GEOLOGICAL SURVEY OF ALABAMA

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ECOSYSTEMS INVESTIGATIONS PROGRAM

CALIBRATION OF THE INDEX OF BIOTIC INTEGRITY FOR THE PLATEAU ICHTHYOREGION IN ALABAMA

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by

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ABSTRACT

The Plateau ichthyoregion in north Alabama was sampled from 2008 through 2011 to develop data for creating and calibrating the Index of Biotic Integrity (IBI). Eighty-seven sites were selected to represent a range of watershed areas and levels of human disturbance. Watershed areas at sampled sites ranged from 3.90 mi^2 up to 921 mi^2 with 36 percent (33 sites) of the watersheds <20 mi^2, 40 percent (36 sites) ranging from 21 to 100 mi^2, and 24 percent (22 sites) >100 mi^2 in area. Rapid habitat assessments were completed for each sample and eight measures of human disturbance were derived for each site from a geographic information system (GIS). Thirty-four candidate IBI metrics were screened for inclusion in the IBI by evaluating their relationship to the habitat assessment and human disturbance metrics. Both human disturbance metrics and habitat metrics were correlated with IBI metrics. Twelve metrics were selected for the Plateau IBI: number of native species, number of cyprinid species, number of sucker species, number of *Lepomis* species, number of darter+madtom species, percent of the dominant species, percent of tolerant species, percent of *Lepomis* species, percent of omnivores and herbivores, percent of top carnivores, percent with DELT+hybrids (DELT=deformities, eroded fins, lesions, tumors) and the percent of simple lithophilic spawners. Only disturbance measures were effective in discriminating sites with good biological condition from sites with poor condition. Habitat measures did not discriminate sites with good biological condition from sites with poor biological condition. Thirty-four percent of the sites scored in the poor to very poor range, 38 percent in the fair range, and 28 percent in the good to excellent range. The range of scores for each integrity class of the Plateau IBI were similar to those developed for the Southern Plains and Ridge and Valley/Piedmont IBI and slightly higher than criteria developed for the Tennessee Valley IBI. The Plateau IBI integrity classes were applied to the USEPA biological condition gradient concept for tiered aquatic life uses to model the response of biological condition to ecosystem stress in the region. This model can be used to better assess stream aquatic life use in Plateau streams and provide an additional water quality screening tool for locating and defining use-impaired streams.

INTRODUCTION

The Geological Survey of Alabama (GSA), in cooperation with the Alabama Department of Environmental Management (ADEM) and the Wildlife and Freshwater Fisheries Division (WFFD) of the Alabama Department of Conservation and Natural Resources (ADCNR), has initiated a multi-year research effort to develop and calibrate a comprehensive fish community bioassessment tool, known as the Index of Biotic Integrity (IBI), for the state of Alabama. This tool will be useful in helping agencies assign designated water-use classifications for all the state's waters to manage water quality more efficiently and effectively, to understand aquatic resources more broadly and in greater depth, and to better manage aquatic habitat. Additionally, this tool will be useful in managing the state's water resources by communicating to the public and water-management agencies more clearly the need for and benefits of incorporating biological perspectives into water resource protection and management. Specifically, the process of establishing minimum instream flows and evaluating environmental flows will benefit substantially by incorporating biological monitoring and assessment methodologies.

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. Ultimately, it is the measurable performance of the natural biological system relative to a reference condition that should be a goal for determining whether or not regulatory programs have successfully maintained or improved water quality or whether instream flows are adequate to sustain biological condition.

Biological assessments can now be used with confidence for water resource evaluation for several reasons. First, technical support for the use of standardized techniques and methods has been developed (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 biological performance measured. And finally, the concept of using data from ecoregional reference watersheds has been incorporated into the evaluation process, compensating for the natural variation inherent in biological populations and systems (U.S. Environmental Protection Agency (USEPA), 2005). Full integration of the chemical-specific, toxicity, and biological water-quality assessment approaches is essential for a broad-based, technically sound, and cost-effective system for regulating and managing water resources.

One of the many assets of the IBI method is its ability to reduce very complex ecological processes into simple terms that managers, industry and business representatives, regulators, and the public can understand. Application of the IBI to fishery management problems and water-quality issues can be done with confidence because the science behind the IBI method is extensive and peer reviewed. The GSA applied the IBI to a large regional watershed, the Cahaba River, in 1997 (Shepard and others, 1997), developing metrics and associated scoring criteria for the first time in an Alabama watershed. Later, in conjunction with ADEM, GSA developed another application of the IBI for streams in the Cahaba and Black Warrior River systems (O’Neil and Shepard, 2000a, b). Since these studies, the GSA has applied the IBI to the Locust Fork system (Shepard and others, 2004), the Mulberry Fork system (Shepard and others, 2002), the Cahaba River system again (O’Neil, 2002), and the Hatchet Creek system (O’Neil and Shepard, 2005). The IBI sampling methodology was refined and the new protocol applied in a study of the Terrapin Creek watershed (O’Neil and others, 2006). The Tennessee Valley Authority (TVA) has used the IBI for many years to assess the biological condition of streams throughout the Tennessee River drainage, and several aspects of the TVA sampling methodology were incorporated into the Alabama Cooperative IBI method (O’Neil and others, 2006).

Although the IBI is routinely used for water-quality regulation in other states and has been successfully applied in selected drainages in Alabama, it is underutilized in Alabama as an assessment tool. Several needs have been identified that should be met before the IBI biomonitoring method can be fully implemented statewide in Alabama for assessing streams and other aquatic habitats. Some of these needs have been met and other research needs are currently underway.

The GSA, in conjunction with WFFD, recently developed a standardized stream sampling protocol during a 3-year study in the Terrapin Creek watershed (O’Neil and others, 2006) for use with the IBI. This sampling protocol is now being used for all IBI fish bioassessments by ADEM, WFFD, and GSA. Research is currently underway to explore lake, reservoir, and nonwadeable river sampling protocols.

Alabama’s high fish biodiversity was evaluated with respect to its high ecoregional and drainage diversity (O’Neil and Shepard, 2007) in order to reduce the set of unique eco-biotic regions to a manageable number for IBI scoring criteria development. This preliminary analysis resulted in five unique ecological-ichthyological regions in Alabama which were termed ichthyoregions: Tennessee Valley, Ridge and Valley/Piedmont, Plateau, Hills and Coastal Terraces, and Southern Plains (fig. 1). Results of criteria development for the Southern Plains were presented in O’Neil and Shepard (2009), for the Tennessee Valley in O’Neil and Shepard (2010), and for the Ridge and Valley/Piedmont in O’Neil and Shepard (2011). Criteria development for the Hills and Coastal Terraces ichthyoregion is slated for late 2011.

Application of the IBI requires accurate species identifications by well-trained individuals. Individuals applying the IBI in Alabama must take this requirement into account because of Alabama’s high fish biodiversity and consequently higher probability of mis-identifications. As such, unsure identity of collected specimens will require that they be brought to the laboratory for identification and verification by outside experts. “Green” non-destructive sampling, meaning identifications are made on site and individuals are returned to the stream, should also be a priority given the impaired state of many waterways and fish species in Alabama.

A list of standardized ecological and tolerance designations for all species of fishes in the state has been presented in other reports (O’Neil and Shepard, 2000b; O’Neil and others, 2006) and was updated for this report. This list should be peer reviewed by fisheries biologists, fish ecologists, and ichthyologists familiar with the state’s fishes. Ichthyoregional and (or) drainage-specific reference sites should be

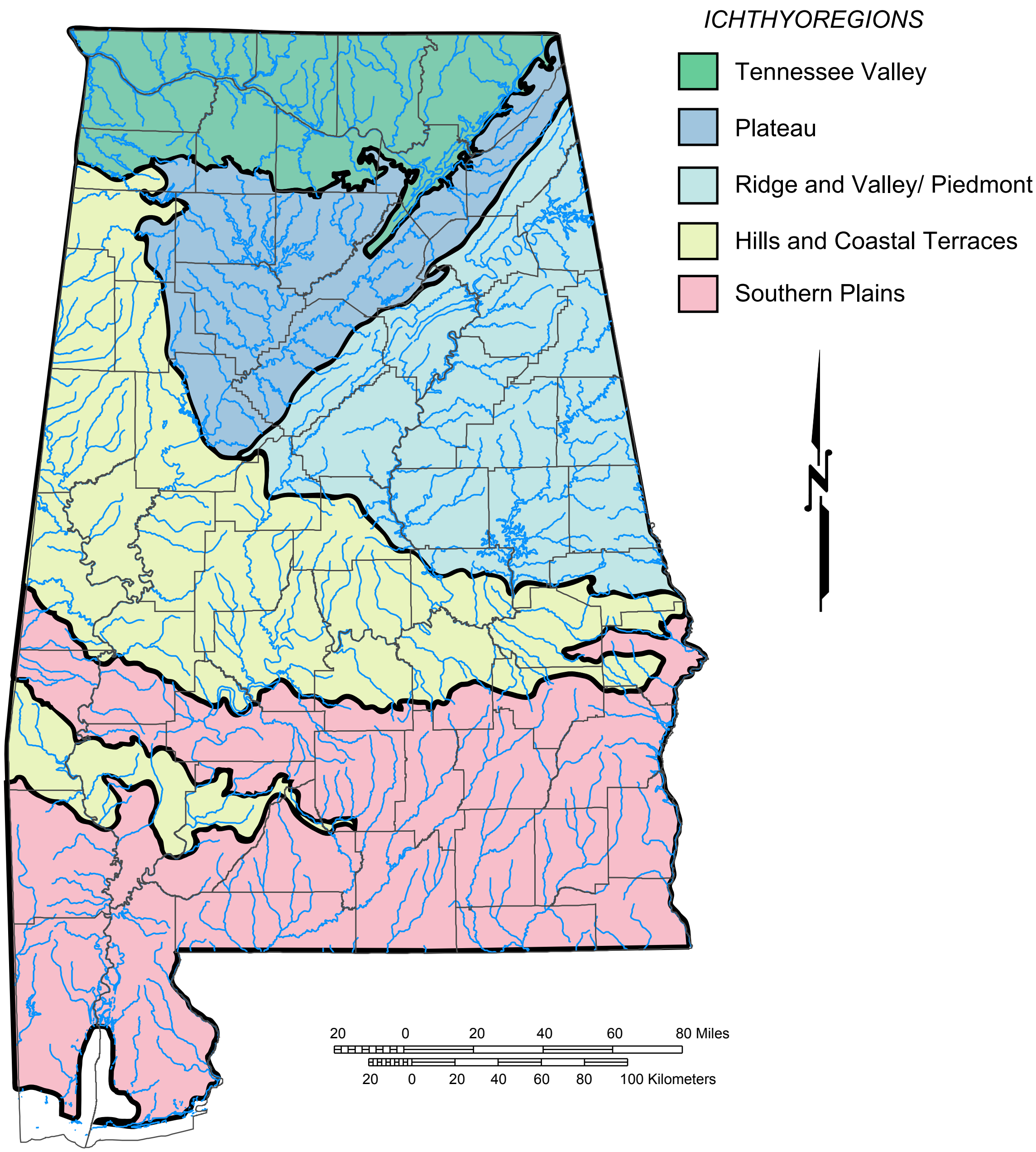


Figure 1. Preliminary ichthyoregion classification for Alabama.

established and sampled systematically over time. The ADEM has established ecoregional reference sites for their macroinvertebrate program, and these sites should be sampled for fishes on a prescribed basis. The WFFD has recognized that additional stream and reservoir assessment tools will be needed to manage habitat and stream resources to benefit fish populations in the state.

ACKNOWLEDGMENTS

Several individuals and institutions assisted with this study, and we sincerely appreciate their time and contributions. Fred Leslie, Chris Johnson, Lynn Sisk, and Norm Blakey of ADEM were involved in designing this cooperative project, discussing many aspects of project implementation, and in providing partial funding under Section 319 of the Clean Water Act. We appreciate the work of Mark Sport for coordinating this project at ADEM. Stan Cook, Nick Nichols, Steve Rider, and Andrew Henderson of WFFD were also instrumental in designing the project, providing funding and encouragement for implementing this study, and participating in field sampling. Biologists with ADEM who participated in field sampling included Dusty Miller, Keith Gilliland, Rick Dowling, Scott Hicks, Aaron Goar, Ranse Williams, Tonya Mayberry, Ron Sparks, Brad Dunham, and Ruthie Young. Biologists with WFFD who assisted with sampling included Jay Haffner, Jerry Moss, Jim Piper, Travis Powell, and Tom Ringenberg. Cal Johnson, Brett Smith, Stuart McGregor, and Sam Justice of GSA assisted with field collections and data entry while Anne Wynn, also of GSA, handled all of the GIS mapping and GIS-based landscape analysis. Charlie Saylor and Amy Wales of the Tennessee Valley Authority worked cooperatively with GSA biologists for several years during which time the basic concepts of the Alabama Cooperative IBI Project were formed and the fundamental sampling concepts were refined.

OBJECTIVES

The goal of year 4 of the Alabama Cooperative IBI Project was to develop a workable and calibrated IBI for the Plateau ichthyoregion. This was accomplished by completing several objectives:

- ❏ Select, by way of in-house analysis and field reconnaissance, IBI sampling sites that reflect a range of watershed sizes and degree of human disturbance and habitat degradation ranging from highly disturbed to minimally disturbed. The sampling sites should also have flow during dry periods and be readily accessible by road and bridge crossings. Emphasis was placed on sites that presented sufficient riffle, run, and pool habitat to produce adequate samples for evaluating IBI metrics and scoring criteria.
- ❏ Attempt to sample approximately 100 sites in the Plateau ichthyoregion. The GSA was tasked with sampling 40 sites, the WFFD in conjunction with the GSA was assigned 20 sites, and ADEM was assigned 40 sites.
- ❏ Sample selected sites using the standardized IBI sampling protocol (O'Neil and others, 2006) and use the resulting data to establish IBI metrics and scoring criteria specific for the Plateau ichthyoregion.

STUDY AREA

PLATEAU ICHTHYOREGION

Classifying the state into unique regions of similar fish community structure and composition—known as ichthyoregions in the Alabama IBI program (fig. 1)—is especially important because of the state's high biodiversity of fishes, large number of unique aquatic habitats, and its unique and complex physiographic, geologic, and ecoregional footprint (O'Neil and Shepard, 2007). The Plateau ichthyoregion generally includes the Black Warrior, Coosa, and Tennessee River systems upstream of the Fall Line. Included ecoregions are 68d - Southern Table Plateaus, 68e - Dissected Plateau, and 68f - Shale Hills (fig. 2) (Griffith and others, 2001). This ichthyoregion encompasses a variety of stream types, habitats, disturbance patterns, and pollution stress. Hydrology in headwater streams can be flashy while flows in larger downstream

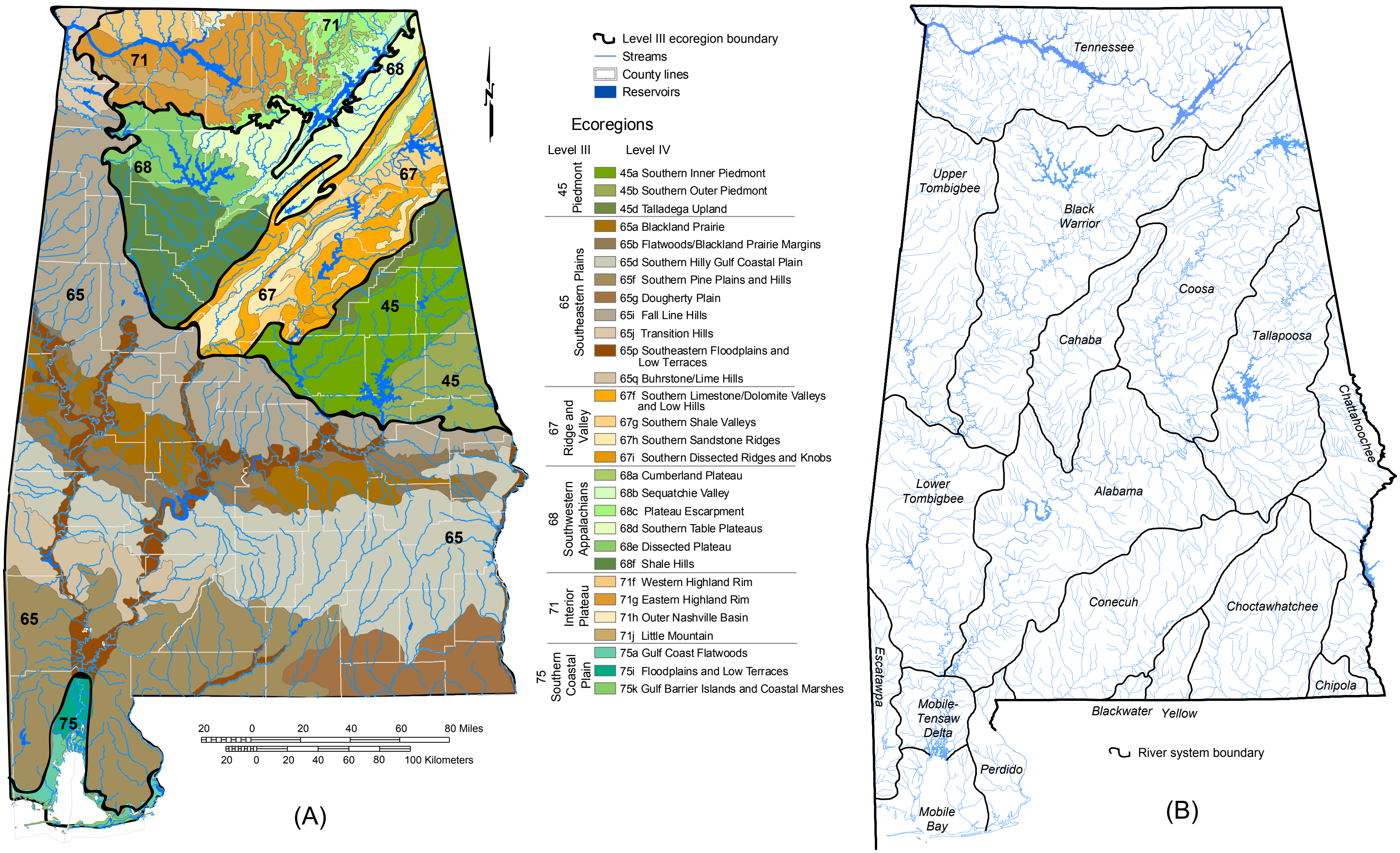


Figure 2. Ecoregions (A) and river systems (B) in Alabama.

reaches is usually sustained through dry periods. Land use practices such as coal mining in the lower Warrior basin, agriculture in Cullman County and on Sand Mountain, and the large urban centers of Birmingham, Tuscaloosa, and Cullman have affected stream biological communities in the region.

METHODS

IBI SAMPLE COLLECTION

A study completed in an earlier phase of the cooperative IBI project (O'Neil and others, 2006) outlined a protocol for collecting a representative fish community sample from which an IBI score could be calculated. Results of the study indicated that sampling should be stratified over four habitat types (riffles, runs, pools, and shorelines) with a minimum of 10 sampling efforts each dedicated to riffle, run, and pool habitats with two additional sampling efforts along stream shorelines. This sampling regime, termed the "30+2" method, was determined sufficient to yield a fish community sample acceptable for calculating IBIs that reflects the biological condition in wadeable streams. A minimum of 32 efforts were completed at all sites, and for those sites with missing or reduced habitat components, the effort was proportioned to habitats that were present.

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 standardized sampling protocol like the 30+2 method has been adopted that assures a representative and consistent fish sample will be collected among sites.

Fish samples collected for purposes other than bioassessment can be problematical when used in the IBI process because these samples are usually biased to the intended use of the data. For example, samples collected for taxonomic purposes target species of research interest and are generally restricted to narrowly defined habitat types, while sampling gear for fisheries investigations typically selects for large, commercially important species or sport fishes.

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 and runs and along shoals. Each sampling team had a variety of seine lengths for different size streams. The standard nylon minnow seine used was 10 to 15 feet wide and 6 feet deep with a delta weave of 3/16 inch. An 8-foot-wide seine was sometimes necessary for very narrow streams, while a 15-foot seine was used in larger streams and rivers.

An effective sampling technique was to use the backpack shocker in combination with the seine. In riffles and runs the seine was set in shallow, rocky areas or deeper, swifter chutes; the backpacker then walked upstream for 15 to 20 feet outside of the area to be sampled and shocked downstream through the habitat, walking toward the seine while 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 involved a crew member walking behind the backpacker and skating his feet from side to side to disturb the bottom and dislodge stunned benthic fishes. Most microhabitats in riffle and run habitats were sampled because they are quite often very productive areas. Vegetated shorelines along riffle and shoal margins were usually very productive areas as were areas where stream flow becomes turbulent when entering or leaving runs and riffles. Plunge pools where runs and riffles transition to pools often yielded a diverse catch of species.

Deeper stream runs and glides between pools were also productive and were sampled by either seining downstream or by moving from bank to bank across the stream in a downstream direction with the seine, either alone or following the backpack shocker. 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 for a few minutes with a shocker and dip nets. Wider seines were more advantageous in pools for trapping fishes.

Shorelines along pools, runs, and riffles can have complex habitat structure and yield sunfish and sucker species not normally found in the basic riffle-run or run-pool sequence in Plateau streams. The shoreline sampling technique consisted of a crew member working the electroshocker in an upstream direction along a shoreline reach for 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. “Habitat” is an inclusive term that incorporates several features and processes in streams including the physical components such as rock and rubble, logs, mud, and 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 a quantitative assessment, the habitat concept is generally narrowed to include the physical components of 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 riffle-run and glide-pool assessment procedures 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 habitat characteristics contribute to the maintenance and health of aquatic biological communities: the availability and quality of the habitat-substrate components and instream cover, morphology of the instream channel, and structure of the bank and riparian vegetation zone (Plafkin and others, 1989). Barbour and others (1999) developed two sets of habitat metrics, one for evaluating upland stream habitat dominated by riffle-run microhabitats 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 (appendix A). The 11 habitat metrics of the glide-pool index and 12 metrics of the riffle-run 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 and 240 for the riffle-run method. Final habitat scores are sometimes compared to reference streams that are minimally, or least, impaired in the area. Habitat quality is also sometimes 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 - 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, cobble, 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.

Epifaunal surface - This parameter evaluates the relative amount and types of natural structures in the stream. Examples include cobble, boulders, trees, logs and branches, and undercut banks, which serve as places for spawning and habitat for aquatic macroinvertebrates and fishes. As variety and abundance of structures decreases, habitat structure becomes simplified and biodiversity will decrease.

Embeddedness - Embeddedness is a measure of the relative degree to which rocks and snags are covered or sunken into the silt, sand, and mud. As substrate features become buried, the available high-quality surfaces for shelter, spawning, and feeding decrease, resulting in reduced biodiversity. This parameter is evaluated in riffle and run habitats and is a substitute for the pool substrate character and variability parameter of the glide-pool method.

Velocity/depth regimes - High-quality riffle-run streams generally have four velocity/depth regimes present: slow-deep, slow-shallow, fast-deep, and fast-shallow. The presence of these regimes determines in part the stream's ability to create stable aquatic habitat and reflects the degree of geomorphic stability. This parameter is a substitute for the pool variability parameter of the glide-pool method.

Man-made channel alteration – 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 - This characteristic quantifies the amount of sediment that has accumulated in pools and changes that have taken place on stream bottoms from 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.

Frequency of riffles - Riffles are high-quality habitat in upland streams and this parameter assesses the frequency of occurrence of riffles in a stream. More riffle habitat generally results in a greater variety and abundance of aquatic organisms. This parameter is a substitute for the channel sinuosity parameter of the glide-pool method for low-gradient streams.

Channel flow status – 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 – Bank stability is a measure of whether banks are eroded or are potentially erodible. 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 indicators of accelerated bank erosion.

Bank vegetative protection – 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 – The degree to which stream side cover has been removed by animal grazing, mowing or herbicides, and 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 mowing and grazing.

Riparian vegetative zone width – 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.

The glide pool habitat assessment method is used to evaluate stream habitat that does not have rocky riffles as found in upland streams above the Fall Line. The glide pool method substitutes three habitat metrics in order to capture habitats characterized by unconsolidated mud and sand substrates and extensive run and glides zones.

Pool substrate characterization – 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, such as 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 – 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.

Channel sinuosity – Streams with a higher degree of sinuosity provide a greater variety of habitats which support increased biodiversity. Streams with sinuous channels also attenuate floods and storm flows more effectively by dissipating energy and protecting banks from excessive erosion.

THE HUMAN DISTURBANCE GRADIENT

Stresses to aquatic resources are diverse in type and magnitude and affect ecosystem processes variably. A conceptual model for what is termed a generalized stressor gradient has been defined by the USEPA (2005) to characterize environmental stresses that cause biological responses within aquatic communities. Events and activities that alter aquatic ecosystems are termed **disturbances**. Aquatic ecosystems normally operate at varying levels of disturbance within their ambient range of natural variation such as flood events and other extreme weather-related phenomena. Disturbances outside of this ambient range are human induced and exert **pressures** on aquatic systems by changing the fundamental environmental processes and ultimately generating **stressors** on the resident biota. Stressors are defined as physical, chemical, or biological factors that cause an adverse response in aquatic biota (USEPA, 2000) with the degree of response determined by the magnitude, frequency, and duration of exposure to stressors. This conceptual process is outlined in figure 3 with an example of how riparian tree removal leads to altered biological condition. Unstable banks (disturbance), caused by tree removal (pressures), leads to increased erosion of fine sediments from stream banks (mechanism). This mechanism causes in-stream siltation (stressor) which smothers the substrate with fine particles and causes gill irritation in fishes (mechanism). The stressor ultimately leads to fish and invertebrate mortality or emigration (biological response) out of the disturbed area.

Karr and others (1986) listed five factors that define the structural and functional integrity of aquatic resources and are the major receptors of ecosystem disturbance: water-quality, flow regime, biotic factors, energy source, and habitat structure. Water-quality factors such as hardness, nutrient concentrations, dissolved oxygen, turbidity, toxic trace metals, and toxic organic compounds all affect, either directly or indirectly, the survival of biota. Factors related to flow regime, including velocity gradients, groundwater inflows, diversions, dams, and relative variability of stream flows indirectly shape habitat quality. Severe disruption of natural flow regimes can accelerate channel scour, introduce additional bedload material, lower base flows, and weaken stream banks. Biotic factors such as increased rates of disease, parasitism, predation, and

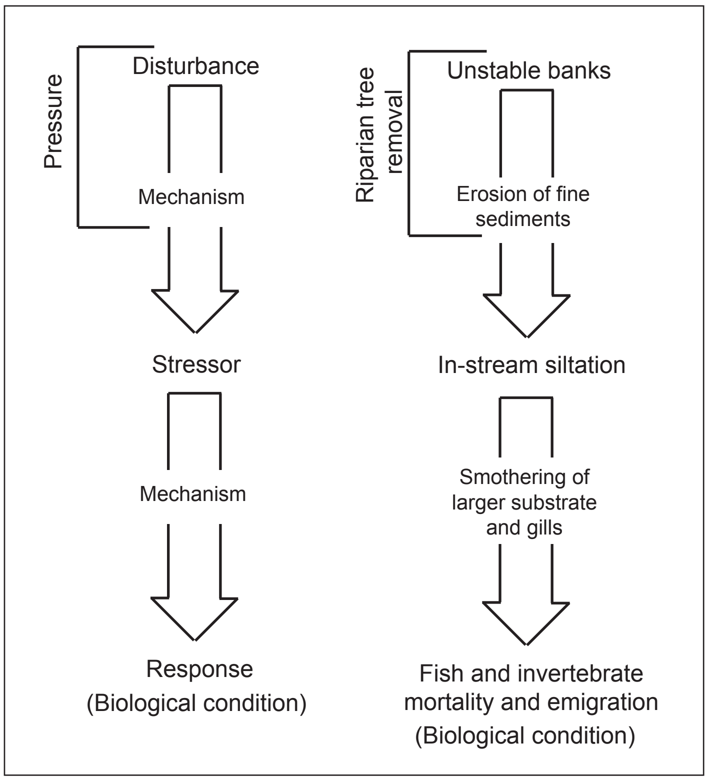


Figure 3. Conceptual model illustrating the relationship between disturbance, stressor, and response (adapted from USEPA, 2005).

competition can directly affect the survival of the resident biota by weakening a population's ability to cope with added environmental stress. Removal of riparian vegetation through logging or urban development disrupts vital sources of energy for the stream including allochthonous organic matter and larger woody debris. Removal of riparian cover also exposes the stream to more sunlight which increases stream temperature and, when coupled with increased nutrient input, can lead to excessive algal growth and eutrophic conditions. Reach-specific habitat variables very often are significant determinants of biological integrity. Increased embeddedness of a naturally variable substrate with fine sediments can lead to loss of habitat diversity and a parallel loss of species diversity. The degree that finer sediments are embedded within coarser substrate, the stability and quality of riparian vegetation cover, and the quality of habitat components such as riffles, pools, and runs are all determinants of biological condition and ultimately to water resource viability.

Biological assessment tools are useful for evaluating stream and habitat conditions in relation to human disturbance. Human activities will degrade water resources by altering one or more of the five basic factors of ecosystem structure and function—water quality, flow regime, biotic factors, energy source, and habitat structure—(Karr and Chu, 1999) through the disturbance-stressor-response model. Because the multimetric IBI is sensitive to changes in these five factors, it can be used to quantify biological effects over a broad range of human disturbance activities. Understanding how the IBI and its individual metrics respond to human disturbance (sensitivity) is therefore a basic step in creating and calibrating an effective IBI index for a region or watershed.

The diverse array of human activities can make the task of defining and quantifying human disturbance difficult, but recent advances in GIS technology have refined our ability to quantify landscape-scale human disturbance. Landscape features that stream ecologists have qualitatively known for years to be sources of ecosystem stress such as type of land cover, type and intensity of land use, number of road-stream intersections, number of point-source discharges, population density, and agricultural animal density can now be quantified into useable datasets using GIS analysis.

Disturbance can be quantified on a number of levels ranging from human disturbance metrics that describe landscape-level features (Brown and Vivas, 2003; Fore, 2004) to the rapid habitat assessment metrics that describe reach-level features (Rankin, 1989; Barbour and others, 1999). Both landscape- and reach-level measures were used in this investigation and are important for quantifying disturbance and relating it to multimetric indices such as the IBI.

The Analytical Tools Interface for Landscape Assessments (ATtILA) program has been developed by the USEPA to readily calculate many common landscape metrics. ATtiLA (version 2004), an Arc View extension, uses GIS data in order to create landscape metrics. Shape files containing population density and roads coverage for each county (U.S. Census Bureau, 2010), streams (USGS, 1999-National Hydrography Database), and a raster grid of land cover (USGS, 2006-National Land Cover Database) were used to develop the following metrics for this project:

- ❑ Human density - (population count per square kilometer of watershed).
- ❑ Phosphorus load- kilograms/hectare/year (kg/ha/yr).
- ❑ Percent urban (percentage of watershed that is urban).
- ❑ Percent barren (percentage of the watershed that is man-made barren).
- ❑ Percent pasture (percentage of the watershed that is pasture).
- ❑ Percent crop (percentage of the watershed that is crop land).
- ❑ Road density (kilometers of roads per square kilometer of watershed).
- ❑ Road x stream crossings (number of road-stream crossings per kilometer of stream).

The human disturbance gradient (HDG) was calculated by weighing the eight selected landscape features listed above by a factor known as the Landscape Development Intensity (LDI) index (Brown and Vivas, 2003) which relates the intensity of human land use to nonrenewable energy flow. The LDI ranges from 0, natural systems, to 10, high intensity central business districts. These weighted values were then summed to yield the final HDG index.

IBI METRICS AND SCORING CRITERIA

Biological responses to stressors in the environment are quantified into measures called metrics that are calculated from fish collection data. 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 sucker 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; and reproduction/fish health metrics measure the relative proportions of species within certain reproductive guilds and the relative presence of health problems such as deformities, eroded fins, lesions, and tumors that may be environmentally caused.

Testing and validating biological responses across a gradient of habitat and(or) human disturbance is an important step in IBI development (Karr and Chu, 1997; Smogor and Angermeier, 1999a). The ability of individual metrics, and ultimately the IBI itself, to segregate most from least degraded and disturbed sites was evaluated by comparing a sample of sites with similar-sized watershed areas from each end of the habitat disturbance gradient similar to the method of Teels and Danielson (2001). All sites were first ordered according to watershed area and this distribution was split into two groups, one consisting of sites with a watershed area <25 mi^2 and the other of sites with a watershed area $\geq$25 mi^2. Within each group, the sites were ordered from those with lowest habitat scores (poor habitat quality) to those with highest habitat scores (good habitat quality). A sample of ten sites was selected from each end of this array and the mean metric values for these two samples were compared using the Student t-test. This procedure was repeated for sites in watersheds $\geq$25 mi^2. This comparative analysis for small and large watersheds was repeated using the human disturbance gradient to sort sites then analyzed in identical fashion.

DESIGNATION OF GUILDS

Biological responses to aquatic ecosystem stressors are manifested through changes in the structure (species diversity and abundance) and function (trophic relationships and reproductive patterns) of faunal communities. Within the fish community, species must be classified into appropriate trophic and reproductive guilds so accurate and responsive IBI metrics can be constructed (Goldstein and Simon, 1999; Simon, 1999a). Guild determination should be based on regionally specific ichthyology texts and natural history information. Recent books of Alabama fishes (Mettee and others, 1996; Boschung and Mayden, 2004) and fish books of adjoining states, Etnier and Starnes (1993) for Tennessee, and Ross (2001) for Mississippi, contain excellent information for establishing guild associations for southeastern fishes. O'Neil and Shepard (2000b) provided a list of all Alabama freshwater fishes with ecological and distributional characteristics that included trophic status and tolerance. This list was modified using definitions and descriptions by Smoger and Angermeier (1999a) and Dauwalter and others (2003) to refine trophic guilds and add reproductive guild designations (appendix B).

Two classification factors were considered for assigning reproductive guild: spawning substrate and spawning behavior. Lithophilic spawners prefer clean mineral substrates (cobble, gravel, sand) to deposit their eggs in or on top of. The non-lithophilic spawner guild uses the remaining types of substrate or spawning surfaces (aquatic vegetation, coarse organic matter, and other features not related to lithophilic substrates). Simple spawners typically invest little energy in nest preparation or parental care and generally broadcast or bury their eggs. Manipulative spawners construct simple nests such as depressions, mounds, or cavities and(or) have some form of parental care such as egg or young guarding. Four reproductive guilds were designated for Alabama fishes: (1) simple lithophils, (2) manipulative lithophils, (3) simple non-lithophilic spawners, and (4) manipulative non-lithophilic spawners.

Trophic guild classifications were slightly more complex with three classification factors considered by Smogor and Angermeier (1999b): number of food types consumed, feeding behavior, and foods consumed. Fish food types were grouped into four categories: detritus, algae or vascular plants, invertebrates, and fish-crayfish. Generalist feeders were those that eat three or more food types; specialists eat only one or at most two types. Benthic versus non-benthic feeding behaviors were also considered in the classification process with benthic behaviors associated with bottom-feeding species. Seven trophic guilds were established:

1. DAH - detritivore, algivore, herbivore. Detritus, algae, and(or) vascular plants comprise the major diet items for this guild with *Campostoma* and *Hybognathus* as examples.
2. AHI - algivore, herbivore, invertivore. This guild is similar to DAH, but species consume less detritus and more invertebrates with *Erimyzon*, *Polyodon*, *Hypentelium* and all carp species as examples.
3. INV - invertivore. These species consume a variety of invertebrate taxa including crustaceans, insects, and mollusks. Examples are *Moxostoma, Fundulus, Ictalurus*, and *Ameiurus*.
4. INS - insectivore. Many species consume insect immatures as their major food type. Practically all of the darters and many cyprinid species are insectivores.
5. PIS - piscivore. Piscivores, such as *Lepisosteus* and *Morone*, consume fishes almost exclusively as adults.
6. IP - invertivore, piscivore. Many large predators, such as *Micropterus* and *Esox,* will consume fishes and larger invertebrates as adults.
7. PAR - parasite. This is a very restricted classification for those species, such as *Ichthyomyzon*, that may parasitize other fishes.

RESULTS AND DISCUSSION

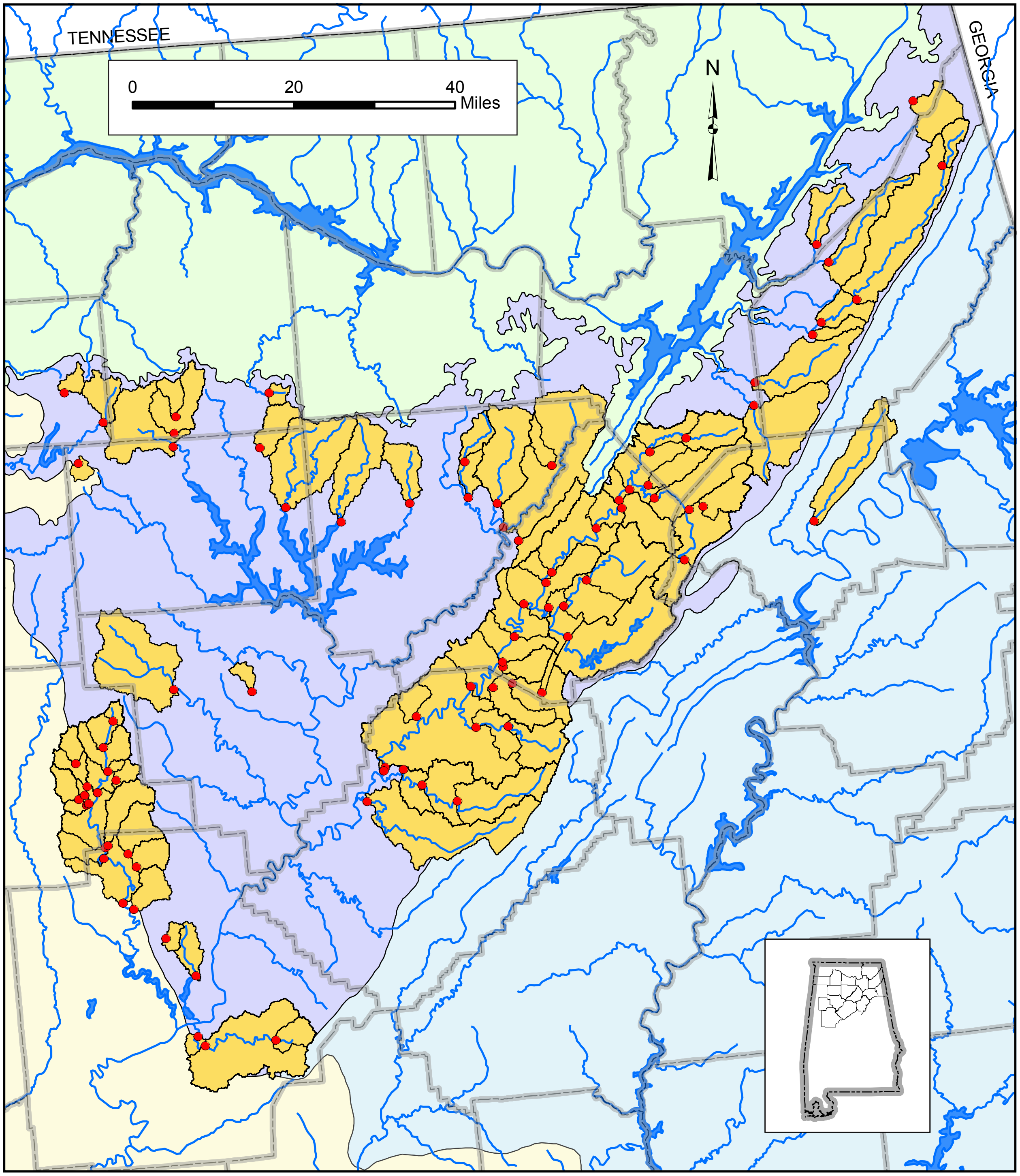
SAMPLING SITES AND COLLECTION RESULTS

Ninety-one samples were collected from 87 sites in 13 counties across central and northeast Alabama to assess fish communities for use in calibrating IBI metrics for the Plateau ichthyoregion (table 1, Appendix C). Sites were selected to represent a range of watershed sizes and levels of human disturbance (fig. 5). Watershed areas at sampled sites ranged from 3.90 mi^2 up to 921 mi^2 with 36 percent (33 samples) of the watersheds <20 mi^2, 40 percent (36 samples) ranging from 21 to 100 mi^2, and 24 percent (22 samples) >100 mi^2 in area.

