ILLINOIS NATURAL HISTORY SURVEY
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Long-term Survey and Assessment of Large-River Fishes in Illinois, 2017

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

F-101-R-29

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.

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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. Eric Schauber, Director of the Illinois Natural History Survey (INHS), and INHS staff provided administrative support. Staff from the Illinois River Biological Station, Great Rivers Field Station, 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 29 (2017-18) of the Long-term Survey and Assessment of Large-River Fishes in Illinois (LTEF), an annual survey 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, four 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 several species of interest to regional managers. Catch rates and species varied among all sampling locations and sampling periods. Gizzard Shad and Emerald Shiners 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. Future analysis of $CPUE_N$ and PSD trends in sportfish populations sampled by the program may indicate inter-annual recruitment patterns or/and long-term trends in Illinois sportfish populations.

Sportfish

Catch rates and sizes of popular sportfish species varied greatly among the rivers and reaches sampled during 2017. Channel Catfish was the most-abundantly collected sportfish species in all segments of our study. Collections of black basses were greatest in the Upper Illinois Waterway. 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 comprehensive 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, though may be trending upwards, inversely tracking relative abundances. Grass Carp in the Lower Mississippi River Sampling Area increased from 4.6% of total catch by biomass during 2016 to 7.8% during 2017. This trend will be monitored in coming years.

JOB ACCOMPLISHMENTS DEFINED BY F-101-R-29 WORK PLAN

Job 1: *Prepare electrofishing equipment and train staff*

Project workers maintained and repaired electrofishing and netting equipment as need throughout Project Segment 29. 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 pulsed-DC electrofishing 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 29.

Job 3: *Update computer database*

All F-101-R Segment 29 (2017) 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 29 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 Jason DeBoer, Andrya Whitten, Jerrod Parker, and Daniel Gibson-Reinemer, and graduate student Sabina Berry presented the results of electrofishing sampling at numerous professional meetings (Appendix II). Project workers also completed the composition of the annual project report. Additionally, **six** peered-reviewed manuscripts produced using LTEF data were published during Project Segment 29:

DeBoer, J. A., A. M. Anderson, and A. F. Casper. 2018. Multi-trophic response to invasive silver carp (*Hypophthalmichthys molitrix*) in a large floodplain river. Freshwater Biology. DOI: 10.1111/fwb.13097

Gibson-Reinemer, D. K., R. A. Sparks, J. L. Parker, J. A. DeBoer, M. W. Fritts, M. A. McClelland, J. H. Chick, and A. F. Casper. 2017. Ecological recovery of a river fish assemblage following the implementation of the Clean Water Act. BioScience 67:957–970.
Selected as Editor's Choice

Love, S. A., N. J. Lederman, R. L. Haun, J. A. DeBoer, and A. F. Casper. 2018. Does aquatic invasive species removal benefit native fish? The response of gizzard shad (*Dorosoma cepedianum*) to commercial harvest of bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*). Hydrobiologia. DOI: https://doi.org/10.1007/s10750-017-3439-1

Parker, J., Cao, Y., Sass, G. G., & Epifanio, J. (2018). Large river fish functional diversity responses to improved water quality over a 28 year period. Ecological Indicators, 88, 322-331. doi: 10.1016/j.ecolind.2018.01.035

Parker, J. L., M. W. Fritts, and J. A. DeBoer. *In press*. Length-weight relationships for small Midwestern US fishes. Journal of Applied Ichthyology. doi: 10.1111/jai.13721

Whitten, A. L. and D. K. Gibson-Reinemer. 2018. Tracking the trajectory of change in large river fish communities over 50 years. American Midland Naturalist 180:94-103.

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PREFACE

This report presents a summary of data collected during 2017 during segment 29 of Federal Aid project F-101-R, the Long-Term Survey and Assessment of Large-River Fishes in Illinois. 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; DeBoer et al. 2015, 2016, 2017). 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 jlparke2@illinois.edu).

CHAPTER 1
INTRODUCTION

The large rivers of Illinois have experienced dramatic changes that have been attributed to both 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 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 critical responses of fish communities to environmental stressors (e.g., floods, droughts) and management actions are inherently out-of-synch or delayed in relation to the driving factor. Thus, long-term, large-scale ecological monitoring data are critical 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 shorter-term programs. A long-term record of consistent and scientifically robust monitoring, such as carried out by the LTEF program for nearly 60 years, is critical for 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, 2018, Gibson-Reinemer et al. 2017), 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, DeBoer et al. 2018, Love et al. 2018), 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 variability, on-going loss of side-channel and backwater habitat to sedimentation, unnatural water-level fluctuations from navigation, poor water quality, and river channel maintenance and dredging activities.

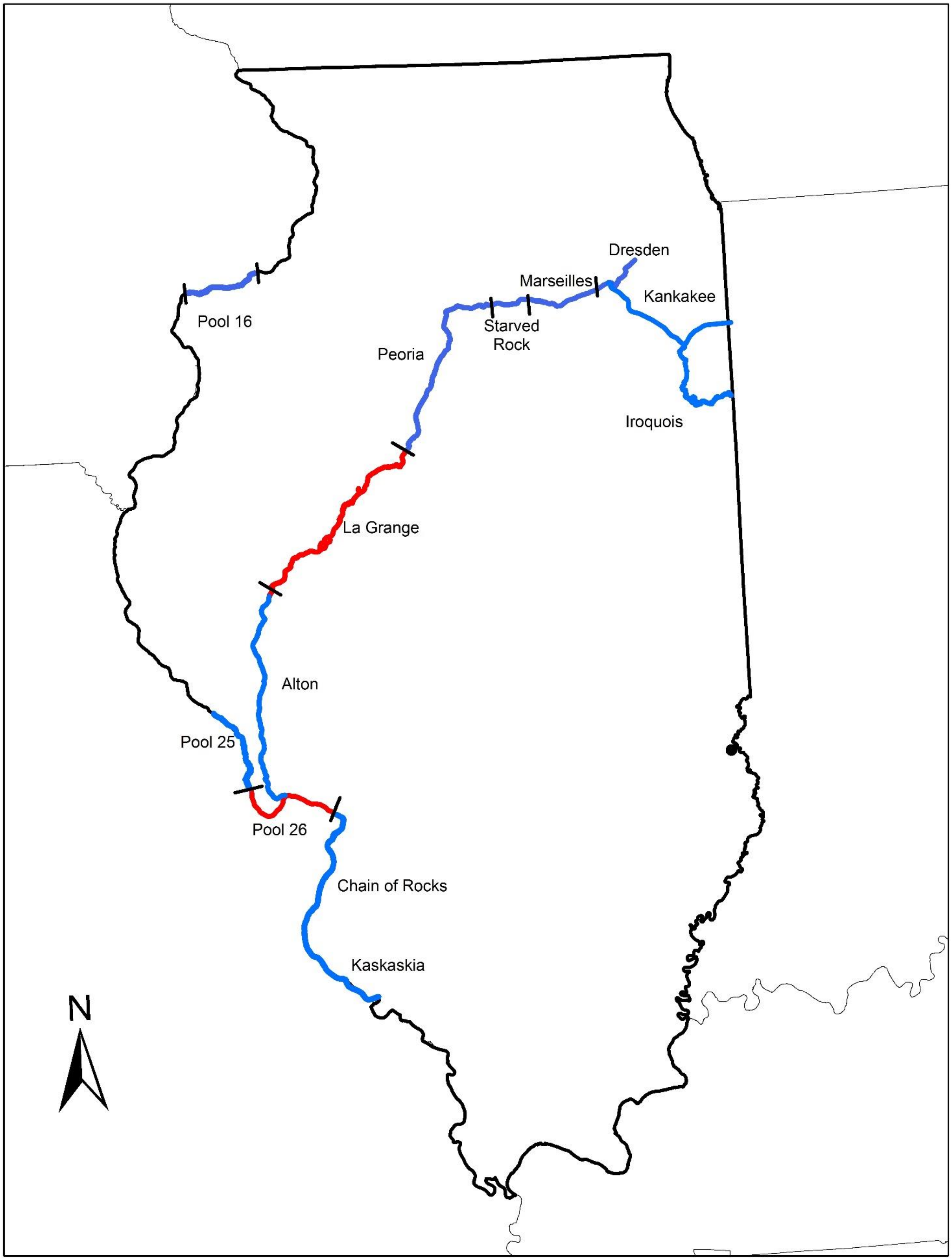

Figure 1.1. Map of the Illinois Waterway, and the Illinois portions of the Mississippi, Iroquois, and Kankakee Rivers illustrating areas sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (colored in blue) during 2017. Areas currently sampled by the U.S. Army Corps of Engineers 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 - Pulsed-DC Electrofishing Collections

Sportfish populations were monitored in 6 reaches of the Illinois Waterway using boat-mounted pulsed-DC electrofishing gear. Additionally, 4 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 La Grange Reach of 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), except for 2 fixed sites in LaGrange Reach (see Figure 2.1).

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 60 Hz 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 < 4 in, and clupeids < 8 in were counted, but not weighed, as we have regression equations developed during 2015 that are > 95% accurate for fishes of this size. This saves time while sampling and reduces bias from weighing very small fishes in field conditions that may bias weight measurements.

In Sections 2.5 and 2.6, we have distinguished between those data collected above and below the Great Bend region of the Illinois River. Therefore, sampling statistics calculated for 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 graphs to increase the spatial continuity of the data used for the following analyses, but not in summary paragraphs or in W_r calculations, as LTRM only weighs select fishes, and only during Period 3.

During 2015, standard 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 2017.

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 2.2 - 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. 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 2.2).

Section 2.3 - 2017 Illinois River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted between 7:50 AM and 5:25 PM central standard time during the three sampling periods specified in Section 2.1. Physical measurements for ancillary water-quality parameters were collected at each DC-sampling site, and are summarized in Table 2.2.

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, divided between main-channel border habitat and side-channel border habitat. Data collected during the three 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 (W_r)] was calculated instead of PSD for Silver Carp (Irons et al. 2011). 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. In previous years' reports, species-specific CPUE plots showed AC and pulsed-DC survey results. In last year's report, and going forward, species-specific CPUE plots show side-channel border (SCB) and main-channel border (MCB) habitats. The pulsed-DC results from previous years and MCB results from 2009-2015 are the same; pulsed-DC sampling was previously only done in MCB habitat. However, most of the historic AC sites were located in SCB (or other off-channel) habitat, thus we decided – for continuity's sake – to label them as such for this report, knowing there are subtle differences among the two gears (e.g., McClelland and Sass 2012).

Table 2.2. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on six reaches of the Illinois River during 2017. 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)	**3.25**	**5106.7 ± 217.5**	**5.3 ± 0.7**	**22.0 ± 2.0**	**71.1 ± 3.2**	**8.0 ± 0.4**	**724.2 ± 31.2**	**493.5 ± 2.6**
Period 1	1.07	5507.5 ± 111.2	6.1 ± 1.6	24.5 ± 1.9	81.1 ± 1.4	7.3 ± 0.4	762.3 ± 20.2	505.1 ± 0.0
Period 2	1.08	5700.0 ± 57.7	4.2 ± 1.1	26.4 ± 3.7	75.6 ± 0.7	8.0 ± 1.1	823.8 ± 13.9	484.3 ± 0.0
Period 3	1.10	4112.5 ± 67.5	5.5 ± 1.3	15.2 ± 2.0	56.8 ± 0.2	8.6 ± 0.2	586.5 ± 5.4	491.1 ± 0.0
Marseilles (RM 247-271.5)	**5.28**	**4739.0 ± 155.8**	**5.9 ± 0.3**	**15.0 ± 1.1**	**71.5 ± 2.6**	**8.3 ± 0.2**	**656.0 ± 19.1**	**7.1 ± 0.5**
Period 1	1.75	5324.3 ± 67.7	6.4 ± 0.7	16.0 ± 0.4	80.3 ± 0.3	7.2 ± 0.1	735.1 ± 7.9	5.7 ± 0.0
Period 2	1.78	5100.0 ± 36.3	5.5 ± 0.4	20.0 ± 1.4	79.2 ± 0.3	7.9 ± 0.2	693.6 ± 4.2	5.3 ± 0.0
Period 3	1.75	3792.9 ± 94.4	5.8 ± 0.4	8.9 ± 0.3	55.0 ± 0.1	9.7 ± 0.1	539.3 ± 5.0	10.3 ± 0.0
Starved Rock (RM 231-247)	**3**	**5100.1 ± 190.3**	**6.3 ± 1.0**	**16.3 ± 1.0**	**77.1 ± 0.2**	**7.6 ± 0.2**	**695.0 ± 40.6**	**460.3 ± 0.5**
Period 1	1	4225.0 ± 59.1	8.9 ± 1.8	13.6 ± 1.3	77.2 ± 0.2	7.3 ± 0.1	506.0 ± 14.0	462.7 ± 0.0
Period 2	1	5437.5 ± 62.5	5.4 ± 1.7	16.1 ± 0.8	77.8 ± 0.2	8.1 ± 0.3	782.8 ± 4.3	459.1 ± 0.0
Period 3	1	5637.8 ± 37.8	4.7 ± 1.2	19.1 ± 1.8	76.3 ± 0.4	7.4 ± 0.4	796.3 ± 8.3	459.0 ± 0.0
Peoria (RM 158-231)	**15.77**	**4954.6 ± 82.6**	**5.1 ± 0.3**	**9.6 ± 0.4**	**75.5 ± 0.9**	**6.9 ± 0.2**	**692.8 ± 15.7**	**21.6 ± 7.1**
Period 1	5.25	4912.9 ± 151.1	5.9 ± 0.7	7.4 ± 0.5	79.1 ± 0.9	6.7 ± 0.2	648.1 ± 26.3	36.8 ± 21.3
Period 2	5.25	5045.8 ± 97.2	4.4 ± 0.5	10.9 ± 0.5	78.8 ± 0.2	7.5 ± 0.3	694.7 ± 19.2	13.3 ± 0.6
Period 3	5.27	4905.0 ± 174.6	4.9 ± 0.5	10.5 ± 0.7	68.6 ± 1.6	6.5 ± 0.3	735.6 ± 32.0	14.6 ± 0.5
La Grange (RM 80-158)	**1.5**	**5127.8 ± 141.3**	**7.0 ± 0.8**	**7.1 ± 1.4**	**77.1 ± 1.5**	**5.0 ± 0.3**	**720.7 ± 29.3**	**8.3 ± 1.4**
Period 1	0.5	5021.0 ± 21.0	9.3 ± 0.8	3.0 ± 0.2	78.9 ± 0.3	4.1 ± 0.1	668.5 ± 5.5	12.5 ± 0.0
Period 2	0.5	4862.5 ± 262.5	5.5 ± 0.5	9.3 ± 1.0	80.0 ± 0.5	5.4 ± 0.0	681.0 ± 2.0	7.3 ± 0.0
Period 3	0.5	5500.0 ± 100.0	6.4 ± 0.4	9.1 ± 1.2	72.5 ± 0.5	5.4 ± 0.3	812.5 ± 10.5	5.1 ± 0.0
Alton (RM 0-80)	**14.25**	**4961.2 ± 60.4**	**5.8 ± 0.6**	**8.4 ± 0.3**	**77.8 ± 1.0**	**5.8 ± 0.2**	**664.4 ± 10.0**	**21.7 ± 0.6**
Period 1	4.75	5099.3 ± 74.6	6.5 ± 1.1	6.7 ± 0.3	81.6 ± 0.7	4.8 ± 0.2	663.2 ± 10.8	23.0 ± 1.0
Period 2	4.75	4751.1 ± 66.3	5.4 ± 1.0	8.7 ± 0.3	79.9 ± 0.3	5.5 ± 0.2	611.8 ± 13.0	21.4 ± 0.8
Period 3	4.75	5033.1 ± 142.4	5.4 ± 1.0	9.9 ± 0.4	72.0 ± 2.4	7.1 ± 0.3	718.2 ± 18.4	20.9 ± 1.1

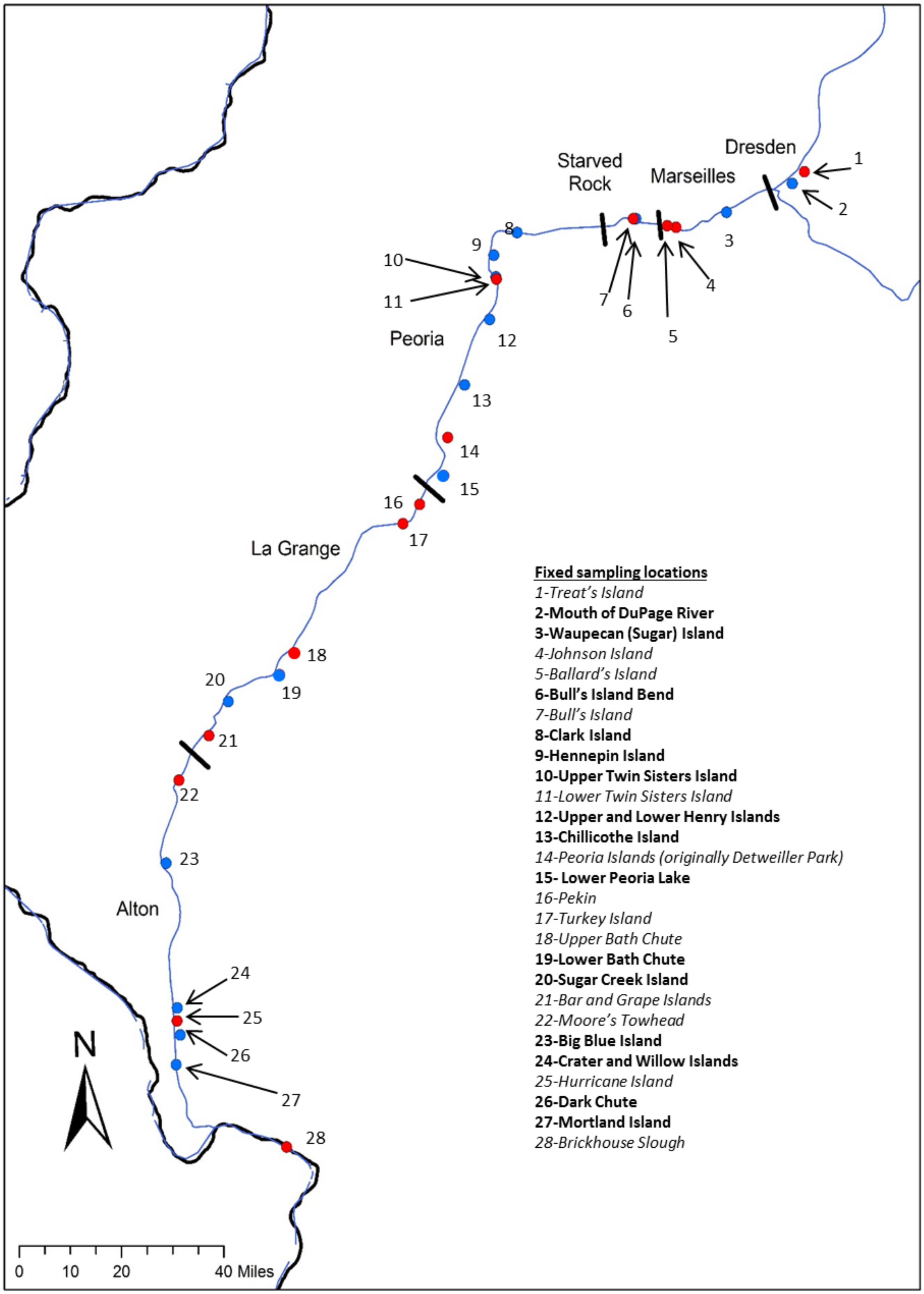

Figure 2.1. Map of the Illinois Waterway, and the fixed locations sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (F-101-R) using AC electrofishing gear 1959-2015. Sites that were abandoned for 2016 and future sampling are listed in italics (red dots); sites that have been assimilated into the pulsed-DC protocol are listed in bold (blue dots).

