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# The Influence Of Water Quality Upon The Benthic Macroinvertebrates of Salt Creek Lancaster County, Nebraska

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# THE INFLUENCE OF WATER QUALITY UPON THE BENTHIC MACROINVERTEBRATES OF SALT CREEK LANCASTER COUNTY, NEBRASKA

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ABSTRACT: A study to determine the influence of water quality upon the diversity and abundance of benthic macroinvertebrates in Salt Creek, Lancaster County, Nebraska was conducted during 1971-72. Water quality in the creek, as indicated by dissolved oxygen and conductivity levels, varies along the course of the creek and is poorest in the lower reaches where wastes from the city of Lincoln are discharged. The changes in water quality are reflected in the community structure and abundance of macroinvertebrates in the creek; the highest community diversity occurred at the upper stations where water quality is unaffected by municipal wastes, while the lowest occurred at the stations immediately downstream from the Lincoln sewage treatment plant. Macroinvertebrates generally considered to be intolerant of pollution were confined to the stations upstream from the treatment plant outfall, while the downstream stations were dominated by those which are associated with polluted environments. Highly significant correlations were observed between average community diversity, dissolved oxygen and conductivity.

## INTRODUCTION

In 1971 the Nebraska Natural Resources Commission received a grant from the United States Environmental Protection Agency to prepare a water quality management plan for the Salt Creek Basin. The Commission was subsequently joined in this effort by the Lower Platte South Natural Resources District and the city of Lincoln, Nebraska. Together they developed a detailed plan for controlling water pollution through the management of wastes from various sources in the Salt Creek Basin. One segment of the plan was concerned with present water quality in Salt Creek and its effect upon the bottom-dwelling organisms there. The Natural Resources Commission contracted with the University of Nebraska to do a study whose objectives were:

1) To determine the presence and abundance of bottom-dwelling organisms living in polluted and non-polluted parts of Salt Creek.
2) To help define the suitability of the water for the various uses outlined in the Nebraska Water Quality Standards, such as the growth and propagation of fish and wildlife.
3) To establish baseline data to be used in evaluating the effectiveness of the management plan as it is implemented.

This report will deal only with the objective given in (1) above and specifically will examine the influence of water quality upon the diversity and

abundance of benthic macroinvertebrates in the creek.

The Salt Creek basin encompasses approximately 1200 square miles and includes portions of Lancaster, Saunders, Seward, Cass, and Butler counties. The city of Lincoln is situated near the geographical center of this basin and is the source of many domestic and industrial wastes that enter the stream. The Salt Creek drainage area is primarily agricultural, as approximately 75 percent of the land is cultivated. Urban and other non-agricultural uses comprise about 10 percent of the drainage area.

Surface drainage is the primary natural source of water in Salt Creek, but discharges from ground water aquifers are responsible for the stream's base flow. Table 1 lists streamflow characteristics of Salt Creek at the selected sampling stations.

Normal annual precipitation at stations along Salt Creek are listed in Table 2 while Table 3 compares the normal and 1972 precipitation recorded

TABLE 1
Streamflow Characteristics of Salt Creek at Sampling Stations

| Station | Drainage | Annual Mean Discharge (1952-70) | Major Tributaries |
|---|---|---|---|
| #1, Roca (on Olive Branch) | 102 sq. miles | 25 cfs (est.) | None |
| #2, Pioneer | 232 sq. miles | 45 cfs (est.) | Olive Branch, Hickman Branch, and Cardwell Branch |
| #3, N. 14th St. (300 yds. above STP) | 680 sq. miles (est.) | 176 cfs | Same as #2 plus Beal Slough, Haines Branch, Middle Creek, Oak Creek, and Antelope Creek |
| #4, N. 27th St. | 684 sq. miles | 213 cfs | Same as #3 |
| #5, Waverly | 853 sq. miles | 240 cfs (est.) | Same as #3 plus Dead Mans Run, Little Salt Creek, and Stevens Creek |
| #6, Greenwood | 1,051 sq. miles | 263 cfs | Same as #5, plus Jordan Creek, Rock, Creek, Camp Creek, and Dee Creek |

Source: Comprehensive Plan for Water Quality Management in the Salt Creek Basin, 1972.

TABLE 2
Normal Annual Precipitation at Stations Along Salt Creek

| Station | Normal Annual Precipitation |
|---|---|
| Roca | 27.21 inches |
| Lincoln | 27.43 inches |
| Ashland | 28.21 inches |

Source: U.S. Weather Bureau Lincoln, Nebraska

TABLE 3
Comparison of Normal and 1972 Precipitation at Lincoln

| Month | Normal | 1972 | Deviation |
|---|---|---|---|
| January | 0.92 inches | 0.20 inches | --0.72 inches |
| February | 1.09 inches | 0.25 inches | -0.84 inches |
| March | 1.73 inches | 0.50 inches | -1.23 inches |
| April | 2.45 inches | 5.41 inches | +2.96 inches |
| May | 3.48 inches | 4.25 inches | +0.77 inches |
| June | 4.50 inches | 2.23 inches | -2.27 inches |
| July | 3.27 inches | 2.20 inches | -1.07 inches |
| August | 3.38 inches | 3,76 inches | +0.38 inches |
| September | 2.87 inches | 2.78 inches | -0.09 inches |
| October | 1.58 inches | 3.22 inches | +1.64 inches |
| November | 1.27 inches | 3.58 inches | +2.32 inches |
| December | 0.90 inches | — | — |
| Total | 27.43 inches | 28.38 inches | +1.85 inches |

Source: U.S. Weather Bureau, Lincoln, Nebraska

at Lincoln. The large amounts of spring rainfall resulted in high discharge rates during late April and May, especially along the lower portion of the stream. During the remainder of the sampling period, the stream maintained near normal flows, as no sustained periods of high rainfall or drought occurred.

