

**Annual Report for Period:** 11/2000 - 10/2001

**Submitted on:** 08/01/2001

**Principal Investigator:** Huenneke, Laura F.

**Award ID:** 0080412

**Organization:** New Mexico St University

**Title:**

LTER IV: Jornada Basin: Linkages in Semi-arid Landscapes

### Project Participants

#### Senior Personnel

**Name:** Huenneke, Laura

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Havstad, Kris

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Peters, Debra

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Monger, Hugh

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Abrahams, Athol

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator/sub-contractor receiving research and travel support

**Name:** Gillette, Dale

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator receiving research and travel support

**Name:** Gutschick, Vincent

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator receiving research support

**Name:** Herrick, Jeffrey

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator receiving research support

**Name:** Lightfoot, David

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator receiving research support

**Name:** Parsons, Anthony

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator/sub-contractor receiving research and travel support

**Name:** Rango, Albert

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator receiving research and travel support

**Name:** Schlesinger, William

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator/sub-contractor receiving research and travel support

**Name:** Wainwright, John

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Investigator/sub-contractor receiving research and travel support

### Post-doc

**Name:** Goslee, Sarah

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Postdoc supported on supplement to explore application of high-resolution satellite imagery

**Name:** Bestelmeyer, Brandon

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Supported on LTER funding and associated grant funding

**Name:** Yao, Jin

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Postdoc on LTER base funding

**Name:** Drewa, Paul

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Postdoc on associated grant.

### Graduate Student

**Name:** McGlone, Christopher

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

MS student

**Name:** Skarsgaard, Amanda

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

MS student

**Name:** Sheehan, Kathi

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Ph.D. student on associated grant

**Name:** Rayburn, Andrew

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

MS student on associated grant

**Name:** Schmidt, Sebastian

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Graduate student at Duke University

**Undergraduate Student**

**Technician, Programmer**

**Other Participant**

**Name:** Whitford, Walter

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Collaborated in data review and publications; no direct financial support

**Name:** Bestelmeyer, Stephanie

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Executive director of Chihuahuan Desert Nature Park and director of Schoolyard LTER Program (supported by NSF and external funding)

**Research Experience for Undergraduates**

**Organizational Partners**

**Duke University**

**USDA Agricultural Research Service**

**Research Foundation of the State University of New York**

**NOAA Air Resources laboratory**

**University of New Mexico**

**University of Leicester**

**King's College, London**

**Chihuahuan Desert Nature Park**

CDNP is our partner in K-12 educational outreach programs. Specifically, CDNP coordinates the Schoolyard LTER program with schools in the region, operates field trips and classroom visits to carry LTER science to students and teachers, and directs summer workshops for regional science teachers.

**Other Collaborators or Contacts**

World Wildlife Fund, Chihuahuan Desert priority program: sharing information and data regarding patterns of biodiversity and ecological threats to biodiversity in the Chihuahuan region

The Nature Conservancy, Las Cruces (NM) office: Chihuahuan Desert priority and conservation planning program

US-AID (Agency for International Development): in 2001 we hosted a visit by Dr. Franklin Moore, Associate Administrator of AID's Global Environment Centre and previous head of US Delegation to the UN Convention to Combat Desertification.

I-LTER: on behalf of LTER Network, hosted two African visitors (Dr. Susan Ringrose, Botswana, and Dr. Joh Henschel, Namibia) to demonstrate data management and research administration in semi-arid ecosystem science, and to explore potential research collaborations related to the establishment of long-term ecological research programs in southern Africa

UNAM: Collaborations continuing with Dra. Maria del Carmen Mandujano, Instituto de Ecologia, Universidad Nacional Autonoma de Mexico, Mexico City, Mexico, and with other researchers at the Mapimi Biosphere Reserve

INIFAP: collaborations continuing with Dra. Alicia Melgoza, INIFAP, Campo Experimental La Campana, Chihuahua.

### 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:**

Student training, theses, and dissertations:

Apel, B. REU participant, summer 2001, NMSU.

Lejeune, M. REU participant, summer 2001, NMSU.

Locklear, A. REU participant, summer 2000, NMSU.

McGlone, C. MS thesis, Lehmann lovegrass interactions with fire and native plants in a desert grassland, NMSU.

Skarsgaard, A. MS in progress, NMSU.

Svensson, A. REU participant, summer 2001, NMSU.

Swink, M. REU participant, summer 2001, NMSU.

Wang, M.-C. Mapping and monitoring land degradation in southern New Mexico using Landsat data. Ph.D. dissertation, 2000, King's College, London.

Postdoctoral training:

Bestelmeyer, Brandon. NMSU, then USDA-ARS.

Drewa, Paul. USDA-ARS.

Goslee, Sara. USDA-ARS, then NMSU.

Yao, Jin. NMSU.

Graduate course, Chihuahuan Desert Ecosystems, taught at NMSU by Monger and Huenneke, spring 2000 semester (see Activities).

Teacher training workshops, summer 2000 and summer 2001, directed by Chihuahuan Desert Nature Park and including presentations by several LTER investigators.

Internships: Biology undergraduates working with Schoolyard LTER and CDNP to implement access for K-12 students and teachers; two undergrads in 2000.

### **Outreach Activities:**

Two of our primary mechanisms for outreach are our annual research symposium and our semi-annual newsletter. The Friends of the Jornada symposium has attracted a growing audience. The 10th annual symposium (in July 2000) and the 11th edition (July 2001) featured new formats emphasizing poster presentations and increased chances for discussion. Bill Schlesinger passed on the role of editing the Jornada Trails newsletter to Laura Huenneke, who supervised production of fall 2000 and spring 2001 issues. The newsletter reaches a variety of researchers, administrators, and land managers across the United States, and is also available on the Jornada Basin LTER web site.

#### Other outreach activities:

H.C. Monger organized and co-led the Desert Project Tour (May 22-25, 2000), which brought 100 scientists from 15 universities, 7 state and federal agencies, 10 consulting firms, and one national lab to NMSU to study desert soils and geomorphology. The Desert Project Tour was highlighted by a television news spot (KRWG-TV, Las Cruces) and by an article in the fall 2000 issue of *New Mexico Resources*.

For the third consecutive year, Jornada LTER and JER scientists spoke at the day-long tour of the Jornada Basin organized as part of the annual Border Book Festival. This year's tour was entitled 'Dreaming Back the Desert' and included LTER scientists Curtis Monger and Jeff Herrick speaking to the general audience of about 100 people.

#### K-12 outreach: Schoolyard LTER/CDNP

The Chihuahuan Desert Nature Park is a non-profit organization that serves as partner to the JER and JRN LTER in educational outreach. The CDNP administers the Schoolyard LTER program with NSF supplemental funding, in addition to running other educational programs with private and foundation support. The Jornada Schoolyard LTER program focuses on setting up long-term plots on land adjacent to schools. Students use these plots to conduct studies that parallel Jornada LTER research. Teachers and students participate in one or more of the following studies:

- 1 - vegetation monitoring (students measure plant composition and cover);
- 2 - weather monitoring (students measure temperature, precipitation, wind speed and wind direction);
- 3 - disturbance experiment: students measure soil and vegetation properties to monitor resistance to and recovery from human disturbance (trampling).

During the past year the number of participating schools increased to 5 (three elementary, one middle school, one high school) in the Las Cruces and El Paso region. These schools serve relatively low-income, primarily Hispanic populations.

Schoolyard participants also take advantage of the Chihuahuan Desert Nature Park's field trips to the Jornada Experimental Range and the CDNP's 'Desert Science in the Classroom' program. Over 7000 K-12 students and 300 teachers participated in CDNP and Schoolyard LTER activities during the 2000 calendar year.

CDNP, Schoolyard LTER, and LTER staff and volunteers coordinated the First Step teacher training program in summer 2000, and are running another teacher training workshop in summer 2001.

