GEOLOGICAL SURVEY OF ALABAMA

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ECOSYSTEMS INVESTIGATIONS PROGRAM

BIOLOGICAL ASSESSMENT OF THE LITTLE CHOCTAWHATCHEE RIVER WATERSHED IN ALABAMA

OPEN-FILE REPORT 1105

by

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ABSTRACT

Biological condition and habitat quality of 10 sites in the Little Choctawhatchee River watershed was evaluated in June-July, 2009. Habitat evaluations ranged from poor to suboptimal with the majority of sites ranking in the marginal to suboptimal range. Reasons for the impaired habitat scores were specifically related to poor instream cover for biota, poor structure of pool habitat, high sediment deposition, scoured and altered channels, and streams with scoured banks and poor bank vegetation. Habitat scores for Little Choctawhatchee sites were within variability observed for other streams in the Choctawhatchee watershed. Biological samples yielded 41 species of freshwater fishes in 14 families with minnows of the family Cyprinidae dominating the catch at 60.7 percent of the total number of individuals captured. The Longnose Shiner, Weed Shiner, and Blacktail Shiner were the most abundant species captured. The index of biotic integrity (IBI) ranged from very poor (22) at site 5a to good (48) at site 6. Most sites ranked as fair in biological condition with scores ranging from 36 to 42. Little Choctawhatchee IBI scores were comparable to a set of scores determined for 23 other sites throughout the Choctawhatchee River watershed in 2008. Sedimentation and erosion are water resource issues in the Little Choctawhatchee watershed affecting biological condition and water quality. Biological condition of streams in the watershed was strongly related to stream flow status, quality of instream cover, and the condition of stream banks and riparian cover.

INTRODUCTION

Events of the last decade, including the droughts of 2000 and 2007 and the unresolved legal disputes among Alabama, Georgia, and Florida concerning water resources in the Apalachicola, Chattahoochee, and Flint Rivers (ACF) and the Alabama, Coosa, and Tallapoosa Rivers (ACT), highlight the need for more comprehensive water resource protection and management. Alabama receives, on average, 55 inches of rainfall each year and has an estimated 553 trillion gallons of water in underground aquifers and a yearly average of 33.5 trillion gallons of water in streams, rivers, and lakes. With this abundance of water resources it is easy to see why we have taken for granted that water would be available in sufficient quantity and quality to meet the needs of our families, businesses, farms, and communities. Recent water shortages, declining water tables, and declining water quality in some areas of Alabama, however, illustrate that adequate supply and quality of water resources is key to local economies and to the long-term health and sustainability of Alabama’s economy.

Like most southeastern states, Alabama’s past planning for water management has been shaped by a desire to satisfy industrial, commercial, and public water needs; respond to federal and state legislation relative to water quality and major navigation channels; and to deal with short-lived water emergency needs during drought periods. Given Alabama’s historic low population density and the seemingly vast supplies of water, this approach was adequate in years past. However, with the emergence of the southeast as an economic force with its associated population and demographic changes, coupled with emerging climatic uncertainties and associated occurrence of severe drought, it has become increasingly apparent that a systematic, science-based approach to water planning and management will be necessary if the southeast is to remain prosperous and productive into the future.

The Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority (CPYRWMA) has, since its inception, worked to assess water supply and quality and develop water supplies in southeast Alabama to satisfy the region’s growing agricultural, industrial, and public needs. This work has included evaluating, on a regional basis, surface and groundwater availability, projecting water needs, and building a unified stakeholder base to not only understand complicated water resource issues but also to work in a collaborative and constructive way to find creative solutions for meeting water-resource challenges in the region—a process known as the watershed management authority concept.

The Little Choctawhatchee River has been proposed as a site for construction of a surface water reservoir to meet future water needs in the CPYRWMA area. Part of the process for evaluating this project includes a detailed evaluation of the quality of streams entering the proposed reservoir. The biological assessment information presented in this report is part of this larger study undertaken to evaluate the chemical and physical water quality of streams tributary to the Little Choctawhatchee River.

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STUDY AREA

The Little Choctawhatchee River originates near the city of Dothan and drains about 160 square miles (mi^2) of watershed before it enters the Choctawhatchee River southeast of Daleville near U.S Hwy. 84. It flows almost exclusively in the Dougherty Plain district of the East Gulf Coastal Plain physiographic section (Sapp and Emplaincourt, 1975) (fig. 1). Residuum of sandy clay and residual clay of Tertiary age is found along hill tops while siliceous claystone, sandy clay, and sandstone–Tallahatta Formation of Tertiary age–crops out along hill slopes. Stream and river valleys are capped by alluvial deposits of Quarternary age. O’Neil and Shepard (2007) classified Alabama into five ichthyoregions which reflect the regional composition and structure of freshwater fish communities: Tennessee Valley, Plateau, Ridge & Valley/Piedmont, Hills and Coastal Terraces, and Southern Plains (fig. 2). The Little Choctawhatchee River flows in the Southern Plains ichthyoregion. The Southern Plains ichthyoregion is comprised of selected stream systems in the lower Tombigbee and Alabama Rivers, streams of the Mobile-Tensaw River Delta, streams draining directly into Mobile Bay, and all coastal river systems in Alabama: the Escatawpa, Perdido, Escambia-Conecuh, Blackwater, Yellow, Choctawhatchee-Pea, Chipola, and Chattahoochee.

METHODS

IBI SAMPLE COLLECTION

Biological samples and habitat evaluations were performed at ten sites in the Little Choctawhatchee River watershed. A study completed in an earlier phase of the

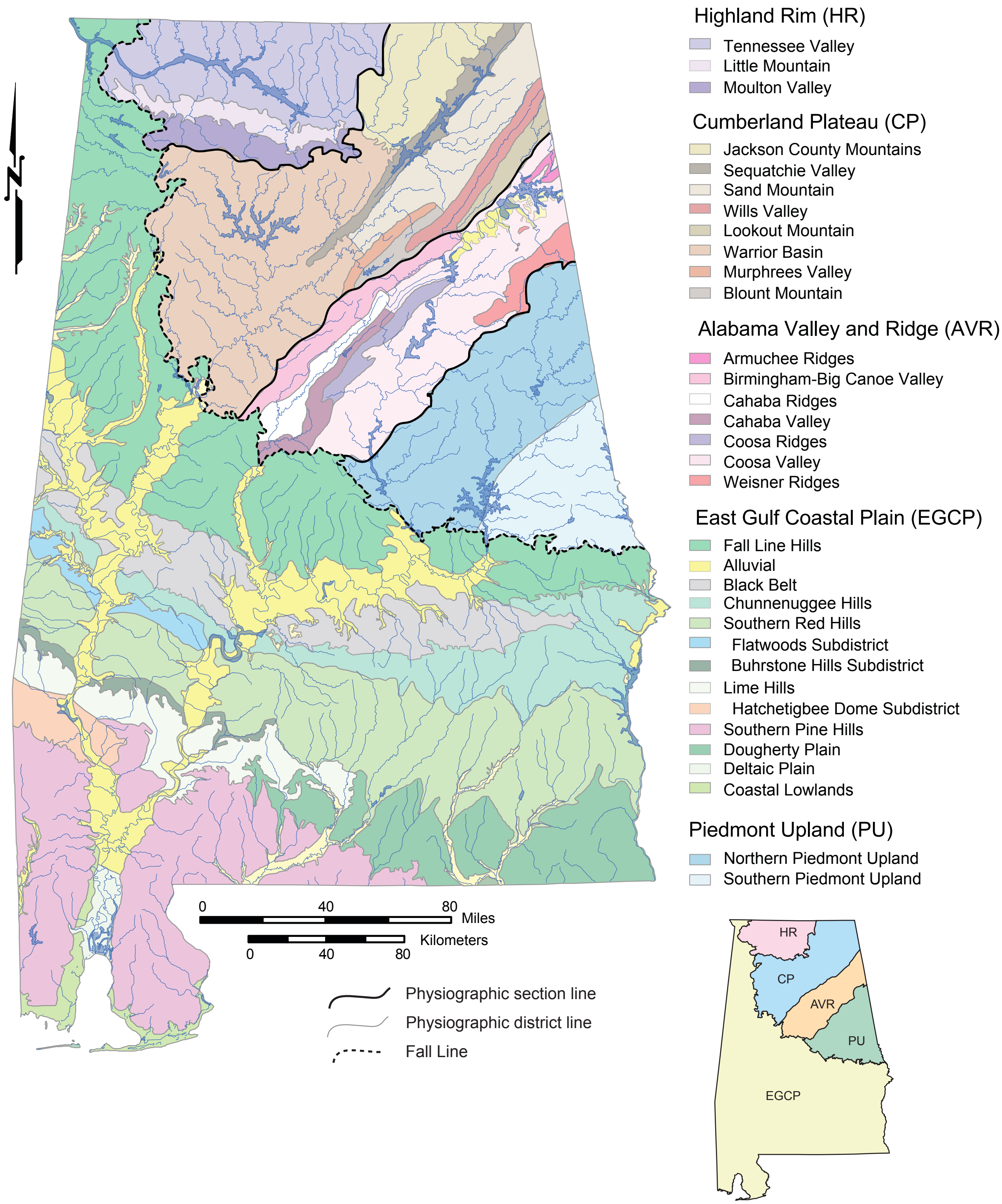

Figure 1. The physiography of Alabama. Districts in each section have been arranged descending from north to south. Alluvial deposits, which parallel the major river channels in the East Gulf Coastal Plain section, also occur in the Alabama Valley and Ridge section.