## MATERIALS AND METHODS

Six sampling stations were selected for this study. Station #1 (Roca) was located about 1-1/2 miles southwest of Roca where a gravel road crosses Olive

Branch. Station #2 (Pioneer) was located at the crossing of Salt Creek and west Pioneer Boulevard, approximately 3/4 mile west of the State Penal Complex. Station #3 (North 14th Street) was located approximately 1/2 mile east of North 14th Street, about 300 yards above the outfall of the Lincoln city sewage treatment plant. Station #4 (North 27th Street) was located at the North 27th Street crossing of Salt Creek while Station #5 (Waverly) was situated approximately two miles west of Waverly where a gravel road crosses the stream. Station #6 (Greenwood) was located about 1/2 mile west of Greenwood where another gravel road crosses Salt Creek (Figure 1).

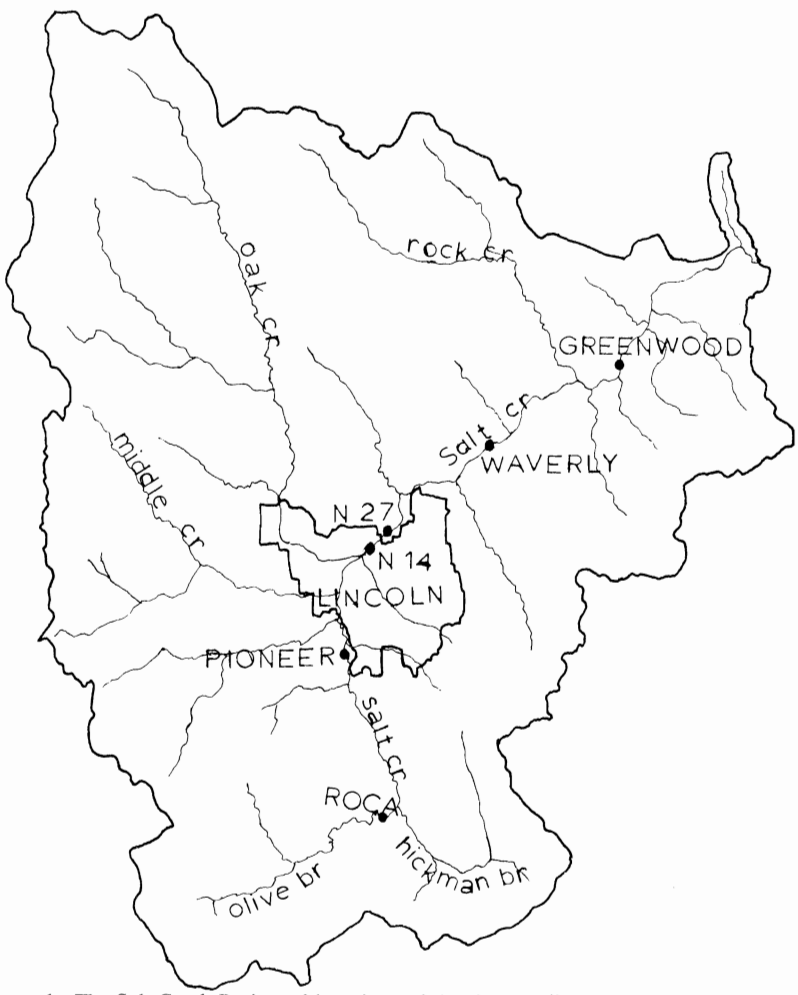


Figure 1 The Salt Creek Basin and locations of the six sampling stations.

At every station, a riffle area and a pool area were selected, and each was sampled with two multiple-plate artificial substrate samplers. Therefore, a total of 24 samplers were kept in service during the study. From April 25 to October 1, the samplers were checked bi-weekly; at the same time, temperature, dissolved oxygen, and conductivity values were measured at each station. The organisms were brushed from the samplers into a collecting bucket and then placed in preservative at the sampling sites for later counting and identification at the laboratory.

To determine if two samplers placed in a given area were sufficient to adequately sample the macroinvertebrates there, five samplers were placed in the riffle area at the Pioneer station and allowed to remain in place for three weeks. Table 4 compares the number of organisms, the number of taxa, and the diversity of organisms collected by each of the samplers.

TABLE 4

The number of specimens, number of taxa, and diversity of organisms collected by five individual samplers placed in the same location.

| Sampler | No. of specimens | No. of taxa | Sequential Comparison Index (SCI)* | Species Diversity (SDI)* |
|---|---|---|---|---|
| 1 | 109 | 10 | 7.90 | 2.34 |
| 2 | 154 | 11 | 7.39 | 2.36 |
| 3 | 132 | 11 | 7.76 | 2.38 |
| 4 | 136 | 11 | 7.98 | 2.45 |
| 5 | 144 | 10 | 7.50 | 2.19 |
| | x 135 | | | |
| | $s^2$ 382 | | | |
| | s 19.5 | | | |

* Equivalent to $DI_T$

** SDI calculated from $d = \sum_{1}^{S} (N_i/N) \log 2 \, Ni/N$ (Patten, 1962.)

The data were then analyzed by comparing the means of all two sampler combinations with the mean of the five samplers. The null hypothesis was that there is no significant difference between the mean of five samplers and the mean of two samplers, $\alpha.05$. Our calculated chi square (6.265) compared with the tabular value (16.92, $\alpha.05$, 9 df.) indicated the null hypothesis should be accepted.

