ILLINOIS

Illinois Natural History Survey

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Long-term Survey and Assessment of Large-River Fishes in Illinois, 2018

Jason A. DeBoer, Andrya L. Whitten, Benjamin J. Lubinski, and John H. Chick

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

F-101-R-30

Annual Report to the Illinois Department of Natural Resources

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DISCLAIMER

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

ACKNOWLEDGMENT OF SUPPORT

Long-term Survey and Assessment of Large-River Fishes in Illinois (F-101-R) is supported by the Federal Aid in Sport Fish Restoration Act (P.L. 81-6814, Dingell-Johnson/Wallop-Breaux), with funds administered by the U.S. Fish and Wildlife Service and the Illinois Department of Natural Resources (IDNR). The Illinois Department of Natural Resources and Dr. 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 30 (2018-2019) 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 and four segments or pools of the Mississippi River. 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 2018. Bluegill was the most-abundantly collected sportfish species in nearly all areas on the IL River, whereas the catfishes were the most-abundantly collected sportfish species on the MS River. Collections of black basses were greatest in the Upper Illinois Waterway. Similar to 2016 and 2017, 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. Our long-term datasets allow us to observe substantial 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, but decreased to 4.9% during 2018. We will continue to monitor this trend in coming years.

JOB ACCOMPLISHMENTS DEFINED BY F-101-R-30 WORK PLAN

Job 1: *Prepare electrofishing equipment and train staff*

Project workers maintained and repaired electrofishing and netting equipment as need throughout Project Segment 30. 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 and Mississippi Rivers during Project Segment 30.

Job 3: *Update computer database*

All F-101-R Segment 30 (2018) 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 30 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, two peered-reviewed manuscripts produced using LTEF data were published during Project Segment 30:

Altenritter, M.E., S. Pescitelli, A.L. Whitten, A.F. Casper. *In Press*. Implications of an invasive fish barrier for the long-term recovery of native fish assemblages in a previously degraded northeastern Illinois river system. River Research and Applications. https://doi.org/10.1002/rra.3457

DeBoer, J. A., M. C. Thoms, A. F. Casper, and M. D. Delong. 2019. The response of fish diversity in a highly modified large river system to multiple anthropogenic stressors. Biogeosciences 124:384-404.

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PREFACE

This report presents a summary of data collected during 2018 during segment 30 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 broad-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, 2018). 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 INHS project staff (Telephone 309-543-6000; email jadeboer@illinois.edu [Havana, IL], or jlparke2@illinois.edu [Champaign, IL]).

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 1999). 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. 2012). 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.

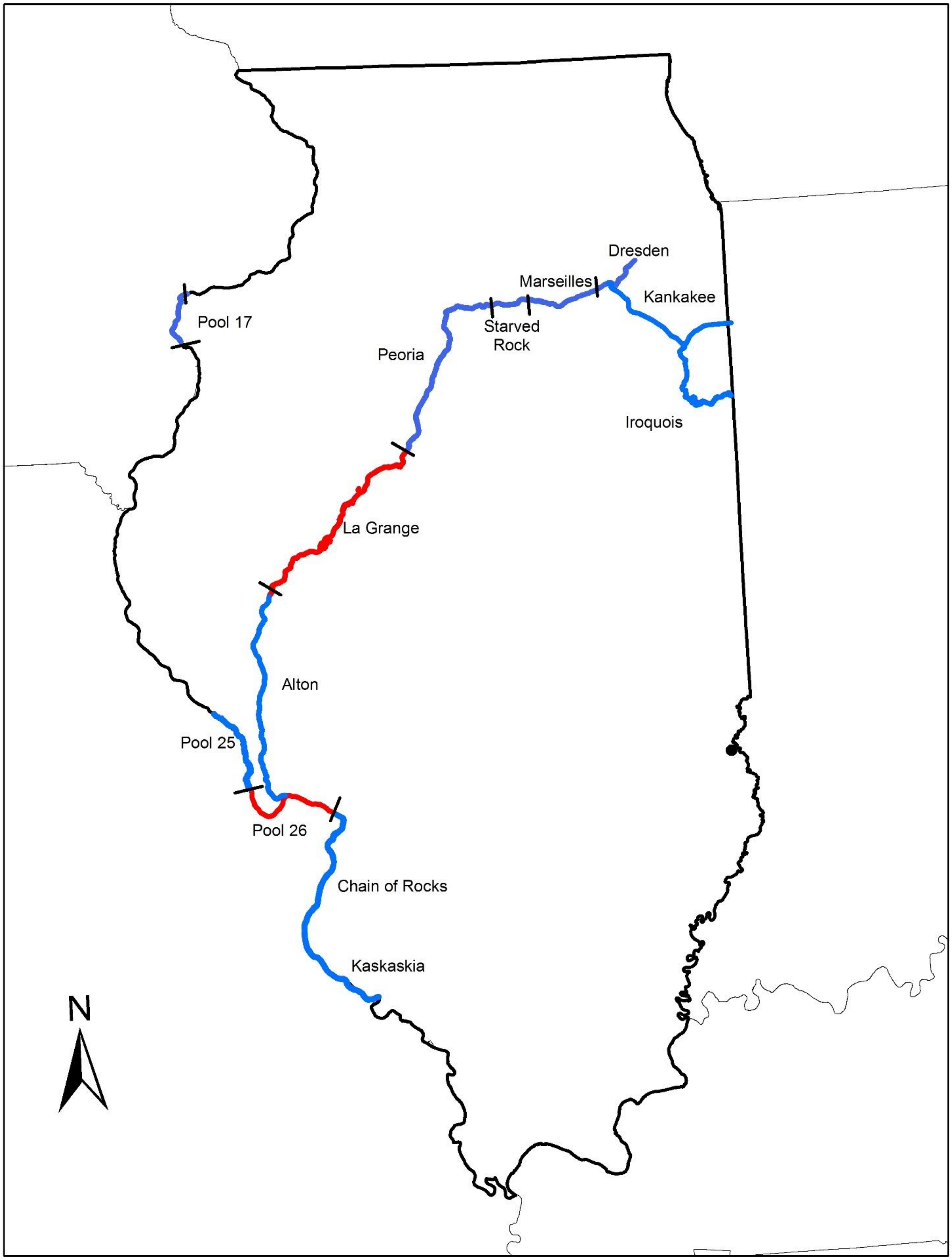

Figure 1.1. Map of the Illinois Waterway, and the Illinois portions of the Mississippi River illustrating areas sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (colored in blue) during 2018. Areas currently sampled by the U.S. Army Corps of Engineers Upper Mississippi 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 (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 3 fixed sites in La Grange Reach (see Figure 2.1). The historical Pekin site on the La Grange Reach (RM 155.1) was added back in for 2018 and future sampling at IDNR request.

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 (total length 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 affect 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 La Grange 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 2018.

