Research and Analysis of Fisheries in Illinois

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EXECUTIVE SUMMARY

Fisheries managers are charged with understanding the interaction between sport fish populations and anglers to inform resource management decision making that 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 research studies 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 27 were executed under Job 101.1, Job 101.3, Job 101.4, Job 101.6, and Job 101.7. Summarized below, these studies were focused on five areas of sport fish restoration and management. First, development of a Fishing Quality Index (FQI) scoring model for largemouth bass (Micropterus salmoides) was completed and verified 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, two experiments studying the effects of catch-and-release angling were completed and results published in peer-reviewed journals. Experiment 3.8 determined the rate at which brood predators consumed embryos in a largemouth bass nest during a catch-and-release angling event, and Experiment 3.6 demonstrated that the size of the remaining brood was a factor determining abandonment decisions by a nest-guarding male largemouth bass. Three other experiments focused on the relationship between reproductive success and recruitment in the black basses. Experiment 3.3 and Experiment 3.4 are field studies investigating the correlation between recruit abundance and reproductive success in largemouth and smallmouth bass, respectively. Experiment 3.9 elucidates the role of brood loss on recruit abundance in experimental research ponds. Third, several studies were completed that investigated the physiological and stress-related responses by native sport fish (Lepomis macrochirus and M. salmoides salmoides) to environmental stressors, such as low oxygen and high carbon dioxide levels (Experiments 4.2 and 4.3). Fourth, field sampling in support of the next iteration of “Fishes of Champaign County” was continued under Job 101.6. Fifth, 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 and 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**

Using long-term sport fisheries data, project staff has completed testing a Fishing Quality Index (FQI) for largemouth bass. Fisheries-dependent data were assembled using creel survey data from 1990 – 2009 and collected in previous segments of Project F-69-R. Satisfaction scores of anglers who were expressly targeting largemouth bass were used as the response variable in the FQI scoring model. IDNR personnel gathered fisheries-independent data during fall boat electroshocking surveys, and common population metrics (PSD, average TL, CPUE, condition, and various RSDs) were used to create a scoring model based on the metrics that were most highly correlated with angler success ratings for largemouth bass (*Micropterus salmoides*). Largemouth bass FQI scoring models will now be verified with additional data, revised as necessary, and finalized. Additionally, FQI scoring models for bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), and crappie (*Pomoxis spp*) will be developed in the next project segment.

**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 2100 hours sampling the Sangamon River, Salt Creek, Rock River, Hennepin Canal, Green River, Central Mississippi tributaries, and the tributaries of
the middle Illinois River. 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 field studies examining processes that determine reproductive success in largemouth bass with the goal of gaining a better understanding how angling during the reproductive period may influence recruitment dynamics and ultimately fishing quality.

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 and 3.4). Further, brood predation during a catch-and-release angling event can happen rapidly, especially in systems with high densities of potential brood predators (Experiment 3.8). Such brood predation can lead to fewer recruits at the end of the first growing season (Experiment 3.9), and play a major role in nest abandonment decisions (Experiment 3.6). Together these studies show how angling is an important determinant of behavior, physiology, and recruitment dynamics in black bass, and how life history characteristics are critical factors in understanding variability in sport fish abundance and ultimately fishing quality.

**JOB 101.4  COORDINATION WITH ONGOING FISHERIES RESEARCH PROJECTS**

Project personnel continue to provide collaborative support for other federally funded research projects related to sport fish, primarily in two areas. First, project personnel assist with data collection and analysis for studies investigating the physiological impacts on native sport fish due to potential solutions dealing with Asian carp (Experiments 4.2 and 4.3). Second, project personnel have established a working collaboration with multiple state and federal agencies evaluating long-term trends in lake trout populations in Lake Michigan (Experiments 4.5, 4.6, and 4.9), as well as investigating the origins of unmarked adult lake trout captured in southern Lake Michigan (Experiment 4.8). These collaborations for important linkages facilitate the development of research questions that address sport fish management needs in Illinois.

**JOB 101.5  SUPPORT AND ENHANCE WEB INTERFACE**

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 27, the website had 273,972 visitors, with a total of 1,299,355 pages viewed, indicating a strong public interest in the information provided about fishing
opportunities in Illinois. To further promote fishing opportunities to anglers in Illinois, project personnel have employed social media tools (i.e., Facebook and Twitter) to develop online communities interesting in Illinois fishing.

**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. To date, 119 sample sites have been completed and approximately 12 sites remain to be sampled in fall of 2014. Over 35,000 individual fish have been collected representing 65 species.

**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 common Illinois sport fish species using fisheries data collected through standardized field sampling and creel surveys

PROCEDURES

Previous attempts by project personnel to relate largemouth bass angling success to angler catch found that angler catch only explained small amounts of variation in angler success scores. This suggests that there are other fisheries-independent factors that may affect an angler’s perception of whether his/her trip was successful. For example, climatic factors, such as air temperature, weather, and wind speed, could directly affect the angler’s perceived success rate. In addition, anglers who are not able to find a suitable angling location due to the number of other anglers utilizing the lake at the same time may rate their angling success low regardless of the number or size of fish angled by that angler. Finally, limnological factors, such as secchi depth and water temperature, may operate as indirect effects mediating catch rates and therefore impacting the angler’s perception of success. These climatic, social, and limnological variable groups all have the potential to predict an angler’s perception of a successful fishing trip, making difficult the development of a robust Fishing Quality Index based solely on fish-related scoring inputs (i.e., relative abundance, population size structure). Accounting for the variation in angler success due to these variables will allow project personnel to improve the FQI scoring model to determine fishing quality while considering factors that influence angler perceptions of fishing quality that are outside the control of fisheries managers.

To account for the variation in angler success rate across both fishery-dependent and fishery-independent predictors, project personnel used multiple factor analyses (MFA) to evaluate the relationships among individual angler catch parameters; climatic, social, and limnological factors; and angler-reported success rate for largemouth bass. Multiple factor analyses group independent variables, much like a principle components analysis (PCA), to explain variation in the dependent variable (angler success). Unlike PCA, MFA combines multiple data sets gathered at the same time into a single analysis, allowing project personnel to simultaneously analyze instantaneous count data and angler catch data collected each year a creel survey was performed on a lake. Instantaneous count data and angler catch data were gathered from creel survey data collected in Segments 4 – 23 of this Project and were used as the independent variables for this analysis. Instantaneous counts provided data on fishery-independent predictors (i.e., environmental, social and limnological factors) of angler success scores. Angler interviews provided data on fishery-dependent predictors, including catch rate (fish/hour), the mean total length of angled largemouth bass, and catch rate of angled largemouth bass over stock (20 cm), quality (30 cm), preferred (36 cm), memorable (38 cm), and trophy (51 cm) sizes (Gabelhouse
MFA will allow project personnel to determine which creel-related variables are the most relevant to angler success across a wide array of angling experiences. By then developing models that reliably use fall electrofishing survey data to predict creel-related variables, managers will be able to evaluate potential angling satisfaction in the following year and begin to manage lakes to increase angling success.

Although environmental and social factors are beyond the control of fisheries managers, they were included in MFA analyses to maximize the amount of variation in angling success explained by the predictors and to determine the explanatory power of fisheries-dependent data in the overall model. The fisheries-dependent predictors found to be most influential to angling success were then compared to fish population data gathered from the previous year’s fall electrofishing survey.

