Sevilleta LTER 1997 Annual Report

Bruce T. Milne, Principal Investigator
Sevilleta LTER II: Biome-level constraints on population, community, and ecosystem responses to climate fluctuation. (DEB 9411976)

1. The Sevilleta LTER Program

The Sevilleta Long-Term Ecological Research Program (LTER) was initiated in October, 1988, and has focused on a suite of ecological hypotheses concerning climate dynamics and the responses of organisms in a biome transition zone in central New Mexico. The Sevilleta LTER research region straddles several major biomes of the Southwest, and the large geographic scale of the Sevilleta region is important for studies that range from genetics and physiology at the organismal level, to the dynamics of biome transition zones. The region is strongly influenced by the El Niño Southern Oscillation (ENSO), with major fluctuations in precipitation on semi-decadal time scales. To date, 100 LTER research papers have been published or are in press.

A. Climate/Meteorology. (Doug Moore)

Climate/meteorological efforts during the past year have focused on maintaining and upgrading the current meteorological network with particular emphasis on installation of soil moisture Time Domain Reflectometry (TDR) instrumentation. There has also been increased effort to directly measure evapotranspiration using Bowen Ratio and Eddy Correlation techniques. Both the soil moisture monitoring and water flux measurements are important in the water balance modeling effort.

Database management continues to be a major part of the meteorological effort and considerable time has been spent making meteorological and climatological information available on the Network. This includes both raw data as well as daily, monthly and annual summaries. This information can be accessed via the Sevilleta - Climate Meteorology Home page at the following URL:
http://sevilleta.unm.edu/meteor/clim-met-home.html

An on-going project is to perform more complete evaluation of the effects of El Niño Southern Oscillation (ENSO) on New Mexico and how that relates to the Sevilleta in particular using GIS spatial analysis techniques available in Arcview 3.0. This involves using an array of High Confidence (HCN) weather stations in and around New Mexico with long-term precipitation and temperature records.

Data management continues to require significant effort in obtaining and archiving of lightning strike location data. There is currently an effort to compare the effectiveness of this data to predict precipitation inputs as compared to that from Nexrad Doppler radar data.

B. Vegetation: Productivity, Populations, and Ecotone Studies. (Bruce Milne, Kimberly Taugher, James Gosz, Debra Coffin)

Overview. During the past year we have completed a large vegetation mapping effort in cooperation with the New Mexico Natural Heritage Program. We also installed 10 new permanent plant transects in our existing

mammal web study sites in an effort to describe the extant vegetation communities, observe changes in composition and diversity over time and provide floral data to accompany our rodent datasets. We are also now studying the changes in floral richness and diversity as well as potential disturbance mechanisms concomitant with the reintroduction of a small population of Gunnison's prairie dog at the Sevilleta National Wildlife Reguge. Data for the vast majority of plant studies at the LTER have been entered, quality checked, analyzed and archived. Analysis of all vegetation transects for 1996 can be found on our web page at: http://www.sevilleta.unm.edu/plant-home.html
Data for our water balance modeling project are analyzed, and are currently being used to build experimental models. Archival for these data are scheduled for the upcoming month.

Water balance model. (Bruce Milne and Scott Martens).

Based on the renewal proposal, the Sevilleta continued to implement a spatially explicit water balance model for the site. We contracted with Dr. Scott Martens to adapt his model, SPLASH, to the Sevilleta. SPLASH couples atmosphere, vegetation, and surface-subsurface hydrology in a distributed, or spatially-explicit, context as a grid of cells. Temporal resolution varies from one second to one day depending on the process simulated. Time steps are adjusted adaptively depending on the fastest water flux to enable efficient computation. This also allows simulation of high-frequency, but important, precipitation or runoff events.

SPLASH includes a microclimate simulator that extrapolates meteorological data (temperature, humidity, precipitation) in space using elevational lapse functions developed previously for the Sevilleta. Solar radiation input, as modified by topography, is also simulated for each cell. Transpiration is estimated using a Penman-Monteith approach. Compartments of water included in the model are canopy storage, snowpack, surface water, unsaturated soil water, and saturated soil water. The fluxes of water modeled are precipitation (rain and snow), canopy throughfall, snowmelt (using an energy balance approach), lateral surface flows (using Manning's equation), infiltration (using Green-Ampt infiltration approach), exfiltration, lateral subsurface flow (using Darcy's law), deep seepage, transpiration, and evaporation from soil and canopy surfaces (using an energy balance approach). Recently completed maps of LAI, plant height, and plant cover will be used in conjunction with two years of monthly plant cover measurements to create monthly resolution plant cover maps for the Sevilleta.

The model was originally designed and used as part of the Sierra Nevada Ecosystem Project at UC Davis where it was applied to forested watershed on the west slope of the Sierra Nevada in California. SPLASH is used for the Canopy Crane site in southern Washington. Eventually, Sevilleta simulations will include carbon and nitrogen cycling modules, e.g., production, decomposition, mineralization, etc., as required for application at the Canopy Crane site. Validation is limited to testing output from components of the model at specific points where pertinent data have been collected, e.g., automated time domain reflectrometry (TDR) measurements of soil moisture, remotely sensed surface temperature measurements made in June 1997 by J. C. Richie from ARS. (http://algodones.unm.edu/waterbal/waterbal.html)

Development of the Sevilleta Vegetation Map. (Bruce Milne, Esteban Muldavin, Greg Shore)

A preliminary vegetation map with nominal 2 ha resolution has been created for the Sevilleta. The map includes 30 vegetation classes derived from an unsupervised classification of 12 Thematic Mapper images collected in three seasons over a four year period. Plant composition, height, and cover were measured at three or more ground points for each class. Leaf area index for the five plant guilds used in the JOR studies were derived for each cover class. The maps provide a valuable resource for the water balance model and serve as general habitat maps for many other studies. Soon, Esteban Muldavin of the New Mexico Heritage Program, will complete a plant classification at the association level from which the 30 classes will be combined, thereby enabling direct comparison with other mapping efforts in the state, i.e., The Gray Ranch,

Melrose Missile Range, White Sands National Monument, Cannon Air Force Base. See data in: (http://algodones.unm.edu/∼bmilne/vegmap/veg.maps.html)

Plant population studies of important grass species. (Debra Coffin).

