Continuation: 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.

We propose to continue to quantify potential changes in water quality and aquatic biota of headwater tributaries of Point Remove and the South Fork Little Red River (SFLRR) and the main stem of the river in the Gulf Mountain Wildlife Management Area (WMA) from natural gas drilling. Further, we will relate water quality and sediment quantity and composition to possible changes in aquatic biota in the streams draining catchments with wells in Gulf Mountain WMA to those that use questionable best management practices (BMPs) in 3 catchments nearby. We sampled streams in Gulf Mountain in autumn 2009, spring 2010, autumn 2010, and spring 2011. We sampled main stem SFLRR in December 2010 and March 2011. Two well pads have been built on Gulf WMA and several more are proposed for 2011. We are requesting funds for 1 additional year of funding to continue to study headwaters and main stem of the SFLRR in Gulf Mountain Wildlife Management Area.

Project managers: Sally Entrekin (tributaries), Assistant Professor at University of Central Arkansas, sentrekin@uca.edu, 180 Lewis Science Center, Conway, AR, 72035. Tele: 501.450.5919, Fax 501.450.5914

Brian Haggard (SFLRR), Associate Professor and Director, Arkansas Water Resources Center, University of Arkansas, haggard@uark.edu, Fayetteville, AR 72701. Tele: 479.575.2879

Project partners:
Ginny Adams, Assistant Professor at University of Central Arkansas, gadams@uca.edu, 180 Lewis Science Center, Conway, AR, 72035. Tele: 501.450.5917

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Michelle Evans-White, Assistant Professor at University of Arkansas, mevanswh@uark.edu, Biological Sciences, Fayetteville, AR, 72701. Tele: 501.575.3075

Steve Filipek, Assistant Chief of Fisheries, Arkansas Game and Fish Commission, 2 Natural Resources Drive, Little Rock, AR 72205; E-mail: sfilipek@agfc.state.ar.us; Tele: 501.223.6369

Jaysson Funkhouser, U.S. Geological Survey Arkansas Water Science Center, 401 Hardin Road, Little Rock, AR 72211; E-mail: jefunkho@usgs.gov ; Tele: 501.228.3600

Lindsey Lewis, United State Fish and Wildlife Service, Lindsey_Lewis@fws.gov, Arkansas Field Office, Conway, AR 72032. Tele: 501.513.4470

Chris Davidson, United State Fish and Wildlife Service, Chris_Davidson@fws.gov, Arkansas Field Office, Conway, AR 72032. Tele: 501.513.4481

Ethan Inlander, Ozark Rivers Program Director, The Nature Conservancy, einlander@tnc.org, 675 N. Lollar Lane Fayetteville, AR, 72701. Tele: 479.973.9110 x222

Daniel Millican, Stream Ecologist, The Nature Conservancy, Fayetteville, AR, dmillican@tnc.org, 675 N. Lollar Lane Fayetteville, AR, 72701. Tele: 479.973.9110

Overall Project Statement:

Project need: Natural gas development is occurring at an unprecedented rate that could impact over 20 U.S. states**.** Our past data indicate cumulative effects of gas development on stream water quality in regions where management practices during well development are uncertain. We will continue to address the potential effects of natural gas development to a particularly sensitive watershed; the SFLRR main stem in north-central Arkansas' Fayetteville Shale gas play. If funded, we will be able to complete a 3rd year of sampling as well as monitor streams as the gas development proceeds on Gulf Mountain Wildlife Management Area (WMA). In addition to addressing a pressing emerging issue, data collected on water levels, species distributions, and abundance over multiple years with varying hydrologic regimes at several sites will contribute to our understanding of the critical flow needs of species of concern (Appendix 5).

Overall Objectives – Sampling will occur from autumn **2011 to autumn 2012**. We will sample variables outlined below twice a year, unless noted otherwise, in spring and in autumn or early winter. In addition, funds will contribute to the continued maintenance of real-time water quality monitoring and gauging of the SFLRR by USGS.

Our primary objective is to quantify potential alterations in water quality in the SFLRR main stem and headwater streams in Gulf Mountain WMA. We began sampling these streams in autumn 2009 and have sampled twice a year since. We will not continue sampling all of the 11 streams off Gulf Mountain. Instead, we will **retain 3 sample sites near Gulf Mountain** located in catchments with high well density and variable BMP implementation (Sunnyside, Black Fork, and East Point Remove catchments). The biological data from the tributaries will be used as a comparison to parallel data collected on the main stem of the SFLRR in Gulf Mountain WMA. The combination of SFLRR main stem and tributary parallel data collection will provide a long term quantitative analysis of potential natural gas development to surface waters in the Fayetteville shale. We will continue to use these data to inform resource managers and concerned citizens of potential threats from gas well development.

Region and study site location - Our study sites are located in the Fayetteville-Shale region of central Arkansas in intermittent streams spanning the Arkansas Valley and Boston Mountain ecoregions (Appendix 1 and 2). Study sites off Gulf Mountain are in the 1st and 2nd congressional districts. Gulf mountain study areas fall within the 2nd congressional district located in Van Buren County.

