# SUMMARY OF STATISTICAL AND TREND ANALYSES OF SELECTED WATER-QUALITY DATA COLLECTED NEAR THE BIG THICKET NATIONAL PRESERVE, SOUTHEAST TEXAS

By Frank C. Wells and Kristin C. Bourdon

---

U.S. GEOLOGICAL SURVEY

Open-File Report 85-183

Prepared in cooperation with the

NATIONAL PARKS SERVICE


Austin, Texas

1985

CONTENTS

## ILLUSTRATION



## TABLES

## METRIC CONVERSIONS

Factors for converting inch-pounds units to metric equivalents are given in the following table:

| From | Multiply by | To obtain |
|---|---|---|
| acre | 0.4047 | hectare |
| cubic foot per second (CFS) | 0.02832 | cubic meter per second |
| degree Fahrenheit (°F) | 5/9 (°F-32) | degree Celsius (°C) |
| inch (in.) | 25.40 | millimeter |
| micromho per centimeter at 25° Celsius (µmhos) | 1.000 | microsiemens per centimeter at 25° Celsius |
| mile | 1.609 | kilometer |
| square mile | 2.590 | square kilometer |

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "mean sea level."

# SUMMARY OF STATISTICAL AND TREND ANALYSES OF SELECTED WATER-QUALITY DATA COLLECTED NEAR THE BIG THICKET NATIONAL PRESERVE, SOUTHEAST TEXAS

By

Frank C. Wells and Kristin C. Bourdon

## ABSTRACT

Statistical and trend analyses of selected water-quality data collected at three streamflow stations in the lower Neches River basin, Texas, are summarized in order to document baseline water-quality conditions in stream segments that flow through the Big Thicket National Preserve in southeast Texas. Dissolved-solids concentrations in the streams are small, less than 132 milligrams per liter in 50 percent of the samples analyzed from each of the sites. Dissolved-oxygen concentrations in the Neches River at Evadale (08041000) generally are large, exceeding 8.0 milligrams per liter in more than 50 percent of the samples analyzed. Total nitrogen and total phosphorus concentrations in samples from this site have not exceeded 1.8 milligrams per liter and 0.20 milligram per liter, respectively.

Trend tests for dissolved solids and major ions indicate that small downtrends in total alkalinity, dissolved calcium, and hardness occurred in the Neches River at Evadale (08041000) and Pine Island Bayou near Sour Lake (08041700). Small uptrends in dissolved sulfate were detected at all three stations in the study area.

## INTRODUCTION

The Big Thicket National Preserve is located in the lower Neches River basin in southeastern Texas north and northwest of the city of Beaumont (fig. 1). The preserve, established by Congress in 1974, is comprised of approximately 84,500 acres in 12 units including 8 land tracts and 4 water corridors. Additional land is still being acquired. The preserve was established to protect remnants of a complex and diverse biological community. The temperate climate and average annual rainfall of approximately 55 in. promote lush growth of vegetation. Immense tupelo and cypress trees are common in some areas of the preserve; but where historical waterways deposited hills of sand, rain percolates through the sand so fast that some desert vegetation grows. Swamp bogs exist near arid sandhills that support cactus and yucca plants. There are 85 species of trees, more than 60 species of shrubs, and nearly 1,000 other flowering plants in the preserve. This abundant vegetation supports a wealth of animal species.

In an effort to preserve the wide diversity of flora and fauna in Big Thicket National Preserve, the National Park Service has proposed a monitoring program to document the influences of land use on the quality of water in streams in or near the preserve. The purpose of this report is to summarize the results of statistical and trend analyses of selected water-quality data collected at three U.S. Geological Survey streamflow stations in or adjacent to Big Thicket National Preserve. These stations include Neches River at Evadale, Texas (08041000); Village Creek near Kountze, Texas (08041500); and Pine Island Bayou near Sour Lake, Texas (08041700). The results of these analyses will aid the National Parks Service in establishing a water-quality data base and in establishing water-quality standards for significant segments of streams that flow through the preserve.

