Site Supplemental Science Request
(YEAR 1 of Budget Pages)

Our strategy for supplemental funding this year is to prioritize funding for the activities that will capture a potentially dramatic research opportunity this summer (I), strengthen weaknesses perceived by reviewers of our proposal (II), and attract new or extend some existing collaborations (III & IV). In the latter category we have specific research interests in mind as well as capitalizing on connections made at our January, 2003, SGS Symposium between our researchers and other local entities interested in the ecosystem. We are also proposing work only recently been made feasible by the establishment of a new special compound analysis laboratory.

I. Rapid Response to Plague Outbreaks to Identify Reservoir Species

We wish to apply for a supplement to enhance our ongoing research on the ecology and genetics of plague on the Shortgrass Steppe LTER (SGS-LTER). Plague, caused by the bacterium *Yersinia pestis*, was introduced into the U.S. around 1900 and has since cycled in populations of rodents found west of the 100th meridian. We wish to study outbreaks of plague in towns of black-tailed prairie dogs (BTPD: *Cynomys ludovicianus*) that our data predict will occur in the next 12 to 18 months. Background data from 21 years of monitoring of prairie dog colonies on this site point to epizootics of plague occurring in towns that are greater than 15 ha in area, and especially during years with increased precipitation caused by El Nino climatic conditions (Figure 1, in Supplementary Documents section). Studies of human plague cases in New Mexico and Arizona show that the incidence of plague is higher following springs and summers of high rainfall and cool temperatures (Parmenter et al. 1999, Enscore et al. 2002, in Supplementary Documents section).

Despite extensive sampling, we have not detected plague epizootics on the SGS-LTER in the last three years, which have been characterized by some of the most severe drought conditions since record keeping began in the 1880's. During this time, prairie dog colonies on SGS-LTER have expanded dramatically (Figure 2). Biologists from the Pawnee National Grassland reported a 62% increase in the area of prairie dog colonies on the grasslands from 2001 to 2002, from 469 ha to 760 ha (R.E. Hill, personal communication). Climatic data indicate this drought cycle is ending, being replaced by El Nino conditions that started during the autumn of 2002. Thus, we predict we are on the brink of die-offs of prairie dogs on the SGS-LTER.

Current funding for the SGS-LTER provides support for general monitoring of prairie dog towns and other rodents, but does not include funding for the level of detail required for examining routes of transmission during plague epizootics. We want to be prepared to respond to plague epizootics immediately, in order to track disease transmission as it occurs. Scavenging of dead BTPD by coyotes, foxes, and vultures is rapid, so we must be able to get there first to sample dead and dying BTPD. Additionally, if we miss this opportunity to study plague outbreaks in the next six months, similar conditions for epizootics will not exist again for many years to come.

What research will be conducted -- We will implement much more intense monitoring of prairie dog towns to be able to detect plague epizootics when they actually begin. Thus we will:

- Capture live (healthy and sick dogs) to take blood and flea samples for plague detection, verifications, isolation (antibody tests of blood, PCR tests of fleas).

- Collect carcasses of deceased prairie dogs. We wish to carry out necropsies and histological analysis of all dead/infected animals to determine the main route of infection. We will be able to distinguish four transmission routes: 1) flea bite: bubonic infection of the lymphatic system; 2) direct prairie dog to prairie dog: primary pneumonic infection in lungs; 3) direct transmission by ingestion of infected carcass: stomach contents, primary septicemia; 4) mechanical transmission of plague by flea bite: primary septicemia without lymphatic (bubonic) infection.

- "Swab" burrows to collect fleas both where dogs have already died and where plague has not yet spread, again testing for plague by PCR and taking live samples of the pathogen if possible.

- Trap other small rodents that live in the same habitat as the BTPD. Test blood and flea samples, as done for BTPD. The four most likely candidates are: grasshopper mouse (*Onychomys leucogaster*), deer mouse (*Peromyscus maniculatus*), Ord's kangaroo rat (*Dipodomys ordii*), and thirteen lined ground squirrels (*Spermophilus tridecemlineatus*).

- Eventually, if we are able to isolate live plague from either animals or fleas, we will be able to use highly variable molecular markers developed in Paul Keim's laboratory at N. Arizona U. to genotype samples. Thus, we can determine the relationship between outbreaks in different colonies and between different rodent species. Additional comparisons will be made with plague strains from historical collections from Colorado and southern Wyoming that are stored at the CDC laboratory in Fort Collins. Preliminary data come from an ongoing genetic study of plague isolates from human cases. The study is by the CDC, supervised by Dr. Ken Gage and conducted by our shared graduate student Jen Lowell.

