

**PHYSICAL, CHEMICAL AND BIOLOGICAL ASSESSMENT OF THE FORKS OF THE LITTLE RED RIVER AND  
BIG CREEK ACROSS A LAND USE GRADIENT**

Physical, chemical and biological evaluation of the effect of land use gradients on streams within the forks of the Little Red River and Big Creek will be completed to specifically address one of the funding priorities of the 2008 State Wildlife Grants. This project will provide an understanding of the relations between watershed attributes (e.g., local and catchment land use) and the stream water quality and biological integrity in these central Arkansas basins. Watershed management plans need to be founded on sound data and science, and this project will provide this valuable information.

*Pre-proposal submitted to the Arkansas Game and Fish Commission  
– 2008 State Wildlife Grants:*

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Total Project Costs: \$299401

State Wildlife Grant Request: \$149700

Matching Funds and In-Kind Services: \$149702  
(Source: *UA Division of Agriculture*)

**Project Overview:** The Little Red River and Big Creek provide unique ecological services to the citizens of central Arkansas, specifically related to fisheries, aquatic recreation and aesthetic quality. These aquatic resources provide the opportunity to fish for warm and cold water species (from smallmouth and largemouth bass to trout). The watershed of the Little Red River and Big Creek extends from the foothills of the Ozark Highlands to the edge of the Delta, and it encircles Greers Ferry Lake. The watersheds are composed of forest and wildlife refuges, agricultural land and pasture, and rural and urban-suburban development.

The Arkansas Comprehensive Wildlife Conservation Strategy (CWCS) drafted in 2005 included a strategic plan to fulfill research needs associated with the status, distribution, and ecological relationships of Species of Greatest Conservation Need (SGCN). The CWCS indicated that in the Ozark Highlands Ecoregion, urban development and poultry-beef cattle operations are the most urgent problems facing SGCN. Furthermore, the priorities of the 2008 State Wildlife Grants include, 'Manage watersheds, addressing physical, chemical, biological and landuse components, to restore or sustain aquatic life in the forks of the Little Red River and Big Creek'. Basically, this specific component of the 2008 request for proposals defines a project that evaluates ecological interactions across land use gradients. The first step to address this priority will require a physical, chemical and biological evaluation of the forks of the Little Red River and Big Creek across a land use gradient. We will establish sampling reaches on streams draining various watersheds, where these watersheds vary from those dominated by forest and wildlife refuge to increased proportions of agricultural land use and rural-suburban development. The sampling reaches will be monitored for water quality, biological integrity (i.e., aquatic invertebrates and fish), and multiple fluvial channel morphological characteristics. Thus, we will be able to evaluate changes in these properties across a watershed land use gradient.

The proposed project involves: (1) a comprehensive water quality assessment of at least 25 sites within these watersheds from the headwaters downstream to the main forks of the Little Red River and Big Creek during the critical flow season in Fall 2008, and (2) the assessment of physical, chemical and biological conditions of select streams within the Little Red River and Big Creek Watersheds during calendar year 2009. Overall, this will be a two-year project integrating the effects of watershed land use on stream water quality, biological integrity and fluvial channel morphology. This project will provide the much needed, sound scientific database with which to start making watershed management decisions to restore and or sustain aquatic life in these streams and rivers and this region.

**Funding Priorities Addressed:** This project specifically addresses one of the 2008 funding priorities, '**Manage watersheds, addressing physical, chemical, biological and landuse components, to restore or sustain aquatic life in the forks of the Little Red River and Big Creek**'. This two year project will initiate a comprehensive water quality assessment of at least 25 stream sampling sites throughout the forks of the Little Red River and Big Creek, and it will provide a complete physical, chemical and biological evaluation of select stream reaches representing watershed draining various land use distributions. This study will provide the scientific data and foundation to manage at the watershed-scale to restore and sustain aquatic life throughout the study watershed, and these findings will be applicable outside the watershed boundaries to other catchments transcending the Ozarks Highlands.

This project also has attributes which address the following 2008 priorities:

**1. Projects that integrate Arkansas Wildlife Action Plan priorities with other land-use or natural resources efforts at the local, state or federal level.**

The UA Division of Agriculture has a vested interest in the quality of our State's waters, and we have been conducting scientific studies statewide to evaluate land use impacts on stream water quality and biological integrity. The Watershed Research and Education Center and the Arkansas Water Resources Center under the UA Division of Agriculture will integrate the

Arkansas Wildlife Action Plan into existing statewide efforts to enhance water quality and agricultural sustainability.

**2. Projects that address the needs of Species of Greatest Conservation Need while benefiting other fish and wildlife.**

Additional element occurrence data and habitat information regarding several SGCN aquatic species could be provided with this project including the Yellowcheek Darter, *Etheostoma moorei* (Arkansas Wildlife Action Plan priority score of 100), the endemic, predaceous diving beetle, *Heterosternuta sulphuricus* (priority score of 80), and the Nearctic paduniellan caddisfly that has been previously collected in the Little Red River watershed, *Paduniella nearctica* (priority score of 80). In addition, fisheries conservation and management has been a priority in Biological Sciences at Arkansas Tech University, and the Yellowcheek Darter is a primary species of interest, particularly in the headwaters of Greers Ferry Lake Watershed.