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 - 2018 Illinois River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted between 7:55 AM and 5:15 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, and 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 2016 and previous years' reports, species-specific CPUE plots showed AC and pulsed-DC survey results. 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 2018. 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**	**5398.3 ± 109.0**	**4.7 ± 1.0**	**25.8 ± 2.8**	**68.8 ± 2.9**	**7.5 ± 0.2**	**838.8 ± 26.0**	**485.8 ± 0.7**
Period 1	1.05	5412.5 ± 270.7	6.2 ± 2.1	18.7 ± 1.8	74.7 ± 1.1	7.7 ± 0.3	788.3 ± 64.6	489.0 ± 0.0
Period 2	1.07	5612.5 ± 109.8	5.1 ± 1.2	23.2 ± 3.8	76.5 ± 0.2	6.8 ± 0.2	816.0 ± 18.0	485.0 ± 0.0
Period 3	1.13	5170.0 ± 112.7	2.2 ± 0.9	35.5 ± 4.6	55.3 ± 0.2	8.0 ± 0.1	912.3 ± 12.1	483.5 ± 0.0
Marseilles (RM 247-271.5)	**5.25**	**5195.2 ± 127.3**	**5.8 ± 0.5**	**27.8 ± 1.9**	**70.0 ± 3.2**	**7.5 ± 0.4**	**785.0 ± 5.2**	**5.3 ± 0.1**
Period 1	1.75	5445.7 ± 133.6	6.0 ± 1.0	20.4 ± 1.3	77.3 ± 5.2	7.4 ± 0.1	759.6 ± 2.2	5.7 ± 0.0
Period 2	1.75	5682.9 ± 53.5	5.5 ± 0.5	24.4 ± 1.1	80.0 ± 0.3	5.6 ± 0.1	806.3 ± 8.6	5.4 ± 0.0
Period 3	1.75	4457.1 ± 20.2	6.0 ± 0.8	38.7 ± 1.1	52.7 ± 0.2	9.5 ± 0.2	789.3 ± 2.5	4.9 ± 0.0
Starved Rock (RM 231-247)	**3**	**5188.3 ± 114.2**	**5.8 ± 0.7**	**22.0 ± 0.9**	**76.4 ± 1.6**	**8.3 ± 0.2**	**741.3 ± 16.6**	**425.6 ± 33.9**
Period 1	1	5282.0 ± 219.9	4.8 ± 0.5	20.9 ± 1.5	83.3 ± 0.1	8.7 ± 0.5	711.0 ± 2.8	371.9 ± 88.4
Period 2	1	4802.0 ± 14.0	7.4 ± 1.5	22.0 ± 2.0	71.9 ± 0.7	8.2 ± 0.1	694.0 ± 3.6	459.4 ± 0.0
Period 3	1	5457.5 ± 105.4	5.3 ± 1.4	23.5 ± 1.0	72.3 ± 0.6	7.9 ± 0.1	826.5 ± 2.7	458.8 ± 0.0
Peoria (RM 158-231)	**15.50**	**5317.4 ± 66.2**	**4.7 ± 0.3**	**12.2 ± 0.5**	**76.5 ± 0.8**	**7.0 ± 0.2**	**753.7 ± 10.6**	**15.5 ± 0.4**
Period 1	5	4989.7 ± 138.0	4.8 ± 0.4	12.3 ± 0.6	79.7 ± 1.1	7.5 ± 0.5	664.3 ± 16.5	19.0 ± 0.6
Period 2	5.25	5568.4 ± 111.5	4.9 ± 0.7	11.7 ± 1.0	79.2 ± 1.0	6.1 ± 0.4	785.4 ± 11.9	13.8 ± 0.3
Period 3	5.25	5378.6 ± 36.8	4.3 ± 0.5	12.7 ± 0.8	70.9 ± 0.9	7.5 ± 0.2	807.1 ± 7.8	13.7 ± 0.3
La Grange (RM 80-158)	**2.25**	**4976.7 ± 214.5**	**7.4 ± 0.8**	**9.6 ± 0.8**	**76.0 ± 2.2**	**5.7 ± 0.6**	**734.7 ± 28.2**	**9.9 ± 1.8**
Period 1	0.75	4710.0 ± 129.3	8.4 ± 1.0	9.4 ± 1.3	78.3 ± 2.0	5.4 ± 0.1	626.7 ± 8.3	14.6 ± 1.3
Period 2	0.75	5600.0 ± 200.0	6.7 ± 1.8	9.3 ± 1.5	82.0 ± 0.8	4.3 ± 1.1	778.3 ± 24.6	5.3 ± 0.0
Period 3	0.75	4620.0 ± 449.3	7.1 ± 1.0	10.0 ± 2.1	67.8 ± 0.9	7.6 ± 0.4	799.0 ± 1.5	7.3 ± 0.0
Alton (RM 0-80)	**14.25**	**4958.5 ± 46.0**	**6.6 ± 0.6**	**9.2 ± 0.2**	**78.3 ± 0.8**	**6.1 ± 0.1**	**653.6 ± 7.2**	**23.6 ± 0.7**
Period 1	4.75	4857.3 ± 56.9	5.5 ± 0.8	9.9 ± 0.5	80.6 ± 0.8	5.8 ± 0.1	615.0 ± 10.3	26.5 ± 1.1
Period 2	4.75	5102.0 ± 107.0	6.0 ± 1.2	8.1 ± 0.3	79.1 ± 0.9	5.7 ± 0.2	670.4 ± 14.4	21.3 ± 1.2
Period 3	4.75	4916.3 ± 56.7	8.3 ± 1.2	9.7 ± 0.2	75.4 ± 1.8	6.8 ± 0.3	675.4 ± 7.0	23.3 ± 1.1

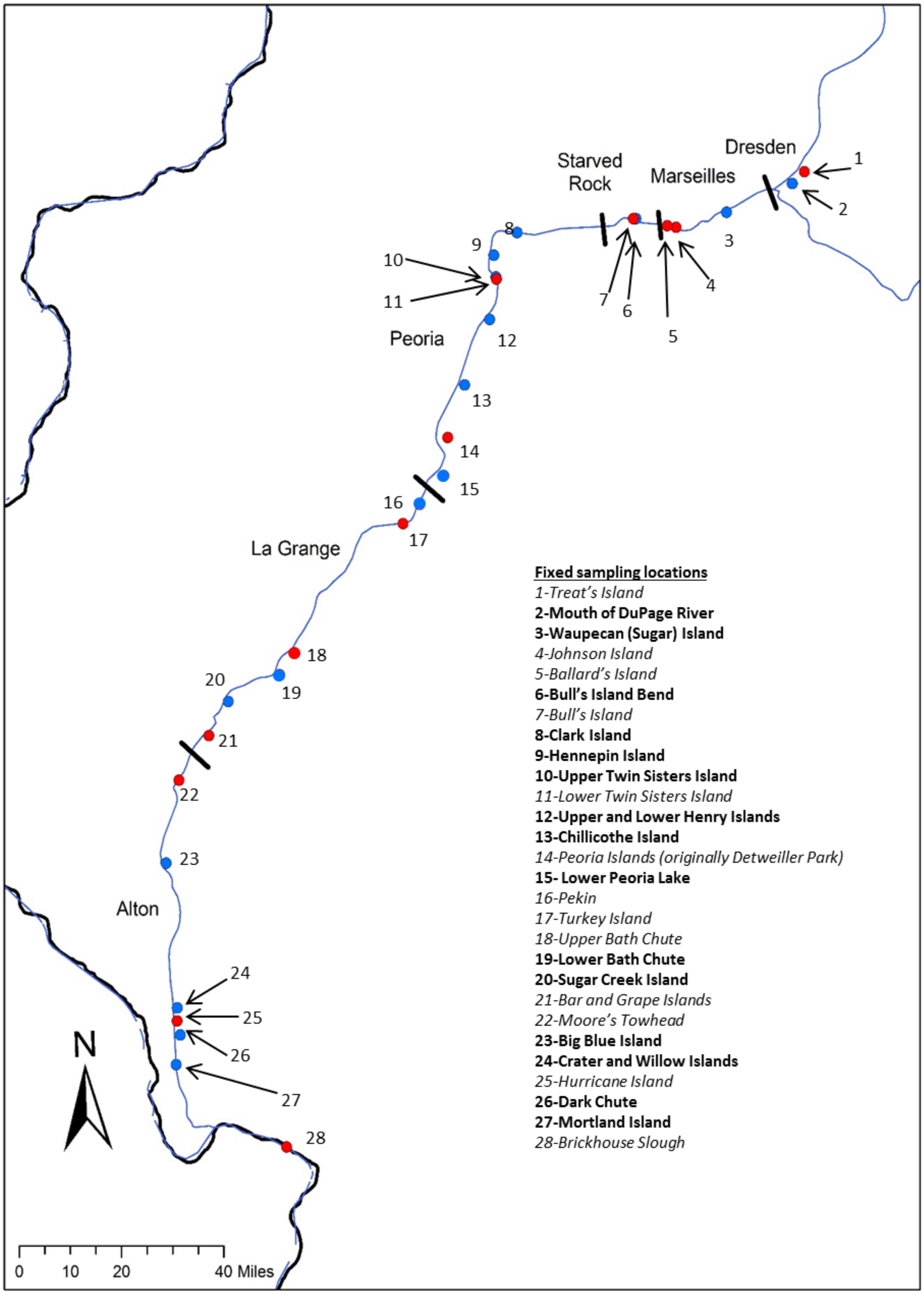

Figure 2.1. Map of the Illinois Waterway, and the fixed locations sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (F-101-R) using AC electrofishing gear 1959-2015. Sites that were abandoned for 2016 and future sampling are listed in italics (red dots); sites that have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

Section 2.5 - 2018 Upper Illinois River Electrofishing Catch Statistics

We collected 2,325 fish representing 49 species and 4 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. Emerald Shiner was the most abundant species in our survey of this region (573 fish; 24.6% of total catch) followed by Bluegill (533; 22.9%), and Pumpkinseed (236; 10.2%). Common Carp contributed the greatest biomass of fishes collected in the survey of this region (244.0 lb; 33.6% total collected biomass), followed by Largemouth Bass (111.6 lb; 15.4%), and Smallmouth Buffalo (60.7 lb; 8.4%).

We collected 7,575 fish representing 61 species and 4 hybrids during 9.0 hours of pulsed-DC electrofishing at 36 sites in main-channel border habitat in this region. Emerald Shiner was the most abundant species in our survey of this region (2,739 fish; 36.2% of total catch) followed by Gizzard Shad (2,113; 27.9%), and Bullhead Minnow (452; 6.0%). Silver Carp contributed the greatest biomass of fishes collected in the survey of this region (306.6 lb; 35.5% total collected biomass), followed by Smallmouth Buffalo (189.8 lb; 22.0%), and Common Carp (131.2 lb; 15.2%).

Threatened and Endangered Species

Seventy-six 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 2018 were the highest on record, 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 the last 5 years.

