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HATCHET CREEK REGIONAL REFERENCE WATERSHED STUDY

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by

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CONTENTS

TABLES

ILLUSTRATIONS

HATCHET CREEK REGIONAL REFERENCE WATERSHED STUDY

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INTRODUCTION

The purpose of this investigation is to provide information to the Alabama Department of Environmental Management (ADEM) about watershed features and current biological and habitat conditions of Hatchet Creek in support of its designation as a regional reference watershed for large flowing rivers in upland regions of Alabama. The ADEM is proposing to use Hatchet Creek as a regional reference watershed for benchmarking water-quality and biological conditions in ecoregions 45 (Piedmont) and 67 (Ridge and Valley) (Griffith and others, 2001). Documenting water quality variation, stream hydrology, watershed features, land-use patterns, and biological conditions in Hatchet Creek will be a necessary requirement for establishing Hatchet Creek as a regional reference watershed. The recently completed draft nutrient Total Maximum Daily Load (TMDL) for the Cahaba River (ADEM, 2004) will be the first large watershed TMDL for a flowing aquatic system that ADEM has issued. Implementation of TMDL requirements requires that reference conditions be used as an established benchmark for measuring TMDL performance, and Hatchet Creek is being proposed to fill this need. The use of reference watersheds is becoming a critical component of water-quality management efforts because of increasing emphasis on protecting not only physical and chemical water quality but also the biological integrity and habitat quality of water bodies.

Establishing a reference watershed condition requires developing a basic ecological understanding of watershed structure and function in a minimally or least impaired condition and how pollution affects its various components. The concept of water resource(s) entails more than the simple availability of water as it has been viewed and practiced in years past. For pollution prevention and control programs to

maintain their effectiveness and enhance/restore the nation's waters, a broader, more inclusive, concept of water resources must be adopted to include all components of the aquatic system including flow regimes, chemical variables, biotic factors, energy sources, and habitat structure. Disruption or changes in any one or combination of these factors will lead to degraded water resources, and very often changes in one factor will lead to synergistic and rapid degradation of the other factors. The degraded water resource may be impaired by heavy sediment loads, algal-choked river channels, loss of species diversity, eroding channel banks, or by other conditions. The regional reference watershed concept will establish a benchmark of watershed condition or performance against which water-quality and water-management objectives can be measured. For the reference watershed concept to be applicable to this process, it must be understood and characterized from several perspectives, including water quality, habitat, biological, physical (physiographic and geological), and hydrological.

SELECTION OF A REFERENCE WATERSHED

All watersheds within a larger river basin network can be aligned along a gradient from most to least impaired based on the level of human disturbance as measured by the amount of landscape modification, the degree of polluted runoff, and the intensity of permitted discharges. An essential task of reference watershed selection is to identify reference watersheds that meet water-quality standards, represent the least-disturbed condition, appear minimally impacted, and are representative of the physical, chemical, and biological components of an ecoregion.

One of the first steps in selecting a reference watershed is to locate a candidate watershed that has been recently assessed, is attaining all of its water-quality standards, and is meeting designated uses. Hatchet Creek meets these criteria with the entire main stem classified at a minimum Outstanding Alabama Water (OAW)/Fish and Wildlife (F&W). Other designated uses include Swimming and other Whole-Body Contact (S) and Public Water Supply (PWS). The ADEM (2002) recently assessed watersheds in the Coosa River system in Alabama relative to their nonpoint-source impairment potential. The Hatchet Creek watershed rated a low potential in most of the

criteria, which included animal husbandry activities, sedimentation, crop land runoff, pasture land runoff, and nonrural sources (urban land use, septic tank failure, storm water permits).

Other criteria for selecting reference watersheds include the relative intensity to which a watershed has been developed or modified by humans through land use changes, land cover alteration, and the discharge of pollutants both permitted and nonpermitted. Selection of a reference watershed should be guided by criteria that are reflective of a least or minimally impaired condition including the following:

- ❑ High percentage of natural vegetation (generally >80 percent forest).
- ❑ No significant siltation or embeddedness of the substrate. Habitat scores in the optimal to suboptimal range for aquatic assessments.
- ❑ Wide stream-side riparian zones (generally >100 feet).
- ❑ Low percentage (<20) of agricultural land use.
- ❑ Low percentage (<15) of urban land use.
- ❑ Low silvicultural activity.
- ❑ Low road density.
- ❑ Low volume of point- and nonpoint-source discharges.
- ❑ Little to no channel alteration.

A second step in selecting a reference watershed is to identify and characterize its physical, chemical, and biological properties, such as physiography/ecoregion, size, land use/land cover, geology, hydrology, aquatic biological communities, water quality regimes, and habitat conditions.

SAMPLING METHODS

The GSA, in conjunction with ADEM, has developed a tool to assess the biological integrity of flowing streams in Alabama (O'Neil and Shepard, 2000). This tool is a modification of the Index of Biotic Integrity (IBI) and is widely used to evaluate streams based on the fish community. The IBI has been used throughout the United States for a number of years, and results of IBI investigations are now accepted and becoming standard practice in water-quality assessment and monitoring programs.

Scoring criteria for the IBI have been established for the Black Warrior River (O'Neil and Shepard, 2000) and the Cahaba River (O'Neil, 2002), and GSA is currently conducting a study to refine the IBI sampling methodology and develop IBI scoring criteria for the Coosa and Tallapoosa River systems. The Cahaba River scoring criteria, with modification for drainage-specific faunal differences, were applied to samples collected in Hatchet Creek.

The use of biological assessment tools to evaluate stream water quality has proliferated since a practical definition of biological integrity was proposed by Karr and Dudley (1981). They defined biological integrity as the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats within a region. This definition of biological integrity is based on measurable characteristics of biological community structure and function and has provided the underlying theory for development of biocriteria for specific ecoregions in some states (Ohio EPA, 1987a).

The process of biological assessment is a systems approach for evaluating water resources that focuses on the actual condition of the resource, assessing chemical and physical water quality, biotic interactions, hydrology, energy and trophic interactions, and habitat structure. The extensively used chemical/physical and whole-effluent toxicity water regulatory approach only measures certain components of a water resource and as such are only surrogate measures for evaluating biological community integrity. Ultimately, it is the measurable performance of the natural biological system relative to a reference condition that is the goal for determining whether or not regulatory programs have successfully maintained or improved water quality. Biological assessments are one of the few ways to directly measure biological performance.

Biological assessments can now be used with confidence for water resource evaluation for several reasons. First, support for the use of standardized techniques and methods has increased during the last decade (Karr and others, 1986; Plafkin and

others, 1989; Barbour and others, 1999). Second, field and laboratory techniques have been refined and modified for use within a regulatory scheme. Third, a practical, working definition of biological integrity has been developed (Karr and Dudley, 1981) from which the process of biological assessment can be defended. And finally, the concept of using data from regional reference watersheds has been incorporated into the evaluation process compensating for the natural variation inherent in biological populations and systems. Full integration of the chemical-specific, toxicity, and biological assessment approaches is essential for a broad-based, technically sound, and cost-effective system for regulating and managing water resources.

Rapid biological assessment requires the time-efficient analysis of stream conditions at a relatively low cost. Assessments must characterize the existence and severity of impairment to water-use classifications, help identify the sources and causes of water-use impairment, evaluate the effectiveness of actions to control water pollution, support water-use attainability studies, and characterize regional biotic components (Plafkin and others, 1989). In conjunction with chemical/physical water-quality measurements and analysis of habitat quality and condition, the biological assessment is an effective tool for assessing and managing water quality within the ecoregion.

The most widely used approach for biological assessment is sampling and analysis of the macroinvertebrate community using the rapid bioassessment protocol (RBP-III) methodology (Plafkin and others, 1989; Barbour and others, 1999) or some variation thereof. Another, less widely used, approach for conducting bioassessments is through sampling and analysis of the fish community. Assessing the biological condition of streams using the fish community has distinct advantages over the use of other aquatic groups.

- Fishes occupy the full range of positions throughout the food chain including herbivores, carnivores, piscivores, omnivores, insectivores, and planktivores, thereby integrating a variety of watershed functions and conditions into their community trophic structure.
- Fishes are generally present in all but the most polluted waters.

- Because fishes are relatively long-lived compared to macroinvertebrates and generally spawn for a restricted period in a year, their population numbers and fluctuations are more stable over longer periods of time.

- Fishes are relatively easy to identify compared to diatoms and macroinvertebrates. Species identification is possible for practically all individuals collected; and, if desired, individuals can be identified by a trained biologist and released in the field. Samples returned to the laboratory can be sorted, identified, and data sheets prepared relatively quickly allowing several samples to be processed in a day.

- Environmental requirements of fishes are relatively well known for a majority of species. Life history information is extensive for many species and detailed distributional information is becoming more available with time.

- Water-quality standards, legislative mandates, and public opinion are more directly related to the status of a lake or stream as a fishery resource. One goal of the Clean Water Act is to make waters “fishable and swimmable,” a directly measurable and attainable concept. Public perception of streams, pollution, and water-quality monitoring is linked closely with fishes because of their value as a food source and as a recreational resource.

Various protocols have been proposed for sampling fish communities in wadeable and nonwadeable streams (Ohio EPA, 1987b; Plafkin and others, 1989; Barbour and others, 1999), and many are accepted techniques for collecting data for use with the IBI. The Tennessee Valley Authority (TVA) has developed a species depletion sampling protocol where a prescribed number of sampling units are collected within unique habitat types (riffles, runs, pools, shorelines). The catch in each unit is identified and recorded on site, and sampling is continued until no new species are collected in the last unit, termed species depletion. Depending on the size (watershed area) and biodiversity of a site, this technique may take several hours, requires on-site identification of the catch, and may require a large field crew.

Another variation of the species-depletion protocol consists of blocking a stream reach at the upstream and downstream ends and making three depletion passes through the reach with a sampling team that spans the stream from bank to bank. After

each pass the catch is identified and held until all sampling is completed. This technique requires on-site identification, a rather large field crew, and only two sites can be sampled per day even if they are in close proximity.

The sampling method used in this study was modified from a protocol described by O'Neil and Shepard (2000) to include more intensive sampling at each site in order to capture as many species as possible (table 1). The most effective sampling combination was a backpack shocker in combination with a seine. In riffles, the net was set in shallow, rocky areas or deeper, swifter chutes. The backpacker walked upstream then proceeded to shock downstream through the riffle to the seine while disturbing the bottom with boots and probes. Stunned fishes in the water column were washed into the net while benthic fishes were dislodged from the bottom by kicking the substrate. Another variation was to have another crew member moving behind the backpacker disturbing the bottom and dislodging stunned benthic fishes. Because riffles are generally highly productive areas, all microhabitats were sampled: the head, foot, middle, and sides. Plunge pools at the foot of a riffle often yielded a diverse catch of cyprinid species.

Stream runs between riffles and pools were also productive habitats and were sampled by either seining downstream or by moving from bank to bank across the stream in a downstream direction either alone or following the backpacker. Pools were generally less productive than runs and riffles but many times contained species not found in either of the other habitats. Lower velocity in pools required more effort to pull the seine through the water column. Following the electroshocker was also effective in pools, as was trapping fishes against the shore or in a slough at the end of a long pool. Wider seines were more efficient for collecting fishes in pools.

