Spring River Management Plan

PART I

FIELD SURVEY

Draft

No Report - Only a Draft

CHAPTER I

INTRODUCTION

Spring River, and its tributary Shoal Creek, exist in an extremely unique area to Kansas. Both streams traverse part of the Ozark Plateau physiographic province, an extension of the Missouri Ozarks. There are only 50 square miles of the plateau in the extreme southeast corner (Cherokee County) of the state (Baughman 1979). As a result, this area offers a contrasting environment to the rest of Kansas and is an area which is irreplaceable. "Priority status" for protection and preservation has been given to the Schermerhorn Park/Shoal Creek area by the U.S. Fish & Wildlife Service (undated) due to its exceptional fauna and Spring River has been designated a "Highest-valued" fisheries resource by the Kansas Fish & Game Commission (Moss and Brunson 1981).

Shoal Creek supports over 80 fish species which ranks it at the top of all Kansas streams in that category (Cross 19 ). It is also noted for its excellent black bass fishery. This broad range of fish species is matched by the diversity of reptiles and and amphibians and plants in the area (Baughman 1979). Two caves in Schermerhorn Park support three Kansas endangered species of amphibians: the cave salamander (Eurycea lucifuga), the grotto salamander (Typhlotriton spelaeus), and the graybelly salamander (Eurycea multiplicata griseogaster). All totalled, the Spring River area provides the critical habitat for eight of Kansas' threatened and endangered species. Besides the three afore mentioned salamanders, the warty-backed mussel (Quadrula nodulata), the Neosho madtom (Noturus placidus), the Arkansas darter (Etheostoma cragini), the central newt (Notophthalmus viridescens louisianensis), and the Northern crayfish frog (Rana areolata circulosa) are included on the Kansas threatened and endangered list and found in the Spring River/Shoal Creek area.

A past attempt by the federal government to obtain limited access to the area met with failure due to opposition from riparian landowners. No acceptable management plan has been implemented for the protection and maintenance of the area. This study was undertaken to identify the extent to which critical habitat has diminished and set up measures to protect such habitat from further disturbance in the Spring River area in Kansas. The objectives of this study were threefold:

(1) Determine the relative abundance and distribution of the aquatic macrofauna of the Spring River drainage in Kansas placing emphasis on assessing the quality of critical habitat and its availability to threatened and endangered species.

(2) Evaluate the significance of present land use practices on faunal composition and distribution by comparison of aerial photographs and identify those issues with probable adverse effects.

(3) Develop a management program acceptable to riparian landowners and local authorities for the maintenance and enhancement of nongame species and to improve the status of

threatened and endangered species found in the Spring River drainage basin.

# CHAPTER II

# BACKGROUND

## Study Area

Spring River. Spring River is the most important tributary in the Neosho system (Branson 1966) with a watershed composed of lands occupied by Missouri, Kansas, and Oklahoma. It arises from numerous springs near Aurora, Lawrence County, Missouri, and flows southwesterly across successively older geological formations--Pennsylvanian, Permian, Cretaceous--to its confluence with the Neosho River about six miles north of Wyandotte, Ottawa County, Oklahoma (Branson 1966). Drainage is primarily from the Springfield Plateau region of the Ozark Highlands (Sauer 1920, Moss 1983). Of the 2150 square miles drained by Spring River, only 500 square miles are located in Kansas (KDHE 1978). There is a total channel length of 21.0 miles for the Kansas segment of Spring River with the average width being 25.0 feet and an average depth of 4.0 feet. Stream elevation declines from 1542 feet mean sea level at the headwaters to about 780 feet at the mouth (Branson 1966). The channel, much-braided in the uplands but well-defined and stable in the lower reaches (Branson 1966) flows through mainly deciduous forests and gently sloping plains covered with fertile soils (Collier 1955). Substrate is very diverse with particle size ranging from rocks to sand and silt (KDHE 1978, Branson 1966). Springfield and Joplin, Missouri, are the two major population centers in the drainage. Outside of these municipalities, agriculture accounts for most of the land use (Collier 1955).

Shoal Creek. There are 159.2 miles of tributary streams of Spring River in Kansas and they average 23.9 feet in width and 1.6 feet deep (KDHE 1978). The two most important tributaries, as noted by Branson (1966), are Cow Creek and Shoal Creek. Shoal Creek has 7.0 miles of channel in Kansas and averages 90.7 feet across and 3.0 feet deep (KDHE 1978). As Branson (1966) describes, it heads near Exeter, Barry County, Missouri, and meets after 76 miles with the Spring River in Cherokee County, Kansas. The elevation declines from 1540 feet mean sea level at the headwaters to 780 feet at its confluence. The main channel is often braided and consists alternately of riffles and pools. The bottom is mostly chert rubble, although there are long stretches of bedrock. The three principal tributaries of Shoal Creek are Clear, Hickory, and Turkey Creeks (Branson 1966).

## Water Uses and Wastewater Sources

In the Spring River Basin, industry is a major wastewater contributor (USWRC 1978). Industry in the Joplin-Carthage area has the most effect on the water quality of the Spring River Basin and sewage and industrial effluents from Carthage pollute the lower Spring River for approximately 15 miles (USWRC 1978). Branson (1966) reported that Cow Creek was heavily polluted with raw sewage, improperly treated wastes, and strip-mine effluence. The polluted conditions in Center Creek (a tributary of Spring River) extended from the mouth of Grove Creek to Spring River at the Missouri-Kansas border. Much of the pollution results from heavy metals, especially zinc, discharged from abandoned mines in the Joplin area (Diffenbach & Ryck 1976). Problems of pollution of both surface and ground water have persisted for many decades in the mined areas around Joplin (USWRC 1978). In an assessment of the aquatic environment in Kanasas, the Kansas Department of Health and Environment (1978) determined the limiting factors to wildlifeand wildlife habitats along Spring River to be agricultural runoff, sedimentation, and algal and aquatic weed growth. For tributary streams (excepting Shoal Creek) these factors proved to be agricultural runoff, acid-mine drainage, and treated urban wastewater effluent.

Much of the stream flow of Shoal Creek is spring water and the creek is utilized as a municipal water supply by both Neosho and Joplin (Dieffenbach & Ryck 1976). Neel (1961) and Branson (1966) reported Shoal Creek to be relatively unpolluted even though both Joplin and Neosho dispose of sewage in the main channel. Branson (1966) indicated that several major tributaries of Shoal Creek were polluted especially Turkey Creek which was found to be grossly polluted. Dieffenbach & Ryck (1976) reiterated this finding and reported Turkey Creek to be grossly polluted for six miles by sewage effluent from Joplin. The Kansas Department of Health and Environment (1978) determined the limiting factors for Shoal Creek to be mined land drainage, industrial wastewater effluent and urban runoff.

Several sites south of Joplin have been considered on Shoal Creek for the construction of a reservoir to meet the needs of an increasing population and industrial center (USWRC 1978). The

Corp of Engineers has already been authorized to preform a preliminary study of the area. Further possible threats of destruction have been identified in a "Concept Plan" prepard by the U.S. Fish & Wildlife Service for Kansas (undated) and it lists housing developments, the construction of a marina on Shoal Creek and pollution from a recently completed sewage disposal site for the city of Joplin as such threats. The proposed re-establishment of the Empire District Electric Company's hydropower plant located in Lowell, Kansas, may also be considered a possible threat.

<u>Endemic and Endangered Species</u>

<u>Macroinvertebrates</u>. In 1979, the first listing of threatened and endangered macroinvertebrate species for Kansas was provided by the Kansas Fish & Game Commission. <u>Quadrula nodulata</u> appeared on this list. The U.S. Fish & Wildlife Service (undated) stated that Cherokee County, Kansas, provided the critical habitat for this species. Distler (1976) recommended that 46 invertebrate species be placed on the original list of threatened and endangered species in Kansas. Of those 46, seven are found in the Spring River/Shoal Creek area and an additional 10 species of terrestrial gastropoda are found in the Ozarkian faunal region of southeastern Kansas on the forest floor, under rocks, etc.

<u>Fish</u>. Moss (1983) found 40 species to be present from his study of riffles in the Neosho River system. Branson et al. (1969) inventoried the fishes of the Spring River drainage in Kansas in their 1963 study and found the fishes represented 14 families, 34

genera, and 88 species. Most records of previous ichthyological investigations in the areea have been presented piecemeal without exact locality data. Cross (1954) recorded Dionda nubila, Notropis boops, and Notropis spilopterus for a Kansas station on Shoal Creek. Cross (loc. cit.) also recorded Notropis boops, N. buchanani, N. spilopterus, and Etheostoma flabellare from three Kansas sites on Spring River. Minckley's & Deacon's (1959) map shows Spring River localities in extreme southeastern Kansas for Pylodictis. Branson (1963) reported 34 specimens of Fundulus sciadicus and nine of Etheostoma microperca from a Kansas site on Shoal Creek and one specimen of Notropis galacturus from Spring River at Baxter Springs. It is thought by Cross (1967) that this latter species resulted from bait import.