Fall electrofishing variables were compared to angling success variables using stepwise multiple regression. Fall electrofishing predictors used in the multiple regression analysis were average total length and weight of stock-sized fish sampled; the catch per unit effort (CPUE, fish/hour) of all largemouth bass, as well as CPUEs of fish > 20cm, > 30cm, > 36cm, > 38cm, between 20–30cm, and between 30–36cm; the percent stock density (PSD) of LMB electrofished; and the relative stock density (RSD) of LMB > 36cm, > 38cm, between 30–36cm, and 30–38cm.

**FQI Scoring** — The multiple regression analysis identified those fisheries-dependent indices that are predictive of the angling factors that are most relevant to angler success while simultaneously accounting for environmental, social and limnological factors. Once fall electrofishing variables were identified, each variable was examined across all lakes in which fall electrofishing survey data is available to find the range of values for each variable. The ranges were then divided into scoring groups in which a simple score for each variable will be assigned based on how each value compared to the overall range of that variable. All variables would then be summed, representing the FQI score for the lake in which a fall electrofishing survey was performed.

**FINDINGS**

The multiple factor analysis of creel survey data suggests that environmental, social, and limnological factors do explain 14% of the variation in the perceived success of largemouth bass anglers, and catch rate variables were found to be much more important (Table 1). Specifically, average total length of largemouth bass caught and the overall largemouth bass catch rate were important predictors of angler success ratings provided by the angler. The positive relationship between these variables and angler success suggests that by increasing the average size and catch rate of angled largemouth bass, a manager could increase the angler satisfaction. To predict both average size and catch rate of angled largemouth bass, each of these variables was then subjected to multiple regression analyses as dependent variables using fall electrofishing data as independent variables.
Table 1: Standardized coefficients of each variable used in the multiple factor analysis and results of the multiple regression analysis comparing each MFA variable to the success of largemouth bass anglers. The magnitude of the standardized coefficient reflects the relative importance of the variable in predicting angler success.

Multiple regression analyses comparing fall electrofishing data to angler average total length suggests that the CPUE of fish 36cm or greater, the RSD of fish 36cm or greater, and the average total length of largemouth bass were all positively related to the average length of angled largemouth bass in the following year (i.e., the average total length of angled fish will be higher in lakes where there was a high density and proportion of bass over 36cm collected in the fall electrofishing survey) (Table 2). In addition, average total length, CPUE of fish 20 – 30cm, and PSD of fish sampled in the fall were the best predictors of angler catch rate, where the CPUE of fish 20 – 30cm is positively related and PSD and average total length showing a strong negative relationship (Table 2).

Table 2: Results of the best models predicting the average total length a catch rate of angled largemouth bass. The magnitude of the standardized coefficient reflects the importance of predicting angler average total length and angler catch rate.
The creation of these models has guided project personnel to the importance of fall electrofishing average total length, CPUE (≥ 36cm), CPUE (20-30cm), RSD 36cm, and PSD on predicting angler satisfaction in the following year. Therefore, each of these variables was calculated for all fall electrofishing surveys reported in the METRICS database (Job 4) to establish a global distribution of these metrics to be used in establishing a standard scoring system for FQI. Project personnel are in the process of assigning a component FQI score corresponding to the raw value of each measured predictor variable. The summation of each component score will represent the overall FQI score. The FQI scoring system will be completed during Segment 28.

RECOMMENDATIONS

The evaluation of relationships between angler satisfaction, fisheries-dependent, and fisheries-independent metrics does not provide any surprising insights for managers relative to improving sport fisheries. The development of FQI, however, certainly provides a novel tool for rapid assessment of fish populations and the quality of the sport fishery it supports, while accounting for the influence of environmental, social, and limnological factors on angler satisfaction. FQI can also support goal setting for fisheries managers striving to provide a quality fishery that can be easily promoted and explained to the general public.

Project personnel will continue to evaluate scoring schemes that will provide the most informative metric to the anglers of Illinois, as well as provide an easy tool for use by fisheries biologists. Upon completion of the scoring system, project personnel will prepare a manuscript for a peer-reviewed journal. In addition, personnel will integrate FQI calculations into the METRICS Fisheries Data System (see Job 4) to allow for the instant calculation of FQI once fall electrofishing data are entered. Finally, integrating FQI calculations into the IFishIllinois website (Job 5) will provide the most up-to-date predictions of angling success to the anglers who utilize these resources.

Once the scoring model for largemouth bass is complete, project personnel will expand the FQI to other sport fish species and assemblages. Based on availability of long-term data on a sufficient number of lakes and years, FQI models should be feasible for bluegill, channel catfish and crappie (both black and white combined). Due to the limited number of lakes fitting the analysis criteria and some sport fish species being limited to certain lakes, it may be more difficult to prepare an FQI for other popular Illinois sport fish such as walleye/sauger, muskellunge, redear sunfish, and smallmouth bass. Project personnel will explore the feasibility of preparing an FQI for these species.

Lastly, project personnel should explore the utility of an overall sport fish community index of fishing quality, whereby species composition, relative abundance, and other community-level descriptors of sport fish populations are incorporated.

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 field sampling 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

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 27, project personnel spent over 4,200 hours assisting the IDNR Division of Fisheries with projects ranging from assorted field samplings throughout the state to processing preserved fish specimens. Project personnel worked directly with IDNR Division of Fisheries to conduct sampling of stream fish assemblages in the Sangamon River, Salt Creek, and Rock River Basins during the summer of 2013.

During the first half of 2014, project personnel coordinated stream sampling in the Hennepin Canal, Green River, Central Mississippi tributaries, and the tributaries of the middle Illinois River. Additional data collection, entry, and analysis for 2013 collections are currently underway, and data collection during 2014 continues during Segment 28. Summary information regarding sampling of sport fish populations in these stream basins will be reported in the next segment report.

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. For example, field sampling efforts support development of fish distribution models under Landscape Conservation Cooperative project “Predicting Climate Change Effects on Riverine Aquatic Insects Using Museum Data and Niche Modeling” (see Experiment 4.7). Coordinated stream surveys should continue in future segments and more detailed, long-term strategies for prioritizing sampling efforts throughout the state should be developed.

**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:

- Evaluate long-term trends and spatio-temporal variation in the quality of sport fish populations
- Conduct experimental and manipulative experiments to identify the biological mechanisms affecting performance metrics in sport fisheries

**Experiment 3.1 – Impacts of angling-induced selection on aggression, nest guarding behavior, and reproductive success of male largemouth bass (M. salmoides)**

Experiment 3.1 was completed in Segment 24 and published in the *Proceedings of the National Academy of Sciences* (Sutter et al., 2012).

**Experiment 3.2 – Physiological mediators of nest abandonment decisions in largemouth bass during the spawning season**

Experiment 3.2 was completed in Segment 24 and published in *Functional Ecology* (Zuckerman et al., 2013).

**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 changes in reproductive success over time in response to the amount of angling that occurs in a single smallmouth bass fishery and what effect angling have on recruitment.

