



LOCAL AND LANDSCAPE HABITAT ASSOCIATION, POPULATION ECOLOGY AND FUTURE RECOVERY OF CRAWFISH FROGS (*RANA AREOLATA*) IN INDIANA



Male crawfish frog in a breeding wetland (note distended vocal sacs).

Current Status

Third year of 3 ½-year project

Funding Sources and/or Partners

State Wildlife Grant (T07R07), Indiana University, DNR Nongame Fund

Project Personnel

Dr. Michael Lannoo, Indiana University School of Medicine
Dr. Daryl Karns, Hanover College (deceased)
Dr. Joe Robb, USFWS, Big Oaks National Wildlife Refuge
Dr. John Whitaker, Indiana State University
Dr. John Crawford, Lindenwood College (on the project from Jan. 1–June 30, 2009)

Perry Williams, USFWS, Big Oaks National Wildlife Refuge

Nate Engbrecht, graduate student, Indiana State University

Jennifer Heemeyer, graduate student, Indiana State University

Vanessa Kinney, graduate student, Indiana State University

Andrew Hoffman, undergraduate, Hanover College

Dr. Alan Pessier, veterinarian, San Diego Zoo (Disease)

Dr. Irene Macallister, U.S. Army Corps of Engineers (Disease)

Dr. Stephen Richter, Eastern Kentucky University (Genetics)

Emily Gustin, Eastern Kentucky University (Genetics)

Dr. Alisa Gallant, USGS EROS Data Center (GIS)

Dr. Robert Klaver, USGS EROS Data Center
(Ecological Modeling)

Bill Peterman, consultant (on the project from Jan. 1–
June 30, 2009)

Alex Robinson, part-time technician
Ashley Buchanan, part-time technician
Lisa Maas, part-time technician
Casey Mefford, part-time technician
John Ryan, part-time technician
Shane Stephens, part-time technician
Austin McClain, part-time technician
B. Jagger Foster, part-time technician
Taenia Wheat, part-time technician
Austin May, part-time technician
Susan Lannoo, consultant (unpaid)
Peter Lannoo, graphics designer (unpaid)

Background and Objectives

Crawfish frogs are large (adults are 3 inches or longer), heavy frogs that spend much of their adult life in crayfish burrows. In Indiana, crawfish frogs (*Lithobates [Rana] areolatus*) are considered state-endangered, and their declining status across much of their range has caused broad concern about their conservation. According to Sherman Minton, crawfish frogs were locally plentiful in southwestern Indiana until about 1970. The reasons for their recent and rapid decline are unknown.

Typically, crawfish frogs are associated with tallgrass prairies or other native grasslands; however, these habitats are increasingly being fragmented by, or converted to, row-crop agriculture. Crawfish frogs are also considered weak larval competitors, which likely results in reduced recruitment into populations. Local and regional declines may be further enhanced by interactions with exotic species and the emergence of infectious diseases. While there is some information on general habitat use and population demographics, the fossorial nature and scarcity of crawfish frogs have made detailed investigations difficult and recovery plans ineffective.

If the ultimate goal for an endangered species is recovery of populations, then distribution, habitat use, and mechanisms of decline must be investigated. The status of the crawfish frog in Indiana presents a unique opportunity for this type of study.

Objectives

1. Determine the status of crawfish frog populations in Indiana.
2. Develop methods to monitor the status of crawfish frog populations in Indiana.
3. Determine population parameters of crawfish frogs on public lands in an effort to delimit potential life-history bottlenecks that affect survival of this species.
4. Define natural history features such as movement patterns (across the landscape), activity patterns (daily and seasonally), and habitat-use features (burrow location) of

crawfish frogs, and identify threats to this species from current landscape attributes (roads, agricultural fields) and land-use practices (frequency of plowing, prescribed burning).

5. Determine the genetic relationships among Indiana crawfish frog populations.
6. Define the role of disease (chytrid fungus) in limiting Indiana crawfish frog populations.
7. Determine how practical captive rearing can be for augmenting populations.
8. Run parallel studies at sites in southwest Indiana (Hillenbrand Fish & Wildlife Area, Dave's Pond) and southeast Indiana (Big Oaks National Wildlife Refuge).
9. Provide management recommendations to Indiana DNR and U.S. Fish and Wildlife Service to maximize the likelihood that crawfish frog populations persist in Indiana.

Methods

We use a wide variety of methods and techniques, including drift fences/pitfall traps, call surveys, seining, minnow trapping, radio telemetry, museum and literature searches, wildlife cameras, song meters, digital videography, pit tagging, toe clipping, microsatellite arrays, histology, PCR analyses, visual surveys, disease surveys, tissue sampling for genetic analysis, and captive rearing, as follows:

- 1) Status: Literature searches, museum searches, call surveys, seining, minnow trapping, song meters;
- 2) Monitoring: Song meters, minnow trapping;
- 3) Population parameters: Drift fences/pitfall traps, radio telemetry, pit tagging, histology;
- 4) Natural history: Drift fences/pitfall traps, radio telemetry, wildlife cameras, videography;
- 5) Genetics: Toe clipping, microsatellite arrays;
- 6) Disease: Swabs for chytrid fungus, histology, PCR;
- 7) Population augmentation: Captive rearing pools, diet, timing;
- 8) Statewide comparison: Two crews, one in southwest Indiana led by Lannoo, the other at Big Oaks led by Karns and Robb.

