Annual Report for Period: 11/2007 - 10/2008
Submitted on: 08/26/2008
Principal Investigator: Peters, Debra P.
Award ID: 0618210
Organization: New Mexico St University
Submitted By:
Peters, Debra - Principal Investigator
Title:
Jornada Basin LTER V: Landscape Linkages in Arid and Semiarid Ecosystems

Project Participants

Senior Personnel

Name: Peters, Debra
Worked for more than 160 Hours: Yes
Contribution to Project:
PI with overall responsibility for project; responsible for plant studies and modeling integration and synthesis

Name: Havstad, Kris
Worked for more than 160 Hours: Yes
Contribution to Project:
Co-PI responsible for large animal studies and integration with ARS unit

Name: Herrick, Jeffrey
Worked for more than 160 Hours: Yes
Contribution to Project:
Co-PI responsible for plant-soil feedback studies, and monitoring studies

Name: Monger, Hugh
Worked for more than 160 Hours: Yes
Contribution to Project:
CO-PI responsible for geomorphology and soil studies, lead contact with NMSU, and interactions with NMSU graduate students

Name: Bestelmeyer, Brandon
Worked for more than 160 Hours: Yes
Contribution to Project:
Co-PI responsible for animal studies, and state-and-transition models

Name: Archer, Steven
Worked for more than 160 Hours: Yes
Contribution to Project:
Senior scientist working on shrub invasion dynamics primarily in mesquite-black grama areas; cross-site comparisons with sites in Sonoran Desert.

Name: Sala, Osvaldo
Worked for more than 160 Hours: Yes
Contribution to Project:
Senior scientist responsible for precipitation manipulation studies and net primary production studies

Name: Fredrickson, Ed
Worked for more than 160 Hours: Yes
Contribution to Project:
Senior scientist responsible for livestock grazing studies with emphasis on comparing traditional cattle breeds with aridland-adapted breeds from Chihuahua, Mexico in terms of how the animals use and interact with their environment, and provide feedbacks to the vegetation. Point of contact with other large animal ecologists in the ARS unit.

Name: Throop, Heather

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist responsible for studies on decomposition, root dynamics, and soil organic matter dynamics

Name: Abbott, Laurie

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist working on plant-soil interactions and remediation studies in mesquite dunelands; NMSU animal and range science department representative on the project.

Name: Gutshick, Vincent

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist working on ecophysiology of shrubs (through 2007)

Name: Parsons, Anthony

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist responsible for hydrology studies in the field thru 2008.

Name: Wainwright, John

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist responsible for hydrological modeling through 2008.

Name: Rango, Al

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist responsible for remote sensing imagery and aerial photo image analysis, documentation, and archival

Name: Schlesinger, William

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist working on nitrogen and biogeochemical cycling; provides overall advice to the project

Name: Okin, Gregory

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist responsible for wind erosion-deposition experiments and modeling

Name: Skaggs, Rhonda

Worked for more than 160 Hours: Yes

Contribution to Project:

Senior scientist responsible for human demographic-economic studies in Dona Ana County, and point of contact for cross-site studies on linked human-natural systems.

Name: Vivoni, Enrique

Worked for more than 160 Hours: No

Contribution to Project:

Senior scientist responsible for hydrology studies in field and modeling starting in 2008.

Post-doc

Name: Steele, Caiti

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Brandon Bestelemyer on remote sensing studies; supported by BLM

Name: Rios Casanova, Leticia
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Bestelmeyer on ants and ecotones

Name: Wills, Skye
Worked for more than 160 Hours: Yes
Contribution to Project:
postdoc working with Herrick on monitoring methods

Name: Peinetti, Raul
Worked for more than 160 Hours: Yes
Contribution to Project:
postdoc working with Peters and Fredrickson to develop animal modeling component, and to synthesize data on large animals

Name: Duniway, Mike
Worked for more than 160 Hours: Yes
Contribution to Project:
postdoc working with Herrick on monitoring impacts of linear disturbances

Graduate Student

Name: Crossland, Keith
Worked for more than 160 Hours: Yes
Contribution to Project:
graduate student working with Monger and Herrick on field data collection and lab analyses related to water dynamics at NPP plots (2006-2008)

Name: Rachal, David
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU PhD student with Monger on geomorphology and wind studies (2007 -)

Name: Weems, Stacey
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU MS student working with Monger on banded vegetation formation (2006-2008)

Name: Riggs, Justin
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU MS student working with Monger on soil studies (2006-2008)

Name: Cruz, Janella
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU MS student working with Monger on soil studies (2006-2008)

Name: Campanella, Andrea
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU PhD student working with Bestelmeyer on plant-animal interactions across ecotones with focus on small animals (2004-2008)

Name: Goolsby, Darroc

Worked for more than 160 Hours: Yes

Contribution to Project:

NMSU PhD student working with Bestelmeyer on landscape survey of vegetation and soils for sites located throughout the Jornada (2006-)

Name: Calkins, Michael

Worked for more than 160 Hours: Yes

Contribution to Project:

NMSU MS student working with Throop on decomposition studies (2006-2007)

Name: Kuok Choy, Lam

Worked for more than 160 Hours: Yes

Contribution to Project:

Univ Sheffield PhD student working with Parsons and Wainwright on hydrological analyses of NPP plots (2007-2008)

Name: Reichmann, Lara

Worked for more than 160 Hours: Yes

Contribution to Project:

Brown University PhD student working with Sala on ANPP and rainfall study using shelters and water additions (2005 -)

Name: Klass, Jeremy

Worked for more than 160 Hours: Yes

Contribution to Project:

NMSU PhD student working with Peters on ecotone studies (2007-)

Name: Hewins, Dan

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate student working with Throop on belowground studies in rainout shelter study (2008-)

Name: Gherardi, Laureano

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate student working with Sala on rainout shelter study (2008-)

Name: Baquera, Noemi

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate student working with Herrick on landuse patterns in Dona Ana county (2006-08)

Name: Hansen, Nicole

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate student working with Herrick on vegetation-soil patterns and wind-water redistribution patterns at Red Lake (2006-08)

Name: Smith, Jane

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate student with Throop working on decomposition and soil organic matter dynamics (2008-)

Undergraduate Student

Name: Adhikari, Pradip

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Bestelmeyer on landscape survey and soil studies (2007)

