ILLINOIS CHAPTER AMERICAN FISHERIES SOCIETY

2018 ILLINOIS REPORT

TO THE

NORTH CENTRAL DIVISION AFS

RIVERS AND STREAMS TECHNICAL COMMITTEE

Respectfully submitted

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COMMERICAL FISHING

Shifting Population Dynamics of the Commercially Exploited Shovelnose Sturgeon in the Wabash River

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The shovelnose sturgeon population in the Wabash River provides an important recreational sport and commercial caviar fishery for both Illinois and Indiana. In fact, it is one of the last commercially viable populations for roe harvest. The Wabash offers vital habitat for shovelnose sturgeon who complete their life cycle in freshwater. Previous studies have shown that increased harvest pressure in this species can affect maturation and result in recruitment overfishing; therefore, it is important to closely monitor exploited populations over time. Over the past decade, many different gears were employed to sample shovelnose sturgeon. Fish captured between the years 2007 and 2016 had an overall mean relative weight of 87, falling within the target range (80-90). The proportional size structure indices for quality, preferred, and memorable size fish were 100, 98, and 70, respectively. Overall, size structure and condition are reflective of a healthy population, but not a stable one, with declines in condition and the proportion of memorable-sized fish over time. We also observed greater estimates of mortality (33-34%) than what was previously estimated for this population (21% in 2013). Gravid females, the fish directly impacted by roe harvest, also showed significant declines in condition, mean fork length, size-at-maturity, and reproductive output over time. This implies that slower-growing and less-rotund females are being selected for as an effect of commercial harvest pressure placed on larger, better condition females. Further monitoring is necessary to support continued sport and commercial shovelnose sturgeon fishing in the Wabash River.

ECOLOGY

Drying Regime and Fish Assemblage Composition in Headwater Streams

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Disturbance regime (e.g., drying, flooding) correlates with fish community composition in many lotic systems. Pooling and drying are natural occurrences in headwater streams (1st through 3rd order) of the Kaskaskia River basin, but the frequency and duration of these events vary annually. Water levels were monitored in 2016 and 2017 to estimate conditions under which headwater streams pool and dry in a sub-basin of the Kaskaskia. Models indicate between 0 and 0.63 of stream length in the sub-basin may pool or dry in August, depending upon timing and volume of precipitation. Fish were surveyed quarterly in the sub-basin and assemblage composition was compared to estimated frequency of pooling and drying. Temporal variability in species richness increased and assemblage similarity decreased as the estimated number of dry days increased. This study suggests processes related to drying regime play an important role in seasonal fish community composition.

Long-term Monitoring Shows How Highly Modified Rivers Respond to Additional Drivers of Change

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Large rivers and their floodplains are some of the most productive ecosystems on earth, yet are the ecosystem most affected by humans. Few studies explicitly explore the effects of or responses to multiple anthropogenic drivers in large river systems. Furthermore, our understanding of how these drivers overlap in space or time, or interact with each other, is lacking. Our study utilizes a nearly 60-year, river-wide dataset to determine if fish assemblage diversity in the Illinois River (ILR) changed in response to three major, system-wide anthropogenic drivers: policy-based water quality improvements (principally the Federal Water Pollution Control Act and the Clean Water Act) and invasion by bigheaded carps. Despite an imposing legacy of negative anthropogenic drivers, the highly modified ILR was still able to respond to additional drivers. Although the response was complex, overall, fish diversity increased substantially in the whole river, and the upper and lower river, and several FFGs displayed diversity increases even more impressive than the combined group. Without long-term and broad-scale data, elucidating complex responses such as this is nearly impossible. We believe that by broadening the spatial, temporal, and contextual scale that we study modified large rivers at, we can yet increase our understanding of how these valuable ecosystems respond to cumulative anthropogenic drivers.

Comparison of Fish Communities in Contiguous Backwater and Vegetated Impounded Areas of Pool 19, Upper Mississippi River

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Lock and dam 19 in Keokuk, Iowa has impounded over 9 m of sediment since 1913, which has created a unique shallow-water ecosystem in pool 19 that is dominated by floating-leaf and submersed aquatic vegetation. The importance of these post-impoundment, vegetated areas for fish is not well understood. To increase our understanding, we compared the community structure, composition, and size structure of fish between vegetated impounded areas and non-vegetated, contiguous backwaters in Pool 19. We sampled 180 randomly stratified sites for four, 6-week periods from May 19th- Oct 31st, 2014. We fished paired sets of tandem fyke (1/4 in. diameter mesh) and mini-fyke nets (1/8 in. diameter mesh) using LTRM standardized methods. We sampled 63,503 fish representing 64 species (48,879 fishes and 50 species from impounded sites and 14,624 fishes and 55 species from contiguous backwater sites). Species composition and structure were highest in the impounded areas. These results suggest that as sediment continues to accumulate and the size of vegetation beds increases

in Pool 19, the resultant aquatic vegetation and associated habitat for catostomids and cyprinids will likely expand.

An Assessment of Night Time Electrofishing in the Lower Wabash River

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The Lower Wabash River, which forms the southeastern border of Illinois with Indiana, is a free-flowing system that supports a robust commercial and sport fishery. Illinois' Long-Term Electrofishing Program (LTEF) monitors fish populations through daytime sampling from June through October annually. Collection of species that are more active during non-summer seasons and night time hours may be limited by LTEF protocol. To address these limitations, we implemented multi-season nighttime pulsed-DC electrofishing starting in Fall 2017. Night time electrofishing data were compared to daytime data from the 2017 LTEF sampling season. Preliminary analyses show that we collected a higher mean (± SE) catch per unit of effort (CPUE; fish per hour) during our night-electrofishing compared to day-electrofishing efforts (Night: 202 ± 23; Day: 119.4 ± 14; $p<0.05$). Differences in mean CPUE for individual families varies in significance between night and day; however, night sampling shows a generally higher catch rate compared to day sampling. The community composition between night and day sampling is relatively similar and the families sampled are proportionate between the two electrofishing methods. Furthermore, length distributions do not differ between the sampled families. These results indicate that the current LTEF day time sampling protocol is sufficient for assessing the fish population in the Lower Wabash River and that night sampling is not necessary.

Differences in Catostomid Fin Morphology between Two Illinois Rivers

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The Sangamon River flows approximately 246 miles through central Illinois and is impounded in Decatur for municipal use. Wastewater effluent is discharged into the river below the dam and constitutes the majority of flow during low water periods. Catostomid species exhibiting fin abnormalities have recently been observed in the river reach between Decatur and Springfield. Previous research indicates Smallmouth Buffalo and River Carpsucker from this stretch of the Sangamon River had caudal fins that respectively comprised 6.98% and 5.48% more of the total body length than that of fish from the Embarras River. We compared total fin morphology for Shorthead Redhorse and River Carpsucker between the Sangamon and Embarras Rivers to determine the extent of elongation. Sangamon River Smallmouth Buffalo fin morphology was analyzed as a baseline for future studies. Fin length and standard length was recorded for all specimens. Landmarks were

placed on lateral fish images utilizing tpsDig2 software and subsequent geometric morphometric analysis was performed with MorphoJ software. Principal Component Analysis (PCA) was used to highlight differences between populations. Preliminary results show that all fins are elongated in the Sangamon River. Fin elongation can negatively affect fish swimming by increasing drag. Future research will be performed to quantify these negative effects by measuring aerobic scope in a flow tank.