Collections were concentrated in streams of the Black Warrior River upstream of the Fall Line (83.5 percent--76 collections) specifically from the Locust, Mulberry, and Sipsey Forks, North River, and a few from other smaller tributaries. One sample was taken in Black Creek, a Coosa River tributary, draining the eastern edge of the Plateau ichthyoregion, and several samples (15.4 percent–15 collections) were taken in Tennessee River tributaries on Sand Mountain and in the upper reaches of Bear Creek in Franklin County which are also in the Plateau ichthyoregion.

In total 33,180 individuals, representing 90 species (table 2), were captured, identified, and released during the study with 26 species in the family Cyprinidae (carps and minnows), 10 species in the family Catostomidae (suckers), 8 species in the family Ictaluridae (catfishes and madtoms), 15 species family Centrarchidae (sunfishes), and 17 species in the family Percidae (darters). The average total catch per collection varied across the systems: 481 (ranging from 124 - 1,036) in the Locust Fork, 378 (102 - 593) in the Sipsey Fork, 377 (35 - 740) in the Mulberry Fork, 338 (72 - 699) in the North River, 190 (95 - 391) in the Tennessee River, and 116 for the single sample in the Coosa River.

Minnows in the family Cyprinidae dominated the fauna, comprising 60 percent of all individuals (19,945) collected at the 87 sites (table 2). Five species comprised most of the cyprinid individuals collected: *Campostoma oligolepis* (Largescale Stoneroller) 21.1 percent, *Notropis stilbius* (Silverstripe Shiner) 9.8 percent, *Cyprinella callistia* (Alabama Shiner) 7.4 percent, *C. venusta* (Blacktail Shiner) 6.6 percent, and



Major streams
Reservoirs
Sites and watersheds
Counties

Ichthyoregions
Hills & Coastal Terraces
Plateau
Ridge & Valley / Piedmont
Tennessee Valley

Figure 4. Location of IBI sampling sites in the Plateau ichthyoregion.

Table 1. IBI sampling sites in the Plateau ichthyoregion, 2008-11.

GSA No.	Stream name	Latitude	Longitude	County	Section, township, range	Watershed area (mi2)	Ecoregion	Sample date
				Black Warrior River - Locust Fork				
2064	Big Mud Creek at Co. Hwy. 21	34.1354	-86.3720	Marshall	sec. 30, T. 10 S., R. 3 E.	19.1	68d	11-Jun-09
1476	Blackburn Fork near Co. Hwy. 15 (Hendrick Mill)	33.8798	-86.5805	Blount	sec. 30, T. 13 S., R. 1 E.	90.3	68d	14-Jul-11
1824	Blackburn Fork at slab ford	33.9358	-86.6159	Blount	sec. 2, T. 13 S., R. 1 E.	190	68d	1-Jul-10
1839	Bristow Creek at Pine Grove (Bud Umphrey Rd.)	34.0881	-86.2573	Etowah	sec. 7, T. 11 S., R. 4 E.	23.1	68d	21-Jul-10
1477	Calvert Prong at Co. Hwy. 33	33.9773	-86.5272	Blount	sec. 22, T. 12 S., R. 1 E.	53.4	68d	13-Jul-11
1478	Calvert Prong at Moss Bridge	33.9351	-86.5825	Blount	sec. 6, T. 13 S., R. 1 E.	81.4	68d	13-Jul-11
1831	Fivemile Creek at Brookside on Cardiff St.	33.6408	-86.9271	Jefferson	sec. 14, T. 16 S., R. 4 W.	80.3	68f	8-Jul-10
1832	Fivemile Creek at Linn Crossing	33.6720	-86.9643	Jefferson	sec. 4, T. 16 S., R. 4 W.	95.8	68f	8-Jul-10
1830	Fivemile Creek at Co. Hwy. 77 (Upper Coalburg)	33.6060	-86.8541	Jefferson	sec. 33, T. 16 S., R. 3 W.	50.2	68f	8-Jul-10
1823	Gurley Creek at Co. Hwy. 133 near Trafford	33.8023	-86.7532	Jefferson	sec. 21, T. 14 S., R. 2 W.	54.3	68f	2-Jul-10
1822	Gurley Creek near Trafford on Thermal Rd.	33.8067	-86.7104	Jefferson	sec. 23, T. 14 S., R. 2 W.	30.7	68f	2-Jul-10
1484	Locust Fork at Ala. Hwy. 160	33.9803	-86.6159	Blount	sec. 23, T. 12 S., R. 1 W.	319	68d	
1826	Locust Fork at Co. Hwy 43 (Vaughns Bridge)	33.8893	-86.6955	Blount	sec. 24, T. 13 S., R. 2 W.	579	68e	1-Jul-10
1825	Locust Fork at Co. Hwy. 13 (Nectar)	33.9459	-86.6691	Blount	sec. 32, T. 12 S., R. 1 W.	552	68d	1-Jul-10
1841	Locust Fork at Co. Hwy. 14 (Stracener Bridge)	34.1143	-86.4387	Blount	sec. 4, T. 11 S., R.2 E.	227	68d	20-Jul-10
2062	Locust Fork at Co. Hwy. 26	34.0678	-86.4942	Blount	sec. 24, T. 11 S., R. 1 E.	268	68d	10-Jun-09
1842	Locust Fork at Co. Hwy. 30	34.0996	-86.4353	Blount	sec. 4, T. 11 S., R. 2E.	255	68d	20-Jul-10
1837	Locust Fork at Co.Hwy. 36	34.1111	-86.3622	Blount	sec. 6, T. 10 S., R. 3 E. 34	122	68d	22-Jul-10
1828	Locust Fork at Deans Ferry	33.8463	-86.7274	Blount	sec. 3, T. 14 S., R. 2 W.	605	68f	30-Jun-10
1838	Locust Fork at Dee Nix Road	33.9956	-86.3103	Etowah	sec. 15, T. 12 S., R. 3 E.	18.6	68d	21-Jul-10
1845	Locust Fork 1 mi. DS of railroad track near Littleton	33.6792	-87.0026	Jefferson	sec. 6, T. 16 S., R. 4 W.	920	68f	14-Sep-10
1846	Locust Fork 1 mi. US of Fivemile Creek	33.6726	-87.0075	Jefferson	sec. 1, T. 16 S., R. 5 W.	921	68f	14-Sep-10
1485	Locust Fork at Swann Bridge	33.9978	-86.6015	Blount	sec. 12, T. 12 S., R. 1 W.	311	68d	
1836	Locust Fork at U.S. Hwy. 278	34.1313	-86.4140	Blount	sec. 27, T. 10 S., R. 2E.	219	68d	22-Jul-10
1829	Locust Fork at Warrior-Kimberly Road (Church St.)	33.8084	-86.8008	Jefferson	sec. 24, T. 14 S., R. 3 W.	708	68f	30-Jun-10
1840	Locust Fork near Walnut Grove	34.0844	-86.2892	Etowah	sec. 14, T. 11 S., R. 3 E.	72.7	68d	21-Jul-10
1827	Longs Branch at Co. Hwy. 22	33.8383	-86.7272	Blount	sec. 10, T. 14 S., R. 2 W.	15.9	68f	30-Jun-10
1833	Sand Valley Creek near Gurley	33.7853	-86.6483	Blount	sec. 28, T. 14 S., R. 1 W.	3.9	68d	7-Jul-10
2065	Slab Creek at Ala. Hwy. 75	34.2128	-86.2798	Marshall	sec. 36, T. 9 S., R. 3 E.	26.3	68d	11-Jun-09
1486	Slab Creek at Co. Hwy. 39	34.1948	-86.3619	Marshall	sec. 6, T. 10 S., R. 3 E.	43.8	68d	
1834	Turkey Creek at Co. Hwy. 121	33.7310	-86.7286	Jefferson	sec. 15, T. 15 S., R. 2 W.	31.6	68f	7-Jul-10
1835	Turkey Creek at Co. Hwy. 129 (Morris)	33.7345	-86.7987	Jefferson	sec. 13, T. 15 S., R. 3 W.	49	68f	7-Jul-10
1475	Village Creek at Buckelew property near Porter	33.6213	-87.0494	Jefferson	sec. 27, T. 16 S., R. 5 W.	94.6	68f	26-Jul-11
1474	Ward Creek at Co. Hwy. 140	33.7641	-86.9249	Jefferson	sec. 2, T. 15 S., R. 4 W.	11.3	68f	26-Jul-11
				Black Warrior River - Mulberry Fork				
1804	Blue Spring Creek at Chambliss Mill	34.0598	-86.6664	Blount	sec. 20, T. 11 S., R. 1 W.	21.9	68d	2-Jun-10
1949	Brindley Creek at Ala. Hwy. 69	34.2095	-86.7665	Cullman	sec. 32, T. 9 S., R. 2 W.	13.9	68d	9-Oct-09
1948	Brindley Creek near confluence with Eightmile Creek	34.1457	-86.7669	Cullman	sec. 29, T. 10 S., R. 2 W.	24.9	68d	16-Sep-09
1866	Crooked Creek at Co. Hwy. 818	34.1233	-87.0486	Cullman	sec. 34, T. 10 S., R. 5 W.	45.8	68d	26-Aug-10
1806	Duck River at Co. Hwy. 38	34.1304	-86.7049	Cullman	sec. 36, T. 10 S., R. 2 W.	57.3	68d	2-Jun-10
1972	Lost Creek at Cedrum	33.8521	-87.4465	Walker	sec. 2, T. 14 S., R. 9 W.	85.8	68f	21-Apr-10
1805	Mulberry Fork at Co. Hwy. 47	34.0863	-86.6965	Blount-Cullma	sec. 13, T. 11 S., R. 2 W.	129	68d	2-Jun-10
1821	Pan Creek at Co. Hwy. 1728	34.1881	-86.5775	Cullman	sec. 7, T. 10 S., R. 1 E.	9.87	68d	5-Aug-10
1974	Town Creek at Maddox Middle School (Jasper)	33.8360	-87.2765	Walker	sec. 9, T. 14 S., R. 7 W.	6.05	68f	21-Apr-10
2013								9-Apr-09
2214								20-May-08

Table 1. IBI sampling sites in the Plateau ichthyoregion, 2008-11--continued.

GSA No.	Stream name	Latitude	Longitude	County	Section, township, range	Watershed area (mi2)	Ecoregion	Sample date
				Black Warrior River - Sipsey Fork				
1993	Borden Creek at Bunyan Hill Rd.	34.3095	-87.3946	Lawrence	sec. 32, T. 8 S., R. 8 W.	38.9	68e	19-May-10
1991	Capsey Creek at Forest Road 266	34.2693	-87.2108	Winston	sec. 18, T. 9 S., R. 6 W.	20.1	68e	18-May-10
1992	Flannigan Creek at Forest Road 208	34.3388	-87.3882	Lawrence	sec. 21, T. 8 S., R. 8 W.	9.43	68e	18-May-10
1996	Rock Creek at Co. Hwy. 66	34.1589	-87.1663	Winston	sec. 21, T. 10 S., R. 6 W.	78.9	68e	20-May-10
1995	Ryan Creek at Co. Hwy. 436	34.1450	-86.8949	Cullman	sec. 30, T. 10 S., R. 3 W.	22.9	68d	20-May-10
1994	Sipsey Fork Co. Hwy. 60 (Recreational area)	34.2853	-87.3991	Winston	sec. 8, T. 9 S., R. 8 W.	91.6	68e	19-May-10
				Black Warrior River - North River				
2011	Bear Creek at old USGS gaging site	33.5423	-87.5616	Tuscaloosa	sec. 26, T. 17 S., R. 10 W.	15.1	68f	28-Apr-09
2084	Cane Creek at Co. Hwy. 63	33.6998	-87.5885	Fayette	sec. 33, T. 15 S., R. 10 W.	6.77	68f	14-Aug-09
2001	Cedar Creek at mouth	33.5806	-87.6214	Tuscaloosa	sec. 18, T. 17 S., R. 10 W.	23	68f	23-Jul-08
1926	Clear Creek at Co. Hwy 93 (lower)	33.6784	-87.6599	Fayette	sec. 11, T. 16 S., R. 11 W.	20.3	68f	2-Sep-09
2007	Clear Creek at Deadwood Creek mouth	33.6623	-87.6525	Fayette	sec. 14, T. 16 S., R. 11 W.	21	68f	14-Aug-08
1927	Clear Creek DS of Bugs Lake	33.6933	-87.6526	Fayette	sec. 2, T. 16 S., R. 11 W.	18.4	68f	2-Sep-09
1928	Clear Creek on Clear Creek road	33.7340	-87.6721	Fayette	sec. 22, T. 15 S., R. 11 W.	8.8	68f	16-Sep-09
2072	Cripple Creek at mouth	33.4666	-87.5753	Tuscaloosa	sec. 22, T. 18 S., R. 10 W.	17.3	68f	14-Jul-09
2004	Deadwater Creek near mouth	33.6616	-87.6530	Fayette	sec. 14, T. 16 S., R. 11 W.	14.7	68f	22-Jul-08
1867 1925	Deadwater Creek near RR tracks	33.6596	-87.6572	Fayette	sec. 14, T. 16 S., R. 11 W.	14.6	68f	26-Aug-10
1868	Deadwater Creek near U.S. Hwy 43 at Bankston	33.6711	-87.6731	Fayette	sec. 10, T. 16 S., R. 11 W.	10.6	68f	26-Aug-10
1929	North River at Ala. Hwy. 102	33.8054	-87.5838	Fayette	sec. 28, T. 14 S., R. 10 W.	4.89	68f	3-Sep-09
1930	North River at Cedar Creek	33.5795	-87.6226	Tuscaloosa	sec. 18, T. 17 S., R. 10 W.	117	68f	3-Sep-09
2005	North River at Co Hwy 30	33.6806	-87.6314	Fayette	sec. 7, T. 16 S., R. 10 W.	54.8	68f	14-Aug-08
2002	North River at Co. Hwy 38	33.4796	-87.5968	Tuscaloosa	sec. 17, T. 18 S., R. 10 W.	224	68f	23-Jul-08
2003	North River at Co. Hwy 63	33.5618	-87.6301	Tuscaloosa	sec. 19, T. 17 S., R. 10 W.	154	68f	22-Jul-08
2085	North River at Jenkins Cemetery	33.7166	-87.6051	Fayette	sec. 29, T. 15 S. R. 10 W.	35.8	68f	7-Aug-09
2086	North River at mouth of Lowery Branch	33.7602	-87.6104	Fayette	sec. 8, T. 15 S., R. 10 W.	15.1	68f	7-Aug-09
2071	Turkey Creek at Ala. Hwy. 69	33.4097	-87.5110	Tuscaloosa	sec. 7, T. 19 S., R. 9 W.	6.07	68f	14-Jul-09
2070	Tyro Creek at upper Tyro Creek road	33.5661	-87.5763	Tuscaloosa	sec. 15, T. 17 S., R. 10 W.	21.6	68f	14-Jul-09
				Black Warrior River				
2083	Hurricane Creek at Ala. Hwy. 216	33.2117	-87.4476	Tuscaloosa	sec. 14, T. 21 S., R. 9 W.	108	68f	30-Apr-09
2082	Hurricane Creek at Holt-Peterson Road	33.2298	-87.4611	Tuscaloosa	sec. 10, T. 21 S., R. 9 W.	113	68f	30-Apr-09
2010	Hurricane Creek at Middle School Road	33.2101	-87.2939	Tuscaloosa	sec. 17, T. 21 S., R. 7 W.	14.2	68f	8-Apr-09
1869	Yellow Creek at Co. Hwy. 89	33.3381	-87.4533	Tuscaloosa	sec. 2, T. 20 S., R. 9 W.	14.9	68f	25-Aug-10
				Coosa River				
1865	Black Creek at Ala. Hwy. 211 (Noccalula Road)	34.0412	-86.0200	Etowah	sec. 29, T. 11 S., R. 6 E.	53.4	68d	31-Aug-10

Table 1. IBI sampling sites in the Plateau ichthyoregion, 2008-11--continued.

GSA No.	Stream name	Latitude	Longitude	County	Section, township, range	Watershed area (mi2)	Ecoregion	Sample date
				Tennessee River				
1924	Bear Creek at Co. Hwy. 93	34.3397	-87.5472	Franklin	sec. 23/24, T. 8 S., R. 10 W.	19.1		8-Jul-09
2055	Flat Rock Creek at Ala. Hwy. 117	34.7697	-85.7057	Jackson	sec. 20, T. 3 S., R. 9 E.	28.4	68d	4-Jun-09
1956	Kirby Creek at Co. Hwy. 38	34.5326	-85.9510	Jackson	sec. 7, T. 6 S., R. 7 E.	21.7	68d	24-Sep-09
1921	Little Bear Creek at Co. Hwy. 34	34.3992	-87.6267	Franklin	sec. 31, T. 7 S., R. 10 W.	7.04	68e	8-Jul-09
2287	Quarter Creek off of George Ave., Haleyville	34.2712	-87.6099	Winston	sec. 17, T. 9 S., R. 10 W.	5.61	68e	20-Aug-08
2063	Reedy Creek at Co. Hwy. 328	34.3734	-85.9805	Dekalb	sec. 2, T. 8 S., R. 6 E.	8.98	68d	10-Jun-09
1950	Scarham Creek at Co Hwy 372 (McVille Road)	34.2984	-86.1166	Marshall	sec. 33, T. 8 S., R. 5 E.	54.5	68d	3-Jun-09
2053								17-Sep-09
2067	Short Creek at Co. Hwy. 543	34.2581	-86.1239	Marshall	sec. 9, T. 9 S., R. 5 E.	71.7	68d	10-Jun-09
2068	South Sauty Creek at Co. Hwy. 47	34.4991	-85.9289	Dekalb	sec. 20, T. 6 S., R. 7 E.	44.1	68d	11-Jun-09
2054	Town Creek at Ala. Hwy. 117	34.6487	-85.6577	Dekalb	sec. 36, T. 4 S., R. 9 E.	11.7	68d	21-Jul-09
2069	Town Creek at Co. Hwy. 843 (43)	34.3933	-85.9584	Dekalb	sec. 25, T. 7 S., R. 6 E.	130	68d	11-Jun-09
2057	Town Creek at Co. Hwy. 50 near Guest,	34.4275	-85.8761	Dekalb	sec. 14, T. 7 S., R. 7 E.	111	68d	5-Jun-09
2029	West Flint Creek at Co. Hwy. 81 (Flint Creek Road)	34.4383	-87.1854	Lawrence	sec. 34, T. 6 S., R. 6 W.	5.59	68e	19-May-09

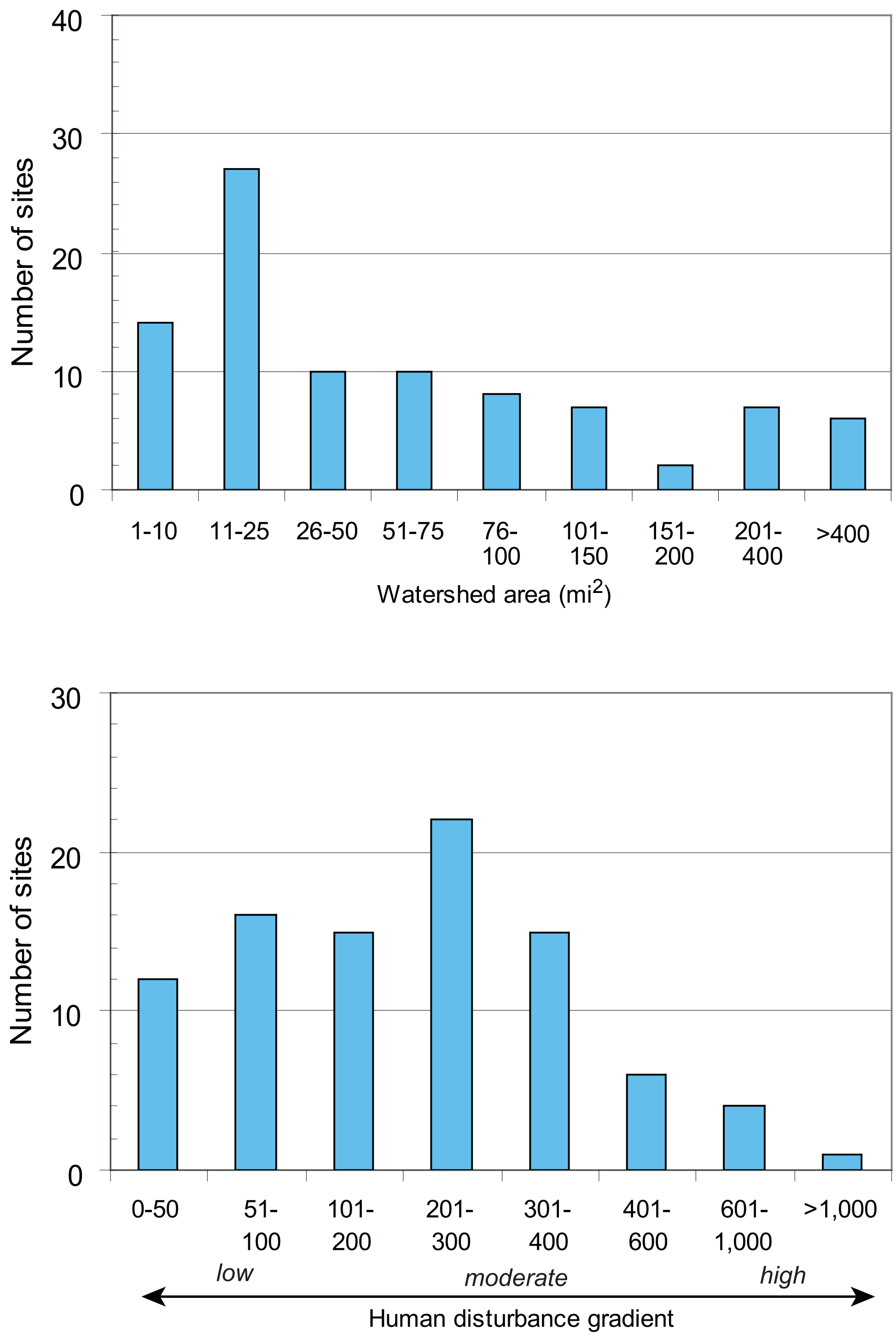


Figure 5. Frequency distribution of sampling sites in the Plateau ichthyoregion by watershed area and human disturbance.

Table 2. Fish species collected in the Black Warrior, Coosa, and Tennessee River systems.

	Black Warrior River										Coosa River		Tennessee River		Total	
	Locust Fork		Mulberry Fork		Sipsey Fork		North River		Miscellaneous							
Family *Species*	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Petromyzontidae - lampreys																
Ichthyomyzon gagei	--	--	--	--	--	--	16	0.23	--	--	--	--	--	--	16	0.05
Lampetra aepyptera	--	--	--	--	--	--	2	0.03	--	--	--	--	--	--	2	0.01
Lepisosteidae - gars																
Lepisosteus osseus	5	0.03	--	--	--	--	3	0.04	--	--	--	--	--	--	8	0.02
Clupeidae - shads herrings																
Dorosoma cepedianum	436	2.67	--	--	--	--	--	--	--	--	--	--	--	--	436	1.31
Dorosoma petenense	--	--	--	--	1	--	--	--	--	--	--	--	--	--	1	0.00
Cyprinidae - carps and minnows																
Campostoma oligolepis	3,565	21.80	1,572	37.93	223	9.84	1,085	15.30	28	5.09	45	38.79	575	21.65	7,093	21.14
Cyprinella callistia	2,120	12.96	110	2.65	124	5.47	74	1.04	18	3.27	--	--	--	--	2,446	7.37
Cyprinella galactura	--	--	--	--	--	--	--	--	--	--	--	--	163	6.14	163	0.49
Cyprinella spiloptera	--	--	--	--	--	--	--	--	--	--	--	--	104	3.92	104	0.31
Cyprinella venusta	1,577	9.64	203	4.90	100	4.41	167	2.35	124	22.55	6	5.17	--	--	2,177	6.56
Hemitremia flammea	--	--	--	--	--	--	--	--	--	--	--	--	10	0.38	10	0.03
Hybopsis winchelli	44	0.27	--	--	--	--	--	--	--	--	--	--	--	--	44	0.13
Luxilus chrysocephalus	24	0.15	7	0.17	14	0.62	513	7.23	35	6.36	--	--	104	3.92	697	2.10
Lythrurus alegnotus	--	--	40	0.97	--	--	--	--	--	--	--	--	--	--	40	0.48
Lythrurus bellus	--	--	--	--	--	--	881	12.42	25	4.55	--	--	32	1.20	938	0.17
Lythrurus fasciolaris	44	0.27	--	--	--	--	--	--	--	--	--	--	5	0.19	49	0.15
Nocomis leptocephalus	--	--	--	--	--	--	50	0.71	--	--	--	--	14	0.53	64	0.19
Notemigonus crysoleucas	3	0.02	--	--	--	--	1	0.01	--	--	--	--	2	0.08	6	0.02
Notropis asperifrons	--	--	26	0.63	221	9.75	48	0.68	--	--	--	--	--	--	295	0.89
Notropis baileyi	--	--	--	--	--	--	274	3.86	7	1.27	--	--	39	1.47	320	0.96
Notropis cahabae	367	2.24	--	--	--	--	--	--	--	--	--	--	--	--	367	1.11
Notropis chrosomus	40	0.24	--	--	--	--	--	--	--	--	--	--	--	--	40	0.12
Notropis stilbius	1,931	11.81	138	3.33	708	31.24	456	6.43	15	2.73	--	--	--	--	3,248	9.79
Notropis texanus	12	0.07	78	1.88	--	--	195	2.75	--	--	--	--	--	--	285	0.86
Notropis volucellus	20	0.12	--	--	--	--	5	0.07	--	--	--	--	--	--	25	0.08
Opsopoeodus emiliae	--	--	--	--	--	--	3	0.04	--	--	--	--	--	--	3	0.01
Pimephales notatus	2	0.01	--	--	3	0.13	19	0.27	--	--	--	--	20	0.75	44	0.13
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	2	0.08	2	0.01
Pimephales vigilax	769	4.70	271	6.54	--	--	2	0.03	26	4.73	--	--	--	--	1,068	3.22
Rhinichthys atratulus	--	--	--	--	--	--	--	--	--	--	--	--	4	0.15	4	0.01
Semotilus atromaculatus	35	0.21	113	2.73	1	0.04	181	2.55	1	0.18	--	--	82	3.09	413	1.24

Table 2. Fish species collected in the Black Warrior, Coosa, and Tennessee River systems--continued.

	Black Warrior River										Coosa River		Tennessee River		Total	
	Locust Fork		Mulberry Fork		Sipsey Fork		North River		Miscellaneous							
Family *Species*	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Catostomidae - suckers																
Carpiodes velifer	2	0.01	--	--	--	--	--	--	--	--	--	--	--	--	2	0.01
Catostomus commersoni	--	--	--	--	--	--	--	--	--	--	--	--	1	0.04	1	0.00
Erimyzon oblongus	--	--	--	--	2	0.09	47	0.66	--	--	--	--	3	0.11	52	0.16
Hypentelium etowanum	199	1.22	12	0.29	21	0.93	60	0.85	4	0.73	15	12.93	--	--	311	0.94
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	20	0.75	20	0.06
Minytrema melanops	--	--	--	--	--	--	9	0.13	1	0.18	--	--	--	--	10	0.03
Moxostoma carinatum	3	0.02	--	--	--	--	--	--	--	--	--	--	--	--	3	0.01
Moxostoma duquesnei	34	0.21	--	--	--	--	--	--	--	--	--	--	--	--	34	0.10
Moxostoma erythrurum	20	0.12	--	--	35	1.54	46	0.65	--	--	--	--	--	--	101	0.30
Moxostoma poecilurum	98	0.60	14	0.34	9	0.40	53	0.75	3	0.55	--	--	--	--	177	0.53
Ictaluridae - North American catfishes																
Ameiurus catus	1	0.01	--	--	--	--	--	--	--	--	--	--	--	--	1	0.00
Ameiurus melas	2	0.01	2	0.05	--	--	--	--	--	--	--	--	2	0.08	6	0.02
Ameiurus natalis	64	0.39	15	0.36	5	0.22	20	0.28	--	--	4	3.45	47	1.77	155	0.47
Ictalurus punctatus	151	0.92	2	0.05	--	--	3	0.04	1	0.18	--	--	--	--	157	0.47
Noturus funebris	--	--	--	--	--	--	11	0.16	--	--	--	--	--	--	11	0.03
Noturus gyrinus	--	--	--	--	--	--	12	0.17	--	--	--	--	5	0.19	17	0.05
Noturus leptacanthus	--	--	9	0.22	3	0.13	45	0.63	15	2.73	--	--	2	0.08	74	0.22
Pylodictis olivaris	80	0.49	6	0.14	--	--	1	0.01	--	--	--	--	--	--	87	0.26
Esocidae - pikes																
Esox niger	1	0.01	--	--	--	--	6	0.08	1	0.18	--	--	--	--	8	0.02
Aphredoderidae - pirate perch	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderus sayanus	--	--	3	0.07	--	--	55	0.78	--	--	--	--	--	--	58	0.17
Atherinopsidae - New World silversides	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Labidesthes sicculus	--	--	--	--	--	--	--	--	2	0.36	--	--	--	--	2	0.01
Belonidae - needlefishes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Strongylura marina	2	0.01	--	--	--	--	--	--	--	--	--	--	--	--	2	0.01
Fundulidae - topminnows																
Fundulus olivaceus	41	0.25	169	4.08	39	1.72	145	2.04	11	2.00	--	--	56	2.11	461	1.39
Poeciliidae - livebearers	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gambusia affinis	74	0.45	15	0.36	--	--	33	0.47	--	--	--	--	8	0.30	130	0.39
Cottidae - sculpins	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cottus carolinae	91	0.56	106	2.56	--	--	--	--	--	--	--	--	56	2.11	253	0.76
Centrarchidae - sunfishes																
Ambloplites ariommus	2	0.01	1	0.02	6	0.26	15	0.21	--	--	--	--	--	--	24	0.07
Lepomis auritus	401	2.45	123	2.97	--	--	--	--	2	0.36	--	--	323	12.16	849	2.56
Lepomis cyanellus	260	1.59	134	3.23	12	0.53	226	3.19	12	2.18	11	9.48	198	7.45	853	2.57
Lepomis gulosus	11	0.07	3	0.07	--	--	24	0.34	2	0.36	--	--	13	0.49	53	0.16
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	5	0.19	5	0.02
Lepomis macrochirus	441	2.70	161	3.89	23	1.02	357	5.03	30	5.45	5	4.31	550	20.71	1,567	4.72
Lepomis marginatus	--	--	2	0.05	--	--	--	--	--	--	--	--	--	--	2	0.01

Table 2. Fish species collected in the Black Warrior, Coosa, and Tennessee River systems--continued.

	Black Warrior River										Coosa River		Tennessee River		Total	
	Locust Fork		Mulberry Fork		Sipsey Fork		North River		Miscellaneous							
Family *Species*	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Centrarchidae - sunfishes (continued)																
Lepomis megalotis	659	4.03	328	7.92	165	7.28	814	11.48	84	15.27	9	7.76	26	0.98	2,085	6.28
Lepomis microlophus	17	0.10	27	0.65	--	--	5	0.07	4	0.73	1	0.86	5	0.19	59	0.18
Lepomis miniatus	--	--	--	--	--	--	18	0.25	3	0.55	--	--	3	0.11	24	0.07
Micropterus coosae	49	0.30	1	0.02	19	0.84	--	--	--	--	15	12.93	--	--	84	0.25
Micropterus dolomieui	--	--	--	--	--	--	--	--	--	--	--	--	3	0.11	3	0.01
Micropterus punctulatus	257	1.57	13	0.31	4	0.18	60	0.85	2	0.36	4	3.45	51	1.92	391	1.18
Micropterus salmoides	87	0.53	26	0.63	2	0.09	52	0.73	1	0.18	1	0.86	49	1.84	218	0.66
Pomoxis nigromaculatus	6	0.04	--	--	--	--	1	0.01	--	--	--	--	1	0.04	8	0.02
hybrid centrarchid	10	0.06	6	0.14	--	--	1	0.01	--	--	--	--	3	0.11	20	0.06
Percidae - perches and darters																
Etheostoma artesiae	74	0.45	97	2.34	42	1.85	172	2.43	26	4.73	--	--	--	--	411	1.24
Etheostoma bellator	17	0.10	--	--	--	--	--	--	--	--	--	--	--	--	17	0.05
Etheostoma sp cf bellator	--	--	--	--	31	1.37	--	--	--	--	--	--	--	--	31	0.09
Etheostoma douglasi	554	3.39	--	--	175	7.72	--	--	--	--	--	--	--	--	729	2.20
Etheostoma duryi	--	--	--	--	--	--	--	--	--	--	--	--	2	0.08	2	0.01
Etheostoma kennicotti	--	--	--	--	--	--	--	--	--	--	--	--	3	0.11	3	0.01
Etheostoma nigripinne	--	--	--	--	--	--	--	--	--	--	--	--	6	0.23	6	0.02
Etheostoma rupestre	34	0.21	--	--	--	--	--	--	--	--	--	--	--	--	34	0.10
Etheostoma stigmaeum	43	0.26	2	0.05	44	1.94	337	4.75	29	5.27	--	--	38	1.43	493	1.49
Etheostoma swaini	--	--	--	--	--	--	39	0.55	--	--	--	--	--	--	39	0.12
Etheostoma sp cf zonistium	--	--	--	--	--	--	--	--	--	--	--	--	21	0.79	21	0.06
Percina brevicauda	108	0.66	--	--	--	--	--	--	--	--	--	--	--	--	108	0.33
Percina kathae	60	0.37	16	0.39	124	5.47	48	0.68	1	0.18	--	--	--	--	249	0.75
Percina maculata	--	--	1	0.02	2	0.09	14	0.20	--	--	--	--	--	--	17	0.05
Percina nigrofasciata	1,393	8.52	289	6.97	86	3.80	388	5.47	37	6.73	--	--	--	--	2,193	6.61
Percina shumardi	4	0.02	--	--	5	0.22	--	--	--	--	--	--	--	--	9	0.03
Percina sipsi	--	--	--	--	17	0.75	--	--	--	--	--	--	--	--	17	0.05
Sciaenidae - drums																
Aplodinotus grunniens	12	0.07	3	0.07	--	--	--	--	--	--	--	--	--	--	15	0.05
Species	55		39		32		51		30		11		42		90	
Individuals	16,356		4,144		2,266		7,092		550		116		2,656		33,180	
No. sites	34		9		6		20		4		1		13		87	
No. collections	34		11		6		21		4		1		14		90	
Avg. catch per collection	481.06		376.73		377.67		337.71		137.5		116		189.71		368.67	

Pimephales vigilax (Bullhead Minnow) 3.2 percent. As in the Tennessee Valley and Ridge and Valley/Piedmont ichthyoregions, Largescale Stonerollers dominated the catch in all Plateau tributaries. Ten sucker species were collected and this family represented about 2.1 percent of the total catch with *Hypentelium etowanum* (Alabama Hogsucker), *Moxostoma poecilurum* (Blacktail Redhorse), and *M. erythrurum* (Golden Redhorse) dominant. Eight species of catfishes and madtoms were collected representing about 1.5 percent of the total catch with *Ictalurus punctatus* (Channel Catfish) and *Ameiurus natalis* (Yellow Bullhead) dominant. *Fundulus olivaceus* (Blackspotted Topminnow) and *Cottus carolinae* (Banded Sculpin) accounted for 1.4 percent and 0.8 percent of the catch, respectively. Sunfishes were common and represented about 18.9 percent of the catch. *Lepomis megalotis* (Longear Sunfish) dominated the sunfish catch at 6.3 percent followed by *L. macrochirus* (Bluegill) at 4.7 percent, and *L. cyanellus* (Green Sunfish) and *L. auritus* (Redbreast Sunfish) both at 2.6 percent. Darters accounted for about 13.2 percent of the catch with *Percina nigrofasciata* (Blackbanded Darter) dominant at 6.6 percent followed by *Etheostoma douglasi* (Tuskaloosa Darter) at 2.2 percent, *E. stigmaeum* (Speckled Darter) at 1.5 percent, and *E. artesiae* (Redspot Darter) at 1.2 percent.

Rapid habitat assessment scores were summed for each site (table 3) to yield a raw total habitat score. This raw value was then divided by the highest possible habitat score for the index (220 for the glide-pool method, 240 for the riffle-run method) to yield a value which was termed percent of maximum habitat (percent max habitat). About 27 percent of the sites ranked in the very poor (≤50 percent max habitat score) to poor (51-60 percent) range, 30 percent in the fair (61 -70 percent) range, 33 percent in the good (71-80 percent) range, and 10 percent in the excellent (>80 percent) habitat quality range.

