ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

# THE LONG-TERM ILLINOIS, MISSISSIPPI, OHIO, AND WABASH RIVERS FISH POPULATION MONITORING PROGRAM 2013

INHS Technical Report 2014 (26)
Project F-101-R, Segment 25

Annual Report prepared for the Illinois Department of Natural Resources, Division of Fisheries and the U.S. Fish and Wildlife Service

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June 30, 2014

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# The Long-Term Illinois, Mississippi, Ohio, and Wabash Rivers Fish Population Monitoring Program

F-101-R-25

Annual Report to the Illinois Department of Natural Resources

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## DISCLAIMER

The findings, conclusions, and views expressed herein are those of the researchers and should not be considered as the official position of the United States Fish and Wildlife Service or the Illinois Department of Natural Resources.

## ACKNOWLEDGMENT OF SUPPORT

The Long-term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program (F-101-R) is supported by the Federal Aid in Sport Fish Restoration Act (P.L. 81-6814, Dingell-Johnson/Wallop-Breaux),with funds administered by the U.S. Fish and Wildlife Service and the Illinois Department of Natural Resources (IDNR). The Illinois Department of Natural Resources and Dr. Brian Anderson, Chief of the Illinois Natural History Survey (INHS), and INHS staff provided administrative support. Staff from the Illinois River Biological Station, National Great Rivers Research and Education Center, Eastern Illinois University, Southern Illinois University, Western Illinois University, and INHS staff based at the University of Illinois Champaign-Urbana provided expertise and support for clerical, data entry, data verification, and field collections. This survey was originally conceived and initiated in 1957 by the late Dr. William C. Starrett.

# EXECUTIVE SUMMARY

This report presents a summary of those data collected during segment 25 (2013-14) of the Long-term Illinois, Mississippi, Ohio, and Wabash Rivers Fish Population Monitoring Program (LTEF), an annual survey executed by members of the Illinois Natural History Survey with funds administered by the U.S. Fish and Wildlife Service and the Illinois Department of Natural Resources. Sampling for the LTEF program was conducted throughout the state's largest rivers: six reaches of the Illinois River Waterway, six segments or pools of the Mississippi River, four segments or pools of the Ohio River, five segments of the Wabash River, and navigable portions of the Iroquois and Kankakee Rives. In all segments of the LTEF program, all fish species collected were accurately identified, tallied, measured, and weighed. The catch rates of sportfish species were calculated as the number of individuals collected per hour ($CPUE_N$ ± standard error). Structural indices [Proportional Size Distribution (PSD) and Relative Weight ($W_r$)] were also calculated for species of interest to regional managers. Catch rates and species richness varied greatly among all sampling locations and sampling periods. Emerald shiners and gizzard shad comprised the majority of the individuals caught, while silver carp and common carp accounted for the greatest proportion of the biomass collected in most sampling areas of the survey. The analysis of $CPUE_N$ and PSD trends in sportfish populations sampled by the program may indicate inter-annual recruitment patterns in sportfish populations around the state. Both shovelnose sturgeon and blue catfish were the two species most commonly encountered in the gill net surveys.

*Sportfish*

Catch rates and sizes of popular sportfish species varied greatly among the rivers and reaches sampled during 2013. Channel catfish was the most-abundantly collected sportfish species in all segments of our study. Collections of black bass species were greatest in the Upper Illinois Waterway and in the Wabash River. Catch rates of Black Crappie and White Crappie were very low among all reaches sampled during 2013. Gill-netting studies in the Mississippi River contributed important insights about the current structure of Shovelnose Sturgeon and Blue Catfish populations in that region. Our long-term datasets allow us to observe tremendous annual variations in the relative abundances and size distributions of many sportfish species, like White Bass. These observations should serve as a catalyst for future research investigating the effects of environmental change and management policy on the health and sustainability of Illinois sportfishes. Although the factors controlling the annual variations in the relative abundances of fishes in Midwestern rivers may be difficult to measure, our ability to detect and possibly explain such changes is dependent upon the execution of well-designed fisheries surveys. The operation and maintenance of the LTEF program and the data it generates can contribute to more complex and nuanced understandings that can, in turn, aid in the development of more effective and sustainable management policies for sportfishes in the rivers of Illinois.

*Invasive Species*

While the main focus of F-101-R programs are to conduct monitoring to improve our understanding of population dynamics, life histories, and habitat requirements of sportfish species, the programs sampling strategies may also be useful for documenting trends in the relative abundance of non-native species occupying Illinois large river ecosystems. However, we advise that researchers use caution when interpreting the data we collect on invasive species as our sampling protocols (e.g. restriction to main-channel habitats) may limit our probability of encountering the greatest densities of the species in some instances. Our monitoring and analyses suggest densities of Silver Carp are greatest in the Lower Illinois River and that body condition of Silver Carp was highest in the lower Mississippi River Sampling Areas and the upper-most reaches of the Wabash River sampled by LTEF crews.

## JOB ACCOMPLISHMENTS DEFINED BY F-101-R-25 WORK PLAN

Job 1: *Prepare electrofishing equipment and train staff*

Project workers maintained and repaired electrofishing and netting equipment as need throughout Project Segment 25. Full-time staff also trained seasonal staff members in the use of computerized data entry programs, electrofishing techniques, troubleshooting and repairing sampling gear, and statistical analysis of fisheries data.

Job 2: *Sample fish by AC electrofishing, pulsed-DC electrofishing, and netting on the Illinois, Mississippi, Ohio, and Wabash Rivers*

Project workers completed all electrofishing and netting assignments in the Illinois, Iroquois, Kankakee, Mississippi, Ohio, and Wabash Rivers during Project Segment 25.

Job 3: *Update computer database*

All F-101-R Segment 25 (2012-13) project data were transferred to the project database and archived in fire-resistant file cabinets at the Illinois River Biological Station, Havana.

Job 4: *Analyze data*

Project staff used Segment 25 data to investigate trends in catch-per-unit effort and stock size indices to investigate spatial and temporal trends in fish populations. Those analyses are included in this report.

Job 5: *Presentation of results*

Project workers, Mark Fritts, Jason DeBoer, Ben Lubinski, and graduate students, Jerrod Parker and Edward Culver, presented the results of electrofishing sampling at professional meetings (Appendix XIX). Project workers also continued the composition of the annual project report. Additionally, three peered-reviewed manuscripts produced using LTEF data were published during Project Segment 25:

Liss, S.A., G.G. Sass, and C.D. Suski. 2013. Spatial and temporal influences on the physiological condition of invasive silver carp. Conservation Physiology (2013) 1: doi:10.1093/conphys/cot017.

Liss, S.A., G.G. Sass, and C.D. Suski. *Accepted for publication 2014*. Influence of local-scale abiotic and biotic factors on stress and nutrition in invasive silver carp. Hydrobiologia.

Lamer, J. T., Sass, G. G., Boone, J. Q., Arbieva, Z. H., Green, S. J., and J. M. Epifanio. 2014. Restriction site-associated DNA sequencing generates high-quality single nucleotide polymorphisms for assessing hybridization between bighead and silver carp in the United States and China. Molecular Ecology Resources. 14(1):79-86

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## PREFACE

This report presents a summary of data collected during 2013 during segment 25 of Federal Aid project F-101-R, the Long-Term Illinois, Mississippi, Ohio, and Wabash Rivers Fish Population Monitoring Program. The purpose of this document is to provide information on the large-scale trends in fish populations in Illinois' large river ecosystems. Although we gather data on many other fish species in the course of our sampling, this report is primarily focused on recreationally valued sportfishes in accordance with Goal 3 of the 2010-2015 Strategic Plan for the Conservation of Illinois Fisheries Resources. Some historical data will be included in this report to facilitate longer-term analyses when appropriate. Previous summaries of the long-term data set, begun in 1957, were given by Sparks and Starrett (1975), Sparks (1977), Sparks and Lerczak (1993), Lerczak and Sparks (1994), Lerczak *et al*. (1994), Koel and Sparks (1999), McClelland and Pegg (2004), McClelland and Sass (2010), and McClelland *et al.* (2012). The format used in this report is revised from previous annual reports on this project (Lerczak *et al*. 1993, 1994, 1995, and 1996; Koel et al. 1997 and 1998; Koel and Sparks 1999; Arnold *et al*. 2000; McClelland and Pegg 2001, 2002, 2003, 2004, 2005; McClelland and Cook 2006; McClelland and Sass 2007, 2008, 2009, 2010; Michaels, Tyszko, and McClelland 2011; Tyszko *et al*. 2012; Fritts *et al.* 2013). The annual reports for project F-101-R will continue to build upon previously collected data. Fish common names used throughout this report follow Page *et al*. (2013). We have used English units of measure throughout the report. While this practice is generally discouraged in scientific writing, the use of the English measurement system is preferred by many public agencies in the United States, including the Illinois Department of Natural Resources. Throughout this report, we have frequently used many abbreviations. Here are the principle abbreviations and definitions:

RM: River Mile
AC: Alternating Current
DC: Direct Current
°F: Temperature expressed as degrees Fahrenheit
Hz: Hertz
W: Watts
µS: Microseimens
ppm: parts per million
in: inches
lb: Pounds

All data collected by F-101-R funded projects is maintained at the Illinois River Biological Station, Havana, IL and most components of project data can be promptly provided upon request. All inquiries about the LTEF dataset should be directed to project staff on site (Telephone 309-543-6000; email mwfritts@illinois.edu, jadeboer@illinois.edu, or afcasper@illinois.edu).

# CHAPTER 1
# INTRODUCTION

The large rivers of Illinois have experienced dramatic changes that have been attributed to natural and anthropogenic forces during the previous century (Theiling 1998). These changes have dramatically altered the viability of our riverine ecosystems, and Illinois' fisheries managers are faced with the increasingly difficult task of maintaining the viability of these once-thriving riverine fisheries (Sparks and Starret 1975). The purpose of this Long-term Illinois, Mississippi, Ohio, and Wabash Rivers Fish Monitoring Program (LTEF) is to provide Illinois' fisheries managers with rigorous and robust information and analyses about the status, trend, condition, and other critical qualities (such as management evaluations) of Illinois's large-river sportfisheries throughout the Illinois River, the Illinois portions of the Mississippi, Ohio, and Wabash rivers, and their tributaries.

Ultimately, the ability of managers, public policymakers, and stakeholders to protect and improve the quality and sustainability of Illinois' sportfish resources depends on accurate assessments of the state of the fisheries. In particular, we need to gain insight into how the fisheries respond to stressors and management actions. Unfortunately, many of the most critical fisheries responses are inherently out-of-synch or delayed in relation to the driving factor (e.g., because of the seasonal cycle of reproduction, fish productivity often requires a full year before it reflects the effects of a flood or a drought). Thus, long-term, large-scale ecological monitoring data are important for making inferences about temporal and spatial variations in the structure and function of ecosystems (Bolgrien *et al.* 2005; Dodds *et al.* 2013). These inferences can enhance the predictive understanding of natural resource managers, aiding them in the development and implementation of more effective resource stewardship policies at local and statewide scales. Standardized, continuous, high-quality fisheries monitoring surveys can therefore offer fisheries managers with critical insights that cannot be provided by other, shorter-term programs. A long-term record of consistent and scientifically robust monitoring, like that carried out by LTEF for over 50 years, is critical to providing insights for successful management.

The LTEF program follows respected, standardized protocols to collect fisheries data using boat-mounted electrofishing and netting gears throughout the largest rivers in Illinois (Figure 1.1). Data generated from these surveys have previously been used to document large-scale changes in the structure of riverine fish communities (Sparks and Starrett 1975, Pegg and McClelland 2004; McClelland *et al.* 2012), estimate the effects of flow alterations on riverine fish communities (Koel and Sparks 2002; Yang *et al.* 2008), investigate the evolving role of non-native species in Illinois' riverine ecosystems (Raibley *et al.* 1995; Irons *et al*. 2006; Irons *et al.* 2007; Sass *et al.* 2010; Irons *et al.* 2011; Liss *et al.* 2013; Liss *et al.* 2014; Lamer *et al.* 2014), and evaluate the efficiency of electrofishing gears for large river fisheries research (McClelland *et al.*2012; McClelland *et al.* 2013). Given this impressive legacy of scientific research, the LTEF program can continue to provide high-quality data for important assessments of riverine sportfish populations in relation to contemporary environmental perturbation such as climate shifts, on-going loss of side-channel and backwater habitat to sedimentation, unnatural water-level fluctuations from navigation, poor water quality, and river channel maintenance and dredging activities.


Figure 1.1. Map of the Illinois Waterway, the Iroquois and Kankakee Rivers, and the Illinois portions of the Mississippi, Ohio, Wabash, Iroquois and Kankakee Rivers illustrating areas sampled by the Long Term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program (colored in blue) during 2013. Areas currently sampled by the US Army Corps of Engineers Upper Mississippi River Restoration Environmental Management Program's (UMRR-EMP) Long Term Resource Monitoring Program component (LaGrange Reach, Illinois River and Pool 26, Mississippi River) are colored red.

# CHAPTER 2
# SPORTFISH ASSESSMENTS IN THE ILLINOIS RIVER

## Section 2.1 - AC Electrofishing Collections

Sportfish populations were monitored at 27 fixed sites along the Illinois and Mississippi Rivers using boat-mounted three-phase AC electrofishing gear: two sites on the lower Des Plaines River, twenty-four sites on the Illinois River, and one site on the Mississippi River near the confluence of the Illinois River (Brickhouse Slough, sampled periodically since 1978; Figure 2.1). Sixteen fixed sites were located exclusively in side-channel habitats and the remaining sites were distributed among side-channel and main-channel border habitats (see Lerczak *et al.*, 1994 for detailed description of site selection). In previous years' sampling, a twenty-eighth location had been sampled at Lambie's Boat Harbor (Illinois River Mile 170.3). However, this sampling location was inaccessible during 2013 because of excessive siltation following floods during spring 2013.

Fish populations were sampled by electrofishing from a 16-ft aluminum boat using a 3000-watt, three-phase AC generator. Sampling at each site typically lasted one hour. Stunned fish were gathered with a dip net [1/4-in mesh] and stored in an aerated livewell until sampling was completed. Fish were then identified to species, measured [total length (TL-mm) and weight (g)], inspected for externally visible abnormalities, and returned to the water.

## Section 2.2 - Pulsed-DC Electrofishing Collections

Sportfish populations were monitored in 5 reaches of the Illinois Waterway using boat-mounted pulsed-DC electrofishing gear. Additionally, 6 segments or pools of the Mississippi River, 4 segments or pools of the Ohio River, and 5 segments of the Wabash River (Figure 1.1) were sampled via the same methodology (see Appendix I). Sites were randomly selected using GIS layers of main channel border habitats in all study areas. The LaGrange Reach on the Illinois River and Pool 26 of the Mississippi River are currently monitored by the U.S. Army Corps of Engineers Upper Mississippi River Restoration Environmental Management Program's (UMRR-EMP) Long Term Resource Monitoring Program component (LTRMP, http://www.umesc.usgs.gov/ltrmp.html) and are, therefore, not included in F-101-R monitoring (Figure 1.1).

Electrofishing collections were conducted according to established LTRMP protocols for monitoring fish populations in large rivers as described by Gutreuter et al. (1995) during three sampling periodsampling periods (15 June – 31 July, 1 August – 15 September, 16 September – 31 October). Boat-mounted pulsed-DC electrofishing was used to catch fish. A three-person crew consisting of a pilot and two dippers performed 15-minute electrofishing runs at a collection site. Power was supplied by a 5,000-W generator with voltage and amperage adjusted to achieve LTRMP standardized power goals using 60Hz and a 25% duty cycle (Gutreuter et al. 1995). Stunned fish were caught with a dip net of 1/8-in (0.3 cm) mesh and placed in an aerated livewell until sampling was completed. Fish were then identified to species, measured (TL and weight), and returned to the water. Non-carp cyprinids, darters, centrarchids < 2 in, and clupeids < 4 in were recorded and weighed as groups.

## Section 2.3 - Ancillary Habitat Quality Measurements

Measurements for ancillary habitat-quality parameters (i.e., water temperature, dissolved oxygen, Secchi disk transparency, conductivity, surface velocity, water depth, and river stage) were recorded prior to each electrofishing run and net set. Stage height was recorded from a single U.S. Army Corps of Engineers or U.S. Geological Survey (USGS) river gauge for each sampled reach for standardization (Table 1.1).

## Section 2.4 - Statistical Analyses

For each site, the number of individual fish and total weight were tallied for each species in the field. The resulting catch data are summarized and reported by river segments. Data collected during multiple sampling periods were pooled for the calculation of catch statistics. Catch rates were quantified as the number of individuals collected per hour of electrofishing (expressed as $CPUE_N$ ± standard error). In regions where the CPUE of sportfish species was greater than 1 fish/hr, proportional size distribution (PSD) scores (Neumann and Allen 2007) were calculated as an index of sportfish size structures. Condition [relative weight (*Wr*)] was calculated for Silver Carp (Irons *et al.* 2011) in those regions where captures exceeded 20 individuals. Recent research in the Wabash River indicates that 60-Hz pulsed-DC electrofishing is ineffective for sampling Flathead Catfish in riverine environments (Moody-Carpenter *et al.*, in preparation). Therefore, Flathead Catfish were excluded from our analyses of catch rates and sportfish size structures.

## Section 2.5 - 2013 Illinois River Ancillary Habitat Quality Data

Sampling using AC electrofishing gear was conducted in full daylight between 8:43 AM and 5:56 PM central standard time from 5-27 September 2013. A complete record of the physical measurements recorded at each sampling location is included in Appendix II. Specific physical habitat values for AC electrofishing surveys (i.e. river stage height and temperature) were within expected ranges established by previous sampling surveys (Lerczak et al. 1994; Koel and Sparks 1999). Pulsed-DC electrofishing was conducted between 8:10 a.m. and 7:40 p.m. central standard time during the three sampling periods specified in Section 2.2. Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 2.1.

Table 2.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on five reaches of the Illinois River during 2013. Values are expressed as the mean observed parameter value ± standard error.

| Navigational Reaches | Total EF Effort (h) | EF Power Used (Watts) | Depth (ft) | Secchi Depth (in) | Water Temperature (°F) | DO (ppm) | Conductivity (µS) | Stage Height (ft) |
|---|---|---|---|---|---|---|---|---|
| **Dresden (RM 271.5-286)** | **2.25** | **5614.3 ± 183.7** | **4.6 ± 0.6** | **35.0 ± 4.5** | **77.1 ± 1.3** | **6.3 ± 0.1** | **772.3 ± 24.2** | **505.0 ± 0.1** |
| Time Period 1 | 0.75 | 5200.0 ± 0.0 | 3.7 ± 1.2 | 24.7 ± 3.9 | 76.3 ± 0.1 | 6.3 ± 0.1 | 717.3 ± 1.3 | 505.4 ± 0.0 |
| Time Period 2 | 0.75 | 6051.3 ± 103.1 | 5.3 ± 0.7 | 48.0 ± 9.1 | 81.4 ± 1.2 | 6.2 ± 0.1 | 865.3 ± 9.1 | 504.8 ± 0.0 |
| Time Period 3 | 0.75 | 5591.7 ± 461.1 | 4.4 ± 1.5 | 32.3 ± 2.0 | 73.4 ± 1.4 | 6.4 ± 0.1 | 734.3 ± 20.3 | 504.8 ± 0.0 |
| **Marseilles (RM 247-271.5)** | **4.50** | **5059.1 ± 110.3** | **5.1 ± 0.3** | **27.8 ± 2.6** | **73.8 ± 1.6** | **7.1 ± 0.1** | **702.1 ± 15.7** | **6.0 ± 0.3** |
| Time Period 1 | 1.50 | 4850.0 ± 22.4 | 5.2 ± 0.5 | 14.6 ± 0.5 | 75.5 ± 0.3 | 7.2 ± 0.1 | 644.5 ± 4.6 | 7.5 ± 0.0 |
| Time Period 2 | 1.50 | 5641.3 ± 80.9 | 4.8 ± 0.4 | 29.9 ± 1.2 | 80.9 ± 0.5 | 6.9 ± 0.2 | 779.0 ± 9.6 | 5.2 ± 0.0 |
| Time Period 3 | 1.50 | 4686.0 ± 112.1 | 5.5 ± 0.8 | 38.8 ± 2.7 | 64.9 ± 0.3 | 7.3 ± 0.3 | 682.7 ± 21.6 | 5.3 ± 0.0 |
| **Starved Rock (RM 231-247)** | **2.25** | **5095.2 ± 157.9** | **4.9 ± 0.5** | **19.7 ± 2.5** | **72.5 ± 2.5** | **8.2 ± 0.4** | **712.7 ± 22.5** | **459.9 ± 0.0** |
| Time Period 1 | 0.75 | 5000.0 ± 0.0 | 5.4 ± 0.6 | 15.7 ± 0.4 | 73.9 ± 0.2 | 7.1 ± 0.2 | 670.0 ± 4.2 | 459.9 ± 0.0 |
| Time Period 2 | 0.75 | 5676.7 ± 69.8 | 4.5 ± 0.6 | 13.9 ± 0.8 | 80.2 ± 0.2 | 9.7 ± 0.5 | 801.7 ± 7.4 | 459.9 ± 0.0 |
| Time Period 3 | 0.75 | 4609.0 ± 51.4 | 4.9 ± 1.3 | 29.5 ± 1.4 | 63.4 ± 0.2 | 7.7 ± 0.4 | 666.3 ± 9.0 | 459.9 ± 0.0 |
| **Peoria (RM 158-231)** | **11.00** | **5442.6 ± 50.8** | **4.2 ± 0.3** | **12.2 ± 0.6** | **75.8 ± 0.7** | **6.9 ± 0.2** | **770.4 ± 10.6** | **16.3 ± 0.4** |
| Time Period 1 | 3.50 | 5075.0 ± 63.1 | 5.1 ± 0.6 | 10.5 ± 0.6 | 76.8 ± 0.9 | 6.7 ± 0.3 | 674.6 ± 7.0 | 19.6 ± 0.5 |
| Time Period 2 | 4.00 | 5777.5 ± 34.9 | 4.2 ± 0.2 | 13.6 ± 0.7 | 80.1 ± 0.3 | 7.0 ± 0.3 | 820.8 ± 5.5 | 14.7 ± 0.0 |
| Time Period 3 | 3.50 | 5427.5 ± 31.6 | 3.3 ± 0.3 | 12.2 ± 1.5 | 70.0 ± 0.8 | 6.9 ± 0.3 | 808.7 ± 6.4 | 14.8 ± 0.1 |
| **Alton (RM 0-80)** | **11.25** | **5473.2 ± 62.6** | **4.7 ± 0.4** | **10.3 ± 0.3** | **78.6 ± 0.8** | **7.1 ± 0.3** | **760.4 ± 13.1** | **16.7 ± 0.4** |
| Time Period 1 | 3.75 | 4992.7 ± 60.5 | 6.6 ± 0.7 | 9.6 ± 0.7 | 80.2 ± 1.1 | 5.2 ± 0.1 | 645.5 ± 6.5 | 15.1 ± 0.1 |
| Time Period 2 | 3.75 | 5809.4 ± 69.9 | 4.0 ± 0.5 | 10.9 ± 0.5 | 82.4 ± 0.4 | 8.9 ± 0.5 | 800.1 ± 5.4 | 15.3 ± 0.1 |
| Time Period 3 | 3.75 | 5617.7 ± 48.1 | 3.7 ± 0.4 | 10.3 ± 0.5 | 73.1 ± 1.2 | 7.1 ± 0.4 | 835.6 ± 10.0 | 19.8 ± 0.5 |

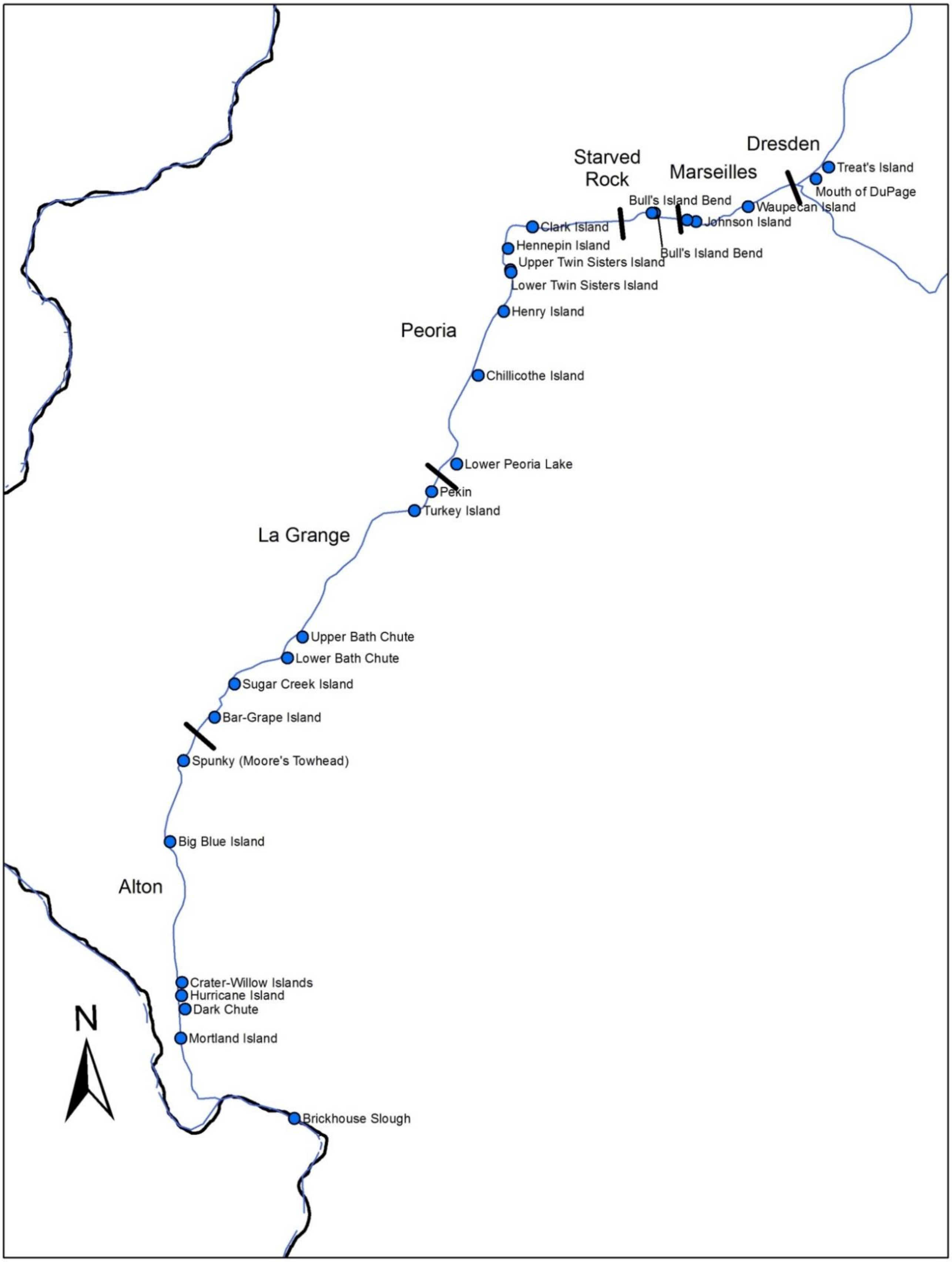



Figure 2.1. Map of the Illinois Waterway, and the fixed locations sampled by the Long Term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program (F-101-R) using AC electrofishing gear during 2013 (blue dots).

**Section 2.6 - 2013 Upper Illinois River Electrofishing Catch Statistics**

In the following section, we have drawn a distinction between those data collected above and below the Great Bend region of the Illinois River. Starrett (1971) suggested that the upper river is best characterized as a less-mature geologic landscape with a narrow valley and more swift currents generated by higher gradients; the lower river represents a much older, lower gradient, alluvial floodplain. Furthermore, Pegg and McClelland (2004) used advanced multivariate analyses of historic LTEF catch records to demonstrate that the fish communities observed in the upper and lower sections of the Illinois River were different. Therefore, sampling statistics developed for those data collected above the Starved Rock Lock and Dam (RM 231; RKM 371.8) will be presented separately from those results derived from the sampling below that structure. Fisheries data collected by LTRMP surveys in the LaGrange Reach in the Lower Illinois River have been included in CPUE calculations to increase the spatial continuity of the data used for the following analyses. These data are a product of the U.S. Army Corps of Engineers' Upper Mississippi River Restoration—Environmental Management Program, LTRMP element, as distributed by the U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin (www.umesc.usgs.gov/ltrmp.html).

We collected 1,169 fish representing 36 species and 3 hybrids from 9 families during 6.2 hours of AC electrofishing at 7 locations on the Upper Illinois and Lower Des Plains Rivers. Bluegill was the most abundant species in our AC electrofishing collections (259 fish; 22.2% of total catch) followed by Bullhead Minnow (187; 16.0%), Emerald Shiner (167; 14.3%), Gizzard Shad (147; 12.6%), and Spotfin Shiner (96; 8.2%). Common Carp contributed the greatest biomass of fishes collected in the Upper Illinois and Lower Des Plaines Rivers (39.6 lb; 21.1% total collected biomass), followed by Smallmouth Buffalo (30.5 lb; 19.8%), Gizzard Shad (27.0 lb; 14.4%), Channel Catfish (26.8 lb; 14.2%), and bluegill (14.5 lb; 7.7%). Comprehensive records of fish collections and biomass at each AC electrofishing site are included in Appendices III and IV.

We collected 2,320 fish representing 38 species and 5 hybrids from 10 families during 9 hours of pulsed-DC electrofishing at 36 sites on the Upper Illinois and Lower Des Plains Rivers. Emerald Shiner was the most abundant species in our pulsed-DC electrofishing collections (657 fish; 28.3% of total catch) followed by Gizzard Shad (447; 19.3%), Bullhead Minnow (288; 12.4%), Bluegill (211; 9.1%), and River Shiner (149; 6.4%). Smallmouth Buffalo contributed the greatest biomass of fishes collected in the pulsed-DC survey of this region (198.0 lb; 40.6% total collected biomass), followed by Gizzard Shad (65.8 lb; 13.5%), Common Carp (61.4 lb; 12.6%), Silver Carp (32.6 lb; 6.7%), and Largemouth Bass (26.2 lb; 5.4%). Comprehensive records of collections and biomass within each reach and sampling periods using pulsed-DC electrofishing gear are included in Appendices V and VI.

*Threatened and Endangered Species*

No fishes included on lists of threatened or endangered species in Illinois were collected in either three-phase AC or pulsed-DC electrofishing surveys of the Upper Illinois River.

*Bluegill*

Catch rates of Bluegill in the Upper Illinois River during 2013 were lower than those observed during 2012, but nearly equal to long-term averages (Figure 2.1). The PSD values calculated from 2013 captures indicates that the Bluegill population of the Upper Illinois River has been dominated by small young-of-year and juvenile individuals since 2006.

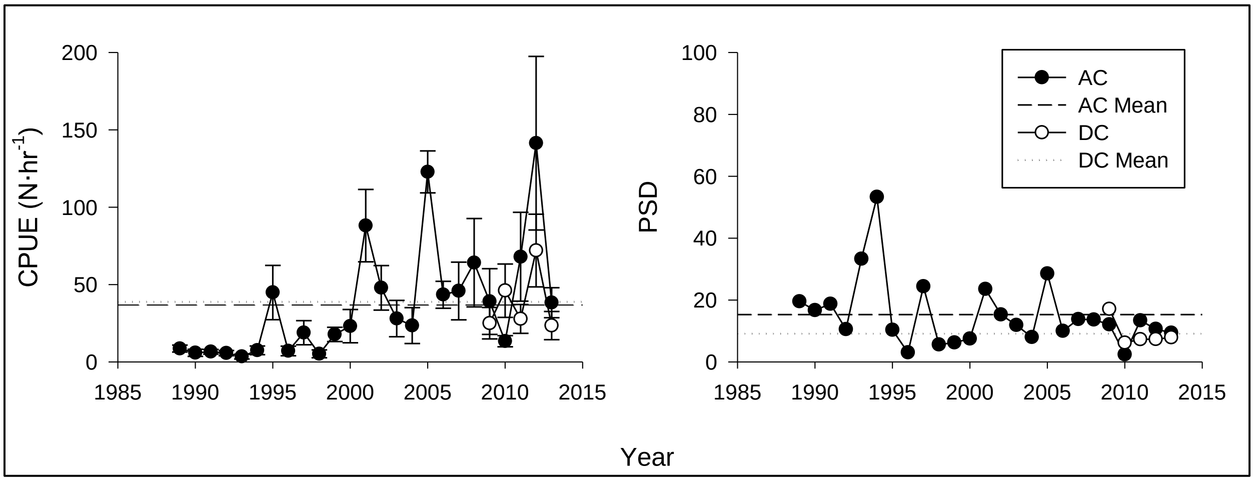



Figure 2.2. Catch per unit effort and proportional size distribution of Bluegill collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Channel Catfish*

Catch rates of Channel Catfish in the Upper Illinois River during 2013 were similar to those observed in 2012 (Figure 2.2). However, it appears that the relative abundance of Channel Catfish is generally lower in the Upper Illinois River than in other study areas covered by LTEF sampling programs. The calculated PSD values suggest that Channel Catfish populations in the Upper Illinois River are dominated by larger, more mature individuals and that the production of smaller, juvenile and young-of-year individuals has been limited since 2010.

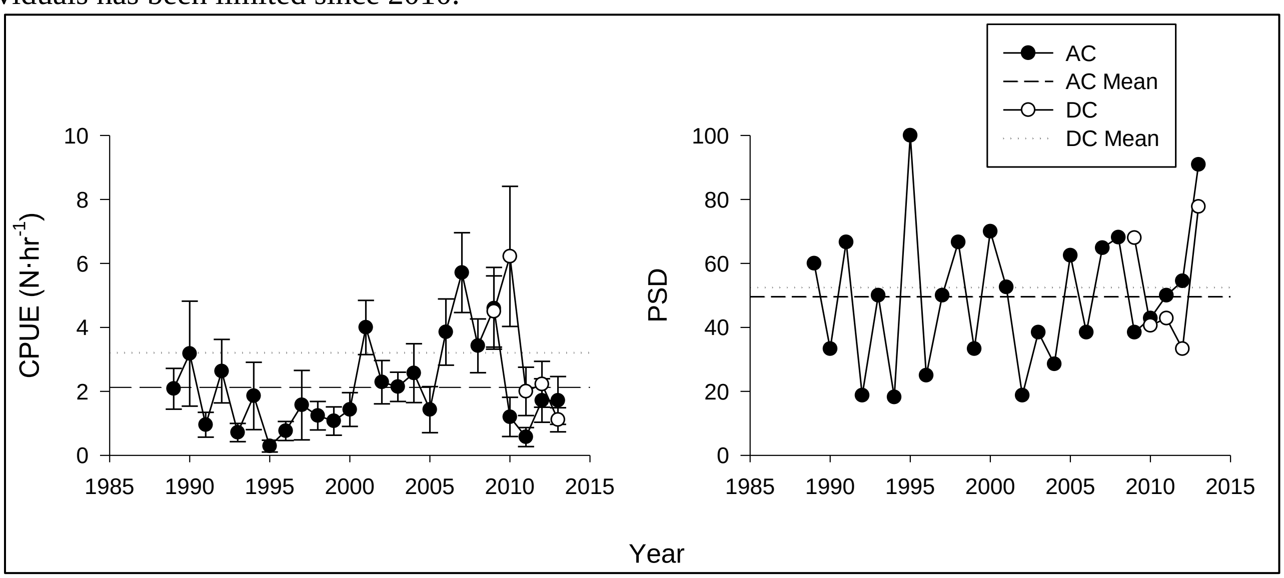



Figure 2.3. Catch per unit effort and proportional size distribution of Channel Catfish collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Largemouth Bass*

Largemouth Bass CPUE in the Upper Illinois River during 2013 was slightly below long-term averages observed since sampling was initiated during 1989 (Figure 2.3). The PSD values calculated during 2013 were marginally above long-term averages. However, inter-annual comparisons of structural index values may be complicated by the considerable variance observed among years.

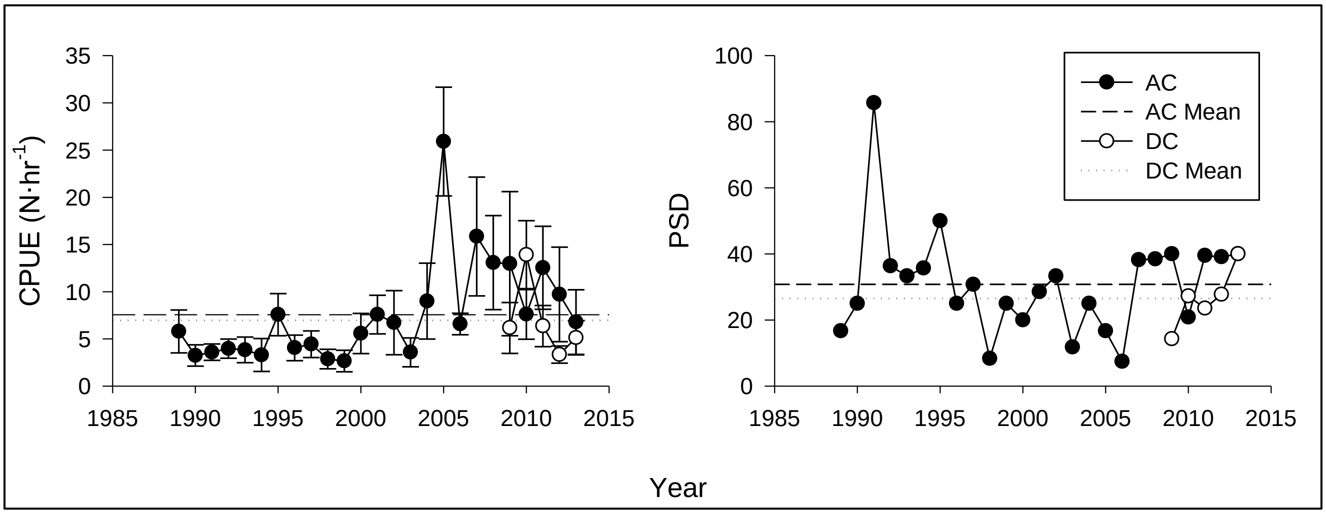



Figure 2.4. Catch per unit effort and proportional size distribution of Largemouth Bass collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Smallmouth Bass*

Mean catch rates of Smallmouth Bass in the Upper Illinois River were lower in 2013 than in 2012. However, there was considerable variance among the catch rates among all sites sampled in the region (Figure 2.4). Additionally, the variability of catch rates and PSD values over time indicates that Smallmouth Bass recruitment trends in this region are sporadic compared with other sportfish species. It is unclear whether these trends are the result of random fluctuations in populations or, alternatively, some outcome of environmental variables controlling recruitment trends or catchability. Future study of the effects of abiotic and biotic environmental variables on the population dynamics of Smallmouth Bass is recommended.

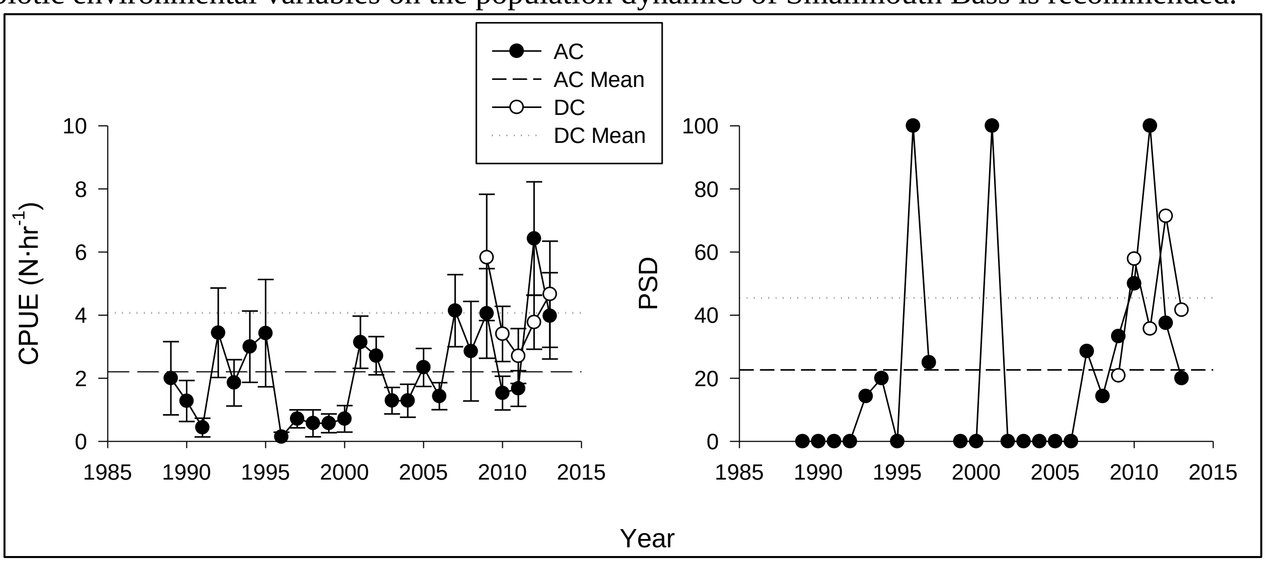



Figure 2.5. Catch per unit effort and proportional size distribution of Smallmouth Bass collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

**Section 2.7 - 2013 Lower Illinois River Electrofishing Catch Statistics**

We collected 3,802 fish representing 50 species and 4 hybrids from 14 families during 19.8 hours of AC electrofishing at 20 locations on the Lower Illinois River and its confluence with the Mississippi River. Gizzard Shad was the most abundant species in our AC electrofishing collections (901 fish; 23.7% of total catch) followed by Freshwater Drum (578; 15.2%), Bluegill (429; 11.3%), Silver Carp (294; 7.7%), and Emerald Shiner (241; 6.3%). Silver Carp contributed the greatest biomass of fishes collected in the Lower Illinois River and Confluence region (896.2 lb; 38.6% total collected biomass), followed by Common Carp (407.8 lb; 17.6%), Smallmouth Buffalo (286.1 lb; 12.3%), Channel Catfish (205.6 lb; 8.9%), and Bigmouth

Buffalo (124.2 lb; 5.4%). Comprehensive records of fish collections and biomass at each AC electrofishing site are included in Appendices III and IV.

We collected 15,020 fish representing 59 species and 3 hybrids from 14 families during 22.25 hours of pulsed-DC electrofishing at 89 sites on the Lower Illinois River. Gizzard Shad was the most abundant species in our pulsed-DC electrofishing collections (9,953 fish; 66.3% of total catch) followed by Emerald Shiner (1,480; 9.9%), unidentified juvenile Catostomids (791; 5.3%), White Bass (271; 1.8%), and Freshwater Drum (260; 1.7%). Common Carp contributed the greatest biomass of fishes collected in the pulsed-DC survey of the Lower Illinois River (834.3 lb; 32.4% total collected biomass), followed by Silver Carp (761.2 lb; 29.6%), Channel Catfish (271.0 lb; 10.5%), Gizzard Shad (129.9 lb; 5.0%), and Smallmouth Buffalo (108.4 lb; 4.2%). Comprehensive records of collections and biomass within each navigational reach and sampling periods using pulsed-DC electrofishing gear are included in Appendices V and VI.

*Threatened and Endangered Species*

Five River Redhorse (Illinois Threatened) were collected during AC electrofishing collections in the Lower Illinois River (Appendix III). One additional River Redhorse and one Greater Redhorse (Illinois Endangered) were collected during pulsed-DC electrofishing collections in the Peoria Reach of the Lower Illinois River (Appendix V).

*Black and White Crappies*

Although CPUE of Black and White Crappies is generally low in our DC electrofishing survey of the lower Illinois River, inter-annual catch rates in the AC electrofishing survey are more reliable and have demonstrated a substantial decline since 2010 (Figure 2.5). However, an analysis of long-term catch rates and PSD values may indicate a 2-3 year, cyclical pattern of recruitment. The relatively high PSD value of the 2013 catch suggests that the population is dominated by mature individuals and that the most recent year classes were relatively small. However, the long-term average PSD value (54) likely indicates that the relative size of individual Crappies collected in our surveys is dependent upon trends in year-class strength of new recruits entering the local population.

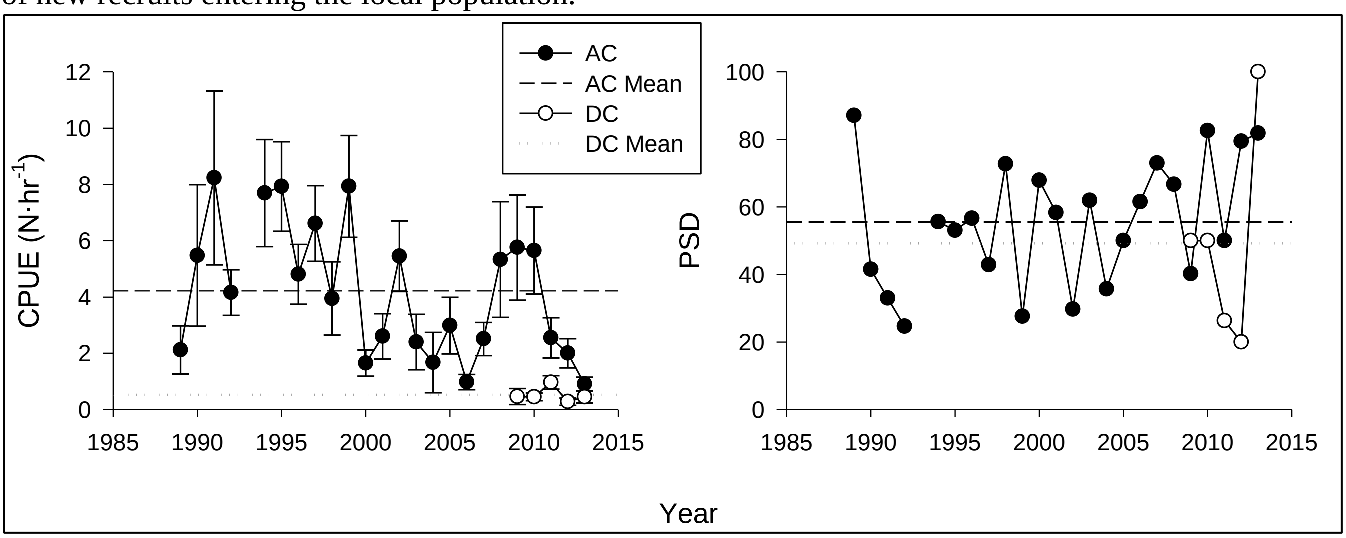



Figure 2.6. Catch per unit effort and proportional size distribution of Black and White Crappies collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Bluegill*

Catch rates of Bluegill in the Lower Illinois River declined during 2013 after having remained relatively high and stable since 2005 (Figure 2.6). The dramatic difference in CPUE between AC and DC electrofishing gears has been consistent since DC sampling began in 2009 and may indicate that the gear and/or sampling design of the AC electrofishing survey is more effective for capturing Bluegill in this region. The relatively low PSD values recorded since sampling began in 1989 are likely indicative of a population dominated by smaller individuals and may also indicate stable trends in annual recruitment.