Section 2.5 - 2017 Upper Illinois River Electrofishing Catch Statistics

We collected 953 fish representing 42 species and 2 hybrids during 2.5 hours of pulsed-DC electrofishing at 9 sites in side-channel border habitat on the Upper Illinois and Lower Des Plains rivers. Bluegill was the most abundant species in our survey of this region (217 fish; 22.8% of total catch) followed by Gizzard Shad (90; 9.4%), and Emerald Shiner (85; 8.9%). Common Carp contributed the greatest biomass of fishes collected in the survey of this region (276.6; 34.7% total collected biomass), followed by Silver Carp (213.8 lb; 26.9%), and Smallmouth Buffalo (111.4 lb; 14.0%).

We collected 2,467 fish representing 57 species and 2 hybrids during 9.0 hours of pulsed-DC electrofishing at 36 sites in main-channel border habitat in this region. Gizzard Shad was the most abundant species in our survey of this region (520 fish; 21.1% of total catch) followed by Emerald Shiner (463; 18.8%), and Bluegill (273; 11.1%). Common Carp contributed the greatest biomass of fishes collected in the survey of this region (202.5 lb; 24.6% total collected biomass), followed by Smallmouth Buffalo (189.8 lb; 23.0%), and Silver Carp (142.6 lb; 17.3%).

Threatened and Endangered Species

Sixty two 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 2017 were above average, though variable, in SCB habitat, and slightly below average in MCB habitat (Figure 2.2). The PSD values indicate that the Bluegill population of the Upper Illinois River has likely been dominated by small young-of-year and juvenile individuals for a while, but PSD has increased in recent years.

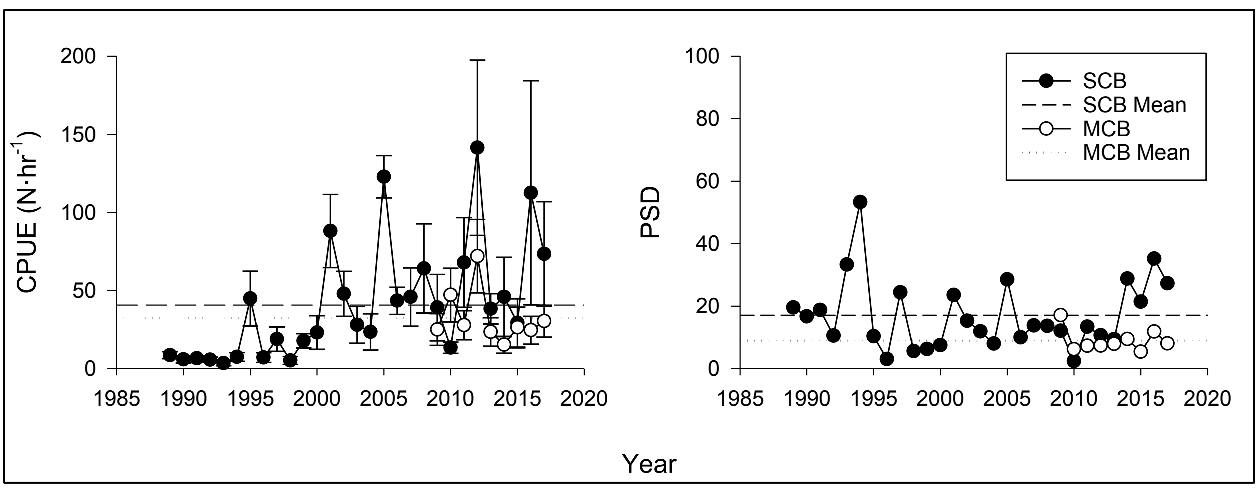

Figure 2.2. Catch per unit effort (mean ± SE; SE is calculated across sites and periods for side-channel border sampling, and across sites and periods for main-channel border sampling) and proportional size distribution of Bluegill collected in side-channel border (SCB) and main-channel border (MCB) electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling initiated in 1989.

Channel Catfish

Catch rates of Channel Catfish in the Upper Illinois River during 2017 were above average for SCB habitat, and slightly below average for MCB habitat (Figure 2.3). 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 PSD values suggest that Channel Catfish surveys in the Upper Illinois River capture larger, mature individuals.

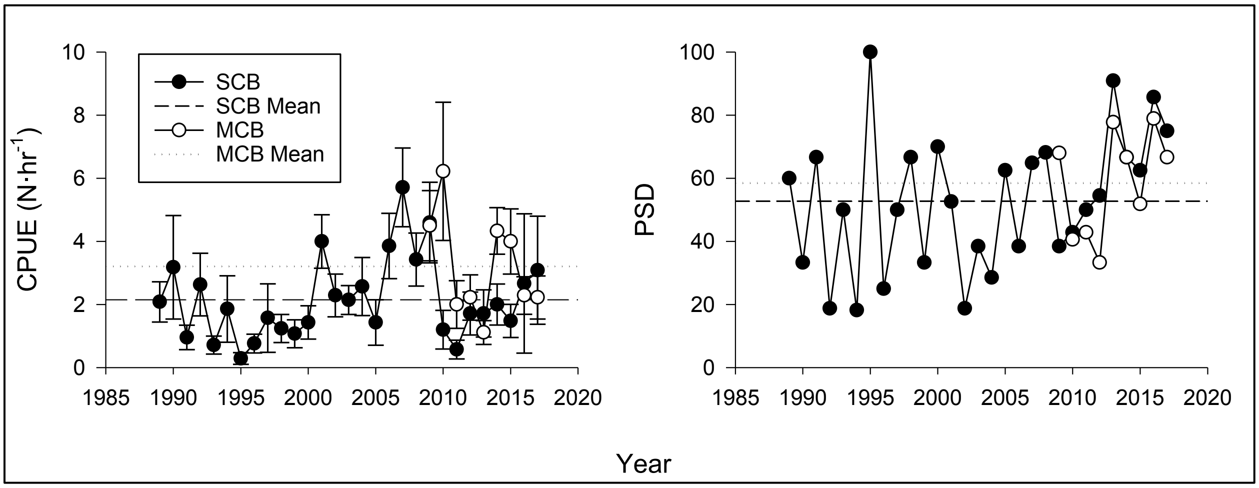

Figure 2.3. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Largemouth Bass

Largemouth Bass CPUE was again very high for SCB habitat, though highly variable (Figure 2.4), likely reflecting the large number of fish sampled from Fixed Site 2, near Channahon, IL (Figure 2.1), and CPUE in MCB habitat was slightly above average. PSD values for both habitat areas were slightly above the long-term averages. There is no doubt the Upper Illinois River has an excellent population of catchable Largemouth Bass.

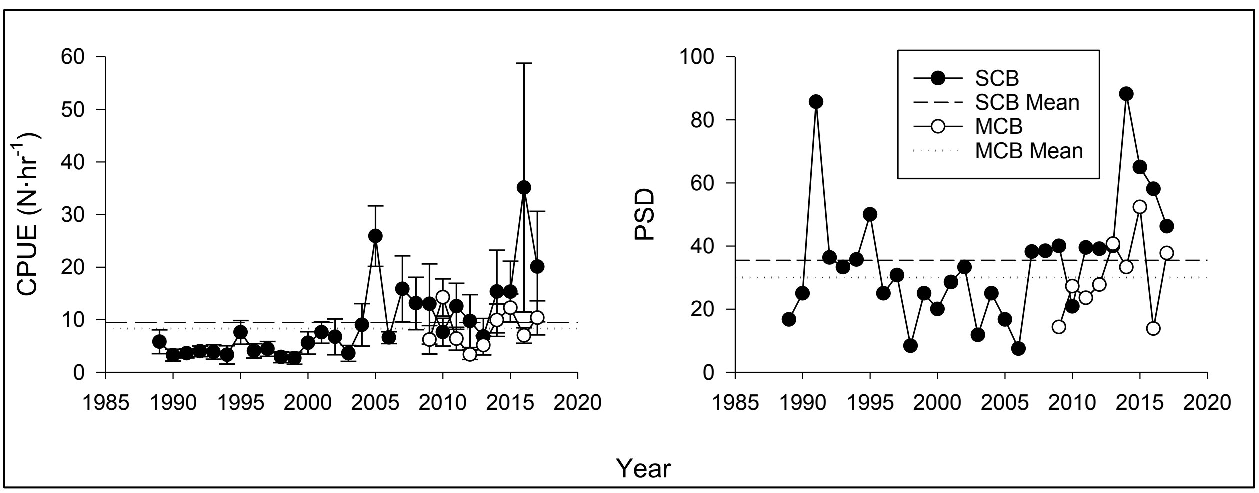

Figure 2.4. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Smallmouth Bass

Similar to 2016, catch rates of Smallmouth Bass in the Upper Illinois River were again the highest ever recorded in both SCB and MCB habitats; catch rates in SCB habitat have been increasing overall since 2000 (Figure 2.5). The variability of PSD values through time indicates that Smallmouth Bass recruitment trends in this region are sporadic. We believe future study of the effects of abiotic and biotic environmental variables on the population dynamics of Smallmouth Bass is warranted.

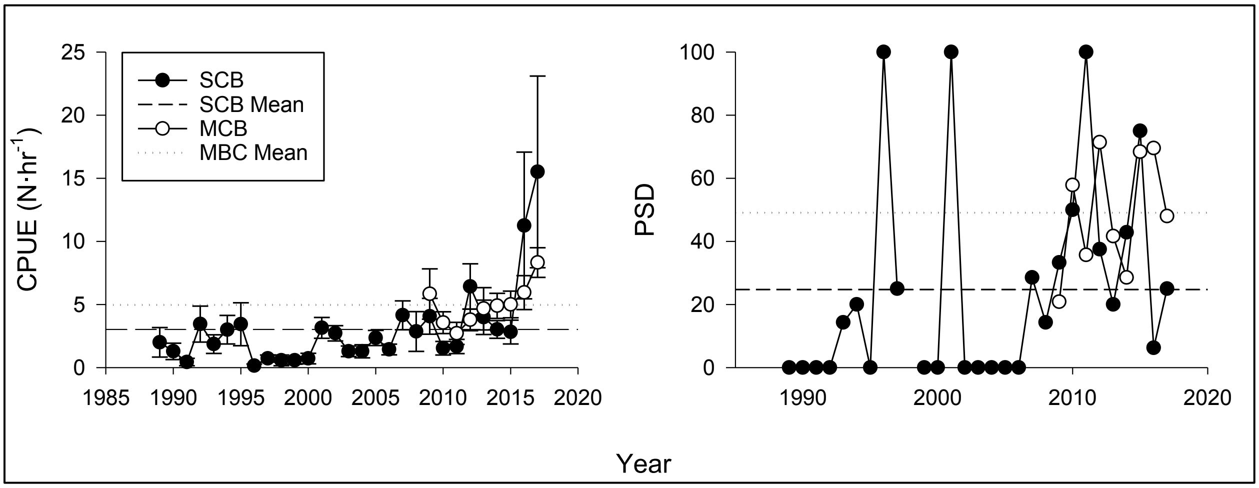

Figure 2.5. Catch per unit effort (mean ± SE) and proportional size distribution of Smallmouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Section 2.6 - 2017 Lower Illinois River Electrofishing Catch Statistics

We collected 4,300 fish representing 51 species and 4 hybrids during 9.0 hours of pulsed-DC electrofishing at 36 sites in side-channel border habitat on the Lower Illinois River. Emerald Shiner was the most abundant species in our survey of this region (1,359 fish; 31.6% of total catch) followed by Silver Carp (626; 14.6%), and Common Carp (415; 9.7%). Silver Carp contributed the greatest biomass of fishes collected in our survey of this region (1995.5 lb; 39.7% total collected biomass), followed by Common Carp (1636.6 lb; 32.5%), and Smallmouth Buffalo (395.8; 7.9%).

We collected 5,101 fish representing 56 species and 1 hybrid during 22.5 hours of pulsed-DC electrofishing at 90 sites in main-channel border habitat this region. Gizzard Shad was the most abundant species in our survey of this region (1,700 fish; 33.3% of total catch) followed by Emerald Shiner (1,078; 21.1%), and Freshwater Drum (262; 5.1%). Silver Carp contributed the greatest biomass of fishes collected in the survey of this region (748.5 lb; 32.6% total collected biomass), followed by Common Carp (572.8 lb; 24.9%), and Smallmouth Buffalo (255.8 lb; 11.1%).

Threatened and Endangered Species

Eight 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.

Black Crappie and White Crappie

Catch rates of Black Crappie and White Crappie in SCB habitat in the Lower Illinois River were lower than 2016, and slightly below the long-term average (Figure 2.6). CPUE of Black Crappie and White Crappie is generally low in our MCB sites in the lower Illinois River, and likely indicates a preference for SCB habitat. PSD values during 2017 were much higher than 2016, and well above average, indicating the year classes we believe were produced during floods in 2013 and 2015 are still present and growing.

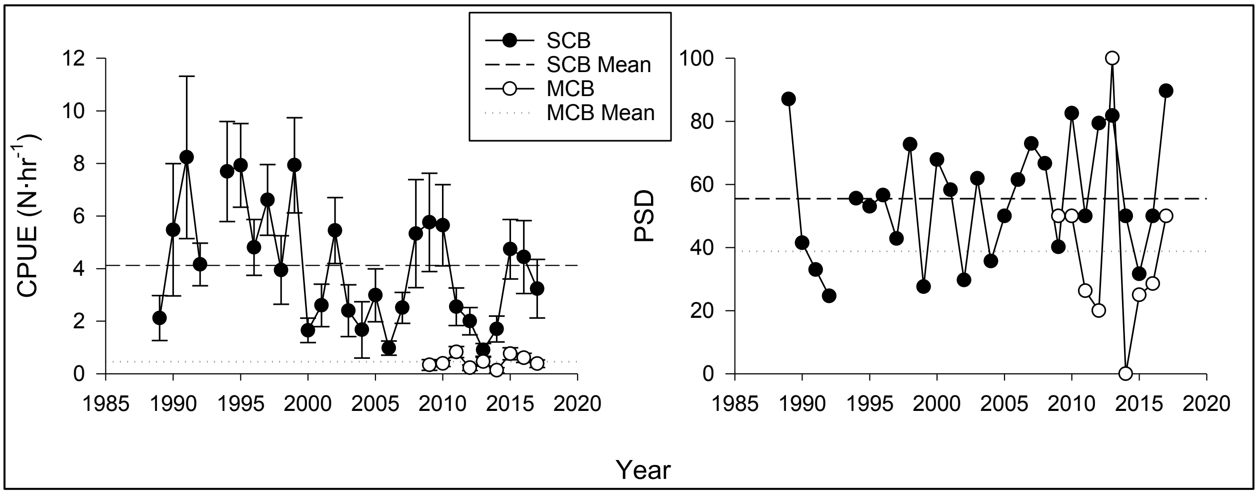

Figure 2.6. Catch per unit effort (mean ± SE) and proportional size distribution of Black Crappie and White Crappie collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling initiated in 1989.

Bluegill

Catch rates of Bluegill in the Lower Illinois River were slightly lower than 2016, though still above long-term averages (Figure 2.7). Also, similar to Crappies, CPUE of Bluegill is generally low in our MCB sites in the lower Illinois River, and likely indicates a preference for SCB habitat. The low PSD values are likely indicative of a population dominated by smaller, younger individuals, likely resulting from poor recruitment, which we believe exists because of depauperate overwintering habitat (Solomon et al. 2017).