A rare and endangered species list was compiled by Cross (1973) for the fishes of Kansas. Of those species found in Spring River and Shoal Creek, Cross listed Noturus placidus as endangered; Hybopsis x-punctata, Nocomis asper, Moxostoma carinatum, Hypentelium nigricans, and Etheostoma blennioidesas endangered in Kansas but not nationally; Noturus miurus and Etheostoma chlorosomum as rare in Kansas but not nationally; and 13 other species as having peripheral populations in Kansas.

Wenke, Hartman, and Klaassen (pers. comm. 1976) submitted a list of fishes to be considered endangered or threatened in Kansas to the Endangered Species Steering Committee. They listed 10 species as endangerd and 24 as threatened. Five of the endangered and 16 of the threatened were from the Spring River/Shoal Creek area. The official listing was cut to only three threatened and three endangered species and Spring River in Cherokee County provides the critical habitat for two of the endangered species: *Etheostoma cragini* and *Noturus placidus* (USFWS undated).

Moss (1981a) compiled life history data for *Noturus placidus* and noted that it has been captured from three localities in the Spring River mainstream. Nine specimens all totalled have been captured including a collection 0.9 km east of the Missouri-Kansas state boundary. The habitats described in Spring River for *placidus* parallels those of the Illinois River where *placidus* has also been found. Moss comments that there are similarities between Spring River and the Illinois River in physiographic drainage, stream size, water quality, and temperatures. Life history information about *Etheostoma cragini* has also been compiled by Moss (1981b). He has captured this darter in Spring River in Cherokee County.

*Herpetofauna*. The first list of threatened and endangered amphibians and reptiles for Kansas was composed by Ashton and Collins (1973) for the Kansas Academy of Sciences. Many of the species on the list were found in the Spring River/Shoal Creek area. Listed was *Typhlotriton spelaeus* as a rare species; *Eurycea longicauda*, *E. lucifuga*, and *E. multiplicata* as endangered in Kansas but not nationally; *Rana areolata* as rare in Kansas but not nationally; and six species which are peripheral to Kansas. A report of the Kansas Herpetological Society (1978) strongly suggested the inclusion of eight additional amphibians and reptiles on the list and of those eight, Spring River provided the critical habitat for *Hyla crucifer*, *Gastrophyrne carolinensis*, *Rana palustris*, and *Rana clamitans melanola*. The official list has not changed since 1976 and it stands at six endangered and two threatened species. The Spring River area provides the habitat for four of the endangered species: *Notophthalmus viridescens*, *Eurycea lucifuga*, *E. multiplicata*, and *Typhlotriton spelaeus* and one threatened species--*Rana areolata* (Collins et al. 1981).

# CHAPTER III

# MATERIALS AND METHODS

## Survey

Field investigations were conducted in March-May and September-October of 1983 and September-October of 1984. Faunal collections included aquatic macroinvertebrates, fish, amphibians, and aquatic reptiles. To characterize communities associated with specific habitats, faunal collections were segregated by habitat type. The major habitat types considered were defined as follows (from Huggins 1981):

Riffle--------- characterized by swift, turbulent water and uneven bottom substrates, typically gravel or rubble.

Run------------ areas of normal, shallow water with consistent, unbroken flow and a fairly even or stable bottom.

Pool----------- reaches where unusually deep water is located, with depth differing drastically and abruptly from adjacent areas.

Backwater------ pockets of the main channel.

Seventeen sampling stations along the Kansas seg ments of Shoal Creek and Spring River were originally chosen for study, however, due to circumstances beyond this researcher's control, only twelve stations were sampled (Fig. 1). Five of these sites corresponded to sites previous ly used by Branson (1966) in his survey of the Spring River Basin.

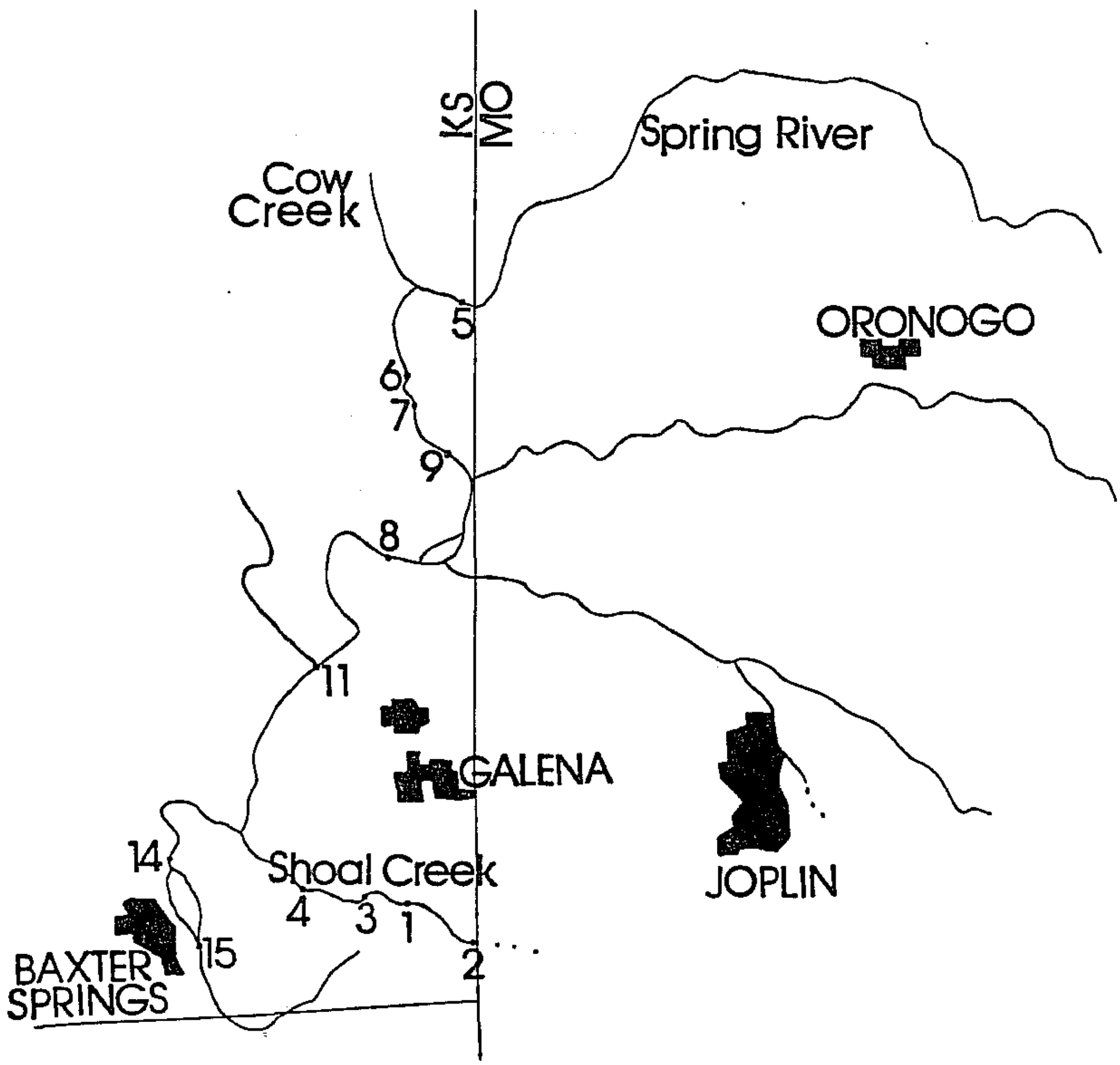


Figure 1. Twelve sampling stations along Spring River and Shoal Creek, Kansas.

## Study Sites

Shoal Creek.

Station 1. T34S,R25E,S35. Located at Schermerhorn Park 2 1/4 miles south of Galena, KS. Banks with no slope to a steep slope of mud and gravel; abundant periphyton; few aquatic macrophytes; four habitat-types present; sparse hardwoods and willows; riparian land used as a city park. Small spring-fed tributary enters here; natural cave present at the spring source.

Station 2. T34S,R34W,S36. Located at Lloyd Schaffer residence adjacent to the MO-KS border.Steep mud and rock bank to even sloped, grassy yard; limited aquatic macrophytes; sparse canopy cover; four habitat-types present; hardwoods and grasses dominate riparian vegetation; riparian land used as pasture and private yard.

Station 3. T34S,R25E,S34. Located at William Powell residence, Horseshoe Bend. East bank with steep rock outcrop, west bank with an even slope of mud and gravel; abundant periphyton; limited aquatic macrophytes; four habitat-types present; canopy cover extensive; abundant hardwoods and grasses dominate riparian vegetation; riparian land undisturbed.

Station 4. T34S,R25E,S33. Located above Empire dam. Even sloped banks bordered by hardwoods and grasses; algae abundant in backwater, macrophytes limited in other areas; extensive canopy cover in backwater; pool and backwater habitats only; riparian land used as pasture (with cattle access to river) and residential, several boat docks present.

Spring River.

Station 5. T33S,R25E,S1. Located at Herschel York residence adjacent to the MO-KS border. Steep mud and gravel banks; little aquatic vegetation; abundant canopy cover; hardwoods and grasses dominate riparian vegetation; four habitat-types present; riparian land used for private residence. Small spring-fed tributary enters here.

