GEOLOGICAL SURVEY OF ALABAMA

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A SURVEY OF FISHES IN THE MURDER CREEK SYSTEM, ALABAMA

OPEN-FILE REPORT 1504

by

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Prepared in cooperation with the U.S. Fish and Wildlife Service and the Alabama Department of Conservation and Natural Resources

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ABSTRACT

A total of 5,691 individuals in 54 species was collected in the Murder Creek system from 24 stations during surveys in 2008 and 2012. The number of species captured at individual stations ranged from 7 to 24 and catch ranged from 27 to 412 individuals per station. The Index of Biotic Integrity (IBI), which is a measure of the site-specific biological health of a stream, ranged from Poor to Excellent with 2 stations rating Poor, 11 stations rating Fair, 10 stations rating Good, and 3 stations rating Excellent. Twenty-two of the 26 habitat assessments completed in conjunction with the fish IBI assessments scored in the optimal to suboptimal range reflecting the availability of generally good habitat conditions throughout the watershed. Four stations scored in the marginal to poor habitat quality range.

INTRODUCTION

The purpose of conducting fish surveys in the Murder Creek system was to document the presence of federally listed species and species of greatest conservation concern, determine fish biodiversity in selected parts of the system, establish baseline biological condition using fish community indices, and determine habitat conditions at selected stream locations. Participants in the Murder Creek surveys were:

- *U.S. Fish and Wildlife Service (USFWS)* - Jeff Powell, Eric Spadgenske, Andy Ford, Patric Harper, Jennifer Pritchett, Matt Lachet
- *Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division (ADCNR)* – Ken Weathers, Rob Andress, Kyle Bolton, Tommy Purcell, Andrew Henderson
- *Geological Survey of Alabama (GSA)* - Patrick O'Neil, Tom Shepard, Brett Smith, Cal Johnson, Anne Wynn

STRATEGIC HABITAT AND RIVER REACH UNITS

The USFWS in cooperation with the ADCNR-Alabama Aquatic Biodiversity Center (AABC) and the GSA have selected watersheds and river segments in the five major hydrologic unit code (HUC) 4 subregions in Alabama (fig. 1) to focus conservation activities for managing, recovering, and restoring populations of rare fishes, mussels, snails, and crayfishes (Wynn and others, 2012). These Strategic Habitat Units (SHUs) and Strategic River Reach Units (SRRUs) include a substantial part of Alabama's remaining high-quality water courses and reflect the variety of aquatic habitats occupied by these species historically and presently. The Murder Creek watershed is one of 51 units selected for management of aquatic biodiversity. The SHUs were selected based on the presence of federally listed and state imperiled aquatic species, potential threats to the species, designation of critical habitat, and the best available information about the essential habitat components required by these species to survive. The habitat components include areas with the following characteristics:

(1) Geomorphically stable stream and river channels.
(2) Stream flow regimes that support normal behavior, growth, and survival of the animals.
(3) Acceptable water-quality conditions necessary for normal behavior, growth, and viability of all life stages of the animals.
(4) A diversity of channel substrate types with minimal amounts of fine sediment and filamentous algae.
(5) For mussels, the presence of fish hosts with adequate living, foraging, and spawning areas.
(6) Few or no competitive or predaceous nonnative species.

The SRRUs were selected based on habitat features listed above and the presence of imperiled species and include river reaches where species restoration and recovery actions are planned or already underway. The basis for restoration and recovery within a designated SHU is the development of SHU-specific watershed assessment information similar to that presented in this report. For species recovery to

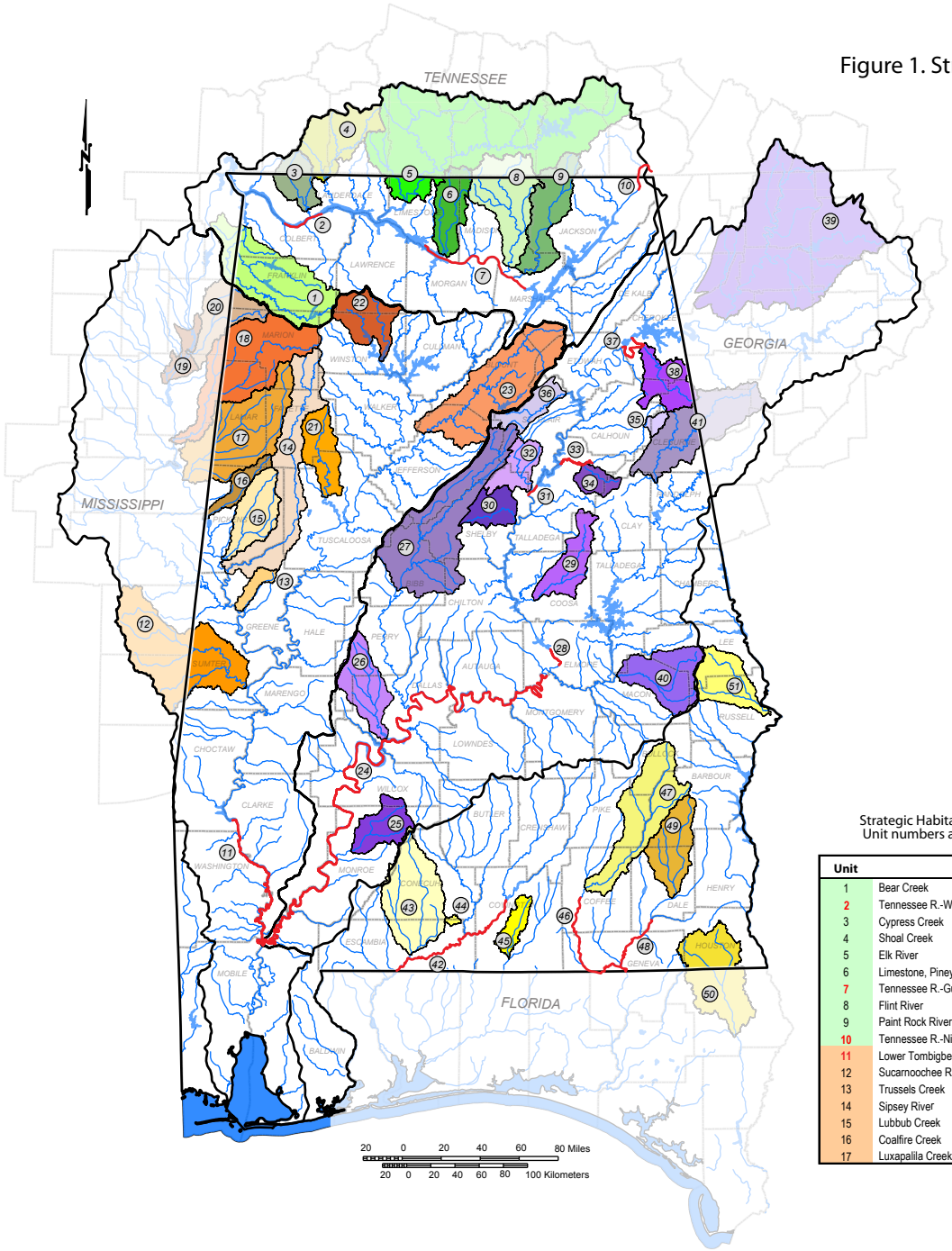
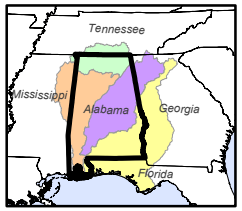


Figure 1. Strategic habitat and river reach units for aquatic species of conservation concern in Alabama.

Explanation

- Rivers and streams
- Open water
- County lines
- Hydrologic Unit Code (HUC) subregion boundary
- Strategic Habitat Unit (SHU)
- Strategic River Reach Unit (SRRU)

National Hydrologic Dataset HUC 4 Subregions in Alabama



Index map of HUC4 subregions in Alabama and neighboring states

- Middle Tennessee - Elk (0603) strategic units no. 1 - 10
- Mobile-Tombigbee (0316) strategic units no. 11 - 23
- Alabama River (0315) strategic units no. 24 - 41
- Choctawhatchee-Escambia (0314) and Apalachicola (0313) strategic units no. 42 - 51

Strategic Habitat Units (SHUs) and Strategic River Reach Units (SRRUs) in Alabama and associated HUC subregions. Unit numbers are grouped by the color of the HUC subregion in which they are located. Units in red font are SRRUs.

Unit	Name	Unit	Name	Unit	Name
1	Bear Creek	18	Buttahatchee River	35	Shoal Creek
2	Tennessee R.-Wilson dam tailwater	19	East Fork Tombigbee River	36	Big Canoe Creek
3	Cypress Creek	20	Bull Mountain Creek	37	Weiss Lake bypass (Dead River)
4	Shoal Creek	21	North River	38	Terrapin Creek
5	Elk River	22	Upper Sipsey Fork	39	Upper Coosa River tributaries
6	Limestone, Piney, Beaverdam Creeks	23	Locust Fork	40	Uphapee Creek
7	Tennessee R.-Guntersville dam tailwater	24	Lower Alabama River	41	Tallapoosa River
8	Flint River	25	Big Flat Creek	42	Conecuh River
9	Paint Rock River	26	Bogue Chitto Creek	43	Murder Creek
10	Tennessee R.-Nickajack dam tailwater	27	Upper Cahaba River	44	Amos Mill Creek
11	Lower Tombigbee River	28	Coosa R.-Jordan dam tailwater	45	Five Runs Creek
12	Sucarnoochee River	29	Hatchet Creek	46	Pea River
13	Trussels Creek	30	Yellowleaf Creek	47	Upper Pea River
14	Sipsey River	31	Coosa R.-Logan Martin dam tailwater	48	Choctawhatchee River
15	Lubbub Creek	32	Kelly Creek	49	West Fork Choctawhatchee River
16	Coalfire Creek	33	Lower Choccolocco Creek	50	Chipola River
17	Luxapalila Creek	34	Cheaha Creek	51	Uchee Creek

proceed systematically and with some reasonable expectation of success, watersheds must be understood from a biological, water quality, land use, and habitat threat perspective. The type of watershed information developed for each SHU is unique and depends on the type and intensity of threats that imperiled species face. This assessment information can include, but is not limited to, additional biological surveys to refine species distributions, surveys to determine water-quality and habitat threats that may affect imperiled species, a landscape analysis to determine land cover and land use patterns, SHU watershed characteristics and land cover changes through time, studies to elucidate poorly understood biological phenomena (reproduction periods, migration routes, and breeding habitats) that are important for managing and recovering species, hydrogeologic studies to determine groundwater characteristics and recharge areas for spring and cave-dwelling species, and biomonitoring studies using multi-metric procedures like the Index of Biotic integrity (IBI) to assess stream biological conditions throughout a SHU for identifying impaired stream reaches.

The next step is to use the assessment data developed during the watershed surveys to identify stream reaches that need protection, management, or restoration. Linking the location of critically imperiled species with threats is a critical part of this process. Linking is accomplished by conducting SHU-specific assessment studies. Although a broad understanding of threats and species distributions is good information, it is sufficient for recovery purposes under the Endangered Species Act (ESA).

Once threats are linked with species and an action plan for recovery has been developed, species restoration can begin. This takes place through a cooperative partnership of local landowners, organizations, and agencies including watershed partnerships, local and county governments, local businesses and farmers, state and federal agencies, and other interested parties using a variety of means such as protecting stream habitat through landowner conservation agreements or land purchase, management of habitat and water quality by eliminating polluted runoff sources and by reducing pollutant loads through best management practice (BMP) implementation, conducting riparian improvement or physically restoring a substantially degraded stream reach, and restoration of biodiversity with culture-raised species. The

USFWS, ADCNR, and GSA have teamed with the Alabama Clean Water Partnership (ACWP) and other water stakeholders to implement watershed restoration activities when possible in selected SHUs. This core group of agencies, organizations, and stakeholders is informally organized into the Alabama Rivers and Streams Network (ARSN), with a stated mission to study, manage, and develop Alabama's water resources in a scientific and comprehensive way to minimize their degradation, maximize their availability for all users, and restore and recover aquatic species.

STUDY AREA

Murder Creek originates in Monroe County, Alabama, near the community of Midway and flows south for approximately 69 miles until its confluence with the Conecuh River near Brewton, Alabama. Headwater tributaries have moderately high gradient at 10 to 16 ft/mi (feet/mile). Just upstream of I-65 the gradient of Murder Creek proper drops substantially to 3 to 6 ft/mi with wooded riparian wetlands developing along stream margins. Gradient remains low throughout the lower watershed dropping to around 2 to 3 ft/mi near Brewton. The Murder Creek watershed is located in three physiographic districts within the East Gulf Coastal Plain physiographic section: the Lime Hills occurs in the upper watershed, the Dougherty Plain in mid-reaches, and the Southern Pine Hills in the lower watershed (fig. 2). Alluvial deposits occur in the lower main channel of Murder Creek

The rugged Lime Hills district is comprised of resistant limestones in Choctaw, Clarke, Monroe, and Conecuh Counties with unique rocky habitats occurring where streams cut down through alluvial sediments to limestone. The southern edge of the Lime Hills district, where it meets the Southern Pine Hills district, is generally a sharp demarcation to the distribution of fish species in the Coastal Plain.

