Annual Report for Period: 11/2004 - 11/2005
Submitted on: 08/25/2005
Principal Investigator: Collins, Scott L.
Award ID: 0217774
Organization: University of New Mexico
Title:
Sevilleta LTER: Long Term Ecological Research in a Biome Transition Zone

Project Participants

Senior Personnel

Name: Collins, Scott
Worked for more than 160 Hours: Yes
Contribution to Project:
Principal Investigator for the Sevilleta LTER Program

Name: Gosz, James
Worked for more than 160 Hours: Yes
Contribution to Project:
Former PI, now Co-PI involved in research on biogeochemistry and plant community dynamics

Name: Yates, Terry
Worked for more than 160 Hours: Yes
Contribution to Project:
Project Leader for research on Hantavirus ecology

Name: Parmenter, Robert
Worked for more than 160 Hours: Yes
Contribution to Project:
Former Project Manager. Continues research program in consumer population dynamics

Name: Wolf, Blair
Worked for more than 160 Hours: Yes
Contribution to Project:
Project Co-PI and leader of the Consumers Research Group

Name: Pockman, William
Worked for more than 160 Hours: Yes
Contribution to Project:
Co-PI and Project leader of the Water in the Environment research group.

Name: Vanderbilt, Kristin
Worked for more than 160 Hours: Yes
Contribution to Project:
Information manager

Name: Dahm, Cliff
Worked for more than 160 Hours: Yes
Contribution to Project:
Formerly interim PI, now leader of the Climate research group.

Name: Muldavin, Esteban
Worked for more than 160 Hours: Yes
Contribution to Project:
Este is a vegetation ecologist

Name: Lightfoot, David
Worked for more than 160 Hours: Yes

Contribution to Project:

David Lightfoot is the lead scientist on the small mammal exclosure study. His specialty is arthropod dynamics, particularly grasshoppers

Name: Allen, Michael

Worked for more than 160 Hours: Yes

Contribution to Project:

Conducts work on mycorrhizae and belowground production in pinyon-juniper woodlands and grassland areas on the Sevilleta

Name: Li, Bai-Lian

Worked for more than 160 Hours: Yes

Contribution to Project:

Larry Li is a theoretical ecologist analyzing spatial patterns and patch dynamics in Sevilleta grasslands

Name: Westman, Carol

Worked for more than 160 Hours: Yes

Contribution to Project:

Carol has students working on soil biogeochemistry and vegetation mapping projects using remotely sensed data.

Name: Small, Eric

Worked for more than 160 Hours: Yes

Contribution to Project:

Eric is one of the lead investigators on the rainout shelter experiments along with Will Pockman. Eric is a hydrologist looking at fine scale moisture fluxes in Sevilleta grasslands and shrublands.

Name: Pennington, Deana

Worked for more than 160 Hours: Yes

Contribution to Project:

Deana was a postdoc investigating the spatial and temporal dynamics of drought at the Sevilleta. She now works for the SEEK project and is supported by the SEV LTER for 1 month each year.

Name: Sinsabaugh, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr Sinsabaugh is an Associate Professor at UNM whose research examines the role of decomposition in nutrient cycling.

Post-doc

Graduate Student

Name: Garcia-Bustamante, Joslyn

Worked for more than 160 Hours: Yes

Contribution to Project:

Joslyn is a PhD student in the Department of Biology at UNM working on thermophilic fungi in the soils of the Sevilleta. She is also our full-time administrative assistant. She maintains project budget spreadsheets and schedules rooms and vehicles for the SEV Field Station

Name: Koontz, Terry

Worked for more than 160 Hours: Yes

Contribution to Project:

Terry is a former member of the field crew specialzing in Botany. She is now a graduate student in Biology at UNM and works on Sevilleta LTER study sites for her thesis concearning seed banks in grasslands. Terri recieved summer graduate support from this grant.

Name: Davidson, Ana

Worked for more than 160 Hours: Yes

Contribution to Project:

Ana Davidson is working on her dissertation research investigating how the presense of prairie dogs and kangaroo rats together and separately affect biodiversity of plants, arthropods, and small mammals and lizards in desert grasslands

Name: Medeiros, Juliana

Worked for more than 160 Hours: Yes

Contribution to Project:

Juliana is completing her Master's Degree research on water relation in different size classes of Creosote bush at the Sevilleta. She will enter a PhD program in Biology at UNM next Fall.

Name: Kurc, Shirley

Worked for more than 160 Hours: Yes

Contribution to Project:

Shrley Kurc is a graduate student at University of Colorado who is supported by the SEV LTER during the summer to support research activies on the Bigfoot project and in the rainout shelter experiment. Her research involves understanding soil moisture dynamics and plant responses in Sevilleta grasslands.

Name: Brandel, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Brian Brandel is a PhD candidate from CSU whose research considers remote sensing of vegetation on the Sevilleta.

Name: Zeglin, Lydia

Worked for more than 160 Hours: Yes

Contribution to Project:

Lydia is a PhD candidate at UNM whose dissertation research is entitled 'Linking structure and function of microbial communities to functionality in the N Cycle'. She receives summer support from this project.

Name: Lauber, Chis

Worked for more than 160 Hours: Yes

Contribution to Project:

Chris is a UNM PhD candidate who received summer support for preliminary PhD research o¡n the Sevilleta NWR which will examine the role of microorganisms as facilitators of nutrient transformation in arid soils.

Name: Gallo, Marcy

Worked for more than 160 Hours: Yes

Contribution to Project:

Marcy is UNM PhD candidate who received summer support for her project entitled 'Microbial diversity in arid ecosystems: connecting function and structure.'

Name: Crenshaw, Chelsea

Worked for more than 160 Hours: Yes

Contribution to Project:

Chelsea is the SevLTER Graduate Student Rep, as well as the LTER Graduate Student Committee Co-Chair. She is a PhD candidate at UNM and received summer support for her research examining rates of NO3 uptake, transformation and denitrification in hyporheic sediments in streams that carry elevated NO3 as a result of agriculture and urbanization

Name: Meehan, Tim

Worked for more than 160 Hours: Yes

Contribution to Project:

Tim is a PhD candidate at UNM. He received summer support for research examining resource use and radio isotopes in a lizard community

Name: McLin, Ryan

Worked for more than 160 Hours: Yes

Contribution to Project:

Ryan is a PhD candidate at NMT. He recisved summer support for research evaluating the relationship between depth of groundwater, soil stratigraphy, and soil salinity in the Rio Grande Bosque near the Sevilleta NWR.

Name: Moses, Melanie

Worked for more than 160 Hours: Yes

Contribution to Project:

Melanie is a PhD candidate at UNM. She received summer support for her research o¡n allometric ant foraging o¡n the Sevilleta NWR

Name: Friggens, Megan

Worked for more than 160 Hours: Yes

Contribution to Project:

Dissertation research supported by SevLTER. See report body.

Name: Stursova, Martina

Worked for more than 160 Hours: Yes

Contribution to Project:

Dissertation research supported by SevLTER. See report body.

Name: Redfern, Joanna

Worked for more than 160 Hours: Yes

Contribution to Project:

Dissertation research supported by SevLTER. See report body.

Name: Edelman, Andrew

Worked for more than 160 Hours: Yes

Contribution to Project:

Dissertation research supported by SevLTER. See report body.

Name: Pershall, Alaina

Worked for more than 160 Hours: Yes

Contribution to Project:

Thesis research supported by SevLTER. See report body.

Undergraduate Student

Name: Tribby, Mariel

Worked for more than 160 Hours: Yes

Contribution to Project:

Summer student employee worked on various SevLTER field initiatives.

Technician, Programmer

Name: Moore, Doug

Worked for more than 160 Hours: Yes

Contribution to Project:

Manages met stations, climate research, NPP datasets, as well as the wireless radio system recently established on the Sevilleta NWR.

Name: Friggens, Mike

Worked for more than 160 Hours: Yes

Contribution to Project:

Mike is our GIS Services and Project Manager.

Name: Wetherill, Karen

Worked for more than 160 Hours: Yes

Contribution to Project:

Karen is head of the field crew. She schedules field crew activities and coordinates data entry and QA/QC by the field crew

Name: Munson, Seth

Worked for more than 160 Hours: Yes

Contribution to Project:

Seth was a member of the field crew during 2002-2004, specializing in plant ecology. He has recently moved on to a PhD program at CSU.

Name: Hickman, Caleb

Worked for more than 160 Hours: Yes

Contribution to Project:

Caleb is a member of the field crew specializing in animal ecology

Name: Craig, John

Worked for more than 160 Hours: Yes

Contribution to Project:

John is a chemist in charge of the SevLTER wetlab and instrumentation. He also manages SevLTER decomp data.

Name: Belludi, Harsha

Worked for more than 160 Hours: Yes

Contribution to Project:

Programmer

Name: Brown, Renee

Worked for more than 160 Hours: Yes

Contribution to Project:

Renee is our systems administrator. She maintains all the SEV computers on campus and at the Field Station. She is also co-managing our wireless network at the Field Site as that is developed.

Name: Zimmerman, Ben

Worked for more than 160 Hours: Yes

Contribution to Project:

Ben worked as a summer intern assisting John Craig.

Name: Dauble, Alison

Worked for more than 160 Hours: Yes

Contribution to Project:

Summer Research Intern

Name: Sweet, Jesse

Worked for more than 160 Hours: Yes

Contribution to Project:

Summer Research Intern

Name: Tovey, M. Garret

Worked for more than 160 Hours: Yes

Contribution to Project:

Summer Research Intern

Name: Nelson, Traci

Worked for more than 160 Hours: Yes

Contribution to Project:

Traci worked as a summer intern in 2003.

Name: Garretson, Eleanor

Worked for more than 160 Hours: Yes

Contribution to Project:

Summer intern worked on various SevLTER field initiatives.

Name: Yeatman, David

Worked for more than 160 Hours: Yes

Contribution to Project:

Summer intern worked on various SevLTER field initiatives.

Other Participant

Research Experience for Undergraduates

Name: Gilman, Casey

Worked for more than 160 Hours: Yes

Contribution to Project:

Casey worked last year with Professors Blair Wolf and Eric Toolson studying the ecophysiology of grasshoppers in blue grama dominated grassland at the Sevilleta. This year she has continued to work with Blair Wolf as an REU student investigating physiological constraints on population biology of a lizard community on the Sevilleta NWR.

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2004 2003

REU Funding: REU supplement

Name: Zieman, Renee

Worked for more than 160 Hours: Yes

Contribution to Project:

Renee comes from Seattle Pacific University, and her REU research examinined invasive plant species on the Sevilleta NWR.

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Seattle Pacific University

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2004

REU Funding: REU supplement

Name: Robinson, Eva

Worked for more than 160 Hours: Yes

Contribution to Project:

Eva came from Colgate University and worked on population dynamics of Ocotillo on the Sevilleta as part of her REU experience.

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Collgate College

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU supplement

Name: Prichard, Drew

Worked for more than 160 Hours: Yes

Contribution to Project:

Participated as an REU and focused his efforts on the fabrication and installation of a rainfall amendment experiment.

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: New Mexico Tech, Socorro NM
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2005
REU Funding: REU supplement

Organizational Partners

University of Colorado at Boulder

University of California-Riverside

University of Nebraska-Lincoln

Fish and Wildlife Service

New Mexico Tech

USDA Forest Service
USFS Staff are collaborating with Sevilleta PI's and staff to study fire effects on grassland composition, shrub species dynamics and pollination ecology and genetic diversity of creosote bush. Also, USFS regional office has provided partial support for a graduate RA working at the Sevilleta.

Other Collaborators or Contacts

See Activities Section of the report

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Findings: (See PDF version submitted by PI at the end of the report)

Training and Development:
The Sevilleta Schoolyard LTER is the Program Bosque Ecosystem Monitoriing Program (BEMP). This program continues to connect students in 16 school systems along the middle Rio Grande through field research activities and student-oriented research symposia. Connections among schools is enhanced because students and teachers collect data in the field on a monthly basis and are also provided with a resource book for classroom activities. Members of the BEMP team as well as undergraduate interns participate and facilitate classroom and field activities. Members of the Sevilleta LTER Program frequently participate in a variety of outreach activities, especially tours of the Sevilleta to a variety of groups (K-12 school groups, university classes, conference attendees, etc.), the annual Sevilleta National Wildlife Refuge Open House, the State Fair of New Mexico, and other types of groups. A group from Belen High School helps Sevilleta scientists with data collection, and in turn these scientists help the students develop classroom-oriented research projects.

This year our Schoolyard LTER program was fortunate to received an Education Enhancement supplement in addition to our annual LTER Program support. The additional funding will be used
to build upon BEMP's demonstrated success of putting students and their teachers into field settings. Additional funds will provide more opportunities and resources for teachers to link field experiences with classroom activities. In particular, BEMP will create a lending library of lesson plans and activity kits that BEMP interns and teachers can readily use with K-12 students. BEMP will work directly with key K-12 students in preparing and coordinating formal presentations and science fair projects. Activity kits and lesson plans will be translated into Spanish for use by Spanish-speaking students and all activities will be placed on the BEMP website where they will be available to teachers throughout New Mexico and elsewhere.

Outreach Activities:

In July 2005 the Sevilleta LTER participated in an outreach visit by Senator Pete Domenici (R-NM). This visit included demonstrations and a poster session on LTER research and it was well attended by the local media. Members of the Sevilleta LTER continue to work with staff at the USFWS Sevilleta National Wildlife Refuge in cooperation with and their outreach programs and activities. Finally, we resubmitted our GK-12 proposal which would link middle school science students and teachers from two rural New Mexico school systems, Belen and Socorro, with the Sevilleta National Wildlife Refuge and the Sevilleta LTER.

see educational activities

Journal Publications

Dahm, C.N., M.A. Baker, D.I. Moore and J.R Thibault, "Biogeochemistry of surface waters and alluvial ground waters in steams and rivers during drought.", Freshwater Biology, p. 1219, vol. 48, (2003). Published

Parmenter, R.R., T.L. Yates, D.R. Anderson, K.P. Burnham, J.L. Dunnum, A.B. Franklin, M.T. Friggens, et al., "Small mammal density estimation: a field comparison of grid-based versus web-based density estimators.", Ecological Monographs, p. 1, vol. 73, (2003). Published

Allen, M.F., J. Lansing and E.B. Allen., "Fine root length, diameter, specific root length and nitrogen concetrations of nine tree species across four North American biomes", Ecological Monographs, p. 293, vol. 72, (2002). Published

Bess, E.C., R.R. Parmenter, S. McCoy and M.C. Molles, Jr., "Responses of a riparian forest-floor arthropod community to wildfire in the Middle Rio Grande Valley, New Mexico", Environmental Entomology, p. 774, vol. 31, (2002). Published

Martinez-Vilalta, J. and W.T Pockman., "The vulnerability to freezing-induced xylem cavitation of Larrea tridentata (Zygophyllaceae) in the Chihuahuan Desert", American Journal of Botany, p. 1916, vol. 89, (2002). Published

Yates, T.L., J.N. Mills, C.A. Parmenter, T.G. Ksiazek, R.R. Parmenter, et al., "The ecology and evolutionary history of an emergent disease: Hantavirus pulmonary syndrome.", BioScience, p. 989, vol. 52, (2002). Published

Weiss, J.L., D.S. Gutzler, J.E.A. Coonrod and C.N. Dahm., "Long-term vegetation monitoring with NDVI in a diverse semiarid setting, Central New Mexico, U.S.A.", Journal of Arid Environments, p. 248, vol. 58, (2004). Published

