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# THE FISHES OF SALT CREEK BASIN, NEBRASKA†

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During April through October 1977 we investigated the distribution of stream fishes from Salt Creek Basin in southeastern Nebraska. A total of 18,560 individuals representing 12 families and 34 species was taken from 125 collections at 102 different localities. Each collected species is reported in the form of an annotated list. *Pimephales promelas, Notropis stramineus, N. lutrensis, Lepomis cyanellus,* and *Ictalurus melas* were most frequently collected. The general low diversity of fish species at most collection sites indicates that the environment in these small streams is quite unstable. Comparisons with previous surveys of the fish fauna in this drainage are evaluated. The results represent base-line data which may be used for future studies of fish fauna and concomitant water-quality changes.

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## INTRODUCTION

Aquatic environments are affected by water resource developments and land use practices in their watersheds. These perturbations are often deleterious to the aquatic biota. Living organisms constantly subjected to this change are an integrated expression of water quality over time.

Fishes constitute a conspicuous part of the aquatic biota. They are of interest for aesthetic, recreational, and scientific reasons. To the general public, fishes are the most understandable symbol of water quality. Their presence or absence is accepted as an index of water quality (Smith, 1971; Denoncourt and Stambaugh, 1974). With increasing encroachment and utilization of waters for agricultural, municipal, and recreational uses, it is important to assess changes in water quality, especially since some minimum quality-standard is necessary before water can be used. Often these perturbations are indirect and go unnoticed unless of large magnitude. Starrett (1951) described the detrimental effect of siltation upon warmwater fish populations of the Des Moines River, Iowa. Erosion and deposition of inorganic sediments in streams can have deleterious effects on fish habitat (Cordone and Kelley, 1961). Irrigation can result in water-quality changes including temperature, increased salinity (Willrich and Smith, 1970), increased turbidity, and intermittency of stream flow (Neel, 1953). Channelization of streams resulting in reduced stream cover and decreased habitat for fish has been reported. Tarplee *et al.* (1971) found that channelized streams had an average carrying capacity of less than one-third that of natural streams. Domestic sewage has been regarded as an organic pollutant, adversely affecting the fish fauna (Katz and Gaufin, 1952; Tsai, 1973). Pesticides picked up by runoff from treated land can be toxic to fish (Tarzwell and Henderson, 1956). Impoundments built for flood control can alter fish distributions (Hynes, 1970).

Larrimore and Smith (1963) evaluated effects of ecological changes on the ichthyofauna that occurred during 60 years in an area that included both intensive farming and urbanization. Not only do human modifications affect the ichthyofauna, but natural climatic changes such as flooding and drought have marked effects on the faunal composition and distribution of stream fishes (Paloumpis, 1958).

Relatively little work has been done on Nebraska's stream fishes and their responses to man's activities. Fish faunal records within the Salt Creek drainage are rather meager. Early records are included in Meek (1894) and Everman and Cox (1896). Bennett (1931) and Johnson (1942) conducted surveys of fishes in Nebraska. More recent surveys dealt with specific drainages in the state. The Nebraska Game and Parks Commission published the *Lower Platte Basin Stream Inventory Report,* which included the Salt Creek Drainage Basin (Bliss and Schainost, 1973).

White perch, *Morone americana,* a recently-introduced exotic species in several reservoirs of the drainage has caused problems serious enough to warrant chemical reclamation. It

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was reported from several locations in streams of this drainage (Hergenrader and Bliss, 1971). Thus, their impact on the native-fish fauna of the streams could cause serious disruptions.

Objectives of this study were to:

1. Obtain information on the present distribution and relative abundance of the ichthyofauna in the streams of the Salt Creek drainage.
2. Document existing physical conditions of stream environments.
3. Describe the present status of white perch in the stream system.

## DESCRIPTION OF STUDY AREA

The Salt Creek Drainage Basin (Fig. 1) comprises approximately 4198 $km^2$ (1621 $mi^2$) in southeastern Nebraska (Jamison, 1974). It includes portions of Lancaster, Saunders, Seward, Cass, and Butler counties. The stream pattern is dendritic and the basin is well drained. Using Horton's (1945) classification scheme, this basin is of sixth order.

The basin is part of a dissected glacial till-plain of eastern Nebraska. Much of the terrace and upland surface of the basin is mantled with loess except in western Lancaster County and southwestern Saunders County, where glacial till may be exposed. Surface deposits and topography of the basin have been the result of Pleistocene deposition and erosion (Anonymous, 1973).

Topography of the basin is sloping to rolling hills, with terraces along Salt Creek in the vicinity of Lincoln and Waverly. Limestone and shale compose the uppermost bedrock, cropping out only in a few places near Ashland.

Major soils in the area developed under tall grass prairie and are of the Sharpsburg-Marshall or Sharpsburg-Shelby groups (Elder, 1969). A localized area of salt flats just northwest of Lincoln contributes salts principally to Little Salt Creek, Oak Creek, and Haines Branch.

Land use is principally agricultural, with cultivated crops including grain sorghum, corn, wheat, and soybeans. Much of the grassland areas are grazed (Table I).

Climate is subhumid continental, characterized by fluctuations of rainfall, temperature, and wind typical of the Great Plains. The average annual precipitation in the basin is approximately 71.1 cm. The normal mean annual temperature is approximately 11.1 C, and the mean frost-free period is 168 to 180 days (Anonymous, 1974).

TABLE I. Land use in the Salt Creek Basin expressed as a percentage of the drainage.*

| Land Use† | Total Hectares | Percent |
|---|---|---|
| Agricultural | 392,036 | 90.8 |
| Urban | 28,008 | 6.5 |
| Forest and Rangeland | 6,848 | 1.6 |
| Water | 3,828 | 0.9 |
| Other | 704 | 0.2 |
| Total | 431,424 | 100.0 |

*Data from remote sensing of the Lower Platte South (1973) and Lower Platte North (1975) Natural Resource Districts land-use inventories. Information was obtained through open file of the Conservation and Survey Division, University of Nebraska.

†"Agricultural" denotes row crop, small grains, pasture, fallow, horticultural, farmsteads, and feedlots.
"Urban" includes residential, commercial, industrial, institutional, transportational, and recreational.
"Water" includes streams, lakes, and reservoirs.
"Other" includes barren land, non-forested wetlands, and uninterpreted area.

Most of the streams can be characterized as small prairie creeks with substantial fluctuations in flow. Many of these creeks exhibit eroded banks. The relatively flat topography, lack of rock outcrops, similarity of soil materials, and intensive land-use practices produce an unusual amount of uniformity in stream environments. Stream bottoms are predominantly silt with areas of current often having a sand or clay substrate. Beaver dams are often found on smaller streams, creating pool habitats. Most streams in this area have undergone some channelization (Bliss and Schainost, 1973). Aquatic macrophytes commonly associated with the streams include species of *Sagittaria, Polygonum, Typha, Lemna, Potamogeton, Najas,* and *Ceratophyllum.* Stream banks support narrow intermittent bands of willows, *Salix* sp.; cottonwoods, *Populus deltoides*; elm, *Ulmus americanus*; ash, *Fraxinus* sp.; mulberry, *Morus rubra*; oak, *Quercus* sp.; and maple, *Acer* sp.

Salt Creek, the major stream draining the study area, originates in the southwestern corner of Lancaster County as the Olive Branch and flows generally northeastward to Ashland, Nebraska, where it enters the Platte River. Overland runoff from precipitation produces the primary source of

