Effect of Partial and Complete Sounder Removal on Movements of Feral Hogs in Arkansas

Feral hog (*Sus scrofa*) populations are expanding in Arkansas and having negative impacts on native ecosystems, plant and animal communities, the agricultural community, as well as conservationists and sportsmen. The effects of removal of portions of hog sounders on movements have been examined in one other state in the southeastern US, but no work has been conducted in Arkansas or on the effects of complete sounder removal. The work that has been conducted suggests that there is a threshold of the number of animals removed that exists before sounders will make use of areas once occupied by other sounders. We propose to determine the effect of removing portions of and all members of sounders on adjacent sounder movements. This study will provide insight into the effort required to effectively remove sounders, how the landscape will be impacted by remaining sounders, and the scale at which sounder removal efforts may need to be focused in order to be successful at eradicating this invasive species.

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Budget-Values given are estimated.

35%-65%	Match	SWG	Total	50%-50%	Match	SWG	Total
Salary and Fringe	78858	43328	122186		100522	21664	122186
Travel		30000	30000			30000	30000
Equipment/Supplies		51000	51000			51000	51000
Publication		1000	1000			1000	1000
Indirect Savings	30705		26785		25398		25398
Sub-total	109563	125328	234891		125920	103664	229584
Indirect		21932	21932			18141	18141
Total	109563	147260	256823		125920	121805	247725

Need: This project will address two of the priorities; one is in the emerging issues and the other is in the habitats. The Emerging Issue this work will address is Invasive Species. The Habitats to be addressed are the Woodlands and Wetlands. The invasive species is feral hogs (*Sus scrofa*) and we propose to assess the response of this species to various levels of eradication in woodlands and wetlands. The proposed work will have an impact, at minimum, on those species of greatest conservation need that occupy woodlands and wetlands and that have a portion of their niche in the understory.

Feral hog populations are expanding throughout many areas of the United States (Gipson and Lee 1999). Negative impacts of feral hogs on native ecosystems (Engeman et al. 2003), water quality (Kaller et al. 2007), and other animal or plant populations (Seward et al. 2004) have been documented. Research has also documented the capacity of feral swine to cause extensive and expensive agricultural damage through rooting and wallowing activities (Pimental et al. 2005) and transmit diseases such as swine brucellosis (*Brucella suis*) and pseudorabies (Hartin et al. 2007). For these reasons and others, many state and federal agencies, conservation organizations, and private landowners have been compelled to implement removal strategies to control hog populations and alleviate their negative ecological and economic impacts. Currently, many wildlife agencies and landowners implement feral hog population control by shooting or trapping; however, it is not clear how efficient management efforts are, in part because feral hog distributions and movement patterns are unknown.

There has been little work that has examined the effect of eradication efforts on feral hogs and their movements following those efforts (Sparklin et al. 2009). Sparklin et al. (2009) found eradication efforts kept densities stable, but did not remove all individuals in a sounder. They suggested that eradication efforts should match the spatial distribution of territories, include removal of entire sounders, and focus on high-quality food resources to maximize efforts. Their work noted that adjacent sounders would take over a territory when a given proportion of individuals in an adjacent sounder were removed. The relationship they described suggested a weak density dependent relationship between territory size and density. Given these findings, it is important to assess any eradication effort using both a method of tracking movements and a method of estimating population size.

Location: The study will be conducted in eastern Arkansas on private and public lands within the Mississippi Alluvial Valley ecoregion. Land use is predominately agricultural, and major crops include rice, soybeans, wheat, and cotton. The majority of remaining forests in eastern Arkansas are bottomland hardwood forests. In southeastern Arkansas, land is primarily private industrial forests dominated by *Pinus taeda* (loblolly pine), with some forests consisting of mixed pines and hardwoods.

Objectives: The objectives of this study are to: 1) determine the effect of complete sounder removal on movements of adjacent sounders; 2) determine the effect of partial sounder removal on movements of adjacent sounders; and, 3) assess the relationship between population size and territory size of sounders.

