

**FIVE MILE CREEK BIOASSESSMENT STUDY: BASELINE EVALUATION OF
STREAM HEALTH USING FISH COMMUNITIES**

by

Louis David Viamonte

Dr. Robert Angus, CHAIR

Dr. Ken Marion

Dr. Robert Stiles

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Five Mile Creek Bioassessment Study: Baseline Evaluation of Stream Health Using Fish Communities

Louis David Viamonte

BIOLOGY

ABSTRACT

During the fall of 2005 and spring of 2006, habitat assessments and rapid bioassessments were conducted at six sites on 100 m reaches on Five Mile Creek in Jefferson County, Alabama and two sites on neighboring rural streams that were used as references. Habitat scores and index of biotic integrity (IBI) scores for the fish communities were calculated for all sites. The IBI scores on Five Mile Creek did not compare well with one of the reference streams and suggest impairment. The habitat scores for the Five Mile Creek sites were similar to the scores of the reference streams. The IBI scores and habitat scores for the Five Mile Creek sites were not significantly correlated, suggesting that the impairment of the fish populations is due mainly to poor water quality. IBI scores were highest at the three downstream sites, furthest away from urbanization and industrialization. Land use data on the surrounding area of Five Mile Creek illustrated that there was a much higher proportion of the land designated as residential and industrial in the upper regions of the stream. This implies that urban and industrial pollution are the main sources of water quality impairment on Five Mile Creek. This study has provided groups actively involved in river restoration efforts, such as the Black Warrior Riverkeeper, the Black Warrior River Clean Water Partnership, and the Five Mile Creek Greenway Partnership, with baseline data on the current biological status of the creek. This baseline can be used in subsequent years as a comparison during

re-assessments to determine if restoration efforts currently in progress are achieving their desired effects.

DEDICATION

I dedicate this thesis to my wife for all her help, support and love she has graciously given to me.

ACKNOWLEDGMENTS

I acknowledge my mentor, Dr. Robert Angus, for the great amount of help and patience he has given to me throughout my time with him. He has truly made this experience a memorable and enjoyable one.

I also acknowledge my other committee members, Drs. Ken Marion and Robert Stiles, for their knowledge and kindness.

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Introduction

Five Mile Creek lies in the Warrior River basin and drains 20,202 hectares of Jefferson County, Alabama. The Creek originates at the eastern base of Red Mountain and there is considerable urban and industrial development in the upper part of the watershed. Industrial discharges, improperly treated sewage and runoff from coal mines, and urban development have all impaired both the water and aquatic habitat quality of Five Mile Creek.

Sloss Industries (a coke producing facility in Tarrant) has been identified as a major contributor to the degradation of the stream. During an assessment of the creek in September 2001, Alabama Department of Environmental Management (ADEM) employees documented significant deterioration of the creek resulting from the Sloss discharge (LEAF 2002). Historically, Five Mile creek had been dubbed “Creosote Creek”, due to the chemical odor and appearance of its water (Freshwater Land Trust 2006). Coal tar creosote is a by-product of the high temperature treatment of coal to make coke and it is toxic to plants, animals, and humans (ATSDR 2002).

Until recent years, Five Mile Creek has been one of the most polluted waterways in Alabama. This was reflected in its official ADEM usage designation of “Agricultural and Industrial” (the lowest level of protection). However, in 2003, ADEM upgraded the status of the entire length of Five Mile Creek to the “Fish and Wildlife” designation. In 1997, only a small downstream portion of the creek had received the upgrade while the much larger upstream portion remained “Agricultural and Industrial.” The new classification reduces the acceptable amount of toxic discharges into the waterway. The

objective is to improve the water quality in the creek to the point where it is once again able to support a reasonably healthy and diverse community of aquatic organisms.

Despite the fact that Five Mile Creek has a history of suffering from human insult, it has not been without its defenders. In recent years, a number of organizations have formed with the intention of restoring and protecting Five Mile Creek and its watershed. These organizations include the Black Warrior Riverkeeper, the Black Warrior River Clean Water Partnership and the Five Mile Creek Greenway Partnership. The Greenway Partnership was created after an intergovernmental agreement was signed by the cities of Birmingham, Center Point, Tarrant, Fultondale, Brookside and Graysville that pledged cooperation to develop a series of parks and greenways along the entire 45.1 km stretch length of Five Mile Creek (Freshwater Land Trust 2006). The Cahaba, Warrior, and Coosa (Cawaco) Resource Conservation and Development Council, the Jefferson County Commission, the Freshwater Land Trust, and the Regional Planning Commission of Greater Birmingham also signed the agreement. The greenway is intended to provide a riparian buffer zone to help improve habitat and water quality of the creek, while at the same time stimulating economic revitalization and growth for the communities along the Creek (Freshwater Land Trust 2006).