Name: Romig, Kirsten
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Bestelmeyer on plant inventories (2007)

Name: Sprague, Jesse
Worked for more than 160 Hours: Yes
Contribution to Project:
worked with Throop on soil organic matter studies (2007)

Name: Meyer, Nichole
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Throop on decomposition studies (2007)

Name: Chisala, Ngawina Veronic
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Throop on decomposition studies (2008)

Name: Midez, Jaime
Worked for more than 160 Hours: Yes
Contribution to Project:
assisted Sala on rainout shelters (2007)

Name: De Lao, Cheryl Maria
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Monger on soil studies (2007-08)

Name: Lewis, Jeremy
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Throoop on decomposition studies (2008)

Name: Perez, Jesus Adrian
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Throop on soil organic matter dynamics (2008)

Name: Clausen, Tim
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Throop on soil organic matter dynamics (2008)

Name: Sebasky, Kristin
Worked for more than 160 Hours: Yes
Contribution to Project:
Brown undergrad working with Sala on rainout shelter study (2008)

Name: Cortner, Owen
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU undergrad working with Monger on soil studies (2008)

Name: Buchanan, Michael
Worked for more than 160 Hours: Yes

Contribution to Project:
NMSU undergrad working with Monger on soil studies (2008)

Name: Kanof, Lauren
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU undergrad working with Monger on soil studies (2008)

Name: Patel, Amith
Worked for more than 160 Hours: Yes
Contribution to Project:
worked on EcoTrends project to check data and metadata from 50 sites (2008)

Name: Venkata, Sri Harsha Veda
Worked for more than 160 Hours: Yes
Contribution to Project:
worked on EcoTrends project assisting Christine Laney in the formatting of data from 50 sites for inclusion in the book (2008)

Technician, Programmer

Name: Burkett, Laura
Worked for more than 160 Hours: Yes
Contribution to Project:
GIS analyst working with Bestelmeyer

Name: Van Zee, Justin
Worked for more than 160 Hours: Yes
Contribution to Project:
project manager for Herrick's plant-soil studies and monitoring research

Name: Anderson, John
Worked for more than 160 Hours: Yes
Contribution to Project:
Site manager for Jornada Basin LTER

Name: Nolen, Barbara
Worked for more than 160 Hours: Yes
Contribution to Project:
Spatial database expert for Jornada Basin LTER (50% NSF, 50% ARS)

Name: Ramsey, Ken
Worked for more than 160 Hours: Yes
Contribution to Project:
Information manager for the Jornada Basin LTER

Name: Kuehner, John
Worked for more than 160 Hours: Yes
Contribution to Project:
LTER field crew technician

Name: Huang, Haitao
Worked for more than 160 Hours: Yes
Contribution to Project:
computer programmer working with Peters on ECOTONE model

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

Contribution to Project:
worked with Bestelmeyer and Herrick on soil sampling

Name: Laney, Christine
Worked for more than 160 Hours: Yes
Contribution to Project:
Coordinator for EcoTrends project

Name: James, Darren
Worked for more than 160 Hours: Yes
Contribution to Project:
assists in field sampling and lab analyses

Name: Courtright, Ericha
Worked for more than 160 Hours: Yes
Contribution to Project:
project manager for Herrick's soil and monitoring studies

Name: Slaughter, Amy
Worked for more than 160 Hours: Yes
Contribution to Project:
working with LTER scientists on field data collection

Name: Tucker Britt, Chandra
Worked for more than 160 Hours: Yes
Contribution to Project:
member LTER field crew (2005-2007)

Name: Wang, Mei
Worked for more than 160 Hours: Yes
Contribution to Project:
LTER lab technician working for Monger

Name: Salembier, Dan
Worked for more than 160 Hours: Yes
Contribution to Project:
LTER field crew member (2008-)

Name: Schauer, Lisa
Worked for more than 160 Hours: Yes
Contribution to Project:
LTER field crew member (2007-)

Other Participant

Name: Laliberte, Andrea
Worked for more than 160 Hours: Yes
Contribution to Project:
collaborator on remote sensing studies

Name: Whitford, Walt
Worked for more than 160 Hours: Yes
Contribution to Project:
working with LTER scientists on small animal studies

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 funded by NSF and external funding

Name: Brown, Joel

Worked for more than 160 Hours: Yes

Contribution to Project:

working with LTER scientists on carbon sequestration issues (NRCS)

Name: Tugel, Arlene

Worked for more than 160 Hours: Yes

Contribution to Project:

working with LTER scientists on soil studies (NRCS)

Name: Belnap, Jayne

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Herrick on soil surface disturbance studies (USGS)

Name: Bleiweiss, Max

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Al Rango on assembling high resolution satellite data base

Name: Brazier, Richard

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Parsons and Wainwright on hydrology studies (Univ Sheffield)

Name: Kustas, Bill

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Rango on JORNEX project (ARS)

Name: Pyke, Dave

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Herrick on soil and vegetation monitoring

Name: Schmugge, Tom

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Rango on JORNEX project

Name: Roemer, Gary

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Bestelmeyer on plant-animal studies across ecotones

Name: Ulery, April

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Herrick and Monger on soil chemical properties

Name: Collins, Scott

Worked for more than 160 Hours: Yes

Contribution to Project:

working with Peters on cross-site studies of ecotones

Name: Gosz, James
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Peters on cross-site ecotone studies

Name: Bailey, Donovan
Worked for more than 160 Hours: Yes
Contribution to Project:
NMSU biology faculty: collaborator with Peters and Havstad working on black grama genetics (2008-)

Research Experience for Undergraduates

Name: Sanders, Brandon
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Bestelmeyer on soil studies

Years of schooling completed: Sophomore
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: 2007
REU Funding: REU supplement

Name: Ebbs, Lisa
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Throop on belowground studies

Years of schooling completed: Sophomore
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: 2007
REU Funding: REU supplement

Name: Johnson, Eric
Worked for more than 160 Hours: Yes
Contribution to Project:
Brown University REU student working with Sala on ANPP and rainfall study

Years of schooling completed: Other
Home Institution: Other than Research Site
Home Institution if Other: Brown University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2007
REU Funding: REU supplement

Name: Ricketts, Sarah
Worked for more than 160 Hours: Yes
Contribution to Project:
working with Monger on soil studies