In order to evaluate the structure of the benthic communities in Salt Creek, the Sequential Comparison Index developed by Cairns and Dickson

(1971) was employed. The Sequential Comparison Index (SCI) is a method for determining relative differences in faunal diversity. The sequential diversity index ($DI_1$) is based upon the number of organisms and the repetition of taxa while the final sequential comparison diversity index ($DI_T$) is equal to the $DI_1$ multiplied by the number of taxa. Cairns and Dickson consider healthy streams with high diversity and balanced density to have $DI_T$ values above 12.0 while polluted communities with skewed population structures have $DI_T$ values under 8.0. It should be noted, however, that their standards were based on data derived primarily from mountain streams of the eastern United States.

## RESULTS AND DISCUSSION

Table 5 compares the temperature, dissolved oxygen, and conductivity measurements taken at the sampling stations on spring, summer, and fall dates. These data show the marked changes in dissolved oxygen and conductivity values along the course of the stream. Table 6, which lists the mean temperature, dissolved oxygen, and conductivity values of the sampling period, emphasizes these changes.

TABLE 5
Physical Measurements of Salt Creek

| | Time of day | Temp | D.O. | Conductivity |
|---|---|---|---|---|
| | | May 11, 1972 | | |
| Roca riffle | 0840 | 11.6°C | 9.1 mg/l | 660μmhos/cm |
| Roca pool | 0840 | 11.8°C | 8.6 mg/l | 680 μmhos/cm |
| Pioneer riffle | 1035 | 12.5°C | 8.4 mg/l | 550 μmhos/cm |
| Pioneer pool | 1035 | 12.5°C | 8.8 mg/l | 550 μmhos/cm |
| N. 14th St. riffle | 1505 | 16.8°C | 8.2 mg/l | 2,600 μmhos/cm |
| N. 14th St. pool | 1505 | 16.5°C | 8.2 mg/l | 2,550 μmhos/cm |
| N. 27th St. riffle | 1435 | 16.0°C | 7.8 mg/l | 2,950 μmhos/cm |
| N. 27th St. pool | 1435 | 16.5°C | 7.7 mg/l | 2,950 μmhos/cm |
| Waverly riffle | 1340 | 15.1°C | 7.1 mg/l | 2,590 μmhos/cm |
| Waverly pool | 1340 | 15.2°C | 7.0 mg/l | 2,620 μmhos/cm |
| Greenwood riffle | 1250 | 15.0°C | 7.6 mg/l | 2,100 μmhos/cm |
| Greenwood pool | 1250 | 15.0°C | 7.4 mg/l | 2,200 μmhos/cm |
| | | Aug. 16, 1972 | | |
| Roca riffle | 0620 | 24.5°C | 6.4 mg/l | 2,150 μmhos/cm |
| Roca pool | 0620 | 24.5°C | 6.1 mg/l | 2,150 μmhos/cm |
| Pioneer riffle | 0700 | 24.0°C | 6.0 mg/l | 1,490 μmhos/cm |

| | | | | |
|---|---|---|---|---|
| Pioneer pool | 0700 | 24.0°C | 5.7 mg/1 | 1,490 μmhos/cm |
| N. 14th St. riffle | 0725 | 21.5°C | 6.8 mg/1 | 10,000 μmhos/cm |
| N. 14th St. pool | 0725 | 21.5°C | 4.3 mg/1 | 10,000 μmhos/cm |
| N. 27th St. riffle | 0800 | 22.6°C | 5.8 mg/1 | 7,900 μmhos/cm |
| N. 27th St. pool | 0800 | 22.2°C | 4.3 mg/1 | 7,800 μmhos/cm |
| Waverly riffle | 0830 | 23.0°C | 3.3 mg/1 | 6,100 μmhos/cm |
| Waverly pool | 0830 | 23.0°C | 1.2 mg/1 | 6,100 μmhos/cm |
| Greenwood riffle | 0900 | 24.4°C | 6.0 mg/1 | 6,900 μmhos/cm |
| Greenwood pool | 0900 | 24.5°C | 5.7 mg/1 | 6,900 μmhos/cm |
| | | Oct. 1, 1972 | | |
| Roca riffle | 1015 | 13.5°C | 10.8 mg/1 | 1,150 μmhos/cm |
| Roca pool | 1015 | 13.8°C | 10.3 mg/1 | 1,140 μmhos/Cm |
| Pioneer riffle | 0945 | 12.9°C | 10.4 mg/1 | 970 μmhos/cm |
| Pioneer pool | 0945 | 12.8°C | 9.2 mg/1 | 980 μmhos/cm |
| N. 14th St. riffle | 0850 | 13.0°C | 10.0 mg/1 | 9,100 μmhos/cm |
| N. 14th St. pool | 0850 | 12.5°C | 9.2 mg/1 | 9,400 μmhos/cm |
| N. 27th St. riffle | 0830 | 14.6°C | 8.4 mg/1 | 7,400 μmhos/cm |
| N. 27th St. pool | 0830 | 15.1°C | 0.6 mg/1* | 7.500 μmhos/cm |
| Waverly riffle | 0800 | 14.2°C | 5.0 mg/1 | 5,500 μmhos/cm |
| Waverly pool | 0800 | 14.1°C | 4.6 mg/1 | 5,500 μmhos/cm |
| Greenwood riffle | 0730 | 13.5°C | 5.2 mg/1 | 5,200 μmhos/cm |
| Greenwood pool | 0730 | 13.5°C | 5.3 mg/1 | 4,900 μmhos/cm |

*Decomposing matter had washed into the pool.