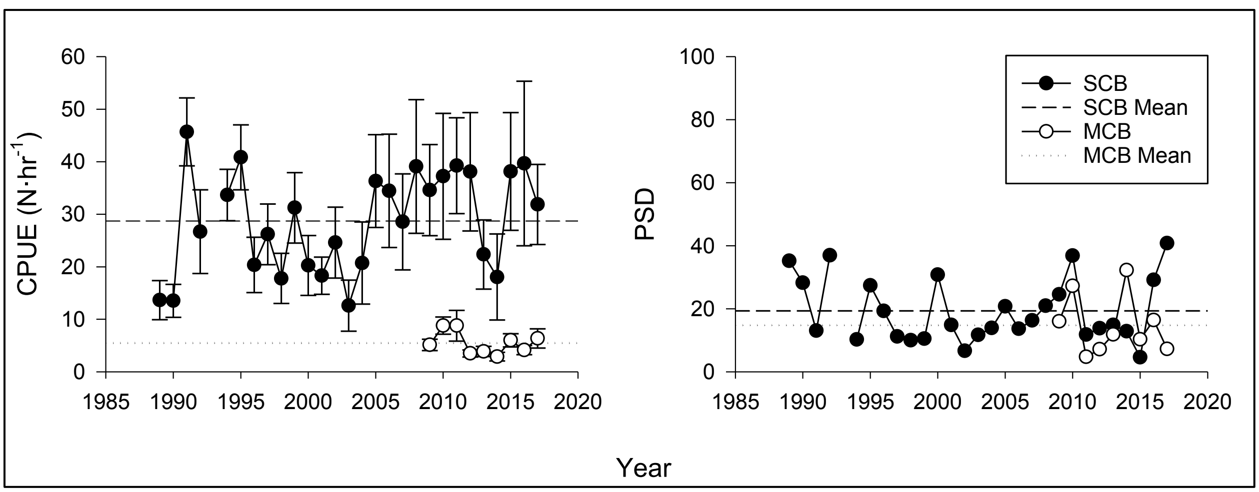

Figure 2.7. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Channel Catfish

Catch rates of Channel Catfish in the Lower Illinois River were again very low in SCB habitat, and average in MCB habitat (Figure 2.8), although PSD values in 2017 in this region were above average for both SCB and MCB habitats. Recent trends in CPUE indicate that Channel Catfish CPUE in SCB habitat in the Lower Illinois River has decreased substantially since 2010. This trend should be monitored in coming years to ensure our changing sampling protocol from 2015 to 2016 is not biasing catch rates, although Upper Illinois River catch rates do not show a similar pattern.

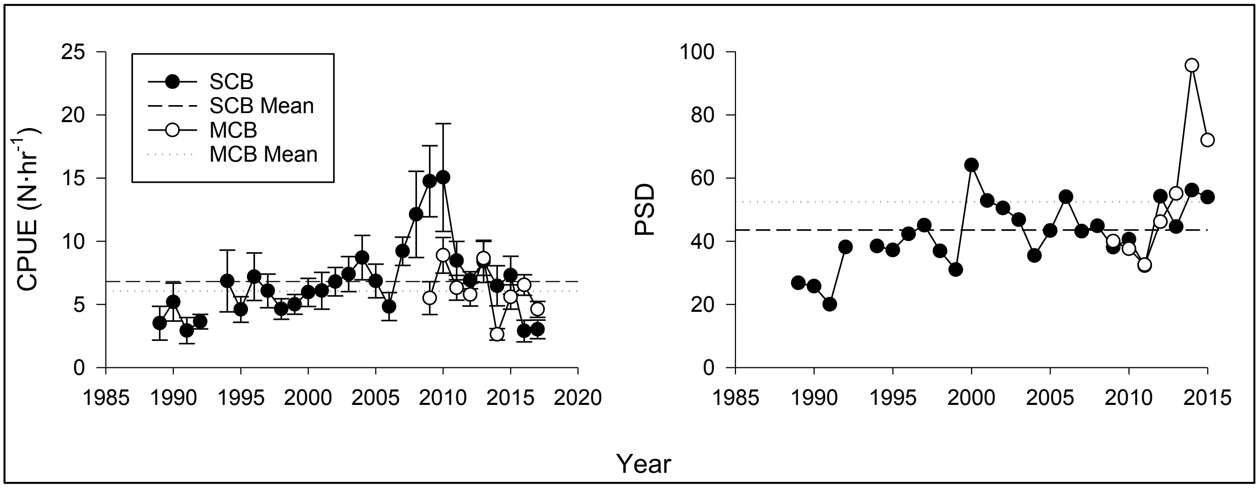

Figure 2.8. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Largemouth Bass

Catch rates of Largemouth Bass in the Lower Illinois River during 2017 were slightly below average in SCB habitat, and low in MCB habitat (Figure 2.9). PSD values calculated for both habitats during 2017 were below average. We believe Largemouth Bass, similar to Bluegill and maybe Crappies, struggle to overwinter successfully in the Lower Illinois River because of poor backwater habitat quality.

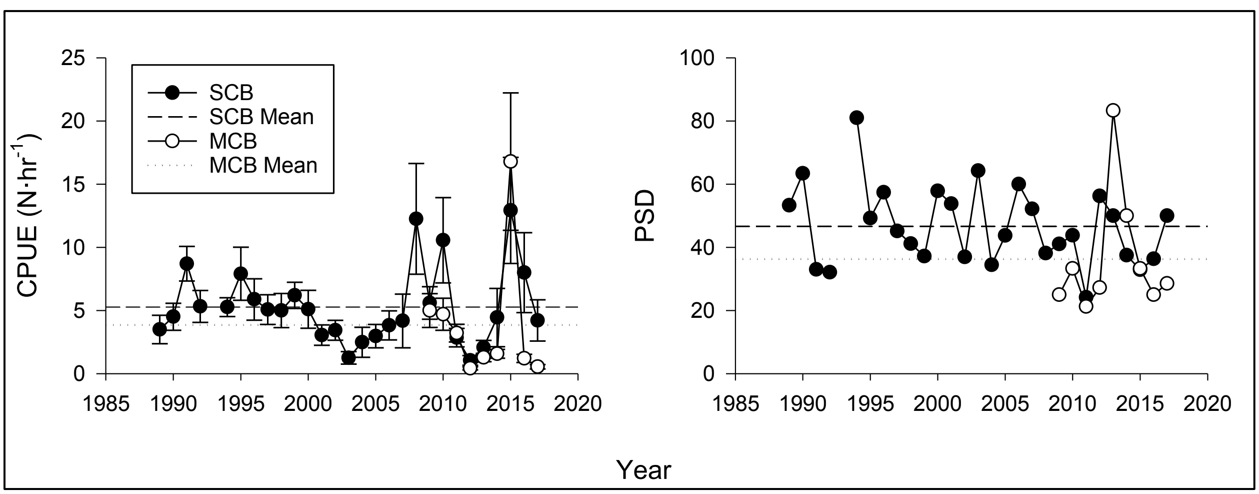

Figure 2.9. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

White Bass

White Bass CPUE in the Lower Illinois River during 2017 was slightly below the long-term average in SCB habitat, and average in MCB habitat (Figure 2.10). The disparity between the average PSD value of White Bass collected in SCB and MCB habitats likely indicates habitat preference of different size classes of White Bass.

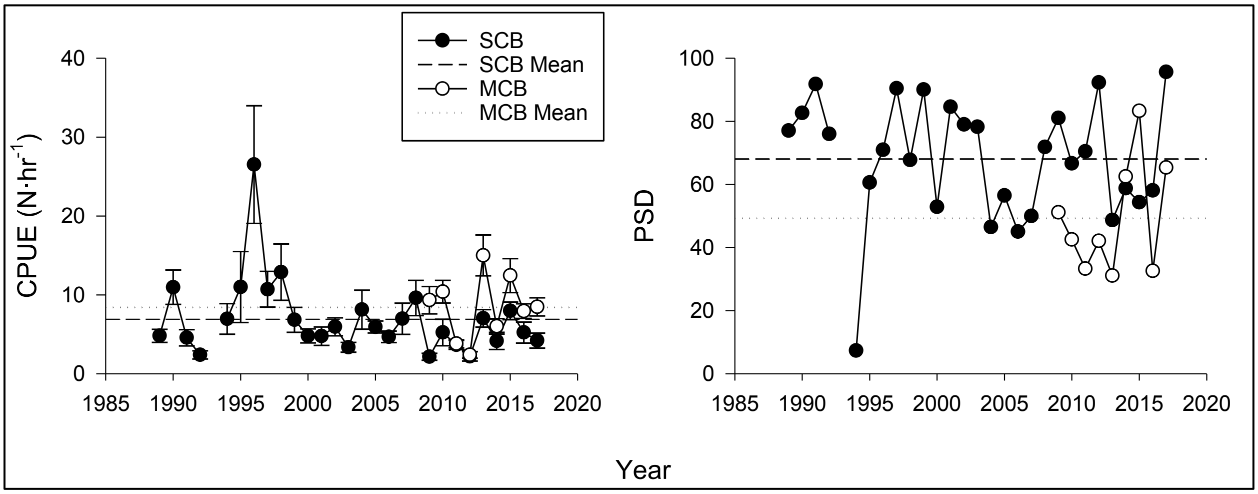

Figure 2.10. Catch per unit effort (mean ± SE) and proportional stock-density of White Bass collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling initiated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

Silver Carp

Silver Carp were first detected in F-101-R surveys in the IL River during 2001 (Figure 2.11). Since 2012, CPUE in SCB habitat has increased every year, and was the third-highest on record during 2017. Catch rates in MCB habitat were below average. Since approximately 2010, the relative weight of Silver Carp in the Lower Illinois River has plateaued around 94 (Figure 2.11). Given both anecdotal and documented evidence of Silver Carp spawning activity during recent high-flow periods, the increase in CPUE of Silver Carp in SCB habitat is not unexpected.

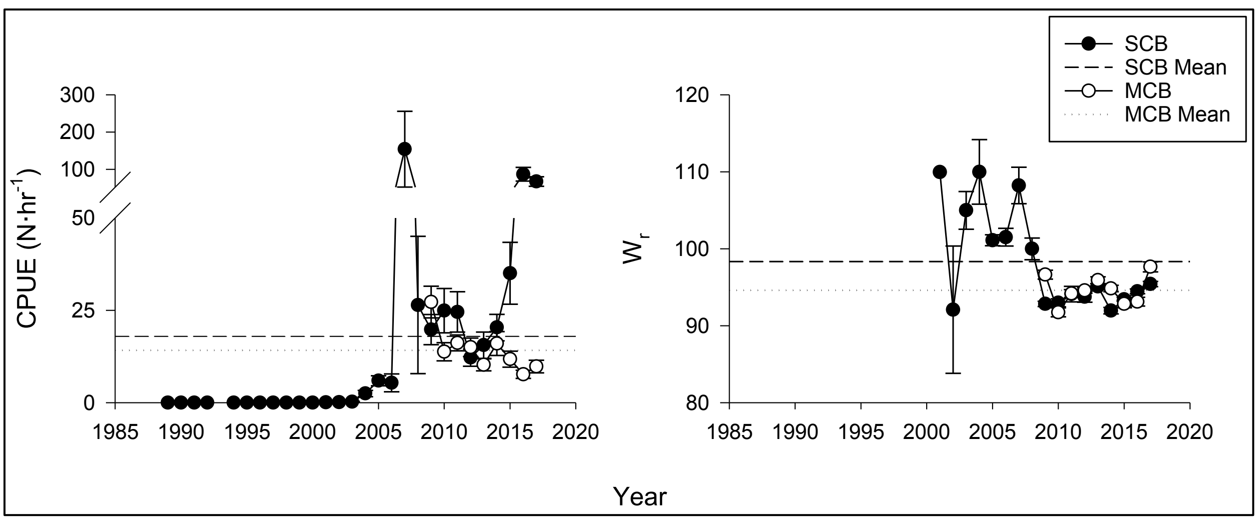

Figure 2.11. Catch per unit effort (mean ± SE) and condition (relative weight-W_r) of Silver Carp collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling initiated in 1989.

Section 2.7 - Additional research projects

Section 2.7.1 - 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 and 2017 to better understand the effect of environmental differences on sportfish life-history expression. 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 presented this research at multiple conferences during 2016, and a comprehensive analysis is in progress, with intent to publish once completed.

Section 2.7.2 – Biotic response to the establishment and expansion of Asian carp in the Illinois River

Invasive species can produce complex and unpredictable effects across multiple trophic levels through a combination of direct and indirect pathways. Invasive silver carp (*Hypophthalmichthys molitrix*) exert substantial pressure on the link between primary production and intermediate trophic levels in large rivers of the Midwestern USA. The goal of our manuscript was to describe the silver carp population invasion in the Illinois River (Illinois, USA), and explore the potential effects of silver carp on the native biota. We obtained 22 years of data from three long-term monitoring programs for phytoplankton, zooplankton, and age-0 and adult native fishes. To determine when silver carp started affecting native biota, we used non-linear regression to estimate the change point in silver carp biomass. We then used piecewise linear regression to separately model the response of phytoplankton and age-0 and adult native fishes, using the model-estimated change point in silver carp biomass. We tested for differences in taxon-specific zooplankton density and biomass between pre- and post-establishment periods using generalized linear models. To explore associations between native biota, silver carp, and other potential drivers, we used single-factor linear-regression models in an information theoretic-based approach. Our analysis showed individual silver carp condition decreased while their population numbers and biomass increased during their establishment in the Illinois River. Concurrently, analysis of 22 years of producer and consumer abundance and biomass data shows phytoplankton density and macrozooplankton density and biomass decreased – zooplankton by over 90% – during the same period, though the responses of age-0 native fish biomass and adult native fish biomass were more nuanced. Our study provides compelling evidence of multiple trophic level effects from the silver carp invasion in North America, and highlights the importance of long-term data collection and monitoring. Our research shows managers that zooplankton and perhaps phytoplankton are quickly and negatively affected by silver carp, which may eventually cascade into higher trophic levels over longer time scales. This manuscript was accepted into *Freshwater Biology*, and the citation is:

DeBoer, J. A., A. M. Anderson, and A. F. Casper. 2018. Multi-trophic response to invasive silver carp (*Hypophthalmichthys molitrix*) in a large floodplain river. Freshwater Biology. DOI: 10.1111/fwb.13097

Section 2.7.3 – Patterns of intersex prevalence, vitellogenin, and reproductive condition in two commercially harvested fish along a pollution gradient in the Illinois River complex

Master's student Madeleine VanMiddlesworth successfully defended her thesis in November 2016. Multiple manuscripts are currently in various stages of completion, including one in revision at the *Journal of Fish Biology:*

VanMiddlesworth, M. M., J. A. DeBoer, M. W. Fritts, J. M. Levengood, and A.F. Casper. In revision. Landscape-scale patterns of intersex prevalence and vitellogenin levels in common carp (Cyprinus carpio) in a floodplain river. Journal of Fish Biology.

Section 2.7.4 – LTEF dataset analysis

The long-term data from LTEF sampling was also the centerpiece of several manuscripts during Segment 29. The citations are:

Gibson-Reinemer, D. K., R. A. Sparks, J. L. Parker, J. A. DeBoer, M. W. Fritts, M. A. McClelland, J. H. Chick, and A. F. Casper. 2017. Ecological recovery of a river fish assemblage following the implementation of the Clean Water Act. BioScience 67:957–970.
Selected as Editor's Choice

Love, S. A., N. J. Lederman, R. L. Haun, J. A. DeBoer, and A. F. Casper. 2018. Does aquatic invasive species removal benefit native fish? The response of gizzard shad (*Dorosoma cepedianum*) to commercial harvest of bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*). Hydrobiologia. DOI: https://doi.org/10.1007/s10750-017-3439-1

Parker, J., Cao, Y., Sass, G. G., & Epifanio, J. (2018). Large river fish functional diversity responses to improved water quality over a 28 year period. Ecological Indicators, 88, 322-331. doi: 10.1016/j.ecolind.2018.01.035

Parker, J. L., M. W. Fritts, and J. A. DeBoer. *In press*. Length-weight relationships for small Midwestern US fishes. Journal of Applied Ichthyology. doi: 10.1111/jai.13721

Whitten, A. L. and D. K. Gibson-Reinemer. *In press*. Tracking the trajectory of change in large river fish communities over 50 years. American Midland Naturalist.

CHAPTER 3
SPORTFISH ASSESSMENTS IN THE MISSISSIPPI RIVER

During 2016, the allocation of sampling pools on the Mississippi River (MS River) was modified to improve sampling efficiency; staff at the Illinois River Biological Station coordinated with Iowa DNR staff who are also using LTRM-based sampling on the MS River. Iowa DNR is on an alternating annual schedule for Pools 16 and 17, and we agreed to sample the opposite pool as them. Thus, this year's report describes sampling in Pool 16 **only**.

The results in the following sections have been divided between those data collected in Pool 16 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, but not in summary paragraphs or in W_r calculations, as LTRM only weighs select fishes, and only during Period 3. 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).

