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Upper Mississippi River fish population monitoring and sport fish assessment in west-central Illinois, 2019

Jason A. DeBoer and James T. Lamer

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F-193-R-06

Annual Report to the Illinois Department of Natural Resources

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DISCLAIMER

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

ACKNOWLEDGMENT OF SUPPORT

The Upper Mississippi River fish population monitoring and sport fish assessment in west central Illinois (F-193-R) is supported by the Federal Aid in Sport Fish Restoration Act (P.L. 81-6814, Dingell-Johnson/Wallop-Breaux), with funds administered by the U.S. Fish and Wildlife Service and the Illinois Department of Natural Resources (IDNR). The IDNR and Illinois Natural History Survey (INHS) provided administrative support. Staff from the Illinois River Biological Station and INHS staff based at the University of Illinois Champaign-Urbana provided expertise and support for clerical, data entry, data verification, and field collections.

EXECUTIVE SUMMARY

This report presents a summary of data collected during segment 06 (2019-2020) of the Upper Mississippi River fish population monitoring and sport fish assessment in west-central Illinois, an annual survey by staff 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 program was conducted on 6 navigational pools of the Upper Mississippi River. All fishes collected were accurately identified, counted, measured, and weighed. The catch rates of several key species were calculated as the number of individuals collected per hour (CPUE ± standard error). Proportional size distribution (PSD) was also calculated for several key species. Catch rates and species varied among all sampling locations and sampling periods. Emerald Shiner and Gizzard Shad comprised most the individuals caught, and Common Carp and Smallmouth Buffalo accounted for the greatest proportion of the biomass collected.

Sportfish

Catch rates and sizes of popular sportfish species varied greatly among the navigation pools sampled during 2019. Bluegill and Channel Catfish were the most-abundantly collected sportfish species in nearly all areas along the Upper Mississippi River, although Largemouth Bass and Smallmouth Bass also appear to have robust populations. The slow but steady increase in White Bass CPUE since 2012 may warrant further investigation. Our long-term datasets allow us to observe substantial annual variations in the relative abundance and size distribution of many sportfish species, like Smallmouth Bass and White Bass. These observations could serve as a catalyst for future research investigating the effects environmental changes and management policies on the sustainability of Illinois' sportfish populations.

Invasive Species

Although the main focus of the F-193-R project is to conduct monitoring to improve our understanding of population dynamics, life histories, and habitat requirements of sportfishes, the program's sampling strategies are also useful for documenting trends in the relative abundance of non-native species occupying Illinois' large river ecosystems. Our surveys suggest Common Carp populations are declining across the region since 2009, which may be the harbinger of good things to come for native fish populations that have been negatively affected by Common Carp. Alternatively, Silver Carp populations (below L&D 19) appear to be increasing since 2012, which may counteract any benefits native fish populations may have gained as a consequence of declining Common Carp populations. We advise that researchers be aware that our sampling protocols (e.g., restriction to main-channel habitats) may limit our probability of encountering the greatest densities of invasive species.

ACCOMPLISHMENTS DEFINED BY F-196-R-06 WORK OBJECTIVES

Objective 1: to annually conduct standardized pulsed-DC electrofishing to monitor the fish community and collect water quality data at 51 locations in pools 19, 20, and 21 on the Upper Mississippi River.

Sampling for 2019 was completed on time despite extreme flooding during Periods 1 and 3.

Objective 2: to annually quantify relative abundance, community composition, and size structure of fish communities using standardized electrofishing at 51 locations in pools 19, 20, and 21 on the Upper Mississippi River.

This report provides quantification of relative abundance, community composition, and size structure of fish communities from Pools 19-21 of the Upper Mississippi River. This report also includes a summary of Upper Mississippi River data collected for Pools 16-18 as part of F-101-R-31. These pools were included in this report to provide continuity and a comprehensive view of the Upper Mississippi River region.

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PREFACE

This report presents a summary of data collected during 2019 during segment 06 of Federal Aid project F-193-R, the Upper Mississippi River fish population monitoring and sport fish assessment in west-central Illinois. The purpose of this report is to provide information on the broad-scale trends for fish populations in Illinois' portion of the Upper Mississippi River. This report also includes a summary of Upper Mississippi River data collected for Pools 16-18 as part of F-101-R-31. These pools were included in this report to provide continuity and a comprehensive view of the Upper Mississippi River region. 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. The annual reports for project F-193-R will continue to build upon previously collected data. Fish common names used throughout this report follow Page et al. (2013). We have used English units of measure throughout the report, as 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 use many abbreviations:

RM: River Mile
DC: Direct Current
°F: Temperature in degrees Fahrenheit
Hz: Hertz
W: Watts
µS: Microseimens
ppm: Parts per Million
in: Inches
lb: Pounds

All data collected by F-193-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 dataset should be directed to INHS project staff (Telephone 309-543-6000; email jadeboer@illinois.edu).

CHAPTER 1
INTRODUCTION

The large rivers of Illinois have experienced substantial changes that have been attributed to both natural and anthropogenic forces during the previous century (Theiling 1999). These changes have dramatically altered the viability of our riverine ecosystems, and Illinois' fisheries managers are faced with the increasingly difficult task of maintaining or rehabilitating these once-thriving riverine fisheries (Sparks and Starret 1975). The purpose of this project is to provide Illinois' fisheries managers with rigorous and robust information and analyses about the status, trend, condition, and other critical qualities (such as management evaluations) of Illinois's large-river sportfisheries throughout this portion of the Upper Mississippi River to allow comparison of the fisheries of this region to the Illinois River, and the Illinois portions of the Middle Mississippi, Ohio, and Wabash rivers.

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, invasive species) and management actions are inherently out-of-synch or delayed in relation to the driving factor. Thus, long-term, large-scale ecological monitoring data are critical for making inferences about temporal variability and spatial heterogeneity in the structure and function of ecosystems (Bolgrien et al. 2005; Dodds et al. 2012). These inferences can benefit natural resource managers, aiding them in the development and implementation of more effective resource stewardship policies at multiple scales. Standardized, continuous, high-quality fisheries monitoring surveys can therefore offer fisheries managers with critical insights that cannot be provided by shorter-term or smaller-scale programs. A long-term record of consistent and scientifically robust monitoring is critical for providing insights for successful management.

