ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

# Long-term Survey and Assessment of Large-River Fishes in Illinois, 2015

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# Long-term Survey and Assessment of Large-River Fishes in Illinois

F-101-R-27

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

Long-term Survey and Assessment of Large-River Fishes in Illinois (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. Leellen Solter, Interim Director 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, 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 26 (2014-15) of the Long-term Survey and Assessment of Large-River Fishes in Illinois (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 on: six reaches of the Illinois River Waterway, six segments or pools of the Mississippi River, and navigable portions of the Iroquois and Kankakee Rivers. 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, and 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 or long-term trends in sportfish populations around the state. Shovelnose Sturgeon was the species most commonly encountered in the gill net surveys; sampling was substantially reduced during the 2015-2016 winter season relative to previous years due to moderate to major flooding during the majority of the field season.

*Sportfish*

Catch rates and sizes of popular sportfish species varied greatly among the rivers and reaches sampled during 2015. 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. 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 abundance and size distribution of many sportfish species, like White Bass. These observations should serve as a catalyst for future research investigating the effects environmental changes and management policies 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 identify, 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*

Although 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 but that body condition of Silver Carp in the Lower Illinois River has been much lower during the last 5-6 years than during the preceding years.

## JOB ACCOMPLISHMENTS DEFINED BY F-101-R-27 WORK PLAN

Job 1: *Prepare electrofishing equipment and train staff*

Project workers maintained and repaired electrofishing and netting equipment as need throughout Project Segment 27. 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 and Mississippi Rivers*

Project workers completed all electrofishing and netting assignments in the Illinois, Iroquois, Kankakee, and Mississippi Rivers during Project Segment 27.

Job 3: *Update computer database*

All F-101-R Segment 27 (2015-16) 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 27 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, Jerrod Parker, and Edward Culver, and graduate student Madeleine VanMiddlesworth, presented the results of electrofishing sampling at professional meetings (Appendix III). Project workers also continued the composition of the annual project report. Additionally, one peered-reviewed manuscript produced using LTEF data was published during Project Segment 27:

Tiemann, J.S., C.A. Taylor, D. Wylie, J. Lamer, P.W. Willink, F.M. Veraldi, S.M. Pescitelli, B. Lubinski, T. Thomas, R. Sauer, and B. Cantrell. 2015. Range Expansions and New Drainage Records for Select Illinois Fishes. Transactions of the Illinois State Academy of Science 108:47-52.

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# PREFACE

This report presents a summary of data collected during 2015 during segment 26 of Federal Aid project F-101-R, the Long-Term Illinois and Mississippi 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; Fritts *et al*. 2014). 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 provided upon request. All inquiries about the LTEF dataset should be directed to project staff on site (Telephone 309-543-6000; email 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 Survey and Assessment of Large-River Fishes in Illinois (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 large rivers of Illinois.

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), determine the impacts of improved water quality (Parker *et al.* 2016), 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.

Although the original fixed-site AC electrofishing program was the genesis of long-term surveys in the region, establishing a standard for sustained, quantitative trends, it now collects data that cannot be compared well to more modern monitoring programs like the U.S. Army Corp of Engineers LTRM element that more frequently sample riverine habitats. Additionally, the difficulty of maintaining fixed sampling stations in habitats affected by anthropogenic and natural disturbances, such as sedimentation and island erosion, further complicates our assumptions of the benefits of the standardization of fixed-site surveys. There is great value in maintaining strictly standardized sampling regimes in order to facilitate comparisons over large timespans, but the logistical costs of maintaining historic operations likely outweighs any benefits of maintaining a separate AC electrofishing program in the Illinois Waterway. Thus, LTEF project managers have decided to suspend the operation of the historic AC electrofishing program in 2016. This expanded implementation of LTRM-based pulsed-DC sampling throughout the Illinois River will likely provide fisheries researchers and managers with more robust and reliable datasets.

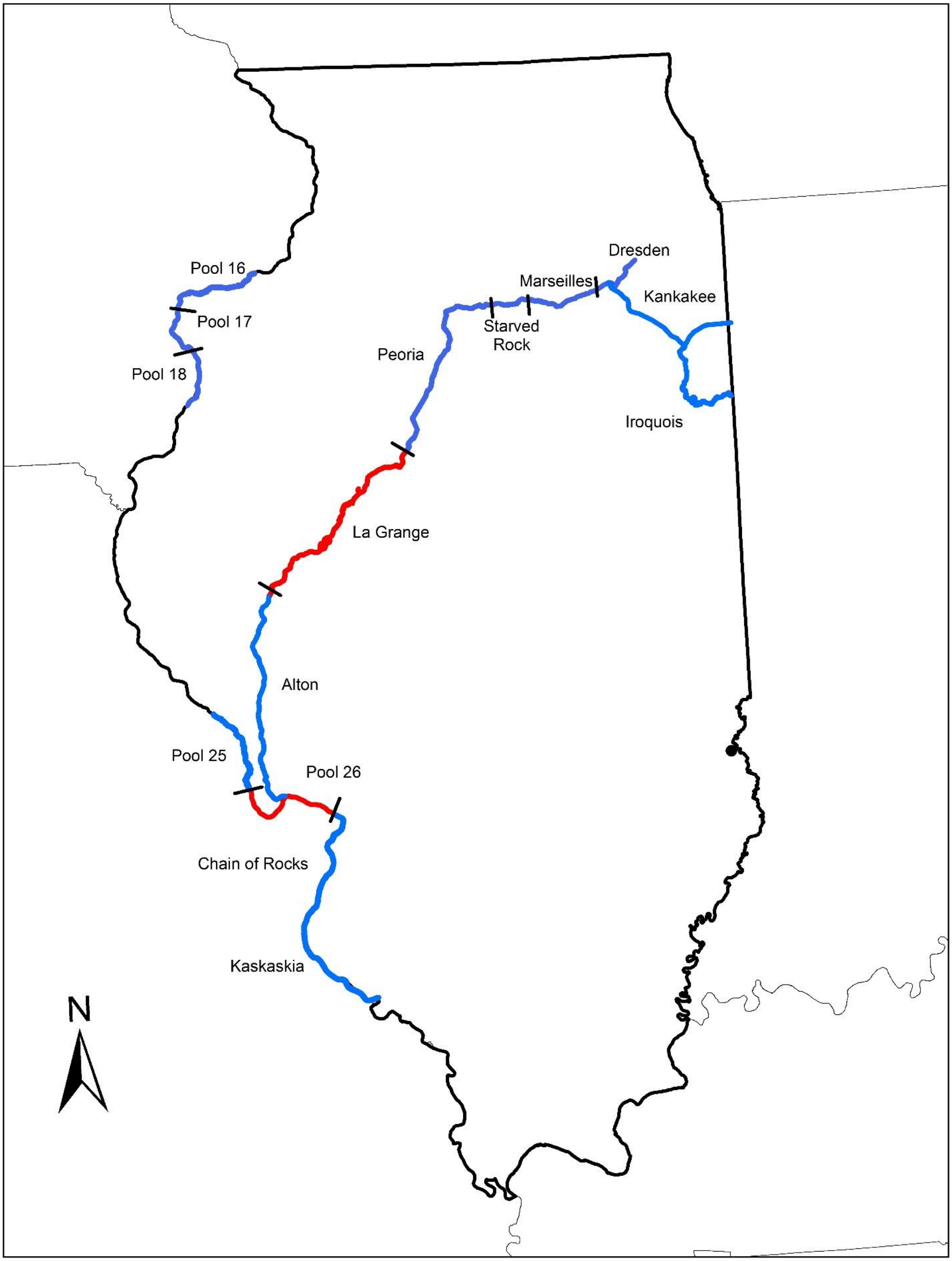


Figure 1.1. Map of the Illinois Waterway, and the Illinois portions of the Mississippi, Iroquois, and Kankakee Rivers illustrating areas sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (colored in blue) during 2015. Areas currently sampled by the US Army Corps of Engineers Upper Mississippi River Restoration Environmental Management Program's (UMRR-EMP) Long Term Resource Monitoring element (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 28 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). During 2015 sampling, pervasive high water conditions caused us to exceed the stage height threshold established for this survey at 8 of the 28 sites sampled: 6 sites in Alton pool, and 2 sites in LaGrange pool.

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 (Appendix II). 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 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 based on established LTRMP protocols for monitoring fish populations in large rivers as described by Gutreuter et al. (1995) during three sampling 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.

During 2015, uniform methods for recording external fish parasites and deformities, eroded fins, lesions, and tumors (DELT) abnormalities were implemented. These methods were based upon Ohio Environmental Protection Agency procedures (1989: Table 2.1). This supplemental data regarding fish health will allow for examinations into the relative health of sportfishes and the environmental quality of the rivers they inhabit. Quantifying the extent of diseases and parasitism in fishes have been used as indicators of biotic integrity since the Karr (1981) originally outlined his methods for the IBI (Index of Biotic Integrity). Illinois does not currently have an IBI, or regional IBIs, for use on the medium to large rivers throughout the state. Documenting the health of riverine fishes throughout the state will prove invaluable for the development of such indices.

Table 2.1. Definition of fish abnormalities documented during 2015.

| Code | Abnormality | Assessment |
|---|---|---|
| **D** | Deformity(ies) | Atypical morphology of skeletal system (Head, Spine, Fins) that does not appear to be healed injury |
| **E** | Eroded Fins | Incomplete fin membranes, spines, rays: asymmetrical (not obviously caused by deformity) |
| **L** | Lesions/Ulcers | Inflamed wounds not obviously caused through by capture during sampling |
| **T** | Tumors | Firm abnormal protruding growths |
| **M** | Multiple DELT | Combination of different DELT categories; deformities (D), eroded fins (E), lesions (L), tumors (T) |
| **AL** | Anchor Worms Light | ≤ 5 anchor worms present |
| **AH** | Anchor Worms Heavy | > 5 anchor worms present |
| **BL** | Black Spot Light | Small slightly raised black spots with relatively large spacing in comparison to body size not covering most of the body: not part of natural coloration |
| **BH** | Black Spot Heavy | Small slightly raised black spots with relatively small spacing in comparison to body size covering most of the body: not part of natural coloration |
| **B** | Blind | Obvious blindness in one or both eyes including completely missing eyes with healed skin |
| **W** | Wound | Wound not accounted for by other codes, excluding obvious recent injuries from capture; ex. broken rostrum, heron injuries, etc. |

## 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 2.1).

## 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 2013). Therefore, Flathead Catfish were excluded from our analyses of catch rates and sportfish size structures.

## Section 2.5 - 2015 Illinois River Ancillary Habitat Quality Data

Sampling using AC electrofishing gear was conducted in full daylight between 7:55 AM and 5:00 PM central standard time from 8 September to 6 October 2014. 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) exceeded expected ranges established by previous sampling surveys (Lerczak et al. 1994; Koel and Sparks 1999) at 8 of 27 sites because of a period of late summer flooding. Pulsed-DC electrofishing was conducted between 7:50 AM and 4:05 PM central standard time during the three sampling periods specified in Section 2.2. Physical measurements for ancillary water-quality parameters were collected at each DC-sampling site, and are summarized in Table 2.2.

Table 2.2. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on five reaches of the Illinois River during 2015. 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** | **6579.4 ± 134.7** | **5.3 ± 0.8** | **25.4 ± 0.3** | **78.2 ± 2.2** | **6.8 ± 0.2** | **977.9 ± 22.5** | **505.2 ± 0.1** |
| Period 1 | 0.75 | 6355.3 ± 317.9 | 4.7 ± 1.8 | 22.0 ± 0.7 | 75.0 ± 1.3 | 6.9 ± 0.1 | 952.0 ± 69.8 | 505.5 ± 0.0 |
| Period 2 | 0.75 | 6906.7 ± 50.9 | 4.0 ± 0.6 | 28.5 ± 0.2 | 85.8 ± 0.8 | 6.6 ± 0.6 | 969.7 ± 14.1 | 504.9 ± 0.0 |
| Period 3 | 0.75 | 6476.3 ± 173.7 | 7.2 ± 0.9 | 25.7 ± 0.4 | 74.0 ± 3.4 | 7.0 ± 0.2 | 1012.0 ± 8.5 | 505.1 ± 0.0 |
| **Marseilles (RM 247-271.5)** | **4.50** | **5651.1 ± 109.7** | **5.0 ± 0.3** | **21.8 ± 0.1** | **75.3 ± 1.9** | **9.0 ± 0.4** | **799.7 ± 19.1** | **6.4 ± 0.4** |
| Period 1 | 1.50 | 5160.0 ± 26.6 | 4.7 ± 0.3 | 15.9 ± 0.1 | 76.4 ± 0.2 | 8.0 ± 0.1 | 698.3 ± 5.4 | 8.5 ± 0.0 |
| Period 2 | 1.50 | 6055.0 ± 78.0 | 5.5 ± 0.7 | 17.5 ± 0.3 | 84.0 ± 1.2 | 9.6 ± 1.0 | 822.2 ± 16.4 | 5.4 ± 0.0 |
| Period 3 | 1.50 | 5738.2 ± 183.4 | 4.8 ± 0.7 | 32.0 ± 0.3 | 65.4 ± 0.6 | 9.5 ± 0.1 | 878.5 ± 6.4 | 5.2 ± 0.0 |
| **Starved Rock (RM 231-247)** | **2.25** | **5328.3 ± 161.8** | **4.9 ± 1.1** | **14.7 ± 0.4** | **75.9 ± 1.6** | **7.9 ± 0.2** | **725.4 ± 21.1** | **460.3 ± 0.2** |
| Period 1 | 0.75 | 5166.7 ± 8.3 | 3.0 ± 1.0 | 10.6 ± 0.4 | 73.9 ± 0.2 | 7.4 ± 0.4 | 691.0 ± 2.6 | 460.9 ± 0.0 |
| Period 2 | 0.75 | 5950.0 ± 26.5 | 7.3 ± 2.9 | 19.0 ± 1.1 | 82.3 ± 0.2 | 8.2 ± 0.4 | 807.3 ± 8.8 | 459.8 ± 0.0 |
| Period 3 | 0.75 | 4868.3 ± 38.3 | 4.3 ± 1.1 | 14.4 ± 0.4 | 71.5 ± 0.1 | 8.2 ± 0.1 | 678.0 ± 14.0 | 460.1 ± 0.0 |
| **Peoria (RM 158-231)** | **11.25** | **5571.1 ± 50.7** | **4.4 ± 0.4** | **15.5 ± 0.1** | **74.9 ± 1.4** | **7.9 ± 0.2** | **802.9 ± 13.4** | **17.1 ± 0.6** |
| Period 1 | 3.75 | 5302.7 ± 43.1 | 6.1 ± 0.4 | 18.2 ± 0.1 | 81.5 ± 0.1 | 7.4 ± 0.1 | 688.0 ± 4.4 | 22.8 ± 0.1 |
| Period 2 | 3.75 | 5930.7 ± 64.9 | 3.1 ± 0.3 | 12.9 ± 0.1 | 81.1 ± 0.5 | 7.3 ± 0.4 | 820.5 ± 4.4 | 15.0 ± 0.0 |
| Period 3 | 3.75 | 5479.9 ± 56.9 | 3.9 ± 0.8 | 15.4 ± 0.3 | 61.9 ± 0.5 | 9.1 ± 0.1 | 900.2 ± 4.8 | 13.5 ± 0.2 |
| **Alton (RM 0-80)** | **11.25** | **4617.7 ± 74.4** | **6.5 ± 0.5** | **11.0 ± 0.2** | **74.1 ± 1.0** | **6.1 ± 0.2** | **603.4 ± 18.6** | **25.7 ± 1.3** |
| Period 1 | 3.75 | 3991.8 ± 52.7 | 11.0 ± 0.5 | 11.9 ± 0.2 | 78.8 ± 0.6 | 5.4 ± 0.2 | 442.1 ± 10.4 | 41.4 ± 0.1 |
| Period 2 | 3.75 | 5060.8 ± 49.5 | 4.2 ± 0.4 | 8.9 ± 0.2 | 77.6 ± 1.1 | 5.9 ± 0.2 | 673.4 ± 16.0 | 21.7 ± 0.1 |
| Period 3 | 3.75 | 4800.6 ± 50.2 | 4.2 ± 0.4 | 12.4 ± 0.2 | 65.8 ± 1.1 | 6.9 ± 0.4 | 694.7 ± 9.1 | 21.5 ± 0.3 |

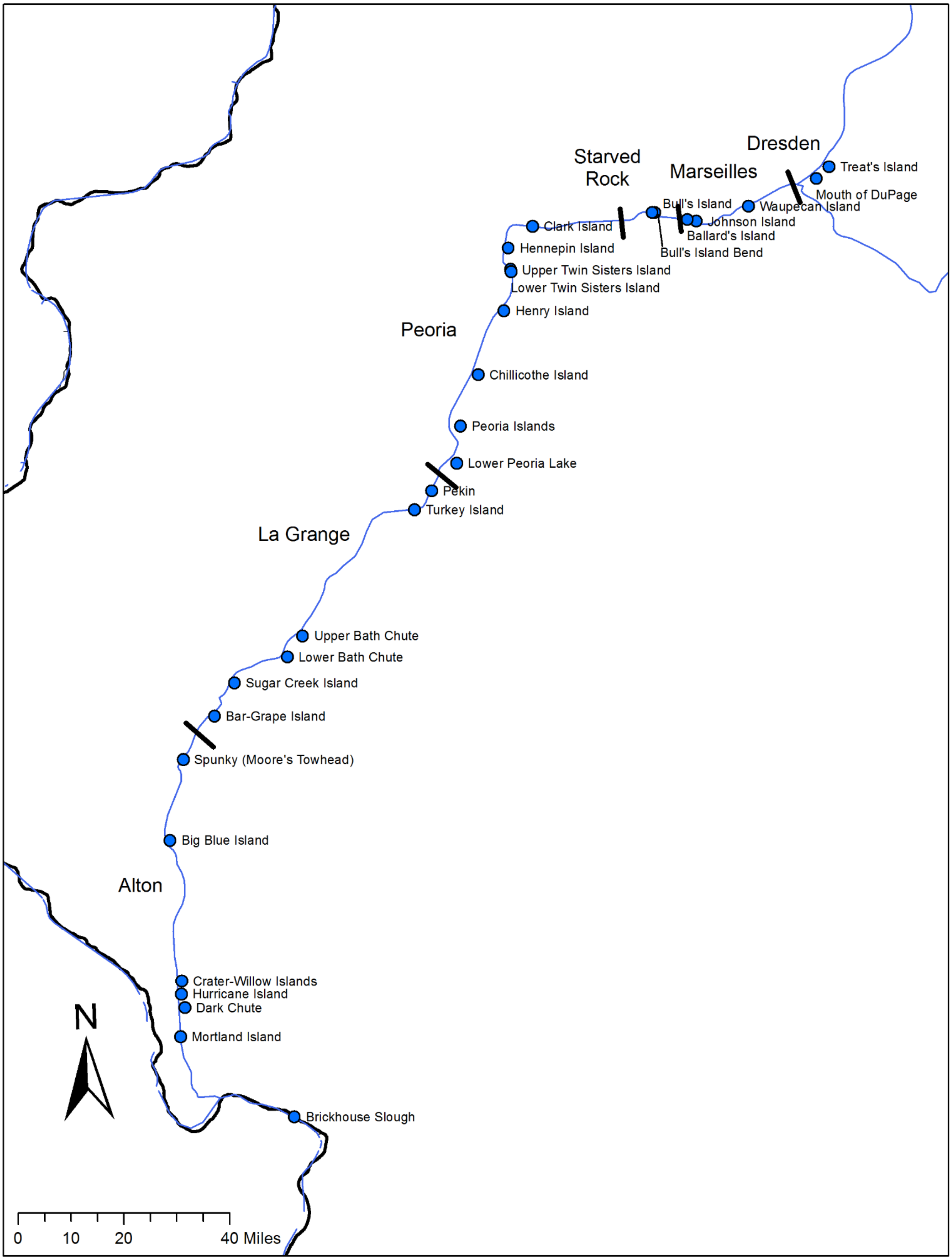


Figure 2.1. Map of the Illinois Waterway, and the fixed locations sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (F-101-R) using AC electrofishing gear during 2015 (blue dots).

