# THE ZOOPLANKTON COMMUNITY OF LAKE O' THE PINES RESERVOIR, TEXAS

by

Eloise Kay Bohmfalk Reynolds, B.S.

Presented to the Faculty of the Graduate School of

Stephen F. Austin State University

In Partial Fulfillment

of the Requirements

For the Degree of

Master of Science

Stephen F. Austin State University

May, 1989

**ABSTRACT**

The zooplankton community of Lake O' the Pines, a warmwater monomictic reservoir located in northeastern Texas, was sampled once a month at each of five sampling stations from February 1986 through January 1987.

Lake O' the Pines had an annual numerical density of 96.10 organisms per liter, which is high when compared to other East Texas reservoirs. The total zooplankton population consisted of 49.43% rotifers, 20.28% copepods, 5.59% cladocera and 24.70% other organisms. Dominant members of the net zooplankton community included the rotifers *Keratella cochlearis* and *Polyarthra*, and copepod nauplii. Other prominent species were the copepods *Diaptomus siciloides* and *Microcyclops varicans*, and the cladocerans *Bosmina longirostris* and *Ceriodaphnia quadrangula*. From examination of the data by station, two unusual trends in the zooplankton communities were noted: both the rotifer and the total zooplankton populations decrease severely toward the upper third of the reservoir. Heavy metal and other contamination deposited in the sediments from local steel mill operations are suspected of contributing to these trends.

## ACKNOWLEDGEMENTS

I would like to express my gratitude to Dr. Jack D. McCullough for his excellent critical advice, continual encouragement, and understanding, which made the completion of my research possible. I would like to extend special thanks to Dr. Fred L. Rainwater and Dr. William W. Gibson for their optimistic support, guidance, and expertise in instruction. A special thank you also goes to my colleagues, Clinton Ready, Phillip Jennings, and John Wilder, whose camaraderie and support have helped me through the difficult times. To Ron Rushing I extend warm thanks for his close friendship as well as his technical advice on computers. I would like to acknowledge all the graduate students, faculty, and staff of the Biology Department for the supportive and congenial atmosphere I have experienced in participating with them. Finally, I would like to express my sincere appreciation for my family, especially my son Michael, whose love and support have given me courage and strength in the pursuit of higher education.

## TABLE OF CONTENTS

**Table of Contents** (continued)

## LIST OF FIGURES

**List of Figures** (continued)

## LIST OF TABLES

**List of Tables** (continued)

## LIST OF APPENDICES

## INTRODUCTION

Zooplankton may be defined as those weakly swimming or floating heterotrophic organisms in an aquatic environment (Hutchinson, 1967). Net plankton are considered to be that portion of the plankton community which can be retained by a No. 20 bolting net which has 76 micron openings (Greenburg, et al., 1985). Although some limnetic species of net zooplankton are predaceous, the majority are detritivorous or herbivorous, and feed on particulate organic matter and phytoplankton in the water column. Since the zooplankton are in turn fed upon by other invertebrate and vertebrate heterotrophs, they are considered to be an essential link in the aquatic community.

Literature concerning the water quality and trophic state of Lake O' the Pines is limited to the few sporadic water quality, sediment, and fish surveys sponsored by the Texas Water Commission (Petrick, 1975; Weber, 1988), the Environmental Protection Agency (National Eutrophication Survey, 1977; Stemberger, 1979), and Texas Parks and Wildlife (Toole, 1983). Little private research has been previously conducted. Witt (1988) established a sampling station near the dam in the deep water area of Lake O' the Pines and one below the Lone Star Reservoir dam on Big Cypress Creek for comparison in his water analysis of heavy metals in Lone Star Reservoir.

Lake O' the Pines was chosen as a research site to expand the current knowledge of its aquatic ecosystem. This thesis represents the first comprehensive study of the zooplankton community of the reservoir. The intent of this project was to gather and document data on the zooplankton community of Lake O' the Pines Reservoir. Several objectives were incorporated as follows:

1. a description of the zooplankton community structure;
2. an interpretation of the relationship between the zooplankton community structure and the trophic status of the reservoir;
3. a comparison of the zooplankton communities of each station, from the shallow region of the headwaters to the deep water area near the dam; and
4. a comparison of the zooplankton community of this reservoir with those of other East Texas reservoirs previously studied.

## Area Description

Lake O' the Pines is a warmwater monomictic reservoir located in the Cypress Creek River Basin, nine miles west of Jefferson, Texas. Approximately 90 percent of the reservoir lies in Marion County, with the remaining portion in Morris and Upshur counties. It was constructed by the U.S. Army Corps of Engineers in 1956. Although the primary function of the reservoir is flood control, it also provides municipal water for local cities, as well as multiple recreation uses for the public. The top conservation pool is 3,800 acre-feet (4,687,680 $m^3$) at 201 feet (61.3 meters) above mean sea level with 1,060 surface acres (429 hectares). The shoreline in the upper and middle portions of the reservoir is shallow and sandy, with inundated brush and timber in the open water areas. Aquatic vascular vegetation (*Hydrilla*, for example) is generally abundant in the late summer throughout the uppermost shallow region and in littoral areas. The lower reservoir has steep sloping banks of sandy loam and clays, with scattered deposits of iron ore in the form of gravel and rock outcroppings. Inflow to Lake O' the Pines is derived primarily from Big Cypress Creek, with substantial inflow from Alley Creek, Boggy Creek and Johnson Creek. The major industry in the area is a large steel mill which discharges into Lone Star Reservoir (formerly Ellison Creek Reservoir). Survey data from a National Eutrophication Survey (1977) conducted by the EPA indicated Lake O' the Pines Reservoir to be eutrophic, ranking 22nd in overall trophic quality out of the 39 Texas reservoirs which were sampled.

Five sampling sites (Figure 1) were established along the length of the reservoir as follows:

**Station 1** was located approximately 600 meters north of the dam, centrally positioned in the deep limnetic region.

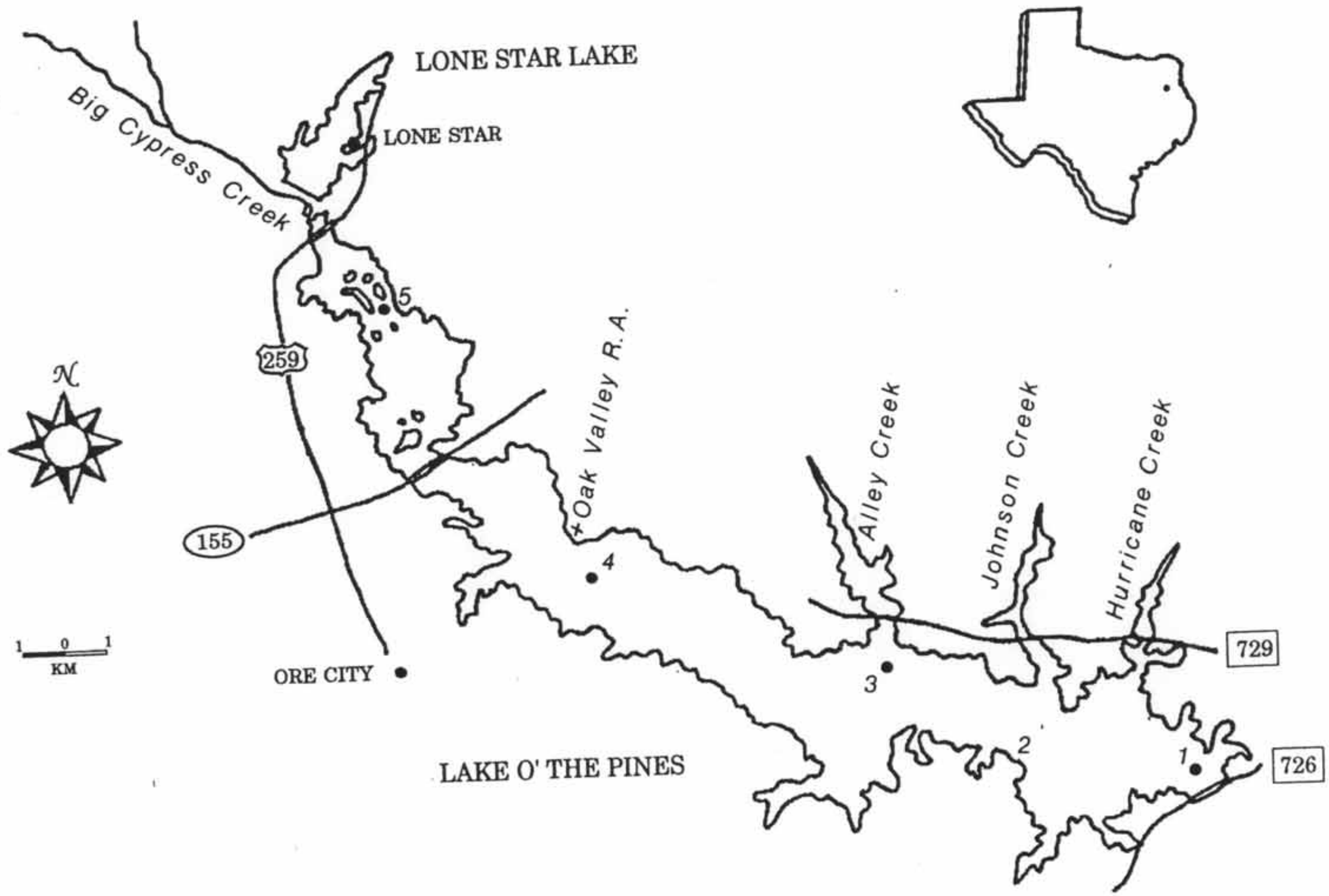
**Station 2** was located in the area where Johnson Creek empties into the reservoir, about 2000 meters downstream from the Hwy 729 bridge which crosses Johnson Creek.

**Station 3** was in the vicinity of the junction with Alley Creek, approximately 1000 meters downstream from the Hwy 729 bridge which crosses Alley Creek.

**Station 4** was approximately 1000 meters southeast of the Oak Valley Recreation Area boat launch.

**Station 5** was located approximately 2000 meters from the Lone Star Boat Launch, in the vicinity of the Daingerfield Pump Station.

**Figure 1.** Map of Lake O' the Pines Reservoir showing the location of sampling stations and the proximity of Lone Star Lake (Ellison Creek Reservoir).



## LITERATURE REVIEW

Several zooplankton studies have been conducted in the East Texas region. Cheatum, et al., (1942) surveyed the zooplankton community of Ellis Lake. Marsh (1973) studied rotifer-algae relationships of Massey Lake. Allard (1974) investigated the zooplankton community of Sam Rayburn Reservoir. Dominant organisms included *Keratella*, *Brachionus*, copepod nauplii and *Ceratium hirundinella* with no significant cladocera numbers. Rogers (1976) investigated some effects of thermal effluent on the zooplankton community in Striker Creek Reservoir. Lee (1977) studied the zooplankton community in a temporary pond. The zooplankton community of hypereutrophic Livingston Reservoir was composed of 64% rotifers, according to Swearingen (1978). The dominant organisms included *Brachionus*, *Keratella*, *Polyarthra*, *Synchaeta*, *Trichocerca*, *Bosmina longirostris* and nauplii. Kines (1980) study of Lake Nacogdoches revealed *Conochiloides*, *Trichocerca*, *Bosmina longirostris* and nauplii as the dominant organisms. *Asplanchna*, *Brachionus*, *Keratella*, *Platyias*, *Bosmina longirostris*, *Chydorus sphaericus*, *Diaptomus* and nauplii were the dominant zooplankters found in Caddo Lake by Venneman (1984). Cichra, et al., (1985) investigated Lake Conroe which had as dominants *Asplanchna*, *Conochilus*, *Polyarthra*, *Synchaeta*, *Bosmina longirostris*, *Ceriodaphnia* and nauplii. Campbell, et al., (1985) also conducted a study on Lake Conroe to investigate zooplankton communities associated with the mats of aquatic vasculars. Lake Houston was eutrophic and had as dominants *Brachionus*, *Hexarthra*, *Polyarthra*, *Pompholyx*, *Bosmina longirostris*, *Ceriodaphnia*, *Chydorus sphaericus*, *Diaptomus* and nauplii (Lacy, 1987). The zooplankton community of Lone Star Reservoir was analyzed by Ready (1988).

Zooplankton populations of other Texas reservoirs have been researched, the earliest of which includes an investigation of plankton dilution in the source streams of Lake Dallas (Evans, 1936), a comparison of three Dallas area lakes (Harris and Silvey, 1940), and a study of White Rock Lake (Patterson, 1942). Gunn (1953) sampled the zooplankton community of the newly-impounded Lake Renshaw in Wise County, Texas, and found rotifers to be the most abundant group. Sublette (1955) studied the physico-chemical and biological components of Lake Texoma, a reservoir on the Texas-Oklahoma border. Research on the zooplankton community of a new Wise County impoundment (Murphy, 1962) revealed that rotifers were the most abundant group and that the dominant species exhibited dicyclic patterns. Becker (1969) examined the systematics and seasonal distribution of Cladocera in several ponds, sloughs, creeks and rivers in Hays County, Texas. Cappel (1970) compared the spatial and temporal aspects of zooplankton populations in Benbrook Lake, Tarrant County. She found that rotifers and copepods were more numerous in the tributaries while cladocerans were more numerous toward the dam. Possum Kingdom Lake and Eagle Mountain Lake were studied by Petit (1973).

A variety of zooplankton studies have been done in the southwest United States. Applegate and Mullan (1967) compared the zooplankton communities of Beaver Reservoir (which was not fully impounded at the time) and Bull Shoals Reservoir (an older reservoir) in Arkansas. Florida reservoirs are similar to Texas reservoirs with regard to their subtropical climate and high nutrient loading. The zooplankton communities of some Florida reservoirs have been studied by Nordlie (1976), Shireman and Martin (1978), Smith, et al (1979), and Blancher (1984). Brooks and Dodson (1965) researched relationships between predation and body sizes of zooplankton.

Allan (1976) produced an article on the life history patterns in zooplankton, in which he asserted that highly unpredictable or seasonal environments favor opportunistic groups. Three groups of zooplankton were of particular interest: the cladocera, the copepods, and the rotifers. Copepods have long life cycles with fewer generations, and show a large degree of specialization. Rotifers and cladocera have shorter life cycles, are unspecialized and develop large transitory populations. Rotifers, however, are smaller in size and have higher rates of reproduction at all temperatures than cladocera and copepods. They are also subject to invertebrate rather than vertebrate predators. Hence, the most opportunistic group is the rotifers, followed in order by cladocera and copepods.

Much research has been done on factors which may affect zooplankton populations and their distribution. Hardy (1935) investigated algal defenses against grazing zooplankters. He concluded that phytoplankton exude a repellent that excludes grazers from regions of high phytoplankton productivity. Hasler and Jones (1949) found that zooplankters seem to avoid highly vegetative areas and that some die when confined to such areas. Porter (1977) suggested that zooplankton may avoid areas of dense higher aquatic plants due to interference with normal swimming, resulting in greater energy expenditure by avoidance movements. However, some studies do not appear to support animal exclusion by aquatic vegetation. Shireman and Martin (1978) described Lake Wales, Florida, as containing a profuse growth of *Hydrilla* which covered approximately 80 percent of the lake surface during the summer. They found the zooplankton population to be abundant, dominated by cladocera. This was attributed to the large amount of vegetation found there. Campbell, et al., (1985) found that the mean densities of zooplankton living in and near dense mats of *Hydrilla* in Lake Conroe, Texas, were high, exceeding 290 individuals per liter. The community was dominated by cladocera, mostly in the family Chydoridae. *Ceriodaphnia* inhabited mainly the open spaces between and adjacent to submerged plants. It was suggested that food supplies for littoral microcrustacea may be virtually unlimited in lakes having aquatic plants, which provide a source of organic detritus and surfaces for attachment of small eponic algae.

Eutrophication is a factor which profoundly affects the zooplankton community structure. Brooks (1969) described the changes in zooplankton community composition with increasing eutrophy. According to Pace

(1986), zooplankton community structure shifts toward an increased relative biomass of microzooplankton with increased lake trophy.

The effect of flow rates on fresh-water zooplankton communities is discussed by Hynes (1972). Studies by Duncan (1984) and Soto, et al., (1984) on tropical reservoirs demonstrate how impoundment water dynamics and the relative locations within the lake (the distance from the dam or from rivers) can affect the composition of zooplankton communities. Both studies noted that high flushing rates may impose serious daily losses on populations of planktonic crustaceans.

The effect of temperature on zooplankton is of great importance. The physiological effect of temperature on rotifers was discussed at length by Edmondson (1946, 1965). King (1972) suggested that rotifers adapt to seasonal changes in the environment (e.g. temperature) through both physiological and genetic mechanisms. The effect of temperature on planktonic crustacea has been investigated by several researchers, including Burns and Rigler (1967), Heinle (1969), Kibby (1971), Patalas (1972), and Herzig (1983). Development time and reproductive rates are temperature dependent for all groups, especially for the highly sensitive rotifers (Allan, 1976). Reat (1983) studied the effect of temperature and body length on the filtering rates of two species of chydorid cladocera. She found that the filtering rates decrease with increasing temperature.

Seasonal changes have a profound effect on the composition and structure of zooplankton communities. Pennak (1969), in his investigation of three Colorado mountain lakes, suggested that there are no typical lakes with regard to zooplankton composition. Smith, et al.,

(1979) studied planktonic crustacea with regard to season, and found that cladocera dominate in the fall and winter, while copepods dominate in the spring. Seasonal cycles in zooplankton have also been noted by Ellsworth (1983). Kratz, et al., (1987) studied long term zooplankton data from lakes and made inferences from spatial and temporal variability in aquatic ecosystems.

Some research has been done concerning metal toxicity and some zooplankton species. Pennak (1946) stated that "trace" elements such as manganese, copper and zinc are toxic to some plankters. The adverse effects of various metals and their lethal concentrations on *Daphnia magna* were reported by Biensinger and Christensen (1972). The acute toxicity of various heavy metals to three representative species of freshwater zooplankton was investigated by Baudouin and Scoppa (1974). Studies on the effect of acute and chronic toxicity of copper on selected species of *Daphnia* were made by Winner and Farrel (1976). They found that chronic effects may be detectable more quickly with smaller species of *Daphnia*, which have shorter life spans. Winner (1981) compared body length, brood size and longevity in *Daphnia magna* as indices of chronic copper and zinc stresses. Kollquist and Meadows (1978) examined the toxic effect of copper on algae and rotifers from a soda lake (Lake Nakuru, East Africa). Zarini, et al., (1983) and Minzoni (1984) studied the effects of aluminum toxicity on zooplankton. Arts and Sprules (1987) did a comparison between the energy reserves of three zooplankton species from Blue Chalk Lake and Round Lake, two Canadian lakes with varying metal concentrations.