II. Data Management

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Our long-term goals for data management continue to be: 1) increasing our web delivery of metadata and data for long-term experiments, 2) increasing our interactions with federal partners/hosts of the SGS LTER site, the Agricultural Research Service and the USFS Pawnee National Grassland by developing a joint spatial data management/experiment management system; 3) leading the way in the network for metadata and data management of simulation models, an area in which we have a major scientific investment: and 4) developing data management interactions for our Schoolyard LTER and Outreach programs. We have made progress in each of these areas and would like to continue moving forward with each.

Reviewers of our recent renewal proposal strongly recommended that we direct more energy to our data management efforts. We are acting on the reviewers suggestions in several ways and are requesting supplemental funds to support these changes:

- increasing our data manager from half-time to full-time effort;
- re-designing our web site and web-based access for long-term data sets is continuing through efforts of our web implementation specialist who will complete her time with us this summer and help launch our re-designed web site;
- and increasing our support for a GIS web programmer.

Part of our request for the Schoolyard LTER project also addresses data handling for the participating schools. Those efforts are described in the SLTER section below.

III. The role of dust deposition in ecosystem dynamics on centennial to millennial time scales: An evaluation of climatic versus atmospheric controls over ecosystem development and biogeochemical cycling.

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In the last SGS-LTER submission we proposed to evaluate paleoclimate and biogeochemical changes over millennial timescales in an attempt to couple our continuing climatic and biotic reconstructions with marine and terrestrial aquatic records. This funding opportunity will allow us to pursue this important aspect of the evolution of the SGS ecosystem by utilizing new isotopic techniques and establish new collaborative efforts in the geosciences. The dynamics of ecosystems over decades to millennia requires consideration of the biogeochemical cycling of C, N, P and cation chemistry and their interactions with climatic controls over vegetation activity. Current conceptual and simulation models of ecosystem, vegetation, pedological, and atmospheric processes are not integrated into a structure where geochemical controls over ecosystem development can be fully considered. **The central and necessary requirements for this integration are the representation of pedogenesis, geochemistry, and the atmospheric processes that transport material over long distances and which link geochemistry and biology through the atmosphere**.

<u>Terrestrial Paleoclimate</u> *:* We will utilize our extensive experience in the study of soil formation and paleosols to provide information on the biotic structure of these systems over the last 28,000 years. Recently, quantitative methods for extracting environmental information from soils have been developed (Kelly, et al, 1998, Kelly et al, 1991a; Kelly et al, 1991b; Amundson et al, 1989; Quade et al, 1989; Cerling, 1984). These methods, which utilize the stable isotope geochemistry of carbon and oxygen, permit reliable and high-resolution climatic information to be extracted from soils. Our new approach is to utilize the carbon isotopic compositions of specific biomarkers ("compound specific isotope analyses", CSIA) derived from higher plants to assess the changes in biota within the SGS region through time. Specifically we will extract and measure the carbon isotopic compositions of long-chain *n*-alkanes and lignin phenols from modern soil and paleosols to evaluate the organic carbon input from vascular plants. Both of these compound classes are used extensively to evaluate terrestrial inputs into both lacustrine and marine environments (Hedges and Parker, 1976, Pagani et al., 2000).

Mineral deposition controls over ecosystem dynamics: We propose to undertake a comprehensive study of the role of mineral weathering versus atmospheric inputs to the nutrient reserves of modern ecosystems. Our objectives are to 1) quantify the inputs of soil nutrients from weathering versus atmospheric sources in diverse ecosystems; 2) utilize stable Sr isotopes as a natural tracer through the atmosphere-soil-plant system to assess nutrient dynamics as a function of nutrient supply of parent materials; 3) use well constrained chronosequences and bioclimatic sequences within and among geographic regions to construct models that assess changes in nutrient dynamics over millennial time scales. The application of Sr isotope geochemistry to soil systems is theoretically simple and straightforward. As stated, the primary sources of cation nutrients (such as Ca, Mg) to the soil ecosystem are the products of chemical weathering and atmospheric deposition. The $^{87}Sr/^{86}Sr$ ratio of chemical weathering products carries the isotopic signature of the parent material. Therefore, the Sr isotopic composition of secondary clays, soil minerals and cation exchange surfaces can be used as an indicator of provenance (Dasch, 1969; Brass, 1975). Similarly, the Sr found on cation exchange surfaces "in theory " is available for plant uptake. Living plants, soil organic matter, and other organic materials may carry the isotopic signature of ecosystems nutrient reservoir. If the *in situ* and external sources of Sr to the soil have distinct Sr isotopic signatures, the $^{87}Sr/^{86}Sr$ ratio can be used to track the movement and provenance of Sr through the ecosystem (Graustein, 1989). Interpretations of dust vs. parent material contributions to nutrient supply are not straightforward however because the mineral aerosol input has occurred for a long time. Thus all ecosystem measurements contain the effects of the input and we have to back out its significance. We can do this by using tracers to determine how much of the nutrients contained in the ecosystem are derived from sources external to that locality. We believe that this can be done using isotopic tracers of provenance because material derived from varied weathering regimes (and dust source area) are isotopically and chemically distinct. The isotopic endmembers required for this analysis will be determined both by the age and composition of the underlying rock and by the intensity and duration of weathering. Once we know how much external material is contained within the ecosystem we can estimate the difference in ecosystem productivity associated with mineral aerosol input by using our new simulation models. Simulations can be tied also to the measured and modeled variation in dust incursion into experimental sites.