As part of the greenway development project, habitat restoration projects will be implemented along Five Mile Creek. In order to determine whether such projects have been successful in improving the biological condition of the river, it is critical to have pre-project data on the current status of biological communities in the creek. U.S. EPA Rapid Bioassessment Protocols (RBPs) provide a means of obtaining quantitative data on the biological status of a river. If the same protocols are used in subsequent years, it is

possible to determine whether the biological communities in the creek have improved subsequent to restoration efforts. RBPs are an assemblage of well-documented methods that can be used to assess habitat quality, water quality, and biological integrity of a stream ecosystem. RBPs work best when a reference site is included in the study. A reference site is a pristine or minimally disturbed site that represents the natural range of variation in water chemistry, habitat and biological conditions for the region where the study is being conducted (Barbour 1999). Reference sites provide an example of a waterway's biological potential if it were not impacted by harmful outside influences. A pristine site along the same stream of interest is the ideal reference site; however, in many parts of the country (especially urban areas) such sites no longer exist. In many studies a relatively undisturbed (usually rural) stream in the same watershed serves as the reference. Others have investigated the utility of using historical data or modeling and extrapolation to provide information on the expected biological status of a stream in the absence of human disturbance (Baker et al. 2005). These techniques can be used to create a "virtual" reference site.

The United States Environmental Protection Agency (EPA) originally formulated RBPs as cost effective methods for analyzing the physical and biological status of a stream. In addition, RBPs have been scientifically validated, are environmentally benign, and produce information that is easily interpretable to the public. The EPA has found that the use of biological monitoring has also helped in identifying the causes of impairment to aquatic ecosystems, evaluating the effectiveness of control and mitigation programs, and documenting the success of watershed management plans (Barbour 1999).

The objectives of the current study were to perform habitat assessments and rapid biological assessments of fish populations at six sites spanning the length of Five Mile Creek and two other nearby sites. All sites sampled lie in the Locus Fork watershed of the Black Warrior River basin. These assessments will provide data that can serve as a baseline for future studies documenting the (hopefully) improving health of Five Mile Creek.

Materials and Methods

Study Sites

The study sites are listed in Table 1 and shown in Figure 1. They consist of six sites on Five Mile Creek and two sites on nearby creeks in the Locus Fork watershed. The Blackburn Fork and Gurley Creek sites were chosen for sampling because they are more rural and were expected to be less impaired, compared to Five Mile Creek, and could serve as reference sites.

Site	County	Lat-Long
Five Mile Creek at Huffman High School Sampled on 6/14/2006	Jefferson	N33° 36.812' W86° 41.108'
Five Mile Creek at Hewitt Park in Tarrant Sampled on 11/09/2005	Jefferson	N33° 36.354' W86° 44.762'
Five Mile Creek at Hwy 31 in Fultondale Sampled on 10/19/2005	Jefferson	N33° 35.448' W86° 48.221'
Five Mile Creek at Brackett Loop Road Sampled on 10/26/2005	Jefferson	N33° 36.315' W86° 53.139'
Five Mile Creek at Cardiff St. in Brookside Sampled on 11/02/2005	Jefferson	N33° 38.217' W86° 55.313'
Five Mile Creek immediately upstream of the Prudes Creek WWTP Sampled on 6/21/2006	Jefferson	N33° 38.300' W86° 56.848'
Gurley Creek at Bone Dry Road Sampled on 7/19/2006	Jefferson	N33° 48.136' W86° 45.179'
Blackburn Fork of the Warrior River at House Rd. Sampled on 6/07/2006	Blount	N33° 52.794' W86° 34.832'

Table 1. The study sites. The Five Mile Creek sites are listed from upstream to downstream.