Section 3.1 - 2017 Mississippi River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted according to the methods described in Section 2.1 between 9:10 AM and 4:00 PM central standard time during the three sampling periods specified in Section 2.1. 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 2017. 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**	**3804.3 ± 77.5**	**4.8 ± 0.8**	**11.0 ± 1.5**	**74.2 ± 0.7**	**9.6 ± 0.9**	**423.9 ± 18.1**	**11.2 ± 0.2**
Time Period 1	1.25	3784.0 ± 244.3	6.8 ± 1.3	7.7 ± 0.3	71.4 ± 0.3	7.7 ± 0.3	447.0 ± 55.3	12.4 ± 0.0
Time Period 2	1.25	3792.0 ± 51.5	4.9 ± 1.4	17.6 ± 1.7	77.1 ± 0.5	14.2 ± 0.8	411.0 ± 10.8	10.3 ± 0.0
Time Period 3	1.25	3837.0 ± 19.2	2.8 ± 0.7	7.7 ± 1.8	74.1 ± 0.3	6.9 ± 0.0	413.8 ± 6.9	11.0 ± 0.0
Pool 25 (RM 242-273.5)	**4.50**	**3908.3 ± 41.3**	**9.3 ± 1.1**	**14.8 ± 1.2**	**76.4 ± 1.4**	**8.9 ± 0.3**	**433.4 ± 6.9**	**36.3 ± 0.2**
Time Period 1	1.50	4110.0 ± 49.0	9.7 ± 2.2	13.5 ± 0.4	83.0 ± 0.6	8.1 ± 0.4	440.3 ± 15.4	37.4 ± 0.4
Time Period 2	1.50	3769.3 ± 24.3	9.9 ± 2.2	19.6 ± 2.3	75.5 ± 1.7	9.9 ± 0.6	411.0 ± 2.0	35.7 ± 0.3
Time Period 3	1.50	3845.5 ± 40.3	8.5 ± 1.2	11.4 ± 1.4	70.7 ± 1.5	8.6 ± 0.4	449.0 ± 9.1	36.0 ± 0.2
Chain of Rocks (RM 165.5-200.5)	**5.25**	**4395.7 ± 117.0**	**9.8 ± 0.7**	**10.6 ± 0.7**	**76.7 ± 1.6**	**7.1 ± 0.3**	**539.1 ± 20.9**	**10.8 ± 1.3**
Time Period 1	1.75	4639.6 ± 154.8	8.4 ± 1.5	8.7 ± 1.4	80.9 ± 1.3	6.8 ± 0.2	560.6 ± 27.2	18.0 ± 0.5
Time Period 2	1.75	4206.7 ± 108.7	10.8 ± 1.4	12.4 ± 0.4	80.6 ± 0.3	6.0 ± 0.4	495.4 ± 24.2	7.4 ± 0.1
Time Period 3	1.75	4340.9 ± 291.0	10.3 ± 0.5	10.7 ± 1.1	68.5 ± 2.5	8.4 ± 0.2	561.3 ± 50.7	7.0 ± 1.9
Kaskaskia (RM 117-165.5)	**7.50**	**4405.7 ± 68.5**	**9.6 ± 0.8**	**9.9 ± 0.9**	**76.6 ± 1.3**	**7.2 ± 0.3**	**536.0 ± 14.9**	**12.7 ± 1.0**
Time Period 1	2.50	4297.9 ± 123.3	8.0 ± 1.4	6.9 ± 0.8	82.7 ± 1.2	6.6 ± 0.2	483.4 ± 19.8	18.1 ± 1.2
Time Period 2	2.50	4439.5 ± 114.4	9.3 ± 1.4	13.9 ± 1.6	78.5 ± 1.2	7.1 ± 0.8	533.3 ± 22.6	8.8 ± 0.8
Time Period 3	2.50	4479.6 ± 122.5	11.5 ± 1.1	9.0 ± 1.5	68.5 ± 1.3	7.8 ± 0.1	591.4 ± 24.2	11.4 ± 1.5

Section 3.2 - 2017 Pool 16 Pulsed-DC Electrofishing Catch Statistics

We collected 3,706 fish representing 42 species during 3.75 hours of pulsed-DC electrofishing at 15 sites in Pool 16. Emerald Shiner was the most abundant species in our catch (2,524; 68.1% of total catch) followed by Gizzard Shad (580; 15.7%), and Unknown Cyprinids (176; 4.7%). Common Carp represented the greatest proportion of the total collected biomass (97.1 lb; 33.5% of total collected biomass) followed by Channel Catfish (23.6 lb; 8.1%), and River Carpsucker (23.1 lb; 8.0%).

Threatened and Endangered Species

No IL or Federally threatened or endangered fishes were collected from Pool 16 during 2017.

Bluegill

Bluegill catch rates in Pool 16 during 2017 were slightly above average since 2014 (Figure 3.1). The PSD value for fish sampled during 2017 was low, perhaps indicating an influx of recruits in 2017.

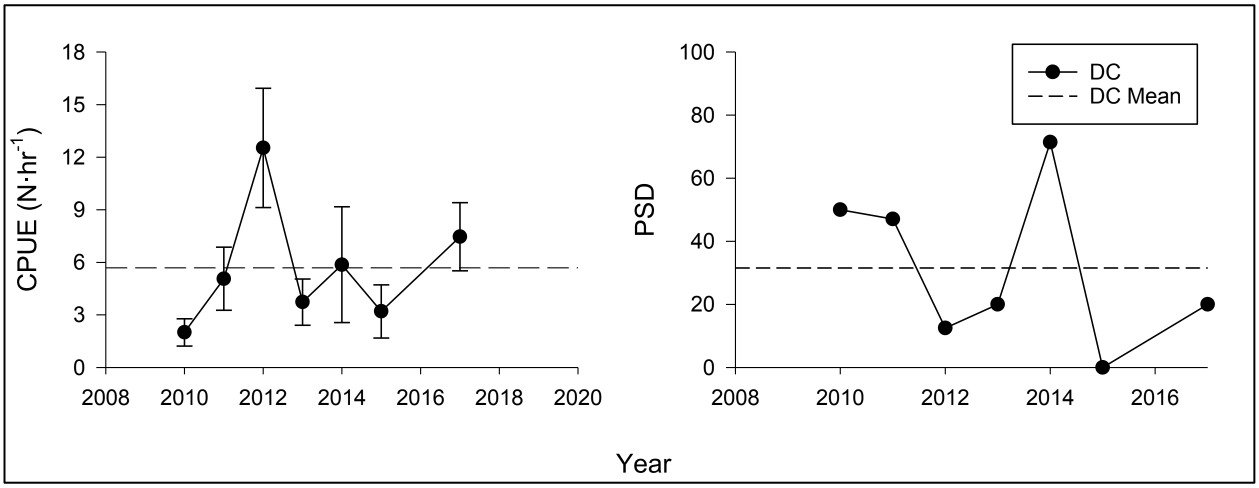

Figure 3.1. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Channel Catfish

Catch rates of Channel Catfish in Pool 17 were average during 2017, whereas PSD values were slightly below average. These results likely indicate that the bulk of the sampled population is relatively stable and comprised of a balance of larger and smaller fish.

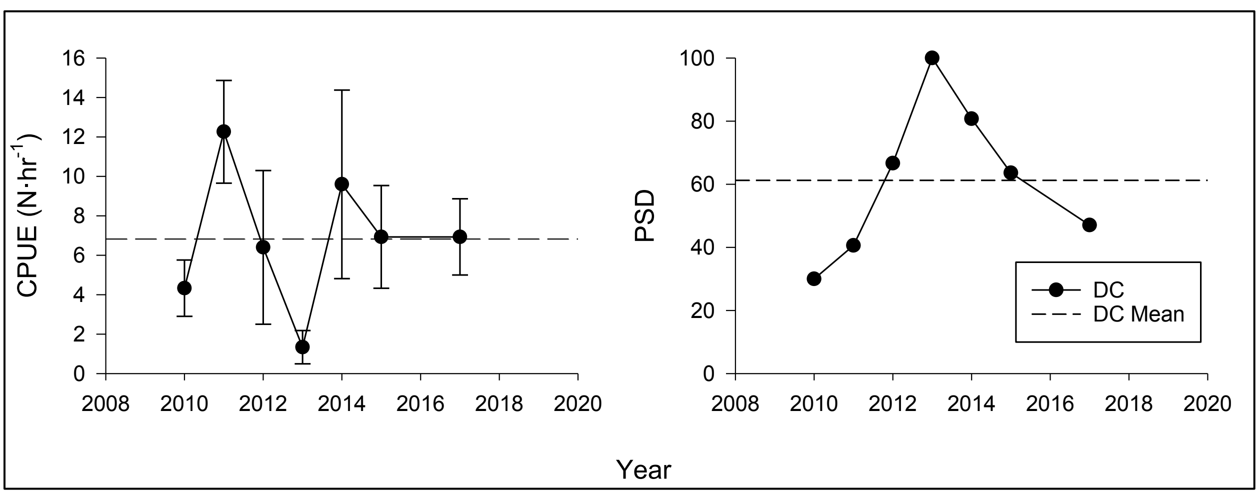

Figure 3.2. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Largemouth Bass

Catch rates of Largemouth Bass in Pool 17 during 2017 were slightly below average (Figure 3.3), with a majority of small fish based on PSD values.

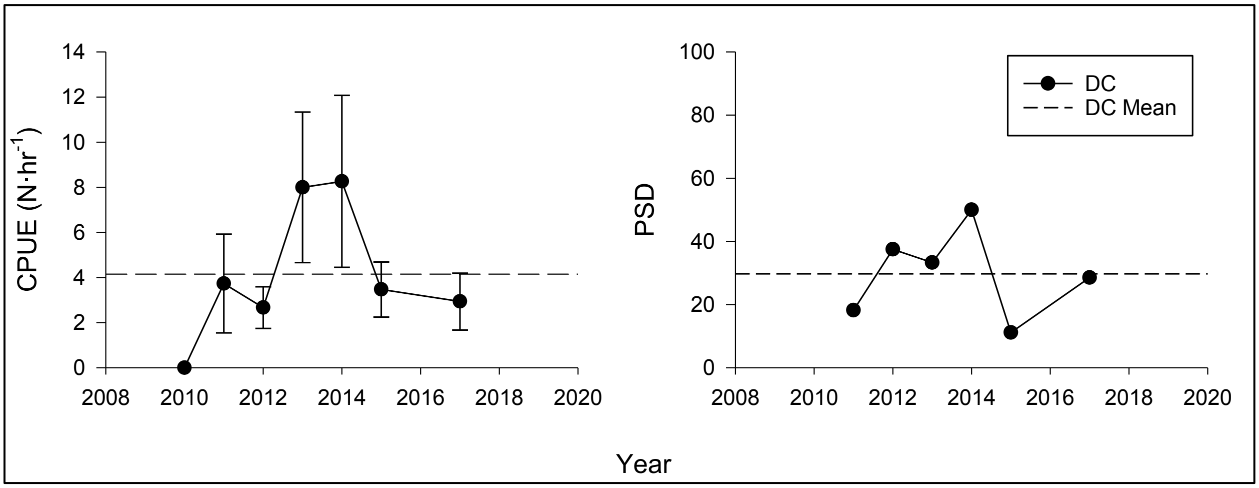

Figure 3.3. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Smallmouth Bass

Smallmouth Bass CPUE in Pool 17 during 2017 was below the long-term average (Figure 3.4). The PSD value for 2017 indicates few large fish are sampled in this area.

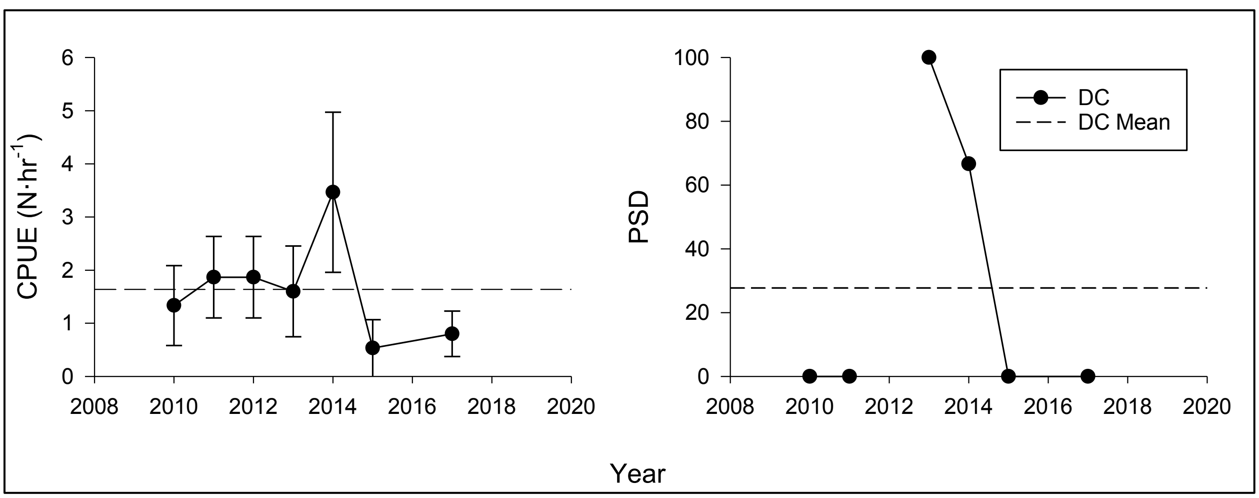

Figure 3.4. Catch per unit effort (mean ± SE) and proportional size distribution of Smallmouth Bass collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

White Bass

Catch rates of White Bass in Pool 17 during 2017 were similar to those in 2015, slightly below the long-term average (Figure 3.5). Variable PSD values likely indicate sporadic recruitment.

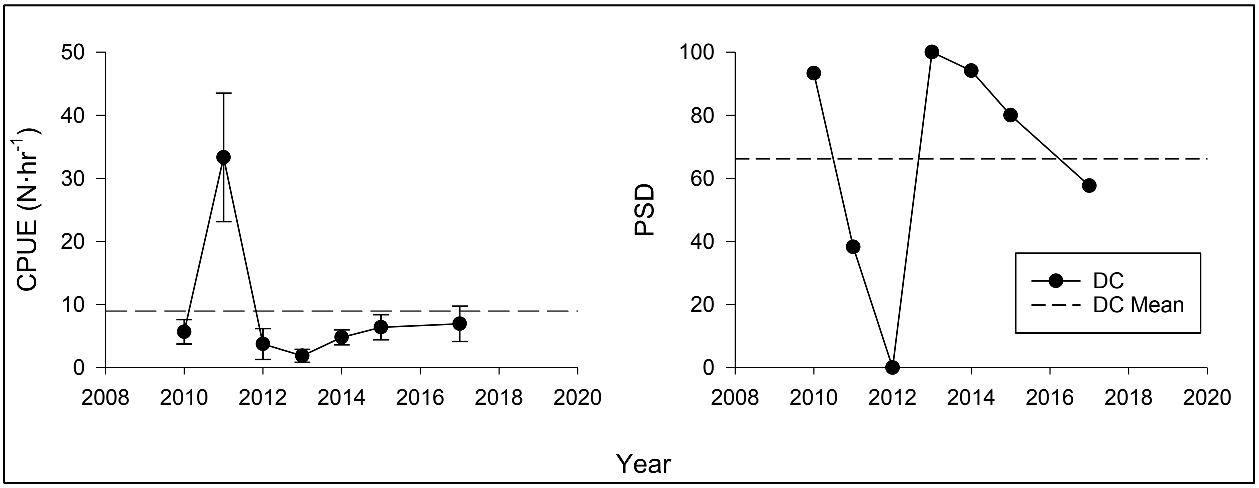

Figure 3.5. Catch per unit effort (mean ± SE) and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Section 3.3 - 2017 Lower Mississippi River Sampling Area Pulsed-DC Electrofishing Catch Statistics

We collected 4,189 fish representing 50 species and 1 hybrid during 17.25 hours of pulsed-DC electrofishing at 69 sites in the Lower Mississippi River Sampling Area. Gizzard Shad was the most abundant species in our catch (1,817 fish; 43.4% of total catch) followed by Emerald Shiner (837; 20.0%), and Common Carp (299; 7.1%). Common Carp represented the largest proportion of the total collected biomass (1,786.7 lb; 51.3% of total collected biomass) followed by Smallmouth Buffalo (333.5 lb; 9.6%), and Grass Carp (270.2 lb; 7.8%).

Threatened and Endangered Species

One Freckled Madtom (Iowa Endangered) was sampled during pulsed-DC electrofishing surveys on the Lower Mississippi River Sampling Area during 2017. This fish was identified in the field, and was not verified by INHS museum staff.

Bluegill

The catch rate of Bluegill in the Lower Mississippi River Sampling Area was average in 2017 after a decline in 2016 (Figure 3.6). Low PSD values indicate that the sampled population is dominated by small individuals, perhaps limited by overwintering habitat like those in the Lower Illinois River. Similar values since 2009 may indicate that annual production of year classes has been relatively consistent.

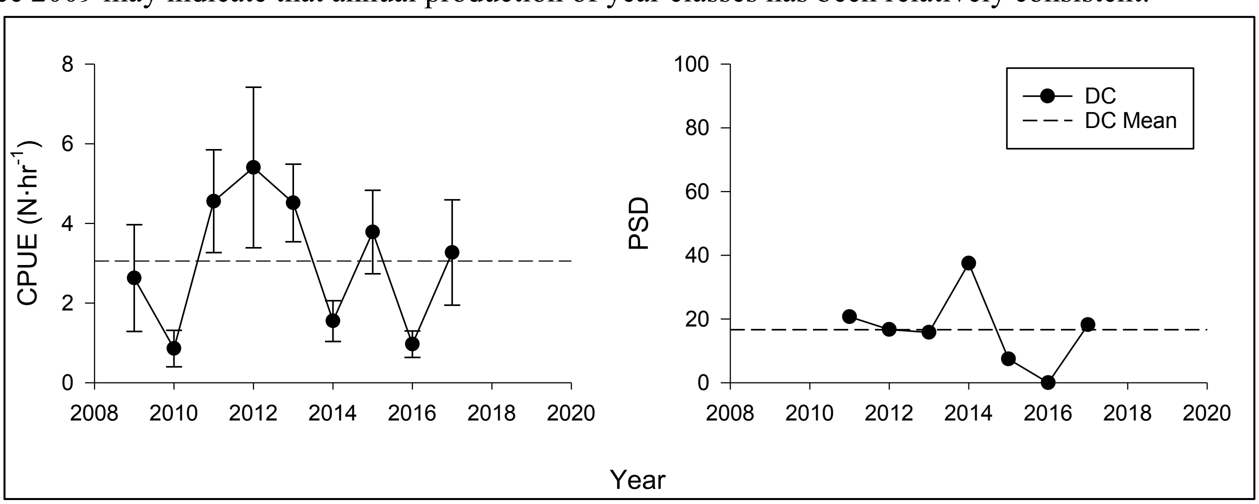

Figure 3.6. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

Channel Catfish

Catch rates of Channel Catfish in the Lower Mississippi River Sampling Area during 2017 were similar to 2016 (Figure 3.7). Typically, high and stable PSD values during the past six years indicated that the sampled population is largely composed of larger individuals.