## METHODS AND MATERIALS

The zooplankton community of Lake O' the Pines was sampled once a month at each of the five sampling stations from February 1986 through January 1987. This was accomplished by using a Teel submersible pump, Model H-Ip809, powered with a McCulloch portable generator, Model H-1500. The pump was calibrated to deliver 33 liters of water per minute. At each station, water was pumped for one minute at every meter of depth from surface to bottom. The water was directed through a No. 20 plankton net which filtered out the net zooplankton. This resulted in a single sample from each station per month. The samples were placed on ice before transporting them to the laboratory.

Procedures for staining, narcotizing and preserving the samples were developed by Venneman (1984). Each sample was warmed to room temperature, then concentrated to a volume of 25 mL. The live zooplankton were first stained with two 0.3 mL increments of a solution of 95% ETOH with a tincture of Rose Bengal at 15 minute intervals. The zooplankton were then narcotized with progressively larger amounts of 95% ETOH in the following increments: 0.3 mL, 0.5 mL, 0.8 mL, 1.5 mL and 5.0 mL. An interval of 15 minutes was allowed between the addition of each increment. Two hours later, 6.3 mL of ETOH was added. Preservation was completed with a 10.0 mL increment of formalin after 48 hours, bringing the total volume to 50 mL.

Organisms were counted and identified by placing a one milliliter aliquot of a sample via a Hensen-Stemple pipette into a Sedgewick-Rafter counting chamber. The counts made on the sample were converted to organisms per liter using the following equation:

$$N = a(b)/c$$

where:

N = the number of organisms per liter of lake water;

a = the average number of individuals per milliliter of the sample;

b = the total number of milliliters of the preserved sample; and

c = the total number of liters of lake water filtered through the plankton net.

The zooplankton were identified to the lowest taxonomic category possible with the aid of Ward and Whipple (1959), Ruttner-Kolisko (1974), Pennak (1978) and Stemberger (1979).

Readings for depth, Secchi disc transparency, temperature, oxygen and conductivity were taken, and field tests for carbon dioxide and alkalinity were performed using methods prescribed by Greenburg, et al., (1985).

## Statistical Methods

The methods for determining species diversity, evenness, and richness have been described by Shannon and Weaver (1949), Pielou (1966), and Margalef (1957), respectively.

1. Species diversity describes the average degree of uncertainty of predicting the taxonomic group of a given individual picked at random from a community (Wilhm and Dorris, 1968).

The equation for calculating the Shannon-Weaver Index (Odum, 1984) is:

$$H = -\sum_{j=1}^{s} (n_i/n) \log_2 (n_i/n)$$

where:

$n_i$ = the number of individuals of the $i^{th}$ species;

n = the number of individuals of all species; and

H = the diversity index.

2. Species evenness concerns the evenness with which the number of organisms present is distributed among the various taxa in a population. The equation for calculating Pielou's Evenness Index (Odum, 1984) is:

$$e = H / \log_e S$$

where:

e = evenness index;

H = Shannon's Index; and

S = the number of species in the sample.

3. Species richness determines how species "rich" a population is considering the number of individual organisms present.

The equation for Margalef 's Richness Index (Odum, 1984) is:

$$d = S\text{-}1 / \log_e N$$

where:

d = richness index;

S = the number of species in the sample; and

N = the number of individuals in a sample.

The species diversity, evenness and richness values were computed on a CP-6 mainframe computer using the program 'SPCNDX1-RUN.' which was written at Stephen F. Austin State University.

Community ordination was the procedure used to classify or group zooplankton communities according to their similarities or dissimilarities in species composition and numbers of species. The formula used by Cox (1967) is as follows:

$$C = 2W/(a+b)$$

where:

C = the community, and

W = the sum of the lower of the two quantitative values for species shared by communities a and b.

The similarity values of C range from 0 (for communities having no species in common) to 1 (for communities identical both in species composition and numbers). These similarity values are subtracted from 0.85 to obtain dissimilarity values, which may then be used to compute X and Y coordinates for each community.

The formula for X is:

$$X = (L^2 + D_a^2 - D_b^2)/2L$$

where:

L = dissimilarity value between communities a and b;

$D_a$ = dissimilarity value between stand a and the stand in question; and

$D_b$ = dissimilarity value between stand b and the stand in question.

The formula for Y is:

$$Y = [(L')^2 + (D_a')^2 - (D_b')^2] /2L$$

where:

L' = dissimilarity value between stands a' and b';

$D_a'$ = dissimilarity value between stand a' and the stand in question; and

$D_b'$ = dissimilarity value between stand b' and the stand in question.

When the resulting coordinates are plotted on a two dimensional graph, the distance between any given set of points is proportional to their dissimilarity. The annual ordination and seasonal ordinations for the station communities were computed on the CP-6 mainframe using the programs 'ORDINATION' and 'L:ORD', also written at Stephen F. Austin State University.

A oneway analysis of variance (ANOVA) was used to test for zooplankton community differences between stations, months and seasons. The statistical model (Ott, 1984) is:

$$Y_{ij} = m + T_i + E_{ij}$$

where:

$Y_{ij}$ = the observed value;

m = the overall mean for the population;

$T_i$ = an effect due to population i; and

$E_{ij}$ = the random error associated with the $j^{th}$ observation from population i.

A Duncan's Multiple Range Test was run on the oneway analysis of variance to determine if any significant differences existed among the groups. The mathematical model for this (Ott, 1984) is:

$$W'_r = q_{(r,v)}[s_w{}^2/n]^{-1/2}$$

where:

$s_w{}^2$ = the mean square within the sample, and

$q_{(r,v)}$ = the critical value of the Studentized range required when the means being compared are r steps apart with v degrees of freedom.

A completely randomized two factor ANOVA was used to test for interactions among stations and seasons. The statistical model (Ott, 1984) is:

$$Y_{ijk} = m + a_i + B_j + (aB)_{ij} + E_{ijk}$$

where:

$Y_{ijk}$ = the $k^{th}$ observation of the $i^{th}$ group and the $j^{th}$ group of the observed parameter;

m = the overall mean for the population;

$a_i$ = the effect of the $i^{th}$ group (station);

$B_j$ = the effect of the $j^{th}$ group (season);

$(aB)_{ij}$ = the interaction effects of $i^{th}$ group on factor a with $j^{th}$ group on factor B; and

$E_{ijk}$ = the random deviation of Y.

A multiple linear regression was used to determine which parameters, if any, would be useful in predicting numbers of each of the major zooplankton groups. The regression model (Ott, 1984) is:

$$Y = B_o + B_1X_1 + B_2X_2 + ... + B_kX_k + E$$

where:

Y = the dependent variable;

$B_o$ = a constant;

$B_1, B_2, ..., B_k$ = coefficients for the $k^{th}$ parameter;

$X_1, X_2, ..., X_k$ = independent variables; and

E = error.

Most of the procedures for executing the statistical analyses were taken from Nie (1983), with the exception of the species diversity index and community ordination programs. All analyses were performed on a Honeywell CP-6 mainframe computer.

## RESULTS AND DISCUSSION

### Species Composition

A cumulative list of zooplankton taxa found at the five stations is given in Table 1. The dominant members of the net zooplankton community of Lake O' the Pines Reservoir included the rotifers *Keratella cochlearis* and *Polyarthra*, and copepod nauplii. Of the adult copepods, *Diaptomus siciloides* was the most numerous calanoid and *Microcyclops varicans* was the most numerous cyclopoid copepod. Of the cladocera, *Bosmina longirostris* had the largest numbers, followed by *Ceriodaphnia quadrangula*. The species composition is comparable to those of other East Texas reservoirs (Allard, 1974; Rogers, 1976; Swearingen, 1978; Kines, 1980; Venneman, 1984; Lacy, 1987; Ready, 1988).

### Numerical Density and Relative Abundance

The annual mean standing crop of net zooplankton for Lake O' the Pines was found to be 96.10 organisms per liter. This annual mean was greater than most of the previously listed East Texas reservoirs (Table 2), excluding Lone Star Reservoir which had an annual mean of 140.60 organisms per liter. Lake O' the Pines' annual mean is similar to that of Keystone Reservoir, Oklahoma (Kochsiek, et al., 1971), but is considerably less than the 710 organisms per liter of Craighead Lake, Arkansas (Nelson and Harp, 1972), and the average 1,152 organisms per liter found in some Colorado lakes (Pennak, 1949).

**Table 1.** Net zooplankton collected at the five sampling stations during the year from February 1986 through January 1987 at Lake O' the Pines, Texas.

| TAXA | STATION 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | X | X | X | X | X |
| *Asplanchna sp.* | X | X | X | X | X |
| *Brachionus angularis* | X | X | X | X | X |
| *Brachionus havanaensis* | X | X | X | X | X |
| *Brachionus quadridentatus* | | | X | X | X |
| *Collotheca mutabilis* | X | X | X | X | |
| *Colurella sp.* | | | | | X |
| *Conochiloides sp.* | X | X | X | X | X |
| *Conochilus sp.* | X | X | X | X | X |
| *Euclanis sp.* | | | | | X |
| *Filinia longiseta* | | X | | | |
| *Gastropus stylifer* | | X | X | | |
| *Hexarthra mira* | | | X | X | X |
| *Kellicottia bostoniensis* | X | X | X | X | X |
| *Keratella cochlearis* | X | X | X | X | X |
| *Lecane sp.* | | | | | X |
| *Monostyla sp.* | | X | X | | X |
| *Mytilina ventralis* | | | | | X |
| *Notholca acuminata* | X | | | X | X |
| *Notholca sp.* | X | X | X | X | X |
| *Platyias patulus* | X | X | | X | X |
| *Platyias quadricornis* | | | | | X |
| *Polyarthra sp.* | X | X | X | X | X |
| *Rotaria sp.* | X | | | | X |
| *Synchaeta sp.* | X | X | X | X | X |
| *Testudinella sp.* | | | X | | X |
| *Trichocerca sp.* | X | X | X | X | X |

**Table 1.** (Continued)

| TAXA | STATION 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | | X | | X | X |
| *Bosmina longirostris* | X | X | X | X | X |
| *Camptocercus rectirostris* | | | | X | |
| *Ceriodaphnia quadrangula* | X | X | X | X | X |
| *Ceriodaphnia reticulatus* | | X | | | |
| *Chydorus sphaericus* | | | | | X |
| *Daphnia parvula* | X | | | | |
| *Daphnia rosea* | X | X | X | X | |
| *Diaphanosoma brachyurum* | X | X | X | X | X |
| *Eubosmina longispina* | X | X | X | X | X |
| *Eurycercus lamellatus* | | | | | X |
| *Holopedium gibberum* | X | X | X | | |
| *Ilyocryptus spinifer* | | | | X | X |
| *Kurzia latissima* | | | | | X |
| *Leptadora kindtii* | | X | | X | |
| *Pleuroxus denticulatus* | | X | | | X |
| *Pleuroxus procurvatus* | | | | | X |
| *Sida crystallina* | | X | | | X |
| *Simocephalus expinosus* | | X | | | X |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | X | X | X | X | X |
| Copepodids | X | X | X | X | X |
| *Diaptomus siciloides* | X | X | X | X | X |
| *Eurytemora affinis* | X | X | X | X | X |
| *Cyclops vernalis* | | | | | X |
| *Diacyclops bicuspidatus thomasi* | X | X | X | X | X |
| *Macrocyclops albidis* | | | | X | X |
| *Mesocyclops edax* | X | X | X | X | X |
| *Microcyclops varicans* | X | X | X | X | X |

**Table 1.** (Continued)

| TAXA | STATION 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Order Arachnida** | | | | | |
| Water mites | | | | X | |
| **Order Diptera** | | | | | |
| *Chaoborus sp.* | | X | | | |
| Chironomids | | X | X | X | X |
| **Order Ostracoda** | | | | | |
| Ostracods | X | X | X | X | X |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | X | X | X | X | X |
| *Difflugia sp.* | X | X | X | | X |
| Unknown peritrich | X | X | X | X | X |

**Table 2.** Annual mean values of density and relative abundance of major zooplankton groups for several East Texas reservoirs.

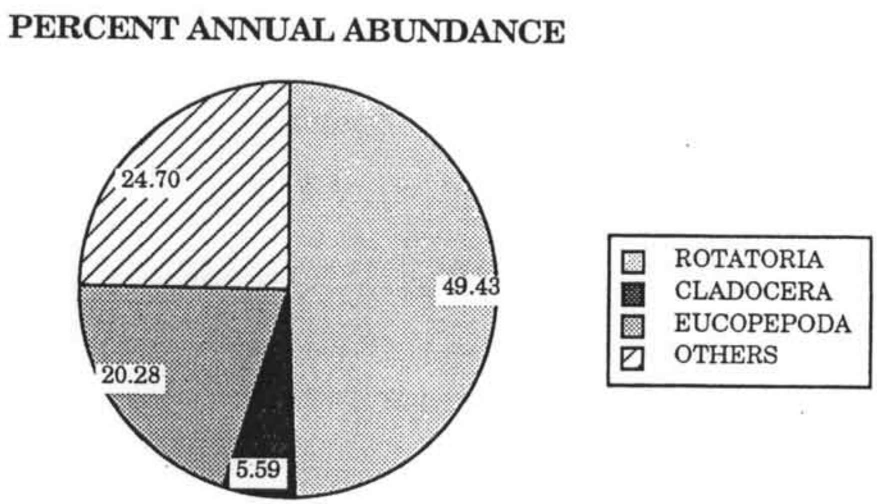
| Reservoir | Density (org/L) | % Rotifers | % Copepods | % Cladocera |
|---|---|---|---|---|
| Conroe (Cichra, et al., 1985) | | | | |
| * 1980 collection: | 26.20 | 63.8 | 6.4 | 27.9 |
| * 1981 collection: | 30.50 | 59.2 | 9.6 | 28.9 |
| Caddo Lake (Venneman, 1984) | 59.60 | 10.0 | 66.6 | 22.8 |
| Houston (Lacy, 1987) | 45.43 | 72.0 | 19.0 | 7.0 |
| Livingston (Swearingen, 1978) | 59.58 | 64.1 | 29.3 | 5.5 |
| Lone Star (Ready, 1988) | 140.60 | 50.2 | 29.7 | 13.3 |
| Murvaul (Rogers, 1976) | 29.55 | 51.7 | 39.9 | 8.3 |
| Nacogdoches (Kines, 1980) | 41.60 | 13.0 | 58.5 | 24.7 |
| Sam Rayburn (Allard, 1974) | 56.00 | * | * | * |
| Striker Creek (Rogers, 1976) | 22.29 | 41.2 | 38.4 | 20.4 |
| Lake O' the Pines (Present study) | 96.10 | 65.6 | 26.9 | 7.4 |

* Not reported

The larger annual means for these more northerly lakes may be due to many circumstances, including differences in rates of predation, differences in longevity and fecundity of zooplankton species attributed to temperature, and variation in sampling techniques.

Combining all samples collected during the present study, rotifers comprised 49.43%, copepods 20.28%, cladocerans 5.59%, and other organisms 24.70% of the total population (Figure 2). The "Others" category contains several species which are not normally part of the

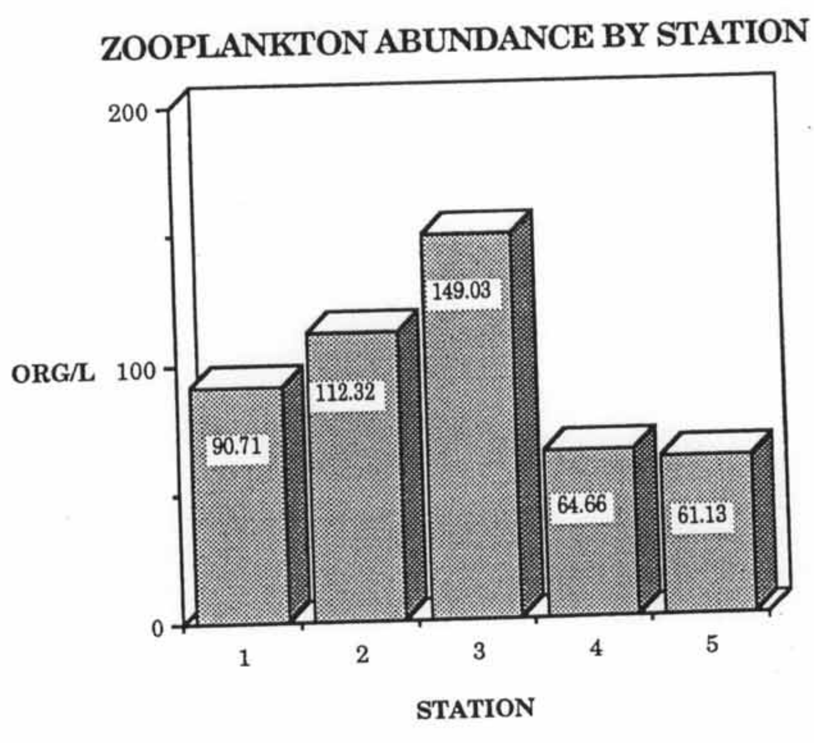
**Figure 2.** Percent annual abundance of all zooplankton groups found at Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.




zooplankton community, and these are generally found in small numbers. The two protozoans, *Ceratium hirundinella* and *Difflugia*, were large enough in size to be retained by the net and were counted. A ciliated protozoan (Order Peritrichida) appeared suddenly in large numbers in the April samples, then disappeared by May. Therefore, this category appears to have a larger influence on the zooplankton community than it actually does. It accounts for much of the variance in the samples by month and by season. Most of the attention of this study will be directed to the three major groups within the zooplankton community: the Order Cladocera, the Order Eucopepoda and the Phylum Rotatoria.

The highest annual numerical density occurred at Station 3, and this declined sharply at station 4 and 5 in the upper third of the reservoir (Figure 3).

**Figure 3.** Total zooplankton for each station of Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.



It appears that the zooplankton numerical density is following an uncommon trend from the headwaters to the dam, as compared to most other East Texas reservoirs (Table 3).

**Table 3.** Average numerical densities of zooplankton for the headwater collection sites and dam collection sites of several East Texas reservoirs.

| Reservoir | Headwaters | Dam Site |
|---|---|---|
| Caddo Lake (Venneman, 1984) | * 64.24 | 63.30 |
| Houston (Lacy, 1987) | ** 39.04 | 35.60 |
| Livingston (Swearingen, 1978) | 53.11 | 52.05 |
| Lone Star (Ready, 1988) | 126.77 | 112.72 |
| Murvaul (Rogers, 1976) | 31.02 | 28.08 |
| Nacogdoches (Kines, 1980) | 69.5 | 21.7 |
| Sam Rayburn (Allard, 1974) | 47.7 | 59.2 |
| Striker Creek (Rogers, 1976) | 23.04 | 18.64 |
| Lake O' the Pines (present study) | 61.13 | 90.71 |

* Stations 1, 2 and 3 in the headwaters averaged; designated collectively as the "swamp region" by Venneman.

