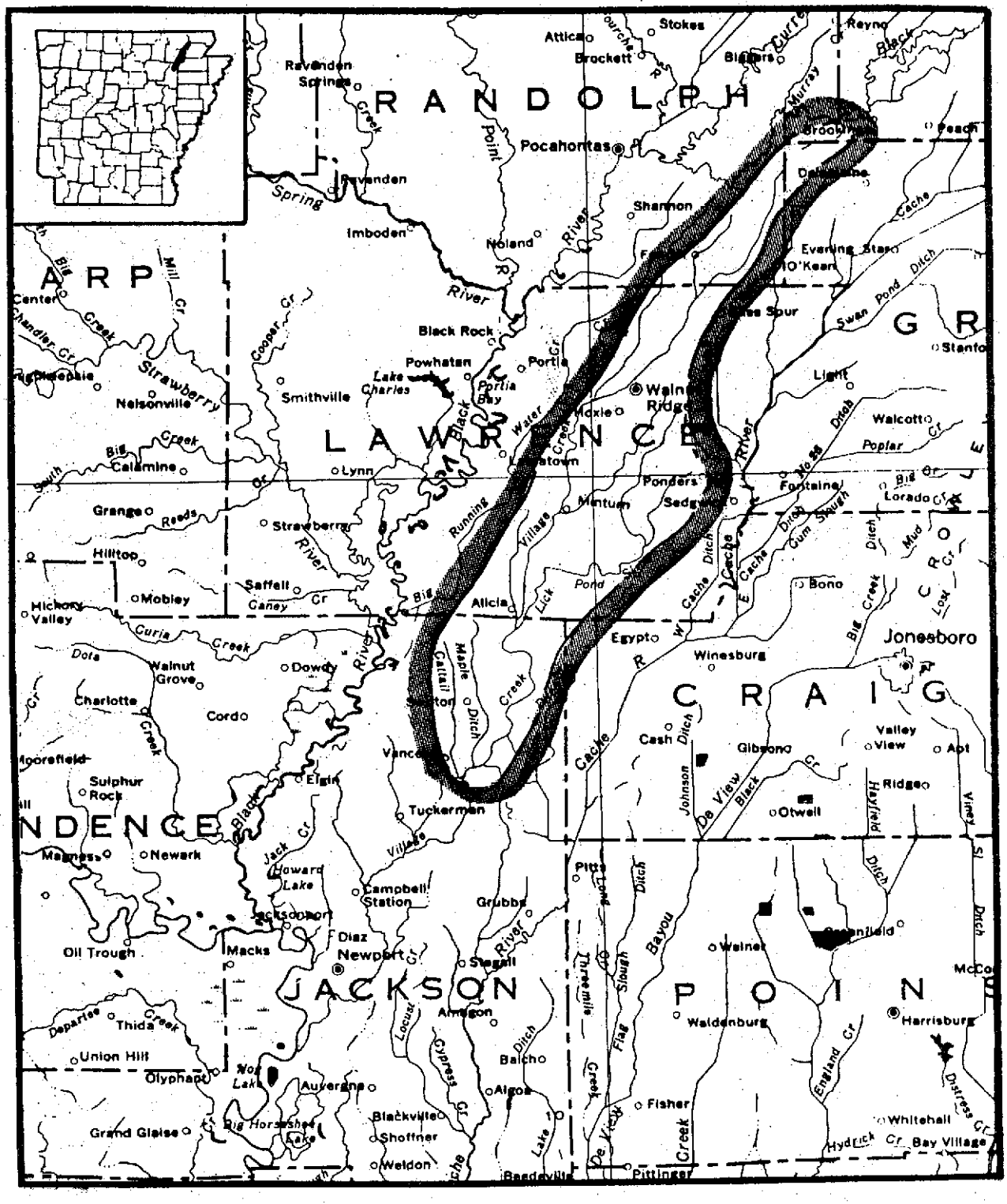
Geology - The watershed of Village Creek is in an area of unconsolidated alluvial deposits with some loess of Pleistocene and Holocene age. These deposits are more than 200 feet thick (USDA 1974, 1978).

Topography - Topography within the watershed is generally level with only minor differences in elevation. Elevation ranges from about 240 to 270 feet above msl. Slopes are usually less than 1%.

Soil Type - Soils within the watershed are predominantly of alluvial origin with some loess and include the Foley-Calhoun association, Crowley-Jackport association, Dundee-Dubbs association and Jackport-Crowley association. The majority of these soils are poorly drained. The Foley-Calhoun complex has a high concentration of sodium and magnesium in the subsoil. This soil complex is also highly erodible. This factor could contribute to the higher levels of total dissolved solids in the Delta Region than are found in similarly sized, least-disturbed streams in other regions.

Land Use and Flora - The watershed lies within the Southern Floodplain forest and the potential typical forest would consist of Oak-Tupelo-Cypress association. However, due to the extensive clearing that has taken place in the Delta for agricultural reasons, only small portions of forest exist.

Figure D-10



10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

VILLAGE CREEK: Drainage area 194 square miles ■ Survey site ▓ Survey area

Generally, these forests are in the floodplain of the streams. In the case of Village Creek, approximately 5% of the watershed is covered by forests including nearly all of the floodplain of the stream. The remainder of the area is agricultural land where soybeans, cotton, rice and wheat are the main crops.

Stream Characteristics - Village Creek is a moderately-sized, meandering stream with very little disruption of its immediate channel and riparian area. Stream gradient was calculated to be 0.5 feet per mile. Village Creek is a typical, relatively undisturbed, sluggish, warmwater Delta stream.

Methodology and Sampling Results

The summer survey was conducted from July 29 to August 2, 1985. Weather during this period was hot and humid. Stream height was recorded as high but falling on July 29, and it fell about 4 inches over the next two days, July 30 and 31. It rose 3 inches from August 1-2. Rainfall of 0.45 inches was recorded at Newport on July 26 and 27, the nearest rainfall station. The rainfall may have caused the fluctuation in water level at the survey site and produced higher than typical summer flows. A brief 15-minute shower was observed at the survey site on July 31.

The spring survey was conducted from April 7-9, 1986. Weather during this period was cloudy to clear. Streamflow was much lower during the spring survey than the summer survey as a result of an abnormally dry early spring in 1986.

Continuous Dissolved Oxygen

Summer - Three continuous D.O. meters were set up 150 to 300 yards upstream of the county road bridge on the afternoon of July 29, 1985, and left in place until August 2. Meter #550 was placed 300 yards above the bridge in the main channel in an area of swiftly flowing water. Meter #6 was placed in the main channel in a "pool" where the stream velocity was less than at Meter #550. Meter #7 was placed out of the main channel in backwater. Only Meter #6 performed adequately to provide continuous data for over 48 hours. The probes on Meters #7 and #550 malfunctioned and only partial data is available from them although Meter #7 did function for over 24 hours. However, only data which met calibration criteria is included herein.

Dissolved oxygen in the main channel ranged from a minimum of 4.4 mg/l (55% saturation) to a high of about 6.0 mg/l (76% saturation). Minimum values occurred from approximately 0200 hours to 1000 hours and maximums occurred from about 1500 hours to 1800 hours each day. The minimum D.O. values may have been elevated due to elevated flows compared to normal summertime low flows. Plots of continuous dissolved oxygen, temperature and percent saturation are shown in Figure D-11.

Spring - Two meters were set up at Village Creek on April 7, 1986. Only Meter #9 functioned satisfactorily during the survey period. A plot of continuous dissolved oxygen, temperature and percent saturation are shown in Figure D-12.

Dissolved oxygen declined and then slowly increased during the spring sampling period. There was no apparent diel variation during the survey period, even during clear days when the temperature did show a diel variation. For example, there was very little variation on April 8 when the minimum, maximum and average D.O. values were 3.7, 4.4 and 4.1 mg/l, respectively. The minimum D.O. value for the survey period was 3.7 mg/l (39% saturation) on April 8. D.O. slowly increased to 4.7 mg/l (45% saturation) by 1100 hours April 9 when the meter was removed. Daily average D.O. values for the spring period were lower than the summer survey period. Flows were some four times higher in the summer and the corresponding higher velocities would provide more reaeration and thus higher D.O. values under these conditions.

Chemical Parameters

Summer - Grab samples were taken during the summer survey at the county bridge in flowing water, well above any areas disturbed by the other survey activity. Three separate samples were taken at 0900 hours, 1030 hours and 1250 hours on July 30, 1985.

Chemical results are shown in Table D-13. Turbidity values during this period were higher than in the smaller Delta streams surveyed. Total phosphorus values were high compared to ortho-phosphorus and this would indicate more suspended, soil-related phosphorus in the water column as opposed to soluble phosphorus. These values were probably related to the higher stream flow due to rainfall in the watershed on July 26 and 27. The BOD_{20} averaged about 4.0 mg/l. This relatively high value could be the result of large amounts of organic material (leaves, fallen trees, limbs, etc.) in the stream itself. The total dissolved

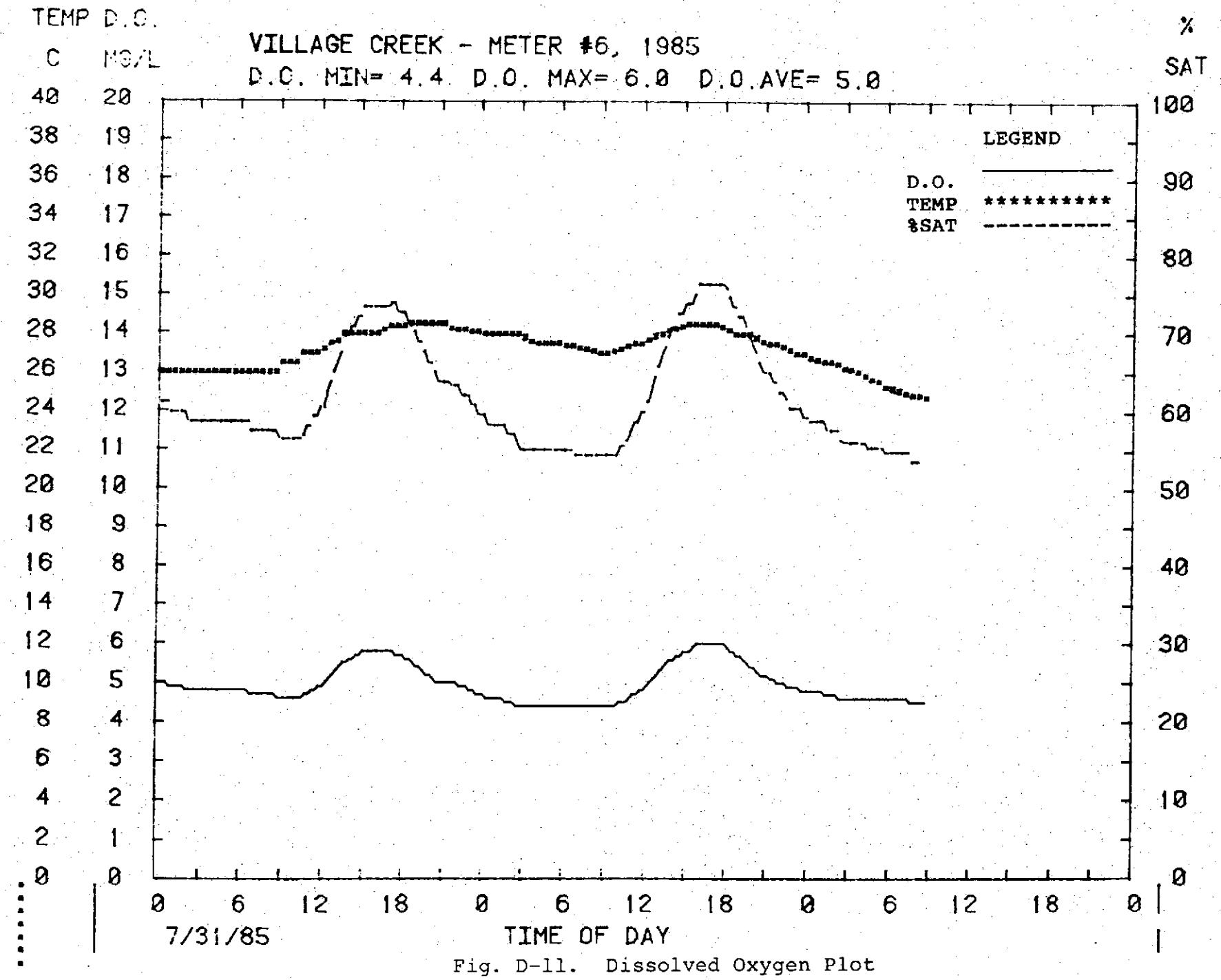


Fig. D-11. Dissolved Oxygen Plot

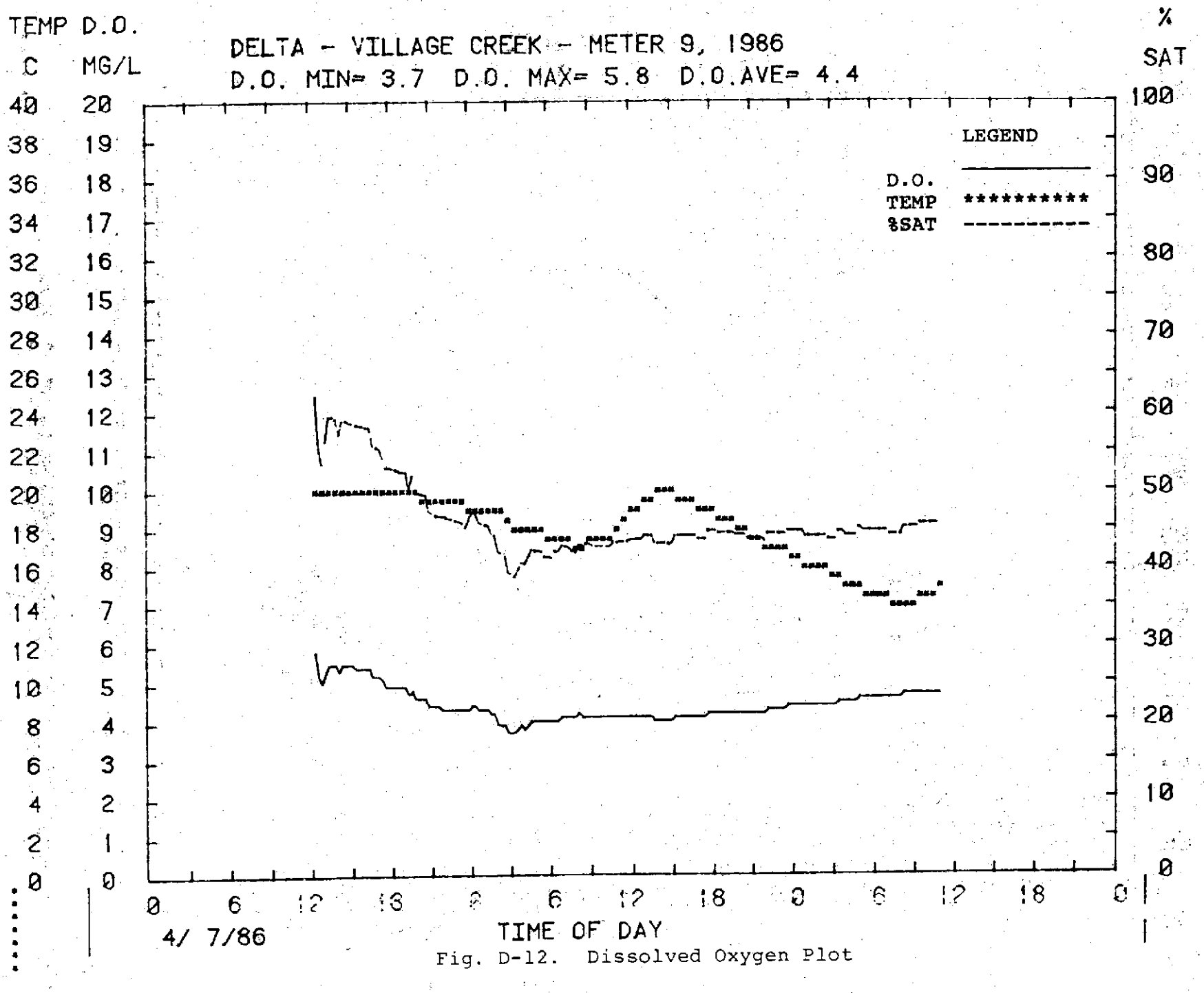


Fig. D-12. Dissolved Oxygen Plot

Table D-13

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Village Creek

Drainage Area: 194 Square Miles

Station Description: County rd. bridge in Section 18, T 13 N, R 1 W, Jackson County

Date: July 30, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	10:30	12:50	
Q, cfs	133.5	133.5	133.5	133.5
Temperature, °C	25	25.5	27	25.8
pH	7.5	7.6	7.5	7.5
Turbidity, ntu	31	30	29	30
TSS, mg/l	36	34	29	33
TDS, mg/l	185	189	177	184
BOD-5, mg/l	1.3	1.2	1.2	1.2
BOD-20, mg/l	4.2	4.3	4.2	4.2
T.Phos., mg/l	0.16	0.16	0.16	0.16
PO4-P, mg/l	0.12	0.07	0.08	0.09
NO2+NO3-N, mg/l	0.11	0.14	0.08	0.11
NH3-N, mg/l	0.06	0.10	0.04	0.07
Cl -, mg/l	9.0	8.5	8.5	8.6
SO4 =, mg/l	12	10	10	11
Fe, mg/l	0.07	0.06	0.07	0.07
Conductivity, μmho	273	294	281	283
Alkalinity, mg/l	118	119	115	117
T. Hardness, mg/l	112	112	104	109
Chlorophyll a, μg/l	9.17	9.43	8.02	8.87
Fecal Coliform	-	-	510	510

Dissolved Oxygen Data for 1 Aug 1985		
	Meter 6	
Average	5.0	
Minimum	4.4	
Maximum	6.0	

solids were also relatively high. Several of the soils in the stream's watershed are high in sodium and magnesium. These minerals play a role in elevating the total dissolved solids.

Spring - During the spring survey, grab samples were taken at the bridge in flowing water near the center of the channel. Three samples were taken on April 8, 1986, at 0910, 1020 and 1108.

Chemical results from the spring are shown in Table D-14. Turbidity values were three times higher than the summer values even though the flow was less. The BOD_{20} values were 12 mg/l, about three times the summer values. Total dissolved solids were about the same as the summer values. Total phosphorus, ortho-phosphorus and nitrate-nitrite were higher in the spring samples.

Physical Parameters

Physical evaluations were made during the summer survey on July 30, 1985. Flow, mean stream velocity and stream transects to assess width, depth, substrate, etc. were all conducted as outlined in the General Methodology of this report.

Summer - Village Creek is a low gradient, meandering stream typical of the Delta (Table D-15). During the survey period the stream width varied from about 220 feet to 990 feet and averaged about 600 feet. Stream depth at the section where flow was measured averaged 3.5 feet. Stream gradient was 0.5 feet per mile. The stream bottom substrate is composed of mud/silt and the least disturbance or increase in stream velocity causes this mud to become resuspended in the water. Instream cover averaged 87% of the stream width and consisted of brush, logs and debris.

Flow in Village Creek was increased due to a rain of about 0.5 inches in the watershed on July 26 and 27. Stream velocity was not measured at this site. Stream canopy was 85 percent, which moderates stream temperature and may also affect photosynthetic activity.

Spring - No additional physical evaluations were made during the spring survey. Flow was estimated to be 33 cfs, about one-fourth of the summer value.

Table D-14

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Village Creek

Drainage Area: 194 square miles

Station Description: County road bridge in Section 18, T 13 N, R 1 W, Jackson County

Date: April 8, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:10	10:20	11:08	
Q, cfs	33 Est			33 Est
Temperature, °C	19	19	19	19
pH	7.29	7.30	7.35	7.3
Turbidity, ntu	100	105	100	102
TSS, mg/l	66	76	76	73
TDS, mg/l	176	187	177	180
BOD-5, mg/l	4.3	5.1	5.6	5.0
BOD-20, mg/l	11.2	12.4	12.9	12.2
T.Phos., mg/l	0.39	0.41	0.42	0.41
PO4-P, mg/l	0.20	0.20	0.20	0.20
NO2+NO3-N, mg/l	0.10	0.13	0.12	0.12
NH3-N, mg/l	0.14	0.13	0.11	0.13
Cl -, mg/l	6	6	5.5	6
SO4 =, mg/l	10	10	10	10
Fe, mg/l	3.0	2.6	2.5	2.7
Conductivity,µmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	54	49	51	51
T. Hardness, mg/l	50	50	50	50
Chlorophyll a,µg/l	-	-	18.5	18.5
Fecal Coliform	-	-	1130	1130

Dissolved Oxygen Data for 8 Apr 1986		
	Meter 9	
Average	4.1	
Minimum	3.7	
Maximum	4.4	

Table D-15

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Village Creek
Date:	7/30/85
Drainage Area:	194 square miles
Watershed Land Use:	92% agriculture 5% forest 3% other
Stream Gradient:	0.5 ft/mile
Mean Channel Width:	923 feet
Mean Stream Width:	609 feet
Mean Stream Velocity:	N/A
Observed Flow:	133.5 cfs
Average Substrate Type:	100% mud/silt
Mean Instream Cover:	87% brush, logs, debris 22% inundated vegetation
Riffle/Pool Ratio of Transects:	100% moderate pool
Mean Bank Overstory Cover:	75% trees 25% shrubs
Mean Bank Ground Cover:	70% grass and forbs 30% dirt
Mean Bank Stability:	100% stable
Mean Stream Canopy:	85% stream canopy
Comments:	

Macroinvertebrate Populations

Eighty-one (81) taxa representing 18 orders were identified from the combined summer-spring qualitative samples (Table A-3, Appendix A). Numerically, the dominant orders, Ephemeroptera, Coleoptera, Amphipoda and Decapoda comprised 26.9%, 17.9%, 13.1% and 10.5% of the sample, respectively. Taxonomically, Coleoptera was represented by almost twice as many taxa as any other order. The dominant taxa were Caenis (22.5%), Hyalella azteca (12%) and Palaemonetes kadiakensis (8%). Other taxa considered as ecologically characteristic of least-disturbed delta streams include Peltodytes, Sialis and Uvarus. Comparative indices indicated that great similarity existed between summer and spring benthic communities (Table D-16). Of the 81 taxa identified from the combined benthic samples, 58 and 62 taxa were identified from the summer and spring samples, respectively. Of those, 39 taxa were present in both samples and comprised 81.6% of all organisms. The 19 and 23 taxa unique to the summer and spring samples comprised 24.8% and 13.1% of their benthic community, respectively.

Summer - Numerically, the dominant orders of the summer benthic community were Coleoptera (27%), Ephemeroptera (22%), Trichoptera (13%) and Decapoda (10%). The dominant taxa included Caenis (17.4%), Phylocentrophus (9.9%), Peltodytes (9.7%) and Palaemonetes kadiaensis (8.7%) (Table A-3, Appendix A).

Spring - The dominant orders of the spring benthic community were Ephemeroptera (30%), Amphipoda (21%) and Coleoptera and Decapoda (10%). The dominant taxa of the spring sample were Caenis (26%) Hyalella azteca (19%) and Palaemonetes kadiakensis (8%). No other taxa comprised greater than 3% of the community. The benthic community could best be described as dominated by taxa which exhibit wide tolerances for many water quality parameters. The abundance of instream cover and growth of emergent vegetative species supply a large variety of microhabitats. This multiplicity of microhabitats and the absence of water level flucuations allows the diversity exhibited by the benthic community (Table D-16). This indicates that a healthy, stable benthic assemblage persists and thrives despite the absence of "high quality" indicators.

Table D-16. Community Analysis of Benthic Samples from Village Creek - 30 minute Qualitative Samples, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	814	992	1942
Total # Taxa	58	62	98
Diversity	4.5605	4.1754	4.9353
Index of Evenness	0.6011	0.6328	0.4479
Index of Dominance	0.7785	0.7013	0.7461
Index of Variety	5.8952	6.1281	8.8801
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.65	
Common taxa Index (range 0-1)		0.63	
Qualitive Similarity Index (range 0-100)		48.0	

Fish Populations

Summer - Approximately one-half acre of an off-channel area was treated with 3 pounds of 5% active rotenone on July 31, 1985. Flows were above normal for the summer season as a result of recent local rains. This caused a noticeable flow through the sample area. A total of 465 fishes from 26 species with a total relative abundance value of 124 and a diversity index of 4.38 were collected during this sample period. Table D-17 lists all species collected at this site. Centrarchidae was the dominant family of fishes, comprising 33.5% of the population relative abundance; however, the mosquitofish and the pirate perch were numerically the most abundant species. Primary feeding fishes made up 5.7% of the population and carnivores comprised 11.3%. No sensitive species were collected at this site (Table D-18). Most of the fishes collected in this sample were small-sized species or small individuals of the larger species. This was probably a result of the shallow and rapidly flowing waters in the sample area. The species distribution, however, appears much as expected.

Spring - Flows were abnormally low during the springtime collection at this site. Additionally, several beaver dams caused most of the water to be pooled. Four nets of 1½", 2", 2¼", and 3½" square mesh were fished overnight on April 8, 1986. Thirty-five (35) fish totalling 117.7 pounds were caught. Carp and smallmouth buffalo, two species which were not taken during the summer sample, dominated the catch, making up 84.6 pounds. Spotted suckers were the most

numerous species netted. Gonad examination indicated that the buffalo and carp were in the process of spawning and the majority of the spotted suckers had completed spawning. The two spotted gar and one drum collected were in the final stage of maturation prior to spawning. One bowfin taken had completed spawning.

Table D-17. Fish Species Collected from Village Creek with Relative Abundance Values

Species		R.A. VALUE
Gambusia affinis	Mosquitofish	12.0
Aphredoderus sayanus	Pirate perch	12.0
Fundulus olivaceus	Blackspotted topminnow	10.5
Lepomis macrochirus	Bluegill	8.0
Lepomis megalotis	Longear	8.0
Etheostoma chlorosomum	Bluntnose darter	7.5
Lepomis punctatus	Spotted sunfish	6.0
Lepisosteus oculatus	Spotted gar	6.0
Notropis emiliae	Pugnose minnow	5.5
Lepomis gulosus	Warmouth	5.5
Notropis fumeus	Ribbon shiner	5.0
Etheostoma gracile	Slough darter	5.0
Lepomis cyanellus	Green sunfish	5.0
Dorosoma cepedianum	Gizzard shad	4.0
Elassoma zonatum	Banded pygmy sunfish	4.0
Notropis texanus	Weed shiner	3.0
Pomoxis nigromaculatus	Black crappie	3.0
Notemigonus crysoleucas	Golden shiner	2.0
Micropterus salmoides	Largemouth bass	2.0
Minytrema melanops	Spotted sucker	2.0
Aplodinotus grunniens	Freshwater drum	2.0
Esox americanus	Grass pickerel	2.0
Ictalurus natalis	Yellow bullhead	1.0
Hybognathus nuchalus	Silvery minnow	1.0
Amia calva	Bowfin	1.0
Noturus gyrinus	Tadpole madtom	1.0
Cyprinus carpio	Carp	S
Ictiobus bubalus	Smallmouth buffalo	S

S - collected in spring sample only

Table D-18. Summary of Fish Population Parameters from Village Creek

Total Species Collected	28.0
Total Number of Individuals	465.0
Total Relative Abundance Value	124.0
Relative Abundance Diversity Index	4.38

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6.0	13.3
CATOSTOMIDAE	2.0	1.6
ICTALURIDAE	2.0	1.6
CENTRARCHIDAE	8.0	33.5
PERCIDAE	2.0	10.1
Primary Feeders	5.0	5.7
Macroinvertebrate Feeders	18.0	83.0
Carnivores	5.0	11.3
Sensitive Species	0.0	0.0

BAYOU DEVIEW

Bayou DeView, located in the northeastern part of the state, was selected as one of the large-sized, relatively undisturbed streams in the Delta Region (Figure D-13). It flows through parts of Greene, Craighead, Poinsett, Jackson, Woodruff and Monroe Counties. Bayou DeView was selected from other possible locations after an on-site visit confirmed its suitability as a least-disturbed stream. It was the largest stream surveyed in the Delta. This stream and its tributaries have some artificial channels, but they are located several miles above the sample site. Bayou DeView starts in northern Craighead County and southern Greene County and flows in a southwesterly direction before joining the Cache River. The general area of the survey site was at the Highway 145 bridge in the SW ¼, NE ¼ of Section 7, R 1 W, T 6 N, Woodruff County.

General Site Discussion

Watershed Size - Drainage area above the Highway 145 bridge is 460 mi^2.

Geology - The watershed of Bayou DeView is in an area of predominantly unconsolidated alluvial deposits and there are some loess deposits east of Bayou DeView of Pleistocene and Holocene age.

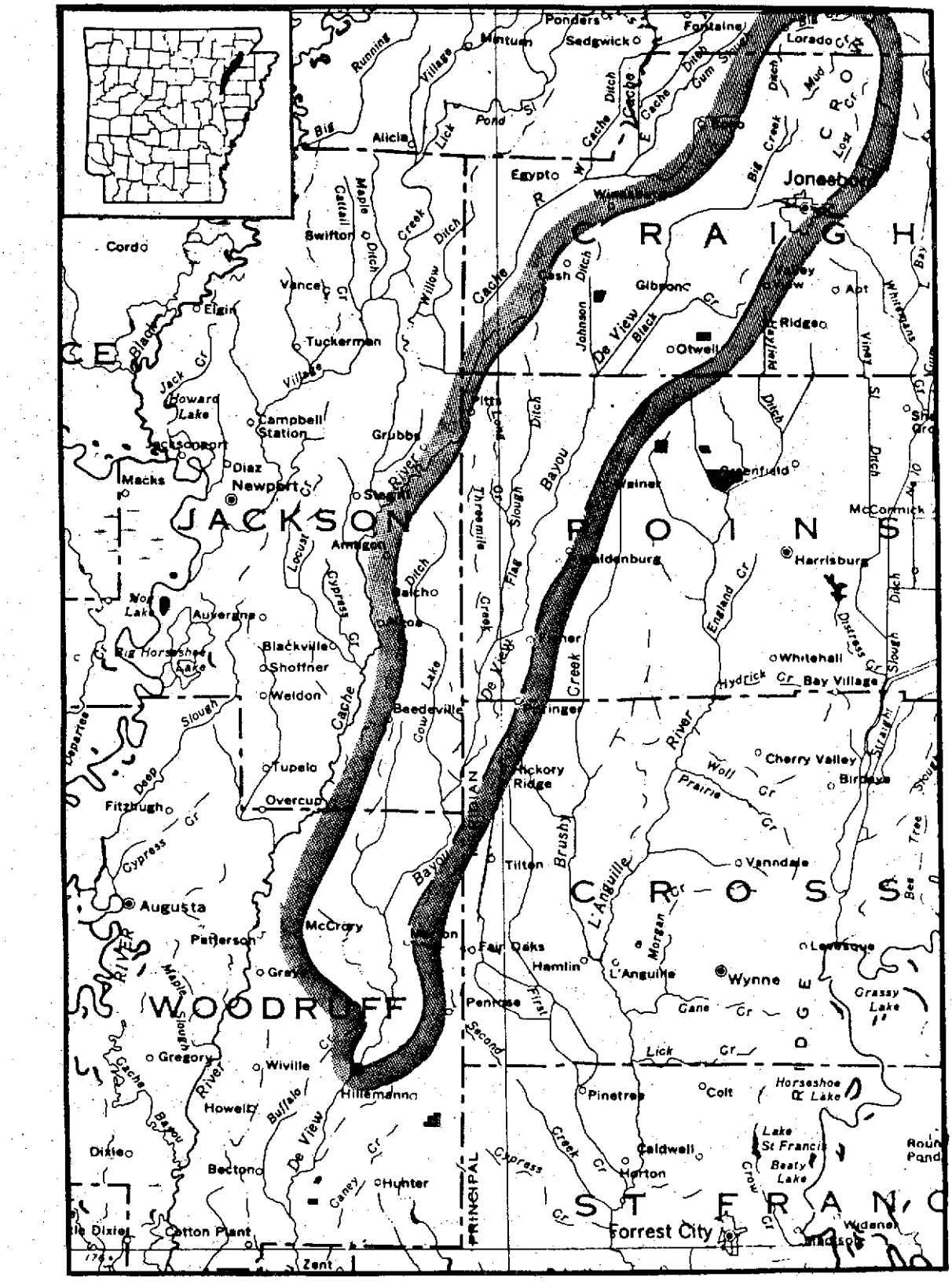
Topography - Topography within the watershed is generally level with only moderate differences in elevation. Elevation ranges from about 190 feet above msl at the sample site to 400 feet above msl on Crowley's Ridge. Slopes are from less than 1% in the floodplain to 8% or more in the loess plains and uplands.

Soil Type - Soils within the watershed are of alluvial and loess origin and are of the Amagon-Foley association and Dundee-Amagon-Foley associations in Woodruff County.

Soils in these associations have a slight to moderate erosion factor. The pH of these soils is strongly acid to very strongly acid. Some of the soils adjacent to the stream have high levels of sodium. This factor may be contributing to the higher total dissolved solids in Bayou DeView than are found in similarly-sized, least-disturbed streams in other regions.

Land Use and Flora - The watershed lies within the Southern Floodplain forest and the potential typical forest would consist of Oak-Tupelo-Cypress association in the lowlands.

Figure D-13



10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

BAYOU DEVIEW: Drainage area 460 square miles ■ Survey site Survey area

However, due to the extensive clearing that has taken place in the Delta for agricultural reasons, only small portions of forest exist. Generally, these forests are in the floodplain of the streams. In the case of Bayou DeView, approximately 28% of the watershed is covered by forests including nearly all the floodplain of the stream. The remainder of the area is agricultural land where soybeans, cotton and wheat are the main crops.

Stream Characteristics - Bayou DeView is one of the larger watersheds in the Delta and has relatively moderate disruption of its immediate channel and riparian area. Stream gradient at the site was calculated to be 0.6 feet per mile. Bayou DeView is a typical, relatively undisturbed, sluggish, warmwater stream of the Delta.

Methodology and Sampling Results

The summer survey was conducted from July 29 through August 2, 1985. Weather during this period was sunny to partly cloudy and hot. Stream flow was relatively stable during the survey period. Stream stage height increased one-tenth the second day and then fell one-tenth each day for the remainder of the survey. Rainfall of approximately 0.75 inch fell in the watershed on July 26 and 27 and caused the flow to be somewhat higher than the typical dry weather flow.

The spring survey was conducted from April 7-9, 1986. Weather during this period was variable. It was partly cloudy when the meters were set up on Monday, April 7, but a rain of about one inch fell on the night of April 7 and early morning of April 8. By 0900 on the morning of April 8, the weather had cleared.

Continuous Dissolved Oxygen

Summer - Three continuous D.O. meters were set up 150 to 600 feet downstream of the Highway 145 bridge on the afternoon of July 29. They were in operation until the morning of August 2. Meter probes were placed at mid-depth in flowing water of the stream channel. Meter #8 was placed in a constricted section of the stream where velocities were high. Meter #9 was placed at the lower end of a pool and Meter #10 at the middle of the pool. Meter #8 had erratic calibration checks; therefore, its data was not transcribed. Meter #9 malfunctioned on the afternoon of July 29. The meter was corrected and recalibrated on the morning of July 30. It performed satisfactorily after this. Meter #10

performed well during the entire survey period.

Dissolved oxygen values from all meters at this site were similar. Dissolved oxygen ranged from a minimum of 4.2 mg/l (53% saturation) to a high of 6.2 mg/l (80% saturation) at Meter #10 during the survey period. Minimum values occurred around 0800 hours and maximums occurred from about 1630 to 1800 hours each day. The minimum D.O. values were somewhat higher than observed in other Delta streams and may be related to the higher than normal flows encountered during the survey period. Plots of continuous dissolved oxygen, temperature and percent saturation are shown in Figures D-14 and D-15.

Spring - Two meters were set downstream of the bridge on the left bank of the stream. Meter #10 was placed about 100 yards downstream and Meter #7 about 150 yards downstream. The probes were placed in moving water at mid-depth. Both meters performed satisfactorily for over 24 hours, but Meter #10 was put out of service on the afternoon of April 8. Only data up to the time Meter #10 was shot was compiled for both meters because Meter 10 was being used to obtain stream temperature. Plots of continuous dissolved, temperature and percent saturation are shown in Figures D-17 and D-18.

Dissolved oxygen values at both meter sites were similar during the spring sampling period. There was a slight increase in D.O. because of the rain during the night of April 7. The minimum D.O., which occurred on April 7 around 2100 hours before the rainfall increased the flow, was about 4.2 mg/l (47% saturation). D.O. was steadily increasing on April 8 and had reached 5.2 mg/l (59% saturation) before the meter was shot. Average D.O. for the period the meters were in operation was 4.7 mg/l.

Chemical Parameters

Summer - Grab samples were taken during the summer survey at the Highway 145 bridge in an area of flowing water. Three separate samples were taken at 0935 hours, 1015 hours and 1105 hours on July 30, 1985.

Chemical results are shown in Table D-19. Turbidity values during this period were higher than observed in the other Delta streams surveyed. Total phosphorus values were high compared to ortho-phosphorus and this would indicate more suspended soil-related phosphorus in the water column as opposed to soluble phosphorus. Nitrate-nitrite values were also higher than observed in other Delta streams surveyed. All of these higher values were probably related to the

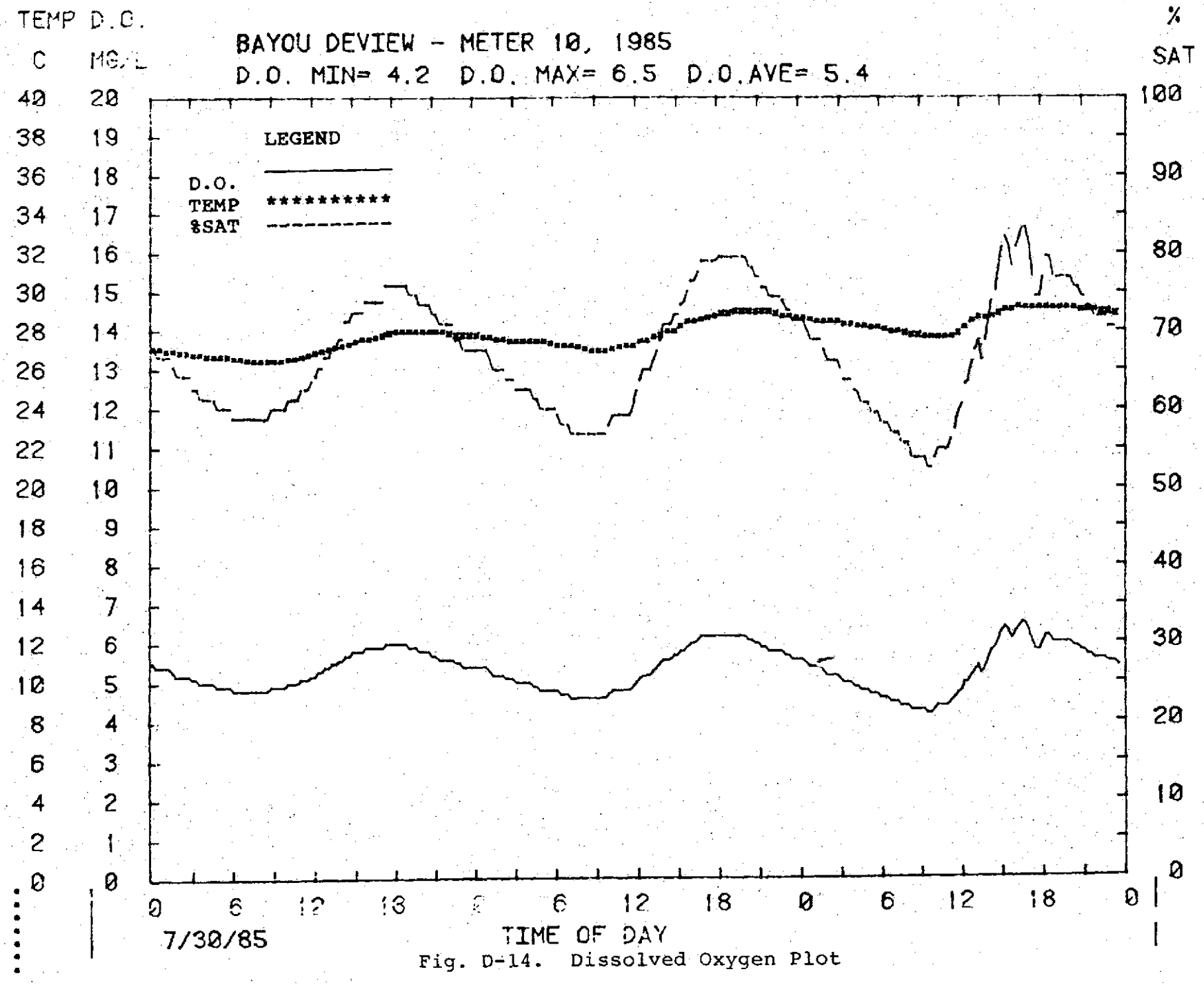


Fig. D-14. Dissolved Oxygen Plot

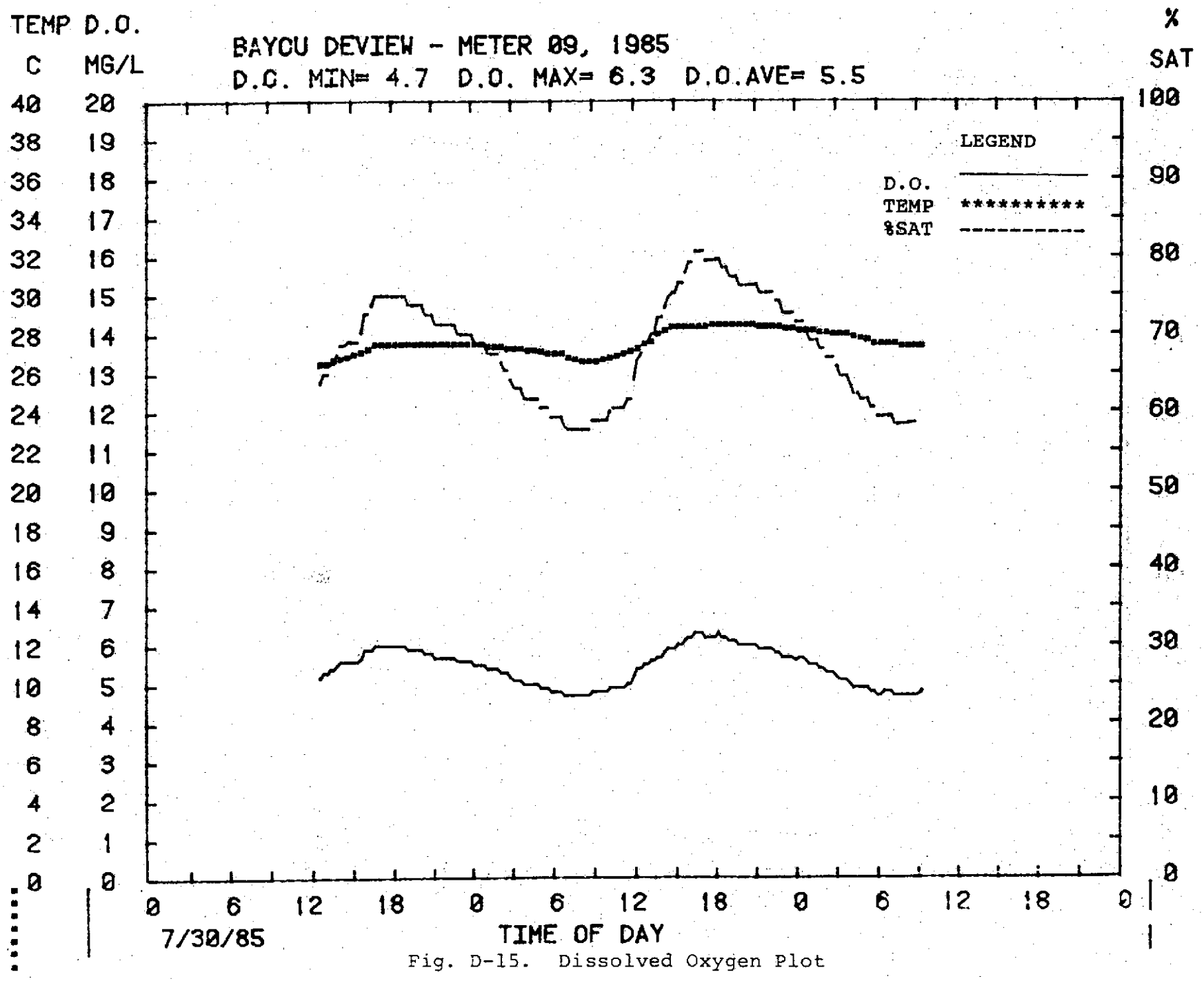


Fig. D-15. Dissolved Oxygen Plot

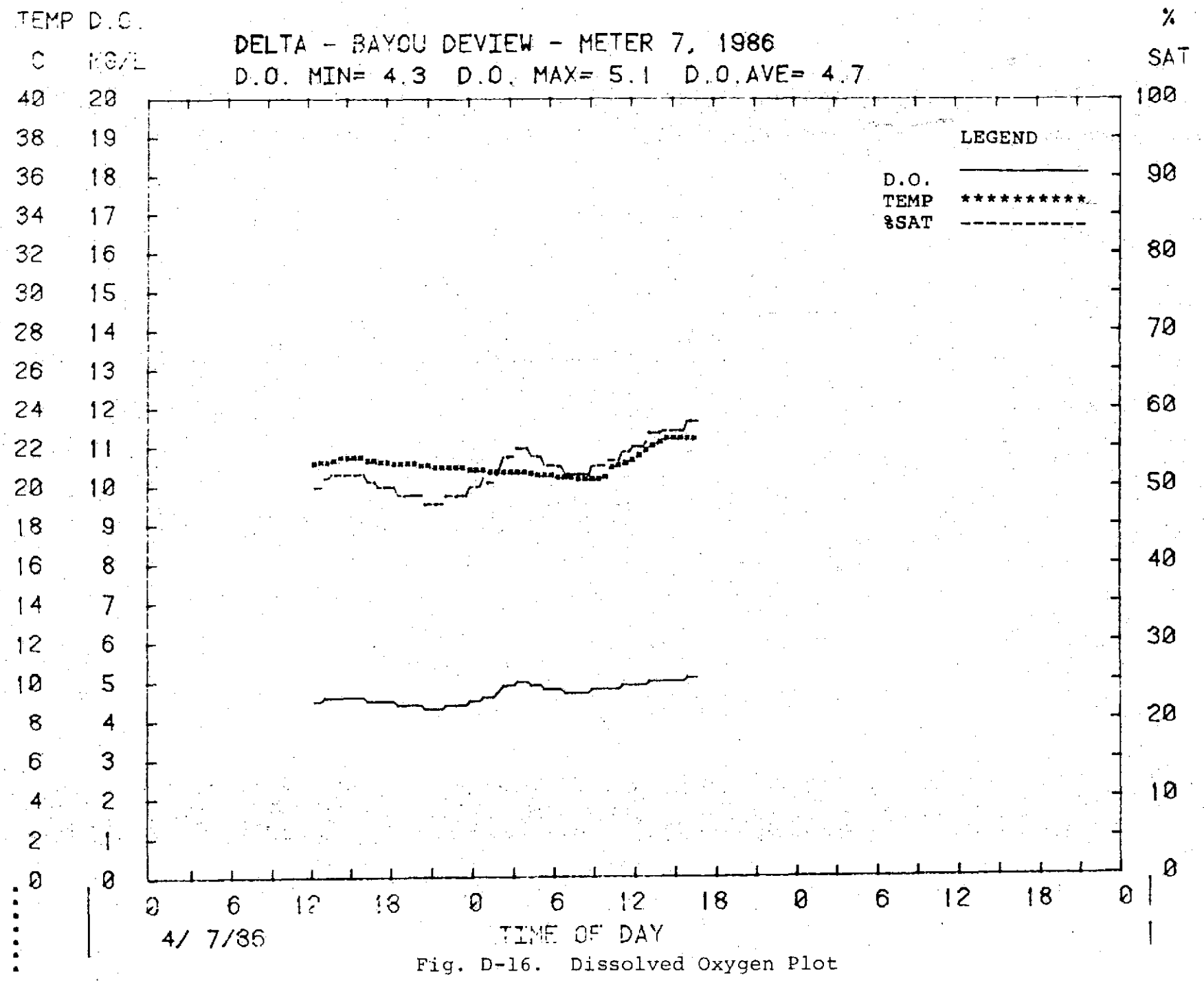


Fig. D-16. Dissolved Oxygen Plot

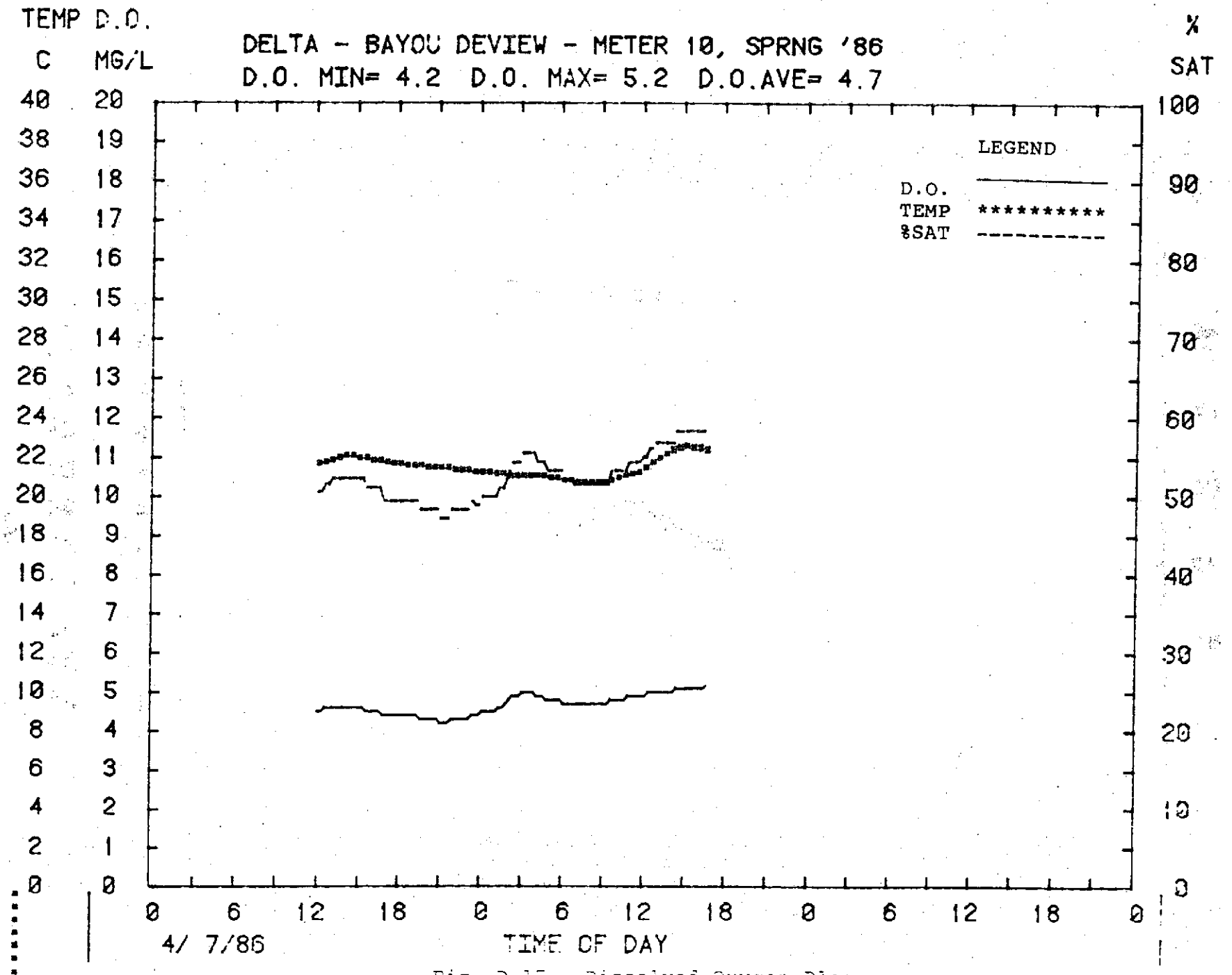


Fig. D-17. Dissolved Oxygen Plot

Table D-19

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Bayou De View

Drainage Area: 460 Square Miles

Station Description: At Hwy. Bridge 145 in Section 7, T 6 N, R 1 W Woodruff County

Date: July 30, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:35	10:15	11:05	
Q, cfs	191	191	191	191
Temperature, °C	27	27	-	27
pH	7.8	7.7	8.1	7.9
Turbidity, ntu	52	50	62	55
TSS, mg/l	58	58	64	60
TDS, mg/l	234	230	231	232
BOD-5, mg/l	1.3	1.6	1.8	1.6
BOD-20, mg/l	5.1	5.3	6.0	5.5
T.Phos., mg/l	0.19	0.19	0.21	0.20
PO4-P, mg/l	0.16	0.07	0.07	0.10
NO2+NO3-N, mg/l	0.68	0.68	0.68	0.68
NH3-N, mg/l	0.08	0.08	0.07	0.08
Cl -, mg/l	9.0	9.0	9.0	9.0
SO4 =, mg/l	23	24	24	24
Fe, mg/l	0.11	0.10	0.11	0.11
Conductivity, μmho	358	358	364	360
Alkalinity, mg/l	135	137	139	137
T. Hardness, mg/l	144	148	146	146
Chlorophyll a, μg/l	12.8	19.4	32.9	21.7
Fecal Coliform			210	210

Dissolved Oxygen Data for 30 Jul 1985		
	Meter 10	Meter 9*
Average	5.4	5.5
Minimum	4.8	4.7
Maximum	6.0	6.3

*Meter 9 data is for 31 Jul 1985

increased stream flow due to the rainfall in the watershed on July 26 and 27.

Spring - During the spring survey, grab samples were taken at the Highway 145 bridge in flowing water near the center of the channel. These samples were taken on April 8, 1986, at 0945 hours, 1040 hours and 1120 hours.

Chemical results for the spring are shown in Table D-20. Turbidity values were four times higher than the summer values even though total suspended solids were only 1.15 times the summer values. Apparently the turbidity is caused by very small, fine particles. The BOD5 values were 3 mg/l, about double the values observed in the summer. Alkalniity and hardness values were 0.17 of the values observed in the summer samples, while the total dissolved solids were only 0.75 of the summer values.

Physical Parameters

Physical evaluations were made during the summer survey on July 30, 1985. Flow, mean stream velocity and stream transects to assess width, depth, substrate, etc. were all conducted as outlined in the General Methodology of this report.

Summer - The results of the summer physical parameters are summarized in Table D-21.

Bayou DeView is a low gradient, meandering stream (in its unchannelized segments) typical of the Delta. During the survey period, the stream width varied from 120 to 990 feet and averaged about 500 feet in the sample area. Stream depth was approximately 4.5 feet. Stream gradient in the area surveyed is 0.6 feet per mile. The stream bottom substrate is composed of a fine, silty clay and the least disturbance or increase in stream velocity causes this mud to become resuspended in the water.

Instream cover averaged 24% of the stream width, with 22% of this being brush, logs and other debris.

Flow in Bayou DeView was up due to about 0.75 inch of rain in the watershed on July 26 and 27. Stream velocity was not measured at this site. Stream canopy measured 60%, which moderates stream temperature and may also affect photosynthetic activity.

Table D-20

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Delta

Stream: Bayou Deview

Drainage Area: 460 square miles

Station Description: Hwy bridge 145, Section 7, T 6 N, R 1 W
Woodruff County

Date: April 8, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:45	10:40	11:20	
Q, cfs	500 Est			500 Est
Temperature, °C	21	21	21	21
pH	6.74	6.74	6.79	6.8
Turbidity, ntu	130	130	125	128
TSS, mg/l	67	76	64	69
TDS, mg/l	172	164	169	168
BOD-5, mg/l	3.0	4.0	2.8	3.3
BOD-20, mg/l	8.0	10.6	7.1	8.6
T.Phos., mg/l	0.28	0.27	0.27	0.27
PO4-P, mg/l	0.15	0.15	0.16	0.15
NO2+NO3-N, mg/l	0.18	0.17	0.17	0.17
NH3-N, mg/l	0.16	0.17	0.15	0.16
Cl -, mg/l	4	4	4	4
SO4 =, mg/l	8	8	9	8
Fe, mg/l	2.5	2.4	2.5	2.5
Conductivity, µmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	21	21	22	21
T. Hardness, mg/l	18	20	22	20
Chlorophyll a, µg/l	-	-	16.7	16.7
Fecal Coliform	-	-	505	505

Dissolved Oxygen Data for 8 Apr 1986		
	Meter 10	Meter 7
Average	4.7	4.7
Minimum	4.2	4.3
Maximum	5.2	5.1

Table D-21

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Bayou Deview
Date:	7/30/85
Drainage Area:	460 square miles
Watershed Land Use:	72% agriculture 28% forest
Stream Gradient:	0.6 ft/mile
Mean Channel Width:	1575 feet
Mean Stream Width:	509 feet
Mean Stream Velocity:	N/A
Observed Flow:	191 cfs
Estimated Mean Depth:	4.5 feet
Average Substrate Type:	100% mud/silt
Mean Instream Cover:	22% brush, logs, debris 2% inundated vegetation
Riffle/Pool Ratio of Transects:	100% deep pool
Mean Bank Overstory Cover:	78% trees 34% shrubs
Mean Bank Ground Cover:	5% grass and forbs 95% dirt
Mean Bank Stability:	100% stable
Mean Stream Canopy:	60% stream canopy
Comments:	

Spring - No additional physical evaluations were made during the spring survey.

Macroinvertebrate Populations

Eighty-seven (87) taxa representing 22 orders were identified from the summer-spring qualitative benthic samples (Table A-4, Appendix A). Numerically, the dominant orders Decapoda, Coleoptera, Amphipoda and Ephemeroptera comprised 25%, 17%, 12% and 10% of the combined samples, respectively. Taxonomically, the sample contained predominantly Coleoptera, Odonata and Hemiptera which accounted for 49% (43 of 87) of the taxa. The dominant taxa included Palaemonetes kadiakensis (22%), Gammarus minus (10%), Caenis (7%) and Peltodytes (4%). Other taxa common to both summer and spring samples and considered as characteristic of the Delta Ecoregion include: Stenacron interpunctatum, Argia, Sialis and Asellus communis.

The comparative indices indicate that the summer-spring samples were more similar than dissimilar (Table D-22). Of the 87 taxa identified from both samples, 60 and 68 were identified from the summer and spring samples, respectively. Of those, 42 taxa were present in both samples and comprised 88.1% of all organisms collected. The 18 and 26 taxa unique to the summer and spring samples comprised only 11.5% and 12.2% of their respective benthic assemblages. None of the taxa unique to only one sample were collected in great enough quantity to be considered a dominant of that community.

Summer - Numerically, the dominant orders of the summer benthic community were Decapoda (32%), Coleoptera (14%), Ephemeroptera (11%) and Hemiptera 10%). Taxonomically, the beetles dominated with 13 taxa, followed by dragon-damsel flies (8 taxa) and true bugs (7 taxa). Only one taxon, Palaemonetes kadiakensis, comprised greater than 10% of the benthic assemblage. Other taxa, not numerically dominant, but considered characteristic benthic organisms of the delta region include Gammarus minus, Argia, Hexagenia limbata, Sialis and Climacia areolaris.

Spring - The dominant orders of the spring benthic sample were Decapoda (21%), Coleoptera (20%) and Amphipoda (15%) and taxonomically, Coleoptera was represented by more than twice as many taxa than any other. The dominant taxa of the spring sample were Palaemonetes kadiakensis (17.6%), Gammarus minus (12.8%) and Caenis and Peltodytes (7%). Other taxa, not numerically dominant, but considered as characteristic spring benthic organisms of the larger delta

streams include Argia, Asellus communis, Ischnura and Sialis.

The majority of the taxa identified are common, wide-spread and have demonstrated wide tolerances for many ecological parameters. In fact, most of these are at best considered to be indicators of only marginal water quality. However, the number of taxa and their distribution within the sample is indicative of a very stable, healthy benthic macroinvertebrate community (Table D-22).

Table D-22. Community Analysis of Benthic Samples from Bayou DeView - 30 minute Qualitative Samples, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	764	1084	1848
Total # Taxa	60	68	87
Diversity	4.3250	4.7637	4.9353
Index of Evenness	0.5767	0.5258	0.4479
Index of Dominance	0.7322	0.7825	0.7461
Index of Variety	6.1603	6.6454	8.8801
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.68
Common Taxa Index (range 0-1)			0.62
Qualitative Similarity Index (range 0-100)			59.0

Fish Populations

Summer - Approximately five pounds of 5% active rotenone were used to treat about one acre of a secondary channel of the Bayou on August 1, 1985. Flows were slightly above normal for the summer season and turbidity was relatively high. A constant flow existed through the area. The lower end of the sample area was partially blocked with a seine and the rotenone was detoxified as it flowed through the end of the sample area. Twenty-four species of fish represented by 462 individuals were collected during this time. Two additional species were collected during the spring sampling. Table D-23 lists all species collected at this site. The population had a total relative abundance value of 139 and a diversity index of 4.31. The dominant family of fishes was Cyprinidae which made up 27.7% of the population. Centrarchidae, which normally dominate Delta Ecoregion fish populations, made up 18.3% of the population but had the largest number of species of the other fish families. Also, a very large population of channel catfish and drum was found. Carnivores of six species made up 23.7% of the population. Only one sensitive species was collected (Table D-24).

The results of this sample were below expectations. Above normal flows may have influenced the results; however, the sub-dominance of sunfishes and the abundance of turbidity-tolerant fishes such as drum, certain minnows, catfish and mosquitofish indicate nonpoint source impact from agricultural activities.

Spring - Trammel nets of 1½", 2", 2½", and 3½" square mesh were fished overnight on April 7, 1986, at this site. The water level was slightly out of the normal banks, turbid and with water temperatures of around 22°C. Fifteen fishes weighing 38.1 pounds were taken. Bowfin and smallmouth buffalo were collected at this time but were not taken in the summer sample. Carp and spotted suckers were in the spawning process and smallmouth buffalo were in the final stage of gonad maturation prior to spawning. Gizzard shad, black crappie and drum were also in the advanced stages of gonad maturation.

Table D-23. Fish Species Collected from Village Creek with Relative Abundance Values

Species		R.A. VALUE
Ictalurus punctatus	Channel catfish	12.0
Pimephales vigilax	Bullhead minnow	12.0
Notropis atherinoides	Emerald shiner	10.0
Gambusia affinis	Mosquitofish	9.0
Etheostoma asprigene	Mud darter	9.0
Aplodinotus grunniens	Freshwater drum	8.0
Aphredoderus sayanus	Pirate perch	8.0
Pylodictis olivaris	Flathead catfish	8.0
Notropis venustus	Blacktail shiner	7.5
Lepomis macrochirus	Bluegill	7.5
Pomoxis nigromaculatus	Black crappie	7.5
Ictiobus niger	Black buffalo	6.0
Notropis emiliae	Pugnose minnow	6.0
*Percina maculata	Blackside darter	6.0
Lepomis punctatus	Spotted sunfish	4.0
Micropterus punctulatus	Spotted bass	3.5
Ictalurus natalis	Yellow bullhead	3.0
Cyprinus carpio	Carp	3.0
Micropterus salmoides	Largemouth bass	2.0
Dorosoma cepedianum	Gizzard shad	2.0
Minytrema melanops	Spotted sucker	2.0
Fundulus notatus	Blackstripe topminnow	1.0
Lepomis megalotis	Longear	1.0
Fundulus olivaceus	Blackspotted topminnow	1.0
Amia calva	Bowfin	S
Ictiobus bubalus	Smallmouth buffalo	S

*Sensitive species
S - collected in spring sample only

Table D-24. Summary of Fish Population Parameters from Bayou DeView

Total Species Collected	26.0
Total Number of Individuals	462.0
Total Relative Abundance Value	139.0
Relative Abundance Diversity Index	4.31

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5.0	27.7
CATOSTOMIDAE	3.0	5.8
ICTALURIDAE	3.0	16.5
CENTRARCHIDAE	6.0	18.3
PERCIDAE	2.0	10.8
Primary Feeders	4.0	7.9
Macroinvertebrate Feeders	16.0	68.4
Carnivores	6.0	23.7
Sensitive Species	1.0	0.7

GULF COASTAL PLAIN ECOREGION

The Gulf Coastal Plain lies in the southern one-third of the state, generally south of a line from Little Rock to Texarkana and west of Bayou Bartholomew. Surface geology consists of gravel, sand, silt and clay deposits of ocean-bed origin dating from Cretaceous through Tertiary Periods of 135 million to 70 million years ago.

Soils in this region have moderate to high permeability. Topography consists of gently rolling hills with local relief of typically less than 100 feet.

Streams in this region are meandering with low to moderate gradients. They consist of pool/riffle combinations, and stream bottoms are generally composed of sand, gravel and silt. Water color is distinctively "coffee-colored."

Native vegetation is loblolly and shortleaf pine and bottomland hardwoods. Much of the natural forest has been converted to loblolly pine monocultures. Land use is predominantly silviculture, followed by agriculture.

Most of this region's major waterways originate in the Ouachita Mountains and drain through the Gulf Coastal Region. The lower Ouachita, Saline and Little Missouri Rivers have their headwaters in the Ouachita Mountains but also drain areas of the Gulf Coastal Plains. Moro Creek is the only major waterway which begins and ends entirely within the region.

Streams selected to represent the Gulf Coastal Region along with the size of the watershed above the selected site are:

Whitewater Creek	23 mi^2
Big Creek	59 mi^2
Derrieusseaux Creek	148 mi^2
Bayou Freeo	156 mi^2
Hudgin Creek	187 mi^2
L'Aigle Creek	232 mi^2
Moro Creek	451 mi^2

Two additional streams, which received most of their critical season flow from groundwater systems, are also included within the discussion on the Gulf Coastal Region. These streams are:

East Fork Tulip Creek	46 mi^2
Cypress Creek	73 mi^2

The initial year's sampling of the Tulip Creek and Cypress Creek watersheds reflects what is now clearly seen as an atypical situation. Recent works published by R. A. Hunrich (USGS, 1983) indicate that some streams within the Gulf Coastal Plains region maintain a year-round flow.

WHITEWATER CREEK

Whitewater Creek begins in the northeast part of Calhoun County and flows in a general southeasterly direction to its confluence with Moro Creek near Tinsman, Arkansas. The sampling site on Whitewater Creek was located at the Highway 274 bridge in the NE ¼ of Section 20, R 12 W, T 12 S (Figure GC-1).

General Site Discussion

Watershed Size - The watershed size of Whitewater Creek above the Highway 274 bridge is 23 mi^2.

Geology - Surface geology in the Whitewater Creek drainage is basically composed of Terrace deposits of the Pleistocene period.

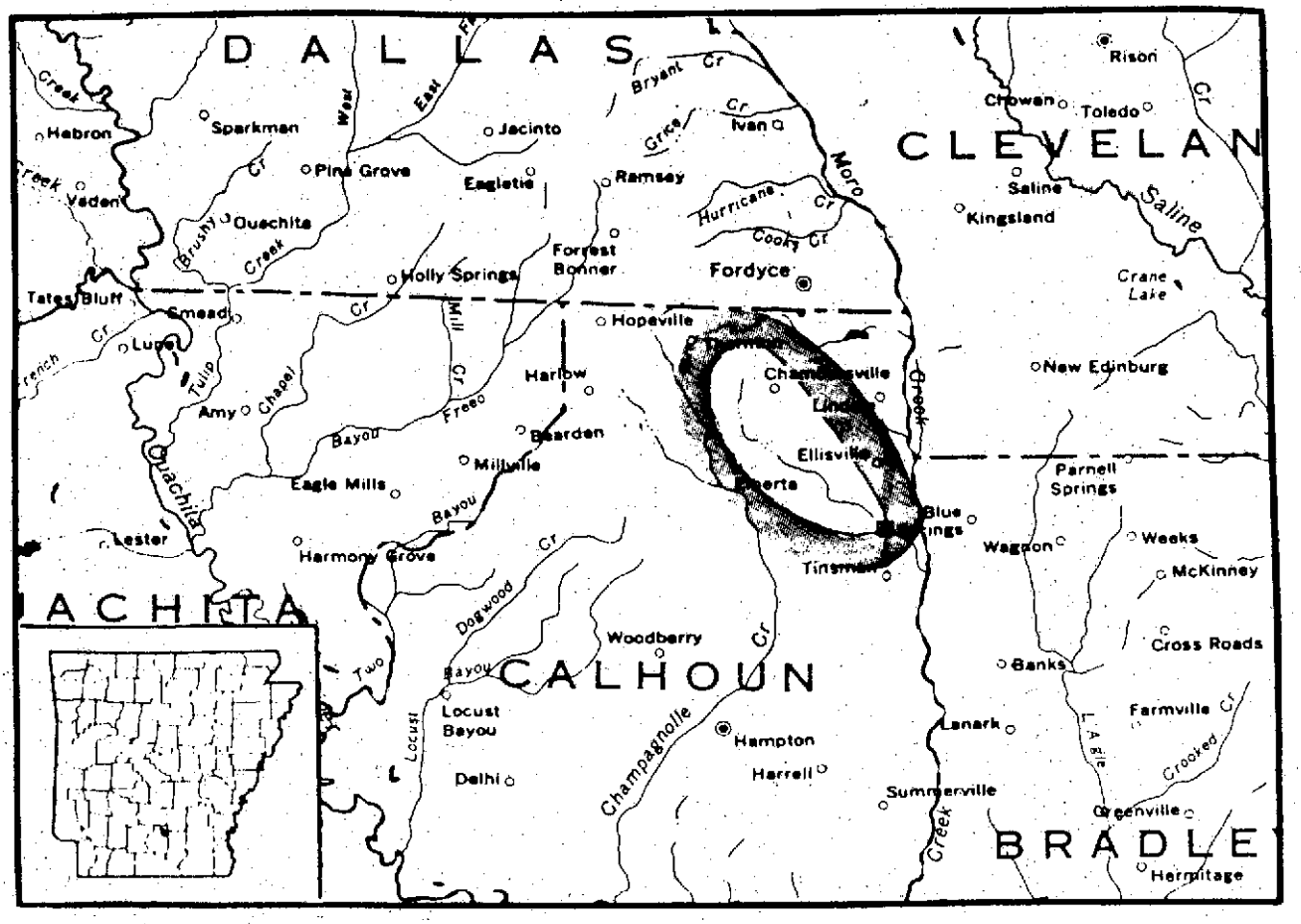
Topography - Topography within the watershed is composed of generally level to gently rolling sand hills directly adjacent to the creek.

Soil Types - The immediate headwater section of Whitewater Creek is dominated by the Savannah-Ruston-Smithdale soil association. This association is made up of moderately well-drained and well-drained, nearly level to moderately sloping, loamy soils on uplands. These soils, formed in thick beds of loamy marine sediments, are found on hilltops and hillsides of the Coastal Plains and are used mainly as woodlands and pastures. The lower section of Whitewater Creek is dominated by the Amy-Smithton-Pheba soil association which is composed of poorly drained and somewhat poorly drained, level to nearly level, loamy soils on uplands. These soils also formed in thick beds of loamy marine sediments and are used mainly as woodlands. Both soil associations ae strongly acid to very strongly acid. There is a severe erosion hazard in the Savannah-Ruston-Smithdale association. Although not prone to erosion, the main limiting factor of the Amy-Smithton-Pheba association is wetness.

Flora - The upland areas within the Whitewater Creek watershed are dominated by pine trees. Other flora identified in the riparian community included sweetgum, elm, hickory, hornbeam, mulberry, maple, black gum and various oak tree species.

Land Use - Land use within the watershed is 91% forestland and 7% agriculture, according to the Soil Conservation Service. The predominant agricultural use is pastureland. The Whitewater Creek watershed has a very low level of man-induced disturbance and is a representative least-disturbed stream in the Gulf Coastal Region.

Figure GC-1



1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

WHITEWATER CREEK: Drainage area 23 square miles ■ Survey site ▒ Survey area

Stream Characteristics - The 1983 USGS stream flow map shows Whitewater Creek to have a Q_{7-10} low flow of zero. During any given year, the flow will normally drop to zero, leaving a series of enduring pools within the stream channel. This is common throughout the Gulf Coastal Region. During the summer survey, conditions on Whitewater Creek were typical of the enduring pool situation. Some of the more significant physical characteristics observed during the survey included the deeply cut stream channel with sandy banks, sandy substrate, low stream gradient, high percentage of instream cover (brush, logs and debris) and high percentage of stream canopy.

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 12-16, 1985; the spring survey was conducted during the week of April 1-4, 1986. Due to laboratory difficulties, the chlorophyll a, fecal coliform and iron measurements were made on May 27, 1986.

Continuous Dissolved Oxygen

Summer - Due to the number of sites observed during this week of sampling, only one meter was used to monitor the temperature and dissolved oxygen at this site. The meter was set up at approximately 11 a.m. on Monday, August 12, 1986, and ran through the remainder of the week, performing satisfactorily throughout the sampling period. The sample site was located approximately 150 yards upstream of the Highway 274 bridge. Whitewater Creek was in an enduring pool situation and the meter was measuring the temperature and dissolved oxygen within one of these pools. The meter was checked daily for calibration. Results obtained during the survey are displayed in Figure GC-2, which shows the recorded temperature, dissolved oxygen and dissolved oxygen saturation. The maximum and minimum D.O. were 4.7 mg/l and 0.2 mg/l, respectively, averaging 2.6 mg/l. Similar to other Gulf Coastal dissolved oxygen graphs, the highest values appear contrary to normal photosynthetic activity in that they occur just after midnight. Summertime D.O. saturations ranged from 10-40% during the survey period.

Spring - On March 31, 1986, a continuously recording D.O. meter was set up at the same location used during the summer survey. Unlike the pooled conditions of summer, Whitewater Creek was flowing, although the early spring of 1986 was atypically dry and stream flows were below normal. Flow was measured to be 2.3 cfs at the time of the survey. Figure GC-3 displays the D.O., temperature and percent saturation. The maximum and minimum D.O. were 6.4 mg/l and 4.8 mg/l, respectively, averaging 5.5 mg/l over the survey period. Due to the low spring flow encountered at this site, the D.O. values were slightly lower than expected.

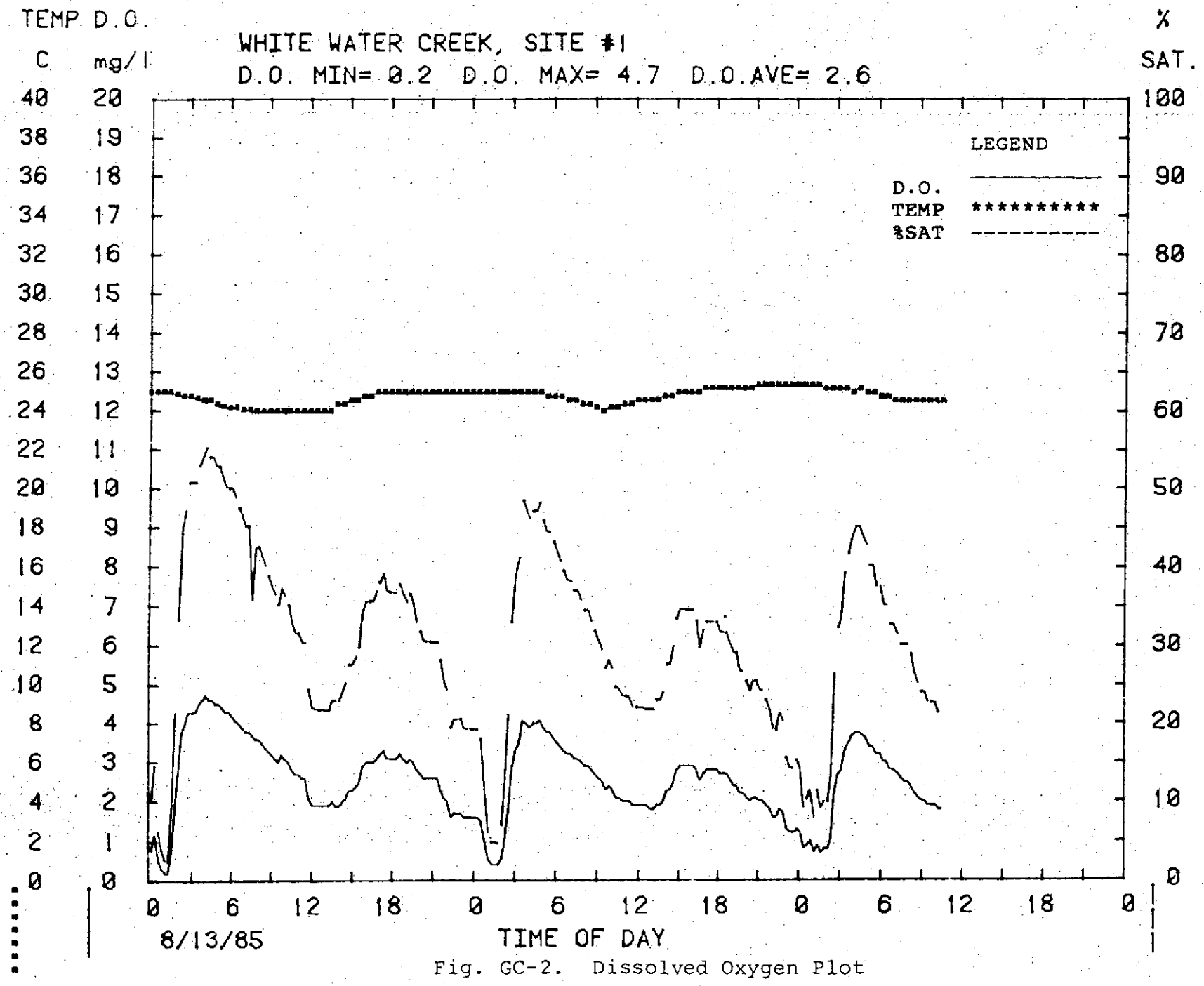


Fig. GC-2. Dissolved Oxygen Plot

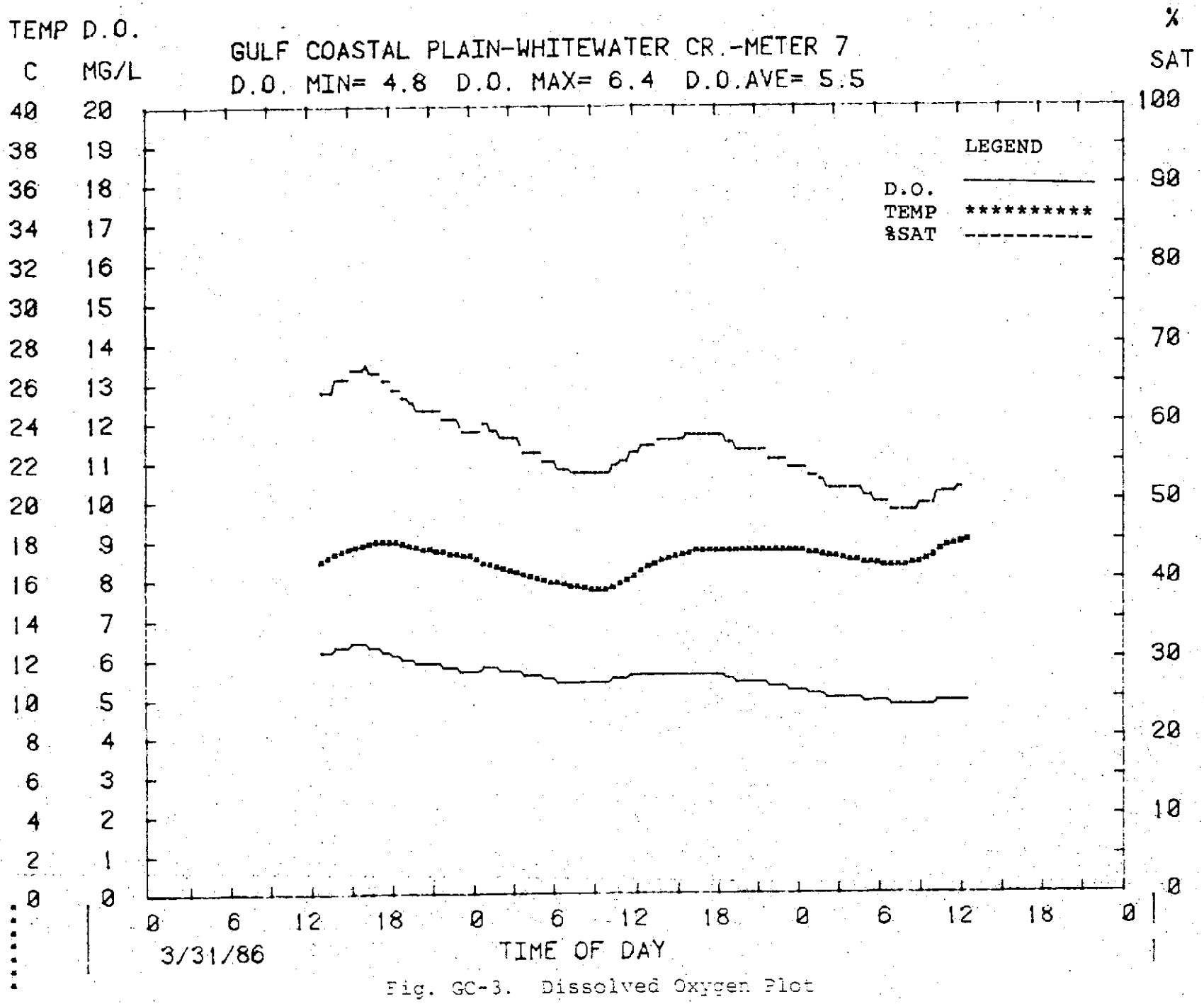


Fig. GC-3. Dissolved Oxygen Plot

Dissolved oxygen percent saturation averaged approximately 60%.

Chemical Parameters

Summer - Chemical data collected during the summer sampling period on August 13, 1985, is displayed on Table GC-1. The seasonal enduring pool status of Whitewater Creek appears to have a significant influence on the water chemistry. The high flows of spring introduce an abundance of organic maaterials from the forest floor and, as the flow recedes, these materials are left to decompose in the enduring pools. Some anaerobic digestion is also apparent as evidenced by the release of hydrogen sulfide gas during any streambed disturbance. The BOD_5 and BOD_{20} were 3.5 mg/l and 6.9 mg/l, respectively, indicating moderate biological activity to be occurring within the water column. Although the nutrient measurements were extremely low, the lentic condition of the stream enhanced phytoplankton growth, as indicated by the chlorophyll ā concentrations measured. Mineral quality in Whitewater Creek reveals very low levels of sulfates (9 mg/l), chlorides (4 mg/l) and total dissolved solids (66 mg/l). Alkalinity and hardness measurements indicate that Whitewater Creek has very "soft" water with little buffering capacity. The characteristic dark brown water of the Gulf Coastal Region was evident at this site. This characteristic color is thought to be a condition related to the specific soil types within the watershed and the leaching of tannins, lignins and perhaps iron from the leaf litter and soils. Turbidity measurements indicate the water is relatively clear (6 NTUs). The test for fecal coliform bacteria revealed the presence of 92 colonies per 100 ml of water tested. This concentration meets the primary contact standard in Regulation No. 2, Arkansas Water Quality Standards.

Spring - The spring samples were collected on April 1, 1986. Results are shown in Table GC-2. Water quality measured during the spring sampling was significantly different in some respects from the summer samples. Most significant was the volume of water or flow available during the spring. The stream was now actually a flowing stream as opposed to a series of enduring pools which were found during the summer. The available flow is thought to be the predominant reason for the observed changes in water quality. The pH measurement was slightly more acidic during the spring sampling. BODs, both 5-day and 20-day, were approximately one-half the concentrations measured during the summer conditions. Chlorophyll ā concentrations were reduced to one-half of those values found during the summer. Nutrient levels were very low and showed no significant change from the summer survey. Mineral quality parameters, such as chlorides, sulfates and total dissolved solids, increased

Table GC-1

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Whitewater Creek

Drainage Area: 23 square miles

Station Description: Hwy. 274 in Section 20, T 12 S, R 12 W, Calhoun County

Date: August 13, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	11:30	11:45	12:00	
Q, cfs	0	0	0	No Flow
Temperature, °C	25	25	25	25
pH	7.0	6.9	6.9	6.9
Turbidity, ntu	7	5	34	6*
TSS, mg/l	8	8	69	8*
TDS, mg/l	64	66	66	66
BOD-5, mg/l	2.9	3.1	4.7	3.5
BOD-20, mg/l	6.4	7.3	7.2	6.9
T.Phos., mg/l	0.11	0.11	0.14	0.12
PO4-P, mg/l	0.04	0.04	0.04	0.04
NO2+NO3-N, mg/l	0.01	<0.01	0.01	0.01
NH3-N, mg/l	0.04	0.02	0.04	0.03
Cl-, mg/l	4	3.5	4	3.7
SO4=, mg/l	8	9	9	9
Fe, mg/l	0.14	0.15	0.21	0.17
Conductivity, µmho	68	70	66	68
Alkalinity, mg/l	25	30	27	27
T. Hardness, mg/l	24	28	34	28
Chlorophyll a, µg/l	8.6	12.9	5.1	8.8
Fecal Coliform	-	-	92	92

Dissolved Oxygen Data for 13 Aug 1985		
	Site 1	
Average	2.8	
Minimum	0.2	
Maximum	4.7	

*Third sample was discarded from average total.

Table GC-2

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Whitewater Creek

Drainage Area: 23 square miles

Station Description: Hwy. 274 in Section 20, T 12 S, R 12 W
Calhoun County

Date: April 1, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	11:25	12:15	13:15	
Q, cfs	2.3	2.3	2.3	2.3
Temperature, °C	17	17	17	17
pH	6.50	6.32	6.32	6.4
Turbidity, ntu	8	8	8	8
TSS, mg/l	8	10	10	9
TDS, mg/l	94	93	94	94
BOD-5, mg/l	1.6	1.4	1.7	1.6
BOD-20, mg/l	4.5	4.3	4.5	4.4
T.Phos., mg/l	-	-	-	-
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.01	0.01	<0.01	0.01
NH3-N, mg/l	0.01	0.01	0.02	0.01
Cl -, mg/l	13	14	13	13
SO4 =, mg/l	14	13	13	13
Fe, mg/l	2.4	2.4	2.3	2.4*
Conductivity,µmho	82	80	77	80
Alkalinity, mg/l	12	11	10	11
T. Hardness, mg/l	22	22	20	21
Chlorophyll a,µg/l	-	-	4.18	4.18*
Fecal Coliform	-	-	108	108*

Dissolved Oxygen Data for 1 Apr 1986		
	Meter 7	
Average	5.5	
Minimum	5.2	
Maximum	5.8	

*These samples were collected on Aug 27th, 1986.

slightly during the higher flows of spring. Fecal coliform bacteria concentrations remained essentially the same for both sampling periods. Turbidity measurements were also the same during both sampling periods.

Physical Parameters

Physical evaluations were made during the week of August 12-16, 1986. Whitewater Creek had reached a routine critical condition for the annual cycle. The stream had essentially stopped flowing, forming a standing waterbody in the immediate streambed. Whitewater Creek is generally characteristic of other Gulf Coastal streams with its low stream gradient, high percentage of instream fishery cover (brush, logs and debris), and moderate canopy covering the stream (Table GC-3).

Macroinvertebrate Populations

Eighty taxa representing 15 orders were identified from the summer-spring benthic samples collected from Whitewater Creek (Table A-5, Appendix A). Numerically, the dominant orders were Decapoda, Coleoptera, Diptera and Odonata, comprising 22%, 18%, 15% and 12% of the organisms, respectively. Taxonomically, the benthic community was predominantly beetles, odonates and true flies. These three orders accounted for 60% of the taxa collected. The dominant taxa common to both samples were Palaemonetes kadiakensis (18%), Peltodytes (6%), Caenis (5%) and Uvarus (4%).

The comparative indices demonstrated that substantial differences existed between the summer and spring benthic community (Table GC-4). These differences were the result of natural seasonal variation which occurs in stable, balanced benthic populations. Of the 80 taxa identified from both samples, 60 were identified from the summer and 58 from the spring benthic samples. Of those, 38 taxa were present in both samples and comprised 77.5% of all organisms. The 22 and 20 taxa unique to the summer and spring samples comprised only 30% and 16% of their associated benthic communities, respectively. Two of the five dominant taxa of the summer benthic community were not collected in the spring sample. However, all taxa characterized as dominant in the spring population were also collected in the summer.

Numerically, the dominant orders of the summer sample were Diptera (26%), Coleoptera (20%), Odonata (14%) and Decapoda (4%). However, taxonomically, Coleoptera was represented by twice the number of taxa than any other group. The dominant taxa of the summer sample were Palaemonetes kadiakensis (10%), Peltodytes (9%), Tanypus (6%), and Sialis and Palpomyia (4%).

Table GC-3

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Whitewater Creek
Date:	8/12/85
Drainage Area:	23 Square Miles
Watershed Land Use:	7% Agriculture 91% Forest 2% Other
Stream Gradient:	2.8 fpm
Mean Channel Width:	29 feet
Mean Stream Width:	15 feet
Mean Stream Velocity:	NA
Observed Flow:	No Flow
Average Substrate Type:	100% Sand
Mean Instream Cover:	32% Brush, Logs, Debris 1% Overhanging Vegetation
Riffle/Pool Ratio of Transects:	100% Shallow Pool
Mean Bank Overstory Cover:	85% Trees 38% Shrubs
Mean Bank Ground Cover:	58% Grass and Forbs 42% Dirt
Mean Bank Stability:	90% Moderate 10% Unstable
Mean Stream Canopy:	96% Canopy
Comments:	

The dominant orders of the spring sample were Decapoda (31%), Coleoptera (17%), and Odonata and Amphipoda (9%). Like the summer sample, the spring sample was taxonomically dominated by beetles. The dominant taxa of the spring were Palamonetes kadiakensis (26%), Caenis and Uvarus (6%) and Cambarinae (5%).

The community parameters indicated a well-balanced, stable benthic community with very high diversity indices (Table GC-4). The percentage composition of functional groups also indicated a balanced trophic structure within the benthic assemblage. The macroinvertebrate community of Whitewater Creek was composed predominantly of taxa which exhibit wide tolerances to most water quality parameters. The presence of abundant instream cover and emergent vegetation provides sufficient microhabitat for the species diversification exhibited by these samples. However, the absence (or reduced number) of taxa considered to be characteristic of naturally high quality water can be attributed to reduced riffle habitat, due primarily to impediment of flow by beaver activity within the watershed.

Table GC-4. Community Analysis of Benthic Samples from Whitewater Creek - 30 minute Qualitative Samples, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	630	732	1362
Total # Taxa	60	58	80
Diversity	5.024	4.5585	5.1943
Index of Evenness	0.4292	0.4922	0.4435
Index of Dominance	0.8506	0.7782	0.8216
Index of Variety	6.3446	5.9901	7.5878
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.64	
Common Taxa Index (range 0-1)		0.63	
Qualitative Similarity Index (range 0-100)		38.0	

Fish Populations

Summer - A pool approximately 80 yards long and 20 feet wide with an average depth of 1.5 feet was treated with 3.5 pounds of 5% rotenone on August 8, 1985. There was no measurable flow and numerous beaver dams created the pool areas. Approximately 15 man-hours were spent collecting the dying fish.

A total of 419 individuals were collected which had a relative abundance value of 149.5 and a diversity index of 4.33. Table GC-5 shows the 25 species of fish collected at this site. All but one was collected in the summer sample. This population was dominated by Centrarchidae, particularly the flier and warmouth; however, small longear were numerically the most abundant sunfish. Macroinvertebrate feeding fishes made up

warmouth; however, small longear were numerically the most abundant sunfish. Macroinvertebrate feeding fishes made up over 90% of the population and no primary feeding fishes were collected (Table GC-6). Only one sensitive fish species, the Creole darter, was taken.

Spring - Three trammel nets were set overnight at this site on March 31, 1986. The nets were 1½", 2", and 2½" square mesh. A dry winter and early spring caused flows to be as low as 2 cfs during the sample period and beaver dams were further retarding flows. Low inflows also caused water temperatures to begin warming earlier than normal.

Water temperatures fluctuated between 16 and 18°C during the spring sample period. Nets caught only seven fish weighing a total of 6.8 pounds. These included chain pickerel, spotted suckers, bowfin and yellow bullhead. The low water levels and beaver dams may have temporarily restricted the movement of fishes in the stream. Examination of gonads indicated that bowfin, spotted suckers and chain pickerel had completed spawning or were still in the process. The yellow bullheads were in early stages of gonad maturation.

Table GC-5. Fishes Collected from Whitewater Creek with Relative Abundance Values

Species		R.A. VALUE
Centrarchus macropterus	Flier	12.0
Lepomis gulosus	Warmouth	12.0
Aphredoderus sayanus	Pirate perch	10.0
Elassoma zonatum	Banded pygmy sunfish	9.0
Esox americanus	Grass pickerel	9.0
Lepomis megalotis	Longear	9.0
Minytrema melanops	Spotted sucker	9.0
Etheostoma gracile	Slough darter	9.0
Etheostoma proeliare	Cypress darter	9.0
Gambusia affinis	Mosquitofish	9.0
Fundulus olivaceus	Blackspotted topminnow	7.5
Notropis umbratilis	Redfin shiner	6.0
Erimyzon oblongus	Creek chubsucker	6.0
Lepomis cyanellus	Green sunfish	6.0
Lepomis punctatus	Spotted sunfish	5.0
Lepomis macrochirus	Bluegill	4.0
Fundulus notatus	Blackstripe topminnow	4.0
Etheostoma whipplei	Redfin darter	4.0
Lepomis symmetricus	Bantam sunfish	3.0
Amia calva	Bowfin	3.0
Etheostoma chlorosomum	Bluntnose darter	1.0
*Etheostoma collettei	Creole darter	1.0
Micropterus salmoides	Largemouth bass	1.0
Ictalurus natalis	Yellow bullhead	1.0
Esox niger	Chain pickerel	S

* - Sensitive species
S - collected in spring sample only

Table GC-6. Summary of Fish Population Parameters from Whitewater Creek

Total Species Collected	25.0
Total Number of Individuals	419.0
Total Relative Abundance Value	149.5
Relative Abundance Diversity Index	4.33

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	1.0	4.0
CATOSTOMIDAE	2.0	10.0
ICTALURIDAE	1.0	0.7
CENTRARCHIDAE	9.0	40.8
PERCIDAE	5.0	16.1
Macroinvertebrate Feeders	21.0	91.3
Carnivores	4.0	8.7
Sensitive Species	1.0	0.7

BIG CREEK

Big Creek begins in southwest Jefferson County and flows south into Cleveland County. The sample site for Big Creek was located at the Highway 133 bridge in Section 37, R 10 W, T 8 S (Figure GC-4).

General Site Discussion

Watershed Size - The watershed size of Big Creek above the highway bridge is 59 mi^2.

Geology - Surface geology in the Big Creek watershed is composed predominantly of deposits of the Jackson group of the Eocene period. The immediate streambed and floodplain are composed of recent alluvium deposits.

Topography - Topography within the Big Creek watershed is generally level to gently rolling sand hills with broad streamside wetland areas directly adjacent to the creek.

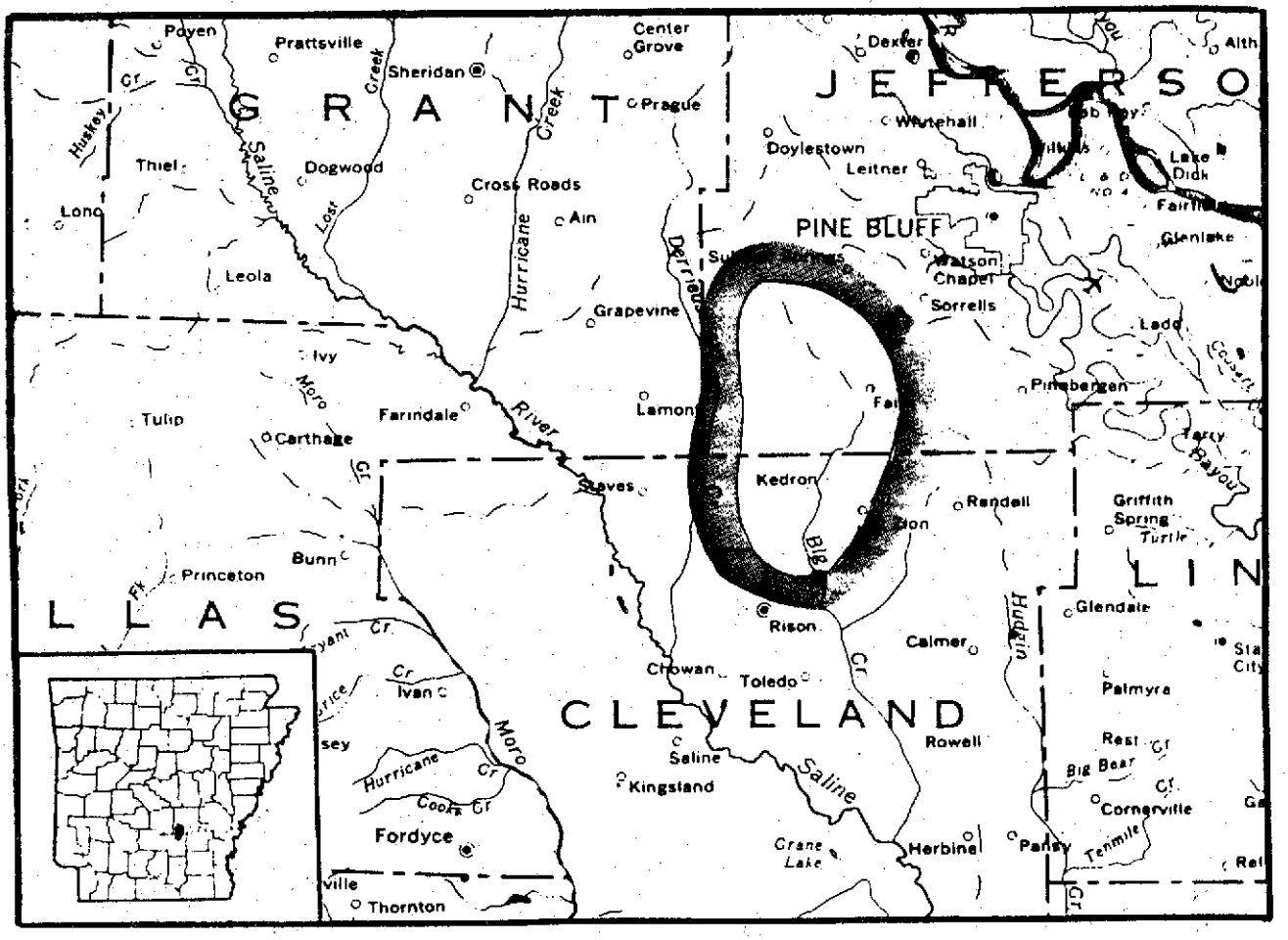
Soil Types - Soil types within the upper drainage of Big Creek are predominantly the Pheba-Savannah-Amy association. This association is composed of poorly drained to moderately well-drained, level to gently sloping, loamy soils on uplands and stream terraces. The lower portion of the watershed beginning at the Jefferson-Cleveland County line, is predominantly the Tippah-Pheba-Boswell association. This association is composed of nearly level to moderately steep, moderately well-drained and somewhat poorly drained soils that have a loamy or clayey subsoil on uplands. The immediate floodplain of Big Creek consists of the Wehadkee-Ochlockonee-Collins association. This association is nearly level, poorly drained to well-drained, frequently flooded soils on bottomlands.

Flora - Loblolly pine and sweetgum trees dominate the forest in the upland areas of the basin. The lower overflow wetland areas are dominated by oak, hickory, beech and cypress trees.

Land Use - Land use within the watershed is 88% forest and 12% agriculture, according to the Soil Conservation Service. The predominant agricultural use is pastureland. The Big Creek watershed has a very low level of man-induced disturbance and is, therefore, a good site to measure least-impaired conditions for the Gulf Coastal Region.

Stream Characteristics - The 1983 USGS stream flow map shows Big Creek to have a Q_{7-10} of zero. This is typical of most Gulf Coastal streams in late summer. These streams quit flowing and develop a series of enduring pools.

Figure GC-4



BIG CREEK: Drainage area 59 square miles ■ Survey site ▓ Survey area

During the survey, Big Creek was in this enduring pool stage. Significant physical characteristics include the deeply cut, meandering stream channel, sandy substrate, low stream gradient, high percentage of instream cover (brush, logs and debris) and high percentage of stream canopy.

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 4, 1986; the spring survey was conducted during the week of March 31, 1986.

Continuous Dissolved Oxygen

Summer - The continuously recording meter was set up at approximately noon on August 4, 1986, 75 yards downstream of the Highway 133 bridge. This sample site was an enduring pool with no obvious flow entering or leaving. Depth at the sampling location was approximately 24 inches, with the probe monitoring the dissolved oxygen and temperature at mid-depth or approximately 12 inches. The meter was checked and calibrated daily. The average D.O. at this site was 1.3 mg/l with a maximum of 2.2 mg/l and a minimum of 0.5 mg/l. The D.O. percent saturation ranged from 10-20% during the sample period (Figure GC-5).

Spring - On March 31, 1986, at approximately 11 a.m., two continuously recording meters were set up to monitor the dissolved oxygen and temperature during the week. Site #1 was located approximately 75 yards downstream of the Highway 133 bridge in a large pool. The depth of the stream was 3 feet and the probe was placed at mid-depth. This meter functioned properly until 1500 hours the second day. Figure GC-6 displays the results of this location. The average D.O. was 5.1 mg/l with a maximum of 6.0 mg/l and a minimum of 3.8 mg/l. The percent saturation ranged from 40-50%. Site #2 was located approximately 100 yards upstream of the Highway 133 bridge and off the main stream in a side channel. This side channel was only about one foot deep. Figure GC-7 displays the results of this location. The average D.O. was 3.4 mg/l with a maximum of 4.6 mg/l and a minimum of 2.4 mg/l. The percent saturation ranged from 30-40%.

This sampling was conducted during what were probably atypical spring conditions. Flow conditions were much lower than normal due to a very dry spring. Flow was measured at 0.5 cfs. This lack of rainfall was apparently causing the stream to approach the enduring pool stage of critical summer conditions, but with cooler water temperatures. These D.O. values are considered lower than normal spring conditions.

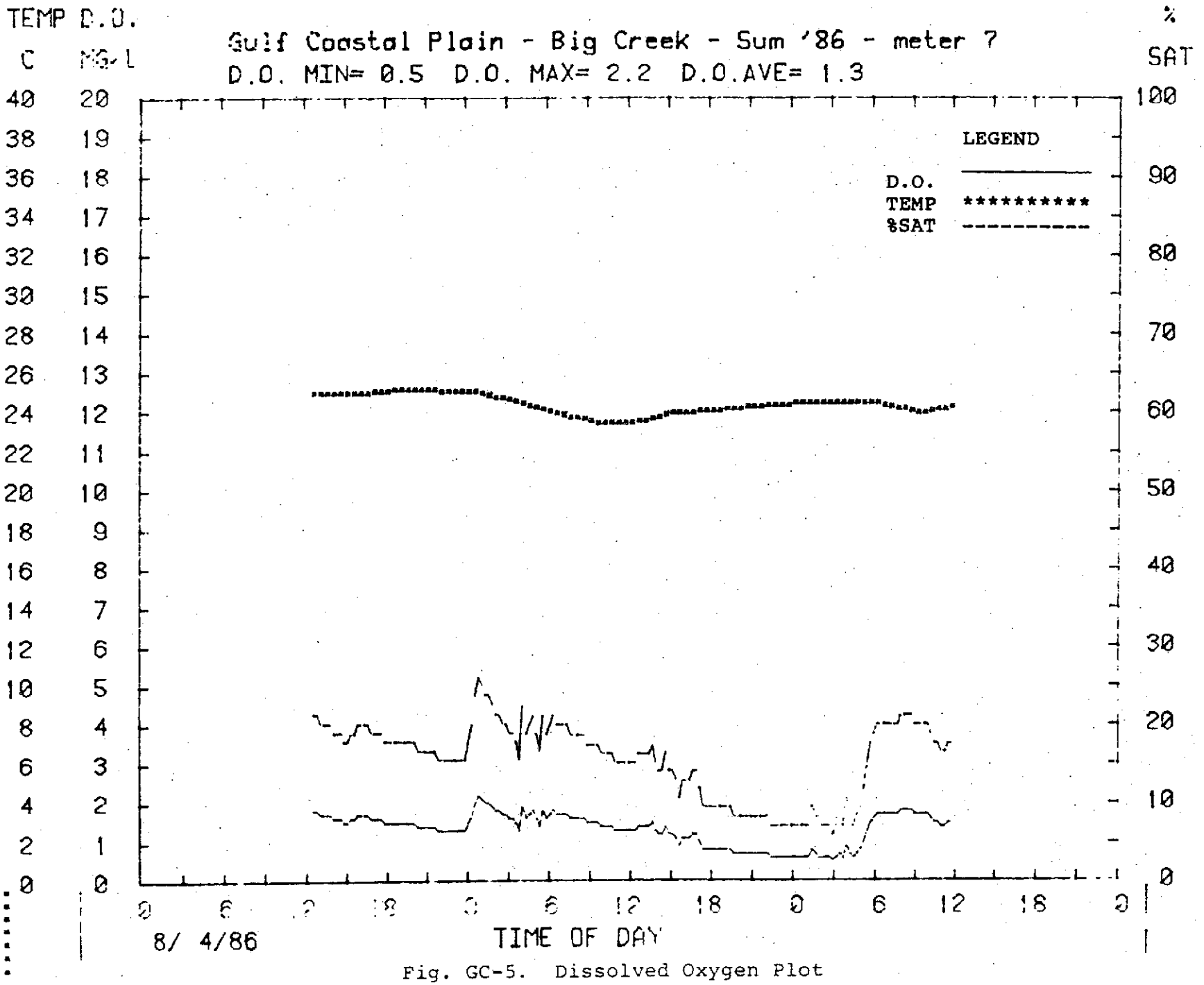


Fig. GC-5. Dissolved Oxygen Plot

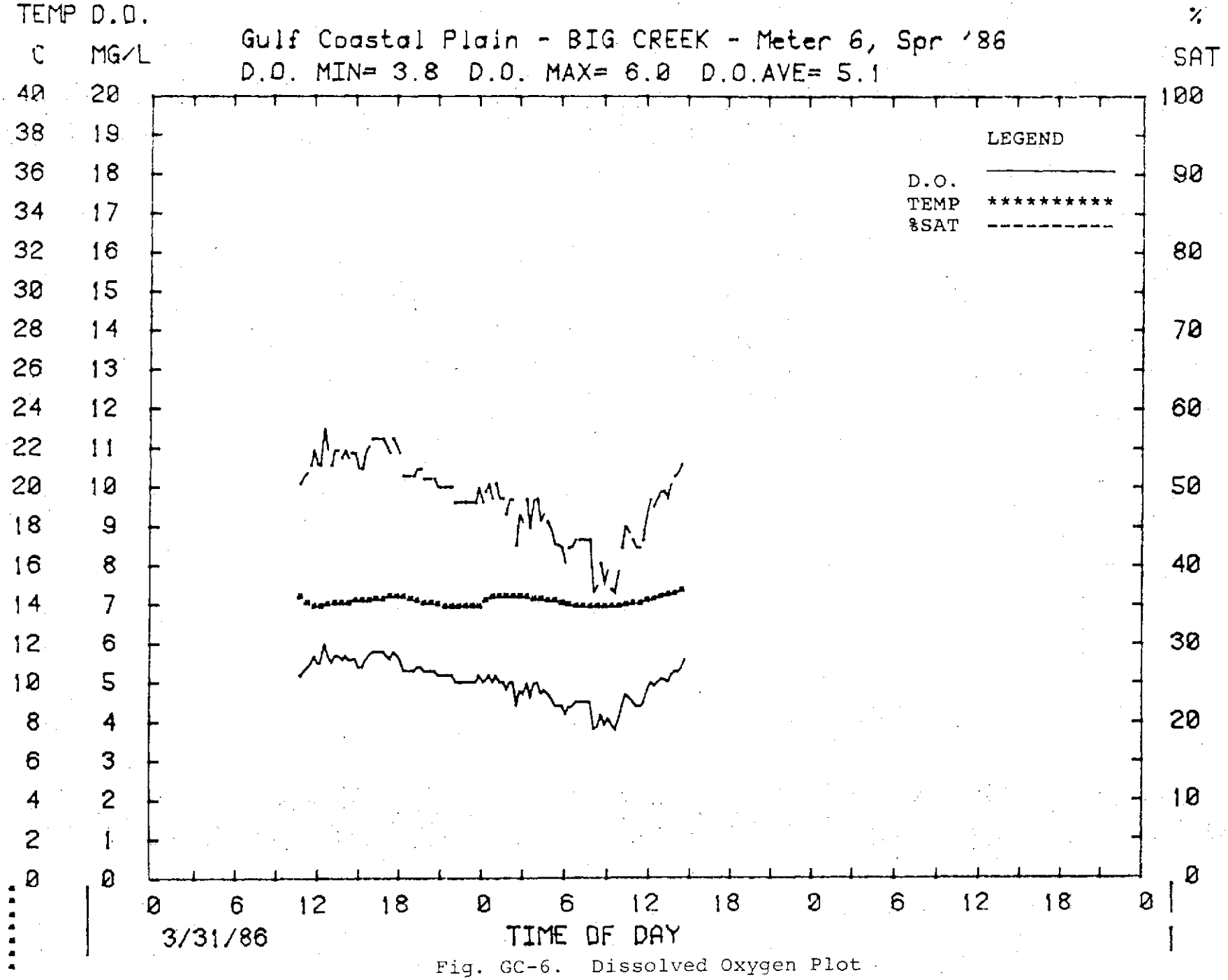


Fig. GC-6. Dissolved Oxygen Plot

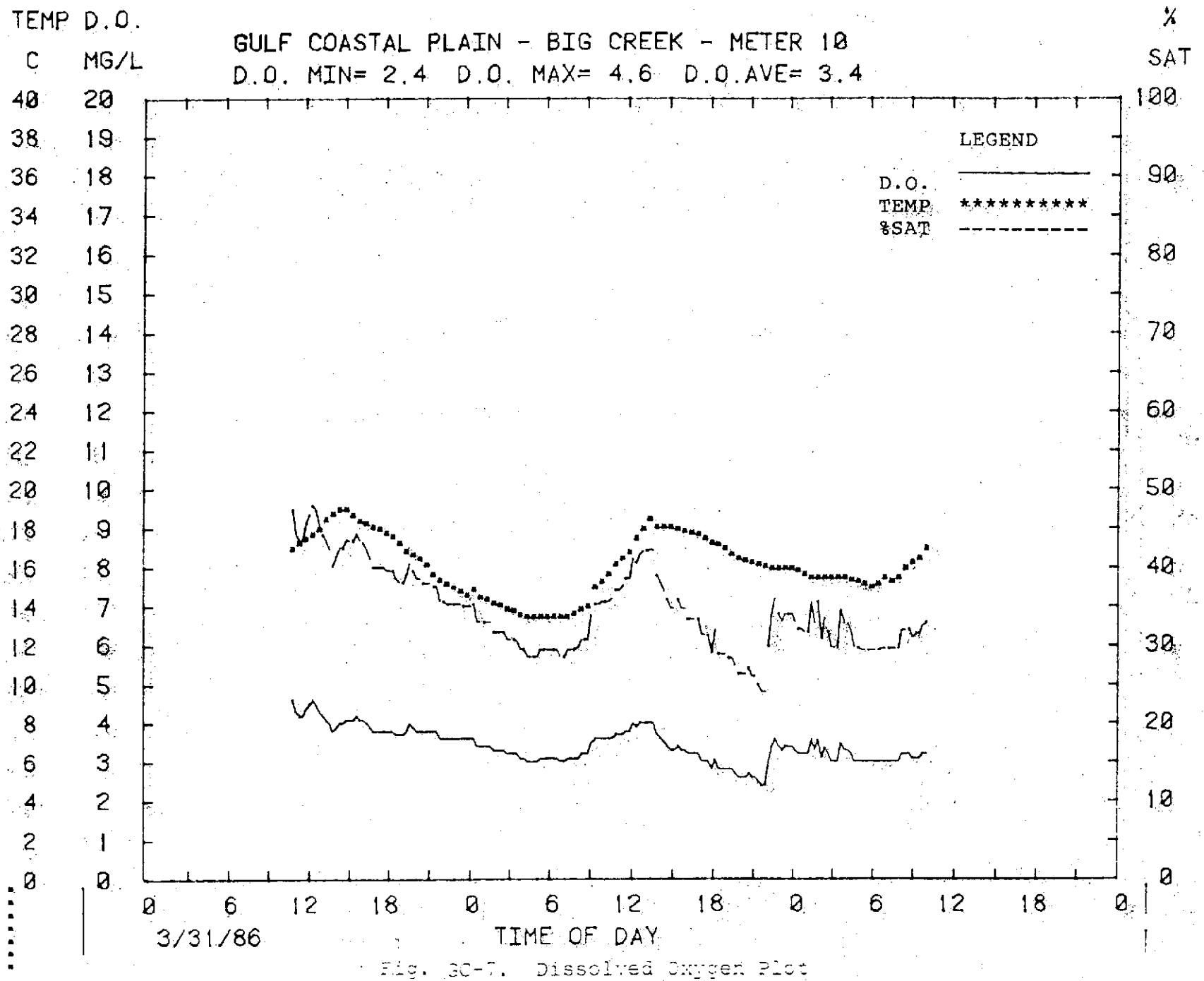


Fig. 3C-7. Dissolved Oxygen Plot

Chemical Parameters

Summer - Chemical data collected during the summer sampling period on August 6, 1986, are displayed in Table GC-7. The BOD_5 and BOD_{20} were 2.6 mg/l and 5.0 mg/l, respectively, indicating some biological activity occurring within the water column. Although the nutrient measurements were extremely low, the lentic condition of the stream enhanced phytoplankton growths as evidenced by the 9.6 μg/l of chlorophyll a measured. Mineral quality analyses from Big Creek reveal very low levels of sulfates (14.6 mg/l), chlorides (3 mg/l) and total dissolved solids (62 mg/l). Alkalinity and hardness measurements indicate that Big Creek has very "soft" water with very little buffering capacity. The characteristic dark brown water of the Gulf Coastal Region was also evident at this site. This water coloration is thought to be related to the specific soil types within the watershed and the leaching of tannins, lignins and perhaps iron from the leaf litter and soils. The test for fecal coliforms reveals only 24 colonies per 100 ml of water, well within the standard for primary contact.

Spring - The spring samples were collected on April 1, 1986. Results are shown in Table GC-8. Water quality measured during the spring sampling period was only slightly different from the summer period. Even though the stream was actually flowing at 0.5 cfs, a "normal" condition would be much greater flow. Chemical parameters measured showed very little change from the summer analysis.

Physical Parameters

Physical evaluations were made during the week of August 6, 1985. Big Creek had reached a routine critical condition for the annual cycle. The stream had stopped flowing, forming standing water within the immediate streambed. Most of the secondary channels and sloughs off the main stream had already dried up. Table GC-9 displays the results of the physical evaluations on Big Creek. Many of these physical parameters can affect not only the use of the stream but the chemical characteristics as well. Characteristics which were common, not only to Big Creek, but also the region are: low stream gradient, high percentage of instream cover (brush, logs and debris) and moderate canopy covering the stream.

Macroinvertebrate Populations

Sixty-four (64) taxa representing 17 orders were identified from the combined summer and spring benthic samples (Table A-6, Appendix A). Numerically, the dominant orders, Coleoptera, Decapoda and Amphipoda comprised 19%, 16% and 16% of the sample, respectively. The dominant taxa were Palaemonetes kadiakensis (14%) and Gammarus fasciatus (12%). Taxonomically, Coleoptera and Odonata dominated the combined sample with 15 and 10 taxa, respectively. Other taxa, not numerically dominant but considered as ecologically characteristic of small least-disturbed Gulf Coastal streams, include Crangonyx gracilis, Peltodytes and Sialis.

Table GC-7

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Big Creek

Drainage Area: 59 square miles

Station Description: Hwy. 133 bridge Sec. 37, T 8 S, R 10 W

Date: August 6, 1986

PARAMETER	TIME COLLECTED 10:00	11:00	12:00	AVERAGE
Q, cfs	---	---	---	No Flow
Temperature, °C	24.2	24.2	24.2	24.2
pH	6.60	6.55	6.60	6.6
Turbidity, ntu	27	26	26	26
TSS, mg/l	14	11	13	13
TDS, mg/l	60	66	61	62.3
BOD-5, mg/l	2.5	2.1	3.2	2.6
BOD-20, mg/l	5.7	4.2	5.3	5.1
T.Phos., mg/l	0.07	0.06	0.07	0.07
PO4-P, mg/l	0.03	0.03	0.03	0.03
NO2+NO3-N, mg/l	0.02	0.02	0.02	0.02
NH3-N, mg/l	0.03	0.03	0.03	0.03
Cl -, mg/l	3	3.5	3	3.0
SO4 =, mg/l	12	14	18	15
Fe, mg/l	---	---	---	
Conductivity μmho	59	60	56.7	59
Alkalinity, mg/l	15	19	15	16
T. Hardness, mg/l	24	24.2	24	24
Chlorophyll a, μg/l	3.2	4.2	21.4	9.6
Fecal Coliform	---	---	24	24

Dissolved Oxygen Data for August 6, 1986		
	pool	
Average	2.3	
Minimum	3.9	
Maximum	1.0	

Table GC-8

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Big Creek

Drainage Area: 59 square miles

Station Description: Hwy. 133 bridge, Section 32, T 8 S, R 10 W, Cleveland County

Date: April 1, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	08:45	09:40	10:30	
Q, cfs	0.5	0.5	0.5	0.5
Temperature, °C	15.5	16.0	16.0	16.0
pH	6.15	6.19	6.06	6.1
Turbidity, ntu	12	13	11	12
TSS, mg/l	22	22	20	21
TDS, mg/l	111	120	116	116
BOD-5, mg/l	1.7	1.6	1.8	1.7
BOD-20, mg/l	5.1	4.8	4.8	4.9
T.Phos., mg/l	0.09	0.07	0.08	0.08
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	0.01	0.01	0.01	0.01
NH3-N, mg/l	0.03	0.02	0.01	0.02
Cl -, mg/l	9	9	9.5	9
SO4 =, mg/l	32	33	33	33
Fe, mg/l	2.4	2.5	2.4	2.4*
Conductivity,µmho	117	116	117	117
Alkalinity, mg/l	8	8	7	8
T. Hardness, mg/l	30	28	32	30
Chlorophyll a,µg/l	-	-	18.8	18.8*
Fecal Coliform	-	-	348	348*

Dissolved Oxygen Data for 1 Apr 1986		
	Meter 10	Meter 6**
Average	3.3	5.1
Minimum	2.4	3.8
Maximum	4.0	6.0

*These data were collected 27 May 1986.
**Meter 6 data is composite data for 31 Mar and 1 Apr.

Table GC-9

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Big Creek
Date:	8/6/85
Drainage Area:	59 Square Miles
Watershed Land Use:	12% Agriculture 88% Forest
Stream Gradient:	2.7 fpm
Mean Channel Width:	40 feet
Mean Stream Width:	6.4 feet (4 of 5 transects dry)
Mean Stream Velocity:	No Flow
Observed Flow:	No Flow
Average Substrate Type:	100% Sand
Mean Instream Cover:	13% Undercut Bank 16% Brush, Logs, Debris
Riffle/Pool Ratio of Transects:	100% Shallow Pool
Mean Bank Overstory Cover:	100% Trees 39% Shrubs
Mean Bank Ground Cover:	34% Grass and Forbs 64% Dirt
Mean Bank Stability:	90% Moderate 10% Unstable
Mean Stream Canopy:	100% Canopy
Comments:	

The summer vs. spring comparison of the benthic communities indicated their assemblages were more similar than dissimilar. The differences were directly associated with seasonal variation which is characteristic of invertebrate populations. Of the 64 taxa identified from the two samples, 43 and 52 taxa were identified from the summer and spring samples, respectively. Thirty-one (31) taxa identified from both samples accounted for 82% of all organisms collected. The 12 and 21 taxa unique to the summer and spring samples comprised only 10.6 and 24.6% of their respective samples.

Summer - The dominant orders of the summer samples were Decapoda (26%), Coleoptera (21%) and Amphipoda (10%). The dominant taxa included Palaemonetes kadiakensis (24%), Uvarus (9%), Lirceus hoppinae (8%), Gammarus fasciatus (7.2%) and Caenis (5.1%). Other taxa, not numerically dominant but ecologically characteristic, include Peltodytes, Neurocordulia and Sialis.

Spring - The dominant orders of the spring sample were Amphipoda (22%), Coleoptera (18.6%) and Isopoda (9.7%). The dominant taxa of the spring sample included Gammarus fasciatus (15%), Asellus dentadactylus, Caenis and Strophopteryx (6%) and Palaemonetes kadiakensis and Uvarus (5%). Four of the five dominant summer taxa were also dominant taxa of the spring sample.

The community parameters were characteristic of a balanced, stable benthic community (Table GC-11). The diversity indices (above 4.0) reflect the variation of habitat types within the stream segment. This was despite zero flow during summer critical conditions and minimum dissolved oxygen values of approximately 1.0 ppm. The majority of insects which were characteristic of this community exhibit wide ranges of tolerance for many water quality parameters. The benthic community of Big Creek demonstrates the ability of insect communities to adapt and flourish in ecosystems with somewhat less than "high quality" water.

Table GC-11. Community Anaylsis of Benthic Samples from Big Creek - 30 minute Qualitative Samples, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	375	458	833
Total # Taxa	43	52	64
Diversity	4.3133	4.7885	4.8561
Index of Evenness	0.5102	0.4732	0.4876
Index of Dominance	0.7949	0.8400	0.8093
Index of Variety	4.9119	5.7698	6.4934
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.65	
Common Taxa Index (range 0-1)		0.60	
Qualitative Similarity Index (range 0-100)		53.0	

Fish Populations

Summer - On August 7, 1985, approximately 250 feet of the stream was treated with 5 pounds of 5% rotenone. Overnight rains had produced a 1 to 3 cfs flow. Prior to that, there was no flow in the stream and water was restricted to small, enduring pools. Five men spent approximately 3 hours dipping fish from the sample area.

Table GC-11 lists the 23 species collected during the summer sample plus one additional species taken the following spring. A total of 338 individuals were collected with a relative abundance value of 135.5 and a diversity index of 4.27. The family Centrarchidae dominated the relative abundance of the fish population (Table GC-12). The flier and banded pygmy sunfish were relatively the most abundant sunfishes, and the pirate perch was numerically the most abundant species. The trophic feeding level of the population was dominated by macroinvertebrate feeders. An atypically large number of golden shiners increased the proportion of primary feeders in the population to 8.1%. Without the golden shiners, which are probably from bait releases or escapes from culture ponds in the watershed, the proportion of primary feeders would be 1.5%. Grass pickerel was the only predator species in the population. Two sensitive species were collected in the summer sample and one additional sensitive species was collected during spring sampling.

Spring - Three trammel nets, two 1½" and one 2" square mesh were set overnight at this site on April 1-2, 1986. Flows in the stream were very low and affected by numerous beaver dams. Flow was measured at 0.5 cfs and the water temperature was 17°C. Nets caught only seven spotted suckers. Electrofishing produced 9 species including one creole darter, a species which was not collected at this site the previous summer.

Gonad examinations indicated that the spotted suckers had completed spawning and that the blackside darters and the creole darter were in the final stage of gonad development prior to spawning. Atypically low springtime flows were probably limiting the use of this stream for fish spawning.

Table GC-11. Fishes Collected from Big Creek with Relative Abundance Values

Species		R.A. VALUE
Aphredoderus sayanus	Pirate perch	12.0
Centrarchus macropterus	Flier	10.0
Elassoma zonatum	Banded pygmy sunfish	9.0
Esox americanus	Grass pickerel	9.0
Etheostoma gracile	Slough darter	9.0
Notemigonus crysoleucas	Golden shiner	9.0

Table GC-11, cont.

Gambusia affinis	Mosquitofish	9.0
Erimyzon oblongus	Creek chubsucker	8.0
Lepomis gulosus	Warmouth	7.0
**Percina maculata*	Blackside darter	7.0
Lepomis cyanellus	Green sunfish	6.5
Notropis chrysocephalus	Striped shiner	6.0
Notropis umbratilis	Redfin shiner	6.0
Fundulus olivaceus	Blackspotted topminnow	6.0
Lepomis macrochirus	Bluegill	5.5
Lepomis megalotis	Longear	5.5
Etheostoma chlorosomum	Bluntnose darter	2.0
Ictalurus natalis	Yellow bullhead	2.0
Etheostoma whipplei	Redfin darter	2.0
Hybognathus nuchalus	Silvery minnow	2.0
Notropis emiliae	Pugnose minnow	1.0
Minytrema melanops	Spotted sucker	1.0
**Percina sciera*	Dusky darter	1.0
**Etheostoma collettei*	Creole darter	S

* - Sensitive species
S - collected in spring sample only

Table GC-12. Summary of Fish Population Parameters from Big Creek

Total Species Collected	24.0
Total Number of Individuals	338.0
Total Relative Abundance Value	135.5
Relative Abundance Diversity Index	4.27

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5.0	17.7
CATOSTOMIDAE	2.0	6.6
ICTALURIDAE	1.0	1.5
CENTRARCHIDAE	6.0	32.1
PERCIDAE	5.0	15.5
Primary Feeders	2.0	8.1
Macroinvertebrate Feeders	21.0	85.3
Carnivores	1.0	6.6
Sensitive Species	3.0	5.9

DERRIEUSSEAUX CREEK

The sample site on Derrieusseaux Creek is located in Cleveland County in Section 5, R 11 W, T 9 S, on a timber-access road south of Highway 35 (Figure GC-8). The creek begins in the southeast corner of Grant County and flows in a southerly direction down the Grant-Jefferson County line into Cleveland County. The sample site on Derrieusseaux is located less than two miles above its confluence with the Saline River.

General Site Discussion

Watershed size - The Derrieusseaux watershed consists of 148 mi^2 above the sample site location.

Geology - Surface geology in the Derrieusseaux Creek drainage is dominated by the Jackson Group deposited in the Eocene era of Tertiary age, while recent alluvium deposits form the present stream flood plain.

Topography - Land form topography is generally level to gently rolling, sand and clay hills with broad, streamside wetland areas directly adjacent to the creek.

Soil Types - The floodplain of Derrieusseaux Creek is dominated by the Wehadkee-Falaya association. These soils are nearly level, poorly drained and somewhat poorly drained and predominantly in bottomlands. They are generally low in natural fertility with slow permeability and medium available water capacity with a poor response to fertilizer. The uplands are dominated by the Tippah-Pheba-Boswell association. These soils are nearly level to moderately steep, moderately well-drained and somewhat poorly drained soils that have a loamy or clayey subsoil. They are moderately acid to very strongly acid.

Flora - The upland areas of this drainage basin are managed for pine. Streamside overflow wetland areas are dominated by oak, hickory, beech and cypress.

Land Use - Land use in the basin, according to the Soil Conservation Service data, is 93% silviculture and 7% agriculture. Agricultural uses are predominantly pastureland. The basin has a low level of man-induced disturbances and represents a least-impaired stream in the Gulf Coastal Region.

Stream Characteristics - Derrieusseaux Creek is typical of the majority of Gulf Coastal streams in that, regardless of the size of the watershed, the stream is in an enduring pool situation during critical conditions in the average water year. The 1983 USGS map shows Derrieusseaux Creek to have a Q_{7-10} of zero. Significant physical characteristics include the deeply cut, sandy stream banks, sandy substrate, low

Figure GC- 8


Detonti
Hensley
Tull
Ico
Redfield
Camp
Wright
Tucker
Belfast
Amber
Jefferson
Horseshoe Lake
Sherrill
Haywood
Pastoria
Samples
Dexter
Prattsville
Sheridan
Prague
Whitehall
Leitner
Dogwood
Cross Roads
Leola
Sulphur Springs
Watson Chapel
Sorrells
Ivy
Ferndale
Faith
Carthage
Kingston
Randall
Griffith Spring
Mt Zion
Bunn
Princeton
Rison
Glendale
Calmer
Crowan
Toledo
Palmyra
Rowell
Saline
Kingsland
Cornerville
GRANT
JEFFERS
PINE BLUFF
CLEVELAND
LI
Simpson Creek
Saline River
Hurricane Creek
Moro River
Big Bear Cr
Turtle Cr
Lake Dick
Scale 1:500,000
1 inch equals approximately 8 miles
10 0 10 20 30 40 Miles
10 0 10 20 30 40 50 Kilometers
DERRIEUSSEAUX CREEK: Drainage area 148 Square miles
Survey site
Survey area

stream gradient, high percentage of instream cover (brush, logs, debris) and high percentage of stream canopy.

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 5-9, 1985; the spring survey took place during the week of March 25-29, 1985.

Continuous Dissolved Oxygen

Summer - The survey was initiated shortly after noon on August 5, 1985. Two continuously recording meters were set up within the same enduring pool, only a short distance apart. Since the pool was approximately 10 feet deep, different depths were monitored. Site #1 was set up to monitor mid-depth (approximately 5') and Site #2 was set up to monitor sub-surface. Both meters were operated continuously until after noon on August 8, 1985. Calibration was checked daily on both meters. Results for Site #1 are displayed in Figure GC-9. The average D.O. was 1.8 mg/l with a maximum of 2.3 mg/l and a minimum of 1.4 mg/l. At Site #2 (Figure GC-10), the average D.O. was 1.7 mg/l with a maximum of 3.3 mg/l and a minimum of 0.1 mg/l. Both sites ranged 20-30% saturation.

Spring - On March 26, 1985, two meters were set up to measure the dissolved oxygen and temperature in Derrieusseaux Creek. Unlike the pooled summer conditions, the creek was now flowing. Site #1 was placed in a riffle while Site #2 was placed in a pool. A review of Figures GC-11 and GC-12, which show dissolved oxygen, temperature and percent saturation, reveals little, if any, differences between the two sites. The flow was falling throughout the survey period and was measured to have fallen more than two feet. The spring and summer conditions are distinctly different. The flowing condition found during the spring is the dominant reason for the higher dissolved oxygen concentrations and higher percent saturations. Average dissolved oxygen concentrations during the spring survey were 7.5-7.8 mg/l with very small diurnal fluctuations. The percent saturation of dissolved oxygen during the spring survey averaged about 80%.

Chemical Parameters

Summer - The results of the chemical sampling on Derrieusseaux Creek on August 6, 1985, are displayed in Table GC-13. The BOD_5 and BOD_{20} were 3.3 mg/l and 8.1 mg/l, respectively, indicating some biological activity occurring within the water column. Although the nutrient measurements were extremely low, the lentic condition of the stream enhanced phytoplankton growths, as evidenced by the 14.2 μg/l of chlorophyll a measured. Mineral quality analyses from Derrieusseaux Creek reveal very low levels of sulfates (8 mg/l), chlorides

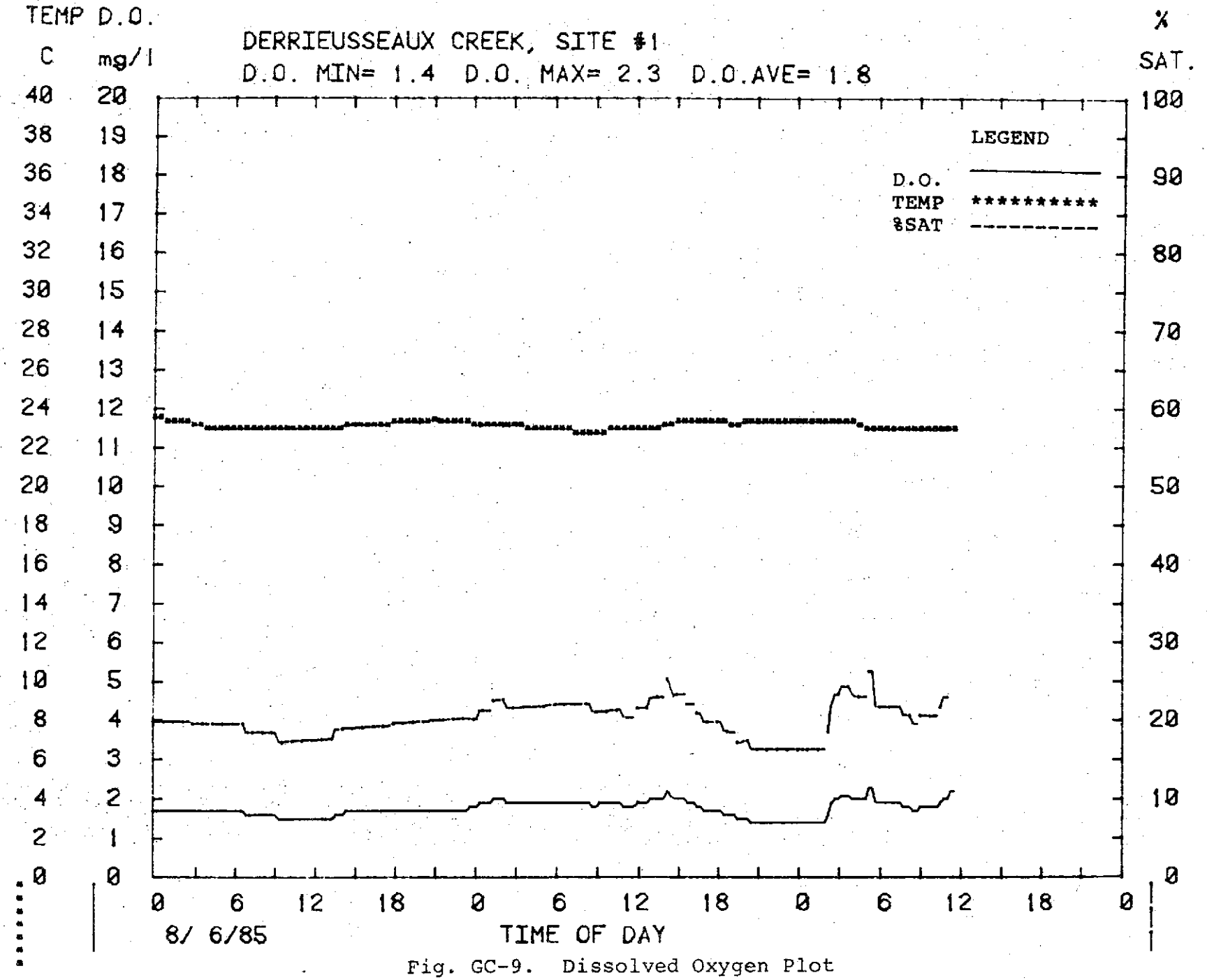


Fig. GC-9. Dissolved Oxygen Plot

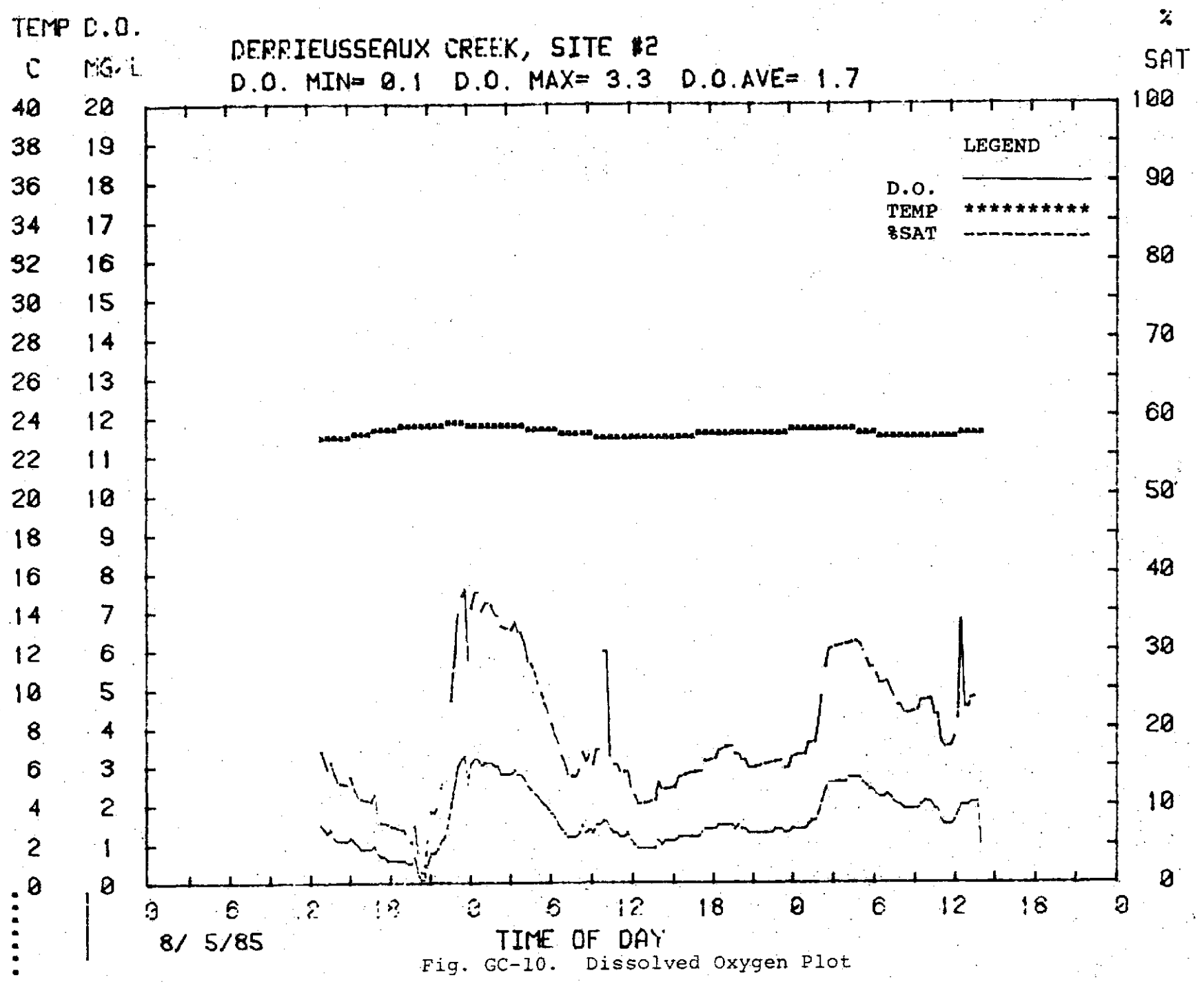


Fig. GC-10. Dissolved Oxygen Plot

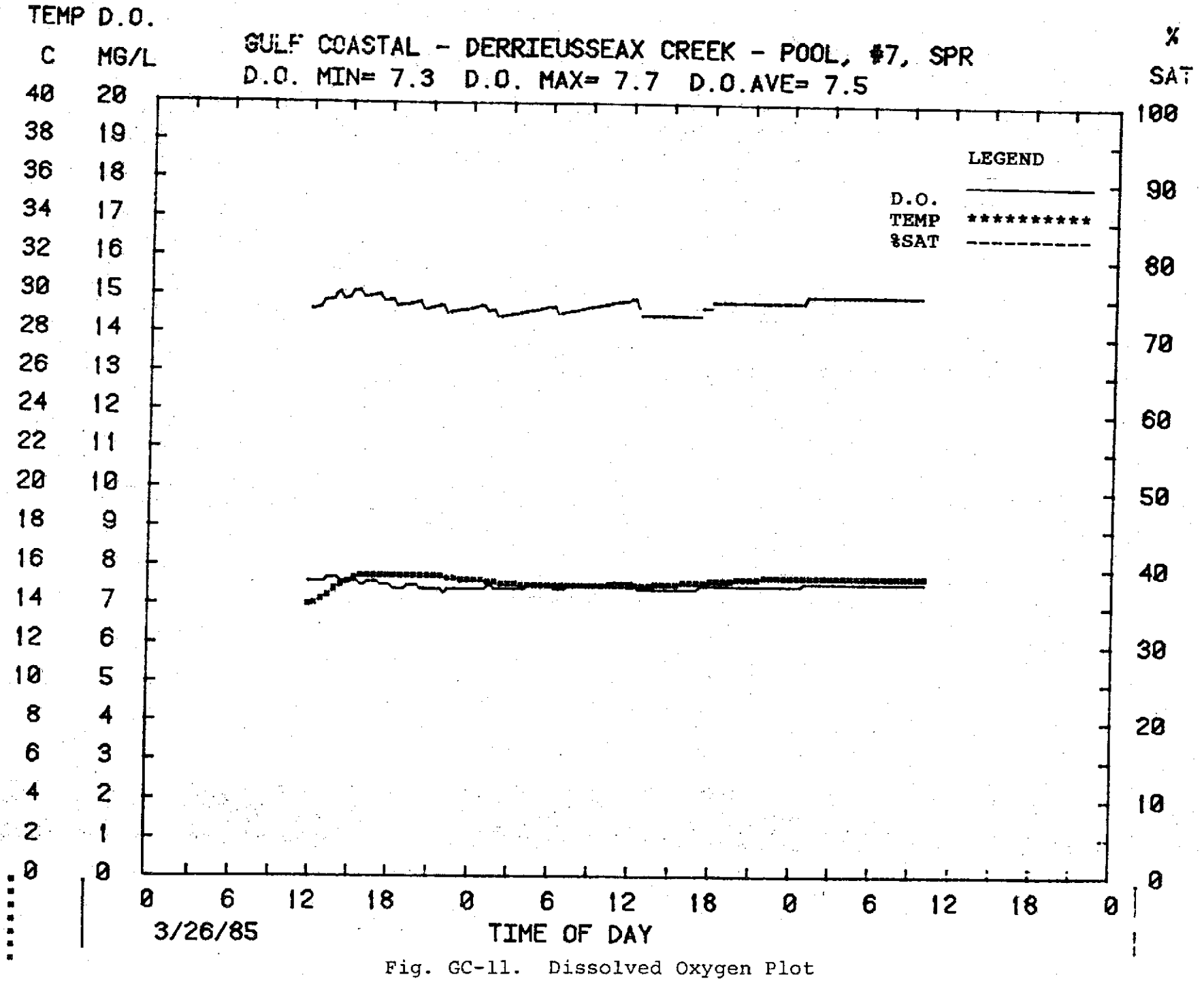


Fig. GC-11. Dissolved Oxygen Plot

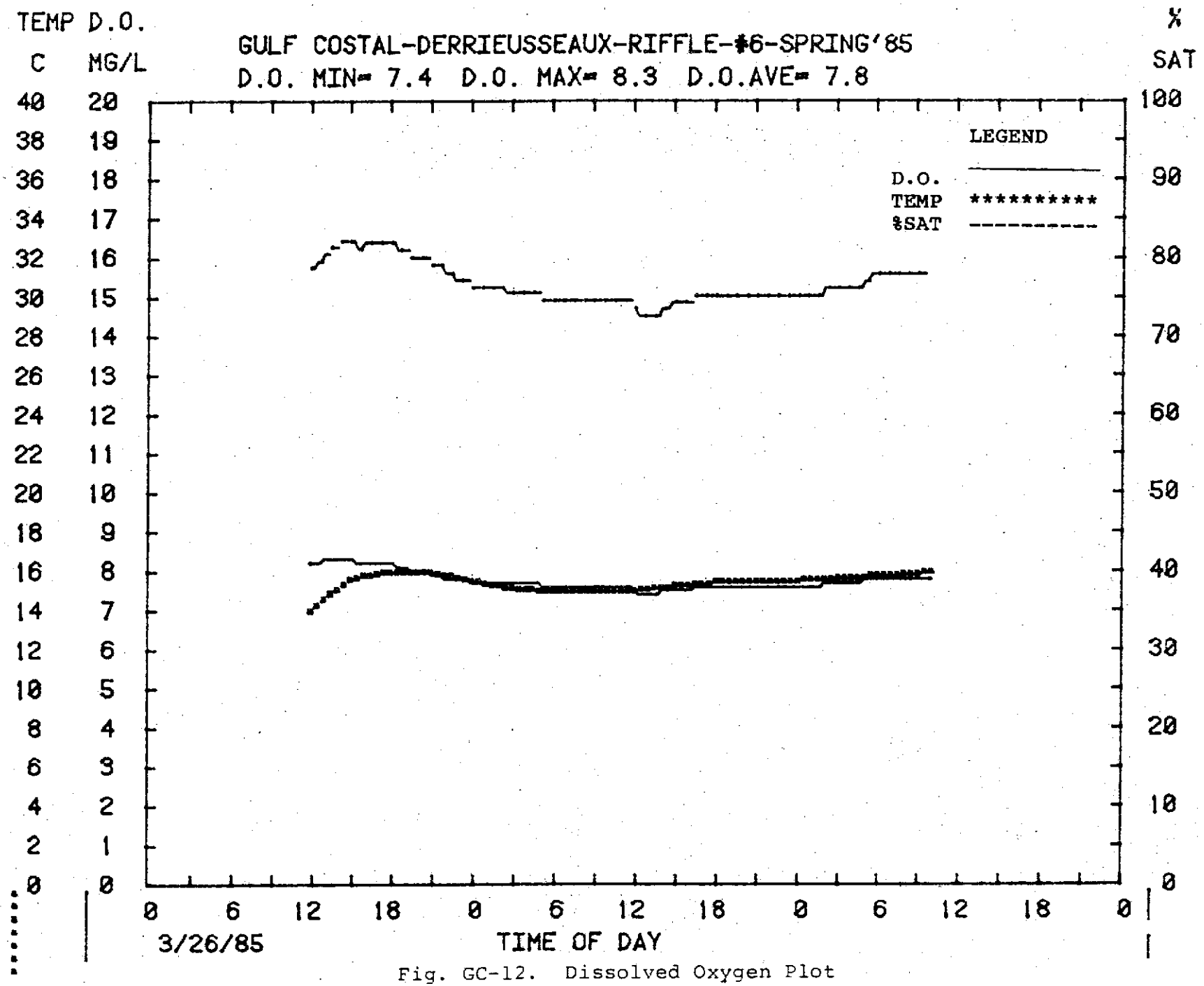


Fig. GC-12. Dissolved Oxygen Plot

Table GC-13

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Derrieusseaux Creek

Drainage Area: 148 Square Miles

Station Description: Timber company road in Section 5, T 9 S, R 11 W

Date: August 6, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:40	10:40	11:45	
Q, cfs	0	0	0	No Flow
Temperature, °C	23	23	23	23
pH	6.7	6.7	6.7	6.7
Turbidity, ntu	7	8	6	7
TSS, mg/l	8	12	10	10
TDS, mg/l	66	64	67	65
BOD-5, mg/l	4.0	3.1	3.0	3.3
BOD-20, mg/l	9.3	7.8	7.2	8.1
T.Phos., mg/l	0.08	0.07	0.07	0.07
PO4-P, mg/l	0.03	0.04	0.03	0.03
NO2+NO3-N, mg/l	0.04	0.04	0.04	0.04
NH3-N, mg/l	0.07	0.06	0.06	0.06
Cl -, mg/l	5	4.5	3.5	4.3
SO4 =, mg/l	9	8	8	8
Fe, mg/l	0.25	0.5	0.2	0.31
Conductivity, μmho	83	83	84	83
Alkalinity, mg/l	-	-	-	-
T. Hardness, mg/l	36	36	42	38
Chlorophyll a, μg/l	18.7	14.6	9.4	14.2
Fecal Coliform	-	-	310	310

Dissolved Oxygen Data for 6 Aug 1985		
	Site 1	Site 2
Average	1.7	1.7
Minimum	1.5	0.9
Maximum	1.8	3.2

(4 mg/l) and total dissolved solids (65 mg/l). The total hardness measurement was 38 mg/l, indicating "soft water." The characteristic dark brown water of the Gulf Coastal Region was also evident at this site. This water coloration is thought to be related to the specific soil types within the watershed and the leaching of tannins, lignins and perhaps iron from the leaf litter and soils. The test for fecal coliform bacteria indicated the presence of 310 colonies per 100 ml of water sampled. Since no known man-induced source of contamination is influencing this isolated pool on Derrieusseaux Creek, it is assumed that natural bacteria levels can at times exceed the primary contact standard.

Spring - The results of spring samples collected on March 27, 1985 are shown in Table GC-14. Water quality measured during the spring sampling was significantly different in some respects from the summer sample. Most significant was the volume of water or flow available. The stream was now actually a flowing stream instead of a series of enduring pools. This flow is felt to be the dominant reason for the observed changes. The pH was measured to be 5.8, again characteristic of the acidic soils found within the Gulf Coastal Region. BOD, both 5-day and 20-day, were approximately one-half the concentrations found during summer conditions. Chlorophyll a concentrations dropped to only trace amounts in the spring survey. Nutrient levels were extremely low and showed no significant change from the summer survey. Mineral concentrations were not significantly different with the exception of sulfates, which revealed slight increases with the higher flows. Fecal coliform bacteria concentrations were substantially lower during the spring survey compared to the summer concentrations, indicating little relationship to point or nonpoint pollution sources. Turbidity measurements were approximately three times higher than the summer measurements.

Physical Parameters

Physical evaluations were made during the week of August 6, 1985. Derrieusseaux Creek had reached a routine critical condition for the annual cycle. The stream had stopped flowing and the only water was found in the deeper enduring pools located in the streambed. All measurements were, by necessity, confined to these existing, pooled conditions. The immediate floodplains of these Gulf Coastal streams are typically very wide with numerous channels at higher flow conditions. Table GC-15 displays the results of the physical evaluation on Derrieusseaux Creek. Land use, topography, soil type, canopy and geology have been mentioned as directly affecting many of the chemical characteristics of the stream. Other characteristics of Derrieusseaux Creek which are also common to the region are sand banks, predominantly sand

Table GC-14

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Derrieusseaux Creek

Drainage Area: 148 Square Miles

Station Description: at end of tar road, NE 1/4, NE 1/4, Section 8, T 9 S, R 11 W, - Cleveland County

Date: March 27, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	12:15	12:45	13:15	
Q, cfs	-	-	-	not taken
Temperature, °C	15	15	15	15
pH	6.0	5.5	5.8	5.8
Turbidity, ntu	30	24	25	26
TSS, mg/l	20	20	18	19
TDS, mg/l	70	71	67	69
BOD-5, mg/l	1.2	1.2	1.2	1.2
BOD-20, mg/l	3.2	3.2	3.2	3.2
T.Phos., mg/l	0.05	0.06	0.05	0.05
PO4-P, mg/l	0.04	0.04	0.04	0.04
NO2+NO3-N, mg/l	0.06	0.06	0.06	0.06
NH3-N, mg/l	0.03	0.03	0.03	0.03
Cl -, mg/l	3	3	5	4
SO4 =, mg/l	12	11	12	12
Fe -,mg/l	0.72	0.70	0.73	0.72
Conductivity,µmho	44	44	43	44
Alkallnity, mg/l	4	6	5	5
T. Hardness, mg/l	12	12	14	13
Chlorophyll a,µg/l	0.6	1.1	0.0	0.6
Fecal Coliform	-	-	80	80

Dissolved Oxygen Data for 27 Mar 1985		
	Pool	Riffle
Average	7.5	7.6
Minimum	7.4	7.4
Maximum	7.6	7.7

Table GC-15

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Derrieuseaux Creek
Date:	8/6/85
Drainage Area:	148 square miles
Watershed Land Use:	7% Agriculture 93% Forest
Stream Gradient:	3.4 fpm
Mean Channel Width:	50 feet
Mean Stream Width:	12 feet
Mean Stream Velocity:	NA
Observed Flow:	No Flow
Average Substrate Type:	4% Gravel 74% Sand 22% Mud/Silt
Mean Instream Cover:	2% Undercut Bank 41% Brush, Logs, Debris
Riffle/Pool Ratio of Transects:	60% Riffle 20% Deep Pool 20% Shallow Pool
Mean Bank Overstory Cover:	9% Trees 17% Shrubs
Mean Bank Ground Cover:	35% Grass and Forbes 65% Dirt
Mean Bank Stability:	30% Stable 40% Moderate 30% Unstable
Mean Stream Canopy:	88% Canopy
Comments:	

substrate, low stream gradient, and a high percentage of instream fishery cover (brush, logs, debris).

Due to the difficulty of making any physical measurements during the higher flows of spring, none were made.

Macroinvertebrate Populations

Eighty (80) taxa representing 18 orders were identified from the summer-spring benthic samples collected from Derrieusseaux Creek. The dominant orders, Coleoptera, Decapoda, Ephemeroptera, Isopoda and Hemiptera comprised 22.9%, 18.1%, 9.2%, 8.1% and 8.0% of the sample, respectively. The dominant taxa were Palaemonetes kadiakensis (15.0%), Lirceus hoppinae (8.1%), Uvarus (7.9%), Caenis (7.7%) and Sialis (7.3%). Other taxa considered as ecologically characteristic but not collected in significant numbers include Chauloides, Gammarus minus, and Peltodytes lengi (Table A-7, Appendix A). The qualitative comparative indices indicated some repetition of taxa between the samples (Table GC-16). Of the 80 taxa identified from the two samples, 29 were identified in both and these accounted for 75% of all organisms collected. There were 34 and 17 taxa unique to the summer and spring samples, comprising 33% and 16% of those samples, respectively. This reflects the natural seasonal variation of insect populations.

Summer - The dominant orders of the summer sample were Coleoptera (26.0%), Megaloptera (14.1%), Diptera (11.8%), Hemiptera (10.8%) and Ephemeroptera (8.8%). The dominant taxa of the summer benthic community were Sialis (14.1%), Celina (12.0%), Hespacorixia (6.8%), Caenis (6.5%) and Musculuim (6.1%)

Spring - The dominant orders of the spring sample were Decapoda (30.3%), Coleoptera (20.0%), Isopoda (14.0%), Ephemeroptera (9.5%) and Amphipoda (9.4%). The dominant taxa were Palaemonetes kadiakensis (25.4%), Lirceus hoppinae (14.0%), Uvarus (11.7%), Gammarus minus (8.9%) and Caenis (8.8%) (Table A-7, Appendix A). Although not in the same order of abundance, the summer and spring samples were dominated by 3 of the same orders, but only had one of the top 5 dominant taxa in common.

The community parameters of the combined samples indicate that the good water quality and the availability of diverse microhabitats has resulted in a healthy, well-balanced macroinvertebrate community. This was confirmed by the percentage distributions among the functional groups of insects and reflected the stability of the benthic community.

Table GC-16. Community Analysis of Benthic Samples from Derrieusseaux Creek - 30 Min. Qualitative Sample, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	801	1584	2385
Total # Taxa	63	46	80
Diversity	4.6516	3.5343	4.6401
Index of Evenness	0.8121	0.6398	0.7339
Index of Dominance	0.4458	0.6295	0.5108
Index of Variety	5.6015	4.6732	7.4234
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.61
Common Taxa Index (range 0-1)			0.46
Qualitative Similarity Index (range 0-100)			33.0

Fish Populations

Summer - The stream at this site contained only isolated pools with no surface flows between them. The area sampled was a large deep pool approximately 150 feet long and 30 feet wide with a maximum depth of about 10 feet. Additionally, a small, shallow, gravel-bottomed pool (40' X 5' X 6") upstream of the larger pool was sampled. Both areas were treated with 5% rotenone on August 7, 1985, and workers spent about 18 man-hours picking up fish from the sample area.

A total of 36 species of fish were collected from the area (Table GC-17). This included 760 individuals with a relative abundance value of 224 and a diversity index of 4.97. Centrarchidae was the dominant family and included nine species and one hybrid (Table GC-18). Six species of Percidae made up 14.5% of the population relative abundance. Many of these came from the small shallow gravel-bottom pool which had no carnivorous fish species. Macroinvertebrate feeding fishes comprised 79.9% of the population. Primary feeders and carnivores made up about equal portions of the remainder of the population. Only four sensitive species were collected, which totalled 7.8% of the population relative abundance.

Spring - Spring sampling at this site was done on March 26-27, 1985. Three 100-foot length trammel nets with square mesh size of 1½", 2" and 3½" were fished overnight. The streamflow was approximately 200 cfs and water temperature was 15°C. Only seven fishes with a total weight of 10.5 pounds were

caught. Examination of the gonads of the captured fish indicated that bowfin had completed spawning, spotted suckers had partially completed spawning with some spawning in progress, and blacktail redhorse were in the early stages of spawning.

Table GC-17. Fishes Collected from Derrieusseaux Creek with Relative Abundance Values

Species		R.A. VALUE
Lepomis gulosus	Warmouth	12.0
Centrarchus macropterus	Flier	12.0
Ictalurus natalis	Yellow bullhead	12.0
Minytrema melanops	Spotted sucker	11.0
Lepomis megalotis	Longear	10.5
Etheostoma gracile	Slough darter	10.0
Aphredoderus sayanus	Pirate perch	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
Notropis umbratilis	Redfin shiner	9.0
Esox americanus	Grass pickerel	9.0
Notemigonus crysoleucas	Golden shiner	8.0
Lepomis macrochirus	Bluegill	7.5
Hybognathus nuchalus	Silvery minnow	7.0
*Moxostoma poecilurum	Blacktail redhorse	7.0
Gambusia affinis	Mosquitofish	6.5
Amia calva	Bowfin	6.0
Etheostoma chlorosomum	Bluntnose darter	6.0
Hybognathus hayi	Cypress minnow	6.0
Etheostoma whipplei	Redfin darter	6.0
Notropis fumeus	Ribbon shiner	6.0
*Percina maculata	Blackside darter	5.5
Erimyzon oblongus	Creek chubsucker	5.0
Lepomis cyanellus	Green sunfish	5.0
Lepomis punctatus	Spotted sunfish	5.0
Elassoma zonatum	Banded pygmy sunfish	4.0
Micropterus salmoides	Largemouth bass	4.0
Notropis texanus	Weed shiner	4.0
Esox niger	Chain pickerel	4.0
Noturus gyrinus	Tadpole madtom	4.0
*Percina sciera	Dusky darter	4.0
Notropis emiliae	Pugnose minnow	3.0
Labidesthes sicculus	Brook silversides	2.0
Notropis chrysocephalus	Striped shiner	2.0
*Etheostoma collettei	Creole darter	1.0
Pomoxis nigromaculatus	Black crappie	1.0
Lepomis hybrid	Hybrid sunfish	1.0

* - Sensitive species
S - collected in spring sample only

Table GC-18. Summary of Fish Population Parameters from Derrieusseaux Creek

Total Species Collected	36.0
Total Number of Individuals	760.0
Total Relative Abundance Value	224.0
Relative Abundance Diversity Index	4.97

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	8.0	20.1
CATOSTOMIDAE	3.0	10.3
ICTALURIDAE	2.0	7.1
CENTRARCHIDAE	10.0	27.7
PERCIDAE	6.0	14.5
Primary Feeders	3.0	10.7
Macroinvertebrate Feeders	28.0	79.9
Carnivores	5.0	9.4
Sensitive Species	4.0	7.8

BAYOU FREEO

Bayou Freeo begins in the southeast part of Dallas County and flows in a southerly direction into the northeast portion of Ouachita County, continuing a southwesterly flow to its confluence with the Ouachita River. The sample site for Bayou Freeo was located at a TAR road approximately two miles downstream of Highway 9. The specific site location was in the SW ¼, SW ¼ of Section 34, R 16 W, T 11 S (Figure GC-13).

General Site Discussion

Watershed Size - The watershed size of the Bayou Freeo drainage above the sample site is 156 mi^2.

Geology - Surface geology of the Bayou Freeo drainage is basically of three types. The headwater area is predominantly Claiborne Group deposits of Eocene Age, the lower drainage is terrace deposits of Pleistocene age. The immediate streambed and floodplain are composed of alluvium deposits of Quaternary Age.

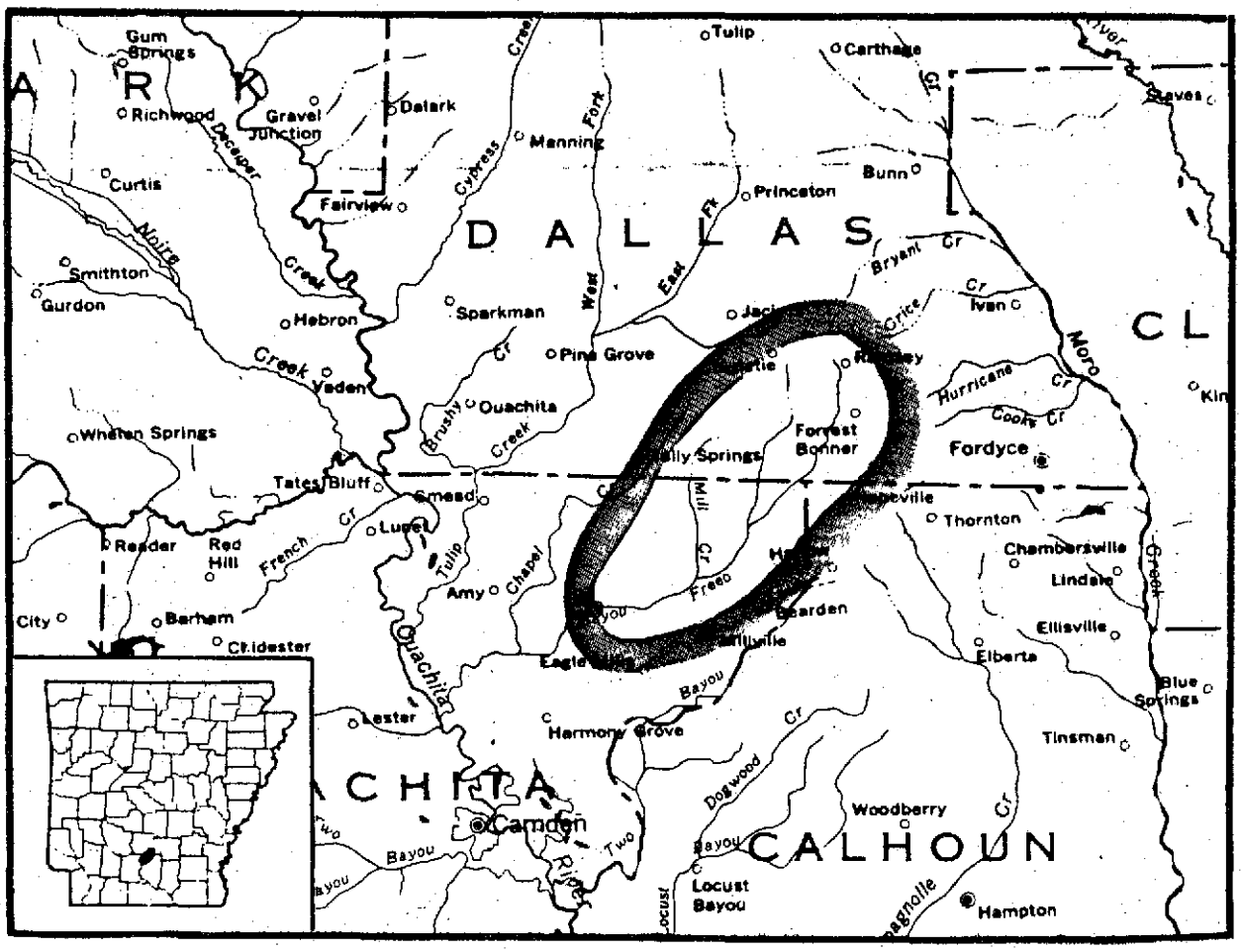
Topography - Topography within the watershed is generally level to gently rolling sand hills with broad streamside wetland areas directly adjacent to the creek.

Soil Types - The extreme fingertips of the headwater area drain a Sacul-Sawyer-Smithdale association, which is a moderately well-drained and well-drained, nearly level to moderately steep, loamy soil on uplands. The majority of the upper watershed drains the Amy-Smithton-Pheba association which is a poorly drained and somewhat poorly drained, level to nearly level, loamy soil on uplands. The mid-section of the watershed from the Ouachita-Dallas County line to the sample site drains a Norfolk-Canaba-Saffell association which is a well-drained, nearly level to moderately sloping, loamy and gravelly soil on gently rolling uplands.

Flora - Loblolly pine, shortleaf pine and sweetgum dominate the forestland in the upland areas of the basin. The lower areas are dominated by oak, hickory, beech and cypress.

Stream Characteristics - The 1983 USGS stream flow map shows Bayou Freeo to have a Q_{7-10} of zero. During the average year, flow normally drops to zero and an enduring pool situation occurs in typical Gulf Coastal streams. Conditions during the survey on Bayou Freeo were typical of this situation. Significant physical characteristics include the deeply cut stream channel with sandy banks, sandy to gravelly substrate, low stream gradient, high percentage of instream fishery cover (brush, logs and debris) and high percentage of stream canopy.

Figure GC-13



1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

FREEO BAYOU: Drainage area 156 square miles ● Survey site ▓ Survey area

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 12-16, 1985; the spring survey was conducted during the week of March 31 - April 4, 1986.

Continuous Dissolved Oxygen

Summer - A continuously recording meter was set to monitor the dissolved oxyen and temperature of Bayou Freeo during this week in August. The meter site was located just slightly upstream of the concrete low water bridge on the first TAR downstream below Highway 9. The meter was checked daily and functioned properly with only minor calibration adjustments. Results of the dissolved oxygen and temperature measurements made during the week are displayed in Figure GC-14. This graph shows a range from 0.9 mg/l to 3.6 mg/l, averaging 1.8 mg/l over the survey period. The graph appears contrary to normal photosynthetic activity. The dissolved oxygen reached a critical minimum about 2100 hours, remaining at that concentration until about midnight. It rapidly increased to a maximum around 0300 hours, remained at this level until 0600 hours then declined until noon, stabilized slightly and gradually declined to the critical 2100 hours again. D.O. saturations ranged from 10-40% during the survey period.

Spring - On March 31, 1986, two meters were set up to measure the dissolved oxygen and temperature in Bayou Freeo. Site #1 was approximately 20 yards upstream of the low water bridge and Site #2 was approximately 50 yards below the low water bridge. Unlike the pooled-up situation of summer, Bayou Freeo was now flowing at 16 cfs. The staff gauge set up for the survey period indicated that the flow was falling slightly during this time. Figures GC-15 and GC-16 display the dissolved oxygen, temperature and percent saturation for both sites during the survey period. Similar results were recorded at both sites. Contrary to the summer season sampling, these results show the effects of increaseed flow and cooler water temperatures. Percent saturations range much higher, averaging near 70%. The actual graphs for dissolved oxygen show a very stable condition, averaging approximately 7 mg/l.

Chemical Parameters

Summer - Chemical data collected during the summer sampling period in Bayou Freeo are displayed in Table GC-19. Typical of the Gulf Coastal Region, the nutrient levels are quite low. Measurements of chlorophyll $\bar{a}$ indicate insignificant amounts of phytoplankton in Bayou Freeo. Mineral quality measured in Bayou Freeo reveals very low levels of sulfates (8 mg/l), chlorides (4.5 mg/l) and total dissolved solids (69 mg/l). Measurements of biological oxygen demand were slightly high; the BOD_5 was 2.2 mg/l and the BOD_{20} was 5.6 mg/l. Though the water was relatively clear (turbidity=12 NTUs), the characteristic dark brown or coffee color was prominent. This

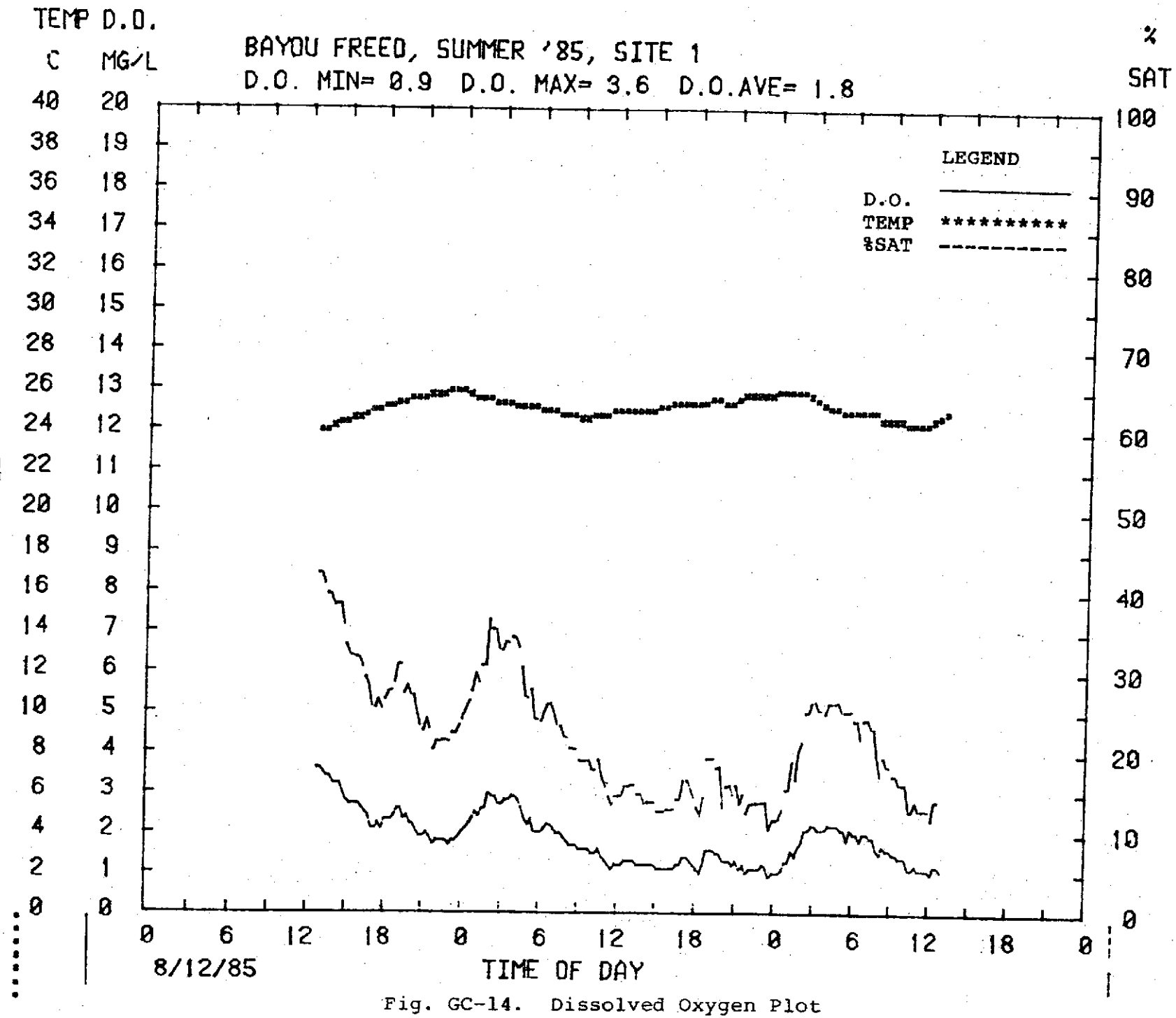


Fig. GC-14. Dissolved Oxygen Plot

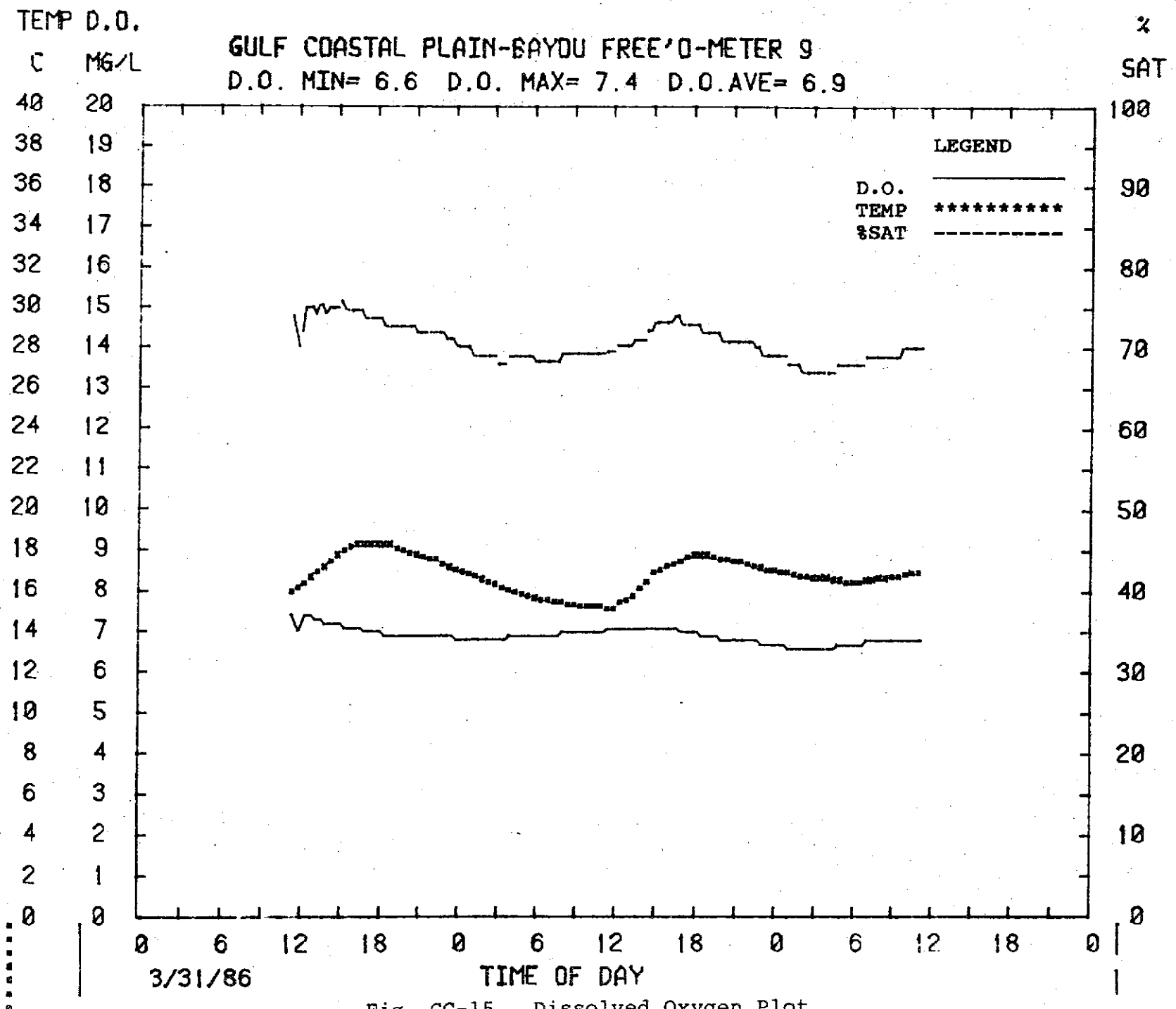


Fig. GC-15. Dissolved Oxygen Plot

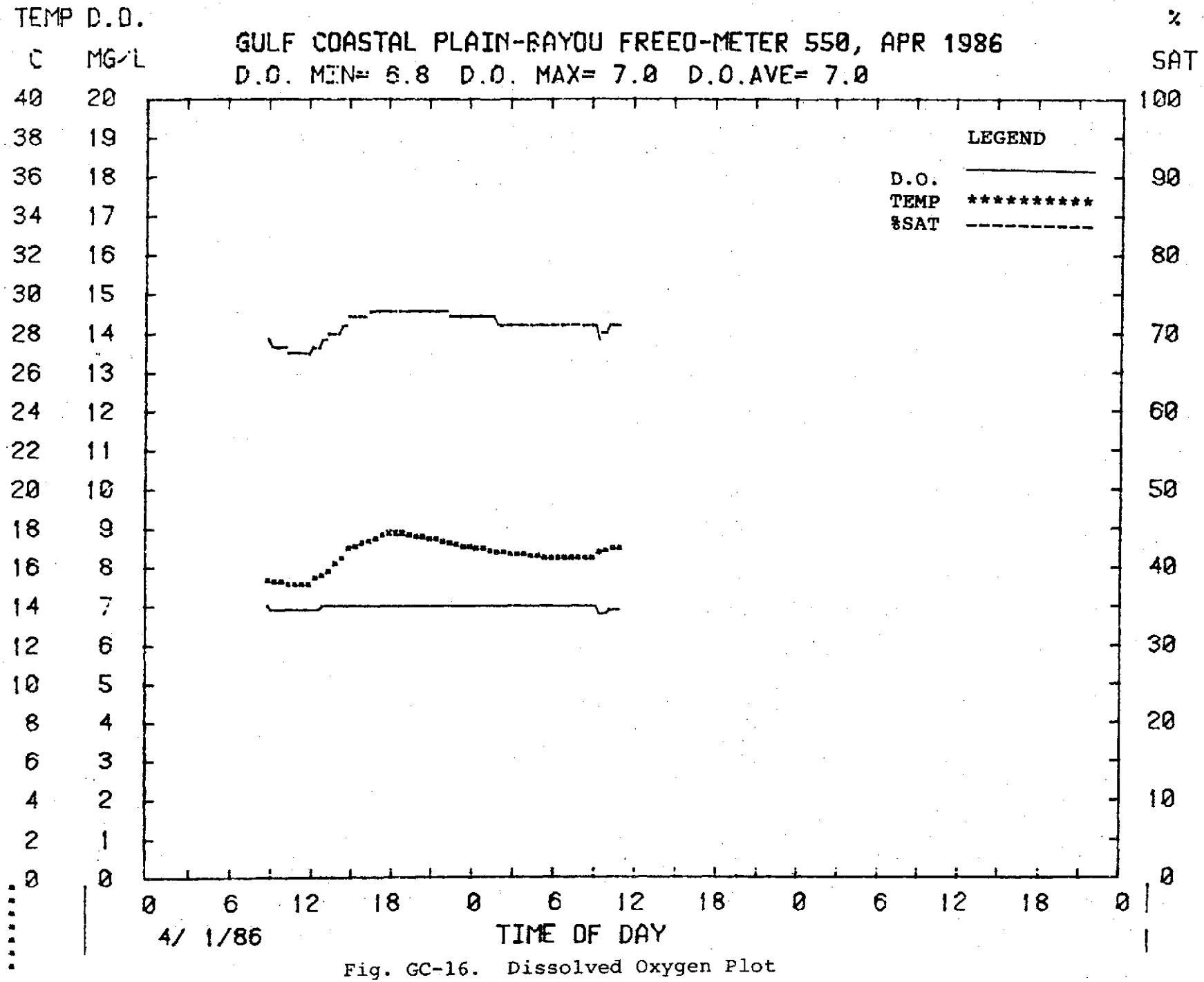


Fig. GC-16. Dissolved Oxygen Plot

Table GC-19

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Bayou Freeo

Drainage Area: 156 Square Miles

Station Description: Timber road in Section 34, T 11 S, R 16 W, Ouachita County

Date: August 13, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:30	10:00	10:30	
Q, cfs	0	0	0	No Flow
Temperature, °C	25	25	25	25
pH	7.0	7.0	7.0	7.0
Turbidity, ntu	12	14	12	12
TSS, mg/l	12	10	9	10
TDS, mg/l	71	72	65	69
BOD-5, mg/l	2.3	2.1	2.4	2.2
BOD-20, mg/l	5.7	5.4	5.7	5.6
T.Phos., mg/l	0.12	0.09	0.09	0.10
PO4-P, mg/l	0.06	0.06	0.06	0.06
NO2+NO3-N, mg/l	0.07	0.06	0.07	0.07
NH3-N, mg/l	0.07	0.07	0.07	0.07
Cl -, mg/l	4	4.5	4.5	4.5
SO4 =, mg/l	8	8	8	8
Fe, mg/l	0.12	0.12	0.11	0.12
Conductivity,µmho	63	65	66	65
Alkalinity, mg/l	27	28	26	27
T. Hardness, mg/l	20	26	32	26
Chlorophyll a,µg/l	2.2	1.4	void	1.8
Fecal Coliform	-	-	52	52

Dissolved Oxygen Data for 13 Aug 1986		
	Site 1	
Average	1.2	
Minimum	0.9	
Maximum	3.0	

characteristic is thought to be related to the specific soil type within the watershed and the leaching of tannins, lignins and perhaps iron from the soils. The test for fecal coliform bacteria indicated a low level of coliform organisms present in Bayou Freeo.