#### Outreach to land management agencies and range management community:

LTER and JER research was highlighted in week-long Rangeland Monitoring training sessions, each involving ~ 30 practitioners: April 2000 (at Sevilleta LTER) and January 2001 (at Jornada LTER). Similar research findings and principles were used as background for 3 additional week-long training sessions in rangeland health evaluation (held at various western US locations) and for one week-long training in the biology and assessment of microbiotic soil crusts (Jornada, February 2001). A draft version of the manual for monitoring rangeland ecosystems, used in these trainings and by several agencies and NGO's, drew on LTER research findings to inform the design and implementation of quantitative ecosystem indicators.

#### Public presentations:

D. Peters and L. Huenneke gave invited presentations at the annual meeting of the New Mexico Native Plant Society in Las Cruces, winter 2000.

L. Huenneke spoke on threats to desert biodiversity at a Full Moon presentation, White Sands National Monument, summer 2000.

L. Huenneke organized and presented two of four lectures (on Global Environmental Change and on Human Population Trends) in a series requested by the Academy for Learning in Retirement, a community educational program in Las Cruces NM.

J.E. Herrick was quoted in a Science (Oct 6, 2000) news story on the effects of soil age on the resilience of arid ecosystems (K. Brown, Ghost towns tell tales of ecological boom and bust, Science 290:35-37).

Las Cruces Sun-News story on leadership of LTER returning to NMSU

### Journal Publications

Buck, B.J. and H.C. Monger, "Stable isotopes and soil-geomorphology as indicators of Holocene climate change, northern Chihuahuan Desert.", Journal of Arid Environments, p. 357, vol. 43, (1999). Published

Cross, A.F. and W.H. Schlesinger, "Biological and geochemical controls on phosphorus fractions in semiarid soils.", Biogeochemistry, p. 155, vol. 52, (2001). Published

Abrahams, A.D., G. Li, C. Krishnan, and J.F. Atkinson, "A sediment transport equation for interrill overland flow on rough surfaces", Earth Surface Processes and Landforms, p. , vol. , ( ). Accepted

Fredrickson, E.L., D.M. Anderson, K.M. Havstad, W.L. Shupe, and M.D. Remmenga, "Pen confinement of yearling ewes with cows or heifers for 14 days to produce bonded sheep", Small Ruminant Research, p. 291, vol. 40, (2001). Published

Fredrickson, E.L., R.E. Estell, K.M. Havstad, W.L. Shupe, and L.W. Murray, "The effect of feeding ewe lambs a 15 % tarbush (*Flourensia cernua*) pellet pre- and post-weaning on the subsequent diet selection of tarbush", Journal of Arid Environments, p. 123, vol. 44, (2000). Published

Gillette, D. and W. Chen, "Particle production and aeolian transport from a 'supply-limited' source area in the Chihuahuan Desert, United States", Journal of Geophysical Research, p. 5267, vol. 106(D6), (2001). Published

Granados-Olivas, A. and H.C. Monger, "Remote sensing technology for development planning along the US-Mexico border: hydrogeology and geomorphology", New Mexico Journal of Science, p. 123, vol. 39, (1999). Published

Hartley, A.E. and W.H. Schlesinger, "Environmental controls on nitric oxide emissions from Northern Chihuahuan Desert soils", Biogeochemistry, p. 279, vol. 50, (2000). Published

Havstad, K.M., W.P. Kustas, A. Rango, J.C. Ritchie, and T.J. Schmutge, "Jornada Experimental Range: a unique arid land location for experiments to validate satellite systems", Remote Sensing of the Environment, p. 13, vol. 74, (2000). Published

Peters, D.P.C. and J.E. Herrick, "Modeling vegetation change and land degradation in semiarid and arid ecosystems: an integrated hierarchical approach", Advances in Environmental Monitoring and Modelling, p. , vol. , ( ). Accepted

Herrick, J.E., "Soil quality: an indicator of sustainable land management?", Applied Soil Ecology, p. 75, vol. 15, (2000). Published

Herrick, J.E., W.G. Whitford, A.G. DeSoyza, J.W. VanZee, K.M. Havstad, C.A. Seybold, and M. Walton, "Soil aggregate stability kit for field-based soil quality and rangeland health evaluations", CATENA, p. 27, vol. 44, (2001). Published

Hochstraser, T., G. Kroel-Dulay, D.P.C. Peters, and J.R. Gosz, "Vegetation and climate characteristics of arid and semi-arid grasslands in North America and their biome transition zone", Journal of Arid Environments, p. , vol. , ( ). Accepted

Huenneke, L.F., D. Clason, and E. Muldavin, "Spatial heterogeneity in Chihuahuan Desert vegetation: implications for sampling methods in semi-arid ecosystems", Journal of Arid Environments, p. 257, vol. 47, (2001). Published

Keane, R.E., M. Austin, C. Field, A. Huth, M.J. Lexer, D. Peters, A. Solomon, and P. Wyckoff, "Tree mortality in gap models: application to climate change", Climatic Change, p. , vol. , ( ). Accepted

Martinez-Rios, J.J. and H.C. Monger, "Soil classification of arid lands using Thematic Mapper data", Revista Terra, p. , vol. , ( ). Accepted

- Michalek, J.L., J.E. Colwell, N.E.G. Roller, N.A. Miller, E.S. Kasischke, and W.H. Schlesinger, "Satellite measurements of albedo and radiant temperature from semi-desert grassland along the Arizona/Sonora border", *Climatic Change*, p. 417, vol. 48, (2001). Published
- Miller, R.E. and L.F. Huenneke, "Demographic variation in a desert shrub, *Larrea tridentata*, in response to a thinning treatment", *Journal of Arid Environments*, p. 315, vol. 45, (2000). Published
- Miller, R.E. and L.F. Huenneke, "The relationship between density and demographic variation within a population of *Larrea tridentata*", *Southwestern Naturalist*, p. 313, vol. 45, (2000). Published
- Nash, M.S., W.G. Whitford, A.G.T. DeSoyza, J.W. VanZee, and K.M. Havstad, "Livestock activity and Chihuahuan Desert annual-plant communities: boundary analysis of disturbance gradients", *Ecological Applications*, p. 814-823, vol. 9, (1999). Published
- Peters, D.P.C., "Plant species dominance at a grassland-shrubland ecotone: an individual-based gap dynamics model of herbaceous and woody species", *Ecological Modelling*, p. , vol. , ( ). Submitted
- Rango, A., S. Goslee, J. Herrick, M. Chopping, K. Havstad, L. Huenneke, R. Gibbens, R. Beck, and R. McNeely, "Remote sensing documentation of historic rangeland remediation treatments in southern New Mexico", *Journal of Arid Environments*, p. , vol. , ( ). Accepted
- Sala, O.E. and 18 others (including L.F. Huenneke), "Global biodiversity scenarios for the year 2100", *Science*, p. 1770, vol. 287, (2000). Published
- Schlesinger, W.H., T.J. Ward, and J. Anderson, "Nutrient losses in runoff from grassland and shrubland habitats in southern New Mexico. II. Field plots", *Biogeochemistry*, p. 69, vol. 49, (2000). Published
- Seybold, C.A. and J.E. Herrick, "Aggregate stability kit for on-site assessments", *CATENA*, p. 37, vol. 44, (2001). Published
- Wainwright, J., A.J. Parsons, and A.D. Abrahams, "Plot-scale studies of vegetation, overland flow and erosion interactions: case studies from Arizona and New Mexico", *Hydrological Processes*, p. 2921, vol. 14, (2000). Published
- Wainwright, J., A.J. Parsons, and W.H. Schlesinger, "Hydrology-vegetation interactions in areas of discontinuous flow on a semi-arid bajada, southern New Mexico", *Journal of Arid Environments*, p. , vol. , ( ). Submitted
- Abrahams, A.D., A.J. Parsons, and J. Wainwright, "Disposition of rainwater under creosotebush", *Journal of Arid Environments*, p. , vol. , ( ). Submitted
- Howes, D.A. and A.D. Abrahams, "Modeling runoff and runoff in a desert shrubland ecosystem, Jornada Basin, New Mexico", *Geomorphology*, p. , vol. , ( ). Submitted
- Huenneke, L.F., J.P. Anderson, M. Remmenga, and W.H. Schlesinger, "Desertification alters patterns of aboveground net primary production in Chihuahuan ecosystems", *Global Change Biology*, p. , vol. , ( ). Submitted
- Okin, G.S. and D.A. Gillette, "Distribution of vegetation in wind-dominated landscapes: implications for wind erosion modeling and landscape processes", *Journal of Geophysical Research*, p. 9673, vol. 106(D9), (2001). Published
- Privette, J.L., G.P. Asner, J. Conel, K.F. Huemmrich, R. Olson, A. Rango, A.F. Rahman, K. Thome, and E.A. Walter-Shea., "The EOS prototype validation exercise(PROVE) at Jornada: Overview and lessons learned.", *Remote Sensing of Environment*, p. 1, vol. 74, (2000). Published
- Rango, A., M. Chopping, J. Ritchie, K. Havstad, W. Kustas, and T. Schmutge., "Morphological characteristics of shrub coppice dunes in desert grasslands of southern New Mexico derived from scanning lidar.", *Remote Sensing of Environment*, p. 26, vol. 74, (2000). Published

