ILLINOIS NATURAL
HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

Research and Analysis of Fisheries in Illinois

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Final Performance Report
1 July 2014 – 30 June 2015

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F-69-R (28)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Fisheries managers are charged with understanding the interaction between sport fish populations and anglers to inform resource management decision making that support and promote 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 three overall goals: (1) conduct a wide variety of investigations that elucidate patterns of variation in sport fish populations and the mechanisms that drive those patterns, (2) communicate research findings and basic assessments of sport fish populations to the angling public, and (3) 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.

Research studies completed in Segment 28 were executed under Job 101.1, Job 101.3, Job 101.6, and Job 101.7. Summarized below, these studies were focused on four areas of sport fish restoration and management.

First, the Fishing Quality Index (FQI) scoring model for largemouth bass (*Micropterus salmoides*) was used to determine biological factors that determine angler satisfaction under Job 101.1 utilizing 20 years of existing creel survey data (collected during previous segments of Project F-69-R) and fisheries-independent samples of sport fish populations throughout Illinois.

Second, an entire series of experiments studying the effects of catch-and-release angling are underway under Job 101.3, examining such aspects of recreation fishing as lure recognition ability (Experiment 3.13), inter-annual nest site fidelity (Experiment 3.4), and management approaches to mitigating the negative impacts of angling nexting black bass (Experiment 3.12). Additinoally, several studies were initiated studying the behavioral, physiological, and genetic factors that determine catchability of Largemouth Bass (Experiments 3.14, 3.15, 3.16).

Third, field sampling and data analysis in support of the next iteration of "Fishes of Champaign County" was completed under Job 101.6.

Fourth, the development of field-based studies examining the effects of urban stream restoration on fish communities, with special emphasis on a smallmouth bass (*Micropterus dolomieu*) urban sport fishery in the Chicago metropolitan area was continued in Job 101.7.

Outreach activities under Job 101.5 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 Job 101.5 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.

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. Through collaborations with the Illinois Department of Natural Resources, Project F-69-R provides additional resources needed to efficiently collect and manage data that reflects that 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.

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.

JOB 101.1 SPORT FISH POPULATION AND SPORT FISHING METRIC

Utilizing findings from previous segments, project staff have completed evaluations of population-level angling satisfaction for largemouth bass anglers, and have demonstrated a significant relationship between fall electrofishing catch rate and angler satisfaction the following season. Further, data show that **angler catch rates are an obvious driver of angler satisfaction, and that angler catch rate is best predicted by fall electrofishing catch rates of largemouth bass that are 20 – 30 cm in length**. These findings indicate that managers can focus on strategies that increase abundance of largemouth bass in that size range to increase angler satisfaction.

JOB 101.2 ENHANCED FIELD SAMPLING OF SPORT FISH POPULATIONS

Project F-69-R has awarded several undergraduate students majoring in fisheries management (or related fields) the opportunity to participate in enhanced field sampling activities during the summer months. Interns worked directly with IDNR Division of Fisheries to conduct sampling of stream fish assemblages**, logging over 1300 hours sampling** the Vermilion River (Illinois River Drainage), Hennepin Canal, Green River, Mississippi South Central tributaries, middle Illinois River tributaries, Iroquois River Basin, Mackinaw River Basin, and Central Mississippi tributaries. This collaboration results in an increased number of sites sampled and promotes the sharing of data in support of research studies under this and other Federal Aid projects.

JOB 101.3 DETERMINE FACTORS AFFECTING FISHING QUALITY

In the current segment, project personnel conducted investigations examining **processes that determine reproductive success in black bass**; investigated **factors that affect catchability of sport fish** using largemouth bass as a model species; surveyed and evaluated **factors affecting Lake Michigan sport fish**, with a particular focus on Lake Trout; and utilized Sport Fish Data Sets to understand **long term changes in stream fish communities** in Illinois. These experiments showed that there is a direct, positive relationship between the number of reproductively successful nests within populations of largemouth and smallmouth bass and recruitment to age 1+ the following season (Experiments 3.3, 3.4, 3.5, 3.9, 3.11, 3.12). Through a combination of field studies and experiments using bred lines of largemouth bass selected for high and low vulnerability to angling, we are revealing both mechanistic and evolutionary impacts of fishing on fish physiology and behavior (Experiments 3.13, 3.14, 3.15, 3.16). Working with the Division of Fisheries Lake Michigan Program, we have focused efforts on surveys and inventories (Experiment 3.18 and 3.19), as well as utilizing long term data (Experiment 3.17, 3.20) to better understand trends in Lake Trout in southern Lake Michigan, particularly in light that rates of natural reproduction are on the rise. Lastly, project personnel have utilized long term data to demonstrate changes in stream fish communities (Experiment 3.10) and have projected changes in species distributions in response to climate change (Experiment 3.21).

JOB 101.4 INFORMATION MANAGEMENT SYSTEMS SUPPORTING ONGOING FISHERIES RESEARCH

Access to fisheries data sets and the efficient and coordinated management of those data sets are critical to the successful completion of all aspects of Project F-69-R. 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 are **developing online data browsing tools** for use by project personnel to support activities in Job 101.1, Job 101.2, Job 101.3, Job 101.5, Job 101.6, and Job 101.7. 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.

JOB 101.5 SUPPORT AND ENHANCE WEB INTERFACE

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 Facebook and Twitter accounts are a vital part of interacting with the angling public.** Illinois anglers typically submit 10 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 brand**, which is tightly aligned with IDNR 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 28, the **website had 282,333 visitors, with a total of 1,434,093 pages** viewed, indicating a strong public interest in the information provided about fishing opportunities in Illinois. Addition of **the "Buy a Fishing License" button has generated 11,047 visits from the I Fish website to the DNR license purchase site**. The popularity of I Fish Illinois has expanded to "bricks and mortar" contact with the public with the inclusion of a **promotional display featuring I Fish Illinois in a fishing exhibit at the Navy Pier Children's Museum in Chicago**.

JOB 101.6 FISHES OF CHAMPAIGN COUNTY

Building on the efforts of Forbes and Richardson (1908), Thompson and Hunt (1930), Larimore and Smith (1963), and Larimore and Bayley (1996), **field sampling for the next iteration of "The Fishes of Champaign County"** was initiated in Segment 25. Field conditions have prevented the completion of all field sampling until near the end of Segment 28 in the Spring 2015, preventing the execution of a full analysis. Early analyses show a **homogenization in fish community composition between the Upper Mississippi and Wabash River headwaters in Champaign County** over the last century. A complete suite of analyses will be conducted in Segment 29, producing a variety of peer review publications and professional presentations.

JOB 101.7 RECOVERY OF URBAN STREAM SPORT FISHERIES

Project staff has coordinated with the Illinois DNR and the Forest Preserve District of DuPage County staff to sample locations on the East Branch and West Branch of the DuPage River in the spring, summer and fall of each year to **evaluate stream fish communities and the ability of these tributaries to support a vibrant recreational fishery**. General sampling of the fish community will provide important information on the sport fishery and the forage fish of urban streams. Additionally, project personnel are collecting acoustic telemetry data to determine typical home ranges and changes in habitat use in response to habitat alterations in an urban landscape.

JOB 101.1 SPORT FISH POPULATION AND SPORT FISHING METRIC

OBJECTIVES

The following components constitute the overall objectives for Job 101.1:

- Develop and test a wadeable and non-wadeable Fishing Quality Index (FQI) for largemouth bass, channel catfish, and panfish species by June 30, 2015.

PROCEDURES

Analyses performed during Segment 27 provided valuable data on the factors that influence success for the individual angler. This data suggest that individual anglers who target largemouth bass tend to be more satisfied with their angling experience when they catch larger fish. Analyses performed during Segment 28 focused on determining which factors influence cumulative angler success for a lake over the period of a year and to determine if the factors found to influence individual angler success are similar to patterns observed over an entire year. From this analysis, project personnel explored how fisheries data collected from fall electrofishing surveys relates to cumulative angling success for a lake in the following year.

Creel surveys were separated into 10 groups based on the average success of largemouth bass anglers calculated from creel survey data (Table 1.1). Additionally, angler catch rates and the average size of angled largemouth bass were calculated for each lake. This data was then averaged for each of the 10 success rate groups and plotted to view any trends. Based on analyses from Segment 27 that focused on the relationship between average fish size and catch rate for individual angling trips, we expected that the average total length of largemouth bass across an entire angling season would be higher in the higher success rate groups but that catch rate among success groups would be consistent across groups.

Group	Ave. Success Percentile	Ave. Success Range	n
1	< 10	1.85 – 3.08	9
2	10 – 19	3.09 – 3.24	9
3	20 – 29	3.27 – 3.42	9
4	30 – 39	3.44 – 3.64	9
5	40 – 49	3.65 – 3.90	9
6	50 – 59	4.00 – 4.24	9
7	60 – 69	4.28 – 4.51	9
8	70 – 79	4.52 – 5.24	10
9	80 – 89	5.48 – 5.89	8
10	>90	5.90 – 7.58	10

Table 1.1. Description of lake groups based on the average success ratting by largemouth bass anglers on lakes in which a creel survey was conducted the year after a fall electrofishing survey was performed.

In all, 91 fall electrofishing surveys were found to occur on lakes in which a creel survey was conducted in the following year. Largemouth bass population data were gathered from fall electrofishing surveys performed on each lake. Population data calculated include density of different size groups in CPUE, percent stock densities, and average size (Table 1.2). Population metrics were then averaged within the 10 success groupings and plotted to evaluate patterns.

Metric Type	Units	Population Metric
Density	# LMB per hour	CPUE of all LMB
		CPUE of LMB > 20 cm (CPUE 20)
		CPUE of LMB > 30 cm (CPUE 30)
		CPUE of LMB > 36 cm (CPUE 36)
		CPUE of LMB > 38 cm (CPUE 38)
		CPUE of LMB 20 cm – 30 cm (CPUE 20-30)
		CPUE of LMB 30 cm - 36 cm (CPUE 30-36)
		CPUE of LMB 36 cm – 38 cm (CPUE 36-38)
Stock Density	% LMB	Percent Stock Density (PSD)
		Relative Stock Density of 36 cm (RSD 36)
		Relative Stock Density of 38 cm (RSD 38)
		Relative Stock Density 30 cm – 36 cm (RSD 30 – 36)
		Relative Stock Density 36 cm – 38 cm (RSD 36 – 38)
Mean Total Length	Centimeters	Average Total Length of all LMB (Avg TL)
		Average Total Length of Stock Sized LMB (Avg TL Stock)

Table 1.2. Fisheries metrics calculated from fall electrofishing surveys on study lakes.

FINDINGS

Trends in annual angler success rating do not follow the expected trends found from individual angler analyses. Plots of average total length of angled largemouth bass and largemouth bass catch rates versus success rate groups suggest that the average total length of angled largemouth bass varies little among success groups and that catch rates are higher in higher success groups (Figure 1.1). Although individual angler success is strongly related to the size of largemouth bass angled, the average total length angled over the course of a year varies little (29 cm to 36 cm) and does not appear to influence the yearly angler success of a lake. This pattern is likely due to similarities in population size structure among lakes resulting in comparable proportions of small and large fish contributing to similar annual mean total length. Although mean total length varies little among success groups, largemouth bass catch rates appear to increase in the higher success rate groups. This suggests that, while maintaining an average size structure of largemouth bass in a lake, increasing the angler catch rate will increase the yearly angler success rate of a lake.

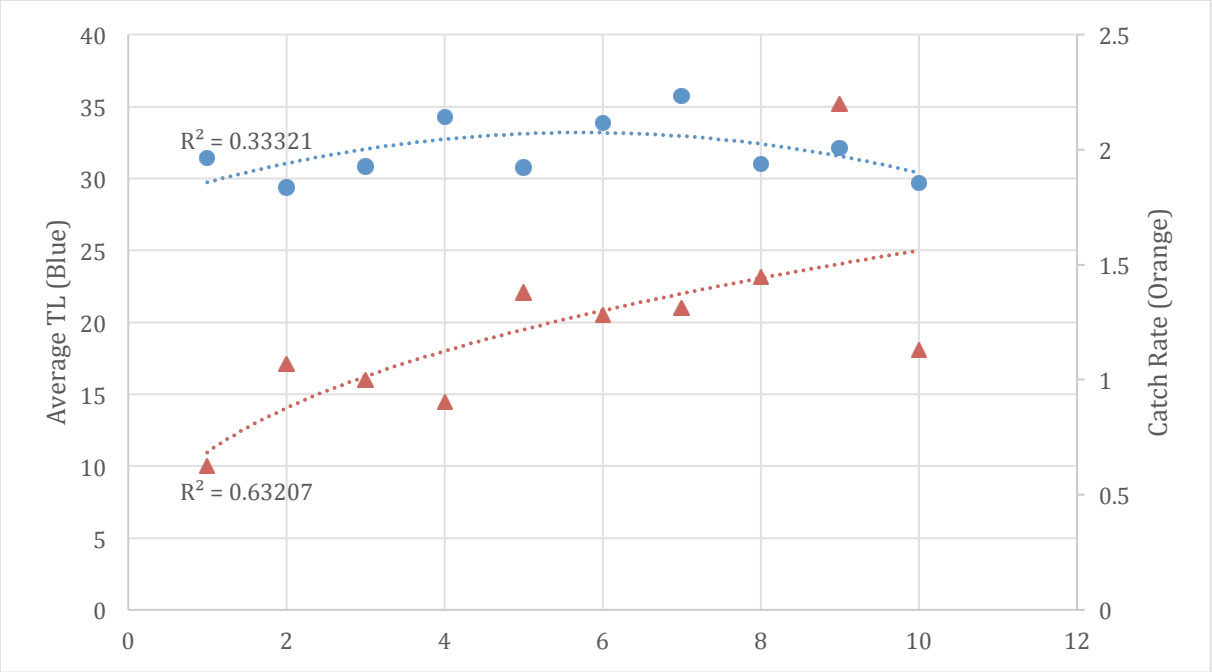


Figure 1.1. Plot of the Average Total Length (blue circles and line) of largemouth bass and Catch Rates of LMB (orange triangles and line) across success rate groups.

Using fall electrofishing data, analyses of largemouth bass population metrics compared to angling success ratings showed similar patterns. A positive relationship between overall electrofishing catch per unit effort and angling success rate group was observed (Figure 1.2). Due to the apparent importance of angler catch rate on the overall angling success of a lake, further plots were created to determine which population metrics are most related angler catch rate. From these plots, it appears that the density of largemouth bass between 20 and 30 cm best relates to the angler catch rate of a lake (Figure 1.3).

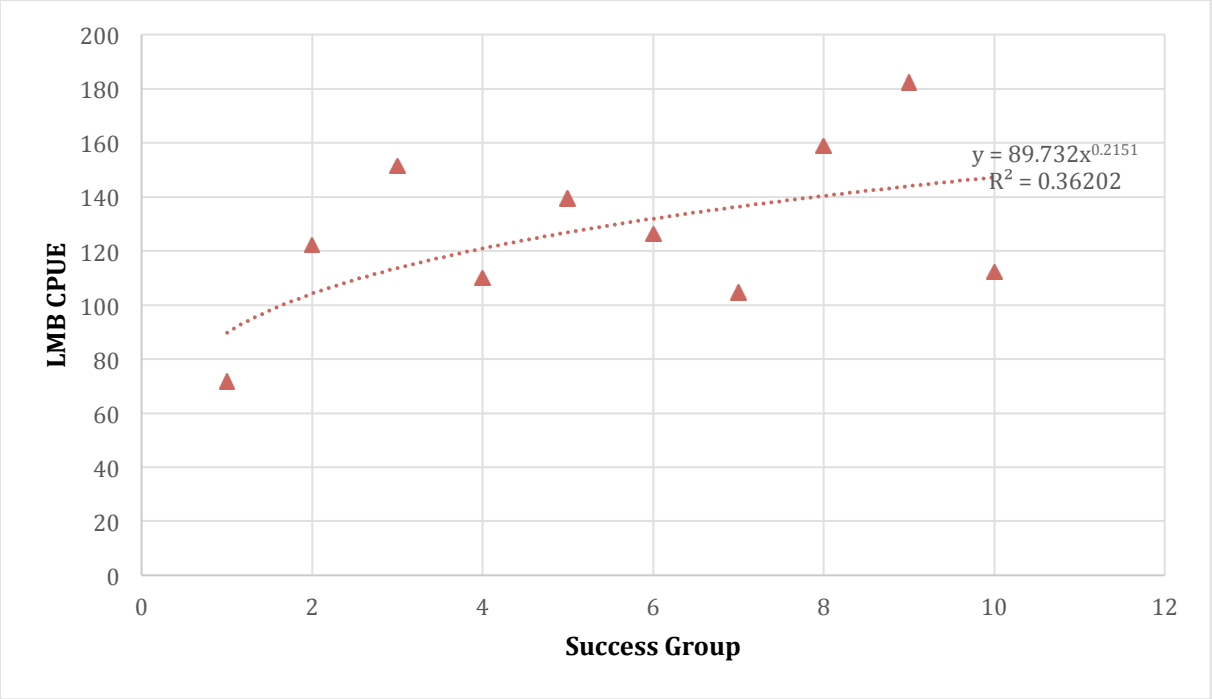


Figure 1.2. Plot of the mean largemouth bass catch per unit effort (fish/hr) based on fall electrofishing for each angling success rating group.

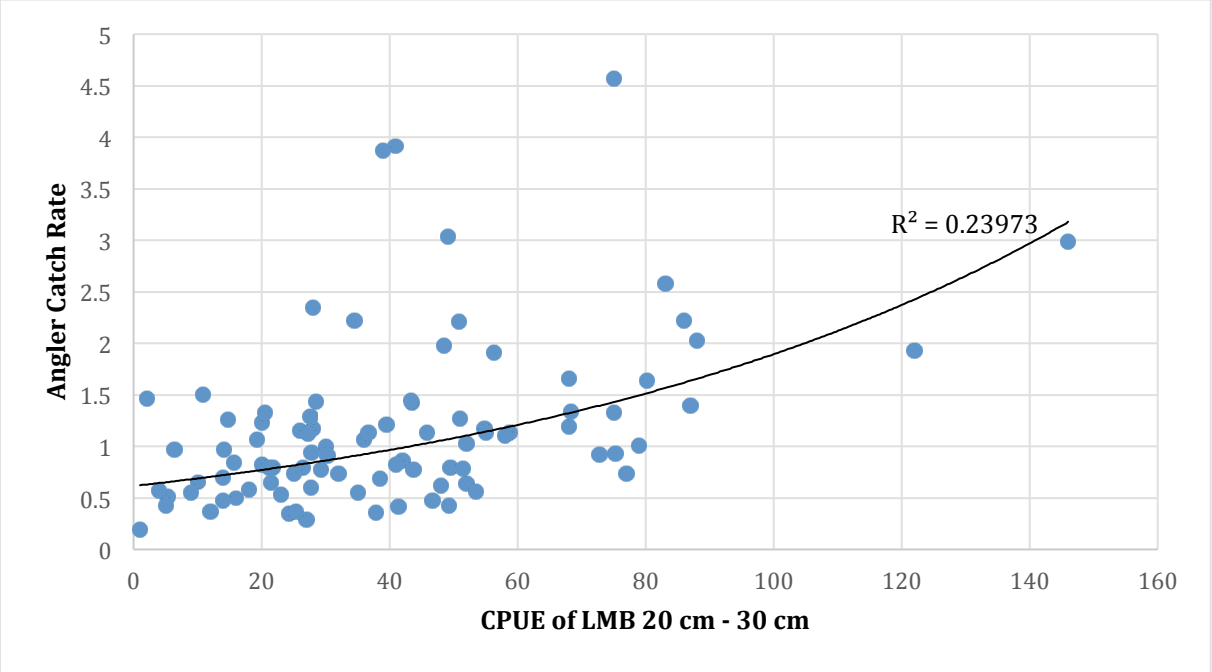


Figure 1.3. Plot of largemouth bass catch per unit effort (fish/hr) of between 20 and 30 cm based on fall electrofishing versus angler catch rate (fish/hr).