**Section 2.6 - 2015 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. 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 LTRM surveys in the LaGrange Reach in the Lower Illinois River have been included in species-specific 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, LTRM 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 1,174 fish representing 40 species and 3 hybrids from 11 families during 5.8 hours of AC electrofishing at 6 locations on the Upper Illinois and Lower Des Plains rivers. Bluegill was the most abundant species in our AC survey of this region (198 fish; 16.9% of total catch) followed by Gizzard Shad (186; 15.8%), and Emerald Shiner (169; 14.4%). Common Carp contributed the greatest biomass of fishes collected in the AC survey of this region (71.6 lb; 22.8% total collected biomass), followed by Largemouth Bass (66.2 lb; 21.1%), and Silver Carp (58.3 lb; 18.6%).

We collected 2,755 fish representing 61 species and 3 hybrids from 16 families during 9 hours of pulsed-DC electrofishing at 36 sites in this region. Gizzard Shad was the most abundant species in our pulsed-DC survey of this region (603 fish; 21.9% of total catch) followed by Emerald Shiner (429; 15.6%), and Bluegill (237; 8.6%). Smallmouth Buffalo contributed the greatest biomass of fishes collected in the pulsed-DC survey of this region (281.9 lb; 24.6% total collected biomass), followed by Common Carp (197.0 lb; 17.2%), and Silver Carp (174.4 lb; 15.2%).

*Threatened and Endangered Species*

Four Banded Killifish (Illinois Threatened) were collected during three-phase AC electrofishing surveys of this region, and five Banded Killifish (Illinois Threatened) were collected during pulsed-DC electrofishing surveys of this region. These fishes were identified in the field and released, and were not verified by INHS museum staff.

*Bluegill*

Catch rates of Bluegill in the Upper Illinois River during 2014 were similar to those during 2013 and 2014, though slightly lower than 2013 and 2014 for DC surveys (Figure 2.1). The PSD values calculated from 2015 indicates that the Bluegill population of the Upper Illinois River has likely been dominated by small young-of-year and juvenile individuals since 2006.

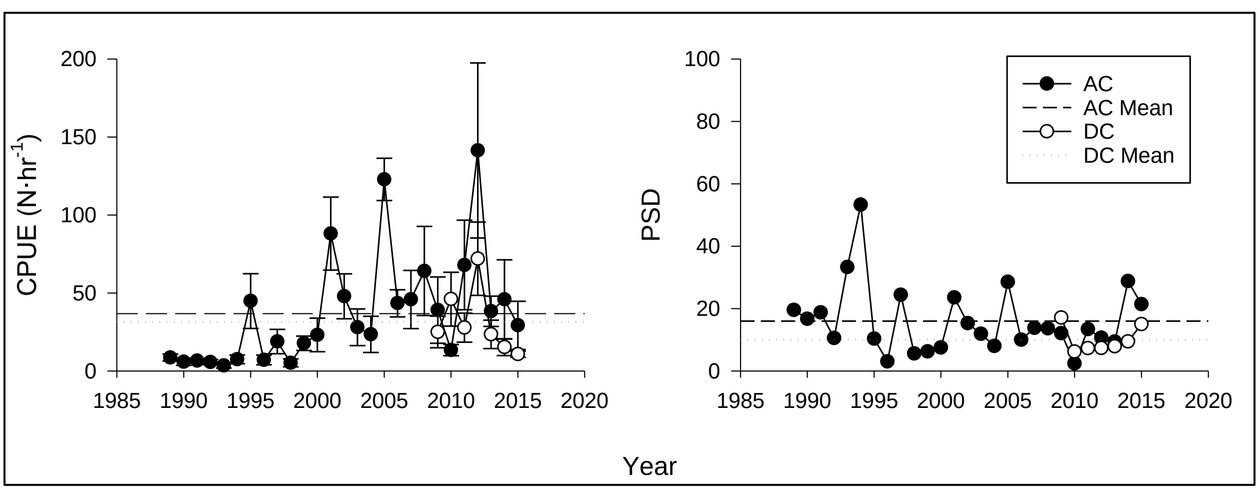


Figure 2.2. Catch per unit effort (mean ± SE; SE is calculated across sites for AC sampling, and across sites and periods for DC sampling) and proportional size distribution of Bluegill collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term 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 2015 were much higher than 2014 for DC surveys, though similar to 2014 for AC surveys (Figure 2.2). 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 sampling of smaller, juvenile and young-of-year individuals has been limited since 2010.

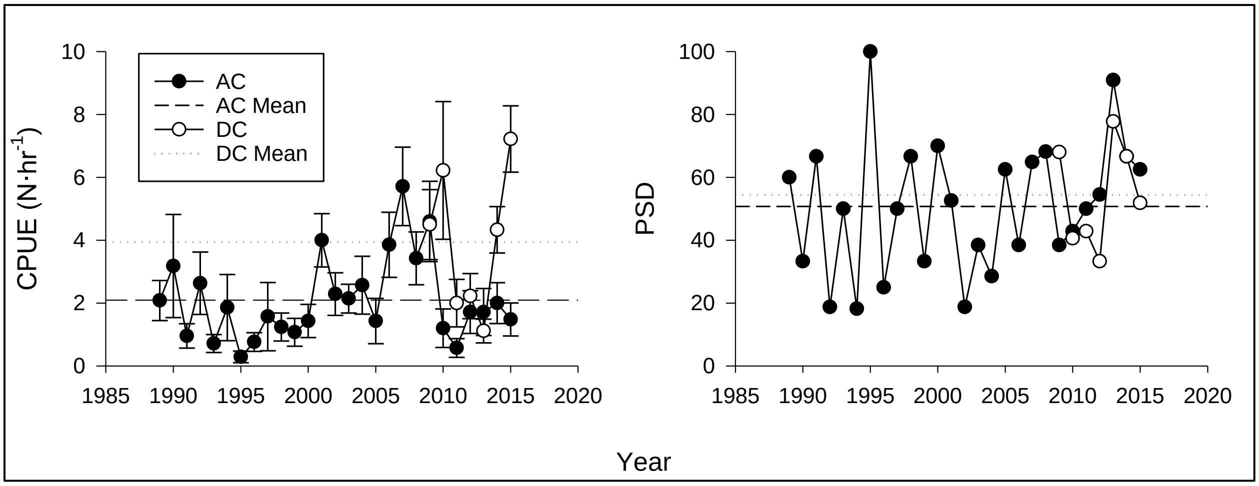


Figure 2.3. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Largemouth Bass*

Largemouth Bass CPUE and PSD in the Upper Illinois River during 2015 was above average for both AC and DC surveys (Figure 2.3), indicating a large population of robust adult fish was sampled. Although concerns, like the presence of intersex condition, may moderate our assessment of this fishery, there is no doubt the Upper Illinois River has an abundant population of catchable Largemouth Bass.

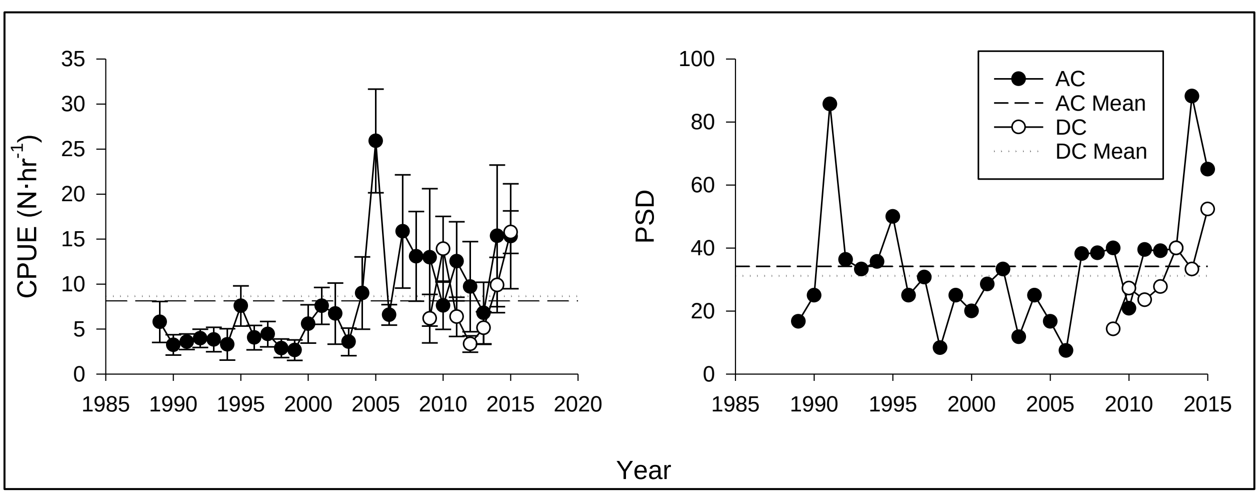


Figure 2.4. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Smallmouth Bass*

Catch rates of Smallmouth Bass in the Upper Illinois River were the highest ever recorded for DC surveys, though AC survey results were near the long-term average (Figure 2.4). Moreover, the variability of CPUE and PSD values over time indicates that Smallmouth Bass recruitment trends in this region are sporadic compared with other sportfish species. Future study of the effects of abiotic and biotic environmental variables on the population dynamics of Smallmouth Bass is warranted.

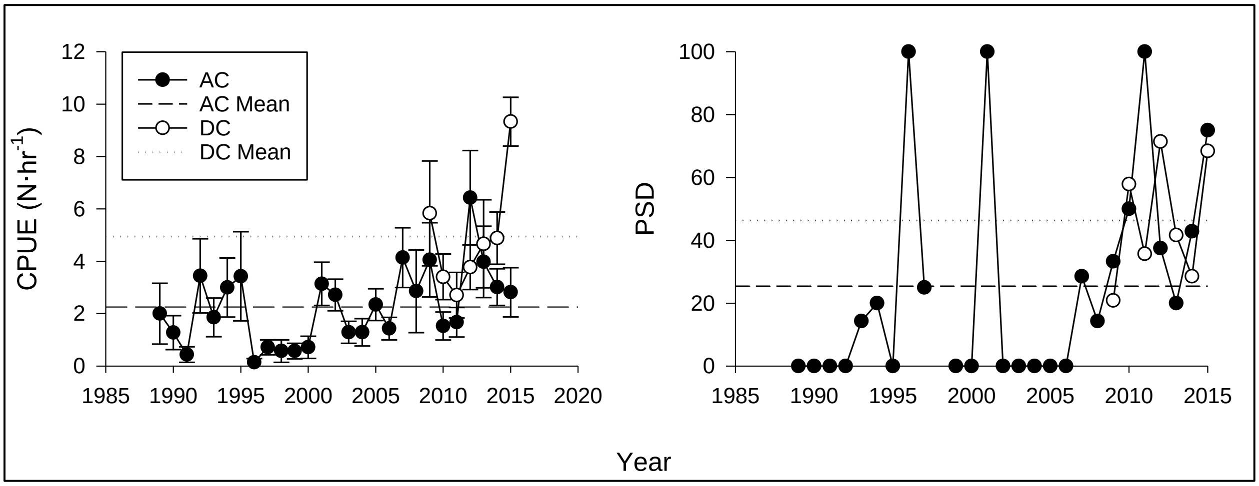


Figure 2.5. Catch per unit effort (mean ± SE) and proportional size distribution of Smallmouth Bass collected by AC and pulsed-DC electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

**Section 2.7 - 2015 Lower Illinois River Electrofishing Catch Statistics**

We collected 5,445 fish representing 63 species and 3 hybrids from 13 families during 20.1 hours of AC electrofishing at 20 locations on the Lower Illinois River and 1 location at its confluence with the Mississippi River. Gizzard Shad was the most abundant species in our AC survey of this region (876 fish; 16.1% of total catch) followed by Bluegill (747; 13.7%), and Silver Carp (697; 12.8%). Silver Carp contributed the greatest biomass of fishes collected in our AC survey of this region (2013.5 lb; 49.9% total collected biomass), followed by Common Carp (954.5 lb; 23.6%), and Channel Catfish (219.3; 5.4%).

We collected 6,276 fish representing 58 species and 3 hybrids from 15 families during 21.75 hours of pulsed-DC electrofishing at 89 sites in this region. Gizzard Shad was the most abundant species in our pulsed-DC electrofishing collections (3,235 fish; 51.5% of total catch) followed by Emerald Shiner (2,265; 36.1%), and Silver Carp (287; 4.6%). Silver Carp contributed the greatest biomass of fishes collected in the pulsed-DC survey of this region (2,846.7 lb; 46.0% total collected biomass), followed by Common Carp (1,501.4 lb; 24.3%), and Channel Catfish (323.1 lb; 5.2%).

*Threatened and Endangered Species*

One American Eel (Illinois Threatened) was collected during three-phase AC electrofishing surveys of this region, and two Banded Killifish (Illinois Threatened) were collected during pulsed-DC electrofishing surveys of this region. The American Eel was preserved as a voucher specimen for the INHS museum; the Banded Killifish were identified in the field and released, and were not verified by INHS museum staff.

*Black Crappie and White Crappie*

Catch rates of Black Crappie and White Crappie from AC surveys in the Lower Illinois River showed a nice rebound in 2015 after several years with low catch rates (Figure 2.5). CPUE of Black Crappie and White Crappie is generally low in our DC electrofishing survey of the lower Illinois River, and likely indicates the habitat sampled by the AC survey is more preferred by Crappies. PSD values during 2014 and 2015 were both lower than during 2013, indicating the possibility of recruitment in recent years, perhaps attributable to large floods in the lower river.

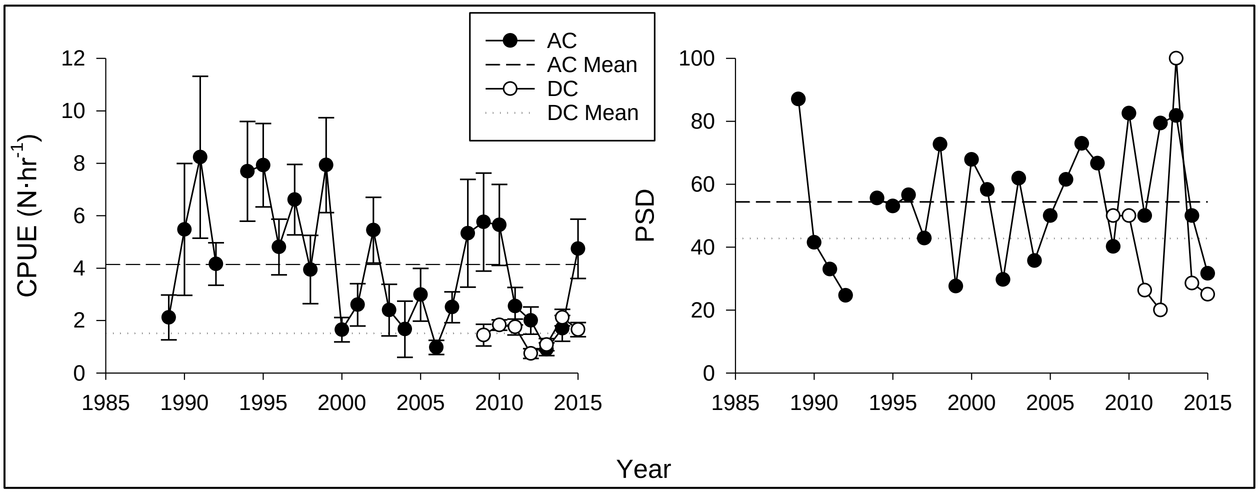


Figure 2.6. Catch per unit effort (mean ± SE) and proportional size distribution of Black and White Crappies collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in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

*Bluegill*

Similar to Crappies, catch rates of Bluegill in the Lower Illinois River from AC surveys rebounded nicely during 2015 (Figure 2.6). The pronounced difference in CPUE between AC and DC electrofishing gears has been consistent since DC sampling began in 2009 and likely indicates the habitat sampled the AC survey is more preferred by Bluegill. The low PSD values are likely indicative of a population dominated by smaller or younger individuals, perhaps resulting from poor recruitment, which may exist because of depauperate overwintering habitat or food limitation.

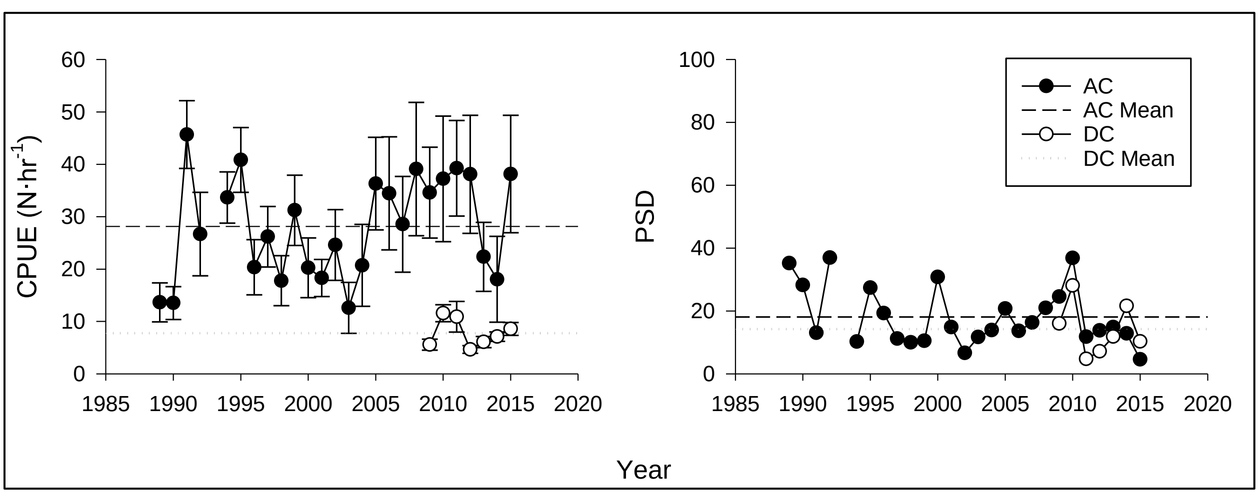


Figure 2.7. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Channel Catfish*

Catch rates of Channel Catfish in the Lower Illinois River were near long-term averages (Figure 2.7), although PSD values in 2015 in this region were above average for both AC and DC surveys. Long-term trends in CPUE and PSD indicate that Channel Catfish populations in the Lower Illinois River are increasing slightly, and may be aging, or individual growth may be increasing.