The Dougherty Plain district extends from the southeast corner of the state west to Conecuh County, forming the eastern edge of the Lime Hills district. It is an extension of an upland in Georgia composed of limestone, sand, and clay. Active solution of the underlying limestone produces many shallow, flat-bottomed depressions that dot the landscape. Small headwater streams are noticeably absent from the Dougherty Plain

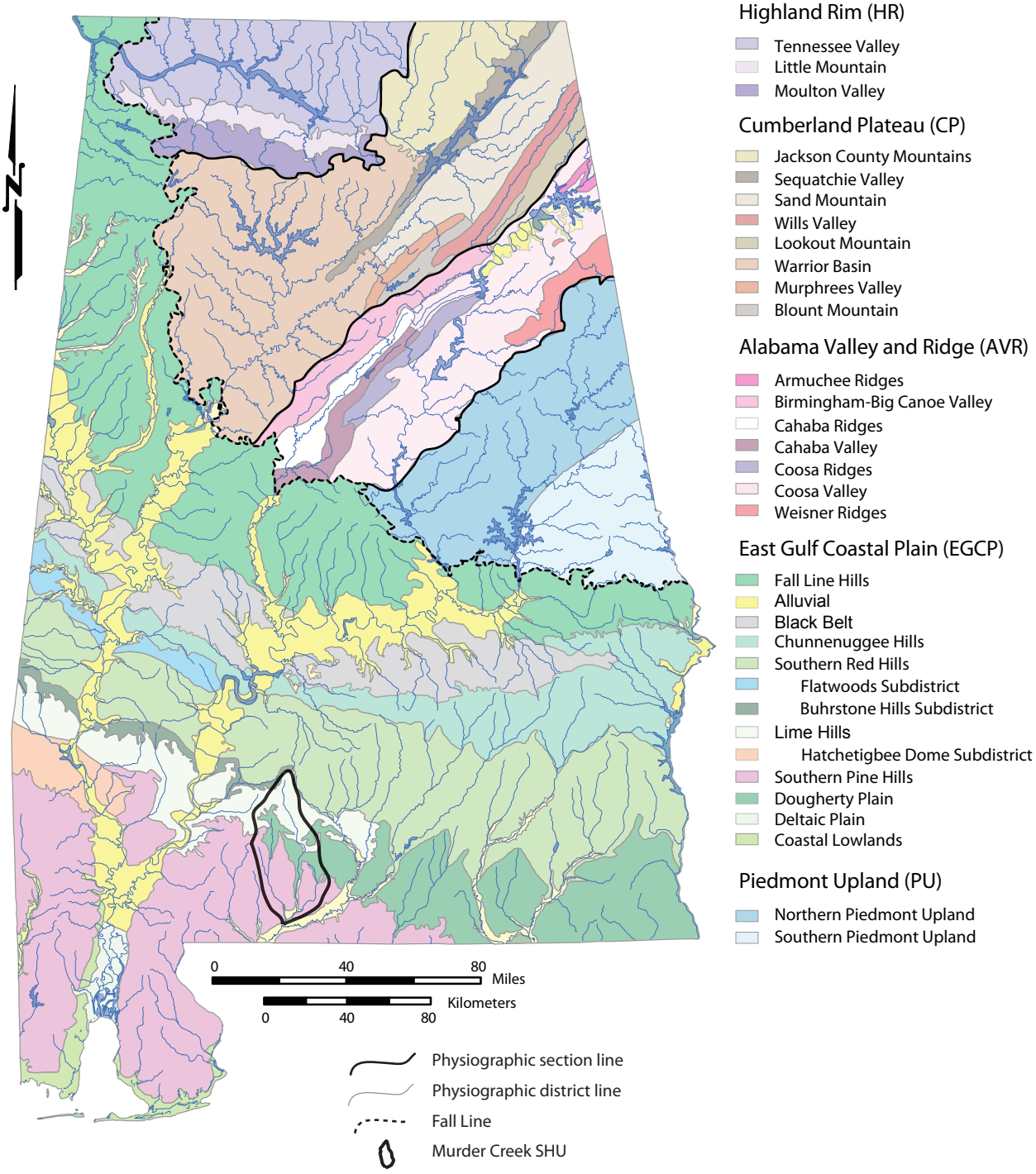


Figure 2. Physiographic map of Alabama. Districts in each section have been arranged decending from north to south. Alluvial deposits, which parallel the major river channels in the East Gulf Coastal Plain section, also occur in the Alabama Valley and Ridge section (modified from Sapp and Emplaincourt, 1975).

district because active solution transfers many of the drainages to underground channels.

The Southern Pine Hills district has a topography of low-relief with broad, rounded ridges and V-shaped valleys with sand and clay sediments. This region is not subject to solution like the Dougherty Plain district and the boundary between the two districts is sometimes a distinct escarpment. Flat uplands with shallow ponds, bogs, and marshes occur throughout the district and many of the valleys are saucer-like and perpetually wetted by seepage from nearby hills. The abundance of warm summer rains is a major factor in leaching fertility from the soil and favoring the growth of pines in this region. Streams are generally well sustained by groundwater flows in summer and are commonly termed "blackwater" creeks, in reference to those streams originating in the Pine Hills proper, where the term refers to the natural color imparted by dissolved and suspended organic matter.

The Murder Creek watershed is predominantly pine and deciduous forest (82 percent) (table 1) with agriculture (row crops and pasture) accounting for around 3.9 percent of the 636-square-mile (mi^2) watershed. Forest cover is greatest in the Cedar Creek subwatershed (87 percent) and lowest in the Burnt Corn Creek subwatershed (79 percent). Upper Murder Creek subwatershed has the greatest percentage of row crop agriculture (1.7 percent) with Burnt Corn Creek the lowest at 1.0 percent. Urban land use is greatest in Upper Murder Creek subwatershed (7.0 percent) and least in the Cedar Creek subwatershed (2.4 percent). The T.R. Miller Wildlife Management Area occupies a significant portion of the Cedar Creek subwatershed.

Few hydromodifications are known in the Murder Creek system outside of small farm ponds and impoundments. Flow at U.S. Geological Survey station 02374700 (Murder Creek at Ala. Hwy. 41) averaged 538 ft^3/s (cubic feet per second) with a minimum flow of 163 ft^3/s in 2013 and a maximum flow of 1,910 ft^3/s in 2005 over a 14-year period of record from 1998-2013. Flow at U.S. Geological Survey station 02374745 (Burnt Corn Creek at Ala. Hwy. 41) averaged 243 ft^3/s with a minimum flow of 51 ft^3/s in 2013 and a maximum flow of 849 ft^3/s in 2005 over the same 14-year period of record. The 7-day, 10-year low flow ($7Q_{10}$) for these sites has been calculated at 90

Table1. Land use/land cover information for the Murder Creek system, Alabama.

Land use-land cover class	Watershed Name-HUC 10									
	Burnt Corn Creek 0314030405		Cedar Creek 0314030404		Lower Murder Creek 314030403		Upper Murder Creek 0314030402		Total watershed	
	Acres	*Percent*	Acres	*Percent*	Acres	*Percent*	Acres	*Percent*	Acres	*Percent*
Row crops	1,153	*1.0*	746	*1.4*	1,290	*1.4*	2,466	*1.7*	5,655	*1.4*
Pasture	3,278	*2.7*	2,061	*3.8*	1,570	*1.7*	3,324	*2.3*	10,233	*2.5*
Forest	93,955	*78.6*	46,866	*86.9*	76,458	*83.7*	117,781	*83.0*	335,060	*82.4*
Urban	6,897	*5.8*	1,276	*2.4*	6,241	*6.8*	9,976	*7.0*	24,390	*6.0*
Water	721	*0.6*	683	*1.3*	515	*0.6*	648	*0.5*	2,567	*0.6*
Mined	1,359	*1.1*	5	*0.0*	59	*0.1*	16	*0.0*	1,439	*0.4*
Other	12,224	*10.2*	2,297	*4.3*	5,244	*5.7*	7,748	*5.5*	27,513	*6.8*
Total	119,587	*100*	53,934	*100*	91,377	*100*	141,959	*100*	406,857	*100*
Sq. miles	187		84		143		222		636	

(Data from: Alabama Soil and Water Conservation Committee, 2007)

ft^3/s for Murder Creek and 20 ft^3/s for Burnt Corn Creek (Atkins and Pearman 1994). Twenty-four sampling stations were established in the Murder Creek system (fig. 3, table 2) for this survey. Some sites were sampled in 2008 while others were sampled in 2012.

METHODS

Fishes were collected using the GSA 30+2 method calibrated for use with the Alabama IBI (O'Neil and others, 2006). This method recommends that sampling be stratified over four habitat types (riffles, runs, pools, and shorelines) with ideally a minimum of 10 sampling efforts within each of the riffle, run, and pool habitat types with two additional sampling efforts along stream shorelines. However, if the availability of a sufficient habitat type is low or missing altogether then sampling effort can be shifted to those that are present as long as a total of 30 efforts plus 2 shoreline efforts are conducted. This sampling regime, termed the "30+2" method, has proven adequate to yield a fish community sample acceptable for calculating an IBI in wadeable streams. Small-mesh minnow seines are used in conjunction with a backpack electroshocker to catch, scoop, or dip stunned fishes and to trap fishes in sloughs and backwaters. At other times, seines are used as the primary gear 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, runs, and glides the seine was set in shallow, rocky areas or deeper, swifter runs; 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

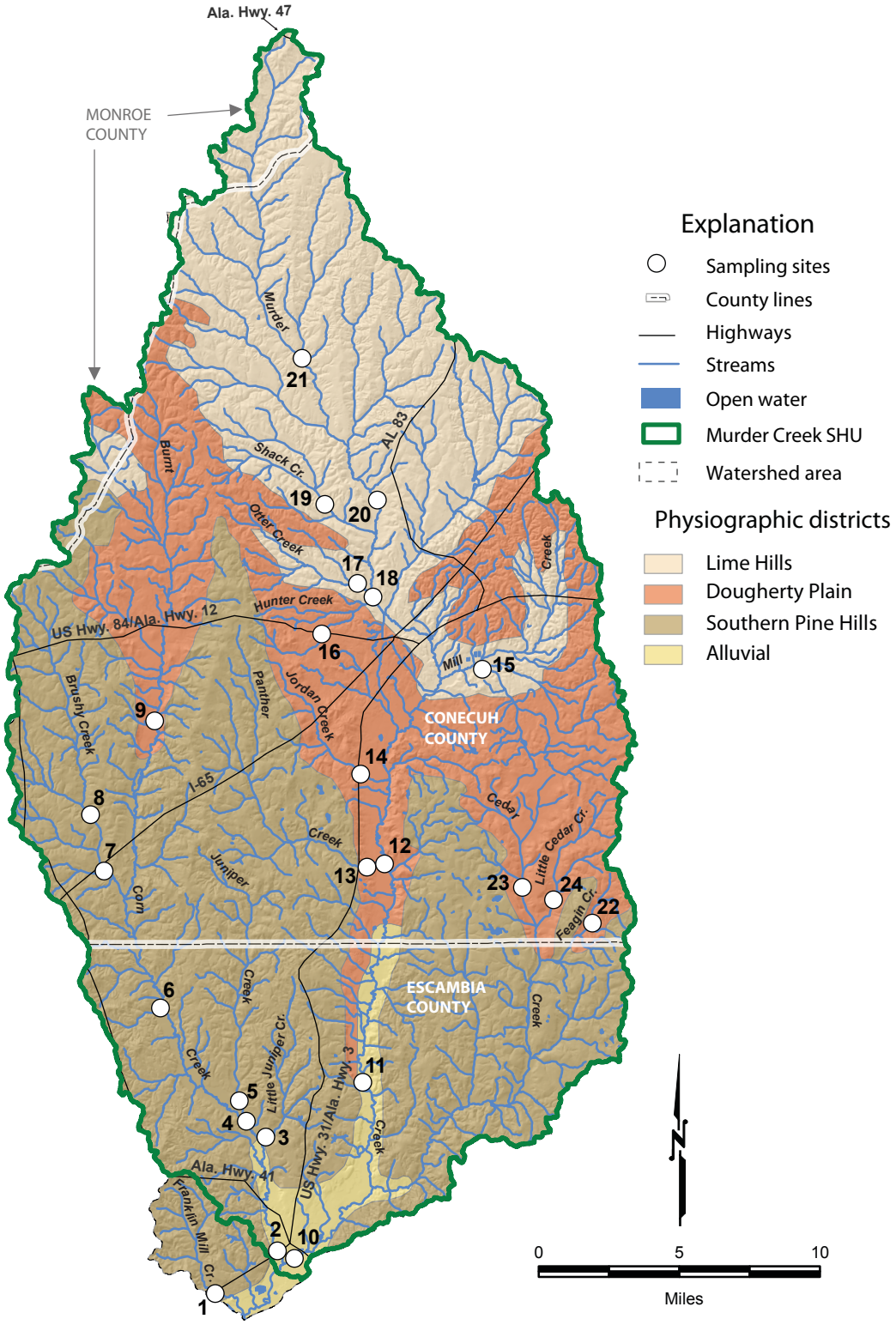


Figure 3. Map of fish sampling stations in the Murder Creek system, Alabama.

Table 2. Fish sampling stations in the Murder Creek system, Alabama.

Station	County	Latitude	Longitude	section, township, range,	Ecoregion [1]	GSA No.	Sample date	Drainage area (mi^2)
1. Franklin Mill Creek at U.S. Hwy. 31	Escambia	31.0799	-87.1140	sec. 1, T. 1 N., R. 9 E.	65f	2256	19-Jun-08	7.53
2. Burnt Corn Creek at U.S. Hwy. 29/31	Escambia	31.1025	-87.0760	sec. 29, T. 2 N., R. 10 E.	65f	2254	19-Jun-08	187
3. Little Juniper Creek at Co. Hwy. 49	Conecuh	31.1619	-87.0848	sec. 5, T. 2 N., R. 10 E.	65f	1225	7-May-12	10.1
4. Burnt Corn Creek at Co. Hwy. 77	Conecuh	31.1693	-87.0978	sec. 6, T. 2 N., R. 10 E.	65f	1226	8-May-12	162
5. Juniper Creek at Co. Hwy. 49	Conecuh	31.1788	-87.1004	sec. 31, T. 3 N., R. 10 E.	65f	1032	7-May-12	20.8
6. Burnt Corn Creek at Co. Hwy. 40	Escambia	31.2291	-87.1484	sec. 15, T. 3 N., R. 9 E.	65f	2274	17-Jul-08	124
7. Brushy Creek near Conecuh Village Campground	Conecuh	31.2996	-87.1821	sec. 20, T. 4 N., R. 9 E.	65f	1223	8-May-12	29.4
8. Brushy Creek at Co. Hwy. 6	Conecuh	31.3270	-87.1905	sec. 8, T. 4 N., R. 9 E.	65f	2273	26-Aug-08	23.6
9. Burnt Corn Creek at George Lee Road	Conecuh	31.3796	-87.1519	sec. 22, T. 5 N., R. 9 E.	65f	1224	8-May-12	54.8
10. Murder Creek at U.S. Hwy. 29/31	Escambia	31.1014	-87.0679	sec. 28, T. 2 N., R. 10 E.	65f	2255	19-Jun-08	435
11. Murder Creek near Kirkland	Escambia	31.1899	-87.0272	sec. 26, T. 3 N., R. 10 E.	65f	1216	7-May-12	329
12. Murder Creek at Co. Hwy. 6, Castleberry	Conecuh	31.3019	-87.0123	sec. 24, T. 4 N., R. 10 E.	65f	2222	19-Jun-08	290
						1217	7-May-12	
13. Panther Creek at U.S. Hwy. 31	Conecuh	31.3019	-87.0233	sec. 23, T. 4 N., R. 10 E.	65f	1208	8-May-12	28.3
14. Jordan Creek at U.S. Hwy. 31	Conecuh	31.3500	-87.0274	sec. 35 T. 5 N., R. 10 E.	65f	1214	8-May-12	9.37
15. Sandy Creek at County Hwy. 29	Conecuh	31.4051	-86.9555	sec. 15, T. 5 N., R. 11 E.	65f	1211	8-May-12	21
16. Hunter Creek at U.S. Hwy. 84	Conecuh	31.4218	-87.0506	sec. 10, T. 5 N., R. 10 E.	65f	1210	7-May-12	2.7
17. Otter Creek upstream of confluence with Murder Creek	Conecuh	31.4421	-87.0214	sec. 36, T. 6 N., R. 10 E.	65f	1221	9-May-12	8.4
18. Murder Creek downstream of Otter Creek	Conecuh	31.4417	-87.0209	sec. 36, T. 6 N., R. 10 E.	65f	1220	9-May-12	122
19. Shack Creek at Co. Hwy. 4	Conecuh	31.4889	-87.0499	sec. 15, T. 6 N., R. 10 E.	65f	1209	7-May-12	12
20. Murder Creek at Co. Hwy. 4	Conecuh	31.4912	-87.0199	sec. 13, T. 6 N., R. 10 E.	65f	1219	8-May-12	93.6
21. Murder Creek at Co. Hwy. 30, Fairnelson	Conecuh	31.5627	-87.0631	sec. 21, T. 7 N., R. 10 E.	65f	2272	18-Jul-08	42.6
						1031	8-May-12	
22. Faggin Creek at Co. Hwy. 6	Conecuh	31.2734	-86.8902	sec. 31, T. 4 N., R. 12 E.	65f	1218	8-May-12	2.52
23. Cedar Creek at Co. Hwy. 6	Conecuh	31.2913	-86.9314	sec. 23, T. 4 N., R. 11 E.	65f	1227	9-May-12	12.2
24. Little Cedar Creek at Co. Hwy. 6	Conecuh	31.2839	-86.9126	sec. 25, T. 4 N., R. 11 E.	65f	1215	9-May-12	8.18

[1] 65f-Southern Pine Plains and Hills

stunned benthic fishes. Vegetated shorelines along pool and shoal margins were usually very productive areas as were areas entering or leaving pools and glides. Plunge pools, that zone immediately downstream 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, trapping fishes against the shore or in a slough at the end of a seine haul. 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. 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.