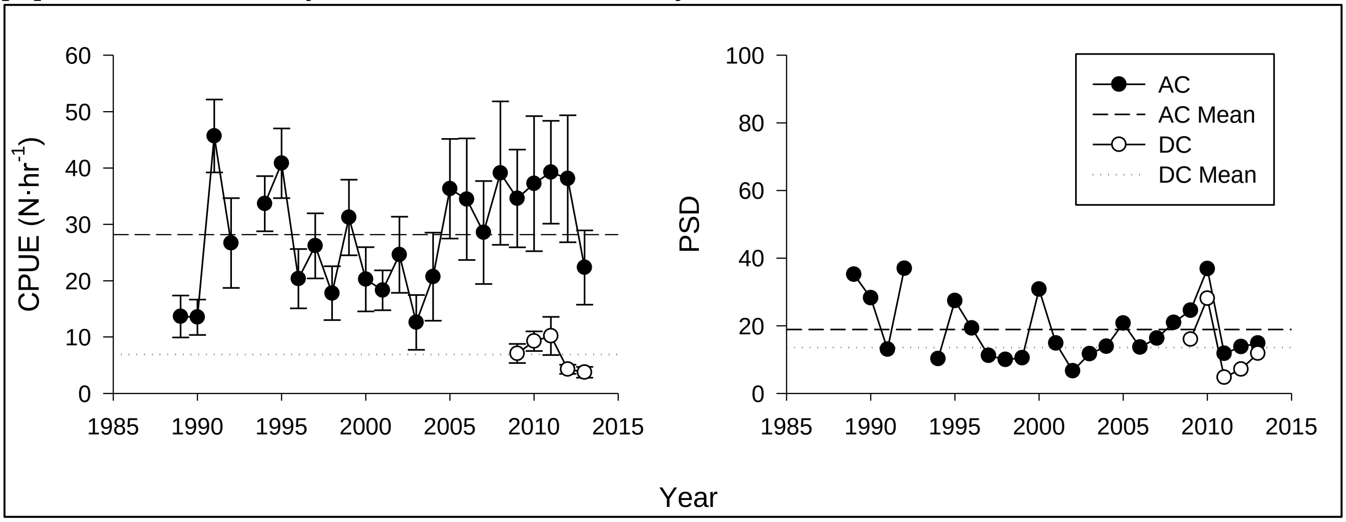



Figure 2.7. Catch per unit effort and proportional size distribution of Bluegill collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Channel Catfish*

Catch rates of Channel Catfish in the Lower Illinois River increased slightly after demonstrating declines in 2011 and 2012 (Figure 2.7). The PSD values observed in 2013 in this region indicate a population with a mix of large and small fish. Long-term trends in CPUE and PSD also suggest that Channel Catfish populations in the Lower Illinois River have maintained a balance among larger, mature fish and smaller recruits in recent years.

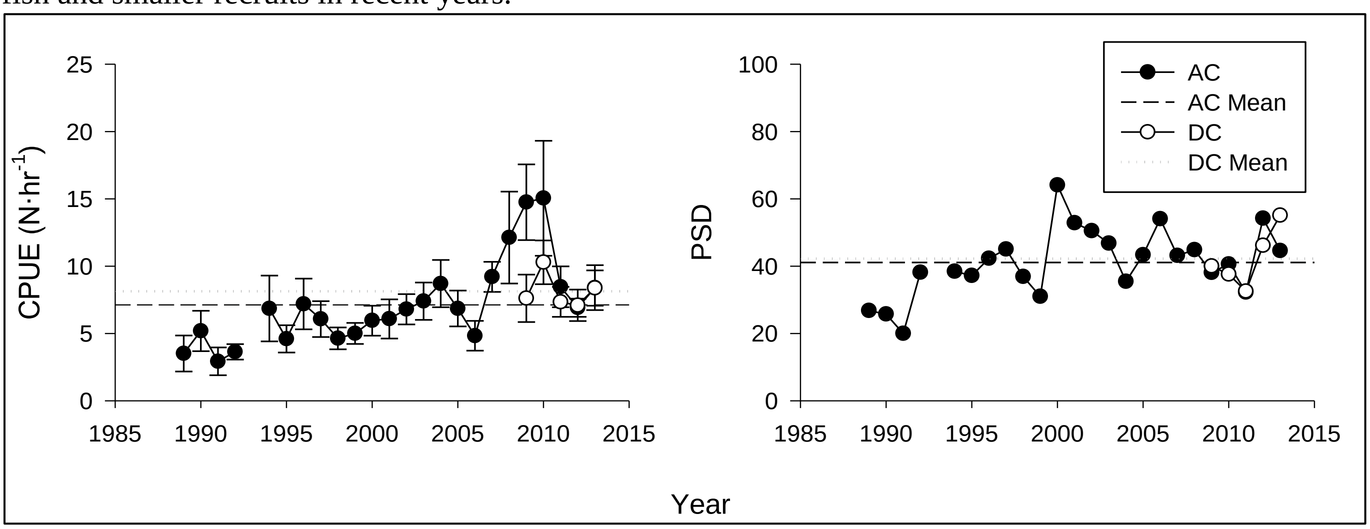



Figure 2.8. Catch per unit effort and proportional size distribution of Channel Catfish collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Largemouth Bass*

Catch rates of Largemouth Bass in the Lower Illinois River during 2013 were slightly higher than those observed during 2012, the lowest CPUE ever recorded since the beginning of both the AC and pulsed-DC electrofishing surveys (Figure 2.8). The PSD values calculated for the catch of both gears suggest that the population maintains a balance of large and small individuals, possibly even an abundance of small fish. However, CPUE trends indicate a steep population decline in this region. It is difficult to determine the cause of this decline, but future study of the effects of abiotic and biotic environmental variables on the population dynamics of Largemouth Bass in this region is recommended.

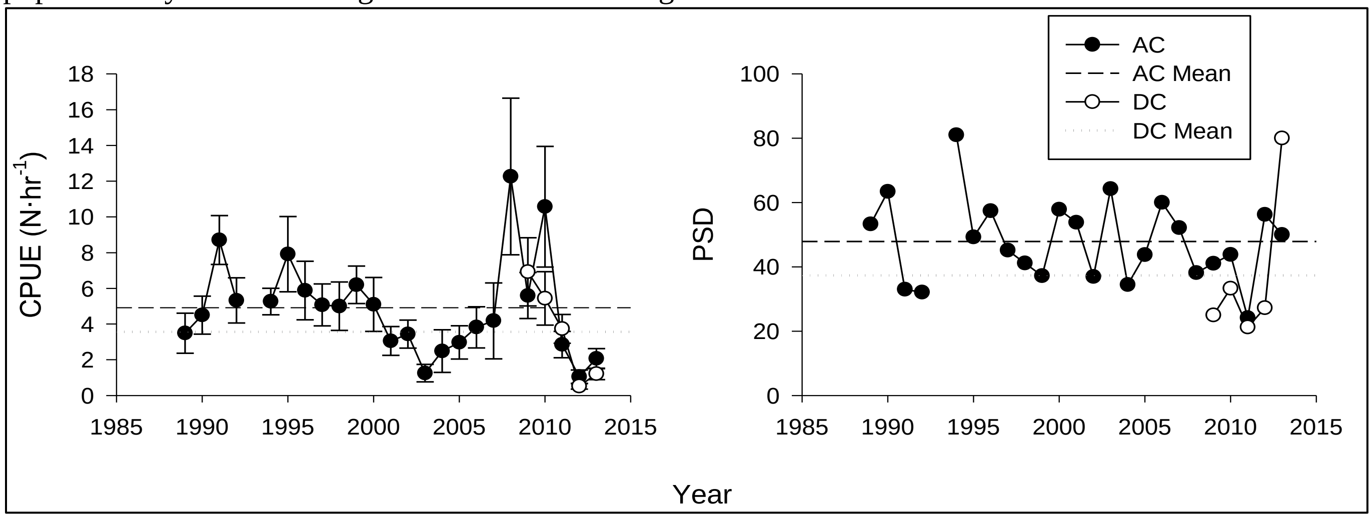



Figure 2.9. Catch per unit effort and proportional size distribution of Largemouth Bass collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*White Bass*

We observed a small increase in White Bass CPUE in the lower Illinois River during 2013 following declines documented during recent years (Figure 2.9). During the course of F-101-R sampling, we have observed only one large increase in catch rates (1996- 26.52 fish/h). The disparity between the average PSD value of White Bass collected in the AC and DC electrofishing surveys may indicate that the gears demonstrate a size-selective bias. Given the relatively low catch rates and the proportion of large fish represented in our AC sampling, our data may suggest that White Bass populations in the Lower Illinois River were dominated by mature fish and that the recruitment of small year-classes may have been limited in recent years. However, our observations during 2013 might also indicate that some small juvenile and/or young-of-year White Bass have begun to recruit to our gear. Again, future study of the effects of abiotic and biotic environmental variables on the population dynamics of White Bass is recommended.

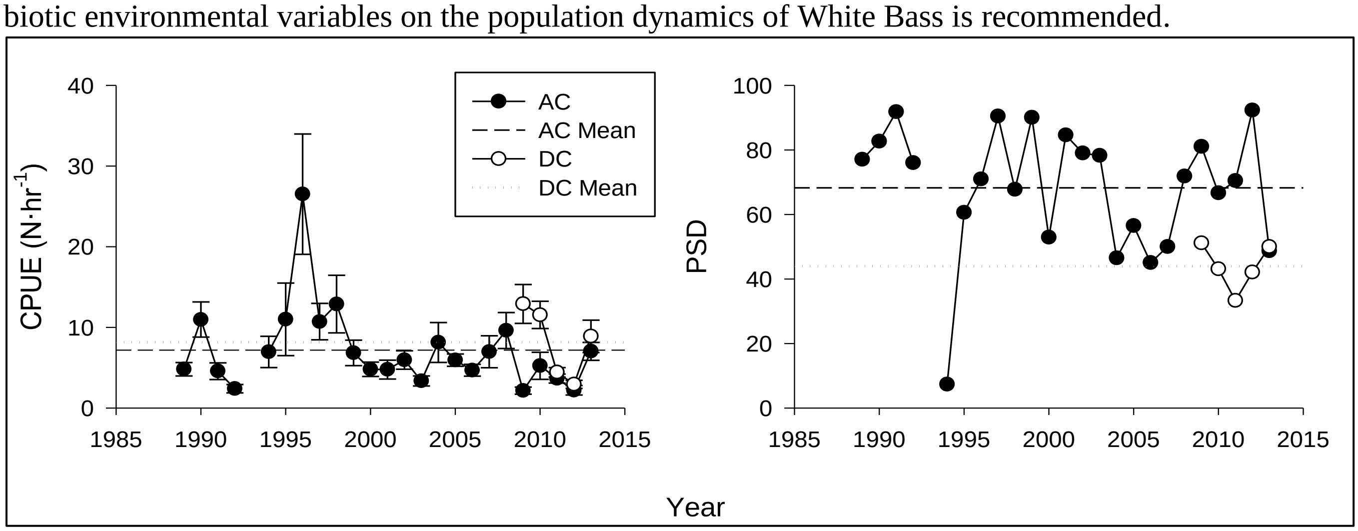



Figure 2.10. Catch per unit effort and proportional stock-density of White Bass collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Silver Carp*

Silver Carp were first detected in F-101-R surveys during 2001 (Figure 2.10). Since then, CPUE has greatly increased to its highest level in 2007 (154.29 fish/h ± 101.75) then receded to current levels (< 20 fish/h). During that same time, the relative weight of Silver Carp in the Lower Illinois River has declined (Figure 2.10). These data suggest that the size of sampled populations in this region have recently stabilized after expansion following their arrival in the Lower Illinois River.

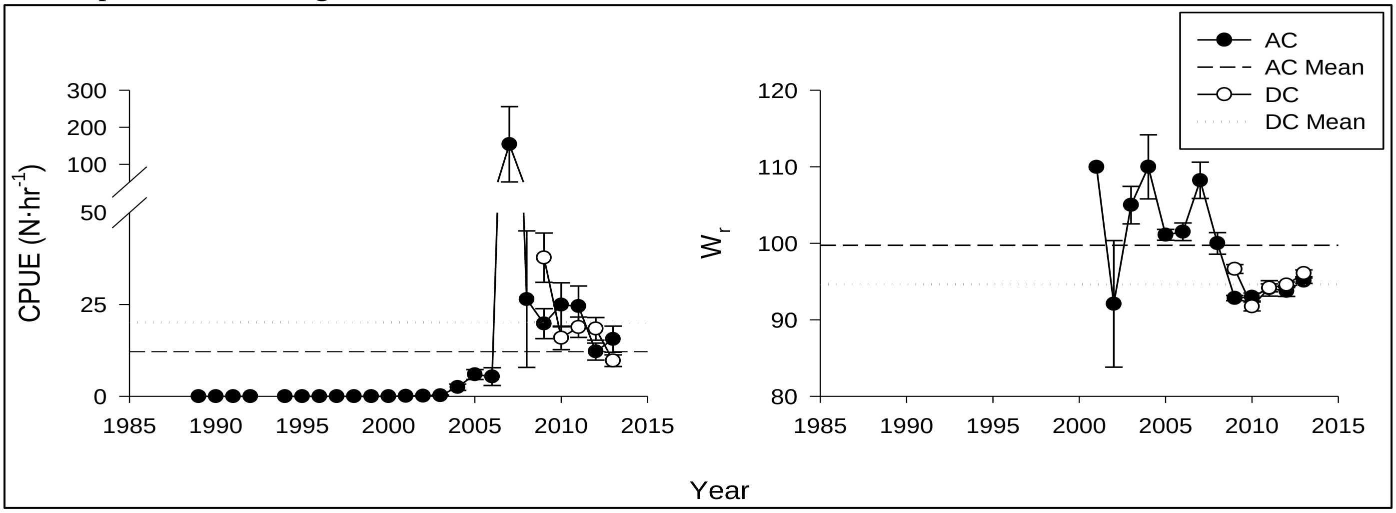



Figure 2.11. Catch per unit effort and condition (relative weight-$W_r$) of Silver Carp collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

**Section 2.8. Long-term Impacts of Water Quality and Climate Variability on Illinois Waterway Fish Assemblages; Thesis research developed by UIUC graduate student Jerrod Parker (Advised by PI's John Epifanio and Yong Cao).**

Special quantitative analyses were performed to model temporal trends for population-level and community-level traits (i.e., functional guilds and indices of biodiversity) with changes in water quality in the Upper Illinois Waterway. The Long-term Fish Population Monitoring Program (LTEF) database was processed to correct for the use of different measurement units, missing data, data entry errors, and differences in sampling event duration. These corrected data were summarized in catch per unit effort by both abundance ($CPUE_n$) and biomass ($CPUE_w$) and were used to calculate proportional changes in predatory game fish and native fish. Indices of assemblage level functional diversity and species richness were also calculated

Water quality data was provided by the Metropolitan Water Reclamation District (MWRD). These data extend from just above Peoria lock and dam (river mile 158.2) to just above the Lockport lock and dam (river mile 291.5). MWRD collected water quality data several times annually from 1983 to 2010 as part of their Illinois Waterway monitoring program. To reduce the noise in fish data introduced by environmental factors other than water quality, regional climate data was obtained from the National Climatic Data Center. Data were processed, compiled, and merged into the LTEF Microsoft Access database.

*Results and Conclusion*

The ability of water quality and climate to explain the changes in fish assemblage structure from 1983 to 2010 in the upper four reaches sampled by LTEF was assessed using modeling approaches. Results suggest water quality played a significant role in the observed fish assemblage changes, and that the effect of water quality diminished downstream. Specifically, decreases in the concentration of unionized ammonia and phenols, and increases in clarity and dissolved oxygen concentrations appear to have been the dominant factors driving the changes in fish assemblage structure. Ultimately, analyses indicate improvement in Chicago Area sewage treatment have allowed the fish assemblages to become much more diverse, and increased abundances of sportfishes.

The data acquired from MWRD offers many possible insights into the biological effects of improved water quality. The assembled trait data and functional diversity analyses may act as a basis for developing an Index of Biotic Integrity for fishes in the Illinois River Waterway. Identification of specific water quality variables strongly associated with changes in the fish assemblages may be used to set monitoring priorities, which may guide future water quality sampling as part of LTEF.

# CHAPTER 3
# SPORTFISH ASSESSMENTS IN THE MISSISSIPPI RIVER

## Section 3.1 - 2013 Mississippi River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted according to the methods described in Section 2.2 between 7:55 a.m. and 6:55 p.m. central standard time during the three sampling periods specified in Section 2.2. Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 3.1.

Table 3.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on six sampling areas of the Mississippi River during 2013. Values are expressed as the mean observed parameter value ± standard error. Stage height data were unavailable for those gauges located on Pool 25 and the Chain of Ricks and Kaskaskia Reaches at the time that this report was compiled.

| Navigational Reaches | Total EF Effort (h) | EF Power Used (Watts) | Depth (ft) | Secchi Depth (in) | Water Temperature (°F) | DO (ppm) | Conductivity (µS) | Stage Height (ft) |
|---|---|---|---|---|---|---|---|---|
| **Pool 16 (RM 457-483)** | **3.75** | **3800.3 ± 60.0** | **14.5 ± 1.7** | **16.5 ± 1.7** | **76.0 ± 0.8** | **7.0 ± 0.3** | **408.0 ± 11.5** | **10.9 ± 0.4** |
| Time Period 1 | 1.25 | 3540.0 ± 24.5 | 19.5 ± 3.4 | 9.8 ± 0.3 | 77.6 ± 0.6 | 6.0 ± 0.1 | 354.0 ± 6.3 | 13.0 ± 0.0 |
| Time Period 2 | 1.25 | 4062.0 ± 30.7 | 13.8 ± 1.5 | 21.7 ± 1.8 | 78.5 ± 0.4 | 8.3 ± 0.6 | 450.2 ± 4.0 | 9.7 ± 0.0 |
| Time Period 3 | 1.25 | 3798.8 ± 46.7 | 10.2 ± 2.4 | 18.0 ± 2.7 | 71.9 ± 0.6 | 6.8 ± 0.3 | 419.8 ± 10.9 | 10.0 ± 0.0 |
| **Pool 19 (RM 364.5-410.5)** | **6.75** | **3853.9 ± 26.3** | **14.5 ± 1.2** | **11.7 ± 0.9** | **75.5 ± 1.2** | **7.4 ± 0.4** | **424.1 ± 5.6** | **526.6 ± 0.3** |
| Time Period 1 | 2.25 | 3811.1 ± 61.1 | 21.3 ± 1.7 | 6.8 ± 1.0 | 78.1 ± 0.8 | 5.4 ± 0.2 | 404.4 ± 14.6 | 528.6 ± 0.1 |
| Time Period 2 | 2.25 | 3950.8 ± 34.2 | 12.3 ± 0.9 | 14.5 ± 1.2 | 80.7 ± 0.7 | 9.9 ± 0.5 | 425.7 ± 1.7 | 525.5 ± 0.0 |
| Time Period 3 | 2.25 | 3799.9 ± 9.0 | 9.8 ± 1.1 | 13.7 ± 0.8 | 67.5 ± 0.7 | 7.0 ± 0.3 | 442.1 ± 1.4 | 525.6 ± 0.0 |
| **Pool 20 (RM 343-364.5)** | **3.00** | **3941.2 ± 44.6** | **16.9 ± 1.8** | **11.8 ± 0.6** | **75.3 ± 2.1** | **6.1 ± 0.2** | **445.4 ± 6.3** | **9.7 ± 1.0** |
| Time Period 1 | 1.00 | 4000.0 ± 81.6 | 23.5 ± 1.0 | 9.4 ± 0.4 | 77.3 ± 0.4 | 6.7 ± 0.3 | 457.5 ± 18.1 | 14.3 ± 0.0 |
| Time Period 2 | 1.00 | 4047.3 ± 30.0 | 13.5 ± 0.9 | 13.3 ± 0.3 | 82.6 ± 0.2 | 5.5 ± 0.2 | 433.0 ± 1.4 | 7.7 ± 0.0 |
| Time Period 3 | 1.00 | 3776.3 ± 17.7 | 13.7 ± 3.2 | 12.7 ± 0.8 | 66.0 ± 0.2 | 6.2 ± 0.1 | 445.8 ± 1.4 | 7.2 ± 0.1 |
| **Pool 25 (RM 242-273.5)** | **4.50** | **3998.8 ± 26.7** | **23.3 ± 3.1** | **15.7 ± 0.8** | **79.0 ± 1.0** | **8.3 ± 0.4** | **448.7 ± 3.6** | **35.9 ± 0.4** |
| Time Period 1 | 1.50 | 4076.7 ± 30.7 | 20.4 ± 5.1 | 11.4 ± 0.4 | 83.2 ± 0.2 | 6.4 ± 0.3 | 434.5 ± 2.9 | 38.4 ± 0.5 |
| Time Period 2 | 1.50 | 4009.7 ± 24.7 | 30.8 ± 6.6 | 18.0 ± 0.3 | 80.2 ± 0.3 | 10.4 ± 0.4 | 462.2 ± 6.8 | 34.8 ± 0.0 |
| Time Period 3 | 1.50 | 3910.0 ± 53.6 | 18.6 ± 2.9 | 17.7 ± 0.9 | 73.6 ± 1.0 | 8.0 ± 0.5 | 449.5 ± 0.2 | 34.5 ± 0.1 |
| **Chain of Rocks (RM 165.5-200** | **5.25** | **4392.0 ± 110.1** | **31.9 ± 2.4** | **11.2 ± 0.8** | **77.4 ± 0.9** | **6.9 ± 0.3** | **543.8 ± 24.0** | **10.0 ± 2.2** |
| Time Period 1 | 1.75 | 4220.1 ± 87.0 | 29.1 ± 4.1 | 7.3 ± 0.4 | 79.5 ± 0.8 | 5.4 ± 0.1 | 493.1 ± 15.2 | 22.7 ± 0.9 |
| Time Period 2 | 1.75 | 4249.1 ± 111.5 | 29.7 ± 3.3 | 12.5 ± 1.2 | 80.1 ± 0.7 | 7.5 ± 0.3 | 497.7 ± 22.4 | 7.6 ± 1.2 |
| Time Period 3 | 1.75 | 4706.6 ± 276.2 | 37.0 ± 4.7 | 13.9 ± 1.2 | 72.5 ± 0.9 | 7.8 ± 0.3 | 640.4 ± 51.8 | -0.2 ± 0.5 |
| **Kaskaskia (RM 117-165.5)** | **7.50** | **4496.5 ± 62.0** | **28.3 ± 2.1** | **11.6 ± 0.5** | **77.5 ± 1.2** | **7.5 ± 0.3** | **566.5 ± 13.0** | **9.8 ± 1.5** |
| Time Period 1 | 2.50 | 4427.2 ± 61.1 | 34.0 ± 3.3 | 9.5 ± 0.7 | 81.5 ± 0.5 | 6.0 ± 0.1 | 540.9 ± 8.2 | 17.7 ± 2.1 |
| Time Period 2 | 2.50 | 4396.1 ± 135.4 | 24.4 ± 3.1 | 11.6 ± 1.0 | 81.4 ± 1.0 | 6.9 ± 0.2 | 520.9 ± 19.1 | 5.3 ± 1.0 |
| Time Period 3 | 2.50 | 4666.2 ± 101.4 | 26.3 ± 4.0 | 13.6 ± 0.6 | 69.6 ± 1.1 | 9.4 ± 0.5 | 637.7 ± 18.4 | 4.4 ± 1.2 |

## Section 3.2 - 2013 Upper Mississippi River Sampling Area Pulsed-DC Electrofishing Catch Statistics

The results included in the following section have been divided between those data collected in Pools 16, 19, and 20 (the Upper Mississippi River Sampling Area) and data collected in Pool 25, the Chain of Rocks Reach, and the Kaskaskia Reach (the Lower Mississippi River Sampling Area). We have made this distinction because of the geographic distance between the two sections. Fisheries data collected by LTRMP surveys in Pool 26 in the Lower Mississippi River Sampling Area have been included in CPUE calculations to increase the spatial continuity of the data used for the following analyses. These data are a product of the U.S. Army Corps of Engineers' Upper Mississippi River Restoration—Environmental Management Program, Long Term Resource Monitoring Program (LTRMP) element, as distributed by the U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin (www.umesc.usgs.gov/ltrmp.html).

We collected 9,754 fish representing 55 species and 2 hybrids from 12 families during 13.5 hours of pulsed-DC electrofishing at 54 sites in the Upper Mississippi River Sampling Area. Emerald Shiner was the most abundant species in our catch (5,162 fish; 52.9% of total catch) followed by unidentified juvenile Cyprinid species (1,098; 11.3%), Gizzard Shad (980; 10.0%), River Shiner (609; 6.9%), and Sand Shiner (453; 4.6%). Common Carp represented the greatest proportion of the total collected biomass (625.6 lb; 55.4% of total collected biomass) followed by Channel Catfish (114.4 lb; 10.1%), Gizzard Shad (82.7 lb; 7.3%), Freshwater Drum (71.9 lb; 6.4%), and Silver Carp (54.9 lb; 4.8%). Comprehensive records of collections and biomass within each pool and sampling periods using pulsed-DC electrofishing gear are included in Appendices VII and VIII.

*Threatened and Endangered Species*

Two Grass Pickerel (Iowa Threatened) and two Bluntnose Darters (Iowa Endangered) were collected during pulsed-DC surveys in Pool 16 in the Upper Mississippi River sampling area. Two Greater Redhorse (Illinois Endangered) were collected during pulsed-DC electrofishing surveys in Pool 19 (Appendix VII).

*Bluegill*

Bluegill catch rates in the Upper Mississippi River Sampling Area during 2013 (8.2 fish/h ± 3.1) were slightly above those recorded during 2011 (5.9 fish/h ± 1.2; Figure 3.1). The relatively low PSD values recorded for Bluegill in recent years suggests that the sampled population is dominated by small individuals.

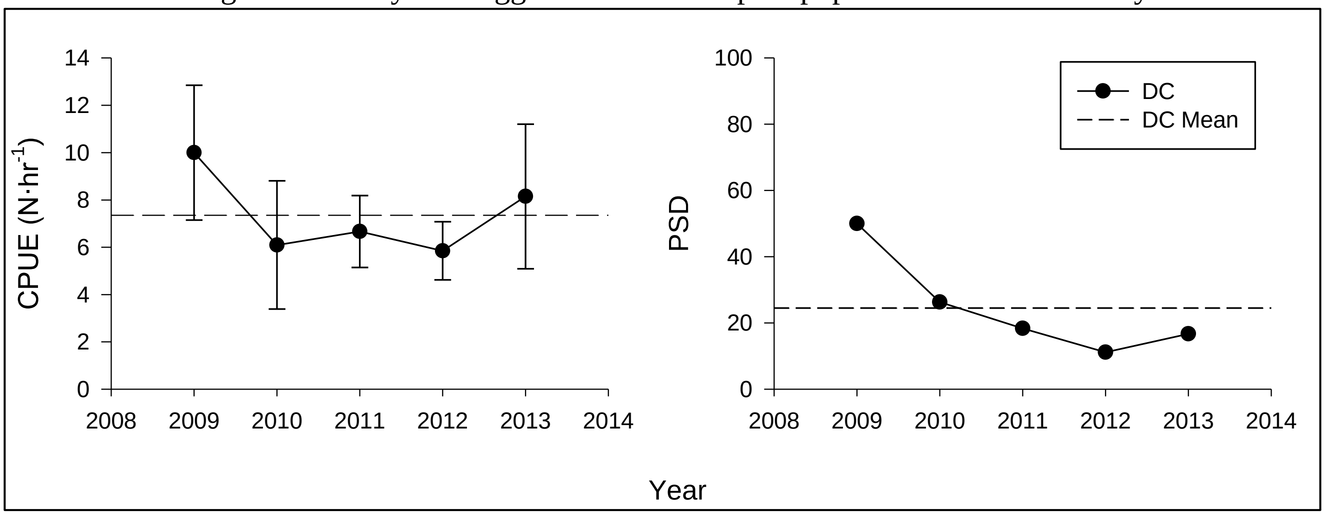



Figure 3.1. Catch per unit effort and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Channel Catfish*

Similar to 2011 and 2012, catch rates of Channel Catfish continued to decline in 2013 (4.6 fish/h ± 1.2) from the highest CPUE recorded during 2010 (27.9 fish/h ± 8.6; Figure 3.2). These declines have been accompanied by an increase in observed PSD values. These results likely indicate that the bulk of the sampled population is comprised of larger, mature fish and that recruitment of smaller size classes was low during 2011, 2012, and 2013.

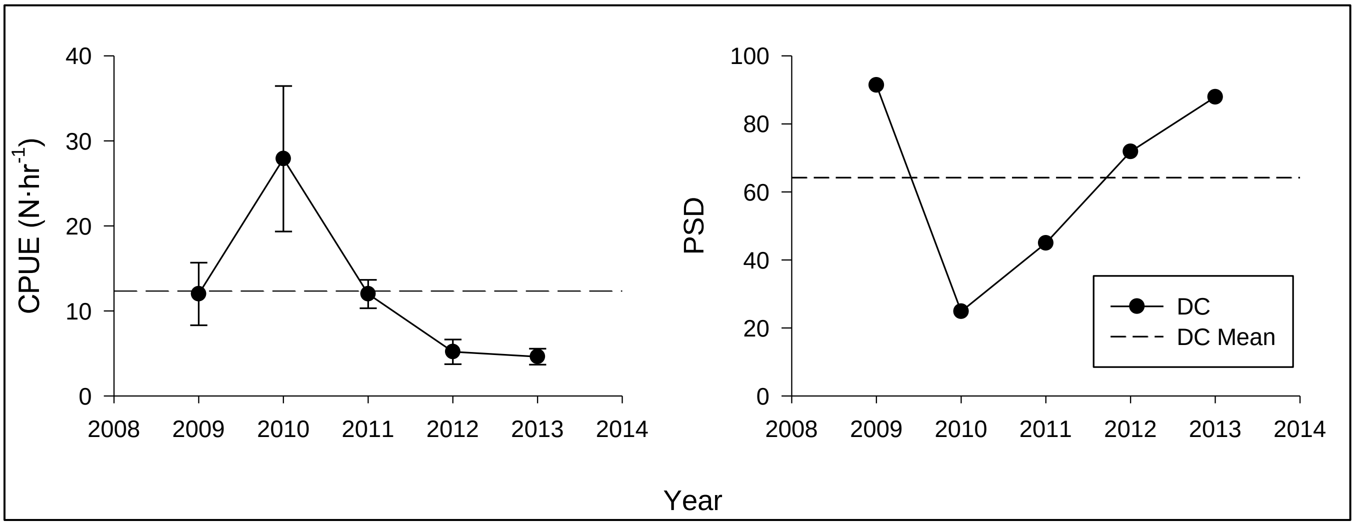



Figure 3.2. Catch per unit effort and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Largemouth Bass*

Catch rates of Largemouth Bass in the Upper Mississippi River Sampling Area have been relatively steady since 2010 (Figure 3.3). The five-year average PSD values indicate that the stock maintains a balance of larger, mature individuals and smaller, younger age groups.

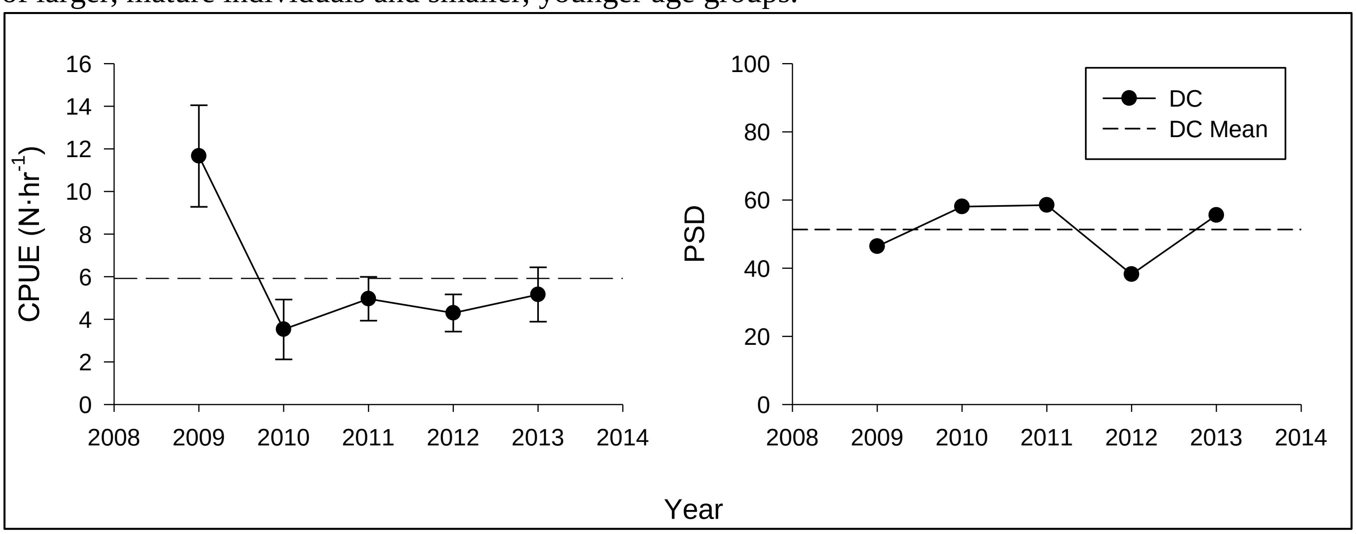



Figure 3.3. Catch per unit effort and proportional size distribution of Largemouth Bass collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Smallmouth Bass*

Smallmouth Bass CPUE in the Upper Mississippi River Sampling Area during 2013 (1.4 fish/h ± 0.6) decreased from that recorded in 2011 (3.3 fish/h ± 0.8; Figure 3.4). This decrease in catch rates was accompanied by an increase in PSD values, likely indicating relatively limited recruitment of smaller size classes during 2013.

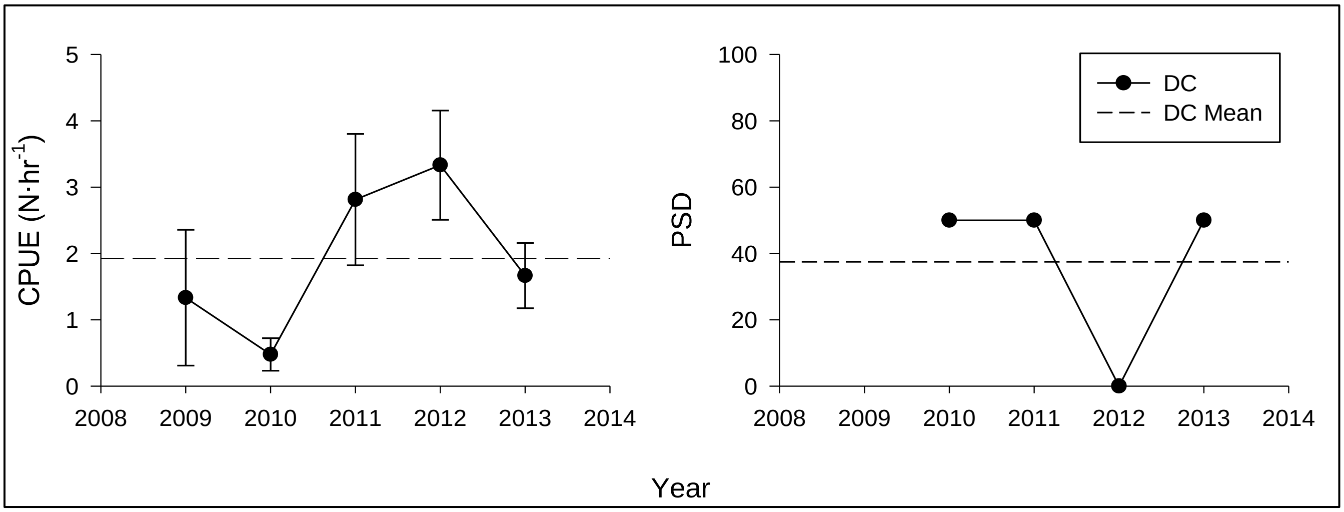


Figure 3.4. Catch per unit effort and proportional size distribution of Smallmouth Bass collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*White Bass*

Catch rates of White Bass in the Upper Mississippi River Sampling Area during 2013 (2.81 fish/h ± 0.91) were very similar to those observed during 2012 (2.96 fish/h ± 0.91; Figure 3.5). The observed increase in PSD values from 2012 to 2013 suggests that a greater proportion of larger, more mature individuals were encountered in our survey during 2013. However, the relatively low PSD value recorded during 2013 (31) indicates that White Bass populations in the Upper Mississippi River sampling area are still dominated by small size classes.

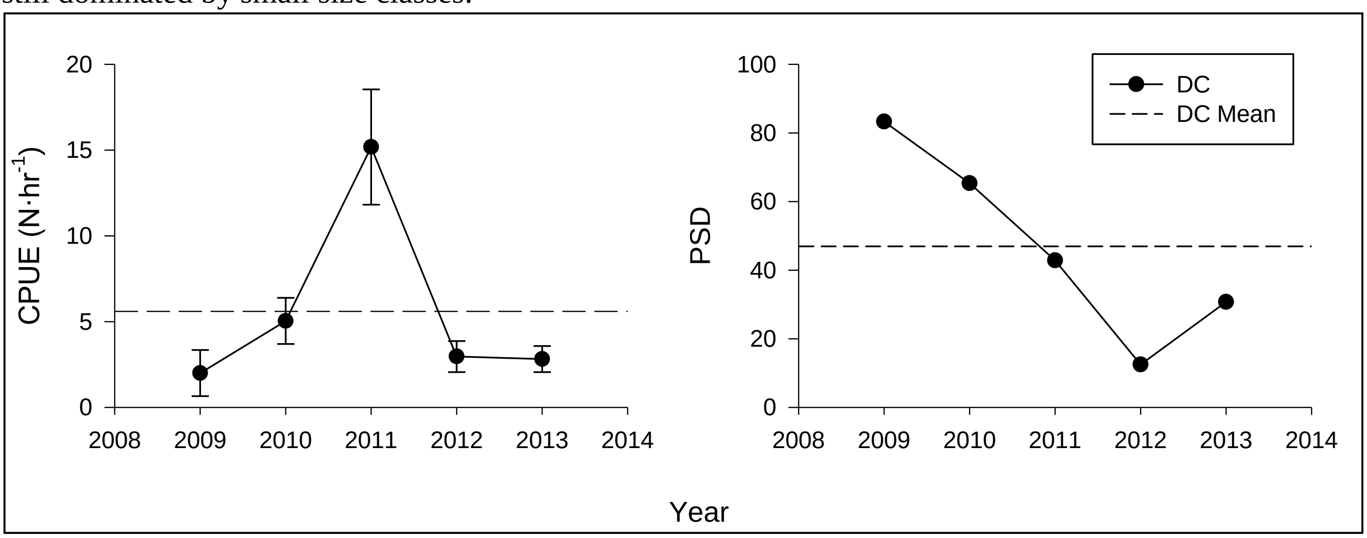


Figure 3.5. Catch per unit effort and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

**Section 3.3 - 2012 Lower Mississippi River Sampling Area Pulsed-DC Electrofishing Catch Statistics**

We collected 3,553 fish representing 47 species and 2 hybrids from 16 families during 17.25 hours of pulsed-DC electrofishing at 69 sites in the Lower Mississippi River Sampling Area. Gizzard Shad was the most abundant species in our catch (930 fish; 26.2% of total catch) followed by Emerald Shiner (863; 24.3%), Common Carp (266; 7.5%), Goldeye (219; 6.2%), and Freshwater Drum (192; 5.4%). Common Carp represented the largest proportion of the total collected biomass (1,225.9 lb; 556.1 kg; 41.3% of total collected biomass) followed by Silver Carp (333.5 lb; 151.3 kg; 11.2%), Smallmouth Buffalo (196.8 lb; 89.3 kg; 6.6%), Channel Catfish (146.4 lb; 66.2 kg; 4.9%), and Gizzard Shad (130.5 lb; 59.2 kg; 4.4%). Comprehensive records of collections and biomass within each pool or reach and within each sampling period using pulsed-DC electrofishing gear are included in Appendices VII and VIII.

*Threatened and Endangered Species*

One Crystal Darter (Missouri Endangered, considered extirpated in Illinois) was collected in the Kaskaskia Reach of the Lower Mississippi River Sampling Area (Appendix VII).

*Bluegill*

The catch rate of Bluegill in the Lower Mississippi River Sampling Area has increased slightly since 2010 (Figure 3.6). Low PSD values indicate that the sampled population is dominated by small individuals and may suggest that annual production of year classes has been consistent since monitoring began.

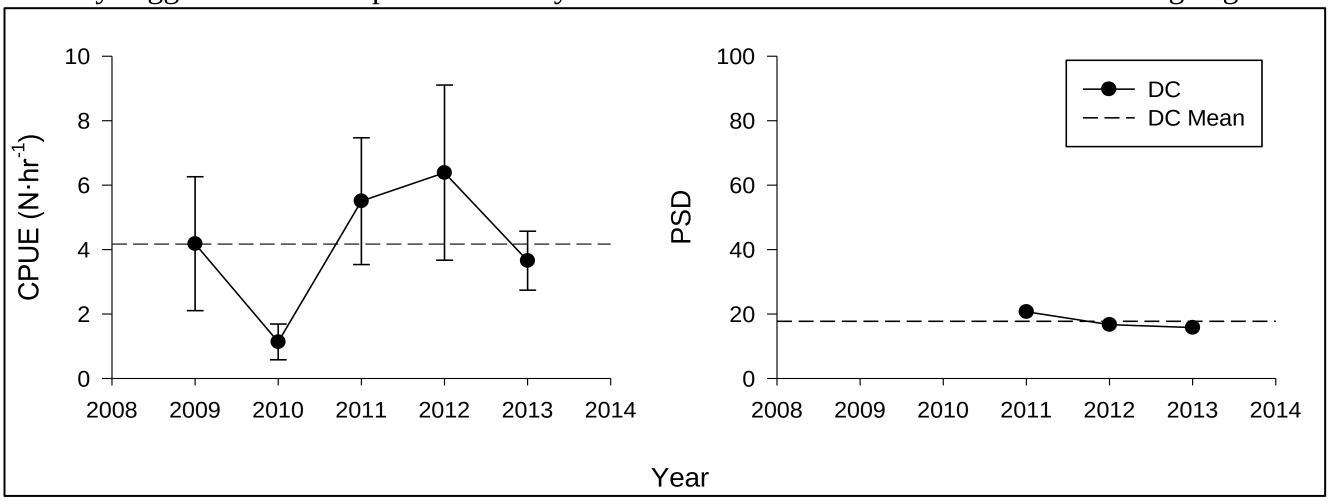



Figure 3.6. Catch per unit effort and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Channel Catfish*

Catch rates of Channel Catfish in the Lower Mississippi River Sampling Area during 2013 (6.2 fish/h ± 1.3) declined slightly from 2012 (8.1 fish/h ± 1.7; Figure 3.7). High and stable PSD values over the past three years indicate that the sampled population is largely composed of larger, mature individuals and that the recent production of smaller size classes of Channel Catfish in this region has been relatively low.

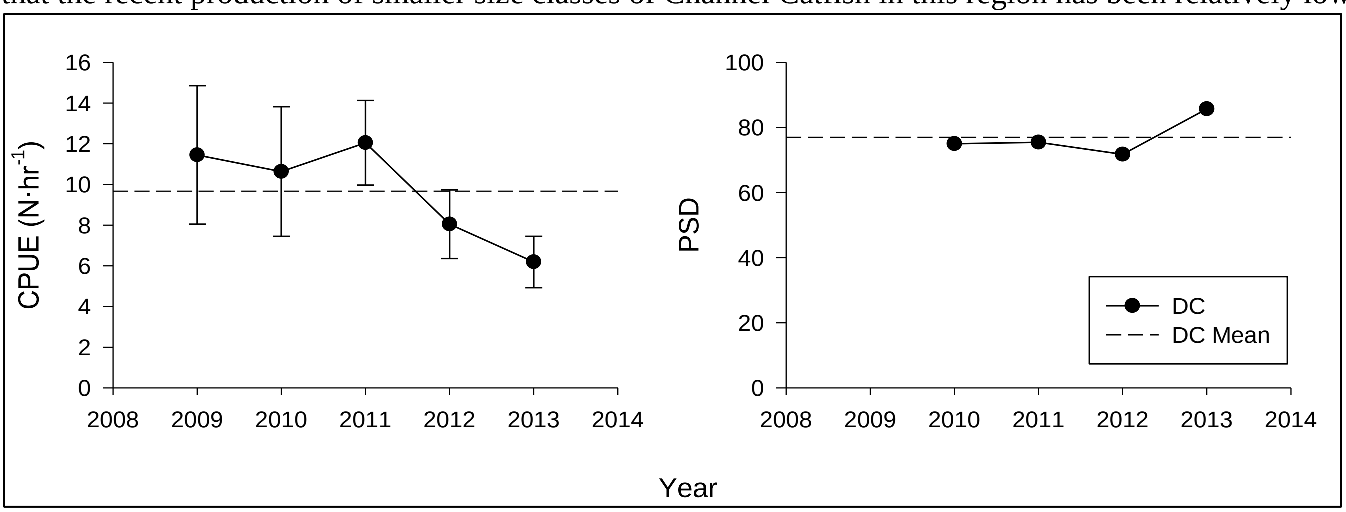



Figure 3.7. Catch per unit effort and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*White Bass*

White Bass CPUE in the Lower Mississippi River Sampling Area has remained stable since 2010 (Figure 3.8). The decline in PSD values observed between 2012 and 2013 sampling suggests that individuals from smaller size classes have begun to occur more frequently in our sampling and that White Bass in the Lower Mississippi River Sampling Area may have experienced some limited reproductive success during early 2013.

