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# Research and Analysis of Fisheries in Illinois 

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# RESEARCH AND ANALYSIS OF FISHERIES IN ILLINOIS 

F-69-R (32)<br>Final Performance Report<br>July 1, 2018 - June 30, 2019<br>Dr. Jeffrey A. Stein

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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 completed in Segment 32 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, a series of six experiments investigating the status and trends of Ancient Sport Fishes (Gars, and Bowfin) were conducted statewide, detailing age and growth methodology; spatial ecology and genetic relatedness; population vital rates; and bowfishing tournament harvest.

Second, one experiment investigating the influence of on the heritability of lure avoidance were conducted, 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 initiated on several impoundments in east central Illinois.

Evaluation of sampling methods initiated under Study 4 focuses on an evaluation of incorporating a fixed/random sample design into fisheries assessments in Illinois impoundments. Specifically, habitat and bathymetric assessments of study lakes were initiated, to be followed by data simulations utilizing sport fish data sets managed under Study 5.

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 efficiently collect and manage data that reflects the status and trends in sport fish populations in Illinois and organizes that information in such a way that the needs of all data users can be more efficiently met. An online permit application system for fishing tournaments throughout Illinois
has been met with great success regarding its ease of use and generation of important data for researchers and managers. A new online data portal accessible by IDNR Division of Fisheries that integrates the Hatchery Information Management System (HIMS) and the assessment data system METRICS has been developed. Informed by repeated consultations with system users in the last segment, the new I Fish Data Portal is scheduled for launch in the first quarter of Segment 33. Achieving this significant landmark supports a transition toward 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 are able to communicate 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 five experiments are underway investigating various aspects of the ecology, life history and management of Gars and Bowfin. To date, data collection and analyses are ongoing to describe population demographics (i.e., relative abundance, distribution, size and age structure) of three gar species throughout the major watersheds in Illinois, therefore, there are no recommendations at this time. Age and growth demographics for Shortnose Gar from the La Grange reach of the Illinois River were analyzed, indicating that Shortnose Gar exhibit slow growth rates, large body size, and variable or infrequent recruitment, which may make them vulnerable to human disturbances. Similarly, analyses of genetic data are in the preliminary stages and conclusions and recommendations are expected in future segments. A sham surgery study to document survival and wound healing rates of Shortnose Gars using specialized surgical methods for transmitter implantation was completed at the INHS pond facility. Project personnel confirmed that the specialized surgical methods were successful and can be used to implant transmitters in gars in the field. In addition, preliminary movement data on Shortnose Gar was obtained on acoustic receivers that were deployed for at the end of 2018, however data collection is ongoing, so there are no recommendations at this time. Creel surveys at bowfishing tournaments in Illinois revealed that bowfishing tournaments harvest is
largely dominated by invasive carp species and native fishes comprise a much smaller percentage of total harvest than anticipated. However, gars harvested at tournaments were substantially larger than gars sampled in our long-term mark-recapture study, suggesting these species have the potential to be susceptible to overfishing.

## 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. One full season of experimental angling has been conducted (2018) and a second is underway (2019). Results and recommendations are expected in Segment 33.

## STUDY 3 COOL WATER SPORT FISHES

Recreational sport fishing in inland waters is a significant economic driver in Illinois, requiring substantial effort to conduct surveys and inventories to monitor the status of the cool water sport fish community. Currently, age determination of Walleye, Sauger, and Saugeye is lacking, limiting the interpretation of data analyses intended to inform sustainable management of cool water species. In collaboration with IDNR personnel, boat electroshocking, fyke netting, gill netting, and other standard fish collections methods will be used to conduct surveys of sport fish populations at regular intervals throughout the spring, summer and fall. Calcified structures will be used for age estimation and will allow generation of growth and mortality patterns and population age structure. Currently, calcified structures are being processed and aged in the laboratory. Project personnel will continue to process structures and assist IDNR with annual fish surveys to collect additional data for population assessments.

## 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 broadly reflect fish populations across the sampled water body. Site selection, however, is not always conducted to reflect all available habitats, which may introduce bias in fish abundance and size structure estimates, depending on the location of fixed sampling sites in relation to habitat type and quality. Evaluations of habitat types and lake morphology in a select number of inland lakes coupled with a two-year trial implementation of a fixed/random sampling design that incorporates the size and diversity of habitat will provide two district data sets for estimation of fish population demographics. The development of this protocol will improve sport fish management in Illinois. Currently, habitat and depth profile data using a side scan sonar unit is being collected and analyzed and will continue into the next segment.

## 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 implemented online hatchery and stocking data systems and have constructed and populated a new web interface for management of fisheries assessments, to be launched in the fall of 2019. Project personnel will continue to provide 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 $6 \quad$ 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 30 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 32, the website had 406,283 users, with a total of $\mathbf{1 , 5 9 8 , 5 2 9}$ pages viewed, indicating a strong public interest in the information provided about fishing opportunities in Illinois. The "Buy a Fishing License" button has generated 38,741 visits from the I Fish Illinois website to the DNR license purchase site.

## STUDY 1 ANCIENT SPORT FISHES

The purpose of this study is to provide data and analyses that describe population dynamics of Holostean fishes in the waters of Illinois. Specifically, information regarding population abundance, size structure, age structure, and habitat use 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 demographic information for up to 10 sites throughout Illinois to determine abundance, size structure, age structure, and habitat use of gars and Bowfin by June 30, 2019.


## PROCEDURES \& FINDINGS

The procedures of Study 1 are comprised of the six 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 - Age determination methodologies

Field work, analyses, and results associated with this experiment were completed and reported in Segment 30 and have now been published by King, et al. in Transactions of the American Fisheries Society. Additionally, a second, related publication commenting on this work was generated and published by Stein et al., in the same journal, and reflects similarities and differences in findings between King et al. and research produced Buckmeier et al. of the Texas Parks and Wildlife Department and was supported in part by the U.S. Fish and Wildlife Service through the State Wildlife Grants Program (Project T-53-1) and the Sport Fish Restoration Program (Projects F-231-R1 and F-231-R2 to the Texas Parks and Wildlife Department and Project F-86-D-1 to the Oklahoma Department of Wildlife Conservation).

Both King et al., and Stein et al. appear in the List of Peer-Reviewed Publications Generated by Project $F-69-R-31$ on page 65 of this report and have been provided electronically to the Illinois Department of Natural Resources at their request as partial fulfillment of the reporting requirements for this project.

No further reporting of this experiment is expected.

## 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 - Long-term mark-recapture assessment

Mark-recapture studies are an effective method for estimating the absolute abundance of individuals in 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 an interim progress report on Experiment 1.2, which began in 2015, and should extend through the 2019 field season.

## OBJECTIVES

Using mark-recapture methods, we aim to estimate the relative abundance, distribution, size structure, and age structure 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 are documenting the total length (mm) and weight (g) of each captured fish, affixing a T-bar anchor tag (Floy tag) into the dorsal musculature, removing the left pectoral fin ray for age estimation, and then releasing individuals at their location of capture. To collect a wide size distribution of fishes, we used a multi gear approach with gill nets, fyke nets, hoop nets, AC electric seine, AC boat electrofishing, and DC boat electrofishing.

Currently, ancient fish data has been collected from the Wabash, Lower Illinois, Upper Illinois, Kaskaskia, Upper Mississippi-Meramec, Lower Ohio, and the Upper Mississippi-SkunkWapsipinicon River Basins. Data collected from the long-term project will ultimately be used to compare populations abundance, distribution, size structure, age structure, and growth and mortality rates of gars and Bowfin throughout Illinois watersheds.

## FINDINGS

To date, a total of 4,092 individuals (938 Longnose Gar, 2,056 Shortnose Gar, 222 Spotted Gar, 867 Bowfin, and 9 young-of-year gars) were sampled throughout seven major watersheds in Illinois (Table 1.2.1). Over half ( $52 \%$ ) of the total number of ancient fish were sampled in the Lower Illinois River Basins (Table 1). Shortnose Gar were the most captured species throughout the state of Illinois, comprising of $50 \%$ of the total catch. Roughly half of the Shortnose Gar (49\%) were sampled in the Lower Illinois River, $36 \%$ in the Wabash River, $14 \%$ in the Upper Mississippi- Meramec, and less than $0.05 \%$ in the Kaskaskia, Lower Ohio, and Upper Illinois combined. Longnose Gar were the second most captured fish in the state, followed by bowfin (Table 1). More Longnose Gar were captured in the Wabash Basin (64\%) relative to all other
watersheds, reaching a total 603 fish in the Wabash River alone (Table 1). Bowfin have been captured in relatively low numbers (less than 60 fish) in all watersheds, except the Illinois River, where 785 individuals have been tagged to date.

Since 2015, 37 out of 4,092 total tagged ancient fishes have been recaptured (Table 1.2.2). This includes 25 Bowfin (Lower Illinois Basin), 2 Longnose Gar (Wabash River Basin), and 10 Shortnose Gar (4 from Wabash and 6 from Lower Illinois River Basins). Recaptured fish comprise less than $0.01 \%$ of the total number of fish tagged since the project began in 2015. In addition, the majority ( $92 \%$ ) of the recaptured data was reported by INHS collaborators or state agencies (U.S. Fish and Wildlife Service and Illinois Department of Natural Resources) during annual fish surveys, whereas only 3 fishes ( 2 Bowfin and 1 Longnose Gar) were reported by anglers.