TABLE 6

Comparison of Mean Physical Measurements For Sampling Period

| Station | Mean Temperature | Mean Dissolved Oxygen | Mean Conductivity |
|---|---|---|---|
| Roca riffle | 20.0 C | 8.0 mg/1 | 1,380 μmhos/cm |
| Roca pool | 20.1 C | 7.8 mg/1 | 1,390 μmhos/cm |
| Pioneer riffle | 20.5 C | 7.7 mg/1 | 1,180 μmhos/cm |
| Pioneer pool | 20.4 C | 7.5 mg/1 | 1,180 μmhos/cm |
| N. 14th St. riffle | 22.7 C | 7.6 mg/1 | 7,900 μmhos/cm |
| N. 14th St. pool | 22.6 C | 7.1 mg/1 | 7,990 μmhos/cm |
| N. 27th St. riffle | 22.2 C | 7.0 mg/1 | 6,450 μmhos/cm |
| N. 27th St. pool | 22.3 C | 5.4 mg/1 | 6,250 μmhos/cm |
| Waverly riffle | 22.0 C | 5.0 mg/1 | 5,290 μmhos/cm |
| Waverly pool | 22.0 C | 4.5 mg/1 | 5,190 μmhos/cm |
| Greenwood riffle | 22.2 C | 5.4 mg/1 | 4,940 μmhos/cm |
| Greenwood pool | 22.3 C | 5.4 mg/1 | 4,920 μmhos/cm |

Near saturation values of dissolved oxygen were found to occur at the Roca and Pioneer stations throughout the sampling period. With the exception of the 4.3 mg/l reading on August 15, the N. 14th Street station also exhibited values above 5.0 mg/l, the level generally considered to be satisfactory for the maintenance of desirable aquatic life. The values at the N. 27th Street station were generally acceptable (only three readings below 5.0 mg/l) as the effect of the sewage treatment plant's effluent was only partially felt. However, the dissolved oxygen values at the Waverly station readily indicate the effect of the sewage effluent as nearly all summer values were below 5.0 mg/l. The dissolved oxygen concentrations on September 17 in the Waverly riffle and pool areas were 1.7 mg/l and 1.8 mg/l respectively. However, the measurements taken at the Greenwood station on that date indicate some recovery of dissolved oxygen as only four values were below 5.0 mg/l, the lowest being 3.4 mg/l.

The lowest conductivity values, means of 1390 μmhos/cm and 1180 μmhos/cm, were measured at the Roca and Pioneer stations respectively. The highest values were measured at the N. 14th Street station where readings around 10,000 μmhos/cm were commonly observed during the period of decreased summer flow. These extreme values are most probably due to the high natural concentration of salts in the ground water around Lincoln. In general, conductivity gradually decreased at each of the subsequent downstream stations, a probable result of dilution.

TABLE 7
Comparison of Benthic Community Population Structures

| Date | Station | # of Specimens | # of Taxa | $DI_1$ | $DI_T$ |
|---|---|---|---|---|---|
| April 25, 1972 | Roca riffle | 82 | 14 | 0.81 | 11.34 |
| | Roca pool | 53 | 10 | 0.80 | 7.95 |
| | Pioneer riffle | 65 | 12 | 0.66 | 7.92 |
| | Pioneer pool | 11 | 5 | 0.64 | 3.20 |
| | N. 14th St. riffle | 23 | 9 | 0.85 | 7.65 |
| | N. 14th St. pool | 9 | 4 | 0.83 | 3.32 |
| | N. 27th St. riffle | 60 | 6 | 0.65 | 3.87 |
| | N. 27th St. pool* | – | – | – | – |
| | Waverly riffle | 44 | 5 | 0.47 | 2.40 |
| | Waverly pool | 89 | 3 | 0.09 | 0.27 |
| | Greenwood riffle* | – | – | – | – |
| | Greenwood Pool* | – | – | – | – |
| May 11, 1972 | Roca riffle | 17 | 7 | 0.83 | 5.78 |
| | Roca pool | 77 | 11 | 0.76 | 8.36 |