Weiss, J.L., D.S. Gutzler, J.E.A. Coonrod and C.N. Dahm, "Seasonal and interannual relationships between vegetation and climate in Central New Mexico, USA", Journal of Arid Environments, p. 507, vol. 57, (2004). Published

Bhark, E.W. and E.E. Small., "The relationship between plant canopies and the spatial variability of infiltration in grassland and shrubland of the northern Chihuahuan Desert", Ecosystems, p. 185, vol. 6, (2003). Published

Small, E.E. and S. Kurc., "Tight coupling between soil moisture and the surface radiation budget in semiarid environments: Implications for land-atmosphere interactions.", Water Resources Research, p. 1278, vol. 39, (2003). Published

Rastetter, E.B., J.D. Aber, D.P.C. Peters, D.S. Ojima and I.C. Burke., "Using mechanistic models to scale ecological processes across space and time", BioScience, p. 68, vol. 53, (2003). Published

Symstad, A.J., F.S. Chapin, D.H. Wall, K.L. Gross, L.F. Huenneke, G.G. Mittelbach, D.P.C. Peters, and D. Tilman., "Long-term and large-scale perspectives on the relationship between biodiversity and ecosystem functioning", BioScience, p. 89, vol. 53, (2003). Published

Hobbie, J.E., S.R. Carpenter, N.B. Grimm, J.R. Gosz and T.R. Seastedt., "The US Long Term Ecological Research Program", BioScience, p. 21, vol. 53, (2003). Published

Turner, M.G., S.L. Collins, A.E. Lugo, J.J. Magnuson, T.S. Rupp and F.J. Swanson., "Disturbance dynamics and ecological response: the contributions of Long-term Ecological Research", BioScience, p. 46, vol. 53, (2003). Published

Abramson, G., V.M. Kenkre, T.L. Yates, and R.R. Parmenter, "Traveling waves of infection in the Hantavirus epidemics.", Bulletin of Mathematical Biology, p. 519, vol. 65, (2003). Published

Petrovskii, S., B.-L. Li, and H. Malchow., "Quantification of the spatial aspect of chaotic dynamics in biological and chemical systems.", Bulletin of Mathematical Biology, p. 425, vol. 65, (2003). Published

Corkidi, L., D.L. Rowland, N.C. Johnson and E.B. Allen., "Nitrogen fertilization alters the functioning of arbuscular mycorrhizas at two semiarid grasslands", Plant and Soil, p. 299, vol. 240, (2002). Published

Johnson, N.C., D.L. Rowland, L. Corkidi, L.M. Egerton-Warburton and E.B. Allen., "Nitrogen enrichment alters mycorrhizal allocation at five mesic to semiarid grasslands", Ecology, p. 1895, vol. 84, (2003). Published

Dahm, C.N., J.R. Cleverly, J.E.A. Coonrod, J.R. Thibault, D.E. McDonnell, and D.J. Golroy., "Evapotranspiration at the land/water interface in a semi-arid drainage basin", Freshwater Biology, p. 831, vol. 47, (2002). Published

Peters, D.P.C., "Recruitment potential of two perennial grasses with different growth forms at a semiarid-arid transition zone.", American Journal of Botany, p. 1616, vol. 89, (2002). Published

Weltzin, JF, ME Loik, S Schwinning, DG Williams, P Fay, B Haddad, J Harte, TE Huxman, AK Knapp, G Lin, WT Pockman, MR Shaw, EE Small, MD Smith, SD Smith, DT Tissue and JC Zak., "Assessing the response of terrestrial ecosystems to potential changes in precipitation.", BioScience, p. 941, vol. 53, (2003). Published

Huxman TE, M.D. Smith, PA. Fay, A.K. Knapp, M.R. Shaw, M.E. Loik,
S.D. Smith, D.T. Tissue, J.C. Zak, J.F. Weltzin, W.T. Pockman,
O.E. Sala, B. Haddad, J. Harte, G.W. Koch,
S. Schwinning, E.E. Small, and D.G. Williams., "Convergence across biomes to a common rain-use efficiency.", Nature, p. 18, vol. 429, (2004). Published

Pringle, C.M., S. Collins., "Needed: a unified structure to support long-term scientific research on public lands.", Ecological Applications, p. 18, vol. 14, (2004). Published

Allen, M.F., W. Swenson, J.I. Querejeta, L.M. Egerton-Warburton, and K.K. Treseder., "Ecology of mycorrhizae: A conceptual framework for complex interactions among plants and fungi.", Annual Review of Phytopathology, p. 271, vol. 41, (2003). Published

Treseder, K.K., C.A. Masiello, J.L. Lansing, M.F. Allen, "Species-specific measurements of ectomycorrhizal turnover under N-fertilization: combining isotopic and genetic approaches.", Oecologia, p. 419, vol. 138, (2004). Published

White, Carleton S., Douglas I. Moore, John A. Craig., "Regional-scale drought increases potential soil fertility in semiarid grasslands.", Biology and Fertility of Soils., p. 73, vol. 40, (2004). Published

Makarieva, A.M., V.G. Gorshkov, B.-L. Li., "A note on metabolic rate dependence on body size in plants and animals.", Journal of Theoretical Biology., p. 301, vol. 221, (2003). Published

Hochstrasser, T., and D. P. C. Peters, "Subdominant species distribution in microsites around two lifeforms at a desert grassland-shrubland transition zone.", Journal of Vegetation Science., p. 615, vol. 15, (2004). Published

Kroel-Dulay, Gy., P. Odor, D. P. C. Peters, and T. Hochstrasser., "Distribution of plant species at a transition zone between the shortgrass steppe and the Chihuahuan desert grassland.", Journal of Vegetation Science., p. 531, vol. 15, (2004). Published

Peters, D. P. C., D. L. Urban, R. H. Gardner, D. D. Breshears, and J. E. Herrick., "Strategies for ecological extrapolation.", Oikos, p. 627, vol. 106, (2004). Published

Peters, Debra P. C., "Selection of models of invasive
species dynamics.", Weed Technology., p. 1236, vol. 18, (2004). Published

Kerkhoff, A.J., S. N. Martens, G.A. Shore and B.T. Milne, "Contingent
effects of water balance variation on tree cover density in semiarid
woodlands.
", Global Ecology and Biogeography, p. 237, vol. 3, (2004). Published

Kerkhoff, A.J., S. N. Martens, and B.T. Milne., "An ecological
analysis of Eagleson's optimality hypotheses.
", Functional Ecology., p. 404, vol. 18, (2004). Published

McClellan. Y, R. August, J. Gosz, S. Gann, R. Parmenter, M. Nelson, and M. Harper., "Plant and Environment Interactions: Uptake Rates of Thorium Progeny in
a Semiarid Environment.
", J. Environ. Qual., p. 1759, vol. 32, (2003). Published

Huxman, TE, D Tissue, K Snyder, J Leffler, K Ogle, WT Pockman, DR Sandquist, and DG Williams., "Precipitation pulses and carbon dynamics in semi-arid and arid ecosystems.", Oecologia, p. , vol. , ( ). Accepted

McCulley RL, EG Jobbagy, WT Pockman, and RB Jackson., "Nutrient uptake as a contributing explanation for deep rooting in arid and semi-arid ecosystems.", Oecologia, p. , vol. , ( ). Accepted

Huxman, TE, BP Wilcox, R Scott, K Snyder, D Breshears, EE Small, KH Hultine, WT Pockman, and RB Jackson., "Ecohydrological implications of woody plant encroachment.", Ecology, p. 208, vol. 86, (2005). Published

Seyfried, M.S., S. Schwinning, M.A. Walvoord, W.T. Pockman, B.D. Newman, R.B. Jackson and F.M. Phillips., "Ecohydrological control of deep drainage in semiarid regions.", Ecology, p. 277, vol. 86, (2005). Published

A.K. Knapp, M.D. Smith, S.L. Collins, N. Zambatis, M. Peel, S. Emery, J. Wojdak, M.C. Horner-Devine, H. Biggs, J. Kruger and S.J. Andelman, "Generality in Ecology: Testing North American Grassland Rules in South African Savannas", Frontiers in Ecology and the Environment, p. 483, vol. 2, (2004). Published

Chen, X., B.-L. Li, and S. Collins, "Multiscale monitoring of multispecies case study: two grass species at Sevilleta.", Plant Ecology, p. 149, vol. 179, (2004). Published

Cook, W., D. Casagrande, D. Hope, P. Grossman, and S. Collins. 2004, "Learning to roll with the punches: Adaptive experimentation in human-dominated systems.", Frontiers in Ecology and the Environment, p. 467, vol. 2, (2004). Published

Davis, M., J. Pergl, A.-M. Truscott, J. Kollmann, J. Bakker, R. Domenech, K. Prach, A.-H. Prieur-Richard, R. Veeneklaas, P. Pysek, R. del Moral, R. Hobbs, S. Collins, S. Pickett, and P. Reich., "Vegetation change: a reunifying concept in plant ecology.", Perspectives in Plant Ecology, Evolution, and Systematics., p. 69, vol. 7, (2005). Published

Duran, K., T. Lowrey, R. Parmenter, and P. Lewis., "Genetic diversity in Chihuahuan Desert populations of creosotebush (Zygophyllaceae: Larrea tridentata).", American Journal of Botany, p. 722, vol. 94, (2005). Published

Body size, energy use, and community structure of small mammals., "Body size, energy use, and community structure of small mammals.", Ecology, p. 1407, vol. 86, (2005). Published

Hochstrasser, T., and D. P. C. Peters., "Subdominant species distribution in microsites around two lifeforms at a desert grassland-shrubland transition zone.", Journal of Vegetation Science, p. 615, vol. 15, (2004). Published

Huxman, T., B. Wilcox, R. Scott, K. Snyder, D. Breshears, E. Small, K. Hultine, W. Pockman, and R. Jackson., "Ecohydrological implications of woody plant encroachment.", Ecology, p. 308, vol. 86, (2005). Published

Kurc, S. A. and Small, E. E., "Dynamics of evapotranspiration in semiarid grassland and shrubland ecosystems during the summer monsoon season, central New Mexico.", Water Resources Research, p. W09305, vol. 40, (2004). Published

Makarieva, A. M., Gorshkov, Victor G., Li, Bai-Lian., "Why do population density and inverse home range scale differently with body size?", Ecological complexity, p. 259, vol. 2, (2004). Published

McFadden, L., M. Eppes, A. Gillespie, and B. Hallet., "Physical weathering in arid landscapes due to diurnal variation in the direction of solar heating.", GSA Bulletin, p. 161, vol. 117, (2005). Published

Morozov, A., Petrovskii, Sergei, Li, Bai-Lian., "Spatiotemporal complexity of patchy invasion in a predator-prey system with the Allee effect.", Journal of theoretical biology, p. , vol. , ( ). Accepted

Pennings, S., C. Clark, E. Cleland, S. Collins, L. Gough, K. Gross, D. Milchunas, and K. Suding., "Do individual plant species show predictable responses to nitrogen addition across multiple experiments?", Oikos, p. , vol. , ( ). Accepted

Peters, D., R. S. Pielke, B. Bestelmeyer, C. Allen, Munson-McGee, S., and K. Havstad., "Cross scale interactions, nonlinearities, and forecasting catastrophic events.", Proceedings of the National Academy of Sciences, p. 15130, vol. 101, (2004). Published

Peters, D. P. C., "Selection of models of invasive species dynamics.", Weed Technology, p. 1236, vol. 18, (2004). Published

Peters, D. P. C., Gosz, James R., Pockman, William T., Small, Eric E., Parmenter, Robert R., Collins, Scott L., Muldavin, Estaban., "Integrating patch and boundary dynamics to understand and predict biotic transitions at multiple scales.", Landscape Ecology, p. , vol. , ( ). Accepted

Petrovskii, S., Morozov, Andrew, Li, Bai-Lian., "Regimes of biological invasion in a predator-prey system with the Allee effect.", Bulletin of Mathematical Biology, p. 637, vol. 67, (2005). Published

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Web/Internet Site

URL(s):
http://sev.lternet.edu
Description:
This is the Sevilleta LTER website.

Other Specific Products

Contributions

Contributions within Discipline:
The Sevilleta LTER has contributed to several important questions within the discipline. In particular, we have shown that aridland vegetation is resilient to haevy grazing by cattle. Results from our long-term studies show that many of the grasslands on the Sevilleta are once again dominated by long-lived perennial C4 grasses and native forbs.

We have concluded that ENSO events are not significant drivers of long-term vegetation change, but they do have short term impacts on netprimary production and consumer dynamics, particularly small mammal populations.

Detailed analyses of soil moisture fluxes show the ability of these systems to respond to precipitation pulses, and that these responses differ somewhat in grassland and shrubland primarily as a function of differences in total vegetation cover, but not in water use, per se.

Past work has shown that these arid grasslands can recover rapidly from fire given sufficient summer precipitation in the year of the fire. Indeed, 2004 was a year of average precipitation that yielded significant aboveground growth by domiant and subordinate species following the 2003 fire. Surveys of shrub responses to fire suggest that nearly all monitored invdividuals have sprouted this year.

Sevilleta personnel continue to play a role nationally in the development and implimentation of EML.

We are just beginning to investagate the causes and consequences of low soil fertility (N and C pools) on ecosystem processes. We hypothesize that low fertility may be a consequence of past grazing coupled with relatively young and active surface soils. This might imply that C and N cycles are mostly decoupled from each other, and from production/decomposition dynamics. In 2005 we received a 'proof of concept' award from NSF-Ecosystems to determine if the N-cycle in aridland ecosystems is driven by fungi rather than soil bacteria. This will be a major line of exploration for future biogeochemical research.

In 2004 we will complete the addition of irrigation systems to increase annual precipitation inputs by 50% and have nearly completed the intallation of a new set irrigation plots that will allow us to control precipitation amount and interval between precipitation events. This experimental infrastructure is now in place and is being tested prior to adding our first pulse of precipitation.

With regard to pulse events and ecohydrology in aridland ecosystems, we have developed a new pulse-dynamics model that incorporates NPP and consumer dynamics that will have broad application in aridland ecosystems worldwide.

Contributions to Other Disciplines:

We continue to maintain our strong linkages between ecological research at the SEV and geoscience research, especially geomorphology and soils, hydrology and climatology. The Sevilleta will serve as a site for the development of models to better predict the North American Monsoon and for scaling up evapotranspiration losses regionally. Current work reflects a collaboration between soil scientists and hydrologists on soil moisture fluxes and how this affects soil development and nutrient transfers in aridlands.

New work in 2004 was designed to investigate how evaporation and transpiration are partitioned in aridland ecosystems. This is a challenging general research question. Sev PI's are working with scientists at Penn State and New Mexico Tech to address this issue.

A new experiment to begin in the fall of 2005 will look at multiple global change effects on species interactions and how interactions may cause the transition from grass-dominated to shrub-dominated ecosystems.

Contributions to Human Resource Development:

The Sevilleta Schoolyard LTER program connects K-12 kids to ecosystem monitoring and research through field and classroom activities. These activities will be further developed with the Education Enhancement funds received in 2005.

