COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 08-1

NSF 08-564 **11/21/08**

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

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NSF PROPOSAL NUMBER

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☐ SMALL BUSINESS ☐ MINORITY BUSINESS
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☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **DISERTATION RESEARCH: Effects of global climate change, loss of mega-herbivore biodiversity, and altered fire regimes on savanna grassland ecosystems**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 14,860	24 months	05/01/09	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
PHS Animal Welfare Assurance Number ________
☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________
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☒ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
SF
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

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Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 08-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution’s expenditure of any funds under the award, in accordance with the institution’s conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

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By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

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(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

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Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ‘‘Disclosure of Lobbying Activities,’’ in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

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By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

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Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

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(2) building (and any related equipment) is covered by adequate flood insurance.

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(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
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Project Summary

Intellectual Merit: Humans are altering the environment locally and globally through climate and land use change. Global temperature is increasing, precipitation patterns are becoming more variable, disturbance regimes are being altered, and ecosystems are being simplified as multi-species communities are replaced by monocultures of crops or livestock. Grasslands, which cover approximately one third of the terrestrial lands, are ecologically and economically significant, thus their responses to environmental change will have dramatic consequences for global patterns of productivity, biodiversity, and food production. This dissertation research investigates how changes in these three main drivers of mesic grassland ecosystems – precipitation, grazing, and fire - interact to affect community composition, structure, and dynamics.

Currently this dissertation research investigates the interactive effects of (1) grazing and fire, and (2) grazing and precipitation on plant community structure in North American (NA – Konza Prairie, KS) and South African (SA – Kruger National Park) savanna grasslands. Funding from NSF will significantly enhance this dissertation by aiding in the addition of two experiments. The first experiment will investigate the interactive effects of all three drivers – grazing, fire, and precipitation – on plant community structure in NA and SA. The second proposed experiment will assess how small-scale patch structure and dynamics in SA grasslands respond to fire along a grazing utilization gradient. Preliminary results show that grass patch structure has no relationship to forb richness or cover, yet higher plant species diversity is found in more heavily grazed areas in both NA and SA. The second experiment will provide information that will help tease apart how fire and grazing intensity alter grass-forb interactions in SA. Little is known about how climate, fire, and grazing interact to affect community properties especially in SA. The current and proposed research will illuminate processes affecting community structure in mesic savanna grasslands that are predicted to experience more extreme droughts, altered fire regimes, and loss of herbivore diversity.

Broader Impacts: This research will investigate the interactive effects of environmental change in savanna grasslands in NA and SA. The comparative approach will greatly enhance the ecological generality of my findings. Based on similar experimental designs and identical sampling protocols in both NA and SA, this research will provide a rigorous assessment of the cumulative effects of long-term fire and grazing regimes, as well as responses to short-term manipulations of herbivores and climate on grassland structure and function. Ultimately this understanding will allow the improvement of savanna grassland models that include fire, grazing, and climate effects on community processes and help further the understanding of how future climate scenarios may impact mesic savanna grassland ecosystems.

This research is directly applicable to the management of biodiversity in the tallgrass prairie in NA as well as in one of the world's premier national parks. Kruger National Park is home to much of the world's remaining charismatic mega-fauna and is a world leader in scientifically-based management practices and policies. This research has and will continue to facilitate work with Kruger National Park management, staff, and scientific community, and by working and travelling in this world renowned area I will gain a unique international experience and form valuable associations within a global ecological community.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Interactive effects of global climate change, loss of mega-herbivore biodiversity, and altered fire regimes on savanna grassland ecosystems

Humans are altering the environment on local and global scales through climate and land use change. In recent years, terrestrial ecosystem responses to anthropogenic global change have become an important societal concern and a focus of intense scientific research (Mooney 1991, Sala et al. 2000, Weltzin 2003). Humans are changing regional and global temperature and precipitation patterns, modifying community composition of ecosystems by replacing multi-species communities with single species monocultures and altering natural disturbance regimes. **For my dissertation, I am investigating how these three factors – climate change, loss of grazing, and altered disturbance regimes – interact to affect plant community composition in savanna grasslands in North America (NA) and South Africa (SA).**

Savanna grasslands cover approximately 36% of the terrestrial land surface (Sala 2001), sequester significant amounts of soil C, house the majority of the world's remaining megafauna, and are economically important as grazing lands (Owen-Smith 1988; Schimel et al. 1994; Allen-Diaz 1996; Fuhlendorf & Engle 2001). I conduct my research in two savanna grassland ecosystems: Kruger National Park (Kruger), in northeastern South Africa, and Konza Prairie Biological Station (Konza) in northeastern Kansas, USA. Grassland ecosystems in these two regions differ in soil nutrient levels (high in NA, low in SA; Scholes et al. 2003a,b), climate (temperate in NA, sub-tropical in SA), and large herbivore species richness (low in NA, high in SA), but they also share many similarities. Most importantly, precipitation, grazing, and fire are the key drivers that maintain these grassland ecosystems (Frank et al. 1998; Bond et al. 2003).

Climate models predict that precipitation regimes are likely to become more variable in the future, including more extreme and prolonged droughts across seasons and fewer but more intense rainfall events within seasons (Gordon et al. 1992, Easterling et al. 2000, Houghton et al. 2001, IPCC 2007,). Such changes have already been documented, but the potential ecological consequences of increased precipitation variability have received much less attention than the effects of elevated CO_2 and temperature (Knapp et al. 2008). Mid-continental areas, where many mesic savanna grasslands occur, are expected to become drier during the growing season with an increased chance of prolonged drought (Wetherald & Manabe 1999, Kothavala 1999) particularly in central and southeastern North America and tropical Africa (Zwiers & Kharin 1998). Grasslands should be especially susceptible to changes in both rainfall amount and variability as they are largely precipitation limited under existing climatic conditions (Sala et al. 1988, Esser 1992, Knapp et al. 2001). Grassland responses to changes in rainfall patterns may have significant consequences for global patterns of productivity and diversity under future climate scenarios (Fay et al. 2003).

