

Project Title: *Assessment of a riparian obligate songbird, the Louisiana Waterthrush, and its prey, aquatic macroinvertebrates, for contamination of streams by hydraulic fracturing on the South Fork Little Red River, Gulf Mountain Wildlife Management Area*

Project Summary: The race to extract natural gas from the Fayetteville Shale play has quickly outpaced research on its environmental effects. The goal of our study is to determine if contaminants indicative of hydraulic fracturing are present in headwater streams and consequently accumulating in Louisiana Waterthrushes and their prey, aquatic macroinvertebrates. Contaminants can bioaccumulate and are predicted to be present in higher concentrations in taxa living in streams with greater densities of gas wells compared to streams with no wells in their catchment. Our findings will build upon ongoing research on natural gas development effects on surface waters in the Fayetteville Shale that has been supported and is awaiting further support from your agency for subsequent years (Entrekin et al. 2012). Our findings will also complement those of a similarly designed and currently funded study in the Marcellus Shale of southwestern Pennsylvania that will fund the 2012 portion of waterthrush research in the Fayetteville Shale. This will allow regional powerful regional comparisons to be made, and will build this study into a two to three year national research project. If contaminants are identified and found to bioaccumulate in Louisiana Waterthrushes in areas of hydraulic fracturing, then broader actions could be taken to mitigate effects on the ecosystem and human health.

Project Leader: *Dr. Leesia Marshall*, Ph.D., University of Arkansas and Post-doctoral Research Associate for the Department of Conservation and Field Research of the National Aviary, lcmarsh@uark.edu, SCEN 632, c/o Dr. K.G. Smith, 1 University of Arkansas, Fayetteville, AR 72701 Tel. 870-416-9509

Project Partners:

Dr. Sally Entrekin, Assistant Professor University of Central Arkansas, sentrekin@uca.edu, 180 Lewis Science Center, Conway, AR 72035 Tel. 501-450-5917

Dr. Steven C. Latta, Director Conservation and Field Research, National Aviary, Steven.Latta@aviary.org, 700 Arch St., Allegheny Commons West, Pittsburgh, PA 15212 Tel. 412-258-9451

Dr. Michelle Evans-White, Assistant Professor, University of Arkansas, mevanswh@uark.edu, SCEN 632, 1 University of Arkansas, Fayetteville, AR 72701 Tel. 501-575-3075

Dr. Kimberly G. Smith, University Professor University of Arkansas, kgsmith@uark.edu, SCEN 632, 1 University of Arkansas, Fayetteville, AR 72701 Tel. 479-575-6359

Project Budget

Total project cost: (50%: match \$ 119,448) (35% match: \$155,547)

Total SWG money requested: \$77,448

Project Statement

Need: This study will address the priority action listed under the Arkansas Wildlife Management Plan 2012 as an emerging issue added at the 2008 Arkansas Wildlife Action Plan Conference: “*Evaluate, monitor and minimize the effects of natural gas development in the Fayetteville Shale natural gas area*”.

Location (Appendix 1): The study will be conducted in Boston Mountains 38 and Arkansas Valley 37 Ecoregions, specifically within the Fayetteville Shale region of central Arkansas in Van Buren County. Habitats include both terrestrial Ozark-Ouachita riparian corridor and riffle lotic aquatic habitat of 2nd - 4th order headwater streams. Headwater streams include tributaries of Point Remove, Cadron, and South Fork of the Little Red River (SFLRR) in the Gulf Mountain Wildlife Management Area (GMWMA). This research will further support ongoing research at these sites since 2009 (Entekin et al. 2012).

Goals and Objectives: The goal of our project is to determine if contaminants from hydraulic fracturing are entering surface and ground water, settling in sediments and microbes, including benthic algae, and then assimilated by benthic macroinvertebrates that are preyed upon by Louisiana Waterthrushes. Contaminant bioaccumulation in breeding waterthrushes will be assessed by collecting feathers for analysis of barium, strontium and arsenic as indicators of contamination from hydraulic fracturing of shale layers or the fracking compounds.

