PATTERN OF INVASION OF A NONINDIGENOUS CYPRINID AND POTENTIAL SHIFTS IN NATIVE FISH ASSEMBLAGE STRUCTURE

by

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ABSTRACT

Invasive species increasingly threaten global biodiversity with faunal homogenizations and are of specific concern in the highly diverse aquatic systems of the Southeast United States. However, patterns of invasion and variables influencing invasion success remain poorly understood. This study had the unique opportunity to follow the introduction, establishment, and invasion processes of nonindigenous Weed Shiner (*Notropis texanus*, Family: Cyprinidae), and to investigate potential shifts in the native fish assemblage in Bear Creek, Alabama and Mississippi, USA, following introduction from the Mobile Basin via the Tennessee-Tombigbee Waterway. Weed Shiner's invasion pattern, based on historical and contemporary fish assemblage surveys from 1998 to 2013, was established by GIS mapping. Shifts were evaluated using Jaccard and Morisita similarity indices and nonmetric multidimensional scaling ordination. Since first observed in Bear Creek in 2007, Weed Shiner rapidly expanded in range and abundance until 2012 when is range contracted and 2013 when abundances declined. Weed Shiner currently persists at the most human-impacted, downstream sites in Bear Creek. Despite the rapid proliferation of Weed Shiner 2007 – 2012, the native fish assemblage has not significantly changed. Rather, the native fish assemblage structure in Bear Creek is highly variable temporally and influenced largely by land-use in the watershed, most notably by high intensity development, mixed-hardwood forest cover and pine monoculture cover. Limiting future Weed Shiner impacts in the system and successful conservation of the Bear Creek fish

assemblage will rely on managing land use changes and mitigating the effects of development in the watershed on the stream.

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SELECTED FORMAT

Ecology of Freshwater Fish

Auburn University Electronic Thesis and Dissertation Guide

COMPUTER SOFTWARE USED

Microsoft Word 2010

Microsoft Excel 2010

R (v2.15.2) with VEGAN Analysis Package

PAST (v3.01)

ArcGIS (v9.3)

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INTRODUCTION

Invasive species present an increasing threat worldwide as anthropogenic activity introduces an increasing number of nonindigenous flora and fauna to new systems (Kopp et al. 2012). Once introduced, nonindigenous species may establish and then proliferate to invasive levels where they begin to negatively impact the native system, fauna or human-valued resources (Fuller et el. 1999, Krebs 2001). Nonindigenous introductions in aquatic systems occur through a variety of means, some intentional, others not. Intentional stocking of nonindigenous fish as sport fish or forage fish to support a sport fishery are responsible for the majority of introductions in the United States. Others have been introduced as ornamentals or as a biological control (Fuller et al. 1999). Unintentional introductions have occurred from accidental bait-fish release, accidental aquaculture release, transportation through ballast water, or large interbasin transfers of water (Fuller et al. 1999, Moyle 1976).

However, many introduced populations fail after initial introduction, fail to establish or fail to increase to invasive levels for various reasons (Kowarik 1995, Krebs 2001, Williamson & Fitter 1996, Zenni & Nuñez 2013). Abiotic resistance from the new physical environment, biotic resistance of the native community, number of founding individuals (propagule pressure) and genetic constraints are the most common reasons for invasion failure (Fridley et al. 2007, Lockwood et al. 2005, Simberloff 2009, Zenni & Nuñez 2013).

Abiotic resistance is the leading cause of failed invasions in fishes (Moyle & Light 1996, Zenni & Nuñez 2013). Abiotic conditions in the introduced range can strongly influence the survival, reproduction ability, and competitive ability of nonindigenous species that have often evolved in response to different abiotic conditions (Bunn & Arthington 2002). Hydrological regime, land use, water availability, water temperature, dissolved oxygen concentrations and physical structure often play the most influential roles on success (Clavero & Hermoso 2011, Helms et al. 2005, Kiernan et al. 2012, Kopp et al. 2012).

Biotic conditions in the introduced range may impede nonindigenous success through biotic resistance (Kennedy et al. 2002). Community-level variables such as predation and competition have been observed inhibiting and eliminating introduced species (Crawley et al. 1999, Kennedy et al. 2013, Zenni and Nuñez 2013). However, fish assemblages are rarely saturated allowing successful nonindigenous species to fill a previously unoccupied niche that allows for successful competition or co-existence with natives (Keirnan et al. 2012, Kopp et al. 2012, Meador and Carlisle 2012, Wagner & Grossman 2013).

Anthropogenic disturbance in a system often alters the abiotic conditions and tips the community balance in favor of nonindigenous species (Kopp et al. 2012, Leprieur et al. 2008, Moyle & Light 1996). Nonindigenous fishes that successfully establish are often cosmopolitan generalists that have flexible diet and habitat requirements and are adapted to reduced flows, flow variability, and shifts in the seasonal timing of high flow events (Bunn & Arthington 2002, Kerinan et al. 2012, Walser et al. 2000). Reduced flows and reduced flow variability have favored generalists, such as member of the Family Centrarchidae which are widely introduced as sport fish, over fluvial specialists in a number of studies (Alexandre et al. 2013, Clavero & Hermoso 2011, Kanno & Vokuoun 2010). Land-use changes can have similar effects on native

fish assemblages through its influence on hydrology and nutrient loading in streams (Brisbois et al. 2008, Dowling 2012, Philips and Johnston 2004a). Beyond providing favorable abiotic conditions to introduced species, anthropogenic disturbance can influence community level interactions between nonindigenous species and native competitors by giving the invaders a competitive advantage for prey and in reproductive potential (Dowling 2012, Johnston & Maceina 2009, Phillips & Johnston 2004b, Wagner & Grossman 2013). For example, Wagner and Grossman (2013) observed that established nonindigenous Yellowfin Shiner (*Notropis lutipinnis*) in an Appalachian Stream had a stronger competitive ability to track local, fluctuating resources than native competitors. The success of introduced fishes relies on a combination of abiotic factors and biotic interactions (Baltz and Moyle 1993).

Increasing global anthropogenic disturbance and alteration of freshwater systems and successful establishment of nonindigenous species has led to the homogenizations of fish fauna worldwide (Villéger et al. 2011). Fish faunal homogenization has been most prevalent in the Palearctic and Nearctic biogeographical realms where it has been linked to nonindigenous success facilitated by hydrological regimen alteration (Meador & Carlisle 2012, Leprieur et al. 2007, Villéger et al. 2011). The threat of endemic species and species diversity loss, particularly endemic species, is especially concerning in the southeastern United States which hosts the highest richness of fish species and high number of endemic species in North America, north of Mexico (Rahel 2000, Scott & Helfman 2011).

Study System and Species of Interest

The Bear Creek system is a tributary to the Tennessee River draining 860 square miles in northern Alabama and northeastern Mississippi and is rich in fish species. The three primary tributaries of the system are Cedar Creek, Little Bear Creek, and Bear Creek. All three were impounded in 1969-1979 midway up the streams and Bear creek has a second impoundment in its upper reaches. Its fish assemblage of approximately 104 native species is extremely diverse and included eight species typical of the Mobile Basin which are not found in any other Tennessee River tributary. Their presence is thought to be evidence of stream capture (Shepard et al. 2009, Mettee et al. 1996, Mettee et al. 2002, Starnes & Etnier1986). Human land-use and altered hydrology from impoundments on all three branches has had detrimental effects on the native assemblage (Phillips and Johnston 2004a, Phillips and Johnston 2004b). The most recent comprehensive survey of the fish fauna was conducted in 2007-2009 and collected 101 fish species, including nonindigenous Blacktail Shiner (*Cyprinella venusta*) and Weed Shiner (*Notropis texanus*) which likely invaded via the Tennessee-Tombigbee Waterway from the Mobile Basin. (Shepard et al. 2009).

The completion of the Tennessee-Tombigbee Waterway (TTW) in 1985 connected the Tennessee River Basin and the Mobile River Basin via the Tennessee and Tombigbee Rivers creating the potential to alter the natural fish assemblages of both rivers (Etnier and Starnes 1993). Before construction of the TTW, the fish assemblages of the Mobile and Tennessee basins were separated since the beginning of geologic Tertiary Period (65 million years ago) with only minor tributary exchanges via stream capture connecting the two, which has allowed for the unique evolution of the fish fauna in each system (Etnier and Starnes 1993). Already, the fish assemblages in the Tombigbee River and TTW have shifted in favor of lentic-associated and

cosmopolitan species in association with the impoundments created by the TTW; it is these species are the most likely to disperse through the TTW into the Tennessee Basin (Strogin et al. 2011, Taylor et al. 2008). The TTW confluence with the Tennessee River is located shortly downstream of the Bear Creek-Tennessee River confluence, making Bear Creek one of the first Tennessee River tributaries to be colonized by Mobile Basin endemics.

The Bear Creek fish fauna has been repeatedly surveyed, beginning in 1968 by B. R. Wall. Since then, it has been surveyed by the Fish Biodiversity Lab at Auburn University in 1998-2000 and 2012 (Phillips 2001, Johnston 2012) The Geological Survey of Alabama, completed a comprehensive survey in 2007-2009 and were the first to find Weed Shiner and other Mobile River Basin endemics in Bear Creek (Shepard et al. 2009). Both teams, along with the United States Fish and Wildlife Service, Alabama Department of Conservation and Natural Resources, and Tennessee Valley Authority, sampled Bear Creek in a cooperative effort in 2013 as part of the Bear Creek Strategic Habitat Unit watershed effort.

Weed Shiner (*Notropis texanus*) is a cosmopolitan cyprinid native to the Gulf of Mexico slope drainages. It ranges from the Suwannee River in Florida to the Nueces River in Texas and north in the Mississippi River Basin to Minnesota. In its native range, the Weed Shiner is found in small low-gradient streams with clear water and sandy substrate and can be found in abundance in shoal areas with emergent vegetation, however these conditions do not characterized the TTW (Mettee et al. 1996). The Weed Shiner possesses many characteristics of a successful invader: tolerance of low and medium flow regimens, an extended spawning season with several spawning events, and a diverse and flexible diet (Etnier & Starnes 1993, Moyle & Light 1996, Walser et al. 2000, Williamson and Fitter 1996). Weed Shiner spawn from as early as March to as late as October depending on region and amount of surface water runoff in

drainage and its diet consists of filamentous algae, detritus, small invertebrates and plant material in the stream drift (Etnier and Starnes 1993, Heins and Rabito 1988, Mettee et al. 1996).

Despite being historically found in Mississippi River drainages, Weed Shiner was not historically present in the Tennessee River (Etnier and Starnes 1993). Weed Shiner was first collected in the Tennessee drainage in Second Creek, Lauderdale County, AL and in Robinson Creek, Hardin County, TN in 1993 and was first found in the Bear Creek System in 2007 (Etnier and Starnes 1993, Shepard et al. 2009, Mettee et al. 1996). Since its appearance in Bear Creek, Weed Shiner has increased in relative abundance and range, occupying the downstream portions of all three main branches of the system. To date, the upstream spread of Weed Shiner has been blocked by impoundments on the three main tributaries.

The objective of this study was to investigate the invasion pattern of Weed Shiner and potential changes in the fish assemblage in a unique stream system in the Southeastern United States. The majority of previous research in aquatic invasion biology has focusses on successfully established invasions years after initial introduction or in well-controlled mesocosms and study ponds. Studies investigating the full introduction, establishment and invasion process in natural systems are still exceedingly rare (Zenni and Nunez 2013). This study had the unique opportunity to observe the chronology and pattern of invasion of a nonindigenous cyprinid and any associated changes in the structure of the recipient fish assemblage.

METHODS

Site Selection

Selection of survey sites was based on availability of historical data and encompassed the entirety of the Bear Creek System. A total of 40 sites were selected for analysis (Figure 1). They were chosen because they were either: 1) sampled in multiple time periods for historic data or 2) Weed Shiner had been collected at them in the past (Appendix A). Contemporary sampling during 2013 was attempted at as many sites as possible but severely hampered due to inclement weather and high flows.

Historical Collections

Historical surveys of the Bear Creek fish assemblage were collected by B. R. Wall in 1968, B. W. Phillips and C. E. Johnston in 1998 to 2000, the Geological Survey of Alabama (GSA) in 2007 to 2009 and C. E. Johnston in 2012. Current collections were made during the summer of 2013 as a cooperative effort between Fish Biodiversity Lab at Auburn University, Geological Survey of Alabama, United States Fish and Wildlife Service, Alabama Department of Conservation and Natural Resources, and Tennessee Valley Authority. Historical data was patchy in the number and locations of collections and was composed of species counts for each collection locality. Only collections conducted in the same localities were used. Localities were

determined from historic GPS coordinates, when available, and cross referenced with locality information recorded by county and road information (Appendix A).

Field Methods

Field methods for sampling in 2013 were conducted following procedures used by the historical surveys since 1998 during as closely as possible. Fish were sampled with an electrofisher and 3.1m seine with 6mm mesh. All microhabitats at each site were sampled until no more unique species are collected after five efforts. Total effort totaled approximately one hour for each collection site. Fish collected with the GSA were in identified in the field by GSA biologists and returned alive to the stream. Voucher specimens were anaesthetized with tricaine mesylate (MS-222) and preserved in 10% formalin for verification. Collections conducted without the GSA were anesthetized with MS-222 and preserved in 10% formalin for later analysis in the Fish Biodiversity Lab at Auburn University (IACUC PRN:2012-2166), and incorporated in the Auburn University Museum of Natural History Ichthyology Collection in Auburn, Alabama.

Data Analyses

Weed Shiner distribution and spread through the system was visualized in ArcGIS 9.3. Both total number of Weed Shiner specimens collected at a site during a specific year, and relative abundance of Weed Shiner were mapped and patterns visually inspected.

Shifts in the fish assemblage structure in Bear creek were qualified using similarity indices, nonmetric multidimensional scaling (NMDS) and examination of relative abundances. NMDS analyses were conducted in R (v2.15.2), using the Vegan analysis package. R is an open source, statistical computing and graphing program (Dixon 2009). Similarity indices and relative and diversity information was generated in PAST (v3.01), which is a free software for scientific data analysis originally created for paleontological applications but exceedingly valuable in all ecological applications (Hammer et al. 2001, Ryan et al. 1995). Relative abundances were calculated in Microsoft Excel 2010.

An NMDS ordination was generated to visually examine differences in species composition collections and Weed Shiner presence. NMDS were constructed using Jaccard Dissimilarity values in R, which was chosen because of the conservative nature of the metric and the wide variety of assemblage structure represented in the data. Any differences seen in the resulting NMDS would be more robust. NMDS were generated for individual collections, without lumping collections from the same site together so that temporal changes in the fish assemblage could be examined as well.

The influence of environmental variables on assemblage structure and Weed Shiner presence were examined via multiple regression analysis and visualized as vectors on the NMDS using the envfit function in the VEGAN package of R. Multiple regression investigating the relationship between environmental variables and assemblage composition were calculated using unique collection codes composed of Site ID-Year to connect assemblage data to corresponding environmental variables for each collection. Examined environmental variables included year of collection, total annual precipitation, site-specific watershed area, percent of land recently disturbed, and the percentage of land covered by: impervious land cover, urban development,

forest, shrub and grassland, nonvascular vegetation and sparse vascular rock vegetation, agricultural vegetation, open water and developed or other human land-use.

Environmental variables were obtained from USGS, National Landcover Dataset and NOAA. Habitat condition, stream flow, and land-use were not recorded in most of the historic data and discharge from the Bear Creek system has not been monitored since the 1970s. Watershed area, impervious cover and urban land cover for each collection site were calculated in USGS Stream Stats. Unique shape files for each site's watershed were also created in Stream Stats for analysis in ArcGIS 9.3. Stream Stats provided land-use and coverage based on the National Land Cover Dataset (NLCD) of 2006 (Fry et al. 2011). Land cover for collections made during the 1998-2000 was obtained from NLCD 2001, and land cover for collections made in 2007-2013 was obtained from NLCD 2006 (Appendix C). NLCD 2001 and 2006 are based on Landsat Thematic Mapper+ imagery from 2001 and 2006, respectively (Fry et al. 2011, Homer et al. 2007). Because discharge data was not available for the Bear Creek System, total annual discharge from the Buttahatchee System (HUC 03160103) and regional precipitation were used as a proxy for water availability. The Buttahatchee system is a smaller system (277 square miles) adjacent to Bear Creek and drains to the Mobile Basin. It was chosen because of its proximity to the Bear Creek system, location in the same physiographic region, and has similar land cover as calculated from NLCD 2006. Discharge was collected from USGS gauge 02438000 and precipitation form NOAA weather station COOP:013620 in Haleyville, AL.

Jaccard and Morisita indices of similarity were calculated for all sites that had multiple years of data using PAST v3.0. In the historic collection conducted by Phillips 2001, sites were only sampled once during 1998, 1999 or 2000 and were combined into a pre2000 group for analysis. Sites were sampled multiple times during 2007 – 2009 and 2012 – 2013; these sites

were not lumped into a time period and were analyzed based on year. In cases where sites were sampled twice in the same year similarity for both collections are reported. Both Jaccard and Morisita similarity indices compare the beta (β) diversity of two collections as a range from 0, indicating completely dissimilar assemblages, to 1, indicating complete similarity. With both indices, index values over 0.7 are considered to indicate highly similar assemblages and values below 0.4 are considered to indicate dissimilar assemblages. Values between 0.4 and 0.7 are considered to be undetermined (Mathews 1988, Philips and Johnston 2004a, Walser et al. 2000). When used together they provide complementary assessments of the similarity of two assemblages (Phillips and Johnston 2004a).

Jaccard Similarity is based on which species are present, absent, or shared between two collections and is considered a conservative and simple metric of similarity. It is not as influenced by rare species as Morisita's and was included in this analysis to account for possible differences in field method collection techniques between collections. The Jaccard Similarity Index (I_J) is calculated between sites *j* and *k* by:

$$I_J = \frac{M}{(M + N_j + N_k)}$$

$$Where\ M = Number\ of\ shared\ species$$

$$N_i = Numer\ of\ unique\ species\ in\ collection\ i$$

$$N_k = Numer\ of\ unique\ species\ in\ collection\ k$$

Morisita's Similarity, by contrast, incorporates relative abundance of species. It therefore is more sensitive to differences in assemblage structures and is considered to be best overall

measure of similarity in ecological communities (Krebs 1999). Morisita's Similarity Index (I_M) is calculated by:

$$\boldsymbol{\lambda_1} = \frac{\sum_i \boldsymbol{x_{ji}}(\boldsymbol{x_{ji}} - \mathbf{1})}{\sum_i \boldsymbol{x_{ji}}(\sum_i \boldsymbol{x_{ji}} - \mathbf{1})}$$

$$\boldsymbol{\lambda_2} = \frac{\sum_i \boldsymbol{x_{ki}}(\boldsymbol{x_{ki}} - \mathbf{1})}{\sum_i \boldsymbol{x_{ki}}(\sum_i \boldsymbol{x_{ki}} - \mathbf{1})}$$

$$I_{\boldsymbol{M}} = \frac{2\sum_i x_{ji}x_{ki}}{(\lambda_1\lambda_2)\sum_i x_{ji}\sum_i x_{ki}}$$

There were 13 sites with data encompassing all study years and relative abundances for these sites were calculated to clarify assemblage shifts seen in the similarity analyses. Relative abundances were calculated as the proportion of the abundance of a species to the total abundance at each site in Microsoft Excel 2010 for the 10 most abundant species at each site.

RESULTS

Invasion Pattern of Weed Shiner in the Bear Creek System

Since first observed in the Bear Creek system Weed Shiner was collected throughout the lower portion of the Bear Creek System at varying abundances. Weed Shiner was found at half of the surveyed sites (21 of 40) and in one third of total collections (37 of 104) since first observed in the system in 2007 (Table 1). The first observation of Weed Shiner in the Bear Creek system consisted of 2 specimens (2.54% relative abundance) at Site 9 (GSA ID: BC-3) collected by the Geological Survey of Alabama, Ecosystem Team (Shepard et al. 2009). Since then, Weed Shiner has showed an initial range expansion throughout the lower portion of the system, followed by a range contraction in 2012 which remained evident in 2013 (Figure 2). Weed Shiner exhibited an increase in relative abundance through 2012 despite the range contraction in 2012, and began to decline in abundance in 2013 while remaining concentrated at the downstream-most sites. In every year sampled, relative abundances varied widely between sites, but were generally highest in the downstream most localities (Figure 3). To date, Weed Shiner has remained confined to the lower half of the Bear Creek system downstream of the impoundments on the Bear Creek, Little Bear Creek, and Cedar Creek.

In 2008, Weed Shiner was found at 11 of 24 sites throughout the lower portion of the system. Collected specimens ranged from one specimen (0.9% relative abundance) at Site 4, to 67 specimens (22.9% relative abundance) at Site 16. Mean relative abundance of Weed Shiner in sites where it was present was 4.6% (Figures 2, 3).

In 2009, Weed Shiner was seen in collections at 10 of 25 sites in numbers ranging from one specimen (0.3% relative abundance) at Site 36, to 115 specimens (22.9% relative abundance) at Site 7 with a mean relative abundance of 6.8% (Figures 2, 3).

In 2012 Weed Shiner range contracted to only 6 of 31 sites but they were found in far higher numbers and relative abundances than previously seen. Weed Shiner collections ranged from seven specimens (1.3% relative abundance) at Site 3, to 140 specimens at Site 7 and 162 specimens at Site 5 (59.3% and 53.1% relative abundance, respectively) with a mean relative abundance of 35.7%.

In 2013, 19 sites were surveyed and Weed Shiner was found at seven of them. Weed Shiner collections ranged from one specimen (<1% relative abundance) at Site 33, to 50 specimens at Site 12 and 19 specimens at Site 13 (15.7% and 14.6% relative abundance, respectively) with a mean relative abundance of 4.5%. Additionally, several young of the year Weed Shiner specimens were collected and preserved as voucher specimens 2013.

Total annual discharge from the Buttahatchee system and regional annual precipitation were used to establish a coarse-scale estimate of water availability for each year during the study period. The Buttahatchee system was used as a proxy for the Bear Creek system because it is located adjacent to Bear Creek in the same physiographic region, and has similar land cover. Based on discharge data, 2009 and 2013 were considered wet years, 2012 was considered dry, and 2008 intermediate (Figure 4). Trends in stream discharge from Buttahatchee Creek and regional precipitation from 1951-2013 were visually examined (Figure 5). Both annual precipitation and discharge from Buttahatchee Creek has increased slightly since 1951. No

easily discernable pattern between water availability and Weed Shiner range or relative abundance was observed.

Initial visual inspection of the nonmetric multidimensional scaling (NMDS) containing all collections from 1998 to 2013 revealed a distinct cluster of collections containing Weed Shiner within the ordination space occupied by all collections (Figure 6). NMDS ordination arranges collection assemblages in ordination space based on faunal dissimilarity, indicating that collections with Weed Shiner exist as a distribution within the boarder range of all collections from the Bear Creek system.

To investigate environmental variables influencing Weed Shiner presence, vectors representing environmental variables were overlain on the NMDS ordination using multiple regression to correlate environmental variables with the distribution of collection composition in ordination space. Weed Shiner presence was associated with increasing watershed size, increasing high intensity development (>1% total land cover), and increasing pine forest cover which was defined as forest composition composed of >75% evergreen (3.2 – 19.8%, Table 2).

Potential fish assemblage shifts due to Weed Shiner Invasion

Nonmetric multidimensional scaling (NMDS) analysis was also used to investigate the influence of environmental variables on fish assemblage structure. Land cover, and watershed area were calculated for the contributing watershed for each site from the National Landcover Dataset (NLCD). NLCD 2001 was used to calculate land cover for collections made before 2001 and NLCD 2006 was used to calculated land cover for collections made after 2006 (Appendix C). Most of the environmental variables analyzed significantly correlated to the collection distribution at the 0.05 level (Table 2). Water-shed area ($p = 0.001$, $r^2 = 0.4609$) mostly strongly

correlated with collection distribution, followed by mixed hardwood and pine forest ($p = 0.001$, $r^2 = 0.3960$), pine monoculture forest cover ($p = 0.001$, $r^2 = 0.2308$), and high intensity developed land ($p = 0.001$, $r^2 = 0.2297$, Table 2). National Land Cover Database (NLCD) data classifies forests as areas dominated (>20% total vegetation) by trees greater than 5m. Mixed hardwood and pine forest cover were indicated by NLCD classification of 'Mixed forest' where neither deciduous nor coniferous vegetation is greater than 75% of tree cover. Pine monocultures were indicated by "Evergreen forest' where at least 75% of tree cover is evergreen. NLCD classifies high intensity development as 80-100% impervious surfaces. Year affects, yearly discharge levels, deciduous forest cover, developed open space, and pasture did not exhibit significant correlation to assemblage structure.

Jaccard and Morisita similarities indicated large fluctuations in assemblage structure during the study period. Jaccard and Morisita similarity indices reported similar results, with Jaccard (I_J) indicating a higher amount of change than Morisita (I_M). Jaccard and Morisita similarities were calculated for all 28 sites and 139 collections that were sampled more than once. Of these, 13 sites had data spanning the entire study period: from before Weed Shiner introduction in 1998-2000 to 2012-2013. Because each site was only sampled once during the 1998-2000 survey, collections made during this period were reported as "pre-2000" to simplify calculations. A summary of Jaccard and Morisita similarities is reported in lieu of a full matrix, with sites where Weed Shiner were collected at any point in the study indicated (Table 3). There were 13 sites that were sampled during the pre-2000 period and 2012 with an average I_J of 0.280 and I_M of 0.327. Twelve sites had I_J values indicating highly dissimilar assemblages, and 10 sites had I_M values indicating highly dissimilar assemblages. No sites had assemblages that were considered similar (I_J or I_M >0.7). There were 14 sites that spanned the pre2000 period to 2013,

13 of which were considered dissimilar by Jaccard's Index (mean I_J = 0.258) and 10 were considered dissimilar by Morisita' Index (mean I_M = 0.354). Only one site was similar, Site 15, had an assemblage structure that remained constant between pre2000 and 2013 according to Morsita's Index (I_M = 0.847).

Composition of the 10 most abundant species of the 13 sites sampled in 1998-2000, 2007-2009, and 2012-2013 time periods were highly variable between years (Appendix B). The majority of assemblages were composed of native stream-associated members of Cypriniformes, Percidae, Fundulidae and Ictaluridae. Few species remained among the 10 most abundant between years and none remained constant in rank. Largescale Stoneroller (*Campostoma oligolepis*) was among the 10 most abundant species in 11 of the 13 sites, especially in most recent years. Centrarchids, which often flourish in homogenized assemblages, were rarely among the most abundant species at sites where they were present (21 and 25), and they did not retain dominance over time.

