

**Project title:**

Habitat use and movement by Strawberry Darter *Etheostoma fragi* within the Strawberry River basin, Arkansas

**Project summary:**

Biodiversity in freshwater ecosystems is in decline at a global scale following wide-spread declines in habitat. Conservation of biodiversity in freshwater systems is limited, in part, due to deficiencies in understanding regarding detailed habitat use for species across multiple temporal and spatial scales. As such, identification of habitats used by freshwater species at different times (e.g., seasons or life-stages) and across different spatial scales (e.g., riffle-run-pool complexes or main-stem and tributary systems) may greatly contribute to conservation measures including habitat restoration or species translocation. The objectives of this project are to quantify 1) seasonal shifts in habitat use and 2) assess movement patterns within and among main-stem and tributary habitats for Strawberry Darter *Etheostoma fragi* within the Strawberry River drainage in north central Arkansas. We will develop habitat suitability and capture-mark-recapture models across seasons to aid in deciphering why seemingly similar habitats (i.e., a series of riffles or similar tributary streams) vary with regard to occupancy of Strawberry Darter. Seasonal habitat use data collected with this study will provide quantifiable measures to guide future habitat rehabilitation projects designed to increase habitat availability. Movement data will allow greater predictability regarding how far the species may move to recolonize areas following local extirpations or where habitat restoration has occurred.

**Project leader:**

Dr. Jonathan Spurgeon, Assistant Professor, Aquaculture and Fisheries Department, University of Arkansas at Pine Bluff, 1200 N. University Dr., Mail Slot 4912, Pine Bluff, AR 71601, [spurgeonj@uapb.edu](mailto:spurgeonj@uapb.edu), (870) 575-8105

**Project partners:**

Mr. Brett Timmons, District 3 Fisheries Supervisor, Fisheries Division, Arkansas Game and Fish Commission, 600-B East Lawson Rd., Jonesboro, AR 72401, [Brett.Timmons@agfc.ar.gov](mailto:Brett.Timmons@agfc.ar.gov), (877) 972-5438

Dr. Steve Lochmann, Professor, Aquaculture and Fisheries Department, University of Arkansas at Pine Bluff, 1200 N. University Dr., Mail Slot 4912, Pine Bluff, AR 71601, [lochmanns@uapb.edu](mailto:lochmanns@uapb.edu), (870) 575-8165

**Project budget summary:**

Budget Item	Year 1	Year 2	Year 3	Total
SWG Request	46109.80	47550.80	13765.40	107426.00
Match Funds	17239.40	17702.40	7154.20	42096.00
Percent Match				39%

## **Project statement:**

***Project need, purpose, and objectives*** — Freshwater biodiversity is under persistent threat from anthropogenic alteration to habitats and changing climate patterns (Jelks et al. 2008). The abundance and distribution of some stream fishes have declined, in part, from loss of habitat including sedimentation following land-use change and in-stream barriers that isolate refuge habitats and source populations. Changing precipitation patterns including prolonged periods of drought may further restrict population connectivity through stream-bed drying and potentially cause local extirpation of species resulting in contractions in distribution. A myriad of conservation practices exist to reverse declining stream fish populations including habitat rehabilitation (e.g., streambank stabilization) or translocation of individuals into new habitats. Habitat management and translocation projects, however, often suffer from a paucity of information regarding specific habitat requirements for a given species. Furthermore, a paradox exists where species' occurrence is not consistent across seemingly similar habitat types at local (e.g., among riffles in a stream segment) or broad spatial (e.g., among tributaries) scales. The patchy distribution of species may result from a combination of factors that may include habitat availability and the species' ability to move among habitats. Untangling the relationship between habitat availability and connectivity is of particular importance for species that are highly endemic and that occur in habitats prone to disturbance. If a species does not readily move among available habitats then habitat management practices may serve little function in expanding the distribution and increasing abundance of the species. Instead, species may need assistance in recolonizing habitats through propagation methods. As such, understanding habitat use patterns and a species' ability to move among habitats is greatly needed to facilitate efficient use of habitat and conservation funds for stream fishes.

The Strawberry Darter is endemic to the Strawberry River basin in north central Arkansas (Robison 1998) and has been listed as a species of greatest conservation need under the Arkansas State Wildlife Management Plan (AGFC 2015). Previous work funded through the Arkansas State Wildlife Grant program suggested Strawberry Darter presence is likely associated with tributaries and upper reaches of the main-stem Strawberry River. The greater probability of presence in tributaries and upper reaches of the main-stem Strawberry River suggests the species may occupy a restricted range within Strawberry River basin (Hecke 2017). Furthermore, multiple occasions occurred where Strawberry Darter were patchily distributed among riffle complexes in the main-stem Strawberry River and tributaries (Hecke 2017). Therefore, Strawberry Darter habitat may be limited throughout a large portion of the species' range or Strawberry Darter are not able to readily recolonize areas once extirpated. There currently exists no information regarding movement patterns of Strawberry Darter among local (pool-riffle-run complexes) or broad (main-stem and tributary systems) spatial scales. The opportunity to conserve Strawberry Darter is dependent on understanding habitat use and the ecologically appropriate spatial and temporal scales at which the species moves among habitat types. The purpose of the proposed project is to increase understanding regarding the diversity of habitat types used by Strawberry Darter and the spatial scales at which individuals use such habitats. The primary objectives of this project are to quantify 1) habitat use among seasons and 2)