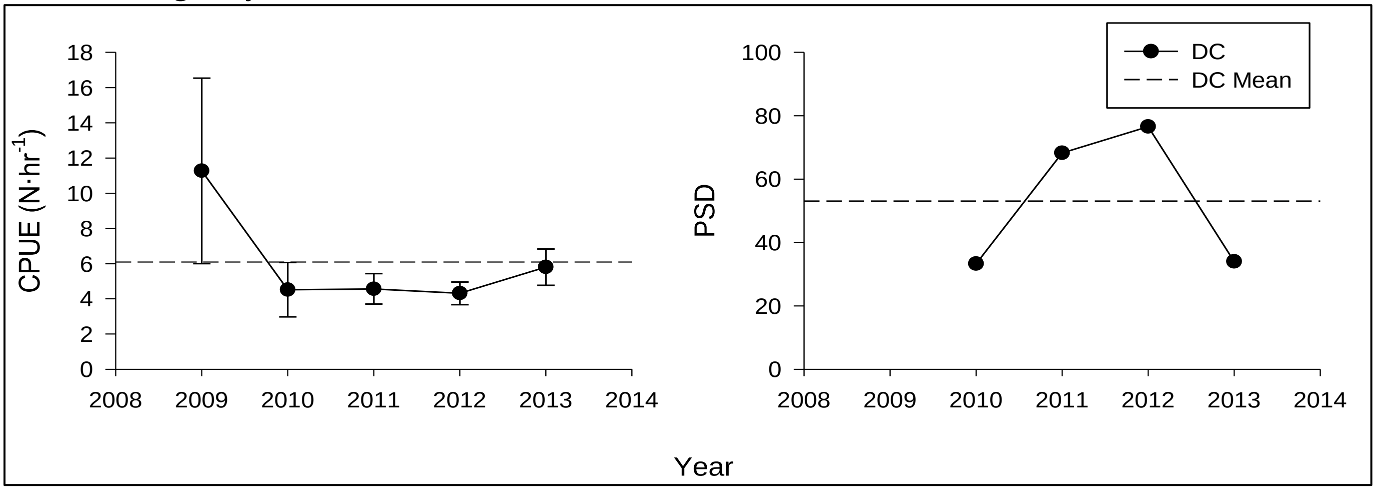



Figure 3.8. Catch per unit effort and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Reaches. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Silver Carp*

Catch rates of Silver Carp in the Lower Mississippi River Sampling Area during 2013 (1.2 fish/h ± 0.3) were slightly less than those observed during 2012 (5.35 fish/h ± 1.30), and substantially less than those recorded in 2010 (18.4 fish/h ± 9.0; Figure 3.9). During this same period, the body condition of Silver Carp has gradually increased. These results likely indicate that the recruitment of smaller juvenile and young-of-year individuals to the sampled population has been limited in recent years following their initial invasion into these habitats.

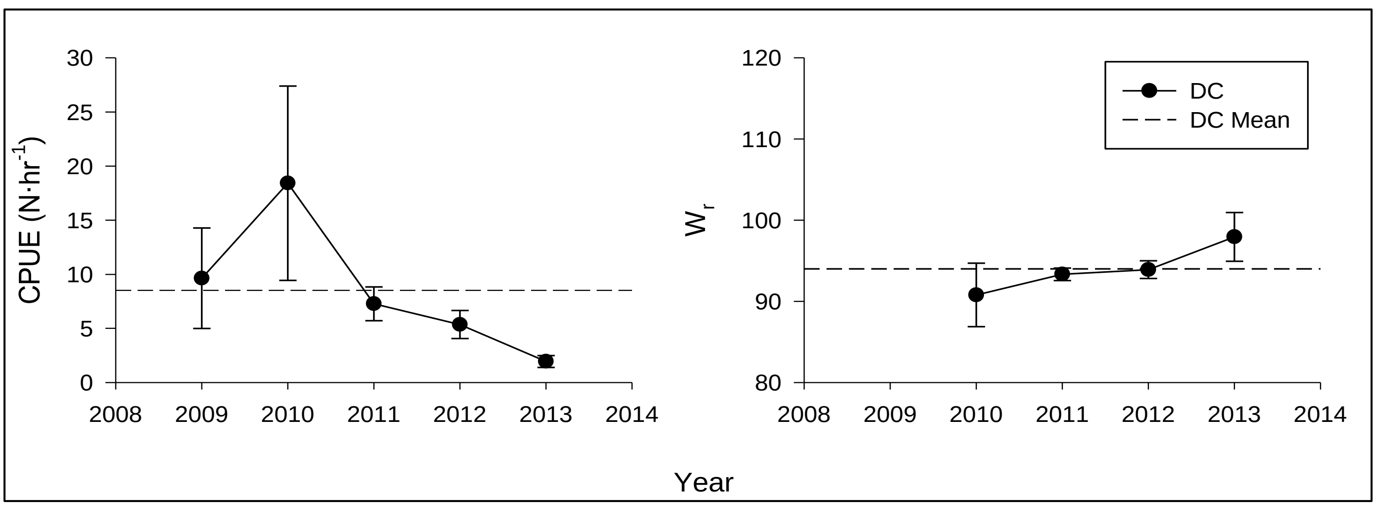



Figure 3.9. Catch per unit effort and condition (relative weight-$W_r$) of Silver Carp collected by pulsed-DC electrofishing survey in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 2009.

## Section 3.4 – 2013 Ancient Sportfish Assessment

Ancient sport fishes were sampled with gill nets in the Chain of Rocks Reach and the Kaskaskia Reach of the Mississippi River (Figure 1.1). Sites were randomly selected using GIS layers of wing dam habitats in both reaches. Gill nets were fished in over-night sets (approximately 24-h soak time) when the surface water temperature was at or below 54.86° F as stated in the Pallid Sturgeon collection requirements

(U.S. Fish and Wildlife Service 2005). Three different mesh sizes of gill nets were used. Two- and three-inch square-mesh gill nets were 150 ft long, 10 ft deep, and were made of #10 monofilament. Five-inch square-mesh gill nets were 300 ft long, 24 ft deep, and were made of #8 monofilament. The three different mesh size nets were fished at randomly selected wing dams, with one net per wing dam. The number of sampling locations in each study reach was based on similar sampling location allocation for the pulsed-DC electrofishing collections. Ancillary habitat and water quality measurements (e.g. dissolved oxygen, current velocity, conductivity, etc.) were taken at each site (Table 3.2). A section of the right pectoral fin ray was removed from a subset of Shovelnose Sturgeon that will be used for age and growth analysis to be completed at a later date.

Table 3.2. Ancillary habitat and water quality measurements measured during gill net collections on the Chain of Rocks and Kaskaskia reaches of the Mississippi River.

| Navigational Reaches | Total Effort (net-night) | Depth (ft) | Secchi Depth (in) | Water Temp. (°F) | DO (ppm) | Conductivity (µS) | Stage Height (ft) |
|---|---|---|---|---|---|---|---|
| Chain of Rocks | 21.0 | 27.5 ± 1.8 | 43.0 ± 3.5 | 5.2 ± 0.4 | 13.4±0.4 | 552.1 ± 17.3 | 5.2 ± 1.1 |
| Kaskaskia | 27.0 | 28.4 ± 1.6 | 22.3 ± 2.6 | 4.6 ± 0.9 | 12.4±0.4 | 531.0 ± 11.9 | 7.8 ± 1.2 |

*Ancient sport fish catch statistics*

We collected 348 fish representing 23 species and 1 hybrid from 12 families during 48 net-days of gill net effort during the winter sampling season of 2013 and 2014 (Table 3.3). Aging structures were collected from 106 shovelnose sturgeon for use in an age and growth analysis to be completed at a later date. Catch rates and species composition varied with reach and mesh size (Table 3.3, Figure 3.10), but variation in our data is substantial and likely merits increasing our sample size next year.

*Chain of Rocks Reach*

Sixty-five fish were collected with 2-in mesh gill nets sampling random wing dam structures during 7 net-days of gill net effort. The most abundantly collected species was Shovelnose Sturgeon (24 fish, 36.9% of total catch), followed by Gizzard Shad (15 fish; 23.1%), and then Longnose Gar (6 fish; 9.2%). Shovelnose Sturgeon represented the largest proportion of the total collected biomass (56.1 lb; 25.4 kg; 38.3% of total collected biomass) followed by Longnose Gar (22.2 lb; 10.1 kg; 15.1%), and Blue Catfish (20.7 lb; 9.4 kg; 14.1%).

Twenty-six fish were collected with 3-in mesh gill nets sampling random wing dam structures during 7 net-days of gill net effort. The most abundantly collected species was Shovelnose Sturgeon (5 fish, 19.2% of the total catch), followed by River Carpsucker (4 fish, 15.4%), and Grass Carp and Freshwater Drum, both (3 fish, 11.5%). Paddlefish represented the largest proportion of the total collected biomass (34.5 lb, 15.6 kg, 22.6% of total collected biomass) followed by Grass Carp (32.0 lb; 14.5 kg; 21.0%), and Shovelnose Sturgeon (14.6 lb; 6.6 kg; 9.6%).

Thirty-seven fish were collected with 5-in mesh gill nets sampling random wing dam structures during 7 net-days of gill net effort. The most abundantly collected species was Blue Catfish (16 fish, 43.2% of the total catch), followed by Shovelnose Sturgeon (9 fish, 24.3%), and Paddlefish (5 fish, 13.5%). Blue Catfish represented the largest proportion of the total collected biomass (269.0 lb, 122.0 kg, 61.2% of total collected biomass) followed by Paddlefish (54.8 lb; 24.9 kg; 12.5%), and Bighead Carp (34.1 lb; 15.5 kg; 7.8%).

*Kaskaskia Reach*

Seventy-one fish were collected with 2-in mesh gill nets sampling random wing dam structures during 9 net-days of gill net effort in the Kaskaskia Reach. The most abundantly collected species was Shovelnose Sturgeon (50 fish, 70.4% of total catch), followed by Longnose Gar (6 fish, 8.5%), and Blue Catfish (3 fish, 4.2%). Shovelnose Sturgeon represented the largest proportion of the total collected biomass (93.4 lb, 42.4 kg, 54.8% of total collected biomass), followed by Longnose Gar (37.2 lb; 16.9 kg; 21.8%) and Blue Catfish (16.2 lb; 7.3 kg; 9.5%).

One hundred four fish were collected with 3-in mesh gill nets sampling random wing dam structures during 9 net-days of gill net effort. The most abundantly collected species was Silver Carp (47 fish, 45.2% of total catch), followed by Blue Catfish (19 fish, 18.3%) and Shovelnose Sturgeon (10 fish, 9.6%). Silver Carp represented the largest proportion of the total collected biomass (206.3 lb, 93.6 kg, 37.2% of total collected biomass), followed by Blue Catfish (120.9 lb; 54.8 kg; 21.8%), and Grass Carp (47.9 lb; 21.7 kg; 8.6%).

Forty-five fish were collected with 5-in mesh gill nets sampling random wing dam structures during 9 net-days of gill net effort. The most abundantly collected species was Paddlefish (15 fish, 33.3% of total catch), followed by Blue Catfish (11 fish, 24.4%), and Shovelnose Sturgeon (8 fish, 17.7%). Blue catfish represented the largest proportion of the total collected biomass (322.4 lb, 146.2 kg, 46.5% of total collected biomass), followed by Paddlefish (211.6 lb; 96. 0 kg; 30.5%), and Silver Carp (46.1 lb; 20.9 kg; 6.6%).

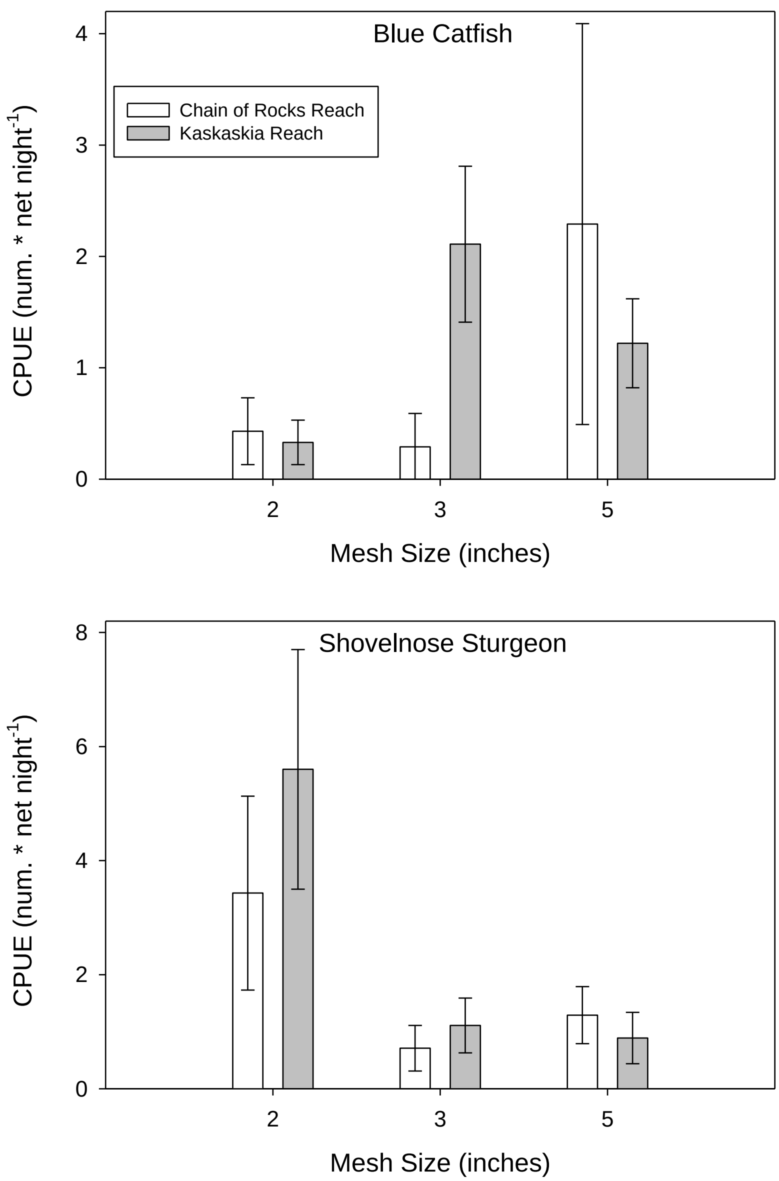



Figure 3.10. Catch-per-Unit-Effort of Blue Catfish and Shovelnose Sturgeon collected with 2-inch, 3-inch, and 5-inch mesh gill nets in the Chain of Rocks and Kaskaskia reaches of the Mississippi River in 2013.

*Ancient Sport Fish Conclusions*

The addition of the 5-inch mesh gill nets led to increased catch rates for Paddlefish and larger size classes of Blue Catfish. The variability in CPUE for these data suggests that we will need to increase sample size if we are to develop a monitoring program capable of tracking variation through time. We likely will explore the possibility of dropping the use of 3-inch mesh gill nets in favor of doubling our effort with 2-inch and 5-inch mesh gill nets.

**Section 3.5 - Assessment of Sportfish Harvest by Commercial Fishers in the Mississippi River**

We compiled commercial harvest data for the Illinois, Mississippi, and Wabash rivers from 1950 – 2012 from the annual IDNR commercial harvest reports. These data include information from both flesh and roe fisheries. Commercial harvest from the Ohio River has only been tracked since 2004 because Illinois did not have legal jurisdiction to regulate commercial harvest from the Ohio River until the end of the 20$^{th}$ century. Because of the small amount of data available, we will not present information on commercial harvest of sport fishes from the Ohio River in this report.

Commercial fishers were not required to report the harvest of catfish by species until 1986. Therefore, to assess the mean relative harvest of sport fishes by species for the Illinois, Mississippi, and Wabash rivers, we restricted analyses to harvest records from 1986 – 2012. The Illinois Department of Natural Resources tracks the commercial fishing licenses sold to fishers who harvested at least 1000 lbs of fish within a year and/or sold all or part of their catch. Commercial fishers who generate all of their income from fishing are designated as full time, and all others are designated as part time.

Beginning in 2007, the Illinois Department of Natural Resources began restricting roe harvest of fishes to a specific season (October 1 – May 31). Data for 2007 include harvest data for shovelnose sturgeon and paddlefish, harvested from January 1, 2007, through May 31, 2008. From 2008 on, harvest figures for shovelnose sturgeon and paddlefish include only the total fish mass harvested during the October 1 – May 31 roe harvest season.

For this report, we are designating the following species as sport fishes: Blue Catfish, Bowfin, Channel Catfish, Flathead Catfish, and Freshwater Drum; Paddlefish and Shovelnose Sturgeon are designated as ancient sport fishes. The Illinois Department of Natural Resources considers all of these species as “major Illinois sport fish” and keeps records of the largest individuals caught by recreational anglers (2013-2015 Illinois Fishing Information, IDNR).

*Results and Conclusions*

The number of commercial fishers in the Illinois and Mississippi rivers has generally declined since 1980, and has held relatively steady in the Wabash River (Figure 3.12). The percentage of commercial harvest comprised of sport fishes was lowest in the Illinois River (14.6 % ± 0.9; mean ± SE), greatest in the Wabash River (70.7% ± 5.1), and intermediate in the Mississippi River (32.0% ± 0.8). Although overall commercial harvest has increased in both the Illinois and Mississippi river since 1980, harvest of sport fishes in these rivers has remained relatively constant (Figure 3.13a, 3.13b). In contrast, overall commercial harvest has remained relatively constant in the Wabash River, but harvest of sport fishes has increased steadily since 1980 (Figure 3.13c). Over the last decade, sport fishes have comprised the majority of fishes harvested commercially in the Wabash River. The substantial increase in total commercial harvest in the Illinois River after 2000 (Figure 3.13a) is a result of increased harvest of Asian carp.

Channel Catfish, Blue Catfish, and Flathead Catfish comprise the majority of sport fishes harvested by commercial fishers (Figure 3.14), followed by Freshwater Drum in the Illinois and Mississippi rivers, and Shovelnose Sturgeon in the Wabash River. Of the two ancient sport fishes harvested commercially, harvest of Shovelnose Sturgeon has increased substantially over the last two decades in the Mississippi and Wabash rivers, whereas harvest of Paddlefish has declined in recent years in the Mississippi River (Figure 3.15). Harvest of Paddlefish in the Illinois and Wabash rivers was generally very low in the Illinois and Wabash rivers from 1950 to 2012, and no Paddlefish were harvested from either river after 2008. The increased harvest of shovelnose sturgeon in the Mississippi and Wabash rivers after 1990 may merit consideration of the implementation of standardized monitoring of ancient sport fishes in additional locations in the Mississippi and Wabash rivers when methodology is finalized (see section 3.3).

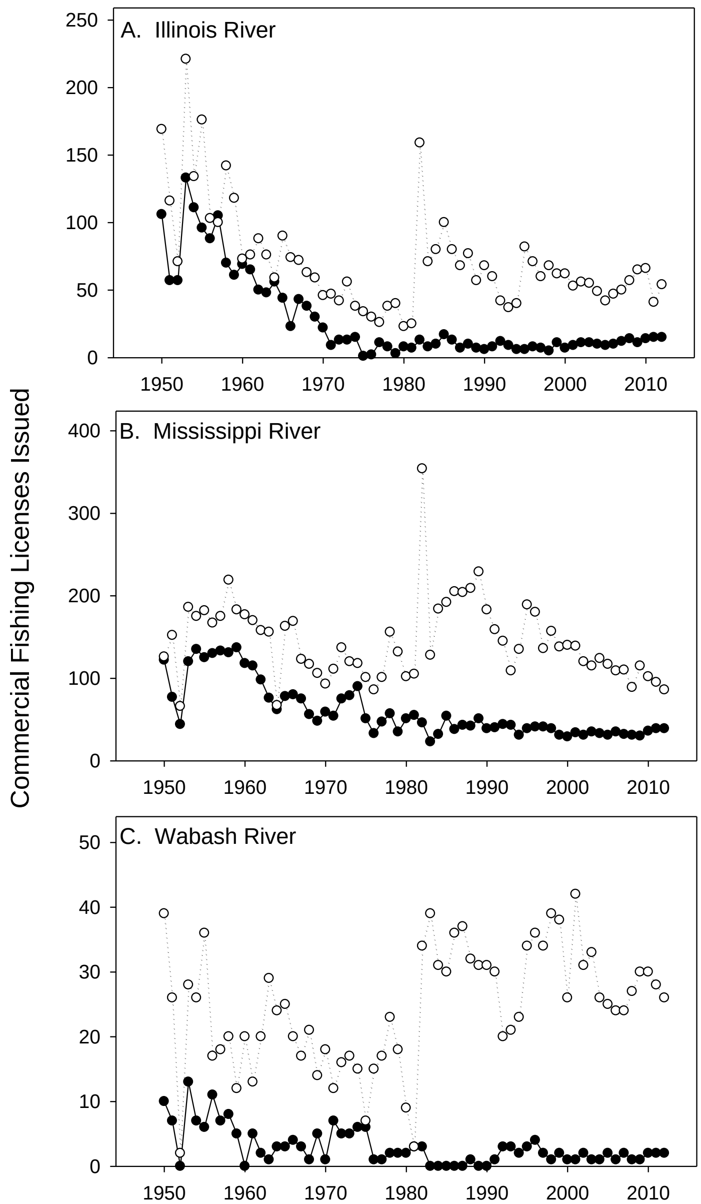



Figure 3.11. The number of commercial fishing licenses issued by the Illinois Department of Natural Resources to full- (black circles) and part-time (white circles) fishers from 1950 to 2012.

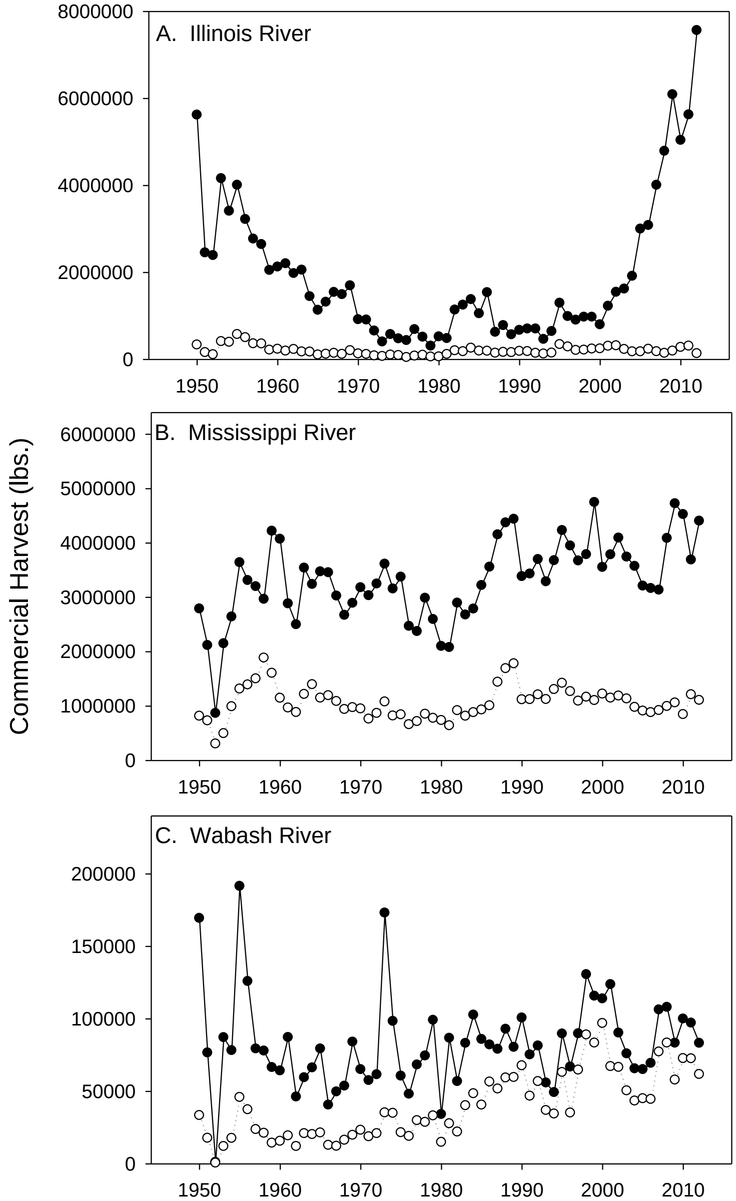



Figure 3.12. Annual harvest totals by Illinois licensed commercial fishers of all fishes (black circles) and sport fishes (white circles) from 1950 – 2012 in the (A) Illinois River, (B) Mississippi River, and (C) Wabash River.

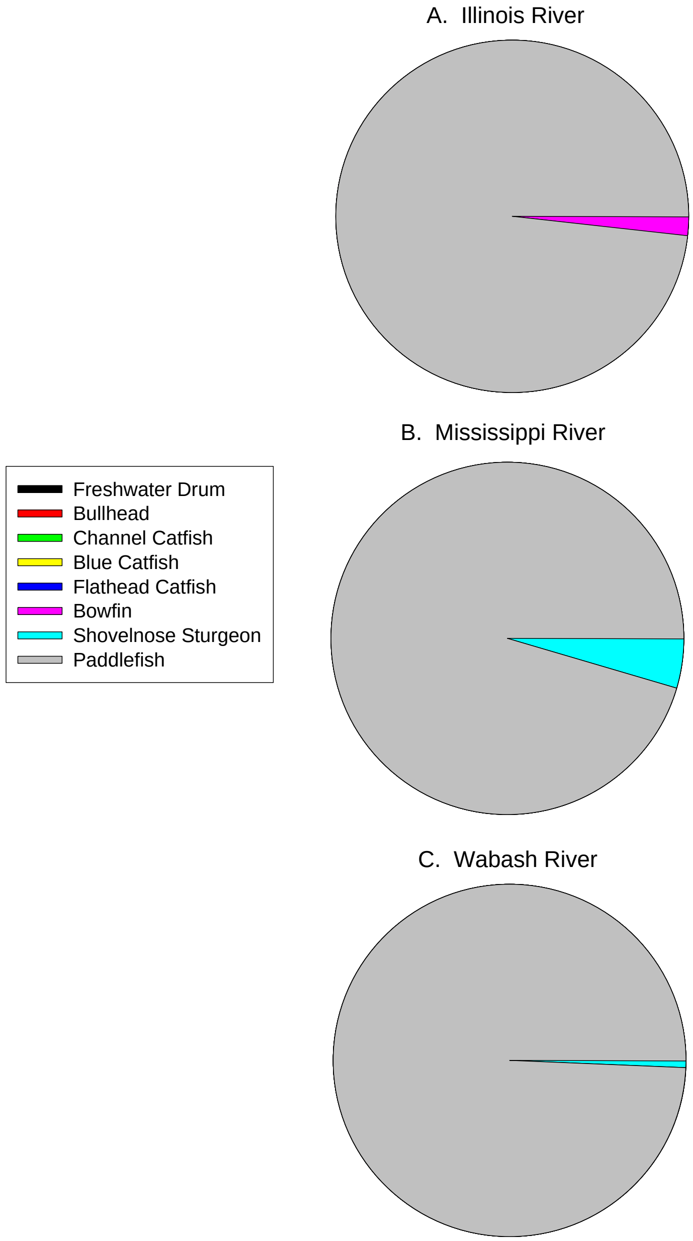



Figure 3.13. The relative abundance (%) of sport fishes harvested by Illinois licensed commercial fishers from 1986 – 2012 in the Illinois, Mississippi, and Wabash rivers.

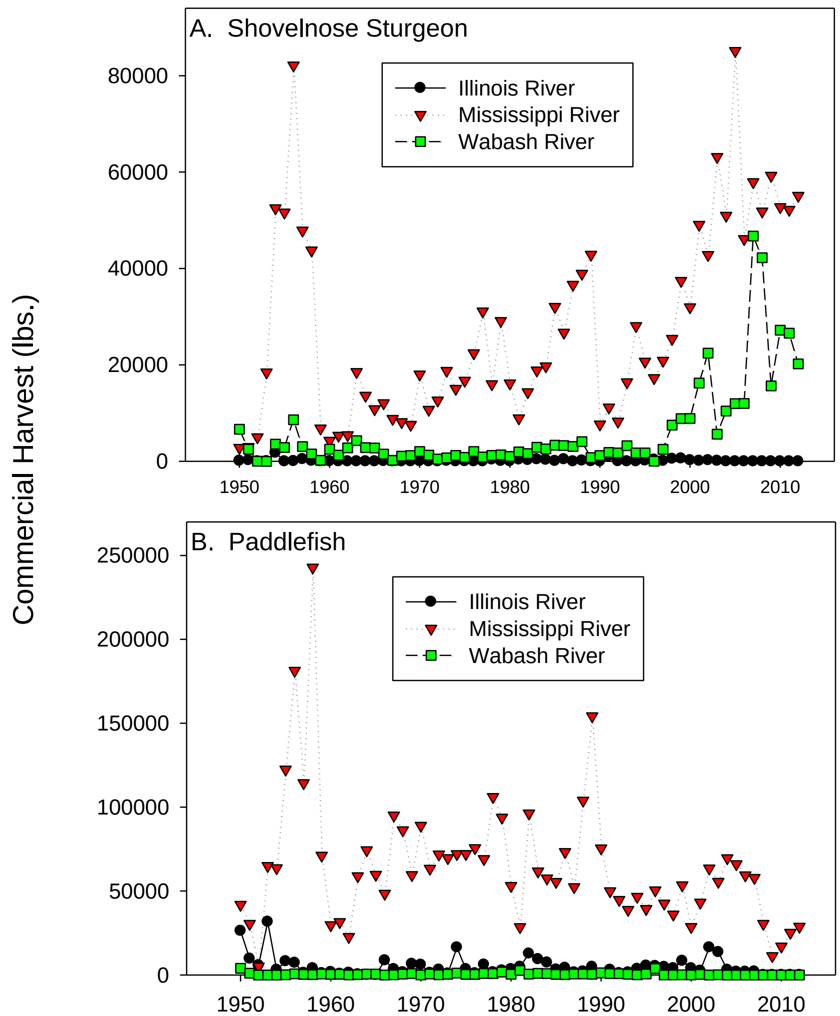



Figure 3.14. Annual harvest by Illinois licensed commercial fishers of (A) Shovelnose Sturgeon and (B) Paddlefish from 1950 to 2012.

**Section 3.6 - Assessment of Injury Rate to Sportfishes from Pulsed-DC Boat Electrofishing; Graduate Research Completed by UIUC MS Student Edward Culver (advised by PI John Chick)**

Electrofishing is one of the most widely used methods to sample fishes in freshwater ecosystems (Reynolds 1996). Early electrofishing equipment used alternating current (AC), but direct current (DC) electrofishing was subsequently developed in part due to concerns that AC electrofishing was injuring fishes. Studies indicated that DC electrofishing resulted in fewer injuries to fishes relative to AC electrofishing, but these studies primarily focused on salmonids (Snyder 2003). More recent studies have shown that injury rate to warmwater fishes using DC electrofishing can be significant, demonstrating a need for further investigation on injury rates to fishes from DC electrofishing (Dolan and Miranda 2004). Additional studies have documented that fish injuries are higher in frequencies of more than 60 Hz, and suggest they be reduced to below 30 Hz to reduce injury (Reynolds and Holliman 2000). The objective of our study was to assess injury rates to multiple species of fish from boat pulsed-DC (PDC) electrofishing. To accomplish this, we sampled fishes from the Mississippi and Illinois rivers for two long-term monitoring programs: The Long Term Resource Monitoring Program (LTRMP, a component of the USACE Upper Mississippi River Restoration Program) and the Long-term Illinois, Mississippi, Wabash, and Ohio Fish Monitoring Program (LTEF, USFWS Sport Fish Restoration Program). Additionally, we conducted sampling to test whether injury rate varied with pulse frequency.

*Methods*

We examined injuries for individuals from seven species of fish: Bluegill, Channel Catfish, Freshwater Drum, and Largemouth Bass were selected because they are popular sport fishes, Gizzard Shad because they are the main forage species for piscivores, and invasive Common Carp and Silver Carp because they are likely negatively impacting habitat and native fishes. Fish were collected from reaches of the Mississippi River near Clarksville, Missouri to its confluence with the Kaskaskia River in Illinois, and reaches of the Illinois River from near Peoria, Illinois to its confluence with the Mississippi River near Grafton, Illinois. We recorded water quality data, electrofishing settings, and the length and weight of fishes for each electrofishing run.

There were major differences in physical and chemical factors between the Mississippi and Illinois rivers during our study, but the length and condition factor for Channel Catfish and Silver Carp were similar in both rivers. While several of the physical and chemical characteristics were highly correlated with one another, differences in conductivity between the two rivers were especially pronounced. Because electrofishing settings are adjusted for water temperature and conductivity to standardize power transfer to fishes (Burkhardt and Gutreuter 1995), differences in conductivity and temperature between the two rivers also lead to differences in the Power (watts), Voltage, and Amperage used during sampling.

To examine the effect of pulse frequency on Silver Carp injury rate, we collected Silver Carp using two pulse frequency settings: 30 Hz (half the pulse frequency used in LTRMP and LTEF) and 120 Hz (twice the pulse frequency using in LTRMP and LTEF) in a side channel of the Illinois River in the LaGrange Reach near Bath, Illinois on September 23, 2013. Fish were euthanized and held on ice for 24 hours before they were necropsied in lab to determine spinal injuries and hemorrhaging.

*Results*

Of the seven species examined, only Silver Carp and Channel Catfish exhibited injuries. Nearly 27% of Channel Catfish collected were injured, and over 62% of Silver Carp were injured (Table 3.3). Silver Carp injury rate differed between the Mississippi and Illinois rivers, but Channel Catfish injury rate did not ($\chi_1^2$=0.102; p=0.749). Silver Carp injury rate differed significantly ($\chi_1^2$=11.192; p<0.001) between the Mississippi and Illinois rivers, with injury rate for the Illinois River more than double that in the Mississippi River (Figure 3.11).

Silver Carp injury rate increased significantly with conductivity ($\chi_1^2$=5.110; p=0.024) and power output ($\chi_1^2$=7.876; p=0.005), but did not vary significantly with voltage ($\chi_1^2$=1.736; p=0.188). Channel Catfish injury rates did not vary significantly with any of these parameters ($\chi_1^2 \leq 2.453$; $p \geq 0.117$). The distribution of Silver Carp among length groups varied significantly ($\chi_2^2$=11.607; p=0.009) between injured and uninjured fish. Silver Carp without injuries were equally distributed amongst length groups, whereas injury rates were greatest in the 500-549mm length group and lowest in the >600mm length group. In contrast, the distribution of silver carp among K groups did not vary for injured and uninjured fish. We found no significant difference in the distribution of Channel Catfish among either length ($\chi_2^2$=2.139; p=0.710) or K groups ($\chi_2^2$=2.149; p=0.341) between injured and uninjured fish.

Injury rate for the two pulse frequencies were significantly different ($\chi_1^2$=8.076; p=0.005), with injury rate greatest (70%) at a pulse rate of 120 Hz, and lowest (33.3%) at a pulse rate of 30 Hz (Table 3.4). For comparison, the mean injury rate for Silver Carp collected with a pulse rate of 60 Hz (standard setting for LTRMP and LTEF sampling) across both the Mississippi and Illinois rivers was 62.4%.

*Conclusions*

This study shows that Channel Catfish and Silver Carp in the Upper Mississippi River Basin are being injured from PDC boat electrofishing as conducted by the LTRMP and LTEF monitoring programs. We are unaware of any peer-reviewed published study documenting injury to Silver Carp from PDC boat electrofishing. In laboratory studies, simulated PDC electrofishing injured Channel Catfish, but to our knowledge this is the first study to look at Channel Catfish injury rates from PDC boat electrofishing *in situ*. We only investigated seven of the 67 species of fish commonly sampled by LTRMP and LTEF, so further investigation of injury to fishes by PDC boat electrofishing is needed. Our study also found that injury rate for Silver Carp was significantly affected by pulse frequency. Given that electric currents are being used as barriers to the movement of invasive Asian carp in the Upper Mississippi River System, our research suggests a high pulse frequency might improve the effectiveness of these barriers.

Table 3.3. The number of injured and uninjured fishes from seven species collected using PDC electrofishing from the Mississippi and Illinois rivers. Data were collected during June 15 – October 31, 2013, by electrofishing crews sampling fishes for the Long Term Resource Monitoring Program and Long-term Illinois, Mississippi, Wabash and Ohio Rivers Fish Monitoring Program.

| Species | Total Caught | Uninjured | Injured | Injury Rate |
|---|---|---|---|---|
| Bluegill | 21 | 21 | 0 | 0.0% |
| Common Carp | 39 | 39 | 0 | 0.0% |
| Channel Catfish | 78 | 57 | 21 | 26.9% |
| Freshwater Drum | 52 | 52 | 0 | 0.0% |
| Gizzard Shad | 51 | 51 | 0 | 0.0% |
| Largemouth Bass | 6 | 6 | 0 | 0.0% |
| Silver Carp | 101 | 38 | 63 | 62.4% |
| **Total** | **348** | **264** | **84** | **24.1%** |

Table 3.4. Total and percentage of injured and uninjured Silver Carp *Hypopthalmichthys molitrix* collected using two different pulse frequencies (30 Hz and 120 Hz) in the LaGrange Reach of the Illinois River. Fish were collected with PDC boat electrofishing in a side channel of the Illinois River. For comparison, the overall injury rate of Silver Carp collected at a pulse frequency of 60 Hz by crews for the Long Term Resource Monitoring Program (LTRMP) and Long-term Illinois, Mississippi, Wabash and Ohio Rivers Fish Monitoring Program (LTEF) is also presented.

| Pulse Frequency | Total | Uninjured | Injured | Injury Rate |
|---|---|---|---|---|
| 30 Hz | 30 | 31 | 9 | 33.3% |
| 120 Hz | 30 | 10 | 20 | 70% |
| From LTRMP and LTEF: | | | | |
| 60 Hz | 38 | 63 | 101 | 62.4% |

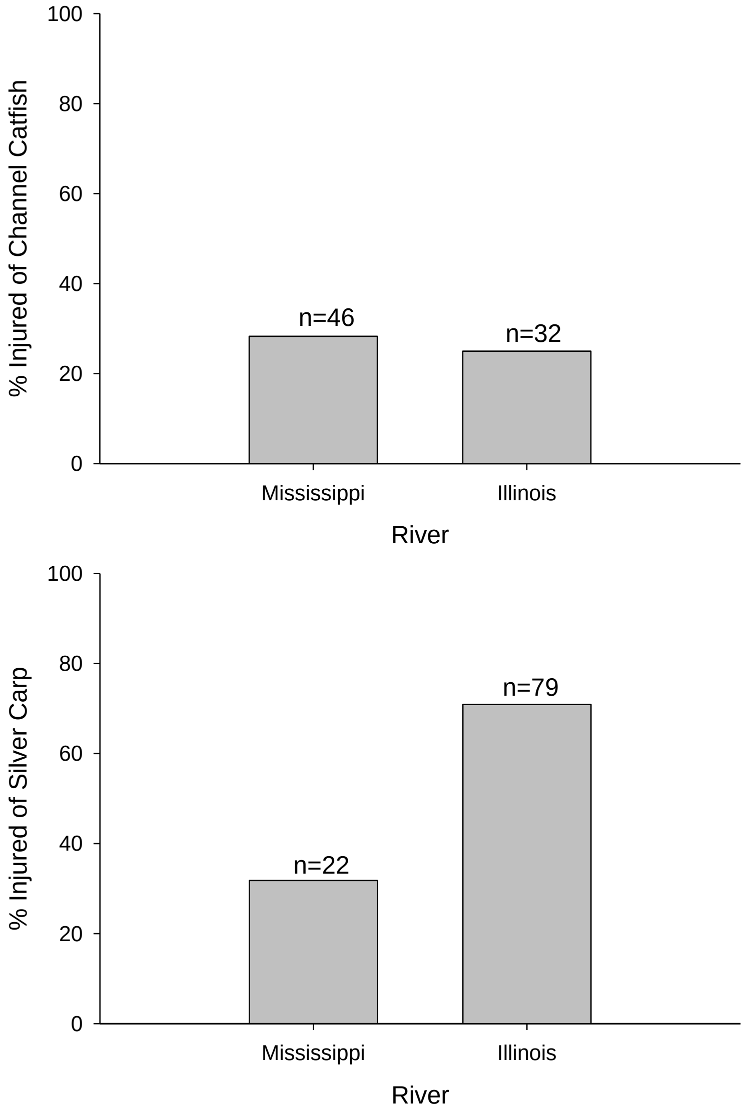



Figure 3.15. Injury rate of Channel Catfish *Ictalurus punctatus* (A) and Silver Carp *Hypopthalmichthys molitrix* (B) in the Mississippi and Illinois rivers collected during June 15 – October 31, 2013, by electrofishing crews sampling fishes for the Long Term Resource Monitoring Program and Long-term Illinois, Mississippi, Wabash and Ohio Rivers Fish Monitoring Program. n = total number caught.

# CHAPTER 4
# SPORTFISH ASSESSMENTS IN THE OHIO RIVER

## Section 4.1 - 2013 Ohio River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted according to the protocols discussed in Section 2.2 between 8:35 a.m. and 4:15 p.m. central standard time during the three sampling periods specified in Section 2.2. Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 4.1.

Table 4.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on four pools of the Ohio River during 2013. Values are expressed as the mean observed parameter value ± standard error.

| Navigational Reaches | Total EF Effort (h) | EF Power Used (Watts) | Depth (ft) | Secchi Depth (in) | Water Temperature (°F) | DO (ppm) | Conductivity (µS) | Stage Height (ft) |
|---|---|---|---|---|---|---|---|---|
| **Smithland (RM 848-918.5)** | **10.50** | **3586.8 ± 33.3** | **7.2 ± 0.5** | **14.4 ± 1.1** | **77.7 ± 0.6** | **6.5 ± 0.1** | **354.6 ± 7.9** | **30.6 ± 0.2** |
| Time Period 1 | 3.50 | 3401.1 ± 13.2 | 8.9 ± 0.8 | 8.6 ± 0.5 | 78.5 ± 0.3 | 6.2 ± 0.1 | 298.4 ± 3.6 | 32.6 ± 0.2 |
| Time Period 2 | 3.50 | 3623.1 ± 29.8 | 6.0 ± 0.5 | 19.1 ± 1.2 | 80.3 ± 0.2 | 7.0 ± 0.1 | 362.2 ± 6.5 | 29.6 ± 0.0 |
| Time Period 3 | 3.50 | 3736.1 ± 70.4 | 6.8 ± 0.8 | 15.4 ± 2.3 | 74.3 ± 1.4 | 6.2 ± 0.2 | 403.1 ± 10.7 | 29.7 ± 0.0 |
| **Pool 52 (RM 918.5-939)** | **3.00** | **3415.0 ± 89.5** | **9.4 ± 1.9** | **18.5 ± 1.4** | **79.4 ± 1.0** | **7.1 ± 0.2** | **294.3 ± 20.2** | **22.5 ± 2.4** |
| Time Period 1 | 1.00 | 3192.5 ± 97.1 | 18.0 ± 0.9 | 15.5 ± 2.5 | 81.0 ± 0.2 | 7.3 ± 0.6 | 250.0 ± 25.9 | 33.9 ± 0.2 |
| Time Period 2 | 1.00 | 3775.0 ± 21.8 | 5.3 ± 0.4 | 17.4 ± 2.4 | 82.3 ± 0.2 | 7.6 ± 0.1 | 367.8 ± 1.8 | 17.5 ± 0.0 |
| Time Period 3 | 1.00 | 3277.5 ± 110.3 | 4.9 ± 0.7 | 22.6 ± 0.9 | 74.8 ± 0.2 | 6.4 ± 0.1 | 265.0 ± 32.7 | 16.1 ± 0.0 |
| **Pool 53 (RM 939-962.5)** | **3.75** | **3439.0 ± 40.2** | **7.0 ± 1.3** | **18.8 ± 1.7** | **79.7 ± 0.6** | **6.9 ± 0.1** | **302.1 ± 10.6** | **26.1 ± 2.9** |
| Time Period 1 | 1.25 | 3304.0 ± 68.7 | 13.1 ± 1.5 | 10.8 ± 0.6 | 80.3 ± 0.7 | 6.5 ± 0.3 | 276.2 ± 15.1 | 41.3 ± 0.6 |
| Time Period 2 | 1.25 | 3500.0 ± 22.1 | 4.3 ± 0.4 | 20.6 ± 0.9 | 81.6 ± 0.7 | 6.9 ± 0.1 | 303.6 ± 5.7 | 20.0 ± 0.0 |
| Time Period 3 | 1.25 | 3513.0 ± 69.8 | 3.5 ± 0.4 | 25.2 ± 0.7 | 77.4 ± 0.4 | 7.3 ± 0.1 | 326.4 ± 24.7 | 16.9 ± 0.0 |
| **OH/MS Confluence (RM 962.5-981)** | **3.00** | **3211.3 ± 29.0** | **9.3 ± 1.7** | **18.9 ± 2.0** | **80.4 ± 0.2** | **6.9 ± 0.2** | **250.8 ± 10.6** | **23.9 ± 3.9** |
| Time Period 1 | 1.00 | 3206.3 ± 55.1 | 16.4 ± 2.3 | 11.8 ± 1.1 | 80.7 ± 0.4 | 7.2 ± 0.4 | 241.5 ± 18.6 | 41.2 ± 0.0 |
| Time Period 2 | 1.00 | 3177.5 ± 73.2 | 6.6 ± 0.0 | 19.1 ± 1.9 | 80.7 ± 0.3 | 6.2 ± 0.1 | 245.5 ± 27.4 | 20.7 ± 0.0 |
| Time Period 3 | 1.00 | 3250.0 ± 0.0 | 4.9 ± 0.7 | 25.8 ± 2.6 | 79.8 ± 0.2 | 7.1 ± 0.2 | 265.3 ± 4.8 | 9.7 ± 0.0 |

## Section 4.2 - 2013 Ohio River Pulsed-DC Electrofishing Catch Statistics

We collected 5,006 fish representing 47 species and 2 hybrids from 13 families during 20.25 h of electrofishing at 81 sites on 4 pools of the Ohio River. Threadfin Shad was the most abundantly collected species (1,424 fish; 28.4% of total catch), followed by Gizzard Shad (1,262 fish; 25.2%), Emerald Shiner (1,062 fish; 21.2%), Mississippi Silvery Minnow (141 fish; 2.8%), and Freshwater Drum (138 fish; 2.8%). Silver Carp contributed the greatest biomass (601.9 lb; 28.7% of total collected biomass) followed by Smallmouth Buffalo (217.3 lb; 10.3%), Freshwater Drum (161.1 lb; 7.7%), Channel Catfish (152.1 kg; 7.2%), and Common Carp (146.6 lb; 7.0%). Comprehensive records of collections and biomass within each pool and sampling period using pulsed-DC electrofishing gear are included in Appendices IX and X.