Data collection is ongoing for this project and will continue into the next segment. Future multigear sampling will focus on the sites with the highest abundance of tagged gars and bowfin (Illinois, Wabash Rivers, Upper Mississippi-Meramec) to help provide recapture information. In addition, efforts to make it easier for anglers to contact us with recapture information are underway. A flier will be posted at boat ramps to inform anglers of our tagging efforts and an online system to report tagged fish will be developed and implemented.

| Watershed |  | Total Count |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Gear | $\begin{gathered} \text { Longnose } \\ \text { Gar } \\ \hline \end{gathered}$ | Shortnose Gar | Spotted Gar | $\begin{aligned} & \text { YOY } \\ & \text { Gar } \end{aligned}$ | Bowfin | Total |
| Wabash |  | 603 | 742 | 69 |  | 57 | 1,471 |
|  | AC Electric Seine |  | 3 | 1 |  |  | 4 |
|  | DC EF | 450 | 711 | 68 |  | 56 | 1285 |
|  | Gill Net | 140 | 11 |  |  |  | 151 |
|  | Hoop Net | 12 | 17 |  |  | 1 | 30 |
|  | Angler | 1 |  |  |  |  | 1 |
| Lower Illinois |  | 205 | 1,009 | 130 | 0 | 785 | 2,129 |
|  | AC EF |  |  |  |  | 1 | 1 |
|  | AC Electric Seine |  | 2 |  |  |  | 2 |
|  | Angler |  |  |  |  | 2 | 2 |
|  | DC EF | 145 | 312 | 48 |  | 199 | 704 |
|  | Electric Trawl |  | 1 |  |  |  | 1 |
|  | Fyke Net | 42 | 590 | 74 |  | 569 | 1,275 |
|  | Mini Fyke Net | 13 | 91 | 8 |  | 13 | 125 |
|  | Hoop Net |  | 2 |  |  |  | 2 |
|  | Hoop Net Tandem |  | 3 |  |  |  | 3 |
| Kaskaskia |  | 2 | 7 | 7 | 0 | 0 | 16 |
|  | DC EF | 2 | 7 | 7 |  |  | 16 |
| Upper Illinois |  | 29 | 4 | 0 | 0 | 10 | 43 |
|  | DC EF | 29 | 4 |  |  | 10 | 43 |
| Upper MississippiMeramec |  | 98 | 293 | 16 | 9 | 4 | 420 |
|  | DC EF | 84 | 193 | 12 | 7 | 2 | 297 |
|  | Fyke Net | 2 | 49 |  | 3 | 1 | 62 |
|  | Mini Fyke Net |  | 18 | 1 | 3 |  | 22 |
|  | Hoop Net | 2 | 2 |  |  |  | 4 |
|  | Unknown | 1 | 8 | 23 | 3 |  | 35 |
| Upper Mississippi-Skunk-Wapsipinicon |  | 1 | 1 | 0 | 0 | 0 | 2 |
|  | DC EF | 1 | 1 |  |  |  | 2 |
| Lower Ohio River |  |  |  | 0 | 0 | 11 | 11 |
|  | Unknown |  |  |  |  | 11 | 11 |
| Total |  | 938 | 2,056 | 222 | 9 | 867 | 4,092 |

Table 1.2.1. Total count of Longnose Gar, Shortnose Gar, Spotted Gar, YOY Gar (young-of-the-year Gar), and Bowfin sampled using a multi-gear approach in seven Illinois watersheds.

| Watershed | Longnose Gar | Shortnose Gar | Bowfin |
| :---: | :---: | :---: | :---: |
| Wabash | $0.33 \%$ | $0.54 \%$ | -- |
| Lower Illinois | -- | $0.59 \%$ | $3.18 \%$ |

Table 1.2.2. The percent of the number 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 indicate no recaptures were recorded in the study thus far.

## RECOMMENDATIONS

This study is ongoing and the collecting, tagging and measuring of individuals will continue into the Segment 33 and will focus on watersheds where the highest number of animals have been tagged to date. In addition, we will advertise our tagging efforts in an attempt to increase the number of tagged fish reports from anglers. To provide accurate abundance, distribution, size structure, and age-related metrics of gars and bowfin throughout Illinois, several years of data collection is needed. Mark recapture data should continue into 2020, as these data will aid in the development of informed management decisions for these native ancient species in Illinois waters.

## 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 - Lower Illinois River Shortnose Gar demographics

## OBJECTIVES

The objective of this Experiment is to use pectoral fin rays to estimate age of gars collected from 2015-2017; and, to describe population age and size structures, growth and mortality rates, and body condition across major habitat types (backwater, side channel, main channel) and flow regimes in the lower Illinois River.

## PROCEDURES

Shortnose gar were collected throughout the La Grange reach from May 2015 through October 2018. In order to capture a wide size distribution of fishes we partnered with the INHS Illinois River Biological Station and the INHS Great Rivers Field Station and used a multi-gear approach with mini fyke nets, fyke nets and DC boat electrofishing. Fishes were weighed (g), measured for total length (TL, mm), and the left pectoral fin ray was removed for age estimation. The majority of fishes captured for this project were also marked with a t-bar anchor tag and released in the location of capture as part of the Long Term Mark-Recapture project. When possible, secchi depth, water depth, water velocity, water temperature, dissolved oxygen, and specific conductivity were measured at each sample site.

Pectoral fin rays were mounted in epoxy resin and sectioned with a Buhler Isomet low-speed saw. Two experienced readers independently aged each fin ray and disagreements in the age estimates were reconciled with a consensus read. Relative abundance (catch per unit effort), size structure, and age structure of Shortnose Gar was described across gears, habitat types (backwater, side channel, main channel), and years when possible. Growth (von Bertalanffy) and mortality (Chapman-Robson) models included all Shortnose Gar regardless of sampling location or year of collection.

## FINDINGS

In total, 814 Shortnose Gar were captured during the study period (Figure 1.3.1). Fyke nets consistently produced the highest CPUE (catch per unit effort; ranging from 2.26 to 9.57 fish per net night) across years of sampling effort, whereas DC EF produced the lowest (ranging from 0.22 to 1.03 fish per 15 minute EF run). In addition, CPUE was highest in backwater habitats relative to main channel or side channel habitats (Figure 1.3.2).

Gar ranged from 276 to 789 mm in total length (mean $=527 \pm 84 \mathrm{~mm} \mathrm{SD}$; Figure 1.3.3). Total length varied among years ( $\mathrm{F}=14.16$; $\mathrm{df}=3,793 ; \mathrm{P}<0.01$ ), where 2015 samples contained larger Shortnose Gar than all other years ( $\mathrm{P}<0.05$; Figure 1.3.4). Total length also varied among gears ( $\mathrm{F}=4.86$; $\mathrm{df}=2,793 ; \mathrm{P}<0.01$ ), where DC EF captured larger Shortnose Gar than fyke nets ( $\mathrm{P}<0.05$; Figure 1.3.5).

Shortnose Gar ranged from 1 to 18 years old (mean $=6.4 \pm 2.98 \mathrm{SD}$ ), with $50 \%$ of fish falling between 4 and 8 years old. The Kolmogorov-Smirnov tests suggest that the age distribution of Shortnose Gar captured in 2015 is different from the distribution of those captured in 2016 ( $\mathrm{D}=$ $0.34 ; \mathrm{P}<0.01$ ) and $2017(\mathrm{D}=0.36 ; \mathrm{P}<0.01)$, but that 2016 and 2017 are not different ( $\mathrm{D}=$ $0.09 ; \mathrm{P}>0.01$; Figure 1.3.6). The von Bertalanffy growth model was fit to Shortnose Gar aged 1 - 14 (Figure 1.3.7) and found the theoretical maximum length $\left(L_{\infty}\right)$ predicted from the model was 822 mm (Table 1.3.2), which is greater than the maximum observed total length in the study $(789 \mathrm{~mm})$. The Chapman-Robson methods estimated instantaneous mortality rate ( Z ) as 0.357 ( $95 \%$ CI $0.300-0.415$ ), and annual survival (S) as $69.9(95 \%$ CI $67.3-72.6)$. The maximum observed age in this study (18 years) was used to estimate instantaneous mortality by the modified Hoenig method (M), which estimated M as 0.347 . This estimate fell within the $95 \%$ CI of $Z$ from the Chapman-Robson method, suggesting that the estimates of mortality are robust with respect to choice of methodology.


Figure 1.3.1. Shortnose Gar capture locations in the La Grange reach of the Illinois River from 2015-2018. The size of the circles is proportional to the number of Shortnose Gar captured. In both frames, the black lines represent the lock and dam complexes that border the La Grange reach.


Figure 1.3.2: The relative abundance of Shortnose Gar in the La Grange reach captured in DC EF, fyke net (fyke) and mini fyke net (mini) LTRM sampling events from 2013-2018. The panels contain estimates for the connected back water (BWC), main channel border (MCB) and side channel border (SCB) habitats, and for the whole study reach. Note that the scale of the $y$-axis varies among the panels. The error bars represent the standard error of the estimate.


Figure 1.3.3: The length frequency distribution of all Shortnose Gar captured in the La Grange reach of the Illinois River from 2015-2018.


Figure 1.3.4: The length frequency distributions of Shortnose Gar captured in the La Grange reach of the Illinois River each year from 2015-2018. Shortnose Gar in 2015 were significantly smaller in TL than those in all other years ( $\mathrm{P}<$



Figure 1.3.5: The length frequency distributions of Shortnose Gar captured in the La Grange reach of the Illinois River by each gear. Shortnose Gar captured by DC EF were greater in TL than those captured by fyke nets ( $P<0.05$ ), and all other gears were similar ( $\mathbf{P}>0.05$ ). In each panel, the sample size and the mean total length $\pm$ SD are indicated. Notice that the $y$-axis differs among panels.


Figure 1.3.6: The age frequency distribution of Shortnose Gar captured in 2015-2017 in the La Grange reach of the Illinois River. The age frequency distribution in 2015 was significantly different from 2016 and 2017 ( $\mathrm{P}<0.01$ ). The top number in each panel is the sample size, and the bottom numbers are the mean age $\pm \mathrm{SE}$.


Figure 1.3.7: Mean length at age and the von Bertalannfy growth model for Shortnose Gar in the La Grange reach. The growth model was fit on ages $1-14$, but older age classes were included for comparison. The grey circles represent individual fish. The black squares and error bars represent the observed mean length at age $\pm$ the standard deviation. The black line is the von Bertalannfy growth model, and the grey ribbon is the $95 \%$ confidence interval of mean length at age predicted by the von Bertalannfy growth model.

| Parameter | Coefficient | $\ldots$ | $95 \%$ Confidence interval |
| :--- | :---: | :---: | :---: |
|  |  | lower | upper |
| $L_{\infty}$ | 821.71 | 747.33 | 964.38 |
| $K$ | 0.09 | 0.06 | 0.12 |
| $t_{0}$ | -5.15 | -6.82 | -3.90 |

Table 1.3.2: Parameters and $95 \%$ confidence intervals of the original von Bertalannfy growth model.

To examine trends of Shortnose Gar populations in finer detail, various population demographics (historical and current population trends, distribution among habitat types, and age/growth/mortality estimates) were evaluated within the Lower Illinois River Basin. Growth models show that Shortnose Gar live longer and have the potential to reach larger sizes than previously expected. In addition, trends in size and age structure over time suggest the species may experience interannual variation in recruitment, which is likely a response to evolving habitats with predictable seasonal variation (I.E. high water events in spring). With slow growth rates, high mortality rates, and periodic spawning life history strategies, this species may require a precautionary management approach to avoid overharvest in the future.