This project on the Upper Mississippi River is part of a larger state-wide program that follows respected, standardized protocols to collect fisheries data using boat-mounted electrofishing allowing data comparisons throughout the largest rivers in Illinois (Figure 1.1). Data generated from these surveys have previously been used to document large-scale changes in the structure of riverine fish communities (Sparks and Starrett 1975, Pegg and McClelland 2004, McClelland et al. 2012, 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. 2017a), investigate the evolving role of non-native species in Illinois' riverine ecosystems (Raibley et al. 1995, Irons et al. 2006, 2007, Lamer et al. 2010, Sass et al. 2010, Irons et al. 2011, Liss et al. 2013, 2014, Lamer et al. 2014, Lampo et al. 2017, DeBoer et al. 2018, Love et al. 2018), and evaluate the efficiency of electrofishing gears for large river fisheries research (McClelland and Sass 2012; McClelland et al. 2013). Given this impressive legacy of scientific research, the expansion of the program to include these additional Mississippi River pools and habitats bordering Illinois (*sensu* Fritts et al. 2017) can continue to provide high-quality data for important assessments of riverine sportfish populations in relation to contemporary environmental perturbation such as climate variability, on-going loss of side-channel and backwater habitat to sedimentation, unnatural water-level fluctuations from navigation, poor water quality, and river channel maintenance and dredging activities.

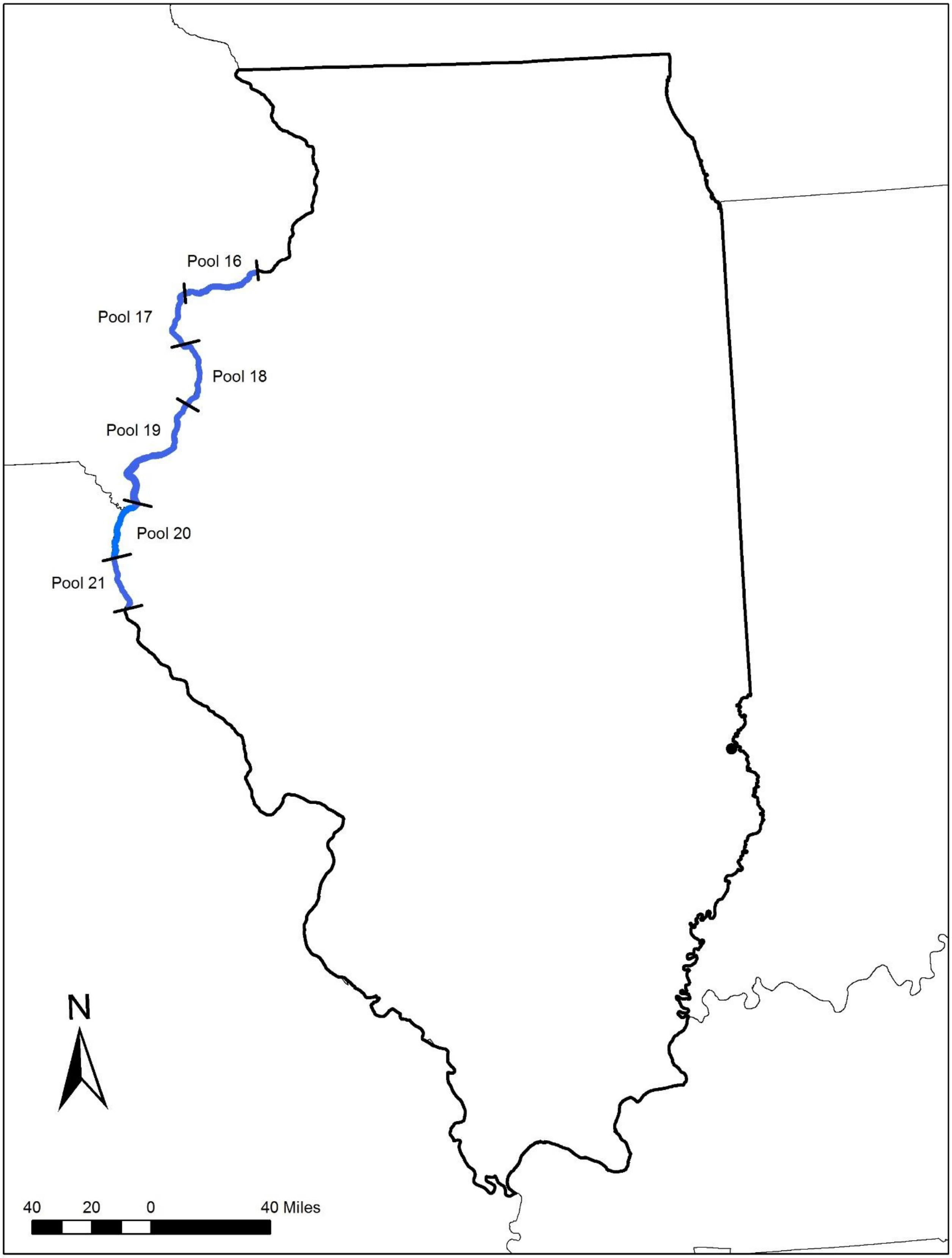

Figure 1.1. Map of the Illinois portions of the Mississippi River illustrating areas sampled by the Upper Mississippi River fish population monitoring and sport fish assessment in west central Illinois (colored in blue) during 2019.

