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Status Assessment of the State-Threatened Gravel Chub (*Erimystax x-punctatus*) in Illinois

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ABSTRACT

The Gravel Chub *Erimystax x-punctatus* (Family Leuciscidae) is an imperiled minnow with a disjunct distribution in Illinois. Due to its affinity for deep, swift flowing water, this species is often difficult to collect with traditional sampling methods and might be overlooked during fish sampling surveys. We performed a status assessment of this rare species with methods that target benthic-dwelling fishes by sampling at 50 sites throughout the species range. In non-wadeable areas, sites were accessed via boat and sampled using a mini-Missouri trawl, whereas in wadeable streams, sites were sampled by kick-seining swift-flowing rocky areas. *Erimystax x-punctatus* was found at 43% of the sites sampled – 41.3% of the sites trawled and 50% of the sites kick-seined – in depths varying from 0.3 to 2.1 m (mean: 0.78 m ± 0.39 m SD) and stream velocities ranging from 0.4 to 2.3 m/s (mean: 1.02 ± 0.45 m/s SD). Density estimates, defined as the number of individuals per 100-m^2 sampled, varied from 0.1 to 2.8 individuals (mean: 0.4 ± 0.79 individuals SD) during the project at positive sites. Our data showed that *E. x-punctatus* is still extant throughout the Rock River drainage and the mainstem Vermilion River (Wabash River drainage), and that this fish showed a strong attraction to high velocity areas over clean, rocky substrates.

INTRODUCTION

The Gravel Chub *Erimystax x-punctatus* (Family Leuciscidae) is a diminutive benthic-dwelling fish (<100 mm) with a disjunct distribution that includes the northern portion of the Ohio River drainage, the upper Mississippi River, the lower Missouri River drainage, and the lower Arkansas River drainage (Harris 1986; Page and Burr 2011). It occupies deeper riffles and runs of moderate to fast current over firm, silt-free rocky substrates in medium to large streams (Smith 1979; Becker 1983; Kansas Fishes Committee [KFC] 2014). Within Illinois, *E. x-punctatus* is extant in the Rock River drainage (e.g., Rock River mainstem, Pecatonica River, Kishwaukee River, and Turtle Creek) and the mainstem Vermilion River (Wabash River drainage) but was known historically from the Mississippi and Wabash mainstem (Smith 1979; Illinois Natural History Survey [INHS] 2021). However, *E. x-punctatus* has experienced a decline in its distribution in Illinois because of siltation in streams (Smith 1971); as a result, the fish is currently listed as a state-threatened species (Illinois Endangered Species Protection Board [IESPB] 2020).

Due to its affinity for deep, swift flowing water, *E. x-punctatus* is difficult to capture with traditional sampling methods, such as electrofishing, and is often missed during normal community assessments (i.e., Neebling and Quist 2011). This observation is likely because *E. x-punctatus* rests under rocks in riffles to avoid the effects of strong currents (Moore and Paden 1950), behaviors similar to those of darters (Family Percidae; Page 1983). Subsequently, the paucity of capture data has led to a general lack of published knowledge regarding the status and life history of *E. x-punctatus* (Stites et al. 2018). The first goal of this project was to perform a status assessment with methods that target benthic-dwelling fishes at pre-determined random locations in order to provide population abundance estimates and update the known range of *E. x-punctatus* in Illinois. The second objective of this study was to investigate habitat associations (e.g., preferred substrate and flow characteristics) of this species.

METHODS

Study Area. Our study occurred in the Rock River drainage in northern Illinois (Figure 1), as well as the Vermilion River mainstem (Wabash River drainage) in Vermilion County (Figure 2), as these are the last known locations for *E. x-punctatus* in Illinois (Smith 1979; INHS 2021). The Rock River originates from the Horicon Marsh, Dodge County, Wisconsin, and flows 512 km in a south-southwesterly direction in southern Wisconsin and northern Illinois before its confluence with the Mississippi River at Rock Island, Rock Island County, Illinois. The Rock River and its tributaries, like the Green, Pecatonica, and Kishwaukee rivers, drain approximately 27,000 km^2. Conversely, the Vermilion River drainage encompasses nearly 4,000 km^2 of eastern Illinois and western Indiana. The Vermilion River mainstem is formed when the Salt Fork and Middle Fork converge east of Danville, Vermilion County, Illinois; the mainstem flows 46 km until it meets the Wabash River in Cayuga, Vermillion County, Indiana. Both the Rock River drainage and Vermilion River drainage occur in watersheds that are primarily agricultural; however, the riparian areas are largely intact, and the stream substrates are predominantly a mixture of sand, gravel/pebble, and cobble (Smith 1968; Smith 1971; Page et al. 1992). Both river drainages are among the highest quality stream systems in Illinois in terms of aquatic biodiversity, as both support a