Site 25 (Appendix B) exhibited the most dramatic increase in centrarchid abundance, but exhibited a rebound to a fluvial associated assemblage in 2012. In 1998, Bluegill Sunfish (*Lepomis macrochirus*) was the most abundant (53% relative abundance) Smallmouth Bass (*Micropterus dolomieu*) 5th most abundant and Green Sunfish (*Lepomis cyanellus*) 7th. In 2009 Bluegill Sunfish again dominated the assemblage at 24% relative abundance. Bluegill were present in the 10 most abundant species in 2012 but composed less than one percent of collected specimens. Green Sunfish and Smallmouth Bass were also collected in 2012, but were not among the most abundant species which were composed of members of Cyprinidae and Percidae. No Bluegill were collected in 2013 and Cyprinidae composed the majority of the

assemblage in addition to one Fundulidae species (Black spotted topminnow, *Fundulus olivaceous*) and one Percidae species (Tennessee darter, *Etheostoma tennesseense*).

DISSCUSSION

Invasion Pattern of Weed Shine r in the Bear Creek System

Presently, Weed Shiner persists in high abundance at the most downstream sites within the Bear Creek system. Nonmetric multidimensional scaling (NMDS) analysis indicated that aside from increasing watershed size, disturbance in the catchment caused by development, agriculture and pine monoculture best explained Weed Shiner presence in collections. This supports the human activity hypothesis which has been observed worldwide as human activity has increased the number of successful nonindigenous species (Kopp et al. 2012, Leprieur et al. 2008). The observed correlation between increasing watershed size was attributed to Weed Shiner persistence in the most downstream sites, which are also the ones with highest levels of human activity. Increasing urbanization, seen in Bear Creek as high intensity land use, has been associated with increases in cosmopolitan species in other stream systems, including increases in Weed Shiner abundance (Helms et al. 2005). Increases in agricultural land use can shift aquatic macroinvertebrate assemblage structure in favor of pollutant and lentic tolerant species through nutrient loading and associated consequences such as alteration of daily dissolved oxygen cycles and eutrophication which likely influence fish assemblages as well (Brisboise et al. 2008). Similar to traditional agriculture, pine monoculture of loblolly and shortleaf pines, exerted a significant influence on Weed Shiner presence which differed from native mixed hardwood-pine forests. (Letson et al. 2010, Shankman &Wills 1995). Pine monoculture can increase discharge variability and decrease total water availability (D'Angelo & Webster 1991, Feeley et al. 2011, Swank & Miner 1968). Theses hydrological alterations are similar to those caused by

impoundments and land-use changes which have been documented to promote cosmopolitan invasive species such as Weed Shiner (Light & Marchetti 2007). Effects of development-related degradation have been observed in fish assemblage structure before visual signs of system degradation are apparent (Schweizer & Matlock 2005). Continued persistence of Weed Shiner at these downstream sites may be an early sign of increasing degradation of the Bear Creek watershed.

As abiotic conditions promote Weed Shiner persistence at human-impacted sites, biotic resistance from the high species richness of the native assemblage is inhibiting Weed Shiner establishment in the rest of the system available to Weed Shiner below the impoundments. Biotic resistance to nonindigenous species establishment has been observed in plant, mammal and insect introductions (Ings et al. 2010, Novillo & Ojeda 2008. Zenni & Ziller 2011, Zenni & Nunez 2013). Literature on biotic resistance however is rare and tends to focus on predation by large piscivourious fish early in the establishment process of a predation-vulnerable introduced species (Moyle & Light 1996). This study saw no evidence of predation as a mechanism of biotic resistance, however that does not mean it is not a factor in the Weed Shiner invasion pattern and should be investigated further. Evidence of biotic resistance via competition in fish is especially rare, partially due to the difficulty of observing competitive interactions. Wagner and Grossman (2013) experimentally observed nonindigenous Yellowfin Shiner (*Notropis lutipinnis*) resource partitioning competition with native Rosyside Dace (*Clinostomus funduloides*). Yellowfin Shiner proved to be competitively dominant in tracking fluctuating resources which aided its establishment in the study system. In its native range, Weed Shiner is competitively inferior to the nonindigenous Rough Shiner (*Notropis baileyi*) and has been reduced in abundance where Rough Shiner has established in the Chattahoochee River system (Walser et al. 2000). The

native fish assemblage in Bear Creek, especially the 33 native cyprinid species including Rough Shiner, that were collected in during this study may be resisting Weed Shiner range expansion beyond the most impacted sites.

Human activity and disturbance of the downstream sites in Bear Creek have shifted resource availability and given Weed Shiner the competitive advantage needed to successfully establish. This has not yet occurred in the majority of the system available to Weed Shiner below the impoundments. Large assemblages are more resistant to invasion as long as resource availability remains constant (Byers & Noonburg 2003). Baltz and Moyle (1993) suggest that both biotic interactions and abiotic conditions influence invasion success. If this is the case in Bear Creek, it is a fascinating example of interplay between the two and resulting effects on the assemblage structure in the short term, and demands further investigation in the long term. Introduced species are more vulnerable to extinction that natives and most introductions fail during the introduction, establishment or invasion processes, though examples of this is underrepresented in the literature (Simberloff and Gibbons 2003, Zenni and Nunez 2013). In 2013, young-of-the-year Weed Shiner were collected, indicating successful spawning in the Bear Creek population. However, whether Weed Shiner is permanently established in Bear Creek has yet to be seen and future monitoring of the Weed Shiner population is needed to determine the ultimate success of this invasion.

Fish Assemblage Shifts in the Bear Creek System

This study saw no evidence of Weed Shiner influence on the native fish assemblage of Bear Creek in the short term. Even assemblages with high species and functional diversity may

be successfully invaded if resources are increased or disturbance occurs (Byers and Noonburg 2003). The Bear Creek assemblage, like many in North America is not saturated and Weed Shiner is taking advantage of unoccupied niche space, aided by anthropogenic disturbance (Gido & Brown 1999, Meador & Carlise 2012).

The fish assemblage structure of Bear Creek is remains dominated by fluvial-associated species, is highly spatially and temporally variable, and is influenced by land-use in the watershed. Assemblage composition in the Bear Creek system remains similar to the fluvial-associate dominated assemblage seen in 1968 (included in Appendices B and D with contemporary collections and relative abundances). However, impoundment construction and changes in land use have increased the abundance of more cosmopolitan species (Phillips and Johnston 2004a, Wall 1968). Both Morisita and Jaccard similarity indices showed drastic shifts in assemblage structure over the course of the study and between sequential years. Investigation of relative abundance did little to clarify trends as the 10 most abundant species rarely remained constant between years. NMDS ordination did reveal correlations between assemblage structure and land use. Collection compositions were distributed along a gradient between open or developed land us and forested land cover. Agricultural land use, specifically row crops, represented a second axis of influence perpendicular to the forest-developed land gradient. Urbanization-induced homogenization of fish assemblages has been well-documented in both low and high diversity systems, through an increase in lentic tolerant and generalist species such as centrarchids occurs even at low development levels of 10-20% (Marvier et al. 2004, Schweizer & Matlock 2005, Sutherland et al. 2002). However, Bear Creek has not yet experienced the extreme homogenization seen in other systems due to the high species richness or the currently low levels of development (6%) in the watershed. Row-crop agriculture land-

use also correlated with collection distributions on the NMDS, though not as strongly as developed land use. This is consistent with other studies that have seen increases in abundances of pollution-tolerant, herbivorous and generalist species as agricultural land use increases nutrient loading in streams and moderates flow variation (Brisbois, et al. 2008, Helms et al. 2000).

The lack of significant correlations between assemblage structure and year in NMDS ordination indicated that interannual variability in the Bear Creek system is not influencing the native fish assemblage, nor is total yearly precipitation and discharge. The insignificant correlation may be due to the use of the proxy watershed, however the proxy watershed had similar land cover and bordered Bear Creek. It is more likely that total water availability is not the primary hydrological factor influencing the fish assemblage in Bear Creek. Timing and duration of flows can determine fish assemblage structure without large changes in total discharge. (Bunn & Arthington 2002, Keirnan et al. 2012). This is likely the case in the Bear Creek system where fish assemblage structure was heavily influenced by land cover which can alter hydrological timing and duration.

Select sites did experience temporary shifts towards lentic-associated Centrarchidae species. Centrarchids, particularly Bluegill Sunfish (*Lepomis macrochirus*), are commonly associated with homogenization when natural hydrological regimens are modified. Site 25, and to a lesser extent Site 21, had high abundances of Bluegill Sunfish and Smallmouth Bass (*Micropterus dolomieu*) in 1998 to 2009 but the assemblage recovered to a fluvial-associate dominated structure composed of cyprinids and percids in 2012 and 2013. Bluegill Sunfish can gain dominance in a system when water availability and flow variability decrease, and when seasonal flows shift from historic timing or disappear entirely, particularly below impoundments

(Clavero & Hermoso 2011, Kiernan et al. 2012). But their abundance can be reduced in both native and introduced ranges and fluvial-associated species promoted when natural flow regimens resume (Keirnan et al. 2012, Meffee 1991). Fish species have evolved in response to specific hydrological regimens of their native ranges and are vulnerable to foreign regimens (Bunn & Arthington 2002). Bluegill Sunfish and Smallmouth Bass require low flow conditions to spawn and are vulnerable to displacement by even moderate flows until they reach 25mm while many cyprinids and percids require moderate flows to spawn and become less vulnerable to flow displacement at only 10mm (Boshung & Mayden 2004, Harvey 1987). Consequently, when natural flows regimens resume, native fluvial specialists increase in abundance and centrarchids decrease (Dowling 2012, Kerinan 2012, Meffee 1991). Sites 21 and 25 are heavily forested, low-order sites, and land-cover analysis did not show significant changes in land use during the study period. However, it is possible that NLCD data used in analysis did not have fine enough resolution to sense small scale, but intense disturbance, or that original Landsat Enhanced Thematic Mapper images (upon which NLCD is based) were taken when disturbance was not visible.

Largescale Stoneroller (*Campostoma oligolepis*) was prevalent throughout the system during this study and the only species to regularly be among the 10 most abundant species. Largescale Stoneroller was rare in B. R. Wall's 1968 survey (included in Appendices B and D with contemporary collections and relative abundances). Adult Largescale Stonrollers are herbivorous, feeding on algae scraped from rocks and their presence may be indicative of increased algal growth from agriculturally loaded nutrients (Brisbois et al. 2008, Boschung & Mayden 2004, Mettee et al. 1996). Bluescale Stoneroller (*Campostoma pauciradii*), which has a similar ecology to Largescale Stoneroller, have been associated with increased development

within watersheds (Helms et al. 2005). Additionally, Largescale Stoneroller exhibit increased growth rates and extended spawning seasons in urbanized streams compared to forested streams due to increased algal biomass and water temperature which may give them a competitive advantage in the Bear Creek system (South & Ensign 2013). Increasing abundance of Largescale Stonerollers from historic levels seen in the 1960s is yet another manifestation of human-modified land use in the Bear Creek watershed.

Interestingly, NMDS ordination revealed that not all forest cover is equal: pine monoculture and mixed hardwood forest cover do influence fish assemblage structure differently. Currently there is no available literature investigating the effects of pine monoculture on stream fish assemblages, but some work has been done on stream macroinvertebrate assemblages. Decreases in stream pH, changes in litter decomposition dynamics and altered hydrological regimens associated with pine monoculture has been documented to decrease macroinvertebrate abundance and shifted remaining assemblage structure which may influence higher trophic levels, including fish (Feeley et al. 2011, Miserendino & Masi 2010, Whiles & Wallace 1997). Additionally, pine monoculture can decrease soil moisture and water retention, increases discharge variability, reduce overall water availability, increase sedimentation, increase turbidity, increase substrate imbededness and increase streambed instability; all hydrological and geophysical alterations that have been shown to shift fish assemblages in favor of lentic-associated and generalist species (Bens et al. 2005, D'Angelo & Webster 1991, Marvier et al. 2004, Meador & Carlise 2012, Kanno & Vokoun 2010, Shankman & Wills 1995, Sutherland et al. 2002, Swank 1968). While forest cover type did negatively influence fish assemblage composition structure, pine monoculture was not as detrimental as development or row crop agriculture and the exact relationship between the two remains

CONCLUSIONS

In the short term, Weed Shiner is established in the Bear Creek system and currently persists in the most-downstream, human-impacted portion of the system. Establishment success has been aided by human activity and resulting alterations to abiotic conditions, while biotic resistance by the recipient fish assemblage has most likely inhibited further spread in the Bear Creek system. Land-use is the primary factor influencing the highly variable and diverse fish assemblage structure in Bear Creek. Development, agriculture, and forest cover type were the most important land covers in determining fish species presence. Pine monoculture does appear to impact fish assemblage structure in a similar manner to agricultural row crops, but to a lesser extent. Managing land-use changes and mitigating human-impacts on the Bear creek system will limit future Weed Shiner invasion success and potential impacts, and will benefit preservation of the native fish assemblage.

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Table 1 – Collections containing Weed Shiner from the Bear Creek system from 2007-2013 including total number of specimens collected and relative abundance of Weed Shiner in the fish assemblage. Weed Shiner was not collected in the Bear Creek System prior to 2007.

Site	GSA ID	Years Weed Shiner were collected	Number of Weed Shiner Specimens Collected	Relative Abundance of Weed Shiner
1	MC1	2009	20	6.8
2	BRC1	2008	1	0.7
3	BRC2	2009	30	4.7
		2012	7	1.3
4	BRC3	2008	1	0.2
5	PC1	2009	99	33.3
		2012	162	53.1
		2013	1	0.7
6	PC2	2009	2	1.0
		2013	6	6.8
7	CDC1	2008	18	13.7
		2009	115	22.9
		2012	140	59.3
9	BC3	2007	2	2.5
11	BC6	2009	18	5.9
		2012	43	40.6
12	BC7	2008	10	1.8
		2012	51	16.9
		2013	50	14.6
13	BC8	2008	3	0.8
		2012	53	42.7
		2013	19	15.7
14	BC9	2009	4	1.4
15	BC10	2008	9	3.2
		2009	2	0.3
		2013	2	2.2
16	BC11	2008	67	22.9
17	BC12	2008	3	0.8
27	RC1	2008	15	3.2
29	CC1	2008	7	2.1
		2009	4	0.6
		2013	6	5.8
30	CC2	2008	12	2.4
		2009	23	3.7
32	CC4	2009	2	1.0
33	CC7	2013	1	0.5
36	LBC2	2009	1	0.3

Table 2 – Environmental variables influencing assemblage structure as in the Bear Creek system calculated from multiple regression using the envfit function in the R package VEGAN. Environmental variables are listed by decreasing influence assemblage structure in the Bear Creek system. Land cover in the contributing watershed for each site, producing a wide range of proportions for each land cover category. Maximum and minimum proportions for each land cover category are reported. Detailed land cover data for each site is availbel in Appendix C.

Environmental Variable	r^2	P-value	Range of landcover (%)
Significant Variables			
Watershed Area	0.461	0.001	-
Mixed Hardwood Forest Cover	0.396	0.001	1 – 20.8
Pine Forest Cover	0.231	0.001	3.2 – 19.8
Developed, High Intensity	0.230	0.001	0 – 0.4
Open Water	0.191	0.001	0 – 5.7
Woody Wetland Cover	0.189	0.001	0 – 8.9
Shrub Cover	0.185	0.001	2.8 – 32.3
Developed, Medium Intensity	0.183	0.001	0 – 1.5
Emergent Herbaceous Wetlands Cover	0.167	0.001	0 – 0.2
Barren Cover	0.153	0.001	0 – 1.1
Grassland Cover	0.145	0.001	0 – 9.9
Developed, Low Intensity	0.136	0.001	0 – 1.5
Impervious Surface Cover	0.122	0.001	0.2 – 3.2
Urban Cover	0.092	0.003	1.9 – 11.4
Cultivated Crop Cover	0.066	0.017	0 – 17.8
Nonsignificant Variables			
Deciduous Forest Cover	0.046	0.066	0.5 – 73.2
Developed, Open Space	0.042	0.069	2.0 – 6.6
Yearly Discharge from Buttahatchee Creek	0.033	0.140	-
Year	0.030	0.151	-
Pasture Cover	0.018	0.352	0 – 35.9

Table 3 - Jaccard and Morisita Similarities for all sites with multiple collections generated in PAST 3.0. Values over 0.7 were interpreted as represented similar assemblages and are *italicized*. Values under 0.4 were interpreted as representing dissimilar assemblages, and are **bolded**. Sites where Weed Shiner were collected at any point in the study are indicated with (*). Mean for these sites is included under total mean. In cases where a site was surveyed multiple times during a single year both resulting similarity values are reported. Jaccard and Morisita values are reportedly separately and indicated by J or M, respectively.

	Site	pre2000-2008		pre2000-2009		pre2000-2012		pre2000-2013		2008-2009	
	Similarity Index:	J	M	J	M	J	M	J	M	J	M
*	1										
*	3										
*	4										
*	5										
*	6	**0.267**		**0.190**	**0.351**	**0.267**	**0.265**	**0.154**	**0.226**		
*	7									0.406	0.699
	8										
*	11									**0.385**	**0.051**
*	12	**0.375**	0.581			**0.375**	0.636	**0.400**	**0.379**		
*	13	**0.364**	**0.114**			**0.364**	**0.163**	**0.292**	**0.287**		
*	14			**0.360**	0.435						
*	15	**0.320**	**0.277**	**0.235**	**0.171**	**0.320**	**0.380**	**0.368**	*0.861*	0.556	*0.847*
*	16									0.524	0.669
	18			**0.160**	**0.109**						
	19	**0.250**	**0.214**	**0.182**	0.519	**0.250**	**0.216**	**0.316**	0.536	0.538	**0.347**
	20	**0.250**	**0.052**			**0.250**	**0.385**	**0.125**	0.495		
	21			0.556	0.500			0.526	0.694		
	22										
	23										
	24										
	25	**0.357**		**0.316**	*0.767*	**0.357**	**0.191**	**0.235**	**0.276**		
	26										
	28										
*	29									0.595	0.661
*	30									**0.334** / 0.486	**0.210** / *0.837*
	31										
*	32	**0.286**	*0.764*	**0.391**	*0.782*	**0.286**	0.583			0.455	*0.820*
*	33										
	34										
	35	0.429	**0.140**	**0.300**	**0.179**	0.429	**0.213**	*0.265 / 0.360*	*0.091 / 0.270*	*0.767*	**0.384**
*	36	**0.250**	0.664	**0.269**	**0.150**	**0.250**	**0.393**	**0.320**	**0.189**	0.483	*0.724*
	37		**0.029**	**0.231**	**0.028**			**0.240**	**0.026**	0.455	**0.215**
	38	**0.286**	**0.353**			**0.286**	**0.338**	**0.280**	**0.396**		
	39	**0.130**	0.500			**0.130**	0.442	**0.095**	**0.231**		
	40	**0.077**	**0.304**			**0.077**	**0.046**	0.000	0.000		
	Total Mean	**0.280**	**0.333**	**0.290**	**0.363**	**0.280**	**0.327**	**0.258**	**0.354**	0.516	0.542
	Mean for Sites with Weed Shiner	**0.322**	0.434	**0.294**	0.435	**0.322**	0.405	**0.303**	0.438	0.487	0.624

Table 3 Continued - Values over 0.7 were interpreted as represented similar assemblages and are *italicized*. Values under 0.4 were interpreted as representing dissimilar assemblages, and are **bolded**. Sites where Weed Shiner were collected at any point in the study are indicated with (*). Mean for these sites is included under total mean. In cases where a site was surveyed multiple times during a single year both resulting similarity values are reported. Jaccard and Morisita values are reportedly separately and indicated by J or M, respectively.

	Site	2008-2012		2008-2013		2009-2012		2009-2013		2012-2013	
	Similarity Index:	J	M	J	M	J	M	J	M	J	M
*	1					0.412	**0.183**				
*	3					0.515	**0.120**				
*	4	**0.265**	**0.386**	**0.316**	**0.253**					**0.219**	**0.085**
*	5					0.536	*0.826*	0.538	**0.392**	0.522	**0.340**
*	6					0.417	*0.834*	**0.364**	*0.836*	**0.333**	*0.944*
*	7		0.493				0.658				
	8					**0.143**	0.504				
*	11	**0.213**	**0.012**			**0.216**	**0.261**				
*	12	0.586	0.634	**0.371**	**0.324**					0.429	0.589
*	13	0.483	**0.337**	0.467	0.536					0.476	0.677
*	14										
*	15	**0.306**	*0.848*	**0.379**	0.491	**0.342**	*0.767*	0.419	**0.311**	**0.296**	**0.311**
*	16	**0.333**	**0.259**			**0.294**	**0.339**				
	18										
	19	**0.318**	*0.708*	**0.258**	0.508	**0.389**	**0.305**	**0.346**	*0.957*	**0.333**	0.456
	20	**0.222**	**0.011**	**0.316**	**0.012**					**0.150**	*0.942*
	21							0.632	0.483		
	22					0.556	*0.857*				
	23					**0.333**	*0.757*				
	24					0.600	*0.923*				
	25					0.500	**0.395**	**0.391**	0.433	0.444	0.618
	26					0.571			0.561		
	28					**0.353**	**0.339**				
*	29	0.419	**0.188**	0.482	0.563	0.424	**0.188**	**0.394**	*0.850*	0.409	**0.103**
*	30										
	31					**0.321**	**0.067**				
*	32	0.433	0.582			**0.370**	*0.810*				
*	33	**0.346**	*0.724*	0.500	0.621					0.474	*0.718*
	34	**0.275**	**0.184**								
	35	0.630	0.419	*0.583 / 0.500*	*0.635 / **0.383***	0.552	**0.369**	*0.611 / 0.531*	**0.397** / 0.457	*0.400 / 0.429*	*0.504 / **0.398***
*	36	**0.250**	*0.890*	0.593	0.603	**0.391**	*0.812*	0.429	0.658	**0.280**	0.682
	37			0.409	0.409			*0.708*	*0.716*		
	38	0.476	**0.356**	0.500	0.516						0.496
	39	0.429	*0.814*	**0.370**	0.660					**0.348**	0.580
	40	**0.188**	**0.343**	**0.214**	**0.141**					**0.176**	**0.029**
*											
Mean		**0.363**	0.455	**0.398**	0.434	0.412	0.516	0.469	0.620	**0.349**	0.505
Mean for Sites with Weed Shiner		**0.376**	0.446	0.419	0.465	**0.392**	0.499	0.429	0.597	**0.395**	0.471

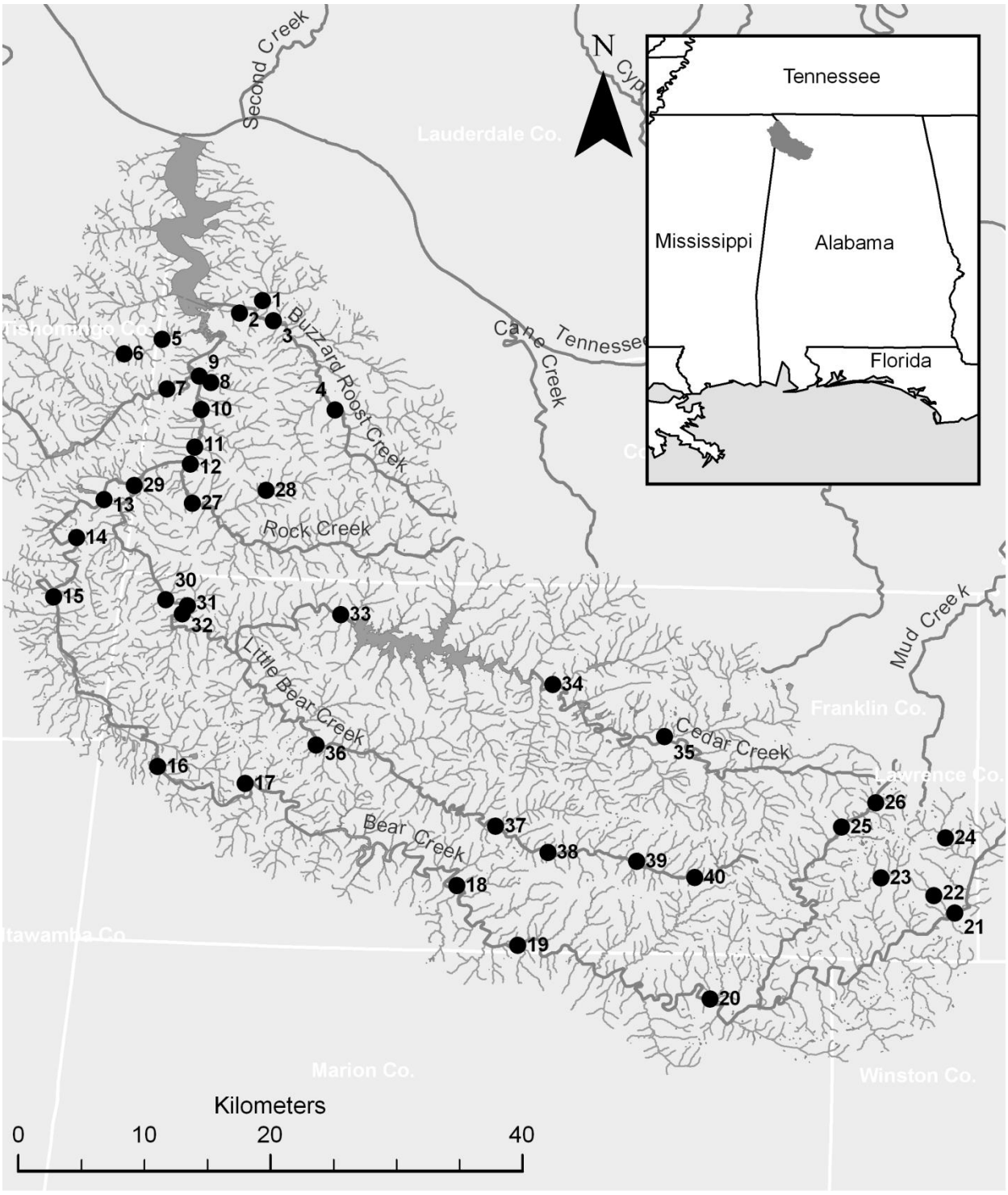

Figure 1 – Map of collection localities in the Bear Creek system in northwest Alabama and northeast Mississippi.

