Stream Fish Communities in the Marmaton River Sub-basin (Missouri and Kansas).

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ABSTRACT

Fish community structure in specific reaches can reflect the reach's habitat and water quality. Overall, fish can be used to assess the current and past conditions of a watershed, offering an integrated indication of watershed conditions. The current study describes the fish community in the Marmaton River sub-basin (HUC code 10290104) of southeast Kansas and west central Missouri and assesses the roles of selected environmental factors on its distribution and abundance. Twelve sites were sampled from the Marmaton River and its tributaries. The sites spanned the watershed from upper to lower and included three major land uses (urban, cropland, and pasture). Fish were sampled by electrofishing and seining. Water quality (minerals and nutrients) were sampled by standard methods and the physical habitat was assessed with five channel morphology measurements, four instream habitat classifications, and two riparian zone measurements. The collection consisted of 42 species from 10 families. The dominant family was Cyprinidae with 60.8% of all specimens collected from 10 species. The Red shiner, Brook silverside, Central stoneroller, and Redfin shiner comprised 67% of the total collection. The Red shiner was the most numerous species (53.4%) in the Marmaton River and second-most (11.5%) in the tributaries. The Central stoneroller was the most numerous in the tributaries (18.4%). Ordination procedures identified groups of sites associated with urban land use (wastewater influences) and watershed position. The water quality and habitat features associated with these groups varied and included the degree of mineralization, nutrients, and morphological features.

INTRODUCTION

In midwestern streams insectivorous cyprinids, such as the redfin shiner and creek chub, are the dominant trophic group and their relative abundance tends to decrease with increased environmental degradation.

Viable populations of top carnivores, the piscivorous fishes, are an indication of a trophically diverse and healthy community. Dominance by omnivorous species often occurs because of fluctuations in or the absence of resources utilized by more specialized fishes.

The current study characterizes the fish community in the Marmaton River sub-basin of southeast Kansas and west central Missouri and assesses the roles of selected environmental factors on its distribution and abundance.

MATERIALS AND METHODS

- Marmaton River sub-basin (hydrologic unit code 10290104) of the Osage basin located in southeast Kansas and western Missouri (Fig. 1)
- sampled from late July to early October 1999
- sample reaches = thirty times the average wetted width (minimum of 150 m or a maximum of 300 m)
- each reach divided into ten equal segments; each with one transect at the upstream end of the segment
- bounding transects selected where there was a natural or artificial fish barrier and a block net could be used across the channel to isolate the fish community
- five channel morphology: (bank incised height, bank-full height, bank angle, wetted width, and water depth) in each segment
- four in-stream habitat: (substrate particle size class, embeddedness rating, habitat type classification, and pool to riffle ratio)
- two riparian zone: (overhead cover and buffer zone widths
- discharge measured from a representative cross-section

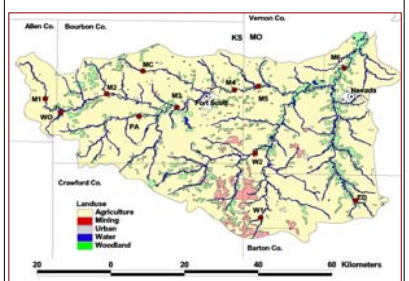

Fig. 1. Area map.

RESULTS - *Water Quality Overview (Table 1)*

- Three of the 5 sites in the eastern portion of the sub-basin (in Missouri) were more mineralized. At M6, W1, and W2, TDS was greater than 0.50 mg/L and conductivity over 1.0 mS/cm. Sulfates were highest at ED and W2 (over 1,000 mg/L), but was also high at M6 (285.0 mg/L). At M4 and M5, sulfate concentrations were intermediate (80.0 mg/L and 35.5 mg/L, respectively) and higher than the remaining sites (1.0-21.5 mg/L).
- TP was highest at M6 (0.46 mg/L) and MC (0.50 mg/L). TP at PA was third highest (0.41 mg/L), followed by the other sites in the 0.10-0.23 mg/L range.
- TRP highest again at M6 (0.39 mg/L), followed by MC at 0.30 mg/L.
- The highest NO3-N concentrations were found among the Marmaton River sites.
- Total NH3-N highest at M6 (0.63 mg/L), but similar among M4 (0.52 mg/L), MC (0.47 mg/L), and W1 (0.46 mg/L).