Shorelines along pool margins can have complex structure and yield game species and larger sucker species not normally found in the basic riffle-run-pool habitats. These habitats were collected using a technique known as shoreline sampling. The shoreline technique was developed by TVA biologists and consists of a crew member working the electroshocker upstream along a shoreline for a length of

Table 1. Fish community sampling procedures used by the Geological Survey of Alabama.

Habitat Selection	Four basic habitat types are sampled at each site: riffles, pools, runs, and shorelines. All sampling is conducted in units called efforts. One effort is equivalent to a riffle kick with the backpack shocker, a pool drag, a run set with the seine, or one shoreline effort. Area is determined for each effort, and the species type and number collected are determined for each effort. At least 10 efforts are expended per habitat, and at least two shoreline efforts are completed at the site.
Sample Gear	Seine (10' wide x 6' deep or 15' wide x 6' deep; 3/16" mesh) Battery- or generator-powered backpack shocker. Dip nets with wood handles. Hip chain (for measuring distance of shoreline samples) Data recording sheet or digital data logger. Plastic jar with preservative for voucher specimens.
Sampling Methods	Riffle kicks with and without backpack shocker. Pool drags with and without backpack shocker. Set downstream of and shock through runs. Set below and shock through plunge pools. Shoreline samples with backpack shocker and dip nets, usually 150 feet long.
Taxonomic Level	All collected individuals identified to species in the field. Occasional voucher specimens, or individuals that can not be field identified, are retained.
QA Procedures	Field: All personnel undergo yearly assessment of sampling techniques: sampling method is refined as needed for project or study. Identifications: One expert fish taxonomist and(or) identifier at a minimum are present for all sampling.
Habitat Assessment	USEPA Physical Habitat Assessment Protocol (Barbour and others, 1999; ADEM, 1999).

approximately 150 feet sampling around all structures. One or two field crew members followed closely with dip nets scooping and identifying the stunned individuals. Distance was measured with a forestry-type hip chain.

SAMPLING GEAR

Of all available sampling equipment, the backpack electrofisher, dip net, and nylon minnow seine are the most popular sampling gear used for bioassessment studies in wadeable streams. Ohio EPA (1987b) exclusively uses electrofishing gear to collect their standardized wadeable stream samples. They concluded that seines are too selective and inefficient, while sampling effort is too variable between field crews. Ohio EPA has adopted biocriteria in their legal water-quality regulations; therefore, sampling protocols that minimize sampling bias and standardize sampling effort are mandatory. This is a strong argument for using electrofishing gear exclusively when young and inexperienced field crews are dispatched to collect fish samples. On the other hand, the knowledgeable use of seines in combination with electrofishing gear can yield representative samples of the fish community for use in assessing stream water quality. As with most sampling gear and techniques, there are advantages and disadvantages to each method.

Advantages of electrofishing

- Electrofishing allows greater standardization of catch per unit effort.
- Electrofishing requires less time and a reduced level of effort than some sampling methods.
- Electrofishing is less selective than seining.
- Electrofishing has minimal effects on fish if properly used.
- Electrofishing is appropriate in a variety of habitats.

Disadvantages of electrofishing

- Sampling efficiency is affected by turbidity and specific conductance.
- Although less selective than seining, electrofishing is size and species selective with larger species more vulnerable to electrofishing.
- Electrofishing is a hazardous operation that may result in injury to people if proper safety procedures are not followed.
- Commercial electrofishing units are expensive (thousands of dollars).

Advantages of seining

- Seines are inexpensive, lightweight, and easily transported to sampling sites.
- Repair and maintenance are easily completed.
- Use of seines is not restricted by water clarity or quality.
- Effects on fish populations are minimal because fish are collected alive and generally unharmed.
- Seines can be effectively used as large dip nets to scoop small individuals.

Disadvantages of seining

- Previous experience, sampling skill, knowledge of fish habitats and behavior, and sampling effort are more critical in seining than in the use of any other sampling gear.
- Sample effort and results for seining are more variable than sampling with electrofishing units or ichthyocides.
- Use of seines is most effective in small streams.
- Standardization of catch per unit effort to ensure data comparability can be more difficult.
- Highly mobile fishes often elude seines and nets.

SAMPLING SITES

A field reconnaissance trip was conducted on August 20, 2004, to evaluate and select stream sites in the Hatchet Creek watershed. Twelve sites were visited and evaluated as to their potential to represent the Hatchet Creek aquatic ecosystem:

Hatchet Creek at East Mill, Clay Co.
Hatchet Creek at Clay Co. Hwy. 7
Hatchet Creek at Ala. Hwy. 148, Clay Co.
Mill Creek north of Ala. Hwy. 148, Clay Co.
Jacks Creek at Coosa Co. Hwy. 40
Socapatoy Creek at Coosa Co. dirt road
Hatchet Creek at U.S. Hwy. 280, Coosa Co.
Hatchet Creek at Coosa Co. Hwy. 66
Hatchet Creek at Coosa Co. Hwy. 511
Hatchet Creek at Dunham property, Coosa Co.
Hatchet Creek at old Hwy. 59 bridge, Coosa Co.
Hatchet Creek at McConnell property, Coosa Co.

Criteria used to select sites in the Hatchet Creek watershed for biological assessment included the following:

- The presence of stable habitat to support diverse fish communities. Critical habitat components included riffles, pools, runs, and shoreline with adequate structure. Stable habitat was indicated by riffles with unembedded gravels and cobbles and pools without excessive siltation.
- The absence of habitat degradation due to excessive loose sediments, poor water quality, or over nutrification.
- The presence of intact and health riparian vegetation.
- Accessibility of the site.
- Wadeability of the stream—use of the IBI requires that stream sites be wadeable in order to apply the sampling methodology .
- Distribution of sites in Hatchet Creek to represent stream conditions ranging from large downstream fish communities to smaller upstream communities.

Four sites were selected in the Hatchet Creek watershed for study, three in the main channel and one on a major tributary, Socapatoy Creek (table 2). Working under the assumption that Hatchet Creek represents a minimally impacted watershed and is representative of a reference condition, Cahaba River watershed sites were matched with Hatchet Creek sites using two criteria. First, Cahaba sites were selected with watershed areas that matched as closely as possible to the watershed areas of selected Hatchet sites. Watershed area is a master variable controlling both hydrological characteristics and biological conditions and should be as similar as possible. Second, it was desirable that Cahaba sites also be as minimally impacted biologically as possible relative to other Cahaba River sites. A tributary was selected in both systems because several of the main tributaries to the Cahaba River are impacted to varying degrees (Buck Creek-nutrients; Shades Creek-urban/sediment; Big Black Creek-mine runoff), and having a reference tributary site in Hatchet may be beneficial in the future when applying TMDL prescriptions and(or) other water-quality limitations.

Table 2. Sampling sites in Hatchet Creek and Cahaba River.

Site No.	Location	County/ Quadrangle	Outcrop geology at site	Latitude-Longitude	Area (mi^2)[1]	Use Classification[2]
Hatchet Creek Sites						
HATC-4	Hatchet Creek at McConnell Property sec. 26, T. 23 N., R. 18 E.	Coosa Co./ Rockford	Pinchoulee Gneiss-Hatchet Creek Group	32.9439 N 86.2358 W	238	OAW S F&W
HAT-2	Hatchet Creek at Dunham Property sec. 11, T. 23 N., R. 19 E.	Coosa Co./ Rockford	Rockford Ggranite	32.9998 N 86.1425 W	125	OAW S F&W
HAT-3	Hatchet Creek at East Mill NE 1/4 sec. 7, T. 22 S., R. 6 E.	Clay Co./ Bulls Gap	Jemison Chert-Chulafinnee Schist	33.1305 N 86.0550 W	59.2	OAW S F&W PWS
SOCC-1	Socapatoy Creek at Coosa Co. road 69 SE1/4 sec.22, T. 23 N., R. 19 E.	Coosa Co./ Rockford	Wedowee group	32.9656 N 86.1496 W	46 (75.9)	F&W
Cahaba River Sites						
C2	Cahaba River at Caldwell Mill Road sec. 3, T.19 S., R. 2 W.	Shelby Co./ Cahaba Heights	Pottsville Formation upper	33.4156 N 86.7403 W	200	F&W
CABJ-6	Cahaba River at Grants Mill Road sec. 33, T.17 S., R.1 W.	Jefferson Co./ Irondale	Pottsville Formation upper	33.5114 N 86.6528 W	129	F&W-(upstream) OAW/PWS-(downstream)
C1	Cahaba River at Whites Chapel sec. 33, T.16 S., R.1 E.	St.Clair Co./ Leeds	Pottsville Formation upper	33.6052 N 86.5494 W	51	F&W
SH-1A	Shades Creek at Hwy. 150 NW1/4 sec. 29, T.19 S., R.3 W.	Jefferson Co./ Greenwood	Parkwood Formation	33.3567 N 86.8781 W	41.4 (139)	F&W

[1]- areas in parentheses are total watershed areas for tribuaries.
[2]- OAW-Outstanding Alabama Water, S-Swimming and other Whole Body Contact, F&W-Fish and Wildlife, PWS-Public Water Supply

RESULTS AND DISCUSSION

WATERSHED CHARACTERISTICS OF HATCHET CREEK

Hatchet Creek drains almost exclusively lands in the Southern Inner Piedmont (ecoregion 45a) bordered to the northwest by the Talladega Upland (45d). The Southern Inner Piedmont consists of dissected irregular plains, tablelands of moderate relief, open hills, and low to moderate gradient streams with mostly cobble, gravel, and sandy substrates (Griffith and others, 2001). Sapp and Emplaincourt (1975) describe the Northern Piedmont Upland (=Southern Inner Piedmont) as a well-dissected upland developed on metamorphosed sedimentary and igneous rocks with elevations generally 1,000 to 1,100 feet in the north and 500 to 600 feet in the south. Baker (1957) described the Piedmont area, more specifically the Ashland Plateau or Northern Piedmont Upland, as the higher and more mountainous region of the Piedmont. The more common rocks in the Ashland Plateau are mica schist, phyllite, and slate. The Hatchet Creek watershed is underlain chiefly by phyllite and slate that have been strongly dissected into prominent valley and ridge features. Other rock types in the area include basic igneous rocks, quartzite, and gneiss (Baker, 1957).

Three 11-digit hydrologic units (HUC-hydrologic unit codes) are included in the Hatchet Creek regional reference watershed, 110 (Upper Hatchet Creek), 120 (Socapatoy Creek), and 130 (Middle Hatchet Creek) (table 3). These three HUCs comprise a land area of approximately 358 square miles (mi^2) (229,346 acres). Based strictly on land cover/land use statistics derived from work of the Natural Resource Conservation Service (NRCS) State Soil and Water Conservation Committee, Hatchet Creek meets several of the selection criteria with forest cover over 90 percent, agricultural use <7 percent, and urban land use <1 percent (table 3). The high percentage of forest cover is a significant advantage to the watershed, providing riparian coverage along stream channels and attenuation of flood effects during storm events.

Water in the Hatchet Creek watershed is of very high quality because of minimal land disturbance, low urban intensity, and low number of permitted discharges. The

Table 3. Estimated land use/land cover percentages for hydrologic units (HUC's) in Hatchet Creek and Cahaba River watersheds.