The Sevilleta also serves as a testbed for the development and implimentation of wireless sensor webs and sensor technology. These projects are scalable, and can be translated to other ecosystems. The SEV provides a technological challenge to the engineers and computer scientists who are developing this technology because of its abundant sunlight and high temperatures. Our past experience in this areawas with Sensor Web 3.1. In collaboration with scientists at JPL and Los Alamos National Labs we will deploy Sensor Web 5.0 pods in our global change experiment, develop algorithms for data outliers on the fly, and start the process of using intelligent sensor technology to operate experimental infrastructure.

We have installed a wireless backbone on the Sevilleta which can serve as a prototype for wireless systems at other relatively remote LTER sites.

We continue to involve undergraduate students in all phases of our project through hiring of summer interns and through the annual REU supplements.

The Sevilleta will host a SEEDS workshop in 2005 as a first step in broadening participant diversity within the Sevilleta LTER and across the LTER Network. Also, Sevilleta scientists are helping to establish a SEEDS chapter here at UNM.

Contributions to Resources for Research and Education:

See about about BEMP.

We resubmitted our GK-12 Track 1 proposal this year in hopes of partnering the Sevilleta with middle school systems in Socorro and Belen, NM, and the education programs at the Sevilleta National Wildlife Refuge.

Contributions Beyond Science and Engineering:

Our research provides key information and understanding about aridland ecosystems that is used by the Fish and Wildlife Service in making management decisions.

Work by Sevilleta scientists on ecosystem processes and restoration in the bosque is contributing directly to the development of a state water plan, and water management through ecological restoration. Plans for extensive restoration continue in 2005 and Sevilleta scientists are actively involved in planning, designing and monitoring these riparian restoration efforts.

In addition, with EPSCoR funding and pending proposals we hope to determine the role of high elevation pinon-juniper ecosystems in ground water recharge, a crucial issue in the arid southwestern US. Pervasive regional drought has caused large scale die-offs in these ecosystems which will have a significant impact on fire frequency and wildlife populations, among other things.

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Unobligated funds: $ 0.00

Animal, Human Subjects, Biohazards: None

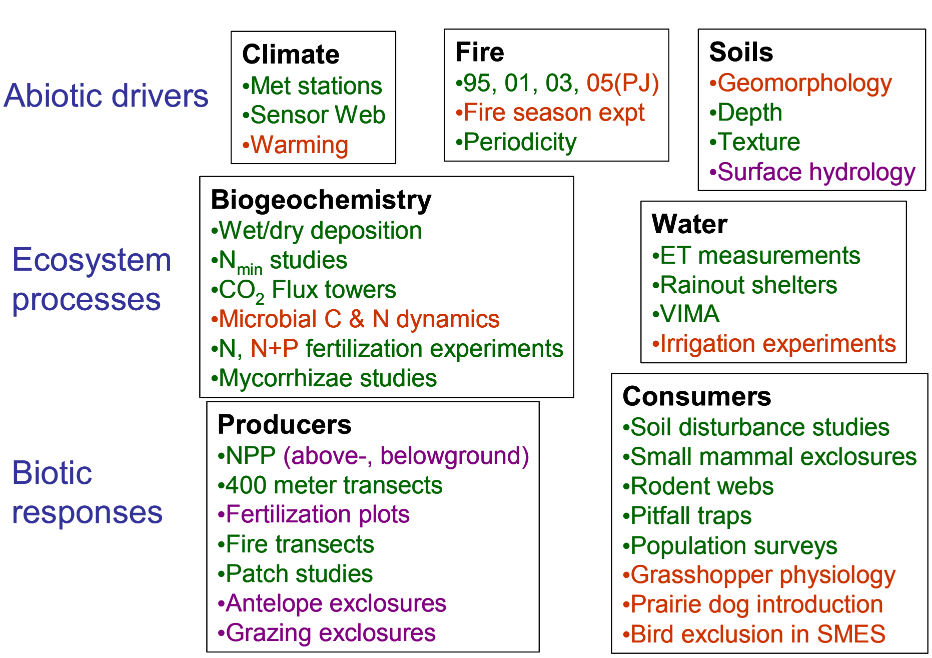
Categories for which nothing is reported:

Any Product

ACTIVITIES

The overarching goal of the Sevilleta LTER Program is *to understand how abiotic pulses and constraints affect species interactions, community structure and ecosystem processes in arid land ecosystems*. The Sevilleta LTER Program is organized around understanding the individual and interactive effects of three key system components: abiotic drivers, ecosystem processes and biotic responses and feedbacks (Fig 1). In our case, the main abiotic drivers are (1) seasonal, annual and decadal variations in climate, (2) geomorphology, soil texture and depth, and surface hydrology, and (3) season and periodicity of fire. These abiotic drivers affect biogeochemical cycles, particularly nitrogen, phosphorus and carbon, as well as water input, storage, use and loss. Biotic responses to the coupling of these abiotic drivers and ecosystem processes include patterns and controls on net primary production, and the distribution, abundance, diversity and dynamics of plant and animal populations and communities. Although there is considerable research linking primary production and plant community structure, one of the core activities of the Sevilleta LTER is to link climate dynamics, disturbances, and soil structure with soil nutrient and water fluxes to better understand seasonal and annual variability in NPP and its impact on the dynamics, distribution and abundance of key aridland consumers, particularly small mammal populations, lizards and arthropods. Our research program is organized into five main research areas: Climate and abiotic drivers (Cliff Dahm, Group Leader), Soils and biogeochemistry (Bob Sinsabaugh, Group Leader), Water fluxes (Will Pockman, Group Leader), Producer dynamics (Esteban Muldavin, Group Leader), and Consumer dynamics (Blair Wolf, Group Leader). New and continuing research includes a wide variety of activities in each sub-area (Fig 1). This figure, along with our new conceptual framework on multi-scale pulse dynamics in aridland ecosystems, forms the basis of our upcoming renewal proposal. Many of the activities and findings in this annual report reflect our response to the 2003 Site Visit. Major recommendations of the site visit team included expanding and generalizing our conceptual framework, increasing our focus on belowground processes, getting more UNM faculty and graduate students involved in Sevilleta LTER research, and increasing our publication output. We have taken these recommendations seriously and we hope this report reflects our response to the review team's major recommendations.

Fig. 1 Current, New and Planned Sevilleta LTER Research Activities



The Sevilleta LTER Program was particularly active during 2004-2005. During the past year we continued our long term observational studies and manipulative experiments, and we added several new, important observational sites and experimental projects. These activities are briefly outlined below in two sections, Continuing Activities and New Activities. Outcomes of some of these activities are highlighted in the "Findings" section.

Continuing Activities: In the area of **climate and abiotic drivers** we continued to maintain a network of seven comprehensive meteorological stations across the Sevilleta National Wildlife Refuge. In addition, we are now a site in NOAA's Climate Reference Network. Finally, the Sevilleta LTER is serving as a test site for the development of intelligent wireless sensor networks for ecological monitoring, in this case monitoring of microclimate under different species of native shrubs (See Findings). In addition, we received funding from NSF-Ecology (Fargione, Collins, Pockman, PI's) to start a new climate manipulation experiments at the Sevilleta that will determine experimentally the effects of increased nighttime temperatures (especially in winter), increased El Nino events, and increased N deposition on interactions between three dominant species, blue grama, black grama and creosotebush. Also, we just completed installation of infrastructure to allow us to manipulate precipitation pulses (size and interval between events) that will allow us to control, to some extent, precipitation, the key driving variable in aridland ecosystems. This will compliment a recently funded experiment (NIGEC, Pockman and Small, PI's) to increase precipitation inputs by 50% adjacent to the existing rainout shelters that reduce precipitation by 50%.

In the conceptual area of **biogeochemistry and soils**, we continued to measure root and mycorrhizae dynamics in an N-fertilization experiment established in 1995 as part of a cross-site study to determine the effect of N deposition on mycorrhiza-plant interactions. Twelve of the 20 plots had minirhizotrons installed several years ago and we continue to take seasonal readings in these minirhizotrons each year. We continued our monitoring of bulk nitrogen deposition at 11 sites across the Sevilleta and wet-dry deposition at two sites. Soil microtopography and Nmin are sampled seasonally in recently burned (2003) and unburned grassland. We have continued fertilizer applications in our long-term N-fertilization experiment (see also New Activities, below). Finally, we continue to maintain three eddy covariance flux towers (in riparian forest, upland grassland and creosote shrubland) at the Sevilleta. These towers measure CO2 and ET fluxes at each site.

We continue to measure soil water dynamics and ecosystem level **water fluxes** in riparian, grassland and shrubland areas of the Sevilleta via numerous soil moisture probes at the Very Intensive Moisture Array site and the rainout shelter plots located in creosotebush, transition and grassland areas, and at three ET flux tower sites in riparian forest, grass and shrub-dominated areas. We will continue to remove 50% of ambient rainfall in replicated plots in grassland, shrubland and transition areas to induce drought and assess the impacts of severe drought on plant physiology and various ecosystem processes (Fig 2). In addition, our new rainfall pulse, 50% water addition and nighttime warming experiments will add to our general understanding of soil water dynamics and ecosystem processes.

Fig 2. Rainout shelters in creosote-dominated shrubland. Similar shelters are located in black grama dominated grassland and in a grass-shrub transition zone. Water addition plots are located behind the rainout shelters.

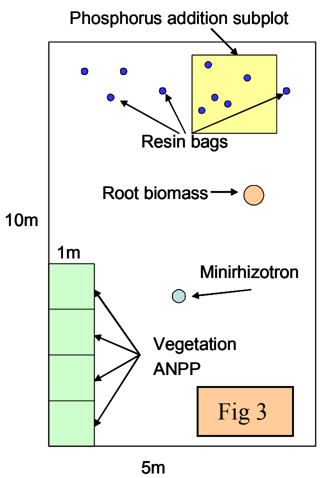
In the area of **producer dynamics**, we continued to measure vegetation composition and structure along two 400-m long permanently located line intercept transects on McKenzie Flats. Data from 1989-2003 were analyzed and presented by Collins et al. at the 2004 ESA Annual Meeting in Portland, OR. In addition, we continued to measure vegetation composition along four 100-m long permanently located line intercept transects that cross a burned-unburned boundary from a wildfire in 1995. We continue to measure plant community composition in grassland and shrubland areas with and without rodents (See Findings), and we continued to maintain and measure plant species and functional group removal experiments (See Findings). In addition, we measure ANPP at our core blue grama, black grama and creosote sites, and we measure belowground root and mycorrhizae dynamics in minirhizotrons in the N fertilization experiment, mixed grass-dominated vegetation near Deep Well, creosote-dominated vegetation near Five Points, mixed grass-shrub vegetation in the rainout shelters, and under fertilized and unfertilized piñon and juniper trees in the Los Piños Mountains.

Continuing measurements of **consumer dynamics** include small mammal and arthropod pitfall traps in blue grama, black grama, creosote, and piñon-juniper sites, and grasshopper populations in grassland, grass-shrub transition and shrub-dominated sites. We also monitor coyote and rabbit abundance on McKenzie Flats. One of the unique activities of the Sevilleta LTER is our long-term monitoring of native bee populations in desert grasslands spearheaded by the head of our field crew, Karen Wetherill, in collaboration with Burt and Rose Pendleton of the USFS Rocky Mountain Research Station in Albuquerque.

New Activities: In the area of **climate and abiotic drivers** we will be installing a new Sensor Web 5.0 network to monitor microclimate variation in our new nighttime warming, El Nino, N-deposition experiment funded by NSF-

Ecology and EPSCoR. Sensor Web 5.0 is a much improved system of wireless sensors developed by Kevin Delin and colleagues at NASA's Jet Propulsion Lab. Wireless sensor networks are not passive dataloggers without wires, instead, they can be programmed to perform QA/QC and activation algorithms, among other duties, on the fly (See Findings). The new experiment where we will install the Sensor Web 5.0 is designed to manipulate key climatic drivers that will ultimately affect microclimate, precipitation and soil moisture dynamics and nutrient availability in a system that is chronically low in water and nitrogen. This experiment links with producer dynamics in that it is designed to determine if predicted changes in rainfall, nitrogen and temperature will increase the rate at which woody vegetation, particularly creosotebush, will invade and eventually replace grass-dominated vegetation.

Water fluxes: Using start-up funds provided by UNM to PI Collins, we are installing a replicated field experiment that will allow us to control the size and frequency of monsoon rainfall pulses in desert grassland. Treatments will include ambient rainfall (reference plots), and plots which receive (1) one large rainfall event each month, (2) two medium-sized rainfall events each month or (3) small, weekly rainfall events. Each of the three rainfall addition treatments will receive the same amount of total rainfall by the end of the monsoon season (July-Sept). Subplots in each treatment plot will receive N fertilizer at a rate of 5gNm-2 in two 2.5g applications each year to allow us to determine how rainfall pulses interact with N dynamics to affect soil C fluxes, community composition and annual aboveground NPP. This experiment is co-located with, and will compliment data from, existing infrastructure that either removes 50% ambient rainfall from replicate plots or increases ambient rainfall by ca. 50% each year (Fig 2).



Biogeochemistry and soils: We have greatly enhanced our research activities in our long-term N-fertilization plots (Fig 3). In 2005, we received "proof of concept" funding from NSF-Ecosystems (Sinsabaugh, Collins, Allen, Hanson, PI's), to investigate the role of fungi in the N cycle of these arid grasslands (See Findings). In addition, we now measure plant species composition, above- and belowground NPP, N and C availability, and extracellular enzyme activities in treatment and control plots. We have also added P-addition subplots within the N fertilization plots so that we can determine the relative roles of N and P in this aridland ecosystem. Increasing our activities in these plots allows us to tie into an important LTER cross site synthesis of fertilization effects on plant community structure and dynamics (Suding, Collins et al. 2005, Pennings et al. 2005). Bryan Brandel, a graduate student at the University of Colorado, is studying N and C dynamics across the grass- to shrubland ecotone. This work will allow him to use remote sensor to scale up N and C processes at the Sevilleta. In addition to our nutrient amendment experiments, two graduate students from the Department of Earth and Planetary Sciences at UNM started to characterize the geology and geomorphology of the McKenzie Flats area, one of our main study areas at the Sevilleta, using a series of deep soil trenches (See Findings).

Producer dynamics: In 2004-5 we initiated collection of plant species composition in 48 permanently located quadrats in two experiments that were initially established in 1993 but lacked consistent vegetation collection protocols. The first experiment addresses the effect of grazing on plant community dynamics in desert grassland. Three replicate 300x300m exclosures were established in a grazed pasture north of the Refuge boundary. These exclosures were paired with three sample areas open to grazing by domestic cattle. In addition, there are three similarly sized sample areas inside the Refuge boundary. This allows us to measure the short-term and long-term recovery dynamics of grasslands following grazing by domestic cattle. Soil N dynamics and standing crop are also measured annually in each treatment. In 2004 we also initiated a similar sampling protocol in another experiment with and without browsing by native antelopes. This experiment has four replicates of the following treatments burned in 2003 or left unburned, fully crossed with open to antelope browsing versus no antelopes.

In 2004-5, we expanded our NPP measurements from only three core areas to ten sites, including burned and unburned grassland, transition, and creosote-dominated shrubland. We also resumed NPP measurements in the herbaceous layer in Piñon-Juniper woodland at Cerro Montosa. Because our NPP measurements are based on non-destructive allometric estimates by species (same as Jornada LTER), we also get accurate long-term measurements of plant community composition at our NPP sites. We added a new sampling protocol in which we now measure belowground standing crop at all sites where we measure aboveground production. In addition, we installed root ingrowth donuts at five sites co-located near minirhizotron arrays as well as in the N-fertilization plots.