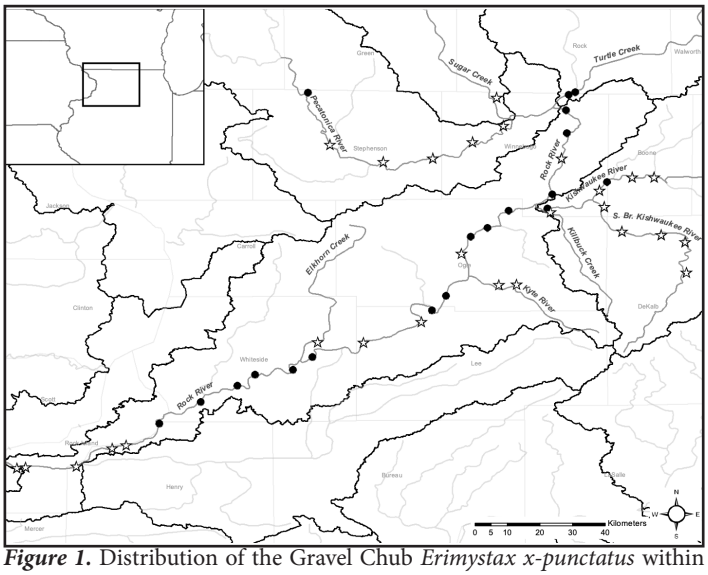

Figure 1. Distribution of the Gravel Chub *Erimystax x-punctatus* within the Rock River drainage, Illinois. Solid circles indicate where the species was collected, and open stars are those sites it was not detected in 2019 and 2021.

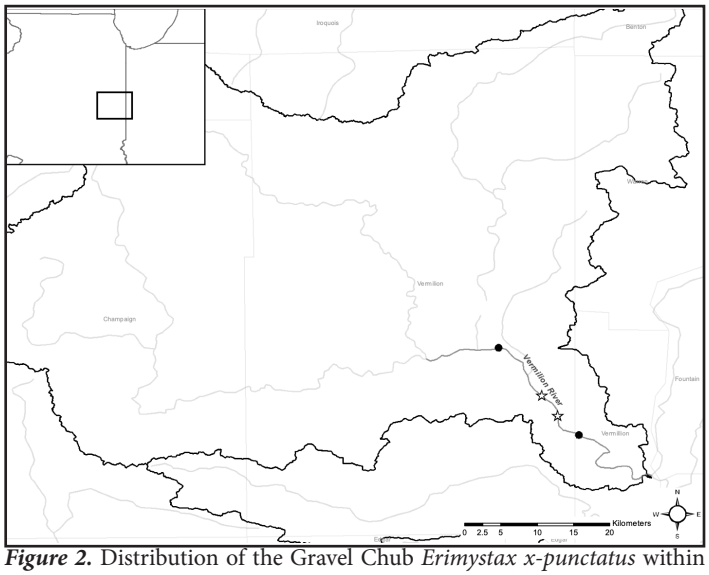

Figure 2. Distribution of the Gravel Chub *Erimystax x-punctatus* within the Vermilion River basin (Wabash River drainage), Illinois. Solid circles indicate where the species was collected, and open stars are those sites it was not detected in 2021.

diverse and abundant fish fauna with over 110 species present (Smith 1979; Becker 1983; Retzer 2005; Burr and Page 2009).

There are two subspecies of the Gravel Chub (Harris 1986; Page and Burr 2011) – *E. x-punctatus trautmani*, which occurs in the Wabash River drainage (i.e., the Vermilion River) and eastward, and *E. x-punctatus punctatus*, which occurs west of the Wabash River drainage (i.e., the Rock River drainage). For our study, we lumped both the Rock River drainage population and the Vermilion River mainstem population simply as *E. x-punctatus*.