Spring - Results of the spring samples collected on April 1, 1986, are shown in Table GC-20. The most significant condition of the spring survey was that the stream was now actually a flowing stream instead of a series of enduring pools as found during the summer sampling period. The pH measurement was slightly more acidic during the spring sampling period. The BODs, both 5-day and 20-day, were slightly less than the summer measurements. Chlorophyll a was present in only trace amounts during the spring season. Nutrient levels were very low in this sampling period. Sulfates, chlorides and total dissolved solids increased slightly with the higher flows, although not significantly. In contrast to the minerals, conductivity, alkalinity and total hardness decreased during the spring period. Fecal coliform measurements showed no significant change from the summer sampling and both spring and summer samples met the primary contact standard. The turbidity measurement was one-half that measured during the summer and both measurements were well within the water quality standard.

Physical Parameters

Physical evaluations were made during the week of August 12, 1985. Bayou Freeo had reached a routine critical condition for the annual cycle. The stream had essentially stopped flowing and formed standing water or enduring pools within the immediate streambed. The immediate floodplain of Bayou Freeo is flat with numerous side channels and sloughs which would contain water during higher flow conditions. Table GC-21 displays the results of the physical evaluation on Bayou Freeo. Land use, topography, soil types, geology, etc., have all been mentioned as directly affecting many of the chemical characteristics of the stream. Characteristics of Bayou Freeo which are also common to the region are: low stream gradient, high percentage of instream fishery cover (brush, logs and debris), and moderate canopy covering the stream.

Macroinvertebrate Populations

Sixty-eight (68) taxa representing 17 orders were identified from the summer and spring benthic communities (Table A-8, Appendix A). Numerically, the dominant orders were Decapoda (15%), Amphipoda (14%), Coleoptera (10%) and Ephemeroptera and Odonata (9%). The taxonomic distribution was uniformly distributed among several groups. The dominant taxa were Hyalella azteca and Cambarinae (7%), Gammarus fasciatus and Palaemonetes kadiakensis (6%) and Sialis (5%). Other taxa, not numerically dominant but considered ecologically characteristic of Bayou Freeo, include Caenis, Libellula

Table GC-20

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Bayou Freeo

Drainage Area: 156 square miles

Station Description: Timber road, Section 34, T 11 S, R 16 W, Ouachita County

Date: April 1, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:20	10:27	11:00	
Q, cfs	16	16	16	16
Temperature, °C	17	17	17	17
pH	6.63	6.58	6.57	6.6
Turbidity, ntu	6	6	6	6
TSS, mg/l	6	6	6	6
TDS, mg/l	76	75	77	76
BOD-5, mg/l	1.3	1.4	1.2	1.3
BOD-20, mg/l	4.0	4.2	4.1	4.1
T.Phos., mg/l	-	-	-	-
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	0.01	0.07	0.01	0.03
NH3-N, mg/l	0.03	0.04	0.02	0.03
Cl -, mg/l	8	8.5	7.5	8
SO4 =, mg/l	10	8	8	9
Fe, mg/l	1.6	1.6	1.6	1.6*
Conductivity,µmho	58	58	56	57
Alkalinity, mg/l	13	11	9	11
T. Hardness, mg/l	16	16	18	17
Chlorophyll a,µg/l	-	-	0.65	0.65*
Fecal Coliform	-	-	48	48*

Dissolved Oxygen Data for 1 Apr 1986		
	Meter 550	Meter 9**
Average	7.0	6.9
Minimum	6.8	6.7
Maximum	7.0	7.1

*These data were collected 27 May 1986.
**Meter 550 data is a composite of Apr 1 and 2 data.

Table GC-21

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Bayou Freeo
Date:	8/12/85
Drainage Area:	156 square miles
Watershed Land Use:	7% agriculture 91% forest
Stream Gradient:	3.0 ft/mi
Mean Channel Width:	47 feet
Mean Stream Width:	26 feet
Mean Stream Velocity:	N/A
Observed Flow:	No Flow
Average Substrate Type:	36% gravel 64% sand
Mean Instream Cover:	74% brush, logs, debris
Riffle/Pool Ratio of Transects:	100% shallow pool
Mean Bank Overstory Cover:	100% trees 5% shrubs
Mean Bank Ground Cover:	44% grass and forbs 56% dirt
Mean Bank Stability:	90% moderate 10% unstable
Mean Stream Canopy:	100% stream canopy
Comments:	

auripennis, Ranatra buenoi and Uvarus. The summer and spring samples were distinctly more similar than dissimilar. Of the 68 taxa identified from the combined samples, 43 and 55 taxa were identified from the summer and spring samples, respectively. The 30 taxa present in both samples accounted for 71% of all organisms collected. The 13 and 25 taxa unique to the summer and spring samples comprised 19.2% and 33% of their respective samples.

Summer - Numerically, the dominant orders of the summer benthic community were Ephemeroptera (19%), Odonata (17%), Decapoda (15%), Hemiptera (12%) and Coleoptera (10%). The summer benthic community lacked a clear numerically dominant taxonomic assemblage. No taxa comprised greater than 10% of the organisms, but 8 taxa were present in quantities greater than 5% (Table A-8, Appendix A). Ecologically characteristic taxa of the summer benthic community were Caenis, Libellula quripennis, Palaemonetes kadiakensis and Sialis.

Spring - The dominant orders of the spring benthic community were Amphipoda (19%), Decapoda (15%) and Coleoptera (10%). The dominant taxa were Hyalella azteca (10.7%) and Cambarinae and Gammarus fasciatus (8.6%). Other taxa, not numerically dominant but considered as ecologically characteristic of the spring benthic community, include Isoperla mohri, Perlesta placida, Palaemonetes kadiakensis and Sialis.

The diversity index of the combined summer-spring sample was well above 5 and would tend to indicate very good water quality (Table GC-22). However, the average summer D.O. was 2.3 mg/l with no measurable flow. Bayou Freeo is a prime example of the ability of insect populations to adjust to natural adverse water conditions when sufficient habitats and adequate perennial water are available. The presence of numerous species found in high quality water is indicative of the ability of benthic populations to recover when conditions improve, even seasonally.

Table GC-22. Community Analysis of Benthic Samples from Bayou Freeo - 30 minute Qualitative Samples, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	302	653	955
Total # Taxa	43	55	68
Diversity	4.7845	4.9125	5.2423
Index of Evenness	0.4325	0.4529	0.4353
Index of Dominance	0.8817	0.8497	0.8612
Index of Variety	5.0981	5.7748	6.7817
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.61
Common Taxa Index (range 0-1)			0.31
Qualitative Similarity Index (range 0-100)			40.0

Fish Populations

Summer - This site was sampled with approximately 3 pounds of 5% active rotenone on August 8, 1985. The sample area was about 250 feet long, with an average width of 30 feet and an average depth of 2 feet. There was a very slight but almost unmeasurable flow. The water was brownish in color with a silver scum. Ten man-hours were used to pick up fish killed by the rotenone.

Thirty-two species of fish from a total of 470 specimens were taken at this site. The total relative abundance value was 176 with a diversity index of 4.72. A list of all species collected and their relative abundance value is given in Table GC-23. Both Centrarchidae and Percidae made up 26.1% of the total relative abundance value of the population. This included one hybrid, 8 species of sunfishes and 8 species of darters (Table GC-24). No primary feeding fishes were collected in this sample and over 93% of the population were macroinvertebrate feeders. Five sensitive species representing 15.3% of the population were also taken.

Spring - Three trammel nets were fished overnight at this site on March 31, 1986. Mesh sizes of the nets were 1½", 2" and 2½" square. The water level was very low from the lack of early springtime rains. Water temperature was 17°C, and visibility into the water was about 12 inches. Only two spotted suckers were caught. One had completed spawning and the other was in the spawning process.

Table GC-23. Fishes Collected from Bayou Freeo with Relative Abundance Values

Species		R.A. VALUE
Aphredoderus sayanus	Pirate perch	12.0
Fundulus olivaceus	Blackspotted topminnow	10.5
Notropis umbratilis	Redfin shiner	10.5
Lepomis megalotis	Longear	10.0
Noturus gyrinus	Tadpole madtom	9.0
*Etheostoma collettei	Creole darter	9.0
Lepomis punctatus	Spotted sunfish	9.0
Esox americanus	Grass pickerel	9.0
*Percina maculata	Blackside darter	8.0
Gambusia affinis	Mosquitofish	7.5
Etheostoma whipplei	Redfin darter	7.0
Lepomis gulosus	Warmouth	7.0
*Percina sciera	Dusky darter	7.0
Centrarchus macropterus	Flier	6.0
Etheostoma proeliare	Cypress darter	6.0
Ictalurus natalis	Yellow bullhead	6.0
Etheostoma chlorosomum	Bluntnose darter	6.0
Erimyzon oblongus	Creek chubsucker	5.0

Table GC-23, cont.

Notropis atherinoides	Emerald shiner	4.5
Elassoma zonatum	Banded pygmy sunfish	4.0
Lepomis cyanellus	Green sunfish	4.0
Lepomis macrochirus	Bluegill	3.0
Minytrema melanops	Spotted sucker	3.0
Etheostoma gracile	Slough darter	2.0
*Moxostoma poecillurum	Blacktail redhorse	2.0
Notropis emiliae	Pugnose minnow	2.0
Micropterus salmoides	Largemouth bass	2.0
Amia calva	Bowfin	1.0
Labidesthes sicculus	Brook silversides	1.0
Lepomis hybrid	Hybrid sunfish	1.0
*Etheostoma parvipinne	Goldstripe darter	1.0
Notropis chrysocephalus	Striped shiner	1.0

* - Sensitive species

Table GC-24. Summary of Fish Population Parameters from Bayou Freeo

Total Species Collected	32.0
Total Number of Individuals	470.0
Total Relative Abundance Value	176.0
Relative Abundance Diversity Index	4.72

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	4.0	10.2
CATOSTOMIDAE	4.0	5.7
ICTALURIDAE	2.0	8.5
CENTRARCHIDAE	9.0	26.1
PERCIDAE	8.0	26.1
Primary Feeders	0.0	0.0
Macroinvertebrate Feeders	29.0	93.2
Carnivores	3.0	6.8
Sensitive Species	5.0	15.3

HUDGIN CREEK

Hudgin Creek begins in the south central part of Jefferson County and flows in a southerly direction along the eastern edge of Cleveland County, cuts across the southwest corner of Lincoln County into the northwest part of Drew County and continues a southerly flow to its confluence with the Saline River in Bradley County. The sample site for Hudgin Creek was located at the Highway 35 bridge in the SE¼, NW¼ of Section 29, R 8 W, T 11 S (Figure GC-17).

General Site Discussion

Watershed Size - The watershed size of Hudgin Creek above the highway bridge is 187 mi^2.

Geology - Surface geology in the Hudgin Creek drainage is basically of two types. The headwater area is predominantly terrace deposits of Quaternary age and the lower drainage is predominantly deposits from the Jackson Group of Eocene age. The immediate streambed and floodplain are recent alluvium deposits.

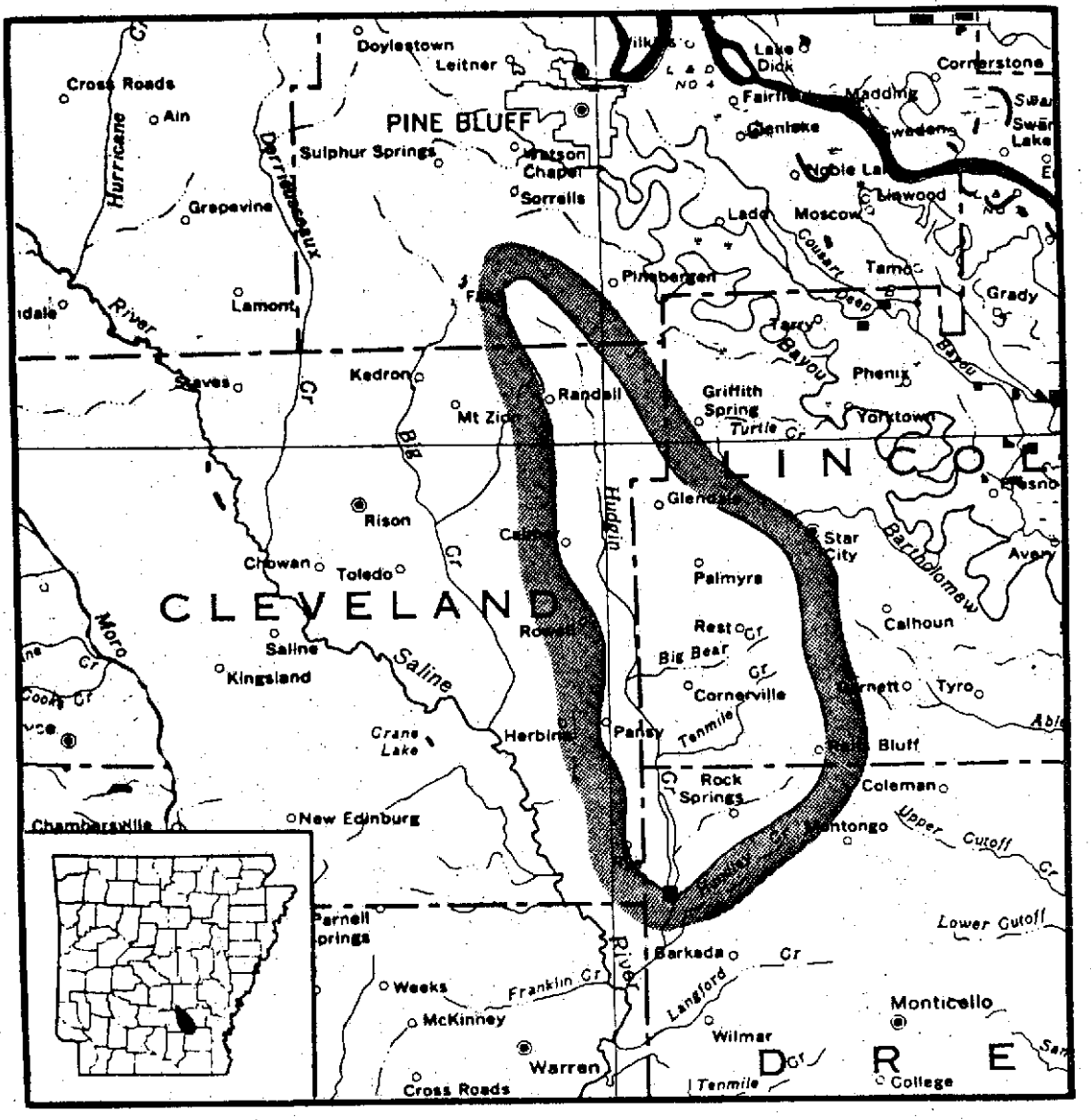
Topography - Topography within the watershed is generally level to gently rolling sand hills with broad streamside wetland areas directly adjacent to the creek.

Soil Types - The upper watershed of Hudgin Creek is in an area that is dominated by the Wehadkee-Ochlockonee-Colins and Tippah-Pheba-Boswell associations. The predominant soil association is the Tippah-Pheba-Boswell. This association consists of nearly level to moderately steep, moderately well-drained and somewhat poorly drained soils that have a loamy or clayey subsoil, found on upland areas. The Wehadkee-Ochlockonee-Collins association is nearly level, poorly drained to well-drained, frequently flooded soil predominantly found in bottomlands. The lower watershed of Hudgin Creek is composed of two additional soil associations, the Amy-Ouachita and the Tippah-Sacul-Amy. The Amy-Ouachita association is poorly drained to well-drained, level, loamy soils on floodplains of local streams. The Tippah-Sacul-Amy association is moderately well-drained and poorly drained, level to moderately sloping, loamy soils on uplands.

Flora - Loblolly pine and sweetgum trees dominate the forest in the upland areas of the basin. Low overflow wetland areas are dominated by oak, hickory, beech and cypress trees.

Land Use - Land use within the watershed is 75% forest and 25% agriculture, according to the Soil Conservation Service. The predominant agricultural use is pastureland. Overall, the watershed has a low level of man-induced disturbance and qualifies as least-impaired for this region.

Figure GC-17



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

HUDGIN CREEK: Drainage area 187 square miles ■ Survey site ▒ Survey area

Stream Characteristics - The 1983 USGS stream flow map shows Hudgin Creek to have a Q_{7-10} of zero. During the average year, flow normally drops to zero and an enduring pool situation occurs in typical Gulf Coastal streams. Conditions during the survey on Hudgin Creek were typical of the enduring pool situation. Significant physical characteristics include the deeply cut stream channel with sandy banks, sandy substrate, low stream gradient, high percentage of instream cover (brush, logs and debris) and high percentage of stream canopy.

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 5-9, 1985; the spring survey was conducted during the week of March 25-29, 1985.

Continuous Dissolved Oxygen

Summer - Three continuously recording meters were set up to monitor the dissolved oxygen and temperature throughout the week. These meters were set up shortly after noon on August 5, 1985. Site #1 was located approximately 75 yards downstream of the Highway 35 bridge, Site #2 was 30 yards upstream of the bridge and Site #3 was 75 yards upstream of the bridge. On the evening of August 7, 1985, Meter #550 located at Site #3 malfunctioned and was terminated. The two remaining meters worked satisfactorily for the entire survey. Due to the lack of flow in Hudgin Creek, both meters were measuring the dissolved oxygen and temperature of the pooled creek. Both meters were checked daily for calibration.

Results obtained during the summer survey are displayed in (Figures GC-18 and GC-19). Each graph displays the D.O., temperature and D.O. saturation for each meter for the survey period. No clear explanation can be offered for the apparent difference in the two graphic recordings. Site #1 recording shows a fairly stable dissolved oxygen graph with a range from 1.7 mg/l to 3.3 mg/l, averaging 2.3 mg/l over the survey period. Site #2 displays substantially more fluctuation with a range of 0.5 mg/l to 3.6 mg/l, averaging 1.6 mg/l over the survey period. The dissolved oxygen peaks appear contrary to normal photosynthetic activity in that they occur at or near midnight. Summertime D.O. saturations ranged from 10-40% during the survey period.

Spring - On March 26, 1985, two meters were set up to measure the dissolved oxygen and temperature in Hudgin Creek. Site #1 was located approximately 100 yards downstream of Highway 35 bridge and Site #2 was approximately 100 yards upstream of the bridge. Unlike the pooled conditions of summer, Hudgin Creek was now flowing. The staff gauge set up for the survey indicated that the creek fell 1.32' from March 26th to March 27th and then rose 1.12' on March 28th. Figures GC-20 and GC-21 display the dissolved oxygen, temperature and percent

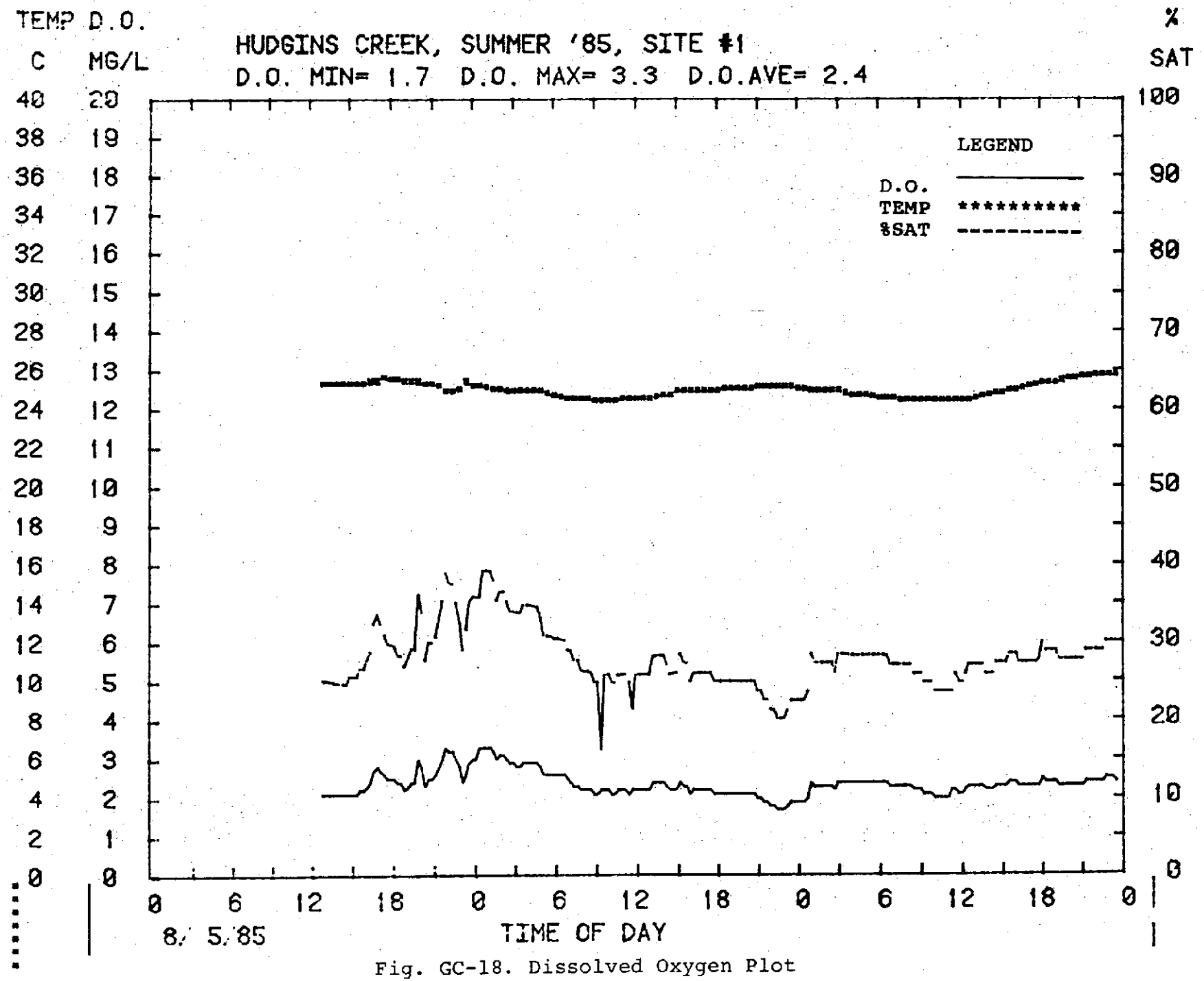


Fig. GC-18. Dissolved Oxygen Plot

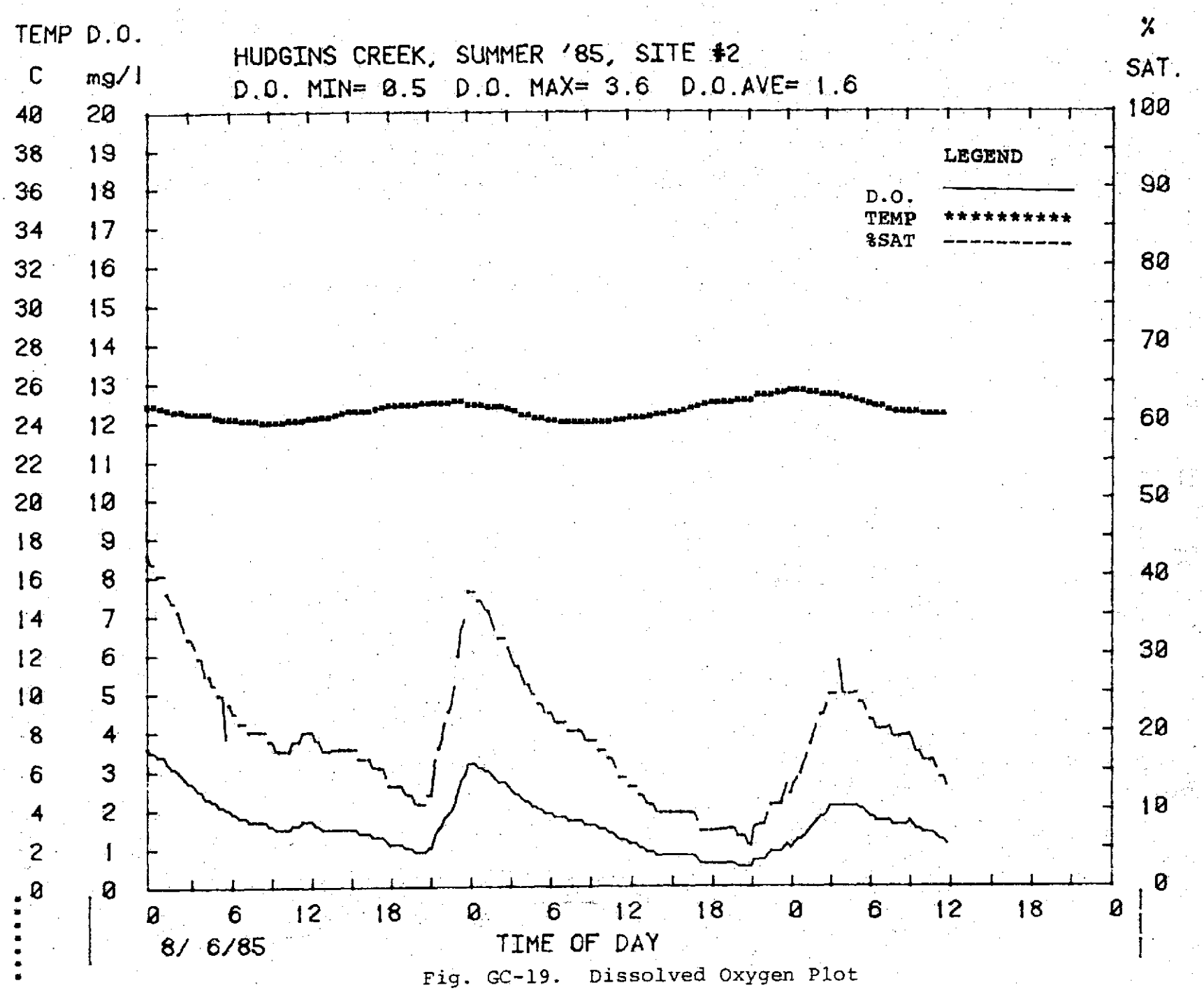


Fig. GC-19. Dissolved Oxygen Plot

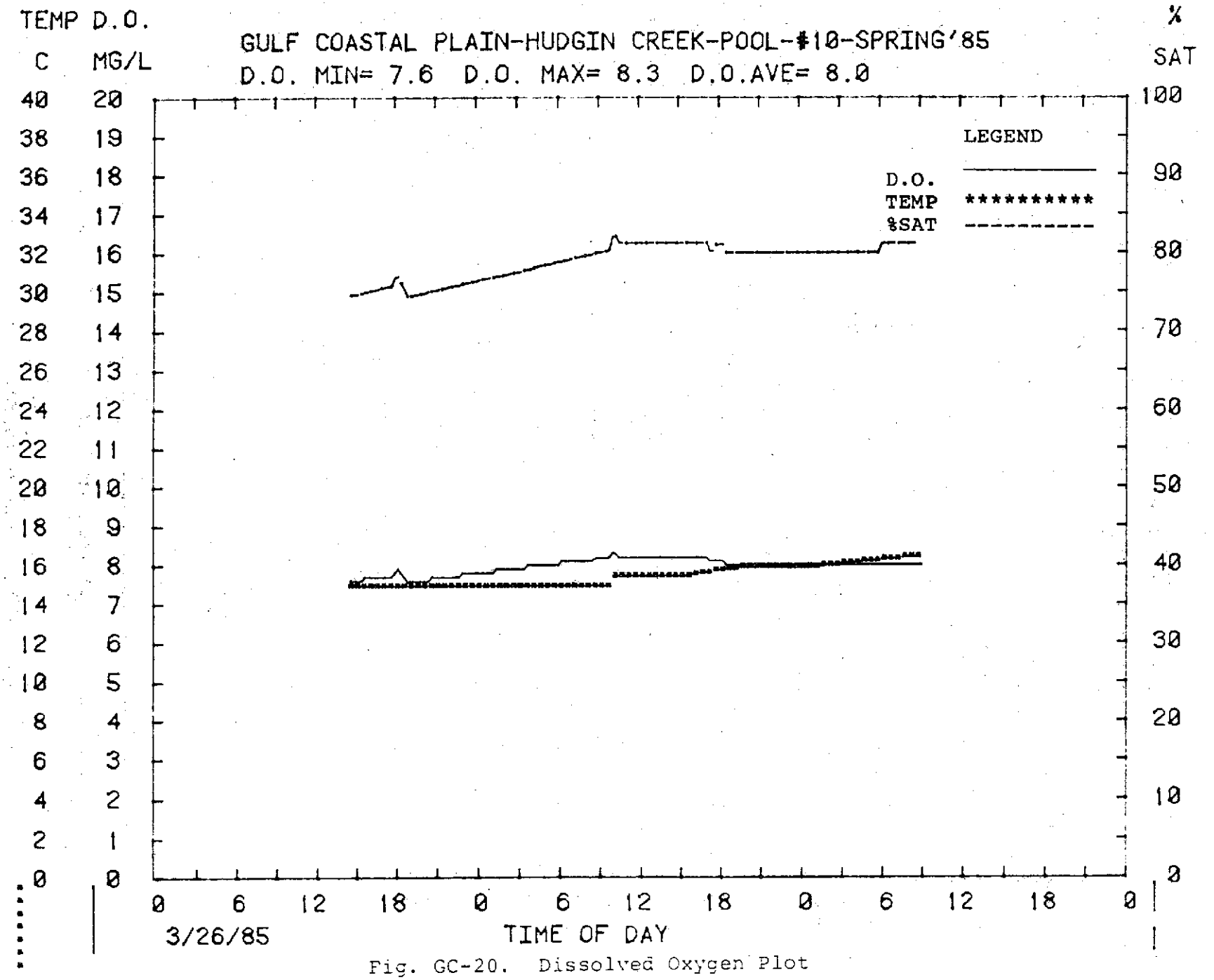


Fig. GC-20. Dissolved Oxygen Plot

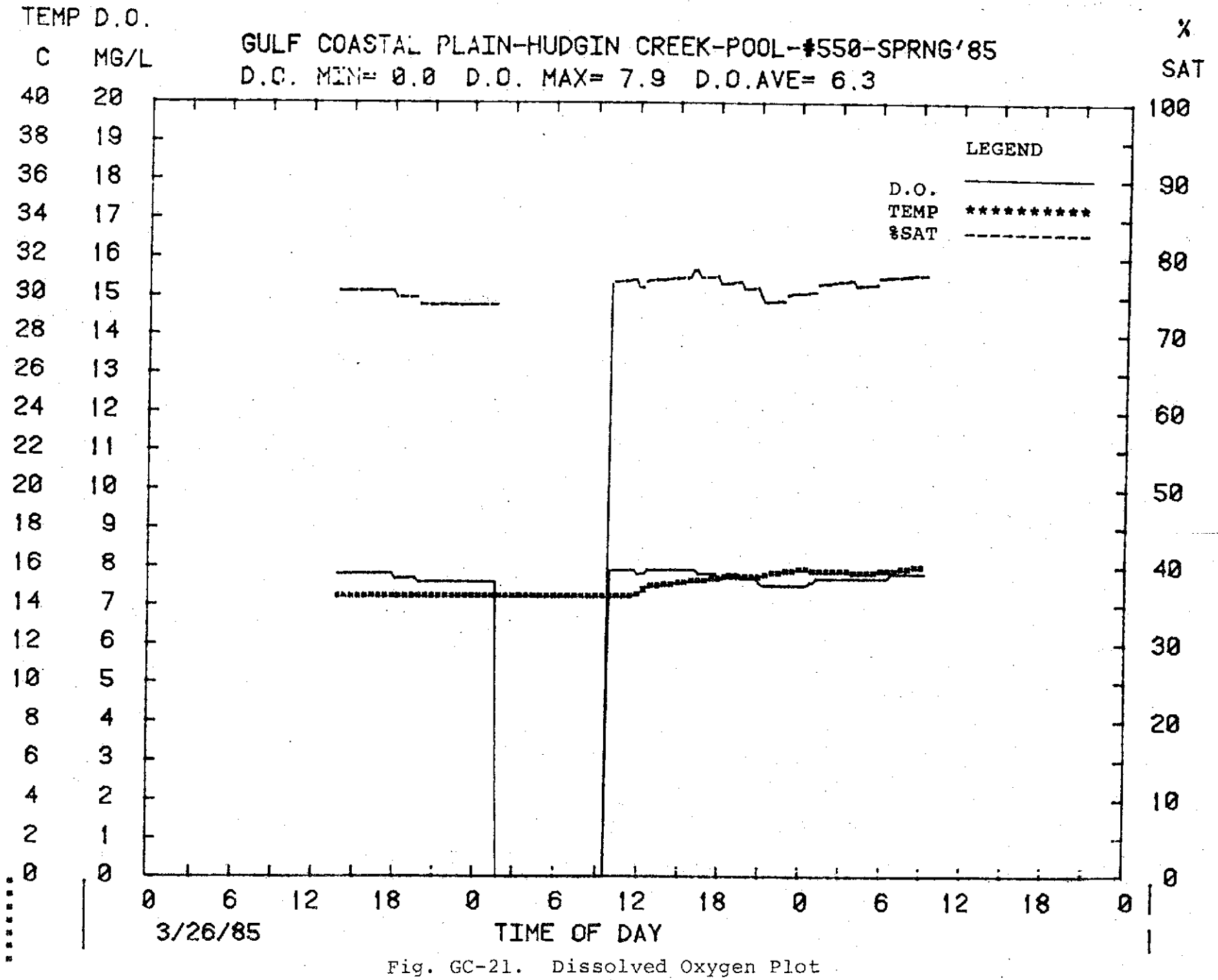


Fig. GC-21. Dissolved Oxygen Plot

saturation for both sites during the spring period.

No significant differences are shown between these two sites. These spring conditions are distinctly different from those observed during the summer period. Dissolved oxygen concentrations are much higher during these springtime conditions predominantly due to the additional flow. Average D.O. from both sites was approximately 8 mg/l. Dissolved oxygen percent saturation averaged approximately 80%.

Chemical Parameters

Summer - Chemical data collected during the summer sampling period in Hudgin Creek is typical of the Gulf Coastal Region (Table GC-25). Even though nutrient concentrations are quite low, the enduring pool stage which develops during summer appears to enhance phytoplankton growth. Chlorophyll ā was measured to be 6.1 μg/l. The photosynthetic activity appears to exert a buffering effect on the normally acidic waters during these summer conditions.

Mineral quality measured in Hudgin Creek reveals very low levels of sulfates (10 mg/l), chlorides (5 mg/l) and total dissolved solids (81 mg/l). Measurements of biochemical oxygen demands were slightly high with the BOD_5 measuring 2.9 mg/l and the BOD_{20} measuring 6.8 mg/l. Even though the water was relatively clear (turbidity was only 8.5 NTUs), the characteristic dark brown or "coffee" color was prominent. This characteristic is thought to be a condition related to the specific soil type within the watershed and the leaching of tannins, lignins and perhaps iron from the soils. The test for fecal coliform bacteria indicated the presence of 200 colonies per 100 ml of water tested, which is the limit for primary contact. This location on Hudgin Creek appeared to be remote from any known source of fecal contamination. Thus, the fecal coliform test is probably measuring natural bacteria levels from organic matter.

Spring - The spring samples were collected on March 22, 1985. Results are shown in Table GC-26. Water quality measured during the spring sampling was considerably different in some respects from the summer samples. Most significant was the volume of water or flow available during the spring. The stream was now actually flowing instead of a series of enduring pools as found during the summer. This flow is the most probable reason for the differences in the spring water quality.

The pH measurement was slightly more acidic during the spring sampling. BODs, both 5-day and 20-day, were less than one-half the concentrations measured during the summer conditions. Chlorophyll ā concentrations dropped to only trace amounts during the spring survey. Nutrient levels were

Table GC-25

STREAM RECLASSIFICATION SURVEY

Chemical Results'

Physiographic Region: Gulf Coastal Plain

Stream: Hudgin Creek

Drainage Area: 187 Square Miles

Station Description: At Hwy. 35 bridge in Section 29, T 11 S, R 8 W

Date: August 6, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	10:00	11:10	
Q, cfs	0.01	0.01	0.01	0.01
Temperature, °C	25	25	25	25
pH	6.9	6.9	6.8	6.9
Turbidity, ntu	8	9	22	8.5*
TSS, mg/l	12	9	59	10*
TDS, mg/l	80	79	83	81
BOD-5, mg/l	2.8	2.6	3.3	2.9
BOD-20, mg/l	6.6	6.3	7.5	6.8
T.Phos., mg/l	0.09	0.08	0.12	0.10
PO4-P, mg/l	0.04	0.04	0.05	0.04
NO2+NO3-N, mg/l	0.03	0.03	0.03	0.03
NH3-N, mg/l	0.02	0.03	0.01	0.02
Cl -, mg/l	4.5	5.0	5.0	5.0
SO4 =, mg/l	10	10	10	10
Fe, mg/l	0.2	NA	NA	0.2
Conductivity, μmho	105	104	95	101
Alkalinity, mg/l	-	-	-	-
T. Hardness, mg/l	40	42	40	40
Chlorophyll a, μg/l	6.5	2.6	9.4	6.1
Fecal Coliform	-	-	200	200

Dissolved Oxygen Data for 6 Aug 1985		
	Site 1	Site 2
Average	2.4	1.8
Minimum	1.7	0.9
Maximum	3.3	3.6

* Third sample was discarded from average.

Table GC-26

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Hudgin Creek
Drainage Area: 170 Square Miles

Station Description: at Highway. 35 bridge, SE 1/4, NW 1/4, Section 29, R 8 W, T 11 S - Drew County

Date: March 27, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	08:55	09:40	10:15	
Q, cfs	-	-	-	not taken
Temperature, °C	15	15	15.5	15
pH	6.3	6.2	6.1	6.2
Turbidity, ntu	26	24	23	24
TSS, mg/l	18	18	20	19
TDS, mg/l	85	88	90	88
BOD-5, mg/l	1.0	0.9	0.9	0.9
BOD-20, mg/l	2.7	2.4	2.5	2.5
T.Phos., mg/l	0.05	0.04	0.06	0.05
PO4-P, mg/l	0.04	0.04	0.05	0.04
NO2+NO3-N, mg/l	0.13	0.12	0.14	0.13
NH3-N, mg/l	0.04	0.05	0.05	0.05
Cl -, mg/l	5	5.5	5	5
SO4 =, mg/l	26	25	24	25
Fe, mg/l	0.76	0.74	0.73	0.74
Conductivity,µmho	80	79	78	79
Alkalinity, mg/l	5	6	5	5
T. Hardness, mg/l	18	20	20	19
Chlorophyll a,µg/l	0.0	0.8	1.2	0.7
Fecal Coliform	-	-	16	16

Dissolved Oxygen Data for 27 Mar 1985		
	Pool	Riffle
Average	7.7	8.1
Minimum	7.5	7.8
Maximum	7.9	8.3

very low and showed no significant change from the summer survey. Mineral quality was not significantly different during the spring, with the exception of sulfates, which increased slightly with the higher flows. Fecal coliform bacteria concentrations were substantially lower during the spring survey, as compared to the summer period. With the much higher flow during the spring season, there is a much greater likelihood of bringing in nonpoint sources of contamination. Yet, to the contrary, the concentration of fecal coliform bacteria shows a significant decline from summer conditions. This is another indication that the higher concentrations found in summer are of natural origin. Turbidity measurements were approximately three times higher in spring than during summer, but still below the Water Quality Standard.

Physical Parameters

Summer - Physical evaluations were made during the week of August 6, 1985. Hudgin Creek had reached a routine critical condition for the annual cycle. The stream had essentially stopped flowing and had formed a standing body of water in the streambed. The immediate floodplain at Hudgin Creek appeared to be quite wide and flat with numerous channels and sloughs which would, at higher flows, be full of water. Table GC-27 displays the results of the physical evaluation on Hudgin Creek. Land use, topography, soil types, canopy and geology have been mentioned as directly affecting many of the chemical characteristics of the stream. Characteristics of Hudgin Creek, which are also common to the region, are low stream gradient, high percentage of instream fishery cover (brush, logs and debris) and moderate canopy covering the stream.

Spring - Due to the difficulty of making any physical measurements during the higher flows of spring, none were made.

Macroinvertebrate Populations

Seventy-eight (78) taxa representing 18 orders were identified from the summer-spring samples of the benthic community of Hudgin Creek. The dominant orders of the combined samples, Coleoptera, Decapoda, Amphipoda, Odonata and Ephemeroptera comprised 22.3%, 16.0%, 10.8%, 8.6% and 8.4% of the benthic community, respectively (Table A-9, Appendix A). The dominant taxa were Palaemonetes kadiakensis (10.5%), Hyalella azteca (9.9%), Sialis (7.2%), Celina augustata (5.5%) and Caenis (4.8%). Other taxa considered ecologically characteristic, but not collected in significant numbers include Peltodytes lengi, Cloeon rubropictum, Ascellus dentadactylus and Traienoides.

The qualitative comparative indices indicated that only slight similarities exist between the summer and spring benthic communities (Table GC-28). Of the 78 taxa identified from the combined samples, 26 were identified from both samples and

Table GC-27

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Hudgin Creek
Date:	8/6/85
Drainage Area:	187 Square Miles
Watershed Land Use:	26% Agriculture 74% Forest
Stream Gradient:	1.4 fpm
Mean Channel Width:	69 feet
Mean Stream Width:	32 feet
Mean Stream Velocity:	NA
Observed Flow:	.01 CFS
Average Substrate Type:	100% Mud/Silt
Mean Instream Cover:	55% Brush, Logs, Debris 3% Inundated Vegetation 1% Overhanging Vegetation
Riffle/Pool Ratio of Transects:	40% Deep Pool 40% Shallow Pool 20% Moderate Pool
Mean Bank Overstory Cover:	88% Trees 73% Shrubs
Mean Bank Ground Cover:	43% Grass and Forbes 57% Dirt
Mean Bank Stability:	10% Stable 70% Moderate 20% Unstable
Mean Stream Canopy:	68% Canopy
Comments:	

accounted for 68% of all organisms collected. There were 37 and 14 taxa unique to the summer and spring samples, respectively, and they comprised 38% and 23% of the numeric totals. The taxonomic differences reflected the natural seasonal variation of insect populations. However, the magnitude of variation may have been increased due to extremely high water conditions present during the spring survey.

Summer - The dominant groups of the summer sample were Coleoptera (18.9%), Amphipoda (13.9%), Decapoda (13.5%), Odonata (11.0%) and Megaloptera (10.3%). The dominant taxa of the summer sample were Hyalella azteca (13.9%), Palaemonetes kadiakensis (10.8%), Sialis (10.2%), Celina augustata (8.7%) and Ischnura (5.1%). The dominant groups of the spring sample were Coleoptera (29.3%), Decapoda (21.0%), Ephemeroptera (7.3%), Gastropoda (7.0%) and Isopoda (6.5%).

Spring - The dominant taxa of the spring sample were Uvarus (12.5%), Cambarinae (10.9%), Palaemonetes kadiakensis (9.9%) and Hydrovatus (8.1%).

The community parameters indicated an extremely balanced benthic community characteristic of good water quality and ample microhabitat. The high water conditions under which the spring sampling was conducted did not result in a reduced diversity. The reduction of taxa collected was offset by the reduction in total numbers of organisms collected. However, this may not be a true indication of the normal springtime benthic populations and is considerably lower than that recorded from other Gulf Coastal streams during the spring.

Table GC-28. Community Analysis of Benthic Samples from Hudgin Creek - 30 minute Qualitative Sample, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined*
Total # Organisms	805	383	1188
Total # Taxa	64	40	78
Diversity	4.7779	4.4725	5.1559
Index of Evenness	0.7963	0.8403	0.8203
Index of Dominance	0.4374	0.3229	0.3949
Index of Variety	6.5265	4.5448	7.5384
COMPARATIVE INDICES			
Dice Index			0.51
Common Taxa Index			0.41
Qualitative Similarity Index (range 0-100)			34.0

*Actual 1 hour sample

Fish Populations

Summer - Approximately 3 pounds of 5% active rotenone was used to treat a pool of about ¼ acre with an average depth of 2½ feet and a maximum depth of 5 feet. The area was sampled on August 6, 1985; there was no flow between pools and the water was a murky brown color with a noticeable surface scum.

Thirty-six species were identified from the 830 individuals collected, resulting in a total relative abundance value of 206.5 and a diversity index of 4.83. The species collected are listed in Table GC-29. The dominant fish family was Centrarchidae with 27.5% of the relative abundance. This was made up of eleven species and one hybrid. Six species of Cyprinidae comprised almost 20% of the population (Table GC-30). Primary feeding fishes made up 10.2% of the population but were represented by only two species, whereas seven species of carnivores made up 13.8% of the population. Three sensitive species comprised 3.6% of the population.

Spring - Three trammel nets with mesh sizes of 1½", 2" and 3½" square mesh were fished overnight on March 26, 1985. Flow was estimated near 300 cfs and water temperature was 15°C. Twenty-one specimens from six species with a total weight of 17.8 pounds were collected, including one species which was not taken in the summer sample. Gonad inspection of these fishes indicated that spotted suckers were in the process of spawning with spawning completed by some. Blacktail redhorse were in final stages of development. Largemouth bass, spotted bass and yellow bullhead showed advanced gonad development.

Table GC-29. Fishes Collected from Hudgin Creek with Relative Abundance Values

Species		R.A. VALUE
Aphredoderus sayanus	Pirate perch	12.0
Etheostoma chlorosomum	Bluntnose darter	12.0
Etheostoma gracile	Slough darter	12.0
Hybognathus nuchalus	Silvery minnow	12.0
Minytrema melanops	Spotted sucker	12.0
Fundulus olivaceus	Blackspotted topminnow	11.0
Lepomis gulosus	Warmouth	10.0
Micropterus salmoides	Largemouth bass	9.0
Lepomis macrochirus	Bluegill	9.0
Gambusia affinis	Mosquitofish	9.0
Hybognathus hayi	Cypress minnow	9.0
Centrarchus macropterus	Flier	8.0
Ictalurus natalis	Yellow bullhead	8.0
Amia calva	Bowfin	7.0
Notropis umbratilis	Redfin shiner	6.5
Lepomis megalotis	Longear	6.0
Notropis emiliae	Pugnose minnow	6.0

Table GC-29, cont.

*Percina maculata	Blackside darter	5.5
Esox niger	Chain pickerel	4.5
Fundulus notatus	Blackstripe topminnow	4.0
Notropis chrysocephalus	Striped shiner	4.0
Lepomis cyanellus	Green sunfish	4.0
Lepomis punctatus	Spotted sunfish	3.0
Esox americanus	Grass pickerel	3.0
Etheostoma whipplei	Redfin darter	3.0
Pomoxis nigromaculatus	Black crappie	2.0
Elassoma zonatum	Banded pygmy sunfish	2.0
*Etheostoma collettei	Creole darter	2.0
Micropterus punctulatus	Spotted bass	2.0
Noturus gyrinus	Tadpole madtom	2.0
Notropis fumeus	Ribbon shiner	2.0
Lepisosteus oculatus	Spotted gar	1.0
Erimyzon oblongus	Creek chubsucker	1.0
Lepomis microlophus	Redear	1.0
Lepomis hybrid	Hybrid sunfish	1.0
Percina caprodes	Logperch	1.0
*Moxostoma poecilurum	Blacktail redhorse	S

*Sensitive species
S - Species collected in spring sample only

Table GC-30. Summary of Fish Population Parameters from Hudgin Creek

Total Species Collected	37.0
Total Number of Individuals	830.0
Total Relative Abundance Value	206.5
Relative Abundance Diversity Index	4.83

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6.0	19.1
CATOSTOMIDAE	2.0	6.3
ICTALURIDAE	2.0	4.8
CENTRARCHIDAE	12.0	27.6
PERCIDAE	6.0	17.2
Primary Feeders	2.0	10.2
Macroinvertebrate Feeders	28.0	76.0
Carnivores	7.0	13.8
Sensitive Species	3.0	3.6

L'AIGLE CREEK

L'Aigle Creek begins in southeast Cleveland County near New Edinburg and flows due south the length of Bradley County before its confluence with the Saline River. The sample site for L'Aigle Creek was located on a TAR in the NE¼ of Section 36, R 11 W, T 15 S (Figure GC-22).

General Site Discussion

Watershed Size - The watershed size of L'Aigle Creek above the sample station is 232 mi^2.

Geology - Surface geology in the L'Aigle Creek drainage is underlain byy the Cockfield Formation of Eocene Age with alluvial deposits of Quaternary Age covering the creekbed and banks. The lower watershed is composed of terrace deposits from the Pleistocene period. The immediate streambed and floodplain are recent alluvium deposits.

Topography - Topography within the L'Aigle Creek watershed is generally level to gently rolling sand hills with broad streamside wetland areas directly adjacent to the Creek.

Soil Types - The upper watershed of L'Aigle Creek is in an area that is dominated by the Savannah-Ruston-Saffell association. This association consists of nearly level to moderately steep soils on upland ridges and side slopes. The lower watershed is composed predominantly of Bibb silt loam and Myatt silt loam. Both of these are a gray colored soil of the bottomlands with poor drainage and a high water table.

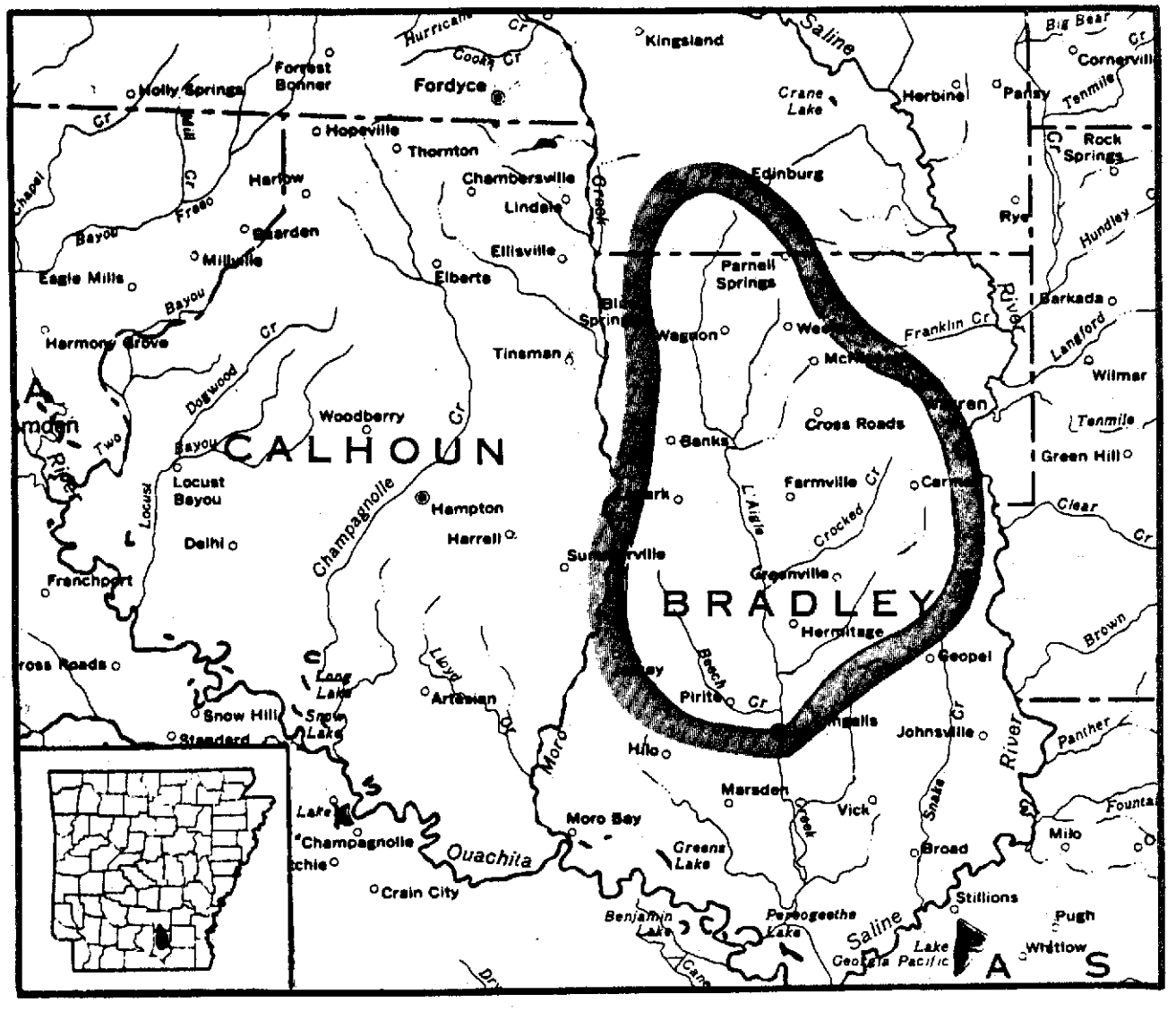
Flora - Loblolly pine and sweetgum trees dominate the forest in the upland areas of the basin. The low overflow wetland areas are dominated by oak, hickory, beech and cypress.

Land Use - Land use within the watershed is 91% forest and 7% agriculture, according to the Soil Conservation Service. The predominant agricultural use is pastureland. The L'Aigle Creek watershed has a very low level of man-induced disturbance and, therefore, is a good representative stream for the Gulf Coastal Region.

Stream Characteristics - The 1983 USGS stream flow map shows L'Aigle Creek to have a Q_{7-10} of zero. During an average year, the flow normally goes to zero and enduring pools develop. This appears to be a typical situation throughout the Gulf Coastal Region.

Conditions during the summer sampling period on L'Aigle Creek reflected the enduring pool situation. Significant physical characteristics include the deeply cut stream channel with sandy banks, sandy substrate, low stream gradient and high percentage of stream canopy.

Figure GC-22



1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

L'AIGLE CREEK: Drainage area 232 square miles ● Survey site Survey area

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 12-16, 1985; the spring survey was conducted during the week of March 24-28, 1986.

Continuous Dissolved Oxygen

Summer - Two continuously recording meters were set up to monitor the dissolved oxygen and temperature throughout the week. These meters were set up shortly after noon on August 12, 1985. Site #1 was approximately 50 yards upstream of the bridge, and Site #2 was located approximately 100 yards downstream of the bridge. Both meters were checked and calibrated daily. At Site #1, there were recurring problems with the pen sticking and the meter was subsequently pulled on August 14, 1985. At Site #2, a precipitate formed in the sampling probe on the second day; it was cleaned and a new membrane was installed before re-calibrating. Due to the lack of flow in L'Aigle Creek, both meters were measuring the dissolved oxygen and temperature of the pooled creek.

Results obtained during the survey week are displayed in Figures GC-23 and GC-24. Each graph displays the D.O., temperature and D.O. saturation for each meter for the survey period. Site #1 recording shows a fairly stable dissolved oxygen graph over the 24-hour period during which the meter functioned. The recording ranged from 1.8 mg/l to 2.8 mg/l with an average of 2.4 mg/l. Results from Site #2 displayed substantially more fluctuation with a range from 1.4 mg/l to 4.7 mg/l, averaging 2.4 mg/l over the survey period. The dissolved oxygen peaks are contrary to normal photosynthetic activity in that they occur at or near midnight and the minimums occur around noon. Summertime D.O. saturations ranged from 20-50% during the survey period.

Spring - On March 24, 1986, two meters were set up to measure the dissolved oxygen and temperature in L'Aigle Creek. Unlike the pooled conditions of summer, L'Aigle Creek was now flowing at approximately 189 cfs. Gauged estimates during the spring survey showed that the creek was falling steadily each day. Figures GC-25 and GC-26 display the dissolved oxygen, temperature and percent saturation for both sites during the survey. Graphs from both sites are relatively flat with minimum fluctuation. The dissolved oxygen concentrations are significantly higher during the spring conditions with both meters recording averages greater than 8.5 mg/l. The dissolved oxygen percent saturation averaged approximately 80%.

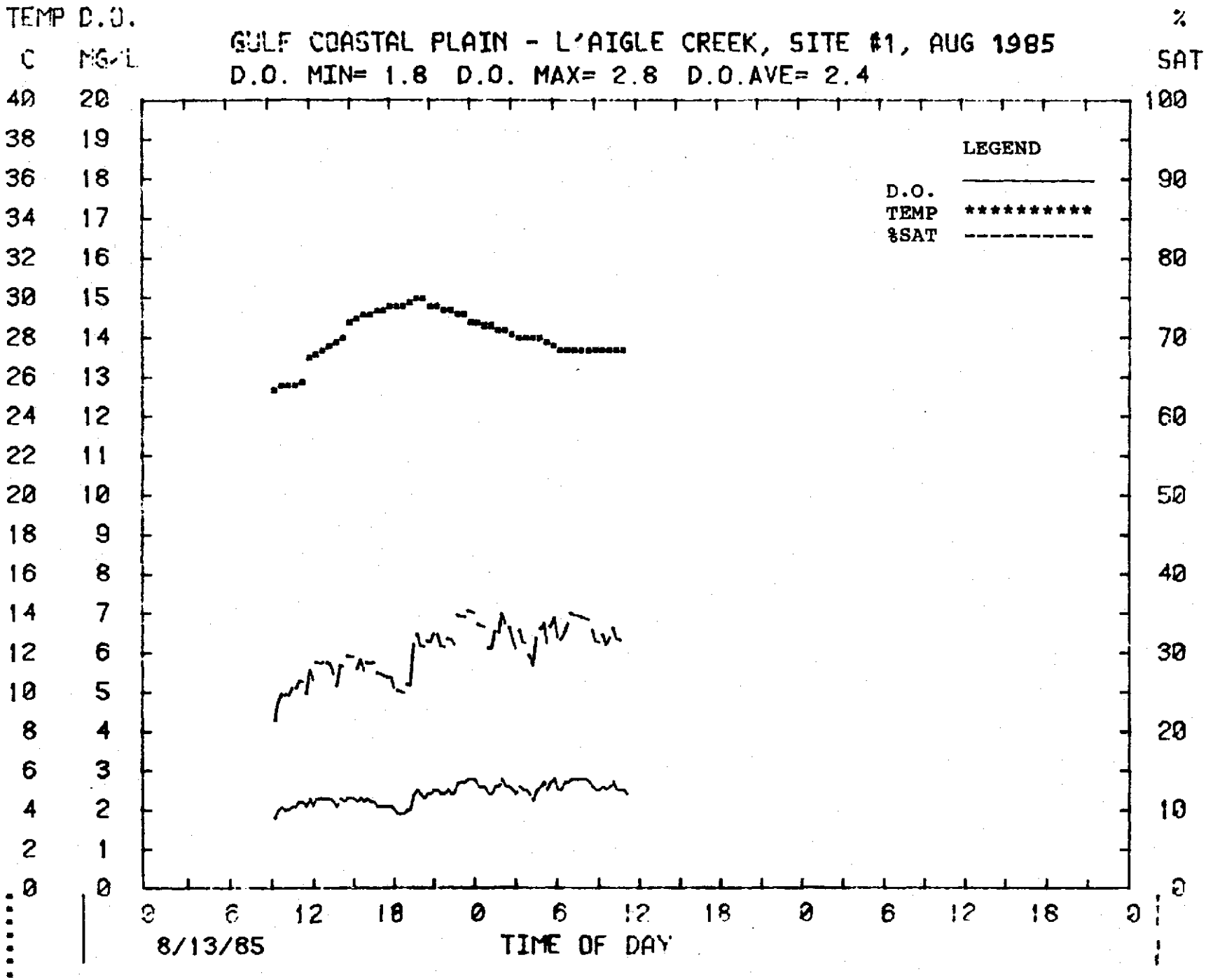


Fig. GC-23. Dissolved Oxygen Plot

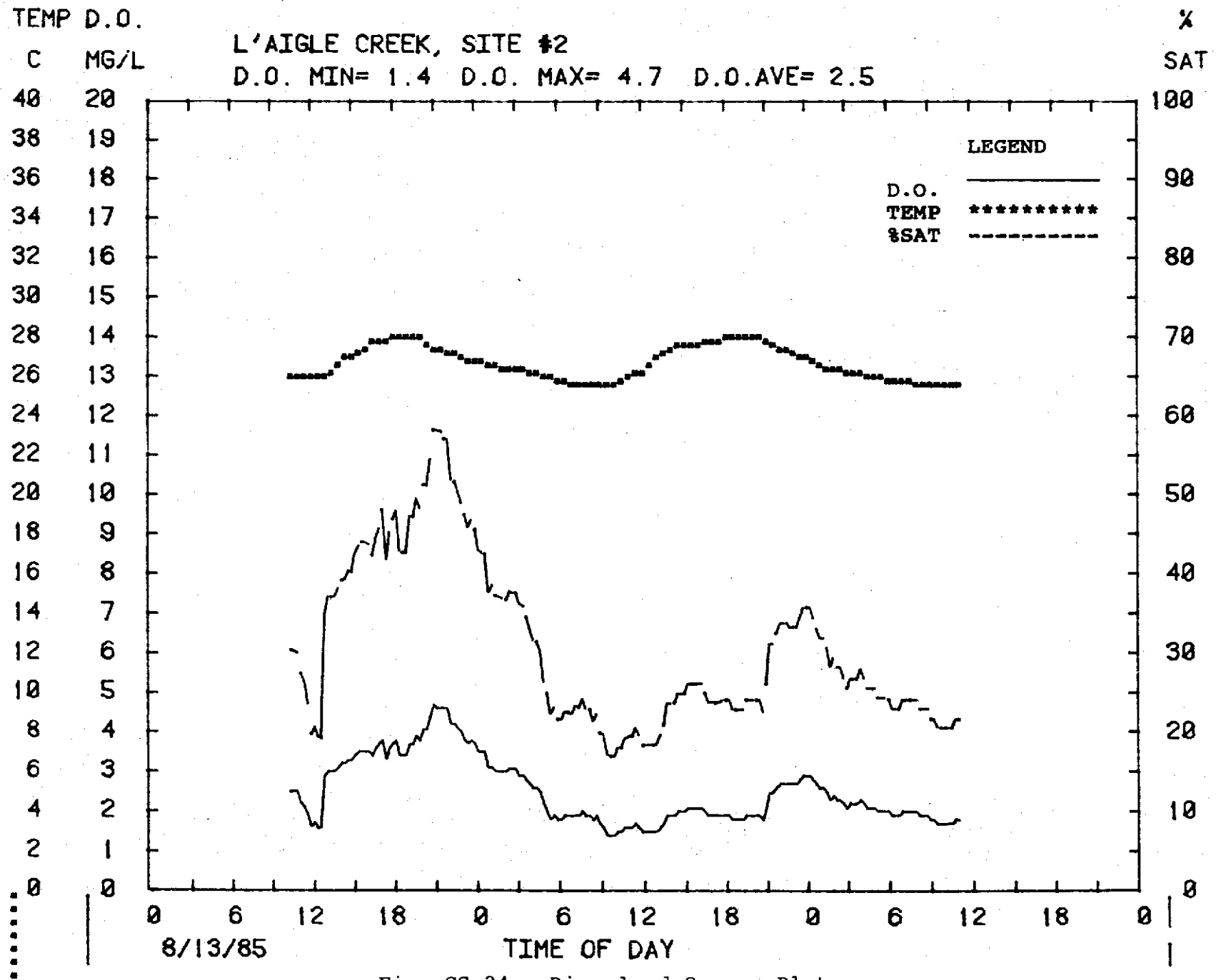


Fig. GC-24. Dissolved Oxygen Plot

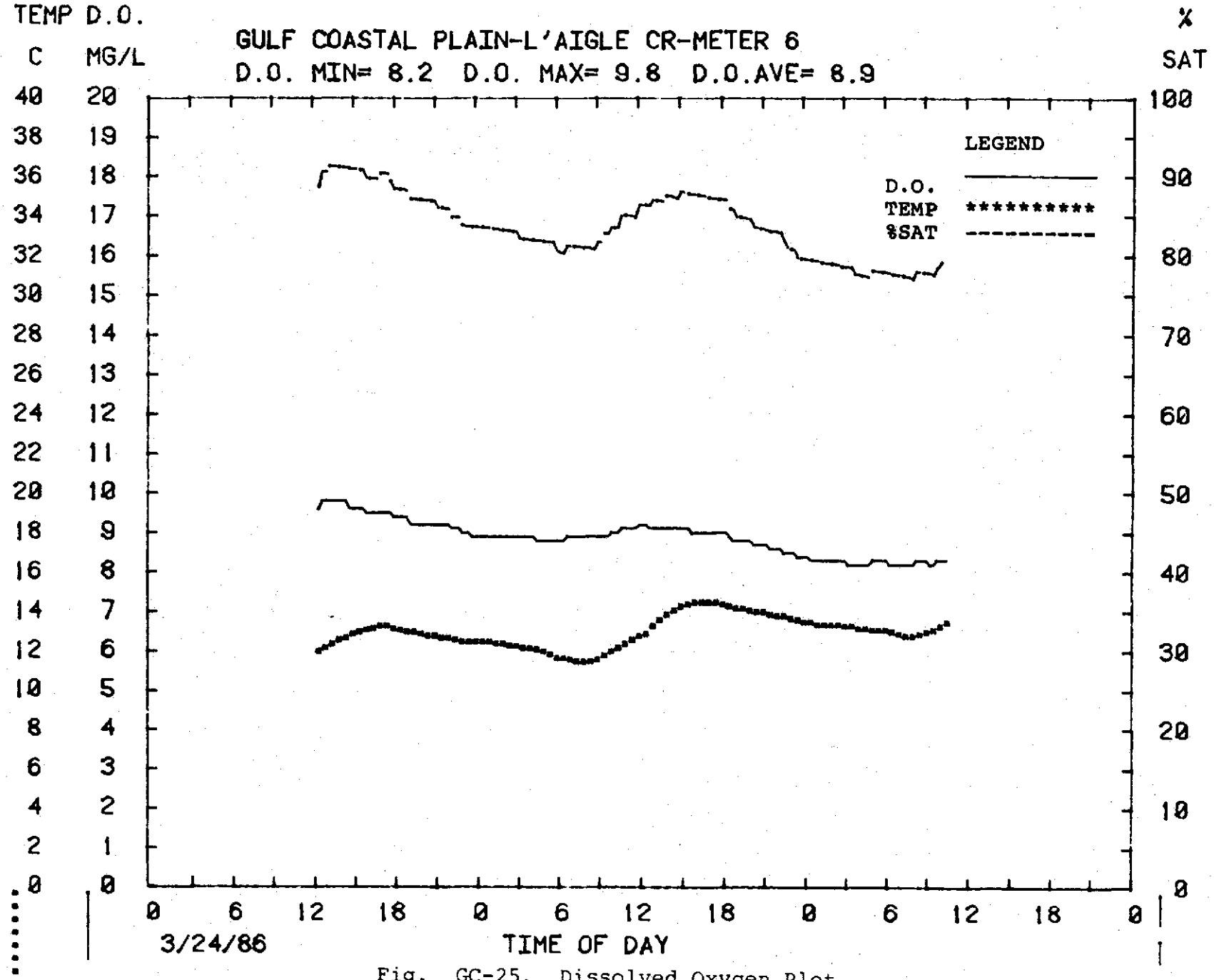


Fig. GC-25. Dissolved Oxygen Plot

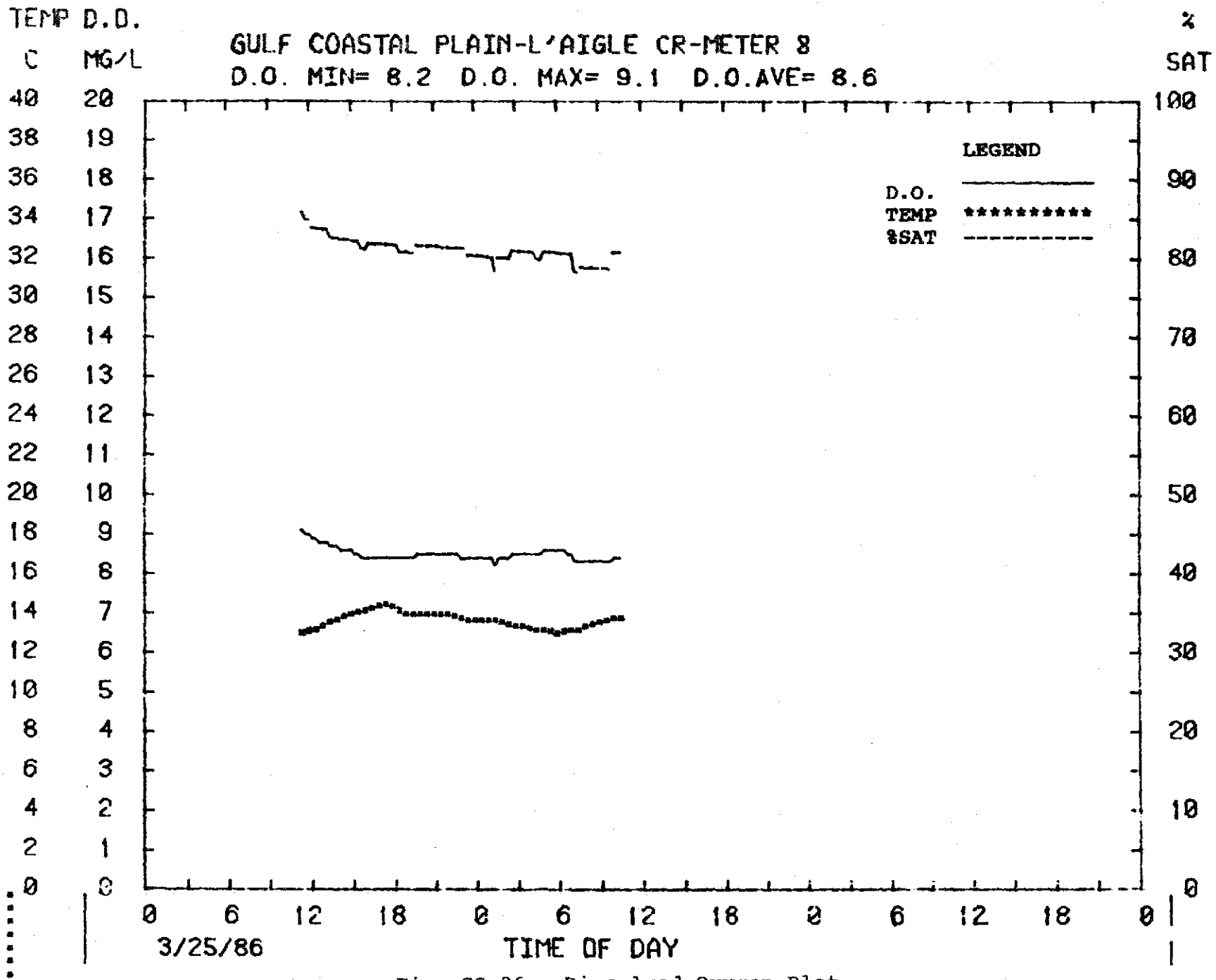


Fig. GC-26. Dissolved Oxygen Plot

Chemical Parameters

Summer - The chemical data shown for L'Aigle Creek is generally typical of other least-disturbed Gulf Coastal streams (Table GC-31). Because the predominant land use is forestland, the potential for nutrient contributions is minimal. This is reflected in the actual analysis for the various nutrients. Even with the low nutrient concentrations, there appears to be a significant phytoplankton population surviving in the enduring pools. Chlorophyll a measurements during the summer conditions averaged 12.3 µg/l. The photosynthetic activity of the phytoplankton appeared to buffer the normally acidic water to near neutral during these summer conditions. Mineral quality measured in L'Aigle Creek reveals very low concentrations of sulfates (9 mg/l), chlorides (5.5 mg/l) and total dissolved solids (64 mg/l). Measurements of biological oxygen demands were slightly high with the BOD_5 measuring 4 ppm and the BOD_{20} measuring 8.7 mg/l. Even though the water was relatively clear (turbidity was only 6.8 NTUs), the characteristic dark brown or "coffee" color was predominant. This characteristic is thought to be a condition related to the specific soil type within the watershed and the leaching of tannins, lignins and, perhaps, iron from these soils. The test for fecal coliforms indicated an insignificant number present and the stream is meeting the primary contact standard.

Spring - The spring samples were collected on March 25, 1986. Results are shown in Table GC-32. Water quality measured during the spring sampling period was only slightly different from the summer period. The most significant aspect of the stream was the volume of water. The stream was now flowing as opposed to the series of enduring pools found during the summer. The available flow is thought to be the main reason for the observed changes in water quality. The pH measurement was slightly more acidic during the spring sampling. BODs, both 5-day and 20-day, were less than one-half the concentrations measured during the summer period. Chlorophyll a concentrations dropped to only trace amounts during the spring survey. Nutrient levels were very low and showed no significant change from the summer period. Mineral quality measurements were very low with no significant change from the summer sampling. Fecal coliform concentrations increased slightly with the higher flow, but were well within the primary contact standard. Turbidity measurements were slightly higher in the spring sampling period, due to the added flow, but still well within water quality standards.

Physical Parameters

Physical evaluations were made during the week of August 12, 1985. L'Aigle Creek had reached a routine critical condition for the annual cycle. The stream had essentially stopped

Table GC-31

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: L'Aigle Creek

Drainage Area: 232 Square Miles

Station Description: County road bridge in Section 36, T 15 S, R 11 W, Bradley County

Date: August 13, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	08:30	09:45	10:45	
Q, cfs	0	0	0	No Flow
Temperature, °C	27	27	27	27
pH	6.6	7.0	6.9	6.8
Turbidity, ntu	7	11	11	9
TSS, mg/l	11	20	24	18
TDS, mg/l	59	67	66	64
BOD-5, mg/l	3.7	4.4	4.1	4.0
BOD-20, mg/l	7.6	9.7	8.9	8.7
T.Phos., mg/l	0.13	0.14	0.12	0.13
PO4-P, mg/l	0.06	0.06	0.06	0.06
NO2+NO3-N, mg/l	0.01	0.01	<0.01	0.01
NH3-N, mg/l	0.05	0.05	0.01	0.03
Cl -, mg/l	5	5.5	5.5	5.5
SO4 =, mg/l	10	9	9	9
Fe, mg/l	0.07	0.09	0.09	0.08
Conductivity,µmho	50	61	60	57
Alkalinity, mg/l	12	17	16	15
T. Hardness, mg/l	16	24	28	22
Chlorophyll a,µg/l	13.7	6.7	16.6	12.3
Fecal Coliform	-	-	20	20

Dissolved Oxygen Data for 13 - 14 Aug 1985		
	Site 1	Site 2
Average	2.4	2.2
Minimum	1.8	1.4
Maximum	2.8	3.7

Table GC-32

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: L'Aigle Creek

Drainage Area: 232 square miles

Station Description: County road bridge, Section 36, T 15 S, R 11 W, Bradley County

Date: March 25, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:30	10:55	11:35	
Q, cfs	189	189	189	189
Temperature, °C	13	13.5	14	13.5
pH	6.68	6.51	6.54	6.6
Turbidity, ntu	22	23	22	22
TSS, mg/l	20	12	12	15
TDS, mg/l	71	73	73	72
BOD-5, mg/l	1.4	1.3	1.3	1.3
BOD-20, mg/l	3.4	3.2	3.1	3.2
T.Phos., mg/l	0.06	0.07	0.07	0.07
PO4-P, mg/l	0.02	0.02	0.02	0.02
NO2+NO3-N, mg/l	0.07	0.07	0.07	0.07
NH3-N, mg/l	0.11	0.10	0.10	0.10
Cl -, mg/l	6.5	5.0	5.0	5.5
SO4 =, mg/l	9	11	11	10
Fe, mg/l	N/A	N/A	N/A	N/A
Conductivity,µmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	9	8	8	8
T. Hardness, mg/l	16	16	16	16
Chlorophyll a,µg/l	-	-	1.64	1.64
Fecal Coliform	-	-	100	100

Dissolved Oxygen Data for 25 Mar 1986		
	Meter 6	Meter 8
Average	8.9	8.6
Minimum	8.4	8.2
Maximum	9.2	9.1

flowing, forming standing water within the immediate streambed. Many of the secondary channels and sloughs off the main stream had already dried up. Table GC-33 contians the results of the physical evaluation on L'Aigle Creek. Many of these physical parameters can affect not only the use of the stream, but the chemical characteristics also. Characteristics which are common, not only to L'Aigle Creek but also the region, include: low stream gradient, high percentage of instream cover (brush, logs and debris) and moderate canopy covering the stream.

Macroinvertebrate Populations

Ninety-three (93) taxa representing 19 orders were identified from the summer and spring qualitative samples of the benthic community (Table A-10, Appendix A). Numerically, the dominant orders were Coleoptera, Odonata, Decapoda and Ephemeroptera, which comprised 19.6%, 16.9%, 16.3% and 15.2% of the organisms collected, respectively. Taxonomically, the dominant orders Coleoptera and Odonata were represented with 19 and 12 taxa, respectively. The dominant taxa were Palaemonetes kadiakensis (13.2%), Caenis (12.6%) and Uvarus (9.7%). Other taxa, not numerically dominant but considered ecologically characteristic of larger least-disturbed Gulf Coastal streams, include: Coptotomus, Hexagenia limbata, Libellula vibrans, Nigronia serricornis, Peltodytes and Sialis.

The comparative indices indicate significant homogenity between the summer-spring samples (Table GC-34). Of the 93 taxa identified from both sample, 73 and 72 were identified in the summer and spring samples, respectively. Of those, the 52 taxa identified from both samples comprised 88.6% of all organisms collected. The 21 and 20 taxa unique to the summer and spring samples, respectively, accounted for only 10.1% and 13.2% of those samples.

Summer - The dominant orders of the summer sample were Coleoptera, Odonata, Ephemeroptera and Decapoda, comprising 21.8%, 21.4% 20.5% and 10.7% of the sample, respectively. The dominant taxa were Caenis (17.6%), Uvarus (11.1%) and Palaemonetes kadiakensis (9.7%). Other taxa, not numerically dominant but ecologically characteristic and unique to the summer sample include Oecetis and Ranatra bueona.

Spring - The dominant orders of the spring benthic sample, Decapoda, Coleoptera and Amphipoda, comprised 25.8%, 15.9% and 10.4% of the sample, numerically. The dominant taxa of the spring benthic community were Palaemonetes kadiakensis (19.3%), Uvarus (23%) and Gammarus minus (8.7%). Other taxa, not numerically dominant but ecologically characteristic and unique to the spring sample include Haliplius, Nigronia serricornis and Perlesta placida. Two of the three dominant taxa of the spring sample were also dominants of the summer

Table GC-33

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	L'aigle Creek
Date:	8/13/85
Drainage Area:	232 square miles
Watershed Land Use:	7% Agriculture 91% Forest 2% Other
Stream Gradient:	2.6 fpm
Mean Channel Width:	89 feet
Mean Stream Width:	34 feet
Mean Stream Velocity:	NA
Observed Flow:	No Flow
Average Substrate Type:	31% Gravel 66% Mud 3% Detritus
Mean Instream Cover:	.5% Undercut Bank 20% Brush, Logs, Debris
Riffle/Pool Ratio of Transects:	40% Deep Pool 60% Moderate Pool
Mean Bank Overstory Cover:	81% Trees 51% Shrubs
Mean Bank Ground Cover:	54% Grass and Forbs 46% Dirt
Mean Bank Stability:	40% Stable 20% Moderate 40% Unstable
Mean Stream Canopy:	47% Canopy
Comments:	

sample. In addition, the majority of the characteristic taxa were present in both samples.

The combined diversity was 5.0437 and indicates the complexity of the benthic community. The community parameters were not signficantly different from summer to spring. The benthic population was extremely diverse and balanced both numerically and taxonomically. This is a result of the microhabitat availability, good water quality and the undisturbed nature of the watershed. The benthic community could best be described as composed mainly of taxa which have demonstrated wide tolerance to water quality parameters with a limited number of taxa which are characteristic of "good" water quality.

Table GC-34. Community Anaylsis of Benthic Samples from L'Aigle Creek - 30 minute Qualitative Samples, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	1710	1002	2712
Total # Taxa	73	72	93
Diversity	4.6489	4.9712	5.0437
Index of Evenness	0.4098	0.4256	0.4099
Index of Dominance	0.7511	0.8057	0.7713
Index of Variety	6.7040	7.1223	8.0665
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.72
Common Taxa Index (range 0-1)			0.71
Qualitative Similarity Index (range 0-100)			50.0

Fish Populations

Summer - The sample area at this location was an isolated pool approximately 250' X 20', with an average depth of three feet. Maximum depth was 6 feet and there was no flow between pools. Brush, logs and treetops were very abundant in the sample area. The pool was treated with 5 pounds of 5% active rotenone on August 14, 1985, and approximately 15 man-hours were spent picking up fish. The site was visited the following day and estimates made of the fish not recovered the first day.

Table GC-35 lists the 33 species of fish collected at this site with their relative abundance value. A total of 631 fish with a relative abundance value of 200 and a diversity index of 4.76 were collected. Centrarchidae was the dominant family of fishes taken. They comprised 32.3% of the relative abundance value (Table GC-36). Primary feeders made up only 3% of the population; however, 17% of the population was carnivorous fishes. Only two sensitive species were taken, which made up 4% of the total population. This population contained a very large percentage of harvestable size fish,

such as grass and chain pickerel, warmouth and bluegill sunfish and largemouth bass.

Spring - Four trammel nets with mesh sizes of 1½" or 2" square were fished overnight at this site on March 25, 1986. The streamflow was about 150 cfs; the channel was full and the water level was falling. Water temperature was 12 to 14°C. Eighteen spotted suckers and four largemouth bass weighing a total of 36.4 pounds were taken. Gonad development in the largemouth bass was in an advanced but not final stage. However, the majority of the spotted suckers were in the spawning process with a few indicating completion of spawning.

Table GC-35. Fishes Collected from L'Aigle Creek with Relative Abundance Values

Species		R.A. VALUE
Ictalurus natalis	Yellow bullhead	12.0
Esox americanus	Grass pickerel	12.0
Minytrema melanops	Spotted sucker	12.0
Lepomis macrochirus	Bluegill	12.0
Lepomis gulosus	Warmouth	10.5
Centrarchus macropterus	Flier	10.5
Esox niger	Chain pickerel	10.0
Aphredoderus sayanus	Pirate perch	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
Gambusia affinis	Mosquitofish	9.0
Lepomis punctatus	Spotted sunfish	9.0
Micropterus salmoides	Largemouth bass	7.5
*Etheostoma collettei	Creole darter	7.0
Etheostoma gracile	Slough darter	7.0
Lepomis cyanellus	Green sunfish	6.0
Etheostoma whipplei	Redfin darter	6.0
Notropis fumeus	Ribbon shiner	6.0
Fundulus notatus	Blackstripe topminnow	6.0
Lepomis megalotis	Longear	6.0
Etheostoma chlorosomum	Bluntnose darter	4.5
Etheostoma proeliare	Cypress darter	4.5
Hybognathus hayi	Cypress minnow	4.0
Notropis atherinoides	Emerald shiner	4.0
Amia calva	Bowfin	2.5
Pomoxis nigromaculatus	Black crappie	2.0
Notropis texanus	Weed shiner	2.0
Erimyzon oblongus	Creek chubsucker	2.0
Notropis emiliae	Pugnose minnow	2.0
Notemigonus crysoleucas	Golden shiner	2.0
Noturus gyrinus	Tadpole madtom	1.0
Elassoma zonatum	Banded pygmy sunfish	1.0
Labidesthes sicculus	Brook silversides	1.0
*Percina sciera	Dusky darter	1.0

*Sensitive species

Table GC-36. Summary of Fish Population Parameters from L'Aigle Creek

Total Species Collected	33.0
Total Number of Individuals	631.0
Total Relative Abundance Value	200.0
Relative Abundance Diversity Index	4.76

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6.0	10.0
CATOSTOMIDAE	2.0	7.0
ICTALURIDAE	2.0	6.5
CENTRARCHIDAE	9.0	32.3
PERCIDAE	6.0	15.0
Primary Feeders	2.0	3.0
Macroinvertebrate Feeders	26.0	80.0
Carnivores	5.0	17.0
Sensitive Species	2.0	4.0

MORO CREEK

Moro Creek begins in the northeast corner of Dallas County flowing south and forming the Dallas-Cleveland, Calhoun-Cleveland and Bradley-Calhoun county lines before its confluence with the Ouachita River. The sample site for Moro Creek was located at the Highway 160 bridge (Figure GC-27).

General Site Discussion

Watershed Size - The watershed size of Moro Creek above the highway bridge is 423 mi^2.

Geology - Surface geology in the Moro Creek watershed is composed of two main types. The headwater area is underlain by deposits of the Cockfield Formation of Eocene Age with alluvial deposits of Quaternary Age covering the creek bed and banks.

Topography - Topography within the Moro watershed is generally level to gently rolling sand hills with broad streamside wetland areas directly adjacent to the creek.

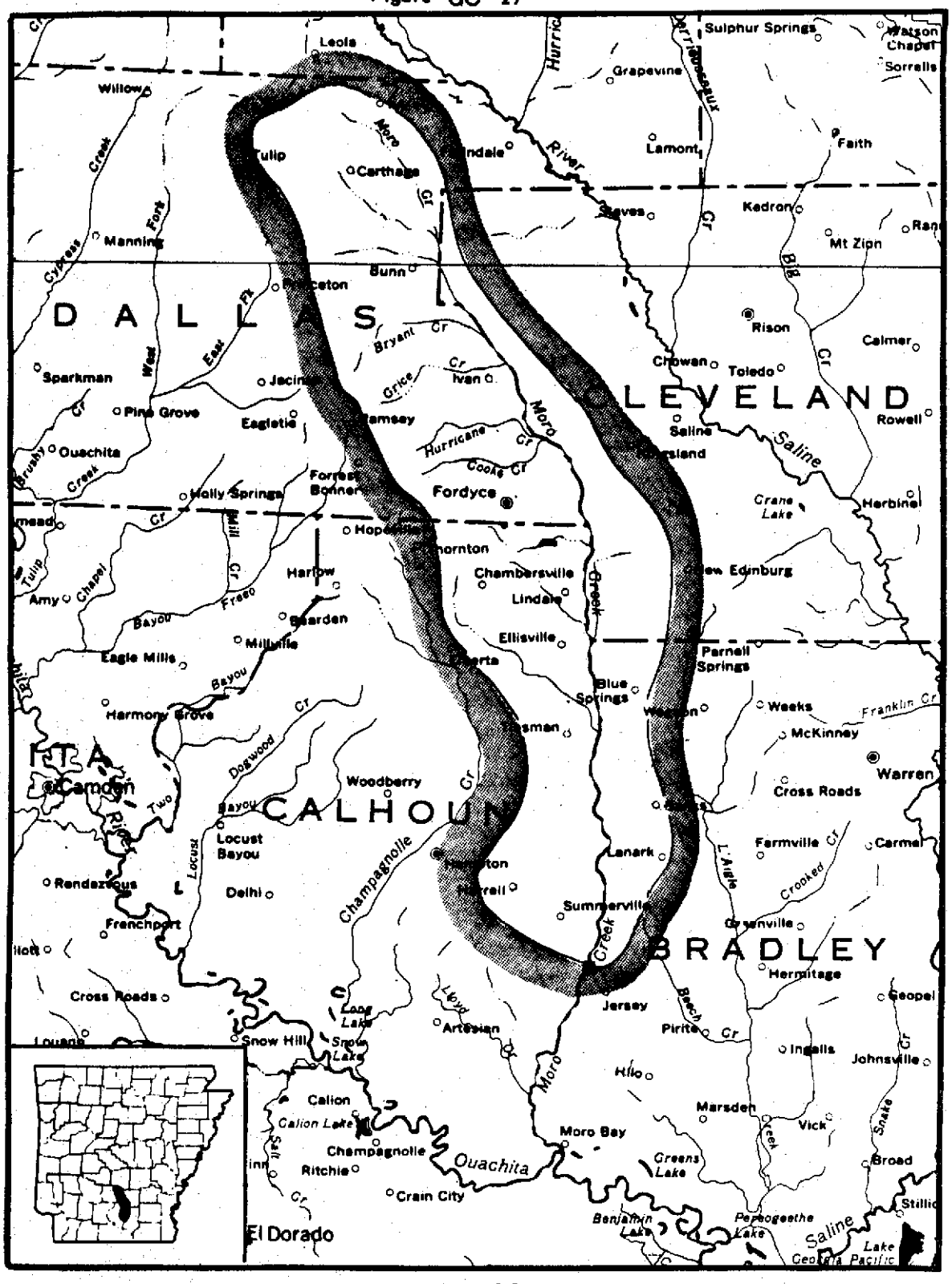
Soil Types - Soil types within the upper drainage of Moro Creek are predominantely the Amy-Smithton-Pheba association. This association is composed of poorly drained and somewhat poorly drained, level to nearly level, loamy soils on uplands. The immediate floodplain of Moro Creek consists of the Guyton association which are poorly drained, level, loamy soils on bottomlands. The lower portion of the Moro drainage continues to have sections of the Amy-Smithton-Pheba soil association as well as Sacul-Smithdale and Savannah-Ruston-Smithdale associations mixed throughout. The Sacul-Smithdale association is moderately well-drained and well-drained, nearly level to moderately steep, loamy soils on uplands. The Savannah-Ruston-Smithdale association consists of moderately well-drained and well-drained, nearly level to moderately sloping, loamy soils on uplands.

Flora - Loblolly pine and sweetgum trees dominate the forest in the upland areas of the basin. The lower overflow wetland areas are dominated by oak, hickory, beech and cypress.

Land Use - Land use within the watershed is 91% forest and 7% agriculture, according to the Soil Conservation Service. The predominant agricultural use is pastureland. The Moro Creek watershed has a very low level of man-induced disturbance and is, therefore, a good location to measure least-impaired conditions for the Gulf Coastal region.

Stream Characteristics - The 1983 USGS stream flow map shows Moro Creek to have a Q_{7-10} of zero. Typically, Gulf Coastal streams stop flowing in the late summer and a series of enduring pools develop. Conditions during the summer survey on Moro Creek followed this pattern. Significant physical

Figure GC-27



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

MORO CREEK: Drainage area 451 square miles ■ Survey site ▒ Survey area

characteristics include the deeply cut meandering stream channel, sandy substrate, low stream gradient, high percentage of instream cover (brush, logs and debris) and high percentage of stream canopy. Significant chemical characteristics include the low hardness, alkalinity and conductivity measurements. Very low concentrations of nutrients and minerals are characteristic of these waters. The BODs, both 5-day and 20-day, were slightly higher than expected in these streams and were suspected to contribute to the low dissolved oxygen measurements recorded at this site. The water had the typical dark coffee color, but the black scum was less prominent at this site and there seemed to be at least an equal amount of duckweed floating on the water's surface.

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 1, 1985; the spring survey was conducted during the week of March 24, 1986.

Continuous Dissolved Oxygen

Summer - Two continuously recording meters were set up to monitor the dissolved oxygen and temperature during the week. One meter was set up approximately 300 yards upstream of the Highway 160 bridge. Site #2 was located downstream at the lower end of the large pool under the bridge. Both meters functioned properly for the survey period. The meters were checked and calibrated daily. Results obtained during the survey week are displayed in Figures GC-28 and GC-29. Each figure displays the D.O., temperature and percentage of D.O. saturation for each meter for the survey period.

The two figures are distinctly different. Site #1, located in the upstream section where the stream has an almost full canopy, is thought to be more representative. The recording is very stable or flat with only minor changes due to temperature changes. Site #2 downstream is atypical because the large pool at the cleared highway right-of-way allows full sunlight and increased wind action on this stream segment. The figure which displays data from #2 Site shows a classical diurnal fluctuation related to the photosynthetic process. The D.O. at Site #1 ranged from 1.9 to 2.4 mg/l and averaged 2.1 mg/l. The range of D.O. at Site #2 was from 2.8 to 5.9 mg/l and averaged 4.1 mg/l. D.O. saturations ranged from 20-30% at Site #1 and 40-70% at Site #2.

Spring - On March 24, 1986, two meters were set up to measure the dissolved oxygen and temperature in Moro Creek. Site #1 was located approximately 300 yards above the Highway 160 bridge and Site #2 was located approximately 300 yards downstream of the bridge. Unlike the pooled conditions of summer, Moro Creek was now estimated to be flowing at 350 cfs. The staff gauge which was set for this survey indicated that the creek was falling slowly during the week. Figures GC-30 and GC-31 display the dissolved oxygen, temperature and percent saturation for both sites during the survey period. No significant differences are found between the two sites. These spring conditions are distinctly different from those observed during the summer period. Dissolved oxygen

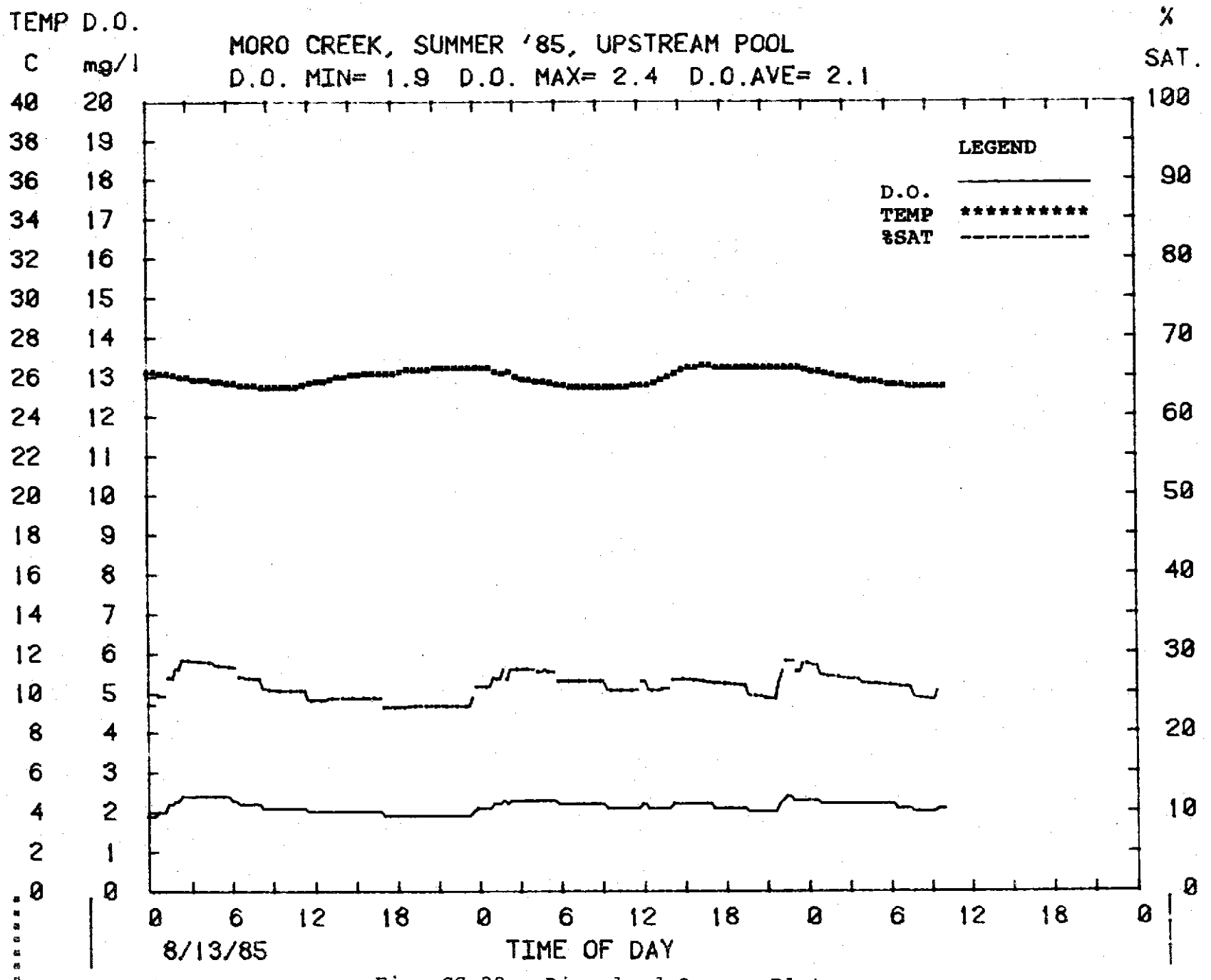


Fig. GC-28. Dissolved Oxygen Plot

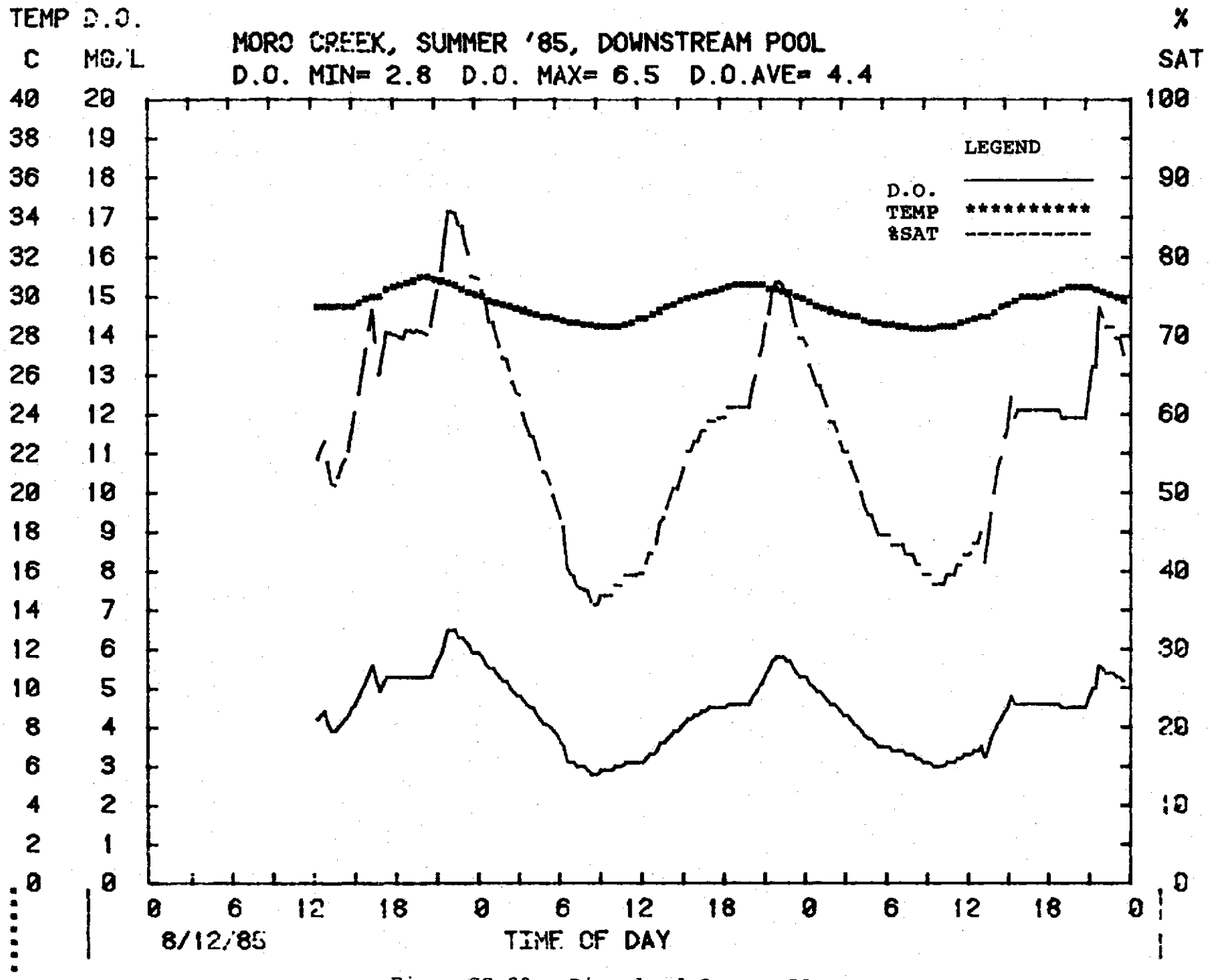


Fig. GC-29. Dissolved Oxygen Plot

These spring conditions are distinctly different from those observed during the summer period. Dissolved oxygen concentrations are much higher under these springtime conditions, mainly due to the additional flow. Average D.O. from both sites was approximately 9 mg/l. Dissolved oxygen percent saturation averaged 80-90%.

Chemical Parameters

Summer - Chemical data collected during the summer sampling period on August 13, 1985 are displayed in Table GC-37. The BOD_5 and BOD_{20} were 1.7 mg/l and 4.2 mg/l, respectively. The nutrient concentrations were very low. This site had a noticeable growth of duckweed floating on the water's surface. Mineral quality in Moro Creek reveals very low lelvels of sulfates (8 mg/l), chlorides (4.6 mg/l) and total dissolved solids (62 mg/l). Alkalinity and total hardness concentrations indicate that Moro Creek has very soft water with very little buffering capacity. The characteristic dark brown color, common throughout waters of the Gulf Coastal Region, was evident at this site. The test for fecal coliform bacteria indicated that the water was meeting the primary contact standard.

Spring - The spring samples were collected on March 25, 1986. Results are shown in Table GC-38. Water quality measured during the spring sampling period was only slightly different from the summer period. The most significant change in the stream was the volume of water now present. The stream was actually flowing as opposed to the series of enduring pools found during the summer. Chemical analyses from spring sampling revealed very little change from the summer analyses.

Physical Parameters

Physical evaluations were made during the week of August 12, 1985. Moro Creek had reached a routine critical condition for the annual cycle. The stream had essentially stopped flowing, forming standing water within the immediate streambed. Many of the secondary channels and sloughs off the main stream had already dried up. Table GC-39 displays the results of the physical evaluations on Moro Creek. Many of these physical parameters affect not only the use of the stream, but the chemical characteristics also. Characteristics which are common, not only to Moro Creek but also the region are: low stream gradient, high percentage of instream cover (brush, logs and debris) and moderate canopy covering the stream.

Macroinvertebrate Populations

Ninety-eight (98) taxa, representing 21 orders, were identified from the summer and spring samples of the benthic community (Table A-11, Appendix A). Numerically, the dominant orders of the combined samples, Coleoptera, Decapoda and Ephemeroptera comprised 31.8%, 18.4% and 13.2% of the sample, respectively. Taxonomically, Coleoptera was represented by

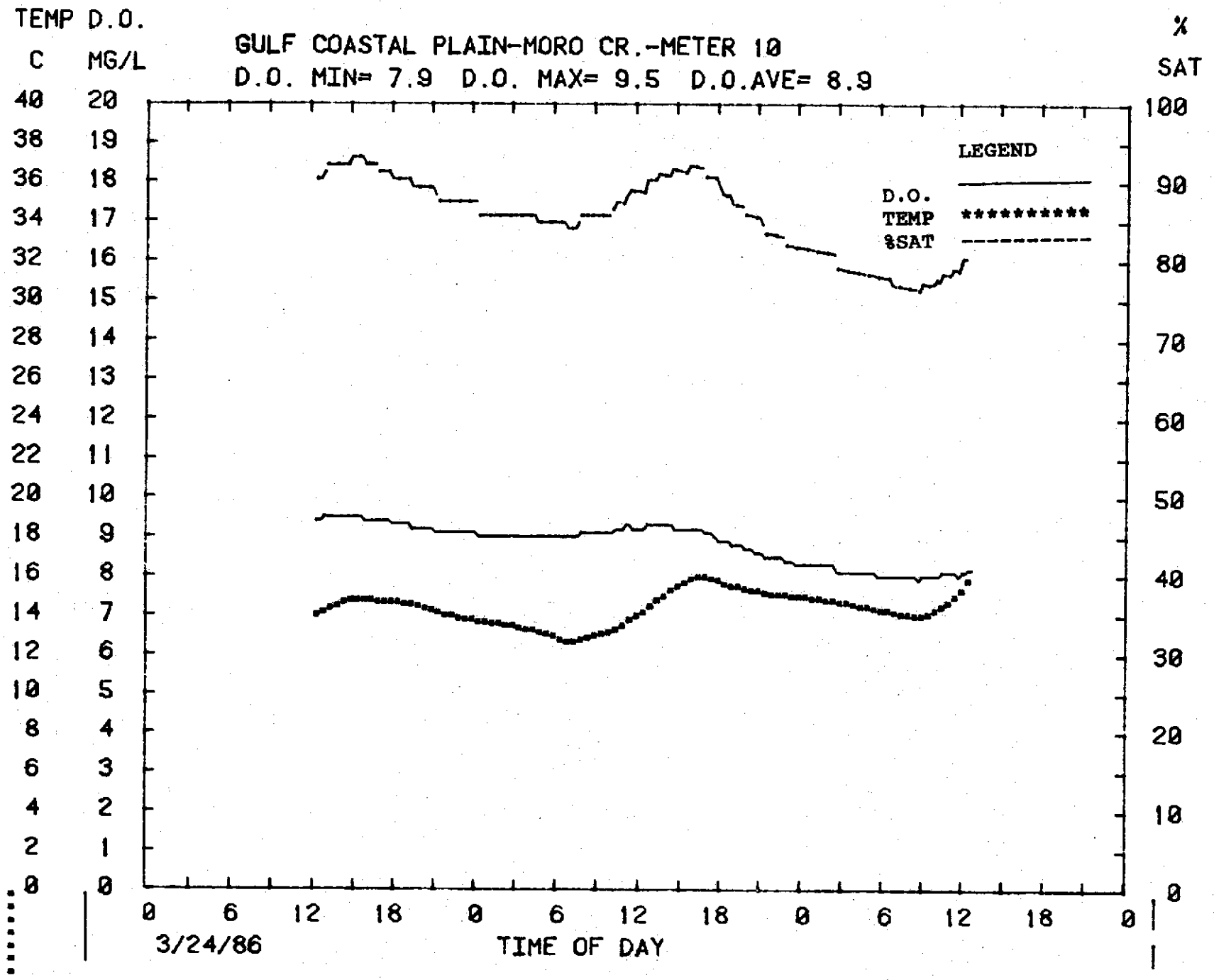


Fig. GC-30. Dissolved Oxygen Plot

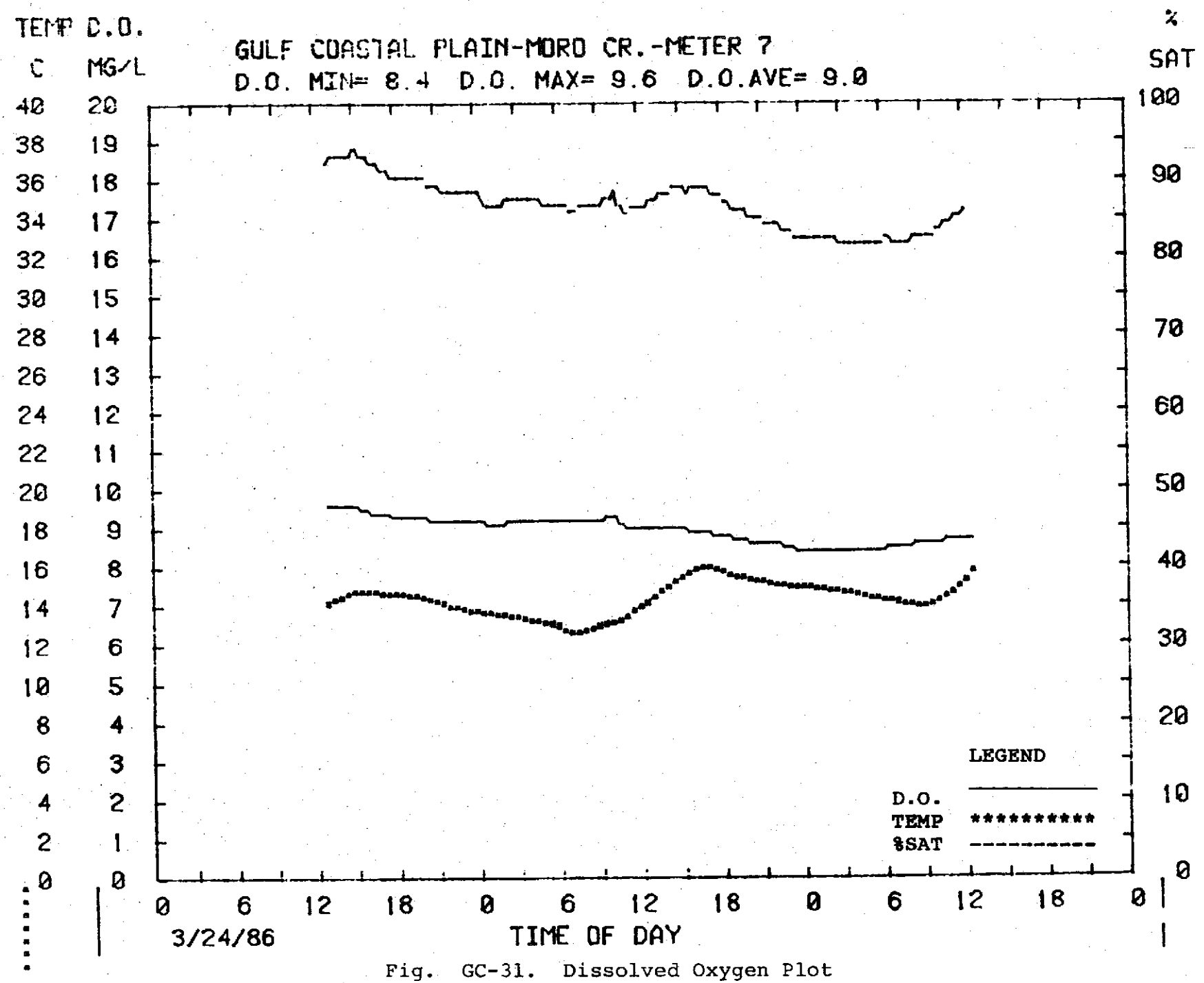


Fig. GC-31. Dissolved Oxygen Plot

Table GC-37

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Moro Creek

Drainage Area: 423 Square Miles

Station Description: Hwy. 160 bridge in Section 9, T 15 S, R 12 W, Bradley-Calhoun County line.

Date: August 13, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:55	10:50	11:30	
Q, cfs	0	0	0	No Flow
Temperature, °C	25	26.5	26.5	26
pH	6.7	6.7	6.8	6.7
Turbidity, ntu	8	10	8	8
TSS, mg/l	8	8	6	7
TDS, mg/l	60	59	65	62
BOD-5, mg/l	1.8	1.6	1.8	1.7
BOD-20, mg/l	4.4	4.0	4.2	4.2
T.Phos., mg/l	0.12	0.11	0.11	0.11
PO4-P, mg/l	0.07	0.07	0.07	0.07
NO2+NO3-N, mg/l	0.05	0.05	0.05	0.05
NH3-N, mg/l	0.09	0.09	0.08	0.09
Cl -, mg/l	5	4.5	4.5	4.6
SO4 =, mg/l	8	8	8	8
Fe, mg/l	0.07	0.07	0.07	0.07
Conductivity,µmho	61	60	60	60
Alkalinity, mg/l	21	20	20	20
T. Hardness, mg/l	22	20	28	23
Chlorophyll a,µg/l	15.3	2.0	void	5.7
Fecal Coliform			64	64

Dissolved Oxygen Data for 13 Aug 1985		
	Upstream	Downstream
Average	2.1	4.2
Minimum	1.9	2.8
Maximum	2.4	5.9

Table GC-38

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Moro Creek

Drainage Area: 451 square miles

Station Description: Hwy 160 bridge, Section 9, T 15 S, R 12 W, Bradley-Calhoun County line

Date: March 25, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:15	10:35	11:09	
Q, cfs	350 Est			350 Est
Temperature, °C	14	14	14	14
pH	6.44	6.44	6.49	6.5
Turbidity, ntu	17	17	17	17
TSS, mg/l	11	14	12	12
TDS, mg/l	78	67	72	72
BOD-5, mg/l	1.5	2.2	1.7	1.8
BOD-20, mg/l	3.4	4.2	3.9	3.8
T.Phos., mg/l	0.06	0.06	0.06	0.06
PO4-P, mg/l	0.01	0.02	0.01	0.01
NO2+NO3-N, mg/l	0.04	0.05	0.04	0.04
NH3-N, mg/l	0.06	0.09	0.06	0.07
Cl -, mg/l	6.5	7.0	7.0	7.0
SO4 =, mg/l	11	12	11	11
Fe, mg/l	N/A	N/A	N/A	N/A
Conductivity,µmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	8	8	8	8
T. Hardness, mg/l	14	16	16	15
Chlorophyll a,µg/l	-	-	3.65	3.65
Fecal Coliform	-	-	40	40

Dissolved Oxygen Data for 25 Mar 1986		
	Meter 10	Meter 7
Average	9.0	9.0
Minimum	8.3	8.4
Maximum	9.3	9.3

Table GC-39

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Moro Creek
Date:	8/13/85
Drainage Area:	423 Square Miles
Watershed Land Use:	7% Agriculture 91% Forest
Stream Gradient:	1.6 fpm
Mean Channel Width:	96 feet
Mean Stream Width:	35 feet
Mean Stream Velocity:	NA
Observed Flow:	No Flow
Average Substrate Type:	26% Gravel 58% Sand 16% Mud/Silt
Mean Instream Cover:	61% Brush, Logs, Debris
Riffle/Pool Ratio of Transects:	20% Riffle 40% Moderate Pool 40% Shallow Pool
Mean Bank Overstory Cover:	95% Trees 12% Shrubs
Mean Bank Ground Cover:	30% Grass and Forbs 70% Dirt
Mean Bank Stability:	60% Stable 40% Moderate
Mean Stream Canopy:	71% Canopy
Comments:	

almost twice as many taxa as any other order. The dominant taxa common to both summer and spring were Uvarus (13.6%), Palaemonetes kadiakensis (13.1%) and Caenis (9.6%). Seasonal variation resulted in significant differences between the summer and spring benthic communities. Of the 99 taxa identified from the combined sample, 70 and 68 taxa were identified from the summer and spring samples, respectively. Of those, 40 taxa were present in both samples and comprised 84.8% of the organisms identified. The 30 and 28 taxa unique to the summer and spring benthos comprised 17.0% and 12.9% of their respective samples. However, the taxonomic distribution between summer and spring dominant orders remained almost identical. The dominant orders of the summer benthic community were Coleoptera (39.5%) and Ephemeroptera (19.9%). The dominant taxa of the summer sample were Uvarus (18.2%), Caenis (15.1%), Hydrovatus (8.0%) and Palaemonetes kadiakensis (7.7%). Other taxa, not numerically dominant but considered ecologically characteristic, includes Coptotomus, Hexagenia limbata, Peltodytes lengi and Sialis.

Spring - The dominant orders of the spring benthic sample were Decapoda (29.7%), Coleoptera (22.1%) and Amphipoda (12.0%). Only Palaemonetes kadiakensis comprised more than 10% of the spring sample. Other taxa considered ecologically characteristic included Gammarus minus, Peltodytes lengi, Sialis and Uvarus.

Analysis of the community parameters indicated a stable, balanced macroinvertebrate assemblage (Table GC-40). The diversity of all samples was at or above 4.5. The majority of the taxa have been shown to exhibit wide tolerance ranges for a variety of water quality parameters, but the diversity and uniform distribution within the ecological feeding groups are representative of the undisturbed nature of the watershed.

Table GC-40. Community Anaylsis of Benthic Samples from Moro Creek - 30 minute Qualitative Samples, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	1082	1720	2802
Total # Taxa	70	68	98
Diversity	4.4975	4.6438	4.9353
Index of Evenness	0.4687	0.4884	0.4479
Index of Dominance	0.7337	0.7628	0.7461
Index of Variety	6.8456	6.7831	8.8801
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.58
Common taxa Index (range 0-1)			0.57
Qualitative Similarity Index (range 0-100)			39.0

Fish Populations

Summer - The sample area on Moro Creek was approximately 400 feet long, 30 feet wide and had an average depth of 2½ feet. It included a large pool connected to a small pool. There was a very slight flow out of the sample area. Approximately 6 pounds of 5% active rotenone were used to sample the population and approximately 15 man-hours were required to pick up the fish.

Forty-nine species were collected during this sample and one additional species was collected in the spring sample (Table GC-41). A total of 1260 specimens were taken on August 14, 1985, with a total relative abundance value of 283 and a diversity index of 5.38. This sample produced the largest species list, the highest relative abundance value and the highest diversity index of any sample of the project. Cyprinidae, Percidae and Centrarchidae provided similar proportions of the total population relative abundance (Table GC-42). Five species of primary feeders made up 8.5% of the population and five species of carnivores made up 11.8% of the population. The remainder of the population was macroinvertebrate feeders. Eight sensitive species were collected which comprised 11.8% of the total population.

Spring - Sampling was done at the site on March 24-25, 1986, using four trammel nets of 1½"(2), 2" and 3½" square mesh. Water temperature ranged from 13 to 16°C and the flow was 300 to 400 cfs.

Nets were set overnight and captured 31 specimens totalling 48.7 pounds and representing 7 species. White crappie were taken in this sample; this species had not been collected in the summer sample. Approximately one-half of the spotted suckers collected had completed spawning and the remainder were in the process of spawning. Chain pickerel and bowfin had completed spawning and the black and white crappie were in the advanced stages of gonad development.

Table GC-41. Fishes Collected from Moro Creek with Relative Abundance Values

Species		R.A. VALUE
Minytrema melanops	Spotted sucker	12.0
Notropis texanus	Weed shiner	12.0
Notropis fumeus	Ribbon shiner	12.0
*Etheostoma collettei	Creole darter	11.0
Aphredoderus sayanus	Pirate perch	10.5
Lepomis gulosus	Warmouth	10.0
Hybognathus hayi	Cypress minnow	9.0
Hybognathus nuchalus	Silvery minnow	9.0
*Percina sciera	Dusky darter	9.0
Lepomis macrochirus	Bluegill	9.0
Percina caprodes	Logperch	9.0
Ictalurus natalis	Yellow bullhead	9.0
Etheostoma chlorosomum	Bluntnose darter	9.0
Fundulus olivaceus	Blackspotted topminnow	8.0
Etheostoma whipplei	Redfin darter	7.5

Table GC-41, cont.

Gambusia affinis	Mosquitofish	7.5
Pomoxis nigromaculatus	Black crappie	7.0
Micropterus salmoides	Largemouth bass	7.0
Esox americanus	Grass pickerel	7.0
Notropis emiliae	Pugnose minnow	7.0
Lepomis megalotis	Longear	6.5
Amia calva	Bowfin	6.5
Fundulus notatus	Blackstripe topminnow	6.0
Esox niger	Chain pickerel	6.0
Centrarchus macropterus	Flier	5.0
Aplodinotus grunniens	Freshwater drum	5.0
Notropis chrysocephalus	Striped shiner	5.0
*Percina maculata	Blackside darter	5.0
Lepomis punctatus	Spotted sunfish	4.5
Etheostoma gracile	Slough darter	4.0
Pimephales vigilax	Bullhead minnow	4.0
Lepomis cyanellus	Green sunfish	4.0
Etheostoma proellare	Cypress darter	4.0
Labidesthes sicculus	Brook silversides	4.0
Notemigonus crysoleucas	Golden shiner	4.0
Elassoma zonatum	Banded pygmy sunfish	4.0
Noturus nocturnus	Freckled madtom	3.0
Erimyzon oblongus	Creek chubsucker	2.5
*Percina ouachitae	Saddleback darter	2.5
Percina shumardi	River darter	2.0
*Moxostoma poecilurum	Blacktail redhorse	2.0
Cyprinus carpio	Carp	2.0
*Ammocrypta vivax	Scaly sand darter	2.0
Notropis umbratilis	Redfin shiner	2.0
Noturus gyrinus	Tadpole madtom	2.0
*Ammocrypta asprella	Crystal darter	1.0
*Notropis amnis	Pallid shiner	1.0
Notropis venustus	Blacktail shiner	1.0
Moxostoma erythrurum	Golden redhorse	1.0
Pomoxis annularis	White crappie	S

* - Sensitive species
S - Collected in spring sample only

Table 42. Summary of Fish Population Parameters from Moro Creek

Total Species Collected	50.0
Total Number Of Individuals	1260.0
Total Relative Abundance Value	283.0
Relative Abundance Diversity Index	5.38

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	12.0	24.0
CATOSTOMIDAE	4.0	6.2
ICTALURIDAE	3.0	4.9
CENTRARCHIDAE	10.0	20.1
PERCIDAE	12.0	23.3
Primary Feeders	5.0	8.5
Macroinvertebrate Feeders	40.0	79.7
Carnivores	5.0	11.8
Sensitive Species	8.0	11.8

GULF COASTAL STREAMS RECEIVING SIGNIFICANT GROUNDWATER FLOW

The East Fork of Tulip Creek and Cypress Creek are two streams within the Gulf Coastal Region which maintain a perennial flow. These streams represent a unique category of streams within the region because of their substantial, constant flows from groundwater contributions. The following data characterizes these two stream systems.

EAST FORK TULIP CREEK

The sample site on East Fork of Tulip Creek was in Dallas County in Section 19, R 15 W, T 9 S at the county road bridge (Figure GC-32). The creek begins in northern Dallas County and flows in a southerly direction, merging with watersheds from the east. It forms a confluence with West Tulip Creek 8 to 10 air miles below the sample site where the flow continues southward to the Ouachita River in the northern section of Ouachita County.

General Site Discussion

Watershed Size - The East Tulip watershed covers 46 square miles above the sample site location.

Geology - Surface geology in the Tulip Creek drainage basin is in the outcrop area of the Sparta Sand Formation of Eocene Age. This interbedded sand and clay deposit is considered lignitic. The creek bed and banks are covered with alluvial deposits of Quaternary Age.

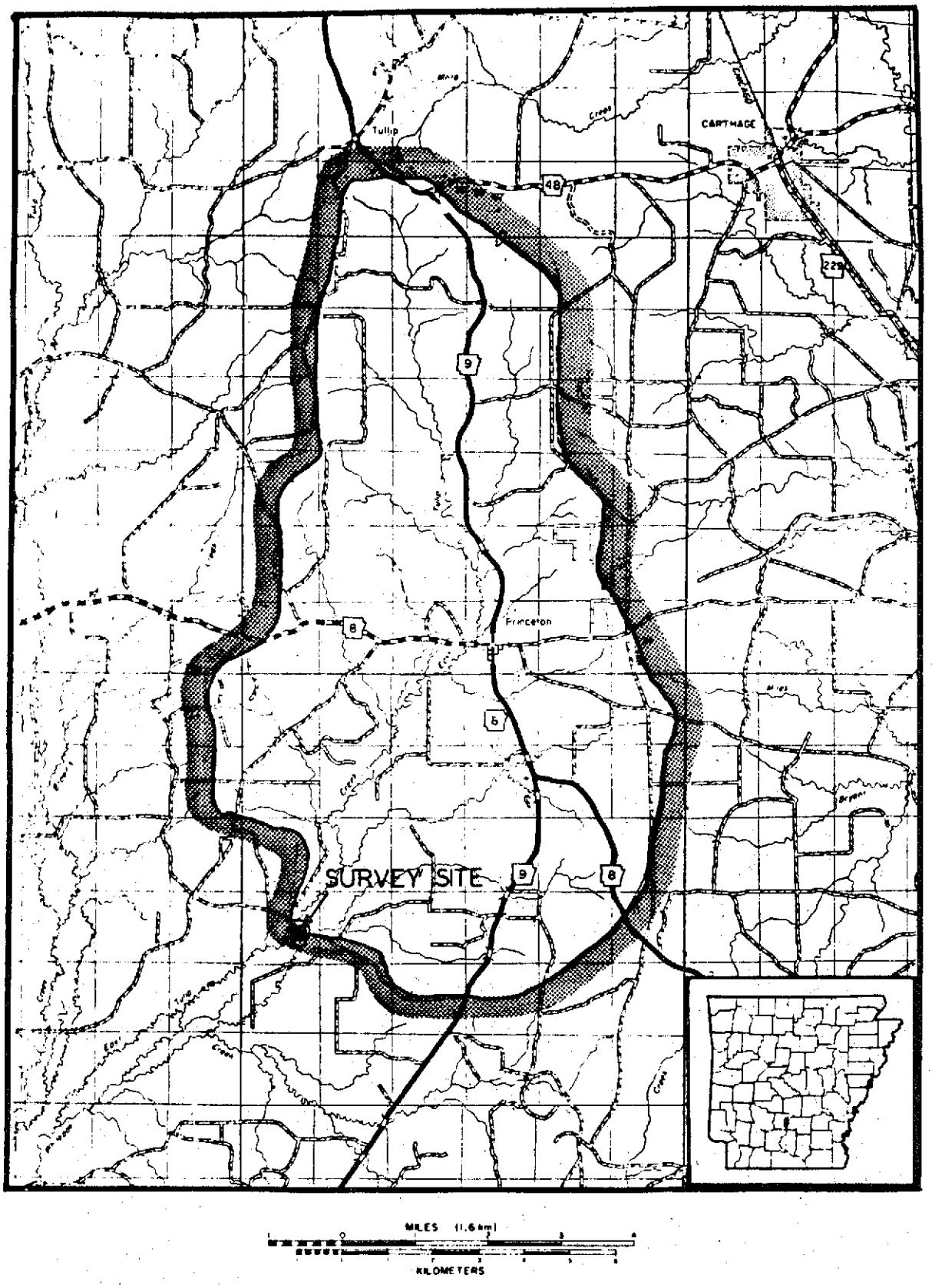
Topography - Land form topography is generally level to gently rolling sand and clay hills with broad streamside wetland areas directly adjacent to the creek.

Soil Types - Tulip Creek is in an area dominated by the Amy-Smithton-Pheba association of soils, a mixture of gravel, sand, silt and clay. These soils in upland areas are generally loamy, poorly drained to somewhat poorly drained and level to nearly level. The erosion factor is slight for these soils. The soils in this association range from strongly acidic to very strongly acidic (pH is in the range of 4.5 to 5.0).

Flora - Loblolly pine and sweetgum trees dominate the forest in the upland areas of the basin. Streamside overflow wetland areas are dominated by beech, oak, and hickory trees.

Land Use - Land use in the basin, according to S.C.S. data, is 96% silviculture and 4% agriculture. Agricultural uses are predominantly pastureland. Overall, the basin has a low level of man-induced disturbances and represents a least-impaired

Figure GC-32



EAST FORK TULIP CREEK: Drainage area 46 square miles ■ Survey site ▒ Survey area

stream in this region.

Stream Characteristics - Most drainage basins of this size in the Gulf Coastal Plain region would be dry or restricted to enduring pools during the dry period of the year. The Tulip Creek watershed, however, contains many springs and the stream has a steady groundwater discharge, causing the creek to flow year around. Both local citizens and the U.S.G.S. confirm that Tulip Creek has never gone dry at the sample site. Compared to the remainder of the Gulf Coastal Plain, this creek is considered part of a unique group and probably cannot be considered representative of the rest of the region. It will probably be considered aspart of a sub-region in the future.

Significant physical characteristics include the sandy stream banks, sandy substrate, low stream gradient, high percentage of instream cover (brush, logs, debris), low number of stream riffles and high percentage of stream canopy.

Of the chemical characteristics, the most unusual is the relatively acidic stream pH (ranging from pH 5.2 to 5.6), and a high degree of color. Both of these characteristics are directly related to soil types found in the basin and are generally characteristic of the entire Gulf Coastal Plain. Other chemical parameters of note are low water temperatures and low levels of nutrients. As would be expected from a least-disturbed stream, the water was very clean.

Methodology and Sampling Results

The summer stream survey was conducted during the week of August 8-12, 1983; the spring survey took place during the week of April 2-6, 1984.

Continuous Dissolved Oxygen

Summer - Dissolved oxygen observations during a high temperature, low flow, critical condition was the goal of the summer survey. In Tulip Creek, a fairly close approximation of critical conditions was observed. Flow in Tulip Creek was near its minimum, according to local residents. Instream temperatures did not approach what is considered the normal maximum of 30°C, partially due to the influence of groundwater and springs. A total stream canopy was also partially responsible for moderating temperatures by keeping the stream shaded.

Three continuous meters were set up in an area 100 to 300 feet upstream of the county road bridge on the afternoon of August 12, 1983, and were operated until the morning of August 12, 1983. All meters performed well and gave similar results.

Results obtained during the week are displayed in Figures GC-33, GC-34 and GC-35. Each graph displays the D.O., temperature and D.O. saturation for each meter for the entire survey period.

Over the survey period, there was surprisingly little variation in the dissolved oxygen concentration during any twenty-four hour period. Normally, the total diurnal fluctuation would be expected to be about 2 mg/l, but at Tulip Creek the diurnal fluctuation was only 0.9 mg/l. Minimum concentrations were also surprisingly high. The minimum over the 72-hour period was only 6.2 mg/l, which is comparable to the highest quality streams in the state.

An explanation of the small diurnal fluctuation in Tulip Creek is based on the physical and chemical characteristics of the stream. Low nutrient levels in the stream combined with very little sunlight penetrating to the stream has resulted in only a small amount of attached or floating algae. Without algae, there is nothing to generate excess oxygen in the stream during the daylight hours and, conversely, little to consume oxygen during the night by respiration. Minimum concentrations remain high because temperatures are kept low by groundwater influence. D.O. saturation varied from 75 to 85% over the survey period, which indicates that no organic loading is influencing D.O. concentrations.

Spring - Two meters were placed upstream of the bridge on April 2, 1984, one at the end of a riffle and one at a pool site. However, both meters malfunctioned and a meter was pulled from the Cypress Creek site and installed at the pool site on Tulip Creek on April 3rd (Tuesday) at about 1500. This meter performed satisfactorily for the remainder of the survey period. Plots of dissolved oxygen, temperature and percent saturation are shown in Figure GC-36.

A heavy rain occurred on April 2nd and caused the flow to increase substantially (the stream rose 8 feet), estimated to be in excess of 200 cfs. Because of the rainfall and increased flow, there was little variation in dissolved oxygen or temperature on April 4th. Flow had dropped on April 5 (to approximately 56 cfs) and instream temperature and D.O. variation were evident. Overall, there was little variation in dissolved oxygen, with a minimum of 8.9 mg/l occurring on April 4th and a maximum of 9.5 occurring on the 5th. Percent saturation values were about 85% and 90%, respectively.

Chemical Parameters

Summer - Chemical data collected during the summer observations of Tulip Creek are displayed in Table GC-43. Items of special interest are the low levels of nutrients,

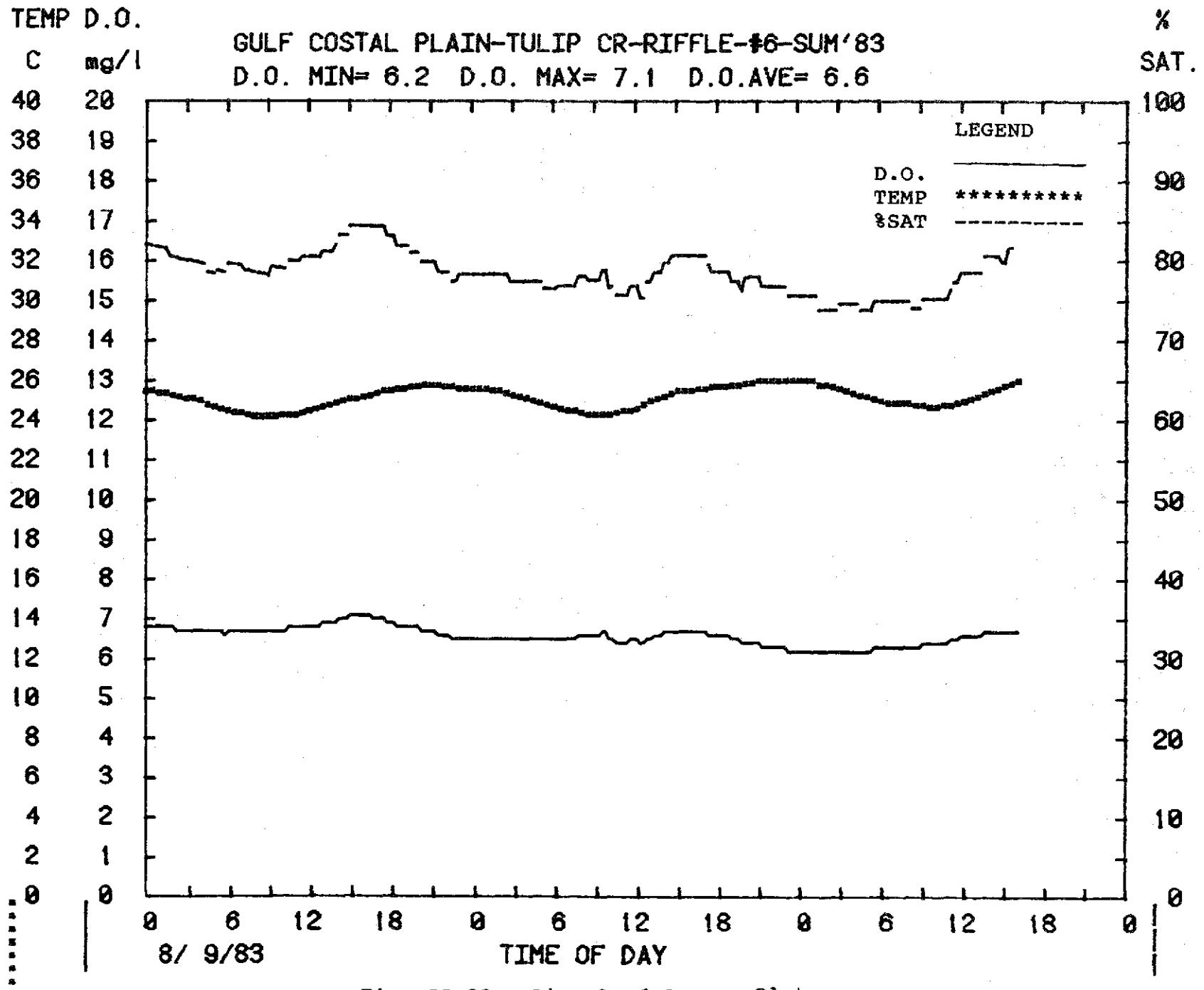


Fig. GC-33. Dissolved Oxygen Plot

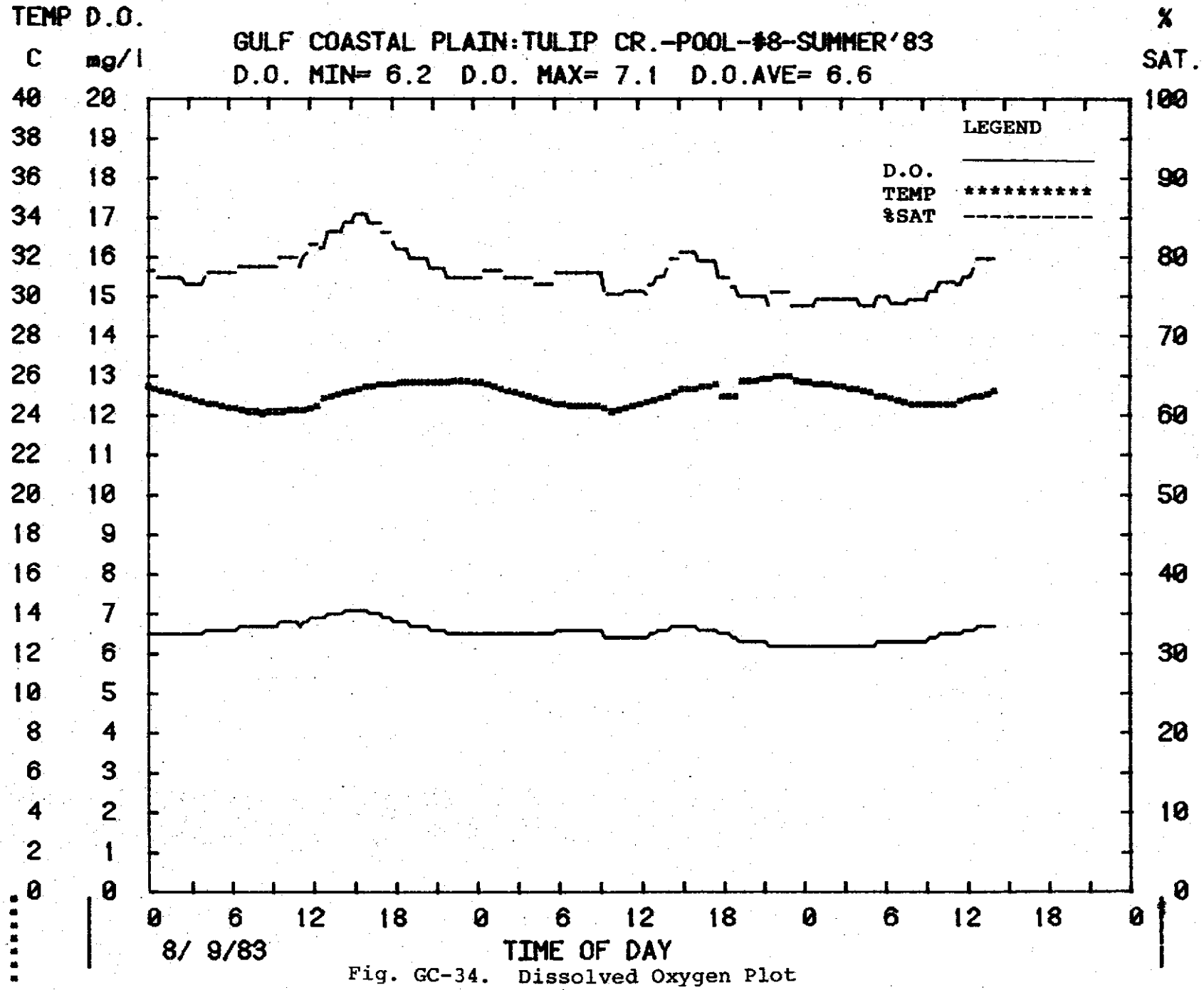


Fig. GC-34. Dissolved Oxygen Plot

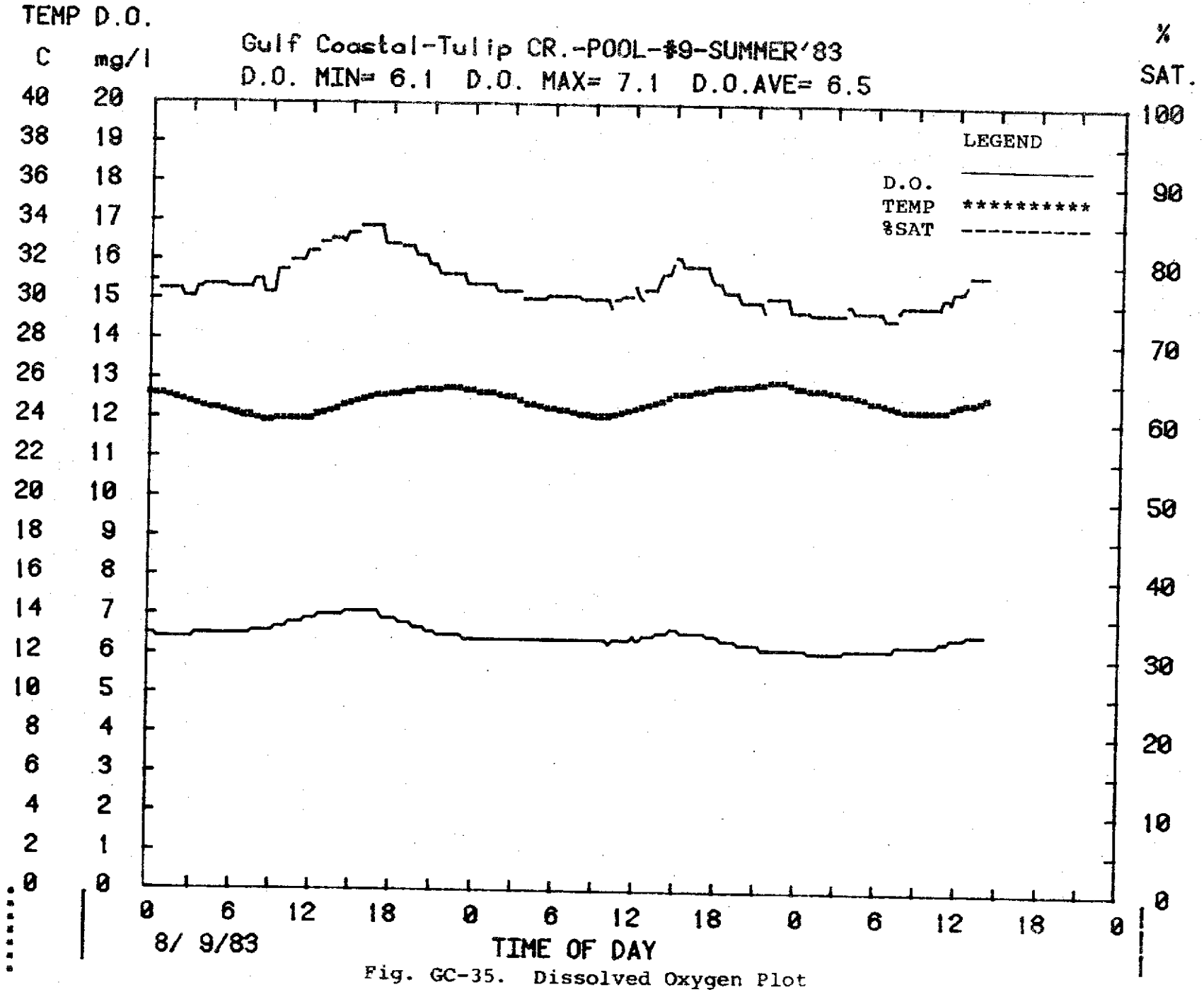


Fig. GC-35. Dissolved Oxygen Plot

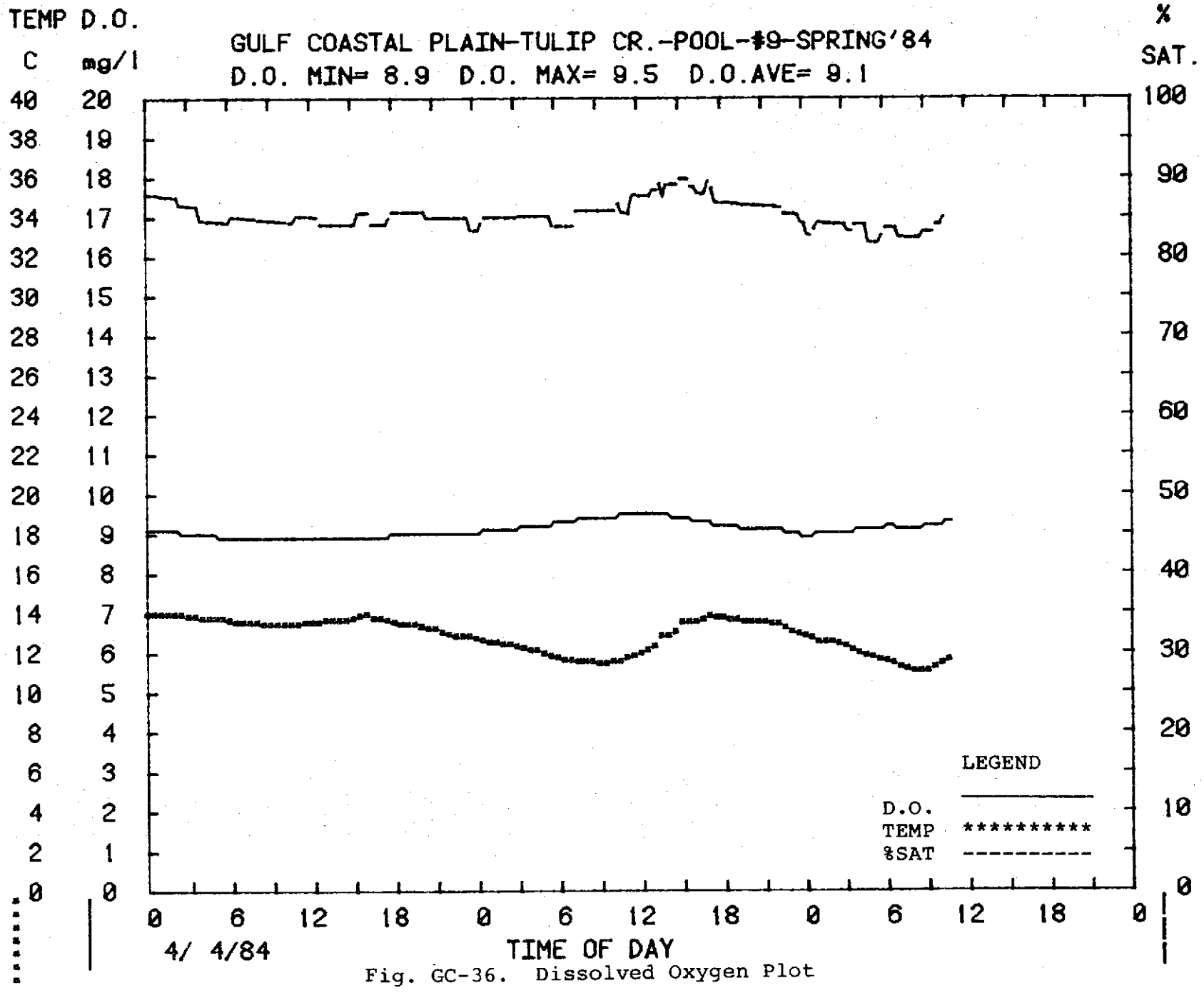


Fig. GC-36. Dissolved Oxygen Plot

Table GC-43

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: East Fork Tulip Creek

Drainage Area: 46 Square Miles

Station Description: 300 feet upstream of bridge on county road in Section 19, T 9 S, R 15 W - Dallas County

Date: August 9, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	10:35	12:51	14:16	
Q, cfs	5.2	5.2	5.2	5.2
Temperature, °C	24	24.5	25	24.5
pH	5.6	5.4	5.2	5.4
Turbidity, ntu	7.8	7.6	7.4	7.6
TSS, mg/l	6	4	4	5
TDS, mg/l	45	50	52	49
BOD-5, mg/l	0.4	0.4	0.3	0.4
BOD-20, mg/l	1.5	1.3	1.4	1.4
T.Phos., mg/l	0.03	0.03	0.02	0.03
PO4-P, mg/l	0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.08	0.08	0.09	0.08
NH3-N, mg/l	0.04	0.04	0.05	0.04
Cl -, mg/l	5	5	5	5
SO4 =, mg/l	2	8	3	4
Fe, mg/l	0.42	0.39	0.43	0.41
Conductivity, μmho	37	38	37	37
Alkalinity, mg/l	8	9	8	8
T. Hardness, mg/l	10	10	12	11
Chlorophyll a, μg/l	1.4	0.5	5.3	2.4
Fecal Coliform	-	-	112	112

Dissolved Oxygen Data for 9 Aug 1983		
	Pool	Riffle
Average	6.7	6.7
Minimum	6.5	6.4
Maximum	7.1	7.1

very low pH, and high iron concentrations.

These parameters may be explained by analyzing the physical characteristics of the stream. Low pH is directly related to the soil types found in the drainage basin. As previously noted, pH is very strongly acidic at all depths of the soil, ranging from 4.5 to 5.0. The pH in the stream is not much different, and ranges from 5.2 to 5.6.

Nutrient levels are low because of land use in the basin. Ninety-six percent of the basin is covered by forests and what little agriculture goes on in the basin is pastureland. All of this results in minimal disturbance of the soils in the basin, no application of commerical fertilizers and very little domestic animal waste which means there are no sources for man-induced nutrients to enter the stream.

The relatively high concentration of iron seems to correlate with color in the stream. Water in the Gulf Coastal Plain is uniform in its brown to black color. Iron is probably responsible for most of the brown color, while tannins and lignins leached from the soil are responsible for the black.

Spring - Spring samples were collected on Thursday instead of Tuesday because rain on Monday night caused the creek to flood on Tuesday. Flow had decreased almost to normal levels by Thursday. Results are shown in Table GC-44.

Water quality measured during the spring sampling was very similar to that of the summer samples. Flow was approximately ten times greater than the low flow measured during the summer and this higher flow resulted in only a slight increase in turbidity. The 20 NTU turbidity measurement is well below the 50 NTU standard for the stream. The pH reading of 5.8, even with the increased flow, shows that the acid condition of the water is related to the soils within the watershed. Nutrient and mineral values remained very low, showing little change from the summer sampling.

Physical Parameters

Physical evaluations were made on August 9, 1983. Flow, mean stream velocity and stream transects to assess width, depth, substrate, etc., were all conducted as outlined in the General Methodology section of this report.

Summer - Tulip Creek is typical of streams in the Gulf Coastal Plain in many ways (Table GC-45). In fact, the only variation from the norm at Tulip Creek was the higher than expected flow. Land use, topography, soil type, canopy, and geology have previously been mentioned as directly affecting many of the chemical characteristics of the stream.

Table GC-44

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: East Fork Tulip Creek

Drainage Area: 46 Square Miles

Station Description: 300 feet above bridge on county road in Section 19, T 9 S, R 15 W - Dallas County

Date: April 5, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:35	10:20	11:50	
Q, cfs *	56	56	56	56
Temperature, °C	12.0	12.0	12.0	12.0
pH	5.8	5.7	5.9	5.8
Turbidity, ntu	20	20	20	20
TSS, mg/l	-	-	-	-
TDS, mg/l	56	51	50	52
BOD-5, mg/l	1.4	1.5	1.2	1.4
BOD-20, mg/l	2.2	2.5	2.2	2.3
T.Phos., mg/l	0.04	0.04	0.04	0.04
PO4-P, mg/l	0.01	0.02	0.02	0.02
NO2+NO3-N, mg/l	0.03	0.03	0.03	0.03
NH3-N, mg/l	0.06	0.09	0.04	0.06
Cl -, mg/l	2.5	3	3	3
SO4 =, mg/l	5	4	5	5
Fe, mg/l	0.48	0.48	0.49	0.48
Conductivity, μmho	34	34	36	35
Alkalinity, mg/l	5	5	5	5
T. Hardness, mg/l	12	14	16	14
Chlorophyll a, μg/l	-	0.3	-	0.3
Fecal Coliform	-	-	30	30
MN mg/l	0.033	0.034	0.039	0.035
COD mg/l	16.0	17.3	14.7	16.0

Dissolved Oxygen Data for 5 Apr 1984		
	Riffle	
Average	9.2	
Minimum	8.9	
Maximum	9.5	

*Flow high due to rain on night of 4-2-84.

Table GC-45

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	East Fork Tulip Creek
Date:	August 9, 1983
Drainage Area:	46 sq. miles
Watershed Land Use:	96% forest 4% agriculture
Stream Gradient:	3.5 ft./mile
Mean Channel Width:	41.4 ft.
Mean Stream Width:	25.8 ft.
Mean Stream Velocity:	.26 ft./sec.
Observed Flow:	5.2 cfs
Average Substrate Type:	100% sand
Mean Instream Cover:	1% undercut bank 51% brush,logs,debris 5% overhanging veg.
Riffle/Pool Ratio of Transects:	0% riffle 0% deep pool 80% moderate pool 20% shallow pool
Mean Bank Overstory Cover:	95% trees 67% shrubs
Mean Bank Ground Cover:	60% grasses forbs 40% dirt
Mean Bank Stability:	0% stable 65% moderate 35% unstable
Mean Stream Canopy:	94.5%

Comments: Substrate type is listed as 100% sand but is more likely to be a mixture of sand/silt/mud; there is a problem in making this distinction.

Other characteristics that stood out at Tulip Creek were banks and substrate consisting entirely of sand, a low stream gradient and a high percentage of instream cover (brush, logs and debris). All of these characteristics are typical of small streams throughout the Gulf Coastal Plain.

Spring - No additional physical evaluations were made during the spring survey other than flow.

Macroinvertebrate Populations

A total of 41 taxa representing 14 orders were identified from samples collected from East Fork Tulip Creek. Fifteen and 33 taxa were identified from the summer and spring samples, respectively. The total number of organisms collected in the spring was almost three times that collected in the summer (Table A-12, Appendix A). These increases were probably a result of the increased sampling effort during the spring survey. It should be noted that spring sampling was hampered by the high water conditions which existed during the survey, thus making it difficult to sample all habitats completely.

The qualitative comparative indices indicated almost a complete lack of uniformity between the summer and spring sample (Table GC-46). These indices are lower than expected due to the two-fold increase in taxa collected during the spring. Seven of the 15 taxa (47%) identified from the summer collection were also present in the spring. Numerically, these seven taxa comprised 69% of the summer sample, but only 20% of the spring sample. The summer sample was dominated by Viviparus (a snail), and Cambarinae (female and immature crayfish). The spring sample was dominated by Stylobromus (an amphipod), Isonychia (a mayfly) and Cambarinae.

The community parameters calculated from the two collections indicated a sharp increase in community diversity from summer to spring (Table GC-46). The diversity index increased by a magnitude of one. This increase was in response to the greater number of taxa collected, as indicated by the fact that the index of variety increased while the index of evenness remained almost identical to summer values. These differences are thought to be associated with the increased sampling effort and not an increase in community quality. The spring sample is probably more indicative of the benthic community and is representative of a diverse, stable ecosystem which can be characterized as having "good" water quality.

Table GC-46. Community Analysis of Benthic Samples from East Fork Tulip Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	45	130	175
Total # Taxa	15	33	42
Diversity	3.3309	4.3104	4.6002
Index of Evenness	0.2721	0.3151	0.2777
Index of Dominance	0.8524	0.8545	0.8586
Index of Variety	2.5492	4.5557	5.3683
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.29
Common Taxa Index (range 0-1)			0.32
Qualitative Similarity Index (range 0-100)			17.0

Fish Populations

Summer - A combination of collecting methods was used at this site. The 3500-watt, 220-volt, a.c. electroshocker transported in a flat-bottomed boat was used to collect fish from the county road bridge upstream for about 200 yards. Also, about one-third of an acre below the bridge was treated with 4 pounds of 7.2% powdered rotenone.

Fishes collected by both methods were lumped together for determination of species relative abundance. A list of all species collected in order of their relative abundance is given in Table GC-47. A total of 703 individuals from 36 species were collected with a total relative abundance value of 238.5, a diversity index of 5.00, and an index of evenness of 0.97 (Table GC-48). Family groupings of species produced seven species of Percidae totaling 19.1% of the population's relative abundance; nine species of Centrarchidae, 25.8%; six species of Cyprinidae, 15.5%; three species of Ictaluridae, 11.3%; and four species of Catostomidae comprised 9.4% of the total. Four species of primary feeding fishes made up 5.5% of the population's relative abundance; 28 species of secondary feeders, 83.8%; and four species of top carnivores comprised 10.7% of the total fish. Six sensitive species made up 18.5% of the population.

Table GC-47 - Fishes Collected from East Fork Tulip Creek with Relative Abundance Values

Species		R.A. VALUE
Notropis umbratilis	Redfin Shiner	12
*Moxostoma poecilurum	Blacktail redhorse	12
Lepomis megalotis	Longear	12
Noturus miurus	Brindled madtom	10.5
Noturus nocturnus	Freckled madtom	10.5
Esox americanus	Grass pickerel	9
Notropis chrysocephalus	Striped shiner	9
Fundulus notatus	Blackstripe topminnow	9
Aphredoderus sayanus	Pirate perch	9
Elassoma zonatum	Banded pygmy sunfish	9
*Ammocrypta vivax	Scaly sand darter	9
*Etheostoma collettei	Creole darter	9
Pimephales notatus	Bluntnose minnow	7.5
Fundulus olivaceus	Blackspotted topminnow	7.5
Micropterus salmoides	Largemouth bass	7.5
Etheostoma gracile	Slough darter	7.5
Moxostoma erythrurum	Golden redhorse	6.5
Lepomis cyanellus	Green sunfish	6.5
Lepomis gulosus	Warmouth	6.5
*Percina sciera	Dusky darter	6.5
Notropis emiliae	Pugnose minnow	6
Ictalurus natalis	Yellow bullhead	6
Micropterus punctulatus	Spotted bass	6
Etheostoma whipplei	Redfin darter	6
*Percina maculata	Blackside darter	6
Lepomis punctatus	Spotted sunfish	5
Gambusia affinis	Mosquitofish	4.5
Centrarchus macropterus	Flier	4.5
Lepomis macrochirus	Bluegill	4.5
Lamprey larvae	Lamprey	3
Amia calva	Bowfin	3
Erimyzon oblongus	Creek chubsucker	2
Minytrema melanops	Spotted sucker	2
Hybognathus nuchalis	Silvery minnow	1.5
*Etheostoma stigmaeum	Speckled darter	1.5
Campostoma anomalum	Stoneroller	1
	Total	238.5

*Sensitive Species

Table GC-48. Summary of Fish Population Parameters from East Fork of Tulip Creek

Total Species Collected	36.0
Total Number Of Individuals	703.0
Total Relative Abundance Value	238.5
Relative Abundance Diversity Index	5.00

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6.0	15.5
CATOSTOMIDAE	4.0	9.4
ICTALURIDAE	3.0	11.3
CENTRARCHIDAE	9.0	25.8
PERCIDAE	7.0	19.1
Primary Feeders	4.0	5.5
Macroinvertebrate Feeders	28.0	83.8
Carnivores	4.0	10.7
Sensitive Species	6.0	18.5

Spring - On April 2, 1984, one 3½" and one 1½" mesh monofilament trammel nets were set below the bridge at the sample site. Also, three hoop nets (one below and two above the bridge) were set. Rain and high water levels reduced efficiency of sampling. Nets could not be checked until the second and third days after they were set.

Nets were filled with leaves and other debris. The only fishes taken were spotted suckers, golden redhorse, and blacktail redhorse, some of which were in breeding condition.

CYPRESS CREEK

Cypress Creek begins in the southern part of Hot Spring County, flows in a southwesterly direction through the western part of Dallas County and enters the Ouachita River about 10-12 air miles below the sample site. The sample site for Cypress Creek was located in Section 3, R 17 W, T 9 S (Figure GC-37).

General Site Discussion

Watershed Size - The watershed size of Cypress Creek above the county road bridge is 73 mi^2. This size of watershed was expected to have zero flow during the summer months. However, in this case, Cypress Creek drains an area with steady groundwater recharge causing year-round flow.

USGS and the Soil Conservation Service list Cypress Creek as a perennial stream approximately 15 miles upstream of the sample site location. At that point the drainage area is 17 mi^2. A perennial stream with a watershed of less than 17 mi^2 is atypical for the Gulf Coastal region. Therefore, the information gathered from this stream should not be extrapolated to the rest of the region, but should be considered a sub-region in the future.

Geology - As with Tulip Creek, Cypress Creek drains an area that is underlain by the Sparta Sand Formation with alluvial deposits underlying the creek bed and surrounding banks.

Topography - Topography within the watershed is generally level to gently rolling sand hills with broad streamside wetland areas directly adjacent to the creek.

Soil Types - Cypress Creek is in an area that is dominated by the Amy-Smithton-Pheba and Pikeville-Savannah-Smithdale associations. The predominant soil association is the Amy-Smithton-Pheba. This association consists of poorly drained to somewhat poorly drained, level to nearly level, loamy soils found on upland areas. The soils of the Pikeville-Savannah-Smithdale association are well drained to moderately well drained, nearly level to moderately sloping, loamy soils found on upland areas.

Soils in both associations are strongly acidic to very strongly acidic (pH values are in the range of 4.5 to 5.5). Erosional potential is slight.

Flora - Loblolly pine and sweetgum trees dominate the forest in the upland areas of the basin. Low overflow wetland areas are dominated by beech, oak and hickory trees.

Figure GC-37

CYPRESS CREEK: Drainage area 73 square miles ■ Survey site ▒ Survey area

Land Use - Land use within the watershed is 73% forest and 27% agriculture, according to the Soil Conservation Service. Based on site observations, the percentage of agriculture appears to be high. Nonetheless, the predominant agricultural use is pastureland. Overall, the watershed has a very low level of man-induced disturbances and qualifies as least-impaired for this region.

Stream Characteristics - Cypress Creek should be considered atypical for this watershed size in the Gulf Coastal Plain due to its continuous flow. The dominant physical characteristics of Cypress Creek consist of moderate bank stability with predominant tree cover, deep pools with few or no riffles and a substrate that consists mostly of sand. The creek has a mean width, depth and velocity of 32 ft., 2.5 ft. and 0.36 fps, respectively, during the critical summer low flow period. Cypress Creek has an almost complete canopy provided by trees.

Methodology and Sampling Results

The summer survey was conducted from August 8, 1983, to August 12, 1983. Weather during this period was sunny to partly cloudy and hot. Rain during the week prior to the survey caused high flows which fell gradually during the survey.

The spring survey was conducted from April 2, 1984, to April 6, 1984. Weather during this period was cloudy to partly cloudy. The weather was rainy prior to the survey period and rain fell again on the night of April 2, 1984. Flows were high but falling during the latter part of the survey.

Continuous Dissolved Oxygen

Summer - Three continuous D.O. meters were set up 500 to 800 feet upstream of the county road bridge on the afternoon of August 8, 1983; they operated until the morning of August 12, 1983. The riffle location was on the downstream side of a man-made, rock dam. All meters performed well and gave nearly identical results.

The continuous D.O. data collected on Cypress Creek during the summer survey showed a slight but consistent decline (6.1 to 5.0) in D.O. over the 72-hour period (Figures GC-38 through GC-40). This decline is probably due to the decrease in flow. The D.O. and percent saturation data indicate little or no diurnal fluctuation. The average temperature in Cypress Creek for this period was 26°C. This temperature is lower than expected and was probably due to the shade provided by the stream canopy and groundwater influences.

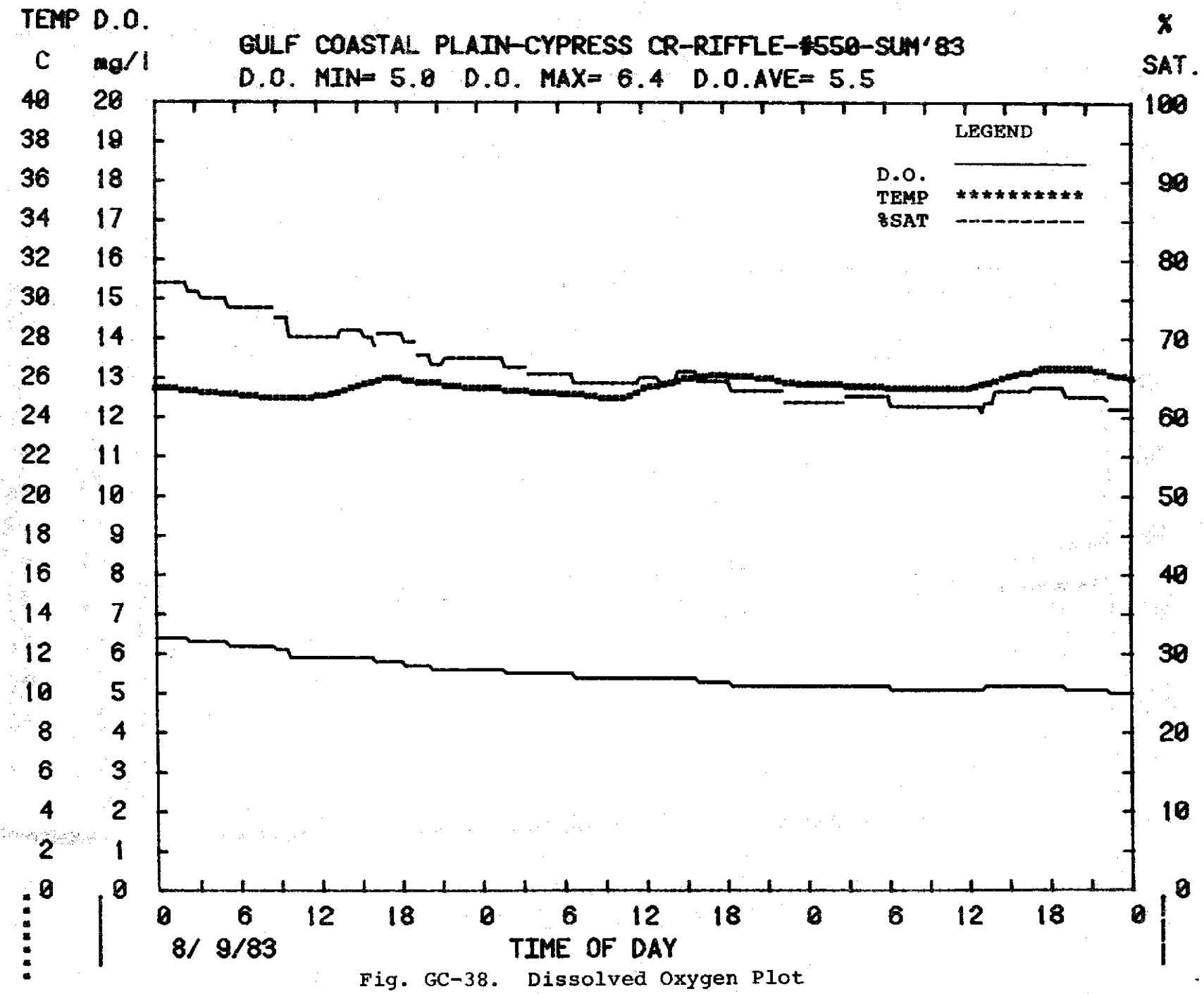


Fig. GC-38. Dissolved Oxygen Plot

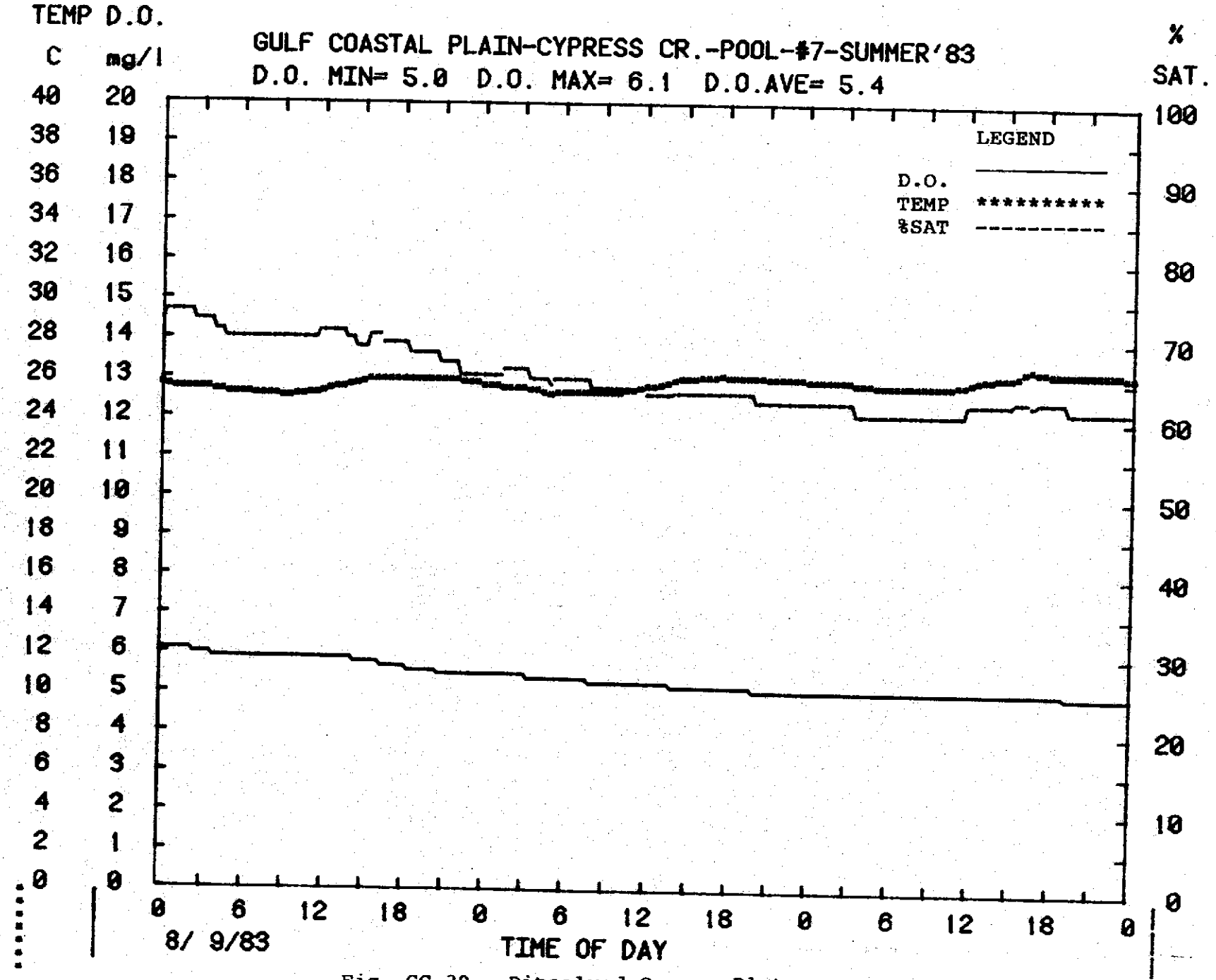


Fig. GC-39. Dissolved Oxygen Plot

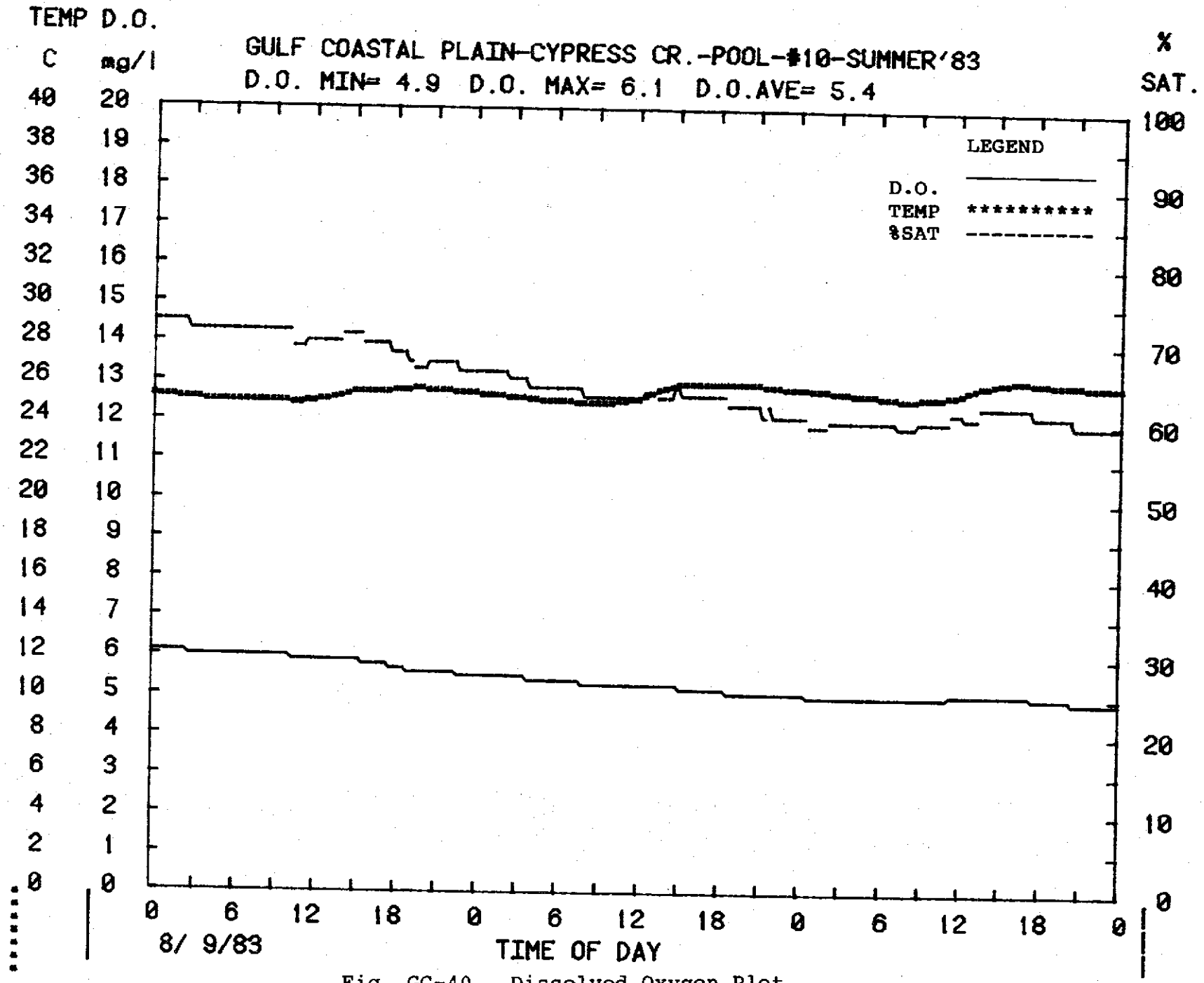


Fig. GC-40. Dissolved Oxygen Plot

Spring - Two continuous D.O. meters were placed upstream of the bridge. However, due to problems at the East Tulip Creek site, one of these had to be transferred after one day. The one meter that was left performed well.