Waterthrushes maintain linear breeding territories along headwater streams. As contaminants from macroinvertebrates are bioaccumulated they are sequestered in growing feathers. Once a feather finishes growth, its blood supply atrophies and feathers become a reliable record of blood levels of contaminate concentrations on the study site (Rocque and Winkler 2005, Burger 1993). This is true also of nestling feather development. We will examine contaminants moving through the food web and into waterthrushes at 3 low density or no well stream reaches [Sis Hollow, Dry, Point Remove (all on Gulf Mtn)] and 3 high density (Black, Sunnyside, East Point Remove) stream reaches. We predict elevated contaminants in foodwebs in high density well drainages. We have 3 main objectives moving across trophic levels and ecosystem types (aquatic to terrestrial). They are described from bottom-up:

1st Objective: *Quantify contaminant levels in water, sediments, and microbial macroinvertebrate food resources.* Water trace element contaminant concentrations are being measured in association with Entrekin et al. 2011 (funded) and 2012 (not funded) headwaters project. We will further analyze dissolved organic carbon concentrations to assess potential organic carbon contamination in 10 grab and 2 storm samples from each site (6 sites x 12 samples x 2 years = 144). To identify vectors of contaminants, we will collect basal food resources (fine sediments, algae and leaf litter) samples for contaminant analysis (2 food types x 3 samples per stream x 6 streams x 2 years = 144; PI Evans-White).

2nd Objective: *Determine if bioaccumulation is occurring in benthic macroinvertebrate food sources to waterthrushes.* Macroinvertebrates are being measured in association with Entrekin et al. 2011 (funded) and 2012 (not funded) headwaters project and will be used for contamination analysis. Short and long-lived macroinvertebrates will be sampled in the same streams along a 200 m stream segment. Three replicate samples of invertebrates *Baetis*, *Cheumatopsyche*, *Caecidotea*, *Stenonema*, and Chironomidae will be sampled (5 taxa x 3 replicates x 6 streams x 2 years = 180; PI: Entrekin)

3rd Objective: *Determine levels of environmental contaminants in feathers of waterthrushes so that comparisons can be made among birds in headwater streams associated with high densities of active gas wells within their drainages and streams lacking gas wells within their drainages.* Feathers will be collected from territories of two or more breeding pairs for each of the six streams studied. Assuming two breeding pairs from each stream and feather samples taken from each pair in early breeding season (to represent conditions in the previous year's breeding season) and late breeding season (to represent conditions in the current breeding season) (6 streams x 2 territories = 24 adults x early and late season feather samples = 48 samples/year. Assuming only a 50 % survival rate to day 9 for nestlings (6 streams x 2 territories x 5 nestlings per territory * 50% = 30 samples/year). Total samples 2013 = 78, Samples for 2012 and 2013 = 156; PIs: Marshall, Latta, and Smith)

Approach: Male Louisiana Waterthrushes with territories upstream and downstream from macroinvertebrate sampling sites will be mist-netted and banded with a unique combination of a metal federal bird band and three colored plastic bands. Sampling area will be constrained by upstream and downstream tributaries that could confound analysis. Sampling will include three streams with a high density of wells within the catchment and three streams without wells or low densities of wells in their catchments (Appendix 1). All adult waterthrushes captured will be

aged as in their first breeding season or as in their second or later breeding season. From each adult we will collect three flight feathers for contaminant analysis. Because Louisiana Waterthrushes have high site fidelity, feathers collected from after second-year birds were very likely grown on the same stream in the previous breeding season. We will also capture the same birds later in the nesting season at which time we can collect the feather that was regrown to replace the previously collected feather, thus allowing for confirmation of in-stream conditions from the current breeding season. We will also search for and monitor nests of waterthrushes and collect breast feathers from each nestling just prior to fledging. These feathers also represent conditions on the natal stream. Feather samples will be sent for contaminant testing to the Dartmouth Toxic Metals Superfund Research Program, New Hampshire.