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: 2007

REU Funding: REU supplement

Name: O'Brien, Orfhlaith

Worked for more than 160 Hours: Yes

Contribution to Project:

REU from Brown working with Sala on NPP-rain addition/rainout study (2008)

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Brown University

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

Fiscal year(s) REU Participant supported: 2008

REU Funding: REU supplement

Name: Fitzgerald, Allison

Worked for more than 160 Hours: Yes

Contribution to Project:

REU student working with D. Bailey on black grama genetics project (2008)

Years of schooling completed: Sophomore

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: 2008

REU Funding: REU supplement

Name: Holcomb, Patrick

Worked for more than 160 Hours: Yes

Contribution to Project:

worked with Mary Lucero (collaborator)to determine the role of plant-fungal interactions on plant performance (2008)

Years of schooling completed: Sophomore

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: 2008

REU Funding: REU supplement

Name: Webb, Frank

Worked for more than 160 Hours: Yes

Contribution to Project:

worked with Ed Fredrickson (Co-PI) and Raul Peinetti (postdoc) to synthesize animal data as input parameters and testing of new animal dynamics model. Collected data in field for testing animal responses to different vegetation-soil conditions. (2008)

Years of schooling completed: Sophomore

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: 2008

REU Funding: REU supplement

Organizational Partners

USDA ARS JER

Houses Jornada Basin LTER main office and laboratories. Provides salary for lead PI and ARS scientists working on the LTER. Collaborative research with other ARS scientists.

Chihuahuan Desert Nature Park

The CDNP is our partner in K-gray educational outreach programs. The CDNP coordinates the Schoolyard LTER program with schools in the region, operates field trips and classroom visits to relate LTER science to students and teachers, direct summer workshops for regional science teachers, and conducts on-site events for the public.

USDA NRCS

Provides collaborative research through activities of Joel Brown and Arlene Tugel, NRCS scientists housed in the same building as the LTER.

USDI BLM

Provides collaborative research on state-and-transition models (Bestelmeyer) and monitoring of vegetation and soils (Herrick, Havstad).

University of Sheffield

Office space, computer, and salary support to Parsons and Wainwright.

Brown University

Provides office space, computers, and salary for Sala and his students.

University of California at Los Angeles

Provides office space, computers, and salary support for Okin and his students.

Duke University

Provides office space, computers, and salary support to Schlesinger (2006-07).

University of Arizona

Provides office space, computers, and salary support to Archer and his students.

New Mexico Institute of Mining and Technology

NM Tech provides office, computer, and lab support for E. Vivoni to participate in the JRN LTER

Other Collaborators or Contacts

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

The Nature Conservancy, Las Cruces office: conservation planning.

UNAM: collaborations with scientists at the Mapimi Biosphere reserve, Mexico.

INIFAP: collaborations with Dr. Alicia Melgoza in Chihuahua, Mexico.

Institute of Ecology and Botany, Vacratot, Hungary: collaborations with Drs. Edit Kovacs Lang and Gyuri Kroel Dulay.

CARSAME (Center for Applied Remote Sensing in Agriculture, Meteorology, and the Environment): collaborations with Dr. Max Bleiwess.

INRAM (Institute for Natural Resource Analysis and Management): NMSU lab for equipment and soil analyses.

University of New Mexico: collaborations with Scott Collins and others on cross-site research.

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:

Teacher training workshops each summer directed by the Chihuahuan Desert Nature Park, including participation by LTER scientists.

Outreach Activities:

see Activities file

Journal Publications

Abrahams, AD; Gao, P, "A bed-load transport model for rough turbulent open-channel flows on plane beds", EARTH SURFACE PROCESSES AND LANDFORMS, p. 910, vol. 31, (2006). Published, 10.1002/esp.130

Beever, EA; Swihart, RK; Bestelmeyer, BT, "Linking the concept of scale to studies of biological diversity: evolving approaches and tools", DIVERSITY AND DISTRIBUTIONS, p. 229, vol. 12, (2006). Published, 10.1111/j.1366-9516.2006.00260.

Bestelmeyer, BT, "Threshold concepts and their use in rangeland management and restoration: The good, the bad, and the insidious", RESTORATION ECOLOGY, p. 325, vol. 14, (2006). Published,

Bestelmeyer BT; Khalil NI; Peters DPC, "Does shrub invasion indirectly limit grass establishment via seedling herbivory? A test at grassland-shrubland ecotones.", Journal of Vegetation Science, p. 363-370, vol. 18, (2007). Published,

Bestelmeyer, BT; Ward, JP; Havstad, KM, "Soil-geomorphic heterogeneity governs patchy vegetation dynamics at an arid ecotone", ECOLOGY, p. 963, vol. 87, (2006). Published,

Bestelmeyer BT; Ward JP; Herrick JE; Tugel AJ, "Fragmentation effects on soil aggregate stability in a patchy arid grassland.", Rangeland Ecology and Management, p. 406-415, vol. 59, (2006). Published,

Bowker, GE; Gillette, DA; Bergametti, G; Marticorena, B, "Modeling flow patterns in a small vegetated area in the northern Chihuahuan Desert using QUIC (Quick Urban & Industrial Complex)", ENVIRONMENTAL FLUID MECHANICS, p. 359, vol. 6, (2006). Published, 10.1007/s10652-005-6021-

Bird SB; Herrick JE; Wander MM; Murray L, "Multi-scale variability in soil aggregate stability: implications for understanding semiarid grassland degradation.", Geoderma, p. 106-118, vol. 140, (2007). Published,

Brazier RE; Parsons AJ; Wainwright J;Powell DM; Schlesinger WH, "Upscaling understanding of nutrient dynamics associated with overland flow in semi-arid environments", Biogeochemistry, p. 265-278, vol. 82, (2007). Published,

Chapin, FS; Woodwell, GM; Randerson, JT; Rastetter, EB; Lovett, GM; Baldocchi, DD; Clark, DA; Harmon, ME; Schimel, DS; Valentini, R; Wirth, C; Aber, JD; Cole, JJ; Goulden, ML; Harden, JW; Heimann, M; Howarth, RW; Matson, PA; McGuire, AD; Melillo, JM; Moon, "Reconciling carbon-cycle concepts, terminology, and methods", ECOSYSTEMS, p. 1041, vol. 9, (2006). Published, 10.1007/s10021-005-0105-

Crisci, JV; Sala, OE; Katinas, L; Posadas, P, "Bridging historical and ecological approaches in biogeography", AUSTRALIAN SYSTEMATIC BOTANY, p. 1, vol. 19, (2006). Published, 10.1071/SB0500

Darby, BJ; Housman, DC; Zaki, AM; Shamout, Y; Adl, SM; Belnap, J; Neher, DA, "Effects of altered temperature and precipitation on desert protozoa associated with biological soil crusts", JOURNAL OF EUKARYOTIC MICROBIOLOGY, p. 507, vol. 53, (2006). Published, 10.1111/j.1550-7408.2006.00134.