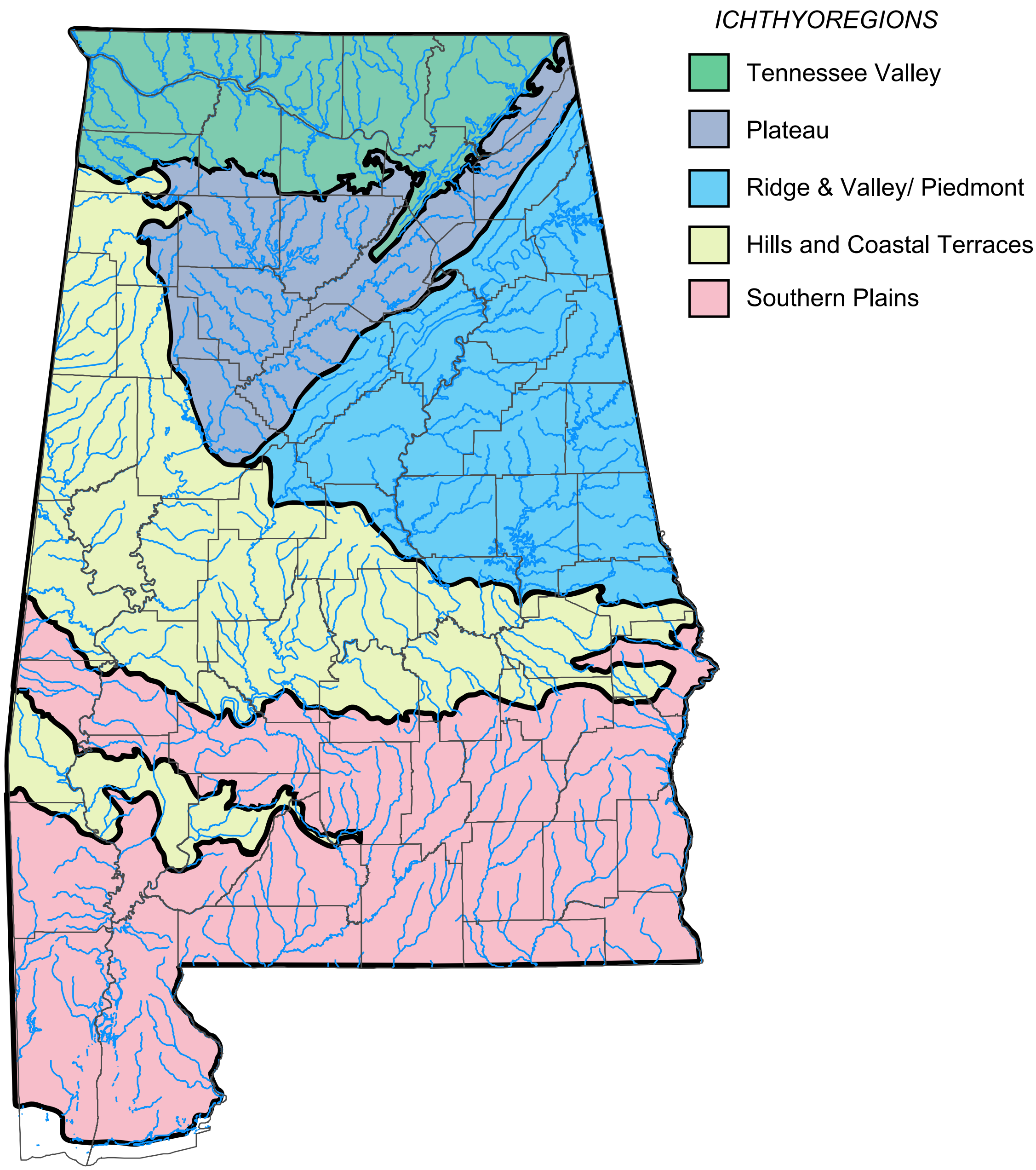

Figure 2. Preliminary ichthyoregion classification for Alabama.

statewide cooperative IBI (Index of Biotic Integrity) project (O’Neil and others, 2006) outlined a fish community sampling protocol that proved acceptable for collecting a representative fish community sample for the purpose of calculating an IBI score. Results of the study indicated that sampling should be stratified over three habitat types (riffles, runs, and pools) with a minimum of 10 sampling efforts each dedicated to these habitats. Two additional sampling efforts along stream shorelines were added to the protocol. This level of sampling effort and intensity, termed the “30+2" method, was determined sufficient to yield a fish community sample acceptable for calculating IBIs that reflect biological condition in wadeable streams. All four habitat types are generally present at sampling sites upstream of the Fall Line whereas hard rock riffles are generally absent at sites downstream of the Fall Line in the Coastal Plain. In general for Coastal Plain streams the typical habitat types are almost exclusively glides (runs) and pools. The 30+2 sampling method was evaluated and found to be applicable to streams in the Alabama Coastal Plain as well (O’Neil and Shepard, 2007). Sampling efforts were proportioned to either runs or pools for those sites where riffles and shoals were absent.

The effectiveness of sampling fishes depends on many factors such as stream size, substrate conditions, flow, amount of cover in the stream channel, type of sampling gear, and the expertise and knowledge of the collectors. Karr (1981) indicated that one of the basic foundations of the IBI is that all species of the fish community should be adequately sampled relative to their proportions in nature with minimal bias towards certain species or size classes of fishes. This is difficult to accomplish unless a representative and valid fish sample can be collected. Within the 30+2 IBI sampling method, small-mesh minnow seines serve as a complement to the electroshocker and are used to catch, scoop, or dip stunned fishes and to trap fishes in sloughs and backwaters. At other times, seines are used as the primary device for capturing fishes in pools, runs, and along shoals. The standard nylon minnow seine used for these samples was 10 feet wide, 6 feet deep, and had a delta weave of 3/16 inch.

An effective sampling technique was to use the backpack shocker in combination with the seine. The seine was set in shallow to deep runs, the backpacker then walked upstream for 15 to 20 feet outside of the area to be sampled, then the backpacker proceeded to shock downstream through the habitat disturbing the bottom. Stunned fishes in the water column were washed into the net, while benthic fishes were dislodged from the bottom by kicking the substrate. A variation of this technique was to have a crew member walk behind the backpacker skating his feet from side to side to disturb the bottom and dislodge stunned benthic fishes. Most microhabitats in run/glide habitats were sampled because they are quite often the most productive areas in Coastal Plain streams. Vegetated shorelines along run and shoal margins were usually very productive areas as were areas where stream flow becomes turbulent when entering runs and glides. Plunge pools where runs and glides transition to pools often yielded a diverse catch of minnow species.

Deeper stream runs and glides between pools were also productive habitats and were sampled by either seining downstream or by moving from bank to bank with the seine across the stream in a downstream direction either alone or following the backpack shocker. Pools were a common habitat feature in the Little Choctawhatchee River watershed and generally supported species not found in either run, glide, or shoreline habitats. Lower velocity in pools required more effort to pull the seine through the water column reducing collecting efficiency. Following the electroshocker was effective in pools, and trapping fishes against the shore or in a slough at the end of a seine haul was also effective. Deep pools with structure were sampled by blocking the downstream end with the seine and working the upstream area with a shocker and dip nets for a few minutes. Wider seines were more advantageous in pools for trapping fishes.

Shorelines along pools, runs, and glides can have complex habitat structure and yield sunfish and sucker species not normally found in the basic run-pool or glide-pool sequence in Coastal Plain streams. The shoreline sampling technique consisted of a crew member working the electroshocker in an upstream direction along a shoreline reach for a length of about 150 feet, shocking around all habitat features. The field crew followed closely, scooping the stunned individuals with dip nets. Distance was measured with a forestry-type hip chain. A minimum of two 150-foot shoreline samples were collected per station.

HABITAT MEASURES

A rapid habitat assessment was completed for each IBI sample collected. Habitat evaluations are an integral part of efforts to describe biological conditions because good biological condition is quite often predicated on the presence of stable and diverse habitat. The term “habitat” is an inclusive term that incorporates several features and processes in streams including the physical components such as rock and rubble, wood, mud, channel and substrate condition; the chemical and physical components of water quality such as pH, dissolved chemical constituents, temperature, and dissolved gases; and flow components such as flood and drought frequencies, velocity regimes, and discharge. For quantitative assessment purposes, the habitat concept is generally narrowed to include the physical components of instream habitat and substrate structure, the degree of channel alteration, and the condition of banks and the adjacent riparian corridor. All of these components directly affect the structure and function of the aquatic biological community and they can be visually assessed for quality and relative degree of impairment. The visual glide-pool assessment procedure used in this study to quantify habitat conditions were originally reported in Plafkin and others (1989) and modified by Barbour and others (1999).

Stream habitat assessments entail evaluating the structure of the surrounding physical habitat that influences water resource quality and thus the condition of the resident biological community (Barbour and others, 1999). Generally, three characteristics of habitat contribute to the maintenance and persistence of aquatic biological communities: the availability and quality of the habitat-substrate components and instream cover–habitat structure; morphology and status of the instream channel–channel condition; and structure of the bank and riparian vegetation zone–bank/riparian condition (Plafkin and others, 1989). Barbour and others (1999) developed two sets of habitat metrics, one for evaluating upland stream habitat dominated by riffle-run habitats and hard substrates and the other for evaluating lowland and Coastal Plain streams that are dominated by glide-pool and run-pool habitats with unconsolidated sandy substrates (table 1). The 11 habitat metrics of the glide-pool index are individually scored on a scale of 0 (poor quality) to 20 (optimal quality) then summed to give a final score, the maximum possible habitat score is 220 for the glide-pool method. Final habitat scores are sometimes compared to reference streams that are minimally, or least, impaired in the area. Habitat quality is also taken as a percentage of the maximum habitat score possible. The percent maximum habitat score method was adopted for this study.