What research will be conducted-- A chronosequences of soils dating back 660,000 years and two stratigraphic exposures of paleosols (which exposes a 30,000-year record of environmental change) will be sampled for this project near Stoneham, Colorado, in the western margins of the Great Plains. The Stoneham site lies near the ecotone separating shortgrass steppe from the mixed grass prairie. This site will be re-described and sampled for, micromorphology, carbonates, phytoliths, intensive dating and organic matter samples for the carbon isotopic compositions of specific biomarkers (CSIA). We further propose to undertake a series of laboratory experiments to investigate the hydrogen isotopic character of higher plant lipids (i.e., *n*-alkanes, *n*-alcohols, isoprenoids, fatty acids) in relationship to varying plant types, soils, and environmental conditions. Ultimately, we aim to explore the utility of hydrogen isotopic compositions (δD) of specific biomarkers as a proxy for specific climatic variables such as relative rates of evapotranspiration and relative humidity and will apply this to the temperate field sites described in this proposal.

IV. Outreach and Collaborations

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We hosted the Sixth Shortgrass Steppe Symposium in January, 2003. One of our main objectives this year was to bring together the diverse group of people interested in the SGS ecosystem, in hopes of establishing new cooperations and collaborations. Participants included our research community, representatives from federal, state and local government agencies, and representatives from the NGO arena. The symposium was very effective in promoting dialogue between researchers and land stewardship groups. Several potential areas were identified for collaborations. One of the keys to success in these efforts has been, and will likely continue to be, the ability of the researchers to understand the information needed by the stewardship groups, and the understanding by the stewardship groups of what data are available and how appropriate data can be obtained.

In order to continue these collaborations, we anticipate smaller interest groups meeting three or four times a year. One such meeting has already occurred at the CPER to discuss SGS habitat and long-range recovery of the mountain plover. Approximately 35 folks spent a day discussing issues and options in long-range planning and research. Because our site and the ARS CPER headquarters are 45 miles from town, to keep participants focused on the issues, and to promote additional discussion, we have found that it is necessary to provide some sort of lunches at these full-day meetings. We have included funds in this supplementary request for three of these interest group meetings to help get these collaborations off the ground.

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Research Experience For Undergraduates Request

(YEAR 2 of Budget Pages)

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Results from Previous REU Supplement

In 2002 we received funding for two REU students, who have completed research projects at the Shortgrass Steppe (SGS) LTER site. One student worked with Dr. Bill Lauenroth and the other with Dr. Mike Antolin. Below, we summarize the projects these students worked on. In addition to their own projects the students assisted each other when more hands or eyes were needed to collect data. A third student funded by the Department of Biology participated in the REU activities and lectures as well as data collection.

Linsdey Bach, Clemson University student

Ms. Bach worked with Dr. Lauenroth to investigate the relationship between canopy reflectance in the visible and near infrared wavelengths and leaf area and biomass. Ms Bach worked on a site that has two radiometers: one in an cattle exclosure and one in a grazed pasture. The radiometers collect reflectance data every minute and a data logger stores hourly averages. Ms Bach estimated green and brown leaf area using the point frame technique and aboveground biomass by harvesting vegetation .

Katherine McAnelly, Colorado State University student

Ms. McAnelly worked with Dr. Antolin on black-tailed prairie dogs. Katie developed a study comparing the reactions of black-tailed prairie dogs in different habitats to two human disturbances. Katie hypothesized that prairie dogs living close to humans in urban areas would see humans as non-predators while those living on the SGS may or may not have that view of humans. Katie observed prairie dog towns close to established human dwellings, those far from dwellings on the SGS and those in a protected city park site. She subjected each town to disturbances from a bicyclist and a runner and monitored the behavior of the prairie dogs. Her observations suggested that prairie dogs living near human activity adapt more readily to runners or bicyclists traversing their towns.

REU Proposal for the Current Year:

We request funding to support two Research Experience for Undergraduates students during the 2003 summer field season. Students will work directly with PI's and their graduate students from the Shortgrass Steppe Long Term Ecological Research project.

Nature of Student Activities

Philosophy:

Our highest priority for students in this project is not that they learn a large number of facts about the ecology of the shortgrass steppe, nor that they become expert in the field, laboratory, or computer analyses. Rather, our primary goal is that the students learn that science is an exciting process of discovery, and that they become interested in the field of ecology. They will be involved in the everyday process of research, but through this, we hope to infuse them with excitement about both science and ecology. Thus, although we focus below on the technical components of their activities, we will place a great deal of our effort with the students on the overall experience.

