Title of Project:
Effects of large-scale habitat manipulation on forest and food chain health in an Ozark Mountain ecosystem.

Summary:
Understanding the responses of organisms to forest management practices is an urgent goal for conservation, and restoration ecology. The AGFC applied large-scale forest manipulations (cut and burn) in an effort to enhance forest quality for wildlife. We propose to extend our NSF-supported research by continuing to monitor plant and animal responses at manipulated and control sites on the Madison Co WMA. With cooperators, our research has currently produced four years of data (2 pre, 1 transitional, 1 post), which will be enhanced by this proposal.

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Project partners: Arkansas Game and Fish Commission (AGFC: Martin Blaney, Carrie McQueen, Bob Wilson, Ray Wiggs), Arkansas Natural Heritage Commission, (ANHC: Douglas Fletcher), Ozark Natural Science Center (ONSC: Jenny Harmon, Jason Kindall).

Total Project Cost (2 years): $267594

Total Funds Requested from SWG (2 years): $131146 (including 10% indirect on SWG total)

Amount and source of matching funds or inkind services: $136448 in Salaries, fringe benefits, equipment and supplies from UA-Fayetteville.

Funding priority.
Our proposed work directly addresses the Arkansas Fire and Forest Ecology Initiative, and in particular, habitat management and fire restoration of terrestrial oak woodland and glade habitats. Understanding the responses of organisms to forest management practices (including thinning, clear cutting, and applications of fire) is an urgent goal for conservation, and restoration ecology. Public opinion often runs against aggressive management practices (cutting and burning) usually in the absence of information or hard data. Needed are carefully designed studies that assess the impact of forest management practices on plant production and animal food chains. We propose to continue monitoring manipulated habitats in Madison County as responses evolve over time, thus, extending National Science Foundation funded work and cooperation (with AGFC, ANHC, and ONSC) that established the project. Extended monitoring will enable us to observe changes that take more than one or two growing seasons to become established. For slow-growing organisms, including snakes, trees, and many game animals, results are expected to take several growing seasons to manifest.

Study location. This study is being conducted in terrestrial hardwood forests at the Ozark Natural Science Center (ONSC), Bear Hollow Natural Area (BHNA, owned by the Arkansas Natural Heritage Commission), and the McIlroy Madison County Wildlife Management Area (MMCWMA) in Madison County, Northwest Arkansas. Cut and burned plots on the MMCWMA are compared to control plots on the MMCWMA and BHNA. This research site has been the focus of 14 years of work on the biology of the Timber Rattlesnake by the project leader.

Conservation Priority. Upland oak ecosystems throughout the Midwest have been severely degraded over the last century. These systems were maintained over 5,000 years ago by Native American‘s use of periodic fires and harvesting (Batek et al. 1999; Spetich 2002). Aggressive harvesting followed by more than 80 years of fire suppression has dramatically altered species dynamics, causing an increase in recruitment of shade tolerant species such as red maple (*Acer rubrum*) while once dominant oaks and hickories have low establishment rates (Spetich 2002). The system has become an even-aged, closed-canopy forest, with relatively little herbaceous understory growth with animal populations dependent on unpredictable acorn mast as a food source, further exacerbating the problem of low oak recruitment (Spetich 2002).

The MMCWMA (along with most of the Ozarks) exhibits all of these degraded forest characteristics. Habitat at the site is a secondary growth of predominantly even-aged oak forest. Trunk and stem density is high and ground-level food input for wildlife is dominated by acorn mast. Such mast crop dependence results in periodic starvation of important predators (e.g. rattlesnakes: Beaupre 2008)) and fluctuations in mammal populations because of erratic food input. The AGFC has applied thinning, clear cutting and fire in an effort to restore forests to their disturbance-dependent condition and to improve the availability of ground-level food and shelter for wildlife species. The AGFC aims to increase the openness of the understory and enhance the biodiversity of seed- and fruit-bearing herbaceous plants at ground level. It is hoped that this manipulation will enhance oak recruitment and significantly increase ground-level food input to reduce the mast-dependent nature of wildlife populations.