### *Threatened and Endangered Species*

No fishes included on lists of threatened or endangered species in Illinois or Kentucky were collected in pulsed-DC electrofishing surveys of the Ohio River.

### *Bluegill*

Catch rates of Bluegill in Illinois portions of the Ohio River decreased markedly during 2013 after having increased in the last three years of sampling (Figure 4.1). Low average PSD values indicate that the sampled population is dominated by small individuals. However, the gradual increase in calculated PSD values since 2011 may indicate a shift in the population's size structure as small recruits grow into larger size classes.

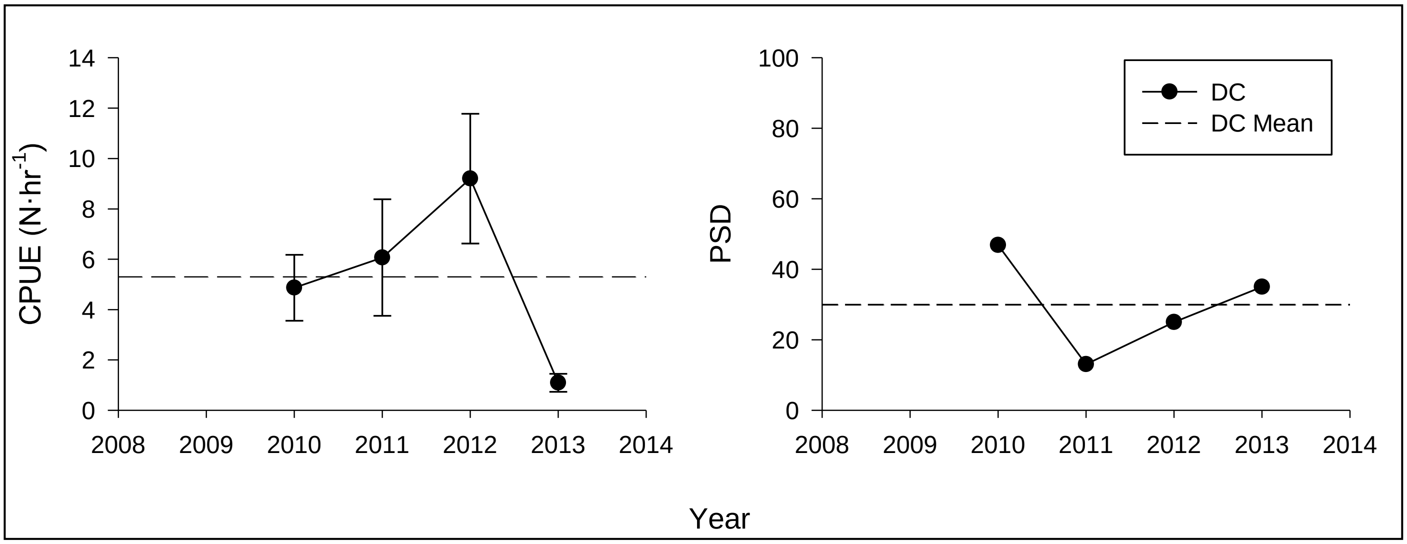



Figure 4.1. Catch per unit effort and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the four pools of the Ohio River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*Channel Catfish*

Channel Catfish catch rates in the Ohio River have decreased since 2011 (Figure 4.2). Average PSD values in all years of sampling indicate that the sampled population maintains a balance of large and small individuals, but that the annual recruitment of smaller, young-of-year individuals to the population may be relatively low.

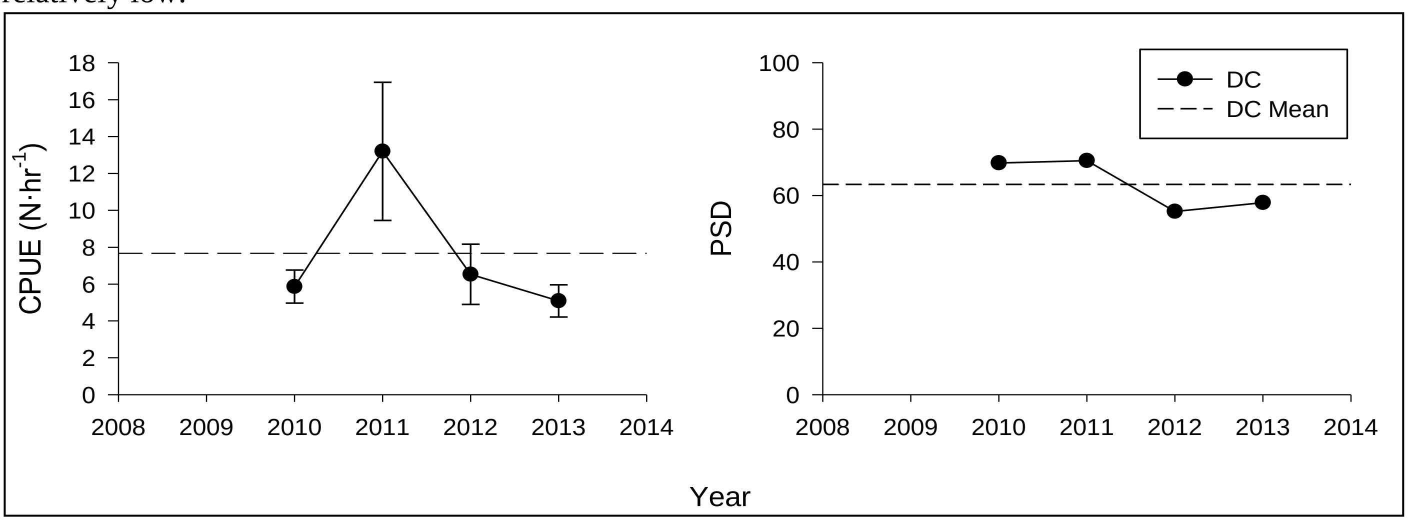



Figure 4.2. Catch per unit effort and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the four pools of the Ohio River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*Largemouth Bass*

Largemouth Bass catch rates in the Ohio River during 2013 (0.5 fish/h ± 0.2) were much lower than those observed in 2012 (3.4 fish/h ± 0.8; Figure 4.3). The PSD value calculated for the 2012 and 2013 catch (56 and 57) was slightly lower than previous years, but still indicated that the sampled population maintains a balance of larger, more mature and smaller, young-of year individuals. Annual production of recruits appears to be relatively low in four years of monitoring.

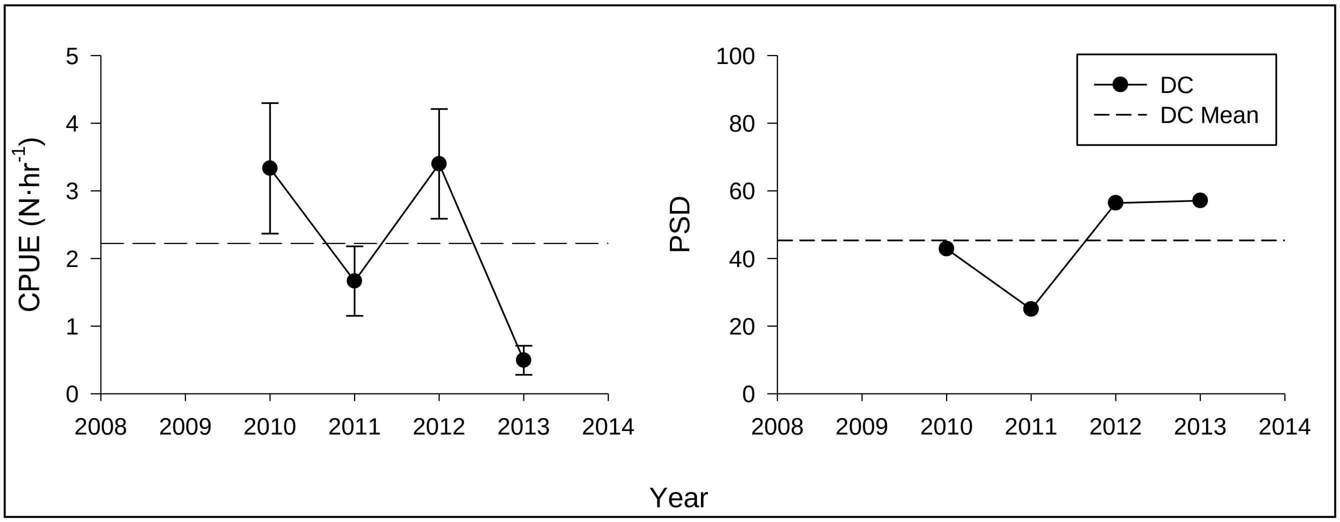



Figure 4.3. Catch per unit effort and proportional size distribution of Largemouth Bass collected by pulsed-DC electrofishing surveys in the four pools of the Ohio River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010

*Spotted Bass*

Catch rates of Spotted Bass in the Ohio River during 2013 (1.8 fish/h ± 0.4) were substantially lower than those recorded in 2012 (10.3 fish/h ± 1.9; Figure 4.4). Although the 2013 PSD value (33) indicates that the sampled population maintains a balance of large and small individuals, the recent decline in PSD value from previous years indicates that relatively few large individuals have been encountered by our surveys since 2011. It is difficult to surmise any trends in annual recruitment through these data, and additional years' data are needed to determine whether this observed trends represent a robust pattern of inter-annual recruitment.

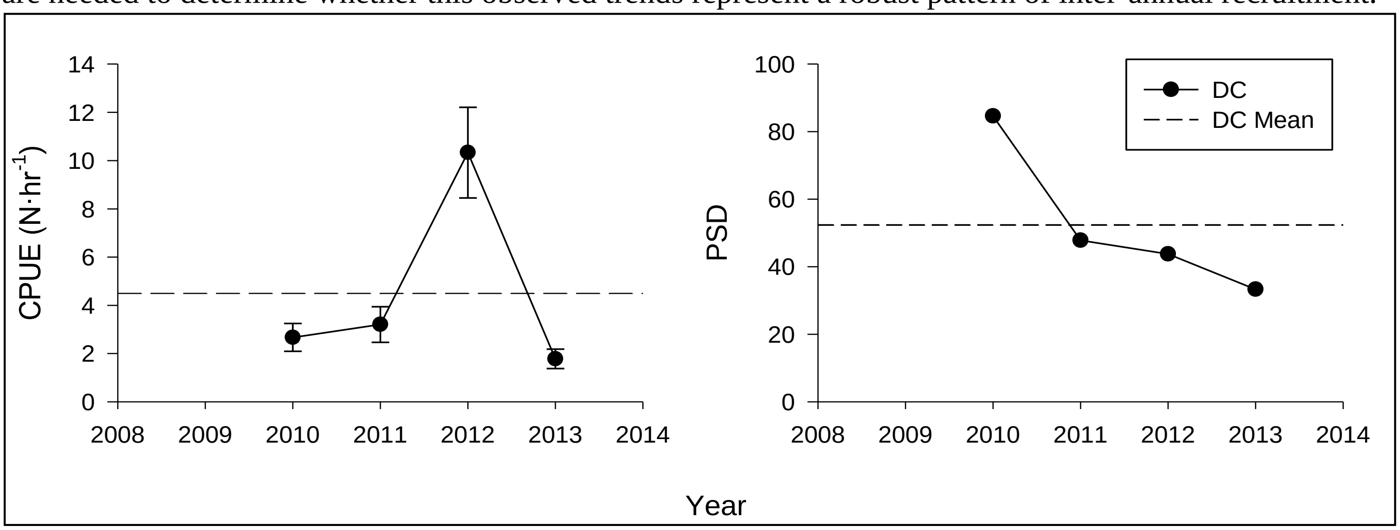



Figure 4.4. Catch per unit effort and proportional size distribution of Spotted Bass collected by pulsed-DC electrofishing surveys in the four pools of the Ohio River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*White Bass*

White Bass catch rates in the Ohio River during 2013 (4.5 fish/h ± 0.6) were more than double than those recorded in 2012 (1.5 fish/h ± 0.4; Figure 4.5), but seem to be in line with our short-term average CPUE. The PSD values calculated for each year of monitoring indicates that the sampled population maintains a balance of large and small individuals. But the gradual increase in PSD value since 2010 could indicate that relatively few recruits have entered the population during 2011 and 2012 and that the population as a whole is aging.

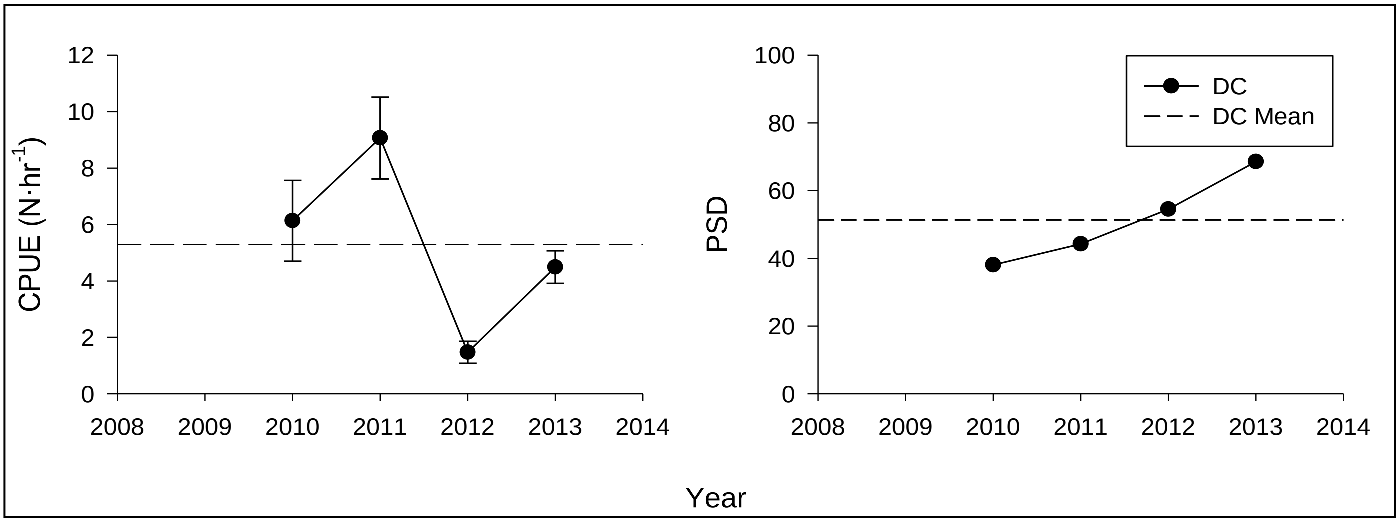



Figure 4.5. Catch per unit effort and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the four pools of the Ohio River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*Silver Carp*

Catch rates of Silver Carp in the Ohio River during 2013 (3.9 fish/h ± 0.6) were very similar to those observed during 2012 (3.5 fish/h ± 1.1) and substantially less than those recorded during 2010 (29.5 fish/h ± 11.2; Figure 4.6). During this same period, the body condition of Silver Carp has remained relatively stable. Similar to the patterns observed in other watersheds monitored by F-101-R sampling, these results likely indicate that growth in the portion of Silver Carp populations encountered in our survey has stabilized.

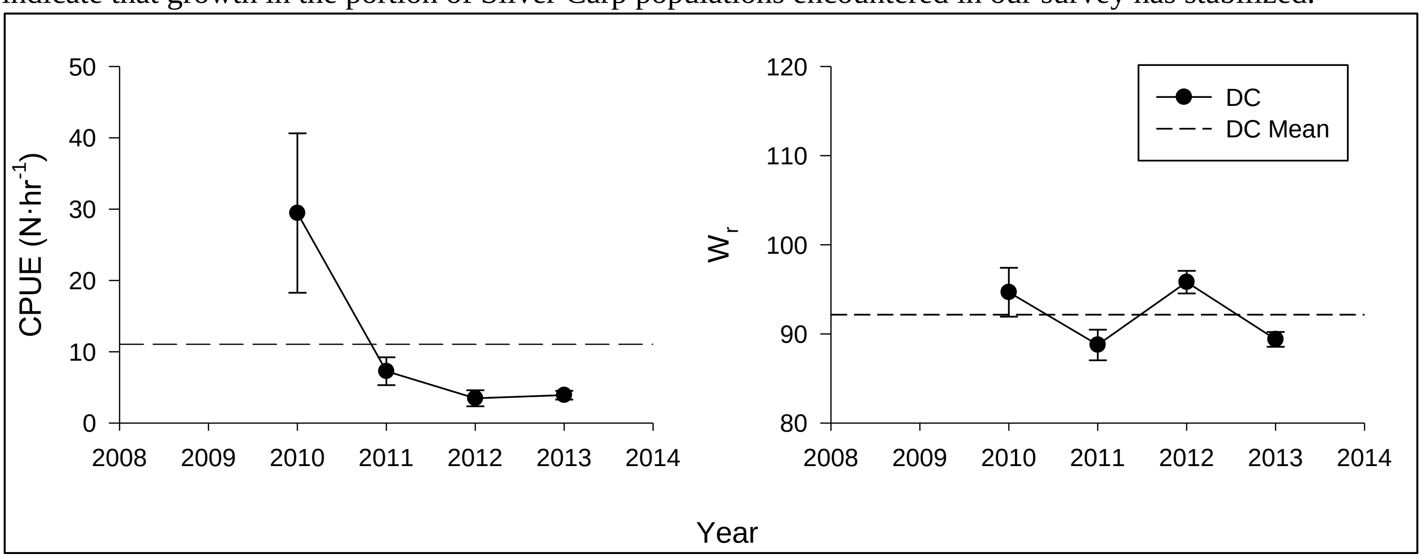



Figure 4.6. Catch per unit effort and condition (relative weight-$W_r$) of Silver Carp collected by pulsed-DC electrofishing survey in the Ohio River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 2010.

# CHAPTER 5
# SPORTFISH ASSESSMENTS IN THE WABASH RIVER

## Section 5.1-2013 Wabash River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted according to the protocols discussed in Section 2.2 between 7:20 a.m. and 6:45 p.m. central standard time during the three sampling periods specified in the Chapter 2. Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 5.1.

Table 5.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on five reaches of the Wabash River during 2013. Values are expressed as the mean observed parameter value ± standard error.

| Navigational Reaches | Total EF Effort (h) | EF Power Used (Watts) | Depth (ft) | Secchi Depth (in) | Water Temperature (°C) | DO (ppm) | Conductivity (µS) | Stage Height (ft) |
|---|---|---|---|---|---|---|---|---|
| **Terra Haute (RM 315.5-351)** | **5.25** | **5485.2 ± 357.5** | **8.4 ± 1.2** | **9.3 ± 0.7** | **75.2 ± 1.4** | **7.2 ± 0.4** | **564.6 ± 13.0** | **5.8 ± 0.8** |
| Time Period 1 | 1.75 | 5843.3 ± 1085.1 | 15.3 ± 0.9 | 5.7 ± 0.9 | 77.5 ± 0.3 | 5.0 ± 0.1 | 494.6 ± 16.8 | 11.0 ± 0.0 |
| Time Period 2 | 1.75 | 5324.3 ± 219.7 | 5.4 ± 1.2 | 10.8 ± 0.5 | 80.9 ± 0.7 | 8.3 ± 0.3 | 619.0 ± 7.6 | 3.4 ± 0.1 |
| Time Period 3 | 1.75 | 5288.0 ± 141.1 | 4.7 ± 0.7 | 11.2 ± 0.4 | 67.2 ± 0.8 | 8.4 ± 0.4 | 580.3 ± 3.2 | 2.9 ± 0.2 |
| **Palestine (RM 351-385.5)** | **4.50** | **6044.4 ± 355.8** | **6.8 ± 0.8** | **10.4 ± 0.5** | **73.9 ± 1.7** | **8.1 ± 0.6** | **550.2 ± 9.0** | **5.3 ± 0.8** |
| Time Period 1 | 1.50 | 7790.0 ± 465.4 | 8.2 ± 2.0 | 9.2 ± 0.6 | 77.2 ± 0.3 | 5.9 ± 0.1 | 520.3 ± 6.5 | 9.0 ± 1.3 |
| Time Period 2 | 1.50 | 5604.5 ± 153.8 | 8.0 ± 0.6 | 11.1 ± 0.9 | 79.3 ± 1.6 | 9.9 ± 0.9 | 581.7 ± 16.3 | 3.9 ± 0.2 |
| Time Period 3 | 1.50 | 4738.8 ± 248.3 | 4.3 ± 0.9 | 10.9 ± 0.8 | 65.2 ± 1.5 | 8.4 ± 0.9 | 548.5 ± 11.7 | 3.1 ± 0.5 |
| **Vincennes (RM 385.5-412)** | **3.75** | **5721.9 ± 383.0** | **3.9 ± 0.7** | **8.9 ± 0.7** | **74.0 ± 2.2** | **7.8 ± 0.3** | **535.9 ± 14.2** | **4.9 ± 1.0** |
| Time Period 1 | 1.25 | 7411.0 ± 434.5 | 6.0 ± 1.3 | 8.0 ± 0.8 | 77.2 ± 1.2 | 7.1 ± 0.4 | 528.6 ± 11.0 | 9.4 ± 1.7 |
| Time Period 2 | 1.25 | 5434.4 ± 145.7 | 2.7 ± 0.7 | 9.3 ± 1.1 | 81.0 ± 1.5 | 8.2 ± 0.4 | 600.6 ± 4.1 | 2.0 ± 0.2 |
| Time Period 3 | 1.25 | 4320.2 ± 323.8 | 3.0 ± 0.8 | 9.3 ± 1.7 | 63.9 ± 2.8 | 7.9 ± 0.8 | 478.6 ± 10.2 | 3.3 ± 0.7 |
| **Mt. Carmel (RM 412-444.5)** | **5.25** | **6256.9 ± 441.8** | **9.7 ± 1.5** | **9.0 ± 1.0** | **75.0 ± 1.6** | **6.0 ± 0.9** | **483.2 ± 20.1** | **6.5 ± 1.3** |
| Time Period 1 | 1.75 | 8573.9 ± 621.8 | 16.4 ± 1.4 | 7.8 ± 0.4 | 78.5 ± 0.3 | 1.5 ± 0.1 | 437.3 ± 2.3 | 14.4 ± 0.8 |
| Time Period 2 | 1.75 | 5682.4 ± 276.7 | 6.3 ± 1.7 | 13.6 ± 0.6 | 80.9 ± 0.5 | 10.1 ± 0.6 | 599.0 ± 16.5 | 2.0 ± 0.0 |
| Time Period 3 | 1.75 | 4514.4 ± 180.6 | 6.5 ± 2.4 | 5.2 ± 1.0 | 65.6 ± 1.3 | 6.5 ± 0.9 | 413.4 ± 18.6 | 3.2 ± 0.3 |
| **New Harmony (RM 444.5-487)** | **6.75** | **6757.7 ± 456.5** | **9.1 ± 1.1** | **8.2 ± 0.7** | **75.3 ± 1.1** | **5.6 ± 0.8** | **448.0 ± 18.6** | **5.0 ± 0.6** |
| Time Period 1 | 2.25 | 9805.1 ± 394.5 | 13.6 ± 1.2 | 9.0 ± 1.0 | 79.2 ± 0.3 | 1.2 ± 0.0 | 388.3 ± 21.3 | 9.1 ± 0.7 |
| Time Period 2 | 2.25 | 5852.8 ± 172.2 | 5.5 ± 0.9 | 11.2 ± 0.5 | 79.0 ± 0.3 | 10.7 ± 0.5 | 568.8 ± 9.0 | 2.2 ± 0.1 |
| Time Period 3 | 2.25 | 4615.3 ± 99.2 | 8.2 ± 2.1 | 4.4 ± 0.3 | 67.6 ± 0.2 | 5.0 ± 0.3 | 387.0 ± 10.8 | 3.8 ± 0.2 |

## Section 5.2-2013 Wabash River pulsed-DC Electrofishing Catch Statistics

We collected 9,446 fish representing 60 species and 3 hybrids from 18 families during 25.5 h of pulsed-DC electrofishing on the Wabash River. Mississippi Silvery Minnow was the most abundant species by number (4,537 fish; 48.0% of total catch), followed by Freshwater Drum (648; 6.9%), Emerald Shiner (541; 5.7%), River Carpsucker (404; 4.3%), and Gizzard Shad (332; 3.5%). Common Carp contributed the greatest biomass (1,841.4 lb; 29.8% of total collected biomass), followed by River Carpsucker (645.6 lb; 10.4%), Silver Carp (617.9 lb; 10.0%), Smallmouth Buffalo (613.6 lb; 9.9%), and Freshwater Drum (497.5 lb; 4.1%). Comprehensive records of collections and biomass within each pool or reach and within each sampling period using pulsed-DC electrofishing gear are included in Appendices XI and XII.

### *Threatened and Endangered Species*

No fishes included on lists of threatened or endangered species in Illinois or Indiana were collected in pulsed-DC electrofishing surveys of the Wabash River.

*Bluegill*

Catch rates of Bluegill in the Wabash River during 2013 (1.5 fish/h ± 0.4) were lower than those recorded during 2012 (3.8 fish/h ± 1.1; Figure 5.1). Low average PSD values (~20) suggests that the sampled population is dominated by small individuals and that the introduction of small, young-of-year recruits to the population has been consistent since we began sampling during 2010. However, a consistently low PSD value could also indicate that older, larger bluegill age classes are infrequently encountered in our surveys (sampling bias) or that young age classes are unable to recruit to older, larger age classes (recruitment failure).

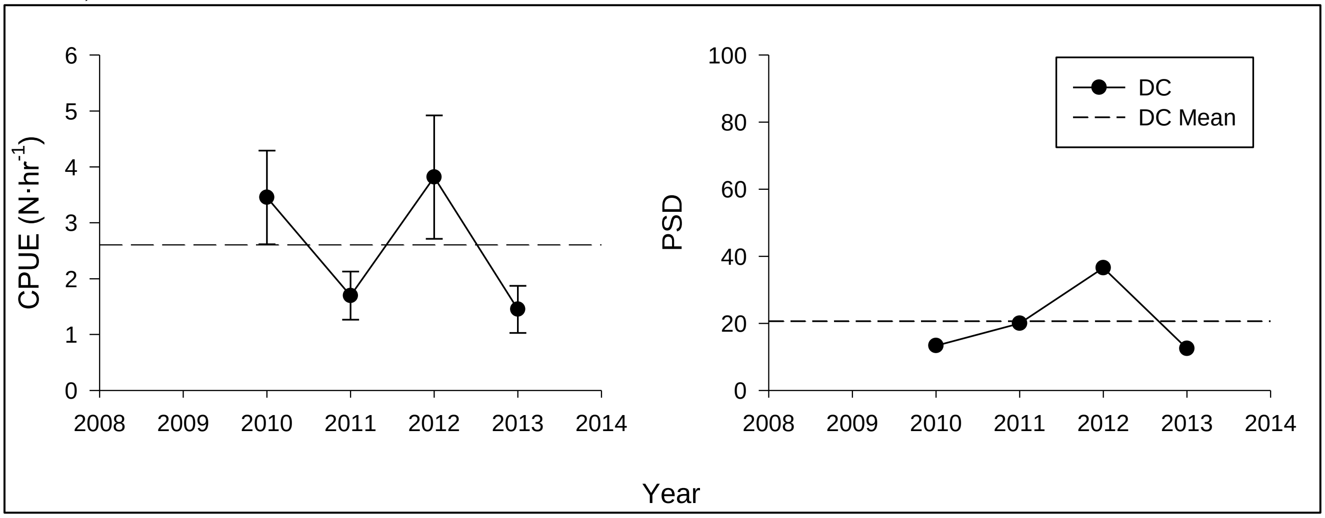



Figure 5.1. Catch per unit effort and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in five reaches of the Wabash River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*Channel Catfish*

Channel Catfish catch rates in the Wabash River were lower in 2013 (8.4 fish/h ± 1.1) than the previous three years (Figure 5.2). Average PSD values in all years of sampling indicate that the sampled population maintains a balance of large and small individuals, but the increase in PSD value since 2010 indicates that relatively few small recruits have entered the population during 2011-2013 and that the sampled population is dominated by larger size classes.

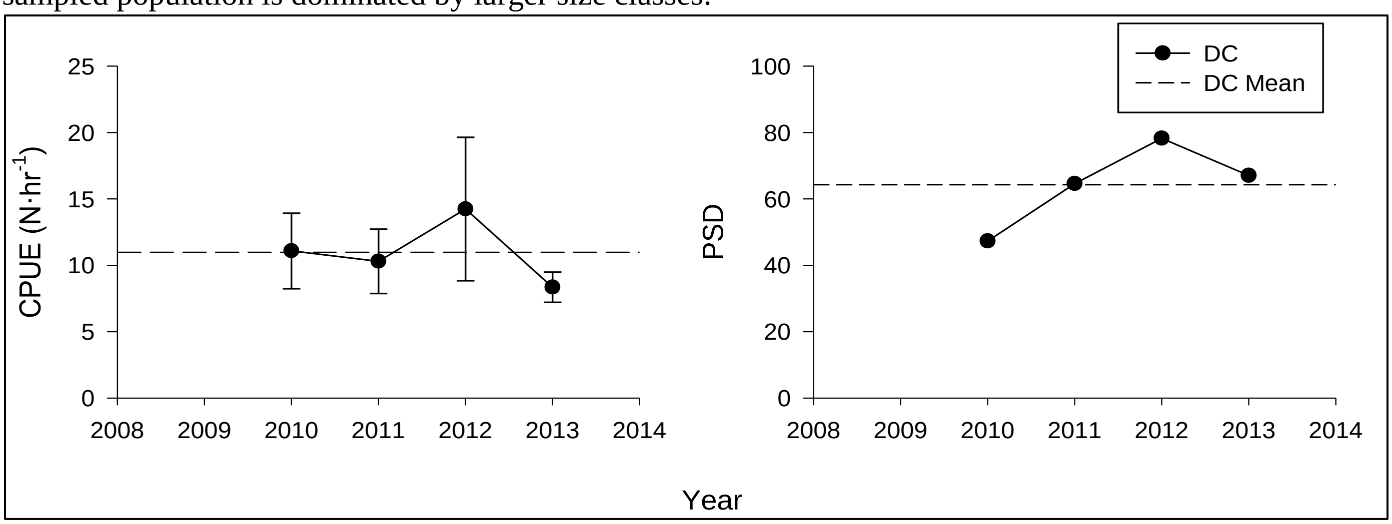



Figure 5.2. Catch per unit effort and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in five reaches of the Wabash River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*Spotted Bass*

Catch rates of Spotted Bass in the Wabash River during 2013 (9.6 fish/h ± 1.2) were lower than those recorded in the previous three years of monitoring (Figure 5.3). However, catch rates in the Wabash River continue to be the highest Spotted Bass CPUE recorded in any of the rivers currently sampled by the LTEF program. The 2013 PSD value (18) suggests that the sampled population is dominated by small individuals. The observed decline in PSD value from previous years indicates that relatively large numbers of small recruits have been encountered in our surveys during 2012 and 2013 and may indicate the introduction of relatively large cohorts of new recruits during those years.

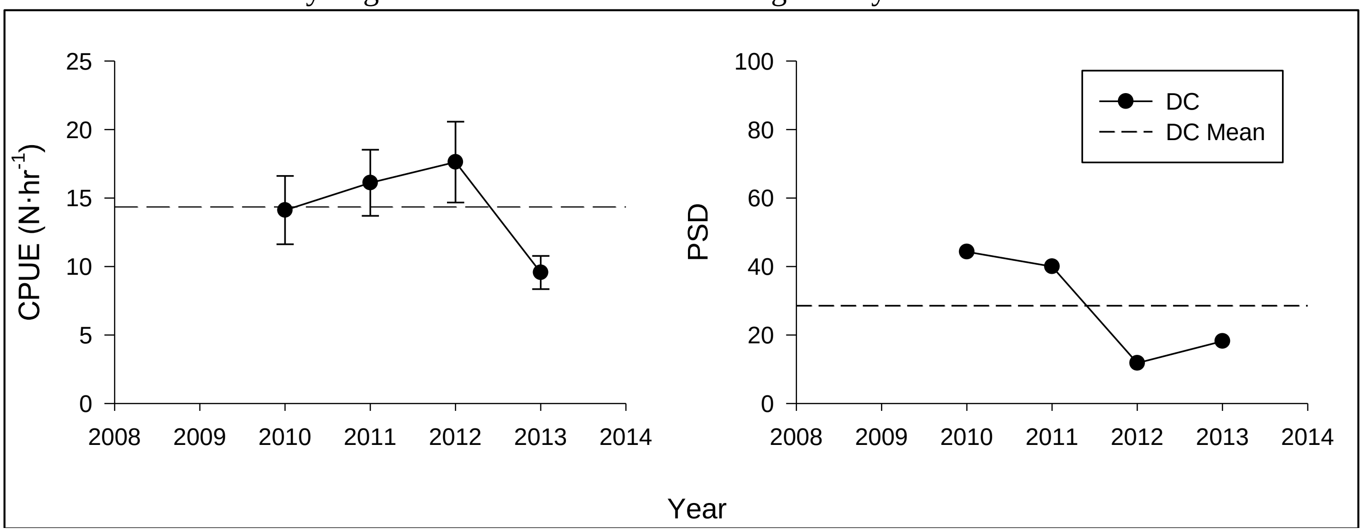



Figure 5.3. Catch per unit effort and proportional size distribution of Spotted Bass collected by pulsed-DC electrofishing surveys in five reaches of the Wabash River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*White Bass*

White Bass catch rates in the Wabash River during 2013 (2.9 fish/h ± 0.5) were similar to those recorded during 2012 (3.0 fish/h ± 0.6; Figure 5.4). The PSD values calculated for each year of monitoring indicates that the sampled population is dominated by larger, mature size classes and that relatively few small recruits have been encountered in our survey since monitoring began in 2010.

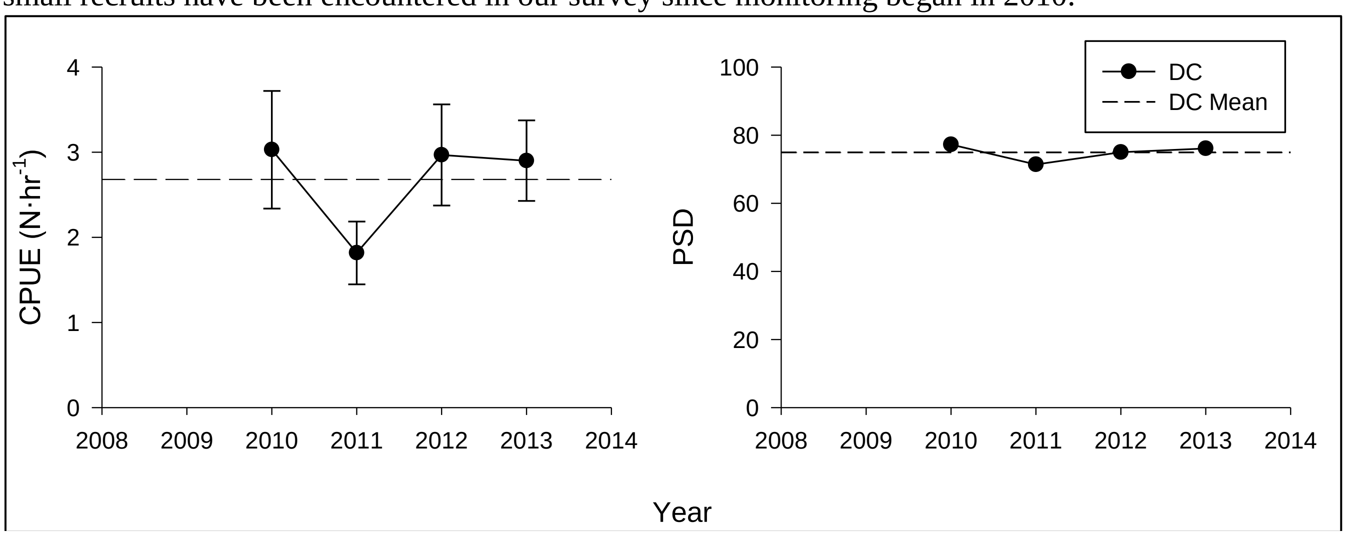



Figure 5.4. Catch per unit effort and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in five reaches of the Wabash River. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2010.

*Silver Carp*

Catch rates of Silver Carp in the Wabash River during 2013 (3.8 fish/h ± 0.8) were lower than those observed in 2012 (8.2 fish/h ± 1.7; Figure 5.5). The body condition of Silver Carp in the Wabash River also declined during 2013 (98) following substantial increases documented during 2012 sampling (106). Similar to the patterns observed in other watersheds monitored by F-101-R sampling, these results likely indicate that the  Silver Carp populations encountered in our survey in the Wabash River may have reached a threshold of population growth, and that resource limitation (interspecific or intraspecific competition) has begun to affect individual condition. Data from additional years of sampling are needed to determine whether this recent decline represents a robust trend in the expansion and growth of Silver Carp populations within this watershed.

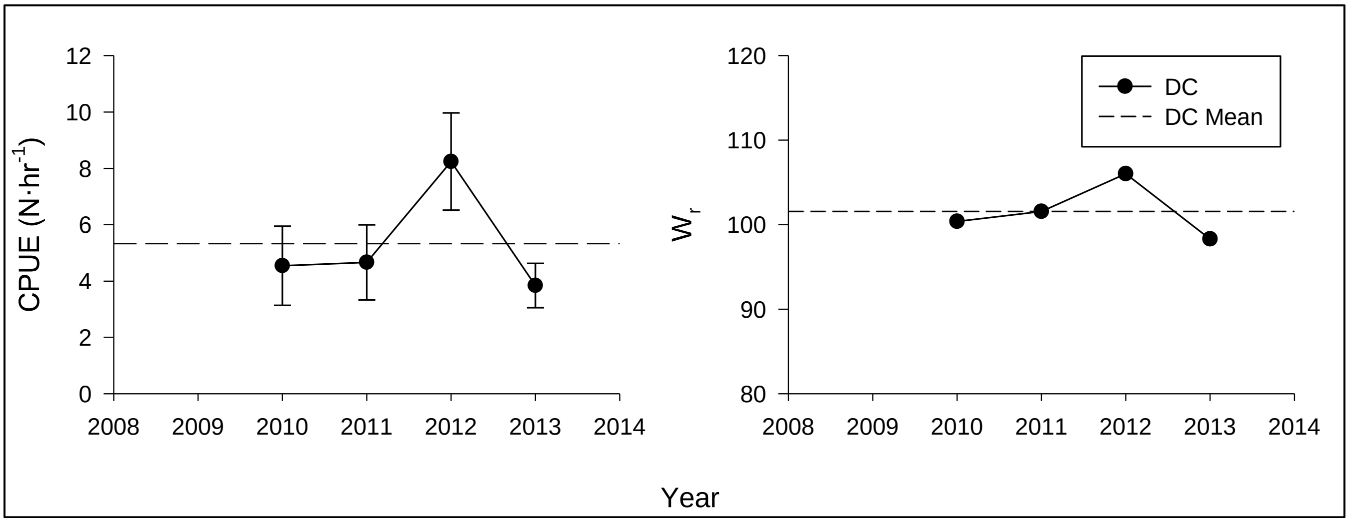



Figure 5.5. Catch per unit effort and condition (relative weight-$W_r$) of Silver Carp collected by pulsed-DC electrofishing survey in the Wabash River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 2010.

**Section 5.3-Wabash River Main Channel-Fixed Location Pulsed-DC Electrofishing Results**

Sampling for the Long-Term Illinois, Mississippi, Ohio and Wabash Rivers Fish Population Monitoring Program during 2012 and 2013 included 4 fixed main-channel sites in the Wabash River (Figure 5.6).  Fixed sites were chosen to best represent shallow main-channel habitat within the Wabash River.  The Darwin site is located at RM 323.5 and falls within the Terre Haute, IN to Palestine, IN reach.  The Darwin site located downstream of an old cutoff known as Aurora Bend and has a predominant substrate of rock in the 3-6 in range.  The Vincennes site is located at RM 382.5 and falls within the Palestine, IN to Vincennes, IN reach.  This site begins downstream of a small island where the main channel abruptly shifts to the Illinois side of the river.  The predominant substrate of the site is rock less than 3 in.  The Mt. Carmel site is located at RM 411 and falls into the Vincennes, IL to Mt. Carmel, IL reach.  The site begins just below an old lock and dam above the confluence of the White River.  The predominant substrate is rock, between 3-6 in, although larger rocks do exist in this area.  The New Haven site is located at RM 468.5 and falls within the New Harmony, IN to the confluence with the Ohio River.  This site is located on the northern side of an island with the majority of the substrate being rock less than 3 in diameter.

Pulsed-DC electrofishing collections were conducted according to described in the Section 2.2 with some modification. When shocking main channel fixed sites, sampling began by facing the boat downstream and turning on the power. When sampling runs extend beyond 200 yards, the operator turns off the power and returns to the beginning of the initial run and begins a parallel run to the first avoiding the path of the previous run.  This procedure can be repeated until the desired 15-minute duration of the run is completed.  Stunned fish were caught with a dip net of 1/8-in mesh and placed in an aerated livewell until sampling was completed.  Fish were then identified to species, measured (TL and weight), and returned to the water.  Non-carp cyprinids, darters, centrarchids < 2.00 in, and clupeids < 3.90 in were not weighed.  Weight estimates were assigned to fish for biomass calculations based on length category (3.50 in = 0.015

lb, 3.10 in = 0.011 lb, 2.80 in = 0.007 lb, 2.40 in = 0.004 lb, and ≤ 2.00 in = 0.002 lb).

Water levels during 2013 sampling periods were similar to 2012 and significantly lower than 2011. The mean sampling depth across locations and sampling periods for 2013 was 4.5 ft and mean stage height at Mt. Carmel was 5.2 ft. We conducted three total hours of electrofishing between July 22 and October 4, 2013. A total of 357 fish with a combined recorded biomass of 930.4 lb were collected. These fish represented 12 families and 32 species. Blue Sucker was the most abundant species by number collected (18.77% of total catch, 67 fish), followed by Shovelnose Sturgeon (14.85%, 53 fish), Freshwater Drum (10.36%, 37 fish), Smallmouth Buffalo (7.56%, 27 fish), and Channel Catfish (5.89%, 21 fish) (see Appendix XIII). Blue Sucker also contributed the greatest biomass (36.64% of total recorded biomass, 113.62 lb/h), followed by Smallmouth Buffalo (20.12%, 62.36 lb/h), Shovelnose Sturgeon (12.43%, 38.55 lb/h), and Longnose Gar (6.39%, 19.81 lb/h) (see Appendix XIV).

Preliminary analysis indicates that the fixed main channel electrofishing offers insights into fish species which are not well represented by standard stratified random sampling. The $CPUE_n$ and $CPUE_w$ of two species in particular, Blue Sucker and Shovelnose Sturgeon, were significantly higher at main channel locations than standard random sites (Table 5.2). This supplemental data may be pertinent to the management commercially harvested shovelnose sturgeon, especially since high mortality rates of older fish in the Lower Wabash River have been attributed to harvests (Kennedy *et al*. 2007).

Table 5.2. Blue Sucker and Shovelnose Sturgeon catch rates ($CPUE_N$ and $CPUE_W$) at four main-channel sampling locations in the Wabash River.

| | Blue Sucker | | Shovelnose Sturgeon | |
|---|---|---|---|---|
| | Main Channel (Fixed) | Main Channel Border (Random) | Main Channel (Fixed) | Main Channel Border (Random) |
| **CPUEn (number/hour)** | 21.33 | 0.05 | 22.33 | 0.01 |
| **CPUEw (lbs/hour)** | 104.99 | 0.26 | 52.06 | 0.02 |

**Section 5.4-Wabash River Channel Cutoff Pulsed-DC Electrofishing Results**

During a June 2008 flooding event on the Wabash River, an initial channel formed that removed approximately 7 miles of previously existing river channel (Figure 4). This new river channel formed at the bend near Mackey Island (RM 479) and effectively cut off Mackey Bend, the former course of the river, which is located near the confluence of the Wabash and Ohio Rivers (Wabash RM 487). During May 2009, a second cut-off channel formed immediately upstream of the first diversion that formed in 2008. The second cutoff channel formed in 2009 has since become the primary channel for the Wabash River and is approximately 0.60 miles in length.

In 2012, fish sampling began at sites located at the entrance of the new cutoff (RM 478.5), in the old river channel (Mackey Bend, RM 483 and 484 according to previous calculations of the length of the Wabash River), and just below the exit of the cutoff (RM 479). At each location, two sampling sites were positioned on the opposite sides of the main channel border (Figure 5.2). Electrofishing collections were conducted according to same established LTRMP protocols as described by Gutreuter et al. (1995) during three sampling periods (15 June – 31 July, 1 August – 15 September, 16 September – 31 October) described in the previous sections. Stunned fish were caught and measured using the same methods described in the previous section for the Wabash River main channel-fixed location pulsed-DC electrofishing collections.

