GEOLOGICAL SURVEY OF ALABAMA

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ECOSYSTEMS INVESTIGATIONS PROGRAM

CALIBRATION OF THE INDEX OF BIOTIC INTEGRITY FOR THE HILLS AND COASTAL TERRACES ICHTHYOREGION IN ALABAMA

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by

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ABSTRACT

The Hills and Coastal Terraces ichthyoregion in Alabama was sampled from 2005 through 2011 to develop data for creating and calibrating the Index of Biotic Integrity (IBI). One hundred and one sites were selected to represent a range of watershed areas and levels of human disturbance. Watershed areas at sampled sites ranged from 4.7 mi^2 up to 333 mi^2, with 37 percent of the watersheds <25 mi^2, 39 percent ranging from 21 to 100 mi^2, and 25 percent >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 Hills and Coastal Terraces 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 insectivorous cyprinids, percent of top carnivores, percent with DELT+hybrids (DELT=deformities, eroded fins, lesions, tumors) and the percent of simple lithophilic spawners. Both disturbance and habitat measures were effective in discriminating sites with good biological condition from sites with poor condition, though the degree varied with the IBI metrics. Twenty-eight percent of the sites scored in the poor to very poor range, 43 percent in the fair range, and 30 percent in the good to excellent range. The range of scores for each integrity class of the Hills and Coastal Terraces IBI were similar to those developed for the Plateau, Southern Plains, and Ridge and Valley/Piedmont IBI and slightly higher than criteria developed for the Tennessee Valley IBI. The Hills and Coastal Terraces 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 Hills and Coastal Terraces 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 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, Hills and Coastal Terraces, Plateau, 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), for the Ridge and Valley/Piedmont in O'Neil and Shepard (2011a), and for the Plateau in O'Neil and Shepard (2011b).

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

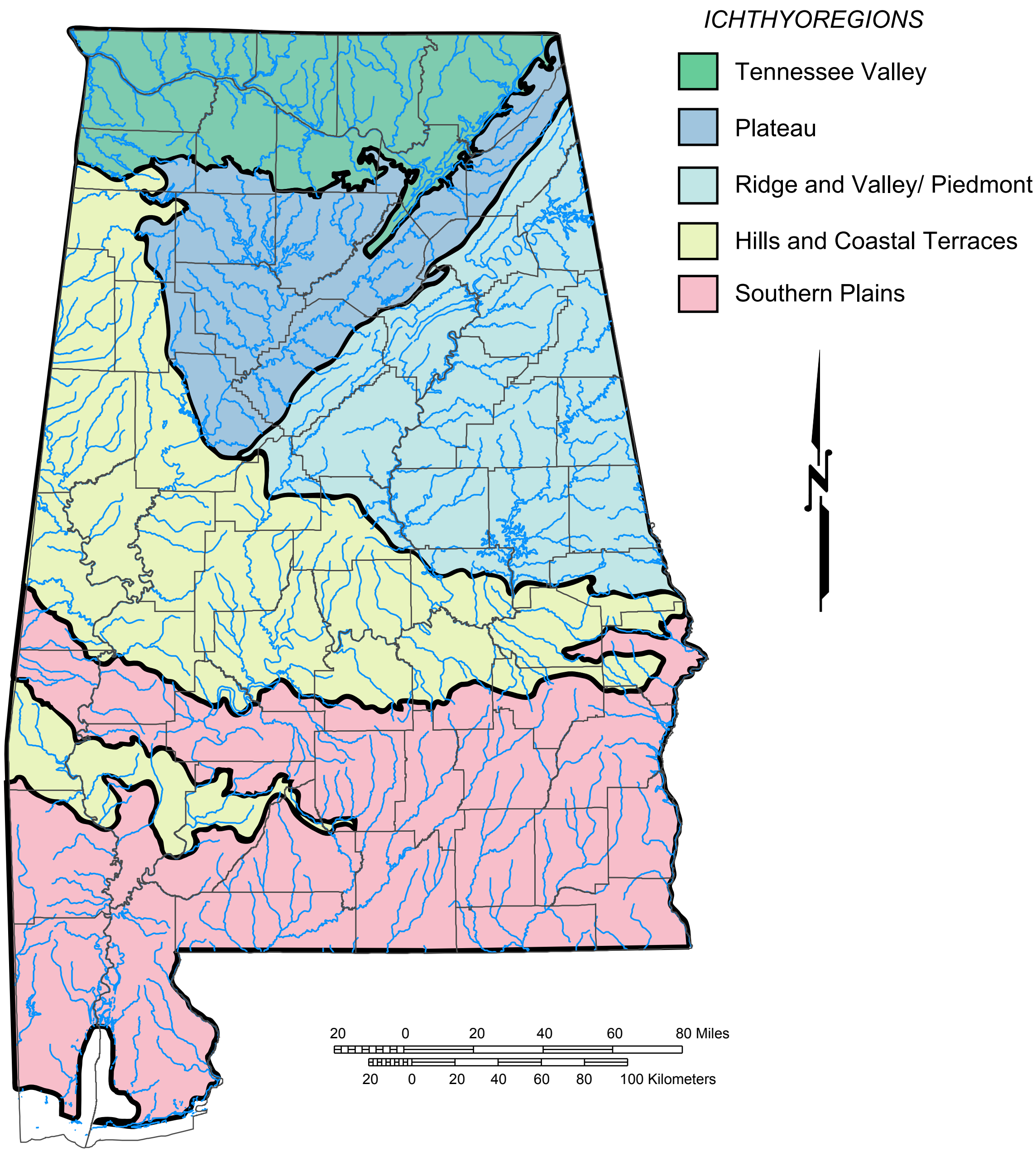


Figure 1. Preliminary ichthyoregion classification for Alabama.

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 have included Dusty Miller, Keith Gilliland, Rick Dowling, Scott Hicks, Aaron Goar, Ranse Williams, Tonya Mayberry, Ron Sparks, Brad Dunham, Ruthie Young, Alicia Phillips, and James Worley. Biologists with WFFD who assisted with sampling this year included Jay Haffner, Jerry Moss, Jim Piper, Travis Powell, Tom Ringenberg, Dave Armstrong, Tommy Purcell, and Kyle Bolton. Cal Johnson, Brett Smith, Stuart McGregor, Sam Justice, and Anne Wynn of GSA assisted with field collections and data entry while Anne Wynn 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 Hills and Coastal Terraces 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 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 Hills and Coastal Terraces ichthyoregion. The GSA was generally 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 Hills and Coastal Terraces ichthyoregion.

STUDY AREA

HILLS AND COASTAL TERRACES 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 Hills and Coastal Terraces ichthyoregion encompasses Mobile basin tributaries in the lower Black Warrior, Cahaba, and Tallapoosa Rivers downstream of the Fall Line and all tributaries of the Tombigbee and Alabama River drainages in Alabama south to the northern boundary of ecoregion 65f–Southern Pine Plains and Hills. Included ecoregions are 68a - Blackland

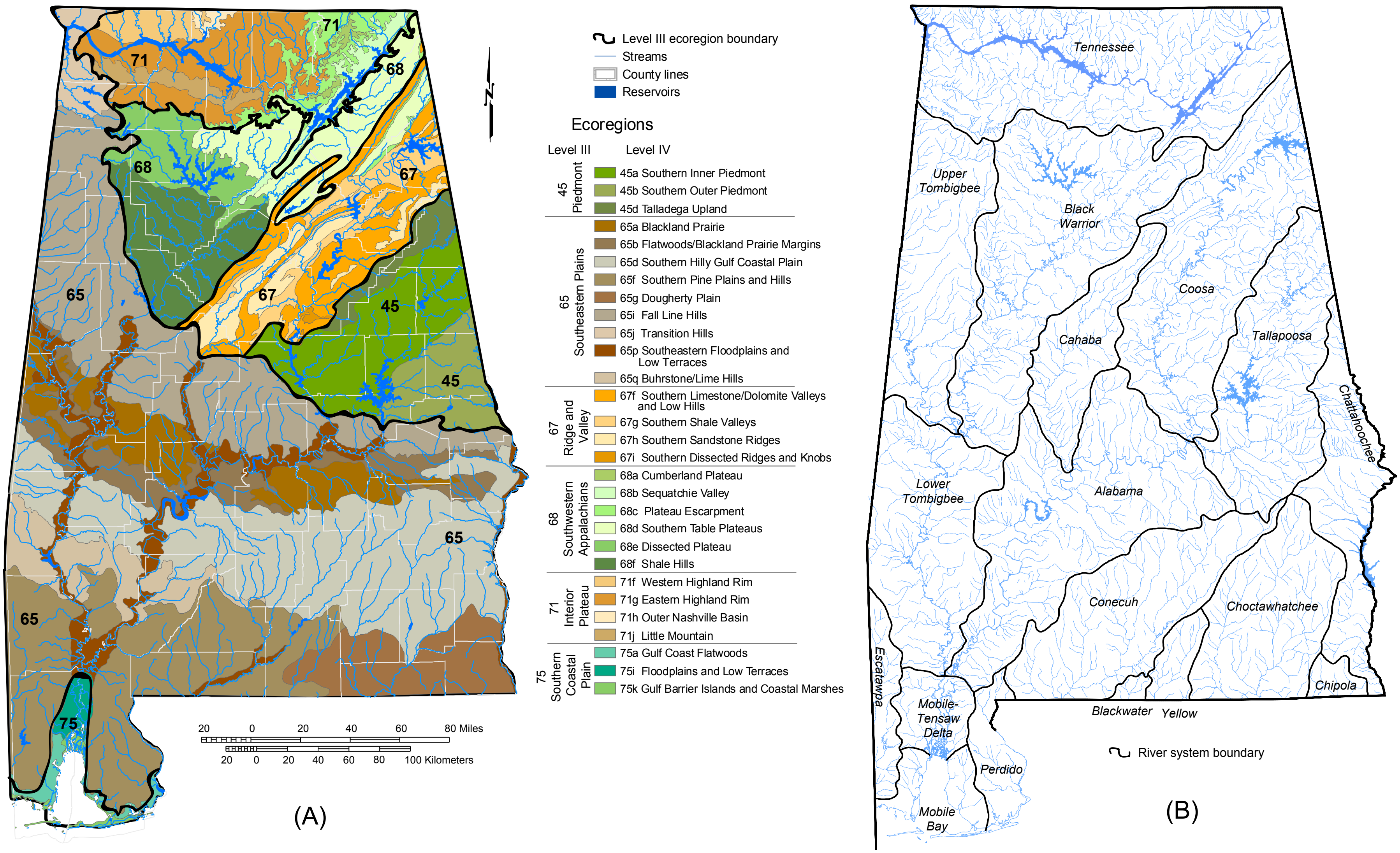


Figure 2. Ecoregions (A) and river systems (B) in Alabama.

Prairie, 65b - Flatwoods/Blackland Prairie Margins, 65i - Fall Line Hills, 65d - Southern Hilly Gulf Coastal Plain, and 65q - Buhrstone/Lime Hills (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 reaches are usually sustained through dry periods. Land use practices in this region are generally agriculture and forest products activities along with the larger urban centers of Montgomery, Tuscaloosa, Selma, and Monroeville.

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 problematic 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 Hills and Coastal Terraces 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 silt, sand, and(or) 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 upstream of 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 glide 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

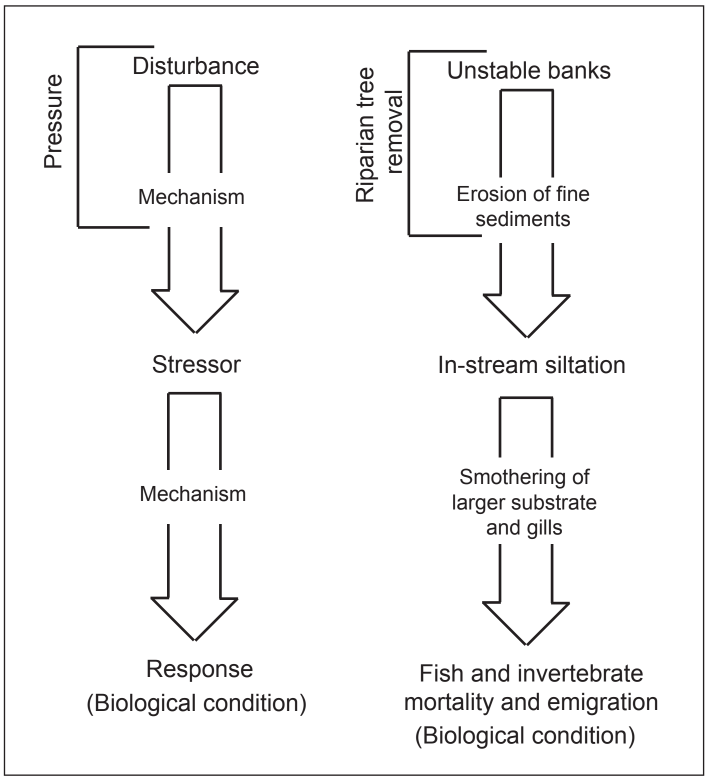


Figure 3. Conceptual model illustrating the relationship between disturbance, stressor, and response (adapted from USEPA, 2005).

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 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:

- DAH - detritivore, algivore, herbivore. Detritus, algae, and(or) vascular plants comprise the major diet items for this guild with *Campostoma* and *Hybognathus* as examples.
- 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.
- INV - invertivore. These species consume a variety of invertebrate taxa including crustaceans, insects, and mollusks. Examples are *Moxostoma, Fundulus, Ictalurus*, and *Ameiurus*.
- INS - insectivore. Many species consume insect immatures as their major food type. Practically all of the darters and many cyprinid species are insectivores.
- PIS - piscivore. Piscivores, such as *Lepisosteus* and *Morone*, consume fishes almost exclusively as adults.
- IP - invertivore, piscivore. Many large predators, such as *Micropterus* and *Esox,* will consume fishes and larger invertebrates as adults.
- 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

Fish assemblage samples were collected from 101 sites in 24 counties across central, northwest, and southwest Alabama to calibrate IBI metrics for the Hills and Coastal Terraces 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 4.7 mi^2 up to 333 mi^2 with 37 percent of the watersheds <25 mi^2, 39 percent ranging from 25 to 100 mi^2, and 25 percent >100 mi^2 in area. Collections were about equally split between the Tombigbee drainage (upper and lower Tombigbee, Black Warrior) with 55 samples and the Alabama drainage (Alabama, Cahaba, Tallapoosa) with 46 samples.

In total 40,784 individuals, representing 110 species and two hybrid forms (table 2), were captured, identified, and released during the study with 30 species in the family Cyprinidae (carps and minnows), 11 species in the family Catostomidae (suckers), 8 species in the family Ictaluridae (catfishes and madtoms), 15 species in the family Centrarchidae (sunfishes), and 24 species in the family Percidae (darters). The average total catch per collection varied across the systems: 418 (ranging from 14 - 1,409) in the Lower Tombigbee, 364 (164 - 957) in the Upper Tombigbee, 411 (74 - 1,156) in the Black Warrior River, 493 (19 - 2,169) in the Alabama River, 333 (75 - 624) in the Cahaba River, and 275 (190 - 386) in the Tallapoosa River.

Minnows in the family Cyprinidae dominated the fauna, comprising 60 percent of all individuals (23,689) collected at 101 sites (table 2). Five species comprised most of the cyprinid individuals collected: *Cyprinella venusta* (Blacktail Shiner) 12.1 percent, *Notropis baileyi* (Rough Shiner) 8.7 percent, *Campostoma oligolepis* (Largescale Stoneroller) 7.7 percent, *Lythrurus bellus* (Pretty Shiner) 6.9 percent, and *N. ammophilus* (Orangefin Shiner) 5.4 percent. Ten sucker species were collected and this family represented about 2.5 percent of the total catch with *Hypentelium etowanum* (Alabama Hogsucker) most dominant at 1.21 percent followed by *Moxostoma poecilurum* (Blacktail Redhorse) at 0.55 percent and *M. erythrurum* (Golden Redhorse) at 0.23 percent.

Table 1. IBI sampling sites in the Hills and Coastal Terraces ichthyoregion, 2005-11.

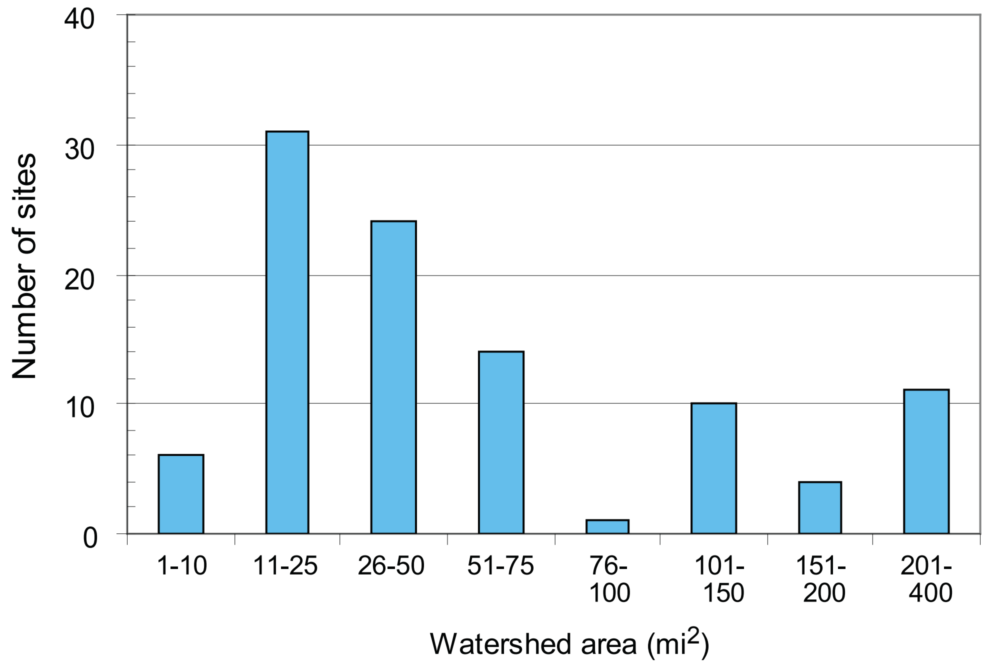
GSA No.	Stream name	Latitude	Longitude	County	Section, township, range	Watershed area (mi^2)	Ecoregion	Sample date
Lower Tombigbee River								
1448	Alamuchee Creek at Co. Hwy. 10	32.41906	88.36827	Sumter	sec. 26, T. 17 N., R. 4 W.	48.5	65d	8-Jul-11
1425	Bashi Creek at Co. Hwy. 7	31.95698	87.86909	Clarke	sec. 3, T. 11 N., R. 2 E.	22	65d	24-Jun-11
1424	Bassett Creek at Ala. Hwy. 178, Fulton	31.78678	87.72820	Clarke	sec. 1, T. 9 N., R. 3 E.	38.7	65q	24-Jun-11
1473	Bassetts Creek at U.S. Hwy. 43	31.46510	88.03110	Washington	sec. 25, T. 6 N., R. 1 W.	136	65f	4-Aug-11
1415	Beaver Creek at Co. Hwy. 75	32.20068	87.90117	Marengo	sec. 8, T. 14 N., R. 2 E.	64.1	65d	20-Jun-11
1422	Big Tallawampa Creek at Co. Hwy. 23	31.86247	88.17225	Choctaw	sec. 34, T. 11 N., R. 2 W.	31.9	65q	23-Jun-11
1420	Bogueloosa Creek at Needham	31.98730	88.33140	Choctaw	sec. 25, T. 12 N., R. 4 W.	19.5	65q	22-Jun-11
1447	Brockway Creek at Co. Hwy. 10	32.33686	88.19785	Sumter	sec. 29, T. 16 N., R. 2 W.	18.5	65d	8-Jul-11
1413	Chickasaw Bogue at Ala. Hwy. 28	32.33609	87.82708	Marengo	sec. 19, T. 20 N., R. 3 E.	269	65b	20-Jun-11
1418	Okatuppa Creek at Co. Hwy. 20	32.08729	88.41232	Choctaw	sec. 20, T. 13 N., R. 4 W.	21.9	65q	22-Jun-11
1423	Okatuppa Creek at Mosley Bridge Road	31.87852	88.29102	Choctaw	sec. 33, T. 11 N., R. 3 W.	210	65q	23-Jun-11
2321	Souwilpa Creek at Co. Hwy. 21	31.82139	88.24317	Choctaw	sec. 24, T. 10 N., R. 3 W.	38.9	65q	9-Aug-07
1421	Surveyors Creek at Co. Hwy. 9	31.87375	88.22657	Choctaw	sec. 31, T. 11 N., R. 2 W.	21.5	65q	23-Jun-11
1414	Sweetwater at Co. Hwy. 6	32.06814	87.90192	Marengo	sec. 29, T. 13 N., R. 2 E.	29.6	65d	20-Jun-11
1419	Tuckabum Cr. at Co. Hwy. 45	32.22472	88.33100	Choctaw	sec. 36, T. 15 N., R. 4 W.	20.4	65d	22-Jun-11
2320	Tuckabum Creek at Ala. Hwy. 17	32.18461	88.17028	Choctaw	sec. 15, T. 14 N., R. 2 W.	115	65d	8-Aug-07
1417	Yantley Creek at Co. Hwy. 7	32.21989	88.27229	Choctaw	sec. 3, T. 14 N., R. 3 W.	27.8	65d	21-Jun-11
Upper Tombigbee River								
1588	Big Creek at Ala. Hwy. 14	33.21128	88.25330	Pickens	sec. 30, T. 21 S., R. 16 W.	45.7	65i	24-May-11
1587	Blubber Creek at New Canaan Road	33.12890	88.19705	Pickens	sec. 22, T. 22 S., R. 16 W.	22.6	65i	24-May-11
1402	Bodka Creek at Ala. Hwy. 17	32.80657	88.31201	Sumter	sec. 8, T. 11 N., R. 3 W.	158	65a	9-Jun-11
1584	Boligee Canal at Co. Hwy. 81	32.76265	88.03143	Greene	sec. 30, T. 21 N., R. 1 E.	17.9	65a	23-May-11
1596	Boxes Creek at Frost Road	33.82450	87.62340	Fayette	sec. 19, T. 14 S., R. 10 W.	7.4	65i	2-Jun-11
1585	Brush Creek at Co. Hwy. 133	32.83113	87.98179	Greene	sec. 3, T. 21 N., R. 1 E.	43.2	65a	23-May-11
1438	Bull Mountain Creek at Mt. Hope Church Road	34.29036	88.09635	Marion	sec. 10, T. 9 S., R. 15 W.	56.1	65i	24-May-11
1444	Buttahatchee River at Ala. Hwy. 129	34.11236	87.73135	Marion	sec. 7, T. 11 S., R. 11 W.	30.4	65e	9-Jun-11
1445	Buttahatchee River at Co. Hwy. 16	34.01859	88.05334	Lamar	sec. 18, T. 12 S., R. 14 W.	329	65i	6-Jul-11
2323	Buttahatchee River at U.S. Hwy. 43	34.10536	87.98917	Marion	sec. 15, T. 11 S., R. 14 W.	277	65i	14-Aug-07
1403	Factory Creek at Ala. Hwy. 39	32.74461	88.16737	Sumter	sec. 3, T. 20 N., R. 2 W.	31.1	65b	9-Jun-11
1440	Hells Creek at Co. Hwy. 41 (Cody Road)	33.73287	87.98056	Lamar	sec. 23, T. 15 S., R. 14 W.	24.4	65i	25-May-11
1437	Hurricane Creek at Taylor Road	34.20704	88.11938	Marion	sec. 9, T. 10 S., R. 15 W.	17.6	65i	24-May-11
1589	Kincaide Creek at St. John Road	33.37611	88.20508	Pickens	sec. 28, T. 19 S., R. 16 W.	17.7	65i	25-May-11
1590	Little Magby Creek at Caston Road	33.50144	88.23352	Pickens	sec. 17, T. 18 S., R. 16 W.	4.7	65i	25-May-11
1594	Little New River at Co. Hwy. 40	33.99080	87.72570	Marion	sec. 19, T. 12 S., R. 11 W.	25.4	68f	1-Jun-11
1591	Lubbub Creek at Co. Hwy 57	33.45734	87.94673	Pickens	sec. 25, T. 18 S., R. 14 W.	23.9	65i	31-May-11
1446	Lubbub Creek at Co. Hwy. 24	33.15525	88.10397	Pickens	sec. 9, T. 22 S., R. 15 W.	291	65i	6-Jul-11
2324	Luxapallila Creek at Co. Hwy. 49	33.59308	87.99036	Lamar	sec. 10, T. 17 S., R. 14 W.	205	65i	15-Aug-07
1592	Luxapallila Creek at unnumbered Co. Hwy.	33.88940	87.83995	Fayette	sec. 30, T. 13 S., R. 12 W.	53.4	65i	31-May-11
1595	Mallard Creek at Texas near U.S. Hwy. 78	33.92898	87.66913	Marion	sec. 14, T. 13 S., R. 11 W.	14	68f	2-Jun-11
1593	Ragsdale Creek at U.S. Hwy. 43 in Hamilton	34.14557	87.98647	Marion	sec. 35, T. 10 S., R. 14 W.	8	65i	1-Jun-11
1441	Sipsey Creek at Co. Hwy. 38	34.01764	88.20086	Lamar	sec. 15, T. 12 S., R. 16 W.	143	65i	10-Jun-11
1434	Sipsey River at Co. Hwy. 50 at Berea	33.84880	87.71540	Fayette	sec. 8, T. 14 S., R. 11 W.	153	65i	9-Jun-11
1583	Taylor Creek at Co. Hwy. 72	32.69602	87.99578	Greene	sec. 21, T. 20 N., R. 1 E.	17.4	65a	23-May-11
2319	Trussells Creek at Co. Hwy 20	32.83356	88.04067	Greene	sec. 2, T. 21 N., R. 1 W.	69	65b	8-Aug-07
1442	Williams Creek at Co. Hwy. 1	34.17024	87.98053	Marion	sec. 23, T. 10 S., R. 14 W.	28	65i	25-May-11

Table 1. IBI sampling sites in the Hills and Coastal Terraces ichthyoregion, 2005-11--continued.

GSA No.	Stream name	Latitude	Longitude	County	Section, township, range	Watershed area (mi^2)	Ecoregion	Sample date
			Black Warrior River					
1439	Brush Creek at unpaved road	32.75086	87.43159	Perry	sec. 36, T. 21 N., R. 6 E.	28.5	65i	17-May-11
1451	South Sandy Creek at Forest Road 706	33.01271	87.48481	Tuscaloosa	sec. 33, T. 24 N., R. 6 E.	47.2	65i	29-Jul-11
1452	Cribbs Mill Creek at Kauloosa Ave.	33.17404	87.56254	Tuscaloosa	sec. 34, T. 21 S., R. 10 W.	11	65i	29-Jul-11
1453	Cypress Creek at Kauloosa Ave.	33.16403	87.55584	Tuscaloosa	sec. 2, T. 22 S., R. 10 W.	11.4	65i	29-Jul-11
1579	Fivemile Creek at Co. Hwy. 42	32.89015	87.73022	Hale	sec. 12, T. 22 N., R. 3 E.	107	65i	17-May-11
1580	Little Prairie Creek at Co. Hwy. 9	32.59318	87.64639	Hale	sec. 26, T. 19 N., R. 4 E.	24.2	65a	17-May-11
1586	Minter Creek at Co. Hwy. 231	32.88095	87.86074	Greene	sec. 14, T. 22 N., R. 2 E.	18.4	65i	24-May-11
1925	Deadwater Creek near RR tracks	33.65964	87.65716	Fayette	sec. 14, T. 16 S., R. 11 W.	14.5	65i	2-Sep-09
2004	Deadwater Creek near mouth	33.66144	87.65375	Fayette	sec. 14, T. 16 S., R. 11 W.	14.7	65i	22-Jul-08
2008	Carroll Creek at Ala. Hwy. 69 near Northport	33.29453	87.56837	Tuscaloosa	sec. 22, T. 20 S., R. 10 W.	20.9	65i	28-Apr-09
2009	Binion Creek at Kemp Road	33.47908	87.70375	Tuscaloosa	sec. 17, T. 18 S., R. 11 W.	11	65i	28-Apr-09
			Alabama River					
1404	Autauga Creek at Co. Hwy. 4	32.42684	86.46123	Autauga	sec. 28, T. 17 N., R. 16 E.	119	65p	14-Jun-11
1432	Bear Creek at Co. Hwy. 1	31.87288	87.57721	Wilcox	sec. 33, T. 11 N., R. 5 E.	25.3	65d	30-Jun-11
2326	Big Flat Creek at Ala. Hwy 41	31.60778	87.41447	Monroe	sec. 1, T. 7 N., R. 6 E.	247	65q	13-Sep-07
1850	Big Flat Creek at River Road	31.71389	87.31101	Monroe	sec. 30, T. 9 N., R. 8 E.	122	65d	29-Sep-10
1407	Big Swamp Creek at Co. Hwy. 23, White Hall	32.32257	86.71255	Lowndes	sec. 36, T. 16 N., R. 13 E.	263	65b	15-Jun-11
1410	Big Swamp Creek at Co. Hwy. 948	32.22085	87.16294	Dallas	sec. 3, T. 14 N., R. 9 E.	35.8	65b	16-Jun-11
1411	Bogue Chitto Creek at Co. Hwy. 115	32.27692	87.28136	Dallas	sec. 16, T. 15 N., R. 8 E.	328	65a	16-Jun-11
1406	Catoma Creek at Co. Hwy. 39	32.27839	86.21915	Montgomery	sec. 13, T. 15 N., R. 18 E.	159	65a	14-Jun-11
2325	Chilatchee Creek at Ala. Hwy. 5	32.23617	87.40972	Wilcox	sec. 30, T. 15 N., R. 7 E.	90	65b	16-Aug-07
1409	Dry Cedar Creek at Co. Hwy. 85	32.11658	86.96022	Dallas	sec. 9, T. 13 N., R. 11 E.	121	65b	15-Jun-11
1433	Goose Creek at Co. Hwy. 32	32.05376	87.55789	Wilcox	sec. 34, T. 13 N., R. 5 E.	50	65d	30-Jun-11
1427	Limestone Creek at Old Salem Creek Road	31.56190	87.42092	Monroe	sec. 24, T. 7 N., R. 6 E.	152	65q	28-Jun-11
1853	Little Mulberry Creek at Co. Hwy. 8	32.58250	86.77760	Autauga	sec. 33, T. 19 N., R. 13 E.	70.8	65i	16-Sep-10
1856	Mulberry Creek at Ala. Hwy. 22	32.80172	86.82162	Chilton	sec. 18, T. 21 N., R. 13 E.	37.7	65i	27-Aug-10
1400	Mulberry Creek at U.S. Hwy. 82	32.75161	86.86879	Chilton	sec. 33, T. 21 N., R. 12 E.	112	65i	8-Jun-11
1408	Old Town Creek at Co. Hwy. 481	32.27176	86.86444	Lowndes	sec. 16, T. 15 N., R. 12 E.	14.2	65b	15-Jun-11
1857	Pine Barren Creek at 7th Avenue	31.82897	86.83461	Butler	sec. 23, T. 10 N., R. 12 E.	18.7	65d	27-Sep-10
1858	Pine Creek at U.S. 31	32.42570	86.41230	Autauga	sec. 25, T. 17 N., R. 16 E.	12.7	65p	15-Sep-10
1405	Pintlala Creek at Co. Hwy. 24	32.17547	86.34490	Montgomery	sec. 22, T. 14 N., R. 17 E.	70.3	65a	14-Jun-11
1426	Pursley Creek at Ala. Hwy. 41	31.95553	87.33725	Wilcox	sec. 2, T. 11 N., R. 7 E.	64.3	65d	28-Jun-11
1859	Robinson Creek at Ala. Hwy. 47	31.68341	87.21802	Monroe	sec. 1, T. 8 N., R. 8 E.	37.78	65q	29-Sep-10
1862	Silver Creek on Private Property Road	31.69510	87.58150	Clarke	sec. 4, T. 8 N., R. 5 E.	25	65p	29-Sep-10
1861	Soapstone Creek upstream of U.S. 80	32.32220	86.90630	Dallas	sec. 31, T. 16 N., R. 12 E.	22	65p	15-Sep-10
1863	Sturdivant Creek at Ala. Hwy. 10	31.83800	86.90900	Wilcox	sec. 13, T. 10 N., R. 11 E.	52.2	65d	27-Sep-10
1401	Swift Creek at Co. Hwy. 67	32.68148	86.68500	Autauga	sec. 29, T. 20 N., R. 14 E.	39	65i	8-Jun-11
1416	Turkey Creek at Ala. Hwy. 25	32.08311	87.65558	Marengo	sec. 3, T. 13 N., R. 4 E.	17	65d	21-Jun-11
1428	Tributary to Limestone Creek at Co. Hwy. 27	31.54478	87.38038	Monroe	sec. 29, T. 7 N., R. 7 E.	18	65q	28-Jun-11
1412	Valley Creek at Ala. Hwy. 22	32.40573	87.03733	Dallas	sec. 35, T. 17 N., R. 10 E.	67	65p	16-Jun-11

Table 1. IBI sampling sites in the Hills and Coastal Terraces ichthyoregion, 2005-11--continued.