Station 6. T33S,R25E,S11. Located above and below Highway 96 bridge. Steep mud banks; moderate aquatic macrophytes; good canopy cover; four habitat-types present; abundant hardwoods and grasses as riparian vegetation; riparian land is highway right-of-way; access from highway to water on both sides of the bridge. Numerous gravel shoals present.

Station 7. T34S,R25E,S3. Located immediately below FAS 1367 bridge. Even sloped banks; limited aquatic macrophytes; minimal canopy cover and sparse hardwoods and grasses along banks; pool and backwater habitats only; riparian land is highway right of way and residential areas. Access to river from highway.

Station 8. T33S,R25E,SE1/4,SE1/4,SE1/4 S27. Located at an old mill race. Steep slopes with an eroding mud bank on west bank,east bank a gravel bar; good canopy cover on east bank; little canopy cover or vegetation on west bank; four habitat-types present; riparian land used as pasture on the west and undisturbed on the east.

Station 9. T33S,R25E,S14. Located approximately 3 mi downstream from Highway 96 bridge. Steep mud banks with thick vegetation; limited aquatic macrophytes; good canopy cover; four habitat-types present; riparian land is undisturbed on the east and used as pasture on the west.

Station 11. T34S,R25E,S11. Located at the confluence of Shawnee Creek. Shallow sloped banks;little aquatic macrophytes; little canopy cover; pool and backwater habitats only; riparian land used as a fishing camp; many pontoon fishing cabins and boat docks.

Station 14. T34S,R24E,S36. Located above confluence with Willow Creek. Steep mud banks; limited aquatic macrophytes; Hydrodiction algae in abundance; little canopy cover; four habitat-types present; riparian land use on the west is the city of Baxter Springs water intake and on the east is pasture.

Station 15. T35S,R25E,S6. Located below the dam at Baxter Springs, KS. Gentle sloped banks of gravel; little canopy cover; aquatic macrophytes abundant; periphyton abundant in riffles; four habitat-types present; riparian land used for city park and camp facilities.

## Physical Parameters

Depth and velocity were measured at one meter intervals along a random transect. Velocity was measured using a MeBflugel current meter and the 0.6 depth method (Felter 1980). Stream discharge (q),for a segment of width,w, with a velocity of v was given by:

$$q_i = v_i d_i w_i$$

The total discharge,Q, was the sum of the discharge for each

The Ecology of Running Waters, H.B. Hynes. 1972 Univ. of Toronto Press 555pp.

segment:

$$Q=\sum_{i=1}^{m} q_i$$

Substrate underlying each transect was described subjectively according to the following classes (from Hynes 19??) 72: bedrock, cobble, gravel, sand and silt.

## Chemical Parameters

Water samples for chemical analysis were secured from run areas using an Alpha water sampler. Water quality was determined in the field using a HACH DREL (HACH Chemical Co., Ames, Iowa). Chemical parameters assessed included dissolved oxygen, turbidity, alkalinity, hardness, and pH. Temperature was recorded using an electric thermistor thermometer.

## Macroinvertebrates

Field Collection. Benthic macroinvertebrates were collected using a Surber sampler (1 ft ) in areas of riffles and runs or an Ekman grab sampler in areas of pools and backwater then washed through a U.S. Standard No. 30 seive. From the seive, the sample was placed on a white porcelain tray and all organisms were sorted and picked in the field then placed in a 60% ethanol-40% formalin solution. For long term storage, the samples were transferred to 70% ethyl alcohol with 1% glycerin. Two to three random samples at each habitat type were collected totalling 105 samples for the 12 stations and 2 re-samples. Stations 1 and 6 were re-sampled in September and October of 1983 to determine if a significant difference in macroinvertebrate faunal composition occurred between spring and fall samplings. It was determined using the Student's T-test that no significant difference could be found, therefore, all data was compared regardless of season.

Identification. Flatworms (Platyhelminthes), segmented worms (Annelids), and roundworms (Nematoda) were identified to order of family and all other benthic macroinvertebrates were identified to family or genus. Lack of time and the scope of this project did not allow for the identification of individuals to the species level. Freshwater Invertebrates of the U.S.(Pennak 1953) and Guide to the Freshwater Invertebrates of the Midwest (State Bio. Survey of Kansas 1981) were the major references used for identification.

Diversity. Benthic community diversity index values for the samples were calculated using two different indexes to eliminate possible misinterpretation of data that might result from the use of just one diversity index. The Margalef index and Shannon-Weaver index were chosen as appropriate indexes because of their extensive use by others on Ozark streams (Ryck 1974; Dieffenbach & Ryck 1976; Wilhm & Dorris 1968).

The Margalef index was calculated using the formula:

$$d= \frac{s-1}{\ln N}$$

where s= the number of types of organisms and N= the total number. This index is highly correlated with both the number of types of organisms and the total number of organisms in the sample. Dieffenbach & Ryck (1976) reported that the Margalef index provides an excellent all-round measure of water quality in Ozark streams. This index, however, has limited usefulness in areas that are polluted by toxic wastes.

The Shannon-Weaver index was calculated using the formula:

$$H = -\sum \frac{n_i}{n} \ln \frac{n_i}{n}$$

where n is the number of organisms in the sample and $n_i$ is the number of individuals of each type. This index weighs the manner in which the number of organisms in the sample are distributed between types. It is a good general index to water quality but it does not adequately identify samples taken from moderately polluted waters. This index does, however, provide a better measure of water quality in streams polluted by toxic wastes than Margalef's index (Weber 1973).

Although the Biotic Index has been used successfully by Jones et al. (1981) to assess water quality in Missouri Ozark streams, this index was not used in this study due to the inability to assign pollution-tolerance values to the macroinvertebrates. Pollution-tolerance values in the literature (Jones et al. 1981; Hilsenhoff 1977) were usually species-specific with very few values applying to an entire genera.

Ryck (1974) found that the number of types of pollution-sensitive Ephemeroptera and Plecoptera from a station provided a qualitative check on water quality. This method was also used in this study.

Coefficients of similarity, described by Burlington (1962), were calculated to determine quantitatively what degree of relationship existed between all stations. A "prominence value" for each family or other taxonomic group present at a station was obtained by multiplying the density of the group at the station by the square root of the frequency of the group at all stations. Using the prominence value, the coefficients of similarity between stations was calculated as follows:

$$C= \frac{2(\Sigma P_l)}{\Sigma P_i + \Sigma P_j}$$

where $\Sigma P_i$ was the sum of the prominence values of all families at station i, $\Sigma P_j$ was the sum at station j, and $\Sigma P_l$ was the sum of the lower of the two prominence values that the two stations had in common for each group.

## Fish

Field Collection. Fish specimens were secured using a 120V D.C. boat-mounted electroshocking unit during two 15-minute intervals and by seining with a 20' 1/4" mesh seine and a 1/8" mesh habitat seine in all habitat types. Individuals were preserved in formalin for 48 hours, rinsed for 48 hours, then placed in 70% ethanol for long-term storage. Fish were identified to species level using Fishes of Missouri (Pflieger 1975) as the main reference. Station 11 was not sampled by electroshocking due to equipment malfunction.

Biotic Integrity. Biotic integrity was determined using the methodology outlined by Karr (1981). Twelve criteria were considered and graded as minus (-), zero (0), or plus (+) then later assigned these values: (-)=1, (0)= 3, and (+)= 5. The criteria examined were: species (total), individuals (total), darter species, sunfish species, sucker species, intolerant species, proportion of omnivores, insectivorous cyprinids, green sunfish, top carnivores, hybrids, and diseased fish. The values were summed over all criteria for each site to provide an index of community quality. The boundaries suggested by Karr (1981) for the classes were followed (Table I).

TABLE I

EVALUATION OF 12 COMPONENTS OF THE BIOTIC INTEGRITY INDEX

| Grd | Pt | Sp | Ind | Dart | Sun | Suc | Intol | %Omn | %Cyp | %GS | %Carn | %Hyb | %Dis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| + | 5 | >20 | >200 | >5 | >4 | >4 | >4 | <20 | >45 | <1 | >10 | 0 | 0 |
| 0 | 3 | 10-20 | 100-200 | 1-4 | 1-3 | 1-3 | 1-3 | 20-45 | 20-45 | 1-5 | 1-10 | 1-5 | 1-5 |
| - | 1 | 0-9 | <100 | 0 | 0 | 0 | 0 | >45 | <20 | >5 | 0 | >5 | >5 |

## Herpetofauna

Amphibians and aquatic reptiles were noted whenever encountered, particularly during seining efforts. A special effort to located threatened and endangered amphibians was put forth at the cave at Schermerhorn Park (Station 1).

# CHAPTER IV

# RESULTS

## Physical and Chemical Parameters

The results of the chemical and physical parameters are summarized in Tables II and III.