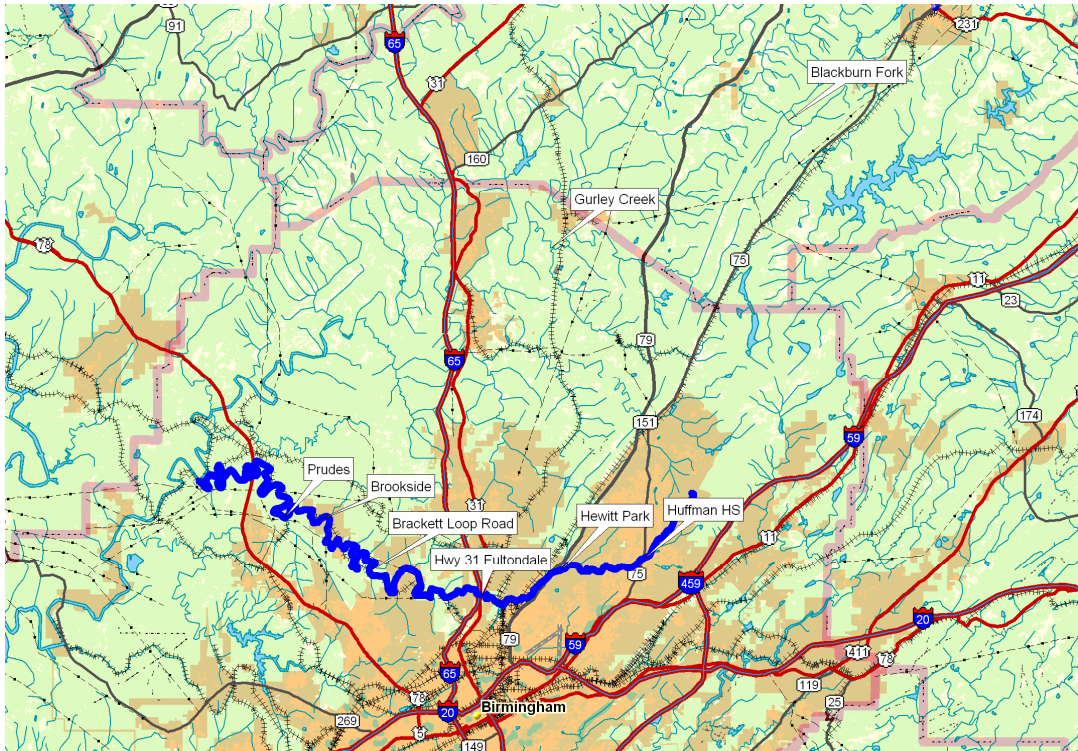


Figure 1. Five Mile Creek including the stream bioassessment sites with the reference sites, Gurley Creek and Blackburn Fork, labeled.

Habitat Assessment Protocol

A habitat assessment and physical/chemical characterization of water quality was performed within each ~100 m sampling reach using the protocols from *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, Second Edition* (Barbour 1999). The habitat assessment was performed after the fish were collected on the same reach. Ten habitat variables were scored: epifaunal substrate/available cover, riffle quality, embeddedness, channel alteration, sediment deposition, frequency of riffles, channel flow status, bank vegetative protection, bank stability, and riparian vegetative zone width. Each habitat variable was given a score ranging from 0-20, with twenty being the highest obtainable score and signifying the most optimal conditions. Each of the ten habitat variable scores were added together to obtain a total habitat score. Dr.

Robert Angus and Dr. Ken Marion, both of the University of Alabama at Birmingham, completed all sections of the field data sheets and habitat assessment forms in consensus. The habitat scores from the six Five Mile Creek sites were then compared with that of the Gurley Creek reference site. The Blackburn Fork reference was not used in the comparison because of a lower-than-expected habitat score, possibly due to recent development in the surrounding area. The habitat score for a site was enumerated as a percent of the score obtained by the reference site and the overall habitat quality was evaluated according to the criteria in Table 2 (EPA 1997).

Quality Designation	Score required*
Excellent	>90%
Good	>75%
Fair	>60%
Poor	≤60%

Table 2. Habitat Quality Criteria (EPA 1997)

*as a percent of the score attained by the reference site.

Fish Sampling Protocol

All sites were sampled upstream from major tributaries and bridge/road crossings. Sampling was done only when the stream level was low to moderate and never immediately after a rainfall. The sampled stream reaches were approximately 100 m long and were chosen to include riffles, runs, pools, undercut banks, and root wads. Two different methods of fish collecting were used: backpack electrofishing and seining. Electrofishing and seining are the most commonly used fish collection methods in fresh water habitats. Both methods are environmentally benign and cause very little mortality

(Barbour 1999). The two methods each have distinct sampling biases. It has been shown that the use of both methods provides a more complete assessment of the species present at a site than either method alone (Onorato et al. 1998). Electrofishing was done with a Smith-Root backpack unit; seining was done with a 1.8 x 4.6 meter, 0.3 cm mesh seine. The stream reach was first sampled by electrofishing, working upstream, for 30 min. All habitats (e.g. riffle, run, pool, undercut bank, and root wad) were sampled in proportion to their abundance in the reach. Fish were placed into 19 L buckets as they were collected. After completion of the electrofishing sample, all fish >20 mm total length were identified to species, enumerated, and weighed by taxonomic group (e.g. minnows, sunfish, bass, suckers, etc.). Any fish that could not be identified with certainty on site were anesthetized with MS-222, preserved in 10% formalin and brought back to the laboratory for identification. After processing, all of the fish captured by electrofishing were released back into the stream (i.e., sampling with replacement). The same reach was then sampled for 30 min. using seines. The fish captured by seining were identified, enumerated, and weighed in the same way as the fish captured by electrofishing.