HABITAT METRICS

Instream cover (INCOV) - This habitat metric refers to the quantity and variety of natural substrate features such as fallen trees, logs, branches, undercut banks, and hard substrate particles that aquatic organisms can use as refugia, feeding sites, or for spawning. A diversity of substrate objects and microhabitat types leads to a diverse and productive aquatic community and, hence, a good biological condition. The presence of clean gravel, rocks, and log snags in flowing streams is generally most desirable. However, other objects such as tree roots, aquatic vegetation, and undercut banks provide good habitat for many species.

Pool substrate characterization (PSUB) - This metric is substituted for embeddedness in the riffle-run index for high-gradient streams and evaluates the type and condition of bottom substrates in pools. Firm substrates, like gravel and sand, and aquatic vegetation generally support a greater variety of aquatic organisms compared to pools with unconsolidated mud, bedrock, and silt with no aquatic vegetation.

Pool variability (PVAR) - This metric evaluates the overall mixture of pool types in the stream relative to size and depth. Pools of variable sizes and depths (large-deep, large-shallow, small-deep, and small-shallow) are preferable to pools of uniform depth (small or large-shallow) because they will generally support a greater variety of organisms. Extreme bedload sedimentation will lead to pools of uniform width and depth which strongly impairs aquatic biodiversity.

Table 1. Habitat evaluation form.

GLIDE/POOL HABITAT ASSESSMENT FIELD DATA SHEET

Name of Waterbody ______________________ Date: ______________

Station Number ______________ Investigators ______________________

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1 **Instream Cover**	> 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	50-30% mix of stable habitat; adequate habitat for maintenance of populations.	30-10% mix of stable habitat; habitat availability less than desirable.	<10% stable habitat; lack of habitat is obvious.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2 **Pool Substrate Characterization**	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3 **Pool Variability**	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4 **Man-made Channel Alteration**	No Channelization or dredging present.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization (>20 years) may be present, but not recent.	New embankments present on both banks; channelization may be extensive, usually in urban or agriculture lands; and > 80% of stream reach is channelized and disrupted.	Extensive channelization; banks shored with gabion or cement; heavily urbanized areas; instream habitat greatly altered or removed entirely.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5 **Sediment Deposition**	<20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	20-50% affected; moderate accumulation; substantial sediment movement only during major storm event; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; mud, silt, and/or sand in braided or non-braided channels; pools almost absent due to deposition.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6 **Channel Sinuosity**	Bends in stream increase stream length 3 to 4 times longer than if it was in a straight line.	Bends in stream increase stream length 2 to 3 times longer than if it was in a straight line.	Bends in stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7 **Channel flow Status**	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8 **Condition of Banks**	Banks stable; no evidence of erosion or bank failure; <5% affected.	Moderately stable; infrequent, small areas of erosion mostly healed over; 5-30% affected.	Moderately unstable; 30-60% of banks in reach have areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along straight section and bends; on side slopes, 60-100% of bank has erosional scars.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
9 **Bank Vegetative Protection (each bank)**	> 90% of the stream bank surfaces covered by vegetation.	90-70% of the streambank surfaces covered by vegetation.	70-50% of the stream bank surfaces covered by vegetation.	<50% of the streambank surfaces covered by vegetation.
Score (LB) ______	10 9 8	7 6	5 4 3	2 1 0
Score (RB) ______	10 9 8	7 6	5 4 3	2 1 0
10 **Grazing or other disruptive pressure (each bank)**	Vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally.	Disruption evident but not affecting full plant growth potential to any great extent; >1/2 of the potential plant stubble height remaining.	Disruption obvious; patches of bare soil or closely cropped vegetation common; <1/2 of the potential plant stubble height remaining.	Disruption of stream bank vegetation is very high; vegetation has been removed to $\leq$ 2 inches average stubble height.
Score (LB) ______	10 9 8	7 6	5 4 3	2 1 0
Score (RB) ______	10 9 8	7 6	5 4 3	2 1 0
11 **Riparian vegetative zone Width (each bank)**	Width of riparian zone >60 feet; human activities (i.e., parking lots, roadbeds, clearcuts, lawns, or crops) have not impacted zone.	Width of riparian zone 60 - 40 feet; human activities have impacted zone only minimally.	Width of riparian zone 40 - 20 feet; human activities have impacted zone a great deal.	Width of riparian zone <20 feet; little or no riparian vegetation due to human activities.
Score (LB) ______	10 9 8	7 6	5 4 3	2 1 0
Score (RB) ______	10 9 8	7 6	5 4 3	2 1 0

Man-made channel alteration (CHAALT) - This metric quantifies the degree of channel alteration, usually in the form of stream channelization. Channelization changes the fundamental hydrodynamic and energy-flow relationships of a stream resulting in bank erosion and habitat degradation. Channel alteration can result in deposition on the inside of bends, below channel constrictions, and where stream gradient flattens. Channelization decreases stream sinuosity thereby increasing velocities and the potential for channel and bank scour and possibly accelerated downcutting of the channel.

Sediment deposition (SED) - This characteristic quantifies the amount of sediment that has accumulated in pools and changes that have taken place on stream bottoms from the processes of erosion and sedimentation. The character of sediment deposits is an indication of the severity of watershed erosion, bank erosion, and stability of the stream. Sediment bars will appear and increase in coverage with continual upstream erosion in the watershed.

Channel sinuosity (CSINU) - Streams with a higher degree of sinuosity provide greater habitat diversity and more opportunities for the stream to support a varied fauna. Streams with sinuous channels are also better structured geomorphologically to hydraulically attenuate floods and storm flows by dissipating energy and protecting banks from excessive erosion.

Channel flow status (CFLOW) - The degree to which a channel is filled with water is important because as flow volume decreases the amount of suitable substrate for aquatic organisms also decreases and biological condition can degrade. Having a suitable amount of submerged area and volume of flow is also important for maintaining acceptable water quality.

Condition of banks (BANKC) - Bank stability is a measure of whether banks are eroded or have the potential for erosion. Steep banks are more likely to collapse and are more prone to erosion than are gently sloping banks and are, therefore, considered unstable. Crumbling and unvegetated banks, exposed tree roots, and exposed soil are signs of accelerated bank erosion.

Bank vegetative protection (BANKVEG) - This metric is an evaluation of the vegetative protection on stream banks and the near-stream portion of the riparian zone. Roots hold soil in place and reduce erosion potential thus enhancing the local aquatic biological community.

Grazing or other disruptive pressure (DISRUP) - The degree to which streamside cover has been removed by animal grazing, mowing or herbicides, and by mechanical tree removal is evaluated for this metric. Streams with natural vegetative cover have been shown to have a higher standing crop and variety of organisms compared to streams that are routinely disrupted or managed through nearby mowing and grazing.

Riparian vegetative zone width (RIPVEG) - The riparian zone serves to buffer the stream from runoff, controls erosion, and provides organic matter and nutrients to the stream. Undisturbed riparian zones with natural vegetation help maintain highly diverse and functional aquatic communities while narrow and impaired riparian zones yield poor biological conditions and are associated with roads, fields, parking lots, and lawns.

IBI METRICS AND SCORING CRITERIA

Stream sample data collected in the Little Choctawhatchee River were evaluated using IBI metrics and scoring criteria recently developed for the Southern Plains ichthyoregion (O’Neil and Shepard, 2009). Typical IBI metrics can be classified into one of four basic types. Diversity metrics generally evaluate total fish community diversity, such as total native species, or components of community diversity, such as darter or minnow species diversity. Trophic metrics evaluate the trophic or production status of a fish community and quantify proportions of fishes in certain feeding guilds. Tolerance and intolerance metrics measure the relative proportions and(or) counts of species present that are either tolerant or intolerant of pollutants, stressors, and habitat degradation. Reproduction/fish health metrics measure the relative proportions of species within certain reproductive guilds and the relative presence of health problems that may be environmentally caused such as lesions, tumors, and deformities. The 12 IBI metrics of the Southern Plains IBI are listed below and each metric is scored by assigning a value of 5 (best condition), 3, or 1 (worst condition). The values of the 12 metrics are then added together for a final IBI score that ranges from 0 (no fish) to 60.

Number of native species (TNSP) - The negative relationship between species richness and habitat degradation is well documented in the early IBI literature (Karr, 1981; Karr and others, 1986; Ohio EPA, 1987a, b). Species richness was found to be the metric most closely correlated with overall IBI score in a study of several regional applications of the IBI by Angermeier and Karr (1986). Hughes and Oberdorff (1999) found the species richness metric was used in all IBI applications they examined outside of the U.S. and Canada. Species richness is strongly related to stream size, stream order, and watershed area in small- to medium-sized watersheds (Karr and others, 1986).

Number of cyprinid species (CYPSP) - Minnows are a diverse and abundant group in the Southern Plains ichthyoregion with a range of tolerances, habitat preferences, and trophic and reproductive guilds (O'Neil and Shepard, 2000). Minnows as a group are adapted to a wide variety of habitats and habitat disturbances and can thrive in highly variable substrate and sediment regimes. The family Cyprinidae becomes more diverse and ecologically dominant moving from Tennessee Valley streams to Mobile River basin streams to coastal drainage streams in the southern part of Alabama. Minnow diversity is high in streams with complex snag and high pool variability. The number of minnow species generally decreases with increasing disturbance and increases with stream size.

Number of centrarchid species (CENTSP) - Sunfishes are a relatively diverse group throughout the Southern Plains ichthyoregion and the glide-pool habitats of these streams tend to favor pool-loving bass and sunfish populations. These larger-bodied fishes need a relatively large amount of habitat space for several species to successfully coexist. As such, the contribution of this metric may be more important in large streams than in small streams. Another advantage of a centrarchid diversity metric is that they are sensitive to physical and chemical degradation and most species are long-lived, incorporating environmental changes over a number of years.