Dobson, A; Lodge, D; Alder, J; Cumming, GS; Keymer, J; McGlade, J; Mooney, H; Rusak, JA; Sala, O; Wolters, V; Wall, D; Winfree, R; Xenopoulos, MA, "Habitat loss, trophic collapse, and the decline of ecosystem services", ECOLOGY, p. 1915, vol. 87, (2006). Published,

Dunway MC; Herrick JE; Monger HC, "The water-holding capacity of petrocalcic horizons", Soil Science Society of America Journal, p. 812-819, vol. 71, (2007). Published,

Flombaum P; Sala OE, "A non-destructive and rapid method to estimate biomass and aboveground net primary production in arid environements.", Journal of Arid Environments, p. 352-358, vol. 69, (2007). Published,

Gillette, DA; Herrick, JE; Herbert, GA, "Wind characteristics of mesquite streets in the northern Chihuahuan Desert, New Mexico, USA", ENVIRONMENTAL FLUID MECHANICS, p. 241, vol. 6, (2006). Published, 10.1007/s10652-005-6022-

Gutschick VP, "Plant acclimation to elevated CO2 - from simple regularities to biogeographic chaos.", Ecological Modelling, p. 433-451, vol. 200, (2007). Published,

Herrick JE; Sarukhan J, "A strategy for ecology in an era of globalization.", Frontiers in Ecology and the Environment, p. 172-181, vol. 5, (2007). Published,

Herrick JE; Schuman GE; Rango A, "Monitoring ecological processes for restoration projects", Journal for Nature Conservation, p. 161-171, vol. 14, (2006). Published,

Howes, DA; Abrahams, AD; Pitman, EB, "One- and two-dimensional modelling of overland flow in semiarid shrubland, Jornada basin, New Mexico", HYDROLOGICAL PROCESSES, p. 1027, vol. 20, (2006). Published, 10.1002/hyp.592

Hu, SX; Abrahams, AD, "Partitioning resistance to overland flow on rough mobile beds", EARTH SURFACE PROCESSES AND LANDFORMS, p. 1280, vol. 31, (2006). Published, 10.1002/esp.133

Mueller EN; Wainwright J; Parsons AJ, "The impact of connectivity on the modelling of overland flow within semiarid shrubland environments", Water Resources Research, p. W09412, vol. 43, (2007). Published, 10.1029/2006WR005006

Mueller EN; Wainwright J; Parsons AJ, "The stability of vegetation boundaries and the propagation of desertification in the American Southwest.", Ecological Modelling, p. 91-101, vol. 208, (2007). Published,

Liu X; Monger HC; Whitford WC, "Calcium carbonate in termite galleries: biomineralization or upward transport?", Biogeochemistry, p. 241-250, vol. 82, (2007). Published,

Peters DPC; Bestelmeyer BT; Turner MG, "Cross-scale interactions and changing pattern-process relationships: consequences for system dynamics.", Ecosystems, p. , vol. , ( ). Accepted,

Peters DPC; Sala OE; Allen CD; Covich A; Brunson M., "Cascading events in linked ecological and economic systems: predicting change in an uncertain world.", Frontiers in Ecology and the Environment, p. 221-224, vol. 5, (2007). Published,

Peters, DPC; Bestelmeyer, BT; Herrick, JE; Fredrickson, EL; Monger, HC; Havstad, KM, "Disentangling complex landscapes: New insights into arid and semiarid system dynamics", BIOSCIENCE, p. 491, vol. 56, (2006). Published,

Peters DPC; Mariotto I; Havstad KM; Murray LW, "Spatial variation in remnant grasses after a grassland-to-shrubland state change: implications for restoration.", Rangeland Ecology and Management, p. 343-350, vol. 59, (2007). Published,

Reynolds JF; Stafford Smith DM; Lambin EF; Turner BL II; Mortimore M; Batterbury SPJ; Downing TE; Dowlatabadi H; Fernandez RJ; Herrick JE; Huber-Sannwald E; Jiang H; Leemans R; Lynam T; Maestre FT; Ayarza M; Walker B., "Global desertification: building a science for dryland development.", Science, p. 847-851, vol. 316, (2007). Published, Roth GA; Whitford WG; Steinberger Y, "Jackrabbit (Lepus californicus) herbivory changes dominance in desertified Chihuahuan Desert ecosystems.", Journal of Arid Environments, p. 418-426, vol. 70, (2007). Published,

Sala, OE; Jackson, RB, "Determinants of biodiversity change: Ecological tools for building scenarios", ECOLOGY, p. 1875, vol. 87, (2006). Published,

Serna-Perez A; Monger HC; Herrick JE; Murray LW., "Carbon dioxide emissions from exhumed petrocalcic horizons.", soil science society of america journal, p. 795-805, vol. 70, (2006). Published,

Spaeth K; Peacock GL; Herrick JE; Shaver P; Dayton R., "rangeland field technques and data applications.", Journal of the Soil and Water Conservation Society, p. 114A-119A, vol. 60, (2006). Published,

Toledo DP; Abbott LB; Herrick JE, "Cover pole design for easy transport, assembly, and field use.", Journal of Wildlife Management, p. , vol. , ( ). Accepted,

Van Vuuren DP; Sala OE; Pereira HM, "The future of vascular plant diversity under four global scenarios.", Ecology and Society, p. 25, vol. 11, (2006). Published, http://www.ecologyandsociety.org/vol11/iss2/art25

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Web/Internet Site

URL(s):

http://www.ecotrends.info

http://jornada-www.nmsu.edu

Description:

The EcoTrends web site was funded by a supplement to the Jornada LTER, and is a joint project with the LTER Network Office, and collaborations with all 26 LTER sites. More than 20,000 long-term datasets are accessible on this website.