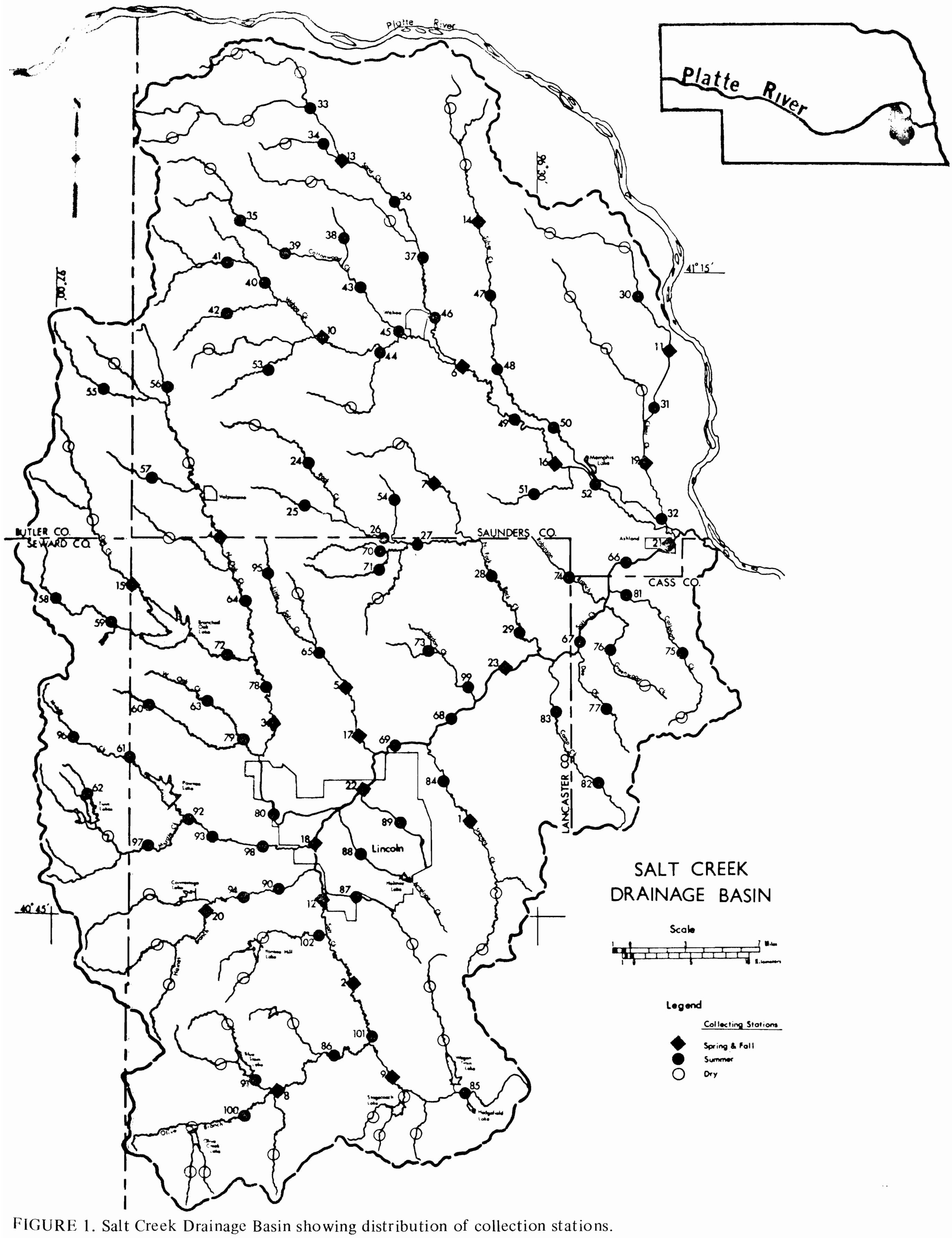


FIGURE 1. Salt Creek Drainage Basin showing distribution of collection stations.

flow. Ground-water aquifers provide the base flows of the stream. Many wastes, both industrial and domestic, enter Salt Creek as it passes through the city of Lincoln. In addition, this creek has been straightened by elimination of selected meanders, from Lincoln to its confluence with the Platte River near Ashland.

Impoundments affect stream flows and the fish fauna of this area. Eleven flood-control reservoirs more than 40 ha in size are situated in the southwestern part of the basin. Numerous small farm ponds are also scattered throughout the region.

## MATERIALS AND METHODS

### Sampling Periods

Field work extended from 11 April through 26 October 1977. One hundred fifty-two sites were selected from county maps at 5 km to 8 km intervals along all tributaries in the drainage. Seasonal changes in fish distributions were described by randomly selecting 15% (23 stations) of the sites, which were visited during the spring (April 11–May 25) and fall (September 12–October 26). Remaining stations were visited once during the summer (June 9–August 23). Stations were systematically assigned numbers based upon dates of sampling, with the exception of those found dry. Figure 1 shows the three categories of collecting stations and their locations in the drainage. Stream name, station number, collection date, legal description, and selected physical characteristics of each collecting site are listed in Table II.

### Sampling Techniques

We attempted to select areas judged representative of the stream. However, unusual habitats such as deep pools under bridges were occasionally included. Generally 61 m (200 ft) of stream were sampled at each site.

Sampling method was determined upon arrival at the site. Collections were made with seines, electrofishing equipment (A.C.), experimental gill-nets, and dip-nets. A combination of techniques was often employed (Table II). All available habitat types within the collection area were sampled.

### Preservation and Identification

Large, easily identified fishes were released at the site of capture after their numbers and total lengths were recorded. Most other specimens were fixed in 10% formalin and taken to the laboratory. Later these specimens were sorted by species, placed in 40% isopropanol, and measured.

Identification aids included Bailey and Allum (1962), Cross (1967), and Pflieger (1975). A representative collec tion of all species was placed in the University of Nebrask State Museum.

### Physical Parameters

A qualitative description of substrate and comment concerning physical or biological alterations was noted Physical data taken at each station included length of section sampled, average width, average depth, and average current velocity.

## ANNOTATED LIST OF SPECIES

A total of 18,560 specimens representing 12 families 22 genera, and 34 species was taken in 125 collections from 102 localities. Scientific and common names used are those adopted by the American Fisheries Society (Bailey *et al.*, 1970). Season of capture (S. = spring, Su. = summer, F. = fall) and corresponding station numbers where the respective species were collected are indicated. Frequencies are percentages of stations within the basin at which that species of fish appeared for each season of sampling.

Catostomidae

*Carpiodes carpio* (Rafinesque), river carpsucker. S. 2, 6, 12, 16, 19, 21, 22, 23; Su. 32, 45, 49, 52, 66, 68, 90, 94; F. 2, 6, 7, 9, 10, 12, 16, 23. This species was the most abundant sucker collected. It was collected at 34.8% of the spring and fall stations, and 10.1% of the summer stations. A lower frequency of 6.4% was recorded for this species by Bliss and Schainost (1973). The greatest number captured at any one site was 70 at station 21. River carpsuckers were taken only in Salt Creek and its major tributaries, and sizes ranged from 72 mm to 485 mm. This species was very susceptible to electrofishing. In many cases, most of the individuals were removed from the stream section sampled. A preference for larger streams with moderate current was apparent.

*Carpiodes cyprinus* (Lesueur), quillback. S. 19, 21, 23; Su. 32, 49, 52; F. 12, 23. This species was collected at 13.0% of the spring stations, 3.8% of the summer stations, and 8.7% of the fall stations. A lower frequency of 3.6% was recorded by Bliss and Schainost (1973). The greatest number collected at any one station was 12 at station 21. It was typical to collect few individuals of this species where it occurred. Specimens ranged from 103 mm to 404 mm. This species was collected only in the larger streams of the drainage, showing a habitat preference similar to that of river carpsuckers. In all cases this species was taken at stations where river carpsuckers also occurred.

TABLE II. Description of collecting stations, 1977.

| Station Name and Number[1] | | Date | Legal Description T | R | Sec | Gear[2] | Length (meters) | Average Width (meters) | Average Depth (meters) | Average Velocity[3] (cm/sec) | Substrate Type[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stevens | 1 | 4/11 | 10N | 8E | 19 | E,B | 76 | 6.38 | 0.59 | N.M. | silt |
| | | 9/12 | 10N | 8E | 19 | E,B | 61 | 6.47 | 0.35 | 7.9 | clay, silt |
| Salt | 2 | 4/12 | 9N | 6E | 36 | E,B | 73 | 7.06 | 0.31 | 14.6 | silt, rock |
| | | 10/3 | 9N | 6E | 36 | E,B | 61 | 7.70 | 0.42 | 18.6 | clay, silt |
| Oak | 3 | 4/18 | 11N | 6E | 20 | E,B | 113 | 3.60 | 0.25 | 26.8 | sand, gravel |
| | | 9/13 | 11N | 6E | 20 | E,B | 61 | 7.19 | 0.19 | 39.3 | sand, gravel |
| N. Br. Oak | 4 | 4/19 | 12N | 5E | 2 | E,B | 76 | 5.94 | 0.77 | N.M. | silt |
| | | 9/16 | 12N | 5E | 2 | E,B | 61 | 5.36 | 0.45 | 28.7 | sand, clay, silt |
| Little Salt | 5 | 4/21 | 11N | 6E | 13 | S,B | 61 | 2.69 | 0.28 | 20.1 | silt, muck, sand |
| | | 9/18 | 11N | 6E | 13 | S,B | 68 | 2.69 | 0.20 | 5.2 | silt, sand, gravel |
| Wahoo | 6 | 4/23 | 14N | 7E | 13 | E,B | 61 | 7.76 | 0.44 | 12.8 | clay, silt, sand |
| | | 9/21 | 14N | 7E | 13 | E,S,B | 61 | 7.55 | 0.61 | 29.6 | clay, silt, sand |
| N. Fk. Rock | 7 | 4/23 | 13N | 7E | 22 | E,B | 61 | 4.61 | 0.69 | N.M. | silt |
| | | 9/20 | 13N | 7E | 22 | E,S,B | 61 | 4.38 | 0.52 | N.M. | silt, clay |
| Salt | 8 | 4/25 | 8N | 6E | 33 | E,B | 61 | 5.50 | 0.17 | N.A. | silt, muck |
| | | 9/19 | 8N | 6E | 33 | E,S,B | 61 | 5.05 | 0.50 | 17.4 | silt, clay |
| Salt | 9 | 4/26 | 8N | 7E | 28 | E,B | 42 | 5.26 | 0.33 | N.M. | silt, clay |
| | | 9/14 | 8N | 7E | 28 | E,B | 61 | 4.85 | 0.43 | 18.9 | clay, silt |
| Wahoo | 10 | 4/28 | 14N | 6E | 10 | E,B | 61 | 8.05 | 0.52 | N.M. | silt, clay |
| | | 9/30 | 14N | 6E | 10 | E,S,B | 43 | – | – | N.A. | clay, silt |
| Clear | 11 | 4/30 | 14N | 9E | 12 | D,S,B | 61 | 6.12 | 0.30 | 10.4 | sand, silt |
| | | 10/2 | 14N | 9E | 12 | E,B | 61 | 6.76 | 0.26 | 7.6 | sand, silt |
| Salt | 12 | 5/3 | 9N | 6E | 11 | E,B | 61 | 7.78 | 0.40 | 18.0 | silt, clay, sand |
| | | 10/5 | 9N | 6E | 11 | S,E,B | 61 | 7.49 | 0.44 | 10.7 | silt, clay |
| Sand | 13 | 5/14 | 16N | 6E | 23 | S,B | 61 | 3.79 | 0.13 | N.M. | sand, clay, silt |
| | | 10/21 | 16N | 6E | 23 | S,E,B | 61 | 4.58 | 0.27 | N.M. | sand, clay, silt |
| Silver | 14 | 5/14 | 15N | 8E | 8 | E,B | 61 | 9.72 | 0.37 | N.M. | silt |
| | | 10/26 | 15N | 8E | 8 | S,E,B | 61 | 12.11 | 0.93 | N.M. | silt, clay |