CHAPTER 2
SPORTFISH ASSESSMENTS IN THE MISSISSIPPI RIVER

Section 2.1 - Pulsed-DC Electrofishing Collections

Electrofishing was conducted throughout the length of Pools 16-21 of the Upper Mississippi River by INHS personnel (see Appendix I). Sites were randomly selected using GIS layers of main-channel border habitats in all study areas. Electrofishing collections were conducted based on established protocols for monitoring fish populations in large rivers as described by Gutreuter et al. (1995) during three sampling periods (15 June – 31 July, 1 August – 15 September, 16 September – 31 October). Boat-mounted pulsed-DC electrofishing was used to catch fish. A three-person crew consisting of a pilot and two dippers performed 15-minute electrofishing runs at each collection site. Power was supplied by a 5,000-W generator with voltage and amperage adjusted to achieve a standardized power goals using 60 Hz and a 25% duty cycle (Gutreuter et al. 1995). Stunned fish were caught with a dip net of 1/8-in (0.3-cm) mesh and placed in an aerated livewell until sampling was completed. Fish were then identified to species, measured (total length and weight), and returned to the water. Non-carp cyprinids, darters, centrarchids < 4 in, and clupeids < 8 in were counted, but not weighed, as we have regression equations developed during 2015 that are > 95% accurate for fishes of this size (Parker et al. 2018). This saves time while sampling and reduces bias from weighing very small fishes in 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 (Baumann et al. 2000: Table 2.1). This supplemental data regarding fish health will allow for examinations into the relative health of sportfishes and the environmental quality of the rivers they inhabit. Quantifying the extent of diseases and parasitism in fishes have been used as indicators of biotic integrity since Karr (1981) originally outlined his methods for the IBI (Index of Biotic Integrity). Illinois does not currently have an IBI, or regional IBIs, for use on the medium to large rivers throughout the state. Documenting the health of riverine fishes throughout the state will prove invaluable for the development of such indices.

Section 2.2 - Ancillary Habitat Quality Measurements

Measurements for ancillary habitat-quality parameters (i.e., water temperature, dissolved oxygen, Secchi disk transparency, conductivity, surface velocity, water depth, and river stage) were recorded prior to each electrofishing run. Stage height was recorded from a single U.S. Army Corps of Engineers or U.S. Geological Survey (USGS) river gauge for each sampled navigation pool for standardization (Table 2.2).

Table 2.1. Definition of fish abnormalities documented during 2019.

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

Section 2.3 - 2019 Mississippi River Ancillary Habitat Quality Data

Pulsed-DC electrofishing was conducted between 8:20 AM and 3:35 PM central standard time during the three sampling periods specified in Section 2.1. Physical measurements for ancillary water-quality parameters were collected at each DC-sampling site, and are summarized in Table 2.2.

Section 2.4 - Statistical Analyses

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). In regions where the CPUE of key sportfishes or invasive fishes was greater than 1 fish/hr, proportional size distribution (PSD) scores (Neumann and Allen 2007) was calculated as an index of size structure. Recent research in the Wabash River indicates that 60-Hz pulsed-DC electrofishing is ineffective for sampling Flathead Catfish in riverine environments (Moody-Carpenter 2013). Therefore, Flathead Catfish were excluded from our analyses of catch rates and size structures.

Table 2.2. Summary of ancillary water quality data collected during pulsed-DC electrofishing surveys on six navigational pools of the Upper Mississippi River during 2019. Values are expressed as the mean observed parameter value ± standard error. Period 1: 15 June – 31 July; period 2: 1 August – 15 September; period 3: 16 September – 31 October.

Navigational Pool		Total EF Effort (h)	EF Power Used (Watts)	Depth (ft)	Secchi Depth (in)	Water Temperature (°F)	DO (ppm)	Conductivity (µS)	Stage Height (ft)
Pool 16 (RM 457-483)		**4.00**	**3580.7 ± 64.2**	**5.9 ± 0.8**	**11.8 ± 1.1**	**73.0 ± 1.1**	**7.4 ± 0.2**	**369.1 ± 14.6**	**12.1 ± 0.9**
	Period 1	1.50	3601.7 ± 36.8	9.0 ± 0.7	13.2 ± 0.8	71.8 ± 2.1	8.0 ± 0.4	383.3 ± 12.3	15.1 ± 0.0
	Period 2	1.25	3783.0 ± 150.0	3.0 ± 1.3	15.2 ± 1.6	77.5 ± 0.5	7.6 ± 0.2	401.4 ± 34.5	6.8 ± 0.0
	Period 3	1.25	3353.2 ± 40.5	4.9 ± 0.7	6.8 ± 1.0	69.8 ± 1.0	6.7 ± 0.3	319.6 ± 14.7	13.7 ± 0.0
Pool 17 (RM 437-457)		**3.00**	**3687.8 ± 76.2**	**7.7 ± 0.8**	**13.0 ± 1.1**	**74.7 ± 2.8**	**13.7 ± 6.0**	**393.6 ± 13.2**	**13.6 ± 0.9**
	Period 1	1.00	3925.0 ± 75.0	7.5 ± 0.5	12.3 ± 0.9	78.8 ± 0.4	7.7 ± 0.1	445.3 ± 15.5	13.0 ± 0.0
	Period 2	1.00	3778.3 ± 12.8	5.5 ± 0.3	17.0 ± 1.0	82.4 ± 0.3	7.9 ± 0.2	383.0 ± 1.7	10.5 ± 0.1
	Period 3	1.00	3360.3 ± 28.8	10.0 ± 1.7	9.5 ± 0.9	62.9 ± 3.4	7.7 ± 0.5	352.5 ± 13.6	17.2 ± 1.2
Pool 18 (RM 410.5-437)		**3.75**	**3590.7 ± 57.2**	**8.1 ± 0.8**	**12.1 ± 0.8**	**67.4 ± 2.3**	**9.0 ± 0.3**	**393.4 ± 7.7**	**13.1 ± 0.9**
	Period 1	1.25	3796.0 ± 29.0	6.8 ± 1.0	11.2 ± 0.8	73.1 ± 0.2	8.0 ± 0.2	423.2 ± 9.2	14.2 ± 0.0
	Period 2	1.25	3671.4 ± 20.6	6.9 ± 1.6	13.9 ± 0.7	73.3 ± 0.3	9.8 ± 0.6	392.8 ± 10.0	8.4 ± 0.0
	Period 3	1.25	3304.6 ± 22.7	10.6 ± 0.9	11.1 ± 1.9	55.9 ± 2.1	9.1 ± 0.5	364.2 ± 2.3	16.8 ± 0.1
Pool 19 (RM 364.5-410.5)		**6.50**	**3623.2 ± 53.9**	**3.1 ± 0.5**	**13.4 ± 0.3**	**70.6 ± 3.1**	**8.6 ± 0.4**	**385.2 ± 2.6**	**14.2 ± 0.5**
	Period 1	2.00	3837.5 ± 21.3	2.1 ± 0.3	13.3 ± 0.6	82.6 ± 0.2	6.4 ± 0.2	395.3 ± 1.6	15.2 ± 0.0
	Period 2	2.25	3798.0 ± 0.0	2.7 ± 0.5	14.1 ± 0.6	80.8 ± 0.3	9.3 ± 0.5	383.1 ± 1.3	10.7 ± 0.0
	Period 3	2.25	3257.8 ± 15.7	4.4 ± 1.2	12.9 ± 0.5	49.7 ± 0.8	9.9 ± 0.1	378.3 ± 6.1	16.8 ± 0.0
Pool 20 (RM 343-364.5)		**3.00**	**3681.8 ± 74.2**	**7.2 ± 0.7**	**11.0 ± 1.0**	**73.3 ± 3.9**	**8.5 ± 0.3**	**386.4 ± 5.4**	**12.8 ± 1.2**
	Period 1	1.00	3843.3 ± 67.7	6.5 ± 1.0	12.1 ± 1.1	82.5 ± 0.4	7.7 ± 0.2	402.3 ± 7.9	13.0 ± 0.4
	Period 2	1.00	3853.0 ± 24.0	5.5 ± 1.4	13.8 ± 0.7	82.3 ± 0.7	8.1 ± 0.4	392.3 ± 2.1	7.9 ± 0.0
	Period 3	1.00	3349.0 ± 0.0	9.5 ± 0.3	7.1 ± 1.0	55.1 ± 0.2	9.9 ± 0.2	364.8 ± 2.6	17.5 ± 0.0
Pool 21 (RM 325-343)		**3.00**	**3638.3 ± 77.9**	**8.2 ± 1.0**	**11.5 ± 0.3**	**70.9 ± 4.5**	**9.3 ± 0.4**	**398.6 ± 5.3**	**14.4 ± 0.7**
	Period 1	1.00	3837.5 ± 32.5	7.3 ± 1.1	10.3 ± 0.4	82.7 ± 0.1	7.7 ± 0.1	411.5 ± 7.7	13.5 ± 0.0
	Period 2	1.00	3798.0 ± 0.0	5.5 ± 1.5	12.4 ± 0.7	80.0 ± 0.2	9.1 ± 0.2	394.0 ± 0.6	12.0 ± 0.0
	Period 3	1.00	3279.5 ± 31.5	11.8 ± 1.2	11.8 ± 0.0	50.0 ± 0.1	11.0 ± 0.2	390.3 ± 13.0	17.6 ± 0.0