WILDLIFE TRACS ACTION LEVELS
Action Level 1: Data Collection and Analysis
Action Level 2: Research, survey or monitoring - fish and wildlife populations

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 1.4.1) are currently in the process of being reamplified and prepared for fragment analysis. Details of laboratory procedures are outlined in the annual report for Segment 31. Preliminary samples were sent for fragment analysis at the UIUC WM Keck Core Sequencing Facility and unfortunately failed QA/QC (quality assurance/quality control) due to evaporation. This requires that the samples be re-amplified and additional optimization with Keck. Re-amplifications are currently ongoing and will continue into the next segment.

## FINDINGS

Microsatellite analyses were planned for this segment, but DNA isolates were


Figure 1.4.1. Locations where tissue samples were collected from gars throughout Illinois. compromised by an equipment failure during storage. DNA from samples will need to be isolated again early in Segment 33, and anaylsis will proceed from there. Therefore, there are no new results on this project to date.

All three Illinois Gar species show evidence of panmixia, with genetic diversity spread throughout the riverscape. Evidence of hybridization/introgression revealed, with morphological data support, that hybridization among Gar species does occur in Illinois. Analysis of the data generated by this study should continue into Segments 32 and 33, in that microsatellite analyses will provide additional 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

In conjunction with genetic data, analyses of the spatial ecology of Gar populations in Illinois are critical to understanding 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 1.5 is to determine use of backwater and main channel habitats of gars in response to season, flow changes, and other abiotic factors 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 determine 1) the required dose of Aqui-S20E to adequately anesthetize Shortnose Gar for surgery, and 2) observe healing rates and complications from using the specialized methodology for transmitter implantation.

## PROCEDURES

## Pond Study

In the current segment, a sham surgery study at the University of Illinois pond facility was completed and data was analyzed. Details on the specific methods of the study were outlined in the annual report for Segment 31.

## Field Study

The field movement study was initiated in collaboration with the INHS Illinois River Biological Station in the current segment. Acoustic transmitters were surgically implanted in 22 Shortnose Gar in the Lower Illinois River (Figure 1). Fish were sampled using fyke nets that were submerged for approximately 24 hours. Fish larger than 360 g were anesthetized using $250 \mathrm{mg} / \mathrm{L}$ Aqui-S20E by emersion. The minimum size limit is required to ensure the transmitter weight (approximately 6.5 g ) does not exceed $2 \%$ of the fish's body weight, as recommended by Winter (1983). Stage 5 anesthesia occurs when reactivity and reflexes are absent and opercular movements are slow and irregular (Summerfelt and Smith, 1990). Once anesthetized, the fish was placed ventral side up on a v-frame surgical trough and an approximately 1.5 inch incision was made on the ventral midline between the pectoral and pelvic fins using an 18 mm cutting disk on a rotary tool. A scalpel was used to carefully penetrate the peritoneal cavity. A 3/64" drill bit on a rotary tool was used to pre-drill 4 suture holes and then the transmitter was inserted in the body cavity. Two monofilament non-absorbable sutures were guided through the pre-drilled holes to close the incision. Fish were weighed, measured, floy tagged, and then placed in a recovery tank containing fresh water. After the fish regained equilibrium and responded to tactile stimuli, it was released at its capture location. Eighteen acoustic transmitters will be surgically implanted in Shortnose Gar in Segment 33.

On June $25^{\text {th }}$, 2018, 13 Vemco VR2 receivers were deployed in the main stem of the Illinois River, side channels, Lily Lake, and Treadway Lake (Figure 1.5.2). One receiver was located by a commercial fisherman and returned to our laboratory on August $22^{\text {nd }}, 2018$, and 11 receivers were retrieved from the river in mid-November 2018 for data download.

In April 2019, personnel deployed 19 Vemco VR2 receivers in the main stem of the Illinois River, side channels, Lily Lake, Treadway Lake, Muscooten Bay, the La Moine River, and the Sangamon River (Figure 1.5.2). These receivers will be retrieved in November 2019 and movement data will be downloaded and combined with 2018 data, and then analyzed in Segment 33.


Figure 1.5.1. Locations where Shortnose Gar ( $\mathrm{N}=22$ ) were captured, implanted with a 69 kHz Vemco acoustic transmitter, and released to monitor movement patterns.


Figure 1.5.2. Placement of Vemco VR2 stationary receivers in 2018 (top panel) and 2019 (bottom panel). Note that 2018 receivers were retrieved and replaced by 2019 receivers. In addition, in 2018, R17 was lost, therefore no data was obtained, and R4 was removed from the water in August (both receivers are indicated by red).

## FINDINGS

## Pond Study

The sham surgery study reviled that in order to anesthetize Shortnose Gar using submersion sedation methods, they must be limited to access atmospheric oxygen. Gars are facultative air breathers that have the capability to gulp air in adverse conditions (for example, during stressful conditions or low oxygen environments). We found that gulping air in the sedation tank was counterproductive to anesthetizing the fish because in order for the drug to anesthetize the fish, it has to pass over the gills to enter the vascular system.

After constructing a barrier to prevent fish from surfacing, we discovered that Shortnose gar became anesthetized at doses ranging from $200 \mathrm{mg} / \mathrm{L}$ to $250 \mathrm{mg} / \mathrm{L}$, however fish did not remain anesthetized for the surgery trough transfer when dosed with $200-230 \mathrm{mg} / \mathrm{L}$ of Aqui-S20E (Table 1.5.1). Fish remained in stage 5 anesthesia for the 5 minute holding on the surgery trough when sedated with 240 and $250 \mathrm{mg} / \mathrm{L}$ of Aqui-S20E (Table 1). Sedation times were significantly longer for fish at the $240 \mathrm{mg} / \mathrm{L}$ relative to fish at $250 \mathrm{mg} / \mathrm{L}(\mathrm{P}=0.022$, Table 1). However, fish recovered within a similar time frame among doses $(240 \mathrm{mg} / \mathrm{L}$ and $250 \mathrm{mg} / \mathrm{L})(\mathrm{P}=0.323$, Table 1.5.1). There was no relationship between sedation and recovery time of fish anesthetized at $240 \mathrm{mg} / \mathrm{L}\left(\mathrm{P}=0.292, \mathrm{~F}=1.336, \mathrm{R}^{2}=0.182\right.$, $)$, but there was a positive correlation between the sedation time and the recovery time of fish anesthetized at $250 \mathrm{mg} / \mathrm{L}\left(\mathrm{P}=0.040, \mathrm{~F}=5.997, \mathrm{R}^{2}=\right.$ 0.428 ,) (Figure 1.5.3).

Fish were assigned an incision score ranging from 0 to 6 ( 0 - completely healed, 6- completely open and infected) every few days to monitor healing rates over the course of the study. No fish was given a score greater than 4 (i.e. partially open and inflamed) throughout the duration of the study. At approximately 8 to 12 days post-op all incisions were in line and closed with some inflammation present, which increased the incision scores for most fish during that time (Figure 1.5.4). At around two weeks post op, all wounds were closed and very little inflammation was observed (Figure 1.5.4). At the end of the study (58-63 days post op), all wounds were completely healed with very minimal scarring and no inflammation (Figure 1.5.3). In addition, sutures were retained long enough for the incisions to heal and at about 2 weeks post op, only 1 fish lost 1 suture. By the end of the study (58-63 days post op) 3 fish lost 1 suture, and 4 fish lost 2 sutures.

This study will be submitted for peer review publication in Segment 33.

| Dose | $\mathbf{N}$ | Sedation Time | Recovery Time | Effective |
| :---: | :---: | :---: | :---: | :---: |
| 200 | 2 | $800 \pm 100(700-900)$ | $31.5 \pm 28.5(3-60)$ | N |
| 210 | 3 | $1110 \pm 105.4(990-1320)$ | $116.7 \pm 68.1(5-240)$ | N |
| 220 | 6 | $1082.5 \pm 93.8(825-1440)$ | $205.8 \pm 60.64(5-450)$ | N |
| 230 | 4 | $1282.5 \pm 181.4(780-1590)$ | $125 \pm 45.7(5-210)$ | N |
| 240 | 8 | $1366.9 \pm 179.0(840-2380)$ | $146 \pm 17.2(82-225)$ | Y |
| 250 | 10 | $926.9 \pm 93.1(660-1680)$ | $244 \pm 51.5(49-488)$ | Y |

Table 1.5.1. Doses ( $\mathrm{mg} / \mathrm{L}$ ) of Aqui-S20E tested, sample size per dose ( N ), average sedation times $\pm$ SE (range) in the knock out tank, recovery times $\pm$ SE (range), and whether (Y/N) that dose was "effective" (i.e. did fish stay sedated for the duration of the surgery transfer/holding period of 5 minutes). Times are reported in seconds.


Figure 1.5.3. Total sedation time versus total recovery time of fish of fish successfully anesthetized with $240 \mathrm{mg} / \mathrm{L}$ (blue dots and line) and $250 \mathrm{mg} / \mathrm{L}$ (orange dots and line) of Aqui-S20E. The equation of the regression line is shown for each dose and the correlation coefficient $\left(\mathbb{R}^{2}\right)$ is also shown next to its corresponding fit.


Figure 1.5.4 Average incision scores over time (with standard errors). 0 indicates that the wound is completely healed with no inflammation, while 5 indicates the wound is open and has moderate to severe inflammation. Surgeries were completed over the course of a several days so the "check" boxes refer to the blocks of time when all fish were scored (i.e. each fish was checked approximately 5 times throughout the study period.). The average incision score is shown above each "check" point.


Figure 1.5.5. Example of the healing process of a sham surgery fish over the duration of the study. At 5 days post-op the incision is in line and closed, little inflammation is present around suture sites, and both sutures are intact. At 58 days post-op, the incision is healed with very minimal scarring, no inflammation, and one suture (bottom one) remains.

## Field Study

In total, 110,532 detections on 20 fish were recorded on the 2018 Vemco VR2 stationary receivers over the course of 5 months. The majority of fish were detected at receivers within the backwater they were tagged (Treadway Lake or Lily Lake). However, movements of two fish were substantially different and indicate that the species may utilize multiple backwaters during a relatively short period of time (Figure 2 and 3).

One individual (Tag \# 1770) moved approximately 13.6 miles between Lily Lake and Treadway over the course of approximately two months. Fish \# 1770 was tagged in Lily Lake on August 26, 2018, and was detected at R16, R15, R14 (in Lily Lake) for about 2 weeks, then entered the main channel of the Illinois River moving upstream (detected at R11 and R10), then entered Treadway Lake and was detected at R5 and R2. The last detection from this individual was on R 2 on November $7^{\text {th }}$ when the receivers were retrieved from the river (Figure 3).