Pelgrum, H., T. Schmutge, A. Rango, J. Ritchie, and B. Kustas., "Length-scale analysis of surface albedo, temperature, and normalized difference vegetation index in a desert grassland.", *Water Resources Research*, p. 1757, vol. 36, (2000). Published

Berckman, S. K. and D. C. Lightfoot., "Harvester ant nest distribution and microhabitat characteristics across the Chihuahuan Desert.", *Southwestern Naturalist*, p. , vol. , ( ). Accepted

### **Books or Other One-time Publications**

Bird, S.B., J.E. Herrick, and M.M. Wander, "Management for carbon sequestration in rangelands: Soil organic matter, soil aggregation, and exploiting heterogeneity", (2001). Book, Published  
 Editor(s): R.F. Follett, J.M. Kimble, and R. Lal  
 Collection: Carbon Sequestration Potential of US Grazing Lands  
 PP 121-138  
 Bibliography: Ann Arbor Press, Chelsea, MI

Drewa, P.B., D.P.C. Peters, and K.M. Havstad, "Fire, grazing, and shrub invasion in the Chihuahuan Desert", ( ). Book, Accepted  
 Editor(s): L.A. Brennan et al.  
 Collection: The Role of Fire in the Control and Spread of Invasive Species. National Congress on Fire Ecology, Prevention, and Management, Proceedings, No. 1.  
 Bibliography: Tall Timbers Research Station, Tallahassee, FL.

Gosz, J.R., D.P.C. Peters, M. Kertesz, E.Kovacs-Lang, Gy. Kroel-Dulay, and S. Bartha, "Organization of grasslands along ecological gradients: US-Hungarian LTER grassland cooperation", (2000). Book, Published  
 Editor(s): K. Lajtha and K. Vanderbilt  
 Collection: Proceedings of the ILTER Regional Workshop  
 PP 67-78  
 Bibliography: Oregon State University Press, Corvallis, OR

Havstad, K.M., "Desertification and Productivity", ( ). Book, Accepted  
 Editor(s): Lal, R.  
 Collection: Encyclopedia of Soil Science  
 Bibliography: Marcel Dekker, Inc.

Havstad, K.M., J.E. Herrick, and W.H. Schlesinger, "Desert rangelands, degradation and nutrients", (2000). Book, Published  
 Editor(s): O. Arnalds and S. Archer  
 Collection: Rangeland Desertification. *Advances in Vegetation Science* 19. PP 77-87  
 Bibliography: Kluwer Academic Publishers, Dordrecht

Herrick, J.E., "Monitoring methodology for pasture degradation and restoration", (2001). Book, Published  
 Editor(s): M. Ibrahim  
 Collection: Proceedings of the International Symposium on Silvopastoral Systems and Second Congress on Agroforestry and Livestock Production in Latin America.  
 PP 2-6  
 Bibliography: San Jose, Costa Rica, April 2001

Huenneke, L.F., "Biodiversity in desert ecosystems of the future: responses to climate change and desertification", ( ). Book, Accepted  
 Editor(s): O.E. Sala, F.S. Chapin and E. Huber-Sannwald  
 Collection: Future Scenarios of Biodiversity: Biological Response to Climate Change  
 Bibliography: Springer-Verlag

Monger, H.C. and L.P. Wilding, "Soil inorganic carbon: composition and formation.", ( ). Book, Accepted  
 Collection: Encyclopedia of Soil Science  
 Bibliography: Marcel-Dekker

Monger, H.C., "Arid Soils", ( ). Book, Accepted  
 Collection: Encyclopedia of Soil Science  
 Bibliography: Marcel-Dekker

Monger, H.C. and E.F. Kelly., "Silica mineral", ( ). Book, Accepted  
 Editor(s): J.B. Dixon and D.G. Schluze  
 Collection: Soil Mineralogy with Environmental Applications  
 Bibliography: Soil Sci. Soc. Am. Book Series

Monger, H.C. and R.A. Gallegos, "Biotic and abiotic processes and rates of pedogenic carbonate accumulation in the southwestern United States: Relationship to atmospheric CO<sub>2</sub> sequestration", (2000). Book, Published  
 Editor(s): R. Lal et al.  
 Collection: Global climate change and pedogenic carbonates  
 PP 273-289  
 Bibliography: CRC Press, Boca Raton

Monger, H.C. and J.J. Martinez-Rios, "Inorganic carbon sequestration in grazing lands", (2001). Book, Published  
 Editor(s): R.F. Follett et al.  
 Collection: The potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect  
 PP 87-118  
 Bibliography: CRC Press, Boca Raton.

Okin, G.S., B. Murray, and W.H. Schlesinger, "Desertification in an arid shrubland in the southwestern United States", (2001). Book, Published  
 Editor(s): A.J. Conacher  
 Collection: Land Degradation  
 PP 53-70  
 Bibliography: Kluwer Academic Publishers, Dordrecht.

Schmugge, T., A. French, J.C. Ritchie, and A. Rango., "Estimation of surface emissivity for arid lands.", (2001). Book, Accepted  
 Collection: Proceedings of the International Symposium on Remote Sensing and Hydrology, Santa Fe, New Mexico.  
 Bibliography: International Association of Hydrological Sciences Publication No. 267.

Chopping, M., T.Schmugge, A. Rango, J.C. Ritchie, W. Kustas, and J.R. Vande Castle., "Impact of structure and composition of shrub-coppice dune landscapes on MASTER reflectance anisotropy.", (2001). Book, Accepted  
 Collection: Proceedings of the International Symposium on Remote Sensing and Hydrology, Santa Fe, New Mexico.  
 Bibliography: International Association of Hydrological Sciences Publication No. 267.

### Web/Internet Site

**URL(s):**

jornada.nmsu.edu

**Description:**

Home page for Jornada Basin LTER program; provides links for personnel, for site bibliography (searchable now in several ways), for available data sets, for documentation on LTER and LTER-related projects.

The Jornada LTER bibliography is now searchable over the Internet using ISI Research (ProCite) Reference Web Poster software. The bibliography site can be accessed at <http://128.123.5.143/ris> or from the Bibliography page accessible from the Jornada LTER home page. The Research Notification table is now queryable over the intranet and accessible to JRN and JER site managers, to aid in research site selection and approval.

### Other Specific Products

**Product Type:** Teaching aids

**Product Description:**

Undergraduate interns for the Schoolyard LTER program wrote and enhanced classroom activity guides to provide followup to field visits to the Jornada site.

**Sharing Information:**

The classroom activity guides are distributed through the Chihuahuan Desert Nature Park's educational activities, including classroom visits, teacher training workshops, and field visits by classes to the Jornada site.

**Product Type:** Teaching aids

**Product Description:**

Fact sheets on various LTER and JER studies were produced for assembly into tour books that can be produced and customized for particular visitors or tour groups.