Section 2.5 - 2019 Upper Mississippi River Electrofishing Catch Statistics

We collected 13,495 fish representing 64 species and 1 hybrid during 23.25 hours of pulsed-DC electrofishing at 93 sites in main-channel border habitat. Emerald Shiner was the most abundant species in our surveys of this region (7,465 fish; 55.3% of total catch) followed by Gizzard Shad (3,203; 23.7%), and Spotfin Shiner (281; 2.1%); all other species were each less than 2% of the total abundance. Common Carp contributed the greatest biomass of fishes collected in the surveys of this region (865.4 lb; 31.6% total collected biomass), followed by Smallmouth Buffalo (299.7 lb; 10.9%), and Channel Catfish (289.3 lb; 10.6%); all other species were each less than 10% of the total biomass.

Threatened and Endangered Species

One Iowa Darter (Illinois Threatened) was collected during pulsed-DC electrofishing surveys of this region. This fish was identified in the field and released and was not verified by INHS museum staff.

Bluegill

Catch rates of Bluegill in the Upper Mississippi River during 2019 were above the 10-year average (Figure 2.2). The PSD values indicate that the Bluegill population of the Upper Mississippi River is likely dominated by smaller individuals, but PSD has been variable over the study period.

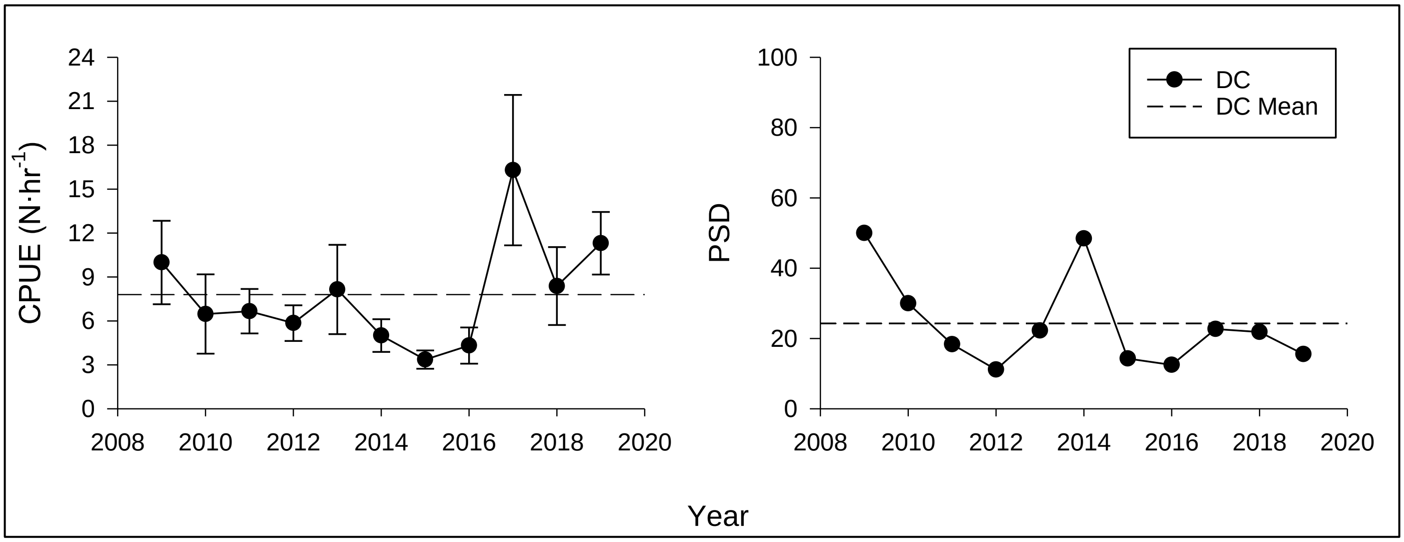

Figure 2.2. Catch per unit effort (CPUE; mean ± SE, calculated across sites and periods) and proportional size distribution (PSD) of Bluegill collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-193-R sampling initiated in 2009.