Expected Results and Benefits: Our project will provide important information on potential impacts of hydraulic fracturing and natural gas extraction in the Fayetteville Shale of central Arkansas particularly as it applies to sensitive riparian ecosystems and streams critical to Arkansas wildlife and human health. If contaminants are detected within food webs steps can be taken to minimize effects of natural gas development. Additionally, comparisons among our findings within the Fayetteville Shale and the Marcellus Shale will permit consideration of the broader implications of hydraulic fracturing and gas extraction throughout the nation. *We anticipate the publication of several peer-reviewed publications in scientific journals addressing the bottom up transfer of contaminants from streams to riparian birds.*

SGCN affected: 1. Speckled Pocketbook Mussel (*Lampsilis streckeri*)
2. Yellowcheek Darter (*Etheostoma moorei*)

Budget:

Budget Category	State	35% Match Scenario			50% Match Scenario		
	Wildlife Grant Funds (Federal)	Cash Match (Non-Federal)	In-Kind Match (Non-Federal)	Total Project Cost	Cash Match (Non-Federal)	In-Kind Match (Non-Federal)	Total Project Cost
Salaries	\$40,548	\$34,000	0	\$74,548	\$47,158	0	\$87,706
Contract Services	\$4,427	\$0	0	\$4,427	\$0	0	\$4,427
Supplies & Materials	\$17,479	\$8,000	0	\$25,479	\$8,000	0	\$25,479
Travel	\$8,880	\$0	0	\$8,880	\$0	0	\$8,880
Equipment	\$0	\$0	0	\$0	\$0	0	\$0
Indirect Costs	\$6,114	\$0		\$6,114	\$22,941		\$29,055
TOTAL	\$77,448	\$42,000	0	\$119,448	\$78,099	0	\$155,547

Note on Matching: *We have ample funds to match either the 35% or 50% scenario. Dr. Latta has invested prior non-federal funding to the project so that it may begin Spring 2012 prior to availability of SWG funds and is available to match with salary at \$28,760. Dr. Smith is available to match this project with salary at \$40,000 and Dr. Marshall will be available to match with her salary of \$13,500. Dr. Entrekin will be matching at \$8,000 and Dr. Evans-White with \$4,098 along with matches they have already made to an ongoing and complementary project (see Entrekin et al. 2012).*

Project Leader:

Dr. Leesia Marshall, Ph.D.

Leesia Marshall has a background in study of behavioral ecology and ornithology with an emphasis on Paruline Warblers. Her Ph.D. research centered about the use of the Louisiana Waterthrush as an indicator of stream ecological integrity and the predator-prey relationships between Louisiana Waterthrushes and benthic macroinvertebrates in the watershed of the upper Buffalo National River. Her responsibilities will be organization of the project and implementation of study of the highest trophic level of organization, i.e. birds and feathers.

Project Partners:

Dr. Sally Entrekin, Ph.D.

Sally Entrekin has a background in aquatic ecology that has focused on food web and organic matter dynamics in headwater streams on which she has published. Her responsibilities on this project will include sampling macroinvertebrates, preparing macroinvertebrate samples for analysis, and analyzing and interpreting macroinvertebrate data.

Dr. Steven C. Latta, Ph.D.

As Director of Conservation and Field Research at the National Aviary in Pittsburgh Steve Latta has focused on the winter ecology of migratory birds, and understanding how migrant and resident species respond to natural and anthropogenic change to their habitat. A focus of current research is how degradation of streams leads to reductions in riparian bird species. Loss of surrounding forest cover, runoff from mines, and other sources of contaminants are thought to adversely affect birds by limiting quality and quantity of insect prey. Since 2006 Dr. Latta has been evaluating the effects of stream quality on the riparian obligate Louisiana Waterthrush (*Parkesia motacilla*) throughout its annual cycle.