A rapid habitat assessment was completed for each IBI sample collected. The visual glide-pool assessment procedure used in this study was 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 persistence 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. 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 for this study was taken as a percentage of the maximum habitat score possible for the glide-pool method.

The biological condition IBI was calculated using metrics and scoring criteria established by O'Neil and Shepard (2012) for the Southern Plains ichthyoregion in Alabama. The Southern Plains IBI is comprised of twelve metrics quantifying biodiversity, trophic structure, tolerance/intolerance, and fish health: number of native species, number of shiner species, number of sucker species, number of centrarchid species, number of darter+madtom species, proportion of tolerant species, proportion of Green Sunfish+Yellow Bullheads, proportion of insectivorous cyprinids, proportion of top carnivores, proportion with DELT+hybrids (DELT=deformities, eroded fins, lesions, tumors), proportion of simple lithophiolic spawning species, and proportion of manipulative nonlithophilic spawning species.

RESULTS AND DISCUSSION

A total of 5,691 individuals in 54 species was collected in the Murder Creek system from 24 stations during surveys in 2008 and 2012 (table 3, appendix). The Blacktail Shiner (*Cyprinella venusta*) was the most abundant species collected with 781 individuals (13.7 percent of total catch) followed by the Sailfin Shiner (*Pteronotropis hypselopterus*) with 641 individuals (11.3 percent), the Blacktip Shiner (*Lythrurus atrapiculus*) with 595 individuals (10.5 percent), the Weed Shiner (*Notropis texanus*) with 423 individuals (7.4 percent), and the Longear Sunfish (*Lepomis megalotis*) with 415 individuals (7.3 percent) (table 3).

The first systematic fish collections in the Murder Creek system were made by Bailey and others (1954)(table 3). They reported a total of 30 species from four stations (Murder Creek at Castleberry [20 July 1931], Bear Creek [6 April 1948], Murder Creek at Brewton [20 July 1931], and Burnt Corn Creek [20 July 1931]). The Bluenose Shiner (*Pteronotropis welaka*) was collected at the Murder Creek Castleberry site. A species

Table 3. List of fishes collected in the Murder Creek system, Alabama, 2008 and 2012, and species of probable occurrence.

Species		Total collected (2008-12)	Bailey, Winn, and Smith (1954)	Probable occurrence [1]	Conservation status [2]
Petromyzontidae-Lampreys					
Ichthyomyzon gagei	Southern Brook Lamprey	2	--	--	P5
Lampetra aepyptera	Least Brook Lamprey	1	--	--	P5
Acipenseridae-Sturgeons					
Acipenser oxyrinchus desotoi	Gulf Sturgeon	--	--	X [3]	P2, T
Lepisosteidae-Gars					
Lepisosteus oculatus	Spotted Gar	2	--	--	P5
Lepisosteus osseus	Longnose Gar	1	--	--	P5
Clupeidae-Herrings and Shads					
Alosa alabamae	Alabama shad	--	--	X	P1
Alosa chrysochloris	Skipjack	--	--	X	P3
Dorosoma cepedianum	Gizzard Shad	--	--	X	P5
Dorosoma petenense	Threadfin Shad	--	--	X	P5
Anguillidae-Freshwater Eels					
Anguilla rostrata	American Eel	7	--	--	P4
Cyprinidae-Minnows and Carps					
Cyprinella venusta	Blacktail Shiner	781	X	--	P5
Hybognathus hayi	Cypress Minnow	--	X	--	P3
Hybopsis sp cf winchelli	Coastal Clear Chub	138	X	--	P5
Lythrurus atrapiculus	Blacktip Shiner	595	X	--	P4
Macrhybopsis sp cf aestivalis	Pallid Chub	--	--	X	P4
Notemigonus crysoleucas	Golden Shiner	1	X	--	P5
Notropis amplamala	Longjaw Minnow	124	X	--	P5
Notropis chalybaeus	Ironcolor Shiner	6	--	--	P1
Notropis harperi	Redeye Chub	57	--	--	P5
Notropis longirostris	Longnose Shiner	84	X	--	P5
Notropis texanus	Weed Shiner	423	X	--	P5
Opsopoeodus emiliae	Pugnose Minnow	3	--	--	P5
Pteronotropis hypselopterus	Sailfin Shiner	641	X	--	P5
Pteronotropis signipinnis	Flagfin Shiner	82	X	--	P5
Pteronotropis welaka	Bluenose Shiner	35	X	--	P2
Semotilus thoreauianus	Dixie Chub	12	--	--	P5
Catostomidae-Suckers					
Carpiodes cyprinus	Quillback	--	--	X	P5
Carpiodes velifer	Highfin Carpsucker	--	--	X	P5
Erimyzon sucetta	Lake Chubsucker	7	--	--	P5
Erimyzon tenius	Sharpfin Chubsucker	--	--	X	P5
Minytrema melanops	Spotted Sucker	3	X	--	P5
Moxostoma carinatum	River Redhorse	--	--	X	P5
Moxostoma poecilurum	Blacktail Redhorse	30	--	--	P5
Ictaluridae - North American Catfishes					
Ameiurus natalis	Yellow Bullhead	4	--	--	P5
Ictalurus furcatus	Blue Catfish	--	--	X	P5
Ictalurus punctatus	Channel Catfish	--	--	X	P5
Noturus funebris	Black Madtom	4	--	--	P5
Noturus gyrinus	Tadpole Madtom	--	--	X	P5
Noturus leptacanthus	Speckled Madtom	72	X	--	P5
Pylodictis olivaris	Flathead Catfish	--	--	X	P5
Esocidae-Pikes					
Esox americanus	Redfin Pickerel	68	X	--	P5
Esox niger	Chain Pickerel	31	X	--	P5
Belonidae-Needlefish					
Strongylura marina	Atlantic Needlefish	--	--	X	P5
Aphredoderidae Pirate Perch					
Aphredoderus sayanus	Pirate Perch	100	--	--	P5

Table 3. List of fishes collected in the Murder Creek system, Alabama, 2008 and 2012, and species of probable occurrence--continued.

Species		Total collected (2008-12)	Bailey, Winn, and Smith (1954)	Probable occurrence [1]	Conservation status [2]
Atherinopsidae - New World Silversides					
Labidesthes sicculus	Brook Silverside	61	X	--	P5
Fundulidae-Topminnows					
Fundulus escambiae	Russetfin Topminnow	--	X	--	P5
Fundulus olivaceus	Blackspotted Topminnow	316	X	--	P5
Poeciliidae-Livebearers					
Gambusia holbrooki	Eastern Mosquitofish	132	X	--	P5
Moronidae-Temperate Basses					
Morone chrysops	White Bass	--	--	X	P5
Morone saxatilis	Striped Bass	--	--	X	P3
Centrarchidae-Sunfishes					
Ambloplites ariommus	Shadow Bass	15	--	--	P5
Centrarchus macropteruis	Flier	--	--	X	P5
Lepomis cyanellus	Green Sunfish	8	--	--	P5
Lepomis gulosus	Warmouth	13	--	--	P5
Lepomis macrochirus	Bluegill	39	X	--	P5
Lepomis marginatus	Dollar Sunfish	3	X	--	P5
Lepomis megalotis	Longear Sunfish	415	X	--	P5
Lepomis microlophus	Redear Sunfish	4	X	--	P5
Lepomis miniatus	Redspotted Sunfish	284	X	--	P5
Lepomis Hybrid		2	--	--	--
Micropterus punctulatus	Spotted Bass	37	X	--	P5
Micropterus salmoides	Largemouth Bass	11	X	--	P5
Pomoxis annularis	White Crappie	--	--	X	P5
Pomoxis nigromaculatus	Black Crappie	--	--	X	P5
Percidae-Perches and Darters					
Ammocrypta bifascia	Florida Sand Darter	38	--	--	P5
Crysallaria asprella	Crystal Darter	--	--	X	P3
Etheostoma colorosum	Coastal Darter	340	--	--	P5
Etheostoma davisoni	Choctawhatchee Darter	3	--	--	P5
Etheostoma edwini	Brown Darter	31	X	--	P5
Etheostoma fusiforme	Swamp Darter	--	--	X	P5
Etheostoma histrio	Harlequin Darter	2	--	--	P5
Etheostoma parvipinne	Goldstripe Darter	3	--	--	P5
Etheostoma proeliare	Cypress Darter	--	--	X	P5
Etheostoma stigmaeum	Speckled Darter	51	--	--	P5
Etheostoma swaini	Gulf Darter	97	X	--	P5
Percina austroperca	Southern Logperch	2	--	--	P3
Percina nigrofasciata	Blackbanded Darter	392	X	--	P5
Percina vigil	Saddleback darter	26	X	--	P5
Sander vitreus	Walleye	--	--	X	P4
Elassomatidae-Pygmy Sunfishes					
Elassoma zonatum	Banded Pygmy Sunfish	19	--	--	P5
Achiridae-American Soles					
Trinectes maculatus	Hogchocker	33	--	--	P5
	Catch	5,691	--	--	--
	Total species	54	30	24	80

[1] - from Mettee and others (1996); Boschung and Mayden (2004)

[2] - P1-highest conservation concern; P2-high conservation concern; P3-moderate conservation concern P4-low conservation concern; P5-lowest conservation concern; T-federally threatened

[3] - X indicates collected or probable occurrence

that was not collected in the current survey, the Russetfin Topminnow (*Fundulus escambiae*), was reported from Murder Creek at Brewton. A record for the undescribed "Pallid Chub" (*Macrhybopsis* sp. cf *aestivalis*) was located in a historical GSA collection, Murder Creek at Kirtland (GSA 5237, 22 October 1990). The Saddleback Darter (*Percina vigil*) and Southern Logperch (*Percina austroperca*) were also taken in this collection.

A list of species not collected in this study but of known or probable occurrence in the Murder Creek system are listed in table 3 (Mettee and others 1996; Boschung and Mayden 2004). Gulf sturgeon (*Acipenser oxyrinchus desotoi*) have been collected relatively recently in 2002 (39 individuals) by USFWS and ADCNR in the Conecuh River at the mouth of Murder Creek. Though no collection records exist for Murder Creek proper, both the Alabama Shad (*Alosa alabamae*) and the Skipjack (*Alosa chrysochloris*) are likely visitors in lower Murder Creek at times since they are known nearby in the main channel Conecuh River. Likewise, the Highfin Carpsucker (*Carpiodes velifer*), Quillback (*Carpiodes cyprinus*), and River Redhorse (*Moxostoma carinatum*) are common species in the Conecuh River and likely inhabitants of lower Murder Creek. Other species, some preferring rivers others preferring streams, that were not collected in this study but of high probability for occurrence in Murder Creek are the Blue Catfish (*Ictalurus furcatus*), Channel Catfish (*Ictalurus punctatus*), and Flathead Catfish (*Pylodictis olivaris*); the Atlantic Needlefish (*Strongylura marina*); the White Bass (*Morone chrysops*) and Striped Bass (*Morone saxatilis*); the Flier (*Centrarchus macropterus*), White Crappie (*Pomoxis annularis*), and Black Crappie (*Pomoxis nigromaculatus*); and a few species of percids including the Crystal Darter (*Crystallaria asprella*), Swamp Darter (*Etheostoma fusiforme*), and Cypress Darter (*Etheostoma proeliare*). The Walleye (*Sander vitreus*) was reported by Brown (1962) as occurring in the Murder Creek system.

The information presented in table 3 yielded a list of 80 species of known, probable, or historic occurrence in the Murder Creek system. Of these 80, 54 species were found in this study, 2 species were collected by Bailey and others (1954) not collected in the present study, and an additional 24 species from literature, historical

sampling records, and highly probable, yet undocumented, occurrences. Two species of highest (P1) and high (P2) conservation concern in Alabama (Mirarchi, 2004) were collected in the Murder Creek system: the Ironcolor Shiner (*Notrpois chalybaeus* - P1) with 6 individuals found at two stations (7, 24); and the Bluenose Shiner (*Pteronotropis welaka* – P2) with 35 individuals found at two stations (11, 24). Another species of conservation concern, which is uncommonly collected in Alabama and ranked as a species of moderate conservation concern (P3), was the Southern Logperch (*Percina austroperca*) with two individuals collected at two stations (2, 12b).

The number of species captured at individual stations ranged from 7 (station 5) to 24 (stations 7 and 13) and catch ranged from 27 individuals (station 5) to 412 individuals (station 14) (appendix). This compares to a median biodiversity of 18.3 species (range of 3 to 35) for 205 stream sites distributed throughout the Southern Plains ichthyoregion. Catch for these same 205 sites ranged from 27 to 1,392 individuals (median = 292).