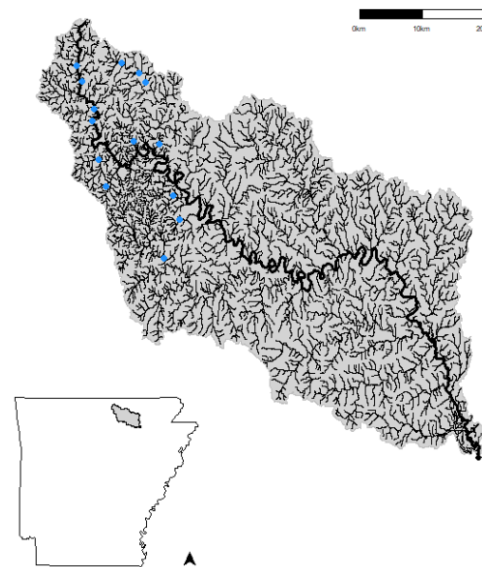
movement within and among main-stem and tributary habitat types for Strawberry Darter within the Strawberry River drainage in north central Arkansas.

**Project location** — The study location will be the Strawberry River basin located in the Ozark Highland Ecoregion of north central Arkansas and includes the counties of Fulton, Izark, Sharp, Lawrence, and Independence.

**Project approach** — We will employ two co-occurring approaches to quantify habitat use and movement of Strawberry Darter within the Strawberry River drainage.

#### *Seasonal habitat use*

We will quantify seasonal shifts in habitat use located in stream reaches known to support Strawberry Darter. We will repeatedly sample locations (i.e., riffle-run-pool series) in headwater reaches of the main-stem Strawberry River and tributary streams where Strawberry Darter have been previously located (Hecke 2017). Seasons sampled will be late winter/early spring (i.e., reproductive period), summer, and fall. We will observe meso- and microhabitat use of Strawberry Darter using prepositioned area electrofishing. Each mesohabitat (i.e., riffle, run, or pool) will be sampled using a stratified random sampling approach. Additionally, we will attempt tandem snorkeling where conditions permit. Numbered markers with attached color tape will be placed on the substrate where each darter was observed. Darter size will be estimated visually (10 cm total length group) and marked on a diving slate. At each darter observation we will determine physical habitat characteristics including mesohabitat type (i.e., riffle, run, or pool), water depth and velocity, substrate size, substrate embeddedness, and the percentage of silt cover. In addition, we will quantify chemical characteristics including dissolved oxygen, turbidity, pH, and conductivity. We will use both univariate and multivariate statistical approaches to evaluate changes in habitat use across seasons. We will assess habitat availability at each riffle-run-pool series by 1) randomly selecting points where Strawberry Darter were absent along each transect and 2) measuring the same habitat characteristics as at darter observations along cross-sectional transects placed every five meters along the transect length. We will assess Strawberry darter habitat selection based on the development of resource selection functions using logistic regression. Habitat models will be assessed under an information theoretic approach using Akaike's Information Criteria (AIC; Burnham and Anderson 2002).



*Figure 1 Location of Strawberry River basin within the Ozark Highlands Ecoregion of Arkansas. The bold line is the mainstem Strawberry River. Blue dots represent sites where habitat use and mark-recapture efforts may be focused.*

*Movement*

We will assess movement of Strawberry Darter between riffle-run-pool series within the main-stem Strawberry River and tributary streams. A combination of back-pack electrofishing and seine netting will be used to capture Strawberry Darter in riffle, run, and pool habitats. At each sample location we will collect fish from three sequential riffle complexes. We will use a capture-mark-recapture framework using color and body placement combinations of elastomer tag marks to distinguish individuals and marking locations. Mark and recapture sampling will be conducted a minimum of three times (i.e., late winter/early spring, summer, and fall) each year in conjunction with habitat use surveys. Mark and recapture locations will be geo-referenced to calculate movement distance. Movement models will be developed to estimate the probability of movement for Strawberry Darter, and assess correlates to movement probability. Movement models will be assessed under an information theoretic approach using AIC (Burnham and Anderson 2002).