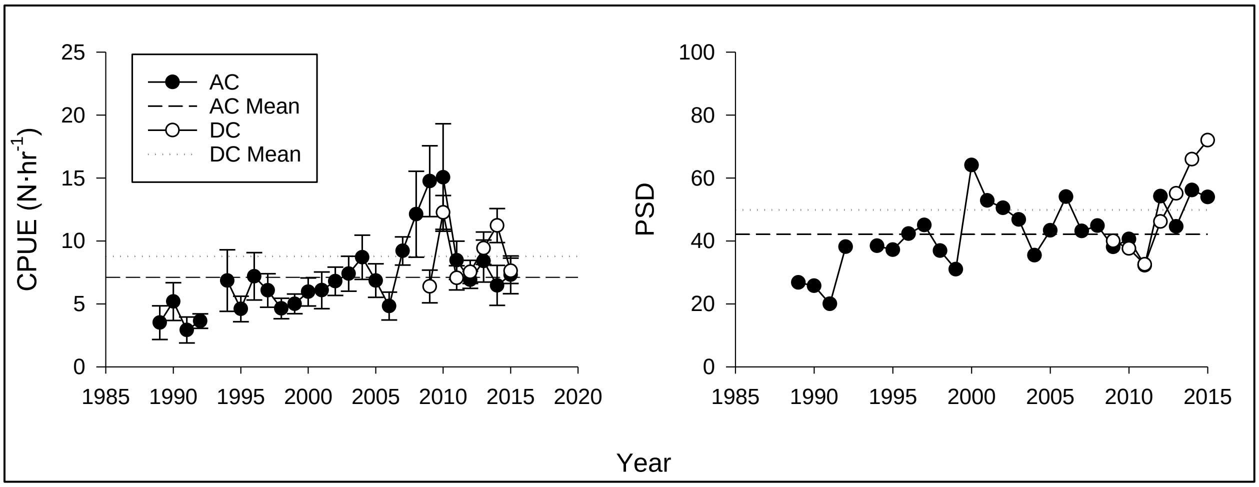


Figure 2.8. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*Largemouth Bass*

Catch rates of Largemouth Bass in the Lower Illinois River during 2015 continued the increase observed during 2014, with both AC and DC CPUEs well above long-term averages (Figure 2.8). The low PSD values calculated for both gears during 2014 indicate a recent influx of new recruits to the population (similar to Crappies), perhaps attributable to large floods in the lower river in recent years.

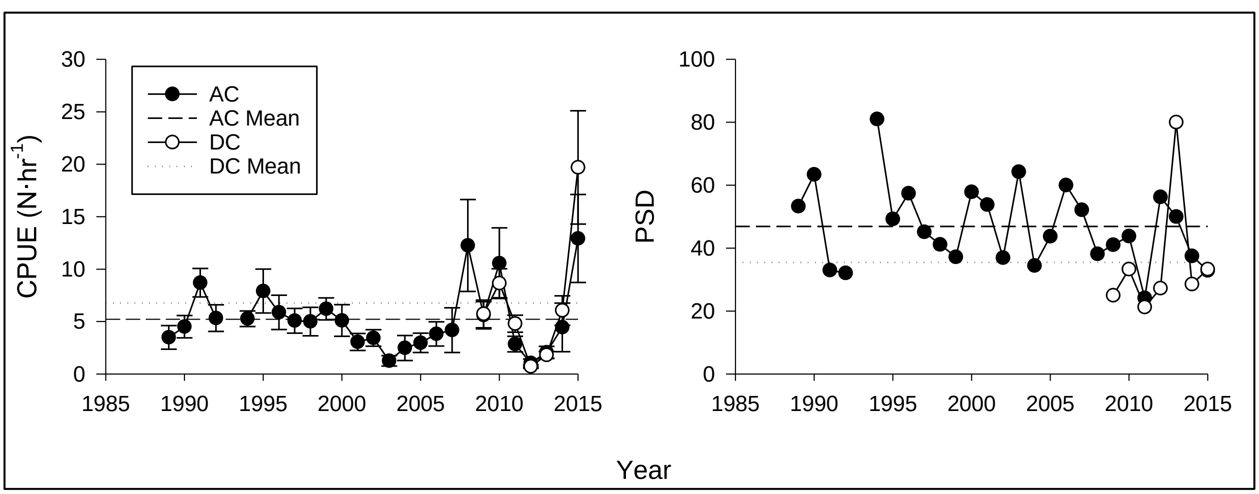


Figure 2.9. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*White Bass*

White Bass CPUE in the lower Illinois River during 2015 was slightly above the long-term average for AC surveys, but was the highest on record for DC surveys (Figure 2.9). 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, or habitat preference of different size classes of White Bass.

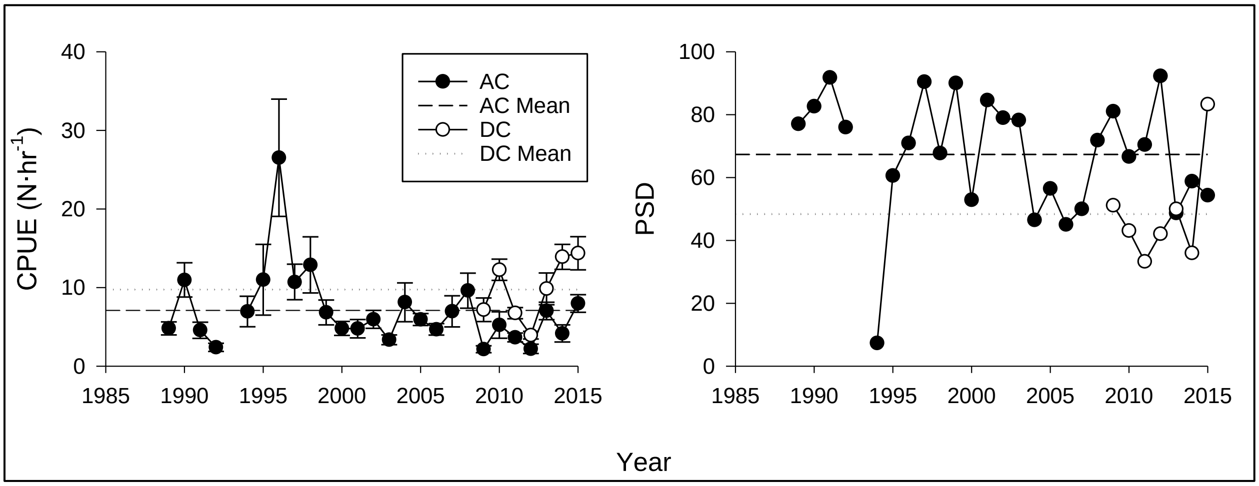


Figure 2.10. Catch per unit effort (mean ± SE) and proportional stock-density of White Bass collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

*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 then receded to current levels (~ 20 fish/h), though did take a marked increase for AC surveys during 2015. During that same time, the relative weight of Silver Carp in the Lower Illinois River has declined (Figure 2.10). Given both anecdotal and documented evidence of Silver Carp spawning activity during 2014, as well as a large increase in young-of-year Silver Carp captured during 2014, the increase in AC survey CPUE of Silver Carp is not unexpected.

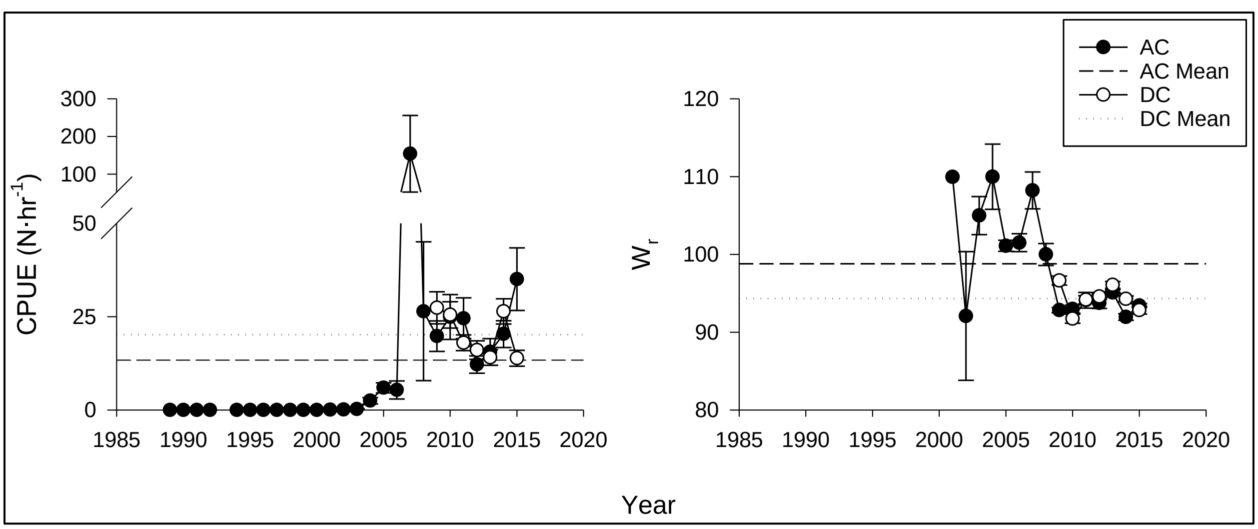


Figure 2.11. Catch per unit effort (mean ± SE) and condition (relative weight-$W_r$) of Silver Carp collected by AC and pulsed-DC electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 1989.

## Section 2.8 - Additional research projects

### Section 2.8.1 - Life-history expression of three popular sportfish from three distinct habitats in the Illinois River Watershed

Understanding how a fish's environment affects life-history expression throughout its geographic range is important for effectively managing and conserving important resources. Largemouth bass, black crappie, and bluegill are popular sportfish in the Midwest, making their management and conservation a priority for many natural resource agencies. We collected Largemouth Bass, Black Crappie, and Bluegill from three distinct habitats in the Illinois River Watershed – the Upper Illinois River/Lower Des Plaines River, LaGrange reach of the Lower Illinois River, and The Nature Conservancy's Emiquon Preserve, a large restored floodplain wetland – during Spring 2015 to better understand the effect of environmental differences on sportfish life-history expression. These habitats vary in many aspects, including location, contaminant load, bathymetry, water turbidity, and macrophyte abundance. We weighed and measured fishes, categorized visible parasite presence or absence, and extracted otoliths (to estimate fish age), gonads (to determine sex, estimate fecundity, and calculate GSI), and livers (to calculate HSI). Many life-history traits differed among habitats, though the results were often sex- and species-specific; the most-dramatic differences were in ovary weight-somatic weight relationships. Environmental factors appear to affect fish life-history expression, but more research is needed on additional factors involved (e.g., biotic interactions) and the mechanisms of effect. We collected fish again during Spring 2016, and plan to present and publish these data once sample processing and a more-thorough analysis is complete.

### Section 2.8.2 – Biotic response to the establishment and expansion of Asian carp in the Illinois River

As a heavily modified river system that connects the Mississippi River watershed to the Great Lakes watershed, the Illinois River Waterway (IRW) is a conduit for the movement of invasive species between watersheds. The most-recent – and perhaps most-feared – invasives are Asian carps, which threaten the Great Lakes themselves, and countless highly productive miles of connected rivers as well. In the 1950s, Illinois Natural History Survey scientists initiated a standardized electrofishing sampling program (Long-Term ElectroFishing - LTEF) on the IRW. The Upper Mississippi River Restoration Program's Long Term Resource Monitoring (LTRM) element combines environmental monitoring, research, systemic data acquisition, and modeling to provide a solid scientific foundation for its partners in the Upper Mississippi River System. Using the unparalleled spatio-temporal record of the LTEF and LTRM programs in Illinois, we present an analysis of ongoing large-scale datasets, including ebbs and flows in Asian carp CPUE, condition, and chronic effects on the fish, zooplankton, and phytoplankton communities. These programs provides biotic community data prior to the invasion and at every step as it happens. This project provides a better understanding of how Asian carps have affected biotic communities throughout the IRW, including the decline of the phytoplankton assemblage, the utter decimation of the zooplankton assemblage, and pulse/press disturbances on the native fish assemblage. We believe these findings may provide indications of how Asian carp populations can become established and grow in novel habitats. This project needs a brief reanalysis before drafting into a manuscript for peer review.

### Section 2.8.3 – Rates of endocrine disruption in two commercial fishes, Common Carp and Channel Catfish, along a downstream gradient in the Illinois River

Endocrine-disrupting chemicals (EDCs) can be found in high concentrations in aquatic systems, especially via point source discharges such as waste water effluent. Controlled exposures in laboratory settings suggest feminization of male fishes, such as the intersex condition in the gonads and the presence of the female-specific lipoprotein, vitellogenin, in blood circulation. Field assessments of the distribution of these characteristics in feral fish populations may provide insight into the extent of endocrine disruption within a system and which species may be more affected. The Illinois River has a notable history of pollution originating from urbanized and industrialized areas, particularly in upstream locations. This study explores patterns of intersex and elevated vitellogenin levels in mature male gonads of Common Carp and

Channel Catfish collected throughout a downstream gradient of sites in the Illinois River. Standard histological techniques were utilized to assess feminization in gonadal samples. For Common Carp, blood plasma was also sampled for detectable levels of vitellogenin via a carp-specific Enzyme-Linked Immunosorbent Assay (ELISA) kit from specimens caught in upper and lower river sites. Evidence of feminization was observed in male testes from both fish species and preliminary results from 2014 suggested a rate of intersex of 12.5% in common carp collected in the upper river. Very low incidence of intersex was seen in both species collected in 2015 from the Illinois River, and no carp collected at the reference site exhibited this condition. Selected sites in the upper and lower river contained male carp with detectable levels of vitellogenin, but these values were not within the range of female levels. A multi-model approach was also utilized to detect landscape effects on health and reproductive parameters, such as land use and National Pollutant Discharge Elimination System (NPDES) pollution load data. There appeared to be no significant negative effects upon fish health with increases in pollution loading, urbanization, or agriculture. Although many studies have examined Common Carp for signs of endocrine disruption, little has been documented for Channel Catfish populations. Both species serve economic and recreational purposes throughout the Illinois River, thus it may be essential to examine the reproductive health of Illinois River fishes and the future implications of feminization of male fish. This graduate research will likely be completed during 2016.

**Section 2.8.4 – LTEF dataset analysis**

Baselines are critical for evaluating changes. We are analyzing the LTEF database to document the profound recovery of sportfish since the initiation of the program. This analysis builds on previous research using the LTEF database, with a specific focus on sportfish populations. We are currently finalizing a manuscript, in preparation for submission to *BioScience,* highlighting the dramatic recovery of sportfish.

The LTEF dataset has also been vital in documenting the collapse of Common Carp, one of the most invasive fish species on the planet. Since the 1970s, a dramatic decline in common carp populations has occurred throughout the Illinois River, with catch rates falling by 90% or more. At the same time, there has been a conspicuous recruitment failure. Similar patterns can be documented in the Upper Mississippi River using LTRM data, but most of the collapse occurred prior to 1990. We are currently using the combined data from LTEF and LTRM to document this collapse. A draft copy of this manuscript is available, and it is intended to be submitted to *Biological Invasions* by the end of June 2016.

The information value of samples depends on the precision with which they are collected. We analyzed a dataset of fish collected in the Kankakee River during the 1980s to assess detection probability for fishes commonly found in the Illinois River watershed. We document the detection probability for 41 species by AC boat electrofishing and shoreline seining. Additionally, we analyzed how environmental covariates (water velocity, turbidity, water temperature, pH, dissolved oxygen, and conductivity) affect the detection probability of each species. Notably, most sportfish had high detection probabilities (e.g., smallmouth bass had a detection probability of ~0.95), whereas many non-game species had much lower detection probabilities. The second round of revisions for this manuscript was submitted to the *North American Journal of Fisheries Management* in June 2016.

# CHAPTER 3
# SPORTFISH ASSESSMENTS IN THE MISSISSIPPI RIVER

During 2015, the allocation of sampling pools on the MS River was modified to improve travel efficiency; staff at the Illinois River Biological Station took control of sampling Pools 17 and 18 (retained sampling on Pool 16), exchanging those pools with staff at Western Illinois University (F-121-R) who took control of sampling Pools 19 and 20 (retained sampling on Pool 21). Thus, this year's report describes changes in Pools 16-18 for the Upper Mississippi River Sampling Area, whereas last year's report described changes in Pools 16, 20, and 21.

## Section 3.1 - 2015 Mississippi River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted according to the methods described in Section 2.2 between 7:45 AM and 5:20 PM 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 2015. 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) |
|---|---|---|---|---|---|---|---|---|
| **Pool 16 (RM 457-483)** | **3.75** | **3786.3 ± 58.4** | **4.4 ± 0.6** | **9.8 ± 0.9** | **76.5 ± 1.2** | **8.2 ± 1.0** | **402.3 ± 12.4** | **11.3 ± 0.4** |
| Time Period 1 | 1.25 | 3720.2 ± 120.8 | 6.2 ± 0.5 | 6.2 ± 0.5 | 74.9 ± 0.4 | 4.8 ± 0.1 | 387.6 ± 27.8 | 13.2 ± 0.0 |
| Time Period 2 | 1.25 | 3871.0 ± 32.1 | 2.8 ± 0.9 | 13.7 ± 0.8 | 82.3 ± 0.9 | 12.9 ± 0.8 | 405.4 ± 2.4 | 10.4 ± 0.0 |
| Time Period 3 | 1.25 | 3767.8 ± 131.1 | 4.1 ± 1.3 | 9.6 ± 0.4 | 72.4 ± 0.6 | 7.1 ± 0.4 | 413.8 ± 27.3 | 10.2 ± 0.0 |
| **Pool 17 (RM 437-457)** | **3.00** | **3904.1 ± 57.0** | **5.9 ± 1.0** | **9.6 ± 0.8** | **75.7 ± 1.1** | **8.3 ± 0.8** | **429.8 ± 10.8** | **8.8 ± 0.8** |
| Time Period 1 | 1.00 | 3903.5 ± 67.1 | 8.3 ± 1.7 | 7.5 ± 0.6 | 75.5 ± 0.7 | 6.6 ± 0.6 | 430.8 ± 15.7 | 12.6 ± 0.0 |
| Time Period 2 | 1.00 | 4052.5 ± 49.6 | 6.1 ± 0.7 | 12.8 ± 0.4 | 80.3 ± 0.4 | 11.7 ± 0.8 | 441.0 ± 13.7 | 6.9 ± 0.1 |
| Time Period 3 | 1.00 | 3756.3 ± 118.9 | 3.4 ± 1.6 | 8.6 ± 1.1 | 71.4 ± 0.6 | 6.6 ± 0.4 | 417.5 ± 27.6 | 6.9 ± 0.0 |
| **Pool 18 (RM 410.5-437)** | **3.75** | **3963.3 ± 50.2** | **6.2 ± 0.8** | **9.2 ± 0.9** | **75.3 ± 0.9** | **8.3 ± 0.4** | **459.2 ± 9.5** | **8.9 ± 0.6** |
| Time Period 1 | 1.25 | 3998.0 ± 56.4 | 6.3 ± 1.1 | 11.3 ± 1.9 | 74.0 ± 0.5 | 6.7 ± 0.3 | 467.0 ± 13.8 | 12.0 ± 0.0 |
| Time Period 2 | 1.25 | 3829.0 ± 104.6 | 7.0 ± 1.8 | 7.5 ± 1.6 | 79.8 ± 0.9 | 9.5 ± 0.7 | 421.4 ± 5.9 | 7.4 ± 0.0 |
| Time Period 3 | 1.25 | 4062.8 ± 70.9 | 5.4 ± 1.4 | 8.7 ± 0.7 | 72.0 ± 0.2 | 8.7 ± 0.5 | 489.2 ± 11.6 | 7.4 ± 0.0 |
| **Pool 25 (RM 242-273.5)** | **4.50** | **3745.9 ± 34.0** | **8.7 ± 0.9** | **10.3 ± 0.7** | **75.2 ± 1.9** | **6.4 ± 0.2** | **409.9 ± 12.7** | **37.2 ± 0.6** |
| Time Period 1 | 1.50 | 3667.8 ± 54.2 | 8.0 ± 0.6 | 7.0 ± 0.6 | 79.8 ± 0.3 | 6.1 ± 0.1 | 372.8 ± 12.6 | 40.6 ± 0.3 |
| Time Period 2 | 1.50 | 3833.8 ± 77.7 | 9.7 ± 2.0 | 10.4 ± 0.4 | 80.8 ± 0.5 | 5.9 ± 0.4 | 398.5 ± 24.0 | 35.8 ± 0.2 |
| Time Period 3 | 1.50 | 3736.2 ± 7.1 | 8.5 ± 1.8 | 13.6 ± 0.8 | 65.0 ± 2.5 | 7.2 ± 0.5 | 458.3 ± 11.8 | 35.1 ± 0.1 |
| **Chain of Rocks (RM 165.5-200.5)** | **5.25** | **4141.5 ± 93.7** | **10.7 ± 1.2** | **7.8 ± 0.7** | **75.2 ± 1.3** | **6.3 ± 0.2** | **500.6 ± 22.9** | **16.8 ± 2.7** |
| Time Period 1 | 1.75 | 3782.0 ± 87.2 | 16.5 ± 1.3 | 4.9 ± 0.6 | 76.9 ± 0.9 | 5.9 ± 0.2 | 403.0 ± 18.3 | 32.9 ± 0.3 |
| Time Period 2 | 1.75 | 4387.1 ± 96.1 | 7.1 ± 0.7 | 8.4 ± 1.0 | 80.1 ± 0.9 | 6.0 ± 0.0 | 533.1 ± 21.1 | 11.3 ± 1.4 |
| Time Period 3 | 1.75 | 4255.4 ± 193.0 | 8.4 ± 1.7 | 10.0 ± 1.4 | 68.7 ± 2.2 | 7.0 ± 0.6 | 565.7 ± 44.7 | 6.2 ± 1.5 |
| **Kaskaskia (RM 117-165.5)** | **7.75** | **4238.1 ± 46.8** | **9.7 ± 0.6** | **7.2 ± 0.6** | **75.0 ± 1.5** | **6.5 ± 0.2** | **529.6 ± 19.7** | **10.1 ± 1.7** |
| Time Period 1 | 2.50 | 3946.6 ± 48.5 | 10.7 ± 1.2 | 3.7 ± 0.4 | 82.4 ± 0.2 | 5.5 ± 0.1 | 412.6 ± 12.2 | 26.2 ± 0.0 |
| Time Period 2 | 2.50 | 4333.7 ± 57.9 | 9.4 ± 0.9 | 8.0 ± 0.6 | 79.7 ± 0.6 | 6.3 ± 0.2 | 522.6 ± 13.8 | 11.4 ± 1.1 |
| Time Period 3 | 2.75 | 4416.2 ± 45.9 | 9.0 ± 1.2 | 9.6 ± 0.8 | 64.0 ± 0.9 | 7.5 ± 0.2 | 642.5 ± 22.0 | 3.2 ± 0.5 |

