1. Cover Page

a. Title: Population status of five stream and river dependent tiger beetles (Family: Cicindelinae)

b. Project Summary: The goal of this study is to determine the population status of five species of river and stream dependent tiger beetles. Each of these species is typically found in sandy environments along major watercourses and all have probably been impacted by river development, dam construction, and river flow modification. Once populations are located, we will attempt to determine the sizes of each population and measure habitat variables that will potentially correlate with population status. Once the range and population sizes of these five species are more fully understood, conservation recommendations can be developed to improve their chance of survival in Arkansas.

c. Project Leaders:

Matthew D. Moran. Professor of Biology, Hendrix College. 1600 Washington Ave. Conway, AR 72032. Phone: 501-450-3814. Email: moran@hendrix.edu

Maureen McClung. Assistant Professor of Biology, Hendrix College. 1600 Washington Ave. Conway, AR 72032. Phone: 501-450-1486. Email: mcclung@hendrix.edu

d. Project Partners: none

e. Project Budget

SWG Requested Amount	$86,979
Match	$48,855
Total	$135,834

2. Project Statement

a. Need: The 2016 State Wildlife Grant Funding Priorities lists tiger beetles as the second highest priority among the insects. Most of the tiger beetle species listed are riparian species dependent on sandy habitats that have sparse vegetation. Little information has been published on these species in recent years, and no comprehensive surveys have been completed since the 1970s (Graves and Pearson 1973). Dam construction (e.g. McClellan-Kerr Navigational System) along the major rivers in Arkansas, and the subsequent reduction in sand bar habitat, is likely to have severely impacted these species. However, several undammed rivers and selected areas within the modified rivers exhibit quality habitat that may support this insect assemblage.

b. Purpose and Objectives: To determine the range, abundance, and habitat characteristics of five species of river and stream dependent tiger beetles (Cicindelidae): *Cicindela duodecimguttata*, *C. formosa pigmentosignata*, *C. hirticollis*, *C. lepida*, and *C. macra*. To develop management activities to decrease the risk of extirpation from Arkansas.

c. Location: Using satellite images and personal experience in the field, we have identified areas along rivers that appear to have appropriate habitat and overlap with the historical ranges of the tiger beetles under study (Figure 1). Most historic populations described below were published in Graves and Pearson (1973). Ecoregions included: Arkansas River Valley, Gulf Coastal Plain, Mississippi Alluvial Plain, Ouachita Mountains, and Ozark Plateau. Counties included: Arkansas, Ashley, Boone, Bradley, Calhoun, Clark, Conway, Desha, Faulkner, Franklin, Jefferson, Lawrence, Lincoln, Lonoke, Marion, Montgomery, Ouachita, Perry, Polk, Pulaski, Randolph, and Union.

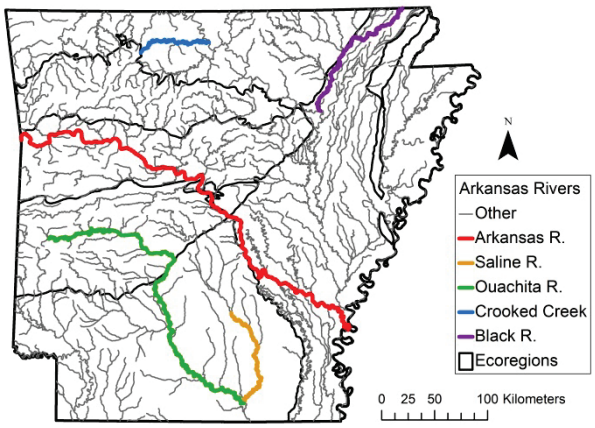

Figure 1. Rivers in Arkansas selected for sampling because of their potential for hosting populations *Cicindela* spp.