Eight measures of human disturbance were calculated using GIS (table 4). These values were then weighted by the LDI (table 5) and the resulting values summed to yield the HDG score for each site. This value allowed comparison of watersheds relative to the degree of disturbance due to human causes—primarily urban and agricultural. The HDG is a unitless measure and varied from <50, a low level of

Table 3. Rapid habitat assessment scores for sites in the Plateau ichthyoregion.

GSA No.	Rapid habitat assessment metrics [1]															Sum	Percent max habitat
	Riffle-run												Glide-pool				
	INCOV	EPISUR	EMBED	VELDEP	CHALT	SEDDEP	RIFREQ	CHSTA	BKCON	BKVEG	DISP	RIPVEG	PSUB	PVAR	CHSIN		
1474	14	14	16	11	15	15	15	10	15	18	16	14	--	--	--	173	72.08
1475	16	17	16	15	17	16	13	17	17	16	16	15	--	--	--	191	79.58
1476	17	17	16	15	16	16	16	17	12	16	16	14	--	--	--	188	78.33
1477	17	17	16	16	17	18	17	16	15	16	16	15	--	--	--	196	81.67
1478	17	17	13	16	17	12	14	13	16	16	14	13	--	--	--	178	74.17
1484	17	12	13	15	17	15	13	14	14	16	17	18	--	--	--	181	75.42
1485	17	16	12	17	17	15	18	16	17	16	15	15	--	--	--	191	79.58
1486	17	14	10	14	17	5	17	16	16	14	14	12	--	--	--	166	69.17
1804	18	18	17	13	15	19	20	18	17	18	18	14	--	--	--	205	85.42
1805	6	7	4	9	14	4	3	11	7	11	13	11	--	--	--	100	41.67
1806	13	15	11	14	15	9	12	17	9	8	17	17	--	--	--	157	65.42
1821	15	4	17	9	16	16	8	11	17	17	17	12	--	--	--	159	66.25
1822	18	18	17	15	16	17	19	17	17	18	18	17	--	--	--	207	86.25
1823	16	15	15	16	18	18	16	13	17	17	18	18	--	--	--	197	82.08
1824	10	8	5	9	14	10	4	15	6	13	16	13	--	--	--	123	51.25
1825	14	14	15	16	18	15	15	15	15	16	16	13	--	--	--	182	75.83
1826	17	17	14	16	17	13	12	18	14	17	18	19	--	--	--	192	80.00
1827	15	13	14	13	16	12	13	15	12	14	13	8	--	--	--	158	65.83
1828	14	12	14	13	18	14	4	12	13	14	18	15	--	--	--	161	67.08
1829	16	14	13	15	16	12	8	15	12	16	16	14	--	--	--	167	69.58
1830	17	17	16	16	16	13	17	17	15	17	17	17	--	--	--	195	81.25
1831	14	12	9	16	16	12	14	16	12	17	17	14	--	--	--	169	70.42
1832	8	6	15	16	17	14	17	17	15	17	17	16	--	--	--	175	72.92
1833	17	16	15	13	17	14	17	14	10	16	18	18	--	--	--	185	77.08
1834	17	18	17	17	17	17	17	17	15	15	14	15	--	--	--	196	81.67
1835	16	17	15	16	15	15	17	17	12	17	17	13	--	--	--	187	77.92
1836	17	16	15	16	16	14	9	18	16	16	16	15	--	--	--	184	76.67
1837	17	16	14	16	14	14	8	13	16	16	16	16	--	--	--	176	73.33
1838	10	--	--	--	13	8	--	15	10	14	16	9	8	11	12	126	57.27
1839	9	7	13	7	7	14	6	7	5	12	14	13	--	--	--	114	47.50
1840	13	14	16	15	12	15	13	10	11	16	16	17	--	--	--	168	70.00
1841	16	16	10	16	16	11	12	16	12	16	16	15	--	--	--	172	71.67
1842	17	12	15	13	17	15	14	10	16	18	18	14				179	74.58
1845	16	18	16	17	18	17	15	17	10	17	19	17	--	--	--	197	82.08
1846	17	15	16	14	18	14	13	17	10	15	18	17	--	--	--	184	76.67

[1] INCOV-instream cover, EPISUR-epifaunal surface development, EMBED-embeddedness, VELDEP-velocity/depth regimes, CHALT-man-made channel alteration, SEDDEP-sediment deposition, RIFREQ-frequency of riffles, CHSTA-channel flow status, BKCON-bank condition, BKVEG-bank vegetative protection, DISP-bank disruptive pressure, RIPVEG-riparian vegetative zone width, PSUB-pool substrate characterization, PVAR-pool variability, CHSIN-channel sinuosity,

Table 3. Rapid habitat assessment scores for sites in the Plateau ichthyoregion--continued.

GSA No.	Rapid habitat assessment metrics [1]															Sum	Percent max habitat
	Riffle-run												Glide-pool				
	INCOV	EPISUR	EMBED	VELDEP	CHALT	SEDDEP	RIFREQ	CHSTA	BKCON	BKVEG	DISP	RIPVEG	PSUB	PVAR	CHSIN		
1865	16	6	17	10	16	18	18	18	18	8	6	2	--	--	--	153	63.75
1866	18	16	17	17	17	16	18	15	16	18	17	17	--	--	--	202	84.17
1867	7	7	7	11	16	7	3	15	7	8	16	16	--	--	--	120	50.00
1868	11	--	--	--	17	10	--	14	11	12	17	15	10	9	13	139	63.18
1869	16	11	12	14	17	10	16	13	14	14	18	17	--	--	--	172	71.67
1921	16	16	10	11	16	13	14	15	10	14	16	13	--	--	--	164	68.33
1924	9	5	2	11	16	4	10	16	5	14	12	12	--	--	--	116	48.33
1925	4	3	11	7	16	4	3	17	7	12	18	15	--	--	--	117	48.75
1926	13	11	11	14	12	11	9	12	12	16	20	14	--	--	--	155	64.58
1927	16	17	17	8	17	16	11	8	17	18	20	8	--	--	--	173	72.08
1928	12	9	12	10	16	14	4	17	8	12	12	12	--	--	--	138	57.50
1929	16	8	12	9	16	10	2	11	6	16	13	8	--	--	--	127	52.92
1930	11	12	8	14	17	7	10	17	7	10	18	17	--	--	--	148	61.67
1948	12	13	13	17	16	12	16	17	10	14	18	16	--	--	--	174	72.50
1949	18	12	12	14	16	12	16	15	14	13	17	16	--	--	--	175	72.92
1950	16	13	12	17	14	12	16	16	12	8	16	16	--	--	--	168	70.00
1956	16	9	15	14	13	16	14	16	15	14	11	5	--	--	--	158	65.83
1972	10	10	19	14	18	19	19	18	18	16	18	16	--	--	--	195	81.25
1974	12	13	16	10	8	9	5	12	12	18	4	8	--	--	--	127	52.92
1991	16	17	14	17	17	12	16	16	15	17	17	17	--	--	--	191	79.58
1992	13	13	13	14	16	10	13	14	8	16	18	18	--	--	--	166	69.17
1993	17	17	15	14	18	13	18	16	12	15	19	18	--	--	--	192	80.00
1994	16	15	15	17	17	11	12	17	14	14	17	18	--	--	--	183	76.25
1995	14	13	15	14	18	17	13	17	13	16	15	13	--	--	--	178	74.17
1996	5	3	3	6	18	6	1	17	8	10	18	18	--	--	--	113	47.08
2001	13	8	7	9	18	6	3	9	11	14	18	16	--	--	--	132	55.00
2002	13	15	16	14	17	12	13	17	11	16	20	16	--	--	--	180	75.00
2003	8	9	12	7	17	10	5	13	13	14	20	14	--	--	--	142	59.17
2004	10	4	10	7	17	9	8	9	10	12	20	18	--	--	--	134	55.83
2005	12	10	10	8	16	5	3	10	10	14	18	19	--	--	--	135	56.25
2007	12	10	10	2	16	6	0	15	8	4	17	12	--	--	--	112	46.67
2010	11	9	12	9	15	9	14	18	16	16	20	18	--	--	--	167	69.58
2011	15	16	17	14	12	13	15	17	9	10	18	15	--	--	--	171	71.25
2013	12	13	11	14	12	10	12	15	9	12	4	4	--	--	--	128	53.33
2029	14	12	9	12	16	7	13	16	4	16	18	18	--	--	--	155	64.58

[1] INCOV-instream cover, EPISUR-epifaunal surface development, EMBED-embeddedness, VELDEP-velocity/depth regimes, CHALT-man-made channel alteration, SEDDEP-sediment deposition, RIFREQ-frequency of riffles, CHSTA-channel flow status, BKCON-bank condition, BKVEG-bank vegetative protection, DISP-bank disruptive pressure, RIPVEG-riparian vegetative zone width, PSUB-pool substrate characterization, PVAR-pool variability, CHSIN-channel sinuosity,

Table 3. Rapid habitat assessment scores for sites in the Plateau ichthyoregion--continued.

GSA No.	Rapid habitat assessment metrics [1]															Sum	Percent max habitat
	Riffle-run												Glide-pool				
	INCOV	EPISUR	EMBED	VELDEP	CHALT	SEDDEP	RIFREQ	CHSTA	BKCON	BKVEG	DISP	RIPVEG	PSUB	PVAR	CHSIN		
2053	16	16	8	16	16	10	13	16	13	16	16	13	--	--	--	169	70.42
2054	16	15	6	16	16	10	12	16	10	16	16	16	--	--	--	165	68.75
2055	10	5	17	13	16	17	16	16	15	16	15	13	--	--	--	169	70.42
2057	16	12	11	13	16	15	15	16	14	14	16	14	--	--	--	172	71.67
2062	11	12	5	15	16	7	8	16	10	16	16	13	--	--	--	145	60.42
2063	16	5	16	15	16	16	16	16	14	16	16	16	--	--	--	178	74.17
2064	13	16	10	13	16	15	14	16	12	14	16	12	--	--	--	167	69.58
2065	4	14	3	13	16	5	9	16	8	14	16	14	--	--	--	132	55.00
2067	8	7	11	10	15	10	4	13	10	12	14	14	--	--	--	128	53.33
2068	13	14	16	16	14	11	13	17	16	14	16	16	--	--	--	176	73.33
2069	11	10	12	13	17	13	10	17	10	14	18	16	--	--	--	161	67.08
2070	5	5	1	1	16	3	0	3	6	14	16	15	--	--	--	85	35.42
2071	17	17	14	11	17	17	14	16	14	16	16	13	--	--	--	182	75.83
2072	3	5	2	8	17	2	4	15	6	14	16	14	--	--	--	106	44.17
2082	7	10	11	14	17	4	9	16	14	14	16	18	--	--	--	150	62.50
2083	12	9	7	11	12	5	10	17	12	14	18	16	--	--	--	143	59.58
2084	17	16	16	14	12	15	12	14	13	16	15	15	--	--	--	175	72.92
2085	14	8	12	10	16	10	5	17	11	16	16	15	--	--	--	150	62.50
2086	8	7	15	12	17	17	2	16	11	16	16	18	--	--	--	155	64.58
2214	12	12	18	10	13	18	12	17	13	12	10	6	--	--	--	153	63.75
2287	8	10	9	8	16	7	8	14	9	14	12	7	--	--	--	122	50.83

[1] INCOV-instream cover, EPISUR-epifaunal surface development, EMBED-embeddedness, VELDEP-velocity/depth regimes, CHALT-man-made channel alteration, SEDDEP-sediment deposition, RIFREQ-frequency of riffles, CHSTA-channel flow status, BKCON-bank condition, BKVEG-bank vegetative protection, DISP-bank disruptive pressure, RIPVEG-riparian vegetative zone width, PSUB-pool substrate characterization, PVAR-pool variability, CHSIN-channel sinuosity,

Table 4. Human disturbance metrics for sites in the Plateau ichthyoregion.

GSA No.	Human density ($no./km^2$)	Phosphorus load (kg/ha/yr)	Land cover (percent)				Road density (km/km^2)	Stream-road crossings (no./km)
			Urban	Barren	Pasture	Cropland		
1474	69.66	0.608	6.33	0.11	23.17	8.01	2.225	0.713
1475	391.89	0.771	55.06	1.11	1.54	0.29	5.788	1.491
1476	22.04	0.443	4.49	0.27	18.24	2.83	1.609	0.671
1477	48.87	0.554	7.93	0.43	29.22	2.94	1.997	0.912
1478	53.31	0.539	7.93	0.64	26.66	3.19	2.050	0.962
1484	42.11	0.704	8.25	0.16	38.32	7.00	1.937	0.784
1485	42.74	0.709	8.36	0.16	38.60	7.11	1.952	0.791
1486	119.25	0.857	19.76	0.08	43.81	6.99	2.756	0.940
1804	39.82	0.585	8.11	0.00	30.55	3.93	2.031	1.050
1805	38.49	0.781	7.60	0.07	50.92	6.97	2.070	0.671
1806	36.45	0.802	7.49	0.03	52.18	7.63	1.923	0.617
1821	30.94	0.892	6.87	0.08	58.83	10.10	1.923	0.780
1822	57.76	0.383	7.51	0.32	9.99	0.82	2.142	0.783
1823	60.88	0.407	7.71	0.32	12.11	1.29	2.145	0.826
1824	36.37	0.491	6.27	0.43	21.99	3.12	1.800	0.777
1825	39.62	0.625	7.43	0.27	32.36	5.56	1.883	0.776
1826	39.55	0.622	7.30	0.26	32.12	5.58	1.883	0.781
1827	40.19	0.331	5.35	1.69	8.74	1.06	1.512	0.559
1828	39.75	0.614	7.21	0.27	31.47	5.45	1.885	0.777
1829	43.45	0.585	7.30	0.32	28.76	4.91	1.948	0.774
1830	524.91	0.816	59.89	0.48	1.08	0.05	5.553	1.871
1831	378.23	0.693	46.30	0.43	2.64	0.18	4.362	1.436
1832	328.55	0.655	42.50	0.40	2.88	0.21	4.015	1.370
1833	18.92	0.395	2.30	0.20	18.58	1.05	1.700	0.701
1834	322.90	0.553	27.73	0.85	5.44	1.08	3.765	1.610
1835	228.12	0.503	19.80	0.60	7.83	1.71	3.066	1.212
1836	49.90	0.722	9.36	0.07	38.38	7.22	2.011	0.781
1837	31.19	0.590	6.62	0.08	30.95	4.62	1.752	0.751
1838	16.78	0.425	3.37	0.03	19.48	1.98	1.264	0.559
1839	27.77	0.555	5.10	0.12	27.77	4.71	1.642	0.784
1840	22.37	0.519	5.47	0.09	26.11	3.32	1.638	0.720
1841	48.95	0.725	9.25	0.10	38.70	7.35	2.005	0.777
1842	47.58	0.725	9.05	0.16	38.60	7.52	2.007	0.794
1845	58.14	0.555	8.39	0.46	24.61	4.39	2.028	0.763
1846	58.11	0.555	8.38	0.46	24.60	4.39	2.028	0.763
1865	38.13	0.451	7.51	0.01	16.06	2.36	1.839	0.677
1866	33.71	0.601	5.75	0.04	39.06	2.85	1.878	0.539
1867	11.22	0.356	5.33	0.00	2.58	3.39	1.605	0.562
1868	13.70	0.349	5.20	0.00	2.67	3.13	1.499	0.433
1869	5.44	0.205	2.15	1.90	1.29	0.00	1.075	0.166
1921	13.07	0.498	6.03	0.23	21.16	2.27	1.640	0.405
1924	6.67	0.376	6.74	0.40	15.14	1.68	1.267	0.241
1925	11.22	0.356	5.33	0.00	2.58	3.39	1.605	0.562
1926	7.51	0.337	4.85	0.17	1.32	3.60	1.607	0.384
1927	6.65	0.324	4.78	0.19	0.88	3.11	1.576	0.383

Table 4. Human disturbance metrics for sites in the Plateau ichthyoregion--continued.

GSA No.	Human density (no./km^2)	Phosphorus load (kg/ha/yr)	Land cover (percent)				Road density (km/km^2)	Stream-road crossings (no./km)
			Urban	Barren	Pasture	Cropland		
1928	7.34	0.326	5.25	0.07	1.06	2.76	1.781	0.476
1929	0.98	0.248	1.61	0.00	2.53	0.30	0.542	0.298
1930	8.67	0.302	3.67	0.22	3.88	1.44	1.340	0.354
1948	50.75	0.884	7.51	0.21	45.79	13.76	2.051	0.586
1949	45.77	0.939	6.68	0.00	49.04	15.75	1.907	0.636
1950	38.79	0.855	7.98	0.04	48.99	10.69	2.302	0.826
1956	42.50	0.939	7.70	0.02	35.57	19.66	2.317	0.731
1972	23.50	0.334	5.33	0.78	11.87	0.50	1.488	0.539
1974	227.38	0.650	31.38	0.00	16.63	0.39	4.480	1.222
1991	4.49	0.296	1.44	0.01	6.07	0.09	0.552	0.035
1992	0.35	0.264	1.33	0.00	0.25	0.07	0.668	0.220
1993	0.58	0.263	1.19	0.00	0.43	0.04	0.628	0.108
1994	1.83	0.272	1.47	0.00	1.44	0.10	0.751	0.086
1995	70.75	0.660	18.59	0.04	30.81	2.59	2.653	0.836
1996	18.11	0.525	4.83	0.07	32.93	1.46	1.407	0.297
2001	16.73	0.287	5.07	1.08	3.89	0.16	1.528	0.364
2002	7.42	0.310	3.18	0.14	4.59	1.85	1.272	0.325
2003	8.40	0.307	3.69	0.20	4.23	1.59	1.325	0.356
2004	11.19	0.356	5.32	0.00	2.62	3.42	1.601	0.560
2005	4.13	0.255	1.93	0.01	2.62	0.18	1.041	0.307
2007	8.95	0.343	4.96	0.12	1.91	3.47	1.590	0.448
2010	6.82	0.294	5.74	0.01	1.56	0.04	0.875	0.098
2011	1.61	0.216	1.35	0.07	0.31	0.00	0.920	0.164
2013	227.38	0.650	31.38	0.00	16.63	0.39	4.480	1.222
2029	4.49	0.265	0.90	0.00	2.33	0.04	0.399	0.130
2053	38.79	0.855	7.98	0.04	49.00	10.69	2.302	0.826
2054	19.44	0.640	5.13	0.25	24.71	9.68	1.734	0.681
2055	32.75	0.658	6.16	0.04	34.15	6.83	1.937	0.671
2057	33.04	0.775	6.91	0.08	40.78	10.07	2.175	0.658
2062	40.64	0.746	8.58	0.12	38.73	8.64	1.987	0.714
2063	19.54	0.855	5.27	0.07	43.97	13.71	1.963	0.626
2064	33.22	0.979	6.77	0.08	52.13	16.33	1.967	0.650
2065	125.46	0.905	25.03	0.04	40.42	7.85	3.212	1.111
2067	51.89	0.845	8.41	0.05	48.20	10.29	2.580	0.901
2068	52.61	0.854	8.84	0.02	44.28	11.89	2.452	0.821
2069	32.36	0.780	6.85	0.07	41.45	10.09	2.147	0.642
2070	0.79	0.235	0.78	0.00	0.36	0.00	0.912	0.193
2071	1.52	0.204	2.26	1.78	0.11	0.00	0.982	0.295
2072	2.87	0.265	2.25	0.06	4.74	0.56	1.058	0.361
2082	71.19	0.371	12.08	0.78	4.20	0.67	1.978	0.568
2083	59.85	0.365	11.46	0.82	4.27	0.65	1.881	0.537
2084	12.42	0.299	3.24	0.00	7.10	0.13	1.799	0.743
2085	1.92	0.239	1.50	0.00	0.92	0.16	0.816	0.228
2086	1.76	0.243	1.94	0.00	1.51	0.13	0.843	0.369
2214	227.38	0.650	31.38	0.00	16.63	0.39	4.480	1.222
2287	113.62	0.641	6.14	0.24	21.44	2.25	3.553	1.052

Table 5. LDI-weighted human disturbance metrics for sites in the Plateau ichthyoregion.

GSA No.	Human density (no./km^2)	Phosphorus load (kg/ha/yr)	Land cover (percent) Urban	Barren	Pasture	Cropland	Road density (km/km^2)	Stream-road crossings (no./km)	Sum
	LDI values								
	1.0	**1.0**	**8.0**	**7.0**	**3.1**	**4.7**	**8.3**	**8.3**	
1474	69.66	0.61	50.61	0.78	71.81	37.67	18.47	5.92	255.53
1475	391.89	0.77	440.46	7.74	4.77	1.38	48.04	12.38	907.42
1476	22.04	0.44	35.95	1.86	56.53	13.29	13.35	5.57	149.04
1477	48.87	0.55	63.42	2.98	90.59	13.80	16.57	7.57	244.36
1478	53.31	0.54	63.46	4.47	82.64	15.01	17.02	7.98	244.43
1484	42.11	0.70	65.98	1.09	118.80	32.89	16.08	6.51	284.17
1485	42.74	0.71	66.88	1.11	119.66	33.40	16.20	6.56	287.27
1486	119.25	0.86	158.10	0.53	135.81	32.84	22.87	7.81	478.07
1804	39.82	0.59	64.88	0.00	94.71	18.47	16.86	8.72	244.03
1805	38.49	0.78	60.80	0.49	157.85	32.76	17.18	5.57	313.92
1806	36.45	0.80	59.92	0.21	161.76	35.86	15.96	5.12	316.08
1821	30.94	0.89	54.96	0.56	182.37	47.47	15.96	6.47	339.63
1822	57.76	0.38	60.08	2.24	30.97	3.85	17.78	6.50	179.56
1823	60.88	0.41	61.68	2.24	37.54	6.06	17.80	6.86	193.47
1824	36.37	0.49	50.16	3.01	68.17	14.66	14.94	6.45	194.25
1825	39.62	0.63	59.44	1.89	100.32	26.13	15.63	6.44	250.09
1826	39.55	0.62	58.40	1.82	99.57	26.23	15.63	6.48	248.30
1827	40.19	0.33	42.80	11.83	27.09	4.98	12.55	4.64	144.42
1828	39.75	0.61	57.68	1.89	97.56	25.62	15.65	6.45	245.20
1829	43.45	0.59	58.40	2.24	89.16	23.08	16.17	6.42	239.50
1830	524.91	0.82	479.12	3.36	3.35	0.24	46.09	15.53	1073.41
1831	378.23	0.69	370.40	3.01	8.18	0.85	36.20	11.92	809.49
1832	328.55	0.66	340.00	2.80	8.93	0.99	33.32	11.37	726.62
1833	18.92	0.40	18.40	1.40	57.60	4.94	14.11	5.82	121.58
1834	322.90	0.55	221.84	5.95	16.86	5.08	31.25	13.36	617.80
1835	228.12	0.50	158.40	4.20	24.27	8.04	25.45	10.06	459.04
1836	49.90	0.72	74.88	0.49	118.98	33.93	16.69	6.48	302.08
1837	31.19	0.59	52.96	0.56	95.95	21.71	14.54	6.23	223.73
1838	16.78	0.43	26.96	0.21	60.39	9.31	10.49	4.64	129.20
1839	27.77	0.56	40.80	0.84	86.09	22.14	13.63	6.51	198.32
1840	22.37	0.52	43.76	0.63	80.94	15.60	13.60	5.98	183.40
1841	48.95	0.73	74.00	0.70	119.97	34.55	16.64	6.45	301.98
1842	47.58	0.73	72.40	1.12	119.66	35.34	16.66	6.59	300.08
1845	58.14	0.56	67.12	3.22	76.29	20.63	16.83	6.33	249.12
1846	58.11	0.56	67.04	3.22	76.26	20.63	16.83	6.33	248.98
1865	38.13	0.45	60.08	0.07	49.79	11.09	15.26	5.62	180.49
1866	33.71	0.60	46.00	0.28	121.09	13.40	15.59	4.47	235.13
1867	11.22	0.36	42.64	0.00	8.00	15.93	13.32	4.66	96.13
1868	13.70	0.35	41.60	0.00	8.28	14.71	12.44	3.59	94.67
1869	5.44	0.21	17.20	13.30	4.00	0.00	8.92	1.38	50.44
1921	13.07	0.50	48.24	1.61	65.60	10.67	13.61	3.36	156.66
1924	6.67	0.38	53.92	2.80	46.93	7.90	10.52	2.00	131.11
1925	11.22	0.36	42.64	0.00	8.00	15.93	13.32	4.66	96.13
1926	7.51	0.34	38.80	1.19	4.09	16.92	13.34	3.19	85.37
1927	6.65	0.32	38.24	1.33	2.73	14.62	13.08	3.18	80.15

Table 5. LDI-weighted human disturbance metrics for sites in the Plateau ichthyoregion--continued.

GSA No.	Human density (no./km^2)	Phosphorus load (kg/ha/yr)	Land cover (percent) Urban	Barren	Pasture	Cropland	Road density (km/km^2)	Stream-road crossings (no./km)	Sum
	LDI values								
	1.0	**1.0**	**8.0**	**7.0**	**3.1**	**4.7**	**8.3**	**8.3**	
1928	7.34	0.33	42.00	0.49	3.29	12.97	14.78	3.95	85.15
1929	0.98	0.25	12.88	0.00	7.84	1.41	4.50	2.47	30.33
1930	8.67	0.30	29.36	1.54	12.03	6.77	11.12	2.94	72.73
1948	50.75	0.88	60.08	1.47	141.95	64.67	17.02	4.86	341.69
1949	45.77	0.94	53.44	0.00	152.02	74.03	15.83	5.28	347.30
1950	38.79	0.86	63.84	0.28	151.87	50.24	19.11	6.86	331.84
1956	42.50	0.94	61.60	0.14	110.27	92.40	19.23	6.07	333.15
1972	23.50	0.33	42.64	5.46	36.80	2.35	12.35	4.47	127.91
1974	227.38	0.65	251.04	0.00	51.55	1.83	37.18	10.14	579.78
1991	4.49	0.30	11.52	0.07	18.82	0.42	4.58	0.29	40.49
1992	0.35	0.26	10.64	0.00	0.78	0.33	5.54	1.83	19.73
1993	0.58	0.26	9.52	0.00	1.33	0.19	5.21	0.90	17.99
1994	1.83	0.27	11.76	0.00	4.46	0.47	6.23	0.71	25.74
1995	70.75	0.66	148.72	0.28	95.51	12.17	22.02	6.94	357.05
1996	18.11	0.53	38.64	0.49	102.08	6.86	11.68	2.47	180.85
2001	16.73	0.29	40.56	7.56	12.06	0.75	12.68	3.02	93.65
2002	7.42	0.31	25.44	0.98	14.23	8.70	10.56	2.70	70.33
2003	8.40	0.31	29.52	1.40	13.11	7.47	11.00	2.95	74.17
2004	11.19	0.36	42.56	0.00	8.12	16.07	13.29	4.65	96.24
2005	4.13	0.26	15.44	0.07	8.12	0.85	8.64	2.55	40.05
2007	8.95	0.34	39.68	0.84	5.92	16.31	13.20	3.72	88.96
2010	6.82	0.29	45.92	0.07	4.84	0.19	7.26	0.81	66.20
2011	1.61	0.22	10.80	0.49	0.96	0.00	7.64	1.36	23.07
2013	227.38	0.65	251.04	0.00	51.55	1.83	37.18	10.14	579.78
2029	4.49	0.27	7.20	0.00	7.22	0.19	3.31	1.08	23.76
2053	38.79	0.86	63.84	0.28	151.90	50.24	19.11	6.86	331.87
2054	19.44	0.64	41.04	1.75	76.60	45.50	14.39	5.65	205.01
2055	32.75	0.66	49.28	0.28	105.87	32.10	16.08	5.57	242.58
2057	33.04	0.78	55.28	0.56	126.42	47.33	18.05	5.46	286.92
2062	40.64	0.75	68.64	0.84	120.06	40.61	16.49	5.93	293.96
2063	19.54	0.86	42.16	0.49	136.31	64.44	16.29	5.20	285.28
2064	33.22	0.98	54.16	0.56	161.60	76.75	16.33	5.40	348.99
2065	125.46	0.91	200.24	0.28	125.30	36.90	26.66	9.22	524.96
2067	51.89	0.85	67.28	0.35	149.42	48.36	21.41	7.48	347.04
2068	52.61	0.85	70.72	0.14	137.27	55.88	20.35	6.81	344.64
2069	32.36	0.78	54.80	0.49	128.50	47.42	17.82	5.33	287.50
2070	0.79	0.24	6.24	0.00	1.12	0.00	7.57	1.60	17.55
2071	1.52	0.20	18.08	12.46	0.34	0.00	8.15	2.45	43.20
2072	2.87	0.27	18.00	0.42	14.69	2.63	8.78	3.00	50.66
2082	71.19	0.37	96.64	5.46	13.02	3.15	16.42	4.71	210.96
2083	59.85	0.37	91.68	5.74	13.24	3.06	15.61	4.46	194.00
2084	12.42	0.30	25.92	0.00	22.01	0.61	14.93	6.17	82.36
2085	1.92	0.24	12.00	0.00	2.85	0.75	6.77	1.89	26.43
2086	1.76	0.24	15.52	0.00	4.68	0.61	7.00	3.06	32.87
2214	227.38	0.65	251.04	0.00	51.55	1.83	37.18	10.14	579.78
2287	113.62	0.64	49.12	1.68	66.46	10.58	29.49	8.73	280.32

disturbance, to more than 1,000, a high level of disturbance (fig. 5). Thirty-one percent of the sites scored in the least disturbed range (<100), 17 percent in the low disturbance range (101-200), 41 percent in the moderately disturbed range (201-400), and 12 percent in the highest disturbed range (>400) (fig. 5).

SELECTION AND SCORING OF PLATEAU IBI METRICS

For IBI metrics to be useful they should have desirable statistical properties, have predictability as to their response to environmental variables of disturbance and habitat degradation, and have the capability to discriminate between impaired streams and those least or minimally impaired. Thirty-six candidate metrics were selected for evaluation in the Plateau IBI because of their use in other IBI applications in Alabama by GSA (O'Neil and Shepard, 2000b, 2009, 2010; O'Neil and others, 2006) and because of their use in many IBI studies (Karr, 1981; Karr and others, 1986; Miller and others, 1988; Paller and others, 1996; Barbour and others, 1999; Simon, 1999b; Schleiger, 2000; McCormick and others, 2001; Teels and Danielson, 2001; Dauwalter and others, 2003; Compton and others, 2003). Angermeier and Karr (1986) conducted a detailed investigation into the relative contribution of various combinations of metrics to IBIs developed for Illinois, Ohio, and West Virginia. One of the important findings of their investigation was that "no metric appeared consistently best or worst at detecting degradation, and an IBI comprising all 12 metrics probably features greater utility than an IBI with fewer metrics."

Metrics were selected for inclusion in the Plateau IBI by evaluating responsiveness, scoring range, and redundancy (Hughes and others, 1998; McCormick and others, 2001), and through best professional judgement. Responsiveness was evaluated by counting the number of significant correlations between IBI metric values and both habitat metric values (table 6) and human disturbance metric values (table 7). It was desirable to have at least five (>20 percent) significant correlations, preferably distributed in both habitat and disturbance categories. For some IBI metrics significant correlations were clumped into one of the two categories (for example, significant correlations for the IBI metric number of omnivores and herbivores were clumped in the human disturbance category). The scoring range of diversity metrics was acceptable if it

Table 6. Correlation coefficients between candidate IBI metrics and habitat assessment metrics.

Candidate IBI metrics	Habitat metrics [1]												
	INCOV	EPISUR	EMBED	VELDEP	CHALT	SEDDEP	RIFREQ	CHSTA	BKCON	BKVEG	DISP	RIPVEG	THAB
Species Richness and Composition													
Number of native sp. *	-0.105	-0.029	-0.013	-0.240	0.104	-0.154	-0.331	-0.213	-0.227	0.042	0.257	0.174	-0.126
Number of cyprinid sp. *	-0.206	-0.113	-0.119	-0.287	0.078	-0.255	-0.391	-0.167	-0.358	-0.085	0.228	0.187	-0.230
Number of shiner sp.	-0.192	-0.067	-0.096	-0.260	0.133	-0.240	-0.379	-0.217	-0.238	-0.069	0.322	0.282	-0.171
Number of sucker sp. *	-0.067	-0.103	-0.100	-0.179	0.265	-0.158	-0.210	-0.167	-0.149	0.055	0.272	0.230	-0.078
Number of *Lepomis* sp. *	-0.050	-0.106	0.073	-0.145	-0.422	0.036	-0.126	-0.204	0.031	0.025	-0.234	-0.209	-0.148
Number of centrarchid sp.	0.083	0.083	0.180	-0.032	-0.289	0.139	-0.016	-0.275	0.167	0.079	-0.179	-0.201	-0.001
Number of darter sp.	0.026	0.109	0.037	-0.116	0.213	-0.052	-0.199	-0.105	-0.170	0.117	0.360	0.280	0.037
Number of dar+madtom sp. *	-0.014	0.052	-0.021	-0.162	0.222	-0.104	-0.242	-0.107	-0.208	0.080	0.346	0.241	-0.023
Number of dar+mad+sculpin sp.	0.013	0.083	-0.001	-0.152	0.225	-0.087	-0.210	-0.092	-0.206	0.106	0.361	0.259	0.007
Number of terete minnow sp.	-0.208	-0.188	-0.138	-0.274	-0.088	-0.235	-0.277	-0.046	-0.451	-0.131	-0.023	-0.049	-0.293
Tolerance - Intolerance													
Percent dominant sp. *	0.063	0.053	0.273	0.086	0.014	0.295	0.181	0.145	0.295	0.178	-0.202	-0.164	0.176
Number of intolerant sp.	-0.010	0.030	0.040	-0.013	0.170	0.047	-0.107	-0.052	-0.102	0.056	0.143	0.180	0.034
Percent tolerant sp. *	0.028	-0.229	-0.025	-0.090	-0.156	0.034	0.032	-0.044	-0.082	-0.049	-0.079	-0.148	-0.095
Percent green sunfish	0.194	-0.078	0.106	0.040	-0.111	0.172	0.176	-0.024	0.132	-0.012	-0.050	-0.067	0.087
Percent stonerollers	0.211	0.262	0.357	0.163	-0.168	0.384	0.317	0.043	0.322	0.189	-0.263	-0.382	0.237
Percent GSF+YBH [2]	0.192	-0.087	0.105	0.052	-0.128	0.186	0.176	-0.013	0.143	-0.016	-0.084	-0.099	0.082
Percent GSF+BG+ YBH+CC [2]	0.126	-0.127	0.053	0.061	-0.154	0.177	0.203	-0.002	0.111	0.009	-0.113	-0.186	0.046
Percent *Lepomis* sp. *	0.006	-0.185	-0.117	-0.050	-0.239	-0.049	0.047	-0.092	-0.005	-0.148	-0.097	-0.135	-0.121
Percent sunfish	0.005	-0.185	-0.118	-0.052	-0.239	-0.051	0.044	-0.095	-0.006	-0.148	-0.094	-0.133	-0.122
Trophic Structure													
Percent omnivores *	0.180	0.259	0.327	0.164	-0.134	0.336	0.264	0.043	0.247	0.179	-0.242	-0.348	0.209
Percent insectivorous cyprinids	-0.138	-0.037	-0.141	-0.025	0.283	-0.165	-0.218	0.031	-0.059	0.041	0.223	0.354	-0.025
Percent invertivores	0.075	0.146	-0.103	0.202	-0.009	-0.067	0.101	-0.020	0.163	0.027	-0.069	-0.016	0.063
Percent top carnivores *	0.221	0.088	0.115	0.020	0.140	0.212	0.174	-0.038	0.236	0.019	-0.116	-0.132	0.138
Abundance, Condition, and Reproduction													
Catch per effort	0.180	0.269	0.163	0.159	0.096	0.126	0.015	0.044	0.054	0.187	-0.012	0.007	0.170
Percent DELT	-0.078	-0.104	0.028	0.002	0.056	0.068	-0.043	0.091	-0.021	0.012	0.087	0.072	0.011
Percent hybrids	0.109	0.119	0.151	0.110	-0.156	0.187	0.213	0.066	0.107	-0.026	-0.160	-0.109	0.114
Percent with DELT+hybrids *	-0.067	-0.092	0.043	0.013	0.041	0.086	-0.022	0.097	-0.011	0.010	0.071	0.061	0.022
Percent simple lithophils *	-0.189	-0.089	-0.196	-0.134	0.176	-0.256	-0.217	0.001	-0.216	-0.073	0.294	0.326	-0.114
Percent manipulative lithophils	0.086	-0.079	0.108	-0.093	-0.287	0.151	0.141	-0.033	0.062	-0.070	-0.257	-0.376	-0.047
Percent lithophilic spawners	-0.090	-0.203	-0.067	-0.271	-0.196	-0.075	-0.046	-0.043	-0.150	-0.174	-0.027	-0.153	-0.187
Number of lithophilic spawners	-0.117	-0.084	-0.038	-0.310	0.079	-0.176	-0.324	-0.231	-0.262	-0.003	0.269	0.202	-0.158
Percent simple nonlithophils	0.127	0.256	0.102	0.316	0.217	0.085	0.099	0.107	0.225	0.209	0.031	0.181	0.248
Percent manipulative nonlithophils	-0.009	0.001	-0.028	0.030	0.056	-0.014	-0.072	-0.101	-0.111	-0.011	0.039	0.051	-0.028
Percent manipulative spawners	0.084	-0.080	0.102	-0.085	-0.275	0.149	0.121	-0.065	0.029	-0.075	-0.250	-0.367	-0.056
Percent nonlithophilic spawners	0.109	0.228	0.080	0.295	0.217	0.070	0.059	0.053	0.155	0.182	0.044	0.182	0.210
Percent simple lithophils+tolerants	-0.181	-0.311	-0.238	-0.229	0.046	-0.247	-0.207	-0.040	-0.311	-0.124	0.247	0.216	-0.212

***** - metric included in Plateau ichthyoregion IBI.

Shaded box highlights coefficients statistically different from 0, critical r value = 0.209 [p=0.05, df=87].

Only sites evaluated with riffle-run protocol included.

[1] INCOV-instream cover; EPISUR-epifaunal surface quality; EMBED-embeddedness; VELDEP-velocity/depth combinations; CHALT-channel alteration; SEDDEP-sediment deposition; RIFFREQ-frequency of riffles; CHSTA-channel flow status; BKCON-bank condition; BKVEG-bank vegetative protection; DISP-grazing or other disruptive pressure; RIPVEG-riparian vegetation zone width; THAB-total habitat score.

