STATE WILDLIFE GRANT—INDIANA
Assessing Juvenile Survival in Eastern Hellbenders

Anesthetized juvenile hellbenders after surgical implantation of pit tags and radio transmitters. (Photo by Emily McCallen)

CURRENT STATUS
Fourth year of a four-year project

FUNDING SOURCES AND PARTNERS
State Wildlife Grant Program (T7R15)
Purdue University

PROJECT PERSONNEL
Dr. Rod N. Williams, Principal Investigator, Purdue University
Emily McCallen, Doctoral Sstudent (2013–present), Purdue University
Erin Kenison, Doctoral Student (2014–present), Purdue University
Brianna Osinski, Master's Student (2015–2017), Purdue University

TECHNICIANS
Nick Burgmeier (2015–2017)
Veronica Yager (2016–2017)
Todd Houser (2017)
Cullen Harris (2016)
Helen Sung (2016)
Brian Tornabene (2015)
Kodiak Hengstebeck (2014)
Lucas Hoehn (2014)
Weston Schrank (2014)
Brandon Zinman (2014)
Matthew Farr (2014)

BACKGROUND AND OBJECTIVES
The Eastern hellbender *(Cryptobranchus alleganiensis alleganiensis)* is a large aquatic salamander that historically occurred throughout much of the eastern United States. During the past few decades, hellbender populations have exhibited rangewide declines and are now listed as threatened or endangered in nearly every state in which they occur. Population declines have

As part of a predator-conditioning treatment for juvenile hellbenders, a largemouth bass is fed a larval tiger salamander. (Photo by Erin Kenison)

been particularly pronounced in the Midwest. Hellbenders are thought to be extirpated from Illinois and continue to require protection in Missouri and Ohio.

In Indiana, hellbenders currently occupy only a 70-mile stretch of the Blue River in the southern part of the state. Population densities throughout this stretch are far lower than those seen in stable populations in other states. Despite repeated searches, there is no evidence of occurrence of sub-adult and larval-age classes. Recent surveys have found few adult females. This suggests that hellbenders in Indiana may already face functional extirpation, and that without conservation actions, they are extremely vulnerable to physical extirpation.

The initial causes of hellbender declines in Indiana are unclear. Factors such as poor water quality, habitat degradation, and human disturbance likely contributed. Once a species' numbers are critically low, it is unlikely it can recover on its own. Earlier studies focused on the effects of water quality and potential human interference. Those studies found little evidence of continued threats. As a result, we focused on two remaining factors to help stabilize the hellbender population in the Blue River: juvenile survival and habitat assessment.

Because there has been no evidence of successful reproduction in 30 years, the first step for stabilizing Indiana's population involved increasing the survival of juvenile hellbenders through captive rearing techniques. A recent population viability analysis suggested that improving survival in this age class would have a greater impact than focusing on adults. While head-starting alone can improve survival, we explored whether advanced conditioning techniques could better prepare captive-reared hellbenders for reintroduction into the wild and further increase survival.

Before the release of captive-reared individuals, it is essential to ensure that species' habitat requirements are adequate to support the conservation measures. Because habitat degradation likely contributed to initial declines, returning hellbenders to degraded sites could lead to translocation failures. We focused on assessing all potential release sites in the Blue River based on physical characteristics and biotic communities to ensure habitat was suitable. Ultimately, we hope to influence rearing methods, release techniques, and management decisions to preserve hellbender populations into the future.

METHODS

We have an active head-starting program at Purdue University's Aquaculture Facility. During the 2012, 2013, and 2015 breeding seasons, we collected nests from nest boxes at a previous augmentation site. This resulted in 267 captive-reared hellbenders to prepare for release. Many underwent various conditioning techniques to prepare them for life in the wild. Eighty hellbenders were raised in raceways to observe the effects of exposure to moving water during the captive-rearing period. These raceways represent more natural systems than the tank systems currently in use because they feature river-like water velocities, gravel substrate, and rock hides. Forty hellbenders were exposed to flowing water during an 18-month period in treatment raceways, and, to act as a control group, 40 additional animals were only exposed to still water. We compared differences in morphology and swim performance between the two groups. These 80 hellbenders will be the first juveniles released into the Blue River. Upon release, they will be radio-tracked to compare the survival rates of the two groups.

We also examined responses to predator conditioning in young hellbenders. Translocations are inherently stressful for animals. Because elevated and prolonged

stress can increase energy demands, susceptibility to diseases and risk of predation, it is highly associated with translocation failure. Young, vulnerable hellbenders detect predatory fish as stressors; therefore, translocations into environments rich in fish diversity and predator kairomones (a chemical emitted by one organism that is detected by another species and gains some advantage as a result) could magnify already elevated stress levels and become detrimental to survival. We investigated the use of predator conditioning to prepare hellbenders, behaviorally and physiologically, for largemouth bass encounters and mitigate predator-associated translocation stress. We reared two-year-old hellbenders with and without continuous exposure to largemouth bass cues for 30 days. After conditioning, we exposed hellbenders to water with low or high concentrations of cues and assessed their metabolic rate as a measure of stress.