Early in the 1990s, project personnel conducted studies to assess how closed seasons protect nesting bass, as well as the how much angling occurred during the reproductive season (Suski et al., 2002; Suski et al., 2003). Project personnel have returned to one of those sites during the 2013 and 2014 spawning seasons to assess the level of angling that is now occurring at that site, and how long-term changes in angling may be impacting reproductive success, and therefore recruitment.

**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. 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.

**FINDINGS**

Based on hook wounding rates, there was 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 (Table 3).

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<thead>
<tr>
<th>Year</th>
<th>% Hook Wounds</th>
<th>% Nest Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>9.7%</td>
<td>61.8%</td>
</tr>
<tr>
<td>1992</td>
<td>14.3%</td>
<td>55.6%</td>
</tr>
<tr>
<td>2013</td>
<td>57.6%</td>
<td>38.7%</td>
</tr>
<tr>
<td>2014</td>
<td>59.1%</td>
<td>40.2%</td>
</tr>
</tbody>
</table>

*Table 3: For each year of the study, the percentage of nesting males that displayed at least one hook wound due to angling and the percentage of nests that successfully raised a brood to brown fry stage.*

**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 smallmouth 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. The results of this experiment are currently being analyzed and prepared for submission to a peer-reviewed journal.

**Experiment 3.4 – Impacts of reproductive success on largemouth bass recruitment**

In addition to the direct relationship between black bass reproductive success and recruitment (Experiment 3.3), we have determined that the angling of nesting 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). We have also shown in small experimental ponds that 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 who were recruited to angle 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.

FINDINGS

This study is approaching the final phase of data collection, and preliminary analyses of this long-term data shows 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 1 and 2).

Figure 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 2007–2013; years with light gray bars had no fishing during the spawning season, whereas years with dark gray bars had catch-and-release fishing during the spawning season.
RECOMMENDATIONS

Further understanding 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 may have important implications, especially for populations with high angling pressure and poor recruitment. Work should continue evaluating the relationship between largemouth bass reproductive dynamics and recruitment, as well as into alternative management scenarios that protect spawning bass, promote high rates of reproductive success, and support strong recruitment.

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.

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.

**FINDINGS**

During the 2014 reproductive season, 94 smallmouth bass nests were located and 40.2% of these successfully raised a brood. Preliminary assessments show a dramatic change in depth of nests, nesting success, and angling pressure (Table 4). Reproductive success recorded for the current study is down dramatically from the early 1990s. 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), and project personnel are currently assessing the photographs taken at individual nests to determine round goby abundance at each nest site. Size of male is also being assessed as a factor in nest abandonment.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total # Nests</th>
<th>Mean Nest Depth (m)</th>
<th>% Nest Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>123</td>
<td>1.4</td>
<td>61.8%</td>
</tr>
<tr>
<td>1992</td>
<td>133</td>
<td>1.2</td>
<td>55.6%</td>
</tr>
<tr>
<td>2013</td>
<td>111</td>
<td>2.6</td>
<td>38.7%</td>
</tr>
<tr>
<td>2014</td>
<td>94</td>
<td>3.1</td>
<td>40.2%</td>
</tr>
</tbody>
</table>

Table 4: 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: Diagram of one of the study areas displaying the location of nests for 1991 and 2014. Each nest is colored by depth, with lighter colors showing shallow nest depths (<1–2 meters) and darker blue colors showing deeper nests (3–5 meters). Water levels were similar across all years. Bathymetry around the islands includes shallow saddles and shoreline adjacent to steep drop-offs, so nest locations that are significantly deeper may appear similar due to the scale of the map.

**RECOMMENDATIONS**

Understanding the impacts invasive species have on sport fish populations is critical when assessing current management strategies. In locations where gobies and black 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 gobies are present. The results of this experiment are currently being analyzed and prepared for submission to a peer-reviewed journal.

**Experiment 3.6 – Impact of brood loss on nest abandonment decisions by largemouth bass**

Fieldwork, analyses and writing associated with this series of experiments have been completed, and final results of this experiment were reported in Segment 25. Results from this work have published in a peer-reviewed journal, as follows:

**Abstract**

Largemouth Bass *Micropterus salmoides* broods were experimentally reduced in size to test whether brood size (BS) and simulated brood depredation affect the decision by a male to continue providing care for its brood or to abandon that brood prematurely before its offspring reach independence. The highest ranked of the generalized linear models predicting brood abandonment was based on the number of offspring remaining in a nest following brood devaluation, indicating that parental male fish reassess the value of a brood following perturbation. Paternal *M. salmoides* were more likely to abandon their broods if initial BS was small before devaluation, and if there was a greater decrease in BS, indicating a threshold for both the amount of brood loss and remaining BS. Larger, older males were also less likely to abandon their brood than smaller, younger conspecifics. These results have broad implications for determining drivers of parental care trade-offs and how individuals assess the value of a brood.

**Experiment 3.7** – Parental care physiology in Centrarchids — insights from bluegill sunfish (*Lepomis macrochirus*) with implications for sport fish conservation

This experiment was terminated in Segment 26, and no further reporting is expected.

**Experiment 3.8** – Quantifying brood predation in Largemouth Bass during a catch-and-release angling event

This experiment was completed in Segment 26, and published in a peer-review journal as follows:


**Abstract**

Largemouth Bass (*Micropterus salmoides*) is a highly popular and widely exploited sport fish that provides paternal care to its offspring during the reproductive season each spring. During a catch-and-release angling event, brood predators (e.g. genera *Lepomis* and *Ambloplites*) can enter Largemouth Bass nests and consume embryos, reducing the parental male’s reproductive success. While the negative impacts of angling nesting bass have been well documented, factors affecting the rate at which embryos are consumed by nest predators have not been studied at either the individual or population scale. We
conducted field observations in nine lakes in southeastern Ontario and southwestern Quebec with abundant Largemouth Bass populations and varying brood predator densities to assess what factors affect how quickly brood predation begins once the male is removed, how quickly a male returns to his nest after release, and which males abandon their nests. Brood predator densities varied among lakes, and when predation occurred (65% of all nests), it began sooner after the male was angled in nests with higher densities of brood predators nearby. The mean return time of a male was 30.0 min after being held in a live well for 15 min. The mean consumption rate (on a per-predator basis) for all nests that experienced predation was 20.9 free-swimming fry predator$^{-1}$ min$^{-1}$, and the rate was higher in nests with higher mating success. The number of free swimming fry consumed was positively correlated with brood predator densities near the nest prior to angling, and the change in brood size was predictive of whether the male abandoned its nest. Predator density, parental male quality, and mating success were not associated with differences in abandonment decisions.

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

Understanding how angling nesting male largemouth bass impacts recruitment at the population level is important for developing truly effective management strategies for maintaining healthy populations of largemouth bass. If catch-and-release angling results in significant brood reduction across an entire population, and recruitment is reduced as a result, management strategies designed to address recruitment problems should consider the protection of spawning and nest-guarding bass. Such strategies may include closed seasons (Kubacki et al., 2002), fish sanctuaries (Suski et al., 2002), habitat modification (Bozek et al., 2002), and/or other regulatory mechanisms (Quinn, 2002). The goal of this study was to test whether or not simulated brood predation on nesting largemouth bass would result in decreases in recruit abundance, biomass, size and/or condition.