There are a number of components to the learning experience for the REU students. We subdivide these components into 1) basic ecology; 2) environmental issues; 3) hypothesis generation in the research process; 4) methods of field and laboratory analysis; 5) data analysis and synthesis; 6) the use of computers in research.

Below, we detail chronologically our plan for how the students will develop this knowledge base.

1. Pre-arrival orientation:

We will send both students a copy of James Michener's "Centennial" before they arrive. This book focuses on the history of European settlement of the northeastern Colorado-southeastern Wyoming region, and provides an excellent introduction to the area, its ecology, and its fascinating history of land use.

2. General Orientation:

The first 2 days of the summer will be spent with a field orientation. The students will accompany project scientists for 2 days in the Pawnee National Grasslands and surrounding area. We will discuss the ecology of the shortgrass steppe, and the common land management practices. We will provide an overview of both the natural history and the human cultural context. We will introduce them to the issues that we are interested in, and work to engage the interest of the students in our research.

3. Field, Lab, and Data Analysis Assistance for Research Projects:

During the first 6 weeks of their time here, the students will assist project scientists in existing research projects. The purpose of this involvement is: 1) to introduce the students to the process of science, including question-generation and design phases; 2) to introduce students to field and laboratory methods in ecosystem ecology, and 3) to allow the students to work as part of a team in the field. We would like the students to get a strong sense of the interdisciplinary and cooperative nature of ecosystem ecology.

Each student will be assigned a professor as a lead mentor from our PI list (one of Drs. Burke, Lauenroth, and Antolin), and a more proximal graduate student mentor as well, with whom the student will work most closely. The mentors will be responsible for providing continuity among the field, lab, and data-analysis activities, and for helping to assure that the student feels connected to the science being conducted. We have found that this nested mentoring allows the student to get the intellectual challenges that they need, as well as the day to day assistance and guidance. Thus, the students may work on some team projects with all 3 scientists listed above, but will primarily focus on work by a single PI and graduate student for this phase of their summer.

4. Independent Research Projects:

During week 5, we will begin to work with the students to develop their own research projects. The student research projects will necessarily be extremely well-focused and simple. During the 7th week of the summer, students will conduct their fieldwork, and during the subsequent weeks, they will complete their lab work.

5. Data analysis

When the students get close to completing their lab analyses (about week 10), we will begin to involve them in data analysis for an existing project. Each student will work closely with his or her mentor in this process, and will learn how the researcher is analyzing her or his data using simple graphical and statistical analysis. Further, the students will work with their mentor to plan their own data analysis.

6. Research Completion and Presentation

Students will complete their projects during the last weeks of the summer program. They will present their results to our research group in a special end-of-season symposium. We will invite members of our extended research group for the Shortgrass Steppe Long Term Ecological Research Project.

7. Ecological Society of America meetings

If funds permit, we plan to take students to the ESA meetings in Tucson, AZ. In the eight-year history of REU student involvement in the SGS-LTER, this trip has often been described as a program highlight. Past REU students attended the ESA meetings and commented on how these meetings helped to characterize many of the components of the science of ecology. This exposure to the current field of ecology is invaluable in providing the students with a sense of the discipline, as well as giving them the chance to make contacts for graduate school.

The Research Environment:

The students will be associated with a large, well-equipped facility and a large group of interesting ecologists. The undergraduates will have access to some of the most sophisticated field, laboratory, and computer equipment available, as well as human resources: :

- a new wet chemistry laboratory complete with some analytical equipment
- the Natural Resource Ecology Laboratory wet chemistry laboratory with a large number analytical instruments (probably most importantly an autoanalyzer and autotitrator)
- the LTER computer facility supported by the College of Natural Resources
- an extended group of graduate students, faculty, and technical support (about 40 persons) who work closely together on the LTER project

Student Participants:

We will target highly qualified students in the recruitment process for REU students. Our Honors program has had very successful recruitment of under-represented groups, with a current enrollment of 30% - more than twice that of the University at large. However, we will not limit our search to Honors students: we will advertise the REUs campus-wide, and, through an email network and the WWW, we will advertise these positions nationally. During the past eight years, we have had at least one woman or minority student as an REU participant. We feel that this is an important component of our REU program and we plan to continue to recruit under-represented groups. In addition, for every year, we have had at least one participant from a small liberal arts college (Denison, Middlebury, Oberlin, Earlham, etc). We feel that we provide a different type of research opportunity to these students as well, and we and our students certainly gain from the perspectives of these liberal arts scholars.