Progress

Papers submitted:

Engbrecht, N.J. and J.L. Heemeyer and M.J. Lannoo. *Lithobates areolatus circulosus* (Northern Crawfish Frog). *Coluber constrictor* (Black Racer). Thwarted Predation. *Herpetological Review*.

Engbrecht, N.J., P.J. Williams, J.R. Robb, D.R. Karns, M.J. Lodato, T.A. Gerardot and M.J. Lannoo. Is there hope for the Hoosier Frog? An update on the status of Crawfish Frogs in Indiana, with recommendations for their conservation.

Proceedings of the Indiana Academy of Science.
Kinney, V.C., J. Maerz and M.J. Lannoo. Adult survivorship, juvenile recruitment, and juvenile fitness metrics in Crawfish Frogs (*Lithobates areolatus*), a cryptic, "near-threatened" species. Conservation Biology.

Papers in press:

Heemeyer, J.L., P.J. Williams and M.J. Lannoo. Obligate crayfish burrow use and core habitat requirements of Crawfish Frogs. Journal of Wildlife Management.

Williams, P.J., J.R. Robb and D.R. Karns. 2012. Habitat selection by crawfish frogs (*Lithobates areolatus*) in a large mixed grassland-forest habitat. Journal of Herpetology.

Papers published:

Engbrecht, N.J. and J.L. Heemeyer. 2010. *Lithobates areolatus circulosus* (northern crawfish frog). *Heterodon platyrhinos* (eastern hog-nosed snake). Predation. Herpetological Review 41:197.

Engbrecht, N. J. and M.J. Lannoo. 2010. A review of the status and distribution of crawfish frogs (*Lithobates areolatus*) in Indiana. Proceedings of the Indiana Academy of Sciences 119:64–73.

Engbrecht, N.J., S.J. Lannoo, J.O. Whitaker and M.J. Lannoo. Comparative morphometrics in ranid frogs (subgenus *Nenirana*): Are apomorphic elongation and a blunt snout responses to deep, small-bore burrow dwelling in crawfish Frogs (*Lithobates areolatus*) Copeia 2011:285–295.

Heemeyer, J.L., V.C. Kinney, N.J. Engbrecht, and M. J. Lannoo. 2010. The biology of crawfish frogs (*Lithobates areolatus*) prevents the full use of telemetry and drift fence techniques. Herpetological Review. 41:42–45.

Heemeyer, J.L. and M.J. Lannoo. 2010. A new technique for capturing burrow-dwelling anurans. Herpetological Review 41:168–170.

Heemeyer, J.L. and M.J. Lannoo. *Lithobates areolatus circulosus* (Northern Crawfish Frog). Winterkill. Herpetological Review 42:261–262.

Hoffman, A.S., J.L. Heemeyer, P.J. Williams, J.R. Robb, D.R. Karns, V.C. Kinney, N.J. Engbrecht, and M.J. Lannoo. 2010. Strong site fidelity and a variety of imaging techniques reveal around-the-clock and extended activity patterns in crawfish frogs (*Lithobates areolatus*). Bioscience 60:829–834.

Kinney, V.C., N.J. Engbrecht, J.L. Heemeyer, and M.J. Lannoo. 2010. New county records for amphibians and reptiles in southwest Indiana. Herpetological Review 41:387.

Kinney, V.C., J.L. Heemeyer, A.P. Pessier, and M.L. Lannoo. Seasonal pattern of *Batrachochytrium dendrobatidis* infection and mortality in *Lithobates areolatus*: Affirmation of Vredenburg's "10,000 Zoospore Rule" PloS One 6(3): e16708.

doi:10.1371/journal.pone.0016708.

Kinney, V.C. and M.J. Lannoo. 2010. *Lithobates areolatus circulosus* (Northern Crawfish Frog). Breeding. Herpetological Review 41:197–198.

Lannoo, M.J., V.C. Kinney, J.L. Heemeyer, N.J. Engbrecht, A.L. Gallant, and R.W. Klaver. 2009. Mine spoil prairies expand critical habitat for endangered and threatened amphibian and reptile species. Diversity 1:118–132.

Theses:

Engbrecht, N.J. 2010. The Status of Crawfish Frogs (*Lithobates areolatus*) in Indiana, and a Tool to Assess Populations. M.S. Thesis, Indiana State University, Terre Haute, IN.

Heemeyer, J.L. 2011. Breeding Migrations, Survivorship, and Obligate Crawfish Burrow Use by Adult Crawfish Frogs (*Lithobates areolatus*). M.S. Thesis, Indiana State University, Terre Haute, IN.