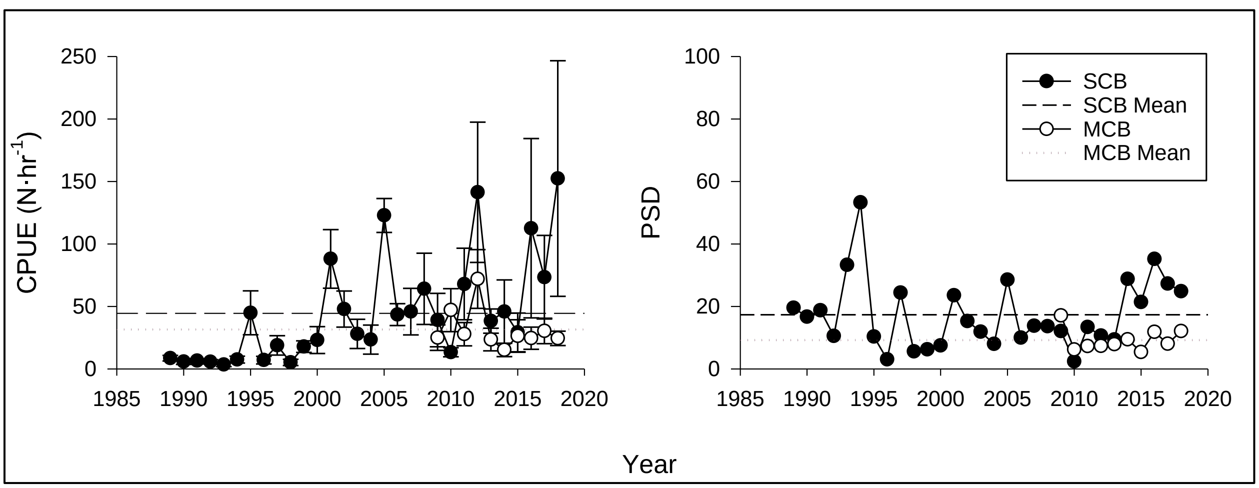

Figure 2.2. Catch per unit effort (mean ± SE; SE is calculated across sites and periods for side-channel border sampling, and across sites and periods for main-channel border sampling) and proportional size distribution of Bluegill collected in side-channel border (SCB) and main-channel border (MCB) 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 2018 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.

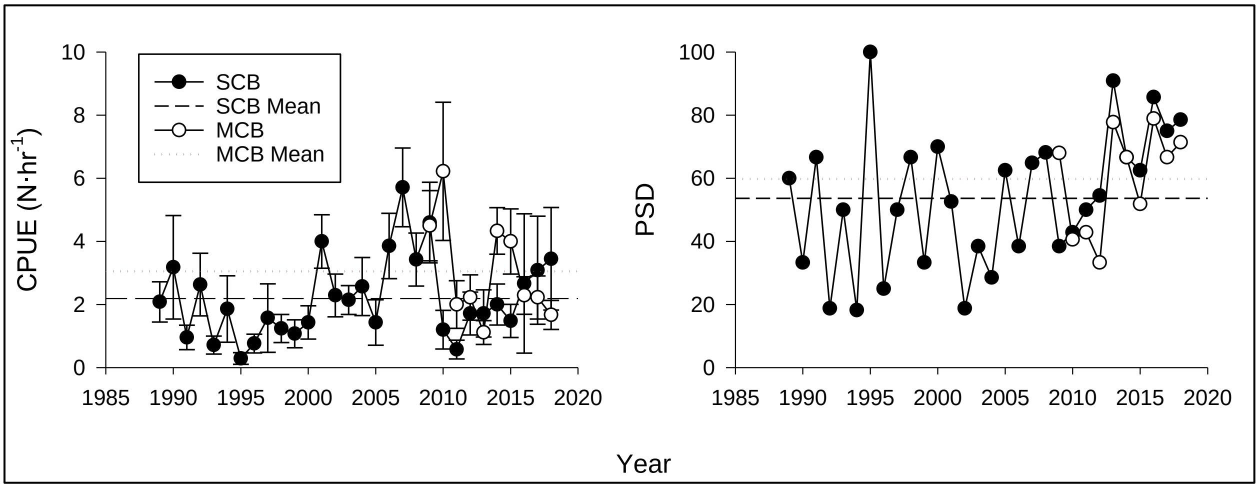

Figure 2.3. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Largemouth Bass

Largemouth Bass CPUE was again very high for SCB habitat (the second-highest value on record), 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 well above average. PSD values for both habitat areas were above the long-term averages. There is no doubt the Upper Illinois River has an excellent population of catchable Largemouth Bass.

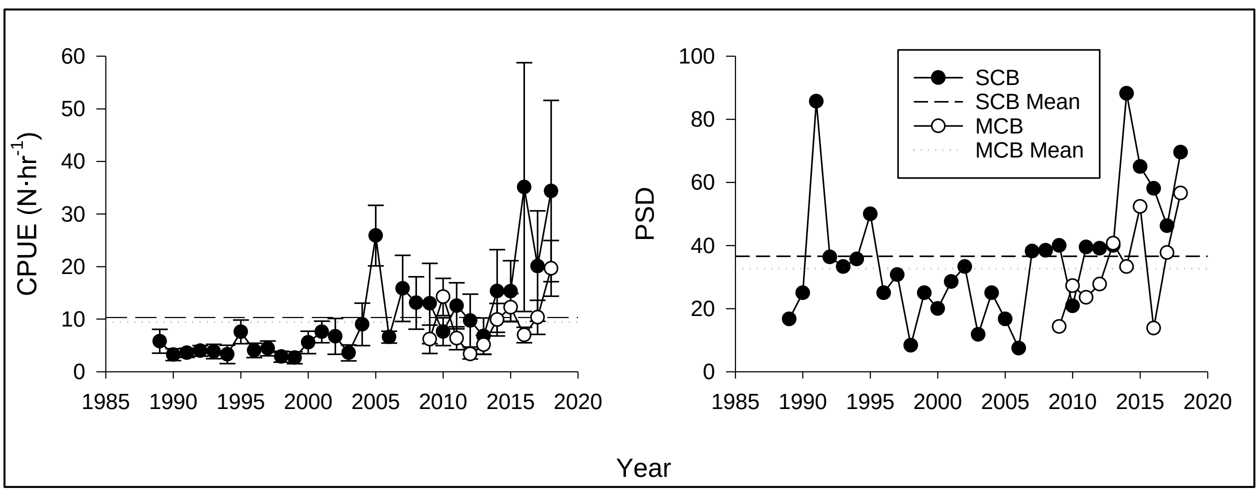

Figure 2.4. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Smallmouth Bass

Similar to 2016 and 2017, catch rates of Smallmouth Bass in the Upper Illinois River were again the highest ever recorded in both SCB and MCB habitats during 2018; 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.

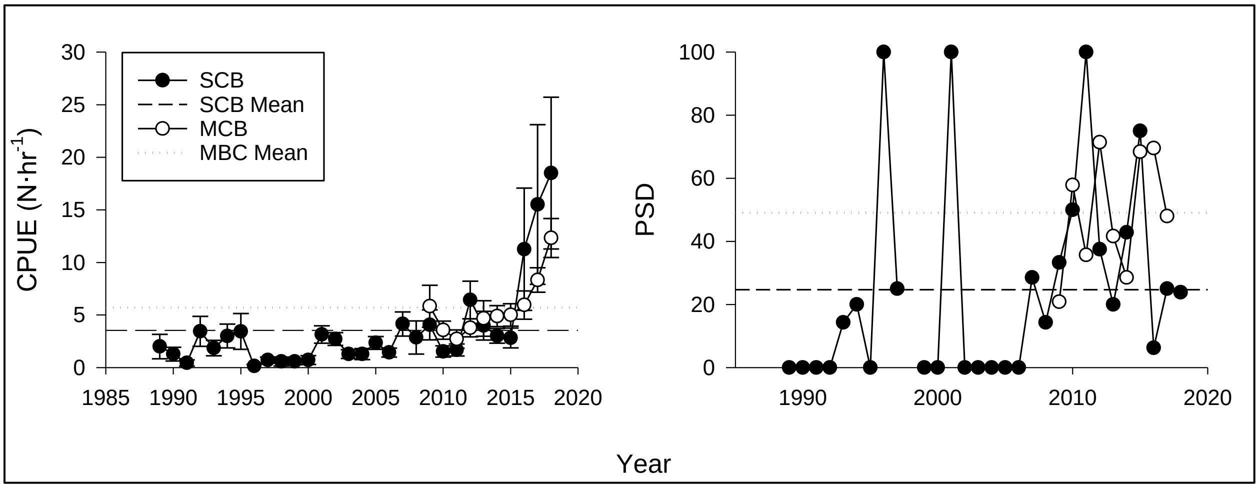

Figure 2.5. Catch per unit effort (mean ± SE) and proportional size distribution of Smallmouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Section 2.6 - 2018 Lower Illinois River Electrofishing Catch Statistics

We collected 6,028 fish representing 59 species and 1 hybrid 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 (2,440 fish; 40.5% of total catch) followed by Gizzard Shad (1,265; 21.0%), and Silver Carp (547; 9.1%). Silver Carp contributed the greatest biomass of fishes collected in the survey of this region (1,568.7 lb; 40.6% total collected biomass), followed by Common Carp (1,145.6 lb; 29.6%), and Smallmouth Buffalo (299.4 lb; 7.7%).

We collected an impressive 12,286 fish representing 65 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 (5,006 fish; 40.7% of total catch) followed by Emerald Shiner (4,538; 36.9%), and Silver Carp (392; 3.2%). Common Carp contributed the greatest biomass of fishes collected in the survey of this region (838.2 lb; 35.2% total collected biomass), followed by Silver Carp (830.9 lb; 34.9%), and Smallmouth Buffalo (179.7 lb; 7.6%).

Threatened and Endangered Species

Seven 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 decreased for the third year in a row, and were well 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 2018 were near average.