Joanna Redfern (graduate student) in collaboration with **Burt Pendleton** (USFS Ecologist) and **Etsuko Nonaka** (graduate student) are in the process of mapping populations of creosotebush (*Larrea tridentata*) and ocotillo (*Fouquieria splendens*) for long term studies of plant population dynamics at the Sevilleta. Nine 20m^2 plots have been established to monitor creosotebush near the Five Points area. The design includes three sets of three plots, where each set of plots includes a low, medium, and high density plot. All of the low and medium density plots and one high density plot have been surveyed this year to determine the number of plants in the plots, and the exact location of each plant within the plot. Three plots (low, medium and high density) were established to monitor ocotillo population dynamics. The steep rocky terrain on which ocotillo grows precludes using the same technique as is used to survey creosotebush plants. GPS will be used to survey ocotillo within these plots. A system to convert the raw location data for each plant in a plot into a stem map for the plot is being developed. For the demographic study of ocotillo size classes (i.e. small, medium, large) are being identified to identify which plants to use to relate size to biomass. The size classes are based on height measurements made in 2003.

Consumer dynamics: In 2005 we initiated an exciting new experimental restoration of Gunnison's prairie dogs at the Sevilleta. Through the hard work of Sevilleta staff and graduate students in partnership with USFWS, private foundations, and a prairie dog restoration specialist, 99 artificial burrows were constructed at the SEV to create three replicate prairie dog colonies with approximately 110 animals added to each new colony. Each replicate colony is paired with a prairie dog-free reference area. Planned long term measurements include plant species composition, above- and belowground standing crop, soil nutrient dynamics and, of course, prairie dog population dynamics.

Soil excavation for artificial prairie dog burrows at the Sevilleta National Wildlife Refuge as part of our new Gunnison's prairie dog restoration experiment. Ninety-nine burrows were excavated by backhoe. A total of 327 prairie dogs was introduced in three replicate colonies on the north end of McKenzie Flats.

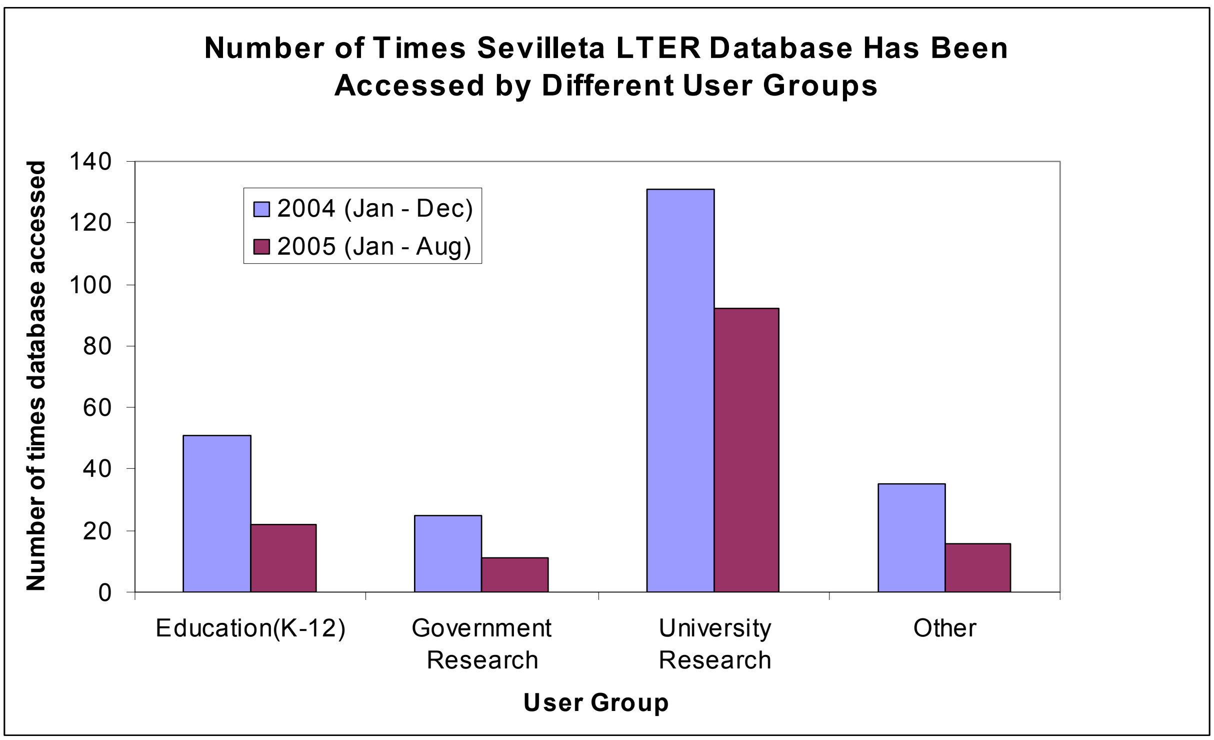
In addition to our restoration experiment, **Megan M. Friggens**, a graduate student at Northern Arizona University, is studying plague ecology of Gunnison's prairie dog to determine if a rodent mediated mechanism exists for plague epizootics. This project is designed to assess whether climate driven-dispersal events of plague (*Yersinia pestis*) reservoir hosts cause plague epizootics in Gunnison's prairie dog (*Cynomys gunnisoni*) colonies. In particular, we examine the relationships between weather patterns (precipitation), vegetation production, rodent and flea densities, prevalence of pathogens within host and vector, and interspecific contact between potential rodent carriers and the prairie dogs inhabiting the Sevilleta National Wildlife Refuge. Another vector-transmitted blood-borne bacterium, *Bartonella,* is also being surveyed from the small mammals captured in this project. *Bartonella* are generally less pathogenic and more frequently (often >50% prevalence) found in their mammal hosts than *Y. pestis.* Thus, *Bartonella* will be used to study interspecific transmission dynamics in the potential absence of plague outbreaks on the Sevilleta. Though several rodent species have been implicated as potential reservoir hosts of plague, no research has assessed the role of these potential reservoir species or their fleas in introducing plague into prairie dog colonies. Since May 2004, surveys have been conducted each spring and fall of the rodents inhabiting a prairie dog town on the Sevilleta and blood and flea samples have been collected from each animal to test for the presence of plague and *Bartonella*.

Tim Meehan (former graduate student and now an Assistant Professor at College of Santa Fe), **Blair Wolf** (LTER-CoPI) and **Casey Gilman** (REU) are in the process of studying carbon and nitrogen turnover in lizard tissues in relation to their metabolic rates. Lizards are important secondary and tertiary consumers in Southwest ecosystems. Stable isotope analysis of lizard tissues can be used to understand the specific roles of lizards in material and energy flux. Interpreting stable isotope data on lizard resource use requires an understanding of isotopic fractionation factors and turnover rates. A diet switching experiment is being conducted to learn how these quantities are related to individual metabolic rate, which is in turn related to an organism's body mass and temperature. This project is still in progress and is expected to continue until spring of 2006. To date, lizards have been collected, housed, and fed a baseline diet with a known isotopic profile. The next step is to switch their diet to one with a different isotopic profile and make a series of measurements of carbon and nitrogen isotopes in their tissues. The diet switch occurred in summer 2005.

In a related study, Graduate students **Alaina Pershall** and **Robin Warne** and CoPI **Blair Wolf** are using stable isotopes to study foodweb dynamics in the creosote-grassland transition zone near Five Points at the Sevilleta. They sampled rodents, lizards, arthropods and vegetation for stable isotope analysis of carbon and nitrogen. Because C3 and C4 plants have growth responses during different seasons, we expect to see a shift in the carbon isotope signal of the sampled organisms reflecting the changes in the vegetation from C3 plants in the spring to C4 in the fall. Twelve pitfall trap arrays with drift fencing were installed this summer for catching lizards, and small mammals were sampled monthly on two rodent trapping webs. All arthropods found in the pitfall traps were collected and grasshoppers were also collected with nets and will be processed for stable isotope analysis. Blood samples from lizards and rodents were collected monthly for stable isotope analysis. This work will continue through 2005 and 2006 growing seasons. Results of the stable isotope analyses are pending.

Information Management

With the assistance of Inigo San Gil of LNO, approximately 40% of the Sevilleta LTER's legacy metadata has been converted into Level 3 or better Ecological Metadata Language (EML), the LTER Network's metadata standard. Sevilleta EML files are being harvested to a centralized Metacat database (http://prairie.lternet.edu:8080/query). This will greatly facilitate the discovery of Sevilleta data.



Updates to the Sevilleta LTER website include the addition of a Wiki to the Intranet, where an IM Handbook is being created. Webmail is now also available via the Intranet, as is an interface where researchers log their visits to the Sevilleta NWR.

The Sevilleta LTER bibliography database was transferred from a text file to the Sevilleta MySQL database. A web application was also created by programmer Harsha Belludi for searching the Sevilleta bibliography and adding new records.

A much-needed backup system for the Sevilleta Sun E450 server was installed in January 2005.

Extracurricular activities:

Kristin Vanderbilt, Sevilleta IM, has served as information management liaison to the Biogeochemistry Committee for the Network Planning Grant. She contributed a poster entitled: "Ecoinformatics Training: Toward Data Sharing and Collaborative Research" to the NSF sponsored workshop "Enhancing Collaborative Research on the Environment in Sub-Saharan Africa (SSA)". Kristin also co-organized a panel discussion at the 2005 Statistical and Scientific Database Management (SSDBM) meeting (Cushing et al. 2005). She is collaborating on a research project with Judy Cushing of Evergreen State College wherein templates for grassland NPP databases are being developed to facilitate data synthesis across LTER sites. Kristin co-taught a week-long ecoinformatics workshop for personnel from the Organization of Biological Field Stations (OBFS), an annual event. As a collaborator on the Science Environment for Ecological Knowledge (SEEK) project, Kristin also co-taught an ecoinformatics workshop for post-docs and junior faculty.

The Sevilleta Research and Education Center, Sevilleta National Wildlife Refuge, New Mexico. A consortium of UNM, NM Tech, NMSU, Sandia and Los Alamos National Labs have integrated and focused their research efforts to address important environmental issues in the state and integrate this research with public education over a broad range of disciplines. A key to the success of this effort is the addition of a Research and Education Center to the Research Field Station on the Sevilleta National Wildlife Refuge (NWR) in Socorro County, New Mexico. *The location in central New Mexico and in the natural environment of a wildlife refuge is key to providing a common base to attract and organize researchers and educators from throughout the state and Southwest Region.* Scientists, resource managers and students from many disciplines will use the facility to plan and carry out multi-disciplinary studies throughout the Rio Grande Valley of New Mexico. Center research capabilities will include laboratories for plant and animal studies, soil and water analyses, genetic studies, microbial research, biodiversity mapping, and infectious disease research. Access to state-of-the-art high performance computing and data management will allow integration of myriad databases generated by Federal, State and University researchers. This integration is needed for the successful incorporation of our scientific understanding to natural resource management activities. There are many independent data generating activities within the state but they are *not* well integrated. Teaching and public outreach facilities will disseminate the information to K-12 students and the general public. The new Center will contribute to:

- **Scientific research for multi-disciplinary projects** – The Sevilleta NWR currently hosts many active research programs and this new facility will allow the needed expansion of research required to better understand environmental issues throughout the broader Rio Grande Basin. These studies will lead directly to "applied" results for society – for example, predictions of human disease outbreaks (hantavirus, plague) based on ecosystem responses to El Niño weather patterns, improved hydrologic data for the Rio Grande that will aid policies on water allocation, habitat needs for aquatic and riparian species (e.g., Silvery Minnow, Willow Flycatcher), and estimating agricultural, range and timber production from satellite-based spectral sensors. New technologies in remote sensing will allow real-time mapping of changes in these patterns and rapid-response capabilities. This also will allow testing of new technologies developed by university and national lab research.
- **Research on management issues involving public lands** – Land management strategies will continue to evolve as social pressures on public natural resources increase. Researchers in the Rio Grande Basin of New Mexico need to work together to address the complexities of human activities and economic development on natural resources and ecosystem health. Given the Sevilleta NWR's history of environmental research and its central geographic location in the New Mexico's Rio Grande Basin, the refuge is ideally suited to become a central hub for research on such topics as range and wildlife management, conservation strategies for endangered species, removal of problem species (e.g., salt cedar), human land use patterns, fire ecology, and ecosystem responses to climate change.
- **Attracting world-class scientists** – Hundreds of scientists/students have been attracted to the science conferences and research capabilities on the Sevilleta NWR over the past decade. This will increase with the new facility and add markedly to the expertise and information available for resource managers, policy-makers and educators. The capabilities also attract other agency research efforts (e.g., NASA validation studies for satellite sensors, ARS research on fire).
- **Public dissemination of research results** – Much of the data generated by government and university researchers remains inaccessible or incomprehensible to the general public. Researchers at the Sevilleta Center would integrate these data, and make them available for public groups and individuals. The Sevilleta NWR has functioned as "neutral ground" for opposing public interest groups (environmentalists to ranchers), and the

expanded Center's facilities will enhance the role of the consortium of institutions in providing a rational scientific basis in public debates on issues of public importance in New Mexico. Conferences at Sevilleta also provide a "neutral ground" atmosphere.

- **Public education** – The proposed Sevilleta Center will provide vastly expanded educational opportunities for K-12, undergraduate and graduate students, and science training opportunities for teachers. Involving students and teachers in research "*in the field"* is critical to the success.

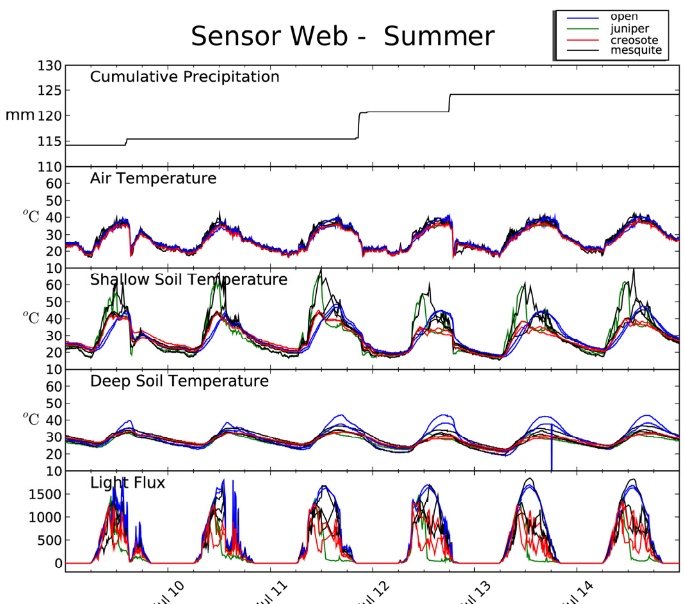
UNM Sevilleta Field Station SMPC Architects

FINDINGS

Climate and abiotic drivers

Fig. 1. Sensor Web 3.1 pod underneath a juniper tree.