HUC code	Subwatershed	Land use/cover areas (acres) [1]							Total Area [2]	
		Crop	Pasture	Forest	Urban	Ponds and Lakes	Mined	Other	acres	sq miles
Hatchet Creek system										
110	Upper Hatchet	75	6,803	88,000	194	265	10	1,103	96,450	150.70
120	Socapatoy	0	2,922	44,539	779	127	0	341	48,708	76.11
130	Middle Hatchet	0	4,209	78,740	295	118	0	926	84,188	131.54
	TOTAL	75	13,934	211,279	1,268	510	10	2,370	229,346	358.35
	Percent	*<0.1*	*6.1*	*92.1*	*0.6*	*0.2*	*<0.1*	*1.0*		
Upper Cahaba system										
010	Big Black	301	2,704	48,551	5,403	806	300	1,796	59,861	93.53
020	Little Cahaba	149	5,494	9,306	9,092	1,758	186	1,230	27,215	42.52
030	Cahaba	317	3,222	28,313	42,184	715	319	2,901	77,971	121.83
	TOTAL	767	11,420	86,170	56,679	3,279	805	5,927	165,047	257.88
	Percent	*0.5*	*6.9*	*52.2*	*34.3*	*2.0*	*0.5*	*3.6*		
060	Shades	275	7,014	41,641	36,174	602	557	2,478	88,741	138.66
	Percent	*0.3*	*7.9*	*46.9*	*40.8*	*0.7*	*0.6*	*2.8*		

[1] Land use estimates compiled from county Soil and Water Conservation Committees conservation assessment worksheets (various methods were used to estimate land area by use type.)

[2] HUC totals were taken from State of Alabama Hydrologic Unit Map with Drainage Areas by Counties and Subwatersheds. U.S. Department of Agriculture, Soil Conservation Service (NRCS) 1985.

Coosa River assessment report (ADEM, 2002) listed 16 active discharge permits in the Hatchet Creek watershed (10 construction stormwater, 2 noncoal mining stormwater, 1 mining NPDES, 2 municipal NPDES, and 1 semi-public/private NPDES), which is low compared to other Coosa River watersheds. Dissolved solids content is generally low because the watershed is underlain by crystalline Piedmont rocks, and pH is near neutral (table 4). Other chemical indicators of watershed disturbance, such as chloride and nitrate, are also low in concentration. Dissolved oxygen levels are high relative to urban watersheds like the Cahaba River.

Discharge records for United States Geological Survey (USGS) station 02408540 (Hatchet Creek below Rockford) for the years 1980-2003 show a minimum flow of 4.4 ft^3/s (cubic feet per second) and a maximum flood flow of 19,500 ft^3/s. Average flow for this period of record was 398 ft^3/s (table 4) or a flow of 1.51 ft^3/s per square mile of drainage area. Comparison of stream flow characteristics between Hatchet Creek and Cahaba River using flow duration analysis (fig. 1), with stream flows normalized to a unit drainage area, demonstrates that both watersheds respond to hydrological events with similar low, normal, and high stream flow characteristics. Shape, aspect, and configuration of a watershed as well as its respective hydrogeologic environment are apparently similar between these two watersheds, yielding similar patterns in flow duration curves. In contrast, compare these two curves to one derived for Big Prairie Creek, which drains an area of the Black Belt underlain by impervious chalk in the East Gulf Coastal Plain of Alabama. Flood lows are generally more extreme, low flows are poorly sustained in dry months, and the stream generally goes dry in drought periods. In like fashion, comparison of flood frequencies between these watersheds (fig. 2) demonstrates that Hatchet Creek and Cahaba River are similar with respect to flood frequency and intensity when compared to Big Prairie Creek, supporting the concept that Hatchet Creek and Cahaba River are controlled by similar hydrogeologic and watershed factors.

Bogan and Pierson (1993) conducted a survey of aquatic gastropods in the Coosa River and included sites in Hatchet and Weogufka Creeks. They reported 11

Table 4. Selected hydrology and water-quality parameters for Hatchet Creek and Cahaba River.

Water quality and hydrological parameters	Hatchet Creek near Rockford 02408500	Hatchet Creek below Rockford 02408540	Cahaba River near Mountain Brook 02423380
Period of record	1962-1979	1980-2003	1985-2003
Watershed area (mi^2)	233	263	140
Average annual discharge (ft^3/s)	385	398	239
Average annual discharge ($ft^3/s/mi^2$)	1.65	1.51	1.71
Specific conductance (µS/cm)	21-80 (40) [149]	24-310 (43) [123]	75-395 (175) [85]
Temperature (°C)	1.0-29 (17) [185]	3.0-33 (19) [125]	3.8-30 (16) [86]
pH (s.u.)	6.0-7.6 (7.0) [73]	6.0-7.3 (6.4) [7]	6.0-8.0 (7.4) [41]
Dissolved oxygen (mg/L)	7.5-14.2 (10.7) [46]	7.3-11.1 (8.3) [7]	5.4-12.6 (8.4) [43]
Chloride (mg/L)	.2-3.6 (1.6) [73]	.6-2.0 (1) [7]	2.1-20 (3.9) [39]
Nitrate-Nitrite (mg/L as N)	0-.7 (.05) [52]	.02-.06 (.04) [2]	.1-1.2 (0.39) [34]
minimim-maximum (median) [sample size]			

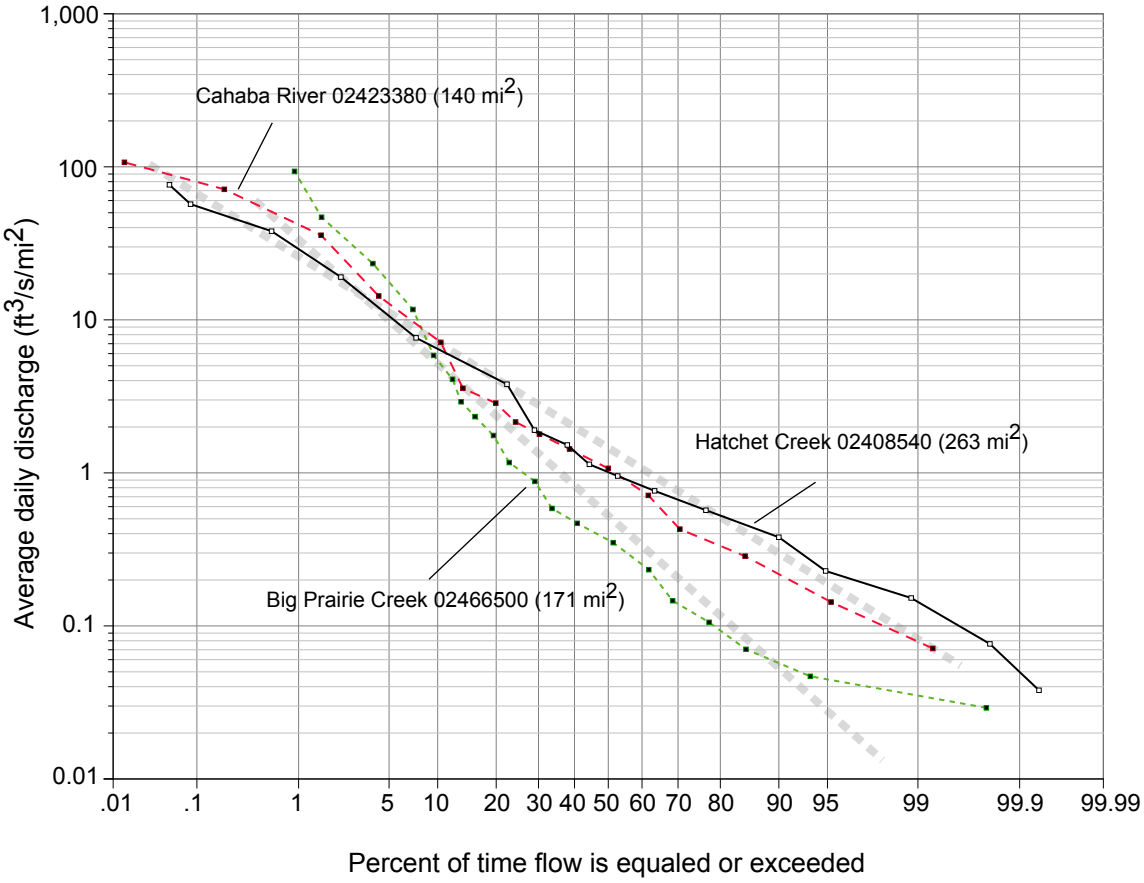

Figure 1. Flow duration curves for stations in Hatchet Creek, Cahaba River, and Big Prairie Creek,

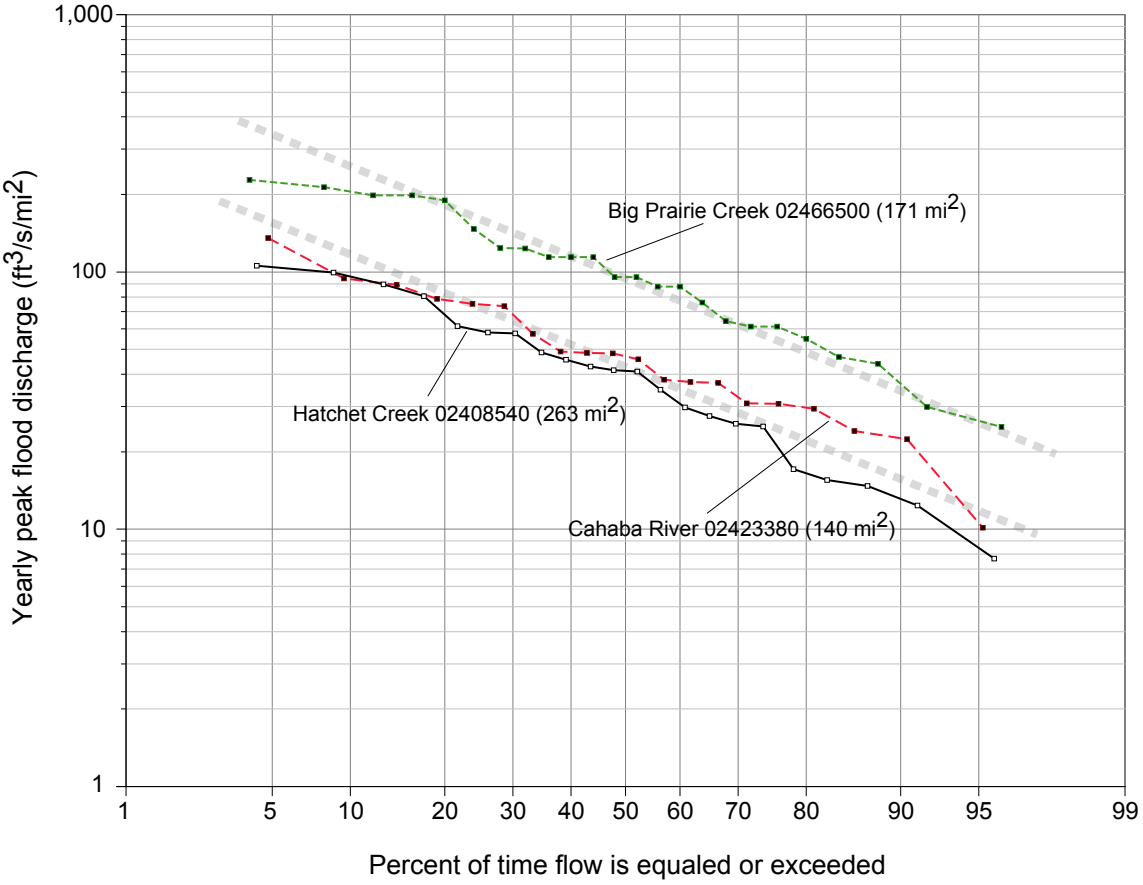

Figure 2. Flood frequency curves for stations in Hatchet Creek, Cahaba River, and Big Prairie Creek,

species present in the two drainages, including the federally endangered Tulotoma (*Tulatoma magnifica*). DeVries (1998) conducted further sampling in Hatchet Creek for Tulotoma and discovered high densities of this species in lower Hatchet from the confluence of Rocky Branch upstream to Tyler Ford, a distance of 8.2 river miles. Pierson (1992) reported six species of mussels in Hatchet Creek including the fine-lined pocketbook (*Lampsilis altilis*) which is listed as a federally threatened species and a species of high conservation concern in Alabama (Mirarchi and others, 2004).

