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THE FISH AND AQUATIC INVERTEBRATES IN SARPY CREEK MONTANA

by

CHRISTOPHER GERARD CLANCEY

A thesis submitted in partial fulfillment
of the requirements for the degree

of

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in

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Approved:

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VITA

Christopher Gerard Clancey was born June 5, 1953, in Havre, Montana to Murel F. and Kathrine R. Clancey. He graduated from Havre High School in June, 1971. In June, 1971, he entered Northern Montana College where he majored in Fish and Wildlife Management. In 1973, he transferred to Montana State University and graduated in June, 1975, with a Bachelors of Science degree in Fish and Wildlife Management. He began graduate studies at Montana State University in June of 1975.

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ABSTRACT

The fish and aquatic macroinvertebrates of Sarpy Creek were studied during 1975 and 1976. Aquatic macroinvertebrate distributions varied according to chemical, physical and biological factors and not due to surface stripmining effects. Basket samplers collected a higher number of genera than substrate samples, although neither method allowed quantitative conclusions to be drawn.

Gamefish are not present in Sarpy Creek during most of the year, however, some use of the creek by gamefish was noted during spring and summer. Late summer appears to be the critical period for fish in the creek.

Presently coal mining is having no obvious effects on the creek. Potential problems of future mining are discussed.

INTRODUCTION

Strip mining of the Fort Union coal deposits is being escalated in southeastern Montana to help meet the nations' increasing energy demands.

Westmoreland Coal Company began surface mining operations in the Sarpy Creek area in 1974. Present activity is limited to Tract III, but future plans are to expand mining to Tract II (Fig. 1).

Amax Coal Company has purchased mining rights on acreage north of Westmoreland's mine and is negotiating with the Crow Indian tribe on future mining claims.

Sarpy Creek flows through the Crow ceded area coal lease upon which present and proposed future mining will take place. Very little work has been done on small streams in eastern Montana and no information was available on the aquatic invertebrates and fish of Sarpy Creek. This study was conducted from spring 1975 through fall 1976 to obtain baseline information on these parameters. Little information is available on the ecology of prairie streams. Palmer (1919) and Jewell (1927) surveyed prairie streams in the midwest, and McCoy and Hales (1974) constructed a species list of organisms in South Dakota streams.

Although little is known about the effects of strip mining in the West, information from this study will be useful in determining future mining and reclamation procedures and their effects on Sarpy Creek.

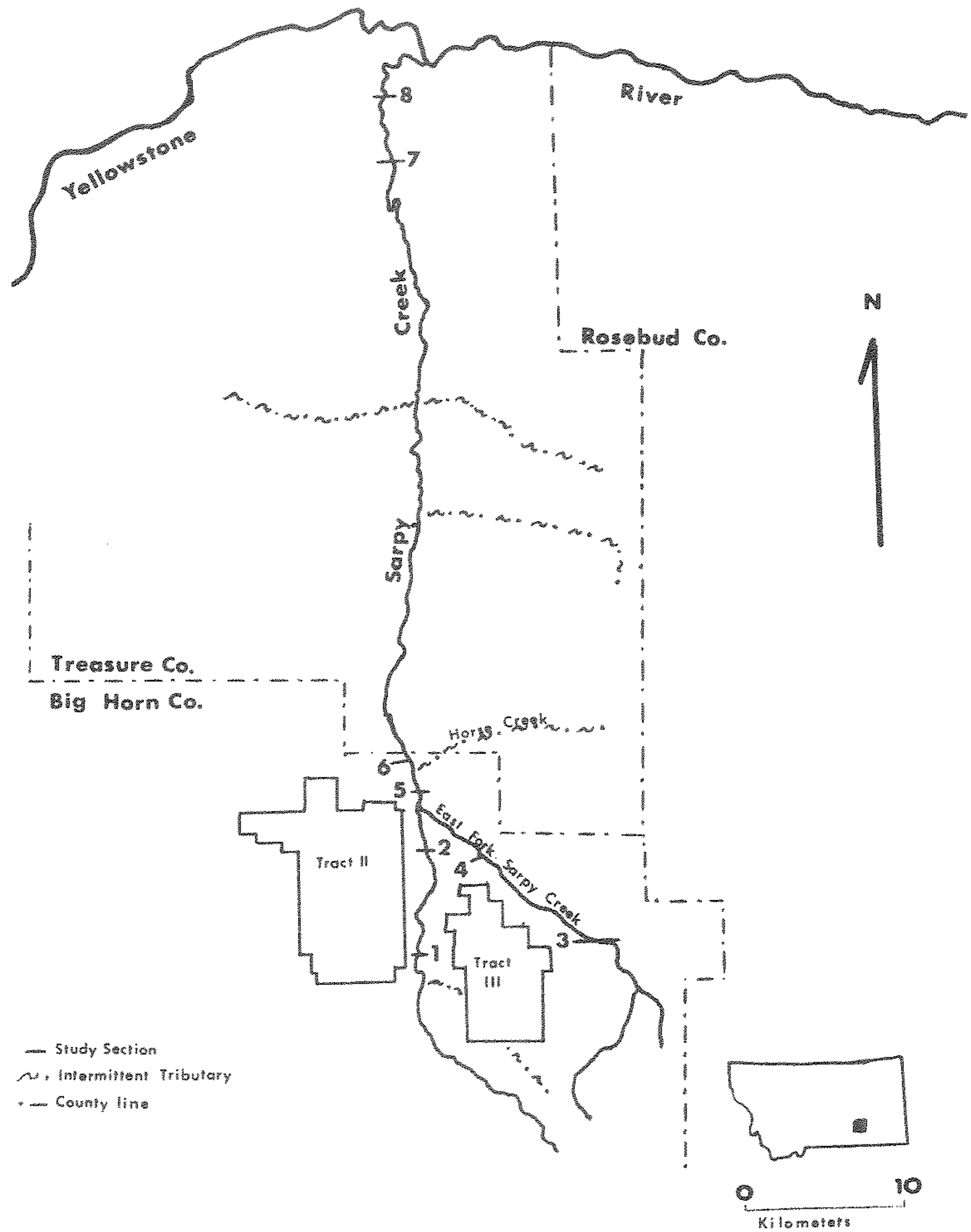

Figure 1. Map of study area, showing location of study sections.

DESCRIPTION OF STUDY AREA

Sarpy Creek arises in the Little Wolf Mountains at an elevation of 1298 meters and flows in a northerly direction for about 132 kilometers through Bighorn and Treasure counties. It empties into the Yellowstone River 8.8 kilometers east of Hysham, Montana, at an elevation of 790 meters (Fig. 1).

The average gradient of the creek is 3.2 m/km. Sarpy Creek drains an area of about 1171 sq. km. in which the major land use is agricultural. Livestock production is the main enterprise, but irrigated crops and non-irrigated cereal grain are also grown in the area (Moshier and Fielder, 1967).

Sarpy Creek is a transition between a typical woodland stream and a true prairie stream (Jewell, 1927). It dries up in late summer during years of average rainfall. In some years, it flows again in the fall and freezes over in winter. In years of particularly low rainfall, it remains dry during the fall except in areas of underground springs. An irrigation return flows into Sarpy Creek above the lowest study section and maintains flow during the late summer period.

Major tributaries are East Sarpy Creek and Horse Creek. Riparian vegetation consists largely of grasses and wild rose (*Rosa sp.*) with an interspersion of other shrubs.

The area is entirely underlain by non-marine strata of the Fort Union Formation, which consists of many beds of sandstone, shale and coal of great variability both in thickness and extent (Moshier and

Fielder, 1967). The valley walls are commonly steep, with sandstone and clinker forming ledges and cliffs in some areas.

Flows and water chemistry of Sarpy Creek have been monitored by the U.S.G.S. and Westmoreland Coal Co. during the past few years. Sarpy Creek waters are alkaline (pH 7.9-8.4), highly colored, slightly turbid, and very hard (100-2000 mg./l.). The water is predominately magnesium and calcium sulphate type, containing 2,000-4,000 mg./l. dissolved solids (BIA, 1976). However, significant amounts of sodium are also present in the water.

MATERIALS AND METHODS

Sampling Stations

Eight stations were sampled on Sarpy and East Sarpy Creek (Fig. 1). Stations one and two were located on Sarpy Creek above the confluence with East Sarpy Creek. Stations three and four were located on East Sarpy Creek above and below the present mine site, respectively. Stations five and six were located on main Sarpy Creek below the confluence of Sarpy and East Sarpy Creek. Stations seven and eight were located on lower main Sarpy Creek, a short distance above it's entrance into the Yellowstone River. Legal descriptions of all sites selected for study appear in the Appendix (Table 1A).

Stream Bottom Substrate

The stream bottom substrate in the eight study sections was classified by relative abundance of bottom substrate types. The scheme used was modified from Biological Field and Laboratory Methods (EPA, 1973).

