Prairie Research Institute
Illinois Natural History Survey

FINAL PERFORMANCE REPORT

1 July 2020 – 30 June 2021

Research and Analysis of Fisheries in Illinois

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RESEARCH AND ANALYSIS OF FISHERIES IN ILLINOIS

F-69-R (34)

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EXECUTIVE SUMMARY

Fisheries managers are charged with understanding the interaction between sport fish populations and anglers to inform resource management decision making that supports and promotes healthy fisheries. Fundamental to this mission is easy access to long-term fisheries data, analytical tools and metrics that offer insight into the quality of a fishery, and an understanding of the factors that influence fish population dynamics. Equally important is the need to communicate this scientific knowledge and promote angling opportunities to the public.

Project F-69-R has four overall goals: (1) conduct a variety of surveys and investigations that elucidate patterns of variation in sport fish populations and the mechanisms that drive those patterns, (2) evaluation methodologies used to collect fisheries data and inform sampling strategies; (3) communicate research findings and basic assessments of sport fish populations to the angling public, and (4) organize, manage, analyze and deliver sport fisheries data to researchers, sport fish managers, and the angling public. Basic and applied research studies, public outreach efforts, and data management activities all work in concert to create a better understanding of the restoration and conservation needs of sport fish populations in Illinois.

Surveys and investigations conducted in Segment 34 were executed under Study 1, Study 2, and Study 3. Summarized below, these studies were focused on three areas of sport fish restoration and management.

First, three experiments investigating the status and trends of ancient sport fishes (Gars and Bowfin) were continued statewide describing population vital rates (completed); spatial ecology and genetic relatedness (ongoing); and specialized surgical methods for transmitter implantation (completed).

Second, one experiment investigating the influence on the heritability of lure avoidance was completed, providing further evidence of the role angling vulnerability plays in fishing quality.

Third, an evaluation of patterns in age and growth of Walleye, Sauger and their hybrids was continued in several impoundments in east central Illinois.

Evaluation of sampling methods under Study 4 focuses on incorporating a fixed/random sample design into fisheries assessments in Illinois impoundments. Specifically, habitat and bathymetric assessments of study lakes are ongoing, population assessments were initiated, and data simulations will begin in Segment 35.

Sport fish data sets are the building blocks that support research studies and outreach activities within Project F-69-R, making the collaborative collection, organization, analysis, and dissemination of sport fish information a critical component of the overall goals of this project. In Study 5, project personnel collaborated with the Illinois Department of Natural Resources to operate and expand on online system to efficiently collect and manage data that reflects the status and trends in sport fish populations in Illinois. An online permit application system for

fishing tournaments continues to be a valuable administrative tool that also generates data regarding the scale of tournament fishing in Illinois. Advancements in the I Fish Data Portal have led to significant progress towards placing more data management responsibility with the IDNR Division of Fisheries, while maintaining collaborative access to data for use in Project surveys and investigations.

Outreach activities under Study 6 primarily consist of the maintenance of the website www.ifishillinois.org. The website is a heavily visited, popular resource for anglers seeking information about sport fishing opportunities in Illinois. The site provides basic information about access, as well as science-based assessments about the quality of sport fishing in Illinois waters. Through Study 6 we communicated the results of sport fish research and analysis, delivering state-of-the-art information to researchers, managers, and the angling public. Social media will continue to be utilized to promote and share information about sport fishing opportunities throughout Illinois. The website, social media, and public outreach activities are essential to sharing public data and information about sport fish populations and management in Illinois.

The importance and value of Project F-69-R lies in the ability to be responsive to emerging sport fish management issues through research studies utilizing long-term sport fish data sets, followed by compelling and salient communications of those findings to the angling public. The Executive Summary provides a brief overview of the accomplishments of each job within the project, followed by a more detailed reporting of the specific procedures, findings and recommendations for future activities under this project.

STUDY 1 ANCIENT SPORT FISHES

A series of three experiments are nearing completion, investigating various aspects of the ecology, life history and management of gars and Bowfin. To date, data collection to describe population demographics of three gar species throughout the major watersheds in Illinois is complete and analyses in HUC-6 watersheds throughout Illinois are presented. Based on these mark—recapture returns and abundance data, populations of Shortnose Gar and Longnose Gar appear substantial across the state's major rivers. Less is understood about Spotted Gar and Bowfin populations, as they were less abundance in our sampling, thus limiting our ability to draw firm conclusions about their sustainability. While there appears to be no urgent need for aggressive management actions for Holostean fishes in the Illinois' large river system, life history characteristics of longevity and slow growth require careful consideration and further study before firmly ruling out the need for harvest restrictions. Analyses of genetic data are proceeding and will provide additional insights into the level of connectivity among subpopulations, the pervasiveness of hybridization, and the role large scale movements may play in Holostean sustainability in large river systems. Movement data generated by an acoustic telemetry study indicate that home ranges of Shortnose Gar vary considerably, hinting at large-scale connectivity of subpopulations throughout the Illinois River. Shortnose Gar predominantly used backwater habitats throughout the year, while sometimes moving to main channel and side channel habitats. Further analyses of the combination of genetic and telemetry data in the next segment will further elucidate population structure and inform management strategies.

STUDY 2 ANGLING VULNERABILITY

In previous project segments, project personnel have conducted investigations examining **factors that affect catchability of sport fish** using Largemouth Bass and Bluegill as a model species. Study 2 is focused on testing the vulnerability to angling of six differentiated lines of Largemouth Bass maintained over 30 years in a captive setting to determine if reductions in angling pressure result in increases in catchability. Three full seasons of experimental angling were conducted from 2018 – 2020, the results of which demonstrated that heritable differences in catchability persisted in F1 and F2 generations of fish despite the absence of angling for three generations of parental lineage preceding the generations tested. These results, as well as the body of research conducted previously, indicate that fisheries induced evolution in largemouth bass recreational fisheries is not rapidly mitigated by no-fishing restrictions, but that slow recovery to baseline levels of vulnerability is likely occurring.

STUDY 3 COOL WATER SPORT FISHES

Recreational sport fishing in inland waters is a significant economic driver in Illinois, requiring significant effort to conduct surveys and inventories to monitor the status of the cool water sport fish community to inform management strategies. Since 2016, project personnel have coordinated with IDNR fisheries biologists to sample populations of Walleye, Sauger and Saugeye in Clinton Lake, Weldon Springs Lake, Dawson Lake, Lake Bloomington, Lake Shelbyville, Lake Decatur, Paradise Lake, Charleston Side Channel, Mattoon Lake, and Evergreen Lake. Using otoliths and dorsal rays, ages were determined by project personnel and demographic data analyzed. Across 12 Illinois lakes, Saugeye grow significantly larger than Walleye or Sauger. Proportional stock density values for Saugeye reflect consistently stable size structure across all study lakes, but values for Walleye were variable across lakes. Body condition index (W_r) were slightly below optimal in most cases, but still within a range indicating populations in good condition, with the exception of the Walleye population in Lake Shelbyville where condition factors were notably lower. Saugeye and Walleye population typically comprised of fish from 1–4 years old, with few fish reaching older ages. Length at age comparisons demonstrated the limiting effect on statewide harvest regulations (14-inch minimum size limit, 6 fish bag limit) on growth in the population; additional analyses in Segment 35 will provide a more nuanced look at this phenomenon. The generation of age data in this study should continue, and expansions to additional water bodies should be carefully considered relative to available resources.

STUDY 4 SAMPLING DESIGN

Currently, surveys and inventories that provide population assessments of sport fishes in Illinois inland lakes rely on repetitive, annual, biennial, or triennial sampling events conducted at fixed sampling locations. Data generated by these samples are assumed to reflect fish populations across the entire waterbody. Site selection, however, is not always conducted to reflect all available habitats, which may introduce bias in abundance and size structure estimates depending on the location of fixed sampling sites in relation to habitat type and quality. To determine existing biases generated from the dependence on fixed-site sampling designs and develop a fixed/random sampling design evaluations of bathymetry and existing habitat types/extents using side scan sonar in seven Illinois impoundments were initiated in the fall of 2019 and are ongoing. Side scan images and bathymetric maps were completed for six out of 10 lakes in east-central Illinois. Fish population sampling will continue in the Fall of 2021 (Segment 35) at which point model simulations of various sampling designs will begin.

STUDY 5 MANAGEMENT OF FISHERIES DATA SYSTEMS

Access to fisheries data sets and the efficient and coordinated management of those data sets are critical to address objectives outlined in the Illinois Department of Natural Resources Division of Fisheries Strategic Plan. Project personnel have continued collaborations with IDNR Division of Fisheries to identify necessary modifications and improvements to the collection, storage, and retrieval of fisheries information by researchers, managers, and the public. Project personnel have developed a **scoping document for developing a data analysis package** that will incorporate frequency, length frequency/condition/CPUE, biomass, catch rate, stock density, wadeable Stream IBI, and large river IBI analyses for selected samples. Project personnel will continue to provide training and technical support for these online systems until such time that support is no longer needed. Further efficiencies and modifications to fisheries information systems should be explored and implemented in future project segments, thus making information about sport fish populations in Illinois more readily accessible to researchers, managers, and the public.

STUDY 6 I FISH ILLINOIS WEBSITE

I Fish Illinois has become **a well-recognized brand** among Illinois anglers, as demonstrated by the growing popularity of www.ifishillinois.org and facilitated by the dominance of social media as a method of creating online communities. **I Fish Illinois Facebook and Twitter accounts are a vital part of interacting with the angling public.** Illinois anglers typically submit 50 inquiries each week, which are answered within 24 hours directly by project personnel or are routed to appropriate DNR staff. Responsiveness to public inquiries has **built confidence and trust in the I Fish Illinois brand**, which is tightly aligned with Illinois Department of Natural Resources Division of Fisheries. Information about visitors to www.ifishillinois.org indicates that the website's popularity and growth is likely the result of **effective coordination between project personnel and IDNR Division of Fisheries**.

The website www.ifishillinois.org provides information about Illinois sport fish, including angling tips and areas for greatest success; fishing reports in a cleaner format; lake profile pages with an expandable map and a fishing forecast as provided by IDNR biologists; informational pages on fishing equipment, fishing tips and taking kids fishing; IDNR fishing programs; and trends in fishing quality. This effort makes sport fisheries-related information readily available to the public and continues to provide immeasurable benefit to current and prospective anglers in Illinois. During Segment 34, the **website had 473,777 users, with a total of 1,624,360 pages** viewed, indicating a strong public interest in the information provided about fishing opportunities in Illinois. The **“Buy a Fishing License” button has generated 63,743 visits from the I Fish Illinois website to the DNR license purchase site**.

STUDY 1 STATUS AND TRENDS OF ANCIENT SPORT FISHES IN ILLINOIS

The purpose of this study is to provide data and analyses that describe temporal movement and habitat use of Shortnose Gar in the waters of Illinois. Specifically, information regarding the correlation between movement patterns and abiotic factors (such as water temperature and flow) will be used to develop management alternatives designed to promote sustainable recreational fishing.

OBJECTIVES

The following components constitute the overall objectives for Study 1:

- Collect and analyze spatial data of Shortnose Gars using a stationary acoustic telemetry receiver array in the Lower Illinois River to determine seasonal movement and habitat use by June 30, 2021.

PROCEDURES & FINDINGS

The procedures of Study 1 are comprised of the three related experiments reported below, each with their own objectives, procedures, findings and recommendations that support the overall objective of describing the dynamics of Holostean fishes in the waters of Illinois.

Experiment 1.1 – Long-term mark-recapture assessment

Mark-recapture studies are an effective method for assessing temporal and spatial trends of a defined wild population. When applied over broad spatial scales, mark recapture studies require the sampling and marking of large numbers of individuals, requiring multiple field seasons to adequately execute the assessment. Therefore, what follows is the final report on Experiment 1.1, which began in 2015 and is now completed.

OBJECTIVES

Using mark-recapture methods, we aim to describe temporal and spatial trends in the distribution, size structure, and body condition of gars and Bowfin throughout major watersheds in Illinois.

PROCEDURES

Various state agencies and universities have been assisting the Sport Fish Ecology Lab with the long-term gar and Bowfin mark-recapture study. These include the Illinois Department of Natural Resources Fisheries Division (IDNR), the INHS Illinois River Biological Station, the INHS Population Monitoring Program (LTEF), INHS Great Rivers Field Station, Eastern Illinois

University, Western Illinois University, the Illinois Bowfishing Association of Illinois, the Bowfishing Association of America, the Tri-State Bowfishers, Missouri Department of Conservation, and personal communications with anglers. Researchers documented the total length (mm) and weight (g) of each captured fish, affixed a T-bar anchor tag (Floy tag) into the dorsal musculature, removed the left pectoral fin ray for age estimation, and then released individuals at their location of capture. To attempt to collect a wide size distribution of fishes, a multi-gear approach with gill nets, fyke nets, hoop nets, AC electric seine, AC boat electrofishing, and DC boat electrofishing was used.

Throughout the findings of this report, we will reference HUC6 (hydrologic unit codes) watersheds. These watersheds were delineated by the U.S. Geological Survey based on surface hydrologic features such as drainage, culture, hydrography, and hydrologic boundaries (Seaber et al., 1987). They are widely accepted for use in describing water and land use activities and provide a standardized base for use by various organizations.

When sample sizes were sufficient, data was evaluated separately for each species and compared over time and between HUC6 watersheds using the statistical programs R Studio and Sigma Plot. Temporal and spatial comparisons in fish size (length frequency), stock density (PSD; Bister et al. 2000), and body condition (relative weight (W_r; Bister et al. 2000) or TL/WT regressions) were calculated.

FINDINGS

From 2015 through 2019, a total of 5,036 individuals (1,258 Longnose Gar, 2,648 Shortnose Gar, 250 Spotted Gar, 871 Bowfin, and 9 young-of-year gars) were sampled at 4,993 sites throughout seven HUC6 watersheds in Illinois (Figure 1.1.1 and Table 1.1.1). The majority of sampling effort over the 5-year study was concentrated in the Illinois River (Lower Illinois watershed), Wabash River (Wabash watershed) and Mississippi River (Upper Mississippi-Meramec watershed) due to consistency of annual fish surveys and the longevity of collaborative efforts with various agencies, namely the INHS Biological Station in Havana (LTEF and LTRMP), Eastern Illinois University (LTEF and graduate student studies), and Missouri Department of Conservation (LTRM) (Figure 1.1.1). Several sites within the Kaskaskia, Lower Ohio, Upper Mississippi-Skunk-Wapsipinicon, and Upper Illinois watersheds were also sampled during the study, but these waters were not revisited on an annual basis by INHS or collaborators (Figure 1.1.1 and Table 1.1.1). Due to low sample size (n < 43 individuals) in the Kaskaskia, Lower Ohio, Upper Mississippi-Skunk-Wapsipinicon, and Upper Illinois basins, these data will not be used to describe temporal or spatial trends in ancient fish populations. Waterbodies within the Upper Mississippi-Maquoketa-Plum, Upper Mississippi-Salt, Rock, Lake Michigan, and Southwestern Lake Michigan were not surveyed for Gar and Bowfin during our study (Table 1.1.1 and Figure 1.1.1).

Spotted Gar

The least likely species to be encountered in any Illinois watershed was Spotted Gar, comprising of only 5% of the total number of fish captured during the 5-year study (Table 1.1.1). In addition, no tagged Spotted Gar were recaptured during the study. Length frequency histograms, relative weight (W_r), and PSD values were calculated for all years combined, and then compared between watersheds because low annual sample sizes restricted temporal assessments within watersheds. Low sample size also limited watershed comparisons, therefore only data from the Lower Illinois and Wabash watershed were used in analyses.

On average, Spotted Gar in the Lower Illinois were larger than those in the Wabash watershed (ANOVA; $P < 0.05$, DF = 1; Figure 2), but with so few fish captured in either watershed these size difference should be interpreted with caution. A total of 59 fish (out of 82 individuals) were stock size or larger (> 300mm) in the Wabash watershed whereas 132 fish (out of 136 individuals) were ≥ stock size in the Lower Illinois watershed. Generally, more quality, preferred, and memorable-sized Spotted Gar were sampled in the Lower Illinois compared to the Wabash watershed (Table 1.1.2). There were no preferred or memorable-sized Spotted Gar collected in the Wabash watershed during the study, whereas 18 and 5 were the PSD-P and PSD-M values, respectively, in the lower Illinois watershed (Table 1.1.2). No trophy size fish were sampled in either watershed.

Despite the low sample size of Spotted Gar in our study, all fish from both the Lower Illinois and Wabash watersheds were in moderate condition (values near 100 represent fish that are in optimal condition), with an average W_r value of 88.5 ± 0.9 (n = 127) and 88.7 ± 1.9 (n =66), respectively (minimum length = 250mm). Considering that almost half as many fish were sampled in the Wabash relative to the Lower Illinois, fish condition was not comparable between watersheds (Figure 1.1.3).

Bowfin

In general, Bowfin were rarely captured in fish surveys throughout Illinois. Most Bowfin captured during the study were in the Lower Illinois watershed during 2016 (n = 232; Table 1.1.1). Bowfin were captured in the Lower Illinois watershed from 2015 through 2018, but no fish were captured during 2019, likely due to ineffective electrofishing in high water. In fact, there were few fish (regardless of species) captured in 2019 in the Lower Illinois, due to flooding. Bowfin were sampled during surveys in the Lower Ohio (during one sampling event), Upper Illinois, Upper Mississippi-Meramec, and Wabash watersheds. Due to low sample sizes, population demographics could only be compared over time (2015-2018) within the Lower Illinois watershed.

The largest Bowfin in the study were surveyed in 2017 (average TL = 594.0 ± 6.4mm), while the smallest fish were sampled in 2015 (546.5 ± 8.1mm; Figure 1.1.4). Bowfin were different sizes between some survey years (One way ANOVA, $P < 0.05$, DF = 1). On average, the smallest Bowfin were captured in 2015 (average TL = 546.5 ± 8.1mm) and 2016 (average TL = 553.3 ± 6.3mm; and did not differ in size between those 2 years ($P > 0.05$). On the contrary, the largest fish were found in 2017 (average TL = 594.0 ± 6.4mm) and 2018 (average TL = 574.3 ± 4.7mm), and fish did not differ in size between those years ($P > 0.05$; Figure 1.1.4). Not surprisingly, smaller fish were sampled in 2015 compared to fish collected in 2017 (Tukey's HSD $P < 0.001$) and 2018 (Tukey's HSD $P < 0.05$), and Bowfin sampled in 2016 were smaller than those sampled in 2017 (Tukey's HSD P < 0.001) and 2018 (Tukey's HSD P = 0.05; Figure 1.1.4).

To evaluate Bowfin body condition, Log10 (WT) was regressed against Log10 (TL) (Blackwell et al., 2000; Figure 1.1.5). No temporal differences were evident, but generally all 4 regressions had a poor fit (i.e., R^2 values < 0.64). It is clear in the figures that the poor fit was due to two obvious clusters of fish that appear in all 4 years (Figure 1.1.5). These two clusters likely represent differences in gender. We did not determine gender during field surveys, but it is generally known that female Bowfin typically grow faster and obtain larger sizes relative to male Bowfin (DeBoer et al., 2020), therefore we hypothesize that fish in the upper cluster represent females and fish in the lower cluster represent males of the population (Figure 1.1.5). Due to the clear distinction here, we suggest that gender be determined in the field when possible and should be taken into consideration when assessing size data for use in management. Juvenile bowfin and adult males often have a yellow-ringed ocellus in the upper portion of the caudal peduncle. This feature is often lost or reduced to an un-ringed black spot in adult females.

The highest recapture rate recorded in our study was Bowfin at 1.53%, (Table 1.1.3). All 12 Bowfin that were recaptured were in the Lower Illinois watershed and were reported by INHS collaborators, state agencies (U.S. Fish and Wildlife Service and Illinois Department of Natural Resources), or the angling public. Six of these fish were from the disconnected backwater of the Illinois River, Hennepin-Hopper Lakes. This 3,000-acre waterbody was consistently surveyed in spring and fall using DC EF and fyke nets by IDNR. Eight of the twelve recaptured fish in Hennepin-Hopper Lakes were captured more than once after initial tagging and one individual was captured yearly from 2016–2018.

Longnose Gar

Over the span of the 5-year study, 1,259 Longnose Gar were collected in 6 watersheds (Table 1.1.1) representing 25% of the total number of fish sampled during the study. The Wabash watershed contained the majority (70%) of Longnose Gar collected in the study, but were also sampled consistently in the Lower Illinois and Upper Mississippi-Meramec watersheds; therefore, spatial, and temporal analyses will include data from these watersheds.

There were no differences in the average total length of Longnose Gars among years in the Upper Mississippi-Meramec watershed (ANOVA on Rank P = 0.04, DF = 3, Dunn's P < 0.05: Figure 1.1.6) or Lower Illinois watershed (P = 0.07, DF = 3; Figure 1.1.7). In the Wabash watershed, fish were smaller in 2018 relative to fish sampled in 2015 (P < 0.001, DF = 4; Dunn's P = 0.002), but fish size was comparable among all other years (Figure 1.1.8). Some resolution to fish recruitment over time can be visualized in the Wabash watershed length frequency histograms; note the cluster of smaller size fish in 2015 shifting to larger size classes each year (Figure 1.1.8). This recruitment trend is not shown in the histograms created for Lower Illinois and Upper Mississippi-Meramec populations (Figure 1.1.6 and 1.1.7). Regardless of year, Longnose Gar from the Wabash watershed (average TL = 692.6 ± 9.0mm; P < 0.05, DF = 2; Dunn's Post Hoc P < 0.001) and Upper Mississippi-Meramec watershed (average TL = 676.2 ± 13.7mm P < 0.05, DF = 2; Dunn's Post Hoc P < 0.001) were on average larger than fish from the

Illinois watershed (average TL = 579.0 ± 9.2mm). Longnose Gar were similar in size between the Wabash and Upper Mississippi-Meramec watershed (Dunn's Post Hoc $P > 0.05$).

To evaluate body condition across watersheds, W_r was calculated for fish that had both total length and weight values. Generally, Longnose Gar were in poor body condition, with a combined average W_r of 78.1 ± 0.4 (*n* = 1123; Figure 1.1.9). However, when compared across watershed, Longnose Gar in the Lower Illinois (average W_r = 79.8 ± 0.8, *n* = 177) were in better condition (although values still indicate fish were in poor body condition) relative to both the Upper Mississippi-Meramec (average W_r = 76.6 ± 1.8, *n* = 90; $P < 0.001$, Dunn's Post Hoc $P < 0.001$) and Wabash watersheds (average W_r = 77.9 ± 0.5, *n* = 856; $P < 0.001$, Dunn's Post Hoc $P < 0.001$; Figure 1.1.9). Fish sampled in the Wabash and Upper Mississippi-Meramec had relatively similar body condition estimates to each other.

A total of 762 Longnose Gar in the Wabash, 177 in the Lower Illinois, and 131 in the Upper Mississippi-Meramec watersheds were ≥ stock size (410mm) and were used to estimate size structure indices (Table 1.1.2). The only watershed that contained trophy size Longnose Gar was the Wabash watershed, with a PSD-T value of 1. In fact, the largest single Longnose Gar were captured over the 5-year study were captured in the Wabash watershed. The Wabash watershed population had a PSD-M value of 10, compared to only 2 in the Upper Mississippi-Meramec; there were no memorable size fish in the Lower Illinois watershed. Preferred and quality size fish were also more abundant in the Wabash population relative to the Upper Mississippi-Meramec and Lower Illinois watersheds. In general, fish in the Lower Illinois were relatively small and very few were of quality size (*n* = 31; Table 1.1.2).

As with all other species in our study, recapture rates were very low for Longnose Gar (Table 1.1.3). Only 2 out of 1,259 total tagged Longnose Gar were recaptured during the 5-year study and both fish were tagged and recaptured in the Wabash River (Table 1.1.3). These fish were captured by anglers; one fish was "disposed of" 3 months after its initial tagging in March of 2015 and the second fish was released after caught. Due to the low recapture rates and lack of documentation of the total effort expended over the past 5 years, it was not possible to estimate population size. Although the vast number of collaborators involved in the study was highly beneficial, total effort was not always recorded, particularly when gar and bowfin were not captured during a survey. Future studies should be sure to carefully document these data to model population size.

Shortnose Gar

Of all four ancient fish species in our study, the most frequently captured was the Shortnose Gar, which comprised more than half of the total fish sampled (Table 1.1.1). Similar to trends of Longnose Gar counts, the bulk of Shortnose Gar data was collected in the Lower Illinois, Upper Mississippi-Meramec, and Wabash watersheds (Table 1.1.1). Data collection spanned across all 5 years in both the Lower Illinois and Wabash, while surveys in the Upper Mississippi-Meramec began in 2016, therefore data from all 3 watersheds will be used in statistical analyses described below.

Shortnose Gar were captured in the Wabash watershed consistently from 2015–2019 at a rate more than 180 individuals per year (Table 1.1.1). The average TL of fish sampled in the Wabash watershed varied between years (P = 0.002, DF = 4); on average, larger fish were sampled in 2017 (average TL = 549.7 ± 6.5mm) relative to all other years (Dunn's Post Hoc P < 0.05 for all pairwise comparisons; Figure 1.1.10). Length frequency histograms provide resolution to the recruitment of Shortnose Gars in the Wabash watershed (similar to trends seen in Longnose Gar in Figure 1.1.8); a cluster of small size fish (around 295 – 395mm TL in 2015) migrating up size classes each year (Figure 1.1.10). Due to the ineffectiveness of nets and gear on small (i.e., juvenile) fishes, very few are typically collected during surveys, however this provides some initial evidence of a potentially healthy and sustainable fishery). Additionally, the wide size range in the histograms suggests that the Wabash watershed has the habitat required to support small (young) fish as well as large (old) fish.