The dissolved oxygen data collected during the spring survey showed a slight diurnal fluctuation of 0.6 mg/l. The weather during this period consisted of extremely heavy rainfall during the first day, which raised the flow in the stream significantly that day. This was followed by sunny days for the rest of the survey. However, the D.O. remained almost constant throughout the survey period (Figures GC-41 and GC-42).

Chemical Parameters

Summer - Grab samples were taken during the summer survey about 200 yards upstream of the county road bridge. These samples were collected on August 9, 1983, at 0940, 1200 and 1420.

Spring - During the spring survey the sampling date was changed from April 3 to April 5, 1984. This change was due to a heavy rainfall which occurred on the night of April 2. The three samples were collected at 0900, 1000 and 1100.

The results of the chemical analyses for summer and spring are given in Tables GC-49 and GC-50, respectively. The nutrient levels in Cypress Creek for both the summer and spring surveys were low. This is probably due to the limited agriculture in the drainage area, most of which was pastureland. The only unusual parameters are the low pH and high total iron. The pH values ranged from 5.6 in the spring to 6.1 in the summer. These values are low but are attributable to the soil types in this watershed. The soil pH varies from 4.5 to 5.5.

The total iron values were high and appear to be directly related to the turbidity. This tends to indicate that the iron is not dissolved but rather suspended in the water column. The summer iron values were higher than in spring and may have been associated with the groundwater flows which dominate during the dry season.

Physical Parameters

The majority of the physical evaluations were made during the summer survey on August 9, 1983. The evaluations were conducted as outlined in the General Methodology of this report. Flow during the summer survey was falling slightly throughout the survey period. Mean stream velocity was 0.36 fps which was somewhat faster than expected. The results are summarized in Table GC-51.

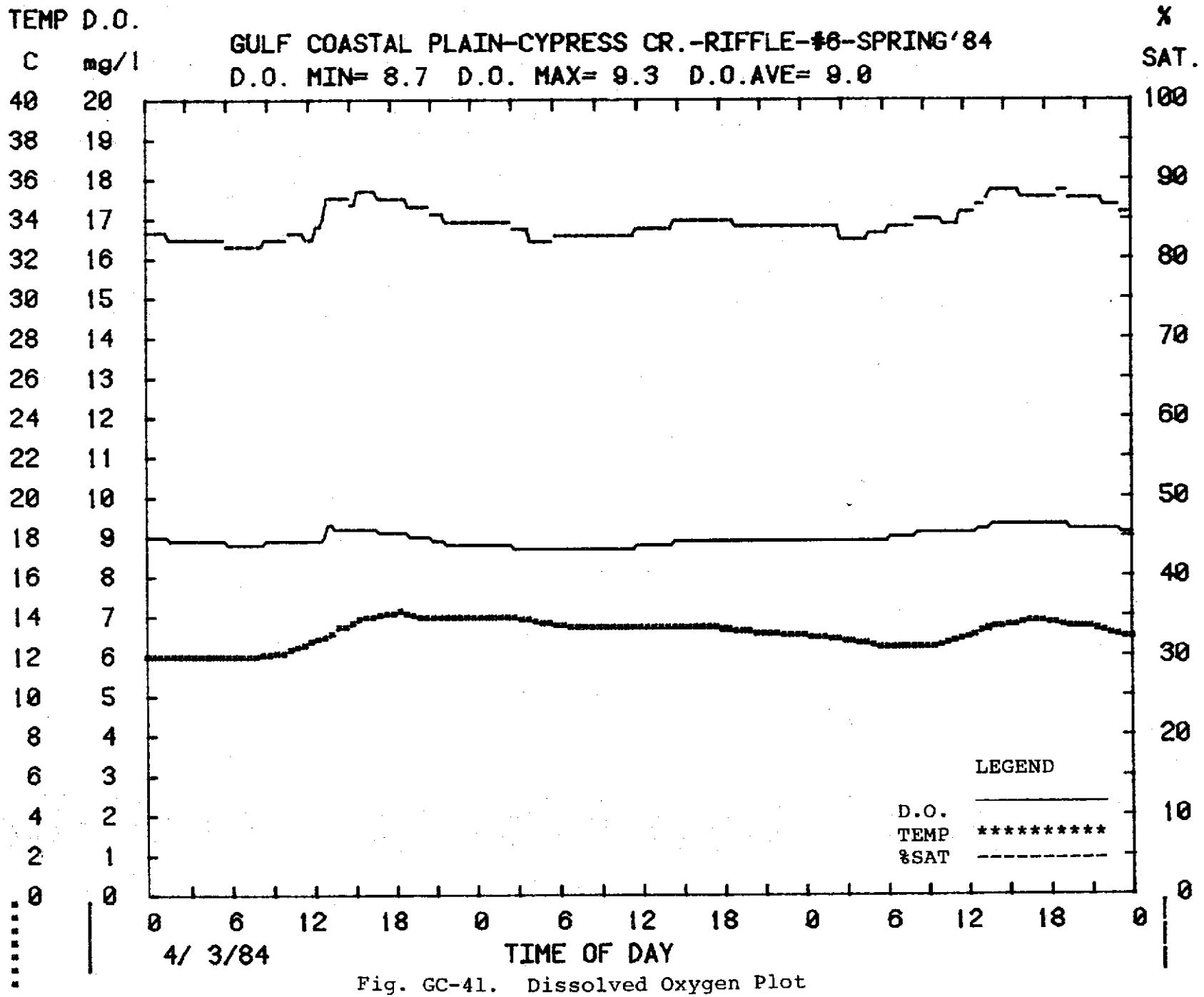


Fig. GC-41. Dissolved Oxygen Plot

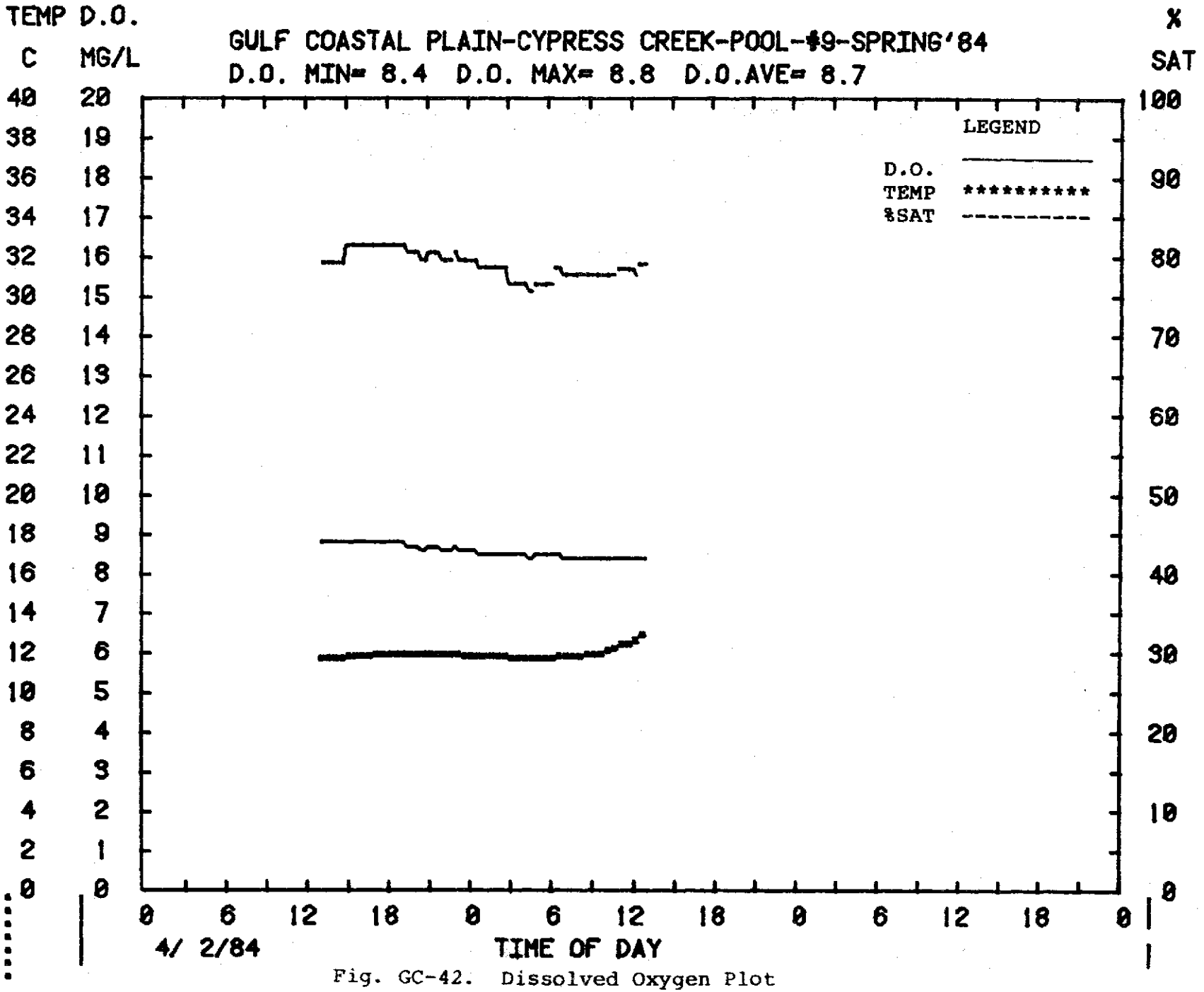


Fig. GC-42. Dissolved Oxygen Plot

Table GC-49

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Cypress Creek

Drainage Area: 73 Square Miles

Station Description: Above riffle (small rock dam) 600 feet above bridge on county road located in Section 3, T 9 S, R17 W - Dallas County

Date: August 9, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	09:40	12:00	14:20	
Q, cfs	10.8	10.8	10.8	10.8
Temperature, °C	25	25	25.5	25
pH	5.9	6.1	6.3	6.1
Turbidity, ntu	22	21	21	21
TSS, mg/l	8	6	8	7
TDS, mg/l	45	44	45	45
BOD-5, mg/l	0.9	0.7	0.6	0.7
BOD-20, mg/l	2.5	2.1	1.7	2.1
T.Phos., mg/l	0.05	0.05	0.04	0.05
PO4-P, mg/l	0.01	0.01	0.03	0.02
NO2+NO3-N, mg/l	0.14	0.14	0.15	0.14
NH3-N, mg/l	0.06	0.06	0.08	0.07
Cl -, mg/l	5	4.5	5	5
SO4 =, mg/l	1	1	<1	<1
Fe, mg/l	1.04	0.91	0.86	0.94
Conductivity, μmho	25	23	25	24
Alkalinity, mg/l	5	5	5	5
T. Hardness, mg/l	10	10	10	10
Chlorophyll a, μg/l	6.2	1.7	1.1	3.0
Fecal Coliform	-	-	172	172

Dissolved Oxygen Data for 9 Aug 1983		
	Pool	Riffle
Average	5.9	6.0
Minimum	5.5	5.6
Maximum	6.1	6.3

Table GC-50

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Gulf Coastal Plain

Stream: Cypress Creek

Drainage Area: 73 Square Miles

Station Description: 600 feet above bridge on county road in Section 3, T 9 S, R 17 W - Dallas County

Date: April 5, 1984

PARAMETER	TIME COLLECTED 09:00	10:00	11:00	AVERAGE
Q, cfs *	~ 150	~ 150	~ 150	~ 150
Temperature, °C	13	13	13	13
pH	5.6	5.6	5.6	5.6
Turbidity, ntu	9.8	9.6	10.0	9.8
TSS, mg/l	-	-	-	-
TDS, mg/l	38	40	40	39
BOD-5, mg/l	1.5	1.4	1.3	1.4
BOD-20, mg/l	2.6	2.4	2.4	2.5
T.Phos., mg/l	0.02	0.06	0.03	0.04
PO4-P, mg/l	0.02	0.02	<0.01	<0.02
NO2+NO3-N, mg/l	0.04	0.04	0.04	0.04
NH3-N, mg/l	0.05	0.03	0.06	0.05
Cl -, mg/l	2	2	2	2
SO4 =, mg/l	3	3	3	3
Fe, mg/l	0.39	0.42	0.36	0.39
Conductivity, μmho	22	22	21	22
Alkalinity, mg/l	2	2	2	2
T. Hardness, mg/l	12	12	8	11
Chlorophyll a, μg/l	-	0.3	0.3	0.3
Fecal Coliform	-	-	10	10
MN mg/l	0.038	0.043	0.040	0.040
COD mg/l	14.0	16.7	12.0	14.2

Dissolved Oxygen Data for 5 Apr 1984		
	Riffle	
Average	9.1	
Minimum	8.9	
Maximum	9.3	

*Flow high due to rain on night of 4-2-84.

Table GC-51

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Cypress Creek
Date:	August 9, 1983
Drainage Area:	73 Sq. miles
Watershed Land Use:	73% forest 27% agriculture
Stream Gradient:	4.2 ft./mile
Mean Channel Width:	44.8 ft.
Mean Stream Width:	32.0 ft.
Mean Stream Velocity:	.36 ft./sec.
Observed Flow:	10.8 cfs
Average Substrate Type:	1% boulder 61% sand 2% rubble 28% mud/silt 8% gravel
Mean Instream Cover:	.6% undercut bank 13% brush,logs,debris 2% overhanging veg. .6% inundated veg.
Riffle/Pool Ratio of Transects:	0% riffle 60% deep pool 20% mod. pool 20% shallow pool
Mean Bank Overstory Cover:	91% trees 18% shrubs
Mean Bank Ground Cover:	21% grasses forbes 79% dirt
Mean Bank Stability:	10% stable 80% moderate 10% unstable
Mean Stream Canopy:	90%

Comments: Substrate type is variable due to the 1st transect being untypical. An old rock dam was located just above that transect.

Cypress Creek is a meandering stream that consists mostly of deep pools with steep, moderately stable banks. The stream substrate consists largely of sand with a moderate amount of instream cover.

Macroinvertebrate Populations

A total of 57 taxa representing 13 orders were identified from summer and spring benthic samples collected within the study area (Table A-13, Appendix A). Twenty-six (26) and 44 taxa were identified from the summer and spring collections, respectively. The total number of organisms collected in the spring was almost twice that collected in the summer. The increases in taxonomic diversity and numerical abundance from summer to spring samples were due, at least in part, to increased sampling effort despite the high volume flows during the spring survey which hindered collection of the deeper water microhabitats.

Numerically, the dominant orders of the summer sample were decapods, coleopterans, and tricopterans, comprising 20.5, 16.2 and 14.5% of the sample, respectively. Taxonomically, the dominant groups were coleopterans, ephemeropterans, and odonates. The dominant orders of the spring sample were the ephemeropterans and coleopterans comprising 39.4 and 16.7% of the numerical total and almost 50% of the taxa.

The qualitative similarity indices indicated only slight uniformity between the summer and spring samples (Table GC-52). However, 14 of the 26 taxa identified from the summer sample were also collected in the spring. Also, four of the five dominant taxa of the summer sample were collected in the spring. The reduced values calculated for the qualitative similarity indices were a result of the large increases in taxa collected during the spring survey and the seasonal progression of insect taxa characteristic of natural communities.

The community parameters calculated for the spring and summer collections indicated a very diverse stable macroinvertebrate community (Table GC-52). There was a slight increase in the diversity indices from summer to spring. This increase was a result of the additional number of taxa collected as evidenced by the increase in index of variety. The decrease in index of evenness and increase in index of dominance were generated by the two fold increase in total number of organisms collected. This increase was due to the increased sampling effort and not a reduction in water quality.

Table GC-52. Community Analysis of Benthic Samples from Cypress Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	117	204	321
Total # Taxa	26	45	57
Diversity	4.2564	4.6433	5.1914
Index of Evenness	0.8952	0.8557	0.8862
Index of Dominance	0.4169	0.5978	0.5216
Index of Variety	3.7843	5.4741	6.8456
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.37
Common Taxa Index (range 0-1)			0.23
Qualitative Similarity Index (range 0-100)			38.0

Fish Populations

Summer - Approximately one-half acre of the stream was treated with 5 pounds of 7.2% powdered rotenone. A total of 950 fishes were collected. Table GC-53 lists all species collected and their relative abundance. There were 42 species collected, with a total relative abundance value of 247, a diversity index of 5.07 and an index of evenness of 0.94 (Table GC-54). Centrarchidae was the dominant family of fishes. Nine species of Centrarchidae made up 24.9% of the total relative abundance; ten species of Percidae, 16.2%; three species of Ictaluridae, 12.1%; five species of Cyprinidae, 11.9% and four species of Catostomidae comprised 8.7% of the total. Primary feeding fishes from three species made up only 2% of the total relative abundance value, 32 species of secondary feeders made up 80.1% and seven top carnivore species comprised 16.2% of the total population. There were nine sensitive species present, totaling 13.8% of the population relative abundance.

Spring - Two trammel nets and three hoop nets were used in an attempt to collect fishes from Cypress Creek. A 3.5-inch mesh and a 1.5-inch monofilament trammel net and three hoop nets were set on April 2, 1984. Increased flows, high water and debris reduced netting efficiency. Two different types of electrofishing gear were also used. They also were inefficient.

Netting produced only one spotted bass, one spotted sucker and a yellow bullhead. All were sexually mature and near or in spawning condition. Electrofishing with the boat-mounted shocker was limited due to navigation difficulties but it produced numerous adult and larvae lamprey and an adult bowfin. The adult lamprey, southern brook and chestnut were apparently in the process of spawning. Collection of the chestnut lamprey increased the total fish species collected to 43.

Table GC-53. Fishes Collected from Cypress Creek on August 11, 1983, with Relative Abundance Values

Species		R.A. VALUE
Noturus nocturnus	Freckled madtom	12.0
Lepomis megalotis	Longear	12.0
Notropis umbratilis	Redfin shiner	12.0
Ictalurus natalis	Yellow bullhead	12.0
Aphredoderus sayanus	Pirate perch	10.5
Esox niger	Chain pickerel	10.5
Centrarchus macropterus	Flier	9.0
Lepomis cyanellus	Green sunfish	9.0
Lepomis gulosus	Warmouth	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
Esox americanus	Grass pickerel	9.0
Etheostoma whipplei	Redfin darter	9.0
*Percina sciera	Dusky darter	8.0
*Etheostoma collettei	Creole darter	7.5
Micropterus punctulatus	Spotted bass	7.5
Fundulus notatus	Blackstripe topminnow	7.5
*Moxostoma poecilurum	Blacktail redhorse	7.5
Notropis chrysocephalus	Striped shiner	7.5
Minytrema melanops	Spotted sucker	7.0
Amia calva	Bowfin	7.0
Micropterus salmoides	Largemouth bass	6.0
Notropis emiliae	Pugnose minnow	6.0
Elassoma zonatum	Banded pygmy sunfish	6.0
*Percina maculata	Blackside darter	6.0
Lepomis punctatus	Spotted sunfish	6.0
Noturus gyrinus	Tadpole madtom	6.0
Moxostoma erythrurum	Golden redhorse	6.0
Gambusia affinis	Mosquitofish	4.5
Etheostoma gracile	Slough darter	4.5
Campostoma anomalum	Stoneroller	3.0
Anguilla rostrata	American eel	3.0
Labidesthes sicculus	Brook silversides	1.5
*Etheostoma parvipinne	Goldstripe darter	1.0
Etheostoma proeliare	Cypress darter	1.0
*Etheostoma stigmaeum	Speckled darter	1.0
Notemigonus crysoleucas	Golden shiner	1.0
Ichthyomyzon gagei	Southern brook lamprey	1.0
Pomoxis nigromaculatus	Black crappie	1.0
*Ammocrypta vivax	Scaly sand darter	1.0
Etheostoma chlorosomum	Bluntnose darter	1.0
*Fundulus catenatus	Northern studfish	1.0
*Hypentelium nigricans	Northern hogsucker	1.0
Ichthyomyzon castaneus	Chestnut lamprey	S
	Total	251.0

* Sensitive species
S - Collected during spring sampling only

Table GC-54. Summary of Fish Population Parameters from Cypress Creek

Total Species Collected	43.0
Total Number Of Individuals	950.0
Total Relative Abundance Value	247.0
Relative Abundance Diversity Index	5.07

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5.0	11.9
CATOSTOMIDAE	4.0	8.7
ICTALURIDAE	3.0	12.1
CENTRARCHIDAE	9.0	24.9
PERCIDAE	10.0	16.2
Primary Feeders	3.0	2.0
Macroinvertebrate Feeders	32.0	81.8
Carnivores	7.0	16.2
Sensitive Species	9.0	13.8

ARKANSAS RIVER VALLEY ECOREGION

The Arkansas River Valley lies in the central portion of the state between the Boston Mountains on the north and the Ouachita Mountains to the south. It is bordered on the east by the Delta (near Little Rock) and continues westward into Oklahoma. The southern boundary of this region is an area of some dispute. Ecoregion maps prepared by Omernik and Hughes delineate the southern boundary of the Arkansas River Valley as generally paralleling the Arkansas River and varying from about 5 to 15 miles south of the river channel. Foti (1974), in the Arkansas Natural Area Plan, establishes several subdivisions of the Ouachita Mountains Division. The eastern one-third of Foti's Fourche Mountain subdivision corresponds to some of Omernik and Hughes most typical Arkansas River Valley; conversely, much of the northwestern part of Omernik and Hughes Ouachita Mountain Ecoregion is within the Arkansas River Valley subdivision of Foti. This latter area of dispute includes two of the sites which were chosen as reference streams of the Arkansas River Valley Ecoregion. Croneis (1930) placed the southern boundary of the western part of the Arkansas River Valley as the "southern limb of the combined Poteau-Menifee synclines." This would place the southwestern boundary along Dutch Creek Mountain and Poteau Mountain, thus placing our Dutch Creek and Petit Jean River reference streams in the Arkansas River Valley Ecoregion, contrary to Omernik and Hughes delineation. Ground reconnaissance of this area and the results of our sampling efforts support Croneis' delineation of the southern boundary of the Arkansas River Valley Ecoregion. It is apparent that the Arkansas River Valley Ecoregion is both a transition area between the Ouachita and Boston Mountains and a unique ecoregion.

This region is underlain by slightly to moderately folded shales and sandstones of Hartshorne and Atoka Formations of Pennsylvanian Age, approximately 300 million years old. In addition, alluvial deposits of Quaternary Age occur in the floodplains of the Arkansas River.

Soils are generally slowly to moderately permeable and have sandy to clayey consistency. The general topography is rolling, but synclinal mountains and mesas exhibit some of the greatest relief and elevations in the state. Relief varies almost 2000 feet in two miles at Mt. Magazine.

Streams in the Arkansas River Valley vary from slow, meandering streams following major valley floors to smaller, pool and riffle types in the smaller watersheds. Stream bottoms can consist of silt, gravel, shale, rubble or solid bedrock. Many of the streams in this region characteristically exhibit a light brown turbidity, which probably results from the shales and soils.

Flora is made up of shortleaf pine and upland hardwoods on the higher elevations and bottomland hardwoods in the river bottom's alluvial soils. The western portion of the region has some scattered areas of prairie.

Land use is primarily farms and pastureland with the bottomland alluvial areas planted in row crops such as soybeans and cotton. Some coal mining occurs in this region and natural gas exploration and production are increasing. In addition, some of the state's larger urbanized areas occur along the Arkansas River.

Predominant streams or rivers draining this region are the Arkansas, Fourche La Fave, Petit Jean, Cadron Creek and the Poteau River.

Reference streams selected from the Arkansas River Valley Ecoregion and the drainage area above the sample sites are as follows:

Mill Creek	17 mi^2
North Fork Cadron Creek	21 mi^2
Tenmile Creek	49 mi^2
Dutch Creek	110 mi^2
Petit Jean River	241 mi^2
Cadron Creek	308 mi^2

MILL CREEK

Mill Creek begins in the steep terrain of northern Faulkner County and flows southerly where it joins Black Fork Creek. Mill Creek then flows into the lowland area of the East Fork Cadron Creek bottoms. After entering East Fork of Cadron Creek and the main stem of Cadron Creek, these waters enter the Arkansas River near Conway, Arkansas. The sample site was at a county road crossing in Section 13, R 13 W, T 7 N (Figure AR-1).

General Site Discussion

Watershed Size - The area of the watershed above the sample site is 17 mi^2. During the summer sampling period there was no noticeable flow between the pools.

Geology - Surface rocks in the Arkansas River Valley are primarily sandstone and shale with alluvial deposits along all the larger waterways within the region.

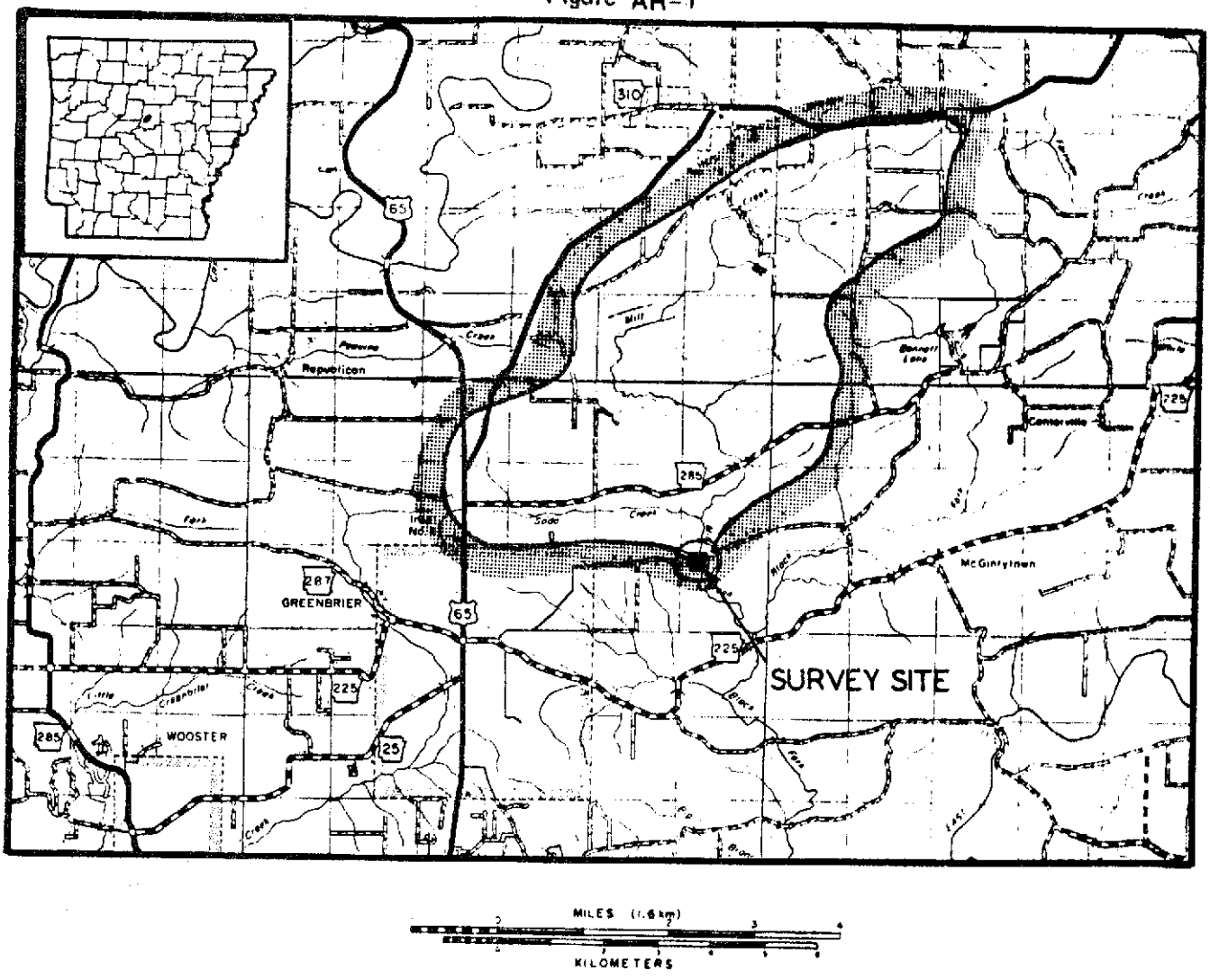
Topography - Stream gradient was measured as 13.5 feet per mile (ft/mi) for Mill Creek using a 7.5 minute quadrangle map from the USGS. The terrain is level to mountainous with erosional and folded hills, cuestas, hogbacks and buttes.

Soil Types - The predominant soil type found within the Mill Creek watershed is the Linker-Mountainburg association. The soils are formed from their parent materials, sandstone and shale. Soils of this association are extremely acidic with pH ranging from 3.6 to 5.5. Linker soils are moderately deep over bedrock whereas Mountainburg soils are generally quite shallow. Both soils are well drained, and have only a slight erosional potential. The predominant land use is pasture since the stony surface and droughty soils limit the row crop potential.

Flora - The general vegetation type for this area is shortleaf pine and upland hardwood. Tree types observed on the streambank of Mill Creek were river birch, river alder, hornbeam, blackgum, shellbark hickory, ironwood, sweetgum, Eastern cedar, shortleaf pine, white oak, post oak, blackjack oak, slippery elm and red maple.

Land Use - Land use in the Mill Creek drainage basin is primarily forests and agriculture. Due to the well-drained nature of the soils and the shallowness of bedrock, timber production is minimal. The majority of the timber appeared to be a slow growth hardwood typically called "scrub timber." Agricultural uses of cleared ground within this drainage were almost wholly pasture for both beef and dairy cattle. Conversation with local farmers during this survey revealed concern for the high temperatures and low rainfall

Figure AR-1



MILL CREEK: Drainage area 17 square miles ■ Survey site ▒ Survey area

and the subsequent effect on their pastures. Many farmers were already having to augment grazing with hay. The most recent information from the Cooperative Extension Service of the Department of Agriculture shows that 57% of the land within the Mill Creek drainage is currently under agricultural uses and 43% is in timber.

Stream Characteristics - Stream characteristics of Mill Creek are detailed within the physical, chemical and biological evaluation results. This specific site was located at the first enduring pools downstream from the intermittent section. Mill Creek behaves as two entirely different streams based on flow conditions. During dry seasons there is no flow or minimal subsurface flows between pools. In rainy seasons, flows are substantial down the narrow valley with its moderate gradient.

The water quality in Mill Creek is generally good, except for the low dissolved oxygen concentrations during the late summer. This condition is typical and the aquatic biota has adapted. However, only slight deterioration of these conditions during the critical period could eliminate these populations.

Broken bedrock substrate, producing large slab rocks at various angles on the stream bottom, provides good instream fishery cover. The mean stream canopy measurement of 56% might well have been greater had it not been for extensive beaver damage within the sample area.

Methodology and Sampling Results

Two studies were carried out on Mill Creek. The first was performed during the week of August 29, 1983, and encompassed all physical, chemical and biological parameters discussed in the General Methodology section. The second survey was conducted in the spring to evaluate the system during a higher flow regime and fish spawning conditions. The spring survey for Mill Creek was performed during the week of April 30, 1984.

Continuous Dissolved Oxygen

Summer - During the summer sampling period on Mill Creek only enduring pools were present. Two meters were set up in a large pool about 200 feet and 500 feet above the bridge. Plots of dissolved oxygen, temperature and percent saturation are shown in Figures AR-2 and AR-3. A rain shower occurred about 0500 hours on August 31 and caused a rapid rise in the dissolved oxygen as shown in the plots. Dissolved oxygen values ranged from 2.0 mg/l (25% saturation) to 5.0 mg/l (60% saturation) during the survey period. Minimum values occurred at about 0900 hours and

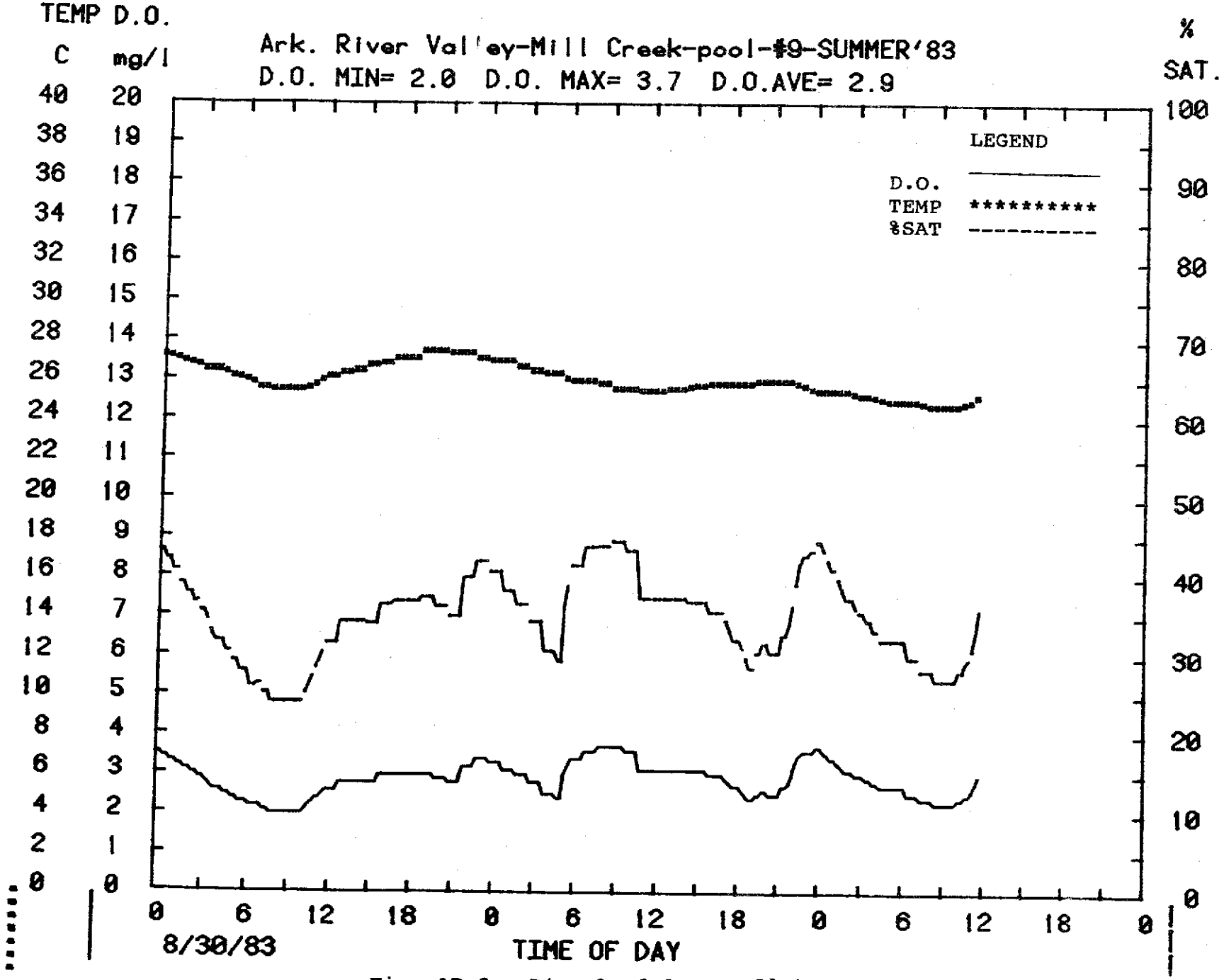


Fig. AR-2. Dissolved Oxygen Plot

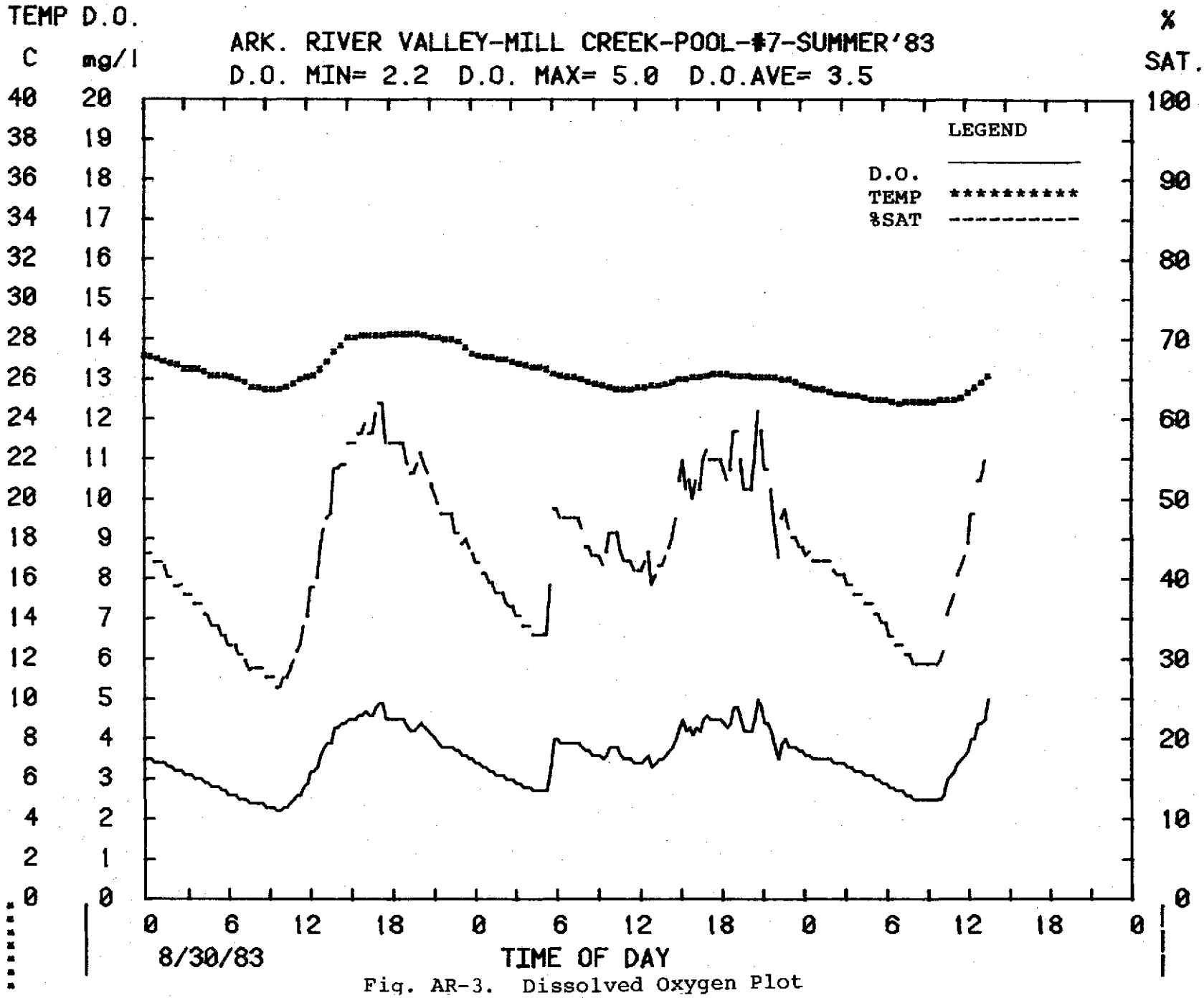


Fig. AR-3. Dissolved Oxygen Plot

maximums about 1600 hours. The D.O. was apparently responding to temperature, zero flow, primary production from algae or aquatic plants and respiration.

Spring - Two meters were set up during the spring survey at the same locations in the large pool as in the summer survey. Plots of D.O., temperature and percent saturation are shown in Figures AR-4 and AR-5. A thunderstorm occurred on May 2 and the cloud cover and rain tended to stabilize the daily fluctuation of these variables. Dissolved oxygen values ranged from 8.1 mg/l to 9.5 mg/l during the survey period and the percent saturation values were much higher than during the summer, ranging from 82% to 98% saturation.

Chemical Parameters

Tables AR-1 and AR-2 show the results of the analyses of chemical grab samples collected during the spring and summer conditions. Water in Mill Creek is low in alkalinity, hardness, minerals and nutrients. During the summer the water takes on a characteristic brown color.

Physical Parameters

Table AR-3 shows the physical results that were measured during the summer and spring. Although the majority of substrate was measured as bedrock, the substrate was actually in the form of thin layers in a parallel bedding plane to the stream bottom. As the bedrock eroded and weathered, large slabs were scattered at various angles, providing good instream cover for fish.

One of the important physical characteristics which separates this stream, and perhaps region, from other streams and regions, is that 17 mi^2 of drainage area does not provide enough groundwater charge to cause flow in Mill Creek during the critical season. This characteristic appears to be typical of the Arkansas River Valley Region as a whole.

Macroinvertebrate Populations

Fifty-seven (57) taxa representing 14 orders were identified from the qualitative macroinvertebrate samples collected from this study site (Table A-14, Appendix A). Nineteen (19) taxa were collected during the summer survey and 43 taxa were identified from the spring sample. The total number of organisms collected in the spring was almost seven times that collected in summer sample (400 vs. 58). These increases were due, at least in part, to the increased sampling effort during the spring survey. The increase also reflects the seasonal variation exhibited by insect communities. The qualitative comparative indices for the

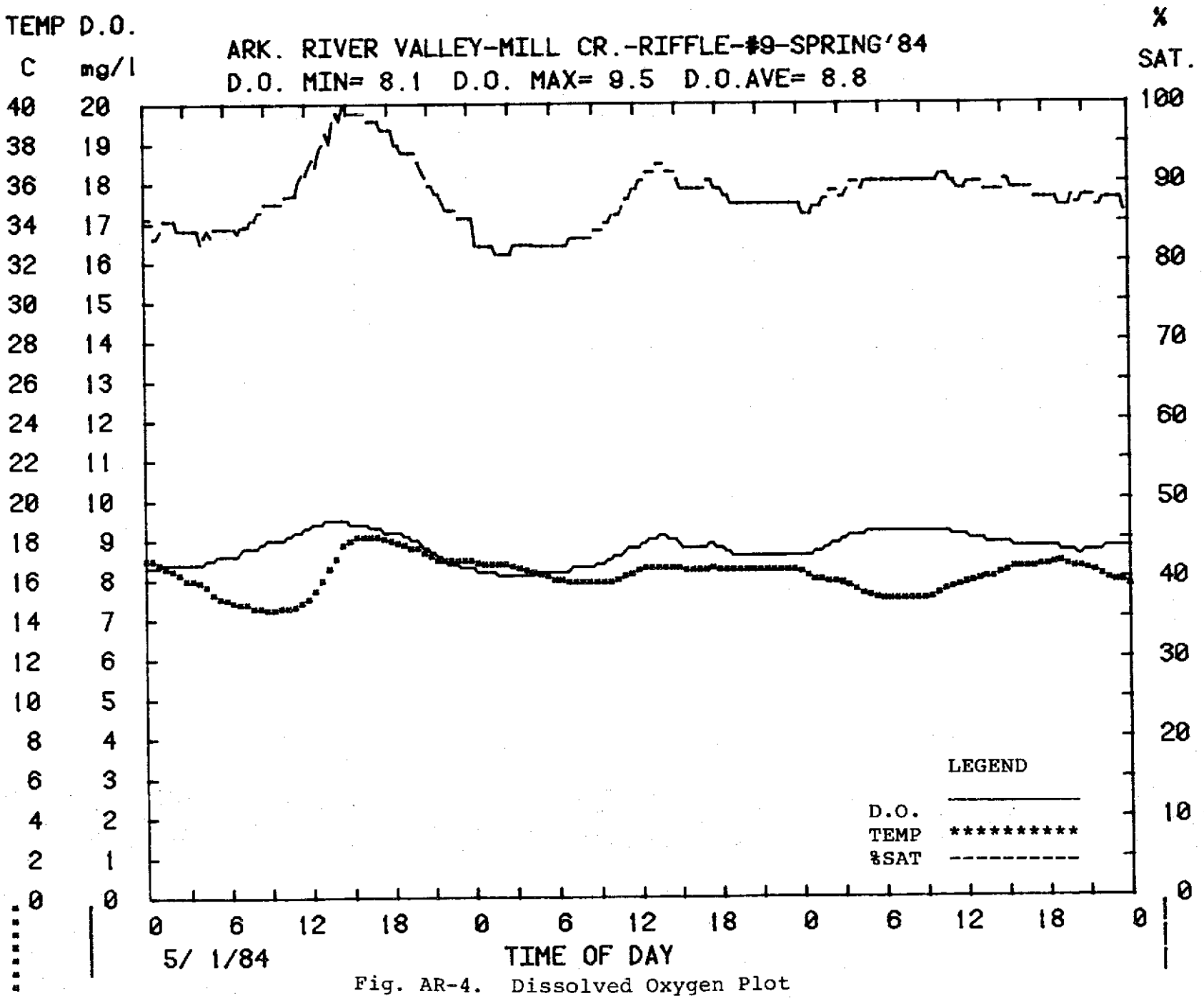


Fig. AR-4. Dissolved Oxygen Plot

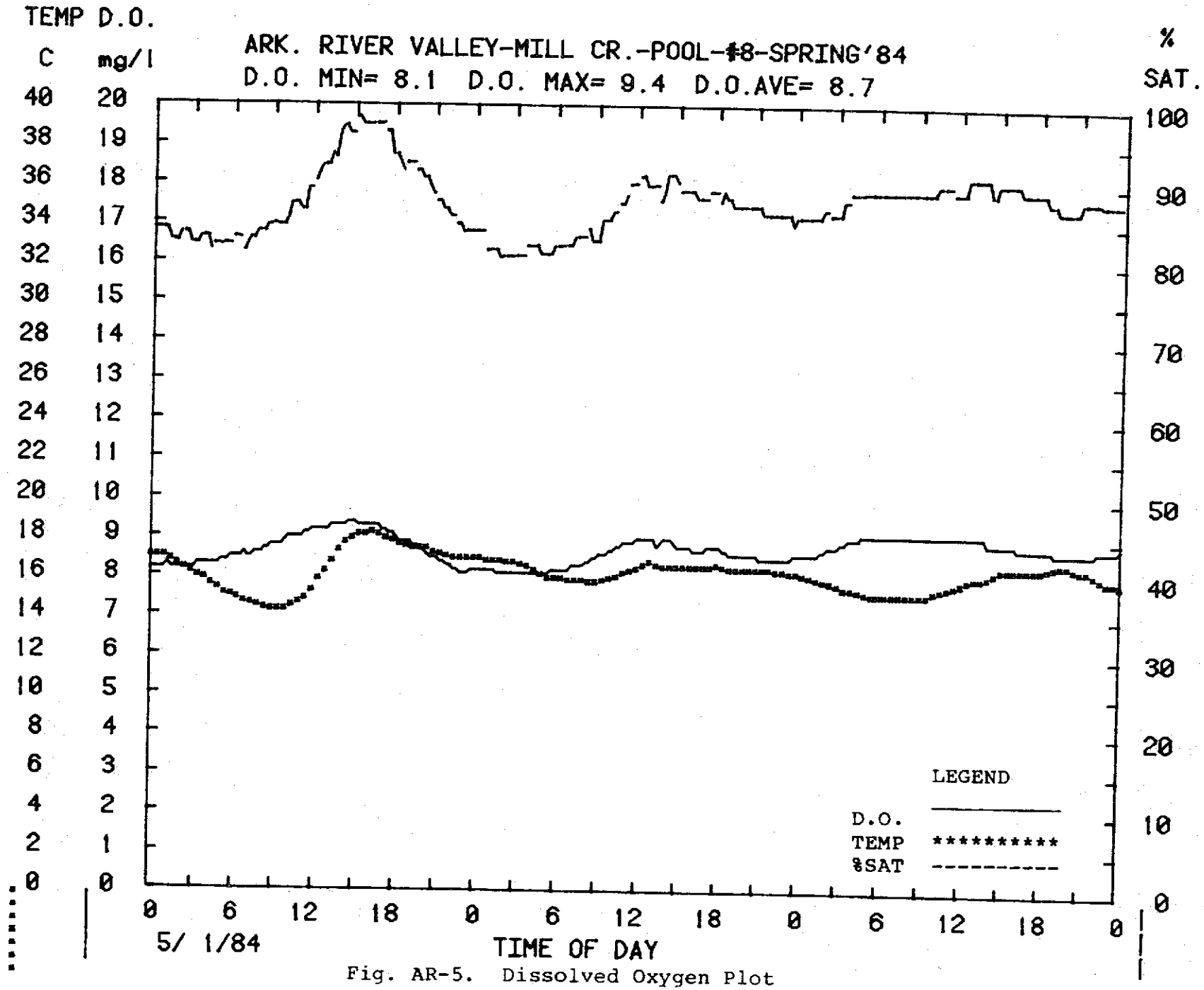


Fig. AR-5. Dissolved Oxygen Plot

Table AR-1

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Mill Creek

Drainage Area: 17 Square Miles

Station Description: 225 feet above bridge on county road in NW 1/4 of Section 13, T 7 N, R 13 W - Faulkner County

Date: August 30, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	09:30	11:40	13:38	
Q, cfs	0	0	0	0
Temperature, °C	26	26	26.5	26
pH	6.2	6.4	6.4	6.3
Turbidity, ntu	8	9	6	8
TSS, mg/l	10	13	7	10
TDS, mg/l	54	51	51	52
BOD-5, mg/l	1.7	2.9	2.8	2.5
BOD-20, mg/l	4.4	5.6	6.4	5.5
T.Phos., mg/l	0.05	0.07	0.06	0.06
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.02	0.03	0.02	0.02
NH3-N, mg/l	0.08	0.08	0.06	0.07
Cl -, mg/l	5.5	5.5	6.5	6
SO4 =, mg/l	<1	<1	<1	<1
Fe, mg/l	0.52	0.55	0.40	0.50
Conductivity,µmho	74	75	75	75
Alkalinity, mg/l	23	22	21	22
T. Hardness, mg/l	-	24	22	23
Chlorophyll a,µg/l	12.8	6.9	13.4	11.0
Fecal Coliform	-	-	220	220

Dissolved Oxygen Data for August 30, 1983		
	Pool	Riffle
Average	3.5	none
Minimum	2.2	"
Maximum	4.9	"

Table AR-2

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Mill Creek

Drainage Area: 17 Square Miles

Station Description: 225 feet above bridge on county road in NW 1/4 of Section 13, T 7 N, R 13 W - Faulkner County

Date: May 1, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:17	10:21	13:32	
Q, cfs	9.8	9.8	9.8	9.8
Temperature, °C	15	15	17	15.5
pH	6	6	6	6
Turbidity, ntu	5.2	5.0	5.8	5.3
TSS, mg/l	5	4	4	4
TDS, mg/l	36	39	39	38
BOD-5, mg/l	0.6	0.8	0.6	0.7
BOD-20, mg/l	1.9	1.9	1.9	1.9
T.Phos., mg/l	0.01	0.01	0.01	0.01
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	0.39	0.40	0.41	0.40
NH3-N, mg/l	0.05	0.01	0.08	0.05
Cl -, mg/l	3.5	4	4	4
SO4 =, mg/l	2	2	2	2
Fe, mg/l	0.22	0.16	0.15	0.18
Conductivity,µmho	34	33	34	34
Alkalinity, mg/l	8	8	8	8
T. Hardness, mg/l	10	12	12	11
Chlorophyll a,µg/l	VOID	VOID	VOID	-
Fecal Coliform	-	-	10	10
MN mg/l	0.025	0.025	0.025	0.025
COD mg/l	8.1	6.1	6.1	6.7

Dissolved Oxygen Data for May 1, 1984		
	Pool	Riffle
Average	8.7	8.9
Minimum	8.1	8.3
Maximum	9.4	9.5

Table AR-3

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Mill Creek
Date:	August 30, 1983
Drainage Area:	17 square miles
Watershed Land Use:	57% agriculture 43% forest
Stream Gradient:	13.5 ft/mile
Mean Channel Width:	39.2 feet
Mean Stream Width:	32.0 feet
Mean Stream Velocity:	0
Observed Flow:	0
Average Substrate Type:	76% bedrock 24% mud/silt
Mean Instream Cover:	1% undercut bank 2% brush, logs, debris 0% overhanging vegetation 0% inundated vegetation
Riffle/Pool Ratio of Transects:	0% riffles 80% deep pools 0% moderate pools 20% shallow pools
Mean Bank Overstory Cover:	56% trees 11% shrubs
Mean Bank Ground Cover:	45% grasses and forbs 55% dirt
Mean Bank Stability:	10% stable 90% moderate 0% unstable
Mean Stream Canopy:	56%

Comments: Considerable damage to stream canopy was observed on both banks as the result of beaver activity.

Mill Creek samples indicates little homogeneity between the spring and summer benthic communities. However, the difference between the summer and spring sample sizes has skewed these indices more than would normal seasonal variation. Only five (26%) of the taxa collected in the summer were also collected in spring.

Summer - The dominant orders of the summer sample were mayflies (25.9%), beetles (18.9%), dipterans (17.2%) and megalopterans (13.8%). Numerically, the dominant taxa were Sialis and Tribelos (13.8%) and Stenonema femoratum and Stenacron interpunctatum (10.3%).

Spring - In contrast, the dominant orders of the spring sample were stoneflies (31.3%), mayflies (18.3%), caddisflies (14.0%) and isopods (12.8%). The dominant taxa of the spring sample were Wormaldia, Lirceus hoppinae and Isoperla mohri comprising 13.8%, 12.8% and 10.5% of the sample, respectively. The seasonal variation was very pronounced among the dominant forms. The change was from typical mesothermal species group in summer to oligothermal species group in spring.

The community parameters calculated for both samples indicated a diverse, well-balanced ecosystem characteristic of "high quality" water. The large increase in sample size did not significantly increase the diversity indices (Table AR-4). There was a reduction in the index of evenness in the spring sample due to the presence of large populations of some winter insect taxa. The effect this had on the diversity indices was compensated for by the increase in total number of taxa collected, i.e., the index of variety.

Table AR-4. Community Analysis of Benthic Samples from Mill Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	58	400	458
Total # Taxa	19	43	57
Diversity	3.9906	4.1599	4.6861
Index of Evenness	0.9233	0.7871	0.8105
Index of Dominance	0.4553	0.3992	0.3984
Index of Variety	3.1910	4.4302	6.1403
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.16	
Common Taxa Index (range 0-1)		0.1	
Qualitative Similarity Index (range 0-100)		1.0	

Fish Populations

Summer - An isolated pool approximately one-third acre in size was treated with two pounds of 7% the active ingredient, powdered rotenone on August 31, 1983.

Twenty-nine (29) species of fish were collected from 739 individuals. They had a total relative abundance value of 192.5, a diversity index of 4.57 and an index of evenness of 0.94 (Table AR-5). Nine species of Centrarchidae dominated the population with 27.3% of the population relative abundance. This was followed by three species of Cyprinids at 15.6%, four species of Catostomidae at 13.2%, two species of Ictaluridae at 10.1% and three species of Percidae at 9.9%. The trophic feeding levels of the population were as follows: two species of primary feeders equaling 11.7% of the total relative abundance value, 29 species of secondary feeders at 75.3% and five species of top carnivores at 13%. Only four sensitive species totaling 11.4% of the relative abundance value were collected at this site (. Although this site had a moderate stream gradient of 13.5 ft/mi, its nearness to larger lowland streams resulted in several "lowland" forms of fishes being collected, e.g., bowfin, spotted sucker, bluegill and drum.

Table AR-6. Fishes Collected from Mill Creek on August 31, 1983, with Relative Abundance Values

Species		R.A. Value
Etheostoma whipplei	Redfin darter	12.0
Lepomis cyanellus	Green sunfish	12.0
Pimephales notatus	Bluntnose minnow	12.0
Moxostoma erythrurum	Golden redhorse	10.5
Dorosoma cepedianum	Gizzard shad	10.5
Ictalurus natalis	Yellow bullhead	10.5
Lepomis megalotis	Longear	10.5
*Noturus exilis	Slender madtom	9.0
Micropterus punctulatus	Spotted bass	9.0
Labidesthes sicculus	Brook silversides	9.0
Minytrema melanops	Spotted sucker	9.0
Esox americanus	Grass pickerel	9.0
Lepomis macrochirus	Bluegill	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
Notropis umbratilis	Redfin shiner	9.0
*Notropis boops	Bigeye shiner	9.0
Erimyzon oblongus	Creek chubsucker	5.0
Percina caprodes	Logperch	4.0
Lepomis gulosus	Warmouth	4.0
Lepomis microlophus	Redear	4.0
Aplodinotus grunniens	Freshwater drum	3.0
Percina maculata	Blackside darter	3.0

Table AR-6, cont.

Amia calva	Bowfin	3.0
Aphredoderus sayanus	Pirate perch	1.5
Pomoxis nigromaculatus	Black crappie	1.5
Micropterus salmoides	Largemouth bass	1.5
Lepomis punctatus	Spotted sunfish	1.0
**Hypentelium nigricans*	Northern hogsucker	1.0
Esox niger	Chain pickerel	1.0
	TOTAL	192.5

* Sensitive species

Spring - Electrofishing was used on May 2, 1984, to collect fishes from Mill Creek. The 3500-watt, 120-volt A.C. generator was utilized. Trammel nets were also set but heavy rains and high water prevented effective collecting with this gear.

Trammel nets could be run only once during the period and one spotted sucker and two golden redhorse were the only fishes collected. Before the rain began, electrofishing was conducted at this site. Of the 18 species collected, four were taken which were not collected at this site the previous summer. This increased the total species collected to 33. The species collected and the number of individuals taken are listed below.

Species	No.
+*Campostoma anomalum*	76
Pimephales notatus	4
+*Pimephales vigilax*	1
Notropis boops	5
+*Notropis emiliae*	2
Notropis whipplei	7
Erimyzon oblongus	13
Hypentelium nigricans	1
Moxostoma erythrurum	2
Ictalurus natalis	1
+*Ictalurus melas*	2
Noturus exilis	7
Fundulus olivaceus	13
Micropterus punctulatus	4
Lepomis cyanellus	19
Lepomis megalotis	11
Lepomis macrochirus	20
Etheostoma whipplei	13

+ Species not collected the previous summer at this site.

Table AR-7. Summary of Fish Population Parameters from Mill Creek

Total Species Collected	33.0
Total Number Of Individuals	739.0
Total Relative Abundance Value	192.5
Relative Abundance Diversity Index	4.57

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	3.0	15.6
CATOSTOMIDAE	4.0	13.2
ICTALURIDAE	2.0	10.1
CENTRARCHIDAE	9.0	27.3
PERCIDAE	3.0	9.9
Primary Feeders	2.0	11.7
Macroinvertebrate Feeders	25.0	75.3
Carnivores	6.0	13.0
Sensitive Species	4.0	11.4

NORTH FORK OF CADRON CREEK

The North Fork of Cadron Creek begins in Cleburne County at the northern edge of the Arkansas River Valley in some of the steepest terrain of this region. It flows generally southwestward for several miles, then begins meandering eastward before flowing into the main stem of Cadron Creek, which flows south and west into the Arkansas River. The North Cadron Creek sample site was 300 feet upstream from the bridge on a county road in Section 21, R 12 W, T 10 N, in Van Buren County (Figure AR-6).

General Site Discussion

Watershed Size - The drainage area above the sample site is 21 mi^2, which provided a measurable flow of 0.07 cfs during the summer sample period.

Geology - The Arkansas River Valley surface rocks are primarily sandstone and shale with alluvial deposits along all the larger waterways within the region. The Cadron Creek watershed is typical of the region.

Topography - The terrain is level to mountainous with erosional and folded hills, cuestas, hogbacks, and buttes. Slopes range from less than 5% to vertical along cap rock cliffs. Elevations range from about 350 to 850 feet msl.

Soil Types - Soil associations found within the North Cadron Creek drainage basin are:

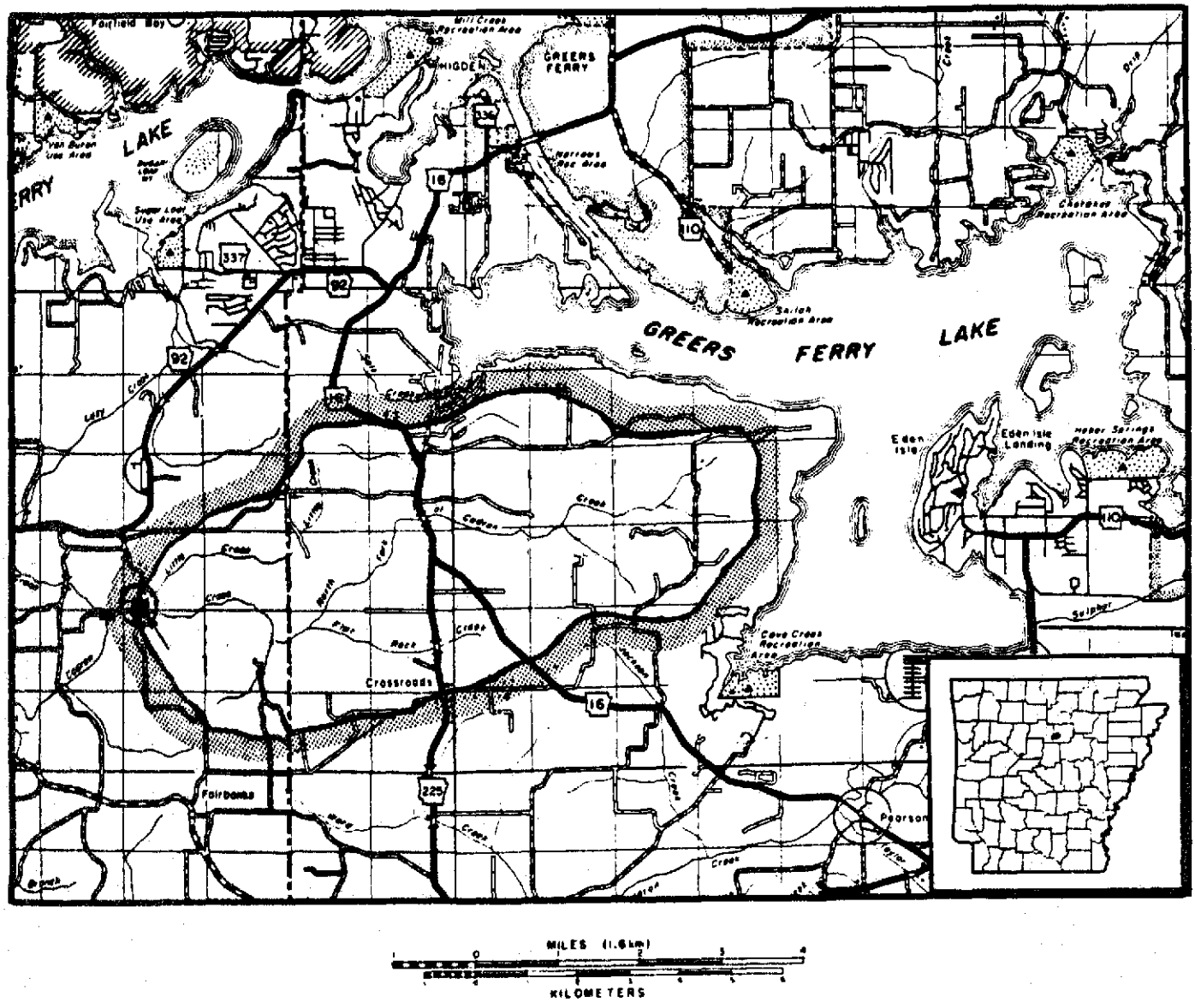
Enders-Steprock: moderately deep and deep, well drained, moderately sloping to steep, gravelly and stony, loamy soils formed in residual and colluvial material, derived from interbedded sandstone, siltstone and shale.

Steprock-Mountainburg-Rock Outcrop: moderately deep and shallow, steep to very steep, well drained, stony and loamy soils formed in residium or colluvium weathered from sandstone or interbedded sandstone, siltstone and shale.

Linker-Steprock-Mountainburg: moderately deep to shallow, gently sloping to moderately steep, well drained, loamy and gravelly soils formed in residium weathered from sandstone or interbedded sandstone, siltstone and shale.

Steprock-Mountainburg: moderately deep and shallow, gently sloping to moderately steep, well drained, stony and gravelly, loamy soils formed in

Figure AR-6



NORTH FORK CADRON CREEK: Drainage area 21 square miles ■ Survey site ▒ Survey area

residium or colluvium weathered from sandstone or interbedded sandstone, siltstone and shale.

Kenn-Ceda-Spadra: deep, well drained, level to nearly level, loamy and gravelly soils formed in alluvium from nearby uplands.

Leadvale-Taft: deep, moderately well drained and somewhat poorly drained, level to gently sloping, loamy soils formed in alluvium and colluvium from nearby uplands.

Flora - The general vegetation type for this area is shortleaf pine and upland hardwoods. Tree types observed on the streambank of North Cadron Creek were river birch, river alder, ironwood, slippery elm and red maple.

Land Use - Land use in the North Cadron Creek drainage basin is 61% forestry and 39% agriculture. The primary agricultural use is pasture for both beef and dairy cattle. Forest production is typically slow growth hardwoods or pines.

Stream Characteristics - Stream characteristics of North Cadron Creek are detailed within the physical, chemical and biological evaluation results. Stream gradient at the sample site is 10 ft/mile.

Methodology and Sampling Results

The summer survey was conducted during the week of August 29, 1983. Rain occurred on the morning of August 31. The second survey, conducted in the spring to evaluate the system during a high flow regime and fish spawning conditions, was performed during the week of April 30, 1984.

Continuous Dissolved Oxygen

Summer - Figures AR-7 and AR-8 show the recorded D.O. and temperature values measured during the summer survey. The summer survey was conducted during minimal flow conditions with a 0.07 cfs flow observed during the survey.

D.O. values during the steady state period prior to the rainfall ranged from a low of 3.2 mg/l to a high of 5.9 mg/l, and the D.O. saturation ranged from 35% to 75%. This apparently large diel fluctuation is very likely the result of suitable substrate for attached algae and the 33% canopy, which allowed ample sunlight to penetrate the stream.

Spring - The spring sampling showed much higher levels of D.O. (Figures AR-9 and AR-10). The minimum recorded was 8.0 mg/l and the maximum was 9.1 mg/l. The percent saturation

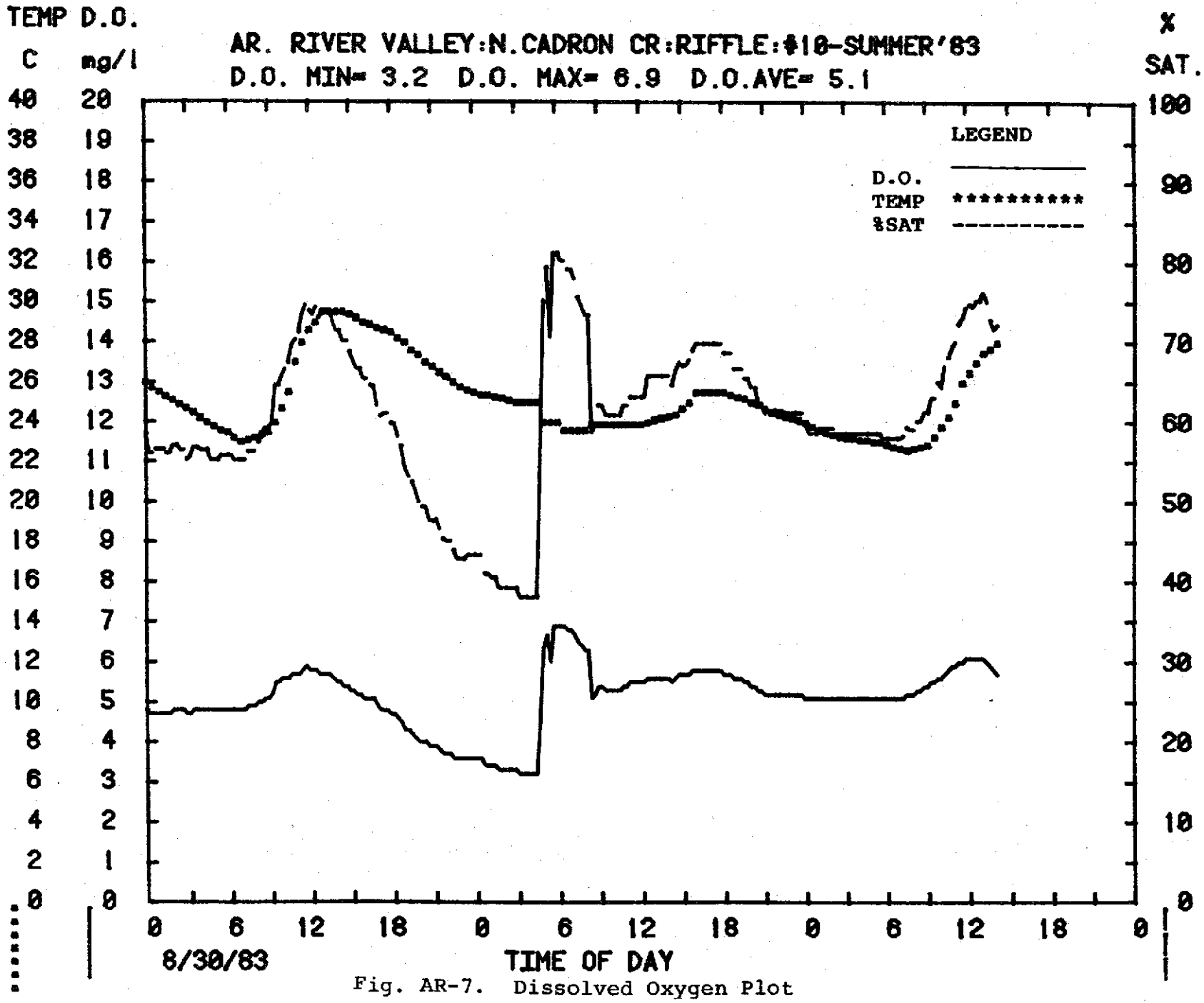


Fig. AR-7. Dissolved Oxygen Plot

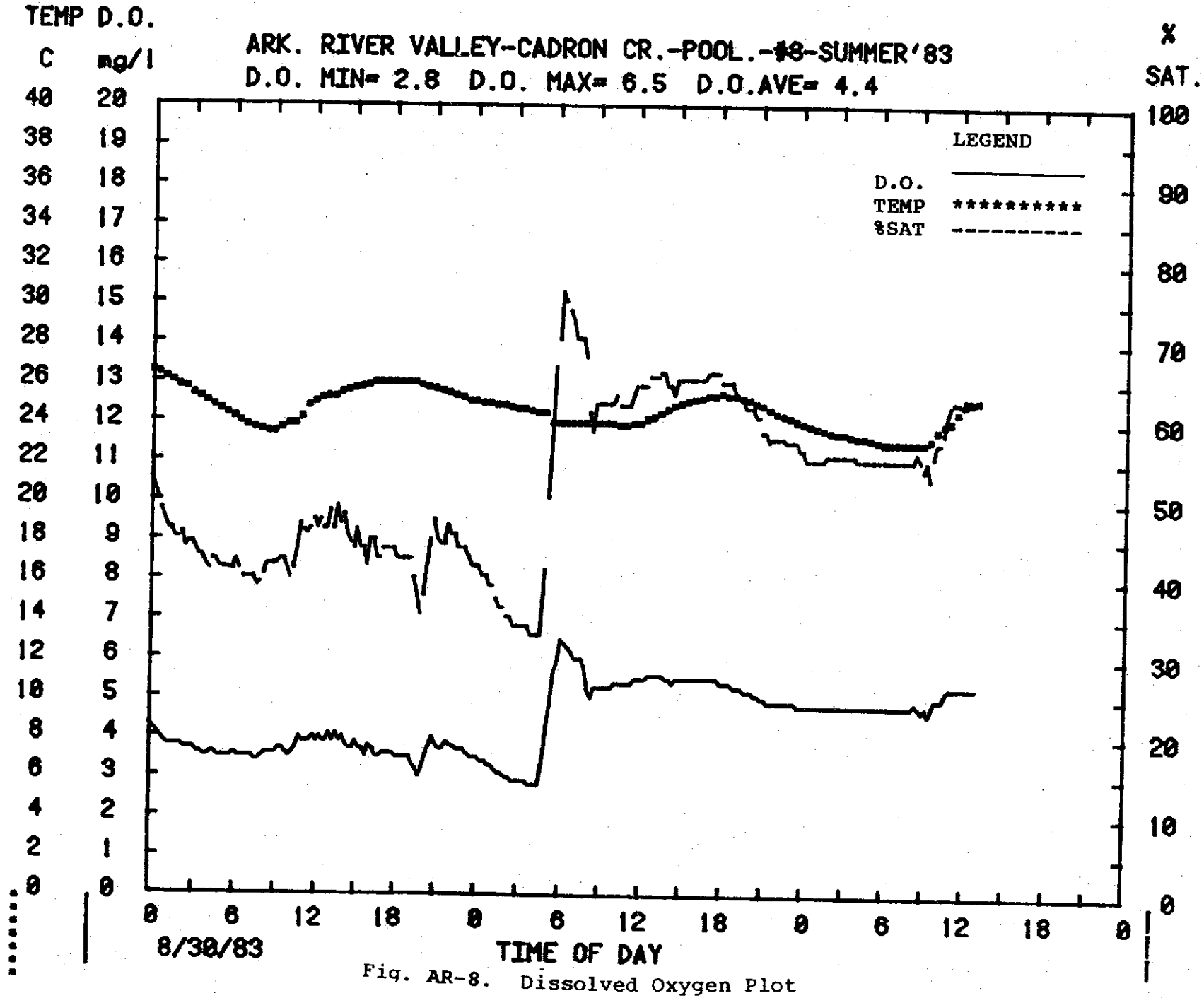


Fig. AR-8. Dissolved Oxygen Plot

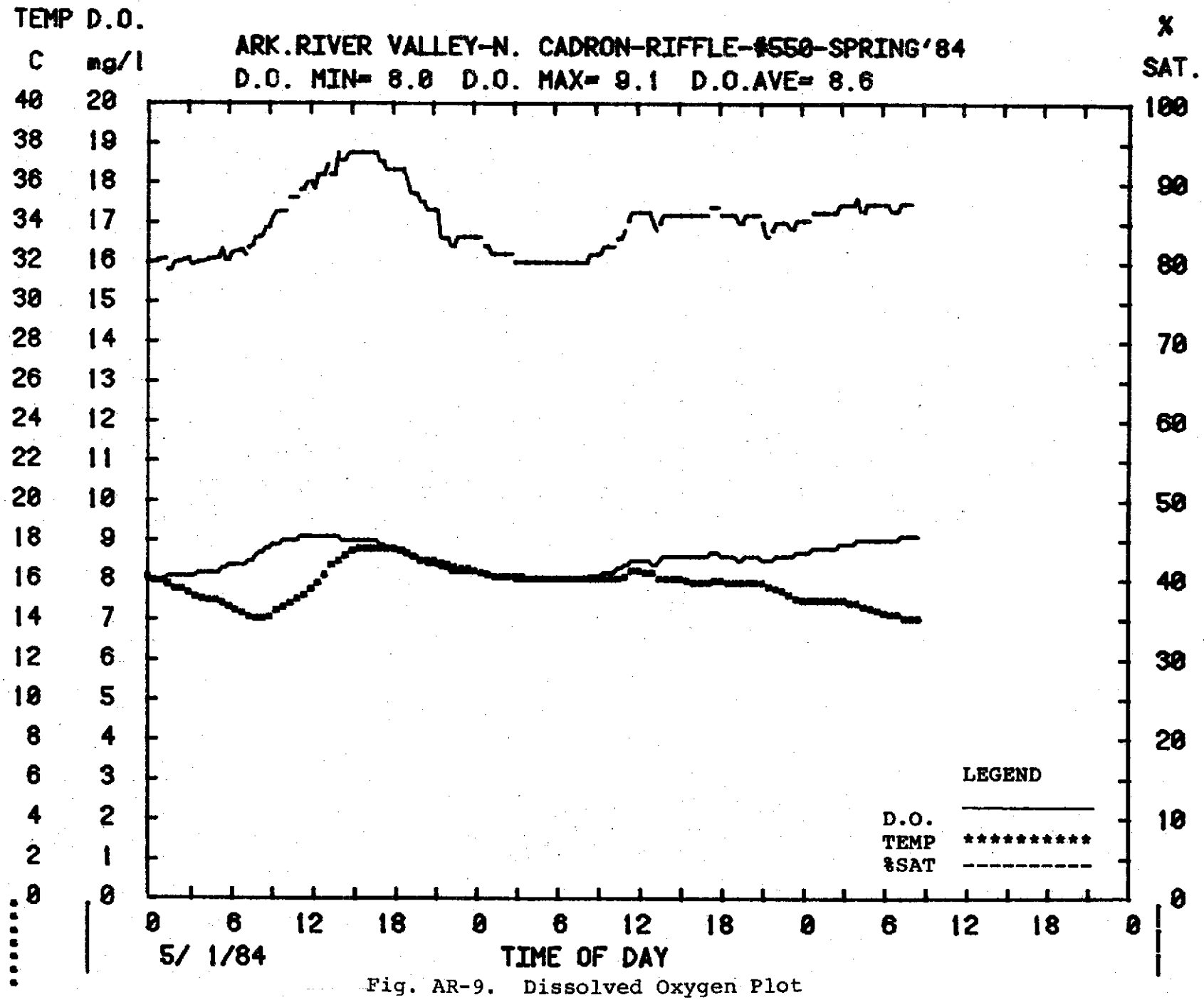


Fig. AR-9. Dissolved Oxygen Plot

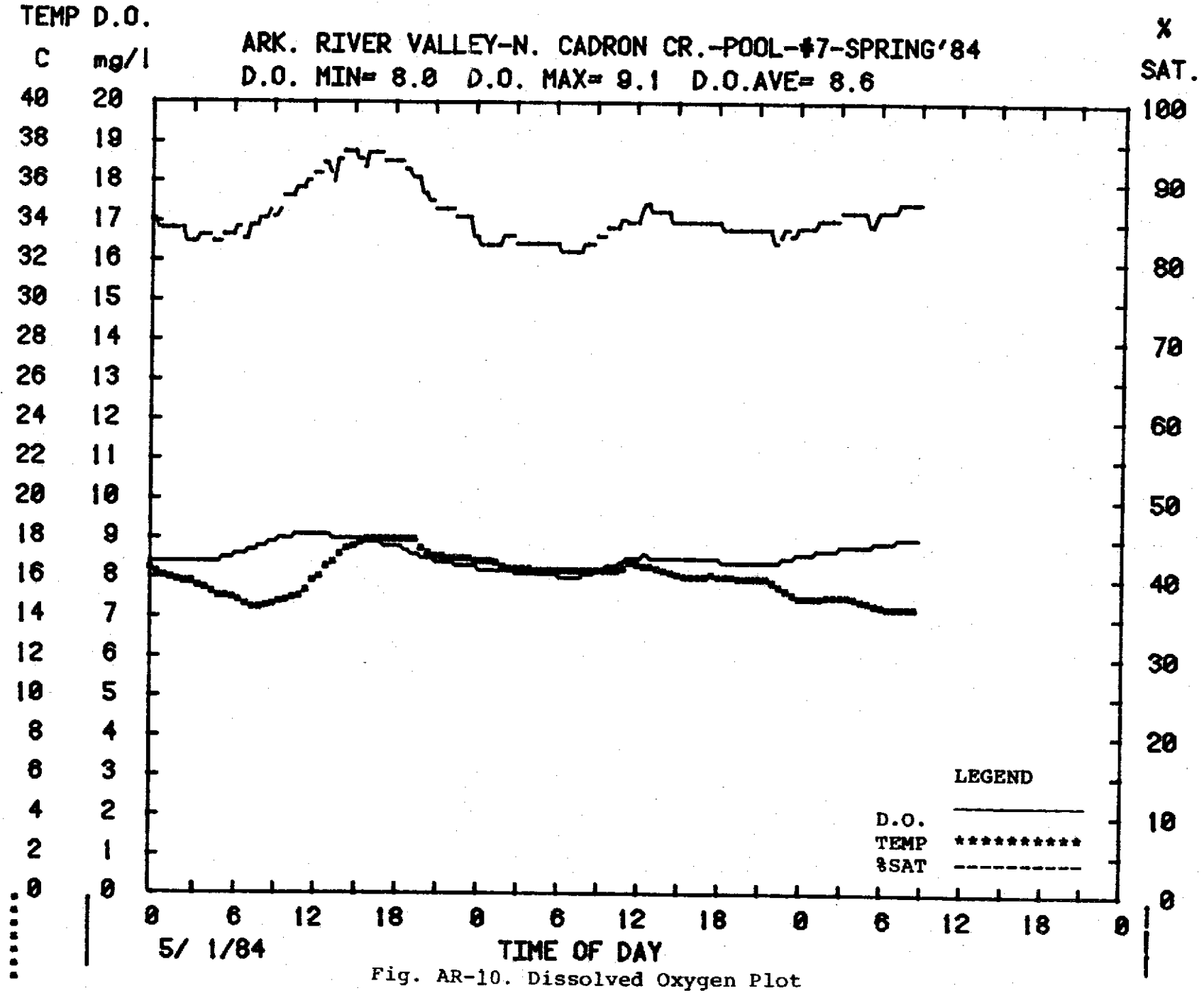


Fig. AR-10. Dissolved Oxygen Plot

values were also much higher, ranging from 80% to 95%. These higher D.O. values recorded during the spring are related to higher flow conditions and cooler water temperatures, which allow high aeration rates.

Chemical Parameters

Tables AR-7 and AR-8 show the results of analysis of the chemical grab samples collected during the spring and summer periods. The results from both sampling periods indicate that North Cadron Creek contains water of good quality.

Generally speaking, the various parameters were slightly higher during the summer conditions, with the exception of D.O., which was lower. The lower D.O. may be a result of the evapotranspiration process. The water could be characterized as having low alkalinity, chlorides, sulfates, total dissolved solids and nutrients. The high fecal coliform values measured during the summer period were probably caused by cattle, which had access to the stream. Total iron was greater than 1 mg/l during the summer and is thought to be a factor in giving the water its characteristic brown color.

Physical Parameters

Stream characteristics of North Cadron Creek are detailed in Table AR-9. The 21 square miles of drainage area provided a small flow through the riffle areas to the pools during the low-flow summertime period. The riffle to pool ratio was 1:1 at this site. The instream substrate type was predominantly bedrock, measured at 57%, while the remainder was boulders (10%), rubble (25%), gravel (6%), with sand/mud/silt forming 2%. Instream fishery cover was measured at 3% brush, 3% inundated vegetation and 1% undercut bank. The banks of the stream were judged to be only moderately stable. The stream canopy at the site was 33%.

Macroinvertebrate Populations

Seventy-four (74) taxa representing 15 orders were identified from the qualitative benthic samples collected from this site. Thirty-six (36) and 56 taxa were identified from the summer and spring samples, respectively (Table A-15, Appendix A). The total number of organisms collected in the spring sample was over twice that collected in the summer (297 vs. 129). These increases were due, at least in part, to the increase in sampling effort during the spring survey. The taxonomic diversity also exhibited a substantial seasonal variation characteristic of macroinvertebrate communities. The qualitative comparative indices calculated for the summer vs. spring samples

Table AR-7

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: North Fork Cadron

Drainage Area: 21 Square Miles

Station Description: 300 feet above bridge on county road in Section 21, T 10 N, R 12 W - Van Buren County

Date: August 30, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	09:15	11:40	13:30	
Q, cfs	0.07	0.07	0.07	0.07
Temperature, °C	24	26	29	26
pH	6.1	6.1	6.5	6.2
Turbidity, ntu	4	4	4	4
TSS, mg/l	2	4	2	3
TDS, mg/l	37	39	37	38
BOD-5, mg/l	1.1	1.3	1.2	1.2
BOD-20, mg/l	3.2	3.8	3.4	3.5
T.Phos., mg/l	0.06	0.05	0.06	0.06
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.07	0.08	0.07	0.07
NH3-N, mg/l	0.08	0.05	0.05	0.06
Cl -, mg/l	4	4	3.5	4
SO4 =, mg/l	<1	<1	<1	<1
Fe, mg/l	1.04	1.14	0.98	1.05
Conductivity,µmho	44	42	43	42
Alkalinity, mg/l	13	12	11	11
T. Hardness, mg/l	18	16	18	17
Chlorophyll a,µg/l	0.1	0.8	2.2	1.0
Fecal Coliform	-	-	2,400	2,400

Dissolved Oxygen Data for August 30, 1983		
	Pool	Riffle
Average	3.7	4.8
Minimum	3.0	3.6
Maximum	4.3	5.9

Table AR-8

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: North Fork Cadron

Drainage Area: 21 Square Miles

Station Description: 300 feet above bridge on county road in Section 21, T 10 N, R 12 W - Van Buren County

Date: May 1, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:15	10:10	11:20	
Q, cfs	10.0	10.0	10.0	10.0
Temperature, °C	15	15.5	16	15.5
pH	5.9	5.4	5.6	5.6
Turbidity, ntu	4	4	4	4
TSS, mg/l	3	4	4	4
TDS, mg/l	31	33	30	31
BOD-5, mg/l	0.5	0.7	0.7	0.6
BOD-20, mg/l	1.6	1.7	2.0	1.8
T.Phos., mg/l	0.01	0.01	0.01	0.01
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.10	0.10	0.11	0.10
NH3-N, mg/l	0.01	0.01	0.01	0.01
Cl -, mg/l	3.5	3	3	3
SO4 =, mg/l	2	2	2	2
Fe, mg/l	0.21	0.23	0.15	0.20
Conductivity,µmho	21	22	22	22
Alkalinity, mg/l	4	4	4	4
T. Hardness, mg/l	6	6	10	7
Chlorophyll a,µg/l	0.9	0.4	1.1	0.8
Fecal Coliform	-	-	160	160
MN mg/l	0.025	0.025	0.025	0.025
COD mg/l	6.1	6.8	6.8	6.5

Dissolved Oxygen Data for May 1, 1984		
	Pool	Riffle
Average	8.7	8.6
Minimum	8.3	8.0
Maximum	9.1	9.1

Table AR-9

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	North Fork Cadron
Date:	August 30, 1983
Drainage Area:	21 square miles
Watershed Land Use:	39% forest 61% agriculture
Stream Gradient:	10.0 ft/mile
Mean Channel Width:	42.3 feet
Mean Stream Width:	20.3 feet
Mean Stream Velocity:	.05 ft/sec
Observed Flow:	.07 cfs
Average Substrate Type:	57% bedrock 25% rubble 6% gravel 5% large boulders 5% boulders 1% sand 1% mud/silt
Mean Instream Cover:	1% undercut bank 3% brush, logs, debris 0% overhanging vegetation 3% inundated vegetation
Riffle/Pool Ratio of Transects:	50% riffles 0% deep pools 0% moderate pools 50% shallow pools
Mean Bank Overstory Cover:	65% trees 16% shrubs
Mean Bank Ground Cover:	50% grasses and forbs 50% dirt
Mean Bank Stability:	15% stable 85% moderate 0% unstable
Mean Stream Canopy:	33%

Comments: Spring flow was estimated at 400 cfs on 5-3-84.

indicate only slight homogeneity between benthic communities (Table AR-10). The increase in taxa and numbers of individuals in the spring sample acted to skew those indices downward.

Summer - The summer sample was dominated by coleopterans (28.7%) and dipterans (27.8%). Chironomus, Ancyronyx variegata, and Tribelos each comprised greater than 10% of the total.

Spring - The dominant orders of the spring sample were stoneflies (36.4%) and caddisflies (14.8%). Only one taxa, the winter stonefly Perlesta placida, comprised greater than 10% of the total. The seasonal variation was exhibited by a change in the dominant species groups from mesoxyphilous species groups in the summer to euoxyphilous species groups in the spring.

The community parameters calculated for both samples indicated well-balanced macroinvertebrate communities resulting from diverse microhabitat availability and excellent quality water. The changes in the community parameters were believed to be the result of increased sampling effort and the seasonal variability of the insect populations and not an actual improvement of water quality.

Table AR-10. Community Analysis of Benthic Samples from North Fork Cadron Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	129	297	426
Total # Taxa	36	56	74
Diversity	4.4371	4.7251	5.3045
Index of Evenness	0.8583	0.8173	0.8439
Index of Dominance	0.5783	0.3475	0.3612
Index of Variety	4.9920	6.5856	8.8257
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.39	
Common Taxa Index (range 0-1)		0.23	
Qualitative Similarity Index (range 0-100)		14.0	

Fish Populations

Summer - On August 31, 1983, approximately 300 feet of the stream was treated with four pounds of 7% powdered rotenone. The rotenone was detoxified at the end of the sample area with potassium permanganate.

Twenty-seven (27) species of fish and 1577 individuals were collected. These species and their relative abundance value are listed in Table AR-11. The total relative abundance value was 201 with a diversity index of 4.53 and an index of

evenness of 0.95. Centrarchidae from six species made up 23.9% of the relative abundance total; Percidae composed 15.2%; Catostomidae, 14.7%; Cyprinidae, 20.4%; and Ictaluridae, 11.9% of the total. Three species of primary feeders made up 10.9% of the population relative abundance; 21 species of secondary feeders equalled 77.9%; and three species of top carnivores comprised 11.2% of the total. Six species of sensitive fishes were collected which comprised 15.7% of the population relative abundance (Table AR-12).

Spring - Monofilament trammel nets were set at this site on May 1, 1984, but heavy rainfall and high water prevented removing fish for several days. When the nets were removed 2 spotted suckers, 1 hogsucker, 1 golden redhorse and 1 green sunfish were captured. All suckers (3 males and 1 female) were in spawning condition.

Table AR-11. Fishes Collected from North Fork of Cadron Creek on August 31, 1983, with Relative Abundance Values

Species		R.A. VALUE
Fundulus olivaceus	Blackspotted topminnow	12.0
Ictalurus natalis	Yellow bullhead	12.0
*Noturus exilis	Slender madtom	12.0
Etheostoma whipplei	Redfin darter	12.0
Erimyzon oblongus	Creek chubsucker	12.0
Campostoma anomalum	Stoneroller	12.0
Lepomis cyanellus	Green sunfish	10.5
Lepomis megalotis	Longear	10.5
Moxostoma erythrurum	Golden redhorse	9.0
Etheostoma spectabile	Orangethroat darter	9.0
Pimephales notatus	Bluntnose minnow	9.0
Notropis umbratilis	Redfin shiner	9.0
*Notropis boops	Bigeye shiner	9.0
Esox americanus	Grass pickerel	7.5
Micropterus salmoides	Largemouth bass	7.5
Micropterus punctulatus	Spotted bass	7.5
Minytrema melanops	Spotted sucker	7.5
*Etheostoma flabellare	Fantail darter	7.0
Lepomis macrochirus	Bluegill	6.0
Lepomis punctatus	Spotted sunfish	6.0
Labidesthes sicculus	Brook silversides	4.5
Aphredoderus sayanus	Pirate perch	4.0
*Percina maculata	Blackside darter	1.5
Notemigonus crysoleucas	Golden shiner	1.0
*Hypentelium nigricans	Northern hogsucker	1.0
Percina caprodes	Logperch	1.0
*Notropis whipplei	Steelcolor shiner	1.0
	Total	201.0

*Sensitive species

Table AR-14. Summary of Fish Population Parameters from North Fork Cadron Creek

Total Species Collected	27.0
Total Number of Individuals	1577.0
Total Relative Abundance Value	201.0
Relative Abundance Diversity Index	4.53

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6.0	20.4
CATOSTOMIDAE	4.0	14.7
ICTALURIDAE	2.0	11.9
CENTRARCHIDAE	6.0	23.9
PERCIDAE	5.0	15.2
Primary Feeders	3.0	10.7
Macroinvertebrate Feeders	21.0	77.9
Carnivores	3.0	11.2
Sensitive Species	6.0	15.7

TENMILE CREEK

Tenmile Creek begins in the southwest corner of Independence County and flows in a generally southerly direction into White County. From there, it continues to flow south and west for several miles until it joins the Little Red River just north of the city of Providence. The sample site was approximately ⅛ mile above the Highway 157 bridge in the NW ¼, NW ¼ of Section 17, R 6 W, T 9 N (Figure AR-11).

General Site Discussion

Watershed Size - The area of the watershed above the sample site is 49 mi^2.

Geology - The predominant geologic formation within the Tenmile Creek watershed is Bloyd shale, and Prairie Grover member of the Hale formation. Surface rocks in the River Valley are primarily sandstone and shale with alluvial deposits along all the larger waterways within the region.

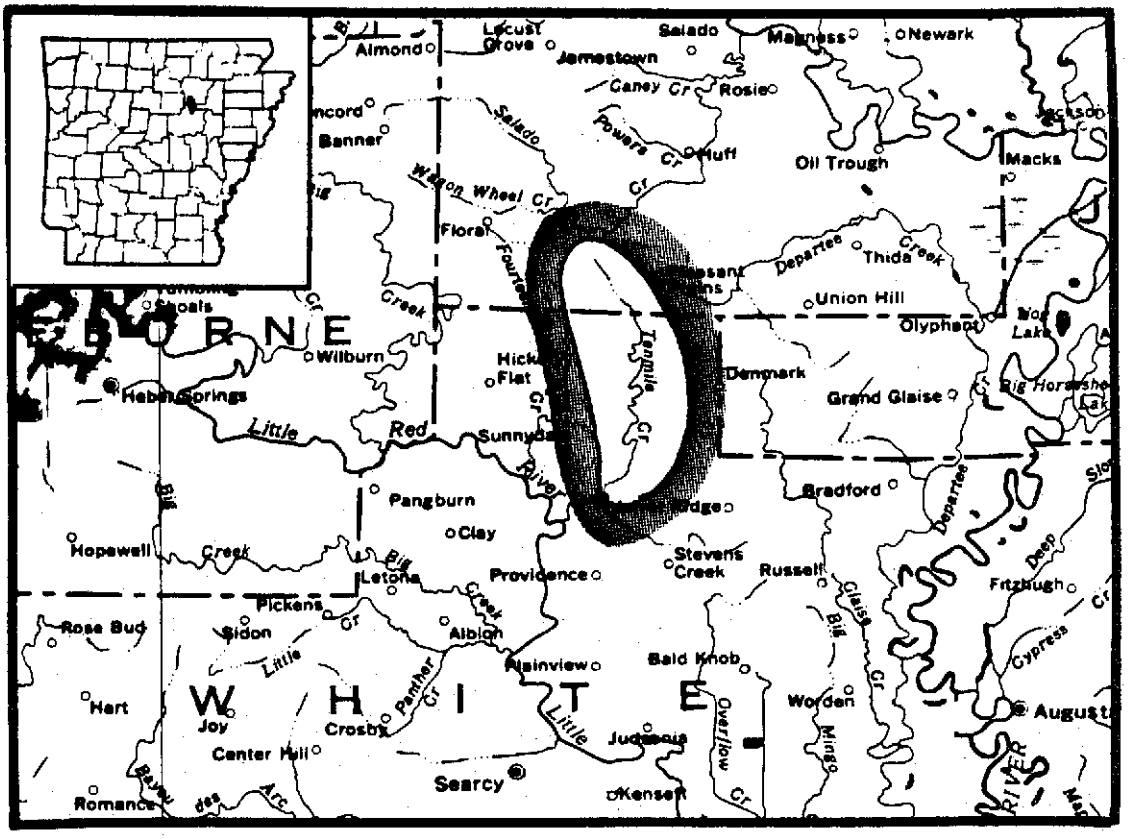
Topography - Stream gradient was measured as 8.1 feet per mile (ft/mi) for Tenmile Creek using a 7.5 minute USGS quadrangle map. The terrain is level to mountainous with erosional and folded hills, cuestas, hogbacks and buttes.

Soil Types - The predominant soil type found in the headwater section of Tenmile Creek is the Linker-Sidon association. The Linker-Sidon association consists of moderately deep and deep, well-drained and moderately well-drained, nearly level to gently sloping, loamy soils formed in residual material. The lower portion of the Tenmile Creek watershed is in the Steprock-Enders association. The Steprock-Enders association is composed of moderately deep and deep, well-drained, moderately sloping to steep, flaggy and stony, loamy soils formed in residual and colluvial material. Both of these soil types are formed in material weathered from acid sandstone, siltstone and shale.

Flora - The general vegetation type for this area is shortleaf pine and upland hardwood. Tree types observed on the streambank of Tenmile Creek were tupelo gum, bald cypress, red maple, alders, river birch, sweetgum, blackgum, hawthorne, white oak and ironwood.

Land Use - Land use in the Tenmile Creek drainage basin is primarily forest and agriculture. The most recent information from the Cooperative Extension Service of the Department of Agriculture shows that 43% of the land within the watershed is currently under agricultural uses and 55% is in timber production.

Figure AR-11



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

TEN MILE CREEK: Drainage area 49 square miles ■ Survey site ▒ Survey area

Stream Characteristics - The 49 mi^2 drainage basin above the sampling station on Tenmile Creek was apparently enough to maintain a small amount of flow (0.2 cfs) between pools during the critical season. Significant physical characteristics include the medium stream gradient, stream substrate composed largely of slab rocks, large pools separated by short riffles and high percentage of stream canopy. Significant chemical characteristics include low alkalinity, hardness, minerals, turbidity and BOD.

Methodology and Sampling Results

Tenmile Creek was studied under critical conditions during late summer and again in a steady-state flow situation during the spawning conditions of spring. The critical conditions were studied the week of August 20, 1984, and the spring conditions during the week of April 15, 1985.

Continuous Dissolved Oxygen

Summer - During the summer sampling period on Tenmile Creek, two meters were set up to monitor temperature, dissolved oxygen and percent saturation. Site #1 was located in the riffle just below the low water ford on Tenmile Creek. Site #2 was located in the pool just downstream of Site #1. Both meters were set up shortly after noon on August 20, 1984. Meter #008 at Site #2 had numerous problems, including a precipitate that formed in the probe head and the chart not turning. Due to these problems, the data from Site #2 was not used. Figure AR-12 shows the recording made at Site #1. The dissolved oxygen ranged from 2.5 mg/l to 5.9 mg/l and averaged 3.7 mg/l over the entire survey period. Dissolved oxygen percent saturation ranged from approximately 30-50%.

Spring - During the spring sampling period on Tenmile Creek, two meters were again set up to monitor temperature, dissolved oxygen and percent saturation. The sites were located in exactly the same place as during the previous summer samples. The flow was substantially higher than the summer period (105 cfs spring flow vs. 0.2 cfs summer flow). Figures AR-13 and AR-14 show the recordings made at both sites. Both meters functioned properly throughout the sampling period. The dissolved oxygen plots from both sites are almost identical and display a typical diel fluctuation related to temperature and photosynthesis. The maximum D.O. was 10/mg/l and the minimum was 8.4 mg/l. Both sites averaged slightly greater than 9 mg/l. Dissolved oxygen percent saturation ranged from approximately 70-100%.

Chemical Parameters

Chemical samples were collected during both spring and summer periods and each consisted of three distinct grab samples. Tables AR-13 and AR-14 show the results of each survey. The chemical results from both spring and summer sampling periods showed little difference between the two.

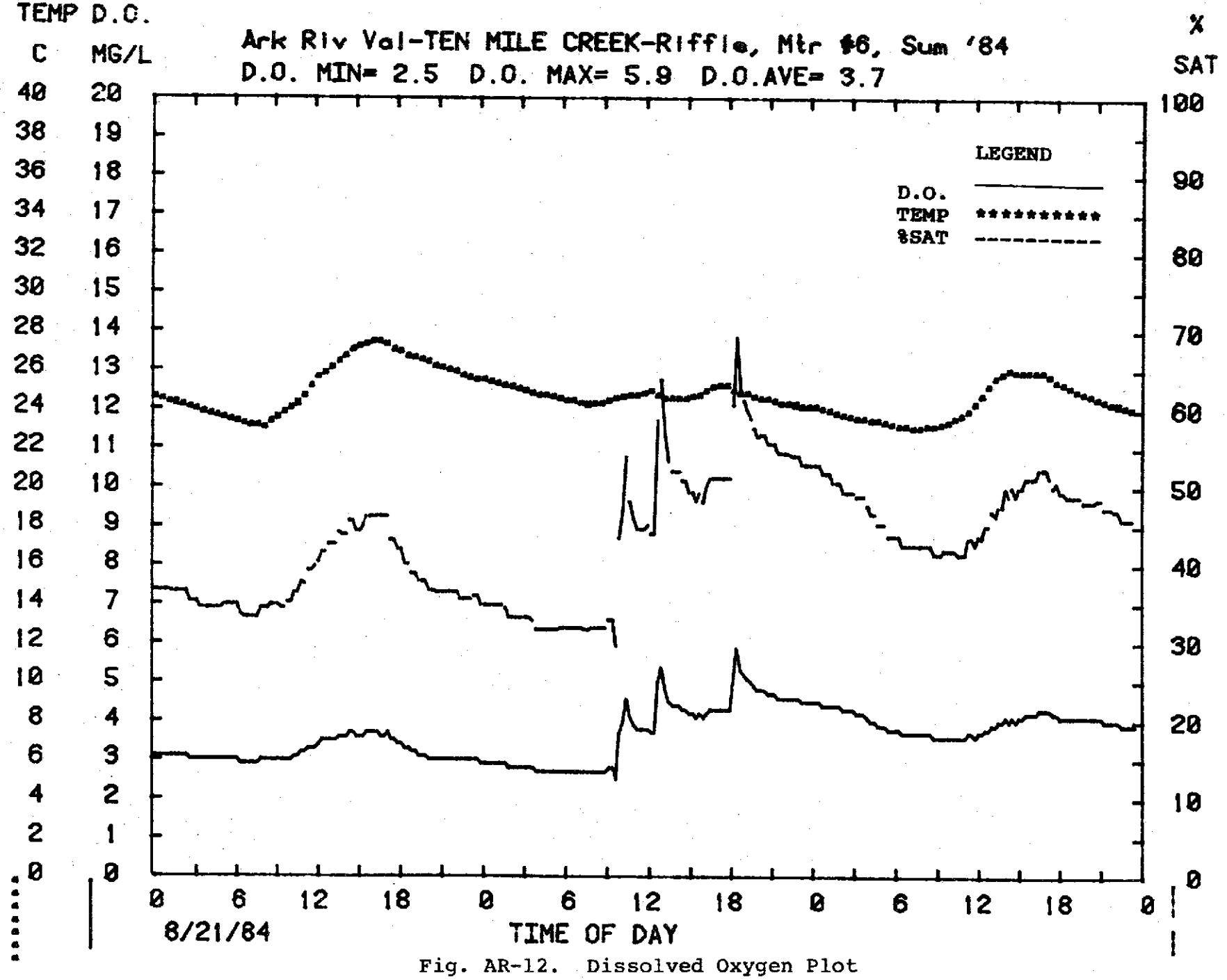


Fig. AR-12. Dissolved Oxygen Plot

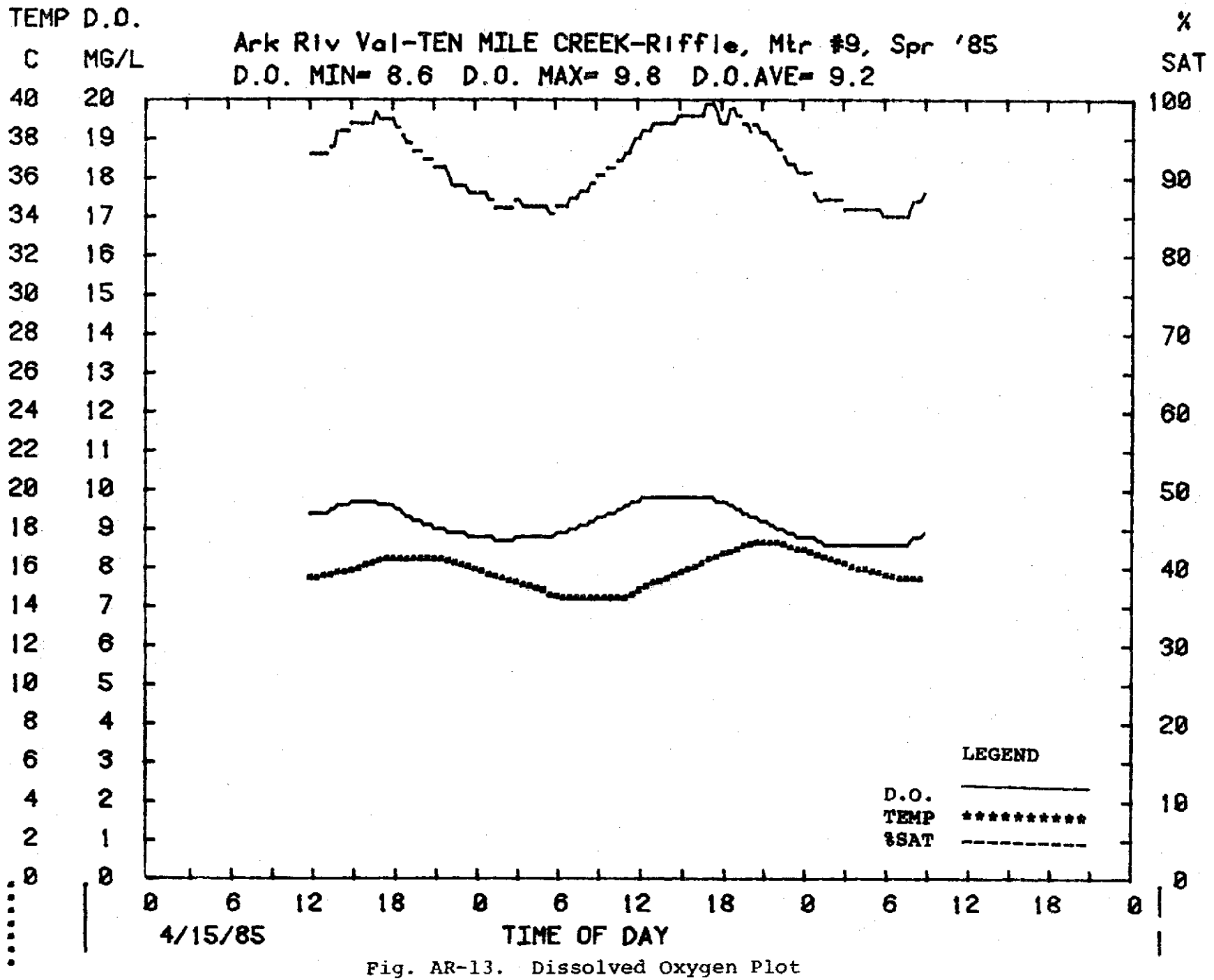


Fig. AR-13. Dissolved Oxygen Plot

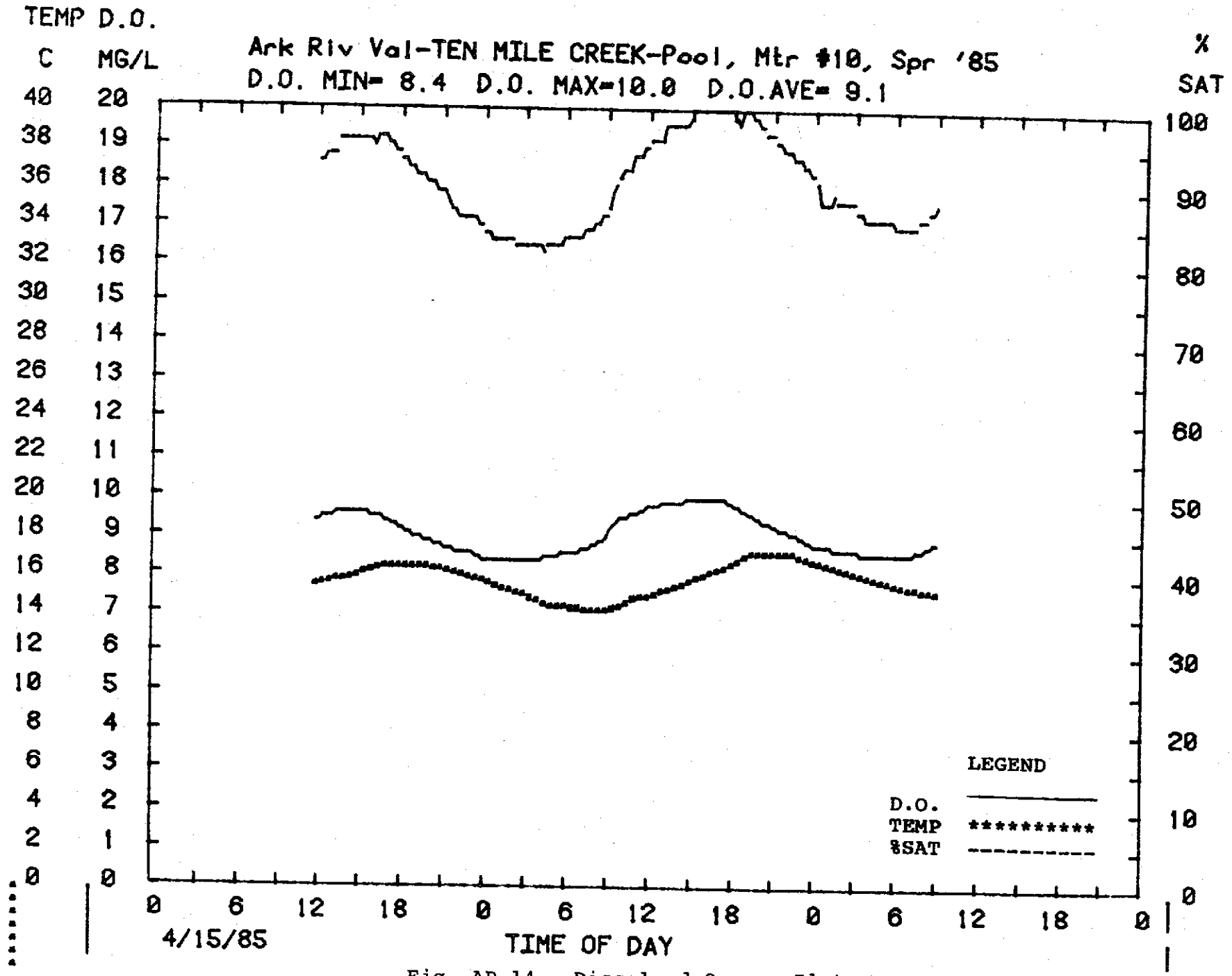


Fig. AR-14. Dissolved Oxygen Plot

Table AR-13

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Ten Mile Creek

Drainage Area: 45 square miles

Station Description: Approximately ¼ mile above Hwy. 57 bridge, NW ¼, NW ¼, Section 17, T 9 N, R 6 W, White County

Date: August 21, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	10:00	11:00	
Q, cfs	~.2	~.2	~.2	~.2
Temperature, °C	23.0	23.0	23.0	23.0
pH	6.6	6.5	6.7	6.6
Turbidity, ntu	2	2	2	2
TSS, mg/l	10	2	2	5
TDS, mg/l	46	48	46	47
BOD-5, mg/l	1.0	1.2	1.0	1.1
BOD-20, mg/l	2.5	2.6	2.5	2.5
T.Phos., mg/l	.16	.16	.16	.16
PO4-P, mg/l	.12	.13	.13	.13
NO2+NO3-N, mg/l	.21	.21	.21	.21
NH3-N, mg/l	.05	.04	.05	.05
Cl -, mg/l	6	6	6	6
SO4 =, mg/l	1	1	2	1
Fe, mg/l	.20	.19	.21	.20
Conductivity μmho	xxx	xxx	xxx	xxx
Alkalinity, mg/l	26	28	28	27
T. Hardness, mg/l	29	28	30	29
Chlorophyll a, μg/l	4.7	6.1	7.0	5.9
Fecal Coliform	xxx	xxx	420	420
T. Manganese	.29	.25	.28	.27

Dissolved Oxygen Data for August 21, 1984		
Average	3.2	
Minimum	2.9	
Maximum	3.7	

Table AR-14

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Ten Mile Creek

Drainage Area: 45 square miles

Station Description: Approximately ¼ mile above Hwy. 57 Bridge, NW ¼, NW ¼, Sec. 17, T 9 N, R 6 W, White County

Date: April 16, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	08:30	10:15	12:00	
Q, cfs	105.2	105.2	105.2	105.2
Temperature, °C	15.0	15.0	15.5	15.0
pH	7.0	6.9	6.9	6.9
Turbidity, ntu	5	5	5	5
TSS, mg/l	4	4	5	4
TDS, mg/l	44	37	34	38
BOD-5, mg/l	0.7	0.8	0.7	0.7
BOD-20, mg/l	2.2	2.4	2.4	2.3
T.Phos., mg/l	.08	.08	.08	.08
PO4-P, mg/l	.04	.04	.04	.04
NO2+NO3-N, mg/l	.27	.25	.23	.25
NH3-N, mg/l	.07	.06	.05	.06
Cl -, mg/l	4	4	4	4
SO4 =, mg/l	3	4	3	3
Fe, mg/l	.34	.26	.40	.33
Conductivity μmho	42	39	38	40
Alkalinity, mg/l	9	8	9	9
T. Hardness, mg/l	12	12	12	12
Chlorophyll a, μg/l	1.9	1.6	2.1	1.9
Fecal Coliform	-	-	233	233

Dissolved Oxygen Data for April 16, 1985		
Average	9.2	
Minimum	8.4	
Maximum	10.0	

Turbidity, TSS, BOD5, BOD20, chlorides, sulfates, alkalinity and total hardness were very low in both seasons. The phosphorus, nitrate and fecal coliform concentrations are probably related to the agricultural uses within the watershed, specifically chicken houses. The fecal coliform bacteria counts during both spring and summer conditions exceeded the primary contact standard.

Physical Parameters

Physical characteristics of Tenmile Creek were measured during the summer survey period and are outlined in Table AR-15. Although the majority of substrate was measured as boulders, these boulders were large slabs of broken layers of parallel bedding planes which were scattered at various angles throughout the stream bottom. Riparian cover at the site was 90.5% tree overstory and 12.5% shrub overstory. Grasses and forbs covered 80.8% of the ground surface leaving 19.2% rock and/or dirt. The banks of Tenmile Creek were estimated to be 67% stable and 33% moderately stable. Riffles occupied 33% of the stream and pools 67%. The mean stream canopy was measured at 87.5%.

Macroinvertebrate Populations

Seventy-eight (78) taxa representing 18 orders were identified from the combined summer-spring qualitative samples. The dominant orders Isopoda (sow bugs), Plecoptera (stoneflies), Ephemeroptera (mayflies) and Amphipoda (side-swimmers) comprised 21.7%, 19.1%, 18.6% and 10.9% of the numerical total, respectively. The dominant taxa were Lirceus hoppinae (21.6%), Perlesta placida (12.2%), and Hyalella azteca (10.9%). Other taxa which were considered characteristic include: Amphinemura delosa, Wormaldia, Nectopsyche, Viviparaus and Amnicola (Table A-16, Appendix A). Qualitative similarity indices showed that the summer and spring samples were more dissimilar than similar (Table AR-16). The majority of the differences are a function of seasonal variation characteristic of invertebrate populations. A total of 3062 specimens were identified from Tenmile Creek and less than 25% of those were collected during the summer survey. Of the 78 taxa identified, 43 and 54 were present in the summer and spring samples, respectively. The 19 taxa which were present in both samples accounted for over one-half (56%) of the numeric total of the combined sample. The 24 taxa unique to the summer sample accounted for 38% of the total organisms collected and the 35 taxa identified only from the spring sample accounted for less than one-half of that sample.

Summer - The dominant orders of the summer collection were Amphipoda, Isopoda and Gastropoda comprising 24.5%, 21.1% and 13.8%, respectively. Only Lirceus hoppinae and Hyalella azteca comprised greater than 10% of the summer sample and

Table AR-15

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Ten Mile Creek
Date:	August 20, 1984
Drainage Area:	49 sqare miles
Watershed Land Use:	43% agriculture 55% forest 2% other
Stream Gradient:	8.1 ft/mile
Mean Channel Width:	61.3 feet
Mean Stream Width:	41.5 feet
Mean Stream Velocity:	<0.1 ft/sec
Observed Flow:	approx. 0.2 cfs
Average Substrate Type:	1.5% large boulder 26% rubble 47% boulders 19.3% gravel 5.2% mud/silt 1.6% sand
Mean Instream Cover:	16.9% inundated vegetation 0% brush, logs, debris 0% overhanging vegetation
Riffle/Pool Ratio of Transects:	33% riffles 33% shallow pools 16.5% deep pools 16.5% moderate pools
Mean Bank Overstory Cover:	90.8% trees 12.5% shrubs
Mean Bank Ground Cover:	80.8% grasses and forbs 19.2% dirt and rock
Mean Bank Stability:	67% stable 33% moderate 0% unstable
Mean Stream Canopy:	87.5%

Comments: Primarily a pool condition - trickle flow through riffles.

both were also collected in large numbers in the spring sample.

Spring - The dominant orders of the spring sample were Plecoptera (25.3%), Ephemeroptera (22.9%), Isopoda (21.8%) and Trichoptera (10.4%). Three of the 54 taxa identified from that sample, Lirceus hoppinae, Perlesta placida and Paraleptholebia, accounted for over 50% of all organisms (50.5%). Other characteristic taxa include Amphinemuria delosa, Wormaldia and Nectopsyche.

Analysis of the community parameters indicated a stable, balanced macroinvertebrate population which reflects the multiplicity of microhabitats and the characteristic summer-spring cycle of insect populations. Although differences exist in taxonomic structure from summer to spring, the indices calculated were nearly identical (Table AR-16).

Table AR-16. Community Analysis of Benthic Samples from Tenmile Creek - 30 Minute Qualitative Sample, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	747	2315	3062
Total # Taxa	43	54	78
Diversity	3.8791	3.9893	4.3887
Index of Evenness	0.7149	0.6932	0.6982
Index of Dominance	0.4092	0.4595	0.4429
Index of Variety	4.4002	4.7419	6.6492
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.42
Common Taxa Index (range 0-1)			0.35
Qualitative Similarity Index (range 0-100)			36.0

Fish Populations

Summer - Approximately five pounds of 7% active rotenone was used to sample the lower end of a long, shallow pool, a riffle area at an abandoned road crossing and a deep pool. The area was sampled on August 22, 1984, and the flow was measured at 0.2 cfs. Fourteen (14) man-hours were spent collecting the fish which included 1411 individuals from 35 species. The total relative abundance value was 219 and the diversity index was 4.86. All fishes collected at this site are listed in Table AR-17. Centrarchidae, Percidae and Cyprinidae were the dominant fish families with each comprising a similar percentage of the total relative abundance. Primary feeders made up 8.9% of the population and carnivores 8.0%. Eight sensitive species comprised 19.9% of the population (Table AR-18).

Spring - Three trammel nets were fished overnight at this site on April 16, 1985. Net sizes were 1", 2" and 3" square mesh. Also, limited electrofishing was done. Streamflow was 105 cfs; water was clear and falling slightly. Water temperatures were between 14°C and 17°C. Netting produced four fish. These included three golden redhorse which were in the process of spawning and one northern hogsucker which had completed spawning. Electrofishing produced 11 species, all of which were collected the previous summer.

Table AR-17. Fishes Collected from Tenmile Creek with Relative Abundance Values

Species		R.A. VALUE
Pimephales notatus	Bluntnose minnow	12.0
Lepomis megalotis	Longear	12.0
Ictalurus natalis	Yellow bullhead	12.0
Fundulus notatus	Blackstripe topminnow	9.0
Aphredoderus sayanus	Pirate perch	9.0
Labidesthes sicculus	Brook silversides	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
*Etheostoma punctulatum	Stippled darter	9.0
*Noturus exilis	Slender madtom	9.0
Erimyzon oblongus	Creek chubsucker	9.0
*Notropis boops	Bigeye shiner	9.0
Etheostoma whipplei	Redfin darter	9.0
Micropterus salmoides	Largemouth bass	8.0
*Etheostoma caeruleum	Rainbow darter	7.5
Notropis chrysocephalus	Striped shiner	7.5
Micropterus punctulatus	Spotted bass	7.5
Lepomis cyanellus	Green sunfish	7.5
Etheostoma proeliare	Cypress darter	7.5
Noturus gyrinus	Tadpole madtom	7.5
Lepomis macrochirus	Bluegill	7.5
Notropis umbratilis	Redfin shiner	6.0
*Etheostoma blennioides	Greenside darter	6.0
Etheostoma chlorosomum	Bluntnose darter	6.0
Campostoma anomalum	Stoneroller	6.0
Lepomis gulosus	Warmouth	4.0
Minytrema melanops	Spotted sucker	2.0
Moxostoma erythrurum	Golden redhorse	2.0
Ictalurus melas	Black bullhead	2.0
Notemigonus crysoleucas	Golden shiner	1.5
Notropis emiliae	Pugnose minnow	1.0
*Hypentelium nigricans	Northern hogsucker	1.0
Esox niger	Chain pickerel	1.0
Lepomis hybrid	Hybrid sunfish	1.0
*Semotilus atromaculatus	Creek chub	1.0
*Percina maculata	Blackside darter	1.0

*Sensitive species

Table AR-18. Summary of Fish Population Parameters from Tenmile Creek

Total Species Collected	35.0
Total Number of Individuals	1411.0
Total Relative Abundance Value	219.0
Relative Abundance Diversity Index	4.86

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	8.0	20.1
CATOSTOMIDAE	4.0	6.4
ICTALURIDAE	4.0	13.9
CENTRARCHIDAE	7.0	21.7
PERCIDAE	7.0	21.0
Primary Feeders	3.0	8.9
Macroinvertebrate Feeders	28.0	83.1
Carnivores	4.0	8.0
Sensitive Species	8.0	19.9

DUTCH CREEK

Dutch Creek begins in central Scott County and flows in an east-northeastly direction into central Yell County, where it joins the Petit Jean River at the city limits of Danville. The Dutch Creek sample site was located at the bridge on a county road in the SE ¼, NE ¼ of Section 14, R 24 W, T 4 N, in Yell County (Figure AR-15).

General Site Discussion

Watershed Size - The drainage area above the sample site is 110 mi^2, which provided a flow of 0.49 cfs during the summer sample period.

Geology - Geology of the Dutch Creek watershed is of the Atokan formation. Its surface rocks are primarily sandstone and shale with alluvial deposits along the immediate floodplain.

Topography - The terrain is level to mountainous with erosional and folded hills, cuestas, hogbacks and buttes. Slopes range from less than 5% to vertical along cap rock cliffs.

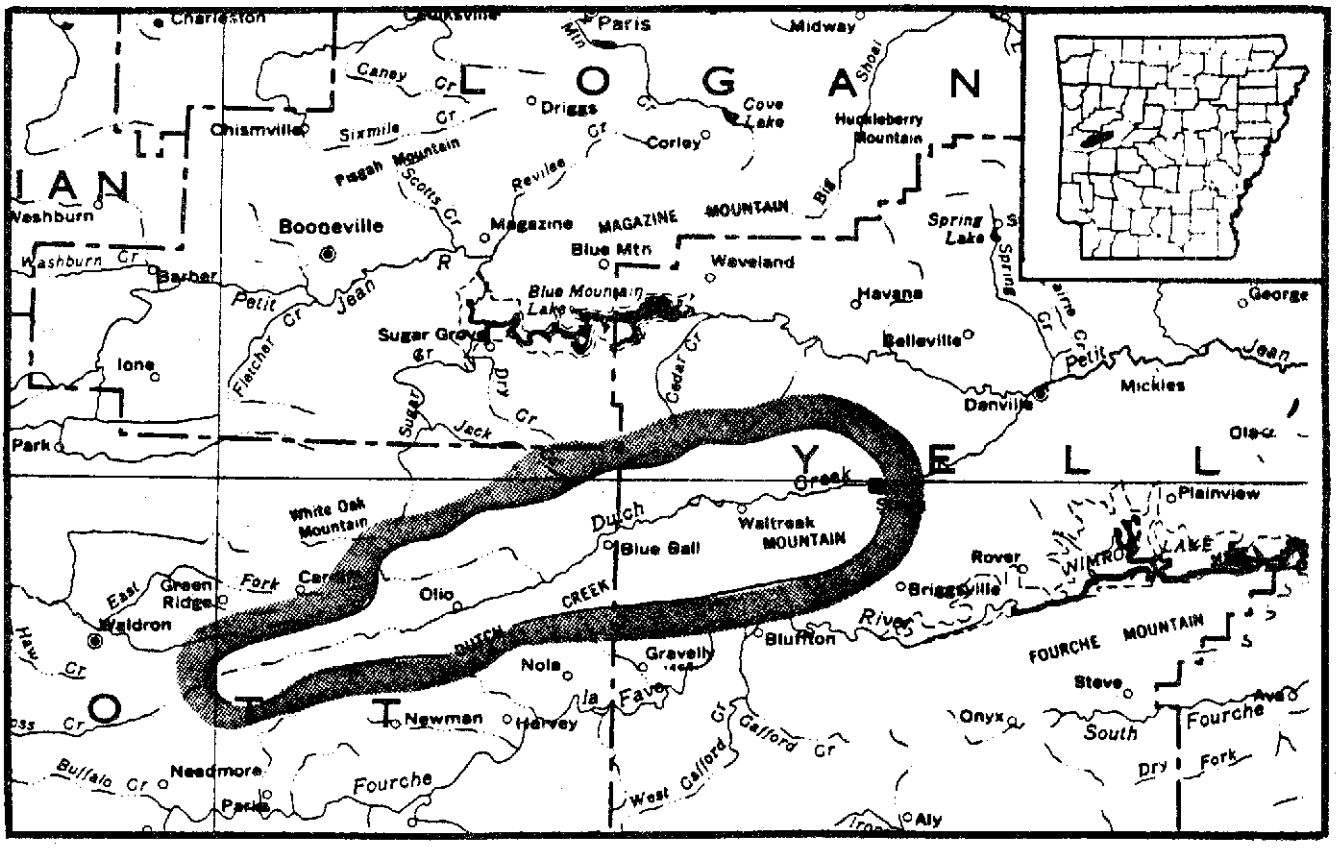
Soil Types - Detailed soils maps of Yell and Scott Counties were not available; however, generalized, statewide soils maps indicate that this watershed is in typical, Arkansas Valley soil associations.

Flora - The general vegetation type for this area is shortleaf pine and upland hardwoods. Tree types observed on the streambank of Dutch Creek were river birch, slippery elm, red maple, sycamore, blackgum, American elm, green ash, water oak, red oak, sweetgum and black walnut.

Land Use - Land use in the Dutch Creek drainage basin is probably evenly divided between forestry and agriculture. The primary agricultural use is pastureland for cattle.

Stream Characteristics - Stream characteristics of Dutch Creek are detailed within the physical, chemical and biological evaluation results. Stream gradient at the sample site is 3.8 ft/mile. Flow measured during the summer sampling period was 0.49 cfs. The predominant substrate type was gravel and the stream had a relatively high amount of instream fishery cover in the form of brush, logs and debris. Dutch Creek had a 98.3% stream canopy cover and the stream possessed the notable, brown water coloration of other Arkansas River Valley streams.

Figure AR-15



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

DUTCH CREEK: Drainage area 110 square miles ■ Survey site ▬ Survey area

Methodology and Sampling Results

Dutch Creek was studied under critical conditions during late summer and again during the spring spawning season. The critical conditions were studied the week of August 20, 1984, and the spring conditions during the week of April 15, 1985.

Continuous Dissolved Oxygen

Summer - During the summer sampling period on Dutch Creek, three meters were set up to monitor temperature, dissolved oxygen and percent saturation. Each meter was checked and calibrated daily. All meters functioned satisfactorily throughout the survey period. Meter #007 at Site #1 was the only meter measuring pool conditions. The dissolved oxygen ranged from 1.3 mg/l to 3.2 mg/l and averaged 2.4 mg/l (Figure AR-16). Meter #009 at Site #2 was set at the bottom of a riffle area and ranged from 1.9 mg/l to 3.8 mg/l and averaged 2.7 mg/l (see Figure AR-17). Meter #550 at Site #3 also measured conditions at the bottom of a riffle area and ranged from 1.8 mg/l to 3.0 mg/l and averaged 2.5 mg/l (Figure AR-18). The percent saturation from all sites averaged approximately 20%-40%.

Spring - During the spring sampling period on Dutch Creek, two meters were again set up to monitor temperature, dissolved oxygen and percent saturation. Site #1 was immediately upstream of the bridge in a riffle. Site #2 was approximately 250 feet below the bridge at the end of the pool. Both meters were checked and calibrated daily. Both meters functioned satisfactorily throughout the survey period. Figures AR-19 and AR-20 display the recording of each meter. The flow was significantly higher in the spring season. These plots display only a small diel fluctuation, ranging from 8.0 mg/l to 8.8 mg/l and averaging 8.4 mg/l. The percent saturation was significantly higher than the critical period, ranging from 80%-90%.

Chemical Parameters

Chemical samples were collected during both spring and summer periods, each consisted of three distinct grab samples. Tables AR-19 and AR-20 show the results of each of these surveys. Observation of the chemical results from both spring and summer sampling periods show only minor differences. The major difference is the flows recorded during each sampling period. As expected, the increased flow during the spring sampling tends to increase certain parameters like turbidity, nitrates, iron and fecal coliform bacteria. An inverse relationship to the increased flow is also observed in parameters like total dissolved solids, biological oxygen demand, alkalinity, total hardness and chlorophyll a. Even though these minor differences have been observed, all values measured during both spring and

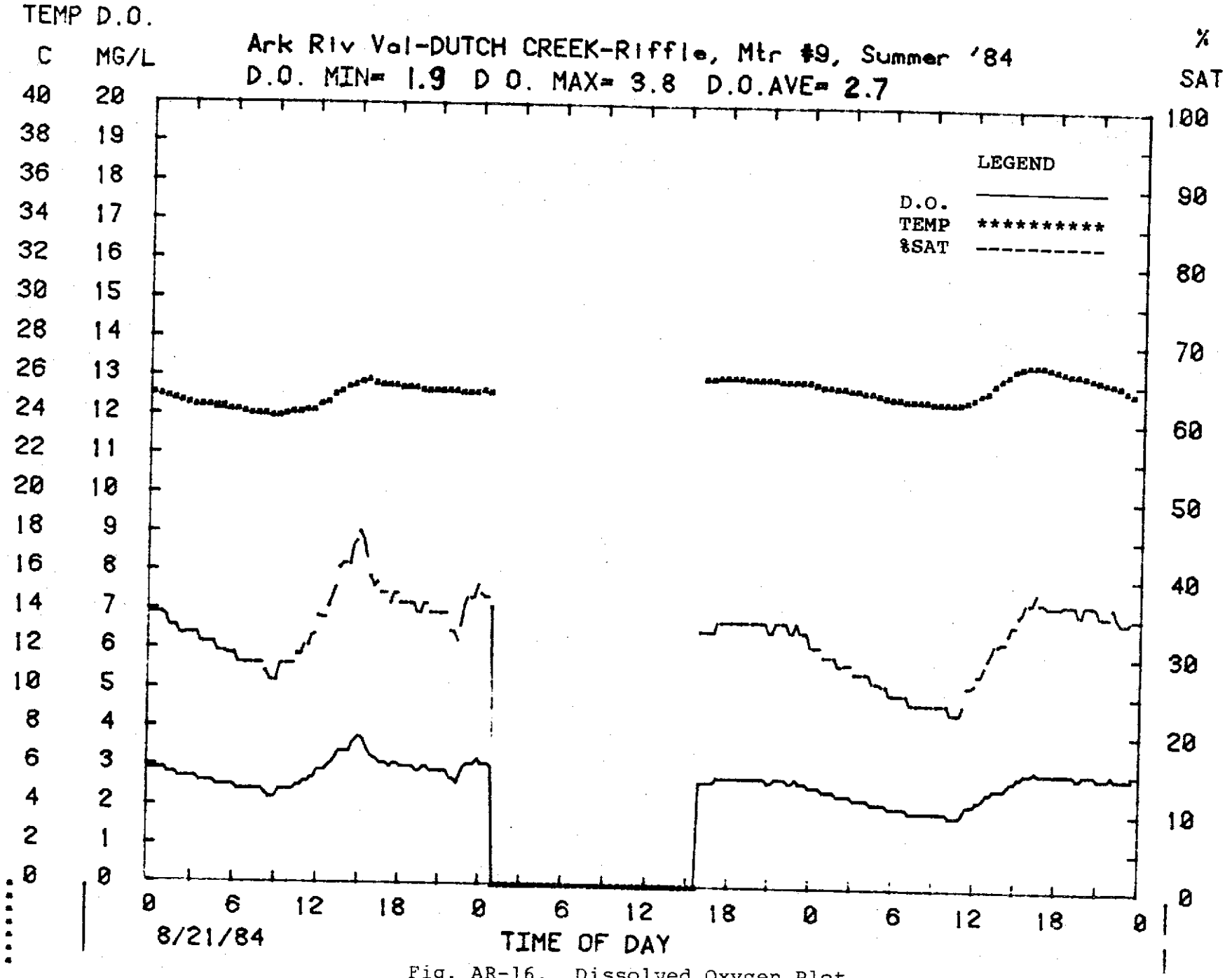


Fig. AR-16. Dissolved Oxygen Plot

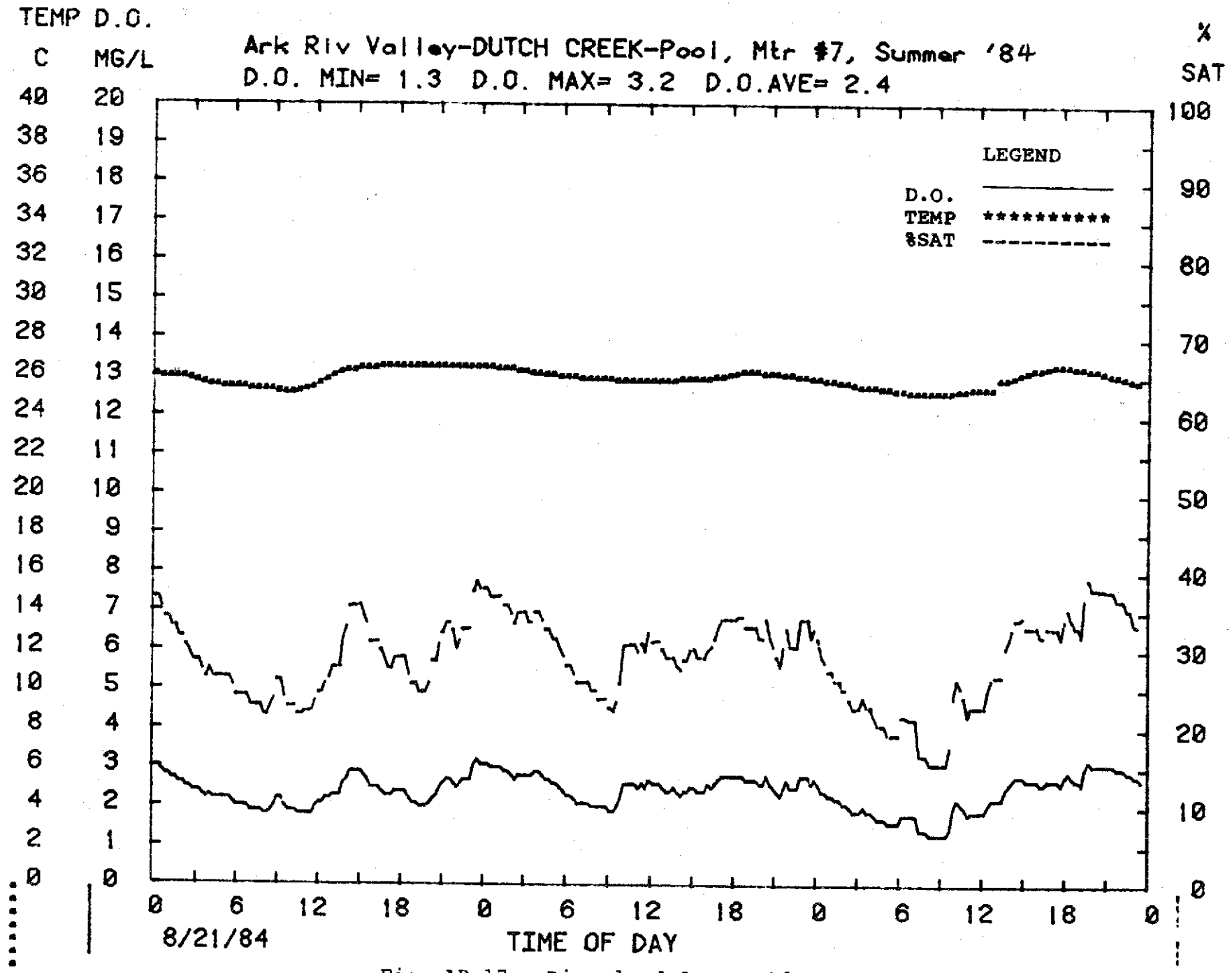


Fig. AR-17. Dissolved Oxygen Plot

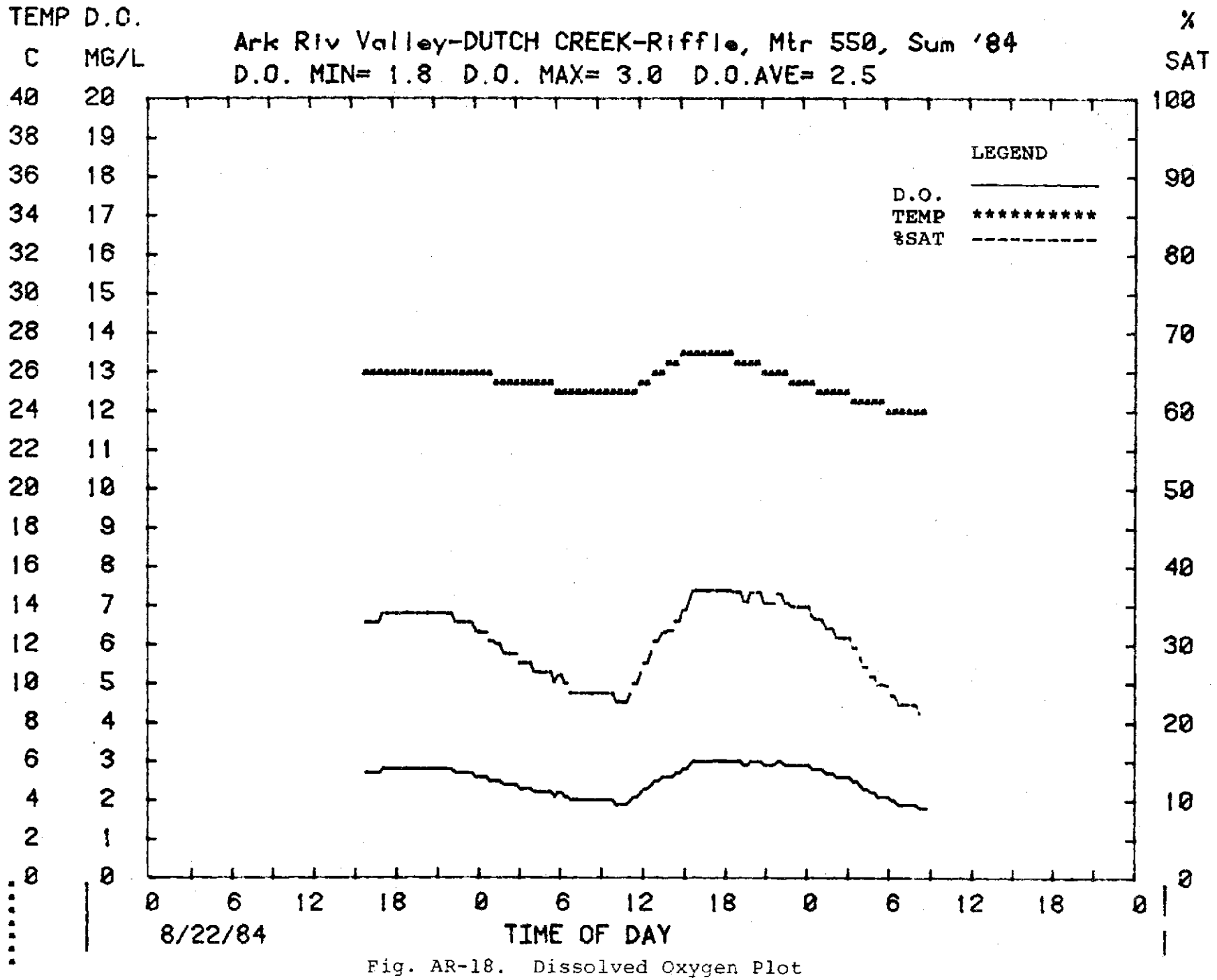


Fig. AR-18. Dissolved Oxygen Plot

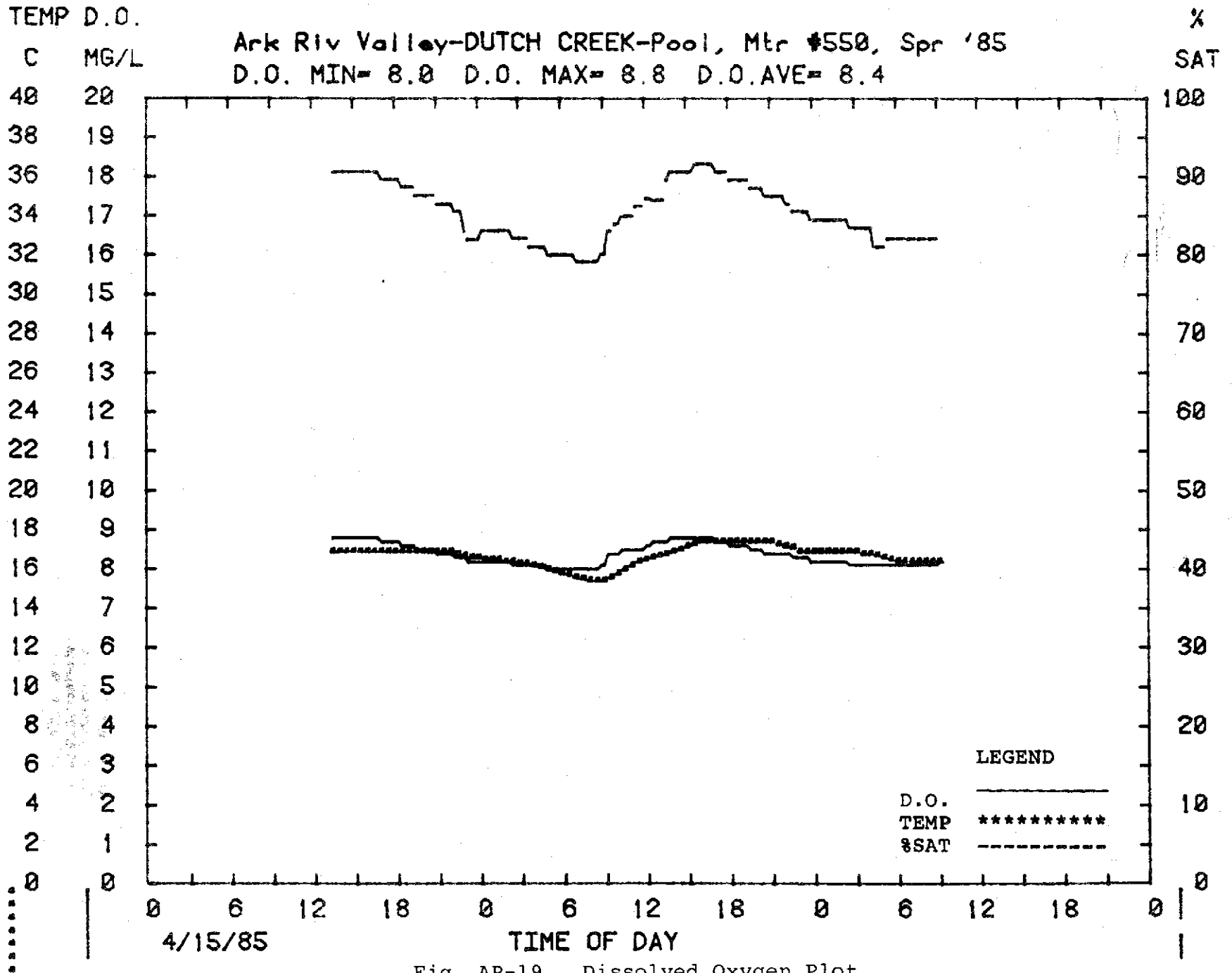


Fig. AR-19. Dissolved Oxygen Plot

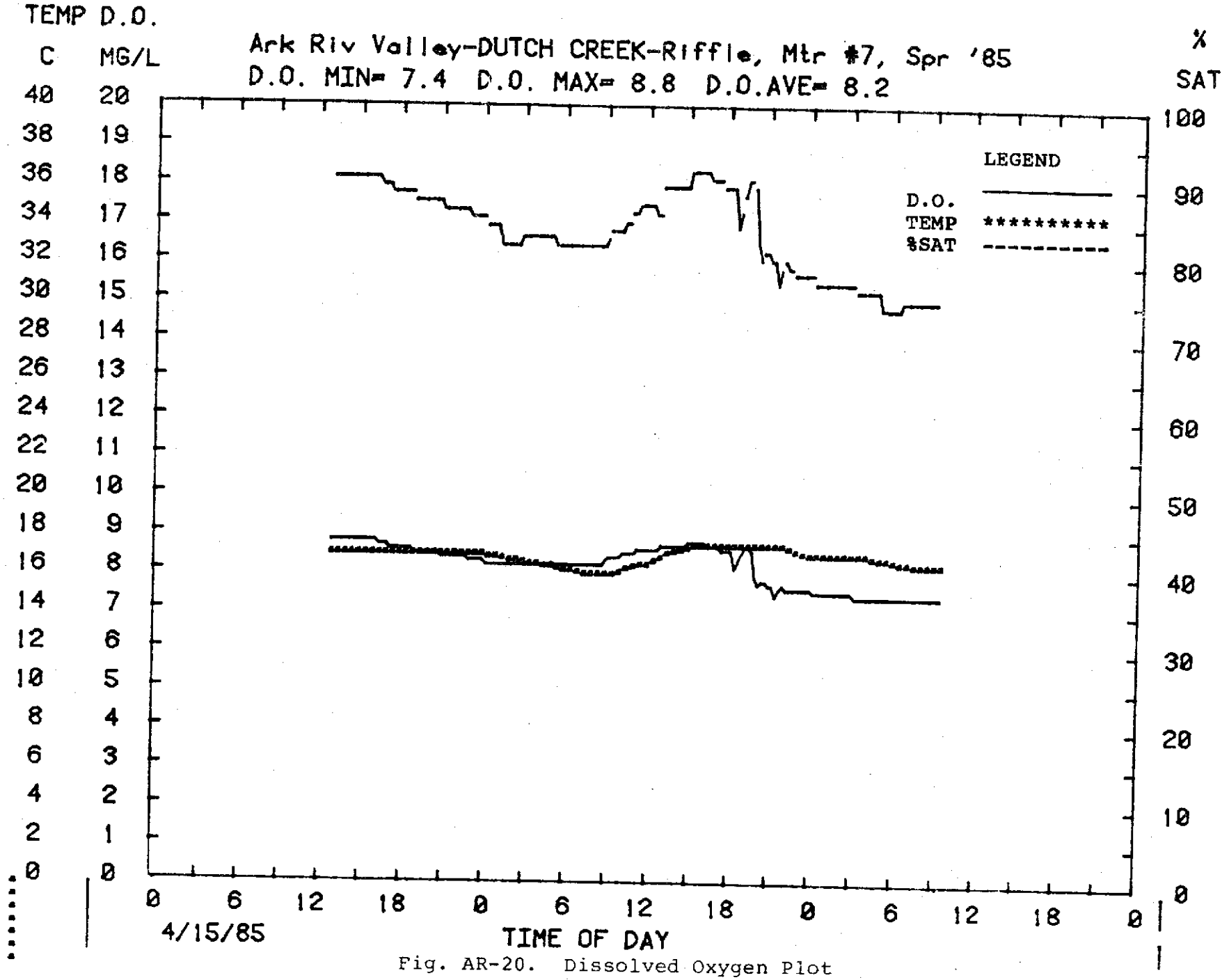


Fig. AR-20. Dissolved Oxygen Plot

Table AR-19

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Dutch Creek

Drainage Area: 110 square miles

Station Description: 100' above bridge, SE ¼, NW ¼, Section 14, T 4 N, R 24 W, Yell County

Date: August 21, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	08:45	10:05	11:35	
Q, cfs	.5	.5	.5	.5
Temperature, °C	25.0	25.0	26.0	25.5
pH	6.5	6.6	6.9	6.7
Turbidity, ntu	4	4	4	4
TSS, mg/l	2	9	3	5
TDS, mg/l	57	59	56	57
BOD-5, mg/l	1.3	1.3	1.3	1.3
BOD-20, mg/l	3.3	3.9	3.8	3.7
T.Phos., mg/l	.05	.05	.05	.05
PO4-P, mg/l	.02	.01	.01	.01
NO2+NO3-N, mg/l	.11	.12	.12	.12
NH3-N, mg/l	.08	.08	.07	.08
Cl -, mg/l	6	6	6	6
SO4 =, mg/l	2	3	1	2
Fe, mg/l	.81	.86	.82	.83
Conductivity μmho	na	na	na	na
Alkalinity, mg/l	33	33	30	32
T. Hardness, mg/l	34	36	33	34
Chlorophyll a, μg/l	5.3	5.4	7.9	6.2
Fecal Coliform	-	-	-	92
Total Manganese	.61	.60	.51	.57

Dissolved Oxygen Data for August 21, 1984		
Average	2.3	
Minimum	1.8	
Maximum	3.2	

Table AR-20

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Dutch Creek

Drainage Area: 110 square miles

Station Description: 100' above bridge, SE ¼, NW ¼, Section 14, T 4 N, R 24 W, Yell County

Date: April 16, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	08:30	09:32	10:30	
Q, cfs	69.7	69.7	69.7	69.7
Temperature, °C	16.0	16.0	16.5	16.0
pH	6.1	6.8	6.8	6.6
Turbidity, ntu	10	10	10	10
TSS, mg/l	8	8	8	8
TDS, mg/l	50	49	54	51
BOD-5, mg/l	0.8	0.5	0.7	0.7
BOD-20, mg/l	2.3	2.3	2.7	2.4
T.Phos., mg/l	0.06	0.05	0.05	0.05
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	0.52	0.51	0.51	0.51
NH3-N, mg/l	0.04	0.04	0.04	0.04
Cl -, mg/l	4	4	4	4
SO4 =, mg/l	6	4	6	5
Fe, mg/l	1.07	0.90	1.04	1.00
Conductivity μmho	53	54	53	53
Alkalinity, mg/l	13	13	13	13
T. Hardness, mg/l	18	20	36	25
Chlorophyll a, μg/l	0.0	1.9	1.3	1.1
Fecal Coliform	-	-	132	132

Dissolved Oxygen Data for April 16, 1985		
	Pool	Riffle
Average	8.4	8.3
Minimum	8.0	7.4
Maximum	8.8	8.8

summer sampling periods are considered to be in the low range for these parameters.

Physical Parameters

Physical characteristics of Dutch Creek were measured during the summer survey period and are displayed in Table AR-21. The substrate type was equally divided between gravel and mud or silt with a minor amount of rubble. Instream fishery cover was abundant. Riparian cover at the site was 97.9% tree overstory with only 7.5% shrubs. Grasses and forbs covered 39.2% of the ground surface leaving 60.8% dirt exposed. The banks of Dutch Creek were estimated to be 83% moderately stable and 17% unstable. Riffles occupied 17% of the stream, and pools 83%. The mean stream canopy was measured at 90.3%.

Macroinvertebrate Populations

Ninety-two (92) taxa representing 18 orders were identified from the combined summer-spring qualitative samples. The dominant orders, Ephemeroptera (mayflies), Coleoptera (beetles), Diptera (true flies) and Trichoptera (caddisflies), comprised 24.0%, 16.8%, 12.5% and 12.5% of the numerical total, respectively (Table A-17, Appendix A). The presence of 18 orders and the even distribution among taxa reflect the great diversity of habitat which exists in Dutch Creek. Conversely, the absence of significant "ecological indicators," (i.e., those taxa which are characteristic of a "high-quality environment") is evidence that some factors were present to limit water quality and the existing ecological balance could be greatly affected even by slight perturbations to the system. Qualitatively, summer and spring samples were similar both numerically and taxonomically. A total of 657 and 755 organisms were identified from the summer and spring samples, respectively. Of the 92 taxa identified from both samples, 62 and 61 were identified from the summer and spring samples, respectively. Thirty-one (31) taxa were found to be present in both samples, indicating a great deal of homogeneity within the stream system and resulting in large qualitative indices. Three of the four dominant orders of the summer sample were also the dominant orders of the spring sample. However, the sequence of occurrence was different due to the seasonal variation characteristic of benthic communities.

Summer - The dominant orders of the summer sample were beetles (28.4%), caddisflies (22.0%), mayflies (11.4%) and odonates(10.5%). Only Cheumatopsyche (a caddisfly) was present in quantities high enough to be considered a dominant.

Spring - In the spring sample, mayflies (35.1%) replaced beetles, which dropped to fourth, as the dominant order. Mayflies were followed by stoneflies, dipterans and beetles with 17.6%, 14.3% and 6.8% of the total, respectively. Although the mayfly-stonefly assemblages dominated the

Table AR-21

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Dutch Creek
Date:	August 20, 1984
Drainage Area:	110 sqare miles
Watershed Land Use:	35% agriculture 65% forest
Stream Gradient:	3.8 ft/mile
Mean Channel Width:	62.2 feet
Mean Stream Width:	37.3 feet
Mean Stream Velocity:	0.05 ft/sec
Observed Flow:	0.49 cfs
Average Substrate Type:	13.4% rubble 43.3% gravel 43.3% mud/silt
Mean Instream Cover:	1.8% undercut bank 44.2% brush, logs, debris
Riffle/Pool Ratio of Transects:	17% riffles 50% deep pools 33% shallow pools
Mean Bank Overstory Cover:	97.9% trees 7.5% shrubs
Mean Bank Ground Cover:	39.2% grasses and forbs 60.8% dirt
Mean Bank Stability:	83% moderate 17% unstable
Mean Stream Canopy:	98.3%

Comments: Primarily a pool condition - just a trickle of flow.

spring sample, there was a noticable absence of high-quality "ecological indicators." The mayfly, Caenis, composed 46% of all mayflies and a single stonefly species, Perlesta placida, accounted for 96% of all stoneflies. Both are considered to be at least tolerant of turbidity and slight organic pollution.

Community parameters calculated for both samples indicated a diverse ecosystem (Table AR-22). This was a direct reflection of the diverse pool-riffle habitats which include extensive amounts of instream cover. However, there was a definite absence of the clear-cut group of dominant taxa which are characteristic of macroinvertebrate communities. The benthic habitat could best be described as tolerable for a wide range of invertebrate species, but not of sufficient quality to support a distinctive assemblage or of such poor water quality to limit a diverse macroinvertebrate community.

Table AR-22. Community Analysis of Benthic Samples from Dutch Creek - 30 Minute Qualitative Sample, 1984-85

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	657	755	1412
Total # Taxa	62	61	92
Diversity	4.5746	4.7005	5.2376
Index of Evenness	0.7683	0.7926	0.8029
Index of Dominance	0.4450	0.4463	0.4448
Index of Variety	6.5172	6.2759	8.6968
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.50	
Common Taxa Index (range 0-1)		0.50	
Qualitative Similarity Index (range 0-100)		25.0	

Fish Populations

Summer - Rotenone was used to treat a moderately sized pool with only slight flow through it. Twelve man-hours were required to collect the fish from the treated area. A total of 2455 specimens of 40 species was taken during the summer sample. An additional four species were collected the following spring. This site had one of the richest fish species list of all sites sampled. Table AR-23 is a list of the species collected. The total relative abundance value for this sample was 266 with a diversity index of 5.07. Cyprinidae was the dominant fish family but it was followed closely by Centrarchidae, Percidae and Ictaluridae. Primary feeding fishes made up 9.2% of the population and carnivores 9.6%. The remainder of the population was macroinvertebrate feeders. Seven sensitive species comprised 12.4% of the population (Table AR-24).

Spring - Nets of 1½", 2½" and 3½" square mesh were set overnight at this site on April 15, 1985. Also, limited electrofishing was done with the backpack shocker. Streamflows were moderately high but falling and the water was relatively clear. Water temperature was 16°C-18°C. Ten fish were caught in the nets and totalled 19.9 pounds. Spotted suckers had completed spawning. The shorthead redhorse and carp were in the spawning process. One male and one female largemouth bass were caught which were surprisingly near the spawning stage. Species taken in the spring sample which were not collected the previous summer were: carp, shorthead redhorse, slim minnow and river carpsucker.

Table AR-23. Fishes Collected from Dutch Creek with Relative Abundance Values

Species		R.A. VALUE
Lepomis megalotis	Longear	12.0
Pimephales notatus	Bluntnose minnow	12.0
Etheostoma whipplei	Redfin darter	12.0
Ictalurus natalis	Yellow bullhead	12.0
Fundulus notatus	Blackstripe topminnow	12.0
Lepomis cyanellus	Green sunfish	10.5
Campostoma anomalum	Stoneroller	10.5
Etheostoma spectabile	Orangethroat darter	10.5
Esox americanus	Grass pickerel	10.0
Noturus miurus	Brindled madtom	9.0
Labidesthes sicculus	Brook silversides	9.0
Notropis emiliae	Pugnose minnow	9.0
Notropis fumeus	Ribbon shiner	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
Etheostoma gracile	Slough darter	9.0
Noturus gyrinus	Tadpole madtom	9.0
*Notropis whipplei	Steelcolor shiner	8.5
Micropterus punctulatas	Spotted bass	8.0
Lepomis macrochirus	Bluegill	7.5
Noturus nocturnus	Freckled madtom	7.5
Percina caprodes	Logperch	7.0
*Notropis boops	Bigeye shiner	6.0
Lepomis punctatus	Spotted sunfish	6.0
*Percina sciera	Dusky darter	6.0
Aphredoderus sayanus	Pirate perch	6.0
*Etheostoma stigmaeum	Speckled darter	6.0
*Noturus exilis	Slender madtom	5.5
Lepomis gulosus	Warmouth	5.0
Notropis umbratilis	Redfin shiner	4.0
Ictalurus punctatus	Channel catfish	4.0
Minytrema melanops	Spotted sucker	2.0
Lepomis hybrid	Hybrid sunfish	2.0
Erimyzon oblongus	Creek chubsucker	2.0
Moxostoma erythrurum	Golden redhorse	2.0
Lepisosteus oculatus	Spotted gar	1.5
Notemigonus crysoleucas	Golden shiner	1.0

Table AR-26, cont.

Species		R.A. VALUE
*Percina maculata	Blackside darter	1.0
Ichthyomyzon sp.	Lamprey larvae	1.0
Pomoxis annularis	White crappie	1.0
Micropterus salmoides	Largemouth bass	1.0
Moxostoma macrolepidotum	Shorthead redhorse	S
Carpiodes carpio	River carpsucker	S
Cyprinus carpio	Carp	S
*Pimephales tenellus	Slim minnow	S

*Sensitive species
S - Collected in spring sample only

Table AR-24. Summary of Fish Population Parameters from Dutch Creek

Total Species Collected	44.0
Total Number of Individuals	2455.0
Total Relative Abundance Value	266.0
Relative Abundance Diversity Index	5.07

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	10.0	22.6
CATOSTOMIDAE	5.0	2.3
ICTALURIDAE	6.0	17.7
CENTRARCHIDAE	9.0	19.9
PERCIDAE	7.0	19.4
Primary Feeders	6.0	9.2
Macroinvertebrate Feeders	32.0	81.2
Carnivores	6.0	9.6
Sensitive Species	7.0	12.4

PETIT JEAN RIVER

The Petit Jean River begins in north central Scott County and southeast Sebastian County and flows an easterly direction through Logan and Yell Counties until its confluence with the Arkansas River. The sample site was located just downstream of the Highway 23 bridge in the NW ¼, NW ¼, Section 18, R 27 W, T 5 N (Figure A-21).

General Site Discussion

Watershed Size - The area of the watershed above the sample site is 241 mi^2. During the summer sampling period, flow was measured at 0.28 cfs and spring flow was estimated to be 300 cfs.

Geology - The predominant geologic formation within the Petit Jean River drainage is the upper Atokan. Surface rocks in the Arkansas River Valley are primarily sandstone and shale with alluvial deposits along the larger waterways.

Topography - Stream gradient was 3.9 feet per mile for this segment of the Petit Jean River, as measured using a 7.5 minute USGS quadrangle map. The terrain is level to mountainous with erosional and folded hills, cuestas, hogbacks and buttes.

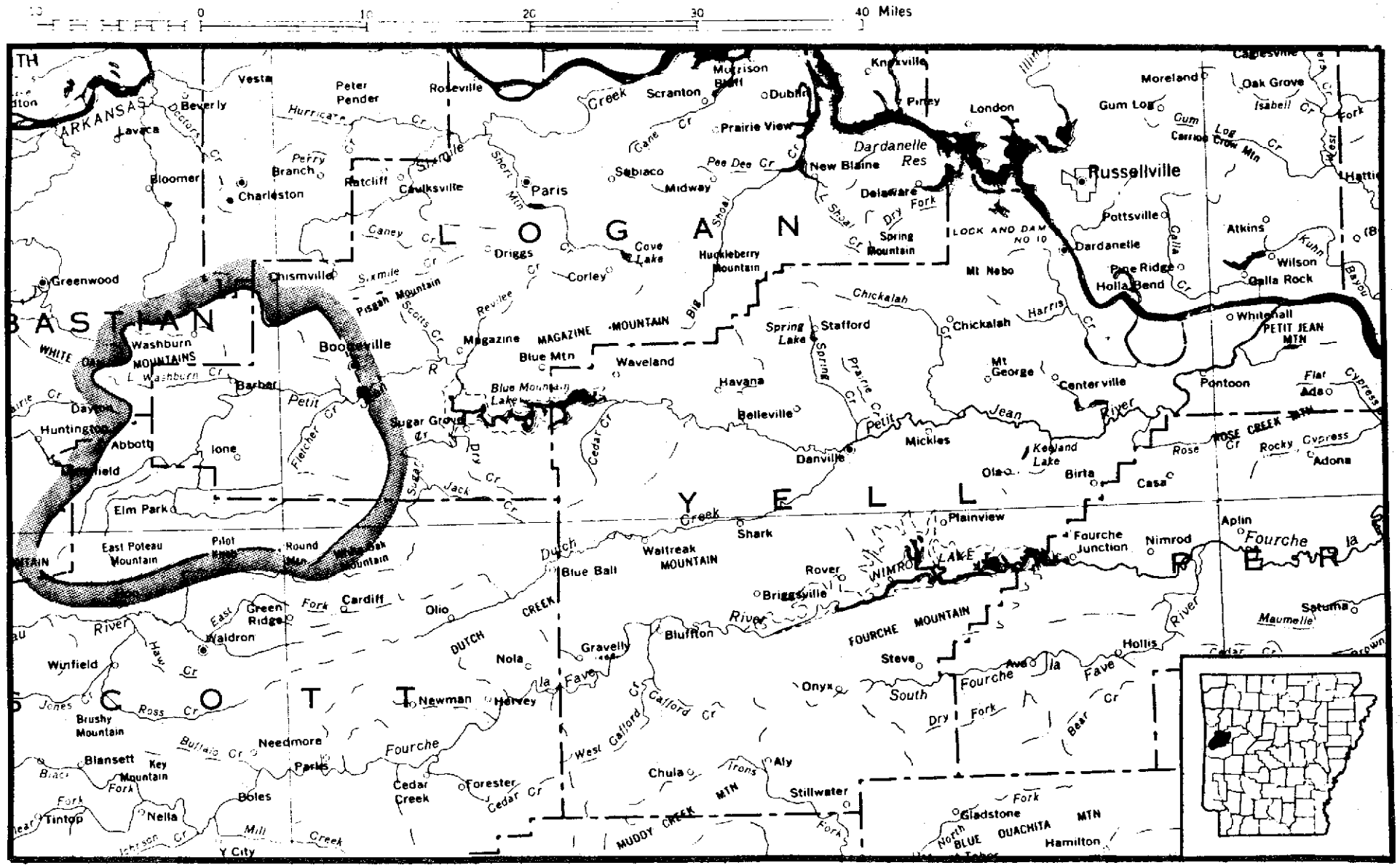
Soil Types - The higher elevations of the headwater area of the upper Petit Jean River drainage is dominated by the Enders-Mountainburg association, a well-drained, gently sloping to steep, deep and shallow, loamy and gravelly or stony soil on hills and mountains. The valleys in the upper drainage are dominated by the Leadvale association, a moderately well-drained, nearly level to gently sloping, deep, loamy soil, on old stream terraces in broad valleys. The narrow floodplain of the main stream channel is dominated by the Barling-Spadra association, a moderately well-drained and well-drained, level to nearly level, deep, loamy soil on floodplains and stream terraces.

Flora - The general vegetation type for this area is shortleaf pine and upland hardwoods. Specific tree types observed on the Petit Jean River were silver maple, box elder, river birch, green ash and sycamore.

Land Use - Land use in the Petit Jean River watershed is evenly distributed between forestlands and agricultural uses. Forestlands occupy 52% of the drainage and agricultural uses about 45% with 3% falling in the other use category. These figures were derived from the Cooperative Extension Service of the Department of Agriculture.

Figure AR-21

PETIT JEAN CREEK: Drainage area 241 square miles ■ Survey site ▒ Survey area



Stream Characteristics - A common characteristic of the Arkansas River Valley Region is the lack of flow during the critical season. The Petit Jean River adheres to this characteristic in that flow was measured at 0.28 cfs at a location with 241 mi^2 of watershed. Significant physical characteristics include a moderate gradient of 3.9 feet per mile, substrate composed of boulders, rubble and gravel, and a minor amount of instream fishery cover. Significant chemical characteristics include low alkalinity, total hardness, minerals and nutrients.

Methodology and Sampling Results

The Petit Jean River was studied under critical conditions during late summer and again during a steady-state flow during spring spawning conditions. The critical conditions were studied the week of August 26, 1985, and the spring conditions during the week of April 14, 1986.

Continuous Dissolved Oxygen

Summer - During the summer sampling period on the Petit Jean River, three continuous recording meters were set up to monitor temperature, dissolved oxygen and percent saturation. Site #1 was located approximately 30 feet upstream of the bridge at the end of the pool. Site #2 was in a riffle approximately 150 feet below the bridge. Site #3 was located approximately 400 feet below the bridge in the center of a large pool. All three meters were set up shortly after noon on August 26, 1985. Each meter was checked and calibrated daily. All meters functioned properly throughout the survey period. The dissolved oxygen at Site #1 ranged from 3.8 mg/l to 6.5 mg/l and averaged 5.1 mg/l (Figure AR-22). The dissolved oxygen at Site #2 ranged from 4.8 mg/l to 5.9 mg/l and averaged 5.5 mg/l (Figure AR-23). The dissolved oxygen at Site #3 ranged from 4.4 mg/l to 6.8 mg/l and averaged 5.6 mg/l (Figure AR-24). Dissolved oxygen percent saturation from all sites averaged approximately 50%-70%.

Spring - During the spring sampling period on the Petit Jean River, two meters were set up to monitor temperature, dissolved oxygen and percent saturation. Site #1 was located approximately 75 yards upstream of the bridge. Site #2 was located approximately 150 yards downstream of the bridge. Both meters were set up shortly after noon on April 19, 1986. Each meter was checked and calibrated daily. Both meters functioned properly throughout the survey period. Figures AR-25 and AR-26 show the recordings made at each of these sites. The dissolved oxygen ranged from 7.8 mg/l to 8.6 mg/l and averaged 8.4 mg/l over the survey period. Dissolved oxygen percent saturation ranged from approximately 80%-90%.

