



Illinois Natural History Survey

PRAIRIE RESEARCH INSTITUTE

Long-term Survey and Assessment of Large-River Fishes in Illinois, 2023

Jason A. DeBoer, Andrya L. Whitten Harris, Eric C. Hine, Michael J. Spear, Stefan R. Tucker, John H. Chick, and James T. Lamer

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

F-101-R-35

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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EXECUTIVE SUMMARY

This report presents a summary of those data collected during segment 35 (2023-2024) 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 five pools and one unimpounded reach of the Illinois River Waterway, and seven pools and two unimpounded reaches of the Mississippi River (separated into Pools 16-21 as the Upper MS River Sampling Area, and Pool 25, Chain of Rocks Reach, and Kaskaskia Reach as the Lower MS River Sampling Area). In all segments of the LTEF program, all fishes collected were accurately identified, tallied, measured, and weighed. The catch rates of sportfish species were calculated as the number of individuals collected per hour ($CPUE_N \pm$ 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. In most sampling areas of the survey, Gizzard Shad and Emerald Shiner comprised most of the individuals caught, and Silver Carp and Common Carp accounted for the greatest proportion of the biomass collected.

Sportfish

Catch rates and sizes of popular sportfish species varied greatly among the rivers and reaches sampled during 2023. The most-abundantly collected sportfish species in the Upper Illinois River were Bluegill and Smallmouth Bass in the main-channel border (MCB) habitat, and Bluegill and Largemouth Bass in the side-channel border (SCB) habitat. In the Lower Illinois River, the 2023 CPUE of characterized sportfish generally decreased or remained the same as 2022. Overall, Bluegill and Freshwater Drum were the most-abundantly collected sportfish species in the MCB habitat, and Bluegill and White Bass in the SCB habitat. In the Upper MS River Sampling Area, Largemouth Bass and Bluegill were the most-abundantly collected sportfish species, whereas Freshwater Drum and Flathead Catfish were the most-abundantly collected sportfish species in the Lower MS River Sampling Area. 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 of 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 long-term fisheries surveys. The operation and maintenance of the LTEF program and the data it generates can contribute to more comprehensive and nuanced understanding that can, in turn, aid in the development of more effective and sustainable management policies for sportfishes in the Illinois rivers.

Invasive Species

Although the primary focus of F-101-R programs is to conduct monitoring to improve our understanding of population dynamics, life histories, and habitat requirements of sportfish species, the program's sampling strategies may also be useful for documenting trends in the relative abundance of non-native species occupying large river ecosystems in Illinois. Our monitoring and analyses indicate densities of Silver Carp are greatest in the Lower Illinois River, and specifically in the SCB habitat. The body condition of Silver Carp in the Lower Illinois River remained the same in MCB habitat but slightly decreased in SCB habitat. In both MS River Sampling Areas, Common Carp once again dominated the biomass.

JOB ACCOMPLISHMENTS DEFINED BY F-101-R-35 WORK PLAN

Job 1: Prepare electrofishing equipment and train staff

Project workers maintained and repaired electrofishing equipment as needed throughout Project Segment 35. Full-time staff also trained seasonal technicians 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 assignments in the Illinois and Mississippi rivers of Project Segment 35.

Job 3: Update computer database

All F-101-R Segment 35 (2023) 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 35 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 presented the results of electrofishing sampling at professional meetings (Appendix II). Project workers also completed the annual project report, an INHS technical report, and two peer-reviewed manuscripts.

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PREFACE

This report presents a summary of data collected during 2023 (segment 35 of Federal Aid project F-101-R) for the Long-Term Survey and Assessment of Large-River Fishes in Illinois. The purpose of this document is to provide: 1) information on the broad-scale and long-term trends in fish populations in the Illinois and Mississippi rivers; 2) updates on stock assessments in the Illinois and Mississippi Rivers; and 3) updates on shovelnose sturgeon (*Scaphirhynchus platorynchus*) surveys and assessment in the Rock River. Although we gather data on many other fishes during sampling, this report is primarily focused on recreationally valued sportfishes in accordance with Goal 5 of the 2017-2022 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). Fish common names used throughout this report follow Page et al. (2013). We have used English units of measure throughout the report; although 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 principal abbreviations and definitions:

RM: River Mile
 AC: Alternating Current
 DC: Direct Current
 °F: Temperature 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).

CHAPTER 1

SURVEY AND ASSESSMENT OF LARGE-RIVER FISHES

Section 1.1 - Introduction

The large rivers of Illinois have experienced substantial changes 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 Starrett 1975). The purpose of this Long-term Survey and Assessment of Large-River Fishes in Illinois (historically known as 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' large-river sportfisheries.

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-sync 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 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 over 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 throughout two of the largest rivers in Illinois (F-101-R; Figure 1.1). Data generated from these surveys have previously been used to document large-scale changes in the structure of riverine fish communities (e.g., Sparks and Starrett 1975; Pegg and McClelland 2004; McClelland et al. 2012; Whitten and Gibson-Reinemer 2018, DeBoer et al. 2019), 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; 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 continues to provide high-quality data for important assessments of riverine sportfish populations in relation to contemporary environmental perturbations, including climate variability, on-going loss of side-channel and backwater habitat to sedimentation, unnatural water-level fluctuations from altered hydrology, changing water quality, and river channel maintenance and dredging activities for navigation.

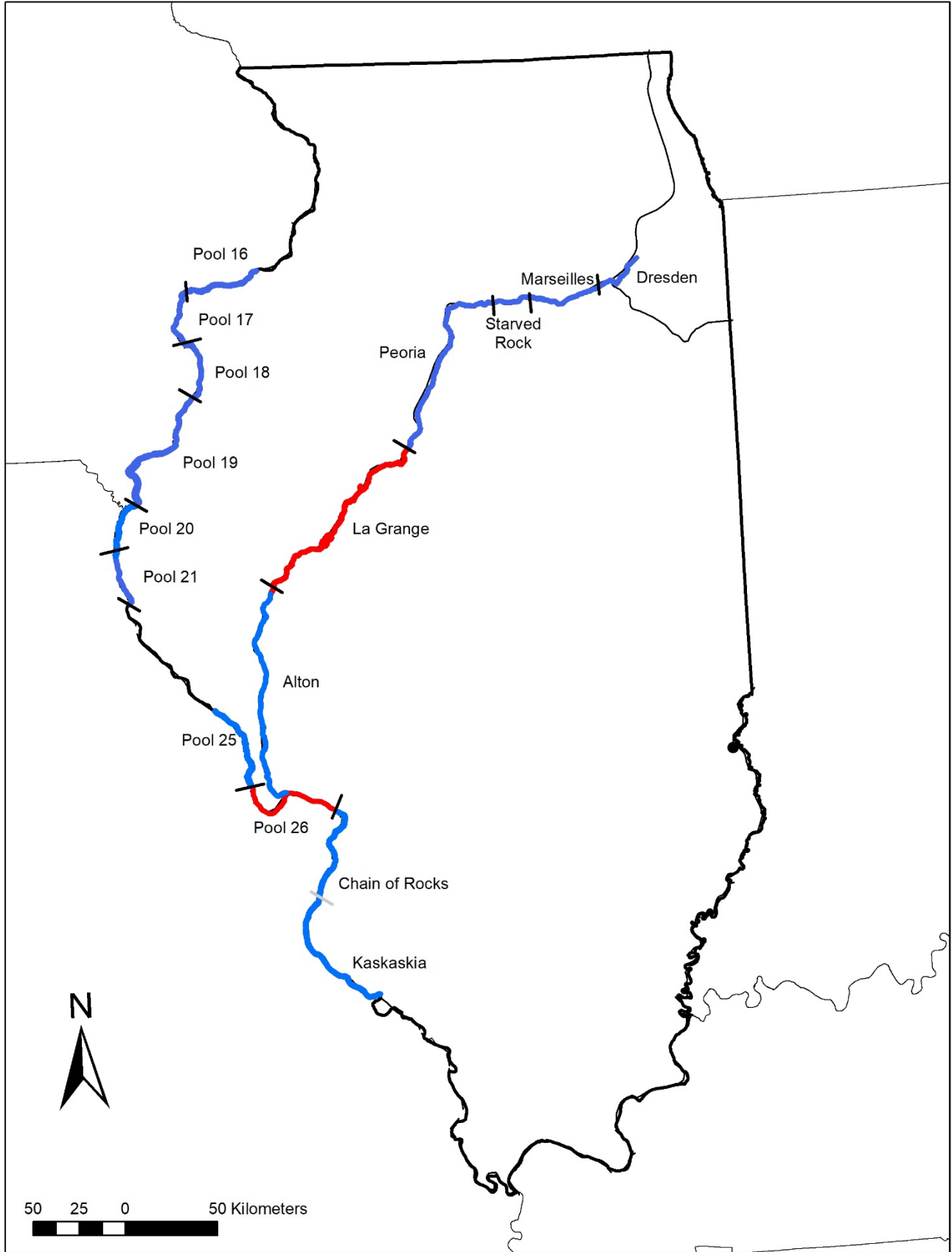


Figure 1.1. Map of the Illinois Waterway and portions of the Mississippi River illustrating areas sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (F-101-R; colored in blue) during 2023. Areas currently sampled by the U.S. Army Corps of Engineers Upper Mississippi River Restoration Program (UMRR) Long Term Resource Monitoring element (LaGrange Pool, Illinois River and Pool 26, Mississippi River) are colored red.

Section 1.2 - Pulsed-DC Electrofishing Collections

During 2023, sportfish populations were monitored in five pools and one unimpounded reach of the Illinois River Waterway and seven pools and two unimpounded reaches of the Mississippi River (separated into Pools 16-21 as the Upper MS River Sampling Area, and Pool 25, Chain of Rocks Reach, and Kaskaskia Reach as the Lower MS River Sampling Area) 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 Program (UMRR) Long Term Resource Monitoring element (LTRM, <http://www.umesc.usgs.gov/ltrm.html>) and are not included in F-101-R monitoring (Figure 1.1), except for 3 fixed sites in La Grange Reach (see Figure 1.2). The third historical Pekin site on the La Grange Reach (RM 155.1) was added back into sampling starting in 2018 at the IDNR's request.

Electrofishing collections were conducted based on established LTRM 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 boat driver 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 LTRM 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 < 7 in were counted and measured to 0.4-in bins 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 windy or wavy field conditions that may affect weight measurements.

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 1.1). This supplemental data about fish health allows for examinations into the relative health of sportfishes and the environmental quality of the rivers they inhabit.

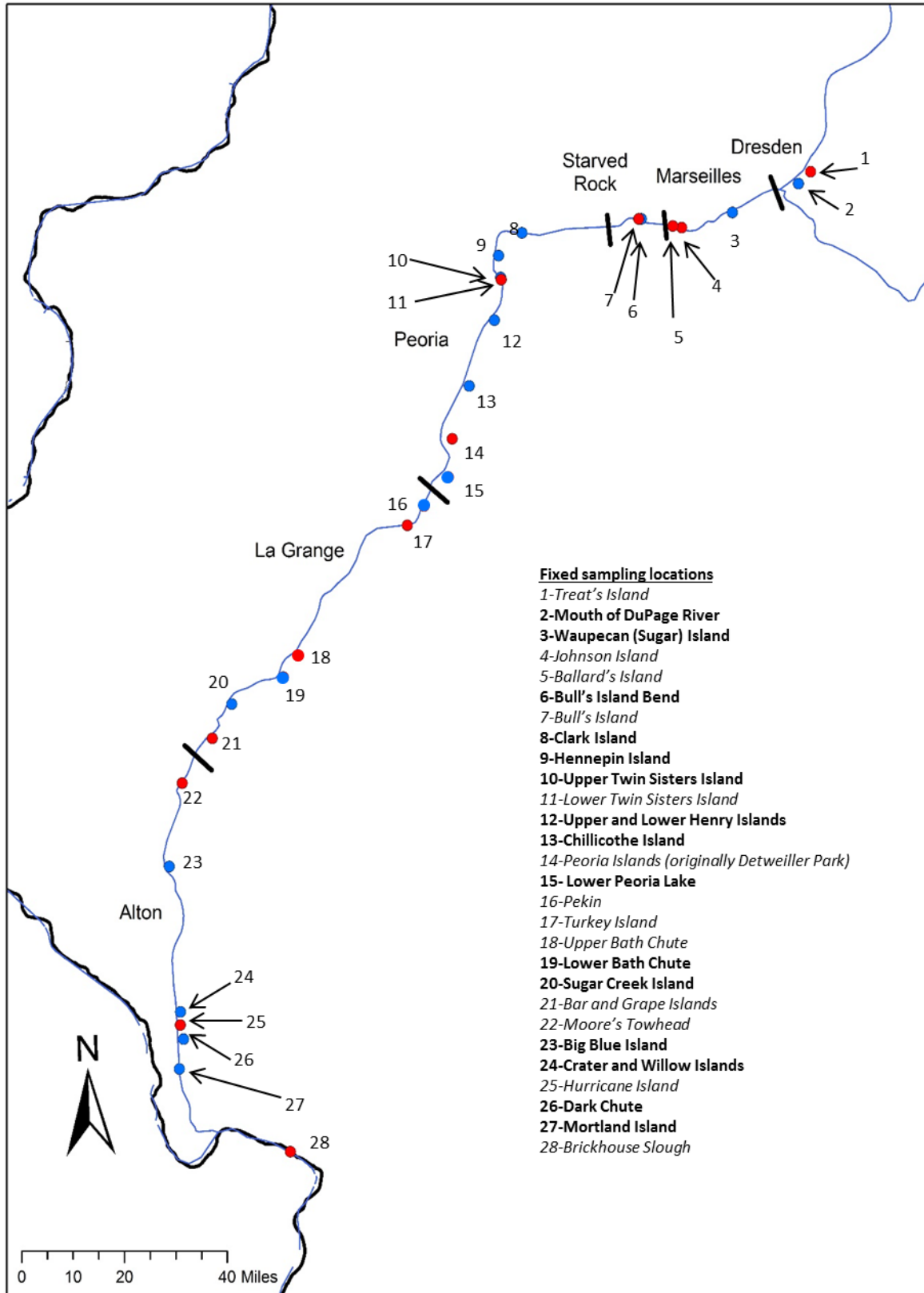


Figure 1.2. Map of the Illinois Waterway, and the fixed locations sampled by the Long-term Survey and Assessment of Large-River Fishes in Illinois (F-101-R) using AC electrofishing gear 1959-2015. Sites that were abandoned for 2016 and future sampling are listed in italics (red dots); sites that have been assimilated into the pulsed-DC protocol are listed in bold (blue dots).

Table 1.1. Definition of fish abnormalities documented during 2023.

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 1.3 - Ancillary Habitat Quality Measurements

Measurements for ancillary habitat-quality parameters (i.e., water temperature, dissolved oxygen, Secchi disk transparency, conductivity, surface velocity, water depth, and river stage) were recorded prior to each electrofishing run. 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.

Section 1.4 - 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 for the Illinois River Waterway; only main-channel border habitat is sampled on the Mississippi River. 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 ± standard error). Proportional size distribution (PSD) (Neumann and Allen 2007) was calculated as an index of sportfish size structure. Body 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 in the Illinois River Waterway, but due to their importance as a commercially caught fish in the three segments of the Lower MS River Sampling Area, they were included in the analyses for this region (Chapter 4; Maher 2019). Additionally, 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 2009-2022 are the same; pulsed-DC sampling previously only occurred 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 between the two gears (e.g., McClelland and Sass 2012).

CHAPTER 2 SPORTFISH ASSESSMENTS IN THE ILLINOIS RIVER

We have distinguished between data collected above and below the Starved Rock Lock & Dam (*sensu* McClelland et al. 2012) for geomorphological reasons (DeBoer et al. 2019), thus separating the Illinois River Waterway into the Upper Illinois River (Section 2.2) and Lower Illinois River (Section 2.3). 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.

Section 2.1 – 2023 Illinois River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted between 7:30 AM and 5:25 PM central time during the three sampling periods specified in Section 1.2. Physical measurements for ancillary water-quality parameters were collected at each DC-sampling site and are summarized in Table 2.1.

Table 2.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on six reaches of the Illinois River Waterway during 2023. Values are expressed as mean \pm standard error.

Navigational Pool	Total EF		Depth	Secchi Depth	Water Temperature	DO	Conductivity	Stage Height
	Effort	EF Power Used						
	(h)	(Watts)	(ft)	(in)	(°F)	(ppm)	(μ S)	(ft)
Dresden Island (RM 271.5-286)	3.07	5195.8 \pm 147.4	5.4 \pm 0.6	26.2 \pm 2.4	68.1 \pm 3.5	8.9 \pm 1.9	771.7 \pm 29.2	485.5 \pm 0.4
Period 1	1.00	4675.0 \pm 92.4	4.1 \pm 1.1	15.6 \pm 1.5	72.6 \pm 0.6	3.6 \pm 0.0	649.8 \pm 22.8	487.4 \pm 0.0
Period 2	1.00	5812.5 \pm 12.5	6.3 \pm 0.9	31.4 \pm 1.3	73.3 \pm 9.2	13.6 \pm 4.6	815.3 \pm 27.6	484.3 \pm 0.0
Period 3	1.07	5100.0 \pm 100.0	5.8 \pm 1.2	31.5 \pm 1.4	58.4 \pm 0.1	9.5 \pm 0.2	850.0 \pm 21.6	484.7 \pm 0.0
Marseilles (RM 247-271.5)	5.25	5140.0 \pm 51.5	5.6 \pm 0.4	33.2 \pm 2.5	74.0 \pm 2.0	6.2 \pm 0.6	731.4 \pm 11.2	5.7 \pm 0.2
Period 1	1.75	5134.3 \pm 69.1	6.0 \pm 0.5	21.9 \pm 1.5	76.2 \pm 0.5	3.0 \pm 0.1	698.1 \pm 13.7	6.9 \pm 0.1
Period 2	1.75	5314.3 \pm 59.5	5.9 \pm 0.5	41.2 \pm 2.0	81.9 \pm 0.3	6.9 \pm 0.2	707.0 \pm 10.9	5.3 \pm 0.0
Period 3	1.75	4971.4 \pm 91.8	5.0 \pm 0.8	36.6 \pm 5.0	63.9 \pm 3.2	8.8 \pm 0.6	789.1 \pm 10.6	5.0 \pm 0.0
Starved Rock (RM 231-247)	3.00	4814.2 \pm 91.3	5.6 \pm 0.8	20.1 \pm 1.0	71.0 \pm 2.8	6.9 \pm 0.7	678.6 \pm 23.7	459.7 \pm 0.0
Period 1	1.00	5182.5 \pm 17.5	6.8 \pm 1.4	22.9 \pm 1.1	79.3 \pm 0.2	3.8 \pm 0.1	711.8 \pm 15.2	459.8 \pm 0.0
Period 2	1.00	4510.0 \pm 106.7	3.4 \pm 0.9	19.1 \pm 0.9	75.8 \pm 0.3	7.0 \pm 0.1	575.8 \pm 12.4	459.6 \pm 0.0
Period 3	1.00	4750.0 \pm 50.0	6.8 \pm 1.3	18.3 \pm 2.0	57.9 \pm 0.4	9.8 \pm 0.3	748.3 \pm 16.7	459.7 \pm 0.0
Peoria (RM 158-231)	15.75	5374.7 \pm 52.0	4.8 \pm 0.3	14.2 \pm 0.6	75.3 \pm 0.8	6.4 \pm 0.3	774.0 \pm 10.2	13.4 \pm 0.2
Period 1	5.25	5462.9 \pm 82.9	5.0 \pm 0.6	13.3 \pm 1.1	77.8 \pm 0.6	4.0 \pm 0.3	783.2 \pm 18.1	13.4 \pm 0.3
Period 2	5.25	5458.1 \pm 116.4	5.0 \pm 0.4	13.9 \pm 1.0	79.6 \pm 0.7	7.4 \pm 0.2	732.8 \pm 20.5	13.3 \pm 0.3
Period 3	5.25	5203.1 \pm 49.9	4.5 \pm 0.4	15.2 \pm 1.1	68.5 \pm 1.3	7.7 \pm 0.2	806.0 \pm 8.5	13.4 \pm 0.3
La Grange (RM 80-158)	2.25	5333.3 \pm 66.7	4.1 \pm 0.4	10.9 \pm 0.8	76.4 \pm 2.8	5.0 \pm 0.7	722.3 \pm 13.2	5.9 \pm 0.3
Period 1	0.75	5333.3 \pm 66.7	3.8 \pm 1.1	10.1 \pm 1.2	82.6 \pm 2.3	2.5 \pm 0.3	685.7 \pm 23.2	6.5 \pm 0.9
Period 2	0.75	5533.3 \pm 66.7	4.6 \pm 0.8	10.2 \pm 1.6	80.5 \pm 0.5	5.5 \pm 0.5	725.3 \pm 14.8	5.8 \pm 0.6
Period 3	0.75	5133.3 \pm 66.7	4.0 \pm 0.6	12.5 \pm 1.3	66.1 \pm 2.5	7.0 \pm 0.1	756.0 \pm 9.1	5.5 \pm 0.1
Alton (RM 0-80)	14.00	5213.7 \pm 64.4	6.2 \pm 0.9	10.1 \pm 0.2	76.2 \pm 1.0	6.6 \pm 0.3	734.4 \pm 7.3	16.5 \pm 0.6
Period 1	4.75	5192.3 \pm 175.6	6.3 \pm 1.5	9.3 \pm 0.4	81.5 \pm 0.7	6.7 \pm 0.7	725.3 \pm 9.4	16.6 \pm 1.5
Period 2	4.50	5179.4 \pm 68.5	11.5 \pm 2.3	11.0 \pm 0.4	79.6 \pm 0.6	6.2 \pm 0.2	687.2 \pm 10.0	17.2 \pm 0.3
Period 3	4.75	5267.6 \pm 44.7	4.8 \pm 1.1	10.1 \pm 0.4	67.6 \pm 1.1	7.0 \pm 0.1	788.2 \pm 3.7	15.7 \pm 1.0

Section 2.2 – 2023 Upper Illinois River Electrofishing Catch Statistics

We collected 1,956 fish representing 44 species and 4 hybrids during 2.3 hours of pulsed-DC electrofishing at a total of 9 sites in side-channel border habitat (3 fixed sites in each of 3 sampling periods) on the Upper Illinois and Lower Des Plains rivers. Bluegill was the most abundant species in our survey of this region (460 fish; 23.5% of total catch) followed by Emerald Shiner (333 fish; 17.0%), and Bullhead Minnow (169 fish; 8.6%). Largemouth Bass contributed the greatest biomass of fishes collected in the survey of this region (186.4 lb; 41.9% total collected biomass), followed by Common Carp (83.9 lb; 18.9%), and Smallmouth Buffalo (24.1 lb; 5.4%).