Assessing Presence of Catostomid Larvae in Tributaries of the Illinois and Wabash River

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Catostomidae, the third largest freshwater fish family, comprises a high percentage of the biomass in both the Illinois and Wabash rivers. Long-term electrofishing fishing (LTEF) data on the Wabash River shows that 12% of the total fishes sampled between 2010-2016 were catostomids. However, there is little information on recruitment and spawning available for this family in large, midwestern rivers and their tributaries. We sampled three tributaries of the Illinois and three tributaries of the Wabash River using drift nets and larval pushes. Larval fish abundance is greater in the Wabash tributaries than in the Illinois tributaries (Wilcoxon Rank-Sum: $V= 91$, $p<0.001$). In 2016, we identified 100 and 2193 catostomid larvae from the Illinois and Wabash tributaries which contributed to 20% and 39%, of each system total samples, respectively. Using logistic regressions, we found that larvae in Illinois tributaries showed a positive relationship with water velocity and dissolved oxygen ($p<0.05$). In Wabash tributaries, we found larvae presence showed a positive relationship with gauge height and discharge ($p<0.05$). Data from 2017 will be added to the analysis. Because of the difficulty to visually identify larvae past family level, future research will examine spawning habits of catostomid species using genetic analysis.

Stress - Not Behavior - Predicts Response to Elevated Carbon Dioxide in Fish

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The behavior of fish after experiencing an external challenge can be influenced by a host of both internal and external factors. Carbon dioxide is known to be a stressor for fish and has been proposed as a non-physical barrier to prevent fish movement. Individual differences in how fish respond to elevated CO_2 exist with some individuals responding at relatively low pressures of CO_2, and others requiring higher pressures of CO_2 to respond. These differences in behavior may play a role in the efficacy of CO_2 a barrier. We sought to determine the role that both stress and personality play in influencing avoidance behavior. To accomplish this goal,

largemouth bass were either injected with cortisol or kept as a control, and then put through a shuttle box assay to define the partial pressure of carbon dioxide before choosing to shuttle to conditions with lower carbon dioxide. In addition, bluegill that had received behavioral testing to identify bold and shy personality types also received identical shuttle box testing, as well as an acute tolerance test. Largemouth bass that received cortisol injections shuttled at significantly higher carbon dioxide concentrations than control fish, but personality in bluegill had no effect on shuttling, or carbon dioxide tolerance. It appears that stress can affect carbon dioxide tolerance, likely through the effects of cortisol on acid-base balance at the gill or through the effects of cortisol on coping styles. This has important implications for a carbon dioxide barrier as stressed fish may be able to challenge the barrier due to elevated cortisol levels.

What is a Rosyface Shiner and Carmine Shiner: Where do They Live: and How Did They Get Here?

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The taxonomy of Rosyface Shiner *Notropis rubellus* and Carmine Shiner *Notropis percobromus* has been in a state of confusion for many years. They are currently recognized as separate valid species based on genetic data, but are anatomically identical as far as we know. This makes them essentially impossible to identify in the field. Furthermore, the edges of the distributions of these cryptic species was hypothesized to be near Illinois, hence it was unclear whether one, the other, or both species were in the state. We collected genetic tissue samples from every primary watershed in Illinois that is reported to have either of these species. The data indicate that Rosyface Shiner is restricted to the Illinois and Vermilion-Wabash watersheds, while Carmine Shiner is found in the Rock basin and other nearby Mississippi tributaries. There is geographic partitioning within Rosyface Shiner, with upper Illinois, Bureau, Mackinaw, and Vermilion-Wabash forming separate populations. There was no clear differentiation among Carmine Shiner localities. Molecular clock estimates the divergence between these two species occurred 2.8-2.6 million years ago, probably around southern Illinois/Kentucky. Glaciers erased much of the biogeographic evidence, but Carmine Shiners appeared to have become established in the Ozarks then colonized northward up the Mississippi. Rosyface Shiner started somewhere near southern Indiana, then colonized central Illinois before expanding into the Great Lakes when Lake Michigan used to flow into the Illinois-Mississippi watershed through the Des Plaines River.

Effect of Environmental Conditions on Measurements of Small-bodied Fishes

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Determination of the biomass of small-bodied forage fishes is of great concern to biologists; however, accurate and precise weight measurements of these fishes in the field can be difficult. We sought to determine the effect that different environmental factors had on the weight and length measurements of small-bodied fishes. To do this we will determine the effect that different conditions have on the weight measurements of small-bodied forage fishes. We will test the effect of the conditions: outside (alive), inside (alive), inside (dead), and inside (preserved), and the interactions of these factors. The results showed that there was no significant difference between the mean weights of the fish taken in each condition. Moreover, when the variance of each condition was taken, the pickled weights had the lowest variance followed by the alive inside, dead inside, and the largest variance was found in the alive outside weights. This shows that, since there is not significant difference between the measurements, the most time efficient way to record small-bodied fishes measurements is by preserving them and weighing them at a later date.

Assessment of Recovery of Riverine Fish Assemblage after an Anthropogenic Disturbance in Kickapoo Creek, Illinois

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Disturbances within communities are common, but the response of fish assemblages to anthropogenic fish kills is rarely investigated. To determine how rapidly, or if recovery occurs without further mitigation, complete quantification of the fish recovery process is necessitated. We evaluated the recovery of Kickapoo Creek, a riverine assemblage in east central Illinois after a fish-kill disturbance in

2001. Samples were taken in several years spanning from 1962 to 2000 preceding the fish kill and within two months after the kill followed by repeated sampling until 2011. The index of biotic integrity of the community started at 33 before the fish kill, dropped to 22 immediately after, and came to a high of 48 by 2006 before declining through. After the kill in 2001, initial species richness decreased from 19.4 to 16 by June 2002; however, within two months, species richness increased 56% and continued increasing through 2011. Ordination reflected rapid responses in fish composition. However, the composition at the end of 2011 was a much different community than before the kill. Species abundant pre-kill were still abundant in later years; however, subordinate species experienced great turnover. There were large scale compositional shifts in the first few years after the kill, followed by relative stasis for a few years. Recovery in this system is hard to assess. Richness and IBI recovered from the disturbance and continued to increase past the pre-kill values. However, the composition of the fish assemblage has remained distinct from pre-disturbance samples for ten years calling into question whether fish communities every truly recover.

Microchemical Analysis of Native Fish Passage through the Brandon Road Lock and Dam

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Fish species richness within the Des Plaines River watershed has increased over the last 30 years. It has been suggested that the majority of new species collected have migrated upstream past the Brandon Road Lock and Dam (BRLD) from the Illinois, Kankakee, and lower Des Plaines Rivers and have been able to persist in the Des Plaines watershed due to increased water quality. Enhancement of BRLD has been proposed to prevent the upstream transfer of aquatic nuisance species (ANS) from the Mississippi River Basin to the Great Lakes Basin and reduce propagule pressure on the upstream Chicago Sanitary and Ship Canal Electric Dispersal Barrier system. While potentially reducing ANS transfer, these proposed modifications may also impact native fish populations by reducing connectivity and therefore access to recruitment sources. To assess current native fish passage through the lock and dam, a microchemical study is being conducted using fin rays from fish collected from the Des Plaines, Illinois, and Kankakee Rivers. We are using Sr:Ca signatures to determine whether fish collected in the Des Plaines have passed upstream through BRLD. Knowledge of the extent to which native fishes pass upstream through BRLD will inform assessment of potential impacts of barrier enhancement at BRLD, and perhaps other lock and dam structures, on native riverine fishes and inform potential strategies to mitigate impacts of barrier enhancement on native fishes.

SPECIES CONSERVATION

Rapid Expansion of Banded Killifish *Fundulus diaphanus* Across Northern Illinois: Dramatic Recovery or Invasive Species?