** Uppermost stations (5 and 7) of the two major headwater forks averaged.

Kochsiek, Wilhm and Morrison (1971) reported that rotifers were most frequent in the upper reaches of Keystone Reservoir, Oklahoma, while cladocerans and copepods were most numerous in the lower reservoir where turbulence was less. These results agree with research at the two headwater stations by Hynes (1972). However, this is not the case for Lake O' the Pines. The numerical density of copepods at the two headwater stations is similar to that of the rotifers, so that they appear to codominate (Figure 4). All three major categories of zooplankton decline at those stations, especially the rotifers (Figure 5). This poses another uncommon trend for East Texas reservoirs (Table 4).

**Figure 4.** Annual abundance by station for the major zooplankton groups found at Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.

| STATION | ROTATORIA | CLADOCERA | EUCOPEPODA | OTHERS |
|---|---|---|---|---|
| 1 | 48.07 | 5.86 | 16.30 | 20.48 |
| 2 | 56.25 | 5.15 | 15.40 | 35.52 |
| 3 | 77.85 | 7.60 | 18.51 | 45.07 |
| 4 | 29.29 | 4.78 | 29.16 | 1.42 |
| 5 | 24.51 | 3.40 | 18.89 | 14.33 |

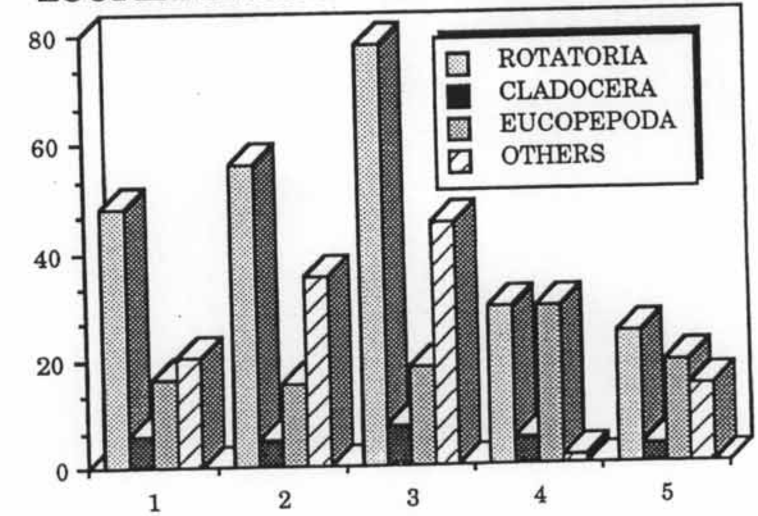


**Figure 5.** Percent annual abundance by station for the three major zooplankton groups found at Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.

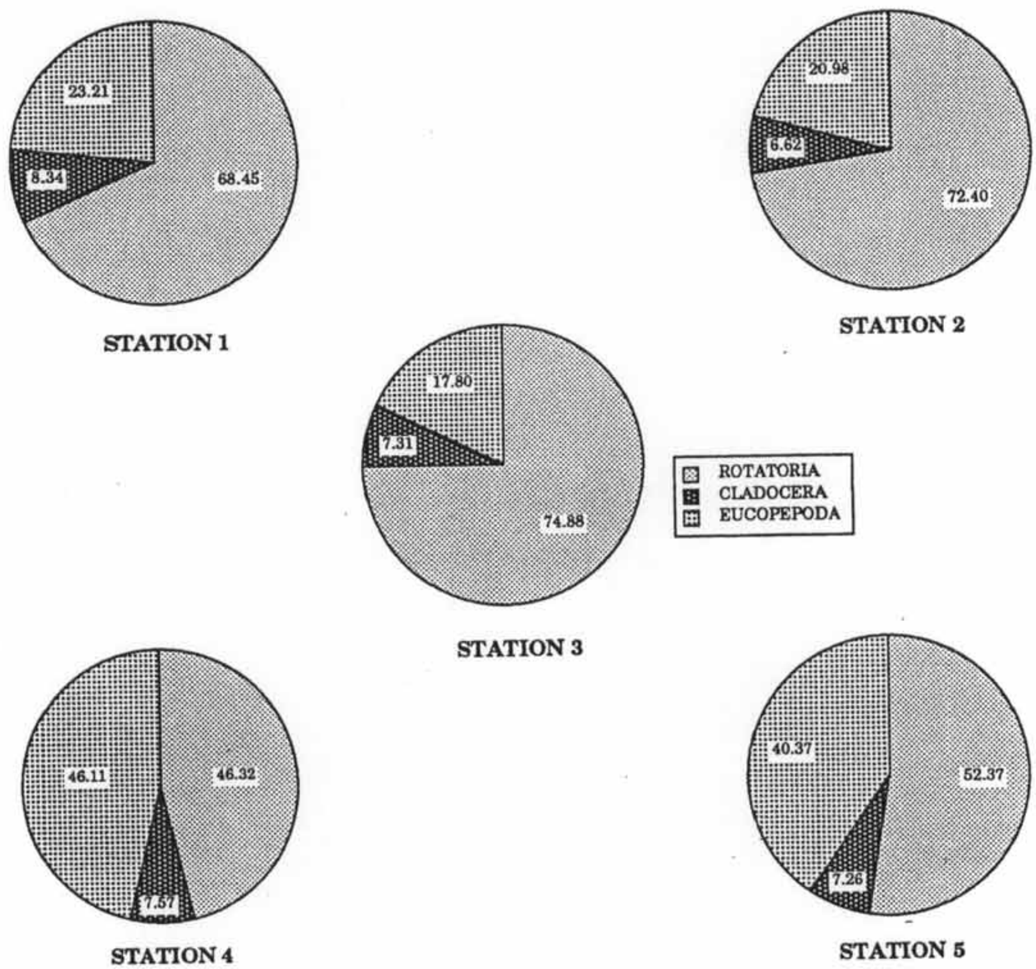


**Table 4.** Average numerical densities for the three major categories of zooplankton at the headwater collection sites and dam collection sites of several East Texas reservoirs.

| | Headwaters | | | Dam Site | | |
|---|---|---|---|---|---|---|
| **Reservoir** | **Clad** | **Cop** | **Rot** | **Clad** | **Cop** | **Rot** |
| Caddo Lake | 1.40 | 2.53 | 0.50 | 0.12 | 2.88 | 1.24 |
| Houston | 1.50 | 3.08 | 17.65 | 3.02 | 16.03 | 16.67 |
| Livingston | 0.80 | 12.98 | 38.58 | 6.96 | 22.0 | 20.19 |
| Lone Star | 15.74 | 28.81 | 73.19 | 21.03 | 37.9 | 39.64 |
| Murvaul | 2.44 | 13.55 | 15.03 | 2.95 | 10.16 | 15.46 |
| Nacogdoches | 6.57 | 12.96 | 1.90 | 12.63 | 43.1 | 8.80 |
| Sam Rayburn | 1.70 | 10.74 | 33.58 | 2.77 | 20.15 | 11.49 |
| Striker Creek | 6.39 | 8.07 | 8.60 | 3.77 | 7.83 | 7.00 |
| Lake O' the Pines | 3.40 | 18.89 | 24.51 | 5.86 | 16.30 | 48.07 |

* Stations 1, 2 and 3 in the headwaters averaged; designated collectively as the "swamp region" by Venneman.

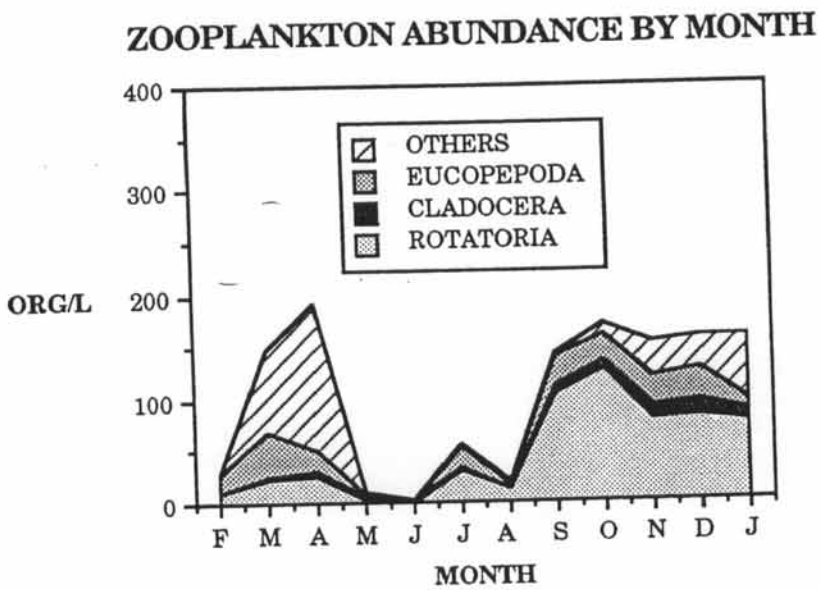
** Uppermost stations (5 and 7) of the two major headwater forks averaged.

The maximum monthly average for total zooplankton was in April at 191.23 organisms per liter, due to the population explosion of the peritrich. October had the next highest value of 169.59, which did not change much through January (Table 5). The minimum monthly average occurred in June at a surprisingly low figure of only 2.68 organisms per liter. Considering the three major groups of zooplankton, rotifers peaked in October, copepods in March, and cladocerans in December (Figure 6). All groups were at their lowest in June.

**Table 5.** Average number of the major zooplankton groups present during each month in organisms/liter.

| MONTH | ROTATORIA | CLADOCERA | EUCOPEPODA | OTHERS |
|---|---|---|---|---|
| January | 76.64 | 9.20 | 11.40 | 61.40 |
| February | 9.26 | 1.74 | 17.94 | 0.06 |
| March | 22.48 | 3.85 | 41.74 | 8.91 |
| April | 25.95 | 3.83 | 21.52 | 139.92 |
| May | 2.48 | 1.43 | 4.38 | 1.10 |
| June | 1.08 | 0.27 | 1.08 | 0.25 |
| July | 31.74 | 1.88 | 18.72 | 3.65 |
| August | 12.88 | 0.69 | 4.52 | 1.59 |
| September | 103.70 | 7.60 | 30.00 | 1.55 |
| October | 127.99 | 7.40 | 24.03 | 10.16 |
| November | 79.75 | 12.57 | 26.28 | 34.24 |
| December | 81.84 | 14.70 | 30.68 | 29.54 |

**Figure 6.** Monthly abundance for the major groups of zooplankton found at Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.




Seasonally, the average numerical density for all organisms was highest in fall at 157 organisms per liter and lowest in summer at only 28 organisms per liter (Figure 7). Of the three major groups, rotifers dominated the summer, fall and winter, with a peak in the fall (Figure 8). Copepods peaked and dominated in the spring, and cladocerans peaked in the winter.

**Figure 7.** Seasonal abundance of major zooplankton groups found at Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.

| SEASON | ROTATORIA | CLADOCERA | EUCOPEPODA | OTHERS | TOTAL |
|---|---|---|---|---|---|
| Spring | 16.94 | 3.04 | 22.55 | 50.00 | 94 |
| Summer | 15.24 | 0.95 | 8.11 | 1.83 | 28 |
| Fall | 103.81 | 9.19 | 26.77 | 15.31 | 157 |
| Winter | 54.43 | 8.50 | 20.62 | 28.11 | 114 |

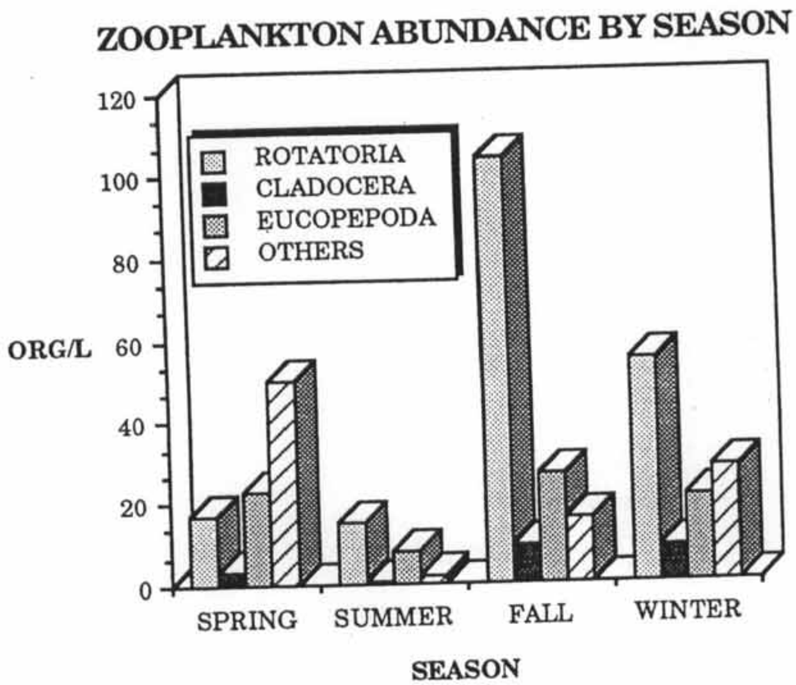
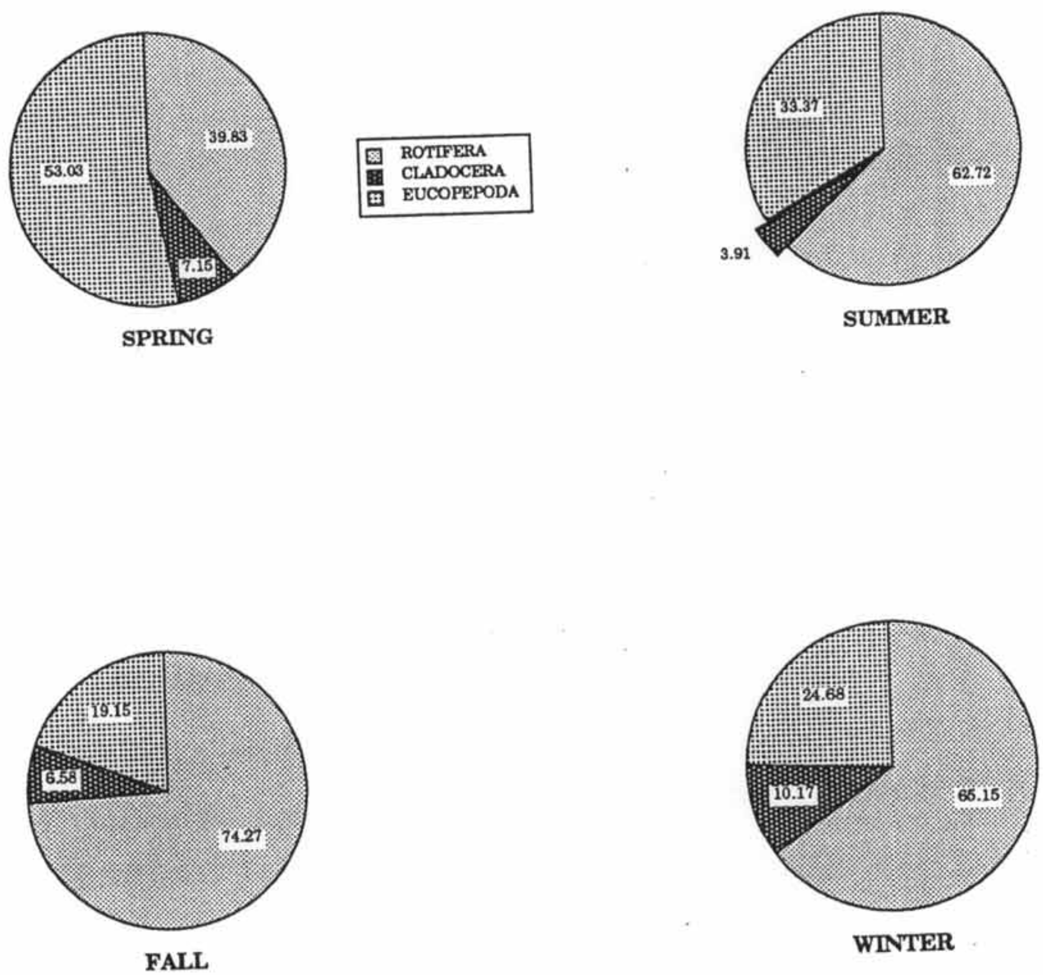


**Figure 8.** Percent abundance by season for the three major zooplankton groups found at Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.



## Comparison of Stations

**Station 1**

Located in the vicinity of the dam, station 1 had an annual population mean of 90.71 organisms per liter. The monthly population means ranged from a high of 211.96 organisms per liter in December to a low of 2.32 organisms per liter in August. Other population peaks were in October at 211.26 organisms per liter and January at 179.80 organisms per liter. The largest percentage of Cladocera occurred there.

**Station 2**

This station had the second highest annual population mean at 112.32 organisms per liter. Total population means by month ranged from a high of 281.24 organisms per liter in October to a low in August of 0.91 organisms per liter. The next highest peak occurred in April at 219 organisms per liter. Means were generally high all through fall and winter.

**Station 3**

Of all the stations, station 3 had the highest annual zooplankton mean at 149.03 organisms per liter. The monthly population means ranged from a high of 435.10 organisms per liter in April to a low of 1.75 organisms per liter in June. Although the number of peritrich organisms was highest at this station in April, the larger mean was not greatly influenced. Other peaks occurred from September through January, the second highest being in November at 368.81 organisms per liter. Of the previously mentioned dominant species, five of them were in their greatest numbers at this station. They were *Bosmina longirostris*, *Ceriodaphnia quadrangula*, *Diaptomus siciloides*, *Keratella cochlearis* and *Polyarthra*.

**Station 4**

The annual population mean for this station was 64.67 organisms per liter, the second lowest mean. Monthly population means ranged from a high of 155.01 organisms per liter in September to a low of 4.00 organisms per liter in June. Another peak occurred in July at 135.21 organisms per liter. Of the dominant organisms, copepod nauplii and *Conochilus* were most numerous in that area. Due to the waning rotifer population, the copepods appeared to codominate with the rotifers. A oneway analysis of variance showed the cladoceran *Camptocercus rectirostris* to be significantly higher at the station 4 (Table 6). The cladoceran was found only at this station, and it was rare.