Scott Collins (Sev PI), **Renee Brown** (Sevilleta Systems Administrator), **Doug Moore** (Met Central Czar) in collaboration with **Kevin Delin** and his team at the Jet Propulsion Lab (JPL), and **Luis Bettencourt**, **Aric Hagberg** and **Levi Larkin** of Los Alamos National Labs (LANL) are developing data analysis and QA/QC protocols for wireless Sensor Web enabled microclimate monitoring for ecological research (Palmer et al. 2005). Specifically, we are using Sensor Web 3.1 to address the question, are all resource islands equal? A fundamental concept in arid land research is the development of island of fertility under woody plants as desertification occurs. However, it is not clear that all such islands are ecologically equivalent. In fall 2003 we installed 12 Sensor Web pods in a study area near the Sevilleta Field Research Station to measure microclimate variables in three open areas, and under three individuals each of creosotebush, juniper, and mesquite (Fig 1). Sensor Web 3.1 pods record the following microclimatic variables every ten minutes: soil temperature (2 depths), soil moisture, air temperature, relative humidity and light. The collaborators from LANL are developing data extraction and QA/QC protocols for analyzing large streams of wireless sensor data. In particular, the group is developing QA/QC algorithms that can be embedded in the Sensor Web network to identify outlier data points on the fly.



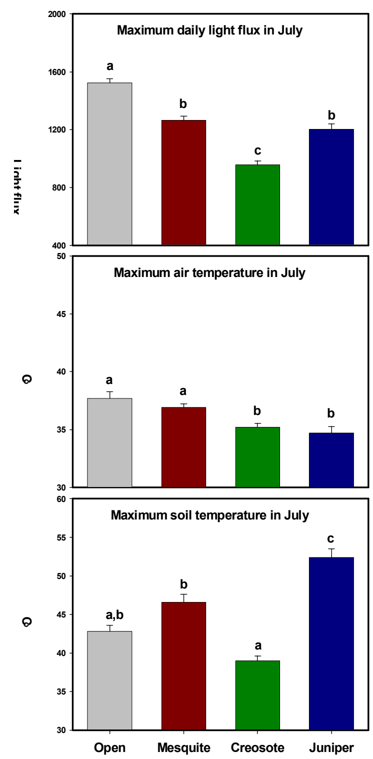


Fig 2. Example of data streams for a five day period in July 2004 (above). Statistical analysis of maximum daily light flux, maximum daily air temperature and maximum daily soil temperature for July 2004 in open areas and areas beneath three shrub species at the Sevilleta (right).

Results indicate that there are significant differences in microclimate under each species leading to greater resource heterogeneity in aridland ecosystems. An example data output stream from the Sensor Web is shown in Fig. 2). Differences in summer light flux beneath species are evident, both in maximum light

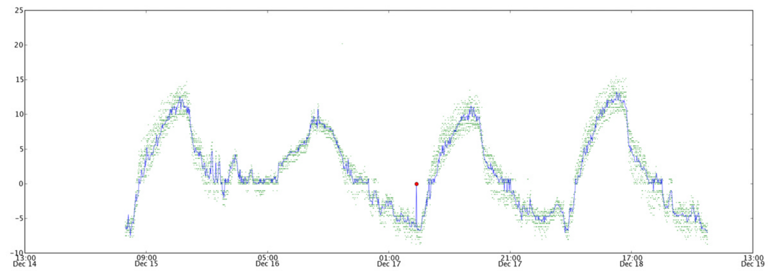


Fig 3. Example of QA/QC procedure. The blue trace is Air Temperature from Pod 12 and the Green Points are from a neighboring pod. The red point by itself is within the regular range of data points, but is out of range for the measurement period (>3 standard deviations away from neighbors [99% CL]. Error detection algorithms can be embedded into the Sensor Web network to detect and flag odd data values.

levels and time of day at which light levels peak. Also, fluxes in deep soil temperatures are generally greater in open areas compared to that under shrubs. Surprisingly, July maximum soil temperature was highest under the evergreen juniper (Fig 2). This occurs, most likely, because juniper litter and organic matter darken the soil such that a greater heat load is transferred to shallow soil depths in the summer time. QA/QC procedures are being developed based on the following premises: (1) environmental data are usually non-stationary because of diurnal, seasonal and annual cycles, (2) over short time frames data should be spatially and temporally coherent over neighboring sensors, (3) differences of commensurate measurements have statistics with bounded variances based on the central limit theorem, (4) because all Sensor Web pods share all data after every measurement, simple estimation methods (e.g. frequency estimation) can be used to characterize the mean and variance, (5) quality control can be implemented on the fly by excluding data points that have large differences to several neighbors, at some predetermined mean and variance (Fig 3). Once developed Sensor Web technology and embedded algorithms can be used to assess treatment efficacy within ecological experiments and eventually, actuation of experimental apparatus. Through our collaboration with JPL and LANL we are developing these algorithms in the context of newly NSF-funded project on the effects of nighttime warming, increased rainfall, and nitrogen deposition experiment at the Sevilleta. This work was presented by Collins et al. in an organized oral session on sensor networks for environmental research at the 2005 ESA Meeting in Montreal.

Water fluxes

Cliff Dahm (Sevilleta CoPI) and colleagues have been measuring rates of evapotranspiration (ET) in the riparian zone along the Rio Grande since 2000. Sites include a cottonwood dominated site with considerable amounts of non-native species in the understory that no longer floods (Albuquerque – SHK), a cottonwood dominated site that floods occasionally (Belen – BLN), a salt cedar and salt grass dominated site on the Sevilleta National Wildlife Refuge (Sevilleta NWR – SEV), a salt cedar dominated site at Bosque del Apache National Wildlife Refuge (Bosque del Apache NWR – BDAS), and a Russian olive and willow dominated site at La Joya State Game Refuge (La Joya SGR – LARO). Growing season ET at the SHK, SEV, and BDAS sites has been measured from 2000 – 2004, the BLN site was operational from 2000 – 2003, and the LARO site has made measurements from 2003 – 2004. Average annual growing season ET is highest in the SHK site with the mixed community of cottonwood overstory and a largely non-native understory. Average annual ET from the SHK site for 2000 – 2003 was 128 cm (± 4 cm). A partial restoration project involving the non-native understory species was begun in 2004. Annual ET in 2004 was 115 cm. The restoration project was completed in the winter of 2005, and annual ET estimates for the growing season of 2005 should help define the impact of this restoration project on overall riparian water use. Average annual ET from the BLN, BDAS, and LARO sites has been similar through the period of measurement (Fig 4). Average annual values for BLN, BDAS, and LARO have been 108, 106, and 112 cm, respectively. Standard error around the mean of these averages is greater at these sites compared to SHK. This reflects the greater interannual variability at these sites. For example, the average annual ET flux at the salt cedar dominated BDAS site has ranged from 88 to 119 cm. The lower values in 2002 and 2003 occur in years with complete drying of the Rio Grande and large draw downs in the water table during the growing season. Salt cedar, a facultative phreatophyte, adapts to the lowered water table by reducing transpiration and decreasing leaf biomass. The BDAS site is scheduled for a salt cedar eradication project in 2006, and this project will allow direct measurement of ET reduction from removal from a dense monotypic stand of

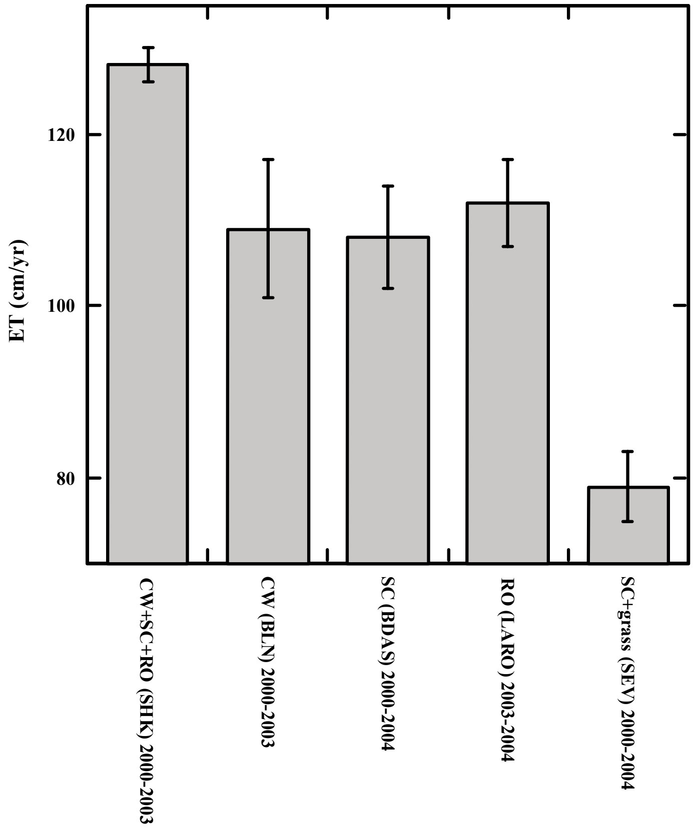


Fig 4. Annual ET (cm/yr) at five tower sites with differing types of riparian vegetation measured with three-dimensional eddy covariance instrumentation. The sites are in the riparian forest (bosque) along the Rio Grande in and adjacent to the Sevilleta NWR.

non-native vegetation. The SEV site has the lowest average rates of annual ET with an average for 2000 – 2004 of 79 cm (± 7). This non-flooding salt cedar and salt grass site is less densely vegetated with a relatively stable groundwater table due to a downstream irrigation diversion dam. Long-term deployment of eddy covariance equipment throughout multiple growing seasons has facilitated an excellent data base from which to evaluate water use by different types of riparian vegetation under differing hydrological conditions.

Biogeochemistry and soils

Debra Bryan (graduate student), **Carolyn Dumrose** (graduate student), **Grant Meyer** (LTER Senior Scientist) and **Les McFadden** (LTER Senior Scientist) all in the department of Earth and Planetary Sciences at UNM are studying deep soil structure and development on McKenzie Flats at the Sevilleta. During the spring and summer of 2005 soils and geologic media were exposed in four large (~11 m x 8m x >2 m depth) soil trenches constructed to OSHA safety requirements on McKenzie Flats. Two trenches were located approximately 3 km apart on an active alluvial fan of the granitic portion of the Los Piños Mountains. The northern-most fan trench study site is covered by C3 and C4 grasses (40%, *Bouteloua* and *Hilaria*), bare patches (29%), sand sage (22%), mormon tea (4%), soapweed yucca (1%) and cacti (1%). The southern-most alluvial fan site is dominated by C3 and C4 grasses (>60%), and also contains mormon tea, fourwing saltbush, soapweed yucca, and cacti. The southern-most trench has higher cover and few bare patches. Soils on both sites are polygenetic and are characterized by multiple depositional and erosional events followed by periods of quiescence leading to soil development. The lower-most exposed horizons are eroded, buried loamy soils exhibiting Stage III-IV calcic soil development indicating great age (several tens to hundreds of thousands of years). These buried soil horizons are overlain by multiple sandy fan deposits with clasts ranging from a few millimeters to several tens of centimeters in diameter. Some fan deposits exhibit incipient soil development but most are unaltered alluvium derived from the processes of erosion and deposition associated with fan development during wetter climatic periods. The lack of significant soil development indicates that these deposits are quite young (few thousands of years) and/or that they have been too disturbed to form soil horizons. Overlying these more clast-rich deposits are modern soils derived from sheet wash (coarse sand, pebbles, and few small cobbles) and eolian fine sand and silt. The modern soils exhibit “A” horizons (darkened by organic matter) and weak “B” horizons (some evidence for elluviation and formation of soil structure), and are likely a few hundred to a few thousand years old. The context of fine grained soils derived from sheet wash overlying cobble to boulder-rich fan sediments, is affecting water infiltration in the upper 0 – 30 cm of the subsurface. In the southern-most trench, some infiltrating waters have evaporated (depositing soil carbonate) prior to moving around boulders contained within the upper 13 cm. In the northern-most trench, the same observations were made for the upper 25 cm. The context of more permeable sediments overlying less permeable soils and sediments at depth may also be affecting soil hydrology: coarse and fine mormon tea and sand sage roots were observed exiting the face of the trench and traveling laterally for some distance before moving downwards. These observations were most often made at horizon boundaries with permeability contrasts in which the overlying sediments were more permeable than the underlying sediments. Water at these boundaries may temporarily “pond” as the process of infiltration begins to slow due to the decrease in permeability. Mormon tea and sand sage roots were found at 90 – 140 cm below the surface in the northern-most trench and mormon tea roots were found at 173 cm depth in the southern-most trench. The depth of root penetration also appears to be correlated to permeability as determined by clast size, clast sorting and the grain size of the matrix.

The remaining two trenches were located on a topographic high bounding the south-western extension of McKenzie Flats. This topographic high is probably a remnant fan surface formed by the Paleo-Palo Duro Wash approximately 800 – 900 Ka. The western-most trench is located near the Five Points Road intersection and is dominated by creosotebush (>75%) and barren patches of land. Some grama grasses are also present, but in small amounts. The lower-portion of the western-most trench contains several fluvial and sheet wash deposits (approximately 80 cm thick) that are nearly completely plugged with gypsic cements. The clasts contained within the lower-portion of the trench include gypsiferous limestones from the Yeso Formation, and are likely the source of the gypsic cements in the surrounding sediments. Immediately above these deposits is a thick (~90 cm), fine-grained, Stage IV+, petrocalcic soil horizon with large (filled) animal burrows and many pisolites. The presence of a laminar, brecciated and massively cemented petrocalcic horizon again indicates great age. The pisolites within this horizon are pebble-sized and contain multiple inner coatings of tan colored cements and one thin outer coating of soil carbonate. Above the surface of the petrocalcic soil is an erosional surface overlain by the modern soil. A thin (13 cm) horizon of unaltered fluvial sand, ripped up carbonate chunks, and eolian silt separates the modern soil from the underlying petrocalcic horizon. The modern soil is 18 cm thick and is derived from ripped-up soil carbonate chunks from the underlying petrocalcic horizon, fine grained sheet wash, and eolian silt. Coarse and abundant creosotebush roots were observed in every horizon, or pocket of sediment, not completely plugged by gypsic cements. This observation indicates that the gypsic cements are chemical or physical barriers to creosotebush roots, or both. Grass roots were observed in the modern soil only. A lens-shaped charcoal deposit was found in contact with the petrocalcic horizon and below the modern soil. This deposit has been sampled for radiocarbon dating.

The eastern Five Points trench is located on a broad, shallow drainage incising the old Paleo-Palo Duro fan deposit and is approximately 0.9 km to the southwest of the other Five Points trench. The most striking feature of this trench is that, despite the fact that it is over 2 m in depth, it is nearly uniformly composed of fine sand and eolian silt. Also, in contrast to all other trench sites, nearly all of the soil horizons are reddened and exhibit clay films (evidence for translocated clay and argillic soils). Like the western Five Points trench, the lower portions (lower four horizons) contain gypsum cements. However, very few Yeso Formation clasts (or any other clasts) were observed in the trench, so the source of the gypsum cements was not immediately determined. The vegetation cover at this trench site is mixed and typically co-dominated by grama grass, creosotebush and bare patches. The cover immediately above the trench was slightly more dominated by grama grass. Creosotebush roots exposed in the trench were not observed below the first clay-rich calcic horizon (~31 – 58 cm). Grass roots were thick in the upper horizons and helped to hold the vertical trench faces. To increase spatial representation of soils, additional trenches and soil cores will be examined in late 2005 and 2006.