Kinney, V.C. 2011. Adult Survivorship and Juvenile Recruitment in Populations of Crawfish Frogs (*Lithobates areolatus*), with Additional Consideration of the Population Sizes of associated Pond Breeding Species. M.S. Thesis, Indiana State University, Terre Haute, IN.

Presentations:

Lannoo, M.J. Habitats lost and habitats found. Association of Zoos and Aquariums Workshop (Keynote). Toledo Zoo, April 2009.

Lannoo, M.J. The Biology of Crawfish Frogs. Association of Zoos and Aquariums Workshop (Keynote). April '10.

Lannoo, M.J. The Conservation Biology of Crawfish Frogs. Iowa Lakeside Lab, June '10.

Lannoo, M.J. The Conservation Biology of Crawfish Frogs. Hoosier Herp Society, September '10.

Lannoo, M.J. Update on the Biology of Crawfish Frogs. Association of Zoos and Aquariums Workshop (Keynote). April '11.

Lannoo, M.J. The Conservation Biology of Crawfish Frogs. SE PARC February '11.

Lannoo, M.J. Update on the Conservation Biology of Crawfish Frogs. Iowa Lakeside Lab, June '11.

Lannoo, M.J. The Biology of Crawfish Frogs. Canadian Association of Herpetologists' Annual Meeting (Keynote), October 11.

Engbrecht, N.J. Status and Distribution of Crawfish Frogs (*Lithobates areolatus*) in Indiana. Indiana Academy of Science, October '09.

Engbrecht, N.J., V.C. Kinney and M.J. Lannoo. Using call counts to estimate anuran population sizes: an example using Crawfish Frogs (*Lithobates areolatus*). SE PARC, February '11.

Engbrecht, N.J. and M.J. Lannoo. Status and conservation of Crawfish frogs in Indiana. SE PARC, February '11.

Heemeyer, J.L. Post-breeding Migration and Habitat Selection of the Crawfish Frog (*Lithobates*

areolatus). Indiana Academy of Science, October '09.

Heemeyer, J.L. and M.J. Lannoo. Crawfish Frog migratory behavior and survival. SE PARC, February '11.

Hoffman, A.S., P.J. Williams, J.R. Robb, and Daryl R. Karns. Activity Patterns of the Crawfish Frog (*Lithobates [Rana] areolatus*) at Crayfish Burrows in Big Oaks National Wildlife Refuge, Southeastern Indiana. Indiana Academy of Science, October '09

Kinney, V.C. Breeding Biology of Crawfish Frogs (*Lithobates areolatus*) in Southwestern Indiana. Indiana Academy of Science. October '09.

Kinney, V.C., J.L. Heemeyer, A.P. Pessier, and M.L. Lannoo. Seasonal pattern of *Batrachochytrium dendrobatidis* infection and mortality in *Lithobates areolatus*: Affirmation of Vredenburg's "10,000 Zoospore Rule" SE PARC February '11.

Williams, P.J., A.S. Hoffman, J.R. Robb, and D.R. Karns. Burrow Selection by the Crawfish Frog (*Lithobates [Rana] areolatus*) in Southeastern Indiana. Indiana Academy of Science, October '09.

Narrative

We have made substantial progress in understanding the life history and natural history features of crawfish frogs in Indiana.

We understand much of their historic distribution and their current distribution, not only in Indiana but throughout states east of the Mississippi River. We understand when they breed, and have identified a large percentage, perhaps all, of their known breeding sites in Indiana. We understand survivability in both egg and larval stages, and in postbreeding adults. We sent water samples of breeding wetlands for analyses.

We have successfully reared large numbers of tadpoles to metamorphosis. We have now tracked crawfish frogs for nearly 9,000 "telemetered frog days" and from these data understand where adult burrows are located, and have made a distinction between primary and secondary burrows. We understand activity patterns and habitat use.

We now understand pattern of infection by the chytrid fungus (*Batrachochytrium dendrobatidis*), which exhibits seasonal waxing and waning and kills about 7 percent of adults during or immediately after breeding.

We have developed a technique for estimating crawfish frog population size based on call characteristics. There are likely fewer than 1,000 crawfish frog adults in Indiana, a figure that confirms their endangered status in the state.

Radiotracking juveniles has been a challenge, but after a major push in 2011 understand that juvenile dispersion mimics adult post-breeding migrations in that juveniles move away from wetlands in a straight line, apparently until they intersect a suitable burrow.

We understand the role that management techniques such as prescribed burning, cultivation, mowing, and

establishing food plots have on populations. We have made arrangements to have genetic analyses done.

Workers within the state communicate frequently. In addition we have set up (sevosa@listserve.eku.edu) as a listserve to communicate with people working on this species group (three species: Crawfish Frogs, Gopher Frogs [*L. capito*], and Dusky Gopher Frogs [*L. sevosus*, which are federally endangered]). The project suffered a major blow when Dr. Karns suddenly and unexpectedly died.

Cost: \$820,518



Fungus-infected (Chytrid) crawfish frog.