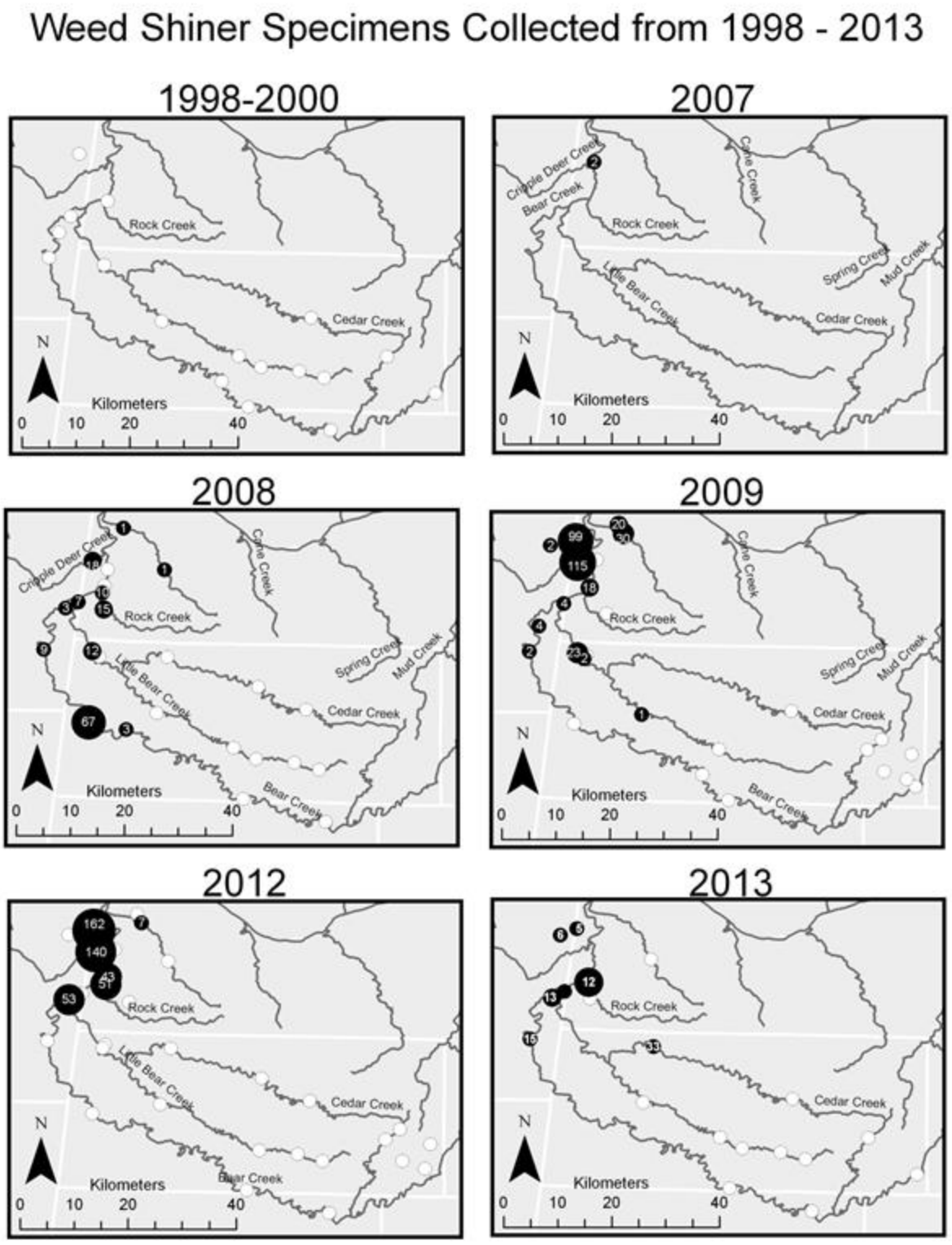

Figure 2 – Absolute abundance of Weed Shiner found at each site over the course of the study. Years 1998 to 2000 were combined because no Weed Shiner was found in the system at that time. White circles (○) denote sites that were surveyed and no Weed Shiner were found. Site where Weed Shiner was present are denoted by graduated black dots (●) labeled with the total number of Weed Shiner specimens that were collected.

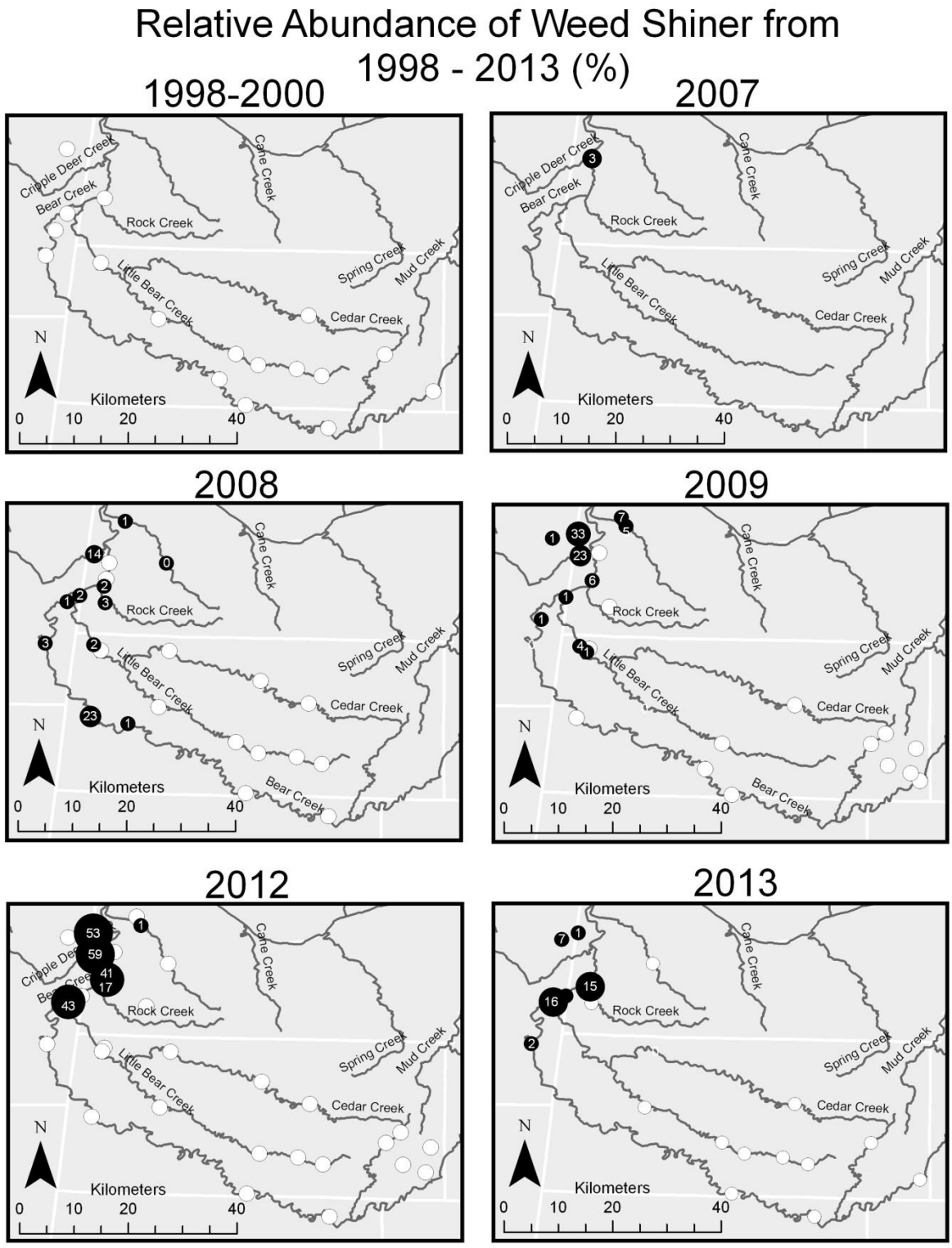

Figure 3 – Relative abundance of Weed Shiner as calculated by the proportion of the assemblage composed of Weed Shiner, found at each site over the course of the study. White circles (○) denote sites that were surveyed and no Weed Shiner were found. Site where Weed Shiner was present are denoted by graduated black dots (●) labeled the relative abundance of Weed Shiner in the fish assemblage rounded to nearest.

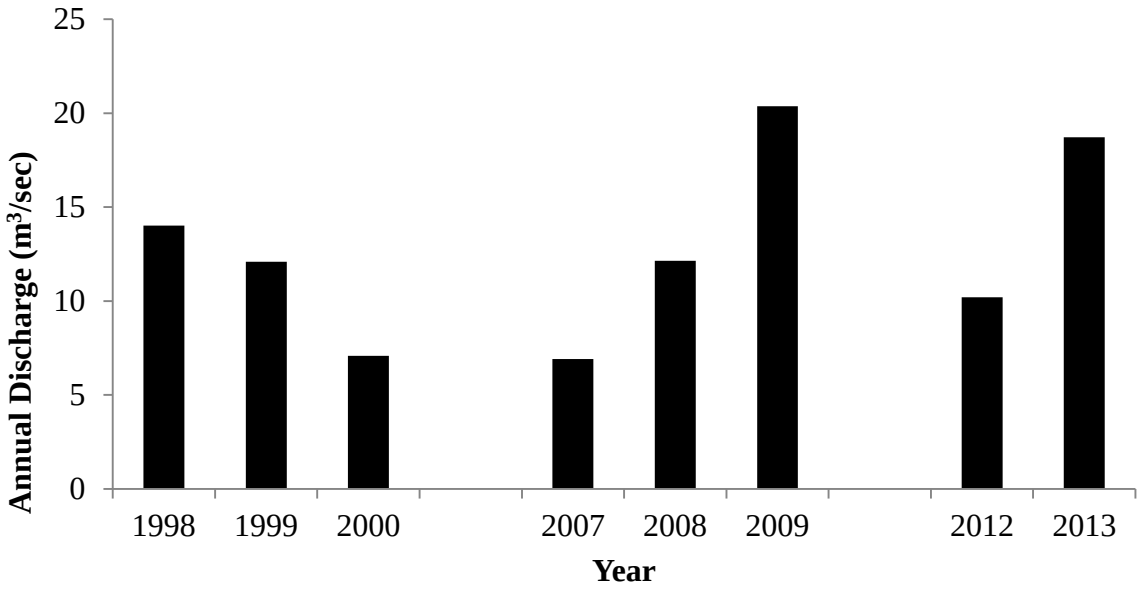

Figure 4 – Average annual discharge from Buttahatchee River used as a proxy for discharge in the Bear Creek system. Discharge was collected from USGS gauge 02438000 on Buttahatchee River below Hamilton AL.

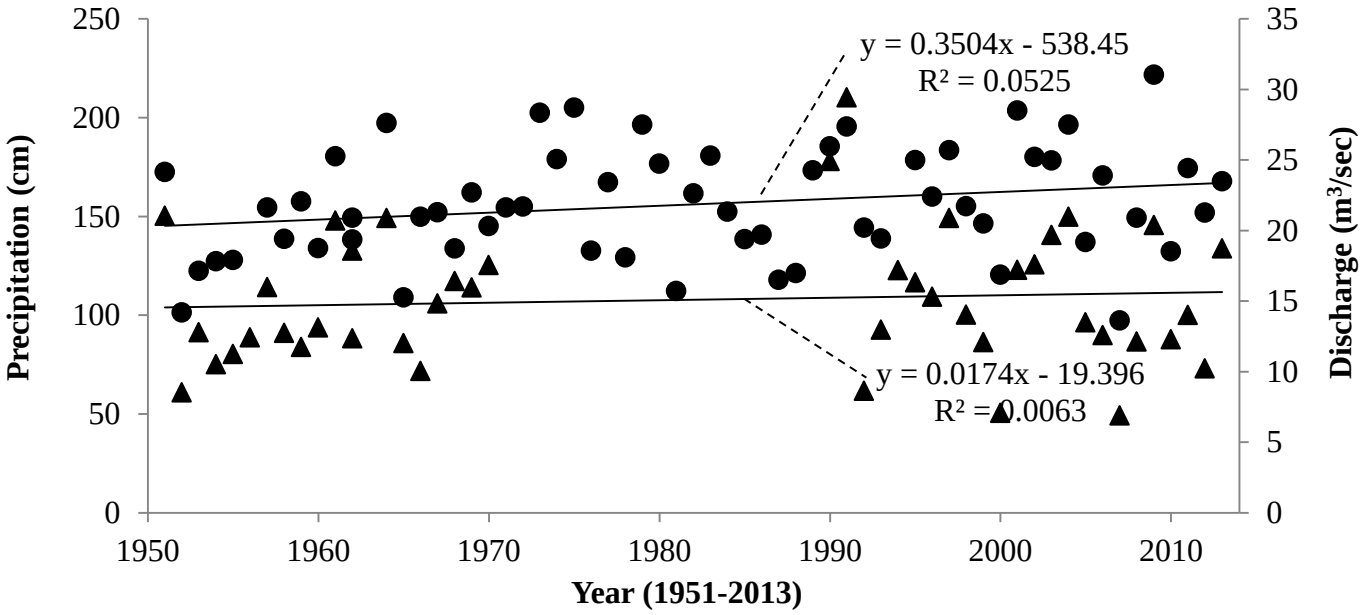

Figure 5 – Time-series of regional annual precipitation (▲) and discharge (●) in the Buttahachee system used as a proxy for precipitation and discharge in the Bear Creek system. Discharge information was acquire from USGS gauge 02438000 on Buttahatchee River below Hamilton, AL and precipitation from NOAA weather station COOP:013620 in Haleyville, AL.

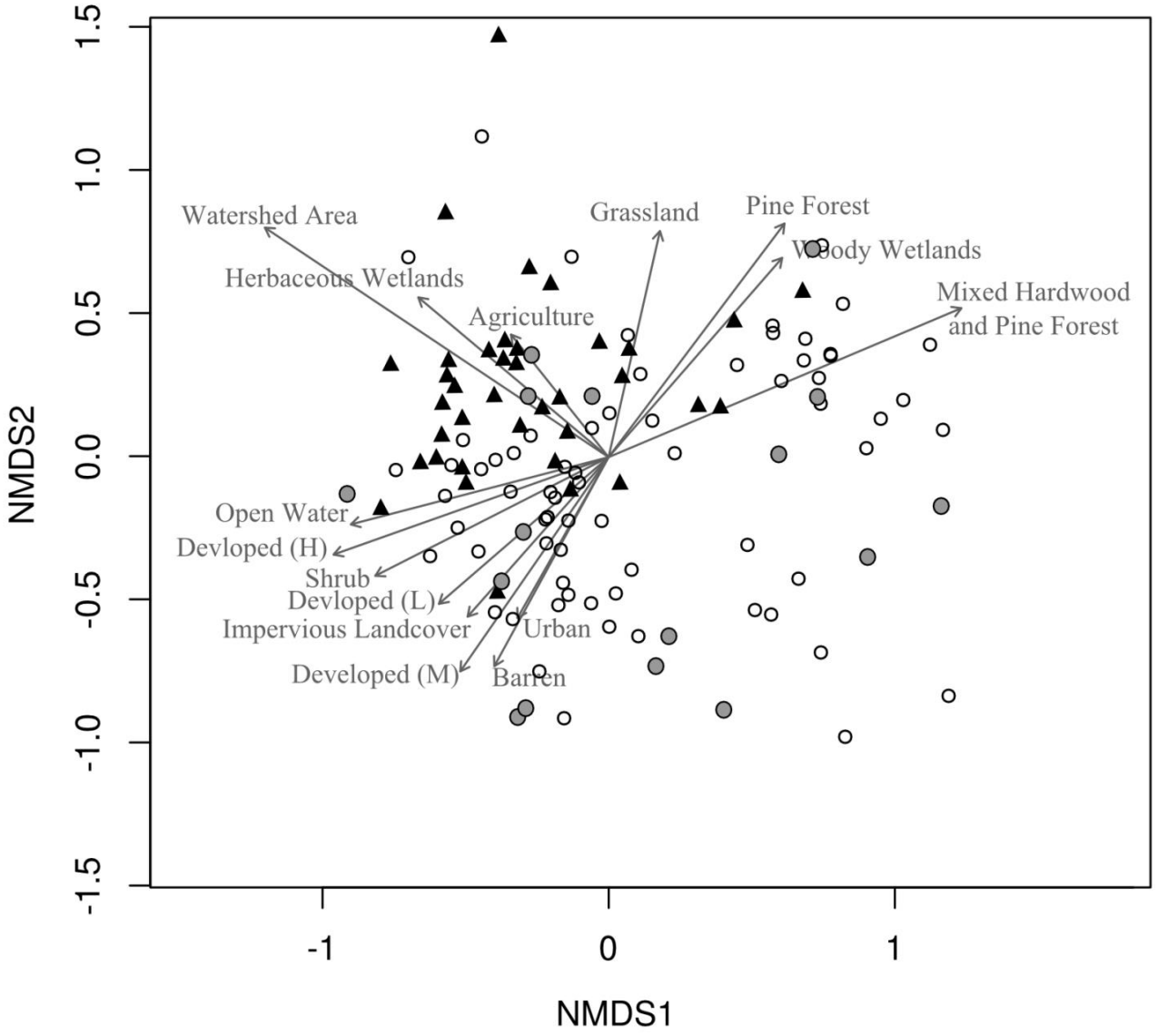

Figure 6 – NMDS ordination of collections in the Bear Creek system from 1998 – 2013 with vectors representing the environmental variables affecting the distribution of collections in ordination space. All displayed environmental vectors are significant at the 0.05 level and were fit to the NMDS ordination using envfit function from the vegan package in R. Collections containing Weed Shiner are indicated with a black triangle (▲), Collections made in Bear Creek after Weed Shiner introduction but not containing Weed Shiner are marked with white circles (○), and those made prior to Weed Shiner introduction are indicated with grey circles (●).

APPENDIX A

COLLECTION RECORDS FOR EACH COLLECTION FROM 1998-2013, FROM THE BEAR CREEK SYSTEM, ALABAMA, USA, USED TO DETERMINE WEED SHINER PATTERN OF INVSION AND SHIFTS IN THE FISH ASSEMBLAGE STRUCTURE

Appendix A – Collection records and site localities for fish faunal surveys in the Bear Creek system from 1998-2007 Collections with Weed Shiner are indicated with (*) following the collection date.

Site	GSA ID	Latitude	Longitude	Location	County, State	Dates Sampled	Historical Data Source	Contemporary Survey Date and Collectors
1	**MC-1**	34.7763 °N	-88.0408 °W	Mill Creek at Mill Creek Loop rd.	Colbert, AL	19-Aug-09 *	Shepard et al. 2009	
						10-Jul-12	Johnston 2012	
2	**BRC-1**	34.7674 °N	-88.0574 °W	Buzzard Roost Creek near US Hwy. 72	Colbert, AL	22-May-08 *	Shepard et al. 2009	
3	**BRC-2**	34.7617 °N	-88.0333 °W	Buzzard Roost at US Hwy. 72	Colbert, AL	12-Aug-09 *	Shepard et al. 2009	
						9-Jul-12*	Johnston 2012	
4	**BRC-3**	34.6981 °N	-87.9890 °W	Buzzard Roost Creek at Co. Hwy. 21	Colbert, AL	6-Aug-08 *	Shepard et al. 2009	
						9-Jul-12	Johnston 2012	
5	**PC-1**	34.7486 °N	-88.1125 °W	Pennywinkle creek at State Line Rd.	Colbert, AL	12-Aug-09 *	Shepard et al. 2009	22-May-13: C. C. Johnson, J. B. Smith, A. M. Best, K. Floyd
						10-Jul-12 *	Johnston 2012	
						22-May-13 *		
6	**PC-2**	34.7417 °N	-88.1550 °W	Pennywinkle Creek at Co. Hwy. 995	Tishomingo, MS	11-Jan-99	Phillips 2001	31-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
						4-May-09 *	Shepard et al. 2009	
						10-Jul-12	Johnston 2012	
						31-Jul-13 *		
7	**CDC-1**	34.7132 °N	-88.1092 °W	Cripple Deer Creek at Co. Hwy. 1	Colbert, AL	19-Aug-08	Shepard et al. 2009	
						19-Aug-09 *	Shepard et al. 2009	
						10-Jul-12 *	Johnston 2012	
8	**TBC-1**	34.7177 °N	-88.0779 °W	Bear Creek Tributary on Buddy Durham Rd.	Colbert, AL	23-Sep-09	Shepard et al. 2009	
						10-Jul-12	Johnston 2012	

Appendix A Continued – Collection records and site localities for fish faunal surveys in the Bear Creek system from 1998-2007 Collections with Weed Shiner are indicated with (*) following the collection date.

Site	GSA ID	Latitude	Longitude	Location	County, State	Dates Sampled	Historical Data Source	Contemporary Survey Date and Collectors
9	**BC-3**	34.7224 °N	-88.0860 °W	Bear Creek, 2 miles upstream of Co. Hwy. 4	Colbert, AL	19-Nov-07 *	Shepard et al. 2009	
10	**BC-5**	34.6984 °N	-88.0846 °W	Bear Creek at river mile 22.25	Colbert, AL	22-May-08	Shepard et al. 2009	
11	**BC-6**	34.6716 °N	-88.0894 °W	Bear Creek at Natchez Trace	Colbert, AL	22-May-08	Shepard et al. 2009	
						13-Aug-09 *		
						10-Jul-12 *	Johnston 2012	
12	**BC-7**	34.6596 °N	-88.0923 °W	Bear Creek at Natchez Trace	Colbert, AL	16-Jun-99	Phillips 2001	31-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
						1-Aug-08 *	Shepard et al. 2009	
						10-Jul-12	Johnston 2012	
						31-Jul-13 *		
13	**BC-8**	34.6342 °N	-88.1541 °W	Bear Creek at MS Hwy. 30	Tishomingo, MS	15-Jun-99	Phillips 2001	31-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
						19-Aug-08 *	Shepard et al. 2009	
						11-Jul-12 *	Johnston 2012	
14	**BC-9**	34.6071 °N	-88.1736 °W	Bear Creek at Tishomingo State Park	Tishomingo, MS	15-Jun-99	Phillips 2001	
						12-Aug-09 *	Shepard et al. 2009	
15	**BC-10**	34.5649 °N	-88.1901 °W	Bear creek at Co. Hwy. 86	Tishomingo, MS	16-Jun-99	Phillips 2001	31-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
						19-Aug-08 *	Shepard et al. 2009	
						21-Aug-09 *		
						11-Jul-12	Johnston 2012	
						31-Jul-13 *		

Appendix A Continued – Collection records and site localities for fish faunal surveys in the Bear Creek system from 1998-2007 Collections with Weed Shiner are indicated with (*) following the collection date.

Site	GSA ID	Latitude	Longitude	Location	County, State	Dates Sampled	Historical Data Source	Contemporary Survey Date and Collectors
						11-Sep-08 *	Shepard et al. 2009	
16	**BC-11**	34.4441 °N	-88.1157 °W	Bear Creek at Co. Hwy	Franklin, AL	10-Jul-09	Shepard et al. 2009	
						11-Jul-12	Johnston 2012	
17	**BC-12**	34.4320 °N	-88.0533 °W	Bear Creek at Co. Hwy. 25	Franklin, AL	5-Aug-08 *	Shepard et al. 2009	
18	**BC-13**	34.3591 °N	-87.9022 °W	Bear Creek at AL Hwy. 187	Franklin, AL	31-Dec-98	Phillips 2001	
						12-Aug-09	Shepard et al. 2009	
						13-Jun-00	Phillips 2001	
19	**BC-14**	34.3163 °N	-87.8586 °W	Bear Creek at Co. Hwy. 57	Franklin, AL	5-Aug-08	Shepard et al. 2009	20-May-13: J, Powell, J. Prichett, J. Gleason, M. Laschett, D. Rollman
						5-Aug-09	Shepard et al. 2009	
						17-Jul-12	Johnston 2012	
						20-May-13		
						12-Jun-00	Phillips 2001	
20	**BC-15**	34.2780 °N	-87.7213 °W	Bear Creek at AL Hwy. 241	Marion, AL	30-Jul-08	Shepard et al. 2009	30-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
						17-Jul-12	Johnston 2012	
						30-Jul-13		
						12-Jun-00	Phillips 2001	
21	**BC-16**	34.3394 °N	-87.5466 °W	Bear Creek at Co. Hwy. 93	Franklin, AL	8-Jul-09	Shepard et al. 2009	23-May-13: C. C. Johnson, P. E. O'Neil, J. B. Smith, E. A. Wynn, W. J. Stiles, A. M. Best
						18-Jun-12	Johnston 2012	

Appendix A Continued – Collection records and site localities for fish faunal surveys in the Bear Creek system from 1998-2007 Collections with Weed Shiner are indicated with (*) following the collection date.

Site	GSA ID	Latitude	Longitude	Location	County, State	Dates Sampled	Historical Data Source	Contemporary Survey Date and Collectors
22	**CSB-1**	34.3517 °N	-87.5616 °W	Chenault Spring Branch at Co. Hwy. 34	Franklin, AL	8-Jul-09	Shepard et al. 2009	
						18-Jun-12	Johnston 2012	
23	**TC-3**	34.3646 °N	-87.5993 °W	Turkey Creek at Co. Hwy. 89	Franklin, AL	13-Aug-09	Shepard et al. 2009	
						18-Jun-12	Johnston 2012	
24	**MB-1**	34.3930 °N	-87.5532 °W	McNair Branch at Co. Hwy. 38	Franklin, AL	13-Aug-09	Shepard et al. 2009	
						18-Jun-12	Johnston 2012	
25	**ULB-2**	34.4008 °N	-87.6275 °W	Little Bear Creek at Co. Hwy. 34	Franklin, AL	12-Jun-00	Phillips 2001	22-May-13: J, Powell, J. Prichett, J. Gleason, M. Laschett, D. Rollman
						8-Jul-09	Shepard et al. 2009	
						13-Jun-12	Johnston 2012	
						22-May-13		
26	**ULB-3**	34.4180 °N	-87.6031 °W	Little Bear Creek at Co. Hwy. 38	Franklin, AL	13-Aug-09	Shepard et al. 2009	
						13-Jun-12	Johnston 2012	
27	**RC-1**	34.6318 °N	-88.0910 °W	Rock Creek at Co. Hwy. 1	Colbert, AL	6-Aug-08 *	Shepard et al. 2009	
28	**CHC-1**	34.6274 °N	-88.0249 °W	Chandelower Creek at Sally Burns Rd. and Co. Rd. 1	Colbert, AL	4-May-09	Shepard et al. 2009	
29	**CC-1**	34.6444 °N	-88.1325 °W	Cedar Creek at Natchez Trace	Colbert, AL	1-Aug-08	Shepard et al. 2009	31-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
						10-Sep-08		
						20-Aug-09 *		
						11-Jul-12	Johnston 2012	
						31-Jul-13 *		

Appendix A Continued – Collection records and site localities for fish faunal surveys in the Bear Creek system from 1998-2007 Collections with Weed Shiner are indicated with (*) following the collection date.