Because of the importance of black grama and creosotebush in Chihuahuan desert ecosystems, and of blue grama in Great Plains grasslands, our plant population studies are focusing on these three species. In 1996, we initiated a seed production study of blue and black grama at 5 sites differing in dominant species (blue grama, blue grama/black grama, black grama, black grama/creosotebush, creosotebush). We plan to collect seeds of these species again in 1997 and 1998 to coincide with the predicted El Niño event. We also collected soil samples for seed bank analyses at these same sites in November (1995) after a severe drought, and again in November and April (1996) after average rainfall conditions. More blue grama seeds were stored in the soil than black grama for all dates, and blue grama was one of the few grasses with seeds in the soil following the drought. In 1996, we conducted a watering experiment to determine if differences in the temporal and spatial distribution of resource use by blue grama, black grama, and creosotebush could account for codominance of these species at the Sevilleta (Coffin 1997a). Blue grama acquired water at cooler temperatures than black grama, and creosotebush acquired water over a broader range of depths than the grasses. Analyses using the ECOTONE model with this information suggest that these differences in resource use are important to patterns in species dominance. The model also predicted that black grama will increase in dominance under increased temperatures expected with elevated CO2 in the future. Effects of grazing on the availability of soil water under canopies of blue grama compared to black grama are being evaluated with the SOILWAT model (Hochstrasser and Coffin 1997). We are currently conducting an experiment of leaf water potential to further investigate differences in species responses. We are also using the SOILWAT model to evaluate the important environmental constraints on seedling establishment of blue and black grama. We will continue our field and modeling analyses in order to better understand the processes controlling species dominance at these sites.

Climate variability and pinyon pine demography. (Julio Betancourt, USGS-Desert Laboratory; Tom Swetnam, Laboratory of Tree-Ring Research, University of Arizona; and Jerry Gottfried, USDA-Forest Service, Tempe, AZ.)

Dendrochronological methods were used to determine the ages (births and deaths) of 850 seedlings, and more than 2000 living and dead trees in the Sierra de los Pinos back to late 1500s. The inclusion of dead trees in our analysis permits reconstruction of dynamic age structures after 1850. Ancillary data collected at each of our five plots (four 1/2 ha and one 11 ha plot) include diameter at root crown, tree height, and canopy dimensions for all pinyons and junipers in the plots. We also sampled soils under living and dead pinyons of known age to evaluate the stability of soil pH, phosphorous, carbon, and nitrogen content 50-100 years after the trees died.

Recruitment episodes are strongly episodic, with major events represented at two or more of the plots in 1630-1670, 1710-1730, 1770-1790, and 1900-1920. Based on the seedling and sapling data, there also appears to be a pulse in recruitment since 1976. The period from 1942-1956 accounts for most of the mortality evident in the vast number of dead trees across the Sierra de los Pinos. This event eliminated most trees established before 1850, shifted the age distribution to younger trees, and decreased the proportion of pinyons to junipers at all of the plots. Below the litter layer, we found no differences in soil carbon and nitrogen between living trees and trees that have been dead for 50 to 100 years. We aggregated births and deaths across all of the plots and compared demographic trends with regional climate reconstructions from tree rings. This comparison suggests the following model for the long-term behavior of these woodlands. First, broadscale mortality during catastrophic droughts, such as 1575-1595, 1667-1680, 1730-1750,

1890-1904, and 1942-1957 release existing seedlings and saplings from competition for light, water and nutrients and open up niches for recruitment. A preferred niche might be the footprint of a dead tree (a pool of soil and carbon and nitrogen), which persists for 100 years or more. Recruitment pulses tend to occur in the first sustained wet period following the drought and the associated mortality. An example of this process may be the pulse in recruitment since 1976, on the heels of the mid-century drought and sustained by a string of wet winters linked to anomalous warming of the tropical Pacific. Most recently, we have expanded the seedling part of our study to other areas in the middle Rio Grande Basin to discriminate between climate and grazing effects (e.g., fencing of the Sevilleta in 1976). Finally, our study underscores the importance of reconstructing, observing, and assessing ecological processes and patterns at the appropriate scales, i.e., mesoscales and centuries. Ecological synchroneity at these scales is the hallmark of climatic effects on ecosystems and is a key to separating cultural from natural causes of environmental change.

Precipitation Seasonality Recorded in Pinyon Pine Cellulose D/H Ratios. (Elise Pendall, Laboratory of Tree-Ring Research, The University of Arizona, Tucson, AZ.)