Project Background. The AGFC’s goal for habitat manipulations was to restore two communities: the first, dominated by shortleaf pine (*Pinus echinata*) with mixed oak species and herbaceous growth, and the second consisting of an herbaceous understory approximating an oak savannah, with post oak (*Quercus stellata*), white oak (*Quercus alba*), black oak (*Quercus velutina*), and black hickory (*Carya texana*). Towards this end, the AGFC has applied three experimental treatments (cutting, burning, and both cutting and burning: completed in March 2008) in selected areas of the MMCWMA. Prior to the manipulations, we selected plots (based on topographic, soil and plant community similarity, ranging in size from 5 to 18 hectares) on the MMCWMA and in BHNA to serve as replicates representing all four possible combinations of these two applied treatments (control, cut but not burned, burned but not cut, and cut and burned). These plots were monitored for two years prior to manipulation. No pre-treatment differences in

soil, vegetation, or small mammal populations were detected between treatment and control plots. Experimental plots were cut in summer 2007, and burns were applied the following spring (March of 2008). Since the manipulations, we have monitored 13 plots (4 control, 3 cut but not burned, 3 burned but not cut, and 3 cut and burned). We have used the AGFC manipulation as an opportunity to evaluate the multi trophic level effects of forest management practices on the Ozark hardwood ecosystem with pre-treatment data and replication. Our cooperation with the AGFC afforded a unique opportunity for research involvement at multiple stages of manipulation. Knowledge of planned manipulations prior to their initiation has ensured that sufficient background data (two years of pre-manipulation baseline data, and one year of data during the manipulations) have been collected to enable comparisons among the sites under previous management techniques. With knowledge of the uniqueness of this research opportunity, we applied for, and successfully obtained, support from the National Science Foundation to initiate the first three years of the research (monitoring during the transitional year, and two post-treatment years). At the close of current NSF funding (Spring 2010), we will have accumulated two full years of post-treatment monitoring. After two years, we expect that the system will still be in transition to the desired communities, thus, we request two additional years (2010, 2011) of funding from SWG to extend post-manipulation monitoring to four years. Dynamic effects of forest manipulation may take years to resolve. Our NSF-funding established the study, and allowed us to measure short term-effects of the manipulations. However, the system is still in transition. Extension of the study will allow us to better assess medium-range effects of large-scale habitat manipulations on vegetation and an animal food chain.

Specific Goals. Our project is focused on the response of primary productivity (plant diversity and density) and an animal food chain (small mammal consumers and their Timber rattlesnake predators) to habitat manipulations. We propose to continue monitoring primary productivity, small mammal populations, and rattlesnake bioenergetic indicators (body condition, growth) in response to AGFC habitat manipulations. Specifically, we will test the following hypotheses:

Hypothesis 1.1: Cutting and burning will result in increased plant density and diversity, especially among herbaceous plants.

Hypothesis 1.2: Small mammal populations will increase in response to improved habitat or food availability on manipulated plots.

Hypothesis 1.3: Rattlesnakes utilizing plots with higher food availability will exhibit improved energetic indicators such as body condition, and increased growth rates.

Treatment-related improvements in the seed–small mammal-rattlesnake food chain are directly applicable to species of general concern by the AGFC and Arkansas Sportsmen (including turkey, quail, squirrels, deer, and other fur-bearers). We are using this rather simple food chain as an index of improvements in habitat quality that will apply broadly to species that feed in the oak forest ecosystem.

Methods. Post-treatment changes in vegetation coverage are monitored using quadrat sampling (3 times per plot per year between May and August). Seed availability is monitored using seed trapping methods (seed traps open from August to February, contents totaled weekly during peak seed fall). We specifically involve students and staff at the Ozark Natural Science Center in seed trapping surveys, thus bringing our science directly into classrooms of NW Arkansas. Responses of small mammal populations are measured with established and reliable small mammal trapping methods. We conduct two small mammal surveys per year (spring, fall), consisting of five trapping nights during each survey at all 13 monitored plots. Using radio telemetry, we monitor body temperatures, habitat use, use of manipulated sites, feeding, body condition, growth rate, and field metabolic rates of snakes for comparison by established statistical techniques (e.g. Beaupre 2008).