IBI Calculation

The data obtained from the rapid bioassessment of all eight sites were used in a multi-metric analysis tool called the Index of Biological Integrity (IBI). Karr and others (1986) created the IBI as a bioassessment tool that is now considered a standard analysis technique for the measurement of stream biological integrity and fishery bioassessment. A modified version of Karr's IBI was used in the study, with assessment guidelines for each metric developed specifically for the Black Warrior River basin (O'Neil 2002). The multi-metric approach utilized in the IBI method is helpful for making objective

evaluations of complex ecological systems (O'Neil 2002). Twelve biological metrics are used in the IBI. They are based on the taxonomic and trophic composition of the fish assemblage and the abundance and health of fish (Barbour 1999). The metrics included in the study are shown in Table 3. They have been used in previous bioassessment studies in the Black Warrior watershed (O'Neil 2002, O'Neil and Shepard 1998).

Metric	Trend Seen With Human Impairment
Number of native species	Declines as sensitive species become rare or extirpated
Number of darter species	Declines as sensitive species become rare or extirpated
Number of minnow species	Declines as sensitive species become rare or extirpated
Number of sunfish species	Declines as sensitive species become rare or extirpated
Number of sucker species	Declines as sensitive species become rare or extirpated
Number of intolerant species	Declines
Proportion as sunfishes	Increases as tolerant species thrive in nutrient rich and severely disturbed streams
Proportion as omnivores and herbivores	Increase in nutrient rich streams
Proportion as insectivorous cyprinids	Declines due to reduced abundance of insect prey
Proportion of top carnivores	Declines in impaired streams
Number collected per hour	Declines if toxicity is a factor Increases in enriched streams
Proportion of individuals with anomalies	Increases due to poor health caused by stress

Table 3. Metrics used in IBI Calculations. (O'Neil 2002, O'Neil and Shepard 1998)

Each metric is scored against an expected value from an approved reference site and given a score of 5, 3, or 1, with 5 being the highest obtainable score (Karr and others 1986). O’Neil and Shepard adapted some of the IBI metrics to account for ecological differences seen in southeastern streams. Metric scoring protocols were also modified to accommodate streams of different sizes. O’Neil and Shepard report that larger streams support more species, thus any IBI metric that measures species richness and composition must be adjusted for size. This has been done by basing scoring criteria on observed metric value vs. drainage area regressions for streams in the southeastern U.S. The scores of all metrics are added to produce the IBI score. The scores range from 12 to 60 with a score falling in the range of 56-60 being the best attainable score and deemed “excellent,” followed by “good (47-55), fair (38-46), poor (26-37), and very poor (<26).” If repeated sampling fails to produce any fish, a “no fish” class is designated (O’Neil 2002, O’Neil and Shepard 1998).

Results

Overall habitat scores for the six sites on Five Mile Creek ranged from 101 to 141. The reference site, Gurley Creek, was scored at 167. When compared with Gurley Creek, habitat scores for three of the Five Mile Creek sites were graded good, and the other three were graded fair (Table 4).

Fish IBI scores and grades for the study sites are also shown in Table 4. As expected, Gurley Creek had the highest IBI score (IBI = 46, grade: fair), which was one point below the score necessary to obtain a grade of good. The six sites on Five Mile Creek had IBI scores ranging from 30 to 42. Four of the sites were graded poor, and two sites were graded fair.

Site	Habitat Score	Habitat Grade	IBI Score	IBI Grade
Huffman	101	Fair	32	Poor
Hewitt	141	Good	30	Poor
Hwy 31	137	Good	32	Poor
Brackett	134	Good	36	Poor
Brookside	117	Fair	42	Fair
Prudes	122	Fair	38	Fair
Gurley	167	Reference	46	Fair
Blackburn	143	Good	38	Fair

Table 4. Scores and grades for habitat and IBI. The six Five Mile Creek sites are listed from upstream to downstream.

No significant correlation was seen when comparing habitat scores of the six Five Mile Creek sites with their IBI scores ($p = 0.57$, Figure 2). When the reference sites were included in the analysis, the correlation was still nonsignificant ($p = 0.31$).