Duncan and others (2001) reported 55 species of fishes in the Hatchet Creek system based on samples collected at 20 sites by Malcolm Pierson from 1981-1999. The blue shiner (*Cyprinella caerulea*), a federally listed threatened species, occurs in Weogufka Creek but has never been reported from Hatchet Creek watershed proper. The coal darter (*Percina brevicauda*) is listed as a species of high conservation concern in Alabama (Mirarchi and others, 2004) and is known in Hatchet Creek only at the U.S. Hwy. 231 road crossing. Duncan and others (2001) calculated IBI scores for samples from 16 sites in the watershed with 69 percent (11 sites) scoring in the good to excellent biological condition range. The highest IBI score (good-excellent) was reported for a site in the West Fork of Hatchet Creek while the lowest IBI score (fair) was reported for Baker Creek.

BIOLOGICAL AND HABITAT ASSESSMENT OF HATCHET CREEK AND CAHABA RIVER

All sampling for this investigation was conducted the week of October 5-8, 2004. Stream habitats were sampled a total of 47 efforts per site (table 5) with 15 efforts in pool, riffle, and run habitats and 2 efforts along shorelines. Some variation in total area sampled per site occurred but this variation was slight with 23,190 ft^2 sampled in Hatchet Creek and 23,810 ft^2 sampled in Cahaba River. The total number of species collected in each watershed (excluding hybrid sunfish) was similar (table 5) with 38 species collected in Hatchet, varying from 20 to 27 per site, and 40 species collected in Cahaba, varying from 19 to 30 per site (appendix). Total catch was substantially different between the two watersheds with 2,968 individuals captured in Hatchet and

Table 5. Collection information for fish samples taken in Hatchet Creek and Cahaba River, 2004.

Site name		Hatchet Creek				Cahaba River			
		HATC-4	HAT-2	HAT-3	SOCC-1	C-2	CABJ-6	C1	SH-1A
		McConnell	Dunham	East Mill	Socapatoy	Caldwell Mill	Grants Mill	Roper Road	Shades @ 150
Date of collection		5 Oct 04	6 Oct 04	6 Oct 04	5 Oct 04	8 Oct 04	7 Oct 04	7 Oct 04	8 Oct 04
Watershed area (mi^2)		238	125	59.2	46	200	129	51	41.1
Sampling time (min)		195	150	125	150	185	130	120	110
		620				545			
Sampling efforts	Pools	15	15	15	15	15	15	15	15
	Riffles	15	15	15	15	15	15	15	15
	Runs	15	15	15	15	15	15	15	15
	Shorelines	2	2	2	2	2	2	2	2
	Total	47	47	47	47	47	47	47	47
		188				188			
Area sampled (ft^2)	Pools	1,840	1,800	2,040	2,120	1,800	2,320	1,920	1,800
	Riffles	1,760	1,800	1,730	1,740	1,800	2,040	1,810	1,800
	Runs	1,760	1,800	1,800	1,800	1,800	1,800	1,920	1,800
	Shorelines	300	300	300	300	300	300	300	300
	Total	5,660	5,700	5,870	5,960	5,700	6,460	5,950	5,700
		23,190				23,810			
Total species		27	23	27	19	30	24	23	20
		38				40			
Total individuals		812	774	654	728	1,754	540	573	1,274
		2,968				4,141			
Catch per hour		250	310	313	291	568	249	286	695
		287				456			
Catch per 1,000 ft^2		143	136	111	122	308	84	96	223
		128				174			

4,141 individuals captured in Cahaba—a 40 percent increase in catch over Hatchet (table 5). Catch rate was higher in the Cahaba with 456 individuals per hour compared to 287 individuals per hour in Hatchet. These differences are also reflected in catch per 1,000 ft^2 of substrate sampled with 128 individuals per 1,000 ft^2 in Hatchet and 174 individuals per 1,000 ft^2 in Cahaba—a 36 percent higher catch rate in Cahaba compared to Hatchet.

Overall species richness of the fish fauna in each watershed was quite similar (table 6) with consistent numbers of species in major fish families. Equal or similar numbers of species were collected in all major fish families except for the sunfish family (Centrarchidae) which was represented by more species in the Cahaba.

Of the 50 species collected during this investigation (table 7), 28 were common to both drainage systems, 10 species were collected only in Hatchet Creek, and 12 species were collected only in Cahaba River. Four of the 10 species only collected in Hatchet are limited to the Coosa and(or) Tallapoosa River systems; these four species are the lined chub, Coosa shiner, Coosa darter, and the bronze darter. Two of the 10 species, the southern brook lamprey and the longnose gar, were not collected but are common in the Cahaba system. Three of the 10 species are not known from the very upper Cahaba River above the Fall Line in our study area. These are the speckled chub, speckled madtom, and southern studfish. The burrhead shiner occurs uncommonly in the upper Cahaba. Likewise, the Alabama darter, one of the 12 species found only in Cahaba River, does not occur in the Coosa River system. Of those 12 species, four are not known from Hatchet Creek—including the pretty shiner, riffle minnow, redspotted sunfish, and redfin darter. Five of the 11 species are known from Hatchet but are uncommon in the system; these are the clear chub, bullhead minnow, yellow bullhead, blackspotted topminnow, redear sunfish, and warmouth. The coal darter is known from both systems but has only been collected at U.S. Hwy. 231 in Hatchet Creek.

Similarity of the fish fauna in these two systems was compared using Jaccard's Similarity Coefficient - *J* (Brower and Zar, 1977) and by calculation of a Pearson

Table 6. Comparison of family species diversity between Hatchet Creek and Cahaba River, 2004.

Family	Number of species	
	Hatchet	Cahaba
Cyprinidae - minnows	11	11
Catostomidae - suckers	5	5
Ictaluridae - catfishes	3	3
Centrarchidae - sunfishes	7	10
Percidae - darters	7	8
Other families	5	3
Total species	38	40

Table 7. Summary list of fishes collected in Hatchet Creek and Cahaba River, 2004.

Scientific name	Common name	Hatchet		Cahaba	
		Total	%	Total	%
Petromyzontidae					
Ichthyomyzon gagei	southern brook lamprey	1	0.03	--	--
Lepisosteidae					
Lepisosteus osseus	longnose gar	1	0.03	--	--
Cyprinidae					
Campostoma oligolepis	largescale stoneroller	68	2.29	1,250	30.19
Cyprinella callistia	Alabama shiner	783	26.39	585	14.13
Cyprinella trichroistia	tricolor shiner	573	19.31	33	0.8
Cyprinella venusta	blacktail shiner	1	0.03	285	6.88
Hybopsis lineapunctata	lined chub	1	0.03	--	--
Hybopsis winchelli	clear chub	--	--	17	0.41
Lythrurus bellus	pretty shiner	--	--	80	1.93
Macrhybopsis aestivalis	speckled chub	36	1.21	--	--
Notropis asperifrons	burrhead shiner	30	1.01	--	--
Notropis stilbius	silverstripe shiner	111	3.74	321	7.75
Notropis xaenocephalus	Coosa shiner	13	0.44	--	--
Notropis volucellus	mimic shiner	80	2.7	44	1.06
Phenacobius catostomus	riffle minnow	--	--	61	1.47
Pimephales vigilax	bullhead minnow	--	--	38	0.92
Semotilus atromaculatus	creek chub	1	0.03	1	0.02
Catostomidae					
Hypentelium etowanum	Alabama hogsucker	106	3.57	255	6.16
Minytrema melanops	spotted sucker	3	0.1	2	0.05
Moxostoma duquesnei	black redhorse	5	0.17	2	0.05
Moxostoma erythrurum	golden redhorse	51	1.72	28	0.68
Moxostoma poecilurum	blacktail redhorse	8	0.27	11	0.27
Ictaluridae					
Ameiurus natalis	yellow bullhead	--	--	2	0.05
Ictalurus punctatus	channel catfish	4	0.13	4	0.1
Noturus leptacanthus	speckled madtom	85	2.86	--	--
Pylodictis olivaris	flathead catfish	3	0.1	1	0.02
Fundulidae					
Fundulus olivaceus	blackspotted topminnow	--	--	24	0.58
Fundulus stellifer	southern studfish	3	0.1	--	--
Poeciliidae					
Gambusia affinis	mosquitofish	7	0.24	12	0.29
Centrarchidae					
Ambloplites ariommus	shadow bass	19	0.64	4	0.1
Lepomis cyanellus	green sunfish	3	0.1	29	0.7
Lepomis gulosus	warmouth	--	--	2	0.05
Lepomis macrochirus	bluegill	7	0.24	288	6.95
Lepomis megalotis	longear sunfish	112	3.77	304	7.34
Lepomis microlophus	redear sunfish	--	--	1	0.02
Lepomis miniatus	spotted sunfish	--	--	6	0.14
Lepomis hybrids	sunfish hybrids	--	--	2	0.05
Micropterus coosae	redeye bass	13	0.44	9	0.22
Micropterus punctulatus	spotted bass	3	0.1	38	0.92
Micropterus salmoides	largemouth bass	1	0.03	9	0.22

Table 7. Summary list of fishes collected in Hatchet Creek and Cahaba River, 2004.

Scientific name	Common name	Hatchet		Cahaba	
		Total	%	Total	%
Percidae					
Etheostoma coosae	Coosa darter	16	0.54	--	--
Etheostoma jordani	greenbreast darter	437	14.73	18	0.43
Etheostoma ramseyi	Alabama darter	--	--	14	0.34
Etheostoma rupestre	rock darter	8	0.27	157	3.79
Etheostoma stigmaeum	speckled darter	49	1.65	2	0.05
Etheostoma whipplei	redfin darter	--	--	3	0.07
Percina brevicauda	coal darter	--	--	1	0.02
Percina kathae	Mobile logperch	7	0.24	33	0.8
Percina nigrofasciata	blackbanded darter	67	2.26	164	3.96
Percina palmaris	bronze darter	234	7.89	--	--
Cottidae					
Cottus carolinae	banded sculpin	17	0.57	1	0.02
Total species collected		38		40	
Total individuals collected		2,967		4,141	

correlation coefficient using log10(n+1) transformation of collection data reported in table 7. The Jaccard coefficient compares the number of species shared in two samples or watersheds (*c*) with the number of unique species in each system (s_1 and s_2): $J = c \div [s_1 + s_2 - c]$. Hatchet Creek and Cahaba River fish faunas, as defined by the stations sampled, were approximately 56 percent similar as calculated using the Jaccard formula, whereas the correlation coefficient for data in table 7 (less hybrid sunfish) was 0.452. Both measures indicate that the fish faunas, as defined within the stations sampled, are around 50 percent similar in species composition.