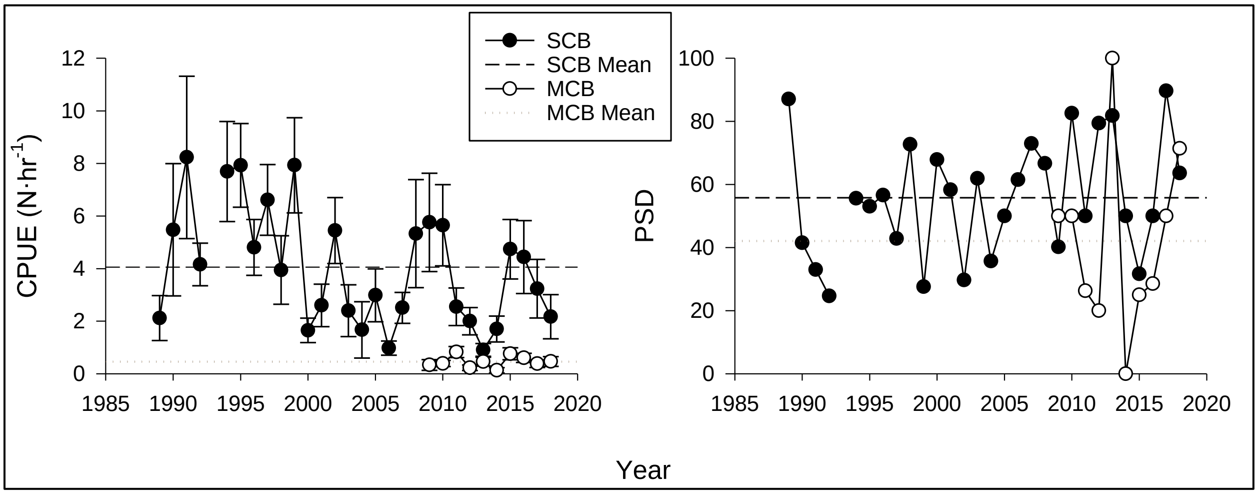

Figure 2.6. Catch per unit effort (mean ± SE) and proportional size distribution of Black Crappie and White Crappie collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used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

Bluegill

Catch rates of Bluegill in the Lower Illinois River were slightly lower than 2017, and near 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).

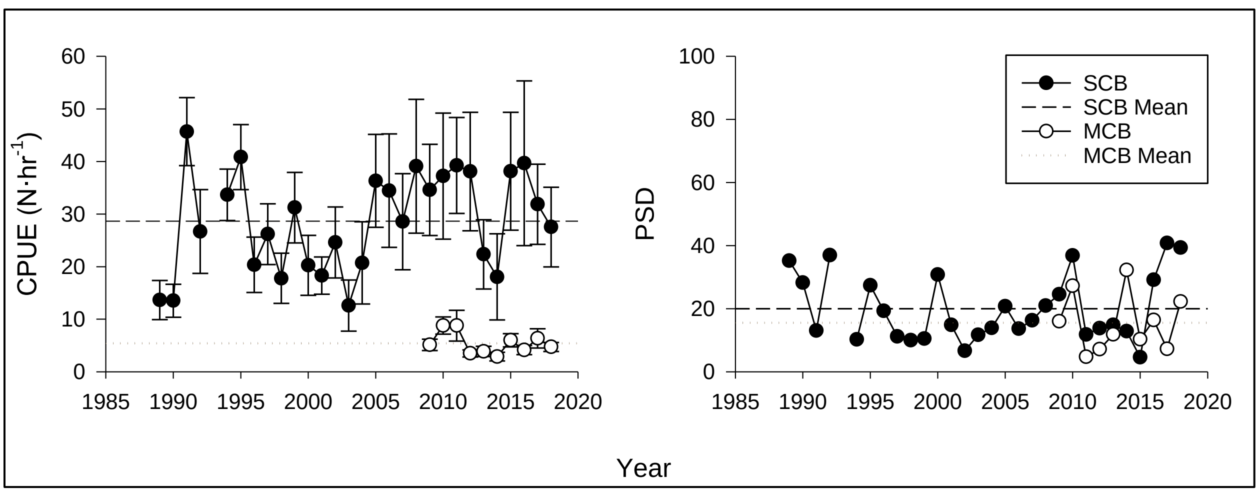

Figure 2.7. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Channel Catfish

After two years of very low catch rates, catch rates of Channel Catfish in the Lower Illinois River rebounded to average during 2018 in SCB habitat, but were below average in MCB habitat (Figure 2.8), although PSD values in 2018 in this region were above average for both SCB and MCB habitats.

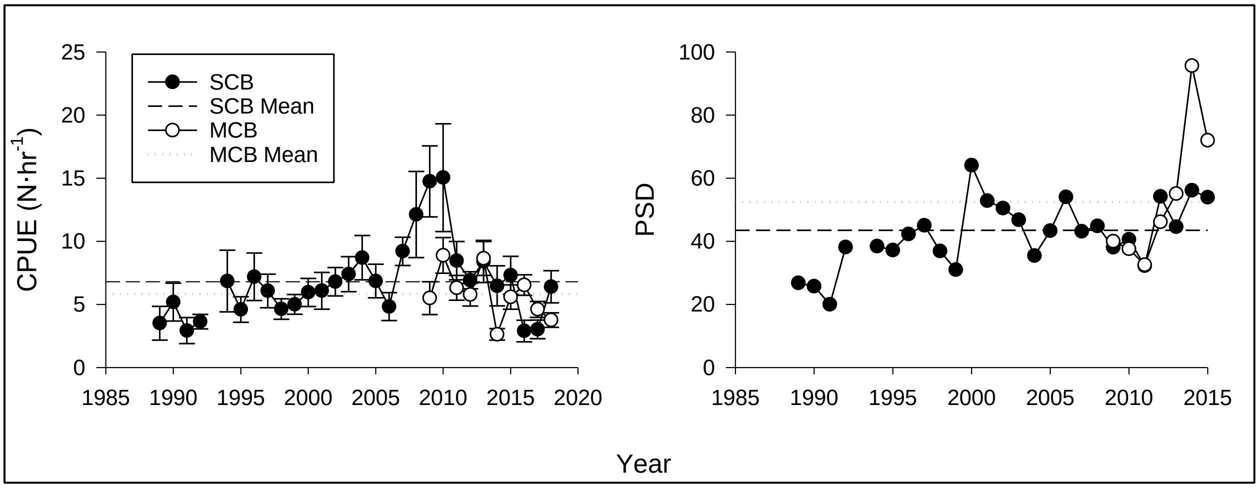

Figure 2.8. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Largemouth Bass

Catch rates of Largemouth Bass in the Lower Illinois River during 2018 were slightly below average in SCB habitat, and low in MCB habitat (Figure 2.9). PSD values calculated for SCB habitat during 2018 were very high, but were below average in MCB habitat. We believe Largemouth Bass, similar to Bluegill and maybe Crappies, struggle to successfully overwinter in the Lower Illinois River because of poor backwater habitat quality.

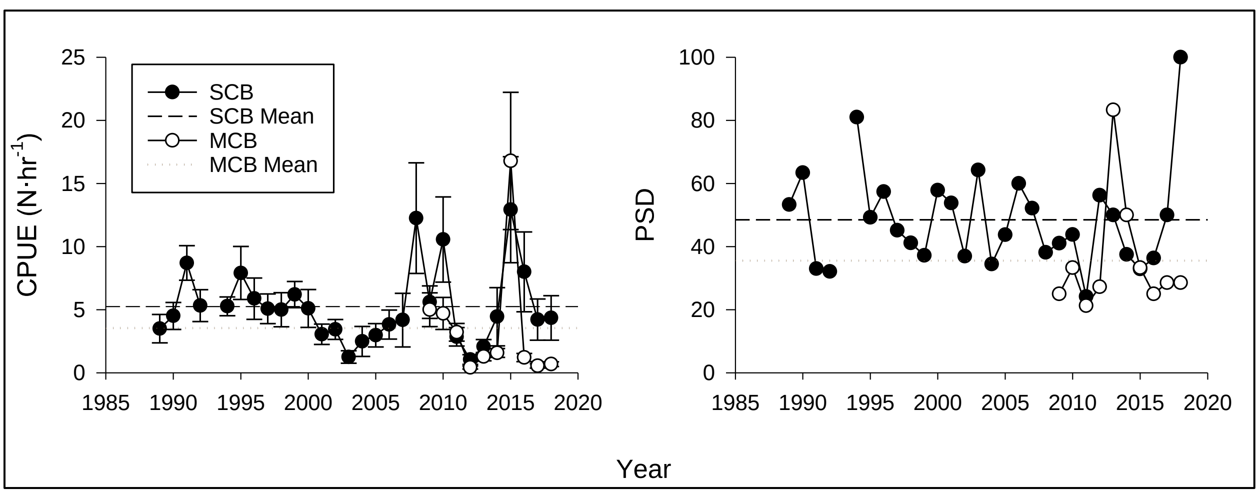

Figure 2.9. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

White Bass

White Bass CPUE in the Lower Illinois River during 2018 was slightly above 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.