A second fish (Tag \# 1784) moved approximately 12.4 miles between Lily Lake and Treadway Lake over the course of approximately 2 weeks (Figure 1.5.6). This individual was tagged on June 27, 2018 in Lily Lake, moved within Lily Lake (detected at R14, R15, R16, and R18) for 2 days, then entered the main channel and moved upstream into Treadway Lake (detected at R4 and R2). This fish then moved back into the main channel and was detected at R3, R6, and then moved back into Treadway Lake and was detected at R2. The last detection was on R5 on July $8^{\text {th }} 2018$. This fish was not detected on our receiver array after this time, which indicates that it likely moved out of the detection range. Efforts to collect gar detection data on receiver arrays belonging to Illinois state agencies and universities are underway and will be included in our final dataset at the conclusion of this project.

The field study is currently ongoing and detections from 2018 will be combined with 2019 detections for movement analyses in Segment 33.


Figure 1.5.6. Tentative movement path of fish \#1770 indicated by the green line. White circles and R\#'s indicate receivers where detections were recorded. The location where the fish was initially tagged in shown by the yellow pin. Pathways from backwaters to the main channel were based on boat access, therefore connections to the main channel may not represent all possible fish access points.


Figure 1.5.7. Tentative movement path of fish \#1784 indicated by the green line. White circles and R\#'s indicate receivers where detections were recorded. The location where the fish was initially tagged in shown by the yellow pin. Pathways from backwaters to the main channel were based on boat access and, therefore connections to the main channel may not represent all possible fish access points.

## RECOMMENDATIONS

Detailing broad scale movement patterns of Shortnose Gar in response to the changes of abiotic factors (season, flow, temperature, etc.) in the lower Illinois River will help identify critical habitat use throughout the year. In addition, movement range data on this species will allow development of an informed management scale (i.e. local or watershed approach). It is essential that transmitters do not impair or inhibit natural fish movement so data reflects true behavior, and as our pond study suggests, fish healed quickly and were not negatively impacted by the specialized surgical procedure. Preliminary field findings show that Shortnose Gars may utilize multiple backwater areas and likely use the main channel of the river as a highway to move among backwaters. In addition, analysis of the genetic connectivity and hybridization rates of gars within and among populations will allow us to determine the extent of movement throughout the fish's lifespan and assess possible natural or man-made barrier influence.

WILDLIFE TRACS ACTION LEVELS

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

As the popularity and intensity of bowfishing tournaments increases in Illinois, there emerges a need to assess the number and character of these tournaments, as well as quantify the species composition, abundance, and biomass harvest during these bowfishing tournament activity.

## OBJECTIVES

The objective of Experiment 1.6 is to broadly assess the species composition of organized bowfishing tournament harvest in Illinois, with specific focus on the proportion of that harvest comprised of Ancient Sport Fishes.

## PROCEDURES

Bowfishing tournaments held in Illinois in 2017 and 2018 were identified using the Illinois Department of Natural Resources Online Tournament Permitting System and were included in an access-point creel survey ( $\mathrm{N}=16$ ). Participating teams were interviewed during the weigh-in at each tournament to obtain fishing effort and harvest information of the entire team, and information about the habits of a single, representative angler of the team.

During the team interviews, personnel recorded the number of anglers, the start and end times of tournament participation, whether all anglers actively fished for the entirety of the tournament, and the total catch by species for each team. When tournament weigh-in circumstances permitted, creel clerks measured total length (TL mm) and weight ( g ) of all harvested gars due to interest in understanding the exploitation of gars in bowfishing tournaments. To characterize the length distribution of gars in populations exploited by bowfishing tournaments, I utilized sampling information on waterbodies where tournaments were held generated by the IDNR and Illinois Natural History Survey (Table 3.1). These length distributions were compared to length distributions of gars harvested during tournaments using one-sided Mann-Whitney $U$ tests.

Personnel interviewed one self-selected member from each interviewed team to collect data on angler habits. Participants were asked questions about their bowfishing tournament participation, monthly non-tournament bowfishing and rod-and-reel activity, their years of experience bowfishing, and if they used archery for other outdoor recreation.

| Species | Waterbody | Source | Year | Gears | Effort | Count |
| :--- | :--- | :---: | :---: | :---: | :---: | :---: |
| Shortnose Gar | La Grange reach, | INHS | $2017-2018$ | Electrofishing | $1,290 \mathrm{~min}$ | 86 |
| Lepisosteus | Illinois River |  |  | Mini fyke net | 60 net nights | 65 |
| platostomus |  |  |  | Fyke net | 248 net nights | 271 |
|  | Starved Rock \& Peoria | IDNR | $2013-2015$ | Electrofishing | 744 min | 33 |
|  | reaches, Illinois River | INHS | $2016-2017$ | Electrofishing | 180 min | 17 |
| Longnose Gar | Kankakee \& | IDNR | $2013-2015$ | Electrofishing | $3,250 \mathrm{~min}$ | 105 |
| L. osseus | Des Plaines Rivers | INHS | 2016 | Electrofishing | 15 min | 8 |

Table 3.1: Description of sampling data used to create length frequency distributions of gars in each waterbody for comparison with gars harvested at bowfishing tournaments.

## FINDINGS

Personnel conducted creel surveys at 16 tournaments throughout Illinois. A total of 147 teams were interviewed and represented over $75 \%$ of total participating teams. Tournament size ranged from 6-30 participating teams and team size ranged from 1-5 anglers per team. An estimated 576 anglers participated across all surveyed tournaments, ranging from $14-95$ anglers per tournament ( $\bar{x}=38 \pm 6 \mathrm{SE}$, Table 3.4). Estimated fishing effort at surveyed tournaments totaled 4,312.2 angler hours and ranged from $94.0-767.8$ angler hours per tournament ( $\bar{x}=287.5 \pm$ 51.0 SE; Table 3.4).

The estimated total harvest was 5,927 fish, ranging from $87-1,346$ fish per tournament ( $\bar{x}=$ $395.11 \pm 0.11 \mathrm{SE}$ ), and overall harvest rates ranged from $0.74-9.24$ fish per angler hour ( $\bar{x}=$ $1.73 \pm 0.41 \mathrm{SE}$; Table 3.4). In total, 18 species were harvested representing six families, and the number of species harvested per tournament ranged from $1-11(\bar{x}=7 \pm 3 \mathrm{SD})$. Carps accounted for $84 \%$ of all harvested fish, suckers for $11 \%$, gars for $4 \%$, and other species for $1 \%$ (Table 3.5). Overall, invasive species were harvested in higher numbers than native species ( $\chi^{2}=2,703.6$, df $=1, \mathrm{p}<0.01$ ). Based on the estimated number of anglers, estimated angling effort, and estimated fish harvested at 16 of 19 permitted tournaments ( $84.2 \%$ of all tournaments), we estimate that 684 anglers fished 5,121 angler hours and harvested 7,039 fish at bowfishing tournaments in Illinois during the study period.

For both Shortnose and Longnose Gars, IDNR and INHS sampling events collected fish with smaller minimum total lengths than bowfishing tournaments held on the same waterbody. In the La Grange reach of the Illinois River, Shortnose Gar harvested at bowfishing tournaments ( $\mathrm{N}=$ 23; $\bar{x}=627 \pm 17 \mathrm{SE})$ were larger than those captured during standard sampling ( $\mathrm{N}=422 ; \bar{x}=$ $531 \pm 4$ SE; U = 7,770; p < 0.01; Figure 3.5). However, in the Starved Rock and Peoria reaches of the Illinois River, Shortnose Gar harvested at bowfishing tournaments ( $\mathrm{N}=24 ; \bar{x}=580 \pm 12$ SE ) were similar in length to those captured during standard sampling ( $\mathrm{N}=50 ; \bar{x}=538 \pm 16 \mathrm{SE}$; $\mathrm{U}=738 ; \mathrm{p}=0.06$; Figure 3.6). Longnose Gar harvested at bowfishing tournaments ( $\mathrm{N}=42 ; \bar{x}=$ $821 \pm 31$ SE) were considerably larger than Longnose Gars captured during standard sampling ( $\mathrm{N}=113 ; \bar{x}=567 \pm 20 \mathrm{SE}$ ) in the Kankakee and Des Plaines rivers $(\mathrm{U}=3,828 ; \mathrm{p}<0.01$; Figure 3.7).

Across all tournaments, creel clerks conducted 118 angler interviews of the estimated 578 total participating anglers ( $25 \%$ ). When anglers were asked about their three favorite target species, participants reported carps (55\%), suckers (17\%), gars ( $21 \%$ ), other species ( $3 \%$ ) and "anything" (3\%) as favorite targets. More participants harvested carp (99\%) than favored targeting them ( $91 \%$; $\mathrm{p}<0.01$ ), whereas fewer participants harvested gars ( $41 \%$ ) than favored targeting them ( $58 \% ; \mathrm{p}<0.01$ ). No significant differences were found between target species favorability and harvest outcomes for suckers (favor $=44 \%$; harvest $=38 \% ; p=0.70$ ) or the other species group (favor $=8 \%$; harvest $=12 \% ; p=0.40$; Figure 3.13).