Ethics Component:

It is both important and appropriate to give the students a strong sense of the process of science as one that is dependent upon integrity at all stages of the process. We propose to introduce students to a collection of topics that relate to an "ethics component," through group discussions and through interactions with mentors. Our students, postdocs, and investigators regularly discuss issues related to our personal commitment to integrity in a competitive environment, such as quality control in research, and behavioral standards for scientists. We are also very interested in topics related to balancing a sense of professional accomplishment with a well-integrated life, particularly as members of under-represented groups in science. We have identified a number of short readings that elaborate upon these topics.

We will have weekly lunchtime discussions with our research group (postdocs and graduate students), as well as the REU students. Currently, we have such weekly meetings with our group, and we blend informal discussions with more formal ones, sometimes with readings as the focus. The informal atmosphere is very effective for focusing on issues that are philosophical yet have great importance to our daily activities. Past REU students have contributed a great deal to these discussions by introducing discussion topics that may not have otherwise been discussed. Some of the most interesting and provocative topics have dealt with the practicalities of a career in science.

Summary

In summary, we are very excited about the opportunity to continue an REU program. We are extremely enthusiastic about the program and the experiences it affords the students and our research group.

Schoolyard LTER Request

(YEAR 3 of Budget Pages)

We request funding ($15,000) to continue the support of our Schoolyard LTER project, directed by Dr. John Moore at the University of Northern Colorado. This program is timely and will augment efforts that are currently in place. We see our SLTER program an excellent opportunity for outreach to the community and as a means to influence and promote science education.

Schools

We will involve 7 schools (one K-6, one 6-12, one middle school and 4 High Schools) from school districts in the northern Front Range and eastern plains of Colorado. The following schools and science teachers have expressed an interest in the program:

School	Science Teacher
Akron High School, Akron, CO	Ms. Deanna Schrock
Frontier Academy, Greeley, CO	Dr. Sean Madden
Greeley West High School, Greeley, CO	Mr. Gary Prewitt
John Evans Middle School, Greeley, CO	Mr. Jason Mclaughlin
Union Colony Prep School, Greeley CO	Ms. Cathy Hoyt
Rocky Mountain High School, Ft. Collins, CO	Mr. Dave Swartz
S. Christa McAuliff Elementary School, Greeley, CO	Ms. Rebecca Rimerez

Plan of Operation

Science and mathematics teachers from the schools will meet with LTER scientists to visit the SGS LTER site and the demonstration plots at UNC. The group will then hold a workshop to discuss potential experiment designs, data collection, protocol on maintaining databases, and means by which the projects can be integrated into curricula. All data collected will be maintained as part of the SGS-LTER database and made available to the teachers and students.

Site Visit and Workshop: LTER scientist will host a site visit at the Shortgrass Steppe LTER and the UNC Campus Ecology demonstration plots. The objectives of the visits are to familiarize the teachers with the LTER site and experiments, and provide an example of how a field experiment can be scaled-down to a schoolyard setting.

The agenda for the workshop will include deciding on the type(s) of experiments to be conducted at the school, guidelines for supplies and equipment, the variables to be sampled, protocol for data collection, guidelines for web pages (format, databases, etc…), and plans to disseminate the materials developed by the group (e.g., data, curricula, lab modules).

Plot Design and Preparation: At the workshop we will decide on one of three scenarios. One scenario would be to replicate the experiment at the UNC demonstration plots (which is patterned after an LTER experiment) at each of the schools. A second would be to have each teacher decide which LTER experiment (from the SGS or any other LTER site) was best suited for their site and curriculum. The third scenario would have the group develop a unique experiment for the schoolyard that was patterned after the LTER model.

SGS-LTER Weather Station Network: We are in the process of establishing a network of weather stations at each of our partner schools. To date we have provided stations for all but one of our schools. We request funding for the purchase of one Davis Instruments Vantage Pro weather station unit. In order that this station be made capable of remote operation, we also request several components in addition to the basic weather station unit. These include a solar panel, needed to power the station remotely; a wireless data transmitter/receiver package, to send the live weather station data to the main computer server; and the Davis software needed to operate the weather station and process its data. We request $2000 to cover the cost associated with purchasing the above equipment.

The weather station will be installed at the Rocky Mountain High School (Ft. Collins, CO) Schoolyard LTER site. The weather station data will be used to investigate the microclimate characteristics of urban locations, looking in particular at the characteristics of air temperature. The data from the weather station will also be used as reference data for ongoing ecological research projects throughout the SGS-LTER schoolyard network.

WebPages: All materials developed from the projects, databases and a profile of the projects objects and participants will be incorporated into the web pages for the Shortgrass Steppe – LTER, the Department of Biological Sciences at UNC, and those of the participating schools (if they have one). The data manager for the SGS-LTER will lead this discussion.

Research Assistance for Minority High School Students (RAMHSS) Request

(YEARS 4 and 5 of Budget Pages)

We are requesting two years of funding for our RAMHSS program directed by Dr. John Moore at the University of Northern Colorado (UNC) as per the agreement we made in 2001. Two years of funding provides ample funds and time to plan ahead given that we work with cohorts of high school students over three year periods. We have provided a list of students that will be eligible for summer and academic years 2003-2004.