The D/H ratio in sap is a tracer of water use by pinyon pine, and D/H in cellulose of tree rings and leaves records precipitation seasonality at sites along a gradient of decreasing monsoon rain. Water use by pinyons shifts from >50 cm to <50 cm depth over the course of the growing season at the Sevilleta LTER, in response to monsoon rain inputs. This contrasts with water use by pinyons at sites in Nevada and northern Arizona receiving less monsoon rain, where deep water (>50 cm) is accessed throughout the growing season. The background source water D/H ratio is related to ENSO-related changes in winter rainfall, and is recorded in tree-ring cellulose at the Sevilleta and in northern Arizona. D/H ratios in sap are enriched during evaporation from needles, imparting a summer humidity signal to photosynthates that is ultimately incorporated into needle cellulose at all sites along the gradient of decreasing summer rainfall. D/H ratios in pinyon needles preserved in packrat middens at the Sevilleta suggest little change over the past ∼40,000 years in monsoon precipitation. Alternatively, tropical moisture sources and abundant late spring precipitation would explain the relatively enriched D/H ratios observed during the Last Glacial Maximum. Data management is in process. All isotopic data (hydrogen and oxygen stable isotopes) from Sevilleta rainfall samples and a few groundwater samples will be contributed to the Sevilleta data base.

C. Nutrient Cycling and Soil Ecology. (Carl White and John Craig)

Primary inputs to ecosystems are determined from chemical analyses of bulk precipitation and the wet/dry collectors (see meteorological section). Annually, replicate litter bags of last year's production of black grama, juniper, Indian rice grass, and creosote are placed at 4 core sites to measure decomposition: Deep Well; Cerro Montosa; Rio Salado; and Red Tank. Collections are made seasonally through the first year and after two years. A fifth species, blue grama, is placed at the Deep Well site also, which represents the most extensive mixture of blue and black grama. The Deep Well site is also a site represented by the LIDET inter-site decomposition study. At these 4 core sites, soil erosion bridges (5 at each site) were installed and are measured to monitor changes in soil microtopography (erosion/deposition). Associated soil analyses include texture, water holding capacity, organic matter, nitrogen mineralization potential, total N and P, and soil conductivity. A synthesis of soil C and N dynamics at a creosote-grassland ecotone was accepted for publication in Ecology.

Data from the C and N dynamics study are available on the web at
http://sevilleta.unm.edu/soil/nc_sub_soil.shtml. A copy of the manuscript with figures and tables is available as well. Also at this address is information on the soil erosion bridge study.

Precipitation chemistry summary and raw data can be viewed at
http://sevilleta.unm.edu/water/ppt_chem/precip_chem.shtml.

Decompostion data are currently being QA/QCed and will be available on the web in the near future. Background information on plant litter deomposition, as well as the LIDET study can be viewed at http://sevilleta.unm.edu/soil/nc_sub_decomp.shtml.

D. Trophic Interactions/Animal Population Studies.

Vertebrates. (Parmenter, Yates, Brown, Friggens, Lightfoot). 1997 is the ninth consecutive year for the spring and fall rodent trapping for the Sevilleta LTER Small Mammal Population Study core dataset. Forty percent of the trapping effort generates material for continuing investigation of taxonomy and population trends of host parasites. This reaserch measures mammal densities at six localities representing the major biomes on the SNWR. A four person crew has completed six weeks of field work this year. We can already see a dramatic population increase this year over the two past drought years, especially within the family Heteromyidae. The Bird Population Trend study consists of seasonal point counts in three habbitat types on the Sevilleta. The bird densities are also up this year, largely a result of bountiful seed crops produced last fall. Rodent data can be viewed at: http://sevilleta.unm.edu/dbl/mammal/doc/master-mammal.lst

Bird data can be viewed at: http://sevilleta.unm.edu/dba/animal/bird_transect.dbf

Arthropods. (Brantley, Parmenter, Lightfoot). The 1996 drought strongly reduced numbers of arthropods collected from the Sevilleta pitfall traps, with abundances not returning to more typical levels until May 1997. Camel cricket numbers increased first, followed by grasshoppers, tenebrionid beetles and spiders. Pitfall sites at Bosque del Apache and in the grasslands of the Magdalena Mountains were closed, but seven study sites remain. The reference collection of several thousand specimens was deposited with the Musuem of Southwestern Biology at the University of New Mexico. Database improvements included the addition of new fields to facilitate data grouping, and a change from species number codes to codes based on species name. This development reflects the growing number of Sevilleta arthropod species that have been identified, rather than listed as "operational taxonomic units." Species distribution data from the Sevilleta have contributed to statewide efforts to inventory arthropod diversity by documenting range extensions and undescribed species. Data are not archived as yet, pending identification confirmations.

E. Disturbance Studies

Wildfires. (Robert Parmenter, James Gosz)

Post-fire measurements of vegetation re-growth is continuing for experimental and natural fire sites on the Sevilleta. Analyses are underway, though data have not been archived. One manuscript on grama grass responses to fires has been published (Gosz and Gosz 1996), and one manuscript on harvester ant responses to fires (Zimmer and Parmenter) has been submitted to *Environmental Entomology*; eight more manuscripts on plants, rodents (2), pronghorn, beetles, grasshoppers, spiders, and homopterans are in preparation.

Prairie dog reintroduction project. (James Gosz, Robert Parmenter, REU-Ana Davidson)

A population reintroduction of Gunnison's prairie dogs was begun in March 1997 in the grasslands near the South Gate region of Sevilleta. The influence of the prairie dogs on vegetation and other rodent species is being measured by REU student Ana Davidson. Data are entered and are being analyzed, but are not archived as yet.