Site	GSA ID	Latitude	Longitude	Location	County, State	Dates Sampled	Historical Data Source	Contemporary Survey Date and Collectors
30	**CC-2**	34.5628 °N	-88.1099 °W	Cedar Creek at Co. Rd. 290	Franklin, AL	31-Jul-08	Shepard et al. 2009	
						6-Aug-08 *	Shepard et al. 2009	
						20-Aug-09 *	Shepard et al. 2009	
31	**CC-3**	34.5584 °N	-88.0944 °W	Cedar Creek at Co. Rd. 190	Franklin, AL	20-Aug-09	Shepard et al. 2009	
32	**CC-4**	34.5529 °N	-88.0983 °W	Cedar Creek at Co. Hwy. 90	Franklin, AL	16-Jun-99	Phillips 2001	
						10-Sep-08	Shepard et al. 2009	
						9-Jul-09 *	Shepard et al. 2009	
						11-Jul-12	Johnston 2012	
33	**CC-7**	34.5522 °N	-87.9851 °W	Cedar Creek at AL Hwy. 247	Franklin, AL	29-Apr-09	Shepard et al. 2009	22-May-13 C. C. Johnson, J. B. Smith, A. M. Best, K. Floyd
						11-Aug-09	Shepard et al. 2009	
						19-Jul-12	Johnston 2012	
						22-May-13		
34	**CC-9**	34.5023 °N	-87.8338 °W	Cedar Creek at Co. Hwy. 73	Franklin, AL	23-May-08	Shepard et al. 2009	
						19-Jul-12	Johnston 2012	
35	**CC-11**	34.4652 °N	-87.7538 °W	Cedar Creek at US Hwy. 43	Franklin, AL	21-Mar-00	Phillips 2001	21-May-13: P. E. O'Neil, E. A. Wynn, A. Ford, W. J. Stiles 1-Aug-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
						31-Jul-08	Shepard et al. 2009	
						9-Jul-09	Shepard et al. 2009	
						19-Jul-12	Johnston 2012	
						21-May-13		
						1-Aug-13		

Appendix A Continued – Collection records and site localities for fish faunal surveys in the Bear Creek system from 1998-2007 Collections with Weed Shiner are indicated with (*) following the collection date.

Site	GSA ID	Latitude	Longitude	Location	County, State	Dates Sampled	Historical Data Source	Contemporary Survey Date and Collectors
36	**LBC-2**	34.4593 °N	-88.0026 °W	Little Bear Creek at AL Hwy. 24	Franklin, AL	7-Jan-99 31-Jul-08 9-Mar-09 * 19-Jul-12 22-May-13	Phillips 2001 Shepard et al. 2009 Shepard et al. 2009 Johnston 2012	22-May-13: P. E. O'Neil, E. A. Wynn, A. Ford, W. J. Stiles
37	**LBC-4**	34.4013 °N	-87.8744 °W	Little Bear Creek at AL Hwy. 187	Franklin, AL	31-Dec-98 21-Nov-08 27-May-09 22-May-13	Phillips 2001 Shepard et al. 2009 Shepard et al. 2009	22-May-13: J, Powell, J. Prichett, J. Gleason, M. Laschett, D. Rollman
38	**LBC-5**	34.3827 °N	-87.8372 °W	Little Bear Creek at Co. Hwy. 122	Franklin, AL	22-Mar-00 21-Nov-08 30-Jul-08 18-Jul-12 21-May-13	Phillips 2001 Shepard et al. 2009 Shepard et al. 2009 Johnston 2012	21-May-13: P. E. O'Neil, E. A. Wynn, A. Ford, W. J. Stiles
39	**LBC-6**	34.3763 °N	-87.7738 °W	Little Bear Creek at Co. Hwy. 59	Franklin, AL	31-Dec-98 18-Aug-08 18-Jul-12 30-30-13	Phillips 2001 Shepard et al. 2009 Johnston 2012	30-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers
40	**LBC-7**	34.3647 °N	-87.7322 °W	Little Bear Creek at McCarley Rd.	Franklin, AL	21-Mar-00 21-Nov-08 12-Jul-12 31-Jul-13	Phillips 2001 Shepard et al. 2009 Johnston 2012	30-Jul-13: A. M. Best, W. J. Stiles, M. L. Stevenson, M. C. Sconyers

APPENDIX B

COLLECTION RECORDS FROM THE BEAR CREEK SYSTEM 1968-2013

Appendix B – Collection records from the Bear Creek system including historical surveys from Wall 1968, Philips 2001, Shepard et al. 2009, and Johnston 2012, and contemporary collections from 2013. Sites 1 – 4.

	Site	**1**	**1**	**2**	**3**	**3**	**4**
	Year	**2009**	**2012**	**2008**	**2009**	**2012**	**2008**
	Taxa	15	9	29	25	25	27
	Individuals	293	90	145	641	523	524
	Shannon (H)	2.110	1.813	2.847	2.326	1.479	2.359
	Evenness (e^H/S)	0.550	0.681	0.594	0.410	0.176	0.392
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						
Lepisossteidae							
Lepisosteus oculatus	spotted gar			1			
Lepisosteus osseus	longnose far			2			
Clupeidae							
Dorosoma cepedianum	gizzard shad			7			
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	19	4	6	150	26	30
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace		19				
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner						
Cyprinella spiloptera	spotfin shiner			3		4	
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner						
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub				1		
Luxilus chrysocephalus	striped shiner	111		3	96	28	144
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner						
Lythrurus fasciolaris	scarlet shiner	33		1	103	3	51
Lythrurus fumeus	ribbon shiner			4		13	
Nocomis leptocephalus	bluehead chub						
Nocomis micropogon	river chub						
Notemigonus crysoleucas	golden shiner						
Notropis atherinoides	emerald shiner						
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner						
Notropis boops	bigeye shiner			13	1	1	37
Notropis micropteryx	highland shiner					2	
Notropis rubellus	rosyface shiner						
Notropis telescopus	telescope shiner						
Notropis texanus	weed shiner	20		1	30	7	1
Notropis volucellus	mimic shiner		1	9	1	339	
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Sites 1-4 Continued.

	Site	1	1	2	3	3	4
	Year	2009	2012	2008	2009	2012	2008
Species	**Common Name**						
Pimephales notatus	bluntnose minnow			1	17		65
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow						
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub	5	25			1	
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker						5
Hypentelium nigricans	northern hogsucker				5	1	3
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker				1		1
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse						
Moxostoma duquesnei	black redhorse			1			
Moxostoma erythrurum	golden redhorse				2		
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead			1	1	1	1
Ictalurus punctatus	channel catfish						
Noturus exilis	slender madtom						
Noturus funebris	black madtom						
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom						
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish						
Esocidae							
Esox americanus	redfin pickerel	4					2
Esox niger	chain pickerel						
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish						
Fundulidae							
Fundulus catenatus	northern studfish						
Fundulus olivaceus	blackspotted topminnow	4		2	1		15
Poeciliidae							
Gambusia affinis	western mosquitofish					2	4
Atherinopsidae							
Labidesthes sicculus	brook silverside					1	3

Appendix B Continued – Sites 1-4 Coninued.

	Site	1	1	2	3	3	4
	Year	2009	2012	2008	2009	2012	2008
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin	39	12		50	22	
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass			8			
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass				9		3
Lepomis auritus	redbreast sunfish			1			
Lepomis cyanellus	green sunfish			2	2	1	28
Lepomis gulosus	warmouth			2			
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill	5		17	62	7	5
Lepomis marginatus	dollar sunfish						
Lepomis megalotis	longear sunfish	14	1	29	36	1	77
Lepomis microlophus	redear sunfish			1			
Lepomis miniatus	redspotted sunfish						1
Micropterus dolomieui	smallmouth bass						1
Micropterus punctulatus	spotted bass			3		1	23
Micropterus salmoides	largemouth bass			9		2	1
Pomoxis annularis	white crappie						
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid						
Percidae							
Etheostoma blennioides	greenside darter				5	2	1
Etheostoma caeruleum	rainbow darter	10	3	1	3	4	2
Etheostoma duryi	black darter	13	6		11	3	16
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter						
Etheostoma jessiae	blueside darter						
Etheostoma kennicotti	stripetail darter						2
Etheostoma nigripinne	blackfin dater	7	19		2		2
Etheostoma nigrum	johnny darter						
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter	7		9	46	50	
Etheostoma tennesseense	Tennessee darter						
Etheostoma simoterum	Tennessee snubnose darter						
Etheostoma stigmaeum	speckled darter						
Etheostoma zonistium	bandfin darter						
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch			2			
Percina caprodes	logperch	2		4	5	1	
Percina evides	gilt darter						
Percina phoxocephala	slenderhead darter				1		
Percina sciera	dusky darter						
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum			2			

Appendix B Continued – Sites 4 – 6.

	Site	4	4	5	5	5	6
	Year	**2012**	**2013**	**2009**	**2012**	**2013**	**1968**
	Taxa	16	23	24	19	16	5
	Individuals	237	673	297	305	148	20
	Shannon (H)	1.626	2.156	2.387	1.479	2.020	1.175
	Evenness (e^H/S)	0.318	0.375	0.454	0.231	0.471	0.648
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						1
Lepisossteidae							
Lepisosteus oculatus	spotted gar						
Lepisosteus osseus	longnose far						
Clupeidae							
Dorosoma cepedianum	gizzard shad						
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	1	221	25	1	10	
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace						
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner		32				
Cyprinella spiloptera	spotfin shiner	2	2				
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner						
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub		55				
Luxilus chrysocephalus	striped shiner	16	30	31	86	42	
Lythrurus ardens	rosefin shiner						9
Lythrurus bellus	pretty shiner						
Lythrurus fasciolaris	scarlet shiner	133	13	3			
Lythrurus fumeus	ribbon shiner	5					
Nocomis leptocephalus	bluehead chub			25	12	16	
Nocomis micropogon	river chub						
Notemigonus crysoleucas	golden shiner						
Notropis atherinoides	emerald shiner						
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner			17	6	44	
Notropis boops	bigeye shiner	22					
Notropis micropteryx	highland shiner						
Notropis rubellus	rosyface shiner						
Notropis telescopus	telescope shiner						
Notropis texanus	weed shiner			99	162	1	
Notropis volucellus	mimic shiner	1		2			
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Sites 4 – 6 Coninued.

	Site	4	4	5	5	5	6
	Year	2012	2013	2009	2012	2013	1968
Species	**Common Name**						
Pimephales notatus	bluntnose minnow		16				
Pimephales promelas	fathead minnow	2					
Pimephales vigilax	bullhead minnow						
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub	1		10	1		
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker				2		
Hypentelium nigricans	northern hogsucker		12		1		
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker						
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse						
Moxostoma duquesnei	black redhorse						
Moxostoma erythrurum	golden redhorse		2	2			
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead						
Ictalurus punctatus	channel catfish						
Noturus exilis	slender madtom		1				
Noturus funebris	black madtom			5	1	7	
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom						
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish						
Esocidae							
Esox americanus	redfin pickerel	1					
Esox niger	chain pickerel						
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish						
Fundulidae							
Fundulus catenatus	northern studfish		13				
Fundulus olivaceus	blackspotted topminnow	23	25	6	3		8
Poeciliidae							
Gambusia affinis	western mosquitofish	7					
Atherinopsidae							
Labidesthes sicculus	brook silverside						

Appendix B Continued – Sites 4 – 6 Coninued.

	Site	4	4	5	5	5	6
	Year	2012	2013	2009	2012	2013	1968
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin		6	4	5		1
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass						
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass		2				
Lepomis auritus	redbreast sunfish						
Lepomis cyanellus	green sunfish		1	1	1	9	
Lepomis gulosus	warmouth						
Lepomis humilis	orangespotted sunfish					1	
Lepomis macrochirus	bluegill		1	8	5	1	
Lepomis marginatus	dollar sunfish						
Lepomis megalotis	longear sunfish	16	17	19	6	2	
Lepomis microlophus	redear sunfish			1			
Lepomis miniatus	redspotted sunfish						
Micropterus dolomieui	smallmouth bass						
Micropterus punctulatus	spotted bass			1	3		
Micropterus salmoides	largemouth bass			3			
Pomoxis annularis	white crappie						
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid			2		2	
Percidae							
Etheostoma blennioides	greenside darter						
Etheostoma caeruleum	rainbow darter		16	3	2	2	
Etheostoma duryi	black darter		2		5	2	1
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter						
Etheostoma jessiae	blueside darter						
Etheostoma kennicotti	stripetail darter						
Etheostoma nigripinne	blackfin dater	1		1	2	2	
Etheostoma nigrum	johnny darter		1				
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter	2	168				
Etheostoma tennesseense	Tennessee darter		29				
Etheostoma simoterum	Tennessee snubnose darter						
Etheostoma stigmaeum	speckled darter				1		
Etheostoma zonistium	bandfin darter	4		21		2	
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch						
Percina caprodes	logperch		8	7		5	
Percina evides	gilt darter						
Percina phoxocephala	slenderhead darter						
Percina sciera	dusky darter			1			
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum						

Appendix B Continued – Sites 6 – 7.

	Site	6	6	6	6	7	7
	Year	**1998**	**2009**	**2012**	**2013**	**2008**	**2009**
	Taxa	5	20	14	10	22	23
	Individuals	13	201	142	88	131	502
	Shannon (H)	1.378	2.353	1.719	1.458	2.659	2.089
	Evenness (e^H/S)	0.793	0.526	0.399	0.430	0.649	0.351
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						
Lepisossteidae							
Lepisosteus oculatus	spotted gar						
Lepisosteus osseus	longnose far						
Clupeidae							
Dorosoma cepedianum	gizzard shad						
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	1	15	3		5	3
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace						
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner						
Cyprinella spiloptera	spotfin shiner			4		2	
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner						
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub						
Luxilus chrysocephalus	striped shiner	6	20	11	6	16	74
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner						
Lythrurus fasciolaris	scarlet shiner			2		8	128
Lythrurus fumeus	ribbon shiner						
Nocomis leptocephalus	bluehead chub		27	12	15		2
Nocomis micropogon	river chub						
Notemigonus crysoleucas	golden shiner		2				
Notropis atherinoides	emerald shiner						
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner	1	64	74	50		
Notropis boops	bigeye shiner						
Notropis micropteryx	highland shiner						
Notropis rubellus	rosyface shiner						
Notropis telescopus	telescope shiner						
Notropis texanus	weed shiner		2		6	18	115
Notropis volucellus	mimic shiner			6		14	86
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

	Site	6	6	6	6	7	7
	Year	1998	2009	2012	2013	2008	2009
Species	**Common Name**						
Pimephales notatus	bluntnose minnow		2				
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow						
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub		2	19			
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker		9				
Hypentelium nigricans	northern hogsucker					1	
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker						4
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse						
Moxostoma duquesnei	black redhorse						
Moxostoma erythrurum	golden redhorse						
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead		2				
Ictalurus punctatus	channel catfish						
Noturus exilis	slender madtom						
Noturus funebris	black madtom		4	1	1		
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom						
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish						
Esocidae							
Esox americanus	redfin pickerel		2				3
Esox niger	chain pickerel					1	
Aphrendoderidae							
Aphredoderus sayanus	pirate perch					5	
Belonidae							
Strongylura marina	Atlantic needlefish						
Fundulidae							
Fundulus catenatus	northern studfish						
Fundulus olivaceus	blackspotted topminnow	2	4	3		9	13
Poeciliidae							
Gambusia affinis	western mosquitofish						17
Atherinopsidae							
Labidesthes sicculus	brook silverside					1	8

	Site	6	6	6	6	7	7
	Year	1998	2009	2012	2013	2008	2009
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin		2	1		3	
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass						
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass						
Lepomis auritus	redbreast sunfish						
Lepomis cyanellus	green sunfish		4		1	2	
Lepomis gulosus	warmouth		1				
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill		9	2	2		11
Lepomis marginatus	dollar sunfish						
Lepomis megalotis	longear sunfish		14			20	16
Lepomis microlophus	redear sunfish					2	1
Lepomis miniatus	redspotted sunfish						1
Micropterus dolomieui	smallmouth bass						
Micropterus punctulatus	spotted bass					3	
Micropterus salmoides	largemouth bass						1
Pomoxis annularis	white crappie						
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid						2
Percidae							
Etheostoma blennioides	greenside darter						
Etheostoma caeruleum	rainbow darter				1		
Etheostoma duryi	black darter	3					
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter						1
Etheostoma jessiae	blueside darter						
Etheostoma kennicotti	stripetail darter					2	2
Etheostoma nigripinne	blackfin dater		5			1	
Etheostoma nigrum	johnny darter					2	3
Etheostoma parvipinne	goldstripe darter			1			
Etheostoma rufilineatum	redline darter						1
Etheostoma tennesseense	Tennessee darter				3	1	
Etheostoma simoterum	Tennessee snubnose darter						
Etheostoma stigmaeum	speckled darter						
Etheostoma zonistium	bandfin darter		11	3	3	10	4
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch						
Percina caprodes	logperch					5	6
Percina evides	gilt darter						
Percina phoxocephala	slenderhead darter						
Percina sciera	dusky darter						
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum						

Appendix B Continued – Sites 8 - 11.

	Site	8	9	10	11	11	11
	Year	2012	2007	2008	2008	2009	2012
	Taxa	5	12	29	42	30	15
	Individuals	21	79	380	1021	306	106
	Shannon (H)	1.297	1.986	2.210	1.955	2.911	2.019
	Evenness (e^H/S)	0.732	0.607	0.314	0.168	0.613	0.502
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey			1			
Lampetra appendix	American brook lamprey				1		
Lepisosteidae							
Lepisosteus oculatus	spotted gar			1			
Lepisosteus osseus	longnose far			3	17	13	
Clupeidae							
Dorosoma cepedianum	gizzard shad		25	92	252		
Dorosoma petenense	threadfin shad			100	457		
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	9			5	18	6
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace						
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner						
Cyprinella spiloptera	spotfin shiner			10	12	11	
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner			1	2		
Cyprinus carpio	common carp				5		
Hybopsis amblops	bigeye chub						
Luxilus chrysocephalus	striped shiner					4	
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner						
Lythrurus fasciolaris	scarlet shiner				1		
Lythrurus fumeus	ribbon shiner						
Nocomis leptocephalus	bluehead chub						
Nocomis micropogon	river chub						
Notemigonus crysoleucas	golden shiner	3					
Notropis atherinoides	emerald shiner						
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner						
Notropis boops	bigeye shiner						
Notropis micropteryx	highland shiner						
Notropis rubellus	rosyface shiner						
Notropis telescopus	telescope shiner						
Notropis texanus	weed shiner		2			18	43
Notropis volucellus	mimic shiner			68	15	3	4
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Sites 8 – 11 Continued .

	Site	8	9	10	11	11	11

	Year	2012	2007	2008	2008	2009	2012
Species	**Common Name**						
Pimephales notatus	bluntnose minnow			1	1		
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow				19	2	
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub	7					
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback					2	
Carpiodes velifer	highfin carpsucker					3	
Erimyzon oblongus	creek chubsucker	1					
Hypentelium nigricans	northern hogsucker				4	13	
Ictiobus bubalus	smallmouth buffalo		7	20	30	8	
Ictiobus niger	black buffalo				3		
Minytrema melanops	spotted sucker		9	4			
Moxostoma anisurum	silver redhorse			1	2	3	
Moxostoma breviceps	smallmouth redhorse			1	3	21	
Moxostoma carinatum	river redhorse		1	3	6	24	
Moxostoma duquesnei	black redhorse			1	2		
Moxostoma erythrurum	golden redhorse			3	5	22	
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead						
Ictalurus punctatus	channel catfish		2	2	3	8	1
Noturus exilis	slender madtom						
Noturus funebris	black madtom						
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom					2	
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish				1		
Esocidae							
Esox americanus	redfin pickerel						
Esox niger	chain pickerel				2		
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish			2	4		
Fundulidae							
Fundulus catenatus	northern studfish				14		3
Fundulus olivaceus	blackspotted topminnow			2	1		2
Poeciliidae							
Gambusia affinis	western mosquitofish						1
Atherinopsidae							
Labidesthes sicculus	brook silverside					4	7

Appendix B Continued – Sites 8 – 11 Continued .

	Site	8	9	10	11	11	11
	Year	2012	2007	2008	2008	2009	2012
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin						5
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass			6	81		
Morone saxatilis	striped bass				10	1	
Centrarchidae							
Ambloplites rupestris	rock bass				2		
Lepomis auritus	redbreast sunfish				2		
Lepomis cyanellus	green sunfish						
Lepomis gulosus	warmouth						
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill		3	22	14	15	1
Lepomis marginatus	dollar sunfish			14			
Lepomis megalotis	longear sunfish		18	2	23	55	5
Lepomis microlophus	redear sunfish		4		3	5	
Lepomis miniatus	redspotted sunfish						
Micropterus dolomieui	smallmouth bass			5	2	2	
Micropterus punctulatus	spotted bass		6	11	5	8	2
Micropterus salmoides	largemouth bass		1		1	2	
Pomoxis annularis	white crappie			1			
Pomoxis nigromaculatus	black crappie				1		
Lepomis spp.	sunfish hybrid						
Percidae							
Etheostoma blennioides	greenside darter						
Etheostoma caeruleum	rainbow darter						
Etheostoma duryi	black darter	1					3
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter			1		2	
Etheostoma jessiae	blueside darter						
Etheostoma kennicotti	stripetail darter						
Etheostoma nigripinne	blackfin dater						
Etheostoma nigrum	johnny darter						
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter				2		20
Etheostoma tennesseense	Tennessee darter					1	
Etheostoma simoterum	Tennessee snubnose darter						
Etheostoma stigmaeum	speckled darter						
Etheostoma zonistium	bandfin darter						
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch					28	
Percina caprodes	logperch			1	2		
Percina evides	gilt darter				2		3
Percina phoxocephala	slenderhead darter					1	
Percina sciera	dusky darter				3	7	
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum		1	1	1		

Appendix B Continued – Sites 12 – 13.

	Site	12	12	12	12	13	13
	Year	**1998**	**2008**	**2012**	**2013**	**1968**	**1999**
	Taxa	14	27	19	21	11	15
	Individuals	96	556	302	343	31	66
	Shannon (H)	2.229	2.468	2.441	2.250	2.125	2.484
	Evenness (e^H/S)	0.664	0.437	0.605	0.452	0.761	0.799
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						
Lepisosteidae							
Lepisosteus oculatus	spotted gar						
Lepisosteus osseus	longnose far						
Clupeidae							
Dorosoma cepedianum	gizzard shad						
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	19	80	43	34		2
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace						
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner				1		
Cyprinella spiloptera	spotfin shiner	4	13	2			8
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner					4	6
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub						
Luxilus chrysocephalus	striped shiner		6	1		4	7
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner						
Lythrurus fasciolaris	scarlet shiner						
Lythrurus fumeus	ribbon shiner						
Nocomis leptocephalus	bluehead chub						
Nocomis micropogon	river chub						
Notemigonus crysoleucas	golden shiner					2	
Notropis atherinoides	emerald shiner						
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner				63		
Notropis boops	bigeye shiner						
Notropis micropteryx	highland shiner			1			
Notropis rubellus	rosyface shiner	1					
Notropis telescopus	telescope shiner					4	
Notropis texanus	weed shiner		10	51	50		
Notropis volucellus	mimic shiner	12	42	45	63		4
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Sites 12 – 13 Continued.

	Site	12	12	12	12	13	13
	Year	1998	2008	2012	2013	1968	1999
Species	**Common Name**						
Pimephales notatus	bluntnose minnow		3				
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow	4					3
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub						
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker						
Hypentelium nigricans	northern hogsucker	19	33	18	8		12
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker						
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse				1		
Moxostoma duquesnei	black redhorse				1		3
Moxostoma erythrurum	golden redhorse		1	1	1		
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead		1				
Ictalurus punctatus	channel catfish		2				
Noturus exilis	slender madtom						
Noturus funebris	black madtom						
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom		1				2
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish						
Esocidae							
Esox americanus	redfin pickerel						
Esox niger	chain pickerel						
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish						
Fundulidae							
Fundulus catenatus	northern studfish	2	21	18	10		
Fundulus olivaceus	blackspotted topminnow		4	3	2	1	3
Poeciliidae							
Gambusia affinis	western mosquitofish	2	27	7	6		
Atherinopsidae							
Labidesthes sicculus	brook silverside			32			

Appendix B Continued – Sites 12 – 13 Continued.

	Site	12	12	12	12	13	13
	Year	1998	2008	2012	2013	1968	1999
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin	16	25	17	3	1	4
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass						
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass						
Lepomis auritus	redbreast sunfish						
Lepomis cyanellus	green sunfish		2				
Lepomis gulosus	warmouth						
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill		6		66		1
Lepomis marginatus	dollar sunfish				6		
Lepomis megalotis	longear sunfish	2			6	9	
Lepomis microlophus	redear sunfish		105	5			
Lepomis miniatus	redspotted sunfish						
Micropterus dolomieui	smallmouth bass						
Micropterus punctulatus	spotted bass				1	1	2
Micropterus salmoides	largemouth bass		6	8	1		
Pomoxis annularis	white crappie	6	3				
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid						
Percidae							
Etheostoma blennioides	greenside darter		6				
Etheostoma caeruleum	rainbow darter						
Etheostoma duryi	black darter		1	7			
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter						
Etheostoma jessiae	blueside darter		2				
Etheostoma kennicotti	stripetail darter						
Etheostoma nigripinne	blackfin dater						
Etheostoma nigrum	johnny darter						
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter	6	121	34	7	1	1
Etheostoma tennesseense	Tennessee darter		2				
Etheostoma simoterum	Tennessee snubnose darter						
Etheostoma stigmaeum	speckled darter						
Etheostoma zonistium	bandfin darter						
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch						
Percina caprodes	logperch	2	27	3	10	2	
Percina evides	gilt darter		6	6			
Percina phoxocephala	slenderhead darter						
Percina sciera	dusky darter	1			3	2	8
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum						

Appendix B Continued – Sites 13 – 14.

	Site	13	13	13	14	14	14
	Year	**2008**	**2012**	**2013**	**1968**	**1999**	**2009**
	Taxa	28	15	16	12	12	22
	Individuals	398	124	121	92	33	282
	Shannon (H)	1.705	1.877	2.288	2.054	2.172	2.244
	Evenness (e^H/S)	0.197	0.436	0.616	0.650	0.731	0.429
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						
Lepisosteidae							
Lepisosteus oculatus	spotted gar						
Lepisosteus osseus	longnose far						
Clupeidae							
Dorosoma cepedianum	gizzard shad						
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	61	11	4		3	22
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace						
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner						
Cyprinella spiloptera	spotfin shiner	17	4	18	1	3	21
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner				1		
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub						
Luxilus chrysocephalus	striped shiner	5			26	2	40
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner						
Lythrurus fasciolaris	scarlet shiner						1
Lythrurus fumeus	ribbon shiner						
Nocomis leptocephalus	bluehead chub						
Nocomis micropogon	river chub						
Notemigonus crysoleucas	golden shiner						
Notropis atherinoides	emerald shiner						
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner						
Notropis boops	bigeye shiner						1
Notropis micropteryx	highland shiner	3	2				
Notropis rubellus	rosyface shiner				8		
Notropis telescopus	telescope shiner						
Notropis texanus	weed shiner	3	53	19			4
Notropis volucellus	mimic shiner	7	20	15			8
Opsopoeodus emiliae	pugnose minnow				16		
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Sites 13 – 14 Continued.