GSA No.	Stream name	Latitude	Longitude	County	Section, township, range	Watershed area (mi^2)	Ecoregion	Sample date
Cahaba River								
1435	Old Town Creek at Ala. Hwy. 175	32.71143	87.27752	Perry	sec. 16, T. 20 N., R. 8 E.	31.2	65i	17-May-11
1436	Rice Creek at Co. Hwy.4	32.55763	87.25370	Perry	sec. 2, T. 18 N., R. 8 E.	27.7	65a	18-May-11
1443	Watters Creek at Ala. Hwy. 14	32.59723	87.20171	Perry	sec. 29, T. 19 N., R. 9 E.	14.3	65i	18-May-11
1577	Caffee Creek at Co. Hwy. 24	33.11505	87.10623	Bibb	sec. 19, T. 22 S., R. 5 W.	28.8	67h	16-May-11
1578	Schultz Creek at Ala. Hwy. 5	33.01331	87.15082	Bibb	sec. 35, T. 24 N., R. 9 E.	70.3	67h	16-May-11
1581	Blue Girth Creek at Ala. Hwy. 25	32.89849	87.31536	Bibb	sec. 7, T. 22 N., R. 8 E.	8	65i	18-May-11
1582	Oakmulgee Creek at Ala. Hwy. 183	32.81043	86.99174	Chilton	sec. 8, T. 21 N., R. 11 E.	32.2	65i	18-May-11
1597	Oakmulgee at Ala. Hwy. 14	32.48043	87.12691	Perry	sec. 1, T. 17 N., R. 9 E.	233	65i	7-Jun-11
1598	Silver Creek near mouth	32.51462	87.18272	Perry	sec. 21, T. 18 N., R. 9 E.	9.5	65i	7-Jun-11
1599	Gulley Creek at Ala. Hwy. 219	32.90028	87.12406	Bibb	sec. 12, T. 22 N., R. 9 E.	9.27	65i	7-Jun-11
Tallapoosa River								
1306	Chewacla Creek at Co. Hwy. 10	32.53575	85.49669	Lee	sec. 24, T. 18 N., R. 25 E.	52.7	65i	7-Jul-09
1307	Opintlocco Creek at Co. Hwy. 26	32.41236	85.61647	Macon	sec. 35, T. 17 N., R. 24 E.	101	65i	8-Jul-09
1880	Uphapee Creek at Ala. Hwy. 81	32.47751	85.69554	Macon	sec. 12, T. 17 N., R. 23 E.	333	65i	2-Sep-10
2661	Chubbehatchee Creek at Co. Hwy 4	32.44870	86.07950	Elmore	sec. 20, T. 17 N., R, 20 E.	61.7	65i	21-Jul-05
2662	Wauxamaka Creek at Co. Hwy 56	32.48928	85.79006	Macon	sec. 6, T. 17 N., R. 23 E.	10.1	65i	21-Jul-05
2665	Choctafaula at Ala. Hwy 186	32.47900	85.62570	Macon	sec 11, T. 17 N., R. 24 E.	55.9	65i	3-Aug-05
2666	Line Creek at Co. Hwy 4	32.30230	85.95440	Montgomery	sec. 10, T. 15 N., R. 21 E.	102.6	65b	3-Aug-05
2667	Chewacla Creek at Co. Hwy. 10	32.53575	85.49669	Lee	sec. 24, T. 18 N., R. 25 E.	52.7	65i	4-Aug-05



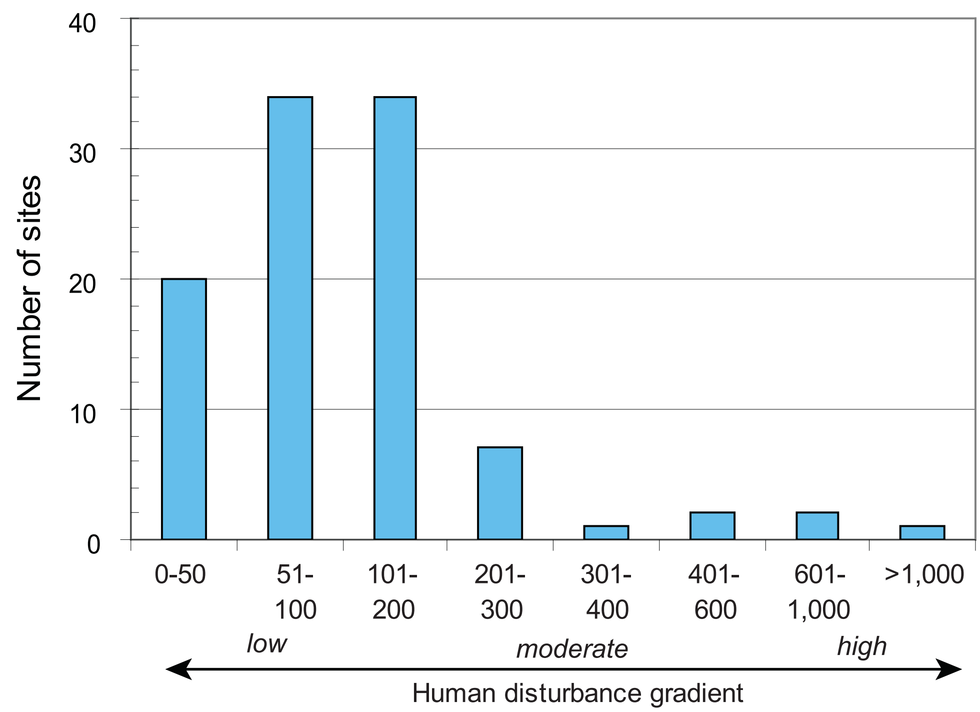


Figure 5. Frequency distribution of sampling sites in the Hills and Coastal Terraces ichthyoregion by watershed area and human disturbance.

Table 2. List of fishes collected in the Mobile River basin.

Family species	Lower Tombigbee No.	Lower Tombigbee %	Upper Tombigbee No.	Upper Tombigbee %	Black Warrior No.	Black Warrior %	Alabama No.	Alabama %	Cahaba No.	Cahaba %	Tallapoosa No.	Tallapoosa %	Total No.	Total %
Petromyzontidae - lampreys														
Ichthyomyzon gagei	7	0.10	--	--	19	0.42	--	--	1	0.03	2	0.09	29	0.07
Lampetra aepyptera	--	--	2	0.02	--	--	--	--	--	--	--	--	2	--
Lepisosteidae - gars														
Lepisosteus oculatus	--	--	1	0.01	--	--	25	0.18	--	--	1	0.05	27	0.07
Lepisosteus osseus	2	0.03	4	0.04	--	--	2	0.01	--	--	--	--	8	0.02
Amiidae - bowfins														
Amia calva	--	--	1	0.01	--	--	--	--	--	--	--	--	1	--
Anguillidae - freshwater eels														
Anguilla rostrata	--	--	1	0.01	--	--	2	0.01	--	--	--	--	3	0.01
Clupeidae - shads														
Dorosoma cepedianum	--	--	60	0.61	--	--	--	--	--	--	--	--	60	0.15
Dorosoma petenense	--	--	14	0.14	--	--	--	--	--	--	--	--	14	0.03
Cyprinidae - carps and minnows														
Campostoma oligolepis	192	2.70	609	6.20	51	1.13	2,041	14.78	56	1.68	194	8.82	3,143	7.71
Cyprinella callistia	323	4.55	195	1.99	--	--	50	0.36	53	1.59	--	--	621	1.52
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--	8	0.36	8	0.02
Cyprinella trichroistia	--	--	--	--	--	--	12	0.09	60	1.80	--	--	72	0.18
Cyprinella venusta	717	10.10	936	9.53	472	10.44	1,916	13.87	593	17.80	287	13.05	4,921	12.07
Hybopsis winchelli	19	0.27	52	0.53	8	0.18	27	0.20	35	1.05	12	0.55	153	0.38
Luxilus chrysocephalus	176	2.48	416	4.24	173	3.82	285	2.06	70	2.10	25	1.14	1,145	2.81
Lythrurus bellus	587	8.27	881	8.97	532	11.76	577	4.18	82	2.46	152	6.91	2,811	6.89
Macrhybopsis storeriana	--	--	--	--	--	--	64	0.46	15	0.45	15	0.68	94	0.23
Nocomis leptocephalus	77	1.08	103	1.05	40	0.88	273	1.98	77	2.31	12	0.55	582	1.43
Notemigonus crysoleucas	--	--	5	0.05	9	0.20	7	0.05	--	--	--	--	21	0.05
Notropis ammophilus	734	10.34	211	2.15	187	4.13	711	5.15	295	8.85	73	3.32	2,211	5.42
Notropis asperifrons	--	--	--	--	--	--	37	0.27	--	--	--	--	37	0.09
Notropis atherinoides	7	0.10	--	--	--	--	54	0.39	3	0.09	60	2.73	124	0.30
Notropis baileyi	554	7.80	507	5.16	501	11.08	768	5.56	1,051	31.54	162	7.37	3,543	8.69
Notropis amplamala	133	1.87	16	0.16	--	--	338	2.45	20	0.60	35	1.59	542	1.33
Notropis candidus	--	--	21	0.21	--	--	--	--	--	--	--	--	21	0.05
Notropis chrosomus	--	--	--	--	--	--	85	0.62	--	--	--	--	85	0.21
Notropis stilbius	85	1.20	487	4.96	3	0.07	34	0.25	14	0.42	13	0.59	636	1.56
Notropis texanus	59	0.83	127	1.29	173	3.82	74	0.54	18	0.54	30	1.36	481	1.18
Notropis volucellus	--	--	15	0.15	--	--	15	0.11	27	0.81	48	2.18	105	0.26

Table 2. List of fishes collected in the Mobile River basin--continued.

Family species	Lower Tombigbee No.	Lower Tombigbee %	Upper Tombigbee No.	Upper Tombigbee %	Black Warrior No.	Black Warrior %	Alabama No.	Alabama %	Cahaba No.	Cahaba %	Tallapoosa No.	Tallapoosa %	Total No.	Total %
Cyprinidae - Continued														
Opsopoeodus emiliae	1	0.01	6	0.06	--	--	1	0.01	2	0.06	1	0.05	11	0.03
Phenacobius catostomus	--	--	--	--	--	--	--	--	1	0.03	--	--	1	--
Pimephales notatus	211	2.97	256	2.61	49	1.08	564	4.08	--	--	21	0.95	1,101	2.70
Pimephales promelas	--	--	2	0.02	19	0.42	2	0.01	--	--	--	--	23	0.06
Pimephales vigilax	83	1.17	285	2.90	242	5.35	99	0.72	160	4.80	1	0.05	870	2.13
Pteronotropis hypselopterus	2	0.03	--	--	--	--	--	--	--	--	--	--	2	--
Pteronotropis signipinnis	31	0.44	--	--	--	--	--	--	--	--	--	--	31	0.08
Semotilus atromaculatus	48	0.68	77	0.78	8	0.18	123	0.89	29	0.87	--	--	285	0.70
Semotilus thoreauianus	--	--	8	0.08	--	--	--	--	--	--	--	--	8	0.02
hybrid cyprinid	--	--	--	--	1	0.02	--	--	--	--	--	--	1	--
Catostomidae - suckers														
Carpiodes cyprinus	--	--	--	--	--	--	10	0.07	--	--	--	--	10	0.02
Carpiodes velifer	--	--	3	0.03	--	--	19	0.14	--	--	--	--	22	0.05
Erimyzon oblongus	35	0.49	16	0.16	8	0.18	16	0.12	1	0.03	--	--	76	0.19
Erimyzon sucetta	--	--	1	0.01	--	--	--	--	1	0.03	--	--	2	--
Erimyzon tenuis	3	0.04	--	--	--	--	--	--	--	--	--	--	3	0.01
Hypentelium etowanum	37	0.52	90	0.92	22	0.49	263	1.91	14	0.42	66	3.00	492	1.21
Ictiobus bubalus	--	--	5	0.05	--	--	--	--	--	--	--	--	5	0.01
Minytrema melanops	8	0.11	16	0.16	4	0.09	4	0.03	3	0.09	2	0.09	37	0.09
Moxostoma duquesnei	--	--	2	0.02	--	--	7	0.05	--	--	3	0.14	12	0.03
Moxostoma erythrurum	9	0.13	28	0.29	7	0.15	37	0.27	--	--	11	0.50	92	0.23
Moxostoma poecilurum	48	0.68	74	0.75	4	0.09	82	0.59	1	0.03	14	0.64	223	0.55
Ictaluridae - North American catfishes														
Ameiurus melas	--	--	1	0.01	--	--	1	0.01	--	--	--	--	2	--
Ameiurus natalis	27	0.38	20	0.20	57	1.26	54	0.39	3	0.09	13	0.59	174	0.43
Ictalurus punctatus	4	0.06	21	0.21	27	0.60	106	0.77	6	0.18	14	0.64	178	0.44
Noturus funebris	10	0.14	23	0.23	10	0.22	4	0.03	4	0.12	4	0.18	55	0.13
Noturus gyrinus	6	0.08	10	0.10	5	0.11	3	0.02	--	--	--	--	24	0.06
Noturus leptacanthus	106	1.49	198	2.02	28	0.62	104	0.75	45	1.35	76	3.46	557	1.37
Noturus munitus	--	--	16	0.16	--	--	--	--	--	--	--	--	16	0.04
Pylodictis olivaris	--	--	4	0.04	--	--	--	--	--	--	--	--	4	0.01
Esocidae - pikes														
Esox americanus	2	0.03	15	0.15	10	0.22	6	0.04	3	0.09	--	--	36	0.09
Esox niger	--	--	5	0.05	2	0.04	2	0.01	3	0.09	1	0.05	13	0.03
Aphredoderidae - pirate perch	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderus sayanus	20	0.28	22	0.22	8	0.18	21	0.15	--	--	3	0.14	74	0.18

Table 2. List of fishes collected in the Mobile River basin--continued.

Family *species*	Lower Tombigbee No.	Lower Tombigbee %	Upper Tombigbee No.	Upper Tombigbee %	Black Warrior No.	Black Warrior %	Alabama No.	Alabama %	Cahaba No.	Cahaba %	Tallapoosa No.	Tallapoosa %	Total No.	Total %
Atherinopsidae - New World silversides														
Labidesthes sicculus	33	0.46	2	0.02	--	--	149	1.08	--	--	--	--	184	0.45
Menidia audens	--	--	2	0.02	4	0.09	--	--	--	--	--	--	6	0.01
Fundulidae - topminnows														
Fundulus notatus	--	--	28	0.29	--	--	--	--	--	--	--	--	28	0.07
Fundulus nottii	5	0.07	--	--	--	--	--	--	--	--	--	--	5	0.01
Fundulus olivaceus	212	2.99	229	2.33	135	2.98	251	1.82	9	0.27	31	1.41	867	2.13
Fundulus stellifer	--	--	--	--	--	--	7	0.05	--	--	--	--	7	0.02
Poeciliidae - livebearers														
Gambusia affinis	72	1.01	103	1.05	106	2.34	527	3.82	4	0.12	49	2.23	861	2.11
Cottidae - sculpins														
Cottus carolinae	--	--	--	--	--	--	34	0.25	54	1.62	73	3.32	161	0.39
Centrarchidae - sunfishes														
Ambloplites ariommus	9	0.13	20	0.20	5	0.11	12	0.09	5	0.15	4	0.18	55	0.13
Centrarchus macropterus	--	--	9	0.09	4	0.09	--	--	--	--	--	--	13	0.03
Lepomis auritus	--	--	--	--	2	0.04	--	--	--	--	5	0.23	7	0.02
Lepomis cyanellus	10	0.14	152	1.55	53	1.17	143	1.04	24	0.72	21	0.95	403	0.99
Lepomis gulosus	13	0.18	30	0.31	16	0.35	37	0.27	3	0.09	4	0.18	103	0.25
Lepomis humilis	--	--	6	0.06	--	--	--	--	--	--	--	--	6	0.01
Lepomis macrochirus	90	1.27	436	4.44	180	3.98	409	2.96	38	1.14	73	3.32	1,226	3.01
Lepomis megalotis	593	8.35	875	8.91	615	13.60	1,657	12.00	135	4.05	165	7.50	4,040	9.91
Lepomis microlophus	5	0.07	13	0.13	1	0.02	4	0.03	--	--	1	0.05	24	0.06
Lepomis miniatus	35	0.49	63	0.64	36	0.80	124	0.90	1	0.03	4	0.18	263	0.64
Micropterus coosae	--	--	--	--	--	--	--	--	1	0.03	2	0.09	3	0.01
Micropterus punctulatus	46	0.65	79	0.80	10	0.22	121	0.88	2	0.06	26	1.18	284	0.70
Micropterus salmoides	19	0.27	32	0.33	32	0.71	77	0.56	2	0.06	21	0.95	183	0.45
Pomoxis annularis	--	--	3	0.03	--	--	--	--	--	--	--	--	3	0.01
Pomoxis nigromaculatus	--	--	17	0.17	--	--	1	0.01	--	--	1	0.05	19	0.05
hybrid centrarchid	--	--	1	0.01	--	--	2	0.01	--	--	--	--	3	0.01

Table 2. List of fishes collected in the Mobile River basin--continued.

Family *species*	Lower Tombigbee No.	Lower Tombigbee %	Upper Tombigbee No.	Upper Tombigbee %	Black Warrior No.	Black Warrior %	Alabama No.	Alabama %	Cahaba No.	Cahaba %	Tallapoosa No.	Tallapoosa %	Total No.	Total %
Percidae - perches and darters														
Ammocrypta beanii	35	0.49	33	0.34	--	--	1	0.01	7	0.21	--	--	76	0.19
Ammocrypta meridiana	18	0.25	18	0.18	6	0.13	2	0.01	8	0.24	--	--	52	0.13
Crystallaria asprella	--	--	--	--	--	--	2	0.01	1	0.03	--	--	3	0.01
Etheostoma artesiae	44	0.62	55	0.56	4	0.09	65	0.47	1	0.03	3	0.14	172	0.42
Etheostoma chlorosomum	--	--	--	--	--	--	3	0.02	--	--	1	0.05	4	0.01
Etheostoma fusiforme	--	--	--	--	--	--	1	0.01	--	--	--	--	1	--
Etheostoma histrio	--	--	7	0.07	6	0.13	2	0.01	2	0.06	--	--	17	0.04
Etheostoma jordani	--	--	--	--	--	--	--	--	33	0.99	33	1.50	66	0.16
Etheostoma lachneri	401	5.65	141	1.44	41	0.91	--	--	--	--	--	--	583	1.43
Etheostoma nigrum	101	1.42	41	0.42	--	--	32	0.23	--	--	13	0.59	187	0.46
Etheostoma parvipinne	6	0.08	7	0.07	--	--	2	0.01	4	0.12	1	0.05	20	0.05
Etheostoma proeliare	2	0.03	--	--	--	--	--	--	--	--	--	--	2	--
Etheostoma ramseyi	--	--	--	--	--	--	281	2.03	31	0.93	--	--	312	0.77
Etheostoma rupestre	465	6.55	592	6.03	3	0.07	352	2.55	22	0.66	33	1.50	1,467	3.60
Etheostoma stigmaeum	142	2.00	399	4.06	202	4.47	80	0.58	32	0.96	31	1.41	886	2.17
Etheostoma swaini	10	0.14	39	0.40	71	1.57	22	0.16	--	--	6	0.27	148	0.36
Etheostoma zonifer	--	--	--	--	--	--	25	0.18	--	--	3	0.14	28	0.07
Percina kathae	5	0.07	8	0.08	130	2.87	11	0.08	1	0.03	--	--	155	0.38
Percina maculata	2	0.03	15	0.15	--	--	7	0.05	--	--	1	0.05	25	0.06
Percina nigrofasciata	357	5.03	339	3.45	172	3.80	427	3.09	166	4.98	228	10.37	1,689	4.14
Percina sciera	--	--	25	0.25	--	--	--	--	--	--	--	--	25	0.06
Percina shumardi	--	--	--	--	--	--	8	0.06	--	--	--	--	8	0.02
Percina suttkusi	3	0.04	--	--	--	--	--	--	--	--	--	--	3	0.01
Percina vigil	2	0.03	118	1.20	9	0.20	7	0.05	--	--	--	--	136	0.33
Sciaenidae - drums														
Aplodinotus grunniens	--	--	13	0.13	1	0.02	1	0.01	--	--	--	--	15	0.04
Elassomatidae - pygmy sunfishes														
Elassoma zonatum	2	0.03	1	0.01	--	--	--	--	--	--	7	0.32	10	0.02
Species	63		84		55		81		56		58		112	
Individuals	7,100		9,819		4,523		13,811		3,332		2,199		40,784	
No. sites	17		27		11		28		10		8		101	
No. collections	17		27		11		28		10		8		101	
Avg. catch per collection	417.65		363.67		411.18		493.25		333.2		274.88		403.8	

Eight species of catfishes and madtoms were collected, representing about 2.6 percent of the total catch, with *Noturus leptacanthus* (Speckled Madtom) most dominant at 1.4 percent followed by *Ictalurus punctatus* (Channel Catfish) at 0.44 percent and *Ameiurus natalis* (Yellow Bullhead) at 0.43 percent. *Fundulus olivaceus* (Blackspotted Topminnow), *Gambusia affinis* (western mosquitofish), and *Cottus carolinae* (Banded Sculpin) accounted for 2.13 percent, 2.11 percent, and 0.39 percent of the catch, respectively. Sunfishes were common and represented about 16.9 percent of the catch. *Lepomis megalotis* (Longear Sunfish) dominated the sunfish catch at 9.9 percent followed by *L. macrochirus* (Bluegill) at 3.1 percent, and *L. cyanellus* (Green Sunfish) at 0.99 percent. Darters accounted for about 15.4 percent of the catch with *Percina nigrofasciata* (Blackbanded Darter) dominant at 4.1 percent followed by *Etheostoma rupestre* (Rock Darter) at 3.6 percent, *E. stigmaeum* (Speckled Darter) at 2.3 percent, and *E. lachneri* (Tombigbee Darter) at 1.4 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 30 percent of the sites ranked in the very poor (≤50 percent max habitat score) to poor (51-60 percent) range, 37 percent in the fair (61 -70 percent) range, 28 percent in the good (71-80 percent) range, and 6 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 disturbance, to more than 1,000, a high level of disturbance (fig. 5). Fifty-four percent of the sites scored in the least disturbed range (<100), 34 percent in the low disturbance range (101-200), 8 percent in the moderately disturbed range (201-400), and 15 percent in the highest disturbed range (>400) (fig. 5).

Table 3. Rapid habitat assessment scores for sites in the Hills and Coastal Terraces 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		
1306	12	11	11	12	10	10	8	9	8	11	12	7	--	--	--	121	50.42
1307	11	10	4	12	13	7	9	11	5	12	8	11	--	--	--	113	47.08
1400	16	--	--	--	14	12	--	16	12	15	14	14	14	10	12	149	67.73
1401	14	--	--	--	16	6	--	16	13	15	14	12	11	15	16	148	67.27
1402	10	--	--	--	16	12	--	14	13	15	17	17	12	12	11	149	67.73
1403	13	--	--	--	16	13	--	6	12	17	17	15	13	10	12	144	65.45
1404	15	--	--	--	16	14	--	16	14	16	11	12	16	16	12	158	71.82
1405	11	--	--	--	15	12	--	4	12	14	14	14	9	11	16	132	60.00
1406	14	--	--	--	14	12	--	8	12	10	16	14	10	14	12	136	61.82
1407	11	--	--	--	16	16	--	16	14	15	16	16	11	12	11	154	70.00
1408	16	--	--	--	16	13	--	4	7	13	10	9	16	12	14	130	59.09
1409	10	--	--	--	16	12	--	7	15	16	17	16	12	8	10	139	63.18
1410	16	--	--	--	18	16	--	10	16	18	17	18	17	17	15	178	80.91
1411	15	--	--	--	16	14	--	5	14	16	16	16	16	11	12	151	68.64
1412	11	--	--	--	16	5	--	14	12	13	16	12	11	11	13	134	60.91
1413	10	--	--	--	16	14	--	10	16	16	16	14	8	14	10	144	65.45
1414	16	--	--	--	15	11	--	10	14	16	17	17	14	12	14	156	70.91
1415	14	--	--	--	16	14	--	6	10	16	16	16	15	12	14	149	67.73
1416	13	--	--	--	16	10	--	7	16	14	17	16	12	10	15	146	66.36
1417	16	--	--	--	18	13	--	12	13	16	16	16	14	16	16	166	75.45
1418	17	--	--	--	16	14	--	16	16	17	16	17	16	17	15	177	80.45
1419	16	--	--	--	16	12	--	15	12	13	15	14	13	16	16	158	71.82
1420	18	--	--	--	16	16	--	16	16	15	14	14	16	18	17	176	80.00
1421	16	--	--	--	16	11	--	12	16	17	16	17	16	15	14	166	75.45
1422	18	--	--	--	16	17	--	14	17	16	16	14	18	16	16	178	80.91
1423	9	--	--	--	16	10	--	14	16	16	16	13	10	6	8	134	60.91
1424	14	--	--	--	6	14	--	11	13	13	10	10	16	14	8	129	58.64
1425	13	--	--	--	12	12	--	15	10	12	12	10	14	16	12	138	62.73
1426	16	--	--	--	16	16	--	16	16	16	16	12	16	14	14	168	76.36
1427	17	--	--	--	18	16	--	16	16	17	16	14	18	18	16	182	82.73
1428	17	--	--	--	17	14	--	16	16	16	16	15	16	18	16	177	80.45
1432	6	--	--	--	15	6	--	9	10	12	11	10	8	6	12	105	47.73
1433	10	--	--	--	16	16	--	6	16	16	13	11	10	10	10	134	60.91
1434	18	--	--	--	17	16	--	16	15	15	14	14	17	18	15	175	79.55
1435	8	--	--	--	14	8	--	14	14	16	17	17	9	8	9	134	60.91

[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 Hills and Coastal Terraces 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		
1436	8	--	--	--	12	10	--	13	8	10	10	14	12	10	12	119	54.09
1437	8	10	8	8	4	8	10	10	5	8	10	7	--	--	--	96	40.00
1438	18	--	--	--	17	16	--	16	14	15	14	12	16	16	16	170	77.27
1439	13	--	--	--	16	8	--	11	11	12	17	19	9	12	14	142	64.55
1440	13	--	--	--	12	13	--	13	10	15	14	11	12	11	8	132	60.00
1441	15	--	--	--	7	6	--	8	7	4	4	2	14	12	10	89	40.45
1442	16	16	16	16	16	17	16	18	18	18	17	17	--	--	--	201	83.75
1443	14	--	--	--	13	12	--	14	10	11	17	14	14	8	10	137	62.27
1444	13	--	--	--	16	12	--	14	10	10	10	9	14	13	16	137	62.27
1445	15	14	12	16	16	9	11	16	10	14	12	12	--	--	--	157	65.42
1446	17	--	--	--	17	13	--	16	14	16	16	16	16	17	16	174	79.09
1447	14	--	--	--	16	12	--	15	12	14	16	14	14	11	14	152	69.09
1448	16	--	--	--	16	12	--	15	14	14	14	8	13	16	16	154	70.00
1451	10	--	--	--	14	6	--	18	14	16	18	20	9	12	12	149	67.73
1452	9	12	4	16	16	2	10	15	8	14	14	13	--	--	--	133	55.42
1453	8	8	4	8	14	4	5	13	10	13	12	10	--	--	--	109	45.42
1473	17	--	--	--	12	15	--	19	16	13	11	14	14	14	14	159	72.27
1577	7	8	6	8	9	6	6	11	11	13	14	16	--	--	--	115	47.92
1578	17	18	16	18	16	16	17	18	16	16	16	14	--	--	--	198	82.5
1579	14	--	--	--	14	11	--	16	10	14	15	12	12	10	16	144	65.45
1580	12	12	12	10	7	9	8	8	10	7	6	4	--	--	--	105	43.75
1581	12	--	--	--	16	11	--	17	16	17	18	16	12	10	14	159	72.27
1582	12	--	--	--	16	8	--	11	10	16	16	17	10	10	14	140	63.64
1583	16	--	--	--	16	13	--	12	10	12	17	17	14	14	14	155	70.45
1584	9	--	--	--	9	14	--	15	15	14	18	16	9	14	3	136	61.82
1585	15	--	--	--	16	12	--	12	16	14	17	15	14	16	16	163	74.09
1586	17	--	--	--	15	6	--	14	15	10	15	16	14	16	16	154	70
1587	16	--	--	--	16	6	--	16	6	12	17	15	13	12	15	144	65.45
1588	17	--	--	--	16	12	--	14	16	16	17	18	18	16	16	176	80
1589	16	--	--	--	15	8	--	12	12	15	17	16	15	16	16	158	71.82
1590	14	--	--	--	15	12	--	16	16	16	17	14	16	16	16	168	76.36
1591	13	--	--	--	16	10	--	14	14	15	18	17	12	14	14	157	71.36
1592	16	--	--	--	8	11	--	15	6	10	12	9	16	16	10	129	58.64
1593	14	--	--	--	10	10	--	14	14	14	12	5	14	13	9	129	58.64
1594	16	16	16	16	16	16	16	15	16	16	16	16	--	--	--	191	79.58

[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 Hills and Coastal Terraces 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		
1595	17	13	14	15	16	16	12	16	17	16	17	16	--	--	--	185	77.08
1596	11	--	--	--	14	13	--	12	4	8	7	6	13	10	14	112	50.91
1597	18	--	--	--	16	14	--	16	16	16	15	15	16	16	16	174	79.09
1598	11	--	--	--	16	9	--	11	14	16	16	15	10	10	16	144	65.45
1599	7	--	--	--	12	7	--	14	12	13	16	17	8	8	15	129	58.64
1850	3	--	--	--	8	7	--	14	3	5	18	13	6	10	7	94	42.73
1853	17	--	--	--	16	15	--	16	14	15	18	17	12	8	7	155	70.45
1856	7	--	--	--	16	9	--	16	4	6	16	14	10	6	7	111	50.45
1857	10	--	--	--	16	9	--	16	10	16	16	16	6	11	6	132	60
1858	8	--	--	--	14	5	--	17	8	8	10	4	8	5	7	94	42.73
1859	8	--	--	--	14	8	--	14	6	8	12	6	10	10	10	106	48.18
1861	12	--	--	--	14	11	--	15	15	15	16	18	12	14	9	151	68.64
1862	12	9	9	14	16	9	14	9	8	11	16	12	--	--	--	139	57.92
1863	8	--	--	--	16	8	--	16	6	13	17	15	7	12	12	130	59.09
1880	12	15	13	17	17	9	14	8	15	16	17	16	--	--	--	169	70.42
1925	4	3	11	7	16	4	3	17	7	12	18	15	--	--	--	117	48.75
2004	10	4	10	7	17	9	8	9	10	12	20	18	--	--	--	134	55.83
2008	13	15	14	12	14	11	9	18	16	16	9	2	--	--	--	149	62.08
2009	12	--	--	--	14	10	--	17	15	18	18	20	11	13	8	156	70.91
2319	17	--	--	--	18	14	--	18	14	16	18	18	15	13	14	175	79.55
2320	15	13	14	14	16	16	13	15	16	15	14	13	--	--	--	174	79.09
2321	13	11	9	13	17	12	11	17	16	16	14	14	--	--	--	163	74.09
2323	15	11	14	15	13	10	14	17	12	12	16	15	--	--	--	164	74.55
2324	14	--	--	--	8	12	--	18	14	14	16	18	16	9	5	144	65.45
2325	13	--	--	--	16	14	--	10	13	15	17	13	12	18	12	153	69.55
2326	16	13	16	16	14	15	16	16	15	17	15	14	--	--	--	183	83.18
2661	8	--	--	--	15	6	--	15	12	12	18	16	8	6	13	129	58.64
2662	4	--	--	--	16	0	--	13	7	6	16	12	11	2	12	99	45.00
2665	8	--	--	--	15	10	--	14	11	14	16	12	11	9	16	136	61.82
2666	6	--	--	--	11	10	--	10	7	12	16	12	7	9	10	110	50.00
2667	17	13	15	17	19	12	16	17	12	18	18	18	--	--	--	192	80.00