[2] GSF-green sunfish, BG-bluegill, YBH-yellow bullhead, CC-channel catfish

Table 7. Correlation coefficients between candidate IBI metrics and human disturbance metrics.

Candidate IBI metrics	Human disturbance metrics [1]								
	HUDEN	PLOAD	PURB	PMMB	PPAS	PCROP	RDDENS	STXRD	HDG
Species Richness and Composition									
Number of native sp. *	-0.070	-0.576	-0.112	0.039	-0.545	-0.540	-0.205	-0.196	-0.297
Number of cyprinid sp. *	-0.133	-0.467	-0.169	-0.024	-0.414	-0.386	-0.250	-0.247	-0.305
Number of shiner sp.	-0.123	-0.459	-0.139	-0.042	-0.413	-0.397	-0.236	-0.259	-0.287
Number of sucker sp. *	-0.114	-0.477	-0.168	0.120	-0.382	-0.416	-0.297	-0.226	-0.290
Number of *Lepomis* sp. *	0.065	0.017	0.050	-0.046	0.004	-0.017	0.108	0.127	0.058
Number of centrarchid sp.	0.104	-0.022	0.088	-0.032	-0.043	-0.119	0.176	0.239	0.075
Number of darter sp.	-0.202	-0.611	-0.247	0.119	-0.513	-0.505	-0.374	-0.358	-0.417
Number of dar+madtom sp. *	-0.240	-0.643	-0.279	0.124	-0.549	-0.496	-0.395	-0.410	-0.459
Number of dar+mad+sculpin sp.	-0.223	-0.651	-0.267	0.121	-0.562	-0.515	-0.388	-0.393	-0.451
Number of terete minnow sp.	-0.108	-0.314	-0.150	-0.021	-0.284	-0.224	-0.186	-0.183	-0.229
Tolerance - Intolerance									
Percent dominant sp. *	0.167	0.215	0.134	0.029	0.211	0.099	0.199	0.204	0.218
Number of intolerant sp.	-0.192	-0.113	-0.210	-0.150	0.047	-0.101	-0.254	-0.223	-0.198
Percent tolerant sp. *	-0.072	0.211	-0.076	-0.090	0.177	0.362	-0.021	-0.024	0.015
Percent green sunfish	-0.130	0.250	-0.139	-0.045	0.292	0.410	-0.070	-0.021	-0.006
Percent stonerollers	0.261	0.171	0.254	0.086	0.107	-0.025	0.313	0.339	0.283
Percent GSF+YBH [2]	-0.134	0.291	-0.138	-0.085	0.335	0.447	-0.056	-0.003	0.008
Percent GSF+BG+ YBH+CC [2]	-0.110	0.329	-0.097	-0.058	0.324	0.487	0.015	0.014	0.043
Percent *Lepomis* sp. *	-0.147	0.308	-0.114	-0.096	0.308	0.490	0.014	-0.028	0.012
Percent sunfish	-0.149	0.302	-0.117	-0.097	0.303	0.487	0.011	-0.031	0.008
Trophic Structure									
Percent omnivores *	0.248	0.181	0.236	0.110	0.144	-0.023	0.298	0.341	0.278
Percent insectivorous cyprinids	-0.062	-0.136	-0.074	-0.028	-0.086	-0.135	-0.155	-0.141	-0.109
Percent invertivores	0.062	0.345	0.095	0.140	0.305	0.332	0.206	0.187	0.202
Percent top carnivores *	0.058	0.044	0.091	-0.002	0.025	-0.081	0.126	0.112	0.074
Abundance, Condition, and Reproduction									
Catch per effort	0.314	-0.001	0.268	0.021	-0.086	-0.226	0.239	0.294	0.236
Percent DELT	-0.065	0.102	-0.057	-0.052	0.121	0.157	-0.018	-0.047	-0.009
Percent hybrids	0.077	0.087	0.066	-0.078	0.055	0.051	0.168	0.147	0.094
Percent with DELT+hybrids *	-0.057	0.110	-0.050	-0.060	0.126	0.162	-0.001	-0.033	0.000
Percent simple lithophils *	-0.171	-0.488	-0.197	-0.060	-0.398	-0.422	-0.378	-0.384	-0.343
Percent manipulative lithophils	-0.031	0.192	-0.012	-0.101	0.155	0.273	0.112	0.090	0.055
Percent lithophilic spawners	-0.227	-0.269	-0.229	-0.201	-0.222	-0.089	-0.258	-0.295	-0.297
Number of lithophilic spawners	-0.171	-0.681	-0.227	0.036	-0.614	-0.566	-0.342	-0.322	-0.426
Percent simple nonlithophils	0.236	0.243	0.229	0.139	0.186	0.065	0.227	0.260	0.286
Percent manipulative nonlithophils	-0.014	0.044	0.000	0.143	0.069	0.017	0.036	0.034	0.018
Percent manipulative spawners	-0.036	0.209	-0.013	-0.058	0.179	0.282	0.125	0.102	0.061
Percent nonlithophilic spawners	0.206	0.237	0.205	0.185	0.196	0.066	0.219	0.248	0.264
Percent simple lithophils+tolerants	-0.252	-0.330	-0.283	-0.149	-0.264	-0.117	-0.428	-0.438	-0.356

***** - metric included in Plateau ichthyoregion IBI.

Shaded box highlights coefficients statistically different from 0, critical r value = 0.205 [p=0.05, df=89]. All sites included in analysis.

[1] HUDEN-human density; PLOAD-phosphorus load; PURB-percent urban cover; PMMB-percent man-made barren cover. PPAS-percent pasture cover; PCROP-percent cropland cover; RDDENS-road density; STXRD-number of stream-road crossings; HDG-total human disturbance gradient score.

[2] GSF-green sunfish, YBH-yellow bullhead, BG-bluegill, CC-channel catfish

was >2 and for percentage metrics if it was >50 percent (table 8). We retained 12 metrics divided among the broad categories of species richness and composition, tolerance-intolerance level, trophic structure, and abundance-condition-reproduction based in part on the methods above (tables 6, 7, 8). Two retained metrics, percent DELT+hybrids and percent top carnivores, did not meet these performance standards. McCormick and others (2001) rejected the DELT metric based on the fact that anomalies occurred rarely in their dataset. We have always included this metric in Alabama IBIs as a measure of urban disturbance and as a metric to further discriminate those urban streams with significant biological degradation due to pollution-induced DELT. Percent top carnivores is usually low for most sites, but we have observed that in high quality streams with a well structured fish community a top carnivore trophic level is usually well represented. As such, this metric can help segregate the very high quality, excellent sites from sites that rank good to very good.

Redundancy of these 12 metrics was evaluated by calculating a cross tabulation correlation coefficient matrix (table 9). McCormick and others (2001) and Compton and others (2003) rejected metrics if correlation coefficients were >0.75. Most all of the 12 selected Plateau IBI metrics met this criterion, and the majority were less than the critical r value for a statistical difference from 0 indicating very low redundancy of the metrics. Number of native species was significantly correlated with number of cyprinid species (r=0.830) and darter+madtom species (r=0.833). We think that although these significant correlations were present, these metrics were desirable to maintain in the IBI for their usefulness in evaluating different fish community functions. The darter+madtom metric is critical for assessing substrate quality, while the cyprinid metric evaluates the condition of a fish guild that broadly uses many unique habitat components that are sensitive to degradation.

The method of Karr and others (1986) was used in scoring the 12 IBI metrics for datasets with some modifications intended to make the index more sensitive to local conditions. Scoring criteria for metrics 1 through 12 were developed by plotting values for these categories as a function of drainage area. Based on these plots, maximum species richness lines were drawn, and the area below this line was generally trisected

Table 8. Statistical and responsive measures for candidate IBI metrics.

Candidate IBI metric	No. of significant correlations				Statistical characteristics					
	HDG [1]	Habitat	Total	%	Avg.	Min.	Max.	Range	SD	CV
Species Richness and Composition										
Number of native sp.	5	5	10	45	17.47	4	32	28	5.68	32.49
Number of cyprinid sp.	6	6	12	55	5.24	1	12	11	2.14	40.92
Number of shiner sp.	6	7	13	59	3.22	0	7	7	1.51	46.69
Number of sucker sp.	6	4	10	45	1.61	0	5	5	1.12	69.97
Number of *Lepomis* sp.	0	3	3	14	3.62	0	6	6	1.04	28.72
Number of centrarchid sp.	1	2	3	14	5.18	2	8	6	1.27	24.45
Number of darter sp.	7	3	10	45	2.79	0	7	7	2.00	71.67
Number of dar+madtom sp.	8	4	12	55	3.04	0	9	9	2.22	72.92
Number of dar+mad+sculpin sp.	8	4	12	55	3.11	0	9	9	2.22	71.26
Number of terete minnow sp.	4	5	9	41	1.91	1	5	4	0.95	49.69
Tolerance - Intolerance										
Percent dominant sp.	3	3	6	27	34.39	13.94	68.24	54.30	12.03	35.00
Number of intolerant sp.	3	0	3	14	0.26	0	2	2	0.47	180.07
Percent tolerant sp.	2	1	3	14	19.60	0.17	90.00	89.83	16.93	86.37
Percent green sunfish	3	0	3	14	4.35	0.00	48.57	48.57	7.40	170.18
Percent stonerollers	5	9	14	64	20.30	0.00	65.55	65.55	16.28	80.20
Percent GSF+YBH [2]	3	0	3	14	5.06	0.00	48.57	48.57	7.89	155.90
Percent GSF+BG+ YBH+CC [2]	3	0	3	14	12.82	0.10	78.24	78.14	15.32	119.50
Percent *Lepomis* sp.	3	1	4	18	23.41	0.00	94.29	94.29	18.69	79.86
Percent sunfish	3	1	4	18	23.49	0.00	94.29	94.29	18.70	79.63
Trophic Structure										
Percent omnivores	5	8	13	59	22.31	0.00	65.55	65.55	16.45	73.71
Percent insectivorous cyprinids	0	4	4	18	30.47	0.00	88.42	88.42	20.78	68.22
Percent invertivores	4	0	4	18	34.16	3.60	76.36	72.76	17.36	50.82
Percent top carnivores	0	3	3	14	2.57	0.00	19.57	19.57	3.55	138.14
Abundance, Condition, and Reproduction										
Catch per effort	6	1	7	32	11.51	1.09	32.38	31.29	7.32	63.61
Percent DELT	0	0	0	0	0.57	0.00	18.06	18.06	2.02	357.04
Percent hybrids	0	1	1	5	0.06	0.00	1.09	1.09	0.20	325.21
Percent with DELT+hybrids	0	0	0	0	0.63	0.00	18.06	18.06	2.02	322.40
Percent simple lithophils	6	5	11	50	24.12	0.00	75.68	75.68	19.77	81.99
Percent manipulative lithophils	1	3	4	18	50.22	2.61	100.00	97.39	24.56	48.90
Percent lithophilic spawners	7	1	8	36	74.34	27.43	100.00	72.57	18.20	24.48
Number of lithophilic spawners	7	5	12	55	11.08	4	20	16	3.70	33.37
Percent simple nonlithophils	6	6	12	55	19.31	0.00	68.52	68.52	16.07	83.25
Percent manipulative nonlithophils	0	0	0	0	6.75	0.00	45.21	45.21	7.47	110.66
Percent manipulative spawners	2	3	5	23	56.96	6.76	100.00	93.24	24.12	42.34
Percent nonlithophilic	6	4	10	45	26.05	0.00	72.57	72.57	18.04	69.23
Percent simple lithophils+tolerants	7	8	15	68	43.72	7.53	90.00	82.47	18.16	41.53

Shaded box highlights metrics included in the Plateau ichthyoregion IBI.

[1] HDG-human disturbance gradient

Table 9. Redundancy analysis for Plateau ichthyoregion IBI metrics.

	IBI metric											
IBI metric	1	2	3	4	5	6	7	8	9	10	11	12
1. Number of native species	**1.000**											
2. Number of cyprinid species	0.830	**1.000**										
3. Number of sucker species	0.713	0.543	**1.000**									
4. Number of *Lepomis* species	0.074	-0.069	-0.093	**1.000**								
5. Number of darter+madtom species	0.833	0.594	0.584	-0.139	**1.000**							
6. Percent dominant species	-0.226	-0.233	-0.109	0.074	-0.195	**1.000**						
7. Percent tolerant species	-0.386	-0.287	-0.286	0.159	-0.388	-0.051	**1.000**					
8. Percent *Lepomis* species	-0.550	-0.458	-0.432	0.187	-0.500	-0.046	0.732	**1.000**				
9. Percent omnivores	-0.068	-0.163	-0.045	0.047	-0.137	0.377	-0.022	-0.167	**1.000**			
10. Percent top carnivores	-0.005	-0.044	-0.097	-0.070	-0.044	-0.118	-0.005	-0.028	-0.004	**1.000**		
11. Percent with DELT+hybrids	-0.162	-0.079	-0.058	-0.031	-0.171	0.164	0.013	0.036	-0.100	-0.091	**1.000**	
12. Percent simple lithophils	0.578	0.504	0.502	-0.232	0.670	-0.242	-0.520	-0.571	-0.356	-0.146	-0.152	**1.000**

Critical r value for statistical difference from 0 = 0.576 [p=0.05, df=10]
shaded box highlights coefficients >0.750

to derive ranges for the scores: 5 (best), 3, or 1 (worst). Several of the IBI metrics that measure species richness and composition are strongly related to stream size with larger streams supporting more species. This relationship is in many cases drainage specific and is generally valid up to a certain critical watershed size, after which species richness remains relatively constant. Regional differences in faunal composition are strongly apparent in Alabama, with distributions of many species highly correlated with ecoregion and (or) specific drainage basins (Mettee and others, 1996). Tolerance and trophic metrics are often unrelated to stream size, and scoring criteria were derived with reference to published values and illustrated by drawing two horizontal lines at metric values that divided the data approximately into thirds.

The 5-3-1 and trisection scoring methods will continue to be utilized as the IBI is developed for the different ecoregions in Alabama. Once statewide sample data have been completed and compiled, we will then convert to a system that scores on a 0 to 100 range as suggested by Hughes and others (1998). However, we need to wait until the full range of metric values can be determined for all regions of the state. This system will be more compatible with multimetric applications used in other states and will provide a refinement to the process for establishing criteria classes.

During development of the Plateau IBI it was discovered that habitat measures in this ichthyoregion consistently performed poorly at discriminating sites with poor habitat quality from sites with good habitat quality, or in some cases that improving IBI scores were statistically related to degrading habitat. We do not have an interpretation for these observations at the moment so for the purposes of this report we are relying more heavily on the human disturbance relationships to interpret the data.

METRICS SELECTED FOR THE PLATEAU IBI

1. NUMBER OF NATIVE SPECIES

We selected number of native species over total number of species in order to exclude several species of nonnative fishes distributed throughout the state which are generally tolerant, invasive, and could detract from the responsiveness of this metric in impaired streams. Hughes and Oberdorff (1999) also recommended that the native species metric was an improvement over total species, particularly where nonnatives are common or highly invasive. The negative relationship between species richness and habitat degradation is well documented (Karr, 1981; Karr and others, 1986; Ohio EPA, 1987a) and 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). In our comparison of candidate metrics we found that total number of native species was negatively correlated with several disturbance metrics, in particular those associated with phosphorus loading, percent pasture coverage, and percent crop coverage. This metric discriminated sites with high disturbance from reference sites in both small and large watersheds. Discrimination power due to habitat disturbance was evident in smaller watersheds, though opposite of predicted (fig. 6), and was poorly defined in large watersheds. In contrast, these relationships were well defined in both the Southern Plains and Tennessee Valley ichthyoregions (O'Neil and Shepard, 2009, 2010) yet poorly defined in the Ridge and Valley/Piedmont (O'Neil and Shepard, 2011). Since this metric is almost universally used for IBI applications we've retained it for the Plateau.

2. NUMBER OF CYPRINID SPECIES

The family Cyprinidae is a diverse and abundant group in the Plateau ichthyoregion and includes species in the genera *Campostoma, Cyprinella, Hemitremia, Hybopsis, Luxilus, Lythrurus, Nocomis, Notemigonus, Notropis*, *Pimephales, Rhinichthys*, and *Semotilus*. Cyprinids are common and abundant throughout the Plateau ichthyoregion with a range of tolerances, habitat preferences, and trophic and reproductive guilds. As a group, cyprinids are adapted to a wide variety of habitats and habitat disturbances and can thrive in highly variable substrate and sediment regimes. Cyprinid diversity is generally high in streams with complex snag and pool variability as well as run habitats with variable flow velocities. The number of cyprinid species was significantly lower in disturbed watersheds (fig. 7) for both small and large watersheds.

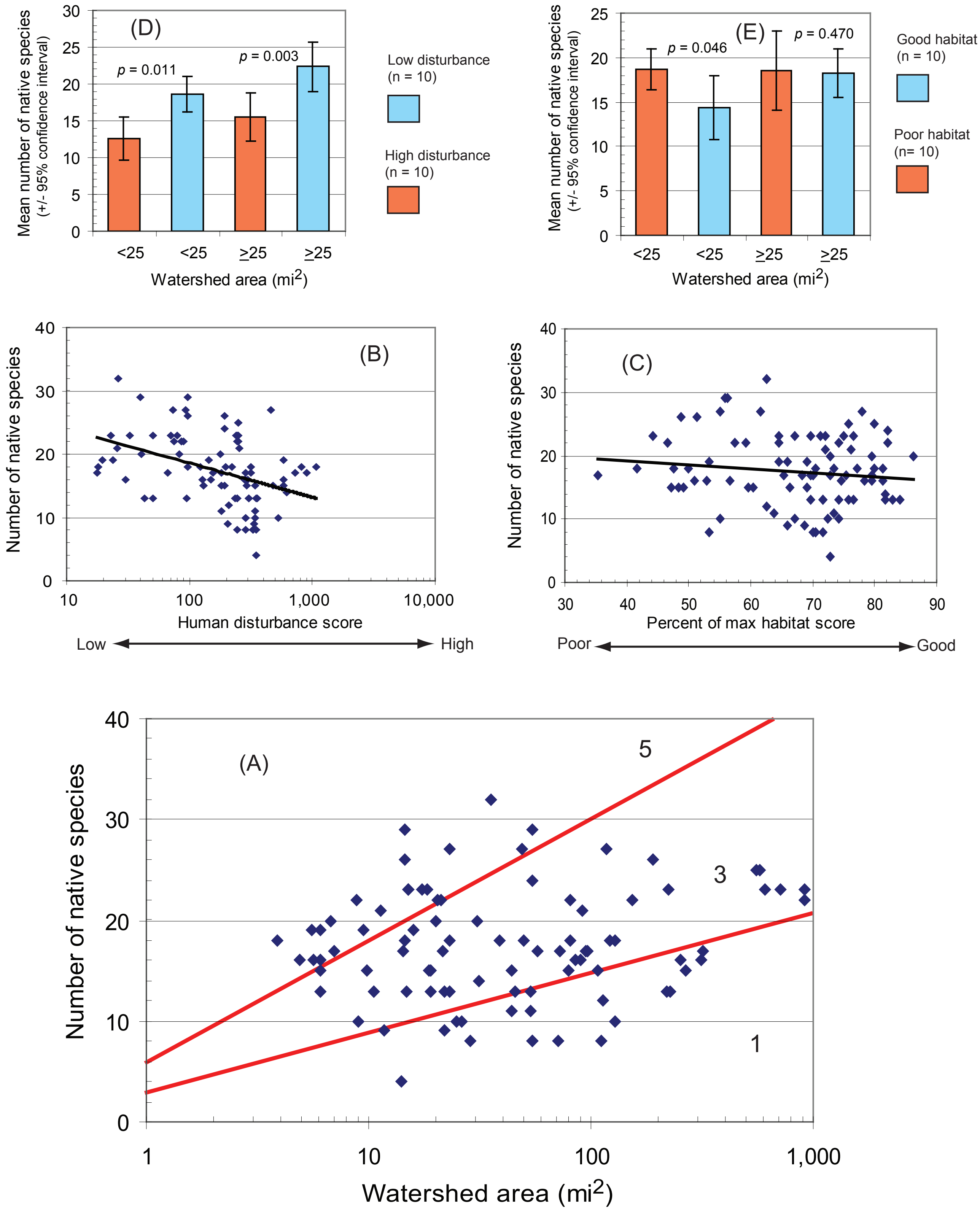


Figure 6. Relationships between the IBI metric number of native species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

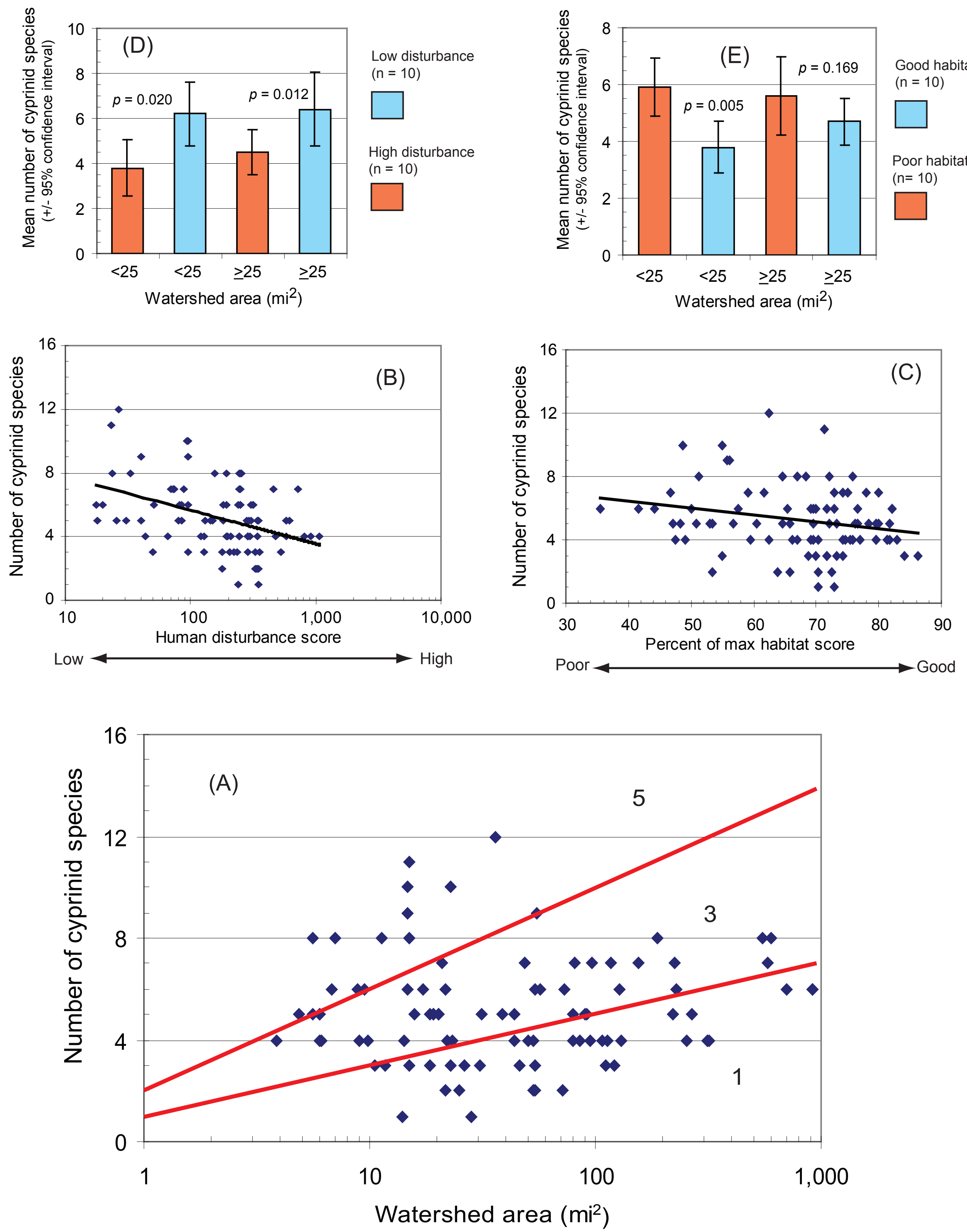


Figure 7. Relationships between the IBI metric number of cyprinid species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

Mean number of cyprinid species was significantly higher in streams with poor habitat while this relationship was poorly defined in larger watersheds.

3. NUMBER OF SUCKER SPECIES

Diversity of sucker species was incorporated in the original midwestern IBI (Karr, 1981) because suckers are sensitive to physical and chemical degradation and because most species are long-lived and adapt to environmental changes over a number of years. Number of sucker species declined significantly with increasing disturbance and was poorly related to habitat quality in the Plateau ichthyoregion (fig. 8). This metric was able to discriminate sites with high disturbance from sites with low disturbance in all watershed sizes.

4. NUMBER OF LEPOMIS SPECIES

Diversity of *Lepomis* species responded poorly to both increasing watershed disturbance and declining habitat quality (fig. 9). Sunfishes are quite adaptable to disturbed conditions and their numbers and diversity will typically increase in these settings. *Lepomis* species diversity and abundance increased with increasing phosphorus loading, percent pasture, and percent row crop. This metric discriminated disturbed sites in small watersheds better than large watersheds while discrimination of sites due to habitat quality was marginal in all watersheds.

5. NUMBER OF DARTER + MADTOM SPECIES

Darters and madtoms are benthic species and generally intolerant of habitat impairments, particularly sedimentation that 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. 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). Paller and others (1996) and Schleiger (2000) modified the darter metric to include madtoms or madtoms+sculpins since these groups are also benthic and are similar to darters in their feeding and spawning requirements. We evaluated the darter metric alone and with madtoms and sculpins but settled on the darter+madtom metric as sufficient since these two families are distributed widely throughout Alabama. This metric declined with increasing watershed disturbance and was poorly related to the habitat

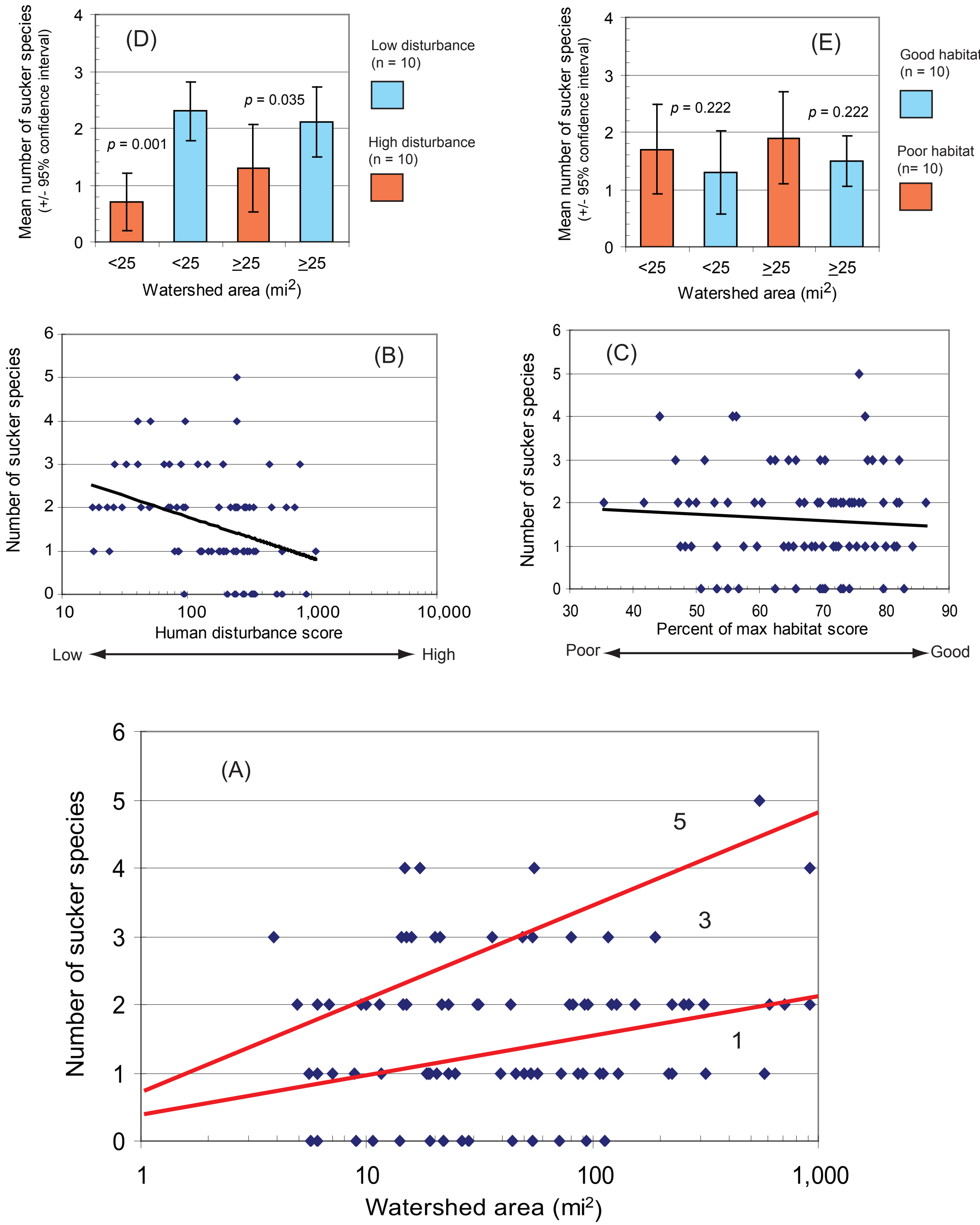


Figure 8. Relationships between the IBI metric number of sucker species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

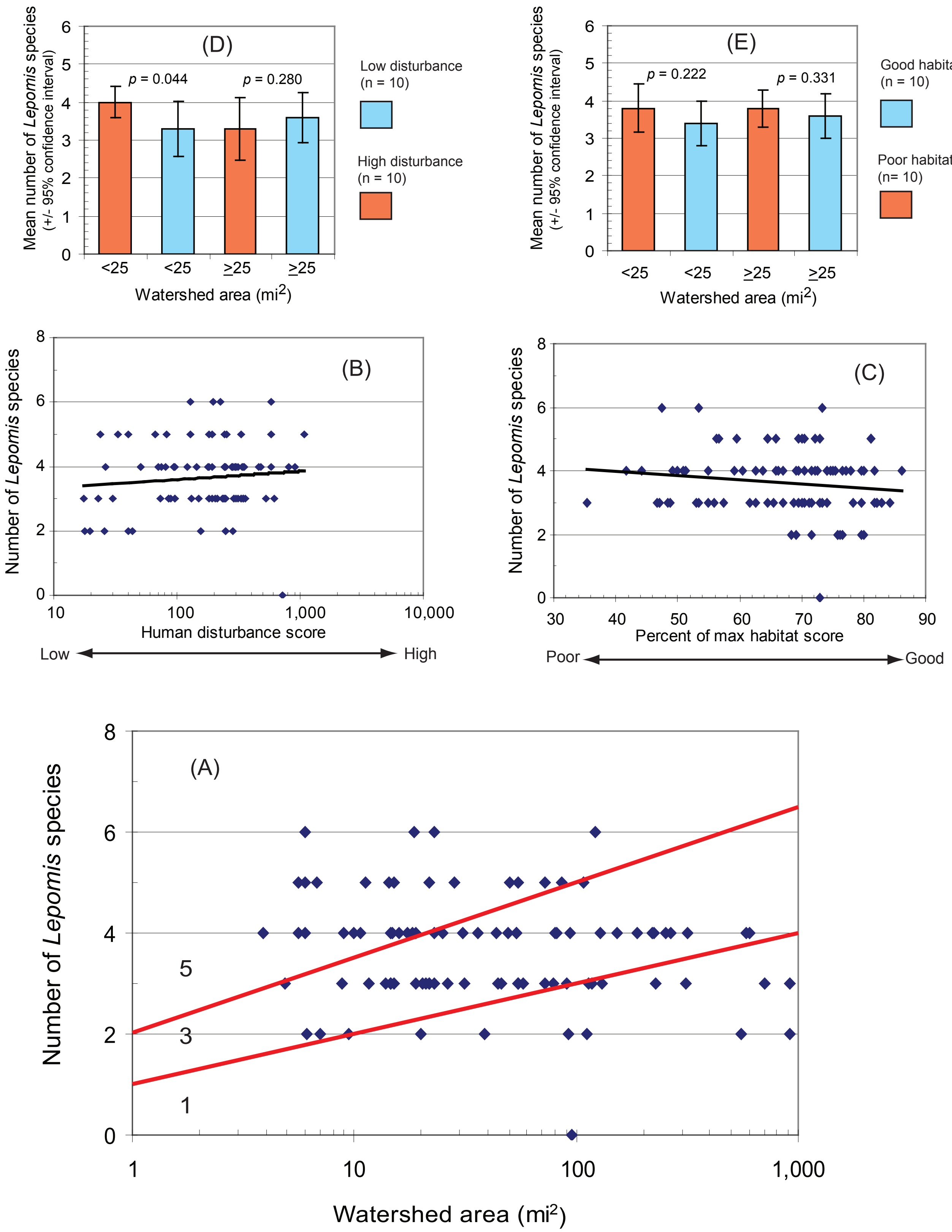


Figure 9. Relationships between the IBI metric number of *Lepomis* species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

metrics. Mean number of darter+madtom species was significantly greater at sites with low disturbance for small and large watersheds (fig. 10). Like darters, madtoms are benthic species and in Plateau streams can be frequently found in snags, leaf packs, root masses, and woody debris along banks as well as gravel and rubble in runs and riffles. These habitat components are important for both darters and madtoms, and their loss or degradation generally leads to fewer species. There were significant negative correlations of darter+madtom species with phosphorus loading, percent pasture, and percent crop land cover.

6. PERCENT DOMINANT SPECIES

Percent dominant species is a traditional measure of community balance based on the concept that healthy aquatic communities have high numbers of species with abundance somewhat evenly distributed among species and not concentrated into one or two species. There were 19 species that ranked most dominant in the 91 collections in the Plateau data set with these species accounting for over 35 percent (11,811) of all individuals collected (33,101). *Campostoma oligolepis* was dominant in 28 collections followed by four species of *Cyprinella* (*callistia, galactura, spiloptera, venusta*) in 20 collections, and four species of *Lepomis* (*auritus, cyanellus, macrochirus, megalotis*) in 18 collections. Other species not considered tolerant were also dominant in some collections: *Notropis cahabae*, *Notropis asperifrons*, and *Etheostoma stigmaeum*. Percent dominant species is likely a reflection of the abundance of preferred habitat of these species. This metric was poorly related to disturbance measures though the trend was higher numbers of the dominant species at disturbed sites. The habitat measures indicated significantly lower percentages in poor habitat of small watersheds while this relationship was ill-defined in large watersheds (fig. 11).