Observations were made along transects at 3-meter intervals in each study section. Depending upon the width of the stream, one to three observations were made across each transect. The areas observed were enclosed by a metal ring with a diameter of 30 centimeters.

Streamside Cover

The streamside habitat was classified according to the amount of cover that it afforded the stream. The height of vegetation and extent of overhang above the creek were recorded with measurements made at 5-meter intervals. Dominant streamside vegetation was listed. Average channel width was also measured.

Aquatic Invertebrates

Because of soft, mucky substrate in the upper six sections invertebrate samples were collected using a Peterson grab (Fig. 2). Surber samplers were used in the two lower sections where the substrate is primarily rock (Fig. 2).

Samples were collected quarterly beginning with spring, 1975. Three samples were taken at each section. The major habitat types received the most intensive sampling. This data was used qualitatively because of the difficulty in obtaining quantitative information using only three samples (Needham and Usinger, 1956).

Invertebrates were also sampled with basket samplers for periods approximating 6 weeks, from spring through fall of 1976. The baskets were composed of 1-inch mesh chicken wire which was cut into 26 cm. x 24 cm. rectangles and formed into cylinders 24 cm. long with a diameter of 8.5 cm. Each cylinder was filled with pieces of "*scoria*"* ranging from 4-6 cm. in diameter. The baskets were suspended from 1/2" iron posts from 1-2 inches above the bottom of the stream. Five samplers

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* Formed from underground burning of coal beds which bakes the overlying strata into masses of brittle rock, often referred to as clinker. Locally it is called *scoria*.

were used at each station. During the spring interval, all baskets were anchored below riffle areas. Subsequent to this, baskets were placed at any spot in the section that contained water of sufficient depth to cover them. In many areas, the creek dried up in late summer.

To prevent loss of insects during sampling, a net was placed immediately downstream and below the basket to collect invertebrates dislodged during basket removals. Rocks were removed from the baskets and washed clean of invertebrates. Any plant material that attached to the basket was retained in the samples. Plant material that accumulated on the post but did not touch the basket was discarded.

The material from each sampler was placed in separate jars and preserved in 10% Formalin. Samples were taken to Montana State University where they were individually washed on a U. S. series number 30 screen. The invertebrates from each sample were hand picked from the material retained by the screen and placed in 10% Formalin.

The Peterson Grab samples from spring and early summer of 1976 were subsampled by the following method. The entire sample was weighed to the nearest gram, and half of the sample was retained for sorting and counting. Numbers of individuals were then multiplied by two for total number of individuals in the sample. Subsampling was necessary because of large quantities of plant material present in the samples.

The organisms were identified to genera using the following keys: Brown (1972), Pennak (1952), Roemhild (1975, 1976), Usinger (1962), Mason (1973), and Ward and Whipple (1963). Pentaneurini and Tanytarsini were identified using Beck and Beck (1966) and Roback (1957), respectively.

Fish

Fish were collected using a D. C. bank electroshocker and anesthesized with MS-222 (*tricainmethansulfonate*). Lengths were recorded in centimeters and weights in grams. All population estimates prior to the fall of 1975 were calculated using the Peterson mark-recapture technique (Ricker, 1968). Beginning with the fall estimates of 1975, population estimates were obtained using the DeLury method (DeLury, 1947). Three shocking runs were made on 150-meter sections and the estimates were calculated using methods described by Zippin (1957).

To meet the assumptions of this method, blocking nets were placed on each end of the sections while shocking was in progress. After each shocking run, stream turbidity was allowed to clear before the subsequent run, therefore, catchability remained essentially constant. Each run was completed in approximately the same amount of time in order to keep fishing effort constant. Holton (1954) noted that fish often avoid the electrode after being shocked previously. Sarpy Creek is narrow enough to shock all areas of a section, so fish avoidance of the electrode is assumed to be minimal.

Fish that could not be identified in the field were preserved in 10% Formalin and taken to Montana State University for positive identification.

At irregular intervals, 200-foot experimental gill nets were set at the mouth of Sarpy Creek at its confluence with the Yellowstone River. Fish were identified in the field with the use of Brown (1971).

RESULTS

Streambottom substrate:

Streambottom substrate was measured in the study sections in late July, 1975. The substrate data are presented in Figure 2.

The substrate of the six upstream sections is composed primarily of muck and plant material. The substrate of the two downstream sections is composed of rock with high amounts of silt.

Sections 1, 4, and 5 contained the highest amounts of muck. Sections 3 and 6 contained the highest amounts of decaying plant material. Egglishaw (1964) correlated high numbers of aquatic invertebrates with high amounts of detritus. Sections 2, 3, and 6 contain some rock substrate. The high amounts of muck and decaying plant material in the six upstream sections is due to the abundant vegetation both in and along the stream, coupled with the sluggish current of the stream.

The two downstream sections maintain a higher flow than the upstream sections. Section 7 is composed of many sizes of rock, from silt to coarse gravel. A considerable quantity of silt is present at this section. Section 8 could not be quantitatively observed because of high turbidities and deep water. This section is composed of all sizes of rock. A good deal of silt is also present at this section.

Streamside cover:

Some habitat characteristics were measured in and along Sarpy

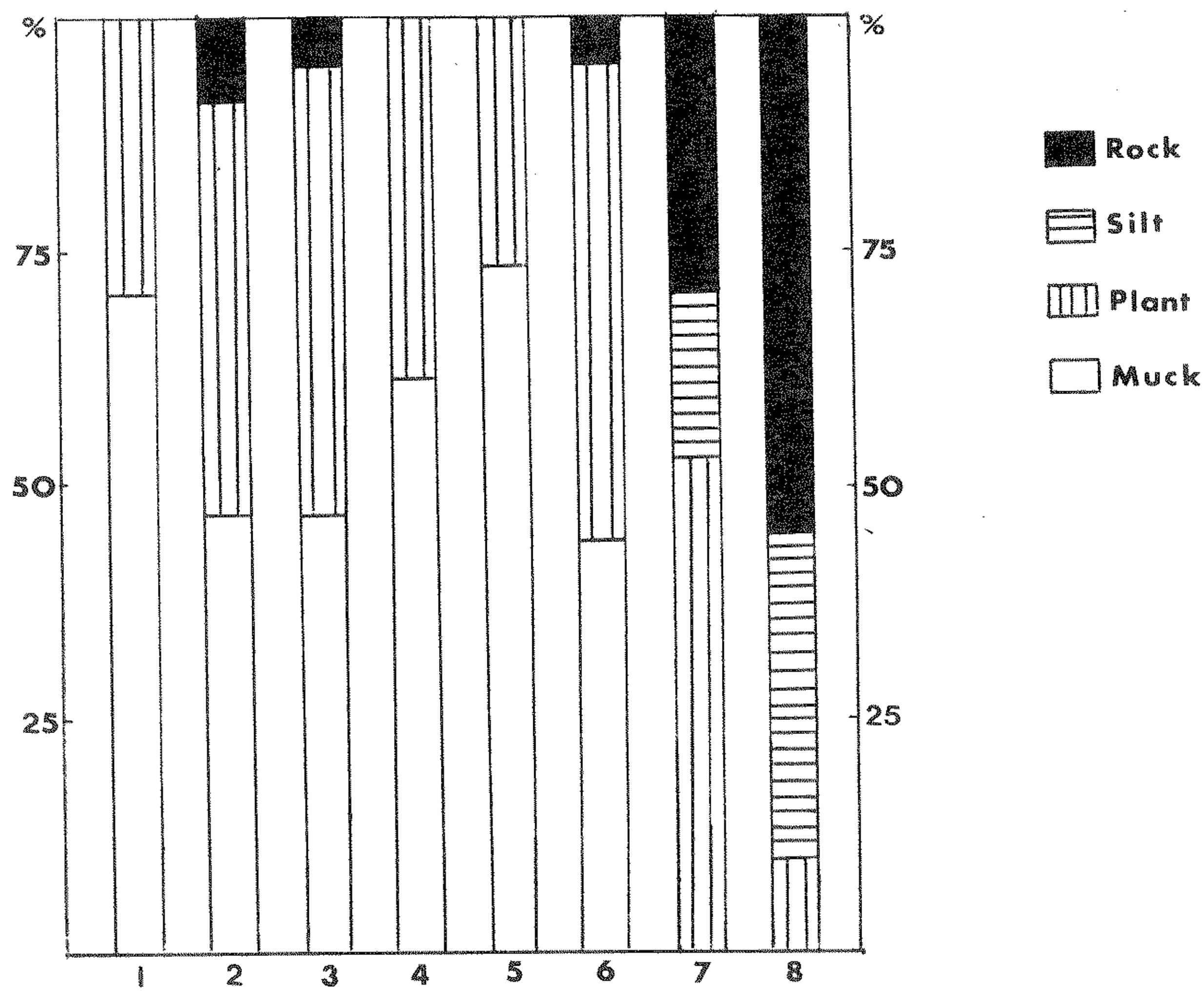

Figure 2. Percent composition of various streambottom substrates in the eight study sections.