TABLE II. (Continued).

| Station Name and Number[1] | | Date | Legal Description T | R | Sec | Gear[2] | Length (meters) | Average Width (meters) | Average Depth (meters) | Average Velocity[3] (cm/sec) | Substrate Type[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Oak | 15 | 5/16 | 12N | 5E | 18 | E,B | 61 | 7.28 | 0.67 | N.M. | silt |
| | | 10/14 | 12N | 5E | 18 | S,E,B | 61 | 5.63 | 0.61 | N.M. | silt, clay, sand |
| Wahoo | 16 | 5/16 | 13N | 8E | 12 | E,B | 61 | 9.25 | 0.39 | 38.4 | silt, clay |
| | | 10/13 | 13N | 8E | 12 | E,B | 61 | 9.39 | 0.50 | 35.1 | clay, silt, sand |
| Little Salt | 17 | 5/17 | 11N | 7E | 30 | S,B | 61 | 6.43 | 0.13 | 21.0 | muck, sand |
| | | 10/26 | 11N | 7E. | 30 | S,B | 61 | 4.88 | 0.13 | N.A. | sand, silt, gravel |
| Salt | 18 | 5/18 | 19N | 6E | 27 | S,B | 61 | 8.10 | 0.27 | 21.0 | sand, muck, silt |
| | | 10/15 | 10N | 6E | 27 | S,E,B | 61 | 9.37 | 0.24 | 29.6 | sand, muck, silt |
| Clear | 19 | 5/20 | 13N | 9E | 11 | E,B | 61 | 6.17 | 0.23 | 21.6 | sand, silt |
| | | 10/12 | 13N | 9E | 11 | E,B | 61 | 6.88 | 0.30 | 23.5 | sand, silt |
| Haines Br. | 20 | 5/23 | 9N | 5E | 11 | E,B | 61 | 3.17 | 0.15 | 7.6 | sand, silt |
| | | 10/4 | 9N | 5E | 11 | E,B | 61 | 1.60 | 0.10 | 8.2 | sand, silt, clay |
| Salt | 21 | 5/24 | 12N | 9E | 1 | E | – | 31.39 | 0.80 | 59.7 | sand, silt, rock |
| | | 10/19 | 12N | 9E | 1 | S,E,G | – | – | – | N.A. | sand, rock |
| Salt | 22 | 5/25 | 10N | 7E | 7 | E,G | – | 23.59 | 1.30 | 47.5 | sand, silt |
| | | 10/18 | 10N | 7E | 7 | S,E,G | – | – | – | N.A. | sand, silt |
| Salt | 23 | 5/25 | 11N | 8E | 4 | E,G | – | 24.37 | 0.79 | 29.9 | sand, muck |
| | | 10/20 | 11N | 8E | 4 | S,E,G | – | – | – | N.A. | sand, muck |
| N. Fk. Rock | 24 | 6/9 | 13N | 6E | 10 | E | 61 | 1.39 | 0.14 | N.M. | silt, clay, sand |
| S. Fk. Rock | 25 | 6/9 | 13N | 6E | 28 | E | 61 | 3.53 | 0.27 | N.M. | silt |
| Rock | 26 | 6/9 | 12N | 7E | 5 | E | 61 | 6.48 | 0.54 | N.M. | silt, clay |
| Rock | 27 | 6/9 | 12N | 7E | 4 | E | 61 | 3.53 | 0.27 | 14.9 | clay, silt |
| Rock | 28 | 6/9 | 12N | 8E | 8 | E | 61 | 5.91 | 0.31 | 9.8 | clay, silt |
| Rock | 29 | 6/10 | 12N | 8E | 27 | E | 61 | 5.67 | 0.23 | 12.8 | clay |
| Clear | 30 | 6/10 | 15N | 9E | 34 | none | – | 1.34 | 0.07 | 14.6 | silt, gravel |
| Clear | 31 | 6/10 | 14N | 9E | 35 | E | 61 | 3.72 | 0.17 | 29.0 | sand, silt, gravel |
| Clear | 32 | 6/10 | 13N | 9E | 35 | E | 61 | 6.63 | 0.16 | 38.1 | sand, silt |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sand* | 33 | 6/11 | 16N | 6E | 3 | E | 61 | 1.22 | 0.19 | N.M. | clay, silt |
| *Spring* | 34 | 6/11 | 16N | 6E | 14 | E | 61 | 2.53 | 0.21 | N.M. | silt |
| Cottonwood | 35 | 6/11 | 15N | 5E | 12 | E | 61 | 1.13 | 0.11 | N.M. | silt |
| Sand | 36 | 6/11 | 15N | 7E | 5 | E | 61 | 5.11 | 0.20 | 13.4 | sand, silt |
| Sand | 37 | 6/11 | 15N | 7E | 22 | E | 61 | 3.42 | 0.26 | 29.3 | clay, sand, rock |
| no name | 38 | 6/23 | 15N | 6E | 12 | E | 37 | 2.98 | 1.96 | N.M. | silt |
| Cottonwood | 39 | 6/23 | 15N | 6E | 16 | S | 61 | 1.33 | 0.08 | 4.3 | clay, silt |
| N. Br. Wahoo | 40 | 6/23 | 15N | 6E | 30 | E | 61 | 2.75 | 0.12 | 11.3 | clay, sand |
| N. Fk. Wahoo | 41 | 6/23 | 15N | 5E | 24 | S | 61 | 1.76 | 0.13 | 34.7 | clay, silt, sand |
| no name | 42 | 6/23 | 14N | 5E | 2 | E | 61 | 1.90 | 0.61 | 36.3 | sand, silt, gravel |
| Cottonwood | 43 | 6/27 | 15N | 7E | 30 | E | 61 | 2.15 | 0.14 | N.M. | clay, silt |
| Miller Br. | 44 | 6/27 | 14N | 7E | 17 | E | 61 | 2.23 | 0.23 | N.M. | clay, silt |
| Cottonwood | 45 | 6/27 | 14N | 7E | 4 | E | 61 | 3.77 | 0.37 | N.M. | clay, silt |
| Sand | 46 | 6/27 | 14N | 7E | 3 | E | 61 | 4.30 | 0.25 | 30.2 | sand, gravel, silt |
| Silver | 47 | 6/27 | 15N | 8E | 32 | E | 61 | 3.70 | 0.11 | 18.3 | clay, silt, sand |
| Silver | 48 | 6/29 | 14N | 8E | 21 | E | 61 | 3.56 | 0.12 | 33.2 | sand, clay |
| Wahoo | 49 | 6/29 | 14N | 8E | 34 | E | 61 | 7.59 | 0.44 | 20.4 | silt, sand, clay |
| Silver | 50 | 6/29 | 13N | 8E | 1 | E | 61 | 4.16 | 0.15 | 33.5 | sand |
| Mosquito | 51 | 6/29 | 13N | 8E | 23 | S,D | 61 | 1.21 | 0.06 | N.M. | clay, silt |
| Wahoo | 52 | 6/29 | 13N | 9E | 20 | E | 61 | 9.15 | 0.37 | 25.6 | silt, sand |
| Wahoo | 53 | 7/1 | 14N | 6E | 20 | S | 61 | 2.24 | 0.16 | 11.0 | silt |
| Hobson | 54 | 7/1 | 13N | 7E | 20 | S | 61 | 1.46 | 0.16 | N.M. | clay, silt |
| Middle Oak | 55 | 7/19 | 14N | 4E | 23 | S | 61 | 1.29 | 0.11 | N.M. | silt, sand |
| Hunter's Slough | 56 | 7/19 | 14N | 5E | 20 | S | 61 | 1.79 | 0.12 | N.M. | clay, silt |
| Bates Br. | 57 | 7/19 | 13N | 5E | 17 | E | 61 | 2.50 | 0.18 | N.M. | clay, muck, silt |
| Middle Oak | 58 | 7/19 | 12N | 4E | 20 | S,E | 61 | 3.11 | 0.12 | N.M. | silt, sand |
| Middle Oak | 59 | 7/20 | 12N | 4E | 26 | E | 61 | 4.45 | 0.19 | N.M. | silt |
| Elk Cr. | 60 | 7/20 | 11N | 5E | 18 | S | 38 | 2.27 | 0.18 | N.M. | silt, muck |
| Middle Cr. | 61 | 7/20 | 11N | 4E | 36 | E | 61 | 1.07 | 0.07 | 16.2 | silt, sand |
| no name | 62 | 7/20 | 10N | 4E | 10 | E | 61 | 5.59 | 0.32 | N.M. | muck |
| West Oak | 63 | 7/20 | 11N | 5E | 15 | D | 46 | 0.96 | 0.08 | N.M. | silt |
| N. Oak | 64 | 7/20 | 12N | 6E | 19 | S | 61 | 2.57 | 0.25 | N.M. | silt, sand |
| Little Salt | 65 | 7/20 | 11N | 6E | 3 | S,D | 55 | 0.89 | 0.09 | 16.2 | silt, muck |
| Salt | 66 | 7/22 | 12N | 9E | 9 | E,S | – | 33.41 | 0.42 | 36.0 | sand, silt, muck |