The largescale stoneroller (*Campostoma oligolepis*), considered tolerant of polluted conditions, was the dominant species in the Cahaba system comprising over 30 percent (1,250 individuals) of the 4,141 individuals collected (table 7). Large numbers of stonerollers, as occur in the Cahaba, generally indicate a biologically degraded stream system due to over-nutrification, over-sedimentation, or both in combination. In contrast, stonerollers comprised only 2.3 percent (68 individuals) of the 2,968 individuals collected in Hatchet. The greenbreast darter (*Etheostoma jordani*) is considered an intolerant species abundant only when water quality and habitat conditions are good. Greenbreast darters comprised 14.7 percent (437 individuals) of the fauna in Hatchet Creek and only 0.4 percent (18 individuals) in the Cahaba River. The wide differences in abundance of these two species strongly indicates that biological condition is impaired in the Cahaba River and is ambient or “normal” in Hatchet Creek.

The IBI scores calculated for each site also reflect biological conditions in each watershed. All sites in Hatchet scored in the good biological condition range (table 8), whereas only one site in Cahaba (C-2, Caldwell Mill) scored good. The remaining sites in Cahaba scored fair. Scores for diversity metrics (1-6) were similar between watersheds, whereas the trophic structure metrics (7-10) generally scored average or low for Cahaba sites.

Habitat differences between the two watersheds are depicted in figures 3 and 4, and actual habitat scores for all sites are shown in table 9. Habitat metric scores were generally lower in Cahaba, indicating habitat quality in the suboptimal to sometimes

Table 8. IBI scores for sites in Hatchet Creek and Cahaba River, 2004.

IBI metric		HATC-4		HAT-2		HAT-3		SOCC-1	
		value	score	value	score	value	score	value	score
1	Total native species	27	5	23	5	27	5	19	5
2	Total darter species	6	5	5	5	7	5	4	5
3	Total minnow species	6	3	9	5	8	5	4	3
4	Total sunfish species	2	3	2	3	3	3	2	3
5	Total sucker species	3	5	2	3	3	5	5	5
6	Intolerant species	1	3	1	3	1	3	1	3
7	Percent sunfish	2.2	5	3.2	5	8.4	5	3.3	5
8	Percent omnivores and herbivores	1	5	0.3	5	3.1	5	6.2	3
9	Percent insectivorous cyprinids	61	5	56	5	50	5	52	5
10	Percent top carnivores	2.2	5	1	3	0.6	3	1	3
11	Catch per hour	250	3	310	3	313	3	291	3
12	Percent anomalies	0	5	0	5	0	5	0	5
IBI score		–	52	–	50	–	52	–	48
Biological condition		good		good		good		good	

IBI metric		C-2		CABJ-6		C-1		SH-1A	
		value	score	value	score	value	score	value	score
1	Total native species	30	5	24	5	23	5	20	5
2	Total darter species	6	5	4	5	5	5	2	3
3	Total minnow species	8	5	6	3	6	3	8	5
4	Total sunfish species	5	5	4	5	3	3	4	5
5	Total sucker species	4	5	4	5	3	5	3	5
6	Intolerant species	1	3	0	1	0	1	0	1
7	Percent sunfish	21	3	27	3	8.4	5	5.5	5
8	Percent omnivores and herbivores	15	3	6.8	3	22	1	69	1
9	Percent insectivorous cyprinids	45	3	38	3	42	3	16	1
10	Percent top carnivores	1.9	3	1.7	3	1.2	3	0.8	3
11	Catch per hour	568	5	249	3	286	3	695	5
12	Percent anomalies	0	5	0	5	0	5	0	5
IBI score		–	50	–	44	–	42	–	44
Biological condition		good		fair		fair		fair	

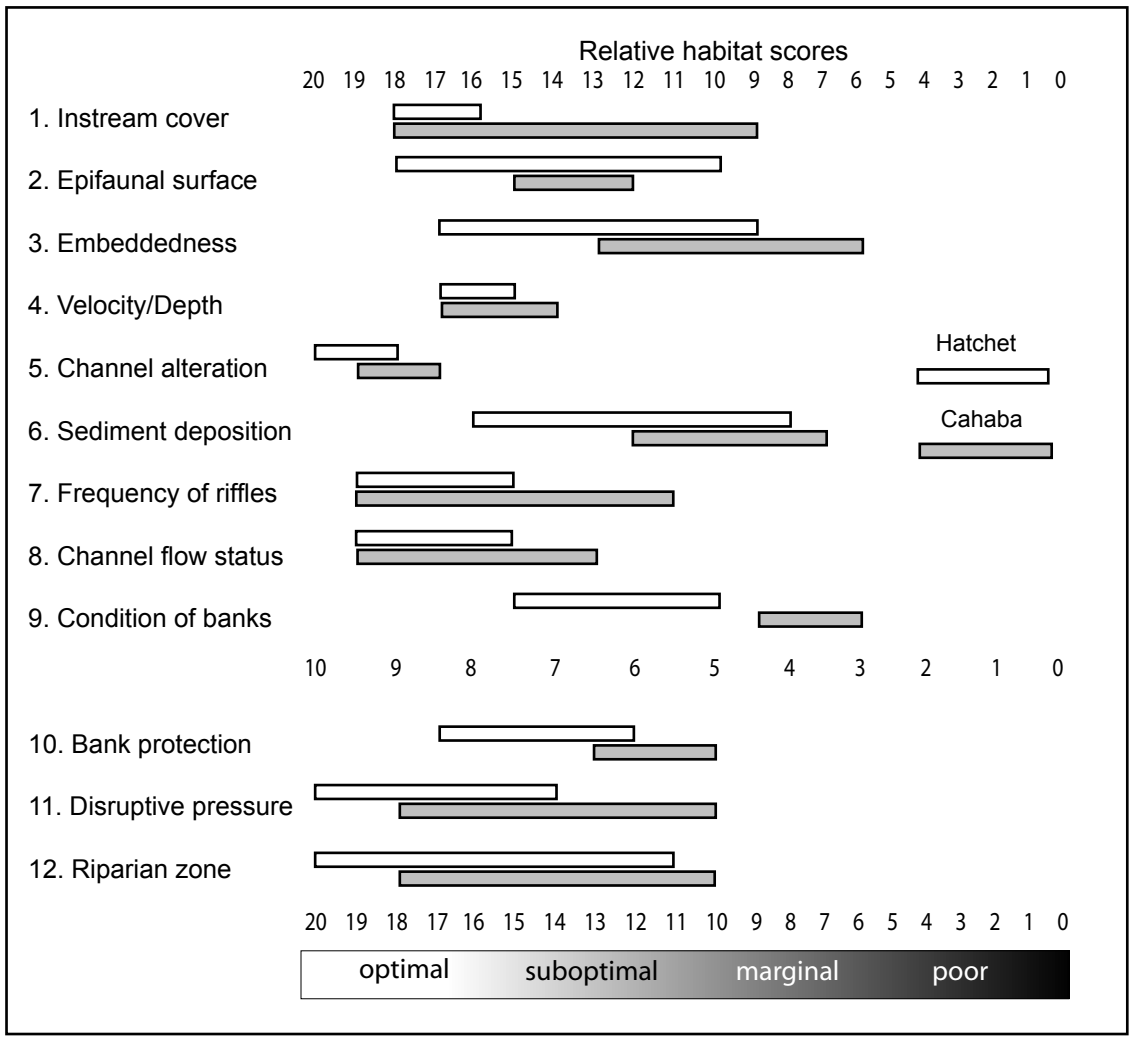

Figure 3. Habitat comparison between sites in Hatchet Creek and Cahaba River, 2004.

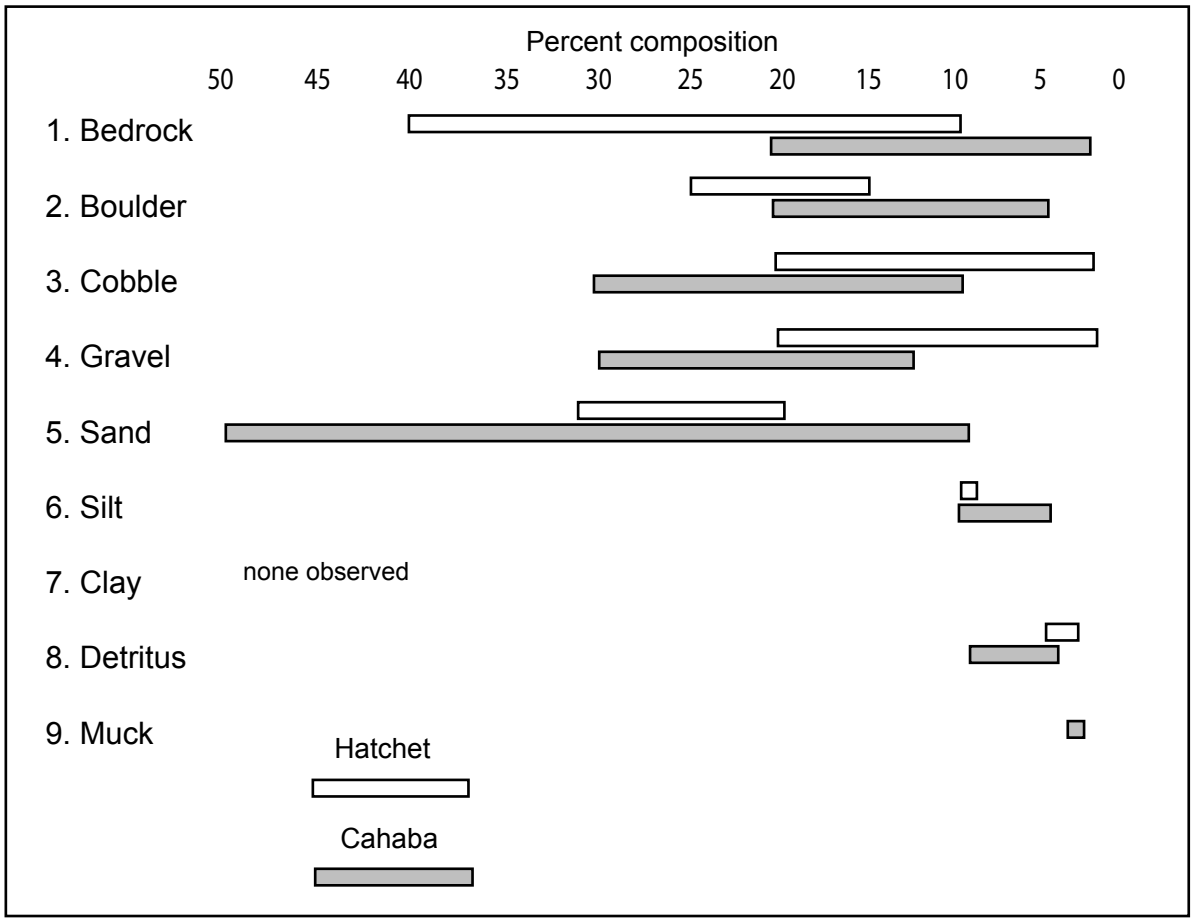

Figure 4. Substrate composition of sites in Hatchet Creek and Cahaba River, 2004.