Tributaries

Study Design and objectives in the tributaries: We are using before-after-control-impact factorial analysis to detect changes in chosen biological attributes following drilling and fracturing. In addition, a suite of multivariate statistics will be used to further examine potential biological effects from pipe line, road, and reservoir densities. Study sites were chosen based on catchment size, land use land cover, and well density (Appendix 3). See the timeline (Table 1) for a summary of data already collected and

projected sampling that will occur if funded. We will add the collection of stream water level to the tributary sampling to address how changing hydrology relates to species distributions and water quality. Entrekin and Evans-White will use a portion of their proposed supply money to purchase 10 PlantCam cameras and 10 staff gages to record hourly water levels (~$ 1000.00).

Measured variables

1. Five benthic sediment samples from each of 10 stream reaches at low flow.
Benthic sediments will be sampled using a corer, collecting a known volume of slurry subsample, and filtered in the laboratory. Sediment content (organic vs. inorganic fractions) and volume will be quantified (following methods outlined by Wallace et al. 2006). (PI Entrekin) (1 year x 2 sampling dates x 10 stream reaches x 5 cores=100 total samples)

2. Two siphon samplers have been placed at each of the 10 study sites to capture suspended sediments during high flows. One set of samplers is set 10 cm above base flow and the other is set 30 cm above base flow. We aim to sample 2 storms per season, including summer and winter, although total number of storms that will occur varies greatly. Ideally, we will sample 1 year x 2 storms x 4 seasons x 2 samplers per stream reach x 10 stream reaches=160 total samples).

3. Ten benthic invertebrate samples will be collected in each stream reach within each representative habitat using a 250 μm mesh Hess sampler. Invertebrates will be collected, preserved in ethanol, enumerated, identified, and biomass will be estimated. Invertebrate richness, diversity, density, life history traits, and biomass will be determined for each stream at base flows only (Entrekin et al. 2007). (PI Entrekin) (1 year x 2 sampling dates x 10 stream reaches x 10 cores=200 total samples).

4. Fish will be sampled at base flows with triple pass electro-fishing. Fish taxa richness, density, and biomass will be quantified. Fish that cannot be identified in the field will be preserved in 10% formalin and taken to the laboratory. Individual fish will be identified and weight and length measurements recorded. (PI G and R Adams).

5. Periphyton will be measured on 10 cobbles in each stream reach within each representative habitat, stored on ice, and analyzed for chlorophyll *a* and ash-free dry mass in the laboratory twice annually (2 sampling dates x 10 reaches x 10 cobbles = 200 total samples). Whole-system metabolism (i.e., gross primary production, community respiration, net ecosystem production) will be measured in each study stream at the same time that periphyton cobbles are collected by determining diel dissolved oxygen patterns using multi-parameter sondes equipped with temperature and dissolved oxygen probes (1 year x 2 sampling dates x 10 reaches = 20 total samples). Water samples will be collected when primary production is being measured and analyzed for total dissolved inorganic nitrogen (NO_3+NO_2-N + NH_4), soluble reactive phosphorus, and total phosphorus (TP) on a Lachat rapid flow analyzer (2 sampling dates x 10 reaches = 20 total samples per chemistry type, 80 total samples). We will also analyze (TP) on storm flow samples collected in the siphon samplers. The number of these samples will depend upon storm events (Evans-White).

6. Water column water samples will be collected from each of the 10 study sites 12 times per year for a total of 120 samples that will be analyzed for conductivity, turbidity, dissolved trace elements (e.g., arsenic, copper, cadmium, calcium, chromium, iron, magnesium, manganese, zinc) using inductively coupled plasma optical emissions spectrometry (ICP–OES). In addition, 3 sediment samples from each of the 10 streams will be collected and analyzed from storm samples collected by siphon samples.

Sediments will be extracted using a Mehlich III method and analyzed on a separate ICP in the Agricultural Diagnostic Lab to detect Al, B, Ca, Cu, Fe, K, Mg, Mn, Na, P, S, and Zn. The University of Arkansas Water Quality Research Lab (Haggard) will be responsible for this component of the study.

7. Each catchment will have a characterization of the land cover, well densities, and unpaved roads identifying total length, density, and hydrologic proximity to streams. Gas infrastructure will be quantified in each catchment as total length of gas pipelines, their proximity to streams, the number of well pads, and their proximity to the stream. In addition, stream bank sediment sources and sinks will be estimated from the site of sampling collection. These spatial data will need to be updated seasonally and they will be used to assist in the interpretation of the biological and sediment data. Ethan Inlander and

Table 1. Proposed timeline for continued sampling on Gulf Mtn WMA. Spr=spring; sum=summer; aut=autumn