|  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ID | $B_{h}$ | $b_{h}$ | $\bar{a} \pm S E$ | $\hat{A}$ | $\bar{e} \pm S E$ | $\hat{E}$ | $\bar{c} \pm S E$ | $\hat{C}$ | $\hat{R} \pm S E$ |
| T1 | 15 | 14 | $2.6 \pm 0.2$ | 40 | $14.9 \pm 1.5$ | 223.2 | $16.4 \pm 2.3$ | 245 | $1.24 \pm 0.20$ |
| T2 | 10 | 5 | $3.0 \pm 0.3$ | 30 | $24.0 \pm 2.5$ | 240.0 | $17.0 \pm 8.8$ | 170 | $0.74 \pm 0.37$ |
| T3 | 30 | 12 | $3.2 \pm 0.3$ | 95 | $22.9 \pm 2.2$ | 687.7 | $21.3 \pm 3.5$ | 638 | $0.95 \pm 0.15$ |
| T4 | 9 | 4 | $4.0 \pm 0.4$ | 36 | $28.8 \pm 4.8$ | 258.8 | $60.5 \pm 27.8$ | 545 | $1.93 \pm 0.59$ |
| T5 | 7 | 4 | $3.3 \pm 0.5$ | 23 | $25.5 \pm 5.5$ | 178.5 | $15.0 \pm 2.3$ | 105 | $0.75 \pm 0.29$ |
| T6 | 9 | 6 | $3.0 \pm 0.3$ | 27 | $29.8 \pm 2.6$ | 268.1 | $47.7 \pm 6.5$ | 429 | $1.66 \pm 0.25$ |
| T7 | 9 | 7 | $3.0 \pm 0.4$ | 27 | $17.5 \pm 3.4$ | 157.8 | $29.7 \pm 6.4$ | 267 | $1.81 \pm 0.30$ |
| T9 | 6 | 6 | $3.5 \pm 0.4$ | 21 | $17.3 \pm 1.6$ | 104.1 | $27.3 \pm 7.2$ | 164 | $1.59 \pm 0.45$ |
| T10 | 7 | 7 | $2.9 \pm 0.3$ | 20 | $19.8 \pm 2.9$ | 138.5 | $19.7 \pm 3.5$ | 138 | $1.17 \pm 0.24$ |
| T11 | 7 | 7 | $2.0 \pm 0.3$ | 14 | $13.4 \pm 2.3$ | 94.0 | $12.4 \pm 1.6$ | 87 | $1.15 \pm 0.28$ |
| T12 | 15 | 15 | $3.3 \pm 0.2$ | 49 | $22.0 \pm 1.3$ | 330.1 | $23.5 \pm 5.7$ | 353 | $1.06 \pm 0.24$ |
| T13 | 8 | 8 | $3.4 \pm 0.2$ | 27 | $32.7 \pm 2.2$ | 261.5 | $28.0 \pm 4.3$ | 224 | $0.91 \pm 0.17$ |
| T14 | 20 | 17 | $2.9 \pm 0.2$ | 58 | $20.5 \pm 1.8$ | 410.2 | $23.9 \pm 3.1$ | 479 | $1.36 \pm 0.24$ |
| T15 | 9 | 9 | $3.3 \pm 0.2$ | 30 | $21.3 \pm 1.9$ | 192.0 | $149.6 \pm 86.6$ | 1,346 | $9.24 \pm 5.88$ |
| T16 | 22 | 16 | $3.6 \pm 0.2$ | 80 | $34.9 \pm 1.4$ | 767.8 | $33.5 \pm 5.0$ | 737 | $1.00 \pm 0.17$ |
| Total | 183 | 137 | $3.1 \pm 0.0$ | $576 \pm 9$ | $23.56 \pm 0.40$ | $4,312.2 \pm 78.3$ | $32.4 \pm 1.2$ | $5,927 \pm 226$ | $1.73 \pm 0.41$ |

Table 3.4: Participation, effort and harvest information from sixteen bowfishing tournaments in Illinois. Creel clerks were unable to collect accurate harvest information at T8, so this tournament was excluded. Columns in the table are as follows: the number of participating teams ( $\boldsymbol{B}_{h}$ ), the number of teams interviewed in the creel survey $\left(\underline{b}_{h}\right)$, the mean number of anglers per team $(\bar{a})$, the estimated number of anglers per tournament $(\widehat{A})$, the mean team fishing effort in angler hours $(\bar{e})$, the estimated total fishing effort in angler hours ( $\widehat{E}$ ), the mean number of harvested fish per team ( $\bar{c}$ ), the estimated number of harvested fish ( $\widehat{C}$ ) and the estimated harvest rate (fish per angler hour ; $\widehat{\boldsymbol{R}}$ ).

|  | $\hat{C} \pm \mathrm{SE}$ | Percent of $\hat{C}$ | $\hat{R} \pm S E^{1}$ | Hours to catch 1 fish |
| :--- | :---: | :---: | :---: | :---: |
| Carp | $4,965 \pm 211$ | 84 | $1.5185 \pm 0.4103$ | $<1$ |
| Silver Carp Hypophthalmichthys molitrix | $3,175 \pm 207$ | 54 | $0.9837 \pm 0.4144$ | $>1$ |
| Common Carp Cyprinus carpio | $1,003 \pm 36$ | 17 | $0.3680 \pm 0.0566$ | $>2$ |
| Bighead Carp H. nobilis | $522 \pm 59$ | 9 | $0.0917 \pm 0.0278$ | $>10$ |
| Grass Carp Ctenopharyngodon idella | $263 \pm 39$ | 4 | $0.0747 \pm 0.0170$ | $>13$ |
| Goldfish Carassius auratus | $1 \pm 0$ | $<1$ | 0.0004 | $>2,363$ |
| Suckers | $651 \pm 44$ | 11 | $0.1344 \pm 0.0240$ | $>7$ |
| Smallmouth Buffalo Ictiobus bubalus | $561 \pm 44$ | 9 | $0.1161 \pm 0.0223$ | $>8$ |
| Silver Redhorse Moxostoma anisurum | $29 \pm 10$ | $<1$ | $0.0051 \pm 0.0030$ | $>197$ |
| River Carpsucker Carpiodes carpio | $19 \pm 4$ | $<1$ | $0.0035 \pm 0.0013$ | $>283$ |
| Golden Redhorse M. erythrurum | $14 \pm 4$ | $<1$ | $0.0029 \pm 0.0015$ | $>339$ |
| Bigmouth Buffalo I. cyprinellus | $13 \pm 2$ | $<1$ | $0.0040 \pm 0.0014$ | $>250$ |
| Quillback Carpiodes cyprinus | $13 \pm 5$ | $<1$ | $0.0025 \pm 0.0012$ | $>399$ |
| Shorthead Redhorse M. macrolepidotum | $2 \pm 1$ | $<1$ | 0.0002 | $>4,110$ |
| Gar | $259 \pm 22$ | 4 | $0.0671 \pm 0.0162$ | $>14$ |
| Shortnose Gar Lepisosteus platostomus | $148 \pm 12$ | 2 | $0.0410 \pm 0.0130$ | $>24$ |
| Longnose Gar L. osseus | $107 \pm 16$ | 2 | $0.0231 \pm 0.0055$ | $>43$ |
| Spotted Gar L. oculatus | $4 \pm 0$ | $<1$ | $0.0030 \pm 0.0022$ | $>333$ |
| Other species | $52 \pm 9$ | 1 | $0.0110 \pm 0.0034$ | $>90$ |
| Freshwater Drum Aplodinotus grunniens | $41 \pm 8$ | 1 | $0.0086 \pm 0.0032$ | $>116$ |
| Gizzard Shad Dorosoma cepedianum | $8 \pm 4$ | $<1$ | $0.0012 \pm 0.0008$ | $>825$ |
| Bowfin Amia calva | $3 \pm 1$ | $<1$ | $0.0012 \pm 0.0007$ | $>832$ |

Table 3.5. Summary of harvest by species and family group across 15 bowfishing tournaments. $\widehat{C}$ is the estimated total harvest at all tournaments, and $\widehat{R}$ is the mean harvest rate (fish per angler hour) of all tournaments.


Figure 3.5: In the La Grange reach of the Illinois River, Shortnose Gar captured at bowfishing tournaments were larger than those captured during sampling events ( $\mathrm{U}=7,770 ; \mathrm{p}<\mathbf{0 . 0 1}$ ). In each panel, the sample size and the mean $\mathrm{TL} \pm \mathrm{SE}$ are given. The bins are left inclusive and right exclusive, and bin labels represent the lower limit. Note that the y-axes differ among panels.


Figure 3.6: The length distributions of Shortnose Gar were similar for those captured at bowfishing tournaments and during sampling events in the Starved Rock and Peoria Reaches of the Illinois River ( $\mathrm{U}=738 ; \mathbf{p}=\mathbf{0 . 0 6}$ ). In each panel, the sample size and the mean $\mathrm{TL} \pm$ SE are given. The bins are left inclusive and right exclusive, and bin labels represent the lower limit.


Figure 3.7: In the Kankakee and Des Plaines Rivers, Longnose Gar captured at bowfishing tournaments were larger than those captured during sampling events $(\mathrm{U}=3,828 ; \mathbf{p}<\mathbf{0 . 0 1})$. In each panel, the sample size and the mean $\mathrm{TL} \pm \mathrm{SE}$ are given. The bins are left inclusive and right exclusive, and bin labels represent the lower limit. Note that the $y$-axes differ among panels.


Figure 3.13: The percentage of tournament bow anglers who favored targeting and whose team harvested at least one fish from the taxonomic groups. The asterisk indicates a Fisher's exact test found significant differences between the favorability and harvest outcome at $\alpha=0.05$.

## RECOMMENDATIONS

Our characterization of bowfishing tournament harvest is the first in Illinois and one of a few in the wider literature. We found that bowfishing harvest is dominated by invasive carp spp. in Illinois and native species comprise a much smaller percentage of total harvest than anticipated. The popularity of certain species among competitive bow anglers is likely influenced by fish body morphology, the fish community composition, and relative abundance. Slender-bodied species, such as gar, may be valued by competitive bow anglers for the skill required to accurately shoot and harvest a smaller target. While gars represented less than $5 \%$ of total bowfishing tournament harvest in Illinois, $58 \%$ of bow anglers reported them among their three favorite target species, suggesting there is substantial interest for a gar fishery in the state. Female gars tend to reach sexual maturity later than and grow larger than males, so competitive bow anglers may disproportionately remove fecund females from the population. Furthermore, the periodic life history strategy of gar spp., characterized by a large adult body size, long life span, late age at maturity, high fecundity and sporadic recruitment, make them susceptible to overfishing.

## WILDLIFE TRACS ACTION LEVELS

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

## RECOMMENDATIONS

Overall, the six experiments outlined above represent a broad, initial approach to understanding the ecology, life history and management of Ancient Sport Fishes. As long term experiments continue into future segments and a better understanding of the management challenges facing the Illinois Department of Natural Resources Division of Fisheries is revealed, new lines of research will likely be the result. For instance, the results of telemetry and genetics studies, in combination with population demographic data will reveal the potential need for regulation on harvest and whether state-wide or site/region-specific approaches are required. Future experiments in this area will require investment in project staff with the skills necessary to put population demographic data to work in models that predict the likely outcomes of various regulatory scenarios. At this time, it is recommended that age and growth, telemetry, genetic, population demographics studies continue into Segments 33 and 34. Investigation of age and growth patterns as well as mark-recapture studies are a part of those demographic analyses, while bowfishing tournament data collection and analysis is now complete; however, a more broad evaluation of the reliability of angler-reported tournament outcomes (Study 4) may be necessary and could include bowfishing tournaments as well as hook and line tournaments in future segments.

## WILDLIFE TRACS ACTION LEVELS

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

## STUDY 2 ANGLING VULNERABILITY

The purpose of this study is to describe the genetic and hormonal control of behaviors and the social learning processes that may determine the propensity of fish to investigate and strike lures. Specifically, the catchability of six groups of genetic crosses (i.e., pure HVB, pure LVB) will be determined in a controlled angling experiment.

## OBJECTIVES

The following components constitute the overall objectives for Study 2:

- Conduct a field experiment to determine the catchability by anglers of experimentally bred lines of largemouth bass by June 30, 2020.