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The distribution of the Illinois state-threatened Banded Killifish *Fundulus diaphanus* remained largely unchanged in Illinois from 1880 to 2000, being restricted mainly to the northeastern corner of the state. One population has remained stable in the glacial lakes region along the southeastern Wisconsin - northeastern Illinois border. Individuals from this population are identified as Western Banded Killifish *F. d. menona*. Starting in 2001, a second population began to spread and become more common along the Lake Michigan shoreline. From there, they expanded through the Chicago Area Waterway System into the Des Plaines River,

and eventually the Illinois River. Historical museum specimens from this area are identified as *F. d. menona*, but recent specimens are identified as hybrids between *F. d. menona* and Eastern Banded Killifish *F. d. diaphanus*. A third population appeared in the Mississippi River near the mouth of the Rock River in 2009, and has spread from there. These individuals are identified as *F. d. menona*. The rapid expansion of Banded Killifish from Lake Michigan to the Illinois River appears to be an invasion of the Eastern subspecies *F. d. diaphanus* and the subsequent hybridization with the native Western subspecies. It is unknown where the Banded Killifish in the Mississippi River came from, but they may have originated from populations 160+ kilometers upstream or human introductions. As the Illinois River and Mississippi River populations continue to expand their ranges, their ecological impacts are unknown at this time.

Conservation Status Ranking of Illinois Fish Species in Greatest Conservation Need

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Conservation ranking is used to prioritize the expenditure of limited conservation resources. Frequently conservation ranking is conducted by taxa experts who have hidden assumptions, personal biases, and individual perceptions of risks. However, the ranking process must be consistent and objective to produce status assessments that are comparable across taxa and time. We have conducted conservation status assessments for Illinois fish Species in Greatest Conservation Need (SGCN) using the NatureServe Conservation Status Assessment method. We will explore the conservation status of IL endangered and threatened species. We will examine change in conservation status over time by comparing our ranks with the original conservation statuses assigned in the 1980s. We will explore the role of data availability in status assessment by comparing conservation status assignments based on recent (<10 years old) and older data.

INVASIVE SPECIES

Human-nature Relationships and Normative Beliefs Influence Behaviors that Reduce the Spread of Aquatic Invasive Species

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Human behaviors that contribute to the spread of aquatic invasive species (AIS) are influenced by myriad social psychological factors that vary across contexts and populations. Understanding such behavior is crucial for forming successful management strategies that minimize environmental impacts while generating support and cooperation among stakeholders. We identified several reasons why recreational anglers and boaters made

decisions that benefited the environment. Specifically, our study addressed the following objectives: 1) examine reported behaviors that minimize the spread of aquatic invasive species, 2) test the effects of social normative beliefs on reported behaviors, and 3) determine the role of human-nature relationships in explaining behavioral patterns. Drawing on a path model of the decisions made by recreationists who completed an on-site survey at two case study sites in Illinois, we observed that reported behavior was positively influenced by normative beliefs and human-nature relationships. Specifically, we observed that anglers' participation in nature-based activities and perceived partnerships with the environment correlated with responses to social pressures that, in turn, positively predicted reported activities that minimized the spread of AIS. These findings advance research on the human dimensions of natural resources by providing insights on the role of social psychological processes that shape behavior, while informing management decisions aimed at minimizing biological invasions in aquatic ecosystems.

Recruitment Sources of Silver Carp in the Ohio River Basin Using Otolith Microchemistry

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Knowledge of natal environments and dispersal of Silver carp (*Hypothalmichthys molitrix*) inhabiting the Ohio River and Kentucky and Barkley Lakes would inform development of strategies to control established and emerging populations. However, the principal natal environments supporting the emerging bigheaded carp population in the Ohio River basin are unknown. There is also a need to assess the role of tributaries as nursery sites to increase understanding of dispersal patterns and better target young fish. The goal of this study was to identify recruitment sources and determine dispersal patterns of Silver carp in the Ohio River basin by analyzing otolith core trace element compositions relative to ambient water elemental measurements. Fish were collected from the Ohio River, and Kentucky and Barkley Lakes from 2014-2017 and water samples were taken during summer 2012-2017. Water samples maintained temporal stability and spatial differentiation for the Ohio River and tributaries during the sampling period. Results to date suggest that most Silver carp in the Ohio River are utilizing tributaries during early life. Results also suggest there is passage of carp through the locks into the lakes from the Ohio River and natural reproduction is occurring in or above Kentucky and Barkley Lakes. Results will inform development of efforts to target and remove spawning and young bigheaded carps as well as direct management efforts in the Tennessee and Cumberland River systems.

Characteristics of Larval Asian Carp Production in Illinois and Wabash River Tributaries

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Asian carps are non-native fishes that have deleterious effects on the ecosystems they invade. Because of their destructive nature, fisheries managers are devoting large amounts of time and effort to limit the spread of these fishes. A better understanding of factors that influence patterns of Asian carp reproduction can help fisheries professionals better manage these species. To examine abiotic factors that influence spatial and temporal patterns of reproduction, we used drift nets and larval push nets in three tributaries of both the Illinois and Wabash Rivers. Relative abundances of larvae were compared for *Hypophthalmichthys* (Silver and Bighead Carp) and Grass Carp. Further, we used regression analyses to determine the strength of the relationship between larval abundances with various abiotic factors of both the tributary and main (Illinois or Wabash) river. In total, 1,239 *Hypophthalmichthys* and 289 Grass Carp were collected from four tributaries. Most (99% of *Hypophthalmichthys* and 99% of Grass Carp) larval Asian carps were sampled in Wabash River tributaries and of those, the Little Wabash River produced 83% of *Hypophthalmichthys* and 100% of captured Grass Carp larvae. Maximum daily river discharge (cubic feet/second) significantly correlated (r^2=0.89, $p<0.05$) with log-transformed larval *Hypophthalmichthys* relative abundance. Additionally, discharge significantly correlated with day of year ($p<0.01$) in the four tributaries where larval Asian carps were sampled and did not in tributaries where larval Asian carps were absent. We expect this research to improve our understanding of Asian carp reproduction and help fisheries professionals to better mediate their spread.

Reproductive Potential of Silver and Bighead Carp in the Upper Mississippi River

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Invasive silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*H. nobilis*) are abundant throughout most of the Mississippi River Basin and are very prolific spawners. Asian carp abundance in the Mississippi River above Lock and Dam 19 is low relative to reaches below the dam. Understanding the reproductive potential (i.e., gonadal-somatic index (GSI) and fecundity) of these low density, poorly understood populations is important to inform Asian carp management in the Upper Mississippi River. We examined and compared GSI of silver carp (females: n= 261, males: n= 430) and bighead carp (females: n= 99, males: n= 235) among pools 17-20 of the Mississippi River with stage IV ovaries. Eggs were removed from three locations in one ovary per fish (silver carp, n=155 and bighead carp, n= 76), counted, and weighted to estimate fecundity. Bighead and silver male GSI is not significantly different between pools. Female silver carp GSI is significantly higher in leading edge populations and decreases as densities increases downstream, Pools 17 >19 (p=0.000), Pools 17 >20 (p=0.000), and Pools 18 > 20 (p=0.001). Bighead carp females have a significantly higher GSI in Pool 18 than Pool 20 (p=.0213). Silver carp averaged 794 eggs/g (sd=137.39, se±11), and bighead carp averaged 468 eggs/g (sd=122.56, se±14) across all pools. Differences in GSI may reflect a release from density dependent factors within the leading edge. Lower densities may allow for more allocation of resources to gonadal growth versus somatic growth above Lock and Dam 19.

Otolith Microstructure and Trace Elemental Analyses of Juvenile Asian Carp in the Upper Mississippi River

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Asian carp (*Hypophthalmichthys molitrix* and *H. nobilis*) can spawn multiple times per year dependent on water temperatures and hydrology. Asian carp densities have been limited above Lock and Dam 19 (LD19) on the Upper Mississippi River due to restrictive upstream passage at the dam. In 2016, the first major reproductive event above LD19 was observed; however, limited information is available on the growth and natal/nursery origin of these new recruits. Understanding growth and spatial life history can be beneficial to the management of Asian carp. Our objectives were to (1) determine hatch date and back-calculated growth in relation to temperature and hydrology and (2) determine natal origin and subsequent spatial distributions of juvenile Asian carp using otolith microchemistry and stable isotope analysis. We collected 12,335 juveniles that ranged from 16–584 mm total length from Pools 16-19 of the UMR between July 2016 and November 2017. Polished otoliths were analyzed to calculate hatch dates from daily growth depositions from one lapillus otolith. Nursery habitats and spatial life history of the Asian carp were determined from one lapillus otolith for microchemistry (Sr:Ca and Ba:Ca ratios), while one asteriscus otolith was prepared for stable oxygen isotope analysis ($\delta^{18}O$). Horton Creek samples from July 15, 2016 had birthdates from June 14, 2016 and samples from September 23, 2016 had birthdates from July 23, 2016, indicating multiple cohorts. Otolith microchemistry suggests 64% of juveniles were spawned above LD19 and around 33% showed signatures consistent with being spawned in the Iowa/Cedar/Skunk Rivers, which empty into the UMR above LD19.