	Site	13	13	13	14	14	14
	Year	2008	2012	2013	1968	1999	2009
Species	**Common Name**						
Pimephales notatus	bluntnose minnow					1	7
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow	2			8		
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub	1					
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker						
Hypentelium nigricans	northern hogsucker	8	3				7
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker						
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse						
Moxostoma duquesnei	black redhorse						
Moxostoma erythrurum	golden redhorse	2					
Ictaluidae							
Ameiurus melas	black bullhead						1
Ameiurus natalis	yellow bullhead						
Ictalurus punctatus	channel catfish						
Noturus exilis	slender madtom						
Noturus funebris	black madtom	3					
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom						
Noturus nocturnus	freckled madtom				4		
Pylodictis olivaris	flathead catfish						
Esocidae							
Esox americanus	redfin pickerel						
Esox niger	chain pickerel						
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish	1					
Fundulidae							
Fundulus catenatus	northern studfish	1	1	1			
Fundulus olivaceus	blackspotted topminnow	7	1	1		3	3
Poeciliidae							
Gambusia affinis	western mosquitofish			2		1	
Atherinopsidae							
Labidesthes sicculus	brook silverside		1	10			

Appendix B Continued – Sites 13 – 14 Continued.

	Site	13	13	13	14	14	14
	Year	2008	2012	2013	1968	1999	2009
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin	3	3				1
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass						
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass						
Lepomis auritus	redbreast sunfish						
Lepomis cyanellus	green sunfish	2					1
Lepomis gulosus	warmouth						
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill	3		14		1	3
Lepomis marginatus	dollar sunfish					2	
Lepomis megalotis	longear sunfish	13			2	3	41
Lepomis microlophus	redear sunfish	1		1			
Lepomis miniatus	redspotted sunfish						
Micropterus dolomieui	smallmouth bass						
Micropterus punctulatus	spotted bass	2		2	2		3
Micropterus salmoides	largemouth bass					1	
Pomoxis annularis	white crappie						
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid						
Percidae							
Etheostoma blennioides	greenside darter	3	1	2			
Etheostoma caeruleum	rainbow darter						
Etheostoma duryi	black darter	1	1				1
Etheostoma flabellare	fantail darter						4
Etheostoma histrio	harlequin darter	1		1	1		
Etheostoma jessiae	blueside darter						
Etheostoma kennicotti	stripetail darter						
Etheostoma nigripinne	blackfin dater						
Etheostoma nigrum	johnny darter						
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter	233	17	24		2	93
Etheostoma tennesseense	Tennessee darter	1					
Etheostoma simoterum	Tennessee snubnose darter						
Etheostoma stigmaeum	speckled darter						4
Etheostoma zonistium	bandfin darter						
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch						
Percina caprodes	logperch	7		4			5
Percina evides	gilt darter	6	3	3			
Percina phoxocephala	slenderhead darter				10		
Percina sciera	dusky darter	1	3		13	11	11
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum						

Appendix B Continued – Site 15.

	Site	15	15	15	15	15	15
	Year	**1968**	**1998**	**2008**	**2009**	**2012**	**2013**
	Taxa	11	12	26	30	21	14
	Individuals	42	117	278	689	157	90
	Shannon (H)	2.027	1.846	2.478	2.035	2.315	2.129
	Evenness (e^H/S)	0.690	0.528	0.459	0.255	0.482	0.601
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						
Lepisossteidae							
Lepisosteus oculatus	spotted gar						
Lepisosteus osseus	longnose far						
Clupeidae							
Dorosoma cepedianum	gizzard shad						
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	3	5	77	177	33	11
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace						
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner						
Cyprinella spiloptera	spotfin shiner		6	3	19		2
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner	11		1			
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub						
Luxilus chrysocephalus	striped shiner	7	51	17	14	16	31
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner						
Lythrurus fasciolaris	scarlet shiner					1	
Lythrurus fumeus	ribbon shiner						
Nocomis leptocephalus	bluehead chub				1		
Nocomis micropogon	river chub		1				
Notemigonus crysoleucas	golden shiner						
Notropis atherinoides	emerald shiner	10					
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner						
Notropis boops	bigeye shiner				5	1	
Notropis micropteryx	highland shiner			25	17	2	4
Notropis rubellus	rosyface shiner						
Notropis telescopus	telescope shiner						
Notropis texanus	weed shiner			9	2		2
Notropis volucellus	mimic shiner					13	3
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Site 15.

	Site	15	15	15	15	15	15
	Year	1968	1998	2008	2009	2012	2013
Species	**Common Name**						
Pimephales notatus	bluntnose minnow		1			1	
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow			1	5		
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub		5			1	
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker			1			
Hypentelium nigricans	northern hogsucker		14	17	84	18	13
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker						
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse						
Moxostoma duquesnei	black redhorse						
Moxostoma erythrurum	golden redhorse		10			1	
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead				1		
Ictalurus punctatus	channel catfish			3	10		
Noturus exilis	slender madtom						
Noturus funebris	black madtom				1		
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom				1		
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish				1		
Esocidae							
Esox americanus	redfin pickerel						
Esox niger	chain pickerel						
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish						
Fundulidae							
Fundulus catenatus	northern studfish				2	1	3
Fundulus olivaceus	blackspotted topminnow	1		6	11	1	4
Poeciliidae							
Gambusia affinis	western mosquitofish		2	12	1		9
Atherinopsidae							
Labidesthes sicculus	brook silverside					1	

Appendix B Continued – Site 15.

	Site	15	15	15	15	15	15
	Year	1968	1998	2008	2009	2012	2013
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin	2		1	4	1	
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass						
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass						
Lepomis auritus	redbreast sunfish						
Lepomis cyanellus	green sunfish			10	1		
Lepomis gulosus	warmouth						
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill	1		3	9		
Lepomis marginatus	dollar sunfish						
Lepomis megalotis	longear sunfish	2	1	29	69	32	
Lepomis microlophus	redear sunfish				2		1
Lepomis miniatus	redspotted sunfish						
Micropterus dolomieui	smallmouth bass						
Micropterus punctulatus	spotted bass		5	4	5	3	2
Micropterus salmoides	largemouth bass	1		3	2		
Pomoxis annularis	white crappie						
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid						
Percidae							
Etheostoma blennioides	greenside darter			1			
Etheostoma caeruleum	rainbow darter					1	
Etheostoma duryi	black darter				1	6	
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter			1			
Etheostoma jessiae	blueside darter			3		2	
Etheostoma kennicotti	stripetail darter						
Etheostoma nigripinne	blackfin dater						
Etheostoma nigrum	johnny darter						
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter			40	231	18	
Etheostoma tennesseense	Tennessee darter						
Etheostoma simoterum	Tennessee snubnose darter						
Etheostoma stigmaeum	speckled darter				1		
Etheostoma zonistium	bandfin darter						
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch						
Percina caprodes	logperch			1	2		4
Percina evides	gilt darter			4	5	4	
Percina phoxocephala	slenderhead darter	2					
Percina sciera	dusky darter	2	16	5	5		1
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum			1			

Appendix B Continued – Site 16 – 18.

	Site	16	16	16	17	18	18	18
	Year	**2008**	**2009**	**2012**	**2008**	**1968**	**1998**	**2009**
	Taxa	19	13	9	24	16	7	22
	Individuals	292	184	54	380	77	45	198
	Shannon (H)	2.346	1.957	2.088	2.268	2.544	1.204	2.394
	Evenness (e^H/S)	0.550	0.544	0.897	0.402	0.795	0.476	0.498
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey							
Lepisossteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far							
Clupeidae								
Dorosoma cepedianum	gizzard shad							19
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	26	23	8	112	6		3
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace							
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner							
Cyprinella spiloptera	spotfin shiner	42	31		32			53
Cyprinella venusta	blacktail shiner					10	1	
Cyprinella whipplei	steelcolor shiner					10		
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub							
Luxilus chrysocephalus	striped shiner	24			34	7	1	6
Lythrurus ardens	rosefin shiner						1	
Lythrurus bellus	pretty shiner					6		
Lythrurus fasciolaris	scarlet shiner	4						
Lythrurus fumeus	ribbon shiner				1			
Nocomis leptocephalus	bluehead chub							
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner					6		
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner					5		
Notropis boops	bigeye shiner				5	1		
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner							
Notropis texanus	weed shiner	67			3			
Notropis volucellus	mimic shiner	2						
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Site 16 – 18 Continued.

	Site	16	16	16	17	18	18	18
	Year	2008	2009	2012	2008	1968	1998	2009
Species	**Common Name**							
Pimephales notatus	bluntnose minnow						1	
Pimephales promelas	fathead minnow					5		
Pimephales vigilax	bullhead minnow				68			
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub				1			
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	2	12	6	6			4
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker							1
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse							6
Moxostoma erythrurum	golden redhorse				1			15
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead							
Ictalurus punctatus	channel catfish				2	2		1
Noturus exilis	slender madtom							
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom							
Noturus miurus	brindled madtom				1			
Noturus nocturnus	freckled madtom				1			
Pylodictis olivaris	flathead catfish				1			1
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish							
Fundulus olivaceus	blackspotted topminnow	16	3	7	2	5	25	6
Poeciliidae								
Gambusia affinis	western mosquitofish			11				
Atherinopsidae								
Labidesthes sicculus	brook silverside	4		5	13			

Appendix B Continued – Site 16 – 18 Continued.

	Site	16	16	16	17	18	18	18
	Year	2008	2009	2012	2008	1968	1998	2009
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin	6	6		41			1
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass							
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish	8	11					3
Lepomis gulosus	warmouth							
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill	3		7	2	1	3	30
Lepomis marginatus	dollar sunfish							17
Lepomis megalotis	longear sunfish	30	46	5	19			
Lepomis microlophus	redear sunfish							
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass							21
Micropterus punctulatus	spotted bass	1	3	4	4	2		2
Micropterus salmoides	largemouth bass		1					
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie							
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter		1					
Etheostoma caeruleum	rainbow darter							2
Etheostoma duryi	black darter	5	1		3	1		1
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter							
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater							2
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter	43	45		21			
Etheostoma tennesseense	Tennessee darter							
Etheostoma simoterum	Tennessee snubnose darter			1				
Etheostoma stigmaeum	speckled darter					1	13	1
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter							
Perca flavescens	yellow perch							
Percina caprodes	logperch	1						
Percina evides	gilt darter	2			3			
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter	6	1		4	9		3
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Site 19

	Site	19	19	19	19	19	19
	Year	**1968**	**1998**	**2008**	**2009**	**2012**	**2013**
	Taxa	18	8	22	18	7	17
	Individuals	93	118	697	267	68	514
	Shannon (H)	2.101	1.522	1.902	1.427	1.716	1.384
	Evenness (e^H/S)	0.454	0.573	0.305	0.231	0.795	0.235
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						
Lepisossteidae							
Lepisosteus oculatus	spotted gar						
Lepisosteus osseus	longnose far						
Clupeidae							
Dorosoma cepedianum	gizzard shad						
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller	2	8	241	17	21	115
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace						
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner						
Cyprinella spiloptera	spotfin shiner	16		206	23	7	30
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner		35				
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub						
Luxilus chrysocephalus	striped shiner	22		44	6	5	20
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner	25	2		6		15
Lythrurus fasciolaris	scarlet shiner			8			
Lythrurus fumeus	ribbon shiner						
Nocomis leptocephalus	bluehead chub				2		
Nocomis micropogon	river chub			1			
Notemigonus crysoleucas	golden shiner						
Notropis atherinoides	emerald shiner	2					
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner	1			4		
Notropis boops	bigeye shiner						
Notropis micropteryx	highland shiner			2	3	20	
Notropis rubellus	rosyface shiner		35				
Notropis telescopus	telescope shiner	11					
Notropis texanus	weed shiner						
Notropis volucellus	mimic shiner						
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Site 19

	Site	19	19	19	19	19	19
	Year	1968	1998	2008	2009	2012	2013
Species	**Common Name**						
Pimephales notatus	bluntnose minnow				3		2
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow	2		1			
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub						
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker						
Hypentelium nigricans	northern hogsucker	1		33	3	4	2
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker						
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse						
Moxostoma duquesnei	black redhorse	2		3			
Moxostoma erythrurum	golden redhorse	1					
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead						1
Ictalurus punctatus	channel catfish	1		1			
Noturus exilis	slender madtom						1
Noturus funebris	black madtom						
Noturus gyrinus	tadpole madtom						
Noturus miurus	brindled madtom						
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish			1			
Esocidae							
Esox americanus	redfin pickerel						
Esox niger	chain pickerel						
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish						
Fundulidae							
Fundulus catenatus	northern studfish						
Fundulus olivaceus	blackspotted topminnow	1		15			
Poeciliidae							
Gambusia affinis	western mosquitofish						1
Atherinopsidae							
Labidesthes sicculus	brook silverside						

Appendix B Continued – Site 19

	Site	19	19	19	19	19	19
	Year	1968	1998	2008	2009	2012	2013
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin						3
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass						
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass						
Lepomis auritus	redbreast sunfish						
Lepomis cyanellus	green sunfish			2	1		
Lepomis gulosus	warmouth						
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill			6	6		
Lepomis marginatus	dollar sunfish			23	4		
Lepomis megalotis	longear sunfish	1		1			4
Lepomis microlophus	redear sunfish						
Lepomis miniatus	redspotted sunfish						
Micropterus dolomieui	smallmouth bass			13	1		
Micropterus punctulatus	spotted bass			1	2		1
Micropterus salmoides	largemouth bass						1
Pomoxis annularis	white crappie						
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid						
Percidae							
Etheostoma blennioides	greenside darter	2	1				3
Etheostoma caeruleum	rainbow darter			11	3		
Etheostoma duryi	black darter						
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter						
Etheostoma jessiae	blueside darter						
Etheostoma kennicotti	stripetail darter						
Etheostoma nigripinne	blackfin dater						
Etheostoma nigrum	johnny darter						
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter		32	72	179	7	298
Etheostoma tennesseense	Tennessee darter						
Etheostoma simoterum	Tennessee snubnose darter			8	2		
Etheostoma stigmaeum	speckled darter	1	1				9
Etheostoma zonistium	bandfin darter						
Etheostoma sp. Cf. zonistum	blueface darter						
Perca flavescens	yellow perch						
Percina caprodes	logperch		4	4	2	4	8
Percina evides	gilt darter						
Percina phoxocephala	slenderhead darter	1					
Percina sciera	dusky darter	1					
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum						

Appendix B Continued – Sites 20-21.

	Site	20	20	20	20	20	21
	Year	**1968**	**2000**	**2008**	**2012**	**2013**	**1968**
	Taxa	9	5	12	10	13	8
	Individuals	49	53	547	159	75	184
	Shannon (H)	1.534	0.861	0.717	1.362	1.554	1.149
	Evenness (e^H/S)	0.515	0.473	0.171	0.391	0.364	0.394
Species	**Common Name**						
Petromyzontidae							
Ichthyomyzon bdellium	Ohio lamprey						
Ichthyomyzon castaneus	chestnut lamprey						
Lampetra appendix	American brook lamprey						
Lepisossteidae							
Lepisosteus oculatus	spotted gar						
Lepisosteus osseus	longnose far						
Clupeidae							
Dorosoma cepedianum	gizzard shad						
Dorosoma petenense	threadfin shad						
Cyprinidae							
Campostoma oligolepis	largescale stoneroller		12		96	44	
Campostoma pauciradii	bluefin stoneroller						
Clinostomus funduloides	rosyside dace			466			
Cyprinella callistia	Alabama shiner						
Cyprinella galactura	whitetail shiner		37	25	10	10	
Cyprinella spiloptera	spotfin shiner					5	
Cyprinella venusta	blacktail shiner						
Cyprinella whipplei	steelcolor shiner	2					
Cyprinus carpio	common carp						
Hybopsis amblops	bigeye chub	2					
Luxilus chrysocephalus	striped shiner	3				1	1
Lythrurus ardens	rosefin shiner						
Lythrurus bellus	pretty shiner			16	15		88
Lythrurus fasciolaris	scarlet shiner				21		
Lythrurus fumeus	ribbon shiner				8		
Nocomis leptocephalus	bluehead chub						1
Nocomis micropogon	river chub						
Notemigonus crysoleucas	golden shiner						
Notropis atherinoides	emerald shiner						
Notropis asperifrons	burrhead shiner						
Notropis baileyi	rough shiner	1					75
Notropis boops	bigeye shiner						
Notropis micropteryx	highland shiner					2	
Notropis rubellus	rosyface shiner						
Notropis telescopus	telescope shiner						
Notropis texanus	weed shiner						
Notropis volucellus	mimic shiner						
Opsopoeodus emiliae	pugnose minnow						
Phoxinus erythrogaster	southern redbelly dace						

Appendix B Continued – Sites 20-21 Continued.

	Site	20	20	20	20	20	21
	Year	1968	2000	2008	2012	2013	1968
Species	**Common Name**						
Pimephales notatus	bluntnose minnow	1					4
Pimephales promelas	fathead minnow						
Pimephales vigilax	bullhead minnow						
Rhinichthys atratulus	blacknose dace						
Semotilus atromaculatus	creek chub						
Semotilus thoreauianus	Dixie chub						
Catostomidae							
Carpiodes carpio	river carpsucker						
Carpiodes cyprinus	quilback						
Carpiodes velifer	highfin carpsucker						
Erimyzon oblongus	creek chubsucker						
Hypentelium nigricans	northern hogsucker	2		7	4	1	
Ictiobus bubalus	smallmouth buffalo						
Ictiobus niger	black buffalo						
Minytrema melanops	spotted sucker				1		
Moxostoma anisurum	silver redhorse						
Moxostoma breviceps	smallmouth redhorse						
Moxostoma carinatum	river redhorse						
Moxostoma duquesnei	black redhorse						
Moxostoma erythrurum	golden redhorse						
Ictaluidae							
Ameiurus melas	black bullhead						
Ameiurus natalis	yellow bullhead						
Ictalurus punctatus	channel catfish						
Noturus exilis	slender madtom						
Noturus funebris	black madtom						
Noturus gyrinus	tadpole madtom				1		
Noturus miurus	brindled madtom						
Noturus nocturnus	freckled madtom						
Pylodictis olivaris	flathead catfish			2			
Esocidae							
Esox americanus	redfin pickerel						
Esox niger	chain pickerel						
Aphrendoderidae							
Aphredoderus sayanus	pirate perch						
Belonidae							
Strongylura marina	Atlantic needlefish						
Fundulidae							
Fundulus catenatus	northern studfish						
Fundulus olivaceus	blackspotted topminnow			3		1	
Poeciliidae							
Gambusia affinis	western mosquitofish						
Atherinopsidae							
Labidesthes sicculus	brook silverside						

Appendix B Continued – Sites 20-21 Continued.

	Site	20	20	20	20	20	21
	Year	1968	2000	2008	2012	2013	1968
Species	**Common Name**						
Cottidae							
Cottus carolinae	banded sculpin						
Moronidae							
Morone chrysops	white bass						
Morone mississippiensis	yellow bass						
Morone saxatilis	striped bass						
Centrarchidae							
Ambloplites rupestris	rock bass					1	
Lepomis auritus	redbreast sunfish						
Lepomis cyanellus	green sunfish			5		1	
Lepomis gulosus	warmouth						
Lepomis humilis	orangespotted sunfish						
Lepomis macrochirus	bluegill			6			6
Lepomis marginatus	dollar sunfish		1	5			
Lepomis megalotis	longear sunfish		1				
Lepomis microlophus	redear sunfish					1	
Lepomis miniatus	redspotted sunfish						
Micropterus dolomieui	smallmouth bass		2	10	1		
Micropterus punctulatus	spotted bass			1		2	
Micropterus salmoides	largemouth bass						
Pomoxis annularis	white crappie						
Pomoxis nigromaculatus	black crappie						
Lepomis spp.	sunfish hybrid						
Percidae							
Etheostoma blennioides	greenside darter	1					
Etheostoma caeruleum	rainbow darter						
Etheostoma duryi	black darter						
Etheostoma flabellare	fantail darter						
Etheostoma histrio	harlequin darter						
Etheostoma jessiae	blueside darter				2		
Etheostoma kennicotti	stripetail darter						
Etheostoma nigripinne	blackfin dater						
Etheostoma nigrum	johnny darter						
Etheostoma parvipinne	goldstripe darter						
Etheostoma rufilineatum	redline darter						
Etheostoma tennesseense	Tennessee darter						
Etheostoma simoterum	Tennessee snubnose darter						3
Etheostoma stigmaeum	speckled darter	20		1		2	6
Etheostoma zonistium	bandfin darter						
Etheostoma sp. Cf. zonistum	blueface darter	17					
Perca flavescens	yellow perch						
Percina caprodes	logperch						
Percina evides	gilt darter						
Percina phoxocephala	slenderhead darter					4	
Percina sciera	dusky darter						
Percina shumardi	river darter						
Sciaenidae							
Aplodinotus grunniens	freshwater drum						

Appendix B Continued – Sites 21 – 22.

	Site	21	21	21	21	21	22	22
	Year	**1998**	**2009**	**2013**	**2013**	**2013**	**2009**	**2012**
	Taxa	13	15	13	15	16	8	6
	Individuals	185	173	162	125	287	81	78
	Shannon (H)	1.711	2.144	2.105	2.278	2.275	1.504	1.399
	Evenness (e^H/S)	0.426	0.569	0.632	0.651	0.608	0.562	0.675
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey							
Lepisosteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far							
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	2	25	16	33	49	1	3
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace						1	
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner							
Cyprinella spiloptera	spotfin shiner							
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner							
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub							
Luxilus chrysocephalus	striped shiner	10	7	13	12	25	12	4
Lythrurus ardens	rosefin shiner							
Lythrurus bellus	pretty shiner	66	28	9	16	25		
Lythrurus fasciolaris	scarlet shiner							
Lythrurus fumeus	ribbon shiner							
Nocomis leptocephalus	bluehead chub		1	7	8	15	11	15
Nocomis micropogon	river chub	3						
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner	44		57	12	69	38	37
Notropis boops	bigeye shiner							
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner							
Notropis texanus	weed shiner							
Notropis volucellus	mimic shiner							
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 21 – 22 Continued.

	Site	21	21	21	21	21	22	22
	Year	1998	2009	2013	2013	2013	2009	2012
Species	**Common Name**							
Pimephales notatus	bluntnose minnow							
Pimephales promelas	fathead minnow							
Pimephales vigilax	bullhead minnow							
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub		3					16
Semotilus thoreauianus	Dixie chub						14	
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	2	3	5	8	13		
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker							
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse							
Moxostoma erythrurum	golden redhorse							
Ictaluidae								
Ameiurus melas	black bullhead				1	1		
Ameiurus natalis	yellow bullhead		1	3		3		
Ictalurus punctatus	channel catfish							
Noturus exilis	slender madtom							
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom		1	4	2	6		
Noturus miurus	brindled madtom							
Noturus nocturnus	freckled madtom	1						
Pylodictis olivaris	flathead catfish							
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish							
Fundulus olivaceus	blackspotted topminnow	4	4	7	8	15		
Poeciliidae								
Gambusia affinis	western mosquitofish							
Atherinopsidae								
Labidesthes sicculus	brook silverside							

Appendix B Continued – Sites 21 – 22 Continued.

	Site	21	21	21	21	21	22	22
	Year	1998	2009	2013	2013	2013	2009	2012
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin							
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass							
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish	1	2		1	1		
Lepomis gulosus	warmouth							
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill	3	47	3	2	5	2	
Lepomis marginatus	dollar sunfish	3	16					
Lepomis megalotis	longear sunfish			9	2	11		
Lepomis microlophus	redear sunfish							
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass		3					
Micropterus punctulatus	spotted bass				2	2		
Micropterus salmoides	largemouth bass							
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie							
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter							
Etheostoma caeruleum	rainbow darter							
Etheostoma duryi	black darter							
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter							
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater							
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter							
Etheostoma tennesseense	Tennessee darter							
Etheostoma simoterum	Tennessee snubnose darter							
Etheostoma stigmaeum	speckled darter	43	22	26	15	41		
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter	3	10	3	3	6	2	3
Perca flavescens	yellow perch							
Percina caprodes	logperch							
Percina evides	gilt darter							
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter							
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Sites 23 – 25.

	Site	23	23	24	24	25	25	25
	Year	**2009**	**2012**	**2009**	**2012**	**1968**	**1998**	**2009**
	Taxa	8	8	14	10	6	7	18
	Individuals	24	53	310	112	159	74	235
	Shannon (H)	1.791	1.491	1.831	1.560	1.061	1.488	2.243
	Evenness (e^H/S)	0.749	0.555	0.446	0.476	0.482	0.633	0.524
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey							
Lepisossteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far							
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller		11	34	9		12	52
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace							
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner							
Cyprinella spiloptera	spotfin shiner							
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner							
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub							
Luxilus chrysocephalus	striped shiner	4		73	16	13	5	18
Lythrurus ardens	rosefin shiner							
Lythrurus bellus	pretty shiner			1				4
Lythrurus fasciolaris	scarlet shiner			22	2			
Lythrurus fumeus	ribbon shiner							
Nocomis leptocephalus	bluehead chub	2	1	16	7	22		2
Nocomis micropogon	river chub					8		
Notemigonus crysoleucas	golden shiner							1
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							1
Notropis baileyi	rough shiner	1	5	121	61	108		
Notropis boops	bigeye shiner							
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner							
Notropis texanus	weed shiner							
Notropis volucellus	mimic shiner							
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 23 – 25 Continued.

	Site	23	23	24	24	25	25	25
	Year	2009	2012	2009	2012	1968	1998	2009
Species	**Common Name**							
Pimephales notatus	bluntnose minnow							
Pimephales promelas	fathead minnow							2
Pimephales vigilax	bullhead minnow							
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub			5	7			12
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker			7				3
Hypentelium nigricans	northern hogsucker					1	6	
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker							
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse							
Moxostoma erythrurum	golden redhorse		3					
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead							3
Ictalurus punctatus	channel catfish							
Noturus exilis	slender madtom							
Noturus funebris	black madtom				3			
Noturus gyrinus	tadpole madtom							1
Noturus miurus	brindled madtom							
Noturus nocturnus	freckled madtom							
Pylodictis olivaris	flathead catfish							
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish							
Fundulus olivaceus	blackspotted topminnow	3	2	1	2		4	14
Poeciliidae								
Gambusia affinis	western mosquitofish							
Atherinopsidae								
Labidesthes sicculus	brook silverside							

Appendix B Continued – Sites 23 – 25 Continued.