Large herbivores increase diversity and patchiness in mesic grasslands by increasing resource heterogeneity and altering plant community structure through grazing selectivity, soil disturbances, and nutrient deposition. Herbivores have significant effects on primary production particularly in grasslands that support large herds of grazers (Frank & Groffman 1998). In several grassland ecosystems, grazing has been shown to have a stimulating effect on plant production (McNaughton 1976, Pandey & Singh 1992, Loeser et al. 2004). This facilitation occurs because grazing increases the availability of light, water, and or nitrogen to plants (McNaughton 1985, Frank & Groffman 1998, Knapp et al. 1998). Light to moderate grazing also increases plant species richness (Collins 1987; Hartnett et al. 1996). The loss of dominant herbivores from grassland ecosystems in NA has been shown to decrease plant species richness and diversity, and the effects of losing the remaining megafauna species are well understood. However, in SA, where the large herbivore community is still extant, the impacts of herbivore species loss are still emerging (Milchunas & Lauenroth 1993, Anderson et al. 2007a).

Fire, unlike herbivory, tends to be a generalist consumer (Bond & Keeley 2005), homogenizing resources (Blair 1997) and plant communities (Collins 1992, Collins & Smith 2006) and is a broad scale disturbance. Fire increases biomass production by stimulating growth, removing moribund material, and increasing light interception. It changes community structure by uniformly removing aboveground biomass, promoting fire-tolerant species, and preventing growth of woody vegetation (Briggs et al. 2005).

Independently, fire and grazing have opposite effects on community composition, but together grazing and fire can increase plant species diversity and community heterogeneity. In a NA savanna grassland, Collins & Smith (2006) found that the interactive effects of grazing and fire change with the scale of measurement, but that separately grazing and fire effects are not scale dependent. At the 10 m^2 scale grazing increased heterogeneity in annually burned sites but decreased heterogeneity in unburned sites. At the 50 m^2 scale, grazing decreased heterogeneity at intermediate fire frequencies and had no effect at other fire frequencies. Grazing and fire frequency also interact on a landscape scale through positive and negative feedbacks (Fuhlendorf & Engle 2001). Herbivores alter fire frequency by removing aboveground biomass and, therefore, decreasing the fuel load, while fires modify herbivore density by altering plant chemistry in a way that attracts herbivores and by removing biomass that could otherwise be consumed by herbivores (Fuhlendorf & Engle 2004).

Much research is being done on the effects of climate change on grassland biodiversity, yet little is known about the interaction between climate variation and grazing or fire. Through my dissertation I will **determine the interactive effects of climate change, large herbivore diversity loss, and altered fire regimes on plant community structure in savanna grasslands (Figure 1).** I will take advantage of an existing cross-continental study to determine the degree to which mechanisms controlling diversity and dynamics in NA savanna grasslands apply to SA systems, and *vice versa* (Knapp et al. 2004).

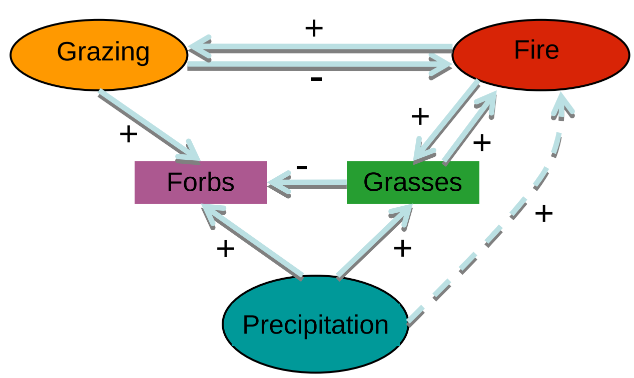

Figure 1. Conceptual diagram of the key drivers and interactions in grassland ecosystems

In NA, mesic grasslands are typically dominated by a small number of C_4 grasses whereas plant species diversity is generally a function of the number of common and rare forb species (Collins & Glenn 1991). Grass abundance is negatively correlated with forb richness (Hartnett et al. 1998). In many cases, fire increases grass abundance and reduces forb diversity whereas grazing reduces grass abundance and increases plant species diversity (Collins & Smith 2006). This interplay between fire and grazing determines grassland species diversity in NA systems, but the extent to which these rules apply in comparable systems in SA where there is a long evolutionary history of grazing and a more diverse herbivore fauna than in NA is unknown, as are the effects of prolonged drought on the impacts of fire and grazing. To understand these interactive effects my **current dissertation research** has three main components.

Experiment #1: Observational study of grassland patch structure and forb diversity

Background & Questions: This observational study was designed to determine the effects of fire and grazing on small-scale patch structure and dynamics in savanna grassland communities. My main questions are: What is the patch structure of each of the dominant grasses in NA and SA? Is patch structure similar in response to fire and grazing in NA and SA? Is forb richness related to grass patch structure? I will also determine the effects of patch forming processes by dominant C_4 perennial grasses and how those processes impact forb species richness and abundance. When measured comparably, I predict that patch structure and dynamics will respond similarly to grazing and fire in NA and SA. The findings from this study will have implications for generalizing across ecosystems with similar physiognomy and drivers.

Methods: Patch composition and structure are being measured in long-term fire and grazing experiments in Kruger and Konza. In December 2006, I established vegetation transects in areas with the following fire and grazing manipulations near Satara in the central area of Kruger: (1) ungrazed, unburned; (2) single grazer (Cape buffalo), unburned; (3) single grazer (Cape buffalo), annually burned; (4) grazed by multiple herbivores, unburned; (5) grazed by multiple herbivores, annually burned. This design allows me to assess the independent and combined effects of fire and herbivore diversity on patch composition and structure in SA savanna grasslands. To measure patch structure and forb richness, I established three parallel transects of 128 0.25m^2 contiguous quadrats at each site. Transects were 100 m apart and oriented from north to south, on nearly level ground. Cover of each plant species rooted in each quadrat was visually estimated in January and March of 2007 and 2008.