**3. Projects that publicize and raise the profile of the Arkansas Wildlife Action Plan with elected officials, decision and policy makers, interested parties (e.g., land trusts), and the general public.**

This project promotes the unique concept of managing our State's waters at the watershed-scale, and we will include an outreach component in this project to communicate these project results to local and state agencies, and even possibly the USACE at the federal level.

**Geographic Area of Study:** The geographic area of study will be the forks of the Little Red River and Big Creek in the Greers Ferry Lake drainage basin transcending the central Ozark Highlands to the Arkansas Delta; the results from this study will be will applicable regionally and can be integrated into other studies evaluating land use effects on stream water quality and biology to have statewide applications in watershed management.

**Methods:** The project has two distinct objectives, and the first is to conduct a water quality assessment of at least 30 sites within the forks of the Little Red River and Big Creek. This will involve the collection of three water samples from each designated sampling site, and the determination of catchment land use percentages upstream from each sampling site. This data provides the basis to evaluate changes in base flow water chemistry along a land use gradient, and several studies in the Ozarks Highlands have that stream nutrient concentrations changed with catchment land use (Haggard et al., 2003, 2007). These data will be collected in Fall 2008.

From the above sampling sites, we will select a subset of stream sampling sites (n=~15) with which to conduct the comprehensive physical, chemical and biological assessment. We will select a subset of sites such that our experimental design has stream sampling sites that vary in base flow water chemistry and catchment area along a land use gradient. For example, we will have stream sites ranging from dominant forested catchment to dominant agricultural and pastureland to those highly influenced by urban development. This gradient will be the cornerstone of our evaluations, and it will allow the projection of how changing watershed attributes (i.e, land use) and management alternatives effect stream water quality, biological integrity (and SGCN species), and fluvial channel morphology. These sites will range from smaller third order streams to larger streams draining into Greers Ferry Lake, where previous studies have been completed on SGCN.

The select stream sampling will be monitored in calendar year 2009 where water samples will be collected on a monthly basis using a fixed sampling date scheme. This water sampling scheme results in data collected primarily during base flow conditions when water chemistry is directly related to aquatic life; a small percentage of water samples (generally less than 25%) are collected during storm event or high flow conditions with this sampling scheme. Water samples will be analyzed for multiple constituents as defined in the **Qualifications** section.

Aquatic life surveys will be conducted in two seasons, and these surveys will include both electro-collection of fish species and systematic habitat sampling of aquatic macroinvertebrates.

The sites included in these surveys will intentionally target areas where SGCN have been currently found and sites where SGCN were historically collected; this will be particularly targeted toward the Yellowcheek Darter and its known distribution. The biological assessments will be conducted at sites appropriate for each type of survey; for example, some of the smaller streams might only have macroinvertebrate collection where as larger stream might only have fish collection. Each biological survey will be used to calculate appropriate biological indices to evaluate the effect of watershed land use changes on aquatic life in these streams.

The fluvial channel morphology will be evaluate once during 2009 using standard techniques and generally following the physical assessment of Rapid Bioassessment Protocols.

**Measurable Products and Outcomes:**

- The project will produce taxonomic lists of aquatic invertebrates and fish at selected sites within the forks of the Little Red River and Big Creek, and any relevant biological and physical habitat information on Species of Greatest Conservation Need will be added to the Comprehensive Wildlife Conservation Strategy (CWCS) database.
- A comprehensive paper will be published in a refereed environmental journal detailing the effects of catchment land use on the water quality, biological integrity, and fluvial channel morphology in the forks of the Little Red River and Big Creek; this manuscript will provide the basis for establishing watershed management options to restore or sustain aquatic life.

**Partnerships and Existing Resources:** This proposal forms a new partnership between the UA Division of Agriculture and Arkansas Tech University to accomplish a comprehensive evaluation of the forks of the Little Red River and Big Creek. The UA Division of Agriculture has the existing resources required to conduct the physical, chemical and aquatic macroinvertebrate assessments, whereas Arkansas Tech University has the necessary resources to conduct fisheries assessments at these sites. Therefore, all expenditures will relate to on-the-ground field work and direct costs related to water quality analyses.

**Long-Term Project Maintenance:** This project team will have defined roles that provide separation of tasks, but these roles will allow us to integrate our knowledge-base and provide a complete assessment as designed in this project. The project leader (Brian Haggard) will have responsibility for coordinating tasks among project partners, and the project leader will be responsible for the comprehensive water quality assessment from water sample collection through analyses. The project partners (Charlie Gagen, Scott Longing and Marty Matlock) will have responsibility for fish collection and assessment, macroinvertebrate collection and evaluation, and fluvial channel morphology and watershed attributes evaluation, respectively.

**Budget:** The requested budget will support the salary and fringe benefits of undergraduates, graduate research assistants, and program associates. Materials and supplies are needed to provide disposable items, bottles, filters, etc. Travel is required for sampling trips (0.43\$ per mi) and to present findings at state and national conferences. The other direct costs include water quality analyses and a subcontract to ATU. Indirect costs (IDC) are limited to the negotiated rate (15%), and the match comes from UA Division of Agriculture. [The budget requested is required to complete a comprehensive assessment, and the budget and scope are negotiable]

<b>BUDGET</b>	<b>GRANT</b>	<b>MATCH</b>	<b>TOTAL</b>
<i>Salary Plus Benefits</i>	\$66,913	\$82,548	\$149,460
<i>Materials &amp; Supplies</i>	\$3,000		\$3,000
<i>Domestic Travel</i>	\$10,750		\$10,750
<i>Journal Fees</i>	\$900		\$900
<i>Other Direct Costs</i>	\$38,750		\$38,750
<b>TOTAL DIRECT COSTS</b>	\$120,313	\$82,548	\$202,860
<b>INDIRECT COSTS</b>	\$18,047	\$67,154	\$85,201
<i>Tuition</i>	\$11,340		\$11,340
<b>TOTAL COSTS</b>	\$149,700	\$149,702	\$299,401

**Qualifications:**

**Project Leader: Brian E. Haggard, PhD**, Associate Professor, University of Arkansas

Brian's primary area of research has been the effect of catchment land use on stream sediment and water quality, and he has published several papers on this topic in the Ozarks:

Haggard and others. 2003. Nitrogen and phosphorus concentrations and export in an Ozark Plateaus catchment in the United States. *Biosystems Engineering* 86(1):75-85.

Haggard and others. 2007. Variations in stream water and sediment phosphorus among select Ozark catchments. *Journal of Environmental Quality* 36: 1725-1734.

Migliaccio, Haggard, Chaubey and Matlock. 2007. Linking watershed subbasin characteristics to water quality parameters in War Eagle Creek Watershed. *Transactions American Society of Agricultural and Biological Engineers* 50(6): 2007-2016.

The UA Division of Agriculture Water Quality Research Lab has the ability to analyze water and sediment samples for numerous constituents including soluble reactive P (SRP), total P, NO<sub>3</sub>-N, NO<sub>2</sub>-N, NH<sub>4</sub>-N, total N, Cl<sup>-</sup>, and total organic C using wet-chemistry autoanalyzers, and several macronutrients and trace elements (e.g., Ca, Cu, Fe, Mg, Mn, and Zn) using Inductively Coupled Plasma Atomic Emission Spectrometry. Brian also has field equipment available to measure generic physico-chemical properties on-site at the stream sampling locations, including pH, conductivity, dissolved O<sub>2</sub> and water temperature.

**Project Partners:** This project includes two project co-investigators from the UA Division of Agriculture in Fayetteville and one from Arkansas Tech University, Russellville.

**Charlie Gagen, PhD**, Professor, Arkansas Tech University

Charlie has the knowledge, experience and understanding of fish collection, identification and management in the Ozark Highlands and throughout central Arkansas watersheds; specifically, Charlie has experience and field identification capabilities related SGCN including the Yellowcheek Darter. Charlie's fisheries laboratory has the field equipment necessary to complete the fish collection, identification and index construction at the stream sampling sites within the forks of the Little Red River and Big Creek. The close proximity of Arkansas Tech University helps facilitate the collection of these biological surveys with ease.

**Scott Longing, PhD**, Postdoctoral Research Associate, University of Arkansas

Scott works within the UA Division of Agriculture Water Quality Research Lab and manages the macroinvertebrate collection, identification and index calculation. Scott has access to all the field equipment needed to complete these biological surveys, including on-site organism sorting and storage. Upon return to the lab, Scott has a high quality compound microscope and fiber optic light source to use in organism identification. He has been collecting and identifying aquatic macroinvertebrates in Arkansas streams for several years, and he has had several specific projects in the Ozark Highlands including an AGFC funded project to evaluate the distribution of predaceous diving water beetles (i.e., *H. sulphurius*) in the Ozarks.

**Marty Matlock, PhD**, Associate Professor, University of Arkansas

Marty has been working in watershed assessment through the Ozarks, with special emphasis on the effects of urban development on the hydrologic regime of streams and ultimate impacts on the water quality and biological conditions. Marty manages the UA Division of Agriculture Watershed Modeling with complete GIS capabilities, and the equipment necessary to conduct physical assessment of fluvial channel morphology. Marty and Brian have been working together since 2001 on projects related to water quality (chemical and biological aspects) in northwest Arkansas and northeast Oklahoma watersheds.

*This Team looks forward to working in central Arkansas in such a unique watershed.*