TABLE II. (Continued).

| Station Name and Number[1] | | Date | Legal Description T | R | Sec | Gear[2] | Length (meters) | Average Width (meters) | Average Depth (meters) | Average Velocity[3] (cm/sec) | Substrate Type[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Salt | 67 | 7/22 | 12N | 9E | 31 | E,S | – | 35.05 | 0.22 | 42.1 | sand, silt, muck |
| Salt | 68 | 7/22 | 11N | 7E | 23 | E,S | – | 21.51 | 0.32 | 37.2 | sand, clay, silt |
| Salt | 69 | 7/22 | 11N | 7E | 33 | S | – | 28.50 | 0.24 | 32.3 | sand, clay, silt |
| no name | 70 | 7/26 | 12N | 7E | 5 | S | 61 | 3.48 | 0.20 | N.M. | silt, muck |
| no name | 71 | 7/26 | 12N | 7E | 7 | S | 61 | 1.74 | 0.17 | N.M. | silt, muck |
| Oak Cr. | 72 | 7/26 | 11N | 5E | 1 | E | 61 | 2.47 | 0.18 | N.M. | silt |
| S. Br. Jordan | 73 | 8/1 | 12N | 7E | 34 | S | 19 | 2.90 | 0.19 | N.M. | muck |
| Robinson | 74 | 8/1 | 12N | 8E | 13 | E | 61 | 2.73 | 0.22 | N.M. | silt, clay |
| Callahan | 75 | 8/1 | 11N | 9E | 1 | S,D | 61 | 2.95 | 0.41 | N.M. | clay, silt, sand |
| Greenwood | 76 | 8/1 | 12N | 9E | 33 | S | 43 | 1.48 | 0.14 | N.M. | clay, silt |
| Dee | 77 | 8/1 | 11N | 9E | 20 | E | 61 | 3.18 | 0.40 | N.M. | silt |
| Oak | 78 | 8/2 | 11N | 6E | 17 | E | 61 | 5.78 | 0.15 | 11.0 | sand, silt |
| West Oak | 79 | 8/2 | 11N | 5E | 25 | S | 54 | 2.98 | 0.23 | N.M. | muck, rock |
| Oak | 80 | 8/2 | 10N | 6E | 17 | E,S | 61 | 9.70 | 0.21 | 10.4 | sand, silt, muck |
| Callahan | 81 | 8/3 | 12N | 9E | 15 | S | 34 | 2.36 | 0.15 | N.M. | clay, silt |
| Camp | 82 | 8/3 | 10N | 9E | 8 | E | 61 | 5.39 | 0.31 | N.M. | silt, muck |
| Camp | 83 | 8/3 | 11N | 8E | 24 | E | 61 | 3.97 | 0.13 | N.M. | silt, muck, sand |
| Stevens | 84 | 8/3 | 10N | 7E | 11 | S | 36 | 2.79 | 0.22 | N.M. | silt, muck, sand, rock |
| no name | 85 | 8/4 | 8N | 7E | 36 | S | 68 | 3.33 | 0.24 | N.M. | clay, silt |
| Salt | 86 | 8/4 | 8N | 6E | 23 | E,S | 61 | 7.26 | 0.36 | 8.8 | silt, clay |
| Beal Slough | 87 | 8/8 | 9N | 6E | 12 | S | 72 | 2.19 | 0.28 | N.M. | silt |
| Antelope | 88 | 8/8 | 10N | 7E | 30 | S | 61 | 2.85 | 0.18 | N.M. | sand, silt |
| Deadman's | 89 | 8/8 | 10N | 7E | 21 | S | 12 | 3.28 | 0.37 | N.M. | silt, rock |
| Haines Br. | 90 | 8/8 | 9N | 6E | 5 | E,S | 61 | 6.16 | 0.17 | 24.7 | sand, silt, muck |
| no name | 91 | 8/9 | 8N | 6E | 30 | S | 29 | 3.34 | 0.19 | N.M. | silt, muck |
| Middle | 92 | 8/11 | 10N | 5E | 22 | E,S | 61 | 6.30 | 0.49 | N.M. | silt, sand, clay |
| Middle | 93 | 8/11 | 10N | 5E | 26 | S | 61 | 3.34 | 0.17 | 13.1 | clay, silt |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Haines Br. | 94 | 8/11 | 9N | 5E | 12 | E,S | 61 | 6.06 | 0.46 | N.M. | silt, clay |
| Little Salt | 95 | 8/12 | 12N | 6E | 8 | S | 41 | 3.18 | 0.20 | N.M. | silt, muck |
| Middle | 96 | 8/12 | 11N | 4E | 27 | S | 60 | 1.16 | 0.09 | 25.6 | sand, gravel |
| Middle | 97 | 8/12 | 10N | 5E | 30 | S | 53 | 2.18 | 0.19 | N.M. | muck, silt, clay |
| Middle | 98 | 8/12 | 10N | 6E | 30 | S | 69 | 4.10 | 0.21 | N.A. | sand, gravel |
| Jordan | 99 | 8/16 | 11N | 7E | 12 | S | 61 | 1.52 | 0.10 | N.M. | clay, silt, sand |
| Olive Br. | 100 | 8/16 | 7N | 6E | 6 | S | 62 | 3.12 | 0.31 | N.M. | silt, clay |
| Salt | 101 | 8/23 | 8N | 7E | 17 | E,S | 61 | 7.91 | 0.31 | 26.2 | clay, silt, rock |
| Cardwell | 102 | 8/23 | 9N | 6E | 22 | S | 37 | 6.18 | 0.34 | N.M. | silt, clay |

[1] Station number follows name of station.

[2] E = electro, S = seining, D = dip-net, G = gill-net, B = blocknets

[3] N.M. = not measurable, N.A. = not available

[4] Substrate types in order of importance.

*Moxostoma macrolepidotum macrolepidotum* (Lesueur), shorthead redhorse. S. 21; Su. 52. This species was collected at 4.3% of the spring stations and 1.3% of the summer stations. The occurrence of this species in this basin was not recorded previously. Johnson (1942) and Bliss and Schainost (1973) collected it in the Platte River bordering the Salt Creek Drainage Basin. Its distribution was limited, and it was collected only at the lower ends of Salt and Wahoo creeks. Its occurrence in this drainage can be attributed to ingress from the adjacent Platte River. The size range for the six specimens collected in spring at station 21 was 120 mm to 148 mm, with an average of 137 mm. The specimen taken at station 52 was 270 mm.