We collected 6,169 fish representing 63 species and 2 hybrids during 9.0 hours of pulsed-DC electrofishing at a total of 36 sites in main-channel border habitat (12 random sites in each of 3 sampling

periods) in this region. Gizzard Shad was the most abundant species in our survey of this region (1,120 fish; 18.2% of total catch) followed by Emerald Shiner (807; 13.1%), and Bluntnose Minnow (772; 12.5%). Silver Carp contributed the greatest biomass of fishes collected in the survey of this region (173.8 lb; 23.8% total collected biomass), followed by Smallmouth Buffalo (113.0 lb.; 15.5%), and Common Carp (88.7 lb; 12.1%).

Threatened and Endangered Species

We caught 105 banded killifish (*Fundulus diaphanus*) in the Upper Illinois River during this grant segment. We did not differentiate between the Eastern and Western subspecies, but will do so going forward, although most killifish sampled by other researchers working in the Illinois River are Eastern, and thus not native (Hartman et al. 2024). No other threatened or endangered species were caught in the Upper Illinois River during this grant segment.

Bluegill

Annual catch rates of Bluegill in the Upper Illinois River are variable but have remained higher than average for the past eight years in SCB habitat and the past two years in MCB habitats (Figure 2.1). The PSD values indicate that the Bluegill population has likely been dominated by small-bodied individuals for a while, but PSD has been above average for the last ten years in SCB habitat, perhaps an artifact of gear selection.

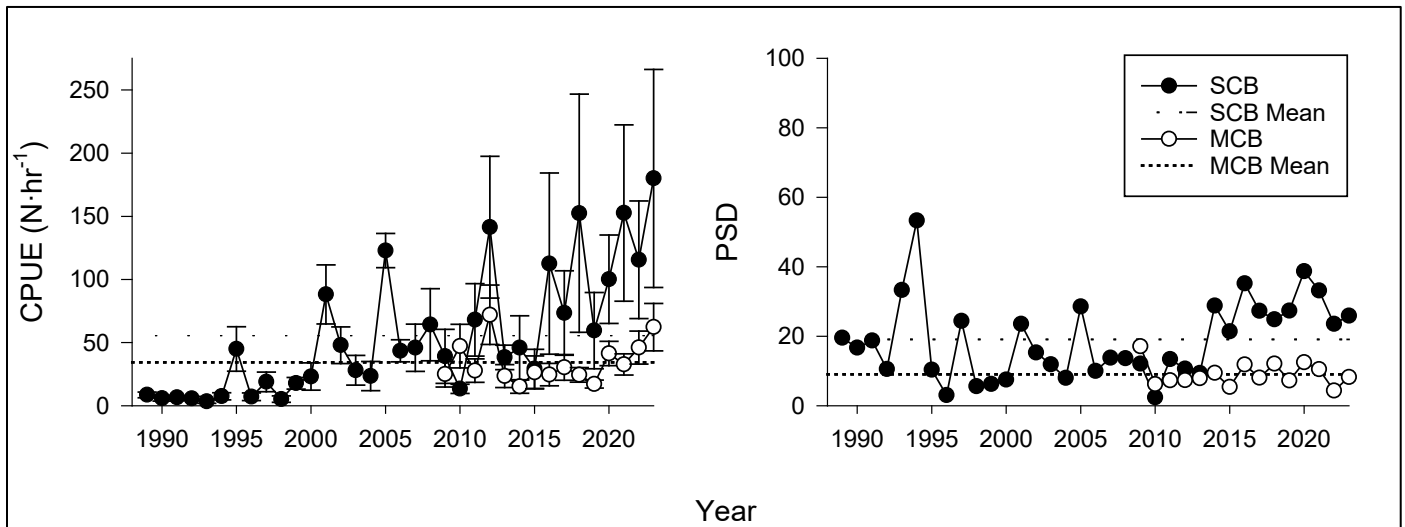


Figure 2.1. Catch per unit effort (mean \pm SE; SE is calculated across sites and periods for side-channel border sampling, and across sites and periods for main-channel border sampling) and proportional size distribution of Bluegill collected in side-channel border (SCB) and main-channel border (MCB) 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 2023 increased in both SCB and MCB habitats with both habitats catch rates higher than average since 2020. In 2022, the MCB habitat catch rate was below average for the first time since 2018 and the lowest recorded (Figure 2.2). The relative abundance of Channel Catfish is generally lower in the Upper Illinois River than the Lower Illinois River, but the Upper Illinois River has higher PSD averages indicating that surveys in the Upper Illinois River generally capture larger Channel Catfish.

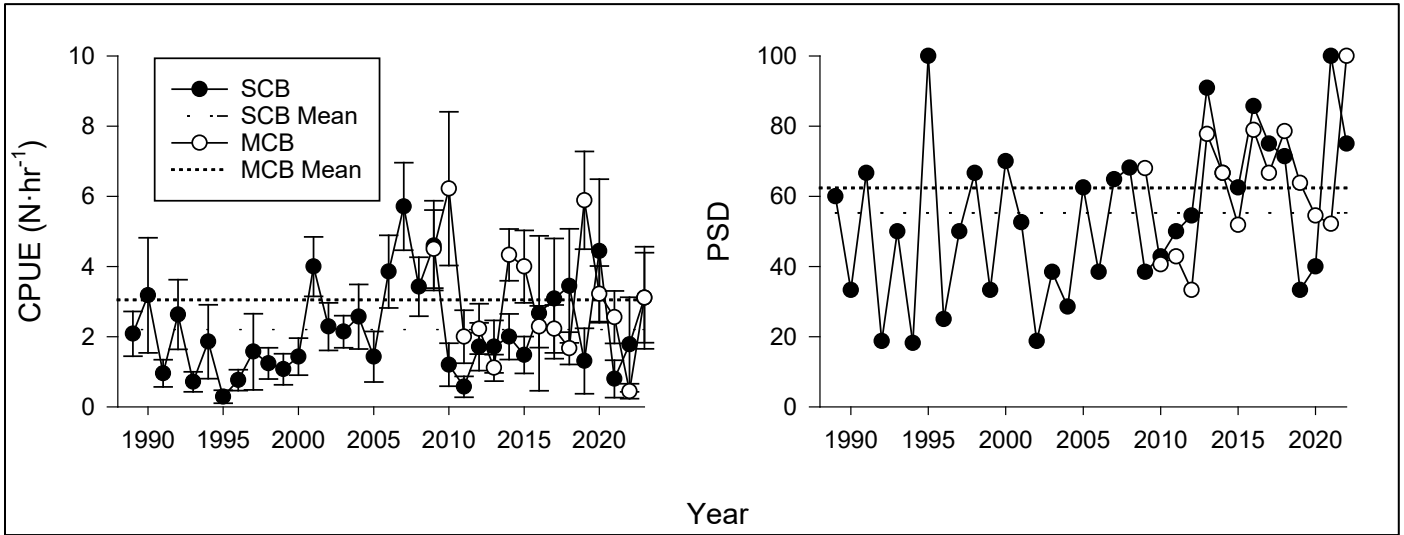


Figure 2.2. Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling initiated in 1989.

Largemouth Bass

Largemouth Bass CPUE was again high for SCB habitat (the third highest value on record) during 2023, though highly variable (Figure 2.3), likely reflecting the large number of fish sampled from Fixed Site 2, near Channahon, IL (Figure 1.2). The CPUE in MCB habitat was average during 2023. PSD values for SCB decreased but have remained similar for the past three years. The MCB habitat PSD decreased below the long-term averages with the increase in MCB habitat CPUE.

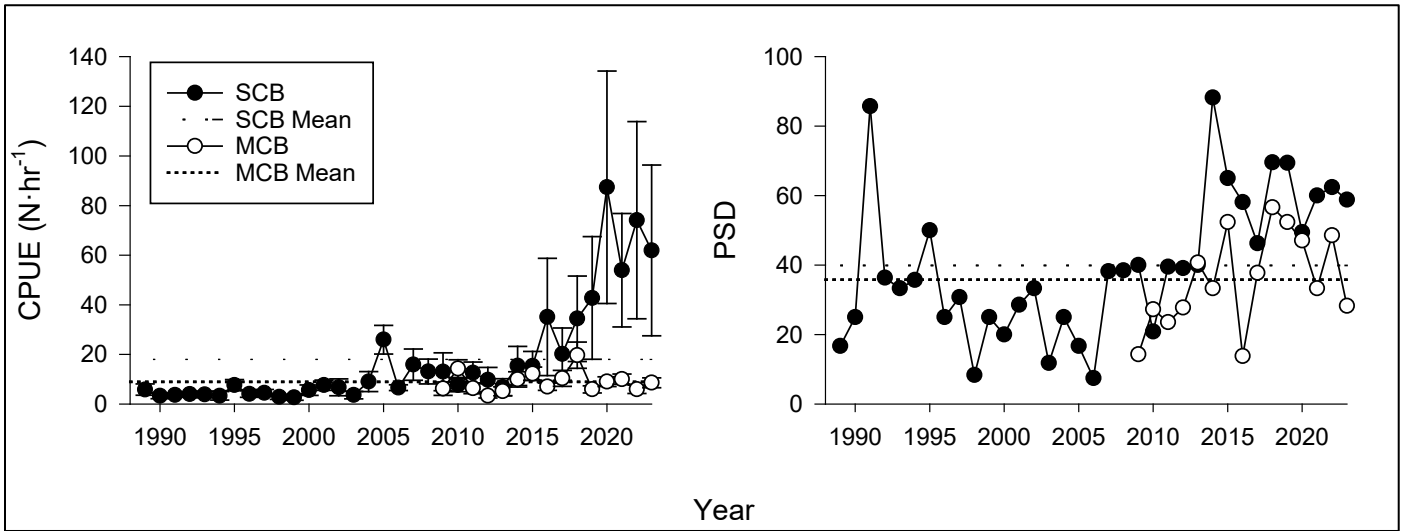


Figure 2.3. Catch per unit effort (mean ± SE) and proportional size distribution of Largemouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Smallmouth Bass

Catch rates of Smallmouth Bass in the Upper Illinois River during 2023 were above average in both SCB and MCB habitats and the highest on record for the SCB habitat (Figure 2.4). The variability of PSD values through time could indicate that Smallmouth Bass recruitment trends in this region are sporadic. Future studies on environmental variables in the Upper Illinois River could identify factors impacting Smallmouth Bass population dynamics.

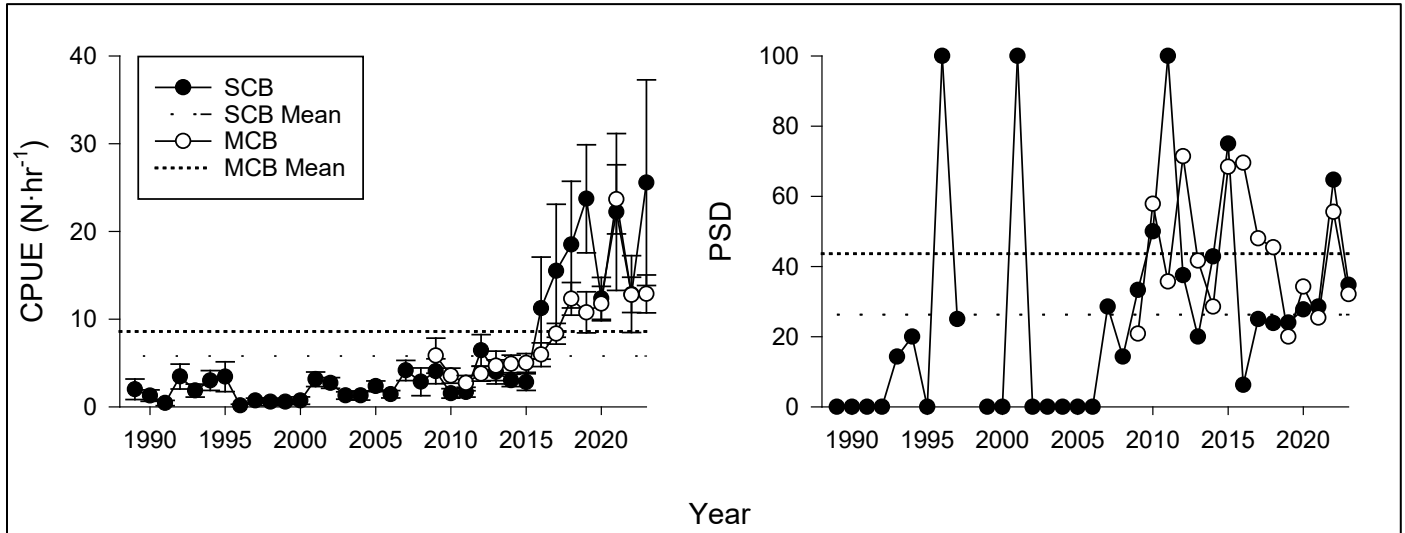


Figure 2.4. Catch per unit effort (mean \pm SE) and proportional size distribution of Smallmouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Upper Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R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

Section 2.3 – 2023 Lower Illinois River Electrofishing Catch Statistics

We collected 6,907 fish representing 53 species and 3 hybrids during 9.0 hours of pulsed-DC electrofishing at 36 sites in side-channel border habitat (12 fixed sites in each of 3 sampling periods) on the Lower Illinois River. Emerald Shiner was the most abundant species in our survey of this region (3,453 fish; 50.0% of total catch) followed by Gizzard Shad (1,397 fish; 20.2%), and Silver Carp (392 fish; 5.7%). Silver Carp contributed the greatest biomass of fishes collected in the survey of this region (1,516.9 lb; 55.6% total collected biomass), followed by Common Carp (550.4 lb; 20.2%), and Smallmouth Buffalo (135.6 lb; 5.0%).

We collected 15,246 fish representing 63 species and 2 hybrids during 22.5 hours of pulsed-DC electrofishing at 90 sites in main-channel border habitat (30 random sites in each of 3 sampling periods) in this region. Gizzard Shad was the most abundant species in our survey of this region (6,218 fish; 40.8% of total catch), followed by Emerald Shiner (5,506 fish; 36.1%), and Bluegill (497 fish; 3.3%). Silver Carp contributed the greatest biomass of fishes collected in the survey of this region (1,863.6 lb; 66.1% total collected biomass), followed by Common Carp (393.5 lb; 14.0%), and Smallmouth Buffalo (153.6 lb; 5.5%).

Threatened and Endangered Species

We caught 19 banded killifish (*Fundulus diaphanus*) in the Lower Illinois River during this grant segment. We did not differentiate between the Eastern and Western subspecies, but will do so going forward. No other threatened or endangered species were caught in the Lower Illinois River during this grant segment.

Black Crappie and White Crappie

The catch rate of Black Crappie and White Crappie in the SCB habitat in the Lower Illinois River decreased below average after increasing to above average in 2022 for the first time in five years (Figure 2.5). The CPUE of Black Crappie and White Crappie remained low and below average in MCB habitat. This trend likely indicates a preference for SCB habitat. The SCB habitat and MCB habitat PSD were both above average, inversely corresponding to their 2023 catch rates.

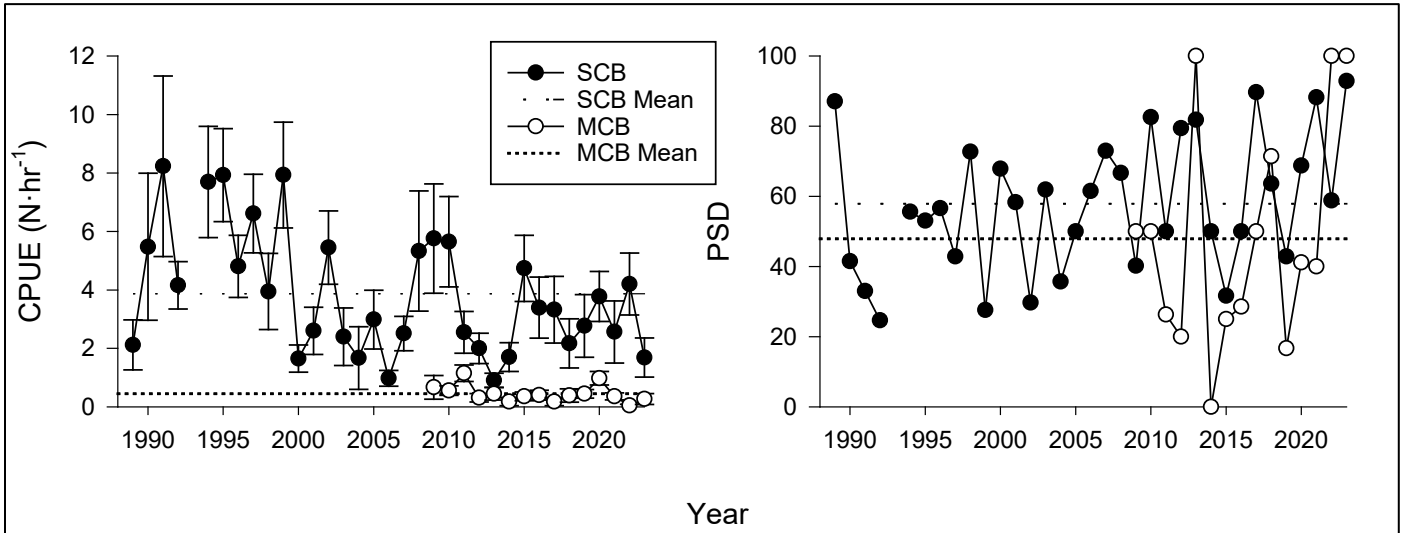


Figure 2.5. Catch per unit effort (mean \pm SE) and proportional size distribution of Black Crappie and White Crappie collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used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

Bluegill

Catch rates of Bluegill in the Lower Illinois River in 2023 continued to decrease to below the 2019 high value and the long-term average for the SCB habitat (Figure 2.6). The catch rate of Bluegill in MCB was the highest on record, although variable, and well above the long-term average. Like 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 generally high PSD values for SCB habitat and variable PSD values in MCB habitat is likely indicative of a population dominated by smaller, younger individuals, and possibly poor adult survival, which may be a result of depauperate overwintering habitat (Solomon et al. 2017).

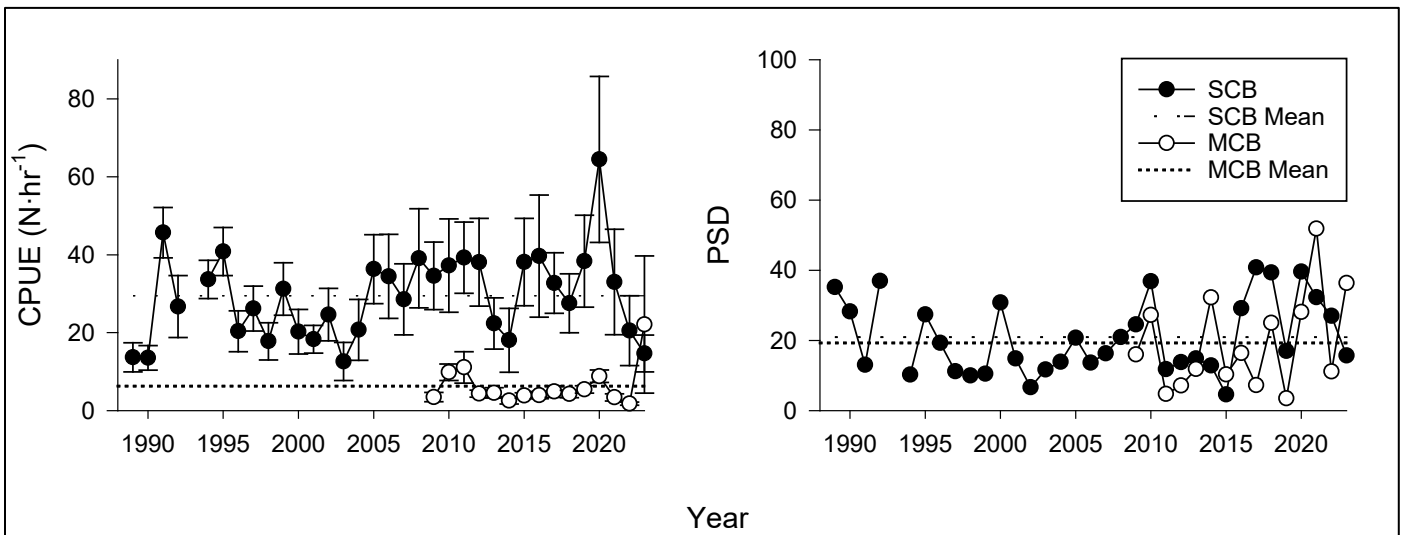


Figure 2.6. Catch per unit effort (mean \pm SE) and proportional size distribution of Bluegill collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Channel Catfish

Catch rates of Channel Catfish in the Lower Illinois River in 2023 continued to decrease for the second year in a row for both habitats (Figure 2.7). PSD values in 2023 in this region continued to decrease for the SCB habitat but increased for the MCB habitat, probably reflecting the decrease in MCB CPUE.