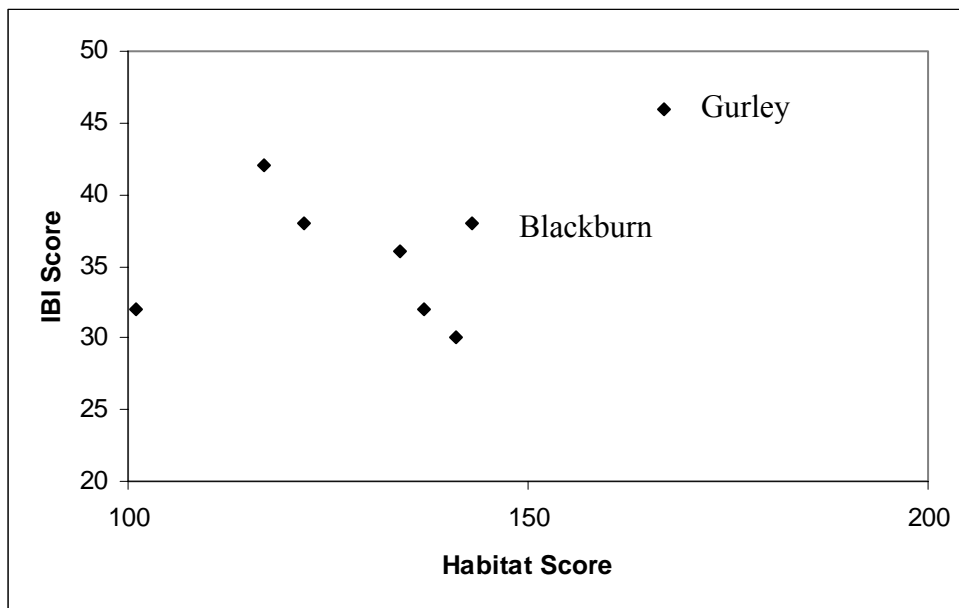


Figure 2. Relationship between IBI Score and Habitat for the six Five Mile Creek sites and the two reference streams (Gurley Creek and Blackburn Fork).

The three most downstream Five Mile Creek sites (downstream sites have larger drainage areas) had higher IBI scores than the three-headwater sites (Figure 3).

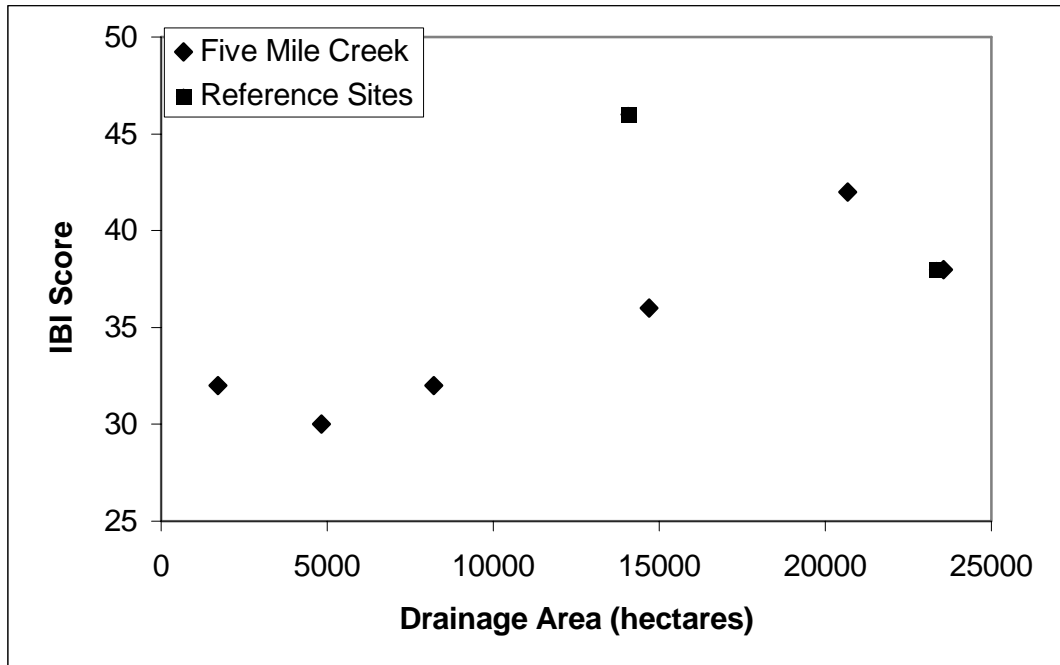


Figure 3. IBI scores and drainage areas for all six Five Mile Creek sites and the two reference sites.

Thirty-one different species of fish were collected (Table 5). *Campostoma oligolepis* (largescale stoneroller) was the most common fish species collected with 948 individuals, followed by *Cyprinella venusta* (blacktail shiner) with 578 individuals, and *Notropis stilbius* (silverstripe shiner) with 523 individuals. These three fish species were by far the most common, accounting for an average of 82.64 percent of the fish collected at each of the six Five Mile Creek sites (Figure 4).