7. PERCENT AS TOLERANT SPECIES

The disproportionate presence of tolerant species is a clear indication that habitat is disturbed or that water-quality conditions are well below optimum, and tolerant species may become very abundant in highly disturbed streams. Species occurring in the Plateau ichthyoregion that were included in this metric were *Luxilus chrysocephalus, Pimephales notatus, P. vigilax, Semotilus atromaculatus, Notemigonus crysoleucas,*

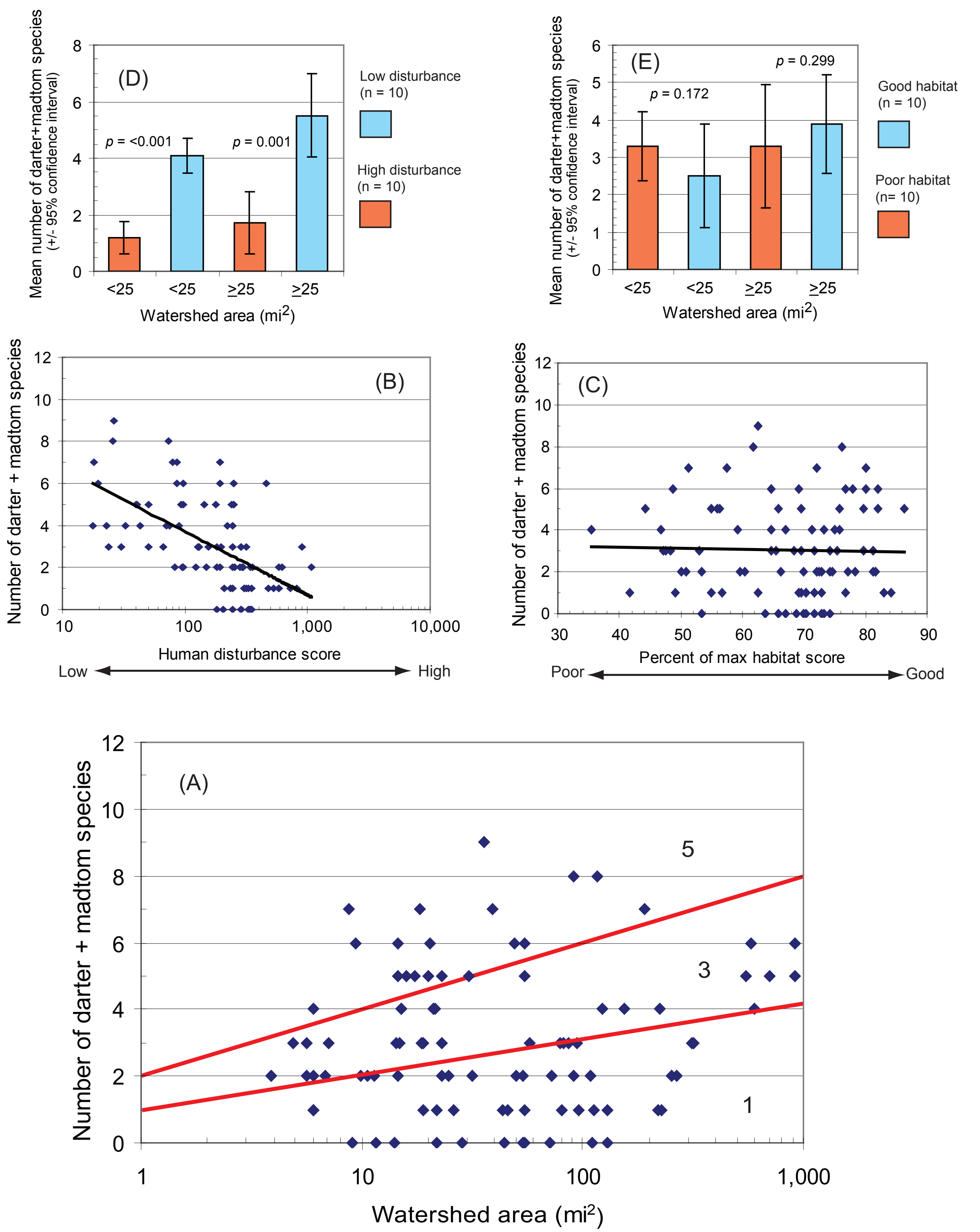


Figure 10. Relationships between the IBI metric number of darter+madtom species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

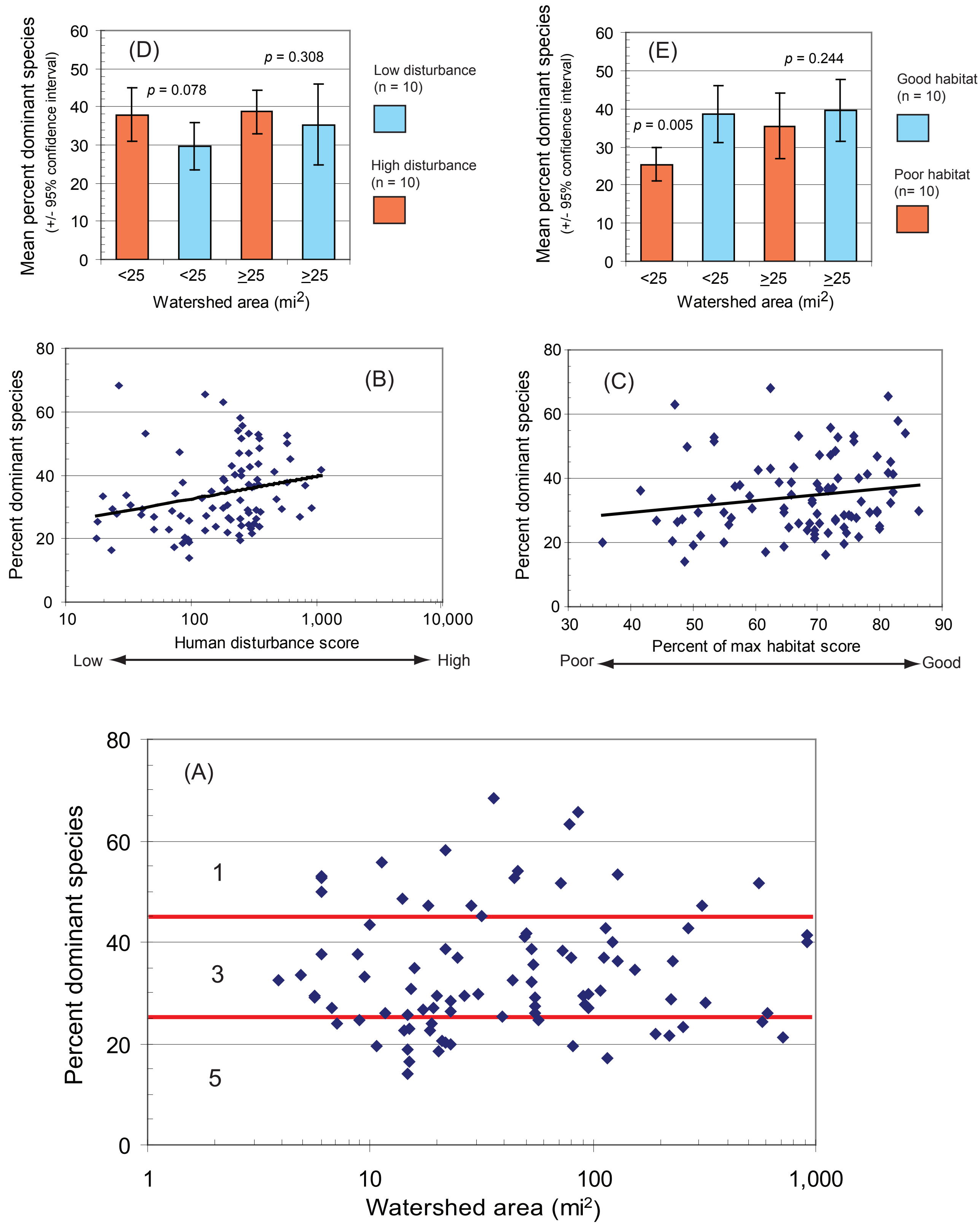


Figure 11. Relationships between the IBI metric percent dominant species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

Rhinichthys atratulus, Minytrema melanops, Gambusia affinis, Ameiurus melas, A. natalis, Lepomis cyanellus, and *L. macrochirus*. It was used by O'Neil and others (2006) as a replacement for Karr's (1981) original green sunfish metric as recommended by Karr and others (1986), Ohio EPA (1987a), and Hughes and Oberdorff (1999). Mean percent of tolerant species was higher in streams with high disturbance in both small and large streams (fig. 12) while it was weakly defined for habitat measures. This metric was not related to stream size, and scoring criteria were adopted from those established for streams in the Tennessee Valley ichthyoregion (O'Neil and Shepard, 2010).

8. PERCENT AS LEPOMIS

The metric percent as *Lepomis* corresponded to landscape-level measures of human disturbance (fig. 13) in small watersheds and to reach-level habitat degradation measures in large watersheds. *Lepomis* as a group are highly tolerant of disturbed habitats and diminished water quality and can thrive in very impaired environments. *Lepomis* populations generally become more abundant as habitat changes from a more riffle-run dominated system to a more pool dominated system. This can occur in areas of increasing habitat degradation due to scour, deposition, and increase of structure.

9. PERCENT AS OMNIVORES AND HERBIVORES

Percent omnivores and herbivores is one of the original metrics proposed by Karr (1981) and is used to detect alterations in the food base caused by physical or chemical impairment that favors species which consume substantial quantities of plant and animal material (Hughes and Oberdorff, 1999). In this metric we include species such as *Campostoma* and *Pimephales*, which can become dominant in impaired streams, particularly those with high nutrient inputs (O'Neil and Shepard, 2000b). In our experience, a proportionally high number of omnivores and herbivores is an excellent measure of stream disturbance, generally caused by over nutrification. This metric increased with increasing human disturbance in all watersheds and declined with increasing good habitat scores (fig. 14).

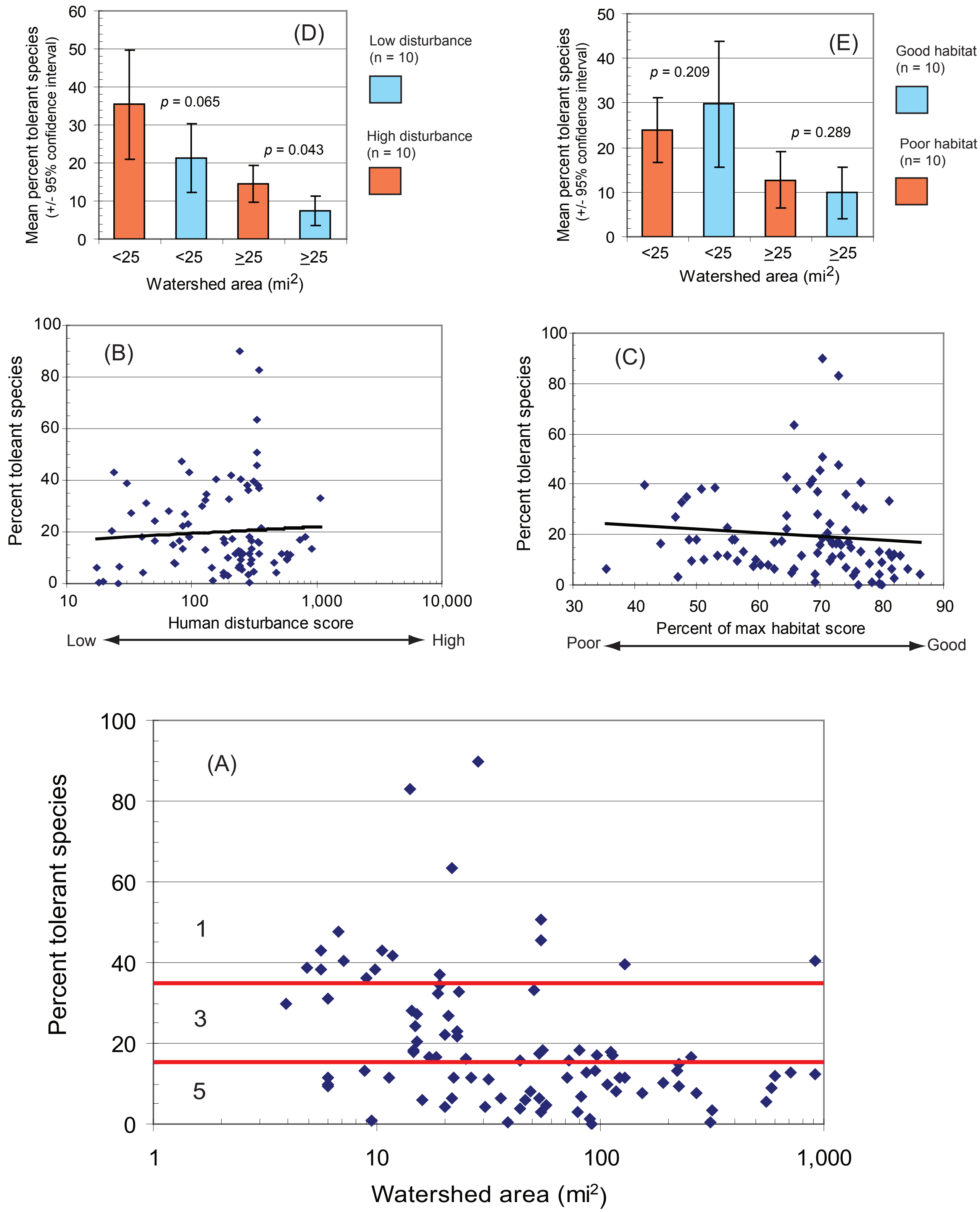


Figure 12. Relationships between the IBI metric percent tolerant species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

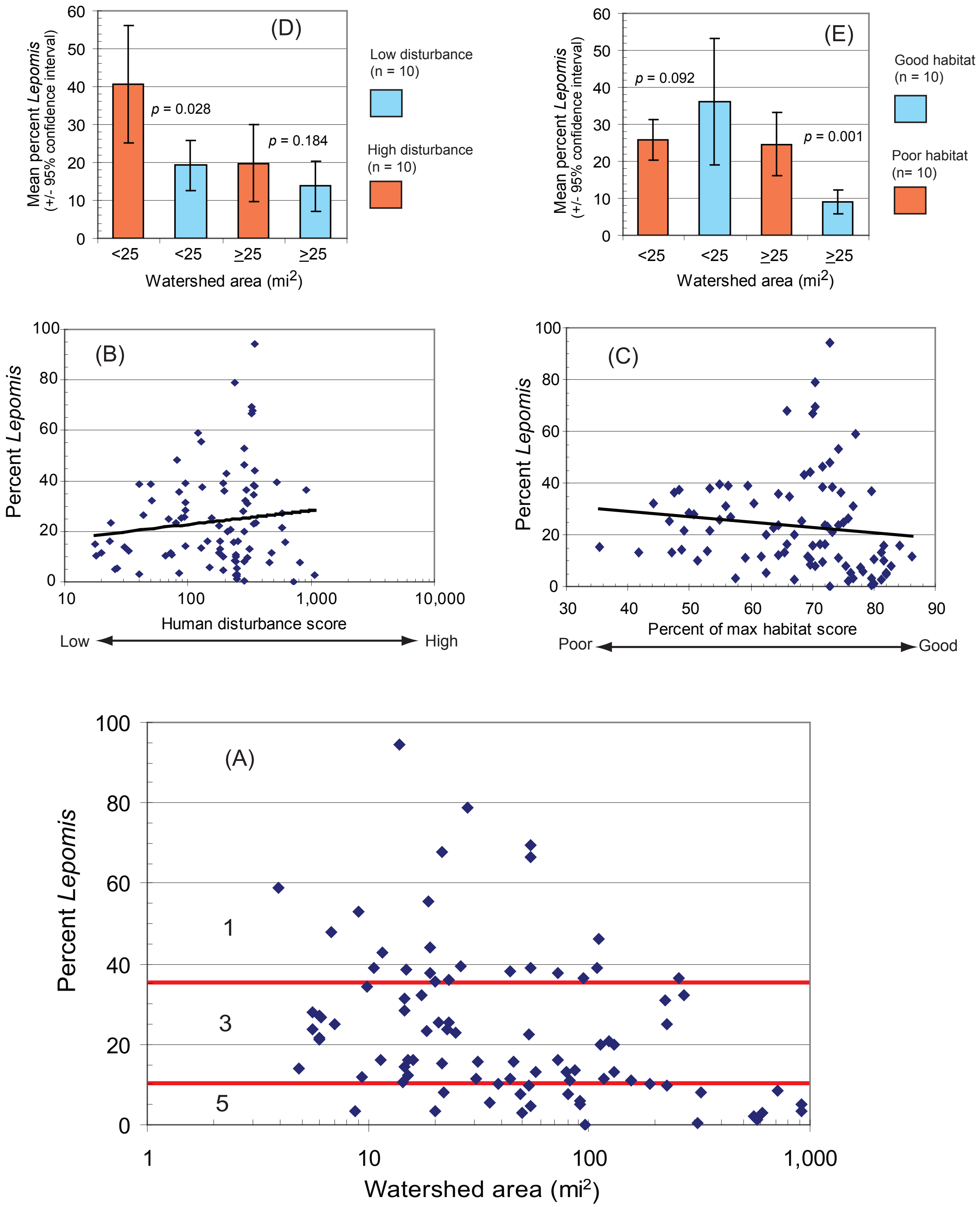


Figure 13. Relationships between the IBI metric percent *Lepomis* and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

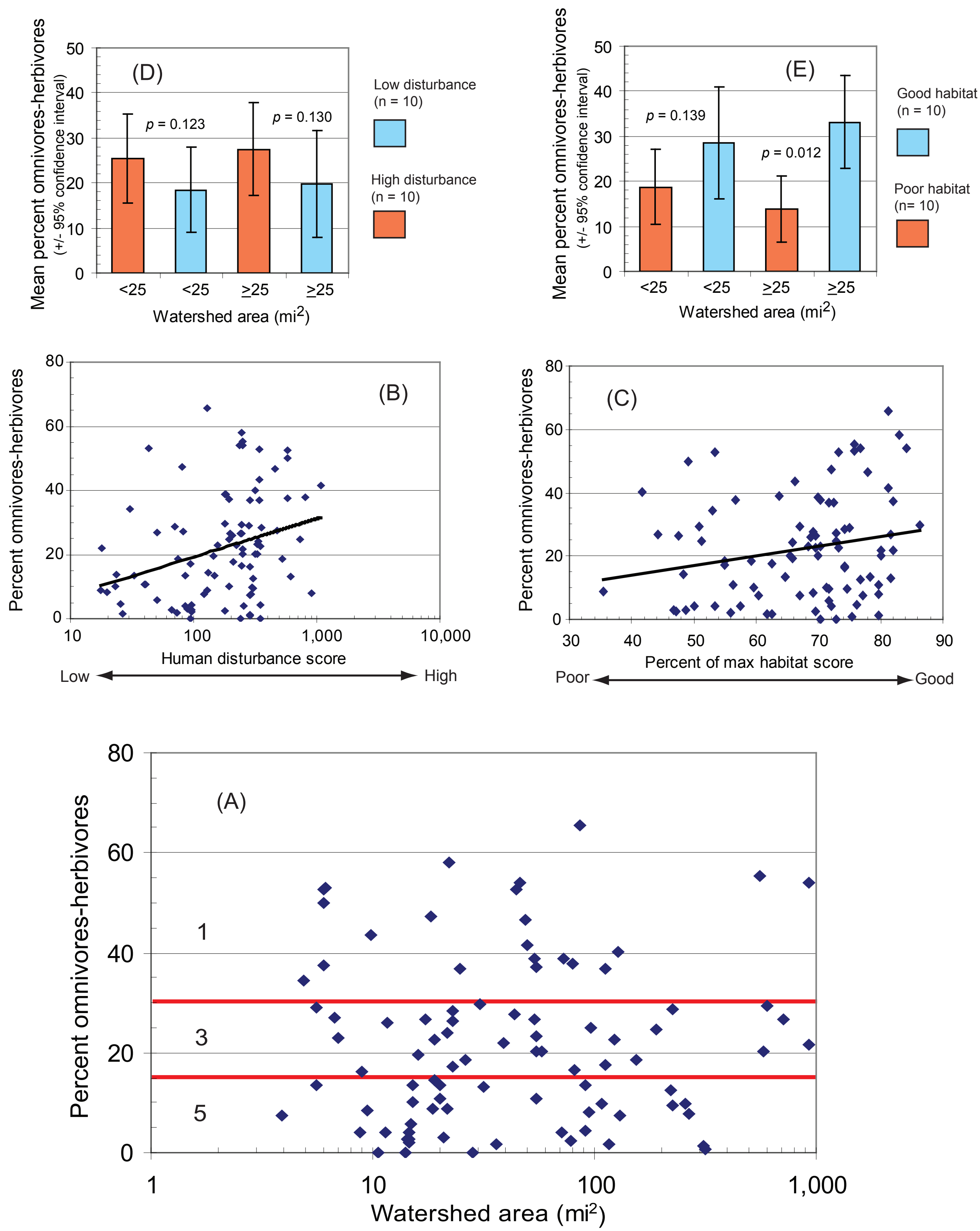


Figure 14. Relationships between the IBI metric percent omnivores-herbivores and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

10. PERCENT AS TOP CARNIVORES

Karr (1981) proposed this metric because healthy populations of top carnivores indicate a highly functional, trophically diverse community. The top carnivore metric was designed to measure biological integrity in the upper 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 *Micropterus, Morone, Pomoxis, Ambloplites, Esox, Lepisosteus,* and *Atractosteus*. 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. The relationships between percent top carnivores and the disturbance and habitat measures were all poorly defined and somewhat conflicting (fig. 15). Disturbance measures indicated more top carnivores in disturbed streams while habitat measures indicated more top carnivores in streams with good habitat. Ohio EPA (1987b) reported that top carnivores are absent or present in very low abundance in headwater streams and they have substituted the top carnivore metric with the proportion of pioneering species metric in watersheds <20 mi^2. This metric will be examined further as more data are collected statewide.

11. PERCENT WITH DELT+HYBRIDS

Incidence of unhealthy individuals as expressed in deformities, eroded fins, lesions, and tumors (DELT) is frequently used as a metric that reflects the fish community's health and condition. These abnormalities, 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. Percent 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. Only about 27 percent of the samples from the Plateau had individuals with

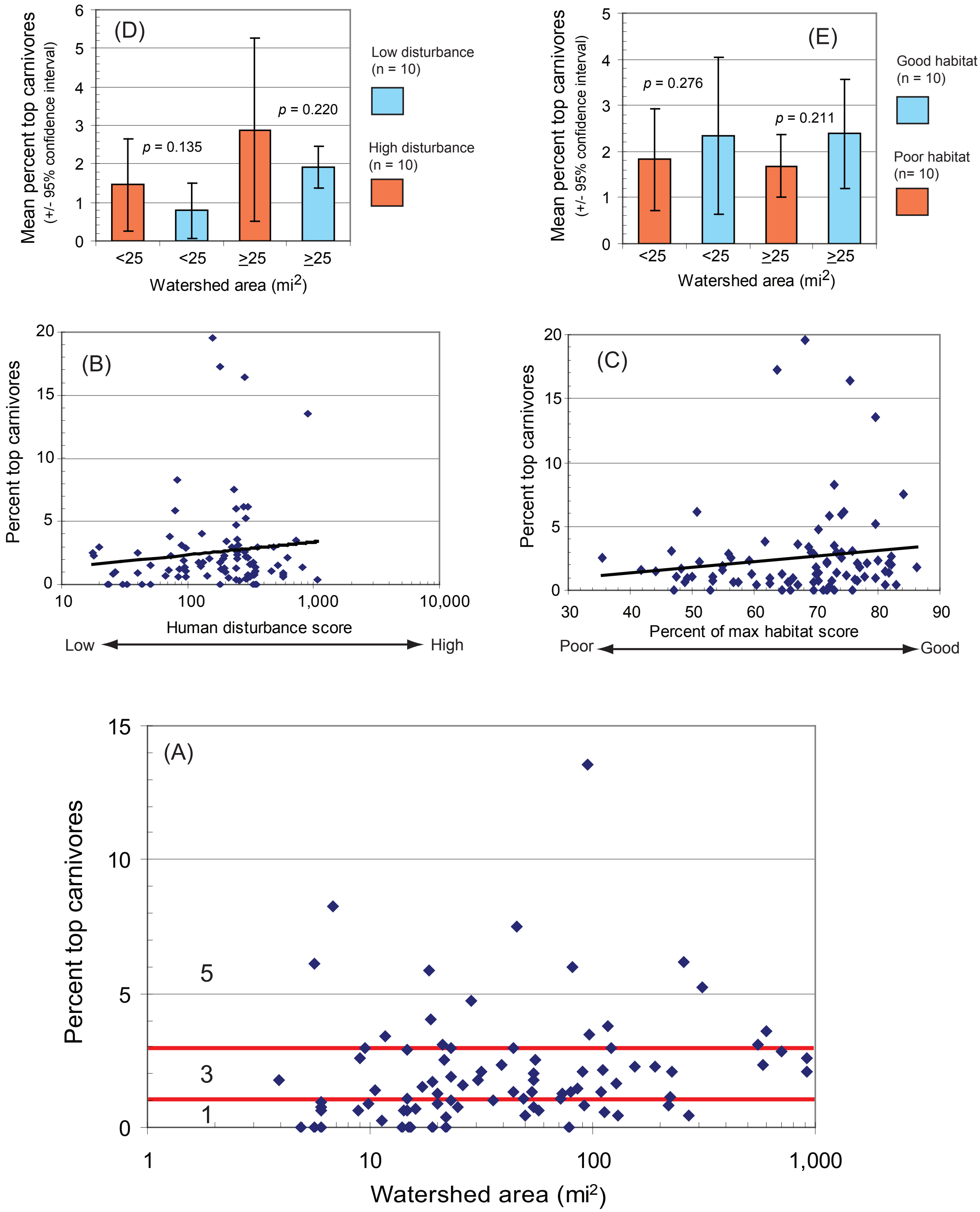


Figure 15. Relationships between the IBI metric percent top carnivores and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

DELTs or hybrids (fig. 16). McCormick and others (2001) decided not to use this metric because of its relative rarity in fish populations. However, we decided to retain the metric as a way to capture degradation outside the usual nonpoint sources in rural areas (sediment and nutrients).

12. PERCENT AS SIMPLE LITHOPHILIC SPAWNERS

Percent simple lithophilic spawning species refers to the percentage of individuals in the sample that utilize rock and mineral substrates for spawning by simply depositing eggs in or over the substrate. This metric includes a host of species statewide, but in the Plateau it includes certain minnow, sucker, and darter species including *Lythrurus alegnotus, L. bellus, Notropis asperifrons, N. stilbius, N. texanus, Hypentelium etowanum, Moxostoma duquesnei, M. erythrurum, M. poecilurum, Etheostoma douglasi, E. stigmaeum, Percina brevicauda, P. nigrofasciata, and P. kathae*. These species are vulnerable to sedimentation, which smothers preferred habitat for spawning and feeding. Watersheds with high human disturbance yielded significantly fewer individuals in this group for both small and large watersheds. Relationships of this IBI metric to habitat measures were poorly defined (fig. 17).

IBI DEVELOPMENT FOR THE PLATEAU ICHTHYOREGION

The 12 selected metrics were used to calculate IBI scores for the sampled sites (tables 10, 11). Biotic integrity classes were derived by evaluating the percentile distribution (10th, 25th, 50th, 75th, and 90th percentiles) of the 91 calculated IBI values and comparing these values with integrity classes established for the Southern Plains ichthyoregion (O'Neil and Shepard, 2009), Tennessee Valley ichthyoregion (O'Neil and Shepard, 2010), and the Ridge and Valley/Piedmont ichthyoregion (O'Neil and Shepard, 2011). The percentile marks were used as guides to place integrity class endpoints which were then adjusted (table 12) to create a balanced distribution of values across the range of IBI scores (fig. 18). Approximately 38.5 percent of the IBIs scored in the fair class, 34 percent scored in the very poor and poor classes, and 27.5 percent scored in the good to excellent classes. Only one site scored in the excellent biological condition range. The IBI was poorly related to habitat scores (fig. 19) yet showed significant

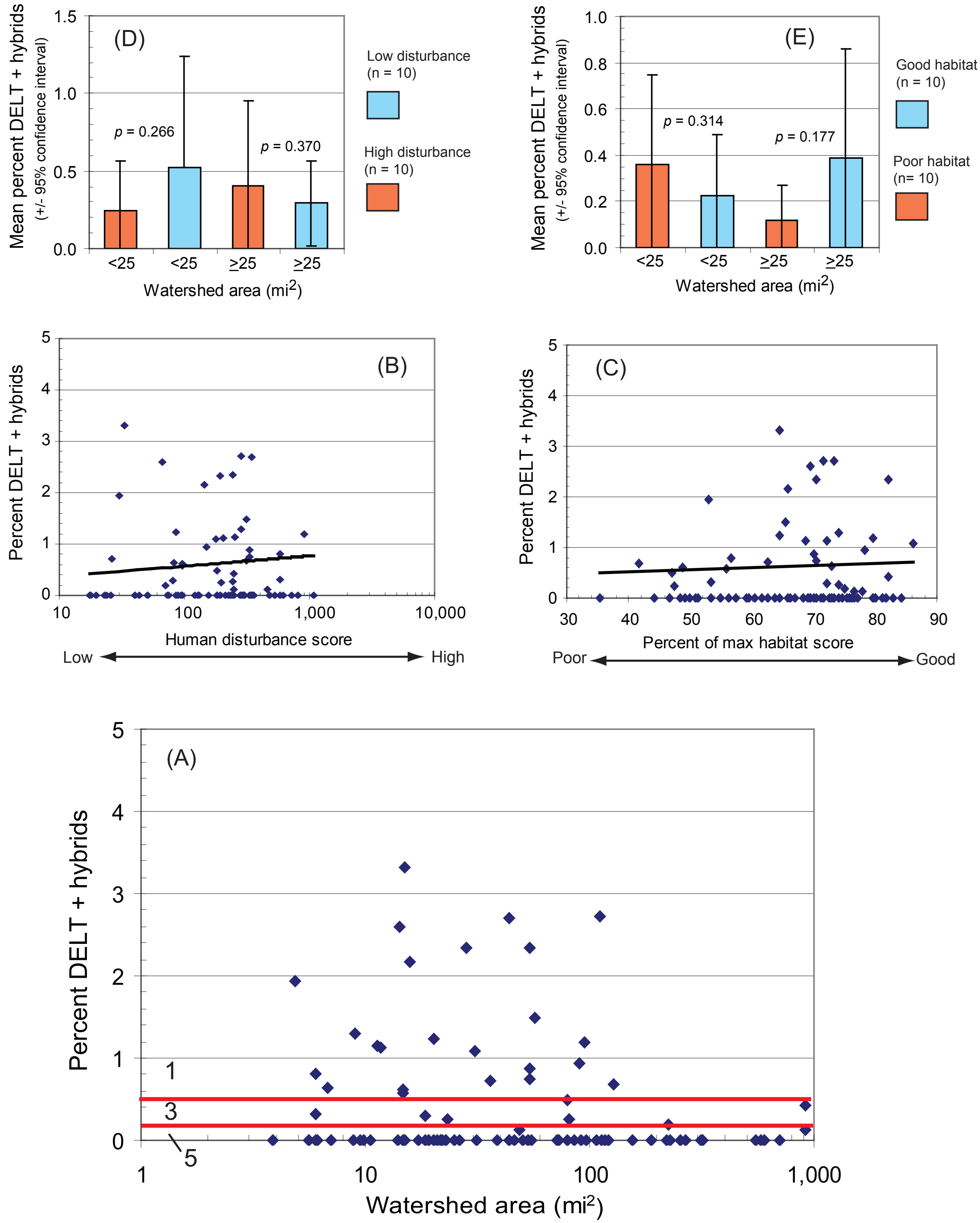


Figure 16. Relationships between the IBI metric percent DELT + hybrids and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

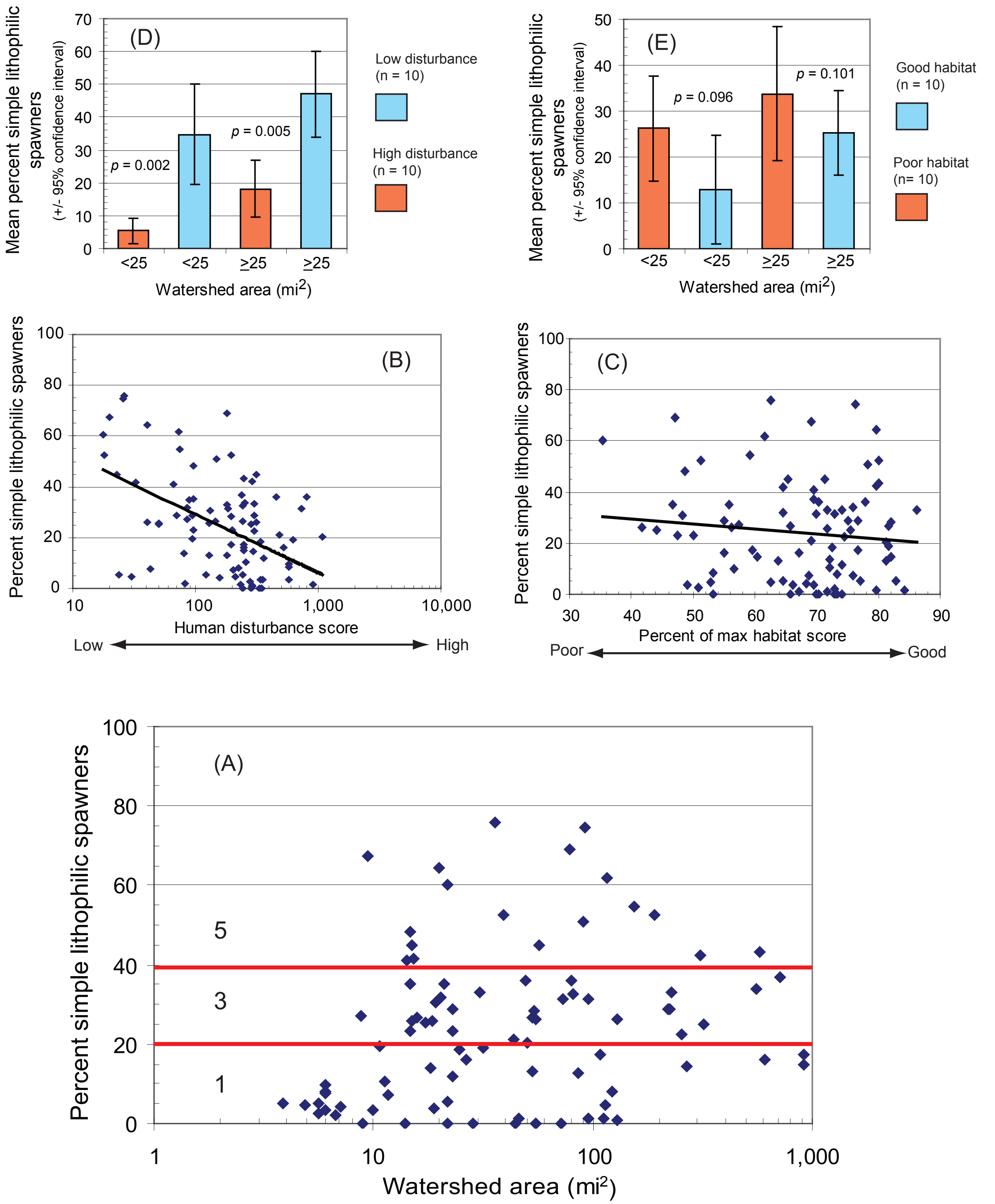


Figure 17. Relationships between the IBI metric percent simple lithophilic spawners and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D) and habitat (E).

Table 10. Fish community values for Plateau IBI metrics.

	IBI metrics [1]											
	1	2	3	4	5	6	7	8	9	10	11	12
GSA no.	TOTSP	CYPRIN	SUCK	LEPOM	DARMD	DOM	TOL	PLEPO	OMNI	TC	DELHY	SIMLTH
1474	21	8	2	5	2	55.68	11.36	16.19	3.98	0.28	1.14	10.51
1475	17	4	0	4	3	29.69	13.3	36.58	8.08	13.54	1.19	1.43
1476	16	5	1	3	2	29.57	1.13	5.84	13.37	2.07	0.94	51.04
1477	13	4	1	4	2	32.18	6.38	9.84	26.6	1.33	0	26.6
1478	22	7	2	4	3	19.48	7.01	10.91	16.62	5.97	0.26	32.73
1484	17	4	1	4	3	28.14	3.55	7.92	0.82	16.39	0	25.14
1485	16	4	2	3	3	47.01	0.29	0.48	1.25	5.21	0	42.28
1486	15	4	2	4	1	32.54	4.04	11.4	27.57	2.94	0	21.14
1804	13	4	0	3	1	58.05	11.53	7.95	58.05	0.4	0	5.37
1805	18	6	2	4	1	36.35	39.59	12.97	40.14	1.62	0.68	26.22
1806	17	6	1	3	3	24.63	4.67	13.16	20.17	0.64	1.49	45.01
1821	15	4	2	4	2	43.5	38.12	34.53	43.5	0.9	0	3.59
1822	20	3	2	4	5	29.76	4.16	11.38	29.76	1.75	1.09	33.04
1823	24	6	3	3	6	35.66	2.91	4.66	37.12	2.04	2.33	28.53
1824	26	8	3	4	7	21.97	10.06	10.06	24.64	2.26	0	52.36
1825	25	8	5	2	5	51.6	5.41	2.3	55.41	3.11	0	33.87
1826	25	7	1	4	6	24.19	9.07	1.16	20.12	2.33	0	43.26
1827	19	5	3	4	5	34.89	6.12	16.19	19.42	0.72	2.16	26.62
1828	23	8	2	4	4	26.14	11.86	2.86	29.29	3.57	0	16.14
1829	23	6	2	3	5	21.1	12.78	8.52	26.57	2.84	0	36.92
1830	18	4	1	5	2	41.61	33.26	2.78	41.61	0.41	0	20.29
1831	18	4	3	4	1	36.78	18.26	7.65	37.72	1.34	0	36.11
1832	17	7	2	0	1	26.87	16.92	0	24.88	3.48	0	31.34
1833	18	4	3	4	2	32.6	29.96	59.03	7.49	1.76	0	5.29
1834	14	5	2	3	2	45.07	11.27	15.85	13.03	2.11	0	19.01
1835	27	7	3	4	6	41.16	8.23	7.63	46.61	1.09	0.12	36.08
1836	13	5	1	4	1	21.65	13.39	31.1	12.6	0.79	0	28.74
1837	18	3	2	6	4	40.1	11.39	20.79	22.77	2.97	0	7.92
1838	15	3	1	6	3	22.58	32.26	55.65	8.87	4.03	0	25.81
1839	18	4	1	6	3	26.46	32.57	36.13	26.46	1.02	0.25	23.16
1840	17	6	1	5	2	38.34	15.64	15.95	38.65	1.23	0	31.29
1841	13	6	1	3	1	36.23	9.28	9.58	9.58	2.1	0	33.23
1842	16	4	2	4	2	23.19	16.67	36.23	9.78	6.16	0	22.46
1845	22	6	2	3	5	41.26	12.38	5.21	21.61	2.61	0.43	14.88
1846	23	6	4	2	6	39.93	40.54	3.19	53.93	2.09	0.12	17.2
1865	11	2	1	4	0	38.79	17.24	22.41	38.79	17.24	0	12.93
1866	13	3	1	3	1	54.11	6.16	15.75	54.11	7.53	0	1.37
1867	18	6	2	4	2	18.95	17.89	28.42	4.21	1.05	0	23.16
1868	13	3	0	4	2	19.44	43.06	38.89	0	1.39	0	19.44
1869	13	3	2	4	3	22.86	24.29	38.57	5.71	0	0	25.71
1921	17	8	1	2	3	23.83	40.43	25.11	22.98	19.57	0	4.26
1924	15	5	1	3	3	27.17	34.68	37.57	14.45	1.73	0	30.64
1925	26	10	2	3	6	13.94	18.18	14.24	2.73	0.61	0.61	48.18
1926	22	5	1	3	6	18.52	22.22	35.8	13.58	1.23	1.23	31.69
1927	23	5	1	4	7	47.21	16.42	23.46	47.21	5.87	0.29	13.78

[1] TOTSP-no. native species; CYPRIN-no. of cyprinid species; SUCK-no. sucker species; LEPOM-no. *Lepomis* species; DARMD-no. darter+madtom species; DOM-proportion of dominant species; TOL-proportion of tolerant species; PLEPO-proportion of Lepomis; OMNI-proportion of omnivores and herbivores;TC-proportion of top carnivores; DELHY-proportion with DELT+hybrids; SIMLTH-proportion of simple lithophilic spawners.

Table 10. Fish community values for Plateau IBI metrics--continued.