**Station 5**

Station 5 had the lowest annual population mean at 61.13 organisms per liter. The monthly numerical density ranged from a high of 147.30 organisms per liter in January to a low of 3.65 organisms per liter in June. Results of a oneway analysis of variance for individual species indicated several organisms to be significantly higher at this station (Table 6). They were the cladocerans *Eurycercus lamellatus, Pleuroxus denticulatus, and Simocephalus expinosus*; the copepod *Macrocyclops albidis*; and the rotifers *Lecane*, *Monostyla* and *Platyias patulus*. These organisms were either peculiar only to

**Table 6**. List of zooplankton with $P < 0.05$ from a oneway analysis of variance and Duncan's Multiple Range Test by station.

| SPECIES | P VALUE | STATION |
|---|---|---|
| Order Cladocera | | |
| *Camptocercus rectirostris* | .0059 | 4 |
| *Eurycercus lamellatus* | .0151 | 5 |
| *Pleuroxus denticulatus* | .0137 | 5 |
| *Simocephalus expinosus* | .0311 | 5 |
| Order Eucopepoda | | |
| *Macrocyclops albidis* | .0016 | 5 |
| Phylum Rotatoria | | |
| *Lecane* | .0016 | 5 |
| *Monostyla* | <.0001 | 5 |
| *Platyias patulus* | .0411 | 5 |

station 5 or were most commonly found there. All were extremely low in number or rare. The Secchi disc transparency values were significantly lower and conductivity values significantly higher than those of other stations (Table 7).

## Diversity, Evenness and Richness

Annual values for diversity, evenness and richness appeared to be high for all stations, particularly station 5 (Figure 9). Monthly values for species diversity, evenness and richness were lowest in August, particularly at stations 2 and 5 (Appendix I). Stations 2 and 5 also produced the least number of zooplankton species in August. Most of the highest values occurred at station 5 as well, especially during the

**Table 7.** Homogeneous subsets of water chemistry parameters with P< 0.05 from a oneway analysis of variance and Duncan's Multiple Range Test by station.

**SECCHI (m) (P=.0001)**

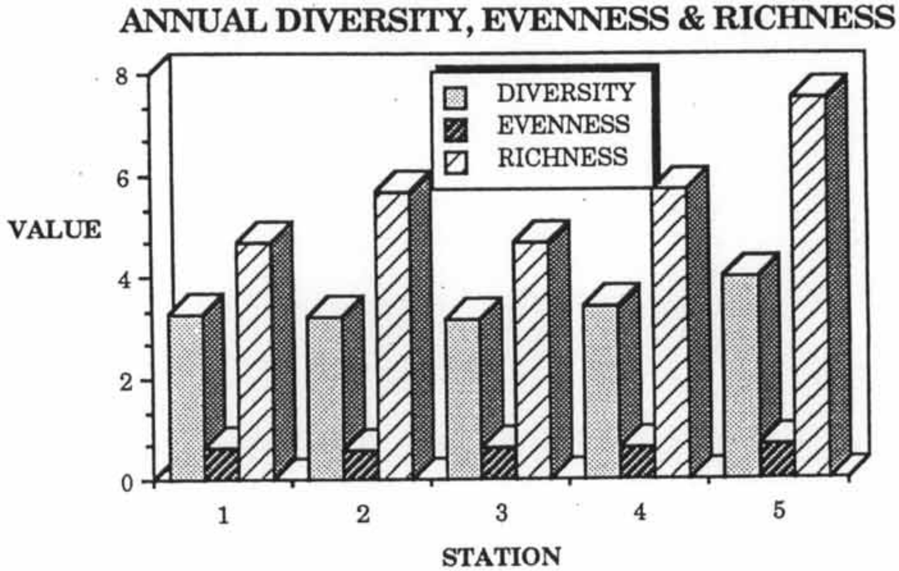
| STATION 5 | STATION 4 | STATION 1 | STATION 2 | STATION3 |
|---|---|---|---|---|
| 0.96 | | | | |
| | 1.70 | 1.81 | 1.82 | 1.93 |

**CONDUCTIVITY ($\mu$mho) (P=.0021)**

| STATION 1 | STATION 2 | STATION 3 | STATION 4 | STATION 5 |
|---|---|---|---|---|
| 122.33 | 124.05 | 125.20 | 142.04 | |
| | | | | 176.80 |

**Figure 9.** Annual species diversity, evenness and richness by station for Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 34 | 3.272 | 0.643 | 4.707 |
| 2 | 42 | 3.222 | 0.598 | 5.677 |
| 3 | 36 | 3.164 | 0.612 | 4.667 |
| 4 | 39 | 3.408 | 0.645 | 5.761 |
| 5 | 51 | 4.026 | 0.710 | 7.538 |



months following the stressful season of summer. On the average, monthly values remained moderately high throughout the year. The diversity index remained moderately high at most stations seasonally (Table 8). The average number of species present was lowest in the summer. Porter (1977) stated that high diversity in plankton communities represents an unstable community structure. Periods of very high diversity reflect times of rapid change in the zooplankton community during which some species are increasing while others are decreasing. The diversity index does not reflect actual population size. The number of organisms per liter may be very low at a given time, while the diversity index may appear relatively high.

## Community Ordination

Community ordination is a procedure whereby the similarity of the stations are based on the number of species that are common among the collecting sites and the number of individuals within each species. An annual community ordination was performed on the cumulative data from Lake O' the Pines Reservoir, and the resulting graph appears in Figure 10. The ordination shows stations 1,2 and 3 to be very similar. Stations 4 and 5 were widely separated, and the procedure suggests both sites to be very unique communities.

**Table 8.** Diversity, evenness and richness values for each season by station for Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.

**SPRING**

| STATION | AVG. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 12 | 2.510 | 0.733 | 2.938 |
| 2 | 13 | 2.410 | 0.683 | 3.091 |
| 3 | 13 | 2.216 | 0.653 | 2.867 |
| 4 | 11 | 2.539 | 0.763 | 2.754 |
| 5 | 19 | 3.283 | 0.786 | 4.035 |

**SUMMER**

| STATION | AVG. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 9 | 2.781 | 0.937 | 2.929 |
| 2 | 7 | 2.366 | 0.930 | 2.531 |
| 3 | 7 | 2.480 | 0.922 | 2.283 |
| 4 | 10 | 2.452 | 0.775 | 2.410 |
| 5 | 9 | 2.461 | 0.855 | 2.501 |

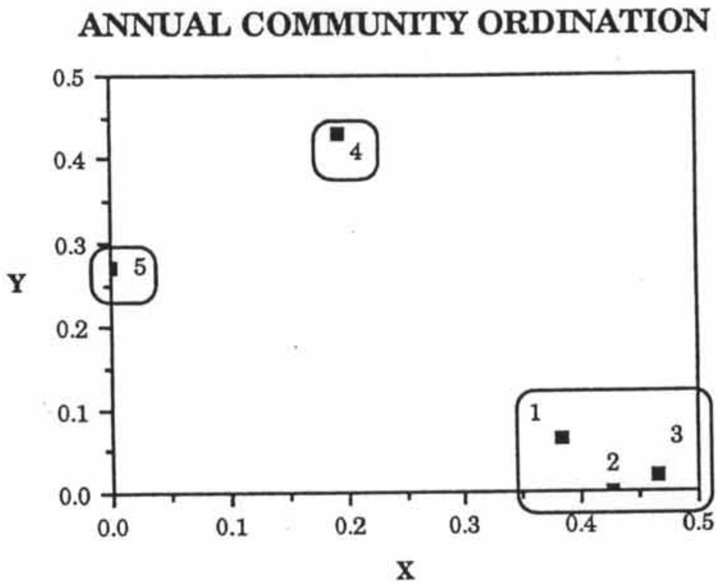
**FALL**

| STATION | AVG. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 16 | 2.738 | 0.701 | 2.877 |
| 2 | 18 | 2.601 | 0.632 | 3.195 |
| 3 | 22 | 2.398 | 0.575 | 3.043 |
| 4 | 16 | 3.253 | 0.738 | 4.216 |
| 5 | 18 | 2.954 | 0.720 | 3.785 |

**WINTER**

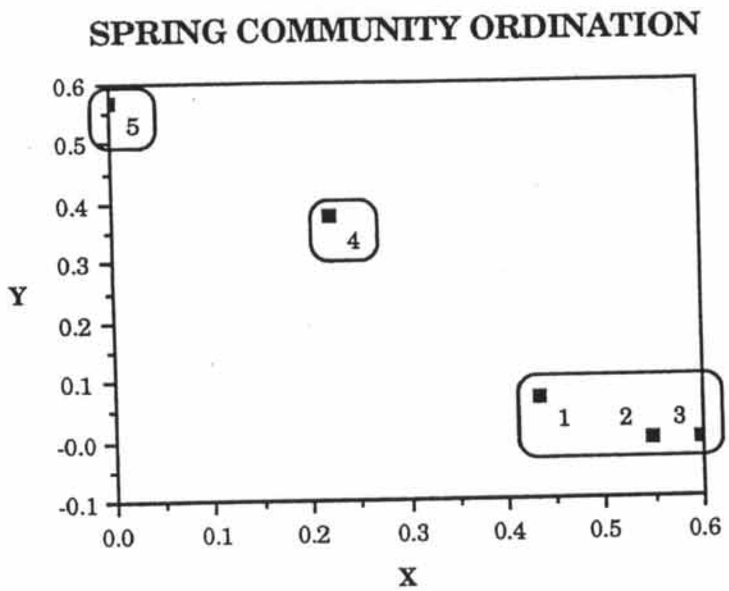
| STATION | AVG. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 12 | 2.493 | 0.703 | 2.638 |
| 2 | 12 | 2.457 | 0.723 | 2.442 |
| 3 | 13 | 2.506 | 0.692 | 2.709 |
| 4 | 12 | 2.554 | 0.712 | 2.913 |
| 5 | 21 | 3.067 | 0.708 | 4.166 |

**Figure 10.** Annual community ordination by station for Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.




Seasonal community ordinations were also performed (Figure 11, Figure 12); these confirmed the distinctiveness of the communities at stations 4 and 5. It is interesting to note the similarity of the plotted positions of the stations between spring and fall communities, and between summer and winter communities. Also, the positions for stations 4 and 5 change from the milder seasons of spring and fall to the more extreme seasons of summer and winter. Perhaps the zooplankton communities of these two stations were more susceptible to seasonal changes due to their shallowness, the chemical properties of the sediment and water column, and the abundant aquatic vascular plants.

**Figure 11.** A comparison of graphs showing community ordination for Spring 1986 and Fall 1986 at Lake O' the Pines Reservoir, Texas.



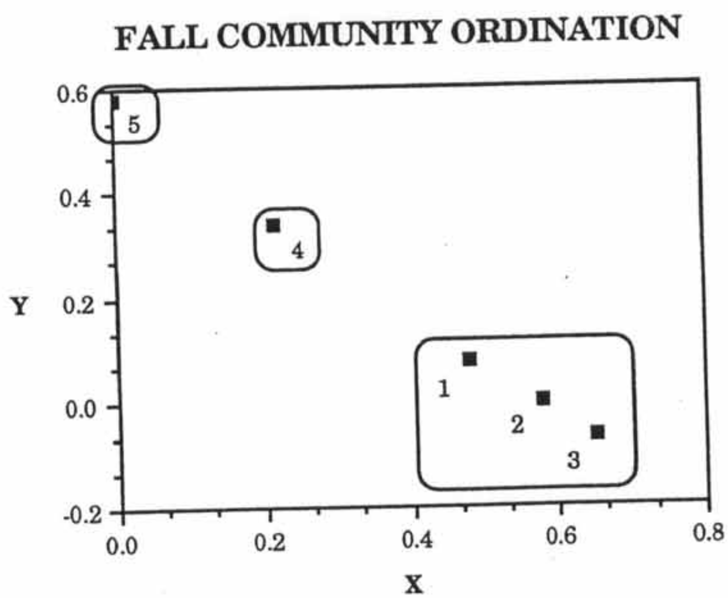
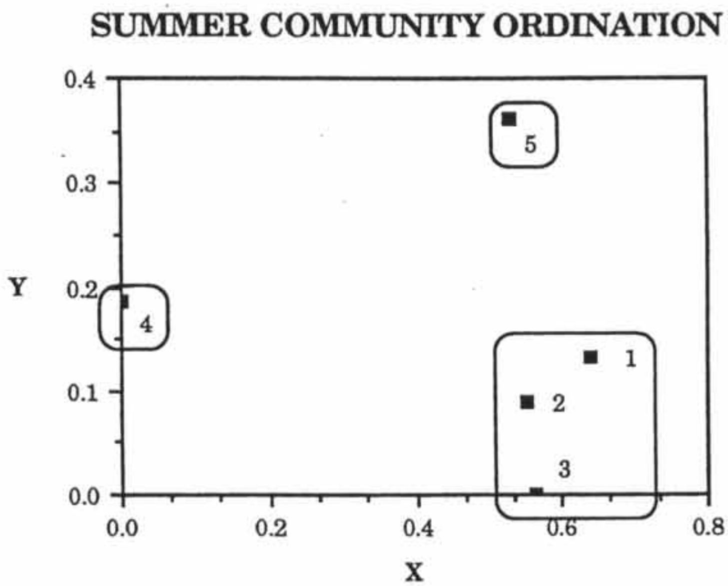
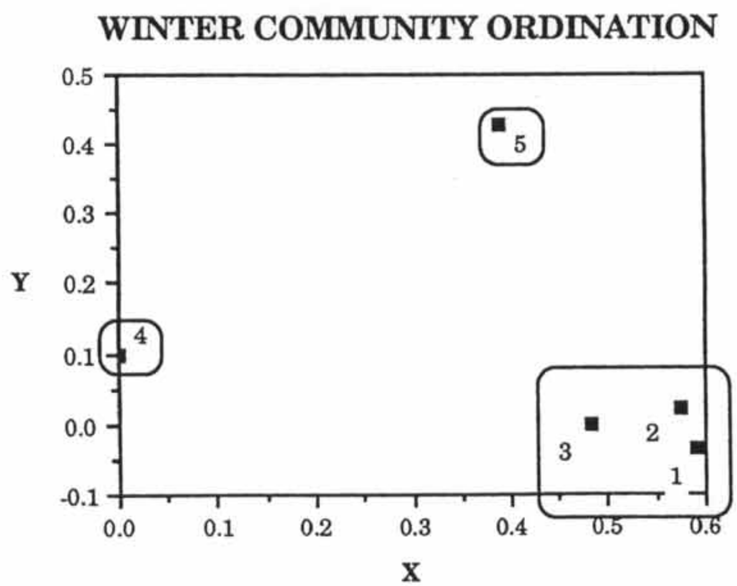



**Figure 12.** A comparison of graphs showing community ordinations for Summer 1986 and Winter 1986-1987 at Lake O' the Pines Reservoir, Texas.



## Analysis of Variance

The results of a oneway analysis of variance showed significant differences between stations at the 95% confidence level for a few species of zooplankton within each major group and for some water chemistry parameters. These will be explained later in a comparison of the stations. The analysis of variance showed no significant difference between the major groups by station; however, an analysis of the major groups by season produced results (Table 9). The cladoceran numbers were significantly fewer in summer and spring, and greater in winter and fall. Copepod numbers decreased significantly in the summer, and rotifers exhibited a significant population increase in the fall. Total zooplankton numerical density was significantly lower in the summer. Analysis of water chemistry parameters by season revealed that summer and winter caused significant extremes. Oxygen values were lowest during summer and highest in winter (Table 10). Conversely, carbon dioxide values were highest in summer and lowest in winter. Conductivity was also significantly higher in summer and lower in winter. A two-way analysis of the major zooplankton groups by season and by station revealed significant differences in rotifer population sizes, and this was confirmed with a oneway analysis of fall rotifer data by station (Table 11). Stations 3 and 5 clearly showed significant extremes in rotifer numerical densities.

**Table 9.** Homogeneous subsets of the three major zooplankton groups and total zooplankton with P < 0.05 from a oneway analysis of variance and Duncan's Multiple Range Test by season.

**ORDER Cladocera (P=.0069)**

| SUMMER | SPRING | WINTER | FALL |
|---|---|---|---|
| 0.95 | 3.04 | | |
| | | 8.50 | 9.19 |

**ORDER Eucopepoda (P=.0088)**

| SUMMER | WINTER | SPRING | FALL |
|---|---|---|---|
| 8.10 | | | |
| | 20.62 | 22.55 | 26.77 |

**PHYLUM Rotatoria (P=<.0001)**

| SUMMER | SPRING | WINTER | FALL |
|---|---|---|---|
| 15.24 | 16.97 | 54.43 | |
| | | | 103.81 |

**TOTAL ZOOPLANKTON (P=.0023)**

| SUMMER | SPRING | WINTER | FALL |
|---|---|---|---|
| 26.12 | | | |
| | 92.54 | 111.67 | 155.09 |

**Table 10.** Homogeneous subsets of water chemistry parameters with P < 0.05 from a oneway analysis of variance and Duncan's Multiple Range Test by season.

**TEMPERATURE (C) (P=<.0001)**

| WINTER | FALL | SPRING | SUMMER |
|---|---|---|---|
| 4.85 | | | |
| | 12.06 | 14.03 | |
| | | | 23.85 |

**OXYGEN (mg/L) (P=<.0001)**

| SUMMER | SPRING | FALL | WINTER |
|---|---|---|---|
| 5.25 | | | |
| | 8.42 | 8.64 | |
| | | | 12.19 |

**CARBON DIOXIDE (mg/L) (P=.0002)**

| WINTER | FALL | SPRING | SUMMER |
|---|---|---|---|
| 5.37 | 9.73 | | |
| | | 62.19 | 110.87 |

**CONDUCTIVITY ($\mu$mho) (P=<.0001)**

| WINTER | SPRING | FALL | SUMMER |
|---|---|---|---|
| 97.75 | | | |
| | 138.15 | 141.19 | |
| | | | 175.25 |

**Table 11.** Homogeneous subsets of total rotifers for Fall by station from a oneway analysis of variance and Duncan's Multiple Range Test.

**PHYLUM Rotatoria (P=.0082)**

| | | | | |
|---|---|---|---|---|
| STATION 5 | STATION 4 | STATION 1 | | |
| 28.34 | 39.50 | 92.69 | | |
| | STATION 4 | STATION 1 | STATION 2 | |
| | 39.50 | 92.69 | 138.93 | |
| | | | STATION 2 | STATION 3 |
| | | | 138.93 | 219.59 |

## Eutrophication and Community Structure

The correlation between zooplankton community structure and the trophic status of a lake can be described as follows: oligotrophic lakes tend to be dominated by calanoid copepods and eutrophic lakes by smaller cladocera, cyclopoid copepods, and rotifers (Brooks, 1969; Patalas, 1972; Porter, 1977; Gannon and Stemberger, 1978; Meyer and Effler, 1980; Blancher, 1984). Calanoid copepods are the most efficient in filtering waters with low algal densities, low productivity being a characteristic of oligotrophic lakes. The smaller zooplankters are better able to escape predation in highly productive eutrophic waters than their larger counterparts and have a higher birth rate (McNaught, 1975). Cyclopoid copepods are raptorial feeders and are more successful under such conditions. Lake O' the Pines is dominated by rotifers and small crustaceans, presumeably the result of eutrophication.