TABLE II

FLOW DATA FOR TWELVE STATIONS, SPRING RIVER AND SHOAL CREEK, KANSAS.

| Station | Ave. Velocity (m/s) | Discharge (m3/s) |
|---|---|---|
| 1 | .30 | 7.66 |
| 2 | .48 | 2.12 |
| 3 | .67 | 5.32 |
| 4 | --- | ---- |
| 5 | .49 | 4.59 |
| 6 | .82 | 3.88 |
| 7 | --- | ---- |
| 8 | .33 | 11.22 |
| 9 | .67 | 13.15 |
| 11 | --- | ---- |
| 14 | .27 | 7.66 |
| 15 | .30 | 6.68 |

TABLE III

CHEMICAL CHARACTERISTICS OF SPRING RIVER AND SHOAL CREEK, KANSAS. READINGS IN PPM

| Sta | Date | Temp( C) Air | Temp( C) Water | Turbidity (JTU*) | D.O. | Hardness | Total Alkalinity | pH |
|---|---|---|---|---|---|---|---|---|
| 1 | 3/83 | 15 | 14 | 10 | 16 | 145 | 110 | 6.8 |
| 2 | 3/83 | 18 | 8 | 8 | 19 | 130 | 150 | 6.8 |
| 3 | 3/83 | 17 | 10 | 9 | 13 | 140 | 150 | 6.6 |
| 4 | 3/83 | 21 | 21 | 6 | 15 | 150 | 110 | 6.6 |
| 5 | 3/83 | 11 | 11 | 8 | 14 | 160 | 120 | 6.6 |
| 6 | 3/83 | 15 | 11 | 8 | 15 | 200 | 140 | 6.8 |
| 7 | 3/83 | 9 | 14 | 11 | 14 | 250 | 110 | 6.6 |
| 8 | 3/83 | 9 | 14 | 11 | 14 | 210 | 130 | 6.7 |
| 9 | 4/83 | 21 | 12 | 25 | 14 | 190 | 140 | 6.6 |
| 11 | 9/84 | 25 | 22 | 8 | 11 | 170 | 140 | 7.2 |
| 14 | 10/84 | 19 | 24 | 0 | 6 | --- | 120 | 6.4 |
| 15 | 10/83 | 19 | 17 | 1.5 | 10 | 180 | 150 | 6.6 |

*Jackson Turbidity Units

## Macroinvertebrates

A total of 3089 macroinvertebrates representing 24 orders and 84 families were collected from the 12 stations (including the 2 resamples). The numbers collected at any one station ranged from 36 as the fewest to 555 as the most. Insect larvae were the dominant bottom-dwelling macroinvertebrates with Diptera, Ephemeroptera, and Trichoptera respectively, being the most common orders collected (Appendix A). These orders represented 74% of the total number. Chironomidae was the dominant family of Diptera collected comprising 86% of the total number of dipterans. Heptageniidae was the most frequently encountered family of Ephemeroptera comprising 45% of the total number of ephemeropterans collected and Hydropsychidae proved to be the most numerous of the Trichoptera with 80% of the trichopterans being members of this family.

Margalef Index. The Margalef index yielded values for the 12 stations between 2.5 and 6.4 (Table IV). Invertebrate samples from unpolluted streams usually have diversity index values greater than 4.0 when calculated by this method. Moderately polluted streams have values between 3.0-3.9, polluted waters between 2.2-2.9, and grossly polluted waters have values less than 2.2 (Ryck 1974). Only stations 1*, 2, and 3 fell into the unpolluted range. Stations 1, 4, 5, 6, 6*, 8, 9, and 15 were judged to be moderately polluted using this index and stations 7, 11, and 14 were considered polluted. No stations were revealed to be grossly polluted.

*re-sample

TABLE IV

INDEX VALUES FOR COLLECTING STATIONS USING MACROINVERTEBRATES, SPRING RIVER AND SHOAL CREEK, KANSAS.

| Station | Margalef Index | Margalef Range | Shannon-Weaver Index | Shannon-Weaver Range | No. of Mayfly & Stonefly Taxa Index | No. of Mayfly & Stonefly Taxa Range |
|---|---|---|---|---|---|---|
| 1 | 3.82 | mod poll | 2.22 | mod poll | 4 | poll |
| 1* | 4.09 | unpoll | 2.49 | mod poll | 3 | poll |
| 2 | 6.43 | unpoll | 2.69 | mod poll | 9 | unpoll |
| 3 | 6.26 | unpoll | 2.27 | mod poll | 7 | poll |
| 4 | 3.03 | mod poll | 2.00 | mod poll | 4 | poll |
| 5 | 3.94 | mod poll | 2.04 | mod poll | 8 | unpoll |
| 6 | 3.01 | mod poll | 2.60 | mod poll | 6 | poll |
| 6* | 3.65 | mod poll | 2.19 | mod poll | 6 | poll |
| 7 | 2.54 | polluted | 1.74 | mod poll | 2 | poll |
| 8 | 3.32 | mod poll | 2.41 | mod poll | 3 | poll |
| 9 | 3.65 | mod poll | 2.25 | mod poll | 6 | poll |
| 11 | 2.51 | polluted | 2.06 | mod poll | 2 | poll |
| 14 | 2.85 | polluted | 1.93 | mod poll | 3 | poll |
| 15 | 3.60 | mod poll | 1.67 | mod poll | 3 | poll |

Shannon-Weaver Index. The Shannon-Weaver index yielded values for the 12 stations between 1.7 and 2.7 (Table IV). Unpolluted streams have diversity index values greater than 3.0 when calculated by this method. Values of less than one have been obtained in areas of heavy pollution and values from 1 to 3 in areas of moderate pollution (Wilhm & Dorris 1968). All stations by this method were considered moderately polluted.

<u>Number of Ephemeroptera and Plecoptera Taxa</u>. Ryck (1974) found that samples from unpolluted streams usually contain at least 8 types of Ephemeroptera and Plecoptera larvae. Stations 2 and 5 had values of 8 or greater but all other stations were below eight (Table IV).

<u>Coefficients of Similarity</u>. Coefficients in this study ranged from 2% similarity between stations 11 and 14 and 77% similarity between stations 6 and 8 (Table V). The most valuable use of the coefficients is comparing the various sampling stations with a clean water area (Wilhm 1967). Station 2 was chosen as the clean water area for this study because of its high index values. Coefficients greater than 60% are high and indicate that the stations being compared have very similar bottom-dwelling communities. Values less than 50% are low and indicate dissimilar communities (MDC 1965). Similarities with station 2 were high for station 3, relatively high for stations 1 and 6, and low for stations 5, 8, 9, 4, 7, 15, 14, and 11 respectively, with stations 2 and 11 showing the least similarity.

Considering all stations, there were consistently low similarities with stations 4, 11, 14, and 15, however, the similarity between stations 14 and 15 was high.

TABLE V.

COEFFICIENTS OF SIMILARITY BETWEEN PRINCIPAL COLLECTING SITES FOR MACROINVERTEBRATES, SPRING RIVER AND SHOAL CREEK, KANSAS.

| Sta. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | (.42) | | | | | (.38) | | | | | | |
| 2 | .53 | | | | | | | | | | | |
| 3 | .66 | .62 | | | | | | | | | | |
| 4 | .39 | .35 | .45 | | | | | | | | | |
| 5 | .39 | .47 | .47 | .26 | | | | | | | | |
| 6 | .48 | .51 | .63 | .33 | .64 | (.41) | | | | | | |
| 7 | .33 | .24 | .41 | .35 | .65 | .39 | | | | | | |
| 8 | .53 | .44 | .65 | .37 | .56 | .77 | .62 | | | | | |
| 9 | .61 | .42 | .63 | .42 | .60 | .56 | .57 | .73 | | | | |
| 11 | .07 | .08 | .11 | .20 | .06 | .05 | .03 | .03 | .12 | | | |
| 14 | .17 | .19 | .26 | .18 | .32 | .33 | .27 | .32 | .28 | .02 | | |
| 15 | .18 | .20 | .26 | .16 | .32 | .31 | .28 | .31 | .28 | .03 | .64 | |

( ) re-sample

Mussels. Mussels were collected and identified from stations 6 and 9. A total of 18 species were identified (Table VI) and one specimen of the endangered (in Kansas) warty-backed mussel (*Quadrula nodulata*) was collected at Station 6. This is the only site Branson(1966) collected individuals of this species as well.

TABLE VI

MUSSELS FROM COLLECTING STATIONS, SPRING RIVER AND SHOAL CREEK, KANSAS

| Species | Station 6 | Station 9 |
|---|---|---|
| *Actinonaias ellipsiformis* | X | |
| *Amblema plicata* | X | |
| *Anadonta grandis* | X | |
| *Cyprogenia abertii* | | X |
| *Elliptio dilatatus* | X | |
| *Fusconaia flava* | X | X |
| *F. flava* form *trigona* | X | |
| *Lampsilis radiata siliquadia* | | X |
| *L. rafinesqueana* | X | X |
| *L. ventricosa* | X | X |
| *Lasmigona complanata* | | X |
| *Pluerobema sintoxia* complex | X | X |
| *Ptyehibranchus occidentalis* | X | X |
| **Quadrula nodulata* | X | |
| *Q. pustulosa* | X | X |
| *Q. quadrula* | X | X |
| *Staphitus undulatus* | X | X |
| *Tritogonia verrucosa* | X | X |

*Endangered in Kansas

## FISH

A total of 3,963 fish were collected from the 12 study sites. This represented 10 families, 26 genera, and 62 species. Ten families and 54 species (2,478 individuals) were collected from Spring River and 9 families and 45 species (1,485 individuals) from Shoal Creek (Appendix B).