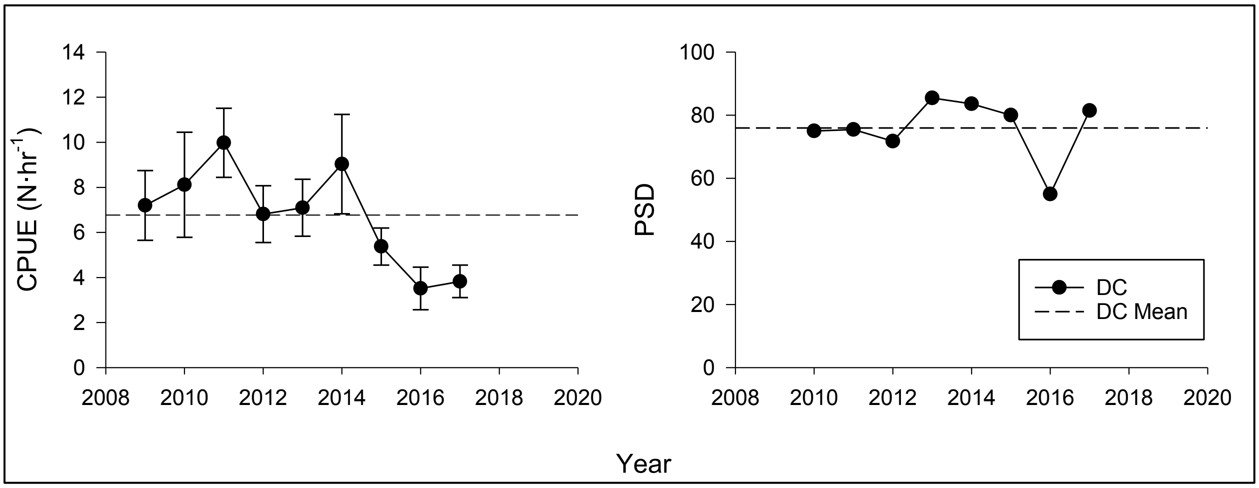

Figure 3.7. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

White Bass

White Bass CPUE was lowest ever during 2017, although CPUE in the Lower Mississippi River Sampling Area has been erratic since 2009 (Figure 3.8), and likely tied to highly variable PSD values, indicating recruitment of White Bass in the Lower Mississippi River sampling reaches may be cyclical or episodic.

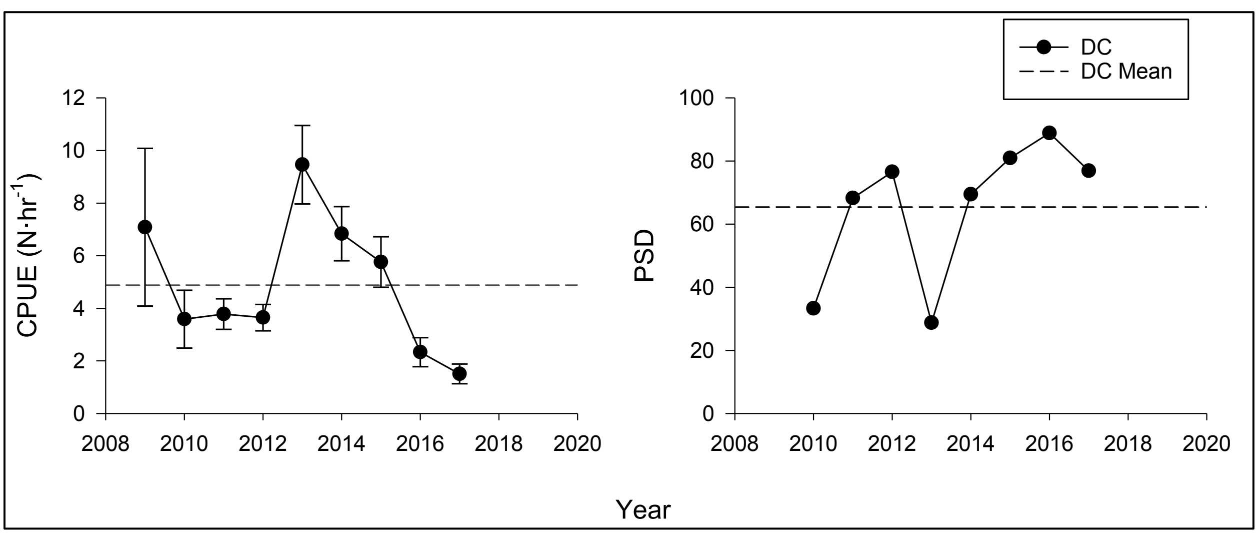

Figure 3.8. Catch per unit effort (mean ± SE) and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Reaches. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

Silver Carp

Catch rates of Silver Carp in the Lower Mississippi River Sampling Area were well below average, (Figure 3.9), likely contributing to a higher than average W_r value.

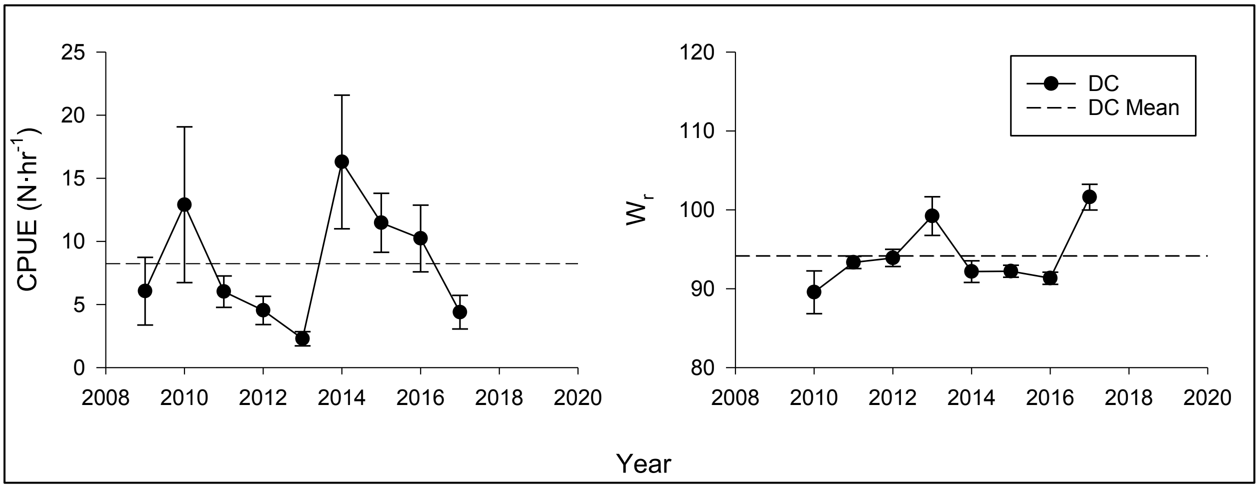

Figure 3.9. Catch per unit effort (mean ± SE) and condition (relative weight-W_r) of Silver Carp collected by pulsed-DC electrofishing survey in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

CHAPTER 4
SPORTFISH ASSESSMENTS OF ILLINOIS RIVER TRIBUTARIES

Section 4.1 Iroquois and Kankakee Rivers Fixed Site Ancillary Habitat Quality Data

Following 2016 (DeBoer et al., 2017) protocols, all Kankakee and Iroquois River fixed sites were surveyed during time period three. Pulsed-DC electrofishing surveys were conducted from 9/7/2017 to 10/21/2017 between the hours of 10:45 and 16:00 central standard following Long Term Resource Monitoring electrofishing procedures (Ratcliff, Gittinger, O'Hara, & Ickes, 2014). Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 4.1.

Table 4.1 Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys of the Iroquois and Kankakee Rivers during 2017. 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	1.00	4350 ± 50	2.25 ±0.7	45 ± 15.3	21.6 ± 1.3	5.5 ± 0.6	579.8 ± 13.7	3.3 ± 0.2
Kankakee	2.25	4616 ± 50	1.4 ± 0.2	99 ± 6.4	21.7 ± 0.9	6.0 ± 0.3	650.8 ± 8.6	1.3 ± 0.1

Section 4.2 Iroquois River Fixed Site Electrofishing Catch Summary

We collected 154 fishes representing 30 species from seven families totaling 248 lb during one hour of pulsed-DC electrofishing at four sites in the Iroquois River (Figure 4.1). Shorthead Redhorse were the most abundant (42 fish, 27% of total catch), followed by Common Carp (16 fish, 10%) and Channel Catfish (15 fish, 10%). Common Carp contributed the greatest biomass of fishes collected (85 lb, 34% of total biomass), followed by Channel Catfish (53 lb, 21%), and Shorthead Redhorse (37 lb, 15%).

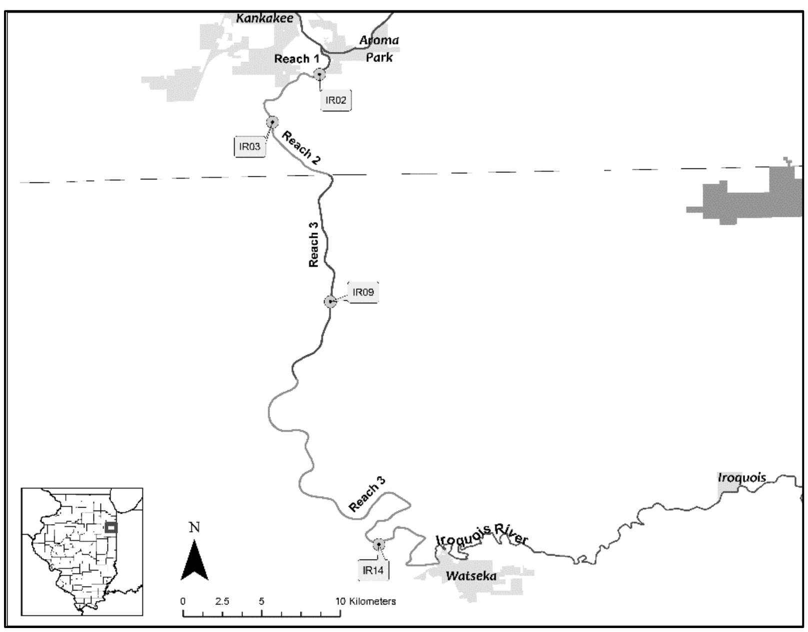

Figure 4.1 Map displaying Iroquois River study reaches and fixed site locations.

Threatened and Endangered Species

Two State Threatened River Redhorse were captured in Reach 2 of the Iroquois River during mainstem fixed site surveys.

Iroquois River Fish Abnormalities

Six DELT or external parasites were documented in the Iroquois River fishes in 2017 (3.9% of fishes) a proportion comparable to 2016's 3.1% and 2015's 3.5%. The abnormalities noted in 2017 included one fish with eroded fins, one with a tumor, two with anchor worms, one with blackspot, and one fish with a head wound.

Channel Catfish

Catch per unit effort (CPUE) for Channel Catfish ranged from 0/hr at Site IR02 to 36/hr at Site IR03 with a mean of 15/hr among sites. The mean length of Channel Catfish in 2017 was 21.4" and the mean weight was 3.5 lb. The largest fish was 25" and weighed 4.8 lb. Similar to all previous years, there was a noticeable absence of young-of-year and juvenile fish with the smallest fish measuring 15.7". The proportional size distribution (PSD) of the population increased again in 2017 to 0.92 while relative weights (W_r) declined slightly (Figure 4.2; Brown, Jaramillo Jr, Gatlin III, & Murphy, 1995). The metrics indicate the population is composed primarily of large healthy adult fish.

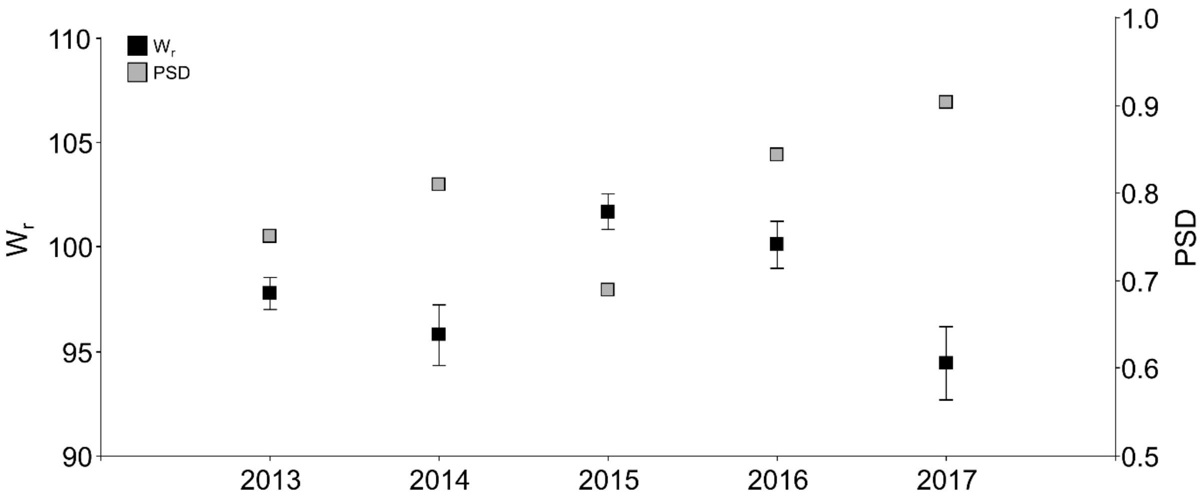

Figure 4.2 Plot displaying the relative weights (W_r) and proportional size distribution (PSD) trends of Iroquois River Channel Catfish.

Section 4.3 Kankakee River Fixed Site Electrofishing Catch Summary

We collected 489 fishes representing 46 species from 13 families totaling 315 lb during 2.25 hours of pulsed-DC electrofishing at nine sites in the Kankakee River (Figure 4.3). Gizzard Shad were the most abundant (110 fish, 23% of total catch), followed by Golden Redhorse (65 fish, 13%) and Bluegill (52 fish, 11%). Channel Catfish contributed the greatest biomass of fishes collected (63 lb, 20% of total biomass), followed by Golden Redhorse (55 lb, 18%), and Common Carp (50 lb, 16%).

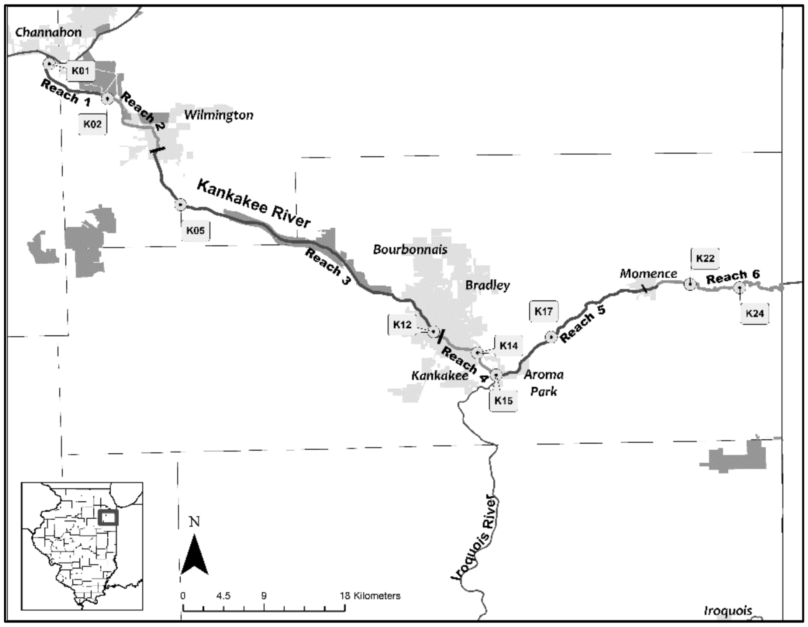

Figure 4.3 Map displaying Kankakee River study reaches and fixed site locations.

Threatened and Endangered Species

Four Illinois State threatened or endangered species were collected during fixed site surveys in the Kankakee River. These included one Banded Killifish and one River Redhorse in Reach 2, one River Redhorse in Reach 3, and one Weed Shiner in Reach 5.

Kankakee River Fish Abnormalities

Eighteen DELT or external parasites were documented in the Kankakee River fishes in 2017 (3.7% of fishes) and little changed from the 3.8% documented in 2016. Abnormalities were documented in nine species. The most common abnormalities were tumors (5 fishes, 1% of fishes) and fish with recent wounds (5 fishes, 1%). We also documented three fishes with eroded fins (0.6% of fishes), three fishes with light anchor worms (0.6%), one fish with a spinal deformity, and one fish with heavy blackspot.

Smallmouth Bass

The CPUE of Smallmouth Bass ranged from 0/hr at sites K01 and K15 to 56/hr at K02 with a mean of 21.3/hr across sites. The mean length of Smallmouth Bass in 2017 was 6.2" and the mean weight was 0.3 lb. The largest fish was 17.6" and weighed 3.1 lb. The Kankakee River's Smallmouth Bass PSD value decreased from the 2016 value of 0.68 to 0.59 in 2017, while the mean W_r value increased slightly to 92.5 (Figure 4.4; Kolander, Willis, & Murphy, 1993).

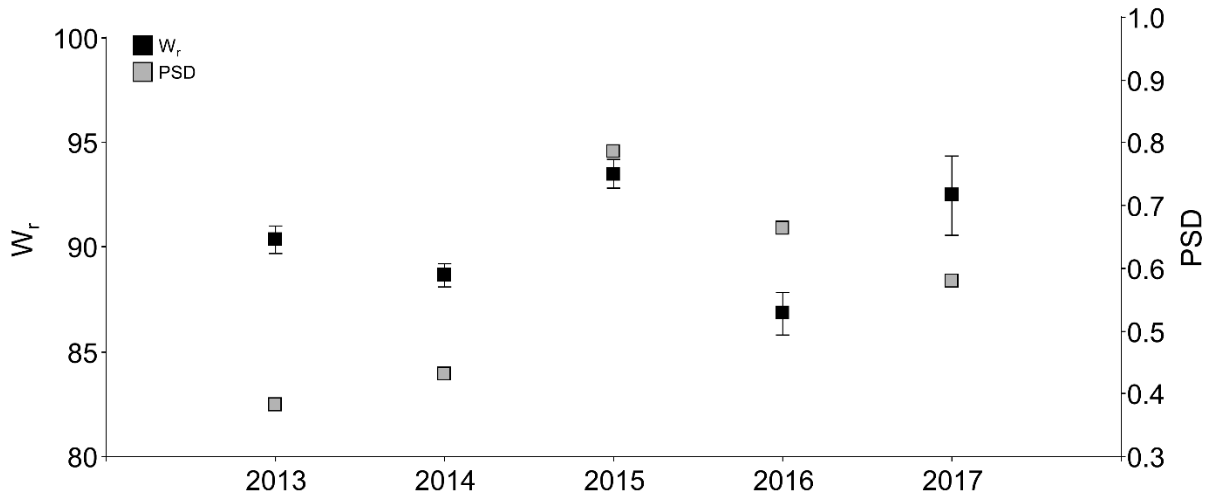

Figure 4.4 Plot displaying the relative weights (W_r) and proportional size distribution (PSD) trends of Kankakee River Smallmouth Bass.