	IBI metrics [1]											
	1	2	3	4	5	6	7	8	9	10	11	12
GSA no.	TOTSP	CYPRIN	SUCK	LEPOM	DARMD	DOM	TOL	PLEPO	OMNI	TC	DELHY	SIMLTH
1928	22	6	1	3	7	37.72	13.37	3.39	3.99	0.6	0	27.15
1929	16	5	2	3	3	33.62	38.79	13.79	34.27	0	1.94	4.53
1930	27	7	3	3	8	17.23	7.98	11.34	1.68	3.78	0	61.76
1948	10	2	1	4	2	36.92	16.15	23.08	36.92	0.77	0	18.46
1949	4	1	0	3	0	48.57	82.86	94.29	0	0	0	0
1950	8	3	0	3	0	28.95	45.61	66.67	20.18	1.75	0.88	0
1956	9	2	0	5	0	38.69	63.32	67.84	24.12	0	0	0
1972	16	4	1	5	3	65.55	12.92	13.4	65.55	1.44	0	12.92
1974	16	5	0	5	1	37.57	9.34	27.04	37.57	0.6	0.8	9.74
1991	20	5	3	2	5	29.38	4.1	3.19	10.71	0.91	0	64.24
1992	19	6	2	2	6	33.23	0.9	11.68	8.38	2.99	0	67.37
1993	18	5	1	2	7	25.19	0.26	10.28	21.85	2.31	0	52.44
1994	21	5	2	2	8	27.66	0.17	5.06	4.55	0.84	0	74.54
1995	13	3	1	3	2	28.43	21.57	23.53	28.43	2.94	0	11.76
1996	15	5	2	3	3	63.08	3.18	12.96	2.44	0	0.49	68.95
2001	27	10	2	4	5	19.89	22.92	25.57	17.05	1.89	0	28.79
2002	23	7	2	4	4	28.71	15.03	24.86	28.71	1.16	0.19	28.9
2003	22	7	2	4	4	34.38	7.57	10.86	18.59	2.3	0	54.61
2004	29	9	4	3	5	25.51	17.97	31.3	2.03	2.9	0.58	35.07
2005	29	9	4	5	5	27.46	18.14	38.79	10.83	2.52	0	26.2
2007	22	7	3	3	4	20.35	26.99	25.22	3.1	3.1	0	34.96
2010	17	4	3	5	3	22.73	27.92	10.39	2.6	0.65	2.6	40.91
2011	23	11	2	3	4	16.28	20.54	16.28	10.08	0	0	44.96
2013	19	5	1	6	2	52.6	11.62	21.41	52.6	0.76	0.31	8.26
2029	19	8	1	5	3	29.32	42.93	23.56	13.61	0	0	5.24
2053	8	2	0	3	1	26.12	50.75	69.4	23.13	0.75	0.75	0
2054	9	3	1	3	0	25.99	41.81	42.94	25.99	3.39	1.12	7.34
2055	8	1	0	5	0	47.06	90	78.82	0	4.71	2.35	0
2057	8	3	1	2	0	36.96	17.93	46.2	36.96	2.17	2.72	1.09
2062	15	5	2	4	2	42.73	7.73	32.27	7.73	0.45	0	14.55
2063	10	4	0	4	0	24.52	36.13	52.9	16.13	2.58	1.29	0
2064	13	5	0	4	1	23.91	36.96	44.2	22.46	0	0	3.62
2065	10	3	0	3	1	29.46	11.63	39.53	18.6	1.55	0	16.28
2067	8	2	0	3	0	51.58	11.58	37.89	4.21	1.05	0	0
2068	11	5	0	3	0	52.7	15.77	38.29	52.7	1.35	2.7	0
2069	10	4	1	3	0	53.24	11.57	19.91	7.41	0.46	18.06	0.93
2070	17	6	2	3	4	20.13	6.29	15.09	8.81	2.52	0	60.38
2071	13	4	2	2	4	53.03	31.06	26.52	53.03	0	0	7.58
2072	23	6	4	4	5	26.82	16.48	32.18	26.82	1.53	0	25.29
2082	12	4	0	3	1	42.86	17.14	20	17.71	0.57	0	4.57
2083	15	4	1	5	2	30.46	9.93	39.07	9.93	1.32	0	17.22
2084	20	6	2	5	2	27.07	47.45	48.09	27.07	8.28	0.64	1.91
2085	32	12	3	4	9	68.24	6.44	5.44	1.57	1	0.72	75.68
2086	23	8	3	5	4	30.66	27.35	12.15	13.54	0	3.31	41.71
2214	15	4	1	4	1	50	9.62	21.32	50	0.94	0	3.58
2287	16	5	0	4	2	29.16	38.11	27.88	29.16	6.14	0	2.56

[1] TOTSP-no. native species; CYPRIN-no. of cyprinid species; SUCK-no. sucker species; LEPOM-no. *Lepomis* species; DARMD-no. darter+madtom species; DOM-proportion of dominant species; TOL-proportion of tolerant species; PLEPO-proportion of Lepomis; OMNI-proportion of omnivores and herbivores;TC-proportion of top carnivores; DELHY-proportion with DELT+hybrids; SIMLTH-proportion of simple lithophilic spawners.

Table 11. Scores for Plateau IBI metrics.

	IBI metrics[1]													
	1	2	3	4	5	6	7	8	9	10	11	12		
GSA no.	TOTSP	CYPRIN	SUCK	LEPOM	DARMD	DOM	TOL	PLEPO	OMNI	TC	DELHY	SIMLTH	Final IBI	Biological condition
1474	5	5	3	5	1	1	5	3	5	1	1	1	36	Fair
1475	3	1	1	3	3	3	5	1	5	5	1	1	32	Poor
1476	3	3	1	3	1	3	5	5	5	3	1	5	38	Fair
1477	3	1	1	3	1	3	5	5	3	3	5	3	36	Fair
1478	3	3	3	3	3	5	5	3	3	5	3	3	42	Good
1484	3	1	1	3	1	3	5	5	5	5	5	3	40	Fair
1485	1	1	3	1	1	1	5	5	5	5	5	5	38	Fair
1486	3	1	3	3	1	3	5	3	3	3	5	3	36	Fair
1804	3	3	1	3	1	1	5	5	1	1	5	1	30	Poor
1805	3	3	3	3	1	3	1	3	1	3	1	3	28	Poor
1806	3	3	1	3	3	5	5	3	3	1	1	5	36	Fair
1821	3	3	3	5	3	3	1	3	1	1	5	1	32	Poor
1822	3	1	3	3	5	3	5	3	3	3	1	3	36	Fair
1823	3	3	3	3	5	3	5	5	1	3	1	3	38	Fair
1824	3	3	3	3	5	5	5	3	3	3	5	5	46	Good
1825	3	3	5	1	3	1	5	5	1	5	5	3	40	Fair
1826	3	3	1	3	3	5	5	5	3	3	5	5	44	Good
1827	3	3	5	5	5	3	5	3	3	1	1	3	40	Fair
1828	3	3	3	3	3	3	5	5	3	5	5	1	42	Good
1829	3	1	3	1	3	5	5	5	3	3	5	3	40	Fair
1830	3	1	1	5	1	3	3	5	1	1	5	3	32	Poor
1831	3	1	3	3	1	3	3	5	1	3	5	3	34	Fair
1832	3	3	3	1	1	3	3	5	3	5	5	3	38	Fair
1833	5	3	5	5	3	3	3	1	5	3	5	1	42	Good
1834	3	3	3	3	1	1	5	3	5	3	5	1	36	Fair
1835	5	3	3	3	5	3	5	5	1	3	5	3	44	Good
1836	1	1	1	3	1	5	5	3	5	1	5	3	34	Fair
1837	3	1	3	5	3	3	5	3	3	3	5	1	38	Fair
1838	3	1	1	5	3	5	3	1	5	5	5	3	40	Fair
1839	3	3	1	5	3	3	3	1	3	3	3	3	34	Fair
1840	3	3	1	5	1	3	3	3	1	3	5	3	34	Fair
1841	1	3	1	1	1	3	5	5	5	3	5	3	36	Fair
1842	1	1	3	3	1	5	3	1	5	5	5	3	36	Fair
1845	3	1	3	1	3	3	5	5	3	3	3	1	34	Fair
1846	3	1	3	1	3	3	1	5	1	3	5	1	30	Poor
1865	1	1	1	3	1	3	3	3	1	5	5	1	28	Poor
1866	3	1	1	3	1	1	5	3	1	5	5	1	30	Poor
1867	3	3	3	5	1	5	3	3	5	3	5	3	42	Good
1868	3	1	1	5	1	5	1	1	5	3	5	1	32	Poor
1869	3	1	3	5	3	5	3	1	5	1	5	3	38	Fair
1921	5	5	3	3	3	5	1	3	3	5	5	1	42	Good
1924	3	3	1	3	3	3	3	1	5	3	5	3	36	Fair
1925	5	5	3	3	5	5	3	3	5	1	1	5	44	Good
1926	5	3	1	3	5	5	3	1	5	3	1	3	38	Fair
1927	5	3	1	5	5	1	3	3	1	5	3	1	36	Fair

[1] TOTSP-no. native species; CYPRIN-no. of cyprinid species; SUCK-no. sucker species; LEPOM-no. *Lepomis* species; DARMD-no. darter+madtom species; DOM-proportion of dominant species; TOL-proportion of tolerant species; PLEPO-proportion of Lepomis; OMNI-proportion of omnivores and herbivores;TC-proportion of top carnivores; DELHY-proportion with DELT+hybrids; SIMLTH-proportion of simple lithophilic spawners.

Table 11. Scores for Plateau IBI metrics--continued.

	IBI metrics[1]													
	1	2	3	4	5	6	7	8	9	10	11	12	Final	Biological
GSA no.	TOTSP	CYPRIN	SUCK	LEPOM	DARMD	DOM	TOL	PLEPO	OMNI	TC	DELHY	SIMLTH	IBI	condition
1928	5	5	3	3	5	3	5	5	5	1	5	3	48	Good
1929	5	5	5	3	3	3	1	3	1	1	1	1	32	Poor
1930	3	3	3	1	5	5	5	3	5	5	5	5	48	Good
1948	1	1	1	3	1	3	3	3	1	1	5	1	24	Very Poor
1949	1	1	1	3	1	1	1	1	5	1	5	1	22	Very Poor
1950	1	1	1	3	1	3	1	1	3	3	1	1	20	Very Poor
1956	1	1	1	5	1	3	1	1	3	1	5	1	24	Very Poor
1972	3	1	1	5	3	1	5	3	1	3	5	1	32	Poor
1974	5	3	1	5	1	3	5	3	1	1	1	1	30	Poor
1991	3	3	5	1	5	3	5	5	5	1	5	5	46	Good
1992	5	5	3	3	5	3	5	3	5	3	5	5	50	Excellent
1993	3	3	1	1	5	3	5	3	3	3	5	5	40	Fair
1994	3	3	3	1	5	3	5	5	5	1	5	5	44	Good
1995	3	1	1	3	1	3	3	3	3	3	5	1	30	Poor
1996	3	3	3	3	3	1	5	3	5	1	3	5	38	Fair
2001	5	5	3	3	5	5	3	3	3	3	5	3	46	Good
2002	3	3	3	3	3	3	3	3	3	3	5	3	38	Fair
2003	3	3	3	3	3	3	5	3	3	3	5	5	42	Good
2004	5	5	5	3	5	3	3	3	5	3	1	3	44	Good
2005	5	5	5	5	3	3	3	1	5	3	5	3	46	Good
2007	5	3	5	3	3	5	3	3	5	5	5	3	48	Good
2010	3	3	5	5	3	5	3	3	5	1	1	5	42	Good
2011	5	5	3	3	3	5	3	3	5	1	5	5	46	Good
2013	5	3	3	5	3	1	5	3	1	1	3	1	34	Fair
2029	5	5	3	5	3	3	1	3	5	1	5	1	40	Fair
2053	1	1	1	3	1	3	1	1	3	1	1	1	18	Very Poor
2054	3	1	1	3	1	3	1	1	3	5	1	1	24	Very Poor
2055	1	1	1	5	1	1	1	1	5	5	1	1	24	Very Poor
2057	1	1	1	1	1	3	3	1	1	3	1	1	18	Very Poor
2062	1	1	3	3	1	3	5	3	5	1	5	1	32	Poor
2063	3	3	1	5	1	5	1	1	3	3	1	1	28	Poor
2064	3	3	1	5	1	5	1	1	3	1	5	1	30	Poor
2065	1	1	1	3	1	3	5	1	3	3	5	1	28	Poor
2067	1	1	1	3	1	1	5	1	5	3	5	1	28	Poor
2068	1	3	1	3	1	1	3	1	1	3	1	1	20	Very Poor
2069	1	1	1	1	1	1	5	3	5	1	1	1	22	Very Poor
2070	3	3	3	3	3	5	5	3	5	3	5	5	46	Good
2071	3	3	5	3	5	1	3	3	1	1	5	1	34	Fair
2072	5	3	5	5	5	3	3	3	3	3	5	3	46	Good
2082	1	1	1	1	1	3	3	3	3	1	5	1	24	Very Poor
2083	3	1	1	3	1	3	5	1	5	3	5	1	32	Poor
2084	5	5	5	5	3	3	1	1	3	5	1	1	38	Fair
2085	5	5	5	3	5	1	5	5	5	1	1	5	46	Good
2086	5	5	5	5	3	3	3	3	5	1	1	5	44	Good
2214	3	3	3	5	1	1	5	3	1	1	5	1	32	Poor
2287	5	5	1	5	3	3	1	3	3	5	5	1	40	Fair

[1] TOTSP-no. native species; CYPRIN-no. of cyprinid species; SUCK-no. sucker species; LEPOM-no. *Lepomis* species; DARMD-no. darter+madtom species; DOM-proportion of dominant species; TOL-proportion of tolerant species; PLEPO-proportion of Lepomis; OMNI-proportion of omnivores and herbivores;TC-proportion of top carnivores; DELHY-proportion with DELT+hybrids; SIMLTH-proportion of simple lithophilic spawners.

Table 12. IBI integrity classes for the Plateau, Southern Plains, Tennessee Valley, and Ridge and Valley/Piedmont ichthyoregions.

Integrity classes	Plateau	Southern Plains	Tennessee Valley	Ridge and Valley/ Piedmont
Very poor - VP	$\leq$ 25	$\leq$ 25	$\leq$ 21	$\leq$ 26
Poor - P	26 - 32	26 - 35	22 - 28	27 - 34
Fair - F	33 - 40	36 - 43	29 - 40	35 - 42
Good - G	41 - 49	44 - 50	41 - 49	43 - 50
Excellent - E	$\geq$50	>50	$\geq$ 50	>50

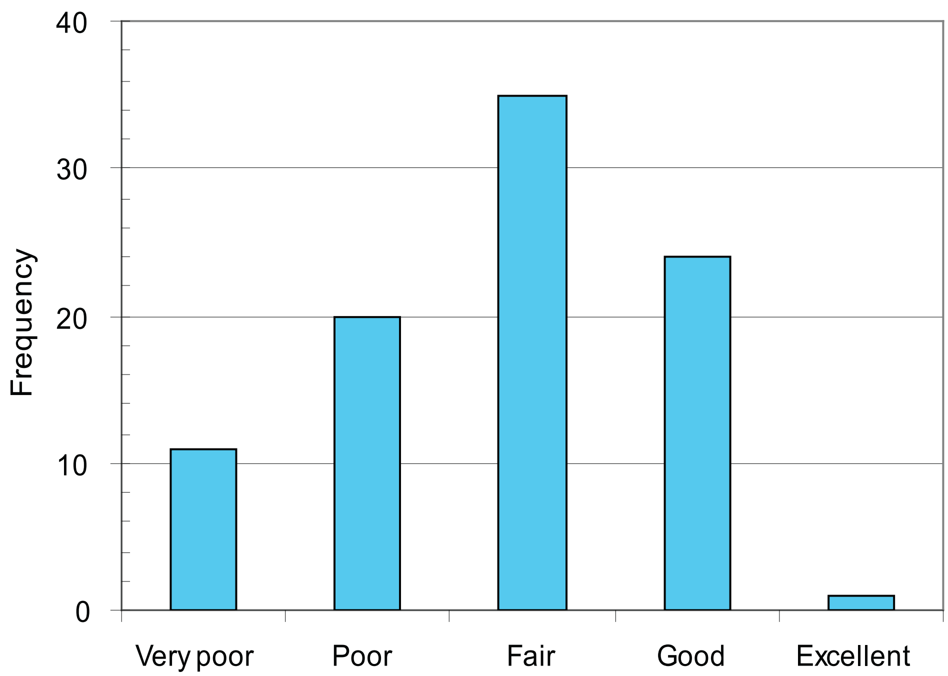


Figure 18. Frequency distribution of IBI integrity classes for sites in the Plateau ichthyoregion.

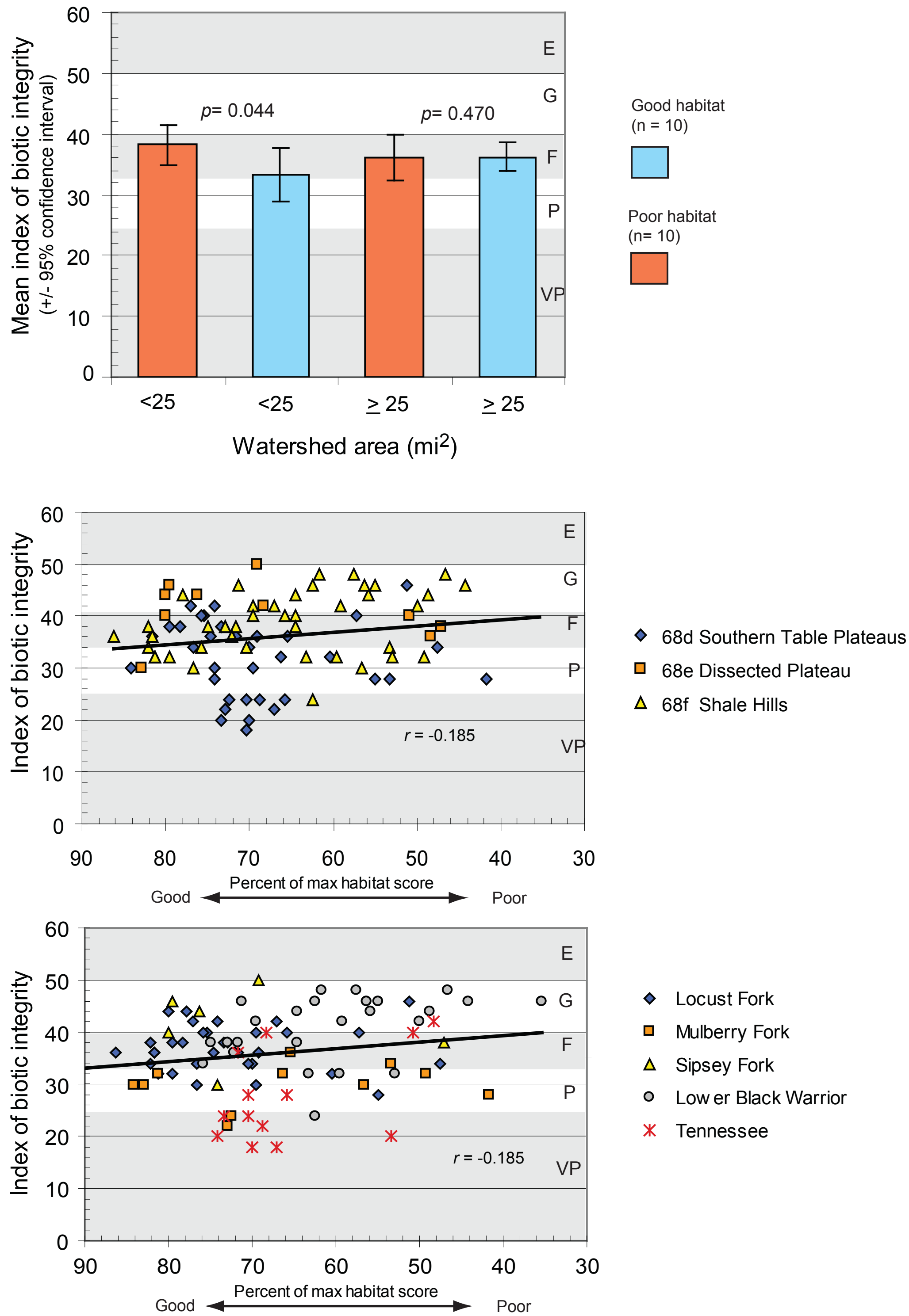


Figure 19. Comparison of the IBI in level IV ecoregions and drainages relative to habitat quality and a comparison of IBI scores for small and large watersheds relative to habitat quality.

correlation with disturbance scores, declining as watershed disturbance increased (fig. 20).

The Plateau IBI was developed as a regional tool for evaluating biological condition in streams of this ichthyoregion. To be useful at this scale, the IBI tool should be reasonably independent of local faunal influences such as river system and ecoregion. The relationships depicted among the IBI and habitat (fig. 19) and disturbance (fig. 20) were further evaluated by segregating data into level IV ecoregions and major drainage systems. These bivariate plots demonstrate a substantial level of overlap across level IV ecoregions and drainages between habitat quality relative to the IBI. Likewise, the relationships between watershed disturbance and the IBI overlapped substantially as well.

The concept of biologically based tiered aquatic-life uses (TALU) is emerging as a framework to incorporate ecologically relevant information into water-quality management decisions, biologically quantify water-quality improvements, and to merge the practice of biological monitoring and assessment with the implementation of water-quality standards (USEPA, 2005). Implementation of aquatic-life uses into water-quality management is developing around a scientific model known as the biological condition gradient (BCG), which describes how certain attributes of aquatic ecosystems, such as community structure, condition of organisms, and ecosystem function, respond to increasing levels of stressors (USEPA, 2005). The BCG can be considered an instream-based aquatic community analog of the classical laboratory-based dose-response toxicity relationship for single species. Dose in the BCG model (x axis) equals increasing levels of stressors and response (y axis) equals some measure of biological condition, such as the IBI.

The BCG model can be applied to the calibrated IBI for the Plateau ichthyoregion with the IBI serving as the measure of biological condition (y axis) and habitat quality (percent of maximum attainable habitat score) or human disturbance serving as the measure of increasing level of ecosystem stress (x axis) (fig. 21). The Plateau IBI was integrated with the BCG model by using the IBI integrity classes (table 12) as tiers and the IBI endpoints within each tier to define a subset of data for calculating statistical

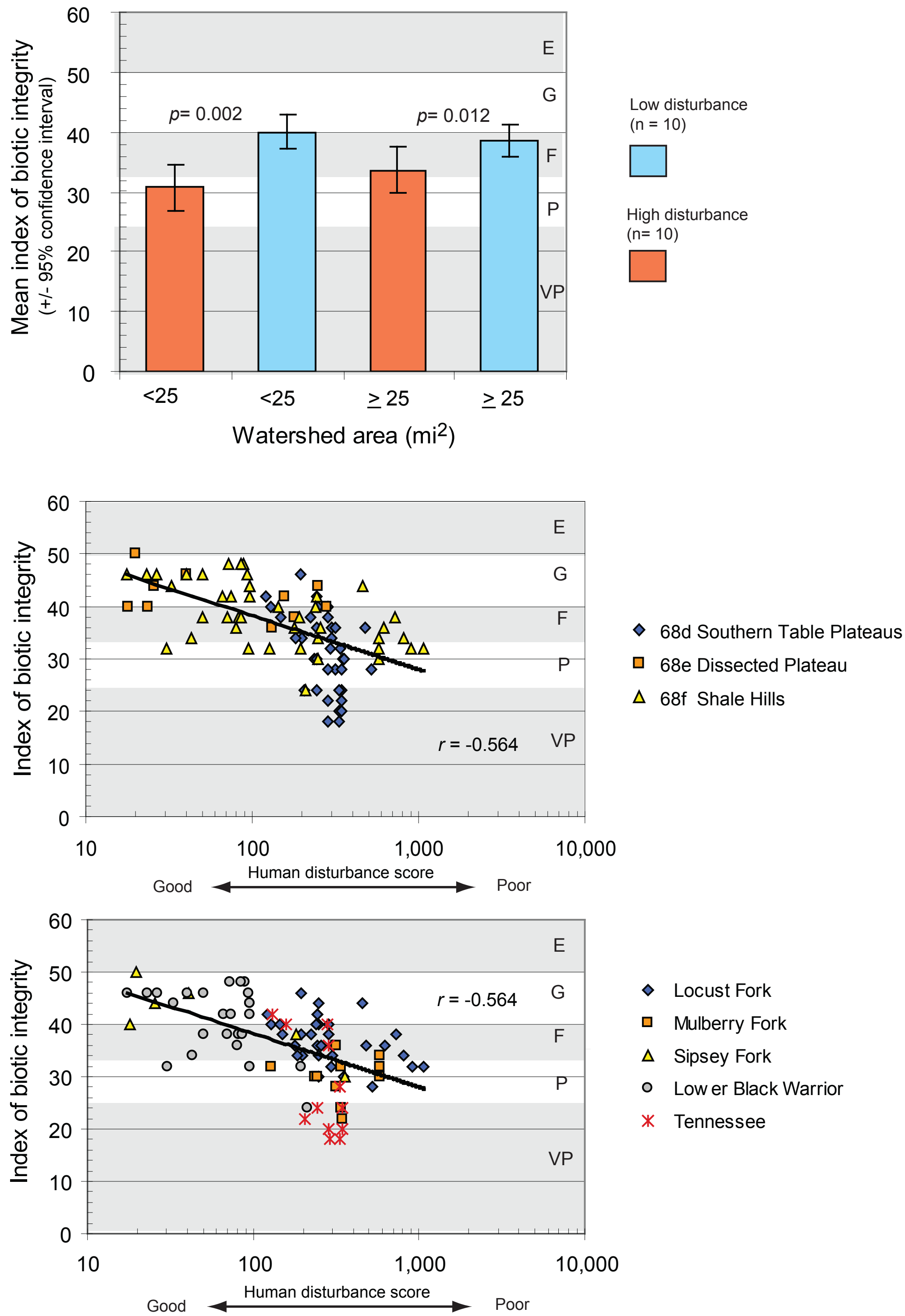


Figure 20. Comparison of the IBI in level IV ecoregions and drainages relative to human disturbance and a comparison of IBI scores for small and large watersheds relative to human disturbance.

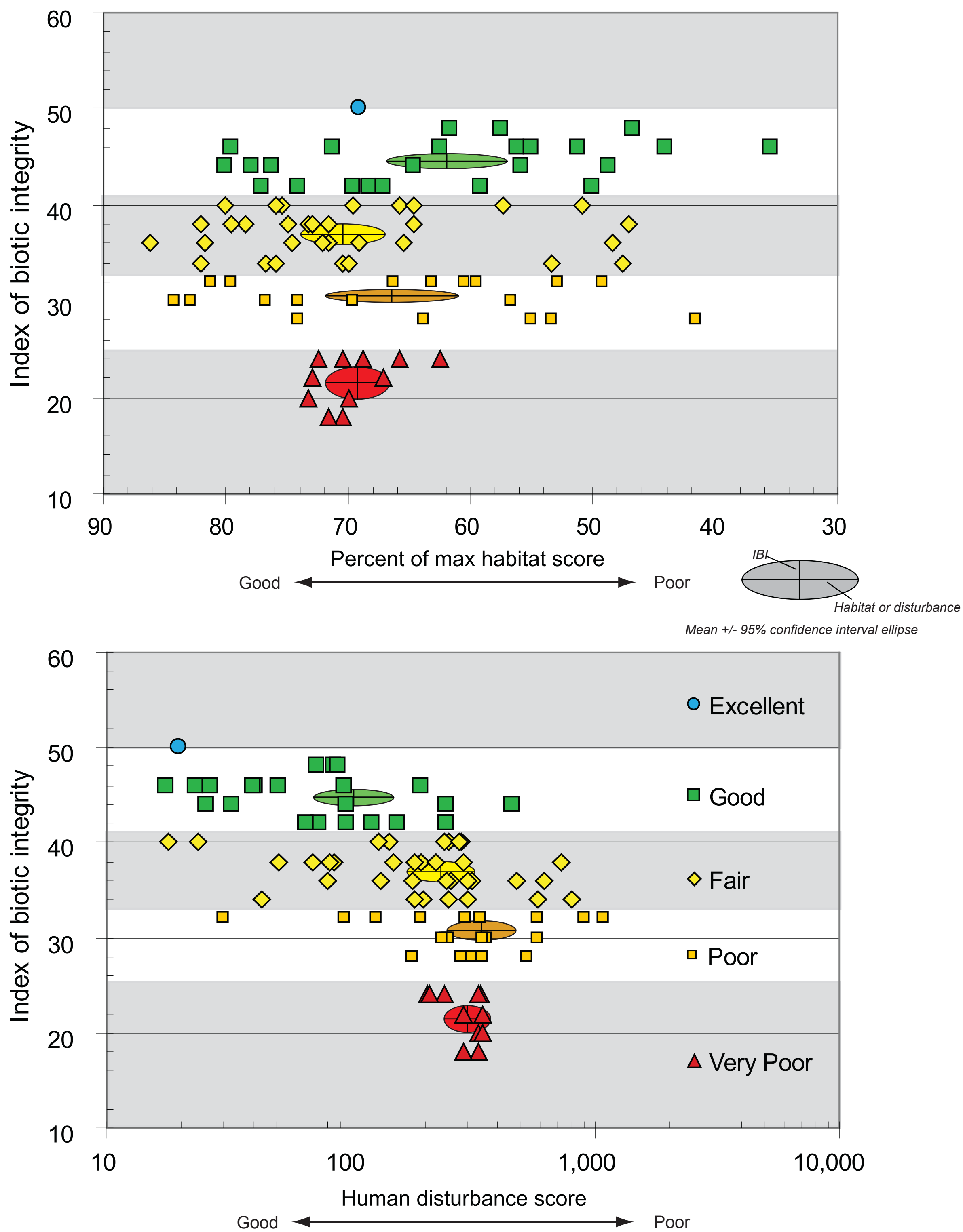


Figure 21. Tiered aquatic life use relationships between the IBI, habitat quality, and human disturbance for sites in the Plateau ichthyoregion.

limits (95% confidence interval) for graphical description. Curves were hand fitted to the biological integrity tiers (fig. 22) ranging from a more gradually declining logistic relationship, curve A, to the very steep relationship depicted in curve C which describes a threshold “all-or-none” relationship where biological condition degrades precipitously when habitat degradation or watershed disturbance reaches a critical threshold. Because the habitat-IBI relationships were so poor, they could not be modeled using this method. The disturbance-IBI relationship was best modeled using curve A which captured all the biological condition tiers from poor to excellent. These results were similar to those described for the Southern Plains, Tennessee Valley, and Ridge and Valley/Piedmont ichthyoregions (O’Neil and Shepard 2009, 2010, 2011). If curve A is used to describe the relationship between biological condition and disturbance, then it can be estimated that when the disturbance index exceeds 200, biological condition will decline to poor scores. A similar result was found for the Southern Plains, Tennessee Valley, and Ridge and Valley/Piedmont ichthyoregions.

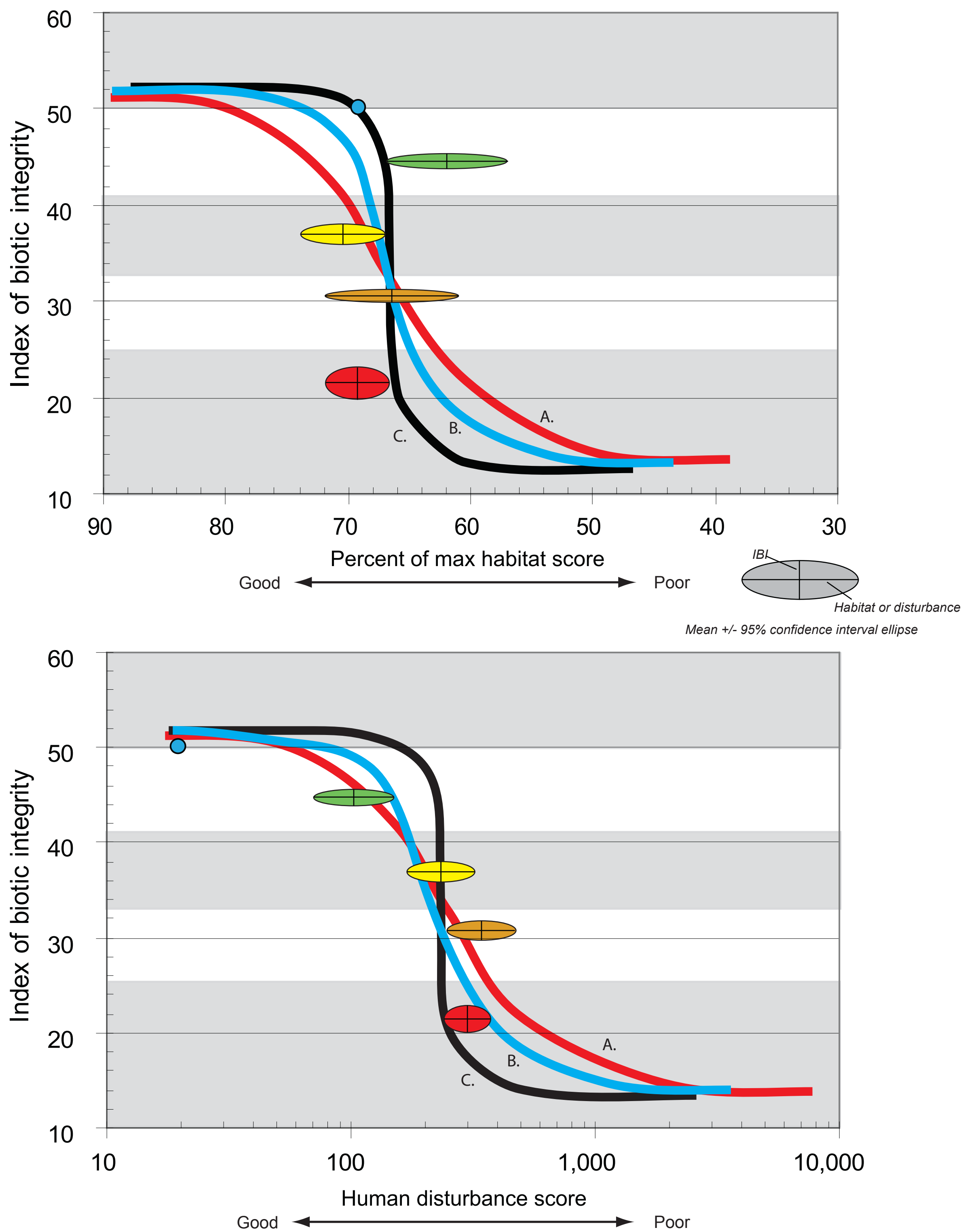


Figure 22. Biological condition gradient models for the Plateau ichthyoregion.

CONCLUSIONS

The IBI has been demonstrated in many states to correspond negatively to increasing levels of watershed disturbance and habitat degradation. We found this to be true for the Plateau ichthyoregion as well although the relationship of the IBI to habitat quality was poorly defined in this ichthyoregion. The degree of watershed disturbance was a good predictor of biological condition as measured with the IBI. Compared to other regions of Alabama, the Plateau ichthyoregion supports a less diverse fish community likely due to both natural zoogeographic considerations and the long-term effects of poor land use practices. Around 28 percent of the sites scored in the good to excellent IBI range, with only one site scoring excellent, indicating highly functional watersheds. About 38 percent of the sites scored in the fair range, indicating watersheds that support a functional fish community yet have nonpoint source pollution problems that are likely linked to excessive sediment or nutrient runoff. Streams in this ichthyoregion have been exposed to widespread agricultural and mining activities for years as well as expanding urban centers and these activities have adversely affected some streams, lowering biological quality. Around 34 percent of the sampled sites scored in the very poor to poor range indicating poorly functioning fish communities with low biodiversity, higher proportions of tolerant species, and out of balance trophic levels. These watersheds are good candidates for implementing conservation activities and can be improved through cooperative watershed management, active restoration of stream channels, and reductions of nonpoint source pollution.

We continue to use some traditional metrics while formulating and calibrating the IBI to Alabama’s ichthyoregions. Several of these metrics are intuitively desirable from an ecological standpoint since they represent aspects of the fish community that should be considered in assessment studies, although in some ichthyoregions they have poor statistical properties compared to other metrics. We will continue this practice until all stream data have been collected and we can compare metrics from the full range of expected biological conditions statewide.