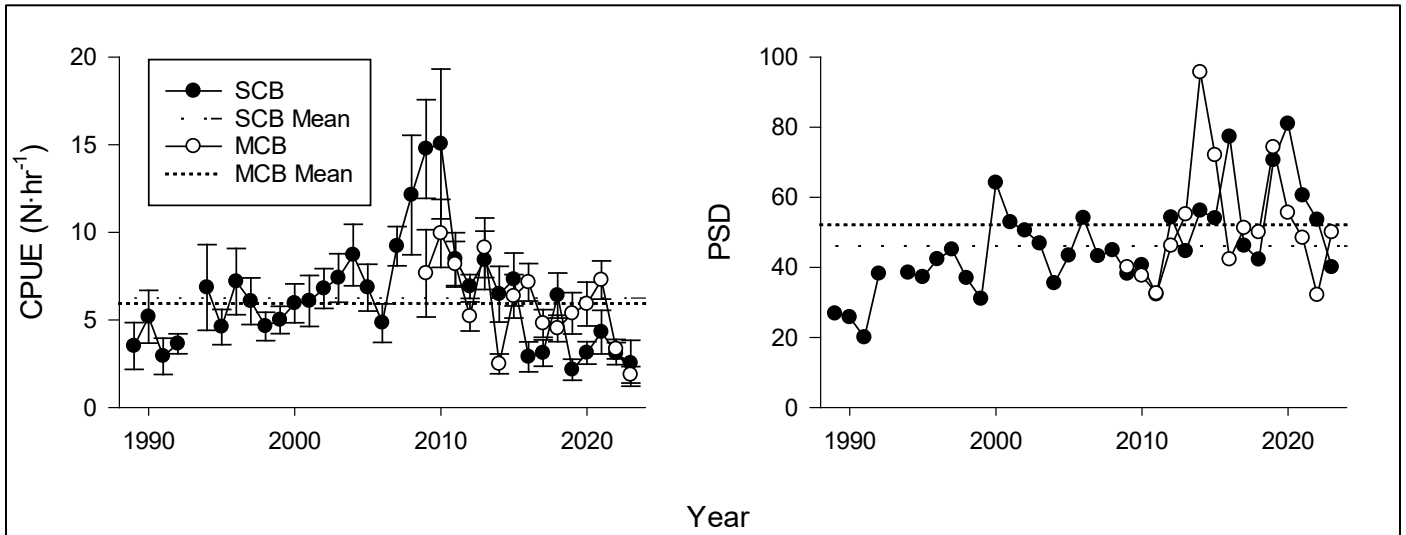


Figure 2.7. Catch per unit effort (mean \pm SE) and proportional size distribution of Channel Catfish collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R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

Largemouth Bass

Catch rates of Largemouth Bass in the Lower Illinois River during 2023 were below average in both habitats (Figure 2.8). The PSD value for Largemouth Bass in SCB habitat continued to decrease and was the lowest on record with the PSD value in MCB rebounding in 2023 from its record low in 2022. 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.

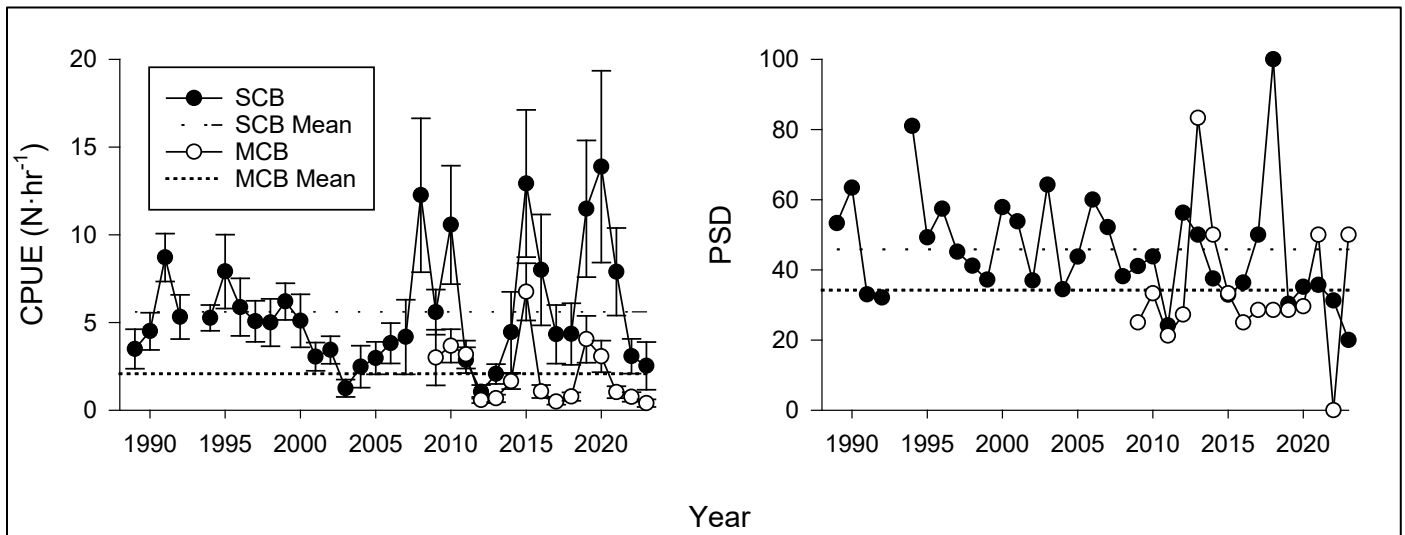


Figure 2.8. Catch per unit effort (mean \pm SE) and proportional size distribution of Largemouth Bass collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R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

White Bass

White Bass CPUE in the Lower Illinois River during 2023 remained below average in both MCB and SCB habitats (Figure 2.9). The PSD value for the SCB habitat remained above average for the seventh year in a row but decreased below average in the MCB habitat. 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.

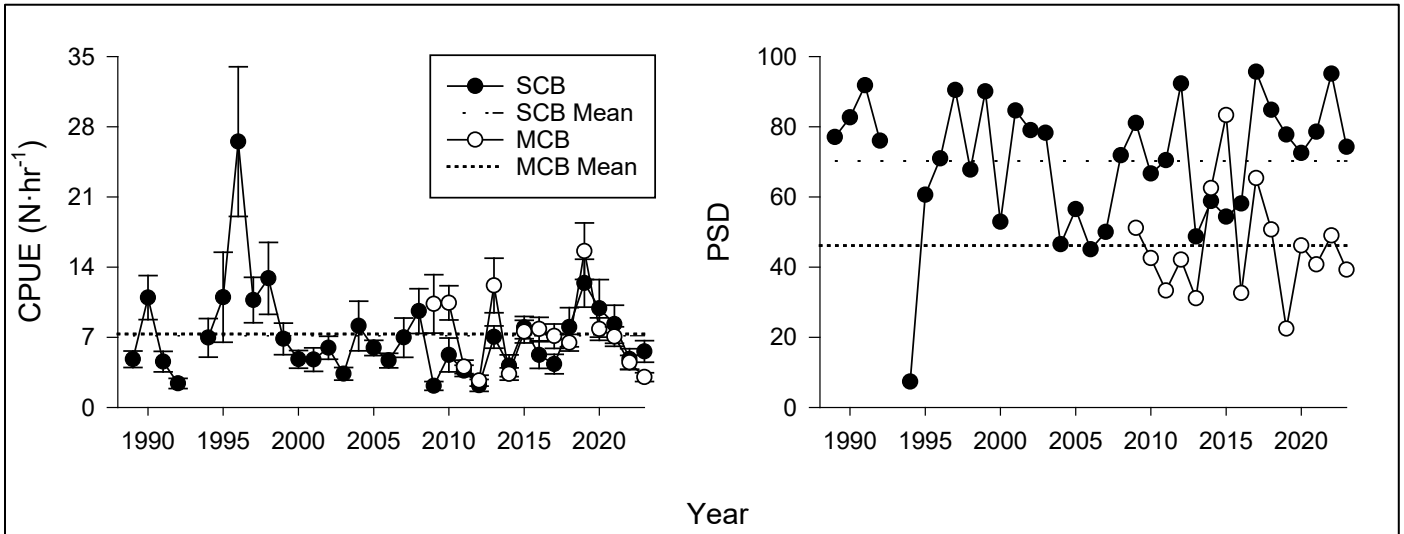


Figure 2.9. Catch per unit effort (mean \pm SE) and proportional stock-density of White Bass collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling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

Silver Carp

Silver Carp were first detected in F-101-R surveys in the IL River during 2001 (Figure 2.10). Silver Carp CPUE in both habitats were both above the long-term average with the SCB habitat CPUE remaining similar to 2022 and the MCB habitat CPUE increasing. The mean relative weight of Silver Carp for both MCB and SCB habitats collectively in the Lower Illinois River is significantly higher from 2020-2023 (97.99 ± 0.17) compared to 2010-2019 (95.10 ± 0.12 ; Figure 2.10).

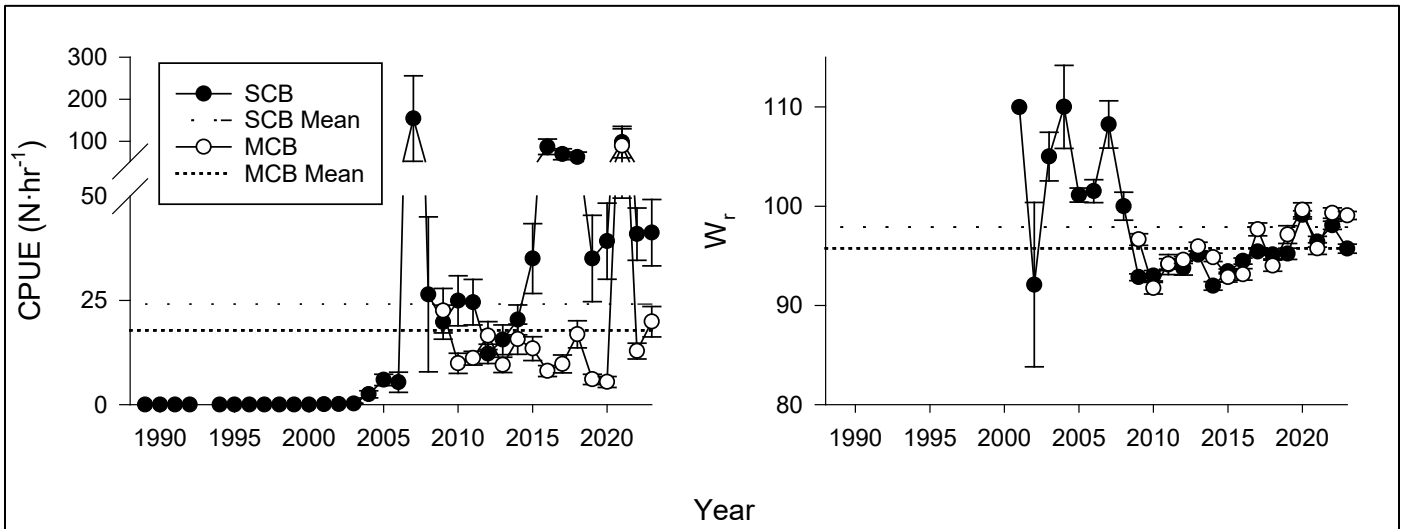


Figure 2.10. Catch per unit effort (mean \pm SE) and condition (relative weight- W_r) of Silver Carp collected in side-channel border and main-channel border electrofishing surveys in the Lower Illinois River. The dashed lines represent the long-term averages in each habitat type used since F-101-R sampling initiated in 1989.

CHAPTER 3 SPORTFISH ASSESSMENTS IN THE UPPER MS RIVER SAMPLING AREA

Sportfish populations were monitored in 6 pools (Pools 16-21) of the Mississippi River using boat-mounted pulsed-DC electrofishing gear. All sites were completed during the 2023 field season. In all study areas, sites were randomly selected using GIS layers of main-channel border habitats.

Section 3.1 - 2023 Upper Mississippi River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted between 8:55 AM and 4:20 PM central time during the three sampling periods specified in Section 1.2. Physical measurements for ancillary water-quality parameters were collected at each DC-sampling 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 navigational pools of the Upper Mississippi River during 2023. Values are expressed as mean \pm standard error. Period 1: 15 June – 31 July; Period 2: 1 August – 15 September; Period 3: 16 September – 31 October.

Navigational Pool	Total EF		Depth (ft)	Secchi Depth (in)	Water			Conductivity (μ S)	Stage Height (ft)
	Effort (h)	EF Power Used (Watts)			Temperature ($^{\circ}$ F)	DO (ppm)			
Pool 16 (RM 457-483)	3.75	3961.8 \pm 55.9	4.2 \pm 0.5	32.2 \pm 2.9	75.1 \pm 1.9	7.6 \pm 0.5	442.7 \pm 14.5	3.5 \pm 0.1	
Period 1	1.25	4004.0 \pm 24.0	4.3 \pm 0.2	24.5 \pm 1.3	78.6 \pm 0.1	9.0 \pm 0.5	452.0 \pm 6.3	3.9 \pm 0.0	
Period 2	1.25	4004.0 \pm 9.8	3.5 \pm 1.1	45.7 \pm 3.4	81.6 \pm 0.2	5.8 \pm 0.1	411.4 \pm 1.9	3.1 \pm 0.0	
Period 3	1.25	3877.4 \pm 171.6	4.7 \pm 1.0	26.5 \pm 3.1	65.1 \pm 0.6	8.0 \pm 0.8	464.6 \pm 42.2	3.4 \pm 0.0	
Pool 17 (RM 437-457)	3.00	3856.8 \pm 60.9	8.6 \pm 1.6	22.2 \pm 1.8	76.4 \pm 3.0	9.0 \pm 0.6	429.7 \pm 6.4	5.7 \pm 0.1	
Period 1	1.00	3925.0 \pm 57.4	5.3 \pm 0.6	18.2 \pm 2.3	81.5 \pm 0.3	11.0 \pm 0.9	432.5 \pm 13.1	5.4 \pm 0.0	
Period 2	1.00	4040.0 \pm 60.0	10.0 \pm 3.6	20.2 \pm 2.4	85.1 \pm 0.2	8.6 \pm 0.7	415.0 \pm 12.3	6.0 \pm 0.0	
Period 3	1.00	3605.5 \pm 12.1	10.5 \pm 2.9	28.1 \pm 2.3	62.5 \pm 0.1	7.3 \pm 0.4	441.5 \pm 1.9	5.9 \pm 0.0	
Pool 18 (RM 410.5-437)	3.75	3991.3 \pm 25.0	8.2 \pm 0.9	19.6 \pm 0.7	79.0 \pm 1.1	7.8 \pm 0.4	437.2 \pm 4.5	5.5 \pm 0.1	
Period 1	1.25	3964.0 \pm 16.0	5.7 \pm 1.5	17.6 \pm 0.6	81.5 \pm 0.4	9.0 \pm 0.1	426.0 \pm 7.2	6.1 \pm 0.0	
Period 2	1.25	4030.0 \pm 55.1	9.8 \pm 0.8	21.3 \pm 0.4	82.1 \pm 0.4	8.3 \pm 0.4	430.8 \pm 1.5	5.2 \pm 0.0	
Period 3	1.25	3980.0 \pm 51.8	9.0 \pm 1.5	20.0 \pm 1.7	73.5 \pm 0.6	6.1 \pm 0.2	454.8 \pm 6.6	5.2 \pm 0.0	
Pool 19 (RM 364.5-410.5)	6.75	3986.1 \pm 33.1	4.3 \pm 0.6	22.0 \pm 1.3	75.6 \pm 1.4	6.7 \pm 0.4	449.5 \pm 2.9	8.0 \pm 0.1	
Period 1	2.25	4059.9 \pm 35.2	3.4 \pm 0.9	24.3 \pm 2.5	79.2 \pm 0.9	8.6 \pm 0.6	457.6 \pm 5.7	8.4 \pm 0.1	
Period 2	2.25	4040.9 \pm 28.8	4.6 \pm 1.0	21.2 \pm 2.6	79.6 \pm 1.0	5.3 \pm 0.4	436.3 \pm 2.1	7.7 \pm 0.1	
Period 3	2.25	3857.6 \pm 73.9	5.0 \pm 1.3	20.6 \pm 1.8	68.0 \pm 2.7	6.1 \pm 0.4	454.7 \pm 3.2	8.0 \pm 0.0	
Pool 20 (RM 343-364.5)	3.00	3925.5 \pm 29.6	7.7 \pm 1.2	21.3 \pm 1.4	76.8 \pm 1.0	5.3 \pm 0.3	432.3 \pm 8.1	7.3 \pm 0.1	
Period 1	1.00	4036.5 \pm 12.8	6.6 \pm 1.4	23.4 \pm 3.3	78.3 \pm 0.1	5.8 \pm 0.2	458.8 \pm 3.8	7.1 \pm 0.1	
Period 2	1.00	3838.0 \pm 15.5	10.4 \pm 3.2	19.1 \pm 1.7	79.7 \pm 1.0	4.2 \pm 0.3	401.0 \pm 5.7	6.9 \pm 0.0	
Period 3	1.00	3902.0 \pm 48.6	6.0 \pm 1.1	21.3 \pm 1.7	72.5 \pm 0.1	5.9 \pm 0.2	437.3 \pm 10.5	7.9 \pm 0.0	
Pool 21 (RM 325-343)	3.00	4005.0 \pm 20.2	7.6 \pm 0.9	20.4 \pm 1.4	76.1 \pm 1.1	6.7 \pm 0.4	454.3 \pm 2.1	11.4 \pm 0.1	
Period 1	1.00	4010.0 \pm 10.0	7.3 \pm 1.9	19.1 \pm 3.0	81.0 \pm 0.1	8.1 \pm 0.1	449.0 \pm 2.7	11.2 \pm 0.0	
Period 2	1.00	4010.0 \pm 10.0	9.3 \pm 1.5	20.8 \pm 2.4	74.5 \pm 0.2	5.7 \pm 0.3	452.0 \pm 1.3	11.5 \pm 0.0	
Period 3	1.00	3995.0 \pm 65.0	6.1 \pm 1.4	21.4 \pm 2.1	72.9 \pm 0.8	6.2 \pm 0.5	462.0 \pm 2.9	11.6 \pm 0.0	

Section 3.2 - 2023 Upper Mississippi River Electrofishing Catch Statistics

We collected 19,660 fish representing 66 species and 2 hybrids during 23.25 hours of pulsed-DC electrofishing at 93 sites in main-channel border habitat (31 random sites in each of 3 sampling periods). Emerald Shiner was the most abundant species in our surveys of this region (9,486 fish; 48.3% of total catch) followed by Gizzard Shad (2,199 fish; 11.2%), and Channel Shiner (2,099 fish; 10.7%). Common Carp contributed the greatest biomass of fishes collected in the surveys of this region (1,286.9 lb; 51.9% total collected biomass), followed by Smallmouth Buffalo (168.9 lb; 6.8%), and Silver Carp (149.5 lb; 6.0%).

Threatened and Endangered Species

We caught 4 banded killifish (*Fundulus diaphanus*) in the Upper MS River Sampling Area during this grant segment. We did not differentiate between the Eastern and Western subspecies, but will do so going forward. No other threatened or endangered species of Illinois or surrounding states were collected during pulsed-DC electrofishing surveys of this region during 2023.

Bluegill

Catch rates of Bluegill in the Upper Mississippi River during 2023 were above average (Figure 3.1). This continues a largely upward trend since 2015. The PSD values indicate that the Bluegill population of the Upper Mississippi River is dominated by smaller individuals, but PSD has been variable since 2009.

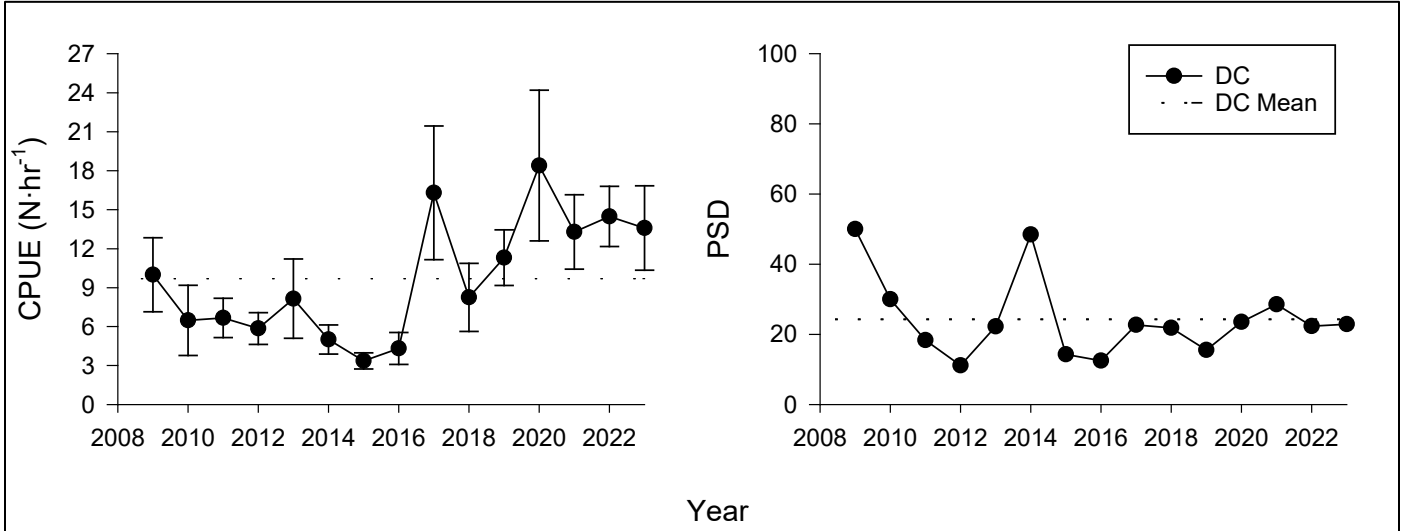


Figure 3.1. Catch per unit effort (CPUE; mean \pm SE, calculated across sites and periods) and proportional size distribution (PSD) of Bluegill collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-101-R sampling expanded in 2009.

