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Influence of Geomorphology on Fish Fauna of a Small Mississippi Bluffline Stream

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Abstract: Fish were collected from 39 sites on the main channel and major tributaries of a highly erosive stream, Hotophia Creek. A total of 2,642 specimens representing 38 species were collected between 1986 through 2003. The bluntface shiner *Cyprinella camura* was the dominant species of fish and when grouped with other cyprinids accounted for 38.0% of the total numbers collected. By weight, *Lepisosteusoculatus, Lepomismegalotis, Ictiobusbubalus,* and *Lepomismacrochirus* were the dominant species; accounting for 49.9% of the total catch. While more diminutive species such as cyprinids that might be subject to predation by large fish more frequently were found in shallow channels. Fishes with specific habitat requirement such as the pirate perch were found in the middle group of sites, that were disturbed by erosion process but that featured the necessary habitat requirements. Sensitive or intolerant species like the Yazoo darter, creek chubsucker and cyprinids in general were more frequently found in the undisturbed and habitat complex channels. This study supports the hypothesis that geomorphological stream stages are associated with specific communities of fishes.

Key words: Stream classification, geomorphology, index of biotic integrity, ecology.

1. Introduction

There are approximately 2.3 million streams comprising more than 5 million linear km in the continental United States [1]. These streams support at least 22% of all warmwater fishing in fresh water [2]. The majority of Mississippi anglers questioned in a state wide survey in 1986 stated that they preferred stream fishing, thus emphasizing the need for more information on the ecology and population dynamics of stream fishes to solve problems of increasing demand on warm water fisheries [3].

Few recent ichthyofauna records are available for northern Mississippi streams. Earlier surveys of area fishes were limited mainly to larger river systems.

Cook [4] studied several loess hill stream sites in her statewide survey. Other collections include the Tippah River system by Randolph and Kennedy [5], and upper Tombigbee River and Yellow Creek by Caldwell [6], Toby Tubby Creek and Clear Creek by Herring [7], Longbranch Creek, Billy's Creek, and Otoucalofa Creek by Hammond [8] and Otoucalofa Creek by Knight and Cooper [9].

Since Hotophia Creek, Mississippi was included in a major stream management program (Demonstration Erosion Control (DEC) Project in the Yazoo Basin) by the U.S. Army Corps of Engineers and the Natural Resources Conservation Service, information on the fish populations of Hotophia Creek was collected to evaluate stream conditions and the environmental soundness of structural and non-structural erosion control efforts. The purpose of this study was to examine effects of geomorphological conditions on diversity, distribution and population dynamics of the fish fauna of Hotophia Creek.

2. Materials and Methods

Hotophia Creek in Panola County, Mississippi (Fig. 1) enters the Little Tallahatchie River downstream of Sardis Lake. Its catchment basin was 8,500 ha, of which 24% were row crops and 14% were pastures. The remainder of the watershed was primarily forest land. Like many streams along the bluffline, Hotophia Creek was characterized by a bottom substrate of sand

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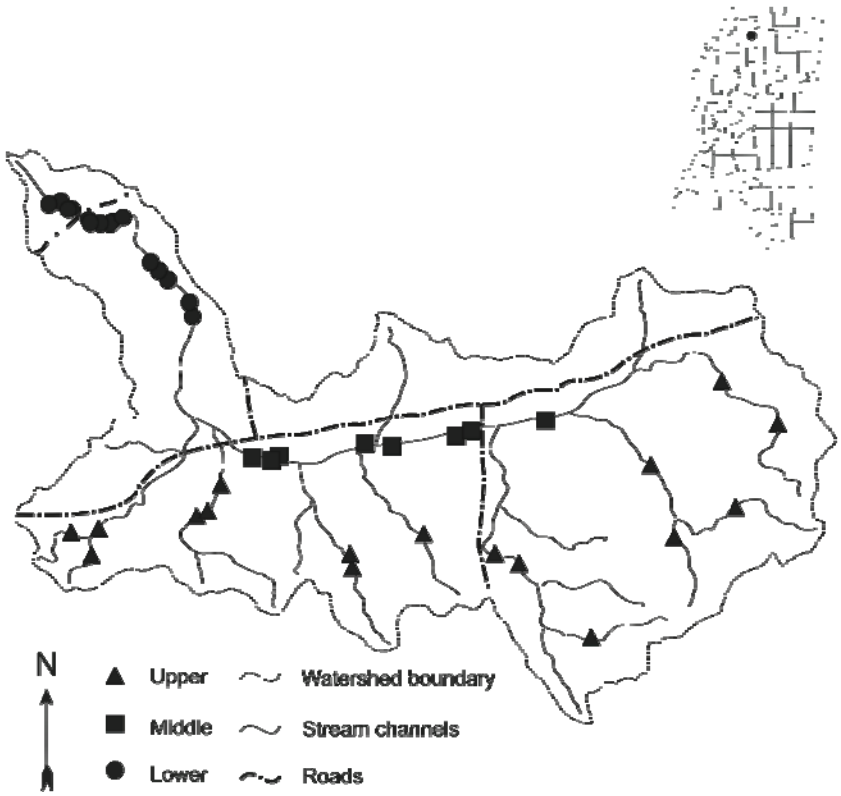