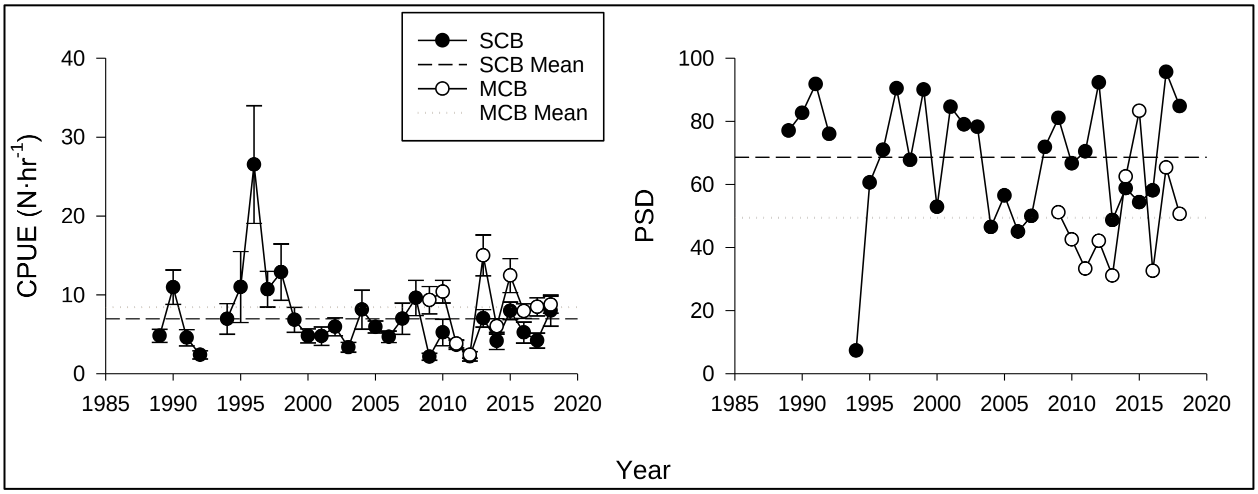

Figure 2.10. Catch per unit effort (mean ± SE) and proportional stock-density of White Bass collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling initiated 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 substantially, and was the fourth-highest on record during 2018. Catch rates in MCB habitat were above 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.

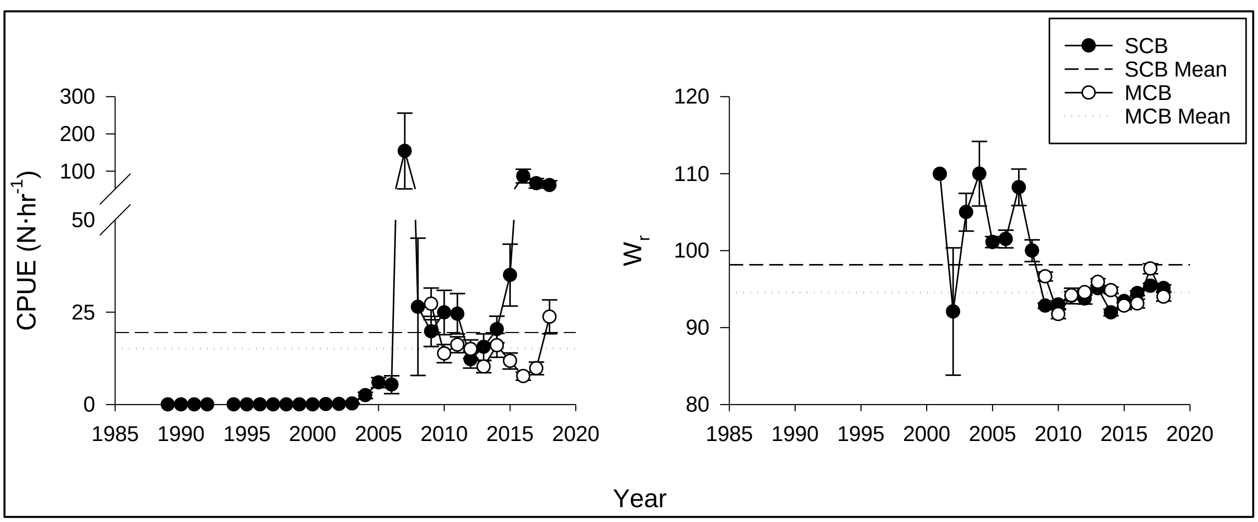

Figure 2.11. Catch per unit effort (mean ± SE) and condition (relative weight-W_r) of Silver Carp collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

CHAPTER 3
SPORTFISH ASSESSMENTS IN THE MISSISSIPPI RIVER

Sportfish populations were monitored in 4 segments or pools of the Mississippi River using boat-mounted pulsed-DC electrofishing gear (see Appendix I). Sites were randomly selected using GIS layers of main-channel border habitats in all study areas. 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 17 for 2018.

The results in the following sections have been divided between those data collected in Pool 16/17 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 - 2018 Mississippi River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted according to the methods described in Section 2.1 between 8:15 AM and 2:55 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 2018. 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 17 (RM 437-457)		**3.00**	**4202.9 ± 127.0**	**7.5 ± 0.8**	**12.0 ± 1.9**	**78.7 ± 1.9**	**6.8 ± 0.2**	**457.6 ± 17.8**	**11.2 ± 0.9**
	Period 1	1.00	4565.0 ± 74.0	6.1 ± 0.9	15.6 ± 1.1	82.9 ± 0.3	7.1 ± 0.3	521.3 ± 12.6	12.4 ± 0.0
	Period 2	1.00	4392.5 ± 7.5	8.1 ± 2.3	17.0 ± 1.0	83.1 ± 0.3	6.8 ± 0.1	468.0 ± 3.3	7.3 ± 0.0
	Period 3	1.00	3651.3 ± 121.3	8.4 ± 0.5	3.5 ± 0.0	70.0 ± 0.2	6.4 ± 0.2	383.5 ± 9.2	13.9 ± 0.0
Pool 25 (RM 242-273.5)		**4.50**	**3950.2 ± 112.5**	**9.6 ± 0.9**	**12.0 ± 0.9**	**70.7 ± 3.3**	**9.1 ± 0.5**	**475.2 ± 15.7**	**41.0 ± 1.0**
	Period 1	1.50	4317.3 ± 205.7	7.5 ± 1.1	10.8 ± 0.6	79.7 ± 0.4	7.5 ± 0.2	516.8 ± 44.6	40.7 ± 0.0
	Period 2	1.50	4061.6 ± 40.5	9.2 ± 2.2	10.9 ± 2.4	80.8 ± 0.7	8.1 ± 0.4	450.8 ± 2.0	37.5 ± 1.0
	Period 3	1.50	3490.3 ± 9.6	12.0 ± 0.9	14.2 ± 0.8	51.6 ± 0.4	11.6 ± 0.1	457.8 ± 1.3	44.6 ± 0.0
Chain of Rocks (RM 165.5-200.5)		**5.25**	**4305.2 ± 164.5**	**10.8 ± 0.8**	**6.1 ± 0.7**	**73.0 ± 2.7**	**7.5 ± 0.4**	**522.5 ± 24.6**	**23.5 ± 1.4**
	Period 1	1.75	4703.6 ± 186.6	9.3 ± 1.6	5.1 ± 0.9	83.1 ± 0.7	6.3 ± 0.1	554.3 ± 34.1	21.7 ± 1.2
	Period 2	1.75	4549.3 ± 352.0	11.5 ± 1.1	6.8 ± 1.8	78.3 ± 2.0	6.9 ± 0.7	536.7 ± 63.6	20.2 ± 3.1
	Period 3	1.75	3662.7 ± 82.5	11.5 ± 1.5	6.5 ± 0.4	57.6 ± 2.1	9.4 ± 0.3	476.4 ± 17.5	28.5 ± 1.2
Kaskaskia (RM 117-165.5)		**7.50**	**4560.1 ± 119.7**	**9.6 ± 0.6**	**8.5 ± 0.4**	**75.2 ± 2.3**	**8.1 ± 0.3**	**565.9 ± 14.2**	**18.6 ± 1.3**
	Period 1	2.50	5014.2 ± 89.4	7.7 ± 0.9	8.2 ± 0.7	84.2 ± 0.6	6.9 ± 0.1	609.1 ± 17.3	19.2 ± 0.0
	Period 2	2.50	4939.7 ± 103.6	9.4 ± 1.2	8.2 ± 0.6	81.4 ± 0.3	7.5 ± 0.2	600.2 ± 17.0	12.9 ± 1.2
	Period 3	2.50	3726.4 ± 59.5	11.6 ± 0.8	9.0 ± 0.7	60.0 ± 3.7	9.8 ± 0.6	488.5 ± 18.7	24.2 ± 0.6

Section 3.2 - 2018 Pool 17 Pulsed-DC Electrofishing Catch Statistics

We collected 1,807 fish representing 42 species during 3.0 hours of pulsed-DC electrofishing at 12 sites in Pool 17. Emerald Shiner was the most abundant species in our catch (996; 55.1% of total catch) followed by Gizzard Shad (160; 8.9%), and River Shiner (123; 6.8%). Flathead Catfish represented the greatest proportion of the total collected biomass (102.6 lb; 27.4% of total collected biomass) followed by River Carpsucker (90.6 lb; 24.2%), and Black Buffalo (46.9 lb; 12.6%).