Minnows (Cyprinidae) comprised 60.11% of the total capture and were distributed between 20 species. The red shiner (*Notropis lutrensis*) was the most abundant minnow comprising 13% of the total capture and 21% of all minnows. The rosyface shiner (*Notropis rubellus*) equaled 11% of the total capture and 18% of the minnows while the bluntnose minnow (*Pimephales notatus*) numbers equaled 9% of all fish and 15% of the minnows. The duskystripe shiner (*Notropis pilsbryi*) and the redfin shiner (*Notropis umbratilis*) both equaled 6% of the total and 10% of all the minnows.

Sunfish (Centrarchidae) were the next most abundant family comprising 13.48% of the total capture and were distributed between 12 species. Bluegill (*Lepomis macrochirus*) proved to be the most frequently encountered sunfish comprising 6% of the total and 43% of all sunfish captures. Longear (*Lepomis megalotis*) numbers were 3% of the total and 22% of the sunfish while spotted bass (*Micropterus punctulatus*) captures equaled 1% of the total and 9% of the sunfish collected.

Darters (Percidae) comprised 7.08% of the total fish captured and were distributed between 13 species. The most common and widespread darter was the orangethroat (Etheostoma spectabile) comprising 4% of the total and 53% of all darters. The banded darter (Etheostoma zonale) occurred 1% of the time and comprised 17% of the total number of darters.

Suckers (Catastomidae) were represented by 7 species and equaled 1.38% of the total capture. The northern hogsucker (Hypentelium nigricans), the spotted sucker (Minytrema melanops), and the river redhorse (Moxostoma carinatum) all tallied at .3% of the total but were 24%, 24%, and 20% of the sucker captures respectively.

Species considered in need of conservation based on reccommendations of the non-game fish committee of the Kansas non-game program (unpubl.) and collected in this survey were (Table VII): Arkansas darter (Etheostoma cragini), redspot chub (Nocomis asper), river redhorse (Moxostoma carinatum), and the brindled madtom (Noturus miurus). The Arkansas darter also appears on the Kansas endangered species list. Peripheral species listed in need of conservation by this same committee which were collected were as follows: black redhorse (Moxostoma duquesnei), speckled darter (Etheostoma stigmaeum), banded darter (E. zonale), greenside darter (E. blennioides), and northern hogsucker(Hypentelium nigricans).

TABLE VII

FISH SPECIES COLLECTED CONSIDERED IN NEED OF CONSERVATION (KS NONGAME FISH COMM, UNPUBL), SPRING RIVER AND SHOAL CREEK, KANSAS

| Species | Station 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENDEMIC | | | | | | | | | | | | |
| *Etheostoma cragini* | 4 | | | | 1 | | | | | | | |
| *Nocomis asper* | 6 | | | | | 4 | | | | | | |
| *Moxostoma carinatum* | 8 | | | | | 2 | | | | | | |
| *Noturus miurus* | | | | | 5 | | | | | | | |
| PERIPHERAL | | | | | | | | | | | | |
| *Moxostoma duquesnei* | 8 | | | | | | | | | | | |
| *Etheostoma stigmaeum* | 5 | 1 | 2 | | | | | | | | | |
| *Etheostoma zonale* | 10 | 1 | 2 | | | 30 | | | | | | 4 |
| *Etheostoma blennioides* | 1 | | | | | | | | | | 1 | |
| *Hypentelium nigricans* | 6 | | 1 | | | 1 | | | | | 5 | |

*Biotic Integrity*. The results of the biotic integrity are summarized in table VIII.

TABLE VIII

BIOTIC INTEGRITY INDEX VALUES, SPRING RIVER AND SHOAL CREEK, KANSAS

| Station | Stream Size | Species (Total) | Ind. (Total) | NUMBER OF Darter Species | Sunfish Species | Sucker Species | Intol Sp. |
|---|---|---|---|---|---|---|---|
| 1 | midriver | 42 | 1056 | 8 | 9 | 4 | 10 |
| 2 | midriver | 24 | 263 | 5 | 4 | 1 | 3 |
| 3 | midriver | 17 | 79 | 3 | 2 | 1 | 4 |
| 4 | midriver | 8 | 60 | 0 | 3 | 0 | 0 |
| 5 | midriver | 21 | 539 | 5 | 2 | 0 | 2 |
| 6 | midriver | 36 | 762 | 6 | 8 | 3 | 5 |
| 7 | midriver | 16 | 182 | 1 | 5 | 1 | 0 |
| 8 | midriver | 10 | 134 | 1 | 2 | 0 | 1 |
| 9 | midriver | 13 | 113 | 2 | 2 | 0 | 1 |
| 11 | midriver | 8 | 55 | 0 | 4 | 0 | 1 |
| 14 | midriver | 28 | 275 | 2 | 5 | 3 | 4 |
| 15 | midriver | 33 | 357 | 5 | 8 | 3 | 3 |

TABLE VII (CON'T)

BIOTIC INTEGRITY INDEX VALUES, SPRING RIVER AND SHOAL CREEK, KANSAS.

| | PROPORTION OF INDIVIDUALS (%) | | | | | | QUALITY | |
|---|---|---|---|---|---|---|---|---|
| Sta | Omni | Insect Cyprinids | Green Sunfish | Top Carn | Hyb | Diseased | Index | Class |
| 1 | 13 | 42 | .3 | 1 | 0 | 0 | 56 | G-E |
| 2 | 14 | 57 | .3 | 0 | 0 | 0 | 52 | Good |
| 3 | 5 | 47 | 0 | 0 | 0 | 0 | 48 | Good |
| 4 | 5 | 33 | 5 | 6 | 0 | 0 | 31 | Poor |
| 5 | 55 | 25 | .1 | 0 | 0 | 0 | 42 | Fair |
| 6 | 30 | 35 | 2 | 2 | 0 | 0 | 50 | Good |
| 7 | 36 | 5 | 1 | 5 | 0 | 0 | 38 | P-F |
| 8 | 66 | 19 | 1 | 0 | 0 | 0 | 32 | Poor |
| 9 | 12 | 15 | 0 | 4 | 0 | 0 | 40 | Fair |
| 11 | 42 | 0 | 0 | 2 | 0 | 0 | 29 | Poor |
| 14 | 52 | 21 | 1 | 3 | 0 | 0 | 46 | F-G |
| 15 | 20 | 9 | .3 | 7 | 1 | 0 | 46 | F-G |

## Herpetofauna

Although a relatively low number of reptiles and amphibians were encountered during this survey, many of those observed were endangered species. A list appears in Table IX.

TABLE IX

HERPETOFAUNA SECURED AT PRINCIPAL COLLECTING STATIONS, SPRING RIVER AND SHOAL CREEK, KANSAS.

| Species | Collection Site |
|---|---|
| $*Eurycea longicauda* | Cave at Schermerhorn Park (Station 1) |
| **Eurycea lucifuga* | Cave at Schermerhorn Park (Station 1) |
| **Typhlotriton spelaeus* | Larvae collected in spring at cave in Schermerhorn Park (Station 1) |
| *Acris crepitans* | ubiquitous |
| *Stenotherus odoratus* | Seined from backwater at Station 1 |
| *Storeria dekayi texana* | Wooded bank at Station 4 |
| **Notopthalmus viridescens* | Many adults collected in a pond on Powell property (Station 3) Efts collected under logs on wooded banks |
| *Nerodia nerodia* | Station 6 |
| *Thamnophis proximus* | Station 15 |

$ Of special concern
* Endangered in Kansas

# CHAPTER V

# DISCUSSION

## Physical and Chemical Parameters

Spring River and Shoal Creek represent well-buffered systems typical of limestone basins. Both streams have high total alkalinites and should be effective in resisting large pH changes. The high alkalinity results from carbon dioxide and water attacking the limestone (a carbonate rock) and dissolving out some of the carbonate to form bicarbonate solutions. Alkalinities in these two systems have declined overall since the Branson (1966) survey. The pH values have also dropped in the past 20 years and I think we are seeing a decline in the buffering capacity of the system. Most likely, acid water from numerous strip mines in the drainage area has been entering into the system and ebbing away at the pH and buffering capacity.

Hardness, an expression representing the total concentration of calcium and magnesium ions, was found to exceed the total alkalinity in most cases indicating some noncarbonate hardness due to magnesium. Using the classification of Brown, Skougstad, and Fishman (1970) for hardness, we can classify the water in Shoal Creek as hard and that in Spring River as hard to very hard. Turbidity measurements ranged from 0 to 25 JTU and dissolved oxygen readings nearly always exceeded the saturation point. No measurements were found to be limiting.