Small scale disturbance studies. (D. Coffin)

We are evaluating the effects of small, patchy disturbances, such as nest sites of harvester ants and mounds

from kangeroo rats, on vegetation dynamics through field studies and simulation modeling. Removal plots (3 m x 4 m) of the dominant species that were initiated in 1995 at five sites along a grassland-shrubland transition zone were resampled in 1996. We found that plant recovery was dependent upon the dominant species removed (Coffin 1997b). Recovery on plots previously dominated by blue grama was largely due to the invasion of species from the surrounding landscape whereas recovery on plots previously dominated by black grama was primarily growth of plants of other species remaining on the plots. Recovery on creosotebush plots was limited to microsites located under shrubs that were removed. These plots will continue to be monitored annually for plant recovery and will be maintained to exclude the previous dominant species from the plots in order to evaluate shifts in dominance through time. As part of this project we are modifying the STEPPE individual plant based model developed for shortgrass steppe communities at the SGS-LTER for grass-shrub ecotones at the Sevilleta. Results from the ECOTONE model indicate that long-term dynamics on these removal plots depend upon the source of propagules, either from the plot, patch or landscape. A recent award to Coffin (DEB97- 07100) will allow us to continue to refine the ECOTONE model for spatial processes (seed dispersal, soil redistribution) occurring across landscapes at the Sevilleta. We will link the model with Arc/Info to access the spatial datalayers already available for the site. We are also analyzing the long-term vegetation transect data to determine the relative importance of patchy disturbances and climate variation to species diversity and composition. Transect data from Rio Salado, Bronco Well, Five Points, and Deep Well from 1989-1996 were separated into undisturbed and disturbed patches, and are being analyzed for temporal and spatial patterns in vegetation.

F. GIS/Remote Sensing. (Greg Shore)

Major tasks undertaken in 1996-97 include: (1) Upgrade/transition primary computer system to Sun Solaris 2.5, and migrate GIS/RS/GPS databases and software to this new system. (2) Complete VegMap Project field work; enter, QA/QC, and archive all field data for Sevilleta LTER and NM Nat Heritage Program for 1994 through 1996; transmit field databases to Dr. Muldavin to complete map labeling, class aggregation, error analysis, and map production Fall 1997. (3) Derive various map products from preliminary VegMap for general use, and for specific use in MODLERS and Water Balance Modeling Projects. Products included average plant cover, height, LAI, and Running's Land Cover Classification, both by image class, and by Jornado LTER (SWB Model) plant guilds within image class. (4) Finish GPS base station installation, real-time DGPS telemetry system, and lightning protection system for same. DGPS telemetry system includes 35W base station transmitter at Sevilleta Field Station, and 17W solar-powered repeater station located on top of Los Pinos mountains on east side of Sevilleta NWR. WWW and anonymous FTP access to GPS base station files to be enabled Fall 1997. (5) Design GIS/RS data management, archiving, and WWW access schema. Conduct ArcView training for PI's, staff, and students. (6) Design VegMap-related research project as part of NASA funded Operational Atmospheric Correction of Satellite Imagery grant, and attended workshop last summer to present proposal. (7) Work with ESA to design and conduct an "Intro to GPS" workshop as part of the annual ESA conference in 1997.

G. Public Outreach. (Robert Parmenter, Terry Yates)

The Sevilleta LTER Program has been featured on public television several times in the past year, and is participating in a future production for PBS. In 1996, we participated in the PBS/Audubon Special, **Wild Wings Heading South**, which featured Sevilleta data on climate change from tree ring analyses and pack rat middens. In addition, the Sevilleta was on the CBS Evening News in June, 1997, in regard to possible Hantavirus problems associated with the predicted 1998 El Niño. The Sevilleta has also been featured repeatedly in local newspapers and on local TV news shows in regard to the El Niño. In September, 1997, we will participate in the making of a PBS teaching video on mathematics and field ecology (C. Marsh's NSF Project). Finally, the Sevilleta LTER group is functioning as the "local organizing committee" for the

Annual Meeting of the Ecological Society of America in Albuquerque, 11-14 August, 1997.

H. REU/UMEB Program. (Ann Evans, Ursula Shepherd, Robert Parmenter, plus many faculty mentors).

The Sevilleta Site REU Program was renewed for 3 years in 1995. The UMEB Program continues to operate in collaboration with the Sevilleta LTER. As in prior years, the goals of these programs are to (1) instruct undergraduates in the principles of scientific research, (2) expose the students to a wide variety of ecological research techniques and career opportunities, (3) facilitate individual student research projects, and (4) encourage students to continue their scientific education in upper-division courses and graduate school. To accomplish these goals, the programs include (1) orientation meetings and a seminar series devoted to the variety of scientific opportunities in ecological research at the Sevilleta, (2) faculty-student one-on-one instruction of hypothesis development and research protocols in ongoing Sevilleta LTER projects, (3) field and laboratory experiences in sampling and data collection, (4) implementation of individual student research projects, carried out under the guidance of student-selected faculty members, (5) a Sevilleta REU Symposium for project presentations by the students, (6) attendance at scientific meetings, and (7) preparation and submission of project manuscripts to scientific journals. These activities integrate all theoretical and technical aspects of the LTER and promote a holistic approach to large-scale ecological studies. All of the 1997 REU/UMEB students have volunteered to assist with the 1997 Ecological Society of America meeting in Albuquerque.

2. Cross-site Activities.

Chihuahuan Desert small mammal exclosure study with Jornada LTER and Mapimi, Mexico.
(David Lightfoot and Jim Brown)

We continue to make routine measurements on the small mammal exclosure study plots at the Sevilleta. Vegetation quadrat measurements, including plant canopy cover, plant species composition, and soil surface disturbance were measured on all quadrats in the autumn of 1996, and early summer of 1997. Grasshopper species composition and abundance, ant nests, and termite foraging activity were measured on all plots at the same time. All data have been entered into computer database files. We have recently implemented the use of a data entry program specifically designed for this project. Image processing analysis of aerial photographs of all study plots is in progress. We will continue with these efforts through 1998. Measurements were also taken at the Jornada LTER, and the Mapimi Biosphere Reserve. We continue to have excellent collaboration and interaction with researchers from the Jornada and Mapimi. We are now supporting four students on the cross-site small mammal exclosure study. One Ph.D. level student, one masters level student, and two undergraduate REU students. All four students are currently conducting their field research at Sevilleta, Jornada, and Mapimi.