Centrarchidae

*Micropterus salmoides* (Lacépède), largemouth bass. Su. 32, 59, 68, 86, 92, 94, 100; F. 2, 9, 12. This species was collected at 8.9% of the summer stations and 13.0% of the fall stations. A lower frequency of 2.7% was recorded by Bliss and Schainost (1973). When this species was found, few individuals were collected. The greatest number collected at any one site was at station 100, where 6 specimens were collected. The overall size of the fish collected was relatively small; most were immatures. Young were first taken on 20 July at station 59. Sizes ranged from 28 mm to 199 mm. This species has been stocked in numerous impoundments throughout the basin. Their small size and close proximity to lakes seem to indicate that most specimens may have been displaced from ponds and lakes due to overflows.

*Lepomis cyanellus* Rafinesque, green sunfish. S. 1, 2, 4, 6, 8-10, 12-14, 16, 19, 22; Su. 24, 26-28, 31, 32, 36, 37, 40, 41, 43-45, 48, 50, 53, 57-61, 64, 66, 67, 71, 72, 74, 75, 77-87, 90, 92-96, 98-102; F. 1-4, 6-12, 14-16, 18, 19, 22. This species was the most abundant and most frequently-collected centrarchid. Green sunfish occurred at 56.5% of the spring stations, 63.3% of the summer, and 73.9% of the fall stations. A lower frequency of 23.6% was reported by Bliss and Schainost (1973). A total of 1296 was collected in this study. The greatest number collected at any one station was 155 from station 1. Most green sunfish were taken from pools such as backwater created by beaver dams. However, this species was found in a variety of habitat types. Green sunfish were often found in stagnant pools where few other species were taken. Lengths ranged from 17 mm to 192 mm for the 1295 specimens measured. One hybrid specimen of *Lepomis cyanellus* X *L. macrochirus* was taken at station 9 during the spring.

*Lepomis macrochirus* Rafinesque, bluegill. S. 1, 9; Su. 32, 58, 100; F. 2, 6, 12, 16, 19. This species was collected at 8.7%, 3.8%, and 21.7% of the spring, summer, and fall stations, respectively. Bliss and Schainost (1973) collected bluegill at 9.1% of their stations. Heavy rains in late summer could explain the higher frequency of fall occurrence. Bluegill are widely stocked throughout the area and probably came from impoundments overflowing into the streams. The bluegill was, in all cases, a minor constituent in the fish fauna. The greatest number captured at any one locality was 16 from station 1. Most of the specimens collected were small (29 mm to 150 mm). This species was taken from all sizes of streams but primarily in pools or areas of little current.

*Pomoxis annularis* Rafinesque, white crappie. S. 1; Su. 100; F. 12, 16. This species was rarely collected, found at 4.3%, 1.3%, and 8.7% of the spring, summer, and fall stations, respectively. With a single exception, only one specimen per station was collected. The greatest number taken came from station 100, where 3 individuals were captured. Sizes ranged from 56 mm to 273 mm. This species probably dispersed from impoundments where it is often stocked in this area. Specimens were collected on only larger streams such as Salt and Wahoo creeks, with the exception of one individual from Stevens Creek. Deep pools were the preferred habitat type.

*Pomoxis nigromaculatus* (Lesueur), black crappie. F. 2, 12. This species was collected at 8.7% of the fall stations. Black crappie were rare except in a few large mainstream pools. Five fish were collected, all taken on Salt Creek, south of Lincoln in Wilderness Park. All fish collected were adults. Sizes ranged from 198 mm to 235 mm. Habitat preference was similar to that of the white crappie.

Clupeidae

*Dorosoma cepedianum* (Lesueur), gizzard shad. S. 21, 23; Su. 69. This species was found at 8.7% and 1.3% of the spring and summer stations, respectively. Bliss and Schainost (1973) reported gizzard shad in 3.6% of their stations. Specimens were taken only from lower portions of Salt Creek. Six individuals were collected. The greatest number collected at any site was 3 from station 21. Sizes ranged from 86 mm to 291 mm.

Cyprinidae

*Cyprinus carpio* Linnaeus, carp. S. 1-4, 6, 7, 9, 10, 12, 14, 16, 19, 21, 22, 23; Su. 26-28, 31, 36, 37, 45, 46, 49, 52, 66-70, 78, 80-83, 86, 90, 94, 101; F. 2, 5-9, 12, 14, 16, 19, 23. This species was widely distributed throughout the drainage. Carp were taken at 65.2%, 30.4%, and 47.8% of the spring, summer, and fall stations, respectively. Bliss and Schainost (1973) collected carp at a lower frequency of 9.1%. There was no apparent preference for a specific habitat. Specimens were collected from all sizes of streams and in both pool and flowing waters. High carp densities were often associated with backwater from beaver dams. The greatest number collected at any site was 52 from station 7. Sizes ranged from

43 mm to 726 mm for the 429 specimens measured. On Camp Creek, station 82, 5 exceptionally-large carp averaging 627 mm were collected. Carp were quite vulnerable to electrofishing. Few specimens were collected on successive runs or captured by blocknets after electrofishing. A mirror carp was collected from each of stations 9 and 81.

*Hybognathus hankinsoni* Hubbs, brassy minnow. S. 11, 19; Su. 32, 69, 81; F. 5, 21. This species was not widely distributed. Specimens were collected at 8.7% of the spring and fall stations, and 3.8% of the summer stations. A higher frequency of 9.1% was reported by Bliss and Schainost (1973). The greatest number collected was 60 from station 81. Sizes ranged from 44 mm to 88 mm. Brassy minnows were most often found in smaller streams, with the exception of two stations on Salt Creek. This species was associated with streams having sandy substrates, clear water, and moderate current. Scale-radii counts given by Pflieger (1975) were unreliable in separating *H. hankinsoni* from the other species of *Hybognathus.* A substantial amount of overlap was apparent, especially with identification of juveniles. Examination of the basioccipital process (an extension of bone at the lower-rear margin of the skull) was made to distinguish this species from *H. nuchalis.* Muscles of the pharyngeal arches were nearly touching at the point of attachment to the basioccipital process, unlike *H. nuchalis.*

*Hybognathus nuchalis* Agassiz, silvery minnow. S. 22; Su. 67, 68; F. 21. This species was not commonly collected, occurring only at 4.3% of the spring and fall stations, and 2.5% of the summer stations. Twenty individuals were collected, with 10 taken from station 68. Sizes ranged from 38 mm to 86 mm. All specimens were taken from Salt Creek. This species was often found in association with the plains minnow, *Hybognathus placitus.* Some difficulty was encountered in distinguishing the silvery minnow from the plains minnow, especially juveniles. External differences employed to distinguish these species were: eye diameter, greater in *H. nuchalis*; distance from tip of snout to back of eye into head width, smaller in *H. nuchalis*; body shape, more rounded in *H. placitus*, especially in adults. Examination of the basioccipital process was necessary because of overlap of external measurements.

*Hybognathus placitus* Girard, plains minnow. S. 2, 6, 18, 22; Su. 67–69; F. 18, 21, 23. This species was collected at 17.4%, 3.8%, and 13.0% of the spring, summer, and fall stations, respectively. It was the most abundant *Hybognathus* species; 284 individuals were collected. Specimens were collected at over one-half of the stations on Salt Creek. Wahoo Creek was the only other stream where this species was captured. The greatest number collected at any site was 198 from station 21. Sizes ranged from 34 mm to 125 mm. This species showed a preference for large streams and sandy substrates. Specimens were most often captured in areas having the greatest current velocity.

*Notemigonus crysoleucas* (Mitchell), golden shiner. S. 9, 22; Su. 85, 86, 91. This species has a limited distribution, occurring at 8.7% and 3.8% of the spring and summer stations, respectively. Bliss and Schainost (1973) rarely collected this species, finding it at only 1.8% of their stations. Recent introductions are assumed to have increased this species' distribution. Occurrence of golden shiners in the streams of the Salt Creek Basin was not documented prior to 1973. The greatest number captured was 11 from station 9. Sizes ranged from 25 mm to 205 mm. In all but one case, this species was collected close to large impoundments, suggesting that dispersion occurred from overflows. Specimens were collected from a variety of habitat types.

*Notropis atherinoides* Rafinesque, emerald shiner. F. 21. Only one occurrence was recorded for this species, and this was 3 individuals taken from Salt Creek at Ashland. Sizes ranged from 42 mm to 51 mm. Bliss and Schainost (1973) collected emerald shiners at only 2.7% of their stations, all on Salt Creek. This species is apparently restricted to the major tributaries of this drainage. Johnson (1942) found emerald shiners only in the eastern portion of the Platte River in Nebraska and its larger tributaries.