Channel Catfish

Catch rates of Channel Catfish in the Upper Mississippi River during 2019 were near average (Figure 2.3). The PSD values suggest that Channel Catfish surveys in the Upper Mississippi River generally capture larger, mature individuals, except for 2010 when numerous small fish were captured.

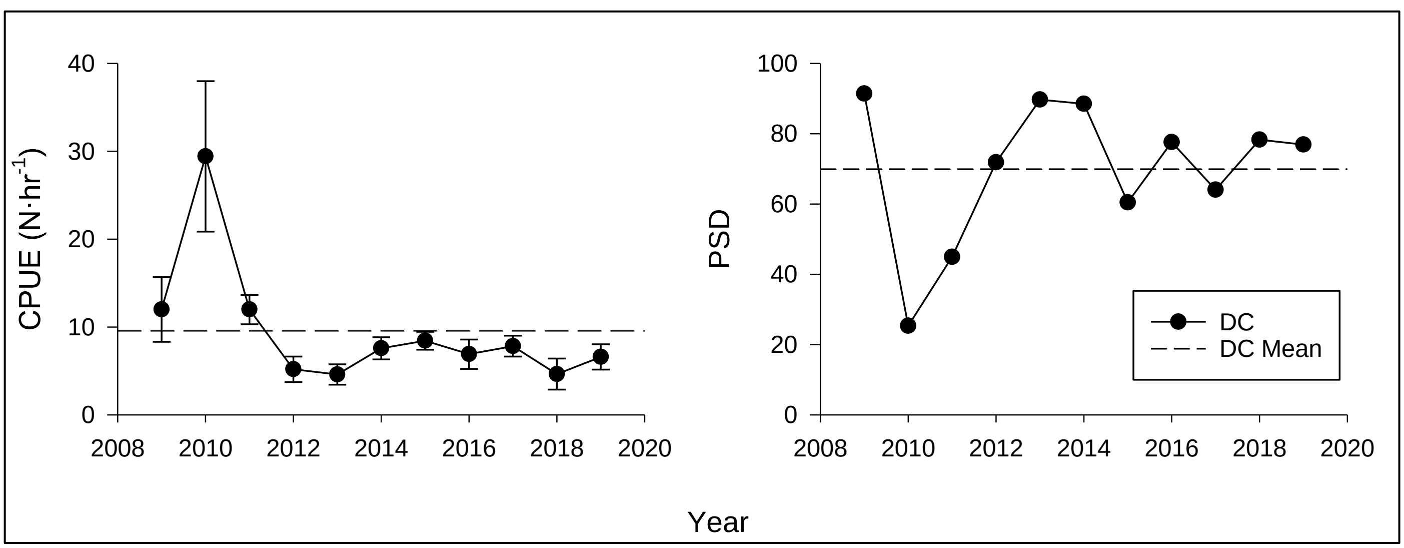

Figure 2.3. Catch per unit effort (CPUE; mean ± SE, calculated across sites and periods) and proportional size distribution (PSD) of Channel Catfish collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-193-R sampling initiated in 2009.

Largemouth Bass

Largemouth Bass CPUE was slightly below average in 2019 (Figure 2.4). Largemouth Bass catch rates have been more variable than most other species reported herein during the last 10 years. PSD values were near average, and appear to indicate a balance of large and small individuals in the region.

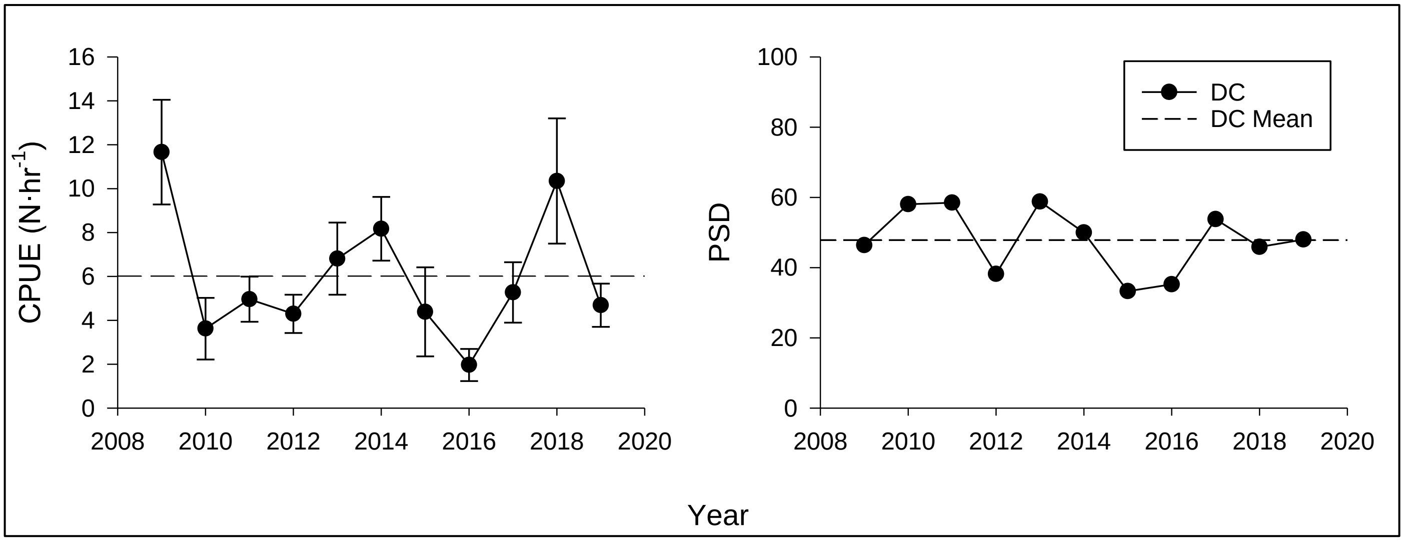

Figure 2.4. Catch per unit effort (CPUE; mean ± SE, calculated across sites and periods) and proportional size distribution (PSD) of Largemouth Bass collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-193-R sampling initiated in 2009.