Burns (1971) reported the average flow in Shoal Creek (above Lowell Reservoir) to be 11.21 cubic meters per second annually with Q80 (flow 80% of the time) being 5.55 cubic meters per second. The average flow in Spring River (also above Lowell Reservoir) was 23.91 cubic meters per second annually with Q75 being 11.89 cubic meters per second. Flow readings taken during this study generally reflect the Q75-80 flows.

## Fauna

Index values along Shoal Creek were generally high using both macroinvertebrates and fish. Station 2 was the only station in which 2 of the 3 macroinvertebrate indexes yielded unpolluted values. Margalef values for station 1* and 3 indicated clean waters and the biotic integrity analysis showed stations 1, 2, and 3 to be in good condition. Station 1 should be considered borderline unpolluted due to the closeness of the sample and re-sample value to 4 using the Margalef index. Station 4, the lowermost station on Shoal Creek, showed lower values for both macroinvertebrate indexes and the biotic integrity analysis. This station was located above the area of the Lowell dam and was an area with only pool-type habitats unlike the other Shoal Creek stations which exhibited riffle-run habitats. This could explain the low similarity that existed between this station and all other stations.

The Spring River stations were more difficult to judge as to water quality due to the discrepancies between macroinvertebrate indexes and the biotic integrity analysis. Stations 5 and 6 reflect the highest quality water of the Spring River stations . Several fish species considered in need of conservation were collected at these sites. The only specimen of the Arkansas darter collected on Spring River was collected at Station 5 and the only specimen of the warty-backed mussel was collected at station 6.

Station 7 produced low index values from the macroinvertebrate indexes but fared slightly better by the biotic integrity analysis. This was another station to exhibit only pool-type habitats. Similarities were surprisingly high between station 7 and the higher quality station 5 suggesting that water quality problems may be less severe than macroinvertebrate analysis indicated.

Station 8, only moderately polluted by macroinvertebrate analysis, was shown to be in poor condition by the fish analysis. This station was the first station below the confluences of both Center Creek and Turkey Creek and some of the water quality problems here could be the result of water quality problems in the two tributaries. Station 9 showed only moderate water quality problems and was judged to be in fair condition.

Station 11 was a third area of solely pool-type habitats. Only 36 macroinvertebrates were collected at this site with the majority of individuals being more tolerant chironomids and naids. Fish numbers were also low at this site but it should be noted that the electrofishing equipment was not functioning properly. Fish data, therefore, must not be considered representative as seining is difficult in deep pool situations and must necessarily be done about the edges. The low macroinvertebrate values could be an indication of industrial pollution from the ALCO chemical plant located upstream. The low values might also reflect some disturbance from the fishing camp situated at this site, or if the fishing was really good here (why else have a fishing camp here??) maybe the fish have eaten all the macroinvertebrates. At any rate, before any real determination can be made, better fish samples should be taken.

The lower stations--14 and 15--generally showed only moderate water quality problems. These were the only stations below the Lowell Reservior and they were located above and below Baxter Springs. Low similarities with other stations but a high similarity between the two were found. This is probably reflecting changes that occur due to being situated below the dam. The high similarity between the two seems to indicate little influence from the Baxter Springs area.

Low Shannon-Weaver index values were characteristic of all stations. As Weber (1973) indicated, the Shannon-Weaver index was a better measure of pollution by toxic wastes than the Margalef. I think it is possible the low Shannon-Weaver values are reflecting some contamination by dioxin. Dioxin has been found in the tissues of fish taken from Spring River (                ) and at this time it is uncertain what the effects of dioxin contamination are.

Five of the 12 stations were sites used by the Branson survey. The overall immpression seems to be that fish populations are reduced. Comparisons to his data showed that he collected a total of 3,587 fish distributed between 88 species at the stations while this survey collected only 2,189 fish distributed between 66 species. There is, of course, no way to gage the catch/unit effort between the two surveys, but, relative effort seems to support this impression.

Applying the biotic integrity analysis technique to the Branson data revealed that quality at stations 1 and 5 had been reduced but quality had apparently improved slightly at station 15 (Table X).

TABLE X

COMPARISON OF BIOTIC INTEGRITY ANALYSIS

SPRING RIVER AND SHOAL CREEK, KANSAS.

| Station | Branson | '83 Survey |
|---|---|---|
| 1 | Excellent | Good-Excellent |
| 2 | Good | Good |
| 5 | Good-Excellent | Fair |
| 6 | Good | Good |
| 15 | Fair | Fair-Good |

The presence or absence of certain species can also be used to reveal any marked changes in a system. In clear, Ozarkian streams, greenside darters (<u>Etheostoma blennoides</u>) are expected to occur (Pflieger 1975). In this survey, one individual at only two stations was collected. Branson consistently sampled this fish and in large numbers. The banded sculpin (Cottus carolinae) was another fish not collected in this survey but frequently collected in the earlier survey. The river redhorse was the only species collected by this survey that was not previously collected by Branson. It is felt that our sucess in sampling this fish is due to our use of electrofishing equipment. Most likely, Branson did not sample this mid-channel sucker since he did not employ this method. Overall, it seems we are seeing more tolerant species like the orangethroat darter replacethe less tolerant species like the greenside darter. If this shift is allowed to continue, the quality of the stream will necessarily decline.

As is apparent in Table IX, the limestone cave and the surrounding area at Schermerhorn Park provides the critical habitat for several endangered salamanders. Since the park is located in the small area of the Ozark region which barely enters Kansas, these species are at the limit of their range in this region, as far as Kansas is concerned. Schermerhorn Park has been identified as the most widely diverse and biologically significant area in the State of Kansas (based upon the collective opinion of a task force composed of members of the Kansas Fish and Game Commission, Kansas Park And Resource Authority, representatives of the biological and natural resource sciences of Kansas State University and the University of Kansas, Kansas Natural History Museum, State Biological Survey, and Kansas Forestry Extension Service) (Letter to Hon. Fred Weaver, House of Representatives from Tom Saunders, U.S.F.W.S. dated

March 8, 1979). Not only are five of eight species of salamanders known to occur in Kansas restricted to this region, an additional three frogs and one snake have their distribution in Kansas in or very near this area (Collins 1975). Along with this unique assemblage of reptiles and amphibians, Schermerhorn Park also supports many rare Kansas plants (Letter to Jerry Nugent U.S.F.W.S. from Ron McGregor, State Biological Survey, dated Dec. 28, 1978). The biological importance of preserving populations of plants and animals at the limit of their ranges is well known. Undoubtedly, the flora and fauna of this area would benefit greatly from the establishment of a non-recreational, natural sanctuary (Collins 1975).

# PART II

# AERIAL PHOTO INTERPRETATION

## Materials and Methods

Aerial black-and-white photographs from 1958 (1:        ) and high altitude infra-red imagery from 1981 (1:        ) were obtained from the U.S. Geological Survey, Rolla, MO. Photos taken during the fall months were chosen as the most appropriate for the measurement of areas for comparisons of land use practices (Avery 1977). The study area was traced onto paper using 40 acres as the smallest area (minimum mapping unit) outlined in a category. Categories were Level I using the hierarchal system of the U.S.G.S. (Anderson et. al. 1976). Level I is based primarily on surface cover. Land use/ land cover classifications at Level I and II are usually adaptable for evaluations of past changes in land use (Avery 1977). The categories recognized for this survey were: cropland, pasture, woodland, urban, and mined areas. The area covered by each class was then determined using a compensating polar planimeter and comparisons were made based on this information.

## Results and Discussion

Aerial photo interpretation indicated that relatively little change has occurred in the study area over the 23 year time span. In this time, urban areas have increased by approximately 2.4% and woodland areas showed a gain of about 1.9% (Table XI). Overall, the total amount of land in crop or pasture declined slightly by approximately 1.7%. During 1981, land in crop decreased by 5.2% and that in pasture increased by 3.5%. This increase in pasture most likely reflects an increase in the number of fallow crop fields. A decrease by about 2.6% was also observed in the total area of mined land. Major areas of cropland and woodland remain, for the most part, unchanged. Riparian areas do not seem to have been reduced substantially either. Among other changes evident are: a new pond at the ALLCO (formerly Gulf) Chemical plant, and new sewage treatment ponds for the cities of Galena and Baxter Springs.