*Notropis blennius* (Girard), river shiner. S. 12, 18, 21, 22, 23; Su. 32, 68, 69; F. 21. This species occurred at 21.7%, 3.8%, and 4.3% of the spring, summer, and fall stations, respectively. Bliss and Schainost (1973) failed to collect this species in the drainage. Previous collection of this species was made by Everman and Cox (1896) on Salt Creek in Lancaster County. This species was never abundant, the greatest number taken at any station was 14 at station 32. Sizes ranged from 29 mm to 90 mm. Individuals were all taken from Salt Creek with one exception, station 32, at the lower end of Clear Creek. This species was found in larger streams having sandy substrate. Specimens were most often captured from areas having fast current.

*Notropis dorsalis* (Agassiz), bigmouth shiner. S. 11, 13, 19, 20; Su. 31, 33, 36, 41, 42, 46, 48, 61, 68, 90, 93, 98, 99; F. 11, 13, 18, 19, 20. This species occurred at 17.4%, 17.7%, and 21.7% of the spring, summer, and fall stations, respectively. Bliss and Schainost (1973) collected this species at a higher frequency (31.8%). It was widely distributed, being found on all sizes of streams. Sizes ranged from 28 mm to 71 mm. The greatest number collected at any station was 65 from station 13 during the fall. This species was found in diverse habitats, but was most abundant in small streams with sandy substrate and moderate current.

*Notropis lutrensis* (Baird and Girard), red shiner. S. 2–4, 6, 8, 10, 12-14, 16, 18, 19, 21; Su. 26-29, 31-33, 37, 40, 41, 43-50, 52, 53, 57, 59, 60, 64, 66-69, 77-79, 81-84, 86, 90, 93, 94, 98, 101; F. 1-5, 7-9, 12-14, 16, 18-21, 23. This species was widely distributed, occurring at 56.5%, 51.9%, and 73.9% of the spring, summer, and fall stations, respectively. Similar results were obtained by Bliss and Schainost (1973). Their survey found that red shiners occurred at 70.9% of the stations visited. Red shiners were sometimes found in large numbers. The greatest number collected at any locality was 308 from station 3. Sizes ranged from 22 mm to 80 mm for the 893 specimens measured. This species was not associated with a specific habitat type. However, greatest numbers came from small streams with moderate current and sandy bottoms.

*Notropis stramineus* (Cope), sand shiner. S. 2, 3, 5-8, 11-14, 16, 18-23; Su. 24, 27-29, 31-33, 36, 37, 39-43, 46-50, 52, 53, 55-57, 60, 61, 64-69, 71-74, 76-81, 83, 90, 92-94, 97-99, 101, 102; F. 1, 3-5, 8, 10, 12, 13, 16-23. This species was frequently collected, occurring at 73.9%, 65.8%, and 69.6% of the spring, summer, and fall stations, respectively. Sand shiners were second in abundance only to *Pimephales promelas.* A total of 5813 individuals was collected. Sizes ranged from 16 mm to 80 mm for the 5506 specimens measured. This species often made up a large part of the fish fauna. The greatest number collected at any locality was 1158 at station 18 during the spring collection. Sand shiners were found in all types of streams, but were most abundant in streams with moderate current and sandy bottoms.

*Phenacobius mirabilis* (Girard), suckermouth minnow. S. 19, 21; Su. 31, 101. This species has a limited distribution, being collected at 8.7% of the spring stations, and 2.5% of the summer stations. Suckermouth minnows were also rare in the survey of Bliss and Schainost (1973). They collected them at 0.9% of their stations. Specimens were captured on two streams, Clear and Salt creeks. Twenty-two individuals were collected during this study, 10 at station 21. Sizes ranged from 68 mm to 97 mm. A preference for swift current and sand or gravel substrates apparently limits the distribution of this species in the drainage.

*Pimephales promelas* Rafinesque, fathead minnow. S. 1-8, 10, 11, 13-16, 18-22; Su. 24-28, 31, 33, 34, 36-51, 53-88, 90, 91, 93-99, 101, 102; F. 1-5, 7, 9-20, 22, 23. This was the most-commonly collected species. It occurred at 82.6%, 89.9%, and 87.0% of the spring, summer, and fall stations, respectively. Bliss and Schainost (1973) obtained similar results, collecting this species at 91.8% of their stations. Fathead minnows were also the most abundant species, making up 25.0%, 41.8%, and 29.4% of the total fish collected for the three seasons. A total of 6255 specimens was collected. This species often occurred in large numbers with few or no other species present. The greatest number taken from any locality was 654 from station 20. Sizes ranged from 10 mm to 80 mm for the 5781 specimens measured. Young-of-the-year were first captured on 25 April at station 8. This species was tolerant of many habitat types, but was most often taken from small, muddy streams. Fatheads were often abundant in stagnant pools.

*Semotilus atromaculatus* (Mitchell), creek chub. S. 2, 5, 7, 8, 10, 12, 20; Su. 27, 31, 36, 37, 41, 42, 61, 69, 74-76, 81, 90, 92-94, 96, 99; F. 8, 11, 13, 15, 20. This species was widely distributed, collected at 30.4%, 22.8%, and 21.7% of the spring, summer, and fall stations. Sizes ranged from 22 mm to 237 mm for all specimens. Young were first collected on 20 July at station 61. Creek chubs were never abundantly collected. The greatest number collected at any site was 17 from station 11. Creek chubs were found in all habitats within the drainage, but were abundant only in the clear, small creeks having a current.

## Cyprinodontidae

*Fundulus kansae* Garman, plains killifish. S. 17, 18, 20; Su. 65, 68; F. 5, 17, 18. This species' distribution was limited to Little Salt Creek, Salt Creek, and Haines Branch. Plains killifish were collected at 13.0% of the spring and fall stations and 2.5% of the summer stations. Sizes ranged from 23 mm to 79 mm for the 210 specimens measured. The greatest number collected at any locality was 84 at station 65. Plains killifish were most abundant in clearer, saline streams with sand bottoms. This species was generally found with few other species of fish. It occurred in several habitat types but was most common in vegetated backwaters.

*Fundulus sciadicus* Cope, plains topminnow. S. 11; Su. 31; F. 11. This species was collected only in isolated areas along Clear Creek. It occurred at 4.3% of the spring and fall stations and 1.3% of the summer stations. Bliss and Schainost (1973) also collected this species only on Clear Creek. Seventy-seven specimens were collected, with all but one coming from station 11. Sizes ranged from 23 mm to 65 mm. This species was found in clear, cool water with little current adjacent to submerged vegetation. It was most abundant in backwaters and ditches bordering the stream. Brook sticklebacks were usually found in association with this species.

## Esocidae

*Esox lucius* Linnaeus, northern pike. S. 19. This species was collected at only 4.3% of the spring stations. Two specimens were collected from one station on Clear Creek. Northern pike are apparently scarce in the stream habitats of this area. There is no prior record of them occurring in the streams of this basin. However, stocking of this species is presently practiced on larger impoundments throughout the drainage. The two specimens collected were mature, averaging 474 mm.

Gasterosteidae

*Culaea inconstans* (Kirtland), brook stickleback. S. 11, 19; F. 11. Clear Creek was the only stream from which this species was collected. Brook stickleback were collected at 8.7% and 4.3% of the spring and fall stations, respectively. Bliss and Schainost (1973) found a similar restricted distribution, collecting this species at only one locality on Clear Creek. The greatest number collected at any locality was 486 from station 11. Brook stickleback collected on 2 October at station 11 were predominantly young-of-the-year. Specimens ranged in size from 19 mm to 65 mm. This species has a restricted habitat of cool, clear, flowing water characteristic of the upper reaches of Clear Creek. Because of these habitat requirements, Schainost (1975) recommended it be placed on Nebraska's threatened-species list. It is apparent that brook stickleback are indicative of good-water quality where they occur.

Hiodontidae

*Hiodon alosoides* (Rafinesque), goldeye. S. 21; Su. 49. Goldeye were rarely collected, occurring at 4.3% and 1.3% of the spring and summer stations. Bliss and Schainost (1973) did not collect this species. Jones (1963) reported that Johnson collected goldeye in this drainage in 1942 from Salt Creek in Saunders County. Goldeye were not abundant; the total number of specimens collected was three. All individuals collected were adults, averaging 300 mm. This species was found in Salt and Wahoo creeks, larger streams in the drainage. Its occurrence in this drainage may be explained by movements out of the Platte River into smaller tributaries. All specimens were collected in the middle portions of streams.