Smallmouth Bass

Catch rates of Smallmouth Bass in the Upper Mississippi River were slightly below average during 2019 (Figure 2.5). The variability of PSD values through time indicates that Smallmouth Bass recruitment trends in this region are sporadic. Years of high CPUE (e.g., 2012, 2017) correspond with years of low PSD, suggesting episodic strong recruitment.

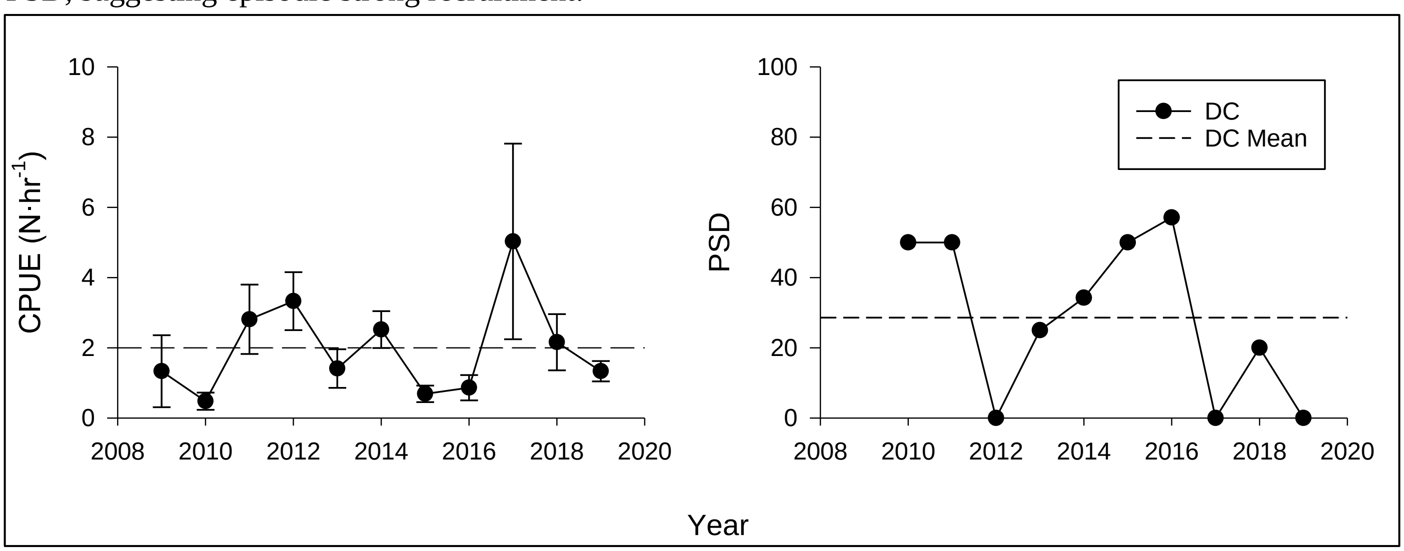

Figure 2.5. Catch per unit effort (CPUE; mean ± SE, calculated across sites and periods) and proportional size distribution (PSD) of Smallmouth Bass collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-193-R sampling initiated in 2009.

White Bass

Catch rates of White Bass in the Upper Mississippi River were slightly above average during 2019, and catch rates since 2012 have increased over time (Figure 2.6), perhaps indicating nominal population growth. 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) do not necessarily correspond with years of low PSD.

