Evaluation and Monitoring of the Impacts of Development of the Fayetteville Shale on White-tailed Deer

Summary: Gas development is known to negatively affect wildlife species in the western U.S., but no assessments have been made of the impact of gas development on wildlife in the southern U.S. A paired plot design will be used to assess the impacts of gas development using white-tailed deer as the model species. We will assess the areas impacted using populations, not individuals, as the sampling units. The work will provide a model for monitoring the impacts of gas development for white-tailed deer and other species over time.

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Total amount of project cost:	$249,250
Total amount of SWG money requested:	$152,900
Amount and source of matching funds or in kind:	$ 96,350

Need

This pre-proposal addresses the evaluation and monitoring of the effects of the development of the Fayetteville Shale, an emerging issue. The Fayetteville Shale (hereafter the Shale) is an area much like other gas deposits found in the western U.S. in that the Shale is expected to contain large deposits of natural gas used to meet the nation's energy needs. Gas development in the western U.S. has been found to negatively affect several wildlife species (Sawyer et al. 2006, Doherty et al. 2008) and it is hypothesized that, given findings from research in the western U.S., wildlife species in Arkansas will respond in a similar fashion as the species in the western U.S. responded. An alternative hypothesis is that wildlife species in Arkansas will not be affected in the same manner as wildlife species in the western U.S. because of the differences in habitat structure and its affect on visibility and noise.

Like mule deer (*Odocoileus hemionus*) in the western U.S., white-tailed deer (*O. virginianus*) in Arkansas may serve as a model species. We propose to use white-tailed deer to examine the effects of gas development because it is a widely distributed species, is adaptable to altered environments, is of great economic importance, and is the most sought after game species in the state. White-tailed deer will provide a model species for evaluation and monitoring, may act as an umbrella species, and can provide for landscape scale mitigation or alternate management approaches if effects are found.

Mule deer have been found to avoid gas development sites. The result has been a reduction in the local populations and habitat use (Sawyer et al. 2006). Implications are that deer populations will decline in response to gas development. Because deer are generational learners regarding habitat use, areas affected will likely require an unknown period of time to be used again. Understanding how gas development affects local deer densities and habitat use is required for proper management in response to this landscape scale disturbance in Arkansas.

Objectives

1. We will test the effect of gas development on the local density of white-tailed deer.
2. We will test the effect of gas development on the local distribution of white-tailed deer.

Expected Results and Benefits

We expect a lower density of white-tailed deer on sites with gas development. We also expect the distribution to indicate avoidance of the development sites. Three overarching benefits will be provided by the work. The first benefit will be baseline data for the impacts over the long-term. The second benefit will be for management of the model species used, white-tailed deer. Knowing the density and distribution around the developed sites will allow managers to take steps to improve habitat around those sites and assess the efficacy of those efforts. Third, the work will provide a model for monitoring white-tailed deer and other species over time.

Approach

The potential for impact requires a definitive, population-based approach given that this disturbance is being applied at the landscape scale. We will use a paired design to determine the effect of gas development on white-tailed deer density and distribution. We will randomly select 5 developed sites, each of which represents an independent population, on which to collect density and distribution data. At least one of those sites will be the Gulf Mountain Wildlife Management Area. For each developed site selected we will randomly locate a paired site on which there is no development. Therefore, data will be collected at 10 sites within the Shale.

We will use modified methods of Kissell and Nimmo (In Press) to determine deer density and distribution on each site. Methods described by Kissell and Nimmo (In Press) use thermal imagery data collected from an aircraft. Flights will begin approximately one hour after sunset

and will be conducted over the same areas each winter (2011 and 2012). Data for a census will be collected on each site and sites will be surveyed three times each year to provide variation within sites as well as among sites. Surveys will be flown at each site using a Enstrom 280-FX helicopter at approximately 457 m above ground level and approximately 90 km/hr. Locations (latitude, longitude), flight paths, altitude, speed, date, and time will be recorded by an onboard global positioning system (GPS) unit and integrated into a geographic information system (GIS). Flight paths will be converted to a shapefile using ArcGIS to insure complete coverage. Flights will not be conducted under conditions that reduced detectability of deer or are not suitable for flying, such as heavy fog, rain, or wind.