Ground-dwelling Arthropods: Bandelier/Sevilleta/Jornada/Mapimi. (David Lightfoot)

We have implemented the same sampling design and protocols for monitoring ground-dwelling arthropods at the Jornada LTER site (NSF funding to the Jornada LTER program) in southern New Mexico, and at Bandelier National Monument (USGS-BRD funding) in northern New Mexico. This extends the Sevilleta ground-dwelling arthropod studies to a regional level, encompassing an environmental gradient from the southern Rocky Mountains to the northern Chihuahuan Desert. All three study areas include a variety of major habitat types, and elevation gradients. We are coordinating sampling times, target arthropod groups, and data formatting at all three sites. We will continue these efforts through 1998.

The Ecology of Small-Scale Disturbances Along a Continental Gradient.
(Debra Coffin, Tamera Minnick)

Many of the small scale disturbance and plant population studies have comparable studies ongoing at the SGS LTER. Furthermore, we are evaluating the probability of seedling establishment for blue and black grama for 16 sites along a climatic gradient from the SGS to Columbus, New Mexico, including the SGS, Sevilleta, and JER LTER sites (Minnick and Coffin 1995). We found the simulated probability of establishment decreased for blue grama and increased for black grama along this north-south transect. Effects of soil texture on these probabilities were recently evaluated (Minnick and Coffin 1997). We are currently conducting a growth chamber study using blue grama seed from the Sevilleta and SGS, and black grama seed from the Sevilleta to determine experimentally the relationship between soil texture, water availability, and seedling establishment for each species. We are continuing a common garden study initiated in 1995 to reveal mechanisms for the exclusion of black grama in northern Colorado, and to compare variation in two populations of blue grama (Minnick and Coffin 1996). Black grama seedlings from the Sevilleta, and blue grama seedlings from the Sevilleta and the SGS are being grown with and without warming chambers at the SGS. Winter mortality in 1995 was low for all treatments, suggesting that low winter temperatures are not the factor constraining the northern limits to the distribution of black grama. Because only seed from black grama plants growing initially at the SGS were viable, and these plants flowered earlier than plants from the Sevilleta, we hypothesize that phenological differences in response to daylength are important in determining the geographic distribution of black grama. We are continuing a study started in 1994 to evaluate the response to disturbance by blue and black grama at the Sevilleta, SGS,

and JER (Minnick and Coffin). We removed half of individual plants of each species at each site where they exist, and have measured annual rate of response by the remainder of the plants. We also removed entire plants to evaluate successional dynamics on these gaps. Very slow response or recovery has been observed; these results are similar to those obtained in previous small-scale disturbance studies at the SGS.

Hungarian cross-site research. (Debra Coffin)

The initiation of collaborative research between scientists at the Sevilleta, Jornada, Short Grass Steppe LTER sites and Hungary is proposed to evaluate the importance of drought and soil texture to arid and semiarid grasslands in both countries. As part of our US-Hungary project (Coffin and Gosz; INT95-13261), we are conducting cross-site comparisons of vegetation pattern and dynamics at three LTER sites (Sevilleta, SGS, JER) and three sites in Hungary along a climatic gradient. In 1997, we are conducting similar spatial sampling of vegetation at all six sites that will allow us to determine the spatial assemblages of species as well as spatial pattern in vegetation from small (1cm) to larger (32m) scales (Kroel-Dulay et al. 1997). Simulation modeling analyses will be used to evaluate current environmental constraints on plant community composition and to predict effects of climate change on vegetation dynamics. James Gosz, Deb Coffin and Sandra Brantley spent two weeks in Hungary in 1996 and Hungarian scientists will work at the Sevilleta and Jornada in 1997.

Nitrogen limitation of mycorrhizae in grassland ecosystems. (Nancy Collins Johnson and Edith B. Allen)

Sevilleta is collaborating on an inter-site mycorrhizae study which examines the effect of N enrichment on grassland mycorrhizae (DEB-9527317). The study examines long-term fertilization plots at Kellogg, Cedar Creek, Konza, Shortgrass Steppe and Sevilleta. In December, 1995, the P.I.'s established nitrogen addition plots near Black Butte at Sevilleta. The plots were fertilized again (with NH_4NO_3)in July and December 1996, and they will be fertilized again in August and December, 1997. Grasses and soils were sampled in April, July and September, 1996. There are measurable changes in root colonization and spore communities (of mycorrhizal fungi) at all of the sites except Sevilleta. The other enrichment experiments have been maintained for 10 or more years so it isn't surprising that Sevilleta hasn't responded yet. The P.I.'s will continue to monitor the responses through next year (and beyond), and will do some functional response experiments using Sevilleta soil inoculum early next year.

3. Network-level Activities.

A. NASA/MODIS MODLERS Project. Bruce Milne has a subaward from Oregon State University to participate in the NASA/MODIS MODLERS Project. This project brings together 14 Long-Term Ecological Research (LTER) Network sites and NASA's MODIS Land (MODLAND) Science Team for the purpose of locally validating Earth Observation System-era global data sets.
(http://atlantic.evsc.virginia.edu/∼jhp7e/modlers/).