Before going into the specifics of the research and how the students would be involved, we would like to discuss why we are in a unique position with regards to the RAMHSS program. Dr. John Moore and his staff at UNC have been involved with minority high school student education since 1985 through Upward Bound. Upward Bound is a program funded by the Department of Education designed to increase the enrollments of first-generation and low-income students in four year colleges. In Colorado, the majority of these students are students of color. Dr. Moore is currently the Director of a Math and Science Upward Bound Program at UNC that serves 45 high school students from schools in the North Denver to Greeley area. We will select students from the Upward Bound program, and team them up graduate student(s) in Dr. Moore's laboratory and a teacher from a nearby school district. We feel that this maximizes the outreach potential of RAMHSS.

The UNC Math and Science Upward Bound serves 15 high schools from the Greeley and Denver areas. The students are housed on the UNC campus during the summer for the Upward Bound Program. By selecting students from the Upward Bound program, the RAMHSS program would include students from areas that we could not normally serve due to distance and logistics. Furthermore, the Upward Bound Students are highly motivated. They have already expressed an interest in math and science careers. The RAMHSS funds would help solidify this interest. Third, if the students are selected from the Upward Bound pool we can arrange for the students to receive college credit.

Research in Prairie Dog Ecology

RAMHSS scholars will assist Dr. Moore and his graduate students in their studies of the impacts of prairie dogs on the structure and stability of soil food webs. We have copied the relevant question and portions of our proposal below.

Changes in Below-ground Allocation and Food Web Stability: Colonization and grazing by prairie dogs reduces standing biomass and the amount and quality of plant material entering the soil. At other sites, grazing has been shown to increase the exudation of labile carbon through plant roots, increase N-mineralization and decomposition rates, and induce shifts from the fungal to the bacterial pathway (Figure 1).

H1: The bacterial pathway is more active than the fungal pathway on active prairie dog towns compared to both inactive towns and to adjacent short grass steppe because

prairie dog activity (e.g., burrowing and grazing) alters soil structure much like agricultural tillage, releasing occluded soil organic matter (SOM) and decreasing the amount of recalcitrant plant materials entering the SOM pool.

H2: Nitrogen retention is more likely to be lower in plots that have been colonized by prairie dogs than in non-colonized native control plots because colonization changes soil structure, plant community structure and plant quality (narrow C:N), inducing a shift in the soil community from dynamically stable to unstable trophic structures (Figure 2).

Prairie dog activities alter the availability of labile SOM and shift the plant community towards weedy species or accelerates root growth and turn-over (narrows C:N ratios of SOM and plant materials). We predict that extinction of prairie dogs will induce a shift in nutrient cycling and community structure towards the fungal "slow" pathway, while newly colonized will shift toward the bacterial "fast" pathway.

We expect that an analysis of the models developed for each site will reveal that sites that retain nitrogen will be more likely to be dynamically stable than sites that retain less nitrogen (Figure 2). A prediction form the hypothesis is that native sites will possess soil food webs that are dynamically more stable than occupied sites, and that after plague epizootics remove prairie dogs, those sites will quickly converge in community composition to the native sites.

Figure 1

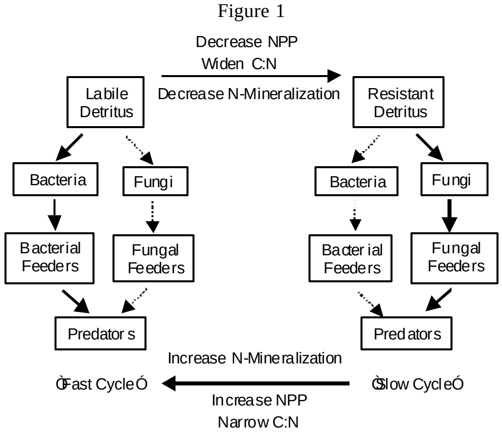


Figure 1. The soil food webs are compartmentalized into three interactive pathways – the root, bacterial and fungal energy channels. Empirical studies at the shortgrass steppe and elsewhere have demonstrated that disturbance can induce changes in the relative flow of nutrients through these pathways and nutrient retention.

Figure 2

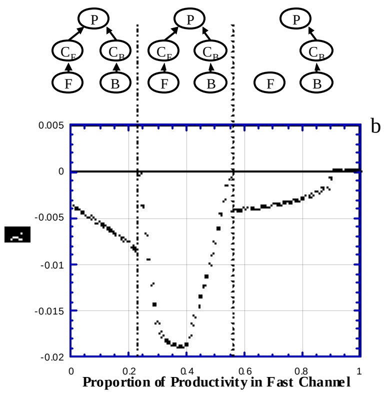


Figure 2. Simulations where the relative proportions of nutrients through the fungal and bacterial channels were altered. Stability is indexed by the most negative eigenvalue, λ. The more stable region occurs when neither the bacterial or fungal energy channel is dominant.