| | | | | | |
|---|---|---|---|---|---|
| | Pioneer riffle | 30 | 7 | 0.68 | 4.76 |
| | Pioneer pool | 61 | 12 | 0.77 | 9.24 |
| | N. 14th St. riffle* | – | – | – | – |
| | N. 14th St. pool* | – | – | – | – |
| | N. 27th St. pool* | – | – | – | – |
| | N. 27th St. riffle* | – | – | – | – |
| | Waverly riffle* | – | – | – | – |
| | Waverly pool** | 32 | 2 | 0.16 | 0.32 |
| | Greenwood riffle* | – | – | – | – |
| | Greenwood pool* | – | – | – | – |
| May 27, 1972 | Roca riffle | 107 | 10 | 0.34 | 3.35 |
| | Roca pool | 33 | 5 | 0.44 | 2.20 |
| | Pioneer riffle | 37 | 6 | 0.50 | 3.00 |
| | Pioneer pool | 18 | 5 | 0.83 | 4.15 |
| | N. 14th St. riffle | 21 | 3 | 0.29 | 0.88 |
| | N. 17th St. pool | 18 | 7 | 0.81 | 5.64 |
| | N. 27th St. riffle | 56 | 6 | 0.40 | 2.37 |
| | N. 27th St. pool | 9 | 2 | 0.45 | 0.88 |
| | Waverly riffle * | – | – | – | – |
| | Waverly pool | 7 | 3 | 0.57 | 1.71 |
| | Greenwood riffle* | – | – | – | – |
| | Greenwood pool* | – | – | – | – |
| June 15, 1972 | Roca riffle | 78 | 12 | 0.70 | 8.40 |
| | Roca pool | 36 | 10 | 0.78 | 7.80 |
| | Pioneer riffle | 80 | 7 | 0.78 | 5.46 |
| | Pioneer pool | 64 | 5 | 0.75 | 3.73 |
| | N. 14th St. riffle | 9 | 2 | 0.33 | 0.67 |
| | N. 14th St. pool | 21 | 3 | 0.72 | 2.14 |
| | N. 27th St. riffle | 31 | 5 | 0.69 | 3.45 |
| | N. 27th St. pool | 63 | 3 | 0.26 | 0.77 |
| | Waverly riffle | 58 | 3 | 0.46 | 1.38 |
| | Waverly pool | 29 | 5 | 0.64 | 3.20 |
| | Greenwood riffle | 38 | 5 | 0.45 | 2.25 |
| | Greenwood pool | 69 | 5 | 0.34 | 1.70 |
| June 30, 1972 | Roca riffle | 105 | 12 | 0.78 | 9.30 |
| | Roca pool | 52 | 8 | 0.76 | 6.08 |
| | Pioneer riffle | 148 | 11 | 0.28 | 3.08 |
| | Pionere pool | 85 | 6 | 0.49 | 2.94 |
| | N. 14th St. riffle | 21 | 5 | 0.66 | 3.30 |
| | N. 14th St. pool | 17 | 5 | 0.88 | 4.40 |
| | N. 27th Riffle | 42 | 9 | 0.71 | 6.35 |

| | | | | | |
|---|---|---|---|---|---|
| | N. 27th St. pool | 61 | 5 | 0.63 | 3.15 |
| | Waverly riffle | 32 | 4 | 0.22 | 0.88 |
| | Waverly pool | 64 | 5 | 0.43 | 2.58 |
| | Greenwood riffle | 68 | 4 | 0.54 | 2.16 |
| | Greenwood pool | 105 | 6 | 0.53 | 3.17 |
| July 15, 1972 | Roca riffle | 132 | 12 | 0.82 | 9.84 |
| | Roca pool | 39 | 6 | 0.73 | 4.38 |
| | Pioneer riffle | 106 | 11 | 0.82 | 8.97 |
| | Pioneer pool | 50 | 9 | 0.63 | 5.67 |
| | N. 14th St. riffle | 13 | 4 | 0.81 | 3.22 |
| | N. 14th St. pool | 29 | 5 | 0.66 | 3.28 |
| | N. 27th St. riffle | 39 | 8 | 0.65 | 5.20 |
| | N. 27th St. pool | 14 | 6 | 0.68 | 4.05 |
| | Waverly riffle | 168 | 4 | 0.30 | 1.20 |
| | Waverly pool | 224 | 6 | 0.34 | 2.04 |
| | Greenwood riffle | 179 | 7 | 0.42 | 2.91 |
| | Greenwood pool | 195 | 4 | 0.37 | 1.46 |
| July 31, 1972 | Roca riffle | 46 | 9 | 0.82 | 7.34 |
| | Roca pool | 38 | 10 | 0.69 | 6.85 |
| | Pioneer riffle | 90 | 10 | 0.82 | 8.20 |
| | Pioneer pool | 46 | 7 | 0.73 | 5.11 |
| | N. 14th St. riffle | 3 | 1 | 0.33 | 0.33 |
| | N. 14th St. pool* | — | — | — | — |
| | N. 27th St. riffle | 34 | 6 | 0.77 | 4.59 |
| | N. 27th St. pool | 7 | 5 | 0.86 | 4.30 |
| | Waverly riffle | 29 | 4 | 0.45 | 1.80 |
| | Waverly pool | 46 | 3 | 0.21 | 0.63 |
| | Greenwood riffle** | 34 | 4 | 0.47 | 1.88 |
| | Greenwood pool | 25 | 4 | 0.54 | 2.16 |
| August 15, 1972 | Roca riffle | 109 | 13 | 0.65 | 8.45 |
| | Roca pool | 30 | 10 | 0.85 | 8.50 |
| | Pioneer riffle | 148 | 9 | 0.77 | 6.89 |
| | Pioneer pool | 16 | 5 | 0.63 | 3.13 |
| | N. 14th St. riffle | 8 | 4 | 0.75 | 3.00 |
| | N. 14th St. pool | 18 | 4 | 0.64 | 2.56 |
| | N. 27th St. riffle | 104 | 6 | 0.62 | 3.72 |
| | N. 27th St. pool | 13 | 4 | 0.69 | 2.76 |
| | Waverly riffle | 176 | 4 | 0.26 | 1.04 |
| | Waverly pool** | 85 | 4 | 0.46 | 1.84 |
| | Greenwood riffle | 173 | 4 | 0.10 | 0.40 |
| | Greenwood pool | 208 | 4 | 0.08 | 0.30 |