Approach: A completely randomized design will be used to assess the effect of eradication efforts on movements and density-territory size relationships. Sounders will be the experimental unit, the treatment will be eradication (complete, partial, and control), and the responses will be movements, territory size, and density. Each treatment will be replicated three times.

Treatments will be based on pairs of adjacent sounders. One sounder of each pair will be randomly chosen to receive a treatment. Data will be collected from the other sounder in the pair.

Corral live traps will be set in areas where known hog activity is occurring. Traps will be baited with corn fermented in a solution of sugar, yeast, and strawberry gelatin andwill be checked daily. Trapping will occur in spring and summer. Captured hogs will be anesthetized to be fitted with radio-collars. One adult, female hog in each sounder will be fitted with a GPS/VHF radio-collar equipped with a 4-hr delay mortality sensor; collars will weigh< 5% of the body weight (Cochran 1980). Each hog captured will received a numbered ear tag in each ear (Seber 1982). Anesthetized hogs will be allowed to recover from sedation and released at the site of capture. Capture, handling, and release of hogs will be performed following guidelines of the American Society of Mammalogists (Gannon et al. 2007) and will be approved by the University of Arkansas at Monticello Institutional Animal Care and Use Committee.

Telemetry, home ranges, and movements: Collection of locations will began approximately 48 hr postcapture to allow for recovery from the stress of capture. Collared hogs will be located every 5 hrs for the study duration, until death, or until transmitter failure. We will use calendar seasons to determine home range sizes and movements.

Using Home Range Tools (Rodgers et al. 2007) for ArcGIS (ESRI, Redlands, CA, USA), fixed kernel estimates (50% and 95% contours; Seaman and Powell 1996, Seaman et al. 1999, Kernohan et al. 2001) will be calculated using the ad hoc bandwidth method (Schroeder 2007). Fixed kernel (95%) home range size estimates using LSCV and minimum convex polygon (MCP) estimates will be also determined to compare results with other feral hog studies. The mean distance moved each season and each month by individual hog sounders will be determined using Hawth's Analysis Tools for ArcGIS (Beyer 2004). Home ranges and movements will be estimated for the first year and treatments applied at the beginning of the second year.

Treatments: One sounder from each pair will be randomly selected to receive a treatment. Those sounders to receive the complete and partial eradication treatments will be captured in corral traps and dispatched using either a bolt-gun or a firearm discharged into the cranium (Gannon et al. 2007).

Population Estimation and Phylogeographical Analysis: Locher et al. (2011) designed, tested, and provided a non-invasive technique for surveying feral hog populations. They used hair-snares to collect hair samples for the purpose of establishing presence at a location. They provided predictive models based on hog presence and landscape metrics using the hair-snare technique and spatial modeling. Their work provided a basis for future examination of the impacts of removal efforts and a method of acquiring DNA for identifying individuals in a population. We will use methods similar to Locher et al. 2011 to collect hair samples for DNA analysis. Use of DNA analysis will provide hog population structure, movement patterns, and whether hogs are from a local sounder. Using these hair samples, we will extract total DNA using standard protocols (Sambrook et al. 1989). Then using primer sequences established for hogs (Larson et. al. 2005, Watanobe et.al. 2003), we will amplify and sequence mitochondrial DNA (mtDNA). The partial sequences will be aligned using a Maximum likelihood analysis conducted with RAxML version 7.2.1 (Stamatakis, 2006; Stamatakis et al., 2005) and distances

will be calculated between sequence in the alignment and a dendrogram will be constructed. Simultaneously, we will use currently available single nucleotide polymorphisms (SNPs) (Amaral et al. 2009) in the sampled DNA to distinguish individuals with family groups. Distances will also be calculated among the locations of the samples and this data will be assessed for correlations with the mtDNA dendrogram. These correlations will give an indication of the genetic diversity within and between sounders and migration within Arkansas resulting in, for the first time, a phylogeographical map of the hog population in Arkansas.