[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 Hills and Coastal Terraces 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		
1306	207.80	0.604	23.58	0.93	14.27	2.87	2.494	0.767
1307	1.58	0.334	2.41	0.01	7.47	3.23	0.608	0.164
1400	16.41	0.353	4.34	0.10	11.59	1.64	1.232	0.306
1401	13.38	0.435	4.12	0.04	16.59	4.21	1.253	0.243
1402	3.71	0.335	4.04	0.15	14.32	1.18	1.027	0.381
1403	2.83	0.610	3.33	0.27	51.13	2.25	0.611	0.232
1404	58.94	0.514	8.22	0.06	12.17	7.97	1.750	0.521
1405	7.54	0.493	2.86	0.00	13.26	9.07	1.085	0.381
1406	6.67	0.423	2.94	0.02	15.62	5.69	0.901	0.285
1407	7.62	0.519	4.19	0.01	14.89	10.49	1.136	0.370
1408	3.04	0.294	2.52	0.00	4.43	1.98	0.906	0.260
1409	2.03	0.342	3.70	0.00	3.78	4.16	1.233	0.406
1410	4.85	0.444	4.42	0.00	11.00	8.20	1.262	0.425
1411	7.26	0.614	4.96	0.06	31.75	8.53	1.053	0.320
1412	49.31	0.393	8.16	0.00	3.25	4.15	2.093	0.366
1413	4.36	0.459	3.29	0.00	31.78	1.36	0.880	0.271
1414	8.88	0.277	3.12	0.03	4.32	0.60	0.918	0.263
1415	2.66	0.283	2.32	0.00	5.35	1.88	0.737	0.132
1416	3.64	0.240	3.12	0.00	0.87	0.15	0.996	0.204
1417	3.13	0.238	2.06	0.00	2.08	0.42	0.602	0.153
1418	0.54	0.223	1.32	0.00	0.77	0.27	0.681	0.056
1419	6.78	0.271	3.89	0.00	3.57	0.51	1.088	0.300
1420	5.09	0.229	3.09	0.00	1.02	0.27	0.927	0.264
1421	6.78	0.230	3.66	0.00	1.19	0.28	1.231	0.255
1422	2.91	0.243	2.55	0.01	0.21	0.50	1.120	0.218
1423	4.27	0.250	2.73	0.01	2.96	0.29	1.026	0.212
1424	48.60	0.331	10.28	0.30	3.73	0.25	2.067	0.560
1425	3.72	0.215	0.96	0.00	0.58	0.05	0.740	0.229
1426	9.25	0.292	3.93	0.00	4.93	0.68	1.056	0.287
1427	24.17	0.323	5.68	0.10	3.78	2.25	1.371	0.209
1428	91.19	0.527	18.18	0.00	7.59	4.40	2.799	0.390
1432	2.46	0.223	1.09	0.00	0.07	0.05	0.715	0.126
1433	3.33	0.253	2.49	0.00	5.03	0.71	0.659	0.165
1434	8.15	0.345	7.14	0.57	6.70	1.77	1.410	0.379
1435	1.95	0.265	3.15	0.00	0.95	0.60	0.905	0.287
1436	25.64	0.378	7.14	0.00	3.95	3.65	1.886	0.418
1437	10.57	0.383	6.41	0.00	15.60	1.12	1.675	0.708
1438	5.08	0.298	3.44	0.00	6.85	0.84	1.114	0.203
1439	2.04	0.280	2.97	0.00	1.60	1.51	1.069	0.292
1440	3.24	0.312	3.94	0.02	2.87	2.11	1.622	0.596

Table 4. Human disturbance metrics for sites in the Hills and Coastal Terraces 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		
1441	9.32	0.349	5.86	0.01	9.14	1.74	1.555	0.625
1442	8.40	0.296	3.76	0.03	6.60	0.71	1.247	0.341
1443	1.26	0.279	3.04	0.00	3.97	0.79	0.864	0.366
1444	11.68	0.357	5.43	0.42	12.56	1.21	1.193	0.165
1445	16.20	0.355	6.18	0.06	8.99	1.33	1.455	0.366
1446	13.06	0.325	4.66	0.03	5.94	2.37	1.267	0.401
1447	4.36	0.259	4.04	0.00	1.12	0.25	1.064	0.173
1448	6.49	0.255	3.00	0.00	4.04	0.06	0.773	0.232
1451	0.17	0.249	1.07	0.00	0.01	0.02	0.925	0.228
1452	935.86	0.998	78.54	0.00	1.00	0.06	7.674	2.838
1453	395.15	0.725	45.45	0.00	4.46	1.78	4.180	1.194
1473	8.58	0.266	3.78	0.02	3.28	0.25	1.364	0.305
1577	39.73	0.311	6.52	0.30	4.06	0.33	1.939	0.579
1578	15.06	0.273	3.19	0.66	3.79	0.28	1.471	0.407
1579	2.68	0.272	2.30	0.00	2.47	1.38	0.938	0.282
1580	23.71	0.771	7.26	0.00	47.54	8.54	1.257	0.479
1581	2.76	0.277	2.32	0.00	2.59	0.34	1.063	0.200
1582	6.91	0.314	4.22	0.00	9.41	0.37	1.099	0.391
1583	1.95	0.513	3.59	0.00	36.51	2.46	0.974	0.320
1584	3.58	0.586	6.01	0.03	44.51	3.13	0.903	0.277
1585	3.95	0.434	4.42	0.00	12.46	5.08	1.005	0.311
1586	4.30	0.297	5.24	0.00	3.13	1.66	1.256	0.394
1587	15.80	0.385	4.71	0.00	4.83	5.12	1.485	0.333
1588	8.54	0.402	4.34	0.00	8.30	4.68	1.225	0.330
1589	4.05	0.315	5.60	0.00	2.34	1.53	1.414	0.291
1590	5.09	0.320	2.65	0.00	0.97	3.77	0.922	0.276
1591	3.61	0.275	3.14	0.00	3.10	1.33	0.960	0.116
1592	41.92	0.441	11.62	0.24	9.90	2.94	2.350	0.861
1593	59.91	0.342	10.66	0.00	2.82	0.45	2.479	0.408
1594	12.19	0.379	6.57	0.04	10.59	2.46	1.481	0.427
1595	12.18	0.421	12.54	0.34	12.97	0.95	1.491	0.522
1596	6.15	0.295	2.11	0.03	7.27	0.68	1.001	0.342
1597	3.24	0.287	3.29	0.06	3.94	1.17	1.025	0.309
1598	0.87	0.275	2.69	0.00	2.65	2.17	0.982	0.132
1599	0.04	0.263	1.89	0.00	0.00	0.34	0.794	0.202
1850	0.85	0.225	1.57	0.01	2.34	0.61	0.853	0.187
1853	9.96	0.391	3.99	0.01	11.23	3.95	1.133	0.219
1856	26.07	0.384	5.25	0.27	14.79	1.58	1.592	0.366
1857	5.40	0.386	3.74	0.00	11.59	3.12	1.041	0.317
1858	428.70	0.760	36.75	0.10	11.09	5.70	3.653	0.820

Table 4. Human disturbance metrics for sites in the Hills and Coastal Terraces 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		
1859	2.92	0.270	1.57	0.00	2.44	1.46	0.633	0.143
1861	10.47	0.389	4.92	0.00	9.05	3.99	1.496	0.410
1862	1.03	0.250	1.35	0.00	0.53	0.01	1.052	0.150
1863	0.97	0.332	2.31	0.00	5.05	3.65	0.931	0.227
1880	63.36	0.449	9.77	0.58	9.21	4.49	1.462	0.413
1925	11.26	0.355	5.14	0.00	2.65	3.42	1.608	0.564
2004	11.19	0.355	5.13	0.00	2.68	3.44	1.601	0.560
2008	122.42	0.405	10.62	0.65	7.80	2.25	2.075	0.771
2009	2.52	0.257	2.23	0.00	1.05	0.80	0.977	0.209
2319	4.69	0.301	2.92	0.01	5.61	1.82	1.058	0.262
2320	5.12	0.252	2.98	0.00	3.27	0.28	0.891	0.265
2321	7.32	0.247	3.80	0.00	1.91	0.62	1.233	0.348
2323	17.69	0.359	6.23	0.07	9.57	1.33	1.481	0.351
2324	19.24	0.427	6.65	0.15	6.35	5.96	1.786	0.610
2325	4.43	0.358	3.18	0.05	15.68	2.14	0.901	0.234
2326	2.04	0.237	1.70	0.01	2.17	0.79	0.771	0.167
2661	28.41	0.356	4.04	0.10	8.80	2.59	1.307	0.308
2662	7.00	0.449	3.61	2.17	13.28	6.42	0.967	0.230
2665	35.81	0.558	7.37	0.20	11.56	9.64	1.644	0.523
2666	2.42	0.485	2.76	0.00	22.64	5.65	0.756	0.282
2667	207.80	0.604	23.58	0.93	14.27	2.87	2.494	0.767

Table 5. LDI-weighted human disturbance metrics for sites in the Hills and Coastal Terraces 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**	
1306	207.80	0.60	188.60	6.52	44.25	13.47	20.70	6.37	488.31
1307	1.58	0.33	19.25	0.09	23.15	15.20	5.05	1.36	66.01
1400	16.41	0.35	34.71	0.70	35.92	7.72	10.22	2.54	108.58
1401	13.38	0.44	32.92	0.31	51.44	19.80	10.40	2.02	130.69
1402	3.71	0.33	32.31	1.08	44.41	5.54	8.53	3.16	99.07
1403	2.83	0.61	26.66	1.87	158.51	10.58	5.08	1.93	208.05
1404	58.94	0.51	65.72	0.43	37.74	37.48	14.52	4.32	219.67
1405	7.54	0.49	22.87	0.00	41.10	42.63	9.00	3.16	126.81
1406	6.67	0.42	23.51	0.11	48.41	26.75	7.48	2.37	115.72
1407	7.62	0.52	33.53	0.08	46.15	49.30	9.43	3.07	149.69
1408	3.04	0.29	20.14	0.00	13.73	9.29	7.52	2.16	56.17
1409	2.03	0.34	29.57	0.03	11.73	19.57	10.24	3.37	76.87
1410	4.85	0.44	35.39	0.00	34.10	38.55	10.47	3.52	127.33
1411	7.26	0.61	39.65	0.39	98.43	40.09	8.74	2.65	197.83
1412	49.31	0.39	65.30	0.00	10.07	19.50	17.37	3.04	164.99
1413	4.36	0.46	26.34	0.02	98.51	6.38	7.30	2.25	145.62
1414	8.88	0.28	24.94	0.22	13.40	2.84	7.62	2.18	60.37
1415	2.66	0.28	18.57	0.00	16.59	8.86	6.12	1.10	54.18
1416	3.64	0.24	24.96	0.00	2.71	0.71	8.27	1.70	42.21
1417	3.13	0.24	16.48	0.00	6.44	1.96	5.00	1.27	34.51
1418	0.54	0.22	10.57	0.00	2.40	1.26	5.65	0.47	21.10
1419	6.78	0.27	31.10	0.00	11.07	2.38	9.03	2.49	63.11
1420	5.09	0.23	24.75	0.00	3.16	1.29	7.70	2.19	44.40
1421	6.78	0.23	29.27	0.00	3.70	1.33	10.22	2.12	53.64
1422	2.91	0.24	20.40	0.09	0.65	2.36	9.29	1.81	37.77
1423	4.27	0.25	21.86	0.04	9.16	1.35	8.51	1.76	47.20
1424	48.60	0.33	82.23	2.07	11.55	1.15	17.15	4.65	167.75
1425	3.72	0.21	7.66	0.00	1.81	0.26	6.14	1.90	21.70
1426	9.25	0.29	31.42	0.00	15.30	3.20	8.77	2.38	70.61
1427	24.17	0.32	45.41	0.72	11.73	10.60	11.38	1.73	106.04
1428	91.19	0.53	145.43	0.00	23.54	20.68	23.23	3.24	307.84
1432	2.46	0.22	8.71	0.00	0.23	0.25	5.93	1.05	18.85
1433	3.33	0.25	19.91	0.00	15.60	3.32	5.47	1.37	49.25
1434	8.15	0.35	57.09	4.02	20.77	8.30	11.71	3.15	113.53
1435	1.95	0.26	25.22	0.00	2.96	2.84	7.51	2.38	43.12
1436	25.64	0.38	57.12	0.00	12.23	17.15	15.65	3.47	131.64
1437	10.57	0.38	51.28	0.00	48.35	5.27	13.90	5.87	135.63
1438	5.08	0.30	27.50	0.00	21.24	3.96	9.25	1.69	69.02
1439	2.04	0.28	23.74	0.00	4.95	7.09	8.87	2.42	49.38
1440	3.24	0.31	31.52	0.12	8.90	9.92	13.47	4.95	72.43

Table 5. LDI-weighted human disturbance metrics for sites in the Hills and Coastal Terraces 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)	Sum
			Urban	Barren	Pasture	Cropland			
	LDI values								
	1.0	**1.0**	**8.0**	**7.0**	**3.1**	**4.7**	**8.3**	**8.3**	
1441	9.32	0.35	46.92	0.04	28.33	8.20	12.90	5.18	111.24
1442	8.40	0.30	30.04	0.19	20.46	3.36	10.35	2.83	75.92
1443	1.26	0.28	24.28	0.00	12.32	3.71	7.17	3.04	52.05
1444	11.68	0.36	43.45	2.96	38.93	5.67	9.90	1.37	114.32
1445	16.20	0.35	49.43	0.41	27.86	6.24	12.08	3.04	115.62
1446	13.06	0.33	37.32	0.20	18.41	11.14	10.52	3.33	94.30
1447	4.36	0.26	32.30	0.00	3.46	1.18	8.84	1.44	51.82
1448	6.49	0.25	24.02	0.00	12.53	0.30	6.41	1.93	51.93
1451	0.17	0.25	8.52	0.00	0.03	0.10	7.68	1.89	18.64
1452	935.86	1.00	628.35	0.00	3.11	0.26	63.69	23.56	1655.82
1453	395.15	0.72	363.60	0.00	13.84	8.36	34.69	9.91	826.27
1473	8.58	0.27	30.26	0.14	10.17	1.16	11.32	2.53	64.43
1577	39.73	0.31	52.18	2.09	12.59	1.54	16.09	4.81	129.34
1578	15.06	0.27	25.54	4.61	11.76	1.31	12.21	3.37	74.13
1579	2.68	0.27	18.37	0.00	7.67	6.51	7.78	2.34	45.62
1580	23.71	0.77	58.09	0.00	147.37	40.12	10.44	3.98	284.48
1581	2.76	0.28	18.56	0.00	8.02	1.61	8.82	1.66	41.70
1582	6.91	0.31	33.73	0.00	29.18	1.74	9.12	3.25	84.24
1583	1.95	0.51	28.73	0.00	113.19	11.58	8.09	2.66	166.72
1584	3.58	0.59	48.09	0.18	137.98	14.72	7.50	2.30	214.92
1585	3.95	0.43	35.34	0.00	38.64	23.88	8.34	2.58	113.16
1586	4.30	0.30	41.93	0.00	9.72	7.82	10.43	3.27	77.76
1587	15.80	0.39	37.67	0.00	14.96	24.07	12.33	2.77	107.97
1588	8.54	0.40	34.69	0.00	25.73	21.99	10.17	2.74	104.25
1589	4.05	0.31	44.82	0.00	7.24	7.19	11.74	2.42	77.77
1590	5.09	0.32	21.23	0.00	3.00	17.74	7.65	2.29	57.32
1591	3.61	0.28	25.15	0.00	9.62	6.27	7.96	0.96	53.85
1592	41.92	0.44	92.97	1.69	30.68	13.83	19.51	7.15	208.19
1593	59.91	0.34	85.28	0.00	8.76	2.10	20.58	3.38	180.35
1594	12.19	0.38	52.55	0.30	32.81	11.57	12.29	3.55	125.64
1595	12.18	0.42	100.34	2.39	40.21	4.46	12.37	4.34	176.70
1596	6.15	0.29	16.87	0.23	22.55	3.20	8.31	2.84	60.43
1597	3.24	0.29	26.31	0.41	12.22	5.51	8.50	2.57	59.05
1598	0.87	0.28	21.51	0.00	8.23	10.22	8.15	1.09	50.34
1599	0.04	0.26	15.09	0.00	0.00	1.60	6.59	1.67	25.26
1850	0.85	0.23	12.59	0.04	7.26	2.84	7.08	1.56	32.45
1853	9.96	0.39	31.96	0.07	34.81	18.58	9.40	1.82	106.98
1856	26.07	0.38	42.00	1.90	45.84	7.40	13.21	3.04	139.84
1857	5.40	0.39	29.95	0.00	35.92	14.67	8.64	2.63	97.60
1858	428.70	0.76	293.96	0.67	34.38	26.77	30.32	6.81	822.38

Table 5. LDI-weighted human disturbance metrics for sites in the Hills and Coastal Terraces 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**	
1859	2.92	0.27	12.53	0.00	7.57	6.84	5.25	1.19	36.57
1861	10.47	0.39	39.35	0.00	28.04	18.74	12.42	3.40	112.81
1862	1.03	0.25	10.83	0.00	1.63	0.06	8.73	1.24	23.77
1863	0.97	0.33	18.52	0.00	15.64	17.14	7.73	1.88	62.22
1880	63.36	0.45	78.15	4.08	28.55	21.10	12.14	3.43	211.25
1925	11.26	0.35	41.10	0.00	8.21	16.09	13.34	4.68	95.04
2004	11.19	0.35	41.06	0.00	8.30	16.17	13.29	4.64	95.01
2008	122.42	0.40	84.93	4.58	24.18	10.56	17.22	6.40	270.71
2009	2.52	0.26	17.87	0.00	3.27	3.74	8.11	1.73	37.50
2319	4.69	0.30	23.37	0.04	17.38	8.53	8.78	2.17	65.27
2320	5.12	0.25	23.86	0.00	10.14	1.33	7.39	2.20	50.30
2321	7.32	0.25	30.36	0.00	5.93	2.93	10.23	2.89	59.92
2323	17.69	0.36	49.84	0.49	29.65	6.26	12.29	2.92	119.50
2324	19.24	0.43	53.20	1.07	19.70	28.03	14.82	5.07	141.56
2325	4.43	0.36	25.47	0.35	48.61	10.03	7.48	1.94	98.66
2326	2.04	0.24	13.61	0.04	6.73	3.73	6.40	1.39	34.17
2661	28.41	0.36	32.36	0.73	27.28	12.16	10.84	2.55	114.68
2662	7.00	0.45	28.91	15.20	41.17	30.19	8.02	1.91	132.85
2665	35.81	0.56	58.97	1.37	35.85	45.31	13.65	4.34	195.85
2666	2.42	0.49	22.12	0.00	70.17	26.57	6.28	2.34	130.38
2667	207.80	0.60	188.60	6.52	44.25	13.47	20.70	6.37	488.31

SELECTION AND SCORING OF HILLS AND COASTAL TERRACES 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 Hills and Coastal Terraces 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 Hills and Coastal Terraces 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 the majority of significant correlations were clumped into one of the two categories (for example, significant correlations for the IBI metric percent dominant species were clumped in the habitat category). The scoring range of diversity metrics was acceptable if it 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

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

Candidate IBI metrics	Habitat metrics [1]											
	INCOV	PSUB	PVAR	CHALT	SEDDEP	CHSIN	CHSTA	BKCON	BKVEG	DISP	RIPVEG	THAB
Species Richness and Composition												
Number of native sp. *	0.402	0.098	0.263	0.051	0.315	0.191	0.000	-0.056	0.506	0.298	0.249	0.353
Number of cyprinid sp. *	0.256	0.077	0.050	0.058	0.208	0.098	-0.087	-0.112	0.392	0.056	0.273	0.192
Number of shiner sp.	0.241	0.049	0.019	0.166	0.199	0.072	-0.080	-0.077	0.324	0.086	0.253	0.193
Number of sucker sp. *	0.310	0.017	0.174	0.117	0.302	0.230	-0.024	-0.061	0.442	0.164	0.036	0.262
Number of *Lepomis* sp. *	-0.010	0.063	0.088	-0.256	-0.006	-0.040	0.211	0.078	0.000	0.102	-0.013	0.025
Number of centrarchid sp.	0.116	0.063	0.186	-0.120	0.095	0.028	0.224	0.104	0.109	0.164	-0.010	0.141
Number of darter sp.	0.410	0.103	0.351	-0.010	0.202	0.186	-0.142	-0.146	0.475	0.388	0.308	0.326
Number of dar+madtom sp. *	0.408	0.116	0.273	0.085	0.221	0.198	-0.075	-0.068	0.456	0.371	0.316	0.352
Number of dar+mad+sculpin sp.	0.422	0.142	0.276	0.112	0.227	0.202	-0.073	-0.071	0.470	0.382	0.316	0.368
Number of terete minnow sp.	0.219	0.112	0.131	-0.181	0.145	0.110	-0.121	-0.149	0.361	0.065	0.191	0.130
Tolerance - Intolerance												
Percent dominant sp. *	-0.342	-0.080	-0.247	-0.055	-0.068	-0.063	0.119	0.147	-0.336	-0.306	-0.124	-0.210
Number of intolerant sp.	0.038	0.073	0.026	0.174	0.057	-0.030	-0.082	-0.200	0.045	-0.002	-0.017	0.012
Percent tolerant sp. *	-0.014	0.018	0.145	-0.405	0.004	0.084	0.094	0.086	0.008	0.051	-0.031	0.000
Percent green sunfish	-0.177	-0.030	-0.068	-0.104	-0.201	-0.157	-0.086	-0.061	-0.109	-0.088	-0.128	-0.185
Percent stonerollers	0.202	0.150	0.226	-0.088	0.011	0.036	-0.161	-0.215	0.332	0.130	0.072	0.103
Percent GSF+YBH [2]	-0.096	0.022	0.018	-0.266	-0.208	-0.059	-0.054	-0.025	0.000	-0.083	-0.036	-0.125
Percent GSF+BG+ YBH+CC [2]	-0.123	0.024	0.010	-0.238	-0.122	-0.036	0.012	0.018	-0.079	-0.059	-0.141	-0.117
Percent *Lepomis* sp. *	-0.148	-0.053	0.159	-0.327	-0.117	-0.110	0.011	-0.017	-0.132	0.016	-0.226	-0.144
Percent sunfish	-0.148	-0.058	0.159	-0.320	-0.118	-0.109	0.015	-0.012	-0.136	0.019	-0.232	-0.144
Trophic Structure												
Percent omnivores	0.239	0.130	0.237	-0.162	0.081	0.091	-0.103	-0.140	0.327	0.197	0.134	0.154
Percent insectivorous cyprinids *	-0.091	-0.015	-0.348	0.192	0.087	-0.003	0.049	0.097	-0.073	-0.177	0.151	-0.021
Percent invertivores	-0.115	0.022	0.205	-0.277	0.042	0.001	0.009	0.008	-0.092	0.024	-0.145	-0.051
Percent top carnivores *	0.077	0.052	0.116	0.072	0.085	0.100	0.099	0.204	0.034	0.068	-0.152	0.115
Abundance, Condition, and Reproduction												
Catch per effort	0.162	0.113	0.174	-0.168	0.124	0.110	0.044	-0.044	0.207	0.207	0.135	0.157
Percent DELT	0.242	0.022	0.224	0.042	-0.018	-0.033	-0.161	-0.160	0.283	0.215	0.179	0.133
Percent hybrids	0.068	0.075	-0.138	-0.042	-0.052	0.030	-0.130	-0.120	-0.005	0.073	0.130	-0.018
Percent with DELT+hybrids *	0.251	0.040	0.181	0.030	-0.031	-0.024	-0.189	-0.185	0.272	0.226	0.206	0.123
Percent simple lithophils *	0.202	-0.097	-0.075	0.218	0.068	-0.078	-0.227	-0.219	0.164	0.039	0.149	0.034
Percent manipulative lithophils	-0.170	0.004	-0.124	0.010	-0.141	-0.085	0.110	0.079	-0.082	-0.118	-0.159	-0.108
Percent lithophilic spawners	0.000	-0.094	-0.227	0.235	-0.102	-0.183	-0.098	-0.128	0.068	-0.104	-0.040	-0.097
Number of lithophilic spawners	0.382	0.114	0.187	0.162	0.298	0.199	-0.042	-0.084	0.551	0.233	0.261	0.344
Percent simple nonlithophils	0.039	0.100	0.232	-0.046	0.217	0.138	-0.010	0.089	0.006	0.122	0.092	0.149
Percent manipulative nonlithophils	-0.040	0.045	0.105	-0.315	-0.073	0.138	0.160	0.102	-0.109	0.030	-0.029	-0.007
Percent manipulative spawners	-0.199	0.029	-0.070	-0.164	-0.187	-0.012	0.202	0.139	-0.146	-0.106	-0.181	-0.115
Percent nonlithophilic spawners	0.001	0.097	0.227	-0.236	0.100	0.184	0.097	0.127	-0.067	0.103	0.044	0.097
Percent simple lithophils+tolerants	0.208	-0.090	0.042	-0.106	0.077	-0.013	-0.166	-0.165	0.185	0.086	0.136	0.037

* - metric included in Hills and Coastal Terraces ichthyoregion IBI.

Shaded box indicates coefficients statistically different from 0, critical r value = 0.222 [p=0.05, df=77], .

[1] INCOV-instream cover; PSUB-pool substrate characterization; PVAR-pool variability; CHALT-channel alteration; SEDDEP-sediment deposition; CHSIN-channel sinuosity; CHSTA-channel flow status; BKCON-bank condition; BKVEG-bank vegetative protection; DISP-grazing or other disruptive pressure; RIPVEG-riparian vegetation zone width

[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. *	-0.088	0.000	-0.023	0.021	0.043	0.046	-0.009	0.011	-0.049
Number of cyprinid sp. *	-0.005	-0.156	0.017	-0.043	-0.253	-0.140	0.055	0.041	-0.040
Number of shiner sp.	0.031	-0.168	0.053	-0.009	-0.302	-0.188	0.090	0.079	-0.014
Number of sucker sp. *	-0.174	-0.136	-0.127	0.135	-0.058	-0.060	-0.078	-0.116	-0.161
Number of *Lepomis* sp. *	0.107	0.375	0.145	0.078	0.447	0.257	0.088	0.135	0.203
Number of centrarchid sp.	0.072	0.366	0.110	0.126	0.448	0.290	0.074	0.119	0.172
Number of darter sp.	-0.227	-0.234	-0.188	-0.031	-0.125	-0.058	-0.170	-0.101	-0.229
Number of dar+madtom sp. *	-0.226	-0.241	-0.183	0.018	-0.141	-0.084	-0.168	-0.106	-0.230
Number of dar+mad+sculpin sp.	-0.214	-0.221	-0.168	0.047	-0.135	-0.067	-0.147	-0.101	-0.215
Number of terete minnow sp.	-0.027	-0.050	-0.013	-0.097	-0.054	-0.023	0.009	-0.007	-0.030
Tolerance - Intolerance									
Percent dominant sp. *	-0.091	-0.170	-0.126	-0.037	-0.097	-0.150	-0.156	-0.220	-0.131
Number of intolerant sp.	0.225	0.207	0.242	-0.044	-0.010	0.087	0.234	0.072	0.232
Percent tolerant sp. *	-0.065	0.197	-0.056	-0.125	0.412	0.186	-0.107	-0.050	0.009
Percent green sunfish	-0.051	0.095	-0.052	0.003	0.195	0.110	-0.058	-0.035	-0.015
Percent stonerollers	0.170	0.177	0.196	0.111	0.014	0.064	0.189	0.079	0.185
Percent GSF+YBH [2]	0.061	0.080	0.045	-0.016	0.084	0.043	0.009	0.015	0.067
Percent GSF+BG+ YBH+CC [2]	0.047	0.235	0.052	0.020	0.336	0.159	0.023	0.036	0.107
Percent *Lepomis* sp. *	-0.022	0.276	-0.026	-0.064	0.459	0.322	-0.072	0.025	0.062
Percent sunfish	-0.024	0.278	-0.027	-0.063	0.463	0.323	-0.074	0.024	0.061
Trophic Structure									
Percent omnivores *	0.068	0.173	0.096	0.011	0.145	0.101	0.067	0.004	0.105
Percent insectivorous cyprinids	0.016	-0.237	0.021	-0.003	-0.368	-0.313	0.039	-0.001	-0.054
Percent invertivores	-0.024	0.165	-0.041	-0.069	0.330	0.249	-0.101	-0.012	0.030
Percent top carnivores *	-0.053	0.077	-0.048	-0.007	0.084	0.219	-0.036	-0.041	-0.025
Abundance, Condition, and Reproduction									
Catch per effort	0.058	0.050	0.069	-0.097	0.040	-0.022	0.038	0.044	0.065
Percent DELT	-0.052	-0.049	-0.025	-0.024	-0.036	-0.075	0.022	0.008	-0.048
Percent hybrids	0.217	0.144	0.206	-0.041	0.012	-0.036	0.215	0.212	0.210
Percent with DELT+hybrids *	0.008	-0.007	0.029	-0.032	-0.028	-0.075	0.073	0.060	0.010
Percent simple lithophils *	-0.065	-0.251	-0.043	0.069	-0.313	-0.251	0.045	0.041	-0.111
Percent manipulative lithophils	0.126	0.207	0.132	0.026	0.106	0.125	0.115	0.056	0.150
Percent lithophilic spawners	0.089	-0.002	0.118	0.101	-0.187	-0.101	0.186	0.110	0.071
Number of lithophilic spawners	-0.020	-0.076	0.034	0.092	-0.165	-0.057	0.083	0.069	-0.021
Percent simple nonlithophils	-0.064	-0.123	-0.093	-0.016	0.002	-0.066	-0.126	-0.065	-0.080
Percent manipulative nonlithophils	-0.070	0.137	-0.084	-0.142	0.287	0.235	-0.155	-0.102	-0.023
Percent manipulative spawners	0.093	0.284	0.091	-0.048	0.260	0.252	0.037	0.004	0.141
Percent nonlithophilic spawners	-0.089	-0.001	-0.119	-0.101	0.182	0.101	-0.187	-0.110	-0.072
Percent simple lithophils+tolerants	-0.122	-0.107	-0.091	-0.028	0.002	-0.116	-0.040	0.003	-0.111

* - metric included in Hills and Coastal Terraces ichthyoregion IBI.

Shaded box highlights coefficients statistically different from 0, critical r value = 0.196 [p=0.05, df=99]. 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- human disturbance gradient score.

[2] GSF-Green Sunfish, BG-Bluegill, YBH-Yellow Bullhead, CC-Channel Catfish

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 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. All of the 12 selected Hills and Coastal Terraces IBI metrics met this criterion with the exception native species vs. cyprinid species (r=0.754). We think that although this significant correlation was present, these metrics were desirable to maintain in the IBI for their usefulness in evaluating different fish community functions and for the fact that this set of IBI metrics was similar to metrics selected for other ichthyoregions.

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 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

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.	0	7	7	33	22.96	3	41	38	6.33	27.55
Number of cyprinid sp.	1	3	4	19	7.54	0	15	15	2.88	38.21
Number of shiner sp.	1	3	4	19	4.91	0	9	9	1.92	39.18
Number of sucker sp.	0	5	5	24	1.73	0	5	5	1.22	70.16
Number of *Lepomis* sp.	4	1	5	24	3.56	0	7	7	1.34	37.52
Number of centrarchid sp.	3	1	4	19	5.09	0	10	10	1.87	36.77
Number of darter sp.	3	6	9	43	4.25	0	9	9	2.12	49.99
Number of dar+madtom sp.	3	6	9	43	5.32	0	11	11	2.52	47.43
Number of dar+mad+sculpin sp.	3	7	10	48	5.42	0	11	11	2.50	46.14
Number of terete minnow sp.	0	1	1	5	2.27	0	5	5	1.22	53.62
Tolerance - Intolerance										
Percent dominant sp.	1	4	5	24	28.17	11.77	76.35	64.58	11.54	40.99
Number of intolerant sp.	5	0	5	24	0.03	0	1	1	0.17	574.40
Percent tolerant sp.	2	1	3	14	15.64	0	71.43	71.43	12.52	80.01
Percent green sunfish	0	0	0	0	1.44	0	28.04	28.04	3.40	236.41
Percent stonerollers	1	2	3	14	5.17	0	46.55	46.55	8.73	168.93
Percent GSF+YBH [2]	0	1	1	5	2.25	0	42.86	42.86	5.37	238.93
Percent GSF+BG+ YBH+CC [2]	2	1	3	14	6.20	0	57.01	57.01	8.83	142.30
Percent *Lepomis* sp.	3	2	5	24	16.27	0	71.03	71.03	14.77	90.83
Percent sunfish	3	2	5	24	16.49	0	71.03	71.03	14.81	89.82
Trophic Structure										
Percent omnivores	0	3	3	14	9.12	0	46.55	46.55	9.36	102.65
Percent insectivorous cyprinids	3	1	4	19	42.21	0	87.72	87.72	20.95	49.63
Percent invertivores	2	1	3	14	31.12	1.91	79.36	77.45	16.83	54.10
Percent top carnivores	0	0	0	0	1.85	0	21.50	21.50	2.50	135.24
Abundance, Condition, and Reproduction										
Catch per effort	0	0	0	0	12.62	0.59	67.78	67.19	10.06	79.70
Percent DELT	0	3	3	14	0.06	0	1.36	1.36	0.21	343.52
Percent hybrids	5	0	5	24	0.01	0	0.50	0.50	0.06	565.07
Percent with DELT+hybrids	0	3	3	14	0.07	0	1.50	1.50	0.24	331.63
Percent simple lithophils	3	1	4	19	31.39	0	66.52	66.52	16.34	52.06
Percent manipulative lithophils	2	0	2	10	37.24	0	84.73	84.73	19.74	53.01
Percent lithophilic spawners	0	2	2	10	68.64	0	97.45	97.45	16.13	23.49
Number of lithophilic spawners	0	6	6	29	13.93	0	24	24	4.21	30.24
Percent simple nonlithophils	0	1	1	5	19.63	0.64	51.79	51.15	11.43	58.24
Percent manipulative nonlithophils	2	1	3	14	11.69	0	71.43	71.43	10.14	86.75
Percent manipulative spawners	3	0	3	14	48.93	12.69	90.21	77.52	19.27	39.39
Percent nonlithophilic	0	2	2	10	31.32	2.55	100	97.45	16.09	51.37
Percent simple lithophils+tolerants	0	0	0	0	47.04	17.67	83.74	66.07	15.35	32.64

Shaded box highlights metrics included in the Hills and Coastal Terraces ichthyoregion IBI.