We collected a total of 2,960 fish with a combined recorded biomass of 1,388.53 lb during a total of 7.5 h of electrofishing. These fishes represented 14 families, 51 species, and 1 hybrid. Sampling was divided into five sets of paired sites located on opposing shores (Figure 5.2). The sites were located above the Wabash's recently formed cutoff, at the origin of the new channel, within the old channel, and below the confluence of the old and new channels. Gizzard Shad were the most abundantly collected species (25.13%

of total catch, 744 fish), followed by Mississippi Silvery Minnow (18.99%, 562 fish), Emerald Shiner (14.80%, 438 fish), Threadfin Shad (8.85%, 262 fish), River Shiner (6.05%, 179 fish), and White Bass (3.41%, 101 fish). Silver Carp contributed the largest proportion of recorded biomass (48.63% of total recorded biomass, 675.21 lb), followed by Smallmouth Buffalo (7.43%, 103.18 lb), Bigmouth Buffalo (5.57%, 77.30 lb), White Bass (5.42%, 75.30 lb), and Longnose Gar (5.35%, 74.33 lb). To allow comparison among locations with different total effort, abundance catch per unit effort (CPUEn) is provided in Appendix XV and Appendix XVI provides biomass catch per unit effort (CPUEw).

The mean sampling depth varied less than 1 ft between 2012 and 2013 indicating the area is likely beginning to stabilize. Mean water velocity during sampling also changed little from 2012, with the exception of a decrease in flow within the old channel. Preliminary analyses of fish assemblage structure indicated 2012 and 2013 had similar fish composition. The exceptions to the similarity between years were a decrease in the abundance of Gizzard Shad and an increase in the biomass of Silver Carp collected at the site above the new channel and the site below the new channel.


Figure 5.6. Map of Wabash River cutoff (RM 478.5-486.0) sampling locations. Green dots indicate specific sampling sites where pulsed-DC electrofishing collections were conducted during 2012-2013.

# CHAPTER 6
# PILOT SPORTFISH ASSESSMENTS ON THE IROQUOIS AND KANKAKEE RIVERS

## Section 6.1-2013 Iroquois and Kankakee Rivers Ancillary Habitat Quality Data

During 2013, pilot electrofishing surveys were initiated in the Iroquois and Kankakee Rivers using both boat-mounted three-phase AC electrofishing and boat-mounted pulsed-DC sampling. In most cases, sampling was conducted according to the same protocols used during pulsed-DC electrofishing surveys in other, larger rivers (Gutreuter *et al.* 1995). However, the specific sampling design was altered to accommodate the difficulties of sampling in shallow water environments. Each river was stratified into sampling reaches delineated by the entrance of second order streams. If a reach was too small to conduct normal sampling, the reach was combined with an adjacent reach. In most of the sampling reaches, fixed sites were established at suitable locations within each sampling reach. Crews attempted to return to each of these fixed sites during the three sampling periods established for the large river pulsed-DC electrofishing program. However, in some locations, it became impossible to sample fixed locations established at the initiation of the survey. In those cases, suitable alternate sampling locations were selected as nearly to the original sampling location as possible.

Pulsed-DC electrofishing was conducted between 6:30 a.m. and 4:49 p.m. central standard time during the three sampling periods specified in the Chapter 1. Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 6.1.

Table 6.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys of the Iroquois and Kankakee Rivers during 2013. Values are expressed as the mean observed parameter value ± standard error.

| River | Total EF Effort (h) | AC EF Effort (h) | DC EF Effort (h) | DC EF Power Used (Watts) | Depth (ft) | Secchi Depth (in) | Water Temperature (°C) | DO (ppm) | Conductivity (µS) | Stage Height (ft) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Iroquois** | **10.75** | **2.75** | **8.00** | **4800.5 ± 69.9** | **2.9 ± 0.2** | **34.3 ± 13.5** | **72.0 ± 1.6** | **7.7 ± 0.3** | **646.3 ± 9.1** | **3.1 ± 0.1** |
| Time Period 1 | 3.75 | - | 3.75 | 4984.5 ± 52.0 | 3.7 ± 0.4 | 29.7 ± 11.7 | 77.3 ± 0.7 | 6.5 ± 0.1 | 665.2 ± 6.1 | 4.1 ± 0.1 |
| Time Period 2 | 3.50 | 1.50 | 2.00 | 4959.8 ± 59.1 | 2.7 ± 0.4 | 35.8 ± 14.1 | 78.9 ± 0.7 | 7.3 ± 0.8 | 645.4 ± 10.1 | 2.4 ± 0.1 |
| Time Period 3 | 3.50 | 1.25 | 2.25 | 4352.3 ± 147.2 | 2.4 ± 0.3 | 38.2 ± 15.1 | 59.3 ± 2.6 | 9.2 ± 0.6 | 627.1 ± 25.0 | 2.6 ± 0.1 |
| **Kankakee** | **17.50** | **3.50** | **14.00** | **4647.5 ± 51.4** | **3.1 ± 0.2** | **97.4 ± 38.4** | **70.2 ± 1.3** | **9.8 ± 0.3** | **636.0 ± 6.4** | **1.6 ± 0.1** |
| Time Period 1 | 6.00 | - | 6.00 | 4560.3 ± 87.7 | 4.0 ± 0.4 | 86.2 ± 33.9 | 73.9 ± 1.2 | 9.2 ± 0.6 | 592.8 ± 13.3 | 2.3 ± 0.2 |
| Time Period 2 | 5.25 | 1.75 | 3.50 | 4997.4 ± 85.9 | 2.9 ± 0.4 | 98.2 ± 38.7 | 79.6 ± 1.0 | 8.5 ± 0.3 | 654.0 ± 7.4 | 1.2 ± 0.1 |
| Time Period 3 | 6.25 | 1.75 | 4.50 | 4491.6 ± 26.2 | 2.5 ± 0.2 | 107.6 ± 42.4 | 58.8 ± 1.6 | 11.4 ± 0.6 | 662.2 ± 4.5 | 1.4 ± 0.1 |

## Section 6.2-2013 Iroquois River Electrofishing Catch Statistics

We collected 942 fishes representing 34 species from 8 families during 2.75 hours of AC electrofishing at 11 locations on the Iroquois River. Orangespotted Sunfish was the most abundant species in our AC electrofishing collections (271 fish; 28.8% of total catch) followed by Longear Sunfish (123; 13.1%), Bullhead Minnow (115; 12.2%), Channel Catfish (100; 10.6%), and Bluegill (44; 4.7%). Channel Catfish contributed the greatest biomass of fishes collected (210.9 lb; 51.2% total collected biomass), followed by Common Carp (100.9 lb; 24.5%), Golden Redhorse (26.7 lb; 6.5%), Silver Redhorse (15.7 lb; 3.8%), and Shorthead Redhorse (8.2 lb; 2.0%).

We collected 4,081 fish representing 51 species and 2 hybrids from 10 families during 9 hours of pulsed-DC electrofishing at 32 sites on the Iroquois River. Spotfin Shiner was the most abundant species in our pulsed-DC electrofishing collections (1,549 fish; 38.0% of total catch) followed by Orangespotted Sunfish (400; 9.8%), unidentified juvenile Cyprinids (308; 7.5%), Channel Catfish (183; 4.5%), and Longear Sunfish (143; 3.5%). Common Carp contributed the greatest biomass of fishes collected in the pulsed-DC survey of this region (310.5 lb; 34.6% total collected biomass), followed by Channel Catfish (199.9 lb; 22.3%), Golden Redhorse (65.1 lb; 7.3%), Black Redhorse (54.9 lb; 6.1%), and Shorthead Redhorse (47.1 lb; 5.3%). Comprehensive records of collections and biomass within each reach and sampling period using both AC and pulsed-DC electrofishing gears are included in Appendices XVII and XVIII.

*Threatened and Endangered Species*

We collected one River Redhorse (Illinois State Threatened) using AC electrofishing gears in the Iroquois River. We also caught four River Redhorse using pulsed-DC electrofishing gears in the same region (Appendix XVII).

**Section 6.3-2013 Kankakee River Electrofishing Catch Statistics**

We collected 859 fishes representing 52 species from 13 families during 3.5 hours of AC electrofishing at 14 sites on the Kankakee River. Longear Sunfish was the most abundant species in our AC electrofishing collections (91 fish; 10.6% of total catch) followed by Channel Catfish (63; 7.3%), Spotfin Shiner (61; 7.1%), Shorthead Redhorse (48; 5.6%), and Golden Redhorse (45; 5.2%). Common Carp contributed the greatest biomass of fishes collected (310.5 lb; 34.6% total collected biomass), followed by Channel Catfish (199.9 lb; 22.3%), Golden Redhorse (65.1 lb; 7.3%), Black Redhorse (54.9 lb; 6.1%), and Shorthead Redhorse (47.1 lb; 5.3%).

We collected 5,718 fish representing 66 species and 2 hybrids from 15 families during 14.0 hours of pulsed-DC electrofishing at 56 sites on the Kankakee River. Spotfin Shiner was the most abundant species in our pulsed-DC electrofishing collections (1,572 fish; 27.5% of total catch) followed by Mimic Shiner (556; 9.7%), Smallmouth Bass (385; 6.7%), Longear Sunfish (370; 6.5%), and Shorthead Redhorse (368; 6.4%). Common Carp contributed the greatest biomass of fishes collected in the pulsed-DC survey (1,086.4 lb; 28.1% total collected biomass), followed by Channel Catfish (463.1 lb; 12.0%), Shorthead Redhorse (346.6 lb; 9.0%), Golden Redhorse (346.4 lb; 9.0%), and River Redhorse (307.7 lb; 8.0%). Comprehensive records of collections and biomass within each reach and sampling period using both AC and pulsed-DC electrofishing gears are included in Appendices XVII and XVIII.

*Threatened and Endangered Species*

We collected two River Redhorse (Illinois State Threatened) using AC electrofishing gears in the Kankakee River. We also caught 51 River Redhorse, four Blacknose Shiner (Illinois State Endangered), two Pallid Shiner (Illinois State Endangered), two Ironcolor Shiner (Illinois State Threatened), and four Weed Shiner (Illinois State Endangered) using the pulsed-DC electrofishing gears in the same region (Appendix XVII).

*Sportfish*

Although it is difficult to provide any robust assessment of the status of sportfish populations in these tributaries from a single year of data, catch rates of many popular sportfishes (i.e., Largemouth Bass and Smallmouth Bass, White Crappie and Black Crappie, Channel Catfish, and Walleye) were higher in the Kankakee and Iroquois Rivers than in other rivers we sampled during 2013. Additional research in these streams will be necessary to determine if these and other tributaries do, in fact, support or contribute to robust sportfish populations in Illinois largest watersheds (Pracheil et al. 2009; Pracheil et al. 2013).

# CHAPTER 7.
# STATEWIDE FISHERIES ASSESSMENTS

## Section 7.1. Spatial and Temporal Influences on the Physiological Condition of Invasive Silver Carp: Thesis research developed by UIUC graduate student Stephanie Liss (Advised by former LTEF PI Greg Sass).

*Background*

Bighead Carp and Silver Carp (hereafter, Asian carp) are invasive species that have the potential to negatively influence freshwater ecosystems. After their introduction to the United States during the early 1970s, Asian carp have become established in the Mississippi River Basin, and their range is expanding. Asian carp have the potential to negatively influence the community structure of native species. For example, Asian carp are efficient, filter-feeding planktivores that negatively affect native obligate or facultative planktivorous fishes (Irons et al. 2007). Currently, factors motivating or controlling the range exapansion of Asian carp have not been well defined, and little is known about the potential consequences of recently discovered hybrids of Bighead Carp and Silver Carp (see section 7.2, below). Improving our understanding of how Asian carp interact with their environment can help describe factors determining their movement and range expansion, and also predict what could happen if Asian carp expand their range into new habitats. The goal of this project was to determine abiotic and biotic factors that influence stress and nutrition in wild-caught silver and bighead carp at different spatial and temporal scales. Thus, we performed three distinct field studies involving wild silver carp, bighead carp, and their hybrids.

*Spatial and temporal influences on the physiological condition of invasive silver carp*

We quantified nutritional and stress parameters (alkaline phosphatase (ALP), cholesterol, protein, triglycerides, cortisol, glucose) in invasive silver carp inhabiting four large rivers over three distinct sampling periods. During each sampling period, we collected blood samples from silver carp in the Illinois River and portions of the Mississippi, Ohio, and Wabash rivers in Illinois. We tested for relationships between silver carp nutrition and stress across rivers, reaches within rivers, and sampling periods. For wild-caught silver carp sampled at broad spatial scales, indices of short-term feeding (triglycerides, protein, and ALP in plasma) were most strongly influenced by sampling period (Figure 7.1a), considered independently for each river. Similarly, sampling period, considered independently for each river was the strongest predictor of variation in silver carp body energy reserves (cholesterol and protein in plasma; Figure 7.1b). Stress-related variables for silver carp (cortisol and glucose in plasma) were highly influenced by sampling period (Figure 7.1c), independent of river or reach.

*Influence of local-scale abiotic and biotic factors on stress and nutrition in invasive silver carp sampling periodsampling period*

We used habitat characteristics, zooplankton concentrations, fish abundances, and species composition and richness data collected by two fish population monitoring programs (LTRMP, LTEF) in the LaGrange Reach, Illinois River, Illinois, to test for factors that influence stress and nutrition in invasive silver carp. We collected blood samples and quantified nutritional and stress metrics (ALP, cholesterol, protein, triglycerides, cortisol, glucose) from individuals inhabiting the LaGrange Reach across three distinct sampling periods. ALP activities in plasma (an indicator of nutrition) were positively correlated with CPUE of gizzard shad, water temperature, and cladoceran concentrations, particularly during the mid- and late-summer sampling periods (Table 7.1). Plasma glucose (an indicator of stress) for silver carp was positively correlated with suspended solids, cladoceran concentrations, water temperature, and CPUE of gizzard shad (Table 7.1). A surprising number of blood-based nutritional and stress metrics (i.e., cholesterol, cortisol, protein, and triglycerides) did not have a single, clear, best-fit model to explain trends in the data. This indicates that variation in the response variables was not explained by the predictors we tested (habitat characteristics, zooplankton concentrations, fish abundances, and species composition and richness data).

*Physiological consequences of hybridization: Backcrossing decreases nutritional performance in invasive Asian carp*

We examined the nutritional performance of invasive Asian carps in the Illinois River, Illinois, using parental bighead carp, parental silver carp, and their reciprocal hybrids by quantifying a suite of nutritional physiological parameters (ALP, calcium, cholesterol, lipase, protein, and triglycerides). Individuals were separated into four distinct genetically-identified groups (parental silver carp, parental bighead carp, advanced generation group hybrids, early generation group hybrids). For wild-caught Asian carp coexisting in the Illinois River, parental silver carp were in better nutritional condition relative to parental bighead carp, exhibiting significantly greater concentrations of triglycerides, protein, and quantities of lipase in plasma (Figure 7.2). Early generation (EG) group individuals and advanced generation (ADV) group backcrosses had nutritional conditions that were statistically similar to either parental bighead or parental silver carp, whereas EG group individuals were not statistically different than parental bighead carp based on the triglycerides, lipase, and protein concentrations; ADV group individuals were more statistically similar to the parental silver carp group based on their nutritional plasma lipase activities and protein concentrations (Figure 7.2). In summary, this research indicates that silver carp range expansion may be limited by factors at broad spatial and temporal scales, as opposed to local abiotic and biotic interactions. Furthermore, decreased nutritional status of hybrid Asian carp may further limit range expansion.

Figure 7.1 Relationship for the best fit AICc ranked model explaining (a) PC1 scores (short-term feeding) for silver carp by sampling period, independent of river, (b) PC2 scores (body energy reserves) for silver carp by sampling period, independent of river, and (c) PC3 (stress) for silver carp by sampling period. Dissimilar letters indicate significant differences across sampling periods, with each river (or period) considered independently.

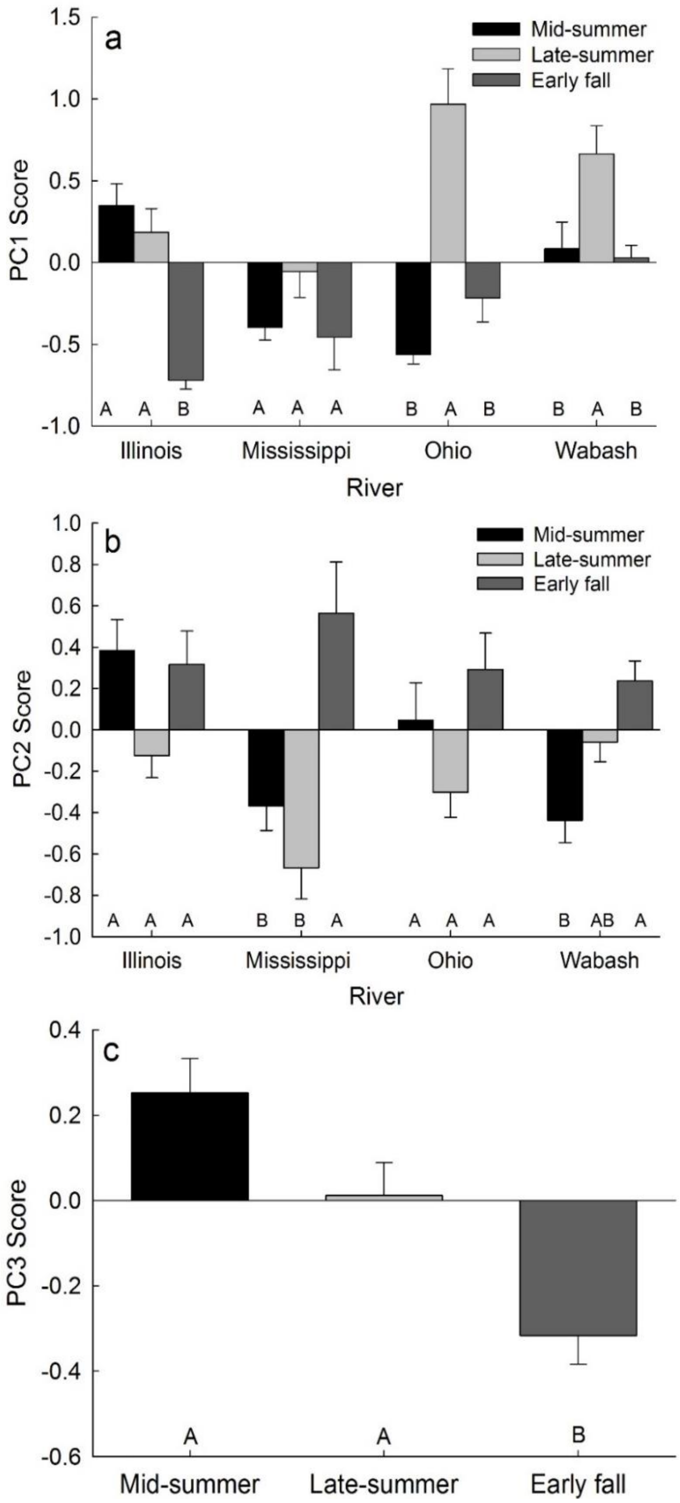
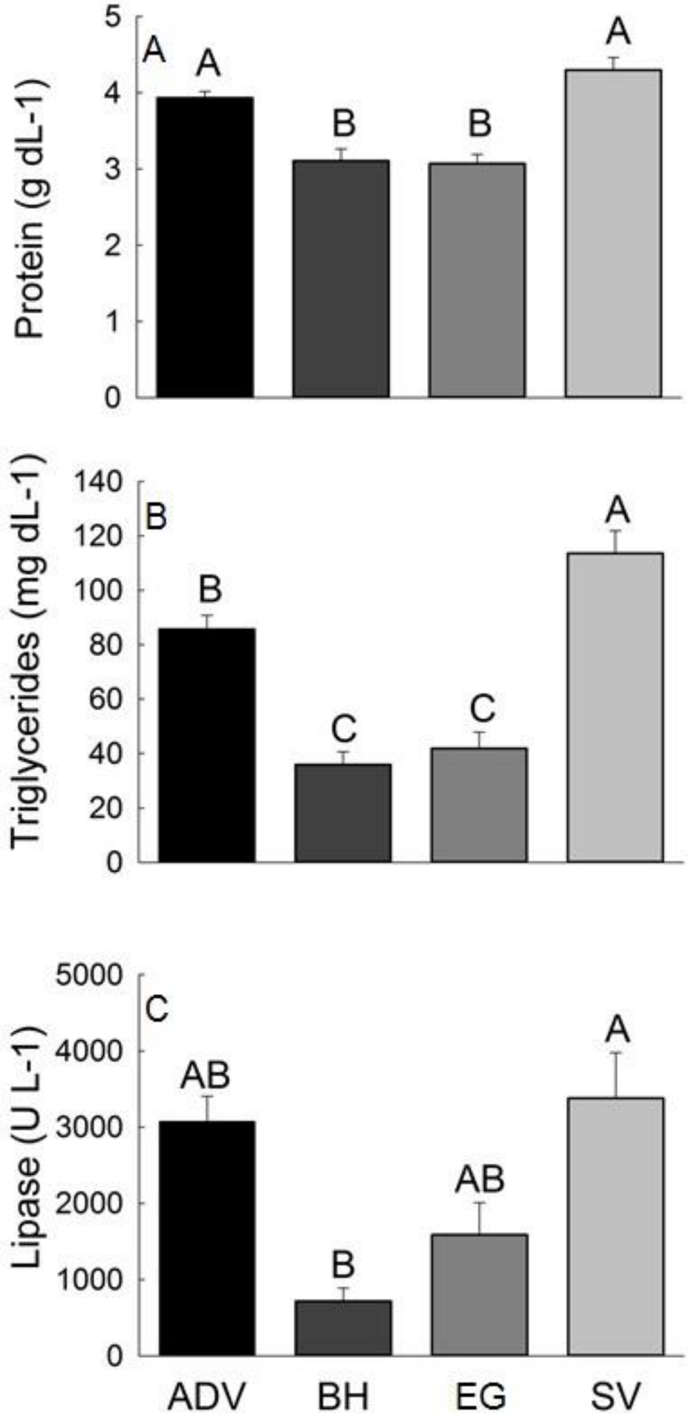


Table 7.1. Influence of local-scale abiotic and biotic factors on stress and nutrition in invasive Silver Carp: model selection results relating predictor variables to variation in alkaline phosphatase (ALP) activities and plasma glucose concentrations for wild-caught Silver Carp (*Hypophthalmichthys molitrix*) collected in the La Grange Reach, Illinois River across three sampling periods in 2011. Models are ranked by differences in AIC values (ΔAICc), and the model with the lowest ΔAICc value is the best fit to the data, with AICc weight determining the best approximating model. CPUE refers to fish caught per electroshocking hour, GZSD refers to gizzard shad (*Dorosoma cepedianum*), SVCP refers to silver carp, and excluding SVCP refers to the abundance of all other fishes caught during sampling.

| ALP Model | AICc | ΔAICc | Model Likelihood | AICc Weight |
|---|---|---|---|---|
| CPUE_GZSD (fish $hr^{-1}$) | 251.44 | 0.00 | 1.00 | 0.68 |
| Temperature (C ) | 254.06 | 2.61 | 0.27 | 0.18 |
| Cladocerans (cladocerans $L^{-1}$) | 254.73 | 3.29 | 0.19 | 0.13 |
| Suspended Solids (mg $L^{-1}$) | 260.34 | 8.89 | 0.01 | 0.01 |
| Planktivore Richness | 279.92 | 28.48 | 0.00 | 0.00 |
| CPUE_excluding SVCP (fish $hr^{-1}$) | 287.91 | 36.47 | 0.00 | 0.00 |
| Planktivore & Omnivore Richness | 288.70 | 37.25 | 0.00 | 0.00 |
| CPUE_SVCP (fish $hr^{-1}$) | 289.95 | 38.51 | 0.00 | 0.00 |
| Rotifers (rotifers $L^{-1}$) | 289.99 | 38.54 | 0.00 | 0.00 |
| Copepods (copepods $L^{-1}$) | 290.64 | 39.19 | 0.00 | 0.00 |
| Total Zooplankton (total zoop. $L^{-1}$) | 290.74 | 39.29 | 0.00 | 0.00 |
| Total Length (mm) | 291.01 | 39.57 | 0.00 | 0.00 |
| Species Richness | 291.05 | 39.61 | 0.00 | 0.00 |
| Total Phosphorus (mg $L^{-1}$) | 291.06 | 39.62 | 0.00 | 0.00 |
| **Glucose Model** | **AICc** | **ΔAICc** | **Model Likelihood** | **AICc Weight** |
| Suspended Solids (mg $L^{-1}$) | 233.28 | 0.00 | 1.00 | 0.42 |
| Cladocerans (cladocerans $L^{-1}$) | 234.21 | 0.92 | 0.63 | 0.26 |
| Temperature (C ) | 234.42 | 1.14 | 0.57 | 0.24 |
| CPUE_GZSD (fish $hr^{-1}$) | 236.95 | 3.67 | 0.16 | 0.07 |
| CPUE_excluding SVCP (fish $hr^{-1}$) | 241.42 | 8.13 | 0.02 | 0.01 |
| Planktivore & Omnivore Richness | 242.17 | 8.89 | 0.01 | 0.00 |
| Total Phosphorus (mg $L^{-1}$) | 246.19 | 12.91 | 0.00 | 0.00 |
| Species Richness | 246.62 | 13.33 | 0.00 | 0.00 |
| Total Zooplankton (total zoop. $L^{-1}$) | 247.44 | 14.16 | 0.00 | 0.00 |
| Copepods (copepods $L^{-1}$) | 247.57 | 14.28 | 0.00 | 0.00 |
| Planktivore Richness | 247.91 | 14.63 | 0.00 | 0.00 |
| Rotifers (rotifers $L^{-1}$) | 248.09 | 14.80 | 0.00 | 0.00 |
| CPUE_SVCP (fish $hr^{-1}$) | 248.10 | 14.82 | 0.00 | 0.00 |
| Total Length (mm) | 248.65 | 15.37 | 0.00 | 0.00 |

Figure 7.2. Physiological consequences of hybridization-backcrossing decreases nutritional performance in invasive Asian carp: Relationship between plasma protein (g $dL^{-1}$) (a), triglycerides (mg $dL^{-1}$) (b), lipase (U $L^{-1}$) (c), and genetic identification grouping (advanced generation = ADV (N=46), parental bighead *Hypophthalmichthys nobilis* = BH (N=6), Early generation = EG (N=9), parental silver *H. molitrix* = SV (N=16)). Dissimilar letters indicate significant differences (α < 0.05). Error bars denote one standard error about the mean.



**Section 7.2. Genetic characterization of Asian carps in Illinois Rivers: Dissertation research developed by UIUC graduate student James Lamer (Advised by LTEF PI John Epifanio, former LTEF PI Greg Sass)**

*Restriction site-associated DNA sequencing generates high-quality single nucleotide polymorphisms for assessing hybridization between bighead and silver carp in the United States and China*

We used restriction-site-associated DNA (RAD) sequencing to reduce the genomes of 45 parental bighead carp and silver carp from the United States and China to isolate species-specific single nucleotide polymorphisms (SNPs) capable of distinguishing parental bighead carp and silver carp from their respective hybrids.

Two hundred sixty-one candidate species diagnostic SNPs were identified after stringent filtering criteria. Validation of SNPs yielded 57 species-diagnostic SNPs capable of identifying bighead carp, silver carp, and their hybrids from the Mississippi River Basin in the United States and the Yangtze River, Amur River, and Pearl River in China. The resultant panel of 57 SNPS provides unprecedented diagnostic utility and power in distinguishing hybrids over any existing techniques. Through our validation procedures, we observed Asian carp hybridization in the Amur River, and consequently, is the first documented hybridization in China.

*Bighead carp and silver carp hybrid swarm in the Mississippi River Basin: Co-introduction to an exotic environment promotes introgressive hybridization*

We collected a total of 2,798 bighead carp, silver carp, and their respective hybrids from nine different locations throughout the Mississippi River Basin (Illinois River Reaches: Alton, LaGrange, Peoria, Marseilles; Lower Mississippi River (LMR): Vicksburg, MS, and Laketon, KY; UMR: Pool 26 and Pool 20; Missouri River: Omaha, NE). Total length, body weight, and gonad weight were recorded, the left pectoral spine and left postcleithrum removed for aging and a small piece of the caudal fin removed for the determination of genetic identity (57 SNP panel) and maternal ancestry (COII mitochondrial SNP).

Over all locations, 1244 of 2798 (44.47%) Asian carp analyzed were of mixed ancestry made up of a complex network of hybrids consisting of $F_1$, $F_2$, several generations of reciprocal backcrosses, and introgressed genotypes consistent with backcross x backcross pairings. All locations sampled contained hybrid individuals. The hybrid combinations followed a bimodal distribution with pure and later generation hybrids being most abundant and $F_1$ and early generation backcrosses least abundant. This indicates that $F_1$ and early generation hybrids are selected against but are maintained in low numbers throughout the population. Maternal contribution to the hybrids was assessed using a species specific SNP isolated from the cytochrome oxidase II (COII) mitochondrial domain for 730 pure and hybrid fishes. Female silver carp x male bighead carp was the predominant cross in all $F_1$'s (13 of 21, 62%) and silver carp was the persistent female parent in all silver carp backcrosses and maintained throughout many of the bighead carp backcrosses (28 of 42, 66.67% of first generation bighead backcrosses contained silver carp mitochondrial DNA). In contrast, bighead carp female mitochondrial DNA was not found in any silver carp backcross beyond the first generation (only 1 of 18 in first generation silver backcrosses).

*Post-zygotic success in Asian carp hybrids as determined by body condition, age at growth and gonadosomatic index (GSI)*

We calculated mean relative weight for each hybrid category per location using total length and weight. We used total length and age derived from sectioned postcleithra to estimate growth as derived from the vonBertalannfy growth equation. We calculated percent stage IV female gonad weight vs. percent body weight among the various hybrid categories.

Over all locations, relative weight (body condition) was significantly lower in $F_1$, $F_2$, and first generation backcrossed individuals compared with either pure species. As the fish becomes more backcrossed (i.e., more genetically similar to the pure species) the body condition is not significantly different. No difference between pure species and any generation after the second generation backcross was observed. Growth was variable across all hybrid categories and locations, showing variable trends among all groups. Only 376 of 2798 fish were females containing stage IV gonads (most reliable stage used as indicator of egg maturity). All hybrid categories had at least one individual at this stage, indicating that the potential for mature egg production is possible for all hybrid combinations. Low sample sizes of early generation hybrids ($F_1$, first generation backcrosses) make comparisons difficult, but the highest mean GSI values were from $F_1$ and first generation backcross silver carp. The remaining hybrid categories showed similar mean GSI values across categories.

# Chapter 8.
# CONCLUSIONS

Fish monitoring conducted on the Illinois, Mississippi, Ohio and Wabash Rivers during 2013 was useful for describing the diversity and heterogeneity of fish communities in large Midwestern Rivers. Additional sampling in the Iroquois and Kankakee Rivers has also provided fresh insights into the unique structure of fish communities in major tributaries of Illinois' large rivers. Catch rates and species richness varied greatly among rivers, among reaches within each river, and among sampling periods. However, any analysis of annual variations in species richness or catch rates should consider the effects of abiotic and biotic factors known to affect the capture efficiency of a specific type of fishing gear (Yuccoz *et al.* 2001). Much of Illinois experienced substantial flooding followed by periods of drought during 2013 (NCDC 2014) and it is possible that the capture efficiency of our sampling gears was altered in some way by the unusual climatic conditions, such as extremely high/low water levels and subsequent changes in water clarity. Nonetheless, we are confident that our current and future efforts to operate a wide-ranging, well-standardized fish monitoring survey of Illinois' largest river systems will contribute to a more comprehensive and nuanced understanding of the spatial and temporal dynamics of fish communities in our state. Although the capture efficiency of our gears may be highly variable among the different biological and environmental conditions encountered in our surveys, our observations of spatial and temporal changes in the relative abundance of some fish species in relation to both localized and large-scale environmental changes may comprise a substantial contribution to our collective intimations of the complexity of large river ecosystems (*sensu* Dodds *et al.* 2012). Inter-annual variations in the relative abundance of important forage species, like gizzard shad, or popular sportfish species, like largemouth bass and catfish, may be related to some combination of timely hydrologic events, broader aquatic community dynamics, and the implementation of fisheries and water-quality management directives. Our ability to effectively detect such changes is dependent upon the collection of fisheries data during additional years' sampling efforts. Our current and previous efforts are forming the basis for more comprehensive and robust analyses that will, hopefully, contribute to the development of more effective and sustainable management policies for the rivers of Illinois.

*Sportfish*

Catch rates and sizes of popular sportfish species varied greatly among the rivers and reaches sampled during 2013. Collections of black bass species were greatest in the Upper Illinois Waterway and in the Wabash River. Catch rates of black and white crappie were very low among all reaches sampled during 2013. Our observations of the tremendous annual variation observed in the relative abundance and size distribution of many sportfish species should serve as a catalyst for future research investigating the effects environmental change and management policy on the health and sustainability of Illinois sportfishes.

*Invasive Species*

While the main focus of F-101-R programs are to conduct monitoring to improve our understanding of population dynamics, life histories, and habitat requirements of recreationally fished species, the programs sampling strategies may also be useful for documenting trends in the relative abundance of non-native species occupying Illinois large river ecosystems. However, we advise that researchers use caution when interpreting the data we collect on invasive species as our sampling protocols (i.e., restriction to main-channel habitats) may limit our probability of encountering the greatest densities of the species in some instances. Our monitoring and analyses suggest densities of Silver Carp are greatest in the Lower Illinois River and that body condition of Silver Carp was highest in the lower Mississippi River Sampling Areas and the upper-most reaches of the Wabash River sampled by LTEF crews. However, given the low catch rates of silver carp (<20 individuals per year) in some regions it is difficult to make robust spatial comparisons of the relative condition of the species in Illinois' rivers. Directed sampling using netting gears in addition to electrofishing in backwater and side-channel habitats may be required to collect sufficient sample sizes of silver carp for inter-annual and spatial comparisons of body condition.

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Appendix I. Reaches and pools sampled by LTEF pulsed-DC electrofishing surveys during 2013 with the upstream and downstream limits (RM), the number of sampling locations within each study area (N), and the locations of the USGS gauges used to record stage height in each study area are included in ascending (downstream to upstream) order.

| River | Reach/Pool | Downstream | Upstream | N | Gauge |
|---|---|---|---|---|---|
| Illinois | Alton | 0.0 | 80.0 | 15 | Florence, IL |
| | Peoria | 158.0 | 231.0 | 14 | Henry, IL |
| | Starved Rock | 231.0 | 247.0 | 3 | Ottawa, IL |
| | Marseilles | 247.0 | 271.5 | 6 | Morris, IL |
| Des Plaines | Dresden | 271.5 | 286.0 | 3 | Brandon Rd Lock and Dam |
| | | | | | |
| Mississippi | Kaskaskia | 117.0 | 165.5 | 10 | Chester, IL (or Brickeys, MO) |
| | Chain of Rocks | 165.5 | 200.5 | 7 | St. Louis, MO |
| | Pool 25 | 242.0 | 273.5 | 6 | Mosier Landing, IL |
| | Pool 20 | 343.0 | 364.5 | 4 | Gregory Landing, MO |
| | Pool 19 | 364.5 | 410.5 | 9 | Ft. Madison, IA |
| | Pool 16 | 457.0 | 483.0 | 5 | Fairport, IA |
| | | | | | |
| Ohio | Confluence | 981.0 | 962.5 | 3 | MS River @ Bird's Point, MO |
| | Pool 53 | 962.5 | 939.0 | 4 | Metropolis, IL |
| | Pool 52 | 918.5 | 939.0 | 4 | Paducah, KY |
| | Smithland | 848.0 | 918.5 | 9 | Golconda, IL |
| | | | | | |
| Wabash | New Harmony | 444.5 | 487.0 | 5 | Mt. Carmel, IL |
| | Mt. Carmel | 412.0 | 444.5 | 4 | Mt. Carmel, IL |
| | Vincennes | 385.5 | 412.0 | 4 | Mt. Carmel, IL |
| | Palestine | 351.0 | 385.5 | 4 | Mt. Carmel, IL |
| | Terra Haute | 315.5 | 351.0 | 5 | Mt. Carmel, IL |

Appendix II. Station information and characteristics during AC electrofishing sampling in 2013. All stations, except where noted, are on the Illinois River and are listed in downstream-to-upstream order. Site miles are the average river mile and refer to Figure 2.1.

| Sampling Order | Date | Name | mean[a] | End time (CST) | Duration (h) | Temp (°F) air | Temp (°F) water | DO (ppm) | DO (% Sat.) | Secchi (in) | Cond. (µmhos) | Vel. (ft/s) | Depth (ft) min | Depth (ft) max | Stage[b] (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach 26, Mississippi River | | | | | | | | | | | | | | | |
| 24 | 26-Sep | Brickhouse Slough | 205.1 | 12:45 PM | 1.0 | 75.4 | 73.9 | 7.3 | 91.0% | 4.3 | 465 | 0.0 | 0.2 | 1.4 | |
| Alton Reach | | | | | | | | | | | | | | | |
| 25 | 27-Sep | Mortland Island | 18.8 | 8:54 AM | 1.0 | 60.0 | 72.9 | 5.1 | 54.2% | 8.3 | 836 | 0.4 | 0.5 | 2.4 | 2.2 |
| 28 | 27-Sep | Dark Chute | 25.0 | 3:20 PM | 1.0 | 82.8 | 74.8 | 6.3 | 84.0% | 8.3 | 865 | 0.3 | 0.2 | 1.5 | 2.2 |
| 27 | 27-Sep | Hurricane Island | 27.5 | 1:41 PM | 1.0 | 75.7 | 73.9 | 5.8 | 72.5% | 8.3 | 867 | 0.4 | 0.2 | 1.5 | 2.2 |
| 26 | 27-Sep | Crater-Willow Island | 30.0 | 11:35 AM | 1.0 | 68.2 | 73.4 | 6.0 | 69.6% | 8.3 | 869 | 0.4 | 0.3 | 1.4 | 2.2 |
| 2 | 6-Sep | Big Blue Island | 58.5 | 11:09 AM | 1.0 | 77.9 | 82.0 | 4.7 | 60.0% | 7.9 | 846 | 0.6 | 0.3 | 1.5 | 2.2 |
| 3 | 6-Sep | Moore's Towhead | 75.3 | 2:20 PM | 1.0 | 85.3 | 84.2 | 5.7 | 77.7% | 6.3 | 831 | 0.2 | 0.2 | 1.8 | 2.3 |
| La Grange Reach | | | | | | | | | | 0.0 | | | | | |
| 23 | 24-Sep | Grape-Bar Islands | 86.4 | 12:49 PM | 1.0 | 67.1 | 72.1 | 5.2 | 59.7% | 6.3 | 880 | 0.7 | 0.6 | 1.8 | 9.6 |
| 22 | 24-Sep | Sugar Creek Island | 94.8 | 10:05 AM | 1.0 | 64.5 | 72.3 | 5.2 | 58.1% | 6.3 | 866 | 1.0 | 0.3 | 1.5 | 9.6 |
| 6 | 10-Sep | Lower Bath Chute | 107.1 | 9:25 AM | 1.0 | 75.9 | 81.3 | 3.8 | 47.6% | 6.3 | 760 | 0.5 | 0.6 | 2.0 | 5.2 |
| 1 | 5-Sep | Upper Bath Chute | 113.0 | 12:49 PM | 1.0 | 86.0 | 82.6 | 4.4 | 60.4% | 7.5 | 809 | 0.3 | 0.5 | 1.5 | 5.5 |
| 12 | 17-Sep | Turkey Island | 148.2 | 10:02 AM | 0.8 | 57.4 | 72.7 | 5.8 | 59.9% | 8.7 | 877 | 0.9 | 0.2 | 2.0 | 2.5 |
| 13 | 17-Sep | Pekin | 154.9 | 11:54 AM | 1.0 | 63.5 | 68.5 | 8.0 | 88.4% | 7.5 | 891 | 0.5 | 0.2 | 2.4 | 430.6 |
| Peoria Reach | | | | | | | | | | | | | | | |
| 10 | 16-Sep | Lower Peoria Lake | 163.6 | 10:20 AM | 1.0 | 68.9 | 64.8 | 4.5 | 52.6% | 5.9 | 1040 | 0.0 | 0.5 | 1.8 | 12.2 |
| 11 | 16-Sep | Lambie's Boat Harbor[c] | 170.4 | - | - | 71.1 | 71.4 | 10.5 | 125.5% | 4.3 | 830 | 0.0 | 0 | 0 | 12.2 |
| 5 | 9-Sep | Chillicothe | 180.9 | 2:16 PM | 1.0 | 86.5 | 84.0 | 5.3 | 73.0% | 10.6 | 864 | 0.2 | 0.6 | 2.4 | 14.6 |
| 4 | 10-Sep | Henry Island | 193.9 | 11:30 AM | 1.0 | 83.6 | 81.7 | 4.6 | 61.8% | 11.8 | 869 | 0.2 | 0.6 | 2.6 | 14.6 |
| 8 | 12-Sep | Lower Twin Sister | 202.8 | 12:39 PM | 1.0 | 79.3 | 83.1 | 5.4 | 69.8% | 14.6 | 894 | 0.5 | 0.3 | 1.8 | 14.6 |
| 7 | 12-Sep | Upper Twin Sister | 203.4 | 10:28 AM | 1.0 | 78.1 | 82.2 | 4.4 | 56.2% | 14.6 | 886 | 0.5 | 0.3 | 2.3 | 14.6 |
| 9 | 12-Sep | Hennepin | 207.9 | 2:35 PM | 1.0 | 82.4 | 84.0 | 6.8 | 90.4% | 20.1 | 882 | 0.4 | 0.6 | 2.0 | 14.6 |
| 14 | 18-Sep | Clark Island | 215.3 | 10:18 AM | 1.0 | 71.2 | 71.1 | 5.6 | 67.0% | 13.4 | 856 | 0.5 | 0.3 | 2.4 | 10.8 |
| Starved Rock Reach | | | | | | | | | | | | | | | |
| 16 | 18-Sep | Bulls Island | 240.7 | 2:36 PM | 0.5 | 80.8 | 75.6 | 6.9 | 90.4% | 28.0 | 829 | 0.8 | 0.2 | 1.2 | 458.9 |
| 15 | 18-Sep | Bulls Island Bend | 241.4 | 1:30 PM | 1.0 | 77.4 | 75.0 | 6.7 | 85.1% | 33.1 | 833 | 0.2 | 0.3 | 1.5 | 458.9 |
| Marseilles Reach | | | | | | | | | | | | | | | |
| 17 | 19-Sep | Ballards Island | 248.0 | 8:43 AM | 1.0 | 70.2 | 76.8 | 6.1 | 72.3% | 24.4 | 870 | 0.7 | 0.2 | 2.4 | 6.4 |
| 18 | 19-Sep | Johnson Island | 249.8 | 10:07 AM | 0.7 | 76.1 | 77.4 | 6.3 | 79.0% | 26.4 | 828 | 0.8 | 0.2 | 1.8 | 6.4 |
| 19 | 19-Sep | Waupecan Island | 260.7 | 12:50 PM | 1.0 | 80.8 | 79.0 | 6.6 | 86.5% | 29.9 | 841 | 0.4 | 0.2 | 2.3 | 6.4 |
| Dresden Reach, Des Plains River | | | | | | | | | | | | | | | |
| 21 | 19-Sep | Du Page River | 277.3 | 5:56 PM | 1.0 | 87.3 | 82.4 | 5.7 | 79.1% | 20.5 | 844 | 0.0 | 0.6 | 3.0 | 505.3 |
| 20 | 19-Sep | Treats Island | 279.9 | 4:00 PM | 1.0 | 88.1 | 82.6 | 6.4 | 89.4% | 27.2 | 835 | 1.2 | 0.3 | 1.5 | 505.3 |

[a] Refers to approximate average river mile electrofished at each site, 1957-2013.

[b] Feet above sea level or river stage (ft) at the U.S. Army Corps of Engineers river gage nearest to the sampling site.