On average, Shortnose Gar in the Lower Illinois watershed were smallest in 2015 relative to all other years (P < 0.001, Dunn's Post Hoc P < 0.001 for all pairwise comparisons; Figure 1.1.11). Unlike the Wabash watershed, length frequency distributions in the Illinois watershed do not clearly indicate fish are being recruited to the population. This may suggest that these smaller size classes utilize habitats that were not surveyed during our study. Little is known about Shortnose Gar movement and habitat use; therefore, our telemetry research (Experiment 1.3) will provide further information that may provide more insight into these findings. Our telemetry study is ongoing and will continue into Segment 35.

Lastly, the average size of Shortnose Gar in the Upper Mississippi-Meramec remained consistent across sampling years and similar to the Lower Illinois, evidence for within watershed recruitment was not visible in the plots (Figure 1.1.12). Although fewer Shortnose Gar were sampled in the Upper Mississippi-Meramec watershed relative to the Wabash and Illinois (Table 1.1.1), fish were larger (Average TL = 547.5 ± 4.4mm, *n* = 389) relative to both the Illinois (529.1 ± 2.6mm, *n* = 1086) and Wabash watersheds (524.2 ± 2.9mm, *n* = 1160; P < 0.001, DF = 2; Dunn's Post Hoc P < 0.001 for all multiple comparisons). Despite these size differences, there was no difference in Log10(TL) vs Log10(WT) regressions between watersheds and overall, all 3 regressions had a good fit (R^2 values were all > 0.87).

Out of a 2,649 tagged Shortnose Gar, only five fish were recaptured during the 5-year study. Three of these fish were recaptured in the Lower Illinois, and two fish were recaptured in the Wabash watershed. Four of these fish were caught by INHS or state agencies, and one fish was reported by a commercial fisherman using hoop nets to target sturgeon/catfish in the Wabash

River. All recaptured Shortnose Gar were found within one year of their initial tagging date and within their respective tagging waterbody. Low recapture rates suggest Shortnose Gar populations are widely abundant throughout Illinois.

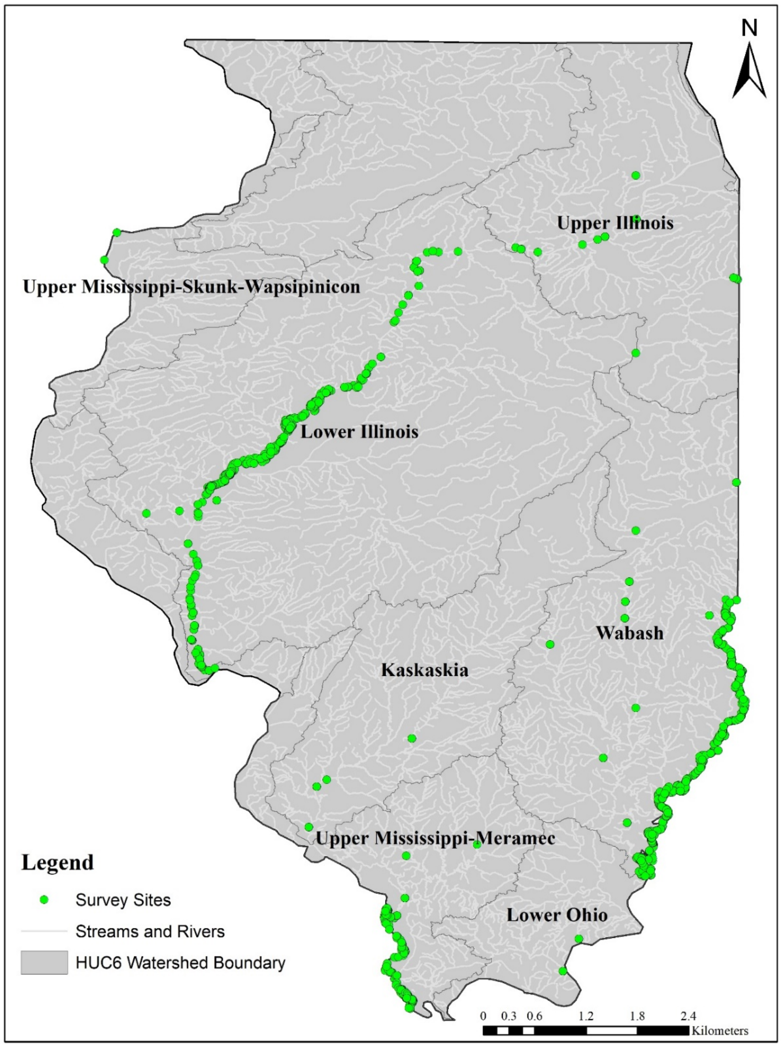


Figure 1.1.1. Sites in Illinois where Gar and Bowfin were sampled by INHS and collaborators from 2015 through 2019. HUC6 watersheds that were not surveyed during the study are not labeled on the map. These include the Upper Mississippi-Maquoketa-Plum, Upper Mississippi-Salt, Rock, Lake Michigan, and Southwestern Lake Michigan.

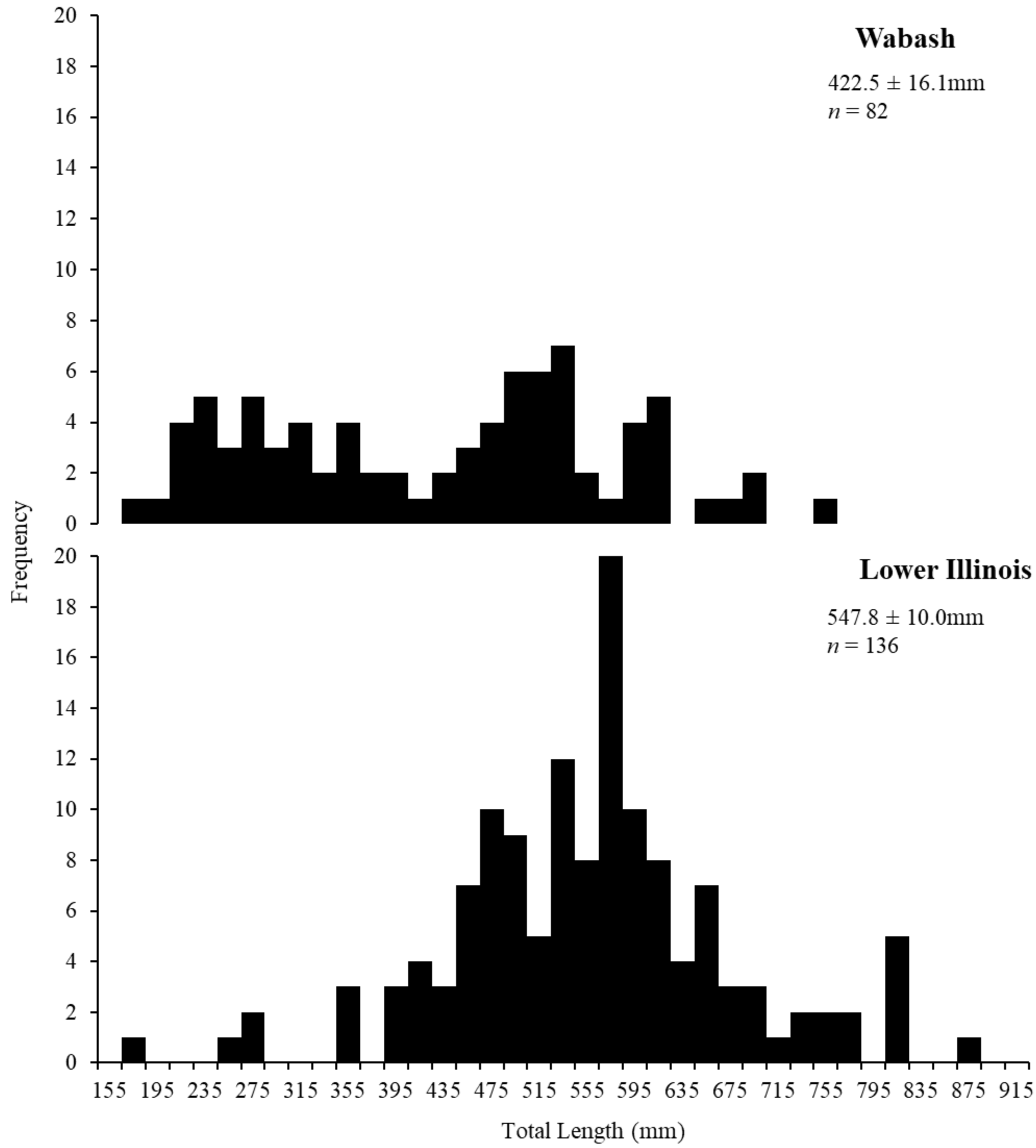


Figure 1.1.2. Length frequency distributions of Spotted Gar captured from 2015 through 2019 in the Wabash and Lower Illinois watersheds. The average total length and sample size of each watershed is shown within its respective plot.

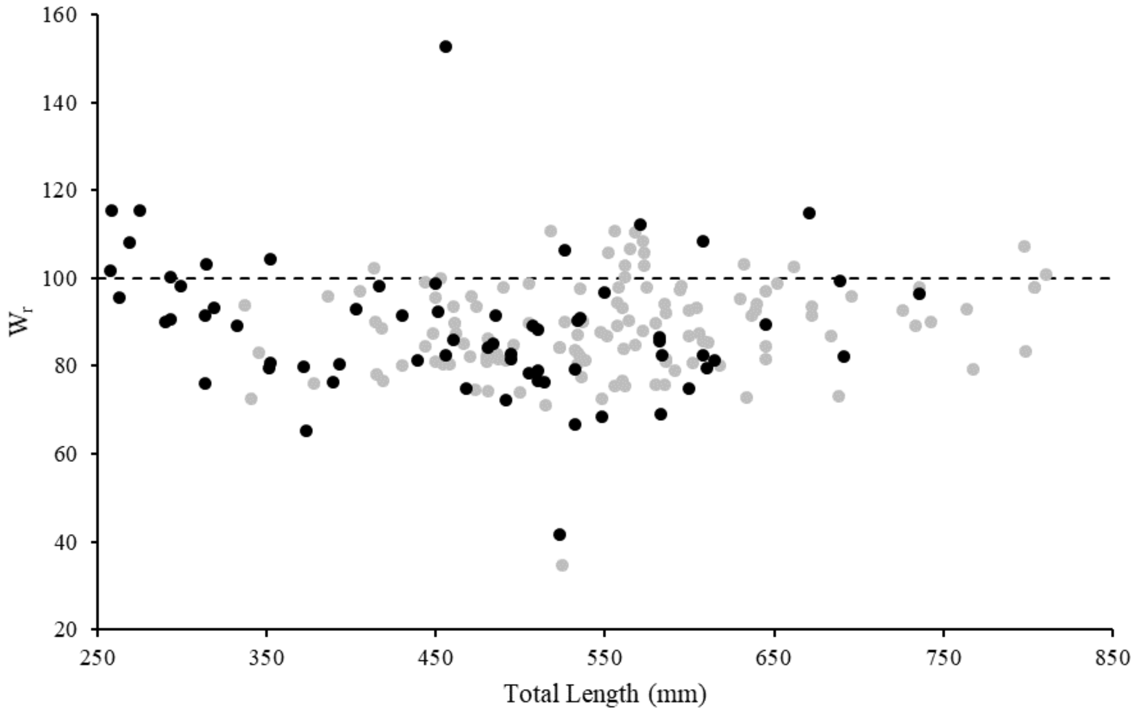


Figure 1.1.3. Relative weight (W_r) for individual Spotted Gar in the Lower Illinois (gray circles, *n* = 127) and Wabash watersheds (black circles, *n* = 66) collected from 2015 through 2019. The horizontal dotted line represents the target W_r value for ideal body condition.

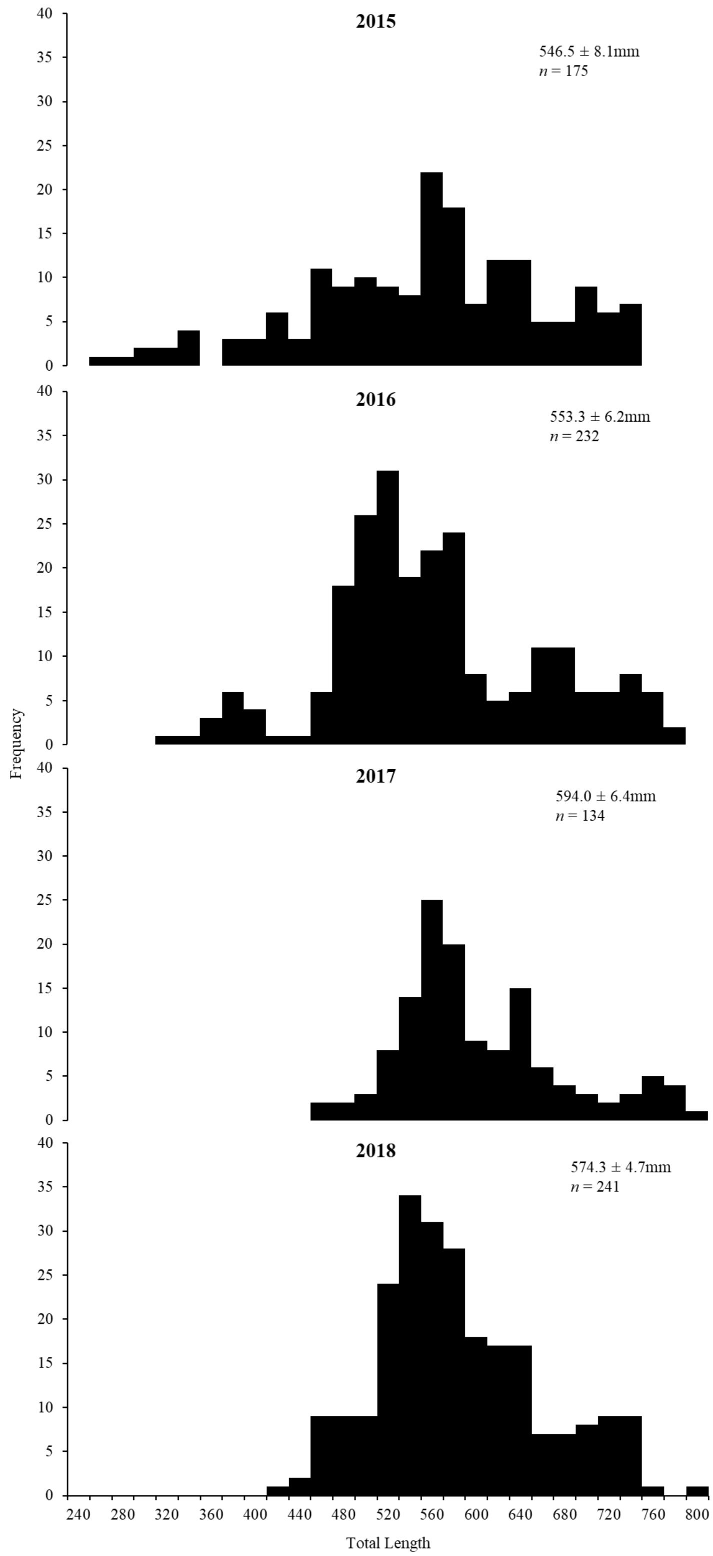


Figure 1.1.4. Length frequency distributions for Bowfin in the Lower Illinois watershed from 2015 through 2018. The average total length and sample size is reported in the respective plots.

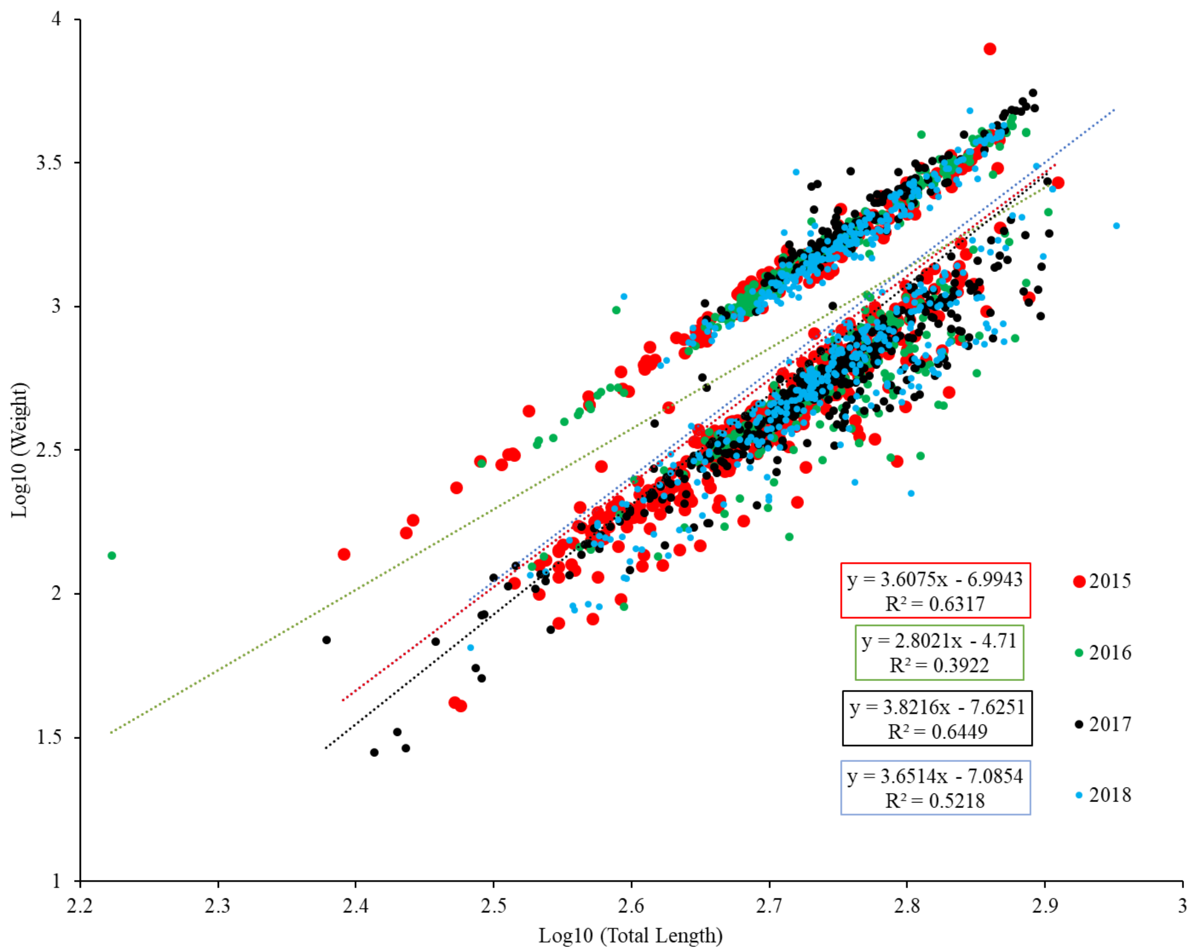


Figure 1.1.5. The Log10 (total length) versus Log10 (weight) of Bowfin in the Lower Illinois watershed from 2015 through 2018 to examine body condition. No temporal differences were evident, but within each year there were two distinct clusters that likely represent gender. The equation for the yearly linear regression and associated R^2 value is shown next for each year—red represents 2015, green represents 2016, black represents 2017, and blue represents 2018 data).

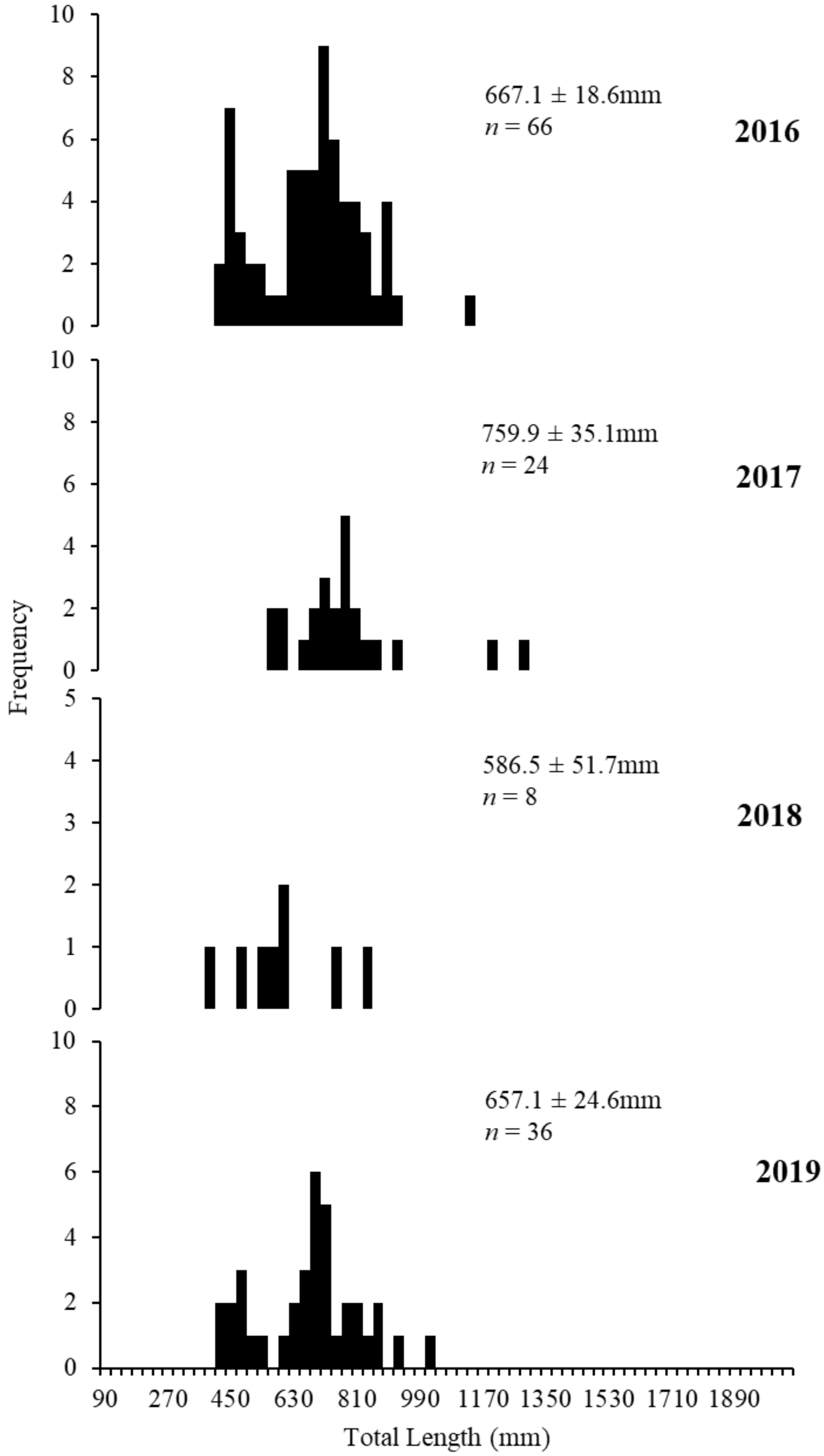


Figure 1.1.6. Length frequency distributions of Longnose Gar in the Upper Mississippi-Meramec watershed from 2016 through 2019. *Note*: The Y-axis scale changes to show better resolution over time.

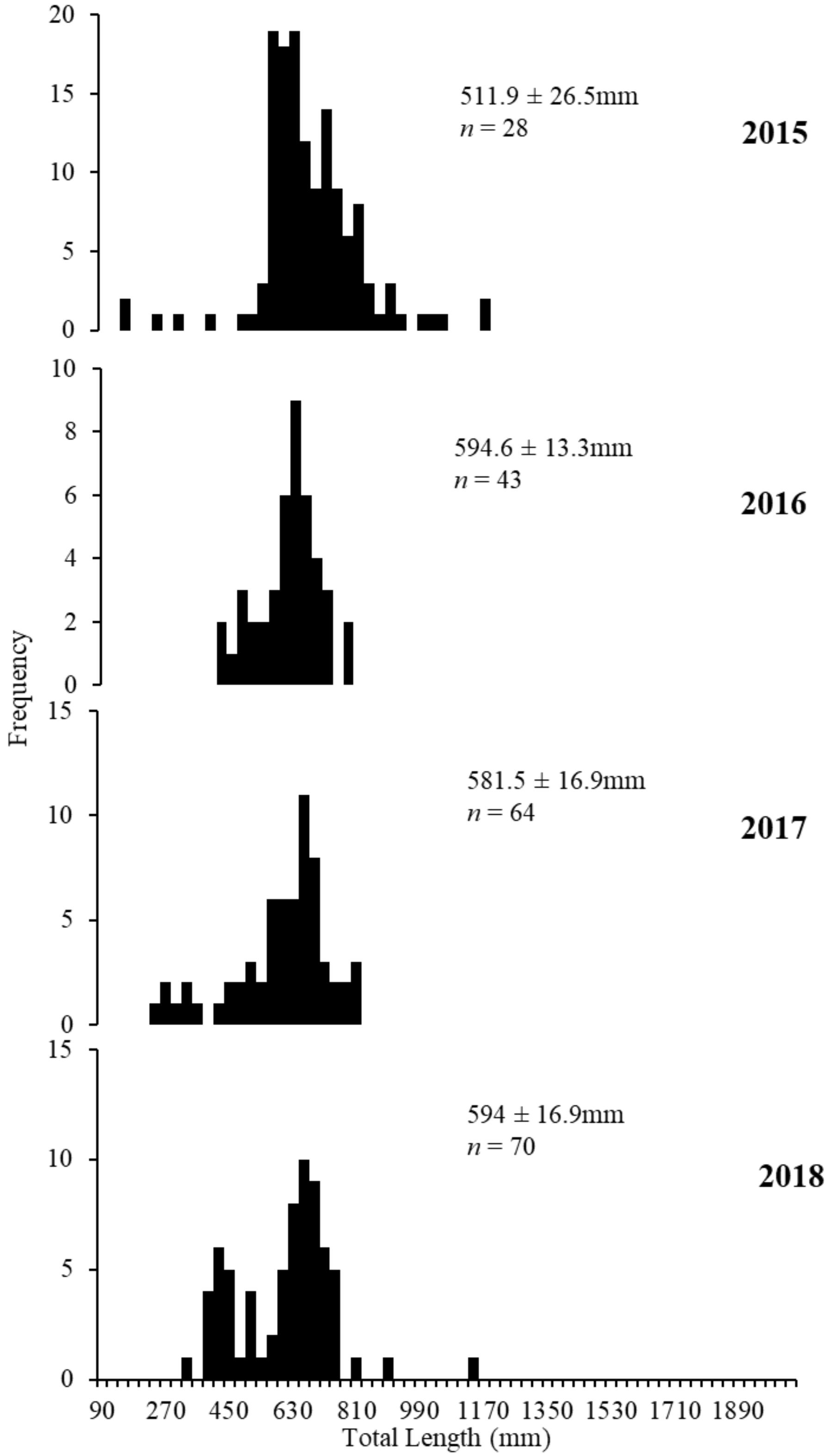


Figure 1.1.7. Length frequency distributions of Longnose Gar sampled in the Lower Illinois watershed from 2015 through 2018. *Note*: The Y-axis scale changes to show higher resolution over time.