At Konza Prairie, replicate watersheds are burned at 1-, 2-, 4- and 20-year intervals (Knapp et al. 1998). A subset of these watersheds has been grazed by bison since 1987. Within this large-scale, ongoing experiment, I used transects similar to those in Kruger to sample vegetation in four watersheds: (1) unburned, ungrazed; (2) annually burned, ungrazed; (3) single grazer (bison), unburned; (4) single grazer (bison), annually burned. Cover of each plant species rooted in each quadrat was visually estimated in June and August of 2007 and 2008. This design allows me to compare the impacts of fire frequency and grazing by a comparable herbivore in NA (bison) and SA (Cape buffalo). It also allows me to determine how decreased herbivore diversity affects grassland structure and dynamics in SA grazing systems, a phenomenon that affected NA grasslands around 12,000 years ago (Axelrod 1985).

Preliminary results: At Konza, grazing increased total species richness at the 0.25m^2 scale in both burned and unburned grassland (Figure 2). In the absence of grazing, fire did not play a dominant role in maintaining species richness; however, fire did significantly reduce forb cover and forb richness. In the presence of grazing fire reduced total richness but did not affect forb cover. Fire increased, whereas grazing decreased, the abundance of the three dominant grasses. Forb abundance and richness were not related to grass cover. At Kruger, grazing without fire increased richness (Figure 2). However, in annually burned sites, grazing by Cape buffalo alone led to higher richness than sites open to multiple grazers. Forb cover was higher in multiple grazer sites. Forb cover and richness were not related to grass cover.

Total community richness at Konza showed similar responses to the quadrat scale richness except that fire decreased richness significantly in the unburned sites at large scales with no affect on grazed sites, while at small scales fire decreased richness on grazed sites with no effect on ungrazed sites. At the community scale at Konza, grazing still significantly increased richness. At the community scale in Kruger, fire decreased richness independent of number of grazers, a trend not seen at the quadrat scale. In the absence of fire, adding a single grazer decreased richness (opposite trend compared to quadrat scale), but adding multiple grazers increased richness. In the presence of fire there was no difference between single and multiple grazers on richness. At the community scale and $0.25 m^2$ scale, Konza responded similarly to grazing and fire; however, Kruger responded differently depending on the scale of analysis. Collins & Smith (2006) found that at Konza, grazing and fire effects on heterogeneity were independent of scale (10-, 50-, and 200 m^2); however, the interactive effects were dependent on scale. I will use this data set to study community composition and structure at multiple scales in order to determine if community responses to fire, grazing, and their interactions are scale specific and if NA and SA savanna grasslands respond in similar ways at different scales.

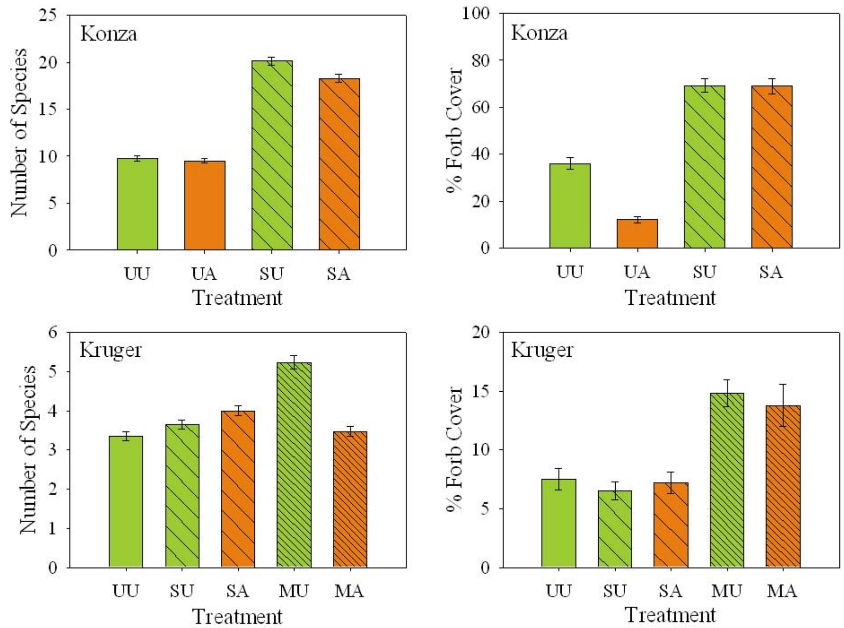

Figure 2. Species richness (left) and forb cover (right) in NA (top) and SA (bottom) savanna grasslands for .25 m^2. MU = Multiple grazers, Unburned; MA = Multiple grazers, Annually burned; SU = Single grazer, Unburned; SA = Single grazer, Annually burned; UU = Ungrazed, Unburned; UA = Ungrazed, Annually burned

Experiment #2 – Interactive effects of drought and grazing

Background & Questions: Little information exists on how climate variation may interact with trophic controls on annual net primary production (ANPP; Frank 2007), and even less is known about how these interactions will affect community structure. Knowing how communities respond to climate variation and grazing will be crucial for grasslands with abundant large herbivores like Kruger and Konza as well as economically important grazing lands around the world. Frank (2007) found that the negative effect of drought on ANPP was exacerbated by grazing. Drought decreases species richness, and grazing increases species richness. Will grazing mitigate the negative effects of drought on species composition, or will it further decrease richness as it does net primary production? How will grazing and drought interact to affect community structure?

Methods: At Kruger and Konza I established a clipping and rainfall manipulation experiment to address the interactive effects of precipitation and grazing on grass-forb interactions and forb diversity at each site. Rainout shelters (Figure 3) that reduce ambient precipitation by 50% were constructed following Yahdjian & Sala (2002) in March 2008 (SA) and August 2008 (NA). Pretreatment data were collected in December – March (SA) and June – August (NA). A 1x1 m plot was established under each rainout shelter and in a corresponding open area. Each plot was then divided into four subplots. Two 50x50 cm clipped and control subplots will be assigned to each replicate rainout shelter (N=7). Grazing will be simulated by clipping all grasses to 5 cm leaving the broad leafed herbaceous species unclipped. Plots were standardized by locating them in areas dominated by *Themeda triandra* in Kruger and *Andropogon gerardii* in Konza. In all plots, cover of each species is estimated twice during the growing season. An ANOVA will be used to determine if drought plus grazing decreases plant species richness in NA and SA.

This experiment will help us to understand the interactive effects of grazing, drought, and water availability on plant community responses at Kruger and Konza. Analysis of pretreatment data found no differences in initial starting conditions. Clipping will begin June 2009 and will occur twice during the growing season through 2011.