Also of note was the lack of darter species (family Percidae) in the Five Mile Creek sites (Table 5). Most darter species are sensitive to disturbance and tend to disappear

from impaired sites. Monitoring darters can help in detecting change in environmental quality (Mettee et al. 1996).

	Huffman	Hewitt	Hwy31	Brackett	Brookside	Prudes	Blackburn	Gurley	Total
Campostoma									
oligolepis	446	131	109	85	5	12	7	153	948
<i>Cyprinella</i>									
<i>callistia</i>	0	0	0	0	0	0	3	36	39
Cyprinella									
venusta	0	0	115	212	197	43	0	11	578
<i>Luxilus</i>									
<i>chrysocephalus</i>	1	2	1	0	1	0	0	0	5
<i>Notomegonus</i>									
<i>crysoleucas</i>	0	0	0	0	0	0	0	1	1
<i>Notropis</i>									
<i>chrosomus</i>	0	0	0	0	0	0	25	0	25
Notropis									
stilbius	0	0	6	14	153	248	40	62	523
<i>Pimephales</i>									
<i>vigilax</i>	0	0	0	1	2	0	0	0	3
<i>Semotilus</i>									
<i>atromaculatus</i>	42	0	3	3	0	0	0	0	48
<i>Hyptentelium</i>									
<i>etowanum</i>	19	9	2	4	5	4	1	4	48
<i>Moxostoma</i>									
<i>erythrum</i>	0	0	0	0	0	10	0	6	16
<i>Ameiurus natalis</i>	0	1	0	0	3	0	0	0	4
<i>Ictalurus</i>									
<i>punctatus</i>	0	0	0	0	1	0	0	0	1
<i>Fundulus</i>									
<i>olivaceus</i>	0	0	0	0	0	0	4	0	4
<i>Gambusia affinis</i>	1	1	24	0	14	0	2	0	42
<i>Chaenobryttus</i>									
<i>gulosus</i>	0	0	0	0	0	0	1	0	1
<i>Lepomis</i>									
<i>cyanellus</i>	20	5	7	3	1	0	0	1	37
<i>Lepomis</i>									
<i>macrochirus</i>	6	6	1	0	1	0	20	1	35
<i>Lepomis</i>									
<i>megalotis</i>	0	4	8	4	35	19	26	12	108
<i>Micropterus</i>									
<i>coosae</i>	0	1	0	0	0	0	2	0	3
<i>Micropterus</i>									
<i>punctulatus</i>	0	0	0	0	3	14	0	8	25
<i>Micropterus</i>									
<i>salmoides</i>	1	0	1	0	1	0	1	0	4
<i>Pomoxis</i>									
<i>nigromaculatus</i>	0	0	0	0	0	0	0	1	1

<i>Etheostoma</i> <i>artesia</i>	0	0	0	0	0	0	0	1	1
<i>Etheostoma</i> <i>douglassi</i>	0	0	0	0	0	0	14	7	21
<i>Etheostoma</i> <i>stigmaeum</i>	0	0	0	0	0	0	0	8	8
<i>Etheostoma</i> <i>artesia</i>	9	0	1	0	0	0	0	0	10
<i>Percina</i> <i>nigrofasciata</i>	0	2	6	1	12	13	5	1	40
<i>Percina</i> <i>brevicauda</i>	0	0	0	0	0	0	0	1	1
<i>Percina caprodes</i>	0	0	0	0	0	0	0	2	2
<i>Cottus carolinae</i>	1	18	0	0	0	0	39	0	58
TOTAL	546	180	284	327	434	363	190	316	2640

Table 5. Species and numbers of all fish collected in the six Five Mile Creek sites and the two Reference streams (Gurley Creek and Blackburn Fork).