The ratio of calanoid copepods to cyclopoid copepods and cladocerans reflects the trophic status of a lake. Gannon and Stemberger (1978) developed the following equation for calculating this ratio:

$$\frac{\text{Calanoid Copepods}}{\text{Cyclopoid Copepods + Cladocera}}$$

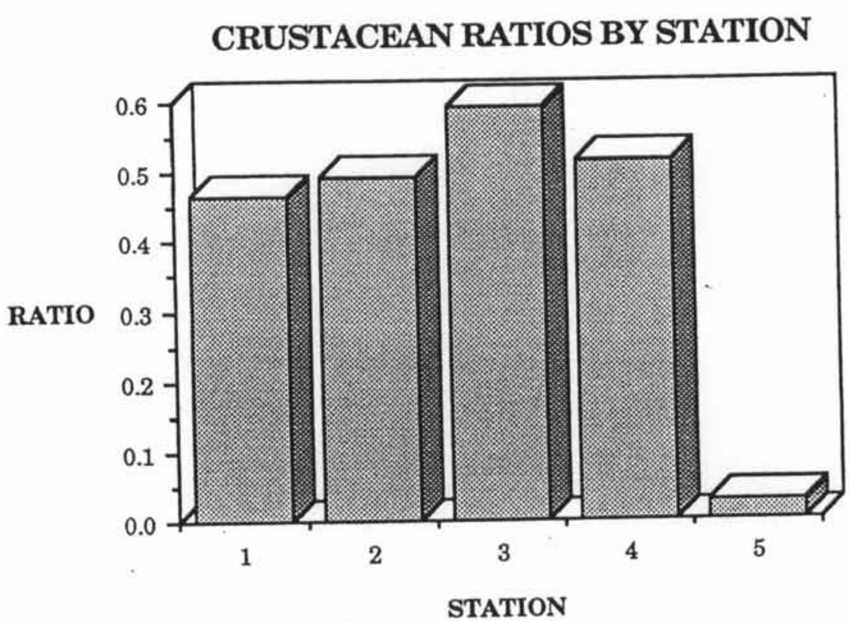
Higher values represent a lesser degree of eutrophy, while lower values indicate greater eutrophy. Annual ratios by station for Lake O' the Pines are given in Figure 13. Stations 1 through 4 had fairly low ratios, ranging from 0.467 to 0.591. The value for station 5, however, was exceedingly low at 0.025, and therefore may represent a very high degree of eutrophy.

Indicators of eutrophy for North America have also been identified by Gannon and Stemberger (1978). Several of these indicator species occurred in Lake O' the Pines during the study period. They were *Brachionus*, *Filinia*, *Keratella*, *Polyarthra*, *Trichocerca*, *Conochiloides*, *Bosmina longirostris*, *Chydorus sphaericus*, *Ceriodaphnia quadrangula*, and *Cyclops vernalis*. This supports the contention that Lake O' the Pines Reservoir is eutrophic. In his comparison of Houston Reservoir to other East Texas reservoirs, Lacy (1987) found the rotifers *Asplanchna*, *Brachionus*, *Conochiloides*, *Conochilus*, *Filinia*, *Kellicottia*, *Keratella*, *Platyias*, *Pleosoma*, *Polyarthra*, *Synchaeta*, *Trichocerca*; the cladocerans *Bosmina longirostris*, *Daphnia*, *Sida crystallina*; the cyclopoid copepod *Mesocyclops*; the calanoid copepod

*Diaptomus*; and copepod immatures to be the most common zooplankters. Lake O' the Pines contained each of these species with the exception of *Pleosoma*.

**Figure 13.** Crustacean ratios by station for Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.

| STATION | RATIO MEAN |
|---|---|
| 1 | 0.467 |
| 2 | 0.494 |
| 3 | 0.591 |
| 4 | 0.516 |
| 5 | 0.025 |



## Effects of Predation

Brooks and Dodson (1965) state that a change from a zooplankton community dominated by small plankters will occur in response to the introduction of planktivorous fishes (also Zaret and Kerfoot, 1975; Drenner and McComas, 1980). Texas Parks and Wildlife (Toole, 1983) reported gizzard shad to be the dominant forage species with threadfin shad listed among the other important forage species in Lake O' the Pines. Since these two species are planktivorous, it is possible that a large population of shad could reduce the numbers of larger crustaceans. However, this size-dependent form of vertebrate predation should not have such a large impact on the smallest species of zooplankton, particularly the rotifers.

## Effects of Local Industry

Some of the point sources of pollution in the vicinity of Lake O' the Pines includes the local steel mill and five municipal and resort sewage treatment plants, according to the Texas Water Commission (Petrick, 1975). Possible non-point sources include septic tank seepage, agricultural runoff, forest drainage and runoff from old stripmining areas. Wastewater discharge from the local steel industry and municipal wastewater plants into Lake O' the Pines and Big Cypress Creek has been previously monitored by the Texas Water Commission (Petrick, 1975) and noted by the E.P.A. (National Eutrophication Survey, 1977). The discharge of treated sewage from the industry was reported to contribute 4,944 lbs/day of $BOD_5$ into Lone Star Reservoir (formerly

Ellison Creek Reservoir) and 58.3 lbs/day into the upper end of Lake O' the Pines. These values exceeded most of the individual municipal treatment plants. This large influx of organics in the upper reaches of Lake O' the Pines accounts for the abundant growth of *Hydrilla* and other aquatic vasculars during the summer months. It is possible that the presence of abundant aquatic vascular plants may have some inhibitory effect on the zooplankton population there, as found by Hardy (1935), Hasler and Jones (1949), and Porter (1977). However, the opposite could also be true according to Shireman and Martin (1978) and Campbell, et al., (1985), who attributed the abundance of Cladocera-dominated zooplankton to the large amount of aquatic vasculars in their studies.

Unacceptable levels of heavy metals, oil, and grease have been found in the sediments of Big Cypress Creek and Lake O' the Pines. Bottom sediments are important in that they appear to be a major contributor of toxic metals to the water column. The Texas Water Commission has been sampling the sediments along Big Cypress Creek and Lake O' the Pines since 1973 (Weber, 1988). Witt (1988) also sampled heavy metals in the water column from Lone Star Reservoir, Big Cypress Creek and Lake O' the Pines. The T.W.C. sampling sites and those of Witt (1988) are shown in Figure 14 and Figure 15. The sediment samples from Big Cypress Creek and Lake O' the Pines revealed concentrations for cadmium, lead, zinc, volatile solids, and oil and grease which were extremely high (Table 12).

**Figure 14.** Map of Lone Star Lake, Big Cypress Creek and Lake O' the Pines Reservoir showing the location of Texas Water Commission (Weber, 1988) and Witt (1988) sampling stations.

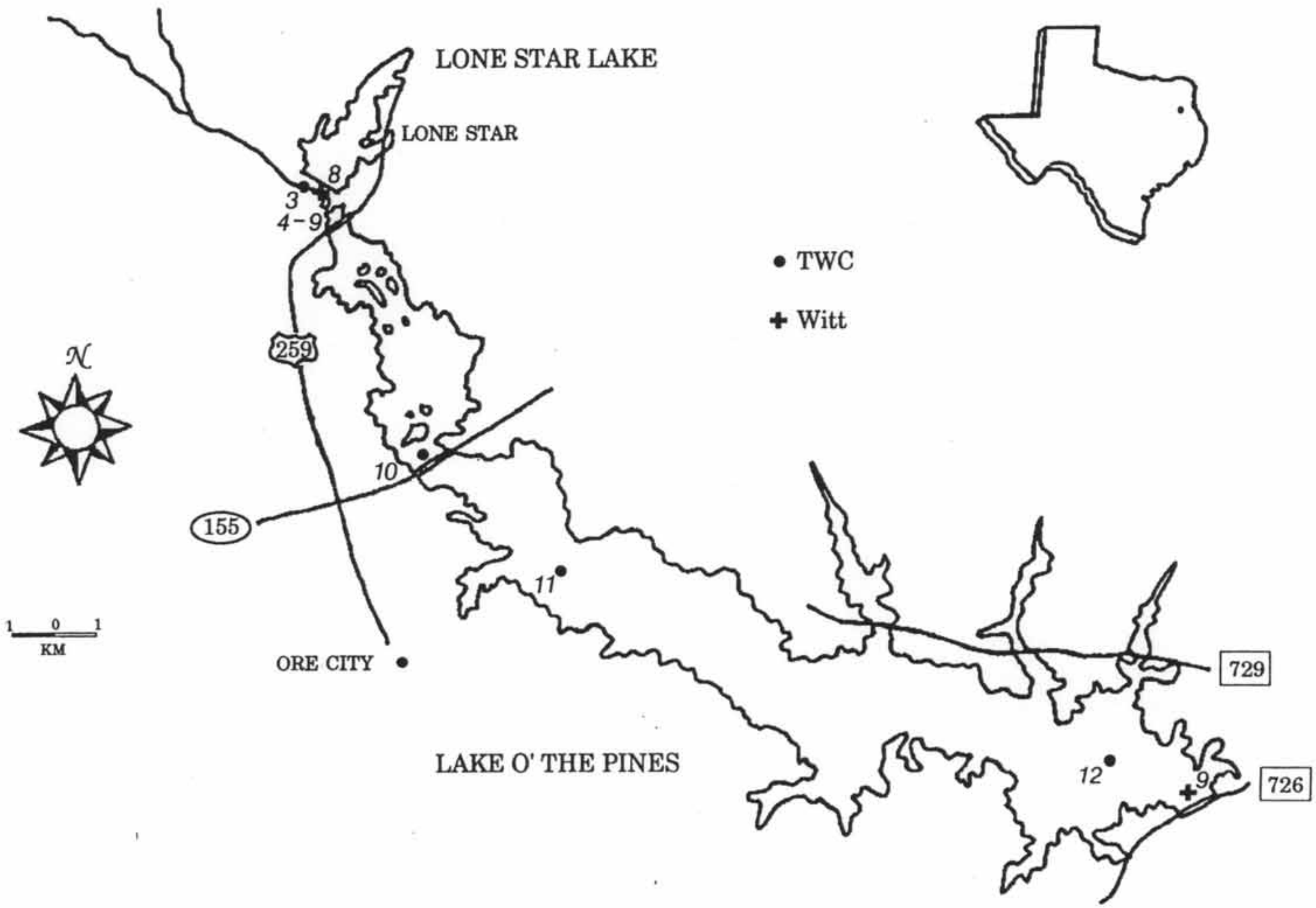


**Figure 15**. Enlarged view of Lone Star Lake, Big Cypress Creek, and Lake O' the Pines Reservoir showing the location of some Texas Water Commission sampling stations.

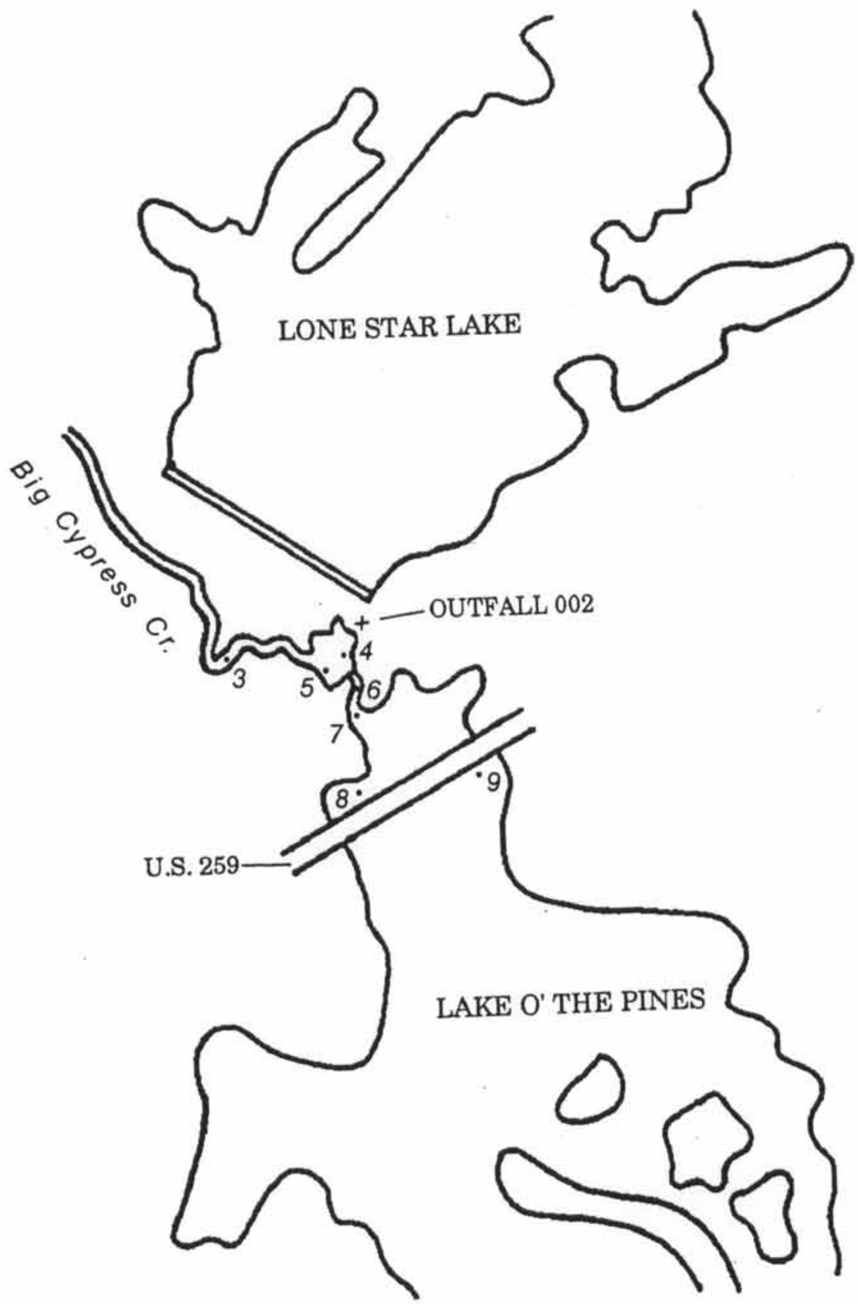


**Table 12.** Average concentrations (in mg/kg) of various sediment parameters in Big Cypress Creek and Lake O' the Pines Reservoir from Texas Water Commission sampling (Weber, 1988) during November 1973 to May 1988.

| TWC STATIONS | As | Cd | Cr | Cu | Pb | Mn | Ni | Zn | VSS | Oil/Grs |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | RESULTS | | | | | |
| Big Cypress Creek | | | | | | | | | | |
| 1 | 3.2 | <0.5 | 19 | 9 | 15 | 350 | 12 | 53 | 41000 | 810 |
| 2 | 1.2 | <0.5 | 8 | 6 | 5 | 260 | 7 | 23 | 24000 | 620 |
| 3 | 1.7 | <1.0 | 17 | 10 | 61 | 481 | 14 | 187 | 83756 | 1094 |
| 4 | 4.8 | 9 | 108 | 62 | 323 | 2380 | 34 | 1420 | 56176 | 15480 |
| 5 | 4.3 | 2 | 33 | 23 | 197 | 720 | 24 | 707 | 101300 | 9171 |
| 6 | 1.1 | 1 | 9 | 6 | 38 | 189 | 7 | 165 | 22758 | 1329 |
| 7 | 1.1 | 2 | 10 | 4 | 62 | 307 | 6 | 388 | 31814 | 1708 |
| 8 | 4.8 | 4 | 39 | 21 | 70 | 927 | 13 | 231 | 50217 | 2078 |
| Lake O' the Pines | | | | | | | | | | |
| 9 (5) | 2.2 | 2 | 23 | 22 | 108 | 1690 | 21 | 441 | 94203 | 5264 |
| 10 | 2.5 | 3 | 19 | 47 | 149 | 775 | 17 | 465 | 103245 | 4579 |
| 11 (4) | 2.7 | 10 | 22 | 25 | 88 | 980 | 16 | 169 | 135802 | 3577 |
| 12 (1) | 10.4 | 1 | 14 | 14 | 28 | 3900 | 17 | 85 | 85292 | 1528 |
| Statewide 90th percentile value for sediment parameters: | 15.7 | 3.0 | 72.1 | 40 | 63 | N A | 31.8 | 120 | 103000 | N A |

*Underline denotes that the value exceeds the statewide 90th percentile value for that parameter.

**Number in parentheses indicates the station of the present study which corresponds to the TWC station.

The T.W.C. reported that the metal, oil and grease pollution originated from the steel mill's waste disposal system. Average concentrations of various sediment parameters show that oil and grease, cadmium, chromium, copper, lead and zinc were also elevated in the upper reaches of Lake O' the Pines. Many of the values exceeded the statewide 90th percentile for sediment parameters. That is, these values ranged in the upper 10% of all statewide values, which makes them among the highest reported by the T.W.C. for the state of Texas.

Witt (1988) established water sampling stations along Lone Star Reservoir, on Big Cypress Creek below the reservoir's dam, and in the deep water area of Lake O' the Pines near the dam. Table 13 shows the annual average for metals in Lone Star Reservoir, Big Cypress Creek, and Lake O' the Pines. Witt's heavy metal analysis of the waters revealed that federal standards for chromium, copper, lead, manganese and zinc were exceeded at times, especially in Big Cypress Creek which feeds Lake O' the Pines. According to Witt, Lone Star Reservoir, Big Cypress Creek and Lake O' the Pines are considered to be soft waters. Low calcium concentrations make these waters more vulnerable to acute and chronic metal toxicity since the dilution effect of calcium and magnesium ions on heavy metals is greatly reduced. The cumulative effect of some metals (like copper and lead) and the synergetic effect of all the metals can cause toxic effects at lower concentrations in this situation.