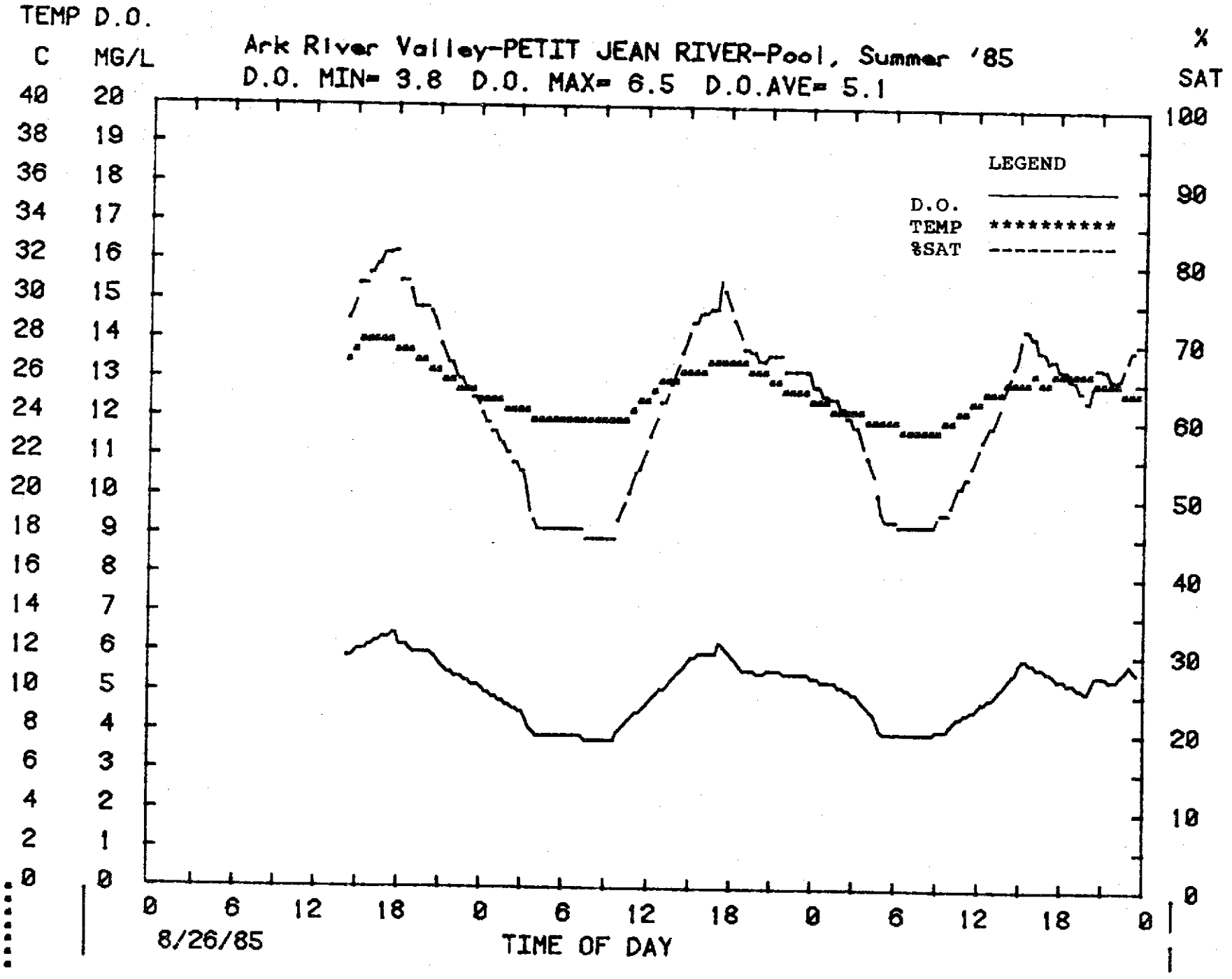


Fig. AR-22. Dissolved Oxygen Plot

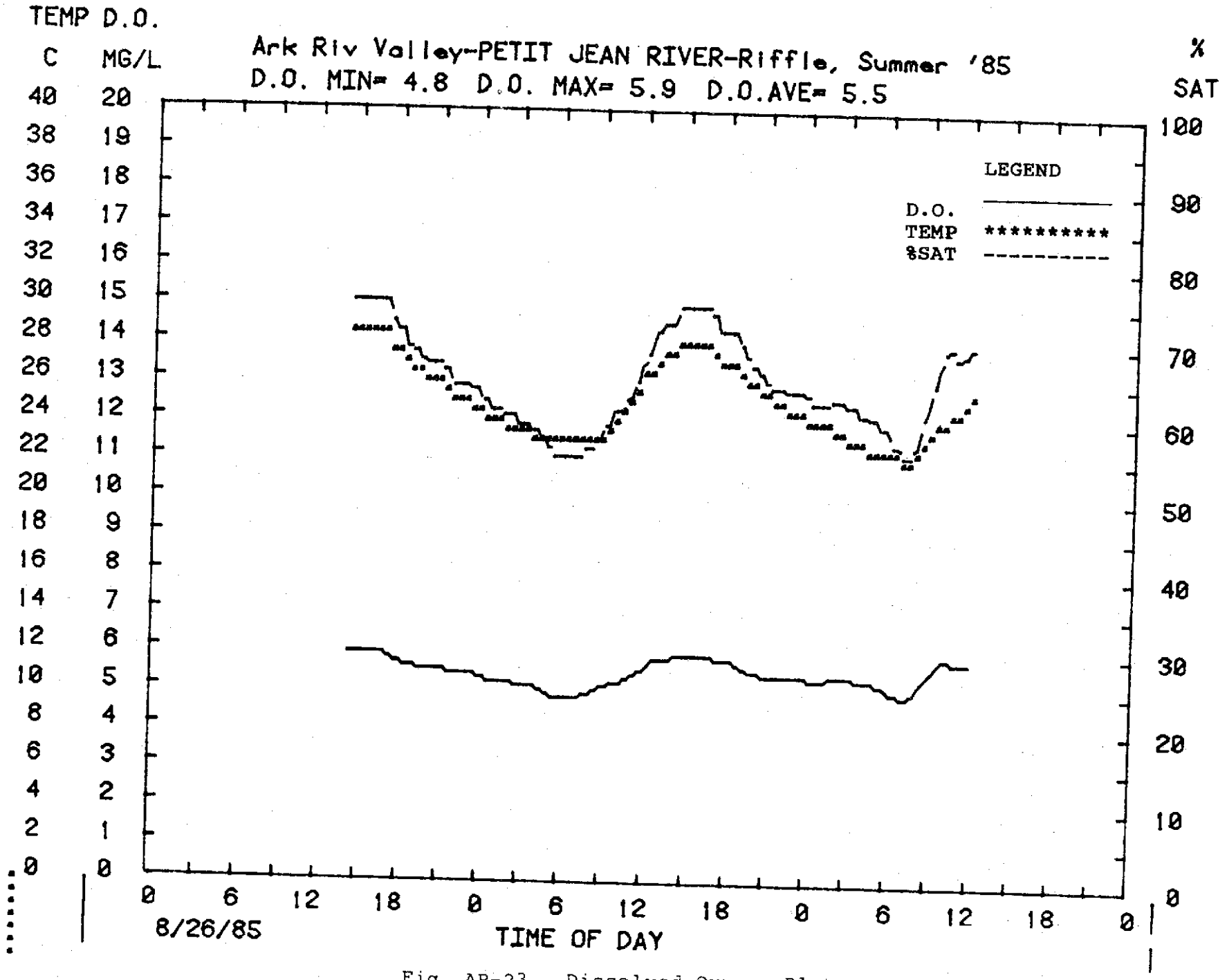


Fig. AR-23. Dissolved Oxygen Plot

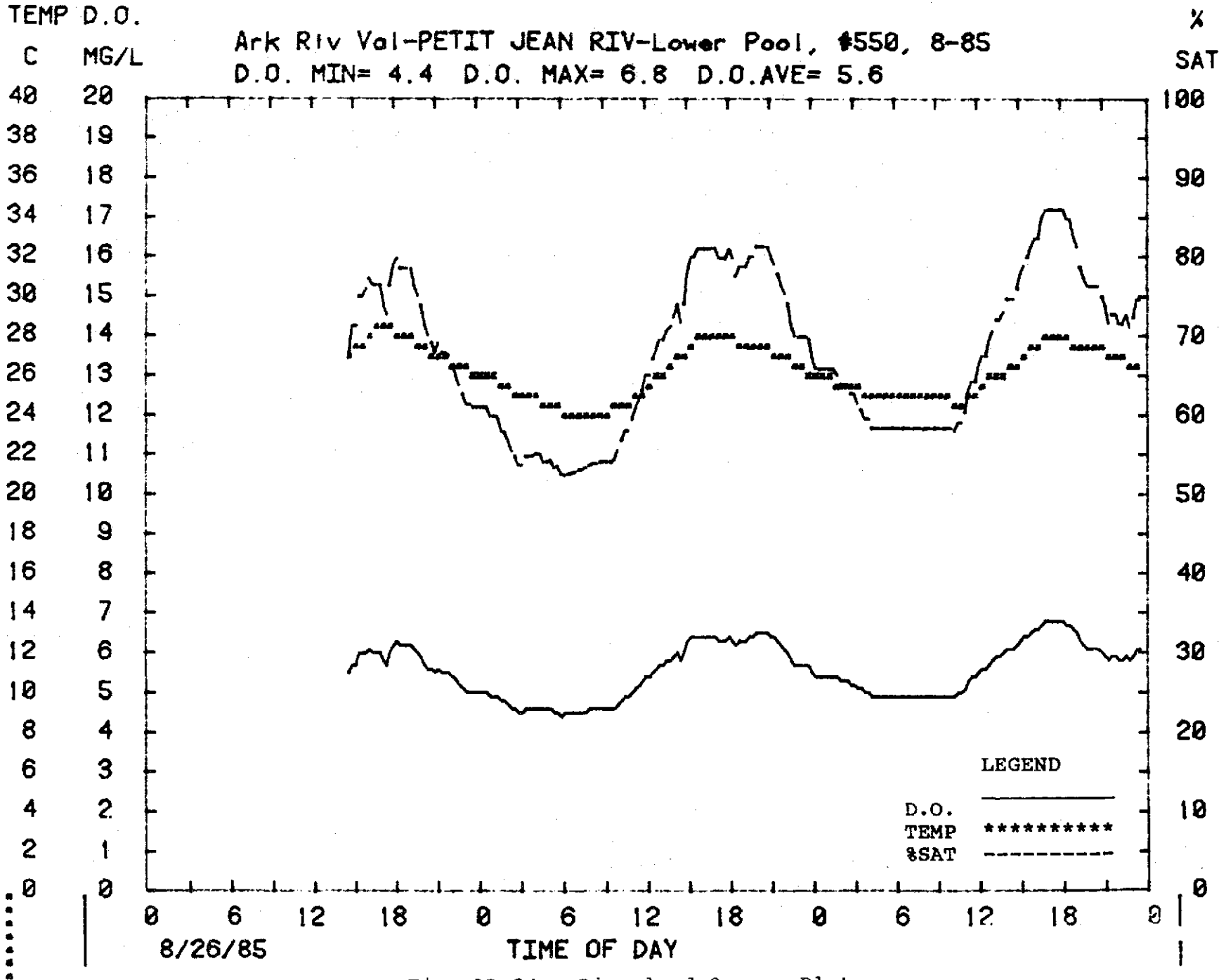


Fig. AR-24. Dissolved Oxygen Plot

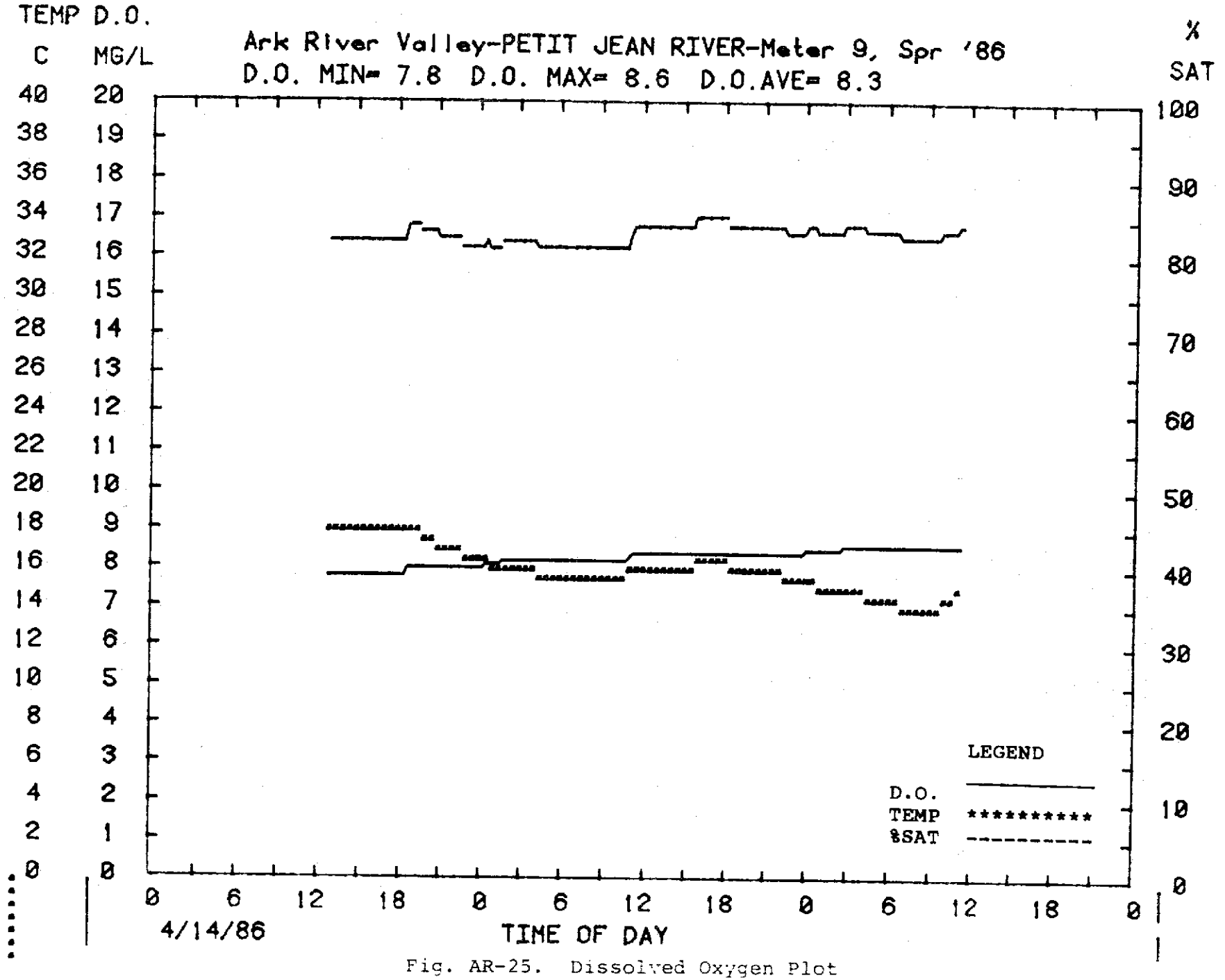


Fig. AR-25. Dissolved Oxygen Plot

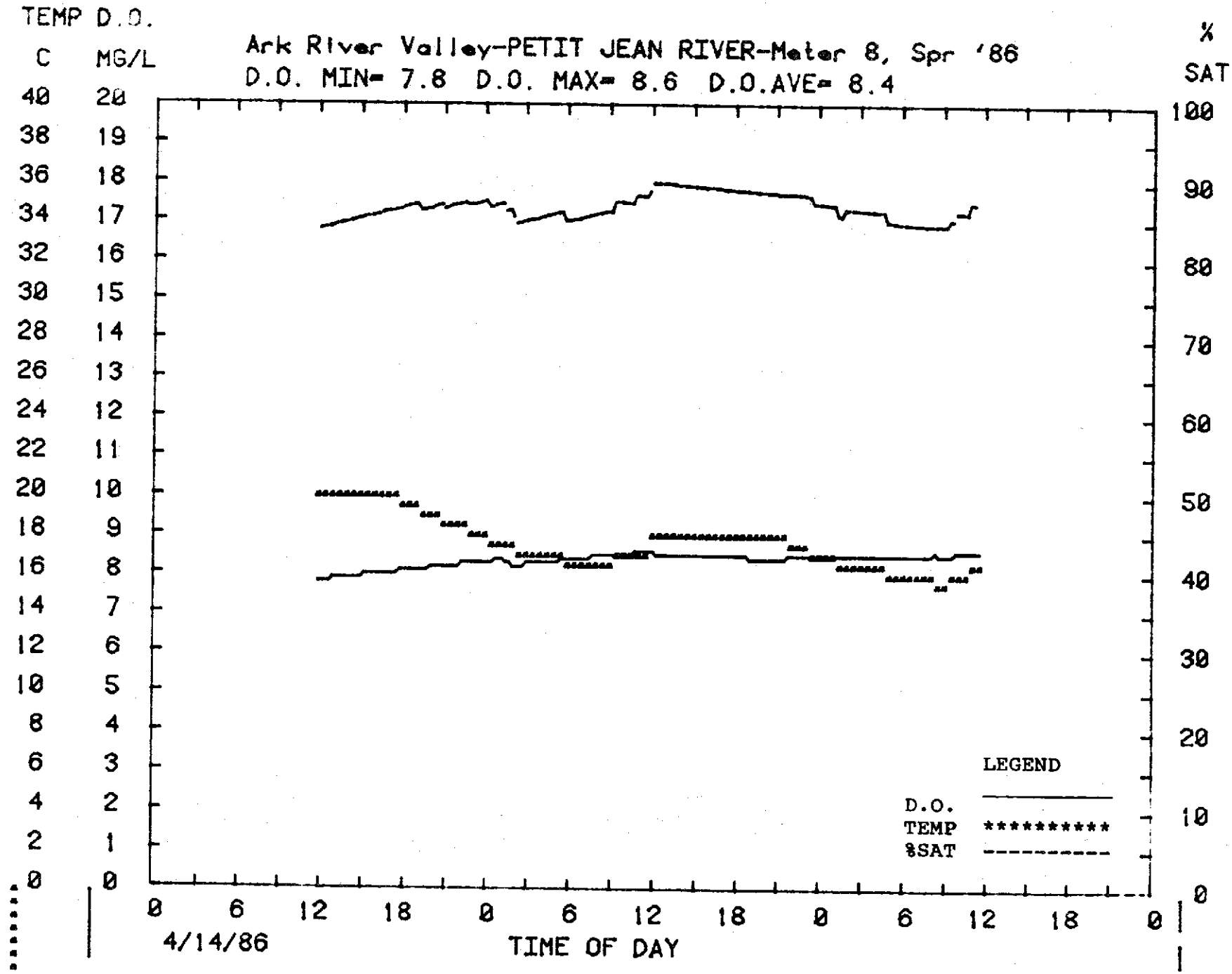


Fig. AR-26. Dissolved Oxygen Plot

Chemical Parameters

Chemical samples were collected during both spring and summer periods and each consisted of three distinct grab samples (Tables AR-25 and AR-26). Observations of the chemical results from both the spring and summer sampling periods reveal only minor differences within parameters between seasons. The most significant difference appears to be the lack of flow during summer which causes some minor increases in various parameters due to evaporation. Parameters such as chlorides, total dissolved solids, conductivity, alkalinity and total hardness showed minor increases during the summer sampling period. The seasonal variations also include higher turbidity and fecal coliform counts and slightly higher nutrient concentrations during the spring conditions. The higher runoff during the spring and the agricultural uses within the watershed are thought to be responsible.

Physical Parameters

Physical characteristics of the Petit Jean River were measured during the summer survey period. The physical substrate in the Petit Jean River was evenly distributed between boulders, rubble and gravel with minor amounts of sand and mud (Table AR-27). Only small amounts of instream fishery cover was observed. Riparian cover at the site was 85% tree overstory and 7% shrubs. Grasses and forbs covered 56% of the ground surface leaving 44% rock and dirt. The banks of the Petit Jean River were judged to be 20% stable, 60% moderately stable and 20% unstable. Riffles occupied 20% of the stream and pools occuped 80% of the stream. The mean stream canopy was measured at 64%.

Macroinvertebrate Populations

One hundred-one (101) taxa, representing 20 orders were identified from the summer and spring samples of the benthic community (Table A-18, Appendix A). The dominant orders, Trichoptera, Ephemeroptera, Diptera, Coleoptera and Odonata comprised 25%, 19%, 12%, 10% and 9% of the sample, respectively. Taxonomically, the benthic community was evenly distributed in that 5 orders were represented by 10 or more taxa. Only two (2) taxa comprised greater than 5% of the combined samples, i.e., *Cheumatopsyche* and *Caenis*. Both of these are common and widespread. Each has been shown to exhibit wide tolerances to many water quality parameters. Other taxa common to both samples included *Argia*, *Corydalus cornutus*, *Stenelmis crenata* and three (3) taxa of bloodworms, *Chironomus*, *Conchaplopia* and *Polypedilum*. The benthic assemblage could best be described as dominated by macroinvertebrates which are widely distributed and can tolerate a wide range of environmental conditions. The population does not exhibit those taxa characteristic of high water quality or those limited by adverse water quality.

Table AR-25

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Petit Jean River

Drainage Area: 241 Square Miles

Station Description: Hwy. 23 bridge in Section 18, T 5 N, R 27 W, Logan County

Date: August 27, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	08:40	09:30	10:30	
Q, cfs	0.28	0.28	0.28	0.28
Temperature, °C	24	24	24	24
pH	7.2	7.2	7.2	7.2
Turbidity, ntu	18	12	13	14
TSS, mg/l	10	12	18	13
TDS, mg/l	90	87	87	88
BOD-5, mg/l	1.4	1.3	1.4	1.4
BOD-20, mg/l	3.9	3.9	4.0	3.9
T.Phos., mg/l	0.06	0.06	0.05	0.06
PO4-P, mg/l	0.02	0.01	0.01	0.01
NO2+NO3-N, mg/l	0.05	0.05	0.04	0.05
NH3-N, mg/l	0.04	0.04	0.03	0.04
Cl -, mg/l	6.5	5.5	5.5	5.8
SO4 =, mg/l	8	8	8	8
Fe, mg/l	0.04	0.06	0.06	0.05
Conductivity,µmho	131	131	128	130
Alkalinity, mg/l	49	50	50	50
T. Hardness, mg/l	38	40	38	38
Chlorophyll a,µg/l	0.0	8.5	8.3	5.6
Fecal Coliform	-	-	32	32

Dissolved Oxygen Data for 27 Aug 1985		
	Riffle	Pool
Average	4.9	5.4
Minimum	3.8	4.8
Maximum	6.3	5.9

Table AR-26

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Petit Jean River

Drainage Area: 241 square miles

Station Description: Hwy 23 bridge in Section 18, T 5 N, R 27 W, Logan County

Date: April 15, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	08:45	09:30	10:00	
Q, cfs	300 EST			300 EST
Temperature, °C	18	18	18	18
pH	6.97	6.96	6.99	7.0
Turbidity, ntu	44	42	43	43
TSS, mg/l	26	28	27	27
TDS, mg/l	74	78	78	77
BOD-5, mg/l	1.5	1.3	1.2	1.3
BOD-20, mg/l	3.0	3.4	3.0	3.4
T.Phos., mg/l	0.06	0.08	0.05	0.06
PO4-P, mg/l	0.04	0.04	0.04	0.04
NO2+NO3-N, mg/l	0.11	0.11	0.10	0.11
NH3-N, mg/l	0.12	0.11	0.10	0.11
Cl -, mg/l	4.5	4.5	4.5	4.5
SO4 =, mg/l	13	12	12	12
Fe, mg/l	1.2	1.1	1.0	1.1
Conductivity,µmho	73	74	71	73
Alkalinity, mg/l	17	16	16	16
T. Hardness, mg/l	24	20	22	22
Chlorophyll a,µg/l	-	-	0.36	0.36
Fecal Coliform	-	-	223	223

Dissolved Oxygen Data for 15 Apr 1986		
	Meter 8	Meter 9
Average	8.4	8.3
Minimum	8.2	8.0
Maximum	8.6	8.4

Table AR-27

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Petit Jean River
Date:	8/27/85
Drainage Area:	241 square miles
Watershed Land Use:	45% Agriculture 52% Forest 3% Other
Stream Gradient:	3.9 fpm
Mean Channel Width:	65 feet
Mean Stream Width:	48 feet
Mean Stream Velocity:	.03 fps
Observed Flow:	.3 CFS
Average Substrate Type:	8% Large Boulder 21% Boulder 33% Rubble 23% Gravel 5% Sand 10% Mud
Mean Instream Cover:	3% Brush, Logs, Debris 1% Undercut Bank 5% Inundated Vegetation
Riffle/Pool Ratio of Transects:	20% Riffle 40% Moderate Pool 40% Shallow Pool
Mean Bank Overstory Cover:	85% Trees 7% Shrubs
Mean Bank Ground Cover:	56% Grass and Forbs 22% Rock 22% Dirt
Mean Bank Stability:	20% Stable 60% Moderate 20% Unstable
Mean Stream Canopy:	64% Canopy
Comments:	

The comparative indices indicated the summer and spring samples were slightly more dissimilar than similar. However, of the 101 taxa identified from the combined summer and spring samples, 41 taxa were present in both samples and those 41 comprised 66% of the samples, numerically. The 28 and 30 taxa unique to the summer and spring samples comprised 32.4% and 37% of their respective benthic assemblages.

Summer - The summer benthic community was numerically dominated by those same orders that dominated the combined assemblage. The dominant taxa of the summer sample were Cheumatopsyche and Caenis. Other taxa, not numerically dominant but considered ecologically characteristic included Corydalus cornutus, Isonychia, Stenelmis crenata and Optisseruis. Taxonomically, Coleoptera and Diptera dominated the benthic assemblages and was represented by 14 and 13 taxa, respectively.

Spring - The dominant orders of the spring benthic community mirrored those of the summer. Only two taxa comprised greater than 5% of the spring sample, i.e., Cheumatopsyche and Eurylophella bicolor (a cold water mayfly). Other taxa, not numerically dominant but ecologically characteristic, include Ancyronyx variegata, Optioservus and Paraleptophlebia.

The community parameters of the benthic community indicated a stable, balanced assemblage. The diversity ranged from 4.4695 to 5.1726 indicating good water quality (Table AR-28). The differences in the diversity of summer and spring was in response to the large population of Cheumatopsyche of the summer sample. The other community parameters indicated no significant differences. The distribution of the functional feeding groups was characteristic of healthy benthic assemblages dominated by collectors, followed in descending order by shredders, predators, scrapers and parasites.

Table AR-28. Community Analysis of Benthic Samples from Petit Jean River - 30 Minute Qualitative Sample, 1985-86

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	1127	798	1925
Total # Taxa	71	73	101
Diversity	4.4695	5.2404	4.5906
Index of Evenness	0.6458	0.4581	0.3872
Index of Dominance	0.7268	0.8466	0.6894
Index of Variety	6.9045	7.4687	8.8171
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.49
Common Taxa Index (range 0-1)			0.45
Qualitative Similarity Index (range 0-100)			45.0

Fish Populations

Summer - Approximately one-half acre was treated with six pounds of 5% active rotenone on August 28, 1985. This included about 400 feet of the stream, most of which was a pool. A short, narrow and very shallow riffle at the head of the pool was also treated. Fish pick-up required 15 man-hours. A total of 1810 individuals were collected from 39 species (two additional species were taken in the spring). They had a total relative abundance value of 247 and a diversity index of 5.03. Table AR-29 lists those species collected. Cyprinidae, Percidae and Centrarchidae had very similar percent of relative abundance values and Ictaluridae made up a relatively high percentage of the population (Table AR-30). Primary feeding fishes of only four species made up 11.7% of the population while eight species of carnivores comprised 8.5% of the total relative abundance. Seven sensitive species were collected at this site.

Spring - On April 14, 1986, four trammel nets of 1½", 2" and 3½" square mesh were set and left overnight. The nets were placed about ½ mile upstream from the summer sample site due to access difficulties. The streamflow was bank full, had high velocity and was relatively turbid, but was falling slightly. Water temperatures were generally between 16°-18°C. Only 12 specimens weighing 34.2 pounds and representing six species were caught. River redhorse made up almost one-half of the weight of the catch. All of these fish and the smallmouth buffalo were in the spawning process or had completed spawning.

Table AR-29. Fishes Collected from Petit Jean River with Relative Abundance Values

Species		R.A. VALUE
Noturus miurus	Brindled madtom	12.0
Pimephales notatus	Bluntnose minnow	12.0
Lepomis megalotis	Longear	12.0
Etheostoma whipplei	Redfin darter	12.0
**Noturus exilis*	Slender madtom	12.0
Noturus nocturnus	Freckled madtom	9.0
Gambusia affinis	Mosquitofish	9.0
Labidesthes sicculus	Brook silversides	9.0
Micropterus punctulatus	Spotted bass	9.0
Moxostoma erythrurum	Golden redhorse	9.0
Lepomis cyanellus	Green sunfish	9.0
Campostoma anomalum	Stoneroller	9.0
Fundulus olivaceus	Blackspotted topminnow	9.0
Lepomis humilis	Orangespotted sunfish	9.0

Table AR-29, cont.

Species		R.A. VALUE
*Percina copelandi	Channel darter	7.5
Pimephales vigilax	Bullhead minnow	7.5
Notropis fumeus	Ribbon shiner	7.5
*Etheostoma stigmaeum	Speckled darter	7.5
Etheostoma spectabile	Orangethroat darter	7.5
Percina caprodes	Logperch	7.0
Notropis umbratilis	Redfin shiner	6.0
Aplodinotus grunniens	Freshwater drum	6.0
Lepomis macrochirus	Bluegill	6.0
Notropis emiliae	Pugnose minnow	6.0
*Percina sciera	Dusky darter	6.0
*Notropis whipplei	Steelcolor shiner	4.5
Dorosoma cepedianum	Gizzard shad	4.0
Ictalurus punctatus	Channel catfish	4.0
Ictiobus bubalus	Smallmouth buffalo	4.0
Pylodictis olivaris	Flathead catfish	2.0
Micropterus salmoides	Largemouth bass	2.0
Minytrema melanops	Spotted sucker	2.0
Morone chrysops	White bass	2.0
Ictalurus natalis	Yellow bullhead	2.0
*Etheostoma histrio	Harlequin darter	1.0
Esox americanus	Grass pickerel	1.0
Notropis venustus	Blacktail shiner	1.0
Lepomis gulosus	Warmouth	1.0
Lepisosteus oculatus	Spotted gar	1.0
*Moxostoma carinatum	River Redhorse	S
Lepisosteus osseus	Longnose gar	S

*Sensitive species
S - Spring Sample Only

Table AR-30. Summary of Fish Population Parameters from Petit Jean River

Total Species Collected	41.0
Total Number of Individuals	1810.0
Total Relative Abundance Value	247.0
Relative Abundance Diversity Index	5.03

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	8.0	21.7
CATOSTOMIDAE	3.0	6.1
ICTALURIDAE	6.0	16.6
CENTRARCHIDAE	7.0	19.4
PERCIDAE	7.0	19.6
Primary Feeders	4.0	11.7
Macroinvertebrate Feeders	29.0	79.8
Carnivores	8.0	8.5
Sensitive Species	7.0	15.6

CADRON CREEK

Cadron Creek begins in southwest Cleborne County and flows southeasterly through the southeast corner of Van Buren County and the northwest corner of Faulkner County, finally forming the Faulkner-Conway County line to its confluence with the Arkansas River. The sample site is located upstream of the bridge on a county road approximately 3.5 miles west of Wooster, Arkansas. The specific site location is SW ¼, SE ¼, Section 31, R 14 W, T 7 N (Figure AR-27).

General Site Discussion

Watershed Size - The area of the watershed above the sample site is 308 mi^2.

Geology - The upper Cadron Creek watershed drains the Atokan Formation undivided and the lower section of the watershed drains the upper part of the Atokan Formation. Surface rocks in the Arkansas River Valley Region are primarily sandstone and shale with alluvial deposits along all the larger waterways.

Topography - Stream gradient was 0.6 feet per mile for this sample location on Cadron Creek as measured from a 7.5 minute USGS quadrangle map. The terrain is level to mountainous with erosional and folded hills, cuestas, hogbacks and buttes.

Soil Types - The predominant soil type found in the upper watershed of Cadron Creek is the Linker-Mountainburg association. This association is well-drained, nearly level to steep, loamy, gravelly and stony soil on benches, ridges, hilltops and mountaintops. Interspersed throughout the Linker-Mountainburg association is the Leadvale-Taft association. This is a moderately well-drained and somewhat poorly drained, nearly level to gently sloping, loamy soil on stream terraces, on benches and in depressions. Much of the immediate floodplain of Cadron Creek is made up of the Spadra-Ouachita-Amy Association. This is a well-drained and poorly drained, level and nearly level, loamy soil on floodplains, natural levees and terraces.

Flora - The general vegetation type for this area is shortleaf pine and upland hardwoods.

Land Use - Land use in the Cadron Creek drainage basin is primarily agricultural. Information from the Cooperative Extension Service of the Department of Agriculture shows that 62% of the lands within the Cadron Creek watershed are currently under agricultural uses and 38% are in forestland.

Stream Characteristics - The low stream gradient measured at the Cadron Creek Station is indicative of the larger watersheds within the Arkansas River Valley Region. The actual volume of water was large with a mean stream width of 93 feet, but there was no measurable flow during critical

Figure AR-27


VAN BUREN
CONWAY
FAULKNER
Old Lexington
Rushing
Parma
Botkinburg
Prim
Rubek
Shirley
Woodrow
Archey
Drasco
Koch Ridge
Clinton
Edgemont
Brownsville
Stark
Greers Ferry Res
Choctaw
Scotland
Culpepper
Gravel Hill
Formosa
Morganton
Crossroads
Bee Branch
Southside
Pearson
Hot Springs
Cleveland
Quitman
Hopewell
Center Ridge
Damascus
Wonderview
Lenty
Martinville
Guy
Rose Bud
St Vincent
Bird Town
Springfield
Republican
Centerville
Hart
Joy
Solgohachia
Bono
Barney
Blackwell (Blackville Sta)
Overcup
Greenbrier
Mount Vernon
Romance
Springhill
Holland
Enola
Floyd
Plumerville
Naylor
Muddy
Hammondsville
Morrilton
Menifee
Old River Lake
Gleason
Conway
Vilonia
El Paso
Hamlet
Toms Mountain
Houston
Perry
Otto
Gold Creek
Lake Conway
Tates
L Cabot
Austin
Bigelow
Scale 1:500,000
1 inch equals approximately 8 miles
10 0 10 20 30 40 Miles
10 0 10 20 30 40 50 Kilometers
CADRON CREEK: Drainage area 308 square miles
Survey site
Survey area

conditions. The stream substrate was 100% mud and silt. Actual instream fishery cover was low at 6% brush, logs and debris. No riffles were in the segment surveyed. The chemical characteristics were similar to other streams within the region with low alkalinity, hardness, mineral and turbidity values.

Methodology and Sampling Results

Cadron Creek was studied under conditions of late summer and again at a steady-state condition during the spring. The critical conditions were studied the week of August 26, 1985, and the spring conditions during the week of April 14, 1986.

Continuous Dissolved Oxygen

Summer - During the summer sampling period on Cadron Creek, three meters were set up to monitor temperature, dissolved oxygen and percent saturation. All three meters were set above the boat ramp at the county road bridge. Each meter was checked and calibrated daily. One of the meters failed to operate properly and the data from it was unsatisfactory. Figures AR-28 and AR-29 show the recordings made during this survey. Dissolved oxygen at Meter #7 ranged from 2.5 mg/l to 8.6 mg/l and averaged 6.0 mg/l over the entire period. Data obtained from Meter #6 ranged from 2.7 mg/l to 9.4 mg/l and averaged 6.5 mg/l over the survey period. Dissolved oxygen percent saturation ranged from approximately 30% to supersaturation.

Spring - During the spring sampling period on Cadron Creek, two meters were again set up to monitor temperature, dissolved oxygen and percent saturation. The sites were again above the boat ramp at the county road bridge. The flow was substantially increased over the summer period. Figures AR-30 and AR-31 show the recordings made at both sites. The meters were checked and calibrated daily. The enhanced flow and cooler temperature apparently flattened out the graph and greatly increased the percent saturation to near 90%. The D.O. ranged from 8.2 mg/l to 9.0 mg/l and averaged 8.6 mg/l for the survey period.

Chemical Parameters

Chemical samples were collected during both spring and summer periods and each consisted of three distinct grab samples. Tables AR-31 and AR-32 show the results of each survey. Observation of the chemical results from both spring and summer sampling periods reveals rather significant differences in these two seasons. Apparently the minimum flows found during the summer sampling period are a factor in the higher concentrations of various parameters found. Parameters such as BOD_5, BOD_{20}, conductivity, alkalinity, total hardness, total dissolved

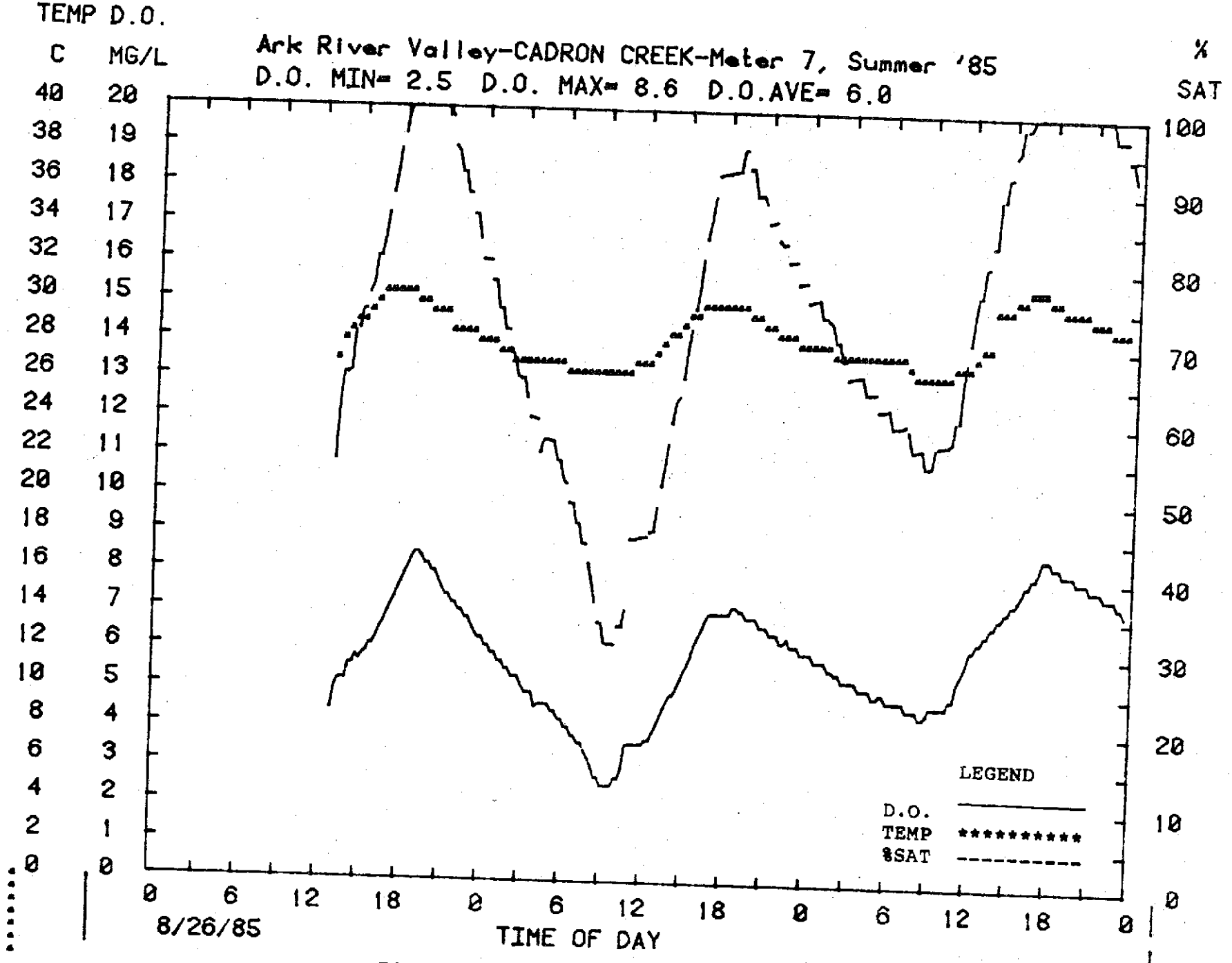


Fig. AR-28. Dissolved Oxygen Plot

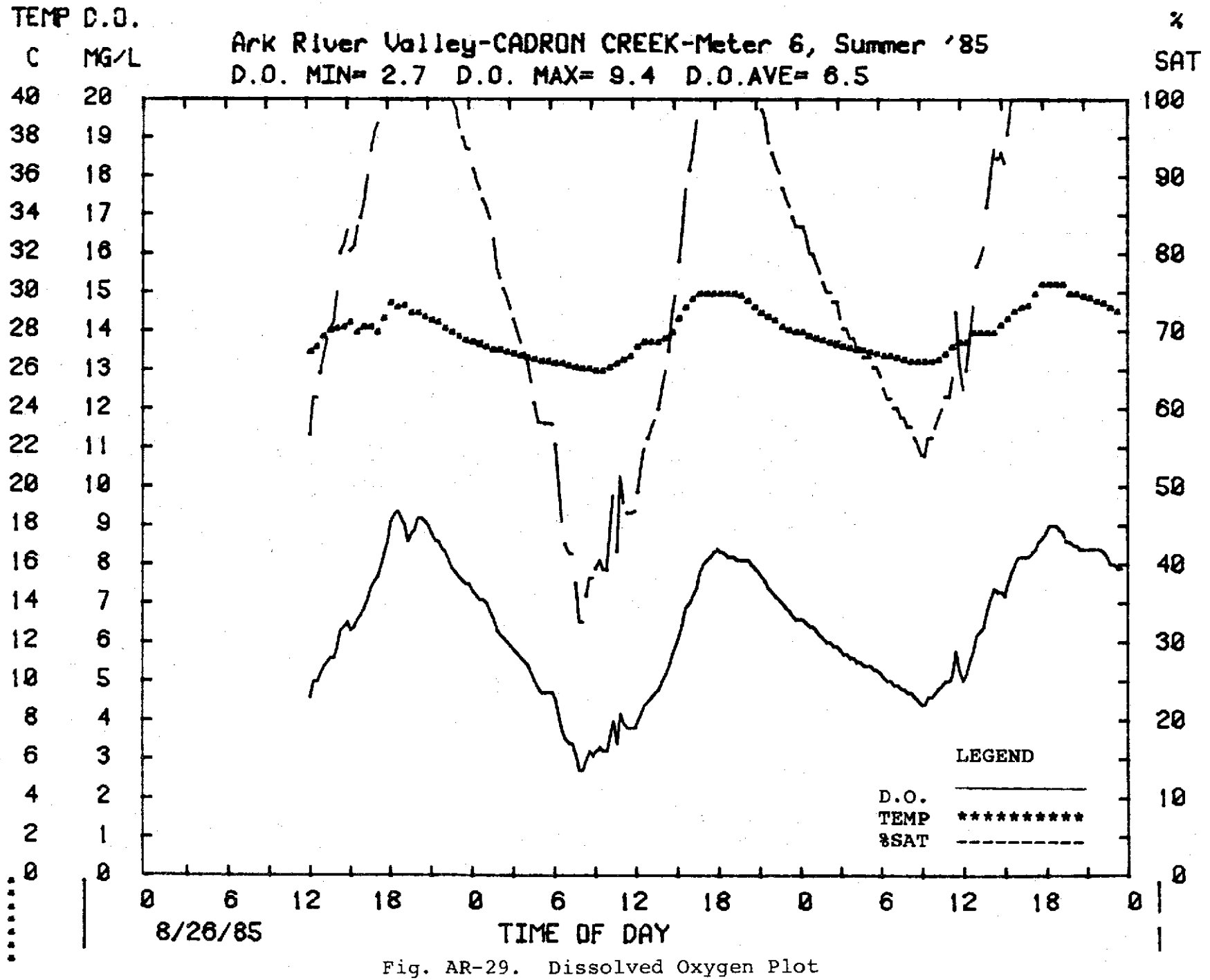


Fig. AR-29. Dissolved Oxygen Plot

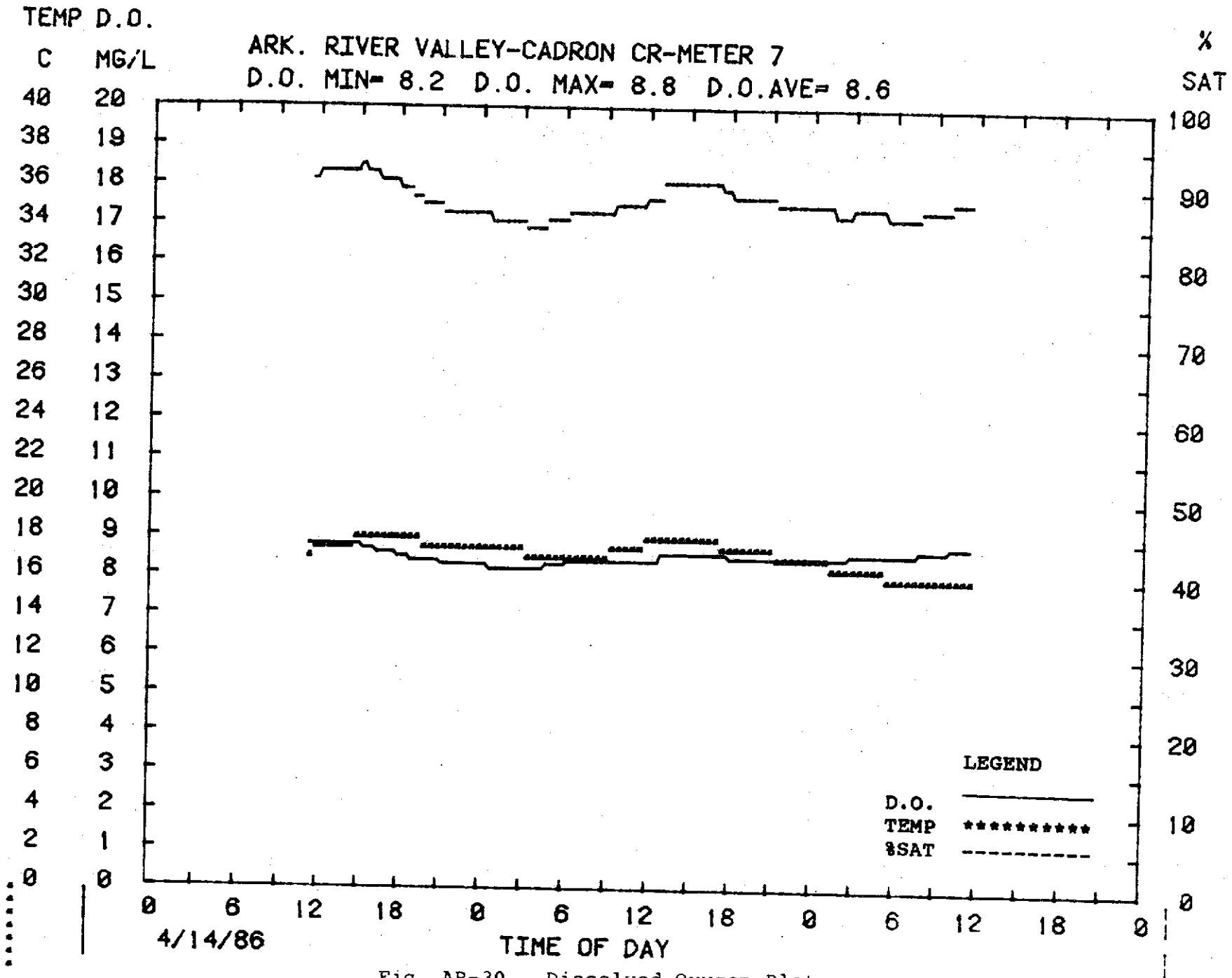


Fig. AR-30. Dissolved Oxygen Plot

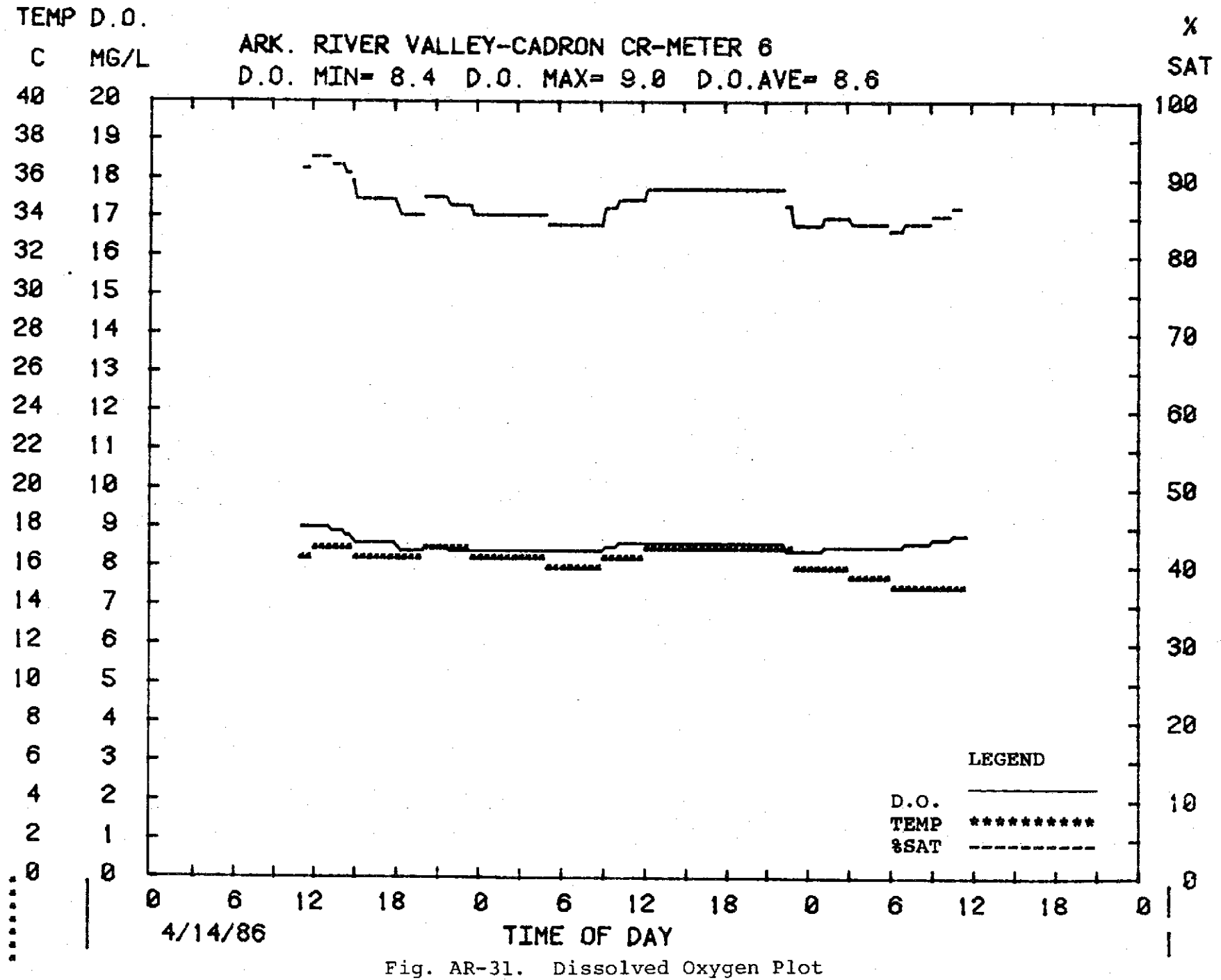


Fig. AR-31. Dissolved Oxygen Plot

Table AR-31

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Cadron Creek

Drainage Area: 308 Square Miles

Station Description: County Road bridge in Section 31, T 7 N, R 14 W
Conway-Faulkner County

Date: August 27, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	10:14	12:05	13:45	
Q, cfs	0	0	0	No Flow
Temperature, °C	26	27	29	27
pH	7.0	7.0	7.1	7.0
Turbidity, ntu	18	13	12	14
TSS, mg/l	20	17	16	17
TDS, mg/l	70	72	72	72
BOD-5, mg/l	3.6	3.3	3.0	3.3
BOD-20, mg/l	9.8	8.7	8.1	8.8
T.Phos., mg/l	0.10	0.09	0.07	0.08
PO4-P, mg/l	0.02	0.02	0.02	0.02
NO2+NO3-N, mg/l	0.04	0.04	0.04	0.04
NH3-N, mg/l	0.04	0.02	0.01	0.02
Cl -, mg/l	5.5	5.0	5.0	5.0
SO4 =, mg/l	4	4	4	4
Fe, mg/l	0.06	0.05	0.06	0.06
Conductivity,µmho	87	88	86	87
Alkalinity, mg/l	32	35	34	34
T. Hardness, mg/l	32	30	32	32
Chlorophyll a,µg/l	28.0	27.8	16.7	24.1
Fecal Coliform	-	-	4	4

Dissolved Oxygen Data for 27 Aug 1985		
	Meter 6	Meter 7
Average	5.8	5.1
Minimum	2.7	2.5
Maximum	8.4	7.2

Table AR-32

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Arkansas River Valley

Stream: Cadron Creek

Drainage Area: 308 square miles

Station Description: County rd bridge in Section 31, T 7 N, R 14 W, Conway-Faulkner County line.

Date: April 15, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	13:15	13:35	14:00	
Q, cfs	500 Est			500 Est
Temperature, °C	18	18	18	18
pH	6.79	6.74	6.72	6.8
Turbidity, ntu	8	10	11	10
TSS, mg/l	14	13	28	18
TDS, mg/l	40	39	35	38
BOD-5, mg/l	0.07	0.09	0.07	0.08
BOD-20, mg/l	1.9	2.4	2.1	2.1
T.Phos., mg/l	0.04	0.04	0.05	0.04
PO4-P, mg/l	0.02	0.03	0.02	0.02
NO2+NO3-N, mg/l	0.44	0.44	0.44	0.44
NH3-N, mg/l	0.08	0.07	0.09	0.08
Cl -, mg/l	3.0	3.5	4.0	3.5
SO4 =, mg/l	3	3	3	3
Fe, mg/l	0.5	0.5	0.6	0.5
Conductivity,µmho	34	34	33	34
Alkalinity, mg/l	5	5	7	6
T. Hardness, mg/l	12	12	10	11
Chlorophyll a,µg/l	-	-	1.1	1.1
Fecal Coliform	-	-	200	200

Dissolved Oxygen Data for 15 Apr 1986		
	Meter 6	Meter 7
Average	8.5	8.4
Minimum	8.4	8.2
Maximum	8.6	8.6

solids, and chlorophyll ā were found to be much higher during the critical summer season when the stream was in more of a lentic state. However, the concentrations of these various parameters would generally be considered low. The chlorophyll ā concentrations measured during the summer season reveal a high level of phytoplankton activity.

Physical Parameters

Physical characteristics of Cadron Creek were measured during the summer survey period and are displayed in Table AR-33. The substrate type was measured as 100% mud and silt. Instream fishery cover averaged 6% brush, logs and debris. Riparian cover at the site was 72% trees and 70% shrubs. Grasses and forbs covered 30% of the ground surface leaving 70% exposed dirt. The banks of Cadron Creek were estimated to be 40% stable, 50% moderately stable and 10% unstable. The stream channel was 100% deep pools with no riffles. Stream canopy was measured at only 22% coverage.

Macroinvertebrate Populations

Seventy-three (73) taxa, representing 18 orders were identified from the summer and spring benthic community samples (Table A-19, Appendix A). The dominant orders of the combined samples, Coleoptera, Diptera and Ephemeroptera, comprised 21.9%, 19.7% and 9.6% of the total sample, respectively. Taxonomically, Coleoptera was represented by twice the number of taxa than any other order. No individual taxa comprised greater than 8% of the total organisms collected. However, several taxa were common to both the summer and spring benthic samples. These were considered to be ecologically characteristic of Cadron Creek and include Uvarus, Peltodytes, Lymnaea, and Cyrnellus fraternis.

The comparative indices indicated that a large degree of uniformity existed between the summer and spring benthic communities (Table AR-34). Of the 73 taxa identified from the combined benthic samples, 31 taxa were identified in both the summer and spring samples. These 31 taxa comprised 77% of all organisms collected. The 15 and 27 taxa unique to the summer and spring samples comprised 16.5% and 29.8% of their respective communities.

Summer - Numerically, the dominant orders of the summer sample were Diptera, Coleoptera and Heterodontida, comprising 26%, 22% and 10.3% of the sample, respectively. Taxonomically, Coleoptera was represented by twice as many taxa as any other group. The dominant taxa of the summer benthic community were Chironomus (11.9%), Uvarus (11.5%), Corbicula flueminia (10.7%), Oligochaeta (8.3%) and Glyptotendipes (5.9%).

Table AR-33

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Cadron Creek
Date:	8-27-85
Drainage Area:	308 square miles
Watershed Land Use:	62% agri. 38% forest
Stream Gradient:	0.6 fpm
Mean Channel Width:	115'
Mean Stream Width:	93'
Mean Stream Velocity:	NF
Observed Flow:	NF
Average Substrate Type:	100% mud/silt
Mean Instream Cover:	0.2% undercut bank 6% brush, logs, debris
Riffle/Pool Ratio of Transects:	100% deep pools
Mean Bank Overstory Cover:	72% trees 70% shrubs
Mean Bank Ground Cover:	30% grass and forbs 70% dirt
Mean Bank Stability:	40% stable 50% moderate 10% unstable
Mean Stream Canopy:	22% canopy
Comments:	

Spring - The dominant orders of the spring sample were Coleoptera (20.9%), Ephemeroptera (14.7%), Diptera (13.2%) and Hemiptera (8.8%). The dominant taxa of the spring sample were Eurylophella temporallis (9.3%), Peltodytes (7.6%), Corbicila flueminia (5.4%) and Hyalella azteca (5.2%).

The community parameters of Cadron Creek indicated a stable, well-balanced benthic population. The diversity indices ranged from 4.5194 to 5.1352, indicating good water quality (Table AR-34). In addition, the distribution of the functional feeding groups was not significantly skewed, although there was a slightly higher percentage of predator insects than normally characteristic of a stable population.

In spite of these factors, several of the dominant taxa of the Cadron Creek benthic community included species which have been characterized as being indicative of or tolerant to excessive organic pollution. The physical charcteristics of Cadron Creek at this location and the surrounding watershed land uses have resulted in a shift in the taxonomic composition of the benthic community away from characteristic Arkansas River Valley assemblages. These conditions include the channelized nature of the stream and steep, clear banks. These characteristics prohibit the littoral zone formation which allows a growth of emergent cover vegetation and the uniformity of depth and substrate.

Table AR-34. Community Analysis of Benthic Samples from Cadron Creek - 30 Minute Qualitative Sample, 1985-86

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	611	591	1202
Total # Taxa	46	58	73
Diversity	4.5195	5.0612	5.1351
Index of Evenness	0.5191	0.5143	0.5159
Index of Dominance	0.8182	0.8639	0.8296
Index of Variety	4.8622	6.1909	7.0373
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.60	
Common Taxa Index (range 0-1)		0.53	
Qualitative Similarity Index (range 0-100)		47.0	

Fish Populations

Summer - The main channel area of the stream, beginning at a slight constriction caused by bank erosion was treated with 10 pounds of 5% active rotenone on August 29, 1985. The kill area was about ½ acre. Most of the fish were picked up from boats since very little of the area was wadable. The area was checked again the following day for fishes that may

have been missed the first day. At this site, 38 species of fish from 1244 individuals with a relative abundance value of 197.5 and a diversity index of 4.91 were collected. A list of species collected is given in Table AR-35. Cyprinidae was the dominant family of fishes collected; it was followed closely by Centrarchidae. Because shad are extremely sensitve to rotenone and because they travel in large schools and move actively up and down the channel, large numbers of dead and dying shad were seen the day after the treatment around the sample area. Primary feeding fishes made up 9.9% of the population relative abundance. This is probably an underrepresentation of the primary feeding element of the fish population since gizzard shad are extremely abundant in the population. Carnivores from 7 species made up 14.4% of the population and 3 sensitive species totalled 5.1% of the population (Table AR-36).

Spring - Overnight netting was done at this site on April 15, 1986, using nets of 1½", 2", 2½" and 3½" -square mesh. The streamflow was within the normal banks and falling. The water was relatively clear with a slight greenish color and a noticeable current. Water temperature was 16°-18°C. Four fishes weighing 15.7 pounds were netted. The smallmouth buffalo, river carpsucker and channel catfish showed signs of advanced gonad maturation in preparation of spawning.

Table AR-35. Fishes Collected from Cadron Creek with Relative Abundance Values

Species		R.A. VALUE
Lepomis macrochirus	Bluegill	12.0
Aplodinotus grunniens	Freshwater drum	12.0
Notropis volucellus	Mimic shiner	12.0
Dorosoma cepedianum	Gizzard shad	12.0
Pimephales vigilax	Bullhead minnow	12.0
Ictalurus punctatus	Channel catfish	9.0
Notropis emiliae	Pugnose minnow	9.0
Notropis atherinoides	Emerald shiner	9.0
Micropterus punctulatus	Spotted bass	8.0
Fundulus olivaceus	Blackspotted topminnow	7.5
Noturus gyrinus	Tadpole madtom	7.5
Lepomis gulosus	Warmouth	6.0
Lepomis megalotis	Longear	6.0
Lepomis humilis	Orangespotted sunfish	6.0
Labidesthes sicculus	Brook silversides	6.0
Notropis venustus	Blacktail shiner	6.0
Notropis fumeus	Ribbon shiner	4.5
Pomoxis annularis	White crappie	4.5
Gambusia affinis	Mosquitofish	4.0
Elassoma zonatum	Banded pygmy sunfish	4.0
Minytrema melanops	Spotted sucker	4.0
Micropterus salmoides	Largemouth bass	4.0
Pimephales notatus	Bluntnose minnow	4.0
**Percina sciera*	Dusky darter	4.0
**Notropis whipplei*	Steelcolor shiner	4.0

Table AR-35, cont.

Etheostoma asprigene	Mud darter	3.0
Carpiodes carpio	River carpsucker	2.5
Aphredoderus sayanus	Pirate perch	2.0
Notropis umbratilis	Redfin shiner	2.0
Lepomis cyanellus	Green sunfish	2.0
*Percina copelandi	Channel darter	2.0
Morone chrysops	White bass	1.0
Moxostoma erythrurum	Golden redhorse	1.0
Ictiobus bubalus	Smallmouth buffalo	1.0
Etheostoma gracile	Slough darter	1.0
Pylodictis olivaris	Flathead catfish	1.0
Lepomis punctatus	Spotted sunfish	1.0
Amia calva	Bowfin	1.0

*Sensitive species

Table AR-36. Summary of Fish Population Parameters from Cadron Creek

Total Species Collected	38.0
Total Number of Individuals	1244.0
Total Relative Abundance Value	197.5
Relative Abundance Diversity Index	4.91

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	9.0	31.6
CATOSTOMIDAE	4.0	4.3
ICTALURIDAE	3.0	8.9
CENTRARCHIDAE	10.0	27.1
PERCIDAE	4.0	5.1
Primary Feeders	4.0	9.9
Macroinvertebrate Feeders	27.0	75.7
Carnivores	7.0	14.4
Sensitive Species	3.0	5.1

OUACHITA MOUNTAINS ECOREGION

The Ouachita Mountains are located in the west-central portion of the state, west of Little Rock and extending into Oklahoma. The region is bordered to the north by the Arkansas River Valley and to the south by the Gulf Coastal Plain.

The Ouachitas are generally composed of severely folded and faulted sandstones, shales and novaculite of Ordovician to Pennsylvanian Periods, exposing some of the oldest rocks in the state. These rocks range in age from 500 million to 300 million years. Local outcrops of igneous rock found in some portions of the Ouachitas (such as the Magnet Cove area) are comprised of an igneous intrusion of the Upper Cretaceous Period. In addition, some interbedded limestone occurs in the strata which make up the lower Ordovician formations. These factors may significantly affect the water chemistry of streams within these areas.

The folding took place because of pressures from the south and, as a result, the mountain ridges run in a generally east-west direction and consist of resistant sandstone and novaculite. Soils are moderately permeable, being thin and stony on ridges and deep in the valleys.

Topography in the Ouachitas varies from rolling hills to very steep, rugged terrain. The east-west tending ridges exhibit strong relief and steep slopes are greater than 50%. Elevations vary from about 400 feet to over 2600 feet above mean sea level.

As a result of the topography, streams usually follow the east-west valleys but occasionally cut across the ridges, producing impressive rapids and waterfalls. The steep slopes and relief promote fast stormwater runoff and streams in the Ouachitas can rise 20 or 30 feet in a few hours. Many of these streams thus have high recreational potential, especially in the form of whitewater boating.

Forests are composed of a mixture of oak, hickory and shortleaf pine. However, large portions of forest are being converted to the production of pine, since the major land use in the Ouachitas is silviculture. Pasture, forage crops and poultry production are the major land uses in the valley floors.

The least-disturbed streams selected for the Ouachita Mountain Region ranged in watershed size from 19 mi^2 to 361 mi^2. Stream gradients ranged from 4.1 to 40 ft/mile. All study streams maintained perennial flows and supported a permanent and diverse biota. A list of these reference streams and size of watershed above the sample site are as follows:

Board Camp Creek	19 mi^2
Little Missouri River	30 mi^2
South Fork Ouachita River	46 mi^2
Cossatot River	120 mi^2
Caddo River	291 mi^2
Saline River	361 mi^2

BOARD CAMP CREEK

Board Camp Creek originates on a steep northern slope of a Ouachita Mountain ridge in the central part of Polk County. It flows generally north to northeast for about 10-12 miles and joins the Ouachita River (Figure OM-1).

The Board Camp Creek sample site was near the town of Board Camp, approximately 150 yards below the Highway 8 bridge in the SW ¼, NE ¼ of Section 32, R 29 W, T 2 S.

General Site Discussion

Watershed Size - The Board Camp Creek drainage area at this site is 19 mi^2.

Geology - The drainage area of the creek contains typical Ouachita Mountains geologic structures. Most of the upper watershed drains the Arkansas Novaculite of Mississippian and Devonian Age. The lower reaches of the creek drain the Stanley Shale formation which is composed primarily of chert and sandstones.

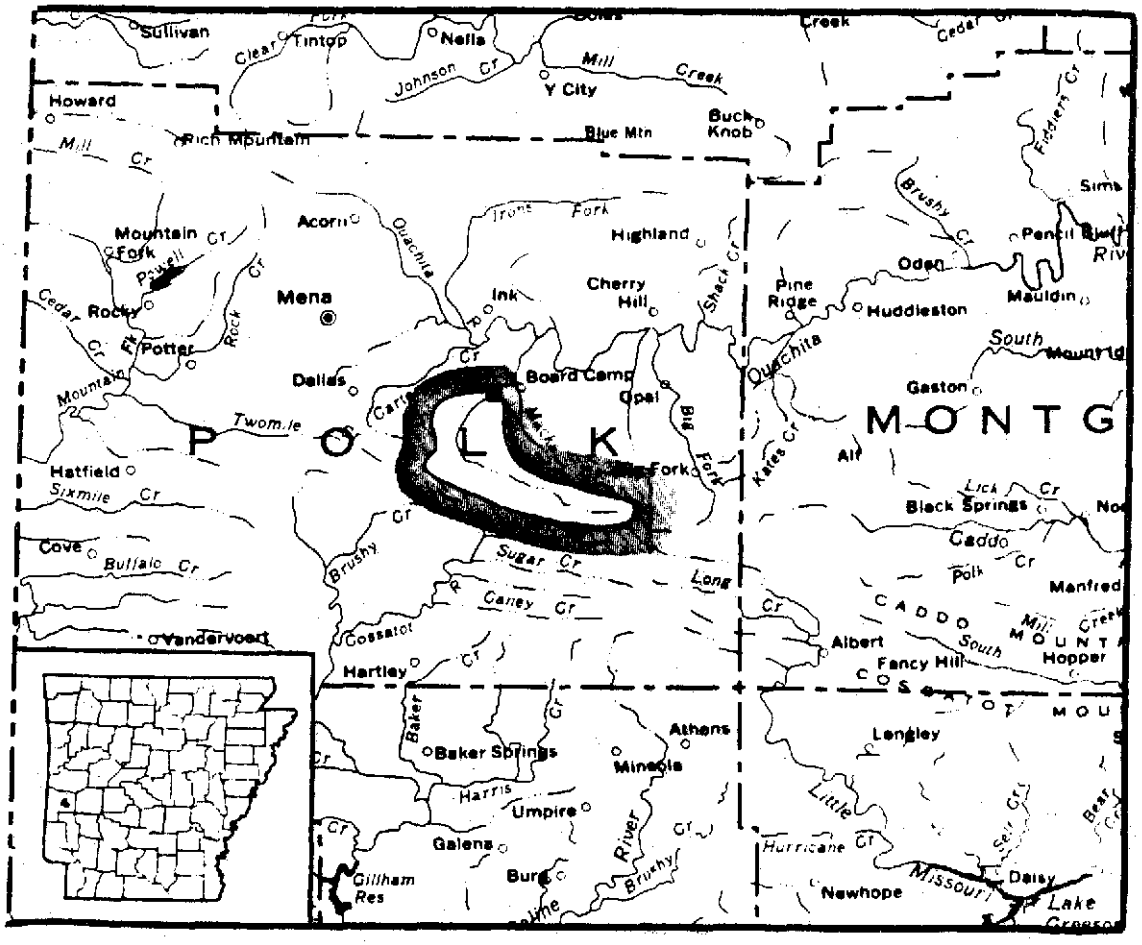
Topography - Topography within the drainage area of this site is very steep in its upper segments; however, it begins to flatten rapidly as it approaches the Ouachita River Valley. Stream gradient at the sample site was measured at 27.8 ft/mile. This value is typical of the Ouachita Mountains Region, although many perennial streams have gradients over 40 ft/mile.

Soil Types - Soils in the drainage area of Board Camp Creek are made up of typical components of the Ouachita Mountain Soils Associations. These are generally well-drained, moderately permeable, steep, very shallow and stony soils on mountains and hills. The soils are likely to be dry part of the year due to little or no rainfall and their high permeability.

Flora - Flora within the drainage area was dominated by loblolly pine-shortleaf pine-mixed hardwood associations. The most abundant streamside hardwoods were river birch, sycamore, sweetgum and maples.

Land Use - Land use in the Board Camp Creek drainage basin is primarily forestry. Forests occupy approximately 90% of the region. Pastureland for hay production and cattle grazing accounts for the remaining land uses. Virtually no row-crops exist in the Ouachita Mountains.

Figure OM-1



1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

BOARD CAMP: Drainage area 19 square miles ● Survey site Survey area

Stream Characteristics - Board Camp Creek is a small stream, less than 30 feet wide during summer flows, with average depths of 0.5 to 1 foot and some deeper pools. A noticeable flow exists during dry seasons. The substrate type is predominantly gravel and rubble and stream canopy is abundant which produces relatively cool water temperatures. Concentrations of minerals and nutrients are low.

Methodology and Sampling Results

The summer sampling at this site occurred during the week of August 6, 1984, and the spring sampling was done April 8-10, 1985.

Continuous Dissolved Oxygen

Summer - Dissolved oxygen was monitored continuously for a 72-hour period with two meters during the summer survey. They were placed at the bottom of a riffle and the middle of a pool approximately 300 and 350 feet below the Highway 8 bridge. Rain occurred on August 9 and the stream rose about 18 inches on August 10. The D.O. ranged from 6.5 mg/l to 8.1 mg/l in both the pool and riffle between August 7 and August 9 (Figures OM-2 and OM-3). Oxygen saturation values were from just less than 80% to 100% and diurnal oxygen fluctuations were generally less than 1.5 mg/l. Steep stream gradient, continuous flows and cool water temperatures were the primary factors involved in these high D.O. values. Organic loading was quite low in Board Camp Creek and did not exert a significant oxygen demand on the stream.

Water temperatures fluctuated between 24°C and 28°C during the summer survey. These temperatures were strongly influenced by the stream canopy, thus allowing D.O. to be at high levels in the cool, shaded waters.

Spring - Spring dissolved oxygen measurements were recorded by two continuously recording meters placed at the middle of a pool and the bottom of a riffle in similar locations to those in the summer survey. The pool meter recorded a minimum D.O. of 8.7 and a maximum of 10.3 mg/l during the 48-hour sample while the riffle meter recorded 9.1 to 10.4 mg/l, respectively. Water temperatures varied diurnally between 10°C and 16°C; however, the diurnal fluctuation in the D.O. was only about 1.5 mg/l (Figures OM-4 and OM-5). Oxygen saturation values remained, for the most part, above 85%.

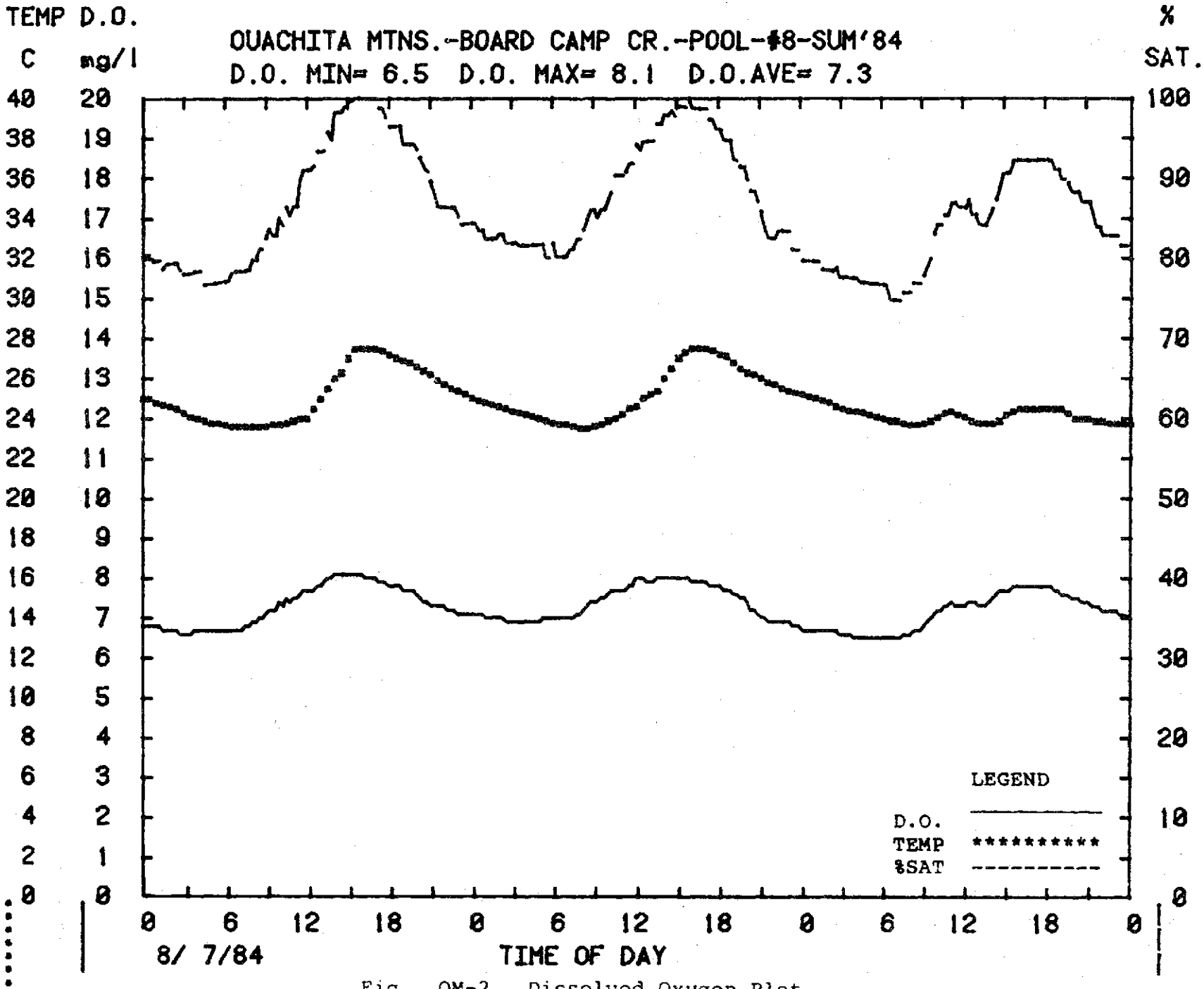


Fig. OM-2. Dissolved Oxygen Plot

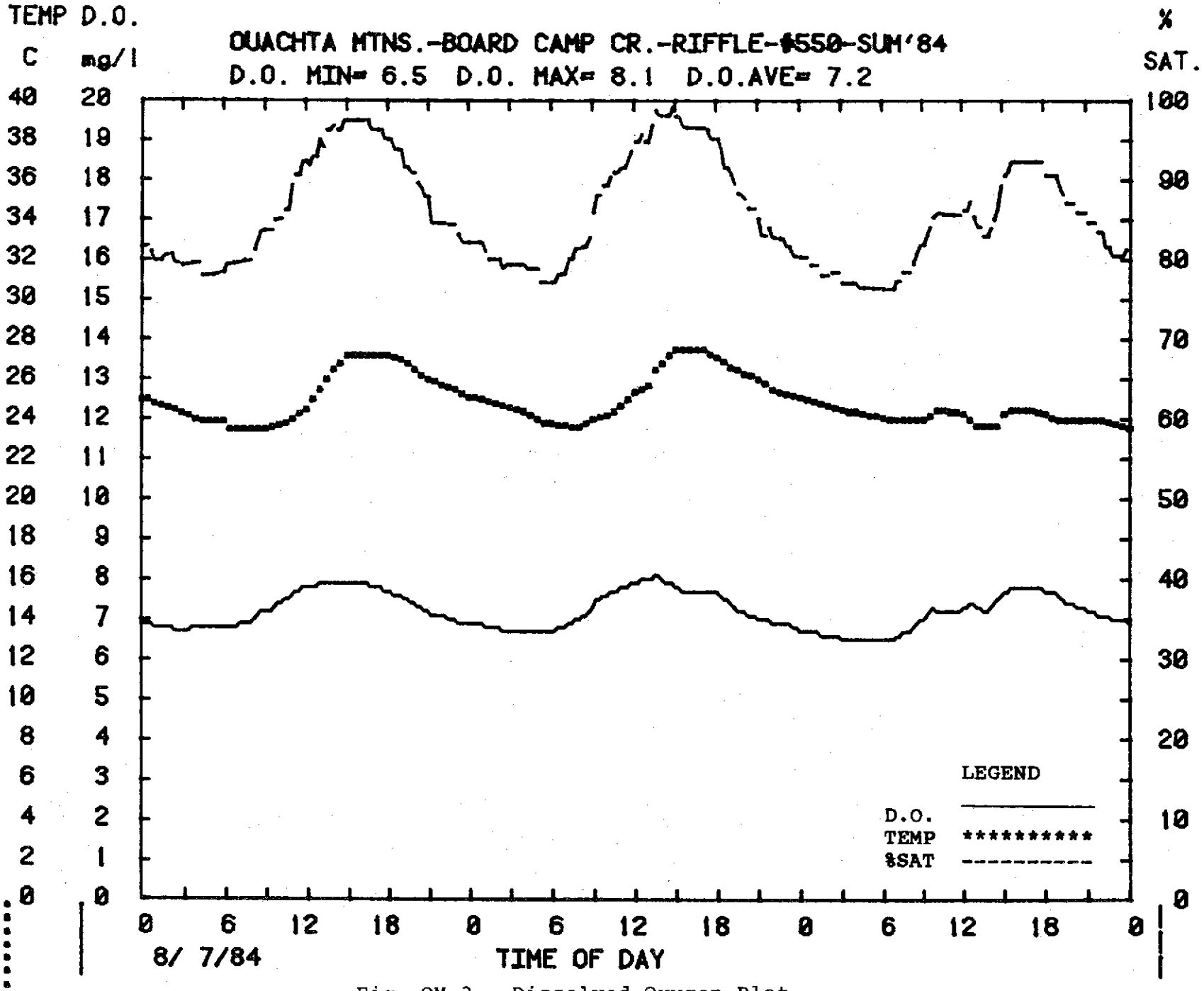


Fig. OM-3. Dissolved Oxygen Plot

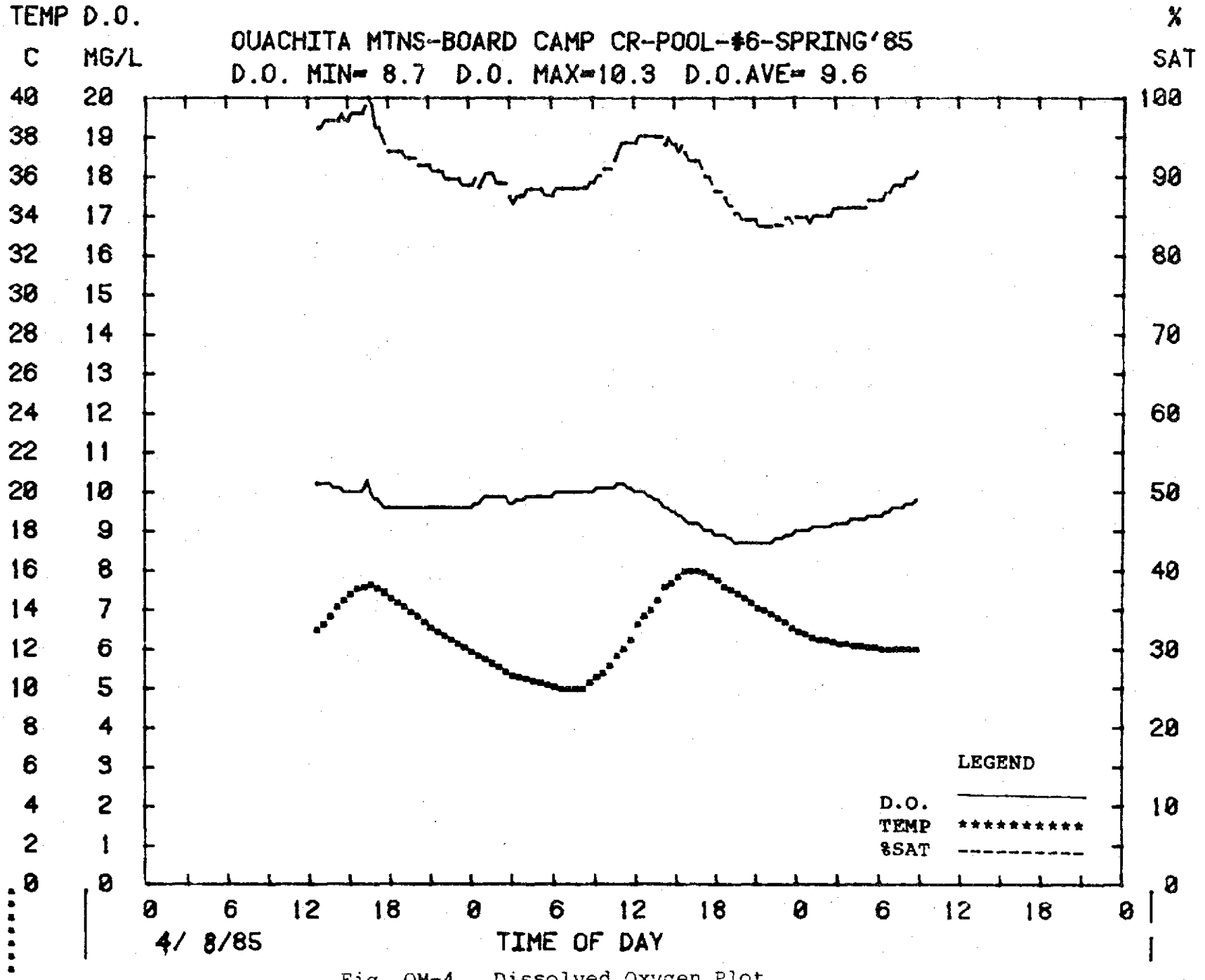


Fig. OM-4. Dissolved Oxygen Plot

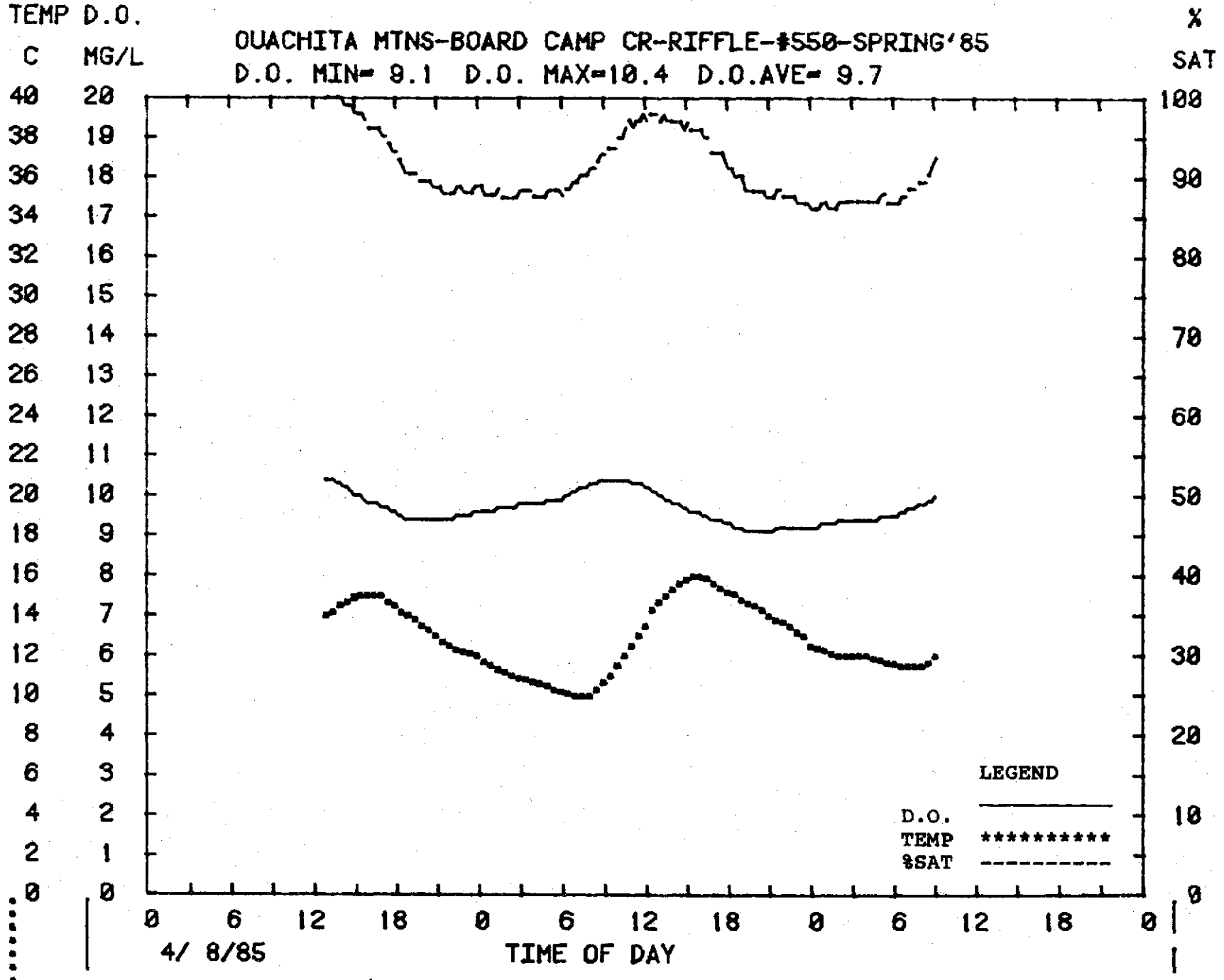


Fig. OM-5. Dissolved Oxygen Plot

Chemical Parameters

Data from water quality sampling for summer and spring periods are given in Tables OM-1 and OM-2, respectively. Results show excellent water quailty with low mineral content, low nutrient values and very little oxygen demand on the water's dissolved oxygen. Little difference between the summer and spring chemical analyses was noted in Board Camp Creek. Although conductivity and total hardness were somewhat higher in the summer sample, this was not reflected in the total dissolved solids or other mineral values analyzed. Biological indicators (BOD, chlorophyll a, fecal coliform) were also low, but an increase in fecal coliform was noted in the summer sample. However, all values were below the standard for primary contact recreation.

Physical Parameters

A summary of the physical features of Board Camp Creek is given in Table OM-3. The substrate was quite diverse. It was dominated by gravel, but with substantial amounts of rubble and bedrock interspersed with boulders. Most of these substrate types provide useful structures and habitat for fish and macroinvertebrates. Other instream cover of logs, brush, debris, overhanging vegetation and inundated vegetation occupied about 18% of the stream channel. This was predominantly overhanging and inundated vegetation.

The riffle pool ratio was 1:1 and the riparian area was densely covered with trees, shrubs, grasses and forbs. This produced stable stream banks in most areas and a stream canopy of 71.5%.

Macroinvertebrate Populations

Seventy-five (75) taxa representing 14 orders were identified from the summer-spring combined samples of the macroinvertebrate community. The dominant orders, Ephemeroptera, Trichoptera and Plecoptera comprised 33.8%, 21.6% and 15.6% of the sample, respectively. The dominant taxa were Eurylophella bicolor (10.4%), Cheumatopsyche (10.7%), Strophoteryx (10.7), Isonychia (7.8%) and Stenonema mediopunctatum (7.6%). Other taxa which were collected consistently and considered as characteristic ecological dominants include Chimarra obscura, Helicospsyche borealis, Stylogomphus albistylus, Calopteryx, Psephenus and Corydalus cornutus (Table A-20, Appendix A). The qualitative similarity indices indicated that the summer and spring samples were similar but also demonstrated significant differences (Table OM-4). Of the 75 taxa identified from the combined samples, 46 and 55 were identified from the summer and spring samples, respectively. Upon comparison,

Table OM-1

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Board Camp Creek

Drainage Area: 19 square miles

Station Description: 150 yards below Hwy. 8 bridge, SW 1/4, NE 1/4, Section 32, T 2 S, R 29 W - Polk County

Date: August 7, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	08:50	10:00	11:10	
Q, cfs	2.7	2.7	2.7	2.7
Temperature, °C	23.5	24.0	24.0	24.0
pH	6.6	6.6	6.7	6.6
Turbidity, ntu	3	4	4	4
TSS, mg/l	<1	2	2	<2
TDS, mg/l	40	39	39	39
BOD-5, mg/l	.8	.6	.6	.7
BOD-20, mg/l	2.1	1.9	1.8	1.9
T.Phos., mg/l	<.01	.01	<.01	<.01
PO4-P, mg/l	.01	.01	.01	.01
NO2+NO3-N, mg/l	.10	.11	.10	.10
NH3-N, mg/l	.01	.01	.01	.01
Cl -, mg/l	5	5	5	5
SO4 =, mg/l	6	7	7	7
Fe, mg/l	na	na	na	na
Conductivity μmho	41	40	40	40
Alkalinity, mg/l	12	12	12	12
T. Hardness, mg/l	48	28	28	35
Chlorophyll a, μg/l	1.1	1.1	na	1.1
Fecal Coliform	-	-	64	64

Dissolved Oxygen Data for August 7, 1984		
	Pool	Riffle
Average	7.3	
Minimum	6.7	
Maximum	7.9	

Table OM-2

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Board Camp Creek

Drainage Area: 19 Square Miles

Station Description: 150 yds below Hwy 8 bridge, SW 1/4, NE 1/4, Section 32, T 2 S, R 29 W - Polk County

Date: April 8, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	11:35	12:15	12:45	
Q, cfs	19.7	19.7	19.7	19.7
Temperature, °C	12	13	13	13
pH	5.9	6.3	6.0	6.1
Turbidity, ntu	3	3	4	3
TSS, mg/l	4	4	4	4
TDS, mg/l	35	28	28	30
BOD-5, mg/l	1.0	1.0	0.7	0.9
BOD-20, mg/l	2.0	1.8	1.7	1.5
T.Phos., mg/l	0.01	0.02	0.02	0.02
PO4-P, mg/l	<0.01	0.02	0.02	<0.02
NO2+NO3-N, mg/l	0.09	0.09	0.09	0.09
NH3-N, mg/l	<0.01	<0.01	<0.01	<0.01
Cl -, mg/l	2	2	2	2
SO4 =, mg/l	5	6	6	6
Fe, mg/l	0.06	0.05	0.04	0.05
Conductivity, μmho	27	27	27	27
Alkalinity, mg/l	7	8	8	8
T. Hardness, mg/l	12	14	12	13
Chlorophyll a, μg/l	0.0	0.0	0.0	0.0
Fecal Coliform	-	-	12	12

Dissolved Oxygen Data for 8 Apr 1985		
	Pool	Riffle
Average	9.8	9.7
Minimum	9.6	9.4
Maximum	10.3	10.4

Table OM-3

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Board Camp Creek
Date:	August 7, 1984
Drainage Area:	19 square miles
Watershed Land Use:	23% agriculture 73% forest 2% other
Stream Gradient:	27.8 ft./mile
Mean Channel Width:	61.3 ft.
Mean Stream Width:	28.5 ft.
Mean Stream Velocity:	.36 fps
Observed Flow:	2.67 cfs
Average Substrate Type:	15.4% bedrock 17.5% rubble 4.6% boulders 62.1% gravel 0.4% sand
Mean Instream Cover:	0.35% undercut bank 0.35% brush, logs, debris 5.6% overhanging vegetation 12.3% inundated vegetation
Riffle/Pool Ratio of Transects:	50% riffles 50% shallow pools
Mean Bank Overstory Cover:	100% trees 34% shrubs
Mean Bank Ground Cover:	40.5% grasses and forbs 12.5% rock 47% dirt
Mean Bank Stability:	40% stable 40% moderate 20% unstable
Mean Stream Canopy:	71.5%
Comments:	

26 taxa were present in both samples while 20 and 29 taxa were unique to the summer and spring sample, respectively. The 26 taxa common to both samples comprised 53% of the benthic organisms collected. The 18 taxa unique to the summer benthic community accounted for 15% of its numerical total, and the 29 taxa unique to the spring sample comprised 58% of that sample.

Summer - The dominant orders of the summer sample were trichopterans (40.4%), ephemeropterans (23.9%) and odonates (8.7%). The dominant taxa of the summer benthic community were Cheumatopsyche (29.5%), Stenonema mediopunctatum (8.7%), Isonychia (5.2%), Hydropsyche similans (5.0%) and Rhagovelia obsea (4.9%). Other taxa collected, not numerically dominant, but considered as ecologically characteristic, include Stylogomphus albystylus, Psephemus herricki and Corydalus cornutus. All of these were also collected in the spring benthic sample.

Spring - The dominant orders of the spring sample were ephemeropterans (37.9%), plecopterans (21.9%) and dipterans (9.4%) (Table OM-4). The dominant taxa of the spring benthic community were Strophoteryx (15.7%), Eurylophella bicolor (15.3%), Isonychia (9.0%), Stenonema mediopunctuatum (7.2%) and Lirceus garmani (6.5%). Other taxa considered as characteristic of the spring benthic community included Amphinemura delosa, Calopteryx, Corydalus cornutus and Psephenus herricki. Of the nine listed above, five were also collected in the summer sample.

The community parameters indicated the benthic population of Board Camp Creek was characteristically diverse and well balanced (Table OM-4). This, as a result of "high quality" water and absence of disturbances within the watershed. The indices of diversity, evenness and dominance exhibited only slight changes seasonally despite the increases in total taxa and a two fold increase in total number of organisms collected during the spring. In addition, the percent composition of functional groups was characteristic of undisturbed, low ordinal streams where collectors are the dominant group followed by predatory insects, with a lesser group of scrapers and shredders.

Table OM-4. Community Analysis of Benthic Samples from Board Camp Creek - 30 Min. Qualitative Sample, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	426	896	1322
Total # Taxa	46	55	75
Diversity	4.2349	4.5512	4.9352
Index of Evenness	0.7667	0.7872	0.7923
Index of Dominance	0.5292	0.4172	0.4476
Index of Variety	5.1519	5.5060	7.1369
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.55	
Common Taxa Index (range 0-1)		0.47	
Qualitative Similarity Index (range 0-100)		32.0	

Fish Populations

Summer - About 100 yards of the stream were sampled with the back-pack electrofishing gear to determine the fish population at this site. Streamflows were very low and water was clear allowing sampling to be very effective. A total of 1,379 individuals were collected, representing 18 species (3 additional species were collected during the spring sampling). The total relative abundance value was 105.5 and the diversity index was 3.83. All species collected during the summer and spring sampling are listed in Table OM-5. Cyprinidae was the dominant fish family but was closely followed by Centrarchidae and Percidae. The only primary feeding fish collected during the summer sample was the stoneroller, but it made up 11.4% of the population relative abundance. Only one species of carnivore, the smallmouth bass, was collected. This species comprised only 3.8% of the population. The remainder of the population was macroinvertebrate feeders. Seven sensitive species made up 45% of the population (Table OM-6).

Table OM-5. Fishes Collected from Board Camp Creek with Relative Abundance Values

SPECIES		R. A. Value
*Etheostoma radiosum	Orangebelly darter	12.0
Campostoma anomalum	Stoneroller	12.0
Lepomis megalotis	Longear	10.5
*Notropis boops	Bigeye shiner	9.5
Noturus nocturnus	Freckled madtom	9.0

Table OM-5, cont.

Lepomis cyanellus	Green sunfish	9.0
*Hypentelium nigricans	Northern hogsucker	7.0
Notropis chrysocephalus	Striped shiner	7.0
*Etheostoma blennioides	Greenside darter	6.5
*Fundulus catenatus	Northern studfish	6.5
*Micropterus dolomieui	Smallmouth bass	4.0
Lepomis macrochirus	Bluegill	4.0
*Pimephales tenellus	Slim minnow	2.0
Ictalurus natalis	Yellow bullhead	2.0
Lepomis hybrid	Hybrid sunfish	1.5
Labidesthes sicculus	Brook silversides	1.0
Fundulus olivaceus	Blackspotted topminnow	1.0
Erimyzon oblongus	Creek chubsucker	1.0
Pimephales notatus	Bluntnose minnow	S
Ictalurus melas	Black bullhead	S
Moxostoma erythrurum	Golden redhorse	S

*Sensitive Species
S - Collected during spring sampling only

Table OM-6. Summary of Fish Population Parameters from Board Camp Creek

Total Species Collected	21.0
Total Number of Individuals	1379.0
Total Relative Abundance Value	105.5
Relative Abundance Diversity Index	3.83

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5.0	28.9
CATOSTOMIDAE	3.0	7.6
ICTALURIDAE	3.0	10.4
CENTRARCHIDAE	5.0	27.5
PERCIDAE	2.0	17.5
Primary Feeders	1.0	11.4
Macroinvertebrate Feeders	19.0	84.8
Carnivores	1.0	3.8
Sensitive Species	7.0	45.0

Spring - Due to the lack of deep pools of sufficient size to use gill netting, the spring sampling was done with the backpack electroshocker. The streamflow was just under 20 cfs, the water was clear and almost all was wadable. Only 12 species were collected, but three species, the bluntnose minnow, golden redhorse and black bullhead, were collected which were not taken in the summer sampling. One adult hogsucker was near spawning and the greenside darter and the orangebelly darter were in breeding colors.

LITTLE MISSOURI RIVER

The Little Missouri River originates on the very steep slopes of the Ouachita Mountains in the southwestern part of Montgomery County. It flows generally southward, crossing many of the east-west ridges of this region. It enters Lake Greeson 10 to 20 miles downstream near the foothills of the Ouachitas.

The Little Missouri River sample site was near the Albert Pike Recreation Area in Montgomery County. The site was 0.5 miles upstream of a low-water bridge on a Forest Service road in the SE ¼ of Section 21, R 27 W, T 4 S (Figure OM-6).

General Site Discussion

Watershed Size - The Little Missouri River drainage area at this site is 30 mi^2.

Geology - The geology of the Ouachita Mountains is sandstone, shale, and novaculite formations from Ordovician through Mississippian Ages. Thrust faults and folds are very common in the Ouachita Mountains and sometimes expose small limestone formations. The area around the Little Missouri River contains typical Ouachita Mountains geologic structures.

The Little Missouri River flows in a southerly direction, cutting through the mountain ridges, while most streams of the region flow parallel to the east-west mountains. This unique flow exposes varying rock formations and creates numerous waterfalls.

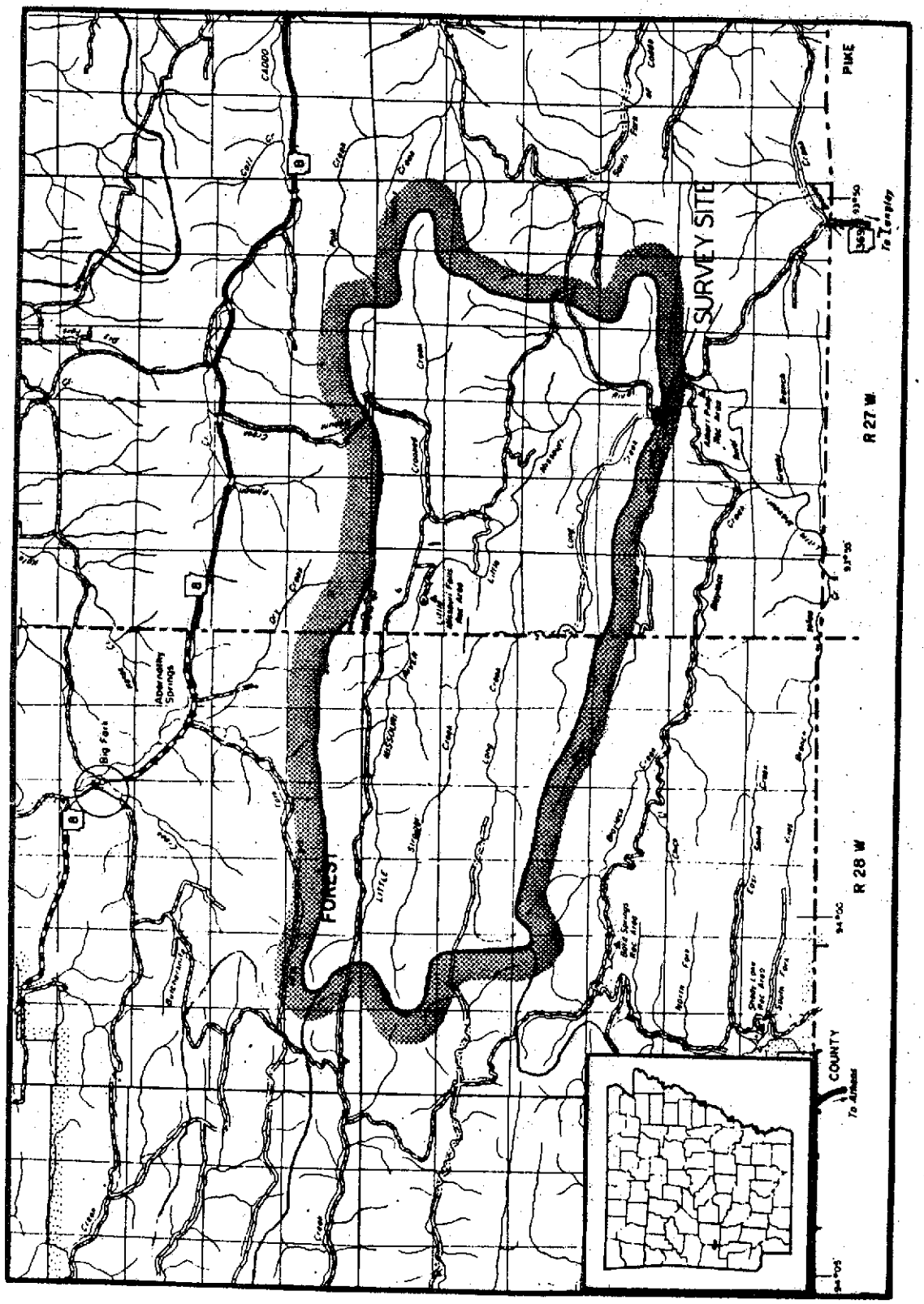
Topography - Topography within the drainage area is very steep. Local relief of the Ouachita Mountains may range up to 1000 feet and slopes of 50% are common.

Stream gradient at the sample site was measured as 29 ft/mile. This value is typical of the Ouachita Mountains Region, though many perennial streams have gradients of over 40 ft/mile.

Soil Types - Soils in the drainage area of the Little Missouri River are Sherwood-Pickens Steep soils. These are typically well-drained, moderately permeable, steep, loamy soils on mountains and hills. The soils are likely to be dry part of the year due to little or no rainfall and their high permeability.

The soil survey for this county has not been completed. The soil pH is believed to range from 4.5 to 5.5 and has only slight erosion potential in the riparian area.

Figure OM-6



LITTLE MISSOURI RIVER: Drainage area 30 square miles

Flora - Flora within the drainage area was dominated by forests consisting of oak, hickory and pine.

Land Use - Land use in the Little Missouri River drainage basin is primarily forestry. Forests occupy approximately 90% of the region. Pastureland for hay production and cattle grazing accounts for the remaining land uses. Virtually no row crops exist in the Ouachita Mountains.

Stream Characteristics - Dominant characteristics of the Little Missouri River included high dissolved oxygen, steep gradient and diverse substrate. These characteristics coupled with coolwater temperatures provided good habitat for a variety of fish and macroinvertebrates. The river has low mineral content, low sedimentation, stable banks, good biological diversity and abundant dissolved oxygen.

Methodology and Sampling Results

The summer sampling occurred during the week of August 15, 1983, and the spring sampling was done during the week of April 16, 1984.

Continuous Dissolved Oxygen

Summer - Dissolved oxygen was monitored using three meters during the summer survey. They were placed at the bottom of a riffle, the middle of a pool and the end of a pool. The data showed a range of D.O. in the summer from 6.6 mg/l to 8.6 mg/l (Figures OM-7 and OM-8). This is a range from 80% saturation to super-saturation. Water temperature reached 26°C during the summery survey. This temperature is probably near the maximum for this stream.

Organic loading was quite low in the Little Missouri and did not exert a significant oxygen demand on the stream. Boulders occupied approximately 24% of the stream channel which increased velocities, thereby increasing aearation potential. The steep gradient, frequent riffle areas, turbulent flow and moderate temperature are all factors involved in maintaining the high dissolved oxygen concentrations recorded at this site.

Spring - Spring dissolved oxygen measurements were recorded by two continuous meters placed at the middle of a pool and the bottom of a riffle. During this survey, the probe on the meter at the middle of the pool failed. This probe was fixed and re-calibrated.

Data from the spring showed a range of D.O. from 8.7 mg/l to 11.0 mg/l (Figures OM-9 and OM-10). This corresponds to 85% and 98% saturation.

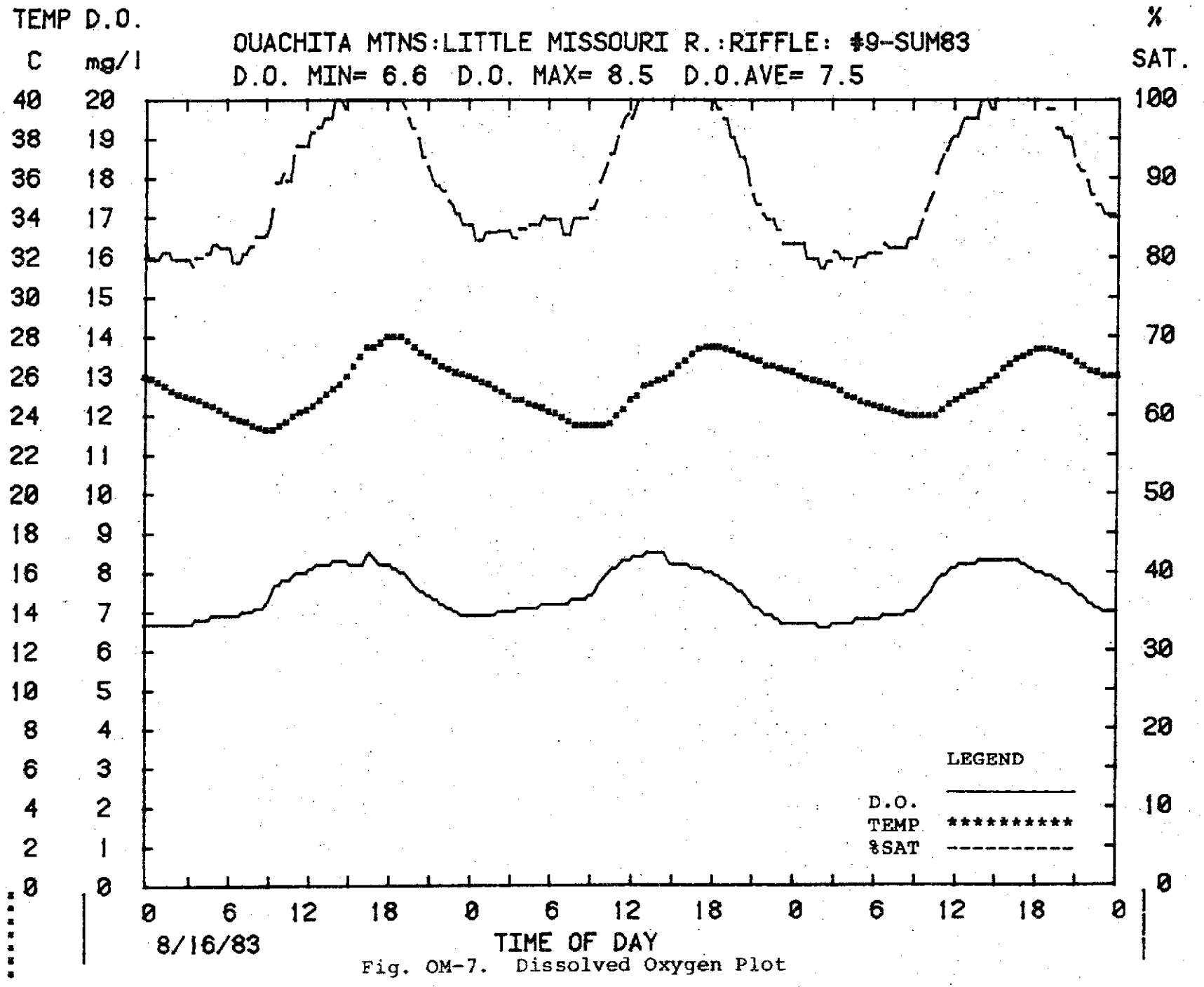


Fig. OM-7. Dissolved Oxygen Plot

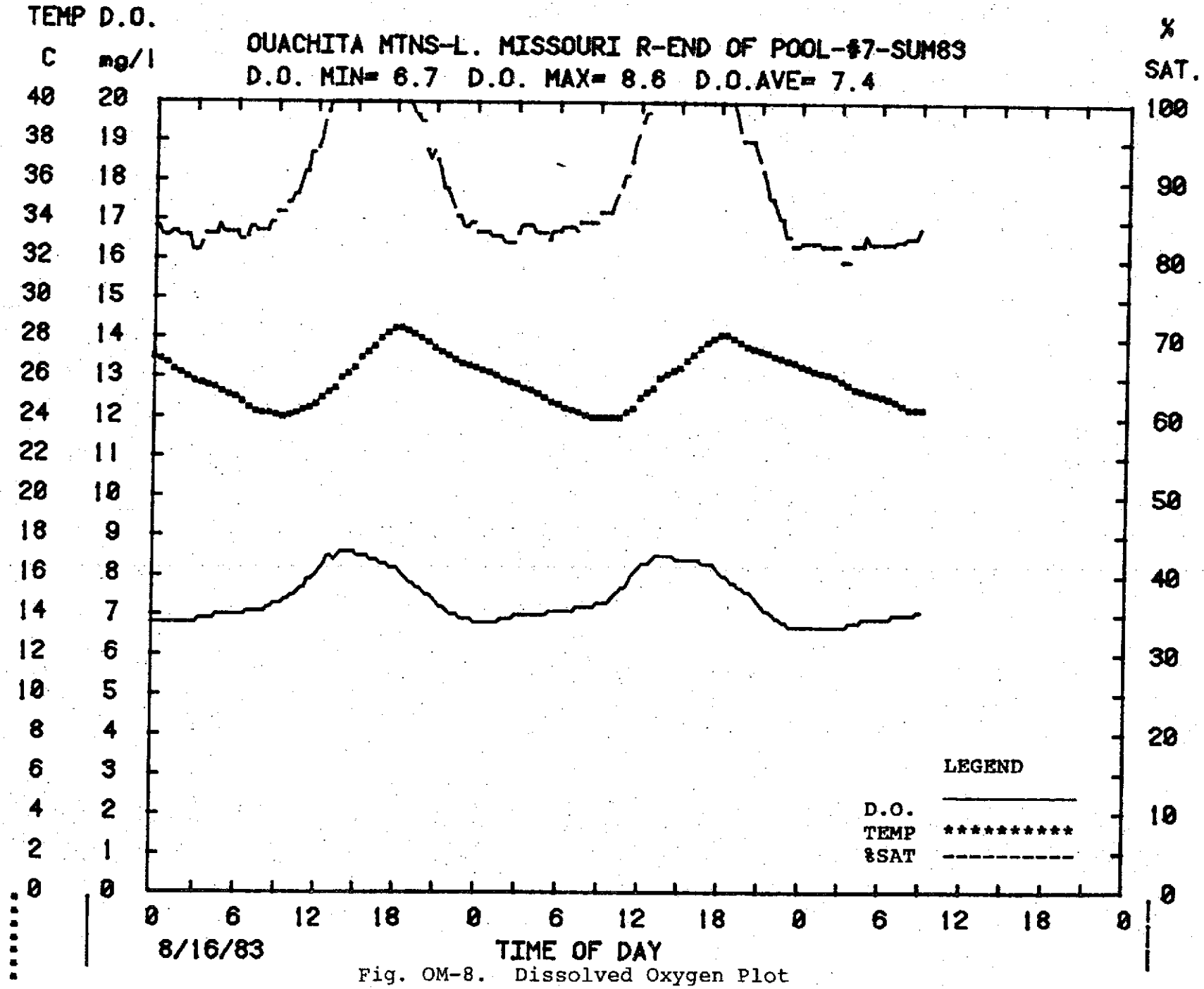


Fig. OM-8. Dissolved Oxygen Plot

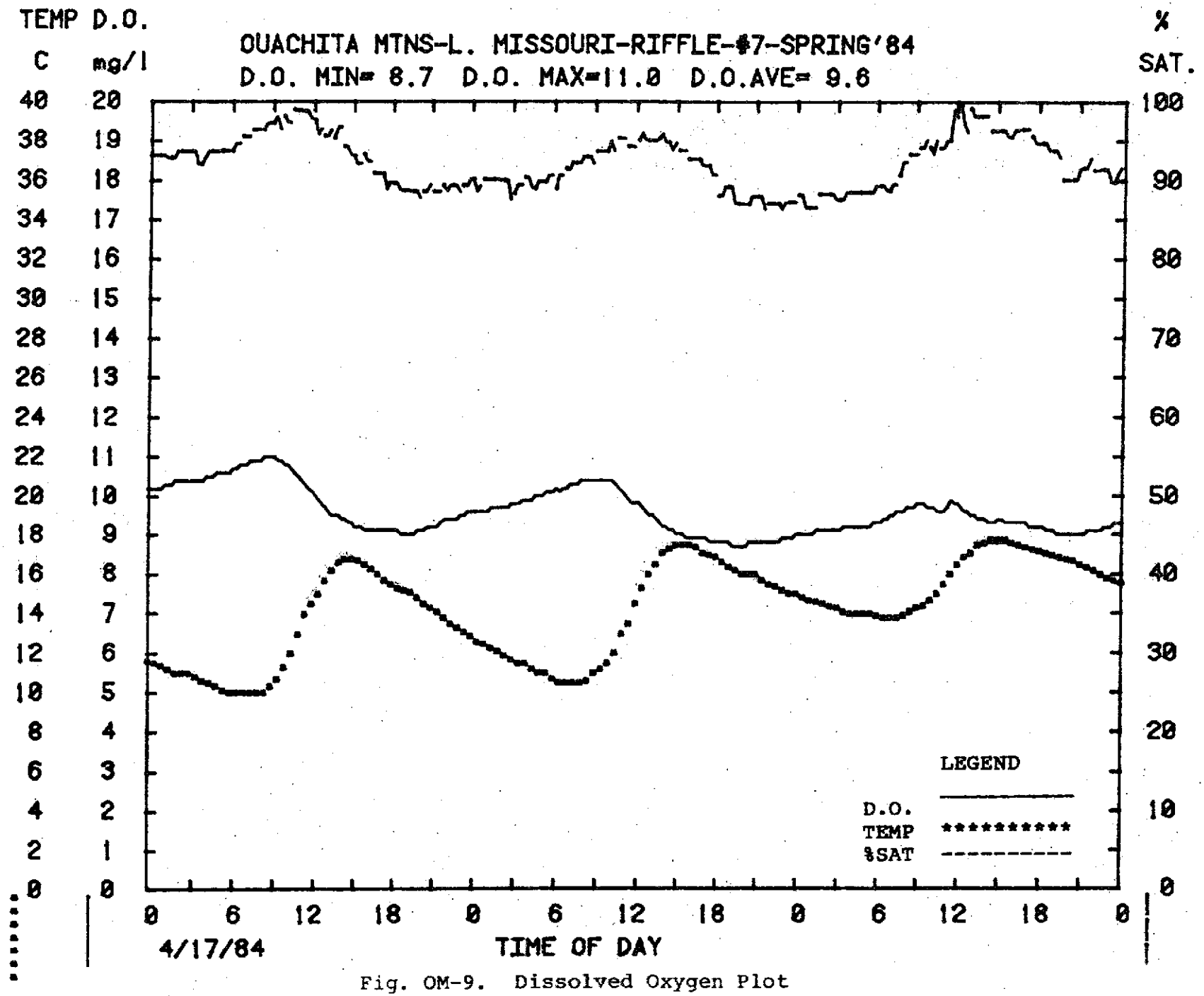


Fig. OM-9. Dissolved Oxygen Plot

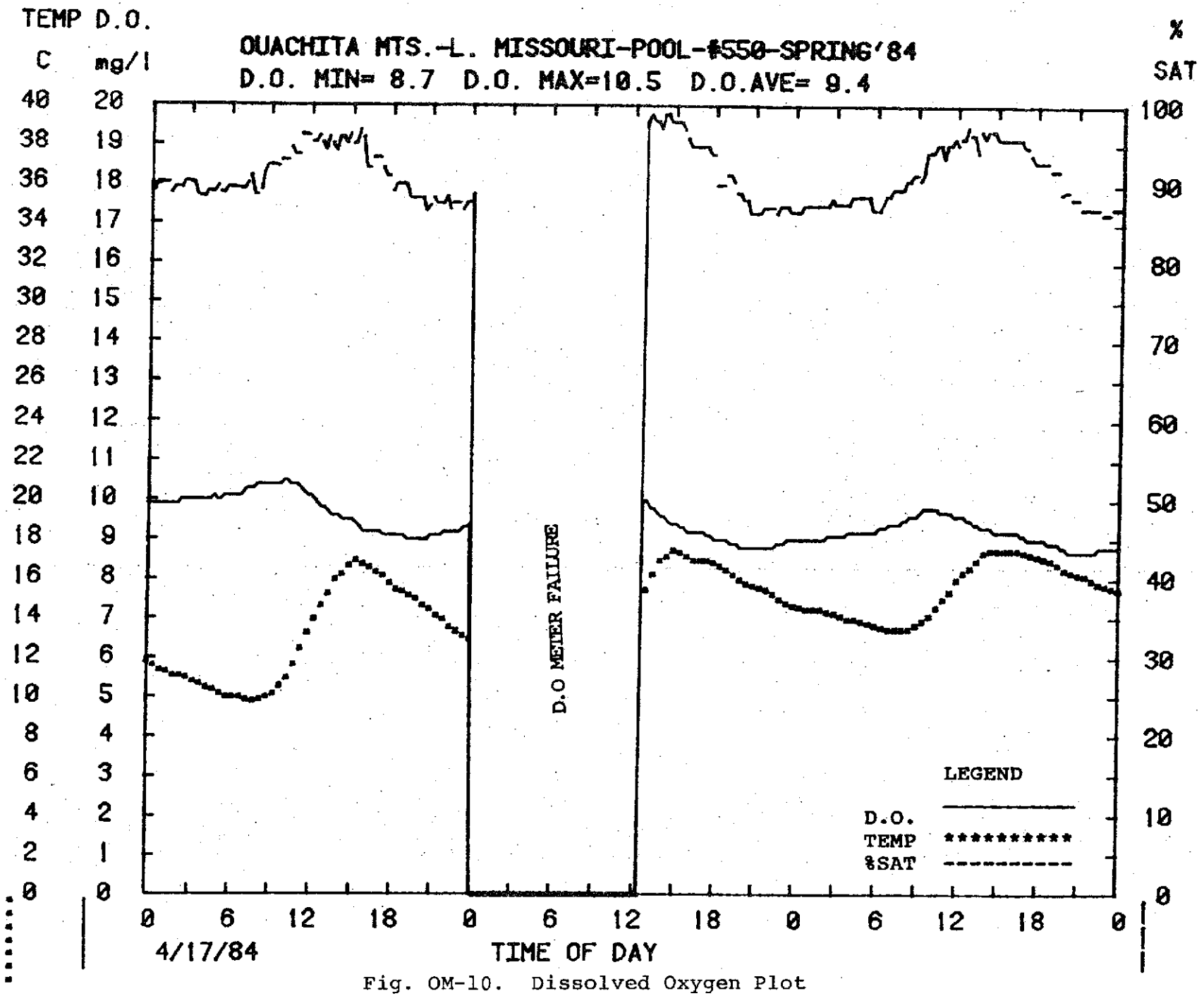


Fig. OM-10. Dissolved Oxygen Plot

Chemical Parameters

Chemical samples collected during the summer survey were taken during a 3.5-hour span (0930-1300 hours). Chemical samples collected during the spring were taken during a 7-hour span (1100-1600 hours). The variation in sampling duration was not significant as the data from each sample group are consistent.

Laboratory and field results (Tables OM-7 and OM-8) showed excellent water quality values for all parameters. Very little difference between the summer and spring chemical analyses were noted in the Little Missouri River. In addition to high D.O. concentrations, the mineral content of the water (chlorides, sulfates, iron, alkalinity and hardness) was very low. Nutrient levels (phosphates, ammonia, nitrites, nitrates) were similarly low. Biological activity indicators (BOD, chlorophyll a, fecal coliform) were low also.

Physical Parameters

Substrate of the Little Missouri River was quite diverse. Bedrock accounted for 2% of the total substrate while large boulders occupied 9%; boulders, 15%; rubble, 50%; gravel, 19%; and sand, 5%. This wide range of substrate size provided a variety of useful structures and habitat for fish and macroinvertebrates.

The pool/riffle ratio was a direct result of stream gradient. Shallow pools formed 50% of the stream and riffles formed 50%. Stream banks were 55% stable and 45% moderately stable.

Flora in the riparian area of the Little Missouri River was composed of 75% tree overstory, 56% shrub overstory, 26% grasses and forbs ground cover and 74% exposed dirt and rock (Table OM-9).

Macroinvertebrate Populations

Fifty-seven (57) taxa representing 11 orders were identified from the study site on the Little Missouri River. Thirty-three (33) and forty-two (42) taxa were identified from summer and spring surveys, respectively (Table A-21, Appendix A). The total number of organisms collected in the spring was three times greater than that collected in the summer. The increase in taxonomic diversity and numerical abundance was due, at least in part, to the increase in sampling effort during the spring survey. The taxonomic diversity also reflects the seasonal progression of macroinvertebrate taxa in natural ecosystems.

Table OM-7

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Little Missouri River

Drainage Area: 30 Square Miles

Station Description: 300 feet above low water bridge on F.S. road in SE 1/4, Section 21, T 4 S, R 27 W - Montgomery County

Date: August 16, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	11:00	13:20	16:00	
Q, cfs	3.9	3.9	3.9	3.9
Temperature, °C	24	26	27.5	26
pH	7.0	7.2	7.7	7.3
Turbidity, ntu	1.4	1.2	2.0	1.5
TSS, mg/l	<1	1	1	<1
TDS, mg/l	41	43	42	42
BOD-5, mg/l	<0.4	0.5	0.5	<0.5
BOD-20, mg/l	1.0	1.2	1.2	1.1
T.Phos., mg/l	0.01	0.02	0.01	0.01
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.02	0.02	0.02	0.02
NH3-N, mg/l	0.01	<0.01	0.01	<0.01
Cl -, mg/l	3	3	2	2.5
SO4 =, mg/l	<1	1	<1	<1
Fe, mg/l	<0.05	<0.05	<0.05	<0.05
Conductivity, μmho	43	43	43	43
Alkalinity, mg/l	13	13	13	13
T. Hardness, mg/l	20	20	16	19
Chlorophyll a, μg/l	0.0	0.3	1.7	0.7
Fecal Coliform	-	-	32	32

Dissolved Oxygen Data for 16 Aug 1983		
	Pool	Riffle
Average	7.5	7.5
Minimum	6.8	6.7
Maximum	8.6	8.5

Table OM-8

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Little Missouri River

Drainage Area: 30 Square Miles

Station Description: Approximately .5 mile above low water bridge on F.S. road in SE 1/4, Section 21, T 4 S, R 27 W - Montgomery County

Date: April 17, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:35	10:30	11:00	
Q, cfs	25.8	25.8	25.8	25.8
Temperature, °C	11	12	15	12.5
pH	6.6	6.5	6.6	6.6
Turbidity, ntu	2.0	2.0	2.0	2.0
TSS, mg/l	<1	1	2	<1
TDS, mg/l	35	34	36	35
BOD-5, mg/l	0.3	0.3	0.3	0.3
BOD-20, mg/l	1.1	0.7	0.9	0.9
T.Phos., mg/l	0.02	0.02	0.03	0.02
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	<0.01	<0.01	<0.01	<0.01
NH3-N, mg/l	<0.01	-	-	<0.01
Cl -, mg/l	5	5	5	5
SO4 =, mg/l	2	1	2	2
Fe, mg/l	<0.025	<0.025	<0.025	<0.025
Conductivity, μmho	26	24	26	25
Alkalinity, mg/l	7	7	7	7
T. Hardness, mg/l	8	8	10	9
Chlorophyll a, μg/l	0.3	0.3	-	0.3
Fecal Coliform	-	-	<4	<4
MN mg/l	<0.025	<0.025	<0.025	<0.025
COD mg/l	<1.0	<1.0	<1.0	<1.0

Dissolved Oxygen Data for 17 Apr 1984		
	Pool	Riffle
Average	9.7	9.9
Minimum	9.0	9.0
Maximum	10.5	11.0

Table OM-9

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Little Missouri River
Date:	August 16, 1983
Drainage Area:	30 sq. miles
Watershed Land Use:	90% forest 9% agriculture 1% grassland
Stream Gradient:	29.4 ft./mile
Mean Channel Width:	47.1 ft.
Mean Stream Width:	31.0 ft.
Mean Stream Velocity:	.44 cfs
Observed Flow:	3.9 cfs
Average Substrate Type:	2% bedrock 9% large boulders 15% boulders 50% rubble 19% gravel 5% sand
Mean Instream Cover:	0% undercut bank 0% brush, logs, debris 4% overhanging vegetation 2% inundated vegetation
Riffle/Pool Ratio of Transects:	50% riffle 0% deep pool 0% moderate pool 50% shallow pool
Mean Bank Overstory Cover:	75% trees 56% shrubs
Mean Bank Ground Cover:	26% grasses and forbs 74% dirt
Mean Bank Stability:	55% stable 45% moderate 0% unstable
Mean Stream Canopy:	24%
Comments:	

The qualitative similarity indices indicated that some duplication of taxa does exist between the summer and spring populations (Table OM-10). Fifty-five percent (55%) of the taxa identified from the summer samples were also collected in the spring.

Summer - The summer and spring benthic communities were dominated by mayflies which comprised 41.6% and 63.8% of the samples, respectively. The dominant taxa of the summer sample were Helichus (a beetle), Stenonema mediopunctatum and Leptophlebia (mayflies) and Tribelos (bloodworm). All of these, except Tribelos, were present in the spring sample.

Spring - The dominant taxa of the spring sample were Ephemerella bicolor, Paraleptophlebia mollis, Stenonema mediopunctatum, Stenonema femoratum (all mayflies) and Agapetus (a caddisfly). The characteristic taxa collected from Little Missouri River could be described as being mesotrophic, saprophobic, euoxyphilous and rheobiotic.

The community parameters calculated were indicative of a diverse and stable macroinvertebrate community. A slight decrease in the diversity indices and index of evenness from summer to spring was observed. These reductions were a result of the large populations of mayflies in the spring sample and not an actual degradation in water quality.

Table OM-10. Community Analysis of Benthic Samples from Little Missouri River - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	89	268	357
Total # Taxa	33	42	57
Diversity	4.4203	3.9979	4.8428
Index of Evenness	0.8423	0.7564	0.8302
Index of Dominance	0.5013	0.5148	0.4687
Index of variety	4.7753	4.9574	6.8791
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.46	
Common Taxa Index (range 0-1)		0.43	
Qualitative Similarity Index (range 0-100)		32.0	

Fish Populations

Summer - Due to the high gradient, low summer flows and the rugged substrate, the 110-volt, A.C. backpack shocker was used to sample this site on August 18, 1983. Approximately 300 yards of the stream segment were sampled in two hours.

Table OM-11 lists the 23 species collected and the corresponding relative abundance value. A total of 359 individuals were collected. The total relative abundance value for this sample was 157.5 with a relative abundance diversity index of 4.24 and an index of evenness of 0.92.

Cyprinidae was the dominant family, comprising 33.7% of the relative abundance value; Centrarchidae totaled 23.5%; Percidae, 19.7%; Catostomidae, 5.7%; and Ictaluridae, 5.1%. The number of species representing each of the above families was 7, 6, 4, 1 and 3, respectively. Primary feeding fishes comprised 15.2% of the relative abundance value of the population; secondary feeders were 72.7% and top carnivores were 12.1% (Table OM-12).

A total of 9 sensitive species were collected at this site which made up 45.1% of the total relative abundance value of the population.

Table OM-11. Fish Species Collected from the Little Missouri River on August 18, 1983, with Relative Abundance Values

Species		R.A. VALUE
Campostoma anomalum	Stoneroller	12.0
*Notropis boops	Bigeye shiner	12.0
Pimephales notatus	Bluntnose minnow	12.0
Lepomis megalotis	Longear sunfish	12.0
*Etheostoma blennioides	Greenside darter	12.0
*Etheostoma radiosum	Orangebelly darter	12.0
*Micropterus dolomieui	Smallmouth bass	9.5
Notropis chrysocephalus	Striped shiner	9.0
*Hypentelium nigricans	Northern hogsucker	9.0
Labidesthes sicculus	Brook silversides	7.5
*Ambloplites ariommus	Shadow bass	7.5
Notropis umbratilis	Redfin shiner	6.0
Ictalurus natalis	Yellow bullhead	6.0
*Fundulus catenatus	Northern studfish	6.0
Fundulus olivaceus	Blackspotted topminnow	6.0
Lepomis cyanellus	Green sunfish	6.0
Percina caprodes	Logperch	6.0
Notropis fumeus	Ribbon shiner	1.0
*Semotilus atromaculatus	Creek chub	1.0
Noturus nocturnus	Freckled madtom	2.0
Lepomis macrochirus	Bluegill	1.0
Micropterus salmoides	Largemouth bass	1.0
*Etheostoma zonale	Banded darter	1.0
*Sensitive species	Total	157.5

Spring - The spring sampling for the Little Missouri River was performed on April 18, 1984. Due to the limited area for netting, only one 1½" mesh trammel net was used to sample this site. Additionally, approximately 300 yards of the stream was electroshocked with the canoe-transported 110-volt A.C., gasoline-powered generator.

Only 2 yellow bullhead, 2 shadow bass and 1 northern hogsucker were collected in the trammel net. Electrofishing yielded 13 species. Two species, rainbow trout and black redhorse, were collected in the spring sample and were not collected during the previous summer. This increased the total species collected to 25 and added two additional sensitive species. Trout are periodically stocked in this stream during the early spring by the Arkansas Game and Fish Commission and rarely survive the summer period. Fishes collected during the spring sample are listed below.

Species		No.
Campostoma anomalum	Stoneroller	3
Notropis boops	Bigeye shiner	5
Pimephales notatus	Bluntnose minnow	1
+Salmo gairdneri	Rainbow trout	1
Hypentelium nigricans	Northern hogsucker	1
+ Moxostoma duquesnei	Black redhorse	2
Ictalurus natalis	Yellow bullhead	2
Noturus exilis	Slender madtom	2
Micropterus dolomieui	Smallmouth bass	4
Ambloplites ariommus	Shadow bass	4
Lepomis megalotis	Longear	21
Etheostoma blennioides	Greenside darter	10
Etheostoma radiosum	Orangebelly darter	10

+Collected during spring sampling only

Additional species recently collected in this area by other workers include: mosquitofish, red-spot chub, steelcolor shiner, slim minnow, channel catfish, flathead catfish, blackstripe topminnow and spotted sunfish (Bacon, personal communication).

Table AR-12. Summary of Fish Population Parameters from Little Missouri River

Total Species Collected	25
Total Number Of Individuals	359
Total Relative Abundance Value	157.5
Relative Abundance Diversity Index	4.24

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	7	33.7
CATOSTOMIDAE	1	5.7
ICTALURIDAE	3	5.1
CENTRARCHIDAE	6	23.5
PERCIDAE	4	19.7
Primary Feeders	2	15.2
Macroinvertebrate Feeders	17	72.7
Carnivores	4	12.1
Sensitive Species	11	45.1

SOUTH FORK OF THE OUACHITA RIVER

This stream begins on the north slope of a typical Ouachita Mountain ridge. It flows generally in an easterly direction, occasionally cutting across ridges to flow northward, and entering Lake Ouachita 10 to 15 miles below the sample site. The watershed area was sufficient to provide adequate flows during critical seasons to support a substantial biotic community.

The site was located 150 feet upstream of a bridge on Highway 379 in Section 29, R 25 W, T 2 S, Montgomery County, Arkansas (Figure OM-11). In this reach of the South Fork, the stream flows easterly, following the direction of the Ouachita Mountain ridges.

General Site Discussion

Watershed Size - South Fork Ouachita drainage area above the sample site is approximately 46 mi^2. This provided a substantial, permanent flow during the dry summer period.

Geology - This sample site is in the outcrop area of the Womble Shale Formation of Ordovician Age. Some limestone outcroppings occur in this drainage which add to the dissolved mineral constituents of the waters.

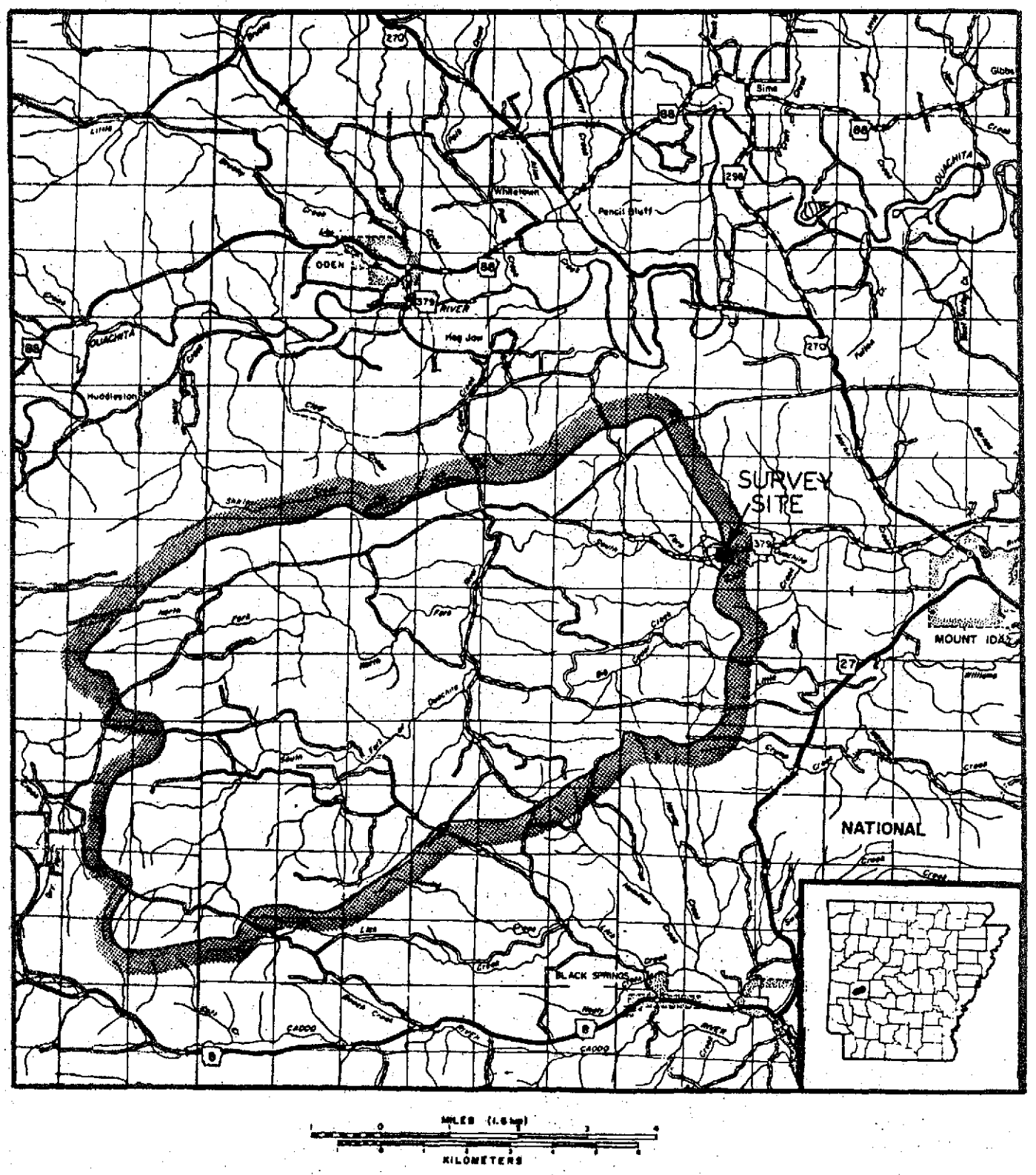
Topography - Topography within the South Fork Ouachita drainage area is quite steep. Local relief ranges up to 1000 feet and slopes of 50% are common. Stream gradient at the sample site is 7.3 ft/mi, lower than most smaller streams in the region.

Soil Types - Soils found in the drainage area of the South Fork were of the Carnasaw-Pickens association which are well drained, slowly to moderately permeable, gently sloping to very steep, loamy and stony soils on uplands. Soils found in the riparian area were the Wickam-Altavista-Congaree association which are well drained, moderately permeable, nearly level to moderately sloping, loamy soils on stream terraces and flood plains.

The alluvial soils in the riparian area were noticeably different from the rest of the drainage area. This was the result of deposition of soils from the drainage area caused by the reduced slope of this section of the stream. The soil pH ranges from 4.5 to 5.5 and has only slight erosion potential in the riparian area.

Flora - Flora in the drainage area was predominantely forests consisting of oak, hickory, and pine.

Figure OM-11



SOUTH FORK OUACHITA RIVER: Drainage area 46 square miles ■ Survey site ▒ Survey area

Land Use - Much of the drainage area of the South Fork is owned by the Federal Government and designated as part of the Ouachita National Forest. Land use in this drainage area is mostly silviculture with a small amount of pastureland in the flood plain of the stream. Although the localized gradients of the South Fork are somewhat less than the Little Missouri River area, row crops are not feasible due to prohibitive slopes.

Stream Characteristics - Dominant characteristics found in the South Fork of the Ouachita River are adequate instream cover, mostly stable banks, high dissolved oxygen content and gravel substrate.

Additional stream characteristics of the South Fork area include moderate mineral content, low sedimentation, and good biological diversity. The South Fork of the Ouachita River was, except for the mineral-related parameters, typical of the least-disturbed streams in the region. Riffles occupy 20% of the stream while shallow pools constitute 30% and deep pools 50%.

Methodology and Sampling Results

The summer sampling was conducted the week of August 15, 1983, and spring sampling was conducted during the week of April 16, 1984.

Continuous Dissolved Oxygen

Summer - Continuous dissolved oxygen was monitored using three meters during the summer survey. They were placed at the bottom of a riffle, the middle of a pool and the end of a pool. The placement of these meters was upstream of the bridge site.

Continuous dissolved oxygen data showed a summer range of D.O. from 5.6 mg/l to 7.2 mg/l corresponding to 65% and 93% saturation, respectively (Figures OM-12 and OM-13). The minimum value observed (5.6 mg/l) could be considered a violation of the state's dissolved oxygen standard for the South Fork of the Ouachita River which is 6 mg/l, but this value is attributed to naturally occurring physical conditions of the stream (slope, overstory cover).

Water temperature reached 28°C during the summer survey. This is very close to maximum summertime temperatures for this stream.

Spring - Spring dissolved oxygen measurements were recorded by two continuous meters placed at the middle of a pool and the bottom of a riffle.

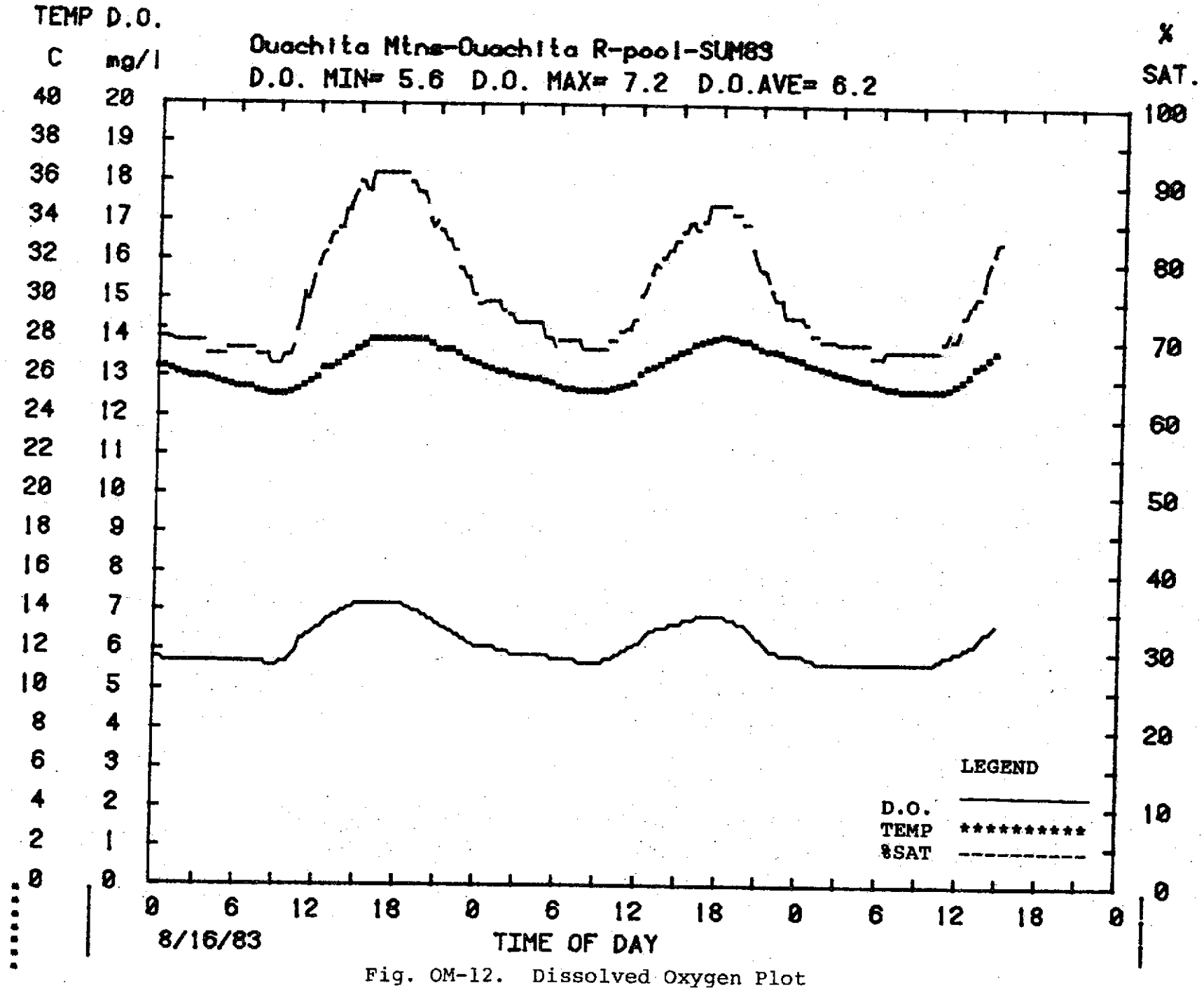


Fig. OM-12. Dissolved Oxygen Plot

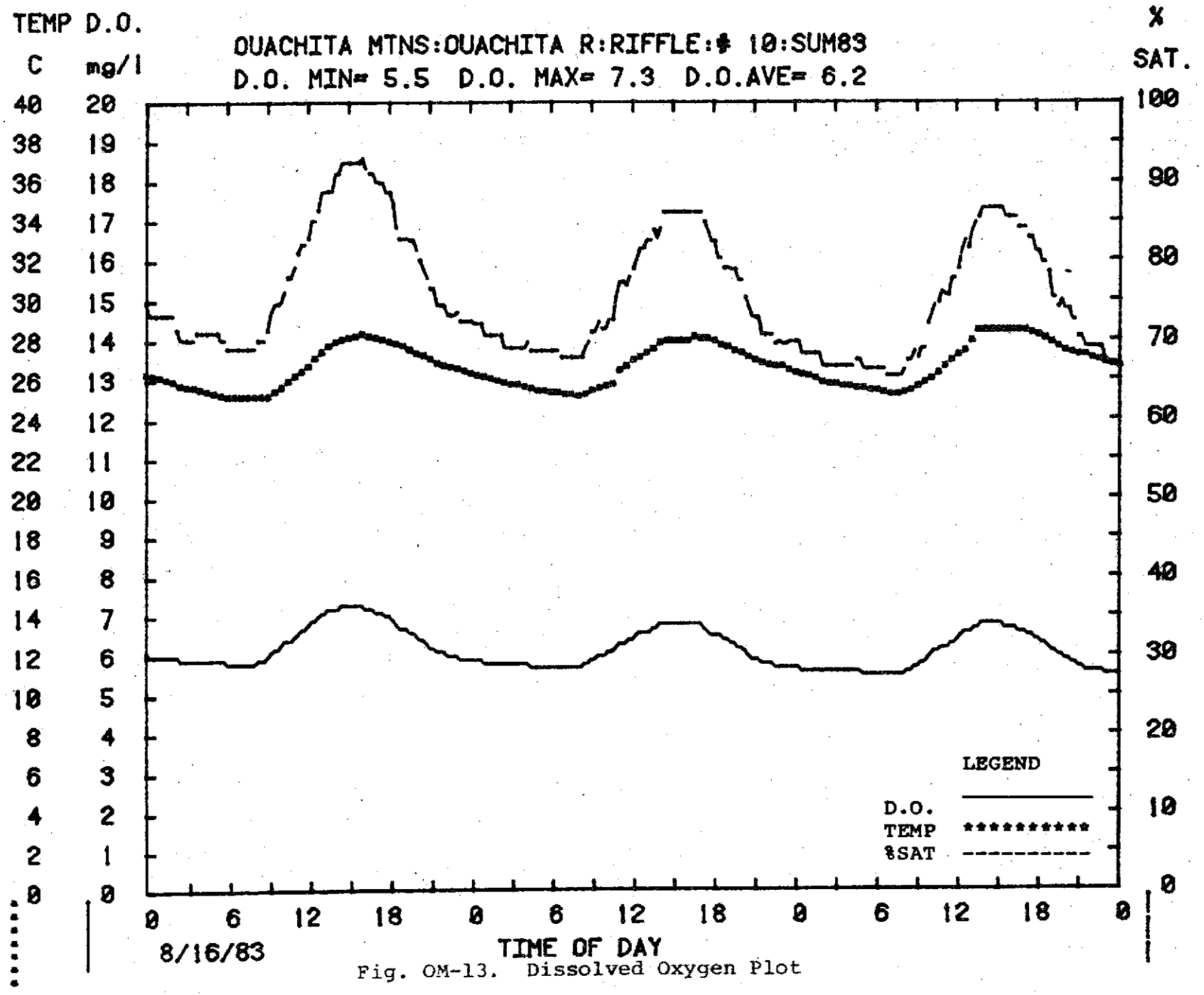


Fig. OM-13. Dissolved Oxygen Plot

Data from the spring indicated a range of 8.3 mg/l to 10.9 mg/l, corresponding to 85% saturation and super-saturation, respectively (Figures OM-14 and OM-15). The spring/summer comparison of D.O. data indicated higher D.O. values during the spring caused by lower temperatures and increased flow. Saturation values were lower during the summer. Comparisons of the dissolved oxygen between pool and riffle during the individual surveys indicated that dissolved oxygen in pools was very similar to that in riffles. The D.O. was controlled by the physical features of the stream such as water temperatures and flow rather than organic loading.

Chemical Parameters

Chemical samples collected during the summer survey were taken in a 4.5-hour span (0910-1344). Chemical samples collected in the spring survey were taken during a 3-hour span. The differences in time spans did not have an impact on the results as the values were very consistent throughout each sample collection.

Laboratory and field results (Tables OM-13 and OM-14) showed little difference for most parameters between the summer and spring surveys. Fecal coliform and pH were the only parameters that varied noticeably between the two samples. Turbidity, TSS, BOD_5, BOD_{20}, total phosphorus, ortho-phosphate, chlorides, sulfates, nitrate+nitrite, total ammonia, total iron and chlorophyll a were very low in both summer and spring.

Unusually high values for this physiographic region were measured for TDS, conductivity, alkalinity and hardness, but the values were consistent for both surveys. These elevated values were probably due to the limestone outcroppings which are found in this watershed. Fecal coliform values were significantly different from the summer to the spring survey. The summer coliform count (620/100 ml) was due to increased animal activity in the nearby pastures which border the South Fork.

Physical Parameters

During the summer survey, physical data and flow were measured and recorded. Dye studies were conducted to determine velocities (Table OM-15). Flows were steady-state during both spring and summer surveys. Physical assessments of the riparian area and channel characteristics were determined as outlined in the General Methodology. Instream cover, pool/riffle determinations, riparian area and substrate types were also noted. The substrate consisted of 91% gravel and 9% mud/silt.

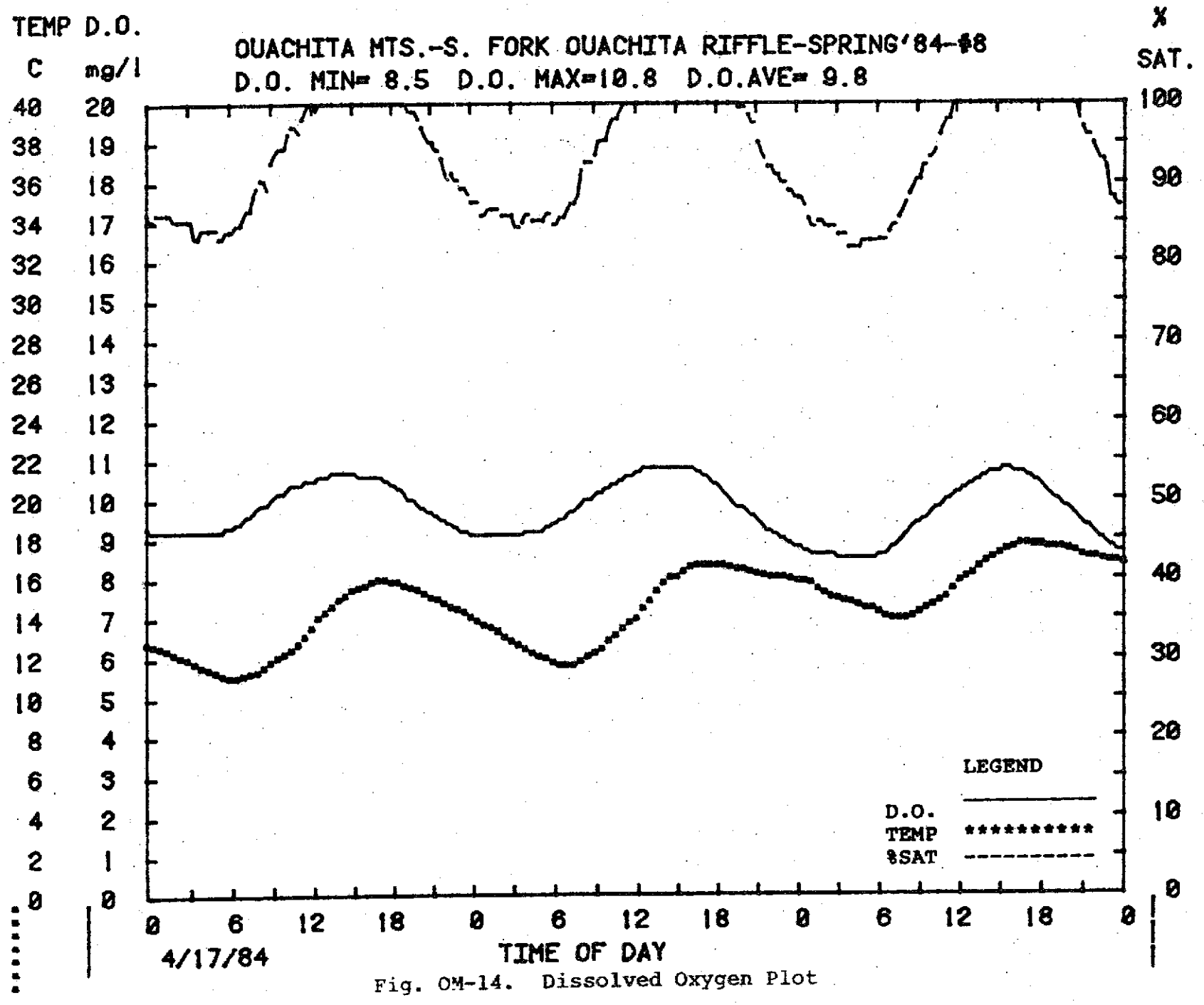


Fig. OM-14. Dissolved Oxygen Plot

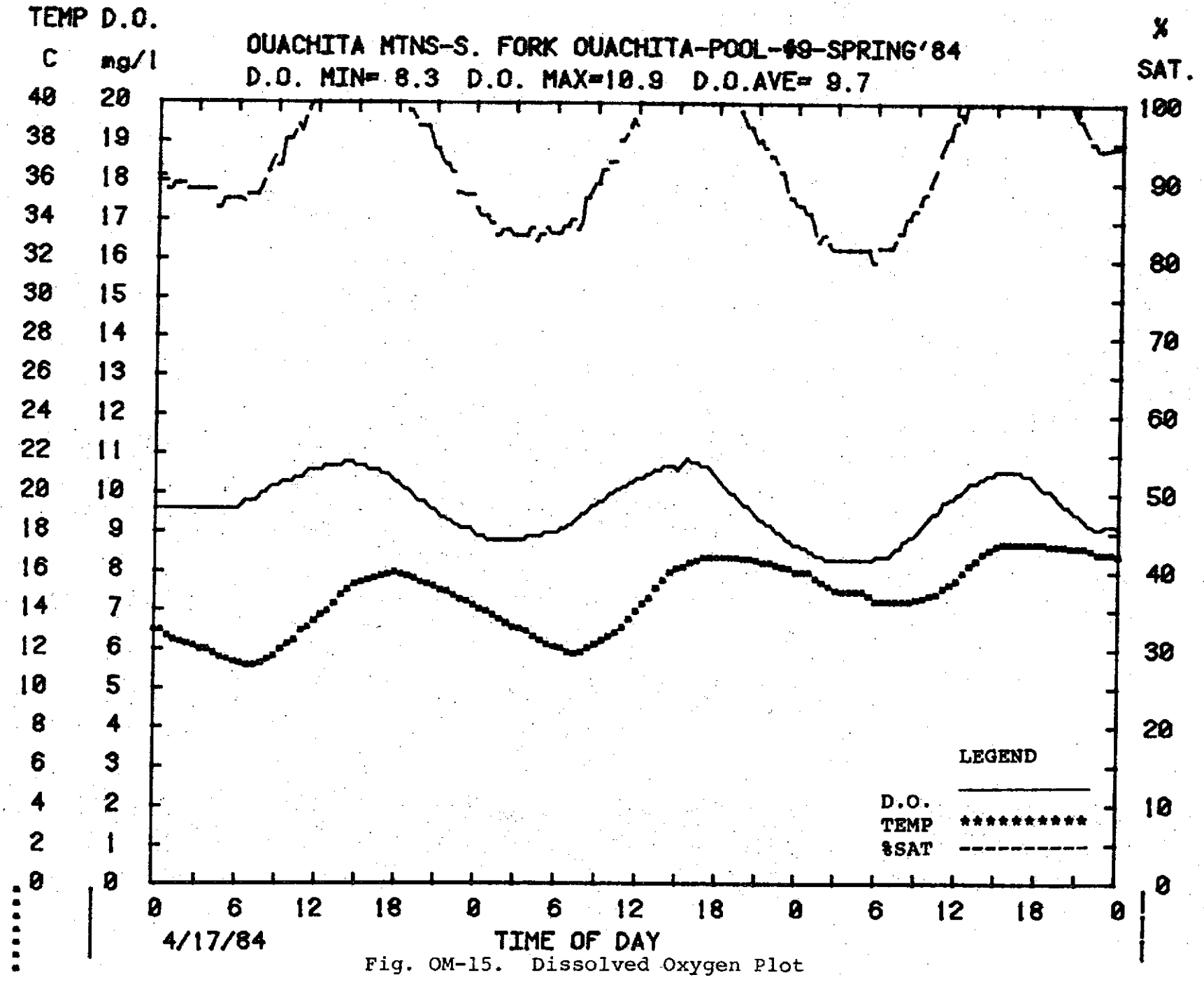


Fig. OM-15. Dissolved Oxygen Plot

Table OM-13

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: South Fork Ouachita River

Drainage Area: 46 Square Miles

Station Description: 150 feet above bridge on Highway 379 in Section 20, T 2 S, R 25 W - Montgomery County

Date: August 16, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	09:10	11:41	13:22	
Q, cfs	6.7	6.7	6.7	6.7
Temperature, °C	25	28	27.5	27
pH	6.5	6.8	6.6	6.6
Turbidity, ntu	2.4	2.0	2.2	2.2
TSS, mg/l	2	2	2	2
TDS, mg/l	103	108	103	105
BOD-5, mg/l	0.9	0.7	0.9	0.8
BOD-20, mg/l	1.8	1.6	1.6	1.7
T.Phos., mg/l	0.02	0.02	0.03	0.02
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.04	0.03	0.03	0.03
NH3-N, mg/l	0.02	0.02	0.02	0.02
Cl -, mg/l	3.5	3.5	3	3
SO4 =, mg/l	2	5	4	4
Fe, mg/l	<0.05	<0.05	<0.05	<0.05
Conductivity, μmho	167	171	164	167
Alkalinity, mg/l	68	69	68	68
T. Hardness, mg/l	88	92	90	90
Chlorophyll a, μg/l	0.0	0.7	1.1	0.6
Fecal Coliform	-	-	620	620

Dissolved Oxygen Data for 16 Aug 1983		
	Pool	Riffle
Average	6.3	6.4
Minimum	5.6	5.8
Maximum	7.2	7.3

Table OM-14

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: South Fork Ouachita River

Drainage Area: 46 Square Miles

Station Description: 150 feet above bridge on Highway 379 in Section 20, T 2 S, R 25 W - Montgomery County

Date: April 17, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	10:00	11:55	
Q, cfs	33.7	33.7	33.7	33.7
Temperature, °C	12.5	12	14	13
pH	7.6	7.5	7.6	7.6
Turbidity, ntu	2.3	1.8	2.2	2.1
TSS, mg/l	2	1	4	2
TDS, mg/l	91	-	92	91
BOD-5, mg/l	0.5	0.4	0.4	0.4
BOD-20, mg/l	1.2	0.8	0.8	0.9
T.Phos., mg/l	0.03	0.03	0.03	0.03
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.06	0.08	0.07	0.07
NH3-N, mg/l	<0.01	0.01	0.01	<0.01
Cl -, mg/l	4.5	5	5	5
SO4 =, mg/l	5	-	7	6
Fe, mg/l	<0.025	<0.025	<0.025	<0.025
Conductivity, μmho	145	150	151	149
Alkalinity, mg/l	60	61	61	61
T. Hardness, mg/l	70	68	68	69
Chlorophyll a, μg/l	0.5	0.3	0.3	0.4
Fecal Coliform	-	-	24	24
MN mg/l	0.025	0.025	0.025	0.025
COD mg/l	1	2	1	1

Dissolved Oxygen Data for 17 Apr 1984		
	Pool	Riffle
Average	10.0	9.9
Minimum	9.1	9.2
Maximum	10.8	10.7

Table OM-15

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	South Fork Ouachita
Date:	August 16, 1983
Drainage Area:	46 square miles
Watershed Land Use:	90% forest 10% grassland
Stream Gradient:	7.3 ft/mi
Mean Channel Width:	47.3 feet
Mean Stream Width:	37.0 feet
Mean Stream Velocity:	.35 fps
Observed Flow:	6.7 cfs
Average Substrate Type:	91% gravel 9% mud/silt
Mean Instream Cover:	3% undercut bank 16% brush, logs, debris 1% overhanging vegetation 0% inundated vegetation
Riffle/Pool Ratio of Transects:	20% riffle 0% deep pool 50% moderate pool 30% shallow pool
Mean Bank Overstory Cover:	85% trees 37% shrubs
Mean Bank Ground Cover:	72% grasses and forbs 28% dirt
Mean Bank Stability:	85% stable 0% moderate 15% unstable
Mean Stream Canopy:	47.5%
Comments:	

Riparian cover at the site was 85% tree overstory and 37% shrub overstory. Grasses and forbs covered 72% of the ground surface leaving 28% rock and/or dirt. The banks of the South Fork were 85% stable and 15% unstable. Mean stream canopy was measured at 45.7%. Riffles occupied 20% of the stream, shallow pools 30% and deep pools 50%.

Instream cover included 3% undercut banks, 16% brush-logs-debris and 1% overhanging vegetation. These values reflect the abundant fishery habitat in the South Fork of the Ouachita.

Macroinvertebrate Populations

Fifty-seven (57) taxa representing 13 orders were identified from samples collected during both stream surveys (Table A-22, Appendix A). Thirty (30) and 46 taxa were identified from the summer and spring surveys, respectively. The total number of organisms collected in the spring survey was almost twice that collected in the summer. The increase in taxonomic diversity and numerical abundance was due, at least in part, to the increased sampling effort during the spring survey. The taxonomic diversity reflects natural seasonal variation within macroinvertebrate populations. The qualitative similarity indices indicated there was some uniformity between summer and spring samples (Table OM-16). Fifty-four percent (54%) of the taxa identified from the summer survey were also collected in the spring. The ephemeropterans dominated both samples numerically. They comprised 46.1% of the summer and 36.3% of the spring collections.

The dominant orders of the summer community were Ephemeroptera (46%), Odonata (17%) and Coleoptera (15%). The dominant taxa of the summer sample were Tricorythodes atratus, Stenonema mediopunctatum and Caenis (all mayflies), Boyeria vinosa (dragonfly) and Viviparus (snail). Only the mayfly, Tricorythodes atratus, was not present in the spring sample.

The dominant orders of the spring community were Ephemeroptera (35%), Gastropdoda (15%), Odonata (10%) and Plecoptera (9.5%). The dominant taxa of the spring sample were Viviparus, Stenonema femoratum, Caenis, Perlesta placida (stonefly) and Ablabesmyia (bloodworm). Viviparus and Caenis were dominant in summer sample, also. The benthic macroinvertebrates collected are characteristic of a highly oxygenated, swift-water, aquatic environment with a large degree of habitat variability.

The community parameters varied only slightly between the summer and spring samples with the exception of total number of organisms and taxa collected (Table OM-16). The

diversity index of the spring sample was slightly higher than the summer diversity. This increase was due primarily to the presence of winter-early spring insect forms which have emerged by late summer. This is also evidenced by the increase in the index of variety. All community parameters were indicative of a very balanced, diverse macroinvertebrate community characteristic of high quality water and an undisturbed watershed.

Table OM-16. Community Analysis of Benthic Samples from South Fork Ouachita River - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	141	262	399
Total # Taxa	30	46	57
Diversity	4.0431	4.6753	5.1005
Index of Evenness	0.8240	0.8513	0.8533
Index of Dominance	0.4402	0.3013	0.3393
Index of Variety	4.0619	5.4586	7.1491
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.46	
Common Taxa Index (range 0-1)		0.27	
Qualitative Similarity Index (range 0-100)		22.0	

Fish Populations

Summer - Electrofishing gear, composed of a 230-volt, 3500-watt gasoline-powered generator floated in a flat-bottomed boat, was used for summer collection of fishes on August 17, 1983. Electrodes were carried by workers wading in the shallow water. Stunned fish were picked up by the workers and by blocking the lower end of riffles with a seine to catch stunned fish as they were washed downstream. One-fourth mile of stream was sampled during a three-hour period.

Thirty-one (31) species of fish were collected at this site. A list of all species collected and their relative abundance value is given in Table OM-17. The total relative abundance value was 250.5 with a relative abundance diversity index of 4.84 and an index of evenness of 0.98. Eight species of Centrachidae made up 27.3% of the relative abundance value of the total population; seven species of Cyprinidae, 27.1%; five species of Percidae, 16.6%; four species of Catostomidae, 13%; and three species of Ictaluridae comprised 6.2% of the total. Primary feeding fishes comprised 9.8% of the relative abundance value; secondary feeders, 73.6% and top carnivores, 16.6% (Table OM-18). Twelve (12) sensitive species were collected and they made

up 41.7% of the relative abundance value of the total population. One specimen of the uncommon, endemic Caddo madtom was collected at this site.

Table OM-16. Fish Species Collected in South Fork Ouachita on August 17, 1983, with Relative Abundance Values

Species		R.A. Value
Campostoma anomalum	Stoneroller	12.0
*Notropis boops	Bigeye shiner	12.0
Notropis chrysocephalus	Striped shiner	12.0
Lepomis megalotis	Longear	12.0
*Etheostoma radiosum	Orangebelly darter	12.0
Pimephales notatus	Bluntnose minnow	10.5
*Micropterus dolomieui	Smallmouth bass	10.5
Micropterus punctulatus	Spotted bass	10.5
*Etheostoma blennioides	Greenside darter	10.5
Percina caprodes	Logperch	10.5
*Nocomis asper	Redspot chub	9.0
*Hypentelium nigricans	Northern hogsucker	9.0
Moxostoma erythrurum	Golden redhorse	9.0
Noturus nocturnus	Freckled madtom	9.0
*Fundulus catenatus	Northern studfish	9.0
Lepomis cyanellus	Green sunfish	9.0
*Moxostoma duquesnei	Black redhorse	8.5
*Ambloplites ariommus	Shadow bass	8.0
*Notropis whipplei	Steelcolor shiner	7.5
Fundulus olivaceus	Blackspotted topminnow	7.5
*Etheostoma zonale	Banded darter	7.5
Micropterus salmoides	Largemouth bass	6.5
Esox americanus	Grass pickerel	6.0
Minytrema melanops	Spotted sucker	6.0
Lepomis microchirus	Bluegill	6.0
Lepomis microlophus	Redear	6.0
Ictalurus natalis	Yellow bullhead	5.5
Notropis atherinoides	Emerald shiner	5.0
Ichthyomyzon sp.	Lamprey larvae	2.0
*Noturus taylori	Caddo madtom	1.0
Etheostoma chlorosomum	Bluntnose darter	1.0
	Total	250.5

*Sensitive species

Spring - Both electrofishing and monofilament trammel nets were used to collect fishes during the spring survey on April 16, 1984. One 1½ " mesh net was set upstream of the access point and one 2" bar mesh net was placed downstream of the bridge. Fish were removed from the nets each of the two following days.

The fishes collected by netting included: 6 spotted suckers, 67 golden redhorse, 13 black redhorse, 2 shadow bass and 2 southern brook lamprey attached to redhorse.

Numerous individuals of all sucker species collected were discharging eggs and milt.

The gasoline-powered generator with 110-volt A.C. output was used for a short distance upstream of the bridge on April 19. Of the 23 species collected in the spring, five species were not found during the previous summer. The summer collection included 13 species not found during the spring. This produced a total species list of 31, with 13 sensitive species. These species differences were due to sampling difficulties during the high flows of the springtime. A list of species and the number of individuals collected is given below:

Species	No.	Species	No.
+Ichthyomyzon gagei	5	Fundulus olivaceous	2
Campostoma anomalum	2	Ictalurus natalis	3
Pimephales notatus	6	Noturus nocturnus	8
Nocomis asper	2	+Aphredoderus sayanus	1
Notropis boops	13	Micropterus salmoides	1
Notropis chrysocephalus	3	Ambloplites ariommus	2
+Notropis umbratilis	1	+Lepomis gulosus	1
Moxostoma erythrurum	3	Lepomis megalotis	13
Moxostoma duquesnei	3	Lepomis cyanellus	5
Hypentelium nigricans	4	Percina caprodes	1
+Erimyzon oblongus	1	Etheostoma radiosum	4
Fundulus catenatus	2		

+Species not collected in summer, 1983

Table OM-18. Summary of Fish Population Parameters from South Fork of the Ouachita River

Total Species Collected	36
Total Number Of Individuals	755
Total Relative Abundance Value	250.5
Relative Abundance Diversity Index	4.84

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	7	27.1
CATOSTOMIDAE	4	13.0
ICTALURIDAE	3	6.2
CENTRARCHIDAE	8	27.3
PERCIDAE	5	16.6
Primary Feeders	3	9.8
Macroinvertebrate Feeders	28	73.6
Carnivores	5	16.6
Sensitive Species	12	41.7

COSSATOT RIVER

The Cossatot River begins on the south slope of some of the most rugged Ouachita Mountain ridges. It flows in a southerly direction, frequently cutting across east-west oriented ridges and producing magnificent waterfalls and whitewater areas. The sample site was located just above the confluence of Pryor Creek, in the SW ¼, NW ¼ of Section 18, R 30 W, T 5 S in Howard County (Figure OM-16). From this reach, the Cossatot flows southerly for 10-15 miles before entering Gillham Reservoir.

General Site Discussion

Watershed Size - The Cossatot River drainage area above the sample site was approximately 120 mi^2. This provided a substantial, permanent flow during the dry summer period.

Geology - The geology of the watershed of this site is typical of the Ouachita Mountains. It is composed primarily of Stanley Shale with some intrusions of Arkansas Novaculite of Mississippian age.

Topography - Topography within the Cossatot River drainage area is quite steep with sharp drops in elevation forming rugged ridges. The stream gradient at the sample site is 40 ft/mi, which is the highest of all the sites sampled throughout the state.

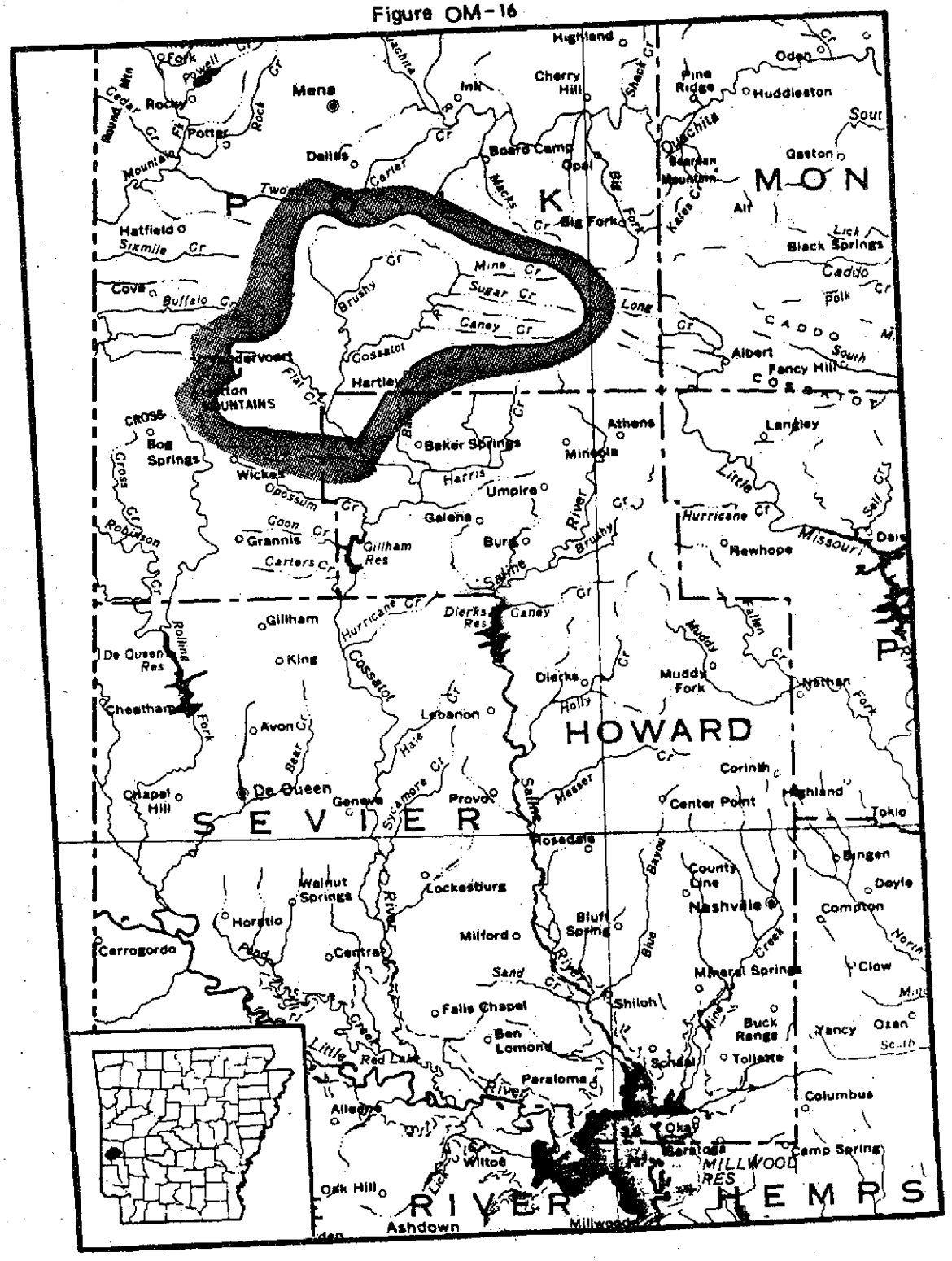
Soil Types - Soils found in the drainage area of the Cossatot River site were dominated by the Pickens-Sherwood-Rock association. These are well-drained to excessively drained soils of low basic fertility. Also included in this association are small areas of Pirum soils which make up small strips of well-drained loamy soils along valley drainageways and narrow, gently sloping ridgetops.

Flora - Flora in the drainage area was predominantly shortleaf pine, loblolly pine and mixed pine and hardwoods. Much of the surrounding area is being converted to mono-culture pine forest.

Land Use - Most of the drainage area of the Cossatot is in the Ouachita National Forest or is owned by large timber companies. Land use in this drainage area is predominantly silviculture. Row crops are not feasible due to prohibitive slopes.

Stream Characteristics - Identifying characteristics found in the Cossatot River are a variety of substrate types dominated by broken bedrock and large boulders. Instream cover such as logs, brushtops and aquatic vegetation is scarce due to high flow velocities which remove this

Figure OM-16



Scale 1:500,000

1 inch equals approximately 8 miles

40 Miles

50 Kilometers

■ Survey site ▒ Survey area

COSSATOT RIVER: Drainage area 120 square miles

material from the main stream channel. Additional stream characteristics include low mineral content, low sedimentation, high velocity of flow and high riffle to pool ratio. The Cossatot River was a very typical least-disturbed stream for this region.

Methodology and Sampling Results

The summer sampling was conducted the week of August 6-10, 1984, and spring sampling was conducted April 8-10, 1985. Fish population sampling was attempted on August 9, 1984, but due to the extremely low conductivity of the water, results were not satisfactory. Additional sampling gear was purchased and a successful sampling was achieved on September 16, 1985.

Continuous Dissolved Oxygen

Summer - Continuous dissolved oxygen was monitored using two meters. One was placed at the bottom of a riffle and the other in a pool. The riffle meter malfunctioned for a period of about 16 hours in the middle of the 72-hour sample period. The pool meter performed properly during the entire period.

Dissolved oxygen ranged from 6.6 mg/l to 8.4 mg/l in the pool and 6.8 mg/l to 8.3 mg/l in the riffle. The oxygen saturation values were from 82% to slightly supersaturated (Figures OM-17 and OM-18). The diurnal fluctuation averaged about 1.5 mg/l. Steep stream gradients produced high flow velocities which resulted in high to supersaturated dissolved oxygen values even with relatively high summer water temperatures. Water temperatures ranged from 26°C to 31°C during the summer survey due to the absence of stream canopy at this site.

Spring - Spring dissolved oxygen was recorded by two continuous meters placed near the same locations as in the summer survey. The D.O. ranged from 9.5 mg/l to 12.6 mg/l with saturation values above 90% (Figures OM-19 and OM-20). Springtime temperatures were from 12°C to 16°C during the sample period. Lower water temperatures and flows of over 5.5 times the summer value resulted in the higher D.O. values and slightly greater oxygen saturation values during the spring survey.