Figure 3. Two rainout shelters at Konza on a 20-year ungrazed watershed

Experiment #3 –Rainfall Manipulation Plots (RaMPs)

Background & Questions: The latest IPCC report predicted that the increase in temporal variability in rainfall may have a larger impact than changes in quantity alone. Knapp et al. (2002) showed that increases in rainfall variability altered plant community composition independent of changes in total precipitation. Therefore, I plan to study how changes in the timing of rainfall events interact with grazing to affect plant community structure. This project will take advantage of preexisting infrastructure at Konza only. The RaMPs have been manipulating climate over twelve plots of grassland for eleven years. Six RaMPs have ambient rainfall, and six have altered rainfall. The altered rainfall treatments decrease the rainfall event frequency without altering the total growing season rainfall amount. The overarching goal of the RaMPs experiment is to determine how grassland ecosystem structure and key processes are affected by long-term alterations in rainfall patterns and increased temperature. Within this ongoing, long-term experiment, I am examining the effects of grazing. As noted above, grazing increases the cover and richness of forbs, and decreases the cover of dominant grasses at Konza. Turner et al. (1993) found that grazing increased ANPP at Konza due to an overcompensation response in the grasses. I predict that delayed rainfall will decrease grass cover and increase forb cover. Within the ambient rainfall treatment, grazing will increase grass biomass due to overcompensation. Within the delayed rainfall treatment, grazing will further decrease grass biomass due to enhanced stress, while increasing forb cover. The grazing overcompensation effect will be lower the second year of the experiment.

Methods: In May 2007, I established 4, 1 m^2 plots under each of the 12 RaMPs. Due to warming treatment space constraints, this experiment is only conducted in ambient temperature (unwarmed) portions of each RaMP. The plots are located in areas in which 8 years of belowground data from paired minirhizotron tubes exists, providing important pre-grazing data. Two of the plots in each RaMP are grazed and two are ungrazed serving as a control. To simulate grazing by large herbivores (cattle and bison), all graminoids are clipped to 5 cm (leaving all forbs unclipped) each month during the growing season (Jun-Aug). Bison diets are typically composed of 90% graminoids (Krueger 1986). Our clipping methods simulate this selective grazing. When clipping occurs, all biomass is collected, sorted by growth form, and weighed. Soil moisture and temperature are also measured. In all plots, cover of all species is estimated twice during the growing season. At the end of the growing season all biomass is collected (and together with the grazing biomass) is used to determine aboveground net primary production (ANPP). Pre-treatment data were collected in 2007, and the simulated grazing began in May 2008 and will continue for two more growing seasons. The data collected will be used to calculate richness, diversity and evenness, and to assess species turnover.

Preliminary Results: No treatment effects on species richness occurred in 2008. Delayed rain treatment caused an increase in forb cover within both grazing treatments; however, grazing had no effect on forb cover under ambient or delayed rainfall treatments. Delayed rainfall decreased grass biomass in each of the three months and overall. ANPP was similar in ambient ungrazed and delayed ungrazed treatments (566 g/m^2 and 549 g/m^2). Delayed grazed plots produced a mean ANPP of 247 g/m^2 while ambient grazed produced 387 g/m^2. Grazing caused a significant decrease in grass ANPP. When ungrazed, ambient and delayed treatments do not affect total grass biomass, however, when grazed, the delay treatment significantly reduced total grass ANPP. Forb and total ANPP for each of the four treatments were not statistically different from one another. These preliminary results suggest that ANPP in grazed grasslands will be more sensitive to changes in rainfall patterns than ungrazed grasslands.

Proposed Improvement Research Projects

In this proposal I request funds to add two additional field experiments - the expansion of the rainout shelter project as well as a clipping experiment. Currently I am investigating the combined affects of fire and grazing as well as the effects of climate and grazing, yet nowhere do I manipulate all three drivers (grazing, fire, and precipitation) in one experiment. My first proposed research project will address this. The second proposed project will address a phenomenon found in preliminary analyses. Results from the observational experiment show that grass patch structure is not related to forb richness or cover, yet higher plant species diversity is found in more heavily grazed areas in both NA and SA (Fynn et al. unpublished data). This second proposed experiment will allow me to tease apart how fire and grazing intensity alter grass-forb interactions in SA.

Proposed Research Project #1 – Interactive effects of drought, grazing, and fire

Background & Questions: Fire is an important force in grasslands around the world, and community structure and ecosystem functioning are impacted strongly by fire frequency (Sauer 1950; Collins 1992; Bond et al. 2005). Savanna grasslands burn on average every two to three years making savannas the most frequently burned ecosystem in the world (Beerling & Osborne 2006). Community composition varies with burning frequency. In Konza, increased burning increases the abundance of the dominant C_4 grasses and reduces the cover of C_3 grasses, forbs, and woody species. Annually burned sites are more homogeneous and less diverse than infrequently burned sites (a 4-year burn). However, annually burned sites are less variable from year to year and demonstrate more stability than 4-year or 20-year burns. Plant communities on annually burned sites differ significantly from plant communities on less frequently burned sites (Collins 2000), and annually burned vegetation is comprised of a nested subset of that which is found on less frequently burned sites (Collins et al. 1995).

My current dissertation allows me to examine the effects of drought and clipping on unburned sites in both SA and NA, yet unburned grassland is not the norm. Therefore, I propose to expand Experiment #2 described above by building rainout shelters in sites burned annually and once every 4 years. This will allow me to study the interactive effects of precipitation, grazing, and fire. Precipitation modifies the impacts of both fire and grazing (Knapp & Hulbert

1986; Milchunas et al. 1994; Anderson et al. 2007b), and I predict that the effects of fire will be lessened in grazed areas under natural rainfall conditions. However, I expect fire to have an increased impact on drought plots, and drought plots to be more strongly affected by grazing.