Channel Catfish

Catch rates of Channel Catfish in the Upper Mississippi River during 2023 were the lowest on record since this sampling started in 2009 (Figure 3.2). The PSD in 2022 was also low, compared to the long-term average in this region, hopefully indicating an influx of younger fish.

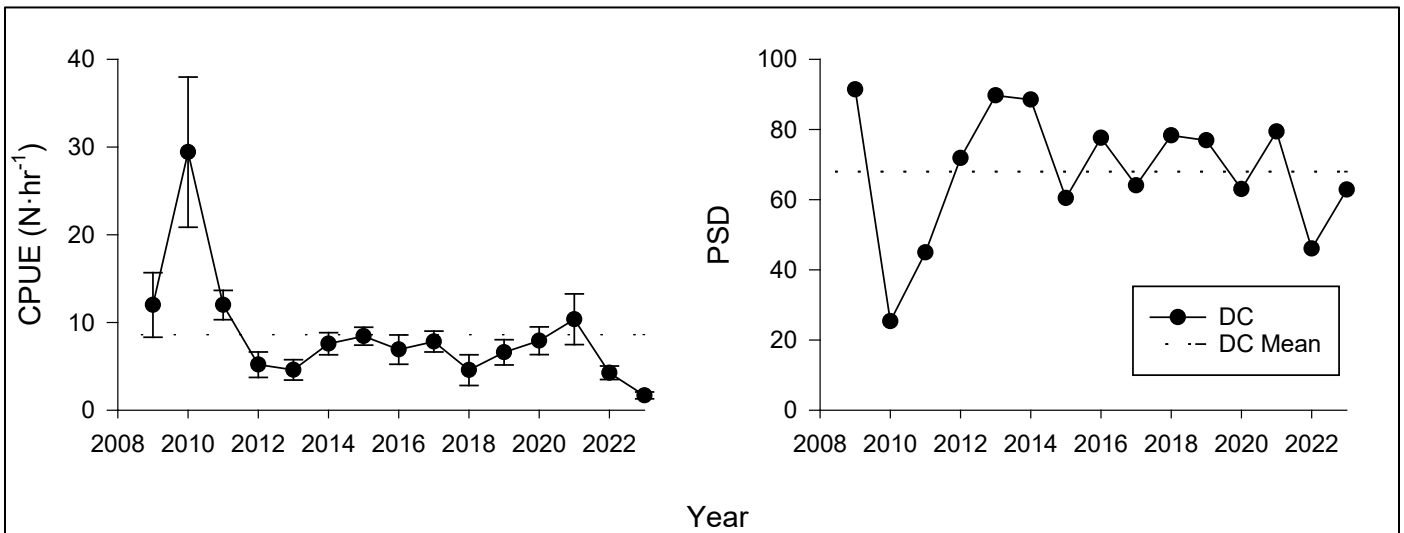


Figure 3.2. Catch per unit effort (CPUE; mean \pm SE, calculated across sites and periods) and proportional size distribution (PSD) of Channel Catfish collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-101-R sampling expanded in 2009.

Largemouth Bass

Largemouth Bass CPUE in 2023 was the highest on record (Figure 3.3). Largemouth Bass catch rates have been more variable during the last 10 years than most other species reported for this sampling area. PSD values were below average, and appear to indicate a balance of large and small individuals in the region.

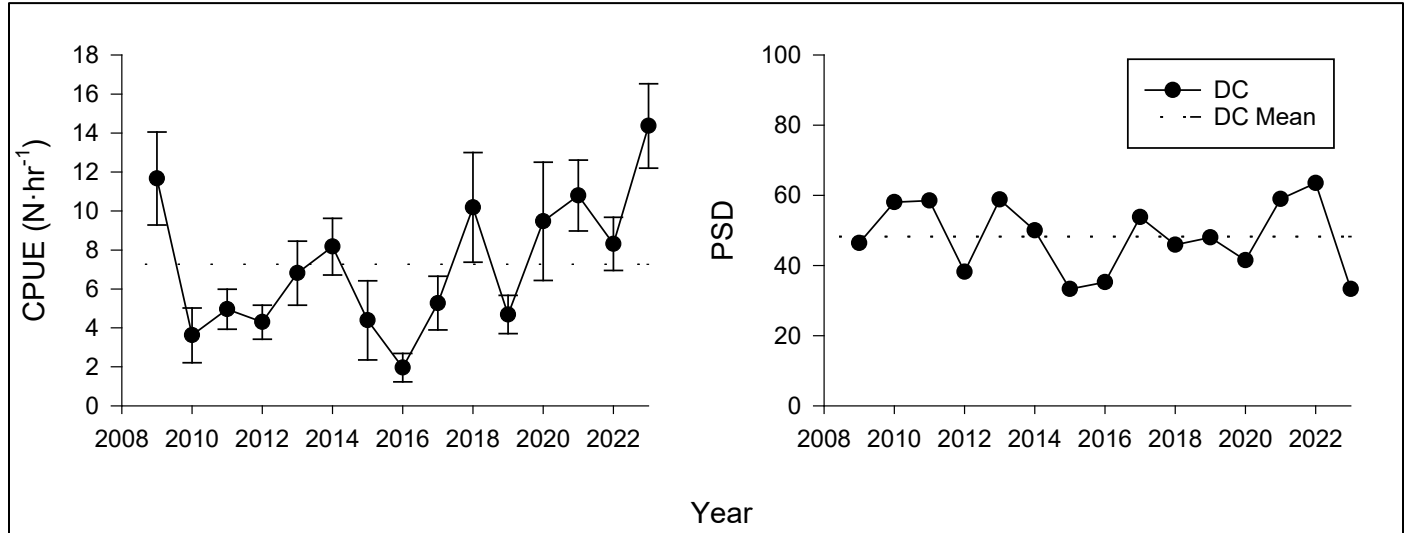


Figure 3.3. Catch per unit effort (CPUE; mean \pm SE, calculated across sites and periods) and proportional size distribution (PSD) of Largemouth Bass collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-101-R sampling expanded in 2009.

Smallmouth Bass

Catch rates of Smallmouth Bass in the Upper Mississippi River were slightly below average during 2023 (Figure 3.4). The variability of PSD values through time indicates that Smallmouth Bass recruitment trends in this region are likely sporadic. Years of high CPUE (e.g., 2012, 2017) correspond with years of low PSD, indicating episodic strong recruitment.

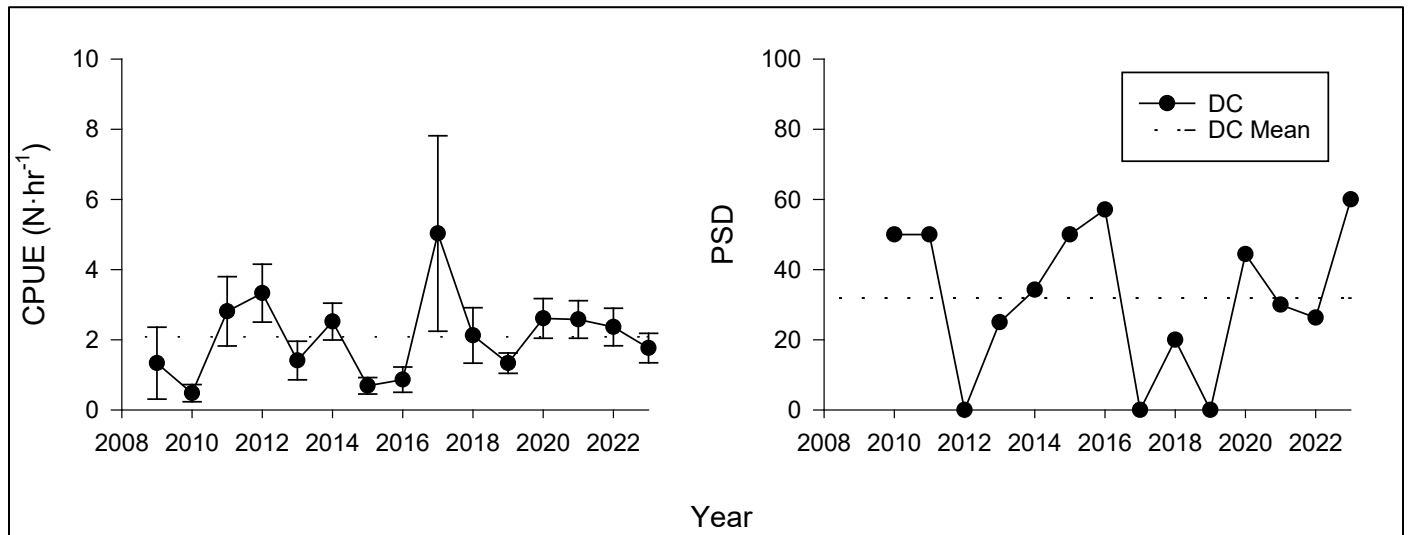


Figure 3.4. Catch per unit effort (CPUE; mean \pm SE, calculated across sites and periods) and proportional size distribution (PSD) of Smallmouth Bass collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-101-R sampling expanded in 2009.

White Bass

Catch rates of White Bass in the Upper Mississippi River were slightly average during 2023 (Figure 3.5), showing a decrease for the third year in a row. The variability of PSD values through time indicates that White Bass recruitment trends in this region are sporadic. Unlike Smallmouth Bass, years of high CPUE (e.g., 2011, 2020) do not necessarily correspond with years of low PSD.

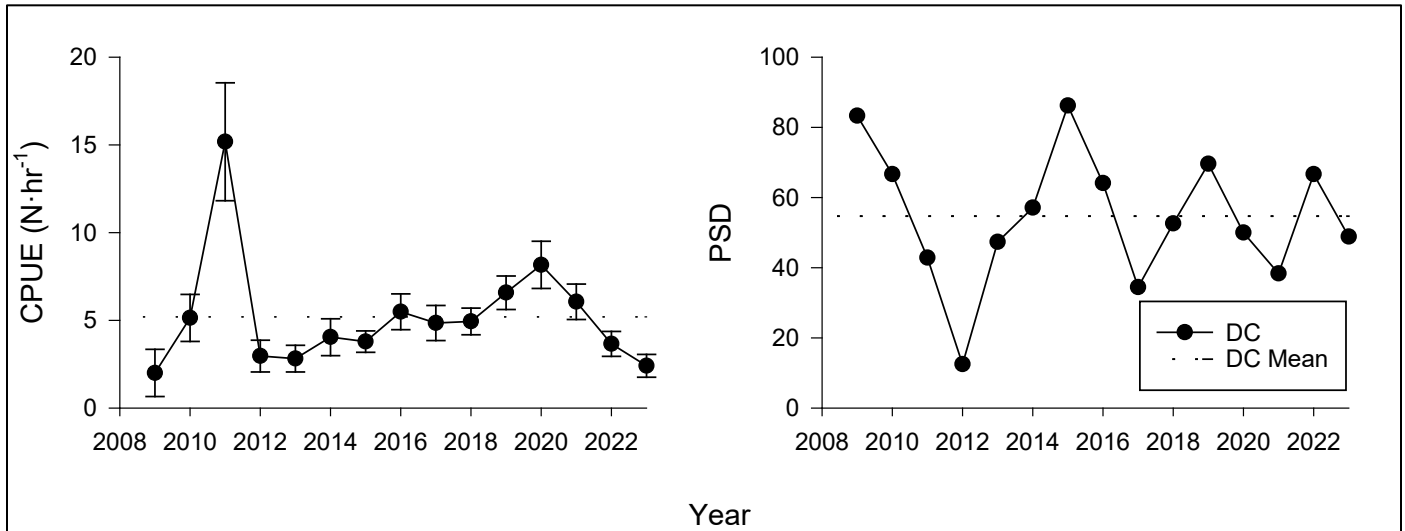


Figure 3.5. Catch per unit effort (CPUE; mean \pm SE, calculated across sites and periods) and proportional size distribution (PSD) of White Bass collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-101-R sampling expanded in 2009.

Silver Carp

Catch rates of Silver Carp are presented for Pools 20 and 21 only, as populations above Lock & Dam 19 are much less abundant and generally inhabit off-channel areas, and thus are rarely encountered in F-101-R sampling. Catch rates of Silver Carp in the Upper Mississippi River were below average during 2023 (Figure 3.6), and W_r increased to 112.2, the highest on record. Decreasing CPUE since 2017 appears to correspond to increased W_r , though more years of data are likely required for a more-robust analysis.

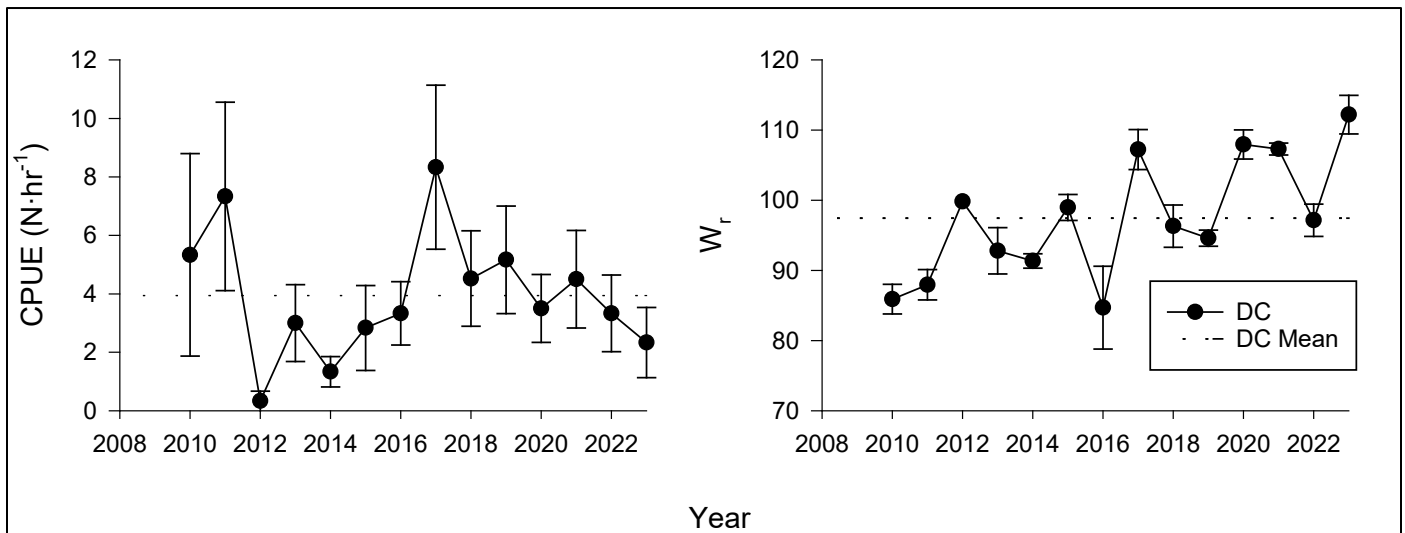


Figure 3.6. Catch per unit effort (CPUE; mean \pm SE, calculated across sites and periods) and proportional size distribution (PSD) of Silver Carp collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-101-R sampling expanded in 2009.

CHAPTER 4 SPORTFISH ASSESSMENTS IN THE LOWER MS RIVER SAMPLING AREA

Sportfish populations were monitored in 1 pool and 2 unimpounded reaches of the Mississippi River using boat-mounted pulsed-DC electrofishing gear: Pool 25, the Chain of Rocks Reach, and the Kaskaskia Reach (the Lower Mississippi River Sampling Area). All sites were completed during the 2023 field season. In all study areas, sites were randomly selected using GIS layers of main-channel border habitats.

Section 4.1 – 2023 Lower Mississippi River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted according to the methods described in Section 1.2 between 8:52 AM and 1:36 PM central time during the three sampling periods specified in Section 1.2. Physical measurements for ancillary water-quality parameters were collected at each site and are summarized in Table 4.1.

Table 4.1. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on three sampling areas of the Lower Mississippi River Sampling Area during 2023. Values are expressed as mean \pm standard error.

Navigational Pool or Reach	Total EF Effort	EF Power Used	Depth	Secchi Depth	Water Temperature	DO	Conductivity	Stage Height
	(h)	(Watts)	(ft)	(in)	(°F)	(ppm)	(μ S)	(ft)
Pool 25 (RM 242-273.5)	4.50	3895.5 \pm 38.2	4.4 \pm 0.9	18.1 \pm 0.7	78.3 \pm 0.5	8.5 \pm 0.5	422.7 \pm 8.3	34.4 \pm 0.1
Period 1	1.50	3961.3 \pm 15.3	4.9 \pm 1.1	17.8 \pm 1.1	80.1 \pm 0.6	10.8 \pm 0.7	435.7 \pm 3.4	34.9 \pm 0.0
Period 2	1.50	3681.5 \pm 2.0	\pm	20.3 \pm 1.1	79.1 \pm 0.4	7.1 \pm 0.2	376.7 \pm 0.9	34.2 \pm 0.0
Period 3	1.50	4043.7 \pm 15.4	3.9 \pm 1.7	16.2 \pm 0.8	75.7 \pm 0.2	7.5 \pm 0.1	455.7 \pm 2.9	34.5 \pm 0.0
Chain of Rocks (RM 165.5-200.5)	5.25	4674.6 \pm 149.4	7.3 \pm 1.2	11.9 \pm 1.0	76.4 \pm 1.5	7.3 \pm 0.3	604.4 \pm 30.4	0.6 \pm 0.7
Period 1	1.75	4904.7 \pm 252.9	6.3 \pm 1.7	12.4 \pm 1.5	81.3 \pm 0.9	8.3 \pm 0.6	606.1 \pm 46.2	1.8 \pm 0.2
Period 2	1.75	4595.6 \pm 265.2	7.9 \pm 2.7	10.1 \pm 2.1	79.6 \pm 0.6	5.9 \pm 0.3	574.9 \pm 56.2	1.1 \pm 2.1
Period 3	1.75	4523.4 \pm 274.2	7.4 \pm 2.1	13.2 \pm 1.3	68.2 \pm 2.3	7.6 \pm 0.1	632.3 \pm 60.6	-1.1 \pm 0.7
Kaskaskia (RM 117-165.5)	7.50	4827.5 \pm 51.2	6.5 \pm 0.9	11.8 \pm 0.4	76.9 \pm 1.6	6.9 \pm 0.1	638.7 \pm 10.8	3.0 \pm 0.4
Period 1	2.50	4954.2 \pm 57.1	8.1 \pm 2.1	11.8 \pm 0.5	83.3 \pm 0.3	6.4 \pm 0.2	613.2 \pm 16.7	4.8 \pm 0.2
Period 2	2.50	4915.8 \pm 89.7	5.3 \pm 1.4	12.5 \pm 0.8	82.3 \pm 0.3	6.7 \pm 0.1	617.3 \pm 14.3	1.3 \pm 0.2
Period 3	2.50	4612.5 \pm 79.2	6.7 \pm 1.3	11.1 \pm 0.6	65.0 \pm 0.8	7.5 \pm 0.1	685.7 \pm 16.8	2.7 \pm 0.5

Section 4.2 – 2023 Lower Mississippi River Sampling Area Pulsed-DC Electrofishing Catch Statistics

We collected 6,349 fish representing 48 species and 2 hybrids during 17.25 hours of pulsed-DC electrofishing at 69 sites (23 random sites in each of 3 sampling periods) in the Lower Mississippi River Sampling Area. Emerald Shiner was the most abundant species in our catch (3,455 fish; 54.4% of total catch), followed by Gizzard Shad (985; 15.5%); all other species were each less than 4% of the total abundance. Common Carp represented the largest proportion of the total collected biomass (585.7 lb; 28.6% of total collected biomass), followed by Silver Carp (477.2 lb; 23.3%), and Smallmouth Buffalo (208.7 lb; 10.2%).

Threatened and Endangered Species

We caught 1 banded killifish (*Fundulus diaphanus*) in the Lower MS River Sampling Area during this grant segment. We did not differentiate between the Eastern and Western subspecies, but will do so going forward. No other threatened or endangered species were collected during pulsed-DC electrofishing surveys of this region during 2023.

Bluegill

The catch rate of Bluegill in the Lower Mississippi River Sampling Area during 2023 was below average (Figure 4.1). The PSD value was below average as well. Prolonged 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.

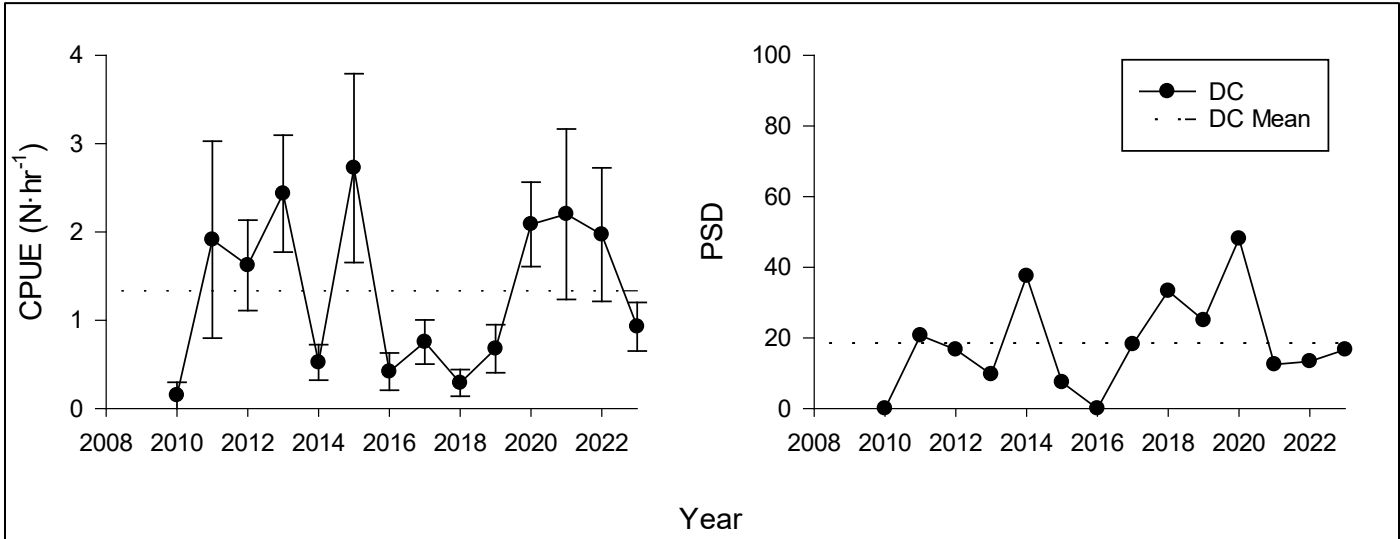


Figure 4.1. Catch per unit effort (mean ± SE) and proportional size distribution of Bluegill collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling expanded in 2009.