1. Arkansas River: numerous sand bars located below major lock and dams including last 20 km of excellent sand bar habitat below Wilbur Mills Dam to the Mississippi River. Four of the five species (*duodecimguttata*, *hirticollis*, *lepida, macra*) have historical populations along the length of the river.
2. Ouachita River: a) above Lake Ouachita where it is undammed and under natural flow conditions (population record of *C. macra*), and b) lower section between Interstate-40 and Louisiana border where numerous large sand bars are located, and is the only historical population of *C. formosa pigmentosignata* within Arkansas.
3. Crooked Creek: undammed and free flowing river with numerous small sandbars and a historical population of *C. duodecimguttata*.
4. Black River (NE Arkansas). This river is in a mostly natural condition, with only one small dam located in Missouri, and moderate areas of sandbar habitats. Two species (*C. duodecimguttata* and *C. hirticollis*) have historical populations here.
5. Saline River: south Arkansas from Warren to Louisiana border. This section of the Saline River has moderate numbers of sand bars and historical populations of *C. lepida.*

d. Approach. During the first year we will focus on identifying the locations of extant populations of the five tiger beetle species. We will survey the sites described under part c. from late April through September, when the beetles are most active. Beetles will be both visually identified and whenever possible, captured by sweep nets, placed in containers, and photographed. These two methods are considered effective for sampling tiger beetles (Pearson and Vogler 2001, Irmler 2010.). The tiger beetles of Arkansas can all be identified in the field by the unique markings on their elytra (Graves and Pearson 1973), so there is no need for destructive collection. They will instead be released alive. Using this sampling method, we anticipate no negative effects on what could be vulnerable populations. By the end of the first year, we expect to have a good understanding of the distribution of these five species.

During the second year we will return to the populations identified the first year and perform a population estimate and habitat analysis for each population. Tiger beetles are active fliers and can be difficult to capture, so we will employ two approaches to estimate population sizes. First, we will utilize transect sampling at each known population (Burnham et al. 1980). Walking randomly selected transects, we will record all individuals detected and their distance and angle from the transect. We will use Program DISTANCE to estimate population sizes while accounting for heterogeneous detection probabilities (Buckland et al. 2001). Secondly, we will employ a catch-effort maximum likelihood estimation technique where we intensively collect beetles for a given period of time. These data are plotted over time to produce a regression line whose intercept predicts population size (DeLury 1947, Gould and Pollock 1997). To reiterate, all specimens will be captured alive (or visually detected) and released.

For each population sampled, we will measure the size of the habitat available (by calculating areas from polygons drawn on Google Earth satellite imagery), substrate composition (Kettler et al. 2001), and percent plant cover (Floyd and Anderson 1987). These covariates will be used to model habitat preference based on population size estimates. From this information we should be able to identify critical habitat for these species and make habitat management recommendations that could maintain or increase the populations of these beetles and improve their probability of survival into the future. (Note: These tiger beetle species may overlap with federally protected populations of Least Terns (*Sternula antillarum*), but we will avoid any disturbance of the birds during nesting season.)

e. Expected Results and Benefits:

This project will improve understanding of the status of five tiger beetle species (see part b.), all of which occupy similar habitat along the larger rivers within Arkansas. Since these rivers are the ones most intensely modified by human activity, their beetle communities have likely been heavily impacted. However, very few published records of these species are available beyond the 1960s and 1970s, when river development reached its peak. This pattern could be a result of extirpation of populations, or simply a lack of research effort. Our study will go far to answer that question. Once we identify surviving populations and habitat preferences for the species in Arkansas, the state will be much better informed about management options.

We propose to involve a substantial number of undergraduate students in the project. The Hendrix College Biology Department has many students interested in field and conservation biology, many of whom go on to graduate school in such disciplines and eventually in careers in wildlife management. Both of us have substantial experience working with undergraduates and have many that have co-authored publications (see CVs). Therefore, this project has the potential to greatly benefit the field of conservation beyond the scope of this grant.