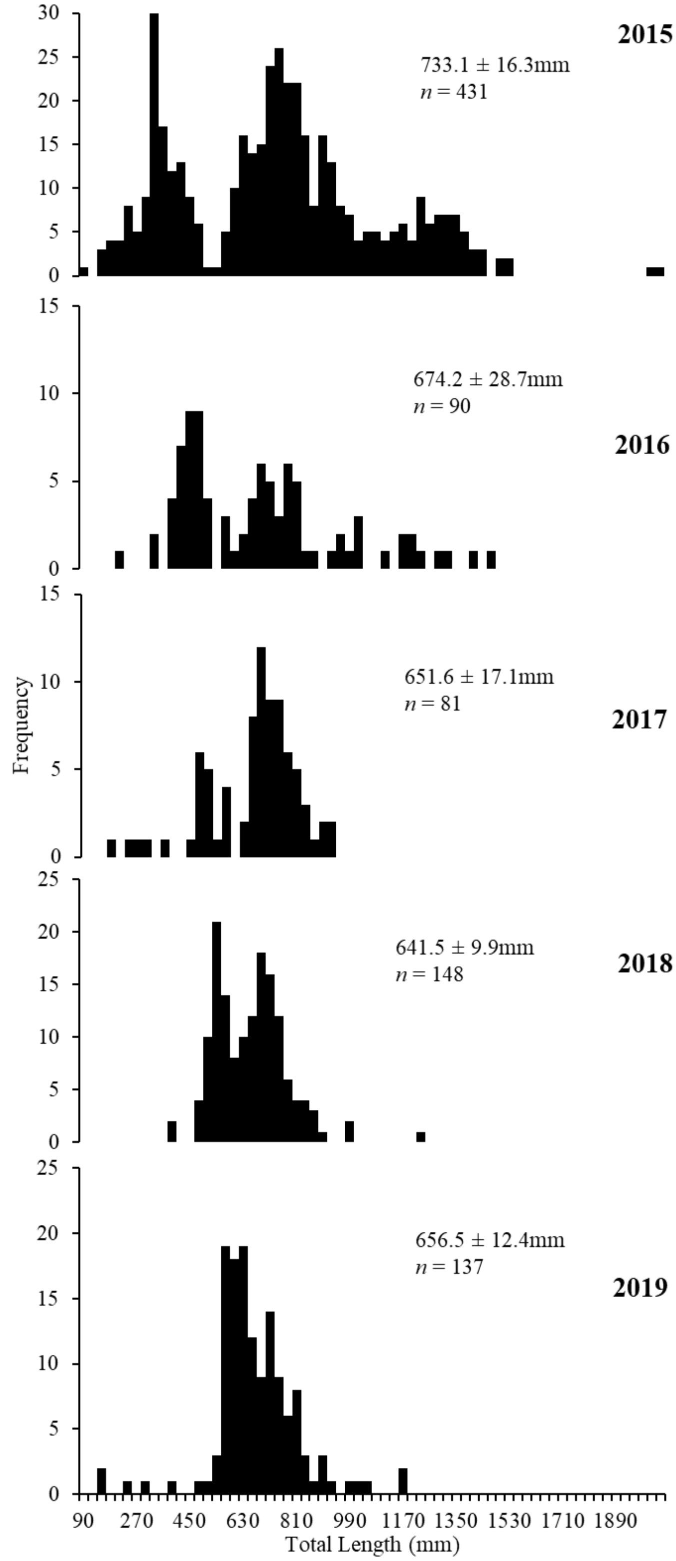


Figure 1.1.8. Length frequency distributions of Longnose Gar in the Wabash watershed from 2015 through 2019. ***Note*****: The Y-axis scale changes to show higher resolution over time.**

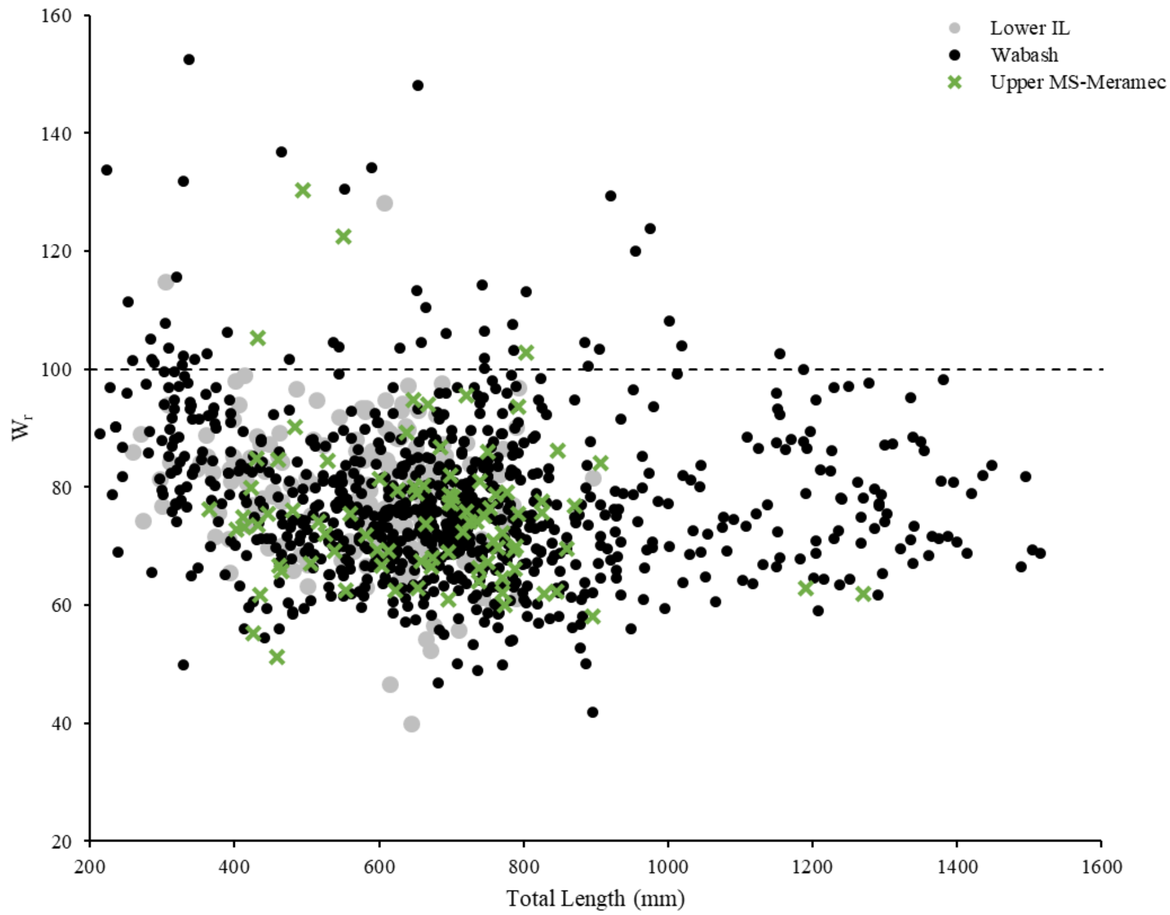


Figure 1.1.9. Relative weight (W_r) for individual Longnose Gar in the Lower Illinois (gray circles), Wabash (black circles), and Upper Mississippi-Meramec watersheds (green X) collected from 2015 through 2019. The horizontal dotted line represents the target W_r value of 100 for ideal body condition.

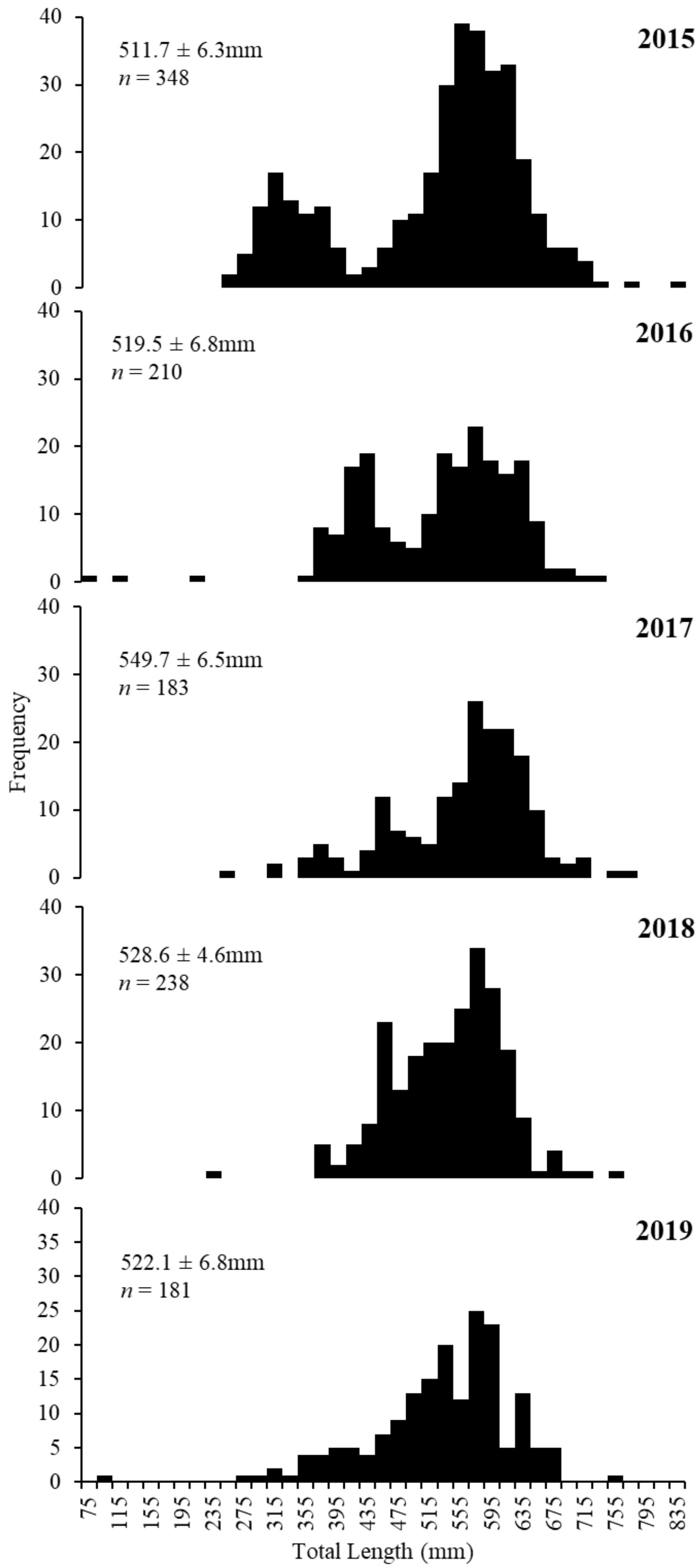


Figure 1.1.10. Length frequency distributions of Shortnose Gar in the Wabash watershed from 2015 through 2019.

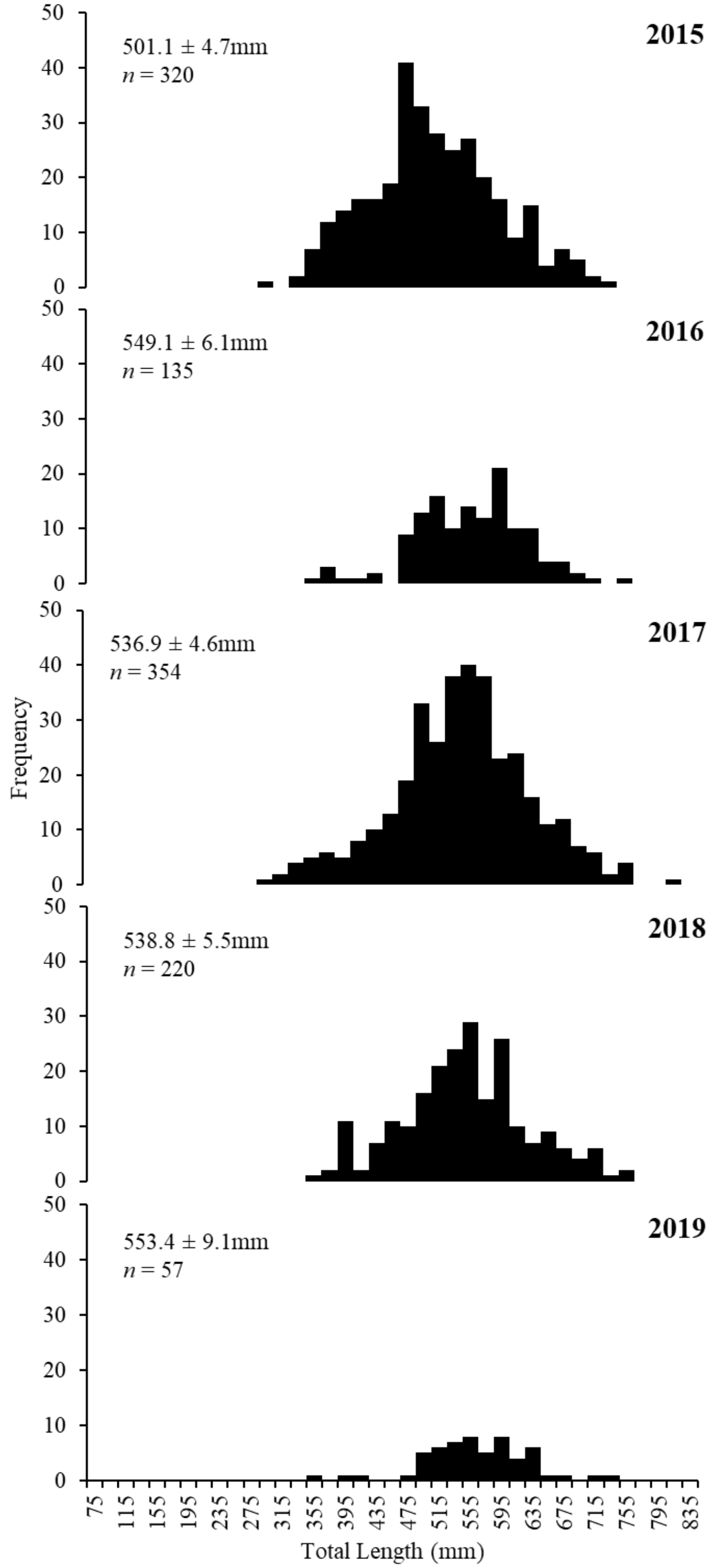


Figure 1.1.11. Length frequency distributions of Shortnose Gar in the Lower Illinois watershed from 2015 through 2019.

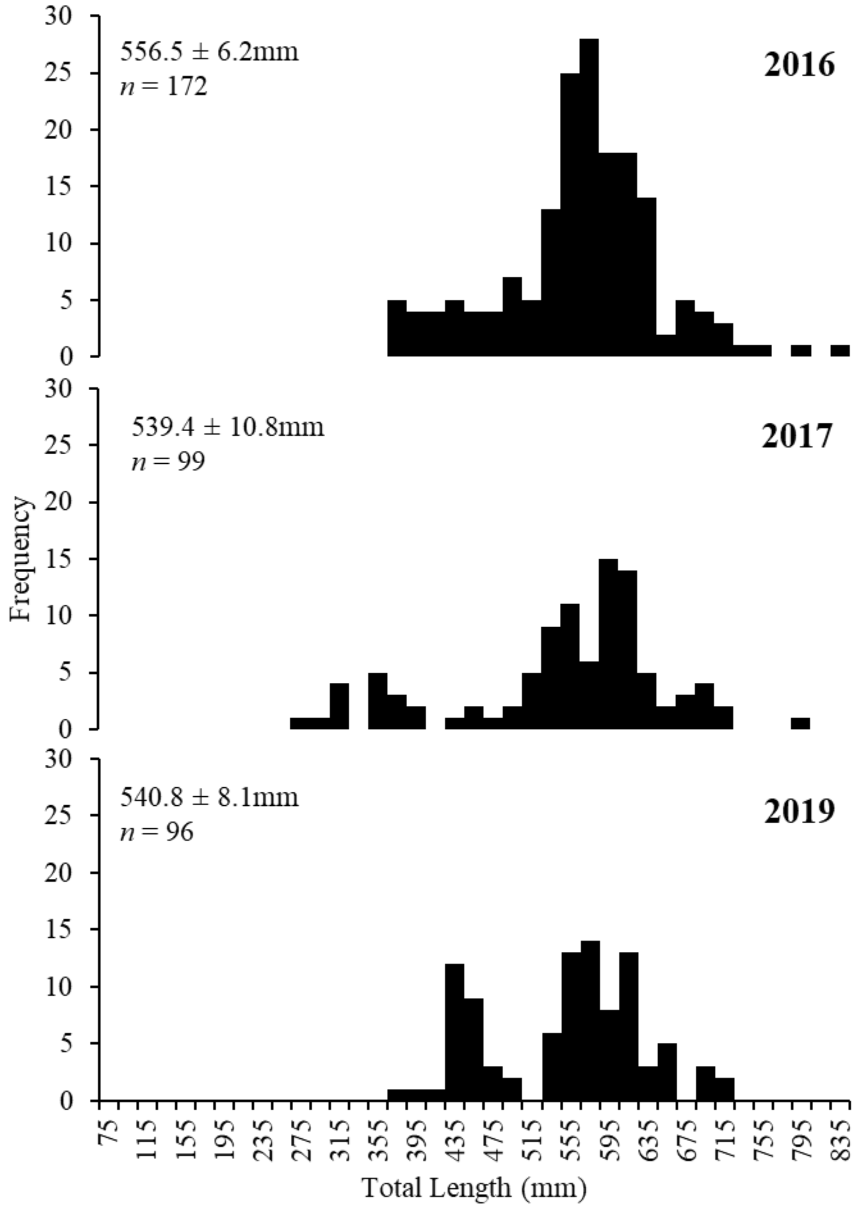


Figure 1.1.12. Length frequency distributions of Shortnose Gar in the Upper Mississippi-Meramec watershed in 2016, 2017, and 2019.

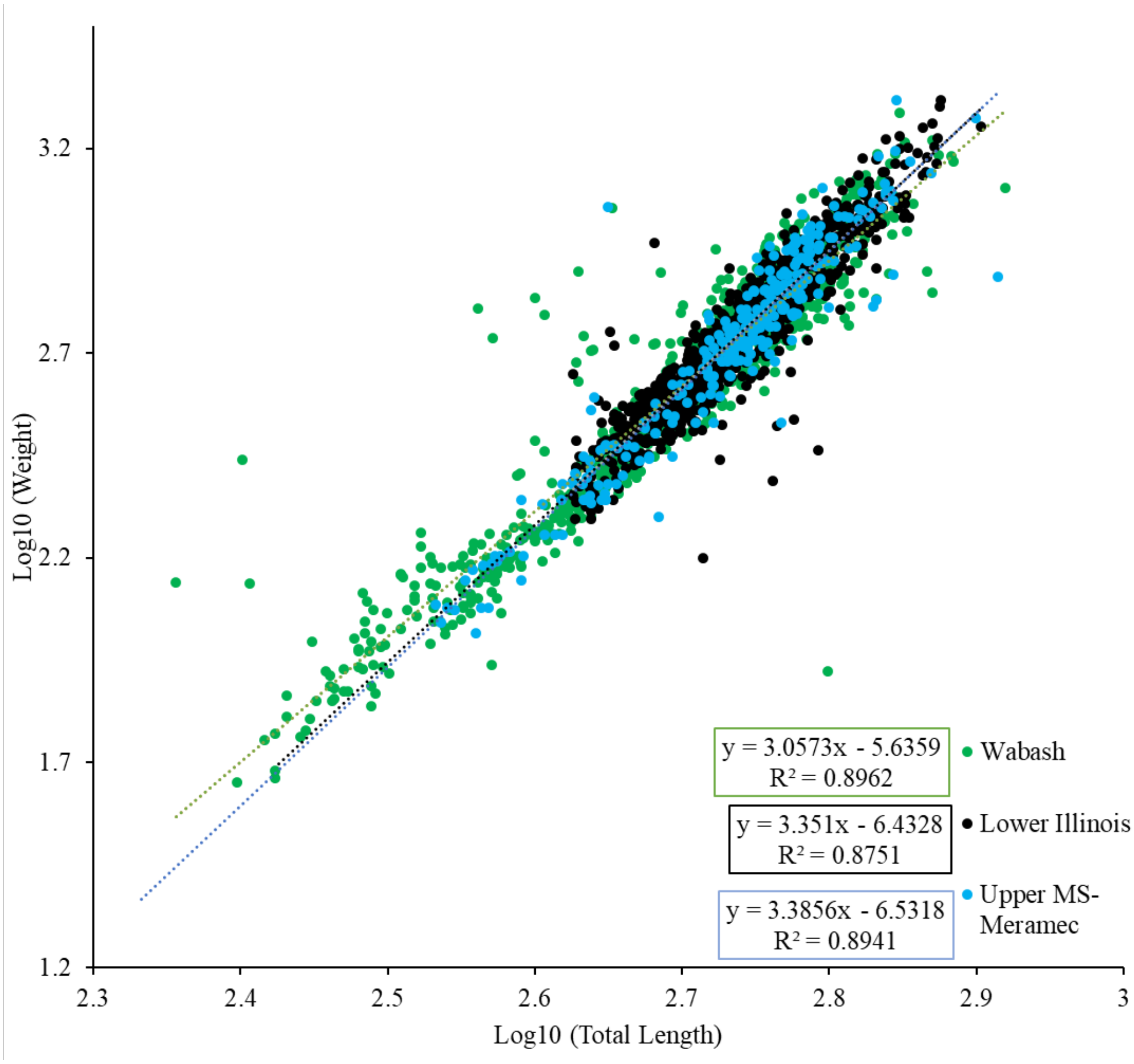


Figure 1.1.13. The Log10 (total length) versus Log10 (weight) of Shortnose Gar in the Wabash, Lower Illinois, and Upper Mississippi-Meramec watersheds from 2015 through 2019. The equation for the linear regression and R^2 value for each watershed is also shown — green represents the Wabash, black represents the Lower Illinois, and blue represents the Upper Mississippi-Meramec watershed.

Watershed		BOW	LOG	SHG	SPG	YOY Gar	Total
Kaskaskia							
	2015		2	7	7		16
	Total		*2*	*7*	*7*		*16*
Lower Illinois							
	2015	176	28	320	51		575
	2016	232	43	135	23		433
	2017	136	64	354	17		571
	2018	241	70	220	39		570
	2019			57	6		63
	Total	*785*	*205*	*1086*	*136*		*2212*
Lower Ohio							
	2015	11					11
	Total	*11*					*11*
Upper Illinois							
	2016	2	29	4			35
	2017	8					8
	Total	*10*	*29*	*4*			*43*
Upper Mississippi-Meramec							
	2016	2	66	172	12	9	261
	2017	1	24	99	1		125
	2018		8	22	3		33
	2019	4	36	96	9		145
	Total	*7*	*134*	*389*	*25*	*9*	*564*
Upper Mississippi-Skunk-Wapsipinicon							
	2016		1	1			2
	Total		*1*	*1*			*2*
Wabash							
	2015	43	432	348	44		867
	2016	8	90	211	9		318
	2017	6	81	183	16		286
	2018		148	238	2		388
	2019	1	137	182	11		331
	Total	*58*	*888*	*1162*	*82*		*2190*
Total		**871**	**1259**	**2649**	**250**	**9**	**5038**

Table 1.1.1. Total count of Bowfin, Longnose Gar, Shortnose Gar, Spotted Gar, YOY gar (young-of-the-year gar) sampled using a multi-gear approach in seven HUC6 watersheds from 2015 through 2019. The most consistent sampling over the 5-year study occurred in the Lower Illinois, Upper Mississippi-Meramec, and Wabash watersheds.

	Total Fish	< Stock	≥ Stock	Quality	Preferred	Memorable	Trophy
Spotted Gar		*< 300mm*	*≥ 300mm*	*480mm*	*640mm*	*790mm*	*990mm*
Wabash	82	72.0 %	28	61	9	-	-
Lower Illinois	136	97.1 %	3	77	18	5	-
Longnose Gar		*<410mm*	*≥ 410mm*	*690mm*	*910mm*	*1140mm*	*1400mm*
Wabash	887	14.1 %	86	56	18	10	1
Lower Illinois	205	13.7 %	86	18	1	-	-
Upper MS-Meramec	134	2.2 %	98	51	5	2	-

Table 1.1.2. The total number of Spotted Gar and Longnose Gar from in each watershed. The percent (%) of fish less than stock length (< Stock), and values for Stock size , Quality size (PSD), Preferred size (PSD-P), Memorable size (PSD-M), and Trophy size (PSD-T) for each species within each watershed. The minimum length limits for the size structure indices are represented in italics within the row of the corresponding species.