Selene Baez (graduate student), **Joe Fargione** (postdoc), **Doug Moore** and **Scott Collins** analyzed our long-term atmospheric N deposition data. In southwestern North America, N deposition has increased steeply in the last two decades due to the rapid growth of urban areas, and to an increase in agriculture and animal production. Recent evaluations of the rates and patterns of N deposition show that areas located near large urban centers are more prone to receive high amounts of atmospheric N. However, for most major cities in the southwest, the actual magnitude and temporal trends in these effects are unknown. The limited available evidence suggests that N deposition in arid ecosystems could stimulate plant growth, but that such responses are often strongly limited by water availability. However, most such studies to date have been short-term N fertilization experiments that often use N addition rates significantly higher than current rates of atmospheric N deposition. Our study examined long- term data on N deposition and net primary productivity on desert grassland vegetation in the northern Chihuahuan Desert. We quantified the rates of N

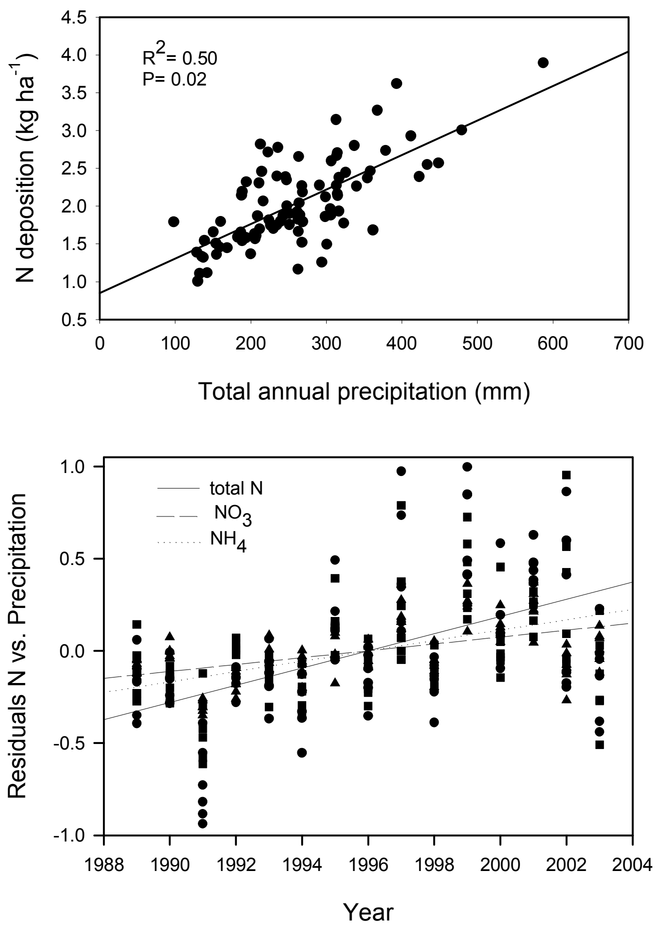


Fig 5. Linear regression of annual N deposition against precipitation (a). Linear regression of the residuals of total N, NO3 and NH4 versus annual precipitation (b). In both analyses each regression line was calculated with N=90.

deposition in native Chihuahuan Desert grass- and shrub-dominated plant communities and assessed the potential effects of N deposition on plant production and community composition in an ungrazed desert grassland community.

Nitrogen deposition was measured between 1989 and 2003 in a network of 6 funnel precipitation collectors located throughout the Sevilleta. These funnels collect all N deposited in precipitation (wet deposition) and any dry deposition that lands on or is washed into the sample. NO_3 and NH_4 were measured using a Technicon Auto-analyzer II and Dionex D-100 Ion Chromatograph that have comparable precision.

The amounts of total N deposited were positively related to precipitation volume (Fig 5). Total N, NO_3, and NH_4 deposition significantly increased from 1989 to 2003 (Fig 5). Total N deposition increased at a rate of 0.047 kg N ha^{-1} yr^{-1}, which corresponds to an annual increase of 2.3% of the long-term average annual deposition of 2.04 kg N ha^{-1}. Therefore, over 15 years of study, the Sevilleta has received 5.6 kg ha-1 of additional N that would not have been deposited if rates had not increased.

Deposition of NH_4 and NO_3 was positively correlated (R^2 = 0.73, P < 0.0001, N = 90). Over the years of the study more N was deposited as NH_4 (55.9%) than as NO_3 (44.1%), and the rates of deposition increase were non-significantly higher for NH_4 (0.028 kg ha^{-1} yr^{-1}) than for NO_3 (0.018 kg ha^{-1} yr^{-1}, P = 0.19 for *t* test of the slopes). The seasonal deposition rates of total N, NO_3 and NH_4 were higher during the summer than during the rest of the year. On average, 46% (0.93 kg ha^{-1}) of the annual N deposition occurred during the summer months. Furthermore, the proportion of N deposited annually during the summer months was positively related to total annual precipitation (Linear regression, R^2=0.12, P=0.001, N=90).

We are still analyzing the long-term relationships between N deposition and net primary production. Nevertheless, N deposition has increased in the Chihuahuan desert in central New Mexico from 1989 to 2003. The observed rate of N deposition, although low in comparison with regional estimates, is increasing. In this ecosystem N deposition maintains constant seasonal patterns related to precipitation. The increased rate of N deposition may not effect ANPP dramatically, but an on-going N fertilization experiment at our site suggests that chronic N deposition will eventually result in higher net primary production and potentially a decrease in legume abundance, a key plant functional type, as has been found across a number of sites in North America (Suding, Collins et al. 2005).

Bryan Brandel, a graduate student with **Carol Wessman** at the University of Colorado, is conducting his dissertation research (Scaling Ecosystem Processes in a *Larrea tridentata* Ecotone: The Influence of Landscape Structure on Ecosystem Function) at the Sevilleta. Woody plant encroachment has occurred in arid and semiarid grasslands worldwide, including the grasslands of the southwestern United States. At the Sevilleta National Wildlife Refuge (NWR) located in central New Mexico, creosotebush (*Larrea tridentata*) has replaced black grama (*Bouteloua eriopoda*) dominated semiarid grasslands along the Chihuahuan Desert biome transition zone. The mechanisms and consequences of woody plant encroachment are uncertain and complex and they have important implications for the functioning of semiarid ecosystems. The general goals of Bryan's research are to assess carbon and nitrogen storage and fluxes in relation to woody plant expansion in semiarid grassland and to utilize remote sensing to scale ecosystem transition processes to the landscape level. In 2003, four 50 m by 50 m plots in a line perpendicular to the shrub-grass transition boundary were established in each of three landscapes at the Sevilleta NWR near Five Points. Shrubland and grassland plots were established in the pure vegetation types while the middle two plots were located in the transition area and defined by relative shrub and grass covers. At random points within each plot, samples were collected beneath the nearest shrub patch, the nearest clump of grass, and the adjacent bare soil interspace. Soil organic carbon and total soil nitrogen to

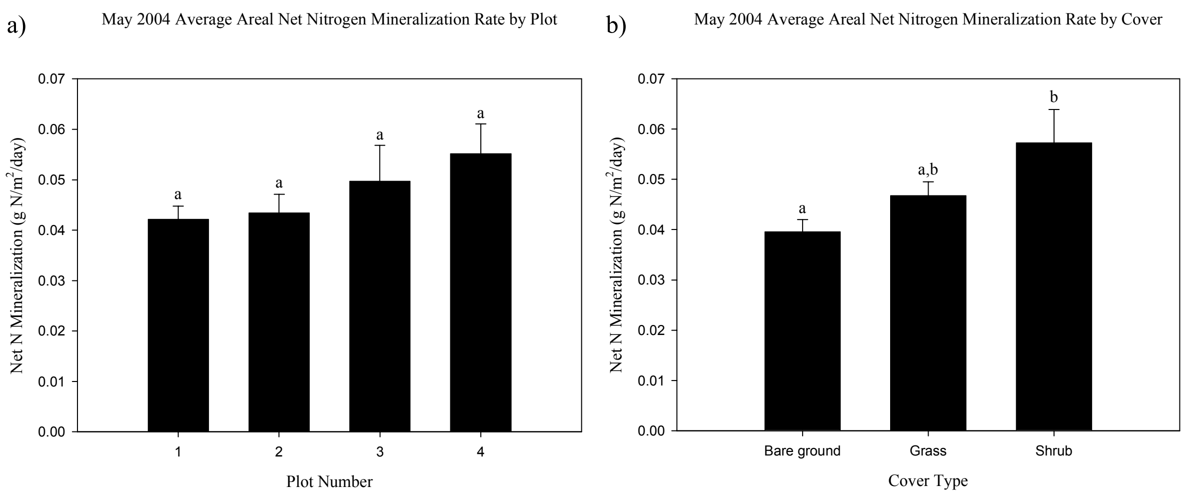


Fig 6. Average (+/- s.e.) net nitrogen mineralization rates by plot (a) and cover type (b) for May 2004 (n=153). Letters above the bars indicate significant differences at $P<0.05$l. (a) There were no significant differences in net nitrogen mineralization between plots (plot 1 is pure shrubland, plots 2 and 3 are located in the transition area, and plot 4 is pure grassland). (b) Average net N mineralization under shrub canopies was significantly greater than average net mineralization in bare ground areas.

20 cm depth were measured in the summer of 2003. *In situ* net nitrogen mineralization rates to 10 cm depth were measured for four periods during May to October 2004 and monthly during the 2005 growing season.

In situ net nitrogen mineralization rates measured in May 2004 show significant differences for cover type, but not plot (Fig 6). Although there appears to be an increase in average net nitrogen mineralization across the transition from pure shrubland to pure grassland, these differences were not significant (Fig 6a). Average net nitrogen mineralization under shrubs (0.057 g N/m^2/day) was significantly greater than the average rate in bare ground (0.040 g N/m^2/day), while the average rate in grass (0.047 g N/m^2/day) was intermediate (Fig 6b). These preliminary results for *in situ* net nitrogen mineralization suggest fractional cover is the only information necessary for scaling nitrogen mineralization across the transition area to the landscape level. However, preliminary results for soil organic carbon and total soil nitrogen show significant differences due to plot and cover type. Thus, scaling these ecosystem properties to the landscape level requires considering both cover type and landscape position. Remote sensing analysis of aerial photography and NASA's Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) data will be used to determine fractional cover of shrubs, grass, and bare ground across the transition area. Fractional cover will then be used to scale field measurements including *in situ* net nitrogen mineralization rates, total soil nitrogen, soil organic carbon, and aboveground biomass carbon to the landscape level.

Bob Sinsabaugh (LTER Senior Scientist), along with graduate students **Chris Lauber, Marcy Gallo, Martina Stursova**, and **Andrea Porras-Alfaro**, and undergraduate students **Kylea Odenbach, Kendra Pitts**, and **Armida Carbajal** are studying microbial ecology, decomposition and the nitrogen cycle in desert grassland at the Sevilleta.

Nitrogen cycle. Nitrogen enrichment of the biosphere is an expanding problem to which arid ecosystems may be particularly sensitive. In semi-arid grasslands, scarce precipitation uncouples plant and microbial activities, and creates within the soil a spatial mosaic of rhizosphere and cyanobacterial crust communities. We are investigating the impact of elevated N deposition on these soil microbial communities at a grama-dominated long-term N fertilization experiment established in 1995. Since 1995 10 replicate 5x10m plots have received a total of 10g Nm-2 in two seasonal applications (spring, fall) of 5gNm-2. For this study, soil samples were collected in July 2004, following two years of severe drought, and again in March 2005 following a winter of record high precipitation. Soils were assayed for potential activities of 20 extracellular enzymes and N_2O production. The rhizosphere and crust-associated soils had peptidase and peroxidase potentials that were extreme in relation to those of temperate soils. N addition significantly enhanced glycosidase and phosphatase activities and depressed peptidase. In contrast to temperate forest soils, oxidative enzyme activity did not respond to N treatment. Across sampling dates, EEA responses correlated with inorganic N concentrations. N_2O generation did not vary significantly with soil cover or N treatment. Microbial responses to N deposition in this semi-arid grassland were distinct from those of forest ecosystems and appear to be modulated by inorganic N accumulation, which is linked to precipitation patterns. A manuscript describing this work is in review at Microbial Ecology.

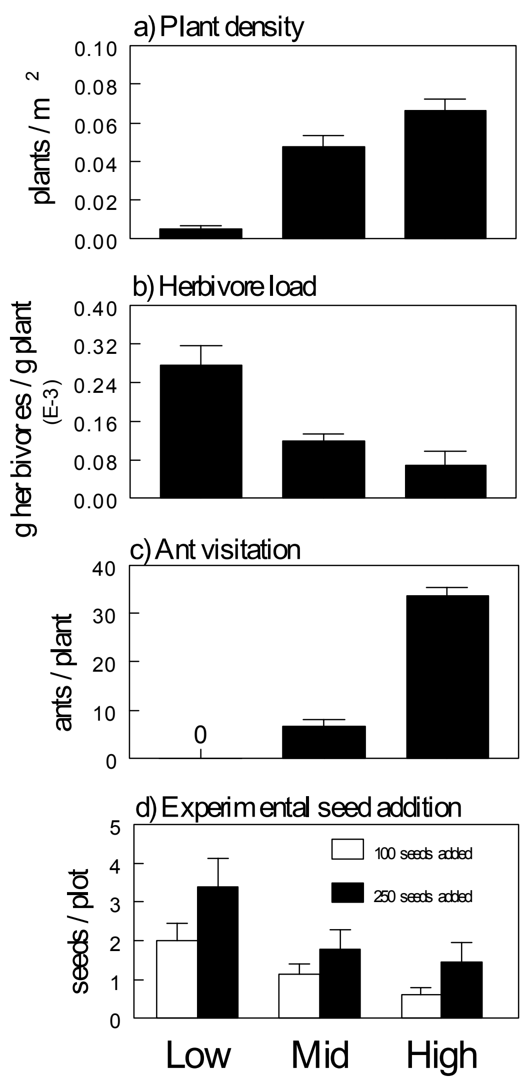
We are extending our analyses of N deposition effects on soil processes to include microbial community composition. Fungal 18S and ITS fragments have been amplified and cloned from grama roots, rhizosphere soil and crust soil using several primer sets. To date about 300 sequences have been collected. Database comparisons indicate a highly diverse fungal community. Dark septate endophytes (Pleosporales and others) and arbuscular mycorrhizal fungi (*Glomus*) dominate in the roots, while the soils contain a diverse mix of ascomycetes, chytrids and basidiomycetes. We have approximately 60 fungal isolates in culture, which we plan to screen for genes that code extracellular proteases and oxidases. Sequencing will continue until we can establish comparative rarefaction curves for each soil type and experimental treatment. A similar fungal community analysis is in progress for ecosystems established on gypsum soil, which represent an even more selective environment.

Radiative decomposition: Standard models for plant litter decomposition, based on measures of N or lignin content and modulated by temperature and moisture variables, do not accurately predict absolute or even relative decomposition rates in arid environments. Many researchers have proposed that photodegradation, rather than microbial degradation, dominates decomposition processes in arid environments, effectively uncoupling soil carbon and nitrogen cycles. However, there has been very little direct investigation. To study this phenomenon, a field experiment was established in May 2004. The 2 x 3 factorial design includes two blocks, one receiving water amendments to facilitate microbial activity and one receiving only ambient precipitation. Within each of these blocks, three replicate plots of each treatment were established: a control treatment receiving ambient levels of UV radiation, a shade treatment receiving 20% of ambient UV levels, and a high UV treatment with UV levels 25% higher than ambient levels. Litterbags containing senesced leaf litter of juniper (*Juniperus monosperma*), piñon (*Pinus edulis*), and cottonwood (*Populus deltoides*) were placed in each plot. Litterbags have been collected every two months for analysis of mass loss, extracellular enzyme activity, nutrient immobilization and dissolved organic matter (DOM) content.