[1] HDG-human disturbance gradient

Table 9. Redundancy analysis for Hills and Coastal Terraces 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	0.754	**1.000**										
3. Number of sucker species	0.621	0.450	**1.000**									
4. Number of *Lepomis* species	0.319	-0.018	0.008	**1.000**								
5. Number of darter+madtom species	0.692	0.440	0.312	-0.071	**1.000**							
6. Percent dominant species	-0.435	-0.187	-0.170	-0.289	-0.352	**1.000**						
7. Percent tolerant species	-0.175	-0.309	-0.223	0.324	-0.276	-0.132	**1.000**					
8. Percent *Lepomis*	-0.097	-0.376	-0.150	0.570	-0.244	-0.133	0.500	**1.000**				
9. Percent insectivorous cyprinids	0.047	0.437	0.027	-0.364	0.047	0.405	-0.417	-0.623	**1.000**			
10. Percent top carnivores	-0.111	-0.329	-0.019	0.122	-0.152	-0.104	0.251	0.442	-0.360	**1.000**		
11. Percent with DELT+hybrids	0.204	0.136	0.251	-0.112	0.254	-0.164	-0.102	-0.120	-0.018	0.090	**1.000**	
12. Percent simple lithophils	0.256	0.279	0.195	-0.325	0.475	-0.328	-0.460	-0.448	0.262	-0.230	0.209	**1.000**

Critical r value for statistical difference from 0 = 0.196 [p=0.05, df=99]

shaded box highlights coefficients >0.750

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.

METRICS SELECTED FOR THE HILLS AND COASTAL TERRACES 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). Total number of native species correlated positively with several habitat metrics, in particular those associated with instream cover, bank vegetation cover, the degree of sediment deposition, and the degree of disruptive pressure in the riparian zone while none of the disturbance metrics were correlated with total native species. Total native species discriminated sites with poor habitat from sites with good habitat in large watersheds. Discrimination power due to human disturbance was poorly defined statistically but was evident in small and large watersheds, though opposite as predicted (fig. 6). Since this metric is almost universally used for IBI applications, we've retained it for the Hills and Coastal Terraces.

2. NUMBER OF CYPRINID SPECIES

The family Cyprinidae is a diverse and abundant group in the Hills and Coastal Terraces ichthyoregion and includes species in the genera *Campostoma, Cyprinella, Hybopsis, Luxilus, Lythrurus, Macrhybopsis, Nocomis, Notemigonus, Notropis*, *Opsopoeodus, Pimephales, Pteronotropis,* and *Semotilus*. Cyprinids are common and abundant throughout the Hills and Coastal Terraces 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 at sites with poor habitat quality (fig. 7) for small watersheds while this relationship for large watersheds was evident, but not statistically significant. The number of cyprinid species-human disturbance relationship was poorly defined in this ichthyoregion.

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 was lower in poor habitat with this relationship statistically significant in large watersheds. Sucker diversity was positively correlated with instream cover, degree of sediment deposition, and bank vegetative cover. Human disturbance metrics were poorly related to sucker diversity in the Hills and Coastal Terraces ichthyoregion (fig. 8).

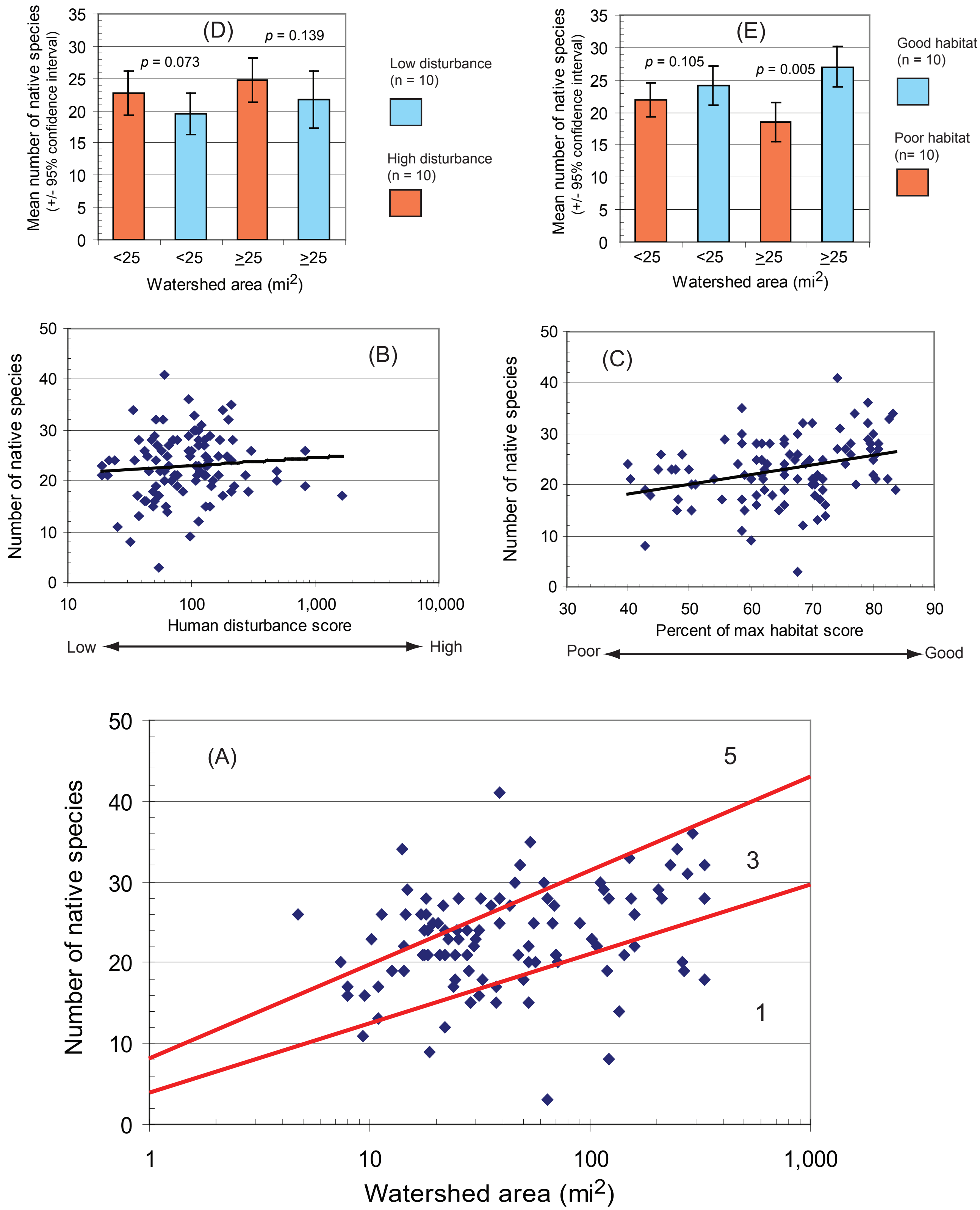


Figure 6. Relationships between the IBI metric number of native species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

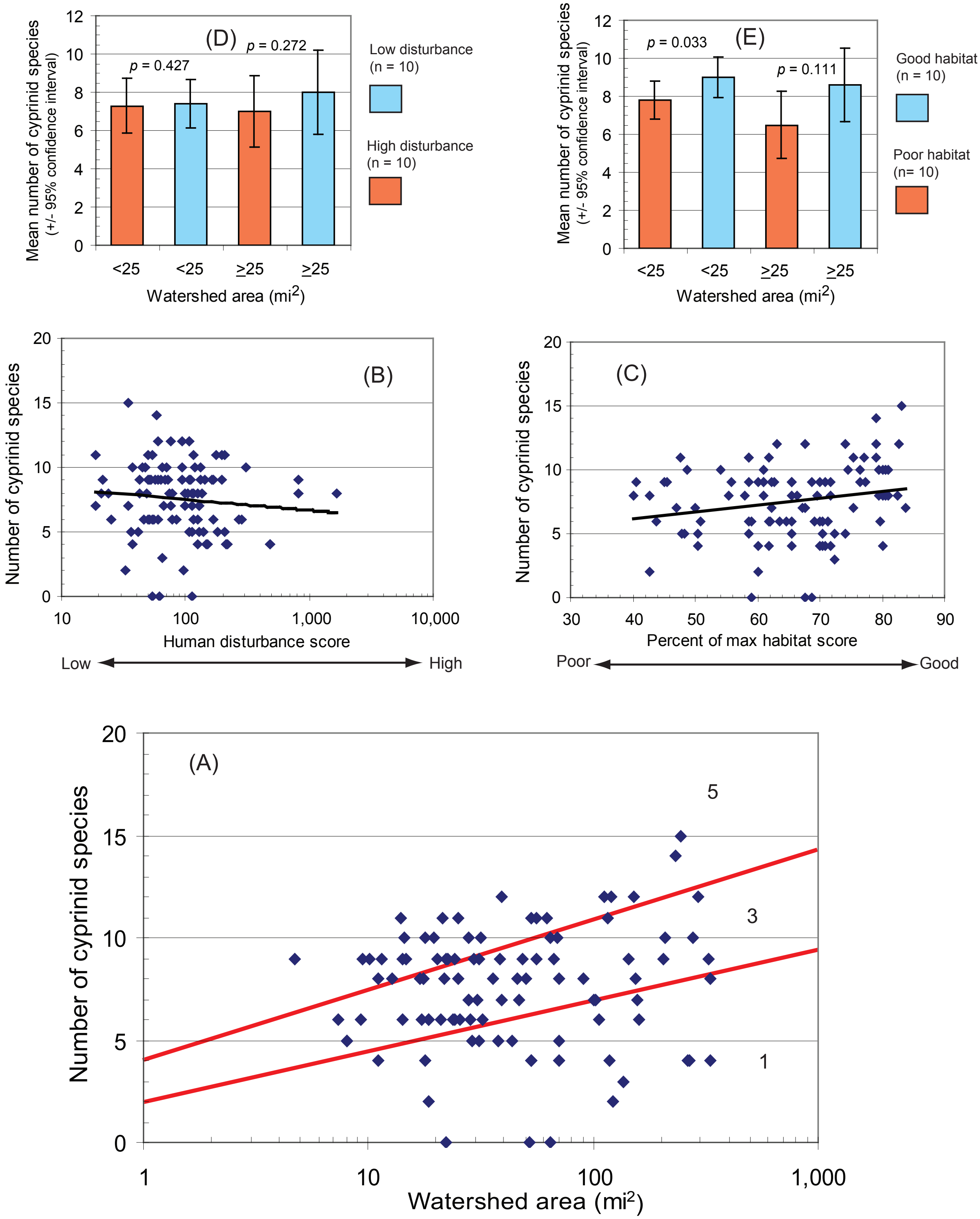


Figure 7. Relationships between the IBI metric number of cyprinid species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

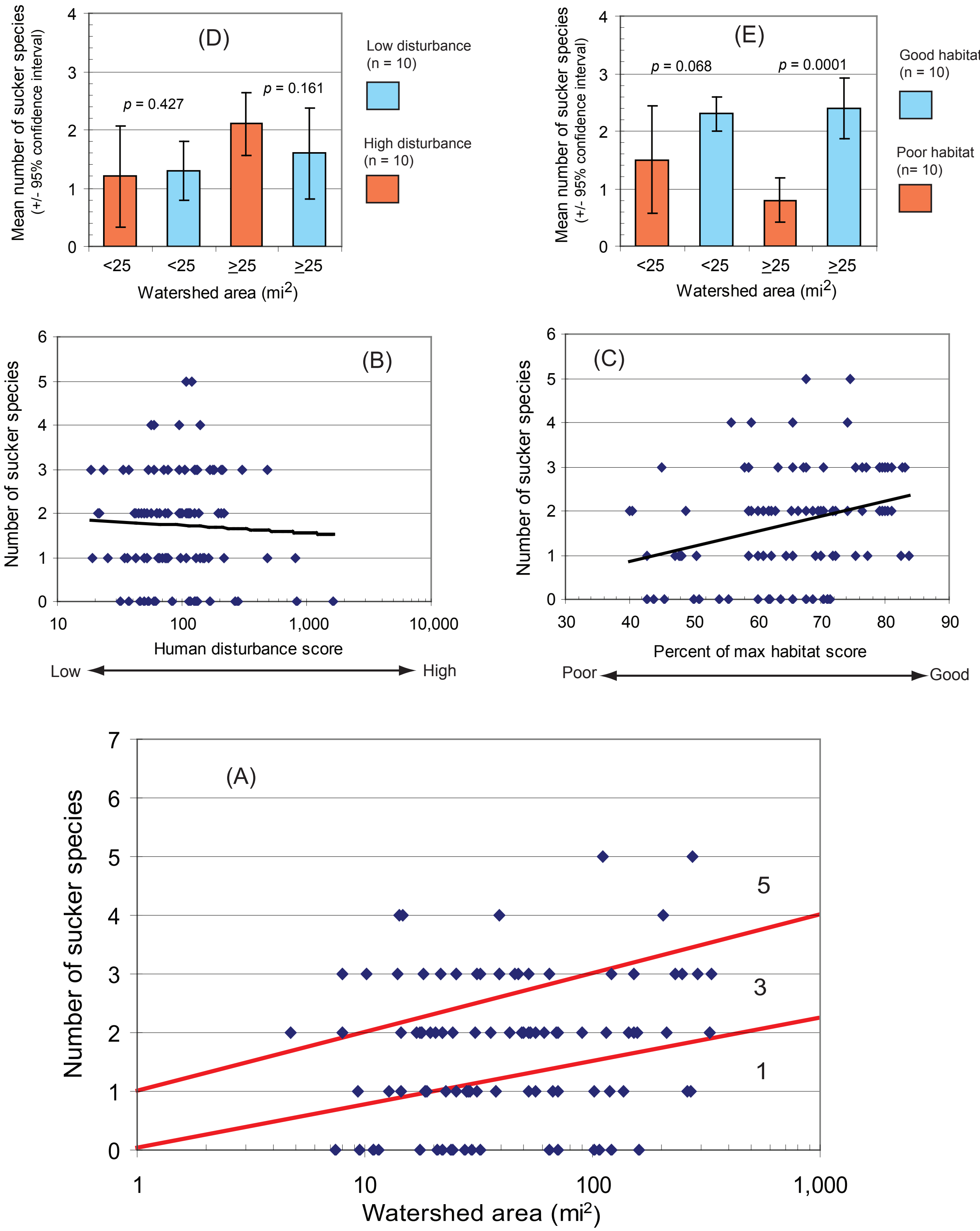


Figure 8. Relationships between the IBI metric number of sucker species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

4. NUMBER OF LEPOMIS SPECIES

Diversity of *Lepomis* species was significantly greater with high levels of human disturbance in both small and large watersheds, while this metric was poorly defined for habitat measures (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.

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 habitat disturbance and was poorly related to the human disturbance metrics. Mean number of darter+madtom species was significantly greater at sites with good habitat for small and large watersheds (fig. 10). Like darters, madtoms are benthic species and in Hills and Coastal Terraces streams are 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 positive correlations of darter+madtom species with instream cover, pool variability, bank and riparian vegetative cover, and degree of disruptive pressure in the riparian zone.

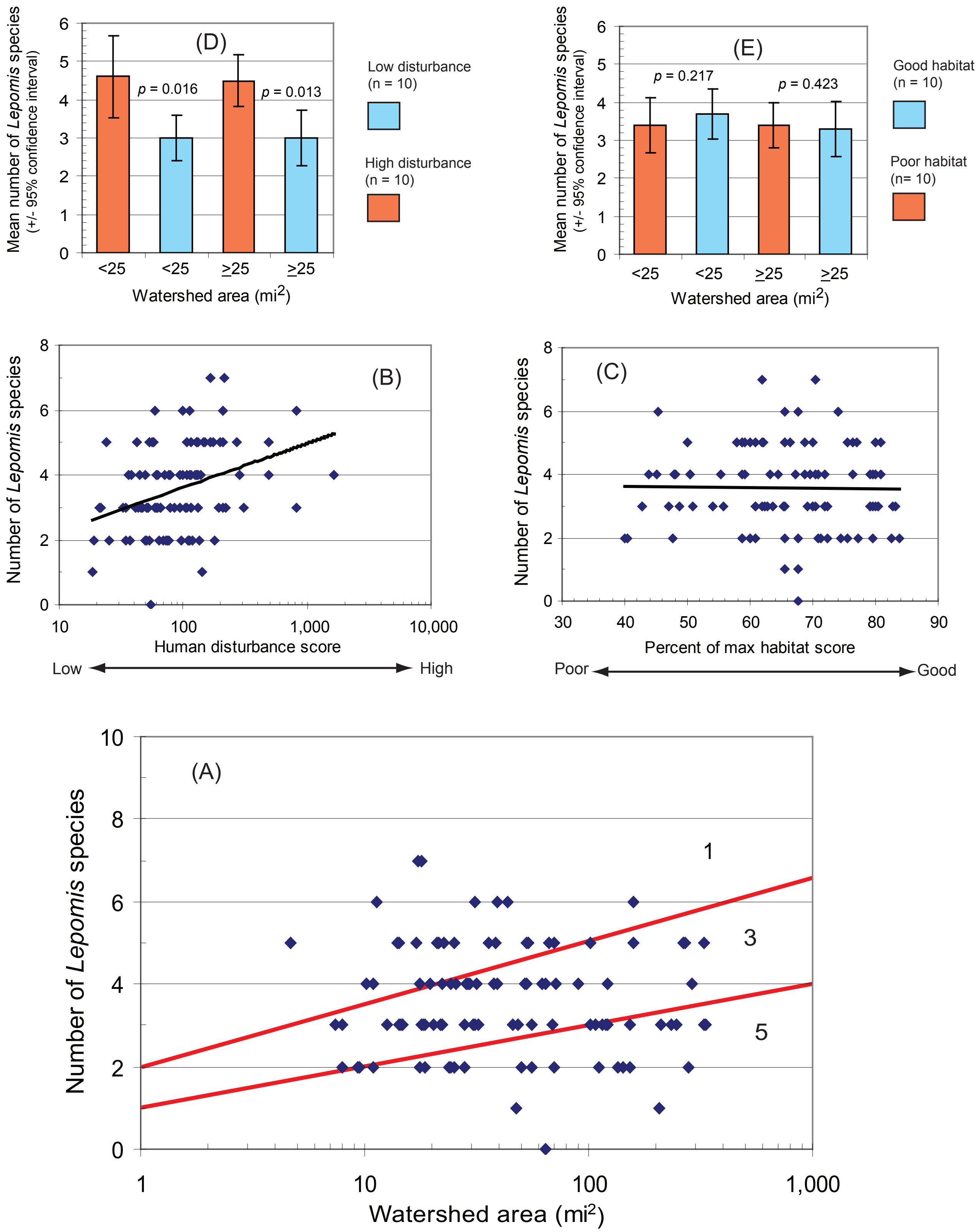


Figure 9. Relationships between the IBI metric number of *Lepomis* species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

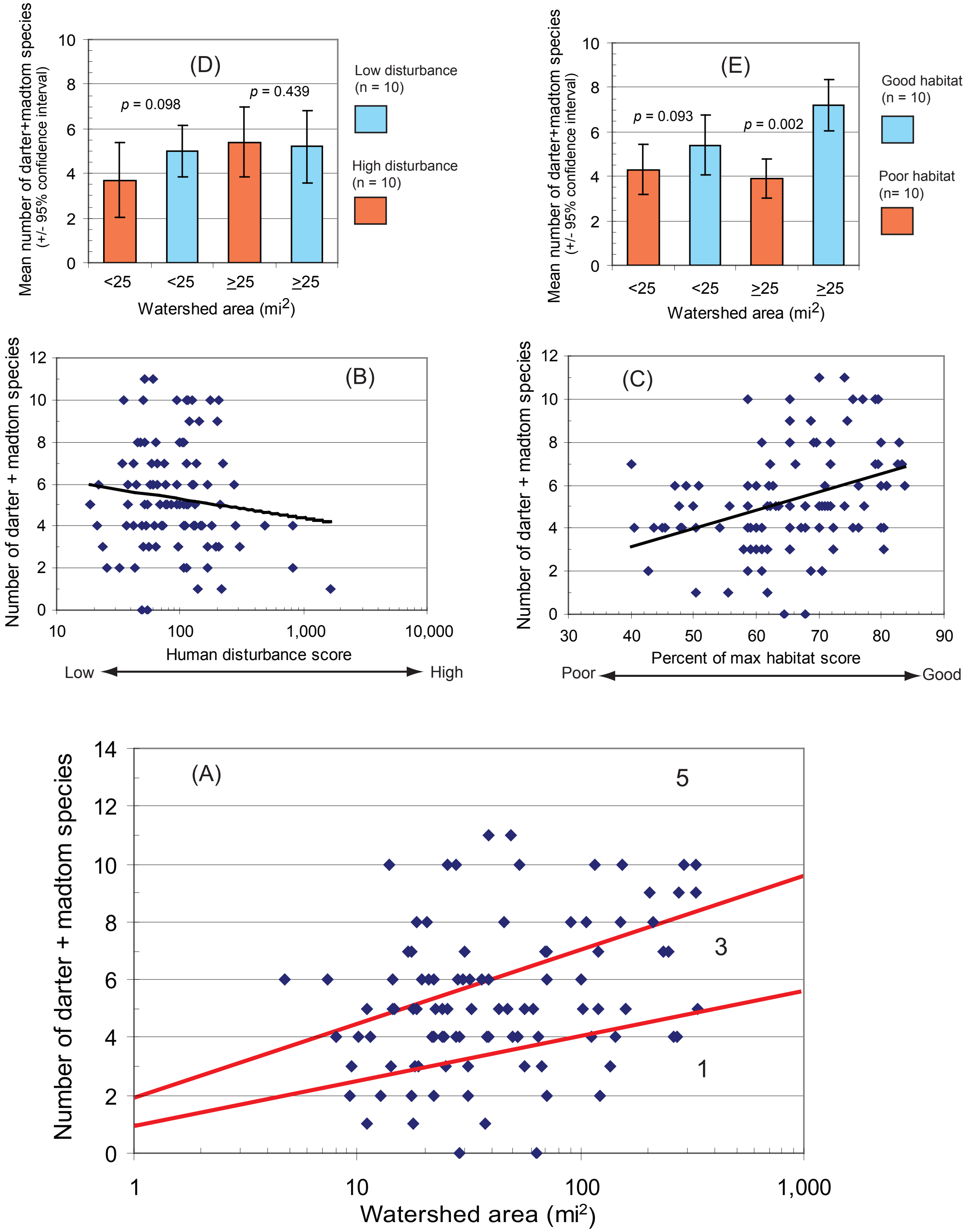


Figure 10. Relationships between the IBI metric number of darter+madtom species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for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

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 22 species that ranked most dominant in the 101 collections in the Hills and Coastal Terraces dataset with these species accounting for over 27 percent (11,227) of all individuals collected (40,784). *Cyprinella venusta* and *Notropis baileyi* were dominant in 20 collections each followed by *Lythrurus bellus* in 13 collections, *Lepomis megalotis* in 12 collections, and *Campostoma oligolepis* in 10 collections. Two species not considered tolerant were also dominant in a few collections: *Etheostoma stigmaeum* and *Percina kathae*. Percent dominant species is likely a reflection of the abundance of preferred habitat of these species. Percent dominant species decreaed with increasing human disturbance, a result opposite of that observed in the Plateau ichthyoregion. Mean percent dominant species was significantly lower in both small and large watersheds with high disturbance. This metric was poorly related to habitat though the trend was higher numbers of the dominant species at sites with poor habitat (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 Hills and Coastal Terraces ichthyoregion that were included in this metric were *Luxilus chrysocephalus, Pimephales notatus, P. vigilax, Semotilus atromaculatus, Notemigonus crysoleucas, Minytrema melanops, Gambusia affinis, Ameiurus melas, A. natalis, Lepomis cyanellus,* and *L. macrochirus*. This metric 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) and also higher in larger streams with poor habitat. This metric was not related to stream size, and scoring criteria were adopted from those

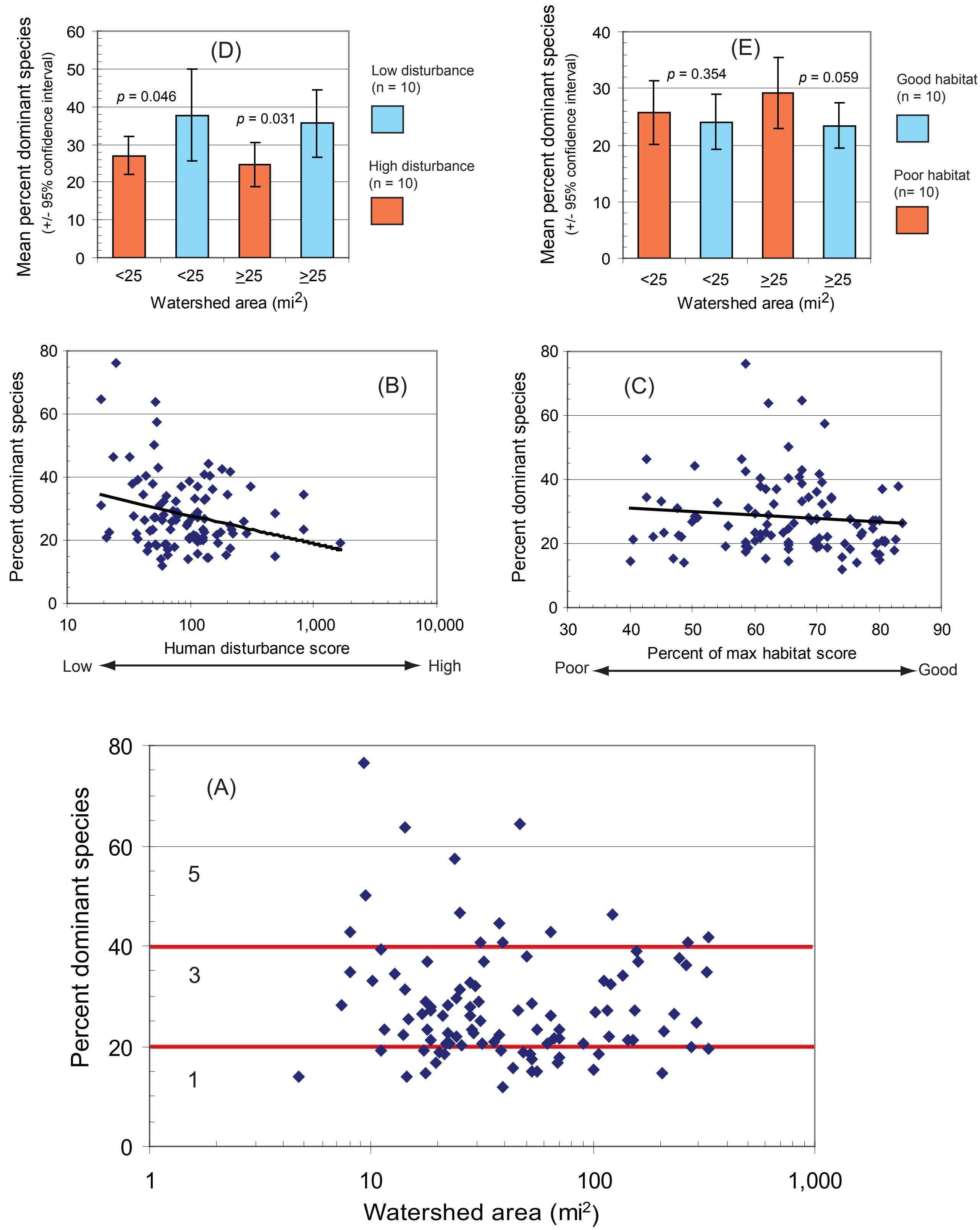


Figure 11. Relationships between the IBI metric percent dominant species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

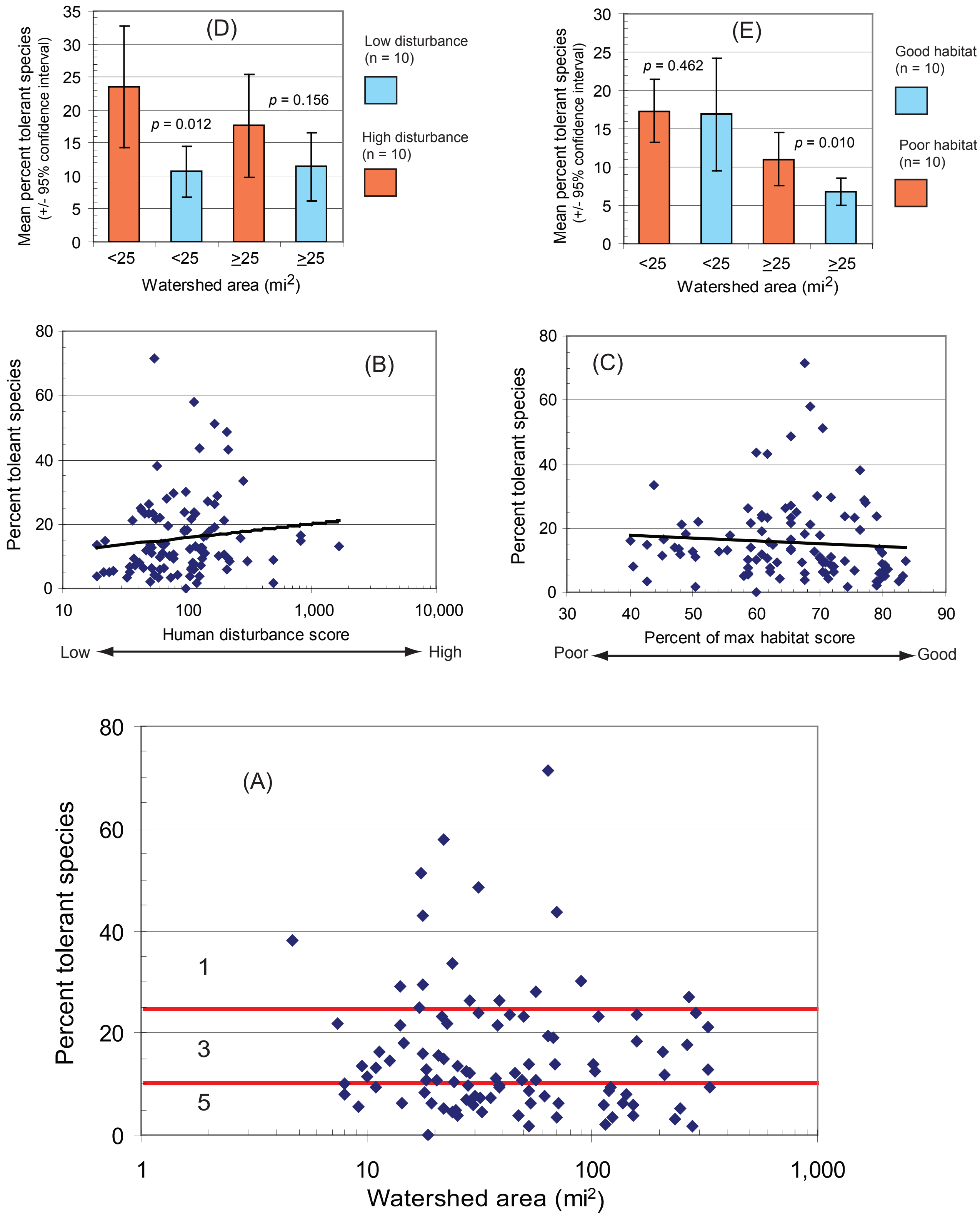


Figure 12. Relationships between the IBI metric percent tolerant species and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

established for streams in the Tennessee Valley ichthyoregion (O'Neil and Shepard, 2010). Higher numbers of tolerant species were correlated with higher phosphorus loads, higher pasture coverage, and altered channel structure.