Channel Catfish

Catch rate of Channel Catfish in the Lower Mississippi River Sampling Area was well below average during 2023 (Figure 3.2). The PSD value during 2023 increased to slightly above average for the first time since 2018.

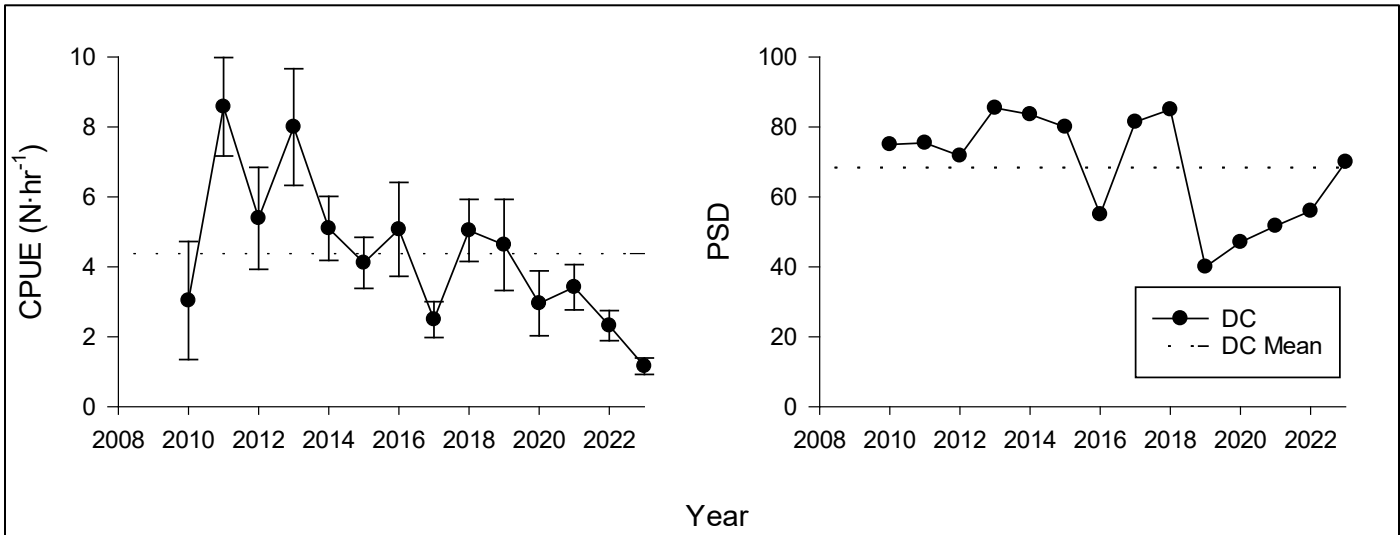


Figure 4.2 Catch per unit effort (mean ± SE) and proportional size distribution of Channel Catfish collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling expanded in 2009.

Flathead Catfish

The catch rate of Flathead Catfish increased in 2023 and remained well above the long-term average (Figure 4.3). Similar to Channel Catfish, Flathead Catfish PSD values remained below average, which reflects an increase in smaller fish sampled in the lower Mississippi sampling area, perhaps indicating an uptick in recruitment or a decrease in larger-bodied adult fish.

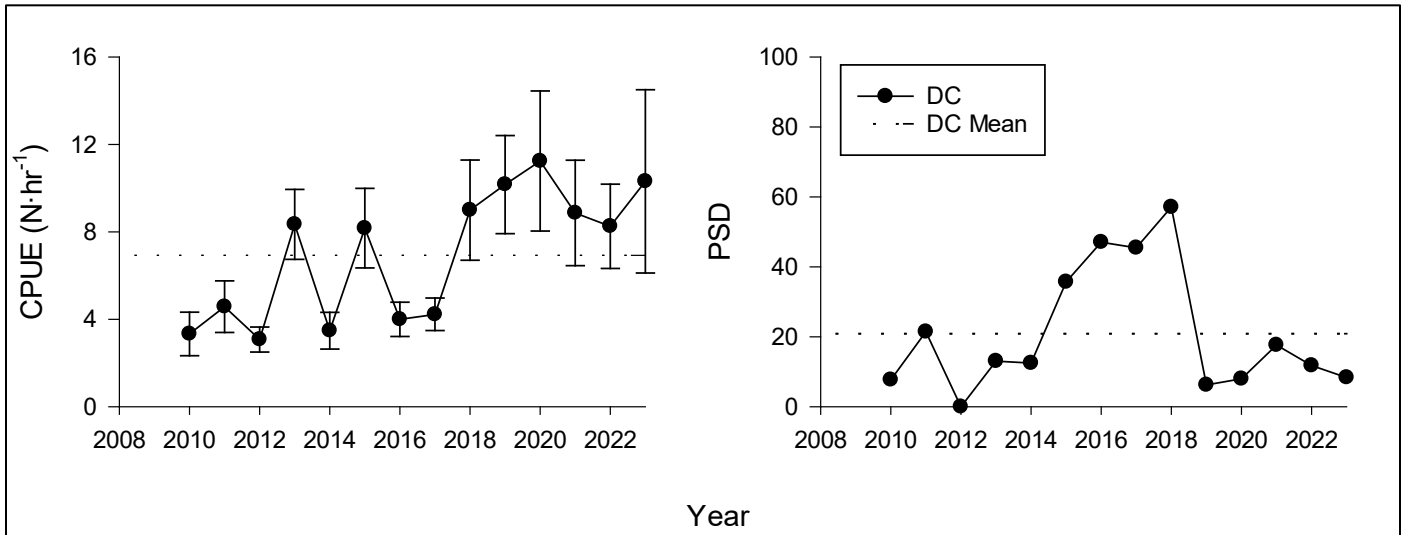


Figure 4.3. Catch per unit effort (mean \pm SE) and proportional size distribution of Flathead Catfish collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling expanded in 2009.

White Bass

White Bass CPUE remained below average in 2023, although CPUE in the Lower Mississippi River Sampling Area has been erratic since 2009 (Figure 4.4), tied to highly variable PSD values. Years of high CPUE (e.g., 2013, 2019) correspond with years of low PSD, potentially indicating, episodic strong recruitment.

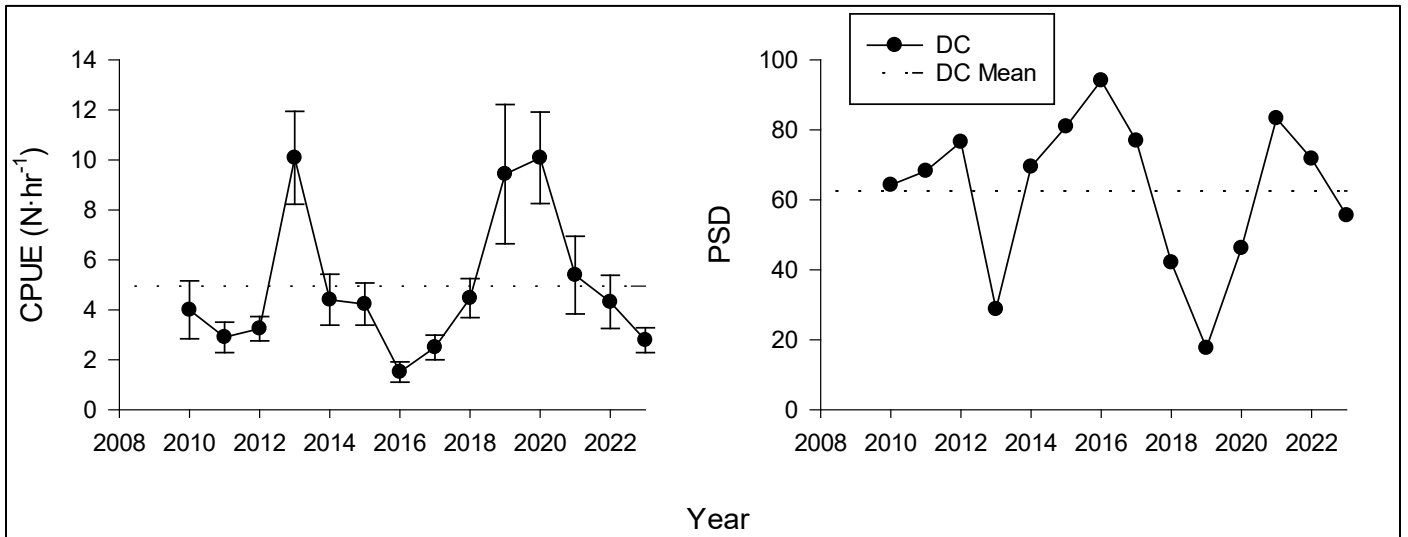


Figure 4.4. Catch per unit effort (mean \pm SE) and proportional size distribution of White Bass collected by pulsed-DC electrofishing surveys in the Lower Mississippi River Reaches. The dashed lines represent the long-term averages since F-101-R sampling expanded in 2009.

Silver Carp

Catch rates of Silver Carp in the Lower Mississippi River Sampling Area remained below average during 2023 (Figure 4.5). The W_r value increased again in 2023, with the decrease in CPUE likely contributing to the increase in W_r values. Similar to the Upper MS River Sampling Area, Silver Carp W_r appears to be increasing over time.

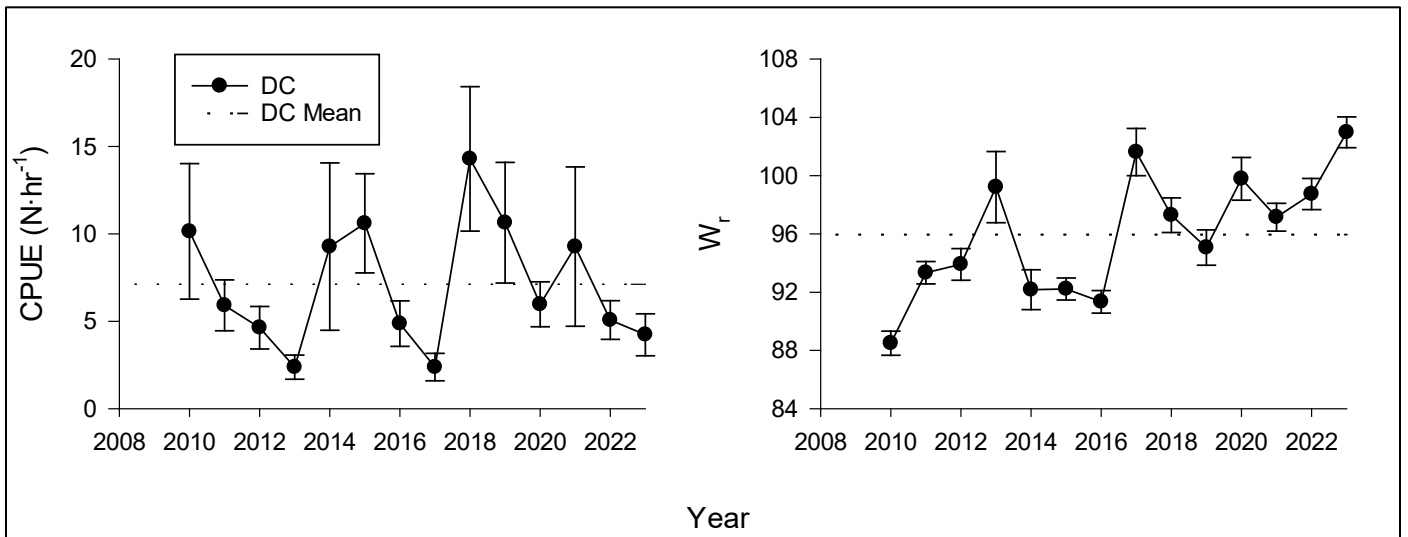


Figure 4.5. Catch per unit effort (mean \pm SE) and condition (relative weight- W_r) of Silver Carp collected by pulsed-DC electrofishing survey in the Lower Mississippi River Sampling Area. The dashed lines represent the long-term averages since F-101-R sampling expanded in 2009.

CHAPTER 5 DISCUSSION and RECOMMENDATIONS

Fish monitoring conducted on the Illinois River Waterway and Mississippi River during 2023 was useful for describing the diversity and heterogeneity of fish communities in these 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 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 comprise 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 White Bass or 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 sampled segments. Overall, catch rates during 2023 increased in the Upper Illinois River and decreased in the Lower Illinois River, while catch rates in the Upper MS River Sampling Area varied by species, and Lower MS River Sampling Area mostly decreased. In the Upper Illinois River, above-average catch rates of Largemouth Bass, Smallmouth Bass, and Bluegill have persisted for the past eight years in SCB habitat. In 2023, CPUE of Smallmouth Bass in the Upper Illinois River SCB habitat increased above the 2021 high-catch record. The PSD of Largemouth Bass in the Upper Illinois River has also remained above average for the past 10 years, with the PSD of Smallmouth Bass annually variable. In the Lower Illinois River, catch rates generally remained higher in SCB habitat for Bluegill, Largemouth Bass, White Bass, and Silver Carp, likely indicating a preference for this habitat. In the Upper MS River Sampling Area, there were decreases in catch rates of Channel Catfish and White Bass, with increases in Largemouth Bass; Bluegill and Smallmouth Bass were largely unchanged. Changes in PSD values did not necessarily mirror changes to catch rates, unlike years past. In the Lower MS River Sampling Area, catch rates of Bluegill, Channel Catfish, and White Bass showed slight decreases in 2023. Of these species, changes to PSD values did not appear uniformly related to catch rates. Despite a slight decrease in catch rates, PSD values for White Bass decreased for the second straight year. Bluegill PSD values were average, despite a decrease in catch rate. Our long-term datasets allow us to observe substantial annual variations in the relative abundance and size distribution of many sportfish species. These observations in all segments of both rivers could serve as a catalyst for future research investigating the effects of environmental changes and management policies on the sustainability of Illinois' sportfish populations.

Invasive Species

Although the primary focus of the F-101-R program is 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. In the Lower Illinois River, 2023 catch rates of Silver Carp remained the same in SCB habitat but increased above average in MCB. The body condition of Silver Carp for both MCB and SCB habitats collectively in the Lower Illinois River was significantly higher from 2020-2023 (97.99 ± 0.17) compared to 2010-2019 (95.10 ± 0.12 ; Figure 2.10). Silver Carp and Common Carp contribute the greatest biomass of fishes to the Lower Illinois River. In the Upper MS River Sampling Area, Silver Carp catch rates were below average and have largely decreased since 2017. Silver Carp biomass ranked third overall, while Common Carp biomass retained its top spot. In the Lower MS River Sampling Area, Silver Carp catch rate decreased for the second straight year, while body condition continued to increase above levels observed in 2018. Common Carp continued to contribute the greatest percent biomass while contributing 2.3% of the total catch. Additionally, Grass Carp decreased sharply from 6.7% of the total biomass in 2021 to 1.6% in 2022, but increased to 2.5% in 2023. Changes to Grass Carp populations may warrant further investigation in future years.

CHAPTER 6 STOCK ASSESSMENTS IN THE IL AND MS RIVERS

Section 6.1 – Stock assessment using historic age and length data

Work continues to characterize region-wide and reach-specific riverine sportfish demographics using bony structure-derived age estimates and body lengths. The collation of individual- and sampling site-level data is still in-progress, but currently represents 14 datasets from 5 regional partner agencies. An iterative process of data collation, exploration, quality evaluation, and paring is ongoing and will be critical to successful stock assessment efforts. Teams of technicians continue to section and age bony structures in the lab.

Responsibilities for this work will transition beginning July 2024 as a new quantitative ecologist is brought on to the LTEF team to lead this effort. The remainder of 2024 will serve as a transitional period during which the stock assessment projects will benefit from both the new staff member and existing quantitative staff. By the end of 2024, this new team member will direct the project.

Section 6.2 – Statistical evaluation of LTEF sampling design effort allocations

Current allocations of sampling effort are being evaluated to define levels of statistical precision and power met by the current sampling design for comparing fisheries metrics across years, river reaches, strata, etc. Fisheries metrics of interest include mean CPUE, PSD, and body condition (W_r). Major research goals include establishing probabilistic expectations for detecting varying effect sizes in temporal or spatial comparisons of these metrics, as well as identifying opportunities for improving effect detection through additional effort allocation or temporal or spatial redistribution of current effort.

Statistical power analysis can quantify a minimum % change in mean CPUE that we can expect to “reliably detect” between study years for a species of interest in a single reach. Effect sizes (% change in mean CPUE) smaller than this identified level may not be reliably detected, and so managers may not seek to structure management action or policy around levels smaller than this identified level. For example, in the Marseilles pool of the Illinois River, historic LTEF sampling indicates that current effort allocations of 18 samples per year can reliably detect an effect size of 30% interannual change in Bluegill CPUE (Figure 6.1). Here, “reliably detected” is a subjective interpretation of quantifiable levels of statistical power and precision, and the quantitative parameters for “reliably” can be adjusted to meet levels of uncertainty acceptable to managers.

The analysis can also estimate the number of additional samples (i.e., electrofishing runs) required to reliably detect a minimum effect size of greatest interest (a presumably smaller % change in mean CPUE than is currently detectable), thereby informing where and how much additional effort should be spent (or where and how current effort can be redistributed) to improve the sampling design’s ability to meet monitoring goals. For example, if managers would like to be able to reliably detect 20% interannual change in mean Bluegill CPUE in Marseilles pool, the analysis indicates sample size should be increased from 18 to 24 samples per year. This amount of additional effort allocation (or current effort reallocation) may be interpreted by management as a reasonable increase if a monitoring goal is to be able to reliably detect 20% interannual change. However, to achieve reliable detectability of a 10% interannual change in mean Bluegill CPUE, the analysis indicates that over 80 samples would be required each year, which may be interpreted as unrealistic.

These analyses can be scaled up across reaches (Figure 6.2) and species (Figure 6.3) to evaluate taxonomic and spatial areas where the current sampling design meets the goals of monitoring and management, and areas where small amounts of additional or redistributed effort allocation could efficiently bring additional species and reaches in line with those goals.

Bluegill, Illinois River
 CPUE Power Analysis, 95% CIE (~80% Power)

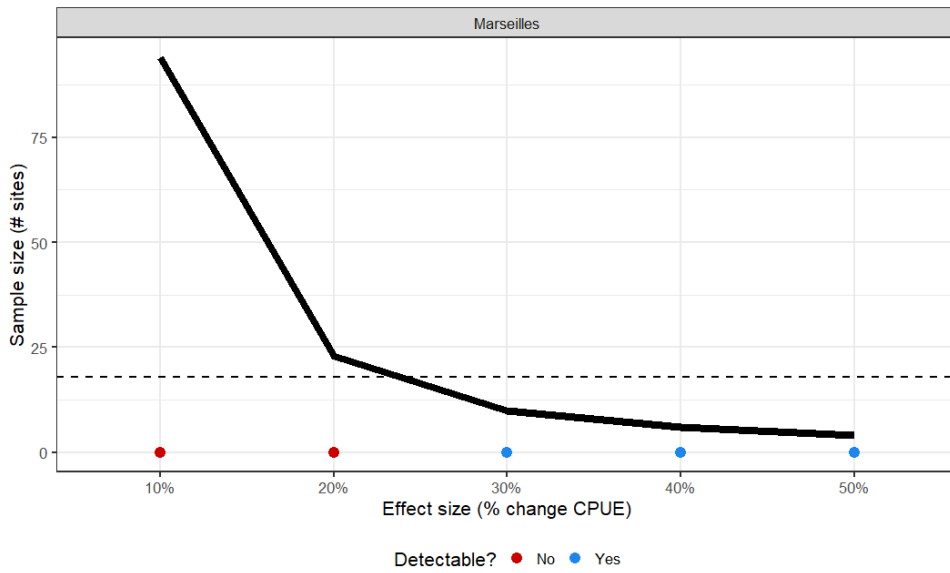


Figure 6.1. Statistical power analysis of the LTEF sampling design to detect interannual % change in catch per unit effort. Data presented are from Bluegill in the Marseilles Pool of the Illinois River. Solid line indicates estimated sample size (number of electrofishing sites) required to reliably (~80% power, 95% confidence interval estimation) detect a given effect size. Dotted line indicates sample size of current LTEF effort allocation in this pool. Colored dots indicate whether a given effect size is reliably detectable at the current LTEF effort allocation (red = no, blue = yes).