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Appendix A

Habitat evaluation forms

ADEM-FIELD OPERATIONS-MONTGOMERY BRANCH
RIFFLE/RUN HABITAT ASSESSMENT FIELD DATA SHEET

Name of Waterbody ______________________ Date: ______________

Station Number ______________ Investigators ______________________

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
1 **Instream Cover**	>50% mix of boulder, cobble, submerged logs, undercut banks, or other stable habitat.	50-30% mix of boulder, cobble, or other stable habitat; adequate habitat.	30-10% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable.	<10% mix of boulder, cobble, or other 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 **Epifaunal surface**	Well-developed riffle and run; riffles as wide as stream and length is 2x the width of stream; abundance of cobble.	Riffle is as wide as stream, but length is <2 times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is <2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3 **Embeddedness**	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble and boulder particles are >75% surrounded by fine sediment.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4 **Velocity/Depth Regimes**	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-shallow, fast-deep).	Only 3 of 4 regimes present. (if fast-shallow is missing, score lower.)	Only 2 of 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5 **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; and 40 - 80% of stream reach is channelized and disrupted.	Banks shored with gabion or cement; >80% of the stream reach channelized and disrupted.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6 **Sediment Deposition**	Little or no enlargement of islands or point bars and less than 5 % of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel or coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstruction, constriction, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; > 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7 **Frequency of Riffles** (Distance between riffles/ stream width)	<5 5 6 7	8 9 11 13 15	16 18 21 23 25	26 28 30 32 34 $\geq$ 35
Score ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8 **Channel flow Status**	Water reaches base of both lower banks.	Water fills >75% of the available channel.	Water fills 75 - 25% 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
9 **Condition of Banks**	Banks stable; no evidence (<5%) of erosion or bank failure.	Moderately stable; infrequent, small areas (5-30%) of erosion mostly healed over.	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
10 **Bank Vegetative Protection**	>90% of the streambank surfaces covered by vegetation.	90-70% of the streambank surfaces covered by vegetation.	70-50% of the streambank 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
11 **Grazing or other disruptive pressure**	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 streambank 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
12 **Riparian vegetative zone (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

ADEM-FIELD OPERATIONS-MONTGOMERY BRANCH
GLIDE/POOL HABITAT ASSESSMENT FIELD DATA SHEET

Name of Waterbody ______________________ Date: ______________

Station Number ______________ Investigators ______________________

Habitat Parameter	Category: 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 streambank surfaces covered by vegetation.	90-70% of the streambank surfaces covered by vegetation.	70-50% of the streambank 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 streambank vegetation is very high; vegetation has been removed to ≤ 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

Appendix B

Reproduction and trophic guild classifications for Alabama fishes

Explanation

Conservation status (Cons. Status)
(from Mirarchi, 2004)
- P1-highest concern
- P2-high concern
- P3-moderate concern
- P4-low concern
- P5-lowest concern
- E-endangered
- T-threatened

Vulnerability (Vulner.)
(From Jelks and others, 2008)
- CS-currently stable
- V-vulnerable

Habitat
- I-impoundment
- R-river
- S-stream
- H-headwater
- Sp-spring
- Ca-cave
- Sw-swamp
- E-estuarine

Distribution (Dist.)
- W-widespread
- R-restricted
- D-disjunct
- Ex-extirpated
- I-introduced

Abundance (Abund.)
- C-common
- O-occasional
- U-uncommon
- R-rare
- Unk-unknown

Reproduction guild (Repro. guild)
- 1-simple lithophils
- 2-manipulative lithophils
- 3-simple nonlithophils
- 4- manipulative nonlithophils

Feeding guild
- DAH-detritovore-algivore-herbivore
- AHI-algivore-herbivore-invertivore
- INV-invertivore
- INS-insectivore
- PIS-piscivore
- PAR-parasite
- IP-invertivore, piscivore

Tolerance
- INT-intolerant
- TOL-tolerant

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
PETROMYZONTIDAE- LAMPREYS								
Ichthyomyzon bdellium - Ohio Lamprey	P5	CS	R, S	R	O	2	PAR	--
I. castaneus - Chestnut Lamprey	P5	CS	I, R, S	W	O	2	PAR	--
I. gagei - Southern Brook Lamprey	P5	CS	R, S	W	O	2	DAH	--
I. greeleyi - Mountain Brook Lamprey	P3	CS	S, H	R	U	2	DAH	INT
Lampetra aepyptera - Least Brook Lamprey	P5	CS	S, H	W	O	2	DAH	--
L. appendix - American Brook Lamprey	P3	CS	S	R	U	2	DAH	--
CARCHARHINIDAE- REQUIEM SHARKS								
Carcharhinus leucas - Bull Shark	P5	CS	E, R	R	R	3	PIS	--
ACIPENSERIDAE- STURGEONS								
Acipenser fulvescens - Lake Sturgeon	Ex	V	R	Ex	Unk	1	INV	--
A. oxyrhinchus desotoi- Atlantic Sturgeon	P2, T	T	R	R	U	1	INV	INT
Scaphirhynchus platorynchus - Shovelnose Sturgeon	Ex	CS	R	Ex	Unk	1	INV	--
S. suttkusi - Alabama Sturgeon	P1, E	E	R	R	R	1	INV	INT
POLYODONTIDAE- PADDLEFISH								
Polyodon spathula - Paddlefish	P4	V	R, I	W	O	3	AHI	--
LEPISOSTEIDAE- GARS								
Atractosteus spatula - Alligator Gar	P3	V	R	R	O	3	IP	--
Lepisosteus oculatus - Spotted Gar	P5	CS	R, I, Sw	W	C	3	IP	--
L. osseus - Longnose Gar	P5	CS	R, I	W	C	3	IP	TOL
L. platostomus - Shortnose Gar	Ex	CS	R, I	Ex	Unk	3	IP	TOL
AMIIDAE- BOWFIN								
Amia calva - Bowfin	P5	CS	R, I, Sw	W	O	4	IP	--
HIODONTIDAE- MOONEYES								
Hiodon alosoides - Goldeye	Ex	CS	R, I	Ex	Unk	1	IP	--
H. tergisus - Mooneye	P4	CS	R, I	W	O	1	IP	--
ANGUILLIDAE- FRESHWATER EELS								
Anguilla rostrata - American Eel	P4	CS	R, I	W	O	3	IP	--
CLUPEIDAE-HERRINGS								
Alosa alabamae - Alabama Shad	P2	T	R	W	R	3	INV	INT
A. chrysochloris - Skipjack Herring	P3	CS	R	W	C	3	INV	--
Dorosoma cepedianum - Gizzard Shad	P5	CS	I, R, S	W	C	3	AHI	TOL
D. petenense - Threadfin Shad	P5	CS	I, R, S	W	C	3	AHI	--
ENGRAULIDAE- ANCHOVIES								
Anchoa mitchilli - Bay Anchovy	P5	CS	E, R	R	C	3	INV	--

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
CYPRINIDAE- CARPS AND MINNOWS								
Campostoma oligolepis - Largescale Stoneroller	P5	CS	S, H	W	C	2	DAH	--
C. pauciradii - Bluefin Stoneroller	P3	CS	S, H	R	C	2	DAH	--
Carassius auratus - Goldfish	P5	CS	I	I, R	U	3	AHI	TOL
Clinostomus funduloides - Rosyside Dace	P5	CS	S, H	R	O	1	INV	--
Ctenopharyngodon idella - Grass Carp	Exotic	CS	R, I	I, W	U	3	AHI	TOL
Cyprinella caerulea - Blue Shiner	P2, T	E	S	R, D	R	3	INS	INT
C. callistia - Alabama Shiner	P5	CS	R, S	W	C	3	INV	--
C. callitaenia - Bluestripe Shiner	P3	V	R, S	R	U	3	INS	INT
C. galactura - Whitetail Shiner	P5	CS	S	R	C	3	INS	--
C. gibbsi - Tallapoosa Shiner	P4	CS	S, H	R	C	3	INS	--
C. lutrensis - Red Shiner	Exotic	CS	I, S	R	R	3	INS	TOL
C. spiloptera - Spotfin Shiner	P5	CS	I, R, S	R	C	3	INS	--
C. trichroistia - Tricolor Shiner	P5	CS	R, S	R	C	3	INS	--
C. venusta - Blacktail Shiner	P5	CS	I, R, S	W	C	3	INV	--
C. whipplei - Steelcolor Shiner	P5	CS	I, R, S	W	C	3	INV	TOL
Cyprinus carpio - Common Carp	Exotic	CS	I, R	I, W	C	3	INV,DAH	TOL
Erimonax monachus - Spotfin Chub	T	T	S	Ex	R	3	INS	INT
Erimystax dissimilis - Streamline Chub	P2	CS	S	R	U	1	INS	INT
E. insignis - Blotched Chub	P3	CS	S	R	U	1	INS	--
Hemitremia flammea - Flame Chub	P4	V	Sp, H	R	O	3	INV	--
Hybognathus hayi - Cypress Minnow	P4	CS	R, I, Sw	W	U	1	DAH	--
H. nuchalis - Mississippi Silvery Minnow	P4	CS	R, I	W	C	1	DAH	--
Hybopsis amblops - Bigeye Chub	P5	CS	S	R	O	1	INS,INV	INT
H. lineapunctata - Lined Chub	P5	V	S, H	R	C	1	INS	INT
H. winchelli -Clear Chub	P5	CS	R, S, I	W	C	1	INS	--
H. sp. cf winchelli -undescribed (Coastal Plain form)	P5	CS	R, S	W	C	1	INS	--
Hypophthalmichthys molitrix - Silver Carp	Exotic	CS	I, R	I	U	3	DAH	TOL
H. nobilis - Bighead Carp	Exotic	CS	I, R	I	U	3	DAH,INV	TOL
Luxilus chrysocephalus - Striped Shiner	P5	CS	S, H	W	C	2	INS,DAH	TOL
L. coccogenis - Warpaint Shiner	P4	CS	S, H	R	O	1	INS,INV	--
L. zonistius - Bandfin Shiner	P5	CS	S, H	R	O	1	INS,DAH	--
Lythrurus alegnotus - Warrior Shiner	P5	CS	S, H	R	O	1	INS	--
L. atrapiculus - Blacktip Shiner	P5	CS	S, H	R	C	1	INS	--
L. bellus - Pretty Shiner	P5	CS	S, H	W	C	1	INS	--

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
L. fasciolaris - Scarlet Shiner	P5	CS	S, H	R	C	1	INS	--
L. fumeus - Ribbon Shiner	P3	CS	S	R	U	1	INS	--
L. lirus - Mountain Shiner	P4	CS	S, H	R	O	1	INS	INT
L. roseipinnis - Cherryfin Shiner	P5	CS	S, H	R	C	1	INS	--
Macrhybopsis aestivalis hyostoma - Shoal Chub	P2	CS	R, S	R	R	1	INS	INT
M. sp cf *aestivalis* - undescribed chubs	P4	T, V	R, S	W	O	1	INS	INT
M . sp. cf *aestivalis* - undescribed Florida Chub	P4	V	R, S	W	O	1	INS	INT
M. storeriana - Silver Chub	P5	CS	I, R, S	W	O	1	INS,INV	--
Nocomis leptocephalus - Bluehead Chub	P5	CS	S, H	W	C	2	INS,AHI	--
N. micropogon - River Chub	P4	CS	S, C	W	U	2	INV	--
Notemigonus crysoleucas - Golden Shiner	P5	CS	I, R, S	W	O	3	INS,AHI	TOL
Notropis albizonatus - Palezone Shiner	P1, E	E	S, H	R	R	1	INS,AHI	INT
N. ammophilus - Orangefin Shiner	P5	CS	R, S	W	C	1	INS,DAH	--
N. amplamala - Longjaw Minnow	P5	CS	R, S	W	C	1	INS,AHI	--
N. ariommus - Popeye Shiner	Ex	V	S	Ex	Unk	1	INS,DAH	--
N. asperifrons - Burrhead Shiner	P5	CS	S	W, D	O	1	INS,DAH	INT
N. atherinoides - Emerald Shiner	P5	CS	I, R, S	W	C	1	INS,AHI	--
N. baileyi - Rough Shiner	P5	CS	S, H	W	C	2	INS,DAH	--
N. boops - Bigeye Shiner	P5	CS	S, H	R	U	1	INS,DAH	INT
N. buchanani - Ghost Shiner	P2	CS	I, R	R	U	1	INS,DAH	INT
N. cahabae - Cahaba Shiner	P1, E	E	R	R	R	3	INS,DAH	INT
N. candidus - Silverside Shiner	P5	CS	I, R	W	C	1	INS,DAH	--
N. chalybaeus - Ironcolor Shiner	P1	V	S, Sp	W	U	1	INS,DAH	INT
N. chrosomus - Rainbow Shiner	P5	CS	H	W, D	O	2	INS,DAH	INT
N. cummingsae - Dusky Shiner	P2	CS	H, Sw	R	U	1	INS,DAH	INT
N. edwardraneyi- Fluvial Shiner	P5	CS	I, R	W	C	1	INS,AHI	--
N. harperi- Redeye Chub	P5	CS	H, Sp	R	U	1	INS,DAH	INT
N. hypsilepis - Highscale Shiner	P3	V	S, H	R	O	1	INS,DAH	INT
N. leuciodus - Tennessee Shiner	P4	CS	S, H	R	O	2	INS,DAH	INT
N. longirostris - Longnose Shiner	P5	CS	R, S	W	C	1	INS,DAH	--
N. maculatus - Taillight Shiner	P4	CS	S, Sw	W	U	3	INS,AHI	--
N. melanostomus - Blackmouth Shiner	P1	T	S	R	R	2	INS	INT
N. micropteryx- Highlands Shiner	P3	CS	S	R	U	1	INS,DAH	INT
N. peterson i- Coastal Shiner	P5	CS	S	R	O	1	INS,DAH	--
N. photogenis - Silver Shiner	P3	CS	S	R	U	1	INS,AHI	INT

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N. stilbius - Silverstripe Shiner	P5	CS	S	W	C	1	INS,DAH	--
N. telescopus - Telescope Shiner	P5	CS	S, H	R	O	1	INS,DAH	--
N. texanus - Weed Shiner	P5	CS	I, R, S	W	C	1	INS,DAH	--
N. uranoscopus - Skygazer Shiner	P3	CS	R	R	C	1	INS,DAH	INT
N. volucellus - Mimic Shiner	P5	CS	R, S	W	C	3	INS,AHI	--
N . sp cf *volucellus* -undescribed (Mobile basin form)	P5	CS	R, S	W	C	3	INS,AHI	--
N. wickliffi - Channel Shiner	P5	CS	I, R	R	U	3	INS,DAH	--
N. xaenocephalus - Coosa Shiner	P5	CS	S, H	R	C	1	INS,DAH	--
N . sp cf *spectrunculus* -undescribed (sawfin shiner)	P4	CS	S, H	R	U	1	INS,DAH	INT
Opsopoeodus emiliae - Pugnose Minnow	P5	CS	I, R, S	W	O	4	AHI	--
Phenacobius catostomus - Riffle Minnow	P5	CS	R, S	W	O	1	INS	--
P. mirabilis - Suckermouth Minnow	P1	CS	S	R	U	1	INS	INT
P. uranops - Stargazing Minnow	P2	CS	S	R	U	1	INS	INT
Phoxinus erythrogaster - Southern Redbelly Dace	P5	CS	S, H	R	O	1	AHI	--
Pimephales notatus - Bluntnose Minnow	P5	CS	R, S, H	W	C	4	DAH,INV	TOL
P. promelas - Fathead Minnow	P5	CS	I, R, S	I	U	4	DAH,INV	TOL
P. vigilax - Bullhead Minnow	P5	CS	I, R, S	W	C	4	DAH,INV	TOL
Pteronotropis euryzonus - Broadstripe Shiner	P2	V	S, Sw	R	O	1	INS,DAH	INT
P. grandipinnis - Apalachee Shiner	P3	CS	S, H	W	C	1	INS,DAH	--
P. hypselopterus - Sailfin Shiner	P5	CS	S, H	W	C	1	INS,DAH	--
P. merlini - Orangetail Shiner	P4	V	S, H	W	C	1	INS,DAH	--
P. signipinnis - Flagfin Shiner	P5	CS	S, Sw	R	O	1	INS,DAH	--
P. welaka - Bluenose Shiner	P2	V	S, Sw	W	U	1	INS,DAH	INT
Rhinichthys atratulus - Blacknose Dace	P5	CS	S, H, Sp	R	O	1	INS	TOL
Semotilus atromaculatus - Creek Chub	P5	CS	S, H, Sp	W	C	2	IP,INS	TOL
S. thoreauianus - Dixie Chub	P5	CS	S, H, Sp	W	O	2	IP,INS	--
CATOSTOMIDAE- SUCKERS								
Carpiodes carpio- River Carpsucker	P5	CS	I, R	R	O	3	DAH,INV	--
C. cyprinus - Quillback	P5	CS	I, R	W	C	3	DAH,INV	--
C. velifer - Highfin Carpsucker	P5	CS	I, R	W	C	3	DAH,INV	--
Catostomus commersoni - White Sucker	P5	CS	S, H, Sp	R	O	1	INV,AH	--
Cycleptus elongatus - Blue Sucker	P3	V	I, R	R	U	1	AHI	INT
Cycleptus meridionalis - Southeastern Blue Sucker	P4	V	I, R	W	C	1	AHI	--
Erimyzon oblongus - Creek Chubsucker	P5	CS	S, H	W	C	2	INV,AH	--
E. sucetta - Lake Chubsucker	P5	CS	S, Sw	W	O	2	AHI	--
E. tenuis - Sharpfin Chubsucker	P5	CS	S, Sw	W	O	2	AHI	--

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Hypentelium etowanum - Alabama Hog Sucker	P5	CS	R, S	W	C	1	AHI	--
H. nigricans - Northern Hog Sucker	P5	CS	R, S	R	C	1	AHI	--
Ictiobus bubalus - Smallmouth Buffalo	P5	CS	I, R	W	C	3	INV	--
I. cyprinellus - Bigmouth Buffalo	P5	CS	I, R	R	O	3	INV	--
I. niger - Black Buffalo	P5	CS	I, R	R	O	3	INV	--
Minytrema melanops - Spotted Sucker	P5	CS	I, R, S	W	C	1	INV,DAH	TOL
Moxostoma anisurum - Silver Redhorse	P5	CS	I, R, S	R	O	1	INV	--
M. breviceps - Smallmouth Redhorse	P5	CS	I, R, S	R	O	1	INV	--
M. carinatum - River Redhorse	P5	CS	I, R	W	O	1	INV	INT
M. duquesnei - Black Redhorse	P5	CS	I, R, S	W	C	1	INV	--
M. erythrurum - Golden Redhorse	P5	CS	I, R, S	W	C	1	INV	--
M. lacerum - Harelip Sucker	Extinct	X	--	Extinct	--	1	INV	--
M. poecilurum - Blacktail Redhorse	P5	CS	I, R, S	W	C	1	INV	--
M . sp cf *poecilurum* - Apalachicola Redhorse	P4	CS	I, R, S	R	O	1	INV	--
Scartomyzon lachneri - Greater Jumprock	P5	CS	I, R, S	R	C	1	INV	--
ICTALURIDAE- BULLHEAD CATFISHES								
Ameiurus brunneus - Snail Bullhead	P4	V	I, R, S	R	O	4	IP,DAH	--
A. catus - White Catfish	P4	CS	I, R, S	W	U	4	IP,DAH	--
A. melas - Black Bullhead	P5	CS	R, S	W	O	4	AHI,PIS	TOL
A. natalis - Yellow Bullhead	P5	CS	I, R, S	W	C	4	AHI,PIS	TOL
A. nebulosus - Brown Bullhead	P5	CS	I, R, S, Sw	W	U	4	IP,DAH	TOL
A. serracanthus - Spotted Bullhead	P3	V	I, R	R	U	4	AHI,PIS	--
Ictalurus furcatus - Blue Catfish	P5	CS	I, R	W	C	4	INV	--
I. punctatus - Channel Catfish	P5	CS	I, R, S	W	C	4	INV	--
Noturus crypticus - Chucky madtom	Ex	E	R, S	Ex	Unk	4	INS,INV	INT
N. eleutherus - Mountain Madtom	P2	CS	R, S	R	R	4	INS,INV	INT
N. exilis - Slender Madtom	P5	CS	S	R	U	4	INS,AH	--
N. funebris - Black Madtom	P5	CS	S, H	W	C	4	INV	--
N. gyrinus - Tadpole Madtom	P5	CS	S, H	W	C	4	INS,INV	--
N. leptacanthus - Speckled Madtom	P5	CS	S, H	W	C	4	INS	--
N. miurus - Brindled Madtom	P2	CS	S	R	U	4	INS,INV	INT
N. munitus - Frecklebelly Madtom	P2	V, E	R, S	D	R	4	INS,INV	INT
N. nocturnus - Freckled Madtom	P5	CS	S	W	U	4	INS,INV	--
N . sp. cf *flavus* - Highlands Stonecat	P2	CS	R, S	R	U	4	INS,AH,PIS	INT
Pylodictis olivaris - Flathead Catfish	P5	CS	I, R	W	O	4	IP	--

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ESOCIDAE-PIKES								
Esox americanus - Redfin Pickerel	P5	CS	S, H, Sw	W	O	3	IP	--
E. masquinongy - Muskellunge	Exotic	CS	I, R, S	I, R	R	3	IP	--
E. niger - Chain Pickerel	P5	CS	I, R, S, Sw	W	O	3	IP	--
SALMONIDAE- TROUTS								
Oncorhynchus mykiss - Rainbow Trout	Exotic	CS	S	I, R	U	1	IP	INT
Salmo trutta - Brown Trout	Exotic	CS	S	I, R	R	1	IP	INT
APREDODERIDAE- PIRATE PERCH								
Aphredoderus sayanus - Pirate Perch	P5	CS	S, H, Sw	W	O	4	INS, PIS	--
AMBLYOPSIDAE- CAVEFISHES								
Speoplatyrhinos poulsoni - Alabama Cavefish	P1, E	E	Ca	R	R	4	DAH,INV	INT
Typhlichthys subterraneus - Southern Cavefish	P3	V	Ca	R	U	4	DAH,INV	INT
MUGILIDAE								
Mugil cephalus - Striped Mullet	P5	CS	E, I, R	W	O	3	DAH,INV	--
ATHERINOPSIDAE- NEW WORLD SILVERSIDES								
Labidesthes sicculus - Brook Silverside	P5	CS	I, R, S	W	C	3	INV	--
Menidia audens - Mississippi Silverside	P5	CS	E, R	R	O	3	INV	--
M. beryllina - Inland Silverside	P5	CS	E, R	R	O	3	INV	--
BELONIDAE- NEEDLEFISHES								
Strongylura marina - Atlantic Needlefish	P5	CS	I, R	W	O	3	PIS	--
FUNDULIDAE- TOPMINNOWS AND KILLIFISHES								
Fundulus albolineatus- Whiteline Topminnow	Extinct	X	--	Extinct	Unk		INV	--
F. bifax - Stippled Topminnow	P3	V	R, S, Sw	R	O	1	INV	--
F. blairae - Western Starhead Topminnow	P4	CS	S, Sw	W	U	3	INV	--
F. catenatus - Northern Studfish	P5	CS	S, H	R	O	1	INV	--
F. chrysotus - Golden Topminnow	P4	CS	Sw	R	U	3	INS,INV	--
F. cingulatus - Banded Topminnow	P4	CS	S, Sp, Sw	R	U	3	INV	--
F. confluentus - Marsh Killifish	P3	CS	S, Sw	R	R	3	INV	--
F. dispar - Starhead Topminnow	P3	CS	I, S, Sw	W	O	3	INV	--
F. escambiae - Russetfin Topminnow	P5	CS	R, S, Sw	W	C	3	INV	--
F. jenkinsi - Saltmarsh Topminnow	P3	CS	S, Sw	R	R	3	INV	--
F. notatus - Blackstripe Topminnow	P5	CS	I, R, S, Sw	W	O	3	AHI	--
F. nottii - Bayou Topminnow	P5	CS	I, R, S, Sw	W	C	3	AHI	--
F. olivaceus - Blackspotted Topminnow	P5	CS	R, S, Sw, H	W	C	3	INV	--
F. pulvereus - Bayou Killifish	P3	CS	R, Sw	R	U	3	INV	--
F. stellifer - Southern Studfish	P5	CS	R, S	W	O	1	INV	--

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Leptolucania ommata - Pygmy Killifish	P4	CS	Sw	R	U	3	INS	--
Lucania goodei - Bluefin Killifish	P3	CS	Sw, Sp	R	O	3	INS	--
L. parva - Rainwater Killifish	P4	CS	E, Sw	R	O	3	INS	--
POECILIIDAE- LIVEBEARERS								
Gambusia affinis - Western Mosquitofish	P5	CS	I, R, S, Sw, H	W	C	4	INS,AHI	TOL
G. holbrooki - Eastern Mosquitofish	P5	CS	I, R, S, Sw	W	C	4	INS,AHI	TOL
Heterandria formosa - Least Killifish	P4	CS	Sw	R	U	4	INS,AHI	--
Poecilia latipinna - Sailfin Molly	P5	CS	Sw	R	O	4	INV	--
CYPRINODONTIDAE- PUPFISHES								
Cyprinodon variegatus - Sheepshead Minnow	P5	CS	Brackish	R	C	2	INV	--
COTTIDAE- SCULPINS								
Cottus bairdi - Mottled Sculpin	P5	CS	S, H	R	O	2	INS,IP	--
C. carolinae - Banded Sculpin	P5	CS	S, H, Sp	W	C	2	INS,IP	--
C. tallapoosae - Tallapoosa sculpin	P3	CS	S, H, Sp	W	C	2	IP	--
C. paulus - pygmy sculpin	P1, T	E	Sp	R	R	2	INV	INT
MORONIDAE- TEMPERATE BASSES								
Morone chrysops - White Bass	P5	CS	I, R	W	O	3	IP	--
M. mississippiensis - Yellow Bass	P5	CS	I, R	W	O	3	IP	--
M. saxatilis - Striped Bass	P3	CS	I, R	W	O	3	IP	--
M. chrysops (male) x *M. saxatilis* (female)	--		I, R	W	O		IP	--
CENTRARCHIDAE- SUNFISHES								
Ambloplites ariommus - Shadow Bass	P5	CS	R, S	W	O	2	IP	INT
A. rupestris - Rock Bass	P5	CS	R, S	R	O	2	IP	INT
Centrarchus macropterus - Flier	P5	CS	R, S, Sw	W	U	4	INV	--
Enneacanthus gloriosus - Bluespotted Sunfish	P4	CS	Sw	R	U	4	INV	--
E. obesus - Banded Sunfish	P3	CS	Sw	R	U	4	INV	--
Lepomis auritus - Redbreast Sunfish	P5	CS	I, R, S	W	C	2	INV	--
L. cyanellus - Green Sunfish	P5	CS	R, S, H	W	C	2	IP	TOL
L. gulosus - Warmouth	P5	CS	R, S. H	W	O	4	IP	--
L. humilis - Orangespotted Sunfish	P5	CS	R, S	W	O	2	INV	--
L. macrochirus - Bluegill	P5	CS	I, R, S, H	W	C	2	INV	TOL
L. marginatus - Dollar Sunfish	P5	CS	R, S	W	O	2	INV	--
L. megalotis - Longear Sunfish	P5	CS	I, R, S, H	W	C	2	INV	--
L. microlophus - Redear Sunfish	P5	CS	I, R, S	W	C	2	INV	--
L. miniatus - Redspotted Sunfish	P5	CS	R, S, H, Sw	W	C	2	INV	--

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Micropterus cataractae - Shoal Bass	P2	V	I, R, S	R	O	2	IP	INT
M. coosae - Redeye Bass	P5	CS	R, S	R	C	2	IP	--
M. dolomieui- Smallmouth Bass	P5	CS	I, R, S	R	C	2	IP	--
M. punctulatus - Spotted Bass	P5	CS	I, R, S, H	W	C	4	IP	--
M. salmoides - Largemouth Bass	P5	CS	I, R, S, Sw	W	C	4	IP	--
Pomoxis annularis - White Crappie	P5	CS	I, R, S	W	O	4	IP	--
P. nigromaculatus - Black Crappie	P5	CS	I, R, S	W	O	4	IP	--
PERCIDAE- DARTERS AND PERCHES								
Ammocrypta beanii - Naked Sand Darter	P5	CS	R, S	W	O	1	INS	--
A. bifascia - Florida Sand Darter	P5	CS	R, S	R	O	1	INS	--
A. meridiana - Southern Sand Darter	P5	CS	R, S	W	O	1	INS	--
Crystallaria asprella - Crystal Darter	P3	V	R	W	U	1	INS	INT
Etheostoma artesiae - Redspot Darter	P5	CS	S, H	W	C	3	INS	--
E. bellator - Warrior Darter	P3	CS	S, H	R	U	3	INS	INT
E. sp. cf *bellator* - undescribed (Locust Fork darter)	P2	E	S, H	R	U	3	INS	INT
E. sp. cf *bellator* - undescribed (Sipsey darter)	P2	T	S, H	R	U	3	INS	INT
E. blennioides - Greenside Darter	P5	CS	R, S, H	R	O	3	INS	--
E. blennius - Blenny Darter	P4	CS	S	R	U	1	INS	INT
E. boschungi - Slackwater Darter	P1, T	E	S, H	R	U	3	INS	INT
E. brevirostrum - Holiday Darter	P1	E	S, H	R	U	3	INS	INT
E. caeruleum - Rainbow Darter	P5	CS	S, H, Sp	R	C	1	INS	--
E. camurum - Bluebreast Darter	P2	CS	R, S	R	U	1	INS	INT
E. chermocki - Vermilion Darter	P1, E	E	S, H, Sp	R	U	3	INS	INT
E. chlorosomum - Bluntnose Darter	P5	CS	S, H	W	O	3	INS	--
E. chuckwachatte - Lipstick Darter	P2	V	S, H	R	O	1	INS	INT
E. cinereum - Ashy Darter	Ex	E	S	Ex	Unk	3	INS	INT
E. colorosum - Coastal Darter	P5	CS	S, H	R	C	3	INS	--
E. coosae - Coosa Darter	P5	CS	S, H	R	C	3	INS	--
E. corona - Crown Darter	P5	T	S, H	R	C	4	INS	--
E. crossopterum- Fringed Darter	P3	CS	S, H	R	O	4	INS	--
E. davisoni - Choctawhatchee Darter	P5	CS	S, H	R	O	4	INS	--
E. ditrema - Coldwater Darter	P2	T	S, H, Sp	R	U	3	INS	INT
E. douglasi - Tuskaloosa Darter	P3	CS	S, H	R	O	1	INS	INT
E. duryi - Black Darter	P5	CS	S, H	R	C	3	INS	--
E. edwini - Brown Darter	P5	CS	S, H, Sw	W	O	3	INS	INT

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E. flabellare - Fantail Darter	P5	CS	S, H	R	C	4	INS	--
E. fusiforme - Swamp Darter	P5	CS	Sw, H	W	U	3	INS	--
E. histrio - Harlequin Darter	P5	CS	R, S	W	U	3	INS	--
E. jessiae - Blueside Darter	P4	CS	S, H	R	U	1	INS	--
E. jordani - Greenbreast Darter	P5	CS	R, S, H	W	O	1	INS	INT
E. kennicotti - Stripetail Darter	P5	CS	S, H	R	O	4	INS	--
E. lachneri - Tombigbee Darter	P5	CS	S, H	W	C	3	INS	--
E. lynceum - Brighteye Darter	P1	CS	S	R	U	3	INS	INT
E. neopterum - Lollipop Darter	P1	V	H	R	U	4	INS	INT
E. nigripinne - Blackfin Darter	P5	CS	S, H	R	C	4	INS	--
E. nigrum - Johnny Darter	P5	CS	S, H	W	C	4	INS	--
E. nuchale - Watercress Darter	P1, E	E	Sp	R	R	3	INS	INT
E. parvipinne - Goldstripe Darter	P5	CS	S, H	W	U	3	INS	--
E. phytophilum - Rush Darter	P1	E	S, H	R	R	3	INS	INT
E. proeliare - Cypress Darter	P5	CS	H, Sw	W	O	3	INS	--
E. ramseyi - Alabama Darter	P5	CS	S, H	W	C	3	INS	--
E. rufilineatum - Redline Darter	P5	CS	R, S	R	C	1	INS	--
E. rupestre - Rock Darter	P5	CS	R, S	W	O	1	INS	--
E. stigmaeum - Speckled Darter	P5	CS	S, H	W	C	1	INS	--
E. swaini - Gulf Darter	P5	CS	S, H	W	O	3	INS	--
E. tallapoosae - Tallapoosa Darter	P4	CS	S, H	R	C	3	INS	--
E. tennesseensis - Tennessee Darter	P5	CS	S, H	R	O	3	INS	--
E. trisella - Trispot Darter	P1	E	S,H	R	U	3	INS	INT
E. tuscumbia - Tuscumbia Darter	P2	T	Sp	R	O	1	INS	INT
E. wapiti - Boulder Darter	P1, E	E	R, S	R	R	1	INS	INT
E. zonale - Banded Darter	P4	CS	R, S	R	O	3	INS	--
E. zonifer- Backwater Darter	P5	CS	H, Sw	W	U	3	INS	--
E. zonistium - Bandfin Darter	P2	CS	S, H	R	O	3	INS	INT
E. sp. cf *zonistium* - undescribed (blueface darter)	P2	T	S, H	R	U	3	INS	INT
Perca flavescens - Yellow Perch	P4	CS	I, R, S	W	O	3	IP	--
P. aurolineata - Goldline Darter	P1, T	T	R, S	R-D	R	1	INS	INT
P. austroperca - Southern Logperch	P3	CS	R, S	R	U	1	INS	--
P. brevicauda - Coal Darter	P2	T	R, S	R	U	1	INS	INT
P. burtoni- Blotchside Logperch	P1	T	R, S	R	R	1	INS	INT
P. caprodes - Logperch	P5	CS	R, S	R	C	1	INS	--
P. crypta - Halloween Darter	P1	V	R, S	R	U	1	INS	INT
P. evides - Gilt Darter	P2	CS	R, S	R	U	1	INS	INT

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
P. kathae - Mobile Logperch	P5	CS	R, S	W	O	1	INS	--
P. lenticula - Freckled Darter	P3	T	R, S	W	U	1	INS	--
P. maculata - Blackside Darter	P5	CS	S, H	W	U	1	INS	INT
P. nigrofasciata - Blackbanded Darter	P5	CS	R, S, H	W	C	1	INS	--
P. palmaris - Bronze Darter	P5	CS	R, S	R	C	1	INS	--
P. phoxocephala - Slenderhead Darter	P1	CS	R, S	R	U	1	INS	INT
P. sciera - Dusky Darter	P5	CS	R, S	W	O	1	INS	--
P. shumardi - River Darter	P5	CS	R, S	W	O	1	INS	--
P. sipsi - Bankhead Darter	P1	E	R, S	R	R	1	INS	INT
P. smithvanizi - Muscadine Darter	P3	V	R, S	R	U	1	INS	--
P. suttkusi - Gulf Logperch	P5	CS	R, S	W	U	1	INS	--
P. tanasi - Snail Darter	P1, T	T	R, S	R	R	1	INS,INV	INT
P. vigil - Saddleback Darter	P5	CS	R, S	W	O	1	INS	INT
Sander canadense - Sauger	P5	CS	I, R	R	O	1	IP	--
S. vitreus - Walleye	P3	CS	I, R	W	U	1	IP	--
SCIAENIDAE- DRUMS								
Aplodinotus grunniens - Freshwater Drum	P5	CS	I, R	W	C	3	INV	--
ELASSOMATIDAE- PYGMY SUNFISHES								
Elassoma alabamae- Spring Pygmy Sunfish	P1	E	Sw, Sp	R	R	4	INV,INS	INT
E. evergladei - Everglades Pygmy Sunfish	P4	CS	H, Sp	R	O	4	INV,INS	--
E. zonatum - Banded Pygmy Sunfish	P4	CS	S, H, Sw	W	C	4	INV,INS	--
PARALICHTHYIDAE- SAND FLOUNDERS								
Paralichthys lethostigma - Southern Flounder	P5	CS	E, I, R	R	O	1	IP	--
ACHIRIDAE- SOLES								
Trinectes maculatus - Hogchoker	P5	CS	E, I, R	R	O	1	IP	--

Appendix C

Plateau ichthyoregion fish community sampling data

GSA no.	1474	1475	1476	1477	1478	1484	1485	1486	1804	1805	1806	1821	1822	1823
Sample date	26-Jul-11	26-Jul-11	14-Jul-11	13-Jul-11	13-Jul-11	2-Aug-11	2-Aug-11	3-Aug-11	2-Jun-10	2-Jun-10	2-Jun-10	5-Aug-10	2-Jul-10	2-Jul-10
Petromyzontidae - lampreys														
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars														
Lepisosteus osseus	--	--	--	--	--	--	2	--	--	--	--	--	--	--
Clupeidae - herrings														
Dorosoma cepedianum	3	--	--	--	--	5	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows														
Campostoma oligolepis	11	34	71	100	54	3	13	150	292	28	93	97	136	245
Cyprinella callistia	--	7	52	121	44	103	487	177	11	18	56	3	68	152
Cyprinella galactura	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella spiloptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	196	125	--	9	75	73	39	20	5	117	26	--	14	27
Hemitremia flammea	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hybopsis winchelli	--	--	--	--	1	--	--	--	--	--	--	--	--	1
Luxilus chrysocephalus	11	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus bellus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
L. bellus x L. alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus fasciolaris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis asperifrons	--	--	--	--	--	--	--	--	--	10	14	2	--	--
Notropis baileyi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis cahabae	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	18	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	2	157	28	59	54	390	77	--	77	61	--	--	73
Notropis texanus	12	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis volucellus	--	--	--	--	4	--	--	--	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	2	--	--	--	10	--	--	--	--	269	2	--	--	10
Rhinichthys atratulus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	9	--	1	--	--	--	--	--	18	--	--	21	--	--
Catostomidae - suckers														
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomus commersoni	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	--	--	1	7	14	--	6	12	--	2	7	2	9	8
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma carinatum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	9	10
Moxostoma erythrurum	6	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma poecilurum	1	--	--	--	3	2	9	3	--	3	--	1	--	3

GSA no. / Sample date	1474 26-Jul-11	1475 26-Jul-11	1476 14-Jul-11	1477 13-Jul-11	1478 13-Jul-11	1484 2-Aug-11	1485 2-Aug-11	1486 3-Aug-11	1804 2-Jun-10	1805 2-Jun-10	1806 2-Jun-10	1821 5-Aug-10	1822 2-Jul-10	1823 2-Jul-10
Ictaluridae - North American catfishes														
Ameiurus catus	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	2	--	--
Ameiurus natalis	--	--	--	--	--	--	--	3	1	1	4	2	--	--
Ictalurus punctatus	--	31	--	4	3	1	--	--	--	--	--	--	2	4
Noturus funebris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus gyrinus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus leptacanthus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	8	--	--	2	4	5	--	--	--	--	--	--	1
Esocidae - pikes														
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Aphredoderidae - pirate perches														
Aphredoderus sayanus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Atherinopsidae - New World silversides														
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Belonidae - needlefishes														
Strongylura marina	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows														
Fundulus olivaceus	14	6	--	--	4	--	--	--	--	2	11	--	1	2
Poeciliidae - livebearers														
Gambusia affinis	4	--	1	--	--	--	--	--	1	--	--	--	--	--
Cottidae - sculpins														
Cottus carolinae	--	--	73	--	--	--	--	--	106	--	--	--	5	--
Centrarchidae - sunfishes														
Ambloplites ariommus	--	--	1	--	1	--	--	--	--	--	--	--	--	--
Lepomis auritus	4	12	--	6	6	9	1	41	--	42	--	16	--	--
Lepomis cyanellus	6	9	2	8	3	2	--	10	26	11	16	37	5	6
Lepomis gulosus	--	--	--	--	--	--	--	--	--	--	--	--	3	--
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	4	47	2	16	14	6	1	9	12	12	--	23	14	4
Lepomis marginatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis megalotis	40	86	27	7	19	12	3	2	2	31	20	1	30	22
Lepomis microlophus	3	--	--	--	--	--	--	--	--	--	26	--	--	--
Lepomis miniatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus coosae	--	10	8	--	--	10	9	4	1	--	--	--	--	1
Micropterus dolomieui	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	1	39	2	5	18	46	38	12	--	4	1	--	6	9
Micropterus salmoides	--	--	--	--	2	--	--	--	1	8	2	2	1	3
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	2	--	2	--	--	--	--	--	--	--	--	--	5	--

GSA no.	1474	1475	1476	1477	1478	1484	1485	1486	1804	1805	1806	1821	1822	1823
Sample date	26-Jul-11	26-Jul-11	14-Jul-11	13-Jul-11	13-Jul-11	2-Aug-11	2-Aug-11	3-Aug-11	2-Jun-10	2-Jun-10	2-Jun-10	5-Aug-10	2-Jul-10	2-Jul-10
Percidae - perches														
Etheostoma artesiae	3	--	--	--	--	--	--	--	--	--	2	11	10	5
Etheostoma bellator	--	--	--	--	--	--	--	--	--	--	--	--	5	--
Etheostoma sp cf bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma douglasi	--	--	92	54	39	10	16	--	--	--	--	--	100	32
Etheostoma duryi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma kennicotti	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma nigripinne	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	--	--	--	--	--	--	--	--	--	--	--	4
Etheostoma stigmaeum	--	--	--	--	--	--	--	--	--	--	--	--	--	4
Etheostoma swaini	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf zonistium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina brevicauda	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	--	1	--	--	3	5	3	--	--	--	14	--	4	3
Percina maculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina nigrofasciata	18	2	21	11	7	21	14	23	27	102	116	3	29	58
Percina shumardi	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Percina sipsi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums														
Aplodinotus grunniens	--	1	--	--	--	--	--	--	--	3	--	--	--	--
Species	21	17	16	13	22	17	16	15	13	18	17	15	20	24
Individuals	352	421	531	376	385	366	1036	544	503	740	471	223	457	687
Catch per effort	11.00	13.16	16.59	11.75	12.03	11.44	32.38	17.00	15.72	23.13	14.27	6.97	13.85	21.47
IBI score	36	32	38	36	42	40	38	36	30	28	36	32	36	38
Biological condition	Fair	Poor	Fair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Fair	Fair