Section 4.4 Kankakee River Northern Pike Demographics and Habitat Use

Introduction

Northern Pike (*Esox lucius*) are one of the largest sportfish species to occur in Illinois and are an economically important species targeted by many anglers. Their distribution in Illinois is primarily limited to the northern third of the state, though there are historical records of populations in lower portions of the state that are presumed extinct (Smith, 2002). Northern Pike broadcast spawn over vegetation in shallow flooded marshes, and thus their preferred habitats are medium and large rivers with access to clear vegetated backwaters (Becker, 1983). These off-channel habitats have been greatly diminished in Illinois through channelization. It is estimated that 22.7% of the total length of Illinois' streams and rivers have been channelized and 5.6% have been leveed (Mattingly, Herricks, & Johnston, 1993). These modifications and others (e.g., damming, removal of riparian vegetation) have greatly reduced the amount of off-channel habitat necessary for healthy populations of Northern Pike (Schoof, 1980).

The Kankakee River from its source near South Bend, Indiana to a bedrock shelf in Momence, Illinois was once a great complex of marshes that created prime habitat for Northern Pike. Levee and drainage districts in Indiana began to drain the marshes for agriculture in the latter half of the 19th Century. By 1918, 400km of meandering river and an accompanying 400,000 acres of marsh were transformed into a 132km drainage ditch and grain fields (Bhowmik, Bonini, Bogner, & Byrne, 1980). The major channelization projects were stopped at the Illinois border and the area between Momence and the Illinois-Indiana State line still contains many sheltered floodplain lakes, oxbows, and side-channels for Northern Pike to utilize. The uniqueness of this remnant section of the Kankakee Grand Marsh prompted large sections of the area to be designated as preserves (i.e., Momence Wetlands Land and Water Reserve, and the Momence Wetlands Nature Preserve).

Standard main-channel border surveys conducted since 2013 through F-101-R indicated that Northern Pike were much more abundant in the Kankakee than in all other rivers sampled through F-101-R, and that they were most abundant in Reach 6 of the Kankakee. The combined CPUE of Northern Pike from 2013-2016 was 3.9/hr in Reach 6, 2.0/hr in Reach 5, and < 0.5/hr in the remaining four reaches. Reach 6 of the Kankakee is highly sinuous and offers access to an abundance of off-channel vegetated habitat (Figure 4.5). The substrate in Reach 6 is dominated by sand, though there are patches of bedrock, gravel, and silt. The riparian zone in Reach 6 is heavily forested with many deadfalls in the water. Large woody debris, emergent willow, and submerged macrophytes create complex habitat for Northern Pike and their prey.

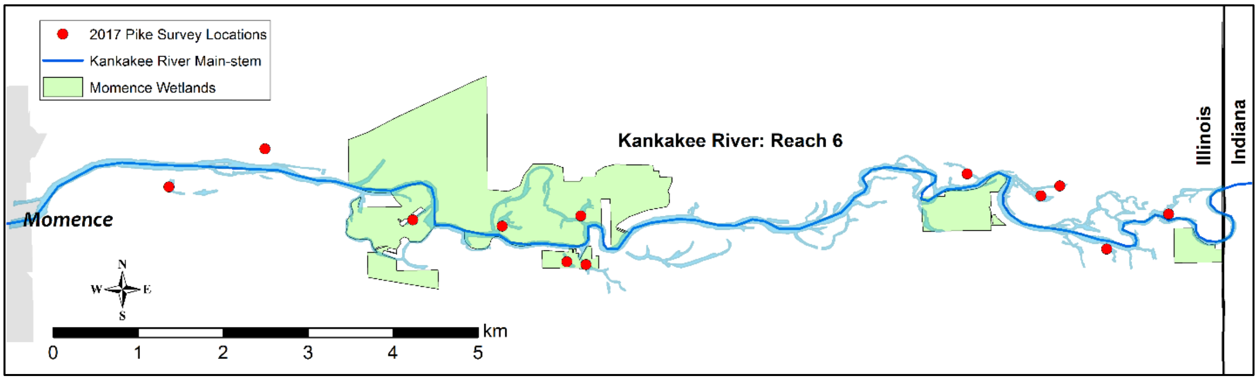

Figure 4.5 Map of Reach 6 of the Kankakee River showing 2017 Northern Pike survey locations and the abundance of off-channel habitat.

Given the Northern Pike's status as a sought-after sportfish, its range's proximity to dense human populations in Northern Illinois, its diminished historical range in the state, and loss of habitat, it is important we understand the remaining wild populations of this species within Illinois. This preliminary study sought to identify off-channel areas for surveys, asses the population demographics, and obtain habitat characteristics.

Methods

Off-channel surveys targeting Northern Pike took place between 3/29/2017 and 6/28/2017. We conducted 4.5 hours of electrofishing at 12 off-channel sites (Figure 4.5) totaling approximately 5 hectares during 15 electrofishing surveys. Three electrofishing methods were employed based upon site accessibility and depth. The two-netter DC-electrofishing boat used for main-channel border surveys was used for 10 surveys at sites accessible through the main-channel of the river. A one-netter DC boat was used for two surveys at sites lacking main-channel access, and a three anode DC tow-barge was used for 3 surveys at sites too shallow for boat operation.

Surveys were conducted under the same protocols used for standard F-101-R surveys (i.e., wattage standardization, full fish assemblage sampling, collection of ancillary habitat and water quality data). However, electrofishing was not constrained to 15 minutes of effort/survey, as our intent was to adequately sample entire backwater areas. In addition to weighing and measuring Northern Pike, we implanted intramuscular Biomark HPT8 passive integrated transponder (PIT) tags in the expaxial muscles on the left side near the center of the dorsal fin and a numbered FLOY FD-68B FF t-bar anchor tag immediately below the dorsal fin origin, took photographs of the urogenital pore for sex determination, and removed the anterior left pectoral ray for age estimation.

Submerged macrophytes within each sampling location were identified to species using Aquatic Plants of the Upper Midwest (Skawinski, 2011). We sought to test for associations between submerged macrophyte diversity and Northern Pike presence, as submerged macrophytes are associated with Northern Pike abundances (Casselman & Lewis, 1996) and their diversity may be indicative of overall habitat quality and level of human disturbance (Beck, Hatch, Vondracek, & Valley, 2010; Nichols, Weber, & Shaw, 2000).

Two urogenital pore images from each Northern Pike were used for sex determination following Casselman (1974). All images were placed in a digital folder and assigned randomly generated names. Three readers assigned sex based on each image and discussions for group consensus were conducted if assignment was not unanimous.

Northern Pike fin rays were set in two part ICE Resin and the proximal end was sectioned to a thickness of 0.8 mm using a Dremel 3000 with a diamond coated blade inset into a custom constructed wooden sled. Sections were then submerged in mineral oil within a watch glass lit from below. Images were captured of the sections using an AmScope MD200 ocular camera inserted into a Leica Wild MZ8. The same process used for sex determination was followed for aging (i.e., two images per fish, randomly named images, three readers, and group consensus).

Results

During 4.5 hours of electrofishing off-channel habitats for Northern Pike we captured 946 individuals of 42 species. Spotfin Shiner (*Cyprinella spiloptera*), Bluegill (*Lepomis macrochirus*), and Bluntnose Minnow (*Pimephales notatus*) were the most abundant species observed in surveys, accounting for 180, 168, and 157 individuals respectively. We captured two Illinois state threatened species (Ironcolor Shiner: *Notropis chalybaeus* and Starhead Topminnow: *Fundulus dispar*) and one state endangered species (Weed Shiner: *Notropis texanus*). Though *F. dispar* is known to occur in the area from IDNR basin surveys, this is the first time Kankakee specimens were documented through F-101-R. We also captured numerous individuals of species rarely encountered during main channel surveys, including 23 Central Mudminnow (*Umbra limi*) and 27 Pugnose Minnow (*Opsopoeodus emiliae*) that provided data needed to construct length-weight parameters for these species.

Thirteen species of submerged macrophytes were identified. The most common species were the native coontail (*Ceratophyllum demersum*), introduced curly-leaf pondweed (*Potamogeton crispus*), and introduced Eurasian watermilfoil (*Myriophyllum spicatum*) occurring in seven, five, and four of the twelve sites respectively. The ten remaining species were native to Illinois. Submerged macrophyte coverage at sites ranged from 0-90% with an average of 20% coverage. Water clarity tended to be high at off-channel sites. Secchi visibility averaged 90 cm and four sites exceeded 120 cm. The dominant substrate among sites was sand with areas of accumulated fines (i.e., silt and clay).

Ten Northern Pike were captured and tagged during 2017 (Table 4.2). They ranged in length from 256 mm to 787 mm and in weight from 90 g to 2891 g. Relative weights (W_r) were calculated following Willis (1989) and were consistent with data from previous years (Figure 4.6). The sexes of captured Northern Pike were equally split with five males and five females. Both sexes had an average age of three years and females tended to be larger than the males at a given age. Spearman correlation found a moderate and positive relationship between Northern Pike abundance and submerged macrophyte species diversity ($\rho = 0.63$, $p = 0.09$).

Table 4.2 Summary statistics for Northern Pike captured in Reach 6 of the Kankakee in 2017. Mean length in millimeters, weight in grams, age in years, and relative weight (W_r) are given with respective minimum and maximum values.

Sex	n	Age (min-max)	Length (min-max)	Weight (min-max)	W_r (min-max)
Female	5	3 (1-4)	550 (256-787)	1217 (97-2891)	0.88 (0.79-0.96)
Male	5	3.2 (1-5)	431 (260-512)	472 (90-755)	0.85 (0.78-0.91)

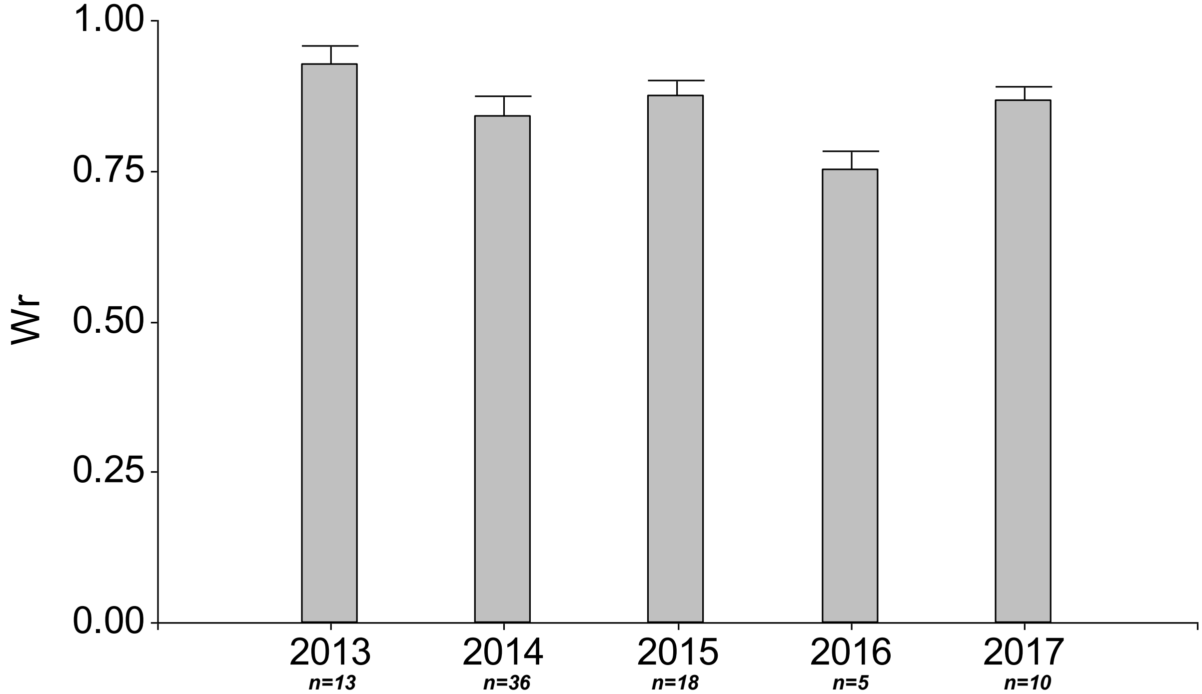

Figure 4.6 Bar chart with standard error bars depicting the relative weight of Kankakee River Northern Pike captured from 2013 to 2017 with the numbers of individuals captured displayed below each year.

Discussion

This preliminary study was successful in identifying several off-channel areas to conduct Northern Pike surveys. Access to these areas is largely governed by water levels and we believe high water levels during surveys were likely responsible for the lowered catch rate of Northern Pike, as increased water volume can reduce electrofishing efficiency (Lyon et al., 2014). However, our catch rate of 2.2 Pike/hour was still highest among river reaches sampled through F-101-R.

All metrics indicate that the Northern Pike population in Reach 6 of the Kankakee River is healthy. A study by Willis (1989) suggests that the W_r values we observed are indicative of a high density slow growing population. Therefore, though Northern Pike are an angler-targeted species in Reach 6 of the Kankakee, the current level of fishing pressure does not appear to have a negative impact on the population. The distribution of ages, equal sex ratios, and availability of spawning habitat illustrates that this population is a good candidate for continued research into the requirements for a healthy self-sustaining Northern Pike population in Illinois. Continued research will better assess habitat characteristics and attempt to clarify relationships between Northern Pike and submerged macrophyte density and diversity. This information could help inform restoration efforts in areas of Illinois where populations have declined or been extirpated.

*Kankakee River Northern Pike surveys were supported in part through an internship to Emily Hamant provided by the National Great Rivers Research & Education Center through grant #NGRREC-IP2017-17.

Section 4.5 Side-scan Sonar Mapping

Introduction

The presence, abundance, and growth of fishes are affected by their physical habitat (Gorman & Karr, 1978; Quist & Guy, 2001). Methods for estimating and classifying physical habitat parameters for aquatic organisms are hampered by their submerged nature. Snorkeling and scuba surveys provide a way for humans to visually observe and classify these habitats. However, swift flowing water and low-visibility reduce the viability of underwater visual observations in many lotic systems. Remote sensing through side-scan sonar has been used to identify and quantify physical river habitat (Kaeser & Litts, 2010; Kaeser, Litts, & Tracy, 2013).

Despite the importance of habitat in structuring fish assemblages and previous studies validating the use of side-scan sonar for classifying habitat, few studies have attempted to directly link side-scan sonar classified habitat with fish assemblage structure. Providing links among aspects of fish assemblages (e.g. abundance and condition of important sport fish species) would allow managers to make better informed decisions regarding habitat management for healthier sport fish populations. The purpose of this study was to classify underwater habitat in the Kankakee and Iroquois Rivers for the development of models to explain some of the variability observed in the fish assemblages.

Methods

Side-scan sonar surveys were conducted with a Humminbird 999ci during high-water events between May 7th and July 9th 2015 in the Kankakee River and between July 7th and 26th 2016 in the Iroquois River. We mounted the transducer to the end of a 2.5 m section of electrical metallic tubing that was then mounted to the safety rails on the bow of an electrofishing boat using conduit clamps secured with wing-nuts. The mounting allowed the depth of the transducer to be adjusted to keep it fully submerged approximately 0.3 m below the water's surface. Videos were recorded at a frequency of 455 kHz to maximize image resolution (Kaeser, Litts, & Tracy, 2013). To ensure image quality was maximized and recordings captured the habitat surveyed by main-channel border electrofishing, sonar transects were run ≤6 kph in a downstream direction 3-5 m from the shoreline.

Sonar videos were processed using SonarTRX software (Leraand Engineering Incorporated). We did not apply slant range correction, because we did not want to remove the potentially valuable information contained in the water column data (e.g., extensions of large woody debris) and it can create blurring (Klaucke, 2018). SonarTRX was used to generate projected mosaics formatted for both ArcGIS and Google Earth.

To allow classification of the imagery data, separate surveys were conducted in the Kankakee River during low water in August 2015. Distinct substrate types were identified based on preliminary sonar imagery. To ground truth the data, qualitative substrate classification of these distinct points were carried out using a combination of hand grabs and visual observation enabled by the shallow clear water of the Kankakee River. We recorded coordinates using a Garmin 76cx and followed qualitative habitat evaluation index substrate protocols (Wang, Lyons, & Kanehl, 1998) to estimate substrate composition proportions within each point. These data were collected at 84 points located throughout the Illinois portion of the Kankakee River and overlaid on sonar mosaics.

Following a review of the river mosaics and ground truth data, we determined that there were seven readily distinguishable substrate types (Table 4.3, Figure 4.7). We used the ground truth images to create an image training dataset of 20 images depicting the different dominant substrate types in varying proportions.

Table 4.3 Table describing the characteristics of the seven substrate classes used to characterize side-scan sonar data.