**Sharing Information:**

These materials are reproduced and distributed to visiting researchers, representatives of land management or research agencies, and public groups; they have proven useful in translating research projects into terms meaningful to the general public and to policy-makers and managers in the region.

**Product Type:** Teaching aids

**Product Description:**

A manual introducing quantitative monitoring methods for grassland and shrubland ecosystems has been developed and used extensively in training land managers and private individuals.

**Sharing Information:**

The draft manual is distributed and used in training sessions, is being used by representatives of a number of agencies and NGO's, and is in review for publication in book form.

## Contributions

**Contributions within Discipline:**

Significance to ecology:

The resource redistribution desertification model articulated by Jornada researchers has been a primary conceptual model for ecosystem work in arid and semiarid systems. The concept that shrub dominance in former grassland establishes and exacerbates patchiness in soil resources has stimulated much work. In particular, the focus on the importance of physical redistribution processes and on the interactions between plant properties and abiotic influences has been a productive stimulus for ecosystem ecologists.

The Jornada basin has long been a key location for empirical description of one of the primary forms of desertification (a global problem). The infrastructure provided by the LTER program has facilitated the Jornada's status as a premier location for experimental and process-level studies.

Key findings based on our long-term work and studies illustrate the pace of response of desert organisms to perturbations and environmental drivers. In particular, we have demonstrated:

- the long lag time for vegetation and soil responses to some disturbances (e.g., the removal of key dominant plant species);
- the response of the system to some changes (e.g., human interference with surface flows of water) only after many decades;
- the inertia provided by shrubs and their enforcement of soil heterogeneity.

The Jornada Basin has also been a key location for understanding the development and function of aridland soils (the Desert Soil Project) and the interaction of soils with vegetation (both as driver and as effect).

A final subdiscipline within ecology in which Jornada research has been important is rangeland ecology. The Jornada Experimental Range, NMSU's College of Agriculture Chihuahuan Desert Rangeland Research Center, and most recently the Jornada Basin LTER are known as major research centers for range science. Jornada scientists have contributed key investigations of the interactions between livestock and other semiarid ecosystem components, from phytochemistry to soils.

**Contributions to Other Disciplines:**

Contributions to other scientific disciplines

As noted above, the Jornada has been an important program supporting the efforts of soil scientists to understand the development and properties (both intrinsic and dynamic) of arid-land soils. LTER research has been particularly important in allowing geomorphologists and soil scientists to explore the feedbacks between soil properties and vegetative cover over different temporal scales.

Jornada-based research is contributing to the development of earth system science and the understanding of several phenomena linked to global environmental change. Specific examples include the interactions between desertification and resulting generation and export of dust, and changes in albedo. Model development here should refine our ability to model biosphere response to climatic change. Finally, the new lines of

Jornada work aimed at understanding carbon budgets and soil carbon and carbonate dynamics are addressing major gaps in our understanding of global carbon balance.

The Jornada is actively supporting the development of remote sensing technology and analysis. Remote sensing in arid regions has been constrained by technical difficulties (such as the predominant influence of the soil surface signal), but the vast expanses of relatively inaccessible arid lands with significant large-scale variation will demand remote sensing for adequate observation. Ground truth data and extensive process-level studies are available for cross-referencing with remotely sensed imagery from aerial and satellite platforms at the Jornada (e.g., the JORNEX and PROVE campaigns). There are few such well-studied locations in semi-arid and arid ecosystems, and thus the Jornada promises to become even more important in extending our capabilities.

#### **Contributions to Human Resource Development:**

The Jornada Basin LTER and associated projects support several postdoctoral researchers and attract visiting postdoctoral scientists supported by other institutions or agencies (e.g., CONACyT). The program supports (directly or indirectly) 6 - 12 or more graduate students at a time, doing thesis or dissertation research related to LTER themes and objectives. The primary academic institutions in which these students earn or are working toward degrees include NMSU, Duke University, SUNY-Albany, and King's College - London.

The Jornada Basin LTER program routinely supports 1 - 3 REU students each summer (and into the academic year where the student's location and schedule permit). NMSU is classified as a minority, Hispanic-serving institution, and we have routinely included minority and female students in our REU program.

#### **Contributions to Resources for Research and Education:**

Field station and field researchers' capabilities:

A supplement to the LTER has provided fiber optic and T-1 connectivity to the Jornada Experimental Range headquarters. Recent renovation of a historic building at that site (the Turney house) has provided a small meeting room and some office space for JER personnel; thus the area is developing as the nucleus of a field facility.

The Jornada program's 'pool' of cell phones are routinely used by LTER and non-LTER researchers and visitors to provide a safety communication mechanism in the remote and difficult terrain.

The Jornada GIS and the spatial database maintained by the JRN site office are being used increasingly for selection and coordination of suitable field sites for prospective projects.

Information resources:

The LTER site bibliography (and search/query capabilities developed this year) have been extensively used by students and instructors as well as researchers.

#### **Contributions Beyond Science and Engineering:**

Contributions to the public welfare and societal concerns

LTER research findings have been used in the development of assessment and monitoring methods appropriate for semi-arid ecosystems. Much of the American west comprises such systems, and there is substantial and contentious debate over the appropriateness of particular land uses and their impacts on ecosystem (and economic) sustainability. These applications thus provide tools needed by regulatory and land management agencies as well as individuals.

Human population and land use patterns are changing rapidly around the world (not just in the arid southwestern US). Jornada research helps to provide a basic understanding of the limits to management of livestock in semiarid systems. Moreover, Jornada research on biodiversity, rangeland water and air quality, and other aspects of human-environment interactions is being used in regional efforts to understand and manage other human activities in semiarid ecosystems (beyond livestock production).

Impacts on scientific literacy in the region:

The Schoolyard LTER program and affiliated educational programs are explicitly attempting to improve the rigor and appeal of scientific education at the K-12 level. We operate in a region of the US with largely poor, largely minority populations (schools in the Las Cruces region routinely have student bodies that are 50 - 80 % Hispanic, with 60 - 90 % of the students qualifying for free/reduced lunch program). Thus the program addresses scientific literacy at the earliest stages for a diverse, under-served population.

### **Special Requirements**

**Special reporting requirements:** None

**Change in Objectives or Scope:** None

**Unobligated funds:** less than 20 percent of current funds

**Animal, Human Subjects, Biohazards:** None

**Categories for which nothing is reported:**

## Findings:

Jornada LTER results have confirmed and extended our understanding of the general conceptual model of increasing resource heterogeneity as the primary (and self-reinforcing) mechanism of desertification where shrublands displace semi-arid grasslands. Ongoing experiments have documented **the stability (inertia) lent to the system by shrub dominance**. An important result being reinforced by several different studies is that **the small-scale interaction of plant with transport vector (wind or water) scales up not just additively, but in a spatially-explicit manner, to determine the overall export from a landscape unit**. For example, the microtopography of shrub mounds and hummocks interacts with stemflow, throughfall, and runoff processes in creosotebush bajada to influence formation of rills and channel flow; the compass orientation of mesquite dunes and geometry of bare areas or “streets” are crucial to the generation of dust from mesquite sites.

Our intensified monitoring of dust generation from a network of sites confirmed that mesquite sites are the most significant sources of material capable of being transported long distances. Recovery and digitizing of old vegetation and soil maps, together with most recent vegetation mapping and current geomorphological mapping, permits us to identify specific locations where vegetation changes have been either more rapid or less rapid than typical – therefore particularly important areas for research into processes facilitating or inhibiting change. Hence our work confirms that **integration of multiple spatial scales (especially that of the landscape) is essential to understanding the consequences of desertification and predicting future system dynamics**.