Fig. 1 Fish collection sites on Hotophia Creek, Mississippi.

with slow to moderate flow in an open channel with no canopy at its confluence with the Little Tallahatchie River. The channel gradually narrows and deepens, changes to clay, and had a nearly total coverage of canopy at its head waters. There were virtually no aquatic macrophytes because of the unstable nature of the stream channel. Watersheds in the loess hills of northern Mississippi were chosen as the sites of both structural and non-structural erosion control and stabilization efforts because they have a history of large scale erosional sequences with massive gully formation and large soil losses from agricultural lands. Hotophia Creek, a tributary of the Tallahatchie River was included in the six original watersheds for the project.

Fish were collected from 39 sites each consisting of stream reaches 100 to 200 m long. Sites were sorted into one of three groups which included aggrading channels (Lower), located near the distal end of the watersheds, mid-watershed sites (Middle) and tributaries and head water channels (Upper). The lower channel group of sites roughly corresponds to Type VI channels as designated by Simon [10] and Bledsoe et al. [11] models of channel evolution. These channels feature developed berms of sand, gravel or mud. They are aggrading or in quasi-equilibrium. Habitat is characterized by uniform velocities, fine bed material and deeper water depths. No pool habitat or large woody debris is present. Middle sites, corresponding to Type IV and V channels [10, 11] exhibit channel widening due to bank failure and may be aggrading or degrading. Large woody debris may be scarce and banks typically lack riparian vegetation. Channel beds are composed primarily of shifting sand. Habitat is highly disturbed and characterized by uniform velocities and shallow depths. The thalweg moves back and forth laterally within the banks with each major storm event. Upper sites were either undisturbed and stable or moderately disturbed due to channel incision caused by migration of head cuts. Banks were heavily vegetated with trees and riparian plants. Large woody debris was abundant. Depths and

velocities were heterogeneous with riffle pool sequences. Bed materials varied between combinations of sand, gravel, hard clay and leaf litter. These channels correspond to Type I or II [10, 11].

Fish were collected using a battery powered, backpack mounted electroshocker set for 200 to 400 volts of pulsed direct current. Current was pulsed at 150 pulses/sec. Voltage was varied depending upon the conductivity of the water. Larger and easily identifiable specimens were weighed and measured for length in the field, then released. Small specimens or those which could not be positively identified in the field were preserved in 10% formalin solution and transported to the laboratory for identification and measuring. Preserved materials were deposited in the National Sedimentation Laboratory Reference Collection or at the Mississippi Museum of Natural Sciences.

3. Results and Discussion

A total of 2,642 fish representing 38 species were collected from 39 sites on Hotophia Creek. Total weight collected from these 39 sites was 11.7 kg Catch per unit of effort was 3.31 kg/hr for all species and site groups while number per unit of effort was 420 fish/hr The most frequently caught species were *Cyprinella camura, Cyprinella venusta, Lepomis megalotis, Lepomis macrochirus,* and *Fundulus notatus* with all found in each of the site groups (Table 1). Spotted gar, *Lepisosteus oculatus* accounted for 13.7% of the total weight of fish collected but only represented 0.68% of the catch by number. *Lepomis megalotis, Ictiobus bubalus, Lepomis macrochirus* and *Cyprinella camura* contributed 12.9%, 12.5%, 10.8% and 7.6% to the total weight respectively.