### Methodology

Statistical analyses of water-quality and related streamflow data were performed by using the Statistical Analysis System (SAS)[1/] developed by the SAS Institute of Cary, North Carolina (SAS Institute, Inc., 1982a,b). This computer system has been interfaced with the Geological Survey's National Water Data Storage and Retrieval System (WATSTORE). The SAS computer programs provide data-management functions such as sorting, merging, copying, and condensing sets of data. SAS also is one of the most advanced proprietory software packages for developing linear-statistical models.

The SAS procedure used for the statistical summary of water-quality data included in this report is the Univariate procedure. This procedure produces simple descriptive statistics of numeric variables and provides detailed information on the distribution of their values. Some of the statistical features obtained with the Univariate procedure and tabulated in this report (table 1) include sample size of the number of observations on which statistical calculations were based and the maximum, minimum, and mean values. Other statistical features obtained for constituents with 5 or more observations include the

---

1/ Use of the trade name in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

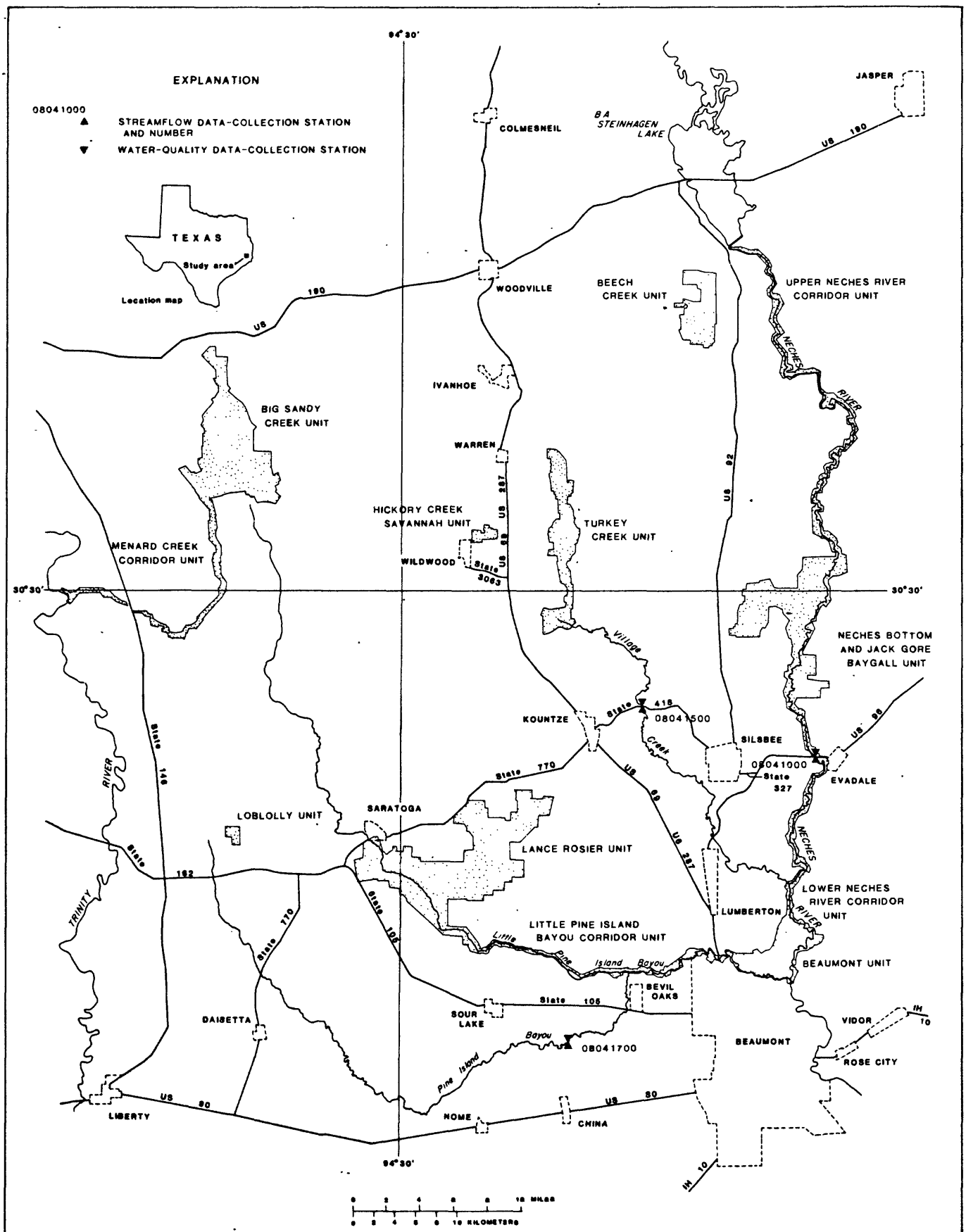


Figure 1.--Generalized map of the Big Thicket National Preserve showing location of streamflow and water-quality data collection stations