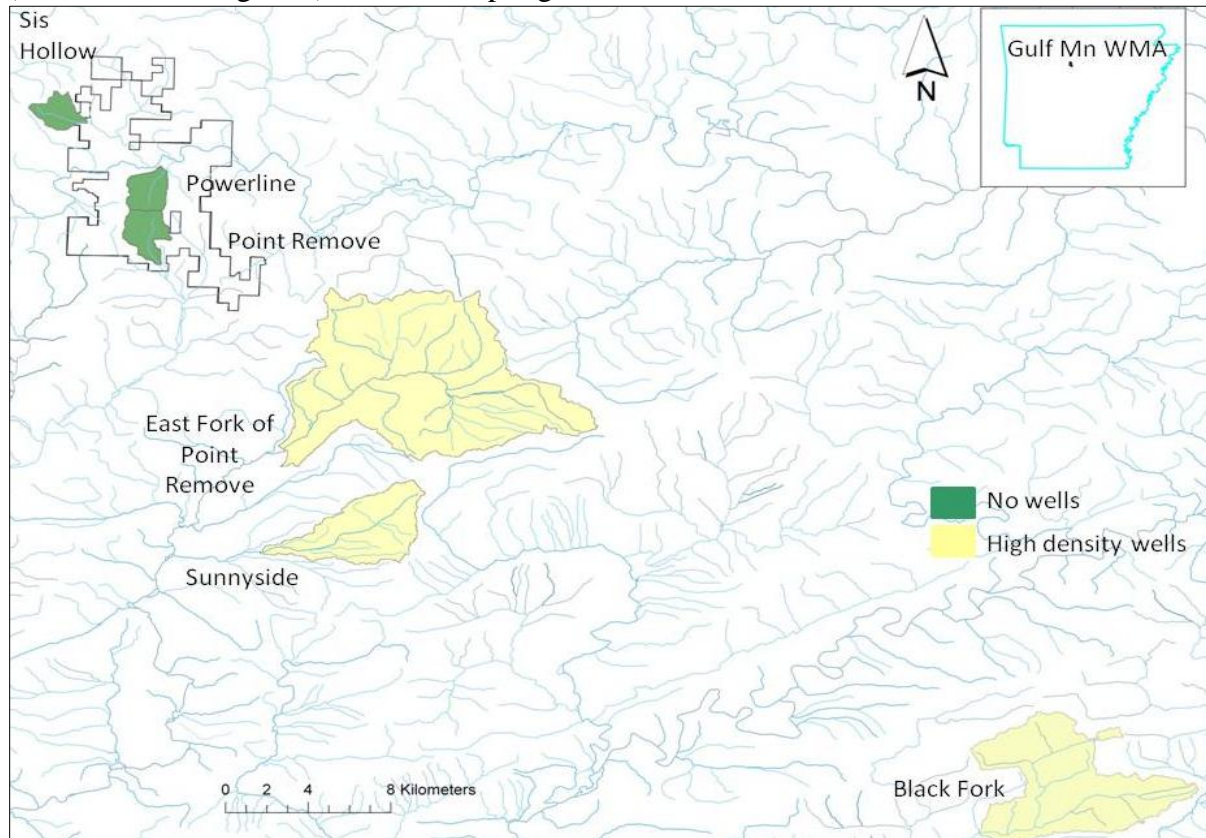
Dr. Michelle Evans-White, Ph.D.

Michelle Evans-White research and scientific publications have focused on roles of animals in organic matter and nutrient dynamics in stream ecosystems and how anthropogenic contaminants may alter species functional roles with respect to community effects and energy and element flow. Her responsibilities on this project will be assessing contaminants in water, sediments, and basal food resources.

Dr. Kimberly G. Smith, Ph.D.

Kimberly G. Smith is University Professor of Biological Sciences at the University of Arkansas. He is a community ecologist who has conducted research on a number of environmental issues such as effects of oil development on the North Slope of Alaska on shorebirds and insect outbreaks in the Ozarks. He and Dr. Marshall have collaborated on a number of research projects, including her dissertation work on Louisiana Waterthrushes. He will be involved with the planning of the waterthrush research and with data analysis.

Appendix 1. Study streams on and near Gulf Mountain Wildlife Management Area with location (Latitude and Longitude) of each sampling site



Near GMWMA _a		On GMWMA	
High Density of Wells	Lat/Long	No Wells	Lat/Long
East Fork Point Remove	35.4332 -92.6124	Sis Hollow	35.5878 -92.6983
Sunnyside	35.3853 -92.6225	Point Remove	35.5219 -92.6673
Black Fork	35.2522 -92.3095	Powerline	35.5134 -92.6471

a. GMWMA = Gulf Mountain Wildlife Management Area

Literature Cited

Burger, J. 1993. Metals in avian feathers: bioindicators of environmental pollution. *Reviews in Environmental Toxicology* 5, 203-311.

Entrekin, S. et al. 2012. Assessing physical, chemical, and biological effects before, after, and during gas well construction in the main stem and tributaries of South Fork Little Red River on Gulf Mountain Wildlife Management Area; 2012 State Wildlife Grant Pre-proposal.

Rocque, D.A., and K. Winkler. 2005. Use of bird collections in contaminant and stable-isotope studies. *Auk* 122(3):990-994.