Threatened and Endangered Species

No Illinois or federally threatened or endangered fishes were collected from Pool 17 during 2018.

Bluegill

Bluegill catch rates in Pool 17 during 2018 were slightly below average since 2014 (Figure 3.1). The PSD value for fish sampled during 2018 was low, perhaps indicating an influx of recruits in 2018.

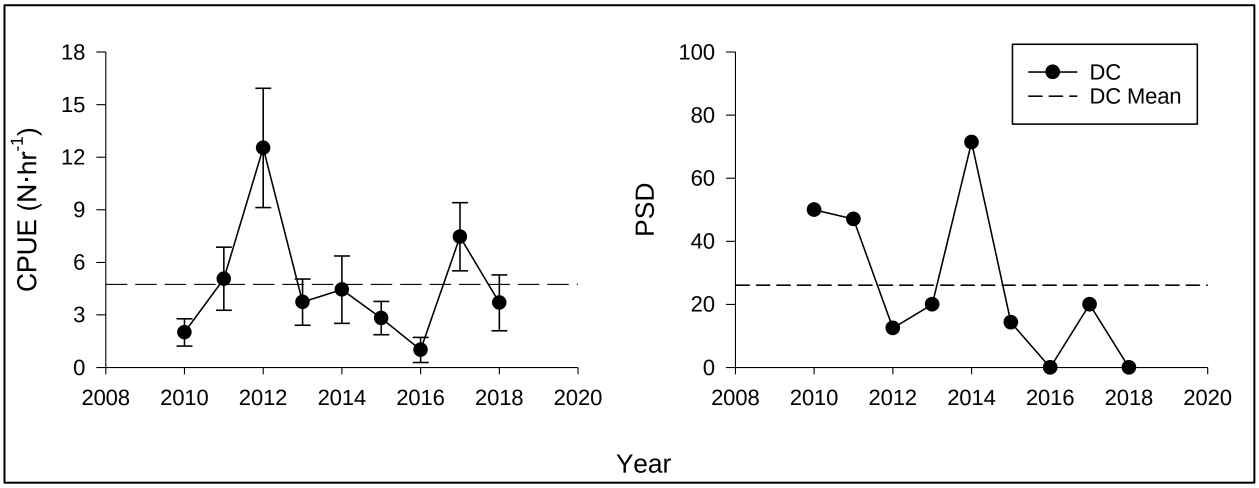

Figure 3.1. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Channel Catfish

Catch rates of Channel Catfish in Pool 17 were well below average during 2018, whereas PSD values were well above average. These results likely indicate that the bulk of the sampled population is generally comprised of a balance of larger and smaller fish.

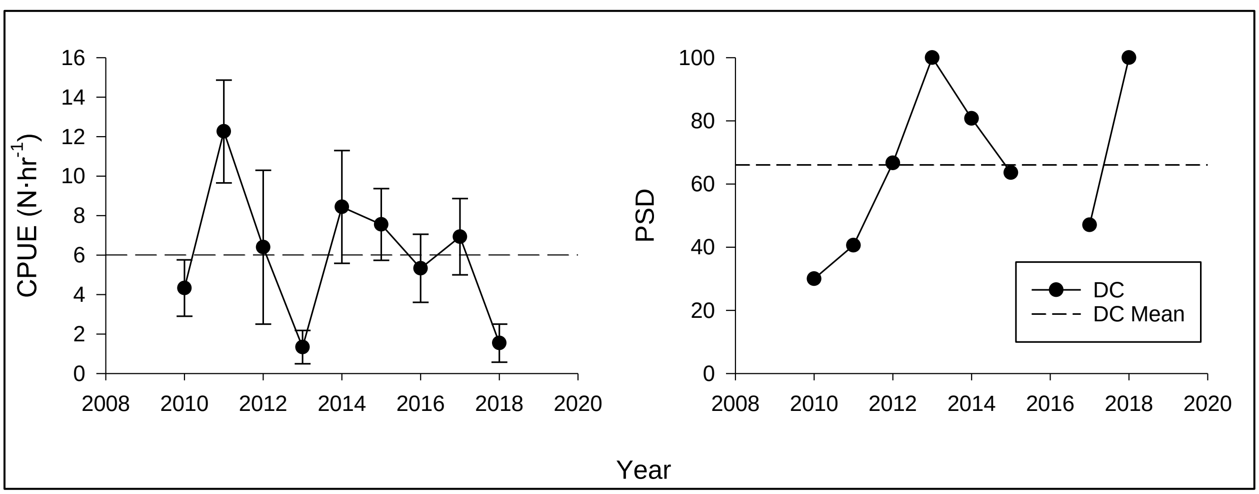

Figure 3.2. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Largemouth Bass

Catch rates of Largemouth Bass in Pool 17 during 2018 were slightly below average (Figure 3.3), with a majority of small fish based on PSD values.

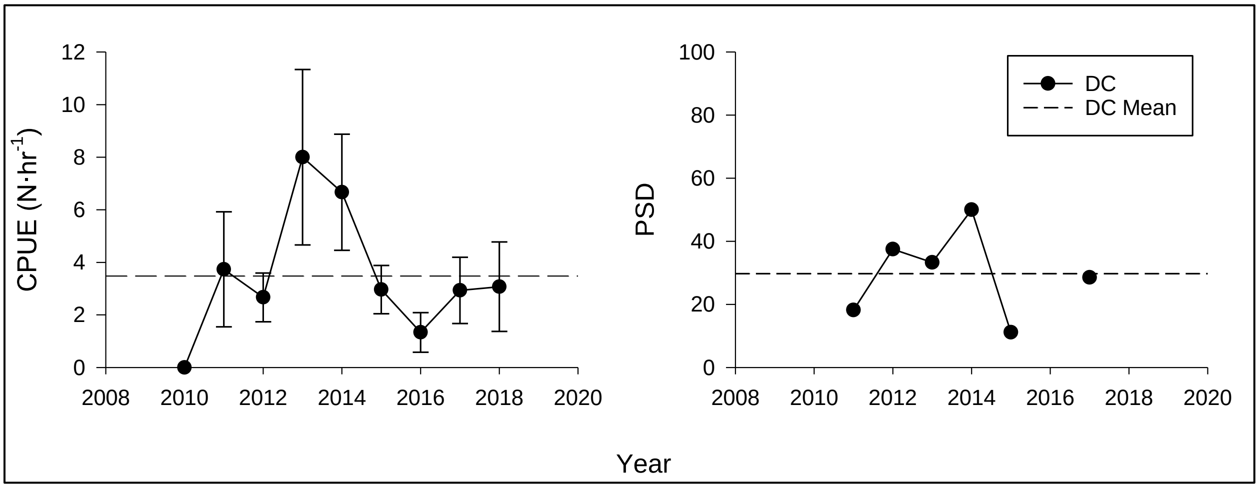

Figure 3.3. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Smallmouth Bass

Smallmouth Bass CPUE in Pool 17 during 2018 was slightly below the long-term average (Figure 3.4). The PSD value for 2018 indicates few large fish are sampled in this area.

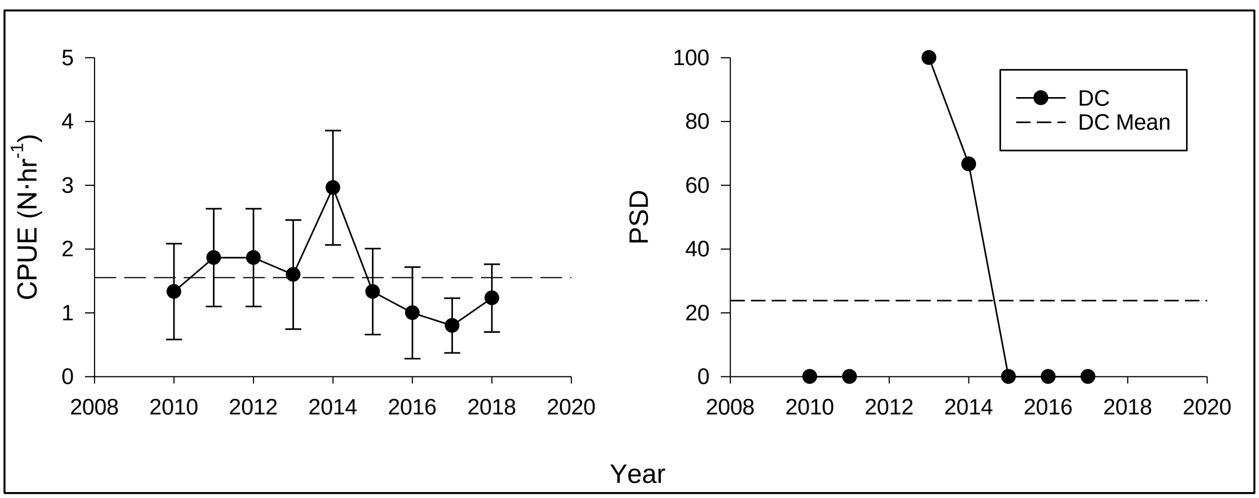

Figure 3.4. Catch per unit effort (mean ± SE) and proportional size distribution of Smallmouth Bass collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

White Bass

Catch rates of White Bass in Pool 17 during 2018 were similar to those since 2015, slightly below the long-term average (Figure 3.5). Decreasing PSD values likely indicate increasing recruitment.