Watershed	Longnose Gar	Shortnose Gar	Bowfin
Lower Illinois	-	0.28%	1.53%
Wabash	0.22%	0.17%	-

Table 1.1.3. The percent of recaptured fish relative to the number of total fish tagged within the corresponding watershed. Species and waterbodies that are not included in the table had no recaptured fish in the study.

RECOMMENDATIONS

Ancient fish are becoming more frequently targeted for sport in Illinois, specifically from anglers using archery. To provide a valuable, sustainable fishery throughout Illinois, population demographic trends over time and space should be well understood. We had the unique opportunity to work with multiple agencies to collect long-term, state-wide data to provide demographic information of gars and Bowfin in Illinois. To our knowledge, this is the first time this breadth of data has been documented in Illinois.

Our data showed very little change in ancient fish population dynamics within each HUC6 watershed over the five-year duration of this study; however, there was evidence of differences in demographics and species composition between watersheds, indicating that management interventions, where needed, should be specific to large watersheds. We found that Shortnose Gar were generally the most abundant species throughout Illinois, followed by Longnose Gar, Bowfin, and lastly, Spotted Gar. Our data shows that the Wabash watershed supports abundant and likely sustainable Shortnose and Longnose Gar populations based on temporal and spatial trends in size structure, body condition, and stock densities. Consistently large numbers of fish were captured, very few tagged fish were recaptured, and length frequency histograms provide evidence of recruitment for both species. In addition, preferred, memorable, and trophy-sized fish were found in the Wabash watershed at higher proportions than both the Lower Illinois (which had no memorable or trophy fish) and the Upper Mississippi-Meramec (which had no trophy-sized fish). These factors indicate well-structured and abundant Shortnose and Longnose Gar populations, although there are areas worth further investigation. Specifically, Holostean fishes are extremely long-lived making the addition of analyses that provide an indication of long-term trends in year class strength a priority.

The Lower Illinois watershed, specifically the Illinois River and its backwaters, support robust Shortnose Gar and Bowfin populations. Longnose Gar and Spotted Gar were also present, but in much lower numbers (similar to numbers captured in the Wabash watershed). Despite the low number of Spotted Gar caught, the Lower Illinois watershed consisted of memorable-sized fish, which is noteworthy. Shortnose Gar and Bowfin were primarily captured in connected and disconnected backwaters of the Illinois River. These areas likely provide important refuge, foraging, and overwintering habitats for the species. However, the literature suggests ancient fishes often utilize these low flow areas as spawning grounds as well, but few small fish were collected in the study, and we did not see any indication of recruitment of Shortnose or Bowfin in our data analysis. Therefore, future research should explore potential spawning areas and refuge for young fish.

Overall, Spotted Gar and Bowfin should be the focus species for research moving forward due to inconsistencies in catch rates over space and time. Our data suggest that these two species likely require more specialized environments for various life history stages relative to Longnose and Shortnose Gar, which are likely more generalist species. Longnose Gar appear to be quite abundant throughout Illinois; however, they are not as widespread as Shortnose Gar. Shortnose Gar were found in all surveyed waters; during any given survey in the 5-year study, this species was most likely to be encountered. Because of this, it would be advantageous to develop stock density values for Shortnose Gar as they could easily become part of a prized recreational fishery in Illinois.

Our study contains extremely valuable information regarding the general status of gar and Bowfin in Illinois; however, several topics still need exploration. Future research should aim to define habitat requirements (especially for Spotted Gar and Bowfin), seasonal/annual home ranges (to determine management scale), and long-term recruitment patterns within each watershed. Our research provides resolution to watershed differences which provide strong evidence that gar species have different specialized habitat requirements to thrive. The results gathered here serve as baseline information that can be expanded to develop informed management strategies of gars and Bowfin in Illinois.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data Collection and Analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations

Experiment 1.2 – Genetic connectivity and hybridization rates

In consultation with the Illinois Department of Natural Resources Division of Fisheries, work was initiated to investigate the genetic structure of gars throughout Illinois.

OBJECTIVES

The objective of this experiment is to determine the genetic relatedness among spatially distinct populations of Shortnose Gar, Longnose Gar, and Spotted Gar and to identify the extent of hybridization among those three species in six representative watersheds throughout Illinois.

PROCEDURES

Pelvic fin samples from 383 gar (67 Spotted Gar, 128 Longnose Gar, and 188 Shortnose Gar) from six Illinois watersheds (Wabash, Lower Illinois, Upper Illinois, Kaskaskia, Lower Ohio, and Upper Mississippi-Meramec Basins; Figure 1.2.1) were re-amplified and prepared for fragment analysis. Details of laboratory procedures are outlined in the annual report for Segment 31. Given difficulties (detailed in Segment 32), we have initiated the development of population genomic data generation. To generate these data, we first optimized a new double-digestion restriction-site associated DNA sequencing (BestRAD) protocol. This requires chemically fragmenting DNA via restriction enzymes, attaching indexes (library preparation), pooling samples, cleaning, and size selecting for 150–300 base pair fragments.

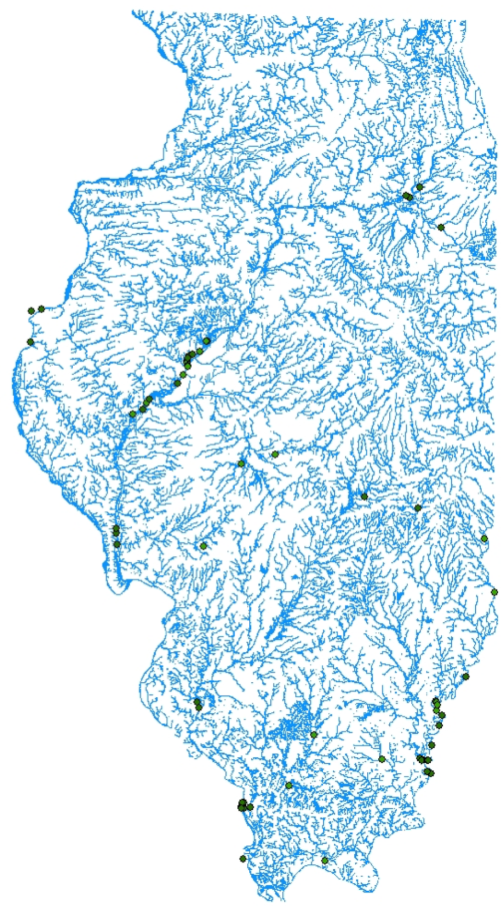


Figure 1.2.1. Locations where tissue samples were collected from gars throughout Illinois.

FINDINGS

Of the 383 individuals, DNA samples from 162 individuals had high enough concentration to be included in library preparation. This included six fish that were identified as hybrids in the field based on morphological features. Of the six putative hybrids, four were assigned as Spotted x Shortnose hybrids and two as Longnose x Shortnose hybrids. The initial step of library preparation consisting of a restrictive enzyme digest was completed using the *SbfI-HF* restriction enzyme.

Project personnel tested eight restriction enzyme pairs to optimize fragment size and quantity. In addition, personnel optimized digestion for all three gar species using the PSTI/MSPI. The enzyme digestion was completed on all 383 gar samples using the optimized conditions and library preparation is currently underway. Library preparation was significantly delayed due to COVID-19; therefore, there are no new results on this project to date.

RECOMMENDATIONS

Analysis of the data generated by this study will continue into Segment 35. Population genomic data will provide fine-scaled insights into barriers to gene flow, degree of introgression, and population demography. Genetic insights can shine a light on how both historical and contemporary processes impact important ichthyofauna, such as the gars, and inform management actions.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data Collection and Analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations

Experiment 1.3 – Movement of Gars using acoustic telemetry

Analyses of the spatial ecology of gar populations in Illinois enhance our understanding of the spatial extent of effective management units for this species complex. Therefore, Illinois Department of Natural Resources Division of Fisheries leadership and Project leaders agreed that continuing an acoustic telemetry study to monitor the movements of gars in the Illinois River would be valuable in generating sound management approaches to sustainability of Ancient Sport Fishes.

OBJECTIVES

The objective of Experiment 1.3 is to use ultrasonic telemetry to explore the use of backwater and main channel habitats of gars in response to season, flow changes, and water temperature in the lower Illinois River. Prior to conducting the field component of this study, project personnel implemented a sham surgery study at the University of Illinois Pond Facility to:

1) evaluate the short- and long-term healing of Shortnose Gar subjected to sham surgeries using the Midwood technique.
2) evaluate recovery and surgical wound healing rates of Shortnose Gar over a 478-day period.

This study was published in the *North American Journal of Fisheries Management* in 2020 (King and Stein, 2020).

PROCEDURES

A field study was initiated in collaboration with the INHS Illinois River Biological Station in Segment 32. Acoustic transmitters were surgically implanted into 40 Shortnose Gar (22 fish in 2018 and 18 fish in 2019) collected from Lilly Lake, Treadway Lake, and the main channel of the Illinois River. The surgical methods used were described in the F69R Annual Performance Report Segment 33 and in a publication from 2020 (King and Stein, 2020). Briefly, Gar were sampled using fyke nets submerged for approximately 24 hours. Fish larger than 360g were sedated in the field and project personnel used a specialized surgical procedure to implant a VEMCO acoustic transmitter (lifespan of ~ 602 days) into the body cavity of each fish. In addition, each fish was weighed, measured, and FLOY tagged before they were released after recovering from surgery.

VEMCO VR2W stationary receivers were used to detect tagged Shortnose Gar within roughly 17.3 river miles (RM) in the Illinois River main channel, side channel, connected backwaters, and tributaries surrounding Beardstown, Illinois (RM 81.6 through RM 98.9; Figure 1.3.1). Thirteen receivers were deployed from June through November 2018, and twelve were retrieved; nineteen receivers were deployed from April through November of 2019 and eighteen were retrieved; and twenty-four receivers were deployed from March through November 2020 and nineteen were retrieved. Generally, receiver placement was similar over the course of the study, however adjustments were made in 2019 and 2020 to expand the detection zone upstream, downstream, and in to the La Moine River (Figure 1.3.1).

Abiotic factors, including water temperature, gauge height, and habitat type, were used in preliminary statistical models to evaluate potential correlations with fish activity (# of receiver relocations which is defined as the number of times a fish moved to a different receiver; Sakaris et al., 2005), home range (the sum of the distance between consecutive receiver relocations), and habitat use (percent of time a fish occupied a specific habitat type; main channel (MC), side channel (SC), backwater (BW), tributary (TRIB). Habitat type was identified for each receiver based on its location. In 2018, there were 11 MC and 7 BW. In 2019, there were 11 MC, 7 BW, 2 TRIB, and 2 SC. In 2020, there were 12 MC, 7 BW, 2 TRIB, 2 SC (Figure 1.3.1).

Water temperature data was obtained with Hobo temperature loggers that were secured to a subset of our acoustic receivers. Water temperature data from the Florence IL USGS gage was also extracted to provide resolution to water temperatures during periods of time when receivers were not in the river (i.e., winter). Average daily water temperatures were calculated using Hobo temperature loggers and the Florence IL gage (Figure 1.3.2). River stage data was extracted from the Illinois River gage at Beardstown (US Army Corps of Engineers) to use for statistical analyses (Figure 1.3.2).

In addition to our receiver array near Beardstown, IL, fish detection data was extracted from acoustic receivers throughout the Upper Mississippi River Watershed Telemetry Array (FishTracks Database is managed by USGS). The array spans 299 miles of the Illinois River, from RM 5.7 near its confluence with the Mississippi River (Alton Pool) to RM 305 in the Lockport Pool and included between 98 to 124 active receivers at any given time from 2018 through 2020.

To evaluate potential influences on the number of receiver relocations, we ran a linear mixed model. We modeled the Log transformed number of relocations with fixed intercept and an interaction term of average monthly temperature and a spring indicator. Season was defined as Spring or not Spring (i.e., Spring = March – May, versus not Spring = June – February based on Julian date). Future analyses will differentiate season by biological relevance; therefore, this distinction is purely a preliminary assessment to visualize data. The random effects included a random intercept for each fish and a random intercept for years nested with month.

Analyses are in the early stages for this study and will become more refined in the next segment. Specifically, we will examine data on a biologically relevant seasonal scale (for example, spawning season), determine linear home range (i.e., the shortest linear distance in the river between the two most extreme detection points), assess seasonal patterns of habitat use (% of relocations within each habitat), and assess patterns of fish activity (# of relocations and the total observed movement of fish). The additional statistical analyses will provide us with a detailed look into to the life history of Shortnose Gar.

FINDINGS

There was a total of 518,936 detections on 39 out of 40 tagged Shortnose Gar during the 3-year study (Table 1.3.1). One fish (ID 1761) was never detected at a receiver after being tagged, whereas 39 individuals were detected at least once during the study. Due to the unknown fate of fish that were detected less than 10 days throughout the study, these individuals were excluded from all analyses (n = 9; Table 1.3.1). Of the remaining 31 fish, the average total number of days a fish was detected at a receiver was 77 days (min = 11 days, max = 251 days) and the average number of days between the first and last fish detection at a receiver was 448 ± 32 days (min = 86, max = 659). Most detections in the study were at receivers within our 17.5-mile array near Beardstown, but Shortnose Gar were also detected at three receivers outside our array — RM 25.4 (near the mouth of Macoupin Creek), RM 81.3 (0.3RM downstream of our Beardstown array), and RM 120.7 (near Havana, IL; Figure 1.3.1). The home range of Shortnose Gar varied from less than 1 mile (0.986km) to more than 50 miles (83.155km). On average, Shortnose Gar home range covered about 14 miles or 22.439km (Table 1.3.1).

Preliminary assessments show that river stage, fish WT, and fish TL did not influence fish activity (i.e., the number of receiver relocations). However, there was an interaction between season and average monthly temperature in that the number of relocations increased with temperature in Spring and not Spring ($P < 0.05$). The increase in activity in relation to increasing water temperature was also seen in Spotted Gar in Louisiana (Snedden et al., 1999). The statistical model also found that fish were more active (i.e., more receiver relocations) during Spring relative to the rest of the year ($P = 0.002$; Figure 1.3.3). It is documented in the literature that spawning of Shortnose Gar occurs when water temperatures are between 19–24°C (Echelle and Riggs, 1972; Carlander, 1969; Potter, 1927). The water temperature in the Illinois River (averaged across all three study years) ranged between 6.35–18.2°C during Spring and 7.4–28.4°C the rest of the year. Based on our preliminary assessment, it is difficult to know whether the increase in activity seen during Spring is indicating a pre-spawn or spawn behavior. Therefore, further analyses to differentiate data by biologically relevant time periods will be implemented in the next segment to provide higher resolution to patterns of habitat use, fish activity, and home range.

RECOMMENDATIONS

Detailing broad scale movement patterns of Shortnose Gar in response to the changes of abiotic factors (e.g., season, river stage and temperature) in the lower Illinois River will aid in the determination of critical habitat use and aid in an informed management scale (i.e., local or watershed approach). Preliminary findings suggest individuals most frequently use backwater habitats, and some of these fish utilize multiple backwaters throughout the year. In addition, fish activity increased as water temperature increased during each season. Home range size varied among fish, but there's evidence showing that Shortnose Gar in the Illinois may have larger home ranges relative to those documented in the literature for other gar species. Further assessment of detection data in relation to abiotic factors will allow resolution to critical habitat use areas and management scale of the species.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data Collection and Analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations

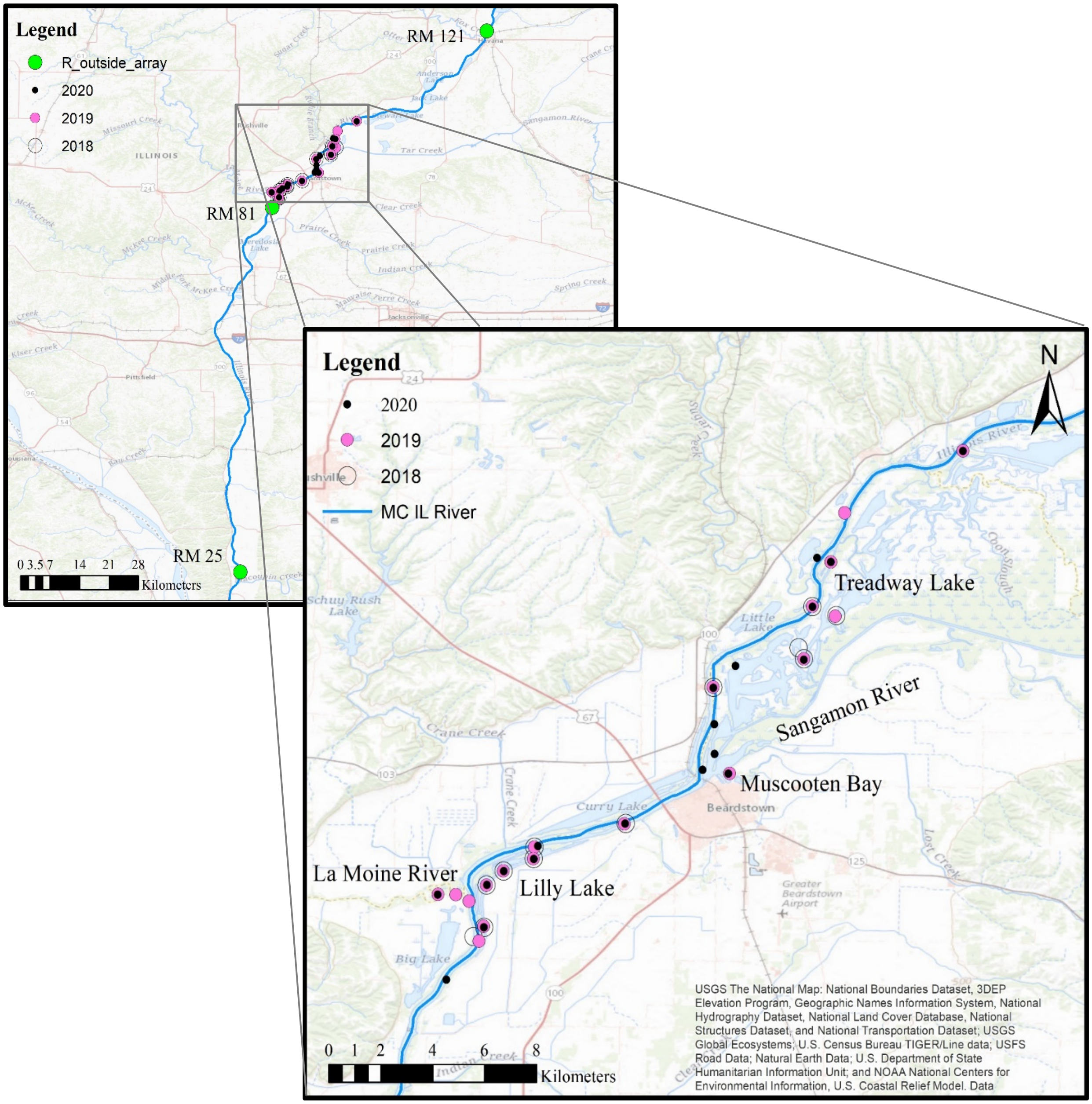


Figure 1.3.1. Maps showing receiver locations where Shortnose Gar were detected during the 3-year study. The back panel map shows the entire lower Illinois River with receivers owned by outside agencies (green circles and river mile (RM), *n* = 3) and our receiver array (enclosed in the gray square). Our receiver array near Beardstown, Illinois is shown in the front panel map. Receivers are color coded based on the year they were deployed. Hollow circles represent the 2018 array (*n* = 12), pink circles represent the 2019 array (*n* = 18), and black dots represent the 2020 array (*n* = 19). The blue line indicates the main channel (MC) of the Illinois River.

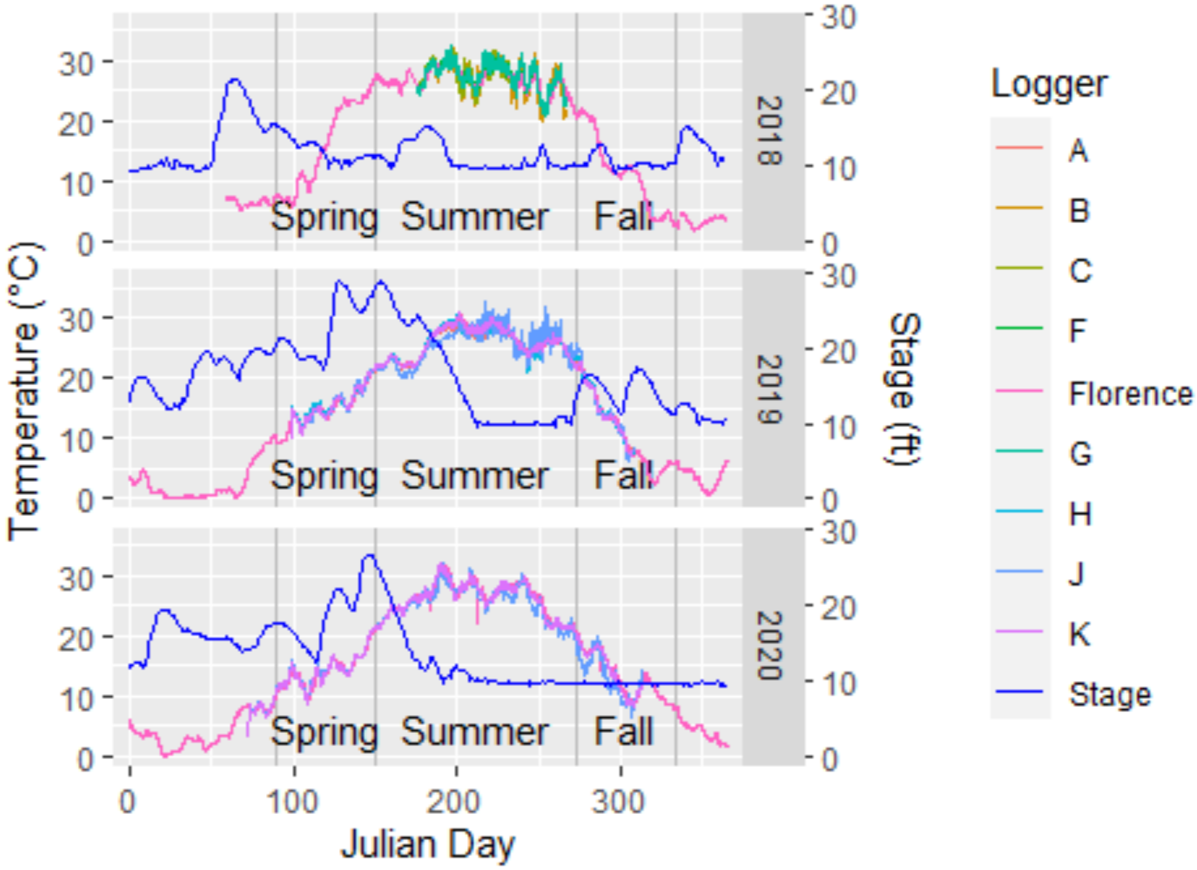


Figure 1.3.2. The average daily temperature (y1-axis) and river stage height (i.e., stage; y2-axis) throughout each year during the 3-year telemetry study. The legend on the right indicates the corresponding color for each individual Hobo temperature logger, Florence temperature gage data, and the Beardstown river stage data.

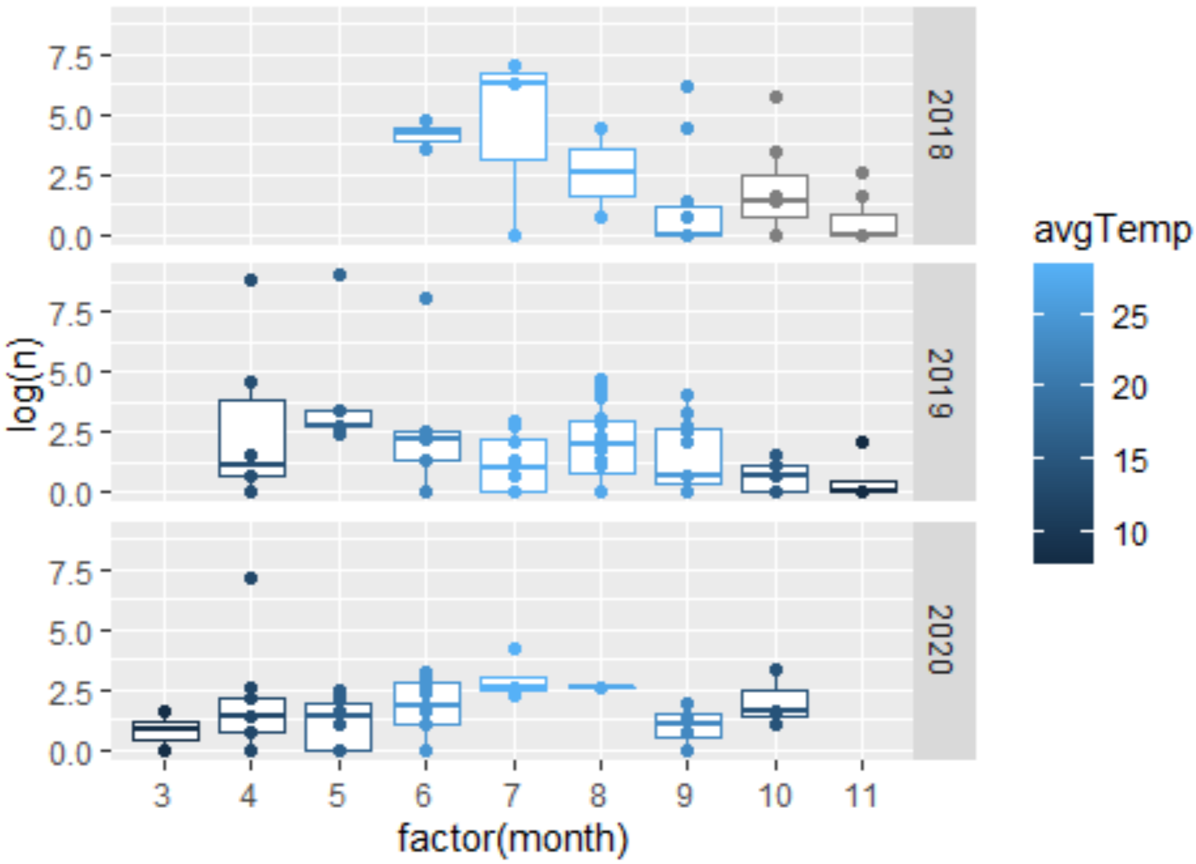


Figure 1.3.3. The log transformed number of relocations (y-axis) for each month (x-axis; months are denoted by number, for example, month 3 is March, month 4 is April, etc.) during the 3-year study. Each point represents values for individual fish. There was no detection data available from December (month 12) through February (month 2), therefore these months were excluded from the plots. Spring was defined as March (month 3) through May (month 5).