## Section 3.2 - 2015 Upper Mississippi River Sampling Area Pulsed-DC Electrofishing Catch Statistics

The results in the following sections have been divided between those data collected in Pools 16, 17, and 18 (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 16,369 fish representing 51 species and 1 hybrid from 10 families during 10.5 hours of pulsed-DC electrofishing at 42 sites in the Upper Mississippi River Sampling Area. Emerald Shiner was the most abundant species in our catch (12,005 fish; 73.3% of total catch) followed by River Shiner (1027; 6.3%), and Gizzard Shad (717; 4.4%). Common Carp represented the greatest proportion of the total collected biomass (788.5 lb; 56.6% of total collected biomass) followed by Channel Catfish (95.9 lb; 6.9%), and River Carpsucker (80.0 lb; 5.7%).

*Threatened and Endangered Species*

One Eastern Sand Darter (Illinois Threatened) was sampled during pulsed-DC electrofishing surveys on the Upper Mississippi River Sampling Area. This fish was identified in the field, and was not verified by INHS museum staff.

*Bluegill*

Bluegill catch rates in the Upper Mississippi River Sampling Area during 2014 were slightly below the mean since 2009, though the Bluegill populations in this area appear to be relatively stable (Figure 3.1). The PSD value for fish sampled during 2015 was below the 5-year average, likely indicating an influx of recruits in 2015.

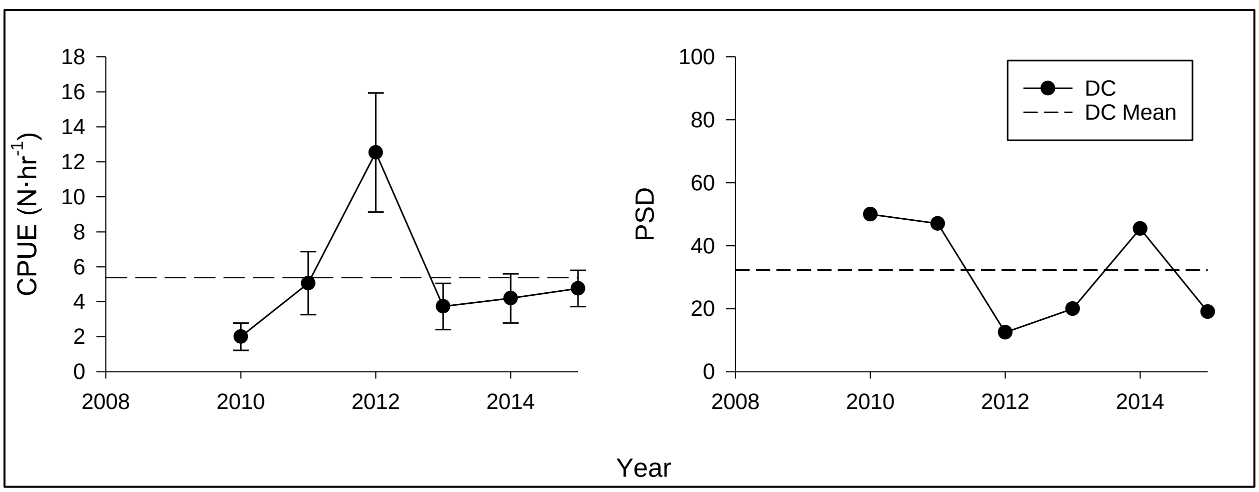


Figure 3.1. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Channel Catfish*

Catch rates of Channel Catfish increased slightly again during 2015 from previous lows during 2012 and 2013, although PSD values decreased nearer the 5-year average. These results likely indicate that the bulk of the sampled population is comprised of larger, mature fish.

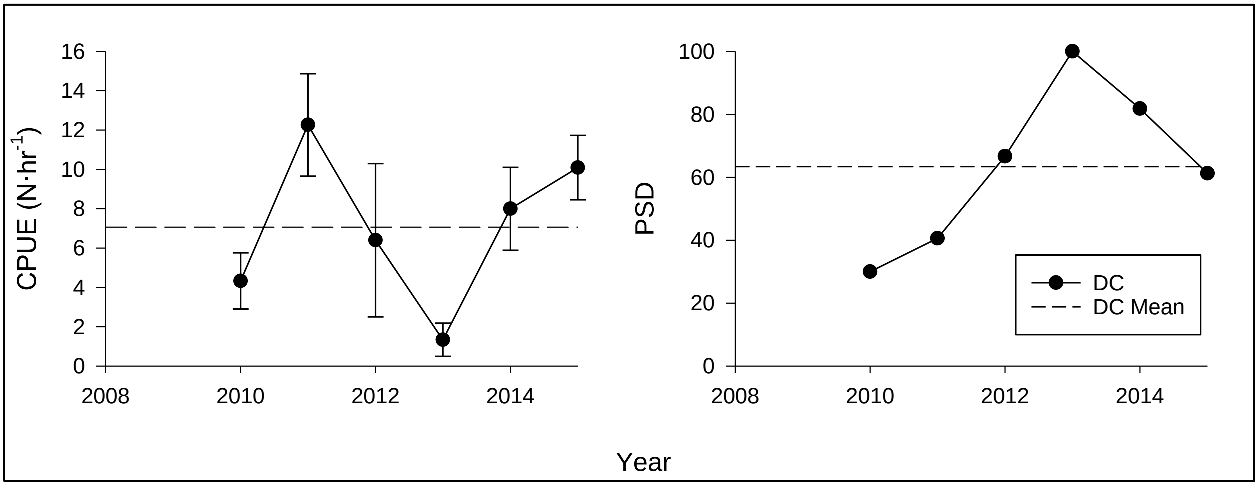


Figure 3.2. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Largemouth Bass*

Catch rates of Largemouth Bass in the Upper Mississippi River Sampling Area have been sporadic since sampling began in 2010, with 2015 CPUE near the 5-year average (Figure 3.3). The low PSD value from fish sampled during 2015 likely indicates an influx of new recruits

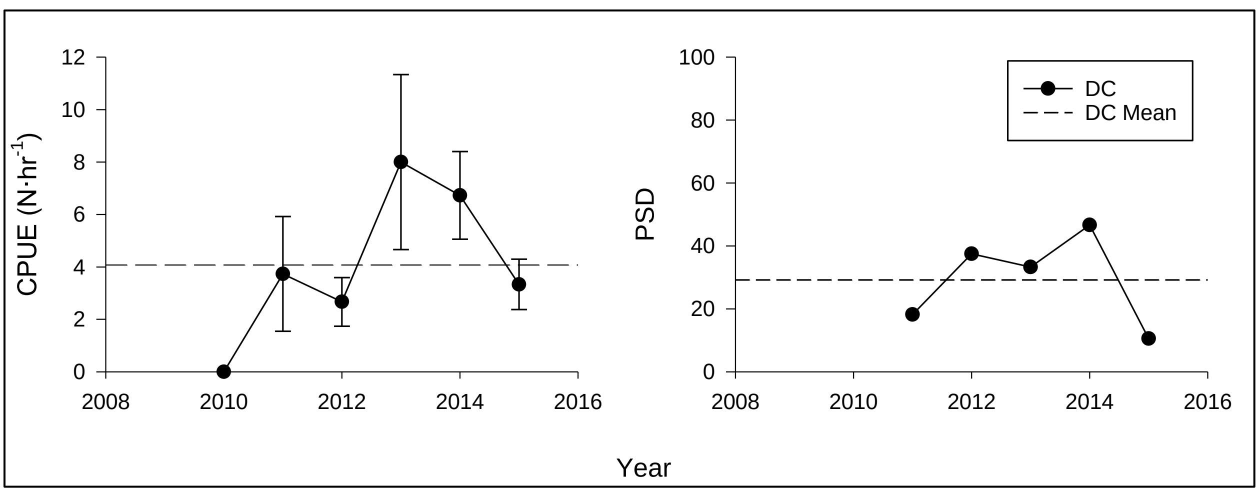


Figure 3.3. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Smallmouth Bass*

Smallmouth Bass CPUE in the Upper Mississippi River Sampling Area during 2015 was slightly below the 5-year average (Figure 3.4). The PSD value for 2015 indicates few large fish were sampled.

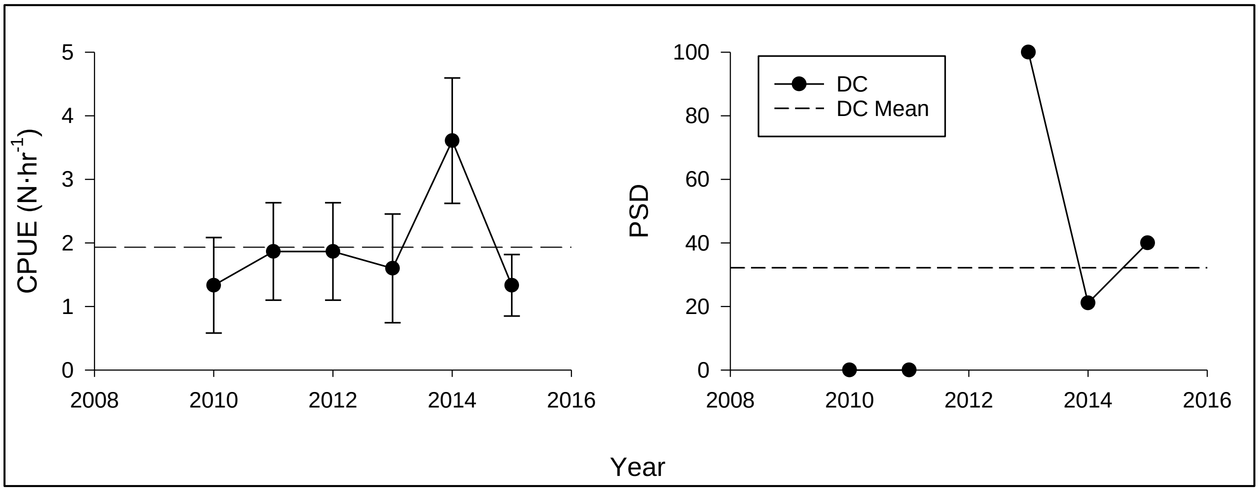


Figure 3.4. Catch per unit effort (mean ± SE) and proportional size distribution of Smallmouth Bass collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*White Bass*

Catch rates of White Bass in the Upper Mississippi River Sampling Area during 2015 were very similar to those observed in recent years (Figure 3.5). The observed increase in PSD values from 2014 to 2015 suggests that a greater proportion of larger individuals were encountered in our survey during 2015.

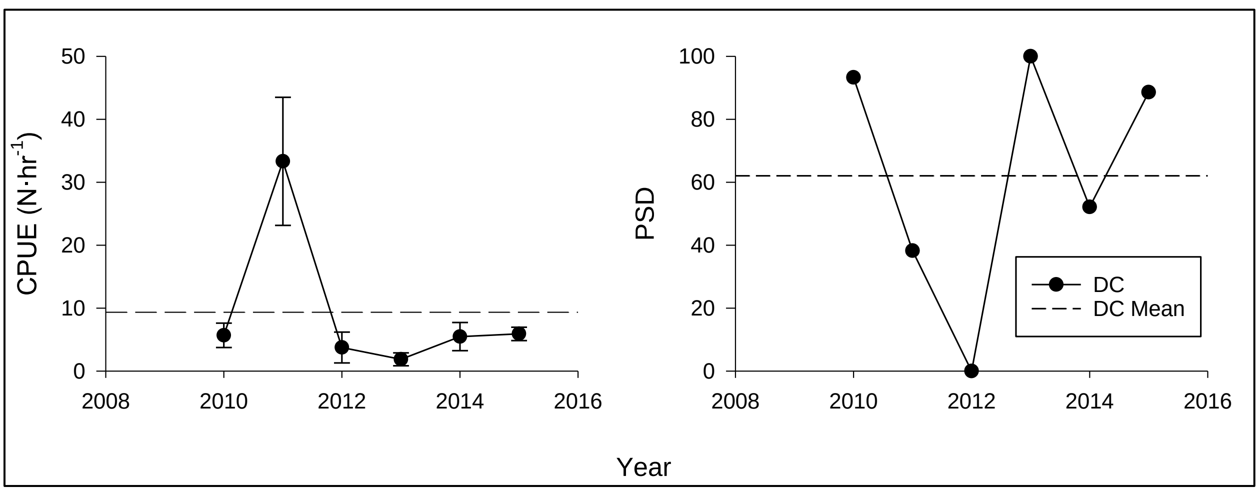


Figure 3.5. Catch per unit effort (mean ± SE) and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the Upper Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

**Section 3.3 - 2015 Lower Mississippi River Sampling Area Pulsed-DC Electrofishing Catch Statistics**

We collected 3,894 fish representing 52 species and 2 hybrids from 15 families during 17.25 hours of pulsed-DC electrofishing at 69 sites in the Lower Mississippi River Sampling Area. Emerald Shiner was the most abundant species in our catch (1,164 fish; 29.9% of total catch) followed by Gizzard Shad (746; 19.2%), and Common Carp (389; 10.0%). Common Carp represented the largest proportion of the total collected biomass (2,170.9 lb; 56.3% of total collected biomass) followed by Silver Carp (389.3 lb; 10.1%), and Smallmouth Buffalo (192.1 lb; 5.0%).

*Threatened and Endangered Species*

Six American Eel (Illinois Threatened) and seven Chestnut lamprey (Iowa Threatened) were sampled during pulsed-DC electrofishing surveys on the Lower Mississippi River Sampling Area. These fish were identified in the field, and were not verified by INHS museum staff.

*Bluegill*

The catch rate of Bluegill in the Lower Mississippi River Sampling Area has rebounded nicely in 2015 after a decline in 2014 (Figure 3.6). Low PSD values indicate that the sampled population is dominated by small individuals, and similar values may indicate that annual production of year classes has been relatively consistent since 2009.

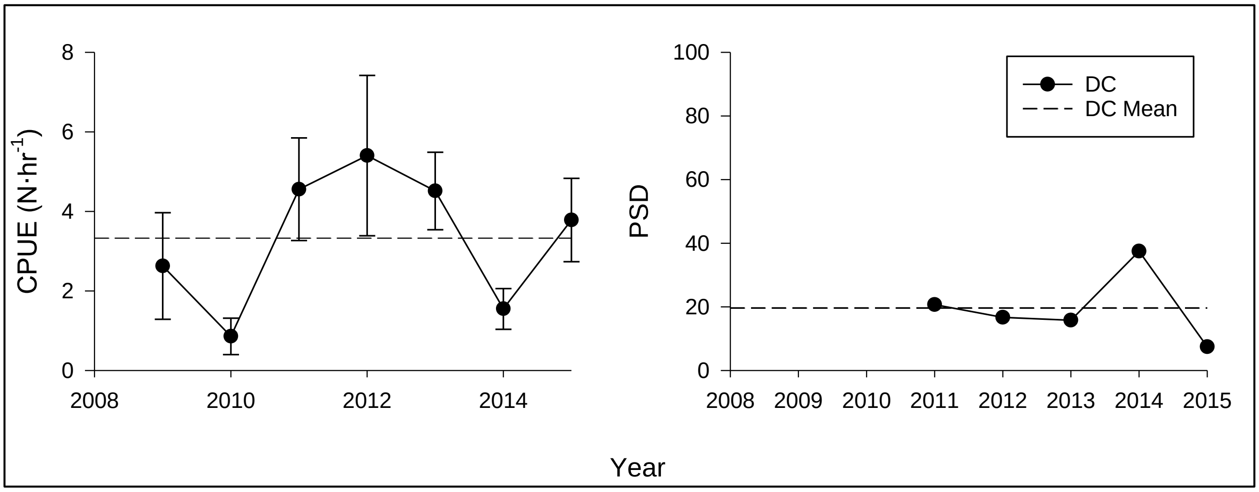


Figure 3.6. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Channel Catfish*

Catch rates of Channel Catfish in the Lower Mississippi River Sampling Area during 2015 decreased slightly from previous years (Figure 3.7). High and stable PSD values over the past five years indicate that the sampled population is largely composed of larger individuals and that the catch of smaller size classes of Channel Catfish in this region has been relatively low.