**PROCEDURES**

This study was conducted in eight 0.3-acre research ponds located at the Aquatic Research Facility of the Illinois Natural History Survey in Champaign, Illinois. Ponds were stocked with approximately 11 male and 9 female adult largemouth bass (> 250 mm TL) over two years when water temperatures reached 10°C, allowing bass to acclimate to pond conditions prior to the onset of spawning at 15°C (Ridgway et al., 1989). This experiment utilized a crossover design where in the first year, ponds were randomly assigned as either a control pond or a treatment pond, and in the second year assignments were reversed. After ponds were stocked with adult bass, swimmers regularly monitored each pond to observe nest-guarding behaviors throughout the reproductive season and to estimate the number of eggs in each nest via egg score (Stein & Philipp, 2014). Swimmers observed parental care activity and development of each brood every 3–5 days until larvae reached the independent free-swimming stage or parental care activity ceased. A given brood was considered successful only if the male raised the offspring to the independent free-swimming stage. In treatment ponds, a swimmer approached the nest of each male during the egg stage of development and removed 50% of that brood with a turkey baster to
simulate brood predation during an angling event. As a procedural control, swimmers also approached nests in control ponds, but none of these broods were devalued. In mid-August, each pond was drained, and all adults and recruits produced were collected. When recruits were larger than 2 standard deviations than the mean recruit total length, they were labeled as cannibals and analyzed as a covariate as described below.

Egg scores for reproductively successful nests were used to determine the number of free-swimming larvae expected to be produced from each nest using the conversion equation published by Stein & Philipp (2014; Experiment 3.8). For treatment pond data, the calculated expectation for total number of free-swimming larvae was reduced by 50% to reflect the removal treatment. Recruit abundance was determined by direct count, and recruit biomass was determined by summing the individual weights of the subsampled recruits with bulk weight measurements of the remaining recruits. For each treatment and control pond, a recruit survival rate was calculated as the number of non-cannibal recruits recovered divided by estimate of free-swimming larvae for that pond. Similarly, the recruit biomass produced was calculated as the total biomass of recruits recovered divided by the estimate of free-swimming larvae for that pond. This analytical approach accounts for natural variation in female fecundity and nesting success among ponds. Because the recruit survival rate and recruit biomass production are proportional data, they were arcsine square root transformed prior to analysis. A linear mixed model (MIXED procedure in SPSS 20.0) with treatment group, pond, and year included as fixed effects and a random effect accounting for the influence of cannibals was used to evaluate the response of four measurements of the recruit population to the treatment. Models predicting recruit survival rate, biomass production, mean total length, and mean Fulton’s condition factor K were the dependent variables in each model and a corresponding random effect of cannibals (i.e., cannibal survival rate, cannibal biomass production, cannibal mean total length, and cannibal Fulton’s condition factor) was included in the model. If recruit survival and growth was density dependent in a compensatory response to simulated brood predation, recruits from treatment ponds should have significantly higher survival and growth rates, resulting in greater total length and higher condition factors.

FINDINGS

The level of reproductive success was similar between the treatment and control ponds across years; i.e., there was no significant difference between control and treatment ponds in the mating success of the males, and therefore, in the estimates of free-swimming larvae of successful nests (F = 2.099; df = 1.14; p = 0.17). In addition, although some natural abandonment occurred in both groups of ponds in both years, nest abandonment rates were similar in control ponds (12.5%) and treatment ponds (8.5%) across years (Fisher’s Exact Test; p = 0.57). Similar rates of natural abandonment indicate that brood devaluation did not trigger widespread nest abandonment in treatment ponds.

Abundance of large recruits that were cannibals averaged less than 1% of the recruits across all ponds and the proportion of cannibal biomass averaged 7.3% across all ponds. The proportion of cannibals was not correlated with recruit survival rate (r = -0.12, p = 0.66), and the proportion of cannibal biomass was not correlated with recruit biomass production (r = -0.06, p = 0.83).
The linear mixed model of recruit survival rate showed no significant difference between control and treatment ponds (F = 3.639; df = 1, 5.063; p = 0.11) with no significant pond (F = 1.120; df = 7.5.111; p = 0.47) or year (F = 2.206; df = 1.5.762; p = 0.19) fixed effects and no significant random effect of cannibal abundance (Wald Z = 0.514; p = 0.67). Brood reductions had a small effect on recruit survival (Cohen’s d = 0.21), which did trend higher in treatment ponds (Figure 3.9.1). There was no significant difference in recruit biomass production between control and treatment ponds (F = 3.591; df = 1, 6; p = 0.11) with no significant pond (F = 1.808; df = 7, 6; p = 0.24) or year (F = 4.312; df = 1, 6; p = 0.08) fixed effects and no significant random effect of cannibal biomass (Wald Z = 0.514; p = 0.67). Brood reductions had a moderate to large effect on recruit biomass (Cohen’s d = 0.71), which trended higher in treatment ponds (Figure 3.9.1). Mean total length was similar between treatment and control ponds for non-cannibal (F = 0.002; df = 1, 14; p = 0.96) and cannibal recruits (F = 0.199; df = 1, 12; p = 0.66). The mean weight of individual recruits from treatment ponds was 1.8 g (SE = 0.2), which was not statistically different (F = 0.021; df = 1, 14; p = 0.89) from the mean weight of non-cannibal recruits from control ponds (1.9 g; SE = 0.3). Furthermore, condition factor among recruits was consistent and showed no significant differences between treatment ponds and control ponds across years (F = 0.014; df = 1, 6; p = 0.907).

Figure 3.9.1. Comparison of recruit survival rate and recruit biomass production between treatment (black bars) and control ponds (white bars).
RECOMMENDATIONS

Although some form of recruitment compensation has been suggested as a mitigating influence to any possible brood predation across populations, no evidence has been reported to support or refute the existence of compensatory survival and growth during the first year of life. On the other hand, there are no published studies indicating whether or not angling-induced brood loss on a population-wide scale is ever large enough to produce a population-level response in recruit abundance, biomass, size, and/or condition. If some form of density-dependent survival and growth, either during parental care or later into the first year of life, is compensating for the elevated rates of embryonic mortality caused by angling-induced brood predation, then recruit abundance, biomass, size, and condition should be similar in systems with and without substantial angling-induced brood predation. Furthermore, for populations in which density-dependent survival compensates for angling-induced brood losses, post-brood loss survival rates should be higher than populations in which there are no angling-induced brood losses. In our study, if treatment ponds had fewer recruits competing for limited food resources, then growth rates would be expected to be higher than in control ponds.

In this experiment, although recruit survival rates in treatment ponds tended to be higher indicating some compensatory survival, differences were not significant, indicating that brood losses were only partially compensated via low levels of density-dependent survival. Because the recruits in treatment and control ponds were similar in TL, weight, and condition, recruits in the treatment ponds did not experience density-dependent increases in growth in response to brood losses. Despite the low statistical power of this study, there was a small effect size in recruit survival rates and a large effect size on biomass production between groups, supporting the conclusion that brood predation has important biological significance in determining recruit abundance, but may not have as strong effect on growth rates.

These data suggest that brood loss during parental care does have the potential to reduce the number of recruits surviving later into summer, and only partial compensation due to density dependent survival and growth occurred. Managers of largemouth bass fisheries with large amounts of spawning season angling effort should be aware of the strong likelihood of negative effects of recruitment due to brood loss, especially in systems with high densities of potential brood predators (see Experiment 3.8).