Table 1. Water quality summary. Data with replicates include means with standard error in parentheses. Site means with different lower case letters are significantly different (P<0.05).

Site	Dissolved Oxygen (mg/L)	Temp. (°C)	Turbidity (NTU)	TDS (mg/L)	Conductivity (mS/cm)	Sulfate (mg/L)	Iron (mg/L)	Total Phos. (mg/L)	TRP (mg/L)	Nitrate Nitrite-N (mg/L)	Total Total NH_3-N (mg/L)
M1	2.2	24	14.8	0.23	0.46	21.5 (0.50) d	0.12 (0.01) def	0.22 (0.01) d	0.10 (0.01) f	0.40 (0.00) d	0.39 (0.02) c
M2	4.9	19	8.8	0.17	0.35	18.5 (0.50) d	0.03 (0.00) fg	0.15 (0.01) d	0.11 (0.00) ef	1.15 (0.05) ab	0.25 (0.01) d
M3	5.6	21	16.9	0.21	0.39	19.5 (0.50) d	0.13 (0.03) de	0.20 (0.03) de	0.09 (0.01) f	0.80 (0.10) c	0.43 (0.02) c
M4	2.9	21	34.6	0.31	0.62	80.0 (0.00) b	0.22 (0.02) c	0.29 (0.02) c	0.16 (0.02) cd	1.10 (0.00) b	0.52 (0.01) b
M5	6.3	22	32.3	0.24	0.48	35.5 (0.50) d	0.12 (0.01) def	0.23 (0.03) d	0.15 (0.01) cde	0.15 (0.05) ef	0.26 (0.04) d
M6	7.4	16	71.8	0.52	1.02	285.0 (194.45) c	0.46 (0.35) b	0.46 (0.33) ab	0.39 (0.27) a	1.30 (0.99) a	0.63 (0.45) a
ED	3.0	23	14.5	0.12	0.25	1,224.0 (124.00)	0.06 (0.02) efg	0.10 (0.01) e	0.08 (0.011)	0.30 (0.00) de	0.40 (0.00) c
MC	6.7	10	33.4	0.15	0.29	18.5 (0.50) d	0.16 (0.03) cd	0.50 (0.04) a	0.30 (0.01) b	0.25 (0.05) de	0.47 (0.04) bc
PA	5.9	24	40.2	0.12	0.24	17.5 (0.50) d	0.41 (0.01) b	0.41 (0.01) b	0.16 (0.01) cd	0.70 (0.10) c	0.39 (0.02) c
W1	7.0	26	2.2	0.87	1.72	57.5 (17.50) d	0.76 (0.07) a	0.13 (0.00) fg	0.12 (0.01) def	0.40 (0.00) d	0.46 (0.01) bc
W2	.	.	11.4	1.23	2.45	1,018.0 (7.00) b	0.04 (0.01) fg	0.15 (0.01) efg	0.12 (0.04) def	0.00 (0.00) f	0.26 (0.04) d
WO	6.4	24	9.8	0.14	0.27	1.0 (0.00) e	0.02 (0.01) g	0.22 (0.00) d	0.19 (0.00) c	0.11 (0.01) f	0.15 (0.05) e

RESULTS - *Habitat Quality Overview (Table 2)*

- Maximum depth varied from 0.5-1.4 m among the river sites and 0.3-1.5 m among the tributary sites. Mean depth varied similarly, from 0.1-0.6 among the river sites and 0.1-0.3 among the tributary sites.
- Bank incised height (BIH) tended to be higher among the river sites compared to the tributary sites and bank full height (BFH) tended to be greater among the main river sites compared to the tributary sites. Bank-full width (BFW) and wetted width (WW) were narrowest among the tributary sites.
- Except for M1 and M2, mean substrate size classes (SSC) in the river sites were in the gravel to sediment classes. Only ED and W2 among the tributary sites were above SSC of 4.
- The lowest percentage overhead covers (OC) were found in the Marmaton River sites downstream of M1 and at the tributary site WO.
- Mean buffer zone width class (BZW) varied widely among all sites from 1.2 (0 to 20 meter range) to 4.0 (30 m or greater).