Disturbance studies at the Jornada are illustrating that **in many cases only a small number of species are capable of rapid response to perturbation** (e.g., the plant diversity experiment). Long-term manipulations and our relocation of historical research sites have dramatically highlighted that **observations over a very long period are necessary to see any response, or to distinguish between responsive and non-responsive points on the landscape** (e.g., relocations of CCC remediation treatments from the 1930’s). Further, species-level characteristics do determine the capacity of the system to tolerate or to recover from disturbance (soil surface disturbance experiments, responses of native and non-native plants to the fire study). Disturbances possess inherent variability that contributes to the heterogenous nature of plant communities (e.g., fire and acute grazing in the stressor study). Acute forms of disturbance constitute extreme events that can greatly influence structure and function of plant communities. Results of current experiments confirm our previous understanding that **initial conditions (or environmental conditions present at the time of disturbance) pose important constraints to system response**. For example, favorable precipitation patterns immediately following the burn applications appear to account for the rather strong recovery of both woody and herbaceous species in the fire study.

Long-term studies of aboveground net primary production in a network of sites demonstrated the difficulty of assessing differences across sites or across years when there is so much spatial and temporal heterogeneity within a single site. It would appear that many reports in the literature are based on sampling too limited to permit statistical comparison. Results from long-term monitoring also highlighted the individualistic responses of major groups of organisms

to climatic variation. For example, rodent and rabbit populations declined in 2000, but increased dramatically during the winter and spring of 2001 in both black grama grassland and creosotebush environments. In contrast, lizard populations decreased across all habitats in 2000, and have not demonstrated an increase yet, while ground-dwelling arthropod densities remained relatively constant over the same period of time.

Finally, early stages of model development have been valuable in formulating research priorities for simulation as well as for empirical work on plant – soil interactions. The model highlights **the potential constraints on vegetation response to climatic influences posed by propagule availability and by soil limitations on plant recruitment**. Ongoing work is aimed at understanding soil-plant-resource interactions as well as individual components such as plant recruitment or soil dynamic properties.

**Overview:** The Jornada Basin LTER program has maintained a long-term focus on desertification, encompassing both mechanics and consequences. Through the first three funding cycles, the chief conceptual model highlighted spatial heterogeneity of both biotic and abiotic elements of semi-arid ecosystems. Our specific focus was on the redistribution of soil resources at the plant-interplant scale – the Jornada desertification model. As outlined in our most recent renewal proposal, we are now aiming at better understanding the consequences (and interactions with other agents of global change) of desertification, and at integrating our approaches to better understand redistribution processes and consequences at multiple scales. In particular, we are interested in the degree to which redistribution forms the basis of linkages among landscape units and determines whether the Jornada Basin as a whole behaves as source or sink for important resources.

The chief activities of the period since submission of our renewal proposal (January 2000) are reported here under the following categories:

1. Studies of transport processes, fluxes, and biogeochemistry of soil resources
2. Work aimed at developing a landscape perspective or at integrating multiple spatial and temporal scales
3. Studies of disturbance and recovery processes
4. Investigations capitalizing on the extended history of research at the Jornada (dating back to early 20<sup>th</sup> century studies)
5. Cross-site studies, both within the LTER Network and with non-LTER sites
6. Information management and infrastructure
7. Scientific presentations at meetings, workshops, etc.
8. Other activities: Site synthesis volume, graduate course
9. Associated grant and contract funding

### **Studies of transport processes, fluxes, and biogeochemistry of soil resources**

Much of our empirical and analytical effort has focused on the agents of redistribution (particularly wind and water), and the biogeochemical results of the action of those agents. Other work is aimed at understanding the distribution of, availability of, and interactions among important resources for plant growth (particularly soil water).

a. **Hydrobiogeochemistry:** The field season of 2000 was largely spent conducting some rainfall simulation experiments in mesquite habitats, focusing on bare and vegetated plots, to determine sediment and nutrient transfers in runoff. These experiments, conducted following the protocols of Schlesinger et al. (1999), produced data on runoff volume, sediment yield, infiltration capacity, and nutrient transport. A draft manuscript reporting these data is in hand, with anticipated submission later this summer. Prototype runoff/sediment/nutrient samplers were installed in summer 2000 for evaluation of performance under field conditions. In 2000, there was also collection of vegetation and soil samples in and adjacent to areas of sediment deposition by discontinuous channels in areas of creosotebush. In spring 2001, the tested runoff/sediment/nutrient samplers were installed at 91 inter-rill sites along vegetation ecotones. Five stock ponds suitable for installation of pressure transducers to measure landscape-scale runoff amounts and timing from different vegetation communities were identified, and instrumentation of these was

to be completed in summer 2001. Bedload sediment samplers were added to existing instrumented watersheds in creosotebush bajada. [Schlesinger, Parsons, Wainwright]

**b. Jornada Basin biogeochemical budgets:** Sebastian Schmidt, a Ph.D. student at Duke, is compiling present-day and historical budgets for the pools of carbon and nitrogen in the soil and vegetation of the Jornada Basin, and flux budgets for CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. For methane, efflux terms include production by ruminant animals and uptake by soils, as are being measured by field studies during summer 2001. These budgets, in combination with historical maps of vegetation in the Basin, will allow us to evaluate the source/sink relation of the Jornada Basin with respect to the atmosphere for specific times since the mid-1800s up to the present. [Schlesinger, Schmidt]

**c. Studies of fluxes of inorganic carbon in desert soils:** Five graduate student projects have been established to advance our understanding of the role pedogenic CaCO<sub>3</sub> plays in the C cycle. The questions being asked are the following: i - Do termites biomineralize carbonate crystals as a cementing agent for gallery construction?; ii - Is CO<sub>2</sub> released from exhumed petrocalcic horizons during rain?; iii - What is the ratio of below-ground carbon to above-ground carbon in black grama grasslands and mesquite shrublands?; iv - How does temperature and soil texture affect soil carbonate formation?; and v - Can x-ray diffraction analysis distinguish limestone-carbonate from pedogenic-carbonate in desert soils? Funding for these projects is provided by the LTER (1 student), CONACYT (1 student), and a USDA-NRI grant (1 student). The other two students are supported by NMSU teaching assistantships. The next phase of our LTER studies will focus on combining the spatial scale with the temporal scale. This will involve investigations of long-term resource fluxes based on maps of Holocene depositional and erosional units (both eolian and fluvial). It will also involve investigations of short-term resource fluxes based on small irrigation studies with Schlesinger to test hypotheses dealing with water movement in the soil profile, solute movement, mineral formation and soil gas dynamics. [Monger]

**d. Development of a dust emissions model for the Jornada Basin:** A primary objective of the project is to develop a model for the aerodynamic effects of the vegetation and soil properties at each of the 15 long-term NPP sites. The dominant dust-producing NPP sites are the three mesquite sites. During April 2000, Gillette obtained additional funding from the US Army Center for Health Promotion and Preventative Medicine, at the Aberdeen Proving Ground (MD), to conduct an intensive study of erosion at the three mesquite sites. During that time D. Gillette and A. Pitchford of the US EPA National Exposure Research Laboratory at Las Vegas made measurements of PM<sub>10</sub> (particle mass concentration for particle size smaller than 10 micrometers) and horizontal sand fluxes from surface to 1 m height. Observations were made for 4 x 4 or 4 x 5 grids at each of the mesquite sites for sand storms on April 15 and April 18-19, 2000. Data from the intensive experiment have been analyzed for the sand fluxes. A manuscript is in the final stages of preparation. To integrate wind observations, vegetation mapping, and sand flux monitoring, a mathematical model was constructed of the mean airborne sand mass flux. The model was an expectation integral that used information about the increase of sand flux with length of the street, a function for the horizontal mass flux based on friction velocity and threshold friction velocity, wind speed probability versus wind directions, probability of street lengths versus direction and probability of friction velocity. The model calculations of

mean sand flux movement showed fairly good agreement with the observed mean sand fluxes at three mesquite sites. [Gillette]

e. **Measurement of atmospheric deposition at each of the 15 NPP sites:** Atmospheric deposition collection devices of the same design as used by the US Geological Survey in its deposition sampling program in the Mojave were installed at the 15 NPP sites in March 2001. After a rusting problem was identified by LTER personnel, the collectors were retro-fitted with stainless steel connectors to correct the problem. The intent is to enable quantitative measurement of dust deposition at each site, and eventual analysis of the chemical composition of that dust, to facilitate the estimation of basin-level biogeochemical budgets. [Gillette, Schlesinger]