	Site	23	23	24	24	25	25	25
	Year	2009	2012	2009	2012	1968	1998	2009
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin							
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass							
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish						3	3
Lepomis gulosus	warmouth							
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill	9	27	9			39	56
Lepomis marginatus	dollar sunfish							
Lepomis megalotis	longear sunfish	1						
Lepomis microlophus	redear sunfish							
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass		3	3	1		5	35
Micropterus punctulatus	spotted bass	1		1				11
Micropterus salmoides	largemouth bass							
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie							
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter							
Etheostoma caeruleum	rainbow darter							
Etheostoma duryi	black darter							
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter			14				
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater							
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter		1					
Etheostoma tennesseense	Tennessee darter							
Etheostoma simoterum	Tennessee snubnose darter							
Etheostoma stigmaeum	speckled darter					7		6
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter	3		3	4			11
Perca flavescens	yellow perch							
Percina caprodes	logperch							
Percina evides	gilt darter							
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter							
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Sites 25 – 28.

	Site	**25**	**25**	**26**	**26**	**27**	**28**	**28**
	Year	**2012**	**2013**	**2009**	**2012**	**2008**	**2009**	**2012**
	Taxa	12	14	16	17	27	10	13
	Individuals	127	226	153	250	476	60	168
	Shannon (H)	1.894	2.133	2.289	1.708	2.087	2.053	1.455
	Evenness (e^H/S)	0.554	0.603	0.617	0.325	0.299	0.779	0.330
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey				21			
Lepisosteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far							
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	16	36	26		25	15	18
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace				96			
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner				5			
Cyprinella spiloptera	spotfin shiner							
Cyprinella venusta	blacktail shiner				4			
Cyprinella whipplei	steelcolor shiner				5			
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub							
Luxilus chrysocephalus	striped shiner	52	28	34		206	4	100
Lythrurus ardens	rosefin shiner							
Lythrurus bellus	pretty shiner	3		1	86			
Lythrurus fasciolaris	scarlet shiner		36	7		8		1
Lythrurus fumeus	ribbon shiner	4						2
Nocomis leptocephalus	bluehead chub	7	3	6				
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner	19	58	3				
Notropis boops	bigeye shiner					2		2
Notropis micropteryx	highland shiner				1			
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner							
Notropis texanus	weed shiner				8	15		
Notropis volucellus	mimic shiner							
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 25 – 28 Continued.

	Site	25	25	26	26	27	28	28
	Year	2012	2013	2009	2012	2008	2009	2012
Species	**Common Name**							
Pimephales notatus	bluntnose minnow					13		
Pimephales promelas	fathead minnow							
Pimephales vigilax	bullhead minnow							
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub	4	3	12				
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker			4		1		
Hypentelium nigricans	northern hogsucker					5		
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker				1			
Moxostoma anisurum	silver redhorse							5
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse				1			
Moxostoma duquesnei	black redhorse							
Moxostoma erythrurum	golden redhorse							
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead		1			2		2
Ictalurus punctatus	channel catfish							
Noturus exilis	slender madtom							
Noturus funebris	black madtom					2		
Noturus gyrinus	tadpole madtom	1	3					
Noturus miurus	brindled madtom							
Noturus nocturnus	freckled madtom							
Pylodictis olivaris	flathead catfish							
Esocidae								
Esox americanus	redfin pickerel				4			
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish							
Fundulus olivaceus	blackspotted topminnow	4	23	2		21	5	15
Poeciliidae								
Gambusia affinis	western mosquitofish					1		
Atherinopsidae								
Labidesthes sicculus	brook silverside							

Appendix B Continued – Sites 25 – 28 Continued.

	Site	25	25	26	26	27	28	28
	Year	2012	2013	2009	2012	2008	2009	2012
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin				1	13		
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass				6			
Morone saxatilis	striped bass				2			
Centrarchidae					1			
Ambloplites rupestris	rock bass					8		
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish	1		2		7	5	
Lepomis gulosus	warmouth							
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill		11	14		4		
Lepomis marginatus	dollar sunfish			1			10	17
Lepomis megalotis	longear sunfish		2			93		
Lepomis microlophus	redear sunfish							
Lepomis miniatus	redspotted sunfish					4		
Micropterus dolomieui	smallmouth bass	4		5				
Micropterus punctulatus	spotted bass			2		4		2
Micropterus salmoides	largemouth bass							
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie				6			
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter					4		
Etheostoma caeruleum	rainbow darter					3	2	1
Etheostoma duryi	black darter					8	5	
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter		8	7		1		
Etheostoma kennicotti	stripetail darter						11	
Etheostoma nigripinne	blackfin dater				2	1	2	1
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter					22		
Etheostoma tennesseense	Tennessee darter		11				1	
Etheostoma simoterum	Tennessee snubnose darter							2
Etheostoma stigmaeum	speckled darter							
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter	12	3	27				
Perca flavescens	yellow perch							
Percina caprodes	logperch					2		
Percina evides	gilt darter							
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter					1		
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Sites 29 – 30.

	Site	29	29	29	29	29	30	30
	Year	**2008**	**2009**	**2012**	**2013**	**2013**	**2008**	**2008**
	Taxa	28	31	16	15	22	20	24
	Individuals	329	657	204	104	790	194	499
	Shannon (H)	2.349	2.595	1.632	1.830	2.242	2.162	2.247
	Evenness (e^H/S)	0.374	0.432	0.320	0.416	0.428	0.434	0.394
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey							
Lepisosteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far	1						
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	35	184	14	10	261	26	42
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace							
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner						3	5
Cyprinella spiloptera	spotfin shiner	17	10	4	7		32	52
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner							
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub					72		
Luxilus chrysocephalus	striped shiner	1	32		3	64	1	20
Lythrurus ardens	rosefin shiner							
Lythrurus bellus	pretty shiner							
Lythrurus fasciolaris	scarlet shiner	2		2	1	35	1	
Lythrurus fumeus	ribbon shiner							
Nocomis leptocephalus	bluehead chub							
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner							
Notropis boops	bigeye shiner				1			
Notropis micropteryx	highland shiner	7	18				3	5
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner							
Notropis texanus	weed shiner	7	4		6			12
Notropis volucellus	mimic shiner	17	20	121	54			
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 29 – 30 Continued.

	Site	29	29	29	29	29	30	30
	Year	2008	2009	2012	2013	2013	2008	2008
Species	**Common Name**							
Pimephales notatus	bluntnose minnow			4		42	9	
Pimephales promelas	fathead minnow							
Pimephales vigilax	bullhead minnow		7					
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub							
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	8	47	1		12	1	3
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker							
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse							
Moxostoma erythrurum	golden redhorse		21	3				
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead							
Ictalurus punctatus	channel catfish		2					1
Noturus exilis	slender madtom							
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom							
Noturus miurus	brindled madtom	2	1					
Noturus nocturnus	freckled madtom						1	
Pylodictis olivaris	flathead catfish	1					1	
Esocidae								
Esox americanus	redfin pickerel		1					
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish	8	7	11	2		2	21
Fundulus olivaceus	blackspotted topminnow	4				3	5	3
Poeciliidae								
Gambusia affinis	western mosquitofish	3	4	20				3
Atherinopsidae								
Labidesthes sicculus	brook silverside		47	7				20

Appendix B Continued – Sites 29 – 30 Continued.

	Site	29	29	29	29	29	30	30
	Year	2008	2009	2012	2013	2013	2008	2008
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin	24	29	4	2	16		7
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass					6		3
Lepomis auritus	redbreast sunfish					9		
Lepomis cyanellus	green sunfish		15			3		
Lepomis gulosus	warmouth					1		
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill	3	2			2		
Lepomis marginatus	dollar sunfish							
Lepomis megalotis	longear sunfish	44	26	4	7	27	67	68
Lepomis microlophus	redear sunfish	1	1		1		1	
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass							
Micropterus punctulatus	spotted bass	3	4	2		2		1
Micropterus salmoides	largemouth bass	1	1			1		1
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie							
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter	4				20	7	21
Etheostoma caeruleum	rainbow darter		1			78		1
Etheostoma duryi	black darter		1			3		3
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter	2	4					
Etheostoma jessiae	blueside darter	1	3		2			
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater							
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter	118	96	3	4	113	15	181
Etheostoma tennesseense	Tennessee darter	3	9		3	17	6	19
Etheostoma simoterum	Tennessee snubnose darter							
Etheostoma stigmaeum	speckled darter							
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter							
Perca flavescens	yellow perch							
Percina caprodes	logperch	6	33	3	1	3	10	3
Percina evides	gilt darter	5	21	1			2	4
Percina phoxocephala	slenderhead darter		6					
Percina sciera	dusky darter	1					1	
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Sites 31 – 33

	Site	31	32	32	32	32	32	33
	Year	**2012**	**1968**	**1999**	**2008**	**2009**	**2012**	**2008**
	Taxa	11	12	11	27	21	16	23
	Individuals	114	105	45	289	193	87	380
	Shannon (H)	1.469	1.717	1.689	2.200	2.213	2.291	2.145
	Evenness (e^H/S)	0.395	0.464	0.492	0.334	0.435	0.618	0.372
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey							
Lepisossteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far					1		1
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							10
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	10	34	16	34	27	6	65
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace	1						
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner			1	3	1		5
Cyprinella spiloptera	spotfin shiner		38	3	22	11	1	
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner		1					
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub							
Luxilus chrysocephalus	striped shiner	20	1	3	1	40	17	13
Lythrurus ardens	rosefin shiner							
Lythrurus bellus	pretty shiner							
Lythrurus fasciolaris	scarlet shiner	7					1	
Lythrurus fumeus	ribbon shiner							
Nocomis leptocephalus	bluehead chub							
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner		1					
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner							
Notropis boops	bigeye shiner							
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner							
Notropis texanus	weed shiner					2		
Notropis volucellus	mimic shiner				3			
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 31 – 33 Continued.

	Site	31	32	32	32	32	32	33
	Year	2012	1968	1999	2008	2009	2012	2008
Species	**Common Name**							
Pimephales notatus	bluntnose minnow		2		8		2	
Pimephales promelas	fathead minnow							
Pimephales vigilax	bullhead minnow				2			8
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub	64	8				1	
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	1	6	1	4	9	4	3
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker					1		
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse							
Moxostoma erythrurum	golden redhorse				1		13	
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead							
Ictalurus punctatus	channel catfish							
Noturus exilis	slender madtom							
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom							
Noturus miurus	brindled madtom							
Noturus nocturnus	freckled madtom							
Pylodictis olivaris	flathead catfish				1			
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish		6	1	3	3	11	
Fundulus olivaceus	blackspotted topminnow		1	1	7			1
Poeciliidae								
Gambusia affinis	western mosquitofish			1	5	1		
Atherinopsidae								
Labidesthes sicculus	brook silverside			1		2		23

Appendix B Continued – Sites 31 – 33 Continued.

	Site	31	32	32	32	32	32	33
	Year	2012	1968	1999	2008	2009	2012	2008
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin	2	6		2	2		1
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass					2		2
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish				3			4
Lepomis gulosus	warmouth							
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill					1		12
Lepomis marginatus	dollar sunfish	1						15
Lepomis megalotis	longear sunfish				60	22	3	
Lepomis microlophus	redear sunfish				1			
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass							
Micropterus punctulatus	spotted bass				3	2	2	
Micropterus salmoides	largemouth bass			1				
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie							
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter				1		1	4
Etheostoma caeruleum	rainbow darter	2						17
Etheostoma duryi	black darter	4			3			9
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter				1			
Etheostoma jessiae	blueside darter				1	1		1
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater							4
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter	2		16	102	52	18	157
Etheostoma tennesseense	Tennessee darter				8	4		19
Etheostoma simoterum	Tennessee snubnose darter						2	
Etheostoma stigmaeum	speckled darter							
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter							
Perca flavescens	yellow perch							
Percina caprodes	logperch				5	1	1	5
Percina evides	gilt darter				4	8	4	1
Percina phoxocephala	slenderhead darter		1					
Percina sciera	dusky darter				1			
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Sites 33 – 35.

	Site	**33**	**33**	**33**	**34**	**34**	**35**	**35**
	Year	**2008**	**2012**	**2013**	**2008**	**2012**	**1968**	**1998**
	Taxa	23	12	16	31	20	8	12
	Individuals	433	334	202	533	826	31	51
	Shannon (H)	2.069	1.575	2.322	2.432	2.128	1.515	1.887
	Evenness (e^H/S)	0.344	0.402	0.637	0.367	0.420	0.569	0.550
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey				1			
Lampetra appendix	American brook lamprey							
Lepisossteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far							
Clupeidae								
Dorosoma cepedianum	gizzard shad				195			
Dorosoma petenense	threadfin shad				13			
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	87	156	50	49	228	1	1
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace							
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner	11	7	6				
Cyprinella spiloptera	spotfin shiner	10		6	31	34	1	17
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner							
Cyprinus carpio	common carp				24			
Hybopsis amblops	bigeye chub							
Luxilus chrysocephalus	striped shiner	92	10	10	22	22	1	2
Lythrurus ardens	rosefin shiner						12	15
Lythrurus bellus	pretty shiner						11	
Lythrurus fasciolaris	scarlet shiner				1			
Lythrurus fumeus	ribbon shiner							5
Nocomis leptocephalus	bluehead chub							
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner							
Notropis boops	bigeye shiner					1		
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner							
Notropis texanus	weed shiner			1				
Notropis volucellus	mimic shiner					118		
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 33 – 35 Continued.

	Site	33	33	33	34	34	35	35
	Year	2008	2012	2013	2008	2012	1968	1998
Species	**Common Name**							
Pimephales notatus	bluntnose minnow	2		27	6			1
Pimephales promelas	fathead minnow							
Pimephales vigilax	bullhead minnow							
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub							
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker				15	1		
Carpiodes cyprinus	quilback					1		
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	10	7	32	2	6	1	
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker				11			
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse				10			
Moxostoma carinatum	river redhorse				1			
Moxostoma duquesnei	black redhorse				11			
Moxostoma erythrurum	golden redhorse		5		4	5		
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead				1			
Ictalurus punctatus	channel catfish	1			6			
Noturus exilis	slender madtom							
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom							
Noturus miurus	brindled madtom							
Noturus nocturnus	freckled madtom							
Pylodictis olivaris	flathead catfish							
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish	6	10	16		72		
Fundulus olivaceus	blackspotted topminnow	4		5	3			
Poeciliidae								
Gambusia affinis	western mosquitofish		46	9	2	163		1
Atherinopsidae								
Labidesthes sicculus	brook silverside	24		1		2		2

Appendix B Continued – Sites 33 – 35 Continued.

	Site	33	33	33	34	34	35	35
	Year	2008	2012	2013	2008	2012	1968	1998
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin					4		
Moronidae								
Morone chrysops	white bass				1			
Morone mississippiensis	yellow bass				65			
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass	3						
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish	7	1	2	10	2	3	
Lepomis gulosus	warmouth				3			
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill		4	5	15	7		1
Lepomis marginatus	dollar sunfish	17	1		10			
Lepomis megalotis	longear sunfish				3			
Lepomis microlophus	redear sunfish							
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass	2			3			
Micropterus punctulatus	spotted bass	1			11	4		
Micropterus salmoides	largemouth bass							
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie	2						
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter	1				9		
Etheostoma caeruleum	rainbow darter	2	7			84		2
Etheostoma duryi	black darter	6		5				
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter							
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater	1						
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter	136	80	20		47	1	3
Etheostoma tennesseense	Tennessee darter	7		7				
Etheostoma simoterum	Tennessee snubnose darter							
Etheostoma stigmaeum	speckled darter							
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter							
Perca flavescens	yellow perch							
Percina caprodes	logperch	1			3	16		1
Percina evides	gilt darter							
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter							
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum				1			

Appendix B Continued – Sites 35 – 36.

	Site	35	35	35	35	35	36	36
	Year	**2008**	**2009**	**2012**	**2013**	**2013**	**1968**	**1998**
	Taxa	26	27	18	31	22	12	13
	Individuals	1340	437	358	318	124	130	198
	Shannon (H)	1.970	2.659	2.409	2.677	2.610	1.648	1.260
	Evenness (e^H/S)	0.276	0.529	0.618	0.469	0.618	0.433	0.271
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey						1	
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey						28	
Lepisosteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far		1		1			
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	598	32	38	63	3	2	10
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace							2
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner						1	23
Cyprinella spiloptera	spotfin shiner	36	19	25	5	8		
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner							
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub	15	12	19	15	5		
Luxilus chrysocephalus	striped shiner	190	28	11	2	13	8	134
Lythrurus ardens	rosefin shiner						1	
Lythrurus bellus	pretty shiner				4			
Lythrurus fasciolaris	scarlet shiner	2	62			6		
Lythrurus fumeus	ribbon shiner			1				
Nocomis leptocephalus	bluehead chub					5		
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner							
Notropis boops	bigeye shiner	3	4	2	1	3		
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner						1	
Notropis texanus	weed shiner							
Notropis volucellus	mimic shiner					2		
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 35 – 36 Continued.

	Site	35	35	35	35	35	36	36
	Year	2008	2009	2012	2013	2013	1968	1998
Species	**Common Name**							
Pimephales notatus	bluntnose minnow	4	7	2	17			4
Pimephales promelas	fathead minnow				1			
Pimephales vigilax	bullhead minnow				3			
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub	1						
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	64	8	9	3	8		1
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker		1					
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse							
Moxostoma erythrurum	golden redhorse	2		1	5			3
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead				2			
Ictalurus punctatus	channel catfish							
Noturus exilis	slender madtom							
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom							
Noturus miurus	brindled madtom							
Noturus nocturnus	freckled madtom							
Pylodictis olivaris	flathead catfish							
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish	6	2	55		1		1
Fundulus olivaceus	blackspotted topminnow	2	15		7			1
Poeciliidae								
Gambusia affinis	western mosquitofish	1	4	11	1	3		
Atherinopsidae								
Labidesthes sicculus	brook silverside					3		

Appendix B Continued – Sites 35 – 36 Continued.

Species	Common Name	Site: 35 Year: 2008	35 2009	35 2012	35 2013	35 2013	36 1968	36 1998
Cottidae								
Cottus carolinae	banded sculpin	12	1		1	1	6	
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass	8	2		1			
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish	7	6		9			
Lepomis gulosus	warmouth				2			
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill		9		12	3		
Lepomis marginatus	dollar sunfish	20	89	11				
Lepomis megalotis	longear sunfish		1		20	4		
Lepomis microlophus	redear sunfish							
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass	2	1	1				
Micropterus punctulatus	spotted bass	5			1	3		
Micropterus salmoides	largemouth bass							
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie							
Lepomis spp.	sunfish hybrid				1			
Percidae								
Etheostoma blennioides	greenside darter	60	13	37	28	2		
Etheostoma caeruleum	rainbow darter	67	47	9	9	2	26	3
Etheostoma duryi	black darter	4	6	75	23			12
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter						2	
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater	1	1		1			
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter	150	31	35	10	34	53	
Etheostoma tennesseense	Tennessee darter	67	24		61	12		
Etheostoma simoterum	Tennessee snubnose darter						1	2
Etheostoma stigmaeum	speckled darter							
Etheostoma zonistium	bandfin darter					2		2
Etheostoma sp. Cf. zonistum	blueface darter							
Perca flavescens	yellow perch							
Percina caprodes	logperch	13	11	16	8	1		
Percina evides	gilt darter							
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter				1			
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Sites 36 – 37.

	Site	36	36	36	36	37	37	37
	Year	**2008**	**2009**	**2012**	**2013**	**1968**	**1998**	**2008**
	Taxa	23	20	12	20	14	11	12
	Individuals	748	291	91	248	72	110	53
	Shannon (H)	1.972	2.006	1.657	2.164	2.286	0.895	2.048
	Evenness (e^H/S)	0.313	0.372	0.437	0.435	0.702	0.222	0.646
Species	**Common Name**							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey							
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey		1					
Lepisossteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far							
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	238	90	44	73	1	2	2
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace							
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner					13		
Cyprinella spiloptera	spotfin shiner						4	
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner							
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub					1	1	6
Luxilus chrysocephalus	striped shiner	237	14	17	11	2		5
Lythrurus ardens	rosefin shiner					2	89	
Lythrurus bellus	pretty shiner							
Lythrurus fasciolaris	scarlet shiner	5	1	4	10			
Lythrurus fumeus	ribbon shiner							
Nocomis leptocephalus	bluehead chub							
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner			1		2		
Notropis boops	bigeye shiner							
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner					4		
Notropis texanus	weed shiner		1					
Notropis volucellus	mimic shiner				3	1		
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 36 – 37 Continued.

	Site	36	36	36	36	37	37	37
	Year	2008	2009	2012	2013	1968	1998	2008
Species	**Common Name**							
Pimephales notatus	bluntnose minnow	6	2		6			
Pimephales promelas	fathead minnow							
Pimephales vigilax	bullhead minnow							
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub			2				
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	17	2		1	3	1	1
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker							
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse	2						
Moxostoma erythrurum	golden redhorse	4			3	15		
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead							
Ictalurus punctatus	channel catfish							
Noturus exilis	slender madtom							
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom							
Noturus miurus	brindled madtom				1			
Noturus nocturnus	freckled madtom							
Pylodictis olivaris	flathead catfish							
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish			1				
Fundulus olivaceus	blackspotted topminnow	3			2			1
Poeciliidae								
Gambusia affinis	western mosquitofish		2	1				
Atherinopsidae								
Labidesthes sicculus	brook silverside							

Appendix B Continued – Sites 36 – 37 Continued.

Species	Common Name	Site 36 Year 2008	36 2009	36 2012	36 2013	37 1968	37 1998	37 2008
Cottidae								
Cottus carolinae	banded sculpin	19	9	4	1	10	2	3
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass	23			7			
Lepomis auritus	redbreast sunfish							
Lepomis cyanellus	green sunfish				2			
Lepomis gulosus	warmouth	1						
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill	8						
Lepomis marginatus	dollar sunfish	16	2					
Lepomis megalotis	longear sunfish				3			
Lepomis microlophus	redear sunfish							
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass	3						
Micropterus punctulatus	spotted bass	1			1			
Micropterus salmoides	largemouth bass							
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie		2					
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter	19	17	1	3			1
Etheostoma caeruleum	rainbow darter	2	22	2	41	9	5	8
Etheostoma duryi	black darter	9	6		55		2	7
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter	11	4		9		1	
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater		1					
Etheostoma nigrum	johnny darter							
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter	71	80	12	4	4	2	1
Etheostoma tennesseense	Tennessee darter	51	33		12			17
Etheostoma simoterum	Tennessee snubnose darter		1	2		5		
Etheostoma stigmaeum	speckled darter						1	
Etheostoma zonistium	bandfin darter							
Etheostoma sp. Cf. zonistum	blueface darter							
Perca flavescens	yellow perch							
Percina caprodes	logperch	1	1					1
Percina evides	gilt darter	1						
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter							
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Sites 37 – 38.

	Site	37	37	38	38	38	38	38
	Year	2009	2013	1968	1998	2008	2012	2013
	Taxa	22	20	23	9	13	18	23
	Individuals	608	315	334	45	86	187	673
	Shannon (H)	2.007	2.409	2.306	1.836	2.086	2.229	2.156
	Evenness (e^H/S)	0.338	0.556	0.436	0.697	0.620	0.516	0.375
Species	Common Name							
Petromyzontidae								
Ichthyomyzon bdellium	Ohio lamprey				3			
Ichthyomyzon castaneus	chestnut lamprey							
Lampetra appendix	American brook lamprey							
Lepisossteidae								
Lepisosteus oculatus	spotted gar							
Lepisosteus osseus	longnose far							
Clupeidae								
Dorosoma cepedianum	gizzard shad							
Dorosoma petenense	threadfin shad							
Cyprinidae								
Campostoma oligolepis	largescale stoneroller	286	64	12	1	4	10	221
Campostoma pauciradii	bluefin stoneroller							
Clinostomus funduloides	rosyside dace							
Cyprinella callistia	Alabama shiner							
Cyprinella galactura	whitetail shiner	10	38	75	12	2	3	32
Cyprinella spiloptera	spotfin shiner							2
Cyprinella venusta	blacktail shiner							
Cyprinella whipplei	steelcolor shiner							
Cyprinus carpio	common carp							
Hybopsis amblops	bigeye chub	27	24	13		2		55
Luxilus chrysocephalus	striped shiner	48	19	21	2	1	43	30
Lythrurus ardens	rosefin shiner			99	11			
Lythrurus bellus	pretty shiner							
Lythrurus fasciolaris	scarlet shiner	1	6			8	3	13
Lythrurus fumeus	ribbon shiner							
Nocomis leptocephalus	bluehead chub			2				
Nocomis micropogon	river chub							
Notemigonus crysoleucas	golden shiner							
Notropis atherinoides	emerald shiner							
Notropis asperifrons	burrhead shiner							
Notropis baileyi	rough shiner			4				
Notropis boops	bigeye shiner							
Notropis micropteryx	highland shiner							
Notropis rubellus	rosyface shiner							
Notropis telescopus	telescope shiner			1				
Notropis texanus	weed shiner							
Notropis volucellus	mimic shiner							
Opsopoeodus emiliae	pugnose minnow							
Phoxinus erythrogaster	southern redbelly dace							

Appendix B Continued – Sites 37 – 38 Conintued.

	Site	37	37	38	38	38	38	38
	Year	2009	2013	1968	1998	2008	2012	2013
Species	**Common Name**							
Pimephales notatus	bluntnose minnow		4	16				16
Pimephales promelas	fathead minnow							
Pimephales vigilax	bullhead minnow							
Rhinichthys atratulus	blacknose dace							
Semotilus atromaculatus	creek chub			6			5	
Semotilus thoreauianus	Dixie chub							
Catostomidae								
Carpiodes carpio	river carpsucker							
Carpiodes cyprinus	quilback							
Carpiodes velifer	highfin carpsucker							
Erimyzon oblongus	creek chubsucker							
Hypentelium nigricans	northern hogsucker	14	2	3	1	1	14	12
Ictiobus bubalus	smallmouth buffalo							
Ictiobus niger	black buffalo							
Minytrema melanops	spotted sucker							
Moxostoma anisurum	silver redhorse							
Moxostoma breviceps	smallmouth redhorse							
Moxostoma carinatum	river redhorse							
Moxostoma duquesnei	black redhorse			1				
Moxostoma erythrurum	golden redhorse			15			1	2
Ictaluidae								
Ameiurus melas	black bullhead							
Ameiurus natalis	yellow bullhead							
Ictalurus punctatus	channel catfish	4						
Noturus exilis	slender madtom						1	1
Noturus funebris	black madtom							
Noturus gyrinus	tadpole madtom							
Noturus miurus	brindled madtom							
Noturus nocturnus	freckled madtom							
Pylodictis olivaris	flathead catfish							
Esocidae								
Esox americanus	redfin pickerel							
Esox niger	chain pickerel							
Aphrendoderidae								
Aphredoderus sayanus	pirate perch							
Belonidae								
Strongylura marina	Atlantic needlefish							
Fundulidae								
Fundulus catenatus	northern studfish	1	9	5		1	34	13
Fundulus olivaceus	blackspotted topminnow	13	8	4		4	5	25
Poeciliidae								
Gambusia affinis	western mosquitofish							
Atherinopsidae								
Labidesthes sicculus	brook silverside						1	

Appendix B Continued – Sites 37 – 38 Continued.