RECOMMENDATIONS

The analyses performed during this Segment are essential steps in determining the relationships between largemouth bass population structure and angler success on Illinois Lakes. By further analyzing these relationships, project personnel will be able to further develop the multispecies FQI metric, as well as provide valuable insight to fisheries managers on which population metrics are most critical in improving angler success on their lakes. By completing these analyses on largemouth bass, project personnel will have developed a methodical framework that can be expanded to other sport fish species in Illinois.

Upon completion of analyses, project personnel plan to prepare manuscripts for peer-reviewed journals, as well as present our findings to fisheries managers at professional conferences. Furthermore, integrating FQI calculations into the METRICS Fisheries Database System will provide the fisheries managers of Illinois an invaluable tool that will instantly predict angler success in a lake following a fall electrofishing survey. Much like an IBI score for streams, multiple parameters will be calculated so the manager will be able to determine where the population within a lake is lacking, allowing for targeted management strategies.

Job 101.1 is now considered complete, and manuscript preparation will be conducted in Segment 29 and reported under Study 3 – Determine Factors Affecting Fishing Quality. Algorithms used to calculate Fishing Quality Index will be refined in Segment 29, incorporated into METRICS, and reported in Segment 29 under Study 4 - Information Management Systems Supporting Ongoing Fisheries Research.

WILDLIFE TRACS ACTION LEVELS

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

JOB 101.2 ENHANCED FIELD SAMPLING OF SPORT FISH POPULATIONS

OBJECTIVES

The following components constitute the overall objectives for Job 101.2:

- Conduct targeted and supplemental assessments of sport fish populations to support the data needs of project activities

- Coordinate with other Federal Aid Projects and Division of Fisheries to fill gaps in sampling effort and create efficiencies among federally supported (DJ) projects annually

PROCEDURES

Project staff will coordinate directly with the Division of Fisheries to determine sport fish population sampling needs in an effort to meet the growing demand for field data collection to support research activities and the analytical needs of fisheries managers. Enhanced field sampling of sport fish populations also provides data needed for FQI development on selected wadeable and non-wadeable waters within the state. Project staff will be used to fill gaps in sampling needs that also support research objectives in this study and create flexibility in apportioning sport fish population sampling efforts to meet the needs of multiple Federal Aid Projects, in addition to the needs of the Division of Fisheries.

FINDINGS

During Segment 28, project personnel spent over 1300 hours assisting the IDNR Division of Fisheries with projects ranging from assorted field samplings throughout the state and processing preserved fish specimens. Project personnel worked directly with IDNR Division of Fisheries to conduct sampling of stream fish assemblages in the Vermilion River (Illinois River Drainage), Hennepin Canal, Green River, Mississippi South Central tributaries, and the tributaries of the middle Illinois River during the summer of 2014.

During the first half of 2015, project personnel coordinated stream sampling in the Iroquois River Basin, Mackinaw River Basin, and Central Mississippi tributaries. In addition, personnel assisted with sampling in Sangchris Lake, Lake Shelbyville, Walnut Point Lake, Oakland City Lake, and Lake Taylorville. Data entry and analysis for 2014 are currently underway, and data collection for the remainder of 2015 continues during Segment 29.

RECOMMENDATIONS

The overall benefit of the collaboration between project personnel and IDNR Division of Fisheries to conduct sport fish assessments is exceptional. Data collected can and will be used to develop and test the FQI metric, provide summary information about sport fish opportunities to the public via www.ifishillinois.org, and support the research and management needs of multiple

collaborators and peers. Coordinated stream surveys should continue in future segments and more detailed, long-term strategies for prioritizing sampling efforts throughout the state should be developed.

Continuing to provide students interested in fisheries science with an opportunity to gain valuable hands-on fisheries skills is essential for educating the next generation of fisheries scientists. The experiences received by student personnel have led many of them to further their education in fisheries science. Recently, six former student personnel have completed, or are completing, advanced degrees.

1. **Austin Rundus** – M.S. in Natural Resources and Environmental Sciences, University of Illinois – Urbana
2. **Kristina Tranel** – M.S. in Urban and Regional Planning, University of Illinois – Urbana
3. **Andrew Stites** – M.S. in Natural Resources and Environmental Sciences, University of Illinois – Urbana. Now Associate Ichthyologist at the Illinois Natural History Survey
4. **Rebecca Haun** – M.S. in Biology, Western Illinois University
5. **Cory Anderson** – M.S. in Biology, Western Illinois University
6. **Andrew Mathis** – M.S. in Biology, Western Illinois University

WILDLIFE TRACS ACTION LEVELS

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

JOB 101.3 DETERMINE FACTORS AFFECTING FISHING QUALITY

OBJECTIVES

The following components constitute the overall objectives for Job 101.3:

- Conduct statistical analyses, observational and manipulative experiments, and genetic analyses that evaluate reproductive ecology and life history, natural reproduction and recruitment dynamics, behavior and spatial distribution of sport fish that affect angling performance metric annually

Several research experiments, ecological field studies, and collaborative activities were conducted in support of the objectives of Job 101.3. The procedures, findings, and recommendations for each of these activities are presented below. Experiments 3.1, 3.2, 3.6, 3.7, and 3.8 were all completed and reported in previous segments.

Experiment 3.3 – Impacts of reproductive success on smallmouth bass recruitment

Project personnel have recently demonstrated the positive relationship between reproductive success and recruitment in black basses (see Segment 26, Experiment 3.3). Personnel have also observed decreases in reproductive success over time in response to increases in angling that occurred in a single Smallmouth Bass fishery (see Segment 27, Experiment 3.3). The effect that this angling-induced decrease in RS is having on recruitment is being assessed in Summer 2015 and will be reported in Segment 29.

PROCEDURES

For this experiment, researchers assessed the level of smallmouth bass spawning, as well as the level of nest success/failure over the entire reproductive season for four years —1991 and 1992 versus 2013 and 2014. Data recorded included depth of nests, total length of the nesting male, mating success assessment, stage of eggs/fry, and if the male displayed a hook wound due to angling. Hook wounding rates were used as a proxy for the level of angling that occurred during the reproductive season. For the 2014 reproductive season, recruitment to age 1+ is being determined by visually assessing the relative number of 1+ smallmouth bass in the study site in the spring and summer of 2015. These observations are currently underway and will be completed during Segment 29.

FINDINGS

As reported in Segment 27, hook wounding rates indicated, a clear increase in angling pressure and a concomitant decrease in reproductive success compared to data collected in the early 1990s. Changes in fishing pressure increased almost 5-fold, with 60% of nesting smallmouths in 2013–2014 having at least one hook wound. In late June of the current segment, project personnel initiated snorkel survey assessments of age 1+ recruit abundance in the study area.

These surveys will continue into July and August of 2015, and the results will be incorporated into analyses. Complete findings will be prepared during Segment 29.

RECOMMENDATIONS

Understanding the long-term consequences angling can have on smallmouth (and largemouth) bass populations in Illinois will continue to improve our ability to manage and conserve this species. This study is part of an effort to show the linkages between reproductive success and year-class strength and how angling nesting bass pays a role in recruitment mechanisms. Management strategies for black bass populations that show wide fluctuations in the number of nesting males or that have decreased recruitment should include considerations for protecting parental care activities. Final data is currently being collected in Segment 29, and the complete results of this experiment will be prepared for submission to a peer-reviewed journal.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.4 – Impacts of reproductive success on largemouth bass recruitment

For a fish to return to a previous nest site, there should be an associated fitness advantage in the form of enhanced reproductive success. It has been suggested that nest site fidelity may offer advantages in the form of efficient movement, neighbor conflicts, and in dominance interactions. In addition, previous nesting success at a particular site and a "win-stay: lose-switch" decision rule may explain whether or not a fish returns to a previous nest site. The purpose of this experiment was to assess the impact of angling on nest site fidelity decisions within largemouth bass.

PROCEDURES

The experiment consisted of a multiple angling treatment conducted in 2004–05 and a single angling treatment conducted in 2014–15. In the first year of the multiple angling treatment (2004), nesting bass were angled multiple times with rod and reel resulting in multiple recaptures during the nesting period. In the first year of the single angling treatment (2014), however, nesting bass were angled and captured only once during the nesting period. In the second year of both treatments (2005 and 2015), nesting bass were angled once during the spawning season to identify individual males tagged in the first year of each treatment. During the first year of both treatments, snorkel surveys of the entire shoreline were conducted throughout the spawning season to locate nesting Largemouth Bass. The entire littoral zone of the lake was surveyed multiple times a season by two snorkelers, resulting in a high nest detection rate throughout the lake.

Largemouth Bass nests were marked with a numbered PVC tag and nest locations recorded on a detailed map of Long Lake. Subsequently, the guarding males were angled from a boat, and a Passive Integrated Transponder (PIT tags, Destron Fearing, South St. Paul, MN, USA) was implanted in the peritoneal cavity of each angled male bass using a hypodermic needle. Males were then released back onto their nest less than 1.5 min after capture. During the second year of each treatment (i.e., 2005 and 2015, respectively) nesting males were located via snorkeling surveys, their nests marked and mapped as described above, and nesting males were angled. The identity of these males was determined by reading the PIT tags implanted during the previous year, and the location of each male's nest in the second year was recorded as described above. The linear distance between first-year nest sites and second-year nest sites was determined using nest locations recorded on the lake map.

FINDINGS

The level of inter-annual nest site fidelity decreased drastically for fish that were fished heavily during the nesting period and experienced high levels of reproductive failure due to premature nest abandonment (Figure 3.4.1).

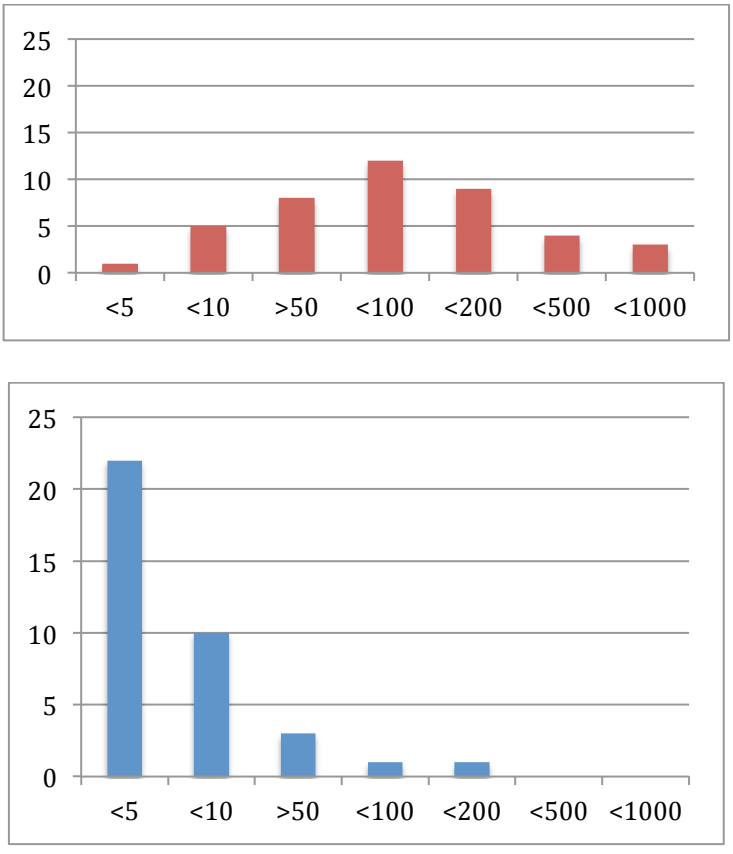


Figure 3.4.1. Inter-annual distance between nest sites for individual male largemouth bass nesting in Year 1 compared to the next year. Distances are broken into categories as shown on the X-axis. The top graph (red bars) show the results for 2004–2005, the year in which males on nests were angled multiple times, causing >90% premature nest abandonment and, therefore, total brood failure. The lower graph (blue bars) show the results for 2014–2015, the year in which males on nests were angled only once, causing <5% premature nest abandonment and, therefore, high levels of reproductive success.

RECOMMENDATIONS

Understanding the long-term consequences that angling can have on smallmouth (and largemouth) bass populations in Illinois will continue to improve our ability to manage these important species. The results of this experiment suggest that angling that causes nest failure in black bass may result in them altering nest site locations. How that affects their reproductive success should be assessed further. Project personnel are currently in the final stages of preparing a peer-reviewed manuscript to be submitted in early 2015.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.5 – Assessing the impacts of invasive species on nesting bass

In the past 20 years, the Great Lakes watersheds have undergone significant ecological alterations due to the introduction of invasive species. The first major invasion occurred in the mid-1990s with the introduction of the zebra mussel (*Dreissena polymorpha*), which quickly spread throughout the Great Lakes region. The quagga mussel (*D. bugensis*) followed in the late-1990s, and currently both species are well established and considered naturalized. One of the consequences of these mussel invasions has been the large blooms of filamentous green algae, *Spirogyra* sp. Although zebra and quagga mussels filter smaller algae, they cannot filter *Spirogyra* sp., which explodes in abundance, creating large green masses throughout the water column. Another major invader, the round goby (*Neogobius melanostomus*), was introduced into the St. Clair River in the early 1990s and quickly spread throughout the Great Lakes. Round gobies have had significant effects on the Great Lakes ecosystem, including competing for food and spawning habitats with native fishes. Nest predation by round gobies (coupled with algae blooms that provide cover for round gobies) are known to have an effect on nesting success (Steinhart et al., 2004).

These environmental changes could have important effects on local populations of sport fish, especially those species that are nest builders and perform parental care, such as the smallmouth bass. Historical data collected during previous segments of this project prior to and during invasive species expansion can be a highly valuable tool when assessing the level of impacts these invaders have had on native populations of sport fish.

PROCEDURES

Early in the 1990s, project personnel performed studies to assess how seasonal closures to angling protect nesting bass, as well as the amount of illegal pre-season angling that occurred within protected waters (Philipp et al., 1997). The St. Lawrence River was one study site within that project. In 2012, project personnel met with researchers at the Thousand Island Biological

Station to compare data sets and to collaborate on field studies to determine the impact zebra mussels and the round goby may have on smallmouth bass during their reproductive season.

In 2013 and 2014, project personnel conducted visual assessments to characterize habitat used by smallmouth bass for reproduction and compared it to similar data collected during the 1991–1992 study. All nests within the study area were monitored for the entire reproductive season (ranging for all years from June 1 – August 14), and snorkelers recorded the following: depth of nests, estimated total length of the nesting male, mating success via egg score (Stein & Philipp, 2014), stage of development of offspring, and the presence of any hook wounds due to angling. A photograph was also taken of each nest area during the egg or egg-sac fry development stage. Evaluations of zebra mussels, presence of algae blooms, and round goby densities were evaluated using a scoring system. Statistical analyses will involve multivariate analyses of potential contributing factors.

FINDINGS

At the end of the 2013 and 2014 reproductive season, 111 and 127 smallmouth bass had spawned, respectively, with 38.7% and 40.1% of these successfully raising broods. Compared to the 1991 and 1992 reproductive seasons, there was a dramatic change in depth of nests and nesting success (Table 3.5.1). This was the result of smallmouth bass utilizing deep areas on the outside of islands bordering the project area that were not utilized for nesting during 1991-1992 (Figure 3.5.1). Project personnel are currently awaiting a more detailed assessment from project partners at the New York Department of Conservation to assess underwater photographs of individual nests to confirm the round goby and zebra mussel abundance.

Year	Total # Nests	Mean Nest Depth (m)	% Nest Success
1991	123	1.4	61.8%
1992	133	1.2	55.6%
2013	111	2.6	38.7%
2014	127	3.1	40.2%

Table 3.5.1: For each year of the study, the total number of nests where spawning occurred, the average depth of nests, and the percentage of nests that successfully raised a brood to brown fry stage.

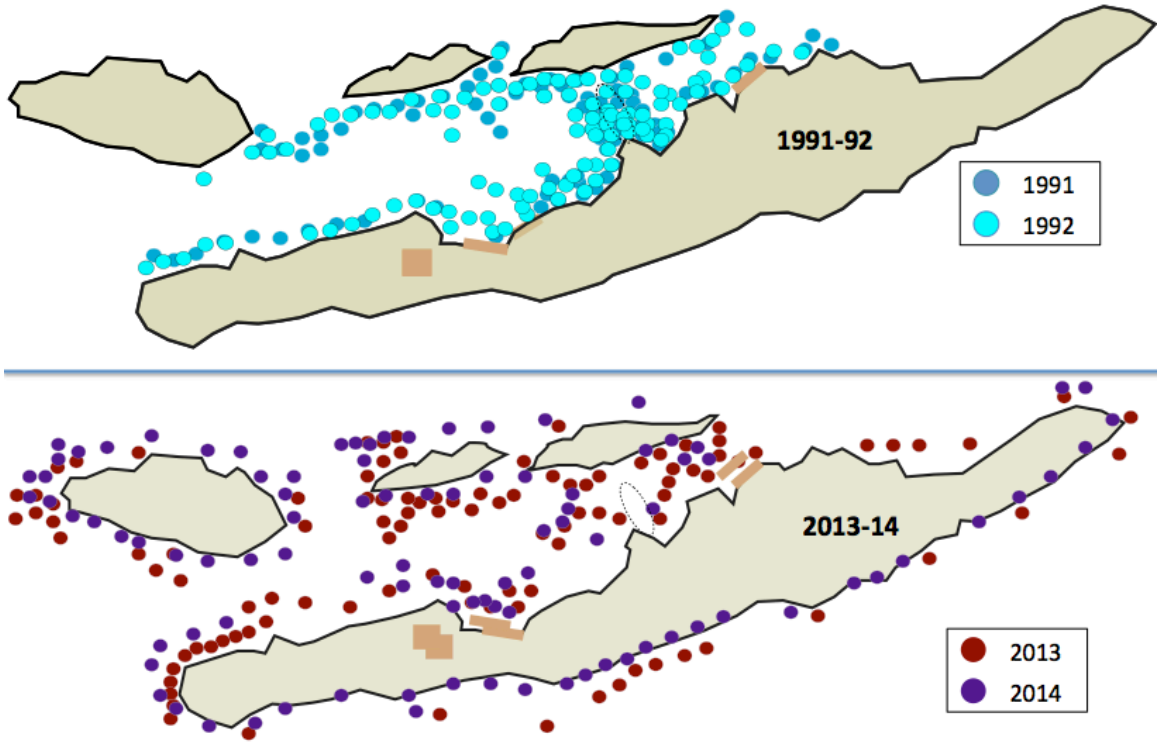


Figure 3.5.1. Diagram of the study islands displaying the changes in location of smallmouth bass nests for 1991–92 and 2013–14. The areas between the islands are shallower, ranging from 0.5 to 2 meters. The areas on the outside of the islands are much deeper, ranging from 3–6 meters.