Lower and middle channel sites were dominated numerically by *Lepomismegalotis, Pimephalesnotatus, Lepomismacrochirus, Cyprinellavenusta,* and*Fundulusnotatus* (Fig. 2) while in upper sites *Notropisrafinesquei* replaced bluegill in the list of the dominant five species. By weight, *Lepomismacrochirus* and *Lepomismegalotis* were among the five dominant species across the three categories of stream channels in Hotophia Creek watershed (Fig. 3). In addition to these two sunfishes, spotted gar, *Lepisosteusoculatus*, smallmouth buffalo, *Ictiobusbubalus*, and channel catfish, *Ictalurus punctatus* accounted for 65% of the catch by weight from the lower stream reaches. The afore mentioned sunfishes along with spotted gar, bluntface shiners, *Cyprinellacamura*, and creekchub suckers, *Erimyzon oblongus* comprised 64% of the catch in middle reaches. The same species found in the middle reaches, with the exception of spotted gar which did not occur in the upper channel group, dominated the catch and with the addition of green sunfish, accounted for 54% of the catch by weight. Average catch per unit of effort was highest in the lower group of sites (5.15 kg/hr), followed by upper (2.12 kg/hr) and middle (1.98 kg/hr) channels while number per unit of effort was higher in the upper channels (486 fish/hr), followed by lower (458 fish/hr) and middle (289 fish/hr) reaches. Intolerant species [12, 13] comprised a greater percentage of the catch in the upper group, 16.7%, versus 11.1% for middle and 7.1% for lower groups of sites.

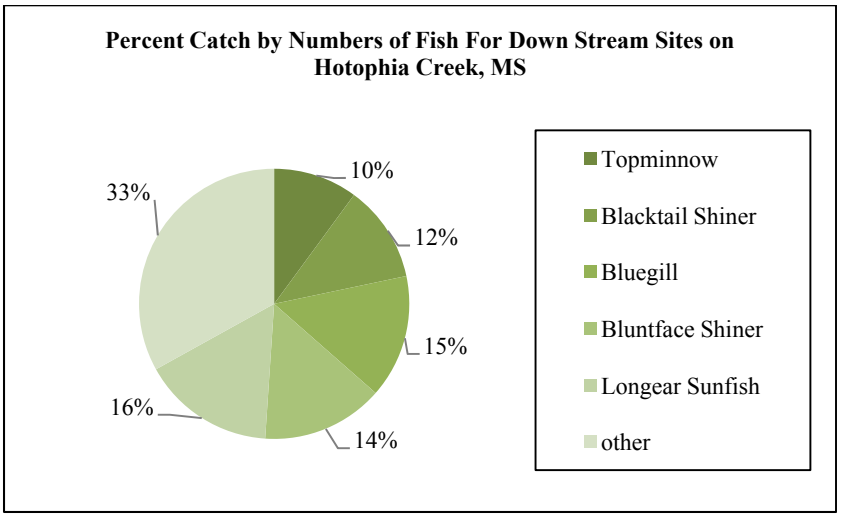
Fourteen species were found across all site groups. As might be expected, four species, all of which attain a larger adult size were unique to the lower channel group including *Ictiobusbubalus*, *Ictiobusniger*, *Lepisosteusosseus* and *Pylodictisolivaris* Gizzard shad. *Dorosomacepedianum* was also found exclusively in the lower channel group. While these fish seldom reach lengths greater than 521 mm gizzard shad are filter feeders requiring deeper more quiescent waters capable of supporting plankton [14].

Golden shiner, *Notemigonuscrysoleucas*, warmouth, *Lepomisgulosus* and pirate perch, *Aphredoderussayanus* were only found in the middle group of stream channels. Species unique to the upper group included: *Etheostomaraneyi*, *Micropterussalmoides*, *Notropisatherinoides* and *Ameiurus nebulosus*; all except for the *M. salmoides* are relatively diminutive as adults.

Table 1 Number of individuals caught and frequency of occurrence with in stream category by species from Hotophia Creek, Panola Co., MS.