	Site	37	37	38	38	38	38	38
	Year	2009	2013	1968	1998	2008	2012	2013
Species	**Common Name**							
Cottidae								
Cottus carolinae	banded sculpin	30	13	11			5	6
Moronidae								
Morone chrysops	white bass							
Morone mississippiensis	yellow bass							
Morone saxatilis	striped bass							
Centrarchidae								
Ambloplites rupestris	rock bass	4	1					2
Lepomis auritus	redbreast sunfish		3					
Lepomis cyanellus	green sunfish	1	1					1
Lepomis gulosus	warmouth							
Lepomis humilis	orangespotted sunfish							
Lepomis macrochirus	bluegill	36	14		1			1
Lepomis marginatus	dollar sunfish						1	
Lepomis megalotis	longear sunfish	20	3	2				17
Lepomis microlophus	redear sunfish	1						
Lepomis miniatus	redspotted sunfish							
Micropterus dolomieui	smallmouth bass							
Micropterus punctulatus	spotted bass	1	1	1				
Micropterus salmoides	largemouth bass	2						
Pomoxis annularis	white crappie							
Pomoxis nigromaculatus	black crappie							
Lepomis spp.	sunfish hybrid							
Percidae								
Etheostoma blennioides	greenside darter							
Etheostoma caeruleum	rainbow darter	11	10	1	5	9	3	16
Etheostoma duryi	black darter	6				13	2	2
Etheostoma flabellare	fantail darter							
Etheostoma histrio	harlequin darter							
Etheostoma jessiae	blueside darter			2		1		
Etheostoma kennicotti	stripetail darter							
Etheostoma nigripinne	blackfin dater							
Etheostoma nigrum	johnny darter			1				1
Etheostoma parvipinne	goldstripe darter							
Etheostoma rufilineatum	redline darter	70	64	17	9	18	35	168
Etheostoma tennesseense	Tennessee darter	14	28			22		29
Etheostoma simoterum	Tennessee snubnose darter						20	
Etheostoma stigmaeum	speckled darter							
Etheostoma zonistium	bandfin darter			22				
Etheostoma sp. Cf. zonistum	blueface darter							
Perca flavescens	yellow perch							
Percina caprodes	logperch	8	3				1	8
Percina evides	gilt darter							
Percina phoxocephala	slenderhead darter							
Percina sciera	dusky darter							
Percina shumardi	river darter							
Sciaenidae								
Aplodinotus grunniens	freshwater drum							

Appendix B Continued – Site 39.

	Site	**39**	**39**	**39**	**39**	**39**
	Year	**1968**	**1998**	**2008**	**2012**	**2013**
	Taxa	14	9	23	17	14
	Individuals	99	29	404	212	93
	Shannon (H)	2.058	2.024	2.348	2.087	2.060
	Evenness (e^H/S)	0.560	0.841	0.455	0.474	0.561
Species	**Common Name**					
Petromyzontidae						
Ichthyomyzon bdellium	Ohio lamprey					
Ichthyomyzon castaneus	chestnut lamprey					
Lampetra appendix	American brook lamprey					
Lepisosteidae						
Lepisosteus oculatus	spotted gar					
Lepisosteus osseus	longnose far					
Clupeidae						
Dorosoma cepedianum	gizzard shad					
Dorosoma petenense	threadfin shad					
Cyprinidae						
Campostoma oligolepis	largescale stoneroller	3	6	138	72	17
Campostoma pauciradii	bluefin stoneroller					
Clinostomus funduloides	rosyside dace					
Cyprinella callistia	Alabama shiner					
Cyprinella galactura	whitetail shiner	18		39	2	5
Cyprinella spiloptera	spotfin shiner		3			
Cyprinella venusta	blacktail shiner					
Cyprinella whipplei	steelcolor shiner					
Cyprinus carpio	common carp					
Hybopsis amblops	bigeye chub	1		22	5	
Luxilus chrysocephalus	striped shiner	1		24		
Lythrurus ardens	rosefin shiner	11	7			
Lythrurus bellus	pretty shiner					
Lythrurus fasciolaris	scarlet shiner			44	12	34
Lythrurus fumeus	ribbon shiner					
Nocomis leptocephalus	bluehead chub	4				
Nocomis micropogon	river chub	6				
Notemigonus crysoleucas	golden shiner					
Notropis atherinoides	emerald shiner					
Notropis asperifrons	burrhead shiner					
Notropis baileyi	rough shiner	34				
Notropis boops	bigeye shiner					
Notropis micropteryx	highland shiner					
Notropis rubellus	rosyface shiner					
Notropis telescopus	telescope shiner	10				
Notropis texanus	weed shiner					
Notropis volucellus	mimic shiner					
Opsopoeodus emiliae	pugnose minnow					
Phoxinus erythrogaster	southern redbelly dace					

Appendix B Continued – Site 39 Continued.

	Site	39	39	39	39	39
	Year	1968	1998	2008	2012	2013
Species	**Common Name**					
Pimephales notatus	bluntnose minnow	2		1		
Pimephales promelas	fathead minnow					
Pimephales vigilax	bullhead minnow					
Rhinichthys atratulus	blacknose dace					
Semotilus atromaculatus	creek chub	1			7	
Semotilus thoreauianus	Dixie chub					
Catostomidae						
Carpiodes carpio	river carpsucker					
Carpiodes cyprinus	quilback					
Carpiodes velifer	highfin carpsucker					
Erimyzon oblongus	creek chubsucker					
Hypentelium nigricans	northern hogsucker	3	1	6	7	5
Ictiobus bubalus	smallmouth buffalo					
Ictiobus niger	black buffalo					
Minytrema melanops	spotted sucker			1		
Moxostoma anisurum	silver redhorse					
Moxostoma breviceps	smallmouth redhorse					
Moxostoma carinatum	river redhorse					
Moxostoma duquesnei	black redhorse					
Moxostoma erythrurum	golden redhorse			1		
Ictaluidae						
Ameiurus melas	black bullhead					
Ameiurus natalis	yellow bullhead			1		
Ictalurus punctatus	channel catfish					
Noturus exilis	slender madtom			13	10	
Noturus funebris	black madtom			5	1	
Noturus gyrinus	tadpole madtom					
Noturus miurus	brindled madtom					
Noturus nocturnus	freckled madtom					
Pylodictis olivaris	flathead catfish					
Esocidae						
Esox americanus	redfin pickerel					
Esox niger	chain pickerel					
Aphrendoderidae						
Aphredoderus sayanus	pirate perch					
Belonidae						
Strongylura marina	Atlantic needlefish					
Fundulidae						
Fundulus catenatus	northern studfish			2		1
Fundulus olivaceus	blackspotted topminnow		3	9		
Poeciliidae						
Gambusia affinis	western mosquitofish					
Atherinopsidae						
Labidesthes sicculus	brook silverside					

Appendix B Continued – Site 39 Continued.

	Site	39	39	39	39	39
	Year	1968	1998	2008	2012	2013
Species	**Common Name**					
Cottidae						
Cottus carolinae	banded sculpin			2	2	1
Moronidae						
Morone chrysops	white bass					
Morone mississippiensis	yellow bass					
Morone saxatilis	striped bass					
Centrarchidae						
Ambloplites rupestris	rock bass					
Lepomis auritus	redbreast sunfish					
Lepomis cyanellus	green sunfish					
Lepomis gulosus	warmouth					
Lepomis humilis	orangespotted sunfish					
Lepomis macrochirus	bluegill					4
Lepomis marginatus	dollar sunfish		1	3		
Lepomis megalotis	longear sunfish			13		2
Lepomis microlophus	redear sunfish					
Lepomis miniatus	redspotted sunfish					
Micropterus dolomieui	smallmouth bass			3	1	
Micropterus punctulatus	spotted bass					2
Micropterus salmoides	largemouth bass					1
Pomoxis annularis	white crappie					
Pomoxis nigromaculatus	black crappie					
Lepomis spp.	sunfish hybrid					
Percidae						
Etheostoma blennioides	greenside darter				1	
Etheostoma caeruleum	rainbow darter				12	6
Etheostoma duryi	black darter	4	2	19	9	
Etheostoma flabellare	fantail darter			26		
Etheostoma histrio	harlequin darter					
Etheostoma jessiae	blueside darter					
Etheostoma kennicotti	stripetail darter		3			
Etheostoma nigripinne	blackfin dater	1	3			
Etheostoma nigrum	johnny darter					
Etheostoma parvipinne	goldstripe darter					
Etheostoma rufilineatum	redline darter			21	45	9
Etheostoma tennesseense	Tennessee darter			10		4
Etheostoma simoterum	Tennessee snubnose darter				23	
Etheostoma stigmaeum	speckled darter					
Etheostoma zonistium	bandfin darter				1	
Etheostoma sp. Cf. zonistum	blueface darter					
Perca flavescens	yellow perch					
Percina caprodes	logperch			1	2	2
Percina evides	gilt darter					
Percina phoxocephala	slenderhead darter					
Percina sciera	dusky darter					
Percina shumardi	river darter					
Sciaenidae						
Aplodinotus grunniens	freshwater drum					

Appendix B Continued – Site 40.

	Site	40	40	40	40	40
	Year	1968	1998	2008	2012	2013
	Taxa	3	3	8	11	9
	Individuals	13	8	8	38	28
	Shannon (H)	0.984	0.736	2.079	1.840	1.776
	Evenness (e^H/S)	0.892	0.696	1.000	0.572	0.656
Species	Common Name					
Petromyzontidae						
Ichthyomyzon bdellium	Ohio lamprey					
Ichthyomyzon castaneus	chestnut lamprey					
Lampetra appendix	American brook lamprey					
Lepisosteidae						
Lepisosteus oculatus	spotted gar					
Lepisosteus osseus	longnose far					
Clupeidae						
Dorosoma cepedianum	gizzard shad					
Dorosoma petenense	threadfin shad					
Cyprinidae						
Campostoma oligolepis	largescale stoneroller			1	1	2
Campostoma pauciradii	bluefin stoneroller					
Clinostomus funduloides	rosyside dace					
Cyprinella callistia	Alabama shiner					
Cyprinella galactura	whitetail shiner					
Cyprinella spiloptera	spotfin shiner					
Cyprinella venusta	blacktail shiner					
Cyprinella whipplei	steelcolor shiner					
Cyprinus carpio	common carp					
Hybopsis amblops	bigeye chub			1		1
Luxilus chrysocephalus	striped shiner			1		
Lythrurus ardens	rosefin shiner					
Lythrurus bellus	pretty shiner					
Lythrurus fasciolaris	scarlet shiner					13
Lythrurus fumeus	ribbon shiner					
Nocomis leptocephalus	bluehead chub					
Nocomis micropogon	river chub					
Notemigonus crysoleucas	golden shiner					
Notropis atherinoides	emerald shiner					
Notropis asperifrons	burrhead shiner					
Notropis baileyi	rough shiner					
Notropis boops	bigeye shiner					
Notropis micropteryx	highland shiner					
Notropis rubellus	rosyface shiner					
Notropis telescopus	telescope shiner					
Notropis texanus	weed shiner					
Notropis volucellus	mimic shiner					
Opsopoeodus emiliae	pugnose minnow					
Phoxinus erythrogaster	southern redbelly dace					

Appendix B Continued – Site 40 Continued.

	Site	40	40	40	40	40
	Year	1968	1998	2008	2012	2013
Species	**Common Name**					
Pimephales notatus	bluntnose minnow					
Pimephales promelas	fathead minnow					
Pimephales vigilax	bullhead minnow					
Rhinichthys atratulus	blacknose dace					
Semotilus atromaculatus	creek chub			1	18	
Semotilus thoreauianus	Dixie chub					
Catostomidae						
Carpiodes carpio	river carpsucker					
Carpiodes cyprinus	quilback					
Carpiodes velifer	highfin carpsucker					
Erimyzon oblongus	creek chubsucker					
Hypentelium nigricans	northern hogsucker				1	2
Ictiobus bubalus	smallmouth buffalo					
Ictiobus niger	black buffalo					
Minytrema melanops	spotted sucker					
Moxostoma anisurum	silver redhorse					
Moxostoma breviceps	smallmouth redhorse					
Moxostoma carinatum	river redhorse					
Moxostoma duquesnei	black redhorse					
Moxostoma erythrurum	golden redhorse					
Ictaluidae						
Ameiurus melas	black bullhead					
Ameiurus natalis	yellow bullhead					2
Ictalurus punctatus	channel catfish					
Noturus exilis	slender madtom				2	
Noturus funebris	black madtom				3	
Noturus gyrinus	tadpole madtom					
Noturus miurus	brindled madtom					
Noturus nocturnus	freckled madtom					
Pylodictis olivaris	flathead catfish					
Esocidae						
Esox americanus	redfin pickerel					
Esox niger	chain pickerel					
Aphrendoderidae						
Aphredoderus sayanus	pirate perch					
Belonidae						
Strongylura marina	Atlantic needlefish					
Fundulidae						
Fundulus catenatus	northern studfish					
Fundulus olivaceus	blackspotted topminnow	7	1	1		
Poeciliidae						
Gambusia affinis	western mosquitofish					
Atherinopsidae						
Labidesthes sicculus	brook silverside					

Appendix B Continued – Site 40 Continued.

	Site	40	40	40	40	40
	Year	1968	1998	2008	2012	2013
Species	**Common Name**					
Cottidae						
Cottus carolinae	banded sculpin				4	
Moronidae						
Morone chrysops	white bass					
Morone mississippiensis	yellow bass					
Morone saxatilis	striped bass					
Centrarchidae						
Ambloplites rupestris	rock bass					
Lepomis auritus	redbreast sunfish					
Lepomis cyanellus	green sunfish	2	1			
Lepomis gulosus	warmouth					
Lepomis humilis	orangespotted sunfish					
Lepomis macrochirus	bluegill	4				2
Lepomis marginatus	dollar sunfish		6	1	1	
Lepomis megalotis	longear sunfish			1		3
Lepomis microlophus	redear sunfish					
Lepomis miniatus	redspotted sunfish					
Micropterus dolomieui	smallmouth bass					
Micropterus punctulatus	spotted bass					
Micropterus salmoides	largemouth bass					1
Pomoxis annularis	white crappie					
Pomoxis nigromaculatus	black crappie					
Lepomis spp.	sunfish hybrid					
Percidae						
Etheostoma blennioides	greenside darter					
Etheostoma caeruleum	rainbow darter				2	
Etheostoma duryi	black darter			1		
Etheostoma flabellare	fantail darter					
Etheostoma histrio	harlequin darter					
Etheostoma jessiae	blueside darter					
Etheostoma kennicotti	stripetail darter					
Etheostoma nigripinne	blackfin dater					
Etheostoma nigrum	johnny darter					
Etheostoma parvipinne	goldstripe darter					
Etheostoma rufilineatum	redline darter				2	2
Etheostoma tennesseense	Tennessee darter					
Etheostoma simoterum	Tennessee snubnose darter				3	
Etheostoma stigmaeum	speckled darter					
Etheostoma zonistium	bandfin darter					
Etheostoma sp. Cf. zonistum	blueface darter					
Perca flavescens	yellow perch					
Percina caprodes	logperch				1	
Percina evides	gilt darter					
Percina phoxocephala	slenderhead darter					
Percina sciera	dusky darter					
Percina shumardi	river darter					
Sciaenidae						
Aplodinotus grunniens	freshwater drum					

APPENDIX C

LAND COVER AND WATERSHED AREA FOR ALL COLLECTIONS SITES CALCULATED FROM NATIONAL LANDCOVER DATASETS 2001 AND 2006, AND USGS STREAMSTATS

Appendix C – Land cover for study sites in the Bear Creek system. Land cover for collections made prior to 2001 was calculated from the National Landcover Dataset 2001 (NLCD 2001) and landcover for collections made after 2007 was calculated from National Landcover Dataset 2006 (NLCD2006). Land cover from NLCD 2001 and NLCD 2006 are reported for sites that were surveyed during both before 2001 and after 2007. Watershed area, impervious land cover, and urban cover were calculated from USGS Stream Stats which is based on NLCD 2006. Land cover type is reported as a percentage of total area.

Site	Land Cover Source	Area (mi^2)	Impervious Landcover	Urban Cover	Open Water	Developed, Open Space	Developed, Low	Developed, Medium	Developed, High	Barren	Deciduous Forest	Pine Forest	Mixed Forest	Shrub	Grassland	Pasture	Cultivated Crops	Woody Wetlands	Herbaceous Wetlands
1	**NLCD 2006**	8.8	0.2	1.9	0.1	2.1	0.0	0.0	0.0	0.0	59.8	9.2	6.8	18.7	0.1	2.5	0.2	0.5	0.0
2	**NLCD 2006**	68.1	0.6	3.4	0.1	2.9	0.7	0.1	0.0	0.0	52.8	6.5	4.0	18.3	2.8	7.5	3.1	1.2	0.1
3	**NLCD 2006**	56.9	0.6	3.3	0.0	2.9	0.7	0.1	0.0	0.0	51.5	6.4	3.5	18.4	3.3	8.4	3.6	1.2	0.1
4	**NLCD 2006**	26.5	0.2	2.0	0.0	2.0	0.2	0.0	0.0	0.0	65.4	6.8	3.3	15.1	5.2	0.9	0.5	0.4	0.0
5	**NLCD 2006**	10.2	0.9	5.4	0.0	4.4	1.3	0.2	0.0	0.0	36.2	14.4	17.1	15.2	2.1	3.0	3.8	2.1	0.0
6	**NLCD 2001**	4.8	1.4	7.0	0.1	5.1	2.3	0.5	0.0	0.0	33.2	13.1	20.8	11.6	0.0	4.0	6.7	2.7	0.1
	NLCD 2006	4.8	1.4	7.0	0.0	5.4	2.3	0.5	0.0	0.0	35.5	15.4	15.4	12.4	0.6	3.7	5.8	2.9	0.1
7	**NLCD 2006**	55.8	0.8	4.8	0.6	4.0	1.1	0.1	0.0	0.9	20.6	17.5	16.0	10.4	4.4	10.2	5.1	8.9	0.2
8	**NLCD 2006**	2.8	0.3	3.3	0.0	3.5	0.3	0.0	0.0	0.0	62.9	7.1	7.2	18.8	0.0	0.1	0.0	0.0	0.0
9	**NLCD 2006**	734.1	1.0	5.1	2.0	4.1	1.3	0.3	0.1	0.2	39.6	10.1	5.7	14.3	2.6	15.8	2.2	1.4	0.1
10	**NLCD 2006**	736.4	1.0	5.1	2.0	4.1	1.3	0.3	0.1	0.2	39.8	10.3	5.6	14.4	2.5	15.7	2.2	1.4	0.1
11	**NLCD 2006**	723.3	1.0	5.2	2.1	4.0	1.3	0.3	0.1	0.2	39.6	10.1	5.7	14.7	2.6	15.8	2.1	1.4	0.1
12	**NLCD 2001**	721.7	1.0	5.2	2.1	3.9	1.3	0.3	0.1	0.2	38.4	10.4	6.1	16.0	0.7	16.4	2.7	1.4	0.1
	NLCD 2006	721.7	1.0	5.2	2.1	3.9	1.3	0.3	0.1	0.2	39.5	10.4	5.7	14.3	2.6	16.0	2.1	1.4	0.1
13	**NLCD 2001**	329.0	1.2	5.8	1.5	4.3	1.5	0.3	0.2	0.2	32.3	12.5	7.9	11.3	1.0	21.2	3.7	2.0	0.2
	NLCD 2006	329.0	1.2	5.8	1.2	3.7	1.3	0.3	0.2	0.2	27.3	10.5	6.3	9.2	2.6	17.8	17.8	1.6	0.1
14	**NLCD 2001**	321.9	1.2	5.8	1.5	4.4	1.4	0.3	0.1	0.2	31.9	12.7	7.7	11.5	1.0	21.5	3.8	2.0	0.2
	NLCD 2006	321.9	1.2	5.8	1.4	4.4	1.5	0.3	0.1	0.3	32.0	12.2	7.4	11.0	3.0	21.2	3.1	2.0	0.1
15	**NLCD 2001**	313.0	1.3	5.8	1.5	4.4	1.4	0.3	0.2	0.2	31.7	12.5	7.6	11.4	1.1	21.9	3.8	1.9	0.2
	NLCD 2006	313.0	1.3	5.8	1.4	4.5	1.4	0.3	0.2	0.3	32.0	12.2	7.2	11.0	3.0	21.4	3.1	1.9	0.1

Appendix C – Land cover for study sites in the Bear Creek system. Land cover for collections made prior to 2001 was calculated from the National Landcover Dataset 2001 (NLCD 2001) and landcover for collections made after 2007 was calculated from National Landcover Dataset 2006 (NLCD2006). Land cover from NLCD 2001 and NLCD 2006 are reported for sites that were surveyed during both before 2001 and after 2007. Watershed area, impervious land cover, and urban cover were calculated from USGS Stream Stats which is based on NLCD 2006. Land cover type is reported as a percentage of total area.

Site	Land Cover Source	Area (mi^2)	Impervious Landcover	Urban Cover	Open Water	Developed, Open Space	Developed, Low	Developed, Medium	Developed, High	Barren	Deciduous Forest	Pine Forest	Mixed Forest	Shrub	Grassland	Pasture	Cultivated Crops	Woody Wetlands	Herbaceous Wetlands
16	**NLCD 2006**	261.5	1.0	5.5	1.6	4.5	1.2	0.2	0.1	0.3	34.6	12.7	7.5	10.8	3.3	20.5	1.6	1.1	0.0
17	**NLCD 2006**	250.2	1.1	5.6	1.7	4.6	1.2	0.3	0.1	0.3	34.3	12.7	7.8	10.5	3.0	20.7	1.6	1.1	0.0
18	**NLCD 2001**	201.3	1.2	6.0	1.6	4.9	1.3	0.2	0.1	0.3	30.0	14.6	9.3	9.1	1.6	23.4	2.4	1.2	0.0
	NLCD 2006	201.3	1.2	6.0	1.5	5.0	1.4	0.3	0.1	0.4	30.1	14.0	8.8	8.9	3.4	23.2	1.7	1.2	0.0
19	**NLCD 2001**	182.2	1.3	6.4	1.7	5.1	1.5	0.3	0.1	0.3	27.7	15.0	9.8	8.8	1.9	24.3	2.4	1.3	0.0
	NLCD 2006	182.2	1.3	6.4	1.7	5.2	1.5	0.3	0.1	0.4	27.6	14.4	9.2	8.7	3.7	24.2	1.7	1.4	0.0
20	**NLCD 2001**	126.5	1.4	6.8	2.3	5.5	1.5	0.3	0.1	0.5	24.2	14.9	10.9	7.0	2.5	26.3	2.3	1.7	0.0
21	**NLCD 2001**	19.0	0.3	2.9	0.1	3.1	0.1	0.0	0.0	0.0	35.8	18.9	14.9	7.1	1.0	15.0	1.0	3.0	0.0
	NLCD 2006	19.0	0.3	2.9	0.1	3.1	0.1	0.0	0.0	0.0	36.2	19.8	14.9	6.9	1.1	14.2	0.5	3.0	0.0
22	**NLCD 2006**	1.8	0.2	2.6	0.0	3.1	0.0	0.0	0.0	0.0	27.1	10.8	15.5	8.5	0.5	33.4	0.1	1.1	0.0
23	**NLCD 2006**	2.4	0.5	3.7	0.2	3.9	0.2	0.0	0.0	0.0	27.6	5.5	11.9	4.6	6.5	35.9	1.2	2.5	0.0
24	**NLCD 2006**	4.8	0.5	3.7	0.9	3.7	0.3	0.0	0.0	0.1	32.3	14.0	11.5	5.7	1.6	27.8	1.2	0.8	0.0
26	**NLCD 2006**	2.9	0.7	4.8	0.2	4.7	0.6	0.0	0.0	0.0	33.4	12.4	9.7	2.8	9.9	25.9	0.0	0.3	0.0
25	**NLCD 2001**	7.1	0.7	4.5	0.1	4.5	0.4	0.1	0.0	0.0	35.2	10.6	8.7	5.2	2.6	30.4	1.0	1.0	0.0
	NLCD 2006	7.1	0.7	4.5	0.1	4.3	0.4	0.1	0.0	0.0	31.6	11.9	8.9	5.3	5.2	30.9	0.2	1.0	0.0
27	**NLCD 2006**	50.5	0.2	2.2	0.0	2.2	0.3	0.0	0.0	0.0	59.7	6.0	1.6	22.2	2.9	2.7	1.1	1.2	0.1
28	**NLCD 2006**	8.5	0.2	2.3	0.0	2.3	0.2	0.0	0.0	0.0	73.2	3.2	1.0	13.1	0.2	5.8	0.8	0.2	0.0
29	**NLCD 2006**	329.9	1.0	4.9	3.1	3.6	1.4	0.4	0.1	0.2	43.5	9.3	4.6	16.9	2.1	13.1	1.1	0.6	0.1
30	**NLCD 2006**	307.8	1.0	5.0	3.3	3.7	1.5	0.4	0.1	0.3	43.7	9.1	4.2	16.9	2.0	13.2	1.0	0.5	0.1

Appendix C – Land cover for study sites in the Bear Creek system. Land cover for collections made prior to 2001 was calculated from the National Landcover Dataset 2001 (NLCD 2001) and landcover for collections made after 2007 was calculated from National Landcover Dataset 2006 (NLCD2006). Land cover from NLCD 2001 and NLCD 2006 are reported for sites that were surveyed during both before 2001 and after 2007. Watershed area, impervious land cover, and urban cover were calculated from USGS Stream Stats which is based on NLCD 2006. Land cover type is reported as a percentage of total area.