References

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f. Budget

	Year 1	Year 2
Grant	**10/1/16-9/30/17**	**10/1/17-9/30/18**
Moran (1.25 months Summer Salary)	8,730	8,730
McClung (1.25 Summer Salary)	6,163	6,163
Adjunct Salary (1 course release for McClung)	3,750	3,750
Student Summer Stipends (yr1: 3,000 X 5; yr2: 3,100 X 5)	15,000	15,500
FICA	2,574	2,611
Fringe Benefits (Faculty Summer Salary)	1,004	1,004
Fuel, Food, and Camping Fees/Supplies	4,500	4,500
Field and lab supplies	1,500	1,500
Subtotal Grant	**43,221**	**43,758**
MATCH		
Moran (Partial Academic Year Salary 1/8 spring semester)	5,238	5,238
McClung (Partial Academic Year Salary 1/8 spring sem.)	3,698	3,698
FICA	683	683
Unrecovered Indirect Costs: 15% of summer salaries	5,046	5,121
Student Summer Housing	3,725	3,725
Vehicle Rental (college van)	6,000	6,000
Subtotal Match	**24,390**	**24,465**
TOTAL MATCH (35.9% of total grant)		**48,855**
SWG REQUESTED AMOUNT		**86,979**
TOTAL GRANT		**$135,834**

3. Qualifications

Dr. Matthew Moran has over 20 years of field research experience. His expertise includes insect ecology, plant-animal interactions, conservation biology, and evolutionary biology. He has published 24 peer reviewed publications (plus three currently in review) and three books.

Education: Ph.D. Ecology, University of Delaware (1996), B.A. Biology, University of Delaware (1991)

Current Position: Professor of Biology, Area Chair: Natural Sciences, Member of the Environmental Studies Program, Hendrix College

Recent Peer Reviewed Publications *undergraduate co-author

Cox, A.B.*, Taylor, N.T.*, Rebein, M.A.*, Song, M.*, **Moran M.D.**, and M.R. McClung. Land use changes from unconventional gas development in public lands of the Fayetteville Shale. Natural Areas Journal, *In review.*

Davis, C.N.* and **M.D. Moran**. An argument supporting de-extinction and a call for field research. Frontiers of Biogeography, *In review.*

Moran, M.D., A.B. Cox*, R.L. Wells*, C.C. Benichou*, and M.R. McClung. 2015. Habitat loss and modification due to gas development in the Fayetteville Shale. Environmental Management 55:1276-1284.

Boone, M J.*, C.N. Davis*, L. Klasek*, J. del Sol*, K. Roehm*, and **M.D. Moran**. 2015. A test of Pleistocene mammal seed dispersal in anachronistic fruits using extant ecological and physiological analogs. Southeastern Naturalist 14:22-32.

Moran, M.D. 2014. Bison grazing increases arthropod abundance and diversity in a tallgrass prairie. Environmental Entomology. 43:1174-1184.

Penner, J.L., K. Zalocusky*, L. Holifield*, J. Abernathy*, B. McGuff*, S. Schichtl*, W. Weaver*, and **M.D. Moran**. 2013. Are high pilferage rates an artefact of experimental design? The effects of food provisioning on foraging behaviour. Southeastern Naturalist 12:589-598.

Roehm, K.* and **M.D. Moran.** 2013. Is the Coyote (*Canis latrans*) a potential seed disperser for the American Persimmon (*Diospyros virginiana*)? American Midland Naturalist 169:414-419.

Dr. Maureen McClung has experience in field studies across a variety of taxa, including birds, primates, insects, and plants. She has worked extensively in the field abroad (New Zealand, Peru) and in Arkansas (Ozark Highlands).

Education: Ph.D. Biology, University of Arkansas (2013), M.Sc. Biology, University of North Carolina (2006), B.A. Biology, Hendrix College (2001)

Current Position: Assistant Professor of Biology, Member of the Environmental Studies Program, Hendrix College

Recent Peer Reviewed Publications

Cox, A.B.*, Taylor, N.T.*, Rebein, M.A.*, Song, M.*, Moran M.D., and **M.R. McClung**. Land use changes from unconventional gas development in public lands of the Fayetteville Shale. Natural Areas Journal, *In review.*

Bradley, C.E.* and **M.R. McClung.** 2015. Vocal divergence and discrimination of long calls in tamarins: a comparison of allopatric populations of *Saguinus fuscicollis nigrifrons* and *S .f. lagonotus*. American Journal of Primatology 77(6): 679-687.

Moran, M.D., A.B. Cox*, R.L. Wells*, C.C. Benichou*, and **M.R. McClung**. 2015. Habitat loss and modification due to gas development in the Fayetteville Shale. Environmental Management 55:1276-1284.