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. In order 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 (n = 1169) were selected from IL DNR basin survey data to assess historical (1974 –1999) and recent (2000 – 2013) species richness and abundance trends. For each sample, species richness and abundance were standardized as catch per unit effort (fish per hour) and then sites were grouped spatially by HUC 8 regions (8-digit hydrologic units defined by the United States Geological Survey) for year-to-year comparisons. Sampling events were grouped temporally into historical (1974–1999) or recent (2000–2013) categories and analyzed separately. 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, for each gear type, within each HUC 8 region. If the ANOVA found significance ($\alpha \leq 0.05$), Tukey’s HSD or Student’s t-test post hoc was used to identify different years. 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 $\geq 0.05$, $R^2 \geq 0.5$), decreasing (ANOVA $\alpha \leq 0.05$, slope $\leq 0.05$, $R^2 \geq 0.5$), stable (ANOVA $\alpha \geq 0.05$), or variable (ANOVA $\alpha \geq 0.05$, slope near zero, $R^2 \leq 0.5$).

FINDINGS

Backpack Electrofishing

There were not a sufficient number of years sampled per HUC 8 region from 1974–1999 to conduct historic analyses on backpack electrofishing data, however five regions (Mackinaw, Salt, Des Plaines, Kankakee, and Iroquois) were sampled during the recent time period (2000–2013). From 2000 – 2013, the Salt, Des Plaines, Kankakee, and Iroquois show stable fish abundance; the Salt, Des Plaines, and Iroquois also have stable species richness, but the Kankakee exhibits variable richness (Figure 3.10.1). No regions have shown increasing abundance or species richness within recent years.

AC Boat Electrofishing

Six regions (Flint-Henderson, Mackinaw, Shoal, Embarras, Middle Kaskaskia, and Upper Mississippi-Cape Girardeau) were historically sampled using AC boat electrofishing. Fish abundance trends were stable for the Mackinaw, Shoal, Embarras, and Upper Mississippi-Cape Girardeau; variable for Flint-Henderson; and decreasing for the Middle Kaskaskia (Figure 3.10.2). Species richness was historically stable for the Mackinaw, Shoal, Embarras, Middle Kaskaskia, and Upper Mississippi-Cape Girardeau, but variable for Flint-Henderson (Figure 3.10.2).

In recent years, fifteen regions were sampled using AC boat electrofishing. Abundance and species richness show stable trends for four regions (Des Plaines, Lower Illinois-Lake Chautauqua, Lower Illinois, and Lower Ohio-Bay). However, the Iroquois and Vermilion-Lower regions exhibited a decrease in species richness in recent years (Figure 3.10.3), which may
indicate these are possible areas of concern. The Embarras is the only region that shows variable abundance with an increase in species richness during recent sampling events.
Figure 3.10.1. Recent basin surveys (2000-2013) using backpack electrofishing show trends in fish abundance (left panel) and species richness (right panel).

Figure 3.10.2. Historical basin surveys (prior to 1999) using AC boat electrofishing show trends in fish abundance (left panel) and species richness (right panel).
Electric Seining

Sampling using electric seine occurred in five regions historically and twenty regions recently. All historic surveyed regions (Flint-Henderson, Lower Illinois-Senachwine Lake, Mackinaw, Lower Illinois, and Upper Mississippi-Cape Girardeau) showed stable abundance and species richness trends (Figure 3.10.4). During recent years, the Lower Illinois, Mackinaw, and Iroquois have declined in fish abundance (Figure 3.10.5). The Lower Illinois and Mackinaw show stable species richness, but the Iroquois may be an area of concern due to the decrease in species richness during recent years (Figure 3.10.5). The only regions with an increasing species richness trend during recent surveys are the Big Muddy and the Middle Wabash-Busseron.
Figure 3.10.4. Historical basin surveys (prior to 1999) using Electric Seine show trends in fish abundance (left panel) and species richness (right panel).

Figure 3.10.5. Recent basin surveys (2000-2013) using Electric Seine show trends in fish abundance (left panel) and species richness (right panel).
RECOMMENDATIONS

Understanding the long-term changes in fish community composition will improve the ability to manage and conserve threatened/endangered species, native species, and sport fishes in Illinois streams. With the preliminary results, we can begin to identify regions that may be of concern to fish communities. However, it is necessary that we also evaluate changes in fish community composition to determine if native fishes, and sport fishes in particular, are the species at risk. Therefore, the next step for this study will be to assess changes in fish community composition (with an emphasis on sport fish species) over time to identify streams that may be in species declines. The information gathered from this study will also be used in conjunction with water quality data collected by the Environmental Protection Agency to evaluate possible causes for fish community change in Illinois streams.

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 – COORDINATION WITH FISHERIES RESEARCH PROJECTS

OBJECTIVES

The following components constitute the overall objectives for Job 101.4:

• Provide supportive information on sport fish population dynamics/structure in study lakes, streams, and rivers associated with ongoing Federal Aid projects (e.g., F-101-R, F-135-R, F-138-R, F-123-R, F-52-R) and other federal- and state-supported activities (e.g., CAWFS-74, USFWS #301819G032)

• Maintain and enhance systems for managing and delivering fisheries data and analyses to data users

• Coordinate with related Federal Aid Projects and support the objectives of those projects where practicable

Several research experiments, ecological field studies, and collaborative activities were conducted in support of the objectives of Job 101.4. The procedures, findings, and recommendations for each of these activities are presented below.

Experiment 4.1 – Improved understanding of environmental tolerances of bass and bluegill

Experiment 4.1 was completed in Segment 24. Results from this experiment were published in the Canadian Journal of Fisheries and Aquatic Sciences (2012).

Experiment 4.2 – Development of molecular tools to quantify stress and disturbance in largemouth bass and bluegill

Experiment 4.2 was completed in Segment 27, and results will be reported in the originating project, CAWS-74. Further, results were published in a peer-reviewed journal, as follows:


ABSTRACT

Hypercarbia, or elevated carbon dioxide, is an environmental challenge that can have detrimental effects on the physiology and performance of aquatic organisms. With aquatic hypercarbia predicted to become more prevalent in the future due to global
climate change, it is important to quantify how hypercarbia impacts aquatic organisms, especially fish. The impact of hypercarbia on the behavior and physiology of fishes has been well studied, but relatively few studies have examined the molecular processes that underlie resulting behavioral and physiological changes. In an effort to define the molecular response of fishes to acute hypercarbia exposure, bluegill (*Lepomis macrochirus*) and silver carp (*Hypophthalmichthys molitrix*) were exposed to either 30 mg L\(^{-1}\) CO\(_2\) (pCO\(_2\) ≈ 15,700 µatm) or ambient (10 mg L\(^{-1}\) CO\(_2\); pCO\(_2\) ≈ 920 µatm) conditions for 1 h and the expression of a variety of genes, across three tissues, were compared. Exposure to 30 mg L\(^{-1}\) CO\(_2\) in bluegill and silver carp resulted in an increase in c-fos, hif1-\(\alpha\), and gr-2 transcripts, while silver carp alone showed increases in hsp70 and hsc70-2 mRNA. This study demonstrates that acute hypercarbia exposure impacts gene expression in a species and tissue specific manner, which can be useful in identifying potential mechanisms for hypercarbia tolerance between species, and pinpoint specific tissues that are sensitive to hypercarbia exposure.