RECOMMENDATIONS

Understanding the impacts invasive species have on sport fish populations is critical when assessing current management strategies. In locations where gobies and smallmouth bass co-exist and where catch-and-release angling pressure is high during the reproductive season, reproductive success, and subsequent effects on recruitment, may be severely impacted. The results of this study may have important implications for managing smallmouth bass populations in areas where round gobies are present. The results of this experiment are currently being analyzed and prepared for submission to a peer-reviewed journal.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.9 – Effects of simulated brood predation on recruitment dynamics in largemouth bass (*Micropterus salmoides*)

Fieldwork, analyses and writing associated with this experiment has been completed, and final results of this experiment were reported in Segment 27. Results from this work are currently in revision following peer review.

ABSTRACT

Angling of nest-guarding male largemouth bass (*Micropterus salmoides*) during the parental care phase disrupts brood defense, leaving offspring vulnerable to predation. Unless the angling-induced predation of the offspring during the parental care phase is compensated by increased survival rates later in the first year of life, it may be a critical factor in determining year class strength within a population. The goal of this study was to simulate brood predation in largemouth bass and test whether or not reductions in brood caused decreases in recruit abundance, biomass, size and/or condition. Populations of adult bass were established in eight experimental research ponds for each of two years and allowed to spawn. During the spawning season in each year, snorkelers located every nest in each pond, and in treatment ponds each brood was experimentally reduced in size by 50% to simulate predation by brood predators during an angling event. Comparing treatment ponds to control ponds and using pre-devaluation estimates of expected fry to standardize for variation among ponds in reproductive success, recruit survival was 39% lower and recruit biomass production was 37% lower. Although higher post-devaluation survival rates in the treatment ponds did appear to partially mitigate recruit losses due to the simulated brood predation, compensatory survival was not great enough to overcome the overall reduction in recruit abundance caused by the treatment.

Experiment 3.10 – Assessment of historical and recent changes in stream fish communities

To support the implementation of effective management strategies supporting the conservation of native fishes in Illinois streams, we must understand how fish communities have changed spatially and temporally. To evaluate these changes, we utilized long-term fish survey data managed under Job 4 of this project to evaluate changes in fish community structure, with an emphasis on sport fish species, and to identify Illinois streams that may be of concern for native species. The current experiment is in progress, and thus far we have conducted basic analyses to evaluate trends in species richness and abundance of all stream fish species.

PROCEDURES

Fish samples collected between 1974 and 2013 were selected from IL DNR basin survey data to assess temporal changes in species richness, relative abundance, and composition. For each sample, species richness and relative abundance were standardized as catch per unit effort (fish per hour) and then sites were grouped spatially by HUC 8 regions/basins (8-digit hydrologic units defined by the United States Geological Survey) for year-to-year comparisons. HUC 8 regions that had less than 2 samples per year or less than 3 years sampled total were excluded from analyses due to lack of data.

A mixed model ANOVA, with year as the fixed effect and site as the random effect, was used to determine differences in fish abundance and species richness between sampling years. This was done for each gear type, within each HUC 8 basin. If ANOVA found significance ($\alpha \leq 0.05$), Tukey's HSD was used post hoc to identify years that differed in abundance or richness. To define trends in species richness and abundance, results from the ANOVA were used in conjunction with a regression analysis using the least squared means of each sampling year. Trends were defined as increasing (ANOVA $\alpha \leq 0.05$, slope ≥ 0.05, $R^2 \geq 0.5$), decreasing (ANOVA $\alpha \leq 0.05$, slope ≤ 0.05, $R^2 \geq 0.5$), stable (ANOVA $\alpha \geq 0.05$), or variable (ANOVA $\alpha \leq 0.05$, slope near zero, $R^2 \leq 0.5$).

To test differences in species composition between years for relative abundance, we used an analysis of similarity (ANOSIM) and similarity percentages procedure (SIMPER) using PRIMER software (Version 6; Primer-E Ltd., Plymouth, England). To decrease effects of single event extremes in CPUE, a fourth root transformation was used on the data, then a Bray-Curtis similarity matrix was created using CPUE of all fish species per HUC 8 region, per gear type. A one-way ANOSIM with pairwise comparisons allowed for statistical comparisons of fish communities between years. When ANOSIM found a difference ($\alpha \leq 0.05$), we then used a SIMPER procedure to determine the fish species contributing to the differences between years. To simplify the large number of tests conducted, year differences in species composition per HUC 8 region (by gear type) were given strength values (0 – 4) depending on statistical results. A zero was assigned if ANOSIM indicated more variability between sites than across years; 1 was assigned if there was no significant difference between years or pairwise comparisons could not find differences; 2 was assigned if 1 to 2 years significantly differed; 3 was assigned if 3 to 4 years significantly differed; and 4 was assigned if 5 to 6 years significantly differed.

FINDINGS

AC Electrofishing

A total of thirty-three HUC 8 regions sampled using AC EF had adequate data to run statistical analyses. The majority showed stable trends of species richness and abundance overtime. The Lower Sangamon, Pecatonica, and Upper Sangamon showed increasing trends in species richness and abundance, while the Kankakee was the only basin that showed decreasing temporal trends in both richness and abundance (Figure 3.10.1).

Nine regions (Embarras, Flint-Henderson, Kankakee, Kishwaukee, La Moine, Lower Fox, Lower Rock, Pecatonica, and Vermilion-Lower) showed significant differences in species composition among at least 3 years sampled from 1974 – 2013 (Table 3.10.1; Figure 3.10.2). Among basins that indicated stable species richness and relative abundance, 36 to 43 fishes contributed to 90% of the dissimilarities between significantly different years. Years that differed and species that contributed to those differences varied per region. For example, in the Embarras between 1996 and 2006, 39 species contributed to year differences and the majority (61.5%) were sport fish. Although a variety of other non-sport fishes contributed to year differences, the top 3 most important sport fish included largemouth bass, golden redhorse, and bluegill, all of which increased in abundance between 1996 and 2006. Conversely, between 1994 and 2004 in Flint-

Henderson, 36 species contributed to year differences and 50% (18) were sport fish. All three of the top contributing sport fishes (bluegill, bigmouth buffalo, and white sucker) decreased in abundance from 1994 and 2004.

Kankakee was the only basin with compositional differences between sampling years and declining temporal trends in relative abundance and species richness (Table 3.10.1; Figures 3.10.1-2). Between 36 and 41 species accounted for 90% of the dissimilarities between significantly different years (both 1994 and 2000 differed from 2010). Thirty-seven species were attributed to differences between 1994 and 2010 and 48.6% were sport fish. White sucker, shorthead redhorse, and green sunfish were the top 3 sport fish contributors, and all decreased in abundance from 1994 to 2010. Similarly, between 2000 and 2010, 51.2% of the differences were attributed to sport fish; the top 3 species decreased in abundance from 2000 and 2010 and were gizzard shad, bluegill, and rock bass.

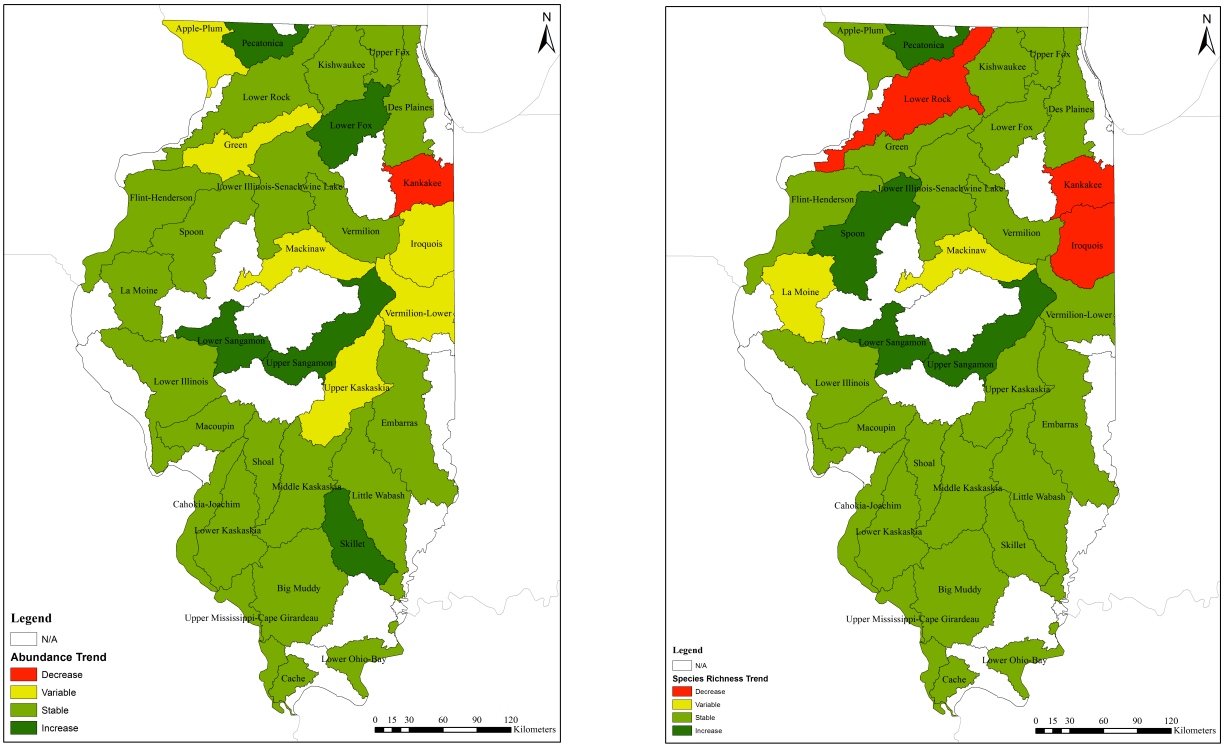


Figure 3.10.1. Fish abundance (left panel) and species richness (right panel) trends from IDNR basin survey data collected via AC Electrofishing from 1974 – 2013.

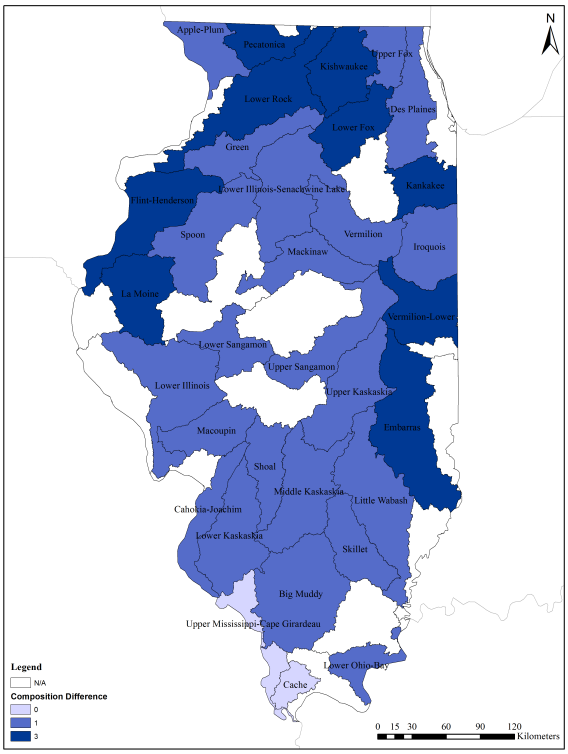


Figure 3.10.2 Strength of compositional differences from IDNR basin survey data collected using AC EF from 1974–2013.

HUC 8 Region	Area (km²)	Years	# Samples	# Sites	Global R	Sig (%)	Comp. Diff.	AB	SPR
Apple-Plum	2217.65	1995-2010	26	11	0.032	28.1	1	Variable	Stable
Big Muddy	6191.13	1988-2003	42	20	0.108	3.3	1	Stable	Stable
Cache	948.22	1992-2004	16	8	-0.051	66.5	0	Stable	Stable
Cahokia-Joachim	2258.84	1984-2010	6	5	0.231	26.7	1	Stable	Stable
Des Plaines	3423.56	1983-2013	37	27	0.058	23.7	1	Stable	Stable
Embarras	**6330.82**	**1974-2011**	**24**	**14**	**0.33**	**0.1***	**3**	**Stable**	**Stable**
Flint-Henderson	**4599.89**	**1991-2009**	**36**	**19**	**0.207**	**0.1***	**3**	**Stable**	**Stable**
Green	2926.72	1991-2009	31	17	0.123	5.1	1	Variable	Stable
Iroquois	3326.65	1994-2010	41	13	0.18	0.1	1	Variable	Decrease
Kankakee	**2263.59**	**1994-2010**	**22**	**16**	**0.627**	**0.1***	**3**	**Decrease**	**Decrease**
Kishwaukee	**3168.07**	**1983-2011**	**18**	**11**	**0.248**	**0.9***	**3**	**Stable**	**Stable**
La Moine	**3494.84**	**1988-2007**	**18**	**12**	**0.372**	**0.4***	**3**	**Stable**	**Variable**
Little Wabash	5563.48	1989-2002	40	21	0.013	40.2	1	Stable	Stable
Lower Fox	**2864.17**	**1982-2012**	**27**	**14**	**0.339**	**0.1***	**3**	**Increase**	**Stable**
Lower Illinois	5888.83	1988-2011	8	4	0.479	9.5	1	Stable	Stable
Lower Illinois-Senachwine Lake	5083.98	1990-2009	12	7	0.043	35.8	1	Stable	Stable
Lower Kaskaskia	4165.34	1996-2007	24	9	0.113	11.4	1	Stable	Stable
Lower Ohio-Bay	1553.65	1986-2010	16	9	0.013	44.6	1	Stable	Stable
Lower Rock	**5582.09**	**1984-2012**	**36**	**25**	**0.325**	**0.1***	**3**	**Stable**	**Decrease**
Lower Sangamon	2313.34	1982-2008	13	6	0.333	1.1	1	Increase	Increase
Mackinaw	2981.85	1986-2010	32	12	0.174	1.8	1	Variable	Variable
Macoupin	2526.23	1998-2011	8	3	0.271	17.1	1	Stable	Stable
Middle Kaskaskia	4458.82	1982-2007	16	6	0.325	1.6	1	Stable	Stable
Pecatonica	**1894.72**	**1984-2007**	**17**	**9**	**0.364**	**0.1***	**3**	**Increase**	**Increase**
Shoal	2377.29	1982-2007	10	5	0.253	14.2	1	Stable	Stable
Skillet	2758.66	1989-2011	20	5	0.092	19.6	1	Increase	Stable
Spoon	4834.30	1995-2010	60	28	0.091	1.8	1	Stable	Increase
Upper Fox	1586.63	1982-2012	16	7	0.334	1	1	Stable	Stable
Upper Kaskaskia	4073.41	1997-2012	15	7	0.106	17	1	Variable	Stable
Upper Miss-Cape Girardeau	1782.37	1987-2009	12	6	-0.091	64.6	0	Stable	Stable
Upper Sangamon	3741.09	1982-2008	14	6	0.086	27.8	1	Increase	Increase
Vermilion	3461.69	1990-2004	16	9	0.05	27.5	1	Stable	Stable
Vermilion-Lower	**3339.30**	**1986-2006**	**33**	**17**	**0.354**	**0.1***	**3**	**Variable**	**Stable**

Table 3.10.1. **Descriptive values (area of HUC 8 region, range of years sampled, number of samples, number of sites), ANOSIM results (Global R statistic, % significance), composition strength values (Comp. Diff.), relative abundance trends (AB), and species richness trends (SPR) for HUC 8 regions sampled using AC EF. An asterisk denotes statistical significance ($\alpha \leq 0.05$).**

Electric Seining

Forty HUC 8 regions sampled using electric seine had adequate data to run composition statistics. Half the regions showed stable species richness and relative abundance values over time (Table 3.10.2). The Embarrass was the only basin that showed increasing trends for abundance and species richness, while the Iroquois was the only region to show decreasing trends (Figure 3.10.3).

Six regions (Cache, Embarras, Flint-Henderson, Lower Illinois-Senachwine Lake, Salt, and The Sny) showed significant differences between years sampled (Table 3.10.2; Figure 3.10.4). Years that differed and species that contributed to those differences varied per region. For example, 1992 and 1999 were the only years that differed in the Cache basin and 34 species contributed to those differences; 32.4% were sport fish (white sucker, yellow bullhead, and green sunfish were the top 3 contributors and only green sunfish decreased between 1992 and 1999). Alternatively, in The Sny, 1992 differed from 1998, 2004, and 2009, and 1998 differed from 2004 and 2009; between 30 and 36 species contributed to 90% of the differences between years. More specifically, 30 species contributed to the differences between 1992 and 2009, 12 (40%) of which were sport fishes (namely, gizzard shad, largemouth bass, and river carpsucker being the top 3 and only largemouth bass showing increased abundance between 1992 and 2009). Conversely, 35 species contributed to differences between 1992 and 1998; 45.7% were sport fish. The top 3 sport fish contributing to differences were gizzard shad, shorthead redhorse, and yellow bullhead. Yellow bullhead and gizzard shad abundance declined between 1992 and 1998, while abundance of shorthead redhorse increased.