Chemical Parameters

Chemical water quality collected during the summer and spring surveys are listed in Tables OM-19 and OM-20. These data indicate that the water quality at this site was low in mineral quantity, low in nutrients and of exceptionally high quality. Total dissolved solids were slightly higher in the

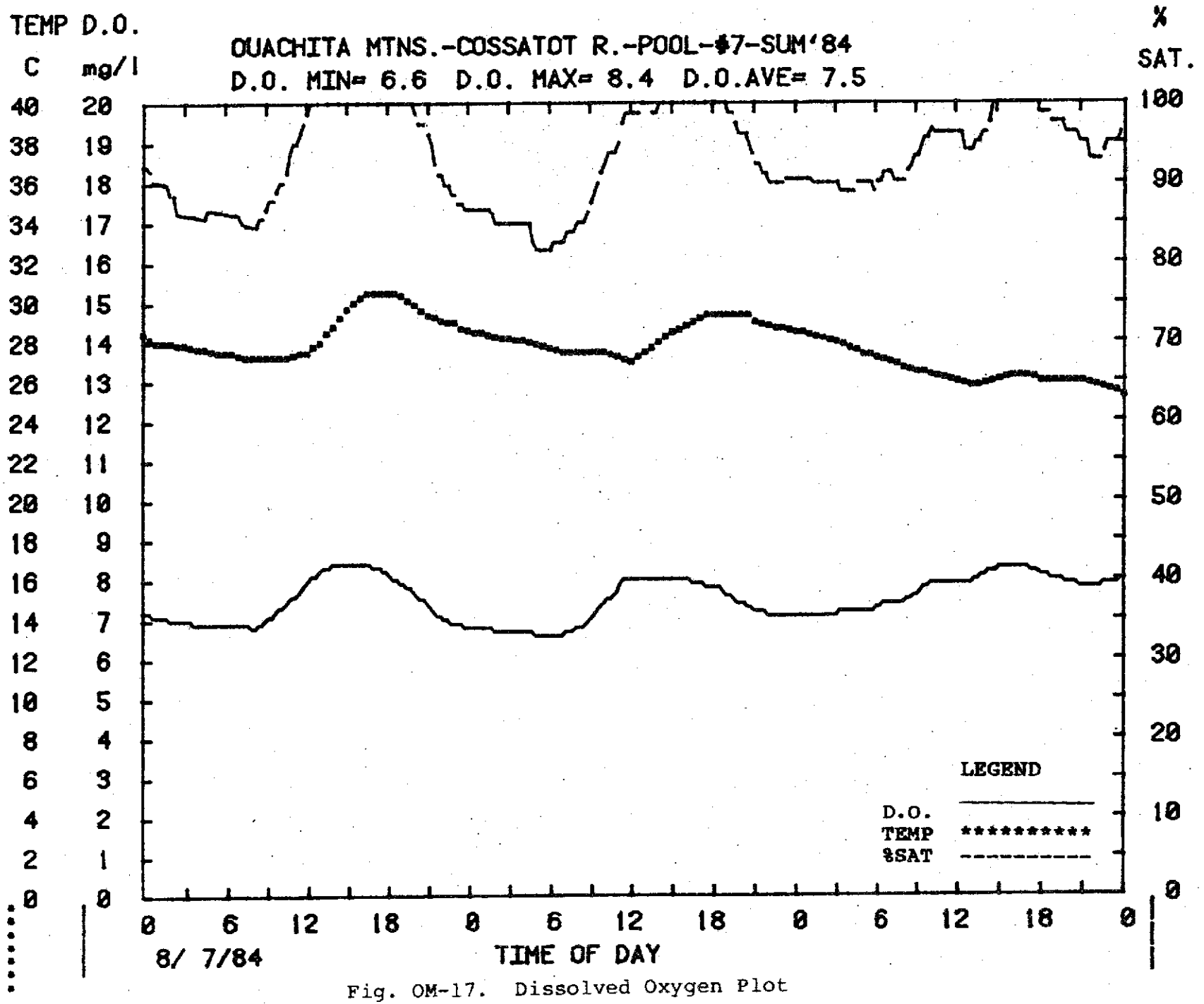


Fig. OM-17. Dissolved Oxygen Plot

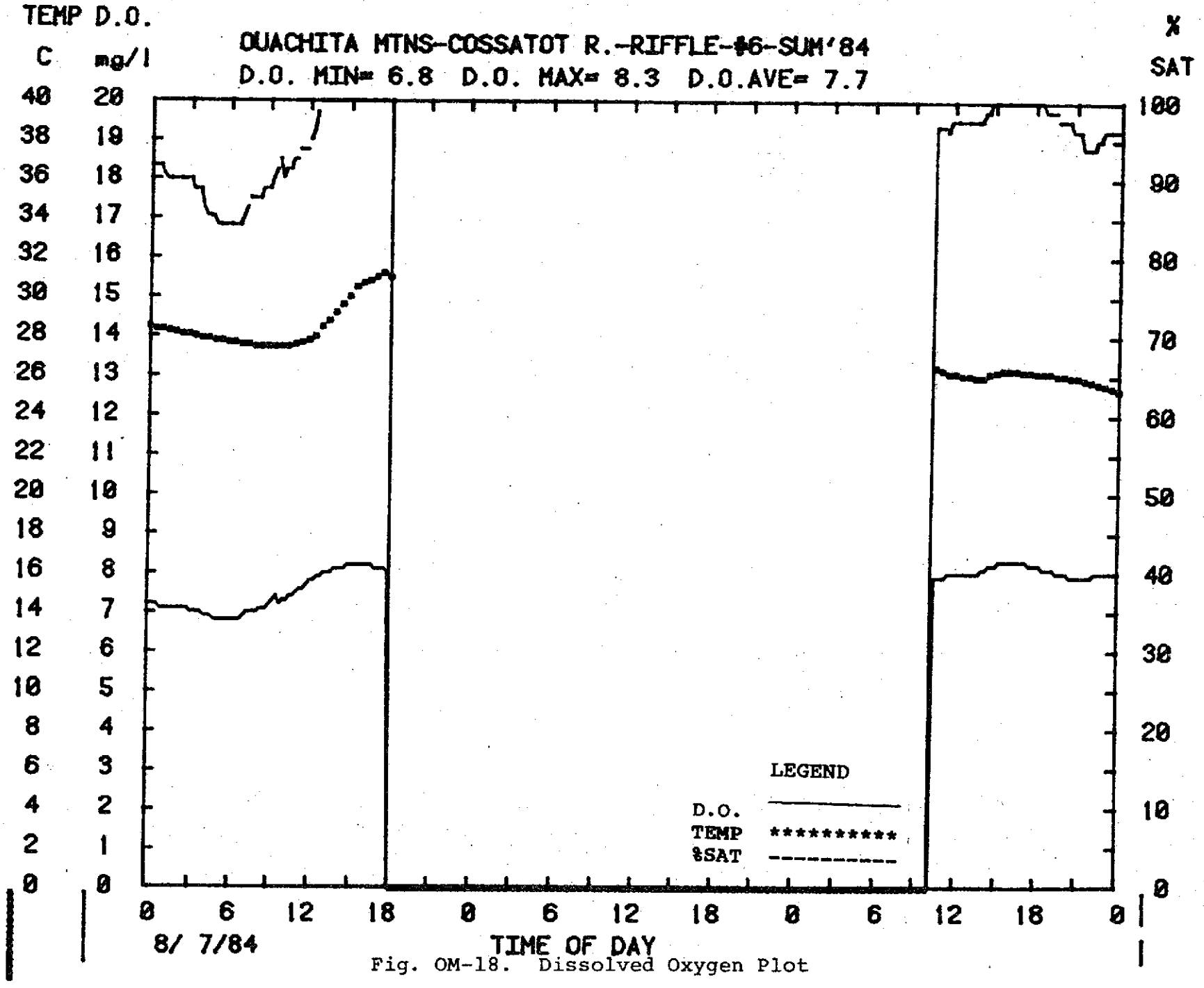


Fig. OM-18. Dissolved Oxygen Plot

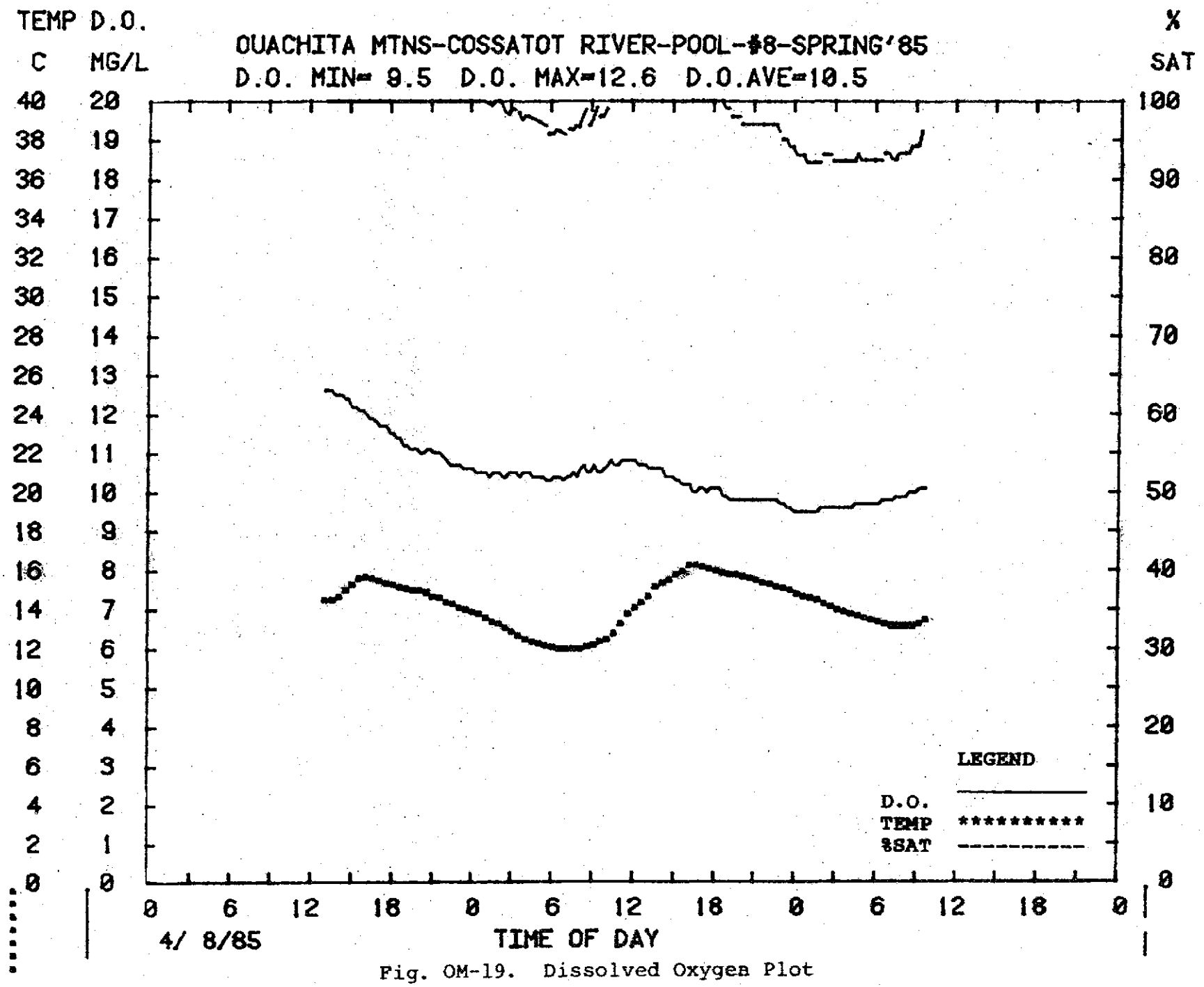


Fig. OM-19. Dissolved Oxygen Plot

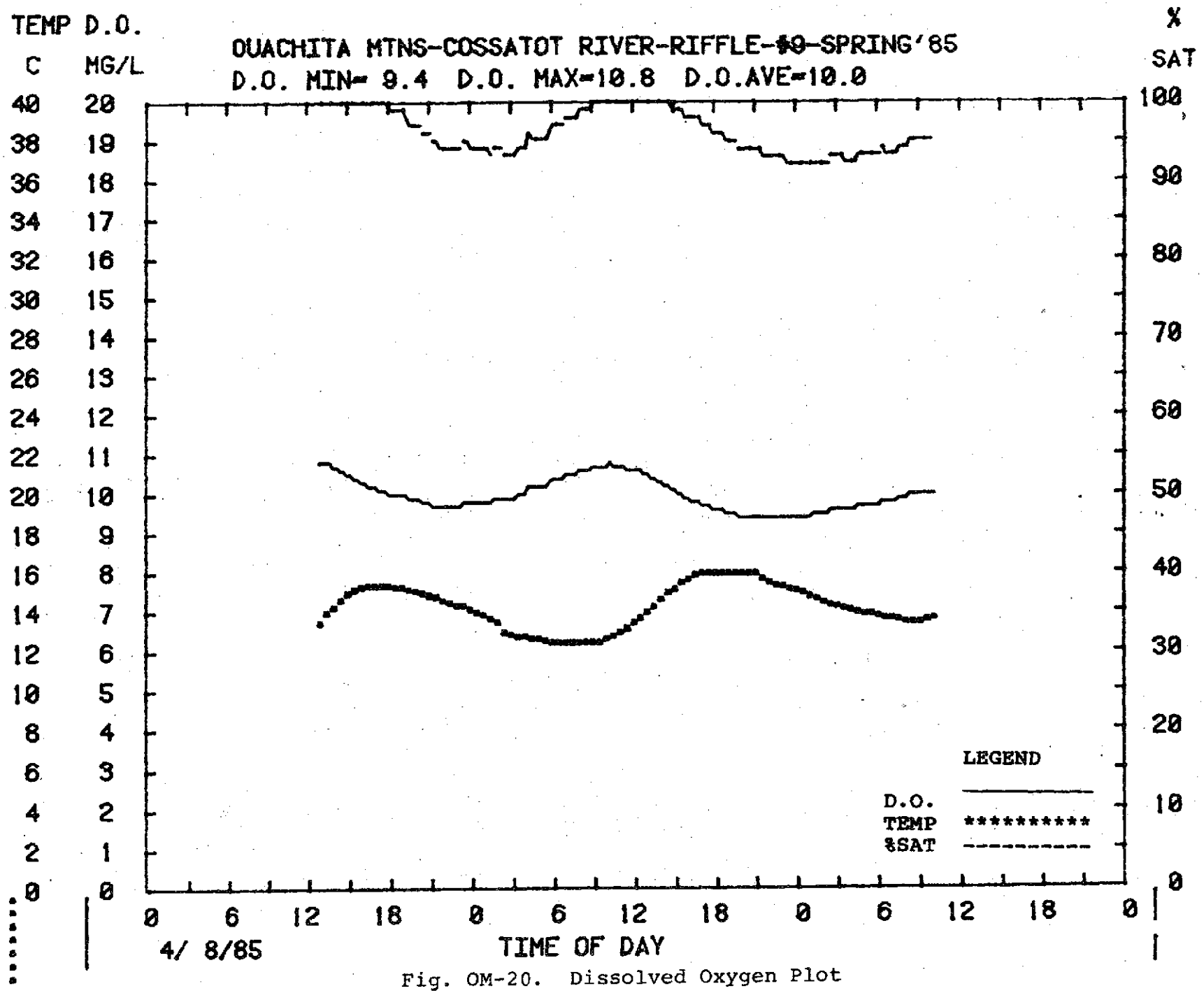


Fig. OM-20. Dissolved Oxygen Plot

Table OM-19

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Cossatot River

Drainage Area: 120 square miles

Station Description: Just above Pryor Creek confluence, SW 1/4, NW 1/4, Section 18, T 5 S, R 30 W - Howard County

Date: August 7, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:50	10:50	12:55	
Q, cfs	17.4	17.4	17.4	17.4
Temperature, °C	25.5	25.5	27.0	26.0
pH	7.1	7.2	7.4	7.2
Turbidity, ntu	2	2	2	2
TSS, mg/l	<1	<1	<1	<1
TDS, mg/l	43	44	39	42
BOD-5, mg/l	.2	.6	.7	.5
BOD-20, mg/l	1.3	2.2	2.1	1.9
T.Phos., mg/l	<.01	<.01	<.01	<.01
PO4-P, mg/l	.01	<.01	<.01	<.01
NO2+NO3-N, mg/l	.02	.02	.02	.02
NH3-N, mg/l	<.01	.01	<.01	<.01
Cl -, mg/l	5	5	5	5
SO4 =, mg/l	7	7	13	9
Fe, mg/l	-	-	-	-
Conductivity μmho	55	54	56	55
Alkalinity, mg/l	21	21	21	21
T. Hardness, mg/l	28	40	32	33
Chlorophyll a, μg/l	.5	.3	-	.4
Fecal Coliform	-	-	10	10

Dissolved Oxygen Data for August 7, 1984		
	Pool	Riffle
Average	7.5	
Minimum	6.8	
Maximum	8.4	

Table OM-20

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Cossatot River

Drainage Area: 120 Square Miles

Station Description: Just above Pryor Creek Confluence, SW 1/4, NW 1/4, Section 18, T 5 S, R 30 W - Howard County

Date: April 8, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	11:52	13:05	14:00	
Q, cfs	97.4	97.4	97.4	97.4
Temperature, °C	18	15	-	16.5
pH	6.7	6.7	6.7	6.7
Turbidity, ntu	3	3	3	3
TSS, mg/l	2	2	2	2
TDS, mg/l	29	30	27	29
BOD-5, mg/l	0.8	0.9	1.0	0.9
BOD-20, mg/l	1.9	1.9	1.9	1.9
T.Phos., mg/l	0.01	0.01	0.01	0.01
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	0.01	0.01	0.01	0.01
NH3-N, mg/l	0.04	0.01	0.01	0.02
Cl -, mg/l	1.5	1.5	1.5	1.5
SO4 =, mg/l	6	6	6	6
Fe, mg/l	0.04	0.07	0.05	0.05
Conductivity, μmho	29	30	30	30
Alkalinity, mg/l	9	9	9	9
T. Hardness, mg/l	8	12	12	11
Chlorophyll a, μg/l	0.0	0.4	0.0	0.2
Fecal Coliform	-	-	4	4

Dissolved Oxygen Data for 8 Apr 1985		
	Pool	Riffle
Average	11.6	10.1
Minimum	10.6	9.7
Maximum	12.6	10.8

summer sample than in the spring. This is also reflected in slightly higher conductivity, alkalinity and total hardness. Other parameters were very similar in the two samples except for flow and water temperatures.

Physical Parameters

Physical data collected from the Cossatot River during the summer survey are summarized in Table OM-21. Flow measurements and time of travel from dye studies were also made. Flows were calculated at 17.2 cfs during the summer and 97.4 cfs in the spring. The flow velocities were 0.47 fps in summer and 1.1 fps in the spring. In general, the physical characteristics of this segment indicate that this is a perennial, high gradient, fast-flowing stream with a high riffle to pool ratio. Although it has a moderately large watershed, it has distinctive headwater stream characteristics, particularly the substrate dominated by bedrock and large boulders.

The substrate of the Cossatot River consisted of 30.6% bedrock, 30.5% large boulders, 17.9% rubble and 11.7% boulders. Less than 3% was sand and gravel. Less than 1% of the summer stream channel contained other instream cover such as logs, brush, debris or inundated vegetation.

The riparian overstory at the site was dominated by trees and shrubs, but no vegetative canopy existed over the summer stream flow in this segment.

Macroinvertebrate Populations

Ninety-two (92) taxa representing 18 orders were identified from the summer-spring samples of the benthic community (Table A-23, Appendix A). The dominant orders, Ephemeroptera, Trichoptera and Isopoda comprised 28.7%, 23.0% and 12.6% of the sample, respectively. The dominant taxa were Eurylophella verisimilis (14.8%), Lirceus garmani (12.6%), Viviparus (4.4%). Other taxa collected with consistency and considered characteristic of Ouachita Mountains streams include Hagenis brevistylus, Helicopsyche borealis, Isonychia, Nectopsyche, Psephenus herricki, and Pseudocloeon dubium.

The qualitative similiarity indices indicated that the summer-spring benthic communities were more similar than dissimilar. Of the 92 taxa identified from the combined samples, 60 taxa were identified in each of the summer and spring samples. Upon comparison, 28 of the 60 taxa were found to be present in both samples and 32 taxa were unique to each. The 28 taxa common to both samples accounted for over one half (53%) of all organisms collected. However, the 34 taxa unique to each benthic sample accounted for 29% and 71% of the organisms of the summer and spring benthic

Table OM-21

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Cossatot River
Date:	August 7, 1984
Drainage Area:	131 square miles
Watershed Land Use:	6% agriculture 93% forest 1% other
Stream Gradient:	40 ft/mi
Mean Channel Width:	187.4 feet
Mean Stream Width:	74.1 feet
Mean Stream Velocity:	0.47 fps
Observed Flow:	17.2 cfs
Average Substrate Type:	36.6% bedrock 30.5% large boulders 11.7% boulders 17.9% rubble 2.7% gravel 0.1% sand
Mean Instream Cover:	0.3% inundated vegetation 0% undercut bank 0% overhanging vegetation
Riffle/Pool Ratio of Transects:	40% riffles 30% deep pools 30% moderate pools
Mean Bank Overstory Cover:	37% trees 27.9% shrubs
Mean Bank Ground Cover:	23.6% grasses and forbs 69.4% rock 8.7% dirt
Mean Bank Stability:	90% stable 10% moderate 0% unstable
Mean Stream Canopy:	0%
Comments:	

communities, respectively. This indicates that, despite being similar taxonomically, the actual numerical composition of the taxa between the summer and spring benthic samples were very different.

Summer - The dominant orders of the summer sample were caddisflies (41.8%) and mayflies (17.4%). Dominant taxa of the summer benthic sample which were not collected during the spring include Hydropsyche simulans, Chimarra obscura and Callibaetis.

Spring - The dominant orders of the spring benthic community were mayflies, sowbugs and stoneflies which comprised 36.6%, 25.5% and 7.6% of the sample, respectively. The dominant taxa of the spring sample were Eurylophella verisimilis, Lirceus garmani, Isonychia, Viviparus and Perlesta placida (Table OM-20). Other taxa which were collected and considered as ecological dominants include Amphinemuria delosa, Hastoperla brevis, Eurylophella bicolor and Calopteryx. Of those common to the spring benthic community, only Isonychia and Viviparus were collected in the summer survey.

The community parameters indicated a diverse, well-balanced benthic community (Table OM-22). The benthic assemblage was characteristic of streams with high gradient, a diversity of substrate types and little or no organic enrichment. There was a significant difference between the measure of diversity from the summer and spring benthic communities. This was despite identical numbers of taxa and total number of organisms. The fluctuation in the indices of dominance and evenness were in response to the large population of two taxa (Eurylophella verisimilis and Lirceus garmani) which dominated the spring community.

Table OM-22. Community Analysis of Benthic Samples from Cossatot River - 30 Minute Qualitative Sample, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	702	696	1398
Total # Taxa	60	60	92
Diversity	4.7118	3.8627	4.9657
Index of Evenness	0.7976	0.6539	0.7612
Index of Dominance	0.4684	0.5251	0.4947
Index of Variety	6.2398	6.2480	8.7089
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.57
Common Taxa Index (range 0-1.0)			0.47
Qualitative Similarity Index (range 0-100)			23.0

Fish Populations

Summer - Two attempts were made to sample this site during the summer period. The first attempt was in August, 1984 and due to the very low conductivity of the water, only seven species were collected with the electrofishing gear. The steep stream gradient caused high velocity flows and the volume of flow was too great to use rotenone. The second collection attempt was made in September, 1985, and a step-up transformer was used with the 3500-watt electrofishing generator. This provided sufficient current in the poorly conductive water to collect a satisfactory sample. Sixteen (16) species were collected during this sample. One additional species was collected during the first attempt and another species was collected in the spring sampling. The total relative abundance value for this population was 101.5 with a diversity index of 3.72. A total of 589 individuals were taken in the second summer sample. A list of all species taken at this site is given in Table OM-23. Cyprinidae and Centrarchidae were the dominant fish families. Only one species of primary feeder, the stoneroller, made-up 11.8% of the population but five species of carnivores made up 12.8%. A total of 52.7% of the population was composed of eight sensitive fish species (Table OM-24). This sample was very typical of a population from high gradient streams of the Ouachita Mountains.

Table OM-23. Fishes Collected from Cossatot River with Relative Abundance Values

SPECIES		R.A. VALUE
*Etheostoma radiosum	Orangebelly darter	12.0
Campostoma anomalum	Stoneroller	12.0
Lepomis megalotis	Longear	12.0
*Notropis snelsoni	Ouachita Mt. shiner	8.5
*Fundulus catenatus	Northern studfish	8.0
*Micropterus dolomieui	Smallmouth bass	8.0
Moxostoma erythrurum	Golden redhorse	7.0
*Notropis boops	Bigeye shiner	7.0
*Moxostoma duquesnei	Black redhorse	7.0
Lepomis cyanellus	Green sunfish	6.0
Fundulus olivaceus	Blackspotted topminnow	6.0
*Ambloplites ariommus	Shadow bass	2.0
Pylodictis olivaris	Flathead catfish	2.0
Ictalurus natalis	Yellow bullhead	2.0
Micropterus salmoides	Largemouth bass	1.0
*Notropis whipplei	Steelcolor shiner	1.0
Lepisosteus osseus	Longnose gar	S
Percina caprodes	Logperch	S

*Sensitive Species
S - Collected during spring sampling only

Table OM-24. Summary of Fish Population Parameters from Cossatot River

Total Species Collected	18.0
Total Number of Individuals	589.0
Total Relative Abundance Value	101.5
Relative Abundance Diversity Index	3.72

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	4.0	28.1
CATOSTOMIDAE	2.0	13.8
ICTALURIDAE	2.0	3.9
CENTRARCHIDAE	5.0	28.6
PERCIDAE	2.0	11.8
Primary Feeders	1.0	11.8
Macroinvertebrate Feeders	12.0	75.4
Carnivores	5.0	12.8
Sensitive Species	8.0	52.7

Spring - Four trammel nets were set overnight at this site on April 8, 1985. Net mesh sizes were 1½ and 2½ inch square. Flows were almost 100 cfs; however, the culverts under the low-water bridge were partially plugged creating a pool above the bridge. Water temperatures were between 12°C and 16°C. A total of 24 fish weighing 27.1 pounds were caught. This represented only four species, and golden and black redhorse made up 79% of the total weight of the catch. One longnose gar was netted which added an additional species to the total collected at this site. Gonad examination indicated that the majority of the golden and black redhorse were in the process of spawning, and the 18-inch flathead catfish had maturing ova.

CADDO RIVER

The Caddo River begins on the south slope of one of the major Ouachita Mountain ridges. This ridge also is the starting point for several other major streams of the Ouachita Mountains such as the Ouachita and Little Missouri Rivers. The Caddo begins its flow in generally an eastward direction, it then turns south to southeast and crosses some east-west oriented ridges. It turns eastward again for about 10 miles before flowing into DeGray Reservoir (Figure OM-21).

The sample site was located at an abandoned low water bridge northeast of Amity in Clark County in Section 24, R 23 W, T 5 N. This is about five miles above the conservation pool of DeGray Reservoir.

General Site Discussion

Watershed Size - Drainage area above the sample site covered approximately 291 mi^2.

Geology - The geology of the watershed of the Caddo River site is composed primarily of Polk Creek Shale and Big Fork Chert in the upper drainage and Stanley Shale in the lower segments. Both segments are interspersed with Arkansas Novaculite, Missouri Mountain Shale and Blaylock Sandstone formations.

Topography - The slopes of the upper watershed of this site are very steep, but they begin to moderate noticeably just above the sample site. Stream gradient at the sample site was measured as 13.3 ft/mile.

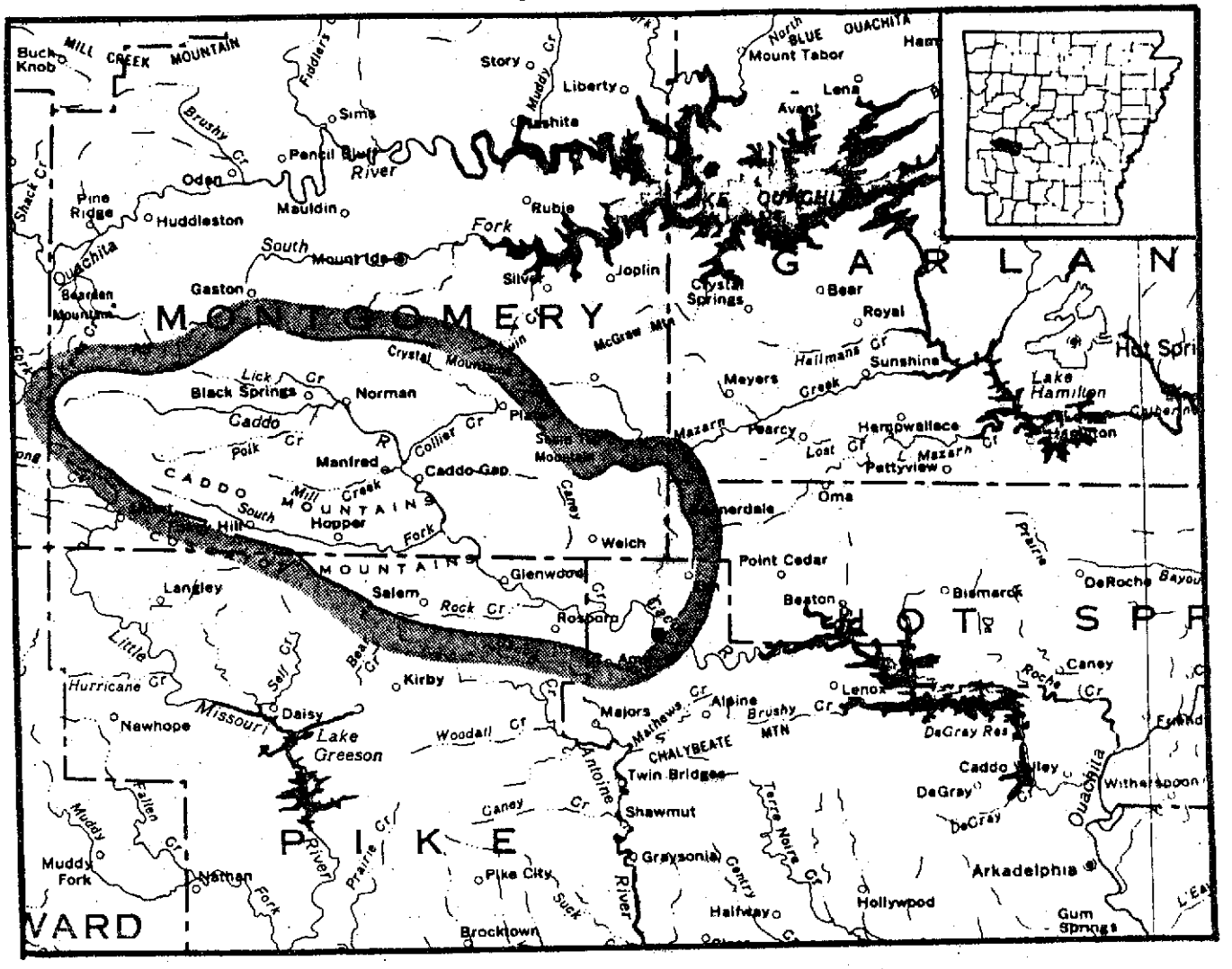
Soil Types - The Ouachita Mountain Soil association is the dominant soil at this site. It is mainly silty clay and silty loam which is relatively deep in the valleys and very shallow and stony on the ridge tops. These soils are moderately permeable and generally well-drained.

Flora - A loblolly pine-shortleaf pine-hardwood association dominates the forest types of this watershed. The riparian area of the sample site was tree and brush covered with the most common trees being sycamore, river birch, maple and sweetgum.

Land Use - The primary land use within the watershed is silviculture with some pastureland and hay production in the flatter valleys. Some truck farms of fruits and vegetables exist, but major row cropping is not practical.

Stream Characteristics - In this stream segment the channel is very wide and the streamflow is divided into several sub-channels except during flood flows. Large, deep pools exist and the riffles are short and narrow but are normally approached downstream by swift chutes along the principal sub-channel. The substrate is very rugged and contains an

Figure OM-21



CADDO RIVER: Drainage area 291 square miles ● Survey site ▓ Survey area

abundance of rubble and boulders with some fractured bedrock. The water is very clear but with a slight greenish color in the large pools. The water is of high quality with low nutrient values and moderately low mineral concentrations. Although stream canopy is fairly sparce, water temperatures generally remain below 30°C.

Methodology and Sampling Results

Summer sampling at this site occurred August 19-22, 1985, and the spring samples were taken April 29-May 1, 1986.

Continuous Dissolved Oxygen

Summer - Three continuously recording meters were installed at this site during the summer sample period. Two meters were placed at the same location in the lower end of the large pool above the abandoned low water bridge. The third meter was placed in a riffle just below the bridge. The riffle meter malfunctioned and the data generated could not be used for analysis.

Dissolved oxygen in the pool ranged from 6.6 to 8.3 mg/l during the 60-hour period of record shown in Figure OM-22. The maximum daily fluctuation of 1.7 mg/l occurred August 21-22, 1985. During the previous period of record, less than 1 mg/l daily fluctuation was recorded. Rain occurred in the watershed on August 19, resulting in a 3.5-inch rise in water level on August 20. By August 22, the water had returned to within one half inch of the starting level. Water temperatures showed a slight but steady decline on August 20, probably as a result of the increased inflow. During the final 24 hours of record, the temperature fluctuated from about 24°C to 28°C. The increased flow may have also temporarily interrupted the typical diurnal fluctuation of dissolved oxygen. Saturation values of D.O. ranged between 80% and 85% during the increased flow period. As the flow subsided and peak concentrations of D.O. began to occur at the end of the daily photic period, saturation values exceeded 100%, apparently as a result of photosynthetic activity.

Spring - Two meters were installed during the spring sample period at the same locations as the riffle and pool meter during the summer sample. Again the riffle meter malfunctioned. The D.O. in the pool ranged from 7.9 to 10.1 mg/l with a maximum diurnal fluctuation of 2.2 mg/l (Figure OM-23). Saturation values were over 85% to supersaturated. Water temperature fluctuated less than 1°C from a consistent 20°C value. Stream flows had been higher before the sample period, but were falling slightly. However, flows were substantially higher than during the summer period and the water was slightly murky.

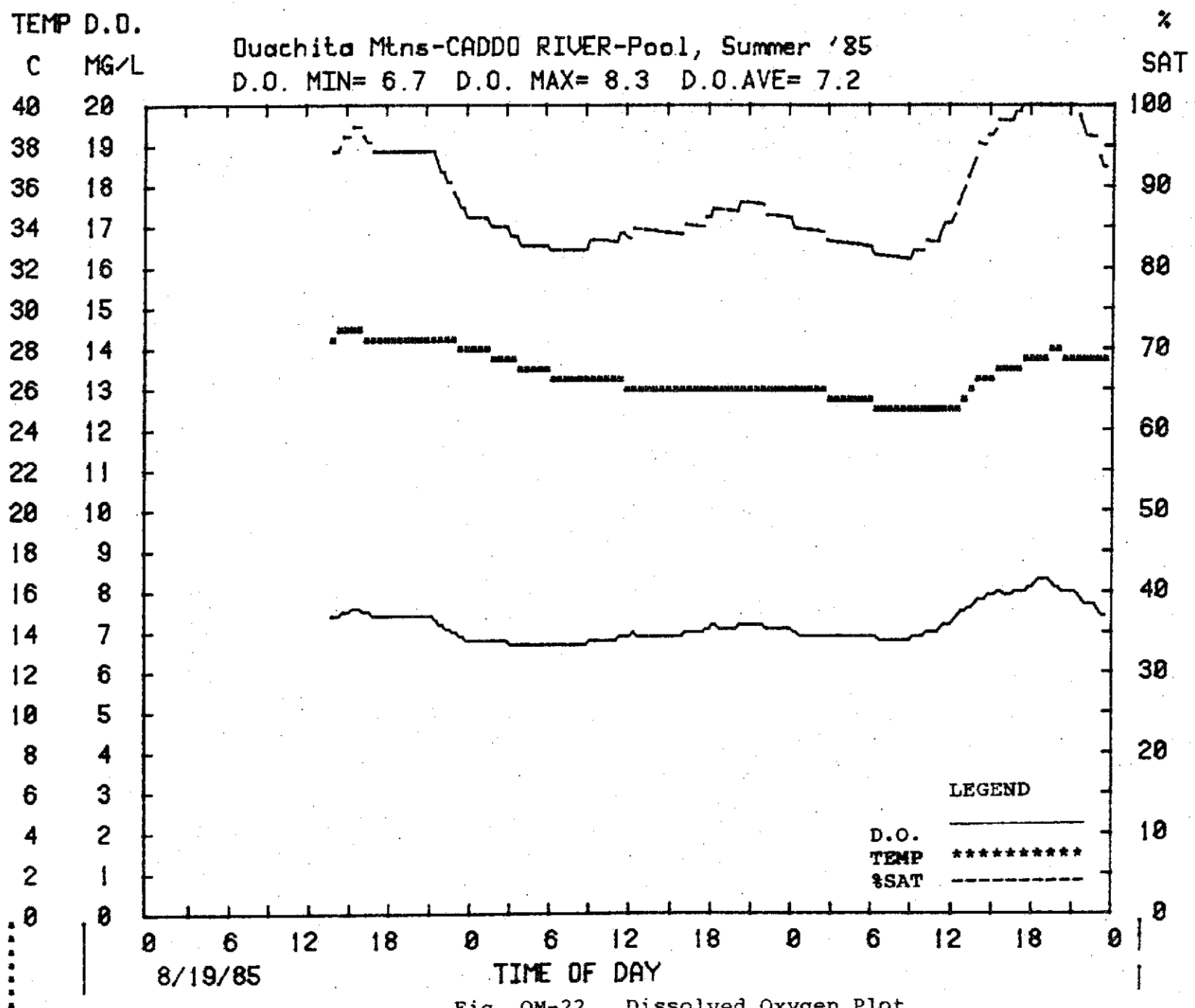


Fig. OM-22. Dissolved Oxygen Plot

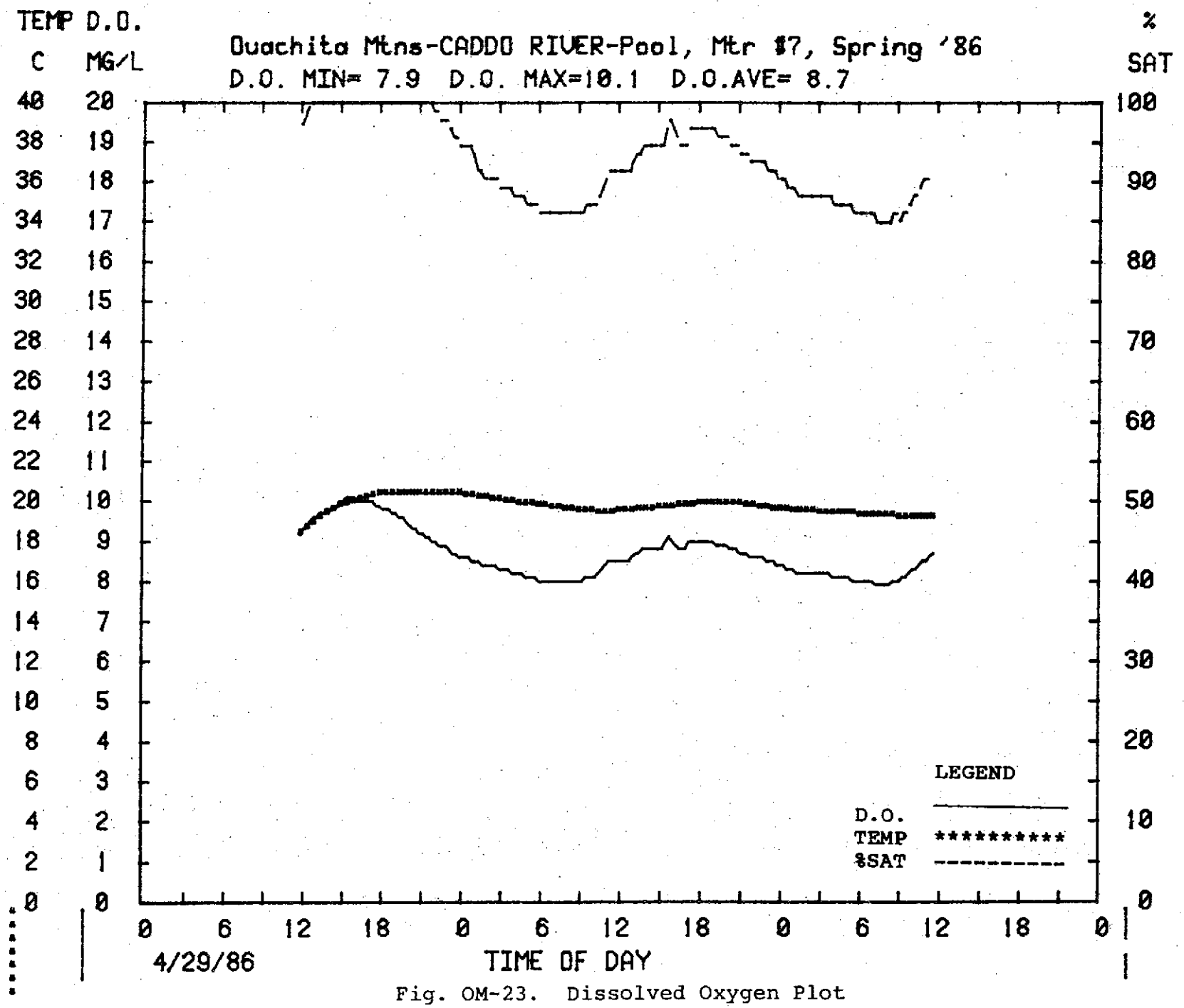


Fig. OM-23. Dissolved Oxygen Plot

Chemical Parameters

Only slight differences were noted between the summer and spring chemical water analyses (Tables OM-25 and OM-26). These differences include slightly high TDS, conductivity, alkalinity and total hardness in the summer samples although flows were three to five times greater during the spring sample period. In general, the water quality at this site on the Caddo River was good; nutrient and mineral quantities were low and there was a very low demand on the water's dissolved oxygen.

Physical Parameters

Key physical characteristics of this sample site are described in Table OM-27. The substrate type is predominantly rubble and boulders; gravel is the next most abundant substrate type. Also found were measurable quantities of detritus, bedrock and sand. Instream cover occupied only 14.3% of the stream width and included mostly inundated vegetation. The pools in this segment were generally long, wide and deep and the riffle areas were composed of narrow, moderately deep chutes approaching short, shallow and narrow gravel areas. The riparian area was tree and brush covered and the bank was generally stable. Due to the wide pools and the constricted riffle areas, the stream canopy covered only 26% of the summer stream width.

Macroinvertebrate Populations

One hundred forty-five (145) taxa representing 20 orders were identified from the combined summer/spring benthic samples from the Caddo River (Table A-24, Appendix A). Numerically, the benthic assemblage was dominated by Ephemeroptera, Trichoptera, Coleoptera and Diptera which comprised 35%, 15%, 11% and 10% of the sample, respectively. Taxonomically, the sample was dominated by Coleoptera and Ephemeroptera which were represented by 31 and 26 taxa, respectively. The dominant taxa included Isonychia (11%), Cheumatopsyche (8%), Tricorythodes and Simulium jenningsi (5%) and Chimarra obscura and Stenonema mediopunctatum (4%). Other taxa, common to both summer and spring and considered ecologically characteristic include Baetis flavigustria, Stenonema femoratum, Stenonema exiguum, Helicopsyche borealis, Helichus, Psephenus herricki, Heterina and Corydalus cornutus.

The comparative indices indicated slightly greater similarity than differences between the summer and spring samples. Of the 145 taxa identified from the combined samples, 67 were identified from both samples. Those 67 taxa comprised 78% of all the organisms collected. The 52 taxa and 26 taxa unique to the summer and spring benthic samples comprised only 21.3% and 23.1% of those samples, respectively. The differences indicated by the qualitative indices reflected the seasonal pattern of continuous transition between summer warmwater forms and winter coolwater species.

Table OM-25

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Caddo River

Drainage Area: 291 Square Miles

Station Description: County Road bridge in Section 24, T 5 S, R 23 W, Clark County

Date: August 20, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:40	10:20	11:05	
Q, cfs	134	134	134	134
Temperature, °C	27	27	27	27
pH	7.6	7.6	7.6	7.6
Turbidity, ntu	3	4	4	4
TSS, mg/l	4	5	5	5
TDS, mg/l	72	79	70	74
BOD-5, mg/l	0.6	0.5	0.6	0.6
BOD-20, mg/l	1.5	1.5	1.6	1.5
T.Phos., mg/l	0.04	0.04	0.03	0.04
PO4-P, mg/l	0.03	0.03	0.03	0.03
NO2+NO3-N, mg/l	0.01	0.01	0.01	0.01
NH3-N, mg/l	0.02	0.02	0.02	0.02
Cl -, mg/l	2.5	3.5	2.5	2.8
SO4 =, mg/l	8	8	7	8
Fe, mg/l	0.02	0.02	0.02	0.02
Conductivity, μmho	107	106	100	104
Alkalinity, mg/l	47	45	43	45
T. Hardness, mg/l	50	52	46	49
Chlorophyll a, μg/l	void	0.3	3.2	1.7
Fecal Coliform	N/A	N/A	N/A	N/A

Dissolved Oxygen Data for 20 Aug 1985		
	Pool	Riffle
Average	6.9	
Minimum	6.7	
Maximum	7.2	

Table OM-26

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Caddo River

Drainage Area: 291 square miles

Station Description: County road bridge in Section 24, T 5 S, R 23 W Clark County

Date: April 30, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:30	10:15	12:00	
Q, cfs	500 Est			500 Est
Temperature, °C	20	20	20	20
pH	7.42	7.45	7.40	7.4
Turbidity, ntu	6	6	6	6
TSS, mg/l	1	<1	<1	1
TDS, mg/l	30	22	18	23
BOD-5, mg/l	0.8	0.6	0.6	0.7
BOD-20, mg/l	1.6	1.6	1.6	1.6
T.Phos., mg/l	0.03	0.03	0.03	0.03
PO4-P, mg/l	0.03	0.03	0.04	0.03
NO2+NO3-N, mg/l	0.07	0.07	0.07	0.07
NH3-N, mg/l	<0.01	0.01	0.01	0.01
Cl -, mg/l	2.5	3.0	2.5	2.5
SO4 =, mg/l	5	6	6	6
Fe, mg/l	0.02	0.02	0.02	0.02
Conductivity, μmho	74	71	73	73
Alkalinity, mg/l	28	28	28	28
T. Hardness, mg/l	34	32	32	33
Chlorophyll a, μg/l	-	-	2.67	2.67
Fecal Coliform	-	-	44	44

Dissolved Oxygen Data for 30 Apr 1986		
	Pool	Riffle
Average	8.5	
Minimum	8.0	
Maximum	9.1	

Table OM-27

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Caddo River
Date:	August 20, 1985
Drainage Area:	291 square miles
Watershed Land Use:	40% agriculture 60% forest
Stream Gradient:	13.3 ft/mi
Mean Channel Width:	315 feet
Mean Stream Width:	127 feet
Mean Stream Velocity:	NA
Observed Flow:	133.8 cfs
Average Substrate Type:	3% bedrock 12% gravel 16% boulder 2% sand 63% rubble 4% detritus
Mean Instream Cover:	0.3% undercut bank 4% brush, logs, debris 3% overhanging vegetation 7% inundated vegetation
Riffle/Pool Ratio of Transects:	80% riffle 20% shallow pool
Mean Bank Overstory Cover:	70% trees 35% shrubs
Mean Bank Ground Cover:	86% grass and forbs 14% dirt
Mean Bank Stability:	10% stable 50% moderate 40% unstable
Mean Stream Canopy:	26% canopy
Comments:	

Summer - The dominant orders of the summer benthic community were Ephemeroptera (38%), Trichoptera (18%) and Coleoptera (12%). Taxonomically, Coleoptera dominated with 25 taxa, followed by Ephemeroptera and Trichoptera with 17 and 15 taxa, respectively. The dominant taxa of the summer sample were Isonychia (15%), Cheumatopsyche (11%), Stenonema mediopunctatum (7%) and Tricorythodes and Chimarra obscura (5%). Only Stenonema mediopunctatum was not a dominant of the combined sample. Other taxa, unique to the summer benthic community and not numerically dominant but ecologically characteristic, include Hexagenia limbata, Stenonema pulchellum, Orthotrichia, Choroterpes and Ectopria.

Spring - The spring sample was dominated by Ephemeroptera (29%), Diptera (20.7%), Coleoptera (10.6%), Trichoptera (9.6%) and Plecoptera (9.2%). Five orders were represented by 10 or more taxa and the mayflies dominated with 19 taxa. Other taxa which were not numerically dominant but considered ecologically characteristic, included Serratella serratoides, Rhithrogena pellucida and Pseudooccloeon dubium.

The community parameters indicated this Caddo River site to have the most diverse benthic assemblages encountered throughout this 3-year study (Table OM-28). All diversities were above 5, indicative of extremely high quality water and enhanced by a multiplicity of microhabitat availability. The ecological feeding groups reflected the transition from a creek or small river to a large river system dominated by pools interspersed with riffles and river habitat. The collectors dominated and scrapers replaced shredders as the second primary group in the benthic sample, indicating a food source dominated by smaller, previously processed allochthonous materials.

Table OM-28. Community Analysis of Benthic Samples from Caddo River - 30 Minute Qualitative Sample, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	2074	3552	5626
Total # Taxa	118	91	145
Diversity	5.1203	5.3796	5.6709
Index of Evenness	0.4969	0.4864	0.4936
Index of Dominance	0.7426	0.8227	0.7898
Index of Variety	----	8.9963	----

COMPARATIVE INDICES	
Dice Index (range 0-1)	0.46
Common Taxa Index (range 0-1)	0.56
Qualitative Similarity Index (range 0-100)	34.0

Fish Populations

Summer - The 3500-watt electrofishing generator was used to sample this site on August 21, 1985. Approximately one mile of the stream was covered; however, much of the area was too deep and swift to sample effectively. Approximately 3 hours were required to collect a satisfactory sample. A total of 36 species were collected during the summer sample and an additional four species were taken in the spring. Table OM-29 lists all species taken at this site. Summer sampling produced 2,230 individuals, a total relative abundance value of 221 and a diversity index of 4.85. Centrarchidae and Cyprinidae dominated the population with Percidae also making up a substantial part. Four species of primary feeding fishes made up 10.2% of the population and seven species of carnivores totalled 11.5%. Sensitive species composed 43.7% of the population and were represented by 13 species (Table OM-30).

Table OM-29. Fishes Collected from Caddo River with Relative Abundance Values

SPECIES		R.A. VALUE
Campostoma anomalum	Stoneroller	12.0
*Notropis boops	Bigeye shiner	12.0
*Etheostoma radiosum	Orangebelly darter	12.0
Lepomis megalotis	Longear	12.0
Percina caprodes	Logperch	11.0
*Hybopsis x-punctata	Gravel Chub	10.5
*Etheostoma blennioides	Greenside darter	10.5
Noturus nocturnus	Freckled madtom	10.5
*Fundulus catenatus	Northern studfish	9.0
Lepomis cyanellus	Green sunfish	9.0
*Etheostoma zonale	Banded darter	9.0
Micropterus punctulatus	Spotted bass	9.0
Pimephales notatus	Bluntnose minnow	7.5
Moxostoma erythrurum	Golden redhorse	7.0
Lepomis macrochirus	Bluegill	7.0
Micropterus salmoides	Largemouth bass	6.0
*Micropterus dolomieui	Smallmouth bass	6.0
Fundulus olivaceus	Blackspotted topminnow	6.0
*Notropis whipplei	Steelcolor shiner	6.0
*Noturus eleutherus	Mountain madtom	6.0
Notropis chrysocephalus	Striped shiner	6.0
*Hypentelium nigricans	Northern hogsucker	5.0
Fundulus notatus	Blackstripe topminnow	4.5
*Ambloplites ariommus	Shadow bass	4.5
*Moxostoma duquesnei	Black redhorse	4.0
Lepomis gulosus	Warmouth	4.0
Minytrema melanops	Spotted sucker	3.0
Lepomis microlophus	Redear	2.0
Dorosoma cepedianum	Gizzard shad	2.0
*Noturus taylori	Caddo madtom	2.0
Labidesthes sicculus	Brook silversides	1.0
Ichthyomyzon sp.	Lamprey larvae	1.0
Erimyzon oblongus	Creek chubsucker	1.0

Table OM-29, cont.

SPECIES		R.A. VALUE
Aphredoderus sayanus	Pirate perch	1.0
Notropis fumeus	Ribbon shiner	1.0
Lepomis hybrid	Hybrid sunfish	1.0
Pomoxis nigromaculatus	Black crappie	S
*Moxostoma carinatum	River Redhorse	S
Ictalurus punctatus	Channel catfish	S
Lepisosteus osseus	Longnose gar	S

*Sensitive Species
S - Collected during spring sampling only

Table OM-28. Summary of Fish Population Parameters from Caddo River

Total Species Collected	40.0
Total Number of Individuals	2230.0
Total Relative Abundance Value	221.0
Relative Abundance Diversity Index	4.85

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	7.0	24.9
CATOSTOMIDAE	6.0	9.0
ICTALURIDAE	4.0	8.4
CENTRARCHIDAE	11.0	27.4
PERCIDAE	4.0	19.2
Primary Feeders	4.0	10.2
Macroinvertebrate Feeders	29.0	78.3
Carnivores	7.0	11.5
Sensitive Species	13.0	43.7

Spring - Both overnight netting and electrofishing were used to sample this area on April 29, 1986. Flows were estimated to be near 500 cfs and water temperature was 18°C to 20°C. Netting with two 1½", one 2" and one 2½" square mesh nets produced 55 fish weighing 146.5 pounds from 11 species. Almost 86% of the catch by weight was longnose gar and channel catfish. Neither species were collected the previous summer; however, both species are common in the downstream reservoir and frequently migrate upstream during the spring and with high inflows. Black crappie and river redhorse were also netted and were not captured in the previous summer sampling. Electrofishing in the spring was limited to the shallow parts of riffles and shallow backwater areas. This method produced 19 species of fish, all of which had been collected the previous summer. Gonad examination of the fishes collected indicated that the redhorse had completed spawning; gizzard shad were in the spawning process; longnose gar, black basses and other sunfishes were in the advanced stages of gonad development; and most of the channel catfish were less developed but were progressing toward maturation. Also most of the Cyprinids and Percids were very near peak spawning period.

SALINE RIVER

The Saline River begins on the east end of the Ouachita Mountains as four distinctive branches. They include the South Fork, which drains the southern most part of the watershed and flows in an easterly direction; the Middle Fork, which is slightly further north and is the most westward drainage; the Alum Fork, which flows south from Lake Winona; and the North Fork, which drains the eastern most edge of the watershed. All of these tributaries come together just north of Benton, Arkansas, and just before the Saline River enters the Gulf Coastal Region of the state.

The sample site is below the confluence of the South Fork, Alum Fork and Middle Fork. It was located at the end of a county road in Section 15, R 16 W, T 2 S (Figure OM-24).

General site Discussion

Watershed Size - The total drainage area at this sample site was 361 mi^2, which is the largest watershed sampled in the Ouachita Mountains Region.

Geology - The majority of the center section of this watershed is composed of geologic formations of Womble Shale of middle and lower Ordovician Age. The fringe area of the watershed contains Polk Creek Shale-Big Fork Chert and Blakely Sandstones. The upper Alum Fork, particularly above Lake Winona, is underlain by the Jackfork Sandstone Formation.

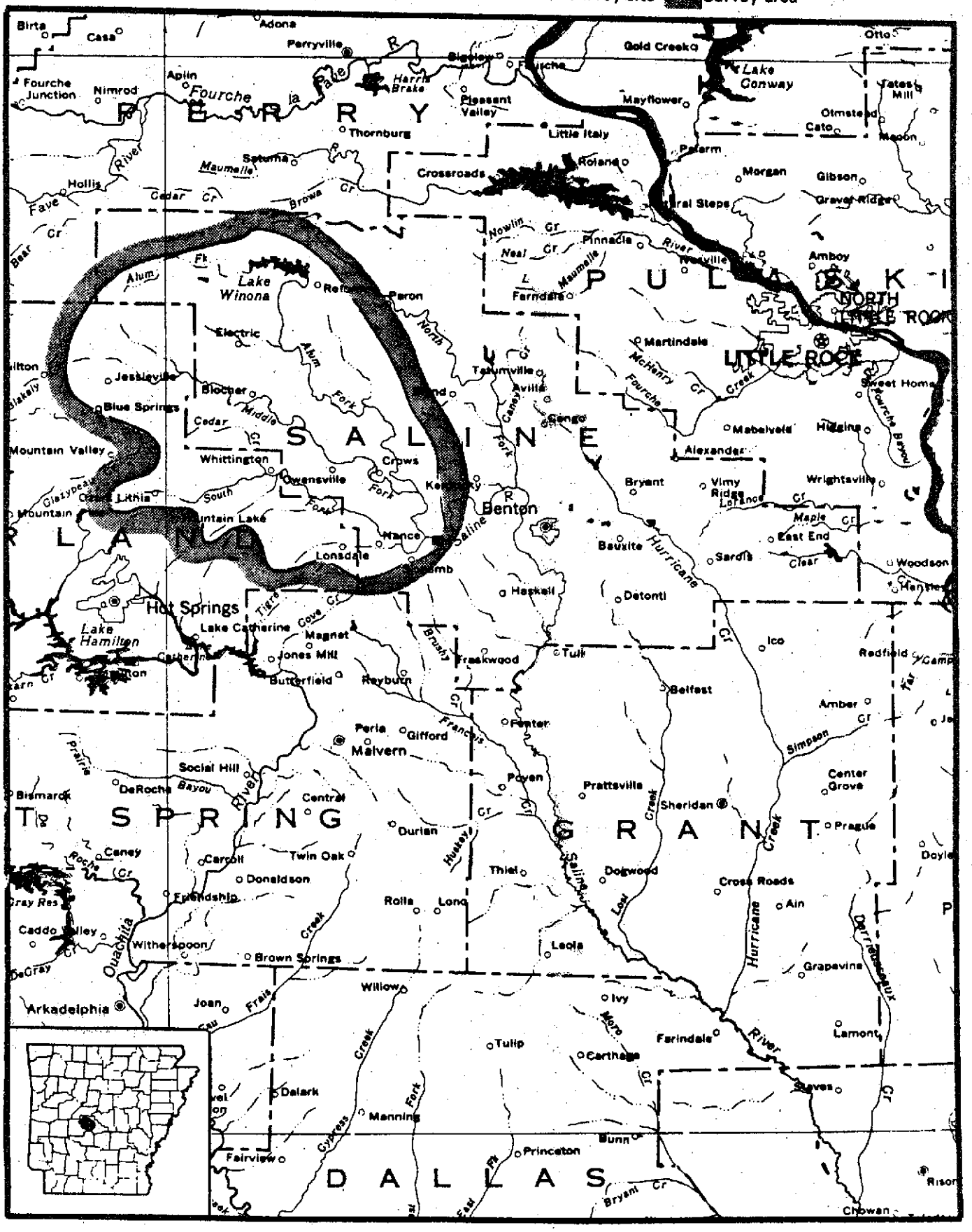
Topography - At this sample site on the Saline River, the general topography is much gentler than the other Ouachita Mountains sites, although occasional steep bluffs with the exposed uplifted and folded geologic formations are seen. The stream gradient was measured as 4.1 ft/mi, which is the lowest of any sample site from the Ouachita Mountains.

Soil Types - The predominant upland soils in this drainage are from the Carnasaw-Townley association. These are well-drained soils on the tops and sides of hills, benches and low ridges in valleys. They are formed in a thin layer of loamy material with underlying clayey material weathered from shales. Along the floodplain of the drainage area, the primary soil type is Ouachita silt loam. This is well-drained, deep and level soil of brown silt loam surface and dark yellowish brown silt loam subsurface. These soils are frequently flooded, have moderate natural fertility and are strongly to very strongly acid. Runoff is slow and permeability is moderately slow.

Flora - The dominant general forest type in this watershed is the loblolly pine-shortleaf pine-hardwood association. Forests of upland hardwood associations also occur in parts of this watershed. The most common riparian trees at the

Figure OM-24

SALINE RIVER: Drainage area 361 square miles ■ Survey site ■ Survey area



sample site were willow, sycamore, alder, maple and red oak.

Land Use - The primary land use in this watershed is timber production; however, along the flat alluvial areas, pastures for hay production and cattle grazing is common.

Stream Characteristics - Some general characteristics of the segment of the Saline River that was sampled include a relatively low stream gradient with long, moderately deep pools; wide, shallow and short riffles; and rubble, gravel and bedrock-dominated substrate types. Instream cover was sparce, but increasing in abundance over the smaller watershed sites. The water was clear with a slight greenish color in the deep pools. Nutrient levels and mineral content of the water was low and biochemical demands on the dissolved oxygen content of the water were very low.

Methodology and Sampling Results

Summer sampling at this site occurred the week of August 19-23, 1985 and the spring sampling was done April 29-May 1, 1986.

Continuous Dissolved Oxygen

Summer - Three meters were installed at this site during the summer period. Two meters were in a pool, one of which was at the lower end of the pool where the velocity begins to increase before entering a riffle area. The data from this meter is shown in Figure OM-25 as the riffle meter. The third meter was installed at the bottom of a riffle. The probe on this meter malfunctioned when a precipitate formed in the probe. Data from this meter was not used. Data from the pool meter is shown in Figure OM-26. The D.O. of the pool meter ranged from 6.2 to 8.6 mg/l with a maximum diurnal fluctuation of 2.2 mg/l. Saturation values ranged from 75% to supersaturated. The D.O. recorded on the "riffle" meter was almost identical to the pool meter except the extremes were 6.0 to 8.5 mg/l. Water temperatures during the period ranged from 25°C to 28°C and fluctuated diurnally in a pattern similar to the D.O. and the D.O. saturation values. The weather during the sample period remained clear to partly cloudy. An afternoon shower occurred on the first day of the period; water levels rose about 1½" over the next two days and then fell about one half inch.

Spring - Two meters were used during the spring sample period. Sets were made in the lower end of a pool and below the riffle at the approximate locations of the summer sets. The riffle meter malfunctioned and the data from the pool meter is shown in Figure OM-27. Water levels were falling noticeably during this period as a result of previous rainfall. Water temperatures ranged from 18°C to 20°C with a slight diurnal fluctuation. The D.O. ranged from 7.2 to

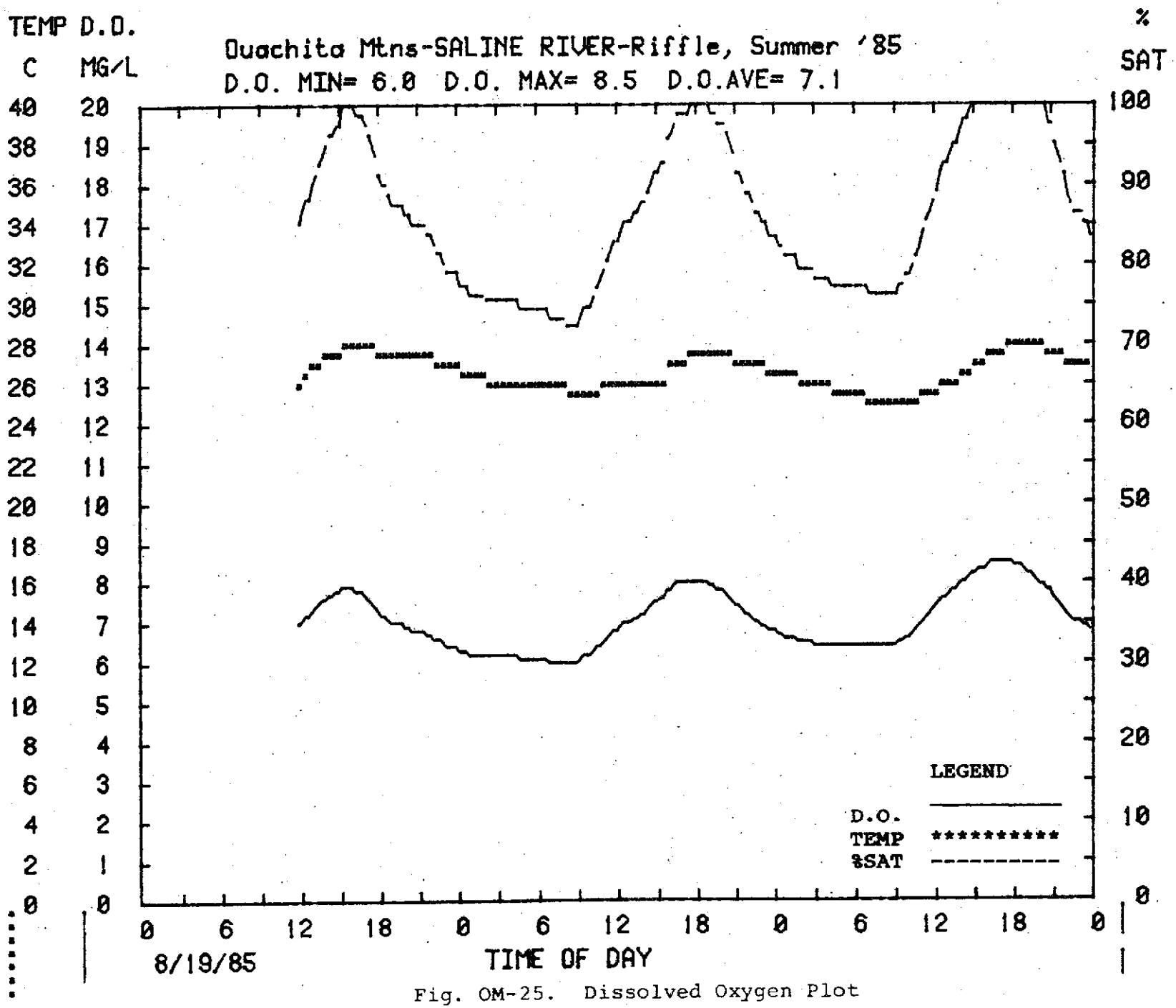


Fig. OM-25. Dissolved Oxygen Plot

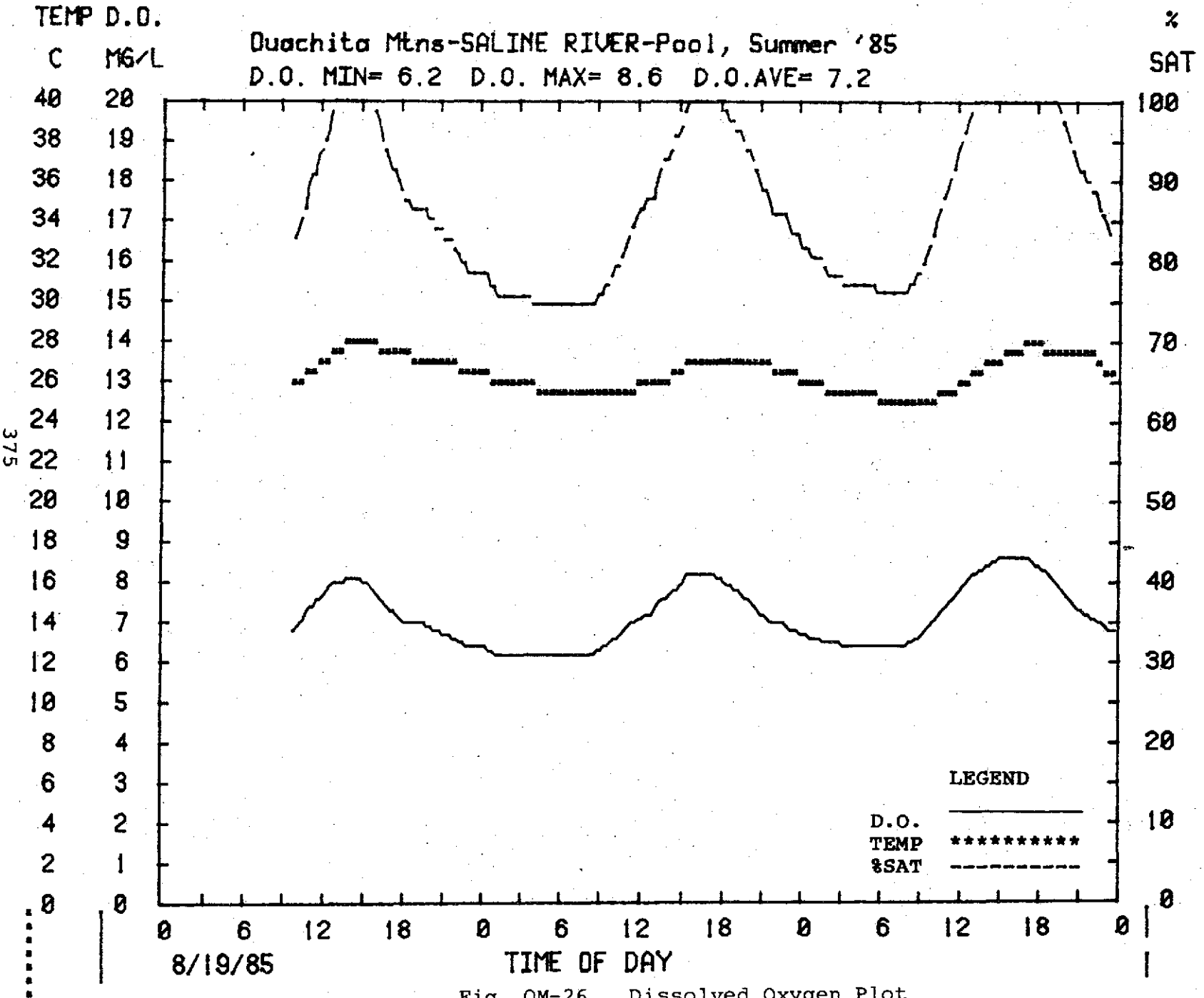


Fig. OM-26. Dissolved Oxygen Plot

Table OM-31

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Saline River

Drainage Area: 361 Square Miles

Station Description: At Smith Ford in Section 15, T 2 S, R 16 W, Saline County

Date: August 20, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	10:00	10:40	12:10	
Q, cfs	53	53	53	53
Temperature, °C	25.5	25.5	26	25.5
pH	7.7	7.6	7.7	7.7
Turbidity, ntu	3	3	3	3
TSS, mg/l	4	2	3	3
TDS, mg/l	75	71	72	73
BOD-5, mg/l	0.5	0.5	0.5	0.5
BOD-20, mg/l	1.1	1.3	1.5	1.3
T.Phos., mg/l	0.03	0.03	0.03	0.03
PO4-P, mg/l	0.04	0.03	0.03	0.03
NO2+NO3-N, mg/l	0.06	0.05	0.04	0.05
NH3-N, mg/l	0.05	0.04	0.03	0.04
Cl -, mg/l	3.0	3.0	3.0	3.0
SO4 =, mg/l	6	6	6	6
Fe, mg/l	0.02	0.02	0.02	0.02
Conductivity, μmho	102	101	106	103
Alkalinity, mg/l	47	47	48	47
T. Hardness, mg/l	42	46	48	45
Chlorophyll a, μg/l	0.5	0.5	0.0	0.3
Fecal Coliform	N/A	N/A	N/A	N/A

Dissolved Oxygen Data for 20 Aug 1985		
	Riffle	Pool
Average	6.8	6.9
Minimum	6.0	6.2
Maximum	8.0	8.2

Table OM-32

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ouachita Mountains

Stream: Saline River

Drainage Area: 361 square miles

Station Description: At Smith Ford in Section 15, T 2 S, R 16 W, Saline County

Date: April 30, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	10:30	11:50	13:00	
Q, cfs	400 EST			400 EST
Temperature, °C	19	20	20	20
pH	7.66	7.63	7.64	7.6
Turbidity, ntu	5	6	5	5
TSS, mg/l	1	5	2	3
TDS, mg/l	54	49	44	49
BOD-5, mg/l	0.7	0.7	0.5	0.6
BOD-20, mg/l	1.8	2.3	1.6	1.9
T.Phos., mg/l	0.02	0.03	0.02	0.02
PO4-P, mg/l	0.02	0.02	0.02	0.02
NO2+NO3-N, mg/l	0.02	0.02	0.01	0.02
NH3-N, mg/l	<0.01	<0.01	<0.01	<0.01
Cl -, mg/l	3.0	2.5	2.5	2.5
SO4 =, mg/l	6	6	8	7
Fe, mg/l	0.2	0.2	0.2	0.2
Conductivity, μmho	111	109	109	110
Alkalinity, mg/l	44	44	42	43
T. Hardness, mg/l	54	48	50	51
Chlorophyll a, μg/l	-	-	1.34	1.34
Fecal Coliform	-	-	40	40

Dissolved Oxygen Data for 30 Apr 1986		
	Meter 8	
Average	8.3	
Minimum	7.3	
Maximum	9.3	

Table OM-33

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Saline River/Alum Fork
Date:	August 20, 1985
Drainage Area:	361 square miles
Watershed Land Use:	5% agriculture 95% forest
Stream Gradient:	4.1 ft/mi
Mean Channel Width:	126 feet
Mean Stream Width:	64 feet
Mean Stream Velocity:	NA
Observed Flow:	33.4 cfs
Average Substrate Type:	26% bedrock 4% large boulder 2% boulder 39% rubble 29% gravel
Mean Instream Cover:	2% brush, logs 3% inundated vegetation
Riffle/Pool Ratio of Transects:	60% riffle 20% moderate pool 20% deep pool
Mean Bank Overstory Cover:	95% trees 40% shrubs
Mean Bank Ground Cover:	72.5% grass and forbs 27.5% dirt
Mean Bank Stability:	100% moderately stable
Mean Stream Canopy:	11% canopy
Comments:	

were unique to the summer and spring samples comprising 42.4% and 45.2.% of their respective samples.

Summer - The dominant orders of the summer sample were Ephemeroptera (25.9%), Coleoptera (25.4%) and Diptera (13.1%), the same as the combined sample. Only Isonychia comprised greater than 10of the summer sample. Others unique to the summer sample and considered ecologically dominant included Gyretes, Helicopsyche borealis, Triaenoides and Stictochironomus. Taxonomically, the distribution of taxa among major groups reflected the broad-based stability as 5 of the dominant orders were represented by 10 or more taxa.

Spring - The dominant orders of the spring samples were Ephemeroptera (35.8%), Coleoptera (19.3%) and Plecoptera (18.2%). Only the stonefly, Perlesta placida, comprised greater than 5% of the numeric total. Other taxa unique to the spring benthic sample included Attanella attenuata. Several other stonefly taxa were present, but in small quantities. Although mayflies and beetles were the dominant orders of both samples, the seasonal variation between summer warmwater and spring coldwater forms acted to reduce the comparative indices.

The community parameters reinforced the magnitude of diversity exhibited by the benthic samples. All diversities were well above 5.0 and indicative of "high quality" water (Table OM-34). This diversity is a result of the least-disturbed nature of the watershed combined with the availability of microhabitat and the seasonal variability of insect populations.

Table OM-34. Community Anaylsis of Benthic Samples from Saline River - 30 Minute Qualitative Sample, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	1126	831	1957
Total # Taxa	82	75	116
Diversity	5.0119	5.1637	5.6403
Index of Evenness	0.4864	0.4167	0.4533
Index of Dominance	0.7883	0.8290	0.8239
Index of Variety	7.9905	7.6299	------
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.54	
Common Taxa Index (range 0-1)		0.51	
Qualitative Similarity Index (range 0-100)		28.0	

Fish Populations

Summer - Sampling at this site was done with the 3500-watt generator and electrofishing gear. Approximately three-fourths mile of the stream was traveled, but large parts of some deep pools could not be effectively collected. About 3 hours of collecting time was expended. Table OM-35

lists all species collected at this site. Thirty-three (33) species were taken during summer sampling and four additional species were taken in the spring. The total number of individuals collected in the summer sample was 1,531. This produced a total relative abundance value of 178.5 and a diversity index of 4.62. Cyprinidae was the dominant fish family and was closely followed by Percidae and Centrarchidae (Table OM-36). Primary feeding fishes of four species made up 13.2% of the population and five species of carnivores comprised 12.9%. A total of 45.9% of the population was composed of sensitive species.

Table OM-35. Fishes Collected from Saline River with Relative Abundance Values

SPECIES		R.A. VALUE
Noturus nocturnus	Freckled madtom	12.0
Etheostoma whipplei	Redfin darter	12.0
*Hybopsis x-punctata	Gravel Chub	12.0
Campostoma anomalum	Stoneroller	12.0
*Etheostoma zonale	Banded darter	12.0
*Etheostoma blennioides	Greenside darter	11.0
*Notropis boops	Bigeye shiner	10.0
Lepomis megalotis	Longear	9.5
Micropterus punctulatus	Spotted bass	9.0
Moxostoma erythrurum	Golden redhorse	7.5
*Moxostoma duquesnei	Black redhorse	7.5
*Micropterus dolomieui	Smallmouth bass	7.0
*Hypentelium nigricans	Northern hogsucker	6.5
Pimephales notatus	Bluntnose minnow	6.0
Notropis chrysocephalus	Striped shiner	6.0
*Etheostoma collettei	Creole darter	5.0
*Ambloplites ariommus	Shadow bass	5.0
Dorosoma cepedianum	Gizzard shad	4.5
*Notropis whipplei	Steelcolor shiner	4.0
Lepomis cyanellus	Green sunfish	2.0
Fundulus olivaceus	Blackspotted topminnow	2.0
Labidesthes sicculus	Brook silversides	2.0
Esox americanus	Grass pickerel	2.0
Noturus miurus	Brindled madtom	2.0
Lepomis macrochirus	Bluegill	2.0
Ichthyomyzon castaneus	Chestnut lamprey	1.0
*Percina copelandi	Channel darter	1.0
Lepomis microlophus	Redear	1.0
Notropis umbratilis	Redfin shiner	1.0
Lepomis gulosus	Warmouth	1.0
Lepomis punctatus	Spotted sunfish	1.0
Percina caprodes	Logperch	1.0
*Etheostoma histrio	Harlequin darter	1.0
Fundulus notatus	Blackstripe topminnow	S
*Noturus lachneri	Ouachita madtom	S
Ictalurus punctatus	Channel catfish	S
*Moxostoma carinatum	River Redhorse	S

*Sensitive Species
S - Collected during spring sampling only

Table OM-36. Summary of Fish Population Parameters from Saline River

Total Species Collected	37.0
Total Number of Individuals	1531.0
Total Relative Abundance Value	178.5
Relative Abundance Diversity Index	4.62

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	7.0	28.6
CATOSTOMIDAE	4.0	12.0
ICTALURIDAE	4.0	7.8
CENTRARCHIDAE	9.0	21.0
PERCIDAE	7.0	24.1
Primary Feeders	4.0	13.2
Macroinvertebrate Feeders	28.0	73.9
Carnivores	5.0	12.9
Sensitive Species	13.0	45.9

Spring - Trammel nets of 1½", 2" and 2½" square mesh were set overnight on April 30, 1986, at this site. Also, electrofishing was done with the backpack shocker on the shallow riffles and shoreline. Flow was estimated to be about 400 cfs and water temperature was between 18°C and 20°C. Only seven fish from three species weighing 20 pounds were caught in the nets; however, two of the species, channel catfish and river redhorse, were not collected the previous summer. Electrofishing produced 23 species. An additional two species from this group were not collected the previous summer. One of these species was the Ouachita madtom which is an endemic species of a very restricted range in the upper Saline River watershed. From gonad examination of many of the collected fishes, it was determined that the river redhorse had completed spawning; one shadow bass was in the spawning process; most of the Cyprinids and Percids were in the final stage of ova maturation; and the madtoms were gravid and nearing maturation.

OZARK HIGHLANDS ECOREGION

The Ozark Highlands, as defined for this project, includes both the Salem and Springfield Plateaus. This area is located in the northwestern and north central portion of Arkansas.

Surface rocks of this region - predominantly sedimentary and carbonaceous - are composed of limestones, dolomites and Jefferson City Dolomite. These formations are approximately the same age as the Ouachitas, dating from the Lower Ordovician (500 million years old) to Mississippian Periods. Weathering of the Boone formation leaves behind a layer of insoluble chert, forming a surface veneer over much of the area where this formation is exposed. As a result, fragments of this chert constitute the principal material of stream beds in these areas.

The entire Ozark Region, including the area discussed here and also the Boston Mountains, was uplifted as a whole with very little folding. Thus, the rock strata are horizontal and continuous. These layers have been deeply and intricately cut by numerous streams and rivers, which has produced rugged terrain of flat-topped mountains with steep slopes and relief. Local relief can be as much as 1000 feet in some areas. Sinkholes and caves are common in this region.

Soils in the Ozark Highlands are slowly to moderately permeable and are composed of silts and loams with some clayey soils associated with the chert. Soils are very shallow on the hillsides and deep in the valley floors.

Streams are composed of pools and riffles with bedrock, chert rubble or gravel substrate. Gradients are moderate to high. There are numerous springs and sinkholes in the area and stream can gain or lose considerable portions of flow via these springs or sinkholes. The streams typically have very low turbidity. Because of the terrain and clear water, these streams have high recreational potential. Designated as a National Scenic River, the Buffalo River is an excellent example.

Forests are upland hardwood with shortleaf pine and cedar glades. Portions of the Springfield Plateau, particularly in the extreme northwest corner of the state, contain upland prairies which are now utilized primarily as pasture.

Land use in the Ozark Highlands consists of diversified agricultural activities (confined animal operations, limited row crops for cannery operations, fruit, berry and grape production) pasturelands and some silviculture. Part of the Ozark National Forest is in this region. The area is popular for camping, canoeing and other outdoor activities.

The reference streams selected in the ecoregion and the size of the watershed above the sample stations are as follows:

South Fork Spavinaw	18 mi^2
Flint Creek	19 mi^2
Yocum Creek	55 mi^2
Long Creek	184 mi^2
War Eagle Creek	263 mi^2
Kings River	526 mi^2

SOUTH FORK OF SPAVINAW CREEK

The watershed of South Fork of Spavinaw Creek is adjacent to and directly north of the Flint Creek drainage. South Fork flows in a northwesterly direction until it flows into the main stem of Spavinaw Creek. Spavinaw Creek then flows southwesterly into the Grand River in Oklahoma.

The sample site on this stream is located in Section 19, R 3 W, T 20 N in northwest Benton County, approximately ¼ mile upstream from the main stem of Spavinaw Creek (Figure OZ-1).

General Site Discussion

Watershed Size - Above the sample site, the watershed drains approximately 18 mi.^{2}.

Topography - This stream, at the study site, has a gradient of 25.5 ft/mi and drains a watershed consisting of rolling hills in excess of 1300 feet high, as well as plateau areas of around 1200 feet in elevation. This is typical of the Springfield Plateau segment of the Ozark Highlands.

Geology - The geology of the area is limestone and chert surface rock associated with the Boone formation.

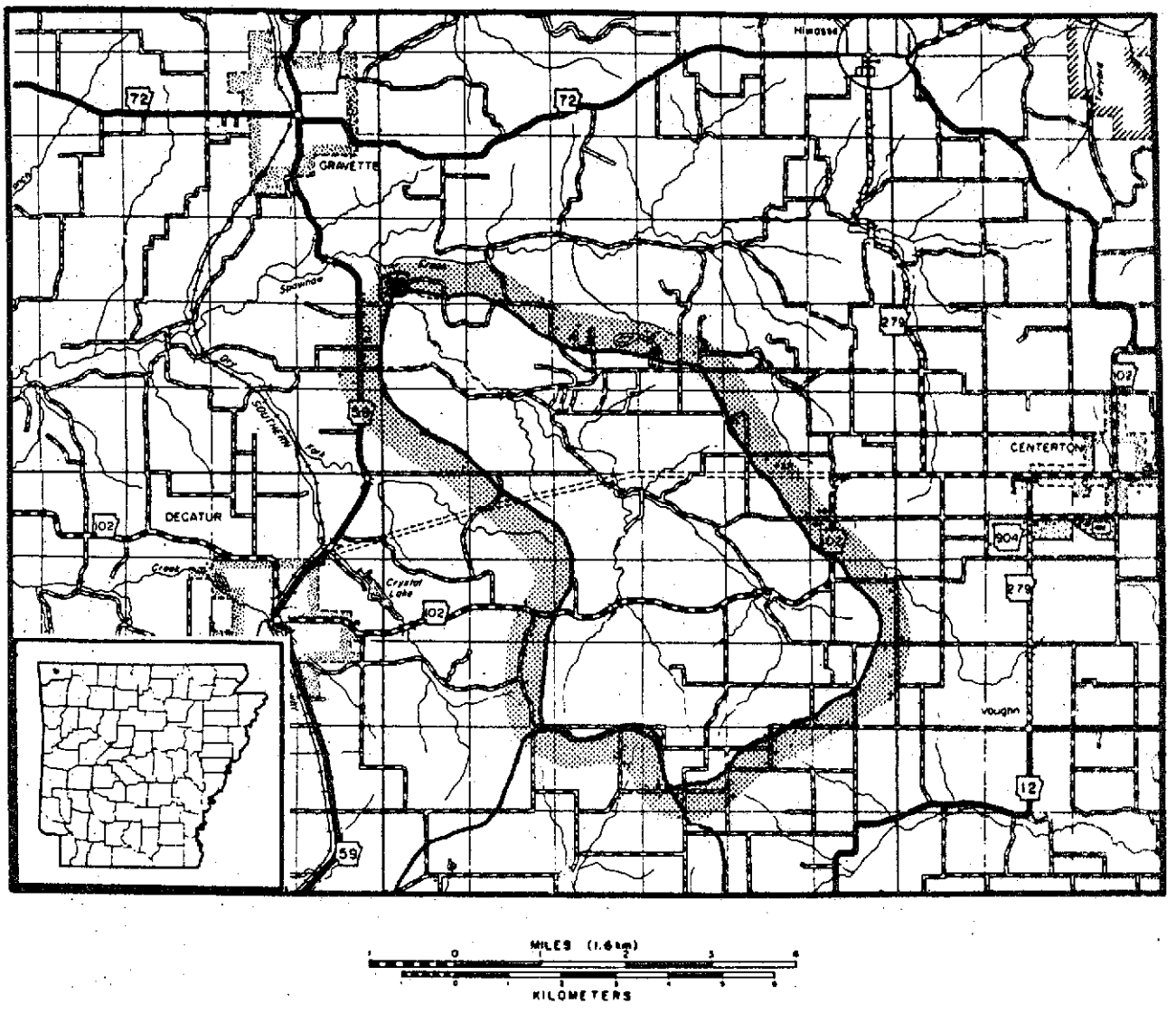
Soil Types - Soils in the Spavinaw Creek area are of two associations. Riparian area soils are of the Secesh-Britwater-Captina association. They are well drained and moderately well drained, level to moderately sloping and deep with loamy soils on floodplains and terraces. These soils are moderately acidic (pH ranges from 5.1 to 6.5). The erosional potential is slight.

The drainage area is dominated by the Clarksville-Nixa-Noark association which is somewhat excessively drained to moderately well drained, gently sloping to steep, deep and moderately deep with cherty soils on hills and ridges. Soil is moderately acidic to very strongly acidic (pH ranges from 4.5 to 6.0). Potential for erosion is moderate.

Flora - Approximately 30% of this watershed is forested. The vegetation is basically the same as that of Flint Creek, with birch, willow and alder adjacent to the stream and oak, hickory, walnut and box elder in the watershed.

Land Use - Approximately 70% of this watershed has been developed for agricultural uses, dominated by cattle and poultry farming. The remainder of the watershed is timbered.

Figure OZ-1



SOUTH FORK SPAVINAW CREEK: Drainage area 18 square miles ■ Survey site ▒ Survey area

Stream Characteristics - South Fork of Spavinaw Creek is a series of riffles and pools at approximately a 50:50% ratio. The substrate is dominated by gravel with the remaining substrate consisting of rubble. The creek has good instream cover composed of inundated vegetation, overhanging vegetation and brush, logs and other debris. The Q_{7-10} for this stream is estimated to be between 0 and 1 cfs, according to U.S.G.S. flow data.

Methodology and Sampling Results

South Fork of Spavinaw Creek was sampled concurrently with Flint Creek. The summer sampling was conducted during the week of September 19-23, 1983. Both creeks were sampled again in the spring of 1984 during the week of May 14-18.

Continuous Dissolved Oxygen

Summer - The continuous recording dissolved oxygen meters were placed in the stream on Monday afternoon; one in a riffle and two others at the middle and end of a pool. The diurnal variation was quite pronounced in both the summer and spring surveys. During the summer, D.O. variations of 2.6 mg/l and 2.2 mg/l were encountered in the pool and riffle samples, respectively (Figures OZ-2 through OZ-4). Dissolved oxygen values recorded on September 19 are more typical of late summer conditions. A cold front moved into the area on September 20 and significantly changed the stream temperature and instream D.O.

Spring - Springtime results showed a greater than 2 mg/l D.O. variation (Figures OZ-5 and OZ-6). This fluctuation again reflects the watershed land use patterns due to the predominance of pastureland drainage. The application of hog and poultry wastes on these pasturelands creates the potential for nutrient contributions to the streams in the region following rainfall events. The nutrients stimulate the growth of algae and periphyton, and the photosynthesis/respiration cycle causes substantial D.O. fluctuations.

Chemical Analyses

Water samples for chemical, chlorophyll $\bar{a}$, and bacteriological analyses were collected on Tuesday of the survey week. Chemical parameters indicated high conductivity and total hardness, low turbidity values, high chlorophyll $\bar{a}$ and fecal coliform bacteria. The results of the chemical analyses have been summarized and included as Tables OZ-1 and OZ-2.

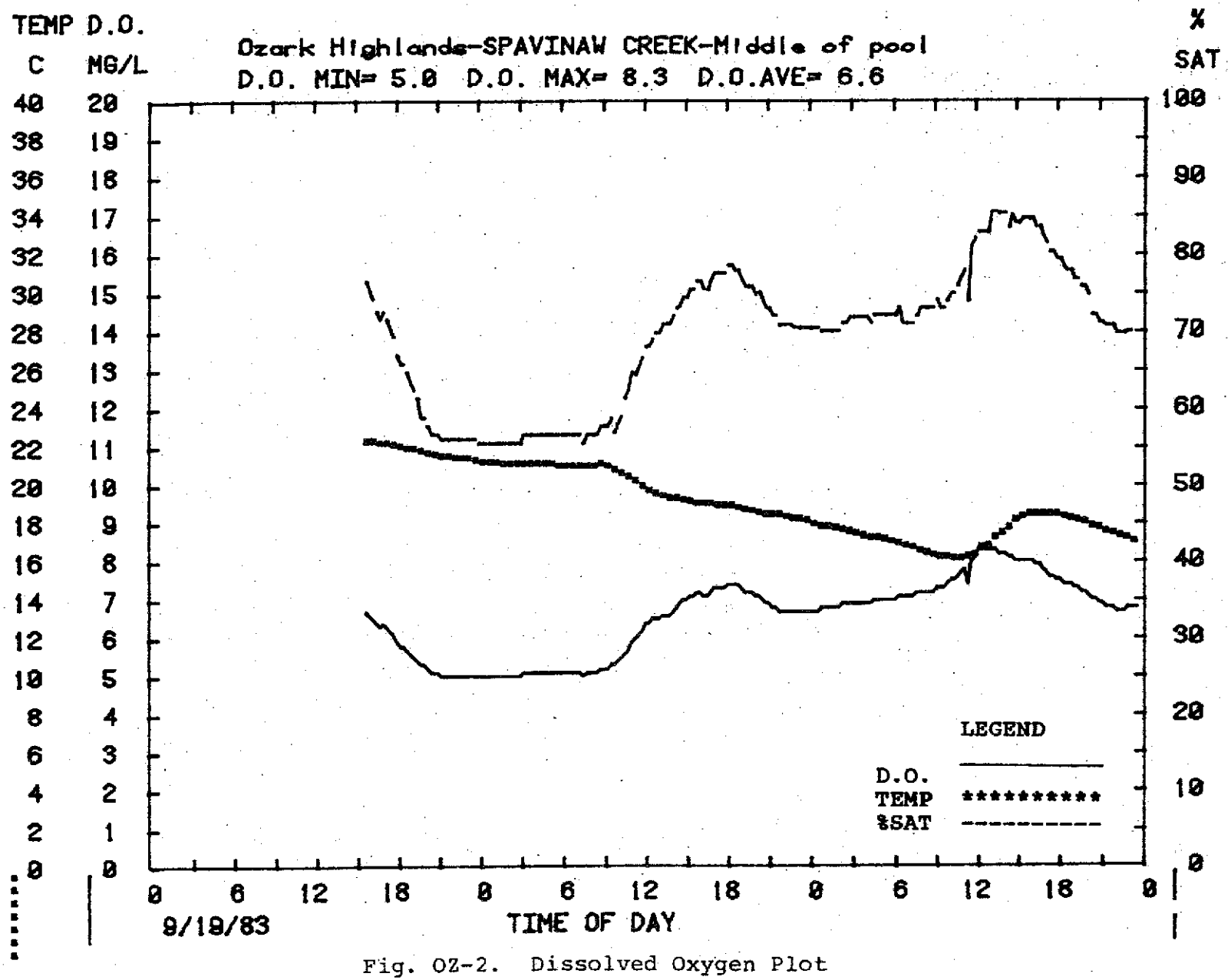


Fig. OZ-2. Dissolved Oxygen Plot

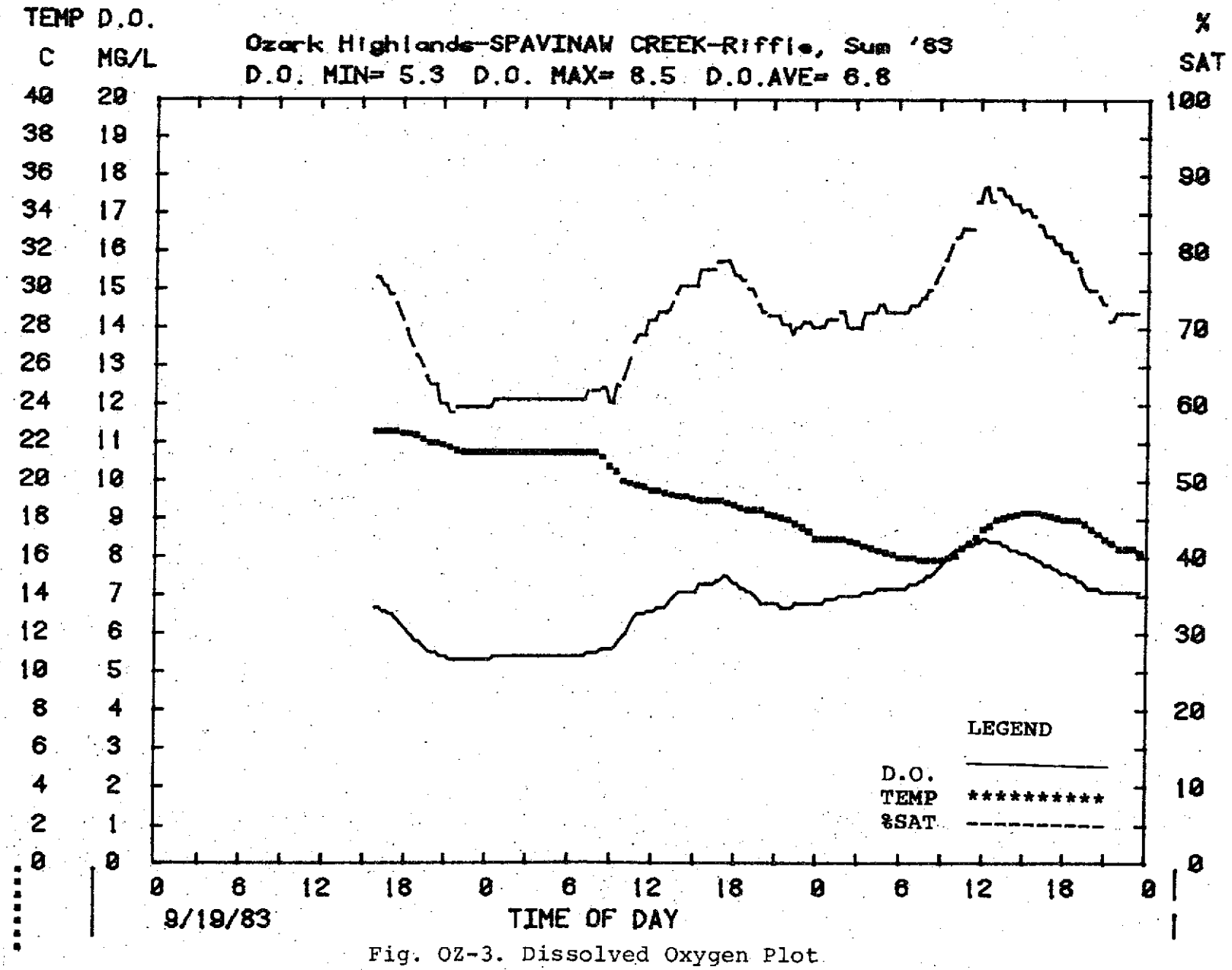


Fig. OZ-3. Dissolved Oxygen Plot

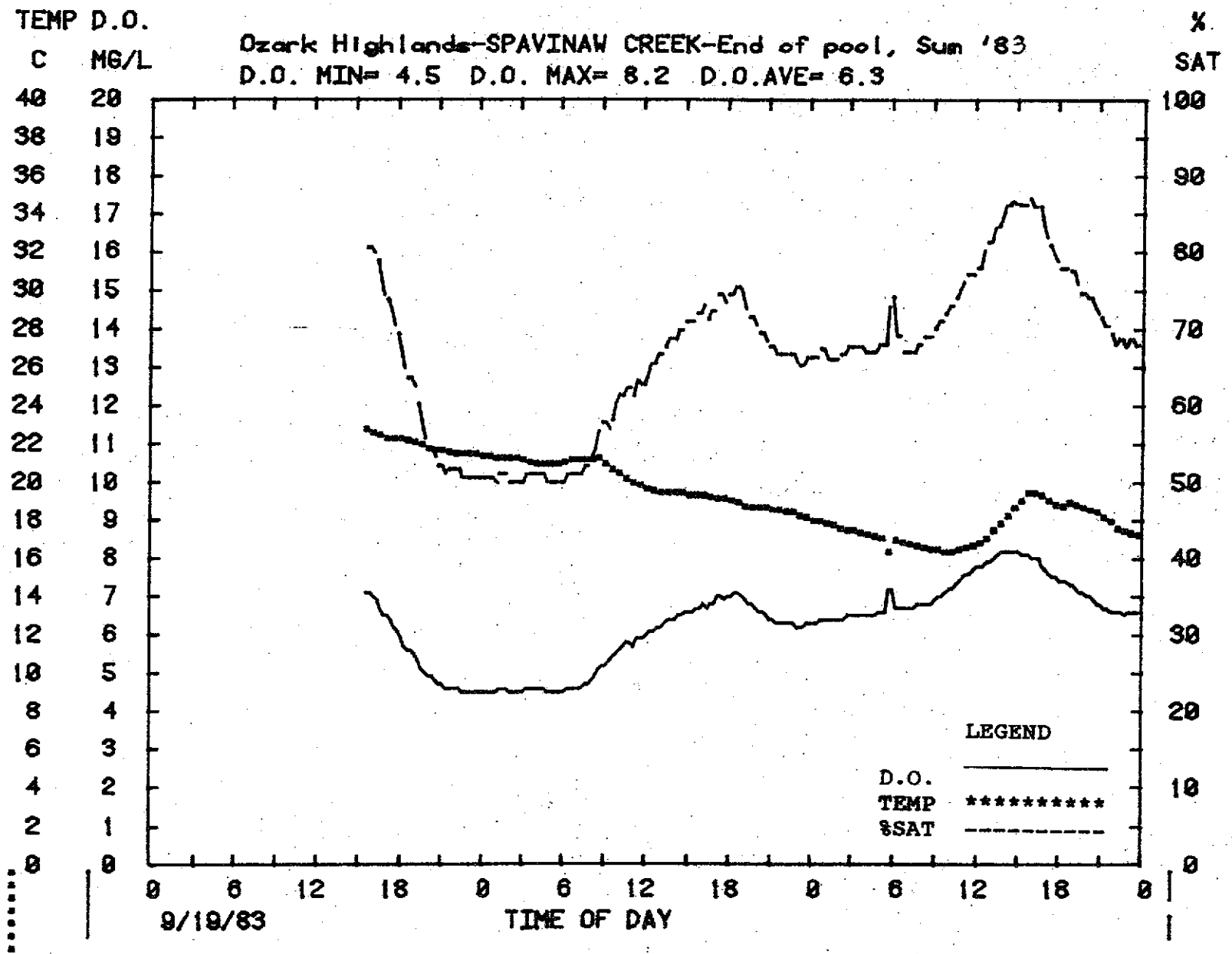


Fig. OZ-4. Dissolved Oxygen Plot

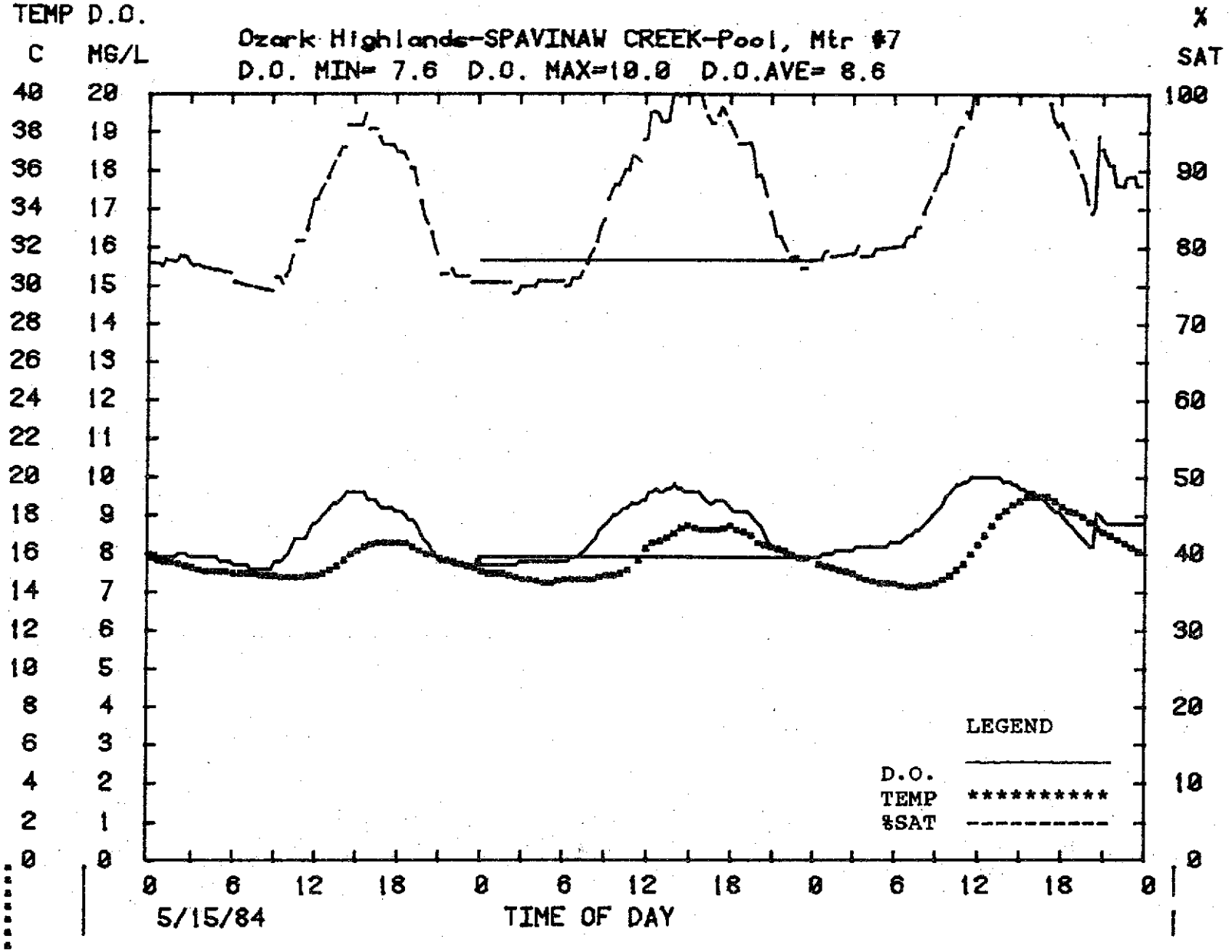


Fig. OZ-5. Dissolved Oxygen Plot

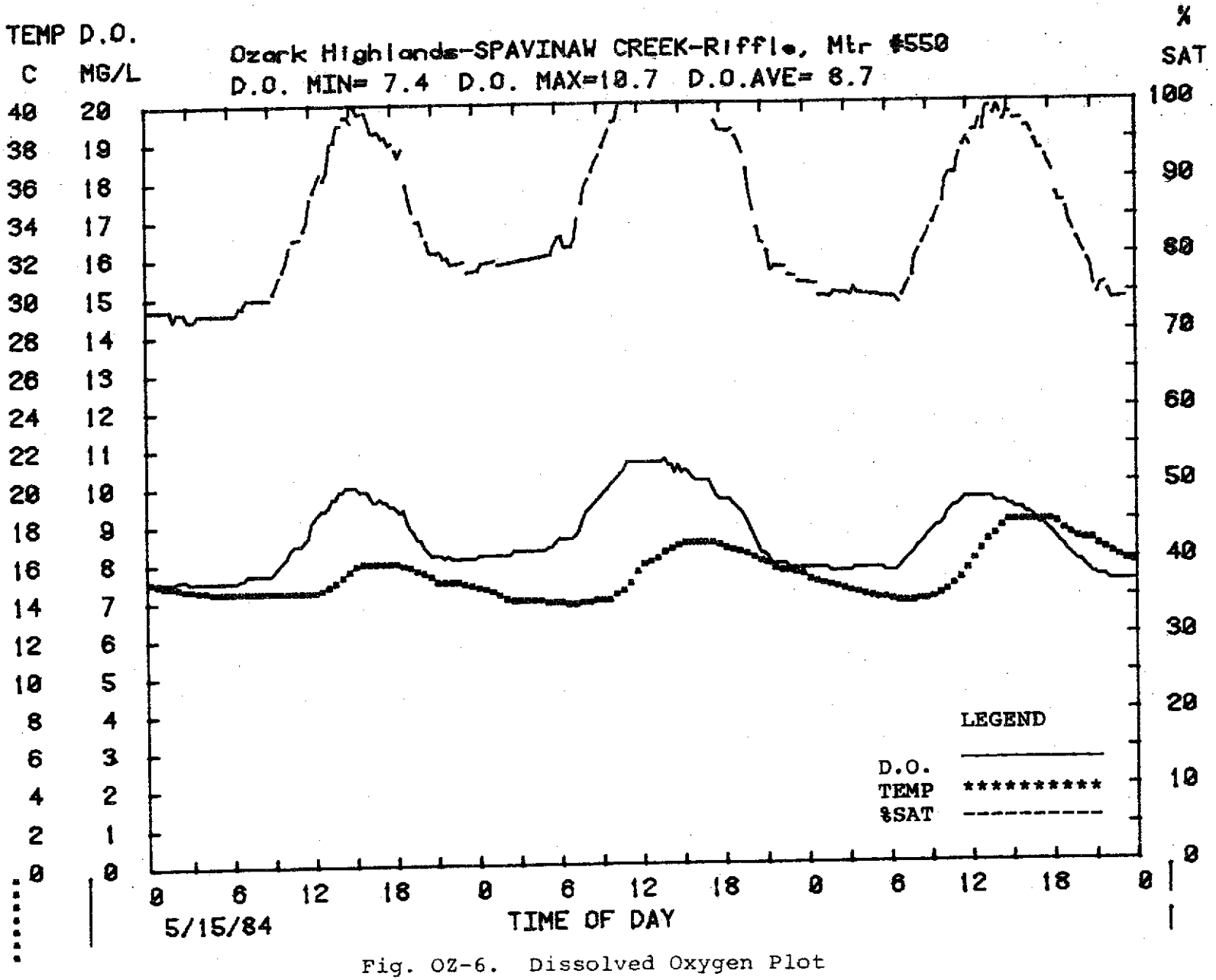


Fig. OZ-6. Dissolved Oxygen Plot

Table OZ-1

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: South Fork Spavinaw Creek

Drainage Area: 18 square miles

Station Description: Middle of pool 150 ft. above bridge on county road in SW ¼ of Section 19, T 20 N, R 32 W, Benton County

Date: September 20, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	09:30	12:30	14:41	
Q, cfs	xxx	1.4	xxx	1.4
Temperature, °C	20.5	20.0	19.5	20.0
pH	6.8	na	na	6.8
Turbidity, ntu	1.8	2.0	0.9	2.0
TSS, mg/l	1	4	1	2
TDS, mg/l	146	144	146	145
BOD-5, mg/l	<.4	0	0	<.2
BOD-20, mg/l	1.3	0.8	0.4	0.8
T.Phos., mg/l	.02	.01	.01	.01
PO4-P, mg/l	.02	.01	.01	.01
NO2+NO3-N, mg/l	.91	.93	.91	.92
NH3-N, mg/l	.01	.01	<.01	.01
Cl -, mg/l	8	8	8	8
SO4 =, mg/l	2	2	1	2
Fe, mg/l	<.05	<.05	<.05	<.05
Conductivity μmho	225	231	225	227
Alkalinity, mg/l	-	-	-	-
T. Hardness, mg/l	120	116	116	117
Chlorophyll a, μg/l	0.3	na	1.1	0.5
Fecal Coliform	-	-	350	350

Dissolved Oxygen Data for September 20, 1983		
	Pool	Riffle
Average	5.7	6.3
Minimum	4.5	5.3
Maximum	7.1	7.5

Table OZ-2

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: South Fork Spavinaw Creek

Drainage Area: 18 square miles

Station Description: Middle of pool 150 ft. above bridge on county road in SW ¼ of Section 19, T 20 N, R 32 W, Benton County

Date: May 15, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:20	09:20	10:45	
Q, cfs	-	-	-	16.9
Temperature, °C	15	15	15	15
pH	7.3	7.3	7.3	7.3
Turbidity, ntu	1.5	4	1.5	2
TSS, mg/l	1	7	2	3
TDS, mg/l	113	115	115	114
BOD-5, mg/l	.5	.7	.6	.6
BOD-20, mg/l	1.5	1.9	1.6	1.6
T.Phos., mg/l	.01	.02	.01	.01
PO4-P, mg/l	.01	.01	.01	.01
NO2+NO3-N, mg/l	1.52	1.52	1.50	1.51
NH3-N, mg/l	.05	.04	.03	.04
Cl -, mg/l	4	4	4	4
SO4 =, mg/l	4	4	3	4
Fe, mg/l	<.02	.04	<.02	.03
Conductivity µmho	183	180	177	180
Alkalinity, mg/l	69	69	69	69
T. Hardness, mg/l	90	92	84	89
Chlorophyll a,ug/l	2.1	1.9	1.1	1.7
Fecal Coliform	-	-	2500	2500

Dissolved Oxygen Data for May 15, 1984		
	Pool	Riffle
Average	8.3	8.4
Minimum	7.6	7.5
Maximum	9.6	10.0

Physical Parameters

The physical characteristics of South Fork of Spavinaw Creek include a watershed with mainly agricultural uses, steep slopes and a substrate dominated by chert gravel. South Fork of Spavinaw Creek had 33% total stream cover, including 23% inundated vegetation (primarily water willow), 5% overhanging vegetation and 5% brush, logs and debris. The mean stream canopy was 19% in the study area.

Summer stream flows were measured as 1.4 cfs at South Fork of Spavinaw and spring flows were 16.9 cfs. The summer stream velocity was 0.55 feet per second over the length of the study site.

The pool/riffle percent ratio was approximately 50:50 and the pools were generally shallow. The estimated average stream depth was less than 0.5 feet while the average width was 27.6 feet during the summer. The spring stream velocity was 1.54 feet per second. A summary of the physical data on this stream is included as Table OZ-3.

Macroinvertebrate Populations

A total of 76 taxa, representing 12 orders, were identified from samples collected in South Fork of Spavinaw Creek (Table A-26, Appendix A). Twenty-three (23) taxa were collected in the summer, and 70 taxa were identified from the spring sample. In addition to the increase in taxa collected, the number of organisms collected in spring was more than five times that collected in fall. Increases were due largely to the increased sampling effort in the spring.

The qualitative comparative indices indicated that the summer and spring samples were slightly dissimilar (Table OZ-4). These values are lower than expected, and were primarily due to the three-fold increase in number of taxa collected in the spring. Seventy-four percent (74%) of the taxa identified from the summer sample were also present in the spring sample. Four of the five dominant groups of the summer sample were also the dominant groups in the spring sample. Numerically, the mayflies, snails, caddisflies and stoneflies collectively composed 73% and 76% of the summer and spring samples, respectively. Taxonomically, these groups accounted for 52% and 59% of the taxa. All five dominant taxa of the summer sample - Viviparus, Cheumatopsyche, Psephenus herricki, Corydalus cornutus and Acroneuria evoluta were also collected in the spring sample.

Community parameters calculated for the South Fork of Spavinaw benthic community resulted in the highest values recorded for the small watershed streams. The diversity index calculated for the spring collection was substantially

Table OZ-3

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	South Fork Spavinaw Creek
Date:	September 20, 1983
Drainage Area:	18 square miles
Watershed Land Use:	70% pastureland 30% forest
Stream Gradient:	25.5 ft/mi
Mean Channel Width:	78.5 feet
Mean Stream Width:	27.6 feet
Mean Stream Velocity:	0.55 ft./sec.
Observed Flow:	1.4 cfs
Average Substrate Type:	13% rubble 87% gravel
Mean Instream Cover:	0% undercut bank 5% brush,logs,debris 5% overhanging vegetation 23% inundated vegetation
Riffle/Pool Ratio of Transects:	50% riffle 0% deep pool 0% moderate pool 50% shallow pool
Mean Bank Overstory Cover:	99% trees 69% shrubs
Mean Bank Ground Cover:	32% grasses and forbs 68% dirt
Mean Bank Stability:	10% stable 55% moderate 35% unstable
Mean Stream Canopy:	19%
Comments:	

greater than that calculated from the summer collection. Likewise, all other parameters calculated exhibited a marked increase. The distribution among taxa was remarkably even. Only one taxa (Viviparus) comprised greater than 10% of the sample.

The major difference in summer and spring samples reflected the inadequate sampling period of the initial summer survey and not a change in water quality from summer 1983 to spring 1984.

Table OZ-4. Community Analysis of Benthic Samples from South Fork Spavinaw Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	163	867	1030
Total # Taxa	23	71	77
Diversity	3.2802	4.9825	4.3311
Index of Evenness	0.7251	0.8102	0.8428
Index of Dominance	0.3931	0.3054	0.3165
Index of Variety	2.9937	7.1709	6.0892
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.40	
Common Taxa Index (range 0-1)		0.34	
Qualitative Similarity Index (range 0-100)		28.0	

Fish Populations

Summer - The South Fork of Spavinaw Creek was sampled for a distance of approximately 400 yards upstream from the low water bridge using electrofishing gear. A 3500-watt, 220-volt, A.C. generator was the power source; it was transported upstream in a canoe as collectors waded the stream. Small mesh seines were used to block off the stream downstream of a sampling location in order to stop fleeing fish as well as to catch stunned fish not picked up during the shocking operation.

Table OZ-5 lists the species collected in order of their relative abundance. Fourteen species were identified from a total of 1111 fish collected at this site. The total relative abundance value was 114.5, the diversity index was 3.55 and the index of evenness was 0.93. Cyprinidae dominated this population, comprising 47.2% of the relative abundance value. Cyprinidae was followed by Percidae at 18.3%, Centrarchidae at 11.8%, Ictaluridae at 10.5%, and Catostomidae at 1.7%. The total number of species for each of these families were 5, 2, 4, 1 and 1, respectively. Two species of primary feeders comprised 19.7% of the total

population relative abundance value, 11 species of secondary feeders totaled 61.5% and three species of top carnivores made up 18.8% of the total (Table OZ-6).

Ten of the 14 species collected were considered sensitive species and they comprised 80.8% of the population relative abundance.

Table OZ-5. Fishes Collected from South Fork Spavinaw Creek on September 21, 1983, with Relative Abundance Value

Species		R.A. Value
*Notropis pilsbryi	Duskystripe shiner	12.0
*Phoxinus erythrogaster	Southern redbelly dace	12.0
*Noturus exilis	Slender madtom	12.0
*Etheostoma flabellare	Fantail darter	12.0
*Cottus carolina	Banded sculpin	12.0
*Semotilus atromaculatus	Creek chub	10.5
Campostoma anomalum	Stoneroller	10.5
*Nocomus asper	Redspot chub	9.0
*Ambloplites rupestris	Rock bass	9.0
Etheostoma spectabile	Orangethroat darter	9.0
*Hypentelium nigricans	Northern hogsucker	2.0
*Micropterus dolomieui	Smallmouth bass	2.0
Lepomis cyanellus	Green sunfish	1.5
Lepomis hybrid	Sunfish (hybrid)	1.0
	Total	114.5

*Sensitive species

Spring - Electrofishing gear was also used to collect fish from this area on May 16, 1984. The 3500-watt, 120-volt, A.C. generator was used at this time. The thirteen species collected and the number of individuals taken are listed below:

Species	Number
Campostoma anomalum	73
Notropis pilsbryi	57
Notropis rubellus	66
Semotilus atromaculatus	18
Phoxinus erythrogaster	98
Nocomus asper	15
Hypentelium nigricans	2
Noturus exilis	70
Ambloplites rupestris	17
Etheostoma spectabile	9
Etheostoma flabellare	55
Etheostoma punctulatum	3
Cottus carolinae	unknown

Two species were collected in this sample which were not taken in the summer of 1983 sample. These were the rosyface shiner and stippled darter. These fishes increased the total species collected to 16 with 12 sensitive species.The green sunfish and smallmouth bass were not collected in this sample but were taken the previous summer. During this sample the following species were exhibiting breeding colorations: stoneroller, duskystripe shiner, redbelly dace, redspot chub and orangethroat darter.

Table OZ-6. Summary of Fish Population Parameters from South Fork of Spavinaw Creek

Total Species Collected	16
Total Number of Individuals	1111
Total Relative Abundance Value	114.5
Relative Abundance Diversity Index	3.55

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6	47.2
CATOSTOMIDAE	1	1.7
ICTALURIDAE	1	10.5
CENTRARCHIDAE	4	11.8
PERCIDAE	3	18.3
Primary Feeders	2	19.7
Macroinvertebrate Feeders	11	61.5
Carnivores	3	18.8
Sensitive Species	12	80.8

FLINT CREEK

Flint Creek begins in the west central part of Benton County and flows in a southwesterly direction. Little Flint Creek flows into the main stem of Flint Creek less than one mile from the Oklahoma border. They enter the Illinois River in northest Oklahoma. The Flint Creek sample site is located in the southwest part of Benton County at the Highway 59 bridge in Section 15, R 33 W, T 18 N (Figure OZ-7).

General Site Discussion

Watershed Size - The total drainage area of Flint Creek above this sample site is 19 $mi.^2$.

Geology - The geology of this watershed is typical of the Springfield Plateau. Surface rock is composed of limestone and chert of the Boone Formation.

Topography - The topography of the area generally consists of relatively flat to rolling hill terrain. Elevations range from approximately 1100 feet adjacent to the stream to as high as 1400 feet in the upper portion of the watershed. The stream gradient at the sample site is 20 ft/mile.

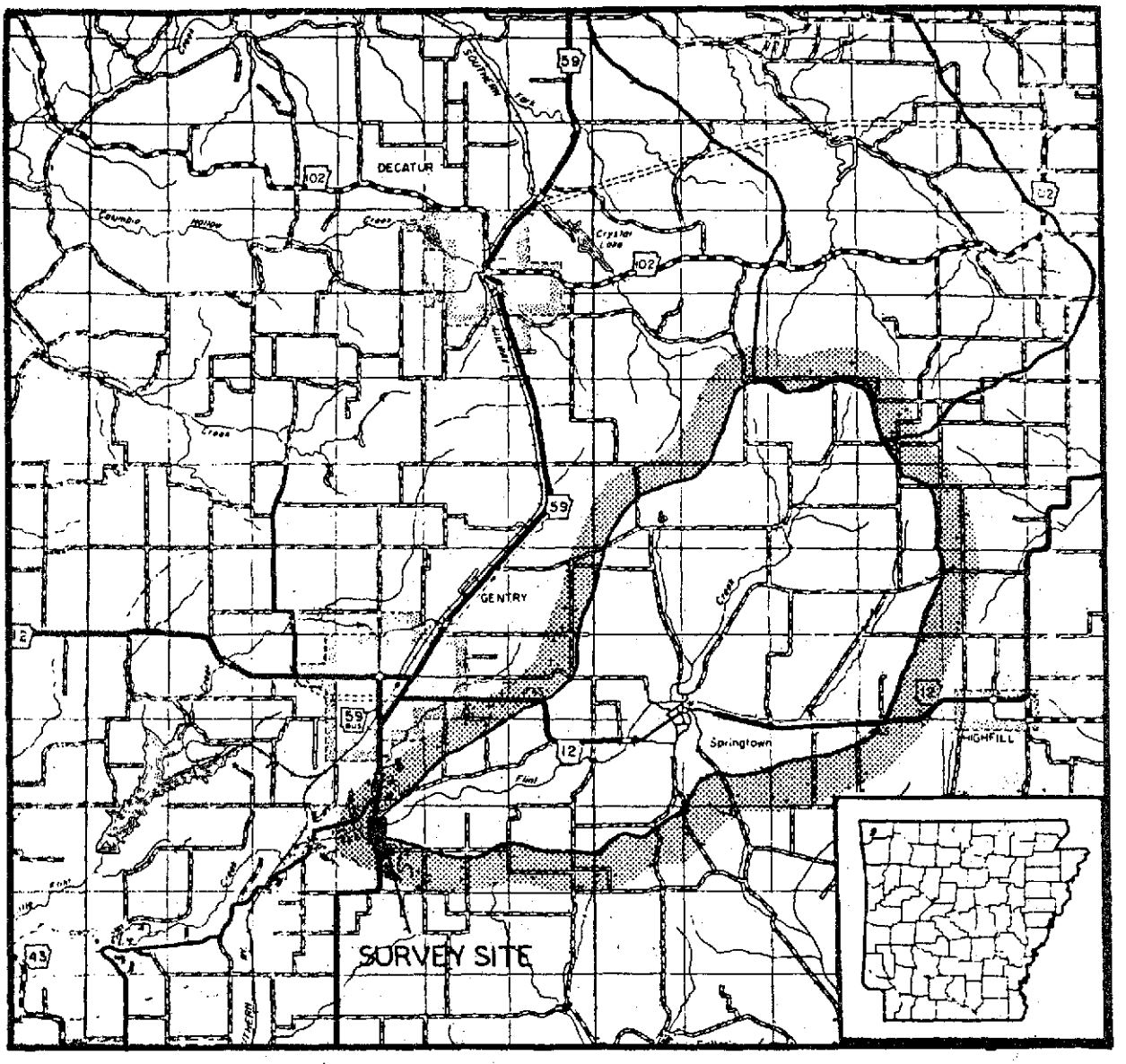
Soil Type - Soils within the riparian area are of the Secesh-Britwater-Captina association which are well-drained and moderately well-drained, level to moderately sloping and deep, with loamy soils on floodplains and terraces. The potential for erosion for soils within this association is only "slight." Acidity is strong to moderate (pH ranges from 5.1 to 6.5).

In the drainage area, the Clarksville-Nixa-Noark association predominates. It is somewhat excessively drained to moderately well-drained, gently sloping to steep, deep and moderately deep, with cherty soils on hills and ridges. Soil is moderately acidic to very strongly acidic (pH ranges from 4.5 to 6.0). The erosional hazard is "moderate."

Flora - Generally, vegetation consists of upland hardwoods in this drainage basin, with the dominant stream bank vegetation consisting of river birch, black willow and river alder. Farther away from the stream's edge, oaks, hickory, ash and box elder are the dominant tree species.

Land Use - Land use is dominated by agricultural development, primarily consisting of cattle farming, hog- and chicken-raising operations, vineyards and orchards. Approximately 80% of the watershed of Flint Creek is used for agriculture while 20% remains forested. Application of chicken litter and hog manure to pastures is a common practice.

Figure OZ-7



FLINT CREEK: Drainage area 19 square miles ■ Survey site ▒ Survey area

Stream Characteristics - Flint Creek, a small, spring-fed stream originating a few miles east-northeast of Gentry, Arkansas, flows in a west-southwest direction into Oklahoma. At the stream study site the average channel width was 34.8 feet and the actual stream width was 28.9 feet during the summer sampling period.

Springs in the watershed provide flow throughout the year; however, the Q_{7-10} of this stream is less than 1 cubic foot per second. The stream consists of alternating riffles and shallow pools at approximately a 40:60% ratio. The stream substrate is dominated by gravel and rubble and has good instream cover for aquatic life.

Methodology and Sampling Results

This site was sampled during the week of September 19-23, 1983, and during May 14-18, 1984.

Continuous Dissolved Oxygen

Summer - Continuous dissolved oxygen and temperature recorders were placed in the pool and riffle areas of the stream. Three meters were installed for the summer sampling, two in the pool and one in the riffle. The meter at the riffle site malfunctioned.

The results of the continuous dissolved oxygen sampling showed that the diurnal variation was larger in Flint Creek than any other small watershed stream sampled (Figures OZ-8 and OZ-9). A variation of 2.8 mg/l was recorded at this location during the summer survey. The summer dissolved oxygen data can be somewhat misleading, unless the associated water temperature is considered. September 19, 1983, the day the continuous meters were placed in the stream, was a typical early fall day with a water temperature of 24°C. A cold front reduced the air temperature approximately 22°F during the next 24-hour period. As a result, the stream temperature dropped 10°C, thereby increasing the dissolved oxygen concentration and saturation percentage. Therefore, only the first day (September 19) is representative of typical summer conditions for Flint Creek.

Spring - Only two meters were used for the spring survey; both functioned properly. The springtime D.O. data produced a diurnal variation of 2.7 mg/l (Figures OZ-10 and OZ-11). The diurnal oxygen variation during both spring and summer may be due to nutrient contributions from the watershed producing algae growth on the substrate and in the water column. With an average stream canopy of only 11%, ample sunlight is available for photosynthetic activity.

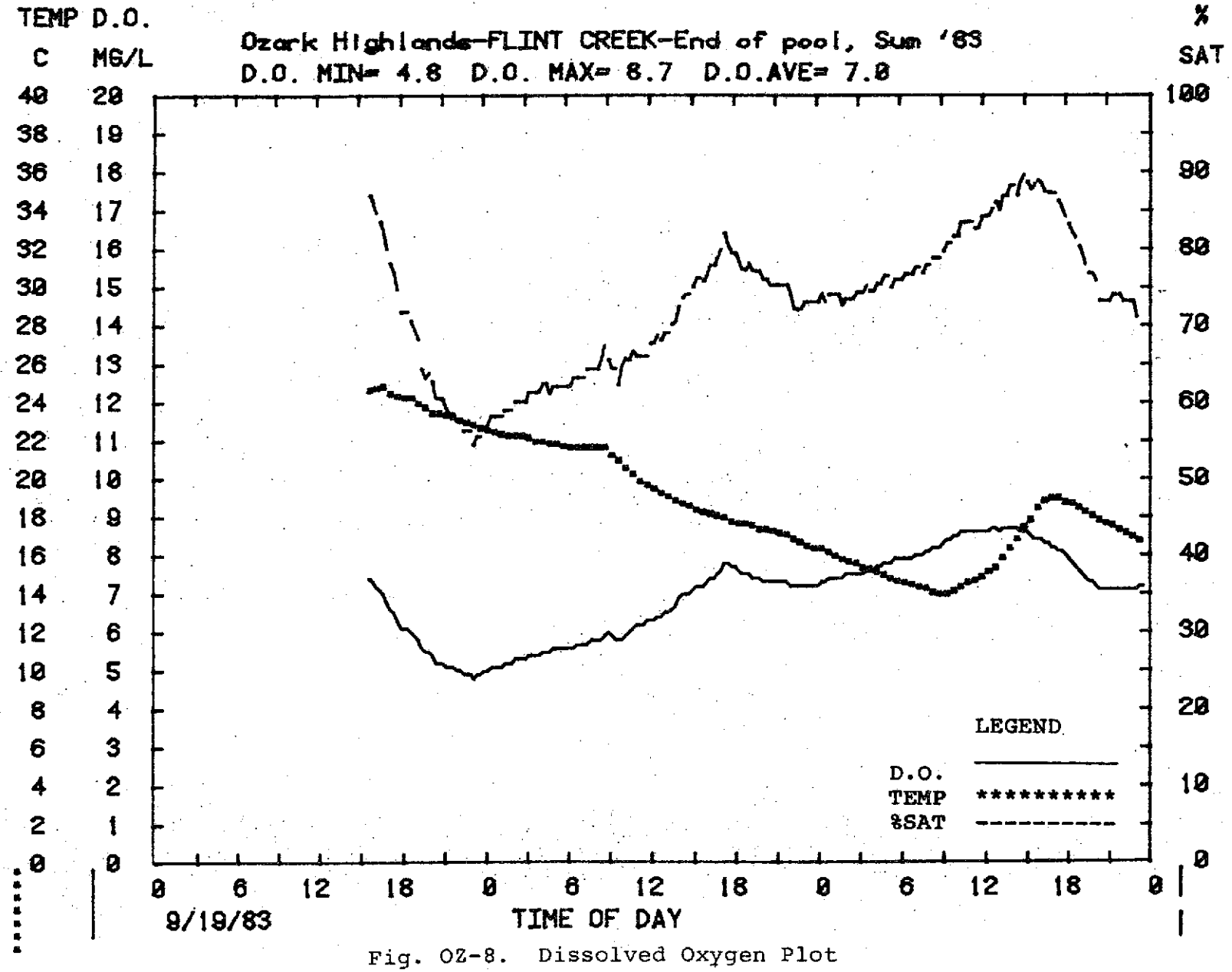


Fig. OZ-8. Dissolved Oxygen Plot

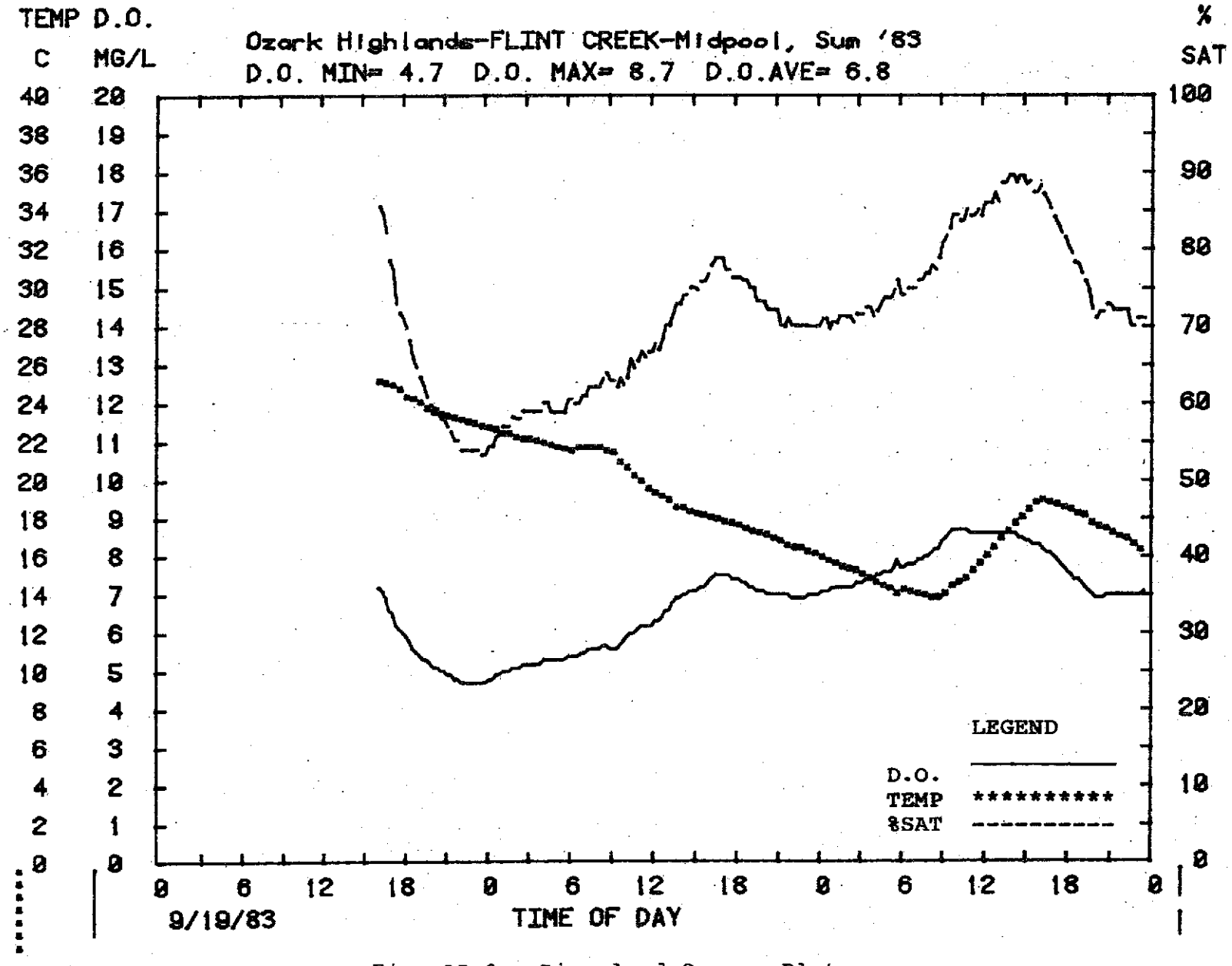


Fig. OZ-9. Dissolved Oxygen Plot

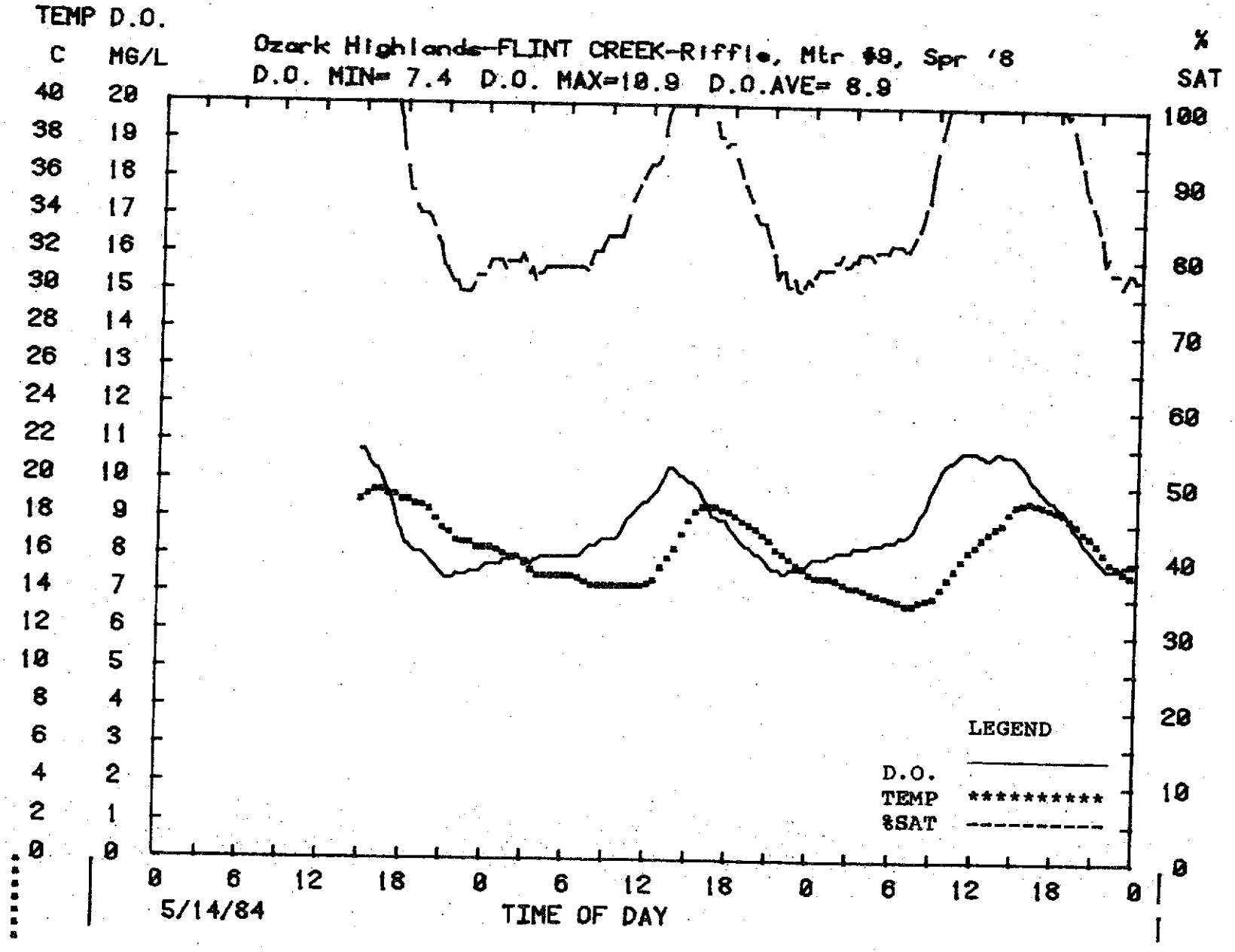


Fig. OZ-10. Dissolved Oxygen Plot

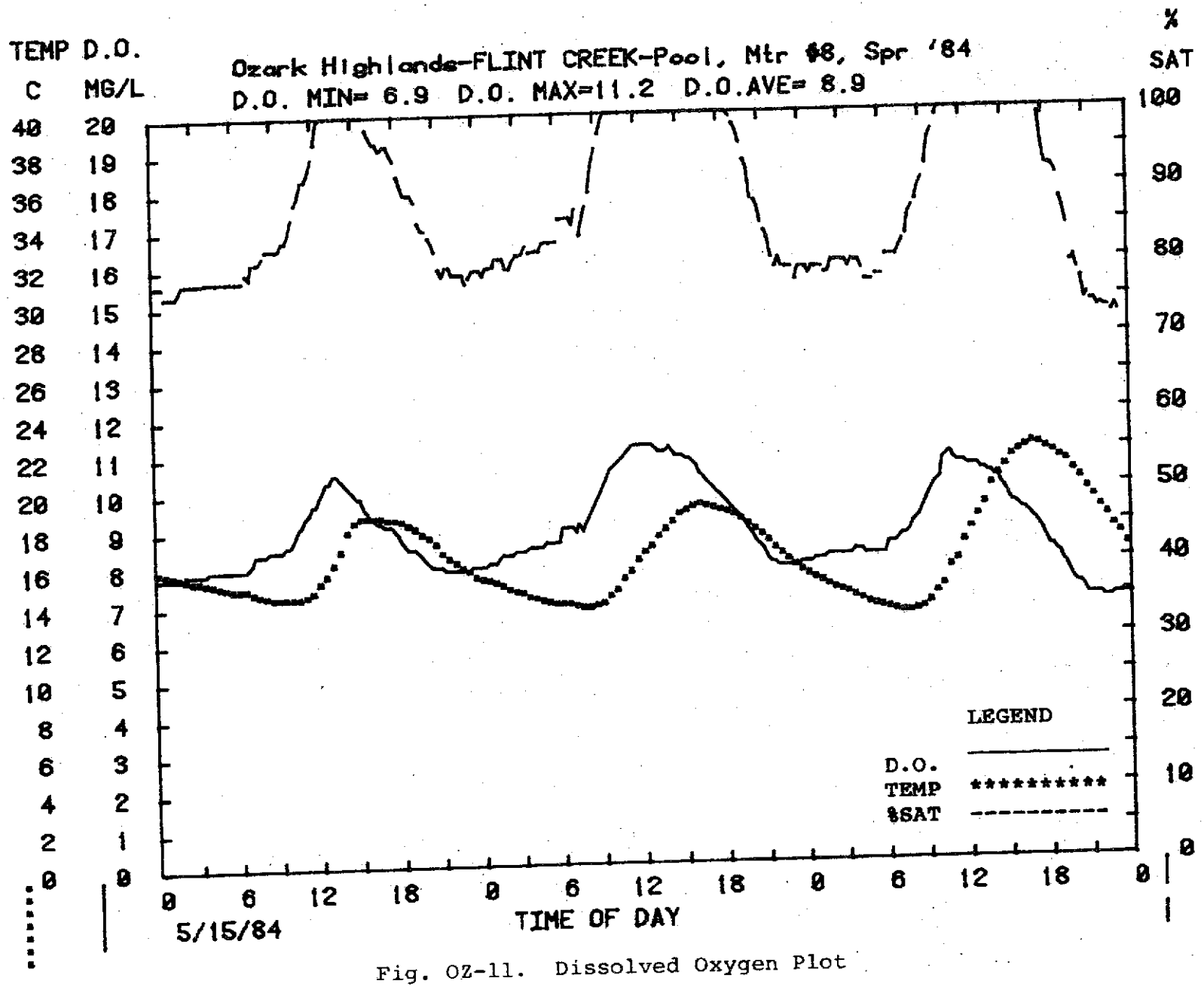


Fig. OZ-11. Dissolved Oxygen Plot

Chemical Parameters

The chemical parameters measured in the summer and spring surveys are listed in Tables OZ-7 and OZ-8. Many of these parameters reflect the agricultural activities in the watershed. The high readings of fecal coliform bacteria and nitrite-nitrate nitrogen are probably due to the practice of spreading poultry manure on pasturelands. The nitrite-nitrate parameter was higher in the spring sample due to the increase in runoff from the watershed. High conductivity and total dissolved solids values are probably a result of the stream flowing through the predominantly limestone geology of this region. Nitrite-nitrate values are higher in the Ozark Highland streams than in any other streams in the state due to the land use practices and the strong contributory groundwater-to-stream base flows.

Physical Parameters

The physical measurements of the stream and evaluation of the watershed composition and uses have been summarized and included as Table OZ-9. Major differences in the physical nature of the stream from summer to spring included a large increase in stream flow and a corresponding increase in stream width and velocity. The stream width changed from 29 feet to 39 feet while the velocity increased from 0.71 fps to 1.76 fps.

Flow measurements revealed flows in the summer survey that exceeded the Q_{7-10} low flows by a substantial amount. Flint Creek had a flow of 4.5 cfs at the time of the survey. The springtime flow was measured at 26.8 cfs. Temperatures of the stream averaged 20°C in the summer and 15°C during the spring survey.

Macroinvertebrate Populations

A total of 78 taxa representing 16 orders were identified from the summer and spring samples collected from Flint Creek (Table A-27, Appendix A). Thirty-eight taxa were collected in the summer while 57 taxa were identified from the spring sample. In addition to the increase in taxa collected, the total number of organisms collected in the spring was more than 2½ times that collected in the summer. These increases were due, at least in part, to the increased sampling effort in the spring. The increase may also reflect the seasonal development-emergence patterns exhibited by insect populations. The large numbers of immature forms present in late winter-early spring gradually decrease, both numerically and taxonomically, later in the year due to emergence and predation.

The qualitative comparative indices indicated that the summer and spring samples did not contain a significant number of taxa in common (Table OZ-10). These figures may

Table OZ-7

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Flint Creek

Drainage Area: 19 square miles

Station Description: At riffle 250 ft. above bridge on Hwy. 59 in Section 15, T 18 N, R 33 W, Benton County

Date: September 20, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	08:45	10:30	14:00	
Q, cfs	na	na	na	na
Temperature, °C	21	20	18	20
pH	na	7.4	7.5	7.5
Turbidity, ntu	3.0	3.5	2.6	3.0
TSS, mg/l	6	8	3	6
TDS, mg/l	142	131	130	134
BOD-5, mg/l	<.9	<1.3	<.7	1.0
BOD-20, mg/l	2.4	3.7	2.6	2.9
T.Phos., mg/l	.07	.09	.08	.08
PO4-P, mg/l	.01	<.01	.01	.01
NO2+NO3-N, mg/l	.89	.96	.92	.92
NH3-N, mg/l	.04	.04	.03	.04
Cl -, mg/l	9.5	9.0	9.5	9.3
SO4 =, mg/l	<1.0	1.0	1.0	1.0
Fe, mg/l	<.05	<.05	<.05	<.05
Conductivity μmho	204	204	209	206
Alkalinity, mg/l	na	na	na	na
T. Hardness, mg/l	104	100	96	100
Chlorophyll a, μg/l	1.9	7.2	0.8	3.3
Fecal Coliform	-	-	-	na

Dissolved Oxygen Data for September 20, 1983		
	Pool	Riffle
Average	6.2	
Minimum	4.7	
Maximum	7.5	

Table OZ-8

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Flint Creek

Drainage Area: 19 square miles

Station Description: At Hwy. 59 bridge in Section 15, T 18 N , R 33 W, Benton County

Date: May 15, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	10:10	11:00	
Q, cfs	-	-	-	26.8
Temperature, °C	15	15	15	15
pH	6.7	6.6	6.8	6.7
Turbidity, ntu	6	7	7	7
TSS, mg/l	16	22	20	19
TDS, mg/l	110	116	107	111
BOD-5, mg/l	1.8	2.9	2.0	2.2
BOD-20, mg/l	4.2	6.5	5.0	5.2
T.Phos., mg/l	.11	.20	.14	.15
PO4-P, mg/l	.07	.12	.08	.09
NO2+NO3-N, mg/l	1.92	1.88	1.80	1.86
NH3-N, mg/l	.09	.12	.09	.10
Cl -, mg/l	5.0	5.0	5.5	5.1
SO4 =, mg/l	7	5	4	5.3
Fe, mg/l	.08	.17	.16	.14
Conductivity μmho	169	171	171	170
Alkalinity, mg/l	61	60	61	61
T. Hardness, mg/l	70	72	72	71
Chlorophyll a, μg/l	4.6	5.2	3.8	4.5
Fecal Coliform	-	-	8800	8800
Manganese	.02	.03	.03	.03

Dissolved Oxygen Data for May 15, 1984		
	Pool	Riffle
Average	8.6	8.5
Minimum	7.8	7.6
Maximum	10.5	10.4

Table OZ-9

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Flint Creek
Date:	September 20, 1983
Drainage Area:	19 square miles
Watershed Land Use:	82% pastureland 18% forest
Stream Gradient:	19.6 ft/mi
Mean Channel Width:	34.8 feet
Mean Stream Width:	28.9 feet
Mean Stream Velocity:	0.71 ft/sec
Observed Flow:	4.5 cfs
Average Substrate Type:	2% boulder 66% gravel 28% rubble 2% sand 2% silt
Mean Instream Cover:	0% undercut bank 2% brush,logs,debris 11% overhanging vegetation 15% inundated vegetation
Riffle/Pool Ratio of Transects:	40% riffle 0% deep pool 0% moderate 60% shallow pool
Mean Bank Overstory Cover:	65% trees 28% shrubs
Mean Bank Ground Cover:	71% grasses and forbs 29% dirt
Mean Bank Stability:	0% stable 100% moderate 0% unstable
Mean Stream Canopy:	11%
Comments:	

be biased downward due to the small sample taken during summer and therefore are not truly indicative of the homogeneity of the two samples. Fifteen taxa (39%) of those identified from the summer sample were also present in the spring sample. With the exception of the stoneflies in the spring sample, the mayflies and caddisflies were the dominant orders in both spring and summer. The mayflies composed 24.6 and 24.5% of summer and spring sample, respectively. Despite constituting nearly the same percentage numerically, the spring sample had 13 taxa of mayflies while the summer had only 9 taxa. The dominant mayfly taxa of the summer sample were replaced with other mayfly taxa in the spring sample. In contrast, the dominant caddisfly taxa were present in both samples.

Several taxa present in both samples were indicators of a clean, highly oxygenated, high quality aquatic ecosystem. The community parameters calculated were also indicative of a very diverse, stable macroinvertebrate community. All the parameters calculated indicated a substantial increase in quality from the summer period to spring. This increase is probably a function of the increased sampling effort and not an actual improvement in water quality.

Table OZ-10. Community Analysis of Benthic Samples from Flint Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	167	433	600
Total # Taxa	38	57	78
Diversity	4.2497	4.8986	5.2504
Index of Evenness	0.8098	0.8473	0.8429
Index of Dominance	0.4246	0.3112	0.3272
Index of Variety	5.0110	6.1798	8.0502
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.32	
Common Taxa Index (range 0-1)		0.24	
Qualitative Similarity Index (range 0-100)		21.0	

Fish Populations

Summer - Approximately 600 yards of Flint Creek above and below the Highway 59 bridge were sampled on September 21, 1983, using the 3500-watt, 220-volt, A.C. generator transported in a canoe. Riffles were blocked with a 20-foot seine while electrofishing upstream.

Fishes collected at this site are listed in Table OZ-11 with their relative abundance value. A total of 1529 individuals from 21 species were collected with a total relative abundance value of 171.5. The diversity index for the

sample was 4.21 with an index of evenness of 0.96. The population was dominated by Cyprinidae with seven species comprising 34.1% of the total relative abundance. These were followed by five species of Centrarchidae comprising 23.3%, two species of Percidae at 12.2%, one species of Ictaluridae at 6.1% and two species of Catastomidae at 5.8%. Three species of primary feeding fishes made up 15.7% of the total population relative abundance, 15 species of secondary feeders constituted 67.7% and three species of top carnivores made up 16.6% of the total. Sensitive species made up 62.1% of the population and totaled 13 species (Table OZ-12). One young white sucker, which has a limited range in Arkansas and has become very uncommon, was collected in this sample.

Table OZ-11. Fishes Collected from Flint Creek on September 21, 1983 with Relative Abundance Values

Species		R.A. VALUE
Campostoma anomalum	Stoneroller	12.0
*Nocomis asper	Redspot chub	12.0
Notropis pilsbryi	Duskystripe shiner	12.0
*Ambloplites rupestris	Rock bass	12.0
*Etheostoma spectabile	Orangethroat darter	12.0
*Noturus exilis	Slender madtom	10.5
Gambusia affinis	Mosquito fish	10.5
*Micropterus dolomieui	Smallmouth bass	10.5
*Cottus carolinae	Banded sculpin	10.5
*Phoxinus erythrogaster	Southern redbelly dace	9.0
*Hypentelium nigricans	Northern hogsucker	9.0
Lepomis megalotis	Longear	9.0
*Etheostoma punctulatum	Stippled darter	9.0
Lepomis cyanellus	Green sunfish	7.5
*Notropis nubilus	Ozark minnow	6.0
*Semotilus atromaculatus	Creek chub	6.0
Fundulus olivaceus	Blackspotted topminnow	6.0
*Fundulus catenatus	Northern studfish	4.5
*Notropis rubellus	Rosyface shiner	1.5
Catostomus commersoni	White sucker	1.0
Lepomis macrochirus	Bluegill	1.0
	Total	171.5

*Sensitive species

Spring - Electrofishing was used to sample approximately 600 yards of Flint Creek above Highway 59 bridge on May 17, 1984. The gear was transported upstream in a canoe and consisted of a 3500-watt, 120-volt A.C. gasoline-powered generator.

A total of 987 individuals were collected representing 18 species. All species collected in this sample were also taken in the summer 1983 sample; however, the Ozark minnow and rosyface shiner were not collected in the spring but were collected the previous summer. One adult white sucker

was also collected in this sample. Adult specimens of stonerollers, redspot chub, duskystripe shiner, southern redbelly dace and orangethroat darter were exhibiting breeding colors on this date. All species and the number of individuals collected in the spring of 1984 are listed below:

Species	Number
Campostoma anomalum	526
Nocomis asper	56
Notropis pilsbryi	230
Semotilus atromaculatus	3
Phoxinus erythrogaster	30
Catostomus commersoni	1
Hypentelium nigricans	15
Gambusia affinis	1
Fundulus catenatus	1
Noturus exilis	15
Micropterus dolomieui	4
Ambloplites rupestris	3
Lepomis cyanellus	14
Lepomis macrochirus	7
Lepomis megalotis	4
Etheostoma spectabile	56
Etheostoma punctulatum	3
Cottus carolinae	18
Total	987

Table OZ-12. Summary of Fish Population Parameters from Flint Creek

Total Species Collected	21
Total Number of Individuals	1529
Total Relative Abundance Value	171.5
Relative Abundance Diversity Index	4.21

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	7	34.1
CATOSTOMIDAE	2	5.8
ICTALURIDAE	1	6.1
CENTRARCHIDAE	5	23.3
PERCIDAE	2	12.2
Primary Feeders	3	15.7
Macroinvertebrate Feeders	15	67.7
Carnivores	3	16.6
Sensitive Species	13	62.1

YOCUM CREEK

The headwaters of Yocum Creek begin near the western edge of the City of Green Forest. The stream travels in a north-northeasterly direction for almost 20 miles prior to its confluence with Table Rock Lake. Except for the immediate headwaters section, the stream flows through a rural watershed dominated by agricultural practices.

The sample site on this stream is located in the NW¼, NE¼ of Section 30, R 22 W, T 21 N in northeast Carroll County, approximately 1 mile northwest of Highway 311 (Figure OZ-12).

General Site Discussion

Watershed Size - Above the sample site, the watershed is approximately 55 mi². From this point, the stream flows approximately 5 miles before entering Table Rock Lake.

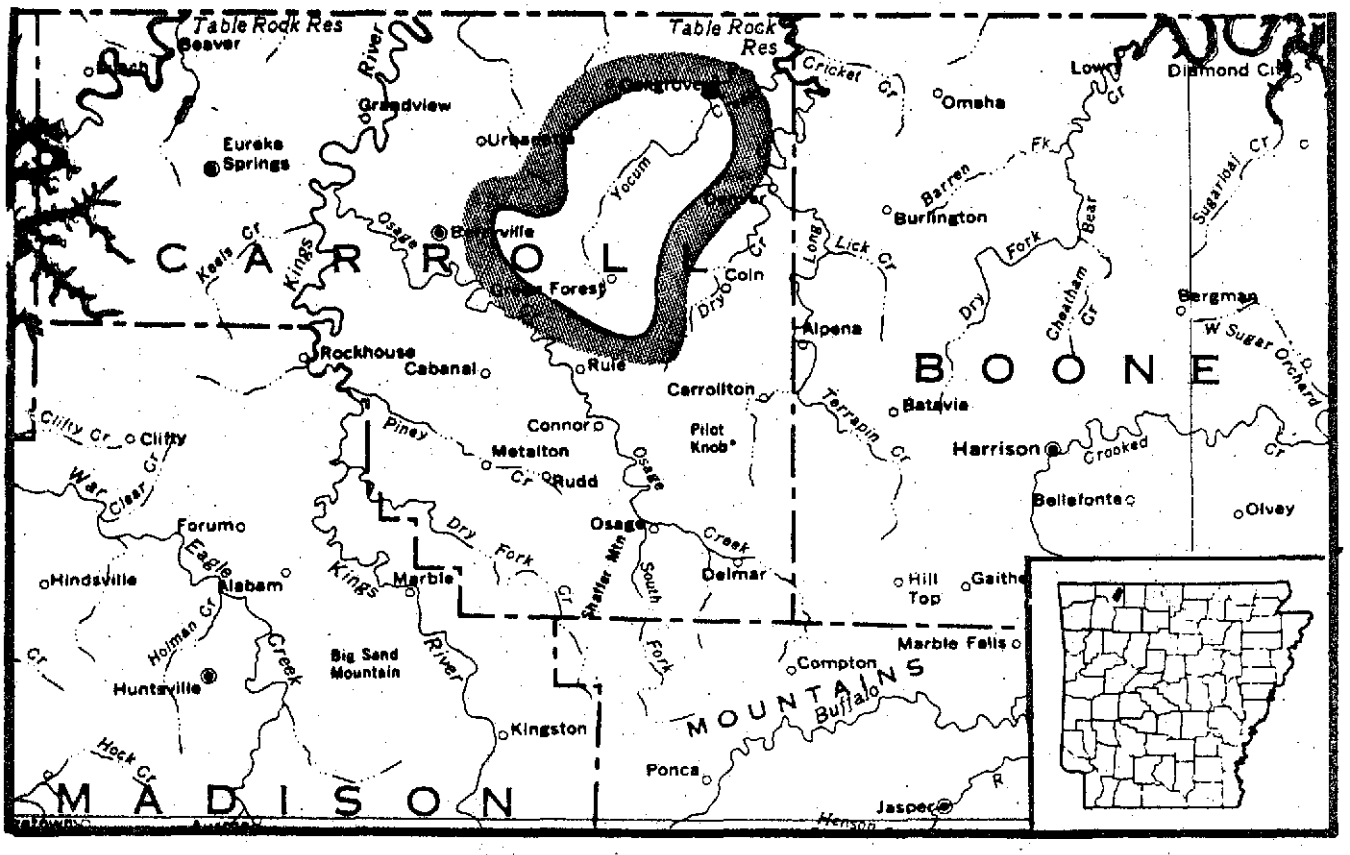
Topography - This stream drains a watershed consisting of rolling hills in excess of 1200 feet high. Much of the stream channel flows through land at around the 1000 feet level. This is typical of many streams in the Springfield Plateau segment of the Ozark Highlands.

Geology - Most of the watershed of Yocum Creek is underlain by the limestone and chert surface rock of the Boone formation. The headwaters of this drainage are underlain by Pitkin Limestone.

Soil Types - Four different soil associations exist in the Yocum Creek drainage. The headwaters region is characterized by the Linker-Cane-Mountainburg Association which is deep to shallow, gently sloping to moderately steep, well-drained and moderately well-drained, stony, loamy and very stony soils that were derived from sandstone. Also located in the headwaters region is the Arkana-Moko Association which is moderately deep and shallow, moderately sloping to very steep, well-drained, very cherty and very stony soils that formed in residuum of limestone or dolomite.

A major portion of the stream channel and the adjacent watershed consisting of a strip approximately 1 mile wide and 10 miles long is Razort-Portia-Britwater Association. This is characterized by deep, level to moderately sloping, well-drained, loamy and gravelly soils that formed in loamy alluvium, residuum of sandstone and old alluvium from limestone.

Figure OZ-12



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

YOCUM CREEK: Drainage area 55 square miles ■ Survey site ▒ Survey area

The lower portion of the watershed, which includes the survey area, consists of the Noark Association which is deep, gently sloping to steep, well-drained, very cherty soils that formed in residuum of cherty limestone. The pH range of this soil is 4.5 to 6.5 and the erosion potential is moderate.

Flora - Approximately 30% of this watershed is forested. Streamside vegetation consists of red cedar and water oak, sycamore, American elm, green ash, black walnut and box elder.

Land Use - Approximately 70% of this watershed has been developed for agricutural uses, dominated by cattle and poultry farming. The remainder of the watershed is timbered.

Stream Characteristics - Yocum Creek is a spring-fed stream that consists of a series of riffles and pools at approximately a 90:10% ratio. The substrate is dominated by gravel with the remaining substrate consisting of rubble, bedrock and boulders. The creek has good instream cover, composed of undercut banks, overhanging vegetation and brush, logs and other debris. The stream slope in the vicinity of the study site is 18.2 feet per mile and due to its domination by riffles has a fast stream velocity (one foot per second during summer survey and 3.3 feet per second in spring). The high spring velocity was influenced by heavy rainfall during the survey. The Q_{7-10} for this stream is 1.3 cfs according to U.S.G.S. flow data.

Methodology and Sampling Results

Yocum Creek was sampled concurrently with Long Creek during the summer survey during the week of August 27-31, 1984. Both creeks were planned to be sampled again in the spring of 1985 during the week of April 30-May 3; however, heavy rainfall postponed the Long Creek survey for one week. Yocum Creek, although receiving rainfall also, was sampled during the week of April 30-May 3.

Continuous Dissolved Oxygen

Summer - The continuously recording dissolved oxygen meters were placed in the stream on Monday afternoon, August 27, 1984, one in a riffle and the other at the middle of a pool. Both meters functioned properly during this survey. Results are found in Figures OZ-13 and OZ-14. A subtantial diurnal variation of 3.3 mg/l was recorded in the pool and riffle. Upon consideration of the watershed use and subsequent nutrient contribution to the stream, this D.O. fluctuation was not totally unexpected. Numerous poultry farms in this watershed and subsequent application of wastes on

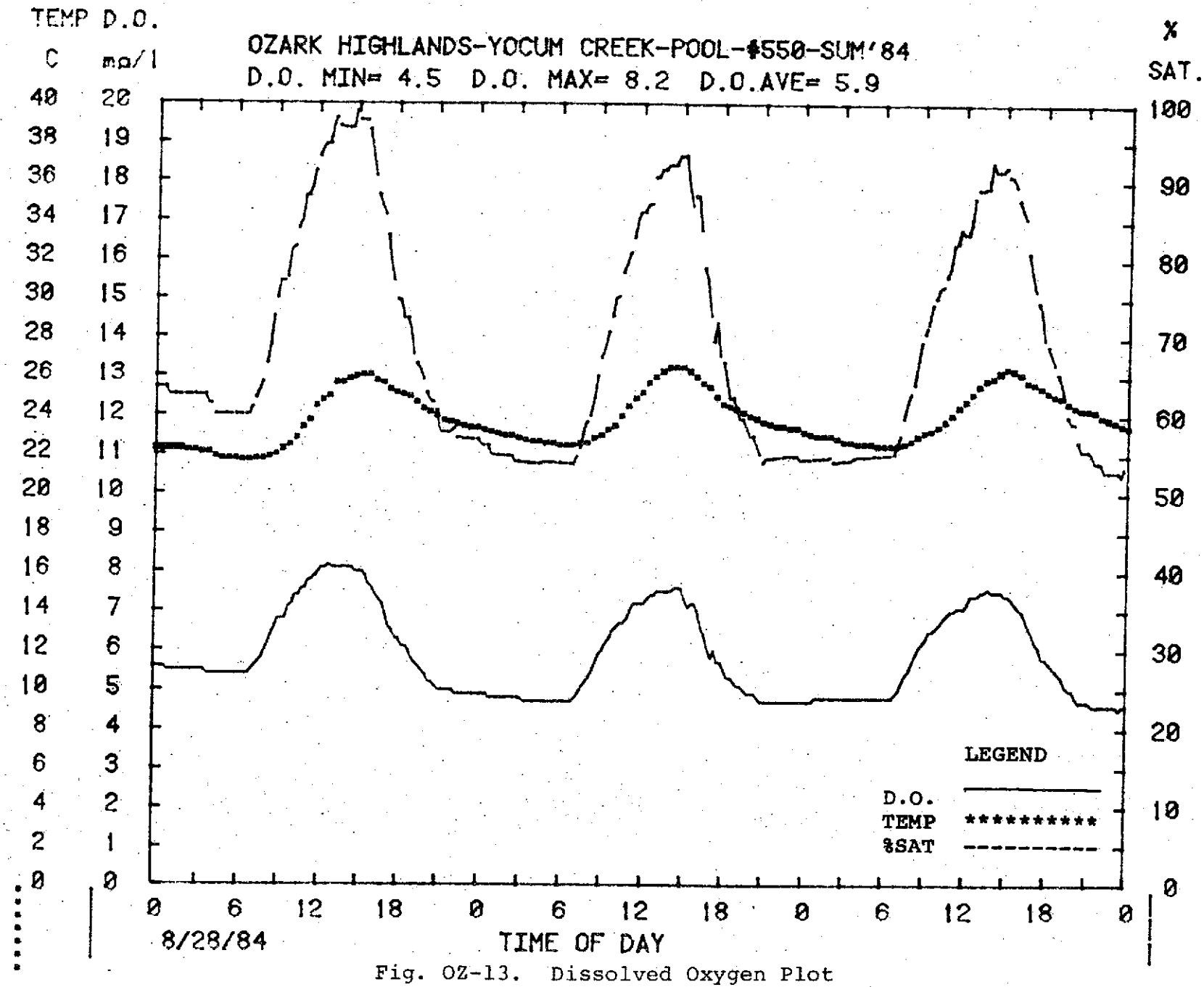


Fig. OZ-13. Dissolved Oxygen Plot

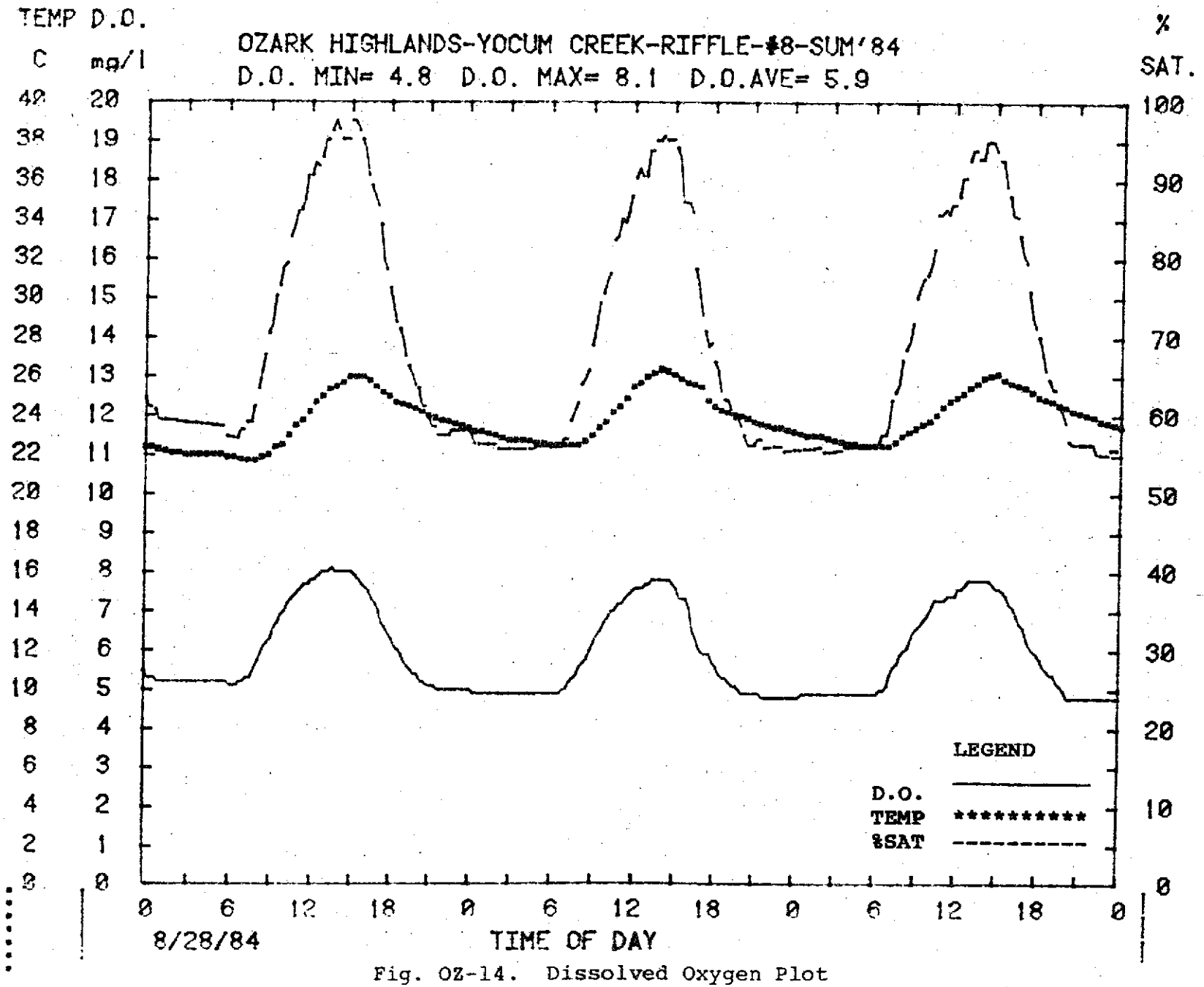


Fig. OZ-14. Dissolved Oxygen Plot

pasturelands provides a significant nutrient loading to Yocum Creek during rainfall events.

Spring - Two meters were used in the spring survey of Yocum Creek. The meter placed in the pool malfunctioned but the riffle meter worked well. The dissolved oxygen diurnal fluctuation during this survey was influenced by heavy rainfall that began only three hours after the meters were installed. Increased flows from rainfall events tend to negate the normal diurnal fluctuation and produces a minimal fluctuation curve on the continuous meter strip-chart. Although a diurnal fluctuation of 1.8 mg/l was recorded, this was due to the initially high D.O. present when the meters were installed with a subsequent D.O. depression occurring as the stream received the watershed runoff during the rainfall period (Figure OZ-15). As a result, the normal diurnal fluctuation was not recorded at this site during this survey. The normal springtime D.O. fluctuation is expected to be much greater than the 1.8 mg/l recorded due to the watershed use patterns and nutrient contributions.

Chemical Parameters

Water samples for chemical, chlorophyll ã and bacteriological analyses were collected on Tuesday of the survey week. The results of the chemical analyses have been summarized and included as Tables OZ-13 and OZ-14. Chemical parameters were similar to those found in other Ozark Highland streams including high conductivity and total hardness, low turbidity values, high chlorophyll ã and fecal coliform bacteria. The total dissolved solids were also high, which is expected, considering the predominantly limestone geologic formations of the watershed. The spring survey had much higher fecal coliform concentrations, higher turbidity and higher suspended solids than the summer survey as well as lower alkalinity and hardness. Both situations reflect the influence of rainfall on the stream.

Physical Parameters

The physical characteristics of Yocum Creek are typical of the Ozark Highland Ecoregion. The watershed is dominated by agricultural uses and the predominant substrate type is gravel. Yocum Creek has 5.4% total instream fishery cover and only 21% canopy in the study area.

As noted earlier, the pool/riffle % ratio was approximately 90:10 and the pools were generally shallow. The estimated average stream depth was approximately 0.5 - 0.75 feet while the average stream width was 26.2 feet during the summer. The average channel width in the study area is 72.2 feet. A summary of the physical data on this stream is included as Table OZ-15.

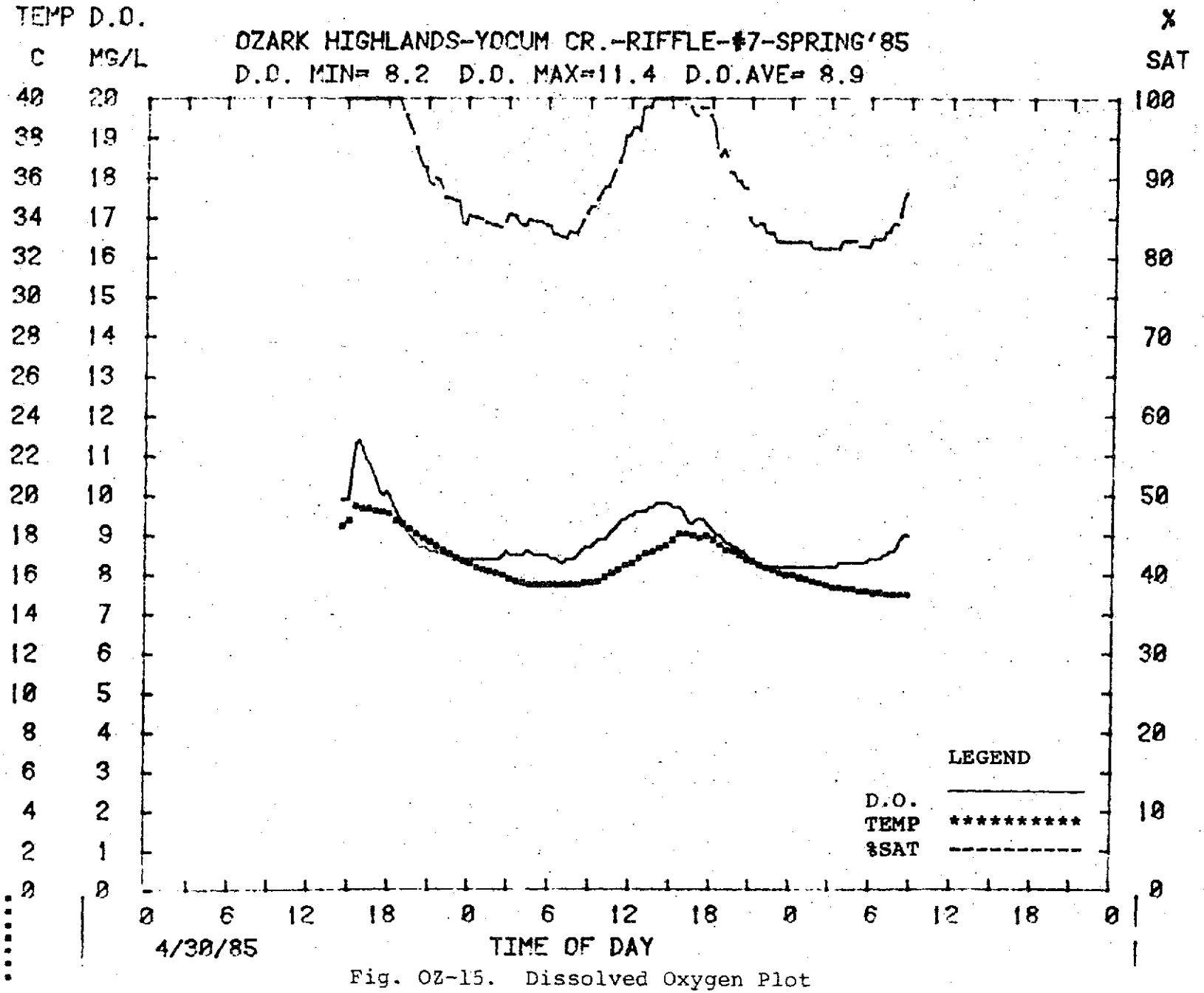


Fig. OZ-15. Dissolved Oxygen Plot

Table OZ-13

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Yocum Creek

Drainage Area: 55 square miles

Station Description: Yocum Creek @ Co. road bridge, approximately one mile west of Hwy. 311, NW ¼, NE ¼ Section 30, R 22 W, T 21 N, Carroll County.

Date: August 28, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	09:50	11:10	
Q, cfs	5.3	5.3	5.3	5.3
Temperature, °C	21	22	23.5	22
pH	void	void	void	void
Turbidity, ntu	2	2	2	2
TSS, mg/l	<1	1	1	1
TDS, mg/l	198	194	189	196
BOD-5, mg/l	0.2	0.7	0.2	0.4
BOD-20, mg/l	1.6	1.8	1.4	1.6
T.Phos., mg/l	0.03	0.03	0.03	0.03
PO4-P, mg/l	0.02	0.02	0.01	0.02
NO2+NO3-N, mg/l	0.72	0.74	0.69	0.72
NH3-N, mg/l	0.03	<0.01	<0.01	<0.02
Cl -, mg/l	8	8.5	9.5	9
SO4 =, mg/l	3	2	2	2
Fe, mg/l	0.02	0.02	0.04	0.03
Conductivity, µmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	155	153	152	153
T. Hardness, mg/l	162	164	158	161
Chlorophyll a, µg/l	0.3	0.5	0.9	0.6
Fecal Coliform	-	-	100	100
Total Manganese	<0.01	<0.01	<0.01	<0.01

Dissolved Oxygen Data for 28 Aug 1984		
	Pool	Riffle
Average	6.3	
Minimum	4.9	
Maximum	8.2	

Table OZ-14

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Yocum Creek

Drainage Area: 55 Square Miles

Station Description: @ Co. road bridge approximately 1 mile west of Hwy. 311 in NW 1/4, NE 1/4, Section 30, R 22 W, T 21 N - Carroll County

Date: May 1, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:40	10:55	11:45	
Q, cfs	161.8	161.8	161.8	161.8
Temperature, °C	16	17	17	17
pH	7.8	8.0	8.0	7.9
Turbidity, ntu	9	8	7	8
TSS, mg/l	12	8	7	9
TDS, mg/l	177	178	169	175
BOD-5, mg/l	1.2	0.9	0.9	1.0
BOD-20, mg/l	2.4	2.1	2.1	2.2
T.Phos., mg/l	0.07	0.07	0.06	0.07
PO4-P, mg/l	0.03	0.03	0.02	0.03
NO2+NO3-N, mg/l	1.55	1.50	1.50	1.52
NH3-N, mg/l	<0.01	<0.01	<0.01	<0.01
Cl -, mg/l	7.5	7	7.5	7.5
SO4 =, mg/l	11	10	10	10
Fe, mg/l	0.18	0.15	0.11	0.15
Conductivity, μmho	270	272	274	272
Alkalinity, mg/l	116	119	120	118
T. Hardness, mg/l	134	136	136	135
Chlorophyll a, μg/l	2.1	1.9	2.1	2.0
Fecal Coliform	-	-	2300	2300

Dissolved Oxygen Data for 1 May 1985		
	Riffle	
Average	8.8	
Minimum	8.2	
Maximum	9.8	

Table OZ-15

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Yocum Creek
Date:	August 28, 1984
Drainage Area:	55 square miles
Watershed Land Use:	67% agriculture 26% forest 4% urban 3% other
Stream Gradient:	18.2 ft/mi
Mean Channel Width:	72.2 feet
Mean Stream Width:	26.2 feet
Mean Stream Velocity:	1.0 fps
Observed Flow:	5.3 cfs
Average Substrate Type:	5.3% bedrock 0.4% boulders 26.7% rubble 68.7% gravel
Mean Instream Cover:	2.3% undercut bank 2.7% brush, logs, debris 0.4% overhanging vegetation
Riffle/Pool Ratio of Transects:	90% riffles 10% moderate pools
Mean Bank Overstory Cover:	71.5% trees 12.3% shrubs
Mean Bank Ground Cover:	69% grasses and forbs 18.5% rock 12.5% dirt
Mean Bank Stability:	45% stable 55% moderate
Mean Stream Canopy:	21%
Comments:	

Macroinvertebrate Populations

Eighty-two (82) taxa representing 17 orders were identified from the benthic samples from Yocum Creek. The dominant orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Gastropoda (snails) comprised 21.8%, 16.0% and 10.4% of the benthic population, respectively. Only the snail, Gyraulus, accounted for greater than 10% of the population. Several taxa were common to both summer and spring and were considered common inhabitants of Ozark Highland streams. These include Helichus, Helicopsyche borealis, Isonychia, Orconectes leptogonopodus, Psephenus herricki, Stenonema mediopunctuatum and Stenonema terminatum. The absence of numerically dominant taxa and the diversity of benthic organisms regarded as indicators of good water quality is evidence of the high quality environment within the watershed (Table A-28, Appendix A).

Qualitative similarity indices indicated that significant differences existed between the summer-spring samples (Table OZ-16). Of the 82 taxa identified, 50 were present in the summer sample and 53 were identified from the spring sample. Of these, 20 taxa were present in both samples while 30 and 33 taxa were unique to the summer and spring samples, respectively. The 20 taxa present in both samples accounted for over one-half of all the benthic organisms collected. The 30 taxa unique to the summer sample comprised 21.6% of the benthic population. The 33 taxa unique to the spring sample accounted for 62% of that sample. The majority of the differences between summer and spring samples can be attributed to the seasonal variation of benthic populations. Over three-fourths of the organisms unique to the spring sample were coldwater stoneflies and mayflies which annually emerge prior to increasing water temperature during the summer season.

Summer - The dominant orders of the summer sample were Gastropoda, Ephemeroptera and Trichoptera, comprising 24.7%, 22.0% and 10.9% of the benthic community, respectively. Only Gyraulus, a snail, was collected in excess of 10% of the numeric total. Other taxa collected and considered as ecological dominants were Calopteryx, Corydalus cornutus, Helicopsyche borealis, Isonychia, Psephenus herricki and Stenonema terminatum.