**Table 13.** Annual means for metals (in $\mu$g/mL) in the water column from Lone Star Reservoir, Big Cypress Creek and Lake O' the Pines Reservoir (Witt, 1988).

| METAL | Lone Star | Big Cypress | Lake O' the Pines |
|---|---|---|---|
| Aluminum | 2.8 | 2.8 | 3.2 |
| Calcium | 30.1 | 19.6 | 9.1 |
| Chromium | 39.0 | 52.0 | 37.0 |
| Copper | 0.01 | 0.03 | 0.01 |
| Lead | 0.04 | 0.04 | 0.03 |
| Magnesium | 4.1 | 3.8 | 3.5 |
| Manganese | 0.79 | 1.97 | 2.07 |
| Potassium | 6.3 | 6.0 | 3.1 |
| Sodium | 14.5 | 19.7 | 10.0 |
| Zinc | 0.52 | 0.54 | 0.49 |

Zooplankton populations are subject to the adverse effects of metal contamination. Pennak (1946) stated that "trace" elements such as manganese, copper and zinc are toxic to some plankters. Winner and Farrell (1976) subjected four species of *Daphnia* to acute and chronic copper stresses, and found a reduction in survival rate at concentrations of greater than 40 $\mu$g/L. A decrease in the instantaneous rate of population growth (r) was exhibited at higher concentrations. Chronic effects were more quickly detected in smaller species of *Daphnia* which have shorter life spans. Arts and Sprules (1987) analyzed the dry weight and lipid content of three zooplankton species (*Holopedium gibberum*, *Epischura lacustris* and *Diaptomus minutus*) in two lakes differing in copper, nickel and aluminum levels. Zooplankton from the lake with higher metal concentrations had a lower dry weight and smaller lipid reserves. Interference in the accumulation of triglycerols was attributed to heavy metal contamination. This would affect the ability of zooplankton to endure periods of food shortage, and possibly result in a detrimental alteration of the paths of energy flow through the trophic levels. According to Winner (1981), who conducted copper and zinc bioassays with *Daphnia magna,* lifetime exposure to elevated concentrations of these metals causes a significant reduction in growth measured as body length. Both body length and longevity were the most sensitive indices of chronic stress than was reproduction. Biensinger and Christensen (1972) tested the effects of various metals on *Daphnia magna*. The results of three-week chronic exposure tests showed that zinc was found to cause a 16% reproduction impairment at 70 $\mu$g/L and a 50% reproduction impairment at 102 $\mu$g/L, with a $LC_{50}$ of 158 $\mu$g/L.

Ready (1988) found that zinc had a negative correlation with total zooplankton numbers in Lone Star Reservoir, indicating that it may have a toxic effect on the zooplankton community. It is possible that zinc and the combined synergistic effect of the other metals was the major cause of the reduced numerical density of zooplankton at stations 4 and 5 in this study. It could be the reason for the extreme reduction of zooplankton numbers in the summer (especially during the month of June). During this time, oxygen is depleted while carbon dioxide increases toward the bottom due to bacterial respiration. The formation of carbonic acid from carbon dioxide causes acidification of the water column, and the resulting lowered pH increases the release of metals from the sediments. Significant seasonal differences for temperature, oxygen, carbon dioxide and conductivity have been noted in this study. Summer values reflect extremes in these parameters which may contribute to the acidification

**Figure 16.** Total zooplankton versus carbon dioxide using annual values by station from Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.

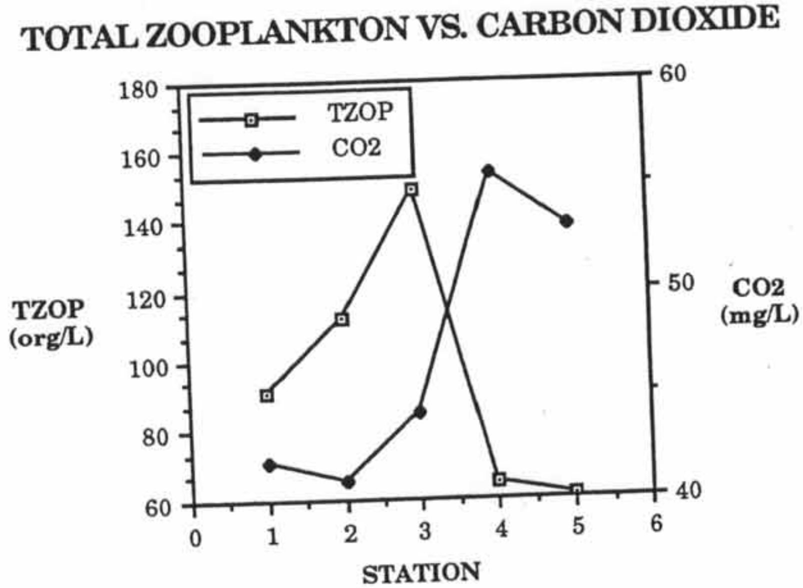
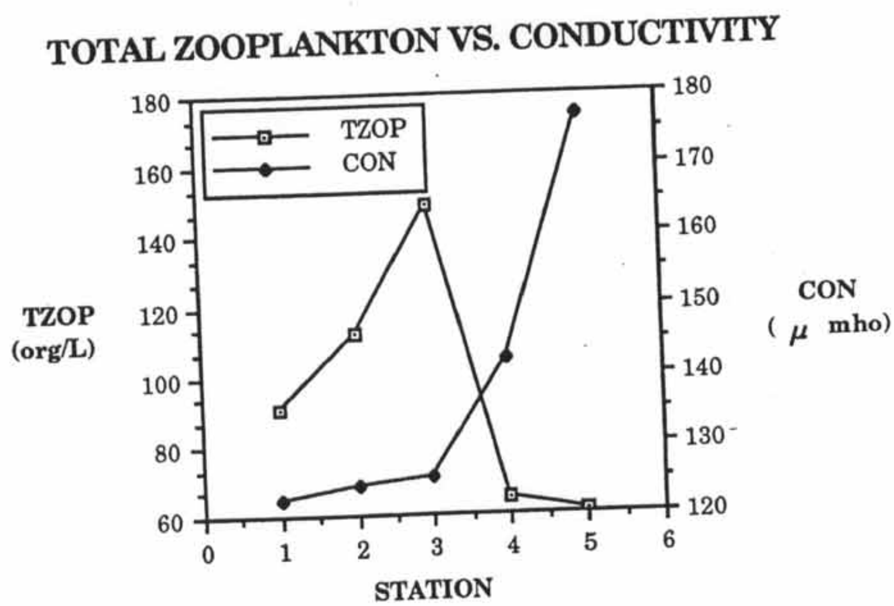



**Figure 17.** Total zooplankton versus conductivity using annual values by station from Lake O' the Pines Reservoir, Texas, from February 1986 to January 1987.



process and the subsequent release of metals from the sediments into the water column. The inverse relationships between total zooplankton and two of the most significant water chemistry parameters were especially evident for stations 4 and 5 (Figure 16, Figure 17).

**Summary**

1. The dominant species of rotifers, copepods and cladocera in Lake O' the Pines indicate a eutrophic environment.
2. The annual mean standing crop of net zooplankton was 96.10 organisms per liter, which was actually higher than that of most other East Texas reservoirs.
3. Rotifers constituted 49.43% of the total population; copepods, cladocera and other organisms comprised 20.28%, 5.59% and 24.70% of the remaining population, respectively.
4. The highest annual numerical density by station was at station 3 at 149.03 organisms per liter, which dropped sharply to 61.13 organisms per liter at station 5 in the headwaters.
5. Rotifers dominated the first three stations, but suffered a decline in numerical density and dominance at stations 4 and 5.
6. The maximum monthly average for total zooplankton occurred in April at 191.23 organisms per liter and the minimum monthly average was in June at only 2.68 organisms per liter, an extremely low figure for a reservoir which supports one of the highest annual zooplankton densities in East Texas.

7. Seasonally, the average numerical density for total zooplankton was highest in fall at 157 organisms per liter, and lowest in summer at 28 organisms per liter.
8. The annual community ordination revealed a wide separation, with regard to similarity in community structure, of stations 4 and 5 from the other stations and from each other.
9. The monthly diversity indices were moderate at most stations, though some monthly values for stations 4 and 5 were very high.
10. Annually, station 5 had the highest diversity index with the next highest values at station 4.
11. Considering the results of sediment analyses conducted by the Texas Water Commission, the decline in the numerical density of rotifers and total zooplankton in the headwaters could be attributed to heavy metal toxicity.

# CONCLUSION

Lake O' the Pines Reservoir compares favorably to other East Texas reservoirs in both species composition and annual numerical density. However, the distribution of zooplankton from the headwaters to the dam did not follow the expected trend. There was an unusual decline in both rotifer and total zooplankton populations in the highly productive headwaters. One possible explanation is that large amounts of aquatic vascular plants have contributed to exclusion of zooplankton in that area. Some studies, however, have not supported this phenomenon. Another explanation is heavy predation by other invertebrates and fishes, but this should not have such a large impact on the highly prolific (and much smaller) rotifers. Finally, it has been revealed that heavy metals have accumulated in the sediments of the upper reaches of the reservoir, and that they are being leached into the water column. The toxic effect of these metals is the most probable answer to the unusual trend in the distribution of zooplankton in Lake O' the Pines Reservoir.

## LITERATURE CITED


Allan, J. David. 1976. Life history patterns in zooplankton. Amer. Nat. 110:165-176.

Allard, David Wayne. 1974. Zooplankton population dynamics at Sam Rayburn Reservoir. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Applegate, R.I. and J.W. Mullan. 1967. Zooplankton standing crops in a new and old Ozark reservoir. Limnol. Oceanogr. 12:592-599.

Arts, Michael T. and W. Gary Sprules. 1987. Energy reserves of three zooplankton species from two lakes with different metal concentrations. Can. Jour. Fish. Aquat. Sci. 44:458-466.

Baudouin, M.F. and P. Scoppa. 1974. Acute toxicity of various metals to freshwater zooplankton. Bull. Environ. Contam. Toxicol. 12 (6):745-751.

Becker, Paul Reese. 1969. The systematics and seasonal distribution of the Cladocera of Hays County. M.S. Thesis. Southwest Texas State University, San Marcos, Texas.

Biensinger, K.E., and G.M. Christensen. 1972. Effects of various metals on survival, growth, reproduction, and metabolism of *Daphnia magna*. Jour. Fish. Res. Bd. Can. 29:1691-1700.

Blancher, Eldon C. II. 1984. Zooplankton-trophic state relationships in some north and central Florida lakes. Hydrobiologia 109:251-263.

Brooks, John Langdon. 1969. Eutrophication and changes in the composition of the zooplankton. Pages 236-255 in: Eutrophication: causes, consequences, correctives. International Symposium on Eutrophication, University of Wisconsin, 1967.

Brooks, John Langdon and Stanley I. Dodson. 1965. Predation, body size, and composition of plankton. Science 150 (3692): 28-35.

Burns, C.W. and F.H. Rigler. 1967. Comparison of filtering rates of *Daphnia rosea* in lake water and in suspensions of yeast. Limnol. Oceanogr. 12:492-502.

Campbell, J.M., J.E. Morris and R.L. Noble. 1985. Spatial variability and community structure of littoral microcrustaceans in Lake Conroe, Texas. Texas Jour. Sci. 36 (4):247-257.

Cappel, Shirley Marsh. 1970. A comparative study of the net plankton populations in the tributaries and the main reservoir of Benbrook Lake, Tarrant County, Texas. M.S. Thesis. Texas Christian University, Fort Worth, Texas.

Cheatum, E.P., A. Metler and M. Longnecker. 1942. Limnological observations on an East Texas lake. Trans. Amer. Micros. Soc. 61:336-348.

Cichra, Mary F., John M. Campbell, Phillip W. Bettoli and William J. Clark. 1985. Zooplankton community structure and dynamics in Lake Conroe, Texas. Texas Jour. Sci. 36 (4):235-246.

Cox, G.W. 1967. Laboratory manual of general ecology. William C. Brown Company Publ., Dubuque, Iowa. 165 p.

Drenner, Ray W. and Steven R. McComas. 1980. The roles of zooplankton escape ability and fish size selectivity in the selective feeding and impact on planktivorous fish. Pages 587-593 in: Kerfoot, W.C., ed. The ecology and evolution of zooplankton communities. Amer. Soc. Limnol. Oceanogr. Spec. Symp. 3. University Press of New England.

Duncan, A. 1984. Assessment of factors influencing the composition, body-size, and turnover rate of zooplankton in Parakrama-Samudra in an irrigation reservoir in Sri Lanka. Symposium on tropical zooplankton, Sao Carlos, Brazil. Hydrobiologia 113:201-216.

Edmondson, W.T. 1946. Factors in the dynamics of rotifer populations. Ecol. Monogr. 16:357-372.

__________________ 1965. Reproductive rate of planktonic rotifers as related to food and temperature in nature. Ecol. Monogr. 35:61-111.

Ellsworth, Patricia M. 1983. Ecological seasonal cycles in a Colorado mountain pond. Jour. Freshw. Ecol. 2:225-237.

Evans, A.A. 1936. Study of plankton dilution in source streams compared with that of Lake Dallas proper (Texas). M.S. Thesis. North Texas State University, Denton, Texas.

Gannon, John E. and Richard S. Stemberger. 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality. Trans. Amer. Micros. Soc. 97 (1):166-235.

Greenberg, Arnold E., R. Rhodes Trussell, and Lenore S. Clesceri (Joint Eds.). 1985. Standard methods for the examination of water and wastewater, 16th edition. Amer. Pub. Health Assoc., Amer. Water Works Assoc., and Water Poll. Control Fed., Washington, D.C. 1268 p.

Gunn, Frances Ann. 1953. A limnological investigation of a freshwater impoundment in Wise County, Texas. M.S. Thesis. Texas Christian University, Fort Worth, Texas.

Hardy, A.C. 1935. Phytoplankton ecology and the hypothesis of animal exclusion. Proc. Linn. Soc. London 148:64-70.

Harris, Benjamin B. and J.K. Gwynn Silvey. 1940. Limnological investigation on Texas reservoir lakes. Ecol. Monogr. 10:11-140.

Hasler, A.D. and E. Jones. 1949. Demonstration of the antagonistic action of large aquatic plants on algae and rotifers. Ecology 30:354-364.

Heinle, D.R. 1969. Temperature and zooplankton. Chesapeake Sci. 10:186-209.

Herzig, Alois. 1983. The ecological significance of the relationship between temperature and duration of embryonic development in planktonic freshwater copepods. Hydrobiologia 100:65-91.

Hutchinson, G. Evelyn. 1967. A treatise on limnology. II. Introduction to lake biology and the limnoplankton. John Wiley and Sons, Inc., New York. 1115 p.

Hynes, H.B.N. 1972. The ecology of running waters. Liverpool University Press, Liverpool, England. 555 p.

Kibby, H.V. 1971. Effect of temperature on the feeding behavior of *Daphnia rosea*. Limnol. Oceanogr. 16:580-581.

Kines, Melonee Jo. 1980. The zooplankton community and primary productivity of Nacogdoches Reservoir, Texas. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

King, C.E. 1972. Adaptation of rotifers to seasonal variation. Ecology 53:408-418.

Kocksiek, Kenneth A., Jerry L. Wilhm and Robert Morrison. 1971. Species diversity of net zooplankton and physicochemical conditions in Keystone Reservoir, Oklahoma. Ecology 52:1119-1125.

Kollquist, T. and B.S. Meadows. 1978. The toxic effect of copper on algae and rotifers from a soda lake (Lake Nakuru, East Africa). Water Res. 12:771-775.

Kratz, Timothy K., Thomas M. Frost and John J. Magnucon. 1987. Inferences from spatial and temporal variability in ecosystems: long term zooplankton data from lakes. Amer. Nat. 129:830-846.

Lacy, Timothy J. 1987. The zooplankton community of Houston Reservoir. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Lee, Robert Damon. 1977. An ecological study of the zooplankton community in a natural temporary pond located in East Texas. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Margalef, Ramon. 1957. La teoria de la informacion en ecologia. Mem. Real Acad. Cinc. Artes Barcelona 23:373-449. (Translated in: Gen. Syst. 3:36-71.)

Marsh, Clois E., Jr. 1973. Seasonal abundance and community structure of algae and rotifers in Massey Lake, Southeast Texas. M.S. Thesis. Lamar University, Beaumont, Texas.

McNaught, D.C. 1975. A hypothesis to explain the succession from calanoids to cladocerans during eutrophication. Verh. Int. Verien. Limnol. 19:724-731

Meyer, M.A. and S.W. Effler. 1980. Changes in the zooplankton of Onondaga Lake, New York, U.S.A., 1969-1978. Environ. Pollut. Ser. A Ecol. Biol. 23 (2):131-152.

Minzoni, F. 1984. Effects of aluminum on different forms of phosphorus and freshwater plankton. Environ. Technol. Lett. 5:425-432.

Murphy, Clifford E. 1962. Plankton population in a new impoundment in Wise County, Texas. Texas Jour. Sci. 14:459.

National Eutrophication Survey, E.P.A. 1977. Report on Lake O' the Pines; Camp, Marion, Morris, and Upshur Counties, Texas. EPA Region VI. Working Paper No. 648. Corvallis Environmental Research Laboratory, Corvallis, Oregon, and Environmental Monitoring and Support Laboratory, Las Vegas, Nevada; with cooperation of Texas Water Quality Board and Texas National Guard.

Nelson, J.H. and G.L. Harp. 1972. Qualitative variation of the net plankton of Craighead Lake (Arkansas). Southwestern Nat. 17:239-248.

Nie, Norman H. (Ed.). 1983. S.P.S.S.-X user's guide. McGraw Hill, New York. 806 p.

Nordlie, F.G. 1976. Plankton communities of three central Florida lakes. Hydrobiologia 48:65-78.

Odum, Eugene P. 1983. Basic ecology. CBS College Publishing, New York. 613 p.

Ott, Lyman. 1984. An introduction to statistical methods and data analysis. PWS Publishers, Boston, Mass. 775 p.

Pace, Michael L. 1986. An empirical analysis of zooplankton community size structure across lake trophic gradients. Limnol. Oceanogr. 31 (1):45-55.

Patalas, K. 1972. Crustacean plankton and the eutrophication of St. Lawrence Great Lakes. Jour. Fish. Res. Bd. Canada 29:1451-1462.

Patterson, Marcile. 1942. A study of the seasonal distribution of plankton in White Rock Lake. Trans. Texas Acad. Sci. 25:72-75.

Pennak, Robert W. 1946. The dynamics of fresh-water plankton populations. Ecol. Monogr. 16:339-355.

________________ 1949. Annual limnological cycles in some Colorado mountain lakes. Ecol. Monogr. 19 (3):233-267.

________________ 1969. Field and experimental winter limnology of three Colorado mountain lakes. Ecology 49:505-520.

________________ 1978. Fresh-water invertebrates of the United States, 2nd edition. John Wiley and Sons, Inc., New York. 803 p.

Petrick, David (Ed.). 1975. Intensive surface water monitoring survey for segment 0403, Lake O' the Pines, Report No. IMS 39. Texas Water Quality Board (T.W.C.), Austin, Texas.

Pettit, John Michael. 1973. Net plankton populations of Eagle Mountain Lake, Tarrant County and Possum Kingdom Lake, Palo Pinto County. M.S. Thesis. Texas Christian University, Fort Worth, Texas.

Pielou, E.C. 1966. The measurement of diversity in different types of biological collections. Jour. Theoret. Biol. 13:131-144.

Porter, Karen G. 1977. The plant-animal interface in fresh-water ecosystems. Amer. Sci. 65:14-168.