TABLE 1.-- STATISTICAL SUMMARY OF SELECTED WATER-QUALITY DATA COLLECTED FOR THREE STATIONS IN THE LOWER NECHES RIVER BASIN, TEXAS

STATION NUMBER: 08041000 STATION NAME: NECHES RIVER AT EVADALE, TEX.

LATITUDE: 302120 LONGITUDE: 0940535 COUNTY: JASPER DRAINAGE AREA: 7951.00 SQUARE MILES

SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED AT PERIODIC INTERVALS FROM OCT. 1960 TO AUG. 1984

[DEG C, degrees Celsius; CFS, cubic feet per second; UMHOS, micromhos per centimeter at 25 degrees Celsius; MG/L, milligrams per liter; UG/L, micrograms per liter; COLS./100 ML, colonies per 100 milliters]

| WATER-QUALITY CONSTITUENT | DESCRIPTIVE STATISTICS | | | | PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SAMPLE SIZE | MAXIMUM | MINIMUM | MEAN | 95 | 75 | MEDIAN 50 | 25 | 5 |
| TEMPERATURE (DEG C) | 177 | 32.00 | 6.00 | 21.01 | 30.55 | 27.00 | 22.00 | 15.25 | 10.00 |
| STREAMFLOW, INSTANTANEOUS (CFS) | 132 | 30099.94 | 155.00 | 7251.04 | 21044.95 | 10924.98 | 4669.99 | 2415.00 | 286.70 |
| SPECIFIC CONDUCTANCE (UMHOS) | 437 | 397.00 | 29.00 | 174.77 | 252.00 | 200.50 | 174.00 | 146.00 | 100.00 |
| OXYGEN, DISSOLVED (MG/L) | 142 | 13.20 | 5.90 | 8.48 | 11.20 | 9.53 | 8.20 | 7.20 | 6.22 |
| OXYGEN, DISSOLVED (PERCENT SATURATION) | 141 | 119.00 | 11.20 | 93.27 | 112.00 | 101.00 | 93.00 | 87.00 | 76.10 |
| OXYGEN DEMAND, BIOCHEMICAL, 5 DAY (MG/L) | 143 | 8.00 | 0.00 | 1.44 | 2.30 | 1.80 | 1.40 | 1.00 | 0.42 |
| ALKALINITY FIELD (MG/L AS CACO3) | 323 | 59.00 | 6.00 | 23.31 | 40.00 | 29.00 | 21.00 | 16.00 | 11.00 |
| NITROGEN, TOTAL (MG/L AS N) | 83 | 1.80 | 0.13 | 0.78 | 1.48 | 0.88 | 0.71 | 0.61 | 0.42 |
| NITROGEN, ORGANIC TOTAL (MG/L AS N) | 103 | 1.40 | 0.03 | 0.60 | 1.26 | 0.72 | 0.59 | 0.42 | 0.17 |
| NITROGEN, AMMONIA TOTAL (MG/L AS N) | 108 | 0.46 | 0.00 | 0.05 | 0.19 | 0.07 | 0.04 | 0.01 | 0.00 |
| NITROGEN, NITRITE TOTAL (MG/L AS N) | 90 | 0.04 | 0.00 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| NITROGEN, NITRATE TOTAL (MG/L AS N) | 135 | 0.50 | 0.00 | 0.08 | 0.20 | 0.10 | 0.05 | 0.01 | 0.00 |