The P2ERLS web site was partially funded by the Jornada LTER. This web site contains general information about >600 research sites located globally. P2ERLS is a portal in that it proves users the ability to search for research sites using defined criteria, and then link to those sites.

The Jornada Basin LTER web site delivers data and associated metadata, and ancillary information about the people and research being conducted at the site.

Other Specific Products

Contributions

Contributions within Discipline:

The original resource redistribution framework for desertification that was articulated by Jornada researchers in the late 1980s has been a primary conceptual model for ecosystems research in arid and semiarid systems globally. The concept that shrub dominance in former grasslands establishes and exacerbates patchiness in soil resources and provides a positive feedback to shrub dominance has stimulated research at the Jornada and many other sites globally. More recently, our landscape linkages framework expands on the plant-interspace model to explicitly include other spatial scales by focusing on transport processes that connect patches. This framework has been successfully used to explain historic patterns that could not be explained with the simple plant-interspace model of Schlesinger et al. (1990). Recent publications describe the landscape linkages framework and new insights provided by it (Peters et al. 2004. PNAS; Peters et al. 2006. BioScience). This framework has also provided new insights beyond desertification with a focus on cross-scale interactions (Peters et al. 2007. Ecosystems) and expansion of the framework to the continental scale (Peters et al. 2008. Frontiers in Ecology and the Environment).

The Jornada Basin has long been a key location for empirical studies of shrub invasion and desertification. The infrastructure provided by the LTER program has facilitated the Jornada's status as a premier location for desert ecology studies.

Key findings from our long-term studies illustrate the pace of response of desert organisms to environmental drivers and disturbance.

Contributions to Other Disciplines:

LTER research on desertification has promoted an understanding by soil scientists about the development and properties of arid-land soils that influence their resilience and resistance. LTER research has been particularly important in allowing geomorphologists and soil scientists to explore the feedbacks between soil properties and vegetation cover over a range of temporal and spatial scales. Range managers are using LTER research to develop State-and-Transition Models for millions of acres of land in the western US.

Jornada research is contributing to the development of Earth system science and the understanding of phenomena linked to global environmental change. Specific examples include interactions between desertification and the generation and export of dust that feeds back to influence ecosystem processes. Recent research on inorganic carbon at the Jornada is increasing knowledge about global carbon balance.

Jornada research is actively supporting the development of remote sensing technology and analysis. Remote sensing in arid regions has traditionally been constrained by technical difficulties (e.g., predominance of the soil surface signal), but the vast expanses of relatively inaccessible arid lands with significant large-scale variation will demand improved remote sensing techniques. Ground truth data and extensive process-level studies are available at the Jornada for cross-referencing with remotely sensed imagery from aerial and satellite platforms (e.g., JORNEX). There are few such well-studied locations in semiarid and arid regions of the world, thus the Jornada will continue to make important contributions to this field.

Contributions to Human Resource Development:

The Jornada LTER and associated projects support several postdoctoral researchers, and attract visiting scientists supported by other institutions. We typically house 2-3 visiting scientists for 3-12 months each year. The program typically directs 6-12 graduate students each year working on LTER-related questions. The program also supports 2-4 REU students each summer, NMSU is a minority, Hispanic-serving institution, and we routinely include minority and female students in our REU program. In addition, Jeff Herrick is active as a mentor in the SEEDS (Strategies for Ecological Education and Development) program for the Ecological Society of America, a Mellon Foundation-supported program that recruits and supports students of color in ecology.

Contributions to Resources for Research and Education:

Jornada headquarters has a fiber optic and T-1 connectivity supported by an LTER supplement. Renovations of a historic building at the site (Turney House) provided a small meeting room and limited office space. The Jornada GIS and spatial database maintained by the JRN site office are being increasingly used by local and visiting researchers for selection and coordination of field sites. The LTER site bibliography with search/query capabilities are increasingly used by students, instructors, and researchers. The EcoTrends web site is being used by educators from other institutions for classes and demonstrations on the value and importance of long-term data to understanding environmental change.

Contributions Beyond Science and Engineering:

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

Human populations and land use patterns are changing rapidly globally, and in particular in the American Southwest. Jornada research provides a basic understanding of the limits to management of livestock in these systems. Moreover, Jornada research on biodiversity, rangeland air and water quality, and other aspects of human-environment interactions are being used in regional efforts to understand and manage other human activities in arid systems beyond livestock production.

Our Schoolyard LTER program and affiliated educational programs are explicitly attempting to improve the rigor and appeal of scientific education and literacy at the K-12 level. We operate in a region of the US with largely poor, minority populations: Las Cruces school are 50-80% Hispanic with 60-90% of the students qualifying for free or reduced lunches. Thus, our program addresses scientific literacy at early stages for a diverse, under-served population.

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Product

ACTIVITIES

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, our conceptual model highlighted fine-scale spatial heterogeneity of both biotic and abiotic elements of semi-arid and arid ecosystems. Our focus was on the redistribution of soil resources at the plant-interplant scale – the Jornada "teeter-totter" desertification model. In LTER IV, we embarked on a new framework aimed at a better understanding of the consequences (and interactions with other agents of global change) of desertification, and of integrating our approaches to better understand redistribution processes and consequences at multiple scales. In LTER V, we are furthering our understanding of these multi-scale processes that lead to cross-scale interactions. In particular, we are interested in the degree to which redistribution of resources (soil, nutrients, water) and propagules form the basis of linkages among spatial units across a range of scales, and explain spatial and temporal variation in patterns and dynamics across the Jornada Basin.

I. Synthesis activities

Conceptual framework development, team building, and new connectivity experiment. Based on comments by the site review team in 2003, we spent a considerable amount of time prior to writing our LTER V proposal discussing: a unifying framework, collaborative research, and multi-scale experiments that would integrate all parts of our research. We met at least monthly, and often more frequently, to discuss the framework and overall hypotheses, and to develop specific testable hypotheses. We had four major PI meetings: one in Cloudcroft, NM in November (2004) and three in Las Cruces, NM in May and July (2005), and April (2007). We agreed on an overall design and hypotheses for our integrated experiment as well as teams of researchers to work on various aspects of the design. Our group became much better integrated as part of this planning process. Two major papers were published describing these ideas (Peters et al. 2004. PNAS, Peters et al. 2006. BioScience). We advertised nationally for three GRA positions that we filled by spring 2007. These students participated in the April 2007 science meeting, and are very quickly contributing to the new and exciting science being developed by our group. Our focus is the importance of connectivity and resource redistribution to landscape complexity across a range of scales, from individual plants to the entire Jornada Basin. We initiated a pilot study in 2007 to test basic assumptions about experimental design and methods to increase or decrease connectivity in resources at multiple scales. We should be in an excellent position to begin our full integrative cross-scale experiment in early 2008.