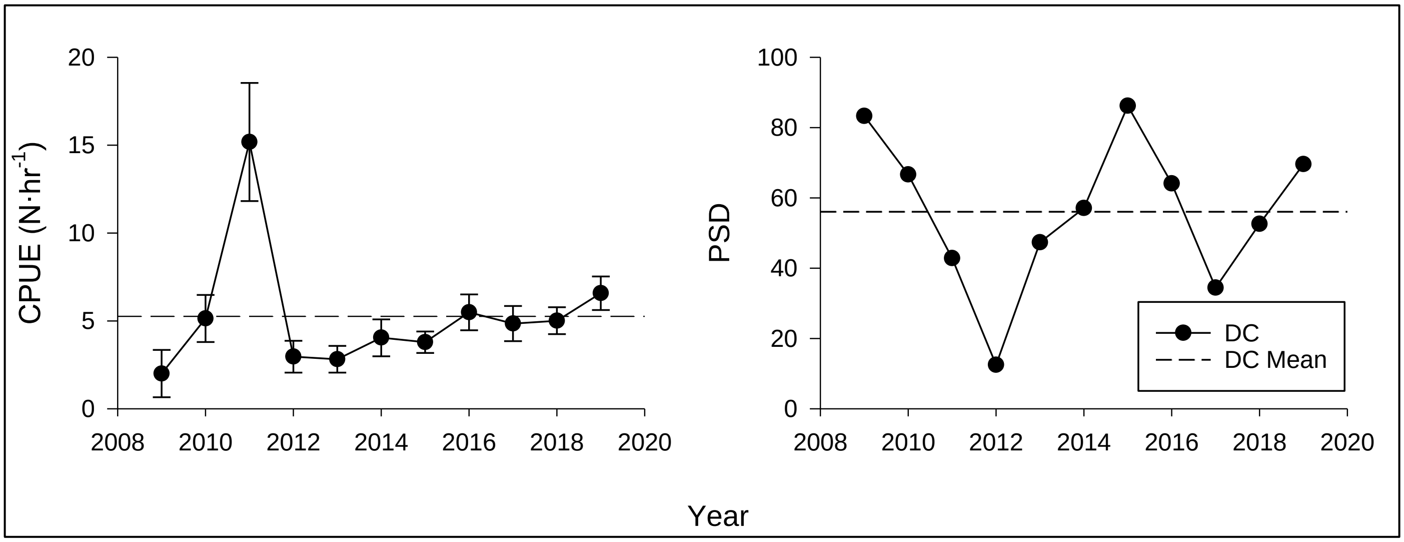

Figure 2.6. Catch per unit effort (CPUE; mean ± SE, calculated across sites and periods) and proportional size distribution (PSD) of White Bass collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-193-R sampling initiated in 2009.

Common Carp

Catch rates of Common Carp in the Upper Mississippi River were below average during 2019, and continued to indicate a long-term decrease in relative abundance (Figure 2.7), perhaps indicating population decline (*sensu* Gibson-Reinemer et al. 2017b). Consistently high PSD values through time indicate that this population is comprised of mostly large adult individuals, which supports published literature suggesting broad-scale population decline.

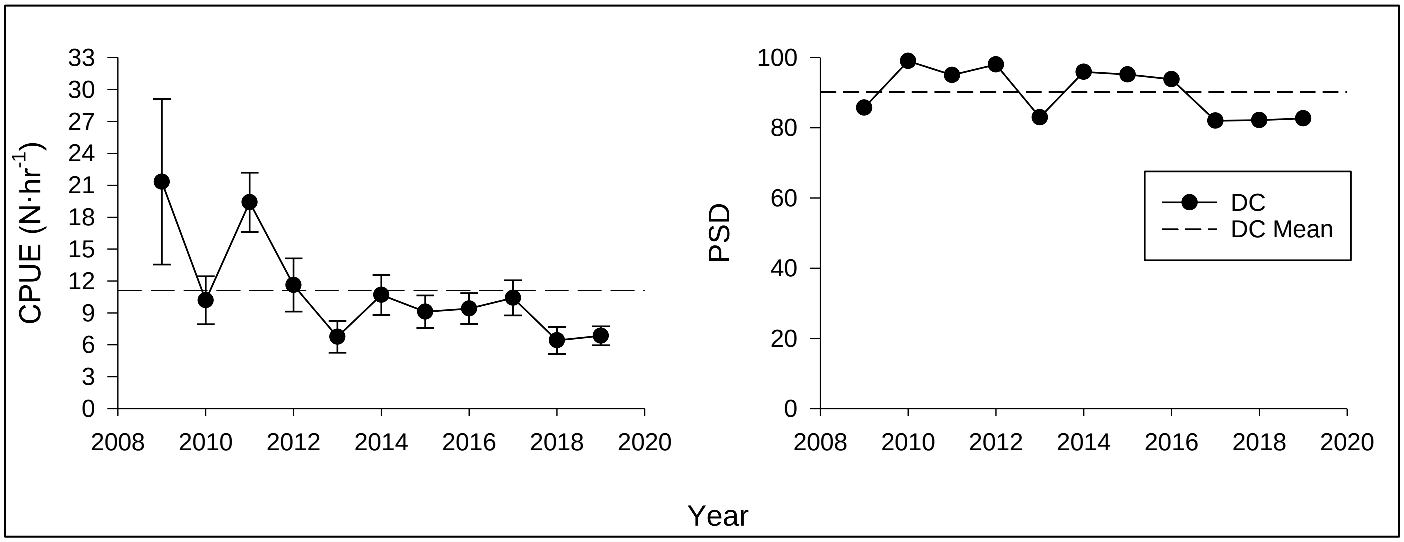

Figure 2.7. Catch per unit effort (CPUE; mean ± SE, calculated across sites and periods) and proportional size distribution (PSD) of Common Carp collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-193-R sampling initiated in 2009.

Silver Carp

Catch rates of Silver Carp are presented for Pools 20 and 21 only, as populations above Lock & Dam 19 generally inhabit off-channel areas, and are rarely encountered in F-193-R sampling. Catch rates of Silver Carp in the Upper Mississippi River were slightly above average during 2019 (Figure 2.8), and have been generally increasing since 2012. The consistently high PSD values through time indicate that this population is comprised of mostly large adult individuals, which supports previously published literature suggesting successful Silver Carp production and recruitment is sporadic (e.g., 2010 in Figure 2.8) in midwestern rivers (Gibson-Reinemer et al. 2017c).