Selection Criteria

Students from under-represented minority groups and/or women will be selected from our pool of Math and Science Upward Bound students. These students are from high schools in the Denver and Greeley areas. In addition to being from under-represented minority groups, these students are either first generation (no one in their immediate family has earned a 4-year degree) or low income (family incomes below 150% of the poverty level, as determined by the Federal Government). To be eligible for the program, all students were required to undergo a formal application process. To remain in the program, students had to maintain satisfactory academic progress based on an individualized plan and behave in a mature manner (no problems with behavior, drugs, etc.).

Students will be evaluated based on their academic performance at their high schools, their previous year's participation in our summer program, and their math and science ACT scores. We have provided a list of potential participants for this summer. All have formally requested that they be considered for participation in some form of summer research. These students were asked to respond to the following in addition to the regular application questions:

1) Why do you think you should be selected for the mentored program?
2) What would you most like to gain from this more independent experience?
3) What qualities will help you succeed as a mentored student?

We have included what information we can about the students for Summer 2003, and the students that will be eligible for Summer 2004, but have excluded their grades, ACT scores and other information that will be used for evaluation for privacy reasons. Dr. Moore and his staff will evaluate their credentials and select five students for RAMHSS support for Summer 2003 and Summer 2004.

Potential Summer 2003 RAMHSS Scholars

School	***Gender***	***Ethnicity***	***High School***
Lourdes Anchondo	F	Hispanic	Adams City
Luis Benitez	M	Hispanic	Lincoln
Deanielle Christopher	F	Caucasian	Windsor
Renee Hernandez	F	Hispanic	Roosevelt
Bridgette McKee	F	Caucasian	Adams City
Paul Ngo	M	Asian	Lincoln
SaDune Quarles	M	African-American	Greeley West
Jaime Salazar	M	Hispanic	Greeley West
John Sigala	M	Hispanic	Denver North
Lucio Smith	M	African-American	Greeley Central
Teresa Trejo	F	Hispanic	Greeley West
David Vargas	M	Hispanic	Greeley West
Danny Vigil	M	Hispanic	Horizen
Kandice Winfield	F	Caucasian	Platte Valley

Potential Summer 2004 RAMHSS Scholars

Student	***Gender***	***Ethnicity***	***High School***
William Esquibel	M	Hispanic	Kennedy
Miguel Gutierrez	M	Hispanic	Northridge
Jessica Montoya	F	Hispanic	Platte Valley
Vy Nguyen	F	Asian	Denver North
Kristina Rodriguez	F	Hispanic	Valley
Cassie Roller	F	Caucasian	Roosevelt
Ashley Saint-Roberts	F	Caucasian	Greeley West

All the students listed above have at least a 3.3 from their respective high schools and 3.8 grade point average from our summer program.

Concluding Remarks

We see this as an excellent opportunity to assist some highly motivated young people. Dr. Moore and his staff have worked with each of the students listed above over the past two years, and all are worthy of support (If there is a way to fund them all, we have the staff in place to work with them). We have over 18 years experience working with high school students and summer programs for high school students. All students are subjected to an orientation that outlines program objectives and expectations. We have a well-tested discipline policy in place, that emphasizes a personal code of conduct, respect for others, and zero-tolerance for drugs and alcohol.

Figures and Literature Cited for Proposed Work

Figures for: I. Rapid Response to Plague Outbreaks to Identify Reservoir Species (YEAR 1 of budget pages)

Figure 1B.) The probability of die-offs of BTPD towns (colonies) in relation to town area during the 21 years between 1980 and 2001. The number of towns of each size in each category are above the bars. Towns larger than15 ha have a high probability of experiencing die-offs.