[c] Lambie's Boat Harbor site (RM 170.6) remained inaccessable throughout 2013 sampling period; sampling was attempted 9/16/2013

Appendix III. Numbers of each fish species collected using AC electrofishing at standardized locations in the Lower Illinois River (Alton and LaGrange Reaches, RM 0-158) during 2013.

| | | Lower Illinois River | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | River Mile | 0.0 | 19.0 | 24.7 | 26.8 | 30.0 | 58.3 | 75.3 | 86.5 | 95.1 | 107.1 | 113.0 | 148.0 | 155.1 |
| Species | Effort (hour) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.67 | 1.0 |
| **Amiidae** | | | | | | | | | | | | | | |
| Bowfin | | | | 1 | | | | | | | | | | |
| **Atherinidae** | | | | | | | | | | | | | | |
| Brook Silverside | | | 1 | | | | 2 | | | | 1 | 1 | | |
| **Catastomidae** | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | | 1 | 1 | 3 | 1 | | 3 | 2 | | 2 | | 1 |
| Black Buffalo | | | | 2 | | | | | | 1 | | | | |
| Golden Redhorse | | 1 | | | | | | | | | | | | 1 |
| Quillback | | | | | | | 1 | 1 | | | | | | |
| River Carpsucker | | 1 | | | | | 1 | 5 | 4 | | | 1 | 1 | 1 |
| River Redhorse | | 1 | | | | 1 | | 1 | | | | 1 | | |
| Shorthead Redhorse | | 1 | 2 | | 3 | | | | | | 2 | | | |
| Smallmouth Buffalo | | 51 | 13 | 6 | 8 | 6 | | 6 | 20 | 5 | 5 | 2 | 6 | 7 |
| **Centrarchidae** | | | | | | | | | | | | | | |
| Black Crappie | | 1 | | 2 | | 1 | 2 | | 3 | | 2 | | 1 | |
| Bluegill | | 5 | 27 | 34 | 38 | 15 | 23 | 4 | 20 | 7 | 8 | 3 | 4 | |
| Green Sunfish | | | | 2 | 2 | 1 | 6 | | | | 1 | | | |
| Largemouth Bass | | 1 | 2 | 2 | 5 | | 2 | | 3 | 1 | | | 1 | |
| Orange Spotted Sunfish | | 10 | | | | 1 | 1 | | 2 | | | | | |
| Smallmouth Bass | | | | 1 | | | | | | | 1 | | | |
| Warmouth | | | | | | | | | | 1 | | | | |
| White Crappie | | | | | | | | | 1 | | | 1 | | |
| **Clupeidae** | | | | | | | | | | | | | | |
| Gizzard Shad | | 217 | 44 | 8 | 54 | 28 | 81 | 161 | 101 | 20 | 5 | 26 | 18 | 29 |
| Skipjack Herring | | | | | | | | | | | 1 | | | |
| Threadfin Shad | | | | | | | | | | | | | 3 | 15 |
| **Cyprinidae** | | | | | | | | | | | | | | |
| Bighead Carp | | | | | | | 1 | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | | 2 | | | | | | | |
| Bullhead Minnow | | 26 | 9 | 7 | 23 | 9 | 12 | | 19 | 13 | 9 | 7 | 5 | 2 |
| Common Carp | | 2 | 4 | 7 | 1 | 6 | 1 | 1 | 5 | 26 | 13 | 5 | | 4 |
| Common Carp X Goldfish | | | 1 | 2 | 1 | | | | | | | | | |
| Emerald Shiner | | | 23 | 29 | 37 | 19 | 4 | 4 | 9 | 1 | 10 | 4 | 24 | 10 |
| Goldfish | | | | 1 | | | | | | | | | | 1 |
| Grass Carp | | 1 | 1 | 1 | 1 | | 2 | | | 3 | 1 | 1 | 1 | |
| Red Shiner | | | | 1 | | 7 | 6 | | | | | | | |
| River Shiner | | 1 | 3 | | 2 | | | | 1 | 1 | 1 | | | |
| Sand Shiner | | | | | | | | | | | 5 | | 2 | |
| Silver Carp | | | 14 | 3 | | 9 | 5 | 4 | 38 | 15 | 2 | 36 | 8 | 5 |
| Silver Chub | | 2 | 1 | 6 | | 1 | | | | | | | 2 | 1 |
| Spotfin Shiner | | | | 4 | | | | | | | | 1 | | |
| Spottail Shiner | | | | | | | | | | | | | | 1 |
| Unidentified Minnow species | | | | | 1 | | | | | | | | | |

Appendix III (continued). Numbers of each fish species collected using AC electrofishing at standardized locations in the Lower Illinois River (Alton and LaGrange Reaches, RM 0-158) during 2013.

| | | Lower Illinois River | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | River Mile | 0.0 | 19.0 | 24.7 | 26.8 | 30.0 | 58.3 | 75.3 | 86.5 | 95.1 | 107.1 | 113.0 | 148.0 | 155.1 |
| Species | Effort (hour) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.67 | 1.0 |
| **Hiodontidae** | | | | | | | | | | | | | | |
| Goldeye | | | | | | | | | | | | | | 2 |
| **Ictaluridae** | | | | | | | | | | | | | | |
| Blue Catfish | | | | | | | | | 1 | | | | | |
| Channel Catfish | | 3 | 12 | 11 | 7 | 33 | 7 | 9 | 7 | 4 | 10 | 3 | 9 | 2 |
| Flathead Catfish | | | 1 | 3 | 2 | 2 | | | 2 | 1 | 5 | 2 | 3 | |
| **Lepisosteidae** | | | | | | | | | | | | | | |
| Longnose Gar | | | | | | | | | | | 1 | | | |
| Shortnose Gar | | | | | | | | | | 1 | | | | |
| **Moronidae** | | | | | | | | | | | | | | |
| White Bass | | 1 | 9 | 9 | 8 | 14 | 6 | 19 | 12 | 4 | 13 | 4 | 7 | 2 |
| White Perch | | | | | | | | | | | | 1 | | |
| Yellow Bass | | | | | | 5 | | | | 1 | | | | 1 |
| **Percidae** | | | | | | | | | | | | | | |
| Logperch | | | | | | | 1 | | 1 | | | | | |
| Sauger | | | | | | 1 | | | | | | | 3 | 5 |
| Walleye | | | | | | 1 | | | | | | | | |
| **Poeciliidae** | | | | | | | | | | | | | | |
| Western Mosquitofish | | | | | | | | | | 1 | | | | |
| **Sciaenidae** | | | | | | | | | | | | | | |
| Freshwater Drum | | 41 | 34 | 41 | 18 | 37 | 26 | 50 | 38 | 58 | 35 | 17 | 24 | 34 |
| Total Individuals | | 367 | 221 | 210 | 240 | 231 | 252 | 341 | 378 | 262 | 239 | 232 | 271 | 280 |
| Total species/hybrids | | 18/0 | 17/1 | 23/1 | 16/1 | 21/0 | 21/1 | 12/0 | 20/0 | 20/0 | 21/0 | 19/0 | 18/0 | 19/0 |

Appendix III (continued). Numbers of each fish species collected using AC electrofishing at standardized locations in the Lower Illinois River (Peoria Reach, RM 158-231) during 2013.

| | | Lower Illinois River | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Family** | River Mile | 163.4 | 180.6 | 193.8 | 202.8 | 203.3 | 207.7 | 215.3 |
| Species | Effort (hour) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Catastomidae** | | | | | | | | |
| Bigmouth Buffalo | | 8 | 5 | | 4 | 9 | 7 | 1 |
| Golden Redhorse | | | | | 1 | | 1 | 1 |
| Quillback | | 2 | | | | | | |
| River Carpsucker | | | | | | | | 1 |
| River Redhorse | | | | | 1 | | | |
| Shorthead Redhorse | | | 2 | | | | | 2 |
| Smallmouth Buffalo | | 15 | 36 | 11 | 12 | 34 | 8 | 26 |
| **Centrarchidae** | | | | | | | | |
| Black Crappie | | | 1 | | 1 | | 1 | 1 |
| Bluegill | | 128 | 48 | 5 | 13 | 13 | 12 | 22 |
| Bluegill X Green Sunfish | | | | | 1 | | | |
| Bluegill X Orange Spotted Sunfish | | 1 | 1 | | | | | 1 |
| Green Sunfish | | 15 | 1 | 1 | | 2 | 2 | 12 |
| Largemouth Bass | | 10 | 2 | | 2 | 2 | 5 | 2 |
| Orange Spotted Sunfish | | 7 | 5 | 7 | | | 4 | |
| Pumpkinseed | | | 1 | | | | | |
| Smallmouth Bass | | 1 | | | | | | 2 |
| Unidentified *Lepomis* hybrid | | 1 | | | | | | |
| **Clupeidae** | | | | | | | | |
| Gizzard Shad | | 40 | 1 | 9 | 16 | 3 | 25 | 15 |
| Skipjack Herring | | 1 | 1 | | | | | 2 |
| Threadfin Shad | | | 1 | | 1 | | 4 | 11 |
| **Cyprinidae** | | | | | | | | |
| Bullhead Minnow | | 13 | 4 | 7 | 1 | 2 | 2 | 11 |
| Common Carp | | 5 | 5 | 1 | 1 | 4 | 1 | 13 |
| Emerald Shiner | | 4 | 1 | 8 | 29 | 14 | 2 | 9 |
| Grass Carp | | | 1 | | 3 | | | |
| Red Shiner | | 5 | | 4 | | | | |
| Silver Carp | | 1 | 11 | 27 | 10 | 56 | 35 | 15 |
| Silver Chub | | 1 | | | | | | 1 |
| Spotfin Shiner | | | 2 | 2 | | | | 10 |
| Spottail Shiner | | | 10 | 4 | 4 | | 15 | |
| **Gobiidae** | | | | | | | | |
| Round Goby | | | | | 1 | | 1 | |
| **Ictaluridae** | | | | | | | | |
| Channel Catfish | | 17 | 2 | 2 | 10 | 4 | 2 | 7 |
| Flathead Catfish | | | 1 | | 2 | 3 | | 1 |
| **Moronidae** | | | | | | | | |
| White Bass | | 2 | 7 | 5 | 4 | 3 | | 4 |
| **Percidae** | | | | | | | | |
| Logperch | | | | | | | 9 | |
| Sauger | | | | | 1 | | 4 | 4 |
| Walleye | | | 4 | 1 | | | | |
| **Sciaenidae** | | | | | | | | |
| Freshwater Drum | | 79 | 16 | 6 | 7 | 4 | 7 | 6 |
| Total individuals | | 356 | 169 | 100 | 125 | 153 | 147 | 180 |
| Total species/hybrids | | 19/1 | 24/1 | 16/0 | 21/1 | 14/0 | 20/0 | 24/1 |

Appendix III (continued). Numbers of each fish species collected using AC electrofishing at standardized locations in the Upper Illinois River (Starved Rock, Marseilles, and Dresden Reaches, RM 231-280) during 2013.

| | | Upper Illinois River | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Family** | River Mile | 240.8 | 241.5 | 248.0 | 249.6 | 260.6 | 277.4 | 279.8 |
| Species | Effort (hour) | 0.5 | 1.0 | 1.0 | 0.7 | 1.0 | 1.0 | 1.0 |
| **Atherinidae** | | | | | | | | |
| Brook Silverside | | | | 2 | | 1 | 3 | |
| **Catastomidae** | | | | | | | | |
| Golden Redhorse | | | 3 | 1 | | 2 | | |
| Quillback | | 1 | 4 | 1 | 3 | | | |
| River Carpsucker | | | | | | 1 | | |
| Shorthead Redhorse | | | | | 1 | | | |
| Silver Redhorse | | | | | | 1 | | |
| Smallmouth Buffalo | | | 3 | 5 | 1 | 5 | | |
| White Sucker | | | | | | | 2 | |
| **Centrarchidae** | | | | | | | | |
| Bluegill | | 6 | 30 | 27 | 7 | 48 | 64 | 77 |
| Bluegill X Green Sunfish | | 3 | | | | | 2 | 4 |
| Bluegill X Orange Spotted Sunfish | | 1 | | | | | | |
| Green Sunfish | | 7 | 11 | 5 | 1 | 4 | 8 | 19 |
| Largemouth Bass | | 1 | | 9 | 1 | 2 | 7 | 26 |
| Longear Sunfish | | | | | | | 1 | |
| Orange Spotted Sunfish | | 2 | | | | | | |
| Pumpkinseed | | | | | | | 2 | |
| Redear Sunfish X Green Sunfish | | | | 3 | | 3 | | 1 |
| Rock Bass | | | | | | | 6 | |
| Smallmouth Bass | | 2 | 2 | 6 | 2 | 2 | 11 | |
| Unidentified *Lepomis* hybrid | | 1 | | | | 1 | 2 | 13 |
| **Clupeidae** | | | | | | | | |
| Gizzard Shad | | 3 | 15 | 16 | 17 | 12 | 77 | 7 |
| Threadfin Shad | | | | | | | 2 | |
| **Cyprinidae** | | | | | | | | |
| Bluntnose Minnow | | | 7 | | | | 1 | 1 |
| Bullhead Minnow | | 21 | 15 | 49 | 44 | 5 | 4 | 49 |
| Common Carp | | | 1 | 1 | | 2 | 6 | 3 |
| Creek Chub | | | | | 2 | | | |
| Emerald Shiner | | 77 | 43 | 6 | 34 | 3 | 4 | |
| Goldfish | | | | | | | 1 | |
| River Shiner | | | | 36 | 1 | | | |
| Sand Shiner | | | | | 3 | 9 | | |
| Silver Carp | | | | | 1 | | | |
| Spotfin Shiner | | 25 | 21 | | 50 | | | |
| Spottail Shiner | | | 1 | | | | | |
| **Gobiidae** | | | | | | | | |
| Round Goby | | | 1 | | | | | |
| **Ictaluridae** | | | | | | | | |
| Brown Bullhead | | | | | | | 1 | |
| Channel Catfish | | | 5 | 1 | | 4 | 1 | 1 |
| Flathead Catfish | | 1 | 1 | | | | 1 | |
| Yellow Bullhead | | | | | | | | 2 |
| **Moronidae** | | | | | | | | |
| White Bass | | | 1 | | | | | |
| **Sciaenidae** | | | | | | | | |
| Freshwater Drum | | 1 | 2 | | | | | 1 |
| Total individuals | | 152 | 166 | 168 | 168 | 105 | 206 | 204 |
| Total species/hybrids | | 12/3 | 18/0 | 14/1 | 15/0 | 15/2 | 19/2 | 10/3 |

Appendix IV. Biomass (lb) of each fish species collected using AC electrofishing at standardized locations in the Lower Illinois River (Alton and LaGrange Reaches, RM 0-158) during 2013. Species comprising <0.1% of relative biomass were not included in table.

| | | Mississippi | Lower Illinois River | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | River Mile | 205.1 | 19.0 | 24.7 | 26.8 | 30.0 | 58.3 | 75.3 | 86.5 | 95.1 | 107.1 | 113.0 | 148.0 | 155.1 |
| species | Effort (h) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.7 | 1.0 |
| **Amiidae** | | | | | | | | | | | | | | |
| Bowfin | | | | 3.64 | | | | | | | | | | |
| **Catastomidae** | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | | 1.98 | 2.65 | 11.45 | 1.86 | | 7.41 | 7.25 | | 5.15 | | 1.98 |
| Black Buffalo | | | | 4.01 | | | | | | 3.24 | | | | |
| Golden Redhorse | | 0.11 | | | | | | | | | | | | 1.22 |
| Quillback | | | | | | | 0.05 | 1.66 | | | | | | |
| River Carpsucker | | 0.07 | | | | | 0.09 | 0.81 | 4.31 | | | 0.29 | 0.40 | 0.31 |
| River Redhorse | | 0.26 | | | | 0.43 | | 0.30 | | | | 0.24 | | |
| Shorthead Redhorse | | 0.06 | 0.04 | | 0.66 | | | | | | 0.02 | | | |
| Smallmouth Buffalo | | 3.09 | 1.30 | 1.68 | 5.77 | 0.38 | | 0.20 | 26.56 | 11.42 | 11.10 | 0.24 | 13.03 | 15.58 |
| **Centrarchidae** | | | | | | | | | | | | | | |
| Black Crappie | | 0.35 | | 0.04 | | 0.01 | 1.46 | | 0.06 | | 0.96 | | 0.27 | |
| Bluegill | | 0.44 | 1.59 | 1.83 | 3.03 | 1.11 | 1.14 | 0.45 | 0.69 | 0.14 | 0.14 | 0.07 | 0.41 | |
| Green Sunfish | | | | 0.13 | 0.02 | | 0.03 | | | | | | | |
| Largemouth Bass | | 0.09 | 0.97 | 0.42 | 3.00 | | 0.82 | | | | | | 0.15 | |
| Orange Spotted Sunfish | | 0.11 | | | | | | | | | | | | |
| Smallmouth Bass | | | | 0.95 | | | | | | | | | | |
| White Crappie | | | | | | | | | 0.52 | | | 0.56 | | |
| **Clupeidae** | | | | | | | | | | | | | | |
| Gizzard Shad | | 3.43 | 0.53 | 0.15 | 0.93 | 0.44 | 1.72 | 2.61 | 1.69 | 0.29 | 0.39 | 0.30 | 0.29 | 0.47 |
| Skipjack Herring | | | | | | | | | | | 0.07 | | | |
| Threadfin Shad | | | | | | | | | | | | | 0.04 | 0.14 |
| **Cyprinidae** | | | | | | | | | | | | | | |
| Bighead Carp | | | | | | | 3.76 | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | | 7.31 | | | | | | | |
| Bullhead Minnow | | 0.07 | | | 0.12 | | | | | | | | | |
| Common Carp | | 4.55 | 9.71 | 27.11 | 0.63 | 22.50 | 2.97 | 0.12 | 29.49 | 133.79 | 42.79 | 10.88 | | 5.74 |
| Common Carp X Goldfish | | | 3.70 | 1.72 | 2.55 | | | | | | | | | |
| Emerald Shiner | | | 0.05 | 0.07 | 0.09 | 0.06 | | | | | | | 0.08 | 0.03 |
| Goldfish | | | | 1.36 | | | | | | | | | | 0.03 |
| Grass Carp | | 6.09 | 6.65 | 4.05 | 5.47 | | 11.96 | | | 13.85 | 3.88 | 5.06 | 5.54 | |
| Silver Carp | | | 51.23 | 9.45 | | 31.11 | 17.89 | 14.50 | 136.98 | 56.44 | 7.09 | 112.82 | 24.55 | 13.88 |
| Silver Chub | | | | 0.04 | | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | | |
| Goldeye | | | | | | | | | | | | | | 0.08 |
| **Ictaluridae** | | | | | | | | | | | | | | |
| Blue Catfish | | | | | | | | | 1.42 | | | | | |
| Channel Catfish | | 2.77 | 15.87 | 11.03 | 8.84 | 53.88 | 5.67 | 5.21 | 8.32 | 4.93 | 18.62 | 5.08 | 0.91 | 1.08 |
| Flathead Catfish | | | | 2.54 | 1.44 | 3.22 | | | 34.83 | 2.28 | 1.48 | 0.53 | 2.69 | |
| **Lepisosteidae** | | | | | | | | | | | | | | |
| Longnose Gar | | | | | | | | | | | 1.51 | | | |
| Shortnose Gar | | | | | | | | | | 1.22 | | | | |
| **Moronidae** | | | | | | | | | | | | | | |
| White Bass | | 0.05 | 0.44 | 3.65 | 0.30 | 1.78 | 1.92 | 1.31 | 1.37 | 1.74 | 0.35 | 0.11 | 0.29 | 0.04 |
| Yellow Bass | | | | | | 0.16 | | | | 0.57 | | | | 0.02 |
| **Percidae** | | | | | | | | | | | | | | |
| Sauger | | | | | | 0.11 | | | | | | | 0.32 | 0.30 |
| Walleye | | | | | | 0.28 | | | | | | | | |
| **Sciaenidae** | | | | | | | | | | | | | | |
| Freshwater Drum | | 0.85 | 4.06 | 6.48 | 1.49 | 3.99 | 1.07 | 3.55 | 3.16 | 15.66 | 6.40 | 0.53 | 1.14 | 1.98 |
| Total fish biomass/site | | 22.39 | 96.14 | 82.33 | 36.99 | 130.91 | 59.72 | 30.72 | 51.77 | 77.49 | 46.34 | 41.01 | 11.35 | 8.73 |

Appendix IV (continued). Biomass (lb) of each fish species collected using AC electrofishing at standardized locations in the Lower Illinois River (Peoria Reach, RM 158-231) during 2013. Species comprising <0.1% of relative biomass were not included in table.

| | | Lower Illinois River | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Family** | River Mile | 163.4 | 180.6 | 193.8 | 202.8 | 203.3 | 207.7 | 215.3 |
| species | Effort (h) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **Catastomidae** | | | | | | | | |
| Bigmouth Buffalo | | 19.28 | 10.64 | | 10.40 | 26.04 | 16.43 | 1.73 |
| Golden Redhorse | | | | | 0.52 | | 0.01 | 0.33 |
| Quillback | | 2.11 | | | | | | |
| River Carpsucker | | | | | | | | 1.96 |
| River Redhorse | | | | | 1.83 | | | |
| Shorthead Redhorse | | | 0.11 | | | | | 0.27 |
| Smallmouth Buffalo | | 10.58 | 13.68 | 19.02 | 20.40 | 66.88 | 16.93 | 48.28 |
| **Centrarchidae** | | | | | | | | |
| Black Crappie | | | 0.63 | | 0.76 | | 0.89 | 0.38 |
| Bluegill | | 10.20 | 2.08 | 0.52 | 1.25 | 1.97 | 0.46 | 1.63 |
| Green Sunfish | | 1.52 | | | | | | 0.19 |
| Largemouth Bass | | 3.11 | 0.93 | | 2.17 | 0.63 | 2.90 | 1.16 |
| Orange Spotted Sunfish | | 0.10 | | | | | | |
| **Clupeidae** | | | | | | | | |
| Gizzard Shad | | 2.62 | | 0.16 | 0.26 | | 0.39 | 0.37 |
| Skipjack Herring | | | 0.06 | | | | | |
| **Cyprinidae** | | | | | | | | |
| Common Carp | | 20.82 | 21.76 | 4.92 | 4.74 | 13.22 | 4.78 | 47.25 |
| Emerald Shiner | | | | | 0.11 | | | |
| Grass Carp | | | 3.11 | | 13.25 | | | |
| Silver Carp | | 2.77 | 26.75 | 66.20 | 26.26 | 158.45 | 92.49 | 47.31 |
| Spottail Shiner | | | 0.05 | | | | 0.09 | |
| **Ictaluridae** | | | | | | | | |
| Channel Catfish | | 22.62 | 5.65 | 4.62 | 10.66 | 7.84 | 1.24 | 10.71 |
| Flathead Catfish | | | 0.41 | | 1.15 | 5.74 | | 3.38 |
| **Moronidae** | | | | | | | | |
| White Bass | | 0.09 | 3.25 | 1.07 | 3.81 | 2.48 | | 1.55 |
| **Percidae** | | | | | | | | |
| Logperch | | | | | | | 0.10 | |
| Sauger | | | | | 0.10 | | 1.25 | 0.21 |
| Walleye | | | 0.17 | | | | | |
| **Sciaenidae** | | | | | | | | |
| Freshwater Drum | | 41.15 | 2.30 | 0.14 | 2.45 | 1.69 | 1.99 | 3.33 |
| Total fish biomass/site | | 136.97 | 91.58 | 96.65 | 100.12 | 284.94 | 139.95 | 170.04 |

Appendix IV (continued). Biomass (lb) of each fish species collected using AC electrofishing at standardized locations in the Upper Illinois River (Starved Rock, Marseilles, and Dresden Reaches, RM 231-280) during 2013. Species comprising <0.1% of relative biomass were not included in table.

| | | Upper Illinois River | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Family** | Mile | 240.8 | 241.5 | 248.0 | 249.6 | 260.6 | 277.4 | 279.8 |
| species | Effort | 0.50 | 1.00 | 1.00 | 0.70 | 1.00 | 1.00 | 1.00 |
| **Catastomidae** | | | | | | | | |
| Golden Redhorse | | | 0.59 | 0.12 | | 1.44 | | |
| Quillback | | 0.39 | 3.58 | 0.87 | 2.03 | | | |
| River Carpsucker | | | | | | 1.38 | | |
| Shorthead Redhorse | | | | | 0.33 | | | |
| Silver Redhorse | | | | | | 3.58 | | |
| Smallmouth Buffalo | | | 5.61 | 14.18 | 1.53 | 9.16 | | |
| White Sucker | | | | | | | 0.46 | |
| **Centrarchidae** | | | | | | | | |
| Bluegill | | 0.38 | 1.41 | 1.58 | 0.56 | 1.80 | 4.19 | 4.61 |
| Bluegill X Green Sunfish | | 0.06 | | | | | 0.12 | 0.17 |
| Bluegill X Orange Spotted Sunfish | | 0.04 | | | | | | |
| Green Sunfish | | 0.28 | 0.34 | 0.22 | 0.03 | 0.13 | 0.36 | 0.97 |
| Largemouth Bass | | 0.04 | | 1.23 | 0.02 | 0.22 | 3.02 | 3.27 |
| Orange Spotted Sunfish | | 0.01 | | | | | | |
| Pumpkinseed | | | | | | | 0.14 | |
| Redear Sunfish X Green Sunfish | | | | 0.11 | | 0.10 | | 0.06 |
| Rock Bass | | | | | | | 0.23 | |
| Smallmouth Bass | | 0.87 | 0.34 | 2.50 | 1.21 | 0.24 | 2.60 | |
| **Clupeidae** | | | | | | | | |
| Gizzard Shad | | 0.79 | 2.96 | 3.10 | 2.77 | 2.22 | 12.78 | 2.39 |
| **Cyprinidae** | | | | | | | | |
| Bullhead Minnow | | 0.04 | 0.03 | 0.12 | 0.07 | | | 0.18 |
| Common Carp | | | 2.64 | 2.61 | | 6.55 | 20.58 | 7.20 |
| Creek Chub | | | | | 0.02 | | | |
| Emerald Shiner | | 0.31 | 0.17 | 0.04 | 0.20 | | | |
| Goldfish | | | | | | | 0.63 | |
| River Shiner | | | | 0.08 | | | | |
| Sand Shiner | | | | | | 0.02 | | |
| Silver Carp | | | | | 2.89 | | | |
| Spotfin Shiner | | 0.06 | 0.05 | | 0.18 | | | |
| **Ictaluridae** | | | | | | | | |
| Brow n Bullhead | | | | | | | 0.71 | |
| Channel Catfish | | | 12.13 | 0.29 | | 7.66 | 2.85 | 3.84 |
| Flathead Catfish | | 0.36 | 0.83 | | | | 5.42 | |
| Yellow Bullhead | | | | | | | | 0.71 |
| **Moronidae** | | | | | | | | |
| White Bass | | | 0.10 | | | | | |
| **Sciaenidae** | | | | | | | | |
| Freshw ater Drum | | 0.17 | 0.35 | | | | | 1.07 |
| Total fish biomass/site | | 3.80 | 31.13 | 27.05 | 11.84 | 34.50 | 54.09 | 24.47 |

Appendix V. Numbers of each fish species collected during 2013 using pulsed-DC electrofishing in five reaches of the Illinois River.

| | | Upper Illinois River | | | | | | | | | Lower Illinois River | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reach | Dresden | | | Marseilles | | | Starved Rock | | | Peoria | | | Alton | | |
| **Family** | Effort/time period (h) | 0.75 | | | 1.5 | | | 0.75 | | | 3.50 | | | 3.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | | | | |
| Bowfin | | | | | | | | | | | 2 | | | | | |
| **Anguillidae** | | | | | | | | | | | | | | | | |
| American Eel | | | | | | | | | | | | | | 1 | | |
| **Atherinidae** | | | | | | | | | | | | | | | | |
| Brook Silverside | | | | | | | | | | | | | | 3 | 5 | 2 |
| **Catostomidae** | | | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | | | | | | | | | 2 | 2 | 3 | 3 | 4 | |
| Black Buffalo | | | | | | | | | | | | | | 9 | 6 | 6 |
| Golden Redhorse | | | | | 4 | 2 | 1 | 3 | | | 5 | | 3 | | | 2 |
| Greater Redhorse | | | | | | | | | | | | | 1 | | | |
| Northern Hogsucker | | | | | | | | | | | | | 1 | | | |
| Quillback | | | | | | | | | 1 | | | | 4 | | | |
| River Carpsucker | | | 1 | | | 1 | 3 | 1 | 5 | | 7 | 1 | 4 | 5 | 18 | 24 |
| River Redhorse | | | | | | | | | | | | 1 | | | | |
| Shorthead Redhorse | | | | | 1 | | | 2 | | 1 | | 3 | 1 | 2 | 14 | 4 |
| Smallmouth Buffalo | | 2 | 2 | | 6 | 9 | 36 | 3 | 8 | 12 | 7 | 13 | 20 | 3 | 62 | 84 |
| Unidentified Catastomid | | | | | | | | | | | 13 | 8 | 20 | 6 | | |
| **Centrarchidae** | | | | | | | | | | | | | | | | |
| Black Crappie | | | | | | | | | | | | 2 | | | | 2 |
| Bluegill | | 42 | 13 | 111 | 19 | 7 | 12 | 1 | 2 | 3 | 9 | 24 | 37 | 7 | 16 | 8 |
| Bluegill X Green Sunfish | | 1 | | | | | 1 | | | | | | | | | |
| Bluegill X Orange Spotted Sunfish | | | | | 1 | | | | | | | 3 | | | | |
| Bluegill X Redear Sunfish | | | | | | 1 | | | | | | | | | | |
| Green Sunfish | | 28 | 3 | 6 | 3 | 2 | 9 | 1 | 1 | 1 | | 1 | 2 | | 1 | |
| Green Sunfish X Orange Spotted Sunfish | | 1 | | | | | | | | | | | | | | |
| Largemouth Bass | | 16 | 3 | 13 | 6 | 1 | 2 | 2 | | 2 | 1 | | 5 | 3 | 3 | 2 |
| Orange Spotted Sunfish | | | | | | | | | | | | 5 | | 1 | 4 | 2 |
| Pumpkinseed | | | | | | 2 | | | | | | 1 | | | | |
| Pumpkinseed X Bluegill | | | | 2 | | | | | | | | | | | | |
| Redear Sunfish | | | | 10 | | | | | | | | | | | 1 | |
| Smallmouth Bass | | 3 | | | 19 | 1 | 1 | 14 | 4 | | 1 | 3 | 1 | | | |
| White Crappie | | | | | | | | | | | 1 | | | 1 | 2 | 2 |
| **Clupeidae** | | | | | | | | | | | | | | | | |
| Gizzard Shad | | 8 | 27 | 30 | 22 | 26 | 150 | 19 | 31 | 79 | 91 | 83 | 259 | 91 | 100 | 608 |
| Skipjack Herring | | | | | | | | | 1 | 1 | 3 | 8 | 22 | 9 | 5 | 6 |
| Threadfin Shad | | | | | | | | | | | 1 | | 10 | | 1 | 4 |
| **Cyprinidae** | | | | | | | | | | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | | | | | | 1 | 1 | | 1 | | |
| Bluntnose Minnow | | 1 | 2 | | 10 | 1 | 2 | | | | 2 | 1 | 1 | | | |
| Bullhead Minnow | | | | 10 | 13 | | 15 | 8 | 13 | 10 | 17 | 7 | 24 | 7 | 15 | 28 |
| Central Stoneroller | | | | 1 | | | 1 | | | | | | | | | |
| Channel Shiner | | | | | | | | | | | | | | 7 | 10 | |
| Common Carp | | 7 | 2 | 5 | | 1 | 1 | 2 | | | 8 | 3 | 75 | 15 | 47 | 98 |
| Emerald Shiner | | 2 | | | 12 | 3 | 14 | 14 | 11 | 15 | 30 | 43 | 45 | 36 | 27 | 66 |
| Fathead Minnow | | | | | | | | | | | 1 | | | | | |
| Golden Shiner | | | | | | | | | | | 2 | | | 3 | | |
| Goldfish | | | | 1 | | | | | | | 2 | | | | | |
| Grass Carp | | | | | | | 1 | | | | | 2 | 2 | | | 8 |

Appendix V (continued). Numbers of each fish species collected during 2013 using pulsed-DC electrofishing in five reaches of the Illinois River.

| | | Upper Illinois River | | | | | | | | | Lower Illinois River | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reach | Dresden | | | Marseilles | | | Starved Rock | | | Peoria | | | Alton | | |
| **Family** | Effort/time period (h) | 0.75 | | | 1.5 | | | 0.75 | | | 3.50 | | | 3.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Cyprinidae (Cont.)** | | | | | | | | | | | | | | | | |
| Red Shiner | | | | | | | | | | | 9 | | 1 | 9 | | 2 |
| Redfin Shiner | | | | | | | | | 1 | | | | | | | |
| River Shiner | | | | | 88 | 4 | 9 | 7 | | 5 | 15 | 3 | 1 | 2 | | 8 |
| Sand Shiner | | | | | 6 | | 9 | | | 6 | 2 | | 6 | | | |
| Silver Carp | | | | | | | | 5 | 3 | | 11 | 54 | 78 | 9 | 22 | 38 |
| Silver Chub | | | | | | | | | | | 2 | | 2 | | 10 | 44 |
| Silverband Shiner | | | | | | | | | | | | 1 | | 1 | 1 | 2 |
| Spotfin Shiner | | | | | 39 | 8 | 3 | 2 | 6 | 3 | 8 | 11 | | 28 | 5 | 12 |
| Spottail Shiner | | | | 3 | 5 | 1 | 1 | 2 | 5 | 3 | 4 | 20 | 15 | | | |
| Striped Shiner | | | | | | | | | | | | 3 | | | | |
| Suckermouth Minnow | | | | | | | | | | | | | | | 2 | |
| Unidentified Cyprinid | | | | | | | | | | | 6 | | | | | |
| **Gobiidae** | | | | | | | | | | | | | | | | |
| Round Goby | | | | | | 1 | | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | | | | |
| Mooneye | | | | | | | | | | | | | | 9 | | |
| **Ictaluridae** | | | | | | | | | | | | | | | | |
| Channel Catfish | | 1 | 1 | | 2 | 4 | | | 2 | | 10 | 6 | 7 | 12 | 46 | 122 |
| Flathead Catfish | | | 1 | | | | | | | | 1 | 1 | 2 | 4 | 7 | 24 |
| **Lepisosteidae** | | | | | | | | | | | | | | | | |
| Longnose Gar | | | | | | | | | | | 1 | 1 | | 8 | | 2 |
| Shortnose Gar | | | | | 1 | | | | | | 2 | 3 | | 13 | 8 | 8 |
| **Moronidae** | | | | | | | | | | | | | | | | |
| Striped Bass X White Bass | | | | | | | | | | | 1 | | | | | |
| White Bass | | | | | 9 | | | 5 | 1 | 1 | 17 | 24 | 13 | 80 | 30 | 64 |
| White Perch | | | | | 1 | | | | | | | | | | | |
| Yellow Bass | | | | | | | | | 2 | | | | | | | 2 |
| **Percidae** | | | | | | | | | | | | | | | | |
| Logperch | | | | | 1 | 2 | 2 | | | | 2 | 17 | 18 | | 3 | 4 |
| Orangethroat Darter | | 1 | | | | | 1 | | | | | | 1 | | | |
| Sauger | | | | | | | | 1 | | | 4 | 9 | 8 | 1 | 2 | 10 |
| Slenderhead Darter | | | | | | | 1 | 1 | | | | | 1 | | 1 | 2 |
| Walleye | | | | | | | | | | | | 2 | 1 | | | 2 |
| Yellow Perch | | | | | | | | | | | 1 | | | | | |
| **Poeciliidae** | | | | | | | | | | | | | | | | |
| Western Mosquitofish | | | | | | | | | | | | | | 2 | 1 | |
| **Sciaenidae** | | | | | | | | | | | | | | | | |
| Freshwater Drum | | | | | 2 | | 3 | | 1 | | 10 | 18 | 22 | 40 | 36 | 134 |
| Total specimens collected | | 113 | 55 | 192 | 270 | 77 | 278 | 93 | 98 | 142 | 312 | 388 | 716 | 431 | 515 | 1436 |
| Total species/hybrids | | 12/1 | 10/0 | 10/1 | 21/1 | 18/1 | 22/1 | 19/0 | 18/0 | 14/0 | 35/2 | 33/2 | 35/0 | 32/1 | 33/0 | 35/0 |

Appendix VI. Biomass (lb) of each fish species collected during 2013 using pulsed DC electrofishing in five reaches of the Illinois River. Species comprising <0.1% of relative biomass were not included in table.

| | | Upper Illinois River | | | | | | | | | Lower Illinois River | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reach | Dresden | | | Marseilles | | | Starved Rock | | | Peoria | | | Alton | | |
| **Family** | Effort/time period (h) | 0.75 | | | 1.5 | | | 0.75 | | | 3.50 | | | 3.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | | | | |
| Bowfin | | | | | | | | | | | 6.71 | | | | | |
| **Anguillidae** | | | | | | | | | | | | | | | | |
| American Eel | | | | | | | | | | | | | | 0.88 | | |
| **Catostomidae** | | | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | | | | | | | | | 6.03 | 3.67 | 12.46 | 7.58 | 9.58 | |
| Black Buffalo | | | | | | | | | | | | | | 39.35 | 14.28 | 15.89 |
| Golden Redhorse | | | | | 0.33 | 0.84 | 1.14 | 1.86 | | | 1.25 | | 0.95 | | | 2.45 |
| Greater Redhorse | | | | | | | | | | | | | 1.46 | | | |
| Northern Hogsucker | | | | | | | | | | | | | 0.37 | | | |
| Quillback | | | | | | | | | 0.39 | | | | | | | |
| River Carpsucker | | | 1.69 | | | 1.64 | 5.19 | 1.43 | 2.61 | | 3.47 | 1.01 | 5.70 | 4.02 | 7.45 | 9.70 |
| River Redhorse | | | | | | | | | | | | 0.83 | | | | |
| Shorthead Redhorse | | | | | 0.96 | | | 1.91 | | 1.33 | | | | 1.70 | 10.78 | 3.71 |
| Smallmouth Buffalo | | 11.70 | 6.18 | | 13.08 | 21.87 | 93.37 | 8.39 | 16.53 | 26.85 | 14.70 | 20.99 | 25.32 | 4.93 | 21.63 | 20.81 |
| Unidentified Catastomid | | | | | | | | | | | 0.18 | | 0.74 | | | |
| **Centrarchidae** | | | | | | | | | | | | | | | | |
| Black Crappie | | | | | | | | | | | | | | | | 1.62 |
| Bluegill | | 3.24 | 1.10 | 5.99 | 0.63 | 0.19 | 0.83 | | 0.16 | 0.21 | 0.30 | 1.85 | 2.91 | 0.16 | 1.19 | 0.73 |
| Bluegill X Green Sunfish | | 0.07 | | | | | | | | | | | | | | |
| Bluegill X Orange Spotted Sunfish | | | | | 0.02 | | | | | | | | | | | |
| Bluegill X Redear Sunfish | | | | | | | | | | | | | | | | |
| Green Sunfish | | 2.29 | 0.29 | 0.42 | 0.07 | 0.03 | 0.19 | 0.07 | 0.08 | 0.07 | | | | | | |
| Green Sunfish X Orange Spotted Sunfish | | 0.05 | | | | | | | | | | | | | | |
| Largemouth Bass | | 11.29 | 2.88 | 1.99 | 4.25 | | 3.82 | 1.38 | | 0.59 | | | 1.20 | 1.97 | 2.44 | |
| Pumpkinseed | | | | | | 0.03 | | | | | | | | | | |
| Pumpkinseed X Bluegill | | | | 0.13 | | | | | | | | | | | | |
| Redear Sunfish | | | | 0.73 | | | | | | | | | | | | |
| Smallmouth Bass | | 1.53 | | | 1.20 | 0.31 | 1.78 | 2.78 | 1.44 | | 0.49 | 0.37 | | | | |
| White Crappie | | | | | | | | | | | | | | 0.30 | | |
| **Clupeidae** | | | | | | | | | | | | | | | | |
| Gizzard Shad | | 1.19 | 5.67 | 4.29 | 2.90 | 3.45 | 32.46 | 3.57 | 3.65 | 8.58 | 9.27 | 9.88 | 11.66 | 16.14 | 32.84 | 50.11 |
| Skipjack Herring | | | | | | | | | 0.09 | 0.03 | 0.76 | 0.17 | 0.64 | 0.17 | 0.41 | |
| **Cyprinidae** | | | | | | | | | | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | | | | | | 2.58 | 5.26 | | 3.11 | | |
| Bluntnose Minnow | | | | | 0.08 | | | | | | | | | | | |
| Bullhead Minnow | | | | 0.65 | 0.29 | | 0.11 | 0.04 | 0.15 | 0.08 | 0.19 | | | | | |
| Common Carp | | 16.90 | 4.94 | 22.00 | | 2.80 | 6.06 | 8.74 | | | 26.80 | 18.43 | 292.26 | 72.16 | 105.19 | 319.46 |
| Emerald Shiner | | | | | 0.33 | | 0.47 | 0.41 | 0.88 | 0.81 | 0.83 | 0.63 | 1.03 | 0.67 | 0.20 | 0.56 |
| Goldfish | | | | 0.69 | | | | | | | 0.21 | | | | | |
| Grass Carp | | | | | | | 14.33 | | | | | 11.16 | 20.45 | | | 58.14 |
| Red Shiner | | | | | | | | | | | 0.08 | | | | | |
| River Shiner | | | | | 0.35 | | | 0.08 | | 0.03 | 0.08 | | | | | |
| Sand Shiner | | | | | 0.02 | | | | | 0.03 | | | | | | |
| Silver Carp | | | | | | | | 17.74 | 14.87 | | 39.90 | 193.32 | 258.71 | 31.95 | 83.79 | 153.56 |
| Silver Chub | | | | | | | | | | | | | | | | 0.44 |
| Spotfin Shiner | | | | | 0.26 | 0.05 | | | 0.04 | 0.04 | 0.15 | | | 0.18 | | |
| Spottail Shiner | | | | 0.03 | 0.03 | | | 0.03 | 0.05 | 0.02 | | 0.25 | | | | |
| Striped Shiner | | | | | | | | | | | | 0.16 | | | | |

Appendix VI (continued). Biomass (lb) of each fish species collected during 2013 using pulsed DC electrofishing in five reaches of the Illinois River. Species comprising <0.1% of relative biomass were not included in table.

| | | Upper Illinois River | | | | | | | | | | Lower Illinois River | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reach | Dresden | | | Marseilles | | | Starved Rock | | | | Peoria | | | Alton | | |
| **Family** | Effort/time period (h) | 0.75 | | | 1.5 | | | 0.75 | | | | 3.50 | | | 3.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | | 1 | 2 | 3 | 1 | 2 | 3 |
| **Hiodontidae** | | | | | | | | | | | | | | | | | |
| Mooneye | | | | | | | | | | | | | | | 1.46 | | |
| **Ictaluridae** | | | | | | | | | | | | | | | | | |
| Channel Catfish | | 2.18 | 2.62 | | 2.74 | 7.79 | | | 1.88 | | | 29.80 | 4.01 | 15.17 | 15.97 | 46.11 | 159.90 |
| Flathead Catfish | | | 2.65 | | | | | | | | | 0.28 | 1.29 | 1.41 | 2.10 | 6.69 | 14.99 |
| **Lepisosteidae** | | | | | | | | | | | | | | | | | |
| Longnose Gar | | | | | | | | | | | | 1.23 | 1.31 | | 9.71 | | 1.34 |
| Shortnose Gar | | | | | 2.35 | | | | | | | 3.15 | 4.45 | | 16.29 | 10.93 | 11.72 |
| **Moronidae** | | | | | | | | | | | | | | | | | |
| Striped Bass X White Bass | | | | | | | | | | | | 1.37 | | | | | |
| White Bass | | | | | 1.83 | | | 2.12 | 0.03 | 0.14 | | 1.82 | 0.7 | 3.82 | 8.32 | 3.77 | 8 |
| White Perch | | | | | 0.03 | | | | | | | | | | | | |
| Yellow Bass | | | | | | | | | 0.18 | | | | | | | | |
| **Percidae** | | | | | | | | | | | | | | | | | |
| Sauger | | | | | | | | 1.22 | | | | | 1.3 | 0.59 | | | 0.78 |
| Walleye | | | | | | | | | | | | | | 2.61 | | | |
| **Sciaenidae** | | | | | | | | | | | | | | | | | |
| Freshwater Drum | | | | | 0.14 | | 7.63 | | 0.03 | | | 0.82 | 2.92 | 2.89 | 23.17 | 8.25 | 10.03 |
| Total fish biomass | | 50.44 | 28.02 | 36.92 | 31.89 | 39.00 | 167.38 | 51.77 | 43.06 | 38.81 | 0.00 | 152.45 | 283.96 | 662.35 | 262.29 | 365.53 | 843.94 |

Appendix VII. Numbers of each fish species collected during 2013 using pulsed-DC electrofishing in six pools/reaches of the Mississippi River.

| | | Upper Mississippi River Pools | | | | | | | | | Lower Mississippi River Reaches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pool/Reach | Pool 16 | | | Pool 19 | | | Pool 20 | | | Pool 25 | | | Chain of Rocks Reach | | | Kaskaskia Reach | | |
| Family | Effort/time period (h) | 1.25 | | | 2.25 | | | 1.00 | | | 1.50 | | | 1.75 | | | 2.50 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | | | | | | | |
| Bowfin | | | | | | | | | | | | | | | | | 1 | | |
| **Anguillidae** | | | | | | | | | | | | | | | | | | | |
| American Eel | | | | | | | | | | | | 1 | | | | | | | |
| **Atherinidae** | | | | | | | | | | | | | | | | | | | |
| Brook Silverside | | | 46 | 4 | | 8 | 2 | | | | 2 | 1 | 2 | | 3 | | | | |
| **Catostomidae** | | | | | | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | 1 | | 1 | | 1 | | | | | 5 | 3 | 2 | | | | 2 | 2 | 26 |
| Black Buffalo | | | | 1 | | | | | | | 2 | | | 2 | | | 3 | 1 | 4 |
| Blue Sucker | | | | | | | | | | | | | | | 6 | 2 | | 1 | 16 |
| Golden Redhorse | | | | 1 | | | 1 | | | 1 | | | | | | | | | |
| Greater Redhorse | | | | | | 2 | | | | | | | | | | | | | |
| Quillback | | | | 1 | | 3 | | | | | | | | | | | | | |
| River Carpsucker | | 4 | 4 | | 2 | 3 | | 17 | | 1 | 6 | 2 | | 44 | 8 | 16 | 18 | 3 | 18 |
| Shorthead Redhorse | | | | | 1 | | 4 | | | | 3 | | | 1 | 2 | | 1 | 2 | 4 |
| Smallmouth Buffalo | | | 5 | | | 2 | 7 | 1 | | | 9 | 5 | 12 | 10 | 12 | 14 | 14 | 13 | 32 |
| Unidentified Catastomid | | | | 1 | 4 | 2 | 2 | | | 2 | 2 | | | | | | 3 | | |
| **Centrarchidae** | | | | | | | | | | | | | | | | | | | |
| Black Crappie | | | | | | | | | 1 | | 2 | | | | | | | | |
| Bluegill | | | 5 | 9 | 5 | 23 | 67 | 1 | | | 12 | 4 | 4 | 6 | 5 | 4 | 3 | 4 | |
| Green Sunfish | | 1 | 2 | | | 1 | 4 | | | 1 | 2 | 1 | 20 | 1 | 1 | 2 | | | |
| Largemouth Bass | | 1 | 22 | 7 | 4 | 29 | 29 | | | | | 2 | | | 2 | 2 | | 2 | |
| Orange Spotted Sunfish | | 1 | | | | | 31 | 1 | | | 5 | 3 | | | | | 1 | 1 | |
| Redear Sunfish | | | | 1 | | | | | | | | | | | | | | | |
| Smallmouth Bass | | | 2 | 4 | | 2 | 10 | | 1 | | | 1 | 10 | | | | | 1 | |
| Spotted Bass | | | | | | | | | | | | | | 1 | 6 | 4 | 1 | 2 | 4 |
| White Crappie | | 1 | | | | | | | | | 1 | | | 2 | | | | | |
| **Clupeidae** | | | | | | | | | | | | | | | | | | | |
| Gizzard Shad | | 4 | 84 | 317 | 38 | 136 | 183 | 23 | 166 | 29 | 1531 | 792 | 376 | 138 | 188 | 940 | 739 | 771 | 382 |
| Skipjack Herring | | | | | | | 1 | | | 1 | | | 2 | 4 | 3 | | | 2 | 4 |
| Threadfin Shad | | | | | | | | | | | | | | | | 8 | | | |
| **Cyprinidae** | | | | | | | | | | | | | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | | | 1 | 1 | | | | | | | | | | 2 |
| Bullhead Minnow | | 13 | 4 | 59 | 8 | 29 | 85 | 4 | 4 | 6 | 43 | 14 | 12 | 1 | 1 | | | | |
| Central Stoneroller | | | | | | 1 | 2 | | | | | 1 | | | | | | | |
| Channel Shiner | | | | 1 | | | | | | 4 | 35 | 3 | 4 | 14 | 15 | 14 | 28 | 4 | 14 |
| Common Carp | | 3 | | 4 | 13 | 15 | 46 | 3 | 2 | 5 | 14 | 23 | 30 | 42 | 33 | 46 | 67 | 48 | 84 |
| Common Carp X Goldfish | | | | | | 1 | 1 | | | | | | | | | | | | |
| Emerald Shiner | | 186 | 43 | 324 | 35 | 1036 | 1347 | 707 | 123 | 1361 | 42 | 40 | 126 | 65 | 109 | 240 | 401 | 117 | 110 |
| Fathead Minnow | | 1 | | | | | | | | | | | | | | | | | |
| Golden Shiner | | 1 | | | | 1 | 2 | | | | | | | | | | | | |
| Grass Carp | | | | | | | | | | | | 1 | | | | | 2 | 1 | |