Larval Fish Community Survey of Pools 19, 18, and 17 of the Upper Mississippi River

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Lock and dam 19 in Keokuk, IA has slowed the establishment of Asian carp in the Upper Mississippi River. Mature Asian carp populations north of lock and dam 19 exist at low densities and are intensively studied. However, larval fish communities in this region are not well characterized or investigated. The objectives of our study were to describe larval fish community structure and monitor for larval Asian carp at their northern invasion front in the Mississippi River. We used quadrafoil light traps to collect larval fish in Pools 17-19 of the Mississippi River. These traps exploit the phototactic swimming behavior of post-yolksac larval fish and are illuminated with green chemical light sticks. We deployed 12 traps per night from May to September of 2016 at water temperatures ≥ 17°C. Traps were fished on 58 sampling days for a minimum of 1 hour (n=649 traps, 1,995 trap hours). We sampled areas in Pools 17-19 with minimal flow consisting of woody, vegetated, and coverless habitats. Native cyprinids and centrarchids dominated our catch. Detections of larval and juvenile Asian carp were widespread in our Pool 19 samples, but absent above lock and dam 18. We also

observed multiple emergences of larval Asian carp, suggesting that there were multiple spawning events and that conditions were adequate for larval Asian carp reproduction and recruitment in Pool 19 of the Upper Mississippi River during the summer of 2016.

Environmental Correlates of Asian Carp Lateral Habitat Use in Starved Rock Pool

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Asian carp (*Hypophthalmichthys* spp.) are advancing upstream in the Illinois River and represent a potential threat to the Great Lakes ecosystem due to an artificial connection to Lake Michigan. To reduce their probability of reaching Lake Michigan, Asian carp in the upper Illinois River are harvested by contracted fisherman, often in lateral habitats (i.e., backwaters, tributaries, and side channels) where they aggregate. Past studies have focused on longitudinal movements of Asian carp in river systems, but little is known about movements into, and use of, lateral habitats. Better understanding lateral movements and habitat use by Asian carp will improve targeted removal efforts in the Illinois River and elsewhere. To achieve this, lateral movements of Asian carp were monitored with passive acoustic telemetry, in the Starved Rock Pool. Environmental conditions (e.g., water temperature, flow and chlorophyll) in the main channel and lateral habitats that influence their movements were measured weekly. Modeling lateral movements of Asian carp based on the environmental conditions in the river will help predict times and locations to target Asian carp removal and reduce the probability of these species invading the Great Lakes.

Mitigating for Barriers to Asian Carp Movement: Implications for Native Aquatic Taxa

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Brandon Road Lock and Dam (BRLD) located on the lower Des Plaines River in Joliet, IL has been identified by the United States Army Corps of Engineers as a potential site for the implementation of aquatic nuisance species (ANS) control measures. Proposed structural control measures are intended to prevent the upriver movement of ANS such as silver and bighead carps through the lock chamber at BRLD. Subsequently, upriver movement by native fishes would also be prevented. Recent surveys of fishes inhabiting the Des Plaines River above BRLD suggest upriver lockage has facilitated improvements in native fish community richness over time. Moreover, substantial investments in this area have been made to re-establish lotic connectivity providing increased habitat for newly arriving native immigrants. Increases in native fish community richness may also benefit mussel recruitment above BRLD. Our research aims to characterize the consequences of hydrologic

separation that is anticipated to truncate this migratory corridor for native fishes. By synthesizing and integrating available information into a conceptual model, we identify potential consequences of hydrologic separation affecting primarily fishes and mussels. We hypothesize that the loss of supplementary immigration of native fishes through BRLD will slow the rehabilitation of upriver fish communities and potentially limit mussel rehabilitation through vector truncation. We anticipate that our conceptual model will eventually serve to guide both future research priorities and mitigation efforts aimed at minimizing any negative outcomes of a hydrologic separation on aquatic resources upriver of BRLD.

Satellite GPS Telemetry of Asian carp in the Upper Illinois River Waterway

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Kevin Irons, Illinois Department of Natural Resources

Monitoring the spread of Asian carp has been a priority since their introduction and particularly important in the last decade as efforts to prevent them from entering Lake Michigan gained momentum. Monitoring movement using acoustic telemetry (manual tracking and stationary receivers) provided a wealth of information to understand Asian carp behavior. The advent of satellite telemetry and real-time, satellite-linked GPS tags has the potential to complement current acoustic efforts by tracking multiple individuals at once without the man hour investment needed to accomplish the same goal using other technologies. Seven Asian carp (two Bighead Carp and five Silver Carp) were tagged with real-time GPS transmitters in the Dresden Reach of the Upper Illinois River between August 3 and August 30, 2017. During the initial trial, six of the fish remained in the lower 6 km of the Dresden Island reach (24 km). Five fish also spent time in the Kankakee River near its convergence with the Illinois River. Over a 24-hour period, one of the Silver Carp traveled approximately 15 km from the lower end of the reach to a known hotspot identified through acoustic telemetry. A total of 173 useable locations have been collected from the seven tags. The data collected from satellite tags is similar to the data collected from acoustic tracking. While some limitations were discovered, real-time GPS tags could be a useful tool to identify real-time aggregations to inform contracted removal on the water, identify habitat use, spawning and feeding locations, and inform management efforts.

Evaluation of an Approach for Removing Invasive Asian Carps from Small Lakes

Neil Rude, Southern Illinois University, Carbondale, IL

David Coulter, Alison Coulter, and Greg Whitledge, Southern Illinois University

Asian carp species are a problematic group of invasive species that have negative ecological, economic, recreational impacts on freshwater ecosystems. While much of the Asian carp management is focused on mitigating these effects and reducing probability of invasion to the Great Lakes from the Illinois River, small watersheds and their associated lakes are also vulnerable to invasion and its negative effects. Therefore, we sought to develop a harvest protocol to remove Asian carps from three Sparta Training Area lakes based on techniques used to remove Asian carps from an Illinois River floodplain lake. The technique slowly herds fish using surface sounds and electrofishing through strategically placed nets to a pre-determined harvest location. We used hydroacoustic surveys to estimate reductions in Asian carp density and biomass pre- and post-harvest. A total of 1,232 kg of Asian carps were removed from the three lakes, with much of the biomass being Silver Carp from two of the lakes (992 kg). Harvest times ranged from 4.25-6.50 hours per lake, resulting in 7-14 kg of Asian carp biomass removed per person-hour. Estimated Asian carp density and biomass were reduced by 58-75% in lakes. Catch per unit effort for our capture gears was often double to one-hundred times higher in the harvest area compared to other locations, indicating our techniques were effective at herding. This study improved our knowledge and techniques for removing Asian carp populations from lakes, and is anticipated to be applicable to similar small recreational lakes that have been invaded. However, future research investigating these techniques their effectiveness should be conducted on larger lakes with different depth and morphometry.