2007-08

Our goal is to develop an experiment to test the relative importance of broad-scale drivers (drought) and fine-scale redistribution of water, soil, and seeds via connectivity by water and wind on the ability of grasses to persist through time despite encroachment by shrubs. Because our methods are novel, we are testing two key aspects using pilot studies in 2007-08. We expect to initiate the full design in 2009 in grass-shrub ecotones at the Jornada and at the Sevilleta. After we have tested these two main components independently, we will design an experiment that combines large rainout shelters with fine-scale changes in connectivity of resources within each shelter.

First, we are testing our ability to modify connectivity via the flow of water and wind at the patch scale. We installed small connectivity obstructions (50 cm tall, 50 cm wide) constructed of hardware cloth in three locations expected to differ in the effects of wind versus water erosion and deposition. Obstructions were located in bare interspaces ca. 1m wide within areas ca. 10 m x 10m. Locations were on a sandy soil dominated by mesquite where wind is the primary vector, and two thin, rocky soils dominated by creosotebush where water is the primary vector: one on a stable surface and the other on an eroding surface. Initial observations show that the obstructions are successful in catching sediment and litter moved by either wind or water. Measurements and photos are being used to document the effects of obstructions. Future studies will determine the number and spatial arrangement of obstructions required for maximum entrapment of material. Our goal is to reduce connectivity of shrubs and bare interspaces thereby increasing connectivity of herbaceous plants. We expect that the accumulation of material under the obstructions will result in feedbacks to seedling establishment such that grasses will become established and grow through time. The result would be a decrease in the areal extent of the bare interspaces and a greater capture of water and materials by the herbaceous plants; thus reducing erosion by wind and water.

Second, we are testing our ability to modify the broad-scale driver of water using large rainout shelters. Small shelters (< 2 m2) are being by Sala and others in a number of herbaceous ecosystem types, including at the JER. We needed to test the durability and microclimatic effects of much larger shelters (300 m2) built by modularizing the Sala design. Large shelters are needed such that connectivity can be manipulated within each shelter using our small obstructions. We installed two large (10m x 30m) rainout shelters based on the Sala design below, but modularized to cover a much larger area. Shelters were constructed in summer 2008: one in a mesquite dominated area with a small amount of grass cover, and one in a mesquite-black grama codominated area. Shelters are being monitored following extreme rain and wind events, and instrumented for soil temperature, soil sediment flux, soil moisture, and light and UV penetration compared to control plots.

Simulation modeling. Another major integrative effort has been to combine the various simulation models. Peters, Parsons, Wainwright, and Herrick have been working to incorporate water redistribution models at fine to patch scales with ECOTONE, our vegetation dynamics model. Peters has also been working with Okin and Herrick to incorporate wind redistribution models at fine to landscape scales into ECOTONE. Fredrickson and Peters are working with an USDA ARS postdoc (Raul Peinetti) to develop an animal redistribution and energetics model to link with ECOTONE. The linked models, called ENSEMBLE, will be used to both understand historic patterns and to predict future dynamics under changing environmental conditions.

2007-08

We used a soil water dynamics simulation model to examine the effects of changes in vegetation from grasslands in 1858 to shrublands at present on seedling establishment of black grama, our historic dominant grass. We found that establishment in general declined with shrub dominance, and that thin, rocky soils dominated by creosotebush had larger declines than sandy soils dominated by mesquite. We also conducted simulations to examine the importance of changes in soil properties on seedling establishment.

Synthesis activities and products. We have been actively engaged in synthesis activities leading to major products.

(1) We published a special issue in 2006 in the *Journal of Arid Environments* based on our new conceptual framework. A total of 10 papers were published in this issue based on Jornada research.

(2) Our LTER synthesis book was published by Oxford University Press in June 2006. This book summarizes much of the work from LTER I-III and provides an introduction to and justification for our new conceptual framework started in LTER IV.

(3) We coordinated a special issue ("Cross scale interactions and spatial heterogeneity: consequences for system dynamics") to be published in *Ecosystems* in late 2007 that extends the Jornada cross-scale framework to other sites and systems. This issue contains papers from two LTER sites (Virginia Coast Reserve [Young], Luquillo [Willig]), a paper from Australia (J. Ludwig), two fire-related papers (C. Allen, Falk), and a paper on animal metapopulations (Schooley).

(4) We are leading a special issue to be published in 2008 in *Frontiers in Ecology and the Environment* on continental-scale research that will draw heavily on LTER network-level science. This special issue will consist of the following 7 papers; each paper has at least one LTER scientist as an author:

Debra Peters, Peter Groffman, Knute Nadelhoffer, Nancy Grimm, Scott Collins, William Michener, and Michael Huston, "Living in an increasingly connected world: a framework for continental-scale environmental science" (submitted May 30, 2007)

John Marshall, John Blair, Al Rango, Mark Williams, Debra Peters, and Syndonia Bret-Harte. "Forecasting Ecosystem Responses to Climate Change and Variability at Regional-to-Continental Scales"

Todd Crowl, Bob Parmenter, and Tom Crist. "The Spread of Invasive Species and Infectious Disease as Drivers of Ecosystem Change Across Regional and Continental Gradients of Climate and Land Use"

Nancy Grimm, David Foster, Peter Groffman, Morgan Grove, Charles Hopkinson, Knute Nadelhoffer, Diane Pataki, and Deb Peters "Land Change: Ecosystem responses to urbanization and pollution"

Chuck Hopkinson Ariel Lugo, Merryl Alber. "Forecasting effects of sea level rise and catastrophic storms on coastal ecosystems"

Craig Williamson, Tim Kratz, Walter Dodds, Margaret Palmer. "Forecasting aquatic system dynamics at regional to continental-scales"

2007-08
The special issue was published in June 2008. Peters was interviewed by Ken Ferguson of Beyond the Frontier, a monthly podcast by ESA (http://www.eas.org/podcast); Dan Kulpinski of Earth and Sky, a radio podcast (http://www.earthsky.org); and Steve Barnett of the Paradise Parking Lot (http://www.prncomm.net).