Table 2. Physical habitat summary.

Group	Parameter	Marmaton River M1	M2	M3	M4	M5	M6	Tributaries ED	MC	PA	W1	W2	WO
Channel Morphology	Maximum Depth (m)	0.9	0.9	1.4	1.0	1.1	0.5	0.9	0.3	0.3	0.6	1.5	0.7
	Mean Depth (m)	0.2	0.1	0.6	0.3	0.3	0.2	0.3	0.1	0.1	0.1	0.3	0.1
	Bank Incised Height (m)	1.6	3.4	4.5	3.8	5.5	5.3	3.4	2.5	2.8	2.2	3.6	1.8
	Bank-full Height (m)	0.6	0.9	1.0	1.3	1.0	1.4	0.9	0.8	0.6	0.7	0.8	0.6
	Bank-full Width (m)	14.5	17.1	22.2	21.8	16.7	25.6	8.7	10.9	10.6	11.1	16.0	12.7
	Wetted Width (m)	11.7	12.4	18.4	14.3	13.1	18.1	6.6	3.7	5.2	8.6	11.0	5.2
	Bank Angle (deg)	146	163.6	132.2	148.1	156.1	160.6	142.15	160.55	153.85	135.25	151.15	162.4
	Discharge (m^3/s)	0.00	0.00	0.00	0.00	0.04	0.33	0.00	0.00	0.04	0.05	0.05	0.01
Instream Habitat	Substrate Size (class average)	2.9	3.9	4.6	4.4	4.6	4.0	4.7	3.8	2.8	3.3	4.9	3.1
	Embeddedness (class average)	1.9	2.7	4.5	4.4	4.4	4.0	4.4	3.7	1.5	1.9	4.9	1.1
	% Pool	90	58	100	66	86	12	100	10	38	74	70	42
	% Run	0	0	0	22	4	68	0	0	46	14	30	2
	% Riffle	10	42	0	12	10	20	0	90	16	12	0	56
Riparian Zone	Overhead Cover (%)	45.0	29.5	19.5	32.5	31.5	8.0	52.0	40.0	68.0	84.0	48.5	18.5
	Buffer Zone Class Width	2.1	1.6	3.8	2.2	3.2	2.0	3.5	1.2	2.0	3.0	3.6	4.0
Watershed	Land Use	pasture	crop	crop	urban	crop	urban	pasture	pasture	pasture	pasture	pasture	crop

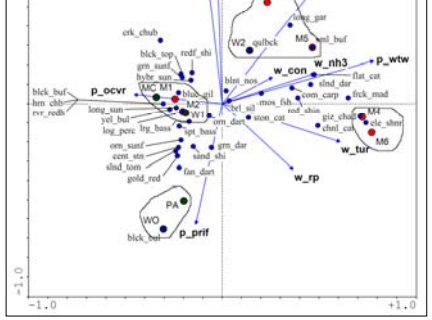

Fig. 2. Ordination diagram with selected environmental variables. Green circles are the tributary sites, red circles the main Marmaton River sites. Species are small blue dots.

RESULTS – *Ordination (Fig. 2)*

- Axis 1 includes overhead cover, conductivity, nutrients, turbidity, and wetted width.
- Axis 2 includes percent riffles, reactive phosphorus, percent pools, sulfates, and embeddedness.
- Five groups of sites can be approximately delineated in ordination space:
  1. M4 and M6 associated with increasing nutrients, turbidity, and wetted width.
  2. Several of the upper watershed sites (M1, M2, MC, and W1) formed a small group associated with increasing overhead cover variable.
  3. Sites M3, M5, and W2 tend to be associated with increasing embeddedness, conductivity, and total ammonia. These are the "middle watershed sites", both on the Marmaton River proper and the Drywood Creek tributary watershed.
  4. PA and WO tend to be associated with increasing percent riffle.
  5. A single site, ED, in the upper left central space with increasing percent pool and sulfates.