The IBI ranged from *Poor* to *Excellent* with two stations (9, 23) rating *Poor*, 11 stations rating *Fair*, 10 stations rating *Good*, and 3 stations rating *Excellent* (table 4, fig. 4). Station 9 scored in the *Poor* range (34) for the IBI due to low shiner and sucker diversity and low percentages of insectivorous cyprinids and simple lithoplilic spawners. Station 23 also scored 34 with low sucker diversity, a high percentage of pollution tolerant species, and a high percentage of manipulative nonlithophilic spawners.

Twenty two of the 26 habitat assessments completed along with the fish IBI assessments in Murder Creek scored in the optimal to suboptimal range reflecting the availability of generally good habitat conditions throughout the watershed (table 4, fig. 5). Four stations (1, 3, 5, 23) scored in the marginal to poor habitat quality range. Station 5, Juniper Creek, scored lowest at 39 percent of max habitat. Substrate at this station was predominantly detritus and fine organic material (fig. 6) and instream cover rated poor. Dissolved oxygen content was very low at 3.7 miligrams per liter (mg/L) (44 percent saturation) (table 5) well below the 5.0 mg/L criteria for streams classified Fish & Wildlife by the Alabama Department of Environmental Management.

Table 4. Habitat and IBI scores for stations in the Murder Creek system, Alabama, 2008 and 2012.

	Station no.						
	1	2	3	4	5	6	7
Habitat metrics	Habitat metric scores						
Instream cover	6	16	8	15	6	11	18
Pool substrate characterization	7	17	10	14	9	12	16
Pool variability	2	17	8	14	11	12	17
Man-made channel alteration	12	17	12	15	6	17	18
Sediment deposition	6	13	14	14	9	11	18
Channel sinuosity	10	12	9	14	5	14	18
Channel flow status	9	13	15	16	9	19	17
Condition of banks	4	14	8	15	7	14	17
Bank vegetative protection	14	14	9	13	9	14	16
Disruptive pressure	12	12	7	12	7	20	15
Riparian vegetative width	8	12	7	13	7	18	16
Total habitat score	90	157	107	155	85	151	186
Percent of maximum habitat score	40.9	71.4	49.0	70.0	39.0	68.6	85.0
IBI metrics	IBI metric values						
1. Total native species	19	23	12	15	7	21	24
2. Number shiner species	2	4	4	4	3	3	6
3. Number sucker species	1	2	0	0	0	1	0
4. Number centrarchid species	6	8	2	5	2	5	7
4. Number darter+madtom species	4	6	3	2	1	6	4
6. Percent of tolerant species	1.2	1.2	1.2	1.0	0	3.5	5.9
7. Percent GSF+YB	0.9	0.4	0	0	0	0	0
8. Percent insectivorous cyprinids	64.0	57.6	67.7	61.8	59.3	54.0	44.1
10. Percent top carnivores	2.3	1.2	0.0	6.9	3.7	2.0	7.6
11. Percent DELT+hybrids	0	0	0	0	0	0	0
11. Percent simple lithophils	82.3	30.4	50.9	35.3	33.3	49.0	29.7
12. Percent manipulative nonlithophils	4.7	2.0	0.0	5.9	3.7	6.4	9.3
IBI metrics	IBI metric scores						
1. Total native species	5	3	3	1	1	3	5
2. Number shiner species	3	3	3	3	3	1	5
3. Number sucker species	3	3	1	1	1	1	1
4. Number centrarchid species	5	3	1	3	1	3	5
4. Number darter+madtom species	5	3	3	1	1	3	3
6. Percent of tolerant species	5	5	5	5	5	5	3
7. Percent GSF+YB	5	5	5	5	5	5	5
8. Percent insectivorous cyprinids	5	3	5	5	3	3	3
10. Percent top carnivores	3	3	1	5	5	3	5
11. Percent DELT+hybrids	5	5	5	5	5	5	5
11. Percent simple lithophils	5	3	3	3	3	3	1
12. Percent manipulative nonlithophils	5	5	5	3	5	3	3
IBI score	54	44	40	40	38	38	44
Biological condition [1]	Excellent	Good	Fair	Fair	Fair	Fair	Good

[1] Very poor <=25, Poor 26-35, Fair 36-43, Good 44-49, Excellent >=50

Table 4. Habitat and IBI scores for stations in the Murder Creek system, Alabama, 2008 and 2012--continued.

	Station no.						
	8	9	10	11	12a	12b	13
Habitat metrics	Habitat metric scores						
Instream cover	13	16	16	18	14	15	17
Pool substrate characterization	10	17	15	19	16	14	13
Pool variability	11	15	13	19	16	16	16
Man-made channel alteration	16	14	13	19	18	16	18
Sediment deposition	13	15	10	16	11	15	12
Channel sinuosity	16	16	11	17	8	15	12
Channel flow status	18	17	12	18	12	18	18
Condition of banks	15	17	13	15	15	17	17
Bank vegetative protection	18	13	14	14	18	15	14
Disruptive pressure	20	15	16	16	14	12	16
Riparian vegetative width	17	15	16	15	16	16	18
Total habitat score	167	170	149	186	158	169	171
Percent of maximum habitat score	75.9	77.0	67.7	85.0	71.8	77.0	78.0
IBI metrics	IBI metric values						
1. Total native species	22	15	22	20	22	23	24
2. Number shiner species	3	2	4	5	3	4	4
3. Number sucker species	1	0	1	1	1	1	1
4. Number centrarchid species	8	4	5	4	6	5	5
4. Number darter+madtom species	6	6	5	5	5	8	6
6. Percent of tolerant species	4.2	6.8	3.9	8.4	5.0	2.3	2.6
7. Percent GSF+YB	0.8	0	0	0	0	0	0
8. Percent insectivorous cyprinids	32.9	17.1	48.0	59.2	55.6	26.0	38.9
10. Percent top carnivores	1.7	1.1	5.0	3.4	2.1	7.6	1.1
11. Percent DELT+hybrids	0	0	0	0	0	0	0
11. Percent simple lithophils	27.4	26.1	38.6	36.3	41.1	41.2	49.8
12. Percent manipulative nonlithophils	8.0	9.1	7.4	10.6	6.6	9.2	6.4
IBI metrics	IBI metric scores						
1. Total native species	5	3	3	3	3	3	5
2. Number shiner species	3	1	3	3	1	3	3
3. Number sucker species	3	1	1	1	1	1	3
4. Number centrarchid species	5	3	1	1	3	3	3
4. Number darter+madtom species	5	5	3	3	3	5	5
6. Percent of tolerant species	5	3	5	3	5	5	5
7. Percent GSF+YB	5	5	5	5	5	5	5
8. Percent insectivorous cyprinids	3	1	3	3	3	1	3
10. Percent top carnivores	3	3	5	5	3	5	3
11. Percent DELT+hybrids	5	5	5	5	5	5	5
11. Percent simple lithophils	1	1	3	3	3	3	3
12. Percent manipulative nonlithophils	3	3	3	3	3	3	3
IBI score	46	34	40	38	38	42	46
Biological condition [1]	Good	Poor	Fair	Fair	Fair	Fair	Good

[1] Very poor <=25, Poor 26-35, Fair 36-43, Good 44-49, Excellent >=50

Table 4. Habitat and IBI scores for stations in the Murder Creek system, Alabama, 2008 and 2012--continued.

	Station no.						
	14	15	16	17	18	19	20
Habitat metrics	Habitat metric scores						
Instream cover	16	15	12	16	18	12	14
Pool substrate characterization	13	13	9	10	14	13	14
Pool variability	15	13	16	10	16	13	16
Man-made channel alteration	16	17	15	16	18	16	16
Sediment deposition	11	10	7	16	15	17	15
Channel sinuosity	15	16	18	17	17	16	16
Channel flow status	15	15	13	16	18	17	18
Condition of banks	13	17	15	16	15	16	18
Bank vegetative protection	16	13	14	16	18	16	17
Disruptive pressure	16	16	18	16	18	18	17
Riparian vegetative width	18	18	18	16	20	20	16
Total habitat score	164	163	155	165	187	174	177
Percent of maximum habitat score	75.0	74.0	70.0	75.0	85.0	79.0	80.0
IBI metrics	IBI metric values						
1. Total native species	22	21	21	14	18	23	18
2. Number shiner species	5	5	2	3	4	3	3
3. Number sucker species	1	1	1	0	1	0	1
4. Number centrarchid species	3	3	7	2	3	6	4
4. Number darter+madtom species	5	5	4	4	5	6	6
6. Percent of tolerant species	0.2	1.0	14.9	0.8	0.7	2.5	0
7. Percent GSF+YB	0	0.3	0.7	0	0	1.0	0
8. Percent insectivorous cyprinids	62.1	47.6	5.9	36.2	43.2	63.7	53.1
10. Percent top carnivores	0.7	4.8	3.5	10.0	2.7	3.4	2.3
11. Percent DELT+hybrids	0	0	1.4	0	0	1.5	0
11. Percent simple lithophils	66.0	38.7	6.6	23.9	48.0	63.7	39.8
12. Percent manipulative nonlithophils	3.4	10.3	16.0	15.4	8.2	5.4	2.3
IBI metrics	IBI metric scores						
1. Total native species	5	3	5	3	3	5	3
2. Number shiner species	5	5	3	3	3	3	3
3. Number sucker species	3	3	5	1	1	1	3
4. Number centrarchid species	3	3	5	3	1	5	3
4. Number darter+madtom species	5	5	5	5	3	5	5
6. Percent of tolerant species	5	5	3	5	5	5	5
7. Percent GSF+YB	5	5	5	5	5	5	5
8. Percent insectivorous cyprinids	5	3	1	3	3	5	3
10. Percent top carnivores	1	5	5	5	3	5	3
11. Percent DELT+hybrids	5	5	1	5	5	1	5
11. Percent simple lithophils	5	3	1	1	3	5	3
12. Percent manipulative nonlithophils	5	3	1	1	3	3	5
IBI score	52	48	40	40	38	48	46
Biological condition [1]	Excellent	Good	Fair	Fair	Fair	Good	Good

[1] Very poor <=25, Poor 26-35, Fair 36-43, Good 44-49, Excellent >=50

Table 4. Habitat and IBI scores for stations in the Murder Creek system, Alabama, 2008 and 2012--continued.

	Station no.				
	21a	21b	22	23	24
Habitat metrics	Habitat metric scores				
Instream cover	16	16	16	14	18
Pool substrate characterization	13	14	15	11	16
Pool variability	12	16	6	9	17
Man-made channel alteration	16	16	14	16	17
Sediment deposition	11	16	14	11	15
Channel sinuosity	16	16	10	13	13
Channel flow status	17	18	10	10	18
Condition of banks	15	16	12	9	16
Bank vegetative protection	18	15	17	9	18
Disruptive pressure	20	14	17	13	18
Riparian vegetative width	16	15	16	11	20
Total habitat score	170	172	147	126	186
Percent of maximum habitat score	77.3	78.0	67.0	57.0	85.0
IBI metrics	IBI metric values				
1. Total native species	20	19	17	18	19
2. Number shiner species	6	6	5	3	6
3. Number sucker species	0	0	1	0	1
4. Number centrarchid species	3	3	2	3	2
4. Number darter+madtom species	6	6	5	4	4
6. Percent of tolerant species	1.2	0	0	23.8	3.0
7. Percent GSF+YB	0	0	0	0.8	0
8. Percent insectivorous cyprinids	71.8	72.4	73.2	39.7	51.6
10. Percent top carnivores	1.2	2.0	2.0	2.4	4.0
11. Percent DELT+hybrids	0	0	0	0	0.7
11. Percent simple lithophils	67.2	73.5	74.2	33.3	52.0
12. Percent manipulative nonlithophils	3.4	2.7	2.0	33.3	8.2
IBI metrics	IBI metric scores				
1. Total native species	3	3	5	3	5
2. Number shiner species	5	5	5	3	5
3. Number sucker species	1	1	5	1	3
4. Number centrarchid species	1	1	3	3	3
4. Number darter+madtom species	5	5	5	3	5
6. Percent of tolerant species	5	5	5	1	5
7. Percent GSF+YB	5	5	5	5	5
8. Percent insectivorous cyprinids	5	5	5	3	3
10. Percent top carnivores	3	3	3	3	5
11. Percent DELT+hybrids	5	5	5	5	1
11. Percent simple lithophils	5	5	5	3	3
12. Percent manipulative nonlithophils	5	5	5	1	3
IBI score	48	48	56	34	46
Biological condition [1]	Good	Good	Excellent	Poor	Good

[1] Very poor <=25, Poor 26-35, Fair 36-43, Good 44-49, Excellent >=50

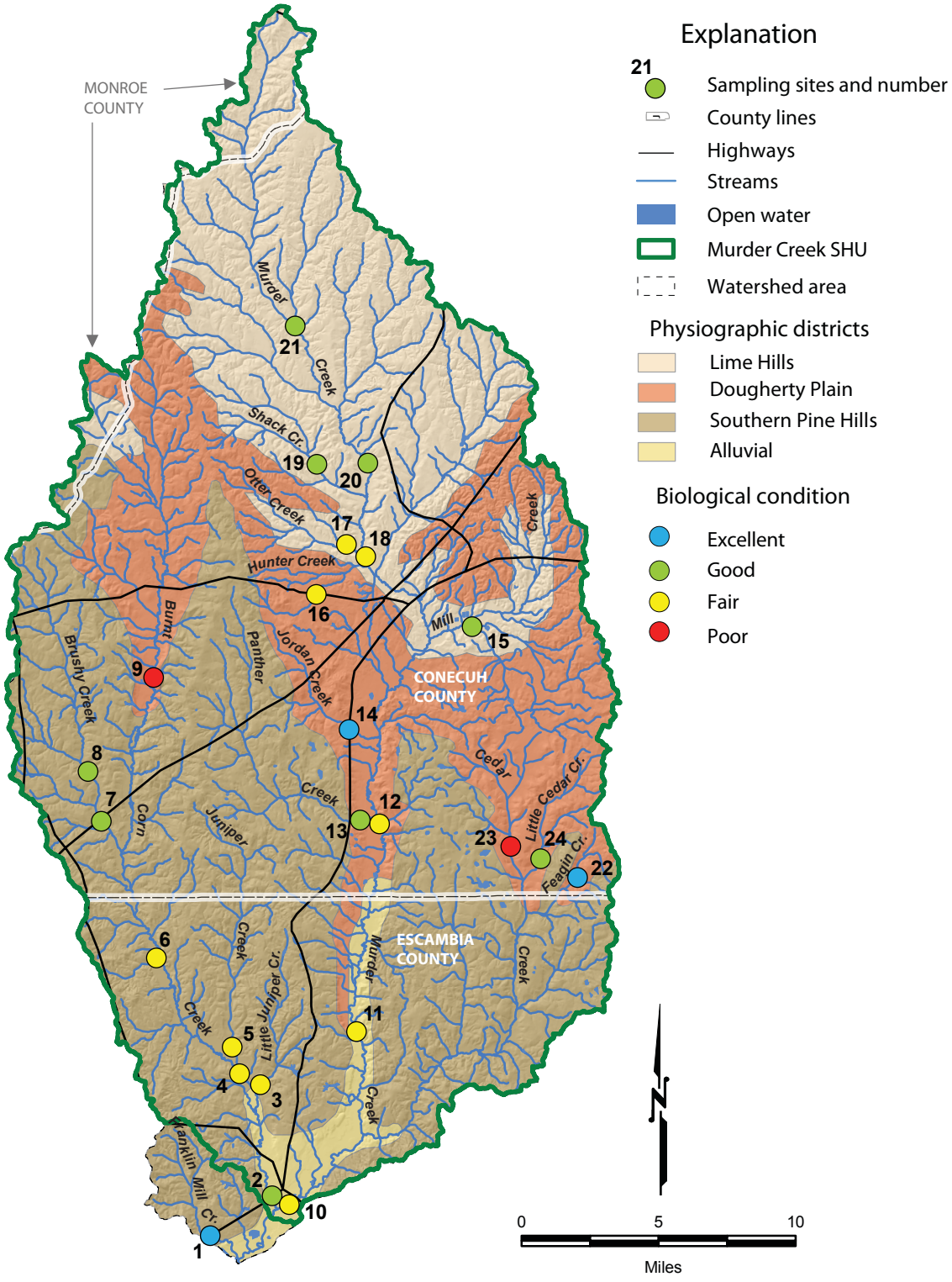


Figure 4. Biological condition of fish sampling stations in the Murder Creek system, Alabama.