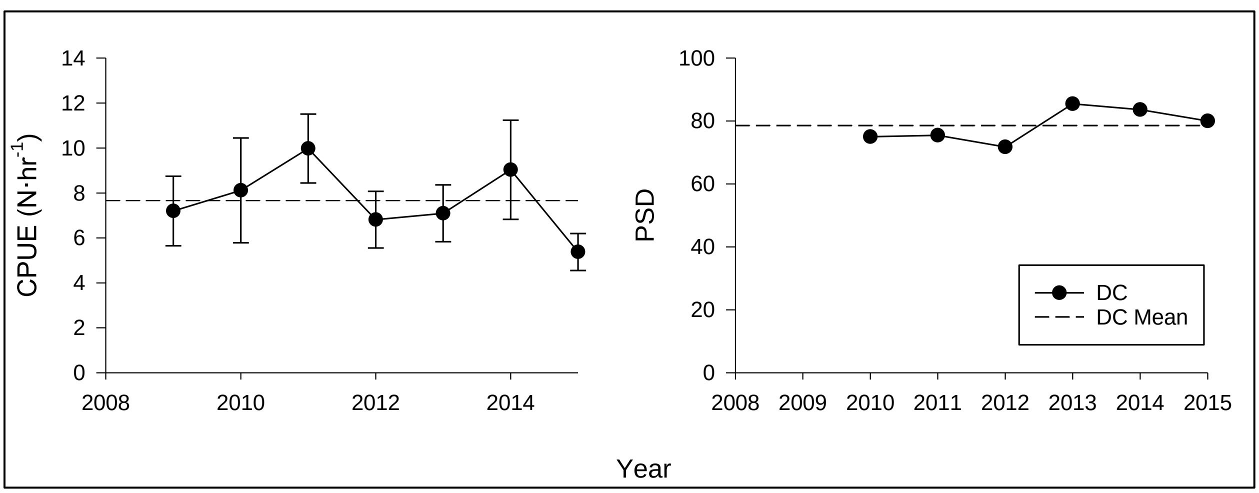


Figure 3.7. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*White Bass*

White Bass CPUE in the Lower Mississippi River Sampling Area has been erratic since 2009 (Figure 3.8), likely tied to highly variable PSD values, indicating recruitment of White Bass in the Lower Mississippi River sampling reaches may be cyclical or episodic.

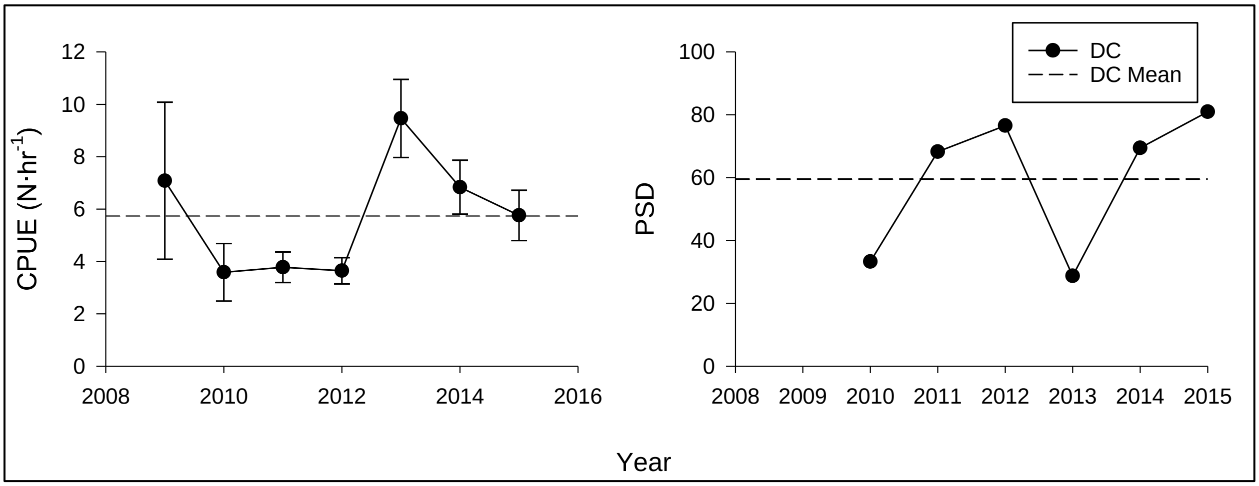


Figure 3.8. Catch per unit effort (mean ± SE) and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Reaches. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

*Silver Carp*

Catch rates of Silver Carp in the Lower Mississippi River Sampling Area decreased slightly from 2014, but were still higher than average (Figure 3.9). The $W_r$ for Silver Carp in this region has remained fairly consistent over time.

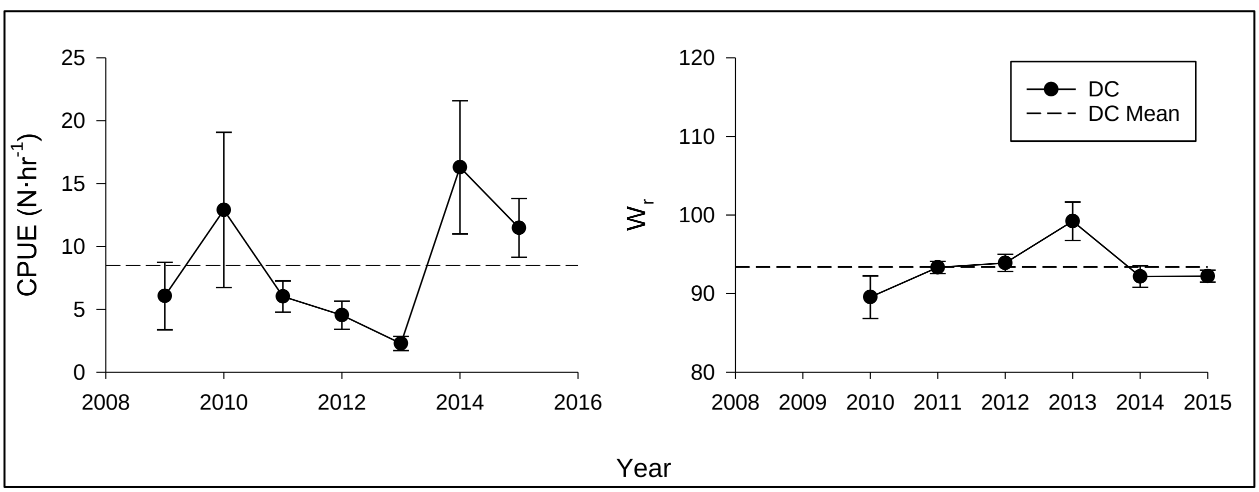


Figure 3.9. Catch per unit effort (mean ± SE) and condition (relative weight-$W_r$) of Silver Carp collected by pulsed-DC electrofishing survey in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages for each gear type used since F-101-R sampling initiated in 2009.

**Section 3.4 – 2015 Ancient Sportfish Assessment**

Ancient sport fishes were sampled with gill nets in the Middle Mississippi River. Sites were randomly selected using GIS layers of wing dam habitats. 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). Two different mesh sizes of gill nets were used. The two-inch square mesh gill nets were 150 ft long, 10 ft deep, and were made of #10 monofilament. We used two, five-inch square mesh size nets that were 300 ft long, 24 ft deep, and were made of #8 monofilament. Sites were defined as areas containing three wing dams, and were randomly selected from all potential sites. At each site sampled, the three wing dams were fished with one of the three nets (2-in or 5-in). 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 Middle Mississippi River.

| Total Effort (net-night) | Depth (ft) | Secchi Depth (cm) | Water Temp (°C) | DO (mg/L) | Conductivity (µS/cm) | Stage Height (ft) |
|---|---|---|---|---|---|---|
| 41 | 33.8 ± 1.3 | 29.0 ± 1.0 | 7.4 ± 0.6 | 11.7 ± 0.2 | 519.0 ± 15.1 | 12.6 ± 0.2 |

In segment 27, we collected 320 fish representing 20 species and 1 hybrid during 36 net-days of gill net effort from 12 sites during the winter sampling season of 2015 and 2016. Aging structures were collected from 175 shovelnose sturgeon for use in an age and growth analysis. One hundred and ninety-nine fish were collected with 2-in mesh gill nets sampling random wing dam structures during 12 net-days of gill net effort. The most abundantly collected species was Shovelnose Sturgeon (152 fish, 76.4% of total catch), followed by Gizzard Shad (9 fish, 4.5%), and then Sauger (5 fish, 2.5%). Shovelnose Sturgeon represented the largest proportion of the total collected biomass (307.6 lb; 139.6 kg; 69.9% of total collected biomass) of the 2-in mesh nets followed by Paddlefish (21.7 lb; 9.84 kg; 4.9%), and Bigmouth Buffalo (16.9 lb; 9.8 kg; 3.8%). One hundred and twenty one fish were collected with 5-in mesh gill nets sampling random wing dam structures during 24 net-days of gill net effort. The most abundantly collected species was Blue Catfish (33 fish, 27.3% of total catch), followed by Shovelnose Sturgeon (25 fish, 20.7%), and then Paddlefish (21 fish, 17.4%). Blue Catfish represented the largest proportion of the total collected biomass (727.3 lb; 329.9 kg; 37.7% of the total collected biomass) of the 5-in mesh nets followed by Paddlefish (386.5 lb; 175.3 kg; 20.1%), and Grass Carp (179.2 lb; 81.3 kg, 9.3%).

Analysis of the catch per net-night for the sampling season shows that Shovelnose Sturgeon captured in 2-in mesh gill nets was consistently the highest of the two mesh sizes (Figure 3.10). Sample sites were reduced during the 2015-2016 winter season relative to previous years due to moderate to major flooding during the majority of our field season. Most wing dams in the Middle Mississippi River are submerged when the gage height of the Saint Louis river gage exceeds 15 ft. There were fewer than 20 days from November 1 to April 1 where the Saint Louis gage was below 15 ft and conditions were safe enough to facilitate sampling (Figure 3.11; USGS 2016).

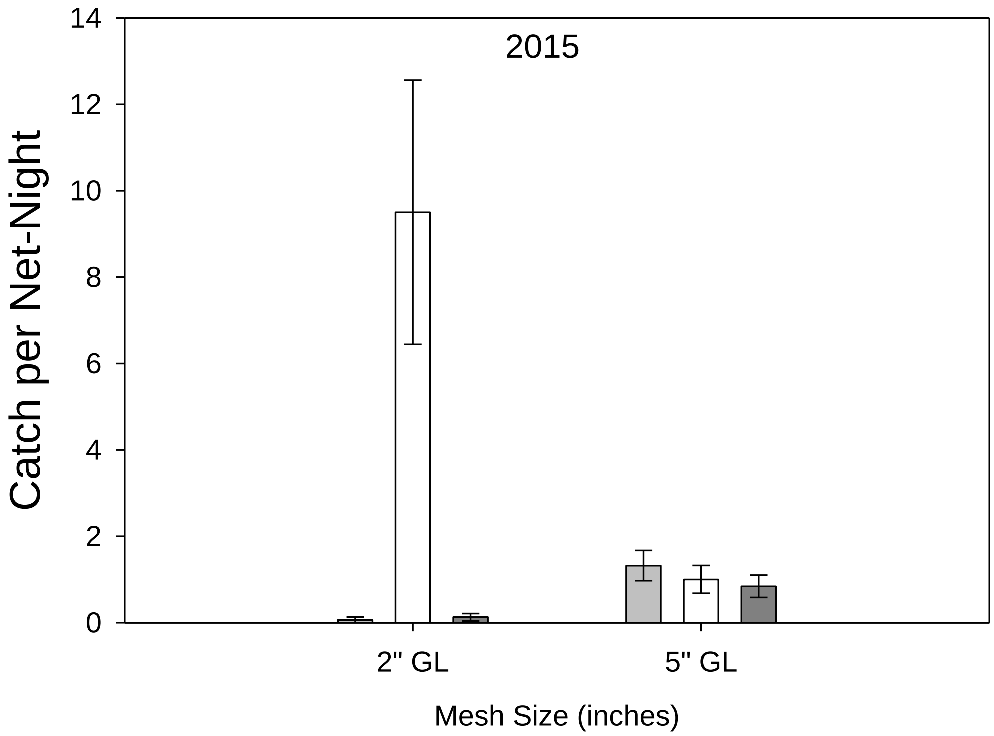


Figure 3.10. Mean catch per net-night of Shovelnose Sturgeon (white bars), Blue Catfish (light grey bars) and Paddlefish (dark grey bars) sampled in the Middle Mississippi River with 2-in and 5-in mesh gill nets from 2015 – 2016.

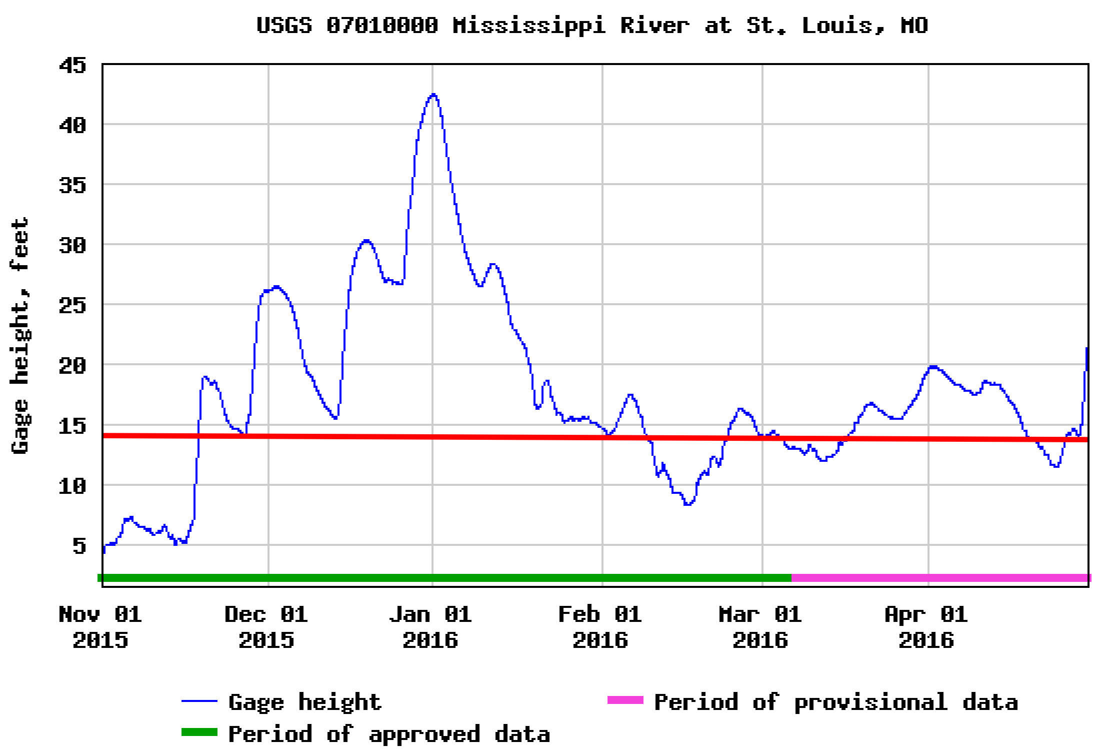


Figure 3.11. Mean gage height in feet of the Saint Louis gage on the Mississippi River in Saint Louis, Missouri. Gage heights above the red line at 15 ft represent water levels above the maximum height of wing dams. Sampling on the Middle Mississippi River is not possible above this line.

# CHAPTER 4
# SPORTFISH ASSESSMENTS ON THE IROQUOIS AND KANKAKEE RIVERS

## Section 4.1 – 2015 Iroquois and Kankakee Rivers Ancillary Habitat Quality Data

The third consecutive year of Iroquois and Kankakee Rivers electrofishing surveys were completed in 2015. All surveys were conducted at the fixed locations selected in 2013. These sites are located upstream of 2nd order and greater tributary confluences with Iroquois and Kankakee main stems.

The Iroquois and Kankakee Rivers experienced an extended period of flooding during Time Period 1 and left a very brief window to conduct electrofishing. A decision was made to focus on the Kankakee River during this window due to the importance of electrofishing data to concurrent fish habitat investigations within the Kankakee.

Pulsed-DC electrofishing was conducted between 9:00 AM and 7:05 PM central standard time during the three time periods specified in Chapter 1. All 2015 Iroquois sites (Figure 4.1) and Kankakee sites (Figure 4.2) were sampled using standard boat mounted pulsed-DC electrofishing following the same protocols governing electrofishing of the larger rivers (Gutreuter et al. 1995). Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 4.1.

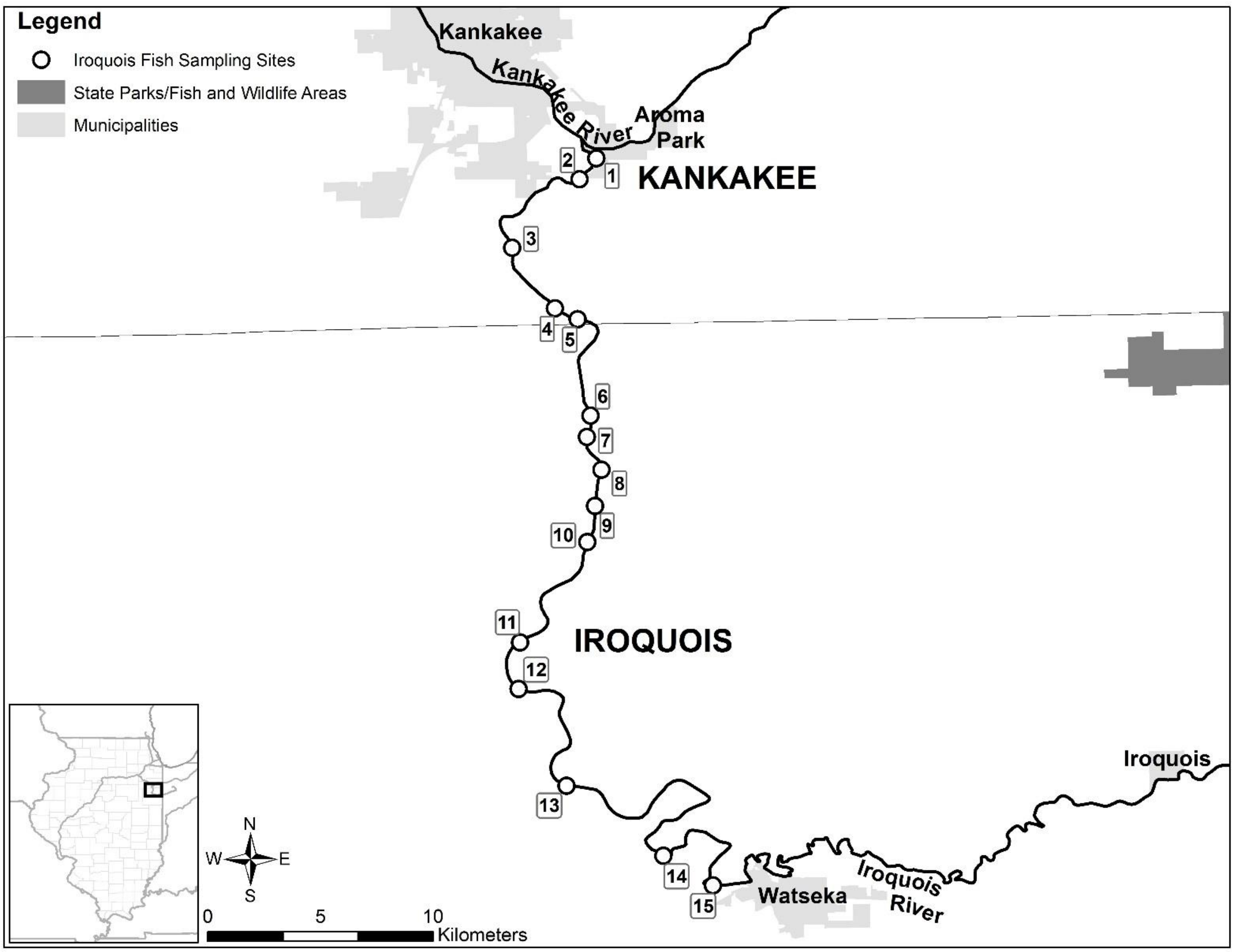


Figure 4.1. Map of the Iroquois River sites sampled by LTEF during 2015.