**Experiment 4.3 – Development of novel chemical barriers to prevent the spread of Asian carp and to protect existing sport fish populations in the Great Lakes**

Experiment 4.3 was completed in Segment 27, and results will be reported in the originating project, CAWS-74. Further, a manuscript was submitted to a peer-reviewed journal and is currently in review, as follows:


**Abstract**

Asian carp are non-native invasive fishes that have quickly become the most abundant fishes in many portions of the Midwestern United States. While Asian carp are currently contained to the Mississippi River basin by three electrified barriers, these fish have the potential to negatively impact the Great Lakes ecosystem if this barrier is breached, and these barriers may be particularly vulnerable to the passage of small fishes. As such, novel barrier technologies would provide an additional mechanism to prevent Asian carp from invading the Great Lakes, and provide redundancy and safety to the current electric barrier. The current study used a combination of molecular and behavioral experiments to determine the effectiveness of carbon dioxide as a chemical deterrent for larval and juvenile fishes, with an emphasis on Asian carp. Juvenile silver carp, bighead carp, bluegill and largemouth bass showed avoidance of elevated CO\(_2\) environments of approximately 200 mg/L. Additionally, exposure to 120 mg/L CO\(_2\) resulted in the induction of hsp70 mRNA in eight day old silver carp fry, while gill c-fos transcripts increased following hypercarbia exposure in all juvenile species examined. Together, results show that CO\(_2\) has potential to deter the movement of larval and juvenile fishes.
**Experiment 4.4 – Pulse-pressure as a deterrent to Asian carp movement**

Participation by project personnel on this experiment has terminated. Work on this project has been assumed by the U.S. Geological Survey, and further outcomes will be the responsibility of USGS personnel.

**Experiment 4.5 – 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. Lake trout CPUE in the fall spawning survey remained high (71 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 the fall samples, research into the origin of unmarked fish was initiated in 2013 (see Experiment 4.7 below). Fall harbor electrofishing saw an increase in CPUE 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.

**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), F-52-R (Lake Michigan Creel Survey), and USFWS Project #301819G032 (Evaluation of Lake Trout reef spawning areas), to determine knowledge gaps and research needs that can be addressed in the next segment of this project. A new project staff was hired in November 2013 to provide
research coordination in collaboration with Illinois DNR Division of Fisheries Lake Michigan Program personnel.

**Experiment 4.6 – Lake-wide coded wire tag collection**

In March of 2012, 2013, and 2014, an estimated 253,000; 228,000; and 230,000 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 2013, continued through the fall 2013, and began again in May 2014 for the season. Data collection for this project occurred simultaneously with fall harbor sampling conducted by the IDNR, and as of November 2013, 1130 specimens were sampled. Of those, 520 (46%) contained coded wire tags. Most Chinook salmon (48%) captured in Illinois waters of Lake Michigan came from Illinois waters, with 30% coming from Wisconsin, 15% from Michigan, 4% from Indiana, and 2% from Lake Huron; 1% of the tags were lost during processing. Approximately half (50.7%) 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 2014 has been collected and will be analyzed when sampling concludes in November. Project personnel participated in winter and summer Lake Michigan Technical Committee Meetings and became 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 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.

**Experiment 4.7 – 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, and a manuscript is being prepared and will be submitted to a peer-reviewed journal during Segment 28.

**Experiment 4.8 – 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.

**FINDINGS**

Under the USFWS CFDA Program 15.662 project funded to J.A.S., the stable isotopic signatures from all potential lake trout sources have been characterized. The trace element analysis has been delayed, and analysis of otoliths from wild or unmarked and hatchery-reared fish from Lakes Huron and Michigan is ongoing. A full report summarizing project results will be finalized in January 2015 and submitted in support of the originating project.

**RECOMMENDATIONS**

F-69-R project personnel will continue to collaborate and provide sample collection and analysis support for the completion of the CFDA Program 15.662 project. After analysis is completed, a manuscript will be submitted for publication to a peer-reviewed journal.
**Experiment 4.9 – Analysis of long term lake trout data**

Data collected from Illinois DNR fall population assessments (Experiment 4.5) 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 1998 to 2013 to evaluate stocking numbers and relative return rates of fish at Julian’s Reef, a designated primary stocking site in Illinois. In addition, project staff plan to compare relative abundance and sources of lake trout between Julian’s Reef (stocked) and an unstocked nearby reef (Waukegan Reef) to assess population characteristics of spawners, including sex ratios, proportion of unmarked fish, growth of tagged fish and estimates of sea lamprey wounding rates.

**FINDINGS**

The data has been assembled in a central database and verified. Data analysis has begun and will continue into the fall/winter of the next segment.

**RECOMMENDATIONS**

F-69-R project personnel will continue data analysis and prepare a manuscript for submission to a peer-reviewed journal. Once completed, findings will be presented at the annual meeting of the International Association of Great Lakes Research (IAGLR) and/or other appropriate meetings and conferences.

**WILDLIFE TRACS ACTION LEVELS**

Action Level 1: Data collection and analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations
Sport Fish Data Set Organization and Access

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

Data browsing tool development has focused on making significant improvements and alterations to handling data generating from IDNR hatchery activities. Utilizing .NET application frameworks, an online tool that prioritizes requests for sport fish stockings, monitors hatchery production, and records the destination of hatchery-reared fishes has been developed and is ready for further testing by hatchery personnel. This “Stocking” node will be fully integrated into future nodes of fisheries data (i.e., sport fish population assessments in lakes, streams, large rivers) so that project researchers will have rapid and simple access to sport fish information about Illinois water bodies that includes management actions, such as stocking events, as well as natural variations in sport fish abundance and distribution. An initial period of testing of the Stocking node was conducted during Segment 26, and a completed application was placed in full production during Segment 27.

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. Project personnel developed several options for modifying how sport fish information is managed to efficiently integrate multiple data sources, include sufficient geospatial data, and broaden the scope of use of the information to support research and management activities. Capitalizing on collaborations with the Iowa Department of Natural Resources, web-based application frameworks for lakes and streams data are being adapted for use by Illinois DNR and fisheries researchers alike. A web application for data entry, browsing and retrieval is still under development for lakes data and is expected for beta release in Segment 28. Significant delays in software development were encountered due to loss of a computer programmer.
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 27. 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. Utilizing project funding to support an experienced programmer who can expedite the completion of this project is intensely warranted.

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 DNR Fisheries

PROCEDURES

During this first year after the implementation of the newly redesigned www.ifishillinois.org website, project personnel have worked to improve and add features to the site to make it the one-stop, go-to site for Illinois anglers. The goal of the website is to make information easily available 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; IDNR fishing programs; and trends in fishing quality. New to the site this segment were the river profile pages; ice fishing information; private ponds and aquatic management information; Family Friendly fishing information; angling-related event calendar; aquaculture information; and several improved lake maps for our most-visited lakes. This effort provides sport fisheries-related information that is readily available to the public and continues to provide immeasurable benefit to current and prospective anglers in Illinois.

The “contact us” feedback form continues to connect us with Illinois anglers who can directly ask questions related to fishing in Illinois. Project personnel receive, on average, 10 inquiries per week, which are answered within 24 hours.