Age and Growth Demographics of Asian Carp in the Upper Mississippi River

Cortney Cox, Western Illinois University, Macomb, IL

Jim Lamer and Alison Lenaerts, Western Illinois University

Brent Knights, U.S. Geological Survey

Kevin Irons, Illinois Department of Natural Resources

Fish age and growth can be used to infer spawning success, recruitment and population age structure. Understanding these dynamics are especially important when assessing the impacts of, and management options for, invasive species. Bighead and silver carp are invasive species that have established throughout much of the Mississippi River Basin. Lock and Dam 19 on the Mississippi River restricts upstream migration of Asian carp and possibly recruitment dynamics in this emerging population. In turn, this restriction might be limiting the potential for further spread upstream. Aging structures obtained from this population above Lock and Dam 19 allow us to determine growth rates and age-at-maturity in this emerging, poorly understood, low-density population. We have collected length and weight data from adult silver carp (n=4912) and bighead carp (n=1269) captured with commercial fishing methods (i.e., gill nets and seines). Pectoral spines, post-cleithra, and vertebrae have been removed from 1229 Asian carp, 30 fish per 50mm size class, to quantify age and growth in pools 16-19 on the Mississippi River. Ages and back calculated growth were used to create growth curves, which indicate greater growth rates of both bighead and silver carp above Lock and Dam 19 than of those below. This is consistent with significantly greater growth rates above the dam than below it. These results will be used to better understand population dynamics of this emerging population to inform control and containment actions.

Natal Environment and Movement of Asian Carp in Pools 16-19 of the Mississippi River

Charmayne Anderson, Western Illinois University, Macomb, IL

Jim Lamer and Cortney Cox, Western Illinois University

Greg Whitledge and Neil Rude, Southern Illinois University

Brent Knights, U.S. Geological Survey

Asian carp are an invasive species in the US and have spread throughout most of the Mississippi River Basin. Expansion above Lock and Dam 19 on the Upper Mississippi River has been impeded by the high head dam at this location, which restricts upstream passage to the lock chamber. To determine the natal sources, including tributaries and other habitats, of adults residing above LD19, we used otolith (lapillus) stable isotope composition and microchemistry on 150 bighead carp (75 male, 75 female) and 150 silver carp (75 male, 75 female) collected from Pools 16-19 in the Upper Mississippi River. Fish isotope ($\delta^{18}O$) and elemental ratios (Sr:Ca and Ba:Ca) were compared to expected values based on isotope and elemental ratios of water from potential natal sources to assign natal source for each fish. Mixed natal environments from above and below LD19 were observed. More than 75% of bighead carp collected from Pools 17, 18, and 19 originated from natal environments above L&D 19. Also, more than 50% of silver carp collected from Pools 17, 18, and 19 had natal environments above L&D 19. Tracking these natal sources through time can be used to monitor the effectiveness of ongoing and potential control efforts above LD19.

Fear and Shoaling in the Midwest: Understanding How Juvenile Bighead Carp Perceive and Avoid Threatening Situations

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David Wahl, Illinois Natural History Survey

Shoaling behavior is one of many important strategies utilized by prey species to gather many types of information about their environment, particularly in regard to threat recognition. By mimicking the response of an experienced individual, naive individuals increase survivability. Overlapping the niches of many native prey species, the widely distributed invasive Asian carp spend much of their early lives vulnerable to predation. By shoaling in single species or mixed species groups, the survivability of these fishes may be increased. The objective of this study was to evaluate the response of naive juvenile Bighead Carp (*H. nobilis*) when grouped with experienced conspecific and heterospecific (*N. chrysoleucas*) shoal mates and exposed to a predator kairomone. Groups were exposed to 20 mL of largemouth bass (*M. salmoides*) odor, and behavior was recorded before and after application. Our results indicate a decrease in activity and nearest neighbor distance for naive carp paired with conspecifics, however individuals paired with an experienced heterospecific displayed a response similar to the fright response of the heterospecific, indicating the alarm response of the

Bighead carp may be somewhat plastic. Future research is needed to determine if subsequent applications of predator kairomones influence the behavior of naive individuals once the experienced individuals are removed.

Diet Analysis of Predatory Fish in Pools 19 & 20 of the Upper Mississippi River with Contrasting Habitats and Asian Carp Abundance

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Cory Anderson, U.S. Fish and Wildlife Service

Jim Lamer, Western Illinois University

Brent Knights and Jon Vallazza, U.S. Geological Survey

The geographic range of silver (*Hypophthalmichthys molotrix*) and bighead carp (*H. nobilis*) has expanded in the Upper Mississippi River. Lock and Dam 19, a significant high-head dam on the UMR, serves as a potential pinch point for Asian carp. Lock and Dam 19 separates vastly different hydrogeomorphic areas in Pool 19 and Pool 20. Pool 19 is characterized by lentic conditions with high abundances of aquatic vegetation and macro-invertebrates, whereas Pool 20 generally lacks lacustrine habitat and associated macrophytes and fauna. Due to the opportunistic nature of predatory fishes, dietary differences are expected between these variable habitats. Also, if larval or juvenile Asian carp occur in these areas, predation on them by native piscivore fishes would be expected. This study examined predatory fish diets in Pools 19 and 20 to determine if significant dietary differences exist between pools including reliance on available larval or juvenile Asian carp. Our data showed no significant dietary differences between pools for any species. Only one Asian carp was found in a diet (Pool 20) suggesting little or no Asian carp spawning or recruitment occurred in these areas during the sampling time frame or these predators did not prey on larval or juvenile Asian carp.

The Presence of Young-of-Year Asian Carp in Diets of Native Fishes in Lower Pool 19 of the Upper Mississippi River

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Brent Knights, U.S. Geological Survey

The movement of invasive Asian carp through Lock and Dam 19 (LD19) on the Upper Mississippi River is restricted as compared to downstream dams. Abundance and reproduction above the dam is relatively low. In 2016, a “rare” recruitment event for Asian carp occurred above LD19 providing us an opportunity to see how native predators in this reach used this novel forage base. Our objectives were to determine the importance and size of Asian carp being consumed. Native predators were collected with electrofishing and tandem fyke nets

from Pool 19. We removed the diets from 23 species of native piscivores (n=726). White bass (*Morone chrysops*), largemouth bass (*Micropterus salmoides*), shortnose gar (*Lepisosteus platostomus*), channel catfish (*Ictalurus punctatus*), bowfin (*Amia calva*), and longnose gar (*Lepisosteus osseus*) represented the majority of samples. Stomach contents were identified to the lowest possible taxonomic unit. Silver carp were consumed by multiple species. Asian carp occurred in largemouth bass (14/85, 16%), white crappie (1/44, 2%), northern pike (1/15, 7%), smallmouth bass (1/16, 6%), and black crappie (1/38, 3%) of diets. This comparison of predator-prey dynamics between reaches with emerging and established population will help better inform potential management efforts, like stocking and habitat restoration for predators, to control Asian carp in the Upper Mississippi River.

Validating Aging Structures and Back-calculation of Age Structures of Silver Carp

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Jim Lamer, Western Illinois University

Brent Knights, U.S. Geological Survey

Jun Wang, Shanghai Ocean University

Levi Solomon and Andrew Casper, Illinois Natural History Survey

Silver carp (*Hypophthalmichthys molitrix*) have invaded most of the Mississippi River and its tributaries. Although fish age is routinely used to inform management decisions, aging structures for silver carp have not been validated against known-age fish to ensure accuracy and utility. We used known-age fish reared in Chinese aquaculture and collected from the La Grange Reach of the Illinois River (tracked annually from a strong 2014-year class) to validate aging structures, determine the best structure and method for back-calculation, and validate back-calculations for silver carp. We removed and processed vertebrae, lapillus otoliths, pectoral spines, and postcleithra from each individual. Annuli were counted and measured using Leica S8APO Stereoscope and associated software to determine back-calculated growth. By using both field and aquaculture reared individuals, we were able to validate year 1 annuli on all structures, Dahl-lea is a better model to use for back-calculation of growth, and all structures are reliable for age, back-calculated growth, and growth estimates.