8. PERCENT AS LEPOMIS

The metric percent as *Lepomis* corresponded to landscape-level measures of human disturbance (fig. 13) and to the more localized reach-level habitat metrics in most watersheds. *Lepomis* abundance was high in watersheds with high disturbance and poor habitat quality. *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, sediment deposition, and increase of physical structure like large debris and woody vegetation. Percent *Lepomis* increased with increasing phosphorus loads, percent pasture, and percent row crop.

9. PERCENT AS INSECTIVOROUS CYPRINIDS

Insectivorous cyprinids are a dominant trophic group in southeastern streams and their abundance generally declines with increasing environmental stress. This is thought to be in response to an altered insect food supply which, in turn, is altered by changes in water quality, energy sources, and habitat (Karr, 1981). Thus, when the community becomes dominated by a few insect taxa in disturbed streams, specialized insectivorous fishes will be replaced by species more suited to exploit the new food base. Ohio EPA (1987b) uses total insectivores, choosing not to restrict the metric to cyprinids only, and reported a positive relationship between percent of insectivores (total) and watershed area up to about 30 mi^2. No such relationship was evident in the Hills and Coastal Terraces data; therefore, Karr's 1981 original scoring criteria were adopted. Percent insectivorous cyprinids declined with increasing disturbance but was poorly defined relative to habitat quality. Mean percent insectivorous cyprinids was lower in watersheds with high disturbance for both small and large streams (fig. 14) and was correlated with higher phosphorus loads, and higher percentages of pasture and row crops land uses.

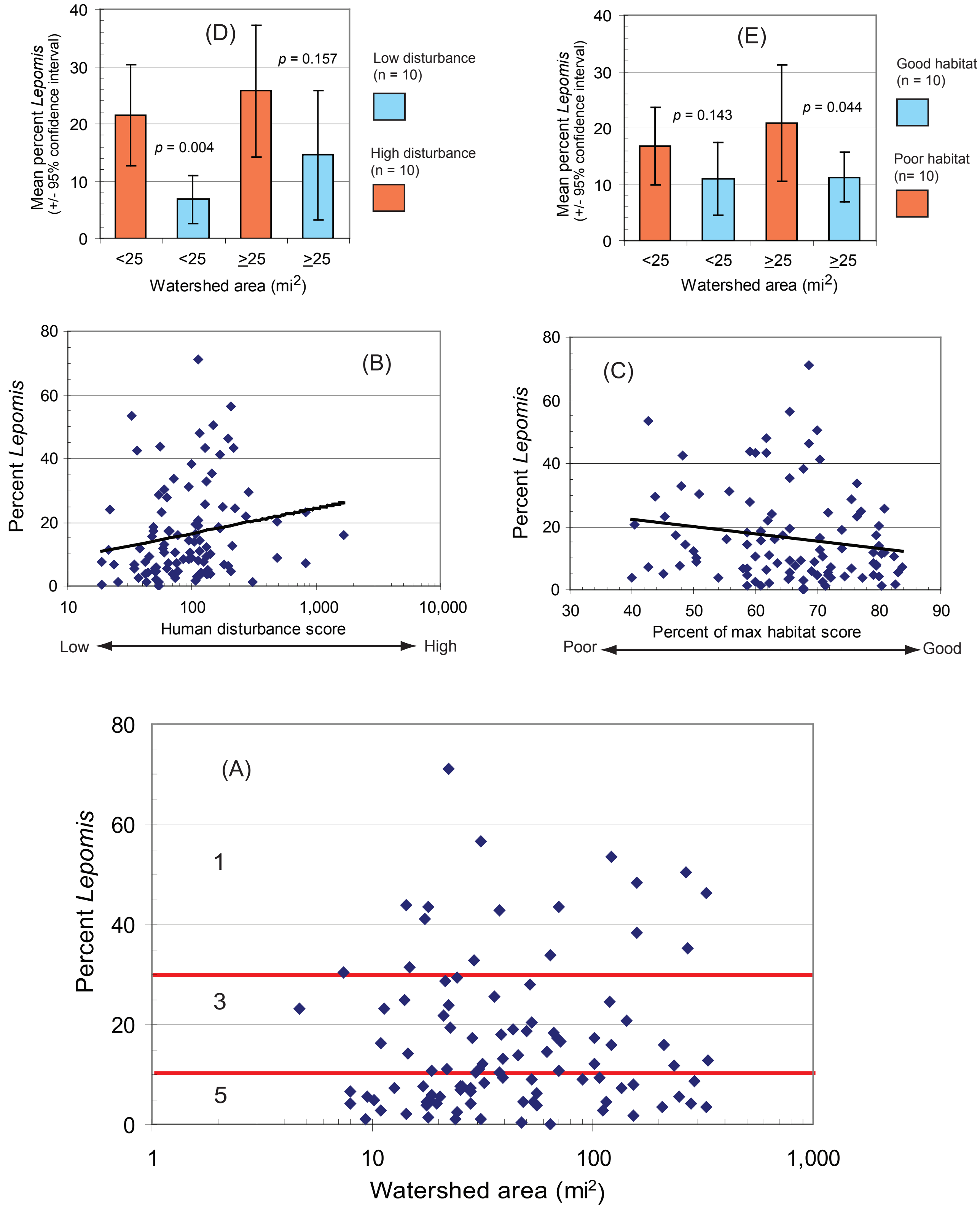


Figure 13. Relationships between the IBI metric percent *Lepomis* and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance (D)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

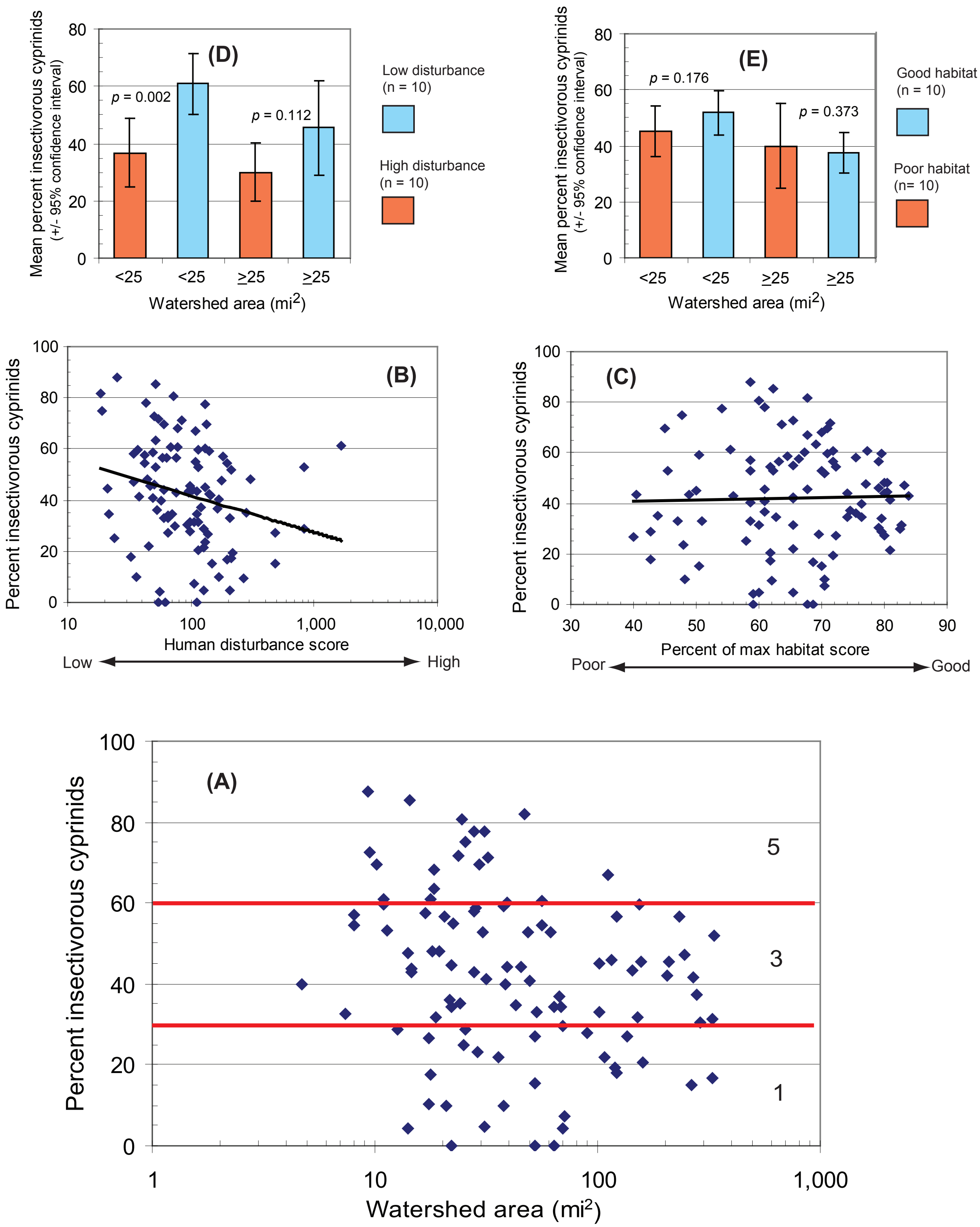


Figure 14. Relationships between the IBI metric percent as insectivorous cyprinids and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area 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 trended to more top carnivores in streams with good habitat though this pattern was poorly defined.

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 sites, and adjusted the scoring criteria accordingly. Only about 13 percent of the samples from the Hills and Coastal Terraces had individuals with 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 spectrum of nonpoint sources in rural areas (sediment and nutrients).

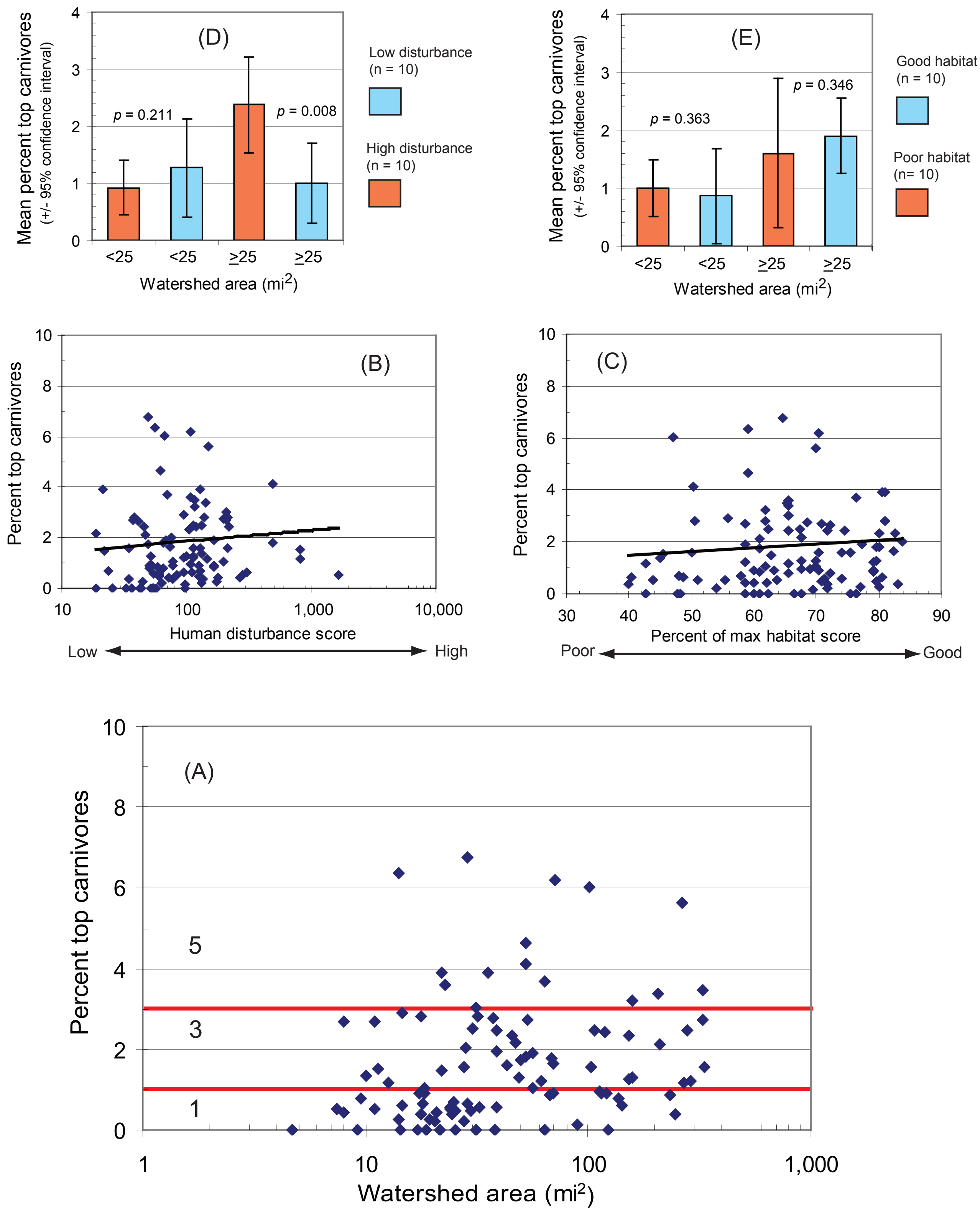


Figure 15. Relationships between the IBI metric percent top carnivores and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

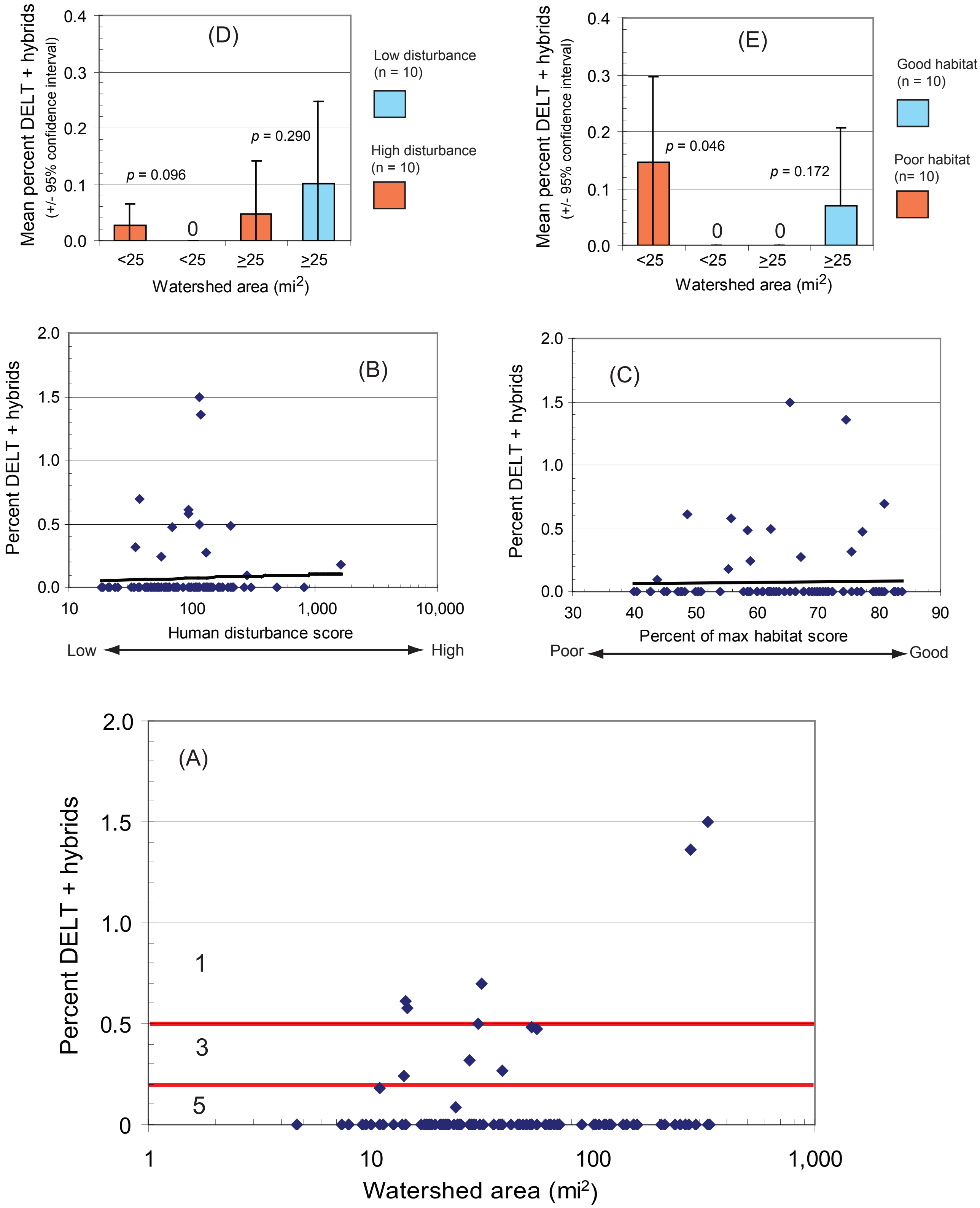


Figure 16. Relationships between the IBI metric percent DELT + hybrids and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area for disturbance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

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 Hills and Coastal Terraces it includes certain minnow, sucker, and darter species including *Hybognathus nuchalis, Lythrurus bellus, Notropis ammophilus, N. amplamala, N. texanus, Hypentelium etowanum, Moxostoma erythrurum, M. poecilurum, Etheostoma rupestre, E. stigmaeum, Percina kathae* and *P. nigrofasciata*. These species are vulnerable to sedimentation, which smothers preferred habitat for spawning and feeding. This metric tended to decline with increasing disturbance and declining habitat quality although these trends were poorly defined. Mean percent simple lithophils was not statistically different in small or large watersheds for either disturbance or habitat metrics (fig. 17). This metric declined as phosphorus load increased and the percentage of pasture and row crop land use increased.

IBI DEVELOPMENT FOR THE HILLS AND COASTAL TERRACES ICHTHYOREGION

The 12 selected metrics were used to calculate IBI scores for the sampled sites (tables 10, 11). Biotic integrity classes were derived by first evaluating the percentile distribution (10th, 25th, 50th, 75th, and 90th percentiles) of the 101 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), Ridge and Valley/Piedmont ichthyoregion (O’Neil and Shepard, 2011a) and the Plateau ichthyoregion (O’Neil and Shepard, 2011b). 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 42 percent of the IBIs scored in the fair class, 28 percent scored in the very poor and poor classes, and 30 percent scored in the good to excellent classes. Only one site scored in the excellent biological condition range. Relationships between the IBI and habitat scores (fig. 19) and human disturbance scores (fig. 20) were significantly different from 0 but were only moderately strong in describing variability.

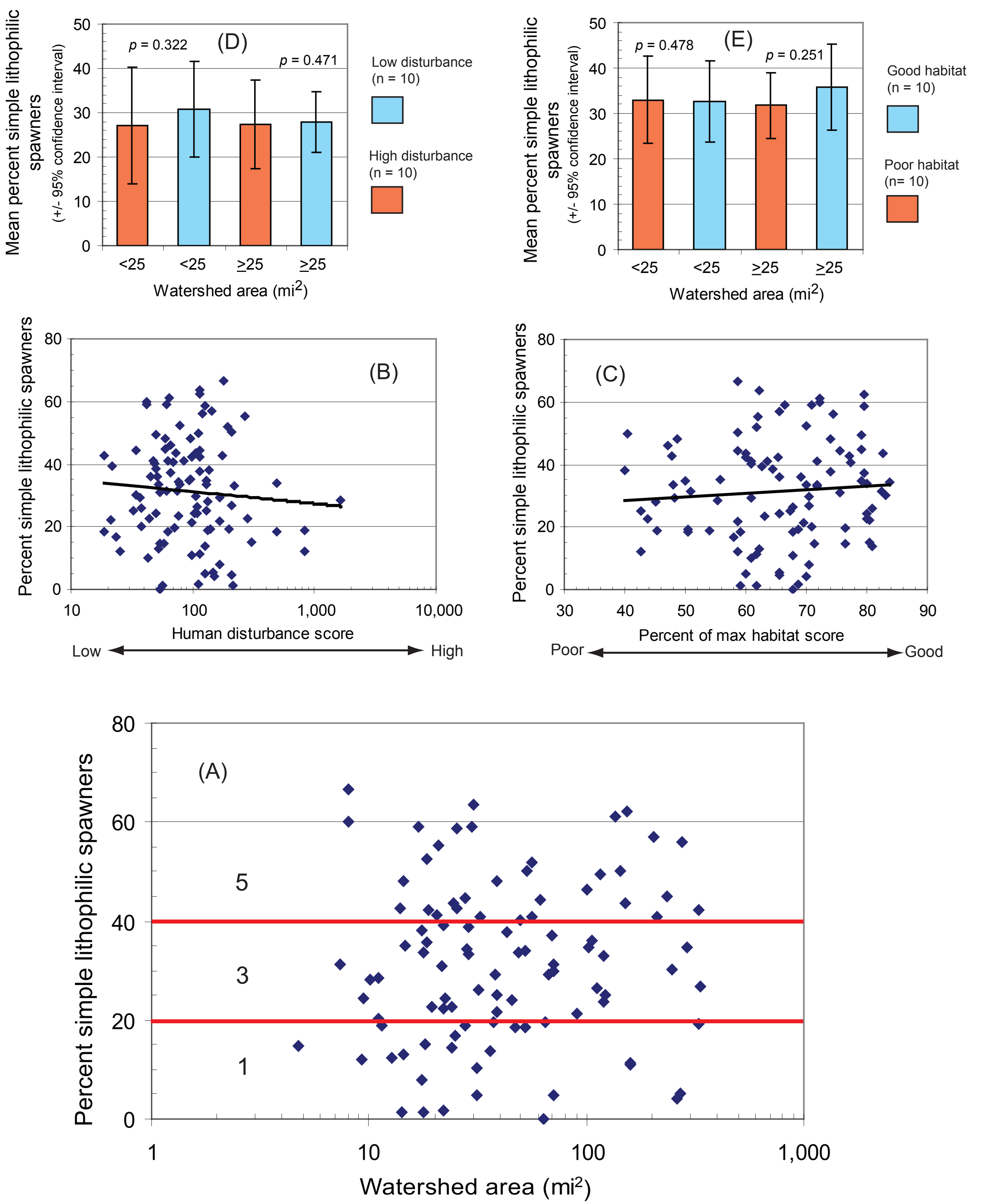


Figure 17. Relationships between the IBI metric percent simple lithophilic spawners and watershed area, disturbance, and habitat. Scoring criteria for metric in relation to watershed area (A); metric relationships to disturbance (B) and habitat (C); and mean metric value in relation to watershed area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

Table 10. Fish community values for Hills and Coastal Terraces 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	INSEC	TC	DELHY	SIMLTH
1306	20	4	1	4	4	28.57	1.59	8.89	15.24	4.13	0	18.41
1307	23	7	1	3	6	15.32	13.81	17.12	33.03	6.01	0	46.25
1400	30	12	5	2	4	33.17	5.97	2.86	67.06	0.95	0	26.49
1401	25	7	3	4	4	40.82	9.32	9.32	60.00	2.47	0.27	25.21
1402	26	7	2	6	5	38.79	18.32	38.15	45.47	1.29	0	10.99
1403	24	5	3	6	3	24.87	48.49	56.53	4.52	3.02	0	4.77
1404	19	4	1	3	7	21.95	8.54	24.39	19.51	2.44	0	32.93
1405	21	4	0	5	6	23.32	43.50	43.50	4.48	0.90	0	4.93
1406	22	6	0	5	5	36.95	23.49	48.19	20.48	3.21	0	11.24
1407	20	4	1	5	4	36.19	17.69	50.40	15.01	5.63	0	4.02
1408	22	6	4	5	3	31.25	21.51	43.87	4.45	6.37	0.24	1.32
1409	28	12	3	4	5	32.37	9.31	15.99	56.75	0.92	0	23.59
1410	27	8	2	5	6	20.73	7.32	25.61	21.71	3.90	0	13.66
1411	32	9	2	5	9	34.62	21.18	46.24	16.86	2.73	0	19.13
1412	25	9	1	5	3	21.60	19.01	18.36	36.72	0.86	0	29.16
1413	19	4	1	5	4	40.59	27.06	35.29	41.76	1.18	0	5.29
1414	22	9	0	4	6	32.17	5.83	10.49	69.70	0.47	0	58.97
1415	3	0	0	0	0	42.86	71.43	0	0	0	0	0.00
1416	26	8	2	5	7	26.59	24.84	7.47	57.58	0	0	58.90
1417	24	7	1	2	10	27.76	6.94	6.62	58.04	1.58	0.32	44.48
1418	21	8	2	3	4	20.67	5.03	11.17	44.69	3.91	0	22.35
1419	25	9	2	3	8	18.90	10.83	5.52	56.69	0.21	0	41.19
1420	25	10	2	4	6	16.63	6.18	4.28	48.22	0.24	0	22.57
1421	27	11	3	5	4	18.38	23.24	28.65	36.22	0	0	30.81
1422	28	10	3	4	6	20.42	7.39	11.97	41.20	2.82	0.70	26.06
1423	28	10	2	3	8	22.98	11.91	15.74	45.53	2.13	0	40.85
1424	28	9	3	5	6	19.27	26.20	17.92	40.08	1.93	0	21.58
1425	24	9	2	3	6	22.72	14.81	23.95	34.32	1.48	0	39.26
1426	28	10	3	4	4	26.16	19.26	33.71	34.51	3.69	0	19.74
1427	33	12	3	3	8	21.37	3.90	1.87	31.67	2.34	0	43.53
1428	26	10	3	3	3	36.90	8.40	1.40	48.09	0.64	0	15.01
1432	23	11	1	2	5	31.18	13.55	7.43	74.94	0	0	42.69
1433	18	8	2	2	4	37.79	23.26	18.60	40.70	1.74	0	40.12
1434	28	8	2	2	10	27.12	5.93	8.05	59.75	1.27	0	62.29
1435	16	9	1	3	2	40.59	24.04	1.13	77.78	0	0	10.20

[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; INSEC-proportion of insectivorous cyprinids;TC-proportion of top carnivores; DELHY-proportion with DELT+hybrids; SIMLTH-proportion of simple lithophilic spawners.

Table 10. Fish community values for Hills and Coastal Terraces 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	INSEC	TC	DELHY	SIMLTH
1436	21	10	0	3	4	32.67	12.55	3.98	77.69	0.20	0	18.92
1437	24	8	2	2	7	14.61	16.10	3.75	26.59	0.37	0	38.20
1438	20	9	1	2	5	23.22	27.96	3.79	60.66	1.90	0.47	40.76
1439	15	6	1	4	0	23.31	26.38	17.18	58.90	6.75	0	38.65
1440	21	9	2	2	4	29.51	10.25	2.46	80.74	0.41	0	43.44
1441	21	9	2	2	4	21.34	7.93	20.73	43.29	0.61	0	50.00
1442	19	7	1	2	6	26.26	9.60	7.07	42.93	2.02	0	34.34
1443	19	9	1	3	5	63.62	6.25	1.92	85.58	0	0	12.98
1444	23	7	2	3	7	29.00	7.50	11.00	53.00	2.50	0.50	63.50
1445	28	8	2	3	10	19.40	12.94	3.48	31.34	3.48	1.50	42.29
1446	36	12	3	4	10	24.57	23.88	8.48	30.62	1.21	0	34.78
1447	24	6	1	3	8	27.24	12.69	5.78	63.43	0.93	0	35.82
1448	32	9	2	3	11	18.63	10.89	4.43	52.95	1.29	0	33.58
1451	21	7	3	1	5	64.50	3.90	0.43	81.82	2.16	0	18.61
1452	17	8	0	4	1	19.08	13.07	16.08	61.13	0.53	0.18	28.62
1453	26	9	0	6	4	23.47	16.41	23.16	53.07	1.53	0	19.02
1473	14	3	1	2	3	34.13	6.35	7.14	26.98	0.79	0	61.11
1577	15	5	1	4	4	22.67	12.00	32.67	23.33	0.67	0	33.33
1578	21	8	1	2	7	17.82	3.30	10.56	29.70	1.65	0	31.35
1579	22	6	0	3	8	18.40	23.31	9.20	22.09	2.45	0	36.20
1580	18	6	0	4	4	22.06	33.56	29.41	35.21	0.52	0.09	22.58
1581	16	5	2	3	4	34.67	8.00	4.00	54.67	2.67	0	60.00
1582	18	6	0	3	5	37.02	4.42	8.29	71.27	0.55	0	40.88
1583	21	6	0	7	2	19.05	51.19	41.07	10.12	0.89	0	8.04
1584	28	4	2	7	1	23.43	43.01	43.36	17.48	2.80	0	1.40
1585	27	5	2	6	5	15.78	23.53	18.98	34.76	1.60	0	37.70
1586	21	6	1	3	5	27.85	10.61	4.77	68.17	1.06	0	52.52
1587	23	9	1	5	5	20.60	21.79	19.40	54.93	3.58	0	24.48
1588	30	8	3	3	8	27.15	12.25	13.91	44.04	2.32	0	24.17
1589	21	8	2	4	5	28.79	29.55	4.55	60.98	0.38	0	33.71
1590	26	9	2	5	6	13.95	38.14	23.02	40.00	0	0	14.65
1591	17	6	0	2	5	57.27	4.36	1.16	71.51	0.58	0	14.53
1592	35	11	2	5	10	17.44	6.08	4.64	32.96	2.72	0.48	50.08
1593	17	5	3	2	4	42.73	10.13	6.61	57.27	0.44	0	66.52
1594	28	6	3	4	10	20.19	3.65	7.54	28.95	0.49	0	58.64

[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 Hills and Coastal Terraces 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	INSEC	TC	DELHY	SIMLTH
1595	34	11	3	5	10	22.35	28.94	24.71	47.53	0.24	0	42.59
1596	20	6	0	3	6	28.13	21.88	30.21	32.81	0.52	0	31.25
1597	32	14	3	3	7	26.53	3.21	11.66	56.56	0.87	0	44.90
1598	16	9	0	2	3	50.13	13.46	5.54	72.56	0.79	0	24.27
1599	11	6	1	2	2	76.35	5.69	1.20	87.72	0	0	11.98
1850	8	2	0	3	2	46.43	3.57	53.57	17.86	0	0	25.00
1853	20	5	2	4	2	21.65	6.19	16.49	7.22	6.19	0	29.90
1856	15	5	1	4	1	44.44	11.11	10.19	59.26	2.78	0	19.44
1857	9	2	1	2	3	21.05	0.00	10.53	31.58	0.00	0	42.11
1858	19	8	1	3	2	34.50	14.62	7.31	28.65	1.17	0	12.28
1859	17	5	1	4	4	22.33	21.36	42.72	9.71	0	0	29.13
1861	12	0	0	4	2	28.04	57.94	71.03	0.00	21.50	0	1.87
1862	24	8	3	5	3	46.55	4.88	6.79	25.00	0.71	0	16.67
1863	15	0	2	4	4	18.60	13.95	27.91	0.00	4.65	0	18.60
1880	18	4	3	3	5	41.73	9.45	12.60	51.97	1.57	0	26.77
1925	26	10	2	3	6	13.94	18.18	14.24	43.64	0.61	0.61	48.18
2004	29	9	4	3	5	25.51	17.97	31.30	42.90	2.90	0.58	35.07
2008	21	6	0	5	6	25.97	15.45	21.89	9.66	0.43	0	55.15
2009	13	4	0	2	5	39.19	9.46	2.70	59.46	2.70	0	20.27
2319	27	10	2	3	7	16.82	13.69	17.24	34.27	1.78	0	37.10
2320	29	11	2	3	10	27.04	2.20	4.61	45.92	0.92	0	49.33
2321	41	12	4	6	11	11.77	9.79	13.17	44.06	0.58	0	48.02
2323	31	10	5	2	9	19.86	1.77	4.22	37.28	2.45	1.36	56.05
2324	29	9	4	1	9	14.46	16.39	3.61	42.17	3.37	0	56.87
2325	25	8	2	4	8	20.38	30.11	8.99	27.85	0.14	0	21.16
2326	34	15	3	3	7	37.67	5.26	5.64	47.37	0.38	0	30.18
2661	30	11	2	4	5	20.40	7.60	14.40	52.80	1.20	0	44.40
2662	23	9	3	4	4	33.03	11.31	4.98	69.68	1.36	0	28.05
2665	25	11	2	3	3	15.12	10.61	6.37	54.38	1.06	0	51.99
2666	23	7	0	5	5	26.84	12.63	12.11	45.26	1.58	0	34.74
2667	22	4	3	5	4	15.03	8.81	20.21	27.20	1.81	0	33.94

[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 Hills and Coastal Terraces IBI metrics.