Table 3. Percentage abundance of fish based on catch per unit effort (fish/hour).

Scientific Name	Common Name	Marmaton River M1	M2	M3	M4	M5	M6	Tributaries WO	MC	PA	W1	W2	ED	All Sites	Main Sites	Tribs Sites	TP	TOL
Cyprinella lutrensis	Red Shiner	20.2	4.5	11.7	79.7	43.1	83.9	0.0	2.1	1.2	2.8	38.4	4.0	34.5	55.6	7.1	O	T
Labidesthes sicculus	Brook Silverside	29.6	30.1	40.9	3.6	12.3	4.3	10.9	1.0	2.7	16.7	14.1	1.6	11.1	13.9	7.5	I	M
Campostoma anomalum	Central Stoneroller	13.4	13.0	0.0	0.0	0.8	0.0	47.1	14.9	23.7	12.0	1.9	0.0	10.3	4.0	18.5	H	M
Lythrurus umbratilis	Redfin Shiner	9.6	18.7	31.8	0.0	0.0	0.0	0.0	7.2	0.8	28.7	3.8	10.4	6.8	5.9	7.8	I	M
Lepomis cyanellus	Green Sunfish	4.2	4.7	3.2	0.0	0.8	0.1	1.2	19.5	3.5	1.4	0.7	29.6	4.6	1.6	8.5	O	T
Pimephales notatus	Bluntnose Minnow	5.6	4.9	3.2	2.0	0.8	0.1	0.3	4.6	2.3	0.0	24.9	0.8	3.7	2.4	5.3	I	M
Lepomis macrochirus	Bluegill Sunfish	5.4	1.6	2.6	0.0	0.8	0.0	14.7	7.2	1.2	1.9	1.4	18.4	3.5	1.2	6.6	I	T
Etheostoma spectabile	Orangethroat Darter	0.0	2.7	0.6	0.2	5.4	0.3	0.9	15.4	5.4	7.4	2.4	0.0	3.2	0.9	6.3	P	M
Fundulus notatus	Blackstripe Topminnow	0.5	2.2	0.0	0.0	1.5	0.2	0.0	22.1	0.4	1.9	0.0	7.2	3.0	0.6	6.1	I	M
Etheostoma blennioides	Greenside Darter	0.0	0.9	0.0	0.2	0.8	0.0	0.0	0.0	28.4	0.9	3.4	0.0	2.9	0.2	6.5	I	M
Ictalurus punctatus	Channel Catfish	0.0	0.2	0.0	9.1	3.8	4.7	1.2	0.0	0.4	0.0	0.5	0.0	2.7	4.5	0.4	I	M
Noturus exilis	Slender Madtom	4.7	0.7	0.0	0.0	0.0	0.0	2.1	1.5	10.5	2.3	0.0	0.0	1.8	0.7	3.2	I	I
Lepomis megalotis	Longear Sunfish	1.9	4.9	0.0	0.0	0.0	0.0	0.9	0.0	0.8	12.0	1.9	0.0	1.7	1.1	2.5	I	I
Notropis ludibundus	Sand Shiner	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	10.1	3.2	1.2	0.0	1.3	0.1	2.8	I	M
Etheostoma flabellare	Fantail Darter	1.6	2.0	0.0	0.0	0.0	0.0	7.1	0.0	3.1	0.0	0.2	0.0	1.1	0.5	1.9	I	M
Micropterus punctulatus	Spotted Bass	0.5	1.1	1.9	0.0	0.0	0.0	5.3	0.5	0.8	0.0	0.0	0.8	0.7	0.3	1.3	O	M
Noturus flavus	Stonecat	0.0	1.6	0.6	0.3	3.8	0.4	0.3	0.0	1.9	1.4	0.7	0.0	0.7	0.7	0.8	I	I
Dorosoma cepedianum	Gizzard Shad	0.0	0.0	0.0	0.0	1.5	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.2	0.0	P	M
Percina phoxocephala	Slenderhead Darter	0.0	0.2	0.0	0.2	13.1	1.2	0.0	0.0	0.0	1.4	0.0	0.0	0.7	1.0	0.2	I	M
Gambusia affinis	Mosquitofish	0.7	0.4	0.0	0.7	4.6	0.2	0.0	0.0	0.0	2.8	1.7	0.0	0.7	0.6	0.7	I	I
Ameiurus natalis	Yellow Bullhead	0.0	0.0	0.6	0.0	0.0	0.0	2.9	1.0	0.8	0.0	0.0	2.4	0.5	0.0	1.1	O	T