Bluegill, Illinois River
 CPUE Power Analysis, 95% CIE (~80% Power)

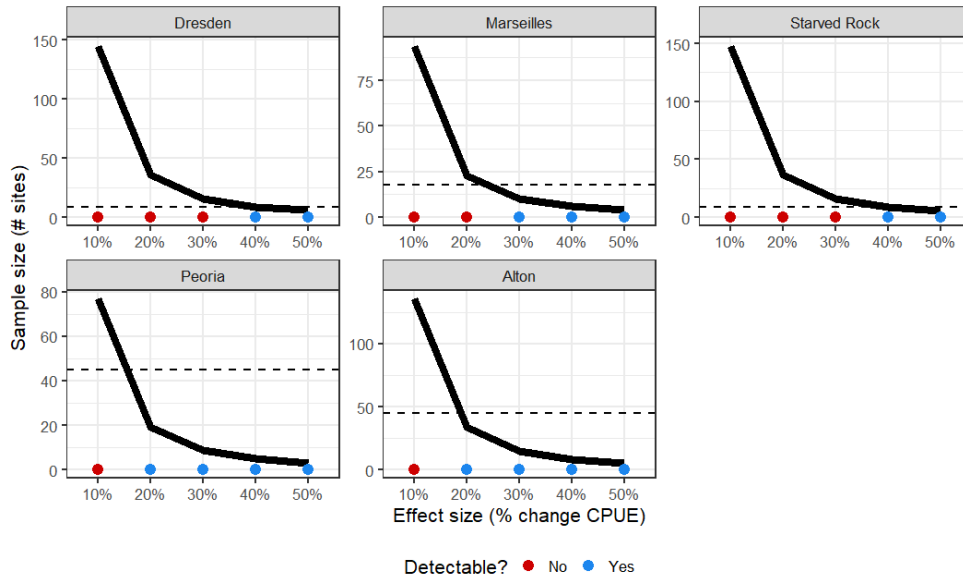


Figure 6.2. Statistical power analysis of the LTEF sampling design for Bluegill CPUE across all study pools of the Illinois River. Solid line indicates estimated sample size (number of electrofishing sites) required to reliably (~80% power, 95% confidence interval estimation) detect a given effect size. Dotted line indicates sample size of current LTEF effort allocation in this pool. Colored dots indicate whether a given effect size is reliably detectable at the current LTEF effort allocation (red = no, blue = yes).

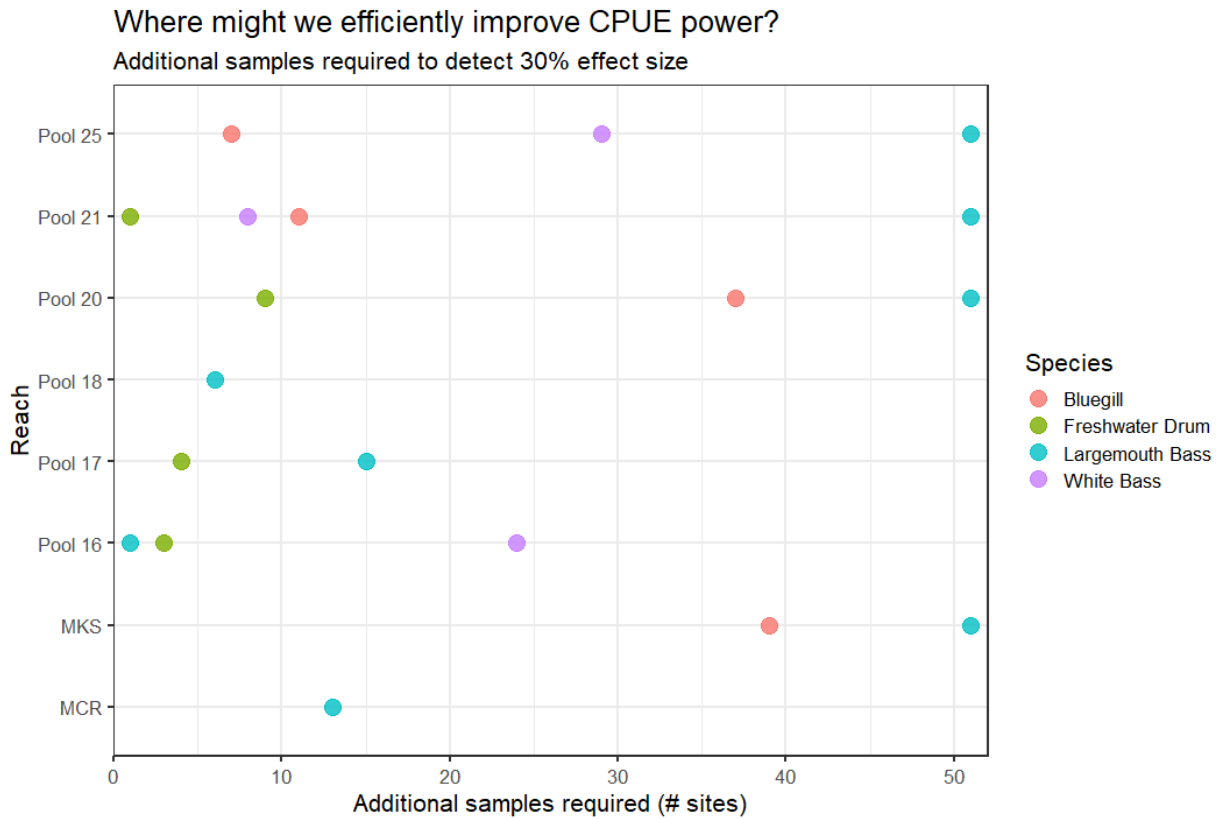


Figure 6.3. Results of power analyses to detect change in interannual mean catch per unit effort (CPUE) across multiple species and study reaches. Points indicate the estimated number of additional samples (above current LTEF sampling design effort allocations) required to reliably detect an effect size of 30% interannual change in mean CPUE (where current effort allocation does not currently meet this threshold). Study reaches with many points on the left-side of the x-axis may indicate places to allocate effort to efficiently extract additional statistical value from the sampling program.

Relative weight (W_r), a measure of body condition, is another fisheries metric we are targeting when assessing the precision achieved by the current sampling design. Because precision of many metrics, including W_r , improve as a function of sample size (in this case, numbers of individual fish captured and weighed) the ability to reliably detect a species' W_r across time or space relies upon the collection of a sufficient number of individuals. Quantifying what that number of individuals is for a given precision is – and how to most efficiently improve that sample size and precision – is another goal of our research.

For example, Largemouth Bass in the Marseilles pool of the Illinois River are historically collected in numbers between 5-15 individuals per year (Figure 6.4). Because the recent multi-agency monitoring (MAM) program has boosted sampling in the Marseilles pool since 2019, we can borrow information from that program's larger sample size of individuals to inform LTEF. By bootstrapping a single year of MAM sampling's Largemouth Bass captures in Marseilles pool, we can estimate the number of individuals required to reliably achieve acceptable levels of W_r precision. Again, definitions of “reliably” and “acceptable” could be adjusted by management, but an example figure below shows that historic LTEF sample sizes (vertical lines) almost always exist below sample sizes where W_r precision reaches diminishing returns with sample size increases, indicating possible room for improvement in the LTEF sampling design for this fisheries metric, this species, and this area. For other species in other areas (Figure 6.5), LTEF sampling design consistently exceeds benchmark sample sizes, indicating these areas may not need additional effort allocated.

Largemouth Bass in Marseilles relative weight precision evaluation

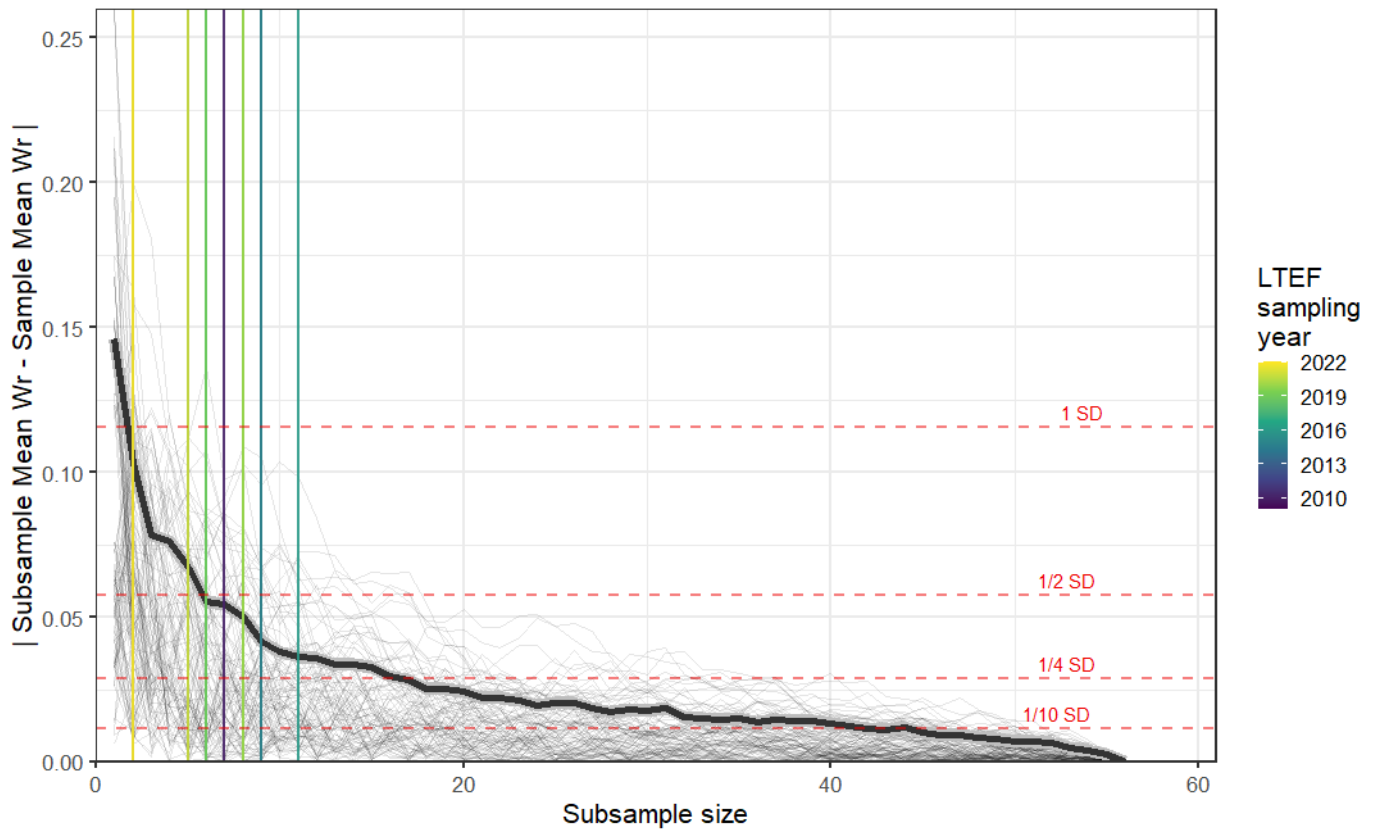


Figure 6.4. Evaluation of current LTEF effort allocation for generating precise estimates of relative weight (W_r), compared to a single year's effort from the multi-agency monitoring (MAM) program. Data depict Largemouth Bass W_r metrics from the Marseilles pool of the Illinois River. Light gray lines represent the absolute value of the difference between moving subsample means and the total sample mean of W_r from 100 bootstrapped (without replacement) draws of one year (2019) of MAM sampling of Largemouth Bass individuals. As sample size increases along the x-axis, the difference between the moving average of the subsample mean and the total sample mean trends towards zero because the subsample data approaches the total sample data. The thick black line represents the 80th percentile of these 100 bootstrapped draws, an arbitrary metric of W_r precision at a given sample size, and also trends towards zero as the subsample number of individuals approaches the total sample number of individuals ($n = 56$). The thick black line illustrates diminishing return of precision as number of individuals increases, where precision is measured as the absolute value of the difference between the subsample mean and the total sample mean. Horizontal dotted lines indicate thresholds of precision, defined as different fractions of one standard deviation (SD) of the total sample's W_r . These thresholds represent possible management targets for precision. Vertical lines indicate historic LTEF annual sample sizes (number of individuals). Color indicates year of LTEF sampling. If a vertical line intersects the solid black line to the left of where a horizontal line intersects the solid black line, that year's LTEF sample fails to meet the precision threshold defined by that horizontal line. None of the historic LTEF years meet the threshold of $1/4$ SD of the MAM sample's W_r . Approximately half of historic LTEF years meet the threshold of $1/2$ SD of the MAM sample's W_r .

White Bass in Alton relative weight precision evaluation

Black: 2019 MAM sampling random draws and 80th percentile

Gradient: LTEF sample sizes 2009-2022

Red: Standard deviation thresholds of full 2019 MAM sample

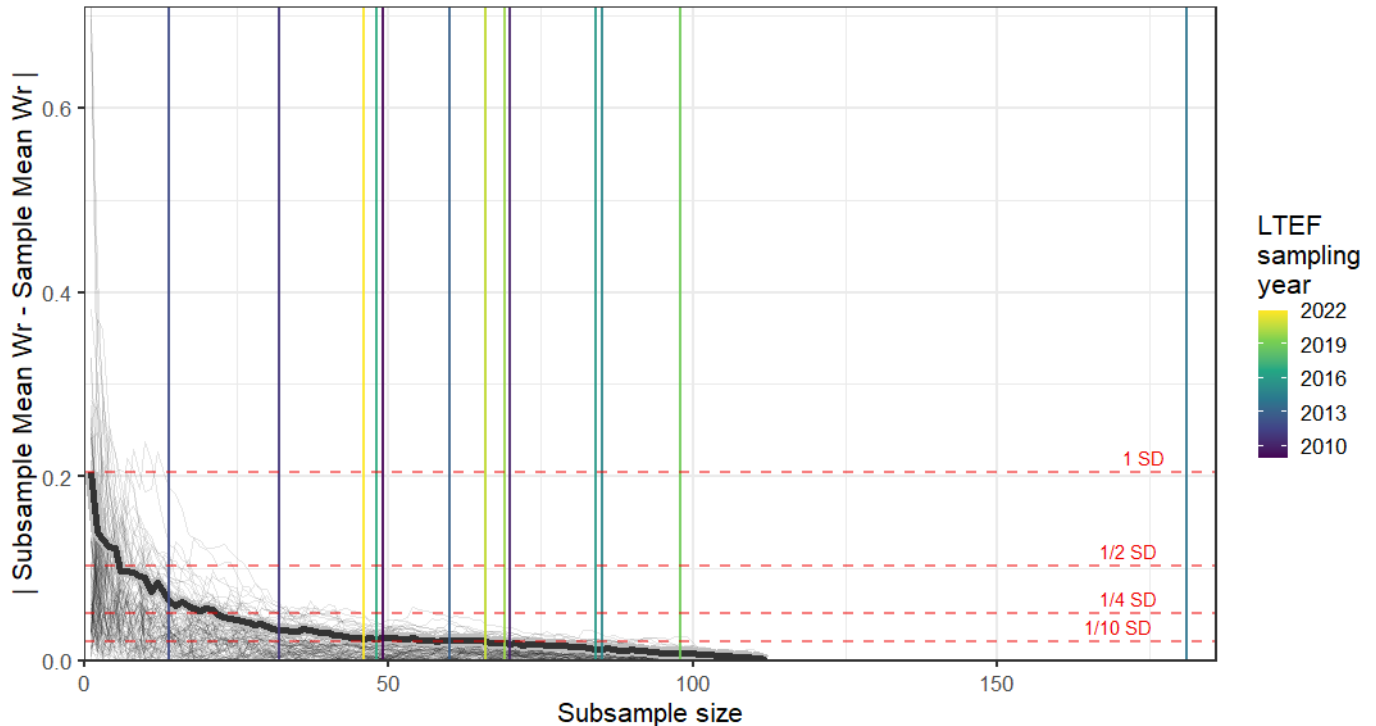


Figure 6.5. Evaluation of current LTEF effort allocation for generating precise estimates of relative weight (W_r), compared to a single year's effort from the multi-agency monitoring (MAM) program. Data depict White Bass W_r metrics from the Alton pool of the Illinois River. Light gray lines represent the absolute value of the difference between moving subsample means and the total sample mean of W_r from 100 bootstrapped (without replacement) draws of one year (2019) of MAM sampling of White Bass individuals. As sample size increases along the x-axis, the difference between the moving average of the subsample mean and the total sample mean trends towards zero because the subsample data approaches the total sample data. The thick black line represents the 80th percentile of these 100 bootstrapped draws, an arbitrary metric of W_r precision at a given sample size, and also trends towards zero as the subsample number of individuals approaches the total sample number of individuals ($n = 56$). The thick black line illustrates diminishing return of precision as number of individuals increases, where precision is measured as the absolute value of the difference between the subsample mean and the total sample mean. Horizontal dotted lines indicate thresholds of precision, defined as different fractions of one standard deviation (SD) of the total sample's W_r . These thresholds represent possible management targets for precision. Vertical lines indicate historic LTEF annual sample sizes (number of individuals). Color indicates year of LTEF sampling. If a vertical line intersects the solid black line to the left of where a horizontal line intersects the solid black line, that year's LTEF sample fails to meet the precision threshold defined by that horizontal line. All of the historic LTEF years meet the threshold of $1/4$ SD of the MAM sample's W_r . Approximately half of historic LTEF years meet the threshold of $1/10$ SD of the MAM sample's W_r .

Where management decides additional sample size could improve precision and therefore the ability to reliably detect interannual change in metrics such as W_r , additional effort allocation can be spatially and temporally guided by these data, too. Partner programs like MAM and LTRM, which sample multiple hydrogeomorphic strata, could inform LTEF to sample side-channels or backwaters in certain pools where additional individuals are needed for fisheries metric precision if those areas show demonstrably higher CPUE metrics than the main-channel typically sampled by LTEF (Figure 6.6). Identifying species and reaches where a reasonable number of additional individuals can improve precision *and* where supplementary sampling in non-traditional sampling strata can efficiently capture those additional individuals at a higher rate than the main-channel stratum might be the best place to start if management decides to act upon these evaluations of the current LTEF sampling design. For example, we have established that additional Largemouth Bass individuals from Marseilles pool might efficiently improve W_r , and MAM data informs us that we may most efficiently capture those additional individuals by targeting the backwater stratum of that pool in supplementary sampling, as the mean CPUE in the backwater is nearly 4

times higher than mean CPUE in the main channel already sampled by LTEF (Figure 6.6). Care should be taken that these backwater individuals are representative of the entire pool's population of that species and don't introduce biases into our fisheries metrics of interest.

Next steps include expanding these analyses to as many species and reaches as are reasonable for evaluating areas for improving the current LTEF sampling design to meet statistical goals of management. Aggregating analyses of individual species and pool combinations up to program-wide recommendations for where to best spend valuable effort remains a challenge. We hope the pursuit of these individual analyses and eventually their aggregation will help inform managers of the statistical power that the LTEF sampling design currently offers and serve as a guide for extracting additional statistical value most efficiently.

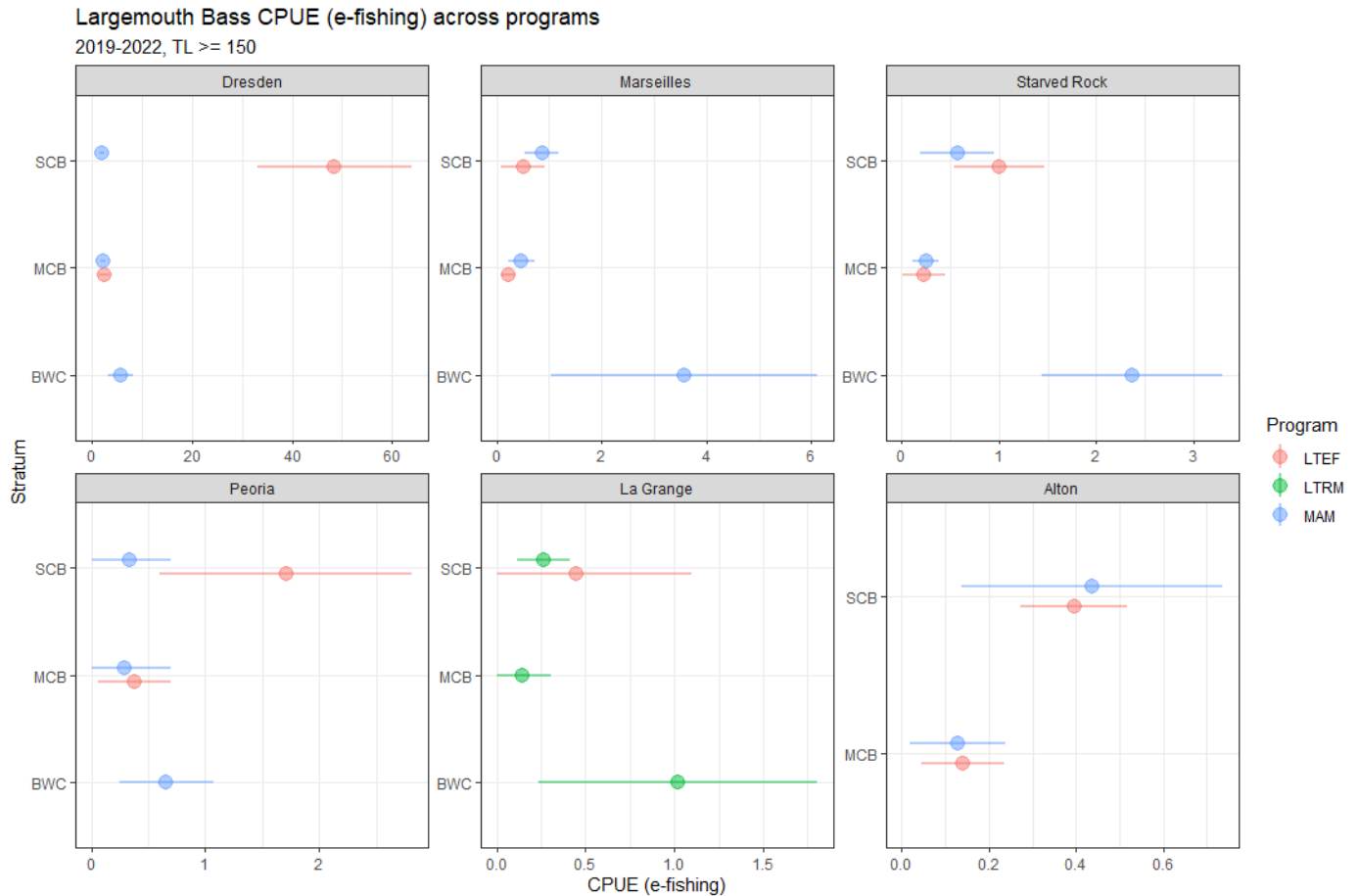


Figure 6.6. Mean and 95% confidence intervals of Largemouth Bass catch per unit effort (CPUE) across study reaches of the Illinois river, as generated by different monitoring programs (red = LTEF, green = Long-Term Resource Monitoring (LTRM), blue = Multi-Agency Monitoring (MAM)). Estimates are generated for each major hydrogeomorphic sampling stratum of the monitoring programs' designs (SCB = side-channel border, MCB = main-channel border, BWC = backwaters (contiguous)).