Zooplankton as an indicator of Recovery Following Asian Carp Harvest during the Unified Method

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Amber Blackert, Ashley Stanley, Kristopher Maxson and Alison Anderson, Illinois Natural History Survey

Silver (*Hypophthalmichthys molitrix*) and Bighead carp (*Hypophthalmichthys nobilis*) populations have been increasing in the Illinois River since the 2000s, causing negative impacts for the aquatic ecosystem, including zooplankton. Because zooplankton form the base of the food web, any impact on them will also be felt at higher trophic levels. In 2015, a study showed that zooplankton densities increased where commercial harvest reduced Asian carp and could therefore be used as an indicator of whether suppression was ecologically effective. In 2016, a more intense form of harvest, the Unified Method, was implemented. This multi-agency effort contracted commercial fishermen to coordinate a large-scale harvest at a pair of Hanson Material Services Sand and Gravel Pits near Morris, Illinois. The west pit is a lentic ecosystem separated from the east pit through a culvert, and the east pit is in turn fully connected to the Illinois River. The Unified Method was implemented in the west pit while no harvest occurred in the east pit. During the 2016 Unified Method, 96,277 pounds of Asian carp were removed. We sampled zooplankton once before harvest and two times after harvest at 15 sites per sampling event for each pit. The effect of harvest was significant only for rotifers and copepods, while the influence of month sampled was significant for all taxa. These results show that while monthly (seasonal) succession is important, it also shows that the plankton with shorter reproduction cycles (rotifers) may respond more quickly to harvest than plankton with longer reproductive cycles (cladocerans).

Diet Overlap of Black Carp and Freshwater Drum

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Greg Whitledge, Southern Illinois University

Black carp (*Mylopharyngodon piceus*) is a large, molluscivorous species native to eastern Asia. It is one of the four Asian carp species, and was introduced to the United States in 1973. Black carp are currently listed under the Lacey Act as an injurious species due to their potential threat to native and endangered riverine mollusks. In 2015, the first age-0 black carp was caught, providing the first evidence of successful establishment and reproduction in the wild. With that discovery, active sampling efforts have now been put in place to specifically target black carp and learn more about their impacts on native species. The objective of this study is to compare the diets of black carp and freshwater drum (another molluscivorous species) using stable isotope and gut content analysis to assess diet and trophic niche overlap. A high degree of diet overlap of black carp and freshwater drum would suggest the potential for black carp to compete with native benthic fishes.

Spatial and Temporal Patterns of Bigheaded Carps in the Upper Illinois River: A Tool to Inform Removal Efforts

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David Coulter and Greg Whitledge, Southern Illinois University

Bigheaded carps (*Hypophthalmichthys* spp.) have invaded much of the Illinois River, their invasion front currently being located in the Dresden Island pool, approximately forty-seven miles from Lake Michigan. In an effort to prevent further upstream movements, contracted harvest efforts take place in the upper Illinois River to diminish population abundance. Due in part to this effort, bigheaded carp density at the invasion front has declined since 2012. However, maximizing harvest becomes challenging with low abundance. Identifying areas within pools where carp congregate could augment removal efficiency, but these areas may change throughout the year due to the dynamic nature of large rivers. This study sought to quantify spatial and temporal patterns of bigheaded carp density in the upper pools of the Illinois River and determine if these patterns were related to environmental conditions. Hydroacoustic surveys were conducted every other month from March-November in 2017 to estimate bigheaded carp density throughout Dresden Island and Marseilles pools. Simultaneously, water quality parameters including temperature, dissolved oxygen, and chlorophyll-a concentration were sampled. Hydroacoustic results indicate low densities of bigheaded carps in main channel habitats, and highly variable usage of backwater habitats throughout the year. Initial qualitative analyses of environmental parameters suggest flow rate, water temperature, and chlorophyll-a concentration may help explain bigheaded carp spatial and temporal patterns within a pool. These results will be useful to inform locations for contracted harvest in the upper pools of the Illinois River and to aid in understanding bigheaded carp habitat use.

Assessing the Efficacy of Pectoral Fin Sexual Dimorphism for Gender Determination of Bighead Carp

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Bighead Carp (*Hypophthalmichthys nobilis*) are an invasive species expanding throughout the Mississippi River Basin. Understanding the population characteristics of Bighead Carp (i.e., sex composition) within their invaded range can help agencies better manage those systems. Previous research has shown that external differences such as rough patches on the pectoral fins of Silver Carp (H. molitrix) can quickly and accurately determine gender. Since Bighead Carp are closely related to Silver Carp, they may also exhibit this pectoral fin sexual dimorphism. However, this gender determination technique has not been validated for Bighead Carp. Consequently, the objective of this study was to assess the utility of using the presence of a rough patch to identify Bighead Carp gender. Bighead Carp were collected from the upper Illinois River during 2017 by contracted commercial fisherman using gill and trammel nets. Gender was first identified by the presence or absence of a pectoral fin rough patch and then verified by gonadal investigation. Bighead Carp total lengths varied between 526 mm and 1200 mm with a mean total length of 832.8 ($n = 563$; SE = 6.3 mm). Overall, the classification success rate was 79.6% with greater success occurring when classifying females (88.8%) rather than males (70.1%). A Chi-square test revealed a significant difference existed between gonadal identification and successful pectoral fin identification ($p\text{-value} < 0.001$). Results indicate that the use of pectoral fin rough patches to identify Bighead Carp gender may lead to inaccurate gender identification, and gonadal identification should be utilized instead.

[From the 2018 Environmental Concerns Report of the Illinois Chapter of AFS]

If bighead and silver Asian carp reach Lake Michigan, a new U.S. Geological Survey study suggests there is plenty of algae near shore (due to the causes just reported) and the unwelcome invaders would congregate in protected waters like Grand Traverse Bay, Lake Macatawa and Green Bay. This could cause a hazard to boaters in these areas since the carp have a tendency to leap out of the water when frightened. Presently Asian Carp are about 50 miles from Lake Michigan, below the electric barriers. A new report by the U.S. Army Corps of Engineers, on ways to combat the spread of Asian Carp was released in August, 2017. The report contends that the best way to keep invasive Asian Carp from entering and wreaking havoc on the Great Lakes would involve a series of water jets, flushing locks and electrical barriers on the Illinois River.

Another Asian Carp was recently found in the Illinois River. Last April a black carp was caught south of Peoria, more than 100 miles farther north that the species has ever been recorded. The numbers are still low, only a few dozen have ever been caught in Illinois waters, but it has the potential to cause great harm. Black Carp eat mussels and snails, some of which are endangered. Other wildlife, which depend on mussels for food, would also be directly affected.

MUSSELS

Adding some Mussel to the Illinois Hatchery System

Diane Shasteen, Illinois Department of Natural Resources, Jake Wolf Memorial Fish Hatchery, Topeka, IL

The Illinois Hatchery System is composed of three facilities; the LaSalle Hatchery in LaSalle County near Marseilles, Jake Wolf Memorial Fish Hatchery in Mason County near Pekin, and Little Grassy Fish Hatchery in Williamson County near Carbondale. The statewide distribution of the three hatcheries allows them to complement and supplement each other, while giving great latitude in rearing a wide variety of species and aiding in the distribution of fish throughout the state. At full capacity, the system is capable of producing 50+ million fish of 18 species. Recently, a new initiative, the Aquatic Biodiversity Program, was undertaken by the Illinois Department of Natural Resources (IDNR) along with partners from the Illinois Natural History Survey and Exelon Corporation. This program will explore the possibility of adding the propagation and culture of freshwater mussels and threatened and endangered fish species to the state hatcheries scope of work. As the first step to this new initiative, mussels from local streams were brought to Jake Wolf and Little Grassy Hatcheries to determine survivability and growth. This first experiment was successful in determining the locations and water sources within each hatchery that are best suited for continued propagation and culture trials. Mussels remain at Jake Wolf to determine overwintering success. Additionally, cultured juvenile mussels of two common species, Plain Pocketbook and Fragile Papershell, were obtained from the Genoa (WI) National Fish Hatchery and are currently being reared at Jake Wolf. Illinois is well on its way to adding some mussel to our Hatchery System.