Micropterus salmoides	Largemouth Bass	0.2	0.2	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.5	0.0	3.2	0.5	0.1	1.0	I	M
Percina caprodes	Log Perch	0.2	0.7	0.0	0.0	0.0	0.0	0.2	1.3	1.2	1.4	0.2	0.8	0.5	0.1	0.9	P	M
Noturus nocturnus	Freckled Madtom	0.0	0.0	0.0	2.1	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	I	T
Semotilus atromaculatus	Creek Chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.9	0.0	3.2	0.4	0.0	0.9	I	M
Pomoxis annularis	White Crappie	0.2	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	6.4	0.3	0.1	0.6	I	T
Polydictis olivaris	Flathead Catfish	0.0	0.0	1.3	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.2	0.4	0.1	P	M
Notropis atherinoides	Emerald Shiner	0.0	0.0	0.0	1.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.0	P	M
Lepomis gulosus	Warmouth	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.2	0.0	0.5	O	T
	Hybrid Sunfish	0.9	0.7	0.0	0.0	0.8	0.0	0.0	0.4	0.0	0.0	0.0	0.8	0.2	0.3	0.2	I	M
Nocomis biguttatus	Hornyhead Chub	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	I	I
Notemigonus crysoleucas	Golden Shiner	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.2	0.0	0.4	P	M
Cyprinus carpio	Common Carp	0.0	0.2	0.0	0.0	2.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	O	T
Lepomis humilis	Orangespotted Sunfish	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.1	0.1	0.1	I	M
Moxostoma erythrurum	Golden Redhorse	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.9	0.0	0.0	0.1	0.0	0.2	I	M
Ameiurus melas	Black Bullhead	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	I	M
Lepisosteus osseus	Longnose Gar	0.0	0.0	0.6	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	P	M
Catostomus commersonii	White Sucker	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.1	I	M
Lepomis microlophus	Redear Sunfish	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	O	M
Ictiobus niger	Black Buffalo	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I	M
Moxostoma carinatum	River Redhorse	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I	I
Ictiobus bubalus	Smallmouth Buffalo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I	M
Carpiodes cyprinus	Quillback	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	O	T
	Species Richness	17	26	13	12	18	14	18	13	20	18	20	16	43	36	34		
	Abundance	543.7	647.8	204.7	1,285.7	180.6	1,155.4	530.3	701.4	633.7	484.2	450.8	289.9					