Methods: I will build 14 additional shelters in both Kruger and Konza: 7 on annually burn and 7 on 4-year burn sites following Yahdjian & Sala (2002). Shelters will be constructed in May (NA) and December 2009 (SA). A 1x1 m plot will be established under each rainout shelter and in an adjacent open area. Each drought and ambient plot will be divided into four subplots. Two 50x50 cm subplots will be clipped and two will serve as controls. Grazing will be simulated by clipping all grasses to 5 cm leaving the broad leafed herbaceous species unclipped. Plots will again be standardized by orienting them in areas dominated by *T. triandra* in Kruger and *A. gerardii* in Konza. In all plots, cover of all species will be estimated twice during the growing season, and data collection will occur for two seasons. Treatment effects on plant community structure will be determined using MANOVA. Grazing, fire, and climatic variability are the essential factors that control the structure and function of grassland ecosystems, and this experiment will allow me to partition the influences of these three key drivers on the plant community.

Proposed Research Project #2 – Fire, grazing, and patch structure: A clipping experiment along a utilization gradient

Background & Questions: I propose a clipping experiment to determine the patch dynamics of different dominant grass species in response to grazing and fire. This experiment will occur only in Kruger as we know more about the effects of grazing and fire in NA. Preliminary results show that grass patch structure has no relationship to forb richness or cover, yet higher plant species diversity (generally driven by forb diversity) is found in more heavily grazed areas in both NA and SA. This experiment will allow me to determine if grazing intensity plays an important role in species diversity. Since preliminary data show that there is no relationship between grass patch structure and forb richness or cover, I predict that there will be no effect of grazing intensity (Figure 4a). An alternative hypothesis is that richness and heterogeneity will be highest at an intermediate grazing intensity (Figure 4b). Theory has suggested that species richness will be maximized at intermediate levels of disturbance (Intermediate Disturbance Hypothesis (IDH); Connell 1978; Huston 1979), yet experimental studies have shown mixed results with different systems exhibiting positive, negative, intermediate, or no response to disturbances and these responses being scale dependent at certain sites (Hobbs et al. 1984; Collins et al. 1995; Archer et al. 1987; Uys et al. 2004; Schwilk et al. 1997). Uys et al. (2004) showed that ungrazed grasslands in southern SA do not support the IDH with regards to fire; in fact forb diversity is unaffected by fire frequency. Do forbs show the same response with regards to grazing intensity? And will fire still remain an inconsequential event for maintaining biodiversity when

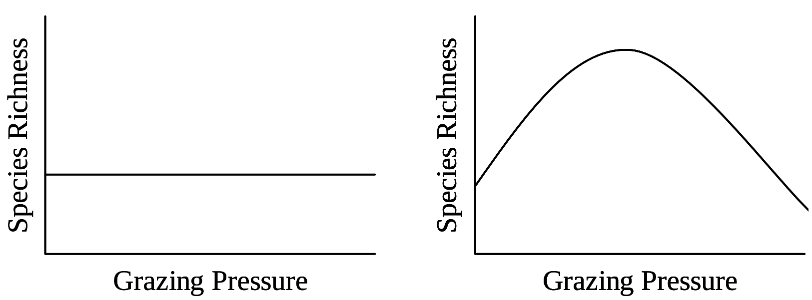

Figure 4. Possible community responses of to grazing – no relation (a) and intermediate disturbance (b) yields highest richness

combined with grazing? A more detailed study is needed to determine the effects of grazing intensity and the interaction with fire on plant diversity in mesic savanna grasslands in Africa.

Methods: I will establish 84 1x1 m plots within the Cape buffalo enclosure at Satara to avoid destruction of plots by herbivores such as elephants. I will establish 28 plots in 3 different burning regimes: annual, 3-year, and unburned. Within each burning regime, 7 replicate plots will be centered on each of four different grass species: *T. triandra*, *Panicum coloratum*, *Digitaria eriantha*, and *Bothriocloa radicans* that collectively represent a grazing intensity gradient. *T. triandra* is highly favored, *P. coloratum* and *D. eriantha* are also consumed on a regular basis, and *B. radicans is* only consumed in periods of intense drought and low forage quality. This preferential grazing gradient does not exist at Konza. Fences (Figure 5) will be built around the plots in order to deter Cape buffalo from grazing the ungrazed subplots. We have successfully used this fencing type to protect plots in SA.

Each permanent 1x1 m plot will be divided into four 0.5x0.5 m subplots. Two of the subplots will be used to simulate grazing by Cape buffalo. Grazing will be simulated by clipping all grasses to 5 cm leaving the forbs unclipped. This simulated grazing will occur twice during the growing season. In all the subplots canopy cover of each species will be visually estimated as in Knapp et al. (2002) twice during the growing season to sample early and late season species. Maximum cover values of each species each year will be used to determine richness, diversity, and dominance as well as changes in composition and species turnover. A species area curve will be used to determine how richness, diversity, and heterogeneity change with increasing intensity of grazing, spatial scales, and fire frequency.

Figure 5. Grazing exclosure fences in Kruger on an annually burned site.

Broader Impacts: This research will investigate the interactive effects of environmental change in savanna grasslands in NA and SA. The comparative approach will greatly enhance the ecological generality of my findings. With comparable experimental designs and identical sampling protocols in both NA and SA, this research will provide a rigorous assessment of the cumulative effects of long-term fire and grazing regimes, as well as responses to short-term manipulations of herbivores and climate on grassland structure and function. Ultimately this understanding will allow us to improve savanna grassland models that include fire, grazing, and climate effects on community processes and help us understand how future climate scenarios may impact mesic savanna grassland ecosystems.

My research is directly applicable to the management of biodiversity in the tallgrass prairie in NA as well as in one of the world's premier national parks. Kruger National Park is home to much of the world's remaining charismatic mega-fauna and is a world leader in scientifically-based management practices and policies. My research has and will continue to facilitate work with Kruger National Park management, staff, and scientific community, and by working and travelling in this world renowned area I will gain a unique international experience and form valuable collaborations within a global ecological community.

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Education

B.A.	1975	Biology	Wittenberg University
M.S.	1977	Botany	Miami University
Ph.D.	1981	Botany	University of Oklahoma

Professional Experience:

2003-	Professor, Department of Biology, University of New Mexico
2003-	PI, Sevilleta LTER
2001-	Adjunct Professor, Arizona State University
1998-	Adjunct Professor, Kansas State University
1992-2003	Program Director, National Science Foundation
1985-1994	Assistant and Associate Professor of Botany, University of Oklahoma.
1984	Postdoctoral Fellow, Dr. Ralph E. Good, Rutgers University.
1981-1983	Visiting Assistant Professor of Botany, University of Oklahoma.
1981	Postdoctoral Research Associate, Dr. Bernd Heinrich, University of Vermont.