	2009			2010			2011			2012			2013			2014		
Sample Collection	**Spr**	**Sum**	**Aut**	**Spr**	**Sum**	**Aut**	**Spr**	**Sum**	**Aut**	**Spr**	**Sum**	**Aut**	**Spr**	**Sum**	**Aut**	**Spr**	**Sum**	**Aut**
Gulf Mtn sediment			x	x		x	*		*	*		*	*		*	*		
All catchment/no-BMP sediment			x	x		x	*		*	*		*	*		*	*		
Gulf Mtn Periphyton and Metabolism			x	x			*		*	*		*	*		*	*		
All catchment/no-BMP Periphyton and Metabolism			x	x			*		*	*		*	*		*	*		
Gulf Mtn Invertebrates			x	x		x	*		*	*		*	*		*	*		
All catchment/no-BMP Invertebrates				x			*		*	*		*	*		*	*		
Gulf Mtn Fish			x	x		x	*		*	*		*	*		*	*		
All catchment/no-BMP Fish				x			*		*	*		*	*		*	*		
Sample processing/Data analysis																		
			Year 1			**Year 2**			**Year 3**			**Year 4**			**Year 5**			
x=completed			SWG 1			SWG 2			Submitted Prepropo			Conti nue if possibl			entinue if possib			
*=projected to do		Report due	9/18/2011			9/18/2012												

Lower sites are reduced to 3 beginning in Autumn 2011

South Fork Little Red River

Location: This project is within the 2nd Congressional District located in Van Buren County, Arkansas (see figure in Appendix 1), and the study area is within the Boston Mountains Ecoregion 38 with the Ozarks Highlands Ecoregion 39 to the north, and Arkansas Valley Ecoregion 37 south (see Figure in Appendix 2).

Project Objectives: The Arkansas Water Resources Center (AWRC), working cooperatively with the University of Central Arkansas (UCA) and the US Geological Survey (USGS) Arkansas Water Science Center proposes to monitor water resources in the Gulf Mountain WMA, specifically the South Fork of the Little Red River. The primary goal of this project is to provide important information on the hydrology and water quality conditions representing baseline conditions of the aquatic resources on the South Fork of the Little Red River, and then to evaluate any changes in the aquatic resources that may occur as a result of the natural gas exploration and development activities within the Gulf Mountain WMA. The specific objectives of this project are (see Timeline table 2):

1. Provide continuous water quality and discharge monitoring on the South Fork of the Litter Red River at the two existing USGS sites upstream and downstream from Gulf Mountain WMA,

2. Collect water samples at four strategic stream sites along the South Fork of the Little Red River,

3. Analyze water samples from these four sites,

4. Collect macroinvertebrate samples and identify organisms to the lowest practical taxonomic level at these four sites seasonally (i.e., twice a year in autumn and spring),

5. Determine benthic sediment composition at these four sites along the South Fork of the Little Red River.

6. And, overall project management and reporting as requested to AGFC.

Project Timeline: This project is for one year from Autumn 2011 through Autumn 2012.

Project Approach: ***Objective 1*** – *Provide continuous water quality at two established USGS sites on the South Fork of the Litter Red River*. One continuous water–quality monitor (turbidity, specific conductance, temperature, dissolved oxygen, and pH), stream stage and precipitation site was installed summer 2010 at the South Fork Little Red River (see Figure in Appendix 4); the site is located downstream of the Gulf Mountain WMA (site 4). The water–quality monitor that is currently in operation at the upstream site (site 1) has been funded by the USDA Forest Service and was installed in May 2009; this proposal anticipates that USDA Forest Service funding will be continued throughout the duration of the proposed project, and as such, funds are not requested to maintain this site. Both sites will continue to measure and record stage, precipitation, turbidity, specific conductance, temperature, dissolved oxygen and pH at 15–minute intervals and transmit these data through satellite transmissions once every hour (more frequent transmissions can occur when the streams are experiencing extreme high–flow conditions) to the USGS Arkansas Water Science Center in Little Rock, Arkansas. The stage, turbidity, specific conductance, temperature, dissolved oxygen, and pH values will be displayed in near real–time fashion at http://ar.water.usgs.gov. The continuous water–quality monitors will be serviced to check the calibration of the instruments and remove any fouling that may occur at least every three weeks or as necessary (Wagner et al., 2006).

Objective 2 – *Collect water sample at four established sites along the South fork of the Little Red River*. The four strategic stream locations include the sites upstream and downstream of the Gulf Mountain WMA, where continuous water quality will be monitored (see Figure in Appendix 4, sites 1 and 4), and two additional sites along the main channel of the South Fork of the Little Red River (sites 2 and 3); these three sites will be upstream, in between, and downstream of major tributaries flowing into the South Fork of the Little Red River. The AWRC will collect grab water samples at these sites, where water samples will be collected from the vertical centroid of flow when possible or from the streambank using appropriate sampling protocols; water samples will be collected at least monthly from these sites. All four of these sites will have siphon samplers installed to collect water samples at a specific depth, which provides an inexpensive, reliable way to collect samples automatically from rising water at predetermined stages (Diehl, 2007); the siphon samplers will be visited and maintained at least monthly by the AWRC. The total number of samples collected will be at least 12 grab samples per year during base flow conditions, and 6 water samples from the siphon samples per year; samples will only be

collected from the siphon samplers when bottles have been filled because increased river depth. The USGS will collect rise, peak and fall water samples during three separate storm events, where the USGS will collect equal-width-increment (EWI) samples following standard protocols. All water samples collected will be delivered to the AWRC Water Quality Lab.