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. Many of the pages are now dynamically produced, making maintenance much more efficient.

FINDINGS

Improvements and Additions to www.ifishillinois.org

LAKE PROFILE PAGES

Throughout the site, lake profile pages were updated with the most current fishing prospects, 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.

An improvement to the lake profile pages we hope will gain momentum by the IDNR biologists is the ability 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 or 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 220 Illinois lakes and reservoirs.

Additionally, all Illinois lakes that are stocked with trout in fall and/or spring are now included on the site. They are clearly marked as being “trout stocked” lakes.

RIVER PROFILE PAGES

River profiles were added to the site, and at present there are 18 rivers featured, seven of which also have fishing reports associated with areas along them. Each river features a map, which we obtained via permission from the Illinois State Water Survey.

ICE FISHING

The unusually cold winter in Illinois prompted project staff to develop an all-new section for Ice Fishing information on our site. Information includes where to fish, fishing gear needed, techniques for ice fishing, tips and safety. For visual appeal, photo credit was obtained from www.illinoiswisconsinfishing.blogspot.com.

FAMILY FRIENDLY FISHING

The Kids Fishing pages continue to be among the top-visited pages on our site. Project staff worked to identify those waters in Illinois that are “Family Friendly” and created a separate family friendly waters listing. All family friendly waters are also included on our regular listing of lake profiles and are distinguished by our Family Friendly logo.

FISHING DIGEST

At the request of the IDNR Public Information Officer, project staff developed a Fishing Digest, which is a compilation of all the weekly fishing reports listed alphabetically by water body on one page. This digest is updated weekly during the fishing season (April – October). The compilation allows for better promotion of our fishing reports via news and social media.
Fishing Report Improvements

In addition to the comprehensive Fishing Digest, several improvements have been made to the reporting feature of weekly fishing reports. These improvements include a safer login for users and the ability for users to edit their weekly fishing reports or to use previous data if conditions remain the same from week to week. Our goal with these improvements was to improve the integrity of our site while making it less time consuming for our reporting volunteers.

Fishing License Button and Analytics

To ensure that every angler can easily access the DNR online fishing license sales page, we have added a “Buy a Fishing License” button 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. This feature was added on August 4, 2013, and since that time, the button was clicked 9,301 times.

PDF Analytics

Google Analytics provides an opportunity to know what information is of the most interest to our users. Project personnel can now 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.

Search Bar

Newly implemented is a site search bar to further enhance the user experience.

Invasive Species

Project personnel continue to work with the Illinois-Indiana Sea Grant staff to include information about Invasive Species in support of their Be a Hero, Transport Zero campaign, including the information about the New Zealand mudsnail.

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 have 939 “likes” on Facebook (a 30% increase over last segment) and 127 Twitter followers (a 38% increase), both showing steady growth.
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) to collect information regarding visitors to [www.ifishillinois.org](http://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, 2013 – June 30, 2014, ifishillinois.org had 273,972 visitors to the site, with a total of 1,299,355 pages viewed.
- On our most visited day, 2149 visitors viewed our site in a 24-hour period. The site averages 1550 visitors each day from May – August.
- Each visitor views an average of 5 pages per visit.
- 77% of our users are from Illinois.
- 34% are mobile (compared to 27% 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 lakes: Fox Chain O’ Lakes, Heidecke, Busse, Shabonna, Braidwood.
- The Kids Fishing pages continue to be in the top 10 most-visited pages on our site.

**Outreach Materials**

To better communicate our outreach needs for the IFishIllinois website to IDNR County Biologists, project personnel presented a poster at the Illinois AFS Meeting. In addition, a handout was developed for the biologist with specific requests and contact information for IDNR Fisheries Management Teams to help us to improve the IFishIllinois website. Project personnel created a 12-page full-color report entitled, “Sport Fish Research in Illinois: A Look Inside Sport Fish Restoration Fund Project F-69-R.” The report targets the agency personnel and the general
public, outlining the history and current activities of this Project. Copies of the report were provided to Illinois Department of Natural Resources Division of Fisheries, as well as U.S. Fish and Wildlife Service Region 3 personnel. Additional copies are available upon request. The success of the report has led to the planning of a similar outreach product encompassing all Sport Fish Restoration Funded Projects in Illinois. That report is expected to be completed in 2015.

**RECOMMENDATIONS**

Overall, the IFishIllinois website is quite popular among Illinois anglers. Project personnel will continue work in Segment 28 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. In addition, project personnel will work with IDNR to have 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 mobile-ready site.

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. This includes monitoring the comments and suggestions from anglers regarding fishing reports and areas in which anglers frequently request a report. Project staff will make a report in this next segment for a recommendation.

Project personnel will simplify data entry for new lake profiles by creating an online form for IDNR biologists to easily add new lakes to the existing database, as well as to edit data for existing lake profiles. 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](http://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 9,388 people and was shared 54 times. At that time, we had only 750 Facebook “friends.” This is a great example of how you can get exposure through different avenues on social media.

Pictures with a story of “real life” are the most popular posts. We encourage all biologists to send us their pictures to help us tell the story of sport fishing in Illinois waters.

Figure 4: 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: Overview of the number of daily visits to the www.ifishillinois.org during Segment 27 (July 1, 2013 – June 30, 2014).
JOB 101.6 – FISHES OF CHAMPAIGN COUNTY

OBJECTIVE

The following components constitute the overall objectives for Job 101.6:

• Analyze the changes in fish species in Champaign County during the past 100 years and identify components of stream fish assemblages that have significantly changed over time, as well as the key factors contributing to those changes over the last century

PROCEDURES

Building on the efforts of Forbes and Richardson (1908), Thompson and Hunt (1930), Larimore and Smith (1963), and Larimore and Bayley (1996), the next iteration of “The Fishes of Champaign County” (FoCC) began in the 2012 field season. The study includes the sampling of fish populations at pre-determined field sites, assembly and analysis of land use and stream habitat data, collection and analysis of physio-chemical habitat data, and analysis of the effect of fish community and environmental parameter interactions on distribution and assemblage characteristics. To the maximum extent practicable, field crews are replicating the sampling methods (e.g., electric seine and block nets) and locations (140+ sample sites) used in previous iterations of this long-term study (previously funded under Federal Research Project F-76-R).

In addition to the field sampling efforts, a mail survey was created and sent to the landowners with sampling locations on or adjacent to their property. This questionnaire was created to assess the attitudes of the landowners toward the streams on their land, as well as how they utilize their stream. Questions included whether the landowners were anglers and if they fished their stream, whether or not they participate in Conservation Reserve Programs, if they have heard of the Illinois Recreational Access Program, and their opinion of the wildlife in their stream.

FINDINGS

At the end of Segment 27, 119 sample sites were completed and approximately 12 sites remained to be sampled in fall of 2014. Those remaining sites consist almost entirely of the main stem of the Sangamon River sites. Sampling the remaining sites on the main stem of the Sangamon River with an electric seine is challenging due to the river’s width and depth and the staffing required. These sites will likely not be sampled until low water levels in late summer/early fall of 2014.