	TagID	TL (mm)	WT (g)	Tagging location	# Days between first and last detection	Total # days detected	Home range (m)	Total # detections
	*1786	709	1072	Lilly Lake	1	2	2003	1128
	*1775	491	400	Treadway	3	4	0	1155
	*1785	539	427	Lilly Lake	3	4	0	684
	*1783	511	430	Lilly Lake	6	7	10538	1247
	*1781	476	387	Lilly Lake	11	9	10510	6019
	1769	642	1124	Treadway	221	11	19430	2058
	1784	579	592	Lilly Lake	302	12	39569	641
	1762	685	1037	Treadway	623	33	24821	898
	1779	471	397	Lilly Lake	658	33	83155	3009
	1767	464	361	Treadway	627	40	57637	6057
2018	1782	538	481	Lilly Lake	647	44	23910	10676
	1774	600	769	Treadway	387	45	1881	5596
	1763	527	479	Treadway	650	48	15725	3802
	1771	556	699	Grape/Bar SC	654	52	50815	2188
	1773	672	1097	Treadway	572	55	6697	1403
	1770	538	605	Lilly Lake	651	70	49812	11412
	1777	552	576	Lilly Lake	448	77	10980	12096
	1780	469	396	Lilly Lake	640	158	2905	48382
	1772	672	1318	Lilly Lake	636	162	986	17485
	1778	643	974	Treadway	659	189	32678	76302
	1776	594	451	Treadway	630	205	1844	48163
	1768	686	1387	Treadway	405	251	1881	99159
	*1761	618	881	Treadway	0	0	0	0
	*14868	548	623	MC	2	3	0	18
	*14860	585	747	Treadway	7	7	1844	1496
	*1760	585	787	Treadway	10	8	17343	769
	1764	665	1496	Lilly Lake	309	18	7635	874
	1758	613	922	Treadway	86	21	1844	816
	14864	617	1059	Lilly Lake	271	35	9975	3014
	14869	510	509	Treadway	306	40	66314	6423
2019	1766	598	862	Treadway	431	45	17347	4879
	14861	570	684	Lilly Lake	316	48	19490	4397
	1757	493	428	Treadway	297	51	31120	5312
	14863	578	702	Treadway	459	54	7421	8665
	14867	620	921	Lilly Lake	306	57	27782	8121
	1759	575	839	Treadway	89	90	1844	43718
	14865	730	1785	Lilly Lake	438	94	25242	15853
	14862	655	1044	Lilly Lake	434	97	24417	16562
	1765	565	746	Treadway	296	97	1844	12866
	14866	700	1459	Lilly Lake	438	153	28611	25593

Table 1.3.1. Descriptive data on the 40 fish detected at receivers during the study. Fish that were excluded from statistical analysis are denoted with asterisks (*n* = 5 tagged in 2019 and *n* = 4 tagged in 2019).

FINDINGS

Age determination for Longnose, Shortnose, and Spotted Gars was reported in Segment 30 and published in 2018 in the *Transactions of the American Fisheries Society* (King et al., 2018). In addition, two additional peer reviewed publications regarding age estimation of gars were accepted, including an "Introduction to a special section: Angling for dinosaurs-Status and future study of the ecology, conservation, and management of ancient fishes" (David et al., 2018) and "Comment: The challenge of age estimation in gars (*Lepisosteus spp*.)" in the *Transactions of the American Fisheries Society* (Stein et al, 2018). Age, growth, mortality, and relative abundance analyses on Shortnose Gar in the Lower Illinois River were reported in detail in Segment 32 and are currently in preparation for peer-reviewed publication in the *North American Journal of Fisheries Management*.

RECOMMENDATIONS

Overall, the three experiments outlined above represent a broad, initial approach to understanding the dynamic ecology, life history and management of ancient sport fishes. As our long-term monitoring of ancient fishes experiment concluded, we now have a better understanding of the management challenges facing the Illinois Department of Natural Resources Division of Fisheries. Shortnose and Longnose Gar populations appear to be thriving in areas where they were consistently encountered in high numbers. It is evident that ancient species distribution, body condition, and recruitment were different across watersheds. Further research to evaluate critical habitat needs, specifically for Spotted Gar and Bowfin, are necessary as these species were infrequently encountered during the 5-year study. The results of the telemetry and genetics studies, in combination with population demographic data, will reveal the potential need for regulation on harvest and whether state-wide or watershed/region-specific approaches are required. At this time, it is recommended that telemetry and genetic studies continue into Segments 35 for analysis and final reporting of results.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data collection and analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations

STUDY 2 EVALUATION OF ANGLING VULNERABILITY IN LARGEMOUTH BASS

The purpose of this continuing study is to evaluate whether removal of angling pressure on a population reverses the catchability of differentiated groups of largemouth selective bred for catchability over multiple generations.

OBJECTIVES

The following components constitute the overall objectives for Study 2:

- Maintain populations of high and low angling vulnerability Largemouth Bass at the University of Illinois Pond Facility and disseminate results of angling projects by June 30, 2021.

PROCEDURES

Detailed procedures for this study were reported previously and are described here briefly. Each year in the spring of 2018 - 2020, fish that were individually marked with a PIT tag were stocked in two replicate ponds to create mixed populations of six genetic crosses related to catchability by angling (Philipp et al., 2009). Each summer, ponds were angled regularly by an experienced angler for 60 minutes using a randomized rotation of four distinct lure types (black worm, silver rapala, white jig, and white spinner bait) for 15 minutes each. The number of casts, strikes, hooked fish, and captures were recorded for each session. When a fish was captured, its PIT tag number and fin clip designating its vulnerability line were recorded, along with the angler and lure used to capture the fish.

FINDINGS

Adult bass used in the angling study were produced in 2012 at the INHS research ponds by using a parental stock of adults of a "high vulnerability" line and a "low vulnerability" line, originally created in the early 1980s (Burkett et al., 1986). Adults were crossed to create two pure parental lines (high vulnerability, HH; low vulnerability, LL), two F1 generation lines by crossing high vulnerability females with low vulnerability males (HxL F1) and separately low vulnerability females with high vulnerability males (LxH F1); and two F2 generation lines by crossing within each of the F1 lines.

From the fall of 2012 to the fall of 2014, the offspring of these six lines were held in replicate common garden pond with equal densities of each of the six crosses to determine differences in growth and survival. Results of that portion of the study were reported in Segment 29.

Between 2018 – 2020, a total of 84 angling sessions were conducted across two replicate ponds, producing 77 captures in which all six genetic lines were represented. Repeat captures comprised 36% of all captures across all years (Table 3.1). To best evaluate vulnerability, the number of casts to first capture was calculated for all individual fish and compared among lines and among years. For the parental generation, high vulnerability fish were captured in fewer casts on average than the low vulnerability fish in both years. For both the F1 and F2 generations, fish with high vulnerability mothers (HxL F1 and HxL F2) were captured in fewer casts than their counterparts with low vulnerability mothers (Figure 3.1). Overall, line differences in catchability appear to have persisted after 3 generations of selection to establish the original parental lines and 4 generations of no selection to maintain differences.

Number of Captures					
Selected Line	**2018**	**2019**	**2020**	**Total**	**Repeat Captures**
Hi Vulnerability	6	1	0	7	1
Lo Vulnerability	11	4	0	15	7
HxL F1	9	5	1	15	4
LxH F1	4	5	1	10	3
HxL F2	11	3	2	16	9
LxH F2	9	4	1	14	4
Totals	**50**	**22**	**5**	**77**	**28**

Table 3.1. Angling captures of adult Largemouth Bass selectively bred for vulnerability to capture by angling.

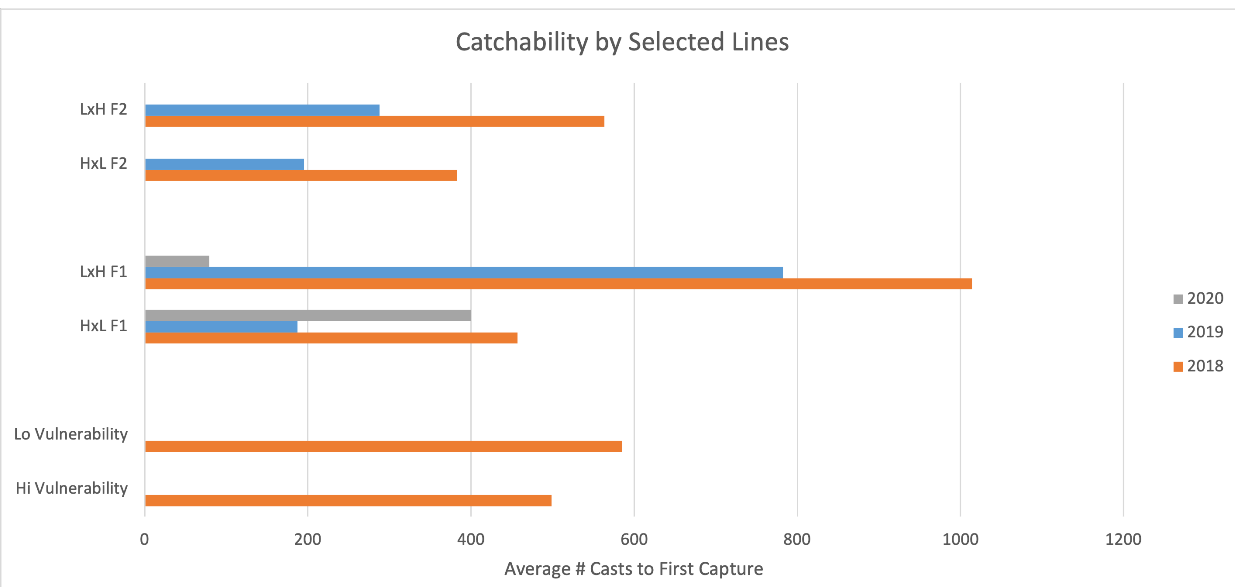


Figure 3.1. Average number of casts presented before first capture of adult Largemouth Bass, compared across groups selectively bred for high or low vulnerability to angling.

RECOMMENDATIONS

Largemouth bass populations are postulated to be subject to human induced rapid evolutionary change in response to recreational angling. Previous studies have demonstrated linkages between fisheries induced evolution, specifically heritability of vulnerability to angling, and physiological and behavioral traits. Using a single cohort of selected and bred lines of Largemouth Bass in common garden studies has demonstrated differences in survival, growth and capture rates across life stages, revealing how recreational angling can alter evolutionary trait functions in just a few generations. Long term patterns in catch rates by recreational anglers likely reflect, in part, the historical constraints of previous selective forces on exploited populations in addition to changes in population abundance and capture efficiency. Reducing angling pressure likely does not provide a rapid return to a previous state of vulnerability to angling in a population, revealing a need of for alternative strategies for offsetting rapid human induced rapid evolutionary change.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data Collection and Analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations

STUDY 3 ASSESSMENT OF COOL WATER SPORT FISH POPULATIONS IN ILLINOIS

The purpose of this Study is to generate age data for cool water sport fishes in Illinois, and to supplement population assessments conducted by IL DNR Division of Fisheries with additional sampling effort if and where needed.

OBJECTIVES

The following components constitute the overall objectives for Study 3:

- Collect and analyze demographic information for walleye, sauger and their hybrids in Lake Decatur, Weldon Springs Lake, Clinton Lake, Lake Shelbyville, Lake Bloomington, Dawson Lake, and Evergreen Lake to assess age related metrics by June 30, 2023.

PROCEDURES

In collaboration with Illinois DNR seasonal fish surveys, Walleye, Sauger, and Saugeye data were collected in Clinton Lake, Weldon Springs Lake, Dawson Lake, Lake Bloomington, Lake Shelbyville, Lake Decatur, Paradise Lake, Charleston Side Channel, Mattoon Lake, and Evergreen Lake using fyke nets and DCEF from 2015 through 2021. Fish were measured in total length (mm) and weighed to the nearest gram (g). The second dorsal fin ray was removed for age estimation, and a subsample of fish were sacrificed and brought back to the laboratory for otolith extraction, tissue sampling, and gender identification. Details describing methods used to process dorsal fin ray and otoliths for age estimation were described in Segment 33. Due to COVID-19 safety restrictions, project personnel were unable to conduct field sampling in spring 2020 for this study, however surveys resumed in fall 2020. Findings presented in this report include data collected from 2015 through 2020.

Trends in size and age distribution, stock density (PSD), body condition (W_r), and length at age of cool water fishes was evaluated in this report. We evaluated temporal trends within lakes for each species and made within-species comparisons among lakes. Low sample sizes for certain combinations of species and waterbody limited these analyses.

Proportional stock density (PSD) and relative stock density (RSD; Gabelhouse 1984) were calculated for species that had length/weight data for at least 10 fish in a waterbody during a specific year. Individual relative weight (W_r) was calculated to evaluate body condition of Walleye and Saugeye that met the minimum length limit of 150mm and 170mm, respectively (Murphy et al., 1990; Flammang et al., 1993). Individual W_r values were averaged within each waterbody and year to facilitate comparisons of body condition for each species between and within lakes over time. If W_r data was normally distributed (Shapiro-Wilk Test) and groups had equal variance (Brown-Forsythe), then a Kruskal-Wallis One Way Analysis of Variance Test

(ANOVA) was used to determine W_r differences. If the distribution of W_r data was non-normal normality and/or had unequal variances, then a Kruskal-Wallis One Way Analysis of Variance on Ranks Test (ANOVA on Rank) was used. Lastly, length and age data were compared among Walleye populations using a Kruskal-Wallis One Way Analysis of Variance Test (ANOVA). A post hoc Tukey-Kramer test was then performed to determine significant age and length differences among populations.

Project personnel will continue to collect cool water sport fish data in collaboration with IL DNR and process calcified structures for estimates of age and population demographics in Segment 35.

FINDINGS

SIZE STRUCTURE AND STOCK DENSITY

In total, 62 Sauger, 468 Walleye, and 766 Saugeye were sampled in 12 lakes from 2015 to 2021 (Table 3.1). Saugeye were larger in total length (445 ± 3.7mm, range = 176-682mm) compared to Sauger (345.6 ± 11.1mm, range = 193-565mm; Tukey-Kramer $P \leq 0.001$) and Walleye (367.5 ± 6mm, range = 82 - 708mm; $P \leq 0.001$). However, Walleye and Sauger were similar in size ($P \geq 0.05$). Smaller size fish of all three species were not well represented in any samples during our study (Figure 3.1). This is likely attributed to the reduced efficiency of DCEF and fyke nets to capture small fish (<200mm TL).

	Sauger	Walleye	Saugeye	Total
2015		**1**	**183**	**184**
Dawson		1	93	94
Evergreen			63	63
Weldon Springs			27	27
2017		**45**	**126**	**171**
Clinton		45		45
Evergreen			95	95
Weldon Springs			31	31
2018	**13**	**52**	**29**	**94**
Clinton		11		11
Decatur		15		15
Mattoon			12	12
Paradise			17	17
Shelbyville	13	26		39
2019	**3**	**177**	**410**	**590**
Charleston Side Channel			12	12
Dawson			134	134
Decatur		43		43
Evergreen			153	153
Lake Bloomington		87		87
Mattoon			34	34
Shelbyville	3	47		50
Weldon Springs			77	77
2020	**45**	**193**	**5**	**243**
Dawson			5	5
Decatur		88		88
Evergreen	1			1
Lake Bloomington		4		4
Shelbyville	38	101		139
Weldon Springs	6			6
2021	**1**		**13**	**14**
Paris East	1		11	12
Paris West			2	2
Total	**62**	**468**	**766**	**1296**

Table 3.1. Total counts of Sauger, Walleye, and Saugeye sampled in each of the 12 lakes sampled from 2015 to 2021.

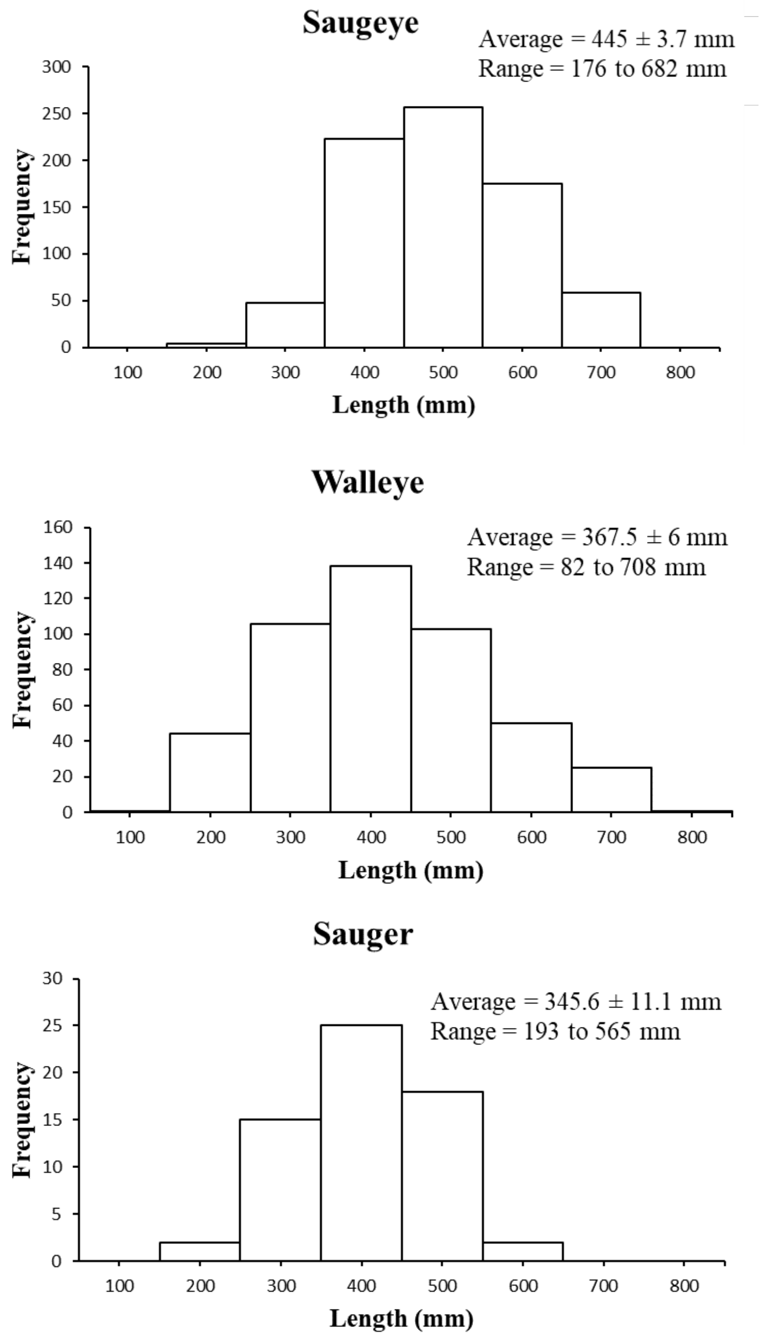


Figure 3.1 Length frequency histogram of Sauger (n = 62), Walleye (n = 468), and Saugeye (n = 766), respectively. Data was pooled across years and waterbody to create histograms. *Note*: Y-axis vary in scale.

A total of 458 Walleye were included in stock density calculations. Lake Bloomington and Clinton Lake had higher RSD-P and RSD-M values for Walleye compared to Lake Shelbyville and Lake Decatur (Table 3.2). No Walleye less than stock length were sampled in Lake Bloomington and Clinton Lake, however up to 70% and 48% of Walleye were less than stock length in Lake Shelbyville (2019) and Lake Decatur (2020), respectively (Table 3.2). Lake Bloomington and Clinton Lake both had PSD values above 80, whereas Lake Shelbyville was < 30 and Lake Decatur ranged between 50 and 69 depending on the year (Table 3.2). Lake Bloomington and Clinton Lake had substantially higher proportions of Preferred and Memorable sized Walleye compared to Lake Shelbyville and Lake Decatur (Table 3.2). No clear differences in stock densities within each waterbody over time was evident.

A total of 759 Saugeye were used to calculate stock density indices. Charleston Side Channel, Mattoon Lake, and Lake Paradise were the only waterbodies that had a substantial portion of Saugeye less than the minimum stock length (Table 3.3). Every lake, aside from Charleston Side Channel and Mattoon Lake, had PSD values > 84 and several contained 100% stock size fish (Table 3.3). Weldon Springs Lake and Evergreen Lake both had relatively high RSD-P values ranging from 42 (Weldon Springs 2019) up to 81 (Evergreen 2017). The highest RSD-P value of Saugeye outside of those two lakes was in Dawson Lake in 2015 (Table 3.3). Evergreen Lake, Weldon Springs Lake, Dawson Lake, and Paris East Lakes all had at least one year with a substantial proportion of the population that was of Memorable size, with the highest RSD-M value in Evergreen Lake in 2017 (42). Evergreen Lake and Weldon Springs Lake contained the most consistent trend of Memorable sized fish over time; multiple years had values over 10 (Table 3.3).

Year	PSD (Quality)	RSD-P (Preferred)	RSD-M (Memorable)	RSD-T (Trophy)	Total # fish	Total # fish ≥ stock	% fish < stock
Lake Bloomington							
2019	89	41	8	0	87	87	0%
Lake Shelbyville							
2018	29	6	0	0	26	17	35%
2019	29	0	0	0	47	14	70%
2020	22	6	1	0	101	85	16%
Lake Decatur							
2018	50	0	0	0	10	10	0%
2019	60	9	3	0	43	35	19%
2020	70	9	2	0	88	46	47%
Clinton Lake							
2017	84	42	20	0	45	45	0%
2018	9	0	0	0	11	11	0%

Table 3.2. Proportional and Relative Stock Density of Walleye (*n* = 458). All Walleye that did not meet the species-specific minimum stock length of 250mm were excluded from the calculations (*n* = 108). Years with less than 10 total fish sampled were excluded from the calculations.

	Year	PSD (Quality)	RSD-P (Preferred)	RSD-M (Memorable)	RSD-T (Trophy)	Total # fish	Total # fish ≥ stock	% fish < stock
Weldon Springs Lake								
	2015	100	70	11	0	27	27	0%
	2017	100	74	29	0	31	31	0%
	2019	86	42	16	0	77	77	0%
Charleston Side Channel								
	2019	50	20	0	0	12	10	17%
Dawson Lake								
	2015	94	31	18	0	93	93	0%
	2019	84	27	7	0	134	134	0%
Evergreen Lake								
	2015	100	27	14	0	63	63	0%
	2017	100	81	42	0	95	95	0%
	2019	88	46	16	0	153	150	2%
Lake Mattoon								
	2018	50	13	0	0	12	8	33%
	2019	38	13	0	0	34	24	29%
Paradise Lake								
	2018	91	9	0	0	17	11	35%
Paris East Lake								
	2021	100	27	18	0	11	11	0%

Table 3.3. Proportional and Relative Stock Density of Saugeye (*n* = 759). All Saugeye that did not meet the species-specific minimum stock length of 230 mm were excluded from the stock density calculations (*n* = 25). Years with less than 10 total fish was excluded from the calculations.

BODY CONDITION

A total of 407 Walleye had length and weight data that were used to calculate body condition (W_r; Figure 3.2). Walleye were generally in good condition in all lakes throughout the study with an average W_r of 92.19 ± 10.28 (Figure 3.2). Walleye condition differed among Lake Decatur, Lake Bloomington, and Lake Shelbyville (ANOVA on Rank $P \leq 0.001$, DF = 2, H = 32.387). Walleye in Lake Bloomington were in better condition compared to Walleye in Lake Shelbyville (Dunn's post hoc $P \leq 0.001$) and Lake Decatur (P = 0.044; Figure 3.2). Walleye in Lake Decatur were in better condition relative to Lake Shelbyville (P = 0.002; Figure 3.2).

Over time, the average W_r of Walleye in Lake Shelbyville varied ($P \leq 0.001$, DF = 2, H = 47.927). There was a substantial decrease in body condition each consecutive year from 2018 through 2020. In 2018 the average W_r of Walleye in Lake Shelbyville was 98.58 ± 8.28, which is very close to the 100.00 marker representing above average body condition (Figure 3.2). In 2019 the average W_r decreased to 92.90 ± 8.58, and in 2020 it decreased further to 85.43 ± 8.38, which represents a body condition that is below ideal (Figure 3.2). The number of Walleye sampled in Lake Shelbyville has increased over time, but body condition decreased, which may be of concern from a management standpoint. Factors that may be causing this trend include an increase in intraspecific competition, reduction of prey species abundance, or a combination of both. Annual stocking of fingerling size Walleye has taken place in Lake Shelbyville since at least 2010 (https://www.ifishillinois.org/programs/waterbody_stocking.php?water_id=00272), which raises the possibility that limited prey availability and density dependence is limiting growth.

A total of 668 Saugeye had length and weight data that were used in body condition estimates (Figure 3.3). Overall, Saugeye were in good condition, with an average W_r value 96.46 ± 10.46 (Figure 3.3). The body condition of fish was different between Evergreen Lake, Dawson Lake, and Weldon Springs Lake ($P \leq 0.001$, DF = 2, H = 68.126). Saugeye from Evergreen Lake had the highest body condition (average Wr = 100.15 ± 11.14), relative to Dawson Lake ($P \leq 0.001$) and Weldon Springs Lake ($P \leq 0.001$; Figure 3.3). Although lower than Evergreen Lake, fish in Weldon Springs and Dawson Lake were in good condition, with average W_r values of 95.05 ± 9.28 and 92.45 ± 8.37, respectively (Figure 3.3).