Table 9. Water quality and habitat information for sampling sites in Hatchet Creek and Cahaba River, 2004.

Site name	Hatchet Creek				Cahaba River			
	HATC-4	HAT-2	HAT-3	SOCC-1	C-2	CABJ-6	C1	SH-1A
	McConnell	Dunham	East Mill	Socapatoy	Caldwell Mill	Grants Mill	Roper Road	Shades @ 150
Date of collection	5 Oct 04	6 Oct 04	6 Oct 04	5 Oct 04	8 Oct 04	7 Oct 04	7 Oct 04	8 Oct 04
Time of collection	1350	1215	1530	1730	1145	1150	1530	1445
In-situ water quality measurements								
Water temperature	21.1	20.0	19.8	19.1	21.1	21.0	20.5	20.5
pH (s.u.)	7.6	6.9	6.6	7.5	6.2	6.1	6.1	6.2
Conductivity (uS/cm)	58	46	47	53	279	218	240	352
Dissolved oxygen	8.3	9.0	8.6	8.5	8.6	8.5	9.3	9.0
Riffle/Run habitat assessment (scores)								
Instream cover	15-16	16-18	16-16	16-16	18-17	16-16	9-10	18-18
Epifaunal surface	10-12	10-10	18-16	10-10	13-13	13-12	13-13	15-14
Embeddedness	16-15	17-17	13-12	9-9	11-13	12-10	6-7	10-11
Velocity/depth	17-16	16-16	16-15	15-15	15-14	17-17	15-15	15-14
Channel alteration	20-19	18-20	19-19	19-19	17-18	19-19	18-18	19-18
Sediment deposition	10-10	16-16	11-11	8-8	10-12	8-7	8-9	7-9
Frequency of riffles	15-16	18-17	18-18	19-19	16-16	18-19	15-16	11-11
Channel flow status	18-19	18-19	15-15	19-19	14-13	19-18	19-19	13-14
Conditions of banks	14-15	15-15	10-10	15-15	9-8	6-6	9-9	6-7
Bank veg. protection [1]	8.5/8.5	7/7	6/8	8.5/8.5	5/5	6/6	6.5/6.5	6/5
Disruptive pressure [1]	9/9.5	10/7	9/9	10/8	6.5/6.5	9/8.5	8.5/5	7.5/5
Riparian vegetation [1]	9.5/9.5	10/5.5	9/9	10/10	7.5/5.5	8/8	9/6	9/5
Composition of substrate (percent)								
Bedrock	40	10	20	30	2	20	5	7
Boulder	20	25	20	15	10	15	5	20
Cobble	2	20	15	10	23	10	10	30
Gravel	2	20	10	10	30	15	20	13
Sand	32	20	20	30	15	30	50	10
Silt	--	--	10	--	10	5	5	10
Clay	--	--	--	--	--	--	--	--
Detritus	4	5	5	5	10	5	5	7
Muck	--	--	--	--	--	--	--	3

[1] - Left bank/right bank scores.

marginal range; whereas scores in Hatchet generally indicated habitat quality in the optimal to suboptimal range (fig. 3, table 9). Instream cover was generally optimal in Hatchet and ranged from optimal to marginal in Cahaba. The epifaunal surface habitat metric was suboptimal in Cahaba and was more variable in Hatchet where it ranged from optimal to marginal. The substrate was generally more embedded in Cahaba (fig. 3) where scores ranged from suboptimal to poor. In Hatchet, the substrate was substantially less embedded with fine sediments and sands and scores ranged from optimal to marginal. Velocity/depth combinations and channel alteration were optimal at both sites. Excessive sediment deposition and poor bank condition were observed more frequently in the Cahaba.

Substrate composition was different between the two systems (fig. 4, table 9). Sites in Hatchet had greater exposure of bedrock and boulder material compared to Cahaba, which had greater substrate coverage of sand, gravel and cobble. These differences may be attributed to two factors: the location of Hatchet Creek in the Piedmont, an area known for extensive exposure of bedrock and boulder, and the higher rates of sedimentation in the Cahaba, causing increased mobility of sands, gravels, and finer sediments.

SAMPLING SITE DESCRIPTIONS

Site HATC-4 - Hatchet Creek at McConnell Property

Site HATC-4 was sampled at a large shoal complex with fractured bedrock and large boulders that comprised a substantial part of the stream bed. Stream width varied from 200 to 300 feet, stream banks varied from 5 to 15 feet high, and the site had mostly open canopy because of its width. Riparian cover was moderately dense along both banks and consisted of shrubs and smaller trees. Sand and gravel filled cracks and crevices in the bedrock and created shoals at the upstream end of the site and intermittently along both shorelines. Water willow and Cahaba lilies were established throughout the shoal. Walking through and sampling in the shoal area was difficult because of the deeply fractured bedrock and large boulders resulting in a longer sampling time (195 minutes) than at other sites.

The most common species at site HATC-4 were the Alabama shiner (*Cyprinella callistia)* at 46.2 percent, followed by the bronze darter (*Percina palmaris)* at 13.7 percent, the tricolor shiner (*Cyprinella trichroistia)* at 8.7 percent, the greenbreast darter *(Etheostoma jordani)* at 8.6 percent, and the speckled madtom (*Noturus leptacanthus*) at 5.1 percent (appendix). Sixteen individuals of the uncommon speckled chub (*Macrhybopsis aestivalis*) were captured. The IBI score (52) ranked this site good relative to biological condition. Eight metrics scored exceptional (5) and four metrics scored average (3) including total minnow and sunfish species, intolerant species, and catch (table 8).

Site HAT-2 - Hatchet Creek at Dunham Property

Site HAT-2 was a shoal-pool complex with a variety of habitat and substrate types. Cobble, small boulders, and gravel were common in riffles and runs, while pool substrate was bedrock with sand, cobble, and some gravel. Bedrock was less exposed compared to site HATC-4. Stream width varied from 100 to 200 feet, stream banks varied from 3 to 10 feet high, and the site was mostly open, but tree canopy covered more of the stream than at site HATC-4. Riparian cover, consisting of shrubs and small trees, was moderately dense along both banks. Water willow was established in the shoal areas. Sampling at this site was much easier compared to site HATC-4 and sampling time was consequently less (150 minutes).

The most common species at site HAT-2 were the greenbreast darter at 26.0 percent, followed by the tricolor shiner at 24.7 percent, the Alabama shiner at 15.4 percent, the mimic shiner (*Notropis volucellus*) at 9.2 percent, and the bronze darter at 5.2 percent. Twenty individuals of the speckled chub were captured. The IBI score (50) ranked this site good relative to biological condition. Seven metrics scored exceptional (5) and five metrics scored average (3) including total sucker and sunfish species, intolerant species, percent top carnivores, and catch (table 8).

Site HAT-3 - Hatchet Creek at East Mill

Substrate at site HAT-3 consisted of rubble and cobble in riffles, gravel and cobble in runs, and pools with sand, some silt, and bedrock. Bedrock was less exposed

compared to both sites HATC-4, and HAT-2. Stream width varied from 50 to 75 feet, stream banks varied from 2 to 5 feet high, and the site had about 50 percent canopy coverage. Riparian vegetation, consisting mainly of shrubs, was moderately dense along both banks. Site HAT-3 was the shallowest of all Hatchet Creek sites sampled, making it easier to sample (125 minutes).

The most common species at site HAT-3 were the tricolor shiner at 32.3 percent, followed by the greenbreast darter at 10.2 percent, the longear sunfish at 7.8 percent, and the Alabama shiner and Alabama hogsucker (*Hypentelium etowanum*), both at 6.4 percent. The headwater character of this site is reflected in the catch of Coosa darters *(Etheostoma coosae*) and burrhead shiners *(Notropis asperifrons*) in low to moderate numbers and a single lined chub (*Hybopsis lineapunctata*). The IBI score (52) ranked this site good relative to biological condition. Eight metrics scored exceptional (5) and four metrics scored average (3) including total sunfish species, intolerant species, percent top carnivores, and catch (table 8).

Site SOCC-1 - Socapatoy Creek

Habitat at site SOCC-1 was diverse, consisting of an extensive sand and gravel shoal for about 150 feet downstream of the bridge, a run-pool complex about 150 feet long upstream of the bridge, and an extensive exposure of bedrock and large boulders further upstream. Riffle and run habitat was common at the base of the large bedrock exposure for about 75 feet. Socapatoy Creek appeared to be carrying a substantial sediment bedload of sand and gravel, since the shoal downstream of the bridge was composed of fresh material likely deposited during high stream flows caused by heavy rainfall during Hurricane Ivan on September 16-17, 2004, about three weeks earlier. Stream width varied from 50 to 75 feet, stream banks varied from 3 to 8 feet high, and the site had about 50 percent canopy coverage. Riparian vegetation, consisting mainly of small trees and shrubs, was moderately dense along both banks. Site SOCC-1 was sampled for 150 minutes.

The most common species at site SOCC-1 were the Alabama shiner at 33.9 percent, followed by the tricolor shiner at 13.7 percent, the greenbreast darter at 13.5

percent, and the Alabama hogsucker and largescale stoneroller *(Campostoma oligolepis*) both at 6.2 percent. The presence of freshly deposited bedload sediment and increased numbers of the Alabama hogsucker and largescale stoneroller indicate that habitat conditions may be degrading at this site. The IBI score (48) was the lowest of the Hatchet Creek sites but still ranked this site good relative to biological condition. Six metrics scored exceptional (5) and six scored average (3) including total minnow and sunfish species, intolerant species, percent omnivores and herbivores, percent top carnivores, and catch (table 8).

Site C-2 - Cahaba River at Caldwell Mill

Habitat at site C-2 was a mixture of exposed bedrock at the upstream end and sand/gravel shoals throughout most of the sampled reach. Shallow, uniform gravel runs with deeper flowing pools at their base were dominant habitat components. A small concrete dam was constructed many years ago upstream of site C-2, and the impounded area functions as an efficient settling basin that traps bedload sediments. Bedrock is exposed downstream of the dam, and in combination with gravel and cobble, forms a long riffle/run zone. Sand and gravel shoals reappear approximately 300 feet downstream of the dam. Much of the main channel of Cahaba River is impacted from bedload sediment; however, the short reach downstream of the dam is likely representative of historical habitats in the system and could serve as a habitat reference site for the upper Cahaba. Stream width varied from 30 to 60 feet, stream banks varied from 10 to 20 feet high, and the site had about 20 to 30 percent canopy coverage. Riparian vegetation was limited along both banks. A golf course runs along the right descending bank and residential lawns lie along part of the left bank. Site C-2 was sampled for 185 minutes because of the large catch of individuals which required more time to identify.