Research Interests: Plant community dynamics, Gradient models and gradient structure, the role of disturbance in communities, fire ecology, patch dynamics, landscape ecology, grassland ecology, nutrient dyndamics, analysis of species distribution and abundance, aridland ecology.

Ten Representative Publications:

Suding, K.N., S.L. Collins, L. Gough, C.M. Clark, E.E. Cleland, K.L. Gross, D.G. Milchunas and S.C. Pennings. 2005. Functional and abundance based mechanisms explain diversity loss due to nitrogen fertilization. **Proceedings of the National Academy of Sciences** 102: 4387-4392.

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Knapp, A.K., J.M. Briggs, S.L. Collins, S.R. Archer, S. Bret-Harte, B.E. Ewers, D.P. Peters, D.R. Young, G.R. Shaver, E. Pendall and M.K. Bayless. 2008. Shrub encroachment in North American grasslands: shift in growth form dominance can rapidly alter control of ecosystem C inputs. **Global Change Biology** 14: 615-623.

Collins, S.L., R.L. Sinsabaugh, C. Crenshaw, L. Green, A. Porras-Alfaro, M. Stursova and L. Zeglin. 2008. Pulse dynamics and microbial processes in aridland ecosystems. **Journal of Ecology** 96: 413-420.

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Veen, G.F., J.M. Blair, M.D. Smith and S.L. Collins. 2008. Influence of grazing and fire frequency on small-scale spatial heterogeneity in a mesic grassland community. **Oikos** 117: 859-866.

Collins, S.L., K.N. Suding, E.E. Cleland, M. Batty, S.C. Pennings, K.L. Gross, J.S. Grace, L. Gough, J. E. Fargione and C.M. Clark. 2008. Rank clocks and plant community dynamics. **Ecology**: *in press.*

Burns, C.A., S.L. Collins and M.D. Smith. Plant community response to loss of large herbivores in South African and North American grasslands. **Biodiversity and Conservation,** *submitted 6/8/2008*.

Synergistic Activities:

2005-2007	Lead PI for the LTER Network Planning Process
2007	SEEDS Fellowship mentor – Jarrod Blue (Davidson University)
2005	Hosted annual SEEDS Workshop at the Sevilleta
2005-	Advisor, UNM Biology SEEDS Chapter
2003-2004	Member, Visions Committee, Ecological Society of America
1992-2003	Program Director, National Science Foundation
1998-	Editorial Board Member-BioScience
2002-2003	Chair Vegetation Section, ESA
2005-2008	Chair Long-term Studies Section, ESA
2003-	Book Review Editor, Journal of Vegetation Science
1992-1996	Associate Editor-Journal of Vegetation Science, 1992-1996
2003-2004	NCEAS KNB Working group on North America-South Africa grasslands
2005-2008	Associate Editor-Journal of Ecology
2007-2010	Associate Editor-Oecologia

PhD Advisor: **Paul G. Risser**, Interim Director, Smithsonian Natural History Museum
PhD Advisees: **Susan Glenn** (Gloucester County College, NJ), **Bruce Hoagland** (U Oklahoma), **Ernie Steinauer** (Mass Audubon Society), **Selene Báez** (U Florida), **Laura Calabrese** (current), **Etsuko Nonaka** (current), **Alejandra Carvajal** (current), **Sally Koerner** (current), **Michell Thomey** (current)
Postdoctoral Fellows: **Joe Fargione** (TNC); **Catherine Burns** (U Maine); **Rich Fynn** (U KwaZulu-Natal)
Institutional Conflicts: Kansas State University, Arizona State University, University of New Mexico
Research Collaborators: **Steve Archer** (U Arizona), **Sara Baer** (SIU-Carbondale), **Mike Batty** (Univ College, London), **Barbara Benson** (U Wisconsin), **Luis Bettencourt** (Los Alamos Natl Lab), **Donnie Bret-Harte** (U Alaska), **John Briggs** (Kansas State), **Dan Childers** (Arizona State), **Chris Clark** (Arizona State), **Elsa Cleland** (NCEAS), **Mark Davis** (Macalester College), **Paolo D'Odorico** (U Virginia), **Stephan De Wekker** (U Virginia), **Brent Ewers** (U Wyoming), **Phil Fay** (Univ Minnesota-Duluth), **Jose Fuentes** (U Virginia), **Laura Gough** (UT-Arlington), **David Gibson** (SIU), **Jim Grace** (USGS), **Peter Groffman** (IES), **Kay Gross** (Michigan State), **Aric Hagberg** (Los Alamos Natl Lab), **Tom Heatherly** (U Nebraska), **Mike Huston** (Texas State) **Alan Knapp** (Colorado State), **Ariel Lugo** (USFS-Puerto Rico), **Dan Milchunas** (Colorado State), **Margaret Palmer** (CBL-U Maryland), **Steve Pennings** (U Houston), **Debra Peters** (USDA-NMSU), **Sujith Ravi**, (U Virginia), **Gus Shaver** (MBL), **Eric Small** (U Colorado), **Melinda Smith** (Yale), **Tom Stohlgren** (USGS-Ft Collins), **Katie Suding** (UC-Irvine), **Ciska Veen** (U Groningen), **Matt Whiles** (SIU), **Ali Whitmer** (UCSB), **Don Young** (VCU).