HUC8	Area (km²)	Years	# Samples	# Sites	Global R	Sig (%)	Comp. Diff.	AB	SPR
Apple-Plum	2217.65	1995-2012	34	16	-0.084	81	0	Decrease	Variable
Bear-Wyaconda	1608.55	1992-2009	14	10	0.02	44.3	0	Stable	Stable
Big Muddy	6191.13	1995-2013	72	47	0.055	13.7	1	Variable	Variable
Cache	**948.22**	**1992-2004**	**19**	**12**	**0.251**	**0.3***	**2**	**Stable**	**Stable**
Cahokia-Joachim	2258.84	1998-2010	26	14	-0.002	47	0	Decrease	Stable
Des Plaines	3423.56	2003-2013	17	10	-0.002	47.8	0	Stable	Stable
Embarras	**6330.82**	**1996-2011**	**63**	**39**	**0.246**	**0.1***	**3**	**Increase**	**Increase**
Flint-Henderson	**4599.89**	**1991-2009**	**20**	**14**	**0.292**	**0.8***	**2**	**Stable**	**Stable**
Green	2926.72	1991-2009	37	15	0.123	2.4	1	Variable	Variable
Iroquois	3326.65	1994-2010	43	18	0.045	11.2	1	Decrease	Decrease
La Moine	3494.84	1988-2007	40	20	0.142	0.6	1	Decrease	Variable
Little Wabash	5563.48	1989-2012	39	22	0.018	34.8	1	Variable	Stable
Lower Fox	2864.17	1996-2012	37	18	-0.007	53.6	0	Stable	Stable
Lower Illinois	5888.83	1988-2011	47	26	0.184	0.1	1	Stable	Stable
Lower Illinois-Lake Chautauqua	4206.17	1997-2013	28	15	0.12	8.1	1	Stable	Stable
Lower Illinois-Senachwine Lake	**5083.98**	**1990-2009**	**31**	**19**	**0.606**	**0.1***	**4**	**Variable**	**Variable**
Lower Kaskaskia	4165.34	1996-2007	30	19	0.06	9.6	1	Stable	Variable
Lower Ohio	1587.24	1992-2004	23	12	-0.023	57.3	0	Stable	Stable
Lower Ohio-Bay	1553.65	1986-2010	29	19	0.125	5.1	1	Stable	Stable
Lower Rock	5582.09	2008-2012	12	12	0.043	45.5	1	Stable	Stable
Lower Sangamon	2313.34	1988-2008	19	11	0.125	11.6	1	Stable	Stable
Lower Wabash	1614.83	1999-2011	10	6	0.405	1.5	1	Stable	Increase
Mackinaw	2981.85	1987-2010	61	28	0.118	1.7	1	Stable	Stable
Middle Kaskaskia	4458.82	1996-2007	29	14	0.131	3.3	1	Stable	Stable
Middle Wabash-Busseron	2264.14	2001-2011	19	10	0.055	22.5	1	Stable	Stable
Middle Wabash-Little Vermilion	537.47	1992-2011	14	7	0.184	19.6	1	Variable	Stable
Peruque-Piasa	822.37	1998-2010	7	5	-0.022	50	0	Stable	Stable
Saline	3058.66	1993-2010	32	25	0.067	22.2	1	Stable	Stable
Salt	**4845.26**	**1997-2009**	**50**	**25**	**0.331**	**0.1***	**4**	**Variable**	**Decrease**
Shoal	2377.29	1996-2007	19	11	0.137	4.6	1	Stable	Stable
Skillet	2758.66	1989-2011	23	8	0.031	35.2	1	Stable	Variable
South Fork Sangamon	3034.24	1996-2008	15	7	0.049	27	1	Stable	Stable
Spoon	4834.30	1995-2010	40	29	0.167	0.6	1	Stable	Variable
The Sny	**2566.12**	**1992-2009**	**26**	**12**	**0.437**	**0.1***	**3**	**Variable**	**Stable**
Upper Fox	1586.63	1996-2012	13	7	-0.119	80	0	Stable	Stable
Upper Kaskaskia	4073.41	1997-2012	41	19	0.142	1.1	1	Stable	Decrease
Upper Mississippi-Cape Girardeau	1782.37	1986-2009	27	17	0.198	1.4	1	Variable	Stable
Upper Sangamon	3741.09	1996-2008	29	14	0.15	2.4	1	Stable	Stable
Vermilion	3461.69	1990-2004	52	32	0.088	3.7	1	Variable	Stable
Vermilion-Lower	3339.30	1986-2011	42	23	0.178	0.1	1	Variable	Stable

Table 3.10.2 (at left on opposite page). **Descriptive values (area of HUC 8 region, range of years sampled, number of samples, number of sites), ANOSIM results (Global R statistic, % significance), composition strength values (Comp. Diff.), relative abundance trends (AB), and species richness trends (SPR) for HUC 8 regions sampled using electric seine. An asterisk denotes statistical significance ($\alpha \leq 0.05$).**

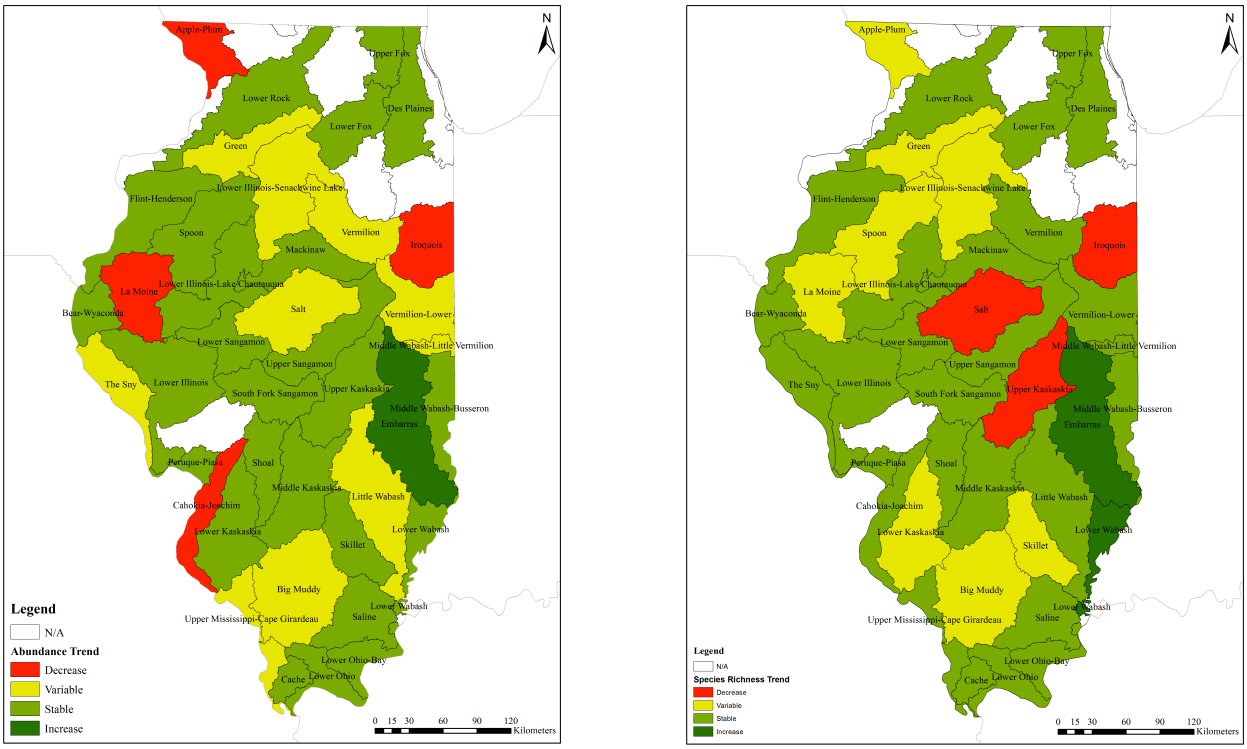


Figure 3.10.3. Fish abundance (left panel) and species richness (right panel) trends from IDNR basin survey data collected via Electric Seine from 1974 – 2013.

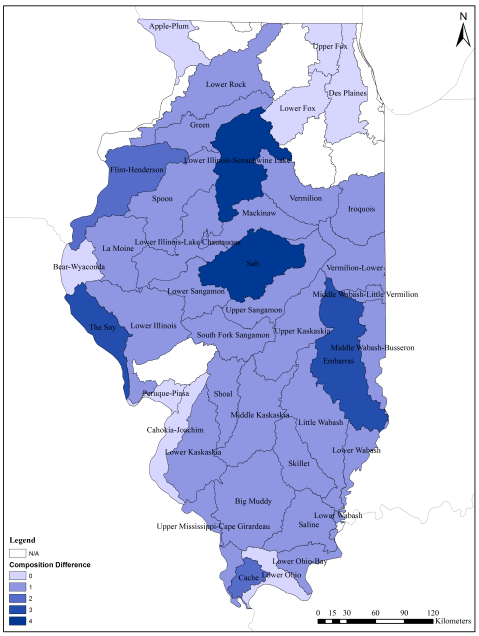


Figure 3.10.4. **Strength of compositional differences from IDNR basin survey data collected using electric seine from 1974-2013.**

RECOMMENDATIONS

Understanding temporal changes in stream fish community composition will improve our ability to manage and conserve native species in Illinois waters. With descriptive results, we can begin to identify areas that may be of concern to our native fishes, specifically native sport fish. Basins that show decreasing relative abundance and richness trends with high variability in species composition between sampling years may indicate the basin has an unstable fish population. In addition, by evaluating differences in composition among sampling years, we can determine specific changes in fish communities, thus furthering our understanding of species that may be in decline. The next step with this study will be obtain creel survey and environmental data so we can focus on basins with declining trends and begin explaining biotic and abiotic factors contributing to temporal changes in stream fishes throughout Illinois.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.11 – Largemouth bass recruitment on small urban lakes

Previous experiments have effectively documented the impact of angling nesting black bass on reproductive success, and have shown preliminary indication of a potential population-level effect on recruitment. This experiment seeks to link springtime angling pressure and catch rates to fall abundance of YOY largemouth bass.

PROCEDURES

In partnership with the Forest Preserve District of DuPage County (FPDDC) and the IDNR Division of Fisheries, nine FPDDC managed lakes were selected for 2015 creel surveys and fall recruitment assessments. Creel surveys were designed and implemented jointly by project personnel and FPDDC personnel, and recruitment assessments are planned for the fall of 2015.

FINDINGS

Creel surveys were initiated in May of 2015, and only a limited amount of data has been collected prior to the end of the current project segment. Full analyses will be reported in Segment 29.

RECOMMENDATIONS

Aside from the benefit of determining the relationship between angling pressure on nesting bass and recruitment, this experiments serves as a pilot effort to reestablish creel surveys on inland lakes and streams in Illinois with the goal of reducing costs and securing quality creel data for use by fisheries managers. Project personnel should continue pursuing the development of

alternative methods of creel surveys with the coordination and support of the Division of Fisheries.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.12 – Whole lake experimental management of largemouth bass

Project personnel have documented that the angling of nesting largemouth bass causes individual brood loss and nest abandonment, thereby resulting in a decrease or complete loss of an individual's reproductive success (Suski and Philipp, 2004; Zuckerman and Suski, 2013; Zuckerman et al., 2014). In addition, it has been shown that in small experimental ponds, individual brood reduction (manual removal of 50% of the eggs) results in a reduction in pond-wide recruitment that approaches 50% (see Experiment 3.9). Additional investigations utilizing natural populations accessible to the angling public would further evaluate the negative impacts of angling nesting bass on reproductive success and recruitment in a realistic management scenario.

PROCEDURES

Project personnel initiated a whole lake experiment in a series of four privately owned natural lakes utilizing two bass management scenarios that were alternated each year. The first management scenario included a closed season for bass, wherein no angling is allowed in the lake until the fourth Saturday in June, at which point bass angling is all catch and immediate release. The second management scenario allowed catch-and-immediate-release angling during the entire season. Angling pressure on nesting bass was applied by both project personnel and by members of the public, anglers who were recruited for the experiment. The relative recruitment for each year was determined the following year by visual observations of age-1 largemouth bass conducted by project personnel. For the study, there were four years each of angling and no angling during the spawning season.

FINDINGS

This study has just completed the eighth year of data collection, and preliminary analyses of this long-term data show a strong negative relationship between the level of angling during the spawning season and year-class strength. In each of the four study lakes, recruitment was substantially higher during years when there was a closed season compared to the years when catch-and-release angling was allowed for the entire season (Figures 3.13.1 and 3.13.2).

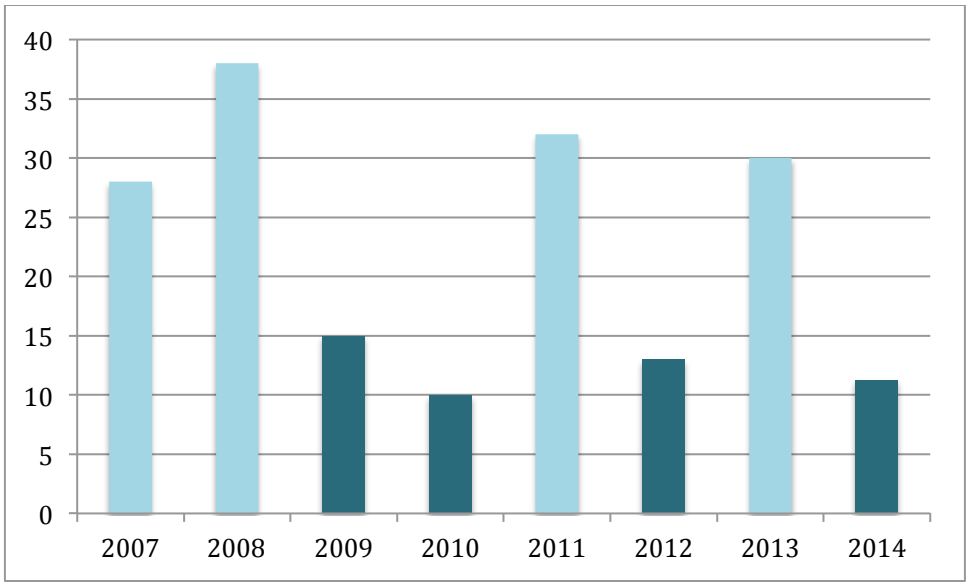


Figure 3.13.1. The pattern of recruitment for one of the study lakes with or without closed seasons during the spawning period: Each bar shows the relative recruitment in Mills Lake from 2007–2014—years with light blue bars had no fishing during the spawning season, whereas years with dark teal bars had C/R fishing during the spawning season.

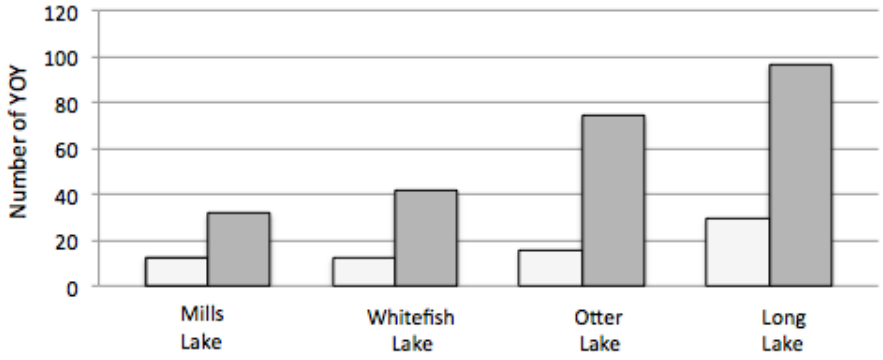


Figure 3.13.2. The pattern of recruitment in years that catch-and-release angling was allowed (light colored bars) and with closed seasons (dark colored bars) during the spawning period. Each bar shows the relative recruitment (number of 1+ LMB during visual surveys) averaged over the treatment years 2007–2014.

RECOMMENDATIONS

Further understanding of the recruitment dynamics for largemouth bass populations will continue to improve management goals and strategies for lakes throughout Illinois. The final results of this study clearly show that the angling of nesting largemouth bass during the spring spawning season has negative impacts on the resulting year class strength, which may be especially important for populations with high angling pressure and poor recruitment. Alternatives to current regulations that allow (or even promote) angling for nesting bass should be explored. These results are currently being prepared for publication in a peer-reviewed journal.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.13 – Lure recognition and hook avoidance in largemouth and smallmouth bass

Catch rates by anglers for black bass often decrease as the angling season progresses (Aldrich, 1939; Bennett and Durham, 1951; Anderson and Dillard, 1968). Many authors have postulated the mechanism for this declining catch rate to be learned lure recognition and/or hook avoidance (Aldrich, 1939; Askey et al., 2006). Hackney and Linkous (1978) reported that largemouth bass (*Micropterus salmoides*) can become conditioned to avoid live bait, but did not find that largemouth bass could be conditioned to avoid artificial lures. A study conducted by Bennett and Durham (1951), however, concluded that largemouth bass become wary of both natural and artificial lures with repeated hooking.

The ability of fish to learn (or not) has important implications into the degree to which angling could induce evolutionary changes in populations. The purpose of this experiment was to assess the ability of bass of both species to recognize a lure and learn to avoid it after 24 hours using nesting males of the two species. Long-term management strategies need to know how angling is affecting bass behavior and physiology (i.e., aggression, parental care, metabolism, etc.) if they are to be successful.

PROCEDURES

Using visual surveys by snorkelers, male largemouth and smallmouth bass that were guarding eggs or egg sac fry were located. Individuals were randomly assigned to one of two treatment groups and were angled on two consecutive days (Table 3.14.1). The first treatment group alternated lure types (ALT) between the first and second days, and the second treatment group were presented a constant lure type (CLT) across both days. For each treatment group, 15 male bass of each species were captured on day one within five casts with a 10cm floating silver stick minnow, and 15 male bass of each species were captured within five casts of a jig with a white twister tail. On day two, the ALT group was presented with five casts using the alternate lure (i.e., fish captured using the silver stick minnow were presented with white jig and *vice versa*). The CLT treatment group was presented with the same lure type on both day one and day two (i.e., fish captured using the silver stick minnow were presented the minnow again, and similarly with fish captured using the white jig). The percentage of males that hit the CLT treatment lure versus the ALT treatment lures within those five casts was compared.

Table 3.14.1. Experimental design for testing daily lure recognition of nesting male largemouth and smallmouth bass. Each set had the same sample size of fish (n= 15). Lures were presented to individual fish a maximum of five times during each angling trial.

Angling Trials	Alternating Lure Types		Constant Lure Types (CLT)	
	Set 1	Set 2	Set 1	Set 2
Day 1	Rapala	White Jig	Rapala	White Jig
	↓	↓	↓	↓
Day 2	White Jig	Rapala	Rapala	White Jig

FINDINGS

Both species clearly showed the ability to recognize lures and to avoid hitting them within 24 hours of their initial angling event (Figure 3.14.1).

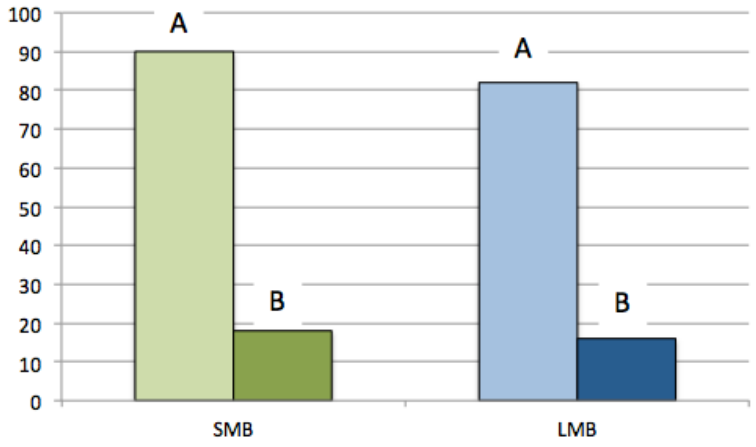


Figure 3.14.1. Percentage of nesting largemouth and smallmouth Bass that struck at least one of the five casts on day two. Lure presentations in the ALT and CLT treatments were as shown in Table 3.14.1. Only bass that struck a lure on day 1 with a Rapala or white jig were sampled on day 2. Sample sizes are shown on the individual bars. Different letters above each treatment indicates a significant difference. The ALT treatment group is the lightly shaded bar, the CLT treatment group is the darkly shaded bar.