The most common species at site C-2 were the Alabama shiner at 20.1 percent, followed by the largescale stoneroller at 12.7 percent, the bluegill at 10.8 percent, the blacktail shiner *(Cyprinella venusta)* at 10.5 percent, and the longear sunfish (*Lepomis megalotis*) at 9.9 percent. One individual of the uncommon coal darter (*Percina*

brevicauda) was collected at this site. The IBI score (50) was the highest of all Cahaba sites and ranked this site good relative to biological condition. Seven metrics scored exceptional (5) and five scored average (3) including intolerant species, percent sunfish, percent omnivores and herbivores, percent insectivorous cyprinids, and percent top carnivores (table 8). Average scores in the trophic function metrics indicate that stream productivity and trophic function are outside the range of watersheds that are minimally or least impaired.

Site CABJ-6 - Cahaba River at Grants Mill

Habitat at site CABJ-6 consisted of a long reach of exposed bedrock that was fractured into deep flowing runs at the downstream end of the sampled reach and was relatively flat and smooth in the central part of the reach. The upper end of the site was bordered by an extensive boulder/bedrock shoal with steep gradient. Fresh sand and gravel deposits occurred throughout the foot of this shoal and appeared to be deposited by recent high stream flows estimated at 25 to 30 feet above base flow level resulting from Hurricane Ivan in September. Stream width varied from 40 to 80 feet, stream banks varied from 5 to 15 feet high, and the site had about 50 percent canopy coverage. Riparian vegetation was primarily trees with some shrub cover. Site CABJ-6 was sampled for 130 minutes.

The most common species at site CABJ-6 were the Alabama shiner at 18.3 percent, followed by the longear sunfish (*Lepomis megalotis*) at 16.5 percent, the silverstripe shiner at 14.6 percent, the bluegill (*Lepomis macrochirus*) at 9.8 percent, and the largescale stoneroller at 6.8 percent. The IBI score (44) ranked this site fair relative to biological condition. Five metrics scored exceptional (5) and six scored average (3) including total minnow species, percent sunfish, percent omnivores and herbivores, percent insectivorous cyprinids, percent top carnivores, and catch. One metric, intolerant species, scored low (1). Average scores in the trophic function metrics and no intolerant species strongly indicates stream impairment at this site.

Site C-1 - Cahaba River at Roper Road

Bedrock was exposed in several areas of the sampled reach at site C-1 with gravel and sand shoals covering most of the bedrock in the central part and heavier coarse sediment deposits in pools at the upstream end. Stream width varied from 30 to 50 feet, stream banks were moderately scoured and varied from 5 to 15 feet high, and the site was mostly open with 20 to 40 percent canopy coverage. Riparian vegetation was primarily trees with some shrub cover on the left descending bank and a golf course on the right bank. Site C-1 was very shallow and easily sampled. Total sample time was 120 minutes.

The most common species at site C-1 were the largescale stoneroller at 21.3 percent, followed by the Alabama shiner at 19.9 percent, the Alabama hogsucker at 13.4 percent, the silverstripe shiner at 12.4 percent, and the blackbanded darter *(Percina nigrofasciata*) at 7.9 percent. The IBI score (42) was the lowest for all sites examined during this study and ranked this site fair relative to biological condition. Five metrics scored exceptional (5) and five scored average (3) including total minnow and sunfish species, percent insectivorous cyprinids, percent top carnivores, and catch. Two metrics, number of intolerant species and percent omnivores and herbivores, scored low (1). Average scores in the trophic function metrics, the lack of intolerant species, and high percentage of species that feed on fine sediments and algae strongly indicates stream impairment at this site.

Site SH-1A - Shades Creek at Hwy. 150

The Shades Creek site had extensive scour of the streambed and stream banks. Shale and sandstone were exposed throughout the reach with a limited amount of sand and gravel along shorelines. Sand and fine sediments accumulated in pools over smooth bedrock with riffles and runs occurring in places where the bedrock was fractured. Exposed bedrock in pools had relatively thick (0.25 to 1.0 inch) accumulations of algae and fine sediments, while riffles exposed to sunlight had a thick algal layer. Stream banks varied from 5 to 10 feet high and were scoured of cover for over 50 percent of the reach length. The site was mostly open with 20 to 40 percent

canopy coverage. It was evident that extreme urban storm water flows and runoff of nutrients and sediments were impacting this site. Site SH-1A was sampled for 110 minutes.

Shades Creek was dominated by species tolerant of impaired stream conditions including the largescale stoneroller at 68.2 percent, followed by the pretty shiner (*Lythrurus bellus*) at 6.2 percent, the blacktail shiner at 5.0 percent, and the Alabama hogsucker and blackbanded darter both at 4.5 percent (appendix). Seven metrics scored exceptional (5) and two scored average (3) including total darter species and percent top carnivores. Three metrics scored low (1) including intolerant species, percent omnivores and herbivores, and percent insectivorous cyprinids. The lack of intolerant species and super high percentages of tolerant species are strong signals indicating stream impairment at this site.

SUMMARY AND RECOMMENDATIONS

Based on preliminary field data reported here and general watershed data relative to land use, human disturbance, hydrology, and previous biological investigations, Hatchet Creek appears to be a suitable regional reference candidate for the following reasons.

- Land disturbance in Hatchet Creek is low with limited agriculture and silviculture activity at the present.
- Urban disturbance is also low in the watershed as is the number of permitted discharges.
- Forest percentage is very high at the present leading to good habitat and biological conditions.
- Hatchet Creek and Cahaba River appear to function in similar fashion hydrologically for low, normal, and high stream flows.
- Habitat quality of streams in Hatchet is generally in the optimal to suboptimal range with low percentages of embeddedness and sediment deposition and optimal to suboptimal condition of the adjacent riparian zone.

- IBI scores at all sites in Hatchet Creek indicated good biological condition based on the resident fish community.

The proposal to use Hatchet Creek as a regional reference watershed condition has significant merit at this time based on available data. The ADEM is currently collecting additional water-quality data to satisfy use attainability questions, to determine in detail the nutrient and algal dynamics in the system, and to begin creating a sufficient data base to adequately characterize seasonal variation of water quality and determine the source(s) of any activities that may ultimately affect the status of water and biological resources in the system.

The use of Hatchet Creek as a regional reference watershed will require that additional information be collected and that a systematic monitoring program for water and biological resources be established for tracking the status of this watershed in the future. Recommendations for additional studies or investigations include:

- Detailed and updated land use/land cover analysis.
- Development of a Hatchet Creek GIS for managing all data.
- Develop seasonal habitat and biological condition patterns at established stations.
- Additional IBI determinations and benthic macroinvertebrate samples at other sites in the watershed.
- Use Hatchet Creek watershed in other TMDL plans as a comparative watershed.
- Write a comprehensive document summarizing all relevant data, creating a detailed characterization and profile of the Hatchet Creek watershed including hydrology, water quality, and biology, and present a plan for how the Hatchet Creek watershed is to be used as a regional reference watershed.
- Initiate a watershed protection and management plan for the Hatchet Creek watershed to maintain its current high quality and status.

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APPENDIX

Fish collection information for sites in Hatchet Creek and Cahaba River

		Hatchet Creek			
		HATC-4		HAT-2	
Scientific name	Common name	N	Percent	N	Percent
Petromyzontidae					
Ichthyomyzon gagei	southern brook lamprey	--	--	--	--
Lepisosteidae					
Lepisosteus osseus	longnose gar	1	0.12	--	--
Cyprinidae					
Campostoma oligolepis	largescale stoneroller	7	0.86	2	0.26
Cyprinella callistia	Alabama shiner	375	46.18	119	15.37
Cyprinella trichroistia	tricolor shiner	71	8.74	191	24.68
Cyprinella venusta	blacktail shiner	--	--	1	0.13
Hybopsis lineapunctata	lined chub	--	--	--	--
Hybopsis winchelli	clear chub	--	--	--	--
Lythrurus bellus	pretty shiner	--	--	--	--
Macrhybopsis aestivalis	speckled chub	16	1.97	20	2.58
Notropis asperifrons	burrhead shiner	--	--	2	0.26
Notropis stilbius	silverstripe shiner	30	3.69	19	2.45
Notropis xaenocephalus	Coosa shiner	--	--	8	1.03
Notropis volucellus	mimic shiner	9	1.11	71	9.17
Phenacobius catostomus	riffle minnow	--	--	--	--
Pimephales vigilax	bullhead minnow	--	--	--	--
Semotilus atromaculatus	creek chub	--	--	--	--
Catostomidae					
Hypentelium etowanum	Alabama hogsucker	7	0.86	12	1.55
Minytrema melanops	spotted sucker	--	--	--	
Moxostoma duquesnei	black redhorse	3	0.37	1	0.13
Moxostoma erythrurum	golden redhorse	--	--	--	--
Moxostoma poecilurum	blacktail redhorse	2	0.25	--	--
Ictaluridae					
Ameiurus natalis	yellow bullhead	--	--	--	--
Ictalurus punctatus	channel catfish	4	0.49	--	--
Noturus leptacanthus	speckled madtom	41	5.05	29	3.75
Pylodictis olivaris	flathead catfish	3	0.37	--	
Fundulidae					
Fundulus olivaceus	blackspotted topminnow	--	--	--	--
Fundulus stellifer	southern studfish	3	0.37	--	--
Poeciliidae					
Gambusia affinis	mosquitofish	1	0.12	--	--
Centrarchidae					
Ambloplites ariommus	shadow bass	12	1.48	4	0.52
Lepomis cyanellus	green sunfish	--	--	--	--
Lepomis gulosus	warmouth	--	--	--	--
Lepomis macrochirus	bluegill	3	0.37	1	0.13
Lepomis megalotis	longear sunfish	15	1.85	24	3.10
Lepomis microlophus	redear sunfish	--	--	--	--
Lepomis miniatus	spotted sunfish	--	--	--	--
Lepomis hybrids	sunfish hybrids	--	--	--	--
Micropterus coosae	redeye bass	4	0.49	3	0.39
Micropterus punctulatus	spotted bass	1	0.12	1	0.13
Micropterus salmoides	largemouth bass	--	--	--	--

		Hatchet Creek			
		HATC-4		HAT-2	
Scientific name	Common name	N	Percent	N	Percent
Percidae					
Etheostoma coosae	Coosa darter	--	--	--	--
Etheostoma jordani	greenbreast darter	70	8.62	201	25.97
Etheostoma ramseyi	Alabama darter	--		--	
Etheostoma rupestre	rock darter	2	0.25	4	0.52
Etheostoma stigmaeum	speckled darter	3	0.37	8	1.03
Etheostoma whipplei	redfin darter	--	--	--	--
Percina brevicauda	coal darter	--	--	--	--
Percina kathae	Mobile logperch	1	0.12	--	--
Percina nigrofasciata	blackbanded darter	16	1.97	10	1.29
Percina palmaris	bronze darter	111	13.67	40	5.17
Cottidae					
Cottus carolinae	banded sculpin	1	0.12	3	0.39
Total species collected		27		23	
Total individuals collected		812		774	