(5) We have been leading the EcoTrends Project since its inception in 2004. EcoTrends currently includes long-term data (> 10 year record) from all 26 LTER sites and an additional 24 sites supported by other agencies (USDA-FS, USDA-ARS, DOE, USGS). We plan on submitting the book, Our Changing World, to Oxford University Press in fall 2007, and will launch the more fully functional web page (http://www.ecotrends.info) at the time of publication.

2007-08
After much deliberation, we decided to use the USDA ARS government publishing office for the EcoTrends book rather than Oxford University Press. This decision will: minimum the purchase cost of each book, allow free distribution and download of pdfs from the entire book or separate chapters, and maintain the creativity of the editors in putting together content. A detailed email was sent in May to each lead PI of the 26 LTER sites requesting a final quality control and completeness check on their site's data and figures. The deadline for returning this information to us is Sept.1. We will then be able to complete all sections of the book except the biotic responses section that is still being compiled. This section will then need to be checked by each lead PI before we complete the book. We expect to submit the book for design layout by the end of 2008.

The EcoTrends web site is being jointly developed with the LNO. We have been actively populating the database as the revised datasets are returned from the PIs. We expect the web site to be fully functional and complete with >20,000 long-term datasets in October after the PIs have completed their quality control checks on the data and metadata.

(6) We are also developing a web portal ___________________to allow easy access to information about ecological research sites globally and links to their web sites. This "network of networks" (Pole to Pole Ecological Research Lattice of Sites: pronounced pearls) will promote collaborative research across a range of scales, from regions to continents and the globe.

2007-08
We now have >600 research sites in our P2ERLS database. These sites span the globe and are not restricted to the US. Because the data required for a site to be added is few (latitude, longitude, mean annual precipitation, mean annual temperature, elevation, ecosystem type, land owner, and research program), we expect many more sites to be added through time. The search engine is complex because of the possible combinations of these relatively few variables, but is powerful in allowing users access to many sites globally.

II. Specific Activities

A. Vegetation dynamics

1. Rapid Pulse Landscape Inventory of Grass Recruitment [Bestelmeyer]. Years of high rainfall may catalyze significant, long-term effects on the trajectory of arid ecosystems. In 2007, we initiated a new study to document the occurrence of perennial grass-dominated areas and establishment patterns of grasses and shrubs following the unprecedented rains of 2006 (in many cases 100% above average) and relatively wet spring of 2007. The landscape-wide inventory will be used to build statistical models of where recruitment did and did not occur as a function of soils, vegetation state, and landscape context. Selected plots will be used to monitor where recent recruitment events result in permanent, transient, or no change in vegetation structure. A rapid assessment of a large number of plots can be used to quantify the contributions of landscape variables to the characteristics and occurrence of vegetation states and serve as a basis for additional experiments. Long-term monitoring in selected plots will be used to test the hypothesis that establishment and community dynamics differ in distinct landscape contexts. Data collected at the plot scale will be coupled with analysis of high-resolution imagery of shrub and perennial grass patch structure. In addition, results from this pattern analysis will be used to assist in the location of future multi-scale connectivity experiments.

We are using a variety of geospatial data (landform, soils, geographic spread, road proximity) to select ca. 200 points spread across the sand sheet and transition zone geomorphic units of the Jornada where grass recruitment was observed to occur. Samples will be stratified according to soils, geomorphology, and climate heterogeneity affecting recruitment will be estimated via changes in the Normalized Difference Vegetation Index based on MODIS imagery (September 2005 vs. September 2006). This analysis will be used to identify parts of the Jornada where production was relatively high vs. low due (largely) to the distribution of rainfall. Soil, landform, and vegetation-type maps will also be used to identify strata. Plots will be 20 x 20 m and established using permanent markers. Vegetation cover and recruitment levels will be photographed and estimated using standardized ocular procedures or using line-point intercept procedures for plots selected for monitoring. Soils will be characterized to using a soil auger and field estimates (following National Cooperative Soil Survey protocols) to estimate A horizon texture, B horizon texture and carbonate accumulation, and calcic horizon development in lower B horizons. A horizon samples and samples with maximum clay accumulation will be further subjected to particle size analysis. Aerial photography gathered as part of the JORNEX project will be classified to vegetated and non-vegetated classes in Erdas Imagine and used to extract landscape variables for each plot including bare ground connectivity, directional connectivity with respect to prevailing winds, and area of vegetation around each plot at several scales. Logistic regression and classification and trees will be used to statistically evaluate the effects of local and landscape variables on recruitment patterns and vegetation structure.

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About 150 plots were sampled in 2007, and are being resampled in 2008 for grass survival. Initial modeling will take place this fall coupled with repeat aerial photo processing. We are analyzing these data as part of Darroc Goolsby’s PhD project. We expect that Darroc will present the results at the 2009 ESA meeting.

2. Remediation of grasslands [Abbott]. Large-scale degradation has resulted in widespread conversion of Chihuahuan Desert grasslands to shrublands dominated by honey mesquite (*Prosopis glandulosa*) on sandy soils. Efforts to control mesquite and re-establish native grassland vegetation have had limited success, possibly because essential water and soil resources are not retained in mesquite dune-dominated systems. Microcatchments may facilitate restoration of natural processes by reducing soil and water losses from the site. In 2003, we initiated an experiment to determine the integrated effects of vegetation manipulation treatments on mesquite control and grassland restoration at the Jornada. Treatments tested were herbicide application (Triclopyr and Clopyralid), and creation of microcatchments, followed by reseeding in June or August; the experiment was repeated in 2004 using a randomized complete block design. We continue to monitor plant cover and density annually, and soil movement every 3 months. By 2007-08, the vegetation manipulations produced patches with large and small interspace gaps suitable for studying aeolian sediment flux. We plan to sample aeolian sediment flux measurements in plots exhibiting different degrees of connectivity in the near future.