RECOMMENDATIONS

Although it is clear that male bass have the ability to recognize lures and avoid them over a 24 hour period, it is not clear whether that learning ability is temporary or not. As a result, the

male's ability to remember lures after one year should be tested if we are to understand the learning process and how it may impact angling success and evolutionary change.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.14 – Relative growth and survival among artificially selected strains of largemouth bass

There has been much work documenting the behavioral and physiological traits of largemouth bass selected for their vulnerability to angling (Philipp et al., 2015). The purpose of this experiment was to assess the relative survival and growth of the two selected lines, as well as their two reciprocal F1 hybrids and F2 generation offspring from those two hybrid lines.

PROCEDURES

For this experiment, we bred in 2012 the following six specific lines of the selected Hi/Lo vulnerability largemouth bass using bass from the fifth generation as parents:

Pure High Vulnerability = HI
Pure Low Vulnerability = LO
HI X LO F1 Hybrid
LO X HI F1 Hybrid
HI X LO F2 Hybrid
LO X HI F2 Hybrid

In fall 2012, brood ponds were drained and equal numbers of equal sized juvenile fish of each of these six strains were stocked into four common garden grow-out ponds. Those ponds were all drained in late summer of 2013, 2014, and 2015 (in progress). Relative survival and growth for each strain is being determined for each pond during Year 2, 3 and 4 of growth.

FINDINGS

Final data analysis will be conducted in Segment 29, after common garden ponds are drained in the fall of 2015.

RECOMMENDATIONS

Understanding how aggression and metabolism combine to determine relative individual survival and growth will help us understand the impacts of fisheries induced evolution.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.15 – Physiological and behavioral correlates of catchability as assessed in a selected population of largemouth bass

Previous studies have detailed the existence of individual personalities (alternatively termed "behavioral syndromes") in various animal taxa (Sih et al. 2004, Bell 2005). It has also been postulated that the behavioral tendencies that make up a "personality" may have ecological consequences for growth and survival (Ioannou et al. 2008, Biro and Stamps 2008). The presence of behavioral tendencies that are consistent across situations must have a genetic and/or physiological underpinning, possibly involving metabolic rate (Stamps 2007) or hormone levels (with stress hormone responsiveness being tied to bold behavior in a "stress coping style", see Koolhaas et al. 1999). The subject of whether personality may impact the likelihood of capture via angling has been rarely studied and has been only recently explored (see Wilson et al. 2011, Harkonen et al. 2014, Biro and Sampson 2015). It is the purpose of this study to examine personality and some of its potential underpinnings (metabolic rate and cortisol responsiveness) to determine if they link with catchability in an experimental population of largemouth bass.

PROCEDURES

In May 2015, a set of largemouth bass were selected for angling vulnerability and put through a behavioral trial designed to assess individual boldness. Following the trial, the fish had their blood drawn both before and after an air exposure stressor to quantify baseline cortisol levels and cortisol scope. The bass were then put into a .13 ha pond at the INHS aquatic research facility, and after one month of re-acclimatization, the fish were angled using a standard protocol that randomized angler position and alternated among three common lure types. Once angling trials conclude, a subset of fish (representing multiple-recaptured fish and non-captured fish, regardless of selection line) will be taken and assessed for metabolic rate via flow-through respirometry.

FINDINGS

As predicted, high vulnerability bass showed greater boldness in behavioral trials than low vulnerability bass (linear mixed model, $p < 0.05$; Figure 3.16.1). The F2 generation hybrid fish (including reciprocal crosses High x Low and Low x High, bred to the second generation) showed moderate behavioral scores that fell between the High and Low Vulnerability bass. However, in contrast to the expectation that greater boldness would be coupled with lower post-stress cortisol levels as part of a "proactive" stress coping style (and vice versa as part of a "reactive" stress coping style), boldness scores were not correlated with individual cortisol values. As of July 2015, angling trials are still ongoing. Trials will be completed and metabolic rate data will be acquired by the end of August 2015, and results reported in future segments.

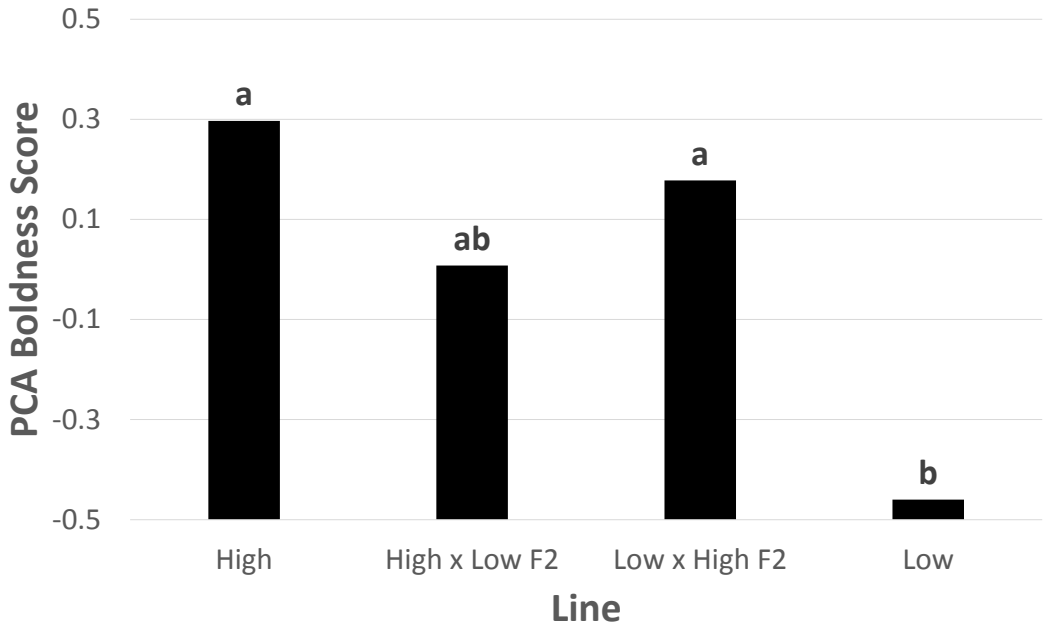


Figure 3.16.1. Boldness scores recorded following behavioral trials of selected lines of largemouth bass. Scores are values derived following extraction of a single component via principal components analysis. Lowercase letters indicate significant differences as determined via pairwise t-tests.

RECOMMENDATIONS

This dataset provides evidence that bold phenotypes may be especially vulnerable to capture by angling. Full conclusions from this study, such as whether metabolic rate is the major driver of vulnerability, will be made following the conclusion of the experiment in August 2015. If this turns out to be the case (with metabolic rate tied to general boldness as well as catchability), then managers should be aware of the impact of selective harvest on fish populations (since metabolic rate is tied to growth and numerous ecological behaviors) and should consider efforts to control not only harvest, but catch-and-release angling during nesting periods, during which time temporary removal can result in the loss of offspring of individuals with bold phenotypes via brood predation.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.16 – Determination of genes associated with increased vulnerability to angling in largemouth bass

The population of selected largemouth bass at the INHS aquatic research facility provides a unique opportunity to conduct studies examining the genetic underpinnings of vulnerability to angling. While targeted approaches such as real-time qPCR expression studies have value, recently developed next-generation transcriptome sequencing methods provide the potential to evaluate the entire transcriptome of subjects and cast a wide net in the search for putative genes underlying a behavioral pattern. With this in mind, this study utilized one of these methods (RNA-seq) in order to determine the genes that may be expressed in response to a fishing lure stimulus, as well as latent differences in gene expression between the high and low vulnerability bass held at INHS.

PROCEDURES

In December of 2014, a set of largemouth bass from the selected lines (12 high vulnerability, 12 low vulnerability) were collected and allowed to acclimate to a temperature of 15°C. The fish were broken into two sets (to be run one after the other), each consisting of 6 high vulnerability and 6 low vulnerability bass. The day before the experiment commenced the fish in a set were moved into one of three 150-gallon tanks (2 highs and 2 lows per tank) and kept overnight. The following day, a simulated angling event was introduced to two of the tanks (with the first tank serving as a control) during which a bass fishing lure (a 4" yellow soft plastic worm) was repeatedly tossed into the tank from behind a blind for a period of 15 minutes. Once this was completed, a period of time was allowed before all fish in the tank were netted and euthanized via overdose of MS-222. Control fish were taken immediately after "angling" concluded in the other two tanks; the second tank's fish were taken 30 minutes afterwards; and the third tank's fish were taken 60 minutes afterwards. The purpose of the 30- and 60-minute time blocks was to ensure that we harvested tissue that allows us to see gene expression in its fullness, as various genes may turn on and off over the course of time following a stimulus.

Once each fish was successfully euthanized, it was measured, weighed, and then dissected. The forebrain of the fish (telencephalon) was removed, as was the remainder of the brain, a piece of the axial muscle, liver, head kidney, and gill. RNA was extracted from the telencephalon tissue in January 2015 and subsequently purified to achieve high quality. Once RNA samples were extracted and diluted, cDNA libraries were constructed for each sample using the Illumina TruSeq™ kit, following the manufacturer's protocol. Individual libraries were uniquely indexed, and the samples were pooled together (8 samples per pool) before being sent to the Keck Center at the University of Illinois for sequencing (HiSeq 2500 high-thouroughput sequencer, 8 pooled samples per lane for a total of 3 lanes run). Sequence results were made available in .fastq format and were downloaded in May 2015.

FINDINGS

Approximately 24 million high quality individual reads of 100 base pairs each were sequenced. Currently the data is being held on file pending training by project personnel to enable data analysis. The training will take place in fall 2015, and the data will be analyzed to identify

differentially expressed genes (between lines and/or time-block treatments) before the conclusion of 2015.

RECOMMENDATIONS

The identification of putative genes that drive vulnerability to angling could serve as a valuable tool for fisheries managers. For instance, managers could potentially sample a population of fish and determine, based on the genetic makeup of the fish vis a vis the putative genes of interest, the overall vulnerability of the population and the extent to which fisheries-induced selection may or may not have altered the population of the water body in question.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.17 – Analysis of long term Lake Trout data in southern Lake Michigan

Data collected from Illinois DNR fall population assessments (Experiment 3.18) may provide insight to long-term trends in the lake trout population in southern Lake Michigan. However, a thorough analysis of these data has not been completed in recent years. The lake trout population has provided sufficiently high catch per unit efforts in the fall spawning surveys to create a stable population, and although there are peer-reviewed assessments of the status of lake trout in the Midlake and Northern Refuges where catches are lower, the population in southern Lake Michigan hasn't been examined and analyzed to date.

PROCEDURES

Project personnel gathered and analyzed lake trout stocking and assessment data spanning 15 years, from 1999 to 2014, to evaluate stocking numbers and progress toward rehabilitation of lake trout at Julian's Reef, a designated primary stocking site in Illinois. In addition, the relative abundance and sources of lake trout were compared between Julian's Reef (stocked) and an un-stocked nearby reef (Waukegan Reef) to assess population characteristics of spawning adults, including sex ratios, age, proportion of unmarked fish, and estimates of sea lamprey wounding rates.

FINDINGS

Data analysis was completed. Project personnel found no difference in relative abundance, hatchery origin, and age structure of the spawning population between the two reefs, however Waukegan Reef had a higher proportion of females present over the assessment period.

Progress is being made toward the rehabilitation goals for Lake Michigan lake trout based on the proportion of females present in the spawning populations, the contribution of older age classes to the adult spawning population increasing at both locations, and the catch per unit effort being sufficiently high at both Julian's and Waukegan Reef to support a self-sustaining population. There has also been an increase to ~50% of unclipped (non-hatchery) lake trout present in the survey in the last three years at both reef locations, suggesting that lake trout natural recruitment may be occurring in southern Lake Michigan. Determining the origin of unmarked fish is an important first step in documenting natural recruitment (e.g., spawning site and strain) of lake trout to better understand the effects of rehabilitation efforts. In addition, research assessing egg deposition and juvenile abundance is needed to evaluate lake trout reproductive success at southern reefs so fishery managers can assess if additional protective measures are required to sustain natural reproduction and whether stocking at sites with natural reproduction should be discontinued.

These findings have been presented at the Midwest Fish and Wildlife Conference and International Association of Great Lakes Research Annual Meetings, and a completed manuscript draft has been distributed for friendly review. Results will be submitted to a peer-reviewed journal in the fall of 2015.

RECOMMENDATIONS

F-69-R project personnel will incorporate the feedback from reviewers and submit the manuscript to *North American Journal of Fisheries Management*. Once complete, findings will be presented at the Annual Meeting of the American Fisheries Society.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.18 – Lake Michigan sport fish assessments

In June of 2010, project personnel began collaborations with the Illinois DNR Division of Fisheries to conduct research studies and management activities on Lake Michigan. Project personnel and DNR staff have begun identifying current and future research needs relative to Great Lakes sport fish restoration for consideration as specific activities in future segments. Project personnel have continued collaborations with the Illinois DNR Division of Fisheries to conduct research studies and management activities on Lake Michigan.

PROCEDURES

Project staff continues to assist with spring predator-prey index netting, yellow perch assessments, and data collection for a lake-wide predator survey, summer harbor electrofishing,

yellow perch beach seine netting, fall salmonid electrofishing, and fall lake trout spawning assessments.

FINDINGS

Project staff collaborated with Illinois DNR Division of Fisheries Lake Michigan Program staff to collect and analyze sport fish assessment data, the results of which are reported in DNR Lake Management Reports. 2014 fall harbor electrofishing saw a decrease in CPUE compared to 2013 at three of the four harbors sampled in Illinois. Processing of samples from spring index, yellow perch, lake-wide predator and summer harbors is ongoing.

Lake trout CPUE in the fall spawning survey remained high (58 fish/1000 feet of net/per day) and over half of the captured trout lacked a fin clip, indicating possible wild origin. In response to the appearance of a substantial portion of unmarked lake trout in fall samples, research into the origin of unmarked fish was initiated in 2013 (see Experiment 3.20 below). With unmarked fish representing greater than half of lake trout collected for a third consecutive sampling year, the ageing of unmarked lake trout otoliths has begun to determine age class structure on the unmarked population. Additional research plans focused on Lake Trout early life stages in southern Lake Michigan are in the initial stages of development.

RECOMMENDATIONS

F-69-R project personnel should continue coordinated data collection and analyses to support Illinois DNR management activities and research studies. F-69-R project staff will meet with Illinois DNR Fisheries Lake Michigan Program staff and staff from other Federal Aid Projects, such as F-138-R (Lake Michigan near-shore fish communities), F-123-R (Yellow Perch), and F-52-R (Lake Michigan Creel Survey) to determine additional knowledge gaps and research needs that can be addressed in the next segment of this project.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.19 – Lake-wide coded wire tag collection

In March of 2012, 2013, 2014 and 2015, an estimated 253,000, 228,000, 230,000 and 230,000 (respectively) Chinook salmon were tagged with coded wire tags at Jake Wolf Fish Hatchery (IDNR) as part of a lake-wide, inter-agency collaboration spearheaded by the U.S. Fish and Wildlife Service and also involving Michigan DNR, Indiana DNR, and Wisconsin DNR. Project personnel have coordinated collection of tag recapture data from tournament and other anglers who caught tagged Chinook salmon.

PROCEDURES

The U.S. Fish and Wildlife Service purchased automated tagging trailers to facilitate the Great Lakes mass-marking project. One goal of the mass-marking project is to implant every stocked Chinook salmon and lake trout with a coded wire tag, which will yield information on natural recruitment and movements throughout the lake, including within and between fisheries jurisdictions. Project personnel have assisted the IDNR with data collection efforts in the fall salmonid electrofishing survey and supervised a U.S. Fish and Wildlife Service technician participating in data collection at Illinois harbors.

FINDINGS

Collection efforts began in May and continued through the fall in each of 2013 and 2014, and began again in May 2015 for the season. In 2014, 41 lake trout were collected. A majority (61%) were stocked with a CWT (17) or lake-wide fin clip (8), with 39% of fish captured unmarked, indicating wild origin. Coded wire tag decoding indicated captured lake trout were originally stocked into Illinois (56%), Wisconsin (38%), and Michigan (6%) waters of Lake Michigan. Data collection for this project occurred simultaneously with fall harbor sampling conducted by the IDNR targeting returning salmonids to stocked harbors, and as of November 2014, 1027 Chinook salmon were sampled. Of those, 487 (47%) contained coded wire tags. Most Chinook salmon (41%) captured in Illinois waters of Lake Michigan came from Wisconsin waters, with 23% coming from Illinois, 21% from Michigan, 8% from Lake Huron, and 7% from Indiana. Approximately half (52.4%) of the Chinook salmon captured were unmarked, indicating fish of natural origin are found in Illinois waters.

Natural reproduction and migration of fish between Great Lakes is something all agencies will need to continue monitoring if reducing the predator burden on alewife (Chinook salmon's main prey fish) populations continues to be a management priority. Additional data for 2015 has been collected, and will be analyzed when sampling concludes in November 2015. Project personnel participated in summer and winter Lake Michigan Technical Committee Meetings as a members of the Salmon Working Group to facilitate collaboration.

RECOMMENDATIONS

F-69-R project personnel should continue working with agency staff to assist the U.S. Fish and Wildlife Service with collecting data for this study. Personnel should continue to attend the Lake Michigan Technical Committee Meetings to discuss findings and collaborate with other agency personnel to determine if additional research questions should be explored.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 3.20 – Identification of lake trout origin

In response to the appearance of a significant portion of unmarked lake trout in fall spawning assessments at Illinois reefs, a proposal was developed and submitted to the USFWS CFDA Program 15.662 to utilize otolith microchemistry to determine the natal origin of unmarked fish. The proposal was successful and an award was issued on July 2, 2013 to J.A.S.

PROCEDURES

Lake Trout heads have been collected from Jordon River, Pendellis Creek, Marquette, and Iron River Hatcheries. Heads were also collected in fall surveys of marked and unmarked lake trout in Lake Huron and Lake Michigan. Otoliths were removed by staff at the IDNR Lake Michigan project office before being sent for trace element and stable isotope analysis. All analyses are completed.

FINDINGS

Under the USFWS CFDA Program 15.662 project funded to J.A.S., the stable isotopic and trace element signatures from all potential lake trout sources have been characterized. Data clearly show that unmarked adult Lake Trout collected in southern Lake Michigan fall gill net surveys are not of hatchery origin, demonstrating successful natural reproduction and recruitment to the adult stage. A full report summarizing project results was finalized in January 2015 and submitted in support of the originating project, and a manuscript for peer review is near completion.