After 385 days for juniper and piñon and 190 days for cottonwood, all litter species show the highest mass loss rates under elevated UV: rate constants are approximately two times larger than those measured for litter in the shade treatment. Light exposure has also significantly affected oxidative and hydrolytic enzyme activities. The EEA effects vary by litter type but suggest that UV exposure has a selective effect on microbial community composition. The composition of extractable DOM also varies with radiative treatment, as measured by both spectroscopic (UV absorbance and fluorescence profiles) and bacterial growth bioassays. Other analyses are still in progress. This study will continue thru 2005.

Producer dynamics

Fig 7. Variation along an elevational habitat gradient in: a) tree cholla density, b) herbivore load (herbivore mass/resource mass), c) ant (*Liometopum apiculatum*) visitation to tree cholla extra-floral nectarines, d) seedlilng recruitment in experimental see addition plots.



Tom Miller, a Ph.D. student with **Svata Louda** at the University of Nebraska-Lincoln is conducting his dissertation research at the Sevilleta. The central goal of his research is to understand how species interactions and abiotic context combine to generate patterns of distribution and abundance. As a model system, Tom is studying the interactions among tree cholla cacti (*Opuntia imbricata*), specialized cactus-feeding insect herbivores, nectar-feeding ants, and arthropod predators. These species occur across a grassland-mountain elevational habitat gradient at the Sevilleta National Wildlife Refuge, and their relative abundances vary systematically with elevation. Patterns of abundance (Fig 7a-c) suggest the hypotheses that: 1) habitat-specific mutualistic interactions between tree cholla and nectar-feeding ants (*Liometopum apiculatum*) at high elevation restrict insect herbivores to lower elevations; and 2) habitat-specific pressure from insect herbivores at low elevation limits tree cholla abundance there. Hypothesis 2 is further supported by experimental results indicating that abiotic constraints on seed germination or seedling survival cannot explain the observed pattern of plant abundance (Fig 7d). Combined, these hypotheses suggest a spatially-dynamic, trait-mediated trophic cascade that generates patterns of abundance across a landscape. This approach to testing these hypotheses consists of experimental manipulations of interaction strengths that are spatially explicit with respect to position along this gradient. This work is designed to tease apart correlations and causations, and match pattern with process.

Burt and **Rose Pendleton** (Senior Scientists, USFS Rocky Mountain Research Station, Albuquerque) along with **Karen Wetherill** (Head of the Sevilleta Field Crew) are studying the mechanisms by which creosotebush is expanding its range and dominance at the Sevilleta. One of the main questions pertaining to the expansion of *Larrea* into the grassland community centers on establishment of *Larrea* through seed. Unpublished data (T. Lowery, *pers. comm.*) indicated that Chihuahuan populations of *Larrea* do not expand clonally as has been reported for Mojave populations. Components of seedling establishment include pollination mode, seed production, dispersal, germination, and environmental conditions necessary for seedling establishment. This research addresses establishment and persistence of *Larrea* through a series of experiments. To date, we have 1) bagged isolated and core *Larrea* plants to determine degree of self-pollination, 2) compiled a list of pollinators found on isolated plants within the grassland as well as for the core population, 3) examined the flowering phenology of isolated and core shrubs, 4) established long-term low- medium- and high-density plots that will allow us to study *Larrea* demographics and track changes in density through time, 5) continued McKenzie Flat fire effect studies looking at shrub mortality and the effect of fire on seedling recruitment, and 6) begun studies of *Larrea* seed dormancy, seed banking, and seedling emergence using 2005-collected seed.

In addition, we have begun a new study looking at fire effects on floral resources for pollinators. In spring and fall of 2005 we have and will conduct insect sweeps, install and monitor bee traps, and make weekly counts of the numbers of flowers of each herbaceous forb species available during peak flowering periods. We have also established seedling emergence plots of 20 forb species looking at plant phenology, including emergence and flowering, and plan growth chamber studies to quantify nectar and pollen production of each species.

In 2005, **Deb Peters** (Sevilleta Senior Scientist) continued her research on ecotone and patch characterization at the Sevilleta. As part of her patch dynamics studies, she investigated the factors influencing invasion success and patch expansion of creosotebush (*Larrea tridentata [Zygophyllaceae]*) within a mosaic of communities dominated by either blue grama or black grama. Frequency of occurrence, height, and surface area of saplings (n=134) and patches of adult plants (n=247) of creosotebush were measured within a mosaic of communities dominated either by the Chihuahuan Desert species, black grama, or the shortgrass steppe species, blue grama located within 1 km of the creosotebush dominated community. Sapling age and year of establishment were estimated from height using previously developed relationships. Cover by species or functional group inside each shrub patch was estimated and compared with the vegetation in the surrounding grass patch. Distance between each creosotebush sapling or patch and the community dominated by this species, the major source of seeds, was measured to examine dispersal constraints.

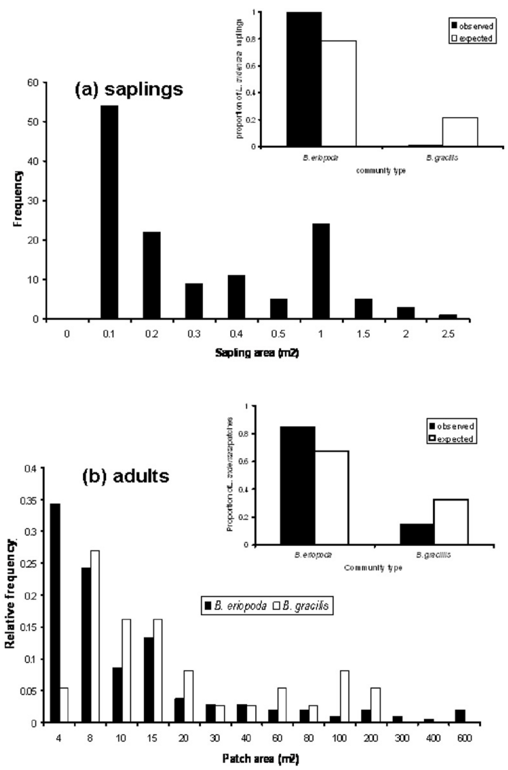


Fig. 8. (a) Frequency distribution of the area of creosotebush saplings found within black grama dominated communities. One sapling found in a blue grama community is not shown. Insert: observed and expected number of creosotebush saplings located within communities dominated by either blue grama (*B. gracilis)* or black grama (*B. eriopoda)*. (b) Frequency distribution of the area of creosotebush patches found within either blue grama or black grama dominated communities. Insert: observed and expected number of creosotebush patches located within communities dominated by either blue grama or black grama.

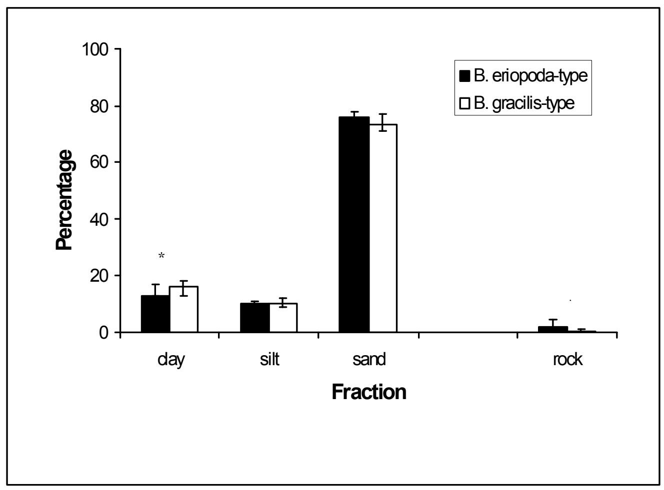


Fig 9. Preliminary analysis of particle size distribution in blue and black grama patches.

Results show that creosotebush saplings (1%) and adult patches (15%) rarely occur in blue grama dominated communities (Fig. 8)(Kröel-Dulay et al. 2004). Establishment events occurred yearly over the past 18 years with the number of saplings related to amount of monsoonal rainfall. Similar relationships between number of plants and patch area in both community types indicate similar rates of patch expansion. Cover of perennial forbs was higher and cover of dominant grasses was lower in creosotebush patches compared with the surrounding vegetation for both community types. There was no relationship between distance from the creosotebush dominated community and sapling age or patch area. Differential invasion success in two grassland communities at this biome transition zone was most likely related to the germination and establishment of colonizing shrub plants rather than seed dispersal constraints or differences in patch expansion of existing plants. The persistence of grasslands at this site despite region-wide expansion by creosotebush may be related to the presence and spatial distribution of blue grama-dominated communities that resist woody plant invasion.

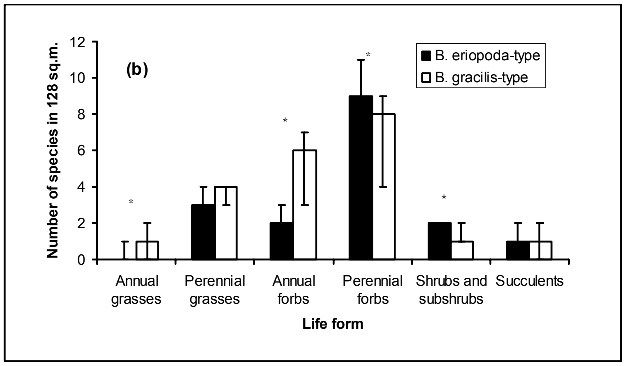


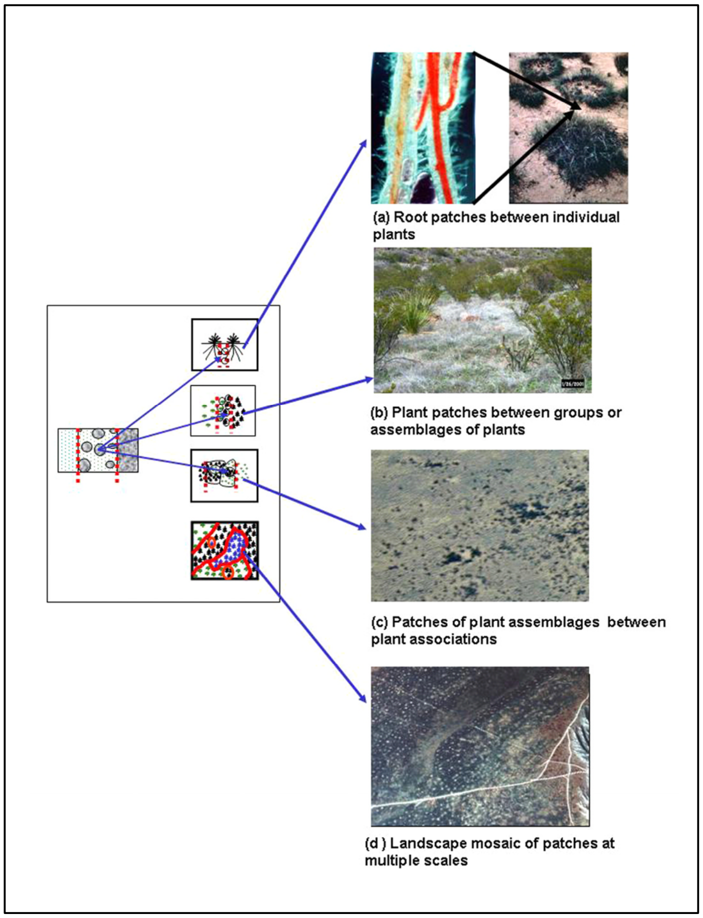
Fig 10. Species composition in blue and black grama patch types.

We continued to analyze the vegetation, soil, and DEM data collected from eight black grama-blue grama transitions, and four creosote-black grama transitions located throughout McKenzie Flats. The following data were collected every 5 m along transects that traversed each ecotone (n=1440): elevation (mm) using a Total Position Station, vegetation cover by species using 0.5 m^2 quadrats, and the GPS coordinates. For two of the four transects, soil samples were collected every 5-10 m from three depths (0-1, 1-5, and 5-20cm). These samples (n=2520) are being analyzed for particle size distribution. We are using the vegetation, soils, and elevation data to test the hypothesis that different kinds of transition zones are found across McKenzie Flats (stable, stationary, shifting), and that these transition zones are controlled by different environmental factors. In addition, a total of 800 blue grama and 400 black grama small patches (< $10m^2$) were measured and geo-referenced.

We also compared the plant species and life form composition of blue grama and black grama patch types at the Sevilleta (Peters et al. *submitted*). Patches were sampled at multiple scales for the occurrence of subordinate species. Association of species with patch type was tested with Chi^2. We also compared our results with the geographic range of each species using floristic manuals and distribution maps to determine if a broader association exists between species and biomes. We found that soils of *B. gracilis*-dominated patches had higher clay and lower rock contents compared with soils of *B. eriopoda*-dominated patches (Fig. 9).Of the 52 species analyzed, most were found associated with one patch type (54%). Sixteen species were associated with *B. gracilis*-dominated patches and 12 species with *B. eriopoda*-dominated patches (Fig. 10). Patches dominated by *B. gracilis* were richer in annuals whereas patches dominated by *B. eriopoda* contained more perennials. Both differences in species characteristics and soil texture between patch types contribute to patch-scale variation and changes in biodiversity across the landscape. Species associated with one of the two patch types occurred across broad geographic ranges. Our results show that patch types at this biome transition zone have characteristic life form and species composition, but the distribution of each subdominant species in these patches cannot be predicted based on its geographic range.

Ecotone conceptual framework. We described an operational framework for understanding and predicting dynamics of these biotic transitions for a range of environmental conditions across multiple spatial scales (Peters et al. *in press*). We define biotic transitions as the boundary and the neighboring states, a more general definition than typically denoted by the terms boundary, ecotone, edge or gradient. We use concepts of patch dynamics to understand the structural properties of biotic transitions and to predict changes in boundaries through time and across space. We developed testable hypotheses, and illustrated the utility of our approach with examples primarily from the Sevilleta (Fig. 11). We discuss three types of ecotones with different dynamics and key controlling factors (stable, shifting, directional). Our framework provides new insights and predictions as to how landscapes may respond to future changes in climate and other environmental drivers.

Fig 11. Conceptual framework of biotic transitions using examples from the Sevilleta and other sites in the Chihuahuan Desert.



Synthesis using simulation modeling. We continue to develop and use a suite of simulation models to address dynamics of arid and semiarid systems. We developed a cellular automata model to simulate landscape scale dynamics across different types of ecotones (stable, shifting, directional) between the three dominant species (blue grama, black grama, creosotebush) at the Sevilleta. The model represents vegetation dynamics under changes in climate and grazing regime through time. In collaboration with the Jornada LTER, we are continuing to modify the ECOTONE simulation model by incorporating the horizontal and vertical distribution of water, nutrients, and soil particles by wind and water across a range of spatial scales, from plants to patches and landscape units. We recently completed the recoding of our soil water model (SOILWAT) into C and C++ to allow easier multi-scale simulations. We are also working with Greg Okin at the University of Virginia to link ECOTONE with his model of wind redistribution of soil particles to allow effects of dynamic vegetation on wind erosion-deposition dynamics. We are also working with Tony Parsons and John Wainwright of England to link ECOTONE with their model of horizontal soil water redistribution across ecotones.