		Hatchet Creek			
		HAT-3		SOCC-1	
Scientific name	Common name	N	Percent	N	Percent
Petromyzontidae					
Ichthyomyzon gagei	southern brook lamprey	1	0.15	--	--
Lepisosteidae					
Lepisosteus osseus	longnose gar	--	--	--	--
Cyprinidae					
Campostoma oligolepis	largescale stoneroller	14	2.14	45	6.18
Cyprinella callistia	Alabama shiner	42	6.42	247	33.93
Cyprinella trichroistia	tricolor shiner	211	32.26	100	13.74
Cyprinella venusta	blacktail shiner	--		--	--
Hybopsis lineapunctata	lined chub	1	0.15	--	--
Hybopsis winchelli	clear chub	--		--	--
Lythrurus bellus	pretty shiner	--		--	--
Macrhybopsis aestivalis	speckled chub	--		--	--
Notropis asperifrons	burrhead shiner	28	4.28	--	--
Notropis stilbius	silverstripe shiner	32	4.89	30	4.12
Notropis xaenocephalus	Coosa shiner	5	0.76	--	--
Notropis volucellus	mimic shiner	--	--	--	--
Phenacobius catostomus	riffle minnow	--	--	--	--
Pimephales vigilax	bullhead minnow	--	--	--	--
Semotilus atromaculatus	creek chub	1	0.15	--	--
Catostomidae					
Hypentelium etowanum	Alabama hogsucker	42	6.42	45	6.18
Minytrema melanops	spotted sucker	2	0.31	1	0.14
Moxostoma duquesnei	black redhorse	--	--	1	0.14
Moxostoma erythrurum	golden redhorse	33	5.05	18	2.47
Moxostoma poecilurum	blacktail redhorse	--	--	6	0.82
Ictaluridae					
Ameiurus natalis	yellow bullhead	--	--	--	--
Ictalurus punctatus	channel catfish	--		--	--
Noturus leptacanthus	speckled madtom	7	1.07	8	1.10
Pylodictis olivaris	flathead catfish	--	--	--	--
Fundulidae					
Fundulus olivaceus	blackspotted topminnow	--	--	--	--
Fundulus stellifer	southern studfish	--	--	--	--
Poeciliidae					
Gambusia affinis	mosquitofish	6	0.92	--	--
Centrarchidae					
Ambloplites ariommus	shadow bass	--	--	3	0.41
Lepomis cyanellus	green sunfish	1	0.15	2	0.27
Lepomis gulosus	warmouth	--	--	--	--
Lepomis macrochirus	bluegill	3	0.46	--	--
Lepomis megalotis	longear sunfish	51	7.80	22	3.02
Lepomis microlophus	redear sunfish	--	--	--	--
Lepomis miniatus	spotted sunfish	--	--	--	--
Lepomis hybrids	sunfish hybrids	--	--	--	--
Micropterus coosae	redeye bass	3	0.46	3	0.41
Micropterus punctulatus	spotted bass	--	--	1	0.14
Micropterus salmoides	largemouth bass	1	0.15	--	--

		Hatchet Creek			
		HAT-3		SOCC-1	
Scientific name	Common name	N	Percent	N	Percent
Percidae					
Etheostoma coosae	Coosa darter	16	2.45	--	--
Etheostoma jordani	greenbreast darter	67	10.24	98	13.46
Etheostoma ramseyi	Alabama darter	--	--	--	--
Etheostoma rupestre	rock darter	2	0.31	--	--
Etheostoma stigmaeum	speckled darter	38	5.81	--	--
Etheostoma whipplei	redfin darter	--	--	--	--
Percina brevicauda	coal darter	--	--	--	--
Percina kathae	Mobile logperch	3	0.46	5	0.69
Percina nigrofasciata	blackbanded darter	14	2.14	27	3.71
Percina palmaris	bronze darter	17	2.60	66	9.07
Cottidae					
Cottus carolinae	banded sculpin	13	1.99	--	--
Total species collected		27		19	
Total individuals collected		654		728	

		Cahaba River			
		C-2		CABJ-6	
Scientific name	Common name	N	Percent	N	Percent
Petromyzontidae					
Ichthyomyzon gagei	southern brook lamprey	--	--	--	--
Lepisosteidae					
Lepisosteus osseus	longnose gar	--	--	--	--
Cyprinidae					
Campostoma oligolepis	largescale stoneroller	222	12.66	37	6.85
Cyprinella callistia	Alabama shiner	352	20.07	99	18.33
Cyprinella trichroistia	tricolor shiner	--	--	--	--
Cyprinella venusta	blacktail shiner	184	10.49	18	3.33
Hybopsis lineapunctata	lined chub	--	--	--	--
Hybopsis winchelli	clear chub	--	--	5	0.93
Lythrurus bellus	pretty shiner	1	0.06	--	--
Macrhybopsis aestivalis	speckled chub	--	--	--	--
Notropis asperifrons	burrhead shiner	--	--	--	--
Notropis stilbius	silverstripe shiner	150	8.55	79	14.63
Notropis xaenocephalus	Coosa shiner	--	--	--	--
Notropis volucellus	mimic shiner	39	2.22	5	0.93
Phenacobius catostomus	riffle minnow	61	3.48	--	--
Pimephales vigilax	bullhead minnow	30	1.71	--	--
Semotilus atromaculatus	creek chub	--	--	--	--
Catostomidae					
Hypentelium etowanum	Alabama hogsucker	91	5.19	30	5.56
Minytrema melanops	spotted sucker	1	0.06	--	--
Moxostoma duquesnei	black redhorse	--		1	0.19
Moxostoma erythrurum	golden redhorse	16	0.91	5	0.93
Moxostoma poecilurum	blacktail redhorse	1	0.06	1	0.19
Ictaluridae					
Ameiurus natalis	yellow bullhead	--	--	--	--
Ictalurus punctatus	channel catfish	2	0.11	1	0.19
Noturus leptacanthus	speckled madtom	--	--	--	--
Pylodictis olivaris	flathead catfish	--	--	1	0.19
Fundulidae					
Fundulus olivaceus	blackspotted topminnow	16	0.91	6	1.11
Fundulus stellifer	southern studfish	--	--	--	--
Poeciliidae					
Gambusia affinis	mosquitofish	4	0.23	--	--
Centrarchidae					
Ambloplites ariommus	shadow bass	4	0.23	--	--
Lepomis cyanellus	green sunfish	1	0.06	--	--
Lepomis gulosus	warmouth	2	0.11	--	--
Lepomis macrochirus	bluegill	190	10.83	53	9.81
Lepomis megalotis	longear sunfish	173	9.86	89	16.48
Lepomis microlophus	redear sunfish	--	--	1	0.19
Lepomis miniatus	spotted sunfish	1	0.06	2	0.37
Lepomis hybrids	sunfish hybrids	--	--	--	--
Micropterus coosae	redeye bass	1	0.06	7	1.30
Micropterus punctulatus	spotted bass	21	1.20	2	0.37
Micropterus salmoides	largemouth bass	8	0.46	--	--

		Cahaba River			
		C-2		CABJ-6	
Scientific name	Common name	N	Percent	N	Percent
Percidae					
Etheostoma coosae	Coosa darter	--	--	--	--
Etheostoma jordani	greenbreast darter	--	--	17	3.15
Etheostoma ramseyi	Alabama darter	14	0.80	--	--
Etheostoma rupestre	rock darter	124	7.07	32	5.93
Etheostoma stigmaeum	speckled darter	2	0.11	--	--
Etheostoma whipplei	redfin darter	--	--	--	--
Percina brevicauda	coal darter	1	0.06	--	--
Percina kathae	Mobile logperch	12	0.68	16	2.96
Percina nigrofasciata	blackbanded darter	30	1.71	32	5.93
Percina palmaris	bronze darter	--	--	--	--
Cottidae					
Cottus carolinae	banded sculpin	--	--	1	0.19
Total species collected		30		24	
Total individuals collected		1,754		540	

		Cahaba River			
		C-1		SH-1A	
Scientific name	Common name	N	Percent	N	Percent
Petromyzontidae					
Ichthyomyzon gagei	southern brook lamprey	--	--	--	--
Lepisosteidae					
Lepisosteus osseus	longnose gar	--	--	--	--
Cyprinidae					
Campostoma oligolepis	largescale stoneroller	122	21.29	869	68.21
Cyprinella callistia	Alabama shiner	114	19.90	20	1.57
Cyprinella trichroistia	tricolor shiner	33	5.76	--	--
Cyprinella venusta	blacktail shiner	20	3.49	63	4.95
Hybopsis lineapunctata	lined chub	--	--	--	--
Hybopsis winchelli	clear chub	4	0.70	8	0.63
Lythrurus bellus	pretty shiner	--	--	79	6.20
Macrhybopsis aestivalis	speckled chub	--	--	--	--
Notropis asperifrons	burrhead shiner	--	--	--	--
Notropis stilbius	silverstripe shiner	71	12.39	21	1.65
Notropis xaenocephalus	Coosa shiner	--	--	--	--
Notropis volucellus	mimic shiner	--	--	--	--
Phenacobius catostomus	riffle minnow	--	--	--	--
Pimephales vigilax	bullhead minnow	--	--	8	0.63
Semotilus atromaculatus	creek chub	--	--	1	0.08
Catostomidae					
Hypentelium etowanum	Alabama hogsucker	77	13.44	57	4.47
Minytrema melanops	spotted sucker	--	--	1	0.08
Moxostoma duquesnei	black redhorse	--	--	1	0.08
Moxostoma erythrurum	golden redhorse	7	1.22	--	--
Moxostoma poecilurum	blacktail redhorse	9	1.57	--	--
Ictaluridae					
Ameiurus natalis	yellow bullhead	--	--	2	0.16
Ictalurus punctatus	channel catfish	1	0.17	--	--
Noturus leptacanthus	speckled madtom	--	--	--	--
Pylodictis olivaris	flathead catfish	--	--	--	--
Fundulidae					
Fundulus olivaceus	blackspotted topminnow	2	0.35	--	--
Fundulus stellifer	southern studfish	--	--	--	--
Poeciliidae					
Gambusia affinis	mosquitofish	4	0.70	4	0.31
Centrarchidae					
Ambloplites ariommus	shadow bass	--	--	--	--
Lepomis cyanellus	green sunfish	2	0.35	26	2.04
Lepomis gulosus	warmouth	--	--	--	--
Lepomis macrochirus	bluegill	36	6.28	9	0.71
Lepomis megalotis	longear sunfish	10	1.75	32	2.51
Lepomis microlophus	redear sunfish	--	--	--	--
Lepomis miniatus	spotted sunfish	--	--	3	0.24
Lepomis hybrids	sunfish hybrids	--	--	2	0.16
Micropterus coosae	redeye bass	1	0.17	--	--
Micropterus punctulatus	spotted bass	5	0.87	10	0.78
Micropterus salmoides	largemouth bass	1	0.17	--	--

		Cahaba River			
		C-1		SH-1A	
Scientific name	Common name	N	Percent	N	Percent
Percidae					
Etheostoma coosae	Coosa darter	--	--	--	--
Etheostoma jordani	greenbreast darter	1	0.17	--	--
Etheostoma ramseyi	Alabama darter	--	--	--	--
Etheostoma rupestre	rock darter	1	0.17	--	--
Etheostoma stigmaeum	speckled darter	--	--	--	--
Etheostoma whipplei	redfin darter	2	0.35	1	0.08
Percina brevicauda	coal darter	--	--	--	--
Percina kathae	Mobile logperch	5	0.87	--	--
Percina nigrofasciata	blackbanded darter	45	7.85	57	4.47
Percina palmaris	bronze darter	--	--	--	--
Cottidae					
Cottus carolinae	banded sculpin	--	--	--	--
Total species collected		23		20	
Total individuals collected		573		1,274	

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