RECOMMENDATIONS

Given the completion of the originating project, personnel associated from this project have terminated work related to this experiment, and no further reporting 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 3.21 – Modeling sport fish distributions in response to climate change

Project activities have been completed under this collaborative experiment with the Landscape Conservation Cooperative project "Predicting Climate Change Effects on Riverine Aquatic Insects Using Museum Data and Niche Modeling." Results were reported in the Segment 26 Annual report. Further, a manuscript has been submitted and is currently in review with the *Canadian Journal of Fish and Aquatic Sciences*.

WILDLIFE TRACS ACTION LEVELS

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

JOB 101.4 – INFORMATION MANAGEMENT SYSTEMS SUPPORTING ONGOING FISHERIES RESEARCH

OBJECTIVES

The following components constitute the overall objectives for Job 101.4:

- Update and enhance information systems for managing and delivering fisheries data and analyses to data users and provide supportive information on sport fish population assessments to ongoing Federal Aid projects and other federal and state fisheries projects annually

PROCEDURES

Access to fisheries data sets and the efficient and coordinated management of those data sets are critical to the successful completion of all aspects of Project F-69-R. As project staff seek to utilize existing fisheries information and ensure that future data collection meets the needs of this and other federal- and state-supported fisheries research, continued access to sport fish data sets are required.

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 are developing online data browsing tools for use by project personnel to support activities in Job 101.1, Job 101.2, Job 101.3, Job 101.5, Job 101.6, and Job 101.7.

FINDINGS

All available 2014 Fisheries sampling data was added to the statewide datasets, along with all submissions of corrections and additions to earlier data. The largest submission was the historical Mississippi River minnow seine samples. This new addition brought the number of samples in the large rivers dataset to 6464, up from 3891 samples in last year's release. An error-correcting statewide dataset batch mechanism was created and used for the assembly of the 2014 sampling data.

The data analysis software tool METRICS was adapted to run conveniently on the new Fisheries field computers. Menu selections were added for functions that were not accessible via the default on-screen keyboard and stylus/finger gesture support was improved. A new computer data entry mechanism was created that closely resembles current field sheets for fish data. It includes error detection and correction functions, and was designed to be easily extensible regarding new fields and tables. The data tables supporting METRICS tables are generated automatically from this single form.

In coordination with Illinois Division of Fisheries Hatchery Program, an online hatchery management web application was developed to plan and track fish production and stocking activities in state-run hatcheries in Illinois. The Hatcheries Information Management System (HIMS) provides the Division of Fisheries easy access to hatchery production planning tools, data entry functionality to maintain state stocking records, and historical data archiving for use in evaluating long term trends and incorporating stocking data into research and management activities. This node of a multi-faceted improvement to management of Sport Fish Data Sets is completed, allowing for work on the development and integration of data collected during surveys and inventories to be integrated into the system.

Sport fish data sets utilized by project personnel come from a variety of relatively isolated sources (e.g., creel surveys, lakes surveys, streams surveys), and the many sampling sites within those data sets continue to lack adequate geospatial referencing to support Project F-69-R objectives. Some progress has been made in capturing geospatial data but additional focus on this task is needed.

RECOMMENDATIONS

Efficiently integrating sport fish data sets is a difficult endeavor that requires the continued attention of F-69-R project personnel and a strong collaborative partnership with IDNR Division of Fisheries. Development of the "Lakes" node should be developed and beta testing conducted during Segment 29. Additional nodes should begin to be developed thereafter. Additionally, project personnel will explore collaborations with IDNR units, as well as other state agencies, to assemble geospatial referencing information about sample sites that is currently missing from sport fish data sets. Geospatial data, along with information about sport fish populations, can then be integrated more efficiently into information delivery systems to the sport fishing public, primarily through activities incorporated into Job 101.5. 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.

Delays in software development continue to slow progress towards an expanded web-based data management system. Shrinking project budgets have been a factor, as have the advanced skills required to develop web-based data management tools, as current project staff are not trained in advanced technologies required to develop integrated systems. Utilizing project funding to support an experienced programmer who can expedite the completion of this project is intensely warranted, but budget constraints limit our ability to commit full time programmer to the task. Utilization of existing University of Illinois staff on an a part time, excess service basis facilitated the completion of HIMS in Segment 28, and will likely be necessary in future segments.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data collection and analysis
Action Level 2: Database Development and Management

JOB 101.5 – SUPPORT AND ENHANCE WEB INTERFACE

OBJECTIVE

The following components constitute the overall objectives for Job 101.5:

- Enhance and maintain a web interface for the dissemination of sport fisheries data and analyses to the public, and develop additional site enhancements upon request of the Division of Fisheries annually

PROCEDURES

Project personnel continually work to improve and add features to the www.ifishillinois.org website to make it the one-stop, go-to site 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 profile pages with an expandable map and a fishing forecast as provided by IDNR biologists; river profile pages; Family Friendly fishing information; IDNR fishing programs; angling-related event calendar; and trends in fishing quality. The "contact us" feedback form continues to connect us with Illinois anglers who can directly ask questions related to fishing in Illinois. In addition, project personnel continue to produce improved maps for our most-visited lakes, provide information on the latest news releases from IDNR, and keep all timely information up front and up to date. Newly in development for this segment on the www.ifishillinois.org website are an online IDNR Tournament Information System, an Invasive Species Information section, and a section on bank fishing opportunities in Illinois.

Project staff continue to maintain and enhance the www.ifishillinois.org website as the primary method for providing online information about sport fishing opportunities to the public. These efforts provide sport fisheries-related information that is readily available to the public and continues to provide immeasurable benefit to current and prospective anglers in Illinois.

FINDINGS

Improvements and Additions to www.ifishillinois.org

ILLINOIS DNR FISHING TOURNAMENT PERMIT INFORMATION SYSTEM

At the request of the IDNR, project personnel has been working to implement an online Fishing Tournament Information System for handling both tournament applications by anglers and online tournament approval by IDNR staff. This system will enable 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 will be able to approve

or deny permits online, have an online listing of all tournaments taking place on Illinois waters, and access all catch data from tournaments to better manage the Illinois fishery resources.

Bank Fishing Opportunities in Illinois

At the request of IDNR, project personnel have been developing an online bank fishing section for Illinois waters as compiled by IDNR County Fisheries Biologists. This section includes such information as location by county, handicap accessibility, and camping and picnicking opportunities.

Lake Profile Pages

This segment over 100 lake profile pages were updated with the most current fishing prospects and lake information, based on the expertise and recent data collected by IDNR fisheries biologists in their Lake Management Reports. Most lake profile pages include a map that is expandable when clicked upon (for all lakes for which maps were available from IDNR). In addition, project personnel continue to create new lake maps for our most-visited lakes. These new maps give anglers improved orientation, provide bathometry information, and clearly show location of boat ramps.

Many lake profile page includes a "fishing forecast," which integrates information provided by IDNR fisheries biologists, including fishing tips. Current fishing reports are embedded on these pages for easy access by anglers. Project personnel have developed two tools for IDNR biologists to enhance these pages: a simple form for both submitting new profiles for water bodies not currently on the site and for editing existing profiles and a "biologist tip" form to add tips to a specific page:

As discussed in the last segment's report, project personnel developed an easy-to-use, online data entry for IDNR biologists to enter new lake profiles to the existing database, as well as to edit data for existing lake profiles. The waters table is embedded, allowing a biologist to quickly look-up the water body for which data is being entered. Biologists can enter data regarding the physical aspects, the location, history, amenities offered, and most importantly, the status of the various fish species found in the lake. In addition, biologists can easily edit existing lake profiles, allowing them to adjust such variables as species in the lake or amenities available while maintaining sections that require no changes.

Project personnel have made it possible for IDNR biologists to add a "biologist tip" to a specific lake page. This is a feature whereby biologists have the opportunity to "tip" anglers to anything related to a specific lake, such as which species are biting that week on what bait or which area of a lake is having the most success. At present, this feature is underutilized, but has great potential for keeping the lake information up to date.

New lakes have been added to the site as per the latest IDNR Lake Management Reports. Currently, the www.ifishillinois.org website lists 251 Illinois lakes and reservoirs. An additional 31 water bodies were added in this segment. 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

Project personnel receive, on average, 10 inquiries per week from Illinois anglers, all of which are answered within 24 hours. Questions range from anglers requesting information about licensing, stocking, regulations, etc., to public libraries asking to be Urban Fishing centers or have summer program support, to CPOs alerting us to changes needed on our site. Project personnel either answer these questions directly or forward them to the appropriate personnel—their IDNR County Fisheries Biologist, the IDNR outreach contacts, or the Assistant Chief of Fisheries. This form has become an invaluable communication channel between IFishIllinois and the public at large.

Fishing License Button and Analytics

To ensure that every angler can easily access the DNR online fishing license sales page, we added a "Buy a Fishing License" button last segment throughout the site. The "Buy a Fishing License" button enables project personnel to track the number of click-throughs from IFish to the DNR license purchase site. In this segment, the button was clicked 11,047 times.

PDF Analytics

Google Analytics provides an opportunity to know what information is of the most interest to our users. Project personnel can track PDF downloads, making us aware of which PDFs are most popular, gaining good insight into subject popularity and where we can use placement improvements on our site. This is a helpful tool for developing new materials for the IFishIllinois website based upon those areas of interest to anglers. Project personnel have organized PDF downloads available on www.ifishillinois.org into one publications library, so they are easily found and accessed. The Fishing Regulation book, the listing of fish dealers and river fishing guides are among the top downloads.

Invasive Species

Project personnel continue to work with the Illinois-Indiana Sea Grant staff to include information about Invasive Species in support of the Be a Hero, Transport Zero campaign. Currently in development is a new site section on invasive species, including approximately 20 common plant and aquatic invasives, which features pictures of the invasives and basic information. This will be fully implemented in the next segment.

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. As of this report date, IFishIllinois has 1877 "likes" on Facebook (a 101% increase over last segment) and 239 Twitter followers (an 82% increase), both showing steady growth.

Facebook is a unique vehicle in that you can reach many more people above and beyond those who have "liked" your page. One example of a social media success story was our post regarding new catfish regulations. This post reached 141,248 people, had 930 shares, 285 likes and 138 comments, many of which required answers or comments through project personnel (Figure 5.1).

In addition, 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 5.2) 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, 2014 – June 30, 2015, ifishillinois.org had 412,996 sessions, 282,333 users, and a total of 1,434,093 pages viewed (previous segment: a total of 1,299,355 pages viewed).
- On our most visited day, 10,054 visitors viewed our site in a 24-hour period. The site averages 1300 visitors each day from May – August.
- Each visitor views an average of 4 pages per visit.
- 73% of our users are from Illinois.
- 46% are mobile (compared to 34% last year).

CONTENT INFORMATION

- The Lake Profile Selector Page is the most-visited page, followed by the Weekly Fishing Report page.
- The Sport Fish of Illinois page is our 3rd most popular page, with largemouth bass being the most researched fish.
- Our top 5 most visited water bodies: Fox River, Fox Chain O' Lakes, Rock River, Heidecke, and Busse.
- The Kids Fishing pages continue to be in the top 10 most-visited pages on our site.

Outreach Materials

To promote the IFishIllinois website, project personnel presented a poster at the National AFS Meeting in Quebec in August 2014 and the Midwest Fish and Wildlife Meeting held in February 2015 in Indiana. Additionally, a poster promoting the IFishIllinois website was developed and is currently on display as part of a fishing exhibit in the Navy Pier Children's Museum in Chicago.

RECOMMENDATIONS

Overall, the IFishIllinois website is quite popular among Illinois anglers. Project personnel will continue work in Segment 29 to expand timely information to Illinois anglers, including a new section on invasive species information as discussed with the Illinois-Indiana Sea Grant staff, improved site maps for lakes in Illinois (in order of popularity), My First Fish photo pages for kids, and endangered species information.

The online Fishing Tournament Information System will launch in the fall of Segment 29, as will the Bank Fishing Opportunities in Illinois site section. In addition, project personnel will continue to work toward a dynamic map of Illinois whereby site-specific areas can be easily displayed for water bodies.

The Kid's Fishing section of IFishIllinois continually ranks in the top 10 most-visited pages. Project personnel has worked to obtain photo releases for pictures of children anglers in Illinois, which will culminate into a "my first fish" section on IFish with links to the junior angler awards.

Project personnel will look into having specific sections of the Regulations Guide, including site-specific regulations, available as part of our site rather than an entire download, which will greatly benefit mobile users.

As mobile users continue to grow, project personnel will work with DNR leadership to determine if development of a mobile application would be beneficial for Illinois anglers. Though the IFishIllinois site is workable in its current format for mobile users, project staff will explore the feasibility of developing a truly mobile-ready site and will investigate the feasibility of developing a true mobile application for smart devices.

Project personnel will continue to use Facebook and Twitter to provide timely sport fish information to the public. This includes information from IDNR news releases; angling opportunities, including tournament information and IDNR-sponsored events; site closures; etc. Project personnel will also continue to use the Twitter feed to report sport fish-related items of interest "live" from any sport fish-related conferences they may be attending. In addition, project personnel will work toward branding IFishIllinois through consistent messaging and a distinctive logo.

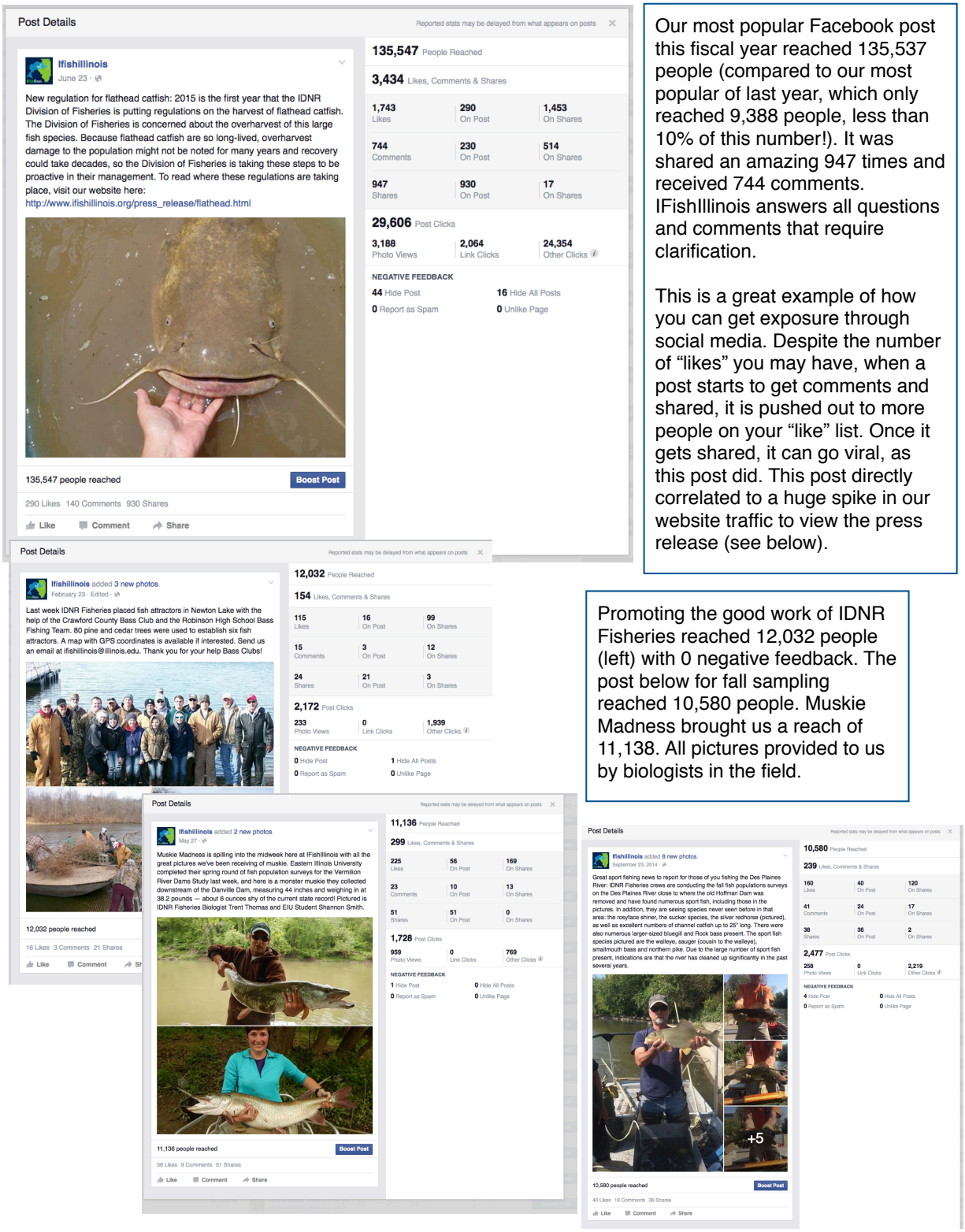
Project personnel will continue to monitor communications from anglers and bring issues to the attention of the IDNR Division of Fisheries.

Project personnel will also continue to encourage biologists to use the "biologist tip" for communicating lake information to anglers in a timely manner.

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. Further integration of fisheries information from data sources including coordination conducted under Job 101.4 of Project F-69-R will provide science-based information for anglers and managers alike. As the development of the Fishing Quality Index proceeds in future segments under Job 101.1, its inclusion in web pages profiling individual lakes as well as statewide status reports will further enhance the quality and quantity of information provided to the angling public.

WILDLIFE TRACS ACTION LEVELS

Action Level 1: Education
Action Level 2: Student Training



Our most popular Facebook post this fiscal year reached 135,537 people (compared to our most popular of last year, which only reached 9,388 people, less than 10% of this number!). It was shared an amazing 947 times and received 744 comments. IFishIllinois answers all questions and comments that require clarification.

This is a great example of how you can get exposure through social media. Despite the number of "likes" you may have, when a post starts to get comments and shared, it is pushed out to more people on your "like" list. Once it gets shared, it can go viral, as this post did. This post directly correlated to a huge spike in our website traffic to view the press release (see below).

Promoting the good work of IDNR Fisheries reached 12,032 people (left) with 0 negative feedback. The post below for fall sampling reached 10,580 people. Muskie Madness brought us a reach of 11,138. All pictures provided to us by biologists in the field.

Figure 5.1: Screen shots from the IFishIllinois Facebook page, demonstrating how project personnel provide angling information, track the online audience, and respond to inquiries from the public.