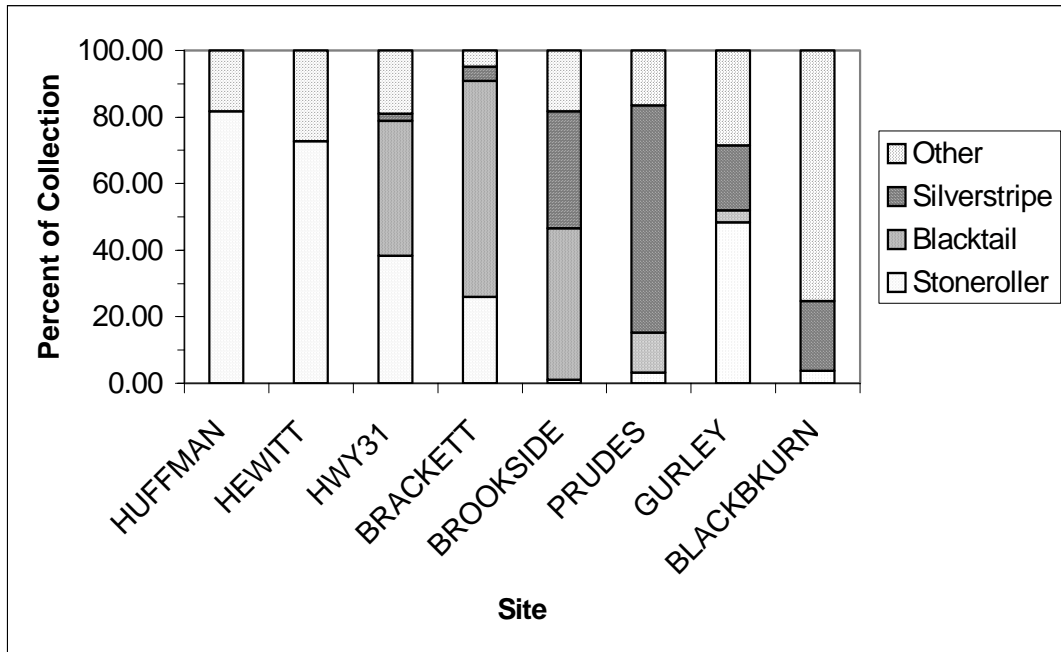


Figure 4. Percent of collection of stonerollers, blacktail shiners and silverstripe shiners caught in the six Five Mile Creek sites and the two Reference streams (Gurley Creek and Blackburn Fork).

Five Mile Creek originates in urban Huffman. As the stream flows downstream, land use patterns gradually change. The proportion of the watershed used for residential

purposes decreases and more land is left as mixed hardwood/evergreen forest. In the uppermost site (Huffman High School), 60.5 percent of the land was residential, while only 19.2 percent was mixed hardwood/evergreen forest. Conversely, in the Prudes Creek watershed (which includes all the previous sub watersheds), 28.4 percent of the land was residential, and 50.4 percent was mixed hardwood/evergreen forest (Table 6).

	Huffman	Hewitt	Hwy 31	Brackett	Brookside	Prudes
Percent Residential	60.54022	53.34076	40.00884	32.21083	29.87472	28.3838
Percent Commercial and Services	8.350056	7.565745	9.227004	6.253047	5.076517	5.45158
Percent Industrial	0.064513	0.212967	3.025965	2.3395	2.821578	2.47740
Percent Transportation, Communication, Utilities	11.4176	13.01282	15.06294	11.45017	9.910645	9.34180
Percent Other Agricultural Lands	0.02779	0.081557	0.047994	0.060343	0.042971	0.03770
Percent Mixedhardwood/Evergreen Forest	19.21632	22.62998	28.15383	42.8568	48.44627	50.4308
Percent Streams and Canals	0.053431	0.11097	0.091811	0.061319	0.068708	0.06714
Percent Lakes		0.033146	0.019505	0.010913	0.007771	0.00681
Percent Strip Mines, Quarries, Gravel Pits		0	0.224214	0.629354	0.589717	1.00758
Percent Unknown	0.330073	3.012065	4.137892	4.127723	3.1611	2.79523

Table 6. Land use percentages. Sites are listed in order from the most upstream (Huffman) to the most downstream (Prudes).

Two other notable geographical trends were noted in the percent omnivores/herbivores and percent insectivores metrics. Omnivores can feed on plant and animal materials while herbivores feed on plant material and insectivores feed on insects (Barbour 1999). The three most common fishes caught (*Campostoma oligolepis*, *Cyprinella venusta*, and *Notropis stilbius*) are all considered omnivores (Mettee et al. 1996). In the sites progressively more downstream, the percent omnivores/herbivores decreased and the percent insectivores increased. The percentage of omnivores/herbivores decreased from 89.3 percent to 3.3 percent and the percentage of

insectivores increased from 7.9 percent to 79.9 percent. These two trends are seen in Figures 5 and 6.