	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	INSEC	TC	DELHY	SIMLTH	IBI	condition
1306	3	1	1	3	3	3	5	5	1	5	5	1	36	Fair
1307	3	1	1	5	3	1	3	3	3	5	5	5	38	Fair
1400	3	5	5	5	1	3	5	5	5	1	5	3	46	Good
1401	3	3	5	3	3	5	5	5	3	3	3	3	44	Good
1402	3	1	3	1	3	3	3	1	3	3	5	1	30	Poor
1403	3	1	5	1	1	3	1	1	1	5	5	1	28	Poor
1404	1	1	1	5	3	3	5	3	1	3	5	3	34	Poor
1405	3	1	1	1	3	3	1	1	1	1	5	1	22	Very Poor
1406	1	1	1	3	3	3	3	1	1	5	5	1	28	Poor
1407	1	1	1	3	1	3	3	1	1	5	5	1	26	Very Poor
1408	5	3	5	1	3	3	3	1	1	5	3	1	34	Poor
1409	3	5	3	3	3	3	5	3	3	1	5	3	40	Fair
1410	5	3	3	1	5	3	5	3	1	5	5	1	40	Fair
1411	3	3	3	3	5	3	3	1	1	3	5	1	34	Poor
1412	3	3	1	1	1	3	3	3	3	1	5	3	30	Poor
1413	1	1	1	3	1	5	1	1	3	3	5	1	26	Very Poor
1414	3	3	1	3	5	3	5	3	5	1	5	5	42	Fair
1415	1	1	1	5	1	5	1	5	1	1	5	1	28	Poor
1416	5	3	3	1	5	3	3	5	3	1	5	5	42	Fair
1417	3	3	1	5	5	3	5	5	3	3	3	5	44	Good
1418	3	3	3	3	3	3	5	3	3	5	5	3	42	Fair
1419	5	5	3	3	5	1	3	5	3	1	5	5	44	Good
1420	5	5	3	1	5	1	5	5	3	1	5	3	42	Fair
1421	5	5	5	1	3	1	3	3	3	1	5	3	38	Fair
1422	5	5	5	3	5	3	5	3	3	3	1	3	44	Good
1423	3	3	3	5	5	3	3	3	3	3	5	5	44	Good
1424	5	3	5	1	5	1	1	3	3	3	5	3	38	Fair
1425	5	5	3	3	5	3	3	3	3	3	5	3	44	Good
1426	3	3	5	3	3	3	3	1	3	5	5	1	38	Fair
1427	3	5	3	5	5	3	5	5	3	3	5	5	50	Excellent
1428	5	5	5	3	3	3	5	5	3	1	5	1	44	Good
1432	3	5	1	5	3	3	3	5	5	1	5	5	44	Good
1433	1	3	3	5	3	3	3	3	3	3	5	5	40	Fair
1434	3	3	3	5	5	3	5	5	3	3	5	5	48	Good
1435	1	3	1	3	1	5	3	5	5	1	5	1	34	Poor

[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; INSEC-proportion of insectivorous cyprinids;TC-proportion of top carnivores; DELHY-proportion with DELT+hybrids; SIMLTH-proportion of simple lithophilic spawners.

Table 11. Scores for Hills and Coastal Terraces 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	INSEC	TC	DELHY	SIMLTH	IBI	condition
1436	3	5	1	3	3	3	3	5	5	1	5	1	38	Fair
1437	5	3	3	5	5	1	3	5	1	1	5	3	40	Fair
1438	3	3	1	5	3	3	1	5	5	3	3	5	40	Fair
1439	1	3	1	3	1	3	1	3	3	5	5	3	32	Poor
1440	3	5	3	5	3	3	3	5	5	1	5	5	46	Good
1441	1	3	3	5	1	3	5	3	3	1	5	5	38	Fair
1442	3	3	1	5	5	3	5	5	3	3	5	3	44	Good
1443	3	5	3	3	5	5	5	5	5	1	5	1	46	Good
1444	3	3	3	3	5	3	5	3	3	3	3	5	42	Fair
1445	3	1	3	5	5	1	3	5	3	5	1	5	40	Fair
1446	3	3	3	3	5	3	3	5	3	3	5	3	42	Fair
1447	5	3	3	3	5	3	3	5	5	1	5	3	44	Good
1448	5	3	3	3	5	1	3	5	3	3	5	3	42	Fair
1451	3	3	5	5	3	5	5	5	5	3	5	1	48	Good
1452	3	5	1	1	1	1	3	3	5	1	5	3	32	Poor
1453	5	5	1	1	3	3	3	3	3	3	5	1	36	Fair
1473	1	1	1	5	1	3	5	5	1	1	5	5	34	Poor
1577	1	1	1	3	3	3	3	1	1	1	5	3	26	Very Poor
1578	3	3	1	5	5	1	5	3	1	3	5	3	38	Fair
1579	3	1	1	5	5	1	3	5	1	3	5	3	36	Fair
1580	3	3	1	3	3	3	1	3	3	1	5	3	32	Poor
1581	3	3	5	3	3	3	5	5	3	3	5	5	46	Good
1582	3	3	1	3	3	3	5	5	5	1	5	5	42	Fair
1583	3	3	1	1	1	1	1	1	1	1	5	1	20	Very Poor
1584	5	1	3	1	1	3	1	1	1	3	5	1	26	Very Poor
1585	5	1	3	1	3	1	3	3	3	3	5	3	34	Poor
1586	3	3	3	3	3	3	3	5	5	3	5	5	44	Good
1587	3	5	1	1	3	3	3	3	3	5	5	3	38	Fair
1588	5	3	5	3	5	3	3	3	3	3	5	3	44	Good
1589	3	3	3	1	3	3	1	5	5	1	5	3	36	Fair
1590	5	5	5	1	5	1	1	3	3	1	5	1	36	Fair
1591	3	3	1	5	3	5	5	5	5	1	5	1	42	Fair
1592	5	5	3	1	5	1	5	5	3	3	3	5	44	Good
1593	3	3	5	3	3	5	3	5	3	1	5	5	44	Good
1594	5	3	5	3	5	3	5	5	1	1	5	5	46	Good

[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 Hills and Coastal Terraces 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	INSEC	TC	DELHY	SIMLTH	IBI	condition
1595	5	5	5	1	5	3	1	3	3	1	5	5	42	Fair
1596	5	3	1	3	5	3	3	1	3	1	5	3	36	Fair
1597	3	5	3	5	3	3	5	3	3	1	5	5	44	Good
1598	3	5	1	3	3	5	3	5	5	1	5	3	42	Fair
1599	1	3	3	3	1	5	5	5	5	1	5	1	38	Fair
1850	1	1	1	5	1	5	5	1	1	1	5	3	30	Poor
1853	3	1	3	3	1	3	5	3	1	5	5	3	36	Fair
1856	1	1	1	3	1	5	3	3	3	3	5	1	30	Poor
1857	1	1	3	5	3	3	5	3	3	1	5	5	38	Fair
1858	3	5	3	3	1	3	3	5	1	3	5	1	36	Fair
1859	1	1	1	3	3	3	3	1	1	1	5	3	26	Very Poor
1861	1	1	1	3	1	3	1	1	1	5	5	1	24	Very Poor
1862	3	3	5	1	1	5	5	5	1	1	5	1	36	Fair
1863	1	1	3	3	3	1	3	3	1	5	5	1	30	Poor
1880	1	1	3	5	3	5	5	3	3	3	5	3	40	Fair
1925	5	5	3	3	5	1	3	3	3	1	1	5	38	Fair
2004	5	5	5	3	5	3	3	1	3	3	1	3	40	Fair
2008	3	3	1	1	5	3	3	3	1	1	5	5	34	Poor
2009	3	1	1	5	5	3	5	5	3	3	5	3	42	Fair
2319	3	3	3	3	5	1	3	3	3	3	5	3	38	Fair
2320	3	3	3	5	5	3	5	5	3	1	5	5	46	Good
2321	5	5	5	1	5	1	5	3	3	1	5	5	44	Good
2323	3	3	5	5	5	1	5	5	3	3	1	5	44	Good
2324	3	3	5	5	5	1	3	5	3	5	5	5	48	Good
2325	3	3	3	3	5	3	1	5	1	1	5	3	36	Fair
2326	3	5	3	5	3	3	5	5	3	1	5	3	44	Good
2661	5	5	3	3	3	3	5	3	3	3	5	5	46	Good
2662	5	5	5	1	3	3	3	5	5	3	5	3	46	Good
2665	3	5	3	3	1	1	3	5	3	3	5	5	40	Fair
2666	3	1	1	3	3	3	3	3	3	3	5	3	34	Poor
2667	3	1	5	1	3	1	5	3	1	3	5	3	34	Poor

[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, Ridge and Valley/Piedmont, and Hills and Coastal Terraces ichthyoregions.

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

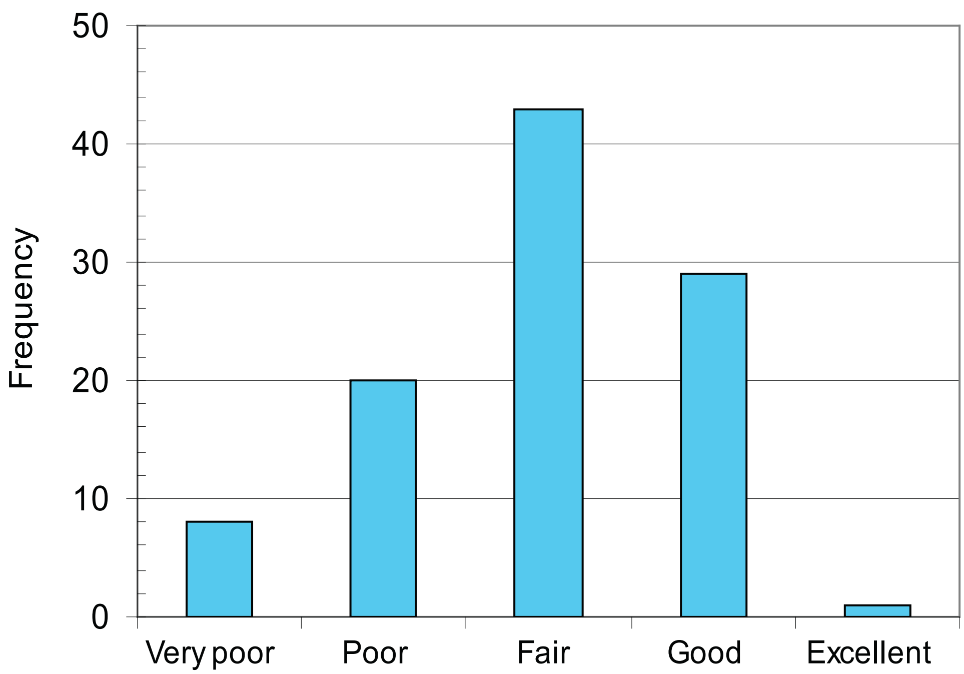


Figure 18. Frequency distribution of IBI integrity classes for sites in the Hills and Coastal Terraces ichthyoregion.

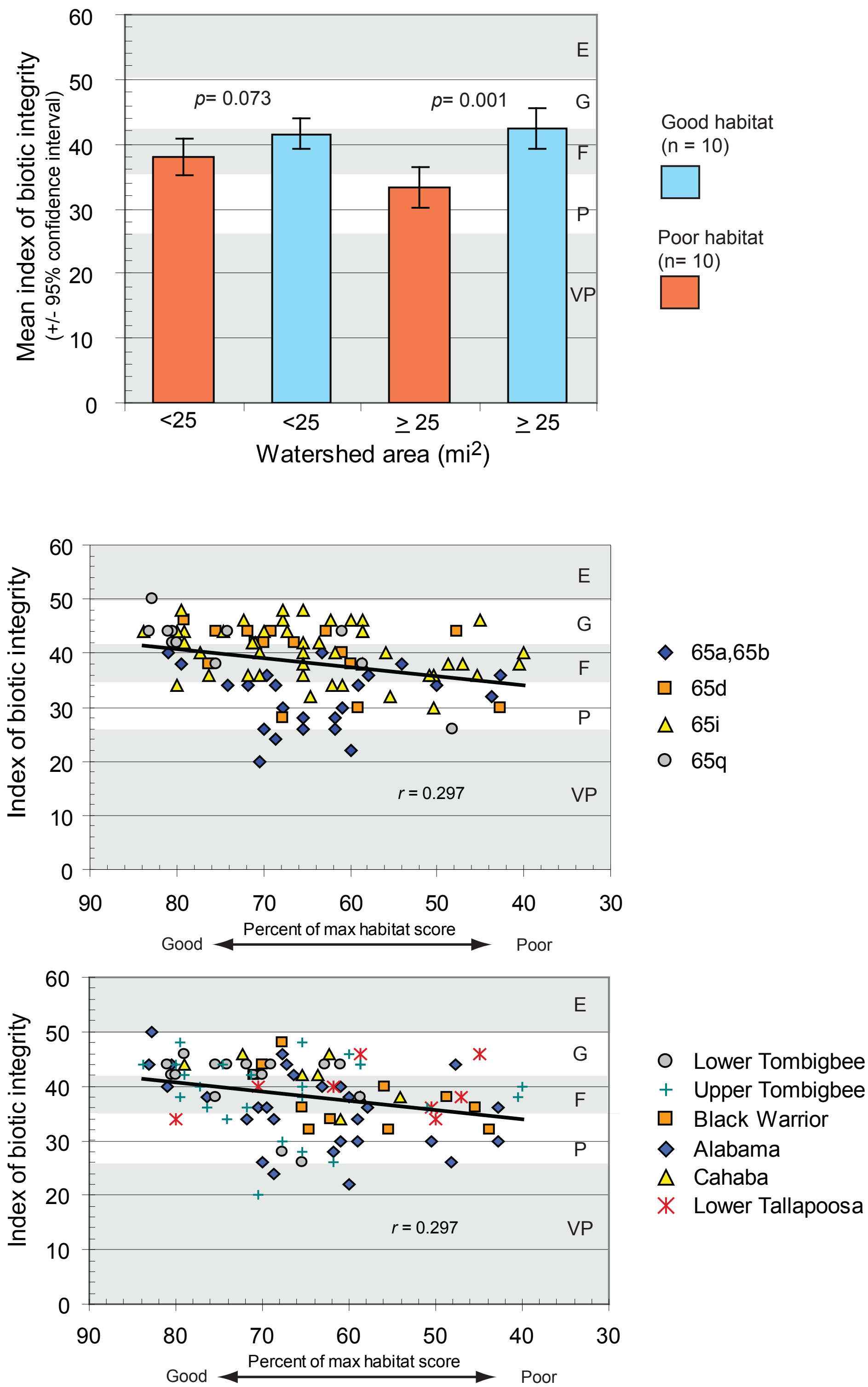


Figure 19. Comparison of the IBI in level IV ecoregions and drainages relative to habitat quality and a comparison of IBI scores for small and large watersheds relative to habitat quality.

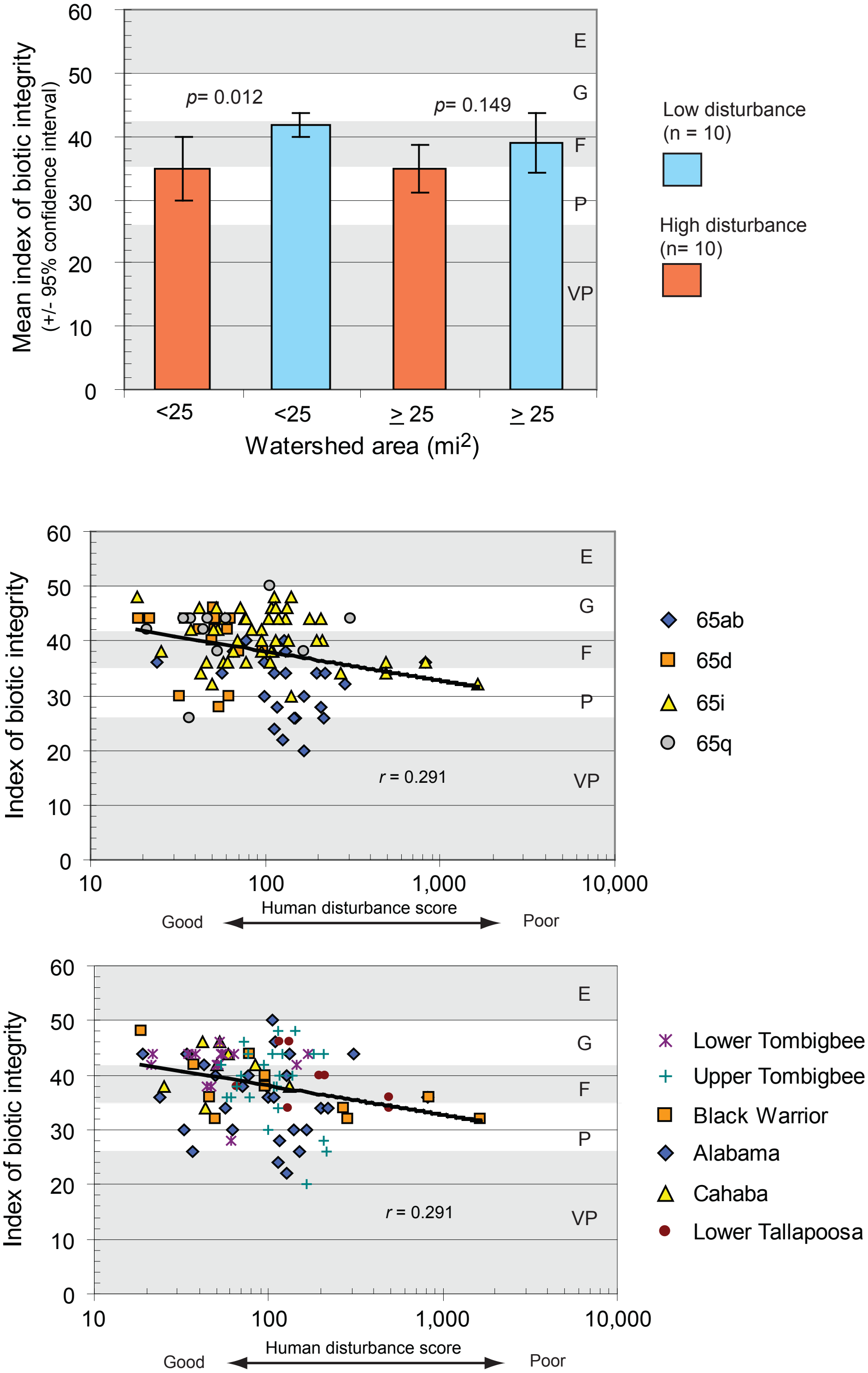


Figure 20. Comparison of the IBI in level IV ecoregions and drainages relative to human disturbance and a comparison of IBI scores for small and large watersheds relative to human disturbance.

The Hills and Coastal Terraces IBI was developed as a regional tool for evaluating biological condition of 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 versus 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 and homogeneity across level IV ecoregions and drainages with respect to habitat quality versus the IBI. Likewise, the relationships between watershed disturbance versus 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) is equated with increasing levels of stressors and response (y axis) is equated with some measure of biological condition, such as the IBI.

The BCG model can be applied to the calibrated IBI for the Hills and Coastal Terraces 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 (HDG index) serving as the measure of increasing level of ecosystem stress (x axis) (fig. 21). The Hills and Coastal Terraces 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 limits (95% confidence interval) for graphical description. Curves were hand fitted to the biological integrity tiers (fig. 22)

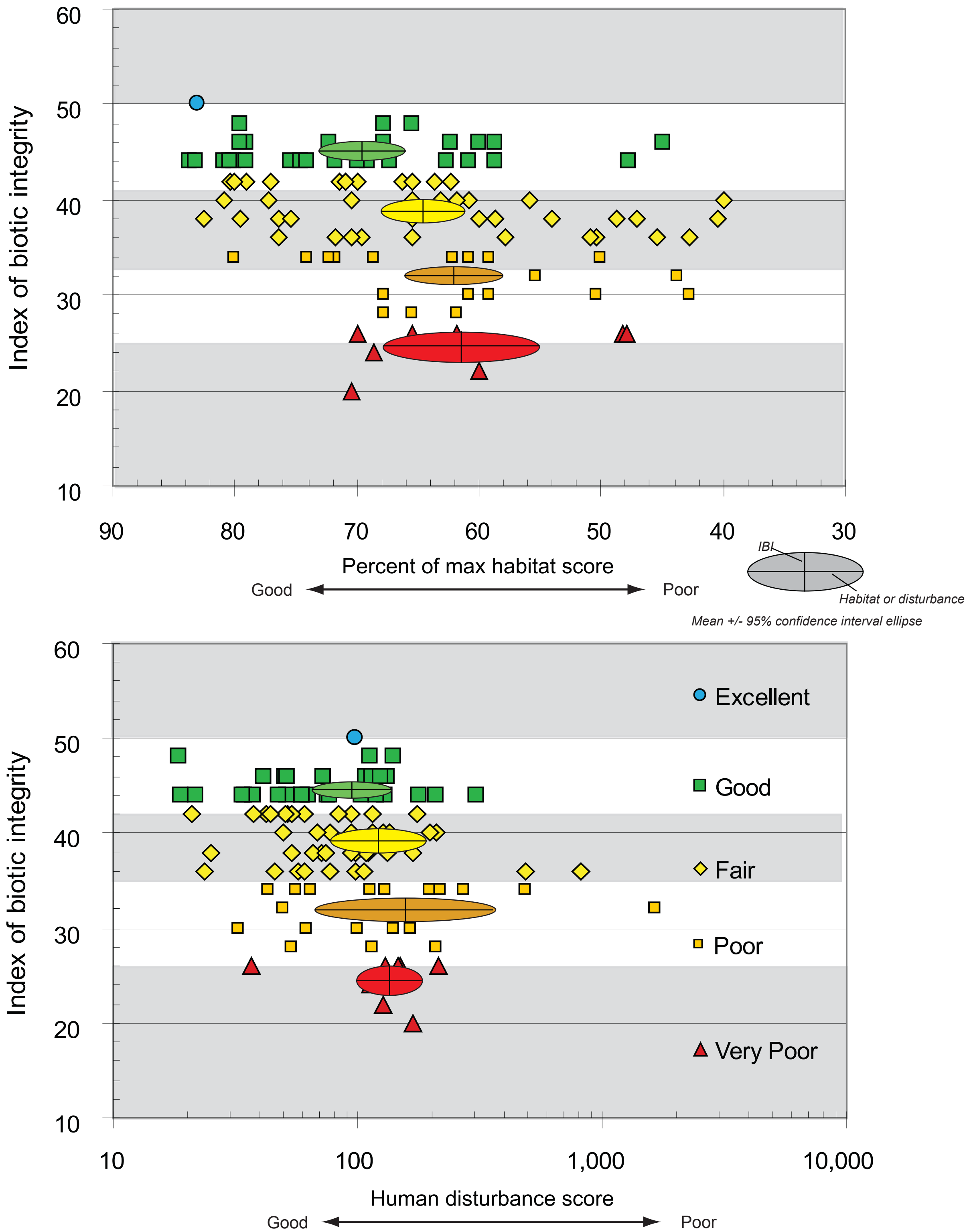


Figure 21. Tiered aquatic life use relationships between the IBI, habitat quality, and human disturbance for sites in the Hills and Coastal Terraces ichthyoregion.

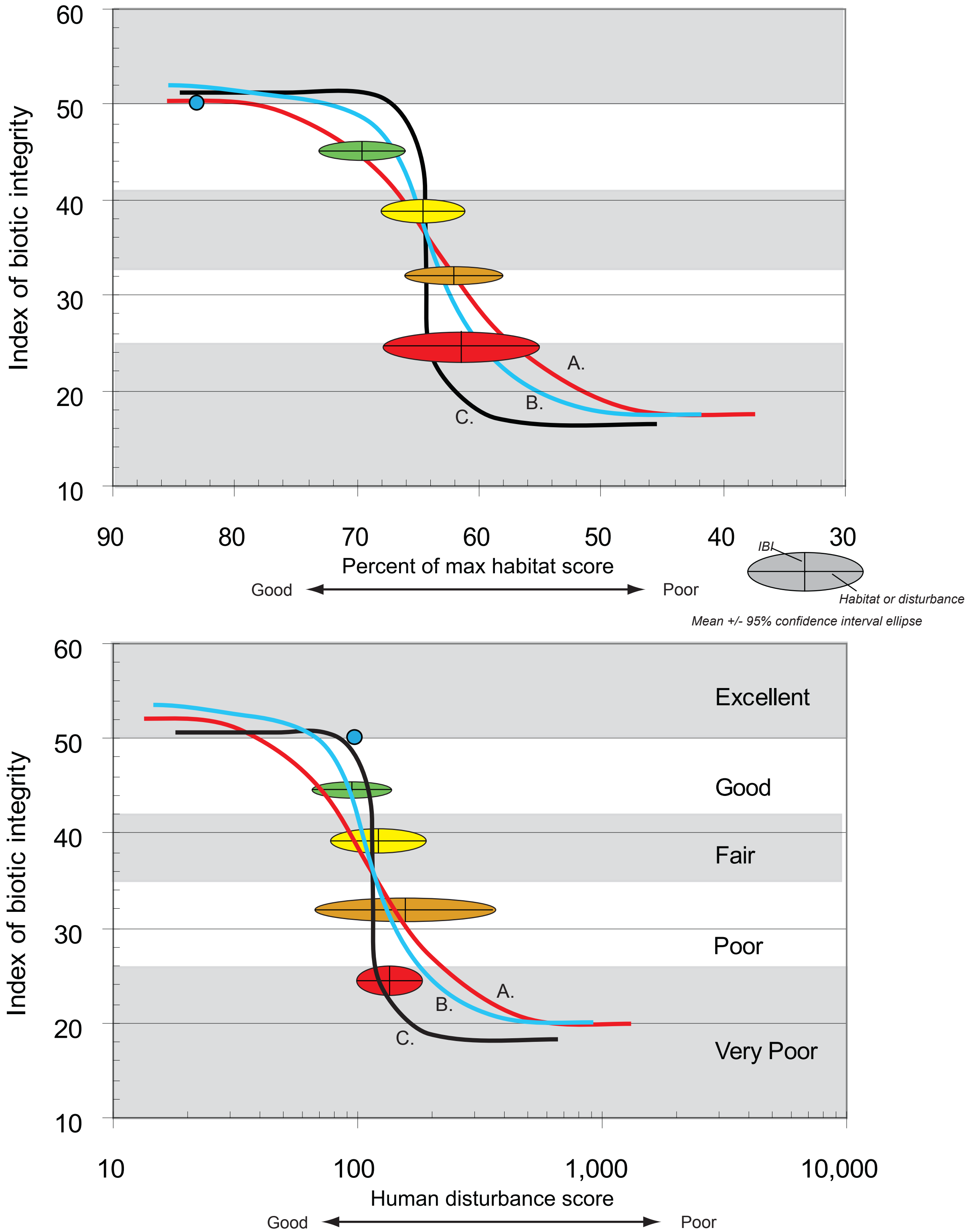


Figure 22. Biological condition gradient models for the Hills and Coastal Terraces ichthyoregion.

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. The habitat-IBI relationship appears to be best modeled by the intermediate curve “B” while the disturbance-IBI relationship is best modeled by curve “C”. These results were similar to those described for the Southern Plains, Tennessee Valley, Ridge and Valley/Piedmont, and Plateau ichthyoregions (O’Neil and Shepard 2009, 2010, 2011a, 2011b). If curve B is used to describe the relationship between biological condition and habitat, then it can be estimated that when habitat scores drop below 65 percent of the maximum attainable then biological condition will decline to poor scores.

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 Hills and Coastal Terraces ichthyoregion as well although the relationship of the IBI to watershed disturbance was less well defined in this ichthyoregion. The degree of habitat quality was a good predictor of biological condition as measured with the IBI. The Hills and Coastal Terraces ichthyoregion supports a comparable diversity to other ichthyoregions, or in some streams a higher diversity, due to both natural zoogeographic considerations and the relatively low impacts of land use in the region. Around 30 percent of the sites scored in the good to excellent IBI range (only one site scored excellent), indicating highly functional watersheds. About 42 percent of the sites scored in the fair range, indicating watersheds that support a functional fish assemblage yet have nonpoint source pollution problems that are likely linked to excessive sediment or nutrient runoff. Streams in this ichthyoregion have been exposed to forestry and wood products activities for years which overall has less impact compared to streams draining urban areas and active agriculture. Around 28 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.

This report completes the series of basic IBI investigations in Alabama's five ichthyoregions. The metrics and scoring criteria proposed in these studies form the basis of using Alabama's freshwater fish assemblages in wadeable streams to evaluate water quality from a more holistic perspective thereby assisting agencies in managing water quality more efficiently and effectively. The IBI will also be helpful in assessing stream biological condition for watershed investigations, understanding aquatic resources more broadly and in greater depth, better managing aquatic habitat, and communicating to the public more clearly the need for and benefits of strong water resources protection and management. The ADEM has recently revised its process for assessment of surface waters in Alabama relative to their designated uses and the procedures that it will use for listing and reporting waters under sections 305(b) and 303(d) of the Clean Water Act. The process that is used to categorize Alabama's waters and determine if they support their designated uses begins with the collection and evaluation of water-quality data, including biological assessments. By incorporating the results of IBI studies into this process ADEM will be able to better define and develop more precise, scientifically defensible, aquatic life uses that account for the natural differences among waterbodies and should result in more appropriate and practical levels of protection for specific waterbodies.

The amount of information and data generated through eight years of IBI studies is substantial. Some of the highlights to date of the Statewide Cooperative IBI Program include:

- ❏ Development of a standardized wadeable stream sampling protocol.
- ❏ Collection of 518 fish assemblage samples throughout the state in all ecoregions using this standard protocol.
- ❏ Completion of EPA rapid habitat assessments and calculation of ADEM's human disturbance gradient metrics for 518 sites.
- ❏ Development of a preliminary ichthyoregion map depicting the natural variability of fish assemblages in relation to the standard EPA ecoregions.
- ❏ Development, selection, and calibration of IBI metrics for five ichthyoregions: Southern Plains, Ridge and Valley/Piedmont, Tennessee Valley, Plateau, and Hills and Coastal Terraces.

Now that a statewide dataset, collected using a standard sampling protocol, has been assembled, further IBI investigations and applications need to be initiated. The goals of this next investigative phase are:

- ❏ Reevaluate the preliminary ichthyoregion map based on sampling results acquired over the last five years and refine the ichthyoregion boundaries as originally established.
- ❏ Refine the IBI tool by evaluating metrics and scoring criteria on a statewide basis within the context of a new ichthyoregion delineation.
- ❏ Finalize the ACCESS data logging system for acquiring data realtime while sampling.
- ❏ Retool the original IBI scoring procedure (0 to 60 scale) to a 0 to 100 scale. The original IBI scale worked well in developing the tool for the state, but it should be reworked to be more compatible with other IBI formulations.

- ❑ Develop an IBI assessment map depicting the biological condition of wadeable streams statewide. This should be in a printed poster format and as a GIS layer for use in water-quality and watershed management.
- ❑ Designate IBI reference sites and stream reaches in each ichthyoregion and subsets of ichthyoregions.
- ❑ Extend IBI theory and practice to instream flow investigations of tributary systems by linking stream sites and reaches with good to excellent biological condition to flow hydrograph statistics and components for each site and by creating new IBI metrics that can have a flow basis.