f. **Dust generation from unpaved roads:** A side project was initiated by a graduate student who is examining the effects of dust generated from dirt roads on lichens and other soil crust-forming organisms. Approaches include both field assessment of the magnitude and distance of dust transport from roads and greenhouse/laboratory study of the effect of experimental dust applications on viability and photosynthetic capabilities of crust organisms. [Herrick, Huenneke, Skarsgaard]

g. **Soil water availability:** We recruited a graduate student to the project, one of whose responsibilities will be to quantify the relative contribution of different forms of caliche to soil water availability at the 15 NPP plots. [Herrick, Peters]

h. **Plant water relations, water vapor flux, and heat flux:** Understanding the physiology of dominant shrub species is crucial to understanding fluxes within and from shrubland sites. Studies of water relations in creosotebush are being carried out with LTER support. One project follows the dynamics of creosotebush recovery from drought. Shrub attributes (including photosynthetic parameters such as maximal carboxylation capacity, quantum yield from chlorophyll fluorimetry, and stomatal control parameters; soil water content; tissue water status; and leaf area) have been followed for four years to understand how individual shrubs survive drought and capitalize on short re-wetting events. Many patterns of acclimation to drought and of recovery dynamics were observed. An analysis of 1300 gas-exchange data sets was completed, using the best available models of photosynthesis. Another project investigates how heat flow in creosotebush stems protects the cambium cells from lethal temperatures. Thermocouples monitored temperatures at stem centers and cambial layers, and the observed patterns were used to develop heat-flow models. Initial estimates for (protective) heat flows were developed, based on aggregating parts of the stem into zones of heat-influx and heat-efflux. The simple resistance model indicated that heat flow by conduction in wood is much too weak to afford protection. Next heat flux by sapflow (supporting leaf transpiration) was quantified. The observed rate of water flow, with a 15 °C gain in temperature, transports almost exactly the projected heat influx. Finally, physiological control of water use is being assessed. Measurements of leaf gas exchange on a number of plant species on the Jornada by Gutschick and his research group have revealed a close agreement of measured stomatal conductance with that predicted from the Ball-Berry model (Ball et al. 1987) that is widely used in climate modelling and hydrology. However, this model only applies to control by the immediate environment of the leaf (PAR flux

density, temperature, windspeed, and CO<sub>2</sub>). An additional layer of stomatal control by root-sourced water stress signals (ABA, abscisic acid) is clear in both herbaceous plants (Tardieu et al. 1998) and woody plants (Niinemets et al. 1999). On sabbatical visits to the laboratory of F. Tardieu in Montpellier, l'Herault, France (supported in part by a supplement to the LTER), Gutschick developed a model synthesizing the Ball-Berry and ABA models. In 2001, final data analyses were made and the manuscript finalized for submission. Long-standing conceptual problems in statistical analyses of the Ball-Berry model were resolved; such problems had limited some application of the model outside of climate and hydrology studies. The joint Ball-Berry / ABA model is being developed for use with soil water status rather than difficult-to-assay ABA as a driving variable. Its application on the Jornada is anticipated. [Gutschick]

- i. **Carbon sequestration studies:** The EPA has funded a project to examine and quantify spatial patterns in carbon dynamics at the Jornada, the Sevilleta LTER site, and a site in northern New Mexico in pinyon-juniper woodlands. Field inventories will be combined with simulation modeling in order to rate management options as to their potential to affect carbon sequestration in different parts of the landscape. [Monger, Peters, Herrick]
- j. **ECOTONE extension:** The US Army has funded work to extend the ECOTONE simulation model of vegetation and soil water dynamics to additional plant communities at the Jornada and on Fort Bliss, TX. ECOTONE was originally parameterized for blue grama, black grama, and creosotebush communities at the Sevilleta. The model is now being parameterized for other important shrubland, grassland, and mixed-dominance associations. [Peters, Havstad]

### **Developing a landscape perspective and integrating multiple spatial and temporal scales**

a. **Geomorphic mapping:** We continued geomorphic mapping to delineate landforms in the Basin, with the ultimate aim of integrating these maps with biogeochemical studies in determining the Basin's status as a source or sink of resources. Our geomorphic mapping covers an area of approximately 2500 km<sup>2</sup>, extending from the southern boundary of CDRRC to the Point of Rocks north of JER, and from the San Andres Mountains to the Rio Grande. To date, this mapping endeavor consists of three maps produced on Landsat images: a physiographic map, a parent material map, and a landform map. The physiographic and parent-material maps are essentially finished and have been digitized. The landform map is scheduled for completion in September, 2001. [Monger, Nolen]

b. **Historical soil maps:** In order to better understand soil resources, the program produced digital map layers from the 'rescue' of 1918 and 1962 soil maps of the Jornada Experimental Range. We can now compare (digitally) the 1918, 1962, Dona Ana Soil Survey, and Desert Project soil maps. These digital maps will soon be available for LTER researchers and will be included in the Soils chapter of the Synthesis Volume. [Monger, Nolen]

Historical vegetation maps: Other digital map layers added to the Jornada GIS include JER vegetation from 1915, a 1942 map of vegetation on the NMSU College Ranch (now the

Chihuahuan Desert Rangeland Research Center, CDRRC), and R. Gibbens's recent re-mapping of vegetation on both the JER and the CDRRC. [Nolen]

c. **Spatial and temporal patterns of NPP:** We continued the seasonal monitoring of plant species composition, aboveground biomass, and aboveground net primary production at the network of 15 permanent sites (3 in each of 5 different vegetation types). We completed and published an analysis of the methodology and power of this design for testing statistically for differences among vegetation types or among seasons. We also submitted a manuscript describing the general patterns of aboveground productivity in the 15 sites over the first 10 years of data collection, focusing on the significant differences between shrub-dominated and grass-dominated ecosystem types. [Huenneke]

d. **Remote sensing of ANPP and vegetation characteristics:** Satellite data from Landsat were purchased for use in studying effectiveness of spectral vegetation indices for assessing net primary productivity. JORNEX campaigns were successfully conducted over CDRRC and JER study areas in September 2000 and May 2001. [Rango]

e. **Synthesizing long-term data sets:** A nationwide search was conducted to fill a postdoctoral position with the LTER. This position will synthesize and integrate various LTER and ARS long-term data sets with a focus on understanding and predicting long-term changes in the vegetation as related to soil properties, land use history, animal distribution and patterns of use, water and soil redistribution. The vegetation data sets of primary interest are the long-term ARS chart quadrats located throughout the Jornada basin, the vegetation maps recreated by Bob Gibbens, and the LTER NPP data collected by Laura Huenneke. Dr. Jin Yao was hired in early June to work on this project. Jin received her PhD from the University of Kansas in December 2000, and has an extensive background in vegetation analyses conducted across spatial and temporal scales. [Peters, Herrick, Huenneke, Havstad]