Using a Bayesian Decision Network to Guide Restoration Efforts for Native Freshwater Mussels

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Sarah Douglass and Alison Stodola, Illinois Natural History Survey

Freshwater mussels are ubiquitous but understudied organisms for which basic parameters such as population dynamics, habitat preference and abundance are often difficult to obtain in the field. They are also among the most imperiled taxa despite their wide distribution throughout North America. Thus, choosing appropriate restoration actions for these species can be challenging. Bayesian Decision Networks (BDNs) are one potentially useful approach which enables managers to incorporate both empirical data and expert opinion when choosing among restoration options. Ellipse (*Venustaconcha ellipsiformis*) are a common mussel species throughout much of the Midwest, but are recognized as a species in greatest conservation need due to low population sizes. Their rareness is likely the result of factors such as pollution, unsuitable flow regimes resulting from impoundment, or lack of appropriate host fish. We used water quality, watershed composition, host fish richness, and mussel presence data paired with expert opinion to determine the best management approach for restoring Ellipse to two target systems, the South Branch Kishwaukee River and the West Branch DuPage River. Potential management decisions included in the network were no action, relocation of adult mussels from nearby populations, propagation and release of juvenile mussels, inoculation and release of host fish, and removal of upstream dams. When incorporating cost, relocation of adult mussels was predicted to be the most effective restoration option. Future efforts of this project will consider additional mussel species, as well as abundance of mussels and host fish.

Freshwater Mussel Movement in the Kishwaukee River

Sarah Douglass, Illinois Natural History Survey, Champaign, IL

How much do mussels move and why? Horizontal movement in mussels and the mechanisms that drive it are poorly understood. According to the literature, several species move due to low water levels, temperature, day length, and perhaps a few others due to reproductive cues. In August 2015, we initiated a capture-mark-recapture mussel population study with special emphasis on rare and state-listed mussels (i.e., PIT-tagged individuals) in the Kishwaukee River at Interstate 90, east of Rockford, Illinois. Recording life history data during repeated sampling events over the next several years allows for a better understanding of biotic and abiotic factors influencing the mussel community within the Kishwaukee River and recolonization efforts within the post-construction stream area. For one objective of the study, we recorded the location (latitude and longitude) with BIOMARK HPR plus readers of PIT-tagged individuals from 2015-2017 during the months of August, September, and October. We modeled species' upstream and downstream movement and used species, size, year, gauge height and flow rate as covariates. We present the preliminary results of factors influencing mussel movement within the Kishwaukee River at Interstate 90.

Freshwater Mussel Growth Rates Differ Along an Environmental Gradient

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David Seidel, SIU-Edwardsville

Brian Metzke, Illinois Natural History Survey

Metrics and indices of assemblage composition have a long history of use as biological indicators of environmental condition (i.e., as bioindicators). In Illinois, commonly used metrics of mussel assemblage composition include species richness (e.g., INAI designation, BSS classification) and the Mussel Community Index. Yet, other metrics calculated from information collected during standard mussel surveys may serve as useful bioindicators. Our objective is to evaluate the relationship between growth rate (mean length at age) of Pistolgrip and Fragile Papershell and environmental setting to identify rate differences along an environmental gradient. Multiple linear regression models indicate growth rate of both species change along a gradient of land use, geology and substrate, but that species differ in which environmental characteristics correlate with growth rate. This study suggests mussel growth rate can aid characterization of environmental condition.

[From the 2018 Environmental Concerns Report of the Illinois Chapter of AFS]

Speaking of mussles, Jeremy Tiemann and Sarah Douglass, at the Illinois Natural History Survey have discovered a new invasive clam species in the Illinois River. A member of the genus Corbicula, it is the 3rd member of this genus to invade the US from Asia.

FISHERIES MANAGEMENT

The Effects of the 2009 Fish Kill on the Flathead Catfish in the Rock River

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In the spring of 2009 a large fish kill occurred on the Rock River between the towns of Dixon and Prophetstown, IL. The catfish were hit particularly hard with a total of 10,717 catfish (both channel catfish and flathead catfish) found in the kill zone, with a total combined weight of 36,000 pounds. The catfish accounted for approximately 15% of all fish killed. Since the fish kill, the Rock River flathead catfish population has been slow to recover. Recovery efforts have focused on stocking and installing catfish spawning structures, as well as monitoring the population. Recent survey data may suggest continuing problems, perhaps due to increasing fishing tournament pressure.

Flood Level Impact on Channel Catfish Hatch Success in the Wabash River

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Eric Hine, Cassi Moody-Carpenter, and Rob Colombo, Eastern Illinois University

Annually, the Wabash River experiences highly variable water levels from March to July, which overlaps the typical timeframe for Channel Catfish (*Ictalurus punctatus*) reproduction in Midwestern lotic systems.

Beginning in 2014, an electrified trawl modeled after Freedman et al.'s methods was used to sample juvenile Channel Catfish (total length < 90 mm) 10 reaches of the Wabash; CPUE was calculated from this data for all years and months sampled. Annual and monthly average discharge rates (cubic feet/second) were calculated using the USGS historical river gauge data collected at the gauge in Mt. Carmel, IL. Annual average discharge was compared with a One-Way ANOVA, followed by a Tukey post-hoc analysis, and showed us the discharge during in 2016 was significantly lower than all other sample years ($p < .05$). Comparing our annual CPUE, a Two-Way ANOVA, followed by a Tukey post-hoc analysis, yielded no significant differences between any years sampled ($p > .05$). Comparing monthly CPUE with the same analysis as annual CPUE, August is the only month sampled that shows a significant difference compared to all other months throughout all sample years ($p > .05$). Our results currently show no apparent connection between discharge and production of young of the year Channel Catfish in the Wabash River, but data will continue to be collected to add more sample years; it is worth noting the increased July CPUE could assist in future research about Channel Catfish spawning habits in lotic systems.

An Estimation of Harvest and Angler Habits at Bowfishing Tournaments in Illinois

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Jeff Stein, Illinois Natural History Survey

Previous efforts to study and manage recreational sport fisheries have largely focused on rod-and-reel anglers, while bowfishing has received little attention in the literature. Bowfishing, however, is growing in popularity in Illinois resulting in harvest of "rough" fish species, including gars, buffalo and invasive carps. Bowfishing tournaments in Arkansas have been reported to harvest large numbers of rough fish at rates higher than those reported from rod-and-reel tournaments. The potential for intense harvest highlights the need to better understand the impacts of harvest mortality resulting from tournament bowfishing on Illinois fisheries. The goal of this ongoing study is to conduct point-access creel surveys at bowfishing tournaments to better understand the habits and preferences of bow anglers, to characterize species-specific bowfishing harvest rates, and to estimate size-specific bowfishing mortality of native gar species. From June-September 2017 a subsample of angling teams at six bowfishing tournaments in Illinois were interviewed, and fishing effort, count of species harvested and individual size metrics of gars were recorded. One angler from each team participating in the creel survey was interviewed ($n = 45$) about their bowfishing experiences, habits and species preferences. Self-reported catch data provided by tournament organizers via the Illinois Department of Natural Resources Online Tournament Permitting System was utilized to corroborate the results of the creel survey analysis. Results will provide information to support management decisions that promote sustainable harvest of rough fish and provide quality recreational opportunities to bow anglers.