Flight line spacing and GPS information minimizes the potential for double counting. Thermal signatures of deer will be identified by their unique shape and brightness relative to the background. Images containing thermal signatures of deer will be exported as 16-bit tagged information file format (TIFF) images. TIFF images will be geo-referenced using the encoded GPS data and transferred into a GIS.

Distance sampling data will be collected from TIFF images containing thermal signatures of deer following methods of Kissell and Nimmo (In Press). Deer density for each site will be estimated using program DISTANCE 6.0, version 2 (Buckland et al. 2001). Perpendicular distance data will be fit to uniform and half-normal key functions with no adjustments, and cosine, simple polynomial, and hermite polynomial adjustments. Minimum Akaike Information Criterion (AIC; Akaike 1973) values will be used to select the best model for each site.

We will use a paired t-test to determine if densities differ between developed and undeveloped sites. Differences in distributions between developed and undeveloped areas will be examined within populations and among populations. Within populations, the distribution of locations of deer will be compared to a random distribution. Among populations, we will use GIS to determine differences in distribution using distances from the developed and control areas with the developed area superimposed on the control area; a paired t-test will be used to quantify differences.

Location of Work

The work may be conducted across the area covered by the Fayetteville Shale (Figure 1). The exact extent of the Shale is not currently known, but has been estimated given exploration efforts and geology. The Shale covers at least 4000 mi^2 and covers portions of the Arkansas Valley, Boston Mountains, and Mississippi Alluvial Plain ecoregions. We will focus on the Gulf Mountain Wildlife Management Area.

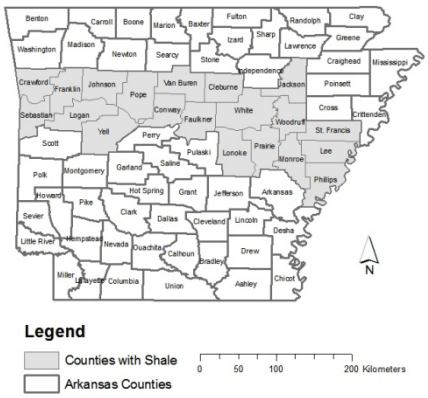

Figure 1. Counties known to contain the Fayetteville Shale.

Budget

The budget will be shared by AGFC and UAM (Table 1). The expected match of 35% will be met by UAM and Chesapeake Energy based on personnel costs. Other proposed costs will cover supplies, contracted services, travel, and publication. An indirect cost of 10% is included.

Table 1. Budget of the pre-proposal for the evaluation and monitoring of the impacts of development of the Fayetteville Shale on White-tailed Deer.

	Year 1		Year 2		Total	
	AGFC	UAM&CE	AGFC	UAM&CE	AGFC	UAM&CE
Personnel						
P.I.	0	20000		20000	0	40000
Technician	0	9375		9375	0	18750
GRA	0	18800		18800	0	37600
Contracted Services						
Flights	60000	0	60000	0	120000	0
Supplies	2000	0	2000	0	4000	0
Travel						
Mileage, Per Diem, & Lodging	5000	0	5000	0	10000	0
Meetings	0	0	3000	0	3000	0
Publication						
Peer-reviewed publication	0	0	2000	0	2000	0
Sub-total	67000	48175	72000	48175	139000	96350
In-direct costs (10%)	6700		7200		13900	
Total	73700	48175	79200	48175	152900	96350
Grand Total						249250

*We have conducted a cost analysis and it is cheaper to invest in the equipment than continually contract with outside companies. The cost of contracting with an outside company for only one year will pay for the cost of the equipment.

Literature Cited

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. - In: B. N. Petran and F. Csaaki (Eds.); International Symposium on Information Theory. Akadeemia, Kiadi, Budapest, 267-281.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. - Oxford University Press, Oxford, UK, 432 pp.

Doherty, K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187-195.