Section 6.3 – Spatially-explicit Smallmouth Buffalo growth rate assessment and sampling strategies

Spatially explicit growth models of Smallmouth Buffalo were created from LTEF reaches and other Upper Mississippi River reaches. Sampling data were evaluated to assess sampling strategy efficiencies across river reach, hydrogeomorphic strata, gear type, and other variables. This work was detailed in our 2023 report, and results have been further refined as part of the peer-review process. These analyses resulted in a manuscript that was accepted for publication in 2024 by the journal *Environmental Biology of Fishes*. Figure 6.7 is borrowed from that manuscript and visualizes the variability in growth parameter estimates and their uncertainty in different reaches of the Upper Mississippi River System.

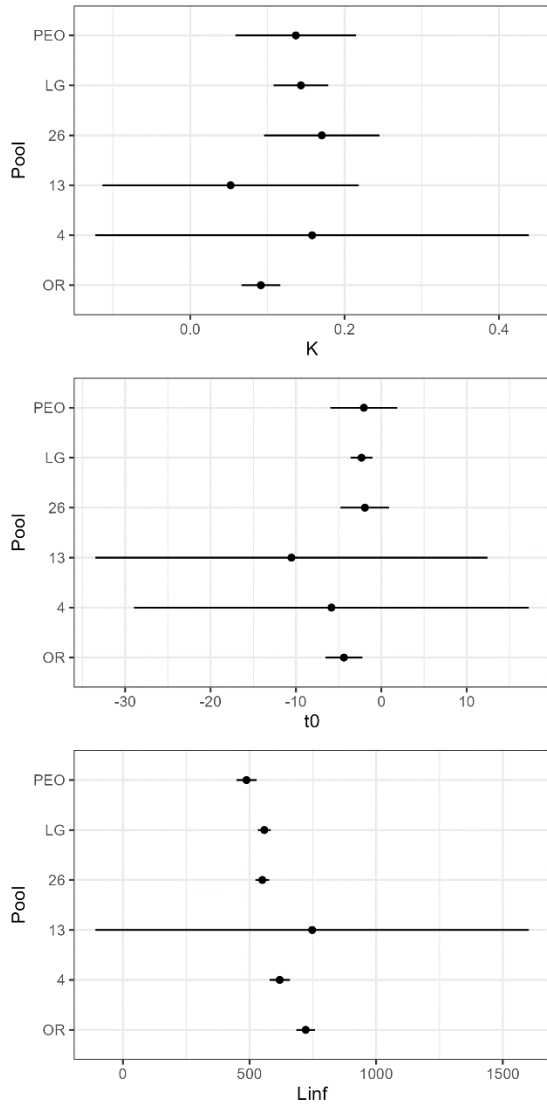


Figure 6.7. From Maxson et al. (2024). Estimated means and 95% confidence intervals for reach-specific model parameter coefficients for von Bertalanffy growth model parameters. Study reach abbreviations are as follows: For the Illinois River, PEO = Peoria pool, LG = La Grange pool; For the Mississippi River, 26 = pool 26, 13 = pool 13, 4 = pool 4, OR = Open River reach.

CHAPTER 7

SURVEY AND ASSESSMENT OF SHOVELNOSE STURGEON IN THE ROCK RIVER

Section 7.1 – Introduction

Sturgeon species around the world have undergone significant population declines over the past century due to a suite of anthropogenic actions, resulting in reduced habitat quality and quantity, and disruption of life history processes. Population declines for nearly all sturgeon species have been attributed to overharvest, construction of dams causing restrictions to migrations and access to habitats, pollution, and poaching (Haxton and Cano 2016, Ustaoglu et al., 2004), as a result ~85% of species globally are listed as threatened or endangered (ICUN). European and Asian sturgeon populations have generally experienced the largest population declines due to overharvest motivated by the caviar industry resulting in nearly all populations in the Black, Caspian, and Adriatic Seas being listed as endangered (Birstein 1993; Birstein & Bauer 1997; He et al., 2017). While numerous European/Asian sturgeon populations have collapsed, the resulting closures and limitations on sturgeon markets (i.e., meat, caviar, and byproducts; Birstein & Bauer 1997) has raised concern that there may be increased demand on North American sturgeon species (Kosh et al., 2009; Zabyelina 2014) including, but not limited to, Atlantic Sturgeon (*Acipenser oxyrinchus*; Dadswell et al., 2017) and Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*; Kosh et al., 2009; Morrow et al. 1998; Quist et al. 2002). Sturgeon species are especially vulnerable to human activities due to their unique life history such as, late maturity, intermittent spawning, large-scale migrations, specific habitat requirement throughout various stages of ontogeny, and high susceptibility of adults to capture/harvest (Boreman 1997; Bruch et al., 2016; Haxton et al., 2014, Quist et al., 2002; Bajer and Wildhaber, 2007).

Shovelnose Sturgeon are the smallest, yet most abundant and widespread sturgeon species in North America, inhabiting large river systems throughout the Mississippi River watershed and associated tributaries (Phelps et al., 2016). Despite their abundance and life history attributes that promote resiliency compared to other sturgeons, populations have been significantly reduced over the past 100 years and are considered extirpated or at-risk across 50% of their native range (Keenlyne 1997). Historically, Shovelnose Sturgeon were unfavored in the commercial fishery market due to their small size, resulting in reduced fecundity, and often viewed as a nuisance by commercial fisherman targeting other sturgeon species (i.e., Lake Sturgeon (*Acipenser fulvescens*); Carlander 1954). However, as global declines of large-bodied sturgeon species became apparent in the 1900's (Birstein 1993; Harkness & Dymond 1961; Haxton et al., 2014), a market for alternative sturgeon species, including Shovelnose Sturgeon, was created. Despite declining population trends, Shovelnose Sturgeon is one of the few species to be commercially and recreationally targeted in North America (Carlson et al., 1985; Keenlyne 1997). Currently, commercial fisheries for Shovelnose Sturgeon in the USA exist in 7 states, and a recreational fishery is legal in 12 states. Moreover, commercial harvest of Shovelnose Sturgeon is primarily focused on the Mississippi River and Missouri River (Keenlyne 1997), though impacts of sport/recreational harvest are unknown but expected to be low. Exploitation of Shovelnose Sturgeon has been documented to affect size and age structures, and reproductive dynamics (Hamel et al., 2015; Quist et al., 2002; Bajer and Wildhaber, 2007), thus a thorough understanding of population dynamics is required to determine status, stability, harvest rates, and regulations of populations (Wildhaber et al., 2011).

The state of Illinois, USA, is centrally located within the Shovelnose Sturgeon's range and surrounded by major river systems with well-studied populations (i.e., Mississippi River, Missouri River, and Wabash River). Populations throughout the Upper Mississippi River (UMR) basin are generally considered stable and are not listed under any conservation status (Keenlyne, 1997; Koch and Quist, 2010). Although commercial harvest of Shovelnose Sturgeon within the UMR and state of Illinois is strictly regulated (i.e., size restrictions and harvest season dates), harvest rates have increased over the past 3 decades (Williamson 1998; Maher 2002; Koch et al., 2009) and are expected to increase basin-wide (Morrow et al., 1998). Alternatively, recreational angling and recreational harvest for the species is currently unregulated in the State and has gained attention and popularity. In recent years (2021-2024), numerous reports of "trophy-class" and state-record size Shovelnose Sturgeon have been captured via

recreational angling in a UMR tributary in northwest Illinois, where an undescribed population is present sparking concern over its population status, sustainability, and need for species-specific management, regulation, and conservation.

The Rock River, located in northwest Illinois, USA, is 481 km long, originating in central Wisconsin and flows through a mixture of urban and agricultural landscapes, before its confluence with the Mississippi River at Moline, Illinois (Figure 7.1). The Rock River is heavily fragmented, with a network of 25 dams throughout its course. Commercial fishing is prohibited in the Rock River, but an unregulated recreational fishery (catch and keep) for Shovelnose sturgeon exists. The Rock River has a history of state record shovelnose sturgeon dating back to 1988, where the state record barely exceeded 5 lbs. Notably, since 2021, this record has been broken numerous times in the Rock River, and the most recent state record was captured in 2024 weighing 12.95 lbs. The Shovelnose Sturgeon population in the Rock River has never been thoroughly examined and described, and all aspects of demographics and dynamics are unknown. Given the recent attention from anglers, lack of regulation, and susceptibility to exploitation, the Illinois Department of Natural Resources has identified this population as a research priority. Demographic descriptions of this population are needed to inform the sustainability of the fishery and guide data-driven management strategies. This research is the first step of several multi-faceted projects needed to further describe and understand this population. The objective of this study was to describe the abundance, size, and age structure of Shovelnose Sturgeon within the Rock River. This data will be used to establish baseline characteristics to measure population-level changes in the future, and identify future research needs to better understand this population.

Section 7.2 – Study Site

This work takes place in the Rock River, Illinois, within the first impounded river section upstream of its confluence with the Mississippi River (Figure 7.1). The first barrier, Milan Dam in Moline Illinois, is located just 7 km upstream from the confluence with the Mississippi river, creating ~153.5 km (95 miles) of impounded river before reaching the second barrier, Sterling Dam, located in Sterling Illinois. The Milan and Sterling dams were constructed in the mid 1800's to early 1900's and are ~10-15' high (Knapp and Russel 2004). This section of the Rock River experiences large fluctuations in seasonal flows and the long-term median flow is 5,130 cfs (USGS 5443500; Rock River Basin Assessment 2006). Fish passage at the Milan Dam is not well understood but has been explored during spring spawning periods with results indicating that fish passage is impossible 99% of the time for Paddlefish (*Polyodon spathula*) and 100% of the time for all other species evaluated, although Shovelnose Sturgeon was not considered in this evaluation (Steel Dam Hydraulic Analysis 2002). Until recently, there has been no scientific or agency reports documenting Shovelnose Sturgeon within the Rock River, despite over 80 fish species being present (Rock River Area Assessment 1996).

Section 7.3 – Fish Collection Methods

A suite of fisheries gear has been used to collect Shovelnose Sturgeon since the inception of the project in 2022. Gear choice and sampling strategy (Table 7.1) has been conducted in an adaptive manner in attempt to respond to changes in environmental conditions and fish behaviors. Currently, fish collection efforts are focused on maximizing capture rates therefore sampling is non-standardized with unequal effort across gears.

Section 7.4 – Data Analyses

Size structure of Shovelnose Sturgeon was described using length frequency distributions and reported as abundance of catch per 25 mm length bin. Length and weight relationships were calculated (pooled total catch from all years/gears). Standard weight (W_s) was calculated for all captured Shovelnose Sturgeon from Quist et al. (1998), using:

$$\log_{10}W_s = -6.287 + 3.330*\log_{10}(FL)$$

where FL represents fork length of the Shovelnose Sturgeon and W_s represents the individual standard weight. Standard weight was used to calculate relative weight (Wr) for each fish, using:

$$Wr = (W/W_s)$$

where W is the observed weight of the individual fish and W_s is the length specific standard weight.

Stock density was evaluated by determining proportional stock density (PSD) and incremental relative stock density (RSD). Terminology in reporting stock densities (i.e., PSD vs RSD) is often confused and clarification should be ensured when reporting these values (see Willis et al., 1993). In this study, Proportional stock density (PSD) was used to assess the size classes of Shovelnose Sturgeon exceeding minimum lengths (FL mm) reported by Quist et al. (1998) and calculated as:

$$\text{PSD-X} = (\text{number of fish} \geq \text{specified length} / \text{number of fish} \geq \text{stock length}) * 100$$

The length categories used to determine PSD included: Stock (S) \geq 250, Quality (Q) \geq 380, Preferred (P) \geq 510, Memorable (M) \geq 640, and Trophy (T) \geq 810. Further, relative stock density (RSD), was calculated as the proportion of individuals within a specific size class as:

$$\text{RSD [X-X]} = (\text{number of fish within size class}) / \text{number of fish} \geq \text{stock length} * 100$$

following size range of : RSD [S-Q] = 250-379 RSD [Q-P] = 380-509, [P-M] = 510-639, [M-T] = 640-809, [T+] = \geq 810.

Age of Shovelnose Sturgeon was estimated by thin-sectioning pectoral ray samples and enumerating identified annuli (Helms, 1974b; Whiteman et al., 2004, Kennedy 2006, Jackson et al., 2006). Pectoral rays were cross-sectioned, using an Isomet low speed saw with a diamond-cutting blade and annuli were identified and enumerated with the aid of a dissecting microscope. One to 3 thin-sections were made per pectoral ray sample in effort to obtain the clearest structure for age estimation. Cross sections were placed onto glass slides and viewed under the dissecting microscope, photographed, and archived. Ages estimated in this study are not to be presented as true age, but rather to provide a comparison to ages estimated from other populations following same methodology, while acknowledging biases associated with pectoral rays and this technique (Whiteman et al., 2004; Rugg et al., 2014).

Section 7.5 – Catch Summary

A total of 905 shovelnose sturgeon captures occurred during this study (Table 7.1), which includes 21 recaptures (see below), resulting in 884 unique individuals. Twelve fish had caudal deformities (1.3% of total catch) and were removed from length and weight analyses. Shovelnose Sturgeon ranged in length from 501-938 mm FL (mean= 767.6 mm, SD= 63.9 mm) and weights from 508-5,874 g (mean= 2,598.9 g, SD= 812.7), see Figures 7.2 and 7.3. A total of 20 males and 24 females was confirmed, all other individuals were undetermined sex. Female gamete stage ranged from F2-F5.

Proportional stock densities (PSD), and incremental relative stock indices (RSD[X-X]) are reported in Table 7.2. PSD could be calculated for all stock classes, however RSD could not be calculated for RSD [S-Q] due to the absence of captured fish within that size class. PSD was 100 for stock and quality size classes followed by 99.9, 97.2, and 25.0 for preferred, memorable and trophy classes respectively. RSD [M-T] hosted the highest proportion of individuals (72.2%), followed by RSD [T+], [P-T], and [Q-P] respectively. Wr of shovelnose sturgeon ranged from 61.5-186.4 (mean= 120.3, SD= 15.8; Figure 3) and was described for each RSD category (Table 2).

Recapture events were rare (N=21, 2.3% of total catch). Time between recapture events ranged from 1-549 days (1.5 years). Most recaptures occurred within 1 year (18/21; 86% of recaptures) which should be expected considering the infancy of the Rock River investigation and ongoing tagging efforts. Although not a primary goal of this study, observations of empirical growth are described. Negative and positive changes in fork length were documented and were not consistent with time. Absolute change in FL ranged from -13 to +63 mm. Long-term monitoring and future capture of tagged individuals will continue to build this dataset and provide clarity on growth rates and trends for this rock river population.

Additionally, in order to estimate the age structure of Shovelnose Sturgeon, and compare to previous regional studies, pectoral rays were collected on a subset of individuals to be used for age estimation. A total of 126 pectoral rays was collected for age estimation (Table 7.3) from Shovelnose Sturgeon ranging in size from 615-938 mm FL (mean = 783.4, SD= 76). The minimum estimated age was 4 years old, whereas the maximum estimated age was 28 years old (mean= 12.1, SD= 4.4). A minimum of 25 age classes are estimated to be present in the Rock River population (Figure 7.5).

Section 7.6 – Discussion and Future work

The capture of adult Shovelnose Sturgeon and preliminary investigation into demographics and population status have been successful. The Rock River hosts a unique population with an exceptionally large proportion of trophy-class fish (25%). Long-term monitoring will continue to describe this population and trends in abundance. Additional surveys and studies are in development and seek to improve our understanding of age and longevity through advanced aging technologies, understanding movements and occupancy through telemetry, and investigating natural reproduction stages and recruitment dynamics.

Section 7.7 - Tables and Figures

Table 7.1. Catch summary and biological description of Shovelnose Sturgeon from the Rock River, IL. TN= Trammel net, EF= Boat electrofishing, TL= Trot line, TW=Balloon trawl, GN=Gill net, AG= Recreational angler, ST=Siamese trawl *total count includes recaptures

Year	Season	Gear	Count	Fork Length (mm)	Weight (g)
				Range (mean, SD)	Range (mean, SD)
2022	Fall	TN	101	565-911 (773.1, 61.2)	1311-4900 (2724.6, 837.0)
2023	Spring	TN	207	501-906 (758.2, 58.2)	508-4824 (2477.9, 692.0)
		EF	28	566-909 (737.9, 80.9)	790-4935 (2334.0, 973.0)
	Fall	TN	59	615-885 (765.1, 63.8)	1040-4968 (2815, 889.4)
		EF	1	747	2122
	Winter	EF	1	760	2438
		TL	90	615-937 (794.8, 67.2)	1002-5271 (2895.5, 826.7)
2024	Winter	TW	179	575-885 (756.3, 61.0)	820-4647 (2390.5, 692.3)
		TL	60	647-888 (792.2, 53.9)	1607-4124 (2795.7, 646.1)
		GN	110	631-930 (768.2, 67.4)	1281-5088 (2519.1, 858.4)
	Spring	AG	1	938	5874
		EF	39	635-911 (789.6, 57.9)	1270-5500 (3071.4, 971.8)
		GN	26	634-856 (742.2, 58.0)	1178-4348 (2295.3, 764.8)
		ST	3	698-905 (798.7, 103.6)	1871-4563 (3069.3, 1370.1)
TOTAL*			905	501-938 (767.8, 63.9)	508-5874 (2599.8, 812.8)

Table 7.2. Stock indices and relative weights (*Wr*) for Shovelnose Sturgeon captured in the Rock River, IL. Proportional stock density (PSD) and relative stock density (RSD) are presented following definitions by Willis et al. (1993) and all metrics were provided by Quist et al. (1998). PSD categories are S=Stock, Q=Quality, P=preferred, M=Memorable, and T=Trophy. RSD categories are RSD [S-Q]= Stock to Quality, [Q-P]= Quality to Preferred, [P-M]= Preferred to Memorable, [M-T]= Memorable to Trophy, and [T+]= \geq Trophy. *Wr* is only provided for RSD [X-X] categories.

Category PSD, [RSD]	PSD Minimum Size (FL mm)	RSD Length Range (FL mm)	PSD	RSD	RSD [X-X] <i>Wr</i> Range (mean, SD)
S, [S-Q]	≥ 250	250-379	100	NA	NA
Q, [Q-P]	≥ 380	380-509	100	0.1	100.5
P, [P-M]	≥ 510	510-639	99.9	2.7	77.7-117.6 (103.8, 10.2)
M, [M-T]	≥ 640	640-809	97.2	72.2	77.5-186.4 (120.5, 15.5)
T, [T+]	≥ 810	≥ 810	25.0	25.0	61.5-169.7 (121.5, 16.0)

Table 7.3. Estimated ages and size ranges of Shovelnose Sturgeon captured in the Rock River, IL.

Estimated Age	Count	Fork Length; min-max (mean, SD)
4	1	681
5	5	621-757 (687.6, 49.9)
6	9	615-709 (664.4, 30.0)
7	4	699-817 (763, 49.7)
8	7	680-844 (738.1, 54.4)
9	10	695-793 (739.9, 39.6)
10	8	615-840 (731.8, 71.4)
11	15	645-885 (784.3, 64.3)
12	12	710-938 (821.4, 67.2)
13	16	764-937 (854.7, 48.9)
14	8	720-875 (794.5, 53.7)
15	6	706-851 (786.3, 52.0)
16	5	792-934 (855, 58.0)
17	4	738-857 (799.8, 49.0)
18	6	767-880 (822.3, 46.9)
19	3	798-845 (821.7, 23.5)
20	2	805-900 (852.5, 67.1)
21	2	767-920 (843.5, 108.2)
22	NA	NA
23	1	782
24	NA	NA
25	NA	NA
26	1	882
27	NA	NA
28	1	832

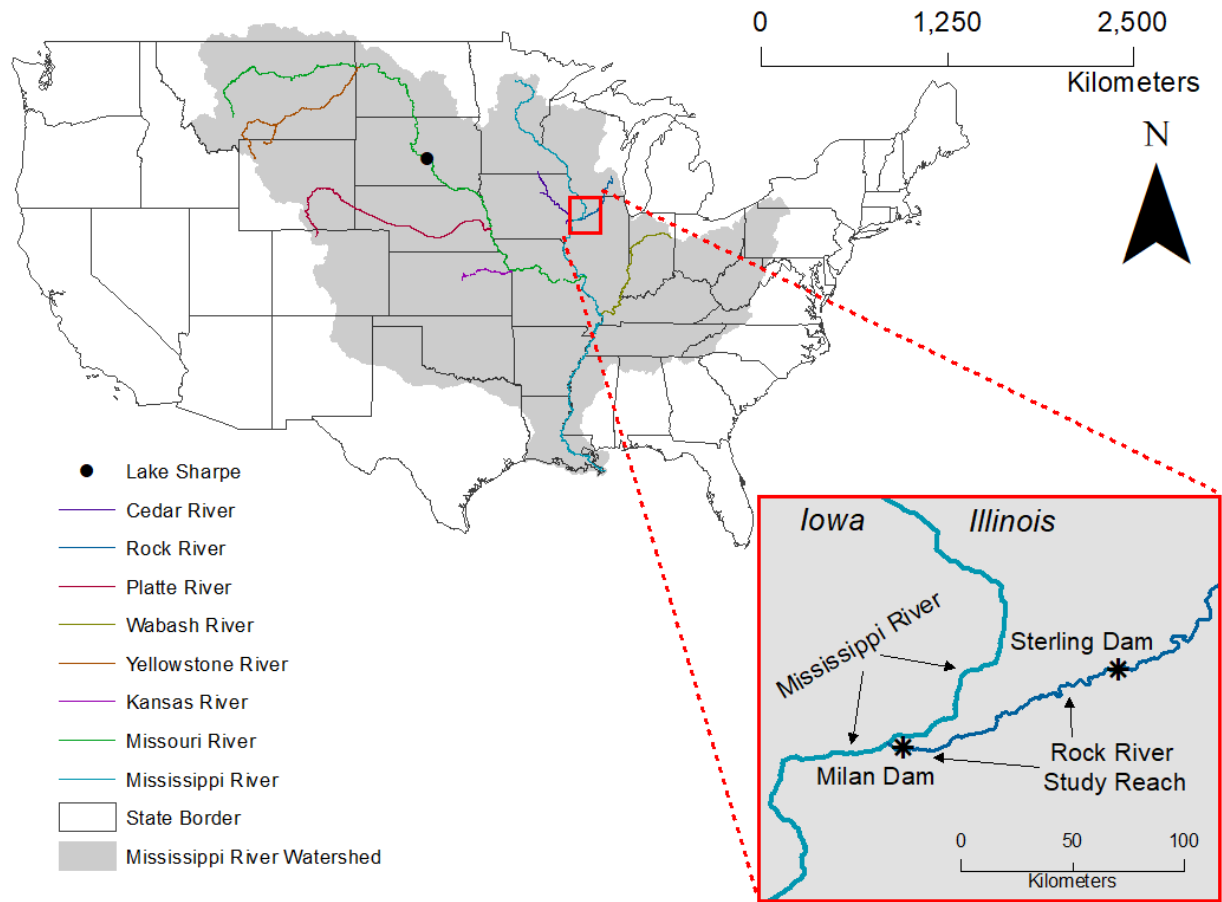


Figure 7.1. Major tributaries hosting Shovelnose Sturgeon within the Mississippi River Watershed, USA. The inset map identifies the Rock River, IL and focal study reach located between the Milan and Sterling dams.