Creek in the study sections on September 11, 1976, (Table 1).

Table 1 gives an estimate of the quality and quantity of streamside cover as well as a qualitative estimate of the major instream cover.

Sections 1, 2, 3, 5, and 6 were bordered by grasses. *Scirpus sp.* was present throughout section 4. Section 7 was bordered mostly by shrubbery. Section 8 was entirely covered by trees, but immediately measurable vegetation was sparse shrubbery. Sections 7 and 8 also contained debris and logjams in the channel.

Sections 5 and 8 had extensive undercut banks for fish cover. In the other sections, cover was mostly in the form of plants growing in and above the water.

Aquatic invertebrates:

Distribution: A list of the aquatic invertebrates and their distribution throughout the eight study sections is presented in Table 2. The entire Chironomid fauna was not identified, however, representatives of each collection were identified. Therefore, a distributional map would be incomplete, and a list of the genera that were identified is presented in Table 2.

Luedtke and Baril (1976) found a similar invertebrate fauna in Rosebud Creek, which lies just east of Sarpy Creek.

Table 1. Mean width, shoreline cover and aquatic vegetation in the study sections of Sarpy Creek as measured on September 11, 1976.

Station	1	2	3	4	5	6	7	8
Mean width (meters)	1.8	2.6	1.7	-	3.9	1.5	3.1	6.6
Mean extent of overhanging vegetation (meters)	.35	.23	.47	-	.94	.25	.31	.41
Dominant streamside vegetation and (% occurrence)	Grass (52) *Rosa sp.* (31)	Grass (42) *Carex sp.* (45)	Grass (53) *Rosa sp.* (42)	*Scirpus sp.* (70) Grass (20)	Grass (72) *Rosa sp.* (24)	Grass (100)	*Rosa sp.* (39) Grass (32) *Fraxinus sp.* (29)	*Fraxinus sp.* (41) (shrub) *Fraxinus sp.* (58) (tree)
Instream cover	*Potamogeton sp.* filamentous green algae	*Typha sp.* *Potamogeton sp.* filamentous green algae	*Chara sp.* filamentous green algae	*Scirpus sp.*	*Potamogeton sp.* undercut banks, water depth	*Chara sp.* filamentous green algae	fallen logs	fallen logs, branches, under-cut banks, water depth

Four genera maintained a continuous distribution throughout the study sections. These genera were *Caenis*, *Physa*, *Simulium*, and *Cheumatopsyche*. Many taxa exhibit a discontinuous distribution between stations. These groups were generally present in low densities and, therefore, were not collected at all sections. The varying habitat undoubtedly affects the distribution and abundance of many forms. This becomes evident when considering genera that were collected at a single station. *Phryganea* and *Ptilostomis* were collected only at section 1. Both were collected from a large, deep pool that was choked with aquatic vegetation during the summer months. *Glyphopsyche* was collected exclusively at section 3. This section was the only upstream section which seemed to maintain a small, but continuous flow throughout the year. *Culex* and *Tubifera* were collected exclusively at section 5. This section is deep and wide, with a very sluggish flow regime. This section contains high amounts of muck in the substrate (Figure 2). Several taxa were collected exclusively at section 8. These taxa probably reflect a true distributional difference and not sampling error because this section has an entirely different substrate and flow regime than the upstream sections (Figure 2). The nine genera collected exclusively at this section were *Asellus*, *Hetaerina*, *Tricorythodes*, *Stenonema*, *Ephemerella*, *Choroterpes*, *Ephoron*, *Mystacides*, and *Isoperla*. These genera preferred the rubble and silty substrate of section 8, and were not collected in the soft bottom

Table 2. Checklist and distribution of aquatic macroinvertebrates in Sarpy Creek, Montana, April, 1975 to November, 1976.

	1	2	3	4	5	6	7	8
Ephemeroptera								
Caenis sp.	X	X	X	X	X	X	X	X
Callibaetis sp.	X	X	X		X	X		
Baetis sp.							X	X
Leptophlebia sp.						X		
Tricorythodes minutus (Traver)								X
Stenonema sp.								X
Ephemerella sp.								X
Choroterpes sp.								X
Ephoron album (Say)								X
Trichoptera								
Limnephilus sp.	X	X	X	X	X	X		
Glyphopsyche sp.			X					
Polycentropus sp.	X	X			X	X	X	
Ptilostomis sp.	X							
Phryganea sp.	X							
Hydroptila sp.		X						
Cheumatopsyche sp.	X	X	X	X	X	X	X	X
Hydropsyche sp.							X	X
Mystacides sp.								X
Plecoptera								
Isoperla sp.								X
Coleoptera								
Agabus sp.	X	X	X	X	X	X	X	
Tropisternus sp.	X	X	X					
Berosus sp.						X		X
Dubiraphia sp.	X	X	X	X	X	X		X
Stenelmis sp.								X
Haliplus sp.	X	X	X	X		X		

Table 2. Continued.

	1	2	3	4	5	6	7	8
Odonata								
Aeshna sp.	X	X	X	X	X	X		X
Libellula sp.	X	X						
Gomphus sp.		X				X		X
Ishnura sp.	X	X	X	X	X	X		X
Amphiagrion sp.	X	X	X	X		X		
Enallagma sp.	X	X	X		X	X		
Argia sp.			X	X				X
Hetaerina americana (Fabricius)								X
Hemiptera								
Corixidae	X	X						
Notonecta spinosa (Hungerford)	X	X						
Notonecta kirbyi (Hungerford)	X							
Ambrysus mormon (Montandon)			X			X		
Diptera								
Chironomidae*	X	X	X	X	X	X	X	X
Culicoides sp.	X		X		X			
Palpomyia complex	X	X	X	X		X		
Tipula sp.	X					X		
Hexatoma sp.	X	X	X	X		X		
Simulium sp.	X	X	X	X	X	X	X	X
Euparyphus sp.	X	X						
Eulalia sp.	X							
Stratiomys sp.		X		X		X		
Chrysops sp.	X	X	X	X	X	X		
Tabanus sp.		X	X			X	X	
Chaoborus sp.	X				X			
Culex sp.					X			
Tubifera sp.					X			

Table 2. Continued.

	1	2	3	4	5	6	7	8
Malacostraca								
Asellus sp.								X
Hyalella azteca (Saussure)	X	X	X	X	X	X	X	
Mollusca								
Physa sp.	X	X	X	X	X	X	X	X
Lymnaea sp.	X		X					
Pisidium sp.	X	X	X	X	X			X
Hirudinea	X	X	X	X		X		X
Oligochaeta	X	X	X	X	X	X		X

* Chironomidae: *Rheotanytarsus sp., Orthocladius sp., Dicrotendipes sp., Chironomus sp., Micropsectra sp., Paratendipes sp., Cricotopus sp., Procladius sp., Conchapelopia sp., Parachironomus sp., Cryptochironomus sp., Endochironomus sp., Tribelos sp., Microtendipes sp., Diplocladius sp., Trissocladius sp., Psectrotanypus sp.*

substrates of the upstream sections.

The most widely distributed mayflies in the creek were *Caenis* and *Callibaetis*. These two genera inhabit similar areas in Sarpy Creek. Slow moving or stagnant water which contains high amounts of vegetation is their preferred habitat (Edmunds et al., 1976). The other genera of mayfly collected in significant numbers in Sarpy Creek was *Tricorythodes*, which was abundant in section 8. Edmunds et al. (1976) have found *Tricorythodes* living among fine sand and gravel in streams which maintain a perceptible current. Such habitat conditions are characteristic of section 8. *Tricorythodes* has also been collected in areas which dry up seasonally (Edmunds et.al., 1976), however, this was not true of Sarpy Creek.

The caddisflies *Limnephilus* and *Polycentropus* were well distributed throughout the study sections. *Polycentropus* spins a snare like structure in still water which would allow them to inhabit the slow moving areas (Philipson, 1954). *Cheumatopsyche* and *Hydropsyche* have similar habits but were found to have different distributions. *Cheumatopsyche*, was collected in all sections, but *Hydropsyche* was only collected in the two downstream sections. *Hydropsyche* is found in colder, larger streams than *Cheumatopsyche* (Ward and Whipple, 1963). The two downstream sections carry more water than the upstream sections and are bordered by trees which shade the stream (Table 1). Therefore the water temperatures do not fluctuate as widely as in the upstream sections. These two genera spin nets which are used to capture food in flowing water (Hynes, 1970). The presence of *Cheumatopsyche* in the upstream sections suggests that it can adapt to slower moving water, higher temperatures and softer substrates, which are limiting the distribution of *Hydropsyche*.

Stoneflies were collected in section 8. *Isoperla* was collected during the Spring of 1976. This is probably the only section they inhabit. Excessive temperatures and intermittency coupled with unsuitable substrate in the upstream sections, limits stoneflies to section 8.