B. LIDET Experiment. Sevilleta continues to participate in the LTER Network, and has included the Sevilleta data in the project analyses.

C. LTER Network Soils Workshop. A follow-up working-session of the LTER Soils Workshop was held at Sevilleta in the spring of 1997.

D. LTER Network Climatology Workshop. Sevilleta will host the upcoming workshop on Meteorological Methods to be held in early October, 1997.

E. NASA Sun Photometer Calibration Study. Sevilleta continues to maintain and service a Sun Photometer for NASA which is important for atmospheric corrections of satellite images.

F. USDA/ARS Project. Sevilleta is actively involved in supplying meteorological and evapotranspiration data to a 1997 USDA-ARS Global Change project that was integrating remotely sensed data with ground measurements of energy budgets and water fluxes.

4. Additional Grant Support.

(Total = 22 grants, $8,026,703)

Sevilleta LTER 1997 Supplement Proposal: REU students with the Sevilleta LTER. NSF, $15,000. PIs: Bruce T. Milne, Robert R. Parmenter, Terry L. Yates, and James R. Gosz.

REU supplement to small mammal exclosure cross-site grant, DEB 95-27583. NSF, $5,000. PIs: David Lightfoot and James Brown.

Estimation of Ecosystem Attributes at the Landscape Scale in a Semi-arid Grassland, Subaward from Oregon State University. 1996-97. NASA, $39,962. PI: Bruce T. Milne.

Ecology of Hantavirus Enzootics: Immune Interventions. Brian Hjelle and Terry L. Yates. Department of Health and Human Services, 1 Aug 1997- 30 Jul 2002, $1,350,000.

Longitudinal Studies of Rodent Reservoirs of Hantavirus in the Southwestern United States. Terry L. Yates. Centers for Disease Control and Prevention, 30 September 1996 - 29 September 1997, $188,989.

Longitudinal Studies of Rodent Reservoirs of Hantavirus in the Southwestern United States. Terry L. Yates. Centers for Disease Control and Prevention, 30 September 1997 - 29 September 1998 (pending), $196,068.

Hantavirus Infections: Ecology, Immunity, and Treatment. Terry L. Yates and Fred Koster. Department of Health and Human Services, 1 Apr 1996 - 31 Mar 2000, $2,038,472.

Relocation and compactorization of the Museum of Southwestern Biology. Timothy Lowrey and Terry L. Yates. National Science Foundation, 15 August 1996 - 31 July 1998, $313,200.

Workshop: US/Mexico collaborative long-term research across North American Biomes. Terry L. Yates. National Science Foundation, 1 Sep 1995 - 31 Mar 1998, $27,180.

Response of Southwestern Montane small mammal communities to global change. Terry L. Yates. US Fish and Wildlife Service, 1 Jul 1994 - 31 Jun 1998, $250,000.

Supplement to Response of Southwestern Montane small mammal communities to global change. Terry L. Yates and Jennifer K. Frey. US Fish and Wildlife Service, 30 Sep 1997 - 30 Sep 1998 (pending), $17,500.

Biological Diversity of New Mexico State Trust Land. Terry L. Yates. New Mexico Land Office, 16 Dec 1996 - 30 June 1999, $10,000.

Replacement and consolidation of research training facilities of the Department of Biology, University of New Mexico. Terry L. Yates, Robert R. Parmenter, and Howard Snell. National Science Foundation, 15 Mar 1997 - 31 March 1998, $960,000 + $2,300,000 matching funds from UNM. NOTE: This project will fund the renovation of a UNM campus building which will house the new offices, laboratories and museum collections of the Sevilleta LTER Program and the LTER Network Office.

Ecosystem and Soil Studies of Native American Runoff Agriculture. NSF, $476,713. P.I.: Jonathan A Sandor, Iowa State University (ISU); Co-P.I.s: Mark Ankeny, Daniel Stephens, Carleton S. White, Stephen E. Williams, and Deborah A. Muenchrath.

Water Quality Study in the Santa Fe Watershed. USDA Forest Service. $20,000. PI: Carleton S. White.

Ecology of Fire in Semi-arid Grasslands. USDA Forest Service, $24,876. P.I. Carleton S. White.

Role of climate in masting, recruitment, and mortality of pinyon pine. USDA-Forest Service, Rocky Mtn. Experimental Station, Middle Rio Grande Ecosystem Program, Interagency Cooperative Agreement RM-28-C4-800. Amount $47,000. 1994-1997. ADOR: Jerry Gottfried. PI: Tom Swetnam, Univ. Arizona, and Julio Betancourt, USGS.

Drought in the American Southwest: Hydrological, Ecological, and Socioeconomic Impacts. USDA-Forest Service, Rocky Mtn. Experimental Station, Middle Rio Grande Ecosystem Program, Interagency Agreement. Amount $20,000. 7/97-9/97. ADOR, Dale Brockway. P.I.: Julio Betancourt, U.S. Geological Survey. Edited book by University of Arizona Press: The 1950's

USGS Paleoecological Research at the Sevilleta LTER. DOI, U.S. Geological Survey, Global Change Program: The paleoecological work at the Sevilleta LTER has been done through cooperative agreements where at least half of the resources have been contributed by USGS.

Precipitation Seasonality Recorded in Pinyon Pine Cellulose D/H Ratios. Elise Pendall, Laboratory of Tree-Ring Research, The University of Arizona, Tucson, AZ. NOAA Paleoclimatology Program #NA56GP0180 to S.W. Leavitt and E. Pendall, and the U.S.Geological Survey Global Change Program to J.L. Betancourt.