Number of darter+madtom species (DARMAD) - Darters and madtoms are benthic species and generally intolerant of habitat impairments, particularly sedimentation which covers their preferred microhabitats. Karr (1981) used darter species richness as one of the original IBI metrics because, as a group, they are sensitive to disturbance. The darters are an even more speciose group in Alabama than in the midwest with nearly 75 species occurring in the state (Mettee and others, 1996). This metric was significantly correlated with habitat quality and discriminated well between poor and good habitat quality in small and large watersheds in the Southern Plains. Like darters, madtoms are benthic species and are frequently found in snags, leaf packs, root masses, and woody debris along banks. These habitat components are important for both darters and madtoms, and their loss or degradation generally leads to fewer darter and madtom species.

Proportion as tolerant species (PTOL) -The presence of tolerant species is a clear indication that habitat is disturbed or that water-quality conditions are well below optimum. Tolerant species may become dominant in streams that are highly disturbed physically and(or) chemically from nonpoint pollution sources. Species occurring in the Southern Plains that were included in this metric were Striped Shiners, Creek and Dixie Chubs, Golden Shiners, Spotted Suckers, Yellow and Brown Bullheads, Green Sunfish, and Bluegills. We have retained a modified Green Sunfish metric to use in conjunction with this metric to capture stream threats and degradation, such as sedimentation and over nutrification, that may be related to agricultural activities.

Proportion of Green Sunfish+Yellow Bullheads (GSFYB) - The metric proportion of Green Sunfish is a classic IBI metric that Karr (1981) used in his original formulation for midwestern streams. Green Sunfish, along with Yellow Bullheads, are highly tolerant of disturbed habitats and diminished water quality and can thrive in impaired streams. Green sunfish are also commonly found in headwater streams because of their hardy nature and ability to tolerate poor flows. This metric is significantly related to habitat quality with proportions increasing in more disturbed habitats particularly when habitat degrades to less than 65 percent of the maximum habitat score.

Proportion as insectivorous cyprinids (INSCYP) - Insectivorous cyprinids are a dominant trophic group in southeastern streams and their abundance generally declines with increasing environmental stress. This is thought to be in response to an altered insect food supply which, in turn, is altered by changes in water quality, energy sources, and habitat (Karr, 1981). Thus, when the community becomes dominated by a few insect taxa in disturbed streams, specialized insectivorous fishes will be replaced by species more suited to exploit the new food base. Insectivorous cyprinids do appear to be more abundant in Southern Plains streams compared to streams in central and north Alabama and, as applied here, include most cyprinid species with the exception of stonerollers and chubs.

Proportion as invertivores (INVERT) - We have adopted this metric as an additional trophic metric. Hughes and Oberdorff (1999) recommend this metric since it is more inclusive and ecologically accurate than percent insectivorous cyprinids as another measure for assessing the degree to which the invertebrate community is degraded. This metric decreases with increasing impairment as the invertebrate community declines and invertivores are replaced by omnivores and herbivores (O’Neil and Shepard, 2000). It was correlated with disturbance for streams in the Valley and Ridge/Piedmont ichthyoregion (O’Neil and others, 2006) and discriminated between disturbed and undisturbed stations in large streams but not in smaller streams in that study. As applied in the Southern Plains this metric includes Blacktail Shiners, suckers, catfish, topminnows, and selected sunfishes.

Proportion as top carnivores (TC) - Karr (1981) proposed this metric because healthy populations of top carnivores indicate a relatively functional, trophically diverse community. The top carnivore metric was designed to measure biological integrity in the upper functional levels of the fish community. To be considered a top carnivore, a species has to consume primarily fish, vertebrates, or crayfish, while species that equally consume other organisms as well are not considered top carnivores. Top carnivores include all black bass, temperate bass, crappie, rock bass, pickerel, walleye, bowfins, and gar species. Hughes and Oberdorff (1999) also point out that top carnivores are susceptible to bioaccumulation of toxins and can be affected by long-term physical and chemical impacts since they are typically long-lived.

Catch per effort (CATCH) - This metric is a measure of the overall density of individuals in the sampled reach expressed as catch per sampling effort and is calculated as the total number of individuals collected in a sample divided by the total number of efforts, usually 32 in the standardized sampling method. Abundance is one of the original Karr (1981) metrics and has been widely employed in IBI applications (Hughes and Oberdorff, 1999). Fish abundance is generally assumed to decrease with increasing habitat disturbance; however, in some streams impacted by nutrient enrichment, increased primary production can lead to very high catch rates due to increased numbers of omnivores and herbivores (O’Neil and Shepard, 2000; Hughes and Oberdorff, 1999; Barbour and others, 1999). We have observed this phenomenon in many nutrient-rich streams in Alabama, particularly those with reduced canopy cover. The usefulness of this metric in IBI applications is still under evaluation.

Number of lithophilic spawners (LITHO) - Number of lithophilic spawners refers to the number of species that utilize rock and mineral substrates for spawning either simply by depositing eggs in the sediment or complexly by manipulating substrate, building gravel or sand nests, or broadcasting eggs over rock and mineral substrates. This metric includes a host of species such as stonerollers, several genera of cyprinids, suckers, selected sunfish, and some darter species. It is significantly related to habitat quality with more species found in good quality habitats.

Proportion with DELT+hybrids (DELT) - Incidence of unhealthy individuals in a fish community in the form of deformities, eroded fins, lesions, and tumors (DELT) is frequently used as a metric to reflect the health and condition of the fish community. These conditions, however, are relatively rare except in all but the most highly degraded streams (Karr and others, 1986). Similarly, hybridization between species is indicative of highly disturbed habitats but it is usually rare in moderately disturbed streams. Proportion of individuals with DELTs and as hybrids are treated as two separate metrics in the original IBI (Karr and others, 1986). Since both conditions are rare, except in highly degraded habitats, we have combined the two as a single metric to help distinguish highly degraded sites affected by chemical and discharged pollutants from moderately degraded ones and adjusted the scoring criteria accordingly.

RESULTS AND DISCUSSION

SAMPLING SITES AND COLLECTION RESULTS

Nine sites were sampled July 28-30, 2009 and one site was sampled June 13, 2008, in streams of the Little Choctawhatchee River watershed (table 2). Most of these sites correspond to those sampled for water quality by the Geological Survey of Alabama Groundwater Assessment Program with the following exceptions. Sites 4 and 9 were dropped for biological assessment because they were too deep to conduct a wading sample. Two sites were relocated for better sampling access: site 5 (labeled 5a for this report) was moved about 1,700 feet downstream of the U.S. Hwy. 231 crossing and site 10 (labeled 10a for this report) was moved about 2.5 miles upstream. Site LCHH-1 was sampled in 2008 as part of the Southern Plains IBI development. Five sites were <10 mi^2 in watershed area, four were between 15 and 25 mi^2, and one exceeded 150 mi^2. Physical characteristics of each site are listed in table 3.

Table 2. Fish community sampling sites in the Little Choctawhatchee River watershed.

Station no.	Stream	County	Area (mi^2)	Longitude (°W)	Latitude (°N)	Section, township, range	Sample date	Sample time
1	Little Choctawhatchee at Ala. Hwy. 84	Dale	159	85.6688	31.2625	sec. 5, T. 3 N., R. 24 E.	28-Jul-09	1220-1400
2	Mossy Camp Branch at Co. Hwy. 55	Dale	5.25	85.6025	31.2822	sec. 25, T. 4 N., R. 24 E.	28-Jul-09	1145-1545
3	Unnamed Tributary at Co. Hwy. 563	Dale	4.50	85.5647	31.2727	sec. 32, T.4 N., R. 25 E.	30-Jul-09	1220-1315
5a	Murphy Mill Branch at Kelly Spring Road	Houston	4.75	85.4615	31.2766	sec. 32, T. 4 N., R. 26 E.	29-Jul-09	1300-1355
6	Little Choctawhatchee at U.S. Hwy. 231	Houston	5.99	85.4387	31.2642	sec. 4., T. 3 N., R. 26 E.	29-Jul-09	1020-1125
7	Rock Creek at Deerpath Road	Houston	7.50	85.4431	31.2517	sec. 59., T. 3 N., R 26 E.	29-Jul-09	0800-0930
8	Beaver Creek at Brannon Stand Road	Dale	18.5	85.4865	31.2178	sec. 24, T. 3 N., R 25 E.	29-Jul-09	1505-1620
10a	Bear Creek at Fortner Road	Dale	19.1	85.5463	31.2076	sec. 28, T. 3 N., R. 25 E.	30-Jul-09	1005-1155
11	Panther Creek at Panther Road	Dale	18.5	85.5838	31.2433	sec. 7, T. 3 N., R. 25 E.	30-Jul-09	0850-0925
LCHH-1	Little Choctawhatchee at Brannon Stand Road	Houston	24.9	85.4820	31.2462	sec. 7, T. 3 N., R. 26 E.	13-Jun-08	0750-0920

Table 3. Watershed and stream characteristics for sites in the Little Choctawhatchee River watershed.