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Appendix A

Habitat evaluation forms

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 $\leq$ 2 inches average stubble height.
Score (LB) ______	10 9 8	7 6	5 4 3	2 1 0
Score (RB) ______	10 9 8	7 6	5 4 3	2 1 0
11 **Riparian vegetative zone Width (each bank)**	Width of riparian zone >60 feet; human activities (i.e., parking lots, roadbeds, clearcuts, lawns, or crops) have not impacted zone.	Width of riparian zone 60 - 40 feet; human activities have impacted zone only minimally.	Width of riparian zone 40 - 20 feet; human activities have impacted zone a great deal.	Width of riparian zone <20 feet; little or no riparian vegetation due to human activities.
Score (LB) ______	10 9 8	7 6	5 4 3	2 1 0
Score (RB) ______	10 9 8	7 6	5 4 3	2 1 0

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

Name of Waterbody ______________________________ Date: ______________

Station Number ______________ Investigators ______________________________

Habitat Parameter	Category: Optimal	Category: Suboptimal	Category: Marginal	Category: 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

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. petersoni - Coastal Shiner	P5	CS	S	R	O	1	INS,DAH	--
N. photogenis - Silver Shiner	P3	CS	S	R	U	1	INS,AHI	INT

FAMILY NAME **Scientific name - common name**	**Cons. status**	**Vulner.**	**Habitat**	**Dist.**	**Abund.**	**Reprod. guild**	**Feeding guild**	**Tolerance**
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	--

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
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	--

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
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								
Speoplatyrhinus 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	--

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
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	--

FAMILY NAME **Scientific name - common name**	**Cons. status**	**Vulner.**	**Habitat**	**Dist.**	**Abund.**	**Reprod. guild**	**Feeding guild**	**Tolerance**
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

FAMILY NAME Scientific name - common name	Cons. status	Vulner.	Habitat	Dist.	Abund.	Reprod. guild	Feeding guild	Tolerance
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

Hills and Coastal Terraces ichthyoregion fish community sampling data

GSA No.	1306	1307	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410
Sample date	7-Jul-09	8-Jul-09	8-Jun-11	8-Jun-11	9-Jun-11	9-Jun-11	14-Jun-11	14-Jun-11	14-Jun-11	15-Jun-11	15-Jun-11	15-Jun-11	16-Jun-11
Petromyzontidae - lampreys													
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars													
Lepisosteus oculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteus osseus	--	--	1	--	2	--	--	--	--	1	--	--	--
Amiidae - bowfins													
Amia calva	--	--	--	--	--	--	--	--	--	--	--	--	--
Anguillidae - freshwater eels													
Anguilla rostrata	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae - shads													
Dorosoma cepedianum	--	--	--	--	10	2	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows													
Campostoma oligolepis	90	1	13	--	2	37	4	--	--	--	260	114	85
Cyprinella callistia	--	--	48	--	--	--	--	--	--	--	--	--	--
Cyprinella gibbsi	5	3	--	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	--	--	--	12	--	--	--	--	--	--	--	--	--
Cyprinella venusta	37	42	139	--	180	4	6	1	67	53	26	247	31
Hybopsis winchelli	--	--	--	--	--	--	--	--	--	--	--	--	--
Luxilus chrysocephalus	--	--	1	22	--	--	2	--	--	--	7	11	10
Lythrurus bellus	6	39	2	10	27	14	--	--	20	3	4	8	22
Macrhybopsis storeriana	--	--	1	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	--	--	2	13	--	--	--	--	--	--	--	--	28
Notemigonus crysoleucas	--	--	--	--	--	--	--	7	--	--	--	--	--
Notropis ammophilus	--	--	49	14	--	--	--	--	10	--	--	133	2
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis baileyi	--	--	37	149	--	--	8	--	--	--	--	1	17
Notropis amplamala	--	20	1	--	--	--	--	--	--	--	--	24	--
Notropis candidus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	--	4	--	3	--	--	--	--	--	--	1	--
Notropis texanus	--	6	--	12	--	--	--	2	--	--	--	--	7

GSA No.	1306	1307	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410
Sample date	7-Jul-09	8-Jul-09	8-Jun-11	8-Jun-11	9-Jun-11	9-Jun-11	14-Jun-11	14-Jun-11	14-Jun-11	15-Jun-11	15-Jun-11	15-Jun-11	16-Jun-11
Cyprinidae - Continued													
Notropis volucellus	--	--	--	--	1	--	--	--	5	--	--	8	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenacobius catostomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	19	--	--	26	13	--	9	60	16	4	13	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	--	--	16	--	6	--	--	--	4	7	--	22	--
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	--	--	--	--	--	29	--	--	--	--	4	1	--
Semotilus thoreauianus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomidae - suckers													
Carpiodes cyprinus	--	--	10	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	16	--	--	--	--	--	--	--	--	3	--
Erimyzon oblongus	--	--	--	2	--	1	--	--	--	--	6	--	--
Erimyzon sucetta	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	7	--	16	18	--	--	--	--	--	--	--	--	4
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	1	1	--	--	--	--	3	--	--
Moxostoma duquesnei	--	--	7	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	--	--	--	--	--	--	--	1	1	--
Moxostoma poecilurum	--	1	4	20	2	3	1	--	--	2	1	3	5
Ictaluridae - North American catfishes													
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	--	--	--	2	--	--	--	1	1	--	11	1	2
Ictalurus punctatus	3	4	3	--	--	4	--	--	--	--	--	--	1
Noturus funebris	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus gyrinus	--	--	--	--	--	--	--	--	1	--	--	--	--
Noturus leptacanthus	23	3	1	2	--	--	6	1	--	--	--	--	4
Noturus munitus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes													
Esox americanus	--	--	--	3	--	--	--	--	--	--	--	--	--
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perch													
Aphredoderus sayanus	--	1	1	2	--	--	--	1	--	--	--	--	1

GSA No.	1306	1307	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410
Sample date	7-Jul-09	8-Jul-09	8-Jun-11	8-Jun-11	9-Jun-11	9-Jun-11	14-Jun-11	14-Jun-11	14-Jun-11	15-Jun-11	15-Jun-11	15-Jun-11	16-Jun-11
Atherinopsidae - New World silversides													
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	44	--	--	--
Menidia audens	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows													
Fundulus notatus	--	--	--	--	2	2	--	--	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus olivaceus	2	16	2	10	--	--	3	11	19	14	48	5	18
Fundulus stellifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Poeciliidae - livebearers													
Gambusia affinis	--	13	2	--	2	33	--	52	22	10	30	9	2
Cottidae - sculpins													
Cottus carolinae	56	--	--	7	--	--	2	--	--	--	--	--	--
Centrarchidae - sunfishes													
Ambloplites ariommus	1	--	--	1	--	--	1	--	1	--	--	--	--
Centrarchus macropterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	4	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis cyanellus	--	--	--	1	7	45	1	11	1	1	34	--	3
Lepomis gulosus	--	--	--	--	2	1	--	7	4	4	--	--	1
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	5	14	5	9	31	70	4	17	29	31	86	14	13
Lepomis megalotis	18	42	7	19	132	99	15	40	184	135	239	104	84
Lepomis microlophus	--	1	--	--	2	1	--	--	--	--	2	1	--
Lepomis miniatus	1	--	--	5	3	9	--	22	22	17	4	3	4
Micropterus coosae	2	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	9	8	2	5	3	8	1	--	14	14	--	7	16
Micropterus salmoides	1	12	1	--	1	4	--	2	1	6	53	--	--
Pomoxis annularis	--	--	--	--	--	3	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	1	--	--	--	--	--
hybrid centrarchid	--	--	--	1	--	--	--	--	--	--	1	--	--

GSA No.	1306	1307	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410
Sample date	7-Jul-09	8-Jul-09	8-Jun-11	8-Jun-11	9-Jun-11	9-Jun-11	14-Jun-11	14-Jun-11	14-Jun-11	15-Jun-11	15-Jun-11	15-Jun-11	16-Jun-11
Percidae - perches and darters													
Ammocrypta beanii	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammocrypta meridiana	--	--	--	--	--	--	--	--	--	--	--	--	--
Crystallaria asprella	--	--	--	--	--	--	2	--	--	--	--	--	--
Etheostoma artesiae	--	--	--	--	--	12	--	3	--	--	3	4	9
Etheostoma chlorosomum	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma histrio	--	--	--	--	--	--	2	--	--	--	--	--	--
Etheostoma jordani	--	22	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma nigrum	--	--	--	--	1	2	--	--	3	5	3	1	--
Etheostoma parvipinne	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma proeliare	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	--	--	--	5	--	--	--	--	--	--	--	14	25
Etheostoma rupestre	4	9	4	--	--	--	--	--	--	--	--	--	--
Etheostoma stigmaeum	12	5	--	--	14	1	1	5	4	6	2	5	3
Etheostoma swaini	--	--	1	3	--	--	--	1	4	--	--	--	--
Etheostoma zonifer	--	--	--	--	--	--	--	25	--	--	--	--	--
Percina kathae	--	--	--	--	--	--	2	--	--	3	--	--	5
Percina maculata	--	1	--	--	2	--	--	--	--	1	--	--	--
Percina nigrofasciata	29	51	23	18	1	--	18	4	22	--	--	5	8
Percina sciera	--	--	--	--	1	--	--	--	--	--	--	--	--
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina vigil	--	--	--	--	--	--	3	--	--	--	--	--	--
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	20	23	30	25	26	24	19	21	22	20	22	28	27
Individuals	315	333	419	365	464	398	82	223	498	373	832	763	410
Catch per effort	9.84	10.41	12.32	11.41	13.65	12.84	2.56	6.97	15.56	12.03	26	23.84	12.81
IBI score	36	38	46	44	30	28	34	22	28	26	34	40	40
Biological condition	Fair	Fair	Good	Good	Poor	Poor	Poor	Very Poor	Poor	Very Poor	Poor	Fair	Fair

GSA No.	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423
Sample date	16-Jun-11	16-Jun-11	20-Jun-11	20-Jun-11	20-Jun-11	21-Jun-11	21-Jun-11	22-Jun-11	22-Jun-11	22-Jun-11	23-Jun-11	23-Jun-11	23-Jun-11
Petromyzontidae - lampreys													
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars													
Lepisosteus oculatus	5	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteus osseus	--	--	1	--	--	--	--	--	--	--	--	--	1
Amiidae - bowfins													
Amia calva	--	--	--	--	--	--	--	--	--	--	--	--	--
Anguillidae - freshwater eels													
Anguilla rostrata	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae - shads													
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows													
Campostoma oligolepis	31	9	--	--	--	--	--	6	--	35	10	58	3
Cyprinella callistia	--	--	--	--	--	--	--	4	--	3	--	22	5
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	19	100	69	32	--	2	39	--	4	52	7	30	54
Hybopsis winchelli	--	--	--	3	--	--	--	--	--	--	--	--	1
Luxilus chrysocephalus	16	--	1	6	--	5	10	9	14	18	13	7	1
Lythrurus bellus	35	--	--	87	--	121	88	17	82	36	10	45	2
Macrhybopsis storeriana	3	54	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	--	4	--	2	--	--	6	6	9	19	--	--	1
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis ammophilus	4	36	1	138	--	116	18	8	78	21	15	6	41
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	--	34	--	--	--	--	--	--	--	--	--	--	--
Notropis baileyi	--	--	--	33	--	--	29	37	89	70	1	--	--
Notropis amplamala	--	--	--	--	--	17	--	5	--	3	16	1	3
Notropis candidus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis texanus	--	--	--	--	--	--	--	--	--	--	5	5	--

GSA No.	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423
Sample date	16-Jun-11	16-Jun-11	20-Jun-11	20-Jun-11	20-Jun-11	21-Jun-11	21-Jun-11	22-Jun-11	22-Jun-11	22-Jun-11	23-Jun-11	23-Jun-11	23-Jun-11
Cyprinidae - Continued													
Notropis volucellus	--	--	--	--	--	--	--	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	1	--	--	--	--	--	1	--
Phenacobius catostomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	20	1	12	16	--	26	9	--	25	--	1	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	11	5	--	--	--	--	--	--	10	--	1	--	17
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	5	19	--	2	--	48	--	--	1	4	11	1	--
Semotilus thoreauianus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomidae - suckers													
Carpiodes cyprinus	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	2	--	--	1	1	--
Erimyzon sucetta	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	--	--	--	--	--	--	--	--	4	16	1	1	3
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	1	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	2	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma poecilurum	15	1	1	--	--	1	1	1	1	3	1	2	2
Ictaluridae - North American catfishes													
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	--	1	--	--	6	5	1	--	1	--	1	7	--
Ictalurus punctatus	1	88	--	--	--	--	--	--	--	--	--	--	4
Noturus funebris	--	--	--	1	--	--	1	--	2	--	--	--	--
Noturus gyrinus	1	--	--	--	--	--	--	--	3	--	--	--	1
Noturus leptacanthus	4	1	--	--	--	--	5	2	7	4	--	5	6
Noturus munitus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes													
Esox americanus	--	--	--	--	--	--	--	--	--	--	--	--	--
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perch													
Aphredoderus sayanus	--	--	--	--	--	2	2	3	--	1	5	--	--

GSA No.	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423
Sample date	16-Jun-11	16-Jun-11	20-Jun-11	20-Jun-11	20-Jun-11	21-Jun-11	21-Jun-11	22-Jun-11	22-Jun-11	22-Jun-11	23-Jun-11	23-Jun-11	23-Jun-11
Atherinopsidae - New World silversides													
Labidesthes sicculus	--	--	1	--	--	--	--	--	--	--	--	4	--
Menidia audens	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows													
Fundulus notatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus olivaceus	8	4	1	13	4	19	6	32	10	18	18	7	3
Fundulus stellifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Poeciliidae - livebearers													
Gambusia affinis	6	5	14	--	4	17	--	--	--	--	4	--	--
Cottidae - sculpins													
Cottus carolinae	--	1	--	--	--	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes													
Ambloplites ariommus	--	--	--	1	--	--	--	--	--	--	--	--	1
Centrarchus macropterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis cyanellus	8	11	1	--	--	2	--	--	--	1	1	3	--
Lepomis gulosus	4	1	1	2	--	1	--	2	1	2	2	--	1
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	27	46	17	1	--	9	2	--	--	3	11	3	9
Lepomis megalotis	152	25	40	41	--	20	19	17	21	12	34	26	27
Lepomis microlophus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis miniatus	12	2	1	1	--	2	--	1	4	--	5	2	--
Micropterus coosae	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	6	2	--	--	--	--	5	4	--	1	--	7	3
Micropterus salmoides	1	2	1	1	--	--	--	3	1	--	--	1	--
Pomoxis annularis	--	--	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--	--	--	--

GSA No.	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423
Sample date	16-Jun-11	16-Jun-11	20-Jun-11	20-Jun-11	20-Jun-11	21-Jun-11	21-Jun-11	22-Jun-11	22-Jun-11	22-Jun-11	23-Jun-11	23-Jun-11	23-Jun-11
Percidae - perches and darters													
Ammocrypta beanii	--	--	--	--	--	--	--	--	--	--	--	--	8
Ammocrypta meridiana	--	--	--	--	--	--	6	--	1	--	--	--	--
Crystallaria asprella	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma artesiae	8	--	--	--	--	6	1	--	--	36	1	1	--
Etheostoma chlorosomum	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma histrio	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma jordani	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	23	--	--	38	11	71	47	--	24	2
Etheostoma nigrum	--	--	1	1	--	10	3	--	3	--	--	--	--
Etheostoma parvipinne	--	--	--	--	--	2	--	--	1	--	1	--	--
Etheostoma proeliare	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	9	1	--	--	--	10	--	--	--	--	--	--	--
Etheostoma rupestre	5	--	--	1	--	--	3	--	--	3	--	4	13
Etheostoma stigmaeum	14	--	5	2	--	9	7	2	--	5	1	--	5
Etheostoma swaini	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma zonifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	1	--	--	--	--	--	--	--	--	--	--	5	--
Percina maculata	4	--	1	--	--	1	1	--	--	--	--	--	--
Percina nigrofasciata	1	10	1	22	--	2	17	7	28	8	8	5	16
Percina sciera	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina vigil	--	--	--	--	--	--	--	--	--	--	--	--	2
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	1	--	--	--	--	--	--	--	--	--	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	32	25	19	22	3	26	24	21	25	25	27	28	28
Individuals	439	463	170	429	14	455	317	179	471	421	185	284	235
Catch per effort	13.72	14.94	5.31	13.41	1.27	14.22	9.61	5.42	14.72	13.16	5.78	8.88	7.34
IBI score	34	30	26	42	28	42	44	42	44	42	38	44	44
Biological condition	Poor	Poor	Very Poor	Fair	Poor	Fair	Good	Fair	Good	Fair	Fair	Good	Good

GSA No.	1424	1425	1426	1427	1428	1432	1433	1434	1435	1436	1437	1438	1439
Sample date	24-Jun-11	24-Jun-11	28-Jun-11	28-Jun-11	28-Jun-11	30-Jun-11	30-Jun-11	9-Jun-11	17-May-11	18-May-11	24-May-11	24-May-11	17-May-11
Petromyzontidae - lampreys													
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	2	--	--
Lepisosteidae - gars													
Lepisosteus oculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteus osseus	--	--	--	--	--	--	--	--	--	--	--	1	--
Amiidae - bowfins													
Amia calva	--	--	--	--	--	--	--	--	--	--	--	--	--
Anguillidae - freshwater eels													
Anguilla rostrata	--	--	--	1	1	--	--	--	--	--	--	--	--
Clupeidae - shads													
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows													
Campostoma oligolepis	19	--	84	137	229	13	--	2	--	5	14	3	--
Cyprinella callistia	--	--	--	--	--	--	--	6	--	--	--	11	--
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	42	13	78	70	1	260	2	33	107	164	3	38	--
Hybopsis winchelli	--	--	--	--	--	--	--	21	--	4	3	1	--
Luxilus chrysocephalus	18	9	43	23	51	5	1	--	15	3	24	49	21
Lythrurus bellus	21	59	20	61	9	142	65	10	18	--	12	20	38
Macrhybopsis storeriana	--	--	--	5	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	8	2	8	18	44	2	1	--	--	14	--	--	2
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	9
Notropis ammophilus	68	42	37	2	8	186	2	--	17	64	--	1	--
Notropis asperifrons	--	--	37	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	--	--	--	1	--	--	--	--	--	--	--	--	--
Notropis baileyi	59	2	--	42	290	17	--	--	179	143	23	--	3
Notropis amplamala	--	14	--	1	5	15	--	--	5	12	--	--	--
Notropis candidus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	14	--	--	--	--	--	--	--	--
Notropis stilbius	--	--	--	--	--	--	--	64	--	--	--	8	--
Notropis texanus	--	--	--	3	--	--	--	--	2	--	6	--	25

GSA No.	1424	1425	1426	1427	1428	1432	1433	1434	1435	1436	1437	1438	1439
Sample date	24-Jun-11	24-Jun-11	28-Jun-11	28-Jun-11	28-Jun-11	30-Jun-11	30-Jun-11	9-Jun-11	17-May-11	18-May-11	24-May-11	24-May-11	17-May-11
Cyprinidae - Continued													
Notropis volucellus	--	--	--	--	--	--	--	7	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenacobius catostomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	100	35	20	2	--	92	7	--	--	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	2	--	--	--	--	--	--
Pimephales vigilax	--	--	2	--	--	1	--	11	86	40	--	--	--
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	4	5	9	--	5	6	20	--	1	5	14	3	--
Semotilus thoreauianus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomidae - suckers													
Carpiodes cyprinus	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	3	--	--	--	1	--	7	--	1	--	--	--	7
Erimyzon sucetta	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	1	--	1	59	62	--	--	4	--	--	2	3	--
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	4	--	--	--	--	--	--	--	--	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	5	1	1	--	--	--	--	--	--	--	--
Moxostoma poecilurum	6	5	8	5	--	1	1	1	--	--	1	--	--
Ictaluridae - North American catfishes													
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	2	3	4	--	1	2	--	1	--	--	2	--	--
Ictalurus punctatus	--	--	--	1	--	--	--	--	--	4	--	--	--
Noturus funebris	--	--	--	--	--	--	--	--	--	--	2	--	--
Noturus gyrinus	--	--	--	--	--	--	--	--	--	--	--	--	--
Noturus leptacanthus	3	1	2	20	4	2	--	3	1	2	17	--	--
Noturus munitus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes													
Esox americanus	--	--	--	--	--	--	--	1	--	--	--	--	10
Esox niger	--	--	--	--	--	--	--	--	--	--	1	3	--
Aphredoderidae - pirate perch													
Aphredoderus sayanus	--	--	--	--	1	--	--	--	--	--	2	--	--

GSA No.	1424	1425	1426	1427	1428	1432	1433	1434	1435	1436	1437	1438	1439
Sample date	24-Jun-11	24-Jun-11	28-Jun-11	28-Jun-11	28-Jun-11	30-Jun-11	30-Jun-11	9-Jun-11	17-May-11	18-May-11	24-May-11	24-May-11	17-May-11
Atherinopsidae - New World silversides													
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--
Menidia audens	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows													
Fundulus notatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus olivaceus	13	18	6	8	1	4	6	1	1	2	16	8	15
Fundulus stellifer	--	--	1	--	--	6	--	--	--	--	--	--	--
Poeciliidae - livebearers													
Gambusia affinis	5	3	4	--	4	4	5	--	--	1	--	--	--
Cottidae - sculpins													
Cottus carolinae	--	--	--	11	3	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes													
Ambloplites ariommus	--	--	1	5	--	--	--	1	--	1	--	--	--
Centrarchus macropterus	--	--	--	--	--	--	--	--	--	--	--	--	4
Lepomis auritus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis cyanellus	1	--	--	--	1	--	--	--	3	6	3	--	3
Lepomis gulosus	1	--	3	--	--	--	--	--	1	--	--	--	3
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	6	1	38	--	4	3	5	2	1	8	--	6	10
Lepomis megalotis	77	92	163	10	6	59	27	17	--	6	7	2	12
Lepomis microlophus	--	--	--	1	--	--	--	--	--	--	--	--	--
Lepomis miniatus	8	4	6	1	--	--	--	--	--	--	--	--	--
Micropterus coosae	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	6	6	20	9	5	--	3	1	--	--	--	--	--
Micropterus salmoides	4	--	2	1	--	--	--	--	--	--	--	--	1
Pomoxis annularis	--	--	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--	--	--	--

GSA No.	1424	1425	1426	1427	1428	1432	1433	1434	1435	1436	1437	1438	1439
Sample date	24-Jun-11	24-Jun-11	28-Jun-11	28-Jun-11	28-Jun-11	30-Jun-11	30-Jun-11	9-Jun-11	17-May-11	18-May-11	24-May-11	24-May-11	17-May-11
Percidae - perches and darters													
Ammocrypta beanii	--	--	--	1	--	--	--	--	3	4	--	--	--
Ammocrypta meridiana	--	--	--	--	--	--	--	11	--	--	--	--	--
Crystallaria asprella	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma artesiae	--	--	--	1	2	3	13	1	--	--	--	--	--
Etheostoma chlorosomum	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma histrio	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma jordani	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	27	24	--	--	--	--	--	1	--	--	21	1	--
Etheostoma nigrum	--	28	--	1	--	--	2	--	--	--	--	--	--
Etheostoma parvipinne	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma proeliare	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	--	--	7	--	--	5	2	--	--	3	--	--	--
Etheostoma rupestre	7	4	--	91	--	--	--	6	--	--	21	2	--
Etheostoma stigmaeum	1	6	6	3	--	1	--	13	--	--	39	38	--
Etheostoma swaini	1	--	--	--	--	--	--	--	--	--	14	--	--
Etheostoma zonifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	--	--	--	--	--	--	--	2	--	--	--	--	--
Percina maculata	--	--	--	--	--	--	1	3	--	--	--	--	--
Percina nigrofasciata	8	25	8	42	33	5	--	7	--	11	18	11	--
Percina sciera	--	--	--	--	--	--	--	--	--	--	--	2	--
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina vigil	--	--	--	4	--	--	--	5	--	--	--	--	--
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	--	--	--	--	--	--	--	1	--	--	--	--	--
Species	28	24	28	33	26	23	19	28	16	21	24	20	15
Individuals	519	405	623	641	786	834	172	236	441	502	267	211	163
Catch per effort	16.22	12.66	19.47	20.03	24.56	26.06	7.17	7.38	13.78	15.69	8.34	6.81	7.09
IBI score	38	44	38	50	44	44	40	48	34	38	40	40	32
Biological condition	Fair	Good	Fair	Excellent	Good	Good	Fair	Good	Poor	Fair	Fair	Fair	Poor

GSA No.	1440	1441	1442	1443	1444	1445	1446	1447	1448	1451	1452	1453	1473
Sample date	25-May-11	10-Jun-11	25-May-11	18-May-11	9-Jun-11	6-Jul-11	6-Jul-11	8-Jul-11	8-Jul-11	29-Jul-11	29-Jul-11	29-Jul-11	4-Aug-11
Petromyzontidae - lampreys													
Ichthyomyzon gagei	--	--	--	--	--	--	--	3	4	1	--	2	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars													
Lepisosteus oculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteus osseus	--	--	--	--	--	--	--	--	--	--	--	--	--
Amiidae - bowfins													
Amia calva	--	--	--	--	--	--	--	--	--	--	--	--	--
Anguillidae - freshwater eels													
Anguilla rostrata	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae - shads													
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows													
Campostoma oligolepis	--	4	13	22	3	4	--	--	--	--	2	45	--
Cyprinella callistia	--	1	52	--	9	9	--	--	--	--	--	--	--
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	36	15	1	36	11	39	142	--	101	2	108	52	--
Hybopsis winchelli	1	--	--	1	--	--	9	--	--	2	--	1	--
Luxilus chrysocephalus	21	5	12	26	4	1	1	37	14	9	2	44	--
Lythrurus bellus	72	9	8	--	58	--	5	62	33	12	22	23	--
Macrhybopsis storeriana	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	5	--	--	34	--	--	9	10	8	7	1	5	--
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis ammophilus	4	--	--	71	3	3	13	95	59	15	27	69	--
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis baileyi	55	3	1	397	--	--	3	146	75	149	99	153	--
Notropis amplamala	--	--	--	3	--	--	--	--	5	--	--	--	--
Notropis candidus	--	--	--	--	21	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	3	11	--	--	10	3	--	--	--	--	--	--
Notropis texanus	8	35	--	--	--	1	--	--	--	--	88	4	1

GSA No.	1440	1441	1442	1443	1444	1445	1446	1447	1448	1451	1452	1453	1473
Sample date	25-May-11	10-Jun-11	25-May-11	18-May-11	9-Jun-11	6-Jul-11	6-Jul-11	8-Jul-11	8-Jul-11	29-Jul-11	29-Jul-11	29-Jul-11	4-Aug-11
Cyprinidae - Continued													
Notropis volucellus	--	--	--	--	--	--	1	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenacobius catostomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	--	--	--	--	--	9	--	10	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	1	3	--	--	--	24	120	--	29	--	--	--	--
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--	--	--	2
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--	--	--	31
Semotilus atromaculatus	--	--	--	7	--	--	2	20	--	--	--	--	--
Semotilus thoreauianus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--	1	--	--
Catostomidae - suckers													
Carpiodes cyprinus	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	--	--	--	3	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	28	--	--	--	--	--
Erimyzon sucetta	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--	--	--	3
Hypentelium etowanum	1	16	3	1	1	--	8	--	--	5	--	--	--
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	--	3	--	1	--	--	--	--
Moxostoma duquesnei	--	--	--	--	1	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	--	--	--	--	--	--	2	--	--	--
Moxostoma poecilurum	1	1	--	--	--	2	3	--	1	2	--	--	--
Ictaluridae - North American catfishes													
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	1	1	2	--	1	--	--	--	4	--	31	22	--
Ictalurus punctatus	--	--	--	1	1	1	1	--	--	1	--	3	--
Noturus funebris	--	--	2	--	--	--	--	3	3	--	--	3	--
Noturus gyrinus	--	--	--	--	1	--	--	--	--	1	--	--	--
Noturus leptacanthus	4	--	16	4	4	2	20	1	8	3	--	--	1
Noturus munitus	--	--	--	--	--	10	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	1	1	--	--	--	--	--	--
Esocidae - pikes													
Esox americanus	--	--	--	--	--	--	--	--	1	--	--	--	1
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perch													
Aphredoderus sayanus	1	--	--	--	--	--	--	9	--	--	--	1	--

GSA No.	1440	1441	1442	1443	1444	1445	1446	1447	1448	1451	1452	1453	1473
Sample date	25-May-11	10-Jun-11	25-May-11	18-May-11	9-Jun-11	6-Jul-11	6-Jul-11	8-Jul-11	8-Jul-11	29-Jul-11	29-Jul-11	29-Jul-11	4-Aug-11
Atherinopsidae - New World silversides													
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	19
Menidia audens	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows													
Fundulus notatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--	--	--	5
Fundulus olivaceus	6	11	--	--	7	2	6	7	5	3	38	19	7
Fundulus stellifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Poeciliidae - livebearers													
Gambusia affinis	--	1	--	--	--	--	--	2	--	--	28	7	3
Cottidae - sculpins													
Cottus carolinae	--	--	--	--	--	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes													
Ambloplites ariommus	--	--	3	--	--	--	1	--	1	--	--	--	--
Centrarchus macropterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	--	--	--	--	--	--	--	--	--	--	--	2	--
Lepomis cyanellus	--	--	5	5	6	--	1	2	--	--	--	10	--
Lepomis gulosus	--	--	--	--	--	1	--	--	--	--	1	7	--
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	2	3	--	1	4	1	2	7	1	--	13	24	5
Lepomis megalotis	4	31	9	6	12	5	45	22	22	1	70	98	4
Lepomis microlophus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis miniatus	--	--	--	--	--	--	1	--	1	--	7	10	--
Micropterus coosae	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	1	1	1	--	5	5	4	1	4	2	--	--	--
Micropterus salmoides	--	--	--	--	--	1	1	4	1	3	3	10	--
Pomoxis annularis	--	--	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	1	--	--	--	--	--	--	--

GSA No.	1440	1441	1442	1443	1444	1445	1446	1447	1448	1451	1452	1453	1473
Sample date	25-May-11	10-Jun-11	25-May-11	18-May-11	9-Jun-11	6-Jul-11	6-Jul-11	8-Jul-11	8-Jul-11	29-Jul-11	29-Jul-11	29-Jul-11	4-Aug-11
Percidae - perches and darters													
Ammocrypta beanii	--	--	--	--	--	16	14	--	24	--	--	--	--
Ammocrypta meridiana	--	--	--	--	--	--	7	--	3	--	--	--	--
Crystallaria asprella	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma artesiae	--	--	--	1	5	--	--	--	--	--	--	--	--
Etheostoma chlorosomum	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma histrio	--	--	--	--	--	3	4	--	--	--	--	--	--
Etheostoma jordani	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	13	--	--	--	1	20	37	5	--	7	1
Etheostoma nigrum	1	--	--	--	--	--	1	19	25	--	--	--	--
Etheostoma parvipinne	--	--	--	1	--	--	--	3	1	--	--	--	--
Etheostoma proeliare	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	--	--	--	2	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	22	--	21	20	43	1	11	--	--	--	--
Etheostoma stigmaeum	5	10	5	--	4	3	3	3	5	--	--	--	--
Etheostoma swaini	--	3	--	--	--	3	--	--	5	1	--	4	--
Etheostoma zonifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	--	--	--	--	2	--	--	--	--	--	--	--	--
Percina maculata	--	--	--	--	--	2	--	--	--	--	--	--	--
Percina nigrofasciata	14	4	19	5	16	11	12	31	40	5	25	27	43
Percina sciera	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina vigil	--	4	--	--	--	17	78	--	--	--	--	--	--
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	--	--	--	--	--	--	1	--	--	--	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	21	21	19	19	23	28	36	24	32	21	17	26	14
Individuals	244	164	198	624	200	201	578	536	542	231	566	652	126
Catch per effort	7.63	5.13	6.19	19.5	6.06	5.29	17	16.24	16.94	7.22	17.69	20.38	3.94
IBI score	46	38	44	46	42	40	42	44	42	48	32	36	34
Biological condition	Good	Fair	Good	Good	Fair	Fair	Fair	Good	Fair	Good	Poor	Fair	Poor

GSA No.	1577	1578	1579	1580	1581	1582	1583	1584	1585	1586	1587	1588	1589
Sample date	16-May-11	16-May-11	17-May-11	17-May-11	18-May-11	18-May-11	23-May-11	23-May-11	23-May-11	24-May-11	24-May-11	24-May-11	25-May-11
Petromyzontidae - lampreys													
Ichthyomyzon gagei	--	--	--	--	--	1	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars													
Lepisosteus oculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteus osseus	--	--	--	--	--	--	--	--	--	--	--	--	--
Amiidae - bowfins													
Amia calva	--	--	--	--	--	--	--	1	--	--	--	--	--
Anguillidae - freshwater eels													
Anguilla rostrata	--	--	--	--	--	--	--	--	1	--	--	--	--
Clupeidae - shads													
Dorosoma cepedianum	--	--	--	--	--	--	--	34	14	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	14	--	--	--	--	--
Cyprinidae - carps and minnows													
Campostoma oligolepis	4	18	--	--	--	--	13	--	--	--	--	27	--
Cyprinella callistia	5	48	--	--	--	--	--	--	--	--	--	--	--
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	26	34	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	--	1	20	190	--	--	7	44	44	80	13	82	--
Hybopsis winchelli	--	--	4	--	--	--	--	--	--	1	--	--	--
Luxilus chrysocephalus	4	1	3	--	5	1	--	--	--	3	26	15	41
Lythrurus bellus	--	1	--	216	26	10	27	1	34	105	43	17	76
Macrhybopsis storeriana	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	1	--	--	--	--	3	--	--	--	--	5	10	24
Notemigonus crysoleucas	--	--	--	--	--	--	--	5	--	--	--	--	--
Notropis ammophilus	--	--	7	1	--	49	--	--	52	68	16	9	9
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis baileyi	--	--	2	--	4	67	--	--	--	--	69	10	35
Notropis amplamala	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis candidus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	4	--	--	--	--	--	--	--	--	--	--	--
Notropis texanus	--	--	--	--	4	2	--	--	--	--	17	--	--