U.S.-Hungary Grassland Comparisons: Response of Vegetation to Environmental Constraints and Global Change. Coffin, D. P., and J. R. Gosz. NSF International Programs (INT95-13261). $156,076. 1996-1999. REU Support for $8000 for 1997. Collaborative project with Hungarian ecologists (Edit Kovacs Lang, Sandor Bartha, and Gabor Fekete) funded by the Hungarian Academy of Sciences.

CAAW: Development of Landscape Analysis Techniques and GIS Expertise to Predict Vegetation Dynamics at Ecotones. Coffin, D. P. NSF Career Advancement Awards for Women (DEB97-07100). $47,380. 1998.

5. 1996-1997 Sevilleta LTER Publications.

A. Journal Articles

Andreas, E.L., R.J. Hill, J.R. Gosz, D.I. Moore, W.D. Otto, A.D. Sarma. 1997. Statistics of surface-layer turbulence and evaluations of eddy-accumulation coefficients over terrain with meter-scale heterogeneity. Boundary-Layer Meteorology. In press.

Frey, Jennifer K. and Terry L. Yates. November, 1996. Mammalian diversity in New Mexico. New Mexico Journal of Science. 36:4-37.

Gosz, Rusty J., James R. Gosz. 1996. Species interactions on the biome transition zone in New Mexico: Response of blue grama (*Bouteloua gracilis*) and black grama (*Bouteloua eripoda*) to fire and herbivory. Journal of Arid Environments, 34:101-114.

Hawkins, Lauraine K. 1996. Burrows of kangaroo rats are hotspots for desert soil fungi. Journal of Arid Environments. 32:239-249.

Herrick, J. E., K. M. Havstad, and D. P. Coffin. 1997. Rethinking remediation technologies for desertified landscapes. Journal of Soil and Water Conservation (July-August): 220-225.

Hraber, Peter T., Bruce T. Milne. 1997. Community assembly in a model ecosystem. Ecological Modeling. In press.

Johnson, Alan R., Colleen A. Hatfield, Bruce T. Milne. 1996. Simulated diffusion dynamics in river networks. Ecological Modelling. In press.

Keitt, T.H., D.L. Urban, and B.T. Milne. 1997. Detecting critical scales in fragmented landscapes. Conservation Ecology [online]1(1): 4. Available from the Internet. URL: http://www.consecol.org/vol1/iss1/art4

Kieft, Thomas L., Carleton S. White, Samuel R. Loftin, Richard Aguilar, John A. Craig, David A. Skaar. 1997. Temporal Dynamics in Soil Carbon and Nitrogen Resources at a Grassland-Creosotebush Shrubland Ecotone. Ecology. In press.

Mehlman, David W. 1996. Change in avian abundance across the geographic range in response to environmental change. Ecological Applications. In press.

Michener, W.K., J.W. Brunt, J. Helly, T.B. Kirchner, S.G. Stafford. 1996. Non-Geospatial Metadata for the Ecological Sciences. Ecological Applications. In press.

Milne, Bruce T., Alan R. Johnson, Timothy H. Keitt, Colleen A. Hatfield, John David, and Peter Hraber. 1996. Detection of critical densities associated with piñon-juniper woodland ecotones. Ecology. 77:805-821.

Mitchell, R.J. 1997. Effects of pollen quantity on progeny vigor: evidence from the desert mustard *Lesquerella fendleri*. Evolution. 51:In press.

Mitchell, R.J. 1997. Effects of pollination intensity on *Lesquerella fendleri* seed set: variation among plants. Oecologia. In press.

Mitchell, R.J., D.L. Marshall. 1997. Nonrandom mating and sexual selection in a desert mustard: an experimental approach. American Journal of Botany. In press.

Post, D.M., J.P. Taylor, J.F. Kitchell, M.H. Olson, D.E. Schindler, and B.R. Herwig. 1997. The role of migratory waterfowl as nutrient vectors in a managed wetland. Conservation Biology. In press.

Roll, J., R.J. Mitchell, R.J. Cabin, D.L. Marshall. 1997. Reproductive success increases with local density of conspecifics in the desert mustard *Lesquerella fendleri*. Conservation Biology. 11:In press.

Schlesinger, William H., Jane A. Raikes, Anne E. Hartley, and Anne F. Cross. 1996. On the spatial pattern of soil nutrients in desert ecosystems. Ecology. 77(2):364-374.

Smith, F. A., H. Browning, and U. L. Shepherd. 1997. Influence of climate change on the body size of woodrats (*Neotoma*) in an arid region of New Mexico. Ecogeography, In press.

Swetnam, T.R. and Betancourt, J.L. 1997. Mesoscale disturbance and ecological response to decadal climate variability in the American Southwest. Journal of Climate (In Press)

White, Carleton S., Yorgos D. Marinakis. 1996. Relationship between the Southern Oscillation and dry deposition of sulfur and soil elements at the Chiricahua National Monument, southeastern Arizona. Biogeochemistry. In press.

White, C.S., S.R. Loftin, and R. Aquilar. 1997. Application of Biosolids to Degraded Semiarid Rangeland: Nine Year Responses. Journal of Environmental Quality. 26:In press.

Wilber, Patricia G., and Michael J. Patrick. 1996. Mark-recapture vs. simulated removal trapping for assessing temporal patterns in ecological communities: An example using coccidian parasites of two species of rodent. American Midland Naturalist. In press.

Wilson, Wade D., John A. Hnida, Donald W. Duszynski. 1997. Parasites of mammals on the Sevilleta National Wildlife Refuge, Socorro, New Mexico: *Cuterebra austeni* and *C. neomexicana* (Diptera: Oestridae) from *Neotoma* and *Peromyscus* (Rodentia: Muridae), 1991-1994. Journal of Medical Entomology. 34:In press.