GSA no.	1824	1825	1826	1827	1828	1829	1830	1831	1832	1833	1834	1835	1836	1837
Sample date	1-Jul-10	1-Jul-10	1-Jul-10	30-Jun-10	30-Jun-10	30-Jun-10	8-Jul-10	8-Jul-10	8-Jul-10	7-Jul-10	7-Jul-10	7-Jul-10	22-Jul-10	22-Jul-10
Petromyzontidae - lampreys														
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars														
Lepisosteus osseus	--	--	1	--	--	--	--	--	--	--	--	2	--	--
Clupeidae - herrings														
Dorosoma cepedianum	--	--	--	--	--	--	300	101	27	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows														
Campostoma oligolepis	85	515	100	52	138	83	404	274	49	17	37	340	31	46
Cyprinella callistia	6	17	60	2	62	8	--	--	21	--	128	37	55	81
Cyprinella galactura	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella spiloptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	22	20	102	97	79	56	9	21	4	3	9	8	10	3
Hemitremia flammea	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hybopsis winchelli	8	2	7	--	2	--	--	--	--	--	--	18	--	--
Luxilus chrysocephalus	--	--	--	--	--	--	7	--	1	--	5	--	--	--
Lythrurus alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus bellus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
L. bellus x L. alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus fasciolaris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis baileyi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis cahabae	4	9	117	--	183	52	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	22	--	--	--	--
Notropis stilbius	21	13	208	24	64	15	144	159	54	--	2	137	35	--
Notropis texanus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis volucellus	15	--	--	--	1	--	--	--	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	35	37	73	2	67	48	--	7	1	--	--	45	1	--
Rhinichthys atratulus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	--	2	--	--	--	--	--	--	4	2	--	10	--	--
Catostomidae - suckers														
Carpiodes velifer	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Catostomus commersoni	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	2	8	--	4	1	2	7	38	2	8	11	15	3	2
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma carinatum	--	3	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	2	1	9	--	--
Moxostoma erythrurum	1	4	--	2	1	2	--	3	--	--	--	--	--	--
Moxostoma poecilurum	2	4	13	1	--	--	--	5	1	1	--	11	--	1

GSA no.	1824	1825	1826	1827	1828	1829	1830	1831	1832	1833	1834	1835	1836	1837
Sample date	1-Jul-10	1-Jul-10	1-Jul-10	30-Jun-10	30-Jun-10	30-Jun-10	8-Jul-10	8-Jul-10	8-Jul-10	7-Jul-10	7-Jul-10	7-Jul-10	22-Jul-10	22-Jul-10
Ictaluridae - North American catfishes														
Ameiurus catus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	--	--	--	--	--	--	6	1	1	4	--	1	3	4
Ictalurus punctatus	4	3	4	--	5	5	--	1	18	--	--	6	--	--
Noturus funebris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus gyrinus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus leptacanthus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	2	12	12	--	5	2	--	--	2	--	--	--	--	--
Esocidae - pikes														
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perches														
Aphredoderus sayanus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Atherinopsidae - New World silversides														
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Belonidae - needlefishes														
Strongylura marina	--	--	1	--	--	1	--	--	--	--	--	--	--	--
Fundulidae - topminnows														
Fundulus olivaceus	--	--	--	--	7	--	--	4	--	--	--	--	--	--
Poeciliidae - livebearers														
Gambusia affinis	--	--	--	--	--	1	3	--	--	6	--	2	--	--
Cottidae - sculpins														
Cottus carolinae	--	--	--	--	--	--	2	--	--	11	--	--	--	--
Centrarchidae - sunfishes														
Ambloplites ariommus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	2	--	1	6	--	--	1	3	--	--	--	--	39	10
Lepomis cyanellus	2	--	1	8	2	5	1	20	--	36	10	7	7	7
Lepomis gulosus	--	--	--	--	--	--	1	--	--	--	--	--	--	3
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	12	15	3	7	14	9	6	7	--	20	17	1	23	12
Lepomis marginatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis megalotis	33	8	5	24	3	28	18	27	--	74	18	53	10	8
Lepomis microlophus	--	--	--	--	1	--	--	--	--	4	--	2	--	2
Lepomis miniatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus coosae	--	--	--	--	--	--	--	--	--	2	5	--	--	--
Micropterus dolomieui	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	5	7	6	1	8	4	--	5	2	2	--	2	2	--
Micropterus salmoides	4	12	1	1	12	8	4	5	3	--	1	5	--	6
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--	1
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--	--	1	--	--

GSA no.	1824	1825	1826	1827	1828	1829	1830	1831	1832	1833	1834	1835	1836	1837
Sample date	1-Jul-10	1-Jul-10	1-Jul-10	30-Jun-10	30-Jun-10	30-Jun-10	8-Jul-10	8-Jul-10	8-Jul-10	7-Jul-10	7-Jul-10	7-Jul-10	22-Jul-10	22-Jul-10
Percidae - perches														
Etheostoma artesiae	1	--	--	4	--	--	11	--	--	--	--	5	--	3
Etheostoma bellator	--	--	--	--	--	--	--	--	--	12	--	--	--	--
Etheostoma sp cf bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma douglasi	27	28	17	17	6	31	--	--	--	1	15	66	--	--
Etheostoma duryi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma kennicotti	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma nigripinne	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	3	23	1	--	--	--	--	--	--	--	--	1	--	--
Etheostoma stigmaeum	4	--	1	5	3	3	--	--	--	--	--	15	--	2
Etheostoma swaini	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf zonistium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina brevicauda	69	6	2	--	6	22	--	--	--	--	--	--	--	--
Percina kathae	11	12	1	1	--	3	--	--	--	--	--	5	--	1
Percina maculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina nigrofasciata	107	235	122	20	30	104	46	64	6	--	25	21	35	10
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina sipsi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums														
Aplodinotus grunniens	--	2	1	--	--	1	1	--	5	--	--	1	--	--
Species	26	25	25	19	23	23	18	18	17	18	14	27	13	18
Individuals	487	998	860	278	700	493	971	745	201	227	284	826	254	202
Catch per effort	15.22	31.19	26.88	8.69	21.88	15.41	30.34	23.28	6.28	7.09	8.88	25.81	7.94	6.31
IBI score	46	40	44	40	42	40	32	34	38	42	36	44	34	38
Biological condition	Good	Fair	Good	Fair	Good	Fair	Poor	Fair	Fair	Good	Fair	Good	Fair	Fair

GSA no.	1838	1839	1840	1841	1842	1845	1846	1865	1866	1867	1868	1869	1921	1924
Sample date	21-Jul-10	21-Jul-10	21-Jul-10	20-Jul-10	20-Jul-10	14-Sep-10	14-Sep-10	31-Aug-10	26-Aug-10	26-Aug-10	26-Aug-10	25-Aug-10	8-Jul-09	8-Jul-09
Petromyzontidae - lampreys														
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars														
Lepisosteus osseus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae - herrings														
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows														
Campostoma oligolepis	11	104	125	31	27	95	113	45	79	4	--	4	52	25
Cyprinella callistia	--	--	5	121	64	85	51	--	22	--	--	--	--	--
Cyprinella galactura	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella spiloptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	--	--	4	8	2	380	115	6	5	4	--	3	--	--
Hemitremia flammea	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hybopsis winchelli	--	--	--	--	--	--	5	--	--	--	--	--	--	--
Luxilus chrysocephalus	--	--	--	--	--	--	--	--	--	4	4	--	18	7
Lythrurus alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus bellus	--	--	--	--	--	--	--	--	--	--	--	--	4	28
L. bellus x L. alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus fasciolaris	--	24	20	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	--	--	--	--	--	--	--	--	--	5	--	--	2	1
Notemigonus crysoleucas	--	--	--	1	--	--	--	--	--	--	--	--	1	--
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis baileyi	--	--	--	--	--	--	--	--	--	9	2	--	1	--
Notropis cahabae	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	16	54	27	46	24	3	21	--	--	--	--	--	--	--
Notropis texanus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis volucellus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	2	--
Pimephales vigilax	--	--	1	1	--	104	325	--	--	--	--	--	--	--
Rhinichthys atratulus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	3	1	--	--	--	--	--	--	--	5	8	1	12	3
Catostomidae - suckers														
Carpiodes velifer	--	--	--	--	--	--	1	--	--	--	--	--	--	--
Catostomus commersoni	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	--	--	--	--	--	3	--
Hypentelium etowanum	2	3	27	--	2	1	1	15	--	8	--	2	--	--
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--	3
Minytrema melanops	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma carinatum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	3	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	1	--	--	--	--	--	1	--	--	--	--
Moxostoma poecilurum	--	--	--	--	1	8	26	--	1	--	--	1	--	--

GSA no.	1838	1839	1840	1841	1842	1845	1846	1865	1866	1867	1868	1869	1921	1924
Sample date	21-Jul-10	21-Jul-10	21-Jul-10	20-Jul-10	20-Jul-10	14-Sep-10	14-Sep-10	31-Aug-10	26-Aug-10	26-Aug-10	26-Aug-10	25-Aug-10	8-Jul-09	8-Jul-09
Ictaluridae - North American catfishes														
Ameiurus catus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	2	8	--	22	4	--	--	4	2	--	3	--	3	1
Ictalurus punctatus	--	--	--	--	--	36	24	--	1	1	--	--	--	--
Noturus funebris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus gyrinus	--	--	--	--	--	--	--	--	--	--	--	--	1	1
Noturus leptacanthus	--	--	--	--	--	--	--	--	--	7	8	15	--	--
Pylodictis olivaris	--	--	--	--	4	17	4	--	6	--	--	--	--	--
Esocidae - pikes														
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perches														
Aphredoderus sayanus	--	--	--	--	--	--	--	--	1	4	3	--	--	--
Atherinopsidae - New World silversides														
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Belonidae - needlefishes														
Strongylura marina	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows														
Fundulus olivaceus	--	--	--	--	--	3	--	--	--	2	1	2	14	4
Poeciliidae - livebearers														
Gambusia affinis	--	22	24	--	--	8	2	--	--	--	--	--	--	--
Cottidae - sculpins														
Cottus carolinae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes														
Ambloplites ariommus	--	--	--	--	--	--	--	--	--	1	1	--	--	--
Lepomis auritus	28	26	20	25	55	--	--	--	--	--	--	--	--	--
Lepomis cyanellus	9	39	16	1	21	1	3	11	5	6	5	--	3	2
Lepomis gulosus	1	1	1	--	--	--	--	--	--	1	2	1	--	--
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	26	58	10	6	21	1	--	5	2	2	11	16	56	47
Lepomis marginatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis megalotis	3	15	5	--	3	46	23	9	16	18	10	6	--	16
Lepomis microlophus	2	3	--	--	--	--	--	1	--	--	--	4	--	--
Lepomis miniatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus coosae	--	--	--	--	--	--	--	15	--	--	--	--	--	--
Micropterus dolomieui	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	--	3	2	7	11	4	9	4	5	--	--	--	35	3
Micropterus salmoides	5	1	2	--	2	3	4	1	--	--	--	--	11	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--	--	--	--	--

GSA no.	1838	1839	1840	1841	1842	1845	1846	1865	1866	1867	1868	1869	1921	1924
Sample date	21-Jul-10	21-Jul-10	21-Jul-10	20-Jul-10	20-Jul-10	14-Sep-10	14-Sep-10	31-Aug-10	26-Aug-10	26-Aug-10	26-Aug-10	25-Aug-10	8-Jul-09	8-Jul-09
Percidae - perches														
Etheostoma artesiae	2	21	9	--	--	--	--	--	--	--	--	--	--	--
Etheostoma bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma douglasi	--	--	--	--	--	1	2	--	--	--	--	--	--	--
Etheostoma duryi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma kennicotti	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma nigripinne	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	--	--	--	1	1	--	--	--	--	--	--	--
Etheostoma stigmaeum	--	3	--	--	--	--	--	--	--	--	--	--	6	22
Etheostoma swaini	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf zonistium	--	--	--	--	--	--	--	--	--	--	--	--	11	10
Percina brevicauda	--	--	--	--	--	--	3	--	--	--	--	--	--	--
Percina kathae	1	--	--	--	1	4	1	--	1	--	--	1	--	--
Percina maculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina nigrofasciata	13	7	28	64	34	117	76	--	--	13	14	14	--	--
Percina shumardi	--	--	--	--	--	2	1	--	--	--	--	--	--	--
Percina sipsi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums														
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	15	18	17	13	16	22	23	11	13	18	13	13	18	15
Individuals	124	393	326	334	276	921	814	116	146	95	72	70	235	173
Catch per effort	3.88	12.28	10.19	10.44	8.63	28.78	25.44	3.63	4.56	3.17	2.40	2.19	7.34	5.41
IBI score	40	34	34	36	36	34	30	28	30	42	32	38	42	36
Biological condition	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Poor	Poor	Good	Poor	Fair	Good	Fair

GSA no.	1925	1926	1927	1928	1929	1930	1948	1949	1950	1956	1972	1974	1991	1992
Sample date	2-Sep-09	2-Sep-09	2-Sep-09	16-Sep-09	3-Sep-09	3-Sep-09	16-Sep-09	9-Oct-09	3-Jun-09	24-Sep-09	21-Apr-10	21-Apr-10	18-May-10	18-May-10
Petromyzontidae - lampreys														
Ichthyomyzon gagei	7	3	--	2	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars														
Lepisosteus osseus	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Clupeidae - herrings														
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows														
Campostoma oligolepis	1	30	161	18	156	4	48	--	23	48	137	189	47	28
Cyprinella callistia	--	--	14	--	--	1	--	--	--	--	--	--	63	2
Cyprinella galactura	--	--	--	--	--	--	--	--	3	--	--	--	--	--
Cyprinella spiloptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	7	6	4	29	--	11	18	--	--	--	5	23	--	1
Hemitremia flammea	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hybopsis winchelli	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Luxilus chrysocephalus	42	9	--	46	56	7	--	--	7	--	7	--	14	--
Lythrurus alegnotus	--	--	--	--	--	--	--	--	--	--	1	16	--	--
Lythrurus bellus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
L. bellus x L. alegnotus	39	28	7	65	2	8	--	--	--	--	--	--	--	--
Lythrurus fasciolaris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	11	--	--	--	--	--	--	--	--	--	--	--	--	--
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	42	111
Notropis baileyi	37	--	--	189	--	--	--	--	--	--	--	--	--	--
Notropis cahabae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	2	--	1	--	--	36	--	--	--	--	--	--	129	59
Notropis texanus	17	9	--	--	--	18	--	--	--	--	--	33	--	--
Notropis volucellus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	1	--	--	--	3	--	--	--	--	--	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rhinichthys atratulus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	6	--	--	17	69	--	--	2	--	5	--	15	--	1
Catostomidae - suckers														
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomus commersoni	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	1	--	--	5	28	--	--	--	--	--	--	--	2	--
Hypentelium etowanum	10	3	--	--	--	1	--	--	--	--	1	--	9	2
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	2	--	--	--	--	--	--	--	--
Moxostoma carinatum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	--	14	--	--	--	--	--	--	--	1	2
Moxostoma poecilurum	--	--	6	--	--	2	5	--	--	--	--	--	--	--

GSA no.	1925	1926	1927	1928	1929	1930	1948	1949	1950	1956	1972	1974	1991	1992
Sample date	2-Sep-09	2-Sep-09	2-Sep-09	16-Sep-09	3-Sep-09	3-Sep-09	16-Sep-09	9-Oct-09	3-Jun-09	24-Sep-09	21-Apr-10	21-Apr-10	18-May-10	18-May-10
Ictaluridae - North American catfishes														
Ameiurus catus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus melas	--	--	--	--	--	--	--	--	--	2	--	--	--	--
Ameiurus natalis	--	1	--	1	1	--	--	--	2	9	--	3	1	--
Ictalurus punctatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus funebris	1	--	5	4	--	--	--	--	--	--	--	--	--	--
Noturus gyrinus	--	--	--	7	--	1	--	--	--	--	--	--	--	--
Noturus leptacanthus	--	15	3	--	--	7	9	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes														
Esox niger	1	--	--	--	--	1	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perches														
Aphredoderus sayanus	2	1	--	3	4	2	--	--	--	--	--	1	--	--
Atherinopsidae - New World silversides														
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Belonidae - needlefishes														
Strongylura marina	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows														
Fundulus olivaceus	4	2	1	--	25	8	--	--	--	--	2	42	2	3
Poeciliidae - livebearers														
Gambusia affinis	--	4	--	--	--	--	--	--	--	--	--	2	--	--
Cottidae - sculpins														
Cottus carolinae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes														
Ambloplites ariommus	--	2	2	--	--	--	--	--	--	--	1	--	1	3
Lepomis auritus	--	--	--	--	--	--	3	6	33	13	4	34	--	--
Lepomis cyanellus	2	--	--	1	26	5	6	17	14	33	1	10	3	2
Lepomis gulosus	--	2	2	--	--	--	--	--	--	7	1	2	--	--
Lepomis humilis	--	--	--	--	--	--	--	--	--	5	--	--	--	--
Lepomis macrochirus	9	40	56	2	25	4	15	10	29	77	19	17	--	--
Lepomis marginatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis megalotis	36	45	21	14	13	18	6	--	--	--	3	73	11	37
Lepomis microlophus	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Lepomis miniatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus coosae	--	--	--	--	--	--	--	--	--	--	--	--	2	7
Micropterus dolomieui	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	1	1	12	2	--	6	--	--	--	--	2	--	1	--
Micropterus salmoides	--	--	5	1	--	1	1	--	2	--	--	3	--	--
Pomoxis nigromaculatus	--	--	1	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	1	--	--	4	--	--

GSA no.	1925	1926	1927	1928	1929	1930	1948	1949	1950	1956	1972	1974	1991	1992
Sample date	2-Sep-09	2-Sep-09	2-Sep-09	16-Sep-09	3-Sep-09	3-Sep-09	16-Sep-09	9-Oct-09	3-Jun-09	24-Sep-09	21-Apr-10	21-Apr-10	18-May-10	18-May-10
Percidae - perches														
Etheostoma artesiae	1	4	2	17	37	6	--	--	--	--	--	36	10	12
Etheostoma bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma douglasi	--	--	--	--	--	--	--	--	--	--	--	--	43	11
Etheostoma duryi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma kennicotti	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--	--	--	--	--	--	--	13
Etheostoma nigripinne	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma stigmaeum	46	6	4	41	3	41	--	--	--	--	2	--	9	13
Etheostoma swaini	1	1	3	7	--	8	--	--	--	--	--	--	--	--
Etheostoma sp cf zonistium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina brevicauda	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	2	2	2	1	--	3	--	--	--	--	1	--	34	25
Percina maculata	--	--	--	--	2	3	--	--	--	--	--	--	--	--
Percina nigrofasciata	43	29	27	29	--	33	19	--	--	--	22	--	15	2
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina sipsi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums														
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	26	22	23	22	16	27	10	4	8	9	16	16	20	19
Individuals	330	243	341	501	464	238	130	35	114	199	209	503	439	334
Catch per effort	10.31	7.59	9.47	15.66	14.50	7.44	4.06	1.09	3.56	6.22	6.53	15.72	12.91	9.54
IBI score	44	38	36	48	32	48	24	22	20	24	32	30	46	50
Biological condition	Good	Fair	Fair	Good	Poor	Good	Very Poor	Very Poor	Very Poor	Very Poor	Poor	Poor	Good	Excellent

GSA no.	1993	1994	1995	1996	2001	2002	2003	2004	2005	2007	2010	2011	2013	2029
Sample date	19-May-10	19-May-10	20-May-10	20-May-10	23-Jul-08	23-Jul-08	22-Jul-08	22-Jul-08	14-Aug-08	14-Aug-08	8-Apr-09	28-Apr-09	9-Apr-09	19-May-09
Petromyzontidae - lampreys														
Ichthyomyzon gagei	--	--	--	--	--	--	--	4	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	2	--	--
Lepisosteidae - gars														
Lepisosteus osseus	--	--	--	--	--	1	1	--	--	--	--	--	--	--
Clupeidae - herrings														
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows														
Campostoma oligolepis	85	27	29	7	90	149	113	3	43	7	4	20	344	6
Cyprinella callistia	18	41	--	--	1	20	19	--	9	--	--	--	--	--
Cyprinella galactura	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella spiloptera	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Cyprinella venusta	5	33	16	45	3	31	13	11	8	2	--	20	4	--
Hemitremia flammea	--	--	--	--	--	--	--	--	--	--	--	--	--	10
Hybopsis winchelli	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Luxilus chrysocephalus	--	--	--	--	63	24	31	38	18	43	35	32	--	28
Lythrurus alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	15	--
Lythrurus bellus	--	--	--	--	--	--	--	--	--	--	25	--	--	--
L. bellus x L. alegnotus	--	--	--	--	3	--	--	40	19	14	--	42	--	--
Lythrurus fasciolaris	--	--	--	--	--	--	--	--	--	--	--	--	--	5
Nocomis leptocephalus	--	--	--	--	4	--	--	8	4	6	--	4	--	--
Notemigonus crysoleucas	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Notropis asperifrons	22	42	2	2	--	--	--	--	--	--	--	10	--	--
Notropis baileyi	--	--	--	--	--	--	5	29	1	--	7	1	--	--
Notropis cahabae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	98	164	--	258	95	59	209	1	5	--	--	5	--	--
Notropis texanus	--	--	--	--	7	--	38	29	32	20	--	--	35	--
Notropis volucellus	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	--	--	3	--	--	--	--	--	--	--	2	--	20
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	--	--	--	--	--	--	--	--	--	--	--	2	--	--
Rhinichthys atratulus	--	--	--	--	--	--	--	--	--	--	--	--	--	4
Semotilus atromaculatus	--	--	--	--	26	1	--	2	--	3	--	2	26	2
Catostomidae - suckers														
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomus commersoni	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Erimyzon oblongus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	--	10	--	--	2	1	8	7	6	2	1	2	--	--
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	--	--	1	3	--	1	--	--	--
Moxostoma carinatum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	6	25	--	1	--	--	--	5	7	5	--	--	--	--
Moxostoma poecilurum	--	--	2	7	7	4	4	2	3	5	2	13	3	--

GSA no.	1993	1994	1995	1996	2001	2002	2003	2004	2005	2007	2010	2011	2013	2029
Sample date	19-May-10	19-May-10	20-May-10	20-May-10	23-Jul-08	23-Jul-08	22-Jul-08	22-Jul-08	14-Aug-08	14-Aug-08	8-Apr-09	28-Apr-09	9-Apr-09	19-May-09
Ictaluridae - North American catfishes														
Ameiurus catus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	--	--	2	2	1	1	--	--	--	--	--	--	1	--
Ictalurus punctatus	--	--	--	--	--	1	1	--	--	--	--	--	--	--
Noturus funebris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus gyrinus	--	--	--	--	2	--	--	--	--	--	--	--	--	--
Noturus leptacanthus	--	3	--	--	--	--	--	2	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes														
Esox niger	--	--	--	--	--	--	--	1	1	--	1	--	--	--
Aphredoderidae - pirate perches														
Aphredoderus sayanus	--	--	--	--	3	--	7	4	4	1	--	2	1	--
Atherinopsidae - New World silversides														
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Belonidae - needlefishes														
Strongylura marina	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows														
Fundulus olivaceus	8	6	5	15	22	5	7	1	12	15	2	5	44	2
Poeciliidae - livebearers														
Gambusia affinis	--	--	--	--	2	--	--	1	19	5	--	--	--	--
Cottidae - sculpins														
Cottus carolinae	--	--	--	--	--	--	--	--	--	--	--	--	--	56
Centrarchidae - sunfishes														
Ambloplites ariommus	--	2	--	--	--	1	--	1	7	--	--	--	--	--
Lepomis auritus	--	--	--	--	--	--	--	--	--	--	--	--	13	9
Lepomis cyanellus	1	--	4	2	18	8	2	8	27	--	2	15	3	8
Lepomis gulosus	--	--	--	--	2	--	1	--	3	1	1	--	--	3
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	--	1	16	6	10	43	12	12	5	10	5	--	46	20
Lepomis marginatus	--	--	--	--	--	--	--	--	--	--	--	--	2	--
Lepomis megalotis	39	29	4	45	105	76	51	88	109	46	6	25	75	5
Lepomis microlophus	--	--	--	--	--	2	--	--	--	--	--	--	1	--
Lepomis miniatus	--	--	--	--	--	--	--	--	10	--	2	2	--	--
Micropterus coosae	9	1	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus dolomieui	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	--	2	1	--	2	4	13	6	2	2	--	--	1	--
Micropterus salmoides	--	--	2	--	8	--	--	2	--	5	--	--	4	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	1	--	--	--	--	--	--	2	--

GSA no.	1993	1994	1995	1996	2001	2002	2003	2004	2005	2007	2010	2011	2013	2029
Sample date	19-May-10	19-May-10	20-May-10	20-May-10	23-Jul-08	23-Jul-08	22-Jul-08	22-Jul-08	14-Aug-08	14-Aug-08	8-Apr-09	28-Apr-09	9-Apr-09	19-May-09
Percidae - perches														
Etheostoma artesiae	6	1	11	2	13	--	--	--	10	--	26	8	33	--
Etheostoma bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma douglasi	27	94	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma duryi	--	--	--	--	--	--	--	--	--	--	--	--	--	2
Etheostoma kennicotti	--	--	--	--	--	--	--	--	--	--	--	--	--	3
Etheostoma lachneri	13	5	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma nigripinne	--	--	--	--	--	--	--	--	--	--	--	--	--	6
Etheostoma rupestre	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma stigmaeum	5	17	--	--	12	17	42	17	9	12	28	33	--	--
Etheostoma swaini	--	--	--	--	--	--	--	3	1	1	--	--	--	--
Etheostoma sp cf zonistium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina brevicauda	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	26	19	8	12	3	3	3	3	6	1	--	8	--	--
Percina maculata	--	--	--	2	--	3	1	--	--	--	--	--	1	--
Percina nigrofasciata	15	54	--	--	23	63	27	16	14	20	6	3	--	--
Percina shumardi	5	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina sipsi	--	17	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums														
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	18	21	13	15	27	23	22	29	29	22	17	23	19	19
Individuals	389	593	102	409	528	519	608	345	397	226	154	258	654	191
Catch per effort	12.16	18.53	3.19	11.36	17.03	16.22	19.00	11.13	12.41	6.85	4.67	8.06	19.82	5.97
IBI score	40	44	30	38	46	38	42	44	46	48	42	46	34	40
Biological condition	Fair	Good	Poor	Fair	Good	Fair	Good	Good	Good	Good	Good	Good	Fair	Fair

GSA no. Sample date	2053 17-Sep-09	2054 21-Jul-09	2055 4-Jun-09	2057 5-Jun-09	2062 10-Jun-09	2063 10-Jun-09	2064 11-Jun-09	2065 11-Jun-09	2067 10-Jun-09	2068 11-Jun-09	2069 11-Jun-09	2070 14-Jul-09	2071 14-Jul-09	2072 14-Jul-09
Petromyzontidae - lampreys														
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars														
Lepisosteus osseus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae - herrings														
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows														
Campostoma oligolepis	31	46	--	68	16	25	31	24	4	117	16	14	70	70
Cyprinella callistia	--	--	--	--	94	--	12	--	--	--	--	--	9	1
Cyprinella galactura	--	--	--	--	--	38	--	--	--	7	115	--	--	--
Cyprinella spiloptera	--	--	--	12	--	4	--	--	49	5	33	--	--	--
Cyprinella venusta	--	--	--	--	2	--	16	29	--	--	--	--	--	15
Hemitremia flammea	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hybopsis winchelli	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Luxilus chrysocephalus	1	7	--	8	--	1	--	--	--	--	3	7	--	--
Lythrurus alegnotus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lythrurus bellus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
L. bellus x L. alegnotus	--	--	--	--	--	--	--	--	--	--	--	25	--	--
Lythrurus fasciolaris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Notemigonus crysoleucas	--	--	--	--	--	--	2	--	--	1	--	--	--	--
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	32	--	--
Notropis baileyi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis cahabae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	--	--	--	11	--	--	13	--	--	--	18	--	25
Notropis texanus	--	--	--	--	--	--	--	--	--	--	--	--	2	--
Notropis volucellus	--	--	--	--	--	--	--	--	--	--	--	1	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rhinichthys atratulus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	--	28	20	--	--	--	3	--	--	1	--	--	4	8
Catostomidae - suckers														
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomus commersoni	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	--	--	--	--	--	1	1
Hypentelium etowanum	--	--	--	--	3	--	--	--	--	--	--	--	--	9
Hypentelium nigricans	--	13	--	2	--	--	--	--	--	--	2	--	--	--
Minytrema melanops	--	--	--	--	--	--	--	--	--	--	--	--	1	2
Moxostoma carinatum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	--	--	--	--	--	--	--	--	1	--	--
Moxostoma poecilurum	--	--	--	--	3	--	--	--	--	--	--	2	--	3

GSA no. / Sample date	2053 17-Sep-09	2054 21-Jul-09	2055 4-Jun-09	2057 5-Jun-09	2062 10-Jun-09	2063 10-Jun-09	2064 11-Jun-09	2065 11-Jun-09	2067 10-Jun-09	2068 11-Jun-09	2069 11-Jun-09	2070 14-Jul-09	2071 14-Jul-09	2072 14-Jul-09
Ictaluridae - North American catfishes														
Ameiurus catus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus melas	--	--	--	--	--	--	2	--	--	--	--	--	--	--
Ameiurus natalis	6	--	7	5	3	1	1	1	4	3	3	--	--	1
Ictalurus punctatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus funebris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus gyrinus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus leptacanthus	2	--	--	--	--	--	--	--	--	--	--	--	1	1
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes														
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perches														
Aphredoderus sayanus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Atherinopsidae - New World silversides														
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Belonidae - needlefishes														
Strongylura marina	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows														
Fundulus olivaceus	--	--	--	--	--	--	--	--	--	--	--	6	--	2
Poeciliidae - livebearers														
Gambusia affinis	--	--	--	--	--	--	--	1	--	--	--	--	1	1
Cottidae - sculpins														
Cottus carolinae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes														
Ambloplites ariommus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	32	37	--	65	51	27	17	38	28	55	24	--	--	--
Lepomis cyanellus	35	8	46	--	2	22	10	1	--	15	3	2	32	10
Lepomis gulosus	--	--	2	--	--	--	1	--	1	--	--	--	--	--
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	26	31	80	20	11	32	33	12	7	15	16	1	3	21
Lepomis marginatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis megalotis	--	--	--	--	7	--	--	--	--	--	--	21	--	51
Lepomis microlophus	--	--	3	--	--	1	--	--	--	--	--	--	--	2
Lepomis miniatus	--	--	3	--	--	--	--	--	--	--	--	--	--	--
Micropterus coosae	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus dolomieui	--	3	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	1	--	--	--	1	--	--	--	--	2	1	4	--	4
Micropterus salmoides	--	3	8	4	--	4	--	2	1	1	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	5	--	1	--	--	--	--	--
hybrid centrarchid	--	1	1	--	--	--	--	--	--	--	--	--	--	--

GSA no.	2053	2054	2055	2057	2062	2063	2064	2065	2067	2068	2069	2070	2071	2072
Sample date	17-Sep-09	21-Jul-09	4-Jun-09	5-Jun-09	10-Jun-09	10-Jun-09	11-Jun-09	11-Jun-09	10-Jun-09	11-Jun-09	11-Jun-09	14-Jul-09	14-Jul-09	14-Jul-09
Percidae - perches														
Etheostoma artesiae	--	--	--	--	--	--	--	--	--	--	--	7	1	6
Etheostoma bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf bellator	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma douglasi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma duryi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma kennicotti	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma nigripinne	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma stigmaeum	--	--	--	--	3	--	--	--	--	--	--	12	--	11
Etheostoma swaini	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma sp cf zonistium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina brevicauda	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	--	--	--	--	--	--	--	--	--	--	--	1	1	8
Percina maculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina nigrofasciata	--	--	--	--	12	--	5	8	--	--	--	5	6	8
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina sipsi	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums														
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	8	9	8	8	15	10	13	10	8	11	10	17	13	23
Individuals	134	177	170	184	220	155	138	129	95	222	216	159	132	261
Catch per effort	4.19	5.53	5.15	5.75	6.88	4.84	4.31	4.30	2.97	6.94	6.55	4.97	4.13	8.16
IBI score	18	24	24	18	32	28	30	28	28	20	22	46	34	46
Biological condition	Very Poor	Very Poor	Very Poor	Very Poor	Poor	Poor	Poor	Poor	Poor	Very Poor	Very Poor	Good	Fair	Good

GSA no.	2082	2083	2084	2085	2086	2214	2287
Sample date	30-Apr-09	30-Apr-09	14-Aug-09	7-Aug-09	7-Aug-09	20-May-08	20-Aug-08
Petromyzontidae - lampreys							
Ichthyomyzon gagei	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--
Lepisosteidae - gars							
Lepisosteus osseus	--	--	--	--	--	--	--
Clupeidae - herrings							
Dorosoma cepedianum	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--
Cyprinidae - carps and minnows							
Campostoma oligolepis	5	15	85	10	37	265	114
Cyprinella callistia	16	2	--	--	--	--	--
Cyprinella galactura	--	--	--	--	--	--	--
Cyprinella spiloptera	--	--	--	--	--	--	--
Cyprinella venusta	75	46	1	1	1	--	--
Hemitremia flammea	--	--	--	--	--	--	--
Hybopsis winchelli	--	--	--	--	--	--	--
Luxilus chrysocephalus	--	--	5	38	46	--	24
Lythrurus alegnotus	--	--	--	--	--	8	--
Lythrurus bellus	--	--	--	--	--	--	--
L. bellus x L. alegnotus	--	--	1	477	111	--	--
Lythrurus fasciolaris	--	--	--	--	--	--	--
Nocomis leptocephalus	--	--	--	7	--	--	11
Notemigonus crysoleucas	--	--	--	--	--	--	--
Notropis asperifrons	--	--	--	4	2	--	--
Notropis baileyi	--	--	--	1	--	--	38
Notropis cahabae	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--
Notropis stilbius	--	15	--	--	--	--	--
Notropis texanus	--	--	3	10	10	10	--
Notropis volucellus	--	--	--	3	--	--	--
Opsopoeodus emiliae	--	--	--	3	--	--	--
Pimephales notatus	--	--	--	1	12	--	--
Pimephales promelas	--	--	--	--	--	--	--
Pimephales vigilax	26	--	--	--	--	--	--
Rhinichthys atratulus	--	--	--	--	--	--	--
Semotilus atromaculatus	--	--	12	1	17	31	11
Catostomidae - suckers							
Carpiodes velifer	--	--	--	--	--	--	--
Catostomus commersoni	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	3	1	7	--	--
Hypentelium etowanum	--	1	1	--	--	--	--
Hypentelium nigricans	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	--	--
Moxostoma carinatum	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	2	11	--	--
Moxostoma poecilurum	--	--	--	1	1	1	--

GSA no. / Sample date	2082 30-Apr-09	2083 30-Apr-09	2084 14-Aug-09	2085 7-Aug-09	2086 7-Aug-09	2214 20-May-08	2287 20-Aug-08
Ictaluridae - North American catfishes							
Ameiurus catus	--	--	--	--	--	--	--
Ameiurus melas	--	--	--	--	--	--	--
Ameiurus natalis	--	--	6	--	5	1	3
Ictalurus punctatus	1	--	--	--	--	1	--
Noturus funebris	--	--	--	1	--	--	--
Noturus gyrinus	--	--	--	2	--	--	3
Noturus leptacanthus	--	--	--	1	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--
Esocidae - pikes							
Esox niger	--	--	--	2	--	--	--
Aphredoderidae - pirate perches							
Aphredoderus sayanus	--	--	4	6	5	--	--
Atherinopsidae - New World silversides							
Labidesthes sicculus	2	--	--	--	--	--	--
Belonidae - needlefishes							
Strongylura marina	--	--	--	--	--	--	--
Fundulidae - topminnows							
Fundulus olivaceus	6	1	3	12	12	68	36
Poeciliidae - livebearers							
Gambusia affinis	--	--	--	--	--	12	8
Cottidae - sculpins							
Cottus carolinae	--	--	--	--	--	--	--
Centrarchidae - sunfishes							
Ambloplites ariommus	--	--	--	--	--	--	--
Lepomis auritus	--	2	--	--	--	5	--
Lepomis cyanellus	3	7	42	2	15	2	9
Lepomis gulosus	--	--	3	2	5	--	--
Lepomis humilis	--	--	--	--	--	--	--
Lepomis macrochirus	1	8	84	3	4	5	94
Lepomis marginatus	--	--	--	--	--	--	--
Lepomis megalotis	31	41	20	31	16	101	5
Lepomis microlophus	--	--	--	--	--	--	1
Lepomis miniatus	--	1	2	--	4	--	--
Micropterus coosae	--	--	--	--	--	--	--
Micropterus dolomieui	--	--	--	--	--	--	--
Micropterus punctulatus	1	1	1	--	--	--	9
Micropterus salmoides	--	1	25	5	--	5	15
Pomoxis nigromaculatus	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--

GSA no.	2082	2083	2084	2085	2086	2214	2287
Sample date	30-Apr-09	30-Apr-09	14-Aug-09	7-Aug-09	7-Aug-09	20-May-08	20-Aug-08
Percidae - perches							
Etheostoma artesiae	--	--	12	25	23	15	--
Etheostoma bellator	--	--	--	--	--	--	--
Etheostoma sp cf bellator	--	--	--	--	--	--	--
Etheostoma douglasi	--	--	--	--	--	--	--
Etheostoma duryi	--	--	--	--	--	--	--
Etheostoma kennicotti	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--
Etheostoma nigripinne	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	--	--	--	--	--
Etheostoma stigmaeum	--	1	--	18	13	--	10
Etheostoma swaini	--	--	--	12	2	--	--
Etheostoma sp cf zonistium	--	--	--	--	--	--	--
Percina brevicauda	--	--	--	--	--	--	--
Percina kathae	--	--	--	1	--	--	--
Percina maculata	--	--	--	2	3	--	--
Percina nigrofasciata	8	9	1	14	--	--	--
Percina shumardi	--	--	--	--	--	--	--
Percina sipsi	--	--	--	--	--	--	--
Sciaenidae - drums							
Aplodinotus grunniens	--	--	--	--	--	--	--
Species	12	15	20	32	23	15	16
Individuals	175	151	314	699	362	530	391
Catch per effort	5.47	4.72	9.81	21.84	11.31	16.06	11.17
IBI score	24	32	38	46	44	32	40
Biological condition	Very Poor	Poor	Fair	Good	Good	Poor	Fair

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