## PROCEDURES

In the spring of 2018, fish were individually marked with a PIT tag and stocked in two replicate ponds to create mixed populations of six genetic crosses. Those crosses were pure high and pure low vulnerability lines (2 groups), high x low F1 and F2 hybrids (2 groups), and low x high F1 and F2 hybrids (2 groups). Beginning in late June 2018, ponds were angled regularly by 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. Angling was suspended in mid-October, both ponds were then drained and all fish enumerated. Fish collected from the drained ponds were measured, fin clips and PIT tags were recorded, and the fish were stocked into two new ponds for overwintering.

In the spring of 2019, ponds holding the fish used in the angling experiment in 2018 were drained, and fish recovered. Two replicate angling ponds were stocked with these same fish in a similar manner as the year prior for a second year of experimental angling. At the end of June 2019, experimental angling was resumed using the same procedures as described above. Angling will continue until late October 2019, weather conditions permitting.

## FINDINGS

Because capture data from both 2018 and 2019 will be combined in the final analysis of angling catchability, no analyses are reported at this time. Analyses are expected in the annual report for Segment 33, deliverable in the fall of 2020.

## RECOMMENDATIONS

Experimental angling should continue until the late fall of 2019 (Segment 33), at which time data collection will conclude and analyses will begin. In next year's Segment 33 report, we expect to be able to synthesize experiments reported in previous segments of this study with the findings of the angling study currently underway, which could lead to recommendations for integrating impacts of fisheries induced evolution into management strategies for largemouth bass. The need for any future studies will be reported at that time.

## WILDLIFE TRACS ACTION LEVELS

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

## STUDY 3 COOL WATER SPORT FISH

This study was developed to understand how the variation in age structure among populations of Walleye, Sauger, and Saugeye throughout Illinois impacts statewide management approaches.

## OBJECTIVES

The following components constitute the overall objectives for Study 3:

- Collect and analyze demographic information for four species of cool water sport fish throughout Illinois to determine population abundance and age structure by June 30, 2020.


## PROCEDURES

In collaboration with IL DNR annual fish surveys, Walleye, Sauger, and Saugeye data were collected in Clinton, Weldon Springs, Dawson, Bloomington, Shelbyville, Decatur, Paradise, Charleston Side Channel, Mattoon, and Evergreen lakes using fyke nets or DCEF from 2015 through 2019. 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.

Dorsal fin spines were processed following the methods of Koch and Neely (2017) to estimate age. The fin rays were cleaned of excess tissue and the most proximal end was sanded with 600 grit sandpaper, ensuring a readable cross-section for subsequent aging. The cross-sections of the fin rays were then illuminated by a fiber optic light and examined under a dissection microscope. Mineral oil was used to reduce glare during age estimation. Otoliths were cleaned of excess tissue then set in epoxy resin molds. Once the epoxy dried for at least 24 hours, the focus of the nucleus was isolated by making two transverse cuts with a Buhler Isomet Low Speed Saw to remove the anterior and posterior ends. The remaining transverse section that included the focus was adhered to a microscope slide using superglue and then sanded with 600 grit sandpaper to view annuli under a dissection microscope. Otoliths will be processed in the next segment and age estimates will be compared to dorsal fin rays.

A subsample of dorsal fin rays from Saugeye were aged independently by two readers. When age estimates did not agree, the two readers came together to agree upon a consensus age for each fish. Coefficient of variation ( $\mathrm{CV}=100 \times \mathrm{SD} /$ mean ), percent agreement, and age bias between readers were calculated to determine the precision of age estimates between readers.

Personnel will continue to collect cool water sport fish data in collaboration with IL DNR and process calcified structures for age estimation in the next segment.

## FINDINGS

In total, 13 Sauger, 185 Walleye, and 664 Saugeye were sampled among 10 lakes from 2015 to present (Table 3.1). Sauger measured between 286 and 506 mm , with an average of $356.8 \pm 21.2$ mm (Figure 3.1) and weighed between 192 and 1325 grams. Walleye ranged from 152 to 708 mm , averaging $449.1 \pm 9.1 \mathrm{~mm}$ in length (Figure 1) and weighed 25 to 4204 grams. Saugeye lengths ranged from 176 to 682 mm , with an average of $459.7 \pm 3.7 \mathrm{~mm}$ (Figure 3.1) and weights ranged from 36 to 4010 grams.

|  | Sauger | Walleye | Saugeye | Total |
| :---: | :---: | :---: | :---: | :---: |
| 2015 |  | 1 | 184 | 185 |
| Dawson |  | 1 | 93 | 94 |
| Evergreen |  |  | 64 | 64 |
| 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 |  | 87 | 325 | 412 |
| Charleston Side Channel |  |  | 12 | 12 |
| Dawson |  |  | 118 | 118 |
| Evergreen |  |  | 118 | 118 |
| Lake Bloomington |  | 87 |  | 87 |
| Weldon Springs |  |  | 77 | 77 |
| Total | 13 | 185 | 664 | 862 |

Table 3.1: Total counts of Sauger, Walleye, and Saugeye sampled in each lake from 2015 to 2019.


Figure 3.1: Length frequency histogram of Sauger $(n=13)$, Walleye $(n=185)$, and Saugeye $(n=664)$, respectively. Note: Frequency axes vary in scale.

Of the total 862 fish, 331 were sacrificed and taken to the lab for otolith extraction, collection of tissue samples, and gonad extraction. These data will be processed in the next segment.

Thus far 294 (out of 862) Saugeye dorsal rays have been processed and aged by two readers. A total of 92 were collected from Dawson Lake, 144 from Evergreen Lake, and 58 from Weldon Springs Lake. The majority of fish in our sample were age 2 (37.0\%) and 3 (22.1\%) (Figure 3.2). The average age of Saugeye was similar among lakes; the average age of fish from Evergreen Lake was $3.1 \pm 0.1$ years old, fish from Dawson Lake was $2.7 \pm 0.1$ years old, and fish from Weldon Springs were $3.5 \pm 0.2$ years old (Figure 3.2).


Figure 3.2: Age frequency histograms of Saugeye $(n=294)$ collected in Evergreen Lake $(n=144)$, Dawson Lake ( $n=92$ ), and Weldon Springs Lake $(\mathrm{n}=58)$ from 2015-2019.

The coefficient of variation among readers was relatively poor (CV = 17\%; Campana (2001) recommends a target CV value of $\leq 5 \%$ ), likely because reader 1 overestimated the age of fish relative to reader 2 for a majority of the samples (Figure 3.3). While readers agreed on ages for only half the fish ( $50.68 \%$ agreement), percent agreement with a one-year was $82.37 \%$ and agreement with two years reached $94.58 \%$ (Figure 3.3).


Figure 3.3: Age bias plot between two readers for age estimates of Saugeye ( $\mathrm{n}=294$ ). Larger bubble size indicates higher frequency of that age combination. Precision measurements are also show in the plot ( $\mathrm{CV}=$ the coefficient of variation, PA = percent agreement, and $1 \mathbf{y r}=$ percent agreement within one year).

## RECOMMENDATIONS

Regular assessment of population dynamics (i.e. age-related metrics, size structure, and body condition) will allow managers to monitor fish populations and ensure a sustainable and healthy fishery for Sauger, Walleye, and Saugeye throughout Illinois. Age determination of individuals within a population paired with surveys of catches will inform regulatory and management decisions to provide sustainable long-term sport fishing opportunities to the public. Data collection and calcified structure processing is ongoing and will continue into Segment 33.

## WILDLIFE TRACS ACTION LEVELS

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

## STUDY 4 SAMPLING DESIGN

The purpose of this Study is to determine the feasibility of a statewide evaluation of fixed site sampling designs for Illinois inland lakes and 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 on up to six inland lakes throughout Illinois by June 30, 2020.


## PROCEDURES

Methods for obtaining habitat characteristics and lake morphology were developed and implemented at Homer Lake. A transducer was mounted on the bow of the boat with an adjustable arm following methods from Kaeser and Litts (2013) and a Humminbird Helix 10 unit was used to collect side-scanned sonar video of aquatic habitat and morphological features.

Prior to data collection at Homer Lake, tentative track paths for the lake were constructed in ArcMap (Figure 4.1) and exported to the Humminbird unit via SD card. It is recommended that the images produced by the side scan sonar overlap about $30 \%$ (Collier and Humber, 2007) for complete coverage of the lake bed. Therefore, having pre-mapped the boat track was essential to accurate and quality data collection. The pre-made tracks could instantly be viewed on the Humminbird unit and easily followed by the captain of the boat once a recording started. After testing different ranges ( $50 \mathrm{ft}, 100 \mathrm{ft}$, and 150 ft ), frequencies $(455 \mathrm{kHz}, 800 \mathrm{kHz}$, and Mega CHIRP), and transducer depths ( 12.7 cm and 25.4 cm ), we determined that the best settings for this project were to set a range of 150 ft , the frequency at Mega CHIRP (highest resolution), and the transducer depth at approximately 25.4 cm below the water level. These settings provided us with the largest range and best quality images for the objectives of this project. Sonar recordings were exported from the Humminbird unit to an SD card at the end of each field day.

The recorded field data was downloaded onto a computer and viewed using HumminbirdPC, HumViewer, and SonarTRX softwares. Using these programs, the sonar recordings can be turned into georeferenced images, which are easily exportable to Google Earth (Figure 1). Here, the underwater aquatic sonar images can be examined to differentiate between habitat type (ex. sand, cobble, vegetation, woody debris). In addition, these data will allow us to map the morphology of the lake and provide detailed depth profiles that will provide baseline information to select fixed and random fish sampling locations for IL DNR annual surveys.

## FINDINGS

Habitat images and morphological profiles for Homer Lake are currently being analyzed by project personnel. Side scan mapping and habitat analysis will continue into Segment 33 to aid in the development of fixed and random site selection for inland lakes.


Figure 4.1. (Left) Tentative boat tracks made in ArcMap for Homer Lake based on a 50ft (30\%) side scan image overlap. (Right) Raw side scan imaging on Homer Lake inputted to Google Earth via SonarTRX. Note: The tentative tracks made on the upper portion of the lake were in shallow water that was not accessible by boat.

## RECOMMENDATIONS

The evaluation of habitat types in inland lakes will aid in the development of fixed/random sampling designs that will lead to valuable datasets for estimation of fish population demographics. Fixed and random sampling designs for inland lakes will increase the accuracy and precision of population estimates and improve sport fish management. Habitat and morphological data is currently being collected and analyzed and will continue into the next segment.

## WILDLIFE TRACS ACTION LEVELS

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

## STUDY 5 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 and integrated approach to information management.

OBJECTIVES
The following components constitute the overall objectives for Study 5:

- Develop and maintain four integrated sport fisheries data sets available to researchers, sport fish managers, and the angling public by June 30, 2019.