The distinction between *Lepomis peltastes* (Northern Sunfish) and *Lepomis megalotis* (Longear Sunfish), begun in 2014, was continued in 2015. Conforming to 2014, this change resulted in no records of *L. megalotis* being recorded in the Iroquois or Kankakee Rivers. Dissections of pharyngeal teeth conducted during 2014 to diagnose possible hybridization between *Cyprinella spiloptera* (Spotfin Shiner) and *Cyprinella lutrensis* (Red Shiner) were not continued during 2015 due to the time intensive nature of the research. This change may have resulted in these hybrids being classified as a parental species. Based upon Illinois fish identification expert opinions, we did not consider *Cyprinella whipplei* (Steelcolor Shiner) extant in the Kankakee River Basin. *Cyprinella* species possessing nine anal rays without the characteristic body depth of *C. lutrensis* were identified as *C. spiloptera* with a non-modal anal ray count.

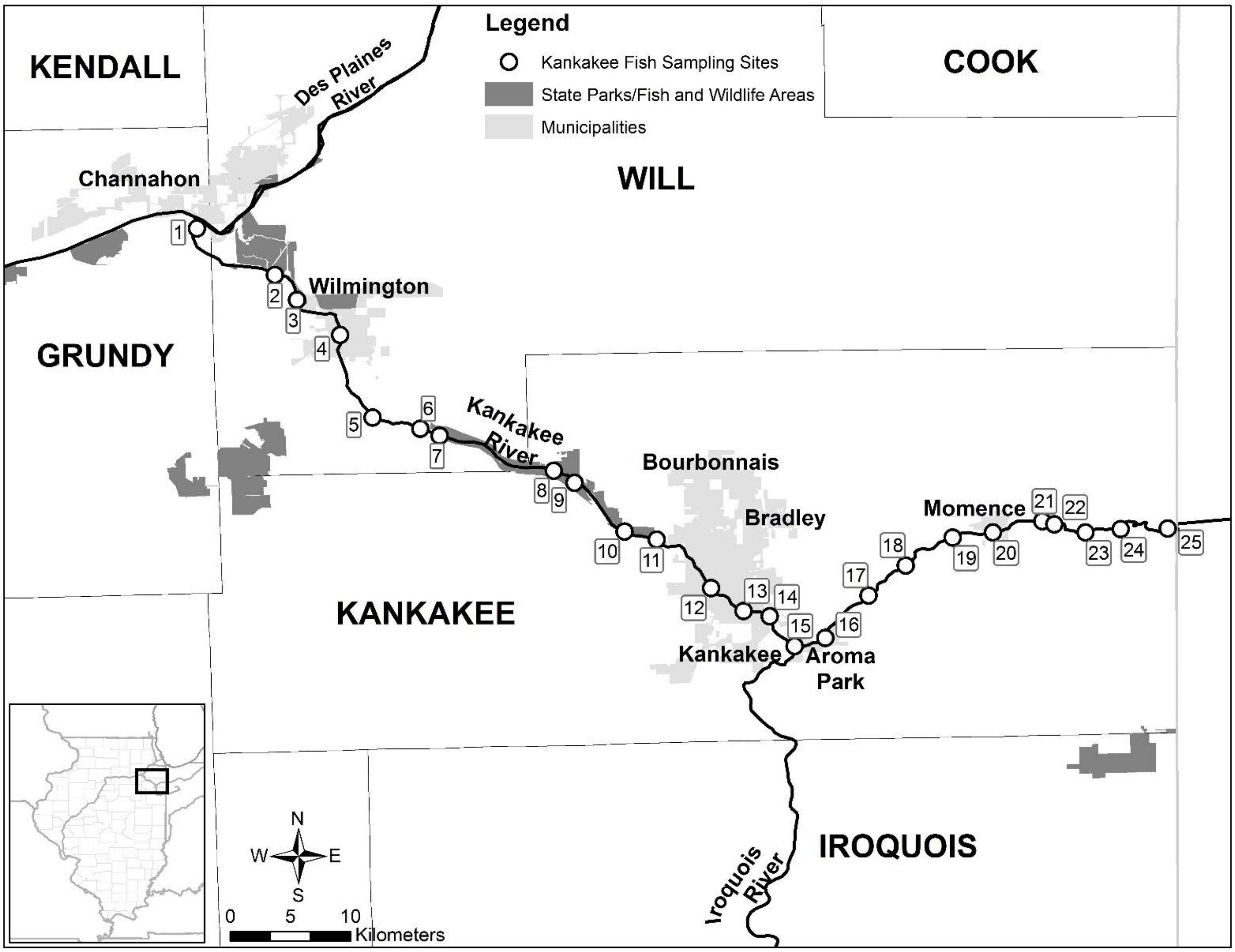


Figure 4.2. Map of the Kankakee River sites sampled by LTEF during 2015.

Table 4.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys of the Iroquois and Kankakee Rivers during 2015. Values are expressed as the mean observed parameter value ± standard error.

| River | Total EF Effort (h) | DC EF Power Used (W) | Depth (ft) | Secchi Depth (in) | Water Temp (°C) | DO (mg/l) | Conductivity (µS/cm) | Stage Height (ft) |
|---|---|---|---|---|---|---|---|---|
| **Iroquois** | 6.25 | 4526.2 ± 80.9 | 2.1 ± 0.2 | 13.7 ± 0.6 | 20.0 ± 1.0 | 4.1 ± 0.2 | 630.4 ± 16.0 | 3.4 ± 0.1 |
| Time Period 1 | - | - | - | - | - | - | - | - |
| Time Period 2 | 3.25 | 4676.2 ± 0.2 | 1.8 ± 0.2 | 12.9 ± 1.1 | 24.6 ± 0.6 | 3.7 ± 0.3 | 599.8 ± 27.6 | 3.7 ± 0.2 |
| Time Period 3 | 3.00 | 4363.8 ± 65.6 | 2.4 ± 0.2 | 14.4 ± 0.5 | 15.0 ± 0.3 | 4.4 ± 0.3 | 663.4 ± 8.6 | 3.2 ± 0.0 |
| **Kankakee** | 12.00 | 4341.25 ± 98.4 | 3.1 ± 0.2 | 24.8 ± 1.8 | 21.9 ± 0.5 | 5.8 ± 0.2 | 579.9 ± 10.5 | 2.6 ± 0.1 |
| Time Period 1 | 5.25 | 4594.8 ± 29.8 | 3.8 ± 0.3 | 24.4 ± 2.3 | 24.5 ± 0.2 | 6.2 ± 0.2 | 584.2 ± 6.1 | 3.2 ± 0.1 |
| Time Period 2 | 1.00 | 4832.5 ± 58.9 | 2.6 ± 0.3 | 40.2 ± 0.5 | 25.3 ± 0.5 | 8.2 ± 0.4 | 636.3 ± 3.3 | 2.0 ± 0.1 |
| Time Period 3 | 5.75 | 4024.3 ± 182.2 | 2.6 ± 0.2 | 23.0 ± 2.7 | 18.9 ± 0.4 | 4.9 ± 0.4 | 566.1 ± 20.7 | 2.2 ± 0.1 |

## Section 4.2 - Iroquois River Electrofishing Catch Statistics

We collected 1,992 fishes representing 53 species from 11 families during 6.25 hours of pulsed-DC electrofishing at 25 sites in the Iroquois River. Spotfin Shiner were the most abundant species (365 fish, 18% of total catch), followed by Channel Catfish (199, 10%), Gizzard Shad (168, 8%), Common Carp (119, 6%), and Bluegill (111, 6%). Common Carp contributed the greatest biomass of fishes collected (625.4 lb, 35% of total collected biomass), followed by Channel Catfish (519.9 lb, 29%), Bigmouth Buffalo (105.4 lb, 6%), and Silver Redhorse (104.0 lb, 6%).

*Threatened and Endangered Species*

One Ironcolor Shiner (State Threatened), seven Weed Shiner (State Endangered), and 28 Blackside Darter (Federally Threatened) were collected during 2015 Iroquois River main stem sampling. These fish were identified in the field, and were not verified by INHS museum staff.

*Iroquois River Fish Abnormalities*

Seventy DELT or external parasites were documented in Iroquois River fishes in 2015 (3.5% of fish). The most common DELT were lesions (0.6% of fish). The most common external parasites were trematodes causing light black spot disease (0.7% of fish). Black spot was most common in Green Sunfish with light and heavy infestations reported in 19 fish (36.5% of Green Sunfish).

*Black Crappie and White Crappie*

Catch rates of Black Crappie and White Crappie increased during 2015 (Figure 4.3). Calculated PSD values are generally high, with the majority of fish falling within a 9” to 12” length class. The limited number of fish captured in smaller length classes may indicate limited reproductive success in recent years.

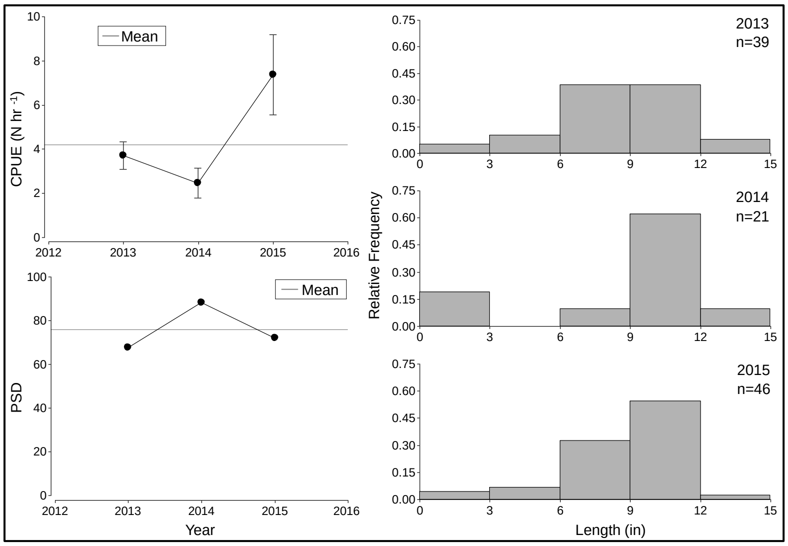


Figure 4.3 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Black and White Crappies collected during electrofishing surveys of Iroquois River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year.

*Bluegill*

Catch rates of Bluegill in the Iroquois River experienced a decline in 2014, but returned to 2013 levels in 2015 (Figure 4.4). Calculated PSD values show a steady increase since sampling began in 2013, but still indicate a population dominated by juvenile fish with a small proportion recruiting to angler desired sizes.

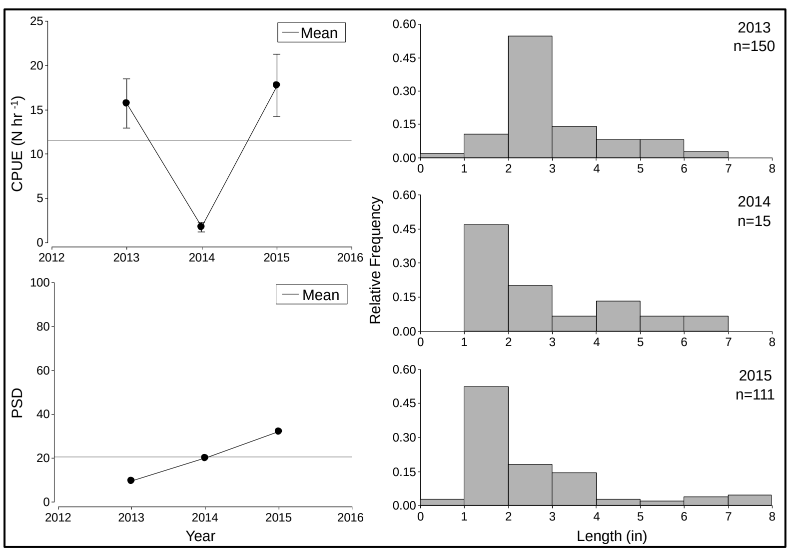


Figure 4.4 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Bluegill collected during electrofishing surveys of Iroquois River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year.

*Rock Bass*

Catch rates for Rock Bass in the Iroquois River increased appreciably in 2015 (Figure 4.5). The calculated PSD values and length distributions indicate a healthy balanced population with a favorable proportion of fish falling within desirable size classes >8".

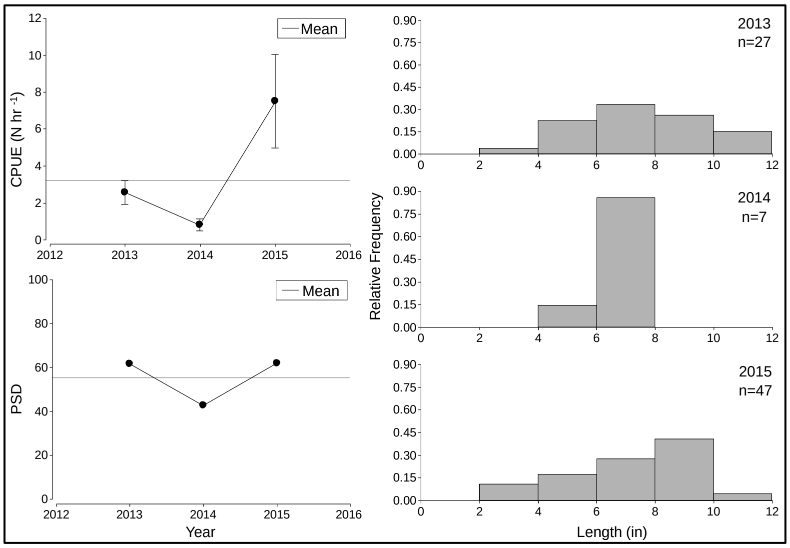


Figure 4.5 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Rock Bass collected during electrofishing surveys of Iroquois River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year.

*Channel Catfish*

The catch rates of Channel Catfish in the Iroquois River are the highest among areas sampled by LTEF. There was a decline in 2014, but catch rates returned to 2013 levels in 2015 (Figure 4.6). Calculated PSD values dropped slightly in 2015, but remain high. The high catch rates and PSD values are indicative of a dense population of adult fish, reflecting a high-quality Channel Catfish fishery. The limited number of young-of-year and juvenile fish could indicate limited reproductive success or that smaller tributaries are being utilized as rearing areas.

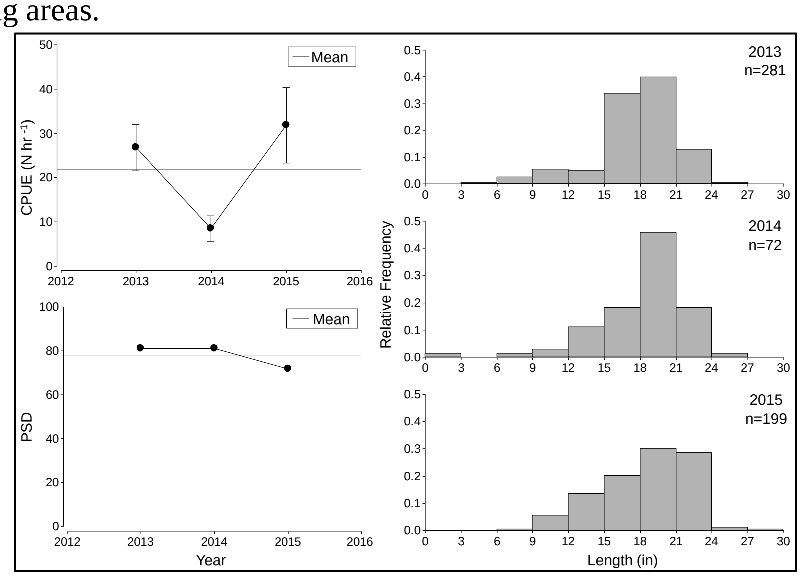


Figure 4.6 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Channel Catfish collected during electrofishing surveys of Iroquois River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year.

*Largemouth Bass*

Catch rates of Largemouth Bass experienced a sharp increase in 2015 (Figure 4.7). The calculated PSD values showed a steep decline in 2014 with a correspondingly sharp increase in 2015. This pattern may indicate high 2014 recruitment into adult classes into 2015, but is more likely an artifact of the small sample size collected in 2014.

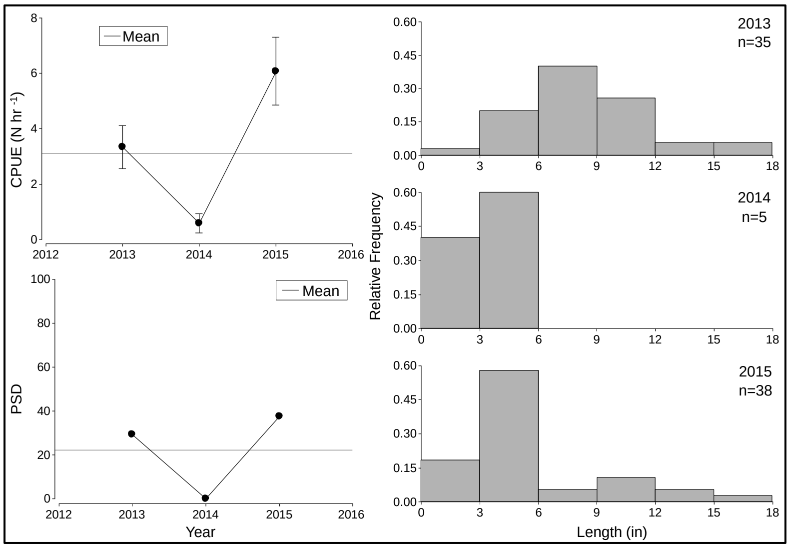


Figure 4.7 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Largemouth Bass collected during electrofishing surveys of Iroquois River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year.

*Smallmouth Bass*

Smallmouth Bass catch rates have been fairly stable over the three sampling years (Figure 4.8). Calculated PSD values have shown a steady increase during this time. Length distribution histograms show this change in PSD was likely caused by a strong year class in 2012 showing high rates of recruitment to larger size classes.

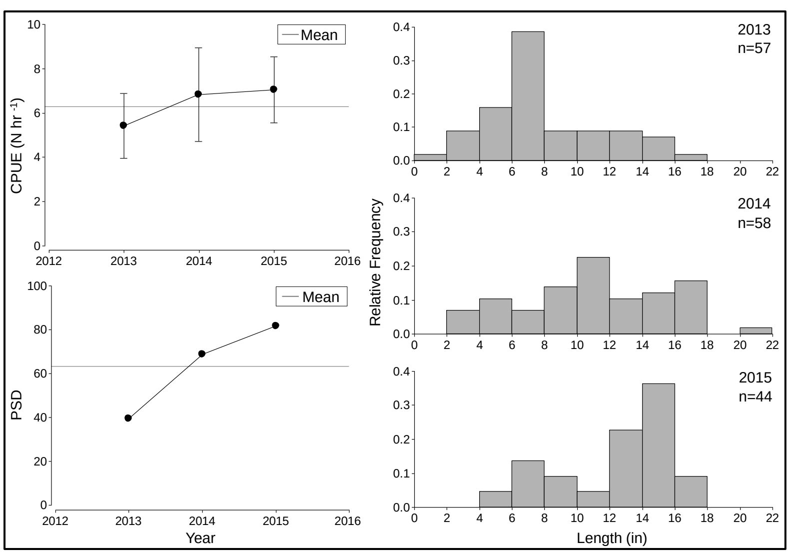


Figure 4.8 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Smallmouth Bass collected during electrofishing surveys of Iroquois River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year.

*Walleye*

Catch rates of Walleye have been steadily increasing since 2013 (Figure 4.9). A higher proportion of quality sized fish were captured in 2014 and PSD declined accordingly in 2015. This could indicate overharvesting of larger individuals, but the Walleye population in the Iroquois River still appears healthy with larger fish providing desirable fishing opportunities.