| NITROGEN, NO2+NO3 TOTAL (MG/L AS N) | 83 | 0.23 | 0.00 | 0.05 | 0.16 | 0.07 | 0.04 | 0.01 | 0.00 |
| PHOSPHORUS, TOTAL (MG/L AS P) | 129 | 0.20 | 0.01 | 0.06 | 0.10 | 0.07 | 0.05 | 0.04 | 0.02 |
| HARDNESS (MG/L AS CACO3) | 420 | 61.00 | 6.00 | 34.49 | 48.00 | 40.00 | 34.00 | 30.00 | 20.00 |
| CALCIUM, DISSOLVED (MG/L AS CA) | 419 | 16.00 | 2.50 | 8.69 | 12.00 | 10.00 | 8.80 | 7.10 | 5.00 |
| MAGNESIUM, DISSOLVED (MG/L AS MG) | 419 | 6.30 | 0.00 | 3.11 | 4.40 | 3.60 | 3.20 | 2.60 | 1.70 |
| SODIUM, DISSOLVED (MG/L AS NA) | 351 | 59.00 | 2.30 | 19.53 | 33.00 | 24.00 | 18.00 | 14.00 | 9.32 |
| POTASSIUM, DISSOLVED (MG/L AS K) | 184 | 4.70 | 0.90 | 2.78 | 3.70 | 3.10 | 2.80 | 2.50 | 1.82 |
| CHLORIDE, DISSOLVED (MG/L AS CL) | 420 | 72.00 | 2.00 | 25.35 | 42.95 | 30.00 | 24.00 | 19.00 | 12.00 |
| SULFATE, DISSOLVED (MG/L AS SO4) | 419 | 34.00 | 2.80 | 17.68 | 28.00 | 21.00 | 17.00 | 14.00 | 10.00 |
| ARSENIC, DISSOLVED (UG/L AS AS) | 53 | 2.00 | 0.00 | 0.58 | 2.00 | 1.00 | 1.00 | 0.00 | 0.00 |
| ARSENIC, TOTAL (UG/L AS AS) | 31 | 3.00 | 0.00 | 1.68 | 3.00 | 2.00 | 2.00 | 1.00 | 0.60 |
| LEAD, DISSOLVED (UG/L AS PB) | 52 | 160.00 | 0.00 | 6.42 | 33.25 | 3.00 | 0.00 | 0.00 | 0.00 |
| LEAD, TOTAL RECOVERABLE (UG/L AS PB) | 31 | 310.00 | 0.00 | 17.81 | 149.20 | 17.00 | 4.00 | 0.00 | 0.00 |
| ZINC, DISSOLVED (UG/L AS ZN) | 55 | 240.00 | 0.00 | 24.91 | 122.00 | 31.00 | 10.00 | 0.00 | 0.00 |
| ZINC, TOTAL RECOVERABLE (UG/L AS ZN) | 31 | 220.00 | 0.00 | 31.81 | 142.00 | 30.00 | 20.00 | 20.00 | 0.00 |
| COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML) | 72 | 1200.00 | 4.00 | 95.47 | 446.50 | 76.50 | 40.00 | 28.00 | 10.60 |
| STREPTOCOCCI, FECAL, KF AGAR (COLS./100 ML) | 72 | 2300.00 | 14.00 | 211.56 | 787.00 | 190.00 | 66.00 | 30.50 | 20.00 |
| SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) | 327 | 219.00 | 13.00 | 98.07 | 143.00 | 110.00 | 96.00 | 83.00 | 58.40 |

TABLE 1.-- STATISTICAL SUMMARY OF SELECTED WATER-QUALITY DATA COLLECTED FOR THREE STATIONS IN THE LOWER NECHES RIVER BASIN, TEXAS--CONTINUED

STATION NUMBER: 08041500 STATION NAME: VILLAGE CREEK NR KOUNTZE, TEX.