Site no.	1	2	3	5	6	7	8	10a	11	LCHH1
Area (mi^2)	159	5.25	4.5	4.75	5.99	7.5	18.5	19.1	18.5	24.9
Watershed features										
Predominant land use	Forest, field, pasture	Forest, field, pasture	Forest	Forest, mixed urban	Mixed urban	Forest, residential	Mixed urban	Forest	Forest	Mixed urban
Local NPS pollution sources	Potential	Obvious	Obvious	Obvious	Obvious	Obvious	Obvious	Potential	Potential	Obvious
Local watershed erosion	Slight	Moderate	Heavy	Moderate	Heavy	Moderate	Moderate	Slight	Moderate	Moderate
Riparian land use										
Land use at reach	Forest	Forest, field, pasture	Forest	Forest, mixed urban	Mixed urban	Forest	Forest	Forest	Forest, mixed urban	Forest, mixed urban
Dominant riparian vegetation	Trees	Trees	Trees, shrubs	Trees	Trees, shrubs	Shrubs, trees	Trees	Trees	Trees	Trees
Instream features										
Reach length (ft)	800	1,000	750	1,000	400	900	800	500	500	500
Stream width (ft)	45	20	20	20	20	25	30	100	30	80
Bank height (ft)	15	20	4	5	5	3	4	na	5	4
Stream depth-riffle (ft)	na	<1	na	na	na	na	na	na	na	na
Stream depth-run (ft)	1-2	<0.5	<1	<1	na	<1	2-4	1-2	1-3	0.5-2
Stream depth-pool (ft)	1-2	na	<2	na	1-4	1-2	na	na	1-3	>2
Canopy cover (percent)	20-40	20-40	20-40	20-40	60-80	80-100	80-100	80-100	80-100	80-100
Estimated gradient (ft/300 ft)	<1	1-3	1-3	1-3	<1	<1	<1	<1	<1	<1
Aquatic vegetation (percent)	0	0	0	0	0	0	0	10	0	10
Flow conditions										
Flow stage	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Low	Normal
Velocity (ft/s)	<1.5	1.5-3.0	1.5-3.0	1.5-3.0	<1.5	1.5-3.0	<1.5	<1.5	<1.5	1.5-3.0
Water quality indicators										
Water odors	Normal	Normal	Normal	Normal	Normal	Sewage	Sewage	Normal	Normal	Normal
Surface oils	None	None	None	None	None	None	None	Sheen	None	None
Turbidity	Slight	Slight	Slight	None	Slight	Slight	Slight	None	Slight	Slight
Water color	Lgt tannic	Lgt tannic	None	Lgt tannic	Lgt tannic	Lgt tannic	Drk tannic	Drk tannic	Dark tannic	Lgt Grey
Sediment quality indicators										
Sediment odors	Normal	Normal	Normal	Normal	Normal	Normal	Sewage, anaerobic	Anaerobic	Normal	Anaerobic
Oils	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Bottom deposits	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Substrate composition (percent)										
Bedrock	0	0	0	0	0	0	0	0	0	0
Boulder	0	0	0	0	0	0	0	0	0	0
Cobble	0	0	0	0	0	0	0	0	0	0
Gravel	15	30	20	5	0	20	10	0	10	0
Sand	80	60	70	90	70	40	80	50	20	60
Silt	0	10	10	5	30	30	10	20	60	20
Clay	5	0	0	0	0	10	0	0	10	0
Detritus	0	0	0	0	0	0	0	0	0	20
Muck (fine organic)	0	0	0	0	0	0	0	30	0	0

Site LCHH-1 had the highest habitat score (165) which represented 75 percent of the maximum score possible (220) (table 4) with site 11 having the next highest score (154) at 70 percent. Although these scores were the highest for this set of samples, they were still only in the suboptimal range of the habitat evaluation tool. Site 5a had the lowest score (86) at 39.1 percent with site 2 the next lowest score (112) at 50.9 percent, which ranked these sites as poor to marginal in habitat quality. Habitat scores for all sites in the Little Choctawhatchee were compared to scores determined for 23 other sites in the Choctawhatchee River (fig. 3). This comparison demonstrated that habitat scores for Little Choctawhatchee sites were all within the variability observed for other streams in the Choctawhatchee watershed and that all Choctawhatchee streams evaluated rated suboptimal or less in habitat quality. Marginal to suboptimal habitat quality is a common condition in many Coastal Plain streams in Alabama particularly in areas with significant row cropping, intensive forest management, and a dense network of unpaved road stream crossings.

Reasons for the poor to submarginal habitat scores were specifically related to poor instream cover for biota, poor structure of pool habitat, high sediment deposition, scoured and altered channels, and streams with scoured banks and poor bank vegetation. In comparison, those sites with the highest habitat scores had better pool habitat quality, less sediment deposition, and generally had stream banks that were vegetated and showed less scour. Excessive sand bedload was a pervasive problem at most sites (fig. 4) and is the major factor affecting many habitat components. Sand bedload is a natural condition in most Coastal Plain streams, but sediment deposition was particularly high at a few sites (1, 5a, and 8).

Thirty-two sampling efforts were completed at all sites with the exception of site 6, Little Choctawhatchee River at U.S. Hwy. 231 (table 5). Only 22 efforts were made at this site because the amount of workable habitat was confined between a deep pool at Hwy. 231 and an upstream forested wetland. Runs and glides dominated stream habitats with over 71 percent of all sampling efforts in these habitats. Pools accounted for about 22 percent of the efforts and shorelines slightly over 6 percent. Only two

Table 4. Habitat scores for sites in the Little Choctawhatchee River watershed.

Habitat metrics	Station no.									
	1	2	3	5a	6	7	8	10a	11	LCHH1
Habitat structure	Metric scores									
Instream cover (ICOV)	11	5	5	3	10	7	9	13	13	15
Pool substrate characterization (PSUB)	6	10	10	6	11	6	10	9	14	12
Pool variability (PVAR)	9	3	5	2	12	12	12	8	12	16
Channel condition										
Man-made channel alteration (CHAALT)	15	11	12	7	7	13	12	16	11	14
Sediment deposition (SED)	7	3	3	2	8	9	5	4	9	12
Channel sinuosity (CSINU)	14	12	10	8	3	11	11	10	15	11
Channel flow status (CFLOW)	16	12	15	10	17	16	17	11	17	13
Bank/riparian condition										
Condition of banks (BANKC)	16	12	14	7	12	6	10	17	11	18
Bank vegetative condition (BANKVEG)	16	10	16	7	16	12	8	14	16	18
Disruptive pressure (DISRUP)	18	16	18	18	18	16	12	18	16	20
Riparian zone width (RIPVEG)	18	18	20	16	12	16	16	20	20	16
Sum	146	112	128	86	126	124	122	140	154	165
Percent of maximum habitat score (220)	66.4	50.9	58.2	39.1	57.3	56.4	55.5	63.6	70.0	75.0

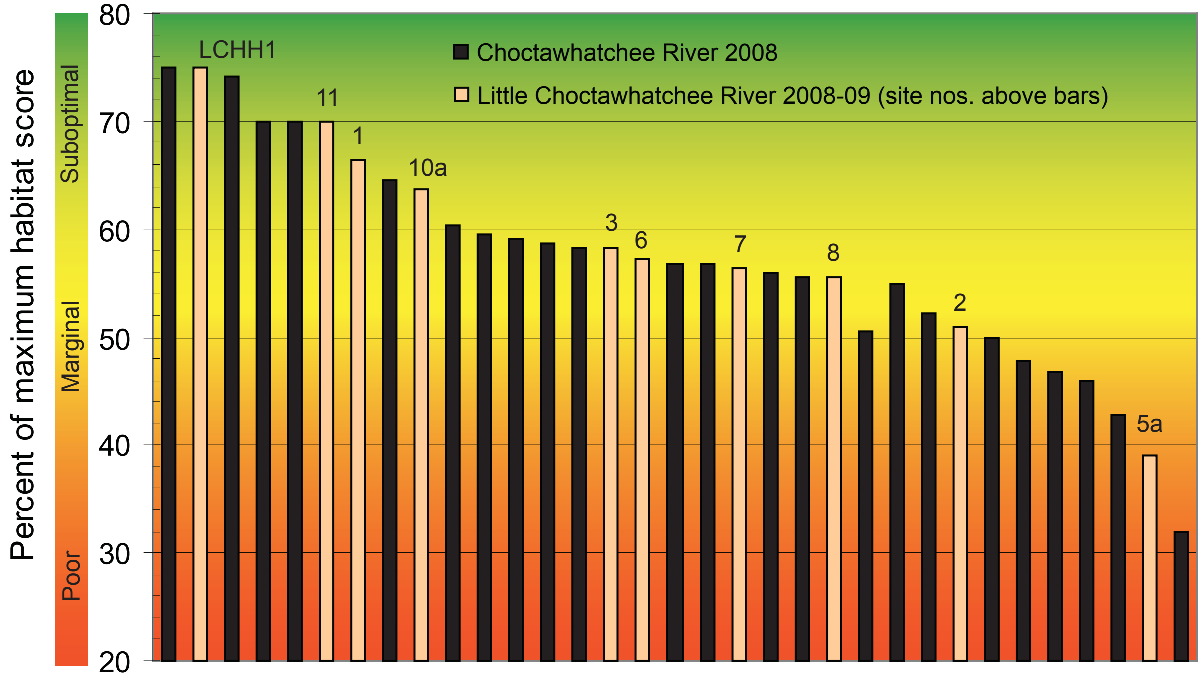

Figure 3. Comparison of habitat scores for Little Choctawhatchee River sites to Choctawhatchee River sites.