| | | | | | |
|---|---|---|---|---|---|
| August 29, 1972 | Roca riffle | 86 | 8 | 0.72 | 5.72 |
| | Roca pool | 47 | 7 | 0.78 | 5.46 |
| | Pioneer riffle | 140 | 11 | 0.79 | 8.64 |
| | Pioneer pool | 33 | 6 | 0.61 | 3.66 |
| | N. 14th St. riffle | 6 | 8 | 0.67 | 2.00 |
| | N. 14th St. pool | 14 | 4 | 0.50 | 2.00 |
| | N. 27th St. riffle | 91 | 6 | 0.70 | 4.17 |
| | N. 27th St. pool | 4 | 4 | 1.00 | 4.00 |
| | Waverly riffle | 178 | 4 | 0.30 | 1.18 |
| | Waverly pool | 61 | 2 | 0.33 | 0.65 |
| | Greenwood riffle | 175 | 3 | 0.35 | 1.05 |
| | Greenwood pool | 172 | 3 | 0.18 | 0.54 |
| Sept.17, 1972 | Roca riffle | 49 | 10 | 0.79 | 7.85 |
| | Roca pool | 30 | 6 | 0.75 | 4.50 |
| | Pioneer riffle | 135 | 10 | 0.78 | 7.75 |
| | Pioneer pool | 59 | 8 | 0.76 | 6.04 |
| | N. 14th St. riffle | 66 | 5 | 0.53 | 2.65 |
| | N. 14th St. pool | 21 | 3 | 0.24 | 0.72 |
| | N. 27th St. riffle | 110 | 4 | 0.48 | 1.90 |
| | N. 27th St. pool | 32 | 5 | 0.28 | 1.40 |
| | Waverly riffle* | — | — | — | — |
| | Waverly pool | 182 | 3 | 0.08 | 0.23 |
| | Greenwood riffle | 173 | 3 | 0.10 | 0.29 |
| | Greenwood pool | 147 | 4 | 0.11 | 0.44 |
| October 1, 1972 | Roca riffle | 110 | 11 | 0.69 | 7.59 |
| | Roca pool | 37 | 10 | 0.76 | 7.60 |
| | Pioneer riffle | 192 | 13 | 0.66 | 8.52 |
| | Pioneer pool** | 21 | 9 | 0.79 | 7.07 |
| | N. 14th St. riffle | 48 | 7 | 0.52 | 3.61 |
| | N. 14th St. pool | 15 | 6 | 0.70 | 4.20 |
| | N. 27th St. riffle | 165 | 6 | 0.58 | 3.48 |
| | N. 27th St. pool | 29 | 6 | 0.80 | 4.77 |
| | Waverly riffle | 3 | 2 | 0.84 | 1.67 |
| | Waverly pool | 162 | 6 | 0.26 | 1.53 |
| | Greenwood riffle | 214 | 6 | 0.13 | 0.75 |
| | Greenwood pool | 180 | 6 | 0.27 | 1.59 |

*Samplers washed away or removed
**Data from one (1) sampler

TABLE 8

Comparison of Mean Benthic Community Structure Values for Sampling Period

| Station | Mean # Specimens | Mean # of Taxa | Mean $DI_1$ | Mean $DI_T$ |
|---|---|---|---|---|
| Roca riffle | 83.7 | 10.7 | 0.72 | 7.72 |
| Roca pool | 42.9 | 8.5 | 0.74 | 6.33 |
| Pioneer riffle | 106.5 | 9.7 | 0.69 | 6.65 |
| Pioneer pool | 42.2 | 7.0 | 0.69 | 7.90 |
| N. 14th St. riffle | 21.8 | 4.3 | 0.57 | 2.73 |
| N. 14th St. pool | 18.0 | 4.6 | 0.66 | 3.13 |
| N. 27th St. riffle | 73.2 | 6.2 | 0.63 | 3.91 |
| N. 27th St. pool | 25.8 | 4.4 | 0.63 | 2.90 |
| Waverly riffle | 86.0 | 3.8 | 0.41 | 1.44 |
| Waverly pool | 89.2 | 3.9 | 0.32 | 1.36 |
| Greenwood riffle | 131.8 | 4.5 | 0.32 | 1.46 |
| Greenwood pool | 137.6 | 4.5 | 0.30 | 1.42 |

The number of specimens, number of taxa $DI_1$ and $DI_T$ values obtained at each station during the sampling period are listed in Table 7. In addition, Table 8 lists the means of these values. These data show that the highest numbers of taxa and the greatest diversities were found at the Roca and Pioneer stations throughout the sampling period. A marked decrease in the number of taxa and diversities occurred at the N. 14th Street station and the lowest numbers of specimens were taken there. The N. 27th Street station showed an increase in all of the above parameters, although some low values were obtained in the pool area where an accummulation of sludge occasionally occurred. The number of specimens generally increased considerably at the Waverly station; however, the number of taxa and diversity values there were generally among the lowest throughout the sampling period. Higher number of taxa and diversity values were obtained at the Waverly station during the spring, but these values were still quite low. From mid-summer on, the highest numbers of specimens were generally taken at the Greenwood station. Although the number of taxa and diversity values were low, they showed an overall slight improvement over the Waverly values. Unfortunately, no data were obtained at the Greenwood station on the first three sampling dates. Respectable numbers of taxa and diversity values may have been obtained then.