Appendix VII (continued). Numbers of each fish species collected during 2013 using pulsed-DC electrofishing in six pools/reaches of the Mississippi River.

| | | Upper Mississippi River Pools | | | | | | | | | Lower Mississippi River Reaches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pool/Reach | Pool 16 | | | Pool 19 | | | Pool 20 | | | Pool 25 | | | Chain of Rocks Reach | | | Kaskaskia Reach | | |
| Family | Effort/time period (h) | 1.25 | | | 2.25 | | | 1.00 | | | 1.50 | | | 1.75 | | | 2.50 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Cyprinidae (continued)** | | | | | | | | | | | | | | | | | | | |
| Ironcolor Shiner | | | 1 | | | | | | | | | | | | | | | | |
| Mimic Shiner | | | | | | | | | | 1 | | | | | | | | | |
| Red Shiner | | | | | | | 1 | | 2 | | | 1 | | 3 | 4 | 2 | 28 | 7 | 4 |
| River Shiner | | 14 | 36 | 161 | 36 | 235 | 105 | 6 | 11 | 5 | 2 | | 10 | 31 | 4 | 2 | 24 | 2 | 2 |
| Sand Shiner | | 14 | | 126 | 34 | 29 | 106 | 18 | 92 | 34 | | | | 1 | | | | | |
| Silver Carp | | | | | | | | 7 | | 2 | 1 | 1 | 6 | 3 | 4 | 8 | 5 | 3 | 10 |
| Silver Chub | | | | 3 | | 2 | 23 | | | 14 | 1 | | | | | | | 2 | |
| Spotfin Shiner | | 75 | 29 | 8 | 12 | 148 | 34 | | 1 | | 231 | 69 | 52 | 17 | 10 | 26 | 24 | 12 | 12 |
| Spottail Shiner | | | 24 | 5 | 1 | 16 | 4 | 6 | | | | | | | | | | | |
| Suckermouth Minnow | | | | 1 | | 1 | | | | | | | | | | | | | |
| Unidentified Cyprinid | | 1 | | 24 | | 816 | 23 | 3 | 82 | 149 | | | | | | | | | |
| **Esocidae** | | | | | | | | | | | | | | | | | | | |
| Grass Pickerel | | 2 | | | | | | | | | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | | | | | | | |
| Goldeye | | | | | 5 | | | 2 | | | | | | 43 | 20 | 6 | 17 | 34 | 18 |
| Mooneye | | 1 | 1 | | | | | | | | | | | 2 | | | 1 | | |
| **Ictaluridae** | | | | | | | | | | | | | | | | | | | |
| Blue Catfish | | | | | | | | | | | | | | | | | 1 | 2 | 28 |
| Channel Catfish | | 3 | | 2 | 26 | 11 | 14 | 1 | | 5 | 6 | 1 | 14 | 16 | 7 | 10 | 6 | 20 | 58 |
| Flathead Catfish | | 1 | 2 | | 4 | | 2 | 1 | 2 | | 8 | 25 | 10 | 6 | 9 | 42 | 10 | 24 | 10 |
| **Lepisosteidae** | | | | | | | | | | | | | | | | | | | |
| Longnose Gar | | 1 | | | 4 | 1 | | 2 | | | 1 | 2 | | 20 | 6 | 4 | 19 | 8 | 26 |
| Shortnose Gar | | | 2 | | | | | | | | 6 | 5 | 6 | 12 | 10 | 4 | 53 | 19 | 26 |
| **Moronidae** | | | | | | | | | | | | | | | | | | | |
| Striped Bass X White Bass | | | | | | | | | | | | | | 1 | | | | 1 | |
| White Bass | | 5 | | 2 | 6 | 13 | 5 | 4 | 1 | 2 | 34 | 21 | 30 | 8 | 6 | 28 | 5 | 20 | 22 |
| **Percidae** | | | | | | | | | | | | | | | | | | | |
| Blackside Darter | | | | | | | | | 1 | | | | | | | | | | |
| Bluntnose Darter | | | | 2 | | | | | | | | | | | | | | | |
| Crystal Darter | | | | | | | | | | | | | | | | | 1 | | |
| Fantail Darter | | | | | | 2 | 3 | | | | | | | | | | | | |
| Johnny Darter | | | | | 1 | | 1 | | | | | | | | | | | | |
| Logperch | | | 1 | | | 1 | 1 | | | | 1 | | | 1 | | | 2 | 7 | |
| Mud Darter | | | 3 | | | 3 | | | | | | | | | | | | | |
| Sauger | | | | | | | | 1 | | | 6 | 1 | 2 | 2 | | | 1 | | |
| Slenderhead Darter | | | | | | | | | | 9 | | 2 | 4 | | 2 | | | | |
| Walleye | | 1 | | | 1 | | | | | | | | | 3 | | | | 1 | |
| Yellow Perch | | | | | | 10 | | | | | | | | | | | | | |
| **Polyodontidae** | | | | | | | | | | | | | | | | | | | |
| Paddlefish | | | | | | | | | | | | | | | | 2 | | | |
| **Sciaenidae** | | | | | | | | | | | | | | | | | | | |
| Freshwater Drum | | 24 | 15 | 36 | 20 | 5 | 15 | 1 | | 18 | 49 | 11 | 22 | 18 | 16 | 14 | 55 | 30 | 82 |
| Total specimens collected | | 359 | 331 | 1105 | 260 | 2588 | 2161 | 810 | 490 | 1650 | 2062 | 1036 | 756 | 518 | 492 | 1440 | 1536 | 1167 | 998 |
| Total species/hybrids | | 23/0 | 20/0 | 22/0 | 24/0 | 24/1 | 29/1 | 18/1 | 16/0 | 17/0 | 22/0 | 23/1 | 25/1 | 24/1 | 27/0 | 29/0 | 24/0 | 30/0 | 26/0 |

Appendix VIII. Biomass (lb) of each fish species collected during 2013 using pulsed-DC electrofishing in six pools/reaches of the Mississippi River. Species comprising <0.1% of relative biomass were not included in table.

| | | Upper Mississippi River Pools | | | | | | | | | Lower Mississippi River Reaches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pool/Reach | Pool 16 | | | Pool 19 | | | Pool 20 | | | Pool 25 | | | Chain of Rocks Reach | | | Kaskaskia Reach | | |
| **Family** | Effort/time period (h) | 1.25 | | | 2.25 | | | 1.00 | | | 1.50 | | | 1.75 | | | 2.50 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | | | | | | | |
| Bowfin | | | | | | | | | | | | | | | | | 7.87 | | |
| **Anguillidae** | | | | | | | | | | | | | | | | | | | |
| American Eel | | | | | | | | | | | | 1.63 | | | | | | | |
| **Atherinidae** | | | | | | | | | | | | | | | | | | | |
| Brook Silverside | | | 0.03 | | | | | | | | | | | | | | | | |
| Catostomidae | | | | | | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | | 4.67 | | 13.56 | | | | | 18.19 | 0.14 | 6.92 | | | | 7.52 | 6.63 | 110.34 |
| Black Buffalo | | | | 5.36 | | | | | | | 11.43 | | | 24.97 | | | 24.24 | 6.37 | 25.50 |
| Blue Sucker | | | | | | | | | | | | | | | 18.34 | 10.19 | | 1.88 | 58.55 |
| Golden Redhorse | | | | 0.22 | | | 0.90 | | | | | | | | | | | | |
| Greater Redhorse | | | | | | 0.42 | | | | | | | | | | | | | |
| Quillback | | | | 0.06 | | 0.93 | | | | | | | | | | | | | |
| River Carpsucker | | 4.04 | 0.15 | | 0.08 | 1.45 | | 4.76 | | 2.07 | 2.85 | 2.17 | | 56.29 | 18.28 | 22.49 | 41.22 | 4.18 | 44.59 |
| Shorthead Redhorse | | | | | 0.20 | | | | | | | | | 0.60 | 2.79 | | 1.21 | 0.35 | 6.60 |
| Smallmouth Buffalo | | | 0.10 | | | 0.10 | 0.61 | 1.86 | | | 6.48 | 9.59 | 25.73 | 26.49 | 33.81 | 49.08 | 45.49 | 38.77 | 111.72 |
| **Centrarchidae** | | | | | | | | | | | | | | | | | | | |
| Black Crappie | | | | | | | | | 0.47 | | | | | | | | | | |
| Bluegill | | | 0.27 | 0.42 | 0.56 | 1.78 | 1.84 | | | | 0.35 | 0.38 | 0.34 | 0.21 | 0.51 | 0.45 | | 0.27 | |
| Green Sunfish | | 0.08 | | | | | | | | | | | 1.37 | | | | | | |
| Largemouth Bass | | 0.64 | 2.81 | 2.04 | 4.84 | 13.55 | 21.21 | | | | | 1.55 | | | 0.10 | 0.13 | | 0.11 | |
| Redear Sunfish | | | | 0.05 | | | | | | | | | | | | | | | |
| Smallmouth Bass | | | 1.22 | 0.17 | | 0.20 | 0.86 | | 0.28 | | | | 3.10 | | | | | 0.74 | |
| Spotted Bass | | | | | | | | | | | | | | | 2.67 | | | | 1.49 |
| White Crappie | | 0.22 | | | | | | | | | | | | 0.23 | | | | | |
| **Clupeidae** | | | | | | | | | | | | | | | | | | | |
| Gizzard Shad | | 1.64 | 8.52 | 28.56 | 6.91 | 10.20 | 14.77 | 7.33 | 3.80 | 1.00 | 16.23 | 17.26 | 18.67 | 2.25 | 7.32 | 18.66 | 12.64 | 12.60 | 24.54 |
| Skipjack Herring | | | | | | | 0.82 | | | 0.82 | | | 0.23 | 0.95 | 0.70 | | | 0.44 | |
| **Cyprinidae** | | | | | | | | | | | | | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | | | 6.89 | 9.46 | | | | | | | | | | 6.18 |
| Bullhead Minnow | | 0.06 | | 0.09 | | | 0.28 | | | | 0.22 | | | | | | | | |
| Common Carp | | 13.49 | | 31.46 | 75.74 | 51.01 | 377.62 | 19.75 | 8.45 | 48.11 | 69.82 | 123.31 | 152.12 | 202.85 | 144.76 | 327.26 | 303.95 | 243.11 | 557.29 |
| Common Carp X Goldfish | | | | | | 0.38 | 1.09 | | | | | | | | | | | | |
| Emerald Shiner | | 0.88 | 0.19 | 0.67 | | 0.43 | 2.20 | 2.43 | 0.48 | 1.70 | 0.17 | | 0.71 | 0.26 | 0.34 | 1.46 | 1.78 | 0.38 | |
| Grass Carp | | | | | | | | | | | | 5.07 | | | | | 16.22 | 11.38 | |
| River Shiner | | 0.04 | 0.12 | 1.19 | 0.15 | 0.28 | 0.35 | | 0.05 | | | | | 0.22 | | | | | |
| Sand Shiner | | | | 0.19 | | | | | 0.06 | | | | | | | | | | |
| Silver Carp | | | | | | | | 41.95 | | 12.25 | 5.99 | 6.38 | 37.74 | 4.93 | 8.15 | 22.01 | 10.84 | 10.43 | 38.71 |
| Silver Chub | | | | | | | 0.25 | | | | | | | | | | | | |
| Spotfin Shiner | | 0.37 | 0.08 | | | 0.15 | | | | | 1.01 | 0.31 | 0.41 | | | | | | |
| Spottail Shiner | | | 0.06 | | | 0.06 | | | | | | | | | | | | | |
| Unidentified Cyprinid | | | | | | 0.07 | | | 0.03 | | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | | | | | | | |
| Goldeye | | | | | | | | 0.19 | | | | | | 1.18 | 0.70 | | | 1.86 | 0.99 |
| Mooneye | | 0.06 | 0.20 | | | | | | | | | | | | | | | | |

Appendix VIII (continued). Biomass (lb) of each fish species collected during 2013 using pulsed-DC electrofishing in six pools/reaches of the Mississippi River. Species comprising <0.1% of relative biomass were not included in table.

| | | Upper Mississippi River Pools | | | | | | | | | Lower Mississippi River Reaches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pool/Reach | Pool 16 | | | Pool 19 | | | Pool 20 | | | Pool 25 | | | Chain of Rocks Reach | | | Kaskaskia Reach | | |
| **Family** | Effort/time period (h) | 1.25 | | | 2.25 | | | 1.00 | | | 1.50 | | | 1.75 | | | 2.50 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Ictaluridae** | | | | | | | | | | | | | | | | | | | |
| Blue Catfish | | | | | | | | | | | | | | | | | 3.49 | 5.92 | 89.00 |
| Channel Catfish | | 15.32 | | 3.64 | 38.51 | 17.97 | 32.59 | 0.23 | | 6.16 | 7.15 | 1.71 | 29.16 | 23.36 | 5.00 | 24.47 | 11.68 | 23.38 | 124.49 |
| Flathead Catfish | | 0.32 | 11.98 | | 1.97 | | 0.33 | 0.35 | 1.90 | | 6.93 | 11.19 | 8.27 | 6.92 | 3.37 | 43.19 | 7.95 | 21.46 | 11.02 |
| **Lepisosteidae** | | | | | | | | | | | | | | | | | | | |
| Longnose Gar | | 2.43 | | | 9.96 | | | 3.95 | | | 1.05 | 5.91 | | 20.54 | 9.11 | 6.88 | 26.60 | 13.45 | 59.57 |
| Shortnose Gar | | | 4.52 | | | | | | | | 2.55 | 1.48 | 2.25 | 14.13 | 5.46 | 6.57 | 61.83 | 19.23 | 37.95 |
| **Moronidae** | | | | | | | | | | | | | | | | | | | |
| Striped Bass X White Bass | | | | | | | | | | | | | | 7.65 | | | | 4.93 | |
| White Bass | | 5.26 | | 0.18 | 2.28 | 1.17 | 1.13 | 0.47 | 0.43 | 0.18 | 31.18 | 2.09 | 2.71 | 0.90 | 0.57 | 6.03 | 0.12 | 6.33 | 9.88 |
| Percidae | | | | | | | | | | | | | | | | | | | |
| Sauger | | | | | | | | 1.71 | | | 0.10 | | 0.23 | | | | | | |
| Walleye | | | | | 0.50 | | | | | | | | | | | | | | |
| Yellow Perch | | | | | | 0.66 | | | | | | | | | | | | | |
| **Sciaenidae** | | | | | | | | | | | | | | | | | | | |
| Freshwater Drum | | 27.80 | 0.40 | 3.72 | 31.10 | 4.34 | 3.86 | 0.22 | | 0.47 | 12.46 | 8.08 | 35.38 | 11.94 | 5.85 | 38.37 | 36.00 | 18.87 | 46.41 |
| Total fish biomass | | 72.65 | 30.65 | 82.69 | 172.80 | 118.71 | 460.71 | 92.09 | 25.41 | 72.76 | 194.16 | 198.25 | 325.34 | 406.87 | 267.83 | 577.24 | 620.65 | 453.07 | 1364.82 |

Appendix IX. Numbers of each fish species collected during 2013 using pulsed-DC electrofishing in four pools of the Ohio River.

| | Pool | Smithland | | | Pool 52 | | | Pool 53 | | | Ohio River Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/time period (h) | 2.25 | | | 1.00 | | | 1.00 | | | 0.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | |
| Bowfin | | | | | | | | | | 2 | | | |
| **Anguillidae** | | | | | | | | | | | | | |
| American Eel | | | | | | | | | | | | | 1 |
| **Atherinidae** | | | | | | | | | | | | | |
| Brook Silverside | | | 1 | | | | | | | | | 1 | |
| **Catostomidae** | | | | | | | | | | | | | |
| Bigmouth Buffalo | | 2 | 3 | 2 | | 2 | | | | | | | |
| Black Buffalo | | 1 | | | | | 1 | | | | | | |
| Highfin Carpsucker | | 7 | 4 | 2 | 1 | | | | | | | | |
| Quillback | | 2 | | | 2 | | | 1 | | | | | |
| River Carpsucker | | 6 | 9 | 15 | 7 | 2 | | 1 | 25 | 14 | 1 | 3 | 2 |
| Silver Redhorse | | 1 | | | | | | | | | | | |
| Smallmouth Buffalo | | 38 | 22 | 10 | 2 | 2 | 2 | 2 | 4 | 1 | 1 | 5 | 8 |
| **Centrarchidae** | | | | | | | | | | | | | |
| Black Crappie | | 4 | 1 | | | | | | 1 | | | | |
| Bluegill | | 2 | 4 | 7 | | | | | 3 | | | 5 | 1 |
| Green Sunfish | | | | | | | | | | | | 1 | |
| Largemouth Bass | | | 2 | 6 | | | | | | | | | 2 |
| Longear Sunfish | | | 2 | 3 | | | 1 | | 1 | | | 3 | 3 |
| Orange Spotted Sunfish | | | | | | | | | 1 | | | 1 | 1 |
| Redear Sunfish | | 2 | 5 | 6 | | | | | | | | | 1 |
| Smallmouth Bass | | | | | | | | | | | | 2 | |
| Spotted Bass | | 1 | 11 | 10 | | 2 | 5 | | 1 | | | 2 | 4 |
| **Clupeidae** | | | | | | | | | | | | | |
| Gizzard Shad | | 35 | 581 | 274 | 15 | 119 | 30 | 16 | 14 | 110 | 2 | 18 | 48 |
| Skipjack Herring | | 6 | 34 | 11 | 4 | 10 | 1 | 12 | 7 | | 3 | 15 | 10 |
| Threadfin Shad | | | 118 | 17 | 528 | 138 | 24 | 3 | 39 | 172 | 13 | 349 | 23 |
| **Cyprinidae** | | | | | | | | | | | | | |
| Bighead Carp | | | | 1 | 1 | | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | 1 | | | | | | | |
| Bullhead Minnow | | 1 | 1 | 1 | | | | | | | | | |
| Channel Shiner | | | 5 | 8 | | | | | 1 | | | 2 | |
| Common Carp | | 1 | 2 | 6 | | | 1 | | 1 | 4 | | 6 | 2 |
| Emerald Shiner | | 24 | 219 | 267 | 5 | 252 | 151 | 2 | 13 | 34 | 4 | 72 | 19 |
| Grass Carp | | 1 | 1 | | | | | | | | | | |
| River Shiner | | | 2 | 128 | | | 6 | | | 4 | | 1 | |
| Silver Carp | | | 4 | 2 | | 4 | | | | | | | |
| Silver Chub | | 24 | 8 | 14 | 6 | 2 | 2 | 7 | 2 | 2 | 6 | 5 | 1 |
| Silvery Minnow | | | 1 | 2 | | | | | | | | | |
| Spotfin Shiner | | 1 | 2 | 2 | | | | | | | | | |

Appendix IX (continued). Numbers of each fish species collected during 2013 using pulsed-DC electrofishing in four pools of the Ohio River.

| | Pool | Smithland | | | Pool 52 | | | Pool 53 | | | Ohio River Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/time period (h) | 2.25 | | | 1.00 | | | 1.00 | | | 0.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Hiodontidae** | | | | | | | | | | | | | |
| Goldeye | | 3 | 1 | | 1 | 1 | | | 1 | 2 | | 2 | |
| Mooneye | | 1 | | | | | | | | | | | |
| **Ictaluridae** | | | | | | | | | | | | | |
| Blue Catfish | | 6 | | | | | | | | | | | |
| Channel Catfish | | 27 | 18 | 17 | 1 | 2 | | 1 | 14 | 15 | | 2 | 6 |
| Flathead Catfish | | 4 | 8 | 3 | | 1 | | | 3 | | 1 | 15 | 11 |
| **Lepisosteidae** | | | | | | | | | | | | | |
| Longnose Gar | | 8 | 10 | 3 | 4 | 3 | 1 | 2 | 6 | 2 | 3 | 9 | 4 |
| Shortnose Gar | | 10 | 12 | 10 | | | | 2 | 16 | 1 | | 11 | |
| Spotted Gar | | 1 | | | | | | | | | | | |
| **Moronidae** | | | | | | | | | | | | | |
| Striped Bass | | 2 | 1 | 1 | | | | | | | | | |
| Striped Bass X White Bass | | 3 | 1 | 1 | | | | | | | | | |
| White Bass | | 22 | 17 | 23 | 2 | 9 | 1 | 1 | 8 | 1 | | 6 | 1 |
| Yellow Bass | | 2 | | | | | | | | | | | |
| **Percidae** | | | | | | | | | | | | | |
| Logperch | | | | | | | | | | 1 | | | |
| Sauger | | | 3 | 1 | | | | 1 | | 4 | | | |
| **Sciaenidae** | | | | | | | | | | | | | |
| Freshwater Drum | | 47 | 11 | 28 | | 1 | | | 13 | 6 | | 18 | 14 |
| Total specimens collected | | 295 | 1124 | 881 | 579 | 551 | 226 | 51 | 174 | 375 | 34 | 554 | 162 |
| Total species/hybrids | | 31/1 | 33/1 | 30/1 | 14/0 | 16/1 | 13/0 | 13/0 | 21/0 | 17/0 | 9/0 | 24/0 | 20/0 |

Appendix X. Biomass (lb) of each species collected during 2013 using pulsed-DC electrofishing in four pools of the Ohio River. Species comprising <0.1% of relative biomass were not included in table.

| | Pool | Smithland | | | Pool 52 | | | Pool 53 | | | Ohio River Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/time period (h) | 2.25 | | | 1.00 | | | 1.00 | | | 0.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | |
| Bowfin | | | | | | | | | | 10.45 | | | |
| **Anguillidae** | | | | | | | | | | | | | |
| American Eel | | | | | | | | | | | | | 1.38 |
| **Catostomidae** | | | | | | | | | | | | | |
| Bigmouth Buffalo | | 17.13 | 20.77 | 7.49 | | 11.05 | | | | | | | |
| Black Buffalo | | 5.56 | | | | | 4.81 | | | | | | |
| Highfin Carpsucker | | 6.51 | 0.60 | 1.23 | 1.99 | | | | | | | | |
| Quillback | | 0.98 | | | 4.21 | | | 2.48 | | | | | |
| River Carpsucker | | 15.18 | 6.14 | 20.11 | 15.24 | 5.04 | | 3.16 | 12.29 | 27.33 | 2.82 | 0.21 | 2.22 |
| Silver Redhorse | | 1.46 | | | | | | | | | | | |
| Smallmouth Buffalo | | 55.64 | 33.81 | 39.90 | 5.94 | 8.84 | 5.61 | 4.64 | 11.57 | 1.20 | 2.52 | 21.95 | 25.65 |
| **Centrarchidae** | | | | | | | | | | | | | |
| Black Crappie | | 1.78 | 0.49 | | | | | | | | | | |
| Bluegill | | 0.39 | 0.57 | 0.87 | | | | | 0.45 | | | 0.43 | 0.08 |
| Largemouth Bass | | | 4.94 | 7.31 | | | | | | | | | 0.07 |
| Longear Sunfish | | | | 0.24 | | | 0.02 | | 0.08 | | | 0.35 | 0.33 |
| Redear Sunfish | | 1.49 | 2.66 | 2.72 | | | | | | | | | 0.09 |
| Spotted Bass | | 2.63 | 5.03 | 4.99 | | | 0.64 | | 0.87 | | | 0.07 | 1.08 |
| **Clupeidae** | | | | | | | | | | | | | |
| Gizzard Shad | | 4.65 | 37.41 | 14.04 | 1.08 | 13.77 | 2.54 | 0.86 | 1.53 | 8.02 | 0.08 | 1.12 | 4.51 |
| Skipjack Herring | | 1.18 | 1.32 | 0.98 | 0.71 | 0.93 | 0.11 | 1.10 | 0.45 | | 0.04 | 0.14 | 0.42 |
| Threadfin Shad | | | 0.31 | 0.26 | 0.57 | 0.19 | 0.12 | | 0.15 | 1.53 | 0.08 | 0.73 | 0.07 |
| **Cyprinidae** | | | | | | | | | | | | | |
| Bighead Carp | | | | 1.47 | 16.31 | | | | | | | | |
| Bighead Carp X Silver Carp | | | | | | 7.56 | | | | | | | |
| Common Carp | | 6.15 | 13.28 | 41.58 | | | 10.89 | | 2.97 | 25.11 | | 34.61 | 12.03 |
| Emerald Shiner | | | 1.12 | 1.07 | | 1.35 | 0.74 | | | | | 0.18 | |
| Grass Carp | | 20.94 | 7.32 | | | | | | | | | | |
| Silver Carp | | 199.51 | 62.02 | 135.32 | 41.61 | 11.01 | 15.23 | 39.56 | 7.68 | 7.96 | 41.00 | 31.88 | 9.15 |
| Silvery Minnow | | | | 0.71 | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | |
| Goldeye | | 1.39 | 0.22 | | 0.31 | 0.26 | | | | 0.10 | | | |
| **Ictaluridae** | | | | | | | | | | | | | |
| Blue Catfish | | 1.33 | | | | | | | | | | | |
| Channel Catfish | | 22.38 | 19.53 | 10.74 | 0.48 | 5.78 | | 0.03 | 42.80 | 40.82 | | 3.28 | 6.28 |
| Flathead Catfish | | 17.70 | 9.46 | 4.69 | | 0.53 | | | 6.82 | | 1.19 | 9.76 | 5.96 |

Appendix X (continued). Biomass (lb) of each species collected during 2013 using pulsed-DC electrofishing in four pools of the Ohio River. Species comprising <0.1% of relative biomass were not included in table.

| | Pool | Smithland | | | Pool 52 | | | Pool 53 | | | Ohio River Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/time period (h) | 2.25 | | | 1.00 | | | 1.00 | | | 0.75 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Lepisosteidae** | | | | | | | | | | | | | |
| Longnose Gar | | 47.04 | 33.47 | 8.22 | 7.01 | 5.65 | 1.91 | 1.38 | 9.18 | 2.31 | 5.59 | 13.91 | 5.92 |
| Shortnose Gar | | 29.57 | 26.56 | 19.72 | | | | 3.85 | 26.62 | 1.85 | | 15.19 | |
| Spotted Gar | | 2.51 | | | | | | | | | | | |
| **Moronidae** | | | | | | | | | | | | | |
| Striped Bass | | 4.27 | 0.58 | 11.90 | | | | | | | | | |
| Striped Bass X White Bass | | 1.75 | 0.39 | 1.49 | | | | | | | | | |
| White Bass | | 19.68 | 5.53 | 24.08 | 0.57 | 5.13 | 0.06 | 0.26 | 1.31 | 0.42 | | 1.89 | 0.12 |
| Yellow Bass | | 0.60 | | | | | | | | | | | |
| **Percidae** | | | | | | | | | | | | | |
| Sauger | | | 2.18 | 0.90 | | | | 0.57 | | 1.12 | | | |
| **Sciaenidae** | | | | | | | | | | | | | |
| Freshwater Drum | | 65.80 | 34.51 | 18.48 | | 0.44 | | | 9.32 | 6.91 | | 7.29 | 18.34 |
| Total specimens collected | | 537.50 | 320.76 | 375.82 | 96.03 | 77.00 | 42.68 | 57.89 | 127.27 | 135.13 | 52.13 | 133.23 | 87.74 |

Appendix XI. Numbers of each species collected using pulsed DC electrofishing in five reaches of the Wabash River during 2013.

| | Reach | Terre Haute to Palestine | | | Palestine to Vincennes | | | Vincennes to Mt. Carmell | | | Mt. Carmel to New Harmony | | | New Harmony to Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/time period (h) | 1.25 | | | 1.00 | | | 1.00 | | | 1.00 | | | 1.25 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Acipenseridae** | | | | | | | | | | | | | | | | |
| Shovelnose Sturgeon | | | | | | | | | 1 | | | | | | 1 | |
| **Amiidae** | | | | | | | | | | | | | | | | |
| Bowfin | | | 1 | 1 | | | | | | | | | | | | |
| **Anguillidae** | | | | | | | | | | | | | | | | |
| American Eel | | | 1 | | | | | | | | | | | | 1 | |
| **Atherinidae** | | | | | | | | | | | | | | | | |
| Brook Silverside | | | | | | | | | | | | | | | 1 | |
| **Catostomidae** | | | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | 2 | 3 | 2 | 2 | 7 | | 4 | | | | 3 | | | 4 | 2 |
| Black Buffalo | | | | | 1 | 2 | | | | 1 | 1 | | | 1 | 3 | 3 |
| Blue Sucker | | 1 | 5 | 13 | 2 | 1 | 1 | | 1 | 2 | | 3 | 2 | | 7 | 1 |
| Golden Redhorse | | | 1 | | | | | | | | | | | | | |
| Highfin Carpsucker | | | | | | | 1 | 1 | | | | | 1 | | | |
| Quillback | | 1 | | 2 | | | 4 | 7 | 1 | 5 | 5 | | 2 | 9 | | 5 |
| River Carpsucker | | 6 | 18 | 33 | 15 | 34 | 24 | 21 | 16 | 58 | 5 | 32 | 38 | 11 | 29 | 64 |
| Shorthead Redhorse | | | 1 | 7 | 5 | 1 | 3 | 1 | | | 1 | | 1 | | | |
| Silver Redhorse | | 1 | | | | | | | | | | | | | | |
| Smallmouth Buffalo | | 1 | 10 | 13 | 14 | 13 | 10 | 6 | 8 | 3 | 12 | 8 | 5 | 11 | 17 | 47 |
| Unidentified Catastomid | | | 1 | | | | | | | 1 | 1 | | | 86 | | 3 |
| **Centrarchidae** | | | | | | | | | | | | | | | | |
| Black Crappie | | | | 1 | | 1 | | | | | | | 1 | | 2 | |
| Bluegill | | | | 2 | | 1 | | | 2 | 5 | | 2 | 4 | 3 | 1 | 17 |
| Green Sunfish | | | 1 | | | | 2 | | | 1 | | 4 | 9 | | 2 | |
| Largemouth Bass | | | | 3 | | | | | | | | | | | | 2 |
| Longear Sunfish | | | 7 | 6 | 3 | 3 | 15 | | 5 | 14 | 1 | 6 | 30 | 115 | 5 | 5 |
| Longear Sunfish X Green Sunfish | | | | | | | | | | 1 | | | | | | |
| Orange Spotted Sunfish | | | | | | 4 | | | | | | | 2 | 1 | 2 | 3 |
| Redear Sunfish | | | | | | | | | | 3 | | | 2 | | | |
| Smallmouth Bass | | | | 2 | | | 2 | | | | | | 1 | | | |
| Spotted Bass | | 5 | 20 | 24 | 17 | 19 | 25 | 2 | 26 | 22 | 7 | 13 | 31 | 7 | 12 | 14 |
| **Clupeidae** | | | | | | | | | | | | | | | | |
| Gizzard Shad | | 9 | 17 | 28 | 36 | 14 | 22 | 19 | 10 | 20 | 9 | 19 | 54 | 25 | 35 | 15 |
| Skipjack Herring | | | | | 1 | | | 1 | | | | 1 | | 5 | 2 | |
| Threadfin Shad | | | | | | | | | | | | | 4 | | | |
| **Cyprinidae** | | | | | | | | | | | | | | | | |
| Bighead Carp | | | | | | | | | | | | | | 1 | | |
| Bighead Carp X Silver Carp | | | | | 1 | | | 1 | | | | | | | | |
| Bluntnose Minnow | | | | | | | | 2 | | | 4 | | | | | |
| Bullhead Minnow | | 1 | 13 | 13 | 9 | 4 | 6 | 3 | 8 | 21 | 4 | 5 | 37 | 9 | 1 | 25 |
| Central Stoneroller | | | 3 | | | | | | | | | | | | | |
| Common Carp | | 6 | 25 | 38 | 19 | 37 | 26 | 12 | 12 | 22 | 8 | 20 | 24 | 2 | 26 | 29 |
| Emerald Shiner | | 4 | 9 | 18 | 14 | 1 | 88 | 8 | 9 | 54 | 12 | 35 | 68 | 53 | 1 | 167 |
| Grass Carp | | | | 2 | 1 | 2 | 1 | | 1 | | | | 1 | | 2 | 1 |
| Redfin Shiner | | | | | | | | | | | | | 1 | | | |
| River Shiner | | 11 | 16 | 8 | 19 | 2 | 3 | 13 | 11 | 10 | 16 | 13 | 60 | 36 | 6 | 17 |

Appendix XI (continued). Numbers of each species collected using pulsed DC electrofishing in five reaches of the Wabash River during 2013.

| | Reach | Terre Haute to Palestine | | | Palestine to Vincennes | | | Vincennes to Mt. Carmell | | | Mt. Carmel to New Harmony | | | New Harmony to Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Effort/time period (h) | 1.25 | | | 1.00 | | | 1.00 | | | 1.00 | | | 1.25 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Cyprinidae (continued)** | | | | | | | | | | | | | | | | |
| Sand Shiner | | 1 | | 7 | | | 1 | | | | | 1 | 17 | 70 | | 2 |
| Silver Carp | | 9 | 8 | 1 | 8 | 8 | 18 | 1 | 1 | 6 | 2 | 2 | 1 | 12 | 10 | 11 |
| Silver Chub | | | 2 | | | | 1 | | 1 | | | 4 | 1 | 1 | 2 | 2 |
| Silvery Minnow | | 68 | 462 | 201 | 562 | 15 | 114 | 13 | 203 | 308 | 2 | 942 | 1164 | 59 | 7 | 417 |
| Spotfin Shiner | | 10 | 27 | 10 | 46 | 6 | 4 | 14 | 13 | 6 | 19 | 11 | 11 | 86 | 8 | 3 |
| Steelcolor Shiner | | | | | | | | | 2 | | 1 | | | 1 | | |
| Suckermouth Minnow | | | 1 | | | | | | | | | | | | | |
| Unidentified Cyprinid | | | | | | | | | 1 | 7 | | 1 | 4 | 1 | 1 | 3 |
| **Gasterosteidae** | | | | | | | | | | | | | | | | |
| Brook Stickleback | | | | 1 | | | | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | | | | |
| Goldeye | | 5 | 1 | | | | | | | | | | | | | |
| **Ictaluridae** | | | | | | | | | | | | | | | | |
| Blue Catfish | | | 2 | | | | | | | 1 | 1 | | | | 2 | 2 |
| Channel Catfish | | 2 | 7 | 29 | 6 | 4 | 13 | 32 | 21 | 11 | 7 | 7 | 22 | 4 | 8 | 40 |
| Flathead Catfish | | 6 | 2 | 4 | 6 | 6 | 5 | 6 | 3 | 5 | 4 | 6 | 3 | 5 | 5 | 4 |
| **Lepisosteidae** | | | | | | | | | | | | | | | | |
| Longnose Gar | | 15 | 1 | 5 | 5 | 1 | 1 | 1 | 2 | 1 | 12 | 1 | 8 | 9 | 1 | 7 |
| Shortnose Gar | | 22 | 19 | 15 | 31 | 13 | 2 | 24 | 9 | 3 | 15 | 14 | 11 | 12 | 25 | 27 |
| Spotted Gar | | | | | | | | | | | | | | 1 | | |
| **Moronidae** | | | | | | | | | | | | | | | | |
| Striped Bass | | | | | | | | | | | | | | | 7 | 4 |
| Striped Bass X White Bass | | | | | 1 | | | | 1 | | | 2 | | 1 | 6 | |
| White Bass | | 2 | 4 | 3 | | 1 | | 3 | | 5 | 5 | 5 | 8 | 13 | 7 | 18 |
| Yellow Bass | | | | | | | | | | | | | | | 1 | 1 |
| **Percidae** | | | | | | | | | | | | | | | | |
| Dusky Darter | | | 2 | | | | | | 1 | | | | | | | |
| Logperch | | | 2 | | 8 | 2 | | | | | | | 4 | | 2 | |
| Sauger | | | 1 | | | 1 | 5 | | | 2 | 2 | 1 | 3 | 2 | 5 | 3 |
| **Petromyzontidae** | | | | | | | | | | | | | | | | |
| Chestnut Lamprey | | | | | | 1 | | | | | | | 1 | | | |
| **Poeciliidae** | | | | | | | | | | | | | | | | |
| Western Mosquitofish | | | | | | | | | | 1 | | 1 | | 1 | | |
| **Polyodontidae** | | | | | | | | | | | | | | | | |
| Paddlefish | | | | | | | | | | | | | | 1 | | |
| **Sciaenidae** | | | | | | | | | | | | | | | | |
| Freshwater Drum | | 29 | 43 | 58 | 35 | 17 | 53 | 58 | 27 | 38 | 22 | 32 | 69 | 17 | 41 | 109 |
| Total specimens collected | | 217 | 736 | 550 | 867 | 221 | 450 | 253 | 396 | 637 | 178 | 1194 | 1705 | 671 | 298 | 1073 |
| Total species/hybrids | | 23/0 | 33/0 | 30/0 | 24/2 | 29/0 | 27/0 | 23/1 | 25/1 | 27/1 | 25/0 | 27/1 | 36/0 | 31/1 | 36/1 | 32/0 |

Appendix XII. Biomass (lb) of each species collected using pulsed DC electrofishing in five reaches of the Wabash River in 2013. Species comprising <0.1% of relative biomass were not included in table.

| | Reach | Terre Haute to Palestine | | | Palestine to Vincennes | | | Vincennes to Mt. Carmell | | | Mt. Carmel to New Harmony | | | New Harmony to Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/time period (h) | 1.25 | | | 1.00 | | | 1.00 | | | 1.00 | | | 1.25 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Acipenseridae** | | | | | | | | | | | | | | | | |
| Shovelnose Sturgeon | | | | | | | | | | | | | | | 1.81 | |
| **Amiidae** | | | | | | | | | | | | | | | | |
| Bowfin | | | 3.15 | 5.80 | | | | | | | | | | | | |
| **Anguillidae** | | | | | | | | | | | | | | | | |
| American Eel | | | 2.00 | | | | | | | | | | | | 2.06 | |
| **Catostomidae** | | | | | | | | | | | | | | | | |
| Bigmouth Buffalo | | 14.23 | 17.27 | 6.30 | 7.55 | 38.66 | | 22.49 | | | | 18.03 | | | 28.11 | 8.02 |
| Black Buffalo | | | | | 3.92 | 9.49 | | | | 2.44 | 8.73 | | | 19.84 | 13.92 | 21.56 |
| Blue Sucker | | 6.15 | 31.01 | 77.25 | 9.15 | 6.79 | 4.93 | | 6.84 | 18.62 | | 14.90 | 11.47 | | 20.94 | 5.23 |
| Golden Redhorse | | | 1.03 | | | | | | | | | | | | | |
| Highfin Carpsucker | | | | | | | 1.12 | | | | | | 0.97 | | | |
| Quillback | | 0.19 | | 1.47 | | | 8.74 | 0.77 | | 1.44 | 10.76 | | | 5.21 | | 0.96 |
| River Carpsucker | | 10.58 | 30.51 | 73.94 | 20.51 | 67.24 | 62.45 | 37.92 | 37.70 | 104.26 | 13.71 | 23.57 | 43.85 | 23.14 | 21.99 | 74.24 |
| Shorthead Redhorse | | | 1.30 | 14.18 | 11.72 | 2.48 | 5.55 | 2.76 | | | 1.88 | | 2.14 | | | |
| Silver Redhorse | | 3.75 | | | | | | | | | | | | | | |
| Smallmouth Buffalo | | 13.45 | 35.61 | 74.66 | 44.95 | 37.46 | 75.12 | 15.99 | 32.83 | 12.69 | 61.97 | 9.89 | 21.38 | 41.92 | 36.13 | 99.54 |
| **Centrarchidae** | | | | | | | | | | | | | | | | |
| Black Crappie | | | | 1.01 | | 0.54 | | | | | | | | | 0.65 | |
| Bluegill | | | | 0.46 | | | | | | | | | | | | 0.57 |
| Green Sunfish | | | | | | | | | | | | 0.37 | | | | |
| Longear Sunfish | | | 0.23 | 0.38 | 0.33 | | 0.39 | | 0.28 | 0.53 | | 0.24 | 0.81 | | | |
| Spotted Bass | | 1.42 | 2.08 | 1.83 | 5.17 | 2.27 | 3.97 | 0.42 | 3.11 | 6.01 | 1.34 | 2.30 | 5.31 | 1.43 | 2.23 | 1.76 |
| **Clupeidae** | | | | | | | | | | | | | | | | |
| Gizzard Shad | | 5.00 | 2.43 | 8.00 | 15.88 | 1.86 | 15.38 | 9.99 | | 7.77 | 0.95 | 3.09 | 4.20 | 3.91 | 6.27 | 2.52 |
| Skipjack Herring | | | | | 0.34 | | | 0.32 | | | | 0.21 | | 1.57 | 1.01 | |
| **Cyprinidae** | | | | | | | | | | | | | | | | |
| Bighead Carp X Silver Carp | | | | | 7.45 | | | 8.82 | | | | | | | | |
| Common Carp | | 27.77 | 139.09 | 219.99 | 114.95 | 238.97 | 193.86 | 66.91 | 71.99 | 135.24 | 35.89 | 91.92 | 166.95 | 17.66 | 160.92 | 159.25 |
| Grass Carp | | | | 24.19 | 11.46 | 29.76 | 10.00 | | 11.46 | | | | 11.03 | | 34.61 | 5.62 |
| Silver Carp | | 53.79 | 64.56 | 7.32 | 35.47 | 74.24 | 125.86 | 5.83 | 7.21 | 29.71 | 2.07 | 22.71 | 4.64 | 27.56 | 51.36 | 105.60 |
| **Hiodontidae** | | | | | | | | | | | | | | | | |
| Goldeye | | 3.51 | 1.37 | | | | | | | | | | | | | |
| **Ictaluridae** | | | | | | | | | | | | | | | | |
| Blue Catfish | | | 27.50 | | | | | | | 7.35 | 0.14 | | | | 23.64 | 2.19 |
| Channel Catfish | | 2.70 | 10.76 | 51.46 | 9.31 | 7.50 | 31.48 | 55.42 | 36.89 | 15.76 | 4.47 | 11.48 | 16.18 | 6.39 | 10.62 | 42.16 |
| Flathead Catfish | | 28.78 | | 9.61 | 7.65 | 18.26 | 24.03 | 10.07 | 7.36 | 11.74 | 22.37 | 4.30 | 3.32 | 5.47 | 7.62 | 10.18 |
| **Lepisosteidae** | | | | | | | | | | | | | | | | |
| Longnose Gar | | 24.19 | 1.67 | 7.46 | 15.49 | 1.79 | 2.04 | 1.89 | 3.78 | 0.44 | 21.20 | 3.54 | 13.36 | 26.95 | 4.46 | 14.72 |
| Shortnose Gar | | 30.75 | 21.98 | 17.30 | 34.84 | 14.24 | 2.30 | 28.39 | 9.88 | 4.40 | 22.53 | 19.60 | 13.36 | 16.29 | 36.03 | 50.58 |
| Spotted Gar | | | | | | | | | | | | | | 2.28 | | |

Appendix XII (continued). Biomass (lb) of each species collected using pulsed DC electrofishing in five reaches of the Wabash River in 2013. Species comprising <0.1% of relative biomass were not included in table.