Population Dynamics of Channel Catfish and Freshwater Drum in Four Rivers of Illinois

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Jim Lamer, Western Illinois University

Jason DeBoer, Jerrod Parker, Ben Lubinski, and Andrya Whitten, Illinois Natural History Survey

Neil Rude and Greg Whitledge, Southern Illinois University

Cassi Moody-Carpenter and Rob Colombo, Eastern Illinois University

Channel catfish (*Ictalurus punctatus*) and Freshwater drum (*Aplodinotus grunniens*) are two prominent North American sport fishes occupying a similar ecological niche in many river systems and are commonly used for both commercial and recreational harvest. Comparison of historically validated ageing structures and length frequency data can reveal dynamics of fish populations, including their recruitment, mortality, and individual growth patterns. While many studies focus on a single region, this collaborative project covers reaches of four major rivers and tributaries spanning Illinois, including the Wabash, Ohio, Illinois, and Pools 16, 19, 20, 21, and 25 of the upper Mississippi river, as well as below lock and dam 26 to the Kaskaskia confluence of the lower Mississippi river. All fish were caught in June through October 2017 using DC electrofishing gear at randomized sites as part of a long term survey for the Illinois Department of Natural Resources. A total of 795 otoliths from freshwater drum and 386 pectoral spines from channel catfish were removed, sectioned, and aged. Mean length at age and growth were characterized and compared among locations. Understanding population dynamics of two common predatory fish spanning Illinois waterways is useful for creating potential management strategies and determining their initial necessity.

Recruitment Sources of Catfishes in the Ohio River: Using Otolith Microchemistry

Devon Oliver, Southern Illinois University, Carbondale, IL

Troy Laughlin, Neil Rude, and Greg Whitledge, Southern Illinois University

U.S. commercial catch of Blue, Flathead, and Channel Catfish has increased from 2004 to 2010 (1472 to 2607 tons, 129 to 156 tons, 758 to 1643 tons); additionally, there is an estimated 7.5 million recreational catfish anglers fishing a total of 104 million angling days with little indication of harvest. However, despite the potential for overfishing of catfish stocks in large rivers and strong interest among recreational anglers for more attention to management of catfishes in Mississippi River basin states, limited data on catfish population demographics are available for many large rivers. This lack of data can result in grave oversight of inter and intra annual variations in recruitment and harvest. Harvest and recruitment fluctuations have been indicated as a cause of sampling variations between sites and years. Intra-annual variation can also result from movement of catfishes between large Midwestern Rivers and their tributaries, and is well documented. The objectives of this study were to identify recruitment sources and base line emigration and immigration rates of catfishes in the Illinois section of the Ohio River. Sampling for catfishes was conducted during June-October 2012-- 2016 using electrofishing, trot lines, and hoop nets. Lapilli otoliths were analyzed for $\delta^{18}O$ and Sr:Ca. Water samples from the Ohio River and tributaries were collected from 2010-2016 and were used to describe river and tributary-specific $\delta^{18}O$ and Sr:Ca signatures. Results of this study will be valuable for protecting important spawning and juvenile nursery habitats and assessing interactions among catfish stocks in the Ohio River and tributaries.

Determining Origin and Movement History of Sauger within the Kaskaskia River Using Otolith Microchemistry

Kasey Seibert, Southern Illinois University, Carbondale, IL

Devon Oliver and Greg Whitledge, Southern Illinois University

Sauger are in decline across much of their range due in part to habitat alteration and fragmentation from dams. The lower Kaskaskia River below the Carlyle Lake dam contains a popular Sauger sport fishery despite the presence of multiple dams on the river. The connection between populations and the contribution of fish from different environments to the Kaskaskia River population is currently unknown. Sauger originating within the middle Mississippi River may contribute to the population within the Kaskaskia River if passage through the navigation dam near the confluence occurs. To address this knowledge gap, we determined origin and movement of Sauger in the Kaskaskia River using otolith microchemistry. Otolith sections were ablated along a transect and Sr:Ca ratios were then calculated across the transect from the core to the edge of the otolith to obtain origin (core) and movement history of each fish. Sauger originating from the Mississippi River represented 5% of fish sampled, while 6% of Sauger originated in the Kaskaskia and then moved into the Mississippi River for short periods and then migrated back into the Kaskaskia River. While Mississippi River Sauger populations do not represent a large contribution to the Kaskaskia River population, this study provides evidence that a small connection between these populations exists. Because of the large population of fish originating within the Kaskaskia River system, fisheries managers should focus on identifying the contribution of hatchery fish that may primarily support the fishery.

WATER QUALITY

[From the 2018 Environmental Concerns Report of the Illinois Chapter of AFS]

Illinois River: There is good news regarding the Illinois River: A new report states that populations of largemouth bass, bluegill, catfish and other sportfish are at the highest levels recorded in more than a century. Their dramatic recovery, from populations close to zero near Chicago throughout much of the 20th century, began just after implementation of the Clean Water Act. "Changes in water quality parallel the return of the sportfish", said study co-author Jerrod Parker, an INHS large river ecologist. He led a 2016 study that found a close relationship between the rebound in fish populations in the upper Illinois River after 1983 and reductions in nitrogen pollution (in the form of ammonia), increases in dissolved oxygen and improvements in water clarity. All of these changes are linked to reductions in sewage effluent, he said.

WOTUS: The fate of the Clean Water Act and the "Waters of the United States" is still being fought in federal court. The US Supreme Court just ruled that challenges to the rule must be heard in federal district court. This was a "win" for environmental groups since the WOTUS law will go back into full effect nationwide until things get sorted out in federal court. However this win could be a short lived. The Trump administration already has plans in place to repeal the law, but no plans to replace it. Replacing the law could take years.

The Middle Fork of the Vermilion River near Oakwood, IL has been receiving contamination from three coal ash ponds adjacent to the river. According to the U.S. EPA, coal ash can contain contaminants like mercury, cadmium and arsenic that can pollute waterways, groundwater, drinking water and the air without proper management. The ponds are left over from an old coal-fired power plant that was closed in 2011. The plant was

originally operated by Illinois Power but was purchased by Dynegy. The runoff from the ponds is contaminating the river, and the river is eroding the banks between the ponds and the river. Two local groups, the Prairie Rivers Network and Eco-Justice Collaborative have been sounding the alarm, and the Prairie Rivers Network plans to file a lawsuit. One complicating factor is the nation's recent scaling back of environmental regulations. The Trump administration has shuttled a 2015 proposal which would strengthen pollution safeguards on coal ash facilities at inactive power plants. Similar action at the state level has stalled as well. The two advocacy groups plan to sue Dynegy under a Clean Water Act provision which allows citizens to challenge companies over water pollution violations. Dynegy has already been cited for groundwater violations at the site. Says Prairie Rivers' water resources engineer Andrew Rehn, "This toxic waste needs to be cleaned up. We want to make sure that Dynegy can't walk away from its responsibility. We all have a right to a clean Vermilion River".

CAFO's: IL Dept. of Agriculture has granted permits for 2 new facilities to be built near Fithian. Each would house up to 8,400 hogs. Meanwhile another facility just finished construction further north in Vermilion County. This facility is also designed to house 8,400 hogs.

Sen. Dave Koehler, (Dem, Peoria), has unveiled a package of legislation that would seek multiple changes in current laws, including extending the amount of time the public has to request hearings, requiring additional permits to expand existing operations, requiring all facilities to register with the Illinois Environmental Protection Agency and requiring waste management plans to be filed before facilities are built.

Mississippi River: Every summer, the Gulf of Mexico is flooded with excess nitrogen and phosphorus from wastewater treatment plants and farm fields along the Mississippi River basin. And every summer, those nutrients create a "dead zone" in the Gulf. To address the issue, the U.S. Environmental Protection Agency formed a task force and required 12 states to develop strategies to reduce agricultural runoff. According to researchers at the University of Illinois, the strategies show promise, and leave room for the addition of certain practical elements that could help decision makers choose specific conservation practices to adopt or avoid. The new study, "Beyond the nutrient strategies: Common ground to accelerate agricultural water quality improvement in the upper Midwest," is published in the Journal of Environmental Management.