Spring - The spring sample was dominated by mayflies and stoneflies comprising 42.4% and 27.7% of the benthic sample, respectively. The spring sample included several mayfly and stonefly taxa which emerge in early spring before water temperatures begin to increase. These taxa were responsible for the majority of the differences between the summer and spring benthic samples. Ecological dominants collected in the spring sample include Acroneuria, Amphinemura delosa,

Eurylophella bicolor, Perlesta placida and Psephenus herricki.

The community parameters calculated indicated that Yocum Creek exhibited excellent water quality (Table OZ-16). The multiplicity of benthic taxa considered as indicators of "high quality" water support this conclusion. However, the dominance of the benthic community by one of two major groups, as exhibited here, indicates that the ability of the community to withstand perturbations may be reduced.

Table OZ-16. Community Analysis of Benthic Samples from Yocum Creek - 30 Minute Qualitative Sample, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	723	993	1716
Total # Taxa	50	53	82
Diversity	4.3424	4.5528	5.0671
Index of Evenness	0.7694	0.7948	0.7948
Index of Dominance	0.3156	0.4057	0.3484
Index of Variety	5.1590	5.2232	7.6316
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.38	
Common Taxa Index (range 0-1)		0.38	
Qualitative Similarity Index (range 0-100)		24.0	

Fish Population

Summer - Fish sampling at this site was done with the 3500-watt, 220-volt, A.C. generator with hand-held electrodes. Approximately 400 yards of the stream was sampled, most of which were were easily accessible with this gear. A total of 1969 specimens were collected representing 20 species. Table OZ-17 list all species collected at this site including the two additional species collected during spring sampling. The summer sample had a relative abundance value of 155.5 and a diversity index of 4.10 (Table OZ-18). Centrarchidae was the dominant fish family comprising 26.7% of the population. Cyprinidae and Percidae followed in order of dominance. Primary feeding fishes made up 8.4% of the population and carnivors made up 13.8%. The remainder were macroinvertebrate feeders. Thirteen sensitive species were collected which totalled 71.1% of the population.

Table OZ-17. Fishes Collected from Yocum Creek with Relative Abundance Values

SPECIES		R.A. VALUES
*Notropis pilsbryi	Duskystripe shiner	12.0
*Etheostoma flabellare	Fantail darter	12.0
Campostoma anomalum	Stoneroller	12.0
*Ambloplites constellatus	Ozark bass	12.0
*Cottus carolinae	Banded sculpin	12.0
*Hypentelium nigricans	Northern hogsucker	12.0
*Etheostoma caeruleum	Rainbow darter	10.5
*Nocomis biguttatus	Hornyhead chub	10.5
*Noturus exilis	Slender madtom	9.0
*Micropterus dolomieui	Smallmouth bass	8.5
Lepomis megalotis	Longear	8.0
*Fundulus catenatus	Northern studfish	8.0
Lepomis cyanellus	Green sunfish	6.0
Lepomis macrochirus	Bluegill	6.0
Etheostoma spectabile	Orangethroat darter	6.0
*Noturus albater	Ozark madtom	4.0
Fundulus olivaceus	Blackspotted topminnow	4.0
Percina caprodes	Logperch	1.0
Notropis nubilus	Ozark minnow	1.0
Micropterus salmoides	Largemouth bass	1.0
*Etheostoma blennioides	Greenside darter	S
*Phoxinus erythrogaster	Southern redbelly dace	S

*Sensitive Species
S-Collected During Spring Sampling Only

Table OZ-18. Summary of Fish Population Parameters from Yocum Creek

Total Species Collected	22
Total Number of Individuals	1969
Total Relative Abundance Value	155.5
Relative Abundance Diversity Index	4.10

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5.0	22.8
CATOSTOMIDAE	1.0	7.7
ICTALURIDAE	2.0	8.4
CENTRARCHIDAE	6.0	26.7
PERCIDAE	5.0	19.0
Primary Feeders	3.0	8.4
Macroinvertebrate Feeders	16.0	77.8
Carnivores	3.0	13.8
Sensitive Species	13.0	71.1

Spring - Sampling on April 30, 1985, at this site was also done with electorfishing gear. Water was clear and flow was measured at 162 cfs. Water temperature ranged from 16 to 20°C. This fluctuation was caused by a cold rain with high winds and a noticeable drop in air temperature. Nineteen species of fish were collected at this time including two species which were not collected during the previous summer. Examination of gonads and external sex characteristics of fishes collected indicated that stonerollers, duskystripe shiner, redbelly dace, greenside darter and fantail darter were in the spawning process with some individuals having completed spawning. All slender madtoms examined indicated completion of spawning and very small young-of-the-year banded sculpins were collected indicating that this species had spawned earlier in the year. Ozark bass and smallmouth bass had well developed gonads in preparation for later spawning.

LONG CREEK

Long Creek has its headwaters in the southwestern part of Boone County. From there it meanders northward, back and forth between Boone and Carroll Counties. The Long Creek sample site is located in the northeast part of Carroll County at a county road bridge approximately 1 mile east of Highway 311 in the SW¼, SE¼ of Section 34, R 22 W, T 21 N (Figure OZ-16).

General Site Discussion

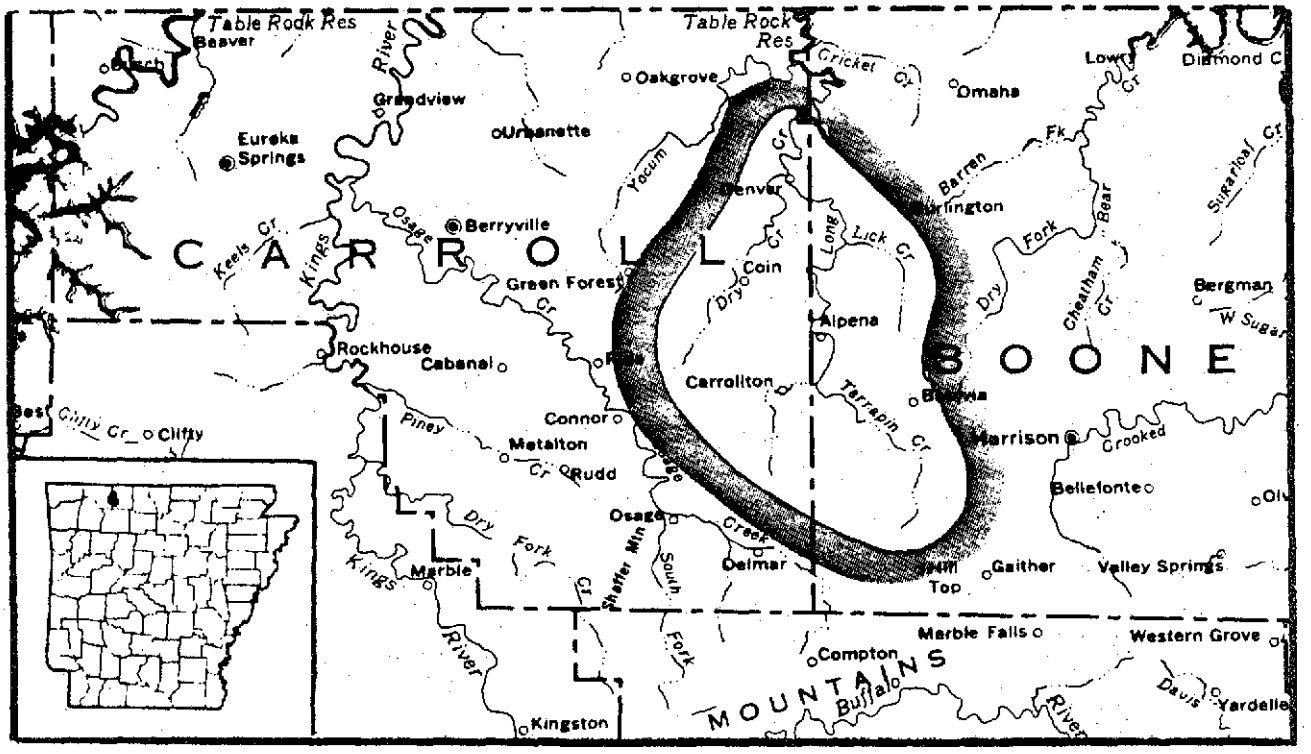
Watershed Size - The total drainage area of Long Creek above this sample site is 184 mi^2. From this point, Long Creek flows another 3-5 miles to its confluence with Table Rock Lake.

Geology - The geology of this watershed is typical of the Springfield Plateau. For most of the watershed, surface rock is composed of limestone and chert of the Boone Formation. The headwaters region of Long Creek is underlain by the Pitkin Limestone Formation.

Topography - The topography of the area generally consists of a rolling hill terrain with sharp bluffs adjacent to the stream in many places. Elevations range from approximately 1050 to 1100 feet adjacent to the stream to as high as 1300 feet in some portions of the watershed in the vicinity of the survey location. The stream gradient at the sample site is 6.8 ft/mile.

Soil Type - Four different soil associations exist in the Long Creek drainage basin. The upper watershed is characterized by the Enders-Nella-Mountainburg Association which varies from deep to shallow, gently sloping to steep, well-drained, stony soils formed in residuum from shale, colluvium from sandstone and residuum from sandstone. Also in this region of the watershed is found the Mountainburg-Linker-Leadvale Association which is classified as shallow, moderately deep and deep; gently sloping to moderately steep, well drained and moderately well drained loamy soils formed in residuum from sandstone and siltstone. A portion of the adjacent watershed of the upper reaches consists of the Razort-Peridge Association which is deep, level to gently sloping, well-drained loamy soils formed in loamy alluvium and old alluvium or residuum from sandstone. Lower sections of Long Creek (which includes the survey area) are composed of the Arkana-Moko Association which is moderately deep and shallow, gently sloping to steep, well-drained cherty and stony soils formed in residuum from limestone.

Figure OZ-16



1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

LONG CREEK: Drainage area 184 square miles ■ Survey site ▒ Survey area

Flora - Generally, vegetation consists of upland hardwoods in this drainage basin, with the dominant species consisting of American elm, boxelder, sycamore, red cedar, black walnut, green ash and several species of oak.

Land Use - Land use is dominated by agricultural development, primarily consisting of cattle farming and poultry production. Approximately 70% of the watershed of Long Creek is used for agriculture while 30% remains forested. Application of chicken litter to pasturelands is a common practice.

Stream Characteristics - Long Creek has its origin in the southwest corner of Boone County and flows in a northerly direction while meandering back and forth between Boone and Carroll Counties. Long Creek flows into Table Rock Lake near the northern border of the state. At the stream study site, the average channel width was 54.8 feet and actual stream width was 39.8 feet during the summer sampling period.

Springs in the watershed provide flow throughout the year, and according to USGS flow data, the Q_{7-10} of this stream is approximately 10 cubic feet per second in the study area. The stream consists of alternating riffles and pools at approximately a 30:70% ratio. The stream substrate is dominated by gravel and sand and has good instream cover for aquatic life.

Methodology and Sampling Results

This site was sampled during the week of August 27-31, 1984, and during the week of May 6-10, 1985.

There was no rainfall during the August survey and stream conditions were considered to be at low flow and high temperatures. Spring sampling originally planned for April 30 was delayed one week due to very heavy rainfall at the beginning of the first week of May. There was no rainfall during the survey week of May 6-10.

Continuous Dissolved Oxygen

Summer - Continuous dissolved oxygen and temperature recorders were placed in the pool and riffle areas of the stream. Two meters were installed for the summer sampling, one in the pool and one in the riffle. Both meters functioned properly during the survey.

The results of the continuous dissolved oxygen sampling showed that the diurnal variation was larger in Long Creek than any other stream sampled (Figures OZ-17 and OZ-18). A

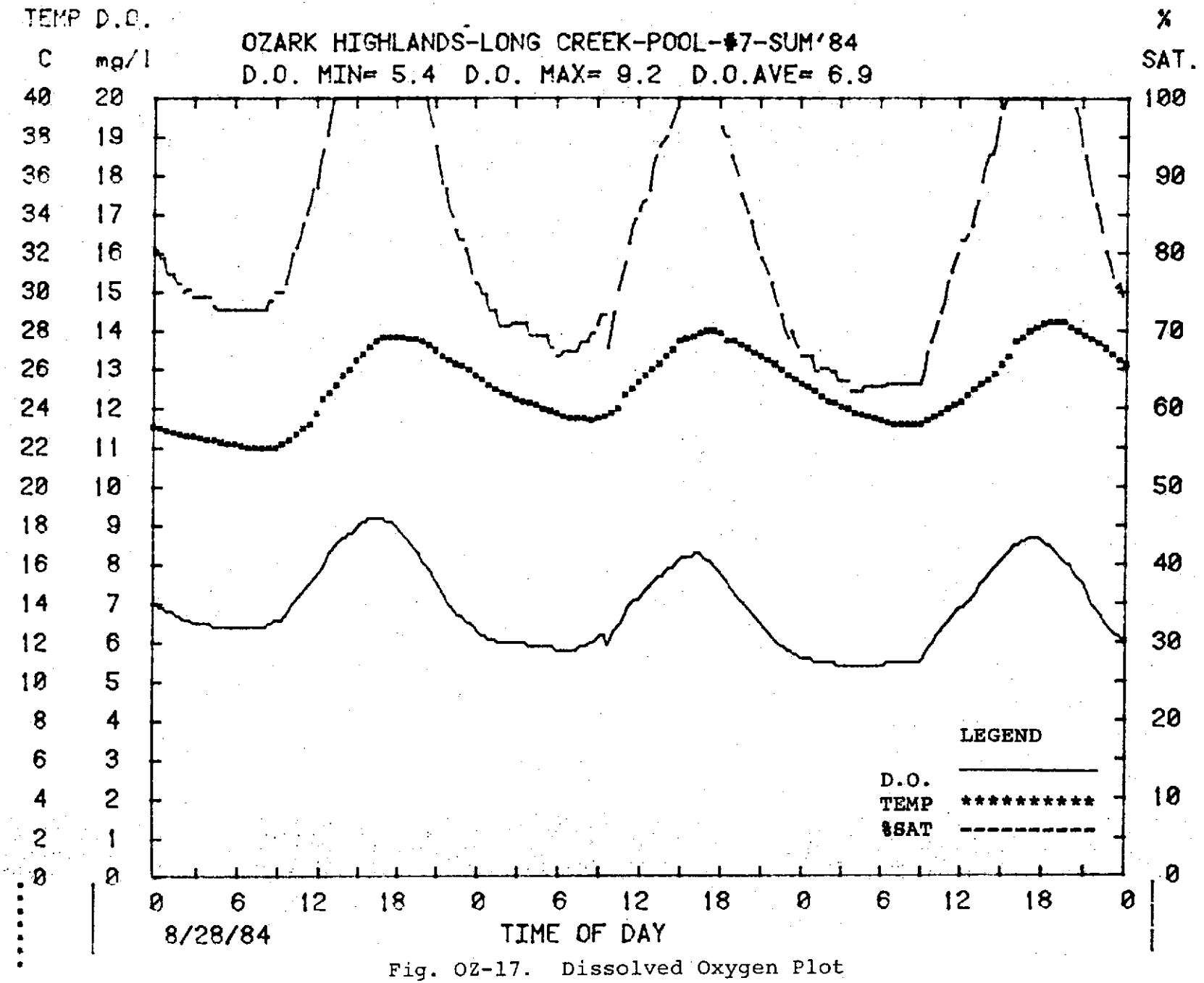


Fig. OZ-17. Dissolved Oxygen Plot

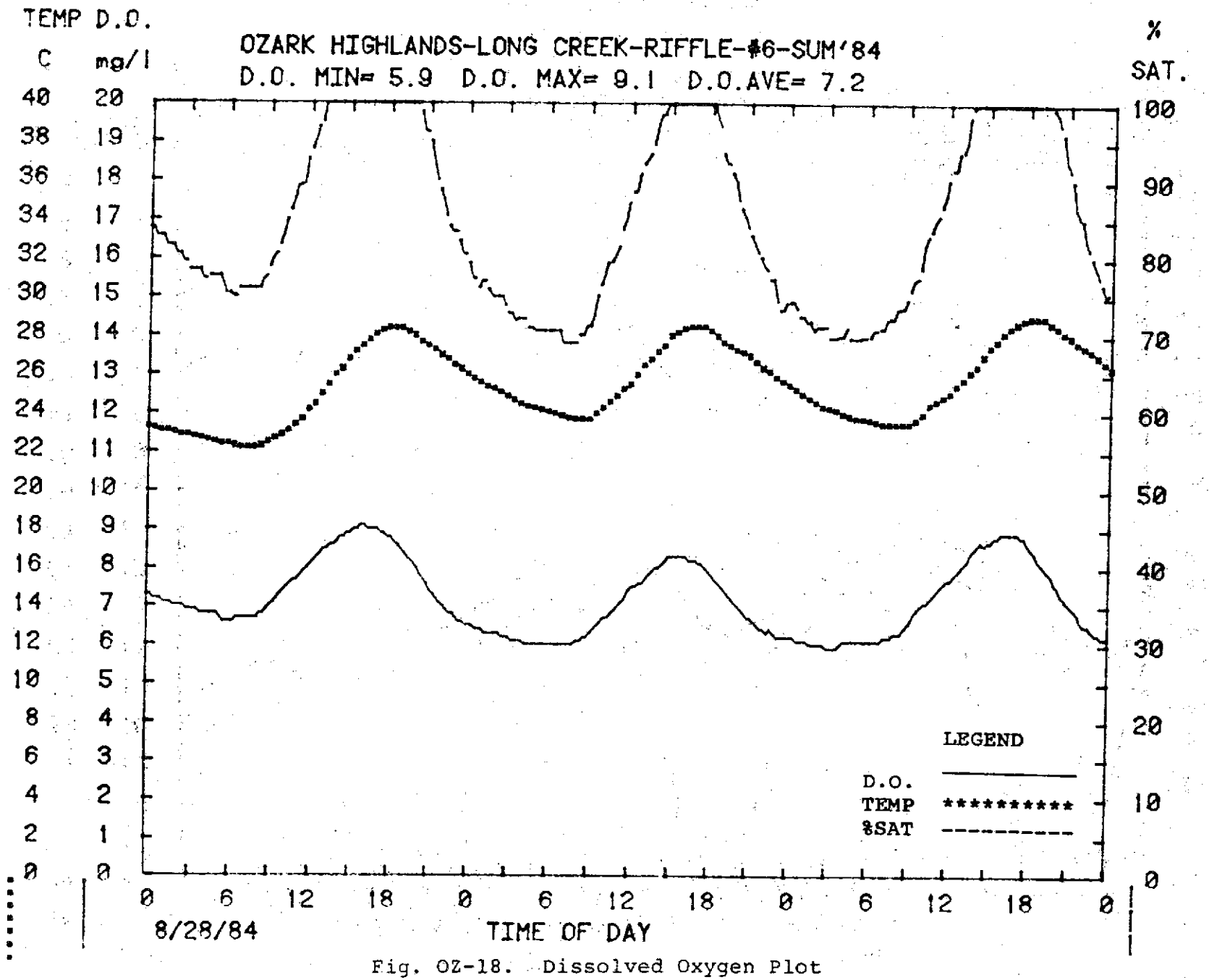


Fig. OZ-18. Dissolved Oxygen Plot

variation of 3.8 mg/l was recorded at this location during the summer survey. This high diurnal variation reflects both the land use and size of the watershed. Application of poultry waste to pastureland is a major contributor of nutrient loading to this stream. In addition to the nutrients being supplied, the stream has developed a pool/riffle percentage ratio of 70:30. Periphyton and algae growth in these pools result in a large diurnal dissolved oxygen variation due to the photosynthesis-respiration processes.

Spring - Two meters were used for the spring survey; both functioned properly. The springtime D.O. data produced a diurnal variation of 4.5 mg/l (Figures OZ-19 and OZ-20). Again, photosynthetic activity was evident and although no chlorophyll a analysis was made on this stream, the associated Ozark Highland stream studied had a springtime value of 2.0 μg/l and attached algae was apparent on the stream substrate. Although the stream sampling was delayed until the week of May 6-10, the continuous dissolved oxygen data was taken during April 30-May 2. The large diurnal fluctuation occurred during the first day, prior to the influence of the heavy rainfall. There was little diurnal fluctuation during the period of high, fast-flowing, muddy water.

Chemical Parameters

The chemical parameters measured in the summer and spring surveys are listed in Tables OZ-19 and OZ-20. Many of these parameters reflect the agricultural activities in the watershed. The high readings of nitrite-nitrate nitrogen are probably due to the practice of spreading poultry manure on pasturelands. The nitrite-nitrate parameters were approximately the same values in both surveys. Normally, spring values tend to be higher due to greater frequency of rainfall on the watershed, but the extremely heavy rainfall that occurred a week prior to sampling may have "flushed" the watershed of this nutrient contribution.
Nitrite-nitrate values are higher in the Ozark Highland streams than in any other streams in the state. High levels of alkalinity, total dissolved solids and hardness can be attributed to the solubility of the limestone rocks in the karst region underlying the watershed.

Physical Parameters

The physical measurements of the stream and evaluation of the watershed composition and uses have been summarized and included as Table OZ-21. Major differences in the physical nature of the stream from summer to spring included a large increase in stream flow (9.5 cfs to 183.2 cfs) and a corresponding increase in stream width and velocity. The

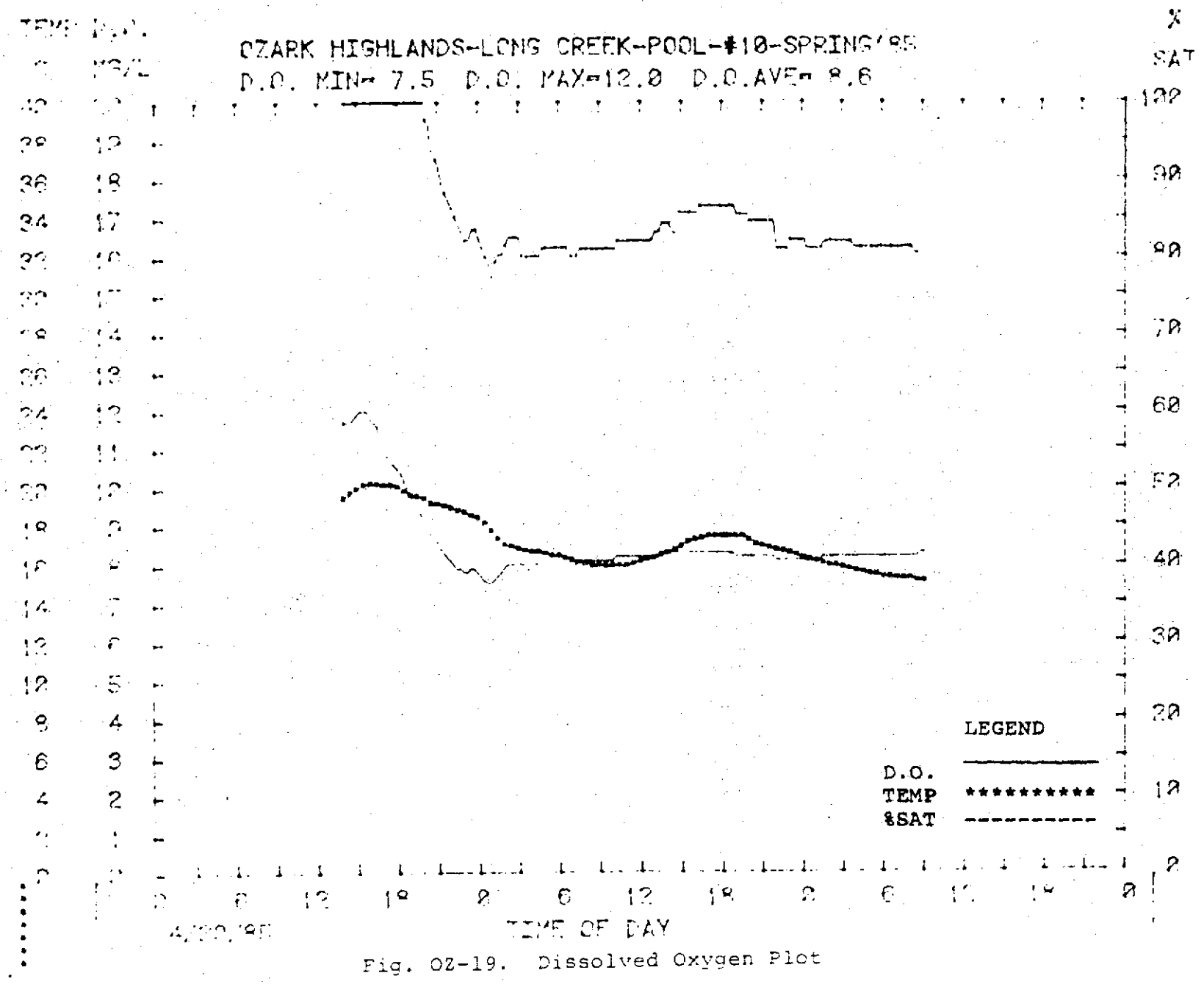


Fig. OZ-19. Dissolved Oxygen Plot

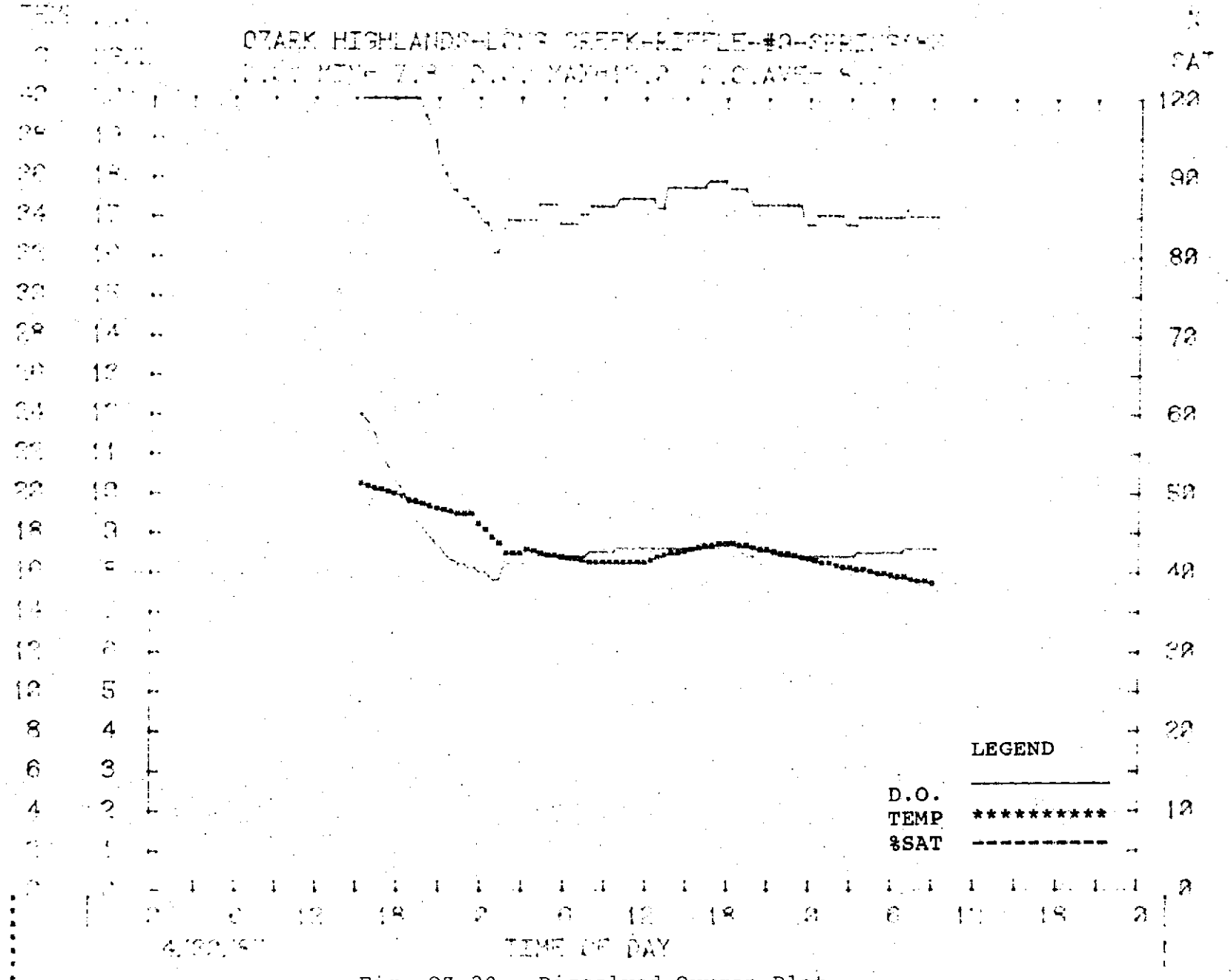


Fig. OZ-20. Dissolved Oxygen Plot

Table OZ-19

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Long Creek

Drainage Area: 184 square miles

Station Description: County road bridge approximately one mile east of Hwy. 311, SW ¼, SE ¼, Section 34, T 21 N, R 22 W, Carroll County.

Date: August 18,1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:10	10:25	11:30	
Q, cfs	9.5	9.5	9.5	9.5
Temperature, °C	22	22	22	22
pH	7.1	7.2	7.1	7.1
Turbidity, ntu	6	4	3	4
TSS, mg/l	10	4	6	7
TDS, mg/l	198	196	199	198
BOD-5, mg/l	0.4	0.4	0.4	0.4
BOD-20, mg/l	1.9	1.8	2.1	1.9
T.Phos., mg/l	0.04	0.03	0.03	0.03
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	1.05	1.05	1.00	1.03
NH3-N, mg/l	0.04	0.04	0.03	0.04
Cl -, mg/l	11	10.5	11	11
SO4 =, mg/l	5	5	4	5
Fe, mg/l	0.10	0.07	0.11	0.09
Conductivity,μmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	146	143	147	145
T. Hardness, mg/l	150	156	156	154
Chlorophyll a,μg/l	1.7	1.8	1.9	1.8
Fecal Coliform	-	-	136	136
T. Manganese, mg/l	0.03	0.01	0.03	0.02

Dissolved Oxygen Data for 28 Aug 1984		
	Pool	Riffle
Average	7.4	
Minimum	6.4	
Maximum	9.2	

Table OZ-20

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Long Creek

Drainage Area: 184 Square Miles

Station Description: County road bridge approximately 1 mile east of Hwy. 311 SW ¼, SE ¼, Section 34, R 22 W, T 21 N - Carroll County

Date: May 6, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	13:30	14:25	16:00	
Q, cfs	183.2	183.2	183.2	183.2
Temperature, °C	19	19	20	19
pH	8.3	8.3	8.4	8.3
Turbidity, ntu	2	2	2	2
TSS, mg/l	3	4	4	4
TDS, mg/l	156	155	141	151
BOD-5, mg/l	1.5	1.3	1.7	1.5
BOD-20, mg/l	2.0	1.7	2.7	2.1
T.Phos., mg/l	0.04	0.04	0.04	0.04
PO4-P, mg/l	0.03	0.03	0.03	0.03
NO2+NO3-N, mg/l	0.95	0.96	0.93	0.95
NH3-N, mg/l	0.03	0.02	0.03	0.03
Cl -, mg/l	5	4.5	4.5	4.5
SO4 =, mg/l	8	8	8	8
Fe, mg/l	0.04	0.03	0.03	0.03
Conductivity, μmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	116	116	113	115
T. Hardness, mg/l	130	132	132	131
Chlorophyll a, μg/l	N/A	N/A	N/A	N/A
Fecal Coliform	N/A	N/A	N/A	N/A

Dissolved Oxygen Data for Apr 30, 1985*		
	Pool	Riffle
Average	8.6	8.7
Minimum	7.5	7.8
Maximum	12.0	12.0

*D.O. measurements taken on this date due to heavy rainfall on May 6, 1985.

N/A - Not Analyzed

Table OZ-21

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Long Creek
Date:	August 28, 1984
Drainage Area:	184 square miles
Watershed Land Use:	50% agriculture 46% forest 4% other
Stream Gradient:	6.8 ft/mi
Mean Channel Width:	54.8 feet
Mean Stream Width:	39.8 feet
Mean Stream Velocity:	0.57 fps
Observed Flow:	9.48 cfs
Average Substrate Type:	11.6% bedrock 2.5% large boulders 0.7% boulders 5.3% rubble 51.3% gravel 24.6% sand 4.3% sand
Mean Instream Cover:	2% undercut bank 2.8% brush, logs, debris 4.3% overhanging vegetation 3% inundated vegetation
Riffle/Pool Ratio of Transects:	30% riffles 20% deep pools 20% moderate 30% shallow pools
Mean Bank Overstory Cover:	79% trees 21% shrubs
Mean Bank Ground Cover:	81.5% grasses and forbs 7.5% rock 11% dirt
Mean Bank Stability:	65% moderate 20% unstable 15% stable
Mean Stream Canopy:	36%
Comments:	

stream width where the flow was taken increased from 24 feet to 40 feet while the velocity increased from 0.57 fps to 3.2 fps.

Flow measurements revealed flows in the summer survey that approximately equaled the Q_{7-10}. Long Creek had a flow of 9.5 cubic feet per second at the time of the survey. The springtime flow was measured at 183.2 cfs. Temperatures of the stream averaged 22°C in the summer and 19°C during the spring survey.

Macroinvertebrate Populations

Ninety-eight (98) taxa representing 16 orders were identified from the qualitative samples collected from Long Creek (Table A-29, Appendix A). The dominant orders, Coleoptera (beetles), Ephemeroptera (mayflies), Gastropoda (snails), Odonata (dragon-flies and damselflies), and Plecoptera (stoneflies), comprised 24.9%, 22.0%, 11.9% and 10.9% of the numeric total, respectively. Only one taxa, Dubiraphia vittata, accounted for greater than 10% of the numeric total. Several taxa were common to both spring and summer samples and are considered characteristic of Ozark Highland streams. These included Dubiraphia vittata, Helichus, Isonychia, Goniobasis and Hetaerina. The even distribution among the major taxonomic groups (4 orders with >10% of the numeric total) and the absence of numerically dominant taxa is an indicator of good water quality in association with a multiplicity of microhabitats.

Qualitative similarity indices indicated that the summer-spring samples were more similar than dissimilar (Table OZ-22). Of the 98 taxa identified; 59 were present in summer sample and 74 were identified from the spring sample. Of those, 35 taxa were present in both samples and 24 and 39 were unique to the summer and spring samples, respectively. The 35 taxa which were found in both samples accounted for 71% of the total organisms. The 24 taxa unique to the summer sample comprised only 13.2% of the total organisms. The 39 taxa unique to the spring sample accounted for 54% of the benthos collected and the stonefly, Perlesta placida, accounted for nearly one half of that.

Summer - The dominant orders of the summer sample were Coleoptera, Odonata, Ephemeroptera and Trichoptera comprising 26.1%, 21.2%, 18.8% and 10.6% of the sample, respectively. Only two taxa, Dubiraphia vittata, and Ischnura accounted for more than 10% of the summer sample. These were also present in the spring sample, but in much smaller quantities. Ecological dominants of the summer sample included Isonychia, Stenonema terminatum, Goniobasis, and Macromia.

The dominant orders of the spring sample were Ephemeroptera (29.4%), Plecoptera (24.7%) and Coleoptera (19.6%). All three were considered as overall dominant orders but not in the order as during spring sampling. The major differences were associated with the cyclic pattern of benthic populations. The dominant taxa, in order of numerical abundance, were Perlesta placida and Helichus. Additional taxa present in significant numbers and considered ecological dominants included Dubiraphia vittata, Eurylophella bicolor, Attenella attenuiata and Goniobasis.

The community parameters calculated also supported the conclusion that Long Creek exhibited excellent water quality (Table OZ-22). The presence of the stonefly, Perlesta placida, in such large quantities acted to decrease the diversity from summer to spring despite the increase in taxa and total population.

Table OZ-22. Community Analysis of Benthic Samples from Long Creek - 30 Minute Qualitative Sample, 1984-85

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	954	854	1808
Total # Taxa	59	74	98
Diversity	5.2468	4.5793	5.2468
Index of Evenness	0.7915	0.7375	0.7915
Index of Dominance	0.3821	0.3627	0.3821
Index of Variety	9.0571	7.4963	9.0572
COMPARATIVE INDICES			
Dice Index		0.55	
Common Taxa Index		0.47	
Qualitative Similarity Index		30.0	

Fish Populations

Summer - The 3500-watt, 220-volt, A.C. generator was used to sample the fish population at this site. Approximately ¼ mile of the stream was sampled in about 3 hours. A total of 2244 individuals from 34 species were collected. Two additional species were taken at this site the following spring. The summer sample produced a relative abundance value of 239.5 and a diversity index of 4.83. Table OZ-23 lists all species collected at this site. Eleven species of Cyprinidae dominated the population and comprised 33.6% of the total. Percidae was the next most abundant fish family at 22.5%. Primary feeding fishes and carnivores made up 13.6% and 12.9% of the population, respectively. The

remainder of the population was macroinvertebrate feeders (Table OZ-24). Nineteen sensitive species represented 64.1% of the total population.

Table OZ-23. Fishes Collected from Long Creek with Relative Abundance Values

SPECIES		R.A. VALUES
*Noturus albater	Ozark madtom	12.0
Percina caprodes	Logperch	12.0
Campostoma anomalum	Stoneroller	12.0
*Hypentelium nigricans	Northern hogsucker	12.0
*Etheostoma juliae	Yoke darter	12.0
*Etheostoma caeruleum	Rainbow darter	12.0
*Notropis pilsbryi	Duskystripe shiner	12.0
Micropterus punctulatus	Spotted bass	12.0
Notropis nubila	Ozark minnow	10.5
*Moxostoma duquesnei	Black redhorse	10.5
*Ambloplites constellatus	Ozark bass	9.5
*Etheostoma blennioides	Greenside darter	9.0
*Cottus carolinae	Banded sculpin	9.0
*Etheostoma zonale	Banded darter	9.0
*Nocomis biguttatus	Hornyhead chub	9.0
Lepomis megalotis	Longear	9.0
Pimephales notatus	Bluntnose minnow	7.5
Notropis chrysocephalus	Striped shiner	6.0
*Notropis galacturus	Whitetail shiner	6.0
*Noturus exilis	Slender madtom	6.0
*Notropis rubellus	Rosyface shiner	6.0
*Hybopsis dissimilis	Streamline chub	6.0
*Notropis boops	Bigeye shiner	4.5
Ictalurus punctatus	Channel catfish	4.5
Lepomis cyanellus	Green sunfish	4.0
*Moxostoma carinatum	River Redhorse	4.0
*Micropterus dolomieui	Smallmouth bass	4.0
Lepomis macrochirus	Bluegill	3.0
Dorosoma cepedianum	Gizzard shad	1.5
Micropterus salmoides	Largemouth bass	1.0
Moxostoma erythrurum	Golden redhorse	1.0
*Fundulus catenatus	Northern studfish	1.0
Labidesthes sicculus	Brook silversides	1.0
Cyprinus carpio	Carp	1.0
Etheostoma spectabile	Orangethroat darter	S
Ictalurus natalis	Yellow bullhead	S

*Sensitive Species
S - Collected during spring sampling only

Table OZ-24. Summary of Fish Population Parameters from Long Creek

Total Species Collected	36.0
Total Number of Individuals	2244.0
Total Relative Abundance Value	239.5
Relative Abundance Diversity Index	4.83

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	11.0	33.6
CATOSTOMIDAE	4.0	11.5
ICTALURIDAE	4.0	9.4
CENTRARCHIDAE	7.0	17.7
PERCIDAE	6.0	22.5
Primary Feeders	5.0	13.6
Macroinvertebrate Feeders	26.0	73.5
Carnivores	5.0	12.9
Sensitive Species	19.0	64.1

Spring - Spring sampling at this site on April 30, 1985, was restricted by high flows. Electrofishing on this date produced 12 species. One trammel net was set on this date, but heavy overnight rains prevented retrieval until one week later. Much of the net was covered by gravel, but four fish of four species were removed from the net. Two species not previously taken from this site were captured in the spring.

The duskystripe shiner and the orangethroat darter exhibited breeding colors and were near spawning. Also young-of-the-year banded sculpins were collected indicating that spawning of this species had taken place.

WAR EAGLE CREEK

War Eagle Creek has its headwaters in the southeast portion of Madison County, with some of its headwater tributaries draining the northern edge of the Ozark National Forest. From the headwaters, War Eagle flows generally northward through Madison County then turns northwesterly in the vicinity of Huntsville. The creek maintains this flow direction through Madison County into the southeast corner of Benton County, then turns south into Washington County where it flows into Beaver Reservoir. War Eagle Creek was sampled at the state Highway 45 bridge in the NW¼ Section 28, R 27 W, T 18 N in northwest Madison County (Figure OZ-21).

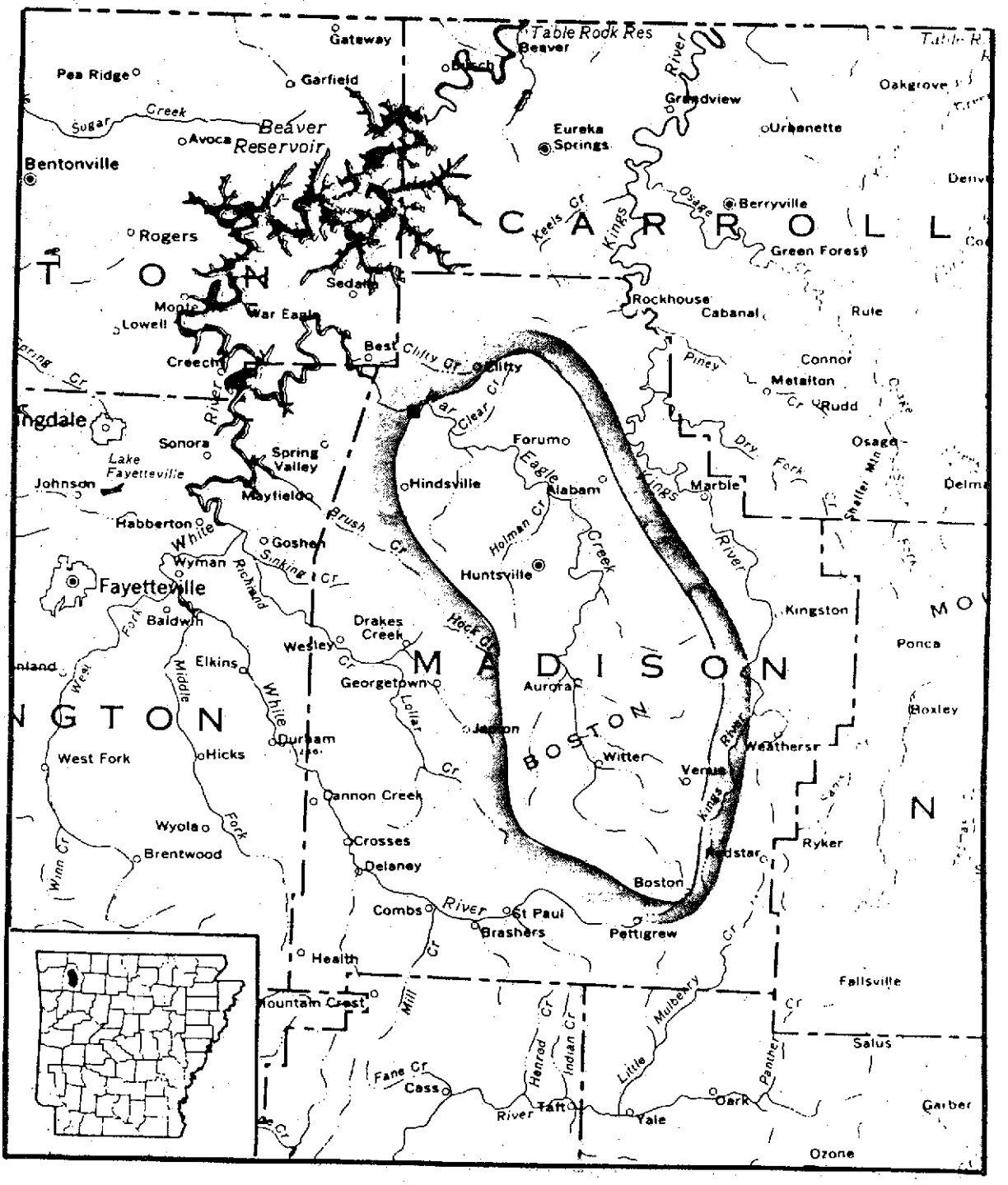
General Site Discussion

Watershed Size - The total watershed drained above the Highway 45 bridge sampling location is 263 mi^2. From this point, the creek flows an additional 15 miles before entering Beaver Reservoir.

Geology - The geology of most of the watershed is typical of the Springfield Plateau; however, the upper headwater portion of War Eagle Creek is located in the Boston Mountains, which is characterized by the Atoka Formation, Bloyd Shale and the Prairie Grove member of the Hale Formation. Mid-level geology consists of Pitkin Limestone, Fayetteville Shale (including Wedington Sandstone members) and Batesville Sandstone. Also included in the mid-level area of the watershed is a band of the Cane member of the Hale Formation. The lower reaches of War Eagle Creek (which includes the study area region) consist of the limestone and chert of the Boone Formation, with patches of Chattanooga Shale, Clifty Limestone and Penters Chert.

Topography - The topography of the area in the region where War Eagle Creek was sampled consists of an approximately 1200 foot base elevation, with many bluffs extending up to near 1500 feet in elevation adjacent to the stream channel. Generally, where sharp bluffs exist on one side, the opposite stream side has a more gradual increase in elevation. Although a part of the Springfield Plateau, much of the adjacent watershed has a distinctive mountainous appearance, with sharp "cuts" between the high ridges. Despite all the high terrain and divides of the adjacent watershed, the stream gradient at the survey site is only 4 feet per mile, substantiating the fact that this portion of War Eagle Creek does flow through a plateau region.

Figure OZ-21



1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

WAR EAGLE CREEK: Drainage area 263 square miles ■ Survey site ▒ Survey area

Soil Types - Four different soil associations exist in the War Eagle Creek drainage basin. Most of the adjacent watershed of the stream from near the headwaters area downstream past the survey area (from Witter to west of the Highway 45 bridge) consists of a band of soils of the Ceda-Leachville-Cleora Association. This band is approximately 1 mile wide and 25-30 miles long. This soil association is characterized by being deep, level to gently sloping, well-drained to moderately well-drained, loamy, gravelly and cobbly soils that formed in alluvium derived mainly from sandstone, siltstone and shale, or in colluvium from sandstone and shale.

The lateral watershed soils of the headwaters region consist primarily of the Enders-Leesburg Association. These soils are deep, gently sloping to steep, well-drained, stony and gravelly, and were formed in residuum of acid shales and in colluvium from acid shale and sandstone.

Some isolated regions of Steprock-Linker-Mountainburg soils in the vicinity of Huntsville exist in the lateral watershed. This soil is moderately deep and shallow, gently sloping to moderately steep, well-drained, loamy, gravelly and stony and was formed in residuum of acid sandstone interbedded with siltstone and shale.

Lateral watershed soil types in the mid to lower level reaches of War Eagle Creek consist of Nixa-Clarksville-Noark Association. These soils are deep, gently sloping to very steep, moderately well-drained to somewhat excessively drained and well-drained, very cherty soils that formed in residuum of cherty limestone.

Flora - The vegetation in this drainage basin generally consists of upland hardwoods. In the vicinity of the study site, streamside trees consist of silver maple, black willow, sycamore, catalpa, river birch, green ash and American elm. Much of the lateral watershed is dominated by a red oak-white oak-hickory climax.

Land Use - Land use in the War Eagle Creek watershed is almost an equal division between agricultural practices and forest (47% to 52%). The agricultural uses of the land consists primarily of cattle farming and poultry production. Most of the forest lands are privately owned and only a very small amount of timbering occurs in this drainage basin. The nonpoint source of contribution of pollutants to War Eagle Creek is dominated by pastureland runoff during rainfall events.

Stream Characteristics - War Eagle Creek originates in the Boston Mountains in the southern portion of Madison County. In the sample region, the mean channel width is 109 feet,

while the mean stream width is 57 feet. Stream velocity was measured at 0.77 feet per second, which is quite fast considering the stream slope is only four feet per mile. The flow during the summer survey period was 25 cubic feet per second, while the spring flow was measured at 101.5 cfs. The survey region has a pool-riffle ratio of 67% to 33% during the summer survey. The stream substrate is dominated by gravel and rubble in the study area. According to U.S.G.S. flow data, War Eagle Creek at Highway 45 has a Q_{7-10} range from 1 to 10 cubic feet per second.

Methodology and Sampling Results

War Eagle Creek was sampled during the period of September 8-11, 1985, and again during May 12-14, 1986. There was a very heavy rainfall on Wednesday of the summer survey week (September 11); however, the physical stream work-up and the water sampling had already been completed. The flow measurements were also taken before the rainfall event. There was no rainfall in the area during the spring survey.

Continuous Dissolved Oxygen

Summer - Two continuously recording dissolved oxygen meters were used in this survey. One meter was placed in the lower portion of a large pool above the Highway 45 bridge, while the other meter was installed in a riffle just below the bridge. Dissolved oxygen and stream temperatures were recorded for a 72-hour period during the summer survey (Figure OZ-22). The pool meter malfunctioned the second day after installation, while the riffle meter functioned properly for the entire period. The meters were calibrated each day with an on-site Winkler titration to insure data accuracy. A diurnal variation of 1.7 mg/l was recorded at this location on War Eagle Creek. This occurred in the first two days prior to the rainfall. The effects of a large volume of watershed runoff tends to lower the overall dissolved oxygen concentration and reduce the magnitude of the diurnal variation due to the influence of increased stream turbidity (as well as cloud cover) on the photosynthetic activity.

Spring - Two meters were also used during the spring survey. The meters were placed in the same general location as in the summer survey. Both meters functioned properly during the 48-hour period of installation. There was no rainfall in the area during the week of the survey; however, the stream stage fell 3½" during the survey period.

The falling water level appeared to have affected the dissolved oxygen concentration, as well as the magnitude of the diurnal variation. For example, the pool meter dropped

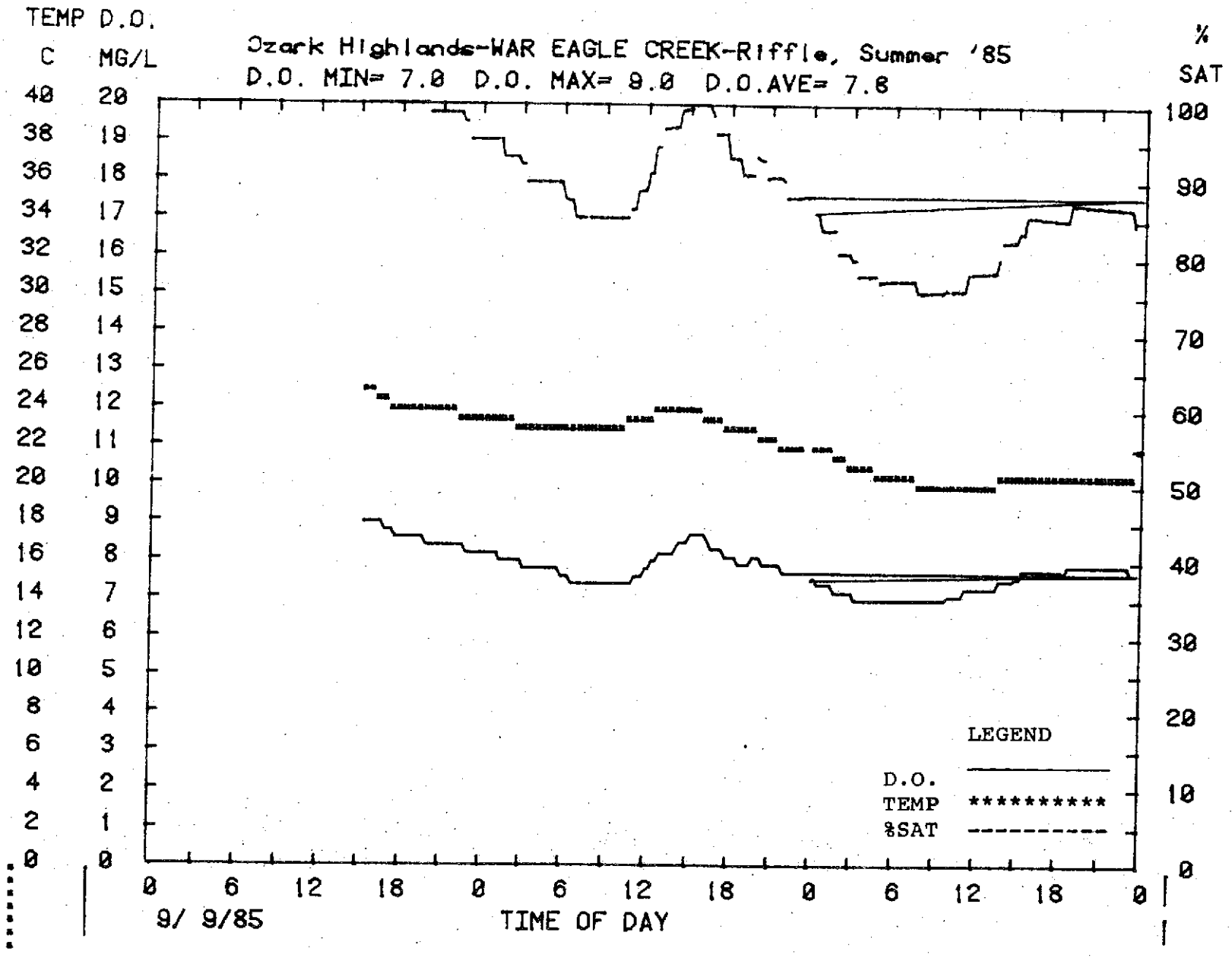


Fig. OZ-22. Dissolved Oxygen Plot

from a high D.O. of 11.2 mg/l to 7.2 mg/l the first day of recording, while the second day ranged from 10.7 mg/l to 7.3 mg/l. The riffle meter had similar fluctuations: 10.8 to 7.4 the first day, while the range was 10.5 to 7.6 the second day (Figures OZ-23 and OZ-24). Again, the high diurnal D.O. fluctuation reflects the watershed use. Application of poultry waste to pasturelands (generally during spring) contributes nutrients utilized by floating and attached algae in the streams.

Chemical Parameters

The chemical parameters measured in the summer and spring survey of War Eagle Creek are listed in Tables OZ-25 and OZ-26. The summer parameters generally have higher values than the spring, with the exception of ammonia. The spring survey ammonia value, at 0.07 mg/l, is over seven times higher than the summer values. This higher value reflects the agricultural practice of spreading poultry wastes on pasturelands during the spring months of the year. This waste material is very high in ammonia, which enters the stream during rainfall events. Another parameter influenced by this waste is nitrite-nitrate nitrogen. Values in excess of 1 mg/l were found in the summer survey while values of 0.6 mg/l were detected in the spring samples. Chlorophyll a values reflected this nutrient contribution, with 5 μg/l and 2.14 μg/l being measured in the summer and spring samples, respectively.

Physical Parameters

The physical measurements of the stream and evaluation of the watershed composition and uses have been summarized and included in Table OZ-27. Major differences in the physical appearance of the stream between the summer and spring surveys included a major increase in stream flow (25 cfs versus 101 cfs) and a corresponding increase in stream width and velocity. The stream width where the flow was taken increased from 22 feet in the summer to 37 feet in the spring, while the maximum recorded velocity rose from 1.5 feet per second to 2.4 feet per second. The maximum depth where flow measurements were made also increased from 1.8 feet to 2.3 feet. As was previously mentioned, the Q_{7-10} for War Eagle Creek in this region is between 1 and 10 cubic feet per second, so the summer survey flow exceeded the Q_{7-10} by a substantial amount. The temperature of the stream averaged only 23°C during the summer survey and had warmed to 21°C during the spring survey.

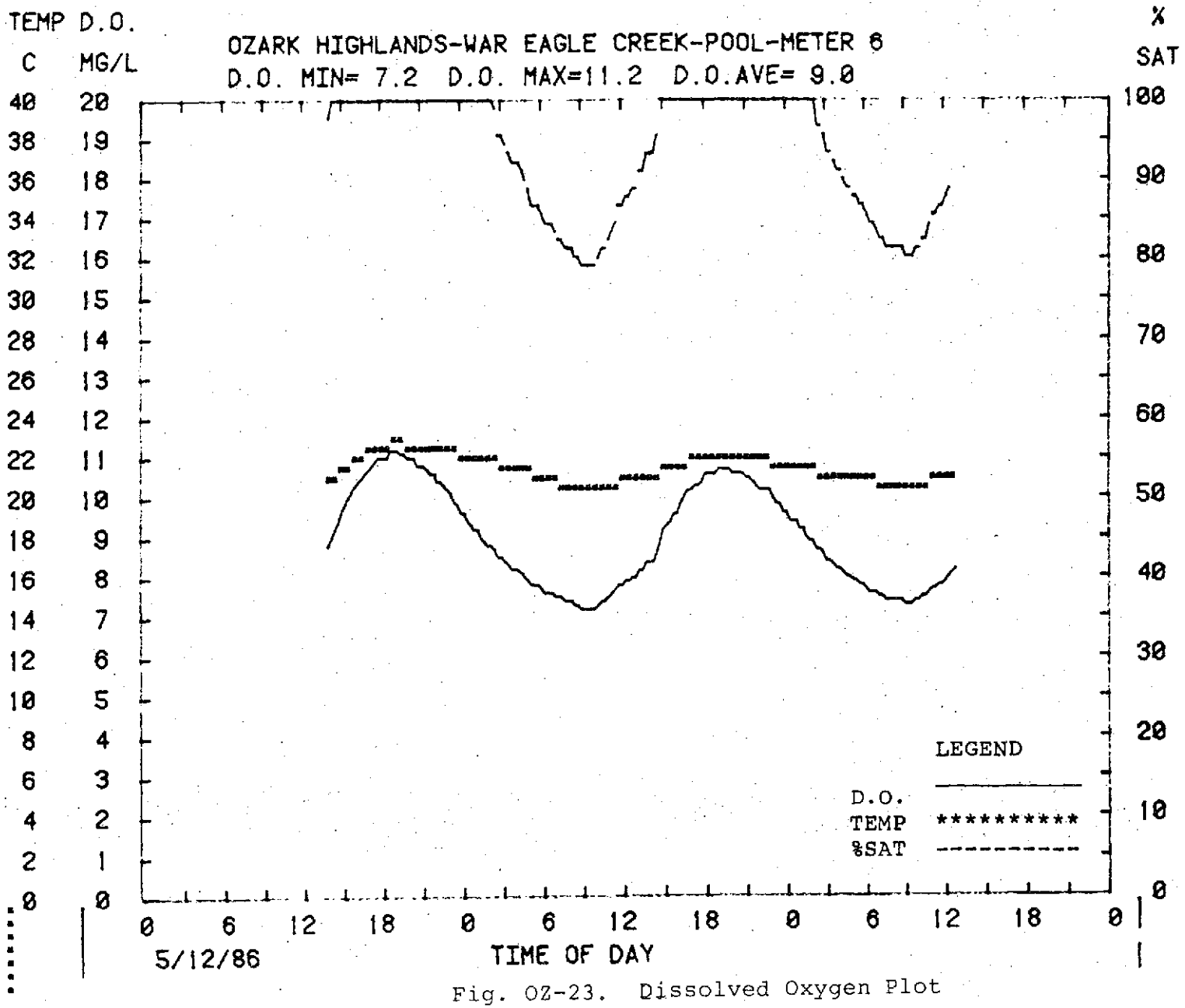


Fig. OZ-23. Dissolved Oxygen Plot

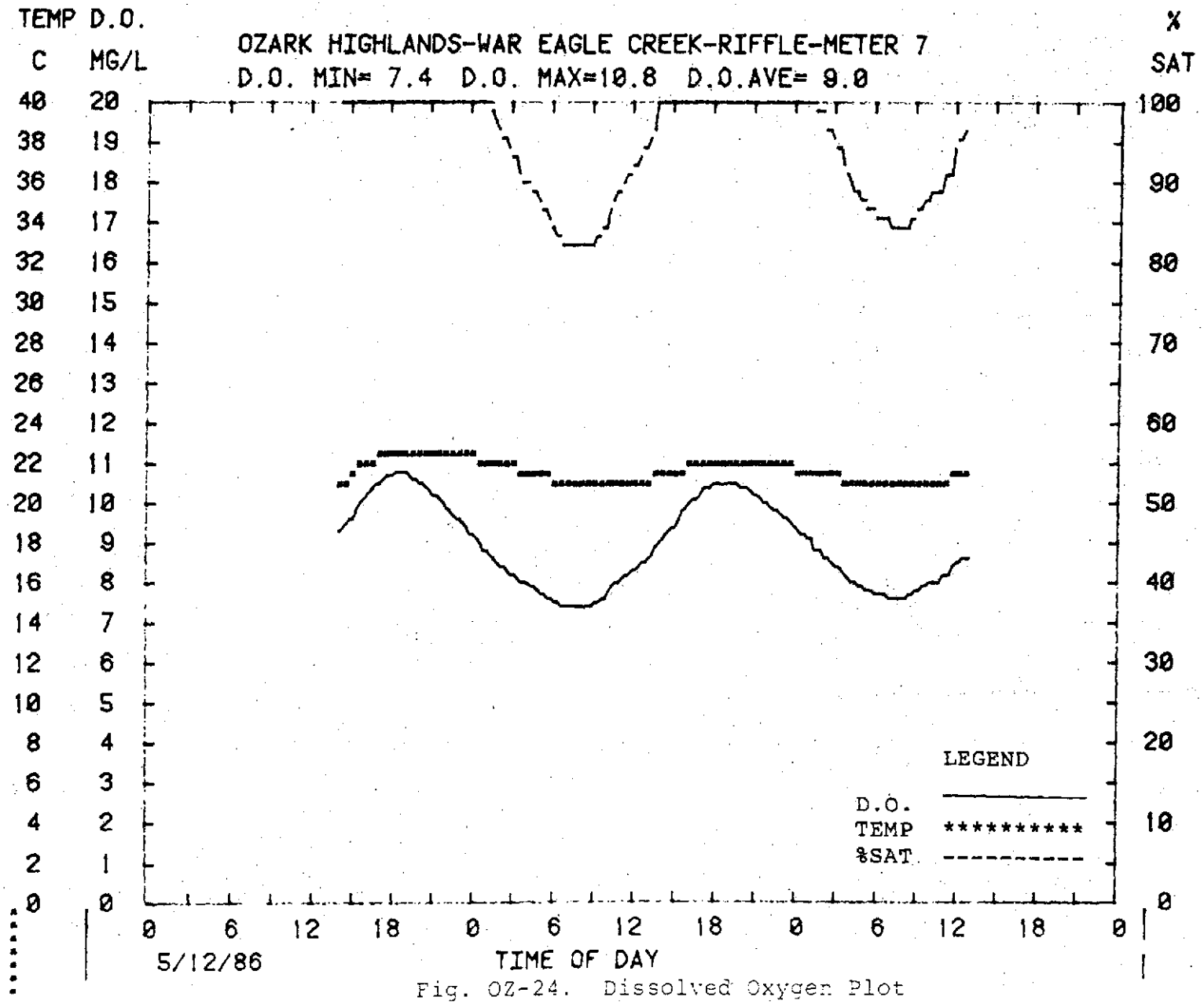


Fig. OZ-24. Dissolved Oxygen Plot

Table Oz-25

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: War Eagle Creek

Drainage Area: 263 Square Miles

Station Description: Hwy 45 bridge in Section 28, T 18 N, R 27 W, Madison County

Date: September 9, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:35	10:20	11:00	
Q, cfs	25.1	25.1	25.1	25.1
Temperature, °C	23	23	23	23
pH	7.9	7.9	7.9	7.9
Turbidity, ntu	5	6	6	6
TSS, mg/l	12	14	12	12
TDS, mg/l	139	138	139	139
BOD-5, mg/l	1.3	1.4	1.3	1.3
BOD-20, mg/l	2.6	2.7	2.5	2.6
T.Phos., mg/l	0.05	0.04	0.05	0.05
PO4-P, mg/l	0.03	0.03	0.03	0.03
NO2+NO3-N, mg/l	1.1	1.25	1.1	1.15
NH3-N, mg/l	<0.01	<0.01	0.01	<0.01
Cl -, mg/l	7	7	7	7
SO4 =, mg/l	8	7	7	7
Fe, mg/l	0.20	0.20	0.18	0.19
Conductivity, μmho	230	246	235	237
Alkalinity, mg/l	107	107	107	107
T. Hardness, mg/l	114	112	110	112
Chlorophyll a, μg/l	7.2	4.5	3.5	5.0
Fecal Coliform	-	-	90	90

Dissolved Oxygen Data for 10 Sep 1985		
	Riffle	
Average	7.9	
Minimum	7.4	
Maximum	8.7	

Table OZ-26

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: War Eagle Creek

Drainage Area: 263 square miles

Station Description: Hwy 45 bridge in Section 28, T 18 N, R 27 W, Madison County

Date: May 13, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:23	10:15	11:05	
Q, cfs	102	102	102	102
Temperature, °C	21	21	21	21
pH	7.75	7.73	7.59	7.7
Turbidity, ntu	4	4	4	4
TSS, mg/l	3	2	4	3
TDS, mg/l	90	96	94	93
BOD-5, mg/l	1.2	1.1	0.9	1.1
BOD-20, mg/l	2.5	2.6	2.1	2.4
T.Phos., mg/l	0.03	0.03	0.02	0.03
PO4-P, mg/l	0.01	0.02	0.02	0.02
NO2+NO3-N, mg/l	0.63	0.62	0.61	0.62
NH3-N, mg/l	0.06	0.07	0.07	0.07
Cl -, mg/l	4.5	4.5	4.0	4.5
SO4 =, mg/l	10	9	7	9
Fe, mg/l	<0.01	<0.01	0.01	<0.01
Conductivity, μmho	164	164	167	165
Alkalinity, mg/l	68	67	68	68
T. Hardness, mg/l	76	76	78	77
Chlorophyll a, μg/l	-	-	2.14	2.14
Fecal Coliform	-	-	48	48

Dissolved Oxygen Data for 13 May 1986		
	Riffle	Pool
Average	8.9	8.9
Minimum	7.4	7.2
Maximum	10.5	10.7

Table OZ-27

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	War Eagle Creek
Date:	September 10, 1985
Drainage Area:	263 square miles
Watershed Land Use:	47% agriculture 52% forest 1% other
Stream Gradient:	4.0 ft/mi
Mean Channel Width:	109 feet
Mean Stream Width:	57 feet
Mean Stream Velocity:	0.77 fps
Observed Flow:	25 cfs
Average Substrate Type:	3% boulder 35% rubble 54% gravel 7% sand 1% mud
Mean Instream Cover:	3% brush, logs, debris 2% overhanging vegetation 3% inundated vegetation
Riffle/Pool Ratio of Transects:	33% riffles 17% moderate pools 50% shallow pools
Mean Bank Overstory Cover:	87% trees 16% shrubs
Mean Bank Ground Cover:	68% grasses and forbs 31% rock 1% dirt
Mean Bank Stability:	33% stable 41% moderate 26% stable
Mean Stream Canopy:	37%
Comments:	

Macroinvertebrate Populations

Ninety-six (96) taxa representing 19 orders were identified from the combined summer and spring samples of the benthic community (Table A-30, Appendix A). The dominant orders Ephemeroptera, Trichoptera and Coleoptera comprised 37%, 11% and 10% of the sample. Taxonomically, Ephemeroptera and Coleoptera were dominant and were represented by 19 taxa each. Cambarus bortoni, Cheumatopsyche, Isonychia, Perlesta placida and Tricorythodes, each comprised greater than 5% of the numerical total. Other taxa, common to both samples and considered as ecologically characteristic included Chimarus obscura, Corydalus cornutus, Macronychus glabratus and Stenonema mediopunctatum.

The qualitative comparative indices indicated that the summer and spring samples were significantly similar (Table OZ-28). Indeed, only 13 and 30 taxa were unique to the summer and spring samples, respectively. These comprised only 7.1% and 22.9% of their respective samples. Fifty-three (53) of the 96 taxa identified from War Eagle Creek were present in both samples and comprised 81.8% of all organisms collected.

Summer - The dominant orders of the summer closely resembled those above. Mayflies accounted for almost 40% of the organisms collected. The dominant taxa of the summer sample included Isonychia (18%), Cheumatopsyche (13%) and Tricorythodes (12%). Other taxa unique to the summer benthic community which were not numerically dominant but considered ecologically characteristic included Ancyronyx variegata and Ceraclea tarsi-punctata.

Spring - The spring sample demonstrated a significant shift of the dominant groups. Mayflies comprised 36% followed by stoneflies (13%) and Decapoda (12%). The dominant taxa of the spring sample were Cambarus bartoni (11%) and Caenis (7%). Other taxa, not numerically dominant but characteristic, included many winter mayflies and three taxa of stoneflies.

The community parameters were characteristic of a balanced, stable benthic community (Table OZ-28). All diversities were high and resulted from the presence of high quality water, habitat diversity and only limited man-induced influence within the watershed. The ecological feeding groups also demonstrated typical seasonal variation. In both samples, collectors dominated. Predators were the next dominant group of the summer sample but were replaced by shredder taxa in the spring. Their function is to cycle the previous fall input of allochthonous material.

Table OZ-27. Community Anaylsis of Benthic Samples from War Eagle Creek - 30 Minute Qualitative Samples, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	954	1611	2563
Total # Taxa	65	83	96
Diversity	4.6094	5.0431	5.1872
Index of Evenness	0.5956	0.4091	0.4652
Index of Dominance	0.7626	0.7911	0.7877
Index of Variety	6.5671	7.6968	8.3895
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.76	
Common Taxa Index (range 0-1)		0.64	
Qualitative Similarity Index (range 0-100)		48.0	

Fish Populations

Summer - Sampling at this site was done with the 3500-watt, 220-volt, A.C. generator. The sample area covered about ½ mile and was sampled in about 2½ hours. Flows were slightly above normal for the summer period and the water was slightly murky from recent rains. A total of 33 species were collected during the summer period (six additional species were collected during the spring). The sample was composed of 2504 individuals producing a relative abundance value of 193.5 and a diversity index of 4.65. All species collected at this site are listed in Table OZ-29. In the summer sample, 11 species of Cyprinidae made up 31.8% of the population. Next in abundance were Centrarchidae and Percidae at 20.9% and 19.9%, respectively. Three primary feeding fish species made up 12.9% and seven carnivorous species comprised 11.9% of the population. The remainder were macroinvertebrate feeders. Twenty sensitive fish species were collected which made up 60.7% of the total population (Table OZ-30).

Table OZ-29. Fishes Collected from War Eagle Creek with Relative Abundance Values

SPECIES		R.A. VALUES
Micropterus punctulatus	Spotted bass	12.0
**Notropis pilsbryi*	Duskystripe shiner	12.0
Notropis nubilus	Ozark minnow	12.0
**Etheostoma caeruleum*	Rainbow darter	12.0
**Etheostoma juliae*	Yoke darter	12.0
Campostoma anomalum	Stoneroller	12.0
Lepomis megalotis	Longear	10.5
**Hypentelium nigricans*	Northern hogsucker	10.5
**Noturus albater*	Ozark madtom	9.0
**Notropis rubellus*	Rosyface shiner	9.0
**Ambloplites constellatus*	Ozark bass	9.0

Table OZ-29, cont.

SPECIES		R.A. VALUES
Moxostoma erythrurum	Golden redhorse	8.0
*Moxostoma duquesnei	Black redhorse	8.0
*Cottus carolinae	Banded sculpin	7.5
*Etheostoma blennioides	Greenside darter	6.0
Notropis chrysocephalus	Striped shiner	5.5
Lepomis cyanellus	Green sunfish	5.0
*Etheostoma zonale	Banded darter	4.5
*Notropis boops	Bigeye shiner	4.0
*Notropis whipplei	Steelcolor shiner	4.0
Fundulus olivaceus	Blackspotted topminnow	4.0
*Noturus exilis	Slender madtom	3.0
Lepomis macrochirus	Bluegill	2.0
*Etheostoma stigmaeum	Speckled darter	2.0
Percina caprodes	Logperch	2.0
Labidesthes sicculus	Brook silversides	1.0
*Noturus flavater	Checkered madtom	1.0
*Moxostoma carinatum	River Redhorse	1.0
Micropterus salmoides	Largemouth bass	1.0
*Notropis galacturus	Whitetail shiner	1.0
Pimephales notatus	Bluntnose minnow	1.0
*Micropterus dolomieui	Smallmouth bass	1.0
*Notropis telescopus	Telescope shiner	1.0
Lepisosteus osseus	Longnose gar	S
Carpiodes velifer	Highfin carpsucker	S
Ictalurus punctatus	Channel catfish	S
Cyprinus carpio	Carp	S
Carpiodes cyprinus	Quillback carpsucker	S
Pylodictis olivaris	Flathead catfish	S

*Sensitive Species
S - Collected during spring sampling only

Table OZ-30. Summary of Fish Population Parameters from War Eagle Creek

Total Species Collected	39.0
Total Number of Individuals	2504.0
Total Relative Abundance Value	193.5
Relative Abundance Diversity Indes	4.65

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	11.0	31.8
CATOSTOMIDAE	6.0	14.2
ICTALURIDAE	5.0	6.7
CENTRARCHIDAE	7.0	20.9
PERCIDAE	6.0	19.9
Primary Feeders	3.0	12.9
Macroinvertebrate Feeders	29.0	75.2
Carnivores	7.0	11.9
Sensitive Species	20.0	60.7

Spring - The springtime sampling was done at this site on May 11-12, 1986, and consisted of overnight sets of three trammel nets with mesh sizes of 1½-, 2- and 2¼-inch square mesh. Also, electrofishing with the 110-volt A.C. generator was carried out in the riffle areas and shallow shoreline to determine the spawning stages of the small fish species. During this time the water temperature was between 20 and 23°C and the flow was measured at 101.6 cfs. Netting produced 27 fish of eight species which weighed 74.1 pounds. Six of these species (longnose gar, highfin carpsucker, quillback carpsucker, carp, channel catfish and flathead catfish) were not collected during the summer sampling. Nineteen species were taken electrofishing, all of these had been collected the previous summer. The carp and both species of carpsuckers were in the spawning process or very near spawning. Channel and flathead catfish and spotted bass were nearing peak spawning condition. Most of the minnows and darters taken electrofishing showed breeding colors and were obviously gravid. The logperch and greenside darter appeared to have partially completed spawning and several young-of-the-year banded sculpins were collected which indicated this species had spawned earlier.

KINGS RIVER

The Kings River originates in the southeast portion of Madison County, just within the north central portion of the Ozark National Forest. The Kings River headwaters and the War Eagle Creek headwaters begin on the opposite sides of the same Boston Mountain ridge. The Kings River flows in a general northerly direction through the eastern side of Madison County, where it becomes the Madison County-Carroll County boundary for a short distance. The river continues flowing northward through the central portion of Carroll County to its confluence with Table Rock Lake in the southern edge of Missouri. Kings River was surveyed at a point in the northern portion of Carroll County approximately two miles north of Highway 62, in the vicinity of Grandview. The sampling location is in the NW¼ Section 10, R 25 W, T 20 N (Figure OZ-25).

General Site Discussion

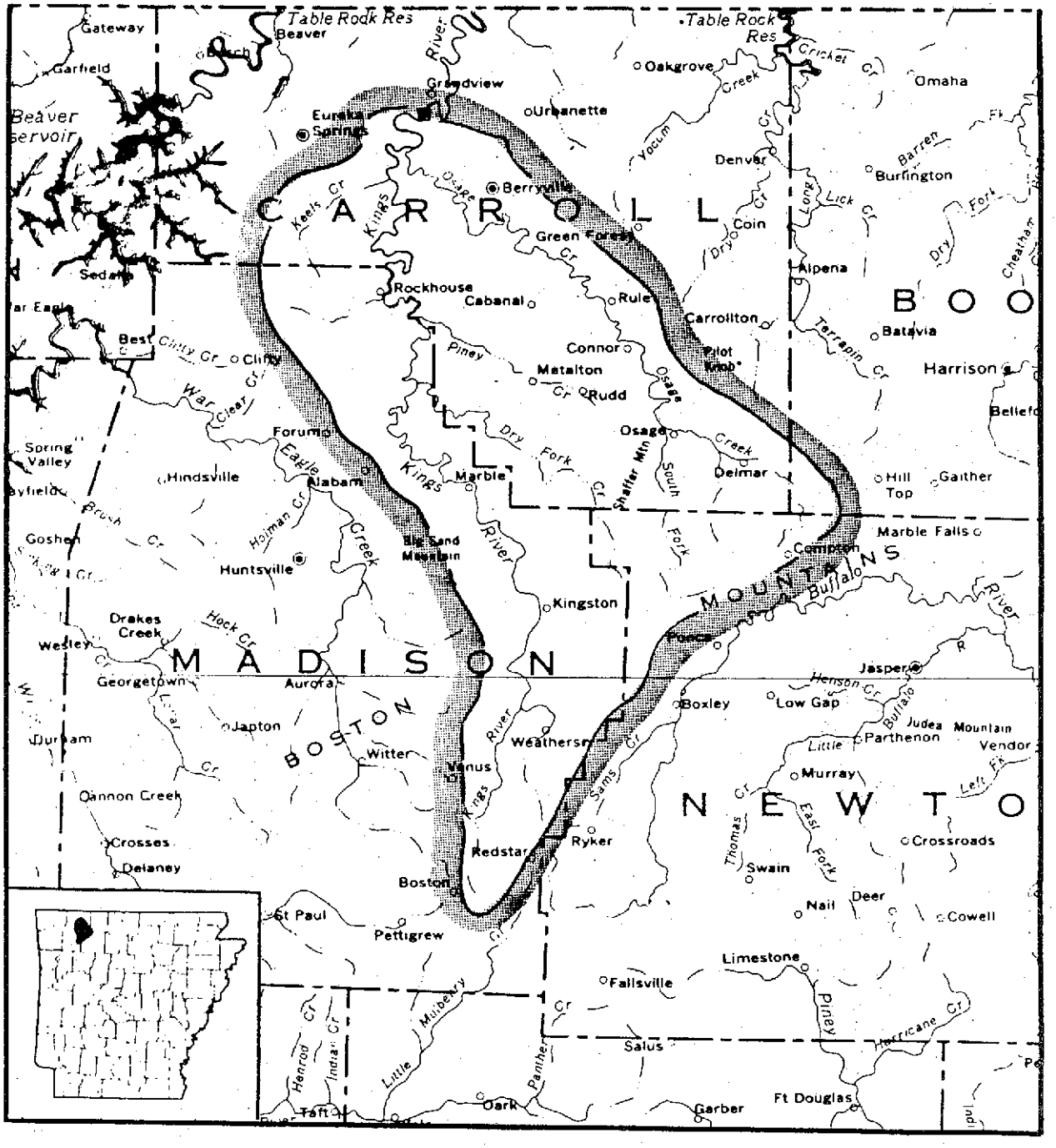
Watershed Size - The total area drained by the Kings River above the survey location is approximately 526 mi^2. From this point the river flows another 14 miles prior to entering the state of Missouri.

Geology - The Kings River drainage has a mixture of geologic formations. The headwaters region is characterized by the Atoka formation, Bloyd Shale, and the Prairie Grove Member of the Hale Formation. The geology of the mid-level portion of the river consists of the Boone Formation while the lower portion, including the survey region, consists of Cotter and Jefferson City Dolomites of Lower Ordovician Age. The lower portion of the Kings River drainage, unlike the remainder of the Ozark Highland streams surveyed, lies within the Salem Plateau.

Topography - The topography of the watershed of this stream ranges from the sharp peaks and deeply divided terrain of the Boston Mountains headwaters to a slightly gentler sloping in the Springfield Plateau region to the lower elevations of the Salem Plateau in the vicinity of the survey area. The base elevation here is approximately 1000 feet with some peaks extending to 1200 feet. Generally, the terrain consists of a rolling hill and valley composition with a gentler slope than in the upstream portions of the watershed. The stream gradient in the vicinity of the sampling site is 4.6 feet per mile, as determined from topographic map calculations.

Soil Types - Several different soil associations exist in the Kings River watershed. The headwaters region is characterized by the Enders-Leesburg group which consists of

Figure OZ-25


CARROLL
MADISON
BOONE
NEWTON
BOSTON MOUNTAINS
Table Rock Res
Beaver Reservoir
Gateway
Garfield
Beaver
Eureka Springs
Grandview
Urbanette
Oakgrove
Omaha
Denver
Burlington
Berryville
Green Forest
Coin
Alpena
Rockhouse
Cabanal
Rule
Carrollton
Batavia
Connor
Metalton
Rudd
Harrison
Pilot Knob
Osage
Delmar
Hill Top
Gaither
Marble Falls
Compton
Best
Clinty
Spring Valley
Hindsville
Forumo
Eagle
Alabam
Marble
Dry Fork
Shaffer Mtn
South Fork
Goshen
Huntsville
Holman Cr
Big Sand Mountain
Kingston
Drakes Creek
Hock Cr
Wesley
Georgetown
Aurora
Boxley
Low Gap
Jasper
Parthenon
Judea Mountain
Vendor
Murray
Japton
Witter
Venus
Weathers
Durham
Cannon Creek
Crosses
Delaney
Redstar
Ryker
Swain
Crossroads
Nail
Deer
Cowell
Boston
St Paul
Pettigrew
Limestone
Fallsville
Salus
Oark
Taft
Garber
Ft Douglas
Scale 1:500,000
1 inch equals approximately 8 miles
40 Miles
50 Kilometers
KINGS RIVER: Drainage area 526 square miles
Survey site
Survey area

Nella-Steprock-Mountainburg soils are also found in the headwaters region. These soils are deep, moderately deep and shallow, gently sloping to very steep, well-drained gravelly, stony, and very stony, which formed in colluvium and residuum of sandstone and small amounts of siltstone and shale. From this soil association, continuing downstream past the survey area, a band of soil approximately 1 mile wide exists on either side of the river. This soil, the Ceda-Leadville- Cleora, consists of deep, level to gently sloping, well-drained to moderately well-drained, loamy, gravelly and cobbly soils that formed in alluvium derived mainly from sandstone, siltstone and shale, or in colluvium from sandstone and shale.

The lateral watershed soil type in the mid-level region of the Kings River is characterized by the Nixa-Clarksville-Noark group. These soils are deep, gently sloping to very steep, moderately well-drained to somewhat excessively drained, very cherty soils that formed residuum of cherty limestone.

Lateral watershed soils of the lower region (in the vicinity of the survey site) consist of two soil associations. The more dominant (in terms of area coverage) are the Arkana-Moko soils which exist in the upper portion of Madison County and in much of the drainage of Carroll County. These soils are moderately deep and shallow, gently sloping to steep, well-drained cherty and stony soils formed in residuum from limestone. Closely associated with this association are the Arkana-Eldon soils which differ from the Arkana-Moko in that they are deeper soils with a gentler slope. This soil group is found in the vicinity of Berryville and northward, as well as near Grandview and northward. The Arkana-Moko and Arkana-Eldon Associations have a pH range of 5.1 to 8.4 and have a moderate soil erosion potential.

Flora - The lower Kings River watershed has an upland hardwoods vegetation type. Within this region, shortleaf pine is found associated with sandstone soils, although none were encountered in the streamside vegetation analysis. Trees commonly found adjacent to the stream in the survey area included red maple, sycamore, alder, river birch, American elm, green ash and sugarberry.

Land Use - The Kings River watershed is, on the whole, dominated by forests (63%), with agricultural activities utilizing approximately 35% of the watershed. In the vicinity of the survey site, where the land is more gently sloping than in the upper watershed, the dominant usage is agriculture. Cattle grazing and poultry production are the dominant agricultural activities within this region. The effect of these activities on the water quality of the Kings River will be addressed in succeeding sections of this report.

Stream Characteristics - The stream slope is 4.6 feet per mile, and is dominated by pool areas over riffles at a ratio of 80:20. Although no velocity measurements were taken, the velocity was slow during the summer survey. The channel width averaged 146 feet in the survey region, while the actual wetted area of the stream averaged 112 feet. The stream substrate is dominated by gravel (25%) and bedrock (23%) while boulders, rubble, sand and silt constituted approximately equal portions of the remainder. The measured summer flow (48.8 cfs) was substantially higher than that presented in U.S.G.S. low flow data for this region of the river. The flow range presented in this data is 1-10 cfs for Q_{7-10} value. The spring survey flow was measured at 251.7 cfs. No rainfall occurred during either week of these surveys.

Methodology and Sampling Results

Kings River was surveyed during the week of September 9-12, 1985, and again during May 12-14, 1986. The survey effort was not hampered or delayed by rainfall in either survey. The river flow of 48.8 cfs, however, was considered to be above normal for the summer period.

Continuous Dissolved Oxygen

Summer - Two continuous dissolved oxygen and temperature recorders were placed in a pool and riffle in the study area of the stream. These meters recorded data for a period of 72 hours (Figures OZ-26 and OZ-27). The riffle meter malfunctioned to the point that adjustments in excess of 1 mg/l were required for daily calibration. The pool meter required daily adjustments as well, but these were less than 1 mg/l. A diurnal dissolved oxygen fluctuation of 2.0 mg/l was recorded from the pool meter during this survey. A higher fluctuation was recorded from the riffle meter, but this data was considered unreliable due to the problems involved in meter calibration and adjustment. The minimum dissolved oxygen recorded in the pool area was 6.4 mg/l. Cloud cover during the last two days of the survey may have prevented a larger diurnal fluctuation than would normally exist.

Spring - Two meters were used in the spring survey. These meters were installed for a 48-hour period in the pool and riffle areas of the stream. Both meters functioned properly during this survey, with only minor adjustments necessary during the daily calibration process. The dissolved oxygen diurnal fluctuation of 5.7 mg/l observed during the spring survey was the highest fluctuation recorded during the 205(j) project. This was not unexpected, however, considering the watershed size and the agricultural activities that exist in this region of the state. The dissolved oxygen range during the spring survey was from a minimum of 7.1 mg/l to a maximum of 12.8 mg/l (Figures OZ-28 and OZ-29). This maximum reading represents a

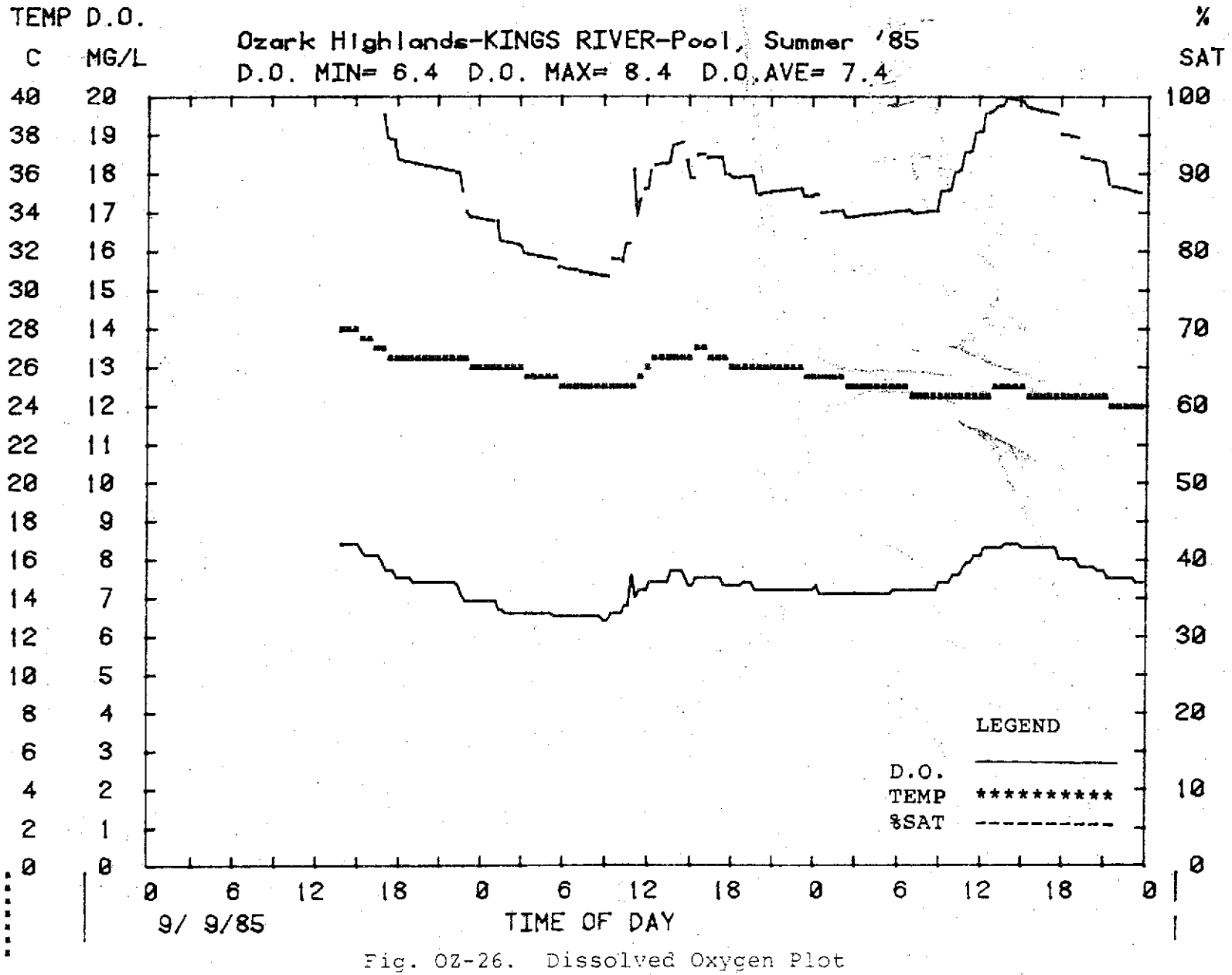


Fig. OZ-26. Dissolved Oxygen Plot

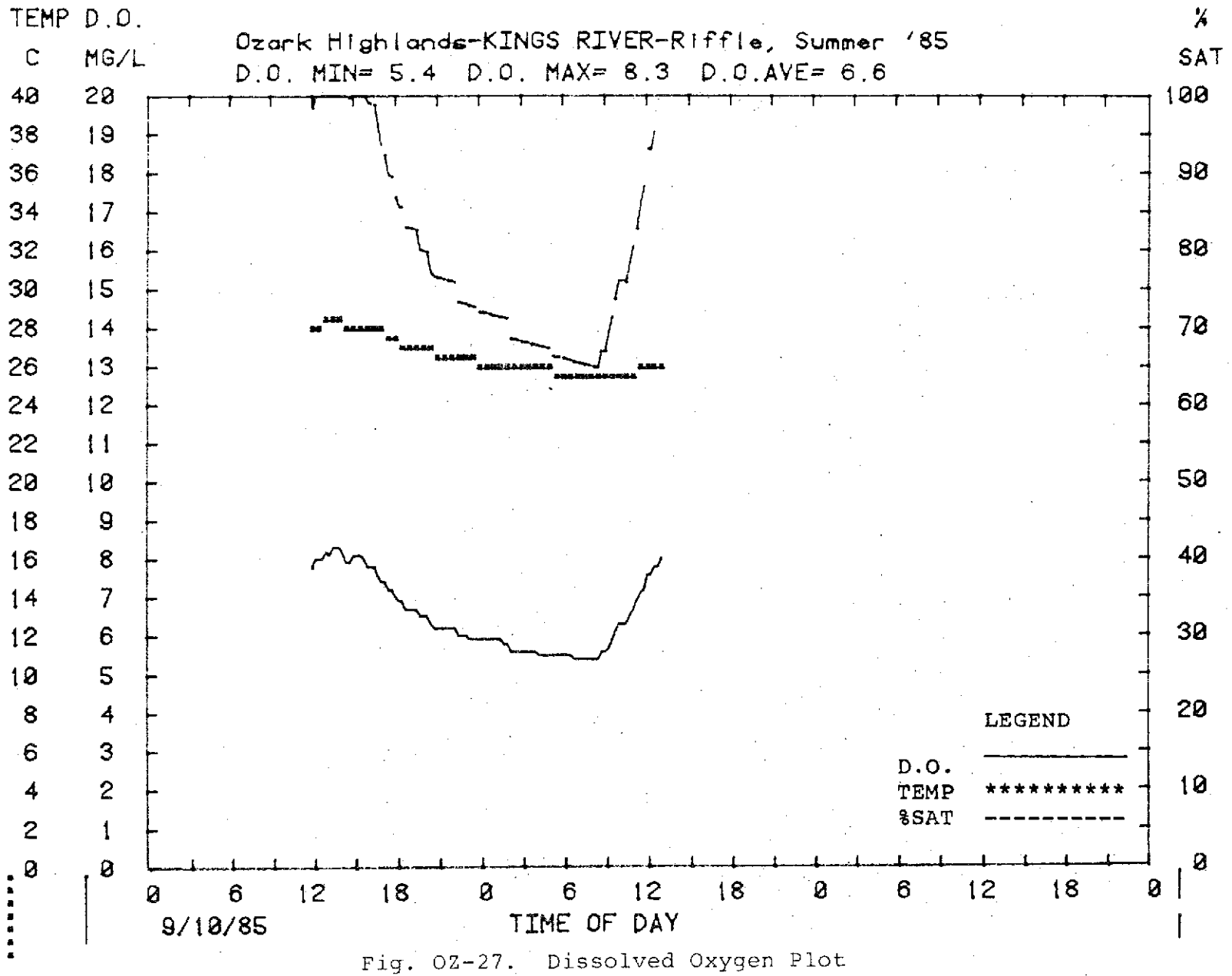


Fig. OZ-27. Dissolved Oxygen Plot

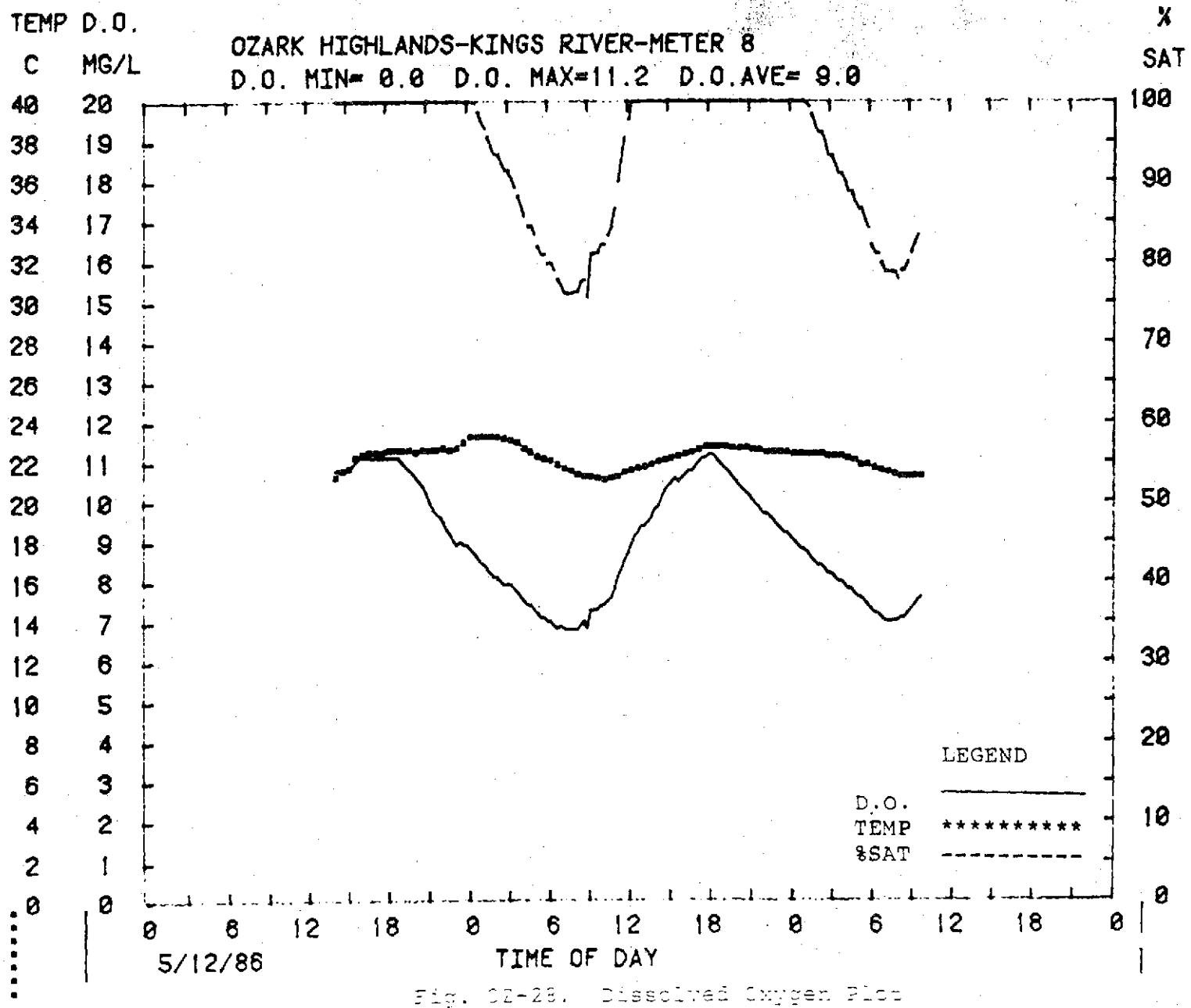


Fig. 22-28. Dissolved Oxygen Plot

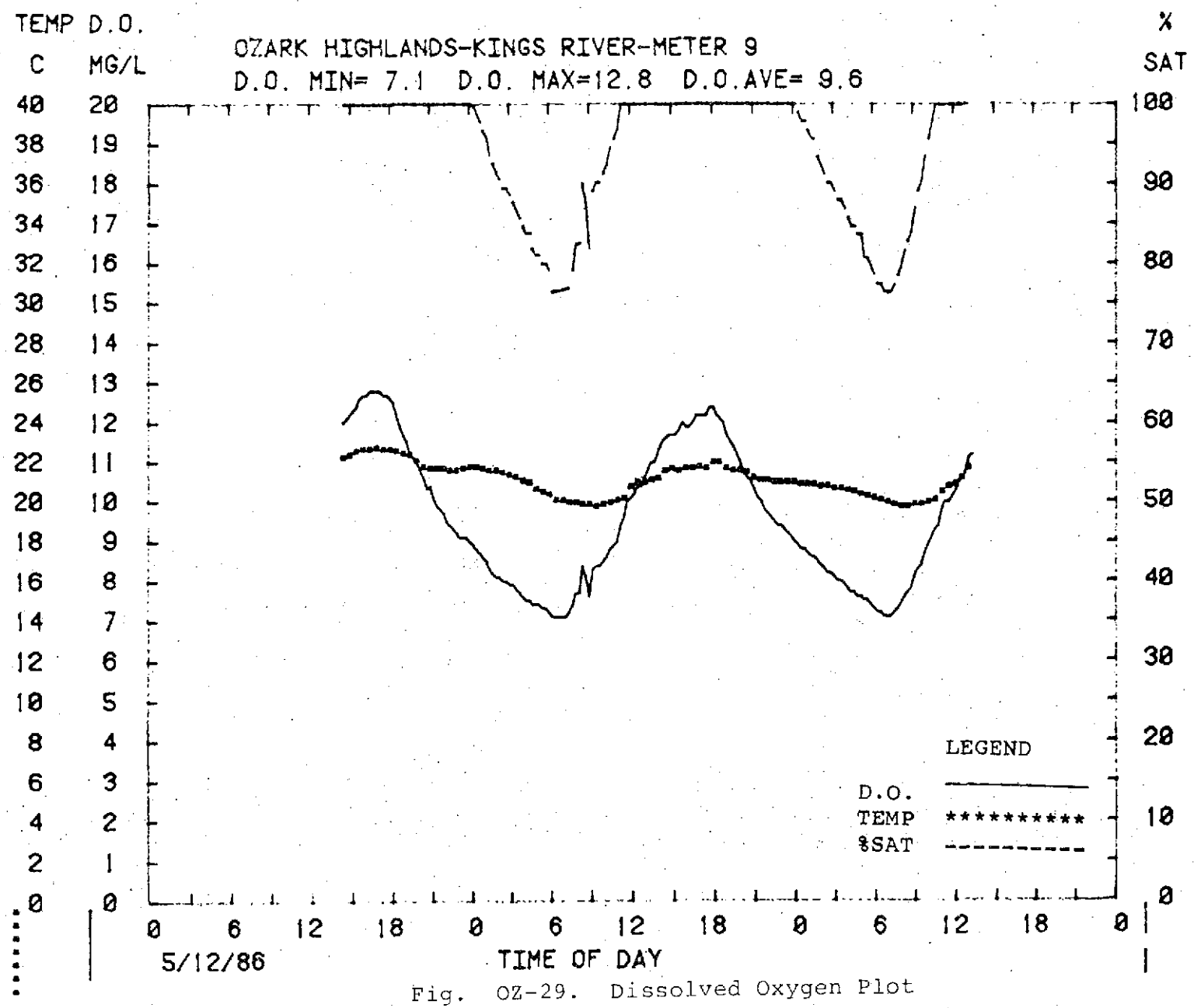


Fig. OZ-29. Dissolved Oxygen Plot

supersaturated condition existing due to the presence of a heavy algae concentration. A water column chlorophyll a content of 6.4 µg/l was analyzed during this survey. This value was the highest recorded from any of the Ozark Highland streams surveyed. The skies were generally clear during this survey, which allows for maximum photosynthetic activity.

Chemical Parameters

The chemical parameters analyzed from the summer and spring surveys of Kings River are listed in Tables OZ-31 and OZ-32. Many of the parameters reflect the nature of the watershed and the agricultural activities therein. Low suspended solids and low turbidity values result from the existing condition of a relatively clear-water stream. High dissolved solids are due to the limestone geology of the watershed. Ammonia and nitrate-nitrogen values from the summer sampling indicate the majority of the nutrients are in the nitrate-nitrite form, whereas the results from the spring survey show an eight-fold increase in the ammonia level. This again reflects the practice of spreading poultry wastes on pasturelands during the early spring months of the year. The end result is an algae "bloom" and periphyton production that creates a supersaturated dissolved oxygen condition with its corresponding large diurnal fluctuations.

Physical Parameters

The physical measurements of the stream and evaluation of the watershed composition and uses have been summarized and included as Table OZ-33. As was previously mentioned, Kings River at the survey site drains a watershed of approximately 526 mi^2. Of this total area, approximately 63% is forested while 35% is developed for agriculture (principally pasturelands) and approximately 2% is used for other purposes. The watershed in the vicinity of the survey area, according to topographic relief maps, is dominated by agricultural land uses.

The stream gradient at the survey site is 4.6 feet per mile. The pool and riffle ratio of 80:20 serves to reduce the overall velocity of this stream, making it the most sluggish of the Ozark Highland streams surveyed. The only observable change in Kings River from the summer to the spring survey was an increase in stream flow from 48.8 cfs in the summer to 252 cfs during the spring survey. The mean summer stream width is 112 feet and with a stream that wide, a five-fold increase in flow from the summer to the spring survey did not appear to substantially change the wetted area width. A small increase in width and depth and with a large increase in stream velocity will generally produce flow increases of this magnitude in streams in this size range.

Table OZ-31

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Kings River

Drainage Area: 526 Square Miles

Station Description: Private road in Section 10, T 20 N, R 25 W, Carroll County

Date: September 9, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:30	10:30	12:15	
Q, cfs	48.8	48.8	48.8	48.8
Temperature, °C	26	26	27	26
pH	7.9	8.0	8.0	8.0
Turbidity, ntu	4	12	4	7
TSS, mg/l	10	9	11	10
TDS, mg/l	156	155	156	156
BOD-5, mg/l	0.5	0.7	0.9	0.7
BOD-20, mg/l	2.0	1.8	2.2	2.0
T.Phos., mg/l	0.10	0.09	0.09	0.09
PO4-P, mg/l	0.07	0.07	0.07	0.07
NO2+NO3-N, mg/l	0.38	0.38	0.37	0.38
NH3-N, mg/l	0.01	0.02	<0.01	0.01
Cl -, mg/l	6	6	6	6
SO4 =, mg/l	12	12	12	12
Fe, mg/l	0.17	0.13	0.17	0.16
Conductivity, μmho	273	284	287	281
Alkalinity, mg/l	129	128	128	128
T. Hardness, mg/l	136	132	130	133
Chlorophyll a, μg/l	1.6	0.5	2.4	1.5
Fecal Coliform	-	-	116	116

Dissolved Oxygen Data for 10 SEP 1985		
	Riffle *	Pool
Average	7.1	7.0
Minimum	5.9	6.4
Maximum	8.3	7.7

*Noon to midnight data only for 10 Sep 1986.

Table OZ-32

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Ozark Highlands

Stream: Kings River

Drainage Area: 526 square miles

Station Description: Private road in Section 10, T 20 N, R 25 W, Carroll County

Date: May 13, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:40	10:35	11:35	
Q, cfs	252	252	252	252
Temperature, °C	21	21	21	21
pH	7.83	7.89	7.97	7.9
Turbidity, ntu	4	3	3	3
TSS, mg/l	4	4	4	4
TDS, mg/l	112	113	109	111
BOD-5, mg/l	1.2	1.0	1.1	1.1
BOD-20, mg/l	2.6	2.4	2.4	2.4
T.Phos., mg/l	0.03	0.02	0.02	0.02
PO4-P, mg/l	0.02	0.02	0.03	0.02
NO2+NO3-N, mg/l	0.19	0.19	0.20	0.19
NH3-N, mg/l	0.09	0.07	0.07	0.08
Cl -, mg/l	3	3	3	3
SO4 =, mg/l	9	7	9	8
Fe, mg/l	-	<0.01	<0.01	<0.01
Conductivity, μmho	207	209	205	207
Alkalinity, mg/l	97	97	97	97
T. Hardness, mg/l	108	106	106	107
Chlorophyll a, μg/l	-	-	6.42	6.42
Fecal Coliform	-	-	28	28

Dissolved Oxygen Data for 13 May 1986		
	Meter 8	Meter 9
Average	8.9	9.5
Minimum	6.8	7.1
Maximum	11.2	12.4

Table OZ-33

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Kings River
Date:	September 10, 1985
Drainage Area:	526 square miles
Watershed Land Use:	35% agriculture 63% forest 2% other
Stream Gradient:	4.6% ft/mi
Mean Channel Width:	146 feet
Mean Stream Width:	112 feet
Mean Stream Velocity:	NA
Observed Flow:	48.8 cfs
Average Substrate Type:	23% bedrock 52% gravel 6% boulder 7% sand 7% rubble 5% mud
Mean Instream Cover:	0.5% undercut bank 1% inundated vegetation
Riffle/Pool Ratio of Transects:	20% riffle 40% moderate pool 40% shallow pool
Mean Bank Overstory Cover:	91% trees 26% shrubs
Mean Bank Ground Cover:	72% grasses and forbs 28% dirt
Mean Bank Stability:	40% stable 60% moderate
Mean Stream Canopy:	29% canopy
Comments:	

Macroinvertebrate Populations

One hundred seventeen (117) taxa representing 21 orders were identified from the summer and spring samples of the benthic community (Table A-31, Appendix A). The dominant orders - Ephemeroptera, Trichoptera, Coleoptera and Diptera - comprised 26.8%, 19.3%, 18.6% and 9.8% of the combined samples, respectively. The dominant taxa which were common to both samples and considered ecologically characteristic were Cheumatopsyche (14.7%), Isonychia (12.2%), Helichus (6.1%) and Simulium jenningsi (6.0%). Other taxa not numerically dominant include Chimarra obscura, Corydalus cornutus, Gyraulus, Hetaerina, Perlesta placida, Psephenus herricki, Stenonema femoratum, Stenonema mediopunctatum and Stenonema pulchellum.

The comparative indices indicated that the summer and spring samples exhibit significant taxonomic homogenity. Of the 117 taxa identified from the combined summer and spring benthic samples, 51 taxa comprising 81.4% of all organisms collected were present in both samples. The 34 and 32 taxa which were unique to the summer and spring samples comprised 17.8% and 19.8% of their respective samples.

Summer - Numerically, the dominant orders of the combined samples were also the dominant orders of the summer benthos sample; Coleoptera replaced Ephemeroptera as the dominant order. Taxonomically, 4 orders were represented by greater than 10 taxa but Coleoptera had almost twice the number of any other. Taxa considered ecologically characteristic of the summer benthic sample but not present in the spring included: Ceraclea, Ephemera simulans, Hagenis brevistylus and Stenelmis exigua.

Spring - The dominant orders of the spring benthic sample were Ephemeroptera (31.8%), Trichoptera (17.3%) and Plecoptera (10.8%). Taxonomically, Ephemeroptera was the dominant order and although not numerically dominant in the spring, Coleoptera and Diptera were taxonomically represented with 15 and 10 taxa, respectively. Taxa unique to the spring benthic community and considered ecologically characteristic include Attenella attenuata, Acroneuria, Eurylophella bicolor, Eurylophella verisimilis, Helicopsyche borealis and Serratella deficiens. Most of the taxa unique to the spring sample were coldwater forms which emerge as adults prior to increases in water temperature.

The community parameters indicate that an extremely diverse, stable, well-balanced benthic community exists as a result of variety and availability of microhabits and high quality water. The benthic community is characterized by the seasonal variation from warmwater summer insect taxa to coldwater winter species. The diversities calculated ranged from 4.859 to 5.0337. There were no significant differences in the other community parameters calculated (Table OZ-34).

Table OZ-34. Community Anaylsis of Benthic Samples from Kings River - 30 Minute Qualitative Samples, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	2701	1817	4518
Total # Taxa	84	83	117
Diversity	4.8597	5.0337	4.9353
Index of Evenness	0.4828	0.4482	0.4479
Index of Dominance	0.7582	0.7896	0.7461
Index of Variety	7.3689	7.5734	8.8801
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.61	
Common Taxa Index (range 0-1)		0.51	
Qualitative Similarity Index (range 0-100)		60.0	

Fish Populations

Summer - Approximately 3/4 mile of this stream was sampled with the 3500-watt, A.C. generator, requiring about 2½ hours collecting time. Large sections of the deep pools could not be effectively sampled, but the areas collected provided a valid sample of the population. A total of 35 species were collected. Table OZ-35 lists these species and their relative abundance value plus the four additional species collected during the spring sampling. The summer sample produced 1281 individuals, a total relative abundance value of 249 and a diversity index of 4.89. Percidae was the dominant fish family, comprising 26.5% of the population. It was closely followed by Cyprinidae and Centrarchidae at 24.1% and 23.3%, respectively. Carnivores of eight species made up 19.1% of the population while five species of primary feeders totalled 11.3% of the population. Twenty sensitive species were collected which made up 59.2% of the population (Table OZ-36).

Table OZ-35. Fishes Collected from Kings River with Relative Abundance Values

Species		R.A. VALUES
Micropterus punctulatus	Spotted bass	12.0
*Etheostoma euzonum	Arkansas saddled darter	12.0
*Etheostoma caeruleum	Rainbow darter	12.0
Campostoma anomalum	Stoneroller	12.0
*Moxostoma duquesnei	Black redhorse	12.0
Percina caprodes	Logperch	12.0
*Etheostoma zonale	Banded darter	12.0
*Notropis pilsbryi	Duskystripe shiner	10.5
*Micropterus dolomieui	Smallmouth bass	10.5
*Hypentelium nigricans	Northern hogsucker	9.0
*Etheostoma juliae	Yoke darter	9.0
Lepomis megalotis	Longear	9.0
*Ambloplites constellatus	Ozark bass	9.0

Table OZ-35, cont.

Species		R.A. VALUES
*Etheostoma blennioides	Greenside darter	9.0
*Moxostoma carinatum	River Redhorse	9.0
Moxostoma erythrurum	Golden redhorse	8.0
Ictalurus punctatus	Channel catfish	8.0
*Hybopsis dissimilis	Streamline chub	8.0
*Noturus albater	Ozark madtom	8.0
*Notropis rubellus	Rosyface shiner	7.5
Lepomis cyanellus	Green sunfish	7.0
Notropis nubilus	Ozark minnow	7.0
Lepomis macrochirus	Bluegill	6.5
Dorosoma cepedianum	Gizzard shad	6.0
Micropterus salmoides	Largemouth bass	4.0
Pylodictis olivaris	Flathead catfish	4.0
*Notropis boops	Bigeye shiner	4.0
Notropis chrysocephalus	Striped shiner	2.0
Cyprinus carpio	Carp	2.0
*Hybopsis amblops	Bigeye chub	2.0
*Notropis greenei	Wedgespot shiner	2.0
*Notropis whipplei	Steelcolor shiner	1.0
Fundulus olivaceus	Blackspotted topminnow	1.0
*Notropis galacturus	Whitetail shiner	1.0
Pimephales notatus	Bluntnose minnow	1.0
Lepisosteus oculatus	Spotted gar	S
Ictalurus melas	Black bullhead	S
Carpiodes velifer	Highfin carpsucker	S
*Stizostedion vitreum	Walleye	S

*Sensitive Species
S - Collected during spring sampling only

Table OZ-36. Summary of Fish Population Parameters from Kings River

Total Species Collected	39.0
Total Number of Individuals	1281.0
Total Relative Abundance Value	249.0
Relative Abundance Diversity Index	4.89

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	13.0	24.1
CATOSTOMIDAE	5.0	15.3
ICTALURIDAE	4.0	8.0
CENTRARCHIDAE	7.0	23.3
PERCIDAE	7.0	26.5
Primary Feeders	5.0	11.3
Macroinvertebrate Feeders	26.0	69.6
Carnivores	8.0	19.1
Sensitive Species	20.0	59.2

Spring - Overnight sets of four trammel nets with mesh sizes of 1½, 2, 2½ and 3½-inch square were used to sample this area during the springtime. Also, the 110-volt, A.C. generator was used to electrofish the riffle and shallow shoreline. During this period the flow was measured at 251.7 cfs and the water temperature ranged from 20 to 23°C. Thirty fish from 13 species weighing a total of 68.3 pounds were taken from the nets. Four species (spotted gar, highfin carpsucker, black bullhead and walleye) were netted which had not been collected the previous summer. Sixteen species, all of which had been taken the previous summer, were collected by electrofishing. Most of the minnows and darters exhibited external breeding characteristics and were gravid. However, the Ozark minnow, greenside darter and some of the slender madtoms appear to have completed spawning as had the river redhorse and walleye. Highfin carpsuckers, Ozark bass and spotted gar were in the process of spawning. The gizzard shad, channel catfish and most of the other Centrarchids were in the last stages of gonad maturation in preparation for spawning.

BOSTON MOUNTAINS ECOREGION

The Boston Mountains ecoregion lies north of the Arkansas River Valley, extending from about Batesville westward to the Arkansas-Oklahoma state line. These mountains were uplifted along with the rest of the Ozark Highlands about 280 million years ago. The Boston Mountains area is the highest portion of the uplift and is also the most eroded.

The rock strata are usually horizontal with very little folding except on the southern edge of the region, where folds dip slightly southward. The strata are predominantly sandstones and shales of Pennsylvanian age (300 million years old). Resistant sandstones in this region, some up to 1,500 feet thick, form massive bluffs near the tops of the mountains.

Soils in the Boston Mountains are thin except in the valley floors. A large variation in soil types exists here but soils are usually slowly to moderately permeable.

The terrain in this region is exceptionally steep and rugged. Local relief can be more than 1000 feet and sideslopes are steep. In many instances, a portion of a mountainside will have precipitous bluffs of several hundred feet. Because of the rugged terrain and steep slopes, runoff is rapid and stream levels can rise quickly. Consequently, these streams are scoured seasonally.

Streams consist of pools and riffles and typically have a combination of sand, gravel, rubble, boulders or bedrock as bottom substrate. Rubble tends to be rounded and collect in the riffle areas. During low flow, water flows through or under these rubble riffle areas. Boston Mountains streams have a characteristic greenish-blue tinge, possibly a result of shales associated with the region. These streams have high aesthetic and recreational value and are some of the most popular streams in the state.

The Boston Mountains Ecoregion is generally forested except for pastureland and small farms. Forests are upland hardwood and some shortleaf pine.

Land use consists of small farms and pastureland in the valley floors and on mountain tops. Silviculture operations dominate other areas. The majority of the Boston Mountains Ecoregion is within the Ozark National Forest. The area has high recreational and aesthetic value and is an extremely popular area for camping, canoeing, hiking and other outdoor activities.

The reference streams selected from this ecoregion and the drainage above the sample sites are as follows:

Indian Creek	47 mi^2
Hurricane Creek	50 mi^2
Archey Creek	107 mi^2
Illinois Bayou	125 mi^2
Lee Creek	168 mi^2
Mulberry River	373 mi^2

INDIAN CREEK

Indian Creek originates in the extreme northwest corner of Pope County. The site selected on Indian Creek was a large pool about 1000 feet below the Forest Service road bridge in Section 17, R 20 W, T 11 N in Pope County (Figure B-1). At the time of the summer survey there was essentially no surface flow in the stream at the bridge. The survey team had to search for a site with a sufficient volume of water to represent typical limnological conditions during low flow. A large pool was selected because it provided the conditions needed for fish to survive in a low flow situation.

General Site Discussion

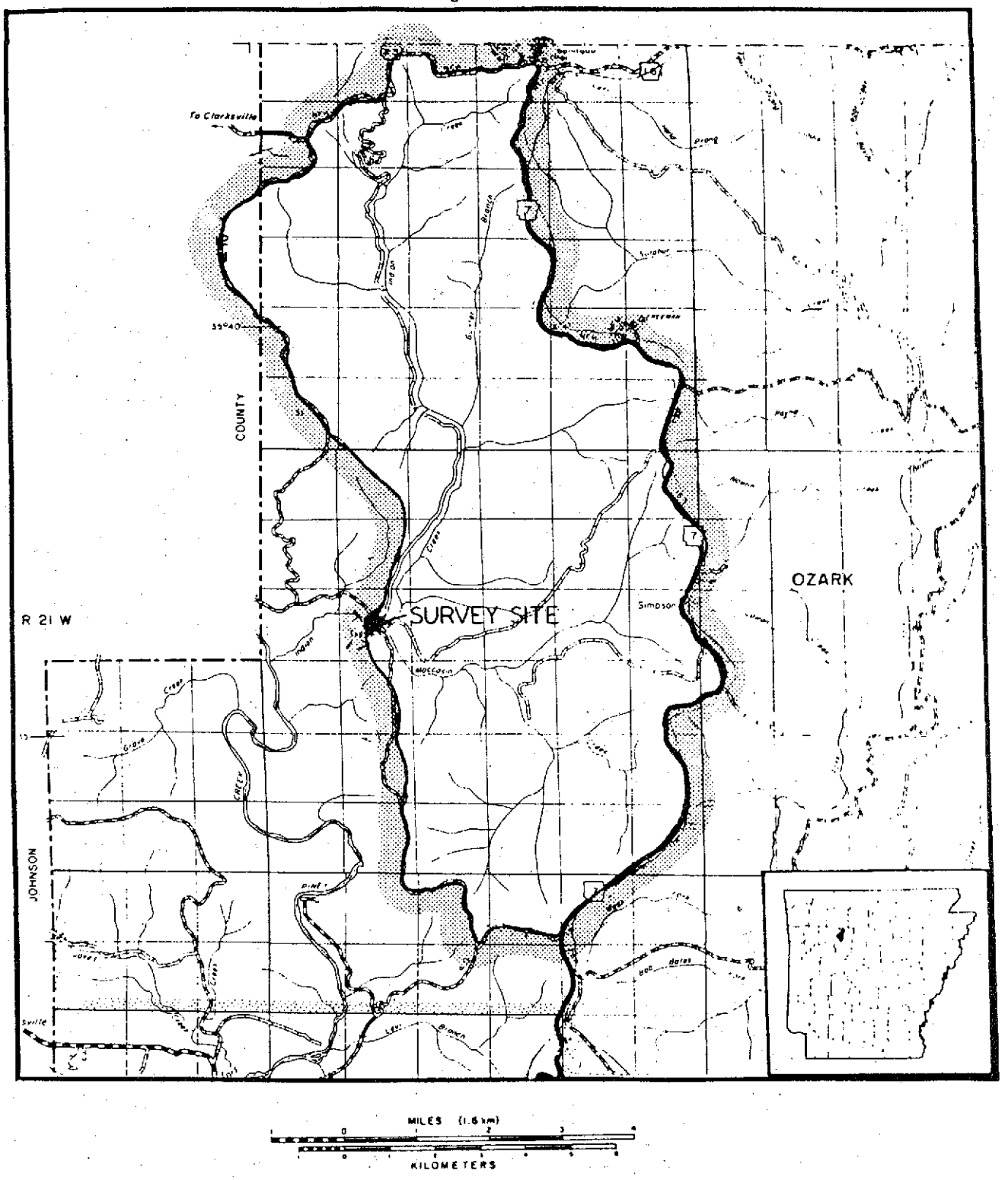
Watershed Size - Drainage basin size at the point of sampling is 47 mi^2. The staff felt this would be near the threshold size for streams in the Boston Mountain Region that would maintain fishable and swimmable uses on a year-round basis. Above the survey site there was no flow and the pools that would last throughout the summer were too small to support a balanced aquatic community.

Geology - Subsurface geology is classified as Bloyd Shale and the Prairie Grove member of the Hale formation. Both are sandstone deposits of Pennsylvanian Age.

Topography - Indian Creek topography can generally be described as mountainous with narrow valleys along major streams. More specifically, the topography is very steep to gently sloping terrain with gently sloping stream valleys. Elevations vary from about 750 to over 2000 feet above mean sea level.

Soil Types - Two major groupings of soils make up the Indian Creek basin. The Nella-Enders-Mountainburg association, the dominant group, is located in the upland portions of the basin. These soils are well drained, gently sloping to very steep, deep and shallow, loamy and stony. The pH ranges from strongly acid to moderately acid (pH 5.5 to 6.0) and the erosion hazard is severe. The Pickwick-Spadra association is found in the stream valleys, and consists of well drained, nearly level to gently sloping, deep loamy soils on stream terraces. The pH ranges from moderately acid to slightly acid (pH 5.6 to 6.5). The erosion potential is slight for soils of this association.

Figure B-1



INDIAN CREEK: Drainage area 47 square miles ■ Survey site Survey area

The pH in Indian Creek was slightly higher than soil pH (pH 6.4 to 6.8) during the summer survey, probably due to the influence of algae. Spring pH values ranged from 5.8 to 6.8, more closely correlating to soils. Springtime flows were high which would tend to decrease the influence of algae.

Flora - Steep upland portions of the basin are covered with hardwood forests comprised of red and black oaks, red cedar and shortleaf pine. Streamside riparian zones are rich in variety. Observed during the survey were: red cedar, sweetgum, sycamore, river birch, American elm, black cherry, river alder, American hornbeam, northern red oak, red maple, white oak, black willow, catalpa, honey locust, green ash, blackgum and shortleaf pine.

Land Use - Data specific to Indian Creek was not available, but data collected by the S.C.S. that combines Indian Creek with a larger area states that 95% of the land is in forest and 5% in pastureland. The majority of the watershed is in the Ozark National Forest. The steep mountainous terrain in the Boston Mountains Region is largely undeveloped. From all observations made during the spring and summer survey, an approximation of 95% forest would be fairly accurate. Indian Creek meets the definition for this project of being least-impaired.

Stream Characteristics - Indian Creek is a mountainous-type stream with a rocky substrate, typical of the Boston Mountain Region. Stream gradient is 32 ft/mile. The creek's most striking characteristics are the rocky substrate, steep gradient and blue-green water. Other characteristics of note are the large number of riffles and low percentage of instream cover.

Methodology and Sampling Results

The summer survey of Indian Creek was conducted from September 12-16, 1983. A follow-up survey was carried out the next spring between May 21 and May 25, 1984, to assess conditions during spawning season. The spring survey had to be delayed for three weeks due to high flows. When the water level dropped, the stream was sampled under typical spring conditions.

Continuous Dissolved Oxygen

Summer - Conditions during the summer survey were typical of the critical low-flow, high-temperature situation in a Boston Mountain stream of this size. Stream flow was too

low to measure between pools, which is normal for late summer. The temperature peaked at 27°C during the week. This is close to the expected maximum of 30°C for the region. Overall, the data approximates an annual worse case situation for dissolved oxygen.

The minimum observed D.O. during the summer survey period differed somewhat between a pool and a riffle (Figures B-2 and B-3). In the pool, the range was 6.4 to 7.8 mg/l, a difference of 1.4 mg/l. The riffle, which was actually the very shallow end of the pool, had a D.O. range from 4.9 to 8.6 mg/l, a difference of 3.7 mg/l.

The daily D.O. cycle was very consistent during the summer survey. Dissolved oxygen peaked each day around 1900 hours and then fell to a minimum around 0400 hours. Dissolved oxygen saturation was also in the same pattern, varying from 75% to 95%. Temperature fell slightly over the period, causing a related rise in the saturation.

Spring - The spring sampling showed much higher levels of dissolved oxygen than were found in the summer (Figures B-4 and B-5). The minimum recorded was 8.7 mg/l and the maximum was 9.2 mg/l. The percent saturation values were also much higher, ranging from 90% to 100%. These higher D.O. values were directly related to higher flows and lower temperatures.

Chemical Parameters

Spring coliform samples were not taken because coliform bottles were not available at the time.

Chemical data collected for the two different periods of the year are displayed in the Tables B-1 and B-2. Water quality at Indian Creek is excellent. The pH is nearly neutral; suspended solids, turbidity and nutrients are very low. Alkalinity, chlorides and sulfates are also extremely low.

Each of these parameters can be traced directly back to the characteristics of the drainage basin. Streams throughout the Boston Mountains Region are noted for having excellent water quality. Low population density, geology, topography and forest cover in the region contribute to excellent water quality.

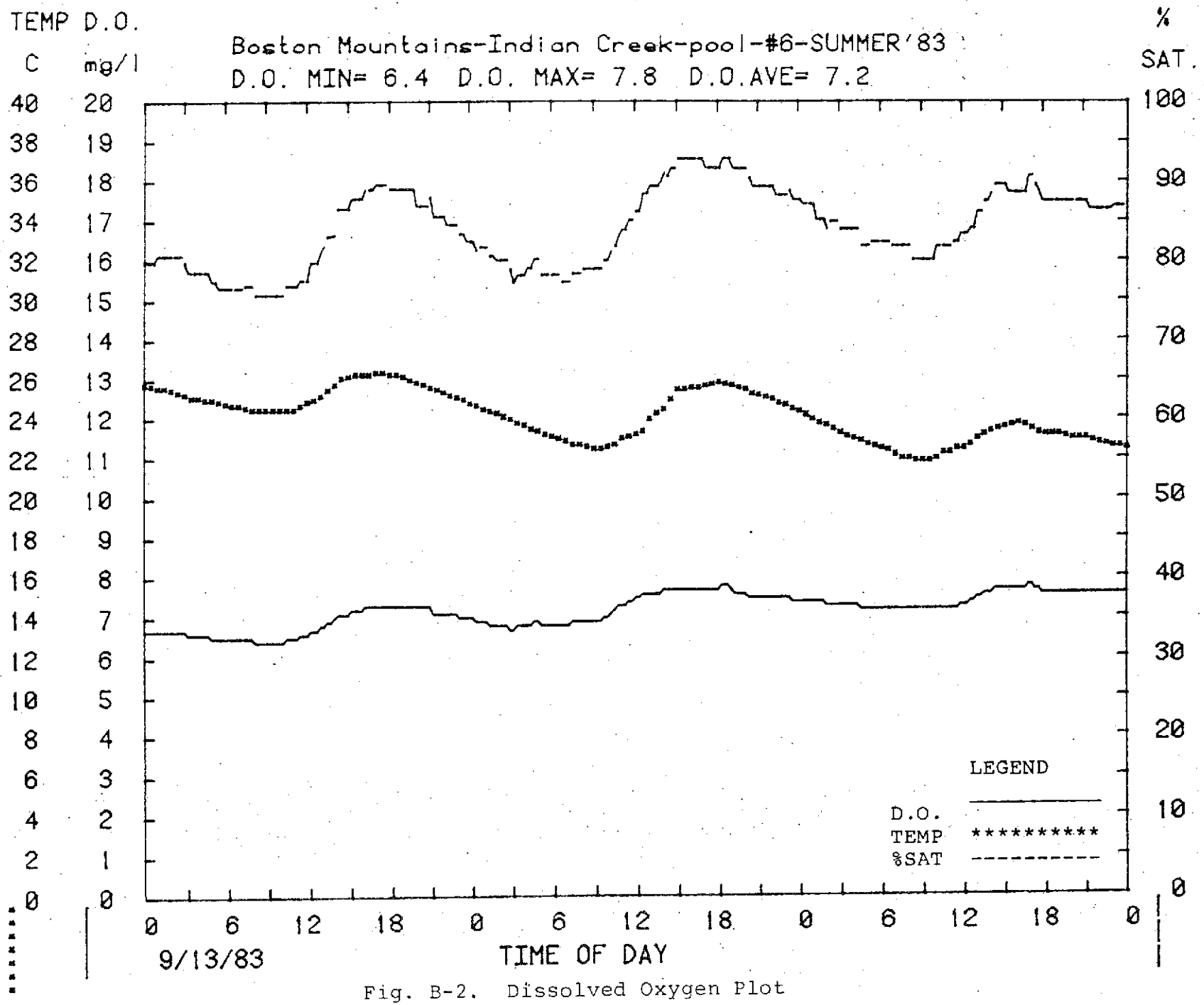


Fig. B-2. Dissolved Oxygen Plot

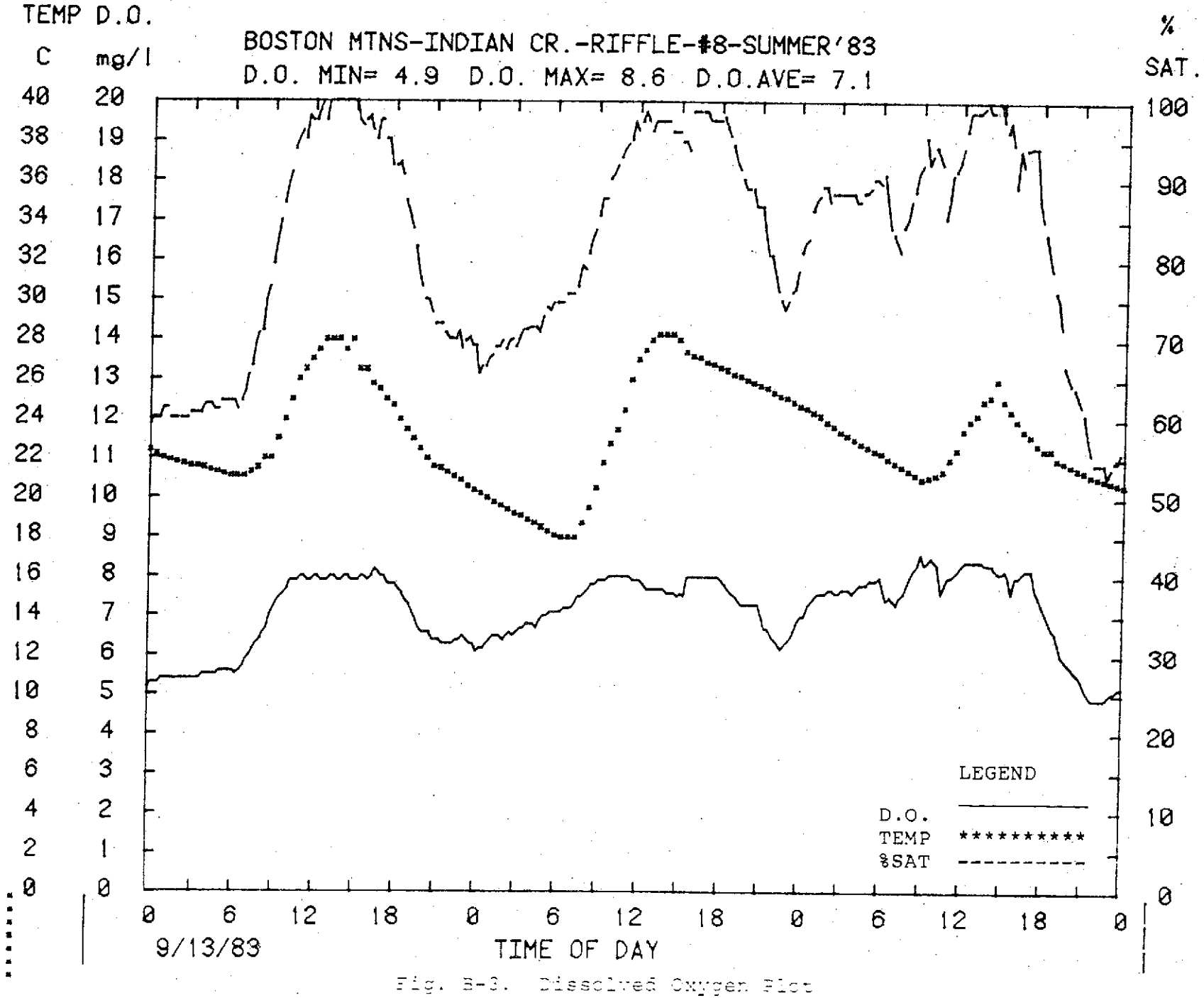


Fig. B-3. Dissolved Oxygen Plot

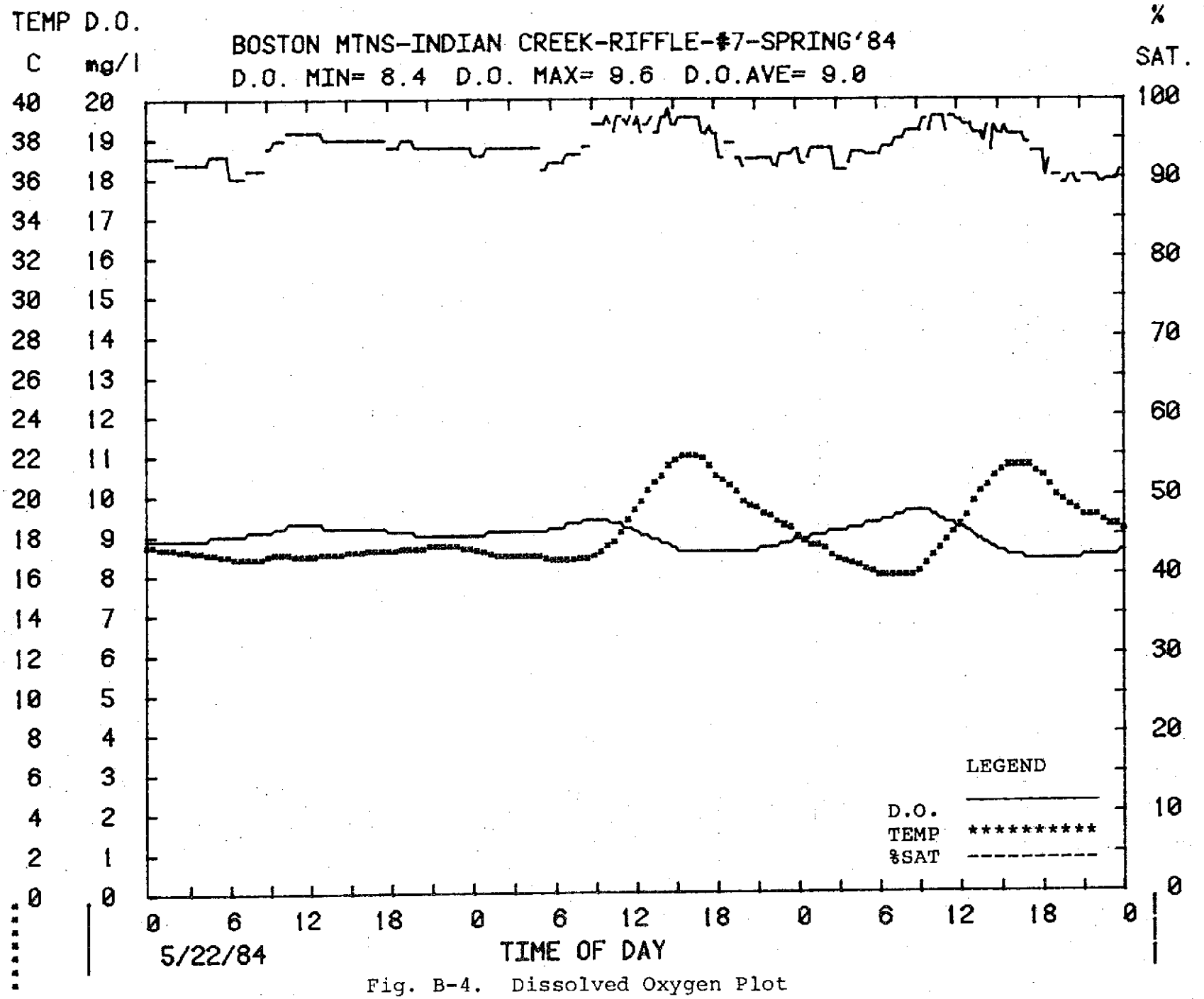


Fig. B-4. Dissolved Oxygen Plot

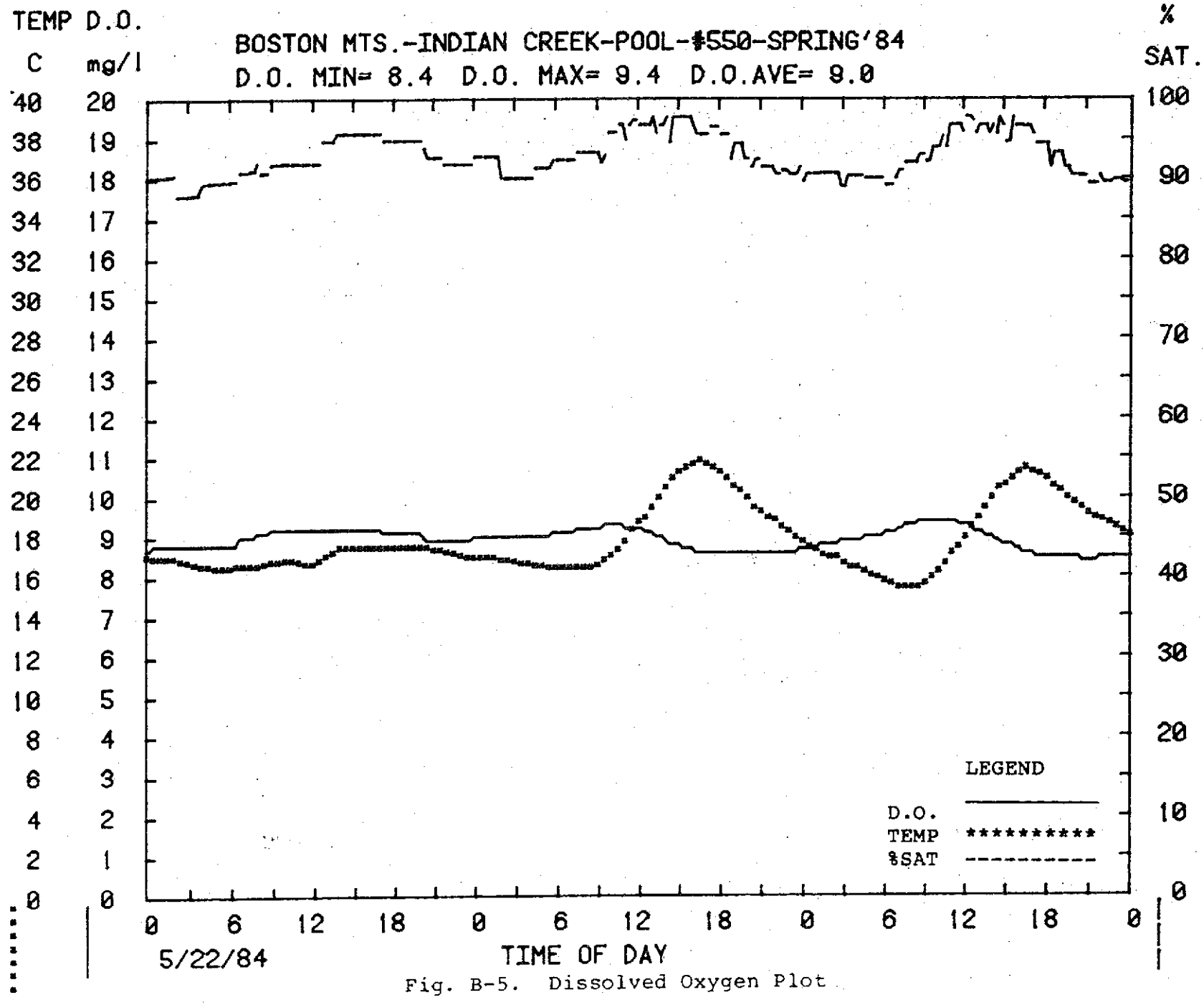


Fig. B-5. Dissolved Oxygen Plot

Table B-1

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Indian Creek

Drainage Area: 47 Square Miles

Station Description: At head of large pool 1000 feet below low water bridge in Section 17, T 11 N, R 20 W - Pope County

Date: September 13, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	10:10	11:30	13:25	
Q, cfs	<0.1	<0.1	<0.1	<0.1
Temperature, °C	23.5	26	27	25.5
pH	6.4	6.7	6.8	6.6
Turbidity, ntu	2.5	2.5	2.5	2.5
TSS, mg/l	<1	<1	<1	<1
TDS, mg/l	33	36	34	34
BOD-5, mg/l	1.1	1.0	1.2	1.1
BOD-20, mg/l	1.8	1.3	1.7	1.6
T.Phos., mg/l	0.01	0.01	0.01	0.01
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	<0.01	0.01	0.01	<0.01
NH3-N, mg/l	0.02	0.03	0.02	0.02
Cl -, mg/l	2.5	2.5	2.5	2.5
SO4 =, mg/l	1	2	2	2
Fe, mg/l	0.09	0.07	0.05	0.07
Conductivity,µmho	45	45	43	44
Alkalinity, mg/l	14	14	14	14
T. Hardness, mg/l	26	22	20	23
Chlorophyll a,µg/l	1.3	0.8	1.1	1.1
Fecal Coliform	-	-	<4	<4

Dissolved Oxygen Data for 13 Sep 1983		
	Pool	Riffle
Average	6.8	6.7
Minimum	6.4	5.2
Maximum	7.3	8.2

Table B-2

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Indian Creek

Drainage Area: 47 Square Miles

Station Description: At head of large pool 1000 feet below low water bridge in Section 17, T 11 N, R 20 W Pope County

Date: May 22, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	10:00	11:00	12:00	
Q, cfs	19.3	19.3	19.3	19.3
Temperature, °C	15.5	17	17	16.5
pH	6.0	6.8	5.8	6.2
Turbidity, ntu	6.4	4.9	5.9	5.7
TSS, mg/l	1	<1	<1	<1
TDS, mg/l	27	28	27	27
BOD-5, mg/l	0.1	0.1	0.0	<0.1
BOD-20, mg/l	1.4	1.4	1.2	1.3
T.Phos., mg/l	0.01	0.01	0.01	0.01
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	<0.01	0.01	0.01	<0.01
NH3-N, mg/l	0.04	0.04	0.04	0.04
Cl -, mg/l	2	2.5	2	2
SO4 =, mg/l	1	1	1	1
Fe, mg/l	0.19	0.12	0.11	0.14
Conductivity,µmho	27	31	31	30
Alkalinity, mg/l	7	9	10	9
T. Hardness, mg/l	12	12	14	13
Chlorophyll a,µg/l	-	-	-	-
Fecal Coliform	-	-	-	-
MN mg/l	<0.025	<0.025	<0.025	<0.025

Dissolved Oxygen Data for May 22, 1984		
	Pool	Riffle
Average	9.0	9.1
Minimum	8.7	8.9
Maximum	9.2	9.3

Cloudy - moderate rain started about 10:15 A.M. 5-22-84

Physical Parameters

Six transects were measured which accurately assessed the physical characteristics of the stream. The results of the physical survey are shown in Table B-3.

Stream substrate is derived from the underlying sandstones and consisted of 43% bedrock and 21% rubble. Steep gradients, a rocky substrate and very low flows resulted in very little instream cover and limited stream canopy. Canopy is restricted mainly to small bushes and brush. Spring floods have very high velocities that prevent older trees from becoming established on the banks.

Macroinvertebrate Populations

The summer and spring collections were conducted as described in the General Methodology. Due to extremely low flow conditions, the summer sample was primarily restricted to pool areas. In contrast, the spring sample was taken over a greater variety of habitat types.

A total of 51 taxa representing 12 orders were identified from summer and spring samples collected from the Indian Creek study site. Twenty-three (23) taxa were identified from the summer sample while 32 taxa were identified in the spring (Table A-32, Appendix A). In addition, the total number of organisms collected more than doubled from summer to spring (135 to 283). The increased sampling effort in the spring was responsible, at least in part, for the increase in taxa and number of organisms collected.

The qualitative comparative indices calculated for the two samples indicated two highly dissimilar communities (Table B-4). Indeed, there were only four taxa present in both samples, e.g., Ablabesmyia, Hyalella azteca, Neureclipsis crepuscularis, and Psephenus herricki. This lack of taxonomic homogeneity reflects the seasonal variation present in natural stream ecosystems, with the natural egg-laying, development and emergent cycle of insect generations. This variation is illustrated by the change in groups found to be dominating the samples. The summer sample was dominated by watermites, odonates and amphipods while the dominant orders of the spring sample were stoneflies, caddisflies and mayflies.

The community parameters calculated for both samples indicated a stable, diverse benthic community resulting from a relatively undisturbed ecosystem with inherently good water quality (Table B-4).

Table B-3

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Indian Creek
Date:	September 13, 1983
Drainage Area:	47 sq. miles
Watershed Land Use:	95% Forest 5% Grassland
Stream Gradient:	32 ft./mile
Mean Channel Width:	53 ft.
Mean Stream Width:	40 ft.
Mean Stream Velocity:	<.01 fps
Observed Flow:	<.01 cfs
Average Substrate Type:	43% bedrock 4% boulder 21% rubble 11% gravel 21% sand
Mean Instream Cover:	0% undercut bank 0% brush,logs,debris 0% overhanging veg. 0% inundated veg.
Riffle/Pool Ratio of Transects:	33% riffle 0% deep pool 50% moderate pool 17% shallow pool
Mean Bank Overstory Cover:	61% trees 25% shrubs
Mean Bank Ground Cover:	36% grasses and forbs 64% rock
Mean Bank Stability:	25% stable 75% moderate 0% unstable
Mean Stream Canopy:	5%

Comments: Land use was extrapolated from a similar area. Flow was inter-gravel.

Table B-4. Community Analysis of Benthic Samples from Indian Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	135	283	422
Total # Taxa	23	33	49
Diversity	3.3681	3.4161	4.2492
Index of Evenness	0.7446	0.6832	0.7568
Index of Dominance	0.4748	0.3492	0.3721
Index of Variety	3.1087	3.8157	5.5236
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.14	
Common Taxa Index (range 0-1)		0.13	
Qualitative Similarity Index (range 0-100)		2.0	

Fish Populations

Summer - An enduring pool of approximately one-third acre with no noticeable flow was treated with four pounds of 7.5% powdered rotenone on September 15, 1983. All fishes observed were picked up over a four- to five-hour period.

Twenty-seven species of fish, 1450 individuals, with a total relative abundance value of 200.5, an index of evenness of 0.94 and a diversity index of 4.49 were collected. A list of all species collected and their relative abundance value is given in Table B-5. The total population relative abundance value was composed of 26.7% Percidae (eight species), 18.5% Cyprinidae (five species), 18% Centrarchidae (five species), 14.5% Catostomidae (three species), and 9.7% Ictaluridae (two species). Primary feeding fishes of three species made up 11.2% of the total relative abundance value; 21 species of secondary feeders, 75.8%; and three species of top carnivores composed 13% of the total (Table B-6).

Eleven sensitive species comprising 40.9.% of the total population relative abundance value were taken in this sample. An unusually large population of intermediate and adult channel catfish was collected at this site. These were probably a result of periodic stocking in the area.

Table B-5. Fish Species Collected from Indian Creek on September 15, 1983, with Relative Abundance Values

Species		R.A. VALUE
Campostoma anomalum	Stoneroller	12.0
*Notropis boops	Bigeye shiner	12.0
Etheostoma spectabile	Orangethroat darter	12.0
Etheostoma whipplei	Redfin darter	12.0
Labidesthes sicculus	Brook silversides	12.0
Moxostoma duquesnei	Black ~~Golden~~ redhorse	11.0
Lepomis megalotis	Longear	11.0
*Noturus exilis	Slender madtom	10.5
Fundulus olivaceus	Blackspotted topminnow	10.5
*Etheostoma blennioides	Greenside darter	10.5
Pimephales notatus	Bluntnose minnow	9.0
Ictalurus punctatus	Channel catfish	9.0
*Hypentelium nigricans	Northern hogsucker	9.0
*Moxostoma erythrurum	Golden redhorse	9.0
*Micropterus dolomieui	Smallmouth bass	9.0
Lepomis cyanellus	Green sunfish	8.0
*Etheostoma zonale	Banded darter	7.5
Micropterus punctulatus	Spotted bass	7.0
*Etheostoma flabellare	Fantail darter	4.5
*Etheostoma punctulatum	Stippled darter	4.5
*Notropis whipplei	Steelcolor shiner	2.5
Aplodinotus grunniens	Freshwater drum	2.0
Cyprinus carpio	Carp	1.5
Percina caprodes	Logperch	1.5
Esox americanus	Grass pickerel	1.0
Lepomis macrochirus	Bluegill	1.0
*Percina maculata	Blackside darter	1.0
	Total	200.5

*Sensitive species

Spring - The same site was sampled the week of May 21-25, 1984. An overnight set of one 1½" mesh trammel net produced no fish. The canoe-transported, gasoline-powered generator with 110-volt, 3000-watt output was used for electrofishing this site for a distance of about 200 yards. A list of fishes collected and the number of individuals is given below.

Species	No.	Species	No.
Campostoma anomalum	81	Etheostoma flabellare	26
Notropis boops	6	Etheostoma blennioides	30
Notropis whipplei	1	Notropis sp.	1
Pimephales sp.	2	Pimephales sp.	1
Noturus exilis	45	Labidesthes sicculus	3
Lepomis megalotis	--	Lepomis cyanellus	--
Etheostoma spectabile	31		

All species collected in the spring sample had been previously collected in the summer. There were, however, 14 species collected the previous summer that were not recorded in the spring.

Table OZ-6. Summary of Fish Population Parameters from Indian Creek

Total Species Collected	27
Total Number of Individuals	1450
Total Relative Abundance Value	200.5
Relative Abundance Diversity Index	4.49

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5	18.5
CATOSTOMIDAE	3	14.5
ICTALURIDAE	2	9.7
CENTRARCHIDAE	5	18.0
PERCIDAE	8	26.7
Primary Feeders	3	11.2
Macroinvertebrate Feeders	21	75.8
Carnivores	3	13.0
Sensitive Species	11	40.9

HURRICANE CREEK

Hurricane Creek begins in the southcentral part of Newton County and flows in a south and southeast direction. It receives drainage from the south and east as it turns to a southwesterly flow before entering Piney Creek in the northeast corner of Johnson County. Piney Creek enters Dardanelle Reservoir on the Arkansas River approximately 40 miles downstream.

The site selected for study on Hurricane Creek was a large pool and riffle about one-half mile upstream of a Forest Service road crossing in the SE¼ of Section 8, R 21 N, T 12 W (Figure B-6). This site was chosen as best representing Hurricane Creek during a low-flow, high temperature situation.

General Site Discussion

Watershed Size - The watershed size above the point of sampling was 50 mi^2.

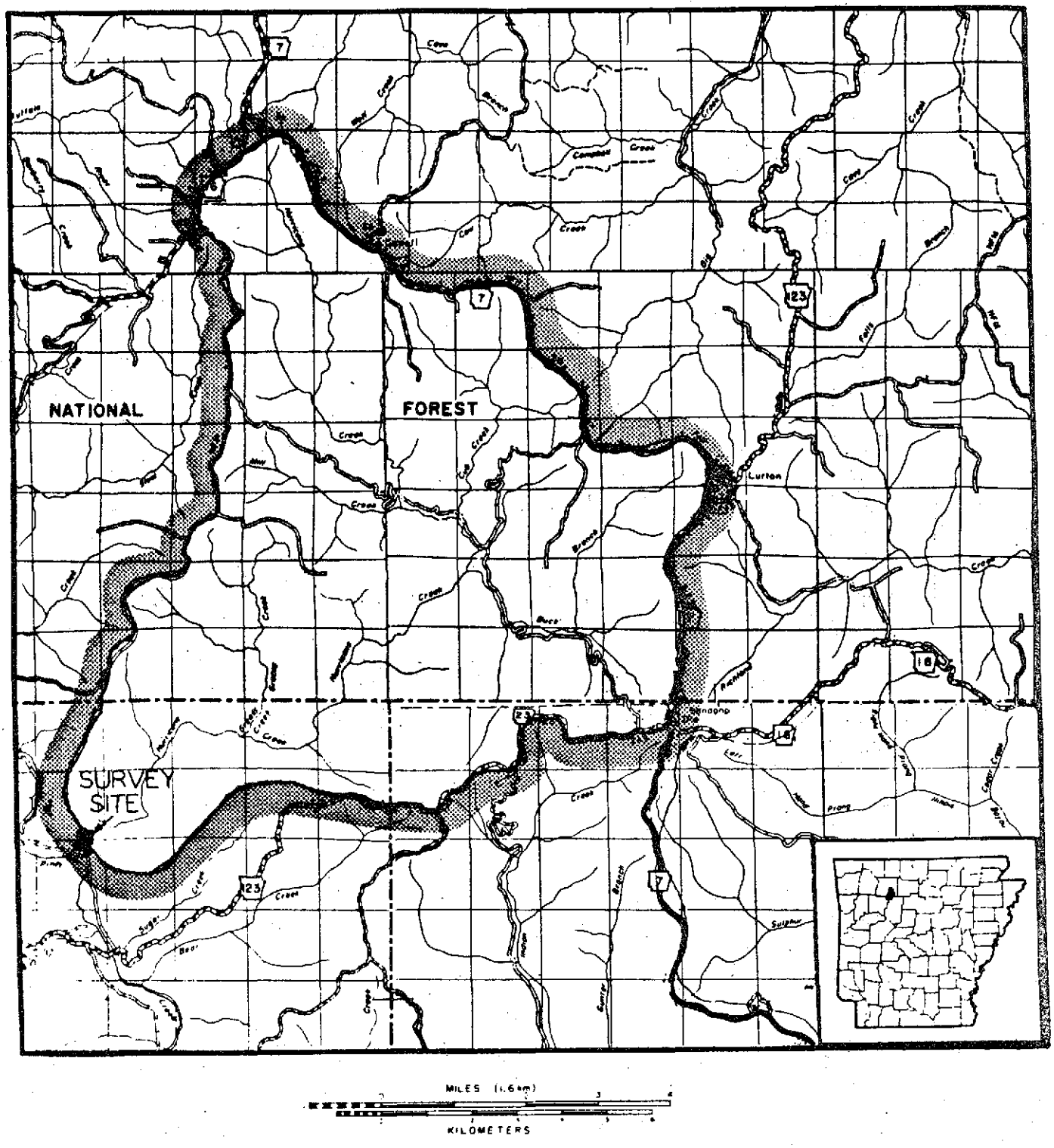
Geology - Cane Hill and Bloyd Shale formations of Pennsylvanian Age underlie most of the watershed.

Topography - The Hurricane Creek basin can generally be described as very mountainous with sheer bluffs and narrow valleys along the major tributaries. The topography is very steep to gently sloping terrain with moderately sloping stream valleys. The Boston Mountains Region has the most relief of any area in the state and the least amount of level land, which results in streams in the region having very high gradients. Elevation varies from near 750 feet to over 2000 feet above msl. Stream gradient at the sample site was 33 ft/mile.

Soil Type - Two major groups of soils make up the Hurricane Creek basin. The Nella-Enders-Mountainburg association is located in the upland portions of the basin. These soils are well-drained, gently sloping to very steep, deep and shallow, and loamy and stoney. The pH ranges from strongly acid to moderately acid (pH 5.5 to 6.0). Potential for erosion is moderate to severe.

The Pickwick-Spadra association is found in the stream valley. It is well-drained, nearly level to gently sloping, deep loamy soils on stream terraces. The pH ranges from moderately acid to slightly acid (pH 5.6 to 6.5). The pH in the stream seems to correlate to the soil pH. Stream pH ranged from 6.5 to 6.2 in the three samples collected. Erosional potential is slight.

Figure B-6



HURRICANE CREEK: Drainage area 50 square miles ■ Survey site ▒ Survey area

Flora - Steep upland portions of the basin are covered with hardwood forest comprised of red and black oaks, red cedar and shortleaf pine. Streamside riparian zones are rich in tree variety. Observed during the survey were beech, sweetgum, sycamore, river birch, hornbeam, umbrella magnolia, mulberry, red maple, dogwood, green ash, slippery elm, catalpa, sugar maple, pecan, river alder, sugarberry, shingle oak and sassafras.

Land Use - Data specific to the Hurricane Creek basin is not available, but data collected by the S.C.S. which includes Hurricane Creek states that 95% of the land is in forests and 5% is in pastureland. The majority of the watershed is in the Ozark National Forest. The steep, mountainous terrain in the Boston Mountains Region is largely undeveloped, and the area around Hurricane Creek is only slightly disturbed. A portion of the Hurricane Creek basin has recently been declared as a National Wilderness Area by the U.S. Congress. Hurricane Creek is considered a good least-disturbed stream for this project.

Stream Characteristics - The watershed size at this site was close to the minimum size in this region which will support a diverse year-round aquatic community. Streams in the Boston Mountains Region require a large drainage basin to maintain a year-round flow. If a smaller basin had been selected, only very small pools would have existed during the summer months and therefore probably would not have supported a healthy aquatic community.

A clean, rocky, mountainous stream best describes Hurricane Creek. The most striking characteristics of the creek are the rocky substrate, steep gradient, and blue-green water. Other characteristics of note are the large number of riffles, low percentage of instream cover and low to moderate amount of stream canopy during the low-flow period.

Methodology and Sampling Results

The summer survey of Hurricane Creek was conducted from September 12-16, 1983. The spring survey was conducted between May 21 and May 25, 1984. Conditions during the summer survey were excellent, but the spring survey had to be delayed for three weeks because of high flow conditions that resulted from heavy rains. Once the spring survey was started, weather conditions were good for the entire week.

Continuous Dissolved Oxygen

Summer - Conditions during the summer survey exemplified the typical high temperature, low flow situation. Stream flow was too low to measure between the pools because it was flowing through the gravel and cobble. Temperature peaked

at 27°C during the week which is close to the expected maximum of 30°C. Overall, the data acquired should closely represent the annual worse case situation for dissolved oxygen.

The minimum D.O. observed for the week was 5.8 mg/l and the maximum was 7.6, a range of 1.8 mg/l (Figures B-7 and B-8). A maximum diurnal fluctuation of 1.4 mg/l was recorded, which is not considered excessive and is an indicator of good water quality.

A pattern of highs and lows for dissolved oxygen developed over the week. Each day the D.O. peaked around 1400 hours, remained stable until 1600 hours, then fell steadily throughout the afternoon and early evening to reach a minimum around 0200 hours. Once the minimum was reached, the D.O. held steady until sunrise. This cycle was repeated each 24-hour period for the entire week. D.O. saturation percentages varied each day from 65 to 85 percent. Water temperature fell slowly over the week causing a concurrent rise in D.O. concentration.

Fluctuations in D.O. in Hurricane Creek were in a pattern that correlated with the movement of the sun. Once sunlight penetrated to the creek, D.O. went up steadily until the angle of the sun became more pronounced. Not so easily understood was the way the minimum reacted. Each night a minimum would be reached shortly after midnight and then remain steady until sunrise. One possible explanation is that algal respiration would equalize with surface reaeration early in the evening and result in a constant D.O. Overall, stream D.O. was indicative of nearly pristine water quality for a Boston Mountain stream.

Spring - The spring sampling showed much higher levels of dissolved oxygen (Figures B-9 and B-10). The minimum recorded was 7.8 mg/l and the maximum was 9.0 mg/l. The percent saturation values were also much higher in the spring, ranging from 85% to 100%. These higher values were directly related to higher flows and lower temperatures.

Chemical Parameters

The summer coliform sample was lost in transit to the laboratory. Spring coliform samples were not taken because coliform bottles were not available at the time.

Chemical data collected from the summer and spring surveys are displayed in Tables B-7 and B-8. Of special interest are the extremely low nutrient levels, low turbidity, low suspended solids and moderate pH. Each of these parameters is related to the physical characteristics of the drainage basin of Hurricane Creek.

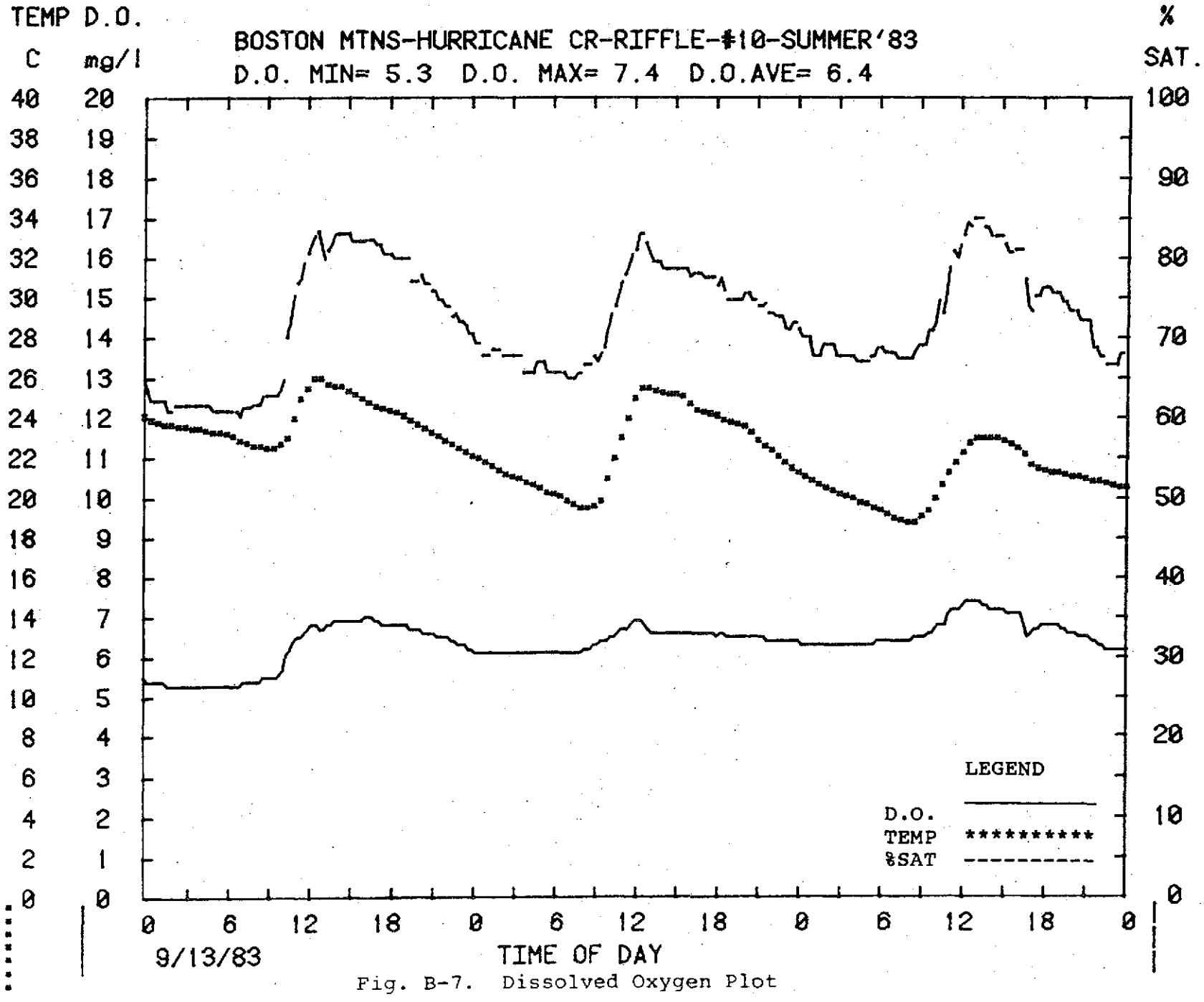


Fig. B-7. Dissolved Oxygen Plot

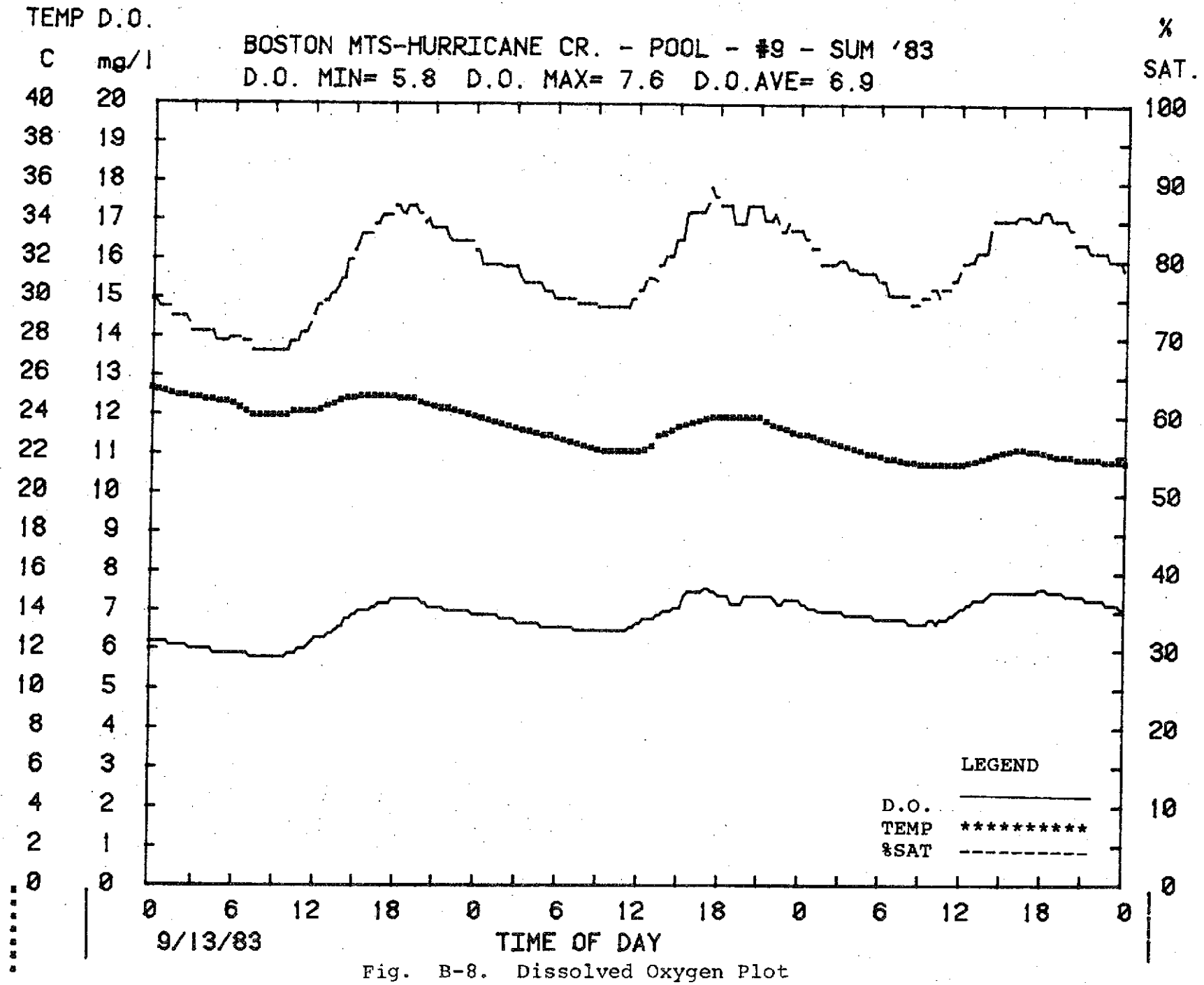


Fig. B-8. Dissolved Oxygen Plot

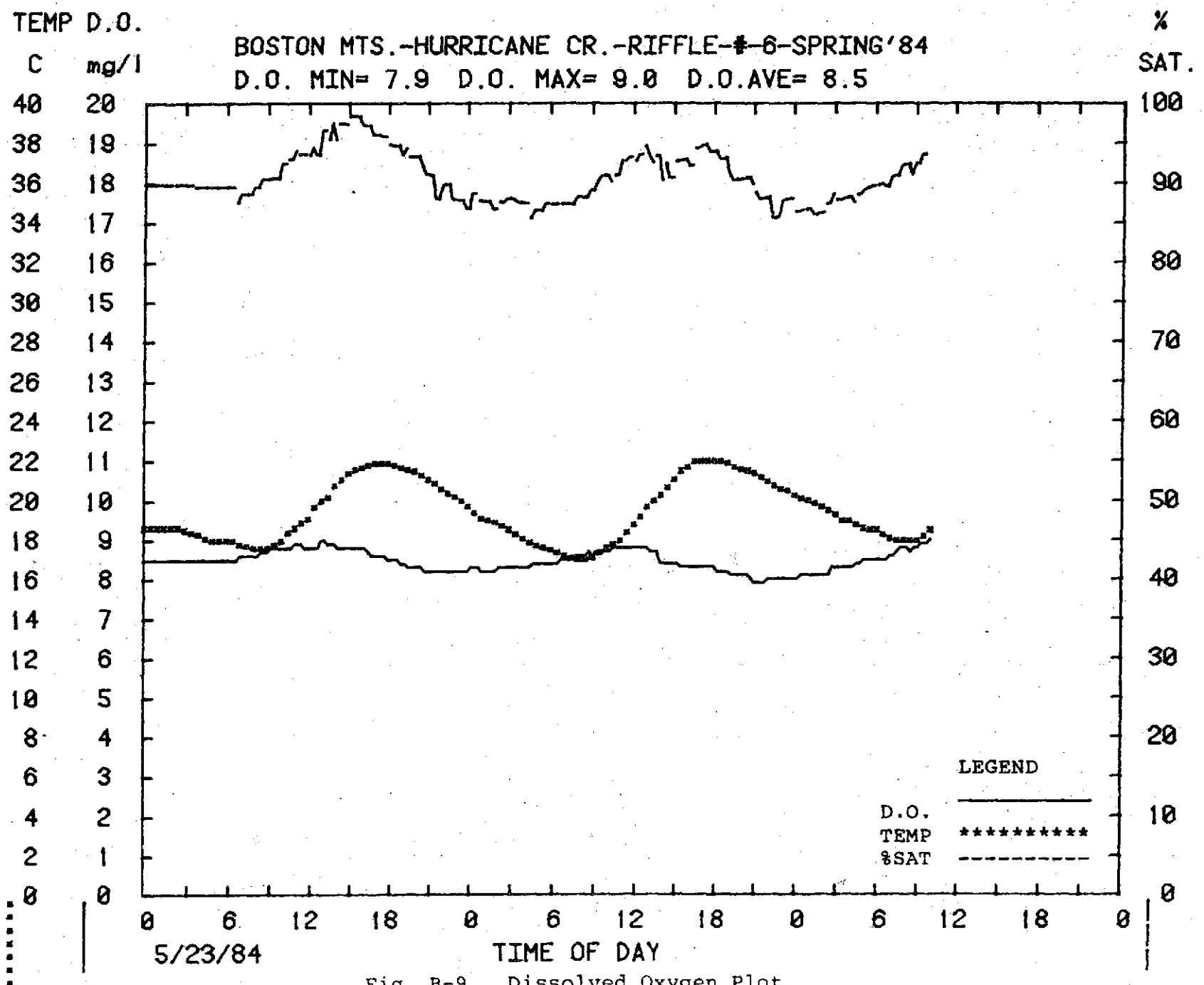


Fig. B-9. Dissolved Oxygen Plot

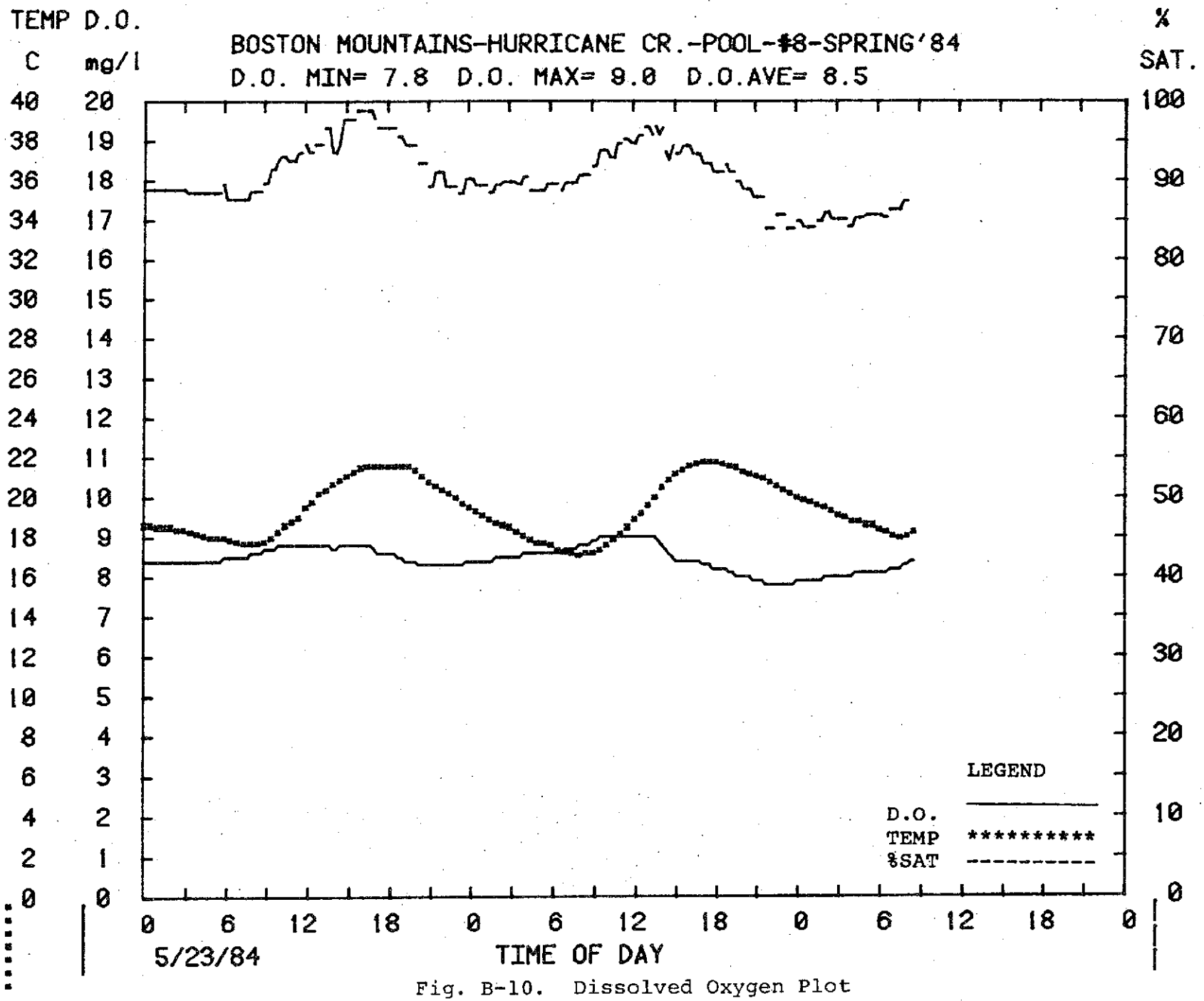


Fig. B-10. Dissolved Oxygen Plot

Table B-7

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Hurricane Creek

Drainage Area: 50 Square Miles

Station Description: Large pool 0.5 miles above F.S. road ford. SE 1/4, Section 8, T 12 N, R 21 W - Johnson County

Date: September 13, 1983

PARAMETER	TIME COLLECTED			AVERAGE
	09:15	11:57	14:30	
Q, cfs	0.1	0.1	0.1	0.1
Temperature, °C	24	24	25	24.5
pH	6.5	6.4	6.2	6.4
Turbidity, ntu	3	19	3	3
TSS, mg/l	2	44	<1	<2
TDS, mg/l	36	33	36	36
BOD-5, mg/l	1.7	2.5	1.6	1.7
BOD-20, mg/l	2.5	4.3	2.0	2.2
T.Phos., mg/l	0.01	0.04	0.01	0.02
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.01	<0.01	<0.01	<0.01
NH3-N, mg/l	0.02	0.01	0.01	0.01
Cl -, mg/l	2.5	2.5	2.5	2.5
SO4 =, mg/l	1	1	2	1
Fe, mg/l	0.07	0.80	0.10	0.09
Conductivity, µmho	56	57	52	54
Alkalinity, mg/l	20	19	20	20
T. Hardness, mg/l	34	26	22	28
Chlorophyll a, µg/l	0.3	6.4	-	0.3
Fecal Coliform	-	-	-	-

Dissolved Oxygen Data for 13 Sep 1983		
	Pool	Riffle
Average	6.5	6.1
Minimum	5.8	5.3
Maximum	7.3	7.0

Note: 11:57 values were not included in the average because the water column at the sample site was disturbed from conducting the transects.