Sampling. Using a random number generator, we selected 50 stream segments in the Rock River drainage and Vermilion River mainstem (Figures 1 and 2), where a stream segment was defined as an area between two incoming stream confluences. Three segments in the Rock River mainstem were sampled in September 2019, and the remaining 47 segments were sampled during the summer of 2021. Inclement weather, high water levels, and a pandemic precluded us from sampling continuously from the onset of the project. Given the rarity of *E. x-punctatus*, specific coordinates are not provided herein but were submitted to the Illinois Department of Natural Resources' Natural Heritage Program, Springfield.

Targeted fish sampling occurred in two ways. First, stream segments in the Rock and Pecatonica rivers were accessed via boat and sampled using a mini-Missouri trawl, which is a modified two-seam slingshot balloon trawl covered with a small-mesh cover (see Herzog et al. [2005] for trawl dimension details). Missouri trawls are an effective way to collect small-bodied benthic fishes in non-wadeable streams (Herzog et al. 2005; Neebling and Quist 2011). Within each segment, five trawl runs were pulled in the best available habitat (e.g., swift flowing water over clean gravel substrates); trawls were deployed from the bow of the boat as the boat was backed downstream. Most trawl runs were standardized to 150-m pulls per river segment; however, trawl runs were reduced to 50-m pulls for fear of entanglement on submerged woody debris in some areas (i.e., the lower Pecatonica River and impounded areas in the Rock River). Alternatively, stream segments in smaller wadeable streams were accessed via kayaks or at road-stream crossings and sampled by kick-seining, which is common technique to capture small benthic fishes (Tiemann et al. 2004; Tiemann et al. 2021). Specifically, up to 20 9-m^2 plots were kick-seined in shallow (<1 meter deep), swift-flowing areas throughout each stream segment. To standardize, our kick-seine method involved disturbing the substrates 3-m upstream from a stationary 3-m wide, 1.25-m high, 6-mm mesh seine and proceeding downstream to the seine in a back-and-forth path covering the width of the seine. To minimize disturbance, plots were sampled near shore to far shore and were sampled from downstream to upstream. At the conclusion of each trawl run and kick-seining set, Gravel Chubs were numerated, measured (mm, stand-length), and placed in an aerated live-well. Most individuals were released at the completion of collection at the site; however, a few individuals were retained as voucher specimens and deposited into the Illinois Natural History Survey Fish Collection, Champaign.

Habitat Association. *Erimystax x-punctatus* habitat associations were determined in wadeable streams by recording water depth (meters) with a meter stick, water velocity (meters per second) at 50% stream depth using a FloWatch Flowmeter (JDC Electronic, Switzerland), and dominant substrate type based upon a modified Wentworth (Cummins 1962; Mullner et al. 2000). For non-wadeable sites, we measured

surface water velocity using a FloWatch Flowmeter and recorded depth and estimated dominant substrate type using a side-scan sonar (Humminbird 999ci, Racine, WI). To standardize the habitat data because one method was visualized and the other was estimated by sonar, we simplified the habitat matrix. We scored habitat as a 0 if smooth surfaces (e.g., silt/sand) were the dominant substrates, a 1 if moderately coarse substrates (e.g., gravel, pebble, cobble) dominated, and a 2 if ragged substrates (e.g., boulder) were prevalent.

Data Analysis. We calculated Pearson's correlation coefficients to examine which variables (depth, stream velocity, and dominant substrate type) are associated with *E. x-punctatus* presence/absence. A sequential Bonferroni-correction of $\alpha = 0.05$ was applied to help limit the Type I error of multiple tests (Rice 1989). We also calculated detection probabilities to determine the number of samples needed for a 95% likelihood of detecting *E. x-punctatus* when trawling or kick-seining (Herzog et al. 2005). Statistical analyses were performed with Microsoft Excel for Mac (Version 16.54).

RESULTS

A total of 69 individuals of *E. x-punctatus* was collected from 21 of the 50 stream segments sampled (Figures 1 and 2). Within the Rock River drainage, *E. x-punctatus* was captured from the Kishwaukee River basin (2 of 11 sites), Pecatonica River (1 of 6 sites), Turtle Creek (1 of 1 site), and Rock River mainstem (15 of 24 sites), but not collected in the Sugar River (0 of 1 site), Kyte River (0 of 2 sites), or Elkhorn Creek (0 of 1 site). Within the Vermilion River mainstem, *E. x-punctatus* was found at 2 of 4 sites.