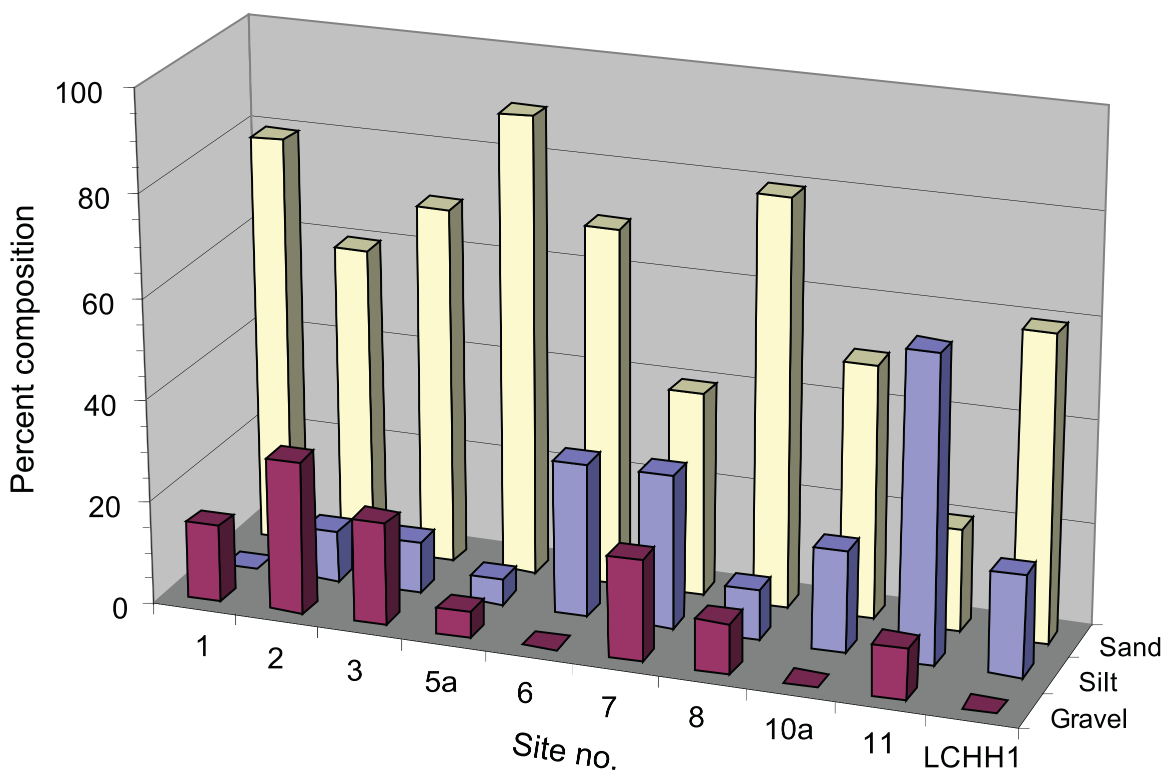

Figure 4. Percent composition of substrate types at Little Choctawhatchee River sites.

Table 5. Metric values and IBI scores for sites in the Little Choctawhatchee River watershed.

Station no.	1	2	3	5a	6	7	8	10a	11	LCHH1
Area (mi^2)	159	5.25	4.5	4.75	5.99	7.5	18.5	19.1	18.5	24.9
Habitat	Number of sampling efforts									
Riffles	0	2	0	0	0	0	0	0	0	0
Runs/Glides	22	25	30	26	13	17	19	25	18	26
Pools	8	3	0	4	7	13	11	5	12	4
Shorelines	2	2	2	2	2	2	2	2	2	2
Total	32	32	32	32	22	32	32	32	32	32
IBI metric	Metric values									
1. Number of native species (TNSP)	24	15	20	7	16	19	21	12	22	20
2. Number of minnow species (CYPSP)	7	5	7	1	4	3	5	3	4	6
3. Number of Centrarchidae species (CENTSP)	9	4	4	3	6	9	9	2	6	4
4. Number of darter+madtom species (DARMAD)	5	2	2	0	4	2	2	5	6	5
5. Percent tolerant species (PTOL)	8.04	1.03	1.77	18.63	3.28	17.92	29.08	0	3.57	2.27
6. Percent green sunfish + yellow bullhead (GSFYB)	4.91	0.51	0.76	4.9	1.64	1.79	2.84	0	2.38	0
7. Percent insectivorous cyprinids (INSCYP)	57.14	74.29	60.25	0	65.57	28.32	30.5	41.27	15.48	43.94
8. Percent invertivores (INVERT)	42.41	0.77	6.58	8.82	27.05	56.63	58.87	10.32	17.86	27.27
9. Percent top carnivores (TC)	3.13	0.51	0.25	0.98	0.82	6.09	1.42	0.79	4.76	1.52
10. Catch per effort (CATCH)	7.0	12.2	12.7	3.2	3.8	8.7	4.4	3.9	2.6	4.1
11. Percent DELT + hybrids (DELT)	0	0.26	0.25	0	0	1.43	1.42	0	0	0
12. Number of lithophilic spawners (LITHO)	16	10	13	4	10	10	13	5	10	9
IBI metric	IBI scores									
1. Number of native species (TNSP)	3	3	5	1	5	5	5	3	5	3
2. Number of minnow species (CYPSP)	3	5	5	1	3	3	3	3	3	3
3. Number of Centrarchidae species (CENTSP)	5	3	5	3	5	5	5	1	5	3
4. Number of darter+madtom species (DARMAD)	3	3	3	1	5	3	1	5	5	5
5. Percent tolerant species (PTOL)	3	5	5	1	5	1	1	5	5	5
6. Percent green sunfish + yellow bullhead (GSFYB)	1	3	3	1	3	3	1	5	1	5
7. Percent insectivorous cyprinids (INSCYP)	3	5	5	1	5	1	3	3	1	3
8. Percent invertivores (INVERT)	3	1	1	1	3	5	5	1	1	3
9. Percent top carnivores (TC)	5	1	1	1	1	5	3	1	5	3
10. Catch per effort (CATCH)	3	1	1	3	3	5	3	1	1	1
11. Percent DELT + hybrids (DELT)	5	3	3	5	5	1	1	5	5	5
12. Number of lithophilic spawners (LITHO)	3	5	5	3	5	5	5	1	3	3
IBI score (sum)	40	38	42	22	48	42	36	34	40	42
Biological condition	Fair	Fair	Fair	Very Poor	Good	Fair	Fair	Poor	Fair	Fair

riffle efforts were made during the entire survey with both at site 2 in a small patch of rip rap near a bridge.

Samples yielded 41 species of freshwater fishes in 14 families with minnows of the family Cyprinidae dominating the catch at 60.7 percent of the total number of individuals captured (1,943) (table 6). The Longnose Shiner, *Notropis longirostris*, was the most dominant minnow at 14.5 percent followed by the Weed Shiner, *Notropis texanus*, at 11.5 percent and the Blacktail Shiner, *Cyprinella venusta*, at 7.5 percent. The next most common family of fishes captured were sunfishes of the family Centrarchidae at 20.5 percent of the total catch. Dominant species in this group were the Redbreast Sunfish, *Lepomis auritus*, at 6.8 percent followed by the Bluegill, *Lepomis macrochirus*, at 3.8 percent, and the Redspotted Sunfish, *Lepomis miniatus*, also at 3.8 percent. Darters of the family Percidae accounted for 9.5 percent of the catch with the Blackbanded Darter, *Percina nigrofasciata*, most common at 5.2 percent followed by the Gulf Darter, *Etheostoma swaini*, at 2.4 percent.

Metric values and IBI scores for Little Choctawhatchee sites are presented in table 5. The IBI varied from very poor (22) at site 5a to good (48) at site 6. Most sites (7 total) were ranked as fair in biological condition with scores ranging from 36 to 42 while one site (10a) scored in the poor range. Little Choctawhatchee IBI scores were comparable to a set of scores determined for 23 other sites throughout the Choctawhatchee River watershed (fig. 5). The very poor score at site 5a was one of the lowest in the entire Choctawhatchee data set while the good score at site 6 was near the upper end of this distribution.

Reasons for the very poor score at site 5a was low biodiversity across almost all fish families, the presence of pollution tolerant species, and poor structure within most trophic groups. The heavy sand bedload and extremely poor physical habitat conditions at this site were major contributors to very poor biological condition scores. The poor IBI score at site 5a was because of average to poor biodiversity scores, poor trophic structure, and poor habitat (mud and silt of a forested wetland) for sand and gravel spawning species. The two tolerance metrics scored very good for this site. In contrast, site 6 scored in the good IBI range because of average to good fish biodiversity scores,

Table 6. Fish sampling data for sites in the Little Choctawhatchee River watershed.

Scientific name	Common name	Station no. 1	2	3	5	6	7
Petromyzontidae - lampreys							
Ichthyomyzon gagei	Southern Brook Lamprey	--	--	1	2	--	--
Lepisosteidae - gars							
Lepisosteus oculatus	Spotted Gar	--	--	--	--	--	2
Anguillidae - freshwater eels							
Anguilla rostrata	American Eel	--	--	--	--	--	--
Cyprinidae - carps and minnows							
Cyprinella venusta	Blacktail Shiner	62	37	11	--	8	6
Hybopsis sp cf winchelli	Undescribed Chub	3	--	--	--	--	--
Lythrurus atrapiculus	Blacktip Shiner	2	--	5	--	4	15
Macrhybopsis sp cf aestivalis	Florida Chub	14	--	--	--	20	--
Notropis amplamala	Longjaw Minnow	6	66	112	--	--	--
Notropis longirostris	Longnose Shiner	13	183	86	--	--	--
Notropis texanus	Weed Shiner	33	2	16	--	48	58
Pteronotropis merlini	Orangetail Shiner	--	--	17	--	--	--
Semotilus thoreauianus	Dixie Chub	--	67	54	71	--	--
Catostomidae - suckers							
Erimyzon sucetta	Lake Chubsucker	--	2	1	--	--	--
Minytrema melanops	Spotted Sucker	--	--	--	--	--	4
Moxostoma poecilurum	Blacktail Redhorse	--	--	2	--	1	--
Ictaluridae - North American catfishes							
Ameiurus natalis	Yellow Bullhead	--	1	3	5	--	2
Ictalurus punctatus	Channel Catfish	3	--	--	--	--	--
Noturus leptacanthus	Speckled Madtom	11	11	4	--	4	--
Esocidae - pikes							
Esox americanus	Redfin Pickerel	--	1	--	--	--	--
Aphredoderidae - pirate perch							
Aphredoderus sayanus	Pirate Perch	4	1	5	--	--	--
Atherinopsidae - New World silversides							
Labidesthes sicculus	Brook Silverside	--	--	--	--	--	--
Fundulidae - topminnows							
Fundulus olivaceus	Blackspotted Topminnow	1	--	--	--	1	4
Poeciliidae - livebearers							
Gambusia holbrooki	Eastern Mosquitofish	--	--	1	14	--	15
Centrachidae - sunfishes							
Ambloplites ariommus	Shadow Bass	4	--	--	--	--	--
Centrarchus macropterus	Flier	--	--	--	--	--	--
Lepomis auritus	Redbreast Sunfish	4	--	9	7	12	86
Lepomis cyanellus	Green Sunfish	12	1	--	--	2	3
Lepomis gulosus	Warmouth	2	--	--	--	--	5
Lepomis macrochirus	Bluegill	7	2	3	--	2	26
Lepomis megalotis	Longear Sunfish	5	--	--	--	7	11
Lepomis microlophus	Redear Sunfish	3	--	--	--	--	11
Lepomis miniatus	Redspotted Sunfish	14	1	1	2	2	10
Micropterus punctulatus	Spotted Bass	3	--	--	--	--	1
Micropterus salmoides	Largemouth Bass	--	1	1	1	1	14
	hybrid Centrarchid	--	--	--	--	--	--
Percidae - perches and darters							
Ammocrypta bifascia	Florida Sand Darter	4	--	--	--	--	--
Etheostoma colorosum	Coastal Darter	1	--	--	--	--	--
Etheostoma davisoni	Choctawhatchee Darter	--	--	--	--	2	5
Etheostoma edwini	Brown Darter	--	--	--	--	--	--
Etheostoma swaini	Gulf Darter	1	--	--	--	4	1
Percina nigrofasciata	Blackbanded Darter	19	12	7	--	4	--
Elassomatidae - pygmy sunfishes							
Elassoma zonatum	Banded Pygmy Sunfish	--	--	4	--	--	--