| | Reach | Terre Haute to Palestine | | | Palestine to Vincennes | | | Vincennes to Mt. Carmell | | | Mt. Carmel to New Harmony | | | New Harmony to Confluence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/time period (h) | 1.25 | | | 1.00 | | | 1.00 | | | 1.00 | | | 1.25 | | |
| species | Time period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Moronidae** | | | | | | | | | | | | | | | | |
| Striped Bass | | | | | | | | | | | | | | | 2.98 | 8.34 |
| Striped Bass X White Bass | | | | | 0.38 | | | | 0.55 | | | 0.59 | | 1.06 | 3.66 | |
| White Bass | | 2.98 | 3.04 | 3.06 | | | | 4.01 | | 3.86 | 4.17 | 3.68 | 5.78 | 4.20 | 6.26 | 10.18 |
| **Percidae** | | | | | | | | | | | | | | | | |
| Sauger | | | 1.24 | | | 1.80 | 3.53 | | | 1.87 | 0.66 | 1.06 | 0.84 | 1.16 | 0.69 | 1.58 |
| **Polyodontidae** | | | | | | | | | | | | | | | | |
| Paddlefish | | | | | | | | | | | | | | 20.61 | | |
| **Sciaenidae** | | | | | | | | | | | | | | | | |
| Freshwater Drum | | 20.22 | 31.67 | 54.21 | 31.75 | 40.00 | 57.92 | 38.36 | 27.37 | 22.36 | 11.88 | 17.61 | 53.01 | 15.70 | 26.87 | 48.61 |
| Total specimens collected | | 249.46 | 429.50 | 659.88 | 388.27 | 593.35 | 628.67 | 310.36 | 257.25 | 386.49 | 224.72 | 249.09 | 378.60 | 242.35 | 504.84 | 673.41 |

Appendix XIII. Numbers of each species collected using pulsed-DC electrofishing in four main-channel sections of the Wabash River during 2013.

| | Reach | Darwin | | | Vincennes | | | Mt Carmel | | | New Haven | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effot/time period (h) | 0.25 | | | 0.25 | | | 0.25 | | | 0.25 | | |
| Species | Time Period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Acipenseridae** | | | | | | | | | | | | | |
| Shovelnose Sturgeon | | | 1 | 3 | 1 | 4 | 7 | | 2 | 26 | | 5 | 4 |
| **Anguillidae** | | | | | | | | | | | | | |
| American Eel | | | | | | | | | | 1 | | | |
| **Catostomidae** | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | 1 | | | | | | | | | | |
| Black Buffalo | | | | | | | | 1 | | | | | |
| Blue Sucker | | | 2 | 8 | 1 | 4 | 11 | 5 | 7 | 12 | | 3 | 14 |
| Golden Redhorse | | 1 | 2 | | | | | | | | | | |
| Highfin Carpsucker | | | 1 | | | | | | | | | | |
| Quillback | | | | 3 | | | | | 2 | | | 2 | 5 |
| River Carpsucker | | | | 3 | 1 | | 2 | 11 | | | 1 | | 1 |
| Shorthead Redhorse | | 1 | 1 | | | 3 | 4 | | | 1 | | | |
| Smallmouth Buffalo | | | 1 | | 2 | 4 | 4 | 5 | 3 | 4 | | | 4 |
| **Centrarchidae** | | | | | | | | | | | | | |
| Spotted Bass | | | | 1 | | | 2 | | | | | | |
| **Clupeidae** | | | | | | | | | | | | | |
| Gizzard Shad | | | | | | | | 1 | | | 1 | 1 | 2 |
| Skipjack Herring | | 1 | | | 1 | | | | | | | 1 | |
| **Cyprinidae** | | | | | | | | | | | | | |
| Bullhead Minnow | | | | 1 | | | | | | | | | |
| Common Carp | | | | | | | | | | | | | 1 |
| Emerald Shiner | | 7 | | | | | 1 | | | 1 | | | 11 |
| Mississippi Silvery Minnow | | | | | | | | | | | | | 12 |
| River Shiner | | | | 3 | | | | | 1 | | | | 1 |
| Silver Carp | | 2 | 3 | 1 | | | 1 | | | | | | 1 |
| Silver Chub | | | | | | | | | | | | | 1 |
| Spotfin Shiner | | | | 1 | | | | | | | | | 2 |
| Suckermouth Minnow | | | | 1 | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | |
| Goldeye | | | | | | | 1 | | | | | | |
| **Ictaluridae** | | | | | | | | | | | | | |
| Channel Catfish | | | | 2 | | | | | 4 | 6 | 1 | 2 | 6 |
| Flathead Catfish | | 1 | | | | | | | | | | | |
| **Lepisosteidae** | | | | | | | | | | | | | |
| Longnose Gar | | 1 | | | | 2 | 3 | | 3 | 4 | 2 | 1 | 2 |
| Shortnose Gar | | 1 | | | | | 1 | | | | | | |
| **Moronidae** | | | | | | | | | | | | | |
| White Bass | | | 2 | 1 | | 1 | 1 | | 1 | | | 1 | 3 |
| **Percidae** | | | | | | | | | | | | | |
| Logperch | | 1 | | 1 | | 4 | | | | | | | |
| Sauger | | | | 1 | | | 1 | | | 1 | | | |
| **Sciaenidae** | | | | | | | | | | | | | |
| Freshwater Drum | | 8 | 8 | 5 | | 7 | 4 | | | 2 | | 2 | 1 |
| Total specimens collected | | 24 | 22 | 35 | 6 | 29 | 43 | 23 | 23 | 58 | 5 | 18 | 71 |
| Total species/hybrids | | 24/0 | 22/0 | 35/0 | 6/0 | 29/0 | 43/0 | 23/0 | 23/0 | 58/0 | 5/0 | 18/0 | 71/0 |

Appendix XIV. Biomass (lb) of each species collected using pulsed-DC electrofishing in in four main-channel sections of the Wabash River in 2013.

| | | Reach | Darwin | | | Vincennes | | | Mt Carmel | | | New Haven | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | | Effot/time period (h) | | 0.25 | | | 0.25 | | | 0.25 | | | 0.25 | |
| | Species | Time Period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Acipenseridae** | | | | | | | | | | | | | | |
| | Shovelnose Sturgeon | | | 1.77 | 5.85 | 1.92 | 7.88 | 16.78 | | 3.55 | 63.19 | | 8.24 | 6.45 |
| **Anguillidae** | | | | | | | | | | | | | | |
| | American Eel | | | | | | | | | | 0.29 | | | |
| **Catostomidae** | | | | | | | | | | | | | | |
| | Bigmouth Buffalo | | | 7.28 | | | | | | | | | | |
| | Black Buffalo | | | | | | | | 7.31 | | | | | |
| | Blue Sucker | | | 11.34 | 38.56 | 3.66 | 22.43 | 82.50 | 25.35 | 40.83 | 56.25 | | 6.79 | 53.16 |
| | Golden Redhorse | | 1.42 | 2.58 | | | | | | | | | | |
| | Highfin Carpsucker | | | 0.18 | | | | | | | | | | |
| | Quillback | | | | 5.64 | | | | | 5.83 | | | 1.97 | 17.23 |
| | River Carpsucker | | | | 6.32 | 2.01 | | 7.70 | 26.94 | | | 0.86 | | 2.15 |
| | Shorthead Redhorse | | 0.31 | 0.19 | | | 1.21 | 9.93 | | | 2.24 | | | |
| | Smallmouth Buffalo | | | 6.61 | | 14.53 | 35.72 | 46.17 | 28.17 | 15.54 | 21.90 | | | 18.45 |
| **Centrarchidae** | | | | | | | | | | | | | | |
| | Spotted Bass | | | | 0.19 | | | 0.32 | | | | | | |
| **Clupeidae** | | | | | | | | | | | | | | |
| | Gizzard Shad | | | | | | | | 0.52 | | | | | 1.22 |
| | Skipjack Herring | | 0.24 | | | 0.67 | | | | | | | 0.23 | |
| **Cyprinidae** | | | | | | | | | | | | | | |
| | Bullhead Minnow | | | | | | | | | | | | | |
| | Common Carp | | | | | | | | | | | | | 0.50 |
| | Emerald Shiner | | | | | | | | | | | | | |
| | Mississippi Silvery Minnow | | | | | | | | | | | | | |
| | River Shiner | | | | | | | | | | | | | |
| | Silver Carp | | 13.32 | 12.77 | 3.32 | | | 6.86 | | | | | | 7.84 |
| | Silver Chub | | | | | | | | | | | | | 0.01 |
| | Spotfin Shiner | | | | | | | | | | | | | |
| | Suckermouth Minnow | | | | | | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | | |
| | Goldeye | | | | | | | 1.04 | | | | | | |
| **Ictaluridae** | | | | | | | | | | | | | | |
| | Channel Catfish | | | | 4.26 | | | | | 6.63 | 6.98 | 0.03 | 1.94 | 2.75 |
| | Flathead Catfish | | 0.77 | | | | | | | | | | | |
| **Lepisosteidae** | | | | | | | | | | | | | | |
| | Longnose Gar | | 1.06 | | | | 3.73 | 19.00 | | 10.01 | 8.72 | 10.03 | 2.31 | 4.56 |
| | Shortnose Gar | | 1.61 | | | | | 1.22 | | | | | | |
| **Moronidae** | | | | | | | | | | | | | | |
| | White Bass | | | 1.85 | 0.86 | | 1.04 | 1.09 | | 1.53 | | | 0.21 | 2.98 |
| **Percidae** | | | | | | | | | | | | | | |
| | Logperch | | 0.01 | | 0.02 | | 0.04 | | | | | | | |
| | Sauger | | | | 1.43 | | | 1.41 | | | 0.09 | | | |
| **Sciaenidae** | | | | | | | | | | | | | | |
| | Freshwater Drum | | 6.34 | 6.40 | 4.35 | | 4.44 | 5.08 | | | 2.49 | | 0.82 | 0.06 |
| | Total fish biomass | | 25.09 | 50.97 | 70.79 | 22.80 | 76.48 | 199.10 | 88.29 | 83.93 | 162.15 | 10.92 | 22.51 | 117.35 |

Appendix XV. Numbers of fish caught per hour of pulsed-DC electrofishing ($CPUE_N$) at four paired sampling sites in a recently-formed cutoff of the lower Wabash River during 2013.

| | Location | Above | | | New Channel | | | Old Channel | | | Below | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/Time Period (h) | 0.50 | | | 0.50 | | | 1.00 | | | 0.50 | | |
| Species | Time Period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | |
| Bowfin | | 2 | | | | | | 1 | 1 | | 6 | | |
| **Atherinopsidae** | | | | | | | | | | | | | |
| Brook Silverside | | | | | | | | | 1 | | | | |
| Inland Silverside | | | | | | 2 | | | 1 | | | | |
| **Catostomidae** | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | | | | | | 1 | 1 | 10 | | | |
| Black Buffalo | | | | | 2 | | 2 | 1 | | | | | |
| Blue Sucker | | | | 2 | 2 | | 2 | | | | 6 | | 6 |
| Highfin Carpsucker | | 2 | | | 6 | | | 3 | 1 | | 4 | | |
| Quillback | | | | | 34 | | | 5 | 12 | | 8 | 2 | |
| River Carpsucker | | 2 | | 18 | 6 | 6 | 2 | 9 | 32 | 2 | 4 | 8 | 8 |
| Smallmouth Buffalo | | 6 | 4 | 10 | | 4 | | 3 | 6 | 30 | 6 | 8 | 6 |
| **Centrarchidae** | | | | | | | | | | | | | |
| Black Crappie | | | | | | | | | | 1 | | | |
| Bluegill | | 6 | | | | | | 2 | 23 | 23 | | | 2 |
| Green Sunfish | | | | | | | | | 2 | | | | 2 |
| Longear Sunfish | | | | | | | | | 4 | | | | |
| Orange Spotted Sunfish | | | | | | | | | 1 | 1 | | | |
| Smallmouth Bass | | 2 | | | | | | | | | | | |
| Spotted Bass | | 2 | 4 | | | 6 | 2 | 1 | 6 | | | | |
| White Crappie | | | | | | | | | | 1 | | | |
| **Clupeidae** | | | | | | | | | | | | | |
| Gizzard Shad | | 8 | 52 | 30 | 6 | 156 | 96 | 169 | 340 | 21 | 20 | 56 | 4 |
| Skipjack Herring | | | 4 | | | | 2 | | 1 | | | | |
| Threadfin Shad | | 8 | | | | 2 | | 46 | 147 | 63 | | 2 | |
| **Cyprinidae** | | | | | | | | | | | | | |
| Bluntnose Minnow | | | | | | | | 1 | | | | | |
| Bullhead Minnow | | 6 | | 2 | | | 2 | 3 | 1 | 11 | 4 | | |
| Channel Shiner | | | | | 32 | | | | | 1 | | | |
| Common Carp | | 2 | | | | | | 1 | | 4 | | 2 | 8 |
| Emerald Shiner | | 2 | 62 | 88 | 4 | 164 | 52 | 22 | 134 | 76 | 12 | 20 | 8 |
| Golden Shiner | | | | | | | | | 1 | | | | |
| Mimic Shiner | | | | | 4 | | | | | 2 | | | |
| Mississippi Silvery Minnow | | 116 | 20 | 212 | 48 | 338 | 240 | 29 | 24 | 19 | 6 | | |
| River Shiner | | 8 | | 4 | 304 | 8 | 4 | 8 | 1 | | 12 | | |
| Rosyface Shiner | | | 2 | | | | | | | | | | |
| Sand Shiner | | | | | 2 | | | | | | | | |
| Silver Carp | | 8 | 4 | 34 | | | 6 | 5 | 15 | 27 | | 4 | 44 |
| Silver Chub | | | | 8 | 2 | | | | | | | | |
| Spotfin Shiner | | 14 | 10 | | 4 | | | 1 | | 6 | 4 | | |
| Steelcolor Shiner | | 10 | | | | | | 5 | | | | | |
| Unidentified Cyprinid | | 4 | | | | | 6 | | | | | | |

Appendix XV (continued). Numbers of fish caught per hour of pulsed-DC electrofishing ($CPUE_N$) at four paired sampling sites in a recently-formed cutoff of the lower Wabash River during 2013.

| | Location | Above | | | New Channel | | | Old Channel | | | Below | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/Time Period (h) | 0.50 | | | 0.50 | | | 1.00 | | | 0.50 | | |
| Species | Time Period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Fundulidae** | | | | | | | | | | | | | |
| Blackstripe Topminnow | | | | | | | | | 1 | | | | |
| **Hiodontidae** | | | | | | | | | | | | | |
| Goldeye | | | 2 | | 2 | | | | | | | | |
| **Ictaluridae** | | | | | | | | | | | | | |
| Blue Catfish | | | | | | | | | | 4 | | | |
| Channel Catfish | | | 4 | | 4 | | 26 | 1 | 3 | 6 | 6 | | 8 |
| Flathead Catfish | | 2 | 8 | 4 | | 2 | | | 1 | 1 | 4 | | |
| **Lepisosteidae** | | | | | | | | | | | | | |
| Longnose Gar | | 10 | | | 6 | | 4 | 1 | 2 | | 10 | 12 | 4 |
| Shortnose Gar | | 2 | 2 | 14 | 6 | | 4 | 2 | 1 | 2 | 8 | | 4 |
| Spotted Gar | | 2 | | | | | | 1 | | | | | |
| **Moronidae** | | | | | | | | | | | | | |
| Striped Bass | | | | 2 | 2 | 2 | | | | | | 2 | |
| Striped Bass x White Bass | | 2 | | | | 4 | | | | | 2 | | 2 |
| White Bass | | 12 | 6 | 6 | 6 | 24 | 14 | 24 | 8 | 3 | 26 | 24 | 14 |
| **Percidae** | | | | | | | | | | | | | |
| Logperch | | | | | | | 2 | | | | | | |
| Sauger | | | | | | | | | 1 | 1 | | | |
| Walleye | | | | | | | | 1 | | | | | |
| **Poeciliidae** | | | | | | | | | | | | | |
| Western Mosquitofish | | | | | | | | 2 | 1 | | | | |
| **Sciaenidae** | | | | | | | | | | | | | |
| Freshwater Drum | | 12 | 4 | 42 | 4 | | 10 | 1 | 2 | 14 | 10 | | 2 |
| CPUEn (fish/h) | | 250 | 188 | 476 | 486 | 718 | 476 | 349 | 775 | 329 | 158 | 140 | 122 |
| Total Species/Hybrids | | 23/1 | 15/0 | 15/0 | 21/0 | 12/1 | 17/0 | 28/0 | 31/0 | 24/0 | 18/1 | 11/0 | 14/1 |

Appendix XVI. Biomass of fish caught per hour of pulsed-DC electrofishing ($CPUE_W$) at four paired sampling sites in a recently-formed cutoff of the lower Wabash River during 2013.

| | Location | Above | | | New Channel | | | Old Channel | | | Below | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | Effort/Time Period (h) | 0.50 | | | 0.50 | | | 1.00 | | | 0.50 | | |
| Species | Time Period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | | | |
| Bowfin | | 5.07 | | | | | | 4.01 | 3.04 | | 25.75 | | |
| **Catostomidae** | | | | | | | | | | | | | |
| Bigmouth Buffalo | | | | | | | | | 9.11 | 68.19 | | | |
| Black Buffalo | | | | | 0.01 | | 13.55 | 6.39 | | | | | |
| Blue Sucker | | | | 8.88 | 1.90 | | 10.76 | | | | 13.23 | | 25.88 |
| Highfin Carpsucker | | 0.33 | | | 0.60 | | | 0.88 | 0.13 | | 0.43 | | |
| Quillback | | | | | 11.08 | | | 0.20 | 0.00 | | 5.96 | 5.11 | |
| River Carpsucker | | 8.73 | | 5.77 | 0.19 | 7.76 | 0.22 | 7.87 | 6.27 | 2.65 | 1.46 | 13.93 | 13.01 |
| Smallmouth Buffalo | | 18.78 | 2.50 | 4.52 | | 15.48 | | 6.46 | 6.30 | 46.78 | 3.76 | 20.73 | 21.52 |
| **Centrarchidae** | | | | | | | | | | | | | |
| Black Crappie | | | | | | | | | | 0.56 | | | |
| Bluegill | | 0.14 | | | | | | 0.03 | 0.74 | 0.05 | | | 0.01 |
| Green Sunfish | | | | | | | | | 0.01 | | | | 0.01 |
| Longear Sunfish | | | | | | | | | 0.13 | | | | |
| Orange Spotted Sunfish | | | | | | | | | 0.01 | 0.02 | | | |
| Smallmouth Bass | | 0.01 | | | | | | | | | | | |
| Spotted Bass | | 0.16 | 0.05 | | | 0.12 | 0.05 | 0.63 | 0.95 | | | | |
| White Crappie | | | | | | | | | | 1.18 | | | |
| **Clupeidae** | | | | | | | | | | | | | |
| Gizzard Shad | | 2.92 | 3.32 | 2.74 | 1.93 | 4.81 | 10.42 | 5.09 | 4.48 | 0.50 | 0.67 | 1.26 | 0.19 |
| Skipjack Herring | | | 0.60 | | | | 1.28 | | 0.01 | | | | |
| Threadfin Shad | | | | | | | | | 0.15 | 0.10 | | | |
| **Cyprinidae** | | | | | | | | | | | | | |
| Channel Shiner | | | | | 0.05 | | | | | | | | |
| Common Carp | | 15.83 | | | | | | 0.01 | | 28.91 | | 6.96 | 56.29 |
| Emerald Shiner | | | 0.01 | 0.15 | | 0.14 | | | 0.04 | 0.08 | | | |
| Golden Shiner | | | | | | | | | | | | | |
| Mimic Shiner | | | | | | | | | | | | | |
| Mississippi Silvery Minnow | | 0.05 | | 1.02 | 0.15 | 0.53 | 1.03 | | 0.02 | | | | |
| River Shiner | | | | | 0.99 | | | | | | | | |
| Silver Carp | | | 29.81 | 271.77 | | | 39.91 | 22.94 | 80.77 | 218.63 | | 34.29 | 329.96 |
| Silver Chub | | | | | 0.03 | | | | | | | | |
| **Hiodontidae** | | | | | | | | | | | | | |
| Goldeye | | | 0.23 | | 0.62 | | | | | | | | |
| **Ictaluridae** | | | | | | | | | | | | | |
| Blue Catfish | | | | | | | | | | 2.55 | | | |
| Channel Catfish | | | 7.78 | | 2.06 | | 56.37 | 0.85 | 4.72 | 11.81 | 2.93 | | 11.07 |
| Flathead Catfish | | 0.07 | 4.22 | 5.41 | | 2.98 | | | 1.64 | 1.87 | 21.16 | | |
| **Lepisosteidae** | | | | | | | | | | | | | |
| Longnose Gar | | 35.05 | | | 8.10 | | 3.46 | 0.02 | 6.81 | | 35.41 | 39.95 | 13.01 |
| Shortnose Gar | | 3.13 | 1.94 | 19.53 | 8.73 | | 6.22 | 4.29 | 0.27 | 2.50 | 18.65 | | 5.24 |
| Spotted Gar | | 7.32 | | | | | | 1.43 | | | | | |
| **Moronidae** | | | | | | | | | | | | | |
| Striped Bass | | | | 10.47 | 3.97 | 0.87 | | | | | | 2.17 | |
| Striped Bass x White Bass | | 12.21 | | | | 3.71 | | | | | 3.16 | | 8.50 |
| White Bass | | 15.09 | 3.80 | 8.25 | 7.06 | 3.77 | 10.53 | 9.57 | 4.80 | 2.08 | 19.13 | 28.70 | 21.35 |
| **Percidae** | | | | | | | | | | | | | |
| Logperch | | | | | | | 0.01 | | | | | | |
| Sauger | | | | | | | | | 0.03 | 0.11 | | | |
| Walleye | | | | | | | | 0.01 | | | | | |
| **Sciaenidae** | | | | | | | | | | | | | |
| Freshwater Drum | | 11.83 | 3.36 | 1.03 | 0.17 | | 0.33 | 0.04 | 1.47 | 2.00 | 3.91 | | 0.10 |
| Total CPUEw (lb/h) | | 136.74 | 57.62 | 339.53 | 47.64 | 40.18 | 154.14 | 70.72 | 131.89 | 390.56 | 155.60 | 153.11 | 506.14 |

Appendix XVII. Numbers of each species collected using pulsed DC electrofishing in the Iroquois and Kankakee River in 2013.

| | | Iroquois River | | | | | Kankakee River | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gear | AC | | pulsed-DC | | | AC | | pulsed-DC | | |
| **Family** | Total Effort (h) | 2.75 | | 8.00 | | | 3.50 | | 14.00 | | |
| species | Time period | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | |
| Bowfin | | | | | | | 1 | 1 | 1 | 1 | |
| **Aphredoderidae** | | | | | | | | | | | |
| Pirate Perch | | | | | | | | | | | 2 |
| **Atherinidae** | | | | | | | | | | | |
| Brook Silverside | | 1 | 16 | 6 | 1 | 17 | 23 | 7 | 2 | 2 | 24 |
| **Catostomidae** | | | | | | | | | | | |
| Bigmouth Buffalo | | | | 5 | 1 | 13 | | 3 | 4 | 4 | 4 |
| Black Buffalo | | | | 1 | 2 | 1 | | | 4 | 13 | 21 |
| Black Redhorse | | 7 | 1 | 2 | 1 | | 28 | 12 | 16 | 12 | 45 |
| Creek Chubsucker | | | | 1 | | | | | | | |
| Golden Redhorse | | 19 | 11 | 19 | 15 | 17 | 27 | 18 | 97 | 37 | 95 |
| Highfin Carpsucker | | | | 1 | 2 | | 2 | | 15 | 6 | 2 |
| Northern Hogsucker | | | | 3 | | | 3 | 16 | 14 | 1 | 8 |
| Quillback | | 2 | | 2 | | 4 | 1 | 2 | 5 | 1 | 5 |
| River Carpsucker | | | | | | | 1 | | 2 | 1 | 1 |
| River Redhorse | | 1 | | 4 | | | 2 | | 23 | 7 | 21 |
| Shorthead Redhorse | | 10 | 19 | 45 | 2 | 15 | 18 | 30 | 165 | 81 | 122 |
| Silver Redhorse | | 2 | 3 | 10 | 7 | 5 | | 3 | 21 | 7 | 12 |
| Smallmouth Buffalo | | | | 4 | 5 | 18 | 3 | 1 | 9 | 11 | 16 |
| Spotted Sucker | | | 2 | | 3 | 9 | 1 | 1 | 2 | | |
| White Sucker | | | | | | | | 1 | | | |
| **Centrarchidae** | | | | | | | | | | | |
| Black Crappie | | | 4 | 6 | 3 | 4 | 7 | 1 | 8 | 5 | 6 |
| Bluegill | | 21 | 23 | 37 | 41 | 50 | 34 | 3 | 38 | 54 | 62 |
| Bluegill X Green Sunfish | | | | | 1 | | | | | | 2 |
| Green Sunfish | | 11 | 4 | 19 | 7 | 17 | 13 | 3 | 16 | 9 | 13 |
| Largemouth Bass | | 2 | 1 | 8 | 12 | 12 | 9 | 9 | 9 | 34 | 30 |
| Longear Sunfish | | 46 | 77 | 37 | 30 | 76 | 85 | 6 | 136 | 65 | 169 |
| Longear Sunfish X Bluegill | | | | 1 | | | | | 1 | | |
| Orange Spotted Sunfish | | 137 | 134 | 83 | 54 | 263 | 30 | 3 | 17 | 8 | 44 |
| Pumpkinseed | | | | | | | | | 1 | | |
| Rock Bass | | 6 | 9 | 5 | 4 | 4 | 32 | 11 | 30 | 31 | 45 |
| Smallmouth Bass | | 8 | 7 | 9 | 6 | 27 | 26 | 10 | 120 | 69 | 196 |
| White Crappie | | 1 | 1 | 10 | 2 | 9 | | 1 | 1 | 1 | |
| **Clupeidae** | | | | | | | | | | | |
| Gizzard Shad | | 2 | | 3 | 23 | 97 | 6 | | 21 | 14 | 145 |
| Threadfin Shad | | | | | | | | | 13 | | 1 |
| **Cyprinidae** | | | | | | | | | | | |
| Blacknose Shiner | | | | | | | | | | 1 | 7 |
| Bluntnose Minnow | | 4 | 7 | 37 | 35 | 57 | 27 | 5 | 63 | 66 | 109 |
| Bullhead Minnow | | 85 | 30 | 21 | 32 | 61 | 6 | 2 | 15 | 8 | 31 |
| Central Stoneroller | | | | | | 1 | | | | | 1 |
| Common Carp | | 11 | 9 | 57 | 30 | 35 | 14 | 25 | 39 | 36 | 66 |
| Emerald Shiner | | | | 4 | 5 | 21 | 1 | | 1 | 3 | 1 |
| Ghost Shiner | | 14 | 12 | 2 | 7 | 17 | | | 1 | | |
| Golden Shiner | | | | | | | 1 | | | 4 | 2 |
| Goldfish | | | 2 | | | | | | | | |

Appendix XVII (continued). Numbers of each species collected using pulsed DC electrofishing in the Iroquois and Kankakee River in 2013.

| | | Iroquois River | | | | | Kankakee River | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gear | AC | | pulsed-DC | | | AC | | pulsed-DC | | |
| **Family** | Total Effort (h) | 2.75 | | 8.00 | | | 3.50 | | 14.00 | | |
| species | Time period | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 1 | 2 | 3 |
| **Cyprinidae (continued)** | | | | | | | | | | | |
| Grass Carp | | | | | | | | 1 | | | |
| Hornyhead Chub | | | | 1 | | | | | | | |
| Ironcolor Shiner | | | | | | | | | | 2 | |
| Mimic Shiner | | | | 13 | 1 | | 25 | 7 | 455 | 30 | 71 |
| Pallid Shiner | | | | | | | | | | | 5 |
| Red Shiner | | | | 9 | | 2 | | | | 1 | |
| Redfin Shiner | | | | 1 | | | | | | | |
| Roseyface Shiner | | | | | | | 6 | 7 | 3 | 5 | 14 |
| Sand Shiner | | | | 9 | 9 | 16 | 9 | 2 | 94 | 28 | 47 |
| Silverjaw Minnow | | | | | | | | | 1 | | |
| Spotfin Shiner | | 36 | 5 | 700 | 295 | 554 | 51 | 10 | 759 | 233 | 580 |
| Spottail Shiner | | | | | | | | | | | 1 |
| Steelcolor Shiner | | 5 | 2 | 95 | 57 | 118 | 7 | 2 | 74 | 26 | 37 |
| Striped Shiner | | 1 | | | | | | | 1 | 2 | 1 |
| Suckermouth Minnow | | | | | 1 | | | | | | |
| Weed Shiner | | | | | | | | | 1 | 3 | |
| Unidentified juvenile Cyprinids | | 1 | | 11 | 273 | 24 | 20 | | | | 74 |
| **Esocidae** | | | | | | | | | | | |
| Grass Pickerel | | | | 7 | 1 | 2 | 7 | 5 | 2 | 4 | 2 |
| Northern Pike | | | | 1 | 1 | | | 3 | 8 | 2 | |
| **Fundulidae** | | | | | | | | | | | |
| Blackstripe Topminnow | | | 1 | 2 | 1 | 4 | 2 | 1 | 3 | | 7 |
| **Ictaluridae** | | | | | | | | | | | |
| Channel Catfish | | 49 | 51 | 108 | 13 | 62 | 22 | 41 | 44 | 21 | 100 |
| Flathead Catfish | | 10 | 1 | 11 | 17 | 6 | | 1 | 10 | 4 | 6 |
| Stonecat | | | | | | | | 2 | | | 2 |
| Yellow Bullhead | | | | | | | | | | | 1 |
| **Lepisosteidae** | | | | | | | | | | | |
| Longnose Gar | | | | | | | 1 | | 7 | 3 | 5 |
| **Moronidae** | | | | | | | | | | | |
| White Bass | | | | | | 1 | | | | | |
| Yellow Bass | | | | | 1 | | | | | | |
| **Percidae** | | | | | | | | | | | |
| Banded Darter | | 1 | 1 | 1 | | | 1 | | 1 | | 11 |
| Blackside Darter | | 2 | 1 | | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| Johnny Darter | | 5 | | | 4 | 5 | 4 | 14 | 2 | 8 | 16 |
| Least Darter | | | | | | | | 1 | | | 1 |
| Logperch | | | | 1 | | 1 | 3 | | 2 | 16 | 6 |
| Sauger | | | | | | | | 1 | | | |
| Slenderhead Darter | | 1 | | | 2 | | 3 | | 2 | 5 | 1 |
| Walleye | | 2 | 5 | 3 | 4 | 7 | 6 | 8 | 14 | 3 | 10 |
| **Petromyzontidae** | | | | | | | | | | | |
| American Brook Lamprey | | | | | | | | 2 | | 1 | |
| **Sciaenidae** | | | | | | | | | | | |
| Freshwater Drum | | | | | | | 8 | | 9 | 7 | 8 |
| Total specimens collected | | 503 | 439 | 1415 | 1012 | 1654 | 577 | 283 | 2405 | 997 | 2315 |
| Total species/hybrids | | 30/0 | 28/0 | 43/1 | 40/1 | 38/0 | 42/0 | 42/0 | 53/1 | 51/0 | 54/1 |

Appendix XVIII. Biomass (lb) of each species collected using pulsed DC electrofishing in the Iroquois and Kankakee Rivers in 2013. Species comprising <0.1% were not included in this table.

| | | Iroquois River | | | | | Kankakee River | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gear | AC | | pulsed-DC | | | AC | | pulsed-DC | | |
| **Family** | Total Effort (h) | 2.75 | | 8.00 | | | 3.50 | | 14.00 | | |
| species | Time period | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 1 | 2 | 3 |
| **Amiidae** | | | | | | | | | | | |
| Bowfin | | | | | | | 2.94 | 2.87 | 3.15 | 3.84 | |
| **Catostomidae** | | | | | | | | | | | |
| Bigmouth Buffalo | | | | 29.50 | 5.26 | 81.89 | | 16.96 | 22.05 | 19.19 | 18.02 |
| Black Buffalo | | | | 11.66 | 4.44 | 6.23 | | | 29.29 | 74.54 | 135.50 |
| Black Redhorse | | 2.73 | 1.33 | | | | 35.72 | 19.15 | 16.68 | 18.88 | 65.63 |
| Golden Redhorse | | 13.08 | 13.62 | 12.90 | 2.96 | 4.58 | 37.69 | 27.37 | 135.15 | 58.25 | 153.02 |
| Highfin Carpsucker | | | | 1.65 | 4.09 | | 3.79 | | 26.79 | 7.76 | 3.18 |
| Northern Hogsucker | | | | 0.64 | | | 3.58 | 25.12 | 14.09 | | 10.40 |
| Quillback | | 3.86 | | 3.00 | | 2.24 | 2.20 | 4.92 | 9.69 | 2.08 | 10.30 |
| River Carpsucker | | | | | | | 1.64 | | 6.18 | 2.60 | 2.52 |
| River Redhorse | | 5.34 | | 19.21 | | | 9.79 | | 123.12 | 36.78 | 147.76 |
| Shorthead Redhorse | | 2.22 | 6.01 | 15.99 | 0.75 | 6.72 | 14.35 | 32.75 | 167.05 | 63.81 | 115.73 |
| Silver Redhorse | | 7.08 | 8.59 | 25.72 | 9.38 | 4.21 | | 7.38 | 47.43 | 19.37 | 28.63 |
| Smallmouth Buffalo | | | | 13.05 | 31.29 | 85.39 | 9.27 | 6.24 | 63.25 | 72.39 | 65.97 |
| Spotted Sucker | | | | | 0.26 | | | | 1.84 | | |
| White Sucker | | | | | | | | 2.66 | | | |
| **Centrarchidae** | | | | | | | | | | | |
| Black Crappie | | | 1.70 | 2.64 | 1.71 | 2.60 | 1.92 | 0.77 | 3.85 | 1.52 | 1.08 |
| Bluegill | | 0.47 | 0.45 | 0.72 | 0.91 | 1.94 | 2.49 | | 3.41 | 6.09 | 4.43 |
| Green Sunfish | | 0.15 | | | 0.23 | 0.58 | 0.51 | | | 0.49 | |
| Largemouth Bass | | 0.51 | 0.57 | 2.54 | 8.96 | 3.71 | 8.21 | 3.78 | 4.07 | 13.13 | 17.70 |
| Longear Sunfish | | 0.50 | 0.99 | 0.93 | 0.66 | 0.82 | 1.96 | | 3.40 | 1.81 | 5.88 |
| Orange Spotted Sunfish | | 0.54 | 0.54 | 0.89 | 0.30 | 0.73 | 0.25 | | | | |
| Rock Bass | | 1.52 | 4.79 | 1.72 | 1.40 | 2.01 | 5.44 | 1.84 | 3.83 | 5.17 | 9.46 |
| Smallmouth Bass | | 3.67 | 4.18 | 0.75 | 3.61 | 11.32 | 7.39 | 8.72 | 51.26 | 21.03 | 62.72 |
| White Crappie | | | 0.46 | 4.24 | | 2.52 | | | | | |
| **Clupeidae** | | | | | | | | | | | |
| Gizzard Shad | | | | | 3.54 | 2.25 | 4.44 | | 8.24 | 5.31 | 48.48 |
| **Cyprinidae** | | | | | | | | | | | |
| Common Carp | | 49.37 | 51.57 | 305.63 | 163.73 | 231.85 | 101.28 | 209.23 | 340.50 | 242.74 | 503.14 |
| Goldfish | | | 1.65 | | | | | | | | |
| Grass Carp | | | | | | | | | 34.26 | | |
| Mimic Shiner | | | | | | | | | 0.74 | | |
| Spotfin Shiner | | | | 1.48 | 0.32 | 0.67 | | | 2.07 | | |
| **Esocidae** | | | | | | | | | | | |
| Grass Pickerel | | | | | | | 0.28 | | | | |
| Northern Pike | | | | | | | | 13.69 | 2.09 | 2.49 | |
| **Ictaluridae** | | | | | | | | | | | |
| Channel Catfish | | 103.63 | 107.31 | 209.36 | 30.58 | 131.09 | 80.94 | 118.95 | 113.03 | 47.92 | 302.17 |
| Flathead Catfish | | 5.70 | 0.17 | 25.57 | 41.46 | 10.12 | | 3.43 | 10.13 | 8.19 | 27.85 |
| **Lepisosteidae** | | | | | | | | | | | |
| Longnose Gar | | | | | | | 1.16 | | 23.68 | 4.13 | 6.27 |
| **Moronidae** | | | | | | | | | | | |
| White Bass | | | | | | 1.89 | | | | | |
| Yellow Bass | | | | | 0.73 | | | | | | |
| **Percidae** | | | | | | | | | | | |
| Sauger | | | | | | | | 1.81 | | | |
| Walleye | | 3.48 | 3.73 | 4.36 | 4.89 | 19.91 | 4.64 | 22.72 | 16.73 | 5.89 | 14.24 |
| **Sciaenidae** | | | | | | | | | | | |
| Freshwater Drum | | | | | | | 23.56 | | 24.57 | 20.05 | 24.56 |
| Total fish biomass | | 203.84 | 207.67 | 694.16 | 321.45 | 615.27 | 365.44 | 530.37 | 1311.61 | 765.45 | 1784.66 |

**Appendix XIX. Publications, reports, and presentations that resulted from research conducted during segments 6-25 of project F-101-R, the Long-term Illinois River Fish Population Monitoring Program (funded under Federal Aid in Sportfish Restoration Act, P.L. 81-681, Dingell-Johnson, Wallup-Breaux).**

I. Book Chapters

Irons, K.S., G.G. Sass, M.A. McClelland, and T.M. O'Hara. The Long Term Resource Monitoring Program: Insights into the Asian Carp Invasion of the Illinois River, Illinois, USA. *In* Invasive Asian Carps in North America. American Fisheries Society Special Publication. Bethesda, MD. 2010.

II. Publications. Manuscripts published or accepted for publication during Segment 25 are printed in bold.

McClelland, M.A., K.S. Irons, G.G. Sass, T. M. O'Hara, and T.R. Cook. 2013. A comparison of two electrofishing methods used to monitor fish on the Illinois River, Illinois, USA. River Research and Applications. 29:125-133

McClelland, M.A., G.G. Sass, T.R. Cook, K.S. Irons, N.M. Michaels, T.M. O'Hara, and C.S. Smith. 2012. The Long-term Illinois River Fish Population Monitoring Program. Fisheries 37(8):340-350.

McClelland, M.A and G.G. Sass. 2012. Assessing fish collections from random and fixed site sampling methods on the Illinois River. Journal of Freshwater Ecology. 27(3): 325-333.

Sass, G.G., T.R. Cook, K.S. Irons, M.A. McClelland, N.N. Michaels, T.M. O'Hara, and M.R. Stroub. 2010. A mark-recapture population estimate for invasive silver carp (*Hypophthalmichthys molitrix*) in the La Grange reach, Illinois River. Biological Invasions 12:433-436.

Irons, K.S. M.A. McClelland, and M.A. Pegg. 2006. Expansion of Round Goby in the Illinois Waterway. *The American Midland Naturalist* 156:198-200.

Irons, K.S., G.G. Sass, M.A. McClelland, and J.D. Stafford. 2007. Reduced Condition Factor of Two Native Fish Species Coincident with Invasion of Non-native Asian Carps in the Illinois River, USA: Evidence for Competition and Reduced Fitness? Journal of Fish Biology 71 (Supplement D), 258-273.

Koel, T.M. 2000. Ecohydrology and development of ecological criteria for operation of dams. Project Status Report 2000-02. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, Onalaska, Wisconsin.

Koel, T.M. 2000. Abundance of age-0 fishes correlated with hydrologic indicators. Project Status Report 2000-03. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, Onalaska, Wisconsin.

Koel, T.M. 1998. Channel catfish (*Ictalurus punctatus*) in the Upper Mississippi River System. Project Status Report 98-11. U.S. Geological Survey, Environmental Management Technical Center, Onalaska, Wisconsin.

Koel, T.M., and R.E. Sparks. 2002. Historical patterns of river stage and fish communities as criteria for operations of dams on the Illinois River. *River Research and Applications* 18:3-19.

Koel, T.M., R. Sparks, and R.E. Sparks. 1998. Channel catfish in the Upper Mississippi River System. Survey Report No. 353. Illinois Natural History Survey, Champaign.

**Lamer, J. T., Sass, G. G., Boone, J. Q., Arbieva, Z. H., Green, S. J., and J. M. Epifanio. 2014. Restriction site-associated DNA sequencing generates high-quality single nucleotide polymorphisms for assessing hybridization between bighead and silver carp in the United States and China. Molecular Ecology Resources. 14(1):79-86**

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1994. Some upstream-to-downstream differences in Illinois River fish communities. Transactions of the Illinois State Academy of Science 87(Supplement):53. (Abstract)

Lerczak, T.V. 1995. Fish community changes in the Illinois River, 1962-1994. American Currents (Summer Issue).

Lerczak, T.V. 1995. The gizzard shad in nature's economy. Illinois Audubon. (Summer Issue). Reprinted in Big River 2(12):1-3.

Lerczak, T.V., and R.E. Sparks. 1995. Fish populations in the Illinois River. Pages 7-9 in G.S. Farris, editor. Our living resources 1994. National Biological Survey, Washington, D.C.

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1995. Long-term trends (1959-1994) *in* fish populations of the Illinois River. Transactions of the Illinois State Academy of Science 88(Supplement):74. (Abstract)

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1995. Long-term trends (1959-1994) in fish populations of the Illinois River with emphasis on upstream-to-downstream trends. Proceedings of the Mississippi River Research Consortium 27:62-63.

Lerczak, T.V. 1996. Illinois River fish communities: 1960's versus 1990's. Illinois Natural History Survey Report No. 339.

**Liss, S.A., G.G. Sass, and C.D. Suski. 2013. Spatial and temporal influences on the physiological condition of invasive silver carp. Conservation Physiology (2013) 1: doi:10.1093/conphys/cot017.**

**Liss, S.A., G.G. Sass, and C.D. Suski. 2014. Influence of local-scale abiotic and biotic factors on stress and nutrition in invasive silver carp. Hydrobiologia: doi: 10.1007/10750-014-1880-y**

McClelland, Michael A., Mark A. Pegg, and Timothy W. Spier. 2006. Longitudinal Patterns of the Illinois Waterway Fish Community. Journal of Freshwater Ecology. 21/1:91-99.

Pegg, M.A. and M.A. McClelland. 2004. Assessment of spatial and temporal fish community patterns in the Illinois River. Ecology of Freshwater Fish 13:125-135.

Pegg, M. A. 2002. Invasion and transport of non-native aquatic species in the Illinois River. Pages 203-209 in A.M. Strawn, editor. Proceedings of the 2001 Governor's conference on the management of the Illinois River System, Special Report Number 27, Illinois Water Resources Center, Champaign, Illinois.

Raibley, P.T., K.D. Blodgett, and R.E. Sparks. 1995. Evidence of grass carp (*Ctenopharyngodon idella*) reproduction in the Illinois and upper Mississippi Rivers. Journal of Freshwater Ecology 10:65-74.

Sparks, R.E. 1995. Value and need for ecosystem management of large rivers and their floodplains. Bioscience 45:168-182.

Sparks, R.E. 1995. Environmental effects. Pages 132-162 *in* S.A. Changnon, editor. The great flood of 1993. University Corporation for Atmospheric Research (UCAR) and Westview Press.

<u>III. Essays</u>

Pegg, M.A. 2002. Aquatic resource monitoring in the Upper Mississippi River Basin. INHS Reports. Number 371:8-9.

<u>IV. Popular Articles</u>

"Monitoring the Illinois River Fisheries." Greg G. Sass and Michael A. McClelland. Outdoor Illinois Magazine. XVII/12:18-19. December, 2009.

<u>V. Technical Papers presented during F-101-R Segment 25 (presenters in bold)</u>

**Culver, E. F.** and J. H. Chick. 2014. SHOCKING RESULTS: Assessing the Injury Rates of Fishes from Pulsed-DC Electrofishing. 2014 Mississippi River Research Consortium. La Crosse, Wisconsin.

**Culver, E. F.** and J. H. Chick. 2014. SHOCKING RESULTS: Assessing the Injury Rates of Fishes from Pulsed-DC Electrofishing. Illinois Chapter of the American Fisheries Society Annual Meeting. Bloomington, IL. March 7, 2014.

**Culver, E. F.** and J. H. Chick. 2014. Assessing the Injury Rates of Fishes from Pulsed-DC Electrofishing. 2014 Midwest Fish and Wildlife Conference. Kansas City, Missouri.

**Culver, E. F.** and J. H. Chick. 2013. Assessing the Injury Rates of Fishes Using Established Boat Pulsed-DC Electrofishing Protocols. 2013 National American Fisheries Society Meeting. Little Rock, Arkansas.

**DeBoer, J. A.**, and M. W. Fritts. 2014. Ecological factors affecting annual production of largemouth bass and bluegill. (poster) The Nature Conservancy's Emiquon Science Symposium. Havana, IL.

**DeBoer, J. A.**, and M. W. Fritts. 2014. Ecological factors affecting annual production of largemouth bass and bluegill. (poster) University of Illinois Lightning Symposium. Champaign, IL.

**DeBoer, J. A.**, and M. W. Fritts. 2014. Ecological factors affecting annual production of largemouth bass and bluegill. (poster) Illinois Chapter of the American Fisheries Society Annual Meeting. Bloomington, IL. March 7, 2014.

**Lubinski, B.J.**, and J.H. Chick. 2013. Highlights from the new Long-Term Illinois, Mississippi, Ohio, and Wabash Rivers Fish Population Monitoring Program. 143rd Annual Meeting of the American Fisheries Society. Little Rock, Arkansas. September 8-12, 2013.

**Parker, Jerrod**. 2014. Long-Term Changes in Illinois River Fish Functional Diversity in Response to Improved Water Quality and Interannual Climate Variability, Illinois Chapter of the American Fisheries Society Annual Meeting. Bloomington, IL. March 7, 2014.

**Parker, Jerrod**. Long-term Responses of Illinois River Fish Assemblages to Improved Water Quality. Special Seminar, Metropolitan Water Reclamation District, Cicero, IL. February 20, 2014.

VIII. Data Requests received during F-101-R Segment 25

1. Mike McClelland, Illinois Department of Natural Resources.
2. Katherine McCain, US Army Corps of Engineers
3. Brian Metzke, Illinois Natural History Survey
4. Bob Hrabik, Missouri Department of Conservation
5. Nick Bloomfield, US Fish and Wildlife Service, LaCrosse Fish and Wildlife Conservation Office
6. John Belcik, Graduate Researcher, Loyola University, Chicago
7. Ruairi MacNamara, Postdoctoral Research Associate, Southern Illinois University