Density estimates varied from 0.1 to 2.8 individuals per 100-m^2 sampled (mean: 0.4 ± 0.79 individuals SD) during the project at positive sites. Within the Rock River basin, density ranged from 0.1 to 2.8 individuals per 100-m^2 sampled (mean: 0.4 ± 0.83 individuals SD), whereas in the Vermilion River mainstem, density at both positive sites was 0.56 individuals per 100-m^2 sampled.

Erimystax x-punctatus was found in depths varying from 0.3 to 2.1 m (mean: 0.78 m ± 0.39 m SD; Figure 3) and stream velocities ranging from 0.4 to 2.3 m/s (mean: 1.02 ± 0.45 m/s SD; Figure 4). Depth ($t = 0.07$, P = 0.53) was insignificant with presence of *E. x-punctatus*. However, presence of *E. x-punctatus* was positively correlated with stream velocity (r = 0.87, P = 0.008) and larger substrates ($t = 0.68$, P = 0.01).

Detection probabilities were 0.16 (± 0.284 SD) when pulling 150-m trawl runs and 0.10 (± 0.207 SD) when kick-seining 9-m^2 plots. These values increased to 0.45 (± 0.297 SD) and 0.40 (± 0.219 SD), respectively, when targeting suitable habitat (swift flowing water over clean, rocky substrates).

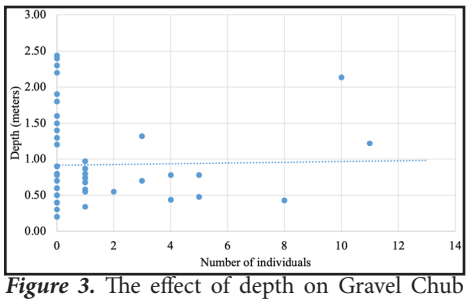

Figure 3. The effect of depth on Gravel Chub *Erimystax x-punctatus* observations at 50 sites in the Rock River drainage and Vermilion River mainsteam (Wabash River drainage), Illinois, in 2019 and 2021. The dotted line represents the best fit trend line relating gravel *E. x-punctatus* observations to depth.

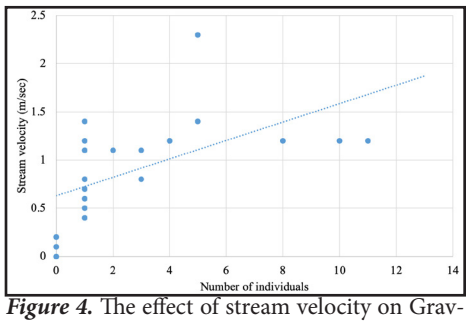

Figure 4. The effect of stream velocity on Gravel Chub *Erimystax x-punctatus* observations at 50 sites in the Rock River drainage and Vermilion River mainsteam (Wabash River drainage), Illinois, in 2019 and 2021. The dotted line represents the best fit trend line relating gravel *E. x-punctatus* observations to stream velocity.

DISCUSSION

Our study offers insight to the current distribution of one of Illinois' rarest fishes, the Gravel Chub. Our data suggest *E. x-punctatus* continues to occur throughout the Rock River drainage and Vermilion River mainstem. The species' affinity for swift flowing water over clean, rocky substrates was evident. We exclusively found the fish in areas with flow and over clean gravel and cobble substrates. Never did we find the fish in stagnant waters or over silty or pure sand substrates, which agrees with other accounts (e.g., Smith 1979; Becker 1983; Pflieger 1997; KFC 2014).

Within the Rock River drainage, *E. x-punctatus* was found at 41.3% of the sites (19 of 46). The fish was most often collected in the Rock River mainstem, as well as the lower stretches of the river's tributaries (i.e., Kishwaukee River and Turtle Creek). However, we failed to collect *E. x-punctatus* in several tributaries where the species was previously reported (Figure 1). We would not be surprised if small, isolated populations exist in these streams. We did find suitable habitat in these areas, but in most cases, the fish has not been reported there since 1970 or earlier (e.g., Kyte River or Elkhorn Creek; INHS 2021). The Pecatonica River was a curious case, as most of the stream was low gradient, stagnant, silted, and woody-debris filled. We boated nearly the entire river from the state-line and only saw one area containing suitable *E. x-punctatus* habitat, which is where we found the species (Figure 1).