Substrate Class	Visual Mosaic Characteristics
Silt	Smooth surface occasionally broken by projections with areas of scour downstream of projections
Sand	Dune formations demarcated by lighter colored peaks and followed by darker shadow
Embedded Rock	Areas of smooth surface frequently broken by projections
Rock	Abundance of projections with little area of smooth surface
Bedrock	Flat planes with frequent fissures and darker areas of depression
Large Woody Debris	Linear generally branching structures that may be partially embedded in other substrates
Aquatic Vegetation	Irregularly shaped hazy area generally in patches sometimes accompanied by lines of dark shadow

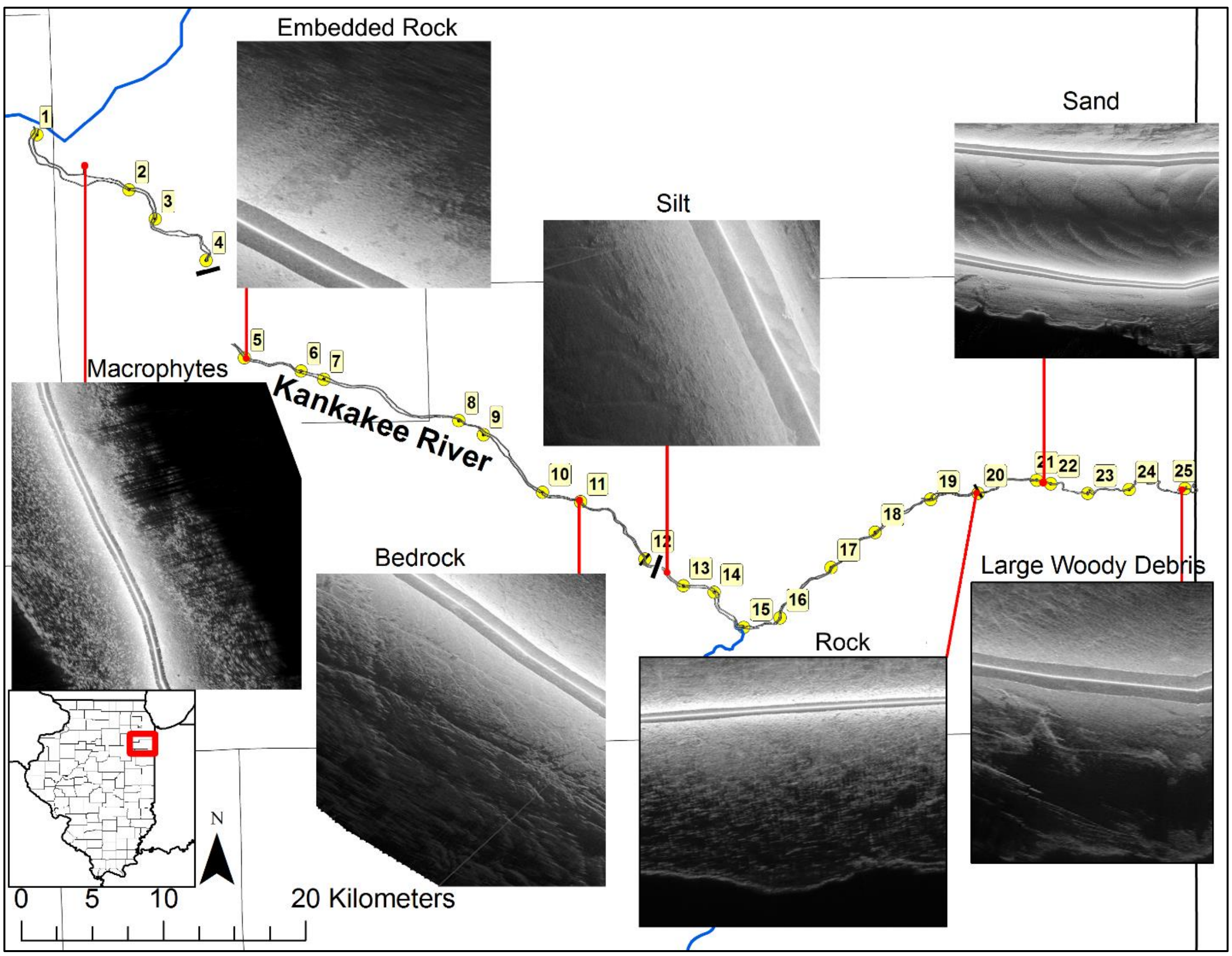

Figure 4.7 Side-scan sonar imagery examples of the seven substrate classes.

The imagery data was assembled in an ArcGIS 10.3 mosaic dataset and adjoining runs were manually clipped to remove image overlap. Single layers were separately constructed for each of the Kankakee's six and the Iroquois' four reaches to allow for better computer performance with the reduced file sizes. Polygons were then constructed in a single layer outlining the visually identifiable substrate classes. Fields specifying each polygon's river and reach identity were included in the classification layer.

Classification data was reviewed and verified by a secondary reader. The classification was determined to be accurate and no discussion for consensus was needed. Lastly, we projected the classified layer, calculated the area of each polygon, and added an area field to the attribute table. The final result was a slightly coarser classification than that used for fixed site classification (DeBoer et al., 2017) with a minimum polygon size of 6 m^2, max of 398,380 m^2 , and mean of 5,836 m^2.

To allow direct comparisons with the site-specific linear models constructed in 2017 (DeBoer et al., 2017), we followed the same methodology and constructed models to assess the ability of substrate composition to explain differences in fish assemblages at the reach level. We pooled fish data collected at fixed sites from 2013 through 2017 and calculated the CPUE of each species. The proportions of each substrate type were calculated for each reach and logit transformed for use as independent variables. Distance-based linear models constructed in Primer 6 & Permanova+ version 6.1.16 (PRIMER-E Ltd 2013) were used to test the ability of substrate differences to explain the Bray-Curtis fish assemblage similarity among reaches. Similarly, linear regression models constructed in R version 3.5.0 were used to test the ability of substrate differences to explain variability in select sportfish CPUE among reaches. All model combinations were evaluated using Akaike Information Criterion adjusted for small sample size (AICc) (Bedrick & Tsai, 1994). If multiple models competed with a Δ AICc of ≤ 2, or a Δ AICc between 2-3 with a higher k than the Δ AICc = 0 model, the model with the highest R^2 was selected as the best model.

Results

A total of 894 ha of imagery was classified with 243 ha in the Iroquois and 651 ha in the Kankakee River (Figure 4.8). The Iroquois River substrates were dominated by silt (60% of classified area) and embedded rock (23%). The remaining substrate classes each accounted for 3% to 6% of the remainder with the exception of submerged aquatic vegetation, which was not found on Iroquois River sonar imagery. Reach 2 of the Iroquois River, which extends from the Kankakee-Iroquois County line to 150 m upstream of the Gooseberry Island Preserve, was largely composed of coarse substrates and dissimilar from the other Iroquois Reaches.

Kankakee River substrates were much more evenly distributed than in the Iroquois. Silt, sand, rock, and embedded rock all accounted for between 20 to 23% of the total area classified. Exposed bedrock accounted for a further 12%, and large woody debris and submerged vegetation each accounted for 1%. Reaches 2 and 3 of the Kankakee were very similar in substrate composition and were originally considered for a combined single reach due to fish assemblage similarities, but were separated into two reaches due to the physical barrier of the Wilmington Dam.

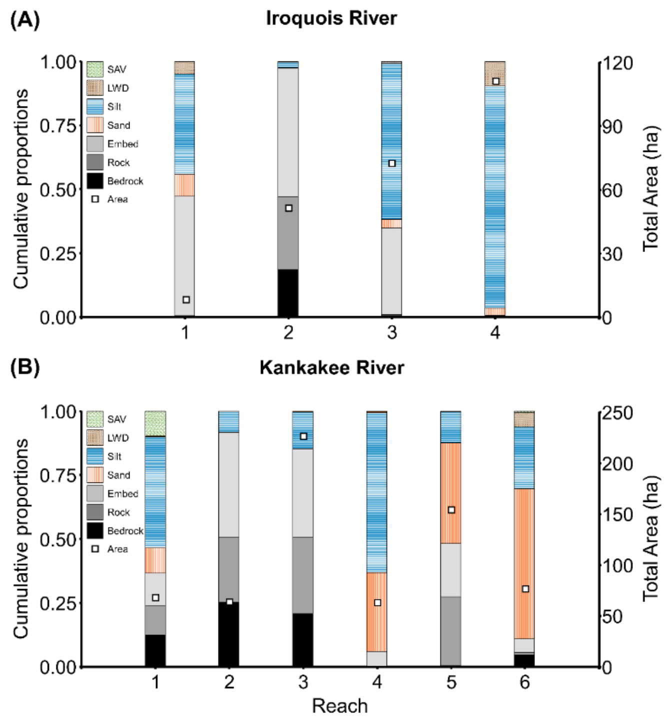

Figure 4.8 Proportional substrate composition of each Reach of the Iroquois (A) and Kankakee (B) Rivers with points indicating the total area classified for each in hectares. *Abbreviations used for some of the substrates: SAV is submerged aquatic vegetation, LWD is large woody debris, and Embed are rocks embedded in fines.

The distance-based linear model explained 50% of the variation in fish assemblage differences among reaches (Figure 4.9). Reach level substrates explained varying proportions differences in sportfish species CPUE (Table 4.4). The best performing model was for Largemouth Bass (79% of variation explained) and indicated that CPUE increases in reaches with greater amounts of sand and aquatic vegetation. Sand and aquatic vegetation were the most frequent substrates included in models with both occurring in four of the eight sportfish models.

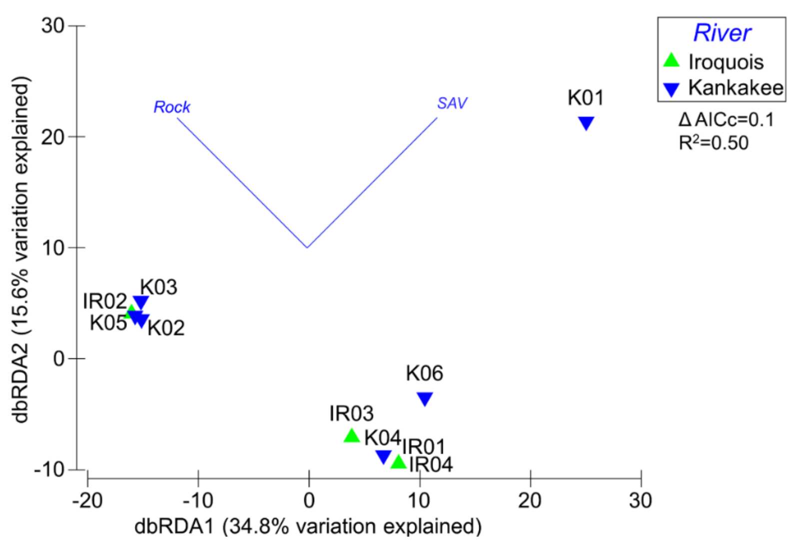

Figure 4.9 Graphic representation of the distance-based linear model selected to explain differences in fish assemblage structure among reaches using substrate proportions.

Table 4.4 Summary of the models selected to explain differences in sportfish catch rates among reaches using substrate proportions. The (+) or (-) next to each variable indicates the direction of the models implied relationship between the variable and the species catch rates.

Species	Best Model	$adjR^2$	Δ AICc
Rock Bass	Rock (+)	0.17	2.5
Bluegill	LWD (+) + SAV (+)	0.63	0.3
Largemouth Bass	Sand(+) + SAV(+)	0.79	0.0
Smallmouth Bass	Bedrock (+) + SAV (-)	0.76	0.0
Channel Catfish	Silt (-)	0.37	0.0
Flathead Catfish	Sand (-)	0.23	1.8
Northern Pike	Sand (+)	0.52	0.0
Walleye	Sand (-) + SAV (-)	0.55	0.0

Discussion

The completed substrate data create a reference to examine the impacts of future physical modifications (e.g. dam construction or removal, levee construction, channel engineering). A reference is particularly important for the Kankakee River where area residents are concerned over the influx of sand into the River. The relative lack of fines below the Kankakee Hydroelectric Dam in Reach 3 illustrate its sequestering effect. Reach 3 contains a renowned Smallmouth Bass fishery and any proposed alterations to the hydroelectric dam's operation should take into account this effect, as the release of fines downstream would have a negative impact on the popular fishery (Stanley & Doyle, 2003).

Our previous analyses found substrate explained some of the variability ($0.12 \leq adjR^2 \leq 0.54$) in sportfish catch rates among sites (DeBoer et al., 2017). Models constructed at the reach scale explained more of the variability in CPUE (mean $adjR^2 = 0.50$) than at the site scale (mean $adjR^2 = 0.29$) with the two exceptions of Rock Bass (site scale $adjR^2 = 0.32$) and Northern Pike models (site scale $adjR^2 = 0.54$). These new whole river data will allow analyses at broader scales to determine if larger areas better explain variability in sportfish catch rates and condition. Moreover, a series of analyses at different spatial scales would better inform the impact of habitat improvement projects directed at specific species and could be used to estimate the size of improvement required.

There are two primary deficiencies in our side-scan sonar data worthy of addressing. First, though depth data consisting of readings every 4-5 m has been extracted from the side-scan sonar surveys, we are unable to use the data at this time. The data contains some aberrant readings that may require field visits to verify and still requires standardization to gage levels during survey runs. Once completed, depth data will be used to construct linear bathymetry maps for the Kankakee and Iroquois Rivers, and will provide another important habitat characteristic for modeling fish assemblage variation. Second, the amount of aquatic vegetation was likely underestimated. Side-scan surveys are best conducted during high water to capture the greatest amount of underwater habitat and these high water conditions generally occur in the late spring through early summer before vegetation has fully developed.

In addition to the management benefits of the side-scan sonar survey, the substrate and depth data will be of direct value to the general public. Completed maps can be released to allow anglers to locate and target different habitats for desired species and our modeling efforts can aid anglers in determining which areas have the greatest potential to contain those species. Lastly, linear bathymetry data would be useful to recreational boaters, as it will allow them to better plan outings with knowledge of expected water depths that can be adjusted for contemporaneous publically accessible stage height.

Section 4.6 Mackinaw River Smallmouth Bass

Introduction

Smallmouth bass (*Micropterus dolomieu*) were one of the first fish species targeted for recreational fishing in North America, especially in the Upper Mississippi Basin (Carlander, 1954).Today they are still one of the most popular sportfish (Quinn & Paukert, 2009). In Illinois, the smallmouth bass fishery is particularly important, due, in part, to limited cold-water fisheries and lack of natural lakes. With a preference for clear cool water with coarse substrates, smallmouth bass are consistently outcompeted by bluegill, green sunfish, black bullheads, and largemouth bass in the warm-water silt-dominated impoundments that make up a large segment of angling opportunities in Illinois (Clodfelter, 1991). Given their recreational importance and habitat preferences, healthy populations of smallmouth bass in Illinois' streams are economically and culturally significant.

The Mackinaw River in Central Illinois (Figure 4.10) has been targeted by IDNR for the improvement of Smallmouth Bass stocks. Part of the improvement effort was an intensive Smallmouth Bass stocking program initiated in 2017 as an attempt to increase the population for anglers. Using the known healthy population of Smallmouth Bass in the Kankakee River for comparison, our ongoing study previously demonstrated that the wild population of Smallmouth Bass in the Mackinaw River were growing well and had good overall condition, but were of low abundance (DeBoer et al., 2017). Our goal with this ongoing study is to determine what ecological factors are limiting Smallmouth Bass abundance within the Mackinaw River.

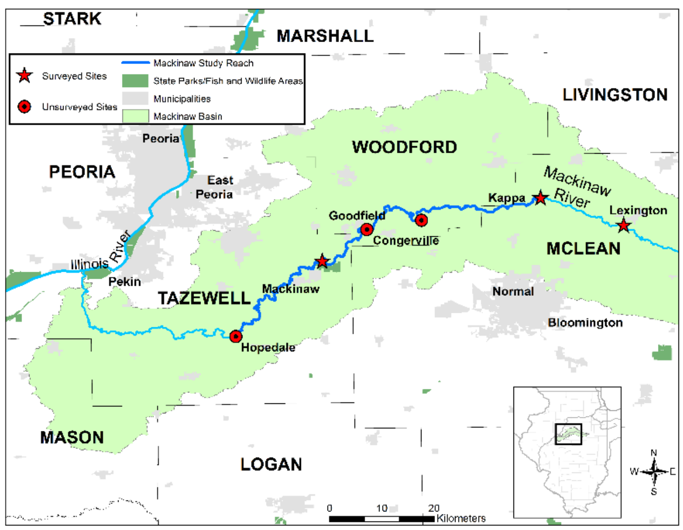

Figure 4.10 Map of the Mackinaw River with the locations of fish sampling sites and the focal reach.

Methods

Seven electrofishing surveys were conducted at three of the six most boat accessible sites between 7/14/2017 and 5/23/2018 (Figure 4.10). One survey was conducted using a three-anode DC tow-barge on 7/14/17 and the remaining six were conducted using a single-netter DC-boat. Three boat electrofishing surveys were conducted in fall 2017 (10/17-10/27) and were repeated in spring 2018 (4/12-5/23). Only Smallmouth Bass were captured during surveys. The time effort of surveys varied based on boat accessibility and ranged from 24 minutes to 142 minutes with a total of 6.9 hours of effort. Captured fish were measured to the nearest millimeter and weighed in grams or centigrams if $\geq$ 200 mm in length. We calculated relative weight of Smallmouth Bass $\geq$ 150 mm to estimate condition (Kolander et al., 1993).

Smallmouth Bass captured in the field were implanted with intramuscular Biomark 8.4 mm passive integrated transponder (PIT) tags in the expaxial muscle on their left side below the inter-dorsal notch. A subset of fish were also tagged with FLOY Tag FF-94 anchor tags printed with a contact phone number on their left side on the anterior portion of the spinous dorsal fin as redundancy to assess tag loss and to allow anglers to report the size and location of captured fish. We also implanted a further 156 Smallmouth Bass with FLOY tags and 98 with PIT and FLOY tags on 10/25/2017 and 194 with PIT tags on 5/24/2018 at Jake Wolf Memorial Fish Hatchery prior to their release in the Mackinaw River.

To further investigate the potential of flashiness to be a cause of the low abundance of Smallmouth Bass, we compiled USGS discharge data from five river stations including the Iroquois at Chebanse, Kankakee at Momence, Kaskaskia at Vandalia, Mackinaw at Congerville, and the Vermillion at Pontiac from the 1945 through 2016 water years. We then calculated the Richards-Baker Flashiness Index (R-B index:) for each water year (Baker, Richards, Loftus, & Kramer, 2004). The R-B index is the sum of the absolute values of daily changes in mean daily flow divided by the summed discharge throughout the time period ($R - B\ Index = \frac{\sum_{i=1}^{n}|q_i - q_{i-1}|}{\sum_{i=1}^{n} q_i}$), so more extreme changes in daily flows increase the R-B index value. Since the R-B index tends to decrease with increases in watershed area, we also calculated a corrected R-B index using the basin size upstream of the gage location: $Corrected\ R - B\ Index = R - B(Basin\ Size\ km^2/1000)$. ANOVA's were used to test for significant differences among the rivers flashiness using the uncorrected and basin size corrected R-B indices. We used Tukey tests for pairwise comparisons to determine if mean flashiness differed significantly among river pairs.