Agabus, *Dubiraphia*, and *Haliplus* show the most uniform distribution among the beetles. *Dubiraphia* is associated with vegetation of slow moving streams (Ward and Whipple, 1963). Brusven (1970) found adult elmids to have a higher occurrence in the drift than the larvae. In this study, the larvae were more abundant on the baskets which may be due to differential colonization between larvae and adults.

Hemiptera are characteristic of still or slow moving waters. Roemhild (1976) has collected *Ambrysus mormon* in the transitional zone of streams like Sarpy Creek which head in the mountains and flow through the prairies.

Aeshna was the most common dragonfly in Sarpy Creek. This climber moves about in the dense vegetation of still waters (Pennak, 1953). The damselflies which are common in Sarpy Creek also inhabit similar areas. One exception is *Argia* which Hynes (1970) found in stony riffles. *Argia* was collected most often in section 8 which contains this type of habitat, however, it was also collected in sections 3 and 4 of East Sarpy Creek which contain very little stony substrate.

Most Diptera showed a scattered distribution throughout the sections. *Simulium*, which requires running water for feeding purposes, was continuous throughout all sections, indicating that short stretches of flowing water are present throughout the creek.

Hyalella azteca was commonly collected in all upstream sections. Pennak (1953) found it to be widely and commonly distributed in slow moving waters.

Snails, oligochaetes, clams and leeches were also common in the slow moving waters of Sarpy Creek.

Abundance:

Figures 3 and 4 show the relative abundance of the invertebrates in each study section. The basket and substrate samplers (Peterson grabs and Surber samples) show many similarities in the predominant groups, but there are obvious differences also.

Both collecting methods indicate Diptera to be the dominant group in most sections. The baskets show a dominance of Diptera in all sections except 3, 6, and 8. In these three sections, Amphipoda, Ephemeroptera, and Trichoptera, respectively, are more plentiful than Diptera. The substrate samplers indicate Amphipoda as the

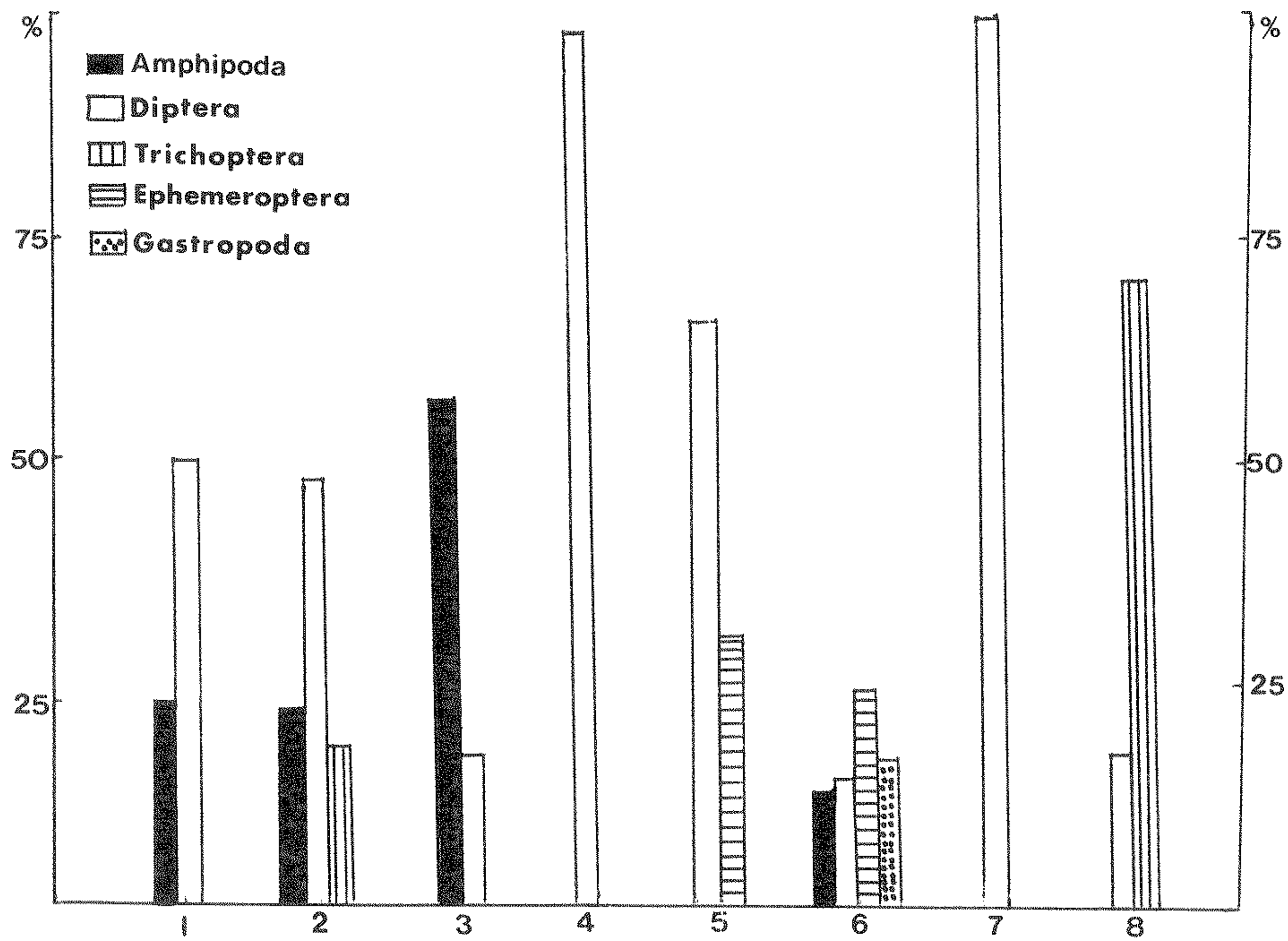

Figure 3. Relative abundance of dominant invertebrates as collected on basket samplers.

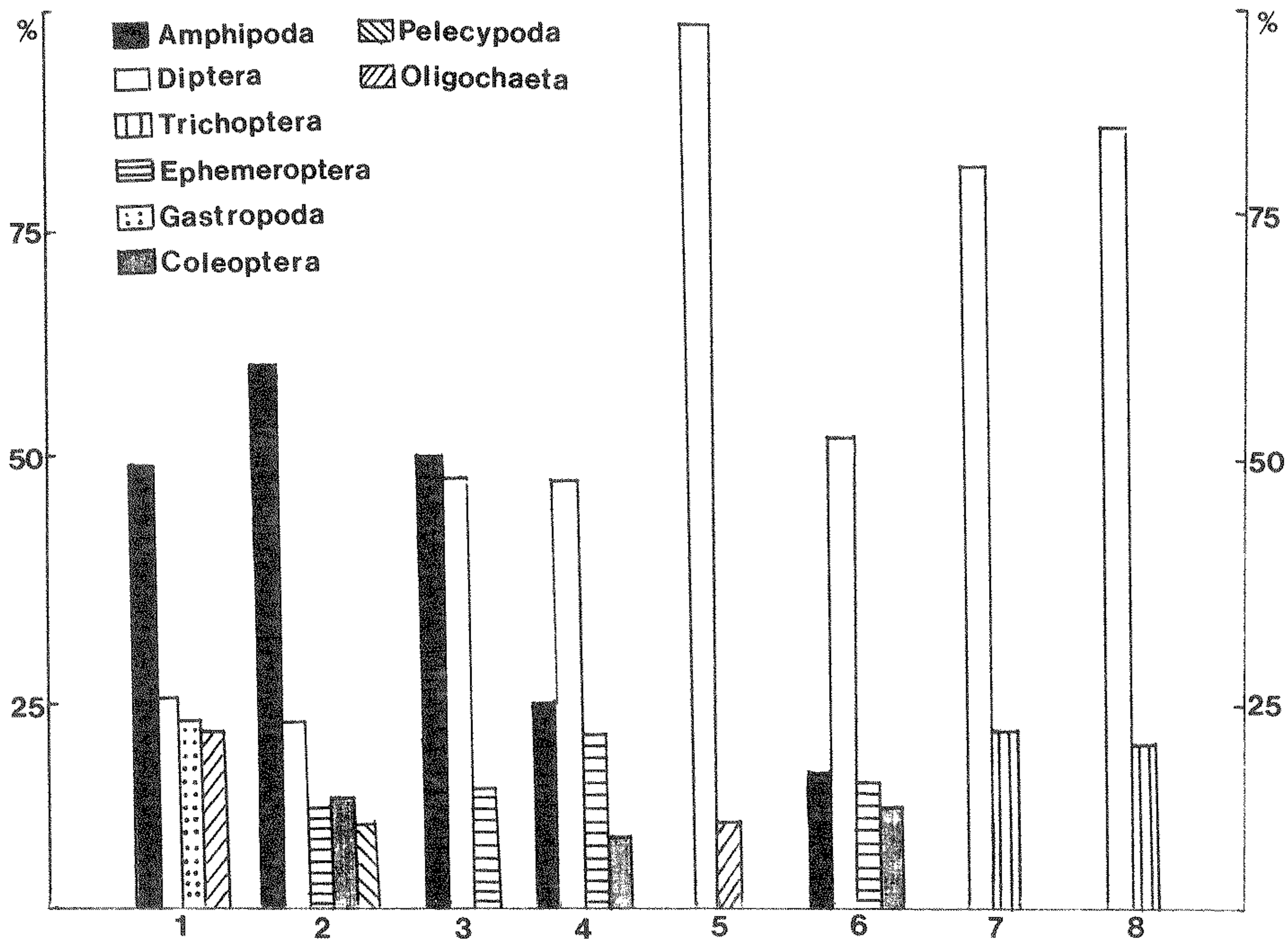

Figure 4. Relative abundance of dominant invertebrates collected in substrate samplers.

dominant group in sections 1, 2 and 3, whereas Diptera is dominant in sections 4-8.