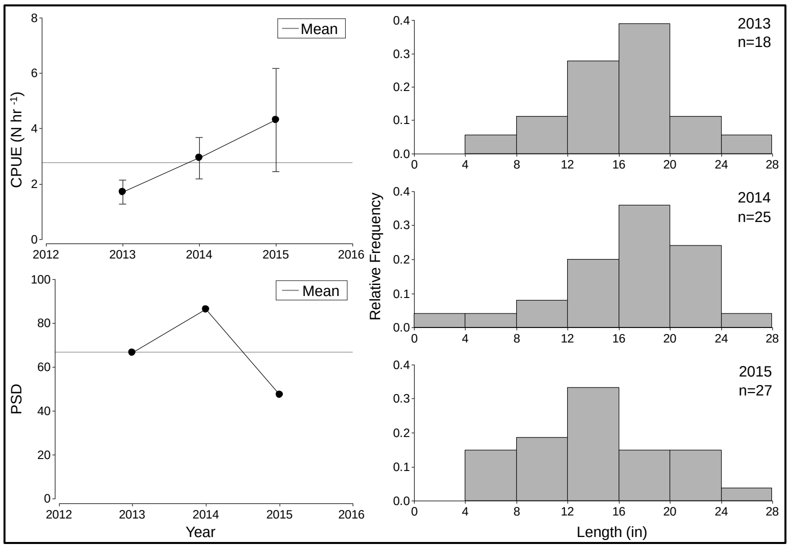


Figure 4.9 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Walleye collected during electrofishing surveys of Iroquois River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year.

## Section 4.3 - Kankakee River Electrofishing Catch Statistics

We collected 4,715 fishes representing 68 species from 14 families during 12 hours of pulsed-DC electrofishing at 48 sites in the Kankakee River. Spotfin Shiner were the most abundant species (576 fish, 12% of total catch), followed by Shorthead Redhorse (496, 11%), Golden Redhorse (316, 7%), and Mimic Shiner (300, 6%). Common Carp contributed the greatest biomass of fishes collected (664.0 lb, 17% of total collected biomass), followed by Golden Redhorse (585.2 lb, 15%), Shorthead Redhorse (537.0 lb, 13%), and Channel Catfish (405.1 lb, 10%).

*Threatened and Endangered Species*

One Ironcolor Shiner (State Threatened), nine Weed Shiner (State Endangered), 36 Blackside Darter (Federally Threatened), and 54 River Redhorse (State Threatened) were collected during 2015 Kankakee River main stem sampling. These fish were identified in the field, and were not verified by INHS museum staff.

*Kankakee River Fish Abnormalities*

One hundred ninety-nine DELT or external parasites were documented in Kankakee River fishes in 2015 (4.2% of fish). The most common DELT were eroded fins (0.9% of fish). The most common external parasites were trematodes causing light black spot disease (0.9% of fish). Black spot was most common in Green Sunfish with light and heavy infestations reported in 41 fish (22% of Green Sunfish).

*Black Crappie and White Crappie*

Though low, catch rates of Black Crappie and White Crappie have been steadily increasing in the Kankakee River since sampling began in 2013 (Figure 4.10). The calculated PSD value declined sharply in 2015 and the length distributions indicate this is due to a strong 2014 year class, which has been successfully recruiting to larger size classes.

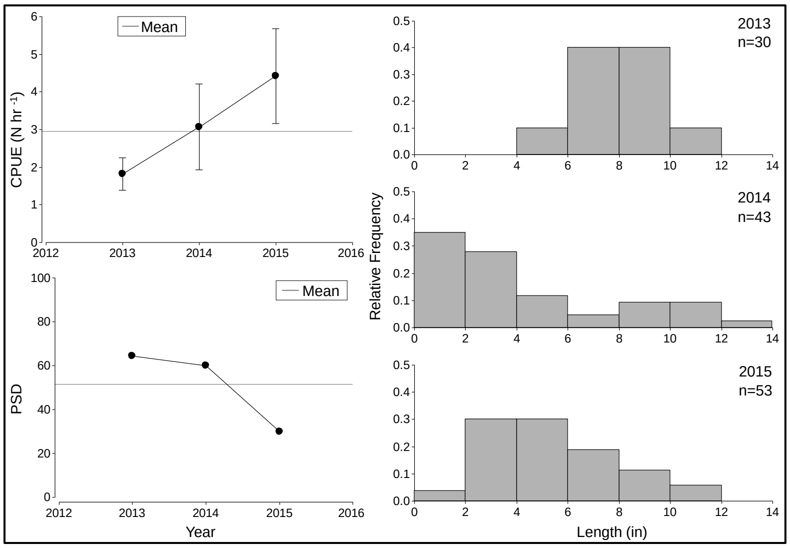


Figure 4.10 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Black and White Crappies collected during electrofishing surveys of Kankakee River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year

*Bluegill*

Catch rates of Bluegill in the Kankakee River have been fairly stable since sampling began in 2013 (Figure 4.11). Bluegill PSD values have been similarly stable through this time and indicate a large population of smaller juvenile fish with few recruiting above seven inches.

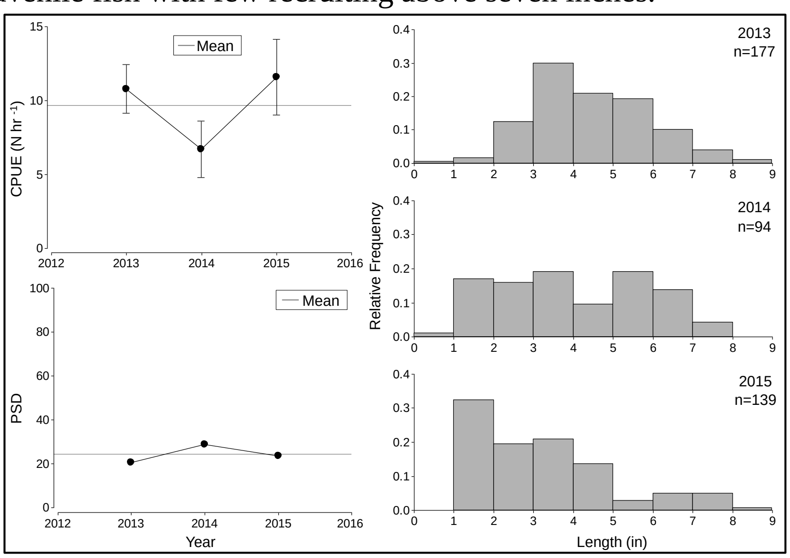


Figure 4.11 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Bluegill collected during electrofishing surveys of Kankakee River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year

*Rock Bass*

The Kankakee has a relatively large population of Rock Bass and catch rates have been fairly stable since sampling began in 2013 (Figure 4.12). Low PSD values and length distributions indicate an abundance of stock length individuals with comparatively few fish in larger length classes. However, the length distributions combined with the high abundance still suggests ample angler opportunities for larger fish.

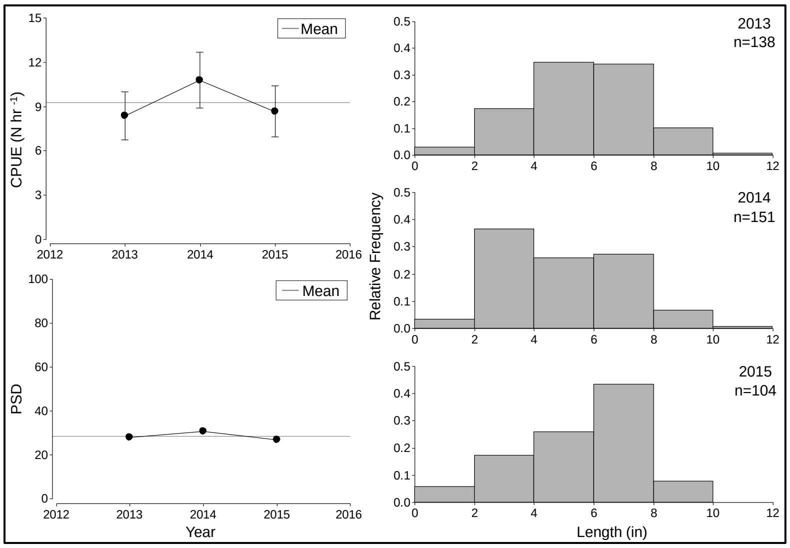


Figure 4.12 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Rock Bass collected during electrofishing surveys of Kankakee River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year

*Channel Catfish*

Catch rates of Channel Catfish in the Kankakee River declined in 2015 (Figure 4.13). The calculated PSD values have remained comparatively stable and high since sampling began in 2013. The PSD trend is shown more clearly in the length distributions with the majority of fish falling into quality and greater length classes. Channel Catfish populations in the Kankakee appear to be primarily composed of larger adult individuals with very few juvenile fish. This could be a sign of poor reproductive success, but the stability of the length frequency distributions seem to suggest a different cause.

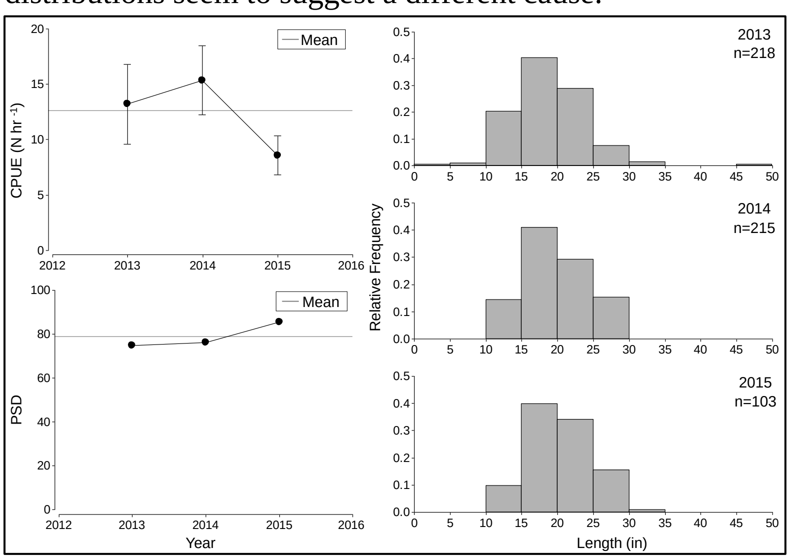


Figure 4.13 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Channel Catfish collected during electrofishing surveys of Kankakee River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year

*Largemouth Bass*

Largemouth Bass catch rates increased substantially in 2015 and reflect a strong 2015 year class (Figure 4.14). The calculated PSD values have remained fairly stable throughout the three years of Kankakee River surveys. Populations of Largemouth Bass in the Kankakee River appear balanced and healthy, but there seems to be limited opportunities for anglers to catch memorable and trophy fish.

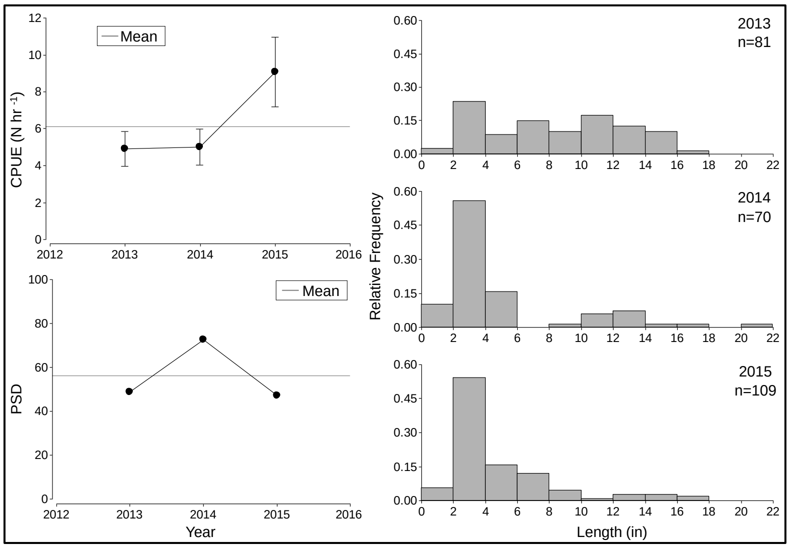


Figure 4.14 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Largemouth Bass collected during electrofishing surveys of Kankakee River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year

*Smallmouth Bass*

The Smallmouth Bass catch rates in the Kankakee River are the highest among the areas sampled through F-101-R. The catch rates have been stable and high since sampling began in 2013 (Figure 4.15). Calculated PSD values increased sharply in 2015. The length frequency distributions suggest the strong 2013 year class successfully recruited to larger size categories.

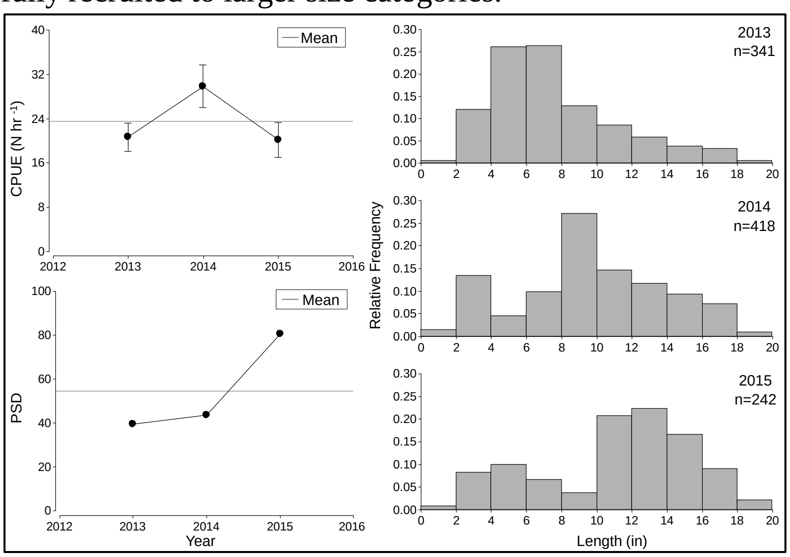


Figure 4.15 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Smallmouth Bass collected during electrofishing surveys of Kankakee River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year

*Walleye*

Catch rates of Walleye in the Kankakee River have remained low and relatively stable in the Kankakee River (Figure 4.16). There was a notable decline in PSD values in 2015, but values are still relatively high. Length distributions of captured fish show a high proportion of angler harvestable fish (>14”) and the 2014 year class appears to be successfully recruiting to larger size classes.

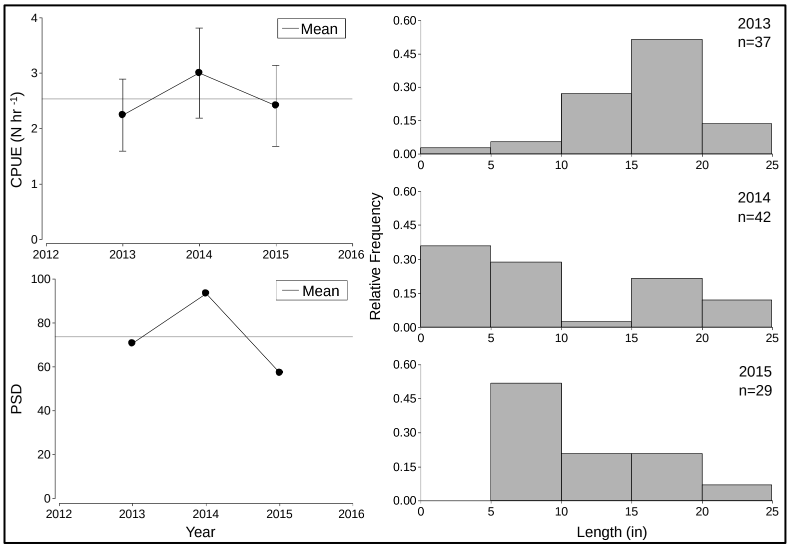


Figure 4.16 Catch per unit effort, proportional size distribution (PSD), and length distribution histograms of Walleye collected during electrofishing surveys of Kankakee River. Mean lines represent the three year average since sampling through F-101-R began in 2013. The n denotes the number of individuals collected in a given year

## Section 4.4 - Kankakee River Side-Scan Sonar Mapping

Side-scan sonar mapping of the near-shore areas within the Kankakee River were completed between 5/7/15 and 6/4/15 using a Hummingbird 999ci HD with bow mounted transducer. The boat was driven downstream between two and four miles per hour while recording video output. One pass was made along each shoreline from the Illinois-Indiana state line to the Kankakee River’s confluence with the Des Plaines River. An effort was made to record the substrate in side channel and connected floodplain lakes where possible. Two gaps in coverage were necessary due to safety concerns or lack of boat access above and below the Kankakee (0.5 km) and Wilmington Dams (6 km). Two continuous 80m wide near-shore sonar images were generated for the remainder of the Kankakee River. For narrow segments of the river, this 160m coverage encompasses the entire channel. Wider river segments lack this full channel coverage.

The sonar video files were processed with SonarTRX (Leraand Engineering Inc.) software into mosaic image files for use in GIS applications (Figure 4.17). The individual mosaics were imported into six separate mosaic datasets using ArcMap 10.2.2 (CITE) representing geomorphically and ecologically distinct segments of the river. The footprints of each mosaic dataset were then manually edited to create continuous images without overlap. When overlap between mosaics occurred, visual assessment was used to select the most detailed image for the continuous mosaic. In the Fall of 2015, 85 individual substrate estimates of the percentage of bedrock (solid slab), boulder (261 mm-4.1 m), rubble/cobble (65-260 mm), gravel (2-64 mm), sand (0.062-1.9 mm), silt (0.004-0.061 mm), clay, and detritus within one-meter transects were taken for ground-truthing. We plan to use supervised learning to classify distinct substrate classes based upon this detailed in-situ substrate analyses.

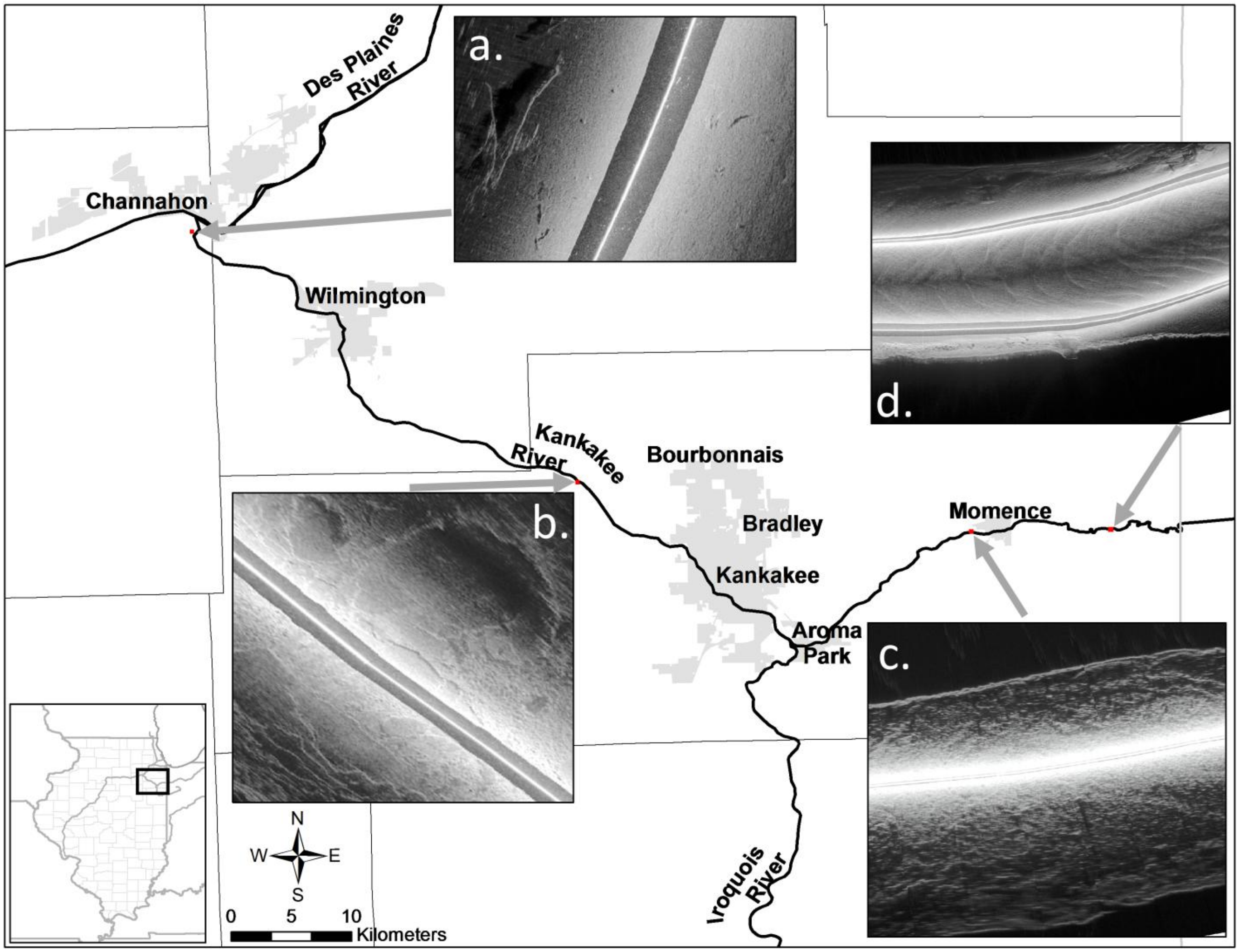


Figure 4.17. Map showing different substrates in the Kankakee River; a.) Silt dominant area near the River mouth. b.) Exposed bedrock within the Kankakee State Park. c.) Boulder and gravel substrate near Momence. d.) Sand dunes near the State Line.