Site	Land Cover Source	Area (mi^2)	Impervious Landcover	Urban Cover	Open Water	Developed, Open Space	Developed, Low	Developed, Medium	Developed, High	Barren	Deciduous Forest	Pine Forest	Mixed Forest	Shrub	Grassland	Pasture	Cultivated Crops	Woody Wetlands	Herbaceous Wetlands
31	**NLCD 2006**	306.1	1.1	5.0	3.3	3.7	1.5	0.4	0.1	0.3	43.8	9.1	4.2	16.9	2.1	13.1	1.0	0.5	0.1
32	**NLCD 2001**	303.3	1.1	5.1	5.7	6.4	2.5	0.6	0.2	0.5	0.5	14.8	7.8	32.3	1.0	24.2	2.6	0.9	0.2
	NLCD 2006	303.3	1.1	5.1	3.3	3.7	1.5	0.4	0.1	0.3	43.7	9.1	4.2	16.8	2.1	13.2	1.0	0.5	0.1
33	**NLCD 2006**	185.1	1.4	5.9	4.0	4.0	2.0	0.5	0.2	0.4	42.1	9.2	5.0	15.5	1.7	13.7	1.2	0.5	0.1
34	**NLCD 2006**	98.5	2.1	8.2	0.8	4.8	3.2	0.9	0.3	0.5	38.3	9.9	6.4	10.5	2.2	19.9	1.5	0.8	0.0
35	**NLCD 2001**	55.1	3.2	11.4	0.6	5.9	4.8	1.4	0.4	0.7	31.8	8.7	7.1	8.5	2.4	24.4	2.3	0.9	0.0
	NLCD 2006	55.1	3.2	11.4	0.6	5.9	4.9	1.3	0.4	0.9	31.2	9.1	6.9	8.6	3.3	24.1	1.8	0.9	0.0
36	**NLCD 2001**	66.0	0.7	4.2	3.9	3.3	0.8	0.2	0.1	0.2	49.5	5.6	3.5	15.8	0.0	15.7	1.1	0.4	0.1
	NLCD 2006	66.0	0.7	4.2	0.0	3.7	0.9	0.3	0.0	0.2	52.4	6.0	3.3	15.3	1.1	15.6	0.7	0.3	0.0
37	**NLCD 2001**	34.6	1.1	5.7	0.6	4.2	1.3	0.4	0.1	0.3	46.7	6.1	4.5	11.2	0.0	23.4	1.0	0.3	0.0
	NLCD 2006	34.6	1.1	5.7	0.5	4.4	1.3	0.5	0.1	0.4	47.2	5.4	4.2	11.1	0.9	23.0	0.7	0.3	0.0
38	**NLCD 2001**	24.2	1.4	6.7	0.8	4.5	1.6	0.5	0.1	0.5	44.1	6.9	5.3	9.9	0.0	24.6	0.9	0.4	0.0
	NLCD 2006	24.2	1.4	6.7	0.7	4.8	1.7	0.7	0.1	0.5	44.2	6.0	4.9	9.9	1.1	24.3	0.6	0.4	0.0
39	**NLCD 2001**	12.1	2.3	9.7	1.1	5.8	2.4	0.9	0.2	0.9	40.0	6.7	5.6	12.0	0.0	23.0	0.7	0.7	0.0
	NLCD 2006	12.1	2.3	9.7	0.9	6.6	2.7	1.3	0.2	1.1	40.2	5.9	5.3	11.8	0.4	22.6	0.4	0.7	0.0
40	**NLCD 2001**	4.3	2.3	9.2	1.5	4.6	2.1	0.4	0.0	0.0	41.1	5.7	4.4	17.5	0.0	20.7	1.0	1.1	0.1
	NLCD 2006	4.3	2.3	9.2	1.4	5.6	2.9	1.5	0.0	1.0	41.2	4.7	4.4	16.2	0.0	19.6	0.5	1.0	0.0

APPENDIX D

RELATIVE ABUNDANCES OF SITES IN THE BEAR CREEK SYSTEM

SURVEYED IN 1998-2000, 2007-2009, and 2012-2013

Appendix D. Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 6 (GSA ID: PC-2)

Total Similarity 1998-2013: 0.154

Year:	**1968**		**1998**		**2009**		**2012**		**2013**	
	rosefin shiner	0.45	striped shiner	0.46	rough shiner	0.32	rough shiner	0.52	rough shiner	0.57
	blackspotted topminnow	0.4	black darter	0.23	bluehead chub	0.13	creek chub	0.13	bluehead chub	0.17
	American brook lamprey	0.05	blackspotted topminnow	0.15	striped shiner	0.1	bluehead chub	0.08	striped shiner	0.07
	banded sculpin	0.05	largescale stoneroller	0.08	largescale stoneroller	0.07	striped shiner	0.08	weed shiner	0.07
	black darter	0.05	rough shiner	0.08	longear sunfish	0.07	mimic shiner	0.04	Tennessee darter	0.03
	largescale stoneroller	0	American brook lamprey	0	bandfin darter	0.05	spotfin shiner	0.03	bandfin darter	0.03
	spotfin shiner	0	spotfin shiner	0	creek chubsucker	0.04	largescale stoneroller	0.02	bluegill	0.02
	striped shiner	0	rosefin shiner	0	bluegill	0.04	blackspotted topminnow	0.02	black madtom	0.01
	scarlet shiner	0	scarlet shiner	0	blackfin dater	0.02	bandfin darter	0.02	green sunfish	0.01
	bluehead chub	0	bluehead chub	0	black madtom	0.02	scarlet shiner	0.01	rainbow darter	0.01

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID:12 (GSA ID:BC-7)

Total Similarity 1998-2013: 0.400

Year:	**1968**	**1998**		**2008**		**2012**		**2013**	
		largescale stoneroller	0.198	redline darter	0.218	weed shiner	0.169	bluegill	0.192
		northern hogsucker	0.198	redear sunfish	0.189	mimic shiner	0.149	rough shiner	0.184
		banded sculpin	0.167	largescale stoneroller	0.144	largescale stoneroller	0.142	mimic shiner	0.184
		mimic shiner	0.125	mimic shiner	0.076	redline darter	0.113	weed shiner	0.146
		white crappie	0.063	northern hogsucker	0.059	brook silverside	0.106	largescale stoneroller	0.099
		redline darter	0.063	western mosquitofish	0.049	northern hogsucker	0.060	northern studfish	0.029
		spotfin shiner	0.042	logperch	0.049	northern studfish	0.060	logperch	0.029
		bullhead minnow	0.042	banded sculpin	0.045	banded sculpin	0.056	northern hogsucker	0.023
		northern studfish	0.021	northern studfish	0.038	largemouth bass	0.026	redline darter	0.020
		western mosquitofish	0.021	spotfin shiner	0.023	western mosquitofish	0.023	western mosquitofish	0.017

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 13 (GSA ID:BC-8)

Total Similarity 1999-2013: 0.292

Year:	**1968**		**1999**		**2008**		**2012**		**2013**	
	longear sunfish	0.290	northern hogsucker	0.182	redline darter	0.585	weed shiner	0.427	redline darter	0.198
	steelcolor shiner	0.129	spotfin shiner	0.121	largescale stoneroller	0.153	mimic shiner	0.161	weed shiner	0.157
	striped shiner	0.129	dusky darter	0.121	spotfin shiner	0.043	redline darter	0.137	spotfin shiner	0.149
	telescope shiner	0.129	striped shiner	0.106	longear sunfish	0.033	largescale stoneroller	0.089	mimic shiner	0.124
	golden shiner	0.065	steelcolor shiner	0.091	northern hogsucker	0.020	spotfin shiner	0.032	bluegill	0.116
	logperch	0.065	mimic shiner	0.061	mimic shiner	0.018	northern hogsucker	0.024	brook silverside	0.083
	dusky darter	0.065	banded sculpin	0.061	blackspotted topminnow	0.018	banded sculpin	0.024	largescale stoneroller	0.033
	blackspotted topminnow	0.032	bullhead minnow	0.045	logperch	0.018	gilt darter	0.024	logperch	0.033
	banded sculpin	0.032	black redhorse	0.045	gilt darter	0.015	dusky darter	0.024	gilt darter	0.025
	spotted bass	0.032	blackspotted topminnow	0.045	striped shiner	0.013	highland shiner	0.016	western mosquitofish	0.017

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 15 (GSA ID:BC-10)

Total Similarity 1998-2013: 0.368

Year:	1968		1998		2008		2009		2012		2013	
	steelcolor shiner	0.26	striped shiner	0.44	largescale stoneroller	0.28	redline darter	0.34	largescale stoneroller	0.21	striped shiner	0.34
	emerald shiner	0.24	dusky darter	0.14	redline darter	0.14	largescale stoneroller	0.26	longear sunfish	0.2	northern hogsucker	0.14
	striped shiner	0.17	northern hogsucker	0.12	longear sunfish	0.1	northern hogsucker	0.12	northern hogsucker	0.11	largescale stoneroller	0.12
	largescale stoneroller	0.07	golden redhorse	0.09	highland shiner	0.09	longear sunfish	0.1	redline darter	0.11	western mosquitofish	0.1
	banded sculpin	0.05	spotfin shiner	0.05	striped shiner	0.06	spotfin shiner	0.03	striped shiner	0.1	highland shiner	0.04
	longear sunfish	0.05	largescale stoneroller	0.04	northern hogsucker	0.06	highland shiner	0.02	mimic shiner	0.08	blackspotted topminnow	0.04
	slenderhead darter	0.05	creek chub	0.04	western mosquitofish	0.04	striped shiner	0.02	black darter	0.04	logperch	0.04
	dusky darter	0.05	spotted bass	0.04	green sunfish	0.04	blackspotted topminnow	0.02	gilt darter	0.03	mimic shiner	0.03
	blackspotted topminnow	0.02	western mosquitofish	0.02	weed shiner	0.03	channel catfish	0.01	spotted bass	0.02	northern studfish	0.03
	bluegill	0.02	river chub	0.01	blackspotted topminnow	0.02	bluegill	0.01	highland shiner	0.01	spotfin shiner	0.02

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 19 (GSA ID:BC-14)

Total Similarity 1998-2013: 0.316

Year:	**1968**		**1998**		**2008**		**2009**		**2012**		**2013**	
	pretty shiner	0.269	steelcolor shiner	0.297	largescale stoneroller	0.346	redline darter	0.670	largescale stoneroller	0.309	redline darter	0.580
	striped shiner	0.237	rosyface shiner	0.297	spotfin shiner	0.296	spotfin shiner	0.086	highland shiner	0.294	largescale stoneroller	0.224
	spotfin shiner	0.172	redline darter	0.271	redline darter	0.103	largescale stoneroller	0.064	spotfin shiner	0.103	spotfin shiner	0.058
	telescope shiner	0.118	largescale stoneroller	0.068	striped shiner	0.063	striped shiner	0.022	redline darter	0.103	striped shiner	0.039
	largescale stoneroller	0.022	logperch	0.034	northern hogsucker	0.047	pretty shiner	0.022	striped shiner	0.074	pretty shiner	0.029
	emerald shiner	0.022	pretty shiner	0.017	dollar sunfish	0.033	bluegill	0.022	northern hogsucker	0.059	speckled darter	0.018
	bullhead minnow	0.022	greenside darter	0.008	blackspotted topminnow	0.022	rough shiner	0.015	logperch	0.059	logperch	0.016
	black redhorse	0.022	speckled darter	0.008	smallmouth bass	0.019	dollar sunfish	0.015	steelcolor shiner	0.000	longear sunfish	0.008
	greenside darter	0.022	spotfin shiner	0.000	rainbow darter	0.016	highland shiner	0.011	pretty shiner	0.000	banded sculpin	0.006
	rough shiner	0.011	striped shiner	0.000	scarlet shiner	0.011	bluntnose minnow	0.011	scarlet shiner	0.000	greenside darter	0.006

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 20 (GSA ID:BC-15

Total Similarity 1998-2013: 0.125

Year:	**1968**		**2000**		**2008**		**2012**	
	speckled darter	0.41	whitetail shiner	0.698	rosyside dace	0.852	largescale stoneroller	0.604
	blueface darter	0.35	largescale stoneroller	0.226	whitetail shiner	0.046	scarlet shiner	0.132
	striped shiner	0.06	smallmouth bass	0.038	pretty shiner	0.029	pretty shiner	0.094
	steelcolor shiner	0.04	dollar sunfish	0.019	smallmouth bass	0.018	whitetail shiner	0.063
	bigeye chub	0.04	longear sunfish	0.019	northern hogsucker	0.013	ribbon shiner	0.050
	northern hogsucker	0.04			bluegill	0.011	northern hogsucker	0.025
	rough shiner	0.02			green sunfish	0.009	blueside darter	0.013
	bluntnose minnow	0.02			dollar sunfish	0.009	spotted sucker	0.006
	greenside darter	0.02			blackspotted topminnow	0.005	tadpole madtom	0.006
					flathead catfish	0.004	smallmouth bass	0.006

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 21 (GSA ID:BC-16)

Total Similarity 1998-2013: 0.526

Year:	**1968**		**1998**		**2009**		**2013**	
	pretty shiner	0.478	pretty shiner	0.357	bluegill	0.272	rough shiner	0.240
	rough shiner	0.408	rough shiner	0.238	pretty shiner	0.162	largescale stoneroller	0.171
	bluegill	0.033	speckled darter	0.232	largescale stoneroller	0.145	speckled darter	0.143
	speckled darter	0.033	striped shiner	0.054	speckled darter	0.127	striped shiner	0.087
	bluntnose minnow	0.022	blackspotted topminnow	0.022	dollar sunfish	0.092	pretty shiner	0.087
	Tennessee snubnose darter	0.016	river chub	0.016	blueface darter	0.058	bluehead chub	0.052
	striped shiner	0.005	bluegill	0.016	striped shiner	0.040	blackspotted topminnow	0.052
	bluehead chub	0.005	dollar sunfish	0.016	blackspotted topminnow	0.023	northern hogsucker	0.045
	largescale stoneroller	0.000	blueface darter	0.016	creek chub	0.017	longear sunfish	0.038
	river chub	0.000	largescale stoneroller	0.011	northern hogsucker	0.017	tadpole madtom	0.021

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 25 (GSA ID: ULB-2)

Total Similarity 1998-2013: 0.235

Year:	**1968**		**1998**		**2009**		**2012**		**2013**	
	rough shiner	0.679	bluegill	0.527	bluegill	0.238	striped shiner	0.409	rough shiner	0.257
	bluehead chub	0.138	largescale stoneroller	0.162	largescale stoneroller	0.221	rough shiner	0.150	largescale stoneroller	0.159
	striped shiner	0.082	northern hogsucker	0.081	smallmouth bass	0.149	largescale stoneroller	0.126	scarlet shiner	0.159
	river chub	0.050	striped shiner	0.068	striped shiner	0.077	blueface darter	0.094	striped shiner	0.124
	speckled darter	0.044	smallmouth bass	0.068	blackspotted topminnow	0.060	bluehead chub	0.055	blackspotted topminnow	0.102
	northern hogsucker	0.006	blackspotted topminnow	0.054	creek chub	0.051	ribbon shiner	0.031	bluegill	0.049
	largescale stoneroller	0.000	green sunfish	0.041	spotted bass	0.047	creek chub	0.031	Tennessee darter	0.049
	pretty shiner	0.000	pretty shiner	0.000	blueface darter	0.047	blackspotted topminnow	0.031	blueside darter	0.035
	scarlet shiner	0.000	scarlet shiner	0.000	speckled darter	0.026	smallmouth bass	0.031	bluehead chub	0.013
	ribbon shiner	0.000	ribbon shiner	0.000	pretty shiner	0.017	pretty shiner	0.024	creek chub	0.013

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 32 (GSA IS:CC-4)
Total Similarity 1999-2012: 0.280

Year:	**1968**		**1999**		**2008**		**2009**		**2012**	
	spotfin shiner	0.362	largescale stoneroller	0.356	redline darter	0.353	redline darter	0.269	redline darter	0.207
	largescale stoneroller	0.324	redline darter	0.356	longear sunfish	0.208	striped shiner	0.207	striped shiner	0.195
	creek chub	0.076	spotfin shiner	0.067	largescale stoneroller	0.118	largescale stoneroller	0.140	golden redhorse	0.149
	northern hogsucker	0.057	striped shiner	0.067	spotfin shiner	0.076	longear sunfish	0.114	northern studfish	0.126
	northern studfish	0.057	whitetail shiner	0.022	bluntnose minnow	0.028	spotfin shiner	0.057	largescale stoneroller	0.069
	banded sculpin	0.057	northern hogsucker	0.022	Tennessee darter	0.028	northern hogsucker	0.047	northern hogsucker	0.046
	bluntnose minnow	0.019	northern studfish	0.022	blackspotted topminnow	0.024	gilt darter	0.041	gilt darter	0.046
	steelcolor shiner	0.010	blackspotted topminnow	0.022	western mosquitofish	0.017	Tennessee darter	0.021	longear sunfish	0.034
	striped shiner	0.010	western mosquitofish	0.022	logperch	0.017	northern studfish	0.016	bluntnose minnow	0.023
	emerald shiner	0.010	brook silverside	0.022	northern hogsucker	0.014	weed shiner	0.010	spotted bass	0.023

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 35 (GSA ID:CC-11)

Total Similarity 1968-2013: 0.265 / 0.360

Year:	1968		1998		2008		2009		2012		2013 MAY		2013 AUG
	rosefin shiner	0.387	spotfin shiner	0.333	largescale stoneroller	0.446	dollar sunfish	0.204	black darter	0.209	largescale stoneroller	0.198	redline darter
	pretty shiner	0.355	rosefin shiner	0.294	striped shiner	0.142	scarlet shiner	0.142	northern studfish	0.154	Tennessee darter	0.192	striped shiner
	green sunfish	0.097	ribbon shiner	0.098	redline darter	0.112	rainbow darter	0.108	largescale stoneroller	0.106	greenside darter	0.088	Tennessee darter
	largescale stoneroller	0.032	redline darter	0.059	rainbow darter	0.050	largescale stoneroller	0.073	greenside darter	0.103	black darter	0.072	spotfin shiner
	spotfin shiner	0.032	striped shiner	0.039	Tennessee darter	0.050	redline darter	0.071	redline darter	0.098	longear sunfish	0.063	northern hogsucker
	striped shiner	0.032	brook silverside	0.039	northern hogsucker	0.048	striped shiner	0.064	spotfin shiner	0.070	bluntnose minnow	0.053	scarlet shiner
	northern hogsucker	0.032	rainbow darter	0.039	greenside darter	0.045	Tennessee darter	0.055	bigeye chub	0.053	bigeye chub	0.047	bigeye chub
	redline darter	0.032	largescale stoneroller	0.020	spotfin shiner	0.027	spotfin shiner	0.043	logperch	0.045	bluegill	0.038	bluehead chub
	longnose far	0.000	bluntnose minnow	0.020	dollar sunfish	0.015	blackspotted topminnow	0.034	striped shiner	0.031	redline darter	0.031	longear sunfish
	bigeye chub	0.000	western mosquitofish	0.020	bigeye chub	0.011	greenside darter	0.030	western mosquitofish	0.031	green sunfish	0.028	largescale stoneroller

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID:36 (GSA ID: LBC-2)

Total Similarity 1998- 2013: 0.320

Year:	**1968**		**1998**		**2008**		**2009**		**2012**		**2013**	
	redline darter	0.408	striped shiner	0.677	largescale stoneroller	0.318	largescale stoneroller	0.309	largescale stoneroller	0.484	largescale stoneroller	0.294
	American brook lamprey	0.215	whitetail shiner	0.116	striped shiner	0.317	redline darter	0.275	striped shiner	0.187	black darter	0.222
	rainbow darter	0.200	black darter	0.061	redline darter	0.095	Tennessee darter	0.113	redline darter	0.132	rainbow darter	0.165
	striped shiner	0.062	largescale stoneroller	0.051	Tennessee darter	0.068	rainbow darter	0.076	scarlet shiner	0.044	Tennessee darter	0.048
	banded sculpin	0.046	bluntnose minnow	0.020	rock bass	0.031	greenside darter	0.058	banded sculpin	0.044	striped shiner	0.044
	largescale stoneroller	0.015	golden redhorse	0.015	banded sculpin	0.025	striped shiner	0.048	creek chub	0.022	scarlet shiner	0.040
	blueside darter	0.015	rainbow darter	0.015	greenside darter	0.025	banded sculpin	0.031	rainbow darter	0.022	blueside darter	0.036
	chesnut lamprey	0.008	rosyside dace	0.010	northern hogsucker	0.023	black darter	0.021	Tennessee snubnose darter	0.022	rock bass	0.028
	whitetail shiner	0.008	Tennessee snubnose darter	0.010	dollar sunfish	0.021	blueside darter	0.014	rough shiner	0.011	bluntnose minnow	0.024
	rosefin shiner	0.008	bandfin darter	0.010	blueside darter	0.015	bluntnose minnow	0.007	northern studfish	0.011	redline darter	0.016

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 37 (GSA ID:LBC-4)

Total Similarity 1998-2013: 0.240

Year:	**1968**		**1998**		**2008**		**2009**		**2013**	
	golden redhorse	0.208	rosefin shiner	0.809	Tennessee darter	0.321	largescale stoneroller	0.470	largescale stoneroller	0.203
	whitetail shiner	0.181	rainbow darter	0.045	rainbow darter	0.151	redline darter	0.115	redline darter	0.203
	banded sculpin	0.139	spotfin shiner	0.036	black darter	0.132	striped shiner	0.079	whitetail shiner	0.121
	rainbow darter	0.125	largescale stoneroller	0.018	bigeye chub	0.113	bluegill	0.059	Tennessee darter	0.089
	Tennessee snubnose darter	0.069	banded sculpin	0.018	striped shiner	0.094	banded sculpin	0.049	bigeye chub	0.076
	telescope shiner	0.056	black darter	0.018	banded sculpin	0.057	bigeye chub	0.044	striped shiner	0.060
	redline darter	0.056	redline darter	0.018	largescale stoneroller	0.038	longear sunfish	0.033	bluegill	0.044
	northern hogsucker	0.042	bigeye chub	0.009	northern hogsucker	0.019	northern hogsucker	0.023	banded sculpin	0.041
	striped shiner	0.028	northern hogsucker	0.009	blackspotted topminnow	0.019	Tennessee darter	0.023	rainbow darter	0.032
	rosefin shiner	0.028	blueside darter	0.009	greenside darter	0.019	blackspotted topminnow	0.021	northern studfish	0.029

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 38 (GSA ID:LBC-5)

Total Similarity 1998-2013: 0.280

Year:	**1968**		**1998**		**2008**		**2012**		**2013**	
	rosefin shiner	0.296	whitetail shiner	0.267	Tennessee darter	0.256	striped shiner	0.230	largescale stoneroller	0.328
	whitetail shiner	0.225	rosefin shiner	0.244	redline darter	0.209	redline darter	0.187	redline darter	0.250
	bandfin darter	0.066	redline darter	0.200	black darter	0.151	northern studfish	0.182	bigeye chub	0.082
	striped shiner	0.063	rainbow darter	0.111	rainbow darter	0.105	Tennessee snubnose darter	0.107	whitetail shiner	0.048
	redline darter	0.051	ohio	0.067	scarlet shiner	0.093	northern hogsucker	0.075	striped shiner	0.045
	bluntnose minnow	0.048	striped shiner	0.044	largescale stoneroller	0.047	largescale stoneroller	0.053	Tennessee darter	0.043
	golden redhorse	0.045	largescale stoneroller	0.022	blackspotted topminnow	0.047	creek chub	0.027	blackspotted topminnow	0.037
	bigeye chub	0.039	northern hogsucker	0.022	whitetail shiner	0.023	blackspotted topminnow	0.027	longear sunfish	0.025
	largescale stoneroller	0.036	bluegill	0.022	bigeye chub	0.023	banded sculpin	0.027	bluntnose minnow	0.024
	banded sculpin	0.033		0.000	striped shiner	0.012	whitetail shiner	0.016	rainbow darter	0.024

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 39 (GSA ID: LBC-6)

Total Similarity 1998-2013: 0.095

Year:	**1968**		**1998**		**2008**		**2012**		**2013**	
	rough shiner	0.343	rosefin shiner	0.241	largescale stoneroller	0.342	largescale stoneroller	0.340	scarlet shiner	0.366
	whitetail shiner	0.182	largescale stoneroller	0.207	scarlet shiner	0.109	redline darter	0.212	largescale stoneroller	0.183
	rosefin shiner	0.111	spotfin shiner	0.103	whitetail shiner	0.097	Tennessee snubnose darter	0.108	redline darter	0.097
	telescope shiner	0.101	blackspotted topminnow	0.103	fantail darter	0.064	scarlet shiner	0.057	rainbow darter	0.065
	river chub	0.061	stripetail darter	0.103	striped shiner	0.059	rainbow darter	0.057	whitetail shiner	0.054
	bluehead chub	0.040	blackfin dater	0.103	bigeye chub	0.054	slender madtom	0.047	northern hogsucker	0.054
	black darter	0.040	black darter	0.069	redline darter	0.052	black darter	0.042	bluegill	0.043
	largescale stoneroller	0.030	northern hogsucker	0.034	black darter	0.047	creek chub	0.033	Tennessee darter	0.043
	northern hogsucker	0.030	dollar sunfish	0.034	slender madtom	0.032	northern hogsucker	0.033	longear sunfish	0.022
	bluntnose minnow	0.020	whitetail shiner	0.000	longear sunfish	0.032	bigeye chub	0.024	spotted bass	0.022

Appendix D. Continued – Relative abundances of sites surveyed in 1998-2000, 2007-2009 and 2012-2013.

Site ID: 40 (GSA ID:LBC-7)

Total Similarity 1998-2013: 0.000

Year:	**1968**		**1998**		**2008**		**2012**		**2013**	
	blackspotted topminnow	0.538	dollar sunfish	0.750	largescale stoneroller	0.125	creek chub	0.474	scarlet shiner	0.464
	bluegill	0.308	blackspotted topminnow	0.125	bigeye chub	0.125	banded sculpin	0.105	longear sunfish	0.107
	green sunfish	0.154	green sunfish	0.125	striped shiner	0.125	black madtom	0.079	largescale stoneroller	0.071
	largescale stoneroller	0.000	largescale stoneroller	-	creek chub	0.125	Tennessee snubnose darter	0.079	northern hogsucker	0.071
	bigeye chub	0.000	bigeye chub	0.000	blackspotted topminnow	0.125	slender madtom	0.053	yellow bullhead	0.071
	striped shiner	0.000	striped shiner	0.000	dollar sunfish	0.125	rainbow darter	0.053	bluegill	0.071
	scarlet shiner	0.000	scarlet shiner	0.000	longear sunfish	0.125	redline darter	0.053	redline darter	0.071
	creek chub	0.000	creek chub	0.000	black darter	0.125	largescale stoneroller	0.026	bigeye chub	0.036
	northern hogsucker	0.000	northern hogsucker	0.000	scarlet shiner	0.000	northern hogsucker	0.026	largemouth bass	0.036
	yellow bullhead	0.000	yellow bullhead	0.000	northern hogsucker	0.000	dollar sunfish	0.026	striped shiner	0.000