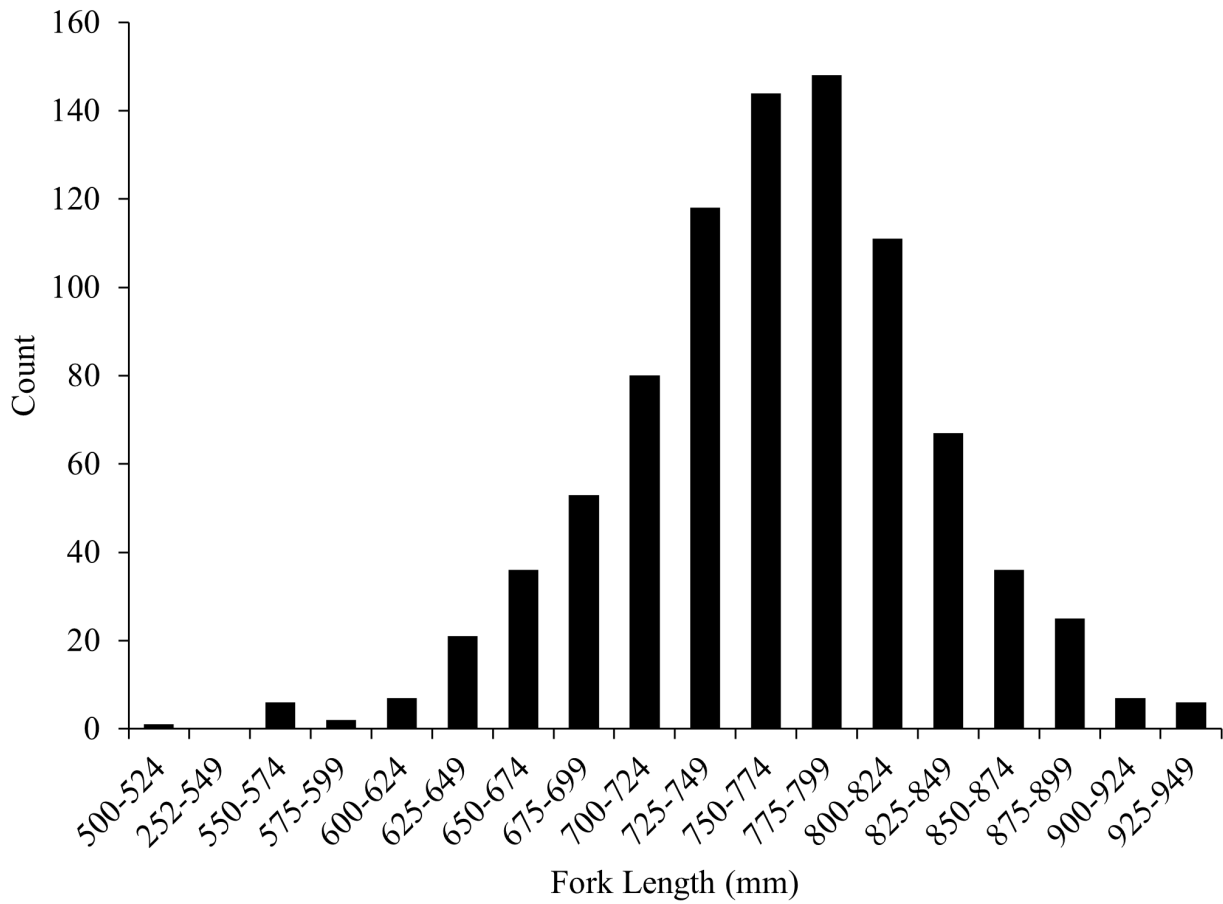


Figure 7.2. Length-frequency histogram of Shovelnose Sturgeon captured (N=893) in the Rock River, IL, 2022-2024.

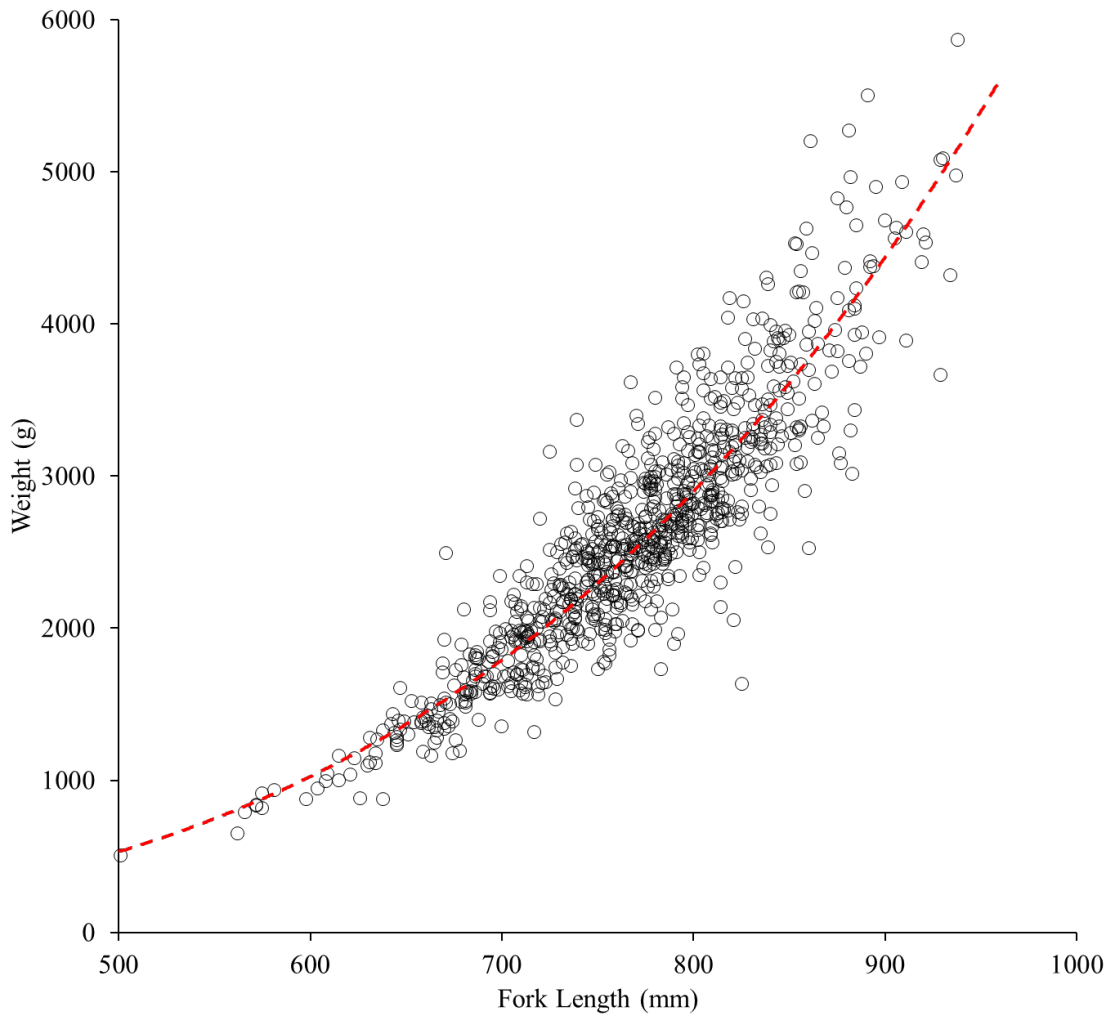


Figure 7.3. Length weight relationship for Shovelnose Sturgeon (N=893) in the Rock River 2022-2024, back-calculated for original data. $Weight = 2.4E-0.7 * L^{3.47}$ ($r^2 = 0.83$)

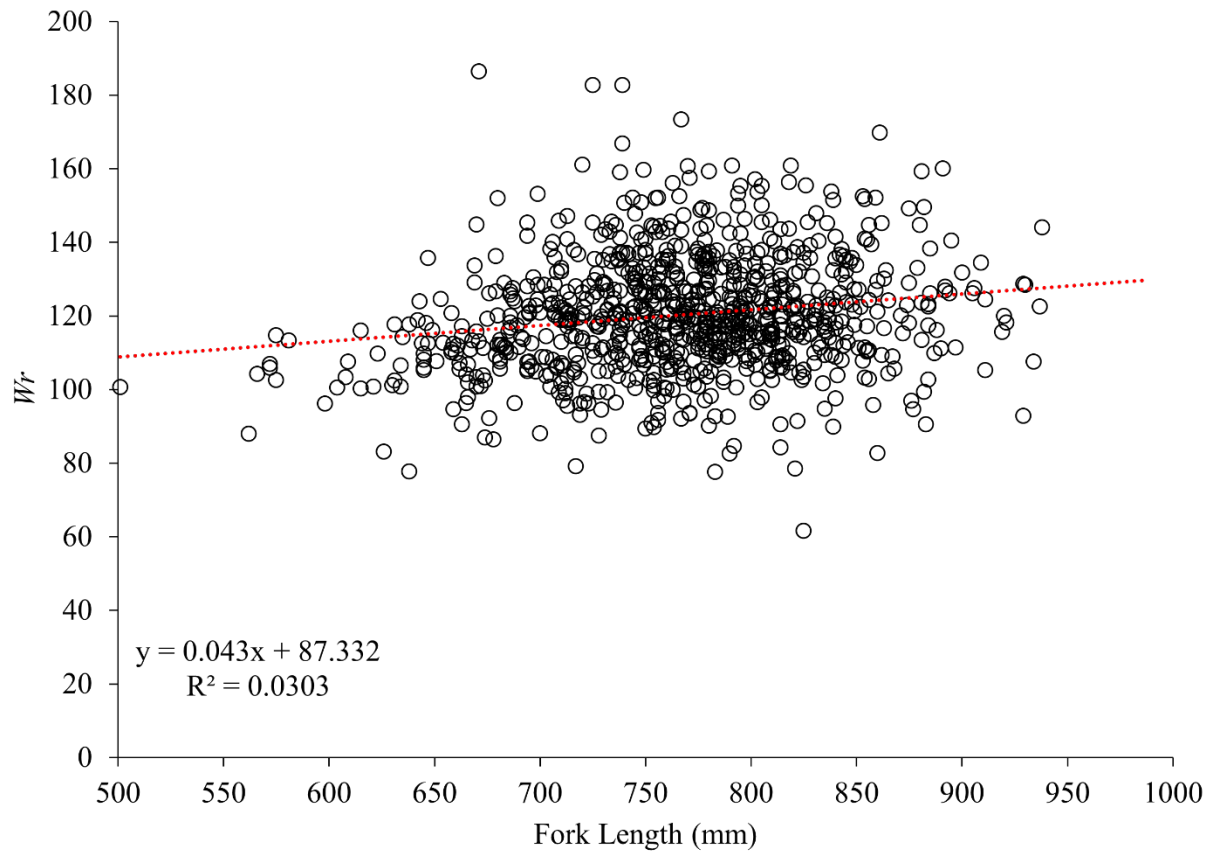


Figure 7.4. Relationship between relative weight (W_r) and fork length of shovelnose sturgeon captured in the Rock River, IL, 2022-2024

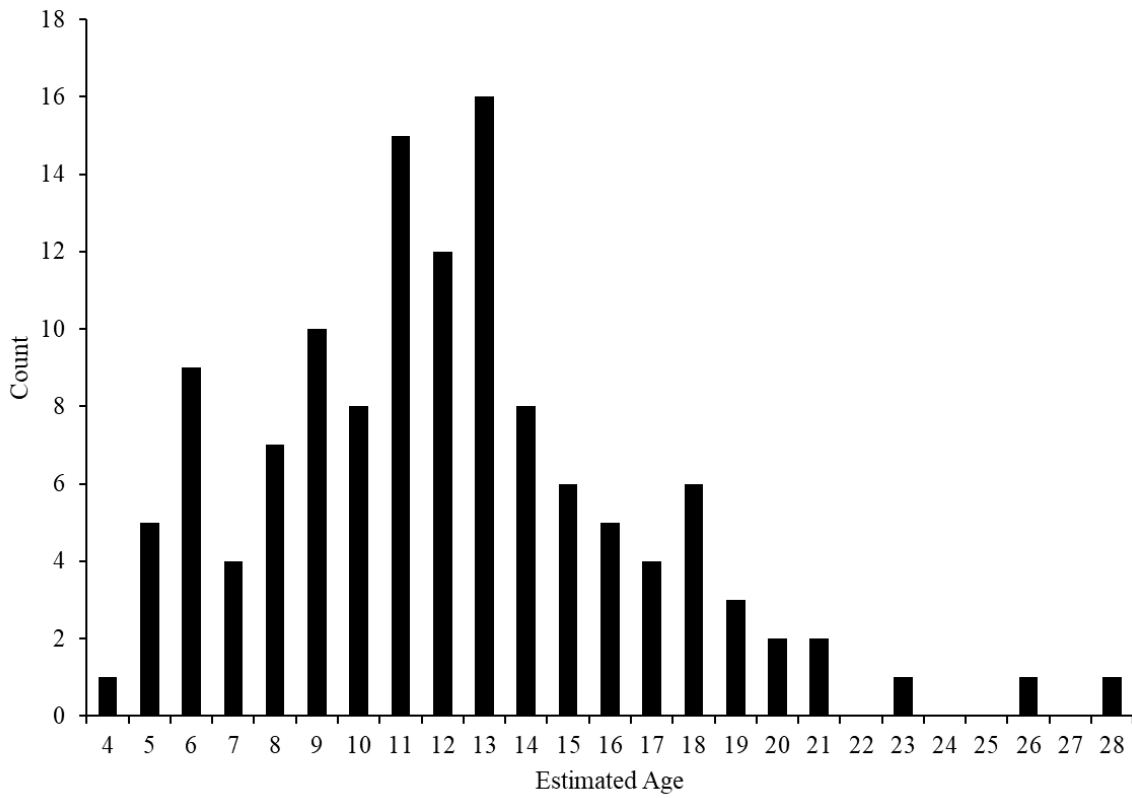


Figure 7.5. Frequency of estimated ages of Shovelnose Sturgeon collected in the Rock River, IL 2022-2024 estimated from thin-sectioned pectoral rays.

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Appendix I. Reaches and pools sampled by INHS randomly selected pulsed-DC electrofishing surveys (and our partners; Southern Illinois University (SIU) and Eastern Illinois University (EIU)) during 2023 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 increasing RM (downstream to upstream) order.

River	Monitoring Institution	Reach/Pool	Downstream	Upstream	N	Gauge
Illinois	INHS, F-101-R	Alton	0.0	80.0	45	Florence, IL
	INHS, F-101-R	Peoria	158.0	231.0	45	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
Mississippi	INHS, F-101-R	Kaskaskia Confluence	117.0	165.5	28	Chester, IL or Brickeys, MO
	INHS, F-101-R	Chain of Rocks	165.5	200.5	20	Saint Louis, MO
	INHS, F-101-R	Pool 25	242.0	273.5	18	Mosier Landing, IL
	INHS, F-101-R	Pool 21	325.0	343.0	12	Quincy, IL
	INHS, F-101-R	Pool 20	343.0	364.5	12	Gregory Landing, MO
	INHS, F-101-R	Pool 19	364.5	410.5	27	Fort Madison, IA
	INHS, F-101-R	Pool 18	410.5	437.0	15	Keithsburg, IL
	INHS, F-101-R	Pool 17	437.0	457.0	12	Muscatine, IA
	INHS, F-101-R	Pool 16	457.0	483.0	15	Fairport, IA
Ohio	SIU, F-187-R	Mississippi Confluence	981.0	962.5	12	Birds Point, MO
	SIU, F-187-R	former Pool 53*	962.5	939.0	15	Metropolis, IL
	SIU, F-187-R	former 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

*SIU has continued to sample Pool 52 and Pool 53 as two distinct units even after the demolition of LD 52 and 53. The new Olmsted Dam is located a little under a mile or so down river from the site of the LD 53.

Appendix II. Publications, reports, and presentations that resulted from research conducted during segments 6-35 of project F-101-R (funded under Federal Aid in Sportfish Restoration Act, P.L. 81-681, Dingell-Johnson, Wallup-Breaux). Manuscripts and other documents published or accepted for publication during Segment 35 are printed in **bold**.

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

Altenritter, M.E., S. Pescitelli, A.L. Whitten, A.F. Casper. 2019. 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/tra.3457>

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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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**Selected as Editor's Choice*

Harris, B.S., M.J. Spear, A.L. Whitten Harris, E.C. Hine, A.W. Lenaerts, A.T. Mathis, K.A. Maxson, M. Myers, M. Oubre, S.J. Schaick, L.E. Solomon, A.T. Wieland, J.A. Williams, and J.T. Lamer. 2024. Invasive round goby distribution, relative abundance, and establishment status in pools of the Illinois Waterway following 30 years of invasion. *Aquatic Invasions*. DOI: 10.1080/02705060.2023.2301096.

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III. Essays and Reports

- DeBoer, J. A., A. L. Whitten Harris, V. E. Kuppek, P. A. Stafford, and J. T. Lamer. 2024. External abnormalities in fish assemblages from four Illinois rivers. Illinois Natural History Survey Technical Report 2024 (04). 17 pages.**
- 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).
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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 35 (presenters in **bold**, ‘*’ denotes student or technician presenter)

Invited presentations:

- Lamer, J.T.** (plus all IRBS staff). 2024. “Harnessing monitoring for interjurisdictional fisheries management.” Upper Mississippi River Conservation Committee annual meeting, Rock Island, IL.
- Spear, M.J.**, B.S. Harris, J.T. Lamer. 2024. “Multi-agency monitoring on the Illinois River: an expansion of LTRM fish methods to every pool of the Illinois River 2019-2023.” Upper Mississippi River Conservation Committee annual meeting, Rock Island, IL.
- Whitten Harris, A.L.**, J.A. DeBoer, M.J. Spear, E.C. Hine, D.R. Roth, J.H. Chick, R.E. Colombo, G.W. Whitley, and J.T. Lamer. 2024. “Electrofishing for answers in large rivers of Illinois.” Upper Mississippi River Conservation Committee annual meeting, Rock Island, IL.

Contributed presentations:

- Harris, B.S.**, A.L. Whitten Harris, M.J. Spear, J.T. Belcik, A.W. Lenaerts, T. Grande, J.T. Lamer. 2024. The forecast for Oriental weatherfish (*Misgurnus anguillicaudatus*) in the Illinois Waterway. Illinois Chapter of the American Fisheries Society. Bloomington-Normal, IL February 27. Poster.
- Spear, M.J.**, B.S. Harris, B. Ickes, T. Bookout, K.J. Jankowski, L.E. Solomon, and J.T. Lamer. 2024. “Reduced commercial vessel traffic drives physical and biological responses in a large river.” Prairie Research Institute Lightning Symposium. Urbana, IL.
- Spear, MJ**, BS Harris, T Bookout, B Ickes, KJ Jankowski, LE Solomon, K Maxson, A Whitten Harris, A Mathis, S Schaick, J Williams, J DeBoer, A Lenaerts, E Hine, J Chick, and JT Lamer. 2024. “Reduction of large vessel traffic improves water quality and alters fish habitat use throughout a large river.” Illinois Chapter of the American Fisheries Society Annual Meeting. Bloomington-Normal, IL.
- Tucker, S.**, J. Schook, J. DeBoer, L. Solomon, and J.T. Lamer. Secrets of the Rock River- Investigations into Shovelnose sturgeon population dynamics. Illinois Chapter of the American Fisheries Society, 62nd Annual Conference, Bloomington-Normal, IL. February 27-29, 2024. (Poster Presentation)

VI. Data Requests received during F-101-R Segment 35

1. Hongyan Zhang, Eureka Aquatic Research LLC
2. Levi Solomon, Illinois Natural History Survey
3. Brandon Harris, Illinois Natural History Survey
4. Steven Sammons, Auburn University
5. Alex Catalano, U.S. Army Corps of Engineers
6. Will Radigan, University of Nebraska Lincoln
7. Andy Fowler, Iowa Department of Natural Resources
8. Brett Miller, Kansas Department of Wildlife and Parks
9. Kathi Jo Jankowski, U.S. Geological Survey
10. Justin VanDeHey, University of Wisconsin-Stevens Point
11. Brian Metzke, IL DNR
12. Dave Coulter, South Dakota State University