B. Book Chapters

Milne, Bruce T. 1997. Applications of fractal geometry in wildlife biology. Pp. 32-69, in: J.A. Bissonette (ed.). Wildlife and Landscape Ecology. Springer-Verlag, New York. In press.

Shanley, J.B, Kendall, C., Pendall, E., Stevens, L.R., Michel, R.L., Phillips, P.J., Forester, R.M., Naftz, D.L., Liu, B., Stern, L., Wolfe, B.B., Chamberlain, C. P., Leavitt, S.W., Heaton, T.H.E., Mayer, B., Cecil, L.D., Lyons, W.B., Katz, B.G., Betancourt, J., McKnight, D.M., Blum, J.D., Edwards, T.W.D., House, H.R., Ito, E., Aravena, R., and Whelan, J.F. 1997. Isotopes as Indicators of Environmental Change. In: Kendall, C. and McDonnell, J.J. (Eds.) Isotopes in Catchment Hydrology, Chapter 23, Elsevier, NY.

C. Other Publications

Betancourt, J.L. 1996. Long and short-term climatic influences on southwestern shrublands. In: Barrow, J. R.; MacArthur, E. D.; Sosebee, R. E.; Tausch, R.J. 1996. Proceedings: symposium on shrubland ecosystem dynamics in a changing climate; 1995 May 23-25; Las Cruces, NM. Gen. Tech. Rep. INT-GTR-338. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, pp. 5-9.

Brantley, S.L. 1997. Surface-active arthropods at the Sevilleta LTER, New Mexico: spatial and temporal patterns in an ENSO-influenced system. Ph.D. Dissertation, University of New Mexico, Albuquerque.

Gottfried, G.J., Swetnam, T.W., Allen, C.D., Betancourt, J.L., Chung-MacCoubrey, A. 1996. Pinyon-juniper woodlands. In: Finch, D. M. and Tainter, J. A., Ecology, Diversity and Sustainability of the Middle Rio Grande Basin. USDA Forest Service General Technical Report RM-GTR-278, pp. 95-132.

Hill, Reginald, James J. Wilson, Achanta D. Sarma, Edgar L. Andreas, James R. Gosz, Douglas I. Moore. 1997. Data sets of the scintillation experiment at Sevilleta. In: NOAA Technical Memorandum ERL ETL. U.S. Department of Commerce. In press.

Hill, Reginald, William D. Otto, James J. Wilson, Achanta D. Sarma, Edgar L. Andreas, James R. Gosz, Douglas I. Moore. 1997. Fluxes of momentum and heat measured at Sevilleta, New Mexico. In: NOAA Technical Memorandum ERL ETL. U.S. Department of Commerce. In press.

Hill, R., William D. Otto, James J. Wilson, Edgar L. Andreas, Achanta D. Sarma, James R. Gosz, Douglas I. Moore. 1997. An evaluation of the scintillation method for obtaining fluxes of momentum and heat. NOAA Technical Memorandum.

Loftin, S.R., R. Aguilar, and G.L. Wolters. 1996. Distribution of Soil OC, TKN, and TP Across a Chihuahuan Desertscrub/Desert Grassland Ecotone Pages 323-324 in N.E. West editor(s). Fifth International Rangeland Congress Symposium Proceedings. International Rangeland Congress, Logan, UT.

Loftin, Samuel R., and Carl S. White. 1996. Potential Nitrogen Contribution of Soil Cryptograms to Post-Disturbance Forest Ecosystems in Bandelier National Monument, NM. In: C. D. Allen (ed.). Proceedings of the 1994 Symposium on the La Mesa Fire, March 29-31, 1994. USDI National Park Service Technical Report. Denver, CO.

Otto, William D., Reginald J. Hill, Archanta D. Sarma, James D. Wilson, Edgar L. Andreas, James R. Gosz, Douglas I. Moore. 1996. Results of the Millimeter-Wave Instrument Operated at Sevilleta, New Mexico. In: NOAA Technical Memorandum. National Oceanic and Atmospheric Administration. In press.

Otto, William D., Reginald J. Hill, James J. Wilson, James R. Gosz, Douglas I. Moore. 1996. Results from optical scintillometers operated at Sevilleta, New Mexico. In: U.S. Department of Commerce, NOAA Technical Report. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Research Laboratories. In press.

Sarma, Achanta D., Reginald J. Hill. 1996. A millimeter-wave scintillometer for flux measurements. In: NOAA Technical Memorandum ERL ETL. U.S. Department of Commerce.

Stafford, S.G., J.W. Brunt, and B.J. Benson. 1996. Training Environmental Information Managers of the Future Pages 111-116 in na editor(s). Proceedings of Eco-Informa '96, Lake Buena Vista, Florida, 4-7 November 1996. ERIM, Ann Arbor, Michigan, USA.

White, Carleton S. 1996. The effects of fire on nitrogen cycling processes within Bandelier National Monument, NM. In: Allen, Craig D. (ed.). Proceedings of the 1994 Symposium on the La Mesa Fire, March 29-31, 1994. USDI National Park Service Technical Report. Denver, CO.

Wolters, G.L., S.R. Loftin, and R. Aguilar. 1996. Changes in plant community composition along a Chihuahuan desertscrub/desert grassland transition zone in central New Mexico. Pages 614-615, in N.E. West, ed. Fifth International Rangeland Congress Symposium Proceedings. International Rangeland Congress, Logan UT.