The Vermilion River mainstem supports a small, yet ever present, population of *E. x-punctatus* (Figure 2). Suitable habitat continues to be present throughout the mainstem. This area is especially deserving of future monitoring, particularly following the removal of the Danville Dam, as several rare fishes have recently undergone range expansions in the basin (Tiemann 2008; Sherwood and Wylie 2015; Tiemann et al. 2015; Tiemann et al. 2020; Tiemann et al. 2021).

Becker (1983) stated that habitat requirements of *E. x-punctatus* are so strict that populations are often isolated and confined to specific habitat types. Never was this theory more evident than when we sampled within the impounded areas of the Rock River. Conversion of lotic habitats to lentic habitats by dams has cascading effects on the stream's hydrogeomorphology, which includes altered physicochemical parameters like a reduction in stream velocity and increased siltation upstream from dams (Tiemann et al. 2004). The resultant effects can be a reduction in benthic species, especially habitat specialist fishes (Tiemann et al. 2004; Santucci et al. 2005; Slawski et al. 2008). Never did we collect *E. x-punctatus* within an impounded area of one of the seven lowhead dams on the lower Rock River, Illinois. These areas lacked the flow and appeared to lack the clean, rocky substrates desired by *E. x-punctatus*. Therefore, we consider habitat fragmentation by dams as a significant threat to *E. x-punctatus* in Illinois, as has been reported for other benthic fishes (Poff et al. 1997; Cooney and Kwak 2013).

The results of our project give a better understanding of the distribution and status of *E. x-punctatus* in Illinois. Our targeted sampling throughout entire reaches of the species' extant range allowed us to show the importance of determining habitat associations for specialist species. By better determining the specific habitat requirements of *E. x-punctatus* (i.e., high velocity areas over clean, rocky substrates), our results make it easier to determine the likelihood of the fish's presence/absence simply by assessing habitat prior to fish surveys. Similar study designs that target benthic fishes could be applied to other rare fish taxa in Illinois with the hopes of yielding analogous results. The data would give natural resource agencies a better understanding of the current statuses of many underrepresented or imperiled taxa, especially those with specific habitat requirements, are difficult to collect, or might not recruit well to standard collecting gear.

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LITERATURE CITED

Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison. 1052 pp.

Burr, B.M., and L.M. Page. 2009. Illinois fish communities: more than a century of change. Pp. 147–162 in C.A. Taylor, J.B. Taft, and C.E. Warwick, editors. Canaries in the catbird seat: the past, present, and future of biological resources in a changing environment. Illinois Natural History Survey Special Publication 30, Champaign.

Cooney, P.B., and T.J. Kwak. 2013. Spatial extent and dynamics of dam impacts on tropical island freshwater fish assemblages. BioScience 63:176–190.

Cummins K.W. 1962. An evaluation of some techniques for the collection and analysis of benthic samples, with special emphasis on lotic waters. American Midland Naturalist 67:477–504.

Harris, J.L. 1986. Systematics, distribution, and biology of fishes currently allocated to *Erimystax* (Jordan), a subgenus of *Hybopsis* (Cyprinidae). Unpublished doctoral dissertation. University of Tennessee, Knoxville, 335 pp.

Herzog, D.P., V.A. Barko, J.S. Scheibe, R.A. Hrabik, and D.E. Ostendorf. 2005. Efficacy of a benthic trawl for sampling small-bodied fishes in large river systems. North American Journal of Fisheries Management 25:594–603.

Illinois Endangered Species Protection Board (IESPB). 2020. Checklist of Endangered and Threatened Animals and Plants of Illinois. Illinois Endangered Species Protection Board, Springfield, Illinois. 10 pp.

Illinois Natural History Survey (INHS) Fish Collection Database, Champaign. 2021. https://biocoll.inhs.illinois.edu/portalx/collections/index.php. Accessed on 1 December 2021.

Kansas Fish Committee (KFC). 2014. Kansas Fishes. University of Kansas Press, Lawrence. 496 pp.

Moore, G.A., and J.M. Paden. 1950. The fishes of the Illinois River in Oklahoma and Arkansas. American Midland Naturalist 44:76–95.

Mullner S.A., W.A. Hubert, and T.A. Wesche. 2000. Visually estimating substrate composition at potential spawning sites for trout in mountain streams. Journal of Freshwater Ecology 15:199–207.