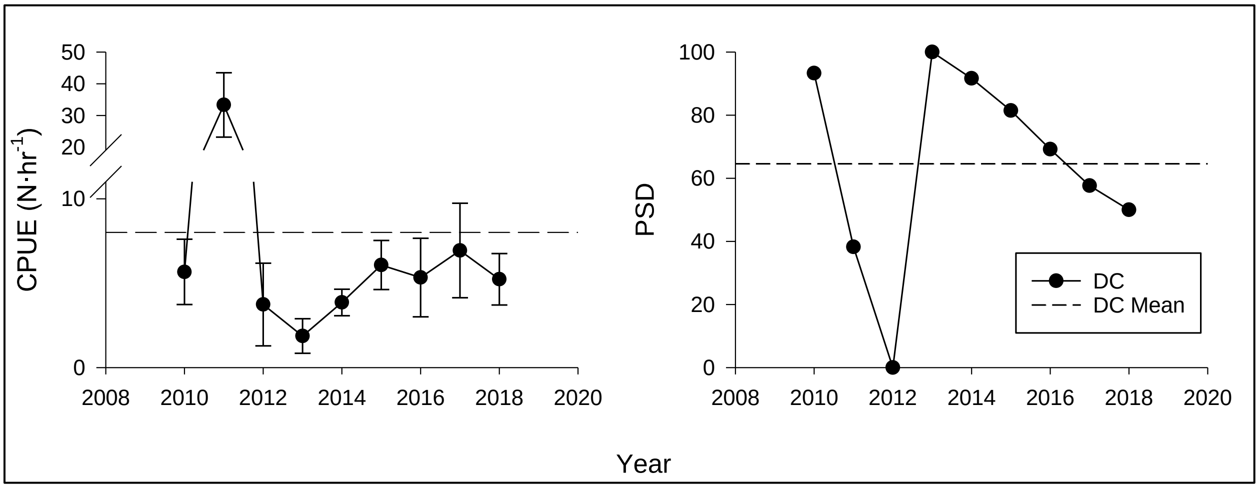

Figure 3.5. Catch per unit effort (mean ± SE) and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in Pool 17. The dashed lines represent the average since F-101-R sampling initiated in 2014.

Section 3.3 - 2018 Lower Mississippi River Sampling Area Pulsed-DC Electrofishing Catch Statistics

We collected 2,889 fish representing 52 species and 2 hybrids during 17.25 hours of pulsed-DC electrofishing at 69 sites in the Lower Mississippi River Sampling Area. Emerald Shiner was the most abundant species in our catch (792 fish; 27.4% of total catch) followed by Gizzard Shad (278; 9.6%), and Silver Carp (246; 8.5%). Common Carp represented the largest proportion of the total collected biomass (1,025.4 lb; 32.9% of total collected biomass) followed by Silver Carp (362.0 lb; 11.6%), and Smallmouth Buffalo (322.4 lb; 10.4%).

Threatened and Endangered Species

Two American Eel (Illinois Threatened) were sampled during pulsed-DC electrofishing surveys on the Lower Mississippi River Sampling Area during 2018. These fish were identified in the field and were not verified by INHS museum staff.

Bluegill

The catch rate of Bluegill in the Lower Mississippi River Sampling Area was below average in 2018 after an increase 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.

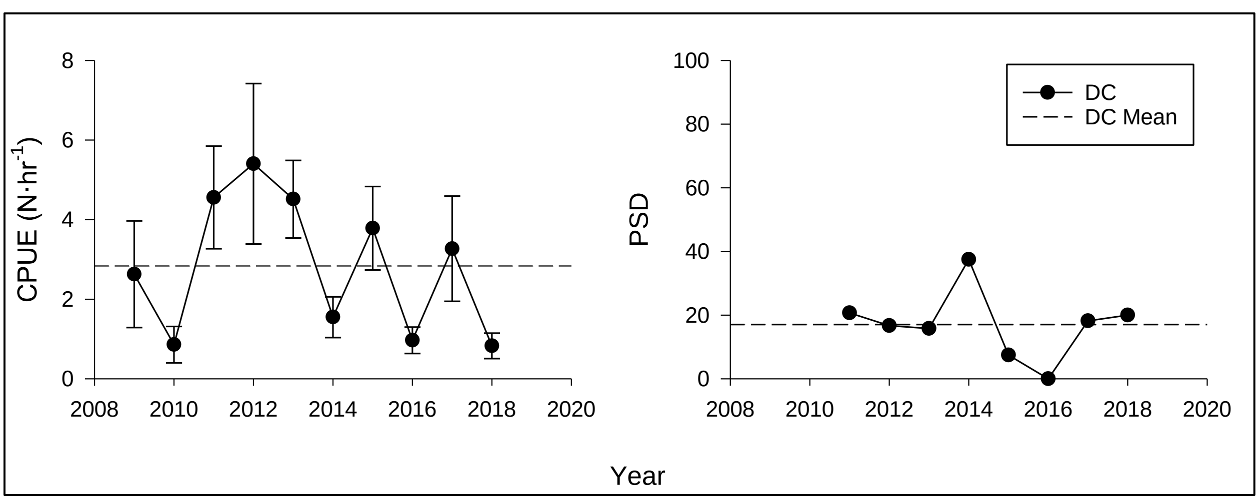

Figure 3.6. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

Channel Catfish

After three consecutive below-average years, catch rates of Channel Catfish in the Lower Mississippi River Sampling Area during 2018 rebounded nicely to average (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.

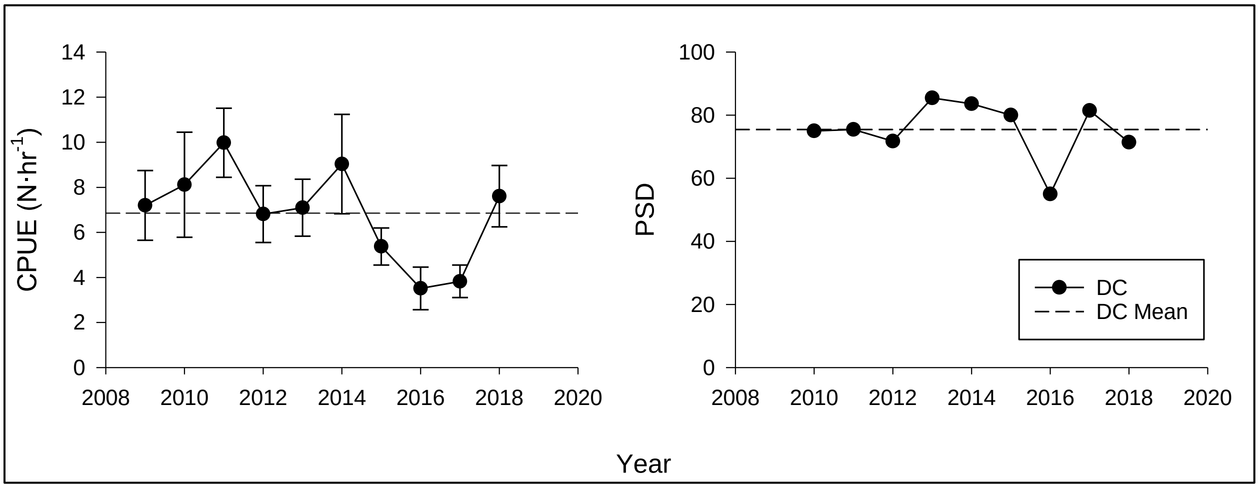

Figure 3.7. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

White Bass

White Bass CPUE was above average during 2018, 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 area may be cyclical or episodic.

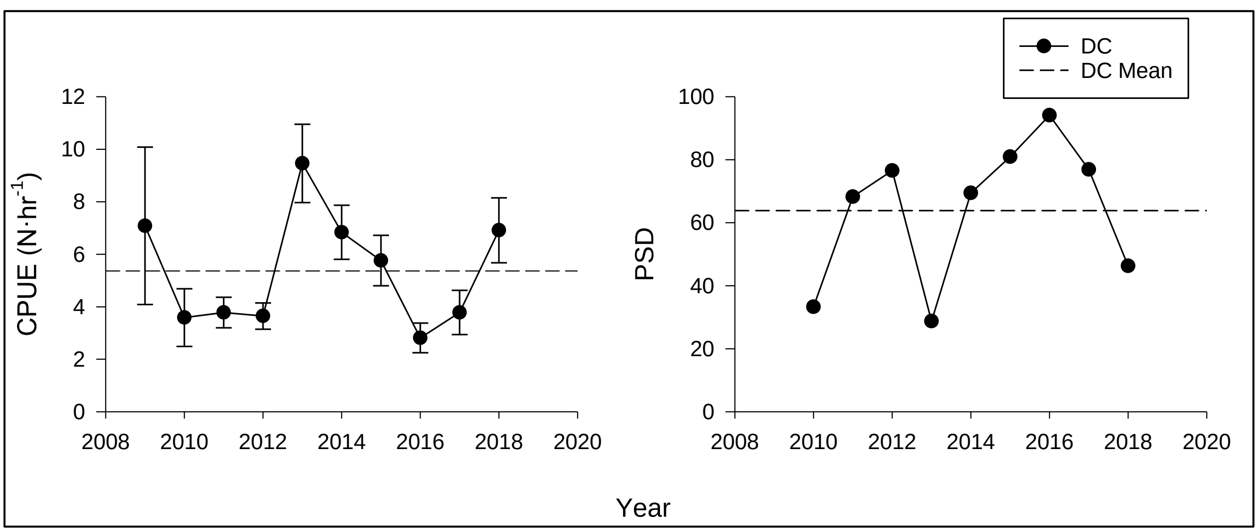

Figure 3.8. Catch per unit effort (mean ± SE) and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Reaches. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

Silver Carp

Catch rates of Silver Carp in the Lower Mississippi River Sampling Area were the highest on record in 2018, (Figure 3.9), likely contributing to the decrease in W_r value.