Objective 2 – *Analyze water samples from the South Fork of the Little Red River*. The collected water samples will be stored on ice, in the dark and then delivered to the AWRC Water Quality Lab. The received water samples specific to this project will be analyzed for conductivity, turbidity, anions, total suspended solids, and total organic carbon. Select water samples will be analyzed for dissolved trace elements using inductively coupled plasma optical emissions spectrometry (ICP–OES); these samples will be those collected and delivered to the AWRC Water Quality Lab within desired holding times.

Objective 3 – *Collect macroinvertebrate samples and identify organisms to the lowest practical taxonomic level at the four established stream locations seasonally (i.e., twice a year).* Collect macroinvertebrate samples and identify organisms to the lowest practical taxonomic level at the five strategic stream locations seasonally (i.e., twice a year). Macroinvertebrates will be quantified in spring and autumn for one year at the four strategic stream locations (See Figure in Appendix 4) along the South Fork of the Little Red River flowing through the Gulf Mountain WMA; invertebrates will be sampled twice a year by the University of Central Arkansas. Five benthic invertebrate samples will be collected [during base flow conditions only] in riffles associated with each of the strategic stream reaches being monitored for water chemistry, and invertebrates will be collected using a modified 250 µm mesh Hess sampler with guzzler pump. Invertebrates will be collected, preserved in ethanol, enumerated, identified to lowest practical taxonomic level, and biomass will be estimated. Invertebrate richness, diversity, density, and life history traits will be recorded (Benke et al., 1999; Poff et al., 2006; Merritt et al., 2008

Objective 4 – *Determine benthic sediment composition at the four sites along the South Fork of the Little Red River*. Fine benthic sediments will be measured in study reaches in the spring and autumn for one year by the University of Arkansas. Within each study reach, sediments will be collected from 5 cores collected along the stream margin and within the thalweg. Prior to disturbing the cores, embeddedness will be assessed visually following Barbour et al. (1999). Sediments within the core will then be disturbed to 10 cm, suspended sediments will be sub–sampled, and total core volume will be estimated from 5 measurements of depth. Fine sediment dry mass and organic content measured as ash–free dry mass (AFDM) of sub–samples will be quantified in the laboratory, similar to described above. Five to 10 cobbles will be collected in each stream reach within each representative habitat, stored on ice, and analyzed for chlorophyll a and ash–free dry mass in the laboratory. Stream metabolism (i.e., gross primary production, community respiration, net ecosystem production) will be estimated by examining diel dissolved oxygen patterns using the continuous water quality monitors at the sites maintained by the USGS in the spring and the autumn (Bott, 2006).

Table 2. Timeline of South Fork Little Red River sampling regime from November 2011 to October 31, 2012.

TASK	2011 NOV	DEC	2012 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	2012 OCT
Objective 1	→	→	→	→	→	→	→	→	→	→	→	→•
Objective 2	→	→	→	→	→	→	→	→	→	→	→	→•
Objective 3	→	→	→	→	→	→	→	→	→	→	→	→•
Objective 4	→	→•			→	→•						
Objective 5	→	→•			→	→•						
Objective 6		→	→•			→	→•			→	→	→•

Measurable products resulting from combined studies:

- Baseline data on periphyton biomass, primary production, and invertebrate and fish diversity, density, and biomass in 12 headwater streams with varying levels of permit densities and land use in understudied habitats.
- A list of key water quality chemistry, biological and habitat indicators will be developed through this project such that the effects of natural gas drilling and development may be ascertained through future SWG projects.
- Provide management recommendations for minimizing sedimentation that may occur from drilling activities.
- Provide data to alert land managers to potential effects of sedimentation from gas drilling on species of concern.
- Submission of at least 3 peer-reviewed scientific publications addressing the effects of natural gas drilling on biota in Arkansas.
- Data will be added to the National Monitoring Partnership database and to the Arkansas Portal in the Conservation Directory
- Generated maps will be made available at www.ArkansasWildlife.com.

- Students and principal investigators will present data at the North American Benthological Society, American Fisheries Society: state and local chapters, American Society of Limnology and Oceanography, and Arkansas Academy of Sciences.

- Annual project updates will be available to the state at the PIs websites (i.e., natural gas blog) and the Arkansas Fish and Wildlife Service webpage.

- The data collected under each of these objectives will be organized into project spreadsheets for distribution to AGFC as requested.