The different results obtained between the sampling methods illustrate the variability of the stream, as well as differences in the selectivity of the sampling methods.

Both methods indicate Diptera to compose over 50% of the taxa in sections 5 and 7. Section 5 is dominated by *Chironomus*. This "bloodworm" thrives in the low oxygen habitat in the muck of this section. Section 7 is the only section that was observed to dry up in both years of the study. As the waters begin to return, this section supports a low population of specialized taxa with *Simulium* and Chironomidae dominant. Hynes (1958), Larimore (1959), and Patrick (1959) studied re-establishment of benthos after a previously dry streambed was flowing again and reported a dominance of *Simulium* and Chironomidae.

The high numbers of amphipods *(Hyalella azteca)* in the upper sections, and their continuing presence through section 6 is related to *Hyalella's* preference for slow moving waters containing high amounts of aquatic vegetation. Cooper (1965) and Eggleton (1952) mention a high correlation between aquatic vegetation and *Hyalella azteca*.

Section 8 is the only section which caddisflies dominate. This is attributed to two genera, *Cheumatopsyche* and *Hydropsyche*. These two genera prefer the rocky substrate and flowing water of this section to the stagnant conditions of the upstream sections.

Section 6 depicts a relatively high number of mayflies, *Caenis* being the dominant group. They are common in soft silty substrates and readily colonized the baskets in this section.

Oligochaetes were important in some grab samples, but were not found to be important in basket collections since the baskets do not sample the sediments inhabited by the oligochaetes, and this group infrequently drifts (Larimore, 1974).

Although the baskets and substrate samplers were collected during different seasons, adequate overlap occurred so that some general comparisons between the methods can be made. Exclusive of Chironomidae, the baskets collected 51 taxa, while the substrate samplers collected 38 taxa. The baskets collected 18 taxa not represented in the substrate samplers while the substrate samplers collected 4 taxa not collected in the baskets. Anderson and Mason (1968) also found baskets to collect more groups than dredges. They found that dredges collect different groups than baskets and suggest using both methods to evaluate pollution effects. Larimore (1974) also found this to be true and he listed several possible explanations.

Due to shifting substrates and rapidly dropping water levels during the summer, the spring interval was the only period in which enough baskets were colonized to allow quantitative information to be analyzed. Of 160 baskets set out during the study, only 91 were considered unaltered by physical conditions.

The use of only one sampling interval to derive quantitative data leaves many questions unanswered. However, an intermittent stream, such as Sarpy Creek, lends itself to useful quantitative data only at this time of year. Stehr and Branson (1938) found that in an intermittent stream, differences in habitat do not affect the faunal sampling as drastically when the stream is flowing, because substrate and habitat differences are minimal in the spring. However, as the stream dries, habitat differences become more pronounced. The interval chosen for evaluation was March 28 - May 14, 1976.

Figure 5 depicts the relative abundance of taxa in each section at this time. Diptera are dominant in all sections. This dominance is mostly attributable to Chironomidae. However section 4 was almost entirely dominated by *Simulium* which Hynes (1970) found to be a sporadic colonizer.

Although this sampling interval probably provides the best quantitative data, analysis of variance indicates the means to be so highly variable that no firm conclusions may be drawn.

The high variation is undoubtedly related to the high variability in habitats found in these warm water streams. Quantitative data is almost entirely lacking in streams comparable to Sarpy Creek (Larimore, 1974).

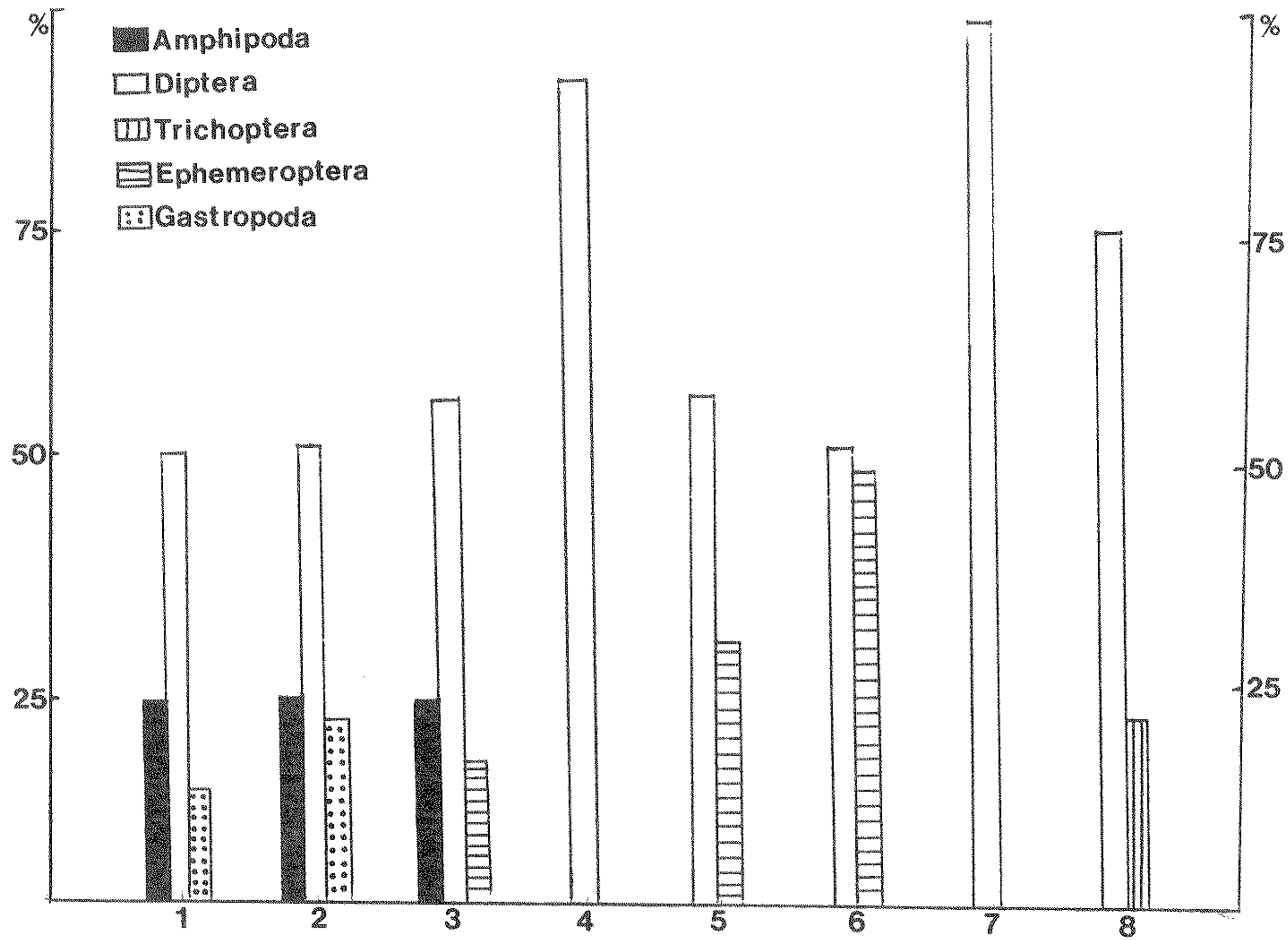

Figure 5. Relative abundance of dominant invertebrates collected on basket samplers from March 28 - May 14, 1976.

Fish:

Distribution:

The distribution of fish species in the eight study sections of Sarpy Creek is given in Figure 6. Elser and Schreiber (1977) collected 16 of these species in Rosebud Creek, which is located just east of Sarpy Creek and is similar in many respects.

Although the white sucker is the dominant species in Sarpy Creek, section 1 contained only two species; fathead minnows and lake chubs. In the August estimate, this section was composed of separate pools with no connecting flows. During low periods, fathead minnow was the only species collected. Starrett (1950) found that fathead minnows did not tolerate competition with other species and preferred streams with high amounts of vegetation. Carlander (1969) reports that the fathead minnow survives in areas that other species can not tolerate.