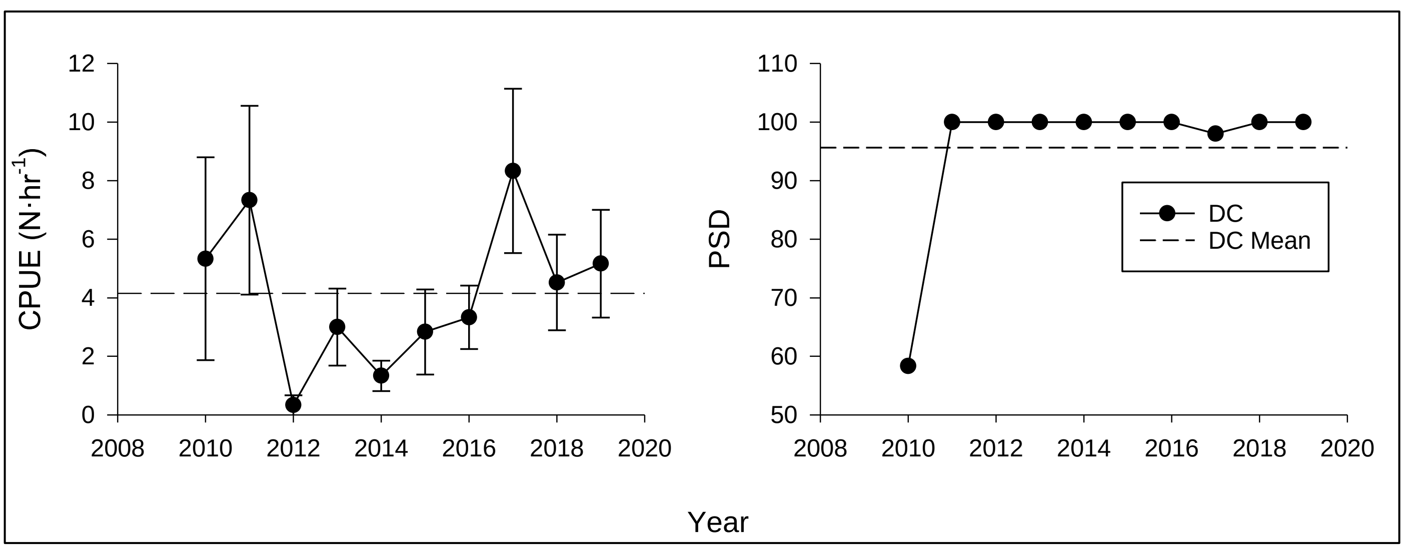

Figure 2.8. Catch per unit effort (CPUE; mean ± SE, calculated across sites and periods) and proportional size distribution (PSD) of Silver Carp collected in main-channel border pulsed-DC electrofishing surveys in the Upper Mississippi River. The dashed lines represent the averages since F-193-R sampling initiated in 2009.

CHAPTER 3

DISCUSSION and RECOMMENDATIONS

Fish monitoring conducted on the Upper Mississippi Rivers during 2019 was useful for describing the diversity and heterogeneity of fish communities in this large Midwestern river. Catch rates and species varied greatly among navigation pools and among sampling periods. We are confident that our current and future efforts to operate a well-standardized fish monitoring survey of Illinois' portion of the Upper Mississippi River system will contribute to a more comprehensive and thorough understanding of the spatial and temporal dynamics of fish communities in our state. Our observations of spatial and temporal changes in the relative abundance of some fish species in relation to both local-scale and large-scale environmental changes comprises a substantial contribution to our collective knowledge of the complexity of large river ecosystems (*sensu* Dodds et al. 2012). Inter-annual variations in the relative abundance of important forage species, like Gizzard Shad, or popular sportfish species, like Largemouth Bass and Channel Catfish, are likely related to 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 can contribute to the development of more effective and sustainable management policies for the large rivers of Illinois.

Sportfish

Catch rates and sizes of popular sportfish species varied greatly among the navigation pools sampled during 2019. Bluegill and Channel Catfish were the most-abundantly collected sportfish species in nearly all areas on the Upper Mississippi River, although Largemouth Bass and Smallmouth Bass also appear to have robust populations. The slow but steady increase in White Bass CPUE since 2012 may warrant further investigation. Our long-term datasets allow us to observe substantial annual variations in the relative abundance and size distribution of many sportfish species, like Smallmouth Bass and White Bass. These observations could serve as a catalyst for future research investigating the effects environmental changes and management policies on the sustainability of Illinois' sportfish populations.

Invasive Species

Although the main focus of the F-193-R project is to conduct monitoring to improve our understanding of population dynamics, life histories, and habitat requirements of sportfishes, the program's sampling strategies are also useful for documenting trends in the relative abundance of non-native species occupying Illinois' large river ecosystems. However, we advise that researchers use caution when interpreting the data we collect on invasive species as our sampling protocols (e.g., restriction to main-channel habitats) may limit our probability of encountering the greatest densities of the species in some instances. Our surveys suggest Common Carp populations are declining across the region since 2009, which may be the harbinger of good things to come for native fish populations that have been negatively affected by Common Carp. Alternatively, Silver Carp populations (i.e., below L&D 19) appear to be increasing since 2012, which may counteract any benefits native fish populations may have gained as a consequence of declining Common Carp populations.

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Appendix I. Reaches and navigation pools sampled by LTEF pulsed-DC electrofishing surveys (and our partners) during 2019 with the upstream and downstream limits (RM), the number of sampling locations within each study area (N), and the locations of the USGS gauges used to record stage height in each study area are included in ascending (downstream to upstream) order.

River	Monitoring Institution	Reach/Pool	Downstream	Upstream	N	Gage
Illinois	INHS, F-101-R	Alton	0.0	80.0	45	Florence, IL
	INHS, F-101-R	Peoria	158.0	231.0	44	Henry, IL
	INHS, F-101-R	Starved Rock	231.0	247.0	9	Ottawa, IL
	INHS, F-101-R	Marseilles	247.0	271.5	18	Morris, IL
Des Plaines	INHS, F-101-R	Dresden	271.5	286.0	9	Brandon Road Lock and Dam
Mississippi	INHS, F-101-R	Kaskaskia Confluence	117.0	165.5	30	Chester, IL or Brickeys, MO
	INHS, F-101-R	Chain of Rocks	165.5	200.5	21	Saint Louis, MO
	INHS, F-101-R	Pool 25	242.0	273.5	18	Mosier Landing, IL
	INHS, F-193-R	Pool 21	325.0	343.0	12	Quincy, IL
	INHS, F-193-R	Pool 20	343.0	364.5	12	Gregory Landing, MO
	INHS, F-193-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	Pool 53	962.5	939.0	15	Metropolis, IL
	SIU, F-187-R	Pool 52	939.0	918.5	12	Paducah, KY
	SIU, F-187-R	Smithland	848.0	918.5	42	Golconda, IL
Wabash	EIU, F -186-R	New Harmony, IN	444.5	487.0	21	Mount Carmel, IL
	EIU, F -186-R	Mt. Carmel, IL	412.0	444.5	27	Mount Carmel, IL
	EIU, F -186-R	Vincennes, IN	385.5	412.0	18	Mount Carmel, IL
	EIU, F -186-R	Palestine, IL	351.0	385.5	21	Mount Carmel, IL
	EIU, F -186-R	Terra Haute, IN	315.5	351.0	15	Mount Carmel, IL