TABLE XI

LAND USE CATEGORIES, SPRING RIVER AND SHOAL CREEK, KANSAS

| Category | 1958 Acres | 1958 % | 1981 Acres | 1981 % |
|---|---|---|---|---|
| Cropland | 9880 | 42.8 | 8715 | 43.0 |
| Pasture | 1440 | 7.0 | 2121 | 10.5 |
| Woodland | 6760 | 33.0 | 7057 | 34.9 |
| Urban | 1600 | 7.8 | 2071 | 10.2 |
| Mined Areas | 820 | 4.0 | 285 | 1.4 |
| TOTAL | 20500 | 100.0 | 20249 | 100.0 |

# PART III

# LANDOWNER SURVEY

# PART IV

# MANAGEMENT RECOMMENDATIONS

# APPENDICES

## APPENDIX A

AQUATIC MACROINVERTEBRATES SECURED AT PRINCIPAL COLLECTING STATIONS, SPRING RIVER AND SHOAL CREEK, KANSAS.

| MACROINVERTEBRATE | COLLECTING STATION | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1* | 2 | 3 | 4 | 5 | 6 | 6* | 7 | 8 | 9 | 11 | 14 | 15 |
| HIRUDINEA | | | | | | | | | | | | | | |
| Glossiphonidae | | | | | | | | | 1 | | | | | |
| Hirudinidae | | | | 1 | | | | | | | | | | |
| Eropobdellidae | 1 | | | | | | 1 | 1 | 1 | 4 | | | | |
| OLIGOCHAETA | | | | | | | | | | | | | | |
| Lumbriculidae | | | 2 | | | | | | | | | | | |
| Naididae | | | | 1 | 4 | 76 | 10 | 3 | 67 | 11 | 18 | 6 | | 9 |
| Tubificidae | | 1 | | 1 | 2 | | | | 1 | | | | | |
| Haplotaxidae | | 3 | | | | | | | | 1 | | | | |
| Branchiobdellida | | | | 1 | | | 22 | | | 1 | 5 | | 1 | 3 |
| GASTROPODA | | | | | | | | | | | | | | |
| Ancylidae | | | | | | | 1 | | | | | | | |
| Physidae | | 11 | | | | | | | | | | | 1 | |
| TUBELLARIA | | | | | | | | | | | | | | |
| Planariidae | 1 | | 1 | | | | | | | | | | 14 | |
| AMPHIPODA | | | | | | | | | | | | | | |
| Talitridae | | | | | | | | | 1 | | | | | |
| Gammaridae | | | | | 3 | | | | | | | | | |
| DECAPODA | | | | | | | | | | | | | | |
| Astacidae | | | | | | | | | | | 1 | | | 3 |

| MACROINVERTEBRATE | COLLECTING STATION | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1* | 2 | 3 | 4 | 5 | 6 | 6* | 7 | 8 | 9 | 11 | 14 | 15 |
| ISOPODA | | | | | | | | | | | | | | |
| Asellidae | 4 | 4 | 8 | 1 | | | | | | | 2 | | | |
| COLEOPTERA | | | | | | | | | | | | | | |
| Dystiscidae | | 5 | | | | | | | | | | | | |
| Elmidae | 2 | 9 | 5 | 13 | | 7 | 6 | 8 | | 5 | 1 | | 17 | 18 |
| Gyrinidae | | | | | | | | | | | | | 18 | |
| Hydraenidae | | | | | | 1 | | | | | | | | |
| Hydrophilidae | | | | | | | | | | | | | 1 | 1 |
| Haliplidae | | | | | | | | | | | | | | 2 |
| Psephenidae | | | 2 | | | | | | | | | | | |
| DIPTERA | | | | | | | | | | | | | | |
| Ceratopogonidae | | 2 | | | 2 | 3 | 1 | 2 | 3 | | 1 | | | |
| Chaoboridae | | | | | | | | | 1 | | | 3 | | |
| Chironomidae | 39 | 5 | 39 | 51 | 35 | 113 | 79 | 40 | 80 | 81 | 65 | 8 | 91 | 92 |
| Cyclorrhapa | | | | | | 1 | | | | | | | | |
| Empididae | | | 2 | | | | | | | | 1 | | | 3 |
| Simuliidae | | 14 | 2 | | | 2 | 6 | 9 | | 3 | 8 | | 37 | 20 |
| Tabanidae | | | | | | | | 1 | | | | | | |
| Tanypodinae | | | | | | | | | 1 | | | | | |
| Tipulidae | | | | 1 | | | | | | 1 | 1 | | | |
| EPHEMEROPTERA | | | | | | | | | | | | | | |
| Baetidae | | 27 | 1 | | | 10 | 10 | 15 | | 1 | 6 | | 39 | |
| Caenidae | | | 41 | 2 | 10 | 5 | | 6 | | | 5 | 6 | 2 | 5 |
| Ephemeridae | 20 | 12 | 1 | 2 | | 11 | 2 | 54 | 5 | | 17 | 2 | | 1 |
| Heptageniidae | 28 | 39 | 67 | 35 | 3 | 61 | 48 | 9 | | 27 | 26 | 3 | 2 | |

| MACROINVERTEBRATE | COLLECTING STATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1* | 2 | 3 | 4 | 5 | 6 | 6* | 7 | 8 | 9 | 11 | 14 | 15 |
| Leptophlebiidae | | | | | | 1 | 4 | | 2 | 21 | | | | |
| Potamanthidae | | | | | | 6 | 4 | 3 | | | 18 | | | |
| Siphlonuridae | | | | | 1 | | | 7 | | | 1 | | | |
| Tricorythidae | | | 1 | | | 22 | | | | | | | | |
| HEMIPTERA | | | | | | | | | | | | | | |
| Belostomatidae | | 2 | | | | | | | 1 | | | | | |
| Corixidae | | | | 1 | 1 | | | 1 | | | | 6 | | 2 |
| Nepidae | | 1 | | | | | | | | | | | | |
| LEPIDOPTERA | | | | | | | | | | | | | | |
| Pyralidae | 1 | 2 | 1 | | | | | | | | | | | 1 |
| MEGALOPTERA | | | | | | | | | | | | | | |
| Corydalidae | 4 | 2 | 8 | | | | | 10 | | | | | 3 | 4 |
| ODONATA | | | | | | | | | | | | | | |
| Aeshnidae | 1 | 1 | | | | | | | | | | | | |
| Calopterygidae | | | | | | | | | | | 1 | | | 3 |
| Coenagrionidae | 2 | 13 | 4 | 2 | 1 | | | 2 | | 1 | | | 5 | 3 |
| Cordulegastridae | | 3 | | | | | | | | 1 | 1 | | | |
| Gomphidae | | 2 | 1 | 2 | | | | | | | | | | |
| Libellulidae | | | | | | | | | | | | | | 1 |
| Macromiidae | | | | | | | | | | | 1 | | | 1 |
| PLECOPTERA | | | | | | | | | | | | | | |
| Chloroperlidae | | | 3 | 1 | | | | | | | | | | |
| Nemouridae | | | 7 | | | | | | | | | | | |
| Perlidae | 10 | | 5 | 1 | | 1 | | 1 | | | | | | 1 |

| MACROINVERTEBRATE | COLLECTING STATION | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1* | 2 | 3 | 4 | 5 | 6 | 6* | 7 | 8 | 9 | 11 | 14 | 15 |
| Taeniopterygidae | | | | 1 | | | | | | | | | | |
| TRICHOPTERA | | | | | | | | | | | | | | |
| Brachycentridae | | | | | | | | | 2 | | | | | |
| Glossosomatidae | 7 | | 23 | 30 | | | | | | | | | | |
| Helicopsychidae | | | 4 | 1 | | | | | | | | | | |
| Hydropsychidae | 2 | 5 | 5 | 1 | | 10 | 3 | 43 | | 2 | 2 | | 217 | 167 |
| Hydroptilidae | | | 4 | 1 | | | | 3 | | | | | 1 | 1 |
| Lepidostomatidae | | | | | | 1 | | | | | | | | |
| Leptoceridae | 1 | | 1 | 1 | | 1 | | | | | | | | |
| Limnephilidae | 1 | | 2 | | | 3 | 3 | | 3 | | | | | 1 |
| Odontoceridae | | | 1 | | | 1 | | | | | | | 3 | |
| Philopotomidae | 1 | | | | | 3 | | 1 | | | | | | |
| Polycentropodidae | | | | | | 1 | | | | | | | | |
| Psychomyiidae | | | | 2 | | | | | | | | | 3 | |
| Rhyacophilidae | 1 | | | | | | | | | | | | | |
| NEMATODA | | | 1 | 1 | | | | | 1 | 1 | | | | |
| HYDRACARINA | | | | | | | | | | | | | | |
| Hygrobatidae | | | 3 | | | 1 | | | | | | | | |
| Lebertiidae | | | 2 | | | | | | | | | | | |
| Limnesiidae | | | 1 | | | | | | | | | | | |
| Mideopsidae | | | 1 | 1 | | | | | | | | | | |
| Pionidae | | | | | | | | | | | | | | |
| Sperchonidae | | | 2 | 1 | | | | | | | | | | |
| Torrenticolidae | | | | | | | | | | | | 2 | | 2 |
| Unionicolidae | | | | | | | | | | | | | | |

| MACROINVERTEBRATE | COLLECTING STATION | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1* | 2 | 3 | 4 | 5 | 6 | 6* | 7 | 8 | 9 | 11 | 14 | 15 |
| COPEPODA | | | 1 | 1 | 23 | | | 1 | | | | 1 | | |
| CLADOCERA | | | | 1 | 11 | | | | | | | | 99 | |
| ROTATORIA | | | 2 | | | | | | | | | | | |
| OSTRACODA | | | | | | | | | | | | | | |
| Cyprinae | | | 1 | | | | | | | | | | | |
| ANOSTRACA | | | | | | | | | | | | | | |
| Chirocephalia | | | | 1 | | | | | | | | | | |
| COLLEMBOLA | | | | | | | | | | | | | | |
| Isotomidae | | | 3 | | | | | | | | | | | |