Neebling, T.E., and M.C. Quist. 2011. Comparison of boat electrofishing, trawling, and seining for sampling fish assemblages in Iowa's nonwadeable rivers. North American Journal of Fisheries Management 31:390–402.

Page, L.M. 1983. Handbook of darters. TFH Publications, Inc. Neptune City, NJ. 271 pp.

Page, L.M., and B.M. Burr. 2011. Peterson Field Guide to Freshwater Fishes of North America North of Mexico. Houghton Mifflin Harcourt, Boston. 663 pp.

Page, L.M., K.S. Cummings, C.A. Mayer, S.L. Post, and M.E. Retzer. 1992. Biologically Significant Illinois streams, an evaluation of the streams of Sllinois based on Aquatic Biodiversity. Technical Report. Illinois Department of Conservation and Illinois Department of Energy and Natural Resources, Springfield, Illinois. 498 pp.

Pflieger, W.L. 1997. The Fishes of Missouri. Missouri Department of Conservation, Jefferson City. 371 pp.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The natural flow regime: a paradigm for river conservation and restoration. BioScience 47:769–784.

Retzer, M.E. 2005. Changes in the diversity of native fishes in seven basins in Illinois, USA. American Midland Naturalist 153:121–134.

Rice, W.R. 1989. Analyzing tables of statistical tests. Evolution 43:223–225.

Santucci, V.J., S.R. Gephard, and S.M. Pescitelli. 2005. Effects of multiple lowhead dams on fish, macroinvertebrates, habitat, and water quality in the Fox River, Illinois. North American Journal of Fisheries Management 25:975–992.

Sherwood, J.L., and D.B. Wylie. 2015. Current status and historic range of one of Illinois' rarest fishes. Transactions of the Illinois State Academy of Science 108:43–46.

Slawski, T.M., F.M. Veraldi, S.M. Pescitelli, and M.J. Pauers. 2008. Effects of tributary spatial position, urbanization, and multiple low-head dams on warmwater fish community structure in a Midwestern stream. North American Journal of Fish-

eries Management 28:1020–1035.
Smith, P.W. 1968. An assessment of changes in the fish fauna of two Illinois rivers and its bearing on their future. Transactions of the Illinois State Academy of Science 61:31–45.
Smith, P.W. 1971. Illinois streams: a classification based on their fishes and an analysis of factors responsible for disappearance of native species. Illinois Natural History Survey Biological Note 76:1–14.
Smith, P.W. 1979. Fishes of Illinois. University of Illinois Press, Urbana, Illinois. 314 pp.
Stites, A.J., J.L. Sherwood, and J.S. Tiemann. 2018. Fecundity estimates of the Gravel Chub, *Erimystax x-punctatus* (Pisces: Leuciscidae). Transactions of the Kansas Academy of Sciences 121:386–390.
Tiemann, J.S. 2008. Distribution and life history characteristics of the state-endangered Bluebreast Darter *Etheostoma camurum* (Cope) in Illinois. Transactions of the Illinois State Academy of Science 101:235–246.
Tiemann, J.S., D.P. Gillette, M.L. Wildhaber, and D.R. Edds. 2004. Effects of lowhead dams on riffle-dwelling fishes and macroinvertebrates in a Midwestern river. Transactions of the American Fisheries Society 133:705–717.
Tiemann, J.S., C.A. Taylor, J. Lamer, P.W. Willink, F.M. Veraldi, S. Pescitelli, B. Lubinski, T. Thomas, R. Sauer, and B. Cantrell. 2015. Range expansions and new drainage records for select Illinois fishes. Transactions of the Illinois State Academy of Science 108:47–52.
Tiemann, J.S., J.L. Sherwood, and A.J. Stites. 2020. Population expansion of the state-threatened Eastern Sand Darter, *Ammocrypta pellucida* (Agassiz, 1863), within the Vermilion River basin (Wabash River drainage), Illinois. Transactions of the Illinois State Academy of Science 113:1–4.
Tiemann, J.S., B.E. Fisher, T. Thomas, J. Adams, C. Moody-Carpenter, A. Jones, and R.E. Colombo. 2021. First occurrence of the Streamline Chub *Erimystax dissimilis* and Tippecanoe Darter *Etheostoma tippecanoe* in Illinois and within the Vermilion River basin (Wabash River drainage). Transactions of the Illinois State Academy of Science 114:35–38.