The presence of lake chubs during the spring of the year could be a result of lack of competition between the two species. The two species may or may not have similar food habits (Baxter and Simon, 1970 and Held and Peterka, 1970) and are both capable of spawning on aquatic plants (Brown et al., 1970 and Baxter and Simon, 1970). This section of stream may not contain suitable spawning areas for other species, including the white sucker, which requires gravel on which to spawn (Reighard, 1920).

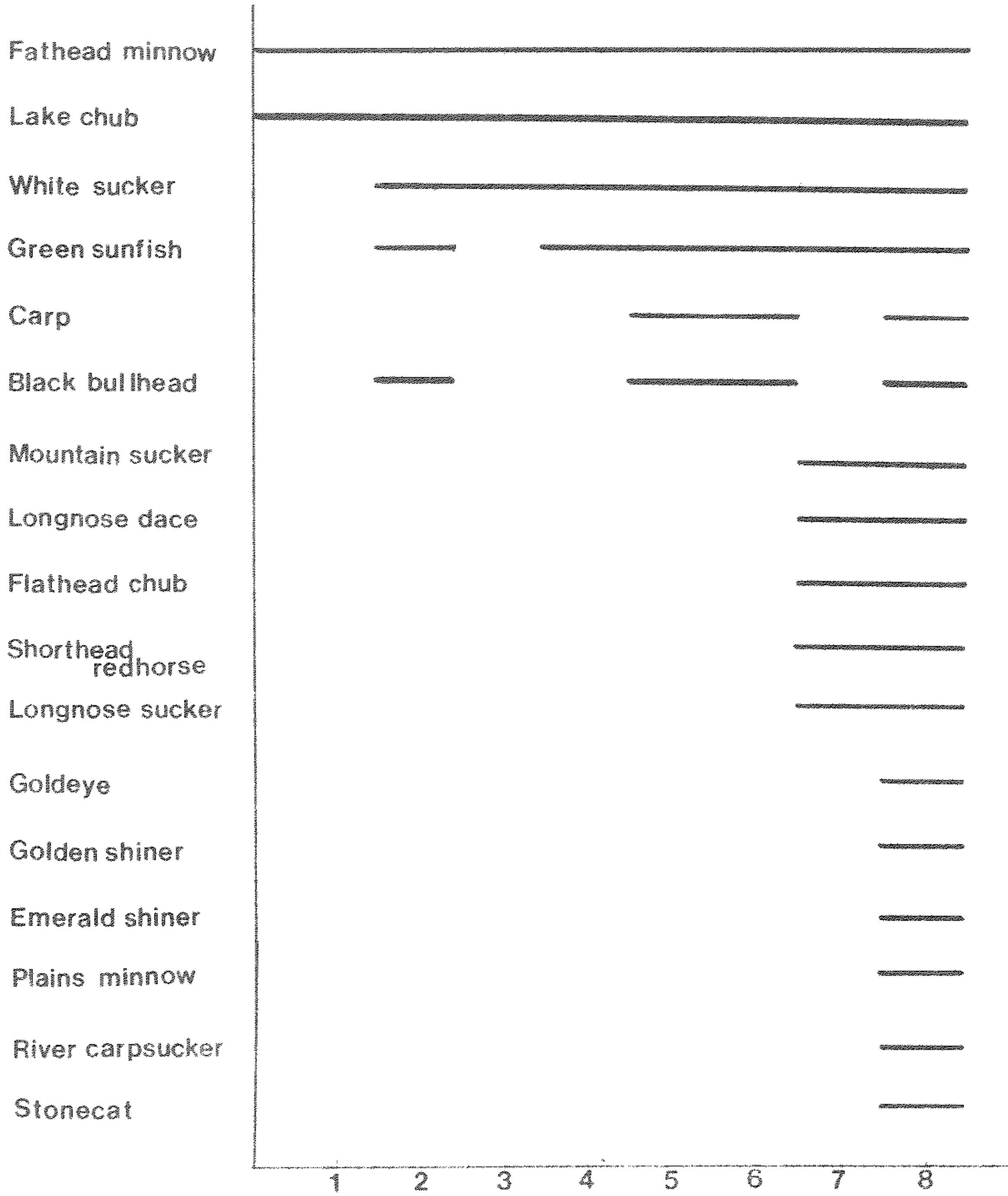

Figure 6. Distribution of fish species in the eight study sections of Sarpy Creek.

Figure 7 illustrates a general increase of species in a downstream direction, with section 8 supporting the greatest number of fish species. Regression analysis showed a positive correlation (r = .91) between miles from headwaters of each section and fish species collected in each section. Sheldon (1968) and Starrett (1950) reported similar findings. The reason for the high number of species in section 8 is the contribution of migrating fish from the Yellowstone River. Elser and Schreiber (1977) also found this to be true of Rosebud Creek. The comparatively stable flow in this section provides much better habitat than the severe upstream environment. The unusually high runoff of 1975 (Figure 8) attracted many large fish to this area (Clancey and Gregory, 1975). Fewer large fish were captured in the spring of 1976 (Tables 3-4A) and no large individuals were found above this area because of reduced flows. Section 8 maintains a flow all year as a result of the Yellowstone Canal irrigation return entering the creek approximately 1 kilometer upstream of the section.

The only important sport fish collected in Sarpy Creek were sauger *(Stizostedion canadense)* and burbot *(Lota lota)*. They were captured in gill net sets at the mouth of Sarpy Creek as it flows into the Yellowstone River.

Abundance:

The results of the population estimates conducted on the eight study sections of Sarpy Creek are tabulated in Tables 2A-5A. The

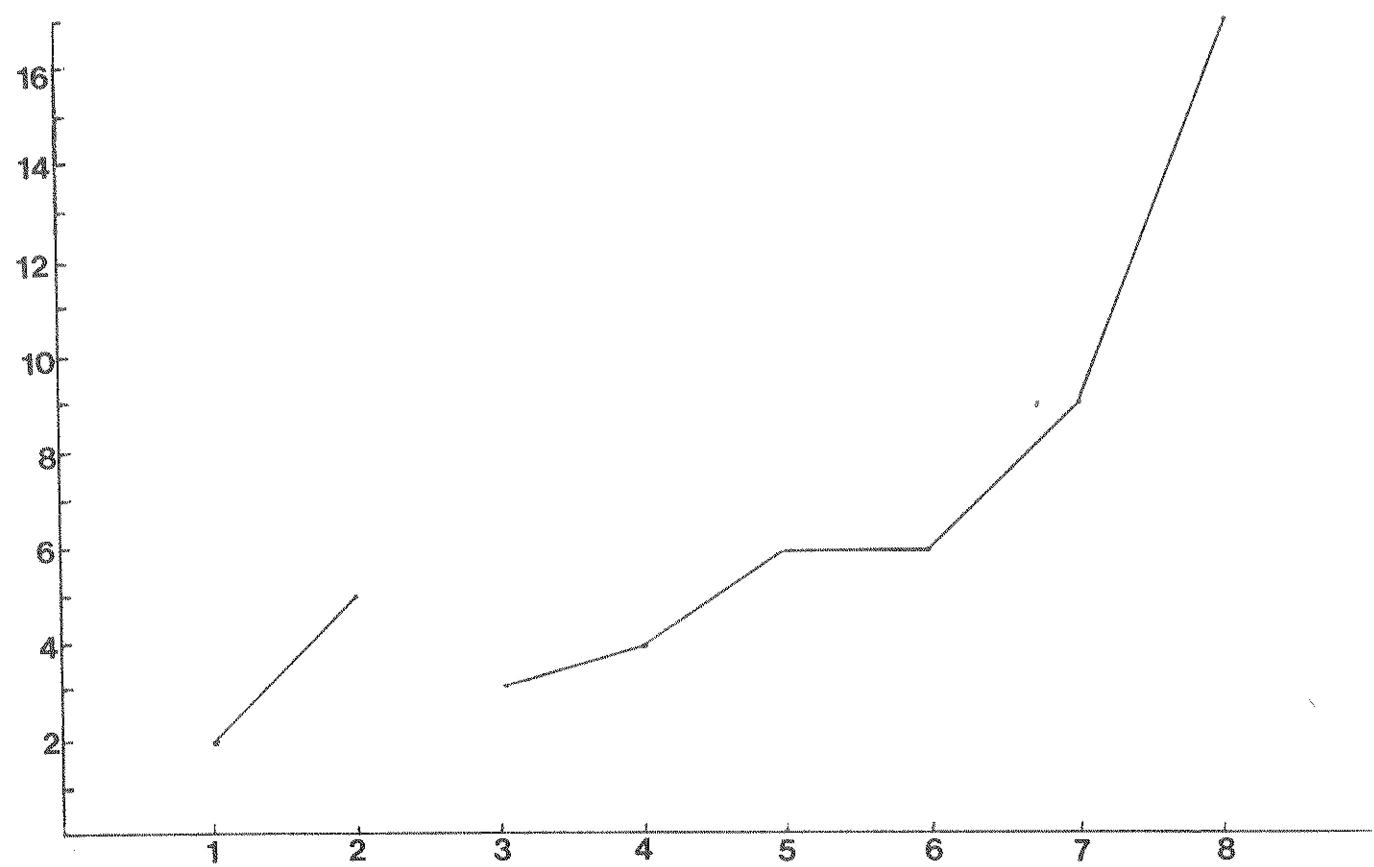

Figure 7. Number of fish species collected in the eight study sections of Sarpy Creek during 1975 - 1976.