APPENDIX B

FISH SPECIES SECURED AT PRINCIPAL COLLECTING SITES, SPRING RIVER AND SHOAL CREEK, KANSAS.

| | COLLECTING STATION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 14 | 15 |
| CLUPEIDAE | | | | | | | | | | | | |
| <u>Dorosoma cepedianum</u> | 26 | | | | | 12 | 4 | | 1 | 2 | 14 | 40 |
| CYPRINIDAE | | | | | | | | | | | | |
| <u>Cyprinus carpio</u> | | | | | | 8 | 4 | | | | 1 | 3 |
| <u>Notemigonus crysoleucas</u> | | | | 1 | | 2 | | | | | | |
| <u>Semotilus atromaculatus</u> | | | | | 1 | | | | | | | 9 |
| *<u>Nocomis asper</u> | 6 | | | | | 4 | | | | | | |
| <u>Hybopsis x-punctata</u> | 6 | 4 | 6 | | | 14 | | | | | 5 | |
| <u>Phenocobius mirabilis</u> | | | | | 45 | 47 | | | 2 | | 1 | |
| <u>Notropis rubellus</u> | 176 | 92 | 2 | 6 | 50 | 65 | | | 4 | | 33 | 1 |
| <u>N. umbratilis</u> | 22 | 2 | 12 | | 50 | 108 | 9 | 25 | 4 | | 2 | 9 |
| <u>N. pilsbryi</u> | 187 | 2 | 7 | | | 55 | | | | | | |
| <u>N. boops</u> | 2 | 20 | 3 | 14 | 10 | 1 | | | | | | |
| <u>N. camurus</u> | 21 | 5 | 7 | | 25 | 21 | | | 9 | | 4 | 11 |
| <u>N. lutrensis</u> | 5 | 10 | 3 | | 170 | 161 | 7 | 58 | 12 | | 57 | 27 |
| <u>N. volucellus</u> | 30 | | | | | | | | | | | |
| <u>N. spilopterus</u> | 1 | | | | | | | | | | | |
| <u>N. galacturus</u> | | | | | | | | | | | 4 | |
| <u>Pimephales promelas</u> | | | | | | | | 2 | | | | 6 |
| <u>P. vigilax</u> | 1 | | | | | | | | | | 64 | |

| | COLLECTING STATION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 14 | 15 |
| P. tenellus | 4 | 26 | | | | | | | | | 10 | 4 |
| P. notatus | 70 | 27 | 1 | 2 | 126 | 43 | 50 | 27 | | 21 | 4 | 1 |
| Campostoma anomalum | 86 | 6 | 14 | | | 6 | | 1 | | | 20 | |
| CATOSTOMIDAE | | | | | | | | | | | | |
| Ictiobus bubalus | | | | | | | 1 | | | | 1 | |
| Minytrema melanops | 1 | | | | | 6 | | | | | 5 | 1 |
| *Moxostoma carinatum | 8 | | | | | 2 | | | | | | 1 |
| M. macrolepidotum | | | | | | | | | | | | 6 |
| M. duquesnei | 8 | | | | | | | | | | | |
| M. erythrurum | | 1 | | | | | | | | | | |
| *Hypentelium nigricans | 6 | | 1 | | | 1 | | | | | 5 | |
| ICTALURIDAE | | | | | | | | | | | | |
| Ictalurus natalis | | | | | | | | 3 | | | | |
| Ictalurus punctatus | 1 | | | | | 5 | 1 | | 9 | | 2 | 6 |
| Noturus exilis | 13 | 7 | 1 | | 2 | 6 | | | | | | |
| *N. miurus | | | | | 5 | | | | | | | |
| N. flavus | | | | | | 4 | | | | | | |
| CYPRINODONTIDAE | | | | | | | | | | | | |
| Fundulus notatus | 10 | 3 | | | | | | | | 1 | | 22 |
| POECILIIDAE | | | | | | | | | | | | |
| Gambusia affinis | 167 | | | | 20 | 22 | 47 | | 47 | 10 | 5 | 2 |
| ATHERINIDAE | | | | | | | | | | | | |
| Labidesthes sicculus | 22 | 4 | 1 | | 1 | | 1 | | | | 35 | 109 |
| CENTRARCHIDAE | | | | | | | | | | | | |
| Micropterus punctulatus | 5 | 1 | | | | 7 | | | | 1 | 31 | 2 |

| | COLLECTING STATION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 14 | 15 |
| *Micropterus salmoides* | 3 | | | | | 8 | 3 | | | 1 | 6 | 8 |
| *Lepomis gulosus* | 3 | | | | | | 1 | | | | | 1 |
| *L. cyanellus* | 4 | 1 | | 3 | 1 | 15 | 2 | 2 | | | 3 | 1 |
| *L. microlophus* | 1 | | | 5 | | 3 | | | | | | |
| *L. macrochirus* | 37 | 18 | 3 | 25 | 2 | 21 | 41 | 1 | | 15 | 27 | 43 |
| *L. humilis* | 17 | 2 | | | 1 | 8 | 3 | | | | 2 | 1 |
| *L. megalotis* | 38 | 2 | 3 | | | 24 | | 1 | 1 | 4 | 38 | 8 |
| *L.cyanellus* x *L.macrochirus* | | | | | | | | | | | | 5 |
| *Ambloplites rupestris* | 3 | | | | | | | | | | | |
| *Pomoxis annularis* | 1 | | | 4 | | 2 | 5 | | | | | 4 |
| *Pomoxis nigromaculatus* | | | | | | 1 | | | 2 | | | 4 |
| PERCIDAE | | | | | | | | | | | | |
| *Percina phoxocephala* | | | | | 4 | 1 | | | 1 | | | 2 |
| *P. caprodes* | 8 | | | | | | | | | | 3 | 1 |
| *P. shumardi* | | | | | | | | | | | | 9 |
| *P. copelandi* | | 1 | | | 1 | | | | 1 | | | |
| *Etheostoma nigrum* | 5 | 1 | | | 5 | 1 | 3 | | | | | |
| *E. stigmaeum* | 5 | 1 | 2 | | | | | | | | | |
| *E. zonale* | 10 | 1 | 2 | | | 30 | | | | | | 4 |
| **E. blennioides* | 1 | | | | | | | | | | 1 | |
| *E. whipplei* | | | | | | 1 | | | | | | 3 |
| *E. punctulatum* | 2 | | | | | | | | | | | |
| **E. cragini* | 4 | | | | 1 | | | | | | | |
| *E. spectabile* | 22 | 26 | 11 | | 16 | 30 | | 14 | 27 | | 1 | |
| *E. flabellare* | | | | | 3 | 14 | | | | | | |

| | COLLECTING STATION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 14 | 15 |
| SCIAENIDAE | | | | | | | | | | | | |
| *Aplodinotus grunniens* | | | | | | | | | | | | 3 |

## APPENDIX C

## LANDOWNER QUESTIONNAIRE

1. How long have you lived on this property?

   ______ less than 2 years

   ______ 2-5 years

   ______ 5-10 years

   ______ 10-20 years

   ______ more than 20 years

2. What is the primary land use of your property?(Check all that apply)

   ______ cropland

   ______ pasture

   ______ residence

   ______ recreation

   ______ other (please specify)

3. If cropland, what are the major crops planted? ______________

4. Do you use this river for any recreational activities?

   ______ Yes

   ______ No

5. Which recreational activities do you use the river for? (Check all that apply)

   ______ Fishing

   ______ Swimming

   ______ Canoeing

   ______ Boating

   ______ Picnicing

   ______ Other

6. How often do you use the river?(Check one)

_____ every day

_____ at least once a week

_____ at least once a month

_____ at least once every two months

_____ never

7. Do you have problems controlling public access?

_____ Yes

_____ No

8. Do you currently allow any public access from your property?

_____ Yes

_____ No

9. Who do you allow to use the stream? (Check all that apply)

_____ Immediate family

_____ Relatives

_____ Friends

_____ Anybody that asks permission

10. Do you think there are pollution problems on Shoal Creek and Spring River?

_____ Yes

_____ No

_____ No opinion

11. Do you think the quality of discharged water from Joplin's sewage treatment plant is degrading Shoal Creek?

_____ Yes _____ No opinion

_____ No

12. Do you think gravel removal operations in Shoal Creek are a problem?

_____ Yes

_____ No

_____ No opinion

13. Are you aware that 8 state threatened and endangered amphibians and fish occur at Schermerhorn Park in Galena, Kansas?

_____ Yes

_____ No

14. Do you favor programs designed to protect unique wildlife and their habitats in Shoal Creek and Spring River?

_____ Yes

_____ No

15. If yes, how do you feel these stream resources should be managed?

_____ By federal laws

_____ By state laws

_____ By property owners

_____ By county ordinances

_____ By a joint state-county commission

_____ Other(please specify)

16. Would you favor tax deduction incentives to help landowners maintain strips of grassland and treebelts on the banks of Shoal Creek and Spring River?

_____ Yes _____ No

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