- Adding monitoring data to the National Monitoring Partnership database (www.nbii.gov)

- Adding monitoring data to the Arkansas Portal in the Conservation Directory (which is currently under construction at www.conservationregistry.org)

- Sharing information with peers through papers and reports at meetings

- Updating the Arkansas Wildlife Action Plan as necessary, based on information from this project

Measurable products realized:

- Construction and use of a blog to inform all of our project partners and researchers at http://ngihs.blogspot.com/

- Excel spreadsheet that details sampling dates-please see for more specific information of sites and dates sampling occurred.

- GIS analysis of well pads and well points, and estimated LULC for each catchment

- New polygons for each watershed from TNC

- Saturday workshop at the Clinton, AR city park, "How to construct a siphon sampler to monitor suspended sediment in your own stream" Approximately 15 people attended the event.

- TNC metrics quantifying well pad density, pad flowlength distances and gradients, and other spatial descriptions of the watershed.

- Presentations to date:

    - Lowry, Michael, Troutman, Tyler. The Effects of Natural Gas Drilling on Decomposition Rates on Headwater Streams in the Fayetteville Shale Gas Play. UCA Research Symposium, UCA, Conway AR, April 2010. (poster)

- Lowry, Michael, Troutman, Tyler. The Effects of Natural Gas Drilling on Decomposition Rates on Headwater Streams in the Fayetteville Shale Gas Play. Arkansas Academy of Science, UALR, Little Rock AR, April 2010. (poster)

- Martindale, L. and Entrekin, Sally. Sediment transport in headwater streams following natural gas drilling. UCA Research Symposium, UCA, Conway AR, April 2010. (poster)

- Entrekin, S.A., M.L. White, G. Adams, R. Adams, L. Lewis. 2009. Effects of natural gas drilling on headwater streams. Presented at the National meeting of the North American Benthological Society, Grand Rapids, MI. (poster)

- Entrekin, S.A., Evans-White, M.L., Adams, G., Adams, R, Lowry, M., Troutman, T. 2010. Effects of natural gas drilling on organic matter dynamics in headwater streams in Arkansas. Presented at the American Fisheries Society Arkansas Chapter, Fort Smith, Arkansas, February 2010. (paper presentation)

- A. Jackson, M.A. Evans-White, S. Entrekin. Effects of natural gas drilling on stream quality and periphyton in the Fayetteville Shale. Arkansas and Oklahoma Joint American Fisheries Society Meeting, February 2010, Fort Smith, AR.(paper presentation)

- Stearman, Loren, Ginny Adams, S. Reid Adams and Sally Entrekin. 2011. Preliminary Impacts of Natural Gas Exploration on Stream Fish Communities. American Fisheries Society Arkansas Chapter Symposium.

- Stearman, Loren, S. Reid Adams and Ginny Adams. 2011. Life History and Ecology of the Redfin Darter. Southwestern Association of Naturalists Annual Meeting (Paper Presentation)

- Stearman, Loren, S. Reid Adams and Ginny Adams. 2011. Life History and Ecology of the Redfin Darter. University of Central Arkansas (Poster Presentation)

- Stearman, L., G. Adams, and R. Adams. Preliminary Results from an Examination of the Effects of Natural Gas Drilling and Fracking in the southern Arkansas Ozarks. Presented at the American Fisheries Society Arkansas Chapter, Fort Smith, Arkansas, February 2010. (Poster presentation)

- Stearman, L., G. Adams, and R. Adams. Preliminary Results from an Examination of the Effects of Natural Gas Drilling and Fracking in the southern Arkansas Ozarks. UCA Research Symposium, UCA, Conway AR, April 2010. (poster)

- Entrekin, S.A., M.L. Evans-White, T. Troutman, and M. Lowry. Effects of natural gas drilling on organic matter dynamics in small streams in Arkansas. North American Benthological Society, June 2010, Santa Fe, NM. (paper presentation)

- Austin, B.J., A. Jackson, M. Evans-White, S. Entrekin. 2010. Periphyton across a gradient of natural gas well density in headwater streams in North Central Arkansas. North American Benthological Society, June 2010, Santa Fe, NM. (poster)

- Stearman,L., G. Adams, R. Adams, and S. Entrekin. 2010. An assessment of the impacts of natural gas drilling in north-central Arkansas. American Fisheries Society, September 2010, Pittsburg, PA (paper presentation).

- Entrekin, S.A., Michelle Evans-White, Ginny Adams, Reid Adams, Karen Steelman, Ethan Inlander, Daniel Millican, Brian Haggard, Lindsay Lewis, Chris Davidson. Does natural gas pose a threat to surface waters? Van Buren County gas advisory commission, October 20, 2010, Clinton, AR (paper presentation).

- Austin, B.J., Aaron Jackson, Michelle Evans-White, Sally Entrekin**.** Periphyton across a gradient of natural gas well densities in headwater streams in North Central Arkansas. Fall 2010 at Arkansas watershed advisory group (AWAG) and NABS 2010 (poster presentation)

- Kelso, J. and S.A. Entrekin. Refuge use by macroinvertebrates in intermittent Ozark streams. University of Central Arkansas College of Natural Sciences and Mathematics Symposium. April 2011.