LATITUDE: 302352 LONGITUDE: 0941548 COUNTY: HARDIN DRAINAGE AREA: 860.00 SQUARE MILES

SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED AT PERIODIC INTERVALS FROM OCT 1962 TO SEPT 1984

| WATER-QUALITY CONSTITUENT | DESCRIPTIVE STATISTICS | | | | PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SAMPLE SIZE | MAXIMUM | MINIMUM | MEAN | 95 | 75 | MEDIAN 50 | 25 | 5 |
| TEMPERATURE (DEG C) | 99 | 35.50 | 4.00 | 19.27 | 27.50 | 25.00 | 20.50 | 15.00 | 7.00 |
| STREAMFLOW, INSTANTANEOUS (CFS) | 84 | 11700.00 | 61.00 | 1112.33 | 3460.00 | 1165.00 | 495.00 | 328.50 | 104.50 |
| SPECIFIC CONDUCTANCE (UMHOS) | 182 | 237.00 | 31.00 | 105.58 | 170.55 | 123.25 | 102.50 | 82.75 | 56.15 |
| ALKALINITY FIELD (MG/L AS CACO3) | 174 | 20.00 | 0.00 | 8.80 | 15.00 | 11.00 | 8.00 | 7.00 | 3.00 |
| NITROGEN, NITRATE TOTAL (MG/L AS N) | 39 | 0.40 | 0.00 | 0.07 | 0.30 | 0.10 | 0.05 | 0.00 | 0.00 |
| HARDNESS (MG/L AS CACO3) | 182 | 26.00 | 5.00 | 17.46 | 24.00 | 20.00 | 18.00 | 15.00 | 11.15 |
| CALCIUM, DISSOLVED (MG/L AS CA) | 182 | 8.10 | 1.50 | 4.90 | 6.77 | 5.80 | 5.00 | 4.10 | 2.72 |
| MAGNESIUM, DISSOLVED (MG/L AS MG) | 182 | 3.00 | 0.00 | 1.27 | 1.88 | 1.50 | 1.30 | 1.10 | 0.62 |
| SODIUM, DISSOLVED (MG/L AS NA) | 141 | 35.00 | 3.50 | 12.42 | 25.00 | 15.00 | 11.00 | 8.30 | 4.82 |
| POTASSIUM, DISSOLVED (MG/L AS K) | 84 | 4.30 | 0.80 | 1.15 | 1.50 | 1.30 | 1.10 | 0.93 | 0.80 |
| CHLORIDE, DISSOLVED (MG/L AS CL) | 182 | 63.00 | 5.90 | 22.50 | 41.85 | 27.00 | 21.00 | 15.75 | 10.00 |
| SULFATE, DISSOLVED (MG/L AS SO4) | 182 | 15.00 | 0.00 | 3.98 | 9.20 | 5.20 | 3.60 | 2.00 | 0.40 |
| SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) | 173 | 126.00 | 17.00 | 61.20 | 91.90 | 71.00 | 61.00 | 50.50 | 29.40 |

TABLE 1.--STATISTICAL SUMMARY OF SELECTED WATER-QUALITY DATA COLLECTED FOR THREE STATIONS IN THE LOWER NECHES RIVER BASIN, TEXAS--CONTINUED

STATION NUMBER: 08041700 STATION NAME: PINE ISLAND BAYOU NR SOUR LAKE, TEX.

LATITUDE: 300621 LONGITUDE: 0942004 COUNTY: HARDIN DRAINAGE AREA: 336.00 SQUARE MILES

SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED AT PERIODIC INTERVALS FROM FEG 1968 TO JUL 1984