## 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. Existing information about fish stocking has been 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. As new data management systems are integrated and brought online, additions of annual data sets have been delayed until final importation of data into new systems, which occurred in Segment 32.

For Segment 32, database development, web application interface, user workflow control, and historical data quality control and importation was executed for the I Fish Data Portal. The I Fish Data Portal integrated the Hatchery Information Management System developed under this project in previous segments as well as METRICS, the data entry and analysis package for fisheries data currently in use by the IDNR Division of Fisheries. The Tournament Permit Information System continues to be maintained by Project personnel as a separate web application integrated with the I Fish Illinois website. Historical creel survey data remains held in archive until future segments when new web interface development is completed and creel data is imported into the integrated data management solution.

## FINDINGS

## I Fish Data Portal

In coordination with Illinois Division of Fisheries Hatchery Program, project personnel developed a new online web application that provides for data entry and extraction and facilitates analysis in of fish stocking activities and fisheries assessment data.

First, statewide hatchery operations and fish stocking activities are planned, tracked and recorded with the Data Portal and are supported by relational databases. Features include:

- Hatchery production request and approval process
- Production plan development and prioritization of requests
- Creation of printable stocking cards for field data entry
- Data entry for stocking events
- Full historical record of all stocking events in Illinois (1993 - present)
- Sorting, filtering and export features for data use

The hatchery component of the Data Portal will replace the Hatchery Information Management System (HIMS) previously developed under this project.

Second, all fish population sampling data conducted by IDNR Division of Fisheries is currently managed within METRICS, a client-based executable program that operates on a PC platform only and accesses data from a pair of flat text files. To modernize the technological approach to data management, improve data security and integrity, offer enhanced features, and provide for an improved user experience, a new web application was developed that is supported by a serverbased relational database. Features include:

- Hierarchical data organization to support efficient data 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 will replace METRICS, previous developed under this project.

## Portal Development Process and Status

In the previous segment (Segment 31), project personnel held several workshops with IDNR field staff to gather input on portal design and desired functionality. During Segment 32, project personnel held numerous planning meetings and provided regular status updates to IDNR project managers. In January 2019, project personnel presented a status report to the IDNR Division of Fisheries leadership team, followed by a preview session held in March 2019 with a select group of field staff. These meetings resulted in a large number of design changes, feature additions, and workflow improvements that were prioritized and executed during the remainder of the segment and into the beginning of Segment 33. Over 200 changes were tracked and completed during this time period, setting the stage for a Fall 2019 launch date. Live, in-person training sessions are scheduled for July through September as final modifications to the system are made. Launch is scheduled for September 16, 2019.

Project personnel manages all phases of the online Tournament Permit Information System for handling both tournament applications by anglers and online tournament approval by IDNR biologists and site supervisors. This system enables tournament organizers to apply for all tournaments online and have a listing of all their online 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, and have access to all catch data self-reported by tournament organizers to inform the management of Illinois fishery resources.

For the calendar year of 2018, 2959 tournament applications were received with 2614 approved, 391 ( $15 \%$ of those approved) were cancelled due to lack of participation ( $28 \%$ ), duplication ( $16 \%$ ), weather ( $32 \%$ ), and other issues such as application for the wrong date, illness, water temp, etc. A full report for 2018 was provided to the IDNR Division of Fisheries and included such information as number of tournaments by waterbody and catch data by species.

Thus far in 2019, 2989 tournament applications have been submitted with 2494 approved. Of those approved there were 283 cancellations, with the majority of reasons listed below:

- Duplicate application (11\%)
- Weather (27\%)
- Lack of participation (33\%)

Given the data of applications versus cancellations, each year Illinois hosts an average of 2500 fishing tournaments. 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 also sent periodically to tournament directors if they have been asked to resubmit a tournament application and have not done so. 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 113 waterbodies that held tournaments in 2018, and of those, 104 were largemouth bass tournaments. While most tournaments are hook and line, there were 12 bowfishing tournaments held in 2018 and 12 bowfishing tournaments held to date in 2019.

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 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 bag weights for largemouth bass recorded for the calendar year.

## 2018 Channel Catfish Tournaments

| Waterbody | Number of <br> Tournaments | Number <br> of Fish | Total <br> Weight (lbs) |
| :--- | :---: | :---: | :---: |
| Braidwood Lake | 1 | 0 | 6 |
| Clinton Lake | 9 | 2309 | 613 |
| Fox River | 6 | 939 | 119 |
| Illinois River | 22 | 10032 | 1737 |
| Iroquois River | 1 | 351 | 59 |
| Kankakee River | 1 | 210 | 35 |
| Mattoon, Lake | 12 | 1576 | 326 |
| Mississippi River | 4 | 1225 | 230 |
| Rend Lake | 2 | 398 | 118 |
| Rock River | 7 | 2343 | 346 |
| Sangchris, Lake | 2 | 190 | 33 |
| Shelbyville, Lake | 1 | 14 | 1 |
| Springfield Lake | 7 | 7255 | 1417 |
| Vandalia Lake | 1 | 803 | 245 |
| Wabash River |  | 76 | 17 |

Table 5.1. Summary of catfish species tournaments for 2018 indicating waterbody, number of tournaments, total number of catfish caught and the total weight of catfish caught.

## 2018 Crappie Tournaments

| Waterbody | Number of <br> Tournaments | Number <br> of Fish | Total <br> Weight <br> (lbs) |
| :--- | :---: | :---: | :---: |
| Banner Marsh Johnson Lake | 2 | 0 | 0 |
| Carlton, Lake | 1 | 35 | 0 |
| Clinton Lake | 6 | 465 | 272 |
| Crab Orchard Lake | 1 | 70 | 47 |
| Decatur, Lake | 4 | 417 | 380 |
| Dolan Lake | 1 | 44 | 27 |
| Evergreen Lake | 2 | 95 | 72 |
| Heidecke Lake | 2 | 6 | 5 |
| Hennepin Canal | 2 | 5 | 2 |
| Illinois River | 4 | 23 | 21 |
| Jacksonville, Lake | 1 | 140 | 70 |
| Kankakee River | 5 | 22 | 13 |
| Kinkaid Lake | 1 | 468 | 331 |
| Mill Creek Lake | 1 | 92 | 53 |
| Mississippi River | 1 | 6 | 7 |
| Ohio River-Smithland Pool | 4 | 198 | 160 |
| Rend Lake | 2 | 106 | 108 |
| Sangchris, Lake | 2 | 250 | 105 |
| Sara, Lake | 11 | 2283 | 1824 |
| Shelbyville, Lake | 2 | 56 | 24 |
| Spring Lake (North) |  |  |  |

Table 5.2. Summary of crappie species tournaments for 2018 indicating waterbody, number of tournaments, total number of crappie caught and the total weight of crappie caught.

## 2018 Largemouth Bass Tournaments

| Waterbody | Number of Tournaments | Number of Fish | Total Weight (lbs) |
| :---: | :---: | :---: | :---: |
| Argyle Lake | 2 | 19 | 34 |
| Banner Marsh Johnson Lake | 21 | 563 | 1251 |
| Banner Marsh Shovel Lake | 9 | 133 | 328 |
| Banner Marsh Wheel Lake | 13 | 260 | 57450 |
| Benton City Lake | 6 | 201 | 2889 |
| Bloomington, Lake | 16 | 358 | 8623 |
| Borah Lake | 22 | 507 | 966 |
| Braidwood Lake | 23 | 1461 | 3528 |
| Cal-Sag Canal, Calumet River, Lake Calumet, Lake Michigan, Little Calumet River | 10 | 266 | 502 |
| Cal-Sag Canal, Calumet River, Lake Calumet, Little Calumet River | 19 | 417 | 784 |
| Canton Lake | 6 | 177 | 313 |
| Canton Park District Lake \#1 | 1 | 35 | 55 |
| Carbondale City Reservoir | 1 | 15 | 25 |
| Carlyle Lake | 7 | 111 | 207 |
| Cedar Lake | 55 | 2734 | 4645 |
| Centralia, Lake | 28 | 595 | 1588 |
| Charleston Side Channel | 5 | 72 | 1612 |
| Clinton Lake | 74 | 2618 | 7294 |
| Coffeen Lake | 54 | 3173 | 8333 |
| Crab Orchard Lake | 34 | 857 | 2547 |
| Dawson Lake | 15 | 403 | 562 |
| Decatur, Lake | 17 | 346 | 738 |
| Des Plaines/Kankakee | 39 | 1602 | 2485 |
| Devils Kitchen Lake | 6 | 490 | 478 |
| Dolan Lake | 1 | 4 | 16 |
| Du Quoin City Lake | 12 | 476 | 838 |
| Dutchman Lake | 1 | 18 | 73 |
| East Fork Lake | 59 | 1919 | 4371 |
| East Lake - World Shooting Complex | 1 | 16 | 58 |
| Embarras River | 11 | 133 | 186 |
| Evergreen Lake | 24 | 710 | 1700 |
| Forbes Lake | 57 | 929 | 1353 |
| Fox Chain -- Channel Lake | 7 | 821 | 2013 |


| Fox Chain -- Grass Lake | 28 | 1859 | 4270 |
| :---: | :---: | :---: | :---: |
| Fox Chain -- Pistakee Lake | 22 | 510 | 988 |
| Fox River | 6 | 194 | 438 |
| Fulton County Camping Lake \#3 | 3 | 67 | 61 |
| Gillespie New City Lake | 4 | 42 | 97 |
| Glenn Shoals Lake | 9 | 311 | 837 |
| Governor Bond Lake | 29 | 230 | 637 |
| Harrisburg City Lake | 8 | 276 | 446 |
| Heidecke Lake | 5 | 41 | 41 |
| Hennepin Canal | 4 | 88 | 177 |
| Illinois River | 22 | 232 | 351 |
| Jacksonville, Lake | 49 | 1881 | 2618 |
| Kankakee River | 3 | 27 | 64 |
| Kaskaskia River | 6 | 49 | 67 |
| Kinkaid Lake | 75 | 2127 | 5824 |
| Lake Nellie | 4 | 40 | 86 |
| Lake Vermilion | 35 | 880 | 2250 |
| Lincoln Trail Lake | 4 | 72 | 76 |
| Little Grassy | 15 | 544 | 742 |
| Lou Yaeger Lake | 4 | 59 | 143 |
| Marion City Lake | 5 | 127 | 187 |
| Mattoon, Lake | 44 | 808 | 1686 |
| Mazonia Lakes | 17 | 413 | 738 |
| Mccleansboro City Lake | 1 | 20 | 49 |
| Mcmaster, Lake (Snakeden Hollow) | 2 | 132 | 43 |
| Mermet State Lake | 10 | 166 | 510 |
| Mill Creek Lake | 65 | 3414 | 5359 |
| Mingo, Lake | 3 | 13 | 22 |
| Mississippi River | 48 | 2967 | 7219 |
| Murphysboro, Lake | 14 | 294 | 700 |
| Newton Lake | 71 | 1446 | 4823 |
| Ohio River | 1 | 22 | 35 |
| Ohio River-Smithland Pool | 32 | 1408 | 2268 |
| Otter Lake | 22 | 634 | 1728 |
| Pana Lake | 14 | 207 | 458 |
| Paradise, Lake | 2 | 34 | 77 |
| Paris Lake East | 34 | 537 | 1052 |
| Paris Lake West | 2 | 18 | 36 |
| Pierce Lake | 1 | 27 | 0 |
| Pinckneyville City Lake | 3 | 20 | 70 |
| Pittsfield Lake | 5 | 97 | 214 |