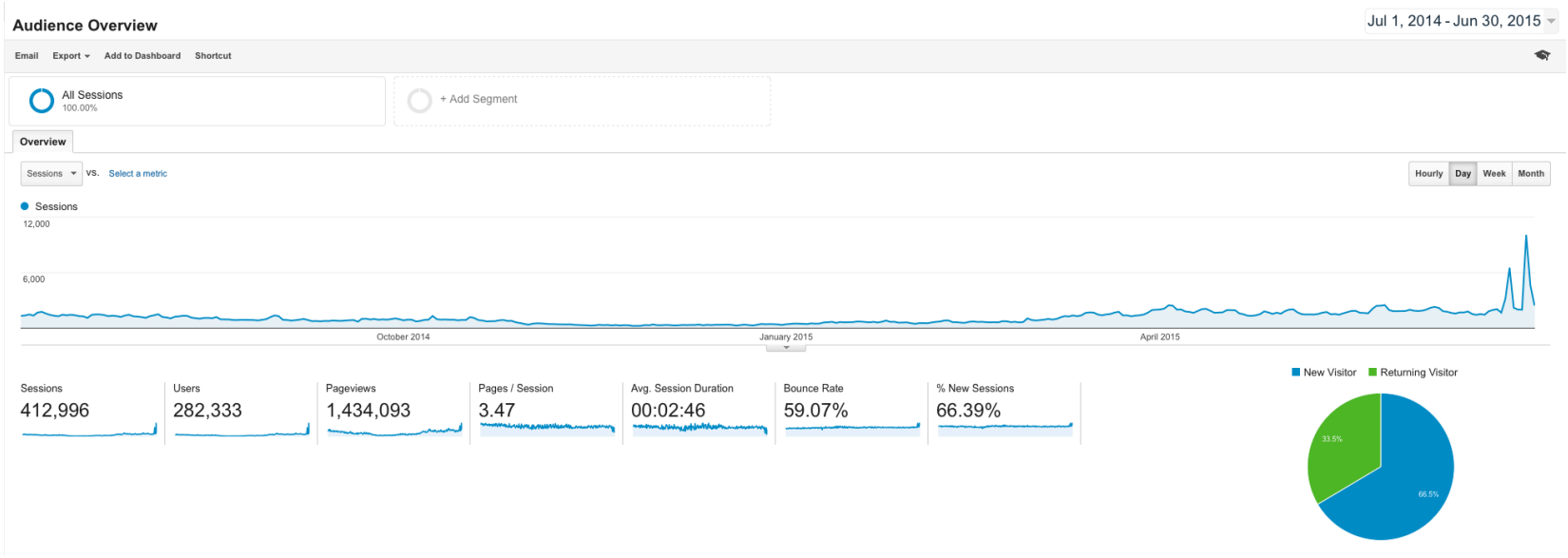


Figure 5.2: Overview of the number of daily visits to the www.ifishillinois.org during Segment 28 (July 1, 2014 – June 30, 2015). Note the spikes on June 25 and June 28th (10, 054 sessions). Both spikes are due to the flathead catfish regulation release. That Facebook post by IFishIllinois went viral over a few days time, as reflected in these spikes (press release on those days got 5172 views and 8413 view respectively).

JOB 101.6 – FISHES OF CHAMPAIGN COUNTY

OBJECTIVE

The following components constitute the overall objectives for Job 101.6:

- Complete data collection and analysis of changes in the distribution and abundance of fish species in Champaign County during the last 100 years and identify factors contributing to those changes by June 30, 2015

PROCEDURES

Project personnel began analyses comparing the fish communities of the headwater streams throughout Champaign County during Segment 28. Due to different sampling methods between the surveys performed by Thompson and Hunt and the following surveys, project personnel had to standardize the species densities based on sampling gear. Thompson and Hunt estimated the square footage of stream that were effectively sampled by each minnow seine haul. These estimations, along with the number of seine hauls performed at each site, allow for the calculation of the density of each species (fish/ft²) at each site. Subsequent Fishes of Champaign County surveys utilized a standard length of 150 feet of stream length and measured the average width of the stream site sampled. These measurements allow for the calculation of fish per square foot of stream for the remaining samples and create a standardized measure of fish density across all time frames.

The density of each species (fish/ft²) was calculated for each site sampled in the headwater streams of Champaign County. Each site was labeled based on the major drainage basin (Upper Mississippi or Wabash) in which it belongs. To determine the similarity among sites in each major drainage basin, a NMDS analysis was performed based on the density of each species at each site sampled. Additionally, an analysis of similarity was performed to determine whether fish communities across the major drainages were significantly different. These analyses were performed for each time period and compared to one another to determine if there has been a change in fish communities over the last 90 years.

FINDINGS

The NMDS plot analyzing the fish communities of each site found during the Thompson and Hunt survey in 1930 suggests the communities in the headwaters of the Upper Mississippi basin (Kaskaskia and Sangamon River basins) were clearly different from the communities found in the headwaters of Wabash River tributaries (Vermilion and Embarras River basins) (Figure 6.1). A similar configuration was apparent in the NMDS plots of the Larimore and Smith sample performed in 1959 (Figure 6.2). Although there is still separation between the major drainage basins in the plot of the 1989 Larimore and Bayley survey, the distinct separation of sites is not as

apparent as was seen in the previous two samples (Figure 6.3). The NMDS plot of the current survey shows an overlap of the fish communities of the two major drainage basins (Figure 6.4).

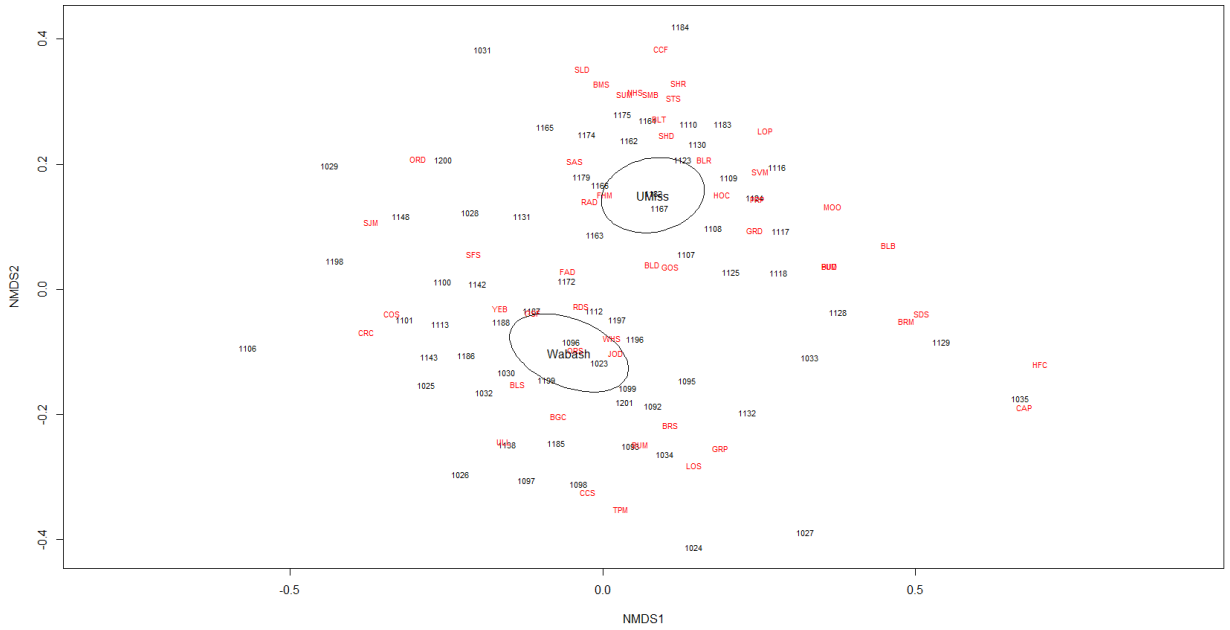


Figure 6.1. NMDS Plot of the density of fish species at each site sampled during the Thompson and Hunt survey of the Fishes of Champaign County. Red letters indicate the abbreviation of fish species. Black numbers indicate the sampling site number. Circles represent a 95% confidence ellipse calculated for sites in each major drainage basin.

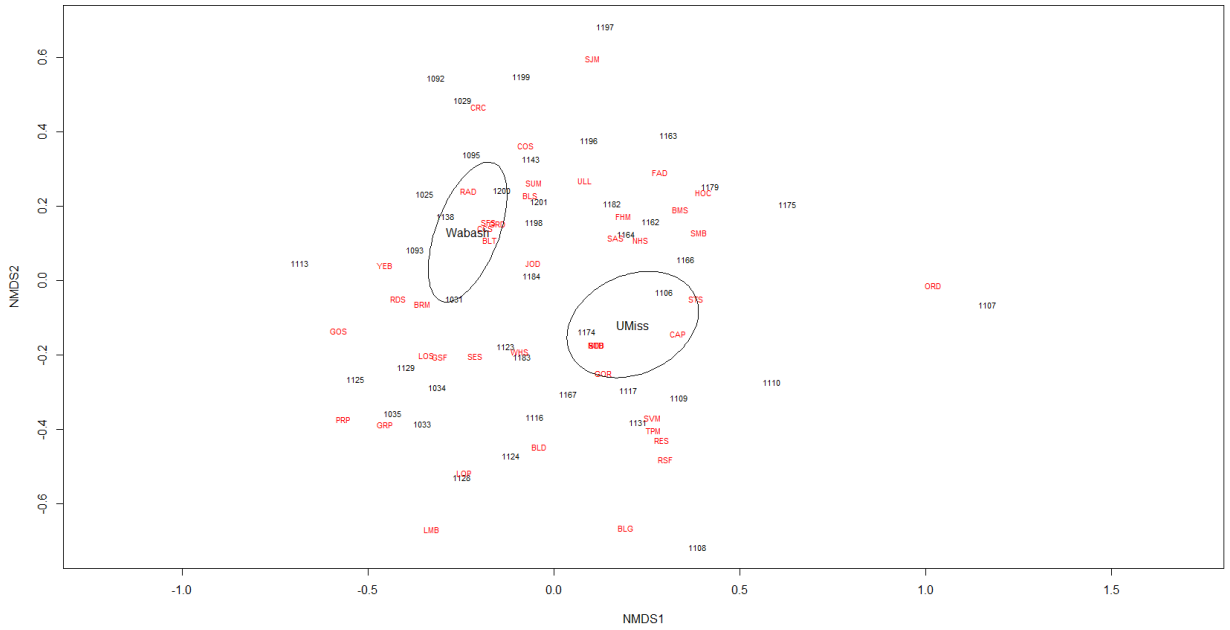


Figure 6.2. NMDS Plot of the density of fish species at each site sampled during the Larimore and Smith survey of the Fishes of Champaign County. Red letters indicate the abbreviation of fish species. Black numbers indicate the sampling site number. Circles represent a 95% confidence ellipse calculated for sites in each major drainage basin.

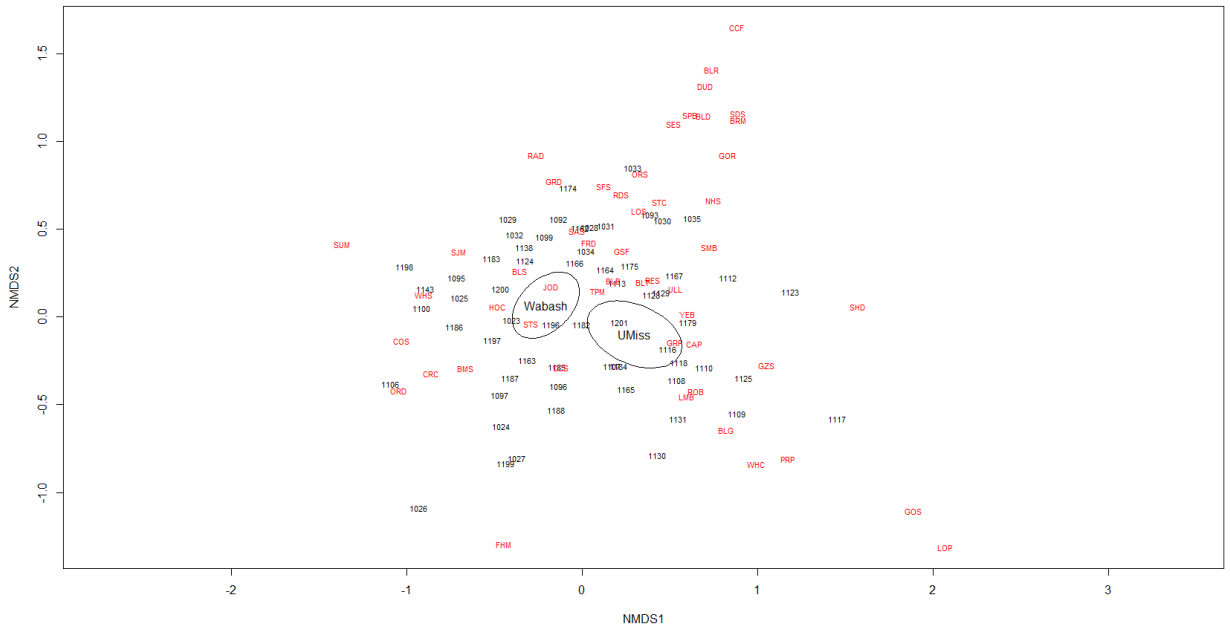


Figure 6.3. NMDS Plot of the density of fish species at each site sampled during the Larimore and Bayley survey of the Fishes of Champaign County. Red letters indicate the abbreviation of fish species. Black numbers indicate the sampling site number. Circles represent a 95% confidence ellipse calculated for sites in each major drainage basin.

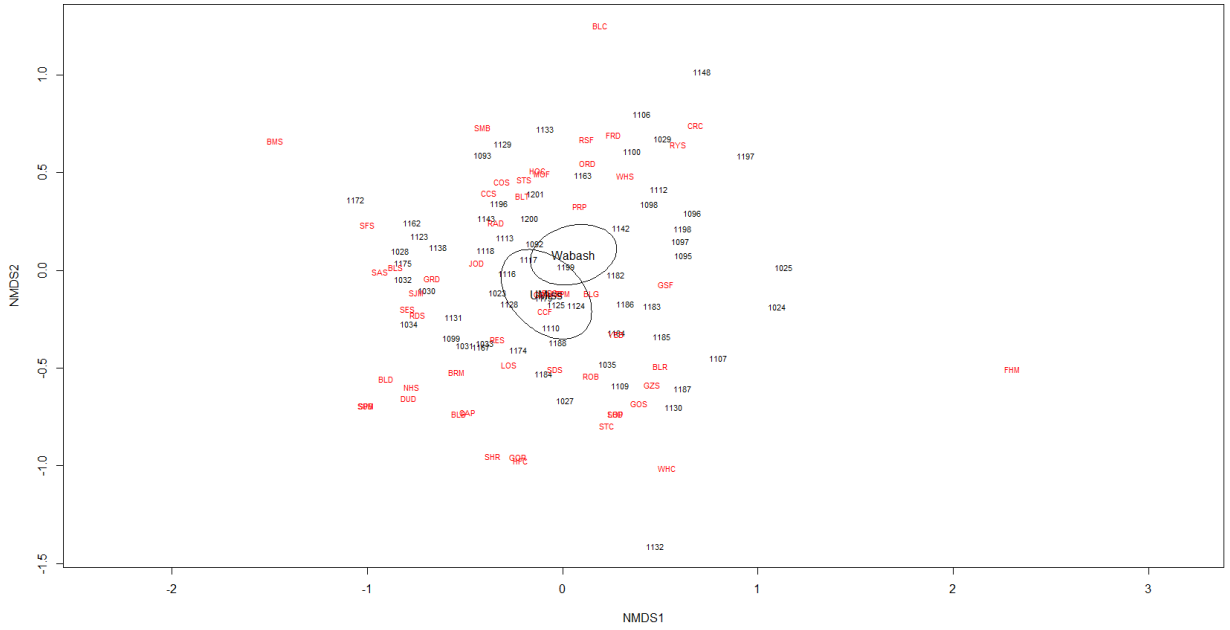


Figure 6.4. NMDS Plot of the density of fish species at each site sampled during the current survey of the Fishes of Champaign County. Red letters indicate the abbreviation of fish species. Black numbers indicate the sampling site number. Circles represent a 95% confidence ellipse calculated for sites in each major drainage basin.

The Analysis of Similarity (ANOSIM) for each time period tends to confirm the patterns found in the NMDS analysis. The ANOSIM of the samples performed by Thompson and Hunt had a sample statistic (Global R) value of 0.321 and a significance level of 0.1%. Five species were responsible for ~ 70% of the dissimilarity among major drainage basins in this sample where Striped Shiner (*Luxilus chrysocephalus*) and Horneyhead Chub (*Nocomis bigattatus*) were most abundant in the Kaskaskia and Sangamon River headwater (Upper Mississippi) and Bluntnose Minnow (*Pimephales notatus*), Silverjaw Minnow (*Notropis buccatus*), and Creek Chub (*Semotilus atromaculatus*) being more abundant in the Embarras and Vermilion River headwaters (Wabash) (Table 6.1).

Species	Mean Wabash Abundance	Mean Upper Miss Abundance	Contribution %
Bluntnose Minnow	1.5	0.42	19.65
Striped Shiner	0	1.06	16.85
Silverjaw Minnow	1.92	0.29	13.66
Creek Chub	0.89	0.4	11.92

Table 6.1. Average abundance and percent contribution of the top 5 fish species contributing to the differences between major drainages shown by the analysis of similarity performed on the Thompson and Hunt Fishes of Champaign County survey data.

ANOSIM performed on the subsequent Larimore surveys continue to suggest significant differences among the headwater fish communities of the major drainage basins (Global Rs of 0.263 and 0.317, Significance levels of 0.1% and 0.1% respectively). The five species found to be drivers of dissimilarity in the Thompson and Hunt survey were also found to be major contributors of dissimilarity in the Larimore samples, although the percent contribution of these five species declined in subsequent samples (Tables 6.2 and 6.3). The ANOSIM performed for the current sample of the headwater fish communities showed no significant difference among the fish communities in the major drainage basins (Global R 0.036, significance level 13.1%). Only 4 of 5 fish species found to be major contributors to the dissimilarities found during the Thompson and Hunt surveys were found to show any contribution to the ANOSIM of the current sample (Table 6.4).

Species	Mean Wabash Abundance	Mean Upper Miss Abundance	Contribution %
Bluntnose Minnow	1.53	1.57	15.5
Striped Shiner	0.4	1.9	11.93
Silverjaw Minnow	0.99	0.18	8.94
Creek Chub	1.88	0.34	18.37
Horneyhead Chub	0.1	0.48	3.75

Table 6.2 Average abundance and percent contribution of the top 5 fish species contributing to the differences between major drainages shown by the analysis of similarity performed on the Larimore and Smith Fishes of Champaign County survey data.

Species	Mean Wabash Abundance	Mean Upper Miss Abundance	Contribution %
Bluntnose Minnow	0.45	0.2	11.25
Striped Shiner	0.24	0.3	10.79
Silverjaw Minnow	0.19	0.02	5.27
Creek Chub	0.4	0.12	12.42
Horneyhead Chub	0.7	0.12	4.42

Table 6.3. Average abundance and percent contribution of the top 5 fish species contributing to the differences between major drainages shown by the analysis of similarity performed on the Larimore and Bayley Fishes of Champaign County survey data

Species	Mean Wabash Abundance	Mean Upper Miss Abundance	Contribution %
Bluntnose Minnow	0.3	0.53	19.28
Striped Shiner	0.15	0.1	9.58
Silverjaw Minnow	0.04	0	1.35
Creek Chub	0.03	0.02	3.58
Horneyhead Chub	NA	NA	NA

Table 6.4. Average abundance and percent contribution of the top 5 fish species contributing to the differences between major drainages shown by the analysis of similarity performed on the current Fishes of Champaign County survey data.