# CHAPTER 5
# CONCLUSIONS

Fish monitoring conducted on the Illinois and Mississippi Rivers during 2015 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 new 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 during the autumn 2015 (NCDC 2015)—during Period 3 of DC sampling, and the end of AC sampling—and it is possible that the capture efficiency of our sampling gears was altered in some way by the unusual weather conditions, such as extremely high water levels and subsequent changes in water velocity and 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 vary 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 Channel 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 2015. Collections of black bass species were greatest in the Upper Illinois Waterway. Catch rates of Black Crappie and White Crappie were very low among all reaches sampled during 2015. 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*

Although 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 indicate 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. 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 2015 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 | Monitoring Institution | Reach/Pool | Downstream | Upstream | N | Gage |
|---|---|---|---|---|---|---|
| Illinois | INHS, F-101-R | Alton | 0.0 | 80.0 | 45 | Florence, IL |
| | INHS, F-101-R | Peoria | 158.0 | 231.0 | 44 | Henry, IL |
| | INHS, F-101-R | Starved Rock | 231.0 | 247.0 | 9 | Ottawa, IL |
| | INHS, F-101-R | Marseilles | 247.0 | 271.5 | 18 | Morris, IL |
| Des Plaines | INHS, F-101-R | Dresden | 271.5 | 286.0 | 9 | Brandon Road Lock and Dam |
| Kankakee | INHS, F-101-R | | | | | |
| Iroquois | INHS, F-101-R | | | | | |
| Mississippi | INHS, F-101-R | Kaskaskia Confluence | 117.0 | 165.5 | 30 | Chester, IL or Brickeys, MO |
| | INHS, F-101-R | Chain of Rocks | 165.5 | 200.5 | 21 | Saint Louis, MO |
| | INHS, F-101-R | Pool 25 | 242.0 | 273.5 | 18 | Mosier Landing, IL |
| | WIU, F-121-R | Pool 21 | 325.0 | 343.0 | 12 | Quincy, IL |
| | WIU, F-121-R | Pool 20 | 343.0 | 364.5 | 12 | Gregory Landing, MO |
| | WIU, F-121-R | Pool 19 | 364.5 | 410.5 | 27 | Fort Madison, IA |
| | INHS, F-101-R | Pool 18 | 410.5 | 437.0 | 15 | Keithsburg, IL |
| | INHS, F-101-R | Pool 17 | 437.0 | 457.0 | 12 | Muscatine, IA |
| | INHS, F-101-R | Pool 16 | 457.0 | 483.0 | 15 | Fairport, IA |
| Ohio | SIU, F-47-R | Mississippi Confluence | 981.0 | 962.5 | 12 | Birds Point, MO |
| | SIU, F-47-R | Pool 53 | 962.5 | 939.0 | 15 | Metropolis, IL |
| | SIU, F-47-R | Pool 52 | 939.0 | 918.5 | 12 | Paducah, KY |
| | SIU, F-47-R | Smithland | 848.0 | 918.5 | 42 | Golconda, IL |
| Wabash | EIU, F -186-R | New Harmony, IN | 444.5 | 487.0 | 21 | Mount Carmel, IL |
| | EIU, F -186-R | Mt. Carmel, IL | 412.0 | 444.5 | 27 | Mount Carmel, IL |
| | EIU, F -186-R | Vincennes, IN | 385.5 | 412.0 | 18 | Mount Carmel, IL |
| | EIU, F -186-R | Palestine, IL | 351.0 | 385.5 | 21 | Mount Carmel, IL |
| | EIU, F -186-R | Terra Haute, IN | 315.5 | 351.0 | 15 | Mount Carmel, IL |

Appendix II. Station information and characteristics during AC electrofishing sampling during 2015. 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 | River Mile mean[a] | End time (CST) | Duration (min) | 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 | | | | | | | | | | | | | | | |
| 21 | 30-Sep | Brickhouse Slough | 205.1 | 11:45 AM | 55 | 62.0 | 70.5 | 7.7 | 83.7% | 5.5 | 463 | 0.1 | 1.0 | 3.0 | |
| Alton Reach | | | | | | | | | | | | | | | |
| 22 | 30-Sep | Mortland Island | 18.8 | 2:54 PM | 60 | 70.0 | 72.5 | 6.1 | 72.1% | 8.3 | 703 | 0.5 | 2.0 | 11.5 | 3.7* |
| 25 | 1-Oct | Dark Chute | 25.0 | 11:36 AM | 60 | 58.0 | 70.2 | 6.6 | 68.6% | 8.7 | 693 | 0.6 | 1.5 | 10.5 | 3.8* |
| 23 | 30-Sep | Hurricane Island | 27.5 | 4:18 PM | 60 | 68.0 | 72.3 | 6.6 | 76.5% | 7.5 | 697 | 0.8 | 1.0 | 12.5 | 3.7* |
| 24 | 1-Oct | Crater-Willow Island | 30.0 | 9:20 AM | 60 | 48.0 | 70.0 | 6.7 | 61.7% | 7.9 | 691 | 0.9 | 1.0 | 13.2 | 3.8* |
| 19 | 28-Sep | Big Blue Island | 58.5 | 10:40 AM | 60 | 71.0 | 73.2 | 5.8 | 69.2% | 5.1 | 708 | 0.3 | 1.0 | 9.5 | 5.8* |
| 20 | 28-Sep | Moore's Towhead | 75.3 | 1:46 PM | 60 | 79.0 | 73.6 | 6.3 | 81.2% | 5.1 | 696 | 0.9 | 1.5 | 10.0 | 5.8* |
| La Grange Reach | | | | | | | | | | | | | | | |
| 8 | 1-Sep | Grape-Bar Islands | 86.4 | 1:07 PM | 55 | 83.0 | 78.3 | 7.1 | 94.9% | 12.6 | 779 | 0.7 | 2.5 | 7.5 | 9.6 |
| 7 | 1-Sep | Sugar Creek Island | 94.8 | 10:18 AM | 60 | 75.0 | 77.9 | 6.0 | 74.5% | 10.6 | 777 | 0.8 | 0.5 | 3.5 | 9.6 |
| 28 | 6-Oct | Lower Bath Chute | 107.1 | 9:40 AM | 40 | 59.0 | 61.0 | 7.9 | 83.1% | 9.4 | 712 | 0.5 | 1.5 | 8.0 | 6.0 |
| 9 | 2-Sep | Upper Bath Chute | 113.0 | 2:58 PM | 60 | 92.0 | 80.6 | 7.5 | 108.2% | 9.8 | 770 | 0.9 | 3.0 | 11.0 | 6.1 |
| 27 | 5-Oct | Turkey Island | 148.2 | 11:40 AM | 37 | 60.0 | 59.4 | 9.6 | 102.1% | 9.4 | 742 | 0.8 | 2.5 | 8.5 | 3.4* |
| 26 | 5-Oct | Pekin | 154.9 | 10:05 AM | 60 | 58.0 | 58.1 | 9.8 | 101.9% | 7.9 | 763 | 0.7 | 1.5 | 18.0 | 431.7* |
| Peoria Reach | | | | | | | | | | | | | | | |
| 6 | 28-Aug | Lower Peoria Lake | 163.6 | 12:20 PM | 60 | 71.0 | 71.8 | 7.9 | 94.3% | 10.2 | 791 | 0.0 | 0.5 | 4.0 | 11.8 |
| 5 | 28-Aug | Peoria Islands | 170.4 | 10:05 AM | 50 | 65.0 | 71.96 | 6.0 | 67.4% | 11.81 | 775 | 0.0 | 0.5 | 5 | 11.8 |
| 2 | 26-Aug | Chillicothe | 180.9 | 2:23 PM | 60 | 70.0 | 74.8 | 7.7 | 91.0% | 9.8 | 763 | 0.8 | 1.5 | 8.5 | 14.6 |
| 1 | 26-Aug | Henry Island | 193.9 | 11:15 AM | 60 | 60.0 | 74.5 | 7.4 | 78.7% | 9.1 | 744 | 0.9 | 1.0 | 8.5 | 14.6 |
| 4 | 27-Aug | Lower Twin Sister | 202.8 | 1:57 PM | 57 | 69.0 | 75.2 | 9.1 | 106.5% | 14.6 | 747 | 0.5 | 2.0 | 7.5 | 14.6 |
| 3 | 27-Aug | Upper Twin Sister | 203.4 | 11:03 AM | 60 | 60.0 | 74.1 | 8.0 | 85.1% | 12.6 | 746 | 0.3 | 1.0 | 10.3 | 14.6 |
| 17 | 17-Sep | Hennepin | 207.9 | 11:05 AM | 60 | 71.0 | 74.8 | 8.2 | 97.9% | 16.5 | 818 | 0.4 | 2.0 | 14.7 | 15.1 |
| 18 | 17-Sep | Clark Island | 215.3 | 2:10 PM | 60 | 83.0 | 74.8 | 8.5 | 113.6% | 16.1 | 807 | 0.4 | 1.0 | 9.3 | 11.5 |
| Starved Rock Reach | | | | | | | | | | | | | | | |
| 11 | 10-Sep | Bulls Island | 240.7 | 12:50 PM | 35 | 69.0 | 81.9 | 7.6 | 88.9% | 30.7 | 867 | 1.1 | 1.5 | 6.0 | 459.5 |
| 10 | 10-Sep | Bulls Island Bend | 241.4 | 11:25 AM | 60 | 73.0 | 81.5 | 6.9 | 84.0% | 22.0 | 857 | 0.5 | 0.5 | 9.5 | 459.5 |
| Marseilles Reach | | | | | | | | | | | | | | | |
| 13 | 14-Sep | Ballards Island | 248.0 | 12:35 PM | 45 | 71.0 | 74.8 | 7.7 | 91.9% | 27.2 | 792 | 0.7 | 0.7 | 4.2 | 5.8 |
| 14 | 14-Sep | Waupecan Island | 260.7 | 3:45 PM | 60 | 82.0 | 75.7 | 8.4 | 111.3% | 26.8 | 751 | 1.1 | 1.0 | 7.0 | 5.8 |
| Dresden Reach, Des Plains River | | | | | | | | | | | | | | | |
| 15 | 15-Sep | Du Page River | 277.3 | 9:05 AM | 60 | 62.0 | 74.8 | 7.8 | 84.8% | 33.1 | 806 | 0.6 | 2.0 | 10.5 | 505.2 |
| 16 | 15-Sep | Treats Island | 279.9 | 11:45 AM | 60 | 72.0 | 77.7 | 7.4 | 89.2% | 42.9 | 804 | 0.2 | 0.5 | 7.0 | 505.2 |

[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.

*Sampling was conducted when river stage exceeded established low-water criteria

Appendix III. Publications, reports, and presentations that resulted from research conducted during segments 6-27 of project F-101-R (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 27 are printed in bold.

**Tiemann, J.S., C.A. Taylor, D. Wylie, J. Lamer, P.W. Willink, F.M. Veraldi, S.M. Pescitelli, B. Lubinski, T. Thomas, R. Sauer, and B. Cantrell. 2015. Range Expansions and New Drainage Records for Select Illinois Fishes. Transactions of the Illinois State Academy of Science 108:47-52.**

Parker, J., J. Epifanio, A. Casper, and Y. Cao. 2016. The effects of improved water quality on fish assemblages in a heavily modified large river system. River Research and Applications 32:992-1007 (DOI: 10.1002/rra.2917)

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

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 736(1): 1-15.

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 1(1):cot017.

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., 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.

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.

McClelland, M.A., M.A. Pegg, and T.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.

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. 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.

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

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.

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.

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.

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)

III. Essays

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

IV. Popular Articles

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

V. Technical Papers presented during F-101-R Segment 27 (presenters in bold, '*' denotes student presenter, '+' denotes invited presentation)

**+DeBoer, J.A.**, M.W. Fritts, D.K. Gibson-Reinemer, and A.F. Casper. 2016. Fish community response to the establishment and expansion of Asian carp along a spatio-temporal gradient. Platform. Midwest Fish and Wildlife Conference. Grand Rapids, MI.

***VanMiddlesworth, M. M.**, A. F. Casper, J. A. DeBoer, and J. M. Levengood. 2016. Rates of endocrine disruption in two commercial fishes along a downstream gradient in the Illinois River. Poster. Pharmaceuticals and Personal Care Products in the Environment Conference, Champaign, IL.

**DeBoer, J. A.**, M. W. Fritts, D. K. Gibson-Reinemer, C. J. Hinz, D. M. Kellerhalls, R. M. Pendleton, L. E. Solomon, and A. F. Casper. 2016. Biotic response to the establishment and expansion of Asian carp in the lower Illinois River. Platform. Mississippi River Research Consortium. LaCrosse, WI.

Fritts, M. W., A. K. Fritts, **J. A. DeBoer**, R. M. Pendleton, L. E. Solomon, T. D. VanMiddlesworth, and A. F. Casper. 2016. Intersex condition in male largemouth bass, bluegill, and black crappie from the Illinois River waterway. Poster. Mississippi River Research Consortium. La Crosse, WI.

***Ward, R.**, M. M. VanMiddlesworth, J. A. DeBoer, R. M. Pendleton. Common carp age and growth trends from the Illinois River. Poster. Mississippi River Research Consortium. La Crosse, WI.

Pendleton, R., A. Casper, A. Fritts, M. Fritts, J. A. DeBoer, **L. Solomon**, and T.D. VanMiddlesworth. 2016. The evaluation of a cost-effective, digital approach to estimate fecundity in freshwater fishes. Poster. Mississippi River Research Consortium. LaCrosse, WI.

**DeBoer, J. A.**, A. K. Fritts, M. W. Fritts, R. M. Pendleton, L. E. Solomon, and T. D. VanMiddlesworth. 2016. Life-history expression of three popular sportfish from three distinct habitats in the Illinois River Watershed. Platform. Joint Conference of the Illinois Lakes Management Association and Illinois American Fisheries Society. Springfield, IL.

**DeBoer, J. A.**, M. W. Fritts, D. K. Gibson-Reinemer, C. J. Hinz, D. M. Kellerhalls, R. M. Pendleton, L. E. Solomon, and A. F. Casper. 2016. Biotic response to the establishment and expansion of Asian carp in the lower Illinois River. Platform. Joint Conference of the Illinois Lakes Management Association and Illinois American Fisheries Society. Springfield, IL.

**Pendleton, R.**, A. Casper, A. Fritts, M. Fritts, J. A. DeBoer, L. Solomon, and T.D. VanMiddlesworth. 2016. The evaluation of a cost-effective, digital approach to estimate fecundity in freshwater fishes. Poster. Joint Conference of the Illinois Lakes Management Association and Illinois American Fisheries Society. Springfield, IL.
*Winner of Best Poster Presentation

**DeBoer, J. A.**, A. K. Fritts, M. W. Fritts, R. M. Pendleton, L. E. Solomon, and T. D. VanMiddlesworth. 2016. Life-history expression of three popular sportfish from three distinct habitats in the Illinois River Watershed. Platform. Midwest Fish and Wildlife Conference. Grand Rapids, MI.

***VanMiddlesworth, M. M.**, A. F. Casper, J. A. DeBoer, and M. W. Fritts. 2016. Rates of endocrine disruption in two commercial fishes along a downstream gradient in the Illinois River. Platform. Midwest Fish and Wildlife Conference. Grand Rapids, MI.

**Pendleton, R.**, A. Casper, A. Fritts, M. Fritts, J. A. DeBoer, L. Solomon, and T. D. VanMiddlesworth. 2016. The evaluation of a cost-effective, digital approach to estimate fecundity in freshwater fishes. Poster. Midwest Fish and Wildlife Conference. Grand Rapids, MI.

**Parker, Jerrod**; Epifanio, John; Cao, Yong; Using Functional Diversity to Examine the Long-Term Effects of Improved Water Quality on Fish Assemblages; 145th Annual Meeting of the American Fisheries Society, Portland, OR.

**Gibson-Reinemer, D.K.** Perspective on changing ecological assemblages: climate warming, invasive species, and recovery. University of Illinois, Illinois Natural History Survey Seminar, April 2016.

**Gibson-Reinemer, D.K.** Untitled keynote presentation at the Peoria Clean Water Celebration, April 2016.

**Gibson-Reinemer, D.K.**, and A.F. Casper. Ongoing improvements in the sportfish of the Illinois River. 15th Biennial Governor's Conference on the Management of the Illinois River System.

**Gibson-Reinemer, D.K.** The power of long-term data in fisheries research. Illinois Department of Natural Resources Science in Support of Management Seminar Series, September 2015.

**Gibson-Reinemer, D.K.**, A.F. Casper, J.H. Chick, M.W. Fritts, and J.A. DeBoer. Waves of invasion and recovery: insights from 57 years of a monitoring program on a large river. American Fisheries Society, August 2015.

**Culver, E. F.**, B. J. Lubinski, and J. H. Chick. Monitoring Populations of Ancient Sport Fishes in the Middle Mississippi River. Annual Meeting of the Illinois Chapter of the American Fisheries Society. Springfield, Illinois.

**Culver, E. F.**, B. J. Lubinski, and J. H. Chick. Monitoring Populations of Ancient Sport Fishes in the Middle Mississippi River. Annual Meeting of the Mississippi River Research Consortium. LaCrosse, Wisconsin.

**Lubinski, Benjamin J.**, J.A. DeBoer, M.W. Fritts, and J.H. Chick. Variation in the community structure of fishes from main channel border habitat among reaches of the Mississippi and Illinois Rivers. 145th Annual Meeting of the American Fisheries Society, Portland, Oregon. August 16-20, 2015.

VI. Data Requests received during F-101-R Segment 27

1. Bob Hrabik, Missouri Department of Conservation
2. Kristen Bouska, U.S. Geological Survey
3. Matt Lubejko, Southern Illinois University
4. David Coulter, Southern Illinois University
5. Mike McClelland, Illinois DNR