Table 6. Fish sampling data for sites in the Little Choctawhatchee River watershed.

Scientific name	Common name	Station no. 8	10a	11	LCHH1	Total
Petromyzontidae - lampreys						
Ichthyomyzon gagei	Southern Brook Lamprey	--	--	--	--	3
Lepisosteidae - gars						
Lepisosteus oculatus	Spotted Gar	--	--	--	--	2
Anguillidae - freshwater eels						
Anguilla rostrata	American Eel	1	--	--	2	3
Cyprinidae - carps and minnows						
Cyprinella venusta	Blacktail Shiner	4	1	1	15	145
Hybopsis sp cf winchelli	Undescribed Chub	--	--	--	1	4
Lythrurus atrapiculus	Blacktip Shiner	2	--	2	10	40
Macrhybopsis sp cf aestivalis	Florida Chub	2	--	--	--	36
Notropis amplamala	Longjaw Minnow	--	--	--	1	185
Notropis longirostris	Longnose Shiner	--	--	--	--	282
Notropis texanus	Weed Shiner	31	28	--	7	223
Pteronotropis merlini	Orangetail Shiner	4	23	5	24	73
Semotilus thoreauianus	Dixie Chub	--	--	--	--	192
Catostomidae - suckers						
Erimyzon sucetta	Lake Chubsucker	--	--	--	--	3
Minytrema melanops	Spotted Sucker	3	--	--	--	7
Moxostoma poecilurum	Blacktail Redhorse	--	--	1	--	4
Ictaluridae - North American catfishes						
Ameiurus natalis	Yellow Bullhead	1	--	--	--	12
Ictalurus punctatus	Channel Catfish	--	--	--	--	3
Noturus leptacanthus	Speckled Madtom	2	7	9	9	57
Esocidae - pikes						
Esox americanus	Redfin Pickerel	--	1	1	1	4
Aphredoderidae - pirate perch						
Aphredoderus sayanus	Pirate Perch	4	5	5	3	27
Atherinopsidae - New World silversides						
Labidesthes sicculus	Brook Silverside	--	--	1	--	1
Fundulidae - topminnows						
Fundulus olivaceus	Blackspotted Topminnow	4	--	3	3	16
Poeciliidae - livebearers						
Gambusia holbrooki	Eastern Mosquitofish	--	--	1	3	34
Centrachidae - sunfishes						
Ambloplites ariommus	Shadow Bass	--	--	1	--	5
Centrarchus macropterus	Flier	1	--	--	--	1
Lepomis auritus	Redbreast Sunfish	7	--	1	6	132
Lepomis cyanellus	Green Sunfish	3	--	2	--	23
Lepomis gulosus	Warmouth	2	--	--	--	9
Lepomis macrochirus	Bluegill	34	--	--	--	74
Lepomis megalotis	Longear Sunfish	3	4	5	2	37
Lepomis microlophus	Redear Sunfish	2	--	--	--	16
Lepomis miniatus	Redspotted Sunfish	24	8	3	8	73
Micropterus punctulatus	Spotted Bass	--	--	--	--	4
Micropterus salmoides	Largemouth Bass	2	--	2	1	23
	hybrid Centrarchid	2	--	--	--	2
Percidae - perches and darters						
Ammocrypta bifascia	Florida Sand Darter	--	--	--	--	4
Etheostoma colorosum	Coastal Darter	--	--	3	3	7
Etheostoma davisoni	Choctawhatchee Darter	--	3	3	--	13
Etheostoma edwini	Brown Darter	--	9	1	3	13
Etheostoma swaini	Gulf Darter	--	25	8	7	46
Percina nigrofasciata	Blackbanded Darter	3	12	21	23	101
Elassomatidae - pygmy sunfishes						
Elassoma zonatum	Banded Pygmy Sunfish	--	--	--	--	4

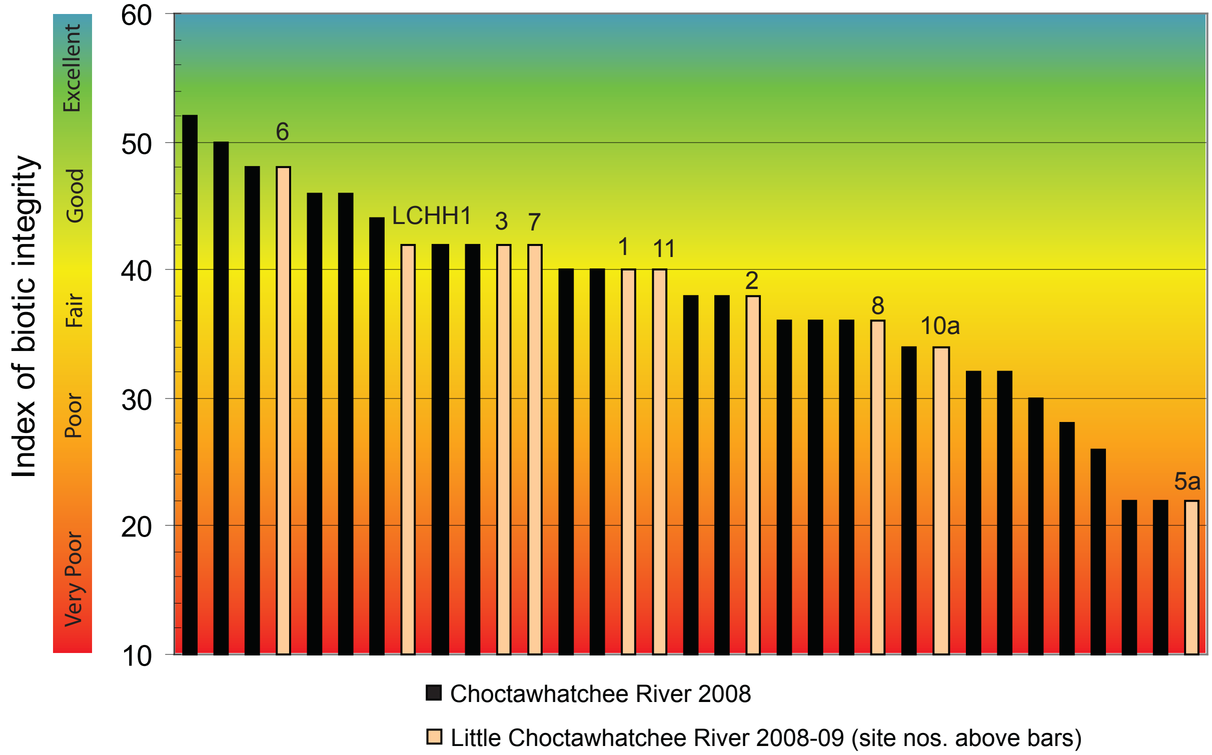

Figure 5. Comparison of IBI scores for Little Choctawhatchee River sites to Choctawhatchee River sites.

average to good tolerance metric scores, and average to good trophic structure. The IBI metric that evaluates fish health relative to deformities, lesions, tumors, and hybrids generally scores good for the majority of stream sites sampled in the state and only begins to negatively affect the IBI when watershed conditions are poor or declining. Two sites, 7 and 8, scored poor for this metric (both are located on urban streams near Dothan) and another two sites, 2 and 3, scored average to poor (both of these sites are on impaired rural streams with significant sand bedload).

RELATIONSHIPS BETWEEN HABITAT AND BIOLOGICAL CONDITION

Biological condition in a stream is determined to a large degree by the quality of suitable habitat available to the resident aquatic species. The general relationships depicted in figures 3 and 5 can be further evaluated and quantified by comparing individual habitat metrics with individual IBI metrics. A Pearson correlation coefficient cross tabulation (table 7) was calculated for the 12 Southern Plains IBI metrics (table 5) and 11 glide-pool habitat metrics (table 4) for the 10 stream sites in Little Choctawhatchee River. The shaded boxes depict those correlation coefficients statistically different from 0, the critical value for p=0.05 was 0.632 and for p=0.10 was 0.549 with 8 degrees of freedom. Fourteen of the correlation coefficients were significantly different from 0 at the p=0.05 level.