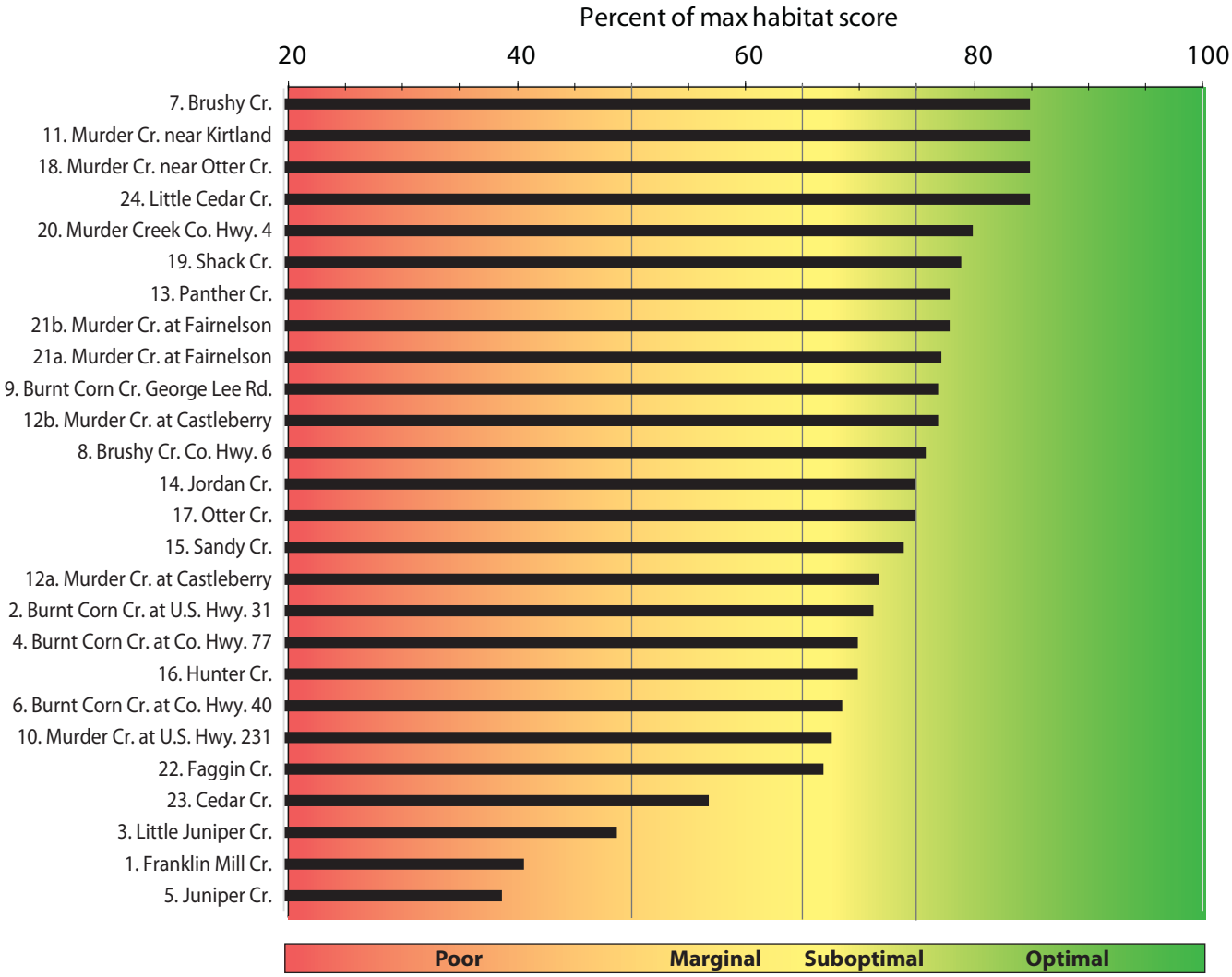


Figure 5. Habitat scores for sites in the Murder Creek system, Alabama.

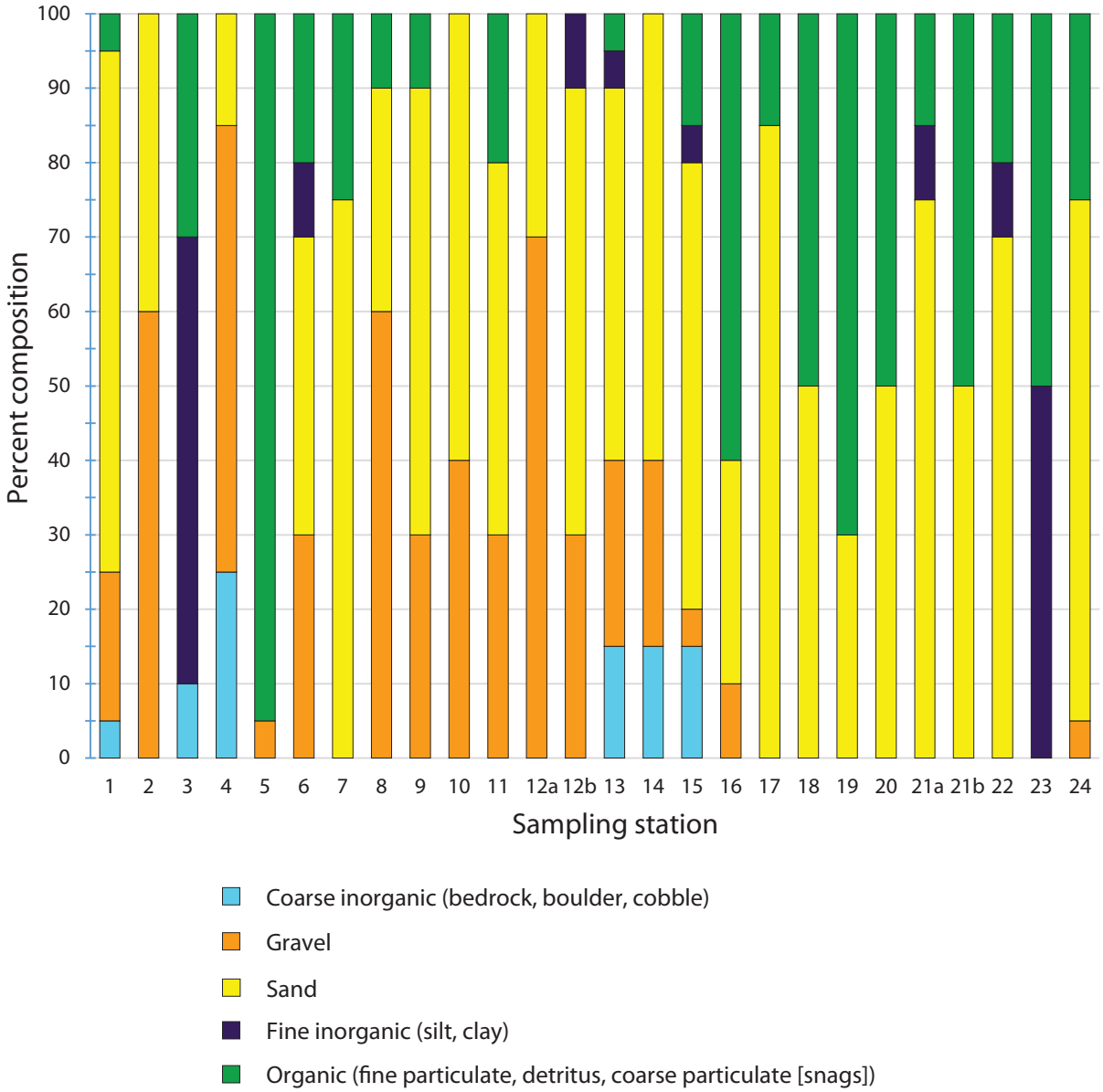


Figure 6. Substrate composition at sampling stations in the Murder Creek system, Alabama.

Table 5. Watershed and stream characteristics for stations in the Murder Creek system, Alabama, 2008 and 2012.

Station no.	1	2	3	4	5	6	7
Area (mi^2)	7.53	187	10.1	162	20.8	124	29.4
GSA No.	2256	2254	1225	1226	1032	2274	1223
Watershed features							
Predominant land use	Industrial	Mixed urban	Forest	Forest	Forest	Forest	Forest
Local NPS pollution sources	Obvious	Potential	None	Potential	Potential	Obvious	None
Local watershed erosion	heavy	Slight	Slight	Slight	Slight	Slight	None
Riparian land use							
Land use at reach	Industrial	Mixed urban	Forest	Forest	Forest	Forest, field, pasture	Forest
Dominant riparian vegetation	Trees	Trees	Trees	Trees	Trees	Trees	Trees
Instream features							
Reach length (ft)	600	500	250	2000	350	600	1000
Stream width (ft)	10	60	12	35	15	60	15
Bank height (ft)	10	15	10	8	10	15	6
Stream depth-riffle (ft)	to 0.5	to 1	na [1]	to 0.5	to 0.5	na	na
Stream depth-run (ft)	to 1	to 2	na	to 1	to 2	to 1	to 1
Stream depth-pool (ft)	<1	>3	to 6	to 4	to 6	>1	>2
Canopy cover (percent)	60-80	40-60	20-40	0-20	60-80	0-20	60-80
Estimated gradient (ft/300 ft)	1-3	1-3	<1	<1	<1	<1	<1
Aquatic vegetation (percent)	0	0	5	5	0	0	5
Flow conditions							
Flow stage	Low	Normal	Above normal	Above normal	Above normal	Low	Normal
Velocity (ft/s)	1.5-3	1.5-3	1.5-3	>3	1.5-3	<1.5	<1.5
Water quality indicators							
Time	1800	1300	1510	1540	1630	1500	1005
Water temperature (ºC)	25.7	28.0	22.0	25.6	24.0	30.0	22.4
pH	5.6	6.9	--	--	--	7.1	--
Specific conductance (μS/cm)	23	3	34	80	51	69	41
Dissolved oxygen (mg/L)	7.3	9.4	2.6	6.9	3.7	6.1	6.0
Percent DO saturation	90	95	30	85	44	80	69
Water odors	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Surface oils	Flecks	None	None	None	None	None	None
Turbidity	Slight	Slight	None	None	Slight	Moderate	None
Water color	Lgt tannic	Lgt tannic	Dark tannic	Lgt tannic	Dark tannic	Lgt tannic	Lgt tannic
Sediment quality indicators							
Sediment odors	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Oils	Slight	Absent	Absent	Absent	Absent	Absent	Absent
Bottom deposits	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Substrate composition (percent)							
Bedrock	0	0	0	0	0	0	0
Boulder	5	0	0	0	0	0	0
Cobble	0	0	10	25	0	0	0
Gravel	20	60	0	60	5	30	0
Sand	70	40	0	15	0	40	75
Silt	0	0	60	0	0	10	0
Clay	0	0	0	0	0	0	0
Fine organic	0	0	40	0	20	0	0
Detritus	0	0	0	0	75	0	0
Snag	5	0	0	0	0	20	25

[1] - na not applicable

Table 5. Watershed and stream characteristics for stations in the Murder Creek system, Alabama, 2008 and 2012--continued.

Station no.	8	9	10	11	12a	12b	13
Area (mi^2)	23.6	54.8	435	329	290	290	28.3
GSA No.	2273	1224	2255	1216	2222	1217	1208
Watershed features							
Predominant land use	Forest, residential	Forest	Mixed urban	Forest	Forest	Forest	Forest
Local NPS pollution sources	Obvious	None	Potential	None	Obvious	None	Potential
Local watershed erosion	Slight	Slight	Moderate	None	Slight	None	Slight
Riparian land use							
Land use at reach	Forest, field, residential	Forest	Mixed urban	Forest	Forest	Forest	Forest
Dominant riparian vegetation	Trees	Trees	Trees	Trees	Trees	Trees	Trees
Instream features							
Reach length (ft)	500	1100	500	600	800	800	900
Stream width (ft)	20	15	150	60	100	60	30
Bank height (ft)	8	6	20	10	15	10	4
Stream depth-riffle (ft)	<0.5	na	to 1	na	na	na	na
Stream depth-run (ft)	to 1	to 1	to 1.5	to 3	to 0.5	to 3	to 1
Stream depth-pool (ft)	<1	>2	>2	to 6	to 2	to 6	>2
Canopy cover (percent)	60-80	40-60	20-40	0-20	0-20	20-40	60-80
Estimated gradient (ft/300 ft)	1-3	<1	1-3	<1	<1	<1	<1
Aquatic vegetation (percent)	0	0	5	0	0	0	0
Flow conditions							
Flow stage	Normal	Normal	Normal	Above normal	Low	Above normal	Normal
Velocity (ft/s)	<1.5	1.5-3	1.5-3	>3	1.5-3	1.5-3	na
Water quality indicators							
Time	1045	1300	1545	1430	--	1650	1110
Water temperature (ºC)	26.0	23.0	29.2	--	--	26.0	22.2
pH	5.4	--	7.5	7.1	--	7.6	7.5
Specific conductance (μS/cm)	50	164	75	84	--	71	119
Dissolved oxygen (mg/L)	7.0	5.9	7.9	9.2	--	8.3	7.9
Percent DO saturation	86	69	104	111	--	100	91
Water odors	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Surface oils	None	None	Flecks	None	None	None	None
Turbidity	None	None	Slight	None	None	None	Slight
Water color	Lgt tannic	Lgt tannic	Lgt tannic	Dark tannic	Lgt tannic	Lgt tannic	Lgt tannic
Sediment quality indicators							
Sediment odors	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Oils	Absent	Absent	Slight	Absent	Absent	Absent	Absent
Bottom deposits	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Substrate composition (percent)							
Bedrock	0	0	0	0	0	0	5
Boulder	0	0	0	0	0	0	0
Cobble	0	0	0	0	0	0	10
Gravel	60	30	40	30	70	30	25
Sand	30	60	60	50	30	60	50
Silt	0	0	0	0	0	0	10
Clay	0	0	0	0	0	10	0
Fine organic	0	0	0	0	0	0	0
Detritus	0	10	0	0	0	0	0
Snag	10	0	0	20	0	0	10

[1] - na not applicable

Table 5. Watershed and stream characteristics for stations in the Murder Creek system, Alabama, 2008 and 2012--continued.