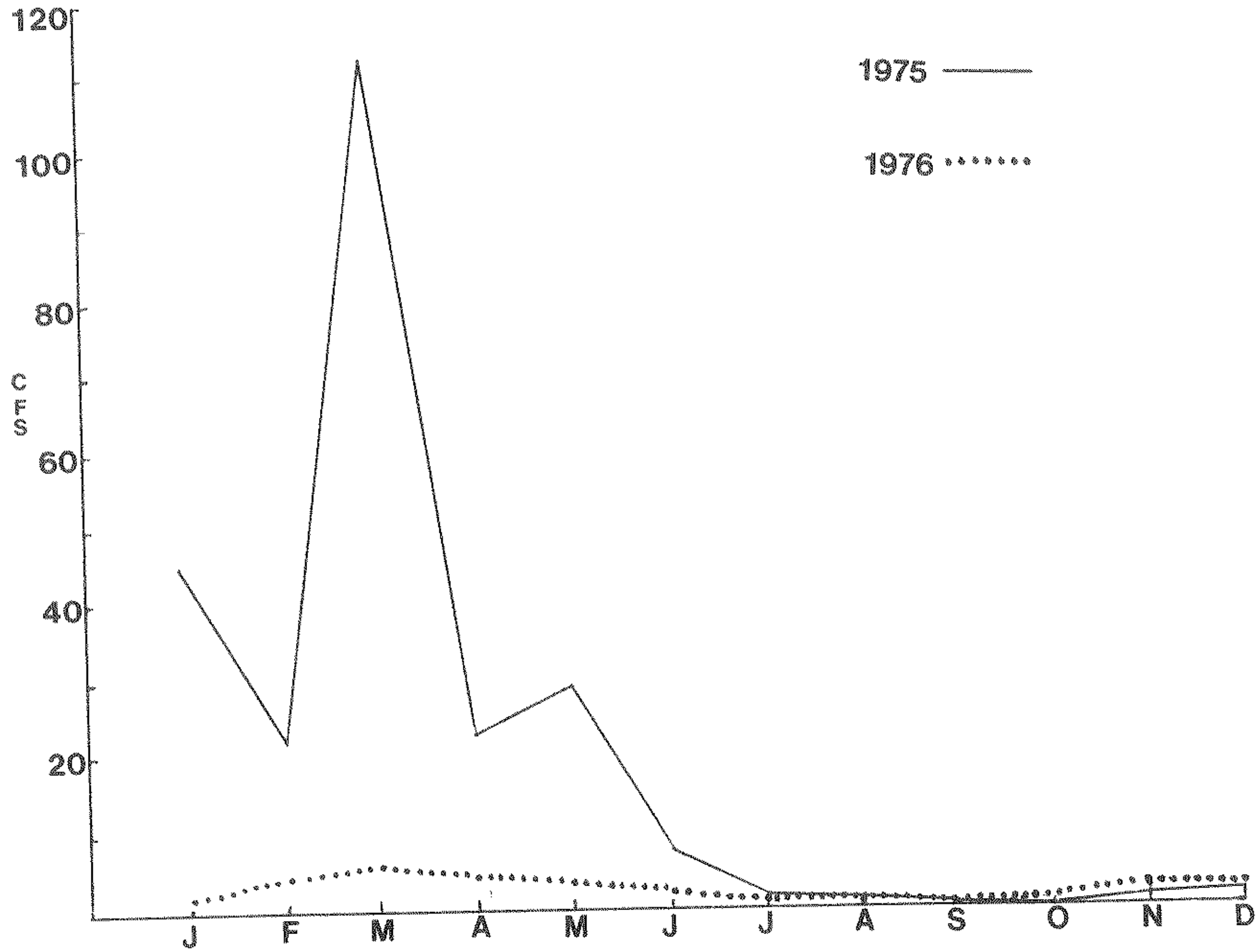

Figure 8. Discharge of Sarpy Creek during 1975 - 1976 (U.S.G.S., 1975 and U.S.G.S. unpublished data).

DeLury method was used on section 1-7, and the Peterson mark-recapture was used on section 8.

The DeLury method was used on sections 1-7 because of high mortalities caused by the high current flow (5 amperes) required to capture small fish and the high temperatures during the summer months. Pratt (1954) found that D. C. shockers caused low mortalities if fish were handled carefully, however, he was working with larger fish in cold water streams. Larimore (1961) reported high mortalities of minnows and suckers after shocking. Another problem with mark-recapture was a low incidence of recapture. Gerking (1950) found that sucker populations have large home ranges and were less territorial than other fish. Funk (1955) and Gunning and Berra (1968) reported warm water fish populations to have a sedentary group and a mobile group. Individuals of the sedentary group had a definite home range. Individuals of the mobile segment did not exhibit a home range and wandered unpredictably within the stream.

Section 8 supports the highest biomass of fish (Tables 2A-5A) due primarily to the high number of flathead chubs in this section. This portion of the creek is nearest the Yellowstone River and maintains flows year round, as stated earlier.

The white sucker predominates in the upper sections. The only other fish present in significant numbers is the lake chub.

Section 5 supports the greatest biomass of the six upstream sections, most of which is composed of white suckers. Section 5 is wide and deep with undercut banks and abundant aquatic vegetation (Table 1). Baxter and Simon (1970) state that this is one of the highly preferred habitats of the white sucker.

Wide variability in population estimates for the study sections reflects differing habitats and uneven distribution of fish (Funk, 1955 and Gunning and Berra, 1968). Larimore (1961) found these factors to be a significant problem in studying small warm water streams, because of such highly diversified habitats. Therefore, any estimate of fish populations based on electrofishing in a stream as variable as Sarpy Creek must be viewed with caution.

Although these factors mask any subtle differences, total biomass of the upper 6 sections for the four sampling periods does show some important trends (Tables 2A-5A). During October of 1975, the creek had resumed flow and the fish were dispersed in the creek. These populations remained stable through the early spring of 1976. In early summer of 1976, fish were spawning in shallower water and were captured more easily. By August, the flows were at their lowest and populations were limited to large, deep pools.

Drying of the stream left fish and invertebrates in isolated pools during the warmest time of year. Young and Zimmerman (1965) reported temperatures in these pools may greatly exceed the lethal limits of many of the inhabitants. Temperatures well in excess of

30°C were common in Sarpy Creek (BIA, 1976 and personal observation).

DISCUSSION

The variability of the habitats of Sarpy Creek makes it difficult to draw any firm quantitative conclusions about the fish and aquatic invertebrates therein. Warmwater streams have received less attention than cold water streams, therefore, little is known about sampling problems in the former (Larimore et al., 1961).

Scott (1958) found that stationary structures such as aquatic macrophytes and debris contained a higher number and more diverse fauna than the streambottom. Therefore, the use of as many collecting methods as possible is an advantage in a stream survey.

The high variability in aquatic invertebrate samples could be better controlled by collecting more samples. The use of fewer sampling stations and more samples per station would be a better indicator of trends than numberous stations with fewer samples per station.

Sarpy Creek may contribute to the sport fish populations in the Yellowstone River by serving as spawning grounds for sauger and other gamefish. Intermittent streams are sometimes used heavily by spring spawning fish(Erman and Hawthorne, 1976). Priegel (1969) noted that sauger spawning occurred within a seven day period in Lake Winnebago, Wisconsin. It is possible that sauger use lower Sarpy Creek as a spawning area and that fish collecting was not in progress during this period. However, gamefish were not collected above the mouth of Sarpy Creek, so their use of the creek may be minimal. Flathead chubs are probably used as forage by gamefish from the Yellowstone River.

In the upper sections of the creek, mortality may be high during dry years. Larimore et al. (1959) reported mortality of fish in similar streams from excessive temperatures, increased BOD, reduced oxygen, and decomposition as the waters stagnate. They also mentioned increased predation by small mammals and herons. Great blue herons *(Ardea herodias)* were commonly sighted along the pools during this time of year in Sarpy Creek.

As the weather cools during the fall and transpiration of riparian vegetation decreases, the streamflow returns and fish are free to disperse throughout the creek. If flow does not resume in the fall, fish remain in these pools, and mortality would probably be excessive. Decomposition of autumn shed leaves which fall into these pools causes high mortalities. Spring flows would allow re-invasion of the survivors (Larimore et al., 1959). I did not observe any return of flow in the fall of 1976 in most sections, so high mortalities may have occurred from fall through winter of 1976.