### **Long-term studies of disturbance and recovery processes**

a. **Soil surface disturbance experiment:** In 1997 a study was initiated under non-LTER funding to apply several types of surface disturbance to desert soils and monitor recovery of soil properties. Surface disturbance plots established in tarbush and creosote plant communities were re-measured and half of each plot was re-disturbed in 2001. While the data have not yet been analyzed, preliminary observations indicate that complete recovery of most soil indicators had occurred at the creosote site, which is dominated by weak cyanobacterial crusts, but not at the tarbush site, which is dominated by soil lichens. [Herrick]

b. **Plant diversity experiment:** This large-scale experiment to understand the impact of reduced species and growth form diversity was maintained and re-sampled. Analyses of plant community composition and recovery through the first 5 years have now been completed and a manuscript is in preparation; preliminary results were presented at several meetings, and the study was incorporated into the GCTE Network of Species Removal Experiments. [Huenneke]

c. **Stressor experiment:** We examined the effects of fire and acute overgrazing on vegetation community responses in the presence of an invasive shrub, *Prosopis glandulosa*, in northern Chihuahuan desert grasslands. Winter, summer, or no acute overgrazing treatments, in the presence and absence of *Prosopis glandulosa*, were applied annually to six 0.5 ha plots within each of three blocks (the stressor experiment) from 1995-2001. Cattle utilization was 65-80% of current year's growth in a single <36 hour period annually. One of two 4m x 5m subplots was burned within each of these 18 plots in August 1994. Cover and frequency of non-woody vegetation were estimated before treatment applications and in summer 2000. Results were compared to patterns seen in 1994; findings are summarized in the Findings section, below. [Havstad]

d. **Fire study:** We examined the effects and interactions of fire and livestock grazing on vegetation community responses in Chihuahuan desert grasslands. Four 200m x 200m plots were established in each of four blocks. Fires were prescribed in June 1999. In October 1999, unfenced plots were exposed to 12 months of continuous grazing; utilization was <40%. Cover was measured before and 14 months after fire using a vertical line point intercept method every 10cm along five 150m transects within each plot. Findings are summarized below. [Havstad, Peters, Drewa]

e. **Fire and consumers:** Field work, data management, and data analysis for animal population studies in the LTER-related fire ecology project were carried out. Species composition and relative abundance were tracked for rodents, grasshoppers, and lizards. [Lightfoot]

Fire and Lehmann lovegrass: A side project related to the fire study was carried out by a master's student, exploring the interaction between fire and the presence of the invasive grass, *Eragrostis lehmanniana*. An established patch of the invasive grass in the study pasture was mapped, and plant species composition and abundance was mapped along permanent transects crossing that patch before and after the application of fire; transects were randomly assigned to burn or control treatments. Soil and litter characteristics were also assessed in the lovegrass patch and in native-dominated portions of the transects. [Huenneke, Herrick, McGlone]

### **Investigations capitalizing on the extended history of research at the Jornada (dating back to early 20<sup>th</sup> century studies)**

a. **Re-construction of historical remediation treatments and photographic archive:** Aerial photos to cover the CDRRC and JER ranches have been purchased to assist in the documentation of historical treatments and to evaluate vegetation change. The following years' photography has been acquired: 1935, 1936, 1937, 1947, 1948, 1955, 1960, 1967, 1972, 1973, 1974, 1980, 1986, 1987, and 1991. In particular, imagery of a little-disturbed pasture on the CDRRC was chosen to evaluate the invasion of shrubs and to document changes since 1935 (see description of archival reconnaissance, below). Various land surface discontinuities have been detected and related to file documentation of rangeland remediation treatments. Some treatments located with aerial photography were previously unknown. An initial paper documenting the usefulness of aerial photography for identifying rangeland remediation treatments is now in press. The knowledge of extent and intensity of rangeland remediation will be used to assist in evaluation of LTER exclosure studies. [Rango, Goslee, Herrick, Havstad, Huenneke]

**b. Archival reconnaissance of mesquite invasion:** Working with supplemental funding derived from the cooperative agreement between NSF and MEDEA, Sarah Goslee (USDA/ARS) and Bill Schlesinger are examining aerial and satellite remote sensing of an area of historical mesquite invasion north of Mount Summerford. The archival record of this photograph allows them to show the pattern of invasion in terms of number and aerial coverage of the shrubs, and to conduct a pattern analysis detailing the process of invasion. Data analysis is largely complete and manuscript preparation is underway. [Schlesinger, Goslee, Peters]

**c. Resampling of historical lagomorph exclosure experiments:** Early in the history of the JER, several large livestock exclosures were established within which shrub removal and lagomorph (rabbit) exclusion treatments were applied. One of these study sites was re-sampled in 1997, and the others were relocated in preparation for resampling in 2001. Preliminary data collected in the 1997 effort indicated that soil C and N was higher in both shrub removal and rabbit exclusion treatments relative to controls, and that there was less gravel in the top 5 cm of the lagomorph exclusion plots. In 2001, we initiated measurements and soil sample collection at all three sites to quantify soil C, N and aggregate stability. [Havstad, Herrick]

### **Cross-site work**

**a. Small mammal impacts on recruitment of perennial grasses:** Brandon Bestelmeyer and Debra Peters received funding from the NSF Cross-site initiative to study the role of small animals on grass recruitment across a climatic gradient that includes three sites in the Chihuahuan desert. The sites range from the Sevilleta National Wildlife Refuge LTER site in central New Mexico to the Jornada Basin and Range LTER in southern New Mexico to Big Bend National Park in southwestern Texas. This project started in 2000, and will continue for 3 years. Efforts to date have focused on site selection and construction and installation of cages suitable for excluding small animals ranging in size from grasshoppers to kangaroo rats and rabbits. Three locations were selected at each site, consisting of an ecotone between black grama grassland and an alternative dominant species, either creosotebush (SEV), honey mesquite (JRN) or chino grama (Big Bend). Cages are being installed this summer (2001), and response variables will be measured for 2 years. One graduate student in the biology department at NMSU (Andrew Rayburn), one technician (Jennifer Johnson) and one postdoc (Tamara Hochstrasser) are working on this project. [Peters, Bestelmeyer, Rayburn, Lightfoot]

**b. US-Hungary collaboration on disturbance effects on grassland diversity patterns:** Debra Peters and Jim Gosz (University of New Mexico) also received funding from NSF Ecological Studies to continue collaborations with a group of ecologists in Hungary headed by Dr. Edit Kovacs Lang, Institute of Ecology and Botany, HAS, Vacratot, Hungary. This project will examine the role of small disturbances in generating landscape- and regional-scale patterns in species diversity. Experiments will be conducted at three LTER sites from the shortgrass steppe in northern Colorado (SGS) to the SEV and JRN in New Mexico. Additional sites will also be done at sites located between the LTER sites. These sites include the Comanche National Grasslands in southeastern Colorado, the Kiowa National Grasslands in northeastern New Mexico, and the Armendaris ranch in south-central New Mexico. Similar experiments will be

conducted at three sites located along a climatic gradient in Hungary. In addition to the experiments, a major focus of this project will be to enhance the potential for future collaborative projects and to increase interactions between US and Hungarian researchers. We will meet these goals through student and junior investigator exchanges between countries. This project will begin in September (2001) and will continue for 3 years. There will be one graduate student in the biology department at NMSU working on the project (Kathi Sheehan). [Peters, Sheehan]

c. **Small mammal exclosure study:** Field work and analysis continued for the cross-site project examining the role of small mammals in desert grassland and shrubland at three Chihuahuan desert sites (Sevilleta, Jornada, and Mapimi Biosphere Reserve in Mexico). Rodents are trapped outside the exclosure, and vegetation, grasshoppers, and soil surface characteristics are assessed in the exclosure treatments. [Lightfoot]

d. **Plant population biology:** Field work and data analysis continued on a demographic study of a prickly pear cactus species, tracking populations in both Jornada and Mapimi Biosphere Reserve. A former postdoctoral associate, now a faculty member at UNAM/Instituto de Ecologia, continues work with Huenneke at the Jornada; a manuscript is nearing completion for submission. [Huenneke, Mandujano]

e. **Chihuahuan rangeland health and sustainable management:** Herrick and Huenneke continue as technical advisors on studies of rangeland ecosystem sustainability administered by researchers at La Campana Experimental Range, Chihuahua (studies funded by CONACyT and by INIFAP).

f. **International:** Gutschick carried out collaborations (in physiological model development) with French researchers at Montpellier supported by an NSF International Programs supplement.