Long term studies of effects of disturbances. We are continuing to examine the effects of small, patchy disturbances on vegetation dynamics at ecotones. We monitor vegetation cover by species annually on 3m x 4m removal plots at five sites located along a grassland-shrubland ecotone on McKenzie Flats as well as a sixth site along the foothills of Los Pinos that represents a predominately blue grama community with very small amounts of black grama and no creosotebush. The five sites have been monitored since 1995 and the sixth was added in 1998. We also added a series of plots with total removals in 2003. Long-term monitoring is needed to determine the species that dominate following the loss of the current dominant.

Consumer dynamics

Ana Davidson (former graduate student, now a postdoc with Gerardo Ceballos at UNAM) and **David Lightfoot** (UNM staff scientist) looked at the keystone role of prairie dogs (*Cynomys* spp.) and banner-tailed kangaroo rats (*Dipodomys spectabilis*) in three grassland ecosystems. Their keystone status is attributed primarily to the effects of their burrowing and foraging behavior. However, these species co-occur in the arid grasslands of the southwestern United States and in Mexico, and differ ecologically in several important respects. We established a cross-site research project that evaluated the comparative and interactive effects of prairie dogs and banner-tailed kangaroo rats in areas where they co-occur at the Sevilleta National Wildlife Refuge, New Mexico, and at Janos, Chihuahua, Mexico (Davidson 2005, Davidson and Lightfoot in press, submitted). We focused our research on the impacts of these rodents on grassland plant and animal communities. We found that vegetation cover, structure, and species richness varied across a gradient extending out from the mound centers, and these patterns differed between prairie dog and kangaroo rat mounds. Certain species and functional groups of plants and arthropods associated differentially with mounds and landscape patches occupied by prairie dogs and banner-tailed kangaroo rats. Where both species co-occurred locally there was greater soil disturbance, more organic material from their feces, and higher activity of other animals, including antelope, rabbits, lizards, and other rodents. The overall effect of prairie dogs and kangaroo rats was to create a mosaic of different patches across the landscape such that their combined activities increased landscape heterogeneity and plant and animal species diversity (Fig. 12).

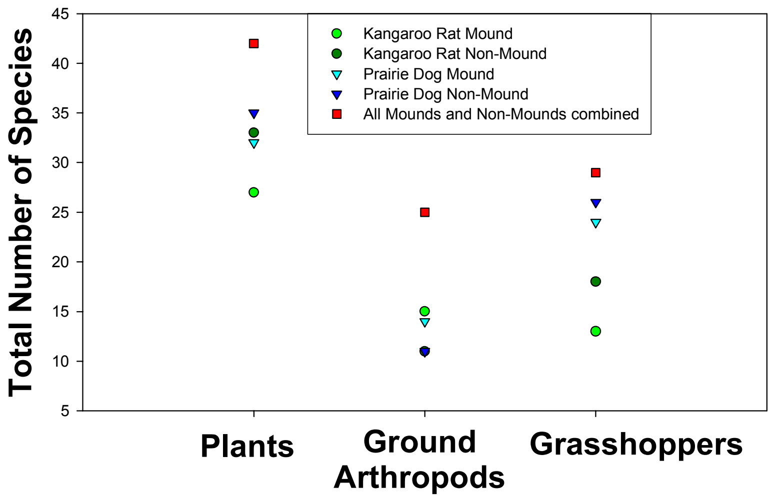


Fig 12. The total number of plants, grasshoppers and other ground-dwelling arthropods on and off K-rat and Prairie Dog mounds at the Sevilleta National Wildlife Refuge. Prairie dog mounds, kangaroo rat mounds, and non-mounds supported different assemblages of plant and arthropod species, and on a per unit area basis, the total accumulated number of species at the mound and landscape-scales was enhanced where prairie dogs and kangaroo rats co-occurred.

Selene Baez, **Scott Collins**, **David Lightfoot** and **Terri Koontz** (graduate student) analyzed data from our long-term small mammal exclosure study established in 1995. Water is widely acknowledged to be the key limiting resource in aridland ecosystems where the amount and timing of precipitation events strongly affect net primary productivity. On the other hand, numerous experimental studies have demonstrated strong consumer control on the composition, production and diversity of aridland plant communities. The mechanisms driving these changes involve consumption of green tissue, seed predation, shifts on species interactions, and alteration of responses to bottom-up inputs. These seemingly contradictory patterns result from non-linear dynamics between rainfall, net primary production and consumers in arid systems which impart high temporal variation in the strength of bottom-up and top-down controls on trophic interactions in aridland ecosystems. Reconciling these competing hypotheses regarding the primacy of top-down and bottom-up controls in aridland ecosystems requires long-term experimental manipulation of consumer and producer communities. To do so, we used a long-term small mammal exclusion experiment designed to evaluate the relative role of bottom-up and top-down controls on plant community structure in low productivity grass- and shrub-dominated Chihuahuan Desert plant communities Baez et al. *submitted*). Specifically, we assessed how bottom-up pulses cascade through vegetation to affect rodent populations and how rodent populations affect plant community structure and dynamics.

We used plant species composition data from 36 permanent 1m2 quadrats in each of four replicate rodent exclosures and open areas in grass- and shrub-dominated vegetation to assess the impacts of small mammals on vegetation dynamics. Rodent abundances outside the exclosures were quantified using data from our core LTER small mammal trapping webs.

We found no significant differences in the cover, species richness, and heterogeneity of grass or shrub vegetation between rodent access and rodent removal treatments (Fig 13). In shrub vegetation, however, plots without rodents had a significantly higher rate of directional change over time compared to sites with rodents (One-way ANOVA, P=0.005, R^2= 0.54, N=8). In grass vegetation, there were no differences in the rate of community change over time for plots with and without rodents (One-way ANOVA, P=0.52, R^2=0.06, N=8).

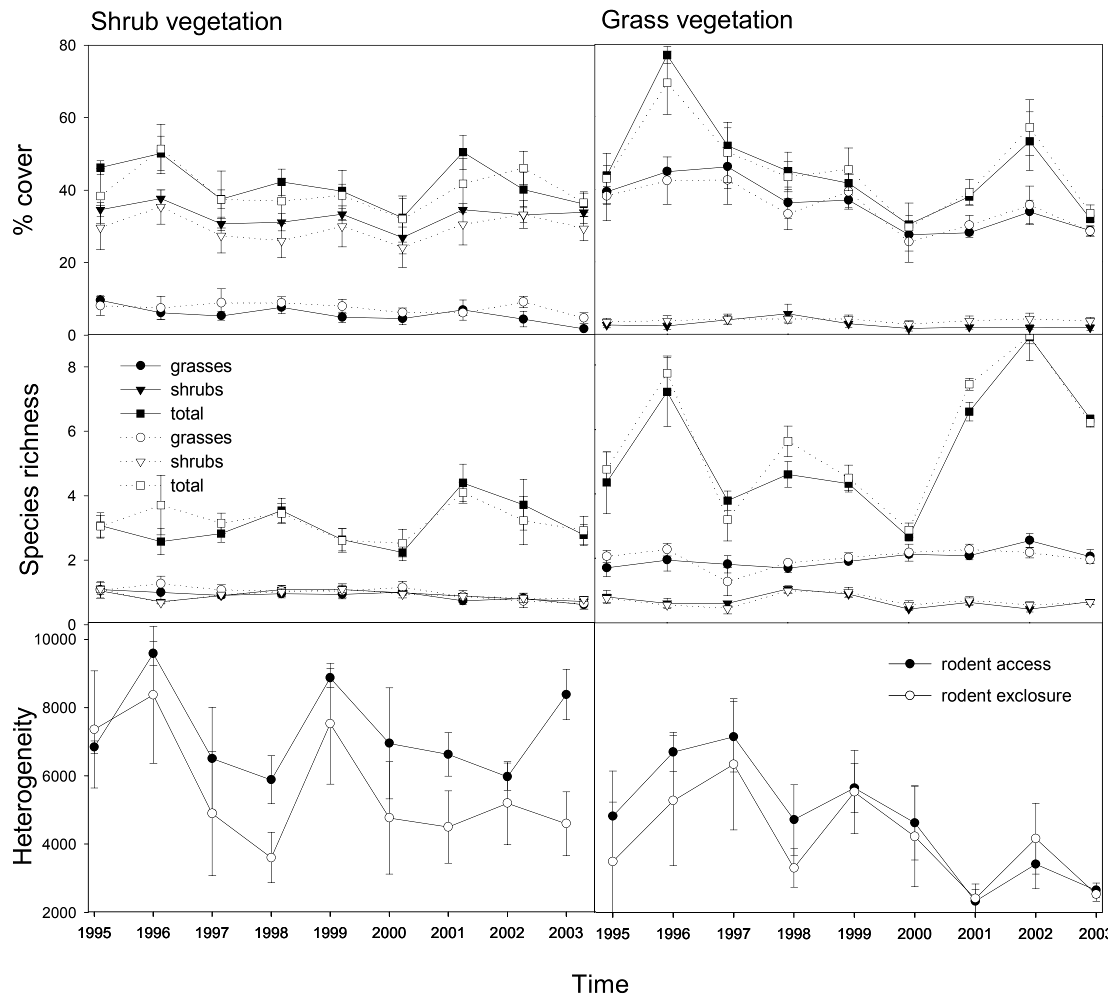


Fig 13. Cover and species richness of functional groups of grass- and shrub-dominated vegetation in rodent removal and control plots.

Overall, we found a positive relationship between precipitation and total cover, and to a lesser extent, diversity of plant functional groups. Cover and diversity in the grassland plots responded positively to summer rainfall, whereas shrub vegetation responded positively to winter rainfall. In only one case did rodent removal affect plant functional type response to seasonal precipitation. In shrub vegetation, control plots had significantly higher heterogeneity compared to rodent removal plots. There were no significant precipitation by treatment interactions.

Precipitation was positively related to consumer density. In grasslands, rodent densities increased in response to summer precipitation of the previous year. Oddly, densities of rodents in grass vegetation were negatively related to the previous year's winter precipitation. This probably resulted from a negative relationship between summer and winter precipitation over the study period rather than a direct reduction of rodent densities due to increased winter rainfall. In shrub vegetation, rodent densities were positively related to summer precipitation of the previous year, and to winter-spring precipitation in the current year.

It is hypothesized that the regulation of plant communities depends on the number of trophic levels of the system, on plant defense resources, and on the level of primary productivity that sustains variable densities of consumers that are interactively controllers or controlled by plants. Characterizing the interactions between producers, consumers, and precipitation is an important step toward understanding the temporal dynamics of bottom-up and top-down regulatory forces in ecosystems. In our arid Chihuahuan Desert system, rodents exerted no top-down control on plant community dynamics, species richness, composition and cover in desert grassland and exerted only minor control in shrub-dominated vegetation. We conclude that bottom-up forces strongly regulate vegetation structure and dynamics in this aridland ecosystem. We suspect that the lack of top-down control results from chronically low rates of net primary production which constrains densities of rodents and other consumers. Whether or not subtle but persistent effects of consumers will eventually lead to changes in community composition in this system remains to be seen.

Andrew Edelman (graduate student) is studying population dynamics and behavior of banner-tailed kangaroo rats (*Dipodomys spectabilis*) on the northern end of McKenzie Flats at the Sevilleta. This summer he began a monthly census and live trapping (3 days/month) of K-rat mounds. The study area is 17.8 ha and contains 147 mounds (8.3 mounds/ha). Over 5 months of trapping, 158 individuals have been marked (females: 37 adults, 42 subadults; males: 26 adults, 52 subadults). Occupancy rate of mounds, based on sign, has fluctuated from a low of 46.3% in March 2005 to a high of 81.7% in August 2005. The large increase in occupancy rate appears to be due to dispersal of subadult kangaroo rats from natal mounds. 12 new mounds have also been built during a 6-month period (8% increase in mounds). Of the 24 subadults where the mother is known, 16.7% have inherited the natal mound after their mother died or disappeared (n = 4), 16.7% have inherited the natal mound after the mother moved to a different mound (n = 4), 29.2% have dispersed to an unoccupied mound (n = 7), and 37.5% have disappeared or remained at the natal mound with the mother (n = 9). Based on live trapping, 75% of adult females (n = 28) and 62% of adult males (n = 16) survived 5 months.

Results from the study on prairie dogs and plague by graduate student **Megan Friggens** of Northern Arizona University show to date that no rodent or flea species collected on the Sevilleta NWR have tested positive for plague. Neither have any of the flea species known to be efficient vectors of plague been found on Sevilleta rodents (Table 1). However, two groups of rodents, *Peromyscus* spp. and *Dipodomys* spp., caught in high numbers on the Sevilleta NWR, are known to be resistant to plague related mortality and have been implicated as maintenance hosts of plague in other ecosystems. *Peromyscus* spp. are found in higher elevation sites on the Sevilleta, while the *Dipodomys* spp. are most concentrated at the site of the prairie dog town. The unique distribution of these rodent species may allow us to define the ultimate role of dispersal in introducing plague to prairie dog colonies. Flea burdens of most rodents appear to be greatest in the spring, which likely corresponds to flea microhabitat (both soil moisture and temperature) requirements (Table 1). No unusual flea-host associations (flea species on non-normal host species) have been found, indicating that a generalist flea species (that feeds on multiple host species) may be required for pathogen transmission between different host species. *Dipodomys spectabilis* carried the greatest diversity of flea species including some generalist species. The dense concentration of *Dipodomys* on prairie dog towns combined with their propensity to carry generalist species of fleas points to the potential role of *Dipodomys* spp. in transferring fleas and pathogens among sympatric rodent species. A closer analysis of the association of *Dipodomys* and *Cynomys* in desert grasslands in conjunction with analyses of the interspecific pathogen transmission between *Dipdomys* and other rodents, may reveal that *Dipodomys* spp. have a huge potential to mediate plague outbreaks in Gunnison's prairie dog populations.

Table 1. Species and prevalence of infestation of fleas collected from 8 rodent species from a prairie dog town on the Sevilleta NWR, New Mexico.

Host	**FleaSpecies**	**Overall Prevalence**	**Prevalence**
Cynomys gunnisoni		0.69	
	Oropsylla hirsuta		0.65
Dipodomys ordii		0.06	
	Meringis arachis		0.06
Dipodomys spectabilis		0.48	
	Echidnophaga gallinacea		0.04
	Malaraeus sinomus		0.04

	Meringis arachis		0.43
Perognathus flavus		0.01	
	Meringis shannoni		0.01
	Orchopeas leucopus		0.01
Peromyscus boylii		0.10	
	Malaraeus sinomus		0.10
Peromyscus eremicus		0.13	
	Orchopeas leucopus		0.13
Peromyscus maniculatus		0.10	
	Peromyscopsylla hesperomys		0.10
Peromyscus truei		0.07	
	Malaraeus sinomus		0.07

Table 2. Flea species collected from 8 rodent species captured during the spring or fall field seasons from a prairie dog town on the Sevilleta NWR, New Mexico.

Host	FleaSpecies	Spring	Fall
Cynomys gunnisoni			
	Oropsylla hirsuta	x	
Dipodomys ordii			
	Meringis arachis	x	
Dipodomys spectabilis			
	Echidnophaga gallinacea		x
	Malaraeus sinomus		x
	Meringis arachis	x	
Perognathus flavus			
	Meringis shannoni	x	
	Orchopeas leucopus		x
Peromyscus boylii			
	Malaraeus sinomus		
Peromyscus eremicus			
	Orchopeas leucopus	x	
Peromyscus maniculatus			
	Peromyscopsylla hesperomys	x	
Peromyscus truei			
	Malaraeus sinomus	x	

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