| WATER-QUALITY CONSTITUENT | DESCRIPTIVE STATISTICS | | | | PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SAMPLE SIZE | MAXIMUM | MINIMUM | MEAN | 95 | 75 | MEDIAN 50 | 25 | 5 |
| TEMPERATURE (DEG C) | 102 | 34.00 | 3.00 | 20.92 | 30.42 | 26.00 | 22.75 | 15.75 | 9.57 |
| STREAMFLOW, INSTANTANEOUS (CFS) | 113 | 12800.00 | 1.00 | 697.98 | 3001.97 | 808.50 | 140.00 | 47.50 | 4.21 |
| SPECIFIC CONDUCTANCE (UMHOS) | 255 | 11600.04 | 32.00 | 338.56 | 702.80 | 360.00 | 256.00 | 163.00 | 77.80 |
| ALKALINITY FIELD (MG/L AS CACO3) | 254 | 90.00 | 7.00 | 33.25 | 62.50 | 46.25 | 31.00 | 21.00 | 11.00 |
| NITROGEN, NITRATE TOTAL (MG/L AS N) | 81 | 4.00 | 0.04 | 0.58 | 1.90 | 0.60 | 0.40 | 0.20 | 0.10 |
| HARDNESS (MG/L AS CACO3) | 254 | 580.00 | 10.00 | 52.29 | 88.50 | 62.25 | 50.00 | 34.00 | 17.75 |
| CALCIUM, DISSOLVED (MG/L AS CA) | 248 | 165.00 | 3.10 | 16.11 | 26.55 | 19.00 | 15.00 | 10.00 | 5.35 |
| MAGNESIUM, DISSOLVED (MG/L AS MG) | 248 | 40.00 | 0.40 | 2.76 | 5.26 | 3.28 | 2.50 | 1.60 | 0.90 |
| SODIUM, DISSOLVED (MG/L AS NA) | 170 | 2350.00 | 3.60 | 45.12 | 72.00 | 38.00 | 26.00 | 14.75 | 7.41 |
| POTASSIUM, DISSOLVED (MG/L AS K) | 105 | 4.50 | 0.90 | 2.21 | 3.84 | 2.60 | 2.00 | 1.60 | 1.13 |
| CHLORIDE, DISSOLVED (MG/L AS CL) | 253 | 3980.00 | 2.40 | 74.50 | 163.00 | 72.00 | 44.00 | 26.00 | 11.70 |
| SULFATE, DISSOLVED (MG/L AS SO4) | 250 | 40.00 | 0.60 | 11.80 | 24.00 | 15.00 | 11.00 | 7.20 | 4.00 |
| SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) | 242 | 6590.00 | 22.00 | 178.88 | 357.80 | 185.00 | 132.00 | 84.75 | 45.00 |

95th, 75th, 50th (median), 25th, and 5th percentile values. The resultant duration table of selected variables shows the percentage of observations in which values were less than or equal to those shown in the table.

A non-parametric SAS procedure (SEASKEN), developed by the Systems Analysis Group of the Geological Survey, was used to test for trends in water-quality data. A detailed description of this SAS procedure is presented by Crawford, Slack, and Hirsch (1983). A brief description is presented in the "Trend Analysis" section of this report.

## STATISTICAL SUMMARY OF WATER-QUALITY DATA

Statistical summaries of selected water-quality data collected at periodic intervals for three stations located on streams in or adjacent to the Big Thicket National Preserve are presented in table 1. Although a detailed analysis of the data is beyond the scope of this report, several water-quality features are noted to exemplify the utility of the data summaries. The dissolved-solids concentrations in the streams are quite small, less than 132 mg/L (milligrams per liter) in 50 percent of the samples analyzed from each of the three sites. Dissolved-oxygen concentrations in the Neches River at Evadale (08041000) exceed 8.0 mg/L in more than 50 percent of the samples analyzed. Total nitrogen and total phosphorus concentrations in samples from this site have not exceeded 1.8 mg/L and 0.20 mg/L, respectively. The dominant species of nitrogen at this location is organic nitrogen.

## TREND ANALYSIS

Trend, for the purposes of this report is defined as a monotonic change with time, occurring either as an abrupt or gradual change in a water-quality constituent or property. Trends in water quality often are not readily apparent. Concentrations of elements or compounds in water often change by only a few percent annually. Trends are often masked by fluctuations in stream discharge, seasonal variations, and sampling and analytical variability. Changes in constituent concentration caused by variation in discharge are particularly troublesome in trend detection efforts. As discharge increases, the concentrations of many water-quality constituents such as dissolved solids decrease. Concentrations of suspended sediment and constituents related to suspended sediment generally increase with increasing streamflow.

Trend tests conducted in this study were performed using the Seasonal Kendall trend procedure outlined by Smith, Hirsch, and Slack (1982) and Crawford, Slack, and Hirsch (1983). The Seasonal Kendall procedure was designed for analysis of time trends in seasonally varying water-quality data from fixed, regularly sampled monitoring sites. This statistical procedure also provides an estimate of the median rate of change of quality over the sampling period (trend slope) and a method for flow-adjusting the data to correct for effects of changing streamflow on trends in the water-quality data.