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Professional Preparation

Clemson University	Biological Sciences	BS with honors, 2005
University of New Mexico	Biology	PhD, 2006-2011 (anticipated)

Appointments

Biology Graduate Student Association President: Fall 2008 – Spring 2009
Graduate Student & Professional Association Council Member – Biology Representative: Fall 2008 – Spring 2009
Graduate Assistantship: Fall 2007 – Present – Lab prep for all University of New Mexico core introductory biology labs
Teaching Assistant: Fall 2006 – Spring 2007 – Biology for Health-Related Sciences (BIOL 124), University of New Mexico
Herbarium Assistant: Clemson University – Fall 2005
Northern Plains Project Internship: Kruger National Park, South Africa – Summer 2004 – Research Intern

Publications N/A

Synergistic Activities

Ecological Society of America Student Section Government - Student Host: August 2008 – August 2009
Distributed Graduate Seminar hosted by NCEAS - Spring 2008 - Present
Ecological Society of America member – Spring 2007 – Present
Society for Conservation Biology member – Spring 2008 – Present
British Ecological Society member– Summer 2008 – Present

Collaborators & Other Affiliations

Collaborators:
John Blair (Kansas State University)
Scott L. Collins (University of New Mexico)
Alan K. Knapp (Colorado State University)
Melinda Smith (Yale University)

Graduate Advisors:
Scott L. Collins (Ph.D., University of New Mexico)

Thesis Advisor and Postgraduate-Scholar Sponsor: N/A

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of New Mexico

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Scott L Collins

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Scott L Collins - none	0.00	0.00	0.00	$ 0	$
2. Sarah Koerner - none	0.00	0.00	0.00	0	
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				3,600	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				7,060	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				7,060	
H. TOTAL DIRECT COSTS (A THROUGH G)				10,660	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)					
TOTAL INDIRECT COSTS (F&A)				0	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				10,660	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 10,660	$

M. COST SHARING PROPOSED LEVEL $ 0 | AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Scott L Collins

ORG. REP. NAME*
Brenda Baker

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

1 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION **University of New Mexico**				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
					Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Scott L Collins**				AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Scott L Collins - none**	0.00	0.00	0.00	$ **0**	$
2. **Sarah Koerner - none**	0.00	0.00	0.00	**0**	
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**3,600**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**600**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**600**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**4,200**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**4,200**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **4,200**	$

M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $		
PI/PD NAME **Scott L Collins**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Brenda Baker**	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION: University of New Mexico				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: Scott L Collins				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. Scott L Collins - none	0.00	0.00	0.00	$ 0	$	
2. Sarah Koerner - none	0.00	0.00	0.00	0		
3.						
4.						
5.						
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3. (0) GRADUATE STUDENTS				0		
4. (0) UNDERGRADUATE STUDENTS				0		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)				0		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0		
2. FOREIGN				7,200		
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS $ 0						
2. TRAVEL 0						
3. SUBSISTENCE 0						
4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				7,660		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				0		
5. SUBAWARDS				0		
6. OTHER				0		
TOTAL OTHER DIRECT COSTS				7,660		
H. TOTAL DIRECT COSTS (A THROUGH G)				14,860		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
TOTAL INDIRECT COSTS (F&A)				0		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				14,860		
K. RESIDUAL FUNDS				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 14,860	$	
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					

PI/PD NAME: Scott L Collins	FOR NSF USE ONLY		
	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: Brenda Baker	Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

E. International Travel

Round trip airfare from Albuquerque to Nelspruit, South Africa currently ranges from $1600 to $2000 depending on season of travel. Thus, I estimate plane fare to be $1800 per trip. I will travel to South Africa twice a year in order to collect early season sampling in December and late season sampling in March. That would be four trips over two years for a total of $7200. My travel to Kansas is paid for by other sources and is, therefore, not included in the budget.

G. Other Direct Costs

Materials and Supplies

Each rainout shelter costs $200 to build. This includes all the needed supplies including plastic shingles, EMT conduit and elbows, nuts and bolts, gutter, rain pipe, rebar, foam, wooden stakes, metal drill bits, and rope. Building 28 shelters will cost $5600.

Each exclosure fence for the 1x1 m^2 clipping plots costs approximately $15. This includes t-posts and fencing. Building 85 will cost $1260.

$200 is requested in year one to purchase field supplies such as flags, meter tapes, a compass, sharpies, clippers, kneepads, and pencils as well as other expenses that arise throughout the course of field work.

$600 is requested in year two for materials and supplies for expected shelter repairs. Although these rainout structures are sturdy, Cape buffalo are strong and weather is unpredictable, so some minor damage is likely to occur throughout the course of this research.

	Cost per item	Number of items	Total Cost
Year One			**$10,660.00**
Konza Rainout Shelters	$200.00	14	$2,800.00
Kruger Rainout Shelters	$200.00	14	$2,800.00
Exclosure Fences	$15.00	84	$1,260.00
Field Supplies			$200.00
Travel			$3,600.00
Year Two			**$4,200.00**
Repair Materials			$600.00
Travel			$3,600.00
Total Cost			**$14,860.00**

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Scott Collins

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Sevilleta LTER IV: Abiotic pulses and constraints: effects on dynamics and stability in an aridland ecosystem

Source of Support: NSF

Total Award Amount: $ 4,920,000 Total Award Period Covered: 11/01/06 - 10/31/12

Location of Project: Sevilleta National Wildlife Refuge

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.50 Sumr: 0.50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Track 1, GK12: E-MRGE: Ecohydrogeology in the Middle Rio Grande Environment

Source of Support: NSF

Total Award Amount: $ 1,663,135 Total Award Period Covered: 05/01/06 - 04/30/09

Location of Project: UNM, Sevilleta NWR, Socorro, Belen and Laguna Pueblo, NM

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 1.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Global change effects on grass-shrub interactions in an arid ecosystem

Source of Support: NSF

Total Award Amount: $ 297,494 Total Award Period Covered: 07/15/05 - 07/14/08

Location of Project: Sevilleta National Wildlife Refuge

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Convergence and contingencies in savanna grasslands

Source of Support: NSF

Total Award Amount: $ 60,000 Total Award Period Covered: 09/01/05 - 08/30/08

Location of Project: Konza Prairie Biological Station & Kruger National Park RSA

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.25 Sumr: 0.25

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: LTREB: Long-term ecosystem responses to more extreme precipitation patterns and warming

Source of Support: NSF

Total Award Amount: $ 300,000 Total Award Period Covered: 05/01/05 - 04/30/10

Location of Project: Konza Prairie Biological Station

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Summ: 0.25

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Scott Collins

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Renovations to increase capacity at the UNM Sevilleta Field Station

Source of Support: NSF

Total Award Amount: $ 250,000 Total Award Period Covered: 12/15/07 - 12/14/10

Location of Project: Sevilleta National Wildlife Refuge

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.10 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Ecosystem consequences of precipitation variability and extremes in semiarid grassland and shrubland