				Category	
Scientific name	Common name	Number caught	Upper	middle	Lower
Aphredoderussayanus	Pirate perch	2		2	
Labidesthessicculus	Brook silverside	8		4	4
Carpiodescarpio	River carpsucker	13		3	10
Ictiobusbubalus	Smallmouth buffalo	18			18
Ictiobusniger	Black buffalo	1			1
Moxostomapoecilurum	Blacktail redhorse	7	1	3	3
Erimyzon oblongus	Creek chubsucker	36	29	7	
Lepomiscyanellus	Green sunfish	144	78	21	45
Lepomisgulosus	Warmouth	2		2	
Lepomishumilis	Orange spotted sunfish	17	13	4	
Lepomismacrochirus	Bluegill	282	59	50	173
Lepomismarginatus	Dollar sunfish	9	2	5	2
Lepomismegalotis	Longear sunfish	343	57	100	186
Micropteruspunctulatus	Spotted bass	46	6	17	23
Micropterussalmoides	Largemouth bass	1	1		
Dorosomacepedianum	Gizzard shad	21			21
Cyprinellacamura	Bluntface shiner	490	227	92	171
Cyprinellalutrensis	Red shiner	43	1	6	36
Cyprinellavenusta	Blacktail shiner	376	161	79	136
Notemigonuscrysoleucas	Golden shiner	1		1	
Notropisatherinoides	Emerald shiner	3	3		
Notropisrafinesquei	Yazoo shiner	178	126	5	47
Pimephalesnotatus	Bluntnose minnow	34	13		21
Pimephalesvigilax	Bullhead minnow	59	1		58
Semotilusatromaculatus	Creek chub	8	7	1	
Fundulusnotatus	Blackspotted topminnow	247	94	35	118
Fundulusolivaceus	Blackstripe topminnow	50	8	31	11
Ameiurusnatalis	Yellow bullhead	33	24	7	2
Ameiurus nebulosus	Brown bullhead	1	1		
Noturusphaeus	Brown madtom	15	11	4	
Ictalurus punctatus	Channel catfish	30		2	28
Pylodictisolivaris	Flathead catfish	2	2		
Lepisosteusoculatus	Spotted gar	9		2	7
Lepisosteusosseus	Longnose gar	1			1
Etheostomaartesiae	Red spotted darter	4	2	2	
Etheostomaraneyi	Yazoo darter	3	3		
Percinasciera	Dusky darter	13	3	5	5
Gambusiaaffinis	Mosquito fish	92	26	19	47

The Yazoo shiner, *Notropisrafinesquei* was found in all groups but was most abundant in shallow sand bed channels of upper watershed sites. Cyprinids were commonly collected at all sites but were most abundant in the upper group. There were seven species of cyprinids in the upper group versus six at the lower and middle reaches. Twice the number of cyprinids were collected from undisturbed upper sites versus more geomorphologically unstable middle sites. Pirate perch, found in the middle reaches, require habitats that feature undercut banks with tangled fine roots. Many of the sites in the middle group were



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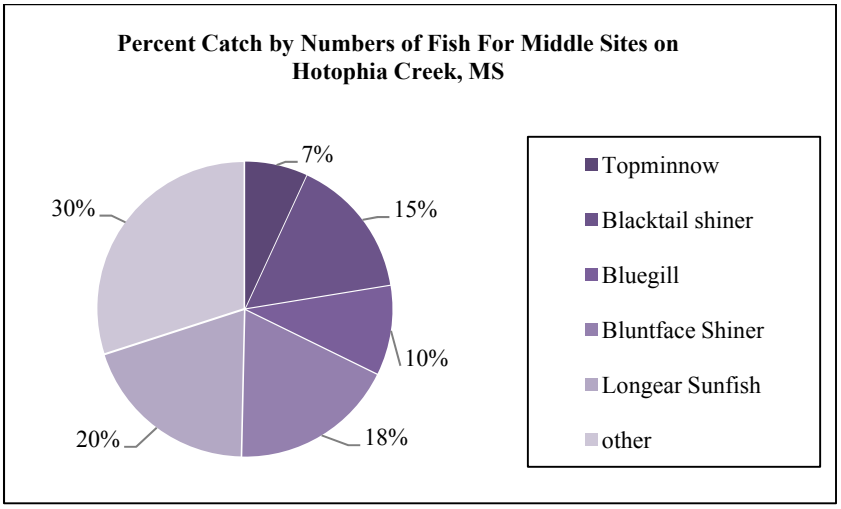