Station no.	14	15	16	17	18	19	20
Area (mi^2)	9.37	21	2.7	8.4	122	12	93.6
GSA No.	1214	1211	1210	1221	1220	1209	1219
Watershed features							
Predominant land use	Forest	Forest	Forest, Agriculture	Forest	Forest	Forest	Forest
Local NPS pollution sources	Obvious	Obvious	Obvious	Potential	None	Obvious	Obvious
Local watershed erosion	Moderate	Moderate	Heavy	Slight	Slight	Moderate	Moderate
Riparian land use							
Land use at reach	Forest	Forest	Forest	Forest	Forest	Forest	Forest
Dominant riparian vegetation	Trees	Trees	Trees	Shrubs	Trees	Trees	Trees
Instream features							
Reach length (ft)	900	800	800	1200	1000	1,500	1200
Stream width (ft)	30	20	20	5	45	10	40
Bank height (ft)	5	5	7	3	10	3	10
Stream depth-riffle (ft)	na	na	na	na	na	na	na
Stream depth-run (ft)	<1	<0.5	<0.5	to 0.25	to 3	1	to 3
Stream depth-pool (ft)	to 3	to 3	to 4	to 1	to 6	>1	to 5
Canopy cover (percent)	60-80	60-80	40-60	60-80	80-100	60-80	60-80
Estimated gradient (ft/300 ft)	<1	<1	<1	1-3	<1	<1	<1
Aquatic vegetation (percent)	0	0	30	0	0	5	5
Flow conditions							
Flow stage	Low	Low	Low	Normal	Normal	Above normal	Normal
Velocity (ft/s)	<1.5	<1.5	<1.5	1.5-3	1.5-3	<1.5	1.5-3
Water quality indicators							
Time	1550	1020	1845	1225	1045	1550	1330
Water temperature (ºC)	22.8	21.9	23.8	22.0	22.0	24.0	24.0
pH	7.8	7.1	7.4	7.2	4.5	6.5	5.6
Specific conductance (μS/cm)	205	173	213	138	65	260	26
Dissolved oxygen (mg/L)	8.5	7.7	5.0	7.8	7.3	5.8	7.7
Percent DO saturation	99	89	60	89	84	63	92
Water odors	Normal	Normal	Organic	Normal	Normal	Normal	Normal
Surface oils	Flecks	None	Flecks	None	None	None	None
Turbidity	Slight	Slight	Moderate	Slight	None	Slight	None
Water color	Dark tannic	Dark tannic	Muddy	Muddy	None	Grey	None
Sediment quality indicators							
Sediment odors	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Oils	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Bottom deposits	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Substrate composition (percent)							
Bedrock	5	10	0	0	0	0	0
Boulder	0	0	0	0	0	0	0
Cobble	10	5	0	0	0	0	0
Gravel	25	5	10	0	0	0	0
Sand	50	60	30	85	50	30	50
Silt	0	5	0	0	0	0	0
Clay	0	0	0	0	0	0	0
Fine organic	0	0	60	0	0	70	0
Detritus	0	15	0	0	0	0	25
Snag	0	0	0	15	50	0	25

[1] - na not applicable

Table 5. Watershed and stream characteristics for stations in the Murder Creek system, Alabama, 2008 and 2012--continued.

Station no.	21a	21b	22	23	24
Area (mi^2)	42.6	42.6	2.52	12.2	8.18
GSA No.	2272	1031	1218	1227	1215
Watershed features					
Predominant land use	Forest/field	Forest	Forest	Forest	Forest
Local NPS pollution sources	Potential	Potential	Potential	None	Potential
Local watershed erosion	Slight	Slight	Slight	None	Slight
Riparian land use					
Land use at reach	Forest	Forest	Forest	Forest	Forest
Dominant riparian vegetation	Trees	Trees	Trees	Trees	Trees,
Instream features					
Reach length (ft)	700	1,200	1200	500	900
Stream width (ft)	30	20	10	Braided	30
Bank height (ft)	10	10	8	8	6
Stream depth-riffle (ft)	na	na	na	to 1	na
Stream depth-run (ft)	to 2	to 2.5	to 0.5	to 4	to 2
Stream depth-pool (ft)	>2	to 5	to 1	to 5	to 4
Canopy cover (percent)	60-80	40-60	80-100	40-60	60-80
Estimated gradient (ft/300 ft)	<1	<1	<1	<1	<1
Aquatic vegetation (percent)	0	0	0	0	0
Flow conditions					
Flow stage	Normal	Above normal	Normal	Normal	Low
Velocity (ft/s)	<1.5	1.5-3	<1.5	<1.5	<1.5
Water quality indicators					
Time	1200	1545	1015	1330	1005
Water temperature (ºC)	23.6	22.0	22.0	21.3	29.0
pH	6.3	6.7	5.7		6.7
Specific conductance (μS/cm)	15	20	34	223	137
Dissolved oxygen (mg/L)	7.3	8.2	7.8	6.0	6.6
Percent DO saturation	86	95	89	68	75
Water odors	Normal	Normal	Normal	Normal	Normal
Surface oils	None	None	None	None	None
Turbidity	Slight	None	None	Slight	None
Water color	Lgt tannic	None	None	Lgt tannic	Dark tannic
Sediment quality indicators					
Sediment odors	Normal	Normal	Normal	Normal	Normal
Oils	Absent	Absent	Absent	Absent	Absent
Bottom deposits	Sand	Sand	Sand	Sand	Sand
Substrate composition (percent)					
Bedrock	0	0	0	0	0
Boulder	0	0	0	0	0
Cobble	0	0	0	0	0
Gravel	0	0	0	0	5
Sand	75	50	70	0	70
Silt	10	0	0	50	0
Clay	0	0	10	0	0
Fine organic	0	0	0	0	0
Detritus	0	25	0	50	0
Snag	15	25	20	0	25

[1] - na not applicable

Banks were in poor condition riparian zones were narrow, and significant disruptive pressure was noted around the stream.

Station 1, Franklin Mill Creek, scored only slightly higher at 41 percent of max habitat (table 5). The substrate here was predominantly sand with some gravel (Fig. 6) and the channel was homogeneous in depth with little pool variability. Riparian width was modest and banks were fairly well vegetated but eroding (table 6). The stream flows under U.S. Hwy. 31 which impacts the site downstream. Just upstream of U.S. Hwy 31 is a mill dam which also has an effect on this station.

Station 3, Little Juniper Creek, scored 49 percent of max habitat. Substrate was predominantly silt and fine organic material (table 6). The stream reach was deep pools, instream cover was homogeneous, bank conditions were poor, and riparian width was narrow. Dissolved oxygen was very low at 2.6 mg/L (30 percent saturation).

Station 23, Cedar Creek, scored 57 percent of max habitat (table 5). Substrate was about an equal mix of silt/clay and detritus (fig. 6). Pools were relatively deep, up to 5 feet, and instream cover was a better mix of hard materials, snags, and finer sediments. Banks were in better condition compared to stations 1, 3, and 5, but still in the poor range. The stream was braided with a relatively low gradient. Dissolved oxygen measured 6.0 mg/L (68 percent saturation).

Several sites (7, 11, 18, 24) all scored 85 percent of max habitat, a high rating, indicating good to very good habitat conditions. Station 7, Brushy Creek, had good instream cover and pool variability with about 75 percent sand cover and 25 percent snag cover, extensive canopy cover, wide riparian zones, and protected banks (table 6). Station 11, Murder Creek near Kirtland, also had good instream cover with around 50 percent sand, 30 percent gravel, and 20 percent snag. Bank cover and riparian zones were good while dissolved oxygen was among the highest measured at 9.2 mg/L (111 percent saturation). Station 18, Murder Creek near Otter Creek, had good instream cover but pool variability appeared reduced and more sediment than normal was observed on the stream bottom. The bottom was about 50 percent sand and 50 percent snags. Canopy cover was high and the banks and riparian cover were in good condition. Station 24, Little Cedar Creek, had high marks for instream cover, bank and

riparian condition, and pool variability. The substrate was comprised of about 70 percent sand, 25 percent snag, and 5 percent gravel. It is of note that the two species of high and highest conservation concern (*Notropis chalybaeus* and *Pteronotropis welaka*) were found at sites 7, 11, and 24, which all scored highest for habitat quality.

The overall quality of aquatic habitat in the Murder Creek system can be categorized as good. The majority of sites sampled in the mid and upper reaches of the watershed scored in the optimal to suboptimal range. The presence of Ironcolor and Bluenose Shiners in this region lends support to this conclusion. Isolated areas of degraded habitat quality were observed but the causes were not readily apparent. Sites 3 and 5, Little Juniper and Juniper Creeks, were in very poor physical condition and in apparent poor water quality condition as well. Further investigation into these small tributaries may be warranted to identify sources of habitat impairment. Franklin Creek, station 1, scored poor in habitat quality but excellent in biological condition.

CONCLUSIONS AND RECOMMENDATIONS

Based on these data a few preliminary action items for the Murder Creek system would be to work with landowners to maintain riparian and stream habitat and water quality conditions. Most of the Cedar Creek subwatershed is forested and much of the stream flows within the boundaries of the T.R. Miller Wildlife Management Area. Landscape conservation practices should be continued and encouraged further in this area to support populations of highest and high conservation concern. Lower Burnt Corn Creek tended to have lower habitat scores reflecting its proximity to Brewton and likely more disruptive land use patterns. Work including road-stream crossing surveys and more extensive habitat evaluations may lead to discovery of the causes of poor habitat conditions in this part of the watershed.

REFRENCES CITED

Alabama Soil and Water Conservation Committee, 2007, Alabama Watershed Assessment: accessed 20 January 2015, available from http://swcc.alabama.gov/pages/watershed.aspx?sm=b_a

Atkins, J.B., and Pearman, J.L., 1994, Low-flow and flow-duration characteristics of Alabama streams: U.S. Geological Survey Water-Resources Investigations Reports 93-4186, 264 p.

Bailey, R.M., Winn, H.E., and Smith, C.L., 1954, Fishes from the Escambia River. Alabama and Florida, with ecologic and taxonomic notes: Proceedings of the Academy of Natural Sciences of Philadelphia, v. 106, p. 109-164.

Barbour, M.T., Gerritsen, Jeroen, Snyder, B.D., and Stribling, J.B., 1999, Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates, and fish, second edition: Washington, D.C., U.S. Environmental Protection Agency, Office of Water, EPA 841-B-99-002.

Boschung, H.T., and Mayden, R.L., 2004, Fishes of Alabama: Smithsonian Books, 736 p.

Brown, B.E., 1962, Occurrence of Walleye, *Stizostedion vireum*, in Alabama, south of the Tennessee Valley: Copeia 1962 (2), p. 469-471.

Mettee, M.F., O'Neil, P.E., and Pierson, J.M., 1996, Fishes of Alabama and the Mobile basin: Oxmoor House, Birmingham, AL, 820 p.

Mirarchi, R.E., ed., 2004, Alabama wildlife. Volume 1. A checklist of vertebrates and selected invertebrates: aquatic mollusks, fishes, amphibians, reptiles, birds, and mammals: Tuscaloosa, Alabama, The University of Alabama Press, 209 p.

O'Neil, P.E. and Shepard, T.E. 2012, Calibration of the index of biotic integrity for the Southern Plains ichthyoregion in Alabama: Alabama Geological Survey Open-File Report 1210, 126 p.

O'Neil, P.E., Shepard, T.E., and Cook, M.R., 2006, Habitat and biological assessment of the Terrapin Creek watershed and development of the Index of Biotic Integrity for the Coosa and Tallapoosa River systems: Alabama Geological Survey Open-File Report 0601, 210 p.

Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross, S.K., and Hughes, R.M., 1989, Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish: Washington, D.C., U.S. Environmental Protection Agency, Office of Water Regulations and Standards, EPA 440-4-89-001.

Sapp, C.D., and Emplaincourt, J., 1975, Physiographic regions of Alabama: Alabama Geological Survey Special Map 168.

Wynn, E.A., O'Neil, P.E., McGregor, S.W., Powell, J.R., Pritchett, J.M., Ford, A.D., & Johnson, P.D., 2012, Strategic habitat and river reach units for aquatic species of conservation concern in Alabama, Geological Survey of Alabama Special Map 248.