The body condition of Saugeye in Evergreen Lake differed between the three sampling years ($P \leq 0.001$, DF = 2, H = 32.574). Saugeye condition increased from 2015 to 2017 ($P \leq 0.001$), then stabilized between 2017 and 2019 (P = 1.000). In 2015 the average W_r of Saugeye in Evergreen Lake was 93.32 ± 7.38 (Figure 3.3). In 2017, the population was in better condition, with an average W_r of 101.30 ± 10.22 (Figure 3.3). The body condition of Saugeye in Weldon Springs Lake also differed over time ($P \leq 0.001$, DF = 2, H = 32.637). Stable body condition values were evident between 2015 (Average W_r = 99.77 ± 7.32) and 2017 (Average W_r = 100.20 ± 7.31), however values decreased substantially in 2019 to an average W_r of 91.32 ± 8.78 ($P \leq 0.001$; Figure 3.3).

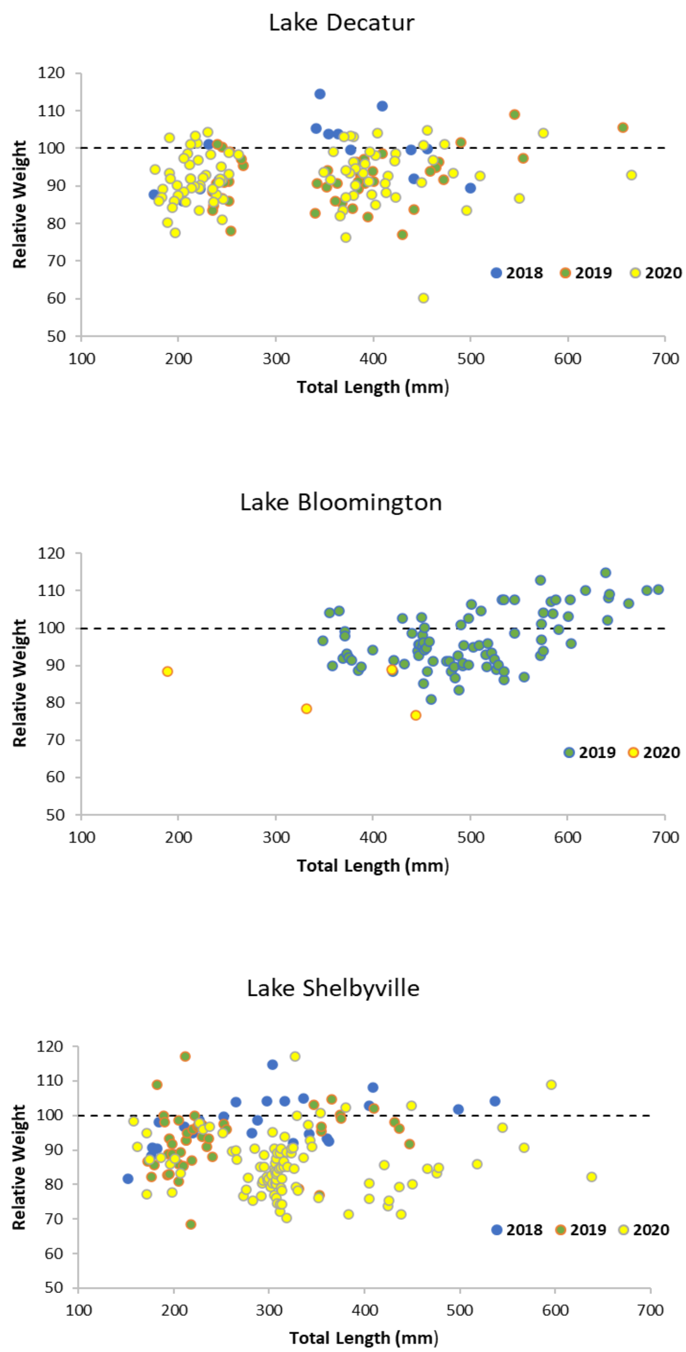


Figure 3.2. Body condition estimates (W_r) of Walleye captured during fishery surveys on Lake Decatur (*n* = 146), Lake Bloomington (*n* = 91), and Lake Shelbyville (*n* = 170). A relative weight of 100 represents above average body condition and is indicated by the dashed line. Walleye which did not meet the species-specific minimum length requirement for W_r were excluded (150mm).

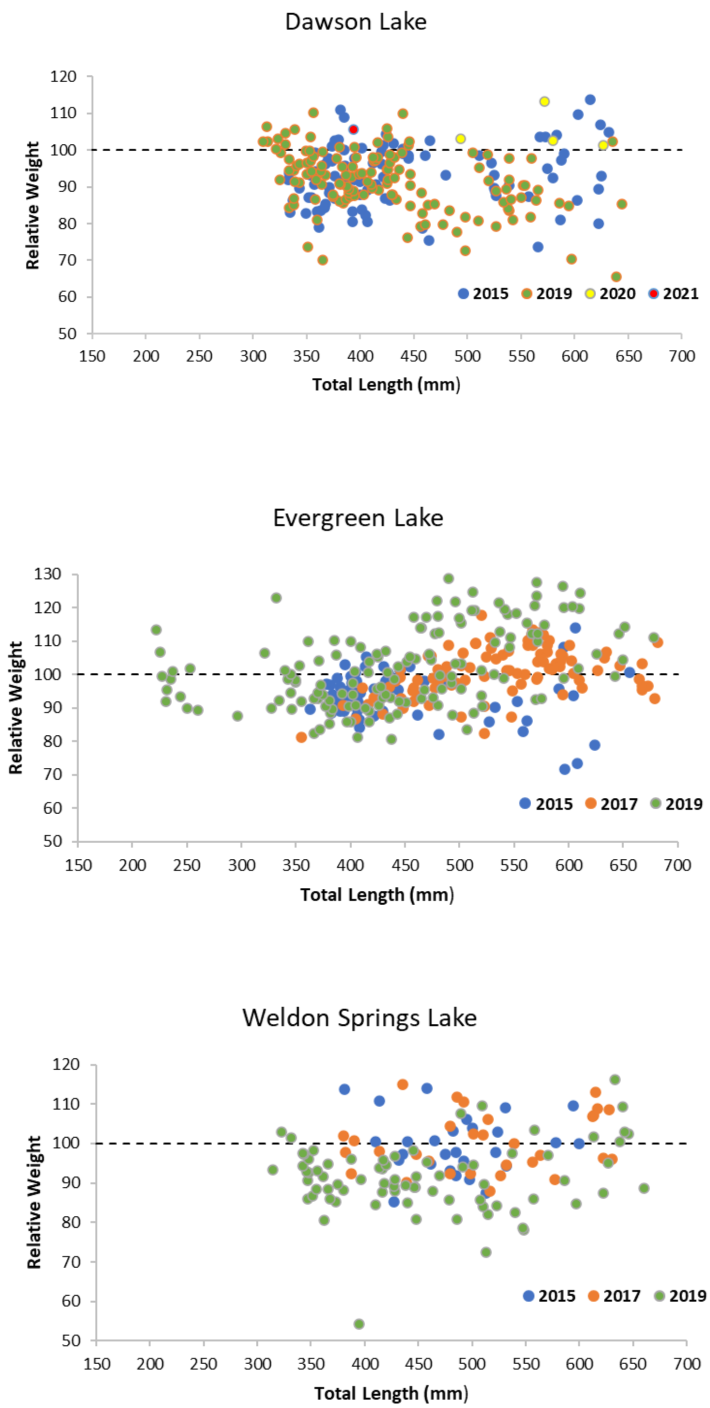


Figure 3.3 W_r of Saugeye (n = 668) captured during fishery surveys on Dawson Lake (*n* = 231), Evergreen Lake (*n* = 302), and Weldon Springs Lake (*n* = 135). A relative weight of 100 represents above average body condition and is indicated by the dashed line. Saugeye which did not meet the species-specific minimum length requirement for W_r were excluded (170mm).

Age Structure

Thus far, 661 (out of 766) Saugeye dorsal rays have been processed in the lab and aged by two readers. The majority of Saugeye in our study were age 2 (33.2%) and age 3 (21.1%) (Figure 3.4). Not surprisingly, very few (*n* = 28) age zero Saugeye were captured during spring and fall surveys even though annual fingerling stocking events had occurred in the lakes during multiple sampling years (https://www.ifishillinois.org/programs/stocking.php). The two methods of capture used in the study (DCEF and fyke nets) are likely the reason that few small fish were surveyed. The average age of Saugeye was different between Dawson Lake, Evergreen Lake, and Weldon Springs Lake ($P \leq 0.05$, DF = 2, F = 20.45). Dawson Lake contained the youngest fish, averaging 2.5 years old (range = 0-9 years old) relative to Evergreen Lake (average =3.2 years; $P \leq 0.001$) and Weldon Springs Lake (2.9 years; $P \leq 0.001$; Table 3.5 and Figure 3.4).

To date, a total of 202 Walleye dorsal rays were aged by two readers (Table 3.5). Average age of fish differed between Walleye populations in Lake Bloomington, Lake Shelbyville, and Lake Decatur ($P \leq 0.05$, DF = 2, F = 3.55). Lake Shelbyville was comprised of the youngest Walleye compared to Lake Decatur (P = 0.030; Table 3.5). The majority of Walleye in Lake Shelbyville were age 2 (33.3%) and 3 (14.0%) based on dorsal ray estimates (Figure 3.5). We sampled few age-0 and age-1 Walleye in the three lakes, suggesting again that this is due to gear capture inefficiency in DCEF and fyke nets.

Waterbody	n	Age ± SE	Age Range
Saugeye			
Evergreen	287	3.2 ± 0.1	1-8
Dawson	223	2.5 ± 0.1	0-9
Weldon Springs	134	2.9 ± 0.1	0-7
Walleye			
Bloomington	86	2.8 ± 0.1	1-7
Shelbyville	57	2.4 ± 0.1	0-7
Decatur	58	3.2 ± 0.3	0-9

Table 3.5. Comparison of average dorsal ray age of Walleye and Saugeye in six of the sampled lakes from 2015–2019.

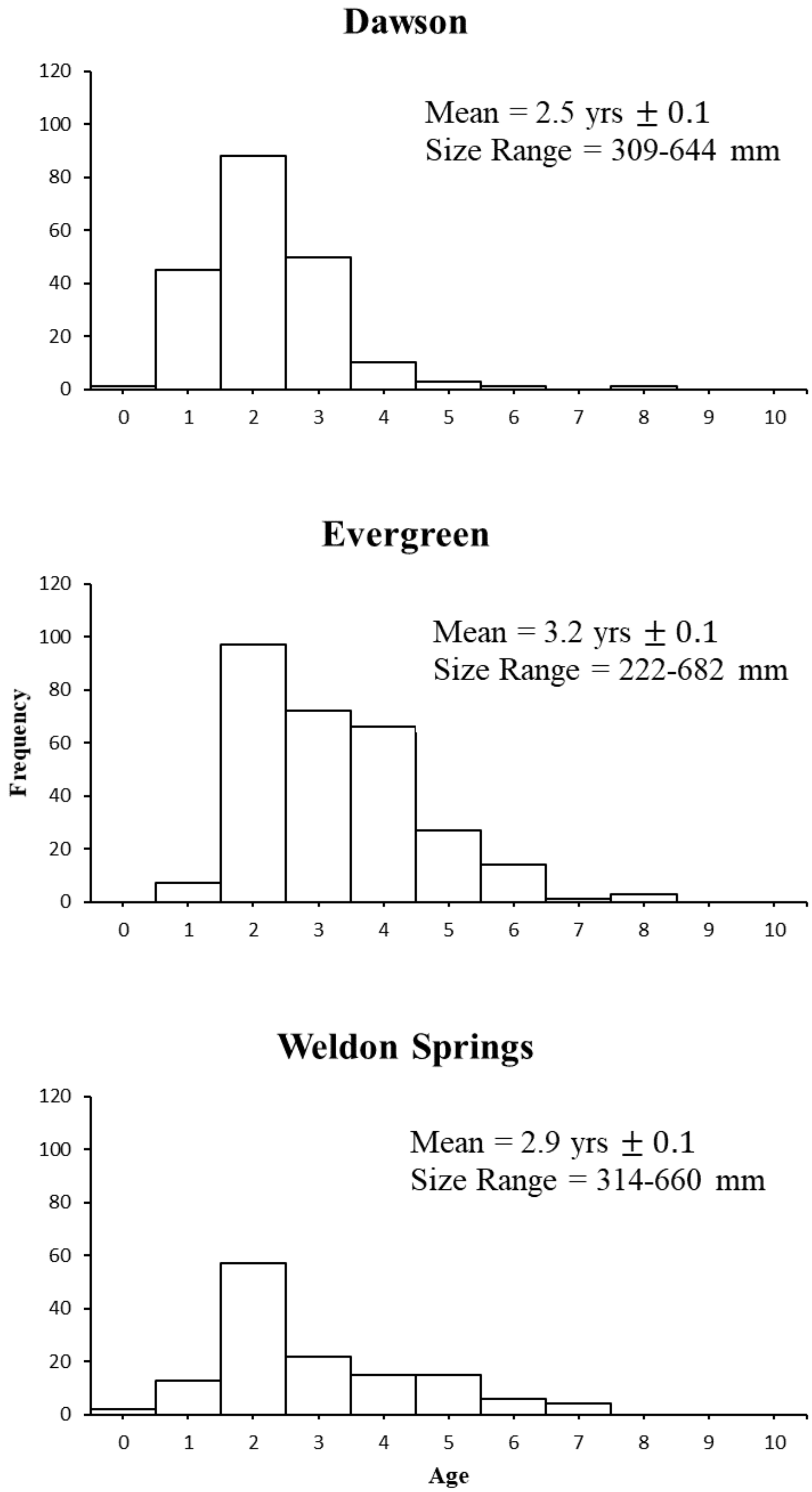


Figure 3.4. Age frequency histograms using dorsal ray ages of Saugeye collected in Evergreen Lake (*n* = 312), Dawson Lake (*n* = 233), and Weldon Springs Lake (*n* = 135) from 2015–2019.

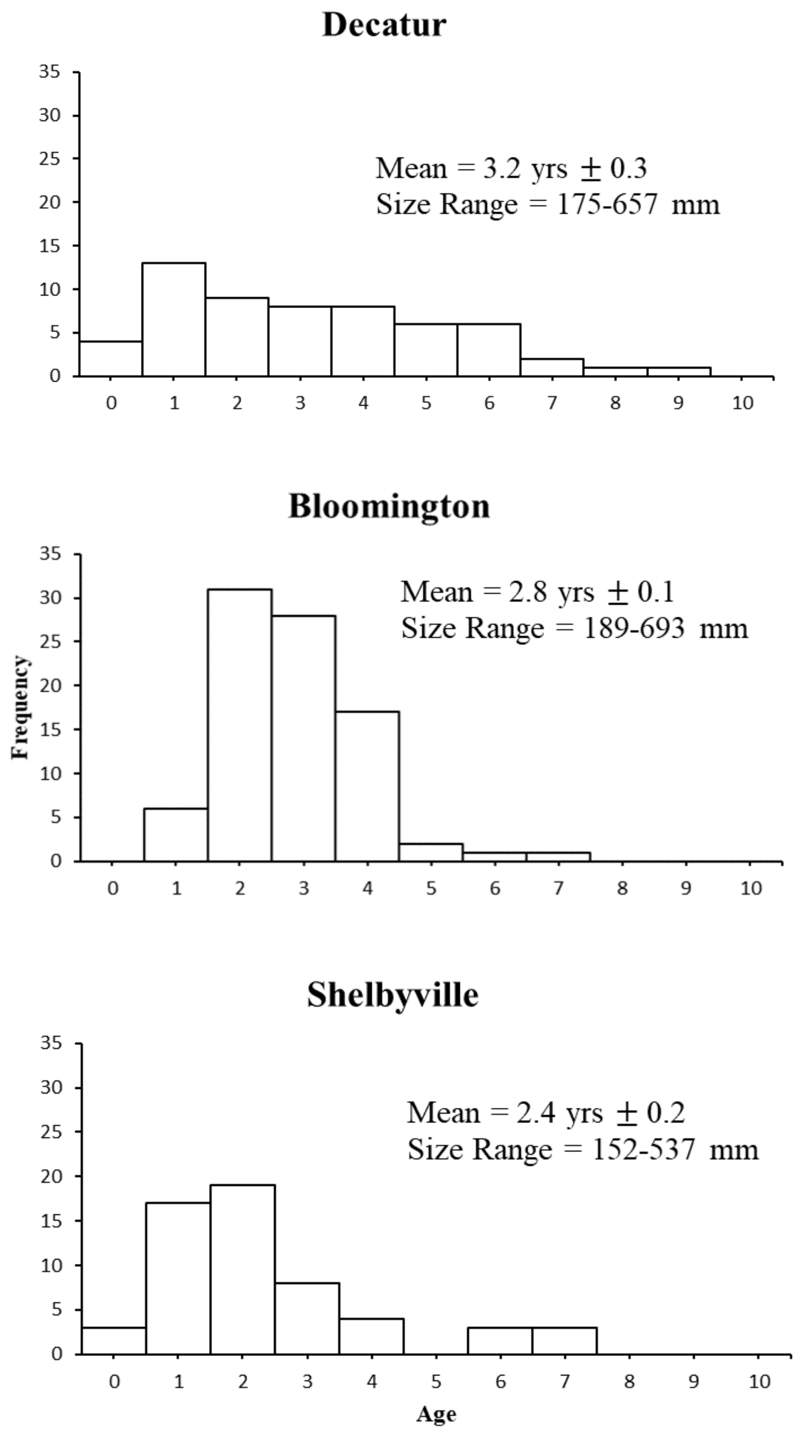


Figure 3.5. Age frequency histograms using dorsal ray ages of Walleye collected in Lake Bloomington (*n* = 86), Decatur Lake (*n* = 58), and Lake Shelbyville (*n* = 31) from 2015–2019.

LENGTH AT AGE

Collection of length and age data are ongoing for Sauger and Saugeye and will be completed in Segment 35; therefore, only Walleye length at age analyses will be presented here. Length at age plots were created to assess how quickly stocked fish reach minimum size limits in Lake Shelbyville, Lake Decatur, and Lake Bloomington (Figure 3.6). The average size of Walleye differed among all three study lakes ($P \leq 0.001$, DF = 2, F = 8.85; Figure 3.6). Specifically, the largest Walleye were collected from Lake Bloomington (mean TL = 490.9 ± 9.3mm), Walleye from Lake Decatur (mean TL = 357.2 ± 13.2mm) were intermediate, and Lake Shelbyville (mean TL = 275.5 ± 12.4mm) had the smallest Walleye. Lake Shelbyville and Lake Decatur had similar length at age curves with little evidence of continued growth past age 2, while Lake Bloomington showed evidence of prolonged growth through age-7. These differences may be in part be related to differences in fishing regulations, harvest rates, and/or may reflect differences in prey availability among the lakes.

Length at age analyses were used to determine when Walleye are reaching the state harvestable size of 14 inches (356mm) in our study lakes. Lake Shelbyville and Lake Decatur have a 14-inch minimum size limit, which is the statewide limit for Walleye in Illinois, whereas Lake Bloomington has a site-specific 18-inch minimum length limit. Lake Bloomington also has a restrictive three fish daily bag limit, whereas Lakes Shelbyville and Decatur have a daily bag limit of six fish. The more restrictive regulations on Lake Bloomington appear to be producing a Walleye population that grows more steadily from age-1 to age-7 and reaches the 18-inch minimum limit around age-3. The restrictive bag limit appears to be allowing some portion of the population to continue to grow beyond 18 inches, while the standard length and bag limits on Lakes Shelbyville and Decatur appear to generate a fishery dominated by 14-inch fish with very limited growth potential (Figure 3.6).

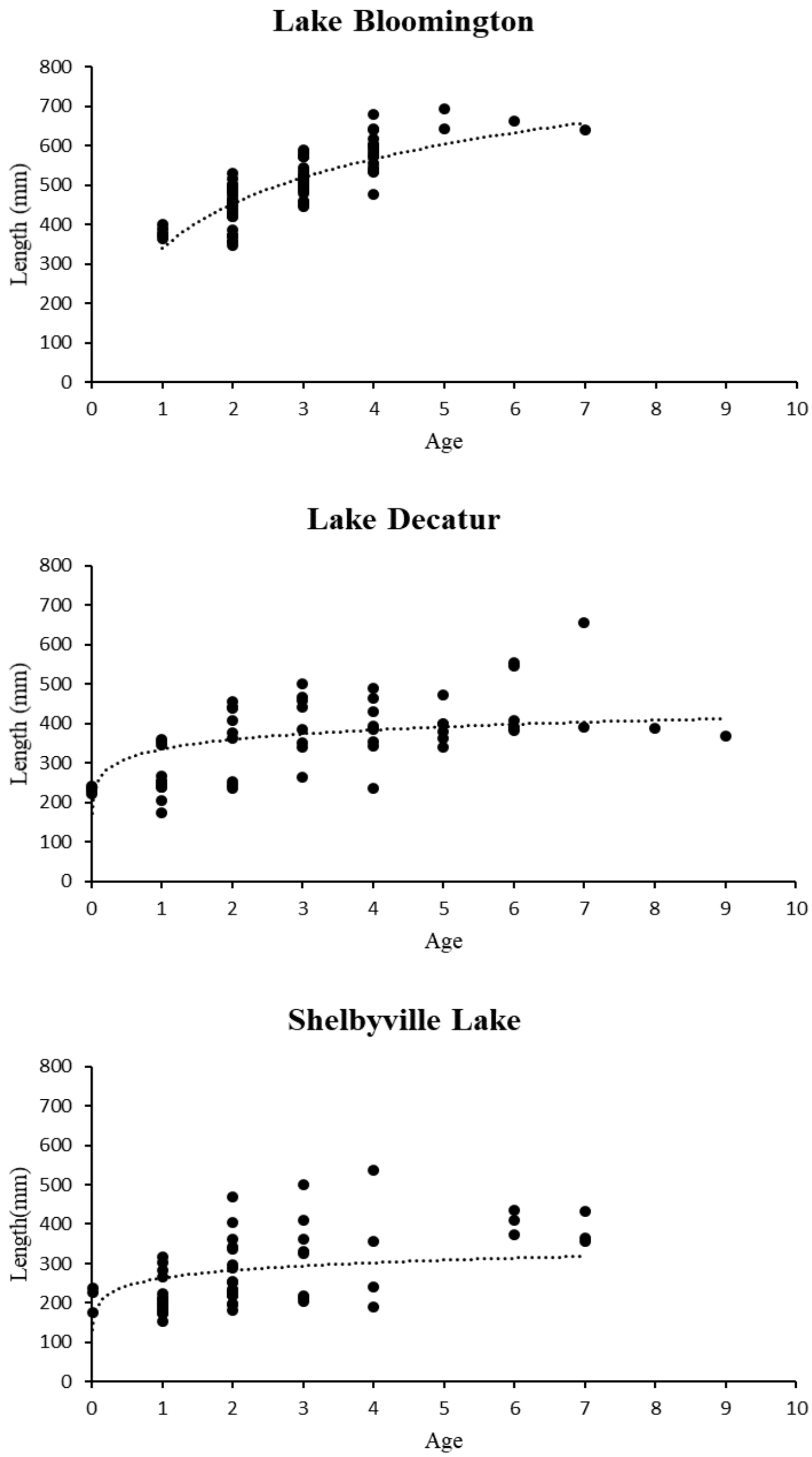


Figure 3.6. Length at age scatterplots for Walley from Lakes Shelbyville (*n*=57), Decatur (*n* =58), and Bloomington (*n* =86).

RECOMMENDATIONS

Regular assessment of population dynamics (i.e., age-related metrics, stock density, size structure, and body condition) allows managers to monitor changes over time and predict impacts of changing fishing regulations. This study provides a detailed evaluation of several populations in Central Illinois and evaluates waterbody differences and changes over time. Preliminary assessment of Walleye data indicates some differences in the size structure and body condition of populations between lakes, likely in response to differences in harvest regulations. Length at age data of Walleye indicate that the restrictive site-specific regulation on Lake Bloomington is producing a fast growing, large-sized fishery. Further data collection is required to evaluate growth trends of all three species. Data collection, calcified structure processing, and analysis is ongoing and will continue into Segment 35.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data collection and analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations

STUDY 4 DEVELOPMENT AND TESTING OF FIXED/RANDOM SAMPLING DESIGN

The purpose of this Study is to determine the feasibility of a statewide evaluation of fixed site sampling designs for Illinois reservoirs.

OBJECTIVES

The following components constitute the overall objectives for Study 4:

- Develop and test a fixed/random site sampling design for the assessment of sport fish populations in Lake Shelbyville, Clinton Lake, Lake Decatur, Lake Bloomington, Homer lake, Lake Paradise, Walnut Point, Evergreen Lake, and Paris Twin Lakes Illinois by June 30, 2023.

PROCEDURES

HABITAT FIELD SURVEYS AND MAPPING

Methods for obtaining habitat characteristics and lake morphology were developed and beta tested at Homer Lake (Figure 4.1 and 4.2) as described in Segment 32. Briefly, tentative boat track paths for each study lake were constructed in ArcMap to ensure side scan images were roughly 30% overlapped (Collier and Humber, 2007). The tentative boat tracks were exported to the Humminbird Helix 10 unit via SD card so personnel could follow the path once in the field.

The recorded field data was downloaded onto a computer and viewed using the program ReefMaster Sonar Viewer. With this application, project personnel were able to identify underwater structures, such as woody debris, vegetation, and bridge abutments. In addition, sediment composition could be differentiated in the side scan images based on unique sonar returns. The coordinates of each unique sediment composition area were identified, then project personnel revisited these sites to verify the type of sediment(s) by using ponar equipment to physically collect and identify the sediment at each location.