Products and Outcomes. This project will result in several publications in the primary literature, specifically aimed at assessing the use of cutting and burning for habitat restoration. Although such habitat management strategies are widely employed, careful studies of their medium to long range effects at multiple trophic levels are few. In addition, we will assess the novel use of bioenergetic responses of a top predator (the Timber Rattlesnake) as an indicator of habitat robustness. Specifically, we will test easily measured bioenergetic variables (growth, body condition) of a predator as indicators of change in primary consumers and producers. The work will provide a critical assessment of the effectiveness of competing strategies for improving forest quality. Information obtained will be of direct relevance to improving the outdoor experience of the citizens of Arkansas, both naturalists and sportsmen. Furthermore, results of this study may provide valuable information to the public that will facilitate more aggressive management strategies should they indeed prove effective. The proposal pursues tangible educational impacts by facilitating direct involvement of thousands of 5th grade students at the Ozark Natural Science Center in seed-fall surveys. The work will also strengthen research ties and cooperation between the University of Arkansas, the AGFC, the Arkansas Natural Heritage Commission and the ONSC.

Use of existing resources. The proposed work builds directly upon 14 years of research on Timber Rattlesnake behavior, physiology and ecology at the MMCWMA funded by the University of Arkansas, the State of Arkansas, and the National Science Foundation. The project piggybacks on an existing AGFC initiative to improve forest quality for wildlife. We have developed a cooperative relationship with the AGFC, the ANHC, and the ONSC for mutual benefit. Our initial funding from the National Science Foundation will expire in Spring 2010, after the collection of only two complete years of post-manipulation data. SWG support, will build on the NSF funds that initiated this research. The required equipment, collaborations, and manipulations are all in place. Methods for monitoring have been completely developed. Because we have already produced results in this system (based on two years of pre-treatment data and two years of post treatment data) we are confident of a very high probability of completing the study successfully. To leverage past federal funding, existing cooperative relationships, existing research equipment and personnel, I request two years of funding from the State Wildlife Grants program to continue this study. The window of opportunity is immediate and will most likely pass without State support.

Proposed total budget. (Project duration 2 years: Jan 1, 2010 – Dec 31, 2011)

Source	Salary/Benefits	Operating	Capital	Indirect	Total
SWG	$86060	$33164	$0	11922	$131146
UA-Fayetteville	$72048	$0	$64400		$136448
Total					$267594

Budget Justification: This preliminary budget requests salaries, tuition, and fringe benefits for two graduate assistants for two years, operating costs that include vehicle mileage, transmitter refurbishment, and equipment maintenance, and 10% indirect cost from SWG. The match from UA Fayetteville includes 25% of two years of project leader salary and fringe benefits, plus capital equipment and supplies including data loggers and related peripherals, radio-transmitters, telemetry receivers, mammal traps, and GPS units. The preliminary budget is based on good faith interpretation of the meaning of call for proposals regarding calculation of indirect cost and qualifications of in-kind matching contributions, and is flexible subject to clarification from the SWG program.

STEVEN J. BEAUPRE

Education:
Ph.D. **The University of Pennsylvania**, Philadelphia, 1993. Major fields: Ecology and Evolutionary Biology.
M.S. **The University of Wisconsin**, Madison, 1987. Major field: Biophysical Ecology.
B.S. **The University of Wisconsin**, Madison, 1982. Major field: Zoology

Academic Positions:
Vice Chair, Department of Biology, University of Arkansas (August 2008 – present)
Professor of Biology, University of Arkansas, (July 2006 - present)
Director, U of Arkansas Stable Isotope Laboratory, University of Arkansas (July 2002 - present)
Associate Professor of Biology, University of Arkansas, Fayetteville (July 2001 - June 2006)
Assistant Professor of Biology, University of Arkansas, Fayetteville (August 1995 - July 2001)

Research Grants: $943106 (for ecophysiology and the timber rattlesnake in NW Arkansas)
Infrastructure Grants: $2147339 (for people and equipment at UA Fayetteville)
Publications: 34 articles and book chapters since 1993.
Invited Talks and Lectures: 45 since 1994.
Meeting Presentations: 34 Since 1992.
Public Outreach: 77 talks, events, media interviews or documentaries since 1995.
Students: Five Ph.D. and four M.S. students produced at UA, Fayetteville since 1995. Currently, six Ph.D. students in progress.