We then extracted all electrofishing (AC and DC) surveys conducted by IDNR in the Iroquois, Kankakee, Kaskaskia, Mackinaw, and Vermillion River mainstems. Catches were combined by water year for each river and the CPUE of Smallmouth Bass was calculated based on the total electrofishing effort for a given water year. A linear regression was used to test the relationship between Smallmouth Bass CPUE and flashiness using the uncorrected and basin size corrected R-B indices. We also used linear regression using water year as the independent variable to determine if there was a significant temporal trend in CPUE or flashiness of the Mackinaw River.

Results

Surveys conducted in fall 2017 captured 241 Smallmouth Bass and CPUE ranged from 0.8 to 129.2 Smallmouth Bass/hour. Of the 241 Smallmouth Bass captured, 112 (46%) had fin clips identifying them as hatchery stocked. Spring 2018 surveys captured 2 Smallmouth Bass at the same sites. CPUE effort ranged from 0 to 1.2 Smallmouth Bass/hour and one of the two captures (50%) had a fin clip identifying it as hatchery stocked. The relative weight of Smallmouth Bass was greatest in hatchery fish prerelease and lower in fish captured through field surveys (Table 4.5). Two FLOY tagged fish were captured downstream of Goodfield and reported by an angler. Both fish had received FLOY tags at Jake Wolf Hatchery on 10/25/17, were caught on 4/22/18 and had grown approximately 2" in length since release.

Table 4.5 Summary of relative weight calculated for Smallmouth Bass ≥150mm.

	n	Mean W_r
Jake Wolf Hatchery	448	103.1
Fall 2017	241	91.9
Spring 2018	2	87.6

Uncorrected R-B index values varied significantly among rivers (p<0.001) with Tukey tests indicating the Kankakee (mean R-B=0.06) had the lowest flashiness and the Mackinaw (mean R-B=0.30) and Vermillion Rivers (mean R-B=0.31) did not differ significantly from one another and had the highest flashiness (Figure 4.11). Basin size corrected R-B values were significantly different among rivers (p<0.001). Tukey tests indicated that all rivers were significantly different from one another with the Kankakee having the lowest flashiness (mean R-B=0.33) and the Kaskaskia having the highest flashiness (mean R-B=1.07).

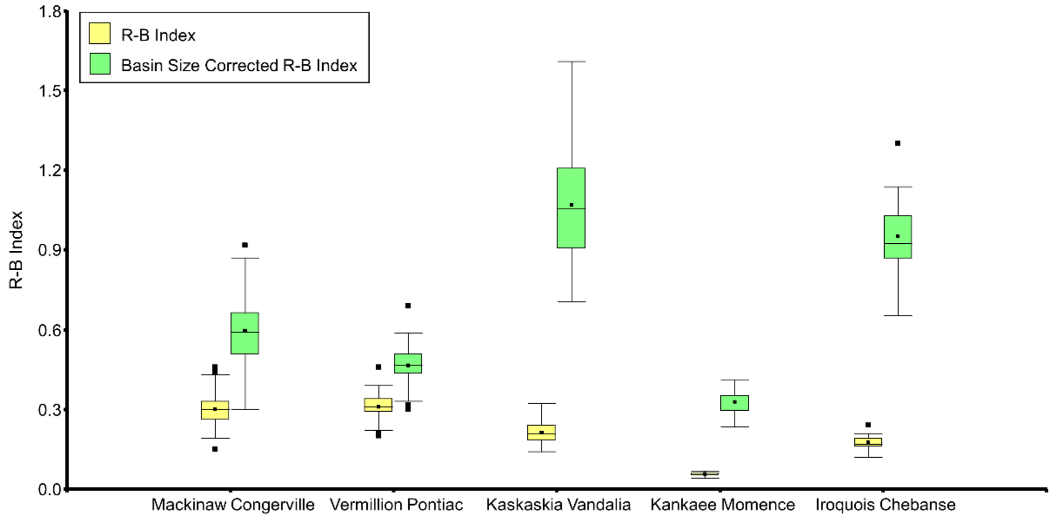

Figure 4.11 Box-plots showing flashiness values for five Illinois Rivers (1945-2016).

The linear relationships between Smallmouth Bass CPUE and flashiness was significant for both the R-B index (p=0.003) and the basin size corrected R-B index (p<0.0001). However, the basin size corrected index explained much more of the CPUE variability (r^2=0.21) than the uncorrected form (r^2=0.09; Figure 4.12). The linear relationships between water year and Smallmouth Bass CPUE, R-B, and corrected R-B were not significant indicating that Smallmouth Bass CPUE and flashiness did not show a significant linear temporal trend in the time period from water year 1985 through 2014.

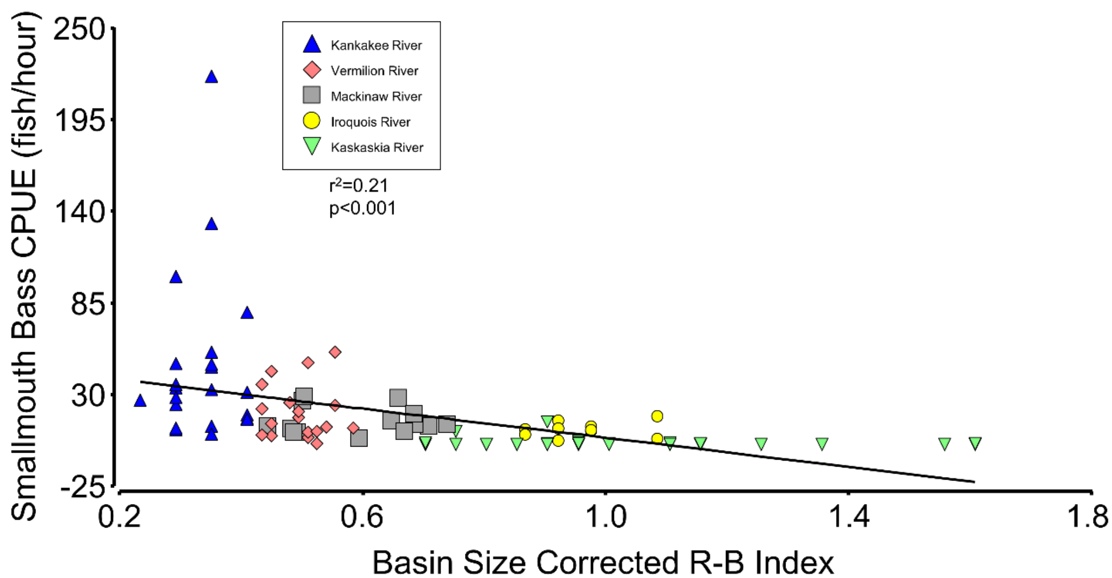

Figure 4.12 Linear regression expressing the relationship between flashiness (R-B index) and smallmouth bass electrofishing catch rates.

Discussion

Approximately 50% of Smallmouth Bass captured during field surveys had received fin clips that allowed us to identify them as hatchery raised and stocked. However, the percentage of stocked fish captured is likely underestimated as 41,695 1-1.5” fish were stocked in June 2017 that did not receive fin clips. The condition of fish indicated by relative weight did decline in fish following release. However, the fish captured during field surveys did maintain a good condition of approximately 90 indicating surviving fish that remained in the Mackinaw mainstem were finding adequate forage.

Our analyses suggest that flashiness plays a role in Smallmouth Bass abundance, with greater flashiness resulting in reduced numbers of Smallmouth Bass in Illinois’ Rivers. We hypothesize that the lack of flashiness in the Kankakee River at Momence, even after accounting for basin size, is attributable to the large area of intact floodplain present upstream of Momence. The floodplain is able to absorb large amounts of water and forests create physical obstructions capable of reducing flow velocity. The variation in Smallmouth Bass abundance not explained by flashiness could be attributable to several factors including structural habitat and temperature which will be investigated in successive surveys and analyses.

The reduction in Smallmouth Bass CPUE between fall 2017 and spring 2018 in the Mackinaw River combined with the relationship between flashiness and CPUE leads us to the hypothesis that lack of suitable overwintering habitat may be a factor contributing to the low abundance of Smallmouth Bass in the Mackinaw River. Previous studies indicated that during winter months, lotic Smallmouth Bass seek shelter from current within their home river (Todd & Rabeni, 1989), or migrate downstream to larger rivers (Langhurst & Schoenike, 1990). Tagged or fin clipped Smallmouth Bass migrating to the Illinois River may be detected by colleagues conducting electrofishing surveys in the La Grange and Peoria Reaches of the Illinois River. In subsequent years we plan to use side-scan sonar to map the Mackinaw River and identify potential overwintering habitats (e.g., deep pools, sheltered areas) for Smallmouth in the Mackinaw. Depth and structure data from side-scan surveys will allow us to identify potential overwintering sites and conduct winter surveys at those locations to confirm the presence of Smallmouth Bass. Habitat improvement projects in the Mackinaw River may be able to reduce local flashiness and create overwintering sites through construction of off-channel habitat and reconnecting floodplain.

CHAPTER 5
CONCLUSIONS

Fish monitoring conducted on the Illinois and Mississippi Rivers during 2017 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 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). 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 2017. 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 2017. Our observations of the 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 program's sampling strategies may also be useful for documenting trends in the relative abundance of invasive 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. Grass Carp in the Lower Mississippi River Sampling Area increased from 4.6% of total catch by biomass during 2016 to 7.8% during 2017. This trend will be monitored in coming years.

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Appendix I. Reaches and pools sampled by LTEF pulsed-DC electrofishing surveys (and our partners) during 2017 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 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. Publications, reports, and presentations that resulted from research conducted during segments 6-29 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 29 are printed in bold.

DeBoer, J. A., A. M. Anderson, and A. F. Casper. 2018. Multi-trophic response to invasive silver carp (*Hypophthalmichthys molitrix*) in a large floodplain river. Freshwater Biology. DOI: 10.1111/fwb.13097

Gibson-Reinemer, D. K., R. A. Sparks, J. L. Parker, J. A. DeBoer, M. W. Fritts, M. A. McClelland, J. H. Chick, and A. F. Casper. 2017. Ecological recovery of a river fish assemblage following the implementation of the Clean Water Act. BioScience 67:957–970.
Selected as Editor's Choice

Love, S. A., N. J. Lederman, R. L. Haun, J. A. DeBoer, and A. F. Casper. 2018. Does aquatic invasive species removal benefit native fish? The response of gizzard shad (*Dorosoma cepedianum*) to commercial harvest of bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*). Hydrobiologia. DOI: https://doi.org/10.1007/s10750-017-3439-1

Parker, J., Cao, Y., Sass, G. G., & Epifanio, J. 2018. Large river fish functional diversity responses to improved water quality over a 28 year period. Ecological Indicators, 88, 322-331. doi: 10.1016/j.ecolind.2018.01.035

Parker, J. L., M. W. Fritts, and J. A. DeBoer. *In press*. Length-weight relationships for small Midwestern US fishes. Journal of Applied Ichthyology. doi: 10.1111/jai.13721

Whitten, A. L. and D. K. Gibson-Reinemer. *In press*. Tracking the trajectory of change in large river fish communities over 50 years. American Midland Naturalist.

Gibson-Reinemer, D. K., Chick, J. H., VanMiddlesworth, T. D., VanMiddlesworth, M. M. and Casper, A. F., 2017. Widespread and enduring demographic collapse of invasive common carp (Cyprinus carpio) in the Upper Mississippi River System. Biological Invasions 19:1905-1916.

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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)

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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.

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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.

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<u>III. Essays</u>

DeBoer, J. A., and L. E. Solomon. 2017. Environmental factors affecting growth rates of popular sportfish in the Illinois River. Illinois Natural History Survey Report 415(3).

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

<u>IV. Popular Articles</u>

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

<u>V. Technical Papers presented during F-101-R Segment 28 (presenters in **bold**, '*' denotes student presenter, '+' denotes invited presentation)</u>

***Berry, S. L.**, J. T. Lamer, J. A. DeBoer, A. L. Whitten, N. P. Rude, G. W. Whitledge, C. J. Carpenter, R. E. Colombo, B. J. Lubinski, and J. L. Parker. 2018. Population Dynamics of Channel Catfish (*Ictalurus punctatus*) and Freshwater Drum (*Aplodinotus grunniens*) in Four Rivers of Illinois. Poster. Midwest Fish and Wildlife Conference. Milwaukee, WI.

***Berry, S. L.**, J. T. Lamer, J. A. DeBoer, A. L. Whitten, N. P. Rude, G. W. Whitledge, C. J. Carpenter, R. E. Colombo, B. J. Lubinski, and J. L. Parker. 2018. Population Dynamics of Channel Catfish (*Ictalurus punctatus*) and Freshwater Drum (*Aplodinotus grunniens*) in Four Rivers of Illinois. Poster. Illinois Chapter of the American Fisheries Society. Grafton, IL.

***Breed, J.M., R.C. Rice,** C.E. Colaninno, J.H. Chick. 2018. Aquatic vegetation and the relative abundance of fish species in the Mississippi and Illinois rivers. Annual Meeting of the Mississippi River Research Consortium, La Crosse, WI.

+Casper, A. F., et al. 2017. Use of long-term data in river science: recent successes and future challenges and opportunities. Platform. 5th Biennial Symposium of the International Society for River Science. Hamilton, NZ.

+Casper, A. F. 2018. Contrasting influence of pollution, policy, and invasive species: Long-term data reveals complex trends in the ecology of the Illinois River. Invited Seminar, Dept. of Environmental Sciences, U. of Toledo.

Chick, J.H., C.E. Colaninno , J.M. Breed, T.C.A. Erickson, T.E. Jung, A. Kumar, L. Martinez, D. Morales, T.Q.H. Nguyen, R.C. Rice, E.S. Troyer, C.J. Williams, M.C. Draghetti, and Q.D. Voss. 2018. Using data from modern fish sampling and deep-time archaeological collections to explore evidence of the anthropocene: the challenge of making apples look like oranges. Annual Meeting of the Mississippi River Research Consortium, La Crosse, WI.

+DeBoer, J. A., M. C. Thoms, M. D. Delong, and A. F. Casper. 2018. Long-term monitoring shows how

highly modified rivers respond to additional drivers of change. Platform. Midwest Fish and Wildlife Conference. Milwaukee, WI.

+**DeBoer, J. A.**, M. C. Thoms, M. D. Delong, and A. F. Casper. 2017. Naughty rivers: conforming or deviating ecosystem responses to anthropogenic drivers. Platform. 5th Biennial Symposium of the International Society for River Science. Hamilton, NZ.

DeBoer, J. A., M. C. Thoms, M. D. Delong, and A. F. Casper. 2018. Long-term monitoring shows how highly modified rivers respond to additional drivers of change. Platform. Illinois Chapter of the American Fisheries Society. Grafton, IL.
†Winner of Best Professional Presentation

DeBoer, J. A., M. C. Thoms, M. D. Delong, and A. F. Casper. 2018. Naughty rivers: conforming or deviating ecosystem responses to anthropogenic drivers. Platform. University of New England Post-Graduate Research Conference. Armidale, NSW, AU.

DeBoer, J. A., M. C. Thoms, M. D. Delong, and A. F. Casper. 2018. The complex response of large river ecosystems to multiple stressors. Platform. Society for Freshwater Science. Detroit, MI.

DeBoer, J. A., A. K. Fritts, M. W. Fritts, R. M. Pendleton, L. E. Solomon, T. D. VanMiddlesworth, and A. F. Casper. 2017. Differences in and factors affecting growth of centrarchid sportfish in the Illinois River. Platform. Joint Summer Meeting of the Centrarchid, Esocid, and Walleye Technical Committees – North Central Division of the American Fisheries Society. Isle, MN.

***Erickson, T.C.A., T.Q.H. Nguyen**, C.E. Colaninno, J.H. Chick. 2018. Exploring the anthropocene through multivariate analysis of diversity metrics in the upper Mississippi River system fish communities. Annual Meeting of the Mississippi River Research Consortium, La Crosse, WI.

+Gibson-Reinemer, D.K., R.E. Sparks, J.J. Parker, A.F. Casper, J.A. DeBoer, M.W. Fritts, M.A. McClelland, and **J.H. Chick**. 2017. Ecological recovery of a large river following the Clean Water Act. Joint Meeting of the Illinois River Coordinating Council, Mississippi River Coordinating Council, Wabash and Ohio Rivers Coordinating Council. Chicago, IL.

*__Hamant E.__, D. Costenbader, J. Epifanio, J. Parker. 2017. Northern Pike Population Demographics and Preferred Habitat in Floodplain Lakes and Backwaters of the Kankakee River. Platform and poster National Great Rivers Research and Education Center Intern Symposium, Godfrey, IL.

*__Jung, T.E., D. Morales__, C.E. Colaninno, J.H. Chick. 2018. Effects of levees and hydrologic alterations to fish communities in the Mississippi River. Annual Meeting of the Mississippi River Research Consortium, La Crosse, WI.

*__Kumar, A., C.J. Williams__, C.E. Colaninno, J.H. Chick. 2018. Effects of the clean water act and water quality on the fish community structure in the Illinois River. Annual Meeting of the Mississippi River Research Consortium, La Crosse, WI.

***Martinez, L., E.S. Troyer,** C.E. Colaninno, J.H. Chick. 2018. Influence of Asian carp on archaeological and modern fish communities of the upper Mississippi River system. Annual Meeting of the Mississippi River Research Consortium, La Crosse, WI.

+**Parker, J. L.,** J. Epifanio, A. Casper, J. Chick, Y. Cao. 2017. Taxonomic and Functional Diversity in Four Large and Intensively-Monitored Midwestern United States Rivers. Platform. 5th Biennial Symposium of the International Society for River Science, Hamilton, New Zealand.

VI. Data Requests received during F-101-R Segment 29

1. Jim Lamer, Western Illinois University
2. Mike McClelland, Illinois DNR
3. Annick Drouin, Quebec Ministère des Forêts, de la Faune et des Parcs
4. David Coulter, Southern Illinois University
5. Kyle Winders, Missouri Department of Conservation
6. Robert Hirschfeld, Prairie Rivers Network
7. John Bruner, University of Alberta

8. Jenna Merry, U. S. Fish and Wildlife Service
9. Nathan Lederman, Illinois DNR
10. Kim Knowles, Prairie Rivers Network
11. Sara Ashcraft, INHS