To help ensure post-release survival, we focused on habitat assessment. First, we examined patterns of habitat use in 10 juvenile hellbenders that were released in a 2010 pilot study. After observing fine-scale patterns of habitat use, we made recommendations for current and future reintroductions. We then conducted a river-wide assessment of habitat suitability, developing GIS layers useful for fine-scale modeling of habitat use. Specifically, we used side-scan sonar technology to classify the substrate of the Blue River and provide river-wide information on depth and sedimentation. The final stage is the development of a habitat suitability model that will include information about both environmental conditions at sites and community dynamics to assess the suitability of sites to guide future reintroductions.

PROGRESS TO DATE

Conditioning of captive-reared hellbenders to moving water and predator cues has been completed. For our first experiment, we found no difference in mass, snout-vent length, and total length growth rates between conditioned and unconditioned hellbenders. We also found that conditioned individuals developed shallower tails during the rearing period. We interpret this as evidence of either energy expenditure or phenotypic plasticity as more streamlined tail forms are found in lotic systems.

Moreover, we found water current to be positively associated with hellbenders' swimming ability. After three swim trials, conditioned hellbenders had faster swim times, required fewer upstream attempts, and were less likely to need manual motivation to reach upstream cover. Moreover, conditioned hellbenders tended to improve these responses through time compared to unconditioned individuals that showed no difference or improvement across the three trials. Together, our data suggest that adding water current to hellbender rearing environments does not adversely affect body morphology. Instead, doing so seems to acclimate hellbenders to moving water and improve their ability to reach upstream shelter. As a result, we advocate incorporating water velocities that mimic natural conditions into hellbender captive rearing programs.

For our predator cue experiment, we found conditioned hellbenders were less active than unconditioned animals when exposed to largemouth bass kairomones. Conditioned individuals also lowered their metabolic rate more than unconditioned individuals. Our study clearly demonstrates that predator conditioning strengthens hellbender behavioral avoidance tactics, produces appropriate risk assessment skills, and advantageously reduces metabolic rate. These behavioral and physiological responses could have profoundly positive effects on hellbender survival and establishment after translocations.

We found altered patterns of habitat use among 10 hellbenders that had been released in the Blue River in 2010. Young hellbenders used smaller and less sheltered rocks than adults did, and did not use nest boxes that were installed for habitat supplementation. Overall high survival rates suggested the site was suitable for future reintroductions. The first 80 juveniles will be released into the site as soon as conditions allow.

Habitat supplementation was altered to specifically benefit juveniles. Instead of installing more nest boxes before release, we installed small, flat rocks under which they could hide. The rocks used resembled those to which juveniles had already been exposed in their artificial raceways. We hypothesize that this form of supplementation will help reduce long-distance dispersal events that may have contributed to the lower survival rate of juveniles in the previous study.

Sonar collection has been completed on the majority of the river, and the entire 70-mile portion will be completed in 2017. Due to depth constraints, we were only able to classify substrate in the lower 22-mile reach of the Blue River. These maps have been created using a semi-automated classification software. They are currently being tested for accuracy using data collected from GPS-enabled underwater cameras. Because hellbender conservation actions are being done in the lower portion of the Blue River, these maps may be useful in the future for exploring fine-scale patterns of habitat use in radio-tracked hellbenders and habitat factors associated with nest box occupancy.

We are taking a community approach to assessing hellbender habitat suitability throughout the Blue River. We are modeling hellbender, crayfish, and mammal populations to account for species interactions that may drive local species occurrences. We collected data on all three populations during the 2014–2015 field seasons, and we are also incorporating data previously collected by the Indiana Department of Natural Resources and the Indiana Department of Environmental Management for testing. GIS layers of soils and land use, along with depth and sedimentation data collected

with the sonar imaging, will provide environmental variables for a local hellbender model. The resulting habitat suitability map will be used to identify priority areas for the release of the remaining captive-reared juvenile hellbenders.

We continued to search for hellbender nest sites and signs of reproduction throughout the 2017 breeding season. While we again observed guarding males, no nests were found. The first 80 hellbenders surgically transplanted with pit tags and radio transmitters in October 2017 are scheduled for release in early November 2017. We will track the juveniles until transmitter failure occurs (likely in early summer 2018). We will use the data collected from radio-tracking to estimate the survivorship, movement, and habitat use patterns of the released juveniles.

We will use data obtained from this project to fulfill two doctoral degree requirements for Purdue University and to provide useful information for other groups, agencies and scientists working with hellbenders. This project encompasses innovative ways to understand and protect an endangered species and may influence future rearing and management decisions for the conservation of the Eastern and Ozark hellbender throughout the nation.

COST: $423,164 FOR THE COMPLETE FOUR-YEAR PROJECT