- Austin, B.J., Aaron Jackson, Kara Brick, Michelle A. Evans-White, Sally Entrekin. Potential Impacts of Natural Gas Wells on Metabolism and Periphyton in Headwater Streams in North Central Arkansas. ASLO 2011, Puerto Rico (Paper presentation)

1. Budget summary

Complete the project budget summary form below.

Budget Category	State Wildlife Grant Funds (Federal)	Cash Match (Non-Federal)	In-Kind Match (Non-Federal)	Total Project Cost
Salaries	140,394.00	-	137,080.00	277,474.00
Contract Services	53,720.00	-	-	53,720.00
Supplies and Materials	19,000.00	-	-	19,000.00
Travel	15,000.00	-	-	15,000.00
Equipment	-	-	-	-
Indirect Costs	21,923.00	-		21,923.00
TOTAL	250,037.00	-	137,080.00	387,117.00

Qualifications of assembled research group:

Sally Entrekin is an aquatic ecologist often studying headwater streams on which she has published. Her responsibilities on this project will include project organization, mentoring of an undergraduate and graduate student to investigate organic matter dynamics and invertebrate community structure.

Ginny Adams research has focused on the conservation of sensitive and endangered species in relation to anthropogenic disturbance. She is an expert in morphology, physiology, life history, genetics, and ecology of invertebrates and fishes on which she has published. Her responsibilities on this project will include mentoring of undergraduate and graduate students in fish collection and identification.

Reid Adams research has focused on physiology and ecology of freshwater fishes and invertebrates in large river systems and has several papers relevant papers on these subjects. He will contribute his broad experience on the ecology of streams and rivers in this region. His responsibilities on this project will include mentoring of undergraduate and graduate students in fish collection and identification.

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 factors may alter species functional roles. Her responsibilities on this project will be monitoring whole-stream metabolism, water chemistry (including storm sampling), and providing analytical support to faculty at UCA.

Chris Davidson is an endangered species biologist with the United States Fish and Wildlife Service. He has national lead on recovery of the federally endangered speckled pocketbook and monitors the activity of natural gas activities in the Little Red River watershed, including authorizing BMPs. He will act in an advisory role to find study sites, gain access to private lands, and disseminate our research results.

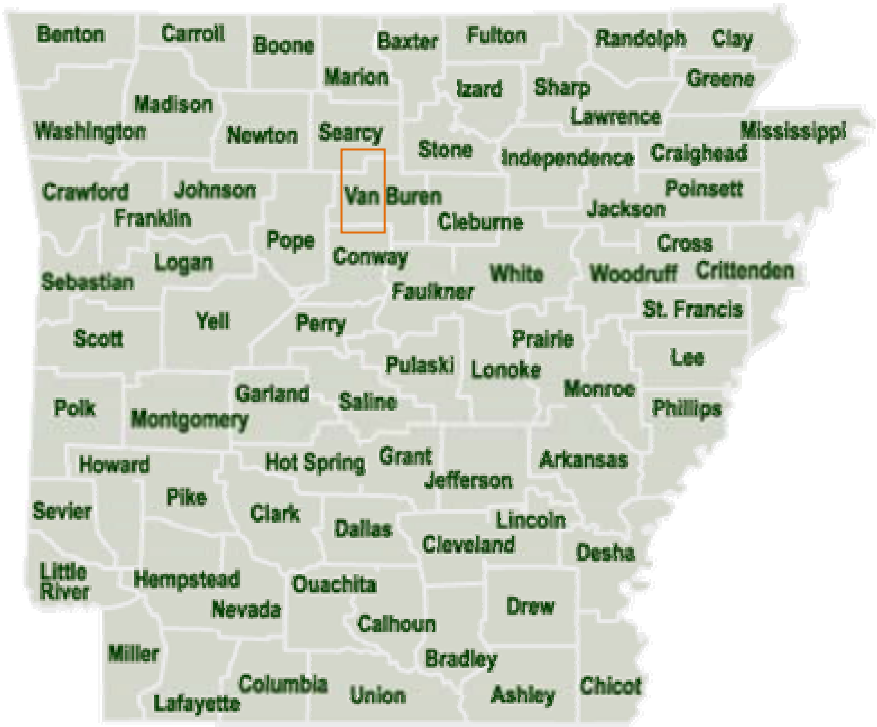
Lindsey Lewis is a biologist with the United States Fish and Wildlife Service. Among his many duties, he monitors the activity of well drillers in the state of Arkansas. He will act in an advisory role to help us find study locations, gain access to private lands, and help disseminate our research results.

Brian Haggard is an associate professor and the director of the Arkansas Water Resources Laboratory and has many years of experience analyzing sediments and water for contaminants. He will run suspended sediment samples at AWRC.