Once back in the laboratory, project personnel used the program SonarTRX to convert the sonar files into raster mosaic files, which are compatible with ArcMap. From here, bathymetric and sediment/structure maps of the following lakes were created: Paris Twin East, Paris Twin West, Homer Lake (Figures 4.1 and 4.2), Evergreen Lake, Paradise Lake, Lake Bloomington, and Walnut Point Lake.

Data collection was temporarily delayed in the spring of 2020 due to restrictions in place during the COVID-19 pandemic but resumed in late fall 2020.

FISH SURVEYS

Spring and fall fish surveys at Paris West Lake, Paris East Lake, Walnut Point Lake, and Homer Lake will generate a set of data to use in tests of sampling designs, beginning in 2021. For each lake, sediment/structure and bathymetric maps were utilized to define 200m electrofishing transects along the shorelines. Transects were delineated, and environmental attributes were accounted for and attributed to each transect using ArcMap as shown in Figure 4.3.

In spring 2021, project personnel completed DC boat electrofishing surveys along the entire shoreline of Paris West Lake, Paris East Lake, Walnut Point Lake, and Homer Lake.

FINDINGS

Data collection and construction of bathymetry maps on Decatur, Clinton, and Shelbyville lakes resumed in the fall of 2020 and will continue into Segment 35 (Table 4.1). Progress of the data processing for Lake Shelbyville, Decatur Lake, and Clinton Lake is outlined in Table 4.1. These maps will be used to collect environmental data on various fixed and random sites that are used for population assessments by the DNR.

Our spring electrofishing surveys totaled to 132 transects with a total electrofishing effort of 28.7 hours, resulting in data collected on 5,455 individual fish. As an example, the count of sport fish species that resulted from our spring EF surveys on Homer Lake are shown in Figure 4.4.

With the completion of spring population surveys, project personnel will begin data analysis to generate population parameter estimates (PSD, relative weight, CPUE) to the environmental data that were obtained using side scan sonar. This technique will not only allow personnel to gather information about fixed survey sites that are currently used by state agencies, but also provide resolution to random sites that may be selected in an a random or hybrid site design. These data will allow us to compare the efficiency and accuracy of different survey designs and make recommendations to state agencies regarding the type of design that should be used to survey Midwestern inland lakes and impoundments.

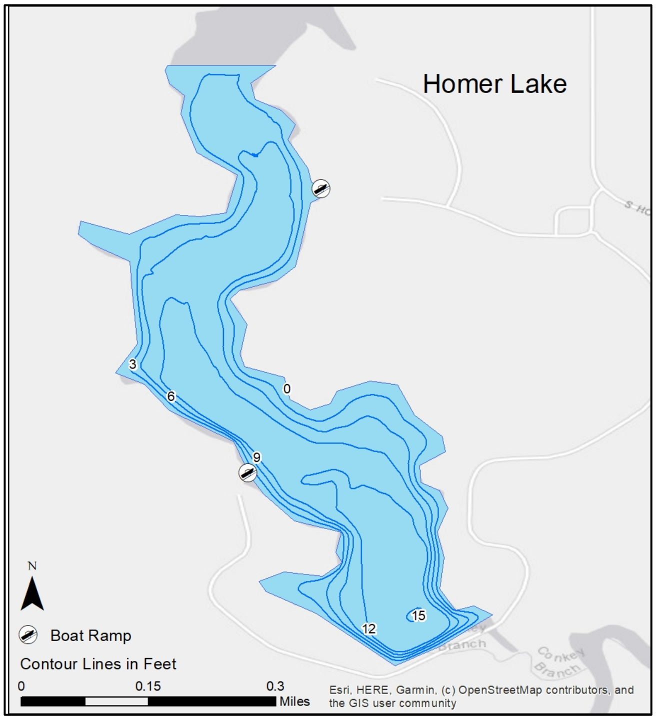


Figure 4.2. Bathymetric map of Homer Lake constructed using side scan sonar data. Note: The northern portion of the lake was not accessible by boat at time of sonar scan collection, so data was not collected in that section.

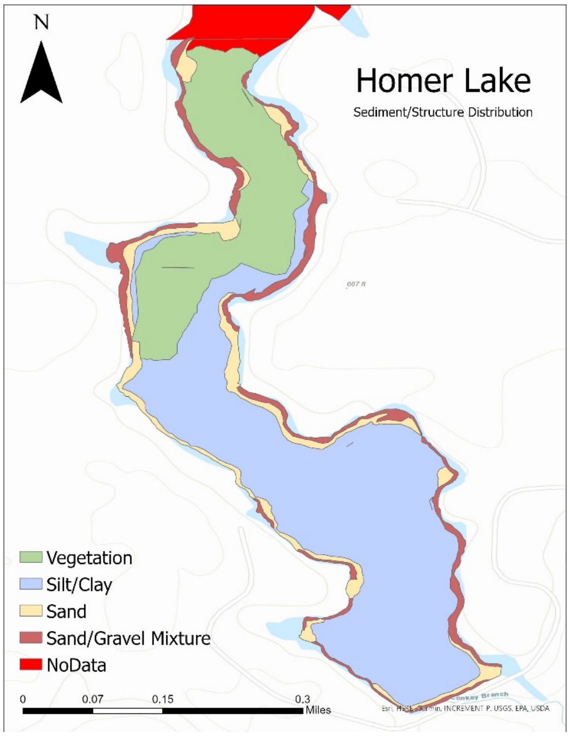


Figure 4.2. Sediment and structure distribution of Homer Lake. Note: The northern portion of the lake was not accessible by boat at time of sonar scan collection, so data was not collected in that section.

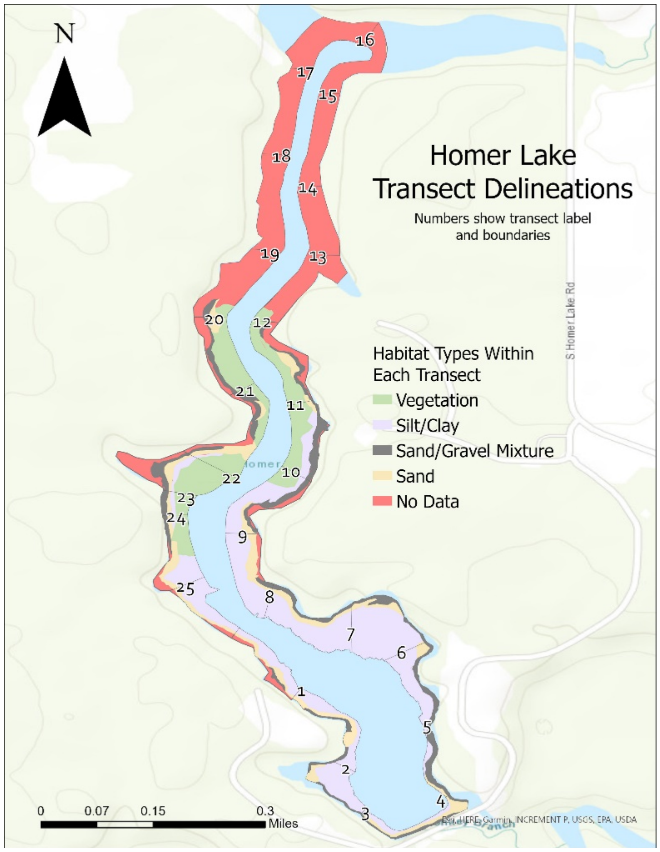


Figure 4.3. Fish transect delineations (numbered 1 through 25) of Homer Lake showing sediment/structure (color coded) of each transect surveyed in 2021 spring and fall electrofishing surveys. Note: The northern section of the lake was accessible later in the year, however, it was still not conducive for collecting quality sonar data resulting in several transects not containing sediment/structure composition data.

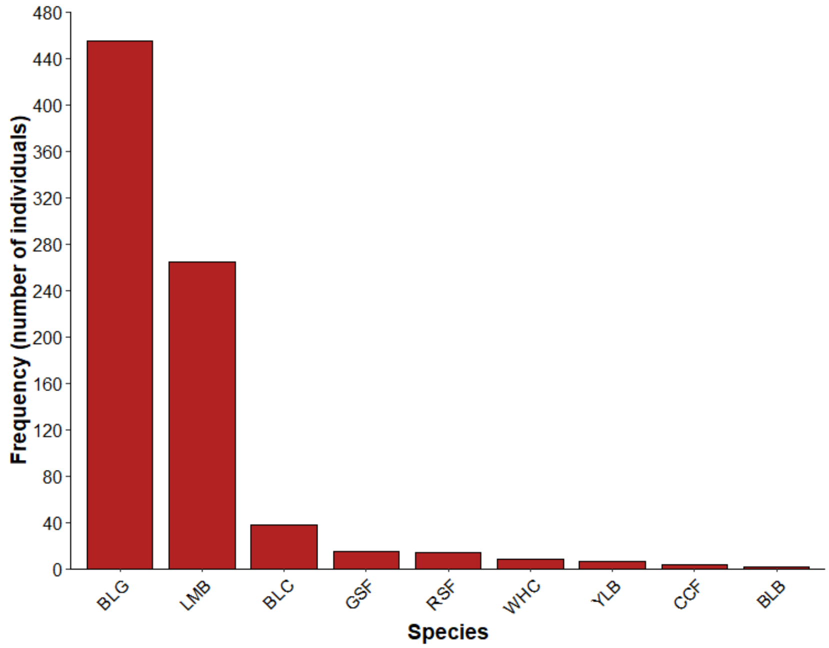


Figure 4.4. Total count of sport fish surveyed using DC EF in Homer Lake.

Lake	Tracks	Sonar Data	Sediment Validation	Bathymetry Map	Sediment/ Structure Map	Spring 2021 Fish Surveys	Fall 2021 Fish Surveys
Homer	✓	✓	✓	✓	✓	✓	
Paradise	✓	✓	✓	✓	✓	--	--
Walnut Point	✓	✓	✓	✓	✓	✓	
Evergreen	✓	✓	✓	✓	✓	--	--
Paris Twin East and West	✓	✓	✓	✓	✓	✓	
Shelbyville	✓	In progress	In progress	In progress	In progress	--	--
Clinton	✓	In progress	✓	In progress	In progress	--	--
Decatur	✓	✓	✓	In progress	In progress	--	--
Bloomington	✓	✓	✓	✓	✓	--	--

Table 4.1. Progress on the making of sonar tracts; scanning; making of bathymetric/sediment and structure maps; habitat validations; and spring and fall electrofishing population surveys categorized by lake. Note: Fish surveys will not be implemented on Paradise Lake, Evergreen Lake, Lake Shelbyville, Clinton Lake, Lake Decatur, and Lake Bloomington.

RECOMMENDATIONS

Fall surveys should be conducted in 2021 on the four study lakes to complete fish population data collection, at which point sampling design alternatives will be defined and tested using the electrofishing dataset. Environmental variables, such as sediment type and presence of structure in inland lakes, will inform fixed/random sampling designs that can be tested and validated using randomization techniques. Information regarding fixed and random sampling designs for inland lakes will increase the accuracy and precision of population estimates and overall will improve sport fish sustainability and management. Data collection and analysis for this study will continue through at least Segment 35 in coordination with Illinois Department of Natural Resources Division of Fisheries.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data collection and analysis
Action Level 2: Techniques Development

STUDY 5 DEVELOPMENT AND MANAGEMENT OF FISHERIES DATA SYSTEMS

The purpose of this Study is to maximize efficiencies among multiple sources and types of fisheries data generated by multiple agency activities by providing an integrated approach to information management.

OBJECTIVES

The following components constitute the overall objectives for Study 5:

- Develop and maintain web-based analytical features for researchers, sport fish managers, and the angling public by June 30, 2021.

PROCEDURES

Project personnel have continued to design, develop, and test web-based information management systems for fisheries data, to be used by agency personnel, researchers, and the general public. In previous project segments, existing information about fish stocking was combined with population assessment data from lakes, rivers and streams throughout Illinois using an integrated set of relational databases and an associated suite of web applications.

In Segment 34, continuation of database development, web application interface development, user workflow control, and historical data quality control and importation was executed for the I Fish Data Portal. The Tournament Permit Information System continues to be maintained by project personnel as a separate web application integrated with the I Fish Illinois website.

FINDINGS

I Fish Data Portal

In coordination with Illinois Division of Fisheries, project personnel launched an online web application for data entry and extraction and facilitates analysis of fish stocking activities and fisheries assessment data. Statewide hatchery operations and fish stocking activities are planned, tracked and recorded with the Data Portal and are supported by relational databases.

All fish population sampling data conducted by IDNR Division of Fisheries is managed through the Data Portal. The Data Portal modernizes the technological approach to data management, improves data security and integrity, offers enhanced features, and provides for an improved user experience.

This web application was launched in the previous segment and is supported by a server-based relational database. Features include:

- Hierarchical fish and environmental data organization to support efficient browsing, filtering and export
- Standardized data elements (e.g., gear types, water bodies, species names/codes) to improve data integrity and consistency
- Real-time integration of entered data into a statewide data system accessible by all users
- Incorporation of detailed fish measurement and marking data
- Improved spatial data management to georeference specific sampling events
- Granular permissions based on user roles and responsibilities to support data integrity and security
- Full historical record of all available assessment data in Illinois (1963 – present)

The fish assessment component of the Data Portal replaces METRICS, previous developed under this project. Additional features, improvements to existing features, and a development strategy for data analysis and reporting features have been developed, and are highlighted in the next section.

Portal Development Process and Status

The IFish Data Portal went live during Segment 33, in September of 2019. Since the initial launch of the IFish Data Portal, project personnel have provided support to staff via email, phone, and through a project tracking module AirTable, through which IDNR staff can report trouble tickets. During Segment 34, 45 tasks were completed to enhance the current system.

Development work during Segment 34 of the Data Portal consists of the designing of a complete analysis package. Project personnel had multiple virtual meetings, emails, and phone calls with IDNR to plan details surrounding the Phase 2 analysis package. A 30-page Analysis Package Scoping Document was created to describe each of the seven analysis modules that will be incorporated into the portal. These modules include Frequency, Length Frequency/Condition/CPUE, Biomass, Catch Rate, Stock Density, Wadeable Stream IBI, and Large River IBI.

Within each module there are several statistical analyses. For each statistical analysis to execute accurately, multiple structural database changes were required. First, 15 new fields were added to the fish species table and 16 were transferred from the old METRICS program. The addition of these fields and associated data is an essential component to provide a foundation for the analysis package as each analysis module requires access to "look-up" information that is specific to a species of fish. Project personnel worked closely with IDNR to obtain accurate data for each Illinois species to incorporate into the species table. The second major structural change accomplished during Segment 34 was the integration of the Samples and Fish Measurements grids, now called the Samples & Measurements grid which will be where users can select desired samples to analyze. In addition, check boxes and select/de-select options were added to the Samples & Measurements grid page to allow users to easily filter/sort and select samples they wish to analyze. Once samples are selected, the user can create a unique name for their (analysis) report and choose whether it should be private or made available to other authorized users of the system. The data from the saved report can also be exported to excel in General Report format. From here, the Frequency module link can be selected to display proportions and counts of various parameters from the selected samples.

After numerous discussions with IDNR, it was agreed that additional features as well as specific alterations and additions to the format of the grids/output tables within the Frequency module were desired. A major discussion point surrounding the analysis package involves the flexibility of grouping options for the user. Currently, the details and limitations surrounding "Output By" (i.e., grouping) options are being outlined in detail for the developer. "Output By" options will provide the user the ability to specify how the data should/should not be grouped when running analyses. The five "Output By" options will include Year, Waterbody, Waterbody Station, Gear Type, and Gear Used. Specific limitations to the various combinations of Output By options for each analysis are currently being discussed with IDNR. The limitations will be set to automatically restrict the user from selecting specific "Output By" combinations to avoid inaccurate analysis outputs within each module. This feature will provide the utmost flexibility for IDNR to view spatial and temporal trends of fisheries data. In addition, the format surrounding three new output tables under the Frequency module were developed with IDNR. The final details for the desired modifications and additions to the analysis package will be sent to the developer at the beginning of Segment 35.

Tournament Permit Information System

Project personnel manages all phases of the online Tournament Permit Information System for handling both fishing tournament applications by anglers and online tournament approval by IDNR biologists and site supervisors. This system enables tournament organizers to have an online account through which they can apply for all fishing tournaments in Illinois and have a listing of all their tournament applications for posting results upon completion. On the administrative side, IDNR staff (both fisheries biologists and site supervisors where applicable) approve or deny permits online, have an online listing of all tournaments taking place on Illinois waters they manage, and have access to all catch data self-reported by tournament organizers to inform the management of Illinois fishery resources. Data reporting is a requirement in order for Tournament Directors to apply for future tournaments. New this year is the addition of the ability to apply for online/internet-based tournaments due to the popularity of "photo tournaments" being held throughout the state. The results will be published in Segment 35.

For the calendar year of 2020, 3041 tournament applications were received. Of those, 2625 (86%) were approved. Of the approved applications, 1127 (43%) were cancelled due to COVID-19 (68%) lack of participation (6%), duplication (9%), and weather (4%). A full report for 2020 was provided to the IDNR Division of Fisheries and included information such as number of tournaments by waterbody and catch data by species.

Thus far in 2021, 2751 tournament applications have been submitted with 2450 (89%) approved. Of those approved, there were 311 cancellations, with the majority of reasons listed below:

- COVID-related (2.6%)
- Duplicate application (36%)
- Weather (8%)
- Lack of participation (18%)
- Conflict (3.2%)

Given the data of permit applications versus cancellations, each year Illinois hosts an average of 2175 fishing tournaments. As noted above, tournament directors must enter their results from their past tournaments in order to be able to apply for any new tournaments, even if it is within the same calendar year. To ensure compliance and as a reminder, emails are sent once a month to directors reminding them to post their data from the tournaments they hosted that have already taken place.

Emails are sent periodically to tournament directors if they have been asked to resubmit a tournament application and have not done so. Beginning in Segment 35, tournament applications that are not resubmitted after 30 days will be sent a reminder and then automatically cancelled. Biologists and site supervisors are also sent reminder emails to approve/deny a tournament application if they have not done so in a timely manner.

There were 92 waterbodies that held tournaments in 2020, and of those, 1497 were largemouth bass tournaments (Table 5.3) . There were no bowfishing tournaments held in 2020.

At the conclusion of a tournament season, all tournament data is compiled and delivered to IDNR Division of Fisheries and will continue to be delivered each calendar year. A summary of the location and number of tournaments that occurred, along with the aggregate number and weight of catfish species (Table 5.1), crappie species (Table 5.2), and Largemouth Bass (Table 5.3) are provided below.

Tournament summary data is available to the public via the IFishIllinois.org website. Data is available by waterbody and includes the number of tournaments held on that waterbody for the previous tournament season, the total number of fish caught by species, and the top 5 largemouth bass and the top 5 total tournament weights for largemouth bass recorded for the calendar year.

RECOMMENDATIONS

Completion of what has come to be known as Phase 1 of the I Fish Data Portal in Segment 33 laid the groundwork for Phase 2, the development and implementation of an analysis package for fisheries managers, during Segment 34. Completed during Segment 34 was the development of the scope of work for Phase 2, which was approved by the IDNR Division of Fisheries. During Segment 35, the analysis package implementation will be completed, beta tested, and launched. This will set the stage for work on Phase 3, which will include the incorporation of Lake Michigan program datasets and field input. In addition, project personnel will work on developing policies and procedures for fielding data requests from outside users and, in some cases, the possibility of granting limited access to data analytics in the system. Delays in the development of the Phase 2 work in the Data Portal were, in part, the consequence of increasing scope and complexity of desired features of the Portal system addressed with a limited and static budget. This should be alleviated in Segment 35 with the hiring of a full-time programmer responsible for Data Portal programming implementation, expected in late fall 2021.

Now that hatchery and fish assessment data is well-organized and easily extracted, and fish assessment data, developing standardized reporting for public viewing on the I Fish Illinois website should be strongly considered in future segments. Doing so would fulfill the overall goal of providing information on quality angling opportunities throughout Illinois using rigorously collected and analyzed data.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data collection and analysis
Action Level 2: Database development and management

2020 Catfish Tournaments

Waterbody	Number of Tournaments	Number of Fish	Total Weight Pounds
CANTON LAKE	1	1	5.6
CLINTON LAKE	8	140	819.48
DES PLAINES/KANKAKEE	1	1	6.5
EAST FORK LAKE	3	58	274.82
EVERGREEN LAKE	1	0	0
FOLI PARK POND (PLANO LAKE)	1	4	0
FOX RIVER	4	169	949.82
ILLINOIS RIVER	17	978	5433.78
JACKSONVILLE, LAKE	2	85	191.9
KANKAKEE RIVER	1	12	98.13
MATTOON, LAKE	13	1	11.13
MISSISSIPPI RIVER	4	164	922.01
NEWTON LAKE	1	35	90.56
PARIS LAKE EAST	1	6	22.25
REND LAKE	2	130	444.54
ROCK RIVER	2	221	801.62
SHELBYVILLE, LAKE	2	38	353.75
SPRINGFIELD LAKE	5	120	1153.51
VANDALIA LAKE	2	0	0

Table 5.1. Summary of Channel Catfish species tournaments for 2020 indicating waterbody, number of tournaments, total number of Channel Catfish caught, and the total weight of Channel Catfish caught.

2020 Crappie Tournaments

Waterbody	Number of Tournaments	Number of Fish	Total Weight Pounds
CARLYLE LAKE	2	170	169.71
CLINTON LAKE	5	109	64.94
CRAB ORCHARD LAKE	1	59	41.1
DAWSON LAKE	1	98	35.56
DECATUR, LAKE	6	364	258.75
EVERGREEN LAKE	3	170	86.42
FOLI PARK POND (PLANO LAKE)	1	0	0
HENNEPIN CANAL	1	5	2.5
KANKAKEE RIVER	1	11	9.5
KINKAID LAKE	1	56	46.62
LITTLE GRASSY	1	12	7.63
MISSISSIPPI RIVER	1	9	8
OHIO RIVER-including Smithland Pool	1	63	58.04
REND LAKE	4	289	326.16
ROCK RIVER	1	0	0
SANGCHRIS, LAKE	2	104	97.12
SHELBYVILLE, LAKE	10	438	356.37
SPRINGFIELD LAKE	2	115	101.69

Table 5.2. Summary of crappie species tournaments for 2020 indicating waterbody, number of tournaments, total number of crappie caught and the total weight of crappie caught.

2020 Largemouth Bass Tournaments

Waterbody	Number of Tournaments	Number of Fish	Total Weight Pounds
BANNER MARSH JOHNSON LAKE	18	680	1770.14
BANNER MARSH SHOVEL LAKE	9	129	387.37
BANNER MARSH WHEEL LAKE	10	309	624.45
BEAVER LAKE, PEABODY RIVER KING SFWA	2	94	51.19
BENTON CITY LAKE	7	246	364.06
BLOOMINGTON, LAKE	14	288	778.86
BORAH LAKE	15	457	954.5
BRAIDWOOD LAKE	11	364	949.31
Cal-Sag Canal, Calumet River, Lake Calumet, Lake Michigan, Little Calumet River	2	13	22.8
Cal-Sag Canal, Calumet River, Lake Calumet, Little Calumet River	28	1301	2885.15
CANTON LAKE	7	139	348.14
CANTON PARK DISTRICT LAKE #1	1	49	71.18
CARLYLE LAKE	8	167	360.19
CEDAR LAKE	53	2181	4085.82
CENTRALIA, LAKE	20	513	1341.34
CHARLESTON SIDE CHANNEL	2	78	154.5
CLEAR LAKE KICKAPOO SP	3	18	38
CLINTON LAKE	49	1270	3459.78
COFFEEN LAKE	26	838	2018.13
CRAB ORCHARD LAKE	20	374	1097.76
DAWSON LAKE	9	240	356.09
DECATUR, LAKE	10	165	327.8
DES PLAINES/KANKAKEE	25	1257	2386.8
DEVILS KITCHEN LAKE	4	190	164.75
DU QUOIN CITY LAKE	5	202	249.8
DUTCHMAN LAKE	2	25	76.29
EAST FORK LAKE	36	1226	2987.23
EVERGREEN LAKE	16	396	1040.14
FOLI PARK POND (PLANO LAKE)	1	5	0
FORBES LAKE	35	779	1769.86
FOX CHAIN -- CHANNEL LAKE	8	745	1563.09
FOX CHAIN -- FOX/SPRING/STATE PARK	3	89	175.1
FOX CHAIN -- GRASS LAKE	24	1764	3333.64
FOX RIVER	5	142	302.15
FULTON CO. CAMPING AND RECREATION AREA	1	98	163.5

GILLESPIE NEW CITY LAKE	6	85	166.65
GILLESPIE OLD CITY LAKE	2	24	57.5
GLENN SHOALS LAKE	5	55	140.54
GOVERNOR BOND LAKE	20	154	350.52
HAMILTON LAKE - BENTON	1	47	60.37
HARRISBURG CITY LAKE	11	389	613.61
HEIDECKE LAKE	4	8	20.4
HENNEPIN CANAL	4	49	83.56
ILLINOIS RIVER	8	74	118.25
JACKSONVILLE, LAKE	34	1242	1911.14
KANKAKEE RIVER	1	7	23.31
KINKAID LAKE	57	1924	5349.59
LAKE NELLIE	15	152	358.24
LAKE VERMILION	18	525	1205.23
LITTLE GRASSY	11	356	464.49
LOU YAEGER LAKE	1	18	46.18
MATTOON, LAKE	38	1175	2418.68
MAZONIA LAKES	13	286	489.07
MCMASTER, LAKE (Snakeden Hollow)	3	145	166.45
MERMET STATE LAKE	2	39	114.79
MICHIGAN, LAKE	1	0	0
MILL CREEK LAKE	41	2058	3710.67
MINGO, LAKE	14	462	354.77
MISSISSIPPI RIVER	54	3759	8845.03
MURPHYSBORO, LAKE	8	280	419.66
NEWTON LAKE	32	544	1826.69
OHIO RIVER -including Smithland Pool	16	906	1665.93
OTTER LAKE	22	678	1719.8
PANA LAKE	8	124	256.16
PARIS LAKE EAST	15	353	683.15
PIERCE LAKE	1	0	0
PINCKNEYVILLE CITY LAKE	1	3	10.25
PITTSFIELD LAKE	7	112	265.91
PRAIRIE LAKE - JIM EDGAR PANTHER CREEK	22	150	350.76
PYRAMID- CAPTAIN-SUPER LAKE	7	215	345.81
PYRAMID- GALUM-GOLDENEYE	3	58	101.07
REND LAKE	56	3230	7552.98
ROCK RIVER	11	77	137.22
SAM DALE LAKE	5	86	158.18
SAM PARR LAKE	24	579	1260.62
SANGCHRIS, LAKE	38	1900	4972.18
SARA, LAKE	42	2190	3902.82

SCHUY-RUSH LAKE	12	564	1017.76
SHABBONA LAKE	4	52	79.94
SHELBYVILLE, LAKE	69	2903	6676.36
SPRING LAKE (North and South)	6	98	242.74
SPRING LAKE (NORTH)	2	95	26.45
SPRING LAKE (SOUTH)	2	8	21.3
SPRINGFIELD LAKE	46	1762	4213.02
TAYLORVILLE, LAKE	5	23	65.25
VANDALIA LAKE	26	674	1513.81
VERMILION RIVER (NORTH FORK)	1	0	0
WASHINGTON CO. LAKE	15	503	766.03
WAVERLY LAKE	3	12	30.32
WEST FRANKFORT NEW CITY	3	23	44.39
WEST FRANKFORT OLD CITY	2	6	11.13

Table 5.3. Summary of Largemouth Bass species tournaments for 2020 indicating waterbody, number of tournaments, total number of Largemouth Bass caught and the total weight of Largemouth Bass caught.