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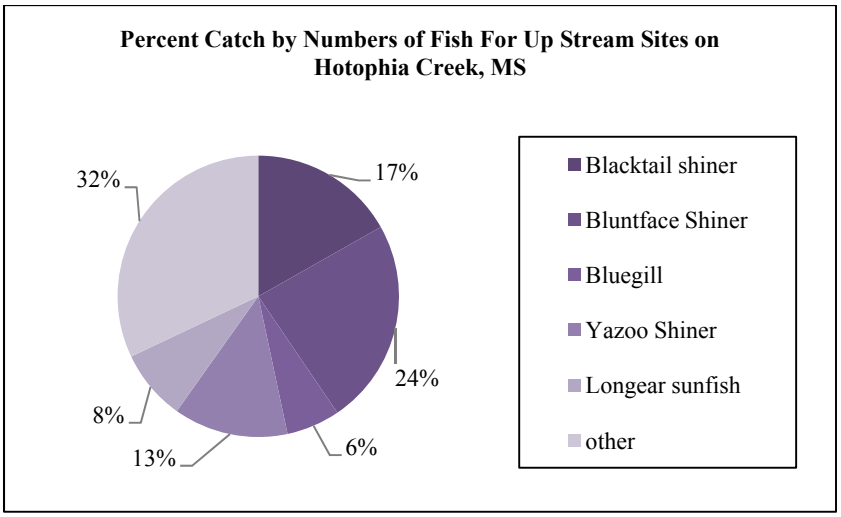
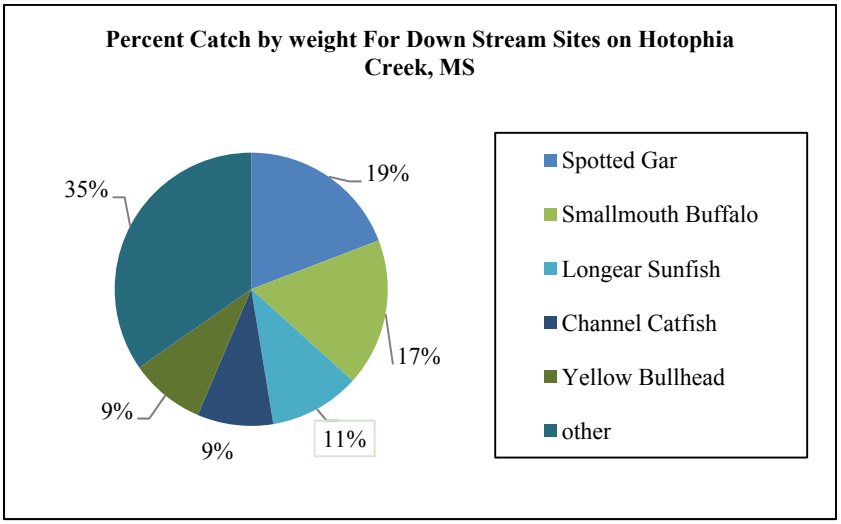


(c)

Fig. 2 Percent composition by number of fish collected from Hotophia Creek, Mississippi: (a) down stream sites, (b) middle sites, (c) up stream sites.



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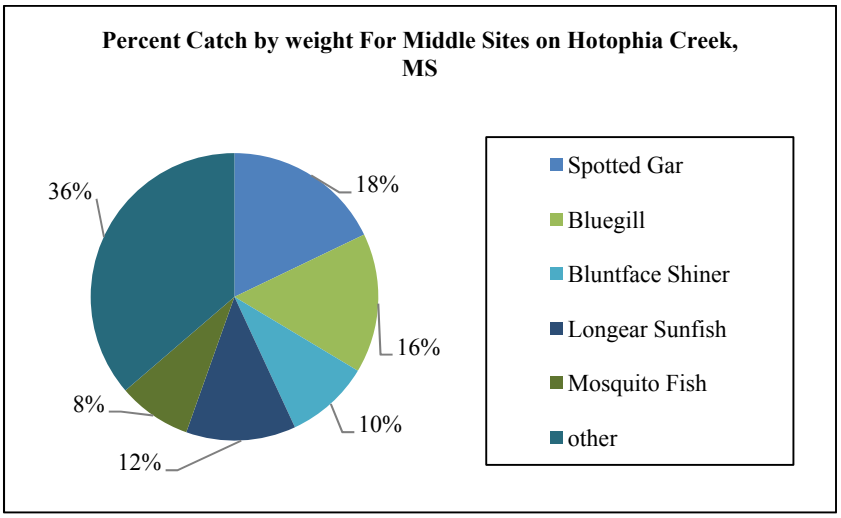