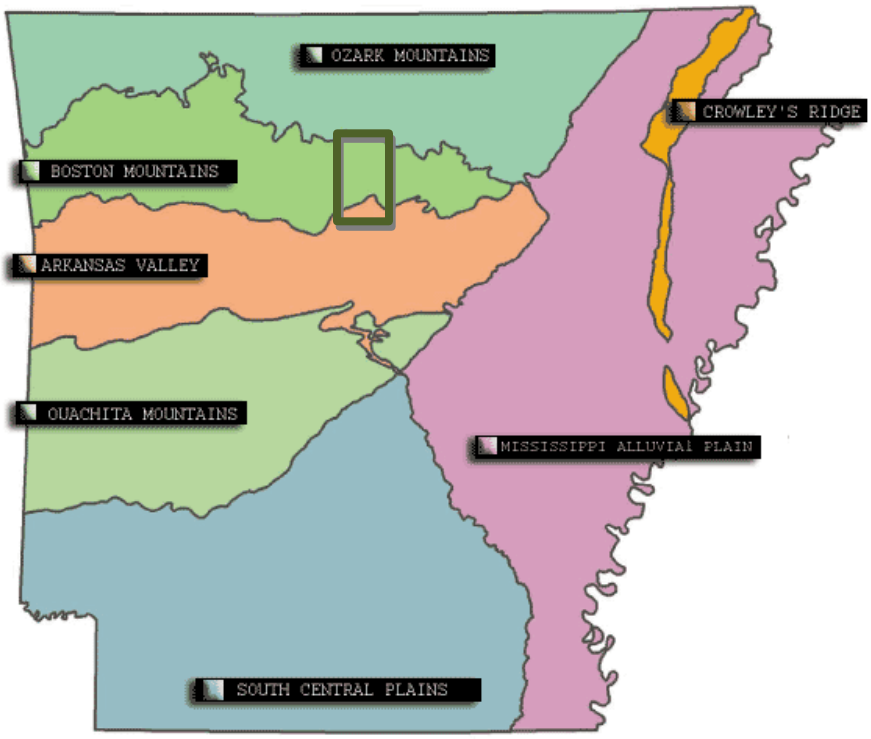
Ethan Inlander is a professional geographer and project manager with over 15 years experience applying geospatial technologies and analyses to land management and conservation issues. His emphases include watershed modeling, riparian mapping and conservation prioritization. His responsibilities on this project will be to provide input on GIS modeling and landscape characterization.

Daniel Millican is an aquatic ecologist with experience in identification of species-environment relationships using multivariate analyses. His responsibilities on this project will be to provide advice on biological and landscape sampling design, and on using statistical analyses to identify landuse influences on biological characteristics.

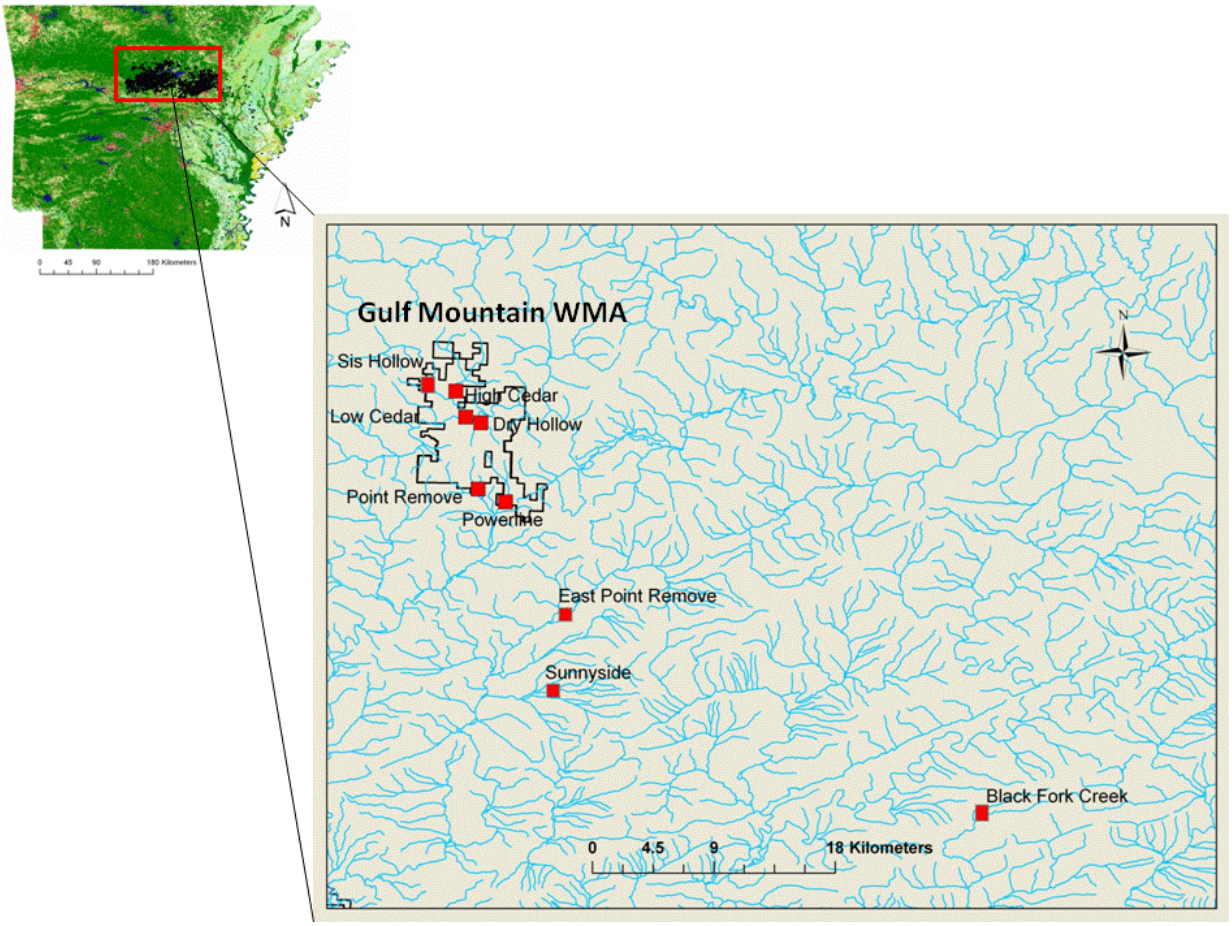
Appendix 1. General location of Gulf Mountain Wildlife Management Area within Arkansas, where the proposed study sites will be located.