RESULTS - *Tolerance and Trophic Guilds (Table 4)*

- Except for sites M4, M5, M6, and W2, the percentage of individuals classified as moderately tolerant was greater than 50%.
- At these four excepted sites, the percentage of tolerant species was highest of the three groups, ranging from 46.9% at M5 to 83.9% at M6.
- Insectivorous species were the majority of species at each site, varying from 7 of 13 at M3 to 20 of 27 at M2, but the majority of individuals at 7 of the 12 sites.
- Among the Marmaton River sites, omnivorous fish were most abundant at M4 (81.7%) and M6 (87.8%), while insectivorous fish were most abundant at M3 (80.5%) and M2 (75.7%).
- Among the tributaries, insectivores were the majority feeding guild at all sites except WO (insectivores and herbivores about equal) and W2, where omnivores were 63.5% of all individuals.
- Predators accounted for 4.8% of the river site individuals (6 of 36 species) and 4.2% of the tributary site individuals (5 of 32 species). The largest proportions of predacious fish were found at ED (16.0%), WO (10.2%), and M4 (10.1%).

RESULTS - *Richness and Evenness (Table 4)*

- Of the 43 species collected (including hybrid sunfish), almost equal numbers were found in the main stem sites (36) and the tributaries (34).
- Species richness varied unsystematically among the Marmaton River sites from 12 at M4 to 27 at M2.
- Among the tributaries, richness varied from 13 at MC to 21 at PA.
- Eveness varied in the Marmaton River from the two lowest values at M4 (0.34) and M6 (0.28) to 0.69-0.73 at the other river sites.
- Tributary site eveness varied from 0.63 to 0.81.
- Pooling individual site data, overall tributary eveness was 0.79 compared to 0.52 in the Marmaton R.

RESULTS - *Abundance of Species and Families (Tables 3 & 4)*

- The Red shiner was the most numerous species (38.0%), followed by the Brook silverside (12.8%), Central stoneroller (9.5%), and Redfin shiner (6.6%).
- Among the Marmaton River sites, the Red shiner comprised 53.4% of the collection and was 83.6% of the collection at M6, declining to 20.2% or less at the 3 upstream sites. The next most abundant species (Brook silverside and Central stoneroller) tended to be more abundant at the upstream sites M1 to M3 compared to the downstream sites M4 to M6.
- The Central stoneroller was the most abundant species in the tributaries (18.3%), while the Red shiner was second (11.5%) and the Brook silverside third (9.2%). While the Central stoneroller was over 10% of the collection at 4 tributary sites (WO, MC, PA, and W1), the Red shiner was dominant only at W2 with 38.4% of the collection.

Table 4. Fish community metrics. The sunfish metric excludes largemouth bass.