| Powerton Lake | 1 | 2 | 0 |
| :--- | :---: | :---: | :---: |
| Prairie Lake - Jim Edgar Panther Creek | 36 | 657 | 1502 |
| Prk - Beaver Lake | 1 | 27 | 0 |
| Pyramid- Captain-Super Lake | 6 | 137 | 186 |
| Raccoon Lake | 1 | 22 | 66 |
| Randolph County Lake | 1 | 4 | 10 |
| Rend Lake | 77 | 3382 | 8449 |
| Rock River | 2 | 10 | 0 |
| Sam Dale Lake | 8 | 141 | 293 |
| Sam Parr Lake | 32 | 396 | 874 |
| Sangchris, Lake | 69 | 3069 | 8224 |
| Sara, Lake | 34 | 1812 | 2849 |
| Schuy-Rush Lake | 14 | 379 | 717 |
| Shabbona Lake | 3 | 56 | 115. |
| Shelbyville, Lake | 68 | 3374 | 7463 |
| Siloam Springs | 1 | 39 | 30 |
| Spring Lake - Macomb | 15 | 2 | 5 |
| Spring Lake (North And South) | 3 | 577 | 1330 |
| Spring Lake (North) | 3 | 119 | 138 |
| Spring Lake (South) | 77 | 2903 | 6064 |
| Springfield Lake | 1 | 28 | 41 |
| Storey, Lake | 7 | 85 | 194 |
| Taylorville, Lake | 35 | 556 | 1234 |
| Vandalia Lake | 5 | 144 | 81 |
| Vermilion River (Illinois) | 1 | 1 | 0 |
| Vermilion River (North Fork) | 1 | 23 | 19 |
| Walnut Point Lake | 18 | 524 | 1066 |
| Washington Co. Lake | 4 | 40 | 107 |
| Waverly Lake | 57 | 132 |  |
| West Frankfort New City | 25 | 49 |  |
| West Frankfort Old City |  |  |  |
|  |  | 2 | 78 |

Table 5.3. Summary of Largemouth Bass species tournaments for 2018 indicating waterbody, number of tournaments, total number of Largemouth Bass caught and the total weight of Largemouth Bass caught.

## RECOMMENDATIONS

Completion of what has come to be known as Phase 1 of the I Fish Data Portal should result in a go-live launch in mid-September. Following that launch, users will be expected to enter all future hatchery and fish assessment data in the Portal, and both HIMS and METRICS will be fully retired. Concurrent with that launch, planning and scoping for minor post-launch improvements ("Phase 1.5 ") and the addition of substantially new features and modifications (Phase 2) should occur in the first quarter of Segment 33. Analytical tools, incorporation of Lake Michigan program datasets, and developing policies and procedures for fielding data requests from outside users and, in some cases, granting limited access to data analytics in the system should all be considered carefully. Most importantly, these items must be carefully prioritized and reconciled with the resources made available through this project. Previous delays in the development of 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.

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

## STUDY 6 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 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 the website www.ifishillinois.org and related social media content for the dissemination information regarding sport fishing opportunities in Illinois, fisheries data and analyses, and state-of-the-art practices that promote the long-term sustainability of fisheries resources in Illinois 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 mostvisited lakes, as well as access points, ramps and major roads; fishing forecasts as provided by IDNR biologists; Family Friendly and bankfishing 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.

In 2017, the Illinois Department of Natural Resources modified its website so that all Illinois fishing information would be directed 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

Improvements and Additions to www.ifishillinois.org
LAKE PROFILE PAGES

Over 120 lake and river profile pages updates were received during this segment, 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 include a map that is expandable when clicked upon (for all lakes for which maps were available from Illinois Department of Natural Resources).

Many lake profile pages also include a "fishing forecast," which integrates information provided by Illinois Department of Natural Resources fisheries biologists, including fishing tips. Current fishing reports are embedded on these pages for easy access by anglers. In addition and when available, a section for "fish attractors" has been made available for anglers to easily know the location of 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. Additional lakes were added to the www.ifishillinois.org website in this segment, bringing the number of Illinois lakes and reservoirs on the site to 320 and 18 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 3449 emails through our Contact Us page (an average of 10/day) from Illinois anglers, all of which are answered within 24 hours. Questions 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

## Buy a Fishing License

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 38,741 times. On Friday, April 5, 2019, the night before the trout spring season opener, that link was clicked 737 times; $16 \%$ of those click-throughs come from the Chicago area.

## 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.

## 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 8198 "likes" on Facebook (a $19 \%$ increase over last segment) and 542 Twitter followers (an $8 \%$ increase).

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, 2018 - June 30, 2019, ifishillinois org had 637,609 sessions ( $9 \%$ increase); 406,283 users ( $7.5 \%$ increase); and a total of 1,598,529 pages viewed.
- The site averages 2525 visitors each day from April - June.
- Each visitor views an average of 3 pages per visit.
- $74 \%$ of our users are from Illinois (the next highest number of users is from Missouri at $6 \%$ and Indiana with $3 \%$ ).
- $56 \%$ are mobile (compared to $52 \%$ last segment).


## TOP-VISITED PAGES

- The Lake Profile Selector Page is the most-visited page, followed by the Weekly Fishing Report page.
- The Trout Stocking page is our $3^{\text {rd }}$ most popular page with 38,349 visitors.
- Not surprisingly, the $4^{\text {th }}$ most-visited page is the Tournament Information System.
- Also among the top pages: Sport Fish of Illinois and bank fishing.
- Our top 10 most visited waters (in order of popularity): Lake Shelbyville, Lake Clinton, Fox River, Braidwood Lake, Rend Lake, Kinkaid Lake, Fox Chain O’ Lakes, Evergreen Lake, Heidecke Lake, Busse Lake and Carlyle Lake.
- The Kids Fishing pages continue to be in the top 10 most-visited pages on our site.


## PDF DOWNLOADS

- The fishing regulations guide was downloaded 13,050 times.
- The fish dealer listing continues to be popular as it was downloaded 1800 times.


## RECOMMENDATIONS

Overall, the IFishIllinois website is very popular among Illinois anglers. Project personnel will continue work in Segment 33 to promote timely information to Illinois anglers. As the budget allows, project personnel are working on a comprehensive dynamic map of the entire state of Illinois clearly identifying site-specific areas, which are then linked to the lake profile pages for each water body.

The Kid's Fishing section of IFishIllinois continually ranks in the top 10 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 has 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. More than half 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.

Project personnel will continue to use Facebook and Twitter to provide timely sport fish information to the public. Project personnel will continue branding IFishlllinois 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. Integration of the Hatcheries Information Management System and the Fisheries Information Management Systems under Study 5 will support real-time summary data to anglers regarding the quality of sport fishing in Illinois and the management practices employed to maintain high-quality angling opportunities in the state.

## WILDLIFE TRACS ACTION LEVELS

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


Posts that feature IDNR fish stockings and fieldwork continue to promote specific lakes and species while demonstrating the good work of our IDNR Fisheries Biologists.

Posts with big catches continue to be extremely popular while promoting fishing in Illinois.
Figure 6.1: 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 6.2: Overview of the number of daily visits to the www.ifishillinois.org during Segment 31 (July 1, 2018 - June 30, 2019).

## List of Peer-Reviewed Publications Generated by Project F-69-R-32

King, S.M., David, S.R., Stein, J.A. 2018. Relative bias and precision of age estimates among calcified structures of Spotted Gar Lepisosteus oculatus, Shortnose Gar Lepisosteus platostomus, and Longnose Gar Lepisosteus osseus. Transactions American Fisheries Society 147(4): 626-638.

Landsman, S., Stein, J.A., Whitledge, G. and Robillard, S.R. 2017. Stable oxygen isotope analysis confirms natural recruitment of Lake Michigan-origin lake trout (Salvelinus namaycush) to the adult life stage. Fisheries Research 190: 15-23.

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., Jeffrey, J.D., Suski, C.D., and Stein, J.A. 2018. Sociable bluegill, Lepomis macrochirus, are selectively captured via recreational angling. Animal Behaviour 142: 129137.

Louison, M.J., Stein, J.A., and Suski, C.D., 2018. Metabolic phenotype is not associated with vulnerability to angling in bluegill sunfish (Lepomis macrochirus). Canadian Journal of Zoology 96(11): 1264-1271.

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.

Patterson, K.A., Stein, J.A. and Robillard, S.R. 2016. Progress toward lake trout rehabilitation at a stocked and unstocked reef in southern Lake Michigan. North American Journal of Fisheries Management 36(6): 1405-1415.

Stein, J.A., King, S.M., Buckmeier, D.L., Smith, N.G. 2018. Comment: The Challenge of Age Estimation in Gars Lepisosteus spp. Transactions American Fisheries Society 147(4): 649652.

Winter, H.N., Louison, M.J., Stein, J.A., and Suski, C.D., 2018. Metabolic response of bluegill to exercise at low water temperature: implications for angling conservation. Environmental Biology of Fishes 101(12): 1657-1667.

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Davis, M. W., 2010. Fish stress and mortality can be predicted using reflex impairment. Fish Fisheries 11: 1-11.

Lennox, R.J., Diserud, O.H., Cooke, S.J., Thorstad, E.B., Whoriskey, F.G., Solem, Ø., Havn, T.B., Uglem, I., 2016. Influence of gear switching on recapture of Atlantic salmon ( Salmo salar ) in catch-and-release fisheries. Ecol. Freshw. Fish 25, 422-428. doi:10.1111/eff. 12223

Midwood, J. D., Reddick, D.T., Brooks J.L., Boston, C., Doka, S.E. Cooke, S. J. 2018 Intracoelomic implantation of transmitters in Longnose Gar. Transactions of the American Fisheries Society Special Section: Angling for Dinosaurs.