Ready, Clinton C. 1988. The zooplankton community of Lone Star Reservoir, Texas. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Reat, Vickie Lynne. 1983. The effects of temperature and body length on the filtering rates of two chydorid cladocera. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Rogers, Gary D. 1976. Some of the effects of a thermal effluent on the zooplankton community in Striker Creek Reservoir, Texas. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Ruttner-Kolisko, Agnes. 1974. Die Binnengewasser. Plankton rotifers, biology and taxonomy. Vol. XXVI, part 1. E. Schweizerbart'she Verlagsbuchhandlung, Stuttgart. 146 p.

Shannon, C.E. and W. Weaver. 1949. The mathematical theory of communication. University of Illinois Press, Urbana, Illinois.

Shireman, J.V. and R.G. Martin. 1978. Seasonal and diurnal zooplankton investigation of a south-central Florida lake. Florida Sci. 41:193-200.

Smith, George A., L.C. Fitzpatrick and W.D. Pearson. 1979. Structure and dynamics of a zooplankton community in a small north-central Texas pond ecosystem. Southwestern Nat. 24 (1):1-16.

Soto, Dorris, Irma Vila and Boris Villalobos. 1984. Temporal and spatial distribution of rotifera in a Chilean reservoir: A possible effect of impoundment hydrodynamics. Hydrobiologia 114:67-74.

Stemberger, Richard S. 1979. A guide to the rotifers of the Laurentian Great Lakes. Grant No. R804652. EPA-60014-79-021. Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Sublette, J.E. 1955. The physico-chemical and biological features of Lake Texoma (Denison Reservoir), Oklahoma and Texas: a preliminary study. Texas Jour. Sci. 7:164-182.

Swearingen, Fontaine Scott. 1978. Zooplankton population dynamics in Livingston Reservoir, Texas. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Toole, Joe E. (Ed.). 1983. Performance report as required by Federal Aid in Fisheries Restoration Act, Federal Aid Project F-30-R-8. Statewide fishery management recommendations. Job A: Existing reservoir and stream management recommendations, Lake O' the Pines, 1982. District III-A. Texas Parks and Wildlife Dept., Austin, Texas.

Venneman, Timothy E. 1984. The zooplankton community of Caddo Lake, Texas and Louisiana, a lake with numerous offshore oil wells. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Ward, Henry B. and George C. Whipple (W.T. Edmondson, Ed.). 1959. Fresh-water biology, 2nd edition. John Wiley and Sons, Inc., New York. 1248 p.

Weber, Thomas. 1988. Lone Star Steel Co. Annual Wastewater Inspection Report. Impact of Outfall 002 on Cypress Creek. District 5. Texas Water Commission, Austin, Texas.

Wilhm, J.C. and Troy C. Dorris. 1968. Biological parameters for water quality criteria. Bioscience 18 (6):477-481.

Winner, R.W. 1981. A comparison of body length, brood size, and longevity as indices of chronic copper and zinc stresses in *Daphnia magna*. Envir. Poll. (Series A) 26:33-37.

Winner, R.W. and N.P. Farrell. 1976. Acute and chronic toxicity of copper to four species of *Daphnia*. Jour. Fish. Res. Bd. Canada 33:1685-1691.

Witt, William Todd. 1988. A heavy metals analysis of Lone Star Reservoir, Lone Star, Texas. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Zaret, Thomas M. and W. Charles Kerfoot. 1975. Fish predation on *Bosmina longirostris*: Body size selection versus visibility selection. Ecology 56:232-237.

Zarini, S., D. Annoni and O. Ravera. 1983. Effect produced by aluminum in freshwater communities studied by "enclosure" method. Environ. Technol. Lett. 4:247-256.

**APPENDIX I.** Zooplankton density values (in org/L) from February 1986 to January 1987 for Lake O' the Pines Reservoir, Texas.

| February, 1986<br>TAXA | STATION<br>1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 0.00 | 0.00 | 0.00 | 0.98 | 0.95 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.15 | 0.73 | 0.29 | 0.00 | 0.00 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.47 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.00 | 0.29 | 0.00 | 0.00 |
| *Eubosmina longispina* | 0.29 | 0.00 | 0.58 | 0.33 | 0.95 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 1.90 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.47 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 9.31 | 12.00 | 19.49 | 7.49 | 5.70 |
| Copepodids | 2.18 | 3.09 | 1.75 | 1.95 | 0.47 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 1.75 | 6.73 | 5.53 | 3.91 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 1.16 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 1.45 | 1.82 | 1.16 | 1.30 | 0.47 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 |
| *Mesocyclops edax* | 0.00 | 0.36 | 0.29 | 0.00 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| February, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 0.00 | 0.00 | 0.29 | 0.00 | 0.00 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | 2.28 | 22.31 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochilus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.47 |
| *Keratella cochlearis* | 0.29 | 0.00 | 1.75 | 0.98 | 0.95 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.29 | 0.00 | 0.00 | 0.98 | 0.95 |
| *Notholca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 2.47 | 3.27 | 7.56 | 0.65 | 0.95 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Trichocerca* | 0.00 | 0.00 | 0.00 | 0.00 | 0. |

**APPENDIX I.** Continued.

| **March, 1986** | **STATION** | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branciopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 0.00 | 0.00 | 0.32 | 0.00 | 4.45 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.00 | 0.18 | 0.00 | 0.00 | 0.64 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 5.73 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.63 | 0.18 | 0.32 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.16 | 0.18 | 0.00 | 0.00 | 0.00 |
| *Eubosmina longispina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.51 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.36 | 0.00 | 0.00 | 1.91 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 1.91 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 31.81 | 24.55 | 28.01 | 58.59 | 21.00 |
| Copepodids | 2.85 | 3.82 | 0.63 | 3.03 | 1.27 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 4.27 | 3.27 | 4.73 | 7.58 | 0.64 |
| *Eurytemora affinis* | 0.16 | 0.00 | 0.32 | 1.52 | 0.64 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.93 | 0.73 | 1.26 | 1.01 | 4.45 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 |
| *Mesocyclops edax* | 0.16 | 0.00 | 0.32 | 0.51 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| **March, 1986** | **STATION** | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 1.91 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 0.00 | 0.00 | 0.00 | 0.00 | 42.64 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 0.63 | 0.36 | 0.63 | 0.00 | 2.55 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.00 | 14.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 2.02 | 17.18 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 2.55 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | 0.00 | 1.27 |
| *Conochilus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.00 | 0.00 | 0.00 | 0.00 | 1.91 |
| *Keratella cochlearis* | 10.13 | 8.18 | 3.78 | 2.53 | 9.55 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 1.27 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 1.27 |
| *Notholca* | 0.79 | 0.18 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 6.96 | 4.36 | 9.45 | 3.03 | 1.27 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.00 | 0.00 | 0.32 | 0.31 | 2.55 |
| *Testudinella* | 0.00 | 0.00 | 0.63 | 0.00 | 0.00 |
| *Trichocerca* | 0.00 | 0.00 | 0.00 | 0.00 | 1.91 |

**APPENDIX I.** Continued.

| April, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 |
| *Bosmina longirostris* | 0.58 | 0.00 | 0.00 | 2.61 | 0.00 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.69 | 0.57 | 0.00 | 0.98 | 0.91 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 1.36 |
| *Daphnia parvula* | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.46 | 0.28 | 0.71 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.81 | 2.28 | 1.66 | 2.93 | 0.00 |
| *Eubosmina longispina* | 0.00 | 0.14 | 0.24 | 0.00 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 1.36 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 4.98 | 8.40 | 26.35 | 18.57 | 28.64 |
| Copepodids | 0.93 | 0.00 | 0.71 | 0.00 | 0.00 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 3.36 | 2.28 | 5.93 | 1.95 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.46 | 0.71 | 1.19 | 0.00 | 1.82 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mesocyclops edax* | 0.35 | 0.28 | 0.71 | 0.00 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| **April, 1986** | **STATION** | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 12.15 | 13.67 | 13.06 | 0.98 | 22.27 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 88.40 | 180.02 | 362.23 | 4.56 | 2.27 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus angularis* | 0.00 | 0.14 | 0.24 | 0.00 | 0.45 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.85 | 0.47 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochilus* | 0.69 | 0.00 | 0.00 | 4.89 | 0.45 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.00 | 0.00 | 0.71 | 0.00 | 0.00 |
| *Keratella cochlearis* | 20.17 | 8.12 | 9.49 | 3.91 | 2.27 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.28 | 0.24 | 0.33 | 32.27 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 7.52 | 1.00 | 11.16 | 20.52 | 1.82 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.58 | 0.00 | 0.00 | 0.33 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Trichocerca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| May, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 0.34 | 0.12 | 0.48 | 0.00 | 0.00 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 |
| *Eubosmina longispina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 1.92 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 1.15 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 0.78 | 0.56 | 1.76 | 1.31 | 10.75 |
| Copepodids | 0.11 | 0.28 | 0.16 | 0.44 | 2.30 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 1.15 |
| *Diacyclops bicuspidatus thomasi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 1.92 |
| *Mesocyclops edax* | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| May, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 1.12 | 0.56 | 0.32 | 0.44 | 2.69 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 0.34 | 0.14 | 0.16 | 0.00 | 0.00 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.32 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 |
| *Conochilus* | 0.00 | 0.00 | 0.00 | 0.00 | 1.15 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.28 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.56 | 0.28 | 0.00 | 0.00 | 0.00 |
| *Keratella cochlearis* | 0.56 | 0.98 | 0.64 | 1.31 | 0.77 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 1.54 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 0.11 | 0.14 | 0.16 | 0.44 | 0.38 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.00 | 0.00 | 0.00 | 0.87 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Trichocerca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.77 |

**APPENDIX I.** Continued.

| **June, 1986** | **STATION** | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 0.26 | 0.36 | 0.22 | 0.53 | 0.00 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eubosmina longispina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 0.26 | 0.12 | 1.09 | 1.33 | 2.00 |
| Copepodids | 0.13 | 0.12 | 0.00 | 0.00 | 0.33 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mesocyclops edax* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| **June, 1986** | STATION | | | | |
|---|---|---|---|---|---|
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 0.78 | 0.12 | 0.00 | 0.00 | 0.00 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.13 | 0.00 | 0.00 | 0.80 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochilus* | 0.13 | 0.12 | 0.22 | 0.80 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Keratella cochlearis* | 0.13 | 0.71 | 0.22 | 0.00 | 0.33 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 0.00 | 0.00 | 0.00 | 0.27 | 0.33 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Trichocerca* | 0.39 | 0.00 | 0.00 | 0.27 | 0.33 |

**APPENDIX I.** Continued.

| **July, 1986** | **STATION** | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 0.00 | 0.00 | 0.00 | 2.52 | 0.40 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.32 | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.00 | 2.63 | 3.15 | 0.00 |
| *Eubosmina longispina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 9.64 | 14.50 | 7.88 | 35.30 | 18.87 |
| Copepodids | 0.44 | 1.10 | 0.26 | 4.10 | 1.20 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mesocyclops edax* | 0.00 | 0.00 | 0.00 | 0.32 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| July, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.15 | 0.16 | 0.26 | 0.00 | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 10.51 | 4.10 | 2.89 | 0.00 | 0.00 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.26 | 0.00 | 1.20 |
| *Asplanchna* | 0.00 | 0.32 | 0.00 | 0.63 | 1.20 |
| *Brachionus angularis* | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.63 | 1.20 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 1.05 | 39.08 | 1.20 |
| *Conochilus* | 1.17 | 3.15 | 1.05 | 10.08 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.80 |
| *Kellicottia bostoniensis* | 0.00 | 0.95 | 0.79 | 0.00 | 0.00 |
| *Keratella cochlearis* | 8.32 | 11.66 | 3.68 | 6.62 | 1.20 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 1.20 |
| *Monostyla* | 0.00 | 0.16 | 0.00 | 0.00 | 0.40 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.32 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.15 | 0.00 | 0.00 | 0.95 | 2.41 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 5.26 | 10.08 | 6.57 | 30.88 | 2.41 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.73 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Trichocerca* | 0.00 | 0.16 | 0.00 | 0.63 | 0.00 |

**APPENDIX I.** Continued.

| August, 1986 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 0.00 | 0.00 | 0.00 | 2.42 | 0.00 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.00 | 0.00 | 0.35 | 0.00 |
| *Eubosmina longispina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.69 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 0.77 | 0.00 | 1.31 | 12.09 | 2.22 |
| Copepodids | 0.00 | 0.00 | 0.00 | 6.22 | 0.00 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mesocyclops edax* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| August, 1986 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 0.00 | 0.18 | 0.00 | 0.00 | 7.78 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 0.19 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.58 | 0.00 | 3.15 | 6.22 | 0.00 |
| *Conochilus* | 0.00 | 0.00 | 1.31 | 45.60 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.35 | 0.00 |
| *Kellicottia bostoniensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Keratella cochlearis* | 0.39 | 0.00 | 0.00 | 0.69 | 0.56 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 0.00 | 0.18 | 1.05 | 1.04 | 0.56 |
| *Rotatoria* | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Trichocerca* | 0.00 | 0.55 | 0.53 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| September, 1986 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 9.64 | 4.50 | 0.85 | 13.82 | 0.00 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.36 | 0.95 | 0.42 | 0.00 | 0.00 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.27 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.55 | 0.00 | 0.00 | 0.86 | 0.00 |
| *Eubosmina longispina* | 0.00 | 1.64 | 0.42 | 3.45 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 12.00 | 13.23 | 5.52 | 37.57 | 24.32 |
| Copepodids | 11.27 | 4.64 | 2.12 | 3.45 | 1.13 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.00 | 0.27 | 0.00 | 0.43 | 0.57 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mesocyclops edax* | 0.73 | 0.41 | 1.27 | 6.91 | 0.57 |
| *Microcyclops varicans* | 8.73 | 4.36 | 0.85 | 9.07 | 0.57 |

**APPENDIX I.** Continued.

| September, 1986 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 1.70 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 0.00 | 0.41 | 2.55 | 0.00 | 0.00 |
| *Difflugia* | 2.36 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.73 | 0.14 | 0.00 | 0.86 | 0.57 |
| *Asplanchna* | 0.00 | 0.14 | 0.00 | 0.00 | 1.70 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.85 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 2.00 | 1.09 | 11.45 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.18 | 0.14 | 5.52 | 1.30 | 0.00 |
| *Conochilus* | 1.09 | 4.91 | 14.85 | 19.86 | 5.66 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 |
| *Keratella cochlearis* | 27.45 | 19.09 | 25.88 | 9.50 | 3.96 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 1.70 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 2.26 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.18 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.36 | 0.68 | 0.00 | 0.00 | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 48.18 | 58.09 | 152.30 | 45.77 | 31.68 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.73 | 3.14 | 0.00 | 0.43 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Trichocerca* | 1.09 | 1.23 | 4.67 | 1.30 | 4.53 |

**APPENDIX I.** Continued.

| October, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 4.67 | 5.71 | 6.57 | 1.18 | 1.05 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ceriodaphnia quadrangula* | 0.85 | 5.71 | 6.06 | 3.55 | 0.53 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.18 | 0.00 | 0.00 | 0.53 |
| *Eubosmina longispina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.18 | 0.25 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 11.45 | 6.07 | 3.54 | 26.39 | 40.97 |
| Copepodids | 7.64 | 0.36 | 1.26 | 2.76 | 0.00 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 0.21 | 0.00 | 0.25 | 0.79 | 0.00 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.42 | 0.00 | 0.00 | 0.00 | 1.05 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 2.10 |
| *Mesocyclops edax* | 0.00 | 0.00 | 0.51 | 0.39 | 0.00 |
| *Microcyclops varicans* | 2.12 | 3.21 | 3.54 | 3.55 | 1.58 |

**APPENDIX I.** Continued.

| October, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.53 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.00 | 2.10 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 21.64 | 16.77 | 8.33 | 0.39 | 1.05 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 1.27 | 2.14 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 1.27 | 2.14 | 2.27 | 0.00 | 1.05 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.51 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.71 | 1.01 | 0.00 | 0.00 |
| *Conochilus* | 3.39 | 10.71 | 55.56 | 1.18 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.85 | 0.00 | 0.25 | 0.39 | 0.00 |
| *Keratella cochlearis* | 110.30 | 106.00 | 64.14 | 8.27 | 0.00 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 2.63 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.00 | 0.25 | 0.00 | 2.10 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 35.00 | 116.71 | 63.64 | 10.24 | 4.73 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.53 |
| *Synchaeta* | 5.94 | 0.00 | 1.01 | 0.39 | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.25 | 0.00 | 0.53 |
| *Trichocerca* | 4.24 | 4.64 | 8.33 | 1.18 | 0.53 |

**APPENDIX I.** Continued.

| November, 1986 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 1.09 | 0.82 | 25.53 | 0.38 | 0.00 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.38 | 0.00 |
| *Ceriodaphnia quadrangula* | 3.27 | 2.86 | 1.31 | 3.03 | 0.00 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.00 | 0.65 | 0.76 | 0.51 |
| *Eubosmina longispina* | 0.73 | 2.45 | 17.02 | 0.00 | 0.51 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 21.45 | 21.27 | 21.60 | 12.88 | 25.76 |
| Copepodids | 4.36 | 7.36 | 4.58 | 1.14 | 0.00 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 0.00 | 0.00 | 1.31 | 1.52 | 0.51 |
| *Eurytemora affinis* | 1.45 | 0.41 | 0.00 | 0.38 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.36 | 0.41 | 0.00 | 0.38 | 0.00 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| *Mesocyclops edax* | 0.00 | 1.23 | 0.00 | 1.14 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | 0.38 | 1.01 |

**APPENDIX I.** Continued.

| November, 1986 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.38 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.33 | 0.38 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.38 | 0.51 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 25.45 | 80.18 | 51.71 | 6.82 | 5.05 |
| *Difflugia* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.65 | 0.00 | 0.00 |
| *Asplanchna* | 1.09 | 1.64 | 0.00 | 0.00 | 0.00 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochilus* | 0.00 | 1.23 | 0.65 | 0.00 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.41 | 0.65 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 0.00 | 0.00 | 0.65 | 0.00 | 0.00 |
| *Keratella cochlearis* | 22.55 | 54.00 | 187.85 | 13.26 | 5.56 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.65 | 0.00 | 1.52 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 1.01 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| *Polyarthra* | 9.82 | 27.82 | 53.67 | 4.58 | 5.05 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 0.36 | 0.00 | 0.00 | 0.00 | 2.02 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| *Trichocerca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |

**APPENDIX I.** Continued.

| December, 1986 | STATION | | | | |
|---|---|---|---|---|---|
| **TAXA** | **1** | **2** | **3** | **4** | **5** |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bosmina longirostris* | 4.75 | 3.39 | 1.31 | 0.85 | 0.00 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | 0.42 | 0.00 |
| *Ceriodaphnia quadrangula* | 15.61 | 6.03 | 15.05 | 4.24 | 0.00 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diaphanosoma brachyurum* | 0.17 | 0.00 | 1.31 | 0.00 | 0.00 |
| *Eubosmina longispina* | 7.81 | 8.67 | 2.62 | 0.00 | 0.00 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Holopedium gibberum* | 0.34 | 0.38 | 0.00 | 0.00 | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 13.92 | 15.08 | 42.55 | 32.67 | 6.11 |
| Copepodids | 5.09 | 7.16 | 12.44 | 6.36 | 1.11 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 1.02 | 0.00 | 1.96 | 1.70 | 0.00 |
| *Eurytemora affinis* | 0.68 | 0.57 | 0.65 | 0.00 | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 0.00 | 0.19 | 0.00 | 0.42 | 0.00 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mesocyclops edax* | 0.68 | 0.38 | 0.65 | 0.42 | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.33 | 1.27 | 0.00 |

**APPENDIX I.** Continued.

| December, 1986 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | 0.42 | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 32.92 | 44.88 | 46.47 | 0.42 | 2.22 |
| *Difflugia* | 3.39 | 16.97 | 0.00 | 0.00 | 0.00 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Asplanchna* | 1.70 | 0.19 | 0.00 | 1.27 | 0.00 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Conochilus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 1.96 | 0.00 | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kellicottia bostoniensis* | 1.70 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Keratella cochlearis* | 53.62 | 50.34 | 110.62 | 1.27 | 2.78 |
| *Lecane* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | 0.00 | 1.67 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Notholca* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Polyarthra* | 65.84 | 44.50 | 44.51 | 1.27 | 0.00 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Synchaeta* | 2.72 | 0.75 | 1.96 | 8.48 | 10.56 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 |
| *Trichocerca* | 0.00 | 0.38 | 0.00 | 0.00 | 0.00 |

**APPENDIX I.** Continued.

| January, 1987 | STATION | | | | |
|---|---|---|---|---|---|
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Phylum Arthropoda** | | | | | |
| **Class Crustacea** | | | | | |
| **Subclass Branchiopoda** | | | | | |
| **Order Cladocera** | | | | | |
| *Alona monocantha* | 0.00 | 0.64 | 0.00 | | 0.55 |
| *Bosmina longirostris* | 8.73 | 2.89 | 1.64 | | 1.09 |
| *Camptocercus rectirostris* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Ceriodaphnia quadrangula* | 1.45 | 2.89 | 1.91 | | 1.09 |
| *Ceriodaphnia reticulatus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Chydorus sphaericus* | 0.00 | 0.00 | 0.00 | | 0.55 |
| *Daphnia parvula* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Daphnia rosea* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Diaphanosoma brachyurum* | 0.00 | 0.32 | 0.00 | | 0.55 |
| *Eubosmina longispina* | 5.45 | 3.53 | 0.55 | | 1.09 |
| *Eurycercus lamellatus* | 0.00 | 0.00 | 0.00 | | 0.55 |
| *Holopedium gibberum* | 0.36 | 0.96 | 0.00 | | 0.00 |
| *Ilyocryptus spinifer* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Kurzia latissima* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Leptadora kindtii* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Pleuroxus denticulatus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Pleuroxus procurvatus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Sida crystallina* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Simocephalus expinosus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| **Subclass Copepoda** | | | | | |
| **Order Eucopepoda** | | | | | |
| Nauplii | 7.27 | 7.71 | 1.36 | | 7.09 |
| Copepodids | 2.18 | 2.89 | 0.82 | | 1.64 |
| **Suborder Calanoida** | | | | | |
| *Diaptomus siciloides* | 1.82 | 0.32 | 1.09 | | 0.55 |
| *Eurytemora affinis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| **Suborder Cyclopoida** | | | | | |
| *Cyclops vernalis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Diacyclops bicuspidatus thomasi* | 2.18 | 2.57 | 0.00 | | 1.64 |
| *Macrocyclops albidis* | 0.00 | 0.00 | 0.00 | | 1.09 |
| *Mesocyclops edax* | 1.45 | 0.00 | 1.91 | | 0.00 |
| *Microcyclops varicans* | 0.00 | 0.00 | 0.00 | | 0.00 |

**APPENDIX I.** Continued.

| January, 1987 | | | | | |
|---|---|---|---|---|---|
| | STATION | | | | |
| TAXA | 1 | 2 | 3 | 4 | 5 |
| **Order Arachnida** | | | | | |
| Water mites | 0.00 | 0.00 | 0.00 | | 0.00 |
| **Order Diptera** | | | | | |
| *Chaoborus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| Chironomids | 0.00 | 0.00 | 0.00 | | 0.00 |
| **Order Ostracoda** | | | | | |
| Ostracods | 0.00 | 0.00 | 0.00 | | 0.00 |
| **Phylum Protozoa** | | | | | |
| *Ceratium hirundinella* | 2.18 | 21.20 | 34.91 | | 56.73 |
| *Difflugia* | 44.73 | 46.58 | 17.45 | | 21.82 |
| Unknown peritrich | 0.00 | 0.00 | 0.00 | | 0.00 |
| **Phylum Rotatoria** | | | | | |
| *Ascomorpha ovalis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Asplanchna* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Brachionus angularis* | 0.00 | 0.00 | 0.00 | | 23.45 |
| *Brachionus havanaensis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Brachionus quadridentatus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Collotheca mutabilis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Collurella* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Conochiloides* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Conochilus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Euclanis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Filinia longiseta* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Gastropus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Hexarthra mira* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Kellicottia bostoniensis* | 0.18 | 0.32 | 0.00 | | 0.55 |
| *Keratella cochlearis* | 96.73 | 93.47 | 45.82 | | 20.18 |
| *Lecane* | 0.00 | 0.00 | 0.00 | | 1.09 |
| *Monostyla* | 0.00 | 0.00 | 0.00 | | 1.09 |
| *Mytilina ventralis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Notholca acuminata* | 0.00 | 0.00 | 0.00 | | 1.09 |
| *Notholca* | 0.00 | 0.00 | 0.27 | | 0.00 |
| *Platyias patulus* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Platyias quadricornis* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Polyarthra* | 5.09 | 10.92 | 2.18 | | 3.82 |
| *Rotatoria* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Synchaeta* | 0.00 | 0.32 | 0.00 | | 0.00 |
| *Testudinella* | 0.00 | 0.00 | 0.00 | | 0.00 |
| *Trichocerca* | 0.00 | 0.00 | 0.00 | | 0.00 |

**APPENDIX II**. Monthly physicochemical data collected during the study period from February 1986 to January 1987.

| MONTH | STATION | Depth (m) | Secchi (m) | Temp. (C) | Oxygen (mg/L) | $CO_2$ (mg/L) | Alkal. (mg/L) | Cond. (mmho) |
|---|---|---|---|---|---|---|---|---|
| February 1986 | 1 | 9.5 | 1.2 | 6.6 | 12.0 | 10.5 | 39.0 | 113.5 |
| | 2 | 8.0 | 1.2 | 6.6 | 12.0 | 9.5 | 37.5 | 98.2 |
| | 3 | 5.5 | 1.3 | 6.6 | 12.1 | 9.5 | 37.5 | 95.0 |
| | 4 | 4.5 | 1.1 | 5.0 | 11.8 | 9.5 | 40.0 | 100.0 |
| | 5 | 2.5 | 0.8 | 4.3 | 12.3 | 9.5 | 40.0 | 142.3 |
| March 1986 | 1 | 8.5 | 1.6 | 9.9 | 10.4 | 9.5 | 50.0 | 113.5 |
| | 2 | 7.5 | 1.7 | 10.0 | 10.1 | 9.0 | 5.0 | 112.7 |
| | 3 | 4.7 | 1.8 | 10.3 | 10.4 | 9.5 | 50.0 | 114.8 |
| | 4 | 3.2 | 1.6 | 10.2 | 10.6 | 10.5 | 50.0 | 122.7 |
| | 5 | 1.2 | 0.5 | 9.8 | 9.4 | 14.5 | 55.0 | 146.5 |
| April 1986 | 1 | 10.5 | 2.1 | 17.4 | 8.5 | 11.0 | 54.0 | 122.7 |
| | 2 | 9.5 | 1.5 | 13.0 | 8.6 | 11.0 | 52.0 | 122.7 |
| | 3 | 5.5 | 1.8 | 13.6 | 8.8 | 20.0 | 54.0 | 127.7 |
| | 4 | 3.5 | 1.2 | 13.9 | 8.5 | 20.2 | 64.0 | 161.2 |
| | 5 | 2.0 | 0.9 | 13.0 | 6.5 | 21.5 | 86.0 | 187.7 |
| May 1986 | 1 | 9.2 | 1.8 | 17.5 | 7.2 | 14.0 | 60.0 | 137.4 |
| | 2 | 7.5 | 1.8 | 17.7 | 7.8 | 11.0 | 44.0 | 135.5 |
| | 3 | 6.2 | 2.1 | 17.7 | 7.3 | 156.7 | 22.0 | 138.4 |
| | 4 | 4.2 | 0.9 | 18.4 | 6.4 | 250.0 | 0.0 | 155.8 |
| | 5 | 2.0 | 0.9 | 18.1 | 5.8 | 364.5 | 0.0 | 173.0 |

**APPENDIX II.** Continued.

| MONTH | STATION | Depth (m) | Secchi (m) | Temp. (C) | Oxygen (mg/L) | $CO_2$ (mg/L) | Alkal. (mg/L) | Cond. (mmho) |
|---|---|---|---|---|---|---|---|---|
| June 1986 | 1 | 9.2 | 2.4 | 24.3 | 5.9 | 155.0 | 0.0 | 151.0 |
| | 2 | 10.5 | 2.1 | 24.0 | 5.8 | 175.0 | 0.0 | 152.3 |
| | 3 | 5.2 | 2.1 | 26.5 | 7.6 | 113.0 | 0.0 | 157.5 |
| | 4 | 4.2 | 1.2 | 27.0 | 6.6 | 99.0 | 0.0 | 179.6 |
| | 5 | 3.7 | 1.2 | 24.0 | 2.4 | 130.5 | 0.0 | 205.0 |
| July 1986 | 1 | 10.5 | 1.5 | 21.8 | 3.9 | 18.0 | 80.0 | 159.4 |
| | 2 | 9.5 | 1.8 | 22.3 | 4.2 | 18.0 | 64.0 | 161.7 |
| | 3 | 5.0 | 1.8 | 24.9 | 6.5 | 12.5 | 50.0 | 165.8 |
| | 4 | 4.5 | 1.5 | 25.1 | 6.0 | 12.0 | 54.0 | 184.0 |
| | 5 | 3.3 | 0.9 | 22.6 | 2.0 | 25.0 | 116.0 | 243.5 |
| August 1986 | 1 | 7.5 | 1.8 | 23.7 | 6.2 | 255.5 | 0.0 | 156.1 |
| | 2 | 8.5 | 1.8 | 22.7 | 5.9 | 225.0 | 36.0 | 159.1 |
| | 3 | 5.2 | 1.5 | 23.8 | 7.6 | 179.0 | 22.0 | 161.0 |
| | 4 | 4.5 | 1.2 | 23.2 | 6.5 | 225.0 | 36.0 | 169.8 |
| | 5 | 2.5 | 1.2 | 21.9 | 1.6 | 20.5 | 124.0 | 223.0 |
| September 1986 | 1 | 8.5 | 1.8 | 19.6 | 5.2 | 12.5 | 60.0 | 157.1 |
| | 2 | 11.2 | 1.8 | 19.8 | 4.6 | 15.0 | 62.0 | 157.8 |
| | 3 | 3.5 | 1.8 | 21.2 | 8.3 | 11.5 | 50.0 | 158.5 |
| | 4 | 3.5 | 2.1 | 21.2 | 7.1 | 14.0 | 59.0 | 160.5 |
| | 5 | 2.5 | 1.2 | 20.3 | 2.3 | 21.5 | 144.0 | 235.3 |

**APPENDIX II.** Continued.

| MONTH | STATION | Depth (m) | Secchi (m) | Temp. (C) | Oxygen (mg/L) | $CO_2$ (mg/L) | Alkal. (mg/L) | Cond. (mmho) |
|---|---|---|---|---|---|---|---|---|
| October 1986 | 1 | 6.5 | 1.5 | 12.7 | 9.9 | 9.0 | 22.0 | 122.7 |
| | 2 | 8.5 | 1.8 | 12.5 | 9.8 | 9.0 | 24.0 | 122.7 |
| | 3 | 5.5 | 1.8 | 12.4 | 9.4 | 9.5 | 28.0 | 119.5 |
| | 4 | 3.2 | 2.7 | 12.6 | 10.3 | 10.0 | 20.0 | 121.5 |
| | 5 | 2.2 | 0.9 | 11.4 | 5.3 | 13.5 | 64.0 | 243.3 |
| November 1986 | 1 | 8.5 | 2.1 | 4.0 | 11.2 | 3.0 | 26.5 | 96.7 |
| | 2 | 7.5 | 2.1 | 4.0 | 11.4 | 3.5 | 10.0 | 100.0 |
| | 3 | 4.2 | 2.7 | 4.0 | 12.0 | 3.0 | 10.0 | 100.0 |
| | 4 | 3.5 | 3.3 | 3.0 | 12.8 | 3.5 | 60.0 | 110.2 |
| | 5 | 2.2 | 0.9 | 2.3 | 10.0 | 7.5 | 46.0 | 112.0 |
| December 1986 | 1 | 9.5 | 2.1 | 1.7 | 12.0 | 2.0 | 20.0 | 90.7 |
| | 2 | 8.5 | 2.1 | 1.7 | 12.2 | 2.0 | 18.0 | 89.4 |
| | 3 | 4.5 | 2.1 | 1.4 | 12.2 | 2.0 | 10.0 | 85.0 |
| | 4 | 3.2 | 1.8 | 0.5 | 11.4 | 2.0 | 20.0 | 106.7 |
| | 5 | 2.2 | 0.6 | 0.2 | 9.2 | 2.5 | 20.0 | 115.0 |
| January 1987 | 1 | 8.5 | 1.8 | 7.3 | 12.6 | 2.0 | 30.0 | 63.3 |
| | 2 | 9.5 | 2.1 | 8.1 | 12.8 | 2.0 | 30.0 | 76.5 |
| | 3 | 5.2 | 2.4 | 7.9 | 13.2 | 2.0 | 35.0 | 79.2 |
| | 4 | 3.5 | 1.8 | 7.0 | 14.6 | 10.5 | 26.5 | 132.5 |
| | 5 | 2.5 | 1.5 | 7.8 | 12.4 | 5.0 | 30.0 | 95.0 |

**APPENDIX III.** Diversity, evenness and richness values for each month by station at Lake O' the Pines Reservoir, Texas.

**February 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 10 | 2.775 | 0.835 | 2.796 |
| 2 | 7 | 2.352 | 0.838 | 1.747 |
| 3 | 12 | 2.705 | 0.754 | 2.857 |
| 4 | 12 | 3.133 | 0.874 | 3.376 |
| 5 | 13 | 2.393 | 0.647 | 3.231 |

**March 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 12 | 2.421 | 0.675 | 2.635 |
| 2 | 12 | 2.565 | 0.716 | 2.758 |
| 3 | 13 | 2.484 | 0.671 | 2.955 |
| 4 | 12 | 1.975 | 0.551 | 2.451 |
| 5 | 28 | 3.753 | 0.781 | 5.327 |

**April 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 16 | 2.160 | 0.540 | 2.994 |
| 2 | 16 | 1.388 | 0.347 | 2.761 |
| 3 | 16 | 1.217 | 0.304 | 2.461 |
| 4 | 14 | 2.916 | 0.766 | 3.081 |
| 5 | 12 | 2.468 | 0.688 | 2.378 |

**May 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 8 | 2.948 | 0.983 | 3.186 |
| 2 | 10 | 3.278 | 0.987 | 3.753 |
| 3 | 8 | 2.948 | 0.983 | 3.186 |
| 4 | 7 | 2.725 | 0.971 | 2.731 |
| 5 | 17 | 3.628 | 0.888 | 4.399 |

**APPENDIX III.** Continued.

**June 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 10 | 3.322 | 1.000 | 3.909 |
| 2 | 6 | 2.585 | 1.000 | 2.791 |
| 3 | 4 | 1.922 | 0.961 | 1.864 |
| 4 | 6 | 2.522 | 0.976 | 2.569 |
| 5 | 6 | 2.522 | 0.976 | 2.569 |

**July 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 10 | 2.698 | 0.812 | 2.393 |
| 2 | 13 | 2.927 | 0.791 | 2.981 |
| 3 | 10 | 2.893 | 0.871 | 2.646 |
| 4 | 14 | 2.722 | 0.715 | 2.619 |
| 5 | 14 | 3.003 | 0.789 | 3.456 |

**August 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 5 | 2.322 | 1.000 | 2.485 |
| 2 | 3 | 1.585 | 1.000 | 1.820 |
| 3 | 7 | 2.624 | 0.935 | 2.339 |
| 4 | 10 | 2.111 | 0.635 | 2.042 |
| 5 | 5 | 1.857 | 0.800 | 1.477 |

**September 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 18 | 2.950 | 0.707 | 3.455 |
| 2 | 24 | 3.064 | 0.668 | 4.682 |
| 3 | 18 | 2.092 | 0.502 | 3.104 |
| 4 | 16 | 3.023 | 0.756 | 2.948 |
| 5 | 14 | 2.719 | 0.714 | 2.911 |

**APPENDIX III.** Continued.

**October 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 16 | 2.505 | 0.626 | 2.781 |
| 2 | 15 | 2.278 | 0.583 | 2.471 |
| 3 | 20 | 2.835 | 0.656 | 3.464 |
| 4 | 14 | 3.408 | 0.645 | 5.761 |
| 5 | 18 | 2.882 | 0.691 | 3.891 |

**November 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 12 | 2.759 | 0.770 | 2.394 |
| 2 | 14 | 2.461 | 0.646 | 2.433 |
| 3 | 26 | 2.268 | 0.567 | 2.561 |
| 4 | 17 | 3.329 | 0.814 | 3.940 |
| 5 | 20 | 3.261 | 0.755 | 4.552 |

**December 1986**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 17 | 2.876 | 0.704 | 3.017 |
| 2 | 16 | 2.926 | 0.731 | 2.810 |
| 3 | 15 | 2.609 | 0.668 | 2.468 |
| 4 | 15 | 2.754 | 0.705 | 3.295 |
| 5 | 9 | 2.657 | 0.838 | 2.330 |

**January 1987**

| STATION | NO. SPECIES | DIVERSITY | EVENNESS | RICHNESS |
|---|---|---|---|---|
| 1 | 14 | 2.283 | 0.600 | 2.483 |
| 2 | 16 | 2.455 | 0.614 | 2.821 |
| 3 | 12 | 2.328 | 0.650 | 2.314 |
| 4 | --- | ------- | ------- | ------- |
| 5 | 21 | 3.054 | 0.695 | 3.941 |