Metric	Marmaton River M1	M2	M3	M4	M5	M6	Tributaries WO	MC	PA	W1	W2	ED	All Sites	Main Sites	Tribs Sites
Species Richness	18	27	13	12	19	13	18	13	21	18	20	17	43	36	34
Shannon-Weiner Diversity Index	2.11	2.35	1.59	0.85	2.04	0.72	1.83	2.13	2.21	2.27	1.89	2.26	2.50	1.86	2.81
Eveness	0.73	0.71	0.62	0.34	0.69	0.28	0.63	0.81	0.72	0.78	0.63	0.80	0.66	0.51	0.80
Atherinidae (# species, % collection)	1 (29.6)	1 (30.1)	1 (40.9)	1 (3.6)	1 (12.3)	1 (4.3)	1 (10.9)	1 (1.0)	1 (2.7)	1 (16.7)	1 (14.1)	1 (1.6)	1 (11.1)	1 (13.9)	1 (7.2)
Catastomidae (# species, % collection)	0 (0.0)	2 (0.4)	0 (0.0)	0 (0.0)	1 (0.8)	0 (0.0)	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.9)	1 (0.2)	1 (0.8)	6 (0.2)	3 (0.1)	3 (0.3)
Centrarchidae (# species, % collection)	7 (13.6)	7 (13.7)	4 (8.4)	0 (0.0)	3 (2.3)	1 (0.1)	6 (26.2)	3 (27.3)	6 (7.0)	4 (15.7)	4 (4.3)	7 (64.8)	10 (11.9)	8 (4.6)	9 (21.3)
sunfish metric (# species, % collection)	6 (13.4)	6 (13.5)	4 (8.4)	0 (0.0)	3 (2.3)	1 (0.1)	5 (22.4)	3 (27.3)	6 (7.0)	3 (15.3)	4 (4.3)	6 (61.6)	9 (11.4)	7 (4.6)	8 (20.3)
Clupeidae (# species, % collection)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.5)	1 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	1 (1.2)	0 (0.0)
Cyprinidae (# species, % collection)	5 (48.9)	7 (44.0)	3 (46.8)	3 (82.7)	4 (46.9)	4 (84.5)	2 (47.4)	5 (30.3)	5 (38.1)	5 (48.6)	5 (70.3)	5 (22.4)	10 (57.6)	9 (69.0)	6 (42.8)
Fundulidae (# species, % collection)	1 (0.5)	1 (2.2)	0 (0.0)	0 (0.0)	1 (1.5)	1 (0.2)	0 (0.0)	1 (22.1)	1 (0.4)	1 (1.9)	0 (0)	1 (7.2)	1 (3.0)	1 (0.6)	1 (6.1)
Ictalaridae (# species, % collection)	1 (4.7)	3 (2.5)	3 (2.6)	4 (12.5)	3 (10.0)	2 (5.1)	5 (7.1)	2 (2.6)	4 (13.6)	2 (3.7)	3 (1.7)	1 (2.4)	7 (6.5)	6 (7.1)	6 (5.6)
Lepisosteidae (# species, % collection)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.04)	1 (0.1)	0 (0.0)
Percidae (# species, % collection)	2 (1.9)	5 (6.5)	1 (0.6)	0 (0.0)	3 (0.5)	3 (19.2)	3 (1.5)	3 (8.2)	1 (16.7)	4 (38.1)	3 (9.7)	5 (7.7)	1 (0.8)	5 (2.8)	5 (15.7)
Poeciliidae (# species, % collection)	1 (0.7)	1 (0.5)	0 (0.0)	1 (0.7)	1 (4.6)	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.8)	1 (1.7)	0 (0.0)	1 (0.7)	1 (0.6)	1 (0.7)
# Intolerant Species	2	6	1	2	2	2	3	1	3	3	3	0	6	6	4
# Moderate Species	13	17	8	8	13	8	12	7	14	12	14	10	29	24	22
# Tolerant Species	3	4	4	2	4	4	3	5	4	3	3	7	8	6	6
% Intolerant CPUE	6.6	7.8	0.6	0.5	19.2	1.7	3.8	1.5	13.2	15.7	4.1	0.0	5.0	3.7	6.8
% Moderate CPUE	63.3	78.0	78.6	15.8	35.4	13.8	91.8	71.2	79.0	80.1	31.4	58.4	51.0	35.8	70.7
% Tolerant CPUE	30.1	14.1	20.8	83.7	45.4	84.5	4.4	27.3	7.8	4.2	64.5	41.6	44.0	60.5	22.5
# Insectivore Species	11	20	7	8	12	9	13	9	16	15	13	9	28	24	22
# Herbivore Species	1	1	0	0	1	0	1	1	1	1	1	0	1	1	1
# Omnivore Species	3	3	2	2	4	4	1	2	2	1	3	4	7	5	4
# Predator Species	3	3	4	2	2	1	3	1	2	1	3	4	7	6	5
% Insectivorous CPUE	58.6	74.6	81.8	8.3	48.5	6.9	42.3	77.9	70.8	84.7	33.8	79.2	45.8	30.9	65.1
% Herbivorous CPUE	13.4	13.0	0.0	0.0	0.8	0.0	47.1	14.9	23.7	12.0	1.9	0.0	10.3	4.0	18.5
% Omnivorous CPUE	25.9	9.4	15.6	82.7	46.2	88.4	0.3	6.7	3.5	2.8	63.5	9.6	39.4	59.8	12.9
% Predacious CPUE	2.1	2.9	2.6	9.1	4.6	4.7	10.3	0.5	1.9	0.5	0.7	11.2	4.6	5.4	3.5

DISCUSSION AND TENTATIVE CONCLUSIONS

- Red shiners are the dominant species in the watershed, with the brook silverside and central stoneroller of more importance in the tributary sites.
- Cyprinids are the major family in the watershed.
- Species richness and eveness do not appear to be related to position in the watershed.
- Eveness was higher among the tributaries than in the main river sites, probably due to the abundance of the Red shiner.
- Moderately tolerant species dominated most sites except, for example, M4 and M6, the urban sites, where tolerant species were more prevalent.
- Insectivores were the majority feeding guild at all sites except WO where omnivores were the majority.
- The Marmaton River sites can be placed into three groups (M1 and M2, M3 and M5, M4 and M6) based on position in watershed and strength of urban influence, overall as a combination of habitat and water quality factors.
- The tributary sites seem to be a mostly heterogeneous collection of sites with some segreg