STUDY 6 MAINTENANCE OF THE I FISH ILLINOIS WEBSITE

The purpose of this study is to provide the angling public with online access to information about angling opportunities and the outcomes of project activities of this and other Federal Aid projects. For over 15 years, this Project has worked collaboratively with IDNR Division of Fisheries to develop content for a public website highlighting places to go fishing in Illinois waters. Through this partnership, activities have greatly expanded in that time, incorporating dynamic, database-driven designs to content delivery that includes summary data gathered through creel surveys and population assessments, as well as lake maps, kids fishing tips, and highlights of research findings supported by the Sport Fish Restoration Program. This ongoing Study is an integral part of engaging the public in fishing.

OBJECTIVES

The following components constitute the overall objectives for Study 6:

- Upgrade and maintain one website and related social media content delivering information about fishing opportunities in Illinois to the angling public annually.

PROCEDURES

Project personnel continually work to improve and keep up to date the www.ifishillinois.org website, ensuring this site is the one-stop, go-to place for Illinois anglers. The goal of the website is to make information easily accessible to anglers while promoting sport fishing opportunities to the public. The website provides information about Illinois sport fish, including angling tips and areas for greatest success; fishing reports; lake profiles of fishable waterbodies (lakes and rivers) throughout Illinois; improved maps that include contour detail and bathymetry data for our most-visited lakes, as well as access points, ramps and major roads; fishing forecasts as provided by IDNR biologists; Family Friendly and bank fishing opportunities; IDNR fishing programs; and an angling-related event calendar. The “contact us” feedback form continues to connect Illinois anglers directly with project personnel to ask questions related to fishing, boating and regulations in Illinois.

Project personnel provide information on the latest news releases from IDNR, making certain to keep all timely information up front and up to date on the website and in social media.

Since 2017, the Illinois Department of Natural Resources website directs all Illinois fishing information to the IFishIllinois site, making the www.ifishillinois.org the official website for the Division of Fisheries. The efforts of project personnel to maintain and enhance the www.ifishillinois.org website as the primary source for information about sport fishing opportunities and sport fisheries-related information to the public provides immeasurable benefit to current and prospective anglers in Illinois.

FINDINGS

Updates and Additions to www.ifishillinois.org

TOURNAMENT APPROVAL

In conjunction with IDNR fisheries, project personnel reworked the tournament approval pages with more distinctive choices for approving/denying a tournament for biologists and site supervisors.

FISH STOCKING

In March 2020, project personnel provided summary fish stocking information from the I Fish Data Portal (Study 5) available to the public on the www.ifishillinois.org website. Stocking information is available by species/year or by waterbody using the selector. Data is included for the past ten years and is updated quarterly (or as directed by the Division of Fisheries) to include most recent stockings. The announcement of these pages was postponed into Segment 34 due to COVID-19, and since the announcement, this information has been popular on the site (5016 page visits) and has been promoted via social media. The stocking information also appears directly on the lake profile pages (Figure 6.1.), and the stocking information on these pages is updated every two months.

HATCHERY SYSTEM

The hatchery pages on the I Fish Illinois website were completely revamped and updated. Project personnel worked with hatchery personnel to provide all-new pages that include location, history, production, species and services for all three of the Illinois Hatcheries. The Illinois Hatcheries were promoted through a slider on the website and through social media.

FISHING REPORT SELECTOR

Per the request of the IDNR Division of Fisheries, the Fishing Report pages were revamped to a format that makes it easier for constituents to readily see the areas for which we had reports available. As this is a popular page on our site, we are working with the IDNR to encourage more reporting from site or park offices, concessions, and bait and tackle shops.

LAKE PROFILE PAGE

Over 200 lake and river profile pages were updated with the most current fishing prospects and waters information, based on the expertise and recent data collected by Illinois Department of Natural Resources fisheries biologists in their Lake Management Reports.

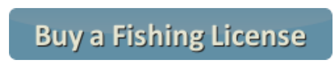
Many lake profile pages also include a "fishing forecast," which integrates information provided by Illinois Department of Natural Resources fisheries biologists, including fishing tips. When available, current fishing reports are embedded on these pages for easy access by anglers. In addition, when applicable, a section for "fish attractors" has been made available for anglers to easily locate the many fish attractors that have been deployed in Illinois waterbodies.

New lakes have been added to the site as per the latest Illinois Department of Natural Resources Lake Management Reports, bringing the number of Illinois lakes and reservoirs on the site to 360 and 19 rivers and their various pools and reaches. Additionally, all Illinois lakes that are stocked with Trout in fall and/or spring are included on the site and marked as being "Trout stocked" lakes.

Contact Us

In this segment, project personnel received 4,580 emails through our Contact Us page (approximating 88 emails/week) from Illinois anglers, most of which are answered within 24 hours. The inquiries range from anglers requesting information about licensing, stocking, regulations, and tournaments to public libraries asking to be Urban Fishing centers or to have summer program support, to Conservation Officers providing guidance on changes needed on our site. Project personnel either answer these questions directly or forward them to the appropriate personnel—the appropriate Illinois Department of Natural Resources District Fisheries Biologist, the Illinois Department of Natural Resources outreach contacts, or the Chief of Fisheries. This form has become an invaluable communication channel between project personnel, the Division of Fisheries, and the public at large.

Fishing License Button and Analytics



To ensure that every angler can easily access the Illinois Department of Natural Resources online fishing license sales page, www.ifishillinois.org prominently features a "Buy a Fishing License" button, which enables project personnel to track the number of click-throughs from the IFishIllinois website to the Illinois Department of Natural Resources license purchase website. In this segment, the button was clicked 63,743 times (a 13% increase over last segment).

Invasive Species

Project personnel continue to work with the IDNR and Illinois-Indiana Sea Grant staff to include information about Invasive Species in support of the Be a Hero, Transport Zero campaign. This information is also incorporated for tournament directors in on the online Tournament Permit Information System. In addition, Project personnel is working with Asian Carp team and Tetra Tech on promoting the rebranding effort of Asian Carp through slider information on the site and pages dedicated to the effort.

SHELBYVILLE, LAKE

Choose another lake

SHELBYVILLE, LAKE FISHING GUIDE

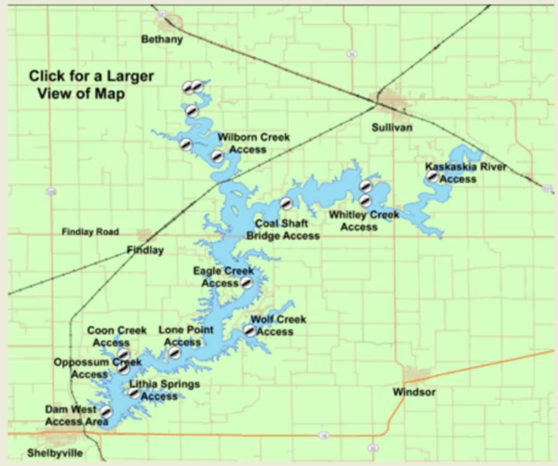
Lake Information

FAMILY FRIENDLY

County: Shelby
Acreage: 11100
Average Depth: 18.9 feet
Shoreline Length: 120 miles

Recreational Amenities

Boat Fishing? Unrestricted
Boat Ramps? Yes
Boat Rental? Yes
Skiing? Yes
Swimming? Yes
Picnicking? Yes
Camping? Yes



Click on area names for a more detailed map.
Coal Shaft Bridge, Coon Creek, Eagle Creek, Kaskaskia River Access, Lithia Springs, Lone Point, Oppossum Creek, Shelbyville Dam, Whitley Creek, Wilborn Creek, Wolf Creek

Maps are not intended for navigation.

There are no zebra mussels in this lake.

Fish Stocking

Year	Species	Size	Count
2019	Muskellunge	Adult	8211
2019	Walleye	Fingerling 1 - 3"	108299
2020	Channel Catfish	Advanced Fingerling 4 - 7"	40144
2020	Muskellunge	Adult	50
2020	Sauger	Fingerling 1 - 3"	85565
2020	Walleye	Fingerling 1 - 3"	149729
2021	Sauger	Fingerling 1 - 3"	140639
2021	Walleye	Fingerling 1 - 3"	18431

Additional information for stocking on SHELBYVILLE, LAKE

Figure 6.1. Fish stocking information is embedded on lake profile pages.

Social Media

The growing popularity of www.ifishillinois.org and the dominance of social media as a method of creating online communities make our Facebook and Twitter accounts a vital part of disseminating information to Illinois anglers. Both of these social media venues are used to announce timely information regarding sport fishing in Illinois, including promotion of IDNR-sponsored events, IDNR press releases pertaining to sport fish and Illinois lakes, tournament announcements, fishing license reminders, and news items that may be of interest to Illinois anglers. The social media presence for IFishIllinois continues to grow. As of this report date, IFishIllinois has 11,500 followers on Facebook (an 18% increase over last segment) and 559 Twitter followers.

Facebook is a unique vehicle in that you can reach many more people above and beyond those who have "liked" your page. The IFishIllinois Facebook posts routinely reach over 20,000 people (Figure 6.1).

Project personnel receive a significant number of messages and questions through Facebook, which are always answered within 24 hours. This has provided us with a direct vehicle in which to communicate with anglers and to gain a sense of community among anglers with the IFishIllinois brand.

Website Statistics Analysis

Project personnel extensively use Google Analytics (Figure 6.2) to collect information regarding visitors to www.ifishillinois.org. Google Analytics provides reports on how often each page is visited, which pages have the highest numbers of visitors, the trends in the website visitors (e.g., higher on weekends, holidays, etc.), which pages have the highest exit rates, etc. Our goal is to focus our time and efforts to improve the site in areas that ensure we are providing information of interest to the public.

Visitor Information

- From July 1, 2020– June 30, 2021, www.ifishillinois.org had 699,398 sessions; 473,777 users; and a total of 1,624,360 pages viewed (Figure 6.3).
- Likely due to COVID-19, our website statistics appear lower in the fourth quarter of Segment 34 as compared to Segment 33 (Figure 6.4). However, this was during the time that State Parks were re-opening and we had high numbers of visitors checking for updates during that time (e.g., on May 2, 2020, the day after State Parks reopened due to COVID-19, we had 5269 visitors), as well as tournament organizers and participants inquiring about feasibility of holding tournaments.
- We had 7,697 visitors combined on Friday, April 2nd and Saturday April 3rd (April 3 was the Spring Trout season opener). Comparatively, we had 4,816 visitors prior to the Fall Trout season opener.
- The site averages 2640 visitors each day from April – June.
- 75% of our users are from Illinois (the next highest number of users is from Missouri at 6%, Wisconsin at 3.5% and Indiana with 2.5%).
- 65% are mobile (compared to 63% last segment).

Top-Visited Pages

- The Lake Profile Selector Page remains the most-visited area of the site.
- The Trout Stocking page is our 2nd most popular page with 48,383 visitors.
- The 3rd most visited page is the fishing report page.
- FAQs ranked the 4th spot, and the Tournament Information System page was just below that.
- Also among the top pages: Sport Fish of Illinois and bank fishing.
- Our top most-visited waterbody pages by far this year were the rivers. This is likely due to many of the impoundments being closed due to COVID.

PDF Downloads

- The fishing regulations guide was downloaded 14,844 times.
- The fish dealer listing continues to be popular as it was downloaded 2,111 times.

COVID-19

Project personnel worked with IDNR on COVID-19 messaging to constituents. Clarification needs resulted in an increase in email inquiries and resulting tournament cancellations. Project personnel provided daily briefings to IDNR for reporting to the Governor's office on the number of communications we received each day as it related to COVID-19, including emails, phone calls, Facebook messaging and tournament cancellations as noted in Study 5.

RECOMMENDATIONS

Overall, the IFishIllinois website is very popular among Illinois anglers. Project personnel will continue work in Segment 35 to promote timely information to Illinois anglers. In Segment 35, project personnel will complete work done in this segment on a comprehensive dynamic map of the entire state of Illinois clearly identifying site-specific areas, which will then be linked to the lake profile pages for each waterbody.

The Kid's Fishing section of IFishIllinois continually ranks in the most-visited pages. Project personnel developed a photo release form to be used for all pictures obtained through social media and email and are planning to culminate this into a "my first fish" section on IFish for those featuring children to encourage youth participation in the sport.

Due to budget constraints, project personnel shelved plans to have specific sections of the Regulations Guide available as part of our site rather than an entire download, which would be of benefit to mobile users. Additionally postponed at this time are any plans to make the IFishIllinois website a mobile-ready site. Modifications to the existing site would require significant resources beyond what is expected to be available in future segments. This mismatch between need and resource allocation risks an erosion of the strong success this project has built in recent segments. Almost two-thirds of all visitors to the website utilize a mobile device; yet the site content is not optimized for viewing on mobile devices, risking future losses of visitorship due to this incompatibility and this should be revisited.

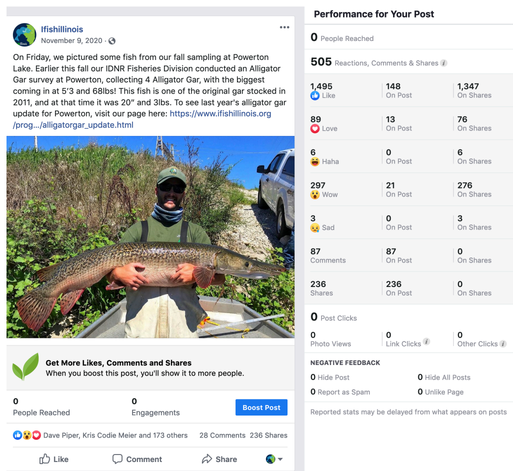
Project personnel will continue to use Facebook and Twitter to provide timely sport fish information to the public. Project personnel will continue branding IFishIllinois through consistent messaging and a distinctive logo. Project personnel will continue to monitor communications from anglers and bring issues to the attention of the Illinois Department of Natural Resources Division of Fisheries.

Information about visitors to www.ifishillinois.org indicates that the website's popularity and growth is likely the result of effective coordination between project personnel and IDNR Division of Fisheries.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Outreach
Action Level 2: Recruitment and Retention Activities

This post from Segment 34 was the most popular post on Facebook for this segment. It reached 232,500 people, was shared 1517 times and had 213 comments. It also was responsible for pushing us over 10,000 likes on Facebook! This post is an excellent example of how IFishIllinois gets exposure through social media.



Posts that feature the IDNR fish stockings and fieldwork continue to promote specific lakes and species while demonstrating the good work of our IDNR Fisheries Biologists. This post reached 75,600 people.

The I Fish Illinois social media pages promote a wide variety of fisheries-related news to support the Division of Fisheries.

The post at left is promoting the habitat structures installed at Crab Orchard and reached 40,500 people.

Always popular are the posts regarding state record-breakers. All comments that require a response are answered by project personnel. There were 63 comments on the post at right.

Figure 6.2. Screenshots from the IFishIllinois Facebook page, demonstrating how project personnel provide angling information, track the online audience, and respond to inquiries from the public.

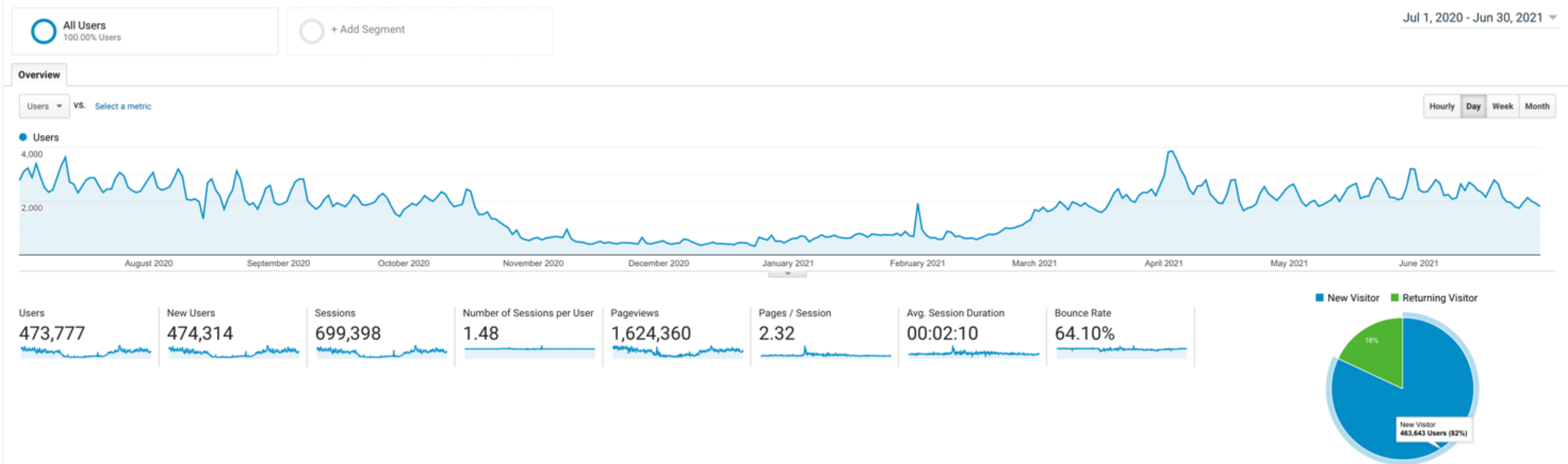


Figure 6.3. Overview of the number of daily visits to the www.ifishillinois.org during Segment 34 (July 1, 2020 – June 30, 2021). Pie chart is of new visitors (blue) versus returning visitors (green).

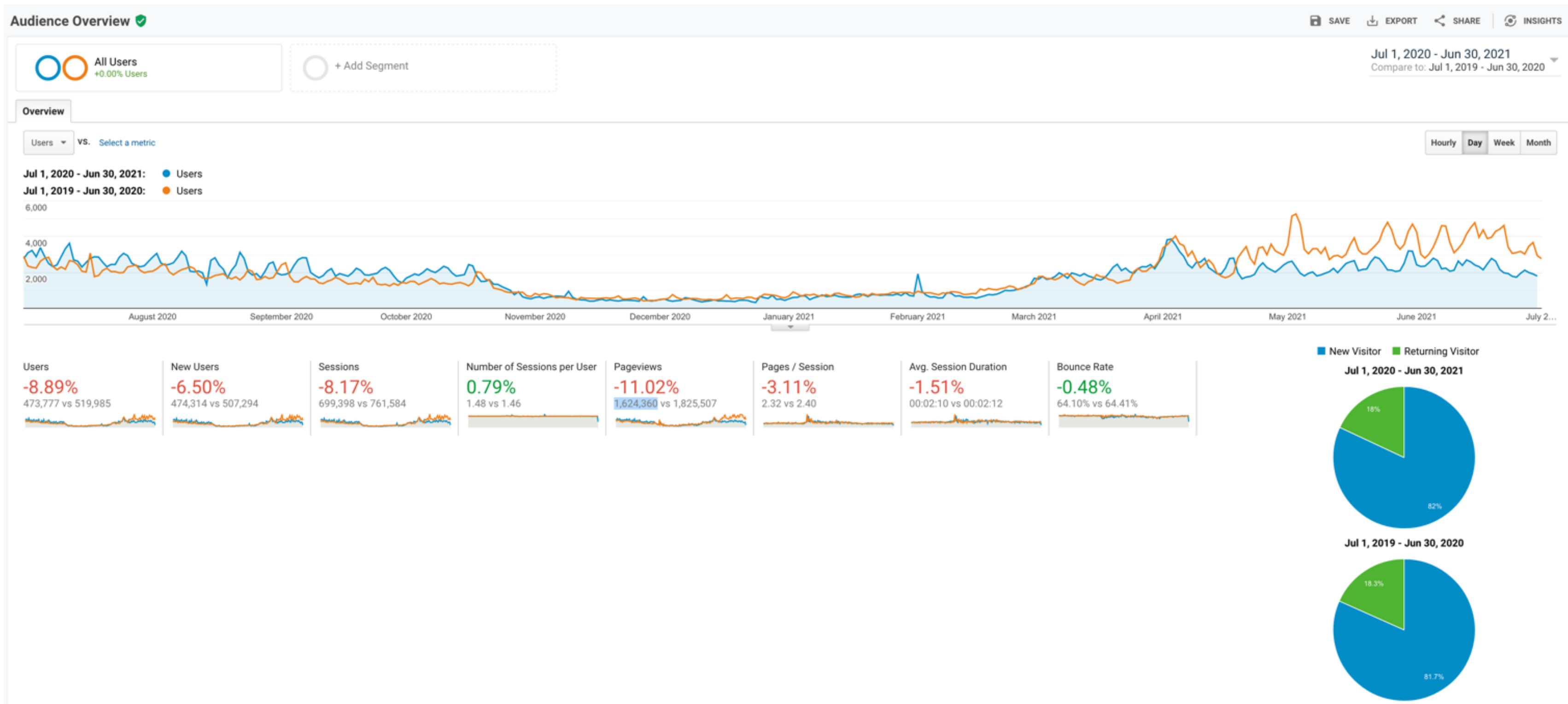


Figure 6.4. Comparison view of the number of daily visits to the www.ifishillinois.org during Segment 34 (July 1, 2020 – June 30, 2021) and the previous segment. Pie chart is of new visitors (blue) versus returning visitors (green). Note the orange line (Segment 33) during the 4th quarter of the segment, likely due to COVID-19 visitors looking for reopenings.

Peer-Reviewed Publications Generated by Project F-69-R (2019–2021)

Bieber, J.F., Louison M.J., Stein, J.A., Suski, C.D. 2019. Impact of Ice-Angling and Handling on Swimming Performance in Bluegill and Largemouth Bass. *North American Journal of Fisheries Management.* 39 (6): 1301-1310.

David, S. R., King, S. M., Stein, J. A. 2018. Introduction to a special section: Angling for dinosaurs-Status and future study of the ecology, conservation, and management of ancient fishes. *Transactions of the American Fisheries Society* 147:623-625.

King, S. M., David, S., Stein, J. A. 2018. Relative bias and precision of age estimates among calcified structures of Spotted Gar, Shortnose Gar, and Longnose Gar. *Transactions of the American Fisheries Society* 147:626-638.

King, S. M. and J. A. Stein. 2020. "Effective Anesthetic Dosage and Recovery from Specialized Surgical Methods in Shortnose Gar." *North American Journal of Fisheries Management* 40:1486-1498.

Louison M.J., Stein, J.A., Suski, C.D. 2019. The role of social network behavior, swimming performance, and fish size in the determination of angling vulnerability in bluegill. *Behavioral Ecology and Sociobiology* 73 (10): 139.

Louison, M.J., Suski, C. D., Stein, J.A. 2019. Largemouth bass use prior experience, but not information from experienced conspecifics, to avoid capture by anglers. *Fisheries Management and Ecology.* DOI: 10.1111/fme.12372.

Louison, M.J., Hage, V.M., Stein, J.A, and Suski, C.D. 2019. Quick learning, quick capture: largemouth bass that rapidly learn an association task are more likely to be captured by recreational anglers. *Behavioral Ecology and Sociobiology* 73(2): 23.

Louison, M.J., Suski, C.D., and Stein, J.A. 2019. Largemouth bass use prior experience, but not information from experienced conspecifics, to avoid capture by anglers. *Fisheries Management and Ecology* DOI: 10.1111/fme.12372.

Stein, J. A., King, S. M., Buckmeier, D. L., and Smith, N. G. 2018. Comment: The challenge of age estimation in gars (*Lepisosteus* spp.). *Transactions of the American Fisheries Society* 147:649-652.

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DeBoer, J. A., S. King, R. Pendleton, L. Solomon, and T.D. VanMiddlesworth. 2020. Bowfin (*Amia calva*). In: Schlesser, N. J., ed. *UMRCC Fisheries Compendium, 4th Edition*. Upper Mississippi River Conservation Committee.

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Gabelhouse Jr, D. W. 1984. A length-categorization system to assess fish stocks. *North American Journal of Fisheries Management*, *4*(3), 273-285.

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