Table B-8

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Hurricane Creek

Drainage Area: 50 mi^2

Station Description: Large pool 0.5 miles above F.S. road ford, SE 1/4, Section 8, T 12 N, R 21 W - Johnson County

Date: May 22, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	08:55	10:55	11:40	
Q, cfs	30.0	30.0	30.0	30.0
Temperature, °C	18	18.5	19	18.5
pH	6.5	6.8	6.8	6.7
Turbidity, ntu	3.3	3.2	3.1	3.2
TSS, mg/l	<1	<1	<1	<1
TDS, mg/l	33	28	30	30
BOD-5, mg/l	0.0	0.2	0.1	0.1
BOD-20, mg/l	1.5	1.3	1.4	1.4
T.Phos., mg/l	0.01	0.01	0.01	0.01
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	<0.01	0.01	<0.01	<0.01
NH3-N, mg/l	0.03	0.03	0.02	0.03
Cl-, mg/l	1	2	2	2
SO4 =, mg/l	<1	<1	1	<1
Fe, mg/l	0.08	0.09	0.09	0.09
Conductivity, μmho	49	44	43	45
Alkalinity, mg/l	14	14	15	14
T. Hardness, mg/l	16	16	20	17
Chlorophyll a, μg/l	-	-	-	-
Fecal Coliform	-	-	-	-
Mn mg/l	0.025	0.025	0.025	0.025

Dissolved Oxygen Data for May 22, 1984		
	Pool	Riffle
Average	8.7	8.7
Minimum	8.4	8.5
Maximum	8.9	8.9

Cloudy - moderate rain started about 10:30 a.m., 5-22-84

The pH in the stream closely correlates with soil acidity. Hardwood forests cover 95% of the basin and are very rarely disturbed by timber-cutting operations. As a result, turbidity and suspended solid values are low, and nutrients that would be attached to soil particles are not present. Streams throughout the Boston Mountains Ecoregion are heavily used for recreation as a result of their physical characteristics.

Physical Parameters

Five transects were measured to determine the physical characteristics of the stream. The results are shown in Table B-9.

Hurricane Creek has many physical characteristics that are unique to streams in the Boston Mountains Ecoregion. Stream substrate is mostly rubble and gravel that originated in the underlying formations of sandstone. Steep mountainous terrain results in high stream gradients. Steep gradients and rock substrate allow very little instream cover due to the higher water velocities during spring flows. Stream canopy is also generally low because spring floods with high velocities create wide channels and cause damage to streamside vegetation.

Macroinvertebrate Populations

The summer and spring collections were conducted as described in the General Methodology. Due to extremely low flow conditions during the summer survey, the collection was taken primarily from standing water (pool) areas. In contrast, the spring sample was taken over a greater variety of habitats.

Twenty (20) and 39 taxa were identified from the summer and spring samples, respectively. A total of 49 taxa representing 13 orders were identified from samples collected in Hurricane Creek (Table A-33, Appendix A). The total number of organisms collected in the spring sample was about six times that of summer (60 to 362). The increased sampling effort in the spring was responsible, at least in part, for the increase in taxa and number of organisms collected.

The qualitative comparative indices calculated for the two samples indicated that although basically dissimilar, they did have some similarities (Table B-10). Fifty percent of the taxa collected in the summer sample were also present in the spring. Also, the caddisflies and mayflies dominated the summer and spring samples in both number of taxa and number of organisms. However, the dominant taxa within each group were different in the summer and spring samples. The

Table B-9

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Hurricane Creek
Date:	September 13, 1983
Drainage Area:	50 sq. miles
Watershed Land Use:	95% forest 5% grassland
Stream Gradient:	33 ft./mile
Mean Channel Width:	62 ft.
Mean Stream Width:	60 ft.
Mean Stream Velocity:	<.01 fps
Observed Flow:	<.01 cfs
Average Substrate Type:	5% boulder 35% rubble 23% gravel 31% sand 6% mud/silt
Mean Instream Cover:	2% undercut bank 1% brush,logs,debris 0% overhanging veg. 0% inundated veg.
Riffle/Pool Ratio of Transects:	0% riffle 60% deep pool 40% moderate 0% shallow
Mean Bank Overstory Cover:	95% trees 49% shrubs
Mean Bank Ground Cover:	52% grasses and forbs 48% dirt
Mean Bank Stability:	40% stable 50% moderate 10% unstable
Mean Stream Canopy:	59%

Comments: Land use was extrapolated from a similar area because data was not available. Flow was estimated because it was inter-gravel.

caddisfly Chimarra obscura and mayfly Stenonema femoratum were dominant in summer, while the caddisfly Wormaldia and mayflies Rhithrogena pellucida and Isonychia were dominant in the spring.

The community parameters calculated for both samples were indicative of a diverse, stable macroinvertebrate community (Table B-10). There was an insignificant reduction in diversity and index of evenness in the spring sample due to the abundance of the caddisfly Wormaldia. This reduction was accompanied by a substantial increase in index of variety due to the two-fold increase in taxa collected. Hurricane Creek could be classified, according to benthic community analysis, as having good water quality.

Table B-10. Community Analysis of Benthic Samples from Hurricane Creek - Qualitative Sample, 1983-84

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	60	362	422
Total # Taxa	20	39	49
Diversity	3.7951	3.2057	3.7773
Index of Evenness	0.8781	0.6065	0.6693
Index of Dominance	0.4956	0.6030	0.5883
Index of Variety	3.2166	4.4790	5.6274
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.34
Common Taxa Index (range 0-1)			0.23
Qualitative Similarity Index (range 0-100)			6.0

Fish Populations

Intermittent flows at this site and difficult access from pool to pool necessitated the use of two types of electrofishing gear for collection. On September 14, 1983, about one-half mile of the stream was sampled using a flat-bottomed boat to transport the 220-volt, 3500-watt, gasoline-powered generator through the large pools. A series of separated, small pools were sampled with a gasoline-powered backpack shocker with 500 volts.

Summer - Twenty-one species of fish and 1107 individuals were collected with a total relative abundance value of 157.5 (Table B-11), a relative abundance diversity index of 4.19, and an index of evenness of 0.95. Four species of Percidae comprised 24.8% and five species of Centrarchidae also totalled 24.8% of the population relative abundance. This was followed closely by five species of Cyprinidae totaling 20.6%; three species of Catostomidae totaling

12.4%; and two species of Ictaluridae, which comprised 8.6% of the total. Primary feeding fishes comprised 8.3% of relative abundance value, secondary feeders comprised 79.3% and top carnivores made up 12.4% of the population. Eleven sensitive species made up 53.0% of the relative abundance value of the total population (Table B-12).

Table B-11. Fishes Collected on Hurricane Creek on September 14, 1983, with Relative Abundance Values

Species		R.A. VALUE
Campostoma anomalum	Stoneroller	12.0
Lepomis megalotis	Longear	12.0
*Notropis boops	Bigeye shiner	12.0
Etheostoma blennioides	Greenside darter	12.0
*Noturus exilis	Slender madtom	10.5
Lepomis cyanellus	Green sunfish	10.5
*Etheostoma spectabile	Orangethroat darter	10.5
*Etheostoma zonale	Banded darter	10.5
Moxostoma duquesnei	Black redhorse	9.0
*Micropterus dolomieui	Smallmouth bass	9.0
Fundulus olivaceus	Blackspotted topminnow	8.0
Micropterus punctulatus	Spotted bass	6.5
*Notropis greenei	Wedgespot shiner	6.0
*Hypentelium nigricans	Northern hogsucker	6.0
Labidesthes sicculus	Brook silversides	6.0
*Etheostoma flabellare	Fantail darter	6.0
*Moxostoma erythrurum	Golden redhorse	4.5
Ictalurus punctatus	Channel catfish	3.0
*Notropis whipplei	Steelcolor shiner	1.5
Pimephales notatus	Bluntnose minnow	1.0
*Ambloplites ariommus	Shadow bass	1.0
	Total	157.5

*Sensitive Species

Spring - One 1½" trammel net, one 2½" mesh trammel net and the canoe-transported, 110-volt A.C., gasoline-powered generator were used for fish sampling during the period of May 21-25, 1984.

Netting produced very limited results at this site; however, electrofishing produced 19 species, four of which were not collected the previous summer. This produced a total of 25 species collected at this site with 12 sensitive species. The species collected electrofishing are listed on the next page.

Species	No.	Species	No.
+Lamprey larvae	2	Lepomis cyanellus	22
Campostoma anomalum	47	Etheostoma blennioides	9
Pimephales notatus	1	Etheostoma spectabile	8
Notropis boops	34	Etheostoma zonale	4
+Notropis emiliae	1	Etheostoma flabellare	2
Labidesthes sicculus	15	*+Percina maculata	1
Fundulus olivaceus	2	Hypentelium nigricans	1
Moxstoma erythrurum	3	+Ictalurus natalis	6
Noturus exilis	15	Micropterus punctulatus	1
Lepomis megalotis	31		

+Species not collected in previous summer collection
*Sensitive species

Table B-12. Summary of Fish Population Parameters from Hurricane Creek

Total Species Collected	25
Total Number of Individuals	1107
Total Relative Abundance Value	157.5
Relative Abundance Diversity Index	4.19

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5	20.6
CATOSTOMIDAE	3	12.4
ICTALURIDAE	2	8.6
CENTRARCHIDAE	5	24.8
PERCIDAE	4	24.8
Primary Feeders	2	8.3
Macroinvertebrate Feeders	19	79.3
Carnivores	4	12.4
Sensitive Species	12	53.0

ARCHEY CREEK

Archey Creek begins in the northwestern corner of Van Buren County and meanders in an easterly direction until it joins the south fork of the Little Red River within the city limits of Clinton.

The site selected for study on Archey Creek was a large pool and short riffle at the termination of a county road that comes off Highway 16 at the power substation in the SE¼, NW¼ of Section 33, R 14 W, T 12 N (Figure B-11). This site was chosen as best representing Archey Creek during a low-flow, high temperature situation. The site was very remote, as is most of the entire basin upstream of the site.

General Site Discussion

Watershed Size - The watershed size above the point of sampling was 107 mi^2.

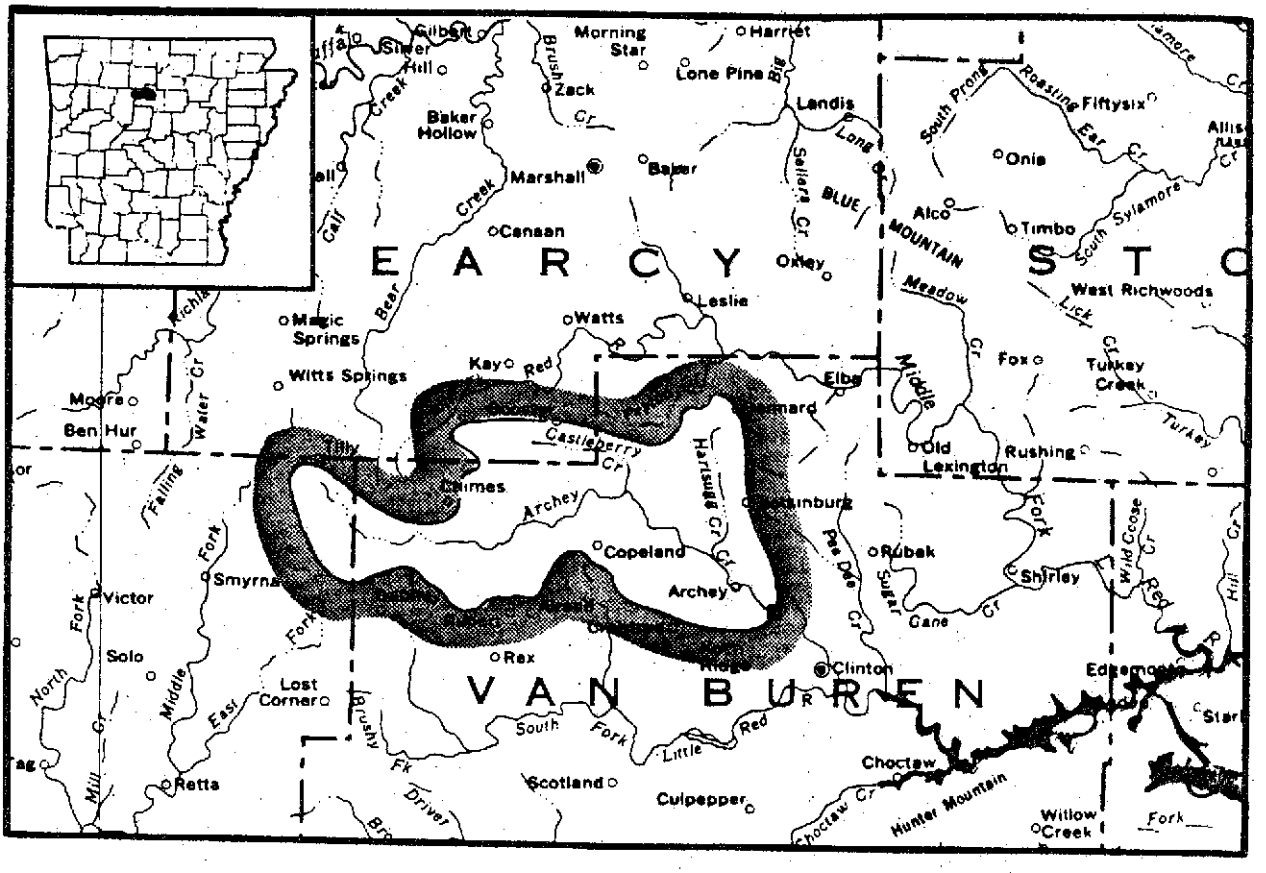
Geology - Cane Hill and Bloyd Shale formations of Pennsylvanian Age, constitute the bulk of the subsurface geology. The valley containing the stream itself is predominantly underlain by the Cane Hill formation.

Topography - The Archey Creek basin can generally be described as very mountainous with sheer bluffs and narrow valleys along the major tributaries. The topography is very steep to gently sloping terrain with moderately sloping stream valleys. The Boston Mountain Region has the most relief of any area in the state and the least amount of level land which results in streams in the region having very high gradients. Elevation varies from near 750 to 2000 feet above msl. Stream gradient at the sample site was 14 ft/mile.

Soil Type - Soil survey data is not available for Van Buren County. The following information was extrapolated from Pope County data and cannot be verified as entirely accurate. The Nella-Enders-Mountainburg association is found in the upland portions of the basin. This soil type is well-drained, gently sloping to very steep, deep and shallow, and loamy and stoney. The pH ranges from strongly acid to moderately acid (pH 5.5 to 6.0). Potential for erosion is moderate to severe.

The Pickwick-Spadra association is found in the stream valley. It is well-drained, nearly level to gently sloping, deep loamy soils on stream terraces. The pH ranges from moderately acid to slightly acid (pH 5.6 to 6.5). The pH in the stream seems to correlate to the soil pH. Stream pH ranged from 6.5 to 6.2 in the three samples collected. Erosional potential is slight.

Figure B-11



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

ARCHEY CREEK: Drainage area 107 square miles ● Survey site ▬ Survey area

Flora - Steep upland portions of the basin are covered with hardwood forest comprised of red and black oaks, red cedar and shortleaf pine. Streamside riparian zones are rich in tree variety. Observed during the survey were sweetgum, sycamore, river birch, black willow and shag bark hickory.

Land Use - The Department of Agriculture Soil Conservation Service has generated information which indicates that 84% of the land in the Archey Creek drainage is forested while 16% is in pastureland. Contrary to all other streams studied within this ecoregion, the majority of the Archey Creek watershed is privately owned.

Stream Characteristics - Watershed size at this site was considered a medium-sized stream under the criteria used in this project. Even so, streams in the Boston Mountain region require a large drainage basin to maintain a year-round flow, and as a result, Archey Creek has a Q_{7-10} flow of zero. In any average drought year, the stream ceases to flow between the pools but the deep pools manage to last until the rainy season. The aquatic community is well adapted to these variations in the flow regime.

A clean, rocky, mountainous stream best describes Archey Creek. The most striking characteristics of the creek are the rocky substrate, steep gradient and blue-green water. Other characteristics of note are the large number of riffles, low percentage of instream cover and a relatively low percent of stream canopy.

Methodology and Sampling Results

The summer survey of Archey Creek was conducted during the week of August 13, 1984. The spring survey was conducted during the week of May 6, 1985. Conditions during the summer survey were excellent. The weather was hot and dry throughout the week. Stream flow was low, around 0.6 cfs, and did not vary significantly over the week.

Spring conditions were quite variable, which is typical for the state. Rain fell on two occasions but both showers were light and caused little runoff. Stream levels were elevated only 0.5 inches during the rain and generally were on a slow fall throughout the week. Flows were calculated during the spring at 122 cfs.

Continuous Dissolved Oxygen

Summer - Conditions during the summer survey exemplified the typical high temperature, low flow situation. Flow was measured during the survey at 0.6 cfs. Temperature peaked at 30°C during the week which is close to the expected maximum. Overall, the data acquired should closely

represent the annual worse case situation for dissolved oxygen.

The minimum D.O. observed for the week was 6.6 mg/l and the maximum was 7.9, giving a range of 1.3 mg/l (Figures B-12 and B-13). The maximum diurnal fluctuation was also 1.3 mg/l which is considered an indicator of good water quality.

A pattern of highs and lows for dissolved oxygen developed over the week. Each day the D.O. peaked around 1500 hours, held steady till 1800 hours, then fell steadily throughout the night and early morning to reach a minimum around 0900 hours. The diurnal cycle for Archey Creek was somewhat different from that of most small streams of this region where the minimum would be reached around 0200 hours in the morning and then hold steady until sunrise. This cycle was repeated on a 24-hour basis for the entire week, which is indicative of a steady-state condition.

D.O. saturation percentages ranged each day from 80 to 100 %. Water temperature was very steady over the week, only fluctuating on a diurnal cycle with the sun.

D.O. fluctuations in Archey Creek followed a pattern that closely correlated with the movement of the sun. Once sunlight penetrated to the creek, D.O. went up steadily until the sun was shaded by the stream canopy. Overall, stream D.O. was indicative of nearly pristine water quality for a Boston Mountain stream.

Spring - The spring sampling showed much higher levels of dissolved oxygen (Figures B-14 and B-15). The minimum value recorded was 8.2 mg/l and the maximum was 9.6 mg/l. The percent saturation values ranged from 90% to 100%. Temperatures ranged from 17° to 20°C on a daily cycle. Higher springtime D.O. values were directly related to higher flows and lower temperatures.

Chemical Parameters

Spring and summer coliform counts were 12 and 4 colonies/100 ml of water, respectively. Both values are low and are indicative of very little disturbance or activity in the basin.

Chemical data collected for the spring and summer surveys are displayed in Tables B-13 and B-14. Of special interest are the extremely low nutrient levels, low turbidity, low suspended solids, and a neutral pH. Each of these parameters is related to the geology and soil characteristics of the basin and low level of disturbance of Archey Creek.

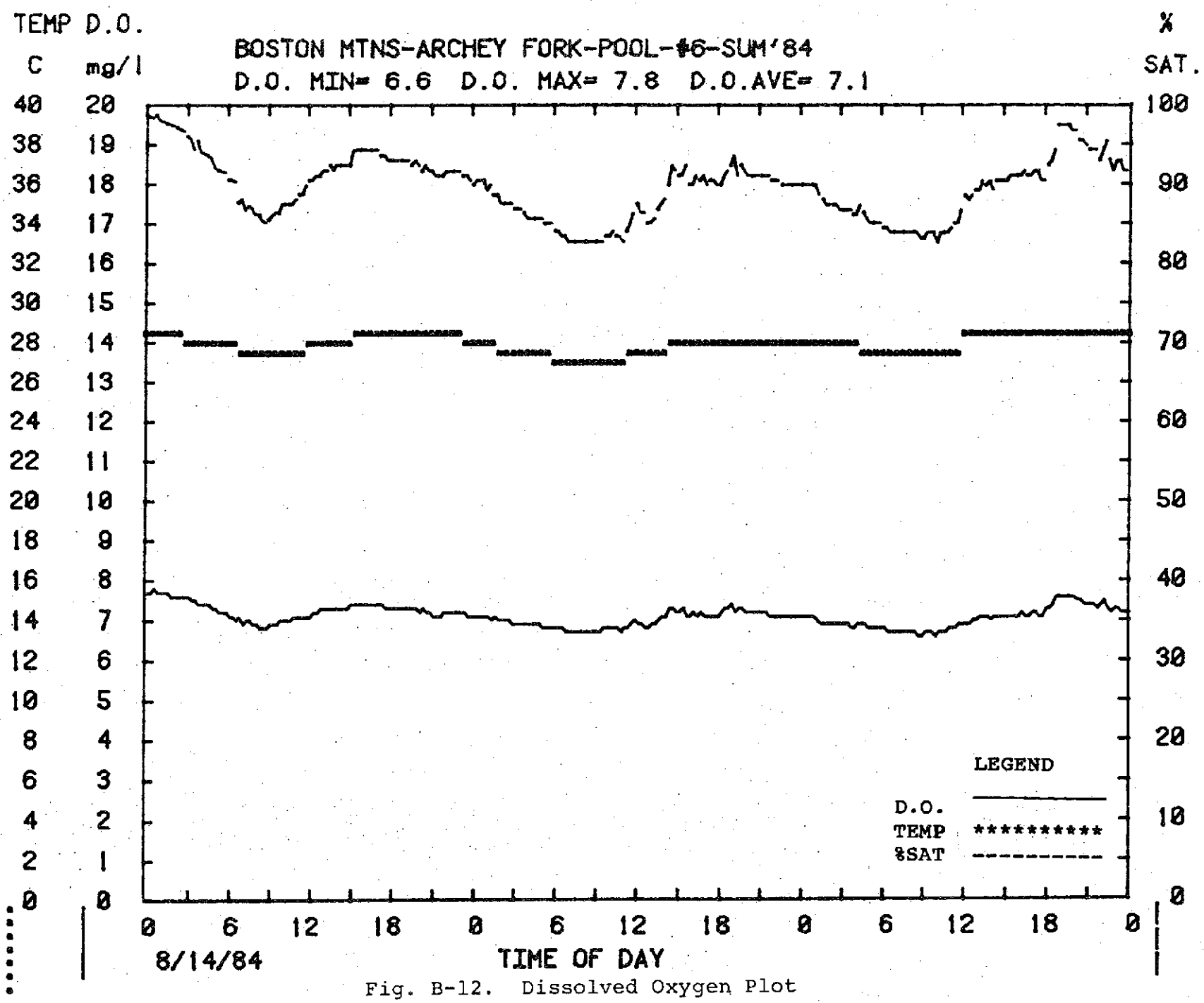


Fig. B-12. Dissolved Oxygen Plot

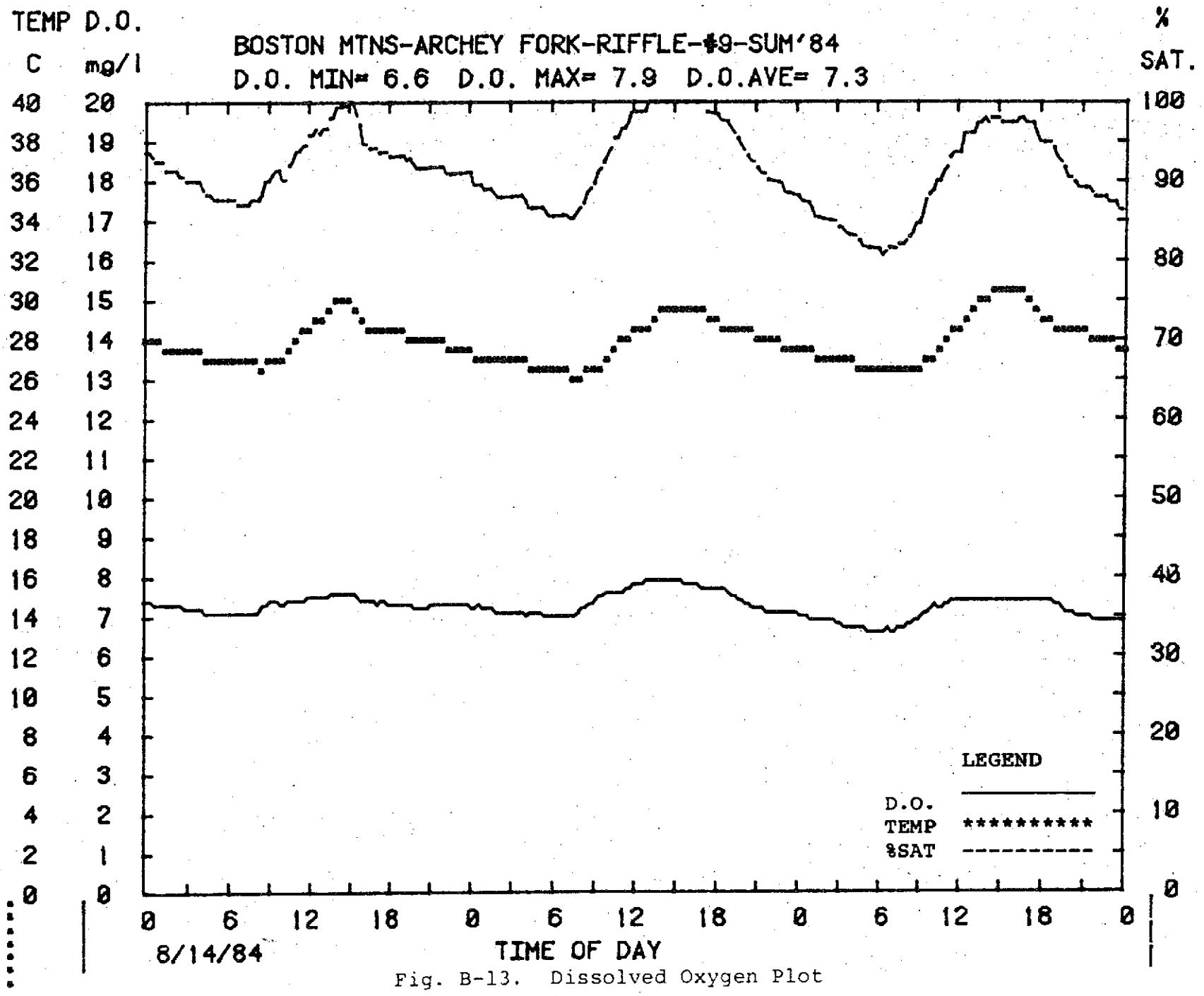


Fig. B-13. Dissolved Oxygen Plot

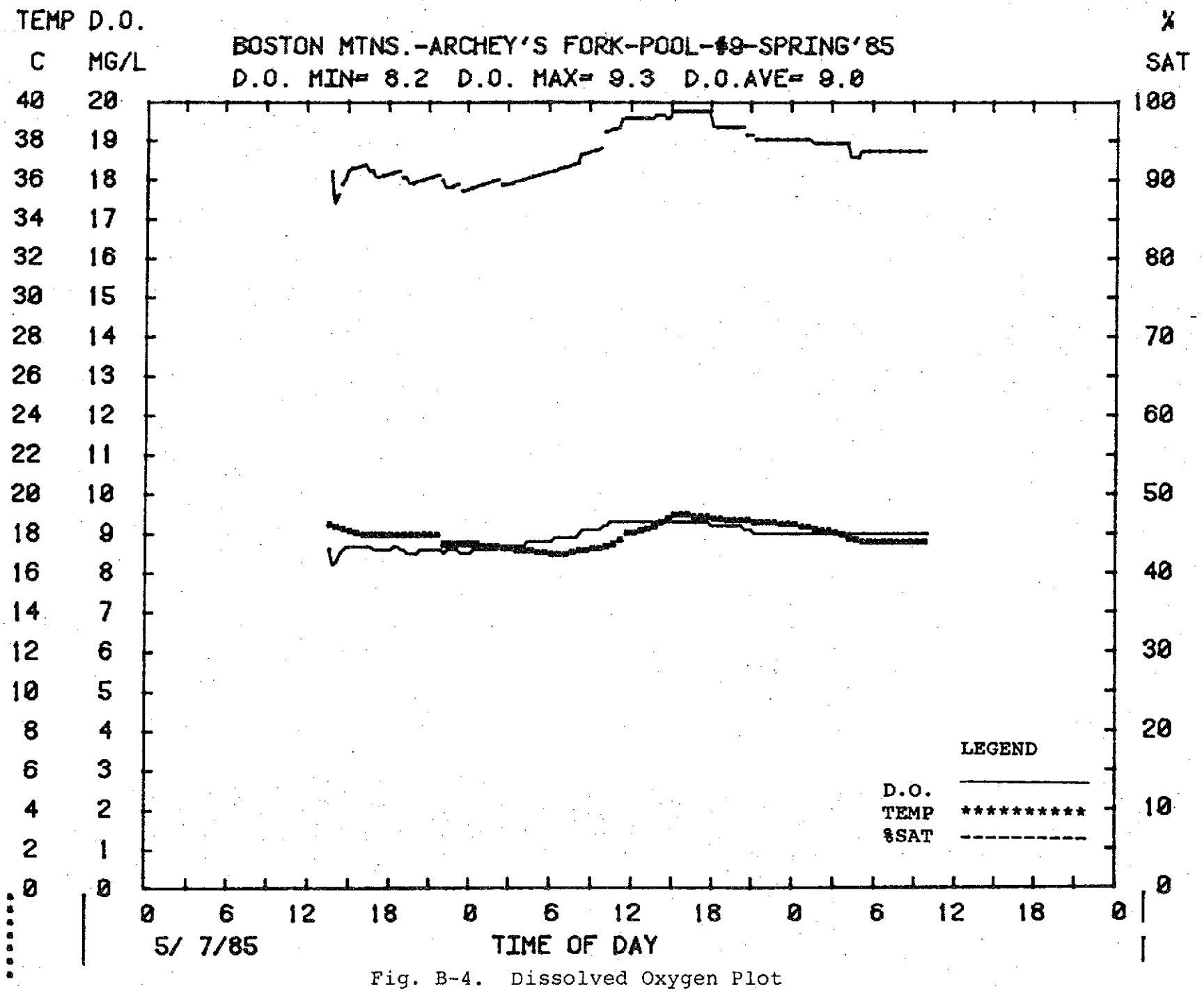


Fig. B-4. Dissolved Oxygen Plot

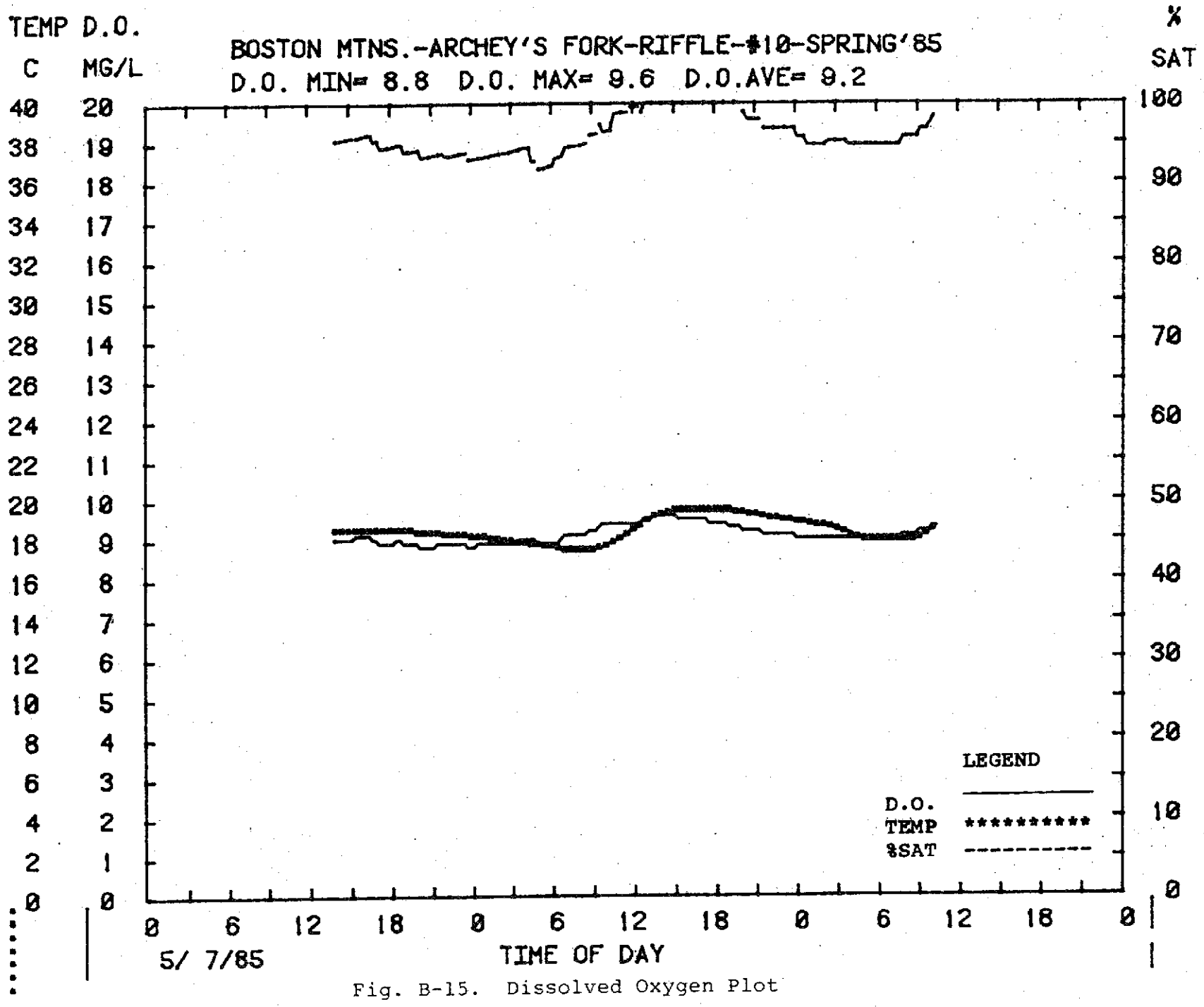


Fig. B-15. Dissolved Oxygen Plot

Table B-13

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Archey Fork Creek

Drainage Area: 107 square miles

Station Description: SE 1/4, NW 1/4, Section 33, T 12 N, R 14 W - Van Buren County

Date: August 14, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:05	10:25	xx:xx	
Q, cfs	.6	.6	.6	.6
Temperature, 0C	27.0	27.5	28.0	27.5
pH	6.9	7.1	7.0	7.0
Turbidity, ntu	3	2	2	2
TSS, mg/l	3	2	2	2
TDS, mg/l	31	33	29	31
BOD-5, mg/l	-	-	-	1.1*
BOD-20, mg/l	-	-	-	3.0*
T.Phos., mg/l	.03	.03	.02	.03
PO4-P, mg/l	.01	.01	.01	.01
NO2+NO3-N, mg/l	.03	.03	.03	.03
NH3-N, mg/l	<.01	<.01	<.01	<.01
Cl -, mg/l	4.0	4.0	4.0	4.0
SO4 =, mg/l	1.0	2.0	2.0	2.0
Fe, mg/l	.22	.18	.17	.19
Conductivity 5mho	46	47	46	46
Alkalinity, mg/l	17	18	18	18
T. Hardness, mg/l	20	20	18	19
Chlorophyll a,5g/l	2.1	1.3	1.5	1.6
Fecal Coliform	-	-	4	4

Dissolved Oxygen Data for August 14, 1984		
	Pool	
Average	7.3	
Minimum	6.8	
Maximum	7.8	

* collected September 4, 1984 at 11:55

Table B-14

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Archey Fork Creek

Drainage Area: 107 Square Miles

Station Description: SE 1/4, NW 1/4, Section 33, T 12 N, R 14 W - Van Buren County

Date: May 7, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	12:50	14:00	14:35	
Q, cfs				121.9*
Temperature, °C	18.5	18.5	19	19
pH	7.1	7.0	7.0	7.0
Turbidity, ntu	4	5	4	4
TSS, mg/l	2	4	4	3
TDS, mg/l	34	34	31	33
BOD-5, mg/l	1.6	1.2	1.3	1.4
BOD-20, mg/l	2.1	1.5	1.5	1.7
T.Phos., mg/l	0.04	0.01	0.01	0.02
PO4-P, mg/l	0.04	0.01	0.01	0.02
NO2+NO3-N, mg/l	0.02	0.02	0.02	0.02
NH3-N, mg/l	0.03	0.02	0.03	0.03
Cl -, mg/l	2.5	2.5	2.5	2.5
SO4 =, mg/l	6	4	6	5
Fe ,mg/l	0.09	0.09	0.04	0.07
Conductivity,µmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	10	10	10	10
T. Hardness, mg/l	12	12	12	12
Chlorophyll a,µg/l	0.0	0.0	0.5	0.2
Fecal Coliform	-	-	12	12

Dissolved Oxygen Data for May 7, 1985		
	Pool	Riffle
Average	8.6	8.9
Minimum	8.2	8.8
Maximum	8.7	9.1

* flow measured on 5-8-85
N/A - Not Analyzed

The pH in the stream closely correlates with soil acidity. Hardwood forests cover 84% of the basin and are very rarely disturbed by timber-cutting operations. As a result, turbidity and suspended solid values are low and nutrients that would be attached to soil particles are not present. Streams throughout the Boston Mountains Ecoregion are heavily used for recreation as a result of their physical characteristics.

Physical Parameters

Ten transects were analyzed for physical characteristics and were determined to accurately represent the stream. The results are shown in Table B-15.

Archey Creek has many physical characteristics that are unique to streams in the Boston Mountains Ecoregion. Stream substrate is mostly rubble/boulders and gravel that originated in the underlying formations of sandstone. Steep mountainous terrain causes high stream gradients. The high stream gradients and rubble substrate result in very little instream cover because of the higher water velocities during spring flows. Stream canopy is normally low because spring floods with high velocities create wide channels and cause damage to streamside vegetation. Stream canopy is also inversely related to stream size as stream width exceeds the maximum canopy of trees. Also, the larger the stream the greater the maximum spring flood which damages the riparian vegatation.

Macroinvertebrate Populations

Ninety (90) taxa representing 14 orders were identified from the benthic samples from Archey Creek (Table A-34, Appendix A). The dominant orders, Ephemeroptera (mayflies), Trichoptera (caddisflies) and Coleoptera (beetles), comprised 31.9%, 30.4% and 12.9% of the benthic community, respectively. Numerically, the samples were dominated by Chimarra obscura and Isonychia which accounted for 12.9% and 13.9% of the total organisms. Several taxa were common to both spring and summer samples and are considered characteristic of Boston Mountains streams. These include Corydalus cornutus, Hageuis brevistylus, Helichus, Helicopsyche borealis and Hetaerina.

Qualitative similarity indices indicated that the benthic communities of the summer-spring seasons were similar (Table B-16). Of the 90 taxa identified from Archey Creek, 63 and 61 were present in the summer and spring samples, respectively. Of those, 34 taxa were identifed from both samples and 29 taxa and 20 taxa were unique to the summer and spring benthic populations, respectively. The 34 taxa present in both samples accounted for 80% of all organisms

Table B-15

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Archey Fork
Date:	August 14, 1984
Drainage Area:	107 sq. miles
Watershed Land Use:	85% Forest 15% agriculture
Stream Gradient:	14 ft./mile
Mean Channel Width:	84.2 ft.
Mean Stream Width:	51.1 ft.
Mean Stream Velocity:	.11 fps
Observed Flow:	.59 cfs
Average Substrate Type:	11% bedrock 23.9% lg. boulder 11.9% boulder 44.4% rubble 7.8% gravel 3.5% sand
Mean Instream Cover:	1.2% undercut bank .4% brush,logs,debris 5.1% overhanging veg. 12.7% inundated veg.
Riffle/Pool Ratio of Transects:	30% riffle 20% deep pool 50% shallow pool
Mean Bank Overstory Cover:	49.3% trees 58.5% shrubs
Mean Bank Ground Cover:	38.5% grasses and forbs 33.8% rock 27.2% dirt
Mean Bank Stability:	50% stable 50% moderate 0% unstable
Mean Stream Canopy:	7%
Comments:	

collected. The 29 taxa unique to the summer sample comprised only 16% of the summer benthic community and the 27 taxa unique to the spring sample accounted for 30% of the sample, numerically.

Summer - The dominant orders of the summer sample were Trichoptera (43.8%), Ephemeroptera (15.6%), Coleoptera (13.3%) and Odonata (10.2%). Numerically, only Chimarra obscura and Cheumatopsyche (both caddisflies) accounted for greater than 10% of the organisms collected. Ecological dominants of the summer benthic community include Isonychia, Helicopsyche, Helichus, Hetaerina and Corydalus cornutus

Spring - The benthic community of the spring was dominated by mayflies (46.3%), caddisflies (16.9%) and beetles (12.5%). Isonychia dominated the spring sample, numerically comprising 20.9% of the sample. The spring sample was also characterized by several coldwater mayflies (Eurylophella temporalis, Rhithrogena) and caddisflies (Wormaldia and Helicopsyche).

The community parameters indicated that a stable, balanced benthic community exists as a result of good quality water and the presence of adequate microhabitats (Table B-16). There were only slight differences in the community parameters between the summer and spring samples.

Table B-16. Community Analysis of Benthic Samples from Archey Creek - 30 Minute Qualitative Sample, 1984-85

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	872	863	1735
Total # Taxa	63	61	90
Diversity	4.2900	4.6960	5.0596
Index of Evenness	0.7177	0.7918	0.7779
Index of Dominance	0.5306	0.5933	0.5595
Index of Variety	6.3471	6.1518	8.2708
COMPARATIVE INDICES			
Dice Index (range 0-1)			0.64
Common Taxa Index (range 0-1)			0.54
Qualitative Similarity Index (range 0-100)			27.0

Fish Populations

Summer - Approximately five pounds of 7% active rotenone was used to treat the lower one-third of a large, deep pool, a long, shallow riffle and a small, deep pool. Only a slight flow existed through the sample area. The rotenone was detoxified at the lower end of the sample area with

potassium permanganate. A total of 2783 fishes were collected, representing 41 species. Two additional species were collected in the spring bringing the total species richness for this site to 43. Table B-17 lists all species collected at this site. The total relative abundance value of the summer sample was 273 with a diversity index of 5.10. Eleven species of Percidae were collected at this site which made up 29.7% of the population. Cyprinidae and Centrarchidae were the next most abundant fish families in the population (Table B-18). Primary feeding fishes made up 7.9% of the population while nine species of carnivores comprised 13.6% of the population. Twenty-one sensitive species were collected which accounted for 59.7% of the population.

Spring - Three trammel nets of 1½, 2 and 3½-inch square mesh were set overnight on May 7 and 8, 1985. The total catch was 23 fish weighing 64.1 pounds. Four spotted gar were collected in the nets. This species had not been collected previously at this site. One walleye was also collected at the site by hook and line, another species that had not been previously collected. During the spring collection, water temperature ranged between 17° and 19°C and the flow was 122 cfs. Golden and black redhorse had completed spawning. The centrarchids and catfish collected showed gonad maturation in preparation for spawning.

Table B-17. Fishes Collected from Archey Creek with Relative Abundance Values

Species		R.A. VALUE
*Etheostoma blennioides	Greenside darter	12.0
*Noturus exilis	Slender madtom	12.0
*Etheostoma caeruleum	Rainbow darter	12.0
Lepomis megalotis	Longear	10.5
Pimephales notatus	Bluntnose minnow	10.5
*Ambloplites ariommus	Shadow bass	10.5
Lepomis cyanellus	Green sunfish	10.0
*Moxostoma duquesnei	Black redhorse	10.0
Percina caprodes	Logperch	9.5
Fundulus olivaceus	Blackspotted topminnow	9.0
Labidesthes sicculus	Brook silversides	9.0
*Notropis greenei	Wedgespot shiner	9.0
*Etheostoma moorei	Yellowcheek darter	9.0
*Notropis boops	Bigeye shiner	9.0
Campostoma anomalum	Stoneroller	9.0
*Hybopsis dissimilis	Streamline chub	9.0
Micropterus punctulatus	Spotted bass	9.0
*Noturus albater	Ozark madtom	9.0
*Micropterus dolomieui	Smallmouth bass	8.5
*Etheostoma euzonum	Arkansas saddled darter	8.0
*Etheostoma stigmaeum	Speckled darter	7.5

Table B-17, cont.

Species		R.A. VALUE
*Etheostoma zonale	Banded darter	7.5
*Notropis whipplei	Steelcolor shiner	7.0
*Percina nasuta	Longnose darter	6.5
*Hypentelium nigricans	Northern hogsucker	6.5
Etheostoma whipplei	Redfin darter	6.0
*Pimephales tenellus	Slim minnow	6.0
Moxostoma erythrurum	Golden redhorse	6.0
Pylodictis olivaris	Flathead catfish	6.0
Lepomis macrochirus	Bluegill	3.5
*Etheostoma punctulatum	Stippled darter	3.0
Ictalurus natalis	Yellow bullhead	2.0
Fundulus notatus	Blackstripe topminnow	2.0
Aplodinotus grunniens	Freshwater drum	2.0
Lepomis gulosus	Warmouth	1.0
Ichthyomyzon sp.	Lamprey larvae	1.0
Dorosoma cepedianum	Gizzard shad	1.0
*Semotilus atromaculatus	Creek chub	1.0
Ictalurus punctatus	Channel catfish	1.0
Morone chrysops	White bass	1.0
Noturus miurus	Brindled madtom	1.0
Lepisosteus oculatus	Spotted gar	S
*Stizostedion vitreum	Walleye	S

*Sensitive species
S - collected in spring sample only

Table B-18. Summary of Fish Population Parameters from Archey Creek

Total Species Collected	43.0
Total Number of Individuals	2783.0
Total Relative Abundance Value	273.0
Relative Abundance Diversity Index	5.10

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	8.0	22.2
CATOSTOMIDAE	3.0	8.2
ICTALURIDAE	6.0	11.4
CENTRARCHIDAE	7.0	19.4
PERCIDAE	11.0	29.7
Primary Feeders	4.0	7.9
Macroinvertebrate Feeders	30.0	78.5
Carnivores	9.0	13.6
Sensitive Species	21.0	59.7

ILLINOIS BAYOU

The East and Middle Forks of the Illinois Bayou originate in the northeast corner of Pope County and flow south-southwest for 15-18 miles, where they form a confluence just north of Hector. From there, the stream flows southwesterly for a few miles until it is joined by the North Fork, then continues this south-southwesterly path for approximately 20 more miles to the Dardanelle Reservoir.

The site selected on Illinois Bayou for fish collection was a large pool about 1000 feet below the Hwy. 27 bridge in the SW¼, NW¼ of Section 24, R 19 W, T 10 N (Figure B-16). At the time of the summer survey there was essentially no surface flow in the stream at the bridge. The survey team had to search for a site having a sufficient volume of water to represent typical limnological conditions during low flow. A large pool was selected because it provided the conditions needed for fish to survive under low flow conditions. All other survey observations were made at the Highway 27 bridge site.

General Site Discussion

Watershed Size - Drainage basin size at the point of sampling is 125 mi^2. This site was selected as representative of a medium-sized Boston Mountains stream.

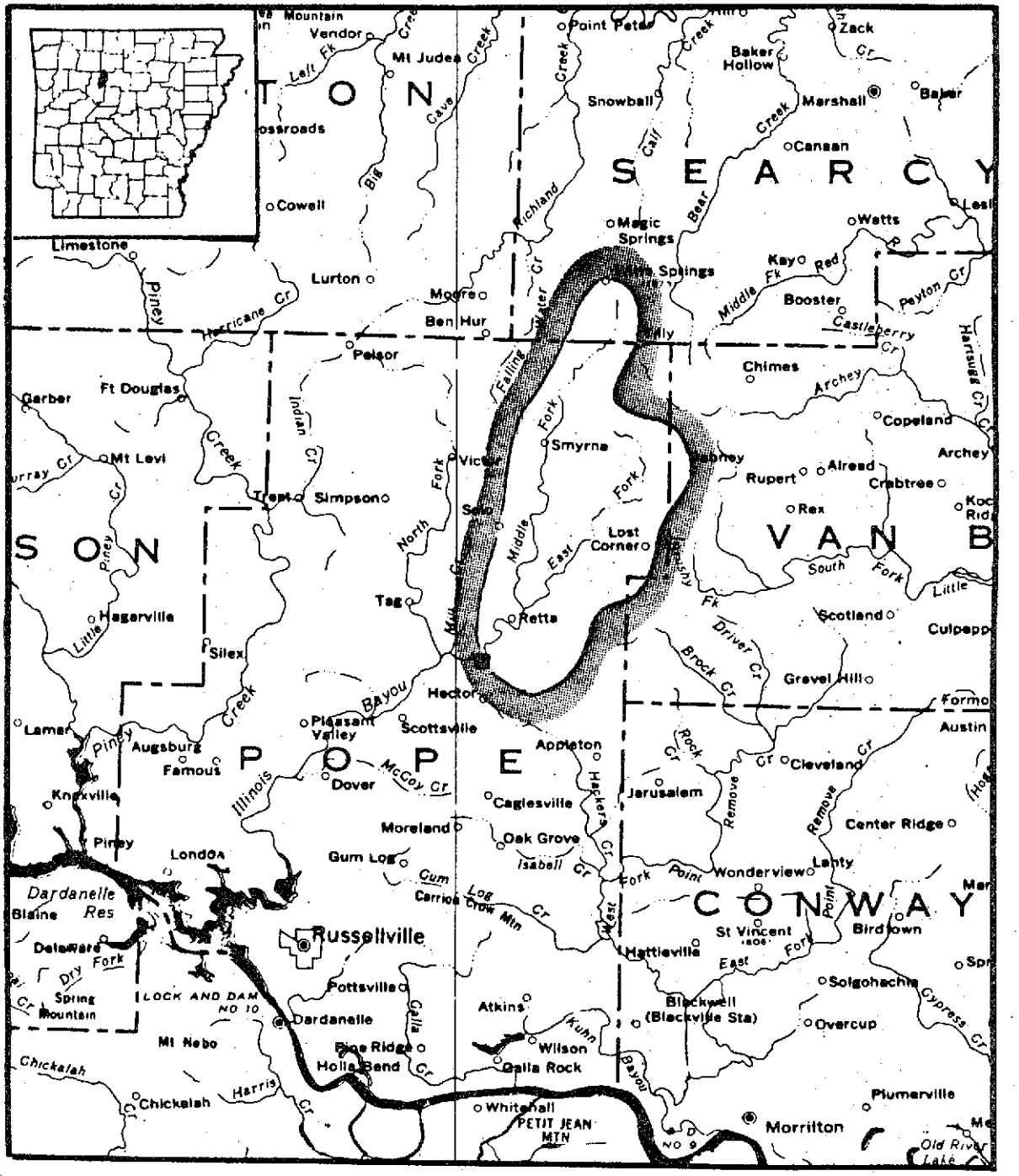
Geology - Subsurface geology of the drainage basin is classified as Bloyd Shale and Prairie Grove members of the Hale formation and the Atoka formation. Both are sandstone deposits of Pennsylvanian Age.

Topography - Illinois Bayou topography can generally be described as mountainous with narrow valleys along major streams. More specifically, the topography is very steep to gently sloping terrain with gently sloping stream valleys. Elevations vary from about 750 to over 2000 feet msl.

Soil Type - Two major groupings of soils make up the Illinois Bayou basin. The Nella-Enders-Mountainburg association, the dominant group, is located in the upland portions of the basin. These soils are well-drained, gently sloping to very steep, deep and shallow, loamy and stony. The pH ranges from strongly acid to moderately acid (pH 5.5 to 6.0), and the erosion hazard is severe.

The Pickwick-Spadra association is found in the stream valleys and is composed of soils which are well-drained, nearly level to gently sloping, deep and loamy, found on stream terraces. The pH ranges from moderately acid to slightly acid (pH 5.6 to 6.5). The erosion potential is slight for soils of this association.

Figure B-16



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

ILLINOIS BAYOU: Drainage area 125 square miles ■ Survey site ▒ Survey area

Flora - Steep upland portions of the basin are covered with hardwood forests comprised of red and black oaks, red cedar and shortleaf pine. Streamside riparian zones are rich in variety. Observed during the survey were red cedar, sweetgum, sycamore, river birch, American elm, black cherry, river alder, American hornbeam, northern red oak, red maple, white oak, black willow, catalpa, honey locust, green ash, blackgum and shortleaf pine.

Land Use - Data specific to Illinois Bayou was not available, but data collected by the S.C.S. that combines Illinois Bayou with a larger area states that 95% of the land is in forest and 5% in pastureland. The majority of the watershed is in the Ozark National Forest. The steep mountainous terrain in the Boston Mountains Region is largely undeveloped. From all observations made during the spring and summer survey, a estimation of 95% forest is probably correct. Illinois Bayou meets the definition for this project of being least-impaired.

Stream Characteristics - Illinois Bayou is a rocky, mountainous stream typical of the Boston Mountains Region. Stream gradient is 12.5 ft/mile. The creek's most striking characteristics are the substrate type, steep gradient, and blue-green water. Other characteristics of note are the large number of riffles and low percentage of instream cover.

Methodology and Sampling Results

The summer survey of Illinois Bayou was conducted during the week of August 13, 1984. A follow-up survey was carried out the next spring during the week of May 6, 1985, to assess conditions during the spawning season.

Weather conditions during the summer survey were ideal. Temperature remained high and steady and little rain fell. Spring conditions were also excellent. Two short showers did fall during the week, but did not influence the stream stage or turbidity.

Continuous Dissolved Oxygen

Summer - Conditions during the summer survey were typical of the critical low-flow, high-temperature situation. Stream flow was too low to measure between pools. The temperature peaked at 31°C during the week. This exceeds the expected maximum for the region. Overall, the data approximates an annual worse case situation for dissolved oxygen.

The minimum observed D.O. during the summer survey period differed somewhat between a pool and a riffle (Figures B-17 and B-18). In the pool, the range was 6.2 to 9.4 mg/l, a

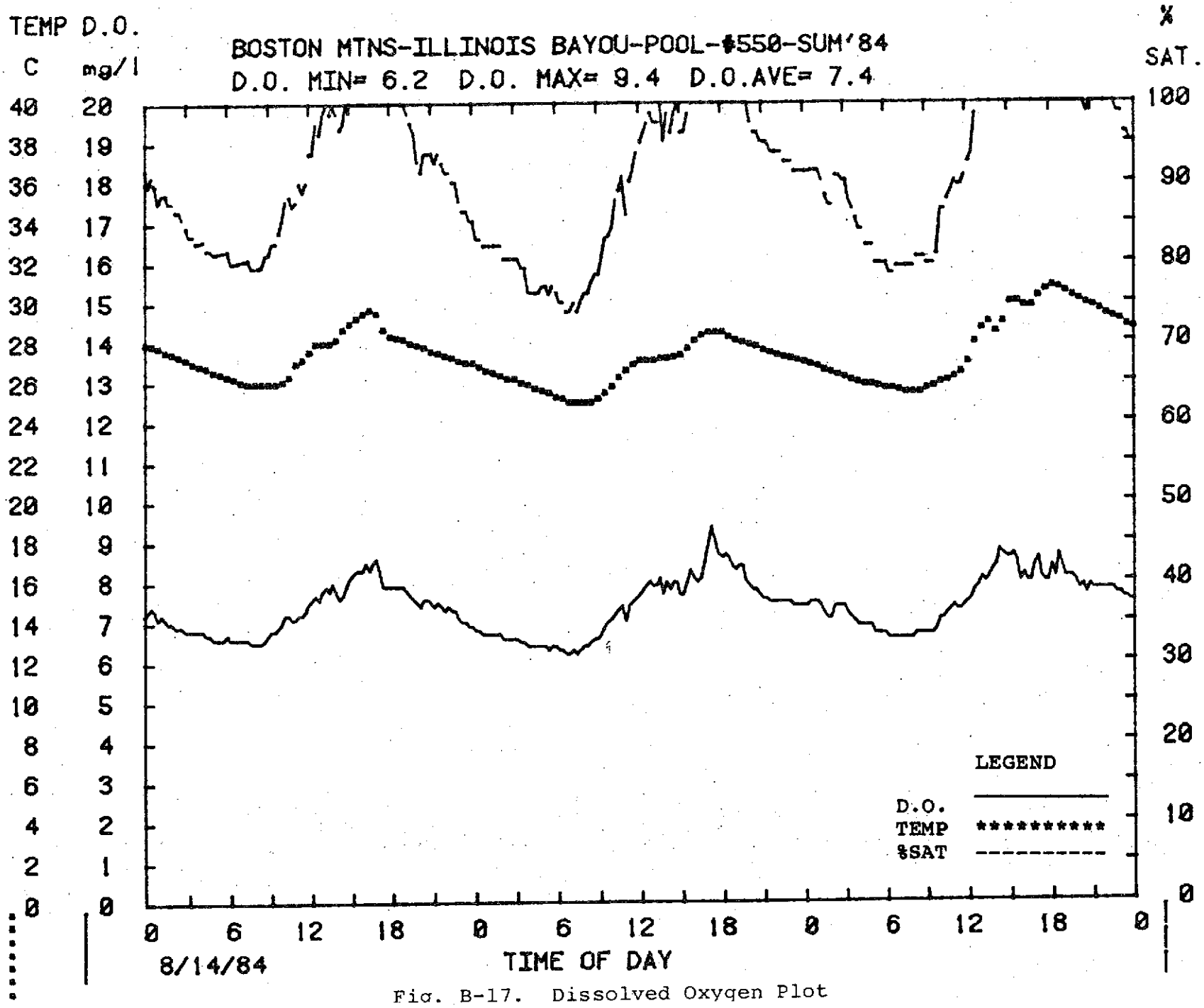


Fig. B-17. Dissolved Oxygen Plot

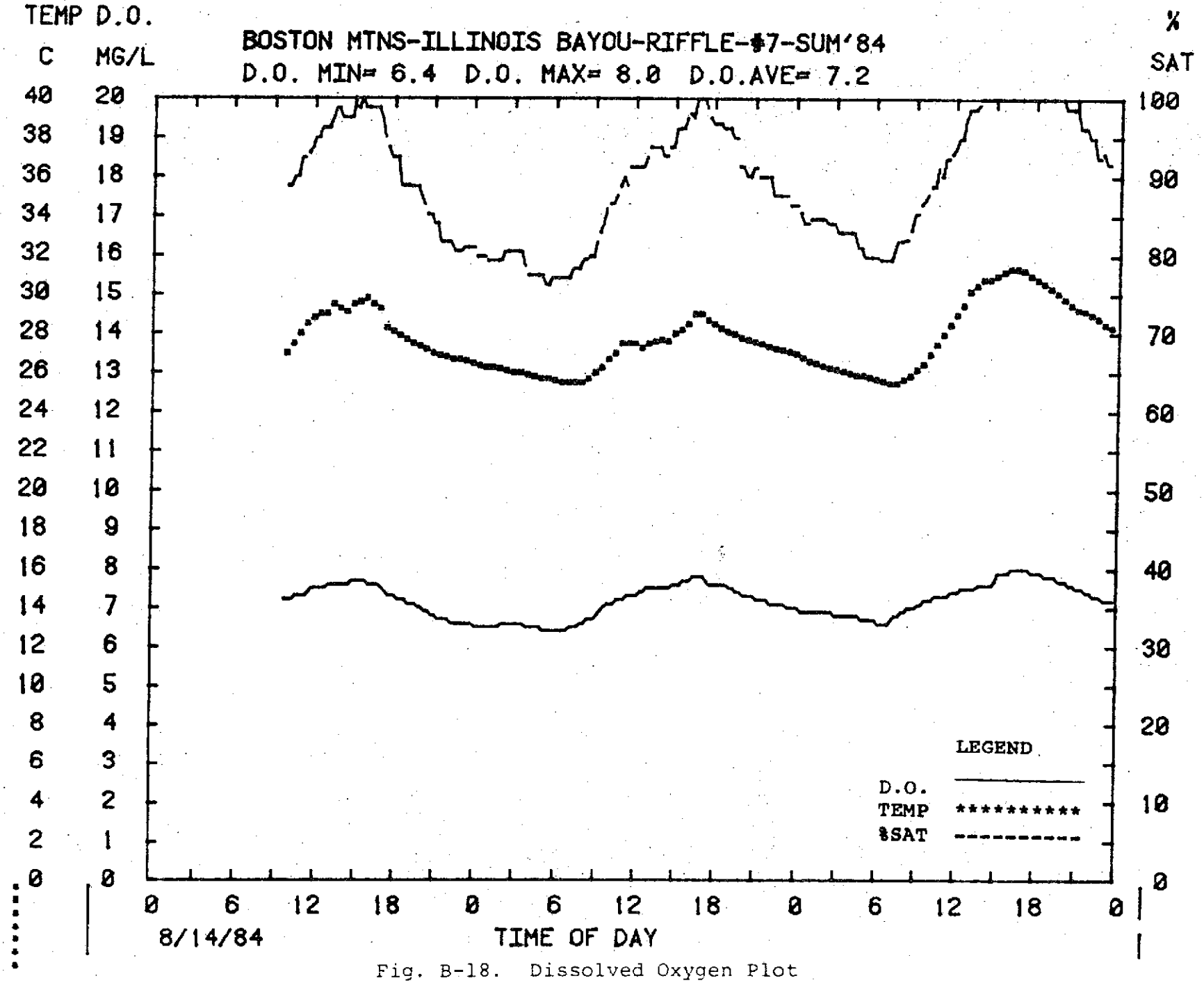


Fig. B-18. Dissolved Oxygen Plot

difference of 3.2 mg/l. The riffle ranged from 6.4 to 8.0 mg/l, a difference of 1.6 mg/l.

Data collected in the riffle varied from the pool for several reasons. What little flow existed was mostly inter-gravel at most points in the stream, and where the water surfaced it was very shallow. Maximum D.O. in the pool was higher probably because of greater production of phytoplankton.

The daily D.O. cycle was very consistent during the summer survey. Dissolved oxygen peaked each day around 1700 hours and then fell to a minimum around 0800 hours. Dissolved oxygen saturation also followed the same pattern, varying from 75% to 100% or greater. Temperature rose slightly over the period, but seemed to have little impact on the dissolved oxygen concentration.

Stream canopy at the sample site was sparse. As a result, D.O. closely followed the solar radiation cycle throughout the 24-hour period by continuing to rise until the sun's rays no longer reached the stream.

Spring - The spring sampling showed much higher levels of dissolved oxygen (Figures B-19 and B-20). The minimum recorded was 8.3 mg/l and the maximum was 9.5 mg/l. The percent saturation values were also higher, ranging from 90% to 100% or greater. These higher D.O. values were directly related to higher flows and lower temperatures. D.O. values between pool and riffle showed only small differences. Daily D.O. cycles were less pronounced than the summer because flow was much higher, thus decreasing the impact of solar radiation.

Chemical Parameters

Chemical data collected for the two different periods of the year are displayed in the Tables B-19 and B-20. Water quality in Illinois Bayou is excellent. The pH is nearly neutral; suspended solids, turbidity and nutrients are very low. Alkalinity, chlorides and sulfates are also extremely low.

Each of these parameters can be traced directly back to the characteristics of the drainage basin. Streams throughout the Boston Mountains Region are noted for having excellent water quality. Low population density, geology, topography and forest cover in the region contribute to excellent water quality.

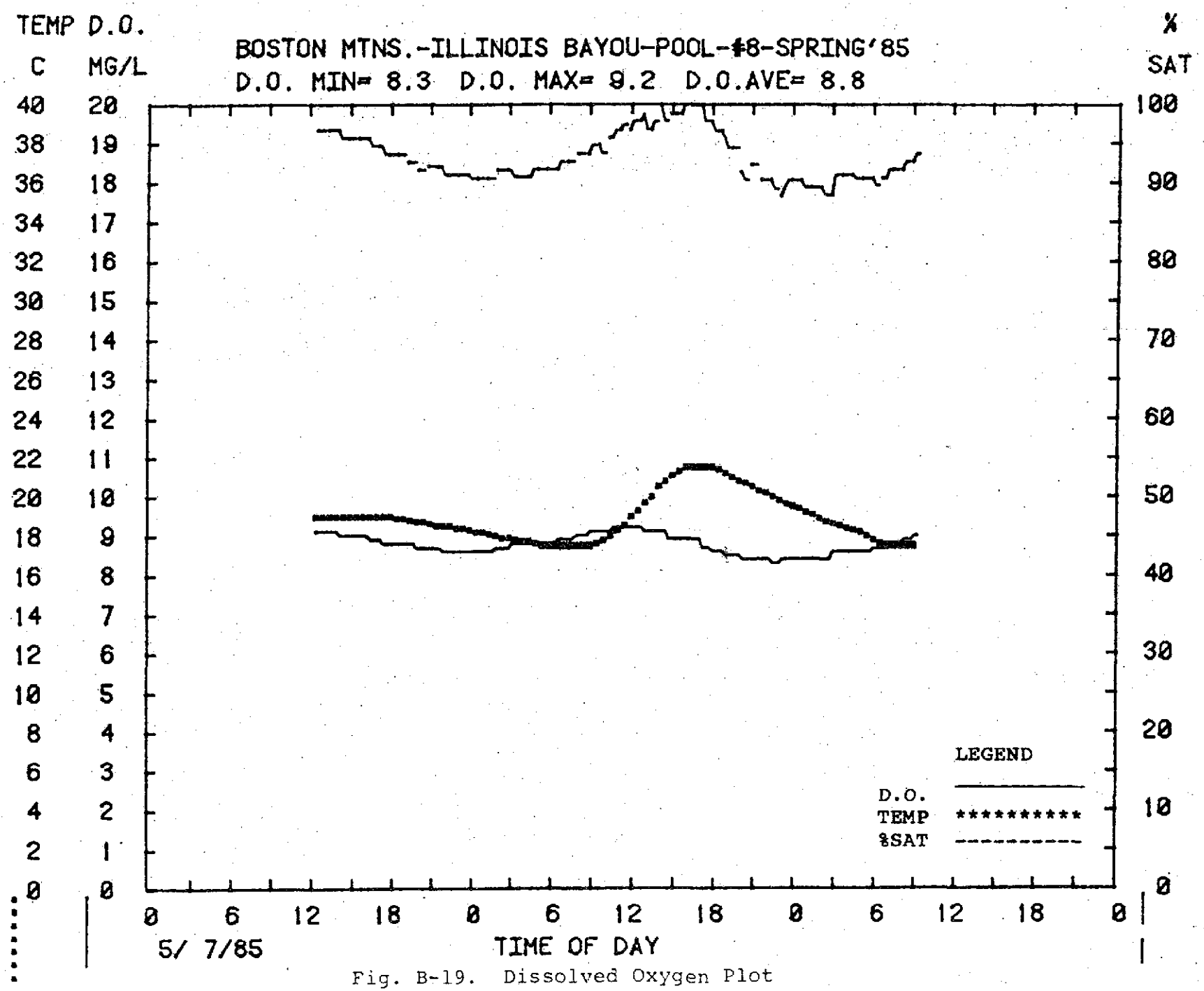


Fig. B-19. Dissolved Oxygen Plot

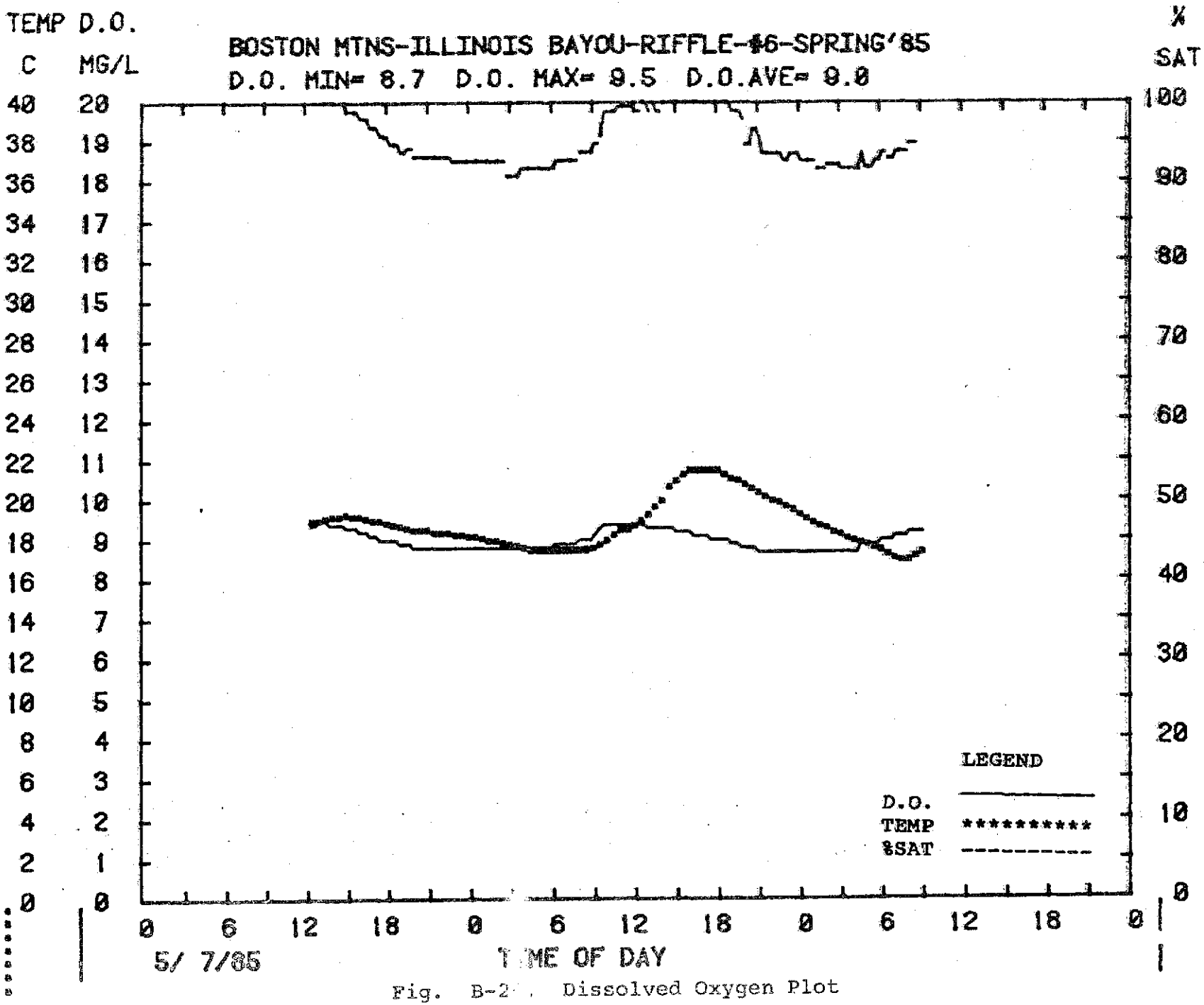


Fig. B-2 . Dissolved Oxygen Plot

Table B-19

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Illinois Bayou

Drainage Area: 125 square miles

Station Description: Illinois Bayou at Hwy. 27 bridge

Date: August 14, 1984

PARAMETER	TIME COLLECTED			AVERAGE
	09:15	10:00	11:30	
Q, cfs	~1	~1	~1	~1
Temperature, 0C	26.0	26.0	xxx	26.0
pH	6.9	6.8	6.8	6.8
Turbidity, ntu	1.8	1.8	1.7	1.8
TSS, mg/l	1	2	2	2
TDS, mg/l	36	37	31	35
BOD-5, mg/l	-	-	-	-
BOD-20, mg/l	-	-	-	-
T.Phos., mg/l	.03	.04	.03	.03
PO4-P, mg/l	.04	.01	.01	.02
NO2+NO3-N, mg/l	.05	.04	.05	.05
NH3-N, mg/l	.05	.01	.01	.02
Cl -, mg/l	4	4	4	4
SO4 =, mg/l	3	2	3	3
Fe, mg/l	.11	.13	.10	.11
Conductivity 5mho	49	47	46	47
Alkalinity, mg/l	17	17	17	17
T. Hardness, mg/l	22	16	18	19
Chlorophyll a,5g/l	.5	2.7	3.2	2.1
Fecal Coliform	-	-	600	600

Dissolved Oxygen Data for August 14, 1984		
	Pool	
Average	7.3	
Minimum	6.5	
Maximum	8.6	

Table B-20

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Illinois Bayou

Drainage Area: 117 Square Miles

Station Description: Illinois Bayou at Hwy. 27 bridge, SW 1/4, NW 1/4, Section 24, T 9 N, R 6 W - Pope County

Date: May 7, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	12:10	13:05	13:30	
Q, cfs	147.2	147.2	147.2	147.2
Temperature, °C	19.5	19	19	19
pH	7.0	7.0	7.0	7.0
Turbidity, ntu	4	4	4	4
TSS, mg/l	4	4	<1	<3
TDS, mg/l	25	21	21	22
BOD-5, mg/l	1.2	1.0	1.1	1.1
BOD-20, mg/l	1.5	1.4	1.5	1.5
T.Phos., mg/l	0.02	0.01	0.01	0.01
PO4-P, mg/l	0.01	0.01	0.01	0.01
NO2+NO3-N, mg/l	0.05	0.03	0.03	0.04
NH3-N, mg/l	0.03	0.02	0.03	0.03
Cl -, mg/l	2.5	2.5	2.5	2.5
SO4 =, mg/l	6	6	6	6
Fe, mg/ l	0.06	0.05	0.04	0.05
Conductivity,µmho	N/A	N/A	N/A	N/A
Alkalinity, mg/l	10	10	10	10
T. Hardness, mg/l	16	12	12	13
Chlorophyll a,µg/l	0.6	0.6	0.3	0.5
Fecal Coliform	-	-	8	8

Dissolved Oxygen Data for May 7, 1985		
	Pool	Riffle
Average	8.8	9.1
Minimum	8.6	8.8
Maximum	9.1	9.5

N/A - Not Analyzed

Physical Parameters

Six transects were used to assess the physical characteristics of the stream. The results of the physical survey are shown in Table B-21.

Stream substrate is derived from the underlying sandstones. It is dominated by bedrock, followed by rubble, gravel and boulders at the Illinois Bayou site. Steep gradients and a rocky substrate result in very little instream cover and limited stream canopy. Canopy is restricted mainly to small bushes and brush because the high velocity of spring floods prevents trees from developing streamside.

Macroinvertebrate Populations

Seventy-six (76) taxa representing 14 orders were identified from the benthic samples collected from Illinois Bayou (Table A-35, Appendix A). Numerically, two orders (Ephemeroptera and Trichoptera) dominated the macroinvertebrate population, comprising 34.7% and 19.1% of the sample, respectively. The dominant taxa were Wormaldia, Pseudocloeon punctiventris, Perlesta placida, Stenonema terminatum and Corydalus cornutus, comprising 12.9%, 11.4%, 5.5%, 4.5% and 3.9% of the sample, respectively. Other taxa which were present in both samples and are considered to be characteristic of Illinois Bayou include Helichus, Isonychia, Stenonema femoratum, and Rhagovelia.

The benthic samples of the summer and spring were similar, as indicated by the qualitative comparative indices (Table B-22). Of the 76 taxa identified, 46 and 52 were present in the summer and spring samples, respectively. Of those, 22 taxa were identified from both samples and 24 and 30 taxa were unique to the summer and spring benthic communities, respectively. The 29 taxa present in both samples accounted for 72% of all organisms collected. The 24 taxa unique to the summer community comprised less than 24% of that sample's numeric total. The 30 taxa unique to the spring sample accounted for 28% of the benthic organisms in that collection.

Summer - The dominant orders of the summer benthic community were ephemeroperans (27.5%), trichopterans (21.6%), coleopterans (13.6%) and odonates (12.6%). The dominant taxa of the summer were Cheumatopsyche (9.7%), Corydalus cornutus (6.4%), Hyallella azteca (7.7%), Helichus (6.3%) and Ischnura (5.1%). Three of the above are common and wide spread; only Corydalus cornutus and Helichus could be considered more restricted to ecologically undisturbed environs and characteristic of high quality water.

Table B-21

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Illinois Bayou
Date:	August 14, 1984
Drainage Area:	125 sq. miles
Watershed Land Use:	82% Forest 18% agriculture
Stream Gradient:	12.5 ft./mile
Mean Channel Width:	83.5 ft.
Mean Stream Width:	42.5 ft.
Mean Stream Velocity:	.1 fps
Observed Flow:	1.0 cfs
Average Substrate Type:	41% bedrock 13% boulder 14% gravel 2% lg. boulder 25% rubble 4% mud
Mean Instream Cover:	2% brush,logs,debris 2% overhanging veg. 3% inundated veg. 0% undercut bank
Riffle/Pool Ratio of Transects:	50% riffle 16.7% deep pool 33.3% shallow pool
Mean Bank Overstory Cover:	70% trees 49.2% shrubs
Mean Bank Ground Cover:	8.2% grasses and forbs 60.8% rock 30% dirt
Mean Bank Stability:	67% stable 33% moderate 0% unstable
Mean Stream Canopy:	8.3%
Comments:	

Spring - The dominant orders of the spring benthic community were mayflies (38.0%) and caddisflies (21.5%). The dominant taxa were Wormaldia (16.9%), Pseudocloeon punctiventris (16.4%), Perlesta placida (8.0%), Stenonema terminatum (4.7%) and Stenonema femoratum (4.2%). In addition, Hetaerina and Helicopsyche borealis were collected with enough frequency to be considered as dominants and characteristic of the spring benthic community.

The community parameters calculated for Illinois Bayou benthic samples indicated a healthy macroinvertebrate community (Table B-22). This community is in direct response to the availability of diverse microhabitat and "high quality" water. These community indicators reflected only minor changes between the summer and spring samples, in response to the naturally occurring, seasonal variation of insect populations. The dominance of both spring and summer samples by ephemeropterans indicates that the balance which exists is vulnerable to very slight disruptions in the aquatic environment.

Table B-22. Community Analysis of Benthic Samples from Illinois Bayou - 30 Minute Qualitative Sample, 1984-1985

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	440	904	1344.0
Total # Taxa	46	52	76.0
Diversity	4.7713	4.4982	5.1861
Index of Evenness	0.8638	0.7891	0.8300
Index of Dominance	0.4446	0.5189	0.4888
Index of Variety	5.1245	5.1934	7.2168
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.58	
Common Taxa Index (range 0-1)		0.42	
Qualitative Similarity Index (range 0-100)		19.0	

Fish Populations

Summer - A narrow, shallow pool expanding into a larger, deep pool was treated with four pounds of 7% rotenone. Approximately 18 man-hours were spent picking up fish from the sample area. A total of 28 species from 2386 specimens were collected during this sample. Two additional species were collected the following spring bringing the total fish species taken at this site to 30 (Table B-23). The summer sample produced a total relative abundance value of 226.5 and a diversity index of 4.62. Percidae was the dominant fish family. It was followed closely by Centrarchidae and Cyprinidae. Macroinvertebrate feeders were the dominant

tropic feeding level. Six species of carnivores made up 15.9% of the population and two species of primary feeders accounted for 9.3% of the population (Table B-24). Thirteen sensitive species comprised 49.5% of the population.

Spring - Three trammel nets of 2", 2½", and 3½" square mesh were set overnight at this site on May 8, 1985. Also, limited electrofishing was done with the backpack shocker. The streamflow was 147 cfs and water temperature ranged from 18° to 22°C. Thirteen fish from four species weighing 35.9 pounds were caught in the nets. River redhorse and gizzard shad were taken in the nets and had not previously been collected at this site. Twelve species were taken electrofishing, all of which had been collected before. Gonad examination of fishes taken in the spring sample indicated that the redhorse had completed spawning; gizzard shad were in the process of spawning and spotted bass and largemouth bass were in the advanced stages of gonad maturation in preparation for spawning. Some of the other cyprinids and some percids were also near or in the spawning process.

Table B-23. Fishes Collected from Illinois Bayou with Relative Abundance Values

Species		R.A. VALUE
*Etheostoma punctulatum	Stippled darter	12.0
Lepomis cyanellus	Green sunfish	12.0
Etheostoma whipplei	Redfin darter	12.0
Etheostoma spectabile	Orangethroat darter	12.0
Lepomis megalotis	Longear	12.0
Campostoma anomalum	Stoneroller	12.0
*Micropterus dolomieui	Smallmouth bass	11.5
Labidesthes sicculus	Brook silversides	10.5
*Notropis boops	Bigeye shiner	10.5
*Moxostoma duquesnei	Black redhorse	10.5
*Noturus exilis	Slender madtom	10.5
Micropterus punctulatus	Spotted bass	10.5
Pimephales notatus	Bluntnose minnow	9.0
*Notropis whipplei	Steelcolor shiner	9.0
*Etheostoma blennioides	Greenside darter	9.0
*Notropis greenei	Wedgespot shiner	9.0
*Etheostoma zonale	Banded darter	9.0
*Hypentelium nigricans	Northern hogsucker	7.5
*Percina nasuta	Longnose darter	7.5
Ictalurus natalis	Yellow bullhead	6.5
Fundulus olivaceus	Blackspotted topminnow	6.0
*Ambloplites ariommus	Shadow bass	6.0
Esox americanus	Grass pickerel	4.5
Micropterus salmoides	Largemouth bass	2.5
Lepomis macrochirus	Bluegill	2.0
Pylodictis olivaris	Flathead catfish	1.0

Table B-23, cont.

Species		R.A. VALUE
Moxostoma erythrurum	Golden redhorse	1.0
Lepomis hybrid	Hybrid sunfish	1.0
*Moxostoma carinatum	River Redhorse	S
Dorosoma cepedianum	Gizzard shad	S

*Sensitive species
S - Collected in spring sample only

Table B-24. Summary of Fish Population Parameters from Illinois Bayou

Total Species Collected	30.0
Total Number of Individuals	2386.0
Total Relative Abundance Value	226.5
Relative Abundance Diversity Index	4.62

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	5.0	21.9
CATOSTOMIDAE	4.0	8.4
ICTALURIDAE	3.0	7.9
CENTRARCHIDAE	8.0	25.4
PERCIDAE	6.0	27.2
Primary Feeders	2.0	9.3
Macroinvertebrate Feeders	21.0	74.8
Carnivores	6.0	15.9
Sensitive Species	13.0	49.5

LEE CREEK

Lee Creek has its headwaters in southern Washington County and meanders in a southwesterly direction into Oklahoma and then back into Arkansas until it joins the Arkansas River near the City of Van Buren.

The site selected for study on Lee Creek was a pool and short riffle at Highway 59 in Section 10, R 32 W, T 11 N (Figure B-21). This site was chosen as best representing a Boston Mountains stream with a large watershed during a low-flow, high-temperature situation. There was no access upstream of the bridge for many miles.

General Site Discussion

Watershed Size - The watershed size above the point of sampling was 168 mi^2.

Geology - The Atoka formation, of Pennsylvanian Age, underlies most of the watershed. The valley containing the stream is underlain in small, interspersed areas of the Bloyd Shale Formation.

Topography - Lee Creek basin can generally be described as very mountainous with sheer bluffs and narrow valleys along the major tributaries. The topography is very steep to gently sloping terrain with moderately sloping to level stream valleys. The Boston Mountains Region has the most relief of any area in the state, and the least amount of level land, which results in streams in the region having very high gradients. Elevation varies from near 750 to 2000 feet msl. Stream gradient at the sample site was 15.3 ft/mile.

Soil Type - The Nella-Enders association is located in the upland portions of the basin. This soil type is well-drained, gently sloping to very steep, deep, loamy and stony soils on hills and mountains. The pH ranges from extremely acid to strongly acid (pH 3.6 to 5.5). Potential for erosion is moderate.

The Spadra association is found in the stream valley. It is composed of well-drained, nearly level, deep, loamy soils on old stream terraces. Erosional potential is slight. The pH ranges from very strongly acid to slightly acid (pH 4.5 to 6.5). Stream pH in the three samples collected ranged from 7.3 to 7.6, which was considerably different from the soil.

Flora - Steep upland portions of the basin are covered with hardwood forests composed of red and black oaks, red cedar and shortleaf pine. Streamside riparian zones are rich in tree variety. Observed during the survey were sweetgum,

Figure B-21



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

LEE CREEK: Drainage area 168 square miles ● Survey site Survey area

sycamore, river birch, shortleaf pine, red cedar, river alder and red maple.

Land Use - Data specific to the Lee Creek basin was collected by the S.C.S. in their statewide RIDS survey. It states that 85% of the land is in forests and 15% is in pastureland. The majority of the watershed is within the boundaries of the Ozark National Forest, which has contributed to the low level of disturbance in the basin. The steep, mountainous terrain in the Boston Mountains region is largely undeveloped, except for the occasional cutting of hardwood timber.

Stream Characteristics - Watershed size at this site was considered to be "large" under the criteria used in this project. Even so, streams in the Boston Mountains Region require a very large drainage basin to maintain year-round flow, and, as a result, Lee Creek has a Q_{7-10} flow of zero at the survey site. In any average drought year, the stream ceases to flow between the pools but the deep pools manage to last until the rainy season. The aquatic community is well adapted to these variations in the flow regime.

Lee Creek is best described as a clean, rock-bottomed, mountainous stream. The most striking characteristics of the creek are the rocky substrate, steep gradient and blue-green water. Other characteristics of note are the large number of riffles, low percentage of instream cover and a relatively low percent of stream canopy.

Methodology and Sampling Results

The summer survey of Lee Creek was conducted during the week of September 2-6, 1985. The spring survey was conducted during the week of May 6, 1986. Conditions during the summer survey were excellent. The weather was hot and dry throughout the week. Stream flow was low and did not vary significantly over the week.

Spring conditions were also excellent, which is not so typical for spring in Arkansas. Stream flow was estimated at 300 cfs and changed very little during the week. The spring survey caught the creek during steady-state high flow conditions, which was the goal of the project.

Continuous Dissolved Oxygen

Summer - Conditions during the summer survey exemplified the typical high temperature, low flow situation. Flow was measured during the survey at 3.5 cfs. Temperature peaked at 33°C during the week which is higher than the expected maximum. Stream canopy immediately upstream of the site has been removed and this probably caused the elevated

temperatures. Overall, the data acquired should closely represent the annual worse case situation for dissolved oxygen.

The minimum D.O. observed for the week was 5.4 mg/l and the maximum was 8.6, giving a range of 3.2 mg/l (Figures B-22 and B-23). A pattern of highs and lows for dissolved oxygen developed over the week. Each day the D.O. peaked shortly after noon, held steady till 1800 hours, then fell steadily throughout the night and early morning to reach a minimum around 0700 hours. Instream reaeration was dominated by photosynthesis as flow was very low in relation to the volume of water in the pools.

D.O. saturation percentages ranged from about 70% to 100% or greater. Water temperature in both the pool and riffle was highly variable. The riffle ranged from 25° to 33°C in one 12-hour period, and the shallow pool from 25° to 30°C. Upstream of the riffle, a large shallow pool that had no canopy seemed to be the cause of the fluctuation in temperature. Temperature in Lee Creek may have been atypical for the region.

Spring - The spring sampling showed much higher levels of dissolved oxygen (Figures B-24 and B-25). The minimum value recorded was 8.0 mg/l and the maximum was 9.7 mg/l. The percent saturation values ranged from 90% to 100%. Temperatures ranged from 18° to 20°C on a daily cycle. Higher springtime D.O. values were directly related to higher flows and lower temperatures.

Chemical Parameters

Spring and summer coliform counts were 56 and 40 colonies, respectively. Both values are low and are indicative of very little disturbance or activity in the basin.

Chemical data collected for the summer and spring surveys are displayed in Tables B-25 and B-26. Of special interest are the extremely low nutrient levels, low turbidity, low suspended solids and a nearly neutral pH. These parameters are related to the geology and soil characteristics of the basin and low level of disturbances in Lee Creek. Hardwood forests cover 85% of the basin and are very rarely disturbed by timber-cutting operations. Streams throughout the Boston Mountains Region are heavily used for recreation as a result of their physical characteristics.

Physical Parameters

Ten transects were analyzed for physical characteristics representative of the stream. The results are shown in Table B-27.

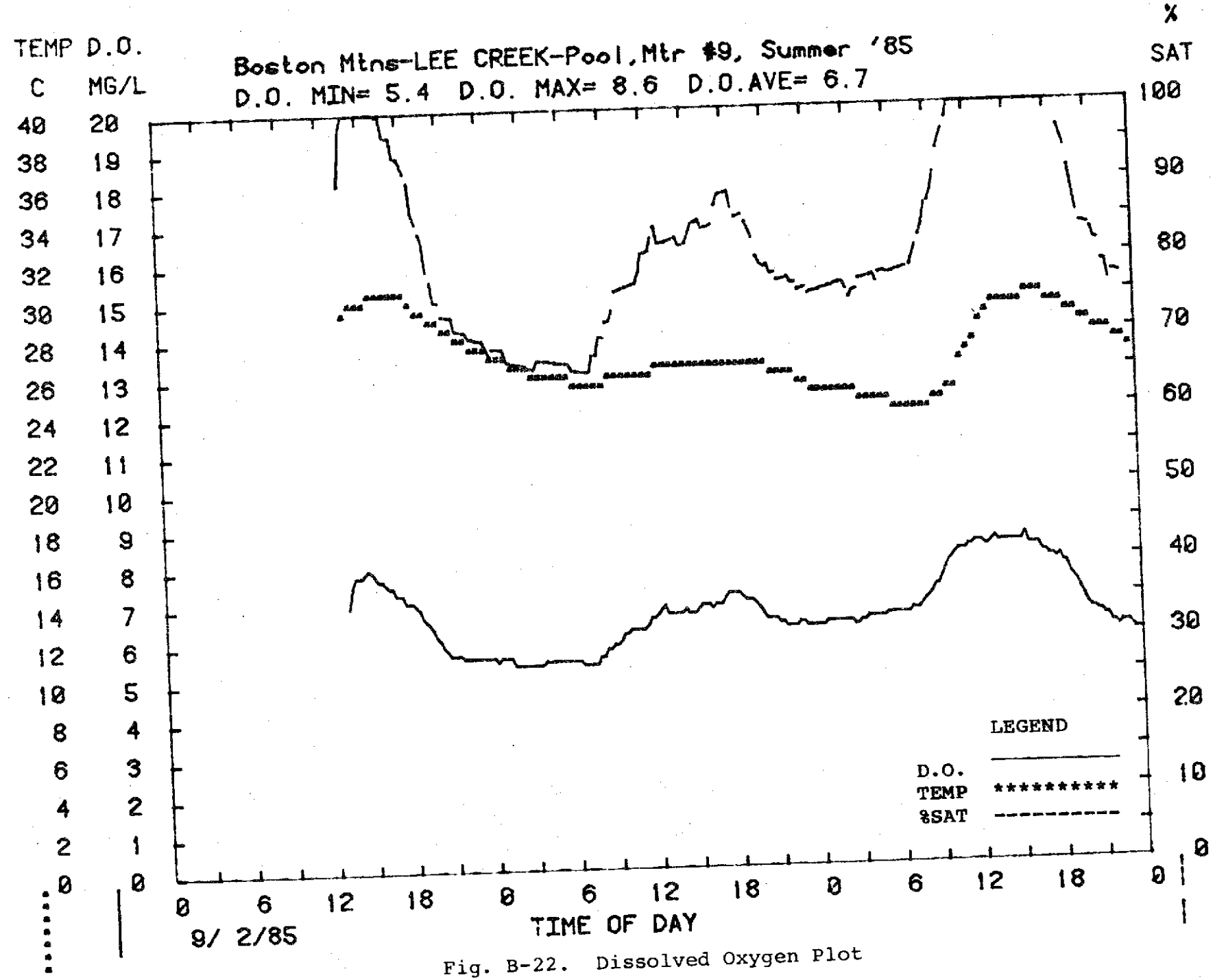


Fig. B-22. Dissolved Oxygen Plot

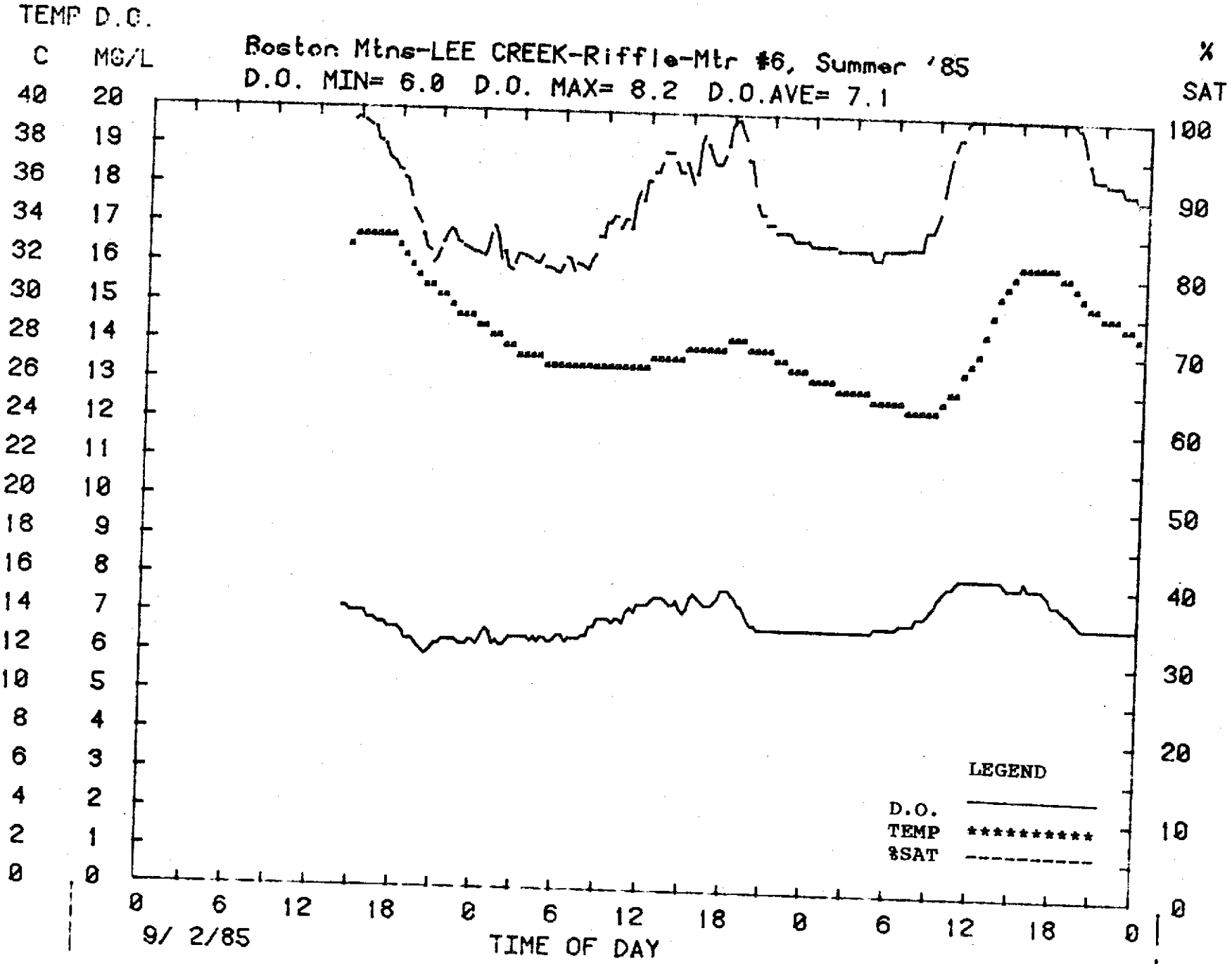


Fig. B-23. Dissolved Oxygen Plot

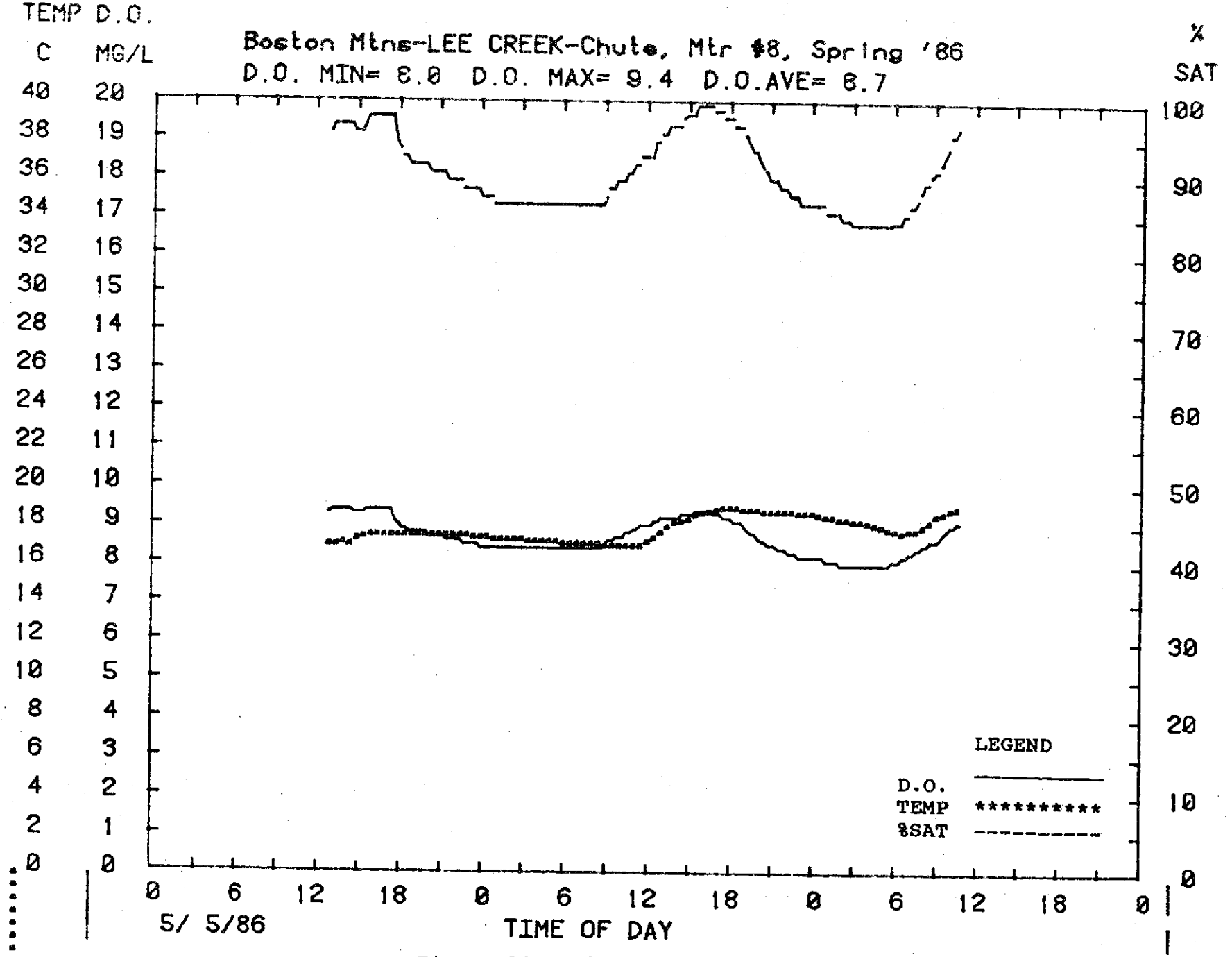


Fig. B-24. Dissolved Oxygen Plot

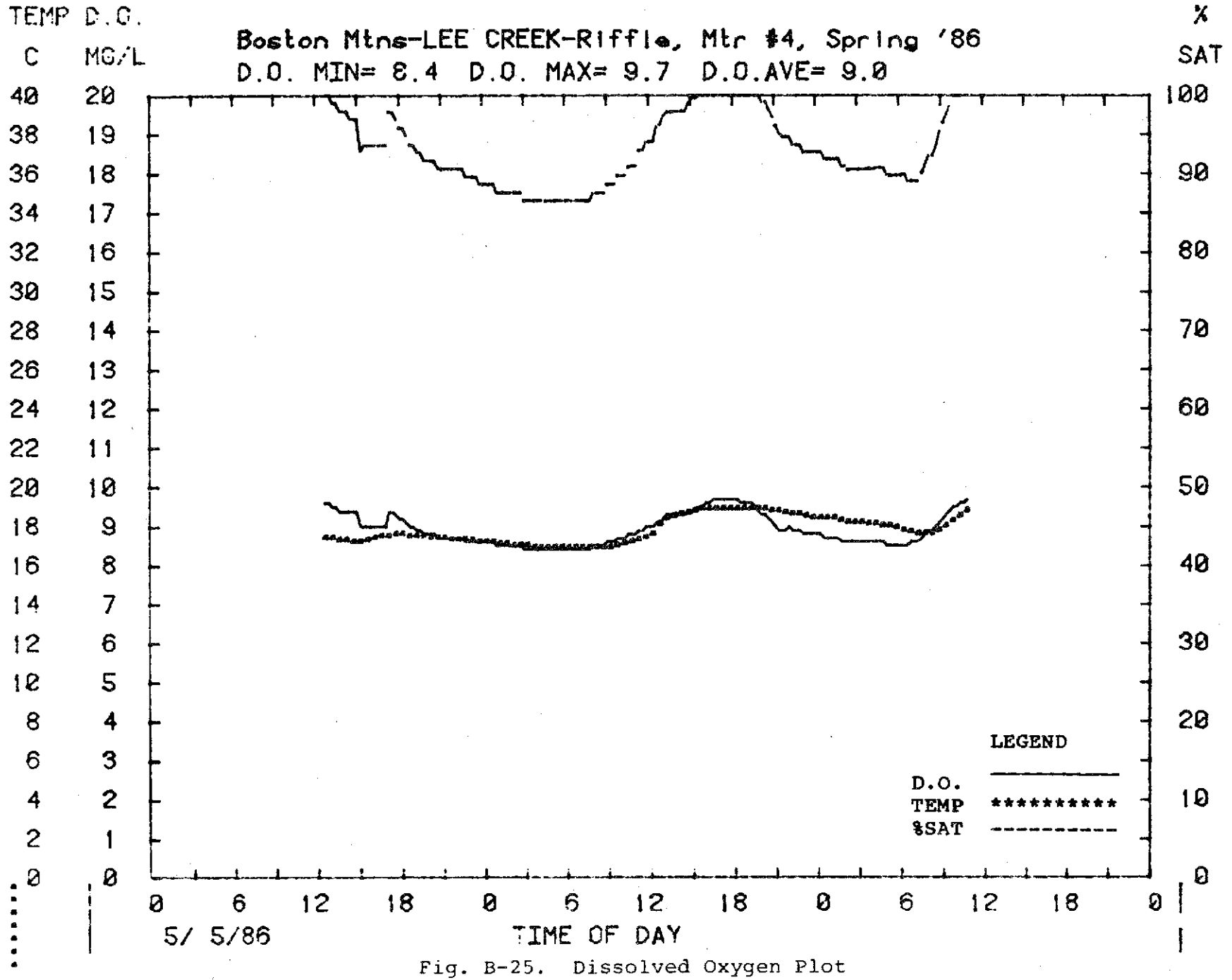


Fig. B-25. Dissolved Oxygen Plot

Table B-25

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Lee Creek

Drainage Area: 168 Square Miles

Station Description: Hwy. 59 bridge in Section 10, T 11 N, R 32 W, Crawford County

Date: September 3, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	08:55	10:00	10:41	
Q, cfs	3.5	3.5	3.5	3.5
Temperature, °C	25	27	26	26
pH	7.3	7.4	7.6	7.4
Turbidity, ntu	2	2	1	2
TSS, mg/l	1	2	1	1
TDS, mg/l	83	90	81	85
BOD-5, mg/l	1.2	1.3	1.1	1.2
BOD-20, mg/l	2.2	2.3	1.8	2.1
T.Phos., mg/l	0.02	0.02	0.02	0.02
PO4-P, mg/l	0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.04	0.03	0.02	0.03
NH3-N, mg/l	0.01	0.01	<0.01	0.01
Cl -, mg/l	11.5	12	11.5	11.5
SO4 =, mg/l	7	6	6	6
Fe, mg/l	0.12	0.15	0.14	0.14
Conductivity,µmho	130	130	129	130
Alkalinity, mg/l	42	42	42	42
T. Hardness, mg/l	42	46	46	45
Chlorophyll a,µg/l	void	void	0.5	0.5
Fecal Coliform	-	-	40	40

Dissolved Oxygen Data for 3 Sep 1985		
	Riffle	Pool
Average	6.9	6.2
Minimum	6.3	5.4
Maximum	7.8	7.2

Table B-26

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Lee Creek

Drainage Area: 168 square miles

Station Description: 50 yds. upstream of Hwy. 59 bridge in Section 10, R 32 W, T 12 N

Date: May 6, 1986

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	10:00	10:30	
Q, cfs	na	na	na	300 est.
Temperature, °C	17	17	17	17
pH	7.42	7.41	7.41	7.41
Turbidity, ntu	12	10	10	10.7
TSS, mg/l	10	3	1	4.7
TDS, mg/l	53	47	52	50.7
BOD-5, mg/l	0.7	0.5	0.4	0.5
BOD-20, mg/l	1.4	1.0	0.9	1.1
T.Phos., mg/l	.06	.04	.05	.05
PO4-P, mg/l	.02	.01	.02	.02
NO2+NO3-N, mg/l	.06	.05	.05	.05
NH3-N, mg/l	<.01	.02	.02	.02
Cl -, mg/l	2.5	2.5	2.5	2.5
SO4 =, mg/l	3	4	3	3.3
Fe, mg/l	-	-	-	-
Conductivity,µmho	70	72	72	71.3
Alkalinity, mg/l	28	27	28	28
T. Hardness, mg/l	34	30	36	33.3
Chlorophyll a,µg/l	-	-	NA	NA
Fecal Coliform	-	-	56	56

Dissolved Oxygen Data for May 6, 1986		
Average	9.0	
Minimum	8.4	
Maximum	9.7	

Table B-27

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Lee Creek
Date:	9/3/85
Drainage Area:	168 square miles
Watershed Land Use:	17% Agriculture 83% Forest
Stream Gradient:	15.3 fpm
Mean Channel Width:	132 feet
Mean Stream Width:	63 feet
Mean Stream Velocity:	0.11 fps
Observed Flow:	3.5 CFS
Average Substrate Type:	54% bedrock 4% large boulders 8% boulders 34% rubble
Mean Instream Cover:	15% inundated vegetation
Riffle/Pool Ratio of Transects:	20% riffle 80% shallow pool
Mean Bank Overstory Cover:	63% trees 41% shrubs
Mean Bank Ground Cover:	43% grass and forbs 47% rock 10% dirt
Mean Bank Stability:	80% stable 20% moderate
Mean Stream Canopy:	0% canopy
Comments:	

Lee Creek has many physical characteristics that are unique to streams in the Boston Mountains Region. Stream substrate types originate from the underlying formations of sandstone. At this site, bedrock dominated, followed by rubble and boulders. Steep gradients and rock substrate result in very little instream cover from brush, trees and logs because of the higher water velocities and scouring action of springtime floods. Stream canopy is also relatively low because spring floods create wide channels and cause damage to streamside vegetation.

Macroinvertebrate Populations

One hundred twenty-three (123) taxa, representing 21 orders, were identified from the combined summer and spring samples of the benthic community. Numerically, the dominant orders, Ephemeroptera, Trichoptera, Coleoptera and Diptera, comprised 32.8%, 16.1%, 13.3% and 12.0% of the benthic organisms, respectively (Table A-36, Appendix A). Taxonomically, the distribution of taxa closely followed the same pattern as above with mayflies, dipterans, beetles, odonates and caddisflies represented by 23, 13, 17, 15 and 12 taxa, respectively. No single taxa comprised greater than 8% of the total sample. Several taxa were common to both samples and considered ecologically characteristic of a large Boston Mountains stream. These include Baetis tricaudatus, Chimarra obscura, Corydalus cornutus, Hagenis brevistylus, Helicopsyche borealis, Hetaerina, Isonychia, Psephenus herricki and Stenonema terminatum.

The qualitative similarity indices reflected the seasonal variation characteristic of macroinvertebrate populations (Table B-28). Several taxa were present in both samples; however, significant differences in the community structure of each sample were evident from the 123 taxa identified from the combined samples. Ninety-seven (97) and 84 taxa were identified from the summer and spring samples, respectively. The 58 taxa identified from both samples comprised 67.4% of all organisms collected. The 39 and 26 taxa unique to the summer and spring samples comprised 18.1% and 48.6% of their respective samples.

Summer - The dominant orders of the summer sample were Ephemeroptera (24.6%), Diptera (20.6%), Trichoptera (20.0%) and Coleoptera (17.8%). Only Chimarra obscura (a caddisfly) comprised greater than 10% of the summer sample. Other taxa unique to the summer benthic community include Choroterpes, Clinotanypus, Heptagenia and Microcylloepus pusillus.

Spring - The dominant orders of the spring sample were Ephemeroptera (41.8%), Plecoptera (18.5%) and Trichoptera (11.8%). The dominant taxa of the spring benthic community were Perlesta placida (15.9%), Baetis tricaudatus (12.3%),

Serratella serratoides (9.7%) and Cheumatopsyche (7.2%). Of these, Perlesta placida and Serratella serratoides are winter-spring, coldwater species which emerge as adults in mid to late spring and were not collected in the summer sample.

The community parameters reflected a balanced, stable benthic community (Table B-28). The standing crop biomass was the second highest encountered throughout the course of this 3-year study, and the diversity (123 taxa) was the greatest. The diversity of microhabitats, variety of substrate particle size, variability of current velocity, the extensive growth of emergent vegetation in both pool and riffle areas and exceptional water quality resulted in this diverse benthic community.

Table B-28. Community Analysis of Benthic Samples from Lee Creek - 30 Minute Qualitative Sample, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total # Organisms	1919	1734	3653
Total # Taxa	97	84	123
Diversity	4.4975	4.7912	5.5432
Index of Evenness	0.4687	0.4836	0.4769
Index of Dominance	0.7337	0.7495	0.7984
Index of Variety	6.8456	7.7138	----

COMPARATIVE INDICES	
Dice Index (range 0-1)	0.64
Common Taxa Index (range 0-1)	0.60
Qualitative Similarity Index (range 0-100)	31.0

Fish Populations

Summer - Approximately ¼ mile of the stream was sampled on September 5, 1985, using the 3,500-watt electrofishing gear. Some very shallow riffles that were not accessible with the heavy gear were sampled with the 300-watt, backpack electrofishing gear. Almost all of the waters within this segment were accessible and efficiently sampled with the combination of gear within a three-hour period. Table B-29 lists the 37 species of fish collected at this site including three species that were collected only during the spring sampling. The summer sample produced 34 species with a total relative abundance value of 203.5 and a diversity index of 4.81. Cyprinidae dominated the population with 32.2% of the relative abundance value. It was followed by Centrarchidae and Percidae. Normally, Percidae dominate the Boston Mountains samples; however, large and almost equal

numbers of bigeye shiner and duskystripe shiners were collected in this sample. The duskystripe shiner and the ozark minnow (also common in the sample) are both more characteristic of the Ozark Highlands and neither species was taken in other Boston Mountains samples. Primary feeding fishes comprised 13.8% of the total relative abundance and carnivores totalled 13.3%. The remainder of the population was macroinvertebrate feeders (Table B-30). Seventeen sensitive species made up 55% of the population.

Spring - Springtime sampling at this site was done with trammel nets of 1½", 2" and 2¼" mesh which were fished overnight, and approximately one hour of electrofishing in the riffles with the backpack shocker. Stream flows were estimated at 300 cfs and the water temperature was 17°C. This is a fairly typical springtime, steady-state flow. The water was clear but with a slightly greenish color. Netting produced eight fish which weighed 20 pounds. These fish represented six species including channel catfish, spotted gar and river redhorse which were not collected from the summer sample. Additionally, 13 species were collected electrofishing; all had been collected during the summer sample. Gonads of the two species of gar and the spotted bass showed obvious development toward spawning but with several weeks of maturation remaining. The redhorse had completed spawning. The stonerollers, slender madtom, fantail darters and banded darters were at or very near spawning.

Table B-29. Fishes Collected from Lee Creek with Relative Abundance Values

Species		R.A. VALUE
*Etheostoma flabellare	Fantail darter	12.0
*Notropis boops	Bigeye shiner	12.0
Campostoma anomalum	Stoneroller	12.0
*Notropis pilsbryi	Duskystripe shiner	12.0
*Micropterus dolomieui	Smallmouth bass	10.5
*Noturus exilis	Slender madtom	10.5
Lepomis megalotis	Longear	10.0
Micropterus punctulatus	Spotted bass	9.5
Notropis nubilus	Ozark minnow	9.0
Moxostoma erythrurum	Golden redhorse	9.0
*Etheostoma blennioides	Greenside darter	7.5
*Notropis greenei	Wedgespot shiner	7.5
*Moxostoma duquesnei	Black redhorse	7.5
*Notropis whipplei	Steelcolor shiner	6.0
Lepomis cyanellus	Green sunfish	6.0

Table B-29, cont.

Species		R.A. VALUE
*Etheostoma zonale	Banded darter	6.0
Micropterus salmoides	Largemouth bass	6.0
Pimephales notatus	Bluntnose minnow	5.0
*Percina nasuta	Longnose darter	5.0
Lepomis macrochirus	Bluegill	5.0
Fundulus olivaceus	Blackspotted topminnow	4.0
*Etheostoma punctulatum	Stippled darter	4.0
*Fundulus catenatus	Northern studfish	4.0
*Hypentelium nigricans	Northern hogsucker	4.0
Percina caprodes	Logperch	4.0
Labidesthes sicculus	Brook silversides	4.0
*Percina maculata	Blackside darter	2.5
Cyprinus carpio	Carp	2.0
Etheostoma whipplei	Redfin darter	2.0
Lepomis humilis	Orangespotted sunfish	1.0
Lepisosteus osseus	Longnose gar	1.0
*Etheostoma stigmaeum	Speckled darter	1.0
Fundulus notatus	Blackstripe topminnow	1.0
Etheostoma spectabile	Orangethroat darter	1.0
Ictalurus punctatus	Channel catfish	S
Lepisosteus oculatus	Spotted gar	S
*Moxostoma carinatum	River redhorse	S

*Sensitive species
S - collected in spring sample only

Table B-30. Summary of Fish Population Parameters from Lee Creek

Total Species Collected	37.0
Total Number of Individuals	1943.0
Total Relative Abundance Value	203.5
Relative Abundance Diversity Index	4.81

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	8.0	32.2
CATOSTOMIDAE	4.0	10.1
ICTALURIDAE	2.0	5.2
CENTRARCHIDAE	7.0	23.3
PERCIDAE	10.0	22.1
Primary Feeders	4.0	13.8
Macroinvertebrate Feeders	27.0	72.9
Carnivores	6.0	13.3
Sensitive Species	17.0	55.0

MULBERRY RIVER

The Mulberry River has its headwaters in southern Madison County and meanders in an southwesterly direction until it joins the Arkansas River near the city of Mulberry.

The site selected for study on the Mulberry River was a large pool and short riffle at a county road that is in Section 6, R 29 W, T 12 N (Figure B-26). This site was chosen as best representing a large Boston Mountains stream during a low-flow, high-temperature situation. The site was the only access to the river for many miles upstream.

General Site Discussion

Watershed Size - The watershed size above the point of sampling was 373 mi^2.

Geology - The Atoka formation of Pennsylvanian Age underlies the watershed. The valley containing the stream itself is underlain in some areas by small amounts of the Bloyd Shale Formation.

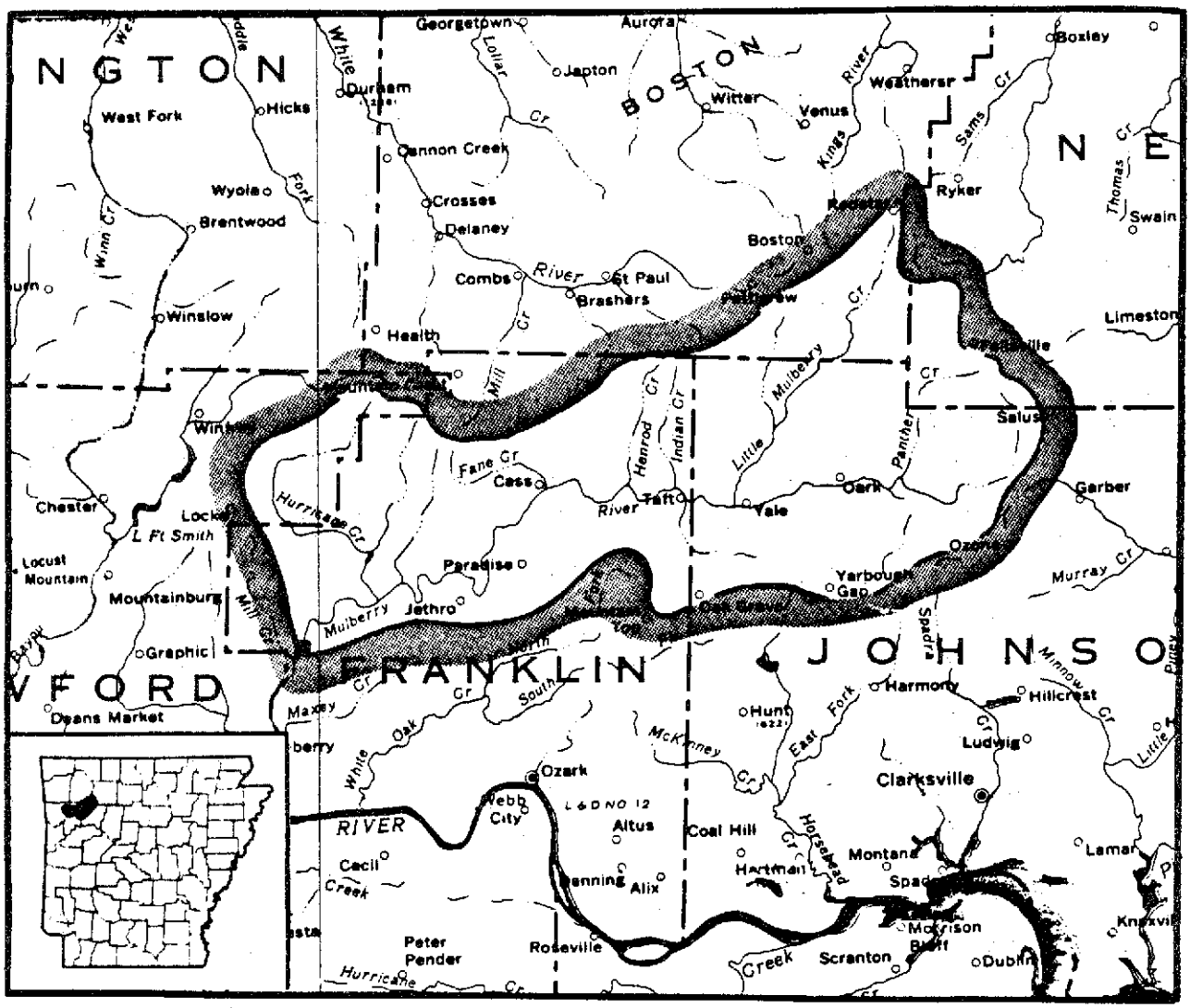
Topography - The Mulberry River basin can generally be described as very mountainous with sheer bluffs and narrow valleys along the major tributaries. The topography is very steep to gently sloping terrain with moderately sloping to level stream valleys. The Boston Mountains Region has the most relief of any area in the state and the least amount of level land, which results in streams in the region having very high gradients. Elevation varies from near 750 to 2000 feet msl. Stream gradient at the sample site was 13.7 ft/mile.

Soil Type - The Nella-Enders-Mountainburg association is located in the upland portions of the basin. This soil type is well-drained, moderately steep to very steep, deep and shallow, gravelly, fine, sandy loam to clay loam subsoil. The pH ranges from moderately acid to slightly acid (pH 5.1 to 6.0). Potential for erosion is moderate to severe.

The Cleora-Dubbs association is found in the stream valley. It is well-drained, nearly level to gently sloping, fine sandy loam to clay loam subsoil. Erosional potential is slight. The pH ranges from moderately acid to slightly acid (pH 6.0 to 6.5). Stream pH in the three samples collected ranged from 7.0 to 7.1, which was considerably different from the soil.

Flora - Steep upland portions of the basin are covered with hardwood forests comprised of red and black oaks, red cedar and shortleaf pine. Streamside riparian zones are rich in tree variety. Observed during the survey were sweetgum, sycamore, river birch, shortleaf pine, red cedar river alder and red maple.

Figure B-26



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

MULBERRY RIVER: Drainage area 373 square miles ● Survey site ▒ Survey area

Land Use - Data specific to the Mulberry River basin was collected by the S.C.S. in their statewide RIDS survey, and indicated that 91% of the land is in forests and 8% is in pastureland. The majority of the watershed is within the boundaries of the Ozark National Forest. This has contributed to the low level of disturbance in the basin. The steep, mountainous terrain in the Boston Mountains Region is largely undeveloped, except for the occasional cutting of hardwood timber. The river has been declared by this department to have extraordinary recreational and aesthetic value to the state.

Stream Characteristics - Watershed size at this site was considered to be a large size stream under the criteria used in this project. Even so, streams in the Boston Mountains region require a large River drainage basin to maintain a year-round flow, and as a result, the Mulberry River has a Q_{7-10} flow of zero at the survey site. In any average drought year, the stream ceases to flow between the pools but the deep pools manage to last until the rainy season. The aquatic community is well adapted to these variations in the flow regime. The Mulberry River is best described as a clean, rocky, mountainous stream. The most striking characteristics of the creek are the rocky substrate, steep gradient and blue-green water. Other characteristics of note are the large number of riffles, low percentage of instream cover and relatively low percentage of stream canopy.

Methodology and Sampling Results

The summer survey of the Mulberry River was conducted during the week of September 2-6, 1985. The spring survey was conducted during the week of May 6, 1986. Conditions during the summer survey were excellent. The weather was hot and dry throughout the week. Stream flow was low, around 6.4 cfs, and did not vary significantly over the week.

Spring conditions were also excellent, which is unusual for spring in Arkansas. Stream flow was estimated at 300 cfs and changed very little during the week. The spring survey seemed to catch the river in a steady-state, spring flow condition, which was the goal of the project.

Continuous Dissolved Oxygen

Summer - Conditions during the summer survey exemplified the typical high temperature, low flow situation. Temperature peaked at 29°C during the week which is close to the expected maximum. Overall, the data acquired should closely represent the annual worse case situation for dissolved oxygen.

The minimum D.O. observed for the week was 6.0 mg/l and the maximum was 7.9, giving a range of 1.9 mg/l (Figures B-27 and B-28). The daily cycle for D.O. observed in the Mulberry River

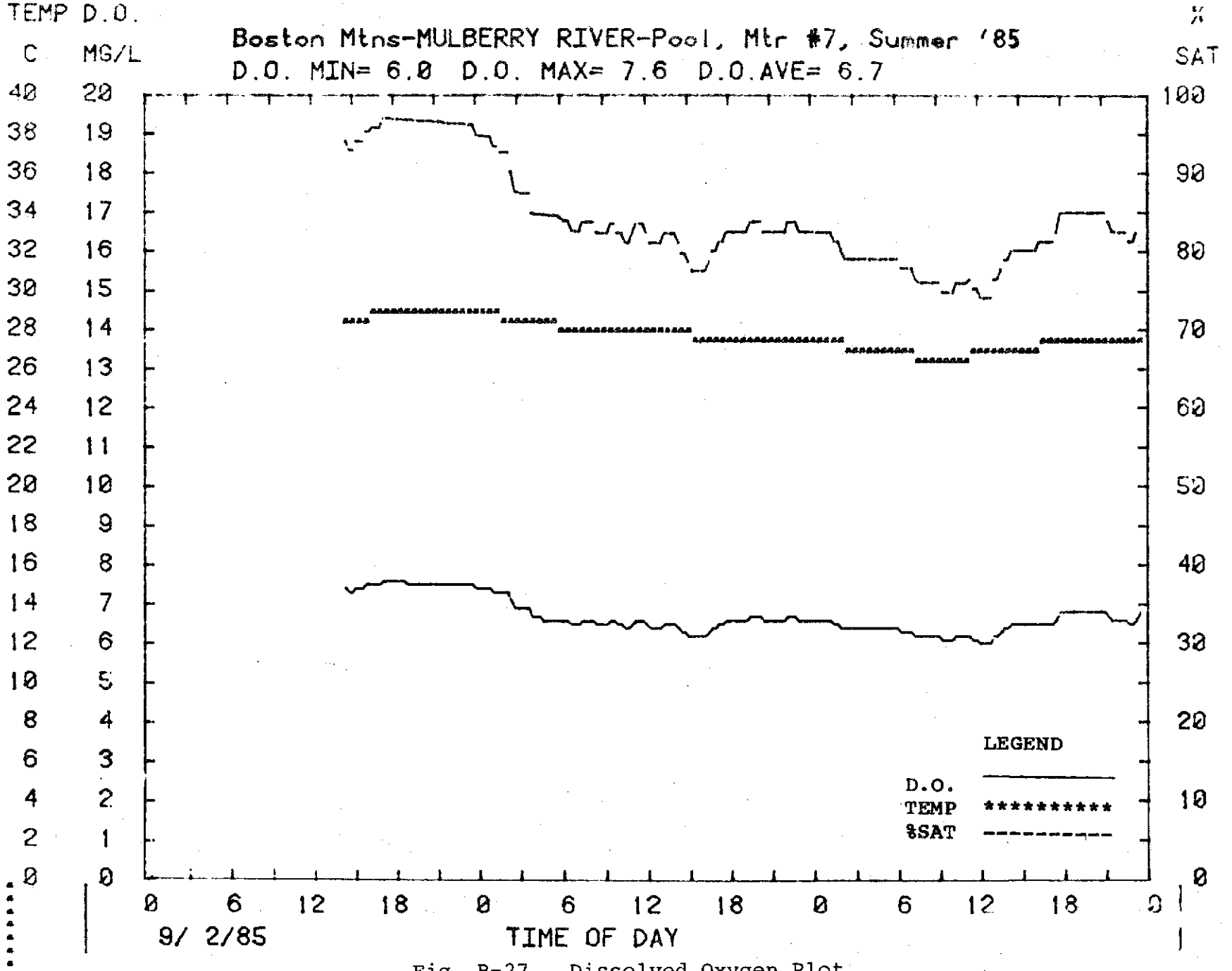


Fig. B-27. Dissolved Oxygen Plot

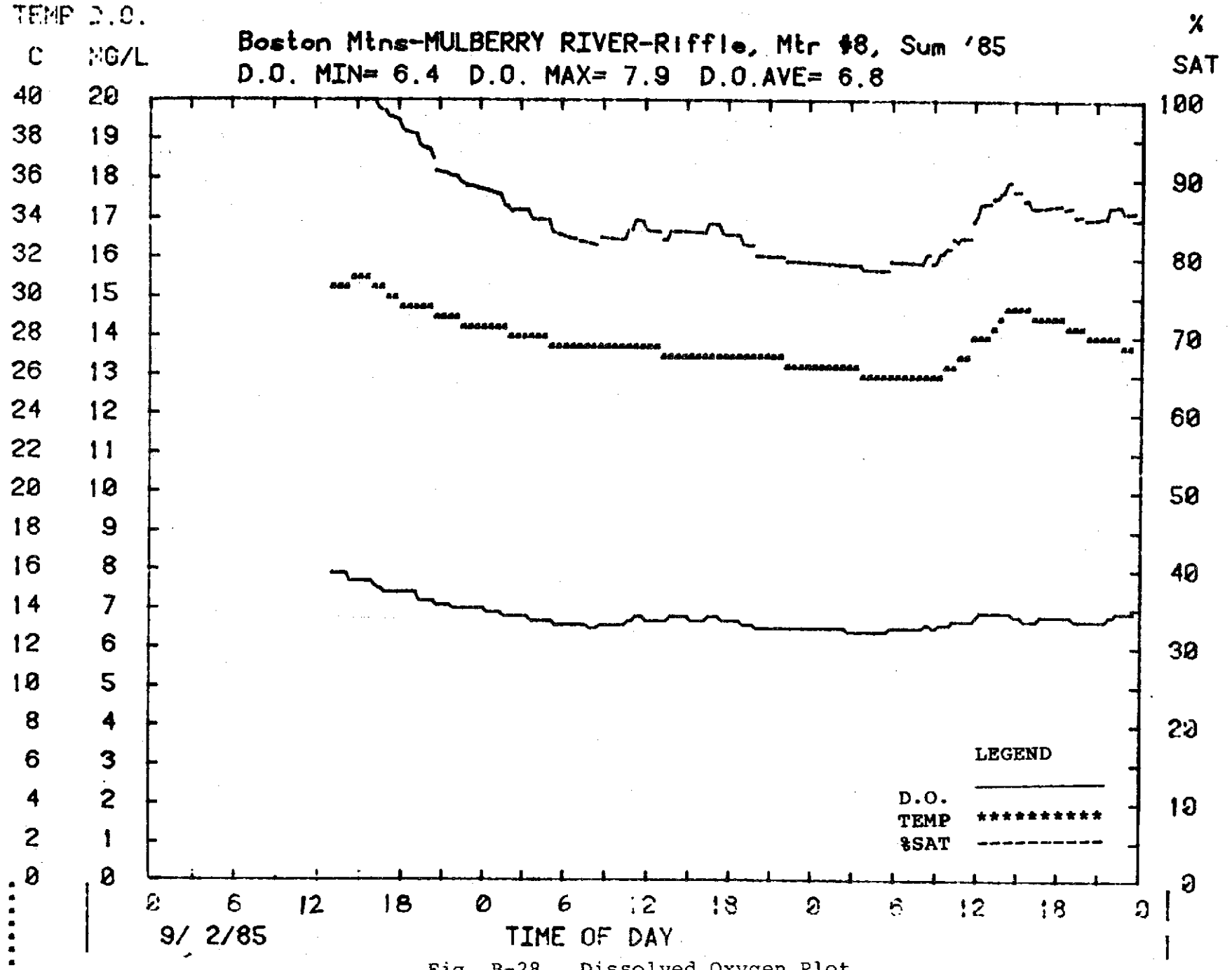


Fig. B-28. Dissolved Oxygen Plot

was considerably different from that of the smaller streams in this region. In those, the cycle was directly related to energy supplied by the sun because flow was low to non-existent and the pools were shallow. In the Mulberry River, the daily variation in D.O. was small and did not seem to vary in accordance with the sun. The cause of this may have been the substantial flow and the considerable depth of the pools. Phytoplankton was very low and the depth of the pools precluded large periphyton production. This kept the effects of photosynthesis to a minimum. With the flow being relatively high, reaeration became the dominant factor in controlling D.O. and therefore was not impacted by the diurnal cycle.

D.O. saturation percentages ranged from 75% to 100%. Water temperature was very steady over the week, with only a minimal change being observed as a result of the sun, because the pools involved were large and deep. Temperature varied less than 2°C for the week.

Spring - The spring sampling showed much higher levels of dissolved oxygen (Figures B-29 and B-30). The minimum value recorded was 8.5 mg/l and the maximum was 9.7 mg/l. The percent saturation values ranged from 90% to 100%. Temperatures ranged from 18° to 20°C on a daily cycle. Higher springtime D.O. values were directly related to higher flows and lower temperatures.

Chemical Parameters

Spring and summer coliform counts were 8 and 72 colonies, respectively. Both values are low and indicative of very little disturbance or activity in the basin.

Chemical data collected for the summer and spring surveys are displayed in Tables B-31 and B-32. Of special interest are the extremely low nutrient levels, low turbidity, low suspended solids and neutral pH. Each of these parameters are related to the geology and soil characteristics of the basin and low level of disturbance in the Mulberry River watershed. Hardwood forests cover 91% of the basin and are very rarely disturbed by timber-cutting operations. As a result, turbidity and suspended solid values are low, and nutrients that would be attached to soil particles are not present. Streams throughout the Boston Mountains Region are heavily used for recreation as a result of these physical characteristics.

Physical Parameters

Ten transects were analyzed for physical characteristics of the stream (Table B-33). The Mulberry River has many physical characteristics that are unique to streams in the Boston Mountains Region. Stream substrate originates from the underlying formations of sandstone. Substrate type was dominated

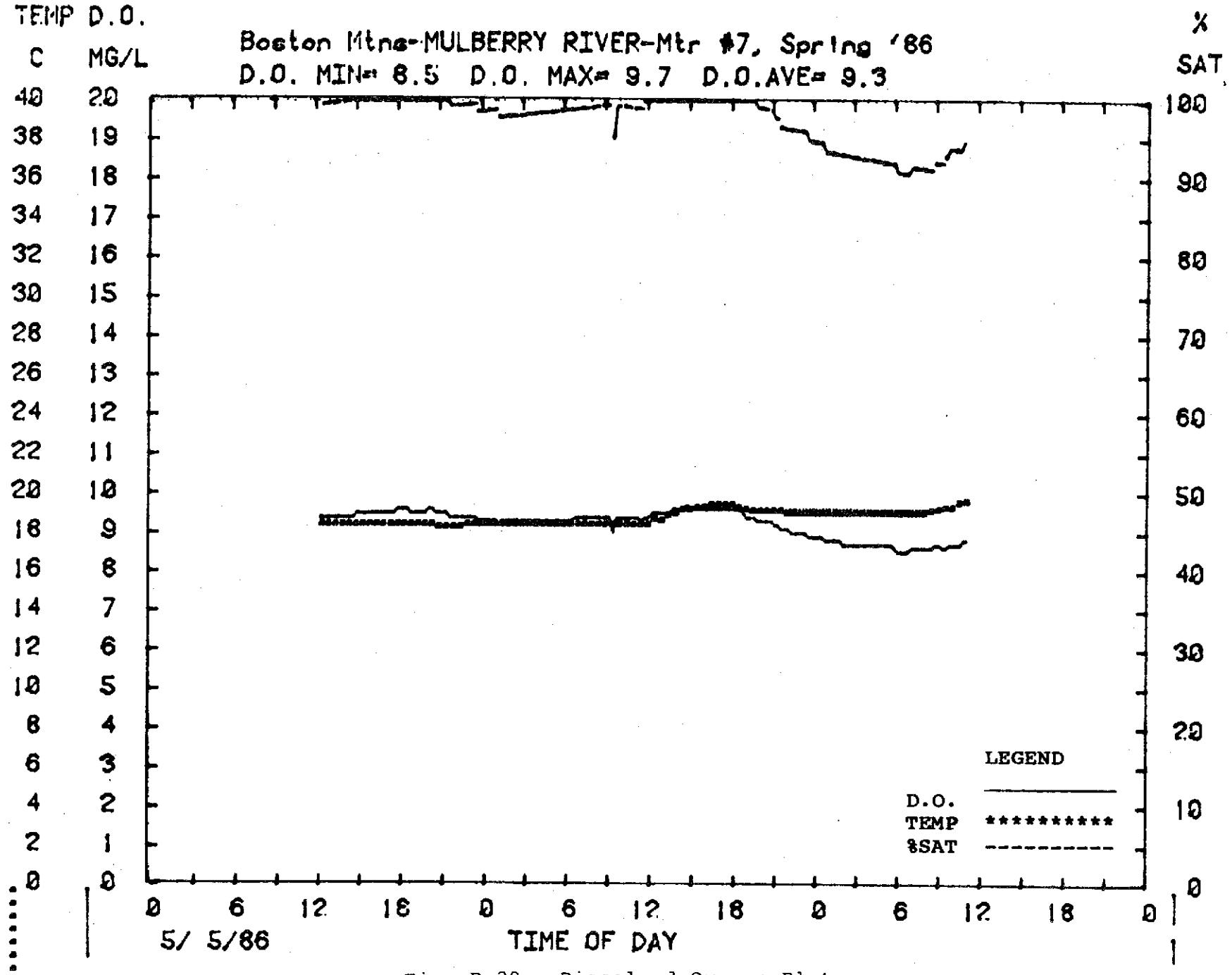


Fig. B-29. Dissolved Oxygen Plot

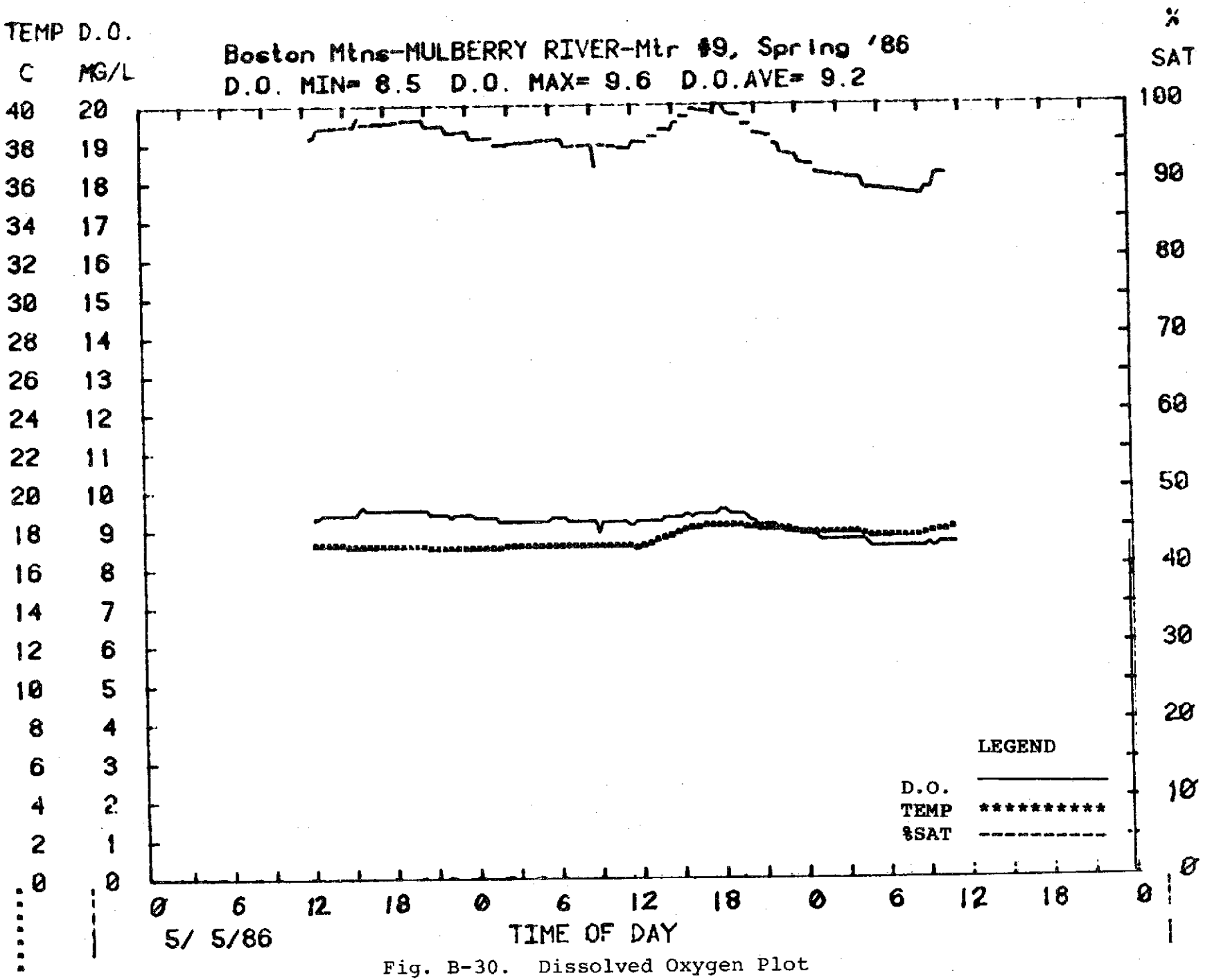


Fig. B-30. Dissolved Oxygen Plot

Table B-31

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Mulberry River

Drainage Area: 373 Square Miles

Station Description: County road ford in Sec 6, T 10 N, R 28 W, Franklin County

Date: September 3, 1985

PARAMETER	TIME COLLECTED			AVERAGE
	09:00	09:45	11:40	
Q, cfs	6.4	6.4	6.4	6.4
Temperature, °C	28	28	28	28
pH	7.3	7.3	7.4	7.3
Turbidity, ntu	2	2	2	2
TSS, mg/l	4	6	6	5
TDS, mg/l	43	33	37	38
BOD-5, mg/l	1.0	1.2	.7	1.0
BOD-20, mg/l	1.7	2.2	1.3	1.7
T.Phos., mg/l	0.03	0.03	0.03	0.03
PO4-P, mg/l	<0.01	<0.01	<0.01	<0.01
NO2+NO3-N, mg/l	0.01	0.01	0.01	0.01
NH3-N, mg/l	<0.01	0.01	<0.01	<0.01
Cl -, mg/l	3	3	3	3
SO4 =, mg/l	5	5	5	5
Fe, mg/l	0.15	0.17	0.16	0.16
Conductivity, μmho	54	52	52	53
Alkalinity, mg/l	20	20	20	20
T. Hardness, mg/l	20	18	20	19
Chlorophyll a μg/l	2.1	0.5	1.5	1.3
Fecal Coliform	-	-	72	72

Dissolved Oxygen Data for 4 Sep 1985		
	Riffle	Pool
Average	6.6	6.4
Minimum	6.4	6.0
Maximum	6.9	6.8

Table B-32

STREAM RECLASSIFICATION SURVEY

Chemical Results

Physiographic Region: Boston Mountains

Stream: Mulberry River

Drainage Area: 373 square miles

Station Description: West of county road in Section 6, R 29 W, T 12 N Franklin County

Date: May 6, 1986

PARAMETER	TIME COLLECTED 09:00	09:50	13:15	AVERAGE
Q, cfs	-	-	-	250 est.
Temperature, °C	18.5	18.5	19	18.5
pH	7.07	7.14	7.11	7.1
Turbidity, ntu	7	7	7	7
TSS, mg/l	2	4	2	2.7
TDS, mg/l	28	24	27	26.3
BOD-5, mg/l	0.6	0.6	0.6	0.6
BOD-20, mg/l	1.1	1.3	1.2	1.2
T.Phos., mg/l	.05	.05	.05	.05
PO4-P, mg/l	.01	.01	na	.01
NO2+NO3-N, mg/l	.05	.05	.04	.05
NH3-N, mg/l	.01	<.01	<.01	.01
Cl -, mg/l	2.5	2.0	2.5	2.3
SO4 =, mg/l	3	5	<1	3
Fe, mg/l	-	-	-	-
Conductivity, µmho	34	32	32	32.7
Alkalinity, mg/l	12	12	12	12
T. Hardness, mg/l	14	12	14	13.3
Chlorophyll a, µg/l	-	-	.27	.27
Fecal Coliform	-	-	8	8

Dissolved Oxygen Data for May 6, 1986		
Average	9.3	
Minimum	8.5	
Maximum	9.7	

Table B-33

STREAM RECLASSIFICATION SURVEY

Physical Results

Stream:	Mulberry River
Date:	9/31/85
Drainage Area:	389 square miles
Watershed Land Use:	10% Agriculture 90% Forest
Stream Gradient:	13.7 fpm
Mean Channel Width:	259 feet
Mean Stream Width:	141 feet
Mean Stream Velocity:	NA
Observed Flow:	6.4 CFS
Average Substrate Type:	56% bedrock 12% large boulders 6% boulders 19% rubble 7% gravel
Mean Instream Cover:	2% brush, logs, debris 0.5% undercut bank
Riffle/Pool Ratio of Transects:	20% riffles 20% shallow pools 60% deep pools
Mean Bank Overstory Cover:	85% trees 14% shrubs
Mean Bank Ground Cover:	74% grass and forbs 26% dirt
Mean Bank Stability:	100% stable
Mean Stream Canopy:	15% canopy
Comments:	

by bedrock, rubble and large boulders. Steep gradients and rock substrate result in very little instream cover because of high water velocities during floodstage flows. Stream canopy is generally less than that of lower gradient streams because spring floods create wide channels and cause damage to streamside vegetation. Stream canopy is also inversely related to stream size since a wide stream channel may exceed the maximum canopy of trees.

Macroinvertebrate Populations

One hundred three (103) taxa, representing 20 orders, were identified from the combined summer and spring benthic samples (Table A-37, Appendix A). Numerically, the dominant orders were Ephemeroptera, Odonata, Trichoptera, Diptera and Coleoptera comprising 22.4%, 13.2%, 13.0%, 12.7% and 10.6% of the sample, respectively. Taxonomically, the dominant orders were Ephemeroptera and Coleoptera. No organisms comprised greater than 10% of the numeric total and only Ischnura (9%) and Isonychia (5%) comprised greater than 5%, numerically. Several taxa, not numerically dominant, were common in both summer and spring samples and are considered ecologically characteristic of the larger Boston Mountains streams. These include Ceraclea tarsi-punctatus, Chimarra obscura, Corydalus cornutus, Helichus, Psephenus herricki, Stenelmis exigum, Stenonema femoratum, Stenonema terminatum and Tricorythodes.

The comparative indices of the summer and spring samples indicated that the two samples were very similar taxonomically (Table B-34). However, seasonal variation accounted for significant differences between the benthic communities. Of the 101 taxa identified, 73 and 80 taxa were identified from the summer and spring samples, respectively. Of those, 50 taxa were present in both samples, comprising 74% of the organisms identified. The 23 and 30 taxa unique to the summer and spring samples accounted for 17.9% and 34.8% of the organisms collected from these respective samples. The low similarity index reflects the shift from summer, warm water forms to spring, cold water insect taxa and the accompanying levels of development among those taxa.

Summer - The dominant orders of the summer sample were mayflies (20.8%), Odonates (17.4%) and caddisflies (14.8%). Taxonomically, very uniform distribution was exhibited by the summer sample, in that 4 orders were represented by 10 or more taxa. Taxa that were not numerically dominant but considered ecologically characteristic of larger Boston Mountains streams and unique to the summer sample included Ectopria, Ephemera simulans, Stenonema exiguum and Stenonema mediopunctatum.

Spring - Although different in sequence, the dominant orders of the spring benthic community were the same as those of the combined sample. Ecologically characteristic taxa unique to the spring sample included Eurylophella temporalis, Helicopsyche borealis, Hetaerina, Perlesta placida, Rhithrogena pellucida and Wormaldia.

The taxonomic diversity and the uniform distribution of taxa among several orders resulted in very high diversity indices (Table B-34). The benthic diversity not only reflects the microhabitat availability, but the presence of numerous taxa which have been characterized as indicators of excellent water quality. The indices of variety and evenness also reflect the balance and stability of the benthic communities.

Table B-34. Community Analysis of Benthic Samples from Mulberry River - 30 Minute Qualitative Sample, 1985-1986

COMMUNITY PARAMETERS	Summer	Spring	Combined
Total Organisms	958	879	1837
Total Taxa	73	80	103
Diversity	5.1480	5.6137	5.8295
Index of Evenness	0.4195	0.4537	0.4326
Index of Dominance	0.8317	0.8880	0.8718
Index of Variety	7.2698	8.0779	9.4068
COMPARATIVE INDICES			
Dice Index (range 0-1)		0.65	
Common Taxa Index (range 0-1)		0.63	
Qualitative Similarity Index (range 0-100)		36.0	

Fish Populations

Summer - Approximately ½ mile of the stream was sampled with the 3,500-watt electrofishing generator. The depth of some of the pools prohibited working the entire area and slowed the progress in other areas. About four hours were spent collecting which yielded 1410 fish from 29 species. Table B-35 lists all species collected at this site including the five additional species collected the following spring. The total relative abundance value for the summer collection was 184 with a diversity index of 4.55. Cyprinidae made up 28% of the total population. This was followed by Percidae and Centrarchidae. The trophic feeding level of the fishes was dominated by macroinvertebrate feeders. Five species of primary feeders made up 12.5% and six species of carnivores made up 14.7% of the total population (Table B-36). One-half of the population relative abundance was composed of 13 sensitive species.

Spring - Both trammel nets and electrofishing were used to sample the area on May 6, 1986. Three trammel nets of 1½", 2" and 2½" square mesh were set overnight. They collected 20 fish of seven species weighing 67.5 pounds. Four species were netted which were not collected the previous summer. Also, one species, the orangethroat darter, was collected electrofishing in the spring and had not been collected in the summer. Streamflow was estimated to be about 300 cfs and the water temperature ranged from 17° to 18°C. River redhorse had completed spawning, carp and one smallmouth buffalo were in the spawning process and largemouth bass, spotted bass and longnose gar were in advanced stages of gonad maturation in preparation for spawning.

Table B-35. Fishes Collected from Mulberry River with Relative Abundance Values

Species		R.A. VALUE
*Notropis boops	Bigeye shiner	12.0
*Noturus exilis	Slender madtom	12.0
*Etheostoma flabellare	Fantail darter	12.0
Campostoma anomalum	Stoneroller	12.0
Lepomis megalotis	Longear	12.0
Lepomis cyanellus	Green sunfish	10.5
*Notropis greenei	Wedgespot shiner	9.0
Pimephales notatus	Bluntnose minnow	9.0
*Etheostoma blennioides	Greenside darter	9.0
Micropterus punctulatus	Spotted bass	9.0
*Etheostoma zonale	Banded darter	9.0
*Hypentelium nigricans	Northern hogsucker	8.5
*Notropis whipplei	Steelcolor shiner	7.5
Percina caprodes	Logperch	7.5
Ictalurus punctatus	Channel catfish	7.0
Micropterus salmoides	Largemouth bass	6.0
*Percina nasuta	Longnose darter	6.0
Fundulus olivaceus	Blackspotted topminnow	5.0
*Micropterus dolomieui	Smallmouth bass	4.0
Moxostoma erythrurum	Golden redhorse	3.0
*Percina maculata	Blackside darter	2.0
Labidesthes sicculus	Brook silversides	2.0
Cyprinus carpio	Carp	2.0
Etheostoma whipplei	Redfin darter	2.0
Lepomis macrochirus	Bluegill	2.0
Pylodictis olivaris	Flathead catfish	1.0
*Percina copelandi	Channel darter	1.0
Lepomis gulosus	Warmouth	1.0
Aplodinotus grunniens	Freshwater drum	1.0
Etheostoma spectabile	Orangethroat darter	S
*Moxostoma carinatum	River Redhorse	S
Lepisosteus osseus	Longnose gar	S
Ictiobus bubalus	Smallmouth buffalo	S
Carpiodes carpio	River carpsucker	S

*Sensitive species
S - Collected in spring sample only

Table B-36. Summary of Fish Population Parameters from Mulberry River

Total Species Collected	34.0
Total Number of Individuals	1410.0
Total Relative Abundance Value	184.0
Relative Abundance Diversity Index	4.55

Population Parameters	No. Sp.	% R.A.V.
CYPRINIDAE	6.0	28.0
CATOSTOMIDAE	5.0	6.3
ICTALURIDAE	3.0	10.9
CENTRARCHIDAE	7.0	24.2
PERCIDAE	8.0	26.4
Primary Feeders	5.0	12.5
Macroinvertebrate Feeders	22.0	72.8
Carnivores	6.0	14.7
Sensitive Species	13.0	50.0

APPENDIX A

Table A-1. Benthic Community of Boat Gunwale Slash Delta Ecoregion Qualitative Sample (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**22**	**10**	**71**	**30**	**93**	**21**
Hydrovatus	3	1	18	8	21	5
Uvarus			21	9	21	5
Copelatus c. princeps	2	1	16	7	18	4
Peltodytes	10	5	3	1	13	3
Gyrinus			5	2	5	1
Berosus	2	1	1	0	3	1
Laccornis	2	1	1	0	3	1
Hydrochus	3	1			3	1
Dineutus (larvae)			1	0	1	0
Haliplus			1	0	1	0
Hydroporus			1	0	1	0
Laccodytes			1	0	1	0
Prionocyphon			1	0	1	0
Tropisternus m. mexicanus			1	0	1	0
AMPHIPODA	**2**	**1**	**54**	**23**	**56**	**12**
Gammarus fasciatus			54	23	54	12
Hyalella azteca	2	1			2	0
ISOPODA	**35**	**16**	**19**	**8**	**54**	**12**
Lirceus lineatus	34	16	18	8	52	12
Asellus sp.	1	0	1	0	2	0
DIPTERA	**32**	**15**	**17**	**7**	**49**	**11**
Tribelos	11	5	2	1	13	3
Chironomus	11	5			11	2
Clinotanypus	8	4			8	2
Tipula			5	2	5	1
Ablabesmyia			4	2	4	1
Bezzia	1	0	1	0	2	0
Polypedilum			2	1	2	0
Tabanus			2	11	2	0
Cryptochironomus	1	0			1	0
Stratiomys			1	0	1	0
EPHEMEROPTERA	**38**	**18**			**38**	**8**
Caenis	19	9			19	4
Centroptilum rufostrigatum	15	7			15	3
Hexagenia limbata	4	2			4	1

Table A-1, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HEMIPTERA	**22**	**10**	**13**	**6**	**35**	**8**
Plea striola	15	7	1	0	16	4
Corxidae			10	4	10	2
Gelastocoris	2	1			2	0
Gerris			1	0	1	0
Mesovelia mulsanti	1	0			1	0
Ranatra australis			1	0	1	0
Ranatra bueno	1	0			1	0
Rheumatobates	1	0			1	0
ANNELIDA	**6**	**3**	**22**	**10**	**28**	**6**
Oligochaeta	2	1	21	10	23	5
Mooreobdella microstoma	2	1			2	1
Mooreobdella anoculata			1	0	1	0
Philobdella gracilis	1	0			1	0
Placobdella ornata	1	0			1	0
DECAPODA	**19**	**9**	**8**	**3**	**27**	**6**
Palaemonetes kadiakensis	19	9	8	3	27	6
GASTROPODA	**17**	**8**	**8**	**3**	**25**	**6**
Viviparus	11	5	3	1	14	3
Physa	4	2	4	2	8	2
Helisoma	1	0	1	0	2	0
Ferrissia	1	0			1	0
COLLEMBOLA			**12**	**5**	**12**	**3**
Isotomurus palustris			12	5	12	3
ODONATA	**8**	**4**	**4**	**2**	**12**	**3**
Ischnura	5	2			5	1
Libellula pulchella	1	0	1	0	2	0
Dromogomphus spoliatus	1	0			1	0
Enallagma	1	0			1	0
Lestes			1	0	1	0
Libellula vibrans			1	0	1	0
Nasiaeschna pentacantha			1	0	1	0
PELECYPODA	**6**	**3**	**6**	**3**	**12**	**3**
Pisidium	6	3	6	3	12	3
MEGALOPTERA	**8**	**4**	**1**	**0**	**9**	**2**
Sialis	8	4	1	0	9	2
Total # Organisms	215		235		450	
Total # Taxa	38		40		59	

*0 - actual value < 1.0 but > 0.0

Table A-2. Benthic Community of Second Creek
Delta Ecoregion
30-minute Qualitative Samples (# org./sample), 1984-85

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**136**	**9**	**650**	**43**	**786**	**28**
Caenis	128	9	403	26	532	14
Stenacron interpunctatum	4	0	216	14	220	6
Hexagenia limbata			31	2	31	1
Centroptilum	4	0			4	0
AMPHIPODA	**509**	**37**	**244**	**16**	**753**	**26**
Gammarus fasciatus	509	37	79	5	588	20
Gammarus minus			124	8	124	4
Hyalella azteca			41	2	41	1
DECAPODA	**230**	**16**	**117**	**7**	**347**	**12**
Palaemonetes kadiakensis	189	13	97	6	286	9
Orconectes	36	2			36	1
Cambarinae			18	1	18	0
Orconectes meeki brevis	4	0			4	0
Procambarus acutus			2	0	2	0
Orconectes neglectus	1	0			1	0
HETERODONTIDA	**178**	**13**	**65**	**4**	**243**	**8**
Corbicula flueminia	178	13	59	3	237	8
Leptodea			3	0	3	0
Pisidium			3	0	3	0
DIPTERA	**64**	**4**	**79**	**5**	**143**	**4**
Thienemanniella			29	1	29	1
Coelotanypus	24	1			24	0
Cryptochironomus	6	0	15	1	21	0
Polypedilum sp. b			21	1	21	0
Procladius	11	0			11	0
Palpomyia tibialis	10	0			10	0
Tribelos	8	0			8	0
Phaenopsectra			5	0	5	0
Chironomus			4	0	4	0
Polypedilum sp. a	4	0			4	0
Tanytarsus			3	0	3	0
Tanypus			2	0	2	0
Haematopota	1	0			1	0

Table 7-2, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPERA	**38**	**2**	**96**	**6**	**134**	**4**
Peltodytes	11	0	21	1	32	1
Stenelmis lateralis			18	1	18	0
Thermonectus basillaris			17	1	17	0
Dineutus assimalis			14	0	14	0
Hydrovatus			11	0	11	0
Stenelmis sexlineata	8	0			8	0
Scirtes	6	0	1	0	7	0
Stenelmis (larva)			7	0	7	0
Peltodytes (larva)	6	0			6	0
Berosus (larva)	1	0	4	0	5	0
Dineutus ciliatus	3	0			3	0
Stenelmis humerosus	3	0			3	0
Gyrinus			2	0	2	0
Deronectes			1	0	1	0
ODONATA	**75**	**5**	**39**	**2**	**114**	**3**
Epitheca princeps	27	1			27	0
Argia	19	1	3	0	22	0
Ischnura			13	0	13	0
Neurocordulia xanthosoma	11	0	1	0	12	0
Gomphus vastus	9	0			9	0
Macromia	6	0	2	0	8	0
Perithemis tenera	8	0			8	0
Boyeria vinosa	6	0			6	0
Dromogomphus spoliatus			4	0	4	0
Enallagma			3	0	3	0
Lestes			2	0	2	0
ISOPODA	**35**	**2**	**50**	**3**	**85**	**2**
Lirceus hoppinae	35	2			35	1
Asellus intermedius			26	1	26	0
Lirceus garmani			16	1	16	0
Asellus communis			8	0	8	0
HEMIPTERA	**46**	**3**	**34**	**2**	**80**	**2**
Corixidae	45		8	0	53	1
Trichocorixa	21	1			21	0
Belostoma	2	0			2	0
Hydrometra martini			2	0	2	0
Gerris			1	0	1	0
Ranatra fusca	1	0			1	0

Table A-2, cont.

TAXA	Summer # org.	%	Spring # org.	%	Combined # org.	%
BASOMMATOPHORA	**14**	**1**	**54**	**3**	**68**	**2**
Gyraulus	6	0	31	2	37	1
Ferrissia	3	0	12	0	15	0
Physa	4	0	8	0	12	0
Helisoma			3	0	3	0
Lymnaea	1	0			1	0
TRICHOPTERA	**11**	**0**	**34**	**2**	**45**	**1**
Cheumatopsyche			32	2	32	1
Oecetis cinerascens	7	0			7	0
Setodes	3	0			3	0
Hydroptila			1	0	1	0
Oecetis arva			1	0	1	0
Pycnopsyche subfasciata	1	0			1	0
MEGALOPTERA	**26**	**1**	**4**	**0**	**30**	**1**
Sialis	26	1	4	0	30	1
OLIGOCHAETA			**19**	**1**	**19**	**0**
Oligochaeta			19	1	19	0
RHYNCHOBDELLIDA	**2**	**0**	**4**	**0**	**6**	**0**
Helobdella stagnalis	1	0	3	0	4	0
Helobdella fusca	1	0			1	0
Placobdella parasitica			1	0	1	0
PHARYNGOBDELLIDAE	**3**	**0**	**2**	**0**	**5**	**0**
Mooreobdella microstoma	3	0	2	0	5	0
PROSOPORA			**4**	**0**	**4**	**0**
Lumbriculus inconstans			4	0	4	0
HAPLOTAXIDA			**2**	**0**	**2**	**0**
Dero			2	0	2	0
ACARINA	**1**	**0**			**1**	**0**
Neumania	1	0			1	0
MESOGASTROPODA			**1**	**0**	**1**	**0**
Amnicola			1	0	1	0
Total # Organisms	1368		1498		2866	
Total # Taxa	44		59		86	

*0 - actual value < 1.0 but > 0.0

Table A-3. Benthic Community of Village Creek
Delta Ecoregion
30-minute Qualitative Samples (# org./sample), 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**187**	**22**	**299**	**30**	**486**	**26**
Caenis	142	17	265	26	407	22
Stenacron interpunctatum	26	3	20	2	46	2
Hexagenia limbata	18	2	14	1	32	1
Centroptilum	1	0			1	0
COLEOPTERA	**220**	**27**	**104**	**10**	**324**	**17**
Peltodytes	79	9	19	1	98	5
Uvarus	56	6	21	2	77	4
Berosus styliferus	34	4	4	0	38	2
Dineutus assimalis	17	2			17	0
Hydroporus sp.	1	0	16	1	17	0
Gyrinus			12	1	12	0
Peltodytes (larva)	7	0	2	0	9	0
Deronectes	6	0	1	0	7	0
Dineutus carolinus			7	0	7	0
Hydrovatus	6	0	1	0	7	0
Macronychus glabratus			7	0	7	0
Phytobius	4	0			4	0
Scirtes	3	0	1	0	4	0
Stenelmis sexlineata	1	0	3	0	4	0
Berosus (larva)			3	0	3	0
Coptotomus	3	0			3	0
Donacia			3	0	3	0
Haliplus			2	0	2	0
Tropisternus (larva)	2	0			2	0
Tropisternus ellipticus			2	0	2	0
Liodessus	1	0			1	0
AMPHIPODA	**24**	**2**	**213**	**21**	**237**	**13**
Hyalella azteca	24	2	198	19	222	12
Gammarus fasciatus			9	0	9	2
Crangonyx gracilis			6	0	6	0
DECAPODA	**89**	**10**	**100**	**10**	**189**	**10**
Palaemonetes kadiakensis	71	8	81	8	152	8
Cambarinae	11	1	14	1	25	1
Orconectes	6	0	3	0	9	0
Cambarellus shufeldtii	1	0	2	0	3	0
TRICHOPTERA	**112**	**13**			**112**	**6**
Phycentropus	81	9			81	4
Neolophylax	31	3			31	1

Table A-3, cont.

TAXA	Summer # org.	%	Spring # org.	%	Combined # org.	%
HEMIPTERA	**54**	**6**	**40**	**4**	**94**	**5**
Corixidae	21	2	15	1	36	1
Mesovelia mulsanti	14	1	4	0	18	0
Gerris	4	0	6	0	10	0
Hydrometra martini	3	0	4	0	7	0
Trepobates	3	0	3	0	6	0
Palmacorixa	5	0			5	0
Ranatra buenoi	1	0	4	0	5	0
Belostoma	2	0			2	0
Hesperocorixa			2	0	2	0
Plea striola			2	0	2	0
Limnoporus	1	0			1	0
DIPTERA	**19**	**2**	**6**	**6**	**7**	**4**
Chironomus	4	0	22	2	26	1
Probezzia	2	0	15	1	17	0
Ablabesmyia	13	1			13	0
Tribelos			8	0	8	0
Corynoneura			4	0	4	0
Tabanus			4	0	4	0
Cryptochironomus			3	0	3	0
Thienemanniella			2	0	2	0
Tipula			2	0	2	0
ODONATA	**22**	**2**	**55**	**5**	**77**	**4**
Macromia			14	1	14	0
Dromogomphus spoliatus	4	0	7	0	11	0
Epitheca princeps	4	0	7	0	11	0
Perithemis tenera	1	0	9	0	10	0
Enallagma	8	0	1	0	9	0
Libellula	1	0	6	0	7	0
Argia			6	0	6	0
Boyeria vinosa	2	0	1	0	3	0
Ischnura			2	0	2	0
Miathyria marcella			2	0	2	0
Dromogomphus spinosus	1	0			1	0
Neurocordulia	1	0			1	0
MEGALOPTERA	**7**	**0**	**40**	**4**	**47**	**2**
Sialis	6	0	38	3	44	2
Chauliodes	1	0	2	0	3	0

Table A-3, cont.