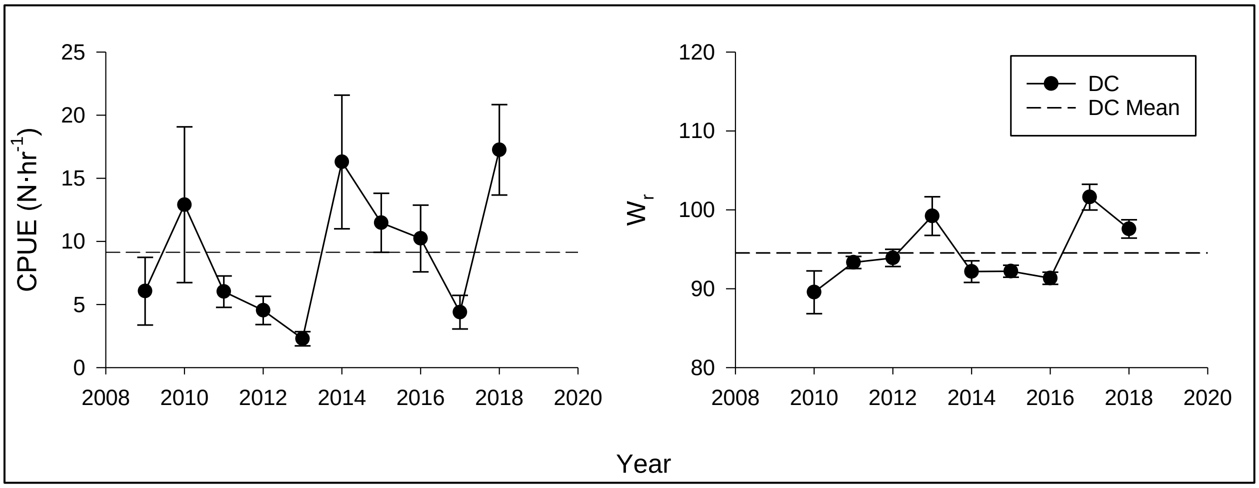

Figure 3.9. Catch per unit effort (mean ± SE) and condition (relative weight-W_r) of Silver Carp collected by pulsed-DC electrofishing survey in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling initiated in 2009.

CHAPTER 4
DISCUSSION and RECOMMENDATIONS

Fish monitoring conducted on the Des Plaines, Illinois, and Mississippi rivers during 2018 was useful for describing the diversity and heterogeneity of fish communities in large Midwestern 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 likely comprises a substantial contribution to our collective knowledge 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 2018. Bluegill was the most-abundantly collected sportfish species in nearly all areas on the IL River, whereas the catfishes were the most-abundantly collected sportfish species on the MS River. Collections of black basses were greatest in the Upper Illinois Waterway. Similar to 2016 and 2017, 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. Our long-term datasets allow us to observe substantial annual variations in the relative abundance and size distribution of many sportfish species, like White Bass. These observations could serve as a catalyst for future research investigating the effects environmental changes and management policies 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 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, but decreased to 4.9% during 2018. We will continue to monitor this trend in coming years.

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Appendix I. Reaches and pools sampled by LTEF pulsed-DC electrofishing surveys (and our partners) during 2018 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-197-R					
Iroquois	INHS, F-197-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-193-R	Pool 21	325.0	343.0	12	Quincy, IL
	WIU, F-193-R	Pool 20	343.0	364.5	12	Gregory Landing, MO
	WIU, F-193-R	Pool 19	364.5	410.5	27	Fort Madison, IA
	WIU, F-193-R	Pool 18	410.5	437.0	15	Keithsburg, IL
	INHS, F-101-R	Pool 17	437.0	457.0	12	Muscatine, IA
	INHS, F-101-R	Pool 16	457.0	483.0	15	Fairport, IA
Ohio	SIU, F-187-R	Mississippi Confluence	981.0	962.5	12	Birds Point, MO
	SIU, F-187-R	Pool 53	962.5	939.0	15	Metropolis, IL
	SIU, F-187-R	Pool 52	939.0	918.5	12	Paducah, KY
	SIU, F-187-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 6-30 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.

Altenritter, M.E., S. Pescitelli, A.L. Whitten, A.F. Casper. *In Press*. Implications of an invasive fish barrier for the long-term recovery of native fish assemblages in a previously degraded northeastern Illinois river system. River Research and Applications. https://doi.org/10.1002/rra.3457

DeBoer, J. A., M. C. Thoms, A. F. Casper, and M. D. Delong. 2019. The response of fish diversity in a highly modified large river system to multiple anthropogenic stressors. Biogeosciences 124:384-404.

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.
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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

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Fritts, M. W., J. A. DeBoer, D. K. Gibson-Reinemer, B. J. Lubinski, M. A. McClelland, and A. F. Casper. 2017. Over 50 years of fish community monitoring in Illinois' large rivers: the evolution of methods used by the INHS's Long-term Survey and Assessment of Large-River Fishes in Illinois. Illinois Natural History Survey Bulletin.

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

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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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Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1995. Long-term trends (1959-1994) in fish populations of the Illinois River. Transactions of the Illinois State Academy of Science 88 (Supplement):74. (Abstract)
Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1995. Long-term trends (1959-1994) in fish populations of the Illinois River with emphasis on upstream-to-downstream trends. Proceedings of the Mississippi River Research Consortium 27:62-63.
Raibley, P.T., K.D. Blodgett, and R.E. Sparks. 1995. Evidence of grass carp (*Ctenopharyngodon idella*) reproduction in the Illinois and upper Mississippi Rivers. Journal of Freshwater Ecology 10:65-74.
Sparks, R.E. 1995. Value and need for ecosystem management of large rivers and their floodplains. Bioscience 45:168-182.
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Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1994. Some upstream-to-downstream differences in Illinois River fish communities. Transactions of the Illinois State Academy of Science 87(Supplement):53. (Abstract)

III. Essays

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.

IV. Popular Articles

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

V. Technical Papers presented during F-101-R Segment 30 (presenters in **bold**, '*' denotes student presenter, '+' denotes invited presentation)

Altenritter ME, Pescitelli S, Whitten A, and Casper A. 2018. Unintended consequences of invasive species management: invasive carp barriers may constrain the native fish assemblage. Oral presentation, Annual meeting of the American Fisheries Society, Atlantic City, NJ.

Anderson, R. L., N. J. Lederman, C. A. Anderson, and J. A. DeBoer. 2019. Potential beneficial effects of invasive silver carp on native fishes. Platform. Midwest Fish and Wildlife Conference. Cleveland, OH.

***Berry, S. L.**, J. T. Lamer, J. A. DeBoer, Whitten, A., Rude, N. P., Whitledge, G. W., Carpenter, C. J., Colombo, R. E., Lubinski, B. J., & Parker J. 2019. Growth Chronology and Population Characteristics of Channel Catfish and Freshwater Drum across six Illinois Rivers. Platform. Midwest Fish and Wildlife Conference, Cleveland, OH.

Anderson, R. L., N. J. Lederman, C. A. Anderson, and J. A. DeBoer. 2019. Potential beneficial effects of invasive silver carp on native fishes. Platform. Illinois Chapter of the American Fisheries Society. Champaign, IL.

***Berry, S. L.**, J. T. Lamer, J. A. DeBoer, Whitten, A., Rude, N. P., Whitledge, G. W., Carpenter, C. J., Colombo, R. E., Lubinski, B. J., & Parker J. 2019. Growth Chronology and Population Characteristics of Channel Catfish and Freshwater Drum across six Illinois Rivers. Platform. Illinois Chapter of the American Fisheries Society. Champaign, IL.

Whitten, A.L., J.A. DeBoer, L.E. Solomon, A.K. Fritts, M.W. Fritts, R.M. Pendleton, T.D. VanMiddlesworth, and A.F. Casper. 2019. Playing to stay in the game: a sportfish's adaptive response to change. Platform. Mississippi River Research Consortium. La Crosse, WI.

VI. Data Requests received during F-101-R Segment 30

1. Peter Alsip, Cooperative Institute for Great Lakes Research
2. David Coulter, Southern Illinois University
3. Jeremy Hammen, U.S. Fish and Wildlife Service
4. Brian Metzke, Illinois DNR
5. Charles Theiling, U.S. Army Corps of Engineers
6. Jeremy Tiemann, Illinois Natural History Survey
7. Joseph Glenzinski, private citizen
8. Andrew Casper, Illinois Natural History Survey
9. Dakota Radford, Eastern Illinois University
10. Tim Bonvechio, Georgia DNR