Appendix

Fish collection data for the Murder Creek system, Alabama

Species		Station			
		1	2	3	4
Petromyzontidae-Lampreys					
Ichthyomyzon gagei	Southern Brook Lamprey	--	--	--	--
Lampetra aepyptera	Least Brook Lamprey	--	--	1	--
Lepisosteidae-Gars					
Lepisosteus oculatus	Spotted Gar	--	--	--	2
Lepisosteus osseus	Longnose Gar	--	--	--	--
Anguillidae-Freshwater Eels					
Anguilla rostrata	American Eel	--	--	--	1
Cyprinidae-Minnows and Carps					
Cyprinella venusta	Blacktail Shiner	--	113	41	38
Hybopsis sp cf winchelli	Coastal Clear Chub	--	4	--	--
Lythrurus atrapiculus	Blacktip Shiner	--	--	46	--
Notemigonus crysoleucas	Golden Shiner	--	--	--	--
Notropis amplamala	Longjaw Minnow	--	3	--	1
Notropis chalybaeus	Ironcolor Shiner	--	--	--	--
Notropis harperi	Redeye Chub	--	--	--	--
Notropis longirostris	Longnose Shiner	--	10	--	7
Notropis texanus	Weed Shiner	--	18	11	17
Opsopoeodus emiliae	Pugnose Minnow	--	--	--	--
Pteronotropis hypselopterus	Sailfin Shiner	183	--	--	--
Pteronotropis signipinnis	Flagfin Shiner	37	--	15	--
Pteronotropis welaka	Bluenose Shiner	--	--	--	--
Semotilus thoreauianus	Dixie Chub	4	--	--	--
Catostomidae-Suckers					
Erimyzon sucetta	Lake Chubsucker	1	--	--	--
Minytrema melanops	Spotted Sucker	--	1	--	--
Moxostoma poecilurum	Blacktail Redhorse	--	4	--	--
Ictaluridae - North American Catfishes					
Ameiurus natalis	Yellow Bullhead	1	--	--	--
Noturus funebris	Black Madtom	4	--	--	--
Noturus leptacanthus	Speckled Madtom	4	3	--	5
Esocidae-Pikes					
Esox americanus	Redfin Pickerel	4	--	--	3
Esox niger	Chain Pickerel	--	--	--	--
Aphredoderidae Pirate Perch					
Aphredoderus sayanus	Pirate Perch	1	--	--	--
Atherinopsidae - New World Silversides					
Labidesthes sicculus	Brook Silverside	--	--	17	--
Fundulidae-Topminnows					
Fundulus olivaceus	Blackspotted Topminnow	8	6	9	11
Poeciliidae-Livebearers					
Gambusia holbrooki	Eastern Mosquitofish	1	--	--	--

Species		Station			
		1	2	3	4
Centrarchidae-Sunfishes					
Ambloplites ariommus	Shadow Bass	--	1	--	1
Lepomis cyanellus	Green Sunfish	2	1	--	--
Lepomis gulosus	Warmouth	1	--	--	--
Lepomis macrochirus	Bluegill	--	1	2	1
Lepomis marginatus	Dollar Sunfish	--	--	--	--
Lepomis megalotis	Longear Sunfish	20	40	9	1
Lepomis microlophus	Redear Sunfish	--	2	--	--
Lepomis miniatus	Redspotted Sunfish	4	8	--	2
Lepomis Hybrid		--	--	--	--
Micropterus punctulatus	Spotted Bass	1	1	--	1
Micropterus salmoides	Largemouth Bass	3	1	--	--
Percidae-Perches and Darters					
Ammocrypta bifascia	Florida Sand Darter	--	4	--	--
Etheostoma colorosum	Coastal Darter	--	2	3	--
Etheostoma davisoni	Choctawhatchee Darter	--	--	--	--
Etheostoma edwini	Brown Darter	2	--	--	--
Etheostoma histrio	Harlequin Darter	--	--	--	--
Etheostoma parvipinne	Goldstripe Darter	--	--	--	--
Etheostoma stigmaeum	Speckled Darter	--	--	3	--
Etheostoma swaini	Gulf Darter	--	--	--	--
Percina austroperca	Southern Logperch	--	1	--	--
Percina nigrofasciata	Blackbanded Darter	63	21	10	11
Percina vigil	Saddleback darter	--	7	--	--
Elassomatidae-Pygmy Sunfishes					
Elassoma zonatum	banded Pygmy Sunfish	--	--	--	--
Achiridae-American Soles					
Trinectes maculatus	Hogchocker	--	5	--	--
	Catch	344	257	167	102
	Total species	19	23	12	15

Species		Station			
		5	6	7	8
Petromyzontidae-Lampreys					
Ichthyomyzon gagei	Southern Brook Lamprey	--	1	--	--
Lampetra aepyptera	Least Brook Lamprey	--	--	--	--
Lepisosteidae-Gars					
Lepisosteus oculatus	Spotted Gar	--	--	--	--
Lepisosteus osseus	Longnose Gar	--	--	--	--
Anguillidae-Freshwater Eels					
Anguilla rostrata	American Eel	--	--	--	--
Cyprinidae-Minnows and Carps					
Cyprinella venusta	Blacktail Shiner	9	31	17	62
Hybopsis sp cf winchelli	Coastal Clear Chub	--	13	1	2
Lythrurus atrapiculus	Blacktip Shiner	2	--	3	1
Notemigonus crysoleucas	Golden Shiner	--	--	1	--
Notropis amplamala	Longjaw Minnow	--	1	--	--
Notropis chalybaeus	Ironcolor Shiner	--	--	1	--
Notropis harperi	Redeye Chub	--	--	--	--
Notropis longirostris	Longnose Shiner	--	--	--	--
Notropis texanus	Weed Shiner	5	64	8	13
Opsopoeodus emiliae	Pugnose Minnow	--	--	--	--
Pteronotropis hypselopterus	Sailfin Shiner	--	--	21	--
Pteronotropis signipinnis	Flagfin Shiner	--	--	--	--
Pteronotropis welaka	Bluenose Shiner	--	--	--	--
Semotilus thoreauianus	Dixie Chub	--	--	--	--
Catostomidae-Suckers					
Erimyzon sucetta	Lake Chubsucker	--	--	--	--
Minytrema melanops	Spotted Sucker	--	2	--	--
Moxostoma poecilurum	Blacktail Redhorse	--	--	--	3
Ictaluridae - North American Catfishes					
Ameiurus natalis	Yellow Bullhead	--	--	--	--
Noturus funebris	Black Madtom	--	--	--	--
Noturus leptacanthus	Speckled Madtom	--	3	1	11
Esocidae-Pikes					
Esox americanus	Redfin Pickerel	--	--	5	--
Esox niger	Chain Pickerel	--	--	--	--
Aphredoderidae Pirate Perch					
Aphredoderus sayanus	Pirate Perch	--	2	1	2
Atherinopsidae - New World Silversides					
Labidesthes sicculus	Brook Silverside	2	7	9	19
Fundulidae-Topminnows					
Fundulus olivaceus	Blackspotted Topminnow	--	6	14	12
Poeciliidae-Livebearers					
Gambusia holbrooki	Eastern Mosquitofish	--	5	3	--

Species		Station			
		5	6	7	8
Centrarchidae-Sunfishes					
Ambloplites ariommus	Shadow Bass	--	2	2	--
Lepomis cyanellus	Green Sunfish	--	--	--	2
Lepomis gulosus	Warmouth	--	1	--	1
Lepomis macrochirus	Bluegill	--	--	3	8
Lepomis marginatus	Dollar Sunfish	--	--	--	1
Lepomis megalotis	Longear Sunfish	6	22	11	29
Lepomis microlophus	Redear Sunfish	--	--	2	--
Lepomis miniatus	Redspotted Sunfish	--	7	1	9
Lepomis Hybrid		--	--	--	--
Micropterus punctulatus	Spotted Bass	1	2	1	3
Micropterus salmoides	Largemouth Bass	--	--	1	1
Percidae-Perches and Darters					
Ammocrypta bifascia	Florida Sand Darter	--	2	--	--
Etheostoma colorosum	Coastal Darter	--	8	3	10
Etheostoma davisoni	Choctawhatchee Darter	--	--	--	1
Etheostoma edwini	Brown Darter	--	--	4	--
Etheostoma histrio	Harlequin Darter	--	--	--	--
Etheostoma parvipinne	Goldstripe Darter	--	--	--	--
Etheostoma stigmaeum	Speckled Darter	--	6	--	5
Etheostoma swaini	Gulf Darter	--	6	--	1
Percina austroperca	Southern Logperch	--	--	--	--
Percina nigrofasciata	Blackbanded Darter	2	11	1	41
Percina vigil	Saddleback darter	--	--	--	--
Elassomatidae-Pygmy Sunfishes					
Elassoma zonatum	banded Pygmy Sunfish	--	--	4	--
Achiridae-American Soles					
Trinectes maculatus	Hogchocker	--	--	--	--
	Catch	27	202	118	237
	Total species	7	21	24	22

Species		Station			
		9	10	11	12a
Petromyzontidae-Lampreys					
Ichthyomyzon gagei	Southern Brook Lamprey	--	--	--	--
Lampetra aepyptera	Least Brook Lamprey	--	--	--	--
Lepisosteidae-Gars					
Lepisosteus oculatus	Spotted Gar	--	--	--	--
Lepisosteus osseus	Longnose Gar	--	--	1	--
Anguillidae-Freshwater Eels					
Anguilla rostrata	American Eel	--	1	--	--
Cyprinidae-Minnows and Carps					
Cyprinella venusta	Blacktail Shiner	14	103	69	76
Hybopsis sp cf winchelli	Coastal Clear Chub	--	11	1	8
Lythrurus atrapiculus	Blacktip Shiner	--	--	--	--
Notemigonus crysoleucas	Golden Shiner	--	--	--	--
Notropis amplamala	Longjaw Minnow	--	2	4	8
Notropis chalybaeus	Ironcolor Shiner	--	--	--	--
Notropis harperi	Redeye Chub	--	--	--	--
Notropis longirostris	Longnose Shiner	--	53	7	--
Notropis texanus	Weed Shiner	1	14	24	42
Opsopoeodus emiliae	Pugnose Minnow	--	--	--	--
Pteronotropis hypselopterus	Sailfin Shiner	--	--	--	--
Pteronotropis signipinnis	Flagfin Shiner	--	--	--	--
Pteronotropis welaka	Bluenose Shiner	--	--	1	--
Semotilus thoreauianus	Dixie Chub	--	--	--	--
Catostomidae-Suckers					
Erimyzon sucetta	Lake Chubsucker	--	--	--	--
Minytrema melanops	Spotted Sucker	--	--	--	--
Moxostoma poecilurum	Blacktail Redhorse	--	5	1	4
Ictaluridae - North American Catfishes					
Ameiurus natalis	Yellow Bullhead	--	--	--	--
Noturus funebris	Black Madtom	--	--	--	--
Noturus leptacanthus	Speckled Madtom	3	4	1	2
Esocidae-Pikes					
Esox americanus	Redfin Pickerel	--	4	--	2
Esox niger	Chain Pickerel	--	--	--	--
Aphredoderidae Pirate Perch					
Aphredoderus sayanus	Pirate Perch	--	1	--	1
Atherinopsidae - New World Silversides					
Labidesthes sicculus	Brook Silverside	--	--	--	--
Fundulidae-Topminnows					
Fundulus olivaceus	Blackspotted Topminnow	5	33	10	9
Poeciliidae-Livebearers					
Gambusia holbrooki	Eastern Mosquitofish	4	8	14	10

Species		Station			
		9	10	11	12a
Centrarchidae-Sunfishes					
Ambloplites ariommus	Shadow Bass	1	--	1	1
Lepomis cyanellus	Green Sunfish	--	--	--	--
Lepomis gulosus	Warmouth	--	--	--	--
Lepomis macrochirus	Bluegill	2	7	--	2
Lepomis marginatus	Dollar Sunfish	--	--	--	--
Lepomis megalotis	Longear Sunfish	5	41	12	13
Lepomis microlophus	Redear Sunfish	--	--	--	--
Lepomis miniatus	Redspotted Sunfish	5	16	1	11
Lepomis Hybrid		--	--	--	--
Micropterus punctulatus	Spotted Bass	--	14	4	1
Micropterus salmoides	Largemouth Bass	--	1	--	1
Percidae-Perches and Darters					
Ammocrypta bifascia	Florida Sand Darter	--	8	1	--
Etheostoma colorosum	Coastal Darter	9	--	1	11
Etheostoma davisoni	Choctawhatchee Darter	--	--	--	--
Etheostoma edwini	Brown Darter	--	--	--	--
Etheostoma histrio	Harlequin Darter	2	--	--	--
Etheostoma parvipinne	Goldstripe Darter	--	1	--	--
Etheostoma stigmaeum	Speckled Darter	1	--	--	--
Etheostoma swaini	Gulf Darter	14	--	--	1
Percina austroperca	Southern Logperch	--	--	--	--
Percina nigrofasciata	Blackbanded Darter	21	24	19	28
Percina vigil	Saddleback darter	--	7	4	7
Elassomatidae-Pygmy Sunfishes					
Elassoma zonatum	banded Pygmy Sunfish	1	--	--	1
Achiridae-American Soles					
Trinectes maculatus	Hogchocker	--	23	3	2
	Catch	88	381	179	241
	Total species	15	22	20	22

Species		Station			
		12b	13	14	15
Petromyzontidae-Lampreys					
Ichthyomyzon gagei	Southern Brook Lamprey	--	1	--	--
Lampetra aepyptera	Least Brook Lamprey	--	--	--	--
Lepisosteidae-Gars					
Lepisosteus oculatus	Spotted Gar	--	--	--	--
Lepisosteus osseus	Longnose Gar	--	--	--	--
Anguillidae-Freshwater Eels					
Anguilla rostrata	American Eel	--	--	3	--
Cyprinidae-Minnows and Carps					
Cyprinella venusta	Blacktail Shiner	13	1	11	39
Hybopsis sp cf winchelli	Coastal Clear Chub	11	9	52	--
Lythrurus atrapiculus	Blacktip Shiner	--	24	148	22
Notemigonus crysoleucas	Golden Shiner	--	--	--	--
Notropis amplamala	Longjaw Minnow	1	--	1	4
Notropis chalybaeus	Ironcolor Shiner	--	--	--	--
Notropis harperi	Redeye Chub	--	--	4	40
Notropis longirostris	Longnose Shiner	2	--	--	--
Notropis texanus	Weed Shiner	7	8	32	23
Opsopoeodus emiliae	Pugnose Minnow	--	--	--	--
Pteronotropis hypselopterus	Sailfin Shiner	--	61	8	11
Pteronotropis signipinnis	Flagfin Shiner	--	--	--	--
Pteronotropis welaka	Bluenose Shiner	--	--	--	--
Semotilus thoreauianus	Dixie Chub	--	1	--	--
Catostomidae-Suckers					
Erimyzon sucetta	Lake Chubsucker	--	--	--	--
Minytrema melanops	Spotted Sucker	--	--	--	--
Moxostoma poecilurum	Blacktail Redhorse	4	3	1	1
Ictaluridae - North American Catfishes					
Ameiurus natalis	Yellow Bullhead	--	--	--	1
Noturus funebris	Black Madtom	--	--	--	--
Noturus leptacanthus	Speckled Madtom	6	5	--	1
Esocidae-Pikes					
Esox americanus	Redfin Pickerel	2	1	1	14
Esox niger	Chain Pickerel	1	--	--	--
Aphredoderidae Pirate Perch					
Aphredoderus sayanus	Pirate Perch	--	3	9	23
Atherinopsidae - New World Silversides					
Labidesthes sicculus	Brook Silverside	--	1	4	--
Fundulidae-Topminnows					
Fundulus olivaceus	Blackspotted Topminnow	10	2	16	11
Poeciliidae-Livebearers					
Gambusia holbrooki	Eastern Mosquitofish	1	6	1	2