**Project expectations and benefits** —A critical information gap exists regarding habitat needs across seasons and mechanisms driving the patchy distribution of Strawberry Darter and similar species in rivers across Arkansas. The seasonal habitat use data collected with this study will provide quantifiable measures to help predict locations suitable for Strawberry Darter and guide future habitat rehabilitation projects designed to increase habitat availability. Additionally, movement models developed in this study will increase understanding of the propensity for movement of the Strawberry Darter among habitats. Taken together, this new information will increase the likelihood that habitat improvement projects or species propagation and translocation projects create suitable conditions that can increase the distribution and abundance of Strawberry Darter. This may be achieved either through construction of suitable habitats followed by colonization or through establishment from hatchery propagation and translocation. Our approach in considering both habitat availability and movement ability of stream fishes will provide new insight into the mechanisms responsible for the patchy distribution of Strawberry Darter and may be applicable to other darter species in multiple locations across Arkansas.

**Proposed budget:**

<b>Budget category</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Total</b>
<b>a. Salary</b>				
Graduate Research Assistant	17800.00	18800.00	9400.00	46000.00
Research technician	10000.00	10000.00	0.00	20000.00
<b>b. Fringe Benefits</b>	8618.00	8928.00	2914.00	20460.00
<b>Total Salary and Fringe Benefits</b>	36418.00	37728.00	12314.00	86460.00
<b>c. Travel</b>	3000.00	3000.00	0.00	6000.00
<b>d. Equipment (snorkel gear, buckets, jars)</b>	0.00	0.00	0.00	0.00
<b>e. Supplies (preservative, office supplies)</b>	2500.00	2500.00	200.00	5200.00
<b>Project Request</b>	41918.00	43228.00	12514.00	97660.00
<b>Indirect Cost (10%)</b>	4191.80	4322.80	1251.40	9766.00
<b>Total Project Request</b>	46109.80	47550.80	13765.40	107426.00
<b>Match</b>				
<b>a. State Non-game Biologist Match (25 h/yr x \$50/h)</b>	1250.00	1250.00	1250.00	3750.00
<b>b. Unrecovered Indirect Cost (59.4% of S&amp;W-Indirect Cost)</b>	12321.40	12784.40	4332.20	29438.00
<b>c. Out of state tuition remission (\$262/credit hour)</b>	3668.00	3668.00	1572.00	8908.00
<b>Total Match</b>	17239.40	17702.40	7154.20	42096.00

### **Project investigator qualifications:**

**Dr. Jonathan Spurgeon** is an assistant professor in the Aquaculture and Fisheries Department at the University of Arkansas at Pine Bluff. He holds a B.S. and M.S. in fisheries and wildlife science from the University of Missouri – Columbia and a PhD in applied ecology from the University of Nebraska – Lincoln. Dr. Spurgeon has over eight years of experience working with threatened and endangered species in both small streams and large river environments. He has published 14 peer-reviewed publications focusing on fish ecology and fish-habitat relationships.

**Mr. Brett Timmons** is the Northeast Arkansas District fisheries supervisor for Arkansas Game and Fish Commission. His responsibilities include managing all waterbodies in northeast Arkansas in the counties of Clay, Craighead, Greene, Fulton, Jackson, Lawrence, Mississippi, Poinsett, Randolph, and Sharp. Brett received a B.S. in Zoology from Southern Illinois University – Carbondale in 2008. Brett received a M.S. in Fisheries from the University of Arkansas at Pine Bluff in 2012. Brett has been conducting fisheries research for 10 years. Brett has been actively involved in darter research including work on the Yellowcheek Darter *Etheostoma moorei* and Strawberry Darter.

**Dr. Steve Lochmann** is a professor in the Aquaculture and Fisheries Department at the University of Arkansas at Pine Bluff. Dr. Lochmann has been conducting fisheries research for more than 25 years. Specifically, he has collected and researched multiple darter species within Arkansas including species of greatest conservation concern such as the Yellowcheek Darter and the Strawberry Darter. Dr. Lochmann has a permit from the USFWS to work with threatened and endangered species. He has supervised the research of more than a dozen master's students over greater than 20 years at the University of Arkansas at Pine Bluff.

### **Literature cited:**

- Burnham, K.P., and D.R., Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. 2<sup>nd</sup> ed. Springer, New York.
- Hecke, K. 2017. Distribution and status of the Strawberry Darter *Etheostoma fragi* in the main stem and tributaries of the strawberry river drainage. Master Thesis. University of Arkansas at Pine Bluff.
- Jelks, H. L., S. J., Walsh, N. M. Burkhead, S. Contreras-Balderas, E. Diaz-Pardo, D. A. Hendrickson, J. Lyons, N. E. Mandrak, F. McCormick, J. S. Nelson, S. P. Platania, B. A. Porter, C. B. Renaud, J. J. Schmitter-Soto, E. B. Taylor, and M. L. Warren, Jr. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. *Fisheries* 33:372-407.
- Robinson, H.W. 1998. Status and survey of the Strawberry Darter *Etheostoma fragi* in Arkansas. U.S. Fish and Wildlife Service Final Project Report. U.S. Fish and Wildlife Service, Jackson, Mississippi.