Currently project personnel are examining the changes in the headwater communities of the drainage basins that have been sampled. The breadth of these surveys has encompassed the entirety of many of the headwater streams of the Embarras, Vermilion, Kaskaskia, and Sangamon River basins. The majority of these headwaters have experienced drastic alterations upon the creation of the drainage districts of Champaign County. Many of the alterations of these
headwaters have occurred within the time frame of this study. Preliminary examinations of the changes in the fish communities of these streams suggest that fish communities have shifted from being mostly dominated by small-bodied species and very few predators, to larger-bodied and more numerous predator species (Figure 6.1).

**RECOMMENDATIONS**

Upon completion of site sampling, project personnel will begin to examine the relationships between landowner opinions and the fish communities found on their land. Questions that will be analyzed with this data are:

1. Are landowners more or less likely to participate in conservation reserve programs based on their perceptions of local stream habitat quality and fish communities?
2. Are landowners more or less likely to participate in conservation reserve programs based on the ownership history of their land?
3. Does the landowners’ assessment of the quality of their stream accurately represent the fish community found there?

In addition, project personnel will provide landowners with an in-depth analysis of streams in their area as a way to promote awareness and stewardship of local sport fish resources.

**WILDLIFE TRACS ACTION LEVELS**

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

![Figure 6.1: Biomass of fish groups based on size and feeding preference of the headwaters of the Embarras River in Champaign County. Feeding groups examined are Small Generalists (GenSm), Large Generalists (GenLg), Small Grazers (GrazSm), Large Grazers (GrazLg), Small Invertevores (InvSm), and Predators (Pred). Note that the biomass of all small-bodied feeding groups has declined since 1989, where biomass of large-bodied and predator groups have been increasing since 1959.](image-url)
JOB 101.7 – RESTORATION OF URBAN STREAM SPORT FISHERIES

OBJECTIVE

The following components constitute the overall objectives for Job 101.7:

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

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 and summer of 2014. 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.

High conductivity in both streams limited capture efficiency of the electric seine; therefore, sampling was conducted using two side-by-side backpack electrofisher 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, scales were removed for aging, and gastric lavage was performed to determine stomach contents. Invertebrate sampling and water quality sampling was also performed at each site. QHEI scores were also created for each site to evaluate habitat quality.

FINDINGS

The fish communities of the East and West Branches of the DuPage River were dominated by four species: green sunfish (*Lepomis cyanellus*), bluntnose minnow (*Pimephales notatus*), bluegill (*Lepomis macrochirus*) and sand shiner (*Notropis stramineus*). Fish abundance was greater in samples collected from the East Branch (n=2010) compared to the West Branch (n=1497), with more fish captured during the fall season (n=2785) than in the spring (n=724).

Species richness was higher on the East Branch than the West Branch in both seasons (Figure 7.1.1). In both tributaries, the four most common families were Centrarchidae, Cyprinidae, Catostomidae, and Ictaluridae, regardless of season. On the West Branch, the fish community was dominated by Centrarchids followed by Cyprinids, but on the East Branch Cyprinids were the dominant family followed by Centrarchids, regardless of season (Figure 7.1.2).
Figure 7.1.1: Fish species diversity (number of species) across eight sites upstream to downstream for the West Branch (top panel) and East Branch (bottom panel) of the DuPage River from Fall 2013 and Spring 2014.
The sport fish community of the two tributaries were dominated by black basses (largemouth bass and smallmouth bass), but did not constitute a major proportion of the sampled community in either branch. Smallmouth were more abundant on the West Branch where they were the 14th most abundant species overall with 75 captured (Table 7.1.1) On the East Branch, only two smallmouth bass were caught in the fall of 2013, and this ranked as the 24th most abundant species captured on this tributary. There were also major seasonal differences as most black bass were captured during the fall. Largemouth bass were caught in about equal numbers on both tributaries and ranked as the 11th and 14th most abundant species on the West and East Branches, respectively.

<table>
<thead>
<tr>
<th>Season</th>
<th>West Branch</th>
<th>East Branch</th>
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<tr>
<td></td>
<td>SMB</td>
<td>LMB</td>
</tr>
<tr>
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</tr>
<tr>
<td>Spring 2014</td>
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<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 7.1.1: Abundance of Smallmouth Bass (SMB) and Largemouth Bass (LMB) on the East and West Branches of the DuPage River during the fall 2013 and spring 2014 sampling seasons.

The communities of the East and West Branches of the DuPage River show some variance in species presences and abundances. However, the largest variance found was between the seasons. The upstream sites and the downstream sites on each river had smaller variances than those between rivers (Figure 7.1.3). However, these variances are minimal compared to the community differences between seasons and appear to be attributable to differences in population size of the four most abundant species—green sunfish, bluntnose minnow, bluegill and sand shiner.

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.
RECOMMENDATIONS

This study will continue through summer of 2015. Additional sampling data will provide more accurate representation of the fish community and more fine scale analyses will be undertaken. Furthermore, invertebrate, habitat, and non-biological data are being collected to measure their impact on fish communities. Seasonal differences in fish community composition could be natural changes due to fish movement through the system, but high conductivity in the spring may bias capture efficiency. Additional data and analyses should be used to determine the source of seasonal variation.

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.

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.

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. 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) and July 2014 (n=3). 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 every 1-2 weeks throughout the summer and fall of 2014.
Preliminary analyses of the data collected from the passive receiver array (VR2Ws) and the manual tracking (VR100) has been undertaken to assess the extent of upstream and downstream movement, areal extent of individual home ranges, and the impact of sporadic high flow rates on smallmouth bass in this urban stream.

**FINDINGS**

Smallmouth bass in the West Branch of the DuPage River exhibit variability in home range size. 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. 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 (Figure 7.2.1).

![Image](image.png)

**Figure 7.2.1: Map showing the movement of an acoustically tagged Smallmouth Bass (#11049) in the West Branch of the DuPage River.**

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 (Figures 7.2.2 – 7.2.4). 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.

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 (Figure 7.2.5). It does appear that some small tributaries, backwater areas and even some mainstream reaches become more accessible and likely more favorable habitat when the river is deeper.

**RECOMMENDATIONS**

This project has just completed the first segment of its pilot phase. Further data collection and the tagging of more smallmouth bass are needed to give a more complete examination of the population. Furthermore, new hypotheses about the population structure of bass in the West Branch of the DuPage River are being developed and examined and will be addressed as this study continues.
Figure 7.2.4: Calculated home range based on kernel density estimation of an acoustically tagged Smallmouth Bass (#11056) in the West Branch of the DuPage River.

Figure 7.2.5: The distance upstream of Fawell Dam (meters; right axis) relative to stream discharge (m$^3$/s at Warrenville, IL) for Smallmouth Bass #11043 (top left), #11044 (top right), #11045 (bottom left) and #11056 (bottom right).
WILDLIFE TRACS ACTION LEVELS

Action Level 1: Data collection and analysis
Action Level 2: Research, survey or monitoring – fish and wildlife populations
## Segment 27 Job Costs - Budget v. Actual

<table>
<thead>
<tr>
<th>Job</th>
<th>Description</th>
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<th>Actual</th>
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| | Total Costs | $1,040,000 | $1,082,820 | $(3,847) |
| | Federal Share | $780,000 | $812,115 | $(2,885) |
| | State Share | $260,000 | $270,705 | $(962) |
Literature Cited