Results of trend tests for the three stations in the study area are presented in tables 2 and 3. The periods of record on which these trend tests were based are shown in table 1. Trend tests for dissolved solids and selected

Table 2.--Trend test results of dissolved solids and selected major ions for three stations in the lower Neches River basin

[+ indicates uptrend; - indicates downtrend; -- indicates no trend; mg/L/yr, milligrams per liter per year]

| Water-quality constituent | Station | | | | | |
|---|---|---|---|---|---|---|
| | Neches River at Evadale (08041000) | | Village Creek near Kountze (08041500) | | Pine Island Bayou near Sour Lake (08041700) | |
| | Change | | Change | | Change | |
| | (mg/L/yr) | (percent/year) | (mg/L/yr) | (percent/year) | (mg/L/yr) | (percent/year) |
| Dissolved solids | -- | -- | -- | -- | -- | -- |
| Total alkalinity | -0.32 | -1.37 | -- | -- | -0.62 | -1.88 |
| Dissolved chloride | -- | -- | -- | -- | -- | -- |
| Dissolved sulfate | +.54 | +3.04 | +0.22 | +5.53 | +.44 | +3.69 |
| Dissolved sodium | +.27 | +1.38 | -- | -- | -- | -- |
| Dissolved calcium | -.13 | -1.44 | -- | -- | -.33 | -2.03 |
| Dissolved magnesium | -- | -- | -- | -- | -.06 | -2.01 |
| Hardness | -.39 | -1.12 | -- | -- | -1.12 | -2.14 |

Table 3.--Trend test results for dissolved oxygen, biochemical oxygen demand, nutrients, minor elements, and indicator bacteria for Neches River at Evadale, Texas (08041000)

[+ indicates uptrend; - indicates downtrend; -- indicates no trend; mg/L, milligrams per liter; µg/L, micrograms per liter; cols./100 mL, colonies per 100 milliliters]

| Water-quality constituents | Concentration units | Change (concentration units/yr) | Change (percent/yr) |
|---|---|---|---|
| Dissolved oxygen | mg/L | +0.07 | +0.83 |
| Biochemical oxygen demand | mg/L | -- | -- |
| Total nitrogen | mg/L | -- | -- |
| Total organic nitrogen | mg/L | +.05 | +8.33 |
| Total ammonia nitrogen | mg/L | -- | -- |
| Total nitrite + nitrate nitrogen | mg/L | -- | -- |
| Total phosphorus | mg/L | -- | -- |
| Total arsenic | µg/L | -- | -- |
| Total lead | µg/L | -- | -- |
| Total zinc | µg/L | -- | -- |
| Fecal coliform | cols./100 mL | -- | -- |
| Fecal streptococci | cols./100 mL | -- | -- |

major ions indicate that small downtrends in total alkalinity, dissolved calcium, and hardness occurred in the Neches River at Evadale (08041000) and Pine Island Bayou near Sour Lake (08041700). A small downtrend also was detected in dissolved magnesium at Pine Island Bayou near Sour Lake. A small uptrend in dissolved sodium was detected at Neches River at Evadale, and small uptrends in dissolved sulfate were detected at all three stations.

Trend tests for dissolved oxygen, biochemical oxygen demand, and selected nutrients, minor elements and indicator bacteria for the Neches River at Evadale (08041000) indicated small uptrends in dissolved oxygen and total organic nitrogen. No trends were detected in selected minor elements or indicator bacteria

## REFERENCES CITED

Crawford, C. G., Slack, J. R., and Hirsch, R. M., 1983, Nonparametric test for trends in water-quality data using the Statistical Analysis System: U.S. Geological Survey Open-File Report 83-550, 102 p.

SAS Institute, Inc., 1982a, SAS user's guide: Basics, 1982 edition: Cary, North Carolina, SAS Institute, Inc., 923 p.

------, 1982b, SAS user's guide: Statistics, 1982 edition: Cary, North Carolina, SAS Institute, Inc., 584 p.

Smith, R. A., Hirsch, R. M., and Slack, J. R., 1982, A study of trends in total phosphorus measurements at NASQAN stations: U.S. Geological Survey Water-Supply Paper 2190, 34 p.