Darter-madtom species richness (DARMAD) was significantly related to instream cover and declined as scores for cover declined (degrading conditions), most typically by sedimentation and erosion (fig. 6). Channel flow status (CFLOW) was an important habitat metric and was significantly correlated with 5 of the 12 IBI metrics. At those sites where flow occupied only a small portion of the available stream channel (low CFLOW scores) due either to depletion, yearly low flows, or withdrawals, several IBI metrics (number of native species, centrarchid species, percent invertivores, and number of lithophilic spawners) were reduced, contributing to lower IBI scores at those sites. These results indicated that flow and the status of flow in the stream channel is a significant variable affecting biological condition.

Bank condition (BANKC) and bank vegetative cover (BANKVEG) were significantly correlated habitat metrics as well (fig. 6). When stream banks were well

Table 7. Correlations between IBI metrics and habitat metrics.

IBI metrics [1]	Habitat metrics [2]										
	Habitat structure			Channel condition				Bank/riparian condition			
	ICOV	PSUB	PVAR	CHAALT	SED	CSINU	CFLOW	BANKC	BANKVEG	DISRUP	RIPVEG
TNSP	0.443	0.299	0.594	0.446	0.562	0.535	0.796	0.269	0.531	-0.220	0.160
CYPSP	0.255	0.258	0.225	0.447	0.213	0.345	0.415	0.617	0.557	0.081	0.231
CENTSP	0.067	-0.224	0.457	0.115	0.382	0.255	0.798	-0.333	-0.042	-0.547	-0.287
DARMAD	0.920	0.521	0.610	0.485	0.631	0.319	0.316	0.667	0.791	0.291	0.235
PTOL	-0.337	-0.434	0.062	-0.188	-0.124	-0.006	0.203	-0.666	-0.712	-0.673	-0.339
GSFYB	-0.291	-0.527	-0.221	-0.307	-0.177	0.112	0.143	-0.426	-0.380	-0.189	-0.165
INSCYP	0.040	0.144	-0.044	0.186	-0.024	-0.158	0.147	0.526	0.405	0.187	-0.059
INVERT	0.222	-0.265	0.636	0.235	0.478	0.110	0.634	-0.263	-0.076	-0.475	-0.402
TC	0.213	-0.135	0.445	0.213	0.565	0.483	0.477	-0.404	0.126	-0.206	0.064
CATCH	-0.546	-0.212	-0.450	0.163	-0.351	0.165	-0.015	-0.004	-0.016	-0.034	0.295
DELT	-0.249	-0.260	0.236	0.117	0.039	0.097	0.392	-0.564	-0.476	-0.753	-0.189
LITHO	0.077	0.034	0.251	0.267	0.207	0.355	0.740	0.177	0.307	-0.287	0.049
IBI	0.407	0.428	0.598	0.164	0.611	-0.078	0.699	0.306	0.716	0.089	-0.208

[1] - Input data are IBI metric values (table 6)

[2] - Input data are habitat scores (table 5)

Shaded box highlights correlation coefficients statistically different from 0

(yellow)	critical r value = 0.632 [p=0.05, df=8].
(cyan)	critical r value = 0.549 [p=0.10, df=8].

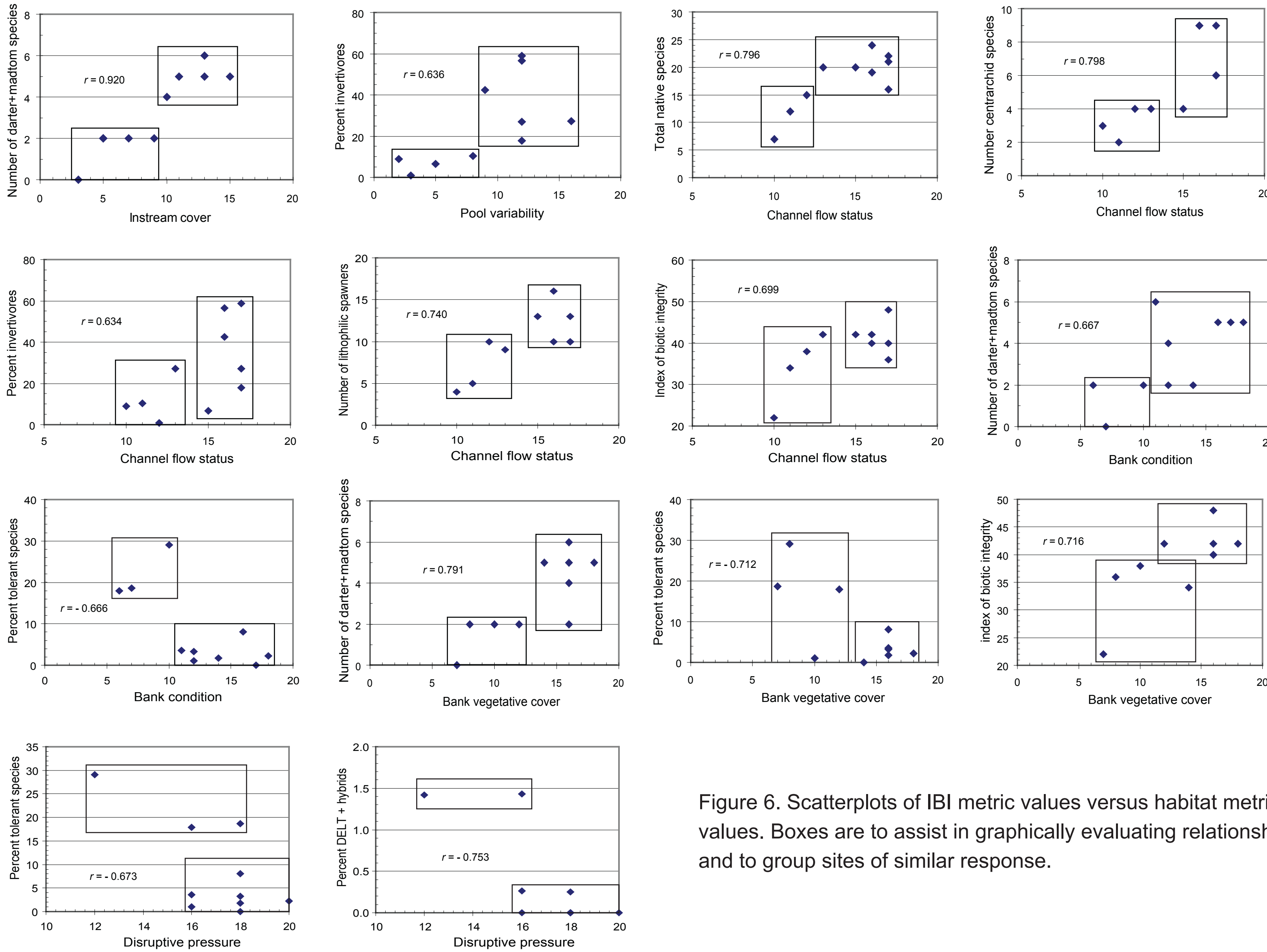

Figure 6. Scatterplots of IBI metric values versus habitat metric values. Boxes are to assist in graphically evaluating relationships and to group sites of similar response.

vegetated and riparian vegetation provided adequate cover and shade, then darter-madtom diversity was high and positively correlated with BANKC and BANKVEG. In contrast these two habitat metrics were negatively correlated with percent tolerant species, i.e. tolerant species increased in abundance as BANKC and BANKVEG were reduced and(or) degraded. Percent tolerant species also increased as disruptive pressures (DISRUP) increased in the bank and riparian zones (mowed grass, paved areas, etc.). Fish anomalies appeared to increase at those sites with high DISRUP scores as well. The IBI responded positively when full, intact riparian zones (BANKVEG) were present at a site.

Because habitat metrics are generally not scored with a high level of measurement precision, the correlations and relationships present in table 7 and fig. 6 should not be interpreted with too much statistical rigor but rather as a means to assist visualizing how biological condition varies with habitat components. The boxes added to the graphs in fig. 6 help organize data points into groups of similar response. As can be seen, some groups are well separated indicating a probable link between biological response/condition and habitat quality.

CONCLUSIONS

The IBI has been demonstrated in many regions over the years to correspond negatively to increasing levels of human disturbance (Crumby and others, 1990; Hughes and others, 1998; Smogor and Angermeier, 1999a, b; Schleiger, 2000; McCormick and others, 2001; Teels and Danielson, 2001; Compton and others, 2003; Dauwalter and others, 2003). We found this to be true as well for the Southern Plains ichthyoregion in Alabama (O’Neil and Shepard, 2009). Fish communities inhabiting streams in this region have for many years been impacted by numerous unpaved road crossings and widespread agriculture. The eastern part of this region is extensively and, in some areas, heavily farmed resulting in stream degradation due to erosion and sedimentation which results in degraded stream habitat and impaired fish communities. The western part of the region is used extensively for growing timber, and stream habitat in this part of the Southern Plains ichthyoregion was impaired by excessive erosion and sedimentation as well (O’Neil and Shepard, 2009).

Sedimentation and erosion are water resource issues in the Little Choctawhatchee watershed affecting biological condition and water quality. Biological condition of streams in the watershed were strongly related to stream flow status, quality of instream cover, and the condition of stream banks and riparian cover. Because biological condition is so closely related to instream habitat, it can be managed and improved by restoring and repairing stream banks and channels where significant erosion is occurring, by applying best management practices for agriculture, unpaved roads, and urban areas to the greatest practical extent possible, and by implementing a cooperative stakeholder project for the Little Choctawhatchee River watershed.

Should a reservoir be constructed in the watershed a partnership of interested landowners, conservation groups, agency representatives, and other stakeholders would be a good mechanism for providing coordination to systematically evaluate stream issues in the watershed and work towards successful, cooperative projects to fix problems. Sedimentation and channel filling would pose a risk to a reservoir on the Little Choctawhatchee River and should be a central focus of this partnership group.

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