Ictaluridae

*Ictalurus melas* (Rafinesque), black bullhead. S. 1, 4, 6-8, 10, 13-15, 21, 23; Su. 26, 33, 43, 45, 47, 57, 59-61, 70-74, 76, 77, 79, 80, 84-86, 94, 96, 102; F. 1-7, 9-11, 14, 15, 22. This species was the most abundant and frequently collected ictalurid, occurring at 47.8%, 30.4%, and 56.5% of the spring, summer, and fall stations, respectively. A lower frequency of 23.6% was found by Bliss and Schainost (1973). Black bullheads were often found in large numbers. The greatest number collected at any locality was 474 from station 43. Young were first collected at this station on 27 June. Sizes ranged from 11 mm to 264 mm. This fish occurred in a variety of habitats, but was most abundant in streams with silt bottom, little current, and with few other species present. This species was often found in isolated pools of intermittent streams where, along with fathead minnows and green sunfish, they made up the major fish fauna. Because of the black bullhead's bottom-dwelling habits, it was not readily susceptible to electrofishing. However, many specimens were often captured by downstream blocknets.

*Ictalurus natalis* (Lesueur), yellow bullhead. S. 6, 8, 9, 19; Su. 31, 37, 46, 75, 76, 81, 83, 90, 93, 100, 101; F. 1, 2, 5, 9, 10, 16, 19. This species was collected at 17.4%, 13.9%, and 30.4% of the spring, summer, and fall stations, respectively. Occurrence of this species in the drainage was not previously documented. Unlike the black bullhead, yellow bullheads were seldom abundant. The greatest number collected at any locality was 16 from station 81. Specimens ranged in size from 34 mm to 234 mm. This fish was usually taken in pools or areas of little current from smaller, less turbid creeks of the drainage.

*Ictalurus punctatus* (Rafinesque), channel catfish. S. 6, 16, 19, 21; Su. 27, 32, 49, 52, 66, 68, 69; F. 1, 2, 6, 12, 16, 18. This species was collected at 17.4%, 8.9%, and 26.1% of the spring, summer, and fall stations, respectively. A lower frequency of occurrence of 4.5% was reported by Bliss and Schainost (1973). This difference could be attributed to the differences in collecting techniques and gear used. Channel catfish were seldom abundantly collected. Seventy-three specimens were collected during the study. The greatest number collected from any site was 25 from station 2. This fall collection was composed only of immatures with an average size of 91 mm. Sizes for all specimens ranged from 25 mm to 449 mm. Adults were taken in Salt, Wahoo, and Clear creeks. Many of the larger fish were taken from pools with submerged brush using electrofishing gear. This species was most common in larger streams of the drainage.

*Noturus flavus* Rafinesque, stonecat. S. 2; Su. 101; F. 2. This species had a limited distribution, being found at only two stations in the upper one-half of Salt Creek. Frequency of occurrence was 4.3% for the spring and fall stations, and 1.3% for the summer stations. Twenty-six specimens were collected. The greatest number collected at any locality was 10 from station 2 during the fall collection. Sizes ranged from 52 mm to 190 mm. Most of the specimens were collected by blocknets. After being stunned by electrofishing, stonecats presumably drifted near the bottom into the downstream blocknet. Stonecats were captured from brush piles and rocky riffles with a moderate to fast current. Johnson (1942) listed madtoms, *Noturus gyrinus*, at one locality on Salt Creek; however, specimens were discarded and identifications cannot be verified.

Lepisosteidae

*Lepisosteus platostomus* Rafinesque, shortnose gar. S. 21, 22, 23; Su. 69. This species was collected only in the middle to lower portions of Salt Creek. The frequency was 13.0% and 1.3% for the spring and summer stations, respectively. Bliss and Schainost (1973) collected this species at 1.8% of their stations. Ten specimens were collected. The greatest number collected from any locality was 4 from station 23. All specimens were adults, ranging in size from 478 mm to 648 mm. This species was usually found in quiet pools and backwaters bordering Salt Creek. Gill-nets set as blocknets were occasionally effective for capturing this fish.

Percichthyidae

*Morone americana* (Gmelin), white perch. S. 2, 21; F. 12. This species was taken only from Salt Creek. It occurred at 8.7% and 4.3% of the spring and fall stations. Bliss and Schainost (1973) reported similar findings, collecting this species only from Salt Creek at 2.7% of their stations. White perch were also taken during a miscellaneous-collecting trip immediately northwest of Roca, Nebraska, while electrofishing approximately 0.4 km of Salt Creek on 7 May. Specimens were collected infrequently along this section of the stream. Twelve specimens were taken, with 7 of these taken on the 7 May miscellaneous collection. All specimens ranged in size from 144 mm to 192 mm and were therefore not young-of-the-year. White perch were collected most often in the deeper stretches of water exhibiting little current. This species was quite susceptible to capture by electrofishing.

Results of this survey suggest that white perch are apparently not reproducing in the streams; all specimens taken were probably remnants of stockings in several reservoirs in the drainage. Although the numbers collected were small, it is important to notice that they are widely distributed along Salt Creek and are in position for easy dispersal to other larger tributaries such as the Platte River.

Sciaenidae

*Aplodinotus grunniens* Rafinesque, freshwater drum. Su. 52. Only one drum was collected from the established stations, yielding a frequency of 1.3%. However, two drums were taken from miscellaneous collections. One was taken from Salt Creek during 19 May in Wilderness Park southeast of Lincoln, and another in Wahoo Creek, approximately 1.6 km southeast of Ithaca, in the fall of 1976. This species was not collected in the drainage by Bliss and Schainost (1973).

The last reported collection of a freshwater drum in this area was by Johnson (1942). He collected drum from Memphis Lake in Saunders County, which is adjacent to station 52. The specimens measured 260 mm and 318 mm. They were collected in deeper pools of the streams. Pflieger (1975) noted that spawning is preceded by movements of adults out of larger rivers into tributary streams. This could account for their occurrence in this drainage.

## DISCUSSION

In relative abundance, members of the minnow family accounted for 78.8% of all fish collected. Ictaluridae and Centrarchidae made up 7.7% and 7.4% of the total, respectively. All other families contributed little to the total number of fish collected. Larimore *et al.* (1952) found that minnows made up 75.3% of all fishes collected on Jordan Creek, Illinois. Starrett (1950) found the fish population of Boone County, Iowa, streams to be composed mainly of minnows. Gerking (1949) and Morris (1960) both used the term "minnow streams" because minnows were the dominant fish present in streams they studied. This term could also be applied to streams of the Salt Creek drainage. Large numbers of minnows suitable for fish bait may be taken from many reaches of the Salt Creek tributaries.

Stations 30, 35, and 89 were not dry, but no fish was collected. Clear Creek, station 30, located immediately south of Yutan, was heavily polluted by domestic sewage from the town. Cottonwood Creek, station 35, was very nearly dry, and only a few small pools were observed at collecting time. Deadman's Run, station 89, located in the city of Lincoln consisted of stagnant pools probably formed from storm runoff.

The greatest number of species from any station was 15, taken in Salt Creek at Ashland, station 21. This relatively high variety of species may be due to its location near the confluence of the North Platte River. Also, it is known that the number of fish species generally increases from the source to the mouth of the stream (Hynes, 1970).

The average number of species was 6.7 for both spring and fall stations, and 4.5 for summer stations. More intensive sampling was done during the spring and fall periods, and this may account in part for these higher values. Another distributional study conducted by Larimore and Smith (1963) found that the average number of species per station in Champaign County, Illinois, streams was 19.0, which is substantially higher than in the Salt Creek Basin.

Spring and fall also yielded similar results in terms of average numbers of individuals per station. The average for the spring stations was 220 and the average for fall was 230 individuals. The summer station average was lower, with only 104 individuals collected per station. The number of individuals per collection varied widely (0-1224) for all collecting dates.

The greatest number of fishes collected came from Salt Creek, station 18. A total of 1224 was collected, but only 6 different species were represented. *N. stramineus* dominated the catch, comprising 1158 individuals.

Instability of water levels in streams of this basin was of primary importance in limiting survival and distribution of the fish fauna. Similar findings have been reported from studies on midwestern streams by Paloumpis (1958), Starrett (1950), Larimore and Smith (1963), and Metcalf (1959). Many of the streams, especially small headwater tributaries, suffered severely from dry weather. Often streams were reduced to a series of disconnected pools with little more than seepage between them. As shown in Table II, many streams exhibited little or no measurable current-velocity.

Survival of fish populations in many streams was possible only because of limited pool habitats that remained. The number of species of fish in many of these pools was small, but the actual number of fish was often high. *P. promelas*, *L. cyanellus*, and *I. melas* were predominantly found in these isolated pools in large numbers. This phenomenon of concentrated numbers of a few species would indicate the presence of limiting factors that allowed only the most tolerant species to survive. Reduction to stagnant pools exposes fish to high temperatures associated with low oxygen and crowded conditions. Metcalf (1959) found that many fishes cannot tolerate such conditions and that only a few hardy species survive. The species that dominated in total numerical abundance are indicative of the precarious conditions that existed in the streams. The five species in order of abundance for all collections were *P. promelas*, *N. stramineus*, *L. cyanellus*, *I. melas*, and *N. lutrensis*. Nearly all of these hardy species are known to be tolerant of drastic fluctuations in water level (Starrett, 1950; Paloumpis, 1958; Hynes, 1970; Pflieger, 1975). *N. stramineus* is perhaps not equally as tolerant of fluctuations in water levels as the other four species. The large number of *N. stramineus* collected is a reflection of its high abundance in larger tributaries.