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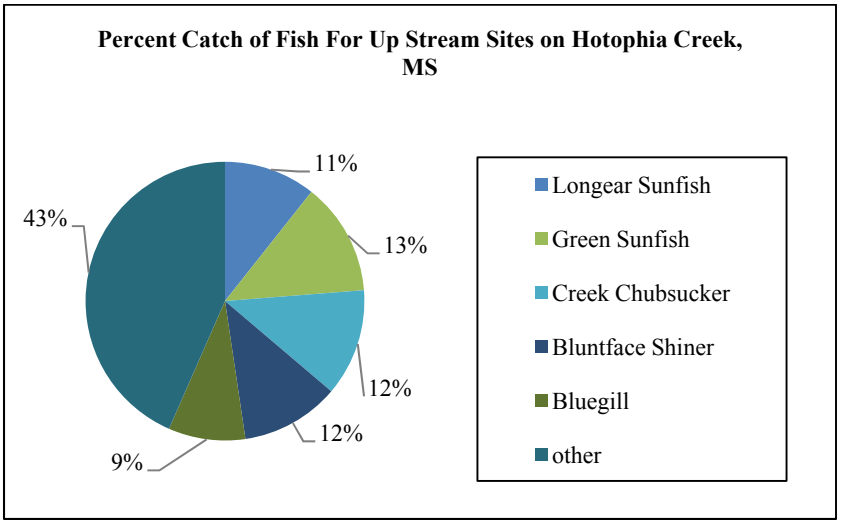

(c)

Fig. 3 Percent composition by weight of fish collected from Hotophia Creek, Mississippi: (a) down stream sites, (b) middle sites, (c) up stream sites.

actively incising and thus providing the preferred habitat of pirate perch.

Two of the 38 species found in Hotophia Creek, *Etheostomaraneyi* and *Ictiobusniger* are listed as species of "Special Concern" by the State of Mississippi and the American Fisheries Society [14, 15]. Special concern status is for those species recognized by state conservation agencies as (1) declining in numbers or distribution but not yet warranting full protection by law or (2) taxa about which too little in known to determine if they are in need of protection. The Yazoo darter has been reported in several northern Mississippi streams [5, 9, 16, 17]. Although the Hotophia Creek collections represent a westward extension of its assumed range, the few individuals collected tend to indicate a remnant populationor loss of critical habitat.

4. Conclusions

Fishes fauna recovered from Hotophia Creek did not differ greatly from those reported in faunal lists from other streams in the loess bluff and central hills of northern Mississippi [9]. Therefore, conclusions based on this study may apply generally to other loess bluff and central hill watersheds. A major assumption of various ecological indices such as Index of Biotic Integrity (IBI) is that water quality and habitat features determine the relative abundance and distribution of fishes in stream watersheds [18]. This study supports the hypothesis that habitat features are important determining factors in the distribution of stream fishes. Simon and Rinaldi [19] reported that the geomorphological processes following channel straightening progress through definable stages. This study shows that these stages are associated with specific communities of fishes.

Fish species attaining large adult sizes such as buffalo and gar were associated with stream types that containeddeeper water habitats. While more diminutive species such as cyprinids that might be subject to predation by large fish more frequently were found in shallow channels. Fishes with specific habitat requirement such as the pirate perch were found in the middle group of sites, comprised of Type IV and V channels and that featured the necessary habitat requirements. Sensitive or intolerant species like the Yazoo darter, creek chubsucker and cyprinids in general were more frequently found in the undisturbed and habitat complex Type I and II channels. While IBI and other indices are valuable tools and may be useful surrogates for estimating impact of poor water quality in impaired streams, caution should be exercised because presence or absence of habitat features may over shadow water quality effects.

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