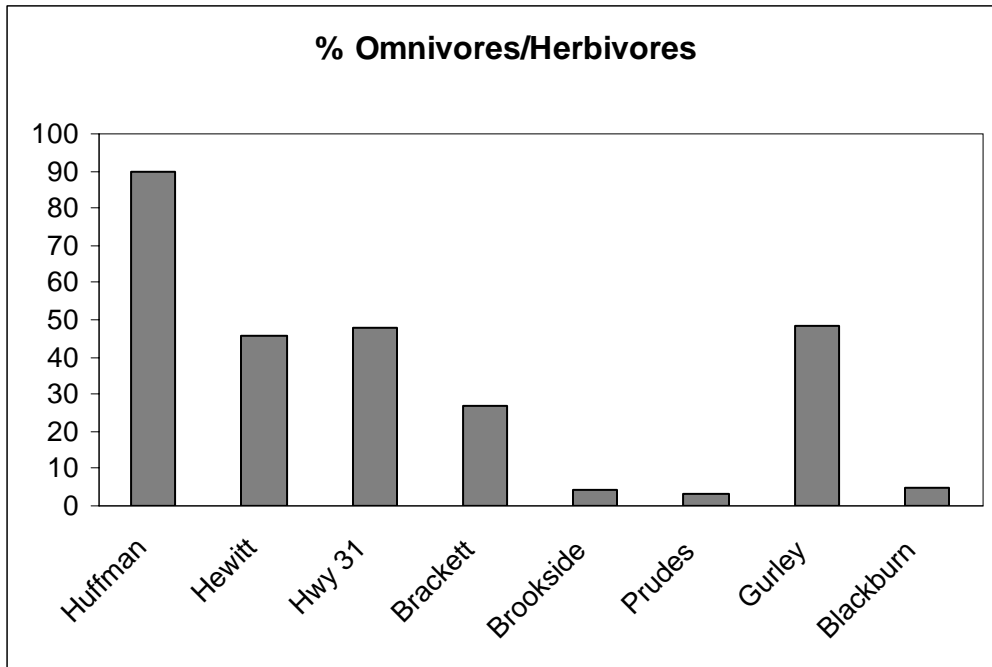


Figure 5. Percent Omnivores/Herbivores. The six Five Mile Creek sites are listed from upstream to downstream. Gurley and Blackburn are the reference sites.



Figure 6. Percent Insectivores. The six Five Mile Creek sites are listed from upstream to downstream. Gurley and Blackburn are the reference sites.

Discussion

Creeks are less impacted when the surrounding watershed is largely undeveloped and has little impermeable area. Conversely, as watersheds become developed, the amount of impermeable surfaces and amount of polluted runoff increase (Bryant 1998). Urban area streams are exposed to many pollutants, including sediment, heavy metals, and organic chemicals (Field 1990). Five Mile Creek is unfortunate in that its headwaters lie in an area of intense urban and industrial development. As a result, the stream has suffered.

Evidence of impairment is evident in the results of the comparisons between the Five Mile Creek sites and the two reference streams from non-urbanized areas (Blackburn Fork and Gurley Creek). Fish bioassessment scores for Blackburn Fork were

not as good as expected, possibly due to its being a tailwater and in the vicinity of several agricultural fields and a newly constructed golf course.

Given the history of Five Mile Creek, the fact that there was no correlation between the IBI and habitat scores, and that the Five Mile Creek habitat scores were fair to good, we conclude that the low IBI scores are primarily the result of a history of poor water quality. The poor water quality was most likely due to urban development in the upstream regions of the creek and the documented industrial pollution from the coal and coke industries. The reduction in urbanization and the increased distance from sources of industrial pollution are probably the main reasons why the IBI scores were consistently higher in the three downstream sites than in the three upstream sites. The downstream sites are also closer to a possible source of recolonization. The Black Warrior River and smaller feeder streams may serve as a reservoir of species diversity that can supply colonists to Five Mile Creek after a discrete pollution event has ended and the water quality again becomes tolerable.

We also observed a shift from populations dominated by omnivorous/herbivorous fish to populations dominated by insectivorous fish species in sites progressively more downstream. This shift is also evidence that Five Mile Creek has been more severely impacted historically in the upstream reaches. As the invertebrate food source decreases in abundance and diversity in response to anthropogenic stressors, there is a shift from insectivorous to omnivorous fish species (Barbour 1999).

Although Five Mile Creek does seem to be somewhat less impacted downstream than in the headwaters, this does not mean that the downstream sites are in good condition. Evidence of impairment included fair IBI scores downstream and the fact that

the entire stream was dominated by only three species. According to the EPA (Barbour 1999), the total number of fish species collected decreases with increased degradation.

The fish and habitat bioassessments that we conducted on Five Mile Creek show patterns indicative of a stream that has suffered from impaired water quality. The bioassessments also provide groups actively involved in river restoration with baseline data on the current biological status of the stream. The data provided by this study can be used as a point of comparison in a few years in order to determine whether the restoration efforts that have been put in place are truly improving the habitat quality and biological diversity of Five Mile Creek. The development of a greenway along the entire length of the stream will improve stream habitat characteristics and streambank stabilization, which should permit the biota of the stream to continue on their path toward ecological recovery. Vegetated land also helps cities meet their ozone requirements, can boost the socioeconomic situations in the surrounding areas, and can attract people to the area for recreational activities. Although impacted, the habitat quality of the stream is still in relatively good condition and with further water quality improvement provided by the Five Mile Creek Greenway Partnerships' restoration efforts, we feel that the biological health of Five Mile Creek will continue to improve.

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