Source of Support: NICCR

Total Award Amount: $ 374,829 Total Award Period Covered: 03/01/08 - 02/28/11

Location of Project: Sevilleta National Wildlife Refuge

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative research: Do vegetation-microclimate feedbacks promote shrub encroachment in the southwestern United States

Source of Support: NSF

Total Award Amount: $ 289,008 Total Award Period Covered: 02/01/08 - 01/31/11

Location of Project: Sevilleta National Wildlife Refuge

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: GK12: ENvironmental CHAnge for New Mexico Teaching (ENCHANT)

Source of Support: NSF

Total Award Amount: $ 2,975,222 Total Award Period Covered: 07/01/09 - 06/30/14

Location of Project: University of New Mexico

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.50 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative research: Convergence and contingencies in savanna grasslands

Source of Support: NSF

Total Award Amount: $ 157,561 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: Konza Prairie Biological Station & Kruger National Park RSA

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Summ: 0.50

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Sarah Koerner

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Interactive effects of global climate change, loss of mega-herbivore bodiversity, and altered fire regimes on savanna grassland ecosystems

Source of Support: National Science Foundation

Total Award Amount: $ 14,860 Total Award Period Covered: 05/01/09 - 04/30/11

Location of Project: Kruger National Park, South Africa and Konza Prairie, Kansas

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Interactive effects of global climate change and grazing on grassland ecosystems

Source of Support: Sigma Xi

Total Award Amount: $ 1,000 Total Award Period Covered: 12/26/08 - 04/01/09

Location of Project: Kurger National Park, South Africa

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Interactive effects of global climate change and grazing on grassland ecosystems

Source of Support: The Lewis and Clark Fund for Exploration and Research

Total Award Amount: $ 5,000 Total Award Period Covered: 04/15/09 - 04/01/10

Location of Project: Kruger National Park, South Africa and Konza Prairie, Kansas

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory:

Clinical:

Animal:

Computer: A Latitude D600 laptop computer with necessary software is available at all times, and travels with the CO-PI to the field sites. While at the University of New Mexico, the PI and CO-PI have access to a HP Laser Jet 2300 Series printer and a HP Color Laser Jet 4600 printer.

Office: Office space is provided at the University of New Mexico for the PI and CO-PI.

Other: Kruger National Park and the Konza Prairie LTER grant access to the PI and CO-PI to use tools such as power drills and saws as well as workshop space for construction purposes.

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

The CO-PI has assembled all necessary equipment for completing fieldwork on this project. Available at all times are quadrats of various sizes needed for sampling community composition.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

The herbarium in Kruger National Park, South Africa will be used for identification of plant species collected at this site.

FACILITIES, EQUIPMENT & OTHER RESOURCES

Continuation Page:

COMPUTER FACILITIES (continued):

The University of New Mexico

Richard M. Cripps, *D. Phil.*
Associate Professor of Biology
Associate Chairman

Tel: (505) 277 2822
Fax: (505) 277 0304
E-mail: rcripps@unm.edu

18th November, 2008
Re: Sarah (Sally) E. Koerner

To whom it may concern,

I am happy to confirm that Sarah (Sally) E. Koerner has advanced to candidacy for a PhD degree in the Biology Department at the University of New Mexico. Please contact me should you have any questions.

Yours sincerely,

Richard M. Cripps
Associate Professor of Biology

Context for Improvement

The proposed research would constitute two additional chapters (4 and 5) of my PhD dissertation that, as a whole, examines the interactive effects of global climate change, grazing, and fire on plant community composition, structure, and dynamics. This research will investigate the interactive effects of environmental change in savanna grasslands in North America (NA – Konza Prairie, KS) and South Africa (SA – Kruger National Park). The comparable experimental designs and identical sampling protocols in both NA and SA will greatly enhance the ecological generality of my findings.

Funding from NSF will significantly enhance this dissertation by aiding in the addition of two experiments. The first experiment will investigate the interactive effects of all three drivers – grazing, fire, and precipitation – on plant community structure in NA and SA. My current dissertation allows me to examine the effects of drought and clipping on unburned sites, yet unburned grassland is not the norm. Therefore, I propose to expand one of my ongoing experiments by building additional rainout shelters in sites burned annually and once every 4 years. The second proposed experiment will assess how small-scale patch structure and dynamics in SA grasslands respond to fire along a grazing utilization gradient. Preliminary results show that grass patch structure has no relationship to forb richness or cover, yet higher plant species diversity (generally driven by forb diversity) is found in more heavily grazed areas in both NA and SA. The second experiment will provide information that will help tease apart how fire and grazing intensity alter grass-forb interactions in SA. Little is known about how climate, fire, and grazing interact to affect community properties especially in SA. Ultimately the understanding gained from this research will allow us to improve savanna grassland models that include fire, grazing, and climate effects on community processes and help us understand how future climate scenarios may impact mesic savanna grassland ecosystems.

Although broad in application and scope, this dissertation project is quite feasible. I have worked in these two sites for several years. I am familiar with the systems as well as sampling protocols. The proposed rainout shelters have already been built on unburned grasslands in both NA and SA. Over the past two years I have established the needed methodology and construction skills required to complete these projects. Critical support from NSF will fund building materials and travel costs to SA. My research to date has been funded by numerous small grants from the University of New Mexico and NSF support to my advisor. However, the sheer number of shelters and the cost of plane tickets are outside the scope of these smaller grants. The requested funding from NSF is, therefore, necessary to add these two new experiments to my existing dissertation research project.

The proposed research departs from funded projects undertaken by my major advisor, Scott Collins. My dissertation work falls within the constraints of an ongoing project which my advisor and three colleagues at Yale, Colorado State and Kansas State started in 2006. The larger project aims to quantify ecosystem and community responses to fire and grazing in savanna grasslands in North America and South Africa. This project is funded by NSF, and the renewal proposal is pending. I am able to utilize the background information and data they have gained as well as the infrastructure they have established. However, my research is unique in that I studying patch structure and grass-forb interactions in the climate change context of altered precipitation regimes. My work adds a new dimension to an already existing project.