GSA No.	1577	1578	1579	1580	1581	1582	1583	1584	1585	1586	1587	1588	1589
Sample date	16-May-11	16-May-11	17-May-11	17-May-11	18-May-11	18-May-11	23-May-11	23-May-11	23-May-11	24-May-11	24-May-11	24-May-11	25-May-11
Cyprinidae - Continued													
Notropis volucellus	--	--	--	--	--	--	--	--	--	--	--	--	--
Opsopoeodus emiliae	--	--	--	--	2	--	--	--	--	--	--	--	--
Phenacobius catostomus	--	1	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	--	--	20	--	--	16	--	52	27	27	10	27
Pimephales promelas	--	--	--	19	--	--	--	--	--	--	--	--	2
Pimephales vigilax	--	--	30	212	--	--	64	3	3	--	1	--	--
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	2
Semotilus thoreauianus	--	--	--	--	--	--	8	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomidae - suckers													
Carpiodes cyprinus	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	--	--	--	1	--	4
Erimyzon sucetta	--	--	--	--	1	--	--	1	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	8	4	--	--	--	--	--	--	--	--	--	6	--
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	1	--	--	3	1	3	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	--	--	--	--	--	--	--	--	2	--
Moxostoma poecilurum	--	--	--	--	--	--	--	--	6	--	--	5	2
Ictaluridae - North American catfishes													
Ameiurus melas	--	--	--	--	--	--	--	1	--	--	--	--	--
Ameiurus natalis	--	--	1	--	--	--	--	--	--	1	--	1	1
Ictalurus punctatus	--	--	--	15	--	--	1	2	2	8	--	2	--
Noturus funebris	--	--	--	--	3	1	--	--	--	1	--	1	2
Noturus gyrinus	--	--	--	2	--	--	2	--	--	--	--	--	--
Noturus leptacanthus	2	10	15	--	--	8	--	--	--	3	--	10	--
Noturus munitus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	1	--
Esocidae - pikes													
Esox americanus	--	--	--	--	--	--	--	--	--	--	12	--	--
Esox niger	--	--	--	--	2	1	--	1	--	--	--	--	--
Aphredoderidae - pirate perch													
Aphredoderus sayanus	--	--	1	--	--	--	--	2	--	--	7	--	--

GSA No.	1577	1578	1579	1580	1581	1582	1583	1584	1585	1586	1587	1588	1589
Sample date	16-May-11	16-May-11	17-May-11	17-May-11	18-May-11	18-May-11	23-May-11	23-May-11	23-May-11	24-May-11	24-May-11	24-May-11	25-May-11
Atherinopsidae - New World silversides													
Labidesthes sicculus	--	--	--	--	--	--	--	--	2	--	--	--	--
Menidia audens	--	--	--	4	--	--	1	1	--	--	--	--	--
Fundulidae - topminnows													
Fundulus notatus	--	--	--	--	--	--	20	4	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus olivaceus	--	--	4	2	1	4	--	--	20	20	11	7	11
Fundulus stellifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Poeciliidae - livebearers													
Gambusia affinis	--	--	--	70	--	2	21	6	13	--	--	5	--
Cottidae - sculpins													
Cottus carolinae	--	54	--	--	--	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes													
Ambloplites ariommus	--	3	2	--	--	--	--	--	--	2	--	1	--
Centrarchus macropterus	--	--	--	--	--	--	--	9	--	--	--	--	--
Lepomis auritus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis cyanellus	2	--	--	25	--	1	10	4	1	--	6	--	4
Lepomis gulosus	1	--	--	--	1	--	1	7	4	1	2	3	--
Lepomis humilis	--	--	--	--	--	--	3	3	--	--	--	--	--
Lepomis macrochirus	12	9	4	42	--	4	61	67	4	6	13	6	1
Lepomis megalotis	34	23	10	255	1	10	53	32	59	11	35	33	4
Lepomis microlophus	--	--	--	--	--	--	1	8	1	--	--	--	--
Lepomis miniatus	--	--	1	18	1	--	9	3	2	--	9	--	3
Micropterus coosae	1	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	--	--	--	--	--	--	--	--	1	--	--	4	--
Micropterus salmoides	--	2	2	6	--	--	3	6	5	2	--	1	1
Pomoxis annularis	--	--	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	1	16	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--	--	--	--

GSA No.	1577	1578	1579	1580	1581	1582	1583	1584	1585	1586	1587	1588	1589
Sample date	16-May-11	16-May-11	17-May-11	17-May-11	18-May-11	18-May-11	23-May-11	23-May-11	23-May-11	24-May-11	24-May-11	24-May-11	25-May-11
Percidae - perches and darters													
Ammocrypta beanii	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammocrypta meridiana	--	--	6	--	--	--	--	--	--	--	--	--	--
Crystallaria asprella	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma artesiae	--	--	--	3	--	--	14	--	--	--	1	--	3
Etheostoma chlorosomum	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma histrio	--	--	6	--	--	--	--	--	--	--	--	--	--
Etheostoma jordani	--	33	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	12	--	--	--	--	1	13	10	--	6
Etheostoma nigrum	--	--	--	--	--	--	--	--	--	--	3	--	4
Etheostoma parvipinne	--	--	--	--	--	--	--	2	3	--	--	--	--
Etheostoma proeliare	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	8	5	--	--	9	4	--	--	--	--	--	--	--
Etheostoma rupestre	--	13	3	--	--	--	--	--	35	--	--	17	--
Etheostoma stigmaeum	20	7	3	44	3	1	--	--	5	2	--	2	2
Etheostoma swaini	--	--	3	--	--	--	--	--	--	--	2	--	--
Etheostoma zonifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	--	1	--	--	--	--	--	--	--	--	--	1	--
Percina maculata	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina nigrofasciata	22	31	27	--	11	12	--	--	8	19	6	8	--
Percina sciera	--	--	--	--	--	--	--	--	--	--	--	1	--
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina vigil	--	--	9	--	--	--	--	--	--	--	--	5	--
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	--	--	--	--	--	--	--	6	1	1	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	15	21	22	19	16	18	21	28	27	21	23	30	22
Individuals	150	303	163	1156	75	181	336	286	374	377	335	302	264
Catch per effort	4.69	9.47	5.09	36.13	2.42	5.66	10.5	8.94	11.69	11.78	10.47	9.15	8.25
IBI score	26	38	36	32	46	42	20	26	34	44	38	44	36
Biological condition	Very Poor	Fair	Fair	Poor	Good	Fair	Very Poor	Very Poor	Poor	Good	Fair	Good	Fair

GSA No.	1590	1591	1592	1593	1594	1595	1596	1597	1598	1599	1850	1853	1856
Sample date	25-May-11	31-May-11	31-May-11	1-Jun-11	1-Jun-11	2-Jun-11	2-Jun-11	7-Jun-11	7-Jun-11	7-Jun-11	29-Sep-10	16-Sep-10	27-Aug-10
Petromyzontidae - lampreys													
Ichthyomyzon gagei	--	--	--	--	--	--	--	--	--	--	--	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars													
Lepisosteus oculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteus osseus	--	--	--	--	--	--	--	--	--	--	--	--	--
Amiidae - bowfins													
Amia calva	--	--	--	--	--	--	--	--	--	--	--	--	--
Anguillidae - freshwater eels													
Anguilla rostrata	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae - shads													
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows													
Campostoma oligolepis	3	--	109	--	68	31	22	2	5	--	--	1	--
Cyprinella callistia	--	--	--	--	14	6	--	--	--	--	--	--	--
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	--	7	17	--	4	25	8	91	190	4	2	3	4
Hybopsis winchelli	--	--	2	--	--	--	--	6	24	--	--	--	--
Luxilus chrysocephalus	47	13	24	15	--	27	--	1	9	5	--	3	8
Lythrurus bellus	58	15	25	97	83	95	54	26	1	--	--	--	--
Macrhybopsis storeriana	--	--	--	--	--	--	--	15	--	--	--	--	--
Nocomis leptocephalus	13	13	19	1	--	4	--	1	17	7	--	2	8
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis ammophilus	--	14	5	--	--	2	1	14	51	29	--	--	4
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	--	--	--	--	--	--	--	3	--	--	--	--	--
Notropis baileyi	60	197	27	18	--	1	--	6	--	255	--	--	48
Notropis amplamala	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis candidus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	--	103	--	13	40	--	10	--	--	--	1	--
Notropis texanus	1	--	3	--	5	6	--	10	--	--	3	--	--

GSA No.	1590	1591	1592	1593	1594	1595	1596	1597	1598	1599	1850	1853	1856
Sample date	25-May-11	31-May-11	31-May-11	1-Jun-11	1-Jun-11	2-Jun-11	2-Jun-11	7-Jun-11	7-Jun-11	7-Jun-11	29-Sep-10	16-Sep-10	27-Aug-10
Cyprinidae - Continued													
Notropis volucellus	--	--	--	--	--	--	--	27	--	--	--	--	--
Opsopoeodus emiliae	6	--	--	--	--	--	--	--	--	--	--	--	--
Phenacobius catostomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	57	--	2	--	--	15	2	--	--	--	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	--	--	--	--	--	--	--	2	32	--	--	--	--
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	17	--	--	1	--	--	3	--	4	12	--	--	--
Semotilus thoreauianus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomidae - suckers													
Carpiodes cyprinus	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	10	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon sucetta	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	--	--	7	1	6	6	--	1	--	--	--	6	6
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	1	1	2	--	1	--	1	--	--	--
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	--	--	--	2	--	--	--	--	--	--	--
Moxostoma poecilurum	1	--	2	9	1	--	--	1	--	--	--	1	--
Ictaluridae - North American catfishes													
Ameiurus melas	--	--	--	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	1	--	2	--	1	3	3	--	3	--	--	--	--
Ictalurus punctatus	--	--	--	--	--	2	--	1	--	--	--	--	--
Noturus funebris	1	9	--	--	--	3	--	--	--	--	--	--	--
Noturus gyrinus	2	--	3	--	--	1	--	--	--	--	--	--	--
Noturus leptacanthus	--	18	44	--	13	1	--	11	--	7	--	16	--
Noturus munitus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes													
Esox americanus	--	1	1	--	--	--	--	--	3	--	--	1	1
Esox niger	--	--	--	--	--	--	--	--	--	--	--	--	--
Aphredoderidae - pirate perch													
Aphredoderus sayanus	1	1	3	--	1	2	2	--	--	--	--	3	--

GSA No.	1590	1591	1592	1593	1594	1595	1596	1597	1598	1599	1850	1853	1856
Sample date	25-May-11	31-May-11	31-May-11	1-Jun-11	1-Jun-11	2-Jun-11	2-Jun-11	7-Jun-11	7-Jun-11	7-Jun-11	29-Sep-10	16-Sep-10	27-Aug-10
Atherinopsidae - New World silversides													
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--
Menidia audens	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows													
Fundulus notatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus olivaceus	30	7	9	12	2	2	17	1	--	--	3	13	--
Fundulus stellifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Poeciliidae - livebearers													
Gambusia affinis	1	--	--	1	--	--	1	1	--	--	--	--	--
Cottidae - sculpins													
Cottus carolinae	--	--	--	--	--	--	--	--	--	--	--	5	5
Centrarchidae - sunfishes													
Ambloplites ariommus	--	1	6	--	1	--	--	1	--	--	--	1	--
Centrarchus macropterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis cyanellus	11	2	3	--	9	15	20	3	3	1	1	1	2
Lepomis gulosus	6	--	1	--	--	2	--	--	--	--	--	1	1
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	30	--	7	5	4	61	13	3	--	--	--	2	2
Lepomis megalotis	47	2	17	10	14	25	25	34	18	3	13	12	6
Lepomis microlophus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis miniatus	5	--	1	--	4	2	--	--	--	--	1	--	--
Micropterus coosae	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	--	--	4	--	1	1	--	2	--	--	--	3	1
Micropterus salmoides	--	--	6	1	--	--	1	--	--	--	--	1	1
Pomoxis annularis	--	--	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--	--	--	--

GSA No.	1590	1591	1592	1593	1594	1595	1596	1597	1598	1599	1850	1853	1856
Sample date	25-May-11	31-May-11	31-May-11	1-Jun-11	1-Jun-11	2-Jun-11	2-Jun-11	7-Jun-11	7-Jun-11	7-Jun-11	29-Sep-10	16-Sep-10	27-Aug-10
Percidae - perches and darters													
Ammocrypta beanii	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammocrypta meridiana	--	--	--	--	--	--	--	8	--	--	--	--	--
Crystallaria asprella	--	--	--	--	--	--	--	1	--	--	--	--	--
Etheostoma artesiae	3	--	--	--	1	2	10	--	--	--	--	--	--
Etheostoma chlorosomum	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--	1	--	--
Etheostoma histrio	--	--	--	--	--	--	--	2	--	--	--	--	--
Etheostoma jordani	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma lachneri	5	15	1	--	29	12	3	--	--	--	--	--	--
Etheostoma nigrum	11	--	--	8	3	1	2	--	--	--	--	--	--
Etheostoma parvipinne	--	--	2	--	--	--	--	--	3	--	--	--	--
Etheostoma proeliare	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	34	--	71	7	--	7	2	--	--	--	--
Etheostoma stigmaeum	--	--	63	30	25	16	3	1	--	--	--	--	--
Etheostoma swaini	--	8	4	4	1	--	--	--	--	--	--	--	--
Etheostoma zonifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	--	--	--	--	1	--	1	--	--	--	--	--	--
Percina maculata	--	--	4	--	2	1	1	--	--	--	--	--	--
Percina nigrofasciata	3	21	63	13	33	4	--	50	14	10	4	21	11
Percina sciera	--	--	2	--	--	--	--	--	--	--	--	--	--
Percina shumardi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina vigil	--	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	26	17	35	17	28	34	20	32	16	11	8	20	15
Individuals	430	344	625	227	411	425	192	343	379	334	28	97	108
Catch per effort	13.44	10.75	19.53	7.09	12.45	13.28	5.82	10.39	11.84	10.44	1.65	3.03	3.38
IBI score	36	42	44	44	46	42	36	44	42	38	30	36	30
Biological condition	Fair	Fair	Good	Good	Good	Fair	Fair	Good	Fair	Fair	Poor	Fair	Poor

GSA No.	1857	1858	1859	1861	1862	1863	1880	1925	2004	2008	2009	2319	2320
Sample date	27-Sep-10	15-Sep-10	29-Sep-10	15-Sep-10	29-Sep-10	27-Sep-10	2-Sep-10	2-Sep-09	22-Jul-08	28-Apr-09	28-Apr-09	8-Aug-07	8-Aug-07
Petromyzontidae - lampreys													
Ichthyomyzon gagei	--	--	--	--	--	--	--	7	4	--	5	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars													
Lepisosteus oculatus	--	--	--	20	--	--	1	--	--	--	--	--	--
Lepisosteus osseus	--	--	--	--	--	--	--	--	--	--	--	--	--
Amiidae - bowfins													
Amia calva	--	--	--	--	--	--	--	--	--	--	--	--	--
Anguillidae - freshwater eels													
Anguilla rostrata	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae - shads													
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows													
Campostoma oligolepis	--	118	--	--	391	--	7	1	3	--	--	133	--
Cyprinella callistia	--	--	--	--	--	--	--	--	--	--	--	--	289
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	--	2	4	--	10	--	53	7	11	2	--	161	173
Hybopsis winchelli	--	--	1	--	--	--	--	--	--	--	--	--	10
Luxilus chrysocephalus	--	13	3	--	19	--	--	42	38	5	6	25	4
Lythrurus bellus	--	--	--	--	--	--	--	39	40	28	9	4	15
Macrhybopsis storeriana	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	--	35	1	--	41	--	--	11	8	1	5	--	6
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis ammophilus	--	--	--	--	3	--	--	--	--	--	--	76	58
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis baileyi	3	8	--	--	137	--	--	37	29	--	29	--	11
Notropis amplamala	--	4	--	--	18	--	--	--	--	--	--	16	--
Notropis candidus	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	71	--	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	3	--	--	--	--	--	13	2	1	--	--	43	85
Notropis texanus	--	--	2	--	23	--	--	17	29	10	--	--	2

GSA No.	1857	1858	1859	1861	1862	1863	1880	1925	2004	2008	2009	2319	2320
Sample date	27-Sep-10	15-Sep-10	29-Sep-10	15-Sep-10	29-Sep-10	27-Sep-10	2-Sep-10	2-Sep-09	22-Jul-08	28-Apr-09	28-Apr-09	8-Aug-07	8-Aug-07
Cyprinidae - Continued													
Notropis volucellus	--	--	--	--	--	--	--	--	--	--	--	3	--
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenacobius catostomus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	--	--	--	--	--	--	--	1	--	1	--	--	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	--	--	--	--	--	--	1	--	--	--	--	48	25
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	--	4	--	--	--	--	--	6	2	--	--	2	--
Semotilus thoreauianus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--	--	--	--
Catostomidae - suckers													
Carpiodes cyprinus	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	1	--	--	--	--	--
Erimyzon sucetta	--	--	--	--	--	--	--	--	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	--	--	--	--	43	--	9	10	7	--	--	--	--
Hypentelium nigricans	--	37	--	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	--	--	--	--	--	--	--	--	--	--	--	--
Minytrema melanops	--	--	--	--	--	--	--	--	1	--	--	--	1
Moxostoma duquesnei	--	--	--	--	--	--	--	--	--	--	--	--	--
Moxostoma erythrurum	--	--	1	--	4	1	1	--	5	--	--	17	--
Moxostoma poecilurum	1	--	--	--	1	1	3	--	2	--	--	4	6
Ictaluridae - North American catfishes													
Ameiurus melas	--	--	1	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	--	10	--	--	9	--	--	--	--	2	--	--	--
Ictalurus punctatus	--	2	--	1	--	--	3	--	--	--	--	--	--
Noturus funebris	--	--	--	--	--	--	--	1	--	--	5	--	--
Noturus gyrinus	--	--	--	--	--	--	--	--	--	2	--	1	1
Noturus leptacanthus	4	3	--	--	19	7	7	--	2	4	1	8	56
Noturus munitus	--	--	--	--	--	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	--	--	--	--	--	--	--	--	--	--	--
Esocidae - pikes													
Esox americanus	--	--	--	--	--	1	--	--	--	--	--	--	--
Esox niger	--	--	--	--	2	--	--	1	1	--	--	--	--
Aphredoderidae - pirate perch													
Aphredoderus sayanus	--	--	7	--	--	3	--	2	4	--	--	--	--

GSA No.	1857	1858	1859	1861	1862	1863	1880	1925	2004	2008	2009	2319	2320
Sample date	27-Sep-10	15-Sep-10	29-Sep-10	15-Sep-10	29-Sep-10	27-Sep-10	2-Sep-10	2-Sep-09	22-Jul-08	28-Apr-09	28-Apr-09	8-Aug-07	8-Aug-07
Atherinopsidae - New World silversides													
Labidesthes sicculus	--	--	--	--	--	--	--	--	--	--	--	--	--
Menidia audens	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows													
Fundulus notatus	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--	--	--	--
Fundulus olivaceus	1	1	8	1	5	8	--	4	1	29	--	12	17
Fundulus stellifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Poeciliidae - livebearers													
Gambusia affinis	--	4	--	2	--	1	--	--	1	--	--	19	--
Cottidae - sculpins													
Cottus carolinae	--	--	--	--	--	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes													
Ambloplites ariommus	--	--	--	--	--	1	--	--	1	--	--	1	5
Centrarchus macropterus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis cyanellus	--	5	13	30	12	1	4	2	8	5	--	--	--
Lepomis gulosus	--	--	--	6	2	2	--	--	--	4	--	--	--
Lepomis humilis	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	--	14	5	30	1	4	7	9	12	59	1	37	1
Lepomis megalotis	1	6	23	10	33	5	5	36	88	33	1	116	61
Lepomis microlophus	--	--	--	--	--	--	--	--	--	1	--	--	--
Lepomis miniatus	1	--	3	--	9	--	--	--	--	--	--	12	3
Micropterus coosae	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	--	4	--	1	1	--	--	1	6	1	--	15	8
Micropterus salmoides	--	--	--	2	3	--	1	--	2	1	2	1	--
Pomoxis annularis	--	--	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	--	--	--	--	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--	--	--	--

GSA No.	1857	1858	1859	1861	1862	1863	1880	1925	2004	2008	2009	2319	2320
Sample date	27-Sep-10	15-Sep-10	29-Sep-10	15-Sep-10	29-Sep-10	27-Sep-10	2-Sep-10	2-Sep-09	22-Jul-08	28-Apr-09	28-Apr-09	8-Aug-07	8-Aug-07
Percidae - perches and darters													
Ammocrypta beanii	--	--	--	--	--	--	--	--	--	--	--	--	3
Ammocrypta meridiana	--	--	--	--	--	--	--	--	--	--	--	--	8
Crystallaria asprella	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma artesiae	--	--	--	--	--	--	--	1	--	--	--	3	2
Etheostoma chlorosomum	--	--	3	--	--	--	--	--	--	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma histrio	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma jordani	--	--	--	--	--	--	2	--	--	--	--	--	--
Etheostoma lachneri	--	--	--	--	--	--	--	--	--	--	4	3	51
Etheostoma nigrum	--	--	--	--	--	1	1	--	--	--	--	2	--
Etheostoma parvipinne	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma proeliare	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	--	--	--	--	--	--	--	--	--	--	--	--	--
Etheostoma rupestre	--	--	--	--	--	--	--	--	--	--	--	143	381
Etheostoma stigmaeum	--	--	--	--	--	--	--	46	17	90	--	52	67
Etheostoma swaini	1	--	2	2	6	1	3	1	3	59	--	--	1
Etheostoma zonifer	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina kathae	--	--	--	--	--	--	--	2	3	121	4	--	--
Percina maculata	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina nigrofasciata	4	1	18	2	48	6	6	43	16	8	2	--	59
Percina sciera	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina shumardi	--	--	8	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina vigil	--	--	--	--	--	--	--	--	--	--	--	--	--
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	--	--	--	--	--	--	--	--	--	--	--	--	--
Species	9	19	17	12	24	15	18	26	29	21	13	27	29
Individuals	19	342	103	107	840	43	127	330	345	466	74	957	1409
Catch per effort	0.59	10.69	3.22	3.34	26.25	1.34	3.97	10.31	10.78	14.56	2.24	29	44.03
IBI score	38	36	26	24	36	30	40	38	40	34	42	38	46
Biological condition	Fair	Fair	Very Poor	Very Poor	Fair	Poor	Fair	Fair	Fair	Poor	Fair	Fair	Good

GSA No.	2321	2323	2324	2325	2326	2661	2662	2665	2666	2667
Sample date	9-Aug-07	14-Aug-07	15-Aug-07	16-Aug-07	13-Sep-07	21-Jul-05	21-Jul-05	3-Aug-05	3-Aug-05	4-Aug-05
Petromyzontidae - lampreys										
Ichthyomyzon gagei	--	--	--	--	--	1	--	1	--	--
Lampetra aepyptera	--	--	--	--	--	--	--	--	--	--
Lepisosteidae - gars										
Lepisosteus oculatus	--	--	1	--	--	--	--	--	--	--
Lepisosteus osseus	--	--	1	--	--	--	--	--	--	--
Amiidae - bowfins										
Amia calva	--	--	--	--	--	--	--	--	--	--
Anguillidae - freshwater eels										
Anguilla rostrata	--	--	--	--	--	--	--	--	--	--
Clupeidae - shads										
Dorosoma cepedianum	--	--	--	--	--	--	--	--	--	--
Dorosoma petenense	--	--	--	--	--	--	--	--	--	--
Cyprinidae - carps and minnows										
Campostoma oligolepis	61	111	10	442	110	12	8	18	--	58
Cyprinella callistia	--	87	--	--	2	--	--	--	--	--
Cyprinella gibbsi	--	--	--	--	--	--	--	--	--	--
Cyprinella trichroistia	--	--	--	--	--	--	--	--	--	--
Cyprinella venusta	101	17	5	195	594	6	32	57	27	33
Hybopsis winchelli	5	3	12	--	26	11	1	--	--	--
Luxilus chrysocephalus	15	6	60	--	42	2	13	10	--	--
Lythrurus bellus	30	9	8	36	19	25	3	2	51	26
Macrhybopsis storeriana	--	--	--	--	1	7	--	8	--	--
Nocomis leptocephalus	--	--	--	--	66	3	6	3	--	--
Notemigonus crysoleucas	--	--	--	--	--	--	--	--	--	--
Notropis ammophilus	86	3	--	95	10	21	25	26	1	--
Notropis asperifrons	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides	7	--	--	--	19	4	--	56	--	--
Notropis baileyi	2	--	5	--	11	51	73	37	1	--
Notropis amplamala	86	--	--	253	--	--	--	15	--	--
Notropis candidus	--	--	--	--	--	--	--	--	--	--
Notropis chrosomus	--	--	--	--	--	--	--	--	--	--
Notropis stilbius	--	146	40	25	--	--	--	--	--	--
Notropis texanus	46	--	45	--	22	12	7	--	5	--

GSA No.	2321	2323	2324	2325	2326	2661	2662	2665	2666	2667
Sample date	9-Aug-07	14-Aug-07	15-Aug-07	16-Aug-07	13-Sep-07	21-Jul-05	21-Jul-05	3-Aug-05	3-Aug-05	4-Aug-05
Cyprinidae - Continued										
Notropis volucellus	--	3	--	--	2	--	--	2	--	46
Opsopoeodus emiliae	--	--	--	--	--	--	--	--	1	--
Phenacobius catostomus	--	--	--	--	--	--	--	--	--	--
Pimephales notatus	3	--	--	294	--	--	--	--	2	--
Pimephales promelas	--	--	--	--	--	--	--	--	--	--
Pimephales vigilax	1	1	--	--	31	--	--	--	--	--
Pteronotropis hypselopterus	--	--	--	--	--	--	--	--	--	--
Pteronotropis signipinnis	--	--	--	--	--	--	--	--	--	--
Semotilus atromaculatus	--	--	4	1	1	--	--	--	--	--
Semotilus thoreauianus	--	--	--	--	--	--	--	--	--	--
hybrid cyprinid	--	--	--	--	--	--	--	--	--	--
Catostomidae - suckers										
Carpiodes cyprinus	--	--	--	--	--	--	--	--	--	--
Carpiodes velifer	--	--	--	--	--	--	--	--	--	--
Erimyzon oblongus	--	--	--	--	--	--	--	--	--	--
Erimyzon sucetta	--	--	--	--	--	--	--	--	--	--
Erimyzon tenuis	--	--	--	--	--	--	--	--	--	--
Hypentelium etowanum	11	13	13	--	11	11	1	28	--	10
Hypentelium nigricans	--	--	--	--	--	--	--	--	--	--
Ictiobus bubalus	--	5	--	--	--	--	--	--	--	--
Minytrema melanops	2	--	3	--	--	1	1	--	--	--
Moxostoma duquesnei	--	1	--	--	--	--	3	--	--	--
Moxostoma erythrurum	9	6	1	19	1	--	--	6	--	4
Moxostoma poecilurum	18	13	17	7	3	--	--	--	--	10
Ictaluridae - North American catfishes										
Ameiurus melas	--	--	--	--	--	--	--	--	--	--
Ameiurus natalis	2	--	--	4	--	3	3	--	3	4
Ictalurus punctatus	--	5	--	--	9	3	--	--	--	1
Noturus funebris	--	2	1	--	4	1	3	--	--	--
Noturus gyrinus	1	--	--	1	--	--	--	--	--	--
Noturus leptacanthus	7	12	26	5	3	9	6	--	18	10
Noturus munitus	--	6	--	--	--	--	--	--	--	--
Pylodictis olivaris	--	--	1	--	--	--	--	--	--	--
Esocidae - pikes										
Esox americanus	--	--	--	--	--	--	--	--	--	--
Esox niger	--	--	--	--	--	--	1	--	--	--
Aphredoderidae - pirate perch										
Aphredoderus sayanus	--	--	--	--	--	2	--	--	--	--

GSA No.	2321	2323	2324	2325	2326	2661	2662	2665	2666	2667
Sample date	9-Aug-07	14-Aug-07	15-Aug-07	16-Aug-07	13-Sep-07	21-Jul-05	21-Jul-05	3-Aug-05	3-Aug-05	4-Aug-05
Atherinopsidae - New World silversides										
Labidesthes sicculus	9	--	--	--	105	--	--	--	--	--
Menidia audens	--	--	--	--	--	--	--	--	--	--
Fundulidae - topminnows										
Fundulus notatus	--	--	--	--	--	--	--	--	--	--
Fundulus nottii	--	--	--	--	--	--	--	--	--	--
Fundulus olivaceus	33	14	18	--	25	2	--	2	8	1
Fundulus stellifer	--	--	--	--	--	--	--	--	--	--
Poeciliidae - livebearers										
Gambusia affinis	37	--	--	348	--	--	--	23	13	--
Cottidae - sculpins										
Cottus carolinae	--	--	--	--	--	--	--	--	--	17
Centrarchidae - sunfishes										
Ambloplites ariommus	1	2	3	--	1	--	--	1	--	2
Centrarchus macropterus	--	--	--	--	--	--	--	--	--	--
Lepomis auritus	--	--	--	--	--	--	1	--	--	--
Lepomis cyanellus	1	--	--	4	--	5	4	3	3	2
Lepomis gulosus	1	--	--	--	--	1	--	--	2	1
Lepomis humilis	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	23	6	--	2	9	8	4	4	3	28
Lepomis megalotis	78	25	15	184	75	22	2	17	13	46
Lepomis microlophus	5	--	--	--	--	--	--	--	--	--
Lepomis miniatus	5	--	--	5	5	--	--	--	2	1
Micropterus coosae	--	--	--	--	--	--	--	--	--	--
Micropterus punctulatus	1	16	8	3	4	1	--	2	1	5
Micropterus salmoides	3	--	--	--	1	2	2	1	2	--
Pomoxis annularis	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	--	--	--	1	--	--	--	--
hybrid centrarchid	--	--	--	--	--	--	--	--	--	--

GSA No.	2321	2323	2324	2325	2326	2661	2662	2665	2666	2667
Sample date	9-Aug-07	14-Aug-07	15-Aug-07	16-Aug-07	13-Sep-07	21-Jul-05	21-Jul-05	3-Aug-05	3-Aug-05	4-Aug-05
Percidae - perches and darters										
Ammocrypta beanii	--	2	1	--	--	--	--	--	--	--
Ammocrypta meridiana	--	--	--	--	2	--	--	--	--	--
Crystallaria asprella	--	--	--	--	--	--	--	--	--	--
Etheostoma artesiae	3	--	--	13	--	3	--	--	--	--
Etheostoma chlorosomum	--	--	--	--	--	1	--	--	--	--
Etheostoma fusiforme	--	--	--	--	--	--	--	--	--	--
Etheostoma histrio	--	--	--	--	--	--	--	--	--	--
Etheostoma jordani	--	--	--	--	--	--	--	9	--	--
Etheostoma lachneri	25	--	19	--	--	--	--	--	--	--
Etheostoma nigrum	21	--	2	6	--	--	--	--	12	--
Etheostoma parvipinne	--	--	--	--	--	--	1	--	--	--
Etheostoma proeliare	2	--	--	--	--	--	--	--	--	--
Etheostoma ramseyi	--	--	--	203	--	--	--	--	--	--
Etheostoma rupestre	37	115	35	7	245	--	--	--	--	20
Etheostoma stigmaeum	33	44	22	12	9	--	--	4	--	10
Etheostoma swaini	3	--	--	--	1	--	--	--	3	--
Etheostoma zonifer	--	--	--	--	--	--	--	--	3	--
Percina kathae	--	--	1	--	--	--	--	--	--	--
Percina maculata	--	--	--	--	--	--	--	--	--	--
Percina nigrofasciata	39	29	38	5	108	19	21	42	9	51
Percina sciera	--	19	--	--	--	--	--	--	--	--
Percina shumardi	--	--	--	--	--	--	--	--	--	--
Percina suttkusi	3	--	--	--	--	--	--	--	--	--
Percina vigil	--	9	--	--	--	--	--	--	--	--
Sciaenidae - drums	--	--	--	--	--	--	--	--	--	--
Aplodinotus grunniens	--	5	--	--	--	--	--	--	--	--
Elassomatidae - pygmy sunfishes	--	--	--	--	--	--	--	--	--	--
Elassoma zonatum	2	--	--	--	--	--	--	--	7	--
Species	41	31	29	25	34	30	23	25	23	22
Individuals	858	735	415	2169	1577	250	221	377	190	386
Catch per effort	26.81	22.97	12.97	67.78	49.28	7.81	6.91	11.78	5.94	12.06
IBI score	44	44	48	36	44	46	46	40	34	34
Biological condition	Good	Good	Good	Fair	Good	Good	Good	Fair	Poor	Poor

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