To the present time, strip mining for coal has had no noticeable effect on the fauna of Sarpy Creek. Sub-surface water from the aquifer in the coal seam is being pumped to a detention pond where it is allowed to settle. Therefore, no wastewater from the mine is presently draining into the creek. When mining activity is increased in the future, precautions will have to be taken for handling this water.

Acid mine drainage will probably not occur in this area because of a relatively low sulfur content in the coal, alkaline ground water to act as a buffer, and unleached overburden to act as a buffer (BIA, 1976). Water quality of any settling pond effluent should be thoroughly monitored.

Disturbance of the aquifer may result in changing patterns of flow in Sarpy Creek. Preliminary reports have shown water levels to decline in the areas of mining (Van Voast and Hedges, 1975). This could cause decreased amounts of water available to Sarpy Creek, especially during the critical summer and fall periods of low water when spring water is the only source of flow for the creek. Detention of water at mine sites could also cause decreased flow in the creek. However, after reclamation, water tables may rise to premining levels (BIA, 1976).

If flow patterns or water quality changes, species composition and distribution of fish and aquatic invertebrates in Sarpy Creek could change. Rare species may become more prevalent and common groups such as white suckers, *Hyalella azteca*, and Chironomidae may be altered.

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APPENDIX

Table 1A. Legal descriptions of study sites on Sarpy Creek.

Study Site	Township	Range	Location
1	T1N	R37E	SE^4, NE^4, Sec. 33
2	T1N	R37E	SE^4, NW^4, Sec. 10
3	T1N	R38E	NE^4, SW^4, Sec. 22
4	T1N	R37E	NW^4, NE^4, Sec. 12
5	T2N	R37E	NW^4, SE^4, Sec. 21
6	T2N	R37E	SE^4, SW^4, Sec. 16
7	T6N	R37E	NE^4, SW^4, Sec. 30
8	T6N	R37E	NW^4, NE^4, Sec. 7

Table 2A. Population characteristics of fish in Sarpy Creek during electrofishing from October 11 - November 11, 1975.

Section	N	S.E.	Avg. length (cm.)	Avg. weight (gm.)	Biomass (gm.)
1	7.0 FHM	0.2	5.8	2.6	18.2
2	8.0 LC	0.0	5.2	1.8	14.4
	2.0 GS	0.0	3.3	0.8	1.6
					16.0
3	30.0 WS	0.0	10.5	20.1	603.0
	35.3 LC	0.6	7.7	5.1	180.0
	38.0 FHM	0.1	6.2	3.1	117.8
					900.8
4*	261.2 WS	45.5	5.8	3.0	783.6
	280.8 LC		7.1	4.2	1179.4
	11.3 FHM	12.4	6.8	3.7	41.8
					2004.8
5	213.6 WS	3.7	11.7	28.2	6023.5
	40.1 FHM	9.5	6.3	2.9	116.3
	15.1 Carp	1.9	10.0	15.7	237.1
	82.6 LC	3.6	3.1	4.6	380.0
	1.0 BB	0.0	17.3	74.0	74.0
	1.0 GC	0.0	3.9	1.0	1.0
					6831.9
6	17.5 WS	1.0	10.3	17.6	308.0
	5.8 LC	5.4	5.7	2.3	13.3
	8.3 FHM	8.0	6.2	2.8	23.2
					344.5

Table 2A. Continued.

Section	N	S.E.	Avg. length (cm.)	Avg. weight (gm.)	Biomass (gm.)
FHC 8*	4133.0 captured in 2 runs	473.0	13.6	31.8	65,714.7
SHR	20		7.7	4.6	
LDN	15		5.3	1.2	
GS	7		7.2	6.1	
LNS	11		15.7	26.9	
Carp	1		12.8	21.0	
FHM	1		5.2	2.0	
WS	17		17.2	101.3	
ES	3		-	-	

* 1000 ft. sections

Table 3A. Population characteristics of fish in Sarpy Creek during electrofishing from March 23 - 31, 1976.

Section	N	S.E.	Avg. length (cm.)	Avg. weight (gm.)	Biomass (gm.)
1	32.1 FHM	0.5	5.5	2.1	67.4
	2.0 LC	0.0	4.2	1.3	2.6
					70.0
2			No fish		
3	46.2 WS	0.6	12.4	24.8	1145.8
	90.2 LC	0.5	8.3	6.6	595.3
	6.2 FHM	0.5	5.9	2.8	17.4
					1758.5
4	53.0 WS	0.0	13.4	30.7	1627.1
	31.1 LC	0.3	8.9	8.0	248.8
					1875.9
5	47.1 WS	3.6	16.9	66.7	3141.6
	6.5 LC	1.2	7.6	6.0	39.0
					3180.6
6	34.7 WS	1.1	12.8	29.7	1030.6
	6.0 LC	0.2	6.8	4.5	27.0
	2.2 FHM	0.7	5.9	3.0	6.6
	3.1 GS	0.4	5.3	4.7	14.6
	6.0 Carp	0.2	7.4	7.3	42.8
					1122.6

Table 3A. Continued.

Section	N	S.E.	Avg. length (cm.)	Avg. weight (gm.)	Biomass (gm.)
7	1.0 LC	0.0	10.9	11.0	11.0
8	4.0 GS		12.0	10.8	
	3.0 MS		6.9	5.7	
	2.0 SHR		7.3	5.5	
	3.0 FHC		8.0	7.0	
	1.0 LND		3.2	1.0	

Table 4A. Population characteristics of fish in Sarpy Creek during electrofishing from June 23 - 30, 1976.

Section	N	S.E.	Avg. length (cm.)	Avg. weight (gm.)	Biomass (gm.)
1	5.0 FHM	1.0	5.8	2.8	14.0
2	1.0 WS	0.0	18.7	65.0	65.0
	14.3 FHM	0.7	7.2	4.4	62.9
	9.6 LC	3.1	7.0	2.7	25.9
	1.0 GS	0.0	9.3	15.0	15.0
					168.8
3	34.5 WS	1.8	14.7	35.3	1217.8
	7.4 FHM	1.0	6.6	3.7	27.4
	121.0 LC	6.5	7.4	4.3	520.3
					1765.5
4	120.2 WS	1.4	10.6	14.0	1682.8
	94.2 LC	1.4	8.0	5.4	508.7
	2.0 FHM	0.0	6.4	3.5	7.0
					2198.5
5	262.4 WS	11.8	15.5	46.8	12280.3
	9.5 FHM	6.3	7.5	4.8	45.6
	74.1 LC	12.3	9.8	10.2	755.8
	8.0 Carp	0.2	9.8	13.1	104.8
	2.2 GS	0.7	5.1	3.0	6.6
	1.0 BB	0.0	12.4	26.0	26.0
					13219.1

Table 4A. Continued

Section	N	S.E.	Avg. length (cm.)	Avg. weight (gm.)	Biomass (gm.)
6	14.3 WS	0.7	16.0	49.0	700.7
	20.9 LC	1.5	8.9	7.5	156.7
	7.0 GS	0.0	6.2	4.3	30.1
	4.0 FHM	0.0	6.7	3.3	13.2
					900.7
7	14.1 WS	0.3	19.6	93.4	1316.9
	17.5 LND	3.6	7.1	3.9	68.2
	25.8 FHM	19.1	7.2	6.8	175.4
	4.3 LC	1.0	9.6	15.5	66.6
					1627.1
8	1725.4 FHC	478.6	10.8	14.1	24328.1
	3.0 GE		31.0	239.0	
	25.0 HR		20.3	210.0	
	3.0 LNS		16.5	56.8	
	6.0 LND		5.8	2.3	
	3.0 GS		7.2	7.0	
	1.0 MS		11.9	23.7	
	5.0 Carp		22.7	175.0	
	9.0 WS		21.9	121.4	

Table 5A. Population characteristics of fish in Sarpy Creek during electrofishing from August 20 - 22, 1976.

Section	N	S.E.	Avg. length (cm.)	Avg. weight (gm.)	Biomass (gm.)
1	FHM		6.1	2.7	
2			Dry Creek		
3	44.7 WS	1.1	13.7	28.9	1291.8
	106.5 LC	2.1	7.3	4.2	447.3
	10.9 FHM	1.6	6.5	3.3	35.9
					1775.0
4	15.3 WS	0.6	12.5	22.3	341.2
	8.0 LC	0.1	8.3	4.7	37.6
	1.0 FHM	0.0	7.1	2.0	2.0
					380.8
5			Dry Creek		
6	1.0 WS	0.0	17.6	38.0	38.0
	1.0 GS	0.0	7.4	5.0	5.0
	8.7 LC	1.4	9.2	6.4	55.7
					98.7
7			Dry Creek		