Kissell, Jr., R. E., and S. K. Nimmo. In Press. A Technique to Estimate White-tailed Deer Density Using Vertical-Looking Infrared Imagery. Wildlife Biology.

Sawyer, H., R. M. Nielson, F. Lindzey, and L. L. McDonald. 2006. Winter Habitat Selection of Mule Deer before and during Development of a Natural Gas Field. Journal of Wildlife Management 70:396-403.

Qualifications

Robert Kissell, holds a Ph.D. degree in Biological Sciences with an emphasis in Fish and Wildlife Management from Montana State University, Bozeman, an M.S. degree in Biology with an emphasis in Vertebrate Zoology from the University of Memphis, and a B.S. degree in Biology from Christian Brothers University.

Dr. Kissell is an Associate Professor with the School of Forest Resources, University of Arkansas at Monticello (UAM) and has served UAM for 8 years. Dr. Kissell has conducted extensive research that used thermal infrared videography for the purpose of estimating densities of deer and medium-sized mammals. Below are examples of that research.

Kissell, Jr., R. E., and S. K. Nimmo. In Press. A Technique to Estimate White-tailed Deer Density Using Vertical-Looking Infrared Imagery. Wildlife Biology.

Kidd, J. B., and **R. E. Kissell, Jr.** 2009. Relationships between Groundwater Level and Furbearer Abundance in the Northern Arkansas Mississippi Alluvial Valley. Ecohydrology 2:472-479.

Tappe, P. A., and **R. E. Kissell, Jr.** 2006. White-tailed deer density estimation using thermal infrared imaging. Advances in deer biology: deer in a changing world. Proceedings of the 6th International Deer Biology Congress 6:146-151.

Kissell, Jr., R. E., and P. A. Tappe. 2005. Response of an Arkansas white-tailed deer population to harvest. Journal of the Arkansas Academy of Science 59:209-212.

Kissell, Jr., R. E., and P. A. Tappe. 2004. An assessment of thermal infrared detection rates using white-tailed deer surrogates. Journal of the Arkansas Academy of Science 58:70-73.

Dr. Kissell has 8 years of experience in conducting studies such as the one in the pre-proposal. He has directed 2 graduate students addressing density-related questions using thermal infrared imagery. Dr. Kissell has a background in remote sensing, GIS, and GPS necessary to conduct the type of research at the landscape scale indicated in the pre-proposal. He has conducted research at the landscape scale in several species-habitat studies.

Dewayne Miller, holds a M.S. in Wildlife and Fisheries Ecology and a B.A. in Political Science from Oklahoma State University. He is a Certified Wildlife Biologist (CWB) through The Wildlife Society and is certified as a Professional Wetland Scientist (PWS) by the Society of Wetland Scientists.

Mr. Miller has over 15 years of experience in environmental and regulatory permitting and compliance. He has expertise in conducting white-tailed deer (WTD) browse surveys, habitat evaluations, FLIR surveys, spotlight surveys, camera census, maintaining buck to doe ratios and genetic culling on two trophy WTD ranches in TX., chemical immobilization of WTD, trapping, transporting, transplanting WTD, WTD heard health evaluation, and managing a captive WTD facility, and telemetry studies involving WTD.

Mr. Miller also has expertise in wetland services including delineation, permitting, mitigation, restoration, and enhancement and designing and implementing terrestrial wildlife and aquatic fishery surveys, lake and river bathymetric studies, habitat mapping, avian and mammal urveys, and developing and implementing lake and wildlife habitat management plans.

Mr. Miller has also developed and implemented wildlife management plans throughout the US. He has conducted pre-construction and post-construction monitoring including native habitat sampling and evaluation, trapping of nuisance wildlife, food plot production and assessments, chemical immobilization of WTD, elk, & Eurasian hogs, and management of wildlife areas.

Mr. Miller also has experience in preparing environmental permit applications and providing regulatory assistance, including permits under the Clean Water Act (CWA) and the Resource Conservation and Recovery Act (RCRA) and documentation under the National Environmental Policy Act (NEPA) including Environmental Impact Statements (EIS) and Environmental Resource Reports (ERR).