## **Information Management and Infrastructure**

a. **GIS/Spatial database and maps** – see Landscape scale work, above. [Nolen and others]

b. **ArcIMS Project:** The Jornada Basin LTER is having a customized ArcIMS implementation developed. This application will provide a dynamic, interactive mapping and querying interface to JRN meta-data and research data using both internet and intranet web sites. Ken Ramsey (data manager) and Barbara Nolen (GIS specialist) have completed training with Environmental Systems Research Institute (ESRI) for the software applications and system architecture design needed to support, maintain, and enhance the ArcIMS application. They have been working to finalize the scope of work and proposal for the contract with ESRI Implementation Services to develop the ArcIMS application. In conjunction with the USDA-ARS Jornada Experimental Range, we are investing in new servers and workstations to support the new application and the integration of data management from LTER and ARS research. [Ramsey, Nolen]

c. **Field Station Connectivity project:** The fiber optic cable has been laid to the Jornada Experimental Range headquarters (HQ) and the phone system (PBX system) is now operational. The T-1 connection to the JER HQ is being finalized in summer 2001, and NMSU is installing

the final equipment needed for data connectivity. This will allow JER and LTER researchers and visitors to communicate and upload collected data more readily to campus and elsewhere. We also anticipate this allowing us to explore spread spectrum technology for automated data collection from selected remote instrumentation across the basin. [Havstad, Ramsey]

**d. Data management infrastructure:** With LTER supplemental funds and with additional support from the USDA-ARS, the JRN servers, RAID box, and tape library are now housed in the new network rack enclosure. This provides a higher degree of physical security as well as protecting the servers and tape library from heat and dust. The new web server and primary domain controller are now operational. The FTP services have been removed from the file server and placed on an older workstation running Netware 5.1 operating system. Two new workstations have been purchased to upgrade the site manager's computer and provide an additional field technician computer. The Jornada LTER bibliography is now searchable over the Internet using ISI Research (ProCite) Reference Web Poster software. The bibliography site can be accessed at <http://128.123.5.143/ris> or from the Bibliography page accessible from the Jornada LTER home page. The Research Notification table is now queryable over the intranet and accessible to JRN and JER site managers, to aid in research site selection and approval. JRN has purchased a color laser printer for the site office and future GIS lab. In addition, the ARS JER has purchased a color plotter for the GIS lab as well. These efforts are all aimed at furthering the integration of information management when the LTER site office, laboratory, and staff members move to join the staff of the Jornada Experimental Range in the new USDA-ARS building now under construction on the NMSU campus. [Ramsey, Anderson, Nolen]

**e. Upgrading of soil thermocouples for climate data:** The Jornada LTER weather station has been in place long enough that some systems have failed or come to need upgrading. Soil temperature measurements had become problematic in recent years, necessitating replacement of soil thermocouples. Gutschick worked with site manager John Anderson to test the reinstalled soil thermocouples. Following modification of the reference junction, the signals were found to be consistent with past data and with predictions of heat-transport theory. To replace the infrared bolometer that failed after 15 years of service, Gutschick designed a drift-free, permanently calibrated system using infrared thermocouples.

### **Meetings and presentations:**

**All Scientists' Meeting, LTER Network, Snowbird UT, summer 2000.** Curtis Monger spoke at a landscape-scale workshop and at a symposium on ecosystem responses to climate change. Huenneke and Lightfoot both spoke in the GCTE species removal workshop; Huenneke helped organize a workshop on invasive species research at LTER sites; Goslee presented the satellite photo reconnaissance of shrub recruitment; Peters's Hungarian collaboration and cross-site SEV-JRN ecotone study were both presented; Peters and Herrick presented their work on plant-soil feedbacks and recruitment constraints on perennial grass recovery following shrub invasion; Peters organized several workshops on integrating ecological studies at the landscape scale.

**Ecological Society Meeting, Snowbird UT, summer 2000.** Contributed papers and posters:

Davidson, A. D., D. C. Lightfoot and G. S. Gosz. Comparative effects of Gunnison's prairie dogs and banner-tailed kangaroo rats on plants and grasshoppers in a semi-arid grassland.

Goslee, SC, DPC Peters, KA Havstad, and WH Schlesinger. Shrub recruitment and survival in desert grasslands.

Herrick, JE, J VanZee, A Melgoza, KM Havstad, and WG Whitford. Integrated soil and vegetation monitoring for grassland, shrubland, and savanna ecosystems.

Hochstrasser, T and DPC Peters. Effects of shrubs and disturbances on pattern and process in Chihuahuan desert grasslands.

Kroel-Dulay, G, T Hochstrasser, and DPC Peters. The influence of kangaroo rat mounds on species diversity and abundance in two grassland types at a semi-arid ecotone.

Lightfoot, D. C. and L. F. Huenneke. The effects of livestock grazing and climate variation on vegetation and grasshoppers in the northern Chihuahuan Desert.

Peters, DPC. Plant species dominance and disturbance at a grassland-shrubland ecotone, USDA-ARS, Jornada Experimental Range.

Bestelmeyer, S, P Hyder, E Fredrickson, K Havstad, J Herrick, L Huenneke, and J Atchley. K-12 environmental science education on the US-Mexican border.

Huenneke, LF, M Buonopane, L Bothern, and JE Herrick. Effects of plant removals on soil surface erosion in a Chihuahuan Desert shrubland.

Gutschick and A. Bloom are organizing a symposium for the 2001 Ecological Society meeting, entitled "Crossroads of animal, plant, and microbial ecology," encouraging communication among the fields of animal, plant, and microbial ecophysiology.

Monger, invited talk at the Soil Science Society of America (Minneapolis, Nov. 2000).

Monger, invited seminar at Texas A&M Univ. (College Station, Feb. 2001).

Monger, invited talk at the National Cooperative Soil Survey (Ft. Collins, June 2001) (also co-chaired the Research Needs Committee there).

Peters organized and Monger attended the Landscape-Scale Workshop at the Sevilleta LTER in April 2001.

ASA-CSSA-Soil Science Society of America annual meeting, 2000: Herrick was author or co-author on three presentations.

Herrick was invited keynote speaker ("Monitoring methodology for pasture degradation and restoration") in the International Symposium on Silvo-pastoral Systems, San Jose, Costa Rica, April 2001.

### **Other activities**

a. **Site synthesis volume:** After a hiatus during which we submitted the renewal proposal and organized the first year of work under the new funding cycle, we have resumed active work on our synthesis volume. Huenneke took the lead in editorial activities as Schlesinger assumed responsibility for covering key additional content.

b. **Graduate course:** As anticipated in our renewal proposal, Monger and Huenneke offered a graduate seminar course at NMSU (“Chihuahuan Desert Ecosystems”). Ten students from a wide range of basic and applied science departments read classic and current literature from Jornada studies and engaged in discussions with many Jornada LTER researchers.

**Associated grant and contract funding**

Monger, HC (with TL Jones and GA Kidron). International Arid Lands Consortium, “Factors controlling microbiotic crusts: Negev and New Mexico.” \$75,000. 2000-2002.

Monger, HC and JE Herrick. USDA National Research Initiative competitive grants program, “CO<sub>2</sub> emissions from the dissolution of soil carbonate as a contributor to greenhouse gases.” \$142,500. 2000-2003.

Peters, DPC. National Science Foundation, LTER Cross-site program, “Regional variation in direct and indirect influences of animals on Chihuahuan desert grasslands.” \$200,000. 2001-2004.

Gillette, D (with A. Pitchford). US Army Center for Health Promotion and Preventative Medicine. “PM<sub>10</sub> and sand fluxes from mesquite-dominated landscapes.”

Herrick, JE. US Dept of Defense, “Calibration, testing and implementation of an ecosystem monitoring protocol for military lands.” \$110,000. 2000-2001.

Herrick, JE (with J. Belnap and D. Pyke). “Monitoring protocols for soil stability at the Lake Mead Recreational Area.” \$44,000. 2000-2001.

Herrick, J. Dept of Defense subcontract from John Carroll University, “Cryptogam study, disturbance effects on soil water infiltration and erosion.” \$18,975. 2000.

Monger, HC, DPC Peters, JE Herrick, and JT Harrington. US EPA, “Carbon sequestration potential of southwestern rangelands.” \$623,600. 2001-2002.

Peters, DPC and KM Havstad. US Army Construction Engineering Research Lab, “Prediction of future plant community dynamics for military installations using simulation modeling.” \$99,036. 2001-2002.