Species		Station			
		12b	13	14	15
Centrarchidae-Sunfishes					
Ambloplites ariommus	Shadow Bass	2	2	--	--
Lepomis cyanellus	Green Sunfish	--	--	--	--
Lepomis gulosus	Warmouth	--	3	--	1
Lepomis macrochirus	Bluegill	2	1	--	--
Lepomis marginatus	Dollar Sunfish	--	--	--	--
Lepomis megalotis	Longear Sunfish	9	17	47	8
Lepomis microlophus	Redear Sunfish	--	--	--	--
Lepomis miniatus	Redspotted Sunfish	2	2	11	13
Lepomis Hybrid		--	--	--	--
Micropterus punctulatus	Spotted Bass	5	--	2	--
Micropterus salmoides	Largemouth Bass	--	--	--	--
Percidae-Perches and Darters					
Ammocrypta bifascia	Florida Sand Darter	2	--	--	--
Etheostoma colorosum	Coastal Darter	10	83	30	51
Etheostoma davisoni	Choctawhatchee Darter	--	--	2	--
Etheostoma edwini	Brown Darter	--	1	3	1
Etheostoma histrio	Harlequin Darter	--	--	--	--
Etheostoma parvipinne	Goldstripe Darter	--	--	--	--
Etheostoma stigmaeum	Speckled Darter	1	16	13	--
Etheostoma swaini	Gulf Darter	14	3	--	12
Percina austroperca	Southern Logperch	1	--	--	--
Percina nigrofasciata	Blackbanded Darter	24	11	13	12
Percina vigil	Saddleback darter	1	--	--	--
Elassomatidae-Pygmy Sunfishes					
Elassoma zonatum	banded Pygmy Sunfish	--	--	--	2
Achiridae-American Soles					
Trinectes maculatus	Hogchocker	--	--	--	--
	Catch	131	265	412	292
	Total species	23	24	22	21

Species		Station			
		16	17	18	19
Petromyzontidae-Lampreys					
Ichthyomyzon gagei	Southern Brook Lamprey	--	--	--	--
Lampetra aepyptera	Least Brook Lamprey	--	--	--	--
Lepisosteidae-Gars					
Lepisosteus oculatus	Spotted Gar	--	--	--	--
Lepisosteus osseus	Longnose Gar	--	--	--	--
Anguillidae-Freshwater Eels					
Anguilla rostrata	American Eel	1	--	--	1
Cyprinidae-Minnows and Carps					
Cyprinella venusta	Blacktail Shiner	--	19	16	--
Hybopsis sp cf winchelli	Coastal Clear Chub	--	--	2	8
Lythrurus atrapiculus	Blacktip Shiner	15	--	--	85
Notemigonus crysoleucas	Golden Shiner	--	--	--	--
Notropis amplamala	Longjaw Minnow	--	--	15	--
Notropis chalybaeus	Ironcolor Shiner	--	--	--	--
Notropis harperi	Redeye Chub	--	--	--	1
Notropis longirostris	Longnose Shiner	--	--	--	--
Notropis texanus	Weed Shiner	2	1	25	13
Opsopoeodus emiliae	Pugnose Minnow	--	--	--	3
Pteronotropis hypselopterus	Sailfin Shiner	--	27	5	20
Pteronotropis signipinnis	Flagfin Shiner	--	--	--	--
Pteronotropis welaka	Bluenose Shiner	--	--	--	--
Semotilus thoreauianus	Dixie Chub	--	--	--	--
Catostomidae-Suckers					
Erimyzon sucetta	Lake Chubsucker	4	--	--	--
Minytrema melanops	Spotted Sucker	--	--	--	--
Moxostoma poecilurum	Blacktail Redhorse	--	--	1	--
Ictaluridae - North American Catfishes					
Ameiurus natalis	Yellow Bullhead	1	--	--	--
Noturus funebris	Black Madtom	--	--	--	--
Noturus leptacanthus	Speckled Madtom	--	7	2	1
Esocidae-Pikes					
Esox americanus	Redfin Pickerel	8	--	--	6
Esox niger	Chain Pickerel	--	13	4	--
Aphredoderidae Pirate Perch					
Aphredoderus sayanus	Pirate Perch	6	10	4	2
Atherinopsidae - New World Silversides					
Labidesthes sicculus	Brook Silverside	--	--	--	--
Fundulidae-Topminnows					
Fundulus olivaceus	Blackspotted Topminnow	35	3	5	12
Poeciliidae-Livebearers					
Gambusia holbrooki	Eastern Mosquitofish	33	1	--	3

Species		Station			
		16	17	18	19
Centrarchidae-Sunfishes					
Ambloplites ariommus	Shadow Bass	--	--	--	--
Lepomis cyanellus	Green Sunfish	1	--	--	2
Lepomis gulosus	Warmouth	3	--	--	1
Lepomis macrochirus	Bluegill	8	--	1	--
Lepomis marginatus	Dollar Sunfish	1	--	--	1
Lepomis megalotis	Longear Sunfish	37	1	5	17
Lepomis microlophus	Redear Sunfish	--	--	--	--
Lepomis miniatus	Redspotted Sunfish	92	3	1	16
Lepomis Hybrid		2	--	--	--
Micropterus punctulatus	Spotted Bass	--	--	--	--
Micropterus salmoides	Largemouth Bass	2	--	--	1
Percidae-Perches and Darters					
Ammocrypta bifascia	Florida Sand Darter	--	--	13	--
Etheostoma colorosum	Coastal Darter	9	34	25	1
Etheostoma davisoni	Choctawhatchee Darter	--	--	--	--
Etheostoma edwini	Brown Darter	6	--	--	3
Etheostoma histrio	Harlequin Darter	--	--	--	--
Etheostoma parvipinne	Goldstripe Darter	--	--	--	--
Etheostoma stigmaeum	Speckled Darter	--	--	--	1
Etheostoma swaini	Gulf Darter	19	6	7	4
Percina austroperca	Southern Logperch	--	--	--	--
Percina nigrofasciata	Blackbanded Darter	2	3	9	2
Percina vigil	Saddleback darter	--	--	--	--
Elassomatidae-Pygmy Sunfishes					
Elassoma zonatum	banded Pygmy Sunfish	1	2	6	--
Achiridae-American Soles					
Trinectes maculatus	Hogchocker	--	--	--	--
	Catch	288	130	146	204
	Total species	21	14	18	23

Species		Station			
		20	21a	21b	22
Petromyzontidae-Lampreys					
Ichthyomyzon gagei	Southern Brook Lamprey	--	--	--	--
Lampetra aepyptera	Least Brook Lamprey	--	--	--	--
Lepisosteidae-Gars					
Lepisosteus oculatus	Spotted Gar	--	--	--	--
Lepisosteus osseus	Longnose Gar	--	--	--	--
Anguillidae-Freshwater Eels					
Anguilla rostrata	American Eel	--	--	--	--
Cyprinidae-Minnows and Carps					
Cyprinella venusta	Blacktail Shiner	43	33	13	7
Hybopsis sp cf winchelli	Coastal Clear Chub	7	2	--	--
Lythrurus atrapiculus	Blacktip Shiner	9	31	66	60
Notemigonus crysoleucas	Golden Shiner	--	--	--	--
Notropis amplamala	Longjaw Minnow	--	19	2	63
Notropis chalybaeus	Ironcolor Shiner	--	--	--	--
Notropis harperi	Redeye Chub	--	--	--	--
Notropis longirostris	Longnose Shiner	--	3	2	--
Notropis texanus	Weed Shiner	9	43	9	30
Opsopoeodus emiliae	Pugnose Minnow	--	--	--	--
Pteronotropis hypselopterus	Sailfin Shiner	--	57	94	135
Pteronotropis signipinnis	Flagfin Shiner	--	--	--	--
Pteronotropis welaka	Bluenose Shiner	--	--	--	--
Semotilus thoreauianus	Dixie Chub	--	--	1	6
Catostomidae-Suckers					
Erimyzon sucetta	Lake Chubsucker	--	--	--	1
Minytrema melanops	Spotted Sucker	--	--	--	--
Moxostoma poecilurum	Blacktail Redhorse	3	--	--	--
Ictaluridae - North American Catfishes					
Ameiurus natalis	Yellow Bullhead	--	--	--	--
Noturus funebris	Black Madtom	--	--	--	--
Noturus leptacanthus	Speckled Madtom	1	1	4	4
Esocidae-Pikes					
Esox americanus	Redfin Pickerel	--	3	--	--
Esox niger	Chain Pickerel	1	--	4	8
Aphredoderidae Pirate Perch					
Aphredoderus sayanus	Pirate Perch	1	4	2	4
Atherinopsidae - New World Silversides					
Labidesthes sicculus	Brook Silverside	--	--	--	--
Fundulidae-Topminnows					
Fundulus olivaceus	Blackspotted Topminnow	16	25	18	27
Poeciliidae-Livebearers					
Gambusia holbrooki	Eastern Mosquitofish	--	3	--	--

Species		Station			
		20	21a	21b	22
Centrarchidae-Sunfishes					
Ambloplites ariommus	Shadow Bass	1	--	1	--
Lepomis cyanellus	Green Sunfish	--	--	--	--
Lepomis gulosus	Warmouth	--	1	1	--
Lepomis macrochirus	Bluegill	--	--	--	--
Lepomis marginatus	Dollar Sunfish	--	--	--	--
Lepomis megalotis	Longear Sunfish	8	10	7	7
Lepomis microlophus	Redear Sunfish	--	--	--	--
Lepomis miniatus	Redspotted Sunfish	2	3	--	19
Lepomis Hybrid		--	--	--	--
Micropterus punctulatus	Spotted Bass	1	--	--	--
Micropterus salmoides	Largemouth Bass	--	--	--	--
Percidae-Perches and Darters					
Ammocrypta bifascia	Florida Sand Darter	6	1	1	--
Etheostoma colorosum	Coastal Darter	2	2	12	16
Etheostoma davisoni	Choctawhatchee Darter	--	--	--	--
Etheostoma edwini	Brown Darter	--	--	5	3
Etheostoma histrio	Harlequin Darter	--	--	--	--
Etheostoma parvipinne	Goldstripe Darter	--	--	--	2
Etheostoma stigmaeum	Speckled Darter	2	1	2	--
Etheostoma swaini	Gulf Darter	1	1	--	--
Percina austroperca	Southern Logperch	--	--	--	--
Percina nigrofasciata	Blackbanded Darter	15	19	13	11
Percina vigil	Saddleback darter	--	--	--	--
Elassomatidae-Pygmy Sunfishes					
Elassoma zonatum	banded Pygmy Sunfish	--	--	--	--
Achiridae-American Soles					
Trinectes maculatus	Hogchocker	--	--	--	--
	Catch	128	262	257	403
	Total species	18	20	19	17

Species		Station		Total
		23	24	
Petromyzontidae-Lampreys				
Ichthyomyzon gagei	Southern Brook Lamprey	--	--	2
Lampetra aepyptera	Least Brook Lamprey	--	--	1
Lepisosteidae-Gars				
Lepisosteus oculatus	Spotted Gar	--	--	2
Lepisosteus osseus	Longnose Gar	--	--	1
Anguillidae-Freshwater Eels				
Anguilla rostrata	American Eel	--	--	7
Cyprinidae-Minnows and Carps				
Cyprinella venusta	Blacktail Shiner	11	2	781
Hybopsis sp cf winchelli	Coastal Clear Chub	3	4	138
Lythrurus atrapiculus	Blacktip Shiner	6	77	595
Notemigonus crysoleucas	Golden Shiner	--	--	1
Notropis amplamala	Longjaw Minnow	--	--	124
Notropis chalybaeus	Ironcolor Shiner	--	5	6
Notropis harperi	Redeye Chub	--	12	57
Notropis longirostris	Longnose Shiner	--	--	84
Notropis texanus	Weed Shiner	--	4	423
Opsopoeodus emiliae	Pugnose Minnow	--	--	3
Pteronotropis hypselopterus	Sailfin Shiner	--	19	641
Pteronotropis signipinnis	Flagfin Shiner	30	--	82
Pteronotropis welaka	Bluenose Shiner	--	34	35
Semotilus thoreauianus	Dixie Chub	--	--	12
Catostomidae-Suckers				
Erimyzon sucetta	Lake Chubsucker	--	1	7
Minytrema melanops	Spotted Sucker	--	--	3
Moxostoma poecilurum	Blacktail Redhorse	--	--	30
Ictaluridae - North American Catfishes				
Ameiurus natalis	Yellow Bullhead	1	--	4
Noturus funebris	Black Madtom	--	--	4
Noturus leptacanthus	Speckled Madtom	3	--	72
Esocidae-Pikes				
Esox americanus	Redfin Pickerel	3	12	68
Esox niger	Chain Pickerel	--	--	31
Aphredoderidae Pirate Perch				
Aphredoderus sayanus	Pirate Perch	8	16	100
Atherinopsidae - New World Silversides				
Labidesthes sicculus	Brook Silverside	2	--	61
Fundulidae-Topminnows				
Fundulus olivaceus	Blackspotted Topminnow	3	10	316
Poeciliidae-Livebearers				
Gambusia holbrooki	Eastern Mosquitofish	28	9	132

Species		Station		Total
		23	24	
Centrarchidae-Sunfishes				
Ambloplites ariommus	Shadow Bass	--	--	15
Lepomis cyanellus	Green Sunfish	--	--	8
Lepomis gulosus	Warmouth	--	--	13
Lepomis macrochirus	Bluegill	1	--	39
Lepomis marginatus	Dollar Sunfish	--	--	3
Lepomis megalotis	Longear Sunfish	8	25	415
Lepomis microlophus	Redear Sunfish	--	--	4
Lepomis miniatus	Redspotted Sunfish	7	49	284
Lepomis Hybrid		--	--	2
Micropterus punctulatus	Spotted Bass	--	--	37
Micropterus salmoides	Largemouth Bass	--	--	11
Percidae-Perches and Darters				
Ammocrypta bifascia	Florida Sand Darter	--	--	38
Etheostoma colorosum	Coastal Darter	2	16	340
Etheostoma davisoni	Choctawhatchee Darter	--	--	3
Etheostoma edwini	Brown Darter	--	3	31
Etheostoma histrio	Harlequin Darter	--	--	2
Etheostoma parvipinne	Goldstripe Darter	--	--	3
Etheostoma stigmaeum	Speckled Darter	--	--	51
Etheostoma swaini	Gulf Darter	5	3	97
Percina austroperca	Southern Logperch	--	--	2
Percina nigrofasciata	Blackbanded Darter	3	3	392
Percina vigil	Saddleback darter	--	--	26
Elassomatidae-Pygmy Sunfishes				
Elassoma zonatum	banded Pygmy Sunfish	2	--	19
Achiridae-American Soles				
Trinectes maculatus	Hogchocker	--	--	33
	Catch	126	304	5,691
	Total species	18	19	54

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