TAXA	Summer # org.	%	Spring # org.	%	Combined # org.	%
ISOPODA	**11**	**1**	**30**	**3**	**41**	**2**
Asellus brevicaudus			24	2	24	1
Lirceus garmani	11	1	6	0	17	0
HAPLOTAXIDA	**12**	**1**	**26**	**2**	**38**	**2**
Nais	4	0	26	2	30	1
Branchiura	8	0			8	1
BASOMMATOPHORA	**10**	**1**	**7**	**0**	**17**	**0**
Ferrissia	4	0	5	0	9	0
Physa	6	0	2	0	8	0
HETERODONTIDA	**13**	**1**			**13**	**0**
Corbicula flueminia	13	1			13	0
MESOGASTROPODA	**13**	**1**			**13**	**0**
Amnicola	13	1			13	0
PHARYNGOBDELLIDAE	**3**	**0**	**2**	**0**	**5**	**0**
Mooreobdella microstoma	3	0	2	0	5	0
RHYNCHOBDELLIDA	1	0	4	0	5	0
Helobdella stagnalis			4	0	4	0
Placobdella ornata	1	0			1	0
PROSOPORA	**4**	**0**			**4**	**0**
Lumbriculidae	4	0			4	0
Total # Organisms	814		992		1806	
Total # Taxa	58		62		81	

*0 - actual value < 1.0 but > 0.0

Table A-4. Benthic Community of Bayou DeView
Delta Ecoregion
30-minute Qualitative Samples (# org./sample), 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**246**	**32**	**229**	**21**	**475**	**25**
Palaemonetes kadiakensis	234	30	191	17	425	22
Cambarinae			35	3	41	2
Orconectes lancifer	6	0	2	0	8	0
Cambarellus shufeldtii			1	0	1	0
COLEOPTERA	**107**	**14**	**18**	**20**	**325**	**17**
Peltodytes	4	0	80	7	84	4
Uvarus	26	3	46	4	72	3
Gyrinus	15	1	11	1	26	1
Macronychus glabratus	23	3			23	1
Berosus styliferus	21	2			21	1
Hydrovatus	4	0	15	1	19	1
Stenelmis (larva)	2	0	13	1	15	0
Stenelmis sexlineata	2	0	7	0	9	0
Berosus (larva)			7	0	7	0
Dineutus americanus			7	0	7	0
Haliplus			6	0	6	0
Scirtes	4	0	2	0	6	0
Derallus			5	0	5	0
Dineutus ciliatus			5	0	5	0
Deronectes			4	0	4	0
Hydrochus	1	0	2	0	3	0
Macronychus (larva)			3	0	3	0
Tropisternis lateralus			3	0	3	0
Dubiraphia vittata	2	0			2	0
Phytobius	2	0			2	0
Celina			1	0	1	0
Coptotomus			1	0	1	0
Dineutus (larva)	1	0			1	0
AMPHIPODA	**68**	**8**	**163**	**15**	**231**	**12**
Gammarus minus	4	8	139	12	203	10
Hyalella azteca	4	0	24	2	28	1
EPHEMEROPTERA	**90**	**11**	**97**	**8**	**187**	**10**
Caenis	51	6	81	7	132	7
Stenacron interpunctatum	28	3	13	1	41	2
Hexagenia limbata	11	1			11	0
Ameletus			3	0	3	0
HEMIPTERA	**78**	**10**	**4**	**4**	**126**	**6**
Corixidae	15	1	31	2	46	2
Trichocorixa	38	4	8	0	46	2
Rheumatobates	16	2			16	0

Table A-4, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Gerris	2	0	3	0	5	0
Gelastocoris occulatus	3	0	1	0	4	0
Hydrometra martini	3	0	1	0	4	0
Belostoma			3	0	3	0
Plea striola	1	0			1	0
Ranatra buenoi			1	0	1	0
ODONATA	**45**	**5**	**75**	**6**	**120**	**6**
Argia	17	2	17	1	34	1
Ischnura			21	1	21	1
Enallagma	9	1	10	0	19	1
Dromogomphus spoliatus	1	0	1	1	12	0
Macromia	4	0			11	0
Dromogomphus spinosus	7	0	3	0	10	0
Libellula			5	0	5	0
Aeschna	3	0			3	0
Boyeria vinosa	2	0			2	0
Perithemis tenera	2	0			2	0
Gomphus			1	0	1	0
ISOPODA	**11**	**1**	**56**	**5**	**67**	**3**
Asellus communis	11	1	41	3	52	2
Lirceus frontalis			15	1	15	0
DIPTERA	**10**	**1**	**45**	**4**	**55**	**2**
Tanypus	2	0	11	1	13	0
Tribelos	4	0	9	0	13	0
Cryptochironomus	3	0	4	0	7	0
Microtendipes			7	0	7	0
Chironomus			5	0	5	0
Probezzia			5	0	5	0
Culicoides			3	0	3	0
Tabanus	1	0	1	0	2	0
MEGALOPTERA	**14**	**1**	**39**	**3**	**53**	**2**
Sialis	14	1	39	3	53	2
OLIGOCHAETA	**23**	**3**	**19**	**1**	**42**	**2**
Oligochaeta	23	3	19	1	42	2
HETERODONTIDA	**15**	**1**	**21**	**1**	**36**	**1**
Corbicula flueminia	15	1	21	1	36	1

Table A-4, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
TRICHOPTERA	**9**	**1**	**23**	**2**	**32**	**1**
Hydropsyche orris			9	0	9	0
Triaenodes tarda			7	0	7	0
Oecetis avara	1	0	4	0	5	0
Cyrnellus fraternus	1	0	3	0	4	0
Pycnopsyche	4	0			4	0
Ceraclea tarsi-punctata	2	0			2	0
Cheumatopsyche	1	0			1	0
HAPLOTAXIDA	**17**	**2**	**7**	**0**	**24**	**1**
Dero	13	1	7	0	20	1
Nais	4	0			4	0
BASOMMATOPHORA	**5**	**0**	**15**	**1**	**20**	**1**
Gyraulus	1	0	13	1	14	0
Physa	4	0	2	0	6	0
PROSOPORA	**7**	**0**	**13**	**1**	**20**	**1**
Lumbriculus inconstans	7	0	13	1	20	1
NEUROPTERA	**12**	**1**			**12**	**0**
Climacia areolaris	12	1			12	0
PLECOPTERA			**8**	**0**	**8**	**0**
Perlesta placida			8	0	8	0
MESOGASTROPODA	**2**	**0**	**3**	**0**	**5**	**0**
Amnicola	2	0	3	0	5	0
PHARYNGOBDELLIDAE	**1**	**0**	**3**	**0**	**4**	**0**
Erpobdella trianulata	1	0	1	0	2	0
Mooreobdella anoculata			2	0	2	0
RHYNCHOBDELLIDA	**1**	**0**	**2**	**0**	**3**	**0**
Placobdella sp. 2			2	0	2	0
Placobdella hollensis	1	0			1	0
LEPIDOPTERA	**2**	**0**			**2**	**0**
Prionoxystus	2	0			2	0
GORDIIDA	**1**	**0**			**1**	**0**
Paragordius	1	0			1	0
Total # Organisms	764		1084		1848	
Total # Taxa	60		68		87	

*0 - actual value < 1.0 but > 0.0

Table A-5. Benthic Community of Whitewater Creek
Gulf Coastal Ecoregion
30-minute Qualitative Sample (# org./sample), 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**74**	**11**	**234**	**31**	**308**	**22**
Palaemonetes kadiakensis	63	10	194	25	257	18
Cambarinae	9	1	37	5	46	3
Procambarus	2	0	2	0	4	0
Cambarus hubbsi			1	0	1	0
COLEOPTERA	**126**	**20**	**128**	**17**	**254**	**18**
Peltodytes	61	9	27	3	88	6
Uvarus	13	2	49	6	62	4
Hydrochus	14	2			14	1
Dineutus ciliatus	1	0	11	1	12	0
Laccophilus	8	1	2	0	10	0
Scirtes	7	1	3	0	10	0
Dineutus emarginatus	1	0	7	0	8	0
Tropisternus lateralis	2	0	6	0	8	0
Hydrovatus	1	0	6	0	7	0
Derallus	1	0	5	0	6	0
Coptotomus	4	0	1	0	5	0
Thermonectus basillaris	4	0	1	0	5	0
Dineutus (larva)			4	0	4	0
Dineutus carolinus	4	0			4	0
Gyrinus			3	0	3	0
Tropisternus (larva)			3	0	3	0
Helichus	1	0			1	0
Helichus (larva)	1	0			1	0
Laccornis	1	0			1	0
Tropisternus mexicanus	1	0			1	0
Uvarus (larva)	1	0			1	0
DIPTERA	**167**	**26**	**48**	**6**	**215**	**15**
Tanypus	41	6			41	3
Palpomyia	31	4	2	0	33	2
Cryptochironomus	29	4			29	2
Chironomus	19	3	7	0	26	1
Probezzia	17	2	7	0	24	1
Tanytarsus	21	3			21	1
Tribelos	3	0	11	1	14	1
Glyptotendipes			9	1	9	0
Tabanus	6	0			6	0
Hemerodromia			5	0	5	0
Ablabesmyia mallochi			4	0	4	0
Haematopota			2	0	2	0
Helius			1	0	1	0

Table A-5, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ODONATA	**92**	**14**	**72**	**9**	**164**	**12**
Enallagma	6	0	27	3	33	2
Dromogomphus spoliatus	26	4	6	0	32	2
Argia			19	2	19	1
Pachydiplax longipennis	9	3	10	1	19	1
Miathyria marcella	4	2	10	1	14	1
Libellula pulchella	2	1	10	1	12	0
Ischnura	1	0	9	1	10	0
Boyeria vinosa	6	0	2	0	8	0
Dromogomphus spinosus	5	0			5	0
Libellula vibrans			5	0	5	0
Macromia			3	0	3	0
Dythemis	1	0	1	0	2	0
Archilestes	1	0			1	0
Basiaeschna janata	1	0			1	0
AMPHIPODA	**23**	**3**	**67**	**9**	**90**	**6**
Gammarus minus	2	0	35	4	37	2
Hyalella azteca	21	3	6	0	27	1
Crangonyx gracilis			17	2	17	1
Gammarus fasciatus			9	1	9	0
EPHEMEROPTERA	**27**	**4**	**58**	**7**	**85**	**6**
Caenis	1	3	51	6	72	5
Stenacron interpunctatum	6	0	7	0	13	0
HEMIPTERA	**29**	**4**	**28**	**3**	**57**	**4**
Ranatra buenoi	6	2	2	0	18	1
Trichocorixa	1	0	11	1	12	0
Gerris	3	0	6	0	9	0
Corixidae	7	1			7	0
Belostoma			3	0	3	0
Hydrometra martini	1	0	2	0	3	0
Palmacorixa			3	0	3	0
Gelastocoris occulatus			1	0	1	0
Ranatra nigra	1	0			1	0
BASOMMATOPHORA	**22**	**3**	**25**	**3**	**47**	**3**
Physa	6	2	21	2	37	2
Gyraulus	2	0	3	0	5	0
Planorbula	3	0	1	0	4	0
Ferrissia	1	0			1	0

Table A-5, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ISOPODA	**11**	**1**	**36**	**4**	**47**	**3**
Asellus dentadactylus	1	1	22	3	33	2
Lirceus hoppinae			14	1	14	1
MEGALOPTERA	**31**	**4**			**31**	**2**
Sialis	31	4			31	2
OLIGOCHAETA	**6**	**0**	**16**	**2**	**22**	**1**
Oligochaeta	6	0	16	2	22	1
MESOGASTROPODA	**12**	**1**	**2**	**0**	**14**	**1**
Amnicola	2	1	2	0	14	1
HETERODONTIDA	**6**	**0**	**7**	**0**	**13**	**0**
Musculium	6	0	7	0	13	0
PLECOPTERA			**11**	**1**	**11**	**0**
Strophoteryx			7	0	7	0
Perlesta placida			4	0	4	0
PHARYNGOBDELLIDAE	**4**	**0**			**4**	**0**
Mooreobdella microstoma	4	0			4	
Total # Organisms	630		732		1362	
Total # Taxa	60		58		80	

*0 - actual value < 1.0 but > 0.0

Table A-6. Benthic Community of Big Creek
Gulf Coastal Ecoregion
30-minute Qualitative Sample (# org./sample), 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**80**	**21**	**85**	**18**	**165**	**19**
Uvarus	35	9	26	5	61	7
Hydrovatus	14	3	12	2	26	3
Dineutus ciliatus	8	2	14	3	22	2
Peltodytes	11	2	7	1	18	2
Tropisternus ellipticus			8	1	8	0
Scirtes	4	1	3	0	7	0
Hydrochus	2	0	3	0	5	0
Tropisternus mexicanus	3	0	2	0	5	0
Dineutus (larva)			4	0	4	0
Deronectes	3	0			3	0
Cymbiodyta			2	0	2	0
Coptotomus			1	0	1	0
Helophorus			1	0	1	0
Hydrophilus			1	0	1	0
Stenelmis lateralis			1	0	1	0
DECAPODA	**100**	**26**	**40**	**8**	**140**	**16**
Palaemonetes kadiakensis	91	24	26	5	117	14
Cambarinae	4	1	11	2	15	1
Procambarus acutus	3	0	3	0	6	0
Astacus	2	0			2	0
AMPHIPODA	**38**	**10**	**101**	**22**	**139**	**16**
Gammarus fasciatus	27	7	73	15	100	12
Hyalella azteca	11	2	9	1	20	2
Crangonyx gracilis			19	4	19	2
ISOPODA	**31**	**8**	**44**	**9**	**75**	**9**
Lirceus hoppinae	31	8	17	3	48	5
Asellus dentadactylus			27	5	27	3
DIPTERA	**17**	**4**	**37**	**8**	**54**	**6**
Glyptotendipes	8	2	1	3	26	3
Prosimulium mixtum	0	0	12	2	12	1
Tanypus	3	0	3	0	6	0
Tanytarsus	4	1			4	0
Chrysops			3	0	3	0
Stenochironomus	2	0			2	0
Helius			1	0	1	0
EPHEMEROPTERA	**23**	**6**	**31**	**6**	**54**	**6**
Caenis	19	5	3	6	50	6
Stenacron interpunctatum	4	1			4	0
HEMIPTERA	**24**	**6**	**25**	**5**	**49**	**5**
Corixidae	2	0	9	1	11	1
Notonecta undulata	7	1	4	0	11	1

Table A-6, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Belostoma	3	0	4	0	7	0
Gerris	3	0	3	0	6	0
Gelastocoris occulatus	3	0	2	0	5	0
Hydrometra martini	1	0	3	0	4	0
Rheumatobates	4	1			4	0
Hesperocorixa	1	0			1	0
ODONATA	**20**	**5**	**25**	**5**	**45**	**5**
Argia	1	0	14	3	15	1
Enallagma	8	2			8	0
Macromia	3	0	3	0	6	0
Neurocordulia	5	1			5	0
Libellula vibrans	2	0	2	0	4	0
Dromogomphus spoliatus	1	0	1	0	2	0
Nasiaeschna pentacantha			2	0	2	0
Boyeria vinosa			1	0	1	0
Ischnura			1	0	1	0
Miathyria marcella			1	0	1	0
PLECOPTERA			**36**	**7**	**36**	**4**
Strophoteryx			28	6	28	3
Acroneuria			6	1	6	0
Amphinemura delosa			1	0	1	0
Taeniopteryx			1	0	1	0
MEGALOPTERA	**16**	**4**	**15**	**3**	**31**	**3**
Sialis	6	4	15	3	31	3
OLIGOCHAETA	**15**	**4**	**6**	**1**	**21**	**2**
Oligochaeta	15	4	6	1	21	2
BASOMMATOPHORA	**3**	**0**	**6**	**1**	**9**	**1**
Physa	2	0	6	1	8	0
Ferrissia	1	0			1	0
MESOGASTROPODA	**1**	**0**	**3**	**0**	**4**	**0**
Amnicola	1	0	3	0	4	0
PHARYNGOBDELLIDAE	**1**	**0**	**2**	**0**	**3**	**0**
Mooreobdella microstoma	1	0	2	0	3	0
PROSOPORA	**3**	**0**			**3**	**0**
Lumbriculus inconstansus	3	0			3	0

Table A-6, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
RHYNCHOBDELLIDA	3	0			3	0
Placobdella parasitica	3	0			3	0
HETERODONTIDA			2	0	2	0
Corbicula flueminia			2	0	2	0
Total # Organisms	375		458		833	
Total # Taxa	43		52		64	

*0 - actual value < 1.0 but > 0.0

Table A-7. Benthic Community of Derrieusseaux Creek
Gulf Coastal Ecoregion
30-minute Qualitative Sample (# org./sample), 1985*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**109**	**13**	**620**	**39**	**729**	**30**
Palaemonetes kadiakensis	67	10	552	34	639	26
Cambarinae	6	0	62	3	68	2
Cambarellus purer	14	1			14	0
Procambarus ouachitae	1	0	4	0	5	0
Cambarellus			2	0	2	0
Orconectes	1	0			1	0
COLEOPTERA	**152**	**18**	**278**	**17**	**430**	**18**
Uvarus	4	0	162	10	166	6
Peltodytes	26	3	66	4	92	3
Celina angustata	65	8	4	0	69	2
Dineutus ciliatus	16	1	22	1	38	1
Hydrochus	17	2			17	0
Laccornis	1	0	8	0	9	0
Haliplus	2	0	6	0	8	0
Deronectes	5	0			5	0
Tropisternus lateralis			4	0	4	0
Tropisternus (larva)			4	0	4	0
Scirtes	3	0			3	0
Tropisternus ellipticus	3	0			3	0
Derallus	2	0			2	0
Hydroporus sp.			2	0	2	0
Hydrovatus	2	0			2	0
Peltodytes (larva)	2	0			2	0
Stenelmis	2	0			2	0
Acilius	1	0			1	0
Laccophilus	1	0			1	0
AMPHIPODA	**112**	**13**	**130**	**8**	**242**	**10**
Gammarus minus			124	7	124	5
Hyalella azteca	112	13	6	0	118	4
ISOPODA	**33**	**4**	**194**	**12**	**227**	**9**
Lirceus hoppinae	33	4	194	12	227	9
EPHEMEROPTERA	**72**	**8**	**132**	**8**	**204**	**8**
Caenis	38	4	122	7	160	6
Cloeon rubropictum	19	2			19	0
Stenacron interpunctatum	7	0	8	0	15	0
Hexagenia limbata	8	0	2	0	10	0
ODONATA	**85**	**10**	**48**	**3**	**133**	**5**
Ischnura	41	5			41	1
Enallagma			18	1	18	0

Table A-7, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Dromogomphus spoliatus	7	0	8	0	15	0
Libellula vibrans	14	1			14	0
Argia			12	0	12	0
Boyeria vinosa	9	1	2	0	11	0
Dromogomphus spinosus	1	0	8	0	9	0
Neurocordulia xanthosoma	8	0			8	0
Perithemis tenera	3	0			3	0
Basiaeschna janata	2	0			2	0
HEMIPTERA	**27**	**3**	**78**	**4**	**105**	**4**
Corixidae	8	0	54	3	62	2
Mesovelia mulsani			8	0	8	0
Gelastocoris occulatus	5	0	2	0	7	0
Notonecta undulata	3	0	4	0	7	0
Gerris			6	0	6	0
Belostoma	2	0	2	0	4	0
Hydrometra martini	3	0			3	0
Limnoporus	2	0			2	0
Plea apopkana	2	0			2	0
Ranatra australis	2	0			2	0
Ranatra buenoi			2	0	2	0
MEGALOPTERA	**83**	**10**	**20**	**1**	**103**	**4**
Sialis	82	10	18	1	100	4
Chauliodes rastinicornis	1	0	2	0	3	0
DIPTERA	**66**	**8**	**32**	**2**	**98**	**4**
Conchapelopia	18	2			18	0
Dicrotendipes	15	1			15	0
Tribelos			12	0	12	0
Rheotanytarsus	11	1			11	0
Corynoneura	9	1			9	0
Chironomus	2	0	6	0	8	0
Thienemanniella			8	0	8	0
Cryptochironomus	4	0			4	0
Haematopota			4	0	4	0
Chaoborus albipes	3	0			3	0
Stenochironomus	3	0			3	0
Tipula			2	0	2	0
Chlorotabanus	1	0			1	0
BASOMMATOPHORA	**17**	**2**	**10**	**0**	**27**	**1**
Physa	8	0	8	0	16	0
Ferrissia	4	0	2	0	6	0
Helosoma antrosa	5	0			5	0

Table A-7, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HETERODONTIDA	**6**	**0**	**16**	**1**	**22**	**0**
Corbicula flueminia	6	0	16	1	22	0
MESOGASTROPODA	**21**	**2**			**21**	**0**
Amnicola	21	2			21	0
OLIGOCHAETA	**12**	**1**	**4**	**0**	**16**	**0**
Oligochaeta	12	1	4	0	16	0
PLECOPTERA			**14**	**0**	**14**	**0**
Perlesta placida			8	0	8	0
Neoperla clymene			6	0	6	0
COLLEMBOLA			**6**	**0**	**6**	**0**
Isotomurus palustris			6	0	6	0
HAPLOTAXIDA	**4**	**0**			**4**	**0**
Amphichaeta	4	0			4	0
PHARYNGOBDELLIDAE	**1**	**0**	**2**	**0**	**3**	**0**
Mooreobdella microstoma	1	0	2	0	3	0
LEPIDOPTERA	**1**	**0**			**1**	**0**
Archips	1	0			1	0
Total # Organisms	801		1584		2385	
Total # Taxa	63		46		80	

*0 - actual value < 1.0 but > 0.0

Table A-8. Benthic Community of Bayou Freeo
Gulf Coastal Ecoregion
30-minute Qualitative Sample (# org./sample), 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**44**	**14**	**98**	**15**	**142**	**14**
Cambarinae	19	6	56	8	75	7
Palaemonetes kadiakensis	22	7	38	5	60	6
Procambarus tenus	3	0	1	0	4	0
Orconectes palmeri			3	0	3	0
AMPHIPODA	**5**	**1**	**127**	**19**	**132**	**13**
Hyalellla azteca	2	0	71	10	73	7
Gammarus fasciatus	3	0	56	8	59	6
COLEOPTERA	**30**	**9**	**63**	**9**	**93**	**9**
Uvarus	6	1	19	2	25	2
Dineutus assimalis	16	5	5	0	21	2
Scirtes	4	1	7	1	11	1
Tropisternus lateralis			11	1	11	1
Hydrovatus			9	1	9	0
Berosus styliferus			6	0	6	0
Gyrinus	1	0	5	0	6	0
Agabus	2	0			2	0
Helichus	1	0			1	0
Hydrochus			1	0	1	0
EPHEMEROPTERA	**58**	**19**	**30**	**4**	**88**	**9**
Caenis	30	9	17	2	47	4
Stenacron interpunctatum	24	7	7	1	31	3
Centroptilum	3	0			3	0
Leptophlebia			3	0	3	0
Eurylophella temporalis			2	0	2	0
Hexagenia limbata	1	0	1	0	2	0
ODONATA	**50**	**16**	**34**	**5**	**84**	**8**
Libellula auripennis	21	6	1	0	22	2
Argia			16	2	16	1
Boyeria vinosa	6	1	5	0	11	1
Macromia	2	0	7	1	9	0
Dromogomphus spoliatus	8	2			8	0
Enallagma	7	2			7	0
Ischnura	4	1	3	0	7	0
Dromogomphus spinosus	2	0	1	0	3	0
Orthemis			1	0	1	0
HEMIPTERA	**36**	**11**	**44**	**6**	**80**	**8**
Corixidae	7	2	28	4	35	3
Hesperocorixa	9	2	4	0	13	1
Gerris	1	0	9	1	10	1
Pseudocorixa	6	1			6	0

Table A-8, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Gelastocoris occulatus	2	0	2	0	4	0
Rheumatobates	4	1			4	0
Mesovelia mulsanti	2	0	1	0	3	0
Ranatra buenoi	3	0			3	0
Notonecta undulata	2	0			2	0
DIPTERA	**13**	**4**	**55**	**8**	**68**	**7**
Chironomus	8	2	17	2	25	2
Simulium			24	3	24	2
Tribelos	5	1	3	0	8	0
Ablabesmyia			6	0	6	0
Tipula			4	0	4	0
Helius			1	0	1	0
ISOPODA			**60**	**9**	**60**	**6**
Asellus dentadactylus			43	6	43	4
Lirceus hoppinae			17	2	17	1
MEGALOPTERA	**19**	**6**	**32**	**4**	**51**	**5**
Sialis	19	6	32	4	51	5
HETERODONTIDA	**10**	**3**	**28**	**4**	**38**	**3**
Musculium			13	1	13	1
Pisidium			12	1	12	1
Corbicula flueminia	7	2			7	0
Lampsilis	3	0	3	0	6	0
TRICHOPTERA	**17**	**5**	**15**	**2**	**32**	**3**
Cheumatopsyche	16	5	13	1	29	3
Pycnopsyche	1	0	1	0	2	0
Ptilostomus			1	0	1	0
PLECOPTERA			**28**	**4**	**28**	**2**
Perlesta placida			18	2	18	1
Isoperla mohri			7	1	7	0
Neoperla clymene			3	0	3	0
BASOMMATOPHORA	**1**	**0**	**20**	**3**	**21**	**2**
Helisoma	1	0	12	1	13	1
Physa			6	0	6	0
Ferrissia			2	0	2	0
OLIGOCHAETA	**4**	**1**	**13**	**1**	**17**	**1**
Oligochaeta	4	1	13	1	17	1
HAPLOTAXIDA	**14**	**4**			**14**	**1**
Chaetogaster	11	3			11	1
Dero	3	0			3	0

Table A-8, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
RHYNCHOBDELLIDA			6	0	6	0
Placobdella parasitica			4	0	4	0
Helobdella stagnalis			2	0	2	0
PHARYNGOBDELLIDAE	1	0			1	0
Mooreobdella microstoma	1	0			1	0
Total # Organisms	302		653		955	
Total # Taxa	43		55		68	

*0 - actual value < 1.0 but > 0.0

Table A-9. Benthic Community of Hudgin Creek
Gulf Coastal Ecoregion
30-minute Qualitative Sample (# org./sample), 1985*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**152**	**18**	**113**	**29**	**265**	**22**
Celina angustata	65	8			65	5
Uvarus	4	0	48	12	52	4
Hydrovatus	2	0	31	8	33	2
Dineutus ciliatus	16	1	11	2	27	2
Peltodytes	26	3			26	2
Deronectes	5	0	19	4	24	2
Hydrochus	17	2			17	1
Hydroporus			3	0	3	0
Scirtes	3	0			3	0
Tropisternus ellipticus	3	0			3	0
Derallus	2	0			2	0
Haliplus	2	0			2	0
Peltodytes (larva)	2	0			2	0
Stenelmis	2	0			2	0
Acilius	1	0			1	0
Deronectes (larva)			1	0	1	0
Laccophilus	1	0			1	0
Laccornis	1	0			1	0
DECAPODA	**109**	**13**	**80**	**20**	**189**	**15**
Palaemonetes kadiakensis	77	10	38	9	125	10
Cambarinae	6	0	42	10	48	4
Cambarellus purer	4	1			14	1
Orconectes	1	0			1	0
Procambarus ouachitae	1	0			1	0
AMPHIPODA	**112**	**13**	**17**	**4**	**129**	**10**
Hyalella azteca	112	13	6	1	118	9
Crangonyx gracilis			11	2	11	0
ODONATA	**85**	**10**	**19**	**4**	**104**	**8**
Ischnura	41	5			41	3
Libellula vibrans	14	1			14	1
Dromogomphus spoliatus	7	0	4	1	11	0
Boyeria vinosa	9	1	1	0	10	0
Neurocordulia xanthosoma	8	0	1	0	9	0
Enallagma			7	1	7	0
Argia			3	0	3	0
Dromogomphus spinosus	1	0	2	0	3	0
Perithemis tenera	3	0			3	0
Basiaeschna janata	2	0			2	0
Cordulegaster obligua			1	0	1	0

Table A-9, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**72**	**8**	**28**	**7**	**100**	**8**
Caenis	38	4	19	4	57	4
Cloeon rubropictum	19	2	0	0	19	1
Stenacron interpunctatum	7	0	7	1	14	1
Hexagenia limbata	8	0	2	0	10	0
MEGALOPTERA	**3**	**10**	**4**	**1**	**87**	**7**
Sialis	82	10	4	1	86	7
Chauliodes rastinicornis	1	0			1	0
DIPTERA	**66**	**8**	**19**	**4**	**85**	**7**
Conchapelopia	18	2			18	1
Dicrotendipes	15	1			15	1
Rheotanytarsus	11	1			11	0
Chironomus	2	0	7	1	9	0
Corynoneura	9	1			9	0
Chaoborus albipes	3	0	4	1	7	0
Cryptochironomus	4	0			4	0
Microtendipes			3	0	3	0
Stenochironomus	3	0			3	0
Tipula			3	0	3	0
Chlorotabanus	1	0			1	0
Haematopota			1	0	1	0
Pilaria			1	0	1	0
ISOPODA	**33**	**4**	**25**	**6**	**58**	**4**
Lirceus hoppinae	33	4	7	1	40	3
Asellus dentadactylus			18	4	18	1
HEMIPTERA	**31**	**3**	**24**	**6**	**55**	**4**
Corixidae	8	0	19	4	27	2
Belostoma	2	0	3	0	5	0
Gelastocoris occulatus	5	0			5	0
Mesovelia mulsanti	4	0	1	0	5	0
Notonecta undulata	3	0	1	0	4	0
Hydrometra martini	3	0			3	0
Limnoporus	2	0			2	0
Plea apopkana	2	0			2	0
Ranatra australis	2	0			2	0
BASOMMATOPHORA	**17**	**2**	**16**	**4**	**33**	**2**
Physa	8	0	16	4	24	2
Helosoma antrosa	5	0			5	0
Ferrissia	4	0			4	0
MESOGASTROPODA	**21**	**2**	**8**	**2**	**29**	**2**
Amnicola	21	2	8	2	29	2

Table A-9, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
TRICHOPTERA			**19**	**4**	**19**	**1**
Triaenodes tarda			19	4	19	1
OLIGOCHAETA	**12**	**1**	**5**	**1**	**17**	**1**
Oligochaeta	12	1	5	1	17	1
HETERODONTIDA	**6**	**0**	**3**	**0**	**9**	**0**
Corbicula flueminia	6	0	3	0	9	0
HAPLOTAXIDA	**4**	**0**			**4**	**0**
Amphichaeta	4	0			4	0
PHARYNGOBDELLIDAE	**1**	**0**	**1**	**0**	**2**	**0**
Erpobdellidae			1	0	1	0
Mooreobdella microstoma	1	0			1	0
PLECOPTERA			**2**	**0**	**2**	**0**
Perlesta placida			2	0	2	0
LEPIDOPTERA	**1**	**0**			**1**	**0**
Archips	1	0			1	0
Total # Organisms	805		383		1188	
Total # Taxa	64		40		78	

*0 - actual value < 1.0 but > 0.0

Table A-10. Benthic Community of L'Aigle Creek
Gulf Coastal Ecoregion
30-minute Qualitative Sample (# org./sample), 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**372**	**21**	**160**	**15**	**532**	**19**
Uvarus	189	11	73	7	262	9
Peltodytes	56	3	19	1	75	2
Coptotomus	32	1	12	1	44	1
Hydrovatus	14	0	16	1	30	1
Stenelmis (larva)	21	1	4	0	25	0
Gyrinus	4	0	14	1	18	0
Tropisternus lateralis	11	0	4	0	15	0
Dineutus emarginatus	11	0	3	0	14	0
Scirtes	7	0	2	0	9	0
Dineutus (larva)			8	0	8	0
Dineutus ciliatus	8	0			8	0
Peltodytes (larva)	8	0			8	0
Tropisternus mexicanus	6	0			6	0
Helocares	1	0	2	0	3	0
Tropisternus (larva)	1	0	2	0	3	0
Berosus styliferus			1	0	1	0
Helophorus	1	0			1	0
Laccophilus	1	0			1	0
Stenelmis lateralis	1	0			1	0
ODONATA	**366**	**21**	**94**	**9**	**460**	**16**
Libellula vibrans	123	7	16	1	139	5
Enallagma	93	5	21	2	114	4
Dromogomphus spoliatus	72	4	8	0	80	2
Boyeria vinosa	43	2	11	1	54	1
Argia	7	0	23	2	30	1
Basiaeschna janata	17	0	1	0	18	0
Dromogomphus spinosus	6	0			6	0
Macromia			6	0	6	0
Gomphus			4	0	4	0
Neurocordulia xanthosoma	1	0	3	0	4	0
Erythemis simplicollis	3	0			3	0
Pachydiplax longipennis	1	0	1	0	2	0
DECAPODA	**183**	**10**	**259**	**25**	**442**	**16**
Palaemonetes kadiakensis	166	9	193	19	359	13
Cambarinae	17	0	43	4	60	2
Orconectes marcus			17	1	17	0
Orconectes sp. 2			6	0	6	0
EPHEMEROPTERA	**351**	**20**	**61**	**6**	**412**	**15**
Caenis	301	17	41	4	342	12
Stenacron interpunctatum	27	1	11	1	38	1
Hexagenia limbata	12	0	7	0	19	0

Table A-10, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Ameletus	4	0	2	0	6	0
Centroptilum	6	0			6	0
Paraleptophlebia	1	0			1	0
AMPHIPODA	**54**	**3**	**110**	**10**	**164**	**6**
Gammarus minus	6	0	87	8	93	3
Hyalella azteca	48	2	23	2	71	2
HEMIPTERA	**67**	**3**	**68**	**6**	**135**	**4**
Corixidae	18	1	39	3	57	2
Belostoma	21	1			21	0
Gerris	8	0	7	0	15	0
Notonecta undulata	4	0	8	0	12	0
Mesovelia mulsanti	6	0	3	0	9	0
Palmacorixa			6	0	6	0
Gelastocoris occulatus	3	0	1	0	4	0
Ranatra buenoi	4	0			4	0
Hebrus			3	0	3	0
Hydrometra martini	2	0	1	0	3	0
Microvelia	1	0			1	0
BASOMMATOPHORA	**71**	**4**	**50**	**4**	**121**	**4**
Helisoma	51	2	42	4	93	3
Ferrissia	8	0	6	0	14	0
Physa	12	0	2	0	14	0
DIPTERA	**58**	**3**	**35**	**3**	**93**	**3**
Tanytarsus	21	1			21	0
Chironomus	15	0	4	0	19	0
Procladius	11	0	1	0	12	0
Einfeldia	3	0	7	0	10	0
Hemerodromia			8	0	8	0
Probezzia			7	0	7	0
Cryptochironomus	4	0			4	0
Tanypus	1	0	3	0	4	0
Tabanus	1	0	2	0	3	0
Tipula			3	0	3	0
Clinotanypus	2	0			2	0
MEGALOPTERA	**38**	**2**	**51**	**5**	**89**	**3**
Sialis	38	2	23	2	61	2
Nigronia serricornis			17	1	17	0
Corydalus cornutus			11	1	11	0
MESOGASTROPODA	**74**	**4**			**74**	**2**
Viviparus	74	4			74	2

Table A-10, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HETERODONTIDA	**9**	**0**	**44**	**4**	**53**	**1**
Corbicula flueminia	6	0	3	3	37	1
Pisidium			9	0	9	0
Elliptio	3	0	4	0	7	0
TRICHOPTERA	**26**	**1**	**16**	**1**	**42**	**1**
Oecetis avara	16	0	3	0	19	0
Polycentropus cinereus	2	0	7	0	9	0
Hydroptila	5	0			5	0
Cyrnellus fraternus	3	0	1	0	4	0
Triaenodes tarda			3	0	3	0
Hydropsyche orris			2	0	2	0
ISOPODA	**22**	**1**	**11**	**1**	**33**	**1**
Lirceus hoppinae	21	1	11	1	32	1
Asellus sp.	1	0			1	0
PLECOPTERA			**21**	**2**	**21**	**0**
Perlesta placida			11	1	11	0
Strophoteryx			6	0	6	0
Isoperla brevis			4	0	4	0
OLIGOCHAETA	**11**	**0**	**7**	**0**	**18**	**0**
Oligochaeta	11	0	7	0	18	0
ACARINA	**2**	**0**	**7**	**0**	**9**	**0**
Forelia	1	0	7	0	8	0
Neumania	1	0			1	0
NEUROPTERA	**1**	**0**	**4**	**0**	**5**	**0**
Climacia areolaris	1	0	4	0	5	0
PROSOPORA	**4**	**0**			**4**	**0**
Lumbriculidae	4	0			4	0
RHYNCHOBDELLIDA			**3**	**0**	**3**	**0**
Helobdella papillata			3	0	3	0
PHARYNGOBDELLIDAE	**1**	**0**	**1**	**0**	**2**	**0**
Mooreobdella anoculata	1	0	1	0	2	0
Total # Organisms	1710		1002		2712	
Total # Taxa	73		72		93	

*0 - actual value < 1.0 but > 0.0

Table A-11. Benthic Community of Moro Creek
Gulf Coastal Ecoregion
30-minute Qualitative Sample (# org./sample), 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**427**	**39**	**380**	**22**	**807**	**28**
Uvarus	197	18	134	7	331	11
Hydrovatus	87	8	34	1	121	4
Dineutus discolor	30	2	72	4	102	3
Coptotomus	65	6	8	0	73	2
Peltodytes	11	1	52	3	63	2
Helophorus	3	0	16	0	19	0
Gyrinus			18	1	18	0
Dineutus emarginatus	17	1			17	0
Hydroporus			14	0	14	0
Dubiraphia vittata			12	0	12	0
Scirtes	1	0	8	0	9	0
Berosus styliferus	2	0	4	0	6	0
Tropisternus (larva)			6	0	6	0
Stenelmis (larva)	5	1			5	0
Berosus (larva)			2	0	2	0
Stenelmis lateralis	2	0			2	0
Thermonectus basillaris	2	0			2	0
Tropisternus lateralis	2	0			2	0
Dineutus (larva)	1	0			1	0
Hydrochus	1	0			1	0
Paracymus	1	0			1	0
DECAPODA	**102**	**9**	**510**	**29**	**612**	**21**
Palaemonetes kadiakensis	83	7	342	19	425	15
Cambarinae	15	1	158	9	173	6
Procambarus elegans	2	0	8	0	10	0
Orconectes palmeri	2	0	2	0	4	0
EPHEMEROPTERA	**215**	**19**	**82**	**4**	**297**	**10**
Caenis	163	1	48	2	211	7
Stenacron interpunctatum	26	2			26	0
Hexagenia limbata	23	2			23	0
Leptophlebia			14	0	14	0
Paraleptophlebia			12	0	12	0
Eurylophella temporalis			4	0	4	0
Ameletus	3	0			3	0
Centroptilum			2	0	2	0
Stenonema vicarium			2	0	2	0
AMPHIPODA	**70**	**6**	**206**	**11**	**276**	**9**
Gammarus minus	9	0	156	9	165	5
Hyalella azteca	61	5	12	0	73	2
Crangonyx gracilis			38	2	38	1

Table A-11, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HEMIPTERA	**39**	**3**	**102**	**5**	**141**	**5**
Corixidae	3	0	56	3	59	1
Gerris	2	0	22	1	24	0
Rheumatobates	16	1			16	0
Hydrometra martini	5	0	4	0	9	0
Buenoa	2	0	6	0	8	0
Gelastocoris occulatus	1	0	6	0	7	0
Trepobates	6	0			6	0
Belostoma			4	0	4	0
Palmacorixa			4	0	4	0
Mesovelia mulsanti	3	0			3	0
Ranatra buenoi	1				1	0
DIPTERA	**36**	**3**	**92**	**5**	**128**	**4**
Chironomus	12	1	28	1	40	1
Cryptochironomus	1	0	18	1	19	0
Tanypus	1	0	12	0	13	0
Tabanus	6	0	4	0	10	0
Conchapelopia	9	0			9	0
Probezzia			8	0	8	0
Procladius			8	0	8	0
Rheotanytarsus	6	0			6	0
Xenochironomus			6	0	6	0
Einfeldia			4	0	4	0
Dixella			2	0	2	0
Tipula			2	0	2	0
Anopheles	1	0			1	0
ISOPODA	**26**	**2**	**100**	**5**	**126**	**4**
Lirceus hoppinae	26	2	80	4	106	3
Asellus sp.			20	1	20	0
ODONATA	**89**	**8**	**24**	**1**	**113**	**4**
Enallagma	29	2	2	0	31	1
Dromogomphus spoliatus	18	1			18	0
Libellula vibrans	16	1			16	0
Argia	3	0	8	0	11	0
Boyeria vinosa	6	0	2	0	8	0
Macromia	4	0	4	0	8	0
Neurocordulia	6	0	2	0	8	0
Dythemis	4	0	2	0	6	0
Gomphus			4	0	4	0
Dromogomphus spinosus	2	0			2	0
Archilestes	1	0			1	0

Table A-11, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HETERODONTIDA	**17**	**1**	**68**	**3**	**85**	**3**
Corbicula flueminia	15	1	62	3	77	2
Elliptio	2	0	6	0	8	0
MEGALOPTERA	**24**	**2**	**42**	**2**	**66**	**2**
Sialis	24	2	42	2	66	2
OLIGOCHAETA	**6**	**0**	**42**	**2**	**48**	**1**
Oligochaeta	6	0	42	2	48	1
BASOMMATOPHORA	**6**	**0**	**22**	**1**	**28**	**0**
Physa	2	0	22	1	24	0
Helisoma	3	0			3	0
Ferrissia	1	0			1	0
TRICHOPTERA	**5**	**0**	**18**	**1**	**23**	**0**
Hydropsychid genus a			8	0	8	0
Triaenodes sp. b			6	0	6	0
Pycnopsyche	2	0	2	0	4	0
Triaenodes tarda	1	0	2	0	3	0
Oecetis cinerascens	1	0			1	0
Polycentropus cinereus	1	0			1	0
PLECOPTERA			**16**	**1**	**16**	**0**
Perlesta placida			12	0	12	0
Isoperla clio			2	0	2	0
Strophoteryx			2	0	2	0
MESOGASTROPODA	**3**	**0**	**8**	**0**	**11**	**0**
Viviparus	3	0	8	0	11	0
ACARINA	**6**	**0**			**6**	**0**
Neumania	6	0			6	0
PHARYNGOBDELLIDAE	**4**	**0**	**2**	**0**	**6**	**0**
Macrobdella	1	0	2	0	3	0
Mooreobdella microstoma	3	0			3	0
PROSOPORA	**5**	**0**			**5**	**0**
Lumbriculidae	5	0			5	0
NEUROPTERA			**4**	**0**	**4**	**0**
Climacia areolaris			4	0	4	0

Table A-11, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HAPLOTAXIDA	2	0			2	0
Nais	2	0			2	0
RHYNCHOBDELLIDA			2	0	2	0
Helobdella papillata			2	0	2	2
Total # Organisms	1082		1720		2802	
Total # Taxa	70		68		98	

*0 - actual value < 1.0 but > 0.0

Table A-12. Benthic Community of East Fork of Tulip Creek
Gulf Coastal Ecoregion
Qualitative Sample (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**2**	**4**	**31**	**23**	**33**	**18**
Isonychia			16	12	16	9
Stenonema terminatum			8	6	8	5
Stenacron interpunctatum			7	5	7	4
Baetis	1	2			1	0
Stenonema exiguum	1	2			1	0
DECAPODA	**7**	**15**	**20**	**15**	**27**	**15**
Cambarinae	7	15	12	9	19	10
Procambarus acutus			6	4	6	3
Palaemonetes kadiakensis			2	1	2	1
AMPHIPODA			**22**	**16**	**22**	**12**
Stygobromus			22	16	22	12
COLEOPTERA	**10**	**22**	**10**	**7**	**20**	**11**
Macronychus glabratus	4	8	2	1	6	3
Helichus	2	4	2	1	4	2
Dineutus americanus	3	6			3	1
Dineutus (larva)			2	1	2	1
Ancyronyx variegata			1	0	1	0
Anodocheilus			1	0	1	0
Hydrocanthus			1	0	1	0
Stenelmis crenata	1	2			1	0
MESOGASTROPODA	**13**	**28**	**3**	**2**	**16**	**9**
Viviparus	13	28	3	2	16	9
DIPTERA	**1**	**2**	**13**	**10**	**14**	**8**
Tipula	1	2	4	3	5	2
Polypedilum			2	1	2	1
Tabanus			2	1	2	1
Tribelos			2	1	2	1
Ablabesmyia			1	0	1	0
Hexatoma			1	0	1	0
Simulium			1	0	1	0
ISOPODA			**10**	**7**	**10**	**5**
Lirceus hoppinae			10	7	10	5
ODONATA	**3**	**6**	**5**	**3**	**8**	**4**
Calopteryx			4	3	4	2
Dromogomphus spoliatus	2	4			2	1
Argia			1	0	1	0
Boyeria vinosa	1	2			1	0

Table A-12, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HEMIPTERA	**4**	**8**	**3**	**2**	**7**	**4**
Rheumatobates	4	8			4	2
Gerris			2	1	2	1
Microvelia			1	0	1	0
PLECOPTERA	**1**	**2**	**6**	**4**	**7**	**4**
Strophoteryx			5	3	5	3
Hastaperla brevis	1	2	1	0	2	1
MEGALOPTERA	**4**	**8**			**4**	**2**
Corydalus cornutus	3	6			3	1
Sialis	1	2			1	0
HETERODONTIDA			**3**	**2**	**3**	**1**
Corbicula flueminia			3	2	3	1
PROSOPORA			**2**	**1**	**2**	**1**
Lumbricidae			2	1	2	1
TRICHOPTERA			**2**	**1**	**2**	**1**
Pycnopsyche subfasciatus			1	0	1	0
Symphitopsyche cheilon			1	0	1	0
Total # Organisms	45		130		175	
Total # Taxa	15		33		42	

*0 - actual value < 1.0 but > 0.0

Table A-13. Benthic Community of Cypress Creek
Gulf Coastal Ecoregion
Qualitative Sample (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**17**	**14**	**80**	**39**	**97**	**30**
Baetis			25	12	25	7
Stenonema terminatum	7	5	14	6	21	6
Pseudocloeon			16	7	16	4
Isonychia			11	5	11	3
Paraleptophlebia	7	5			7	2
Stenonema pulchellum			6	2	6	1
Stenacron interpunctatum	1	0	4	1	5	1
Stenonema exiguum	2	1	1	0	3	0
Attenella attenuata			1	0	1	0
Hexagenia limbata			1	0	1	0
Stenonema smithae			1	0	1	0
DIPTERA	**9**	**7**	**35**	**17**	**44**	**13**
Ablabesmyia			12	5	12	3
Conchapelopia	6	5			6	1
Cricotopus			6	2	6	1
Bezzia			5	2	5	1
Tribelos			3	1	3	0
Brillia	2	1			2	0
Simulium			2	0	2	0
Tanytarsus			2	0	2	0
Hexatoma			1	0	1	0
Microtendipes	1	0			1	0
Pentaneura			1	0	1	0
Polypedilum			1	0	1	0
Stenochironomus			1	0	1	0
Tipula			1	0	1	0
TRICHOPTERA	**19**	**16**	**17**	**8**	**36**	**11**
Chimarra obscura	4	3	12	5	16	4
Neureclipsis crepuscularis	10	8	1	0	11	3
Hydropsyche frisoni	5	4	1	0	6	1
Cyrnellus fraternus			3	1	3	0
COLEOPTERA	**20**	**17**	**8**	**3**	**28**	**8**
Ancyronyx variegata	11	9			11	3
Stenelmis humerosus	5	4			5	1
Macronychus glabratus			4	1	4	1
Dineutus ciliatus	1	0	1	0	2	0
Dineutus americanus	1	0			1	0
Dubiraphia vittata	1	0			1	0
Gyretes	1	0			1	0
Stenelmis (larva)			1	0	1	0
Stenelmis decorata			1	0	1	0

Table A-13, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**24**	**20**	**1**	**0**	**25**	**7**
Cambarinae	13	11			13	4
Palaemonetes kadiakensis	11	9	1	0	12	3
AMPHIPODA	**3**	**2**	**20**	**9**	**23**	**7**
Hyalella azteca	3	2	14	6	17	5
Stygobromus			6	2	6	1
ODONATA	**15**	**12**	**2**	**0**	**17**	**5**
Boyeria vinosa	11	9			11	3
Macromia	3	2			3	0
Calopteryx	1	0	1	0	2	0
Neurocordulia			1	0	1	0
ISOPODA			**13**	**6**	**13**	**4**
Lirceus hoppinae			13	6	13	4
PLECOPTERA			**13**	**6**	**13**	**4**
Perlesta placida			10	4	10	3
Isoperla mohri			2	0	2	0
Amphinemura delosa			1	0	1	0
MEGALOPTERA	**3**	**2**	**8**	**3**	**11**	**3**
Corydalus cornutus	3	2	8	3	11	3
HEMIPTERA	**7**	**5**			**7**	**2**
Rhagovelia	5	4			5	1
Microvelia	1	0			1	0
Plea striola	1	0			1	0
PROSOPORA			**6**	**2**	**6**	**1**
Lumbricidae			6	2	6	1
HETERODONTIDA			**1**	**0**	**1**	**0**
Arkansia wheeleri			1	0	1	0
Total # Organisms	117		204		321	
Total # Taxa	26		42		57	

*0 - actual value < 1.0 but > 0.0

Table A-14. Benthic Community of Mill Creek
Arkansas River Valley Ecoregion
Qualitative Sample (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
PLECOPTERA			**125**	**31**	**125**	**27**
Isoperla mohri			42	11	42	9
Perlesta placida			37	9	37	8
Hastaperla brevis			26	7	26	6
Amphinemura delosa			19	5	19	4
Acroneuria mela			1	0	1	0
EPHEMEROPTERA	**15**	**26**	**73**	**18**	**88**	**19**
Paraleptophlebia guttata			28	7	28	6
Heptagenia			15	4	15	3
Eurylophella temporalis			9	2	9	2
Pseudocloeon punctiventris			9	2	9	2
Serratella deficiens			9	2	9	2
Stenonema femoratum	6	10	2	1	8	2
Stenacron interpunctatum	6	10			6	1
Hexagenia limbata	2	3			2	0
Caenis	1	2			1	0
Eurylophella sp.			1	0	1	0
TRICHOPTERA			**56**	**14**	**56**	**12**
Wormaldia			55	13	15	3
Ochrotrichia			1	0	1	0
COLEOPTERA	**11**	**19**	**42**	**11**	**53**	**12**
Stenelmis humerosus			15	4	15	3
Hydroporus (larvae)			8	2	8	2
Stenelmis (larvae)			7	2	7	2
Psephenus herricki	4	7	1	0	5	1
Ancyronyx variegata	2	3	1	0	3	1
Dineutus emarginatus			3	1	3	1
Dineutus (larvae)			3	1	3	1
Dineutus ciliatus	2	3			2	0
Sperchopsis			2	1	2	0
Uvarus	1	2	1	0	2	0
Coptotomus	1	2			1	0
Hydroporus			1	0	1	0
Hydrovatus	1	2			1	0
ISOPODA			**51**	**13**	**51**	**11**
Lirceus hoppinae			51	13	51	11
DIPTERA	**10**	**17**	**22**	**6**	**32**	**7**
Tribelos	8	14	1	0	9	2
Simulium jenningsi			7	2	7	2

Table A-14, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DIPTERA						
Palpomyia			3	1	3	1
Ablabesmyia			2	1	2	0
Hexatoma			2	1	2	0
Microtendipes	2	3			2	0
Prosimulium mixtum			2	1	2	0
Polypedilum			1	0	1	0
Tabanus			1	0	1	0
Tipula			1	0	1	0
MEGALOPTERA	**8**	**14**	**3**	**1**	**11**	**2**
Sialis	8	14			8	2
Corydalus cornutus			3	1	3	1
AMPHIPODA			**9**	**2**	**9**	**2**
Hyalella azteca			9	2	9	2
DECAPODA	**2**	**3**	**6**	**2**	**8**	**2**
Cambarinae (female & imt.)			6	2	6	1
Orconectes marchandi	2	3			2	0
ODONATA	**5**	**9**	**3**	**1**	**8**	**2**
Macromia	3	5			3	1
Enallagma			2	1	2	0
Helocordulia uhleri	2	3			2	0
Libellula pulchella			1	0	1	0
ANNELIDA			**7**	**2**	**7**	**2**
Lumbriculidae			6	2	6	1
Mooreobdella microstoma			1	0	1	0
ACARINA	**4**	**7**			**4**	**1**
Lebertia	4	7			4	1
GASTROPODA			**3**	**1**	**3**	**1**
Ferrissia			1	0	1	0
Gyraulus			1	0	1	0
Physa			1	0	1	0
HEMIPTERA	**3**	**5**			**3**	**1**
Notonecta	2	3			2	0
Lethocerus	1	2			1	0
Total # Organisms	58		400		458	
Total # Taxa	19		43		57	

*0 - actual value = < 1.0 but > 0.0

Table A-15. Benthic Community of North Fork Cadron Creek
Arkansas River Valley Ecoregion
Qualitative Samples (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
PLECOPTERA			**108**	**36**	**108**	**25**
Perlesta placida			68	23	68	16
Isoperla mohri			14	5	14	3
Hastaperla brevis			13	4	13	3
Amphinemuria delosa			12	4	12	3
Isoperla clio			1	0	1	0
COLEOPTERA	**37**	**29**	**34**	**11**	**71**	**18**
Ancyronyx variegata	16	12	2	1	18	4
Stenelmis (larva)	6	5	8	3	14	3
Stenelmis humerosus	4	3	8	3	12	3
Dineutus ciliatus			6	2	6	1
Uvarus			5	2	5	1
Scirtes	3	2	1	0	4	1
Dubiraphia vittata	3	2			3	1
Hydroporus	1	1			1	0
Dubiraphia (larva)	1	1			1	0
Enochrus	1	1			1	0
Helochares			1	0	1	0
Hydroporus (larva)			1	0	1	0
Laccobius			1	0	1	0
Paracymus	1	1			1	0
Peltodytes	1	1			1	0
DIPTERA	**36**	**28**	**33**	**11**	**69**	**16**
Tribelos	14	11	8	3	22	5
Chironomus	19	15			19	5
Polypedilum			6	2	6	1
Tipula			5	2	5	1
Cryptochironomus			3	1	3	1
Hexatoma			3	1	3	1
Conchapelopia	2	2			2	1
Haematopota			2	1	2	1
Procladius			2	1	2	1
Simulium jenningsi			2	1	2	1
Palpomyia			1	0	1	0
Paralauterborniella	1	1			1	0
Pilaria			1	0	1	0
TRICHOPTERA	**2**	**2**	**44**	**15**	**46**	**11**
Orthotrichia			26	9	26	6
Ceraclea tarsi-punctatus			9	3	9	2
Agapetus			3	1	3	1
Leptocella			2	1	2	1

Table A-15, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Limnephilus			2	1	2	1
Neureclipsis crepuscularis	2	2			2	1
Triaenodes			1	0	1	0
Wormaldia			1	0	1	0
EPHEMEROPTERA	**8**	**6**	**21**	**7**	**29**	**7**
Caenis	4	3	3	1	7	2
Dannella provonshia			7	2	7	2
Paraleptophlebia guttata			4	1	4	1
Pseudocloeon			4	1	4	1
Stenonema femoratum	3	2	1	1	4	1
Stenacron interpunctatum	1	1	1	0	2	1
Baetis tricaudatus			1	0	1	0
ODONATA	**11**	**9**	**18**	**6**	**29**	**7**
Ischnura	5	4	5	2	10	2
Gomphus exilis			4	1	4	1
Dythemis velox	1	1	2	1	3	1
Boyeria vinosa	2	2			2	1
Dromogomphus spoliatus			2	1	2	1
Erythrodiplax	2	2			2	1
Hetaerina			2	1	2	1
Libellula vibrans			2	1	2	1
Argia	1	1			1	0
Sympetrum			1	0	1	0
AMPHIPODA	**1**	**1**	**13**	**4**	**14**	**3**
Hyalella azteca	1	1	13	4	14	3
HEMIPTERA	**10**	**8**	**3**	**1**	**13**	**3**
Rheumatobates	6	5			6	1
Hydrometra martini	1	1	2	1	3	1
Hebrus	1	1			1	0
Merragata	1	1			1	0
Microvelia	1	1			1	0
Trepobates			1	0	1	0
ACARINA	**12**	**9**			**12**	**3**
Lebertia	10	8			10	2
Geayia ovata	2	2			2	1
ISOPODA	**4**	**3**	**7**	**2**	**11**	**3**
Lirceus hoppinae	4	3	7	2	11	3
DECAPODA	**2**	**2**	**8**	**3**	**10**	**2**
Cambarinae (female & imt.)			6	2	6	1
Orconectes meeki brevis			2	1	2	1
Orconectes putnami	2	2			2	1

Table A-15, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
MEGALOPTERA	**5**	**4**	**3**	**1**	**8**	**2**
Corydalus cornutus	4	3	3	1	7	2
Sialis	1	1			1	0
ANNELIDA			**4**	**1**	**4**	**1**
Lumbricidae			3	1	3	1
Helobdella stagnalis			1	0	1	0
COLLEMBOLA	**1**	**1**			**1**	**0**
Bourletialla spinata	1	1			1	0
PELECYPODA			**1**	**0**	**1**	**0**
Ferrissia			1	0	1	0
Total # Organisms	129		297		426	
Total # Taxa	36		56		74	

*0 - actual value < 1.0 but > 0.0

Table A-16. Benthic Community of Ten Mile Creek
Arkansas River Valley Ecoregion
30-minute Qualitative Samples (# org./sample), 1985-1986*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ISOPODA	**159**	**21**	**506**	**21**	**665**	**21**
Lirceus hoppinae	159	21	504	21	663	21
Asellus brevicaudatus			1	0	1	0
Asellus sp.			1	0	1	0
PLECOPTERA			**586**	**25**	**586**	**19**
Perlesta placida			375	16	375	12
Amphinemura delosa			185	7	185	6
Zealeuctra			24	1	24	0
Phasganophora			1	0	1	0
Strophoteryx			1	0	1	0
EPHEMEROPTERA	**42**	**5**	**530**	**22**	**572**	**18**
Choroterpes	6	0	289	12	295	9
Stenacron interpunctaum	8	1	72	3	80	2
Stenonema femoratum	4	0	47	2	51	1
Caenis diminuta	11	1	32	1	43	1
Pseudocloeon			22	0	22	0
Dannella provonshai			19	0	19	0
Centroptilum	4	0	14	0	18	0
Heptagenia			15	0	15	0
Eurylophella bicolor			11	0	11	0
Tricorythodes	8	1			8	0
Callibaetis			4	0	4	0
Serratella deficiens			3	0	3	0
Ameletus			2	0	2	0
Hexagenia limbata			1	0	1	0
AMPHIPODA	**185**	**24**	**151**	**6**	**336**	**10**
Hyalella azteca	185	24	151	6	336	10
TRICHOPTERA	**11**	**1**	**241**	**10**	**252**	**8**
Wormaldia			125	5	125	4
Nectopsyche			52	2	52	1
Agapetus			27	1	27	0
Cheumatopsyche	9	1	13	0	22	0
Rhyacophila			19	0	19	0
Pycnopsyche subfaciata			3	0	3	0
Hydroptila			2	0	2	0
Brachycentrus	1	0			1	0
Ceraclea tarsi-punctata	1	0			1	0

Table A-16, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**32**	**4**	**110**	**4**	**142**	**4**
Stenelmis convexula			38	1	38	1
Helichus			33	1	33	1
Dineutus discolor	7	0	21	0	28	0
Stenelmis (larva)	1	0	12	0	13	0
Dubiraphia vittata	9	1			9	0
Scirtes	5	0			5	0
Stenelmis humerosus	5	0			5	0
Berosus (larva)	1	0	3	0	4	0
Hydrocanthus	1	0	3	0	4	0
Ancyronyx variegata	3	0			3	0
MESOGASTROPODA	**55**	**7**	**53**	**2**	**108**	**3**
Viviparus	55	7			55	1
Amnicola			53	2	53	1
ODONATA	**71**	**9**	**17**	**0**	**88**	**2**
Ischnura	53	7			53	1
Didymops transversa			13	0	13	0
Enallagma	12	1			12	0
Macromia	2	0	3	0	5	0
Libellula vibrans	3	0			3	0
Dromogomphus spinosus	1	0			1	0
Neurocordulia			1	0	1	0
DIPTERA	**14**	**1**	**56**	**2**	**70**	**2**
Simulium jenningsi			31	1	31	1
Tanytarsus			13	0	13	0
Tipula			8	0	8	0
Chironomus	6	0			6	0
Stenochironomus	2	0	3	0	5	0
Pentaneura	4	0			4	0
Polypedilum	2	0			2	0
Tabanus			1	0	1	0
BASOMMATOPHORA	**49**	**6**	**7**	**0**	**56**	**1**
Helisoma	36	4			36	1
Physa	6	0	5	0	11	0
Ferrissia	7	0			7	0
Gyraulus			2	0	2	0
HEMIPTERA	**49**	**6**	**3**	**0**	**52**	**1**
Gerris	21	2	2	0	23	0
Mesovelia mulsanti	16	2			16	0
Trepobates	1	0	11	0	12	0
Plea striola			1	0	1	0

Table A-16, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**10**	**1**	**34**	**1**	**44**	**1**
Cambarinae	8	1	26	1	34	1
Orconectes	2	0	8	0	10	0
PLUMATELLINA	**39**	**5**			**39**	**1**
Pectinatella magnifica	39	5			39	1
HETERODONTIDA	**12**	**1**	**8**	**0**	**20**	**0**
Corbicula flueminia	12	1	8	0	20	0
MEGALOPTERA	**13**	**1**	**4**	**0**	**17**	**0**
Sialis	13	1			13	0
Corydalus cornutus			4	0	4	0
OLIGOCHAETA			**8**	**0**	**8**	**0**
Oligochaeta			8	0	8	0
ACARINA	**5**	**0**			**5**	**0**
Geayia ovata	3	0			3	0
Lebertia	2	0			2	0
PHARYNGOBDELLIDAE			**1**	**0**	**1**	**0**
Mooreobdella anoculata			1	0	1	0
RHYNCHOBDELLIDA	**1**	**0**			**1**	**0**
Helobdella fusca	1	0			1	0
Total #of organisms =	747		2315		3062	
Total #of taxa =	43		54		78	

*0 - actual value < 1.0 but > 0.0

Table A-17. Benthic Community of Dutch Creek
Arkansas River Valley Ecoregion
30-minute Sample (# org./sample), 1985-1986*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**75**	**11**	**265**	**35**	**340**	**24**
Caenis diminuta	22	3	123	16	145	10
Stenonema femoratum	1	0	58	7	59	4
Stenacron interpunctatum	48	7			48	3
Heptagenia			24	3	24	1
Attenella attenuata			20	2	20	1
Paraleptophlebia			20	2	20	1
Baetis			13	1	13	0
Ephemerella needhami			5	0	5	0
Hexagenia limbata	1	0	1	0	2	0
Tricorythodes	2	0			2	0
Ameletus			1	0	1	0
Stenonema exiguum	1	0			1	0
COLEOPTERA	**187**	**21**	**51**	**6**	**238**	**16**
Helichus	43	6	27	3	70	4
Stenelmis crenata	61	9	1	0	62	4
Dineutus discolor	34	5	9	1	43	3
Stenelmis convexula	16	2	6	0	22	1
Gyrinus	10	1	7	0	17	1
Dineutus americanus	4	0			4	0
Scirtes	4	0			4	0
Tropisternus	4	0			4	0
Tropisternus ellipticus	4	0			4	0
Ancyronyx variegata	3	0			3	0
Dubiraphia (larva)	1	0			1	0
Dubiraphia quadrinotata			1	0	1	0
Hydroporus sp.	1	0			1	0
Tropisternus lateralis	1	0			1	0
Uvarus	1	0			1	0
TRICHOPTERA	**146**	**22**	**32**	**4**	**178**	**12**
Cheumatopsyche	137	20	21	2	158	11
Chimarra obscura	8	1			8	0
Hydroptila			6	0	6	0
Agapetus			2	0	2	0
Ceraclea tarsi-punctata	1	0	1	0	2	0
Triaenodes sp. b			1	0	1	0
Triaenodes tarda			1	0	1	0
DIPTERA	**68**	**10**	**109**	**14**	**177**	**12**
Tribelos	26	3			26	1
Cricotopus			24	3	24	1
Polypedilum	2	0	19	2	21	1
Tipula	1	0	18	2	19	1
Hexatoma	2	1	6	0	18	1

Table A-17, cont.

TAXA	Summer org.	Summer %	Spring org.	Spring %	Combined org.	Combined %
Ablabesmyia	6	2			16	1
Procladius	4	0	9	1	13	0
Cryptochironomus			12	1	12	0
Tabanus	3	0	4	0	7	0
Bezzia	1	0	5	0	6	0
Tanytarsus			6	0	6	0
Chrysops	1	0	3	0	4	0
Pilaria			3	0	3	0
Chironomus	1	0			1	0
Stenochironomus	1	0			1	0
PLECOPTERA			**133**	**17**	**133**	**9**
Perlesta placida			128	16	128	9
Amphinemura delosa			2	0	2	0
Prostoia completa			2	0	2	0
Hastaperla brevis			1	0	1	0
ODONATA	**70**	**10**	**25**	**3**	**95**	**6**
Argia	36	5	1	0	37	2
Macromia	12	1	7	0	19	1
Enallagma	8	1	8	1	16	1
Dromogomphus spinosus	6	0	4	0	10	0
Nasiaeschna pentacantha	4	0			4	0
Basiaeschna janata	3	0			3	0
Helocordulia			3	0	3	0
Cordulegaster obligua			1	0	1	0
Erythemis simplicollis	1	0			1	0
Libellula auripennis			1	0	1	0
HEMIPTERA	**33**	**5**	**10**	**1**	**43**	**3**
Rheumatobates	19	2	4	0	23	1
Gerris	3	0	6	0	9	0
Mesovelia mulsanti	5	0			5	0
Ranatra buenoi	2	0			2	0
Ranatra kirkaldyi	2	0			2	0
Trepobates	2	0			2	0
HETERODONTIDA	**24**	**3**	**14**	**1**	**38**	**2**
Corbicula flueminia	24	3	14	1	38	2
MEGALOPTERA	**21**	**3**	**12**	**1**	**33**	**2**
Corydalus cornutus	10	1	12	1	22	1
Sialis	10	1			10	0
Chauliodes	1	0			1	0
ISOPODA			**31**	**4**	**31**	**2**
Lirceus garmani			29	3	29	2
Asellus brevicaudus			2	0	2	0

Table A-17, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**14**	**2**	**15**	**1**	**29**	**2**
Cambarina	12	1	6	0	18	1
Palaemonetes kadiakensis	2	0	4	0	6	0
Cambarus bartoni			5	0	5	0
AMPHIPODA			**19**	**2**	**19**	**1**
Hyalella azteca			16	2	16	1
Stygobromus			3	0	3	0
BASOMMATOPHORA	**6**	**0**	**11**	**1**	**17**	**1**
Physa	2	0	9	1	11	0
Gyraulus	4	0	1	0	5	0
Ferrissia			1	0	1	0
TRICLADIDA	**2**	**0**	**11**	**1**	**13**	**0**
Dugesia tigrina	2	0	11	1	13	0
OLIGOCHAETA			**8**	**1**	**8**	**0**
Oligochaeta			8	1	8	0
ACARINA	**1**	**0**	**6**	**0**	**7**	**0**
Geayia ovata	1	0	6	0	7	0
PHARGOBDELLDAE	**6**	**0**			**6**	**0**
Mooreobdella microstoma	6	0			6	0
RHYNCHOBDELLIDA	**3**	**0**	**3**	**0**	**6**	**0**
Helobdella stagnalis			3	0	3	0
Batrachobdella	1	0			1	0
Helobdella fusca	1	0			1	0
Helobdella punetatolin	1	0			1	0
NEUROPTERA	**1**	**0**			**1**	**0**
Climacia areolaris	1	0			1	0
Total # of organisms	657		755		1412	
Total # of taxa	62		61		92	

*0 - actual value < 1.0 but > 0.0

Table A-18. Benthic Community of Petit Jean River
Arkansas River Valley Ecoregion
30-minute Qualitative Samples (# org./sample), 1985-1986*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
TRICHOPTERA	**344**	**30**	**144**	**18**	**488**	**25**
Cheumatopsyche	313	27	121	15	434	22
Hydropsyche simulans	7	0	8	1	15	0
Chimarra obscura	12	1			12	0
Polycentropus cinereus	4	0	3	0	7	0
Nectopsyche	2	0	3	0	5	0
Cyrnellus fraternus			4	0	4	0
Pycnopsyche			4	0	4	0
Hydroptila	3	0			3	0
Oecetis	2	0	1	0	3	0
Ceraclea tarsi-punctata	1	0			1	0
EPHEMEROPTERA	**271**	**24**	**103**	**12**	**374**	**19**
Caenis	59	14			159	8
Isonychia	41	3	13	1	54	2
Eurylophella bicolor			47	5	47	2
Paraleptophlebia	4	0	19	2	23	1
Tricorythodes	21	1			21	1
Stenacron interpunctatum	18	1			18	0
Stenonema terminatum	14	1			14	0
Stenonema exiguum	12	1			12	0
Ameletus			6	0	6	0
Heptagenia			4	0	4	0
Pseudocloeon dibium			4	0	4	0
Stenonema mediopunctatum			4	0	4	0
Baetis hageni			3	0	3	0
Serratella serratoides			3	0	3	0
Choroterpes basalis	2	0			2	0
DIPTERA	**151**	**13**	**88**	**11**	**239**	**12**
Polypedilum	39	3	21	2	60	3
Chironomus	18	1	24	3	42	2
Conchapelopia	25	2	17	2	42	2
Cricotopus	31	2	4	0	35	1
Tanypus	3	0	6	0	9	0
Chrysops	8	0			8	0
Hexatoma	8	0			8	0
Microtendipes			8	1	8	0
Stenochironomus	8	0			8	0
Hemerodromia	1	0	3	0	4	0
Thienemanniella	4	0			4	0
Pentaneura	3	0			3	0
Tipula			3	0	3	0
Anopheles	2	0			2	0
Tabanus	1	0	1	0	2	0
Simulium jenningsi			1	0	1	0

Table A-18, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**117**	**10**	**92**	**11**	**209**	**10**
Stenelmis crenata	27	2	33	4	60	3
Stenelmis (larva)	16	1	19	2	35	1
Ancyronyx variegata	19	1	12	1	31	1
Optioservus	6	0	16	2	22	1
Dineutus ciliatus	15	1	6	0	21	1
Dubiraphia vittata	11	0			11	0
Tropisternus ellipticus	6	0	1	0	7	0
Dubiraphia	6	0			6	0
Berosus (larva)	4	0			4	0
Peltodytes	3	0			3	0
Dineutus			2	0	2	0
Gyrinus	1	0	1	0	2	0
Scirtes	1	0	1	0	2	0
Berosus styliferus			1	0	1	0
Hydroporus sp.	1	0			1	0
Uvarus	1	0			1	0
ODONATA	**112**	**9**	**64**	**8**	**176**	**9**
Argia	28	2	27	3	55	2
Enallagma	52	4			52	2
Macromia	19	1	2	0	21	1
Ischnura	6	0	11	1	17	0
Progomphus			13	1	13	0
Boyeria vinosa	4	0	4	0	8	0
Dromogomphus spoliatus	1	0	7	0	8	0
Basiaeschna janata	1	0			1	0
Libellula vibrans	1	0			1	0
BASOMMATOPHORA	**13**	**1**	**71**	**8**	**84**	**4**
Physa	3	0	34	4	37	1
Lymnaea	6	0	21	2	27	1
Gyraulus	4	0	16	2	20	1
DECAPODA	**2**	**0**	**51**	**6**	**53**	**2**
Cambarinae			31	3	31	1
Palaemonetes kadiakensis			17	2	17	0
Orconectes meeki brevis			3	0	3	0
Orconectes putnami	2	0			2	0
AMPHIPODA	**18**	**1**	**32**	**4**	**50**	**2**
Hyalella azteca	16	1	21	2	37	1
Gammarus minus	2	0	11	0	13	0
MEGALOPTERA	**35**	**3**	**14**	**1**	**49**	**2**
Corydalus cornutus	31	2	13	1	44	2
Sialis	4	0	1	0	5	0
PLECOPTERA			**47**	**5**	**47**	**2**
Perlesta placida			37	4	37	1

Table A-18, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Hastaperla brevis			8	1	8	0
Amphinemura delosa			1	0	1	0
Phasganophora			1	0	1	0
HETERODONTIDA	**17**	**1**	**25**	**3**	**42**	**2**
Corbicula flueminia	1	1	16	2	33	1
Pisidium			9	1	9	0
OLIGOCHAETA	**12**	**1**	**21**	**2**	**33**	**1**
Oligochaeta	12	1	21	2	33	1
ISOPODA	**8**	**0**	**20**	**2**	**28**	**1**
Lirceus hoppinae	8	0	16	2	24	1
Asellus communis			4	0	4	0
HEMIPTERA	**10**	**0**	**12**	**1**	**22**	**1**
Rheumatobates	4	0	2	0	6	0
Gerris	2	0	2	0	4	0
Mesovelia mulsanti			3	0	3	0
Corixidae			2	0	2	0
Microvelia			2	0	2	0
Ranatra kirkaldyi	1		1	0	2	0
Trepobates	2	0			2	0
Rhagovelia	1	0			1	0
ACARINA	**11**	**0**	**3**	**0**	**14**	**0**
Geayia ovata	11	0	3	0	14	0
PHARYNGOBDELLIDAE	**4**	**0**	**4**	**0**	**8**	**0**
Mooreobdella microstoma	4	0	4	0	8	0
RHYNCHOBDELLIDA			**4**	**0**	**4**	**0**
Placobdella papilliferia			3	0	3	0
Placobdella parasitica			1	0	1	0
NEUROPTERA	**1**	**0**	**2**	**0**	**3**	**0**
Climacia areolaris	1	0	2	0	3	0
COLLEMBOLA	**1**	**0**			**1**	**0**
Isotomurus palustris	1	0			1	
GORDIIDA			**1**	**0**	**1**	**0**
Paragordius			1	0	1	0
Total # of organisms	1127		798		1925	
Total # of taxa	71		73		101	

*0 - actual value < 1.0 but > 0.0

Table A-19. Benthic Community of Cadron Creek
Arkansas River Valley Ecoregion
30-minute Qualitative Samples (# org./sample), 1985-1986*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**140**	**22**	**124**	**20**	**264**	**21**
Uvarus	70	11	27	4	97	8
Peltodytes	15	2	45	7	60	4
Deronectes	23	3			23	1
Hydrovatus	19	3			19	1
Berosus styliferus	4	0	8	1	12	0
Dineutus			12	2	12	0
Helophorus			10	1	10	0
Gyrinus			7	1	7	0
Hydrochus	1	0	6	1	7	0
Dineutus (larva)	1	0	2	0	3	0
Scirtes			3	0	3	0
Bidessus	2	0			2	0
Hydrocanthus			2	0	2	0
Tropisternus	2	0			2	0
Bagous			1	0	1	0
Berosus (larva)	1	0			1	0
Helichus			1	0	1	0
Helocares	1	0			1	0
Listronotus	1	0			1	0
DIPTERA	**159**	**26**	**78**	**13**	**237**	**19**
Chironomus	73	11	24	4	97	8
Glyptotendipes	36	5	21	3	57	4
Tribelos	22	3			22	1
Tanypus	11	1	9	1	20	1
Conchapelopia			16	2	16	1
Probezzia	9	1	3	0	12	0
Cryptochironomus	8	1			8	0
Tipula			4	0	4	0
Tabanus			1	0	1	0
EPHEMEROPTERA	**28**	**4**	**87**	**14**	**115**	**9**
Eurylophella temporalis			55	9	55	4
Stenacron interpunctatum	21	3	16	2	37	3
Caenis	5	0	12	2	17	1
Heptagenia			2	0	2	0
Stenonema femoratum	2	0			2	0
Paraleptophlebia			1	0	1	0
Pseudocloeon dibium			1	0	1	0
HETERODONTIDA	**63**	**10**	**32**	**5**	**95**	**7**
Corbicula flueminia	63	10	32	5	95	7

Table A-19, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
BASOMMATOPHORA	**35**	**5**	**36**	**6**	**71**	**5**
Lymnaea	21	3	16	2	37	3
Physa	14	2	17	2	31	2
Gyraulus			3	0	3	0
DECAPODA	**32**	**5**	**38**	**6**	**70**	**5**
Palaemonetes kadiakensis	27	4	26	4	53	4
Cambarinae	3	0	8	1	11	0
Orconectes	2	0	4	0	6	0
OLIGOCHAETA	**51**	**8**	**13**	**2**	**64**	**5**
Oligochaeta	51	8	13	2	64	5
AMPHIPODA	**17**	**2**	**44**	**7**	**61**	**5**
Hyalella azteca	14	2	31	5	45	3
Gammarus minus	3	0	11	1	14	1
Crangonyx gracilis			2	0	2	0
HEMIPTERA	**8**	**1**	**52**	**8**	**60**	**4**
Corixidae			29	4	29	2
Gerris	3	0	6	1	9	0
Hebrus			8	1	8	0
Gelastocoris occulatus			4	0	4	0
Belostoma	1	0	1	0	2	0
Mesovelia mulsanti			2	0	2	0
Ranatra buenoi	2	0			2	0
Rheumatobates	2	0			2	0
Notonecta			1	0	1	0
Pelocoris			1	0	1	0
ODONATA	**17**	**2**	**40**	**6**	**57**	**4**
Ischnura	3	0	27	4	30	2
Macromia	4	0	6	1	10	0
Argia	6	0	3	0	9	0
Neurocordulia nolesta	1	0	2	0	3	0
Dromogomphus spoliatus	2	0			2	0
Perithemis tenera			2	0	2	0
Boyeria vinosa	1	0			1	0
HAPLOTAXIDA	**39**	**6**	**8**	**1**	**47**	**3**
Dero	26	4	8	1	34	2
Nais	13	2			13	1
TRICHOPTERA	**2**	**0**	**26**	**4**	**28**	**2**
Cyrnellus fraternus	2	0	26	4	28	2

Table A-19, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ISOPODA	**13**	**2**	**5**	**0**	**18**	**1**
Lirceus hoppinae	13	2	2	0	15	1
Asellus communis			3	0	3	0
MEGALOPTERA	**3**	**0**	**2**	**0**	**5**	**0**
Sialis	3	0	2	0	5	0
PHARYNGOBDELLIDAE	**4**	**0**	**1**	**0**	**5**	**0**
Mooreobdella	4	0	1	0	5	0
GORDIIDA			**2**	**0**	**2**	**0**
Paragordius			2	0	2	0
RHYNCHOBDELLIDA			**2**	**0**	**2**	**0**
Helobdella stagnalis			2	0	2	0
PLECOPTERA			**1**	**0**	**1**	**0**
Hastaperla brevis			1	0	1	0
Total # of organisms	611		591		1202	
Total # of taxa	46		58		73	

*0 - actual value < 1.0 but > 0.0

Table A-20. Benthic Community of Board Camp Creek
Ouachita Mountains Ecoregion
30-minute Qualitative Samples (# org./sample), 1984-1985*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**102**	**23**	**345**	**38**	**447**	**33**
Eurylophella bicolor			139	15	139	10
Isonychia	22	5	82	9	104	7
Stenonema mediopunctatum	37	8	65	7	102	7
Tricorythodes	13	3	13	1	26	1
Paraleptophlebia			16	1	16	1
Stenonema terminatum			14	1	14	1
Stenacron interpunctatum	13	3			13	0
Heptagenia			8	0	8	0
Caenis	7	1			7	0
Stenonema femoratum	6	1	1	0	7	0
Choroterpes basalis	2	0	2	0	4	0
Pseudocloeon dibium	1	0	1	0	2	0
Serratella deficiens			2	0	2	0
Baetis tricaudatus			1	0	1	0
Hexagenia limbata			1	0	1	0
Leptophlebia	1	0			1	0
TRICHOPTERA	**172**	**40**	**59**	**6**	**231**	**17**
Cheumatopsyche	125	29	18	2	143	10
Chimarra obscura	16	3	12	1	28	2
dropsychid genus a	21	4			21	1
Pycnopsyche subfasciata			13	1	13	0
Helicopsyche borealis	6	1	4	0	10	0
Rhyacophila			5	0	5	0
Polycentropus cinereus			4	0	4	0
Hydropsyche frisoni			3	0	3	0
Oecetis avara	2	0			2	0
Triaenodes tarda	2	0			2	0
PLECOPTERA	**7**	**1**	**199**	**22**	**206**	**15**
Strophoteryx			143	15	143	10
Amphinemura delosa			33	3	33	2
Perlesta placida			18	2	18	1
Perla clymene	7	1	4	0	11	0
Phasganophora			1	0	1	0
DIPTERA	**16**	**3**	**85**	**9**	**101**	**7**
Polypedilum	4	0	23	2	27	2
Prosimulium mixtum			19	2	19	1
Ablabesmyia	1	0	17	1	18	1
Tribelos			11	1	11	0
Tipula			8	0	8	0

Table A-20, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Cricotopus	2	0	4	0	6	0
Simulium jenningsi	6	1			6	0
Tanypus			3	0	3	0
Antocha	1	0			1	0
Atherix variegata	1	0			1	0
Chrysops	1	0			1	0
ODONATA	**37**	**8**	**52**	**5**	**89**	**6**
Stylogomphus albistylus	7	1	14	1	21	1
Enallagma	12	2	6	0	18	1
Calopteryx	4	0	11	1	15	1
Macromia			13	1	13	0
Argia	7	1	4	0	11	0
Hetaerina	5	1			5	0
Hagenius brevistylus	1	0	3	0	4	0
Boyeria vinosa	1	0			1	0
Dromogomphus spoliatus			1	0	1	0
ISOPODA			**59**	**6**	**59**	**4**
Lirceus garmani			59	6	59	4
COLEOPTERA	**26**	**6**	**30**	**3**	**56**	**4**
Psephenus herricki	13	3	18	2	31	2
Microcylloepus pusillus	5	1	7	0	12	0
Dineutus ciliatus	2	0	3	0	5	0
Stenelmis lateralis	2	0	2	0	4	0
Stenelmis (larva)	2	0			2	0
Paracymus	1	0			1	0
Stenelmis humerosus	1	0			1	0
MEGALOPTERA	**14**	**3**	**21**	**2**	**35**	**2**
Corydalus cornutus	14	3	17	1	31	2
Sialis			4	0	4	0
HEMIPTERA	**24**	**5**	**9**	**1**	**33**	**2**
Rhagovelia	21	4	6	0	27	2
Gerris			3	0	3	0
Microvelia	2	0			2	0
Trepobates	1	0			1	0
AMPHIPODA	**10**	**2**	**18**	**2**	**28**	**2**
Hyalella azteca	10	2	12	1	22	1
Gammarus fasicata			6	0	6	0
BASOMMATOPHORA	**13**	**3**	**2**	**0**	**15**	**1**
Lymnaea	13	3			13	0
Physa			2	0	2	0

Table A-20, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DECAPODA	**3**	**0**	**6**	**0**	**9**	**0**
Cambarinae	3	0	4	0	7	0
Orconectes meeki brevis			2	0	2	0
OLIGOCHAETA			**8**	**0**	**8**	**0**
Oligochaeta			8	0	8	0
ACARINA	**1**	**0**	**3**	**0**	**4**	**0**
Lebertia			3	0	3	0
Hydrachna	1	0			1	0
RHYNCHOBDELLIDA	**1**	**0**			**1**	**0**
Placobdella parasitica	1	0			1	0
Total # Organisms	426		896		1322	
Total # Taxa	46		55		75	

*0 - actual value < 1.0 but > 0.0

Table A-21. Benthic Community of Little Missouri River
Ouachita Mountains Ecoregion
Qualitative Sample (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**37**	**42**	**171**	**64**	**208**	**58**
Ephemerella bicolor			68	25	68	19
Paraleptophlebia mollis			39	15	39	11
Stenonema mediopunctatum	8	9	14	5	22	6
Heptagenia	6	7	9	3	15	4
Stenonema femoratum	1	1	12	5	13	4
Baetis flavistriga			10	4	10	3
Leptophlebia	8	9	1	0	9	3
Baetis hageni			7	3	7	2
Isonychia	4	5	3	1	5	1
Stenacron interpunctatum	2	2	3	1	5	1
Paraleptophlebia guttata	4	5			4	1
Stenonema terminatum			4	2	4	1
Stenonema pulchellum	3	3			3	1
Pseucocloeon dubium	1	1			1	0
Tricorythodes			1	0	1	0
COLEOPTERA	**15**	**17**	**17**	**6**	**32**	**9**
Helichus	11	12	2	0	13	4
Psephenus herricki			9	3	9	3
Dineutus discolor			4	2	4	1
Stenelmis humerosus	2	2	2	1	4	1
Hydrovatus	1	1			1	0
Stenelmis (larva)	1	1			1	0
DIPTERA	**12**	**14**	**17**	**6**	**29**	**8**
Ablabesmyia			10	4	10	3
Tribelos	8	9			8	2
Simulium jenningsi			3	1	3	0
Antocha			1	0	1	0
Cricotopus	1	1			1	0
Cryptochironomus			1	0	1	0
Dixella	1	1			1	0
Eukiefferiella			1	0	1	0
Hemerodromia	1	1			1	0
Procladius	1	1			1	0
Tabanus			1	0	1	0
PLECOPTERA	**3**	**3**	**23**	**9**	**26**	**7**
Neoperla clymene	2	2	5	2	7	2
Amphinemuria delosa			6	2	6	2
Phasganophora capitata			5	2	5	1
Perlesta placida			3	1	3	1
Hastaperla brevis	1	1	1	0	2	1
Isoperla brevis			2	1	2	1
Isoperla mohri			1	0	1	0

Table A-21, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ODONATA	**9**	**10**	**12**	**5**	**21**	**6**
Calopteryx	1	1	6	2	7	2
Stylogomphus albistylus	2	2	3	1	5	1
Boyeria vinosa	2	2	2	1	4	1
Ischnura	2	2			2	1
Macromia	1	1	1	0	2	1
Hagenis brevistylus	1	1			1	0
TRICHOPTERA	**1**	**1**	**20**	**8**	**21**	**6**
Agapetus			11	4	11	3
Cheumatopsyche	1	1	4	2	5	1
Helicopsyche borealis			4	2	4	1
Brachycentrus americanus			1	0	1	0
HEMIPTERA	**5**	**6**	**2**	**1**	**7**	**2**
Microvelia			2	1	2	1
Rhagovelia obesa	2	2			2	1
Treptobates	2	2			2	1
Ranatra buenoa	1	1			1	0
DECAPODA	**3**	**3**	**3**	**1**	**6**	**2**
Cambarinae (female & imt.)	3	3	2	1	5	1
Orconectes difficilis			1	0	1	0
MEGALOPTERA	**3**	**3**	**2**	**1**	**5**	**1**
Corydalus cornutus	3	3	2	1	5	1
AMPHIPODA			**1**	**0**	**1**	**0**
Hyalella azteca			1	0	1	0
ACARINA	**1**	**1**			**1**	**0**
Hydrachna	1	1			1	0
Total # Organisms	89		268		357	
Total # Taxa	33		42		57	

*0 - actual value < 1.0 but > 0.0

Table A-22. Benthic Community of South Fork Ouachita River - Qualitative Sample (# org./sample) 1983-84*
Ouachita Mountains Ecoregion

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**65**	**46**	**95**	**36**	**160**	**40**
Tricorythodes	37	26			37	9
Eurylophella temporalis			30	11	30	8
Stenonema femoratum	1	1	23	9	24	6
Caenis	10	7	11	4	21	5
Stenonema mediopunctatum	14	10	5	2	19	5
Isonychia	4	3	10	4	14	4
Stenacron interpunctatum			9	3	9	2
Eurylophella bicolor			4	2	4	1
Choroterpes	2	1			2	1
Leptophlebia			2	1	2	1
Habrophlebiodes			1	0	1	0
ODONATA	**24**	**17**	**27**	**10**	**51**	**13**
Stylogomphus albistylus	3	2	11	4	14	4
Boyeria vinosa	11	8	2	1	13	3
Ischnura	7	5	6	2	13	3
Calopteryx	2	1	3	1	5	1
brevistylus	1	1	3	1	4	1
Neurocordulia molesta			2	1	2	1
GASTROPODA	**11**	**8**	**39**	**15**	**50**	**13**
Viviparus	11	8	37	14	48	12
Ferrissia			1	0	1	0
Gyraulus			1	0	1	0
COLEOPTERA	**21**	**15**	**9**	**3**	**30**	**8**
Dubiraphia vittata	6	4			6	2
Helichus	3	2	2	1	5	1
Stenelmis	5	4			5	1
Macronychus glabratus	2	1	1	0	3	1
Ancyronyx variegata	2	1			2	1
Gyrinus	2	1			2	1
Helichus (larva)			2	1	2	1
Psephenus herricki			2	1	2	1
Berosus			1	0	1	0
Laccornis			1	0	1	0
Microcylloepus pusillus	1	1			1	0
PLECOPTERA	**1**	**1**	**25**	**10**	**26**	**7**
Perlesta placida			14	5	14	4
Amphinemura delosa			5	2	5	1
Isoperla brevis			4	2	4	1
Neoperla clymene	1	1	1	0	2	1
Hastaperla brevis			1	0	1	0

Table A-22, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined org.	Combined %
DIPTERA	**1**	**1**	**22**	**8**	**23**	**6**
Ablabesmyia			15	6	15	4
Tipula			4	2	4	1
Polypedilum			1	0	1	0
Simulium jenningsi			1	0	1	0
Stenochironomus			1	0	1	0
Tribelos	1	1			1	0
DECAPODA	**3**	**2**	**12**	**5**	**15**	**4**
Cambarinae			7	3	7	2
Orconectes bisectus	3	2			3	1
Orconectes leptogonopodus			3	1	3	1
Orconectes difficilis			2	1	2	1
TRICHOPTERA	**3**	**2**	**11**	**4**	**14**	**6**
Agapetus			6	2	6	2
Pycnopsyche			2	1	2	1
Nectopsyche	1	1	1	0	2	1
Helicopsyche borealis			1	0	1	0
Oecetes arva	1	1			1	0
Polycentropus remotus			1	0	1	0
Tascobia	1	1			1	0
AMPHIPODA			**12**	**5**	**12**	**3**
Hyalella azteca			11	4	11	3
Stygobromus			1	0	1	0
PELECYPODA	**4**	**3**	**7**	**3**	**11**	**3**
Corbicula flueminia	4	3	7	3	11	3
MEGALOPTERA	**1**	**1**	**3**	**1**	**4**	**1**
Corydalus cornutus	1	1	3	1	4	1
HEMIPTERA	**4**	**3**			**4**	**1**
Rheumatobates	3	2			3	1
Gerris	1	1			1	0
ACARINA	**3**	**2**			**3**	**1**
Hydrachna	3	2			3	1
Total # Organisms	141		262		399	
Total # Taxa	30		46		57	

*0 - actual value < 1.0 but > 0.0

Table A-23. Benthic Community of Cossatot River
Ouachita Mountains Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**122**	**17**	**251**	**36**	**373**	**26**
Eurylophella verisilis			207	29	207	14
Pseudocloeon dibium	51	7	7	1	58	4
Stenacron interpunctatum	19	2			19	1
Isonychia	17	2			17	1
Callibaetis	14	1			14	1
Eurylophella bicolor			14	2	14	1
Stenonema femoratum	6	0	8	1	14	1
Stenonema mediopunctatum	7	0	6	0	13	0
Ephemerella needhami			5	0	5	0
Stenonema exiguum	4	0			4	0
Choroterpes basalis	2	0			2	0
Eperous			2	0	2	0
Tricorythodes	2	0			2	0
Ephemerella argo			1	0	1	0
Stenonema tripunctatum			1	0	1	0
TRICHOPTERA	**294**	**41**	**21**	**3**	**315**	**22**
Cheumatopsyche	131	18	11	1	142	10
Hydropsychid genus a	62	8			62	4
Chimarra obscura	61	8			61	4
Helicopsyche borealis	28	3	4	0	32	2
Nectopsyche	11	1	3	0	14	1
Brachycentrus			1	0	1	0
Ceraclea tarsi-punctata	1	0			1	0
Chimarra aterrima			1	0	1	0
Pycnopsyche subfasciata			1	0	1	0
ISOPODA			**176**	**25**	**176**	**12**
Lirceus garmani			176	25	176	12
COLEOPTERA	**61**	**8**	**46**	**6**	**107**	**7**
Stenelmis humerosus	21	2	17	2	38	2
Stenelmis (larva)	12	1	14	2	26	1
Psephenus herricki	17	2	6	0	23	1
Microcylloepus pusillus	5	0	2	0	7	0
Paracymus	2	0	1	0	3	0
Berosus (larva)			2	0	2	0
Microcylloepus (larva)			2	0	2	0
Berosus	1	0			1	0
Chaetarthria	1	0			1	0
Ectopria			1	0	1	0
Hydrovatus	1	0			1	0
Laccobius			1	0	1	0
Tropisternus	1	0			1	0

Table A-23, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ODONATA	**61**	**8**	**32**	**4**	**93**	**6**
Argia	17	2	1	0	18	1
Dromogomphus spinosus	16	2	2	0	18	1
Enallagma	10	1	5	0	15	1
Macromia	7	0	6	0	13	0
Hagenius brevistylus	7	0	2	0	9	0
Stylogomphus albistylus			7	1	7	0
Calopteryx			4	0	4	0
Boyeria vinosa			3	0	3	0
Hetaerina	1	0	2	0	3	0
Basiaeschna janata	1	0			1	0
Epitheca princeps	1	0			1	0
Somatochlora	1	0			1	0
DIPTERA	**41**	**5**	**24**	**3**	**65**	**4**
Tribelos	18	2	8	1	26	1
Simulium jenningsi	4	0	4	0	8	0
Tabanus	8	1			8	0
Cricotopus	4	0	3	0	7	0
Prosimuluim mixtum			6	0	6	0
Atherix variegata	3	0			3	0
Ablabesmyia mallochi			2	0	2	0
Hexatoma	2	0			2	0
Ablabesmyia	1	0			1	0
Limnophila			1	0	1	0
Tipula	1	0			1	0
MESOGASTROPODA	**32**	**4**	**28**	**4**	**60**	**4**
Viviparus	32	4	28	4	60	4
HEMIPTERA	**21**	**2**	**36**	**5**	**57**	**4**
Ranatra nigra			28	4	28	2
Rhagovelia	10	1	3	0	13	0
Metrobates	5	0	1	0	6	0
Gerris			4	0	4	0
Mesovelia mulsanti	3	0			3	0
Palmacorixa	2	0			2	0
Ranatra kirkaldyi	1	0			1	0
PLECOPTERA	**4**	**0**	**53**	**7**	**57**	**4**
Perlesta placida			22	3	22	1
Amphinemura delosa			14	2	14	1
Hastaperla brevis			11	1	11	0
Isoperla namata			3	0	3	0
Acroneuria mela	2	0			2	0
Neoperla	2	0			2	0
Phasganophora			2	0	2	0
Isoperla brevis			1	0	1	0

Table A-23, cont.

TAXA	Summer org.	%	Spring org.	%	Combined org.	%
MEGALOPTERA	**23**	**3**	**10**	**1**	**33**	**2**
Corydalus cornutus	21	2	9	1	30	2
Sialis	2	0	1	0	3	0
DECAPODA	**12**	**1**	**9**	**1**	**21**	**1**
Cambarinae	12	1	5	0	17	1
Orconectes marchandi			3	0	3	0
Orconectes neglectus			1	0	1	0
BASOMMATOPHORA	**9**	**1**	**2**	**0**	**11**	**0**
Gyraulus	4	0	2	0	6	0
Ferrissia	5	0			5	0
AMPHIPODA	**4**	**0**	**3**	**0**	**7**	**0**
Hyalella azteca	4	0	3	0	7	0
LEPIDOPTERA	**6**	**0**	**1**	**0**	**7**	**0**
Nymphula	6	0			6	0
Petrophila			1	0	1	0
OLIGOCHAETA	**5**	**0**			**5**	**0**
Oligochaeta	5	0			5	0
PHARYNGOBDELLIDAE	**5**	**0**			**5**	**0**
Mooreobdella microstoma	5	0			5	0
PROSOPORA			**4**	**0**	**4**	**0**
Lumbricidae			4	0	4	0
RHYNCHOBDELLIDA	**2**	**0**			**2**	**0**
Helobdella punetatolin	1	0			1	0
Placobdella parasitica	1	0			1	0
Total # Organisms	702		696		1398	
Total # Taxa	60		60		92	

*0 - actual value < 1.0 but > 0.0

Table A-24. Benthic Community of Caddo River
Ouachita Mountains Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**794**	**38**	**1053**	**29**	**1847**	**32**
Isonychia	324	15	126	3	450	7
Tricorythodes	119	5	183	5	302	5
Pseudocloeon dibium			159	4	159	2
Stenonema mediopunctatum	150	7	9	0	159	2
Caenis	10	0	108	3	118	2
Stenonema femoratum	7	0	108	3	115	2
Serratella serratoides			96	2	96	1
Baetis flavistriga	2	0	93	2	95	1
Stenonema terminatum	20	0	51	1	71	1
Baetis	52	2			52	0
Hexagenia limbata	39	1			39	0
Stenacron interpunctatum	24	1	9	0	33	0
Eurylophella bicolor			27	0	27	0
Rhithrogena pellucida			24	0	24	0
Stenonema exiguum	10	0	12	0	22	0
Stenonema pulchellum	21	1			21	0
Attenella attenuata			12	0	12	0
Heptagenia maculipennis			12	0	12	0
Siphlonurus			12	0	12	0
Heptagenia	5	0	6	0	11	0
Choroterpes	6	0	3	0	9	0
Ephemerella argo			3	0	3	0
Paraleptophlebia	3	0			3	0
Ephemera simulans	1	0			1	0
Potamanthus	1	0			1	0
DIPTERA	**104**	**5**	**738**	**20**	**842**	**14**
Simulium jenningsi	1	0	546	15	547	9
Tanytarsus			66	1	66	1
Stenochironomus	4	0	48	1	52	0
Hexatoma	37	1			37	0
Polypedilum	24	1	12	0	36	0
Cricotopus			24	0	24	0
Atherix variegata	4	0	12	0	16	0
Probezzia	2	0	12	0	14	0
Ablabesmyia	10	0			10	0
Tabanus	3	0	6	0	9	0
Microtendipes	8	0			8	0
Tipula	2	0	6	0	8	0
Tribelos	2	0	6	0	8	0
Pherbellia	3	0			3	0
Atrichopogon	2	0			2	0
Bezzia	1	0			1	0
Simulium	1	0			1	0

Table A-24, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
TRICHOPTERA	**390**	**18**	**342**	**9**	**732**	**13**
Cheumatopsyche	231	11	108	3	339	6
Chimarra obscura	109	5	72	2	181	3
Helicopsyche borealis	4	0	72	2	76	1
Brachycentrus	1	0	24	0	25	0
Hydropsyche simulans	1	0	21	0	22	0
Nectopsyche	1	0	18	0	19	0
Triaenodes sp. b	7	0	12	0	19	0
Hydroptilla hamata	11	0	6	0	17	0
Hydropsyche venularis	10	0			10	0
Orthotrichia	8	0			8	0
Oecetis cinerascens	1	0	6	0	7	0
Polycentropus centralis	2	0	3	0	5	0
Oecetis avara	2	0			2	0
Oecetis eddlestoni	1	0			1	0
Oxyethira	1	0			1	0
COLEOPTERA	**254**	**12**	**387**	**10**	**641**	**11**
Helichus	51	2	114	3	165	2
Stenelmis lateralis	56	2			56	0
Peltodytes	2	0	51	1	53	0
Gyretes	22	1	27	0	49	0
Psephenus herricki	6	0	39	1	45	0
Microcylloepus pusillus			36	1	36	0
Microcylloepus (larva)	6	0	18	0	24	0
Ancyronyx variegata	17	0	6	0	23	0
Tropisternus ellipticus	14	0	9	0	23	0
Dineutus ciliatus	11	0	9	0	20	0
Macronychus glabratus	19	0			19	0
Optioservus	7	0	12	0	19	0
Ancyronyx variegata			18	0	18	0
Stenelmis sexlineata			12	0	12	0
Dubiraphia			9	0	9	0
Macronychus glabratus			9	0	9	0
Hetereimis	8	0			8	0
Hydrocanthus	1	0	6	0	7	0
Gonielmis			6	0	6	0
Scirtes			6	0	6	0
Neoelmis caesa	5	0			5	0
Berosus striatus	4	0			4	0
Ectopria	3	0			3	0
Tropisternus lateralis	3	0			3	0
Coptotomus	2	0			2	0
Dubiraphia vittata	2	0			2	0
Helophorus	2	0			2	0
Stenelmis crenata	2	0			2	0
Tanysphyrus	2	0			2	0
Tropisternus (larva)	2	0			2	0
Uvarus	2	0			2	0
Chaetarthria	1	0			1	0

Table A-24, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Dineutus sp. 2	1	0			1	0
Dineutus (larva)	1	0			1	0
Hydrocanthus (larva)	1	0			1	0
Paracymus	1	0			1	0
PLECOPTERA	**15**	**0**	**327**	**9**	**342**	**6**
Perlesta placida			225	6	225	3
Neoperla	14	0	93	2	107	1
Hastaperla brevis			6	0	6	0
Acroneuria	1	0	3	0	4	0
ODONATA	**166**	**8**	**135**	**3**	**301**	**5**
Enallagma	26	1	51	1	77	1
Hetaerina	47	2	12	0	59	1
Macromia	15	0	24	0	39	0
Argia	20	0	9	0	29	0
Dromogomphus spoliatus	25	1			25	0
Stylogomphus albistylus	2	0	12	0	14	0
Basiaeschna janata	11	0			11	0
Neurocordulia xanthosoma			9	0	9	0
Hagenius brevistylus	2	0	6	0	8	0
Dythemis	1	0	6	0	7	0
Boyeria vinosa	6	0			6	0
Gomphus externus	5	0			5	0
Dromogomphus spinosus	1	0	3	0	4	0
Gomphus vastus	1	0	3	0	4	0
Ischnura	4	0			4	0
MESOGASTROPODA	**120**	**5**	**93**	**2**	**213**	**3**
Lioplax	98	4			98	1
Viviparus	3	0	93	2	96	1
Hydrobia nickliniana	19	0			19	0
DECAPODA	**22**	**1**	**162**	**4**	**184**	**3**
Cambarinae	9	0	129	3	138	2
Orconectes	6	0	21	0	27	0
Procambarus tenus	1	0	12	0	13	0
Cambarus hubbsi	6	0			6	0
HETERODONTIDA	**75**	**3**	**87**	**2**	**162**	**2**
Corbicula flueminia	75	3	87	2	162	2
MEGALOPTERA	**62**	**2**	**33**	**0**	**95**	**1**
Corydalus cornutus	61	2	24	0	85	1
Sialis	1	0	9	0	10	0

Table A-24, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
BASOMMATOPHORA	**21**	**1**	**48**	**1**	**69**	**1**
Physa	12	0	18	0	30	0
Gyraulus	2	0	18	0	20	0
Ferrissia	7	0	12	0	19	0
HEMIPTERA	**26**	**1**	**42**	**1**	**68**	**1**
Mesovelia mulsanti	4	0	21	0	25	0
Metrobates	15	0			15	0
Gerris			9	0	9	0
Rhagovelia	2	0	6	0	8	0
Gelastocoris occulatus			6	0	6	0
Trepobates	3	0			3	0
Rheumatobates	2	0			2	0
ISOPODA	**6**	**0**	**48**	**1**	**54**	**0**
Lirceus hoppinae	6	0	48	1	54	0
AMPHIPODA	**5**	**0**	**15**	**0**	**20**	**0**
Hyaella azteca	5	0	12	0	17	0
Gammarus fasciatus			3	0	3	0
HAPLOTAXIDA			**18**	**0**	**18**	**0**
Nais			18	0	18	0
LEPIDOPTERA	**2**	**0**	**15**	**0**	**17**	**0**
Petrophila			9	0	9	0
Prionoxystus			6	0	6	0
Parargyractis	2	0			2	0
PHARYNGOBDELLIDAE	**2**	**0**	**9**	**0**	**11**	**0**
Mooreobdella microstoma	1	0	9	0	10	0
Dina lateralis	1	0			1	0
OLIGOCHAETA	**7**	**0**			**7**	**0**
Oligochaeta	7	0			7	0
PROSOPORA	**2**	**0**			**2**	**0**
Lumbriculidae	2	0			2	0
TRICLADIDA	**1**	**0**			**1**	**0**
Cura foremanii	1	0			1	0
Total # Organisms	2074		3552		5626	
Total # Taxa	118		91		145	

*0 - actual value < 1.0 but > 0.0

Table A-25. Benthic Community of Saline River
Ouachita Mountains Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**292**	**25**	**298**	**35**	**590**	**30**
Isonychia	147	13	21	2	168	8
Tricorythodes	62	5	27	3	89	4
Caenis	24	2	58	6	82	4
Eurylophella temporalis			37	4	37	1
Stenacron interpunctatum	14	1	19	2	33	1
Serratella serratoides			32	3	32	1
Baetis flavistriga	14	1	15	1	29	1
Stenonema pulchellum	6	0	14	1	20	1
Stenonema terminatum	5	0	13	1	18	0
Rhithrogena pellucida			15	1	15	0
Stenonema exiguum	2	0	13	1	15	0
Stenonema femoratum	9	0			9	0
Attenella attenuata			8	0	8	0
Callibaetis			7	0	7	0
Potamanthus	6	0	1	0	7	0
Eurylophella bicolor			6	0	6	0
Stenonema mediopunctatum			6	0	6	0
Ephoron leukon			4	0	4	0
Heptagenia			2	0	2	0
Hexagenia limbata	1	0			1	0
Paraleptophlebia	1	0			1	0
Siphlonurus	1	0			1	0
COLEOPTERA	**286**	**25**	**160**	**19**	**446**	**22**
Helichus	79	7	27	3	106	5
Gyretes	93	8			93	4
Dineutus discolor	71	6			71	3
Optioservus	22	1	9	1	31	1
Stenelmis sexlineata			31	3	31	1
Microcylloepus pusillus	4	0	20	2	24	1
Macronychus glabratus			21	2	21	1
Psephenus herricki	4	0	14	1	18	0
Stenelmis (larva)			17	2	17	0
Microcylloepus (larva)			11	1	11	0
Macronychus glabratus	4	0			4	0
Ancyronyx variegata	2	0	1	0	3	0
Gyrinus			3	0	3	0
Dubiraphia (larva)			2	0	2	0
Tropisternus (larva)	2	0			2	0
Berosus striatus	1	0			1	0
Berosus (larva)			1	0	1	0
Dubiraphia vittata			1	0	1	0
Gonielmis			1	0	1	0
Hydaticus			1	0	1	0
Tanysphyrus	1	0			1	0

Table A-25, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Tropisternus lateralis	1	0			1	0
Tropisternus mexicanus	1	0			1	0
Uvarus	1	0			1	0
DIPTERA	**147**	**13**	**52**	**6**	**199**	**10**
Stictochironomus	93	8			93	4
Tribelos	24	2	2	0	26	1
Ablabesmyia	2	0	17	2	19	0
Cricotopus			15	1	15	0
Simulium jenningsi	8	0	5	0	13	0
Tanytarsus	8	0	3	0	11	0
Bezzia			7	0	7	0
Microtendipes	4	0			4	0
Tipula	2	0	2	0	4	0
Hemerodromia	3	0			3	0
Polypedilum	2	0	1	0	3	0
Hexatoma	1	0			1	0
PLECOPTERA	**4**	**0**	**151**	**18**	**155**	**7**
Perlesta placida			139	16	139	6
Acroneuria mela	4	0	3	0	7	0
Acroneuria evoluta			4	0	4	0
Hastaperla brevis			2	0	2	0
Neoperla			2	0	2	0
Amphinemura delosa			1	0	1	0
ODONATA	**109**	**9**	**23**	**2**	**132**	**6**
Ischnura	48	4			48	2
Hetaerina	14	1	2	0	6	0
Argia	8	0	7	0	15	0
Basiaeschna janata	12	1			12	0
Macromia	7	0	3	0	10	0
Enallagma	9	0			9	0
Stylogomphus albistylus	1	0	8	0	9	0
Gomphus vastus	7	0			7	0
Boyeria vinosa			2	0	2	0
Dromogomphus spinosus	1	0	1	0	2	0
Dromogomphus spoliatus	1	0			1	0
Somatochlora	1	0			1	0
TRICHOPTERA	**86**	**7**	**42**	**5**	**128**	**6**
Cheumatopsyche	8	0	39	4	47	2
Chimarra obscura	31	2	3	0	34	1
Triaenodes sp. b	29	2			29	1
Oecetis eddlestoni	6	0			6	0
Helicopsyche borealis	4	0			4	0
Hydropsyche simulans	2	0			2	0

Table A-25, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Ochrotrichia	2	0			2	0
Phylocentropus	2	0			2	0
Cernotina	1	0			1	0
Neureclipsis crepuscula	1	0			1	0
MEGALOPTERA	**43**	**3**	**11**	**1**	**54**	**2**
Corydalus cornutus	39	3	9	1	48	2
Sialis	4	0	2	0	6	0
HERODONTIDA	**35**	**3**	**11**	**1**	**46**	**2**
Corbicula flueminia	35	3	11	1	46	2
DECAPODA	**17**	**1**	**24**	**2**	**41**	**2**
Cambarinae	12	1	21	2	33	1
Procambarus tenus	4	0			4	0
Cambarus hubbsi	1	0	2	0	3	0
Procamburus ouachitae			1	0	1	0
HEMIPTERA	**28**	**2**	**7**	**0**	**35**	**1**
Rheumatobates	12	1			12	0
Gerris	6	0	2	0	8	0
Trepobates	5	0			5	0
Mesovelia mulsanti	4	0			4	0
Rhagovelia			3	0	3	0
Gelastocoris occulatus			2	0	2	0
Metrobates	1	0			1	0
BASOMMATOPHORA	**24**	**2**	**2**	**0**	**26**	**1**
Physa	23	2			23	1
Gyraulus	1	0	2	0	3	0
ISOPODA	**4**	**0**	**21**	**2**	**25**	**1**
Lirceus hoppinae	4	0	21	2	25	1
OLIGOCHAETA	**11**	**0**	**10**	**1**	**21**	**1**
Oligochaeta	11	0	10	1	21	1
AMPHIPODA	**16**	**1**	**4**	**0**	**20**	**1**
Hyalella azteca	16	1	4	0	20	1
MESOGASTROPODA	**13**	**1**	**7**	**0**	**20**	**1**
Viviparus	7	0	1	0	8	0
Anculosa			6	0	6	0
Hydrobia nickliniana	6	0			6	0
ACARINA	**4**	**0**	**1**	**0**	**5**	**0**
Geayia ovata	4	0	1	0	5	0

Table A-25, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
RHYNCHOBDELLIDA	**2**	**0**	**3**	**0**	**5**	**0**
Placobdella papillifera	1	0	3	0	4	0
Batrachobdella	1	0			1	0
PHARYNGOBDELLIDAE	**1**	**0**	**3**	**0**	**4**	**0**
Dina lateralis	1	0	2	0	3	0
Mooreobdella microstoma			1	0	1	0
PROSOPORA	**4**	**0**			**4**	**0**
Lumbriculidae	4	0			4	0
LEPIDOPTERA			**1**	**0**	**1**	**0**
Prionoxystus			1	0	1	0
Total # Organisms	1126		831		1957	
Total # Taxa	82		75		116	

*0 - actual value < 1.0 but > 0.0

Table A-26. Benthic Community of South Fork of Spavinaw Creek
Ozark Highlands Ecoregion
Qualitative Samples (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**30**	**18**	**236**	**27**	**266**	**26**
Eurylophella temporalis			77	9	77	8
Paraleptophlebia gutatta			31		31	3
Ephemerella argo			29	3	29	3
Baetis intercalaris	20	12			20	2
Ephemerella bicolor			17	2	17	2
Pseudocloeon dubium			16	2	16	2
Paraleptophebia mollis			16	2	16	2
Stenonema pulchellum	4	3	10	1	14	1
Heptagenia	6	4	6	1	12	1
Baetis tricaudatus			3	0	3	0
Leptophlebia			3	0	3	0
Siphlonurus quebecensis			3	0	3	0
Isonychia			2	0	2	0
Stenacron interpunctatum			2	0	2	0
Caenis			1	0	1	0
Eurylophella funerallis			1	0	1	0
Stenonema femoratum			1	0	1	0
GASTROPODA	**62**	**38**	**164**	**19**	**226**	**22**
Viviparus	61	37	125	14	186	17
Physa			19	2	19	2
Helisoma			15	2	15	2
Gyraulus	1	1	3	0	4	0
Ferrissia			2	0	2	0
TRICHOPTERA	**19**	**12**	**160**	**19**	**179**	**17**
Cheumatopsyche	6	4	67	8	73	7
Chimarra obscura	1	1	51	6	52	5
Pycnopsyche subfaciata			21	2	21	2
Helicopsyche borealis	1	1	7	1	8	1
Symphitopsyche bifida	8	5			8	1
Polycentropus cinereus			6	1	6	1
Neophylax	3	2	1	0	4	0
Agapetus			2	0	2	0
Ceraclea tarsi-punctatus			2	0	2	0
Polycentropus interruptus			2	0	2	0
Ochrotrichia			1	0	1	0
PLECOPTERA	**9**	**6**	**99**	**1**	**108**	**11**
Acroneuria evoluta	8	5	28	3	36	4
Neoperla clymene	1	1	33	4	34	3
Amphinemuria delosa			13	2	13	1
Phasganophora capitata			10	1	10	1
Hastaperla brevis			5	1	5	1

Table A-26, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Perlesta placida			4	0	4	0
Isoperla mohri			3	0	3	0
Isoperla brevis			1	0	1	0
Isoperla namata			1	0	1	0
Perlinella dryno			1	0	1	0
DECAPODA	**2**	**1**	**56**	**7**	**58**	**6**
Cambarinae	2	1	38	4	40	4
Orconectes sp.			17	2	17	2
Orconectes neglectis			1	0	1	0
ODONATA	**4**	**3**	**51**	**6**	**55**	**5**
Stylogomphus albystylus			32	4	32	3
Hetaerina			17	2	17	2
Boyeria vinosa	2	1	2	0	4	0
Argia	1	1			1	0
Dromogomphus spinosus	1	1			1	0
COLEOPTERA	**21**	**13**	**28**	**3**	**49**	**5**
Psephenus herricki	21	13	20	2	41	4
Peltodytes			3	0	3	0
Optioservis			2	0	2	0
Dubiraphia vitatta			1	0	1	0
Optioservis (larva)			1	0	1	0
Hydroporus			1	0	1	0
DIPTERA	**6**	**4**	**35**	**4**	**41**	**4**
Polypedilum	2	1	8	1	10	1
Ablabesmyia			8	1	8	1
Chironomus	3	2	1	0	4	0
Simulium jenningsi			4	0	4	0
Tribelos			4	0	4	0
Circotopus			3	0	3	0
Tipula			3	0	3	0
Brilla			2	0	2	0
Hexatoma			2	0	2	0
Aedes	1	1			1	0
AMPHIPODA			**16**	**2**	**16**	**2**
Hyalella azteca			16	2	16	2
HEMIPTERA	**4**	**3**	**7**	**1**	**11**	**1**
Gerris	3	2	1	0	4	0
Microvelia			4	0	4	0
Belostoma			2	0	2	0
Rhagovelia	1	1			1	0

Table A-26, cont.

TAXA	Summer # org.	%	Spring # org.	%	Combined # org.	%
MEGALOPTERA	**6**	**4**	**4**	**0**	**10**	**1**
Corydalus cornutus	6	4	4	0	10	1
LEPIDOPTERA			**1**	**0**	**1**	**0**
Parargyractis			1	0	1	0
Total # Organisms	163		867		1030	
Total # Taxa	23		71		77	

*0 - actual value < 1.0 but > 0.0

Table A-27. Benthic Community of Flint Creek
Ozark Highlands Ecoregion
Qualitative Samples (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**42**	**25**	**106**	**25**	**148**	**24**
Baetis tricaudatus			34	8	34	6
Eurylophella temporalis			21	5	21	4
Ameletus lineatus	17	10			17	3
Stenonema pulchellum	1	1	13	3	14	2
Isonychia	3	2	8	2	11	2
Caenis	1	1	8	2	9	2
Stenonema femoratum	7	4			7	1
Choroterpes basilis	6	4			6	1
Stenonema mediopunctatum	5	3			5	1
Paraleptophlebia			4	1	4	1
Pseudocloeon dubium			4	1	4	1
Stenacron interpunctatum			4	1	4	1
Stenonema terminatum			3	1	3	1
Heptagenia			2	0	2	0
Leptophlebia			2	0	2	0
Stenonema exiguum			2	0	2	0
Baetis hageni	1	1			1	0
Siphlonurus marshalli			1	0	1	0
Tricorythodes	1	1			1	0
DECAPODA	**3**	**2**	**64**	**15**	**67**	**11**
Cambarinae			46	11	46	8
Orconectes punctimanus	3	2	18	4	21	4
PLECOPTERA	**5**	**3**	**61**	**14**	**66**	**11**
Perlesta placida			45	10	45	7
Acroneuria arida	5	3	4	1	9	2
Amphinemuria delosa			8	2	8	1
Isoperla brevis			2	0	2	0
Hastaperla brevis			1	0	1	0
Neoperla clymene			1	0	1	0
TRICHOPTERA	**22**	**13**	**42**	**10**	**64**	**11**
Helicopsyche borealis	12	7	24	6	36	6
Neophylax	2	1	7	2	9	2
Cheumatopsyche	3	2	3	1	6	1
Chimarra obscura			5	1	5	1
Symphitopsyche bifida	5	3			5	1
Agapetus			1	0	1	0
Hydropsyche			1	0	1	0
Pycnopsyche			1	0	1	0
AMPHIPODA	**45**	**6**	**7**	**2**	**52**	**9**
Hyalella azteca	45	20	7	2	52	9

Table A-27, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DIPTERA	**3**	**2**	**40**	**9**	**43**	**7**
Polypedilum	2	1	21	5	23	4
Chironomus			6	1	6	1
Simulium jenningsi			5	1	5	1
Brilla			3	1	3	0
Ptychoptera			3	1	3	0
Neoscatella			2	0	2	0
Atrichopogon			1	0	1	0
Conchapelopia	1	1			1	0
Limnophora			1	0	1	0
GASTROPODA	**10**	**6**	**33**	**8**	**43**	**7**
Physa	3	2	25	6	28	5
Ferrissia			7	2	7	1
Viviparus	7	4			7	1
Lymnaea			1	0	1	0
ODONATA	**18**	**11**	**10**	**2**	**28**	**5**
Hetaerina	4	2	6	1	10	2
Ischnura	7	4			7	1
Argia	3	2			3	0
Boyeria vinosa			3	1	3	0
Calopteryx	3	2			3	0
Sympetrum corruptum			1	0	1	0
Stylogomphus albistylus	1	1			1	0
COLEOPTERA	**7**	**4**	**19**	**4**	**26**	**4**
Psephenus herricki	5	3	13	3	18	3
Gonielmis			2	0	2	0
Helochares			2	0	2	0
Stenelmis	1	1			1	0
Dubiraphia vittata	1	1			1	0
Scirtes			1	0	1	0
ISOPODA			**21**	**5**	**21**	**4**
Lirceus hoppinae			21	5	21	4
MEGALOPTERA	**4**	**2**	**10**	**2**	**14**	**2**
Corydalus cornutus	4	2	10	2	14	2
ANNELIDA			**13**	**3**	**13**	**2**
Mooreobdella microstoma			12	3	12	2
Bdellarogatis plumbea			1	0	1	0

Table A-27, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HEMIPTERA	**9**	**5**	**3**	**1**	**12**	**2**
Treptobates	2	1	1	0	3	0
Rheumatobates	2	1			2	0
Corixidae			1	0	1	0
Gerris			1	0	1	0
Hydrometra martini	1	1			1	0
Metrobates	1	1			1	0
Microvelia	1	1			1	0
Ranatra fusca	1	1			1	0
Rhagovelia	1	1			1	0
LEPIDOPTERA			**4**	**1**	**4**	**1**
Parargyractis			4	1	4	1
PELECYPODA	**2**	**1**			**2**	**0**
Corbicula flueminia	2	1			2	0
TURBELLARIA	**1**	**1**			**1**	**0**
Dugesia tigrina	1	1			1	0
Total # Organisms	167		433		600	
Total # Taxa	38		57		78	

*0 - actual value < 1.0 but > 0.0

Table A-28. Benthic Community of Yocum Creek
Ozark Highlands Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**162**	**22**	**422**	**42**	**584**	**34**
Eurylophella bicolor			146	14	146	8
Caenis	5	0	83	8	88	5
Baetis tricaudatus	43	5	21	2	64	3
Stenonema terminatum	36	4	28	2	64	3
Isonychia	36	4	21	2	57	3
Ephemerella dorothea			49	4	49	2
Stenonema mediopunctatum	20	2	20	2	40	2
Stenacron interpunctatum	3	0	18	1	21	1
Choroterpes basalis	3	0	12	1	15	0
Pseudocloeon dibium			14	1	14	0
Heptagenia	5	0	7	0	12	0
Pentagenia vittigera	7	0			7	0
Stenonema exiguum	3	0			3	0
Eurylobdella lutulenata			2	0	2	0
Hexagenia limbata	1	0			1	0
Leptophlebia			1	0	1	0
PLECOPTERA			**275**	**27**	**275**	**16**
Acroneuria evoluta			139	13	139	8
Perlesta placida			71	7	71	4
Amphinemura delosa			53	5	53	3
Neoperla clymene			11	1	11	0
Zealeuctra			1	0	1	0
BASOMMATOPHORA	**178**	**24**	**21**	**2**	**199**	**11**
Gyraulus	175	24	21	2	196	11
Physa	2	0			2	0
Helisoma	1	0			1	0
TRICHOPTERA	**79**	**10**	**60**	**6**	**139**	**8**
Cheumatopsyche	51	7			51	2
Chimarra obscura	1	0	26	2	27	1
Helicopsyche borealis	19	2			19	1
Agraylea			18	1	18	1
Polycentropus interuptus			14	1	14	0
Pycnopsyche subfasciata	7	0			7	0
Triaenodes tarda			2	0	2	0
Hydropsyche aerata	1	0			1	0
COLEOPTERA	**41**	**5**	**73**	**7**	**114**	**6**
Psephenus herricki	17	2	31	3	48	2
Helichus	7	0	23	2	30	1
Dubiraphia vittata	12	1			12	0
Optioservus			7	0	7	0

Table A-28, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Stenelmis sexlineata	1	0	4	0	5	0
Agabus			2	0	2	0
Hydrobius			2	0	2	0
Macronychus glabratus	1	0	1	0	2	0
Tropisternus			2	0	2	0
Brachyvatus			1	0	1	0
Dineutus	1	0			1	0
Dubiraphia (larva)	1	0			1	0
Stenelmis (larva)	1	0			1	0
ISOPODA	**53**	**7**	**33**	**3**	**86**	**5**
Lirceus hoppinae	53	7	32	3	85	4
Asellus sp.			1	0	1	0
DECAPODA	**56**	**7**	**18**	**1**	**74**	**4**
Cambarinae	25	3	12	1	37	2
Orconectes	31	4	6	0	37	2
ODONATA	**60**	**8**	**5**	**0**	**65**	**3**
Calopteryx	34	4			34	1
Hetaerina	10	1			10	0
Boyeria vinosa	7	0			7	0
Stylogomphus albistylus	7	0			7	0
Gomphus	1	0	3	0	4	0
Hagenius brevistylus	1	0	1	0	2	0
Lestes			1	0	1	0
HEMIPTERA	**30**	**4**	**17**	**1**	**47**	**2**
Gerris			16	1	16	0
Rhagovelia	16	2			16	0
Trepobates	11	1			11	0
Microvelia	2	0			2	0
Lipogomphus			1	0	1	0
Ranatra australis	1	0			1	0
MEGALOPTERA	**33**	**4**	**9**	**0**	**42**	**2**
Corydalus cornutus	31	4	9	0	40	2
Sialis	2	0			2	0

Table A-28, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DIPTERA	**19**	**2**	**16**	**1**	**35**	**2**
Tipula			9	0	9	0
Polypedilum	7	0			7	0
Ablabesmyia	6	0			6	0
Limonia			4	0	4	0
Cardiocladius	2	0			2	0
Chironomus	2	0			2	0
Antocha			1	0	1	0
Atherix variegata	1	0			1	0
Cryptochironomus	1	0			1	0
Culex pipiens			1	0	1	0
Culicoides			1	0	1	0
AMPHIPODA	**9**	**1**	**16**	**1**	**25**	**1**
Hyalella azteca	9	1	15	1	24	1
Allocrangonyx			1	0	1	0
PROSOPORA			**19**	**1**	**19**	**1**
Lumbriculidae			19	1	19	1
OLIGOCHAETA			**6**	**0**	**6**	**0**
Oligochaeta			6	0	6	0
HETERODONTIDA	**3**	**0**			**3**	**0**
Pisidium	3	0			3	0
LEPIDOPTERA			**2**	**0**	**2**	**0**
Archips			2	0	2	0
PHARYNGOBDELLIDAE			**1**	**0**	**1**	**0**
Mooreobdella microstoma			1	0	1	0
Total # Organisms	723		993		1716	
Total # Taxa	50		53		82	

*0 - actual value < 1.0 but > 0.0

Table A-29. Benthic Community of Long Creek
Ozark Highlands Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**179**	**18**	**254**	**29**	**433**	**23**
Isonychia	58	6	8	0	66	3
Caenis diminuta	13	1	49	5	62	3
Stenonema terminatum	51	5	5	0	56	3
Eurylophella bicolor			51	5	51	2
Attenella attenuata			43	5	43	2
Stenonema mediopunctatum	30	3	12	1	42	2
Tricorythodes	15	1	21	2	36	1
Paraleptophlebia			23	2	23	1
Baetis tricaudatus	6	0	3	0	8	0
Ephemerella argo			8	0	8	0
Ephemerella needhami			8	0	8	0
Ameletus	3	0	3	0	6	0
Stenonema femoratum			6	0	6	0
Stenacron interpunctatum	1	0	4	0	5	0
Pseudocloeon			4	0	4	0
Potamanthus			3	0	3	0
Serratella deficiens			2	0	2	0
Ephemerella catawba			1	0	1	0
Hexagenia limbata	1	0			1	0
Stenonema exiguum	1	0			1	0
COLEOPTERA	**249**	**26**	**168**	**19**	**417**	**23**
Dubiraphia vittata	123	12	42	4	165	9
Helichus	36	3	87	10	123	6
Macronychus glabratus	61	6	1	0	62	3
Gyrinus			13	1	13	0
Ancyronyx variegata	8	0			8	0
Optioservus	8	0			8	0
Peltodytes			6	0	6	0
Scirtes	5	0			5	0
Ancyronyx (larva)	4	0			4	0
Hydroporus sp.			4	0	4	0
Stenelmis sexlineata			4	0	4	0
Uvarus			3	0	3	0
Dineutus	1	0	1	0	2	0
Hydrovatus			2	0	2	0
Sperchopsis			2	0	2	0
Stenelmis (larva)	2	0			2	0
Berosus			1	0	1	0
Microcylloepus pusillus	1	0			1	0
Tropisternus (larva)			1	0	1	0
Tropisternus ellipticus			1	0	1	0

Table A-29, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ODONATA	**201**	**21**	**37**	**4**	**238**	**13**
Ischnura	134	14	8	0	142	7
Boyeria vinosa	19	1	8	0	27	1
Macromia	21	2	5	0	26	1
Hetaerina	12	1	2	0	14	0
Argia	12	1	1	0	13	0
Calopteryx			5	0	5	0
Hagenius brevistylus	2	0	2	0	4	0
Dromogomphus spinosus			2	0	2	0
Dromogomphus spoliatus			2	0	2	0
Gomphus apomyius			1	0	1	0
Gomphus maxwelli			1	0	1	0
Stylogomphus albistylus	1	0			1	0
PLECOPTERA			**212**	**24**	**212**	**11**
Perlesta placida			211	24	211	11
Isoperla namata			1	0	1	0
TRICHOPTERA	**101**	**10**	**41**	**4**	**142**	**7**
Cheumatopsyche	18	1	27	3	45	2
Triaenodes tarda	15	1	1	0	16	0
Mystacides sepulchralis	15	1			15	0
Helicopsyche borealis	8	0	4	0	12	0
Chimarra obscura	11	1			11	0
Hydroptila	8	0	3	0	11	0
Symphitopsyche bifida	5	0	3	0	8	0
Oecetis	4	0	2	0	6	0
Pycnopsyche subfasciata	1	0			1	0
MESOGASTROPODA	**36**	**3**	**40**	**4**	**76**	**4**
Goniobasis	36	3	32	3	68	3
Lioplax			8	0	8	0
DIPTERA	**51**	**5**	**8**	**2**	**69**	**3**
Polypedilum	33	3	3	0	36	1
Ablabesmyia	12	1			12	0
Cricotopus	4	0	4	0	8	0
Simulium jenningsi	1	0	2	0	3	0
Tipula			3	0	3	0
Cryptochironomus			2	0	2	0
Tanytarsus			2	0	2	0
Anopheles	1	0			1	0
Chrysops			1	0	1	0
Limnophora aequifrons			1	0	1	0

Table A-29, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HEMIPTERA	**40**	**4**	**8**	**0**	**48**	**2**
Rhagovelia	22	2			22	1
Trepobates	13	1	5	0	18	0
Gerris			3	0	3	0
Belostoma	2	0			2	0
Hydrometra martini	1	0			1	0
Metrobates	1	0			1	0
Rheumatobates	1	0			1	0
MEGALOPTERA	**31**	**3**	**6**	**0**	**37**	**2**
Corydalus cornutus	31	3	6	0	37	2
AMPHIPODA	**30**	**3**	**5**	**0**	**35**	**1**
Hyalella azteca	30	3	5	0	35	1
DECAPODA	**10**	**1**	**23**	**2**	**33**	**1**
Cambarinae	9	0	18	2	27	1
Orconectes marcus			3	0	3	0
Orconectes neglectus			2	0	2	0
Orconectes meeki brevis	1	0			1	0
ISOPODA			**31**	**3**	**31**	**1**
Lirceus garmani			31	3	31	1
BASOMMATOPHORA	**17**	**1**	**3**	**0**	**20**	**1**
Ferrissia	7	0	3	0	10	0
Physa	6	0			6	0
Helisoma	4	0			4	0
OLIGOCHAETA	**2**	**0**	**6**	**0**	**8**	**0**
Oligochaeta	2	0	6	0	8	0
NEUROPTERA	**4**	**0**			**4**	**0**
Climacia areolaris	4	0			4	0
HETERODONTIDA	**3**	**0**			**3**	**0**
Corbicula flueminia	3	0			3	0
PHARYNGOBDELLIDAE			**2**	**0**	**2**	**0**
Mooreobdella microstoma			2	0	2	0
Total # Organisms	954		854		1808	
Total # Taxa	59		74		98	

*0 - actual value < 1.0 but > 0.0

Table A-30. Benthic Community of War Eagle Creek
Ozark Highlands Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**379**	**39**	**587**	**36**	**966**	**37**
Tricorythodes	121	12	161	9	282	10
Isonychia	172	18	99	6	271	10
Caenis	6	0	113	7	119	4
Stenonema femoratum	14	1	49	3	63	2
Stenonema mediopunctatum	42	4	20	1	62	2
Pseudocloeon punctiventris	1	0	42	2	43	1
Baetis flavistriga	4	0	23	1	27	1
Eurylophella verisimilis			25	1	25	0
Paraleptophlebia			21	1	21	0
Stenacron interpunctatum	8	0	8	0	16	0
Stenonema terminatum	5	0	9	0	14	0
Eurylobdella lutulenata			6	0	6	0
Serratella serratoides			4	0	4	0
Stenonema pulchellum	4	0			4	0
Ephemera simulans	2	0			2	0
Ephemerella catawba			2	0	2	0
Eurylophella bicolor			2	0	2	0
Hexagenia limbata			2	0	2	0
Rhithrogena pellucida			1	0	1	0
TRICHOPTERA	**188**	**19**	**97**	**6**	**285**	**11**
Cheumatopsyche	128	13	55	3	183	7
Chimarra obscura	43	4	28	1	71	2
Ceraclea tarsi-punctata	12	1	2	0	14	0
Triaenodes tarda	3	0	7	0	10	0
Helicopsyche borealis			4	0	4	0
Hydropsyche aerata	2	0			2	0
Nectopsyche			1	0	1	0
COLEOPTERA	**115**	**12**	**152**	**9**	**267**	**10**
Macronychus glabratus	30	3	41	2	71	2
Helichus	27	2	26	1	53	2
Gyrinus	19	1	9	0	28	1
Stenelmis lateralis	8	0	13	0	21	0
Dineutus (larva)			17	1	17	0
Ancyronyx variegata	12	1			12	0
Dubiraphia vittata			12	0	12	0
Optioservus	2	0	8	0	10	0
Stenelmis (larva)	6	0	3	0	9	0
Ancyronyx variegata (l.)	4	0	3	0	7	0
Tropisternus (larva)			6	0	6	0
Ectopria	1	0	4	0	5	0
Macronychus (larva)			4	0	4	0

Table A-30, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Brachyvatus	3	0			3	0
Dubiraphia (larva)			3	0	3	0
Tropisternus ellipticus	2	0	1	0	3	0
Cymbiodyta			1	0	1	0
Psephenus herricki	1	0			1	0
Uvarus			1	0	1	0
PLECOPTERA	**2**	**0**	**210**	**3**	**212**	**8**
Perlesta placida	1	0	192	11	193	7
Acroneuria evoluta	1	0	12	0	13	0
Hastaperla brevis			3	0	3	0
Isoperla namata			3	0	3	0
DECAPODA	**11**	**1**	**199**	**12**	**210**	**8**
Cambarus bartoni			183	11	183	7
Cambarinae	7	0	13	0	20	0
Orconectes marcus	4	0	2	0	6	0
Orconectes neglectus			1	0	1	0
ODONATA	**89**	**9**	**89**	**5**	**178**	**6**
Ischnura	47	4	38	2	85	3
Argia	18	1	21	1	39	1
Enallagma			12	0	12	0
Boyeria vinosa	3	0	8	0	11	0
Macromia	8	0	3	0	11	0
Basiaeschna janata	8	0			8	0
Hetaerina	4	0	4	0	8	0
Dromogomphus spoliatus	1	0	3	0	4	0
DIPTERA	**34**	**3**	**110**	**6**	**144**	**5**
Simulium jenningsi	2	0	33	2	35	1
Polypedilum	3	0	24	1	27	1
Cricotopus	6	0	13	0	19	0
Polypedilum sp. 2	16	1			16	0
Tanytarsus			13	0	13	0
Probezzia			12	0	12	0
Ablabesmyia			10	0	10	0
Tipula	4	0	1	0	5	0
Hexatoma	3	0			3	0
Rheotanytarsus			3	0	3	0
Thienemanniella			1	0	1	0

Table A-30, cont.

TAXA	Summer org.	%	Spring org.	%	Combined org.	%
HEMIPTERA	**18**	**1**	**37**	**2**	**55**	**2**
Trepobates	14	1	17	1	31	1
Rhagovelia	1	0	11	0	12	0
Gerris	1	0	4	0	5	0
Metrobates			3	0	3	0
Belostoma	1	0	1	0	2	0
Gelastocoris occulatus			1	0	1	0
Mesovelia mulsanti	1	0			1	0
AMPHIPODA	**19**	**1**	**31**	**1**	**50**	**1**
Hyalella azteca	19	1	31	1	50	1
MEGALOPTERA	**29**	**3**	**20**	**1**	**49**	**1**
Corydalus cornutus	24	2	19	1	43	1
Sialis	5	0	1	0	6	0
HETERODONTIDA	**19**	**1**	**20**	**1**	**39**	**1**
Corbicula flueminia	13	1	12	0	25	0
Lampsilis	6	0	8	0	14	0
BASOMMATOPHORA	**15**	**1**	**16**	**0**	**31**	**1**
Gyraulus	7	0	7	0	14	0
Ferrissia	4	0	6	0	10	0
Physa	4	0	3	0	7	0
ISOPODA	**8**	**0**	**14**	**0**	**22**	**0**
Asellus sp.	8	0	3	0	11	0
Lirceus garmani			11	0	11	0
ACARINA	**5**	**0**	**13**	**0**	**18**	**0**
Lebertia	5	0	13	0	18	0
OLIGOCHAETA	**3**	**0**	**13**	**0**	**16**	**0**
Oligochaeta	3	0	13	0	16	0
MESOGASTROPODA	**8**	**0**	**1**	**0**	**9**	**0**
Pyrgulopsis	8	0			8	0
Goniobasis	0	0	1	0	1	0

Table A-30, cont.

TAXA	Summer org.	%	Spring org.	%	Combined org.	%
PROSOPORA	7	0			7	0
Lumbricidae	7	0			7	0
RHYNCHOBDELLIDA	3	0	2	0	5	0
Placobdella parasitica	3	0	2	0	5	0
PHARYNGOBDELLIDAE	2	0			2	0
Mooreobdella microstoma	2	0			2	0
Total # Organisms	954		1611		2565	
Total # Taxa	65		83		96	

*0 - actual value < 1.0 but > 0.0

Table A-31. Benthic Community of Kings River
Ozark Highlands Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**635**	**23**	**578**	**31**	**1213**	**26**
Isonychia	339	12	212	11	551	12
Pseudocloeon			88	4	88	1
Stenonema pulchellum	41	1	39	2	80	1
Tricorythodes	73	2			73	1
Caenis	33	1	34	1	67	1
Eurylophella verisimilis			63	3	63	1
Stenonema mediopunctatum	28	1	33	1	61	1
Baetis flavistriga	24	0	31	1	55	1
Stenonema femoratum	49	1	2	0	51	1
Serratella deficiens			24	1	24	0
Stenacron interpunctatum	19	0	3	0	22	0
Attenella attenuata			19	1	19	0
Ephemera simulans	19	0			19	0
Stenonema terminatum	7	0	6	0	13	0
Eurylophella lutulenata			11	0	11	0
Eurylophella bicolor			4	0	4	0
Ephemerella needhami			3	0	3	0
Rhithrogena pellucida			3	0	3	0
Choroterpes basalis	2	0			2	0
Ephemerella catawba			2	0	2	0
Ephemerella argo			1	0	1	0
Paraleptophlebia	1	0			1	0
TRICHOPTERA	**557**	**20**	**314**	**17**	**871**	**19**
Cheumatopsyche	426	15	239	13	665	14
Ceraclea transversus	66	2			66	1
Chimarra obscura	41	1	23	1	64	1
Helicopsyche borealis			26	1	26	0
Hydroptila	4	0	17	0	21	0
Hydropsyche aerata	11	0			11	0
Triaenodes tarda	7	0	1	0	8	0
Ceraclea tarsi-punctata	2	0	4	0	6	0
Oecetis	0	0	4	0	4	0
COLEOPTERA	**665**	**24**	**177**	**9**	**842**	**18**
Helichus	255	9	21	1	276	6
Dubiraphia vittata	124	4	27	1	151	3
Stenelmis lateralis	89	3	4	0	93	2
Psephenus herricki	3	0	41	2	44	0
Ancyronyx variegata (l.)	6	0	28	1	34	0
Stenelmis exigua	31	1			31	0
Dineutus americanus	17	0	13	0	30	0
Ancyronyx variegata	21	0	7	0	28	0
Stenelmis (larva)	25	0			25	0

Table A-31, cont.

TAXA	Summer org.	%	Spring org.	%	Combined org.	%
Macronychus glabratus	23	0			23	0
Dubiraphia (larva)	17	0	2	0	19	0
Microcylloepus pusillus	2	0	14	0	16	0
Berosus (larva)	13	0			13	0
Microcylloepus (larva)	13	0			13	0
Macronychus glabratus (l.)			10	0	10	0
Ectopria	4	0	3	0	7	0
Tropisternus ellipticus	6	0			6	0
Optioservus	3	0	2	0	5	0
Deronectes	4	0			4	0
Stenelmis crenata	4	0			4	0
Gyrinus			3	0	3	0
Dineutus (larva)	2	0			2	0
Tropisternus mexicanus	1	0	1	0	2	0
Uvarus	2	0			2	0
Enochrus			1	0	1	0
DIPTERA	**267**	**9**	**177**	**9**	**444**	**9**
Simulium jenningsi	181	6	89	4	270	5
Polypedilum	33	1	17	0	50	1
Tanytarsus	21	0	21	1	42	0
Cricotopus	12	0	24	1	36	0
Dicrotendipes			9	0	9	0
Cryptochironomus			7	0	7	0
Ablabesmyia	6	0			6	0
Clinotanypus	4	0			4	0
Hexatoma			4	0	4	0
Stenochironomus	4	0			4	0
Thienemanniella	4	0			4	0
Sympotthastia			3	0	3	0
Chrysops	1	0	1	0	2	0
Tipula			2	0	2	0
Atrichopogon	1	0			1	0
ODONATA	**210**	**7**	**59**	**3**	**269**	**5**
Ischnura	85	3			85	1
Argia	57	2	3	0	60	1
Hetaerina	38	1	19	1	57	1
Enallagma	11	0	27	1	38	0
Macromia	7	0	4	0	11	0
Basiaeschna janata	4	0			4	0
Hagenius brevistylus	4	0			4	0
Boyeria vinosa	2	0	1	0	3	0
Dromogomphus spoliatus	1	0	2	0	3	0
Ophiogomphus			3	0	3	0
Arigomphus lentulus	1	0			1	0

Table A-31, cont.

TAXA	Summer org.	Summer %	Spring org.	Spring %	Combined org.	Combined %
PLECOPTERA	**6**	**0**	**197**	**10**	**203**	**4**
Perlesta placida	3	0	135	7	138	3
Neoperla clymene	1	0	31	1	32	0
Acroneuria			28	1	28	0
Hastaperla brevis			2	0	2	0
Phasganophora capitata	2	0			2	0
Amphinemura delosa			1	0	1	0
BASOMMATOPHORA	**6**	**0**	**145**	**7**	**151**	**3**
Gyraulus	6	0	142	7	148	3
Ferrissia			3	0	3	0
MEGALOPTERA	**94**	**3**	**27**	**1**	**121**	**2**
Corydalus cornutus	94	3	27	1	121	2
HEMIPTERA	**85**	**3**	**28**	**1**	**113**	**2**
Metrobates	39	1	11	0	50	1
Rhagovelia	27	0	12	0	39	0
Trepobates	16	0			16	0
Gerris			3	0	3	0
Belostoma	2	0			2	0
Mesovelia mulsanti	1	0	1	0	2	0
Gelastocoris occulatus			1	0	1	0
MESOGASTROPODA	**33**	**1**	**32**	**1**	**65**	**1**
Pyrgulopsis	29	1			29	0
Viviparus			23	1	23	0
Goniobasis			9	0	9	0
Pleurocera	4	0			4	0
DECAPODA	**32**	**1**	**22**	**1**	**54**	**1**
Cambarinae	21	0	16	0	37	0
Orconectes marcus	11	0	4	0	15	0
Orconectes neglectus			2	0	2	0
HETERODONTIDA	**35**	**1**	**11**	**0**	**46**	**1**
Corbicula flueminia	31	1	11	0	42	0
Ligumia	4	0			4	0
AMPHIPODA	**26**	**0**	**3**	**0**	**29**	**0**
Hyalella azteca	26	0	3	0	29	0
OLIGOCHAETA	**21**	**0**	**7**	**0**	**28**	**0**
Oligochaeta	21	0	7	0	28	0
ISOPODA	**19**	**0**	**2**	**0**	**21**	**0**
Lirceus garmani	19	0	0	0	19	0
Asellus sp.			2	0	2	0

Table A-31, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ACARINA	**4**	**0**	**13**	**0**	**17**	**0**
Geayia ovata	4	0	13	0	17	0
HAPLOTAXIDA			**16**	**0**	**16**	**0**
Pristina			16	0	16	0
LEPIDOPTERA	**1**	**0**	**7**	**0**	**8**	**0**
Petrophila	1	0	7	0	8	0
RHYNCHOBDELLIDA	**3**	**0**			**3**	**0**
Placobdella parasitica	3	0			3	0
PHARYNGOBDELLIDAE	**2**	**0**			**2**	**0**
Mooreobdella microstoma	2	0			2	0
Total # Organisms	2701		1817		4518	
Total # Taxa	84		83		117	

*0 - actual value < 1.0 but > 0.0

Table A-32. Benthic Community of Indian Creek
Boston Mountains Ecoregion
Qualitative Samples (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
PLECOPTERA			**134**	**47**	**134**	**32**
Perlesta placida			62	22	62	15
Isoperla mohri			61	22	61	15
Amphinemuria delosa			8	3	8	2
Acroneuria evoluta			1	0	1	0
Acroneuria mela			1	0	1	0
Hastaperla brevis			1	0	1	0
TRICHOPTERA	**4**	**3**	**67**	**24**	**71**	**17**
Wormaldia			64	23	64	15
Neurclipsis crepuscularis	2	2	2	1	4	1
Cyrnellus fraternus	2	2			2	0
Agapteus			1	0	1	0
EPHEMEROPTERA	**5**	**4**	**40**	**14**	**45**	**11**
Rhithrogena pellucida			10	4	10	2
Paraleptophlebia guttata			6	2	6	1
Stenonema terminatum			6	2	6	1
Eurylophella verisimilis			5	2	5	1
Stenonema femoratum	5	4			5	1
Isonychia			4	1	4	1
Ameletus lineatus			3	1	3	1
Eurylophella bicolor			2	1	2	0
Pseudocloeon punctiventris			2	1	2	0
Caenis			1	0	1	0
Serratella serratoides			1	0	1	0
ACARINA	**35**	**26**			**35**	**8**
Lebertia	34	25			34	8
Gaeyia ovata	1	1			1	0
ODONATA	**33**	**24**	**1**	**0**	**34**	**8**
Ischnura	29	22			29	7
Basiaeschna jantata	1	1			1	0
Boyeria vinosa			1	0	1	0
Dromogomphus spoliatus	1	1			1	0
Eurythemis simplicicollis	1	1			1	0
Macromia	1	1			1	0

Table A-32, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
DIPTERA	**8**	**6**	**21**	**7**	**29**	**7**
Simulium jenningsi			12	4	12	3
Ablabesmyia	3	2	1	0	4	1
Tribelos	4	3			4	1
Polypedilum			3	1	3	1
Prosimulium mixtum			3	1	3	1
Chironomus	1	1			1	0
Hexatoma			1	0	1	0
Probezzia			1	0	1	0
AMPHIPODA	**22**	**16**	**1**	**0**	**23**	**6**
Hyalella azteca	22	16	1	0	23	6
COLEOPTERA	**9**	**7**	**10**	**4**	**19**	**5**
Dubiraphia vitatta	5	4			5	1
Microcylloepus pusillus			4	1	4	1
Stenelmis humerosus			4	1	4	1
Psephenus herricki	2	2	1	0	3	1
Ancyronyx variegata	1	1			1	0
Berosus	1	0			1	0
Stenelmis (larva)			1	0	1	0
HEMIPTERA	**15**	**11**			**15**	**4**
Rheumatobates	11	8			11	3
Mesovelia mulsanti	3	2			3	1
Ranatra kirkaldyi	1	1			1	0
DECOPODA	**2**	**2**			**2**	**0**
Orconetes sp.	2	2			2	0
ISOPODA			**5**	**2**	**5**	**1**
Lirecus hoppinae			5	2	5	1
GASTROPODA	**2**	**2**			**2**	**0**
Gyraulus	2	2			2	0
Total # Organisms	135		283		418	
Total # Taxa	23		33		51	

*0 - actual value < 1.0 but > 0.0

Table A-33. Benthic Community of Hurricane Creek
Boston Mountains Ecoregion
Qualitative Samples (# org./sample), 1983-84*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
TRICHOPTERA	**23**	**38**	**160**	**44**	**183**	**43**
Wormaldia			157	43	157	37
Chimarra obscura	13	22	2	0	15	3
Cheumatopsyche	8	13	1	0	9	2
Ceraclea tarsi-punctatus	1	2			1	0
Neureclipsis crepusculari	1	2			1	0
EPHEMEROPTERA	**16**	**27**	**51**	**14**	**67**	**16**
Rhithrogena pellucida			19	5	19	5
Isonychia	1	2	13	3	14	3
Stenonema femoratum	6	10	1	0	7	2
Stenonema terminatum	2	3	4	1	6	1
Stenacron interpunctatum	4	7			4	1
Ameletus lineatus			3	1	3	1
Caenis	2	3	1	0	3	1
Pseudocloeon dubium			3	1	3	1
Serratella serratoides			3	1	3	1
Ephemerella argo			1	0	1	0
Ephemerella temporalis			1	0	1	0
Heptagenia			1	0	1	0
Paraleptophlebia gutatta			1	0	1	0
Tricorythodes	1	2			1	0
PLECOPTERA			**51**	**14**	**51**	**12**
Perlesta placida			45	12	45	10
Acroneuria mela			2	1	2	0
Amphinemuria delosa			2	1	2	0
Acroneuria evoluta			1	0	1	0
Hastaperla brevis			1	0	1	0
ISOPODA			**41**	**11**	**41**	**10**
Lirceus hoppinae			41	11	41	10
DECAPODA	**2**	**3**	**16**	**4**	**18**	**4**
Cambarinae			12	3	12	3
Orconetes sp.			4	1	4	1
Orconectes meeki brevis	2	3			2	0
ODONATA	**4**	**6**	**11**	**3**	**15**	**3**
Ischnura	1	2	10	3	11	3
Argia	3	5			3	1
Macromia			1	0	1	0

Table A-33, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**5**	**8**	**10**	**3**	**15**	**4**
Stenelmis humerosus	1	2	4	1	5	1
Stenelmis (larva)			4	1	4	1
Psephenus herricki	3	5			3	0
Ancyronyx variegata			1	0	1	0
Helichus			1	0	1	0
Microcylloepus pusillus	1	2			1	0
DIPTERA	**1**	**2**	**11**	**3**	**12**	**3**
Polypedilum			5	1	5	1
Cryptochironomus			2	1	2	0
Tabanus	1	2	1	0	2	0
Ablabesmyia			1	0	1	0
Simulium jenningsi			1	0	1	0
Tipula			1	0	1	0
MEGALOPTERA	**5**	**8**	**4**	**1**	**9**	**2**
Corydalus cornutus	5	8	4	1	9	2
ANNELIDA			**4**	**1**	**4**	**1**
Lumbricidae			4	1	4	1
HEMIPTERA	**2**	**3**	**1**	**0**	**3**	**1**
Rhagovelia	2	3			2	0
Gerris			1	0	1	0
AMPHIPODA			**2**	**1**	**2**	**0**
Hyalella azteca			2	1	2	0
GASTROPODA	**2**	**3**			**2**	**0**
Viviparus	2	3			2	0
Total # Organisms	60		362		422	
Total # Taxa	20		39		49	

*0 - actual value < 1.0 but > 0.0

Table A-34. Benthic Community of Archey Creek
Boston Mountains Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**136**	**15**	**408**	**47**	**544**	**31**
Isonychia	61	6	181	20	242	13
Stenacron interpunctatum	4	0	76	8	80	4
Stenonema tripunctatum			44	5	44	2
Stenonema terminatum	38	4			38	2
Eurylophella temporalis			35	4	35	2
Caenis	1	0	25	2	26	1
Tricorythodes	24	2			24	1
Paraleptophlebia			16	1	16	0
Rhithrogena pellucida			12	1	12	0
Baetis tricaudatus	1	0	9	1	10	0
Heptagenia	3	0	6	0	9	0
Pseudocloeon dibium	3	0			3	0
Ephemerella argo			2	0	2	0
Stenonema femoratum	1	0	1	0	2	0
Baetisca			1	0	1	0
TRICHOPTERA	**382**	**43**	**145**	**16**	**527**	**3**
Chimarra obscura	211	24	8	0	219	12
Cheumatopsyche	144	16	23	2	167	9
Wormaldia			63	7	63	3
Helicopsyche borealis	12	1	31	3	43	2
Hydropsyche orris	11	1			11	0
Nectopsyche	1	0	10	1	11	0
Ceraclea tarsi-punctata	2	0	4	0	6	0
Pycnopsyche subfasciata			4	0	4	0
Brachycentrus			1	0	1	0
Micrasema			1	0	1	0
Pycnopsyche sp. 2	1	0			1	0
COLEOPTERA	**12**	**12**	**108**	**12**	**220**	**12**
Helichus	28	3	38	4	66	3
Ancyronyx variegata	28	3	9	1	37	2
Stenelmis crenata			25	2	25	1
Dubiraphia vittata	12	1	11	1	23	1
Psephenus herricki	15	1	4	0	19	1
Stenelmis humerosus	13	1			13	0
Microcylloepus pusillus	3	0	6	0	9	0
Dineutus ciliatus			8	0	8	0

Table A-34, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Stenelmis (larva)	4	0	1	0	5	0
Berosus styliferus			4	0	4	0
Hydroporus sp.	2	0			2	0
Hydrovatus	1	0	1	0	2	0
Macronychus glabratus	2	0			2	0
Berosus	1	0			1	0
Berosus (larva)	1	0			1	0
Dubiraphia (larva)	1	0			1	0
Haliplus			1	0	1	0
Sperchopsis	1	0			1	0
ODONATA	**89**	**10**	**39**	**4**	**128**	**7**
Hetaerina	24	2	11	1	35	2
Argia	31	3	3	0	34	1
Macromia illinoiensis	15	1			15	0
Ischnura	12	1	2	0	14	0
Macromia magnifica			9	1	9	0
Enallagma			6	0	6	0
Hagenius brevistylus	1	0	5	0	6	0
Boyeria vinosa	3	0			3	0
Dromogomphus spinosus	3	0			3	0
Stylogomphus albistylu			3	0	3	0
DIPTERA	**48**	**5**	**35**	**4**	**83**	**4**
Polypedilum	13	1	12	1	25	1
Tribelos	19	2	6	0	25	1
Cricotopus	2	0	4	0	6	0
Prosimulium mixtum			6	0	6	0
Tabanus	4	0	1	0	5	0
Hexatoma	3	0	1	0	4	0
Chironomus	3	0			3	0
Tanypus			3	0	3	0
Tipula	1	0	2	0	3	0
Rheotanytarsus	1	0			1	0
Simulium jenningsi	1	0			1	0
Stenochironomus	1	0			1	0
PLECOPTERA			**57**	**6**	**57**	**3**
Perlesta placida			33	3	33	1
Neoperla clymene			12	1	12	0
Hastaperla brevis			8	0	8	0
Strophoteryx			4	0	4	0
HEMIPTERA	**42**	**4**	**12**	**1**	**54**	**3**
Trepobates	29	3		0	32	1
Gerris			7	0	7	0
Rhagovelia	4	0			4	0
Microvelia	2	0	1	0	3	0

Table A-34, cont.

TAXA	Summer org.	Summer %	Spring org.	Spring %	Combined org.	Combined %
Gelastocoris occulatus	2	0			2	0
Hebrus	2	0			2	0
Mesovelia mulsanti	2	0			2	0
Gelastocoris			1	0	1	0
Palmacorixa	1	0			1	0
MEGALOPTERA	**34**	**3**	**9**	**1**	**43**	**2**
Corydalus cornutus	32	3	8	0	40	2
Sialis	2	0	1	0	3	0
ISOPODA			**35**	**4**	**35**	**2**
Lirceus garmani			35	4	35	2
DECAPODA	**13**	**1**	**4**	**0**	**17**	**0**
Cambarinae	9	1	4	0	13	0
Orconectes	4	0			4	0
BASOMMATOPHORA	**4**	**0**	**6**	**0**	**10**	**0**
Ferrissia			6	0	6	0
Physa	3	0			3	0
Gyraulus	1	0			1	0
OLIGOCHAETA	**3**	**0**	**5**	**0**	**8**	**0**
Oligochaeta	3	0	5	0	8	0
AMPHIPODA	**6**	**0**			**6**	**0**
Hyalella azteca	6	0			6	0
ACARINA	**3**	**0**			**3**	**0**
Lebertia	3	0			3	0
Total # Organisms	872		863		1735	
Total # Taxa	63		61		90	

*0 - actual value < 1.0 but > 0.0

Table A-35. Benthic Community of Illinois Bayou
Boston Mountains Ecoregion
30-minute Qualitative Sample (# org./sample) 1984-85*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**121**	**27**	**345**	**38**	**466**	**34**
Pseudocloeon	2	0	149	16	151	11
Isonychia	18	4	29	3	47	3
Stenacron interpunctatum	34	7	11	1	45	3
Stenonema tripunctatum			43	4	43	3
Stenonema femoratum	3	0	39	4	42	3
Caenis	12	2	23	2	35	1
Tricorythodes	32	7			32	2
Stenonema terminatum	16	3			16	1
Paraleptophlebia			13	1	13	0
Serratella serratoides			8	0	8	0
Heptagenia			6	0	6	0
Rhithrogena pellucida			6	0	6	0
Dannella lita			5	0	5	0
Baetis tricaudatus			4	0	4	0
Callibaetis			4	0	4	0
Eurylophella temporalis			3	0	3	0
Choroterpes	2	0			2	0
Eurylophella bicolor			2	0	2	0
Baetis	1	0			1	0
Ephemera simulans	1	0			1	0
TRICHOPTERA	**63**	**14**	**195**	**21**	**258**	**19**
Wormaldia			153	16	153	11
Cheumatopsyche	39	8	13	1	52	3
Helicopsyche borealis			27	2	27	2
Chimarra obscura	18	4	1	0	19	1
Polycentropus cinereus	6	1			6	0
Pycnopsyche subfasciata			1	0	1	0
ODONATA	**51**	**11**	**65**	**7**	**116**	**8**
Hetaerina			36	3	36	2
Ischnura	21	4	8	0	29	2
Macromia magnifica	18	4	6	0	24	1
Argia	11	2	11	1	22	1
Stylogomphus albistylus			4	0	4	0
Dromogomphus spoliatus	1	0			1	0

Table A-35, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
PLECOPTERA			**89**	**9**	**89**	**6**
Perlesta placida			73	8	73	5
Neoperla clymene			12	1	12	0
Acroneuria			3	0	3	0
Isoperla mohri			1	0	1	0
COLEOPTERA	**60**	**13**	**28**	**3**	**88**	**6**
Helichus	26	5	12	1	38	2
Psephenus herricki	16	3			16	1
Dubiraphia vittata	9	2			9	0
Stenelmis humerosus	1	0	8	0	9	0
Stenelmis (larva)	3	0	4	0	7	0
Dineutus	3	0			3	0
Gyretes			3	0	3	0
Ancyronyx variegata	2	0			2	0
Berosus (larva)			1	0	1	0
DIPTERA	**25**	**5**	**62**	**6**	**87**	**6**
Simulium jenningsi			35	3	35	2
Cricotopus			12	1	12	0
Tribelos	8	1			8	0
Tabanus	6	1	1	0	7	0
Pentaneura	1	0	3	0	4	0
Polypedilum			4	0	4	0
Bezzia	3	0			3	0
Microtendipes	3	0			3	0
Tanytarsus			3	0	3	0
Tipula			3	0	3	0
Tanypus	2	0			2	0
Anopheles	1	0			1	0
Haematopota	1	0			1	0
Pilaria			1	0	1	0
AMPHIPODA	**31**	**7**	**21**	**2**	**52**	**3**
Hyalella azteca	31	7	21	2	52	3
MEGALOPTERA	**28**	**6**	**13**	**1**	**41**	**3**
Corydalus cornutus	26	5	13	1	39	2
Sialis	2	0			2	0
DECAPODA	**1**	**0**	**36**	**3**	**37**	**2**
Cambarinae (female & Imt.)	1	0	36	3	37	2

Table A-35, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HEMIPTERA	**28**	**6**	**9**	**0**	**37**	**2**
Rhagovelia	11	2	6	0	17	1
Trepobates	7	1	1	0	8	0
Mesovelia mulsanti	4	0	2	0	6	0
Metrobates	5	1			5	0
Microvelia	1	0			1	0
ISOPODA	**12**	**2**	**18**	**1**	**30**	**2**
Lirceus hoppinae	12	2	18	1	30	2
BASOMMATOPHORA	**5**	**1**	**13**	**1**	**18**	**1**
Gyraulus	1	0	13	1	14	1
Physa	3	0			3	0
Ferrissia	1	0			1	0
ACARINA	**15**	**3**	**2**	**0**	**17**	**1**
Lebertia	15	3	2	0	17	1
OLIGOCHAETA			**8**	**0**	**8**	**0**
Oligochaeta			8	0	8	0
Total # Organisms	440		904		1344	
Total # Taxa	46		52		76	

*0 - actual value < 1.0 but > 0.0

Table A-36. Benthic Community of Lee Creek
Boston Mountains Ecoregion
30-minute Qualitative Sample (# org./sample) 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**473**	**24**	**725**	**41**	**1198**	**32**
Baetis tricaudatus	22	1	214	12	236	6
Serratella serratoides			169	9	169	4
Stenonema terminatum	136	7	17	0	153	4
Caenis	87	4	47	2	134	3
Isonychia	72	3	41	2	113	3
Attenella attenuata			73	4	73	1
Rhithrogena pellucida			69	3	69	1
Tricorythodes	49	2	8	0	57	1
Choroterpes	41	2			41	1
Stenacron interpunctatum	29	1	4	0	33	0
Paraleptophlebia			25	1	25	0
Dannella provonshai			17	0	17	0
Heptagenia	16	0			16	0
Hexagenia limbata			12	0	12	0
Ephemerella argo			9	0	9	0
Eurylophella temporalis			8	0	8	0
Stenonema exiguum	2	0	6	0	8	0
Stenonema femoratum	7	0			7	0
Ameletus			6	0	6	0
Ephemera simulans	4	0			4	0
Stenonema mediopunctatum	4	0			4	0
Leptophlebia	3	0			3	0
Pseudocloeon	1	0			1	0
TRICHOPTERA	**383**	**19**	**204**	**11**	**587**	**16**
Chimarra obscura	253	13	14	0	267	7
Cheumatopsyche	98	5	125	7	223	6
Wormaldia			36	2	36	0
Helicopsyche borealis	16	0	14	0	30	0
Hydroptila hamata			9	0	9	0
Triaenodes	8	0			8	0
Pycnopsyche	3	0	1	0	4	0
Agraylea			3	0	3	0
Nectopsyche			2	0	2	0
Oxyethira	2	0			2	0
Rhyacophila	2	0			2	0
Phylocentropus	1	0			1	0

Table A-36, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
COLEOPTERA	**342**	**17**	**145**	**8**	**487**	**13**
Psephenus herricki	169	8	42	2	211	5
Stenelmis (larva)	54	2	71	4	125	3
Stenelmis exigua	28	1	11	0	39	1
Microcylloepus pusillus	29	1			29	0
Stenelmis crenata	20	1	2	0	22	0
Dubiraphia (larva)	11	0	2	0	13	0
Dubiraphia vittata	7	0	4	0	11	0
Microcylloepus pusillus	4	0	3	0	7	0
Scirtes	6	0	1	0	7	0
Tropisternus ellipticus	2	0	3	0	5	0
Donacia			4	0	4	0
Uvarus	4	0			4	0
Berosus (larva)	1	0	2	0	3	0
Tropisternus (larva)	3	0			3	0
Ectopria	2	0			2	0
Brachyvatus	1	0			1	0
Endalus	1	0			1	0
DIPTERA	**396**	**20**	**70**	**4**	**466**	**12**
Polypedilum	136	7	4	0	140	3
Clinotanypus	62	3			62	1
Helius	21	1	23	1	44	1
Chironomus	42	2			42	1
Ablabesmyia	24	1	5	0	29	0
Simulium jenningsi	12	0	12	0	24	0
Cryptochironomus	22	1	1	0	23	0
Stenochironomus	22	1	1	0	23	0
Nilotanypus	18	0			18	0
Atherix variegata	13	0			13	0
Cricotopus			11	0	11	0
Tabanus	9	0			9	0
Hemerodromia	4	0	3	0	7	0
Procladius	4	0	3	0	7	0
Tipula	3	0	4	0	7	0
Pseudosmittia	4	0			4	0
Haematopota			2	0	2	0
Probezzia			1	0	1	0
PLECOPTERA	**24**	**1**	**320**	**18**	**344**	**9**
Perlesta placida			276	15	276	7
Zealeuctra			23	1	23	0
Neoperla	20	1	2	0	22	0
Allocapnia	1	0	14	0	15	0
Acroneuria evoluta	3	0	3	0	6	0
Isoperla mohri			2	0	2	0

Table A-36, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
ODONATA	**95**	**4**	**60**	**3**	**155**	**4**
Ischnura	33	1	9	0	42	1
Hetaerina	6	0	27	1	33	0
Argia	24	1	2	0	26	0
Stylogomphus albistylus	2	0	8	0	10	0
Dromogomphus spoliatus	8	0	1	0	9	0
Enallagma	8	0			8	0
Macromia	1	0	7	0	8	0
Hagenius brevistylus	3	0	2	0	5	0
Calopteryx			3	0	3	0
Epitheca princeps	3	0			3	0
Erythemis simplicollis	3	0			3	0
Basiaeschna janata	2	0			2	0
Boyeria vinosa	1	0			1	0
Dromogomphus spinosus	1	0			1	0
Neurocordulia xanthosoma			1	0	1	0
ISOPODA	**17**	**0**	**80**	**4**	**97**	**2**
Lirceus lineatus			73	4	73	1
Asellus sp.	14	0			14	0
Lirceus garmani	3	0	7	0	10	0
DECAPODA	**24**	**1**	**35**	**2**	**59**	**1**
Cambarinae	14	0	22	1	36	0
Orconectes meeki brevis	8	0	6	0	14	0
Orconectes putnami	2	0	3	0	5	0
Orconectes palmeri			4	0	4	0
MEGALOPTERA	**43**	**2**	**16**	**0**	**59**	**1**
Corydalus cornutus	39	2	16	0	55	1
Sialis	4	0			4	0
HEMIPTERA	**34**	**1**	**10**	**0**	**44**	**1**
Gerris	6	0	4	0	10	0
Mesovelia mulsanti	9	0	1	0	10	0
Rhagovelia	7	0	3	0	10	0
Trepobates	8	0			8	0
Gelastocoris occulatus	1	0	2	0	3	0
Ranatra kirkaldyi	2	0			2	0
Hydrometra martini	1	0			1	0
AMPHIPODA	**22**	**1**	**14**	**0**	**36**	**0**
Hyalella azteca	22	1	14	0	36	0
HETERODONTIDA	**17**	**0**	**17**	**0**	**34**	**0**
Corbicula flueminia	17	0	17	0	34	0

Table A-36, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
BASOMMATOPHORA	**22**	**1**	**8**	**0**	**30**	**0**
Gyraulus	15	0			15	0
Physa	3	0	8	0	11	0
Helisoma	4	0			4	0
OLIGOCHAETA	**9**	**0**	**17**	**0**	**26**	**0**
Oligochaeta	9	0	17	0	26	0
ACARINA	**10**	**0**	**3**	**0**	**13**	**0**
Krendowskia similis	8	0	2	0	10	0
Neumania	1	0	1	0	2	0
Sperchon	1	0			1	0
LEPIDOPTERA	**1**	**0**	**4**	**0**	**5**	**0**
Petrophila	1	0	3	0	4	0
Prionoxystus			1	0	1	0
PHARYNGOBDELLIDAE	**2**	**0**	**2**	**0**	**4**	**0**
Mooreobdella microstoma	2	0	2	0	4	0
MESOGASTROPODA			**3**	**0**	**3**	**0**
Anculosa			3	0	3	0
PROSOPORA	**3**	**0**			**3**	**0**
Lumbricidae	3	0			3	0
RHYNCHOBDELLIDA	**1**	**0**	**1**	**0**	**2**	**0**
Placobdella parasitica	1	0	1	0	2	0
COLLEMBOLA	**1**	**0**			**1**	**0**
Isotomurus palustris	1	0			1	0
Total # Organisms	1919		1734		3653	
Total # Taxa	97		84		123	

*0 - actual value < 1.0 but > 0.0

Table A-37. Benthic Community of Mulberry River
Boston Mountains Ecoregion
30-minute Qualitative Sample (# org./sample) 1985-86*

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
EPHEMEROPTERA	**199**	**20**	**212**	**24**	**411**	**22**
Isonychia	63	6	33	3	96	5
Tricorythodes	18	1	49	5	67	3
Stenonema terminatum	30	3	24	2	54	2
Stenonema femoratum	9	0	36	4	45	2
Caenis	28	2			28	1
Baetis tricaudatus	6	0	17	1	23	1
Stenonema mediopunctatum	22	2			22	1
Eurylophella temporalis			17	1	17	0
Ephemera simulans	11	1			11	0
Heptagenia	2	0	9	1	11	0
Stenacron interpunctatum			11	1	11	0
Paraleptophlebia guttata			9	1	9	0
Stenonema exiguum	7	0			7	0
Rhithrogena pellucida			3	0	3	0
Brachycercus	2	0			2	0
Serratella serratoides			2	0	2	0
Choroterpes	1	0			1	0
Hexagenia limbata			1	0	1	0
Potamanthus			1	0	1	0
ODONATA	**167**	**17**	**76**	**8**	**243**	**13**
Ischnura	136	14	38	4	174	9
Hetaerina			19	2	19	1
Argia	9	0	3	0	12	0
Dromogomphus spoliatus	4	0	6	0	10	0
Neurocordulia xanthosoma	6	0	4	0	10	0
Erythemis simplicollis	8	0			8	0
Macromia	4	0	3	0	7	0
Enallagma			2	0	2	0
Stylogomphus albistylus			1	0	1	0
TRICHOPTERA	**142**	**14**	**97**	**11**	**239**	**13**
Chimarra obscura	60	6	8	0	68	3
Cheumatopsyche	37	3	19	2	56	3
Triaenodes tarda	15	1	12	1	27	1
Wormaldia			21	2	21	1
Ceraclea tarsi-punctata	9	0	11	1	20	1
Pycnopsyche	9	0	4	0	13	0
Potamyia			8	0	8	0
Helicopsyche borealis			7	0	7	0

Table A-37, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
Nectopsyche	3	0	4	0	7	0
Polycentropus cinereus	4	0	2	0	6	0
Hydropsyche simulans	3	0			3	0
Cyrnellus fraternus	2	0			2	0
Brachycentrus			1	0	1	0
DIPTERA	**90**	**9**	**144**	**16**	**234**	**12**
Polypedilum	41	4	10	1	51	2
Prosimuluim mixtum			45	5	45	2
Simulium jenningsi	2	0	27	3	29	1
Helius	2	0	21	2	23	1
Ablabesmyia philosphagnous	8	0	5	0	13	0
Cryptochironomus			13	1	13	0
Tanytarsus	2	0	11	1	13	0
Stenochironomus	12	1			12	0
Tribelos	11	1			11	0
Cricotopus	3	0	6	0	9	0
Hemerodromia	6	0			6	0
Tabanus	1	0	4	0	5	0
Tipula	2	0	2	0	4	0
COLEOPTERA	**68**	**7**	**127**	**14**	**195**	**10**
Psephenus herricki	12	1	31	3	43	2
Dubiraphia vittata	13	1	8	0	21	1
Stenelmis exigua			1	2	21	1
Microcylloepus pusillus	1	0	19	2	20	1
Ancyronyx americanus	7	0	12	1	19	1
Dineutus variegata			14	1	14	0
Dubiraphia	14	1			14	0
Berosus			10	1	10	0
Ectopria	9	0			9	0
Berosus (larva)	6	0			6	0
Ancyronyx variegata	2	0	3	0	5	0
Scirtes	2	0	2	0	4	0
Gyrinus			3	0	3	0
Stenelmis (larva)			3	0	3	0
Tropisternus ellipticus	2	0			2	0
Microcylloepus pusillus			1	0	1	0
AMPHIPODA	**73**	**7**	**19**	**2**	**92**	**5**
Hyalella azteca	73	7	2	0	75	4
Gammarus fasciatus			17	1	17	0

Table A-37, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
PLECOPTERA	**7**	**0**	**70**	**7**	**77**	**4**
Perlesta placida			62	7	62	3
Neoperla clymene	6	0	3	0	9	0
Acroneuria evoluta	1	0	4	0	5	0
Allocapnia			1	0	1	0
ACARINA	**68**	**7**	**4**	**0**	**72**	**3**
Krendowskia similis	62	6	1	0	63	3
Geayia ovata	6	0	3	0	9	0
HETERODONTIDA	**12**	**1**	**49**	**5**	**61**	**3**
Corbicula flueminia	9	0	37	4	46	2
Pisidium	3	0	12	1	15	0
BASOMMATOPHORA	**31**	**3**	**12**	**1**	**43**	**2**
Ferrissia	15	1	6	0	21	1
Physa	9	0	6	0	15	0
Gyraulus	7	0			7	0
DECAPODA	**22**	**2**	**20**	**2**	**42**	**2**
Cambarinae	12	1	8	0	20	1
Orconectes meeki brevis	4	0	9	1	13	0
Orconectes sp. 2	6	0			6	0
Orconectes palmeri			3	0	3	0
HEMIPTERA	**13**	**1**	**20**	**2**	**33**	**1**
Rhagovelia	4	0	9	1	13	0
Rheumatobates	6	0			6	0
Ranatra kirkaldyi	1	0	3	0	4	0
Gerris	2	0	1	0	3	0
Trepobates			3	0	3	0
Gelastocoris occulatus			2	0	2	0
Mesovelia mulsanti			2	0	2	0
ISOPODA	**21**	**2**	**4**	**0**	**25**	**1**
Lirceus garmani	21	2	4	0	25	1
MEGALOPTERA	**19**	**1**	**4**	**0**	**23**	**1**
Corydalus cornutus	18	1	4	0	22	1
Sialis	1	0			1	0
OLIGOCHAETA	**6**	**0**	**15**	**1**	**21**	**1**
Oligochaeta	6	0	15	1	21	1

Table A-37, cont.

TAXA	Summer # org.	Summer %	Spring # org.	Spring %	Combined # org.	Combined %
HAPLOTAXIDA	12	1	3	0	15	0
Pristina	12	1	3	0	15	0
PROSOPORA	4	0			4	0
Lumbricidae	4	0			4	0
PHARYNGOBDELLIDAE			3	0	3	0
Mooreobdella microstoma			3	0	3	0
NEUROPTERA	2	0			2	0
Climacia areolaris	2	0			2	0
RHYNCHOBDELLIDA	2	0			2	0
Placobdella parasitica	2	0			2	0
Total # Organisms	958		879		1837	
Total # Taxa	73		80		103	

*0 - actual value < 1.0 but > 0.0

APPENDIX B

List of Scientific and Common Names of Fishes Collected

Family and Species	Common Name
PETROMYZONTIDAE	Lampreys
Ichthyomyzon castaneus	Chestnut lamprey
Ichthyomyzon gagei	Southern brook lamprey
Ichthyomyzon sp.	Lamprey larvae
AMIIDAE	Bowfins
Amia calva	Bowfin
LEPISOSTEIDAE	Gars
Lepisosteus oculatus	Spotted gar
Lepisosteus osseus	Longnose gar
Lepisosteus platostomus	Shortnose gar
CLUPEIDAE	Herrings
Dorosoma cepedianum	Gizzard shad
SALMONIDAE	Trout
**Salmo gairdneri*	Rainbow trout
ESOCIDAE	Pikes
Esox americanus	Grass pickerel
Esox niger	Chain pickerel
CYPRINIDAE	Minnows
Campostoma anomalum	Central stoneroller
Cyprinus carpio	Carp
Hybognathus hayi	Cypress minnow
Hybognathus nuchalus	Silvery minnow
**Hybopsis amblops*	Bigeye chub
**Hybopsis dissimilis*	Streamline chub
**Hybopsis x-punctata*	Gravel chub
**Nocomis asper*	Redspot chub
**Nocomis biguttatus*	Hornyhead chub
Notemigonus crysoleucas	Golden shiner
**Notropis amnis*	Pallid shiner
Notropis atherinoides	Emerald shiner
**Notropis boops*	Bigeye shiner
Notropis chrysocephalus	Striped shiner
Notropis emiliae	Pugnose minnow
Notropis fumeus	Ribbon shiner

*Notropis galacturus	Whitetail shiner
*Notropis greenei	Wedgespot shiner
Notropis lutrensis	Red shiner
Notropis maculatus	Taillight shiner
Notropis nubilus	Ozark minnow
*Notropis pilsbryi	Duskystripe shiner
*Notropis rubellus	Rosyface shiner
*Notropis snelsoni	Ouachita Mt. shiner
*Notropis telescopus	Telescope shiner
Notropis texanus	Weed shiner
Notropis umbratilis	Redfin shiner
Notropis venustus	Blacktail shiner
Notropis volucellus	Mimic shiner
*Notropis whipplei	Steelcolor shiner
*Phoxinus erythrogaster	Southern redbelly dace
Pimephales notatus	Bluntnose minnow
*Pimephales tenellus	Slim minnow
Pimephales vigilax	Bullhead minnow
*Semotilus atromaculatus	Creek chub
CATOSTOMIDAE	Suckers
Carpiodes carpio	River carpsucker
Carpiodes cyprinus	Quillback carpsucker
Carpiodes velifer	Highfin carpsucker
Catostomus commersoni	White sucker
Erimyzon oblongus	Creek chubsucker
Erimyzon sucetta	Lake chubsucker
*Hypentelium nigricans	Northern hogsucker
Ictiobus bubalus	Smallmouth buffalo
Ictiobus cyprinellus	Bigmouth buffalo
Ictiobus niger	Black buffalo
Minytrema melanops	Spotted sucker
*Moxostoma carinatum	River Redhorse
*Moxostoma duquesnei	Black redhorse
Moxostoma erythrurum	Golden redhorse
Moxostoma macrolepidotum	Shorthead redhorse
*Moxostoma poecilurum	Blacktail redhorse
ANGUILLIDAE	Freshwater eels
Anguilla rostrata	American eel
ICTALURIDAE	Freshwater catfishes
Ictalurus melas	Black bullhead
Ictalurus natalis	Yellow bullhead
Ictalurus punctatus	Channel catfish
*Noturus albater	Ozark madtom
*Noturus eleutherus	Mountain madtom
*Noturus exilis	Slender madtom
*Noturus flavater	Checkered madtom
Noturus gyrinus	Tadpole madtom
Noturus miurus	Brindled madtom
*Noturus lachneri	Ouachita madtom

Noturus nocturnus	Freckled madtom
*Noturus taylori	Caddo madtom
Pylodictis olivaris	Flathead catfish
CYPRINODONTIDAE	Killifishes
*Fundulus catenatus	Northern studfish
Fundulus notatus	Blackstripe topminnow
Fundulus olivaceus	Blackspotted topminnow
POECILIIDAE	Livebearers
Gambusia affinis	Mosquitofish
APHREDODERIDAE	Pirate perches
Aphredoderus sayanus	Pirate perch
ATHERINIDAE	Silversides
Labidesthes sicculus	Brook silversides
PERCICHTHYIDAE	Temperate basses
Morone chrysops	White bass
CENTRARCHIDAE	Sunfishes
*Ambloplites ariommus	Shadow bass
*Ambloplites constellatus	Ozark bass
*Ambloplites rupestris	Rock bass
Centrarchus macropterus	Flier
Elassoma zonatum	Banded pygmy sunfish
Lepomis cyanellus	Green sunfish
Lepomis gulosus	Warmouth
Lepomis humilis	Orangespotted sunfish
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear
Lepomis microlophus	Redear
Lepomis punctatus	Spotted sunfish
Lepomis symmetricus	Bantam sunfish
Lepomis hybrid	Hybrid sunfish
*Micropterus dolomieui	Smallmouth bass
Micropterus punctulatus	Spotted bass
Micropterus salmoides	Largemouth bass
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
PERCIDAE	Perches
*Ammocrypta asprella	Crystal darter
*Ammocrypta vivax	Scaly sand darter
Etheostoma asprigene	Mud darter
*Etheostoma blennioides	Greenside darter
*Etheostoma caeruleum	Rainbow darter
Etheostoma chlorosomum	Bluntnose darter
*Etheostoma collettei	Creole darter
*Etheostoma euzonum	Arkansas saddled darter
*Etheostoma flabellare	Fantail darter

	Etheostoma gracile	Slough darter
*	*Etheostoma histrio*	Harlequin darter
*	*Etheostoma juliae*	Yoke darter
*	*Etheostoma moorei*	Yellowcheek darter
*	*Etheostoma parvipinne*	Goldstripe darter
	Etheostoma proeliare	Cypress darter
*	*Etheostoma punctulatum*	Stippled darter
*	*Etheostoma radiosum*	Orangebelly darter
	Etheostoma spectabile	Orangethroat darter
*	*Etheostoma stigmaeum*	Speckled darter
	Etheostoma whipplei	Redfin darter
*	*Etheostoma zonale*	Banded darter
	Percina caprodes	Logperch
*	*Percina copelandi*	Channel darter
*	*Percina maculata*	Blackside darter
*	*Percina nasuta*	Longnose darter
*	*Percina ouachitae*	Saddleback darter
*	*Percina sciera*	Dusky darter
	Percina shumardi	River darter
*	*Stizostedion vitreum*	Walleye
SCIAENIDAE		Drums
	Aplodinotus grunniens	Freshwater drum
COTTIDAE		Sculpins
*	*Cottus carolinae*	Banded sculpin

*Sensitive species

APPENDIX C

Criteria for Assigning Relative Abundance Values to Fishes

VALUE

4 - Abundant - Species or age group collected easily in a variety of habitats where species expected; numerous individuals seen with consideration of sampling gear limitations and expected abundance of such species; a dominant species of the species group.

3.5 - Common to Abundant

3 - Common - Species or age group collected in most areas where such species would exist; individuals frequently seen and apparently well established in the population; one of the more frequent species of the species group.

2.5 - Present to Common

2 - Present - Species or age group collected with enough frequency to indicate the likely presence of an established population but definitely a subordinate species in the species group.

1.5 - Rare to Present

1 - Rare - Species or age group represented by only one or very few individuals in the population; more than likely a remnant, migrant or a displaced species.

Values are assigned to the adult, intermediate and young age group of each species; therefore, the maximum value for a species is 12 and the minimum is 1.

Literature Cited

American Fisheries Society. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication No. 12. 174pp.

APHA, AWWA and WPCF, Standard Methods for the Examination of Water and Wastewater. 14th Edition. American Public Health Association, Washington D.C.

Arkansas Department of Planning. December 1974. Arkansas Natural Area Plan. Little Rock, Arkansas.

Arkansas Department of Pollution Control and Ecology. 1984. Arkansas Water Quality Inventory Report 1984. Little Rock, Arkansas. 495 pp.

Arkansas Department of Pollution Control and Ecology. 1986. Arkansas Water Quality Inventory Report 1986. Little Rock, Arkansas. 401 pp.

Bailey, R.G. 1976. Ecoregions of the United States. Map (Scale 1:7,500,000). USDA Forest Service. Intermountain Region. Ogden, Utah.

Boesch, D. F. 1957. Application of numerical classification in ecological investigations of water pollution. EPA-600/3-77-033, U.S. EPA, Corvallis, Oregon.

Cairns, J., and K. L. Dickson. 1971. A simple method for the biological assessment of the effects of waste discharges on aquatic bottom dwelling organisms. Journal Water Pollution Control Federation, 43(5):755-752.

Croneis, C. 1930. Physiography of the Paleozoic Area of Arkansas. Ark. Geol. Surv. Bull. 3:7-19.

Environmental Protection Agency 1983. Technical Support Manual: waterbody surveys and assessments. Office of Regulations and Standards. Washington, D.C.

Foerster, J. W. 1974. Thermal effects on the Connecticut River: phycology and chemistry. Journal Water Pollution Control Federation, 46:21.

Foti, T.L. 1974. Natural Divisions of Arkansas. In: Arkansas Natural Area Plan. Arkansas Department of Planning. pp. 11-34.

Hunrichs, R.A. 1983. Identification and Classification of Perennial Streams of Arkansas. Map 1:500,000. Arkansas Geological Commission.

Jaccard, P. 1912. The distribution of flora in an alpine zone. New Phytol., 11:37.

Johnson, M. G., and R. O. Brinkhurst. 1971. Associations and species diversity in benthic macroinvertebrates of Bay of Ouninti and Lake Ontario. Jour. Fish. Res. Bd. Canada, 28:1683.

Kaesler, R. L., and J. Cairns, Jr. 1972. Cluster analysis of data from limnological surveys of the Upper Potomac River. Am. Midland Naturalist, 88:56.

National Oceanic and Atmospheric Administration (NOAA). 1976. Climate of Arkansas, Climatography of the United States No. 160.

Omernik, J. M., M. A. Shirazi and R. M. Hughes. 1981. A Synoptic Approach For Regionalizing Aquatic Ecosystems. Paper presented at workshop, Inplace Resource Inventories: Principles and Practices, A National Workshop, 9-14 August, at University of Maine, Orono.

Pielou, E. C. 1975. Ecological Diversity. Wiley-Interscience, N.Y., 165.

Shannon, C. E., and W. Weaver. 1963. The Mathematical Theory of Communication. University of Illinois Press. Urbana, Illinois.

Terrell, J.W., T.E. McMahon, P.D. Inskip, R.F. Raleigh and K.L. Williamson. 1982. Habitat Suitability Index Models: Appendix A. Guidelines for Riverine and Lacustrine Applications of Fish HSI Models with the Habitat Evaluation Procedures. FWS/OBS-82/10.A. U.S. Department of Interior. Washington, D.C. 54 pp.

U.S. Department of Agriculture. 1966. Soil Survey of St. Francis County, Arkansas. 81 pp.

U.S. Department of Agriculture. 1974. Soil Survey of Jackson County, Arkansas. 74 pp.

U.S. Department of Agriculture. 1978. Soil Survey of Lawrence County, Arkansas. 79 pp.

Wilhm, J. L., and T. C. Dorris. 1968. Biological parameters for water quality criteria. Bioscience, 18:6.