RECOMMENDATIONS

Upon completion of remaining sample sites in the late summer of 2015, project personnel will begin to analyze the full dataset from the current and previous surveys for preparation of an updated INHS Bulletin, peer reviewed journal articles, and professional presentations. Such analyses will allow project personnel to:

1. Determine changes in stream fish communities over the past century and explore causes that may have contributed to observed changes.
2. Advise fisheries managers on changes in stream fish communities and collaborate on future research to further explain mechanisms of change.
3. Provide an updated database of data collected from all Fishes of Champaign County surveys to current and future fisheries researchers.

WILDLIFE TRACS ACTION LEVELS

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

JOB 101.7 – RESTORATION OF URBAN STREAM SPORT FISHERIES

OBJECTIVE

The following components constitute the overall objectives for Job 101.7:

- Investigate factors affecting the re-establishment of sport fishes in a restored section of the West Branch of the DuPage River, DuPage County, Illinois annually

Experiment 7.1 – Impacts of restoration efforts on the sport fish and forage fish population in an urban stream

PROCEDURES

To evaluate the impact of restoration efforts in the West Branch of the DuPage River, an assessment of the abundance and distribution of sport fishes and, more broadly, the stream fish community was executed beginning in the fall of 2013 and repeated in the spring, summer, and fall of 2014, as well as the spring of 2015. Eight sampling sites on West Branch and eight on the East Branch of the DuPage River were selected to represent diverse stream habitats to ensure detection of the entire stream fish community assemblage throughout the study reaches.

High conductivity in both streams (overall mean = 1021 µs/cm) limited capture efficiency of the electric seine; therefore, sampling was conducted using two side-by-side backpack electrofishing units. Each sampling event consisted of an upstream pass followed by a downstream pass covering a 150' reach bound by block nets on both the upstream and downstream ends. All fish captured were identified to species, measured, weighed, and released back into the stream. All smallmouth bass measuring more than 200mm in length were externally marked with floy tags, and scales were removed for aging. Invertebrate sampling and water quality sampling was also performed at each site. QHEI scores were calculated for each site to evaluate habitat quality.

FINDINGS

In the summer of 2014, QHEI scores were calculated for all eight sites in each river. QHEI scores are calculated based on six individual metrics combining for a possible maximum score of 100.

The West Branch of the DuPage River had higher overall QHEI scores compared to the East Branch (Mann Whitney $U=57$, p-value < 0.01; Figure 7.1.1) likely the result of the physical restoration of the West Branch prior to this study. Differences in QHEI was driven by improvements in substrate quality, channel morphology, and pool/glide & riffle/run quality.

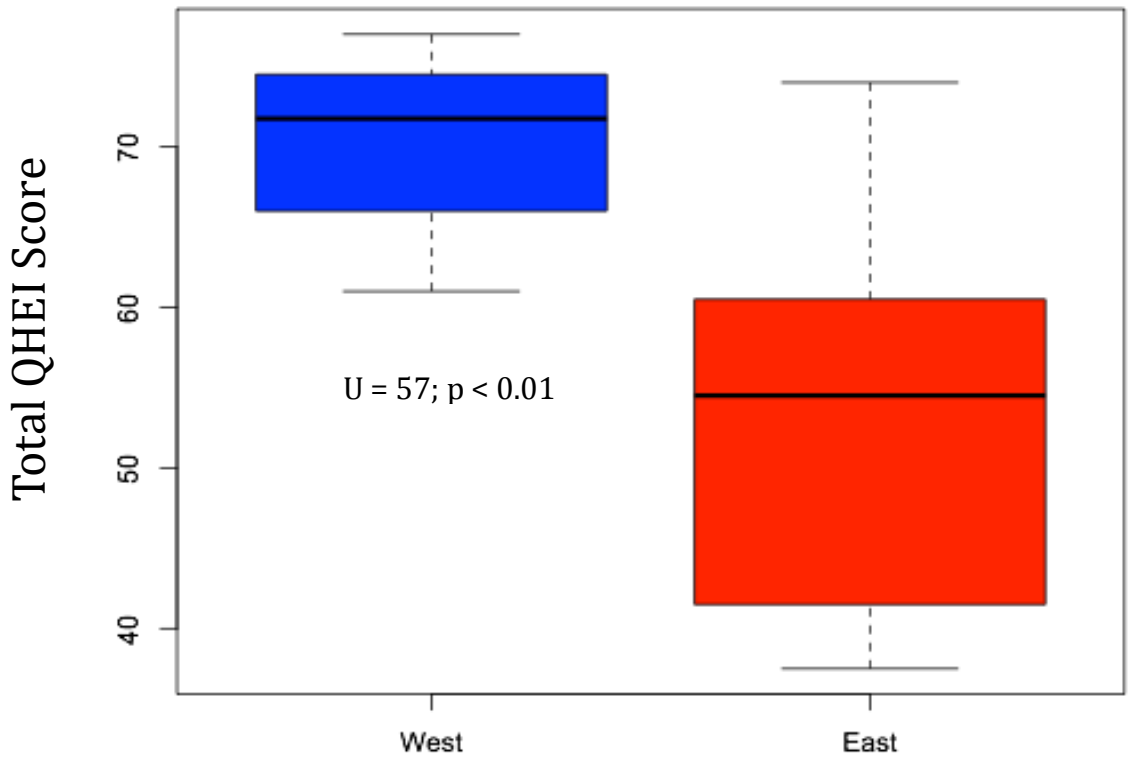


Figure 7.1.1. Boxplot showing total QHEI score for the West and East Branches of the DuPage River. Eight sites on each branch were scored using the Ohio EPA QHEI scoring system, and differences between the two branches were significantly different based on a Mann-Whitney U Test. Error bars represent 95% confidence limits around the mean.

The fish communities of the East and West Branches of the DuPage River were dominated by three species: green sunfish (*Lepomis cyanellus*), bluntnose minnow (*Pimephales notatus*), and bluegill (*Lepomis macrochirus*), with green sunfish making up almost 40% of the total catch over the 5 sampling seasons. A total of 10,234 fish representing 38 species were sampled over the course of this study. Conductivity was highly negatively correlated to species richness (r^2 = -0.41), as well as CPUE (r^2 = -0.529). Due to high conductivity in the spring and summer, those samples had lower species richness and lower CPUE (fish/hour). Comparisons between branches, therefore, were restricted to samples from the fall of 2013 and 2014. Species richness was higher on the East Branch than the West Branch in the fall of 2013, but there was no difference between the branches in the fall of 2014 (Figure 7.1.2).

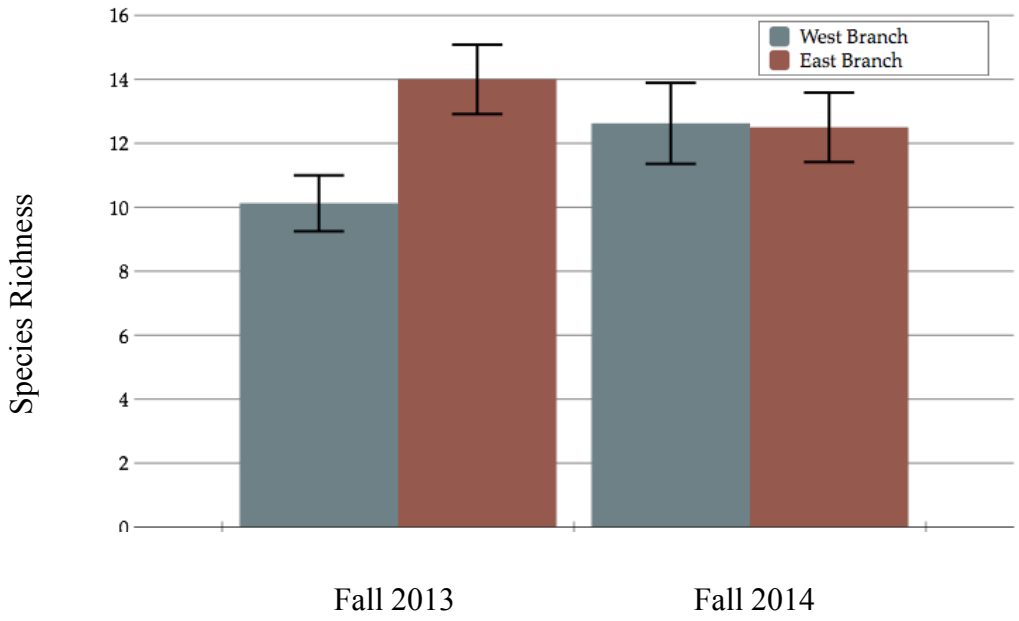


Figure 7.1.2. Comparison of species richness values on the West and East Branches of the DuPage River in the fall of 2013 and 2014. Error bars represent 1 standard error around the mean of eight sites on each branch.

Members of the Centrarchidae, including green sunfish, bluegill, largemouth bass, and smallmouth bass, dominated the fish community on both East and West Branch. Largemouth and smallmouth bass were the two major sport fish species occurring in our sampling, but did not comprise a large component of the community based on abundance. Largemouth bass were found in relatively similar numbers on both branches, while smallmouth bass occurred in much higher abundances on the West Branch in both 2013 ($p < 0.001$) and 2014 ($p < 0.001$). Both streams contained few adults, indicating that these headwater streams may be providing habitat four juvenile fish.

During summer 2014 sampling at Greene Valley Forest Preserve, the furthest downstream site on the East Branch, project personnel collected and identified the first documented occurrence of the invasive round goby (*Neogobius melanostomus*) on the DuPage River. In the summer of 2015 sample at the same site, five more round gobies were collected.

RECOMMENDATIONS

This study is scheduled to complete field data collection in the fall of 2015. Sampling of benthic invertebrates and abiotic factors have been collected and will continue to be processed and analyzed. Completion of this experiment is expected in Segment 29. Project personnel will continue to monitor the Green Valley Forest Preserve site for round goby on the DuPage River and will report any findings to the IDNR, USGS and DuPage County personnel.

WILDLIFE TRACS ACTION LEVELS

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

Experiment 7.2 – Habitat use of smallmouth bass (*Micropterus dolomieu*) in the restored reach of an urban stream

PROCEDURES

Project staff conducted field testing of acoustic telemetry tags and receivers to determine their range and effectiveness in the West Branch of the DuPage River. Tags were selected to incorporate the results of range testing, maximize probability of detection, accommodate the expected range of fish sizes, and maximize battery life of the acoustic tags. Vemco V9-2X type tags were selected to emit a low power acoustic signal every 60 to 180s, lasting 484 days and capable of being surgically implanted into fish >100g.

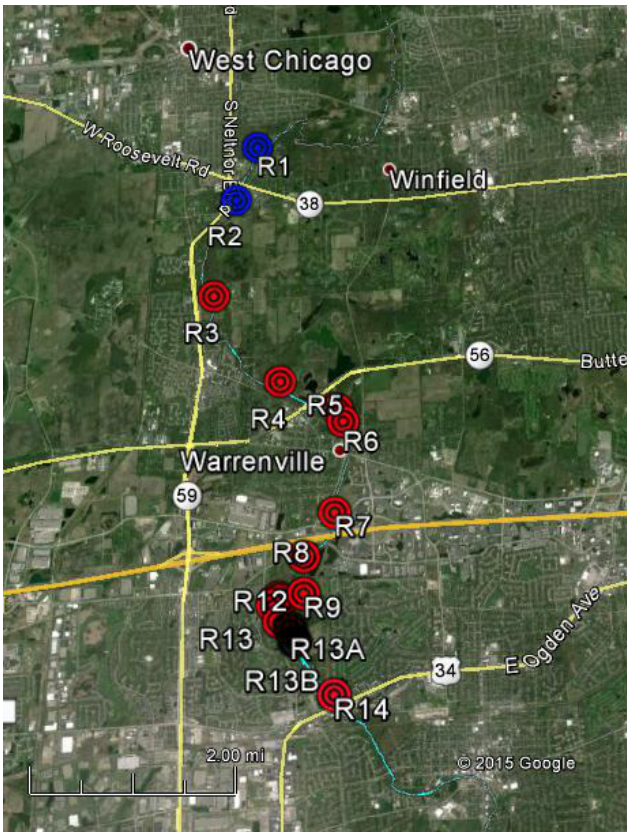


Figure 7.2.1: Configuration of passive receiver array in the West Branch of the DuPage River, including a table of detection data. Red represents receivers in place from July 2014 – present, blue from July 2014 – April 2015, and black receivers May 2015 – present.

An initial pilot study was undertaken on eight fish captured in October 2013, with an initial deployment of the VR2W passive receiver array in the river (Figure 7.2.1). Receiver data was retrieved, and the receivers were immediately returned to the river in April 2014. Additional smallmouth bass were implanted in April 2014 (n=9), July 2014 (n=3), October 2014 (n=3) and November 2014 (n=2). After initial analysis of receiver data, adjustments and additions to the configuration of the receiver array were made in July 2014. Furthermore, manual tracking of tagged smallmouth bass using a canoe and a VR100 hydrophone began in May 2014, and continued throughout the summer and fall of 2014. Preliminary analyses of the data collected from the passive receiver array (July 2014 – April 2015) and the manual tracking (May 2014 – December 2014) has been undertaken to assess the extent of upstream and downstream movement, areal extent of individual home ranges, the impact of sporadic high flow rates on smallmouth bass in this urban stream and fish residency around individual VR2Ws. Manual tracking continued starting May 2015.

FINDINGS

Most tagged smallmouth bass in the West Branch of the DuPage River remained within our research area for much of the study time. Both active tracking with a VR100 hydrophone on a canoe and passive tracking using an array of VR2Ws located permanently in the river were successful in capturing the temporal locations of these acoustically tagged fish. One fish, #11046, disappeared from the study early and was not located within the active tracking period (May 2014 to December 2014) or the passive tracking period (July 2014 to April 2015). Detection of each fish varied with one fish (#11059) detected more than 100,000 times (all at receiver 4), this fish was also actively tracked on 82.5% of the trips. Fish #11042 to #11049 were not detected after February 2015, which coincided with the estimated life of the acoustic tags.

Smallmouth bass in the West Branch of the DuPage River exhibit variability in home range size. Initial analysis showed that individuals #11043, 11045, 11046, 11047 spent all their time in a small home range (<1 km), while other fish traveled greater distances and explored smaller tributaries. These exploratory behaviors were typically short in duration and were followed by a return to a home range, often located at the capture/release site. Analysis of the passive array data found that many of the individuals (n=10) spent much of their time resident to individual VR2W receivers and/or areas of the stream (72.0 - 87.1% residency). Fish #11044 moved from McDowell Grove north to just below Warrenville Grove and then back, greater than 3 km, each way; and fish #11049 moved >1.5 km north to Blackwell Forest Preserve, then moved south to a position intermediate to the two locations. Data suggest that passage through Fawell Dam may be possible for smallmouth bass on the West Branch. Fish #11042 was tagged in October 2013, and in April 2014 was recorded passing the receiver below Fawell Dam. This fish was located in August 2014 back above Fawell Dam after a four-month absence from the receiver array and manual tracking ranges. The examination of home ranges of the smallmouth bass in the West Branch of the DuPage River has shown a variety of patterns. Deeper, wider reaches, such as some areas in McDowell Grove, seem to support multiple tagged adult bass, while other fish appear to move from one home range to another without much delay in between.

With tracking data that extended through three seasons, home range and movement data were evaluated by different groups. There were no detectible differences in home range areas among spring, summer and fall 2014 sampling periods (ANOVA; $P>0.05$) or by fish size group greater than or less than 400mm TL (ANOVA; $P>0.05$). While sizes of home ranges were not shown to differ in sizes from season to season, the locations of home ranges were shown to differ. For example #11058 had a home range that extended from receiver 6 in Warrenville Road to receiver 7, just north of Highway 88 for spring and summer 2014, but moved north between receivers 5 and 6 in Warrenville Grove in the fall. This change may have been a result of the fish moving a deeper area when water conditions get colder.

In relation to flood events, our results to date are inconclusive as to the impact on smallmouth bass. While some fish have been shown to move downstream after high flow events, other individuals have shown little movement or upstream movement. It does appear that some small tributaries, backwater areas and even some mainstream reaches become more accessible and likely more favorable habitat then the river is deeper.

Station	Receiver	Location	Detections	Total Fish	Fish Released
R1	122738	West DuPage Woods	0	0	0
R2	122739	Gary's Mill Road	0	0	0
R3	122740	Mack Road	0	0	0
R4	122741	Blackwell Forest Preserve	177392	4	3
R5	122742	Warrenville Grove North	76661	7	0
R6	122743	Warrenville Grove South	126877	7	7
R7	122744	Ferry Road	13819	4	0
R8	122745	McDowell Grove North	134	4	0
R9	125388	McDowell Grove Central	9541	3	0
R10	125389	McDowell Grove Side	5006	8	0
R11	125390	McDowell Grove Ramp	203263	11	15
R12	125391	McDowell Grove Bridge	366774	14	0
R13	125392	McDowell Grove South	16657	9	0
R14	125393	Fawell Dam	0	0	0

Table 7.2.1. Smallmouth bass detections at each of the VR2W receivers in the West Branch of the DuPage River.

RECOMMENDATIONS

This project has now completed a pilot phase and a full year of tracking data collection. Further data collection and the tagging of more smallmouth bass are needed to give a more complete examination of the population to analyze if the findings from one year are similar to the next year. With the summer of 2014 and spring 2015 being two of the highest rainfall years of recent record, the abilities of smallmouth bass to adapt to the high level flows would be more easily evaluated when compared to drier years. Furthermore, new hypotheses about the population structure of bass in the West Branch of the DuPage River are being developed and examined and should be addressed.

WILDLIFE TRACS ACTION LEVELS

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

Segment 28 Job Costs - Budget v. Actual

	Budget	Actual	Over/(Under)
Job 101.1 – Sport Fish Population and Sport Fishing Metric	$14,709	$15,680	$971
Job 101.2 – Enhanced Field Sampling of Sport Fish Populations	$189,261	$181,008	$(8,253)
Job 101.3 – Determine Factors Affecting Fishing Quality	$477,990	$475,003	$(2.987)
Job 101.4 – Information Management Systems Supporting Ongoing Fisheries Research	$122,275	$115,662	$(6,613)
Job 101.5 – Support and Enhance Web Interface	$112,856	$111,748	$(1,108)
Job 101.6 – Fishes of Champaign County	$60,110	$75,968	$15,858
Job 101.7 – Recovery of Urban Stream Sport Fisheries	$158,668	$136,263	$(22,405)
Total Costs	**$1,135,869**	**$1,111,332**	**$(24,537)**
Federal Share	**$851,902**	**$833,499**	**$(18,403)**
State Share	**$283,967**	**$277,833**	**$(6,134)**

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