APPENDIX 2 – General location of the study site, Gulf Mountain Wildlife Management Area, in Arkansas relative to the various defined ecoregions.



Appendix 3: Study site locations on Gulf Mountain Wildlife Management Area in North-Central Arkansas.

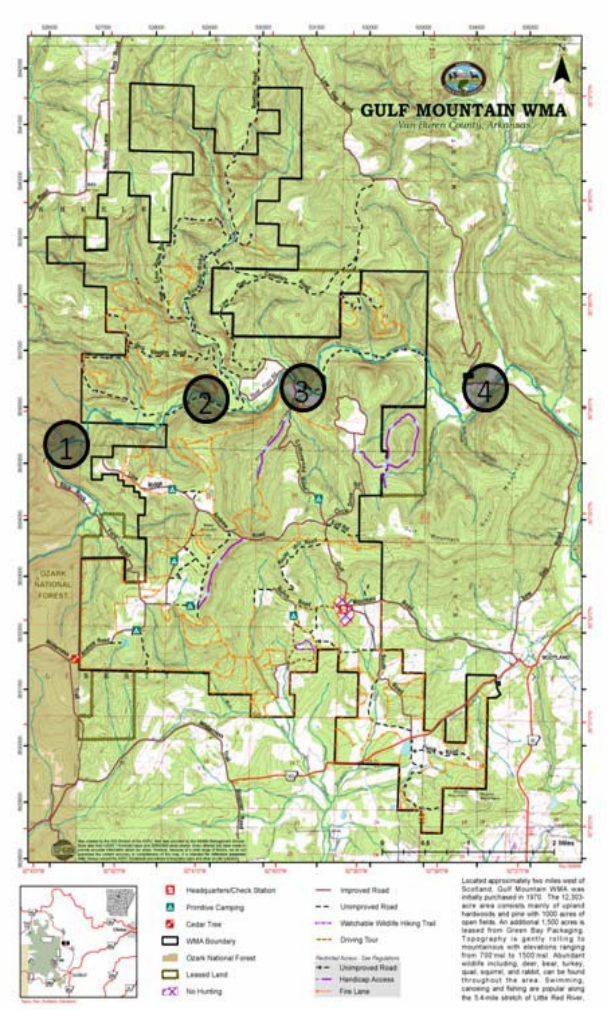


GPS coordinates for tributary sampling on Gulf Mountain.

Location	Creek	Latitude	Longitude
Off Gulf Mtn	Black Fork	35.25	-92.31
Off Gulf Mtn	Hogan/Cove	35.38	-92.46
Off Gulf Mtn	Sunnyside	35.39	-92.62
Gulf Mtn	High Cedar	35.59	-92.68
Gulf Mtn	Powerline	35.51	-92.65
Gulf Mtn	Dry Hollow	35.57	-92.66
Gulf Mtn	East Point	35.52	-92.67
Gulf Mtn	Low Cedar	35.57	-92.67
Gulf Mtn	Sis Hollow	35.59	-92.70
Gulf Mtn	Point Remove	35.52	-92.67

GCS_North_American_1983
Datum: D_North_American_1983

Appendix 4: Sampling locations on the South Fork of the Little Red River on Gulf Mountain Wildlife Management Area, Arkansas.



Appendix 5. Species of greatest conservation need in the South Fork Little Red River and tributaries.

Priority Score	**Common Name**	**Scientific name**
80	Speckled Pocketbook Mussel	*Lampsilis streckeri*
100	Yellowcheek Darter	*Etheostoma moorei*
Some invertebrates of conservation concern may be present in the intermittent streams, such as *Allocapnia* ssp., *Paucicalcaria*, and *Leuctra*.		