3. Spatial variation in ANPP [Herrick]. In 2007, we initiated a new study at each of the 15 NPP plots representing the 5 major plant communities on the Jornada. This study was designed to address three objectives. (1) Increase our understanding of variability in spatial pattern in the long-term NPP plots. We measured the size distribution of intercanopy gaps along 4 transects in each plot. We will also analyze spatial pattern on high resolution aerial photographs using e-cognition. The information on spatial pattern will be used to compare NPP plots with the plots established in the new connectivity study. (2) To compare vegetation measurement methods as a basis for comparing trends and patterns in the NPP data with other long-term datasets based on plant cover. We measured plant cover and composition using three commonly used field-based approaches: ocular estimates of $1m^2$ quadrats, quadrat point-frames, and a line-point intercept. We will repeat these three methods using the aerial photographs. (3) To compare among ground-based measurements and between ground-based and air photo-based measurements to determine the most efficient sampling methods to address multiple objectives in desert environments. We completed this study in 2008 and are currently analyzing the data in preparation for writing the manuscript.

4. Response of NPP to water and nitrogen [Sala]. We are continuing a study to examine the role of meristem density limitation in the response of aboveground net primary production to changes in water availability. In 2003, plots were established within a 400 ha pasture co-dominated by *Bouteloua eriopoda* and *Prosopis glandulosa.* Three 1-ha exclosures constructed in 1998 are being used to allow replication of treatments, and to avoid effects of grazing and trampling as confounding factors on plant and soil responses. We manipulate nitrogen (N) soil availability (ambient N and increased N) and incoming precipitation ranging from -80% to +80% of controls (five levels of precipitation) using a combination of passive rainout shelters and irrigation. We are using 12 replicates (4 replicates/exclosure) in the water interception and water addition treatments per nutrient level, and 18 replicates (6 reps/ exclosure) in the control treatment per nutrient level, which produces a total of 132 2.5m x 2.5m experimental units.

The rainout shelter design consists of a metal structure that supports V-shape clear acrylic bands. The bands intercept a fraction of incoming precipitation that is then routed outside the plot by a gutter. Different levels of rainfall interception are achieved by modifying the number of bands.

We are using two types of shelters that intercept 50% and 80% of the precipitation. To irrigate the plots, we installed a PVC irrigation system that pumps water from a water truck to the desired plot. Rain water is collected from the Jornada headquarters roof to a fiberglass tank that is then transported to the exclosures with a water truck.

The shelters were operational starting in 2007. We will collect vegetation responses for the next two years at which time the watering and drought treatments will be reversed to examine the influence of time lags in response. In addition, minirhizotron tubes were installed in 2007 in a subset of the plots. We will begin monitoring root response (growth, biomass, and turnover) to treatments in fall 2007.

Rainout shelter that intercepts 80% of the incoming precipitation. Constructed and installed in November of 2006.

Irrigation system made of PVC piping and valves that conducts water to each plot **(a)**. The plots have two sprinklers covering 6.25 m^2 **(b)**. The irrigation system was installed during spring of 2007.

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In 2008, we completed two field seasons of measurements of aboveground measures (meristem density, plant density and cover by species). We plan on reversing treatments in fall 2008 such that drought treatments become rain addition plots and vice versa to examine time lags and hysteresis in responses.

[Throop] Minirhyzotron tubes were installed in a subset of plots in 2007 to monitor root responses (growth, biomass, turnover) to treatments. Root images were collected in 2008 that will be analyzed in 2008-09. In addition, we are collecting plant physiological measurements (water potential, photosynthetic capacity, chlorophyll fluorescence) in response to major rain events. Data to date suggest strong differences in physiological responses to precipitation between mesquite and black grama.

5. Remote sensing of ANPP and vegetation characteristics [Rango]. 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 CDDRC and JER study areas in September and May in every year possible since 2000, including 2007 and 2008. We also acquired Quickbird images and purchased two Unmanned Aerial Vehicles (UAVs) to obtain 5cm resolution aerial photography. Fine-scale UAV images are being used to measure gap and patch sizes as well as percent bare soil and vegetation ground cover. One m resolution remote sensing data are being used to assess the pattern of ecological states while 15-30m resolution data are being used to delineate uniform landscape units.

<u>**In 2008,**</u> we successfully tested our UAVs in takeoffs, landings, and ability to fly prescribed routes. We also certified our ground crew with the FAA.

6. Analysis of long-term data sets [Peters, Sala]. We are analyzing our long-term ANPP dataset collected since 1989 to determine if predictions about the relationship between ANPP and species richness found in more mesic grasslands hold true for arid systems.

<u>**In 2008,**</u> we re-examined several key assumptions associated with the conversion of volume to biomass and production that resulted in values that are too high relative to other sites with similar annual precipitation (e.g., the Sevilleta). Based on these analyses, we modified our equations in two ways: (1) we force the y-intercept through 0 in our biomass to volume conversions similar to the Sevilleta equations, and (2) we removed Yucca species from our analyses. Field observations indicate that Yucca species are often measured incorrectly because of their morphology. After modifying our analyses, our ANPP values are now more comparable to other sites with similar precipitation. Additional analyses were then conducted to examine relationships between ANPP and APPT for five vegetation states (grasslands and shrublands). See Findings for results; several manuscripts will be submitted for publication soon that discuss these results.

7. Regional vegetation and landform mapping [Monger]. We are developing a landform map of the Chihuahuan Desert to provide a broad-scale understanding of desertification dynamics, and to place Jornada site results into a broader content. We are also using historic vegetation maps and climate records to examine changes in the geographic distribution of the Chihuahuan Desert boundary through time. We are collaborating with Juan Martinez-Rios (University of Durango) and Alfredo Granados-Olivas (University of Juarez) on these projects.

<u>**New in 2007-08**</u>

8. Landscape reconstruction of vegetation change pattern [Bestelmeyer]. We are studying several landscapes, including Chupadera Mesa, the Jornada Basin, Potrillos Mountains, possibly the Santa Rita Experimental Range, and several others to be identified this year. The procedure will be: (1) map areas based on ecosystem state, (2) inventory vegetation and soils in each state, (3) couple inventories and maps to GLO surveys, and (4) use repeat aerial photography to assess recent changes in vegetation, soils, and state condition.

9. Social-ecological structure of Chihuahuan Desert ecosystems [Bestelmeyer, Skaggs]. At the broader scale of the Chihuahuan Desert, we are addressing two key questions: (1) are there systematic relationships among soils, vegetation states, and human-dimension variables at a regional scale? (2) Are certain biophysical conditions more likely than others to produce a cycle of ranch failure and degradation characterized by high turnover rates, agency conflict, and accelerating loss of grassland? We are characterizