PROJECT TITLE: **A BASELINE EVALUATION NECESSARY TO MONITOR THE LONG-TERM EFFECTS OF LAND USE CHANGES PLANNED FOR TWO ECOLOGICALLY SENSITIVE WATERSHEDS IN NORTHEASTERN ARKANSAS, THE SPRING AND STRAWBERRY RIVERS**

PROJECT SUMMARY: Dramatic changes in land use are occurring in northeastern Arkansas as poultry production expands eastward across the Ozark ecoregion. This change in land use is anticipated to result in water quality declines in a very aesthetically and ecologically significant area. An ecological study is proposed for the Spring and Strawberry River systems. The goal of this research is to provide baseline water-quality and biological data that will facilitate later comparisons of ecological conditions before and after land use changes. Ecological conditions will change more dramatically and rapidly in small streams; thus, 24 wadeable stream sites are targeted for sampling. The primary objective of this study will be to use biological metrics to compare the condition of periphyton, macroinvertebrate, and fish assemblages to selected nutrient and sediment related water-quality and habitat variables prior to dramatic changes in land use (and land use intensity) that are expected over time.

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PROJECT PARTNERS: Billy Justus, Aquatic Research Biologist, USGS, Lower Mississippi-Gulf Water Science Center, Little Rock, AR; Jeff Quinn, Fishery Biologist, Arkansas Game & Fish Commission, Mayflower, AR

ESTIMATED PROJECT COST:

SWG amount requested - $101,586
Match amount provided - $57,876
Total project amount - $159,462

PROJECT STATEMENT: In 2014 and 2015, Arkansas ranked third in the nation in poultry production and a rapid poultry expansion is occurring eastward across the Ozark ecoregion in northern Arkansas. Associated changes in land use (i.e. conversion from forest to either poultry houses or pasture where litter is spread for hay and cattle production) are anticipated to result in water quality declines in this very ecologically significant area. Poultry processing facilities have been upgraded or recently constructed in northeastern Arkansas, and an estimated 700-800 poultry houses are planned for construction in the following watersheds: Spring River (11010010), Eleven Point River (11010011), Strawberry River (11010012) and Current River (11010008). Because of their proximity to a processing facility in Batesville, many new poultry houses likely will be constructed within the Spring and Strawberry River basins. Many stream miles of the Spring and Strawberry rivers are designated as Outstanding Resource Waters (e.g. Ecologically Sensitive Waters and Extraordinary Resource Waters, APC&EC, 2015), and this proposal addresses those two river basins.

The karst geology of the Salem Physiographic Province of the eastern Ozark Highland ecoregion results in a strong spring influence, and in the typical historic setting, Ozark streams are known for their pristine nature. Compared to nutrient concentrations in wadeable streams across the United States, Herlihy and Sifneos (2008) determined that TP and TN concentrations for reference streams in the nutrient ecoregion containing the Ozarks were typically lowest and second lowest (respectively) of the 11 nutrient ecoregions evaluated.Based on Arkansas Natural Resource Commission records for 2015, poultry houses in Arkansas produced an average of 154.2 tons of litter/house. However, annual litter production for the expansion could range from 108,000 to 123,000 tons over the short term (with construction of more poultry houses being possible over the long term). Further, because of the availability of litter for fertilizer, and associated increases in grass and hay production, cattle feeding capacity will also increase in the area, resulting in increased nutrient and sediment runoff into streams in this ecologically significant area.

Associated with their strong spring influence, the Spring and Strawberry rivers also have cooler water temperatures than many other Ozark streams. Perhaps related to these cool temperatures, the two rivers have been identified as supporting some of the highest levels of aquatic biodiversity in the state. In addition to being inhabited by numerous federally threatened or endangered species (e.g. Curtis Pearlymussel, Pink Mucket) numerous other state and federally recognized Species of Greatest Conservation Need (SGCN) are found there (e.g. mussels such as the Rabbitsfoot and Ebonyshell; and fishes such as the Crystal and Strawberry Darters). However, the current status of many of the SGCNs is unknown or incomplete. Arkansas ranks fifth in the nation in fish biodiversity and sixth in crayfish diversity, but both rivers contain large areas with data gaps for fishes and crayfishes (Arkansas Wildlife Action Plan, 2015). Relatedly, relatively little is known about the current status of aquatic biological communities in the Spring and Strawberry rivers.

In addition to their ecological significance, the two watersheds are aesthetically and economically significant. Both are important sport fishery resources. Some segments of both are considered to have world class smallmouth bass fisheries, and segments of the Spring also have excellent walleye and trout fisheries. Canoe outfitters operate on segments of both rivers.

Fish and nutrient water quality samples have been collected from a few sites in the Spring and Strawberry basins in recent years by the Arkansas Department of Environmental Quality (ADEQ); however, the biological and chemical data necessary to do a thorough baseline ecological evaluation for these sensitive watersheds is far from complete. Given their aesthetic, economic, and ecological significance, an ecological study is needed that will establish a baseline data set to facilitate long-term ecological evaluations.

PURPOSE AND OBJECTIVES: The purpose of this project will be to provide baseline water-quality and biological data to facilitate later comparisons for ecological characteristics measured before and after land use changes in these northeast Arkansas watersheds. Ecological conditions will change more dramatically and rapidly in small streams; thus, 24 wadeable stream sites are targeted for sampling. The primary objective of this study will be to use biological metrics to compare the condition of periphyton, macroinvertebrate, and fish assemblages to selected nutrient and sediment related variables prior to changes in land use that are likely to occur over time.

LOCATION: Field reconnaissance will be conducted at streams with wadeable stream reaches within the two watersheds to select 24 sampling sites. Geographic information system analysis will be used to select sites along a forest/pasture gradient in each watershed.

RESEARCH APPROACH: Water-quality samples will be collected following USGS protocols. Water will be collected during baseflow conditions on three occasions—in each of the two months prior to biological sampling for periphyton, macroinvertebrates, and fish and at the time of biological sampling. Water samples will be grabbed from three locations in the stream cross section. Water for dissolved nutrients will be filtered on-site with a 0.45-µm filter, and unfiltered water will be collected for total nutrients. Samples for TSS and turbidity also will be collected. All samples will be analyzed at the Ecotoxicology Research Facility (ERF), an EPA-certified laboratory (Certification AR-00917).

At the time of site reconnaissance and on all sampling occasions, conductivity, pH, water temperature, and dissolved oxygen (DO) will be measured using a calibrated multi-probe field meter (e.g. Thermo Orion Symphony Meter, Hampton, NH or Yellow Springs Instrument, Yellow Springs, OH). Temperature monitors (HOBOs), set to record water temperature on an hourly basis, will be deployed at half the monitoring sites by AGFC personnel.

All sampling will be conducted in a preselected reach of a length approximately equivalent to 20 times the mean wetted channel width (but having a minimum reach length of 150 m and a maximum of 300 m) under baseflow conditions in late summer. Periphyton, macroinvertebrate, and fish samples will be collected and processed with USGS methods used previously for assessments conducted at approximately 50 Ozark streams. Fish will be collected using electrofishing (backpack or barge electrofishing units) as the primary sampling method with seining as a supplemental method. Except for small fish that are difficult to identify without magnification or are otherwise unknown, fish will be identified in the field and released at the point of capture. A quantitative periphyton subsample will be collected from five cobbles at each of the five riffle locations (i.e. 25 subsamples will be composited). In addition to a sample for species identification, an aliquot of the periphyton sample will be filtered for

chlorophyll *a* analysis (at ERF). Macroinvertebrate samples will be collected from coarse-grained riffle substrates adjacent to locations where periphyton samples are collected. Five discrete macroinvertebrate subsamples collected with a Slack sampler from riffles will be combined to form that sample. Taxonomy for the periphyton and macroinvertebrate samples will be conducted at the ERF laboratory, with a subset of samples sent to contract laboratories for quality assurance purposes.

Habitat measurements made in conjunction with biological sampling, will provide evidence regarding sedimentation and associated compromised substrate quality. Habitat characteristics will be recorded at 11 equidistant transects. Macroalgae cover will be visually estimated at each of 5-1 m^2 quadrats (two edges of water and three locations spaced at equal intervals across each of the 11 transects).

EXPECTED RESULTS AND BENEFITS: As human population increases, animal production will continue to expand into remote areas where many reference quality streams are located. Stream nutrient conditions change over extended periods and the ecological consequences, although sometimes dire, are often complex and difficult to thoroughly document. Baseline ecological data are a necessary component that must be available before the public can be adequately informed and important ecological resources receive due consideration and adequate protection. Consequently, the increased capability for long-term monitoring is anticipated to be perhaps the greatest benefit of this project. Data collected for this study also will facilitate comparisons for how poultry production influences water quality and ecological conditions in ecologically sensitive areas across space (the entire Ozark ecoregion). Graduate students working on this project will be a vital part of field collections and laboratory analyses, and a Master of Science thesis and peer-reviewed publications are planned.

Table 1. Budget (Spring and Strawberry Rivers)		
	Request	Match
Salaries & Benefits		
PI Salary (Jennifer Bouldin)		$ 4,402
Grad Student	$ 36,000	
AGFC biologist		$ 2,880
Fringe		$ 1,019
Travel *		$ 7,200
Equipment (vehicles, shocker maintenance, WQ monitors)	$ 50	$ 1,440
Supplies (preservative, lab/sampling supplies)		$ 700
Sample analysis		$ 9,000
Subtotal A-State	$ 36,050	$ 26,641
Subaward - USGS	$ 61,931	
Project Cost	$ 97,981	
IDC (10%, 29.73% match)	$ 3,605	$ 10,718
IDC on Match		$ 10,584
IDC on Subaward (39.73% of first $25,000)		$ 9,933
Total Request/Match	**$ 101,586**	**$ 57,876**
*housing during travel (48 nights for 6 people) @$125/night		

QUALIFICATIONS:

Dr. Jennifer Bouldin received her PhD in Environmental Sciences from Arkansas State University and is a Professor of Environmental Biology at A-State. She has been the Director of the Ecotoxicology Research Facility (ERF) since 2006. She maintains USEPA certification and requires an annual inservice for Good Laboratory Practice for all researchers, technicians and students at the ERF. She and her students have published on water, soil and sediment toxicology, and long-term watershed studies including the Spring, Strawberry, Cache, Buffalo, and L'Anguille rivers. The ERF is a multidisciplinary research facility utilizing whole organism bioassays, organism collection and identification, and analytical analyses with the GCMS, AA, and Skalar SAN nutrient analyzer.

Billy Justus has a Bachelor of Science in wildlife management (1987) and a Master of Science in biology (1990), both of which he acquired from A-State. From 1989 until 1995, he was employed as an aquatic biologist with the Mississippi Department of Environmental Quality but has worked at USGS since 1995. As a research aquatic biologist for USGS, most of Billy's projects are multidisciplinary ecological studies that investigate interactions between aquatic biota and multiple types of environmental stressors. Some of his most recent publications have identified biological thresholds for various constituents (i.e. dissolved oxygen and nutrients). He has been an electrofishing field trainer for USGS and has led fish sampling crews and served as field taxonomist in 18 states.

Jeff Quinn is a Stream Fisheries Biologist with the Arkansas Game and Fish Commission. He received his M.S. degree from the University of Arkansas, and has been employed with AGFC since 1998. He has published 13 peer-reviewed papers in scientific journals and books, and is an American Fisheries Society Certified Fisheries Professional.