The ubiquitous distribution and abundance of *P. promelas* in this drainage is an indication of the stream's condition. This species is typically abundant in intermittent streams because of its tolerance for high temperatures, extreme turbidity, and low oxygen (Pflieger, 1975). Often this species comprised the entire fish population on smaller tributaries of this drainage. Fathead minnows are seldom abundant in habitats that support a variety of other fishes due to their intolerance of other species (Starrett, 1950).

As would be expected with extreme variation in stream habitats from season to season, relative abundances of species varied during the study. However, some species showed little change in occurrence despite the great changes that took place in the stream habitats. The predominant species in this drainage are apparently successful in maintaining themselves regardless of the drastic changes which occur in the habitat.

Species that were rarely collected or showed a restricted distribution may maintain their populations in the drainage by movement out of the Platte River which acts as a refugium. Examples would be the shorthead redhorse, drum, and goldeye. Dispersion from surrounding lentic habitats during overflows from previous stockings also contributes to the scattered occurrence of uncommon species found in the streams. The brook stickleback and plains topminnow were exceptions; their occurrence in this drainage is only possible because the specific habitat requirements for survival are available in Clear Creek. Rare species such as these are of special significance since they may serve as sources of fish faunal changes with subsequent environmental change.

Salt, Wahoo, Rock, and Clear creeks are the larger streams of this drainage and provide an adequate water flow and sufficient habitat to support the most diverse fish faunas in this area. Channel catfish, one of the highly-prized game fishes found in these streams, was collected in these four creeks. Young-of-the-year were found in these streams indicating that spawning habitat is available. Large, rough fishes such as carp and river carpsucker were commonly associated with these larger streams and usually comprised most of the fish biomass.

Siltation resulting from human alterations of the landscape is the primary type of pollution occurring in streams of this drainage. Detrimental effects of silt upon small, warm-water fish populations in Iowa were described by Starrett (1951). He found that eggs and young of early spawners were subjected to flooding and siltation, which often resulted in extensive fluctuations in population sizes. Hynes (1970) states that silt affects stream biota by reducing light penetration and blanketing the substrate. The main effect of sediment on adult fishes is reduction of respiratory surface due to clogging of gills. However, there is no apparent direct effect caused by reasonable amounts of silt (Wallen, 1951). Because of low gradients exhibited by most streams in this area, problems of silt pollution are compounded during low flows. Minckley (1959) found that muddy-bottom streams in the Big Blue Basin, Kansas, supported populations composed primarily of fathead minnow, red shiner, creek chub, green sunfish, yellow bullhead, black bullhead, and carp. His findings are similar to the results of this study. All of these species were especially prevalent in most streams of the Salt Creek drainage.

There is some concern about effects of sewage and industrial effluents discharged from the urban area of Lincoln on depletion and migration of fishes in Salt Creek. Bliss and Schainost (1973) concluded that the section of Salt Creek within Lincoln and for some distance downstream is degraded with respect to fish habitats as evidenced by low population diversity when compared to an upstream station and a sampling station located some distance downstream from Lincoln's effluents. Fish populations in the affected areas improved when runoff increased streamflow. The more diverse fish

TABLE III. Comparison of fish species collected from the Salt Creek Drainage by Johnson (1942), Bliss and Schainost (1973) and this study (1977).

| Family | Species | 1942 | 1973 | 1977 |
|---|---|---|---|---|
| Catostomidae | *Carpiodes carpio* | | X* | X |
| | *C. cypinus* | | X | X |
| | *Mosostoma macrolepidotum* | | | X |
| Centrarchidae | *Micropterus salmoides* | X | X | X |
| | *Lepomis cyanellus* | X | X | X |
| | *L. humilis* | X | X | |
| | *L. macrochirus* | X | X | X |
| | *Pomoxis annularis* | | X | X |
| | *P. nigromaculatus* | | X | X |
| Clupeidae | *Dorosoma cepedianum* | X | X | X |
| Cyprinidae | *Cyprinus carpio* | X | X | X |
| | *Hybognathus hankinsoni* | X | X | X |
| | *H. nuchalis* | X | X | X |
| | *H. placitus* | | X | X |
| | *Hybopsis storeriana* | | X | |
| | *Notemigonus crysoleucas* | | X | X |
| | *Notropis atherinoides* | X | X | X |
| | *N. blennius* | | | X |
| | *N. dorsalis* | | X | X |
| | *N. lutrensis* | X | X | X |
| | *N. stramineus* | X | X | X |
| | *Phenacobius mirabilis* | | X | X |
| | *Pimephales promelas* | X | X | X |
| | *Semotilus atromaculatus* | | X | X |
| Cyprinodontidae | *Fundulus kansae* | | X | X |
| | *F. sciadicus* | | X | X |
| Esocidae | *Esox lucius* | | | X |
| Gasterosteidae | *Culaea inconstans* | | X | X |
| Hiodontidae | *Hiodon alosoides* | X | | X |
| Ictaluridae | *Ictalurus melas* | X | X | X |
| | *I. natalis* | | | X |
| | *I. punctatus* | | X | X |
| | *Noturus flavus* | | X | X |
| | *N. gyrinus* | X | | |
| Lepisosteidae | *Lepisosteus osseus* | | X | |
| | *L. platostomus* | | X | X |
| Percichthyidae | *Morone americana* | | X | X |
| Sciannidae | *Aplodinotus grunniens* | X | | X |
| | Number of Species | 16 | 31 | 34 |

*X = Collected

populations occur during this time, presumably due to ingress migrations from both upstream and downstream locations which support more diverse and abundant fish populations (Anonymous, 1973).

Examination of the number of species collected during this study from stations located along the length of Salt Creek can serve as an indicator of the degree of pollution and the limitations imposed on fish distribution occurring on this stream. Katz and Gaufin (1952) and Tsai (1968) both evaluated sewage effluents by the number of fish species present.

The most diverse fish fauna above Lincoln was at station 12, where 13 species were taken. This number of species is a reflection of a rather unaltered stretch of stream located in Wilderness Park. The greatest number of species (15) downstream from Lincoln was at station 21, the farthest downstream station on Salt Creek. There were 10 and 4 species collected for spring and fall, respectively, at station 22, immediately below the sewage discharge at Lincoln.

The effects of effluents from Lincoln are apparently not severe enough to eliminate fish life in Salt Creek, even during abnormally low-water levels which occurred during this study. However, there is evidence to indicate reduction in the number of species and their abundance. The fish fauna immediately below Lincoln was composed primarily of large, rough fishes such as carp, shortnose gar, and river carpsuckers. Few cyprinids were collected, unlike the sample sites above and some distance downstream from Lincoln. Fish fauna improved in a downstream progression from Lincoln both in terms of numbers and variety. Fish populations on Salt Creek are generally quite variable. This high variability in fish populations makes evaluations difficult without intensive sampling at frequent time intervals throughout the year. Differences in numbers of species taken at different times at the collecting stations is presumably due to both the migratory habits of the fish and the failure to capture all species present.

Unfortunately, early collectors reported little information from the Salt Creek Basin. Thus, faunal changes that may have occurred prior to Johnson's (1942) study are impossible to evaluate. From 13 collecting localities in the drainage, Johnson collected 16 species. Two species, the tadpole madtom *Noturus gyrinus* (Mitchell), and orangespotted sunfish *Lepomis humilis* (Girard) were not taken during this study. Faunal changes following Johnson's work have probably been slight even though our list of species collected is considerably longer than his. This probably reflects Johnson's effort in surveying fishes of the entire state rather than concentrating on a single basin.

More recent data compiled by Bliss and Schainost (1973) from a survey of 110 localities in the basin found three species that were not taken during this study: longnose gar, *L. osseus* (Linnaeus), orangespotted sunfish, *L. humilis*, and silver chub, *Hybopsis storeriana* (Kirtland). Six species not reported by that survey were collected in this 1977 resurvey: *M. macrolepidotum, N. blennius, I. natalis, E. lucius, H. alosoides,* and *A. grunniens.* A complete species list of the two previous surveys is compared with this study in Table III.

Although Bliss and Schainost (1973) added valuable information to our knowledge of stream fishes of Salt Creek Basin, the effectiveness of their collection gear (seines), limited the thoroughness of their study. Also, results were reported only qualitatively as species names and collection locality. Other limitations of their collections are that few environmental parameters were measured and no reference specimen was retained in a museum.

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