Oxygen, one of the primary requisites for animal existence, appears to play a major role in determining the structure of the benthic communities along the course of Salt Creek. Figure 2, a comparison of the average dissolved oxygen and $DI_T$ values of the sampling stations, illustrates the

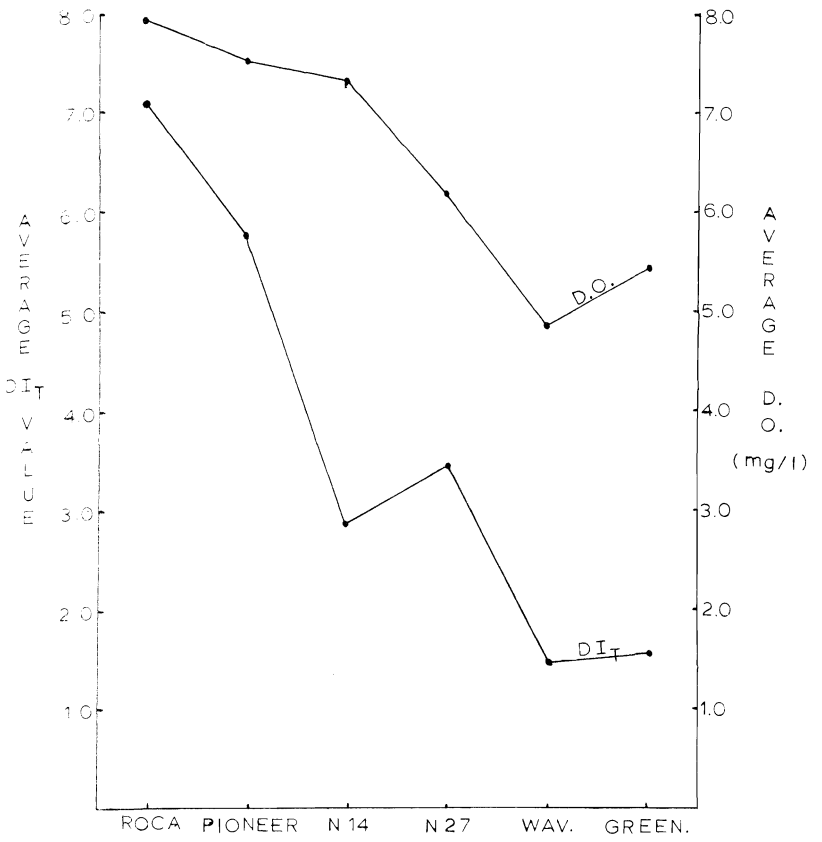


Figure 2 Relationship between mean community diversity ($DI_T$) and mean dissolved oxygen concentrations in Salt Creek. The correlation is significant at the $\alpha 01$ level.

strong positive correlation between these parameters. The computed r for this correlation is highly significant (r=.5206, calc. t 6.1891 tab.t $\alpha$.01, 2.625, 100 d.f.). Figure 2 suggests, however, that an additional factor is influencing $DI_T$ at the North 14th Street Station. This factor is likely conductivity. Figure 3 depicts the strong negative correlation between $DI_T$ and conductivity, which is highly significant (r=-.5137, calc.t 6.1651, tab.t $\alpha$01, 2.625, 100 d.f.). It is reasonable to suppose that both low dissolved oxygen and high conductivity can strongly affect the benthos, and that their effects are probably synergistic rather than additive. It is interesting that these strong correlations are observed between the means of the measured parameters, when in reality, the extremes are probably the most powerful determinants of community

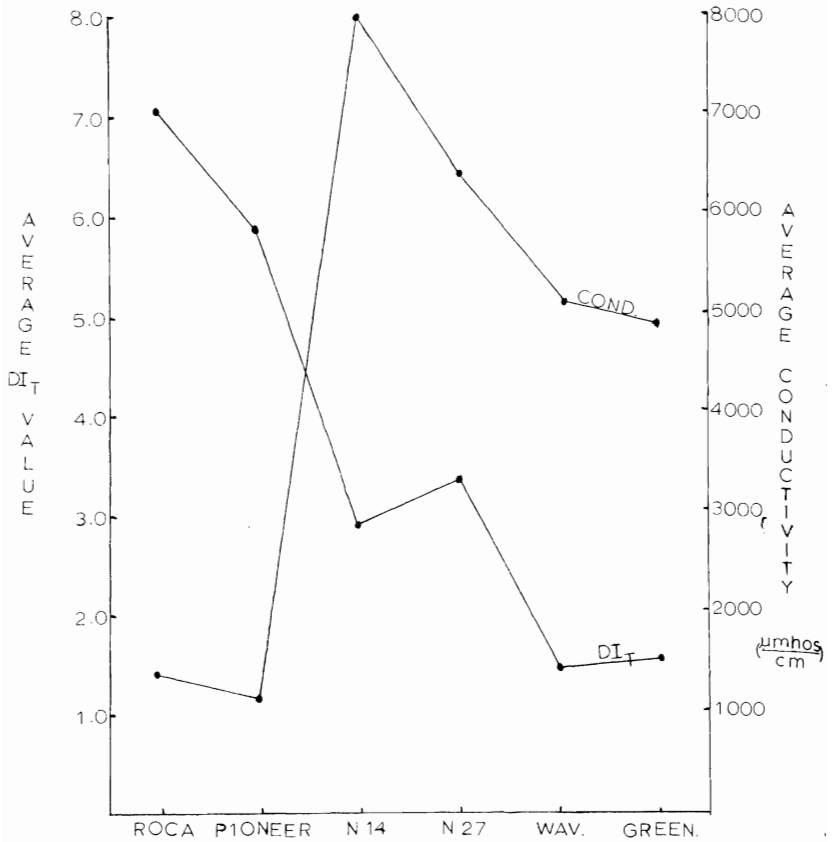


Figure 3 Relationship between mean community diversity ($DI_T$) and mean conductivity in Salt Creek. The correlation is significant at the $\alpha$.01 level.