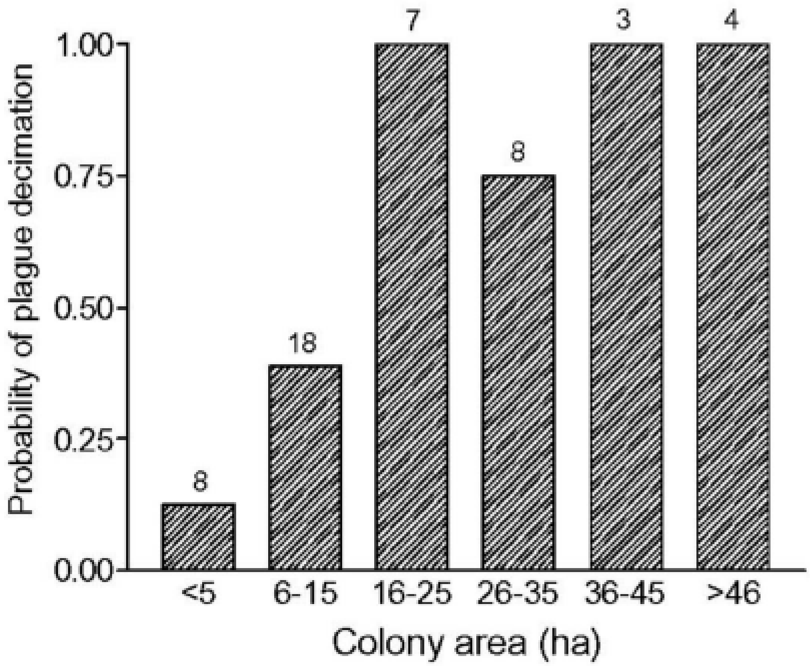


Figure 2: Changes in size of prairie dog towns on the CPER/SGS-LTER and PNG

Figure 2A.) Area of six BTPD towns between 1980 and 2001, on the western portion of the Pawnee National Grassland that adjoins the CPER/LTER site in northern Colorado. The towns have continued to expand during 2001-2002.

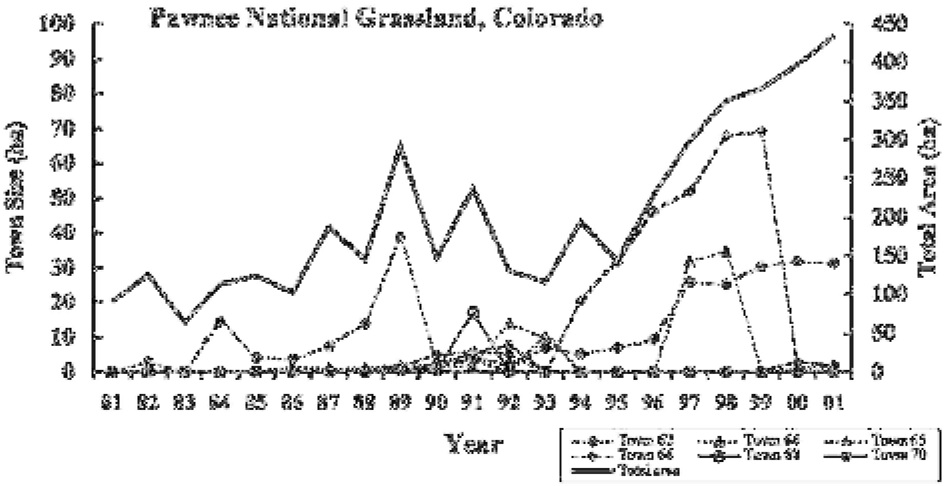
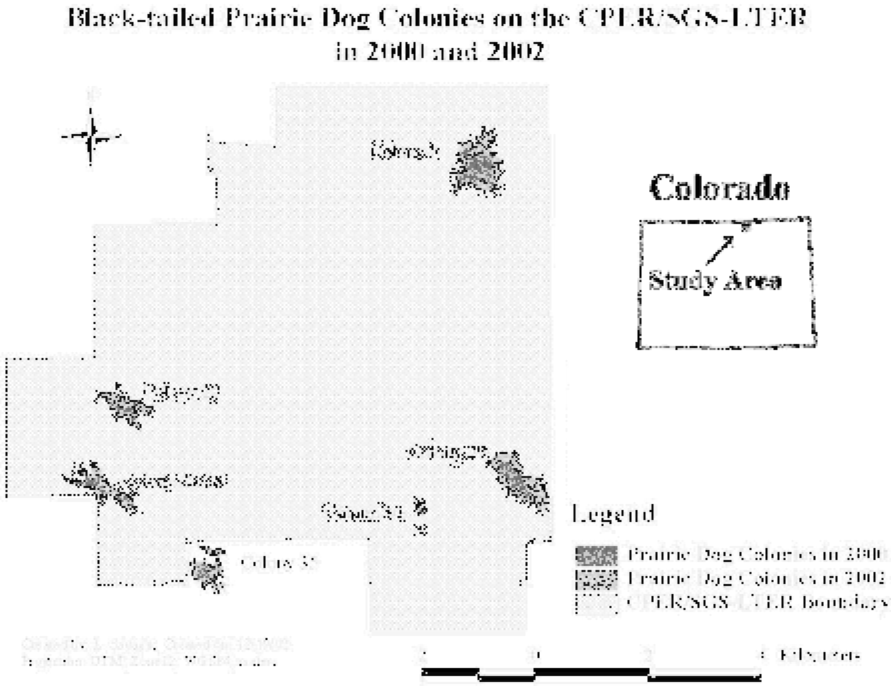


Figure 2B.) Maps of prairie dog towns (colonies) on the CPER/LTER site in 2000 and 2002. Data were generated from GPS coordinates describing the outermost extent of active BTPD burrows in each town, GPS data collected in autumn after time of annual dispersal of BTPD.



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