Expected Results and Benefits: We expect sounders to demonstrate proportional responses to the treatments. We also expect territories to respond inversely to reduced densities. We further expect to determine the spacing patterns of sounders so that removal efforts can be appropriately applied where hogs are problematic. A list of SGCN include, but is not limited to any mammals, ground nesting-birds, insects, invertebrates that occur adjacent to streams, fishes and amphibians that occur in small streams that occur in the Mississippi Alluvial Plain or West Gulf Plain ecoregions.

Budget

	YR 1		YR 2				
	UAM/ GVSU	SWG	UAM/ GVSU	SWG	Total UAM	Total SWG	Total
PI	7162		7162		14324	0	14324
Fringe	2256		2256		4512	0	4512
PI	7162		7162		14324	0	14324
Fringe	2256		2256		4512	0	4512
PI	5500		5500		11000	0	11000
Fringe	2100		2100		4200	0	4200
PT	10080		10080		20160	0	20160
Fringe	2913		2913		5826	0	5826
GRA1		20000		20000	0	40000	40000
Fringe		1664		1664	0	3328	3328
Travel		15000		15000	0	30000	30000
Equipment/Supplies		43500		7500	0	51000	51000
Publication				1000	0	1000	1000
Indirect Savings	19640		11065		30705	0	30705
Sub-total	59069	80164	50494	45164	109563	125328	234891
Indirect		14029		7904		21933	21933
Total	59069	94193	50494	53068	109563	147261	256824

Dr. Robert E. Kissell, Jr. is an Associate Professor in the School of Forest Resources at the University of Arkansas at Monticello. He has experience conducting telemetry-based research on large and medium-sized mammals, modeling resource selection based on telemetry data, and estimating population size using various techniques. Robert recently completed a project, in collaboration with Dr. Locher (see below), investigating the efficacy of hog detection methods; results from that work were used, in part, as a basis for this proposal. Two of his most recent publications addressed population estimation of white-tailed deer and resource selection by swamp rabbits; results from both were published in international journals.

Dr. Joshua P. Adams has seven years of experience in a laboratory setting with the isolation and analysis of genomic information from organisms. He also has extensive experience with the bioinformatic aspects needed for completion of this project including both sequence analysis and phylogenetic construction. He has gone through focused training sessions in the bioinformatics field by completing the Mississippi State University Computational Biology Certificate Program and the Bioinformatics and Computational Systems Biology Summer Institute at Iowa State University. Two key citations demonstrating his capacity for this work include:
Hsu, C-Y., **Adams, J.P.**, Kim, H., No, K., Ma, C., Strauss, S.H., Drnevich, J., Vandervelde, L., Ellis, J.D., Rice, B.M., Wickett, N., Gunter, L.E., Tuskan, G.A., Brunner, A.M., Page, G.P., Barakat, A., Carlson, J.E., dePamphilis, C., Luthe, D.S., and Yuceer, C. 2011. *FT* duplication coordinates reproductive and vegetative growth in perennial poplar. Proceedings of the National Academy of Sciences. 108(26):10756-10761.
Adams, J.P., A. Adeli, C-Y Hsu, R. Harkess, G. Page, C. dePamphilis, E. Schultz, and C. Yuceer. 2011. Poplar maintains zinc homeostasis with heavy metal genes *HMA4* and *PCS1*. Journal of Experimental Botany. 62(11):3737-3752.

Dr. Alexandra (Ali) Locher is an Assistant Professor in the Natural Resources Management Program in the Biology Department at Grand Valley State University. She has experience with spatial modeling of wildlife habitat and populations and wildlife responses to management activities. Her most recent research publications have been published in the *Northern* and *Southern Journals of Applied Forestry*, *Forest Ecology and Management*, and the *Journal of Wildlife Management*. Ali recently completed a project through the University of Arkansas at Monticello investigating the efficacy of hog detection methods. Results were used, in part, to design this study. Ali will contribute to this research project by assisting with the overall study and field sampling design, providing assistance with hog surveys and capture, provide input on the development of spatial models, and contribute to drafting materials for the final reports and deliverables.