structure (lowest dissolved oxygen or highest conductivity). According to Gaufin and Tarzwell (1952) pollutional associations are characterized by few species but large numbers of organisms that have low oxygen requirements or special adaptations for obtaining oxygen. This accounts for the high numbers of organisms taken at the Waverly and Greenwood stations.

Table 9 represents a comparison of representative organisms taken at the sampling stations during the study period. Some organisms such as the hellgrammite, alderfly larva, black fly larva, fingernail clam and limpet, which are normally associated with clean water environments, were entirely limited to the Roca and Pioneer stations. Mayfly nymphs and caddisfly larvae, other organisms indicative of high water quality, were nearly limited to the Roca and Pioneer stations but did occur in low numbers at the other stations

TABLE 9
Comparison of Representative Organisms Taken with Multi-Plate Samplers

| Organism | Roca | Pioneer | N 14th St. | N 27th St. | Waverly | Greenwood |
|---|---|---|---|---|---|---|
| Hellgrammite (Order Megaloptera) | Rare | Uncommon | Absent | Absent | Absent | Absent |
| Alderfly Larva (Megaloptera) | Occasional | Rare | Absent | Absent | Absent | Absent |
| Mayfly Nymphs (Ephemeroptera) | Abundant | Abundant | Occasional | Occasional | Uncommon | Uncommon |
| Damselfly Nymphs (Odonta) | Abundant | Abundant | Common | Common | Uncommon | Uncommon |
| Dragonfly Nymphs (Odonata) | Absent | Rare | Uncommon | Uncommon | Absent | Absent |
| Caddisfly Larvae (Trichoptera) | Abundant | Abundant | Rare | Rare | Absent | Rare |
| Aquatic Beetles (Coleoptera) | Common | Common | Rare | Uncommon | Uncommon | Rare |
| Black Fly Larvae and/or Pupae (Diptera) | Common | Common | Absent | Absent | Absent | Absent |
| Bloodworm Larvae and/or Pupae (Diptera) | Common | Common | Common | Common | Abundant | Abundant |
| Shore fly Larvae (Diptera) | Absent | Absent | Occasional | Rare | Uncommon | Absent |
| Sludgeworm (Annelida) | Occasional | Occasional | Occasional | Occasional | Common | Rare |
| Leeches (Annelida) | Uncommon | Absent | Absent | Absent | Uncommon | Rare |
| Snails (Mollusca) | Abundant | Common | Common | Abundant | Occasional | Occasional |
| Fingernail Clams (Mollusca) | Common | Common | Absent | Absent | Absent | Absent |
| Limpet (Mollusca) | Occasional | Rare | Absent | Absent | Absent | Absent |
| Nematode (Nematoda) | Rare | Absent | Uncommon | Uncommon | Absent | Absent |
| Amphipod (Arthropoda) | Absent | Absent | Absent | Absent | Rare | Rare |
| Aquatic True Bugs (Hemiptera) | Uncommon | Uncommon | Absent | Rare | Uncommon | Rare |

during the spring and October 1 sampling dates when the highest dissolved oxygen values were measured there. Surprisingly, no dragonfly nymphs, also clean-water organisms, were found at the Roca station. Limited numbers of them were taken at the Pioneer, North 14th Street and North 27th Street stations, but they were never found at the Waverly and Greenwood stations. Damselfly nymphs, organisms which can tolerate a relatively wide range of water quality, were found at all the sampling stations but were most common at the Roca and Pioneer stations. On the other hand, the bloodworms and sludgeworms, which are typical in polluted conditions and have low oxygen requirements, reached their highest numbers at the Waverly and Greenwood stations. Their predominance was greatest during the summer when different species of bloodworms comprised nearly all of the various taxa taken at these two stations. Due to the low numbers of leeches, nematodes, and amphipod collected, no statements about them are made other than the fact that they were present.

## CONCLUSIONS

Based on the data derived from this study, the following conclusions are presented:

1) Definite differences in the structure of benthic communities in Salt Creek do exist and these differences are most probably a result of the variation of water quality along the course of the stream.
2) Relatively high water quality exists at the Roca and Pioneer stations. This is indicated by the high benthic diversities and the presence of clean-water organisms found there.

3) Low water quality, especially during the summer, exists at the Waverly and Greenwood stations. This is exemplified by the low benthic life diversities, scarcity of clean-water organisms, and the high numbers of organisms indicative of pollution found there.
4) Intermediate water quality, as indicated by the limited numbers of clean-water organisms and the moderate benthic life values obtained exists at the North 14 Street and North 27th Street stations.
5) The polluted water benthic communities found at the Waverly and Greenwood stations are characterized by the presence of (a) few species, (b) large numbers of organisms, (c) primarily scavenger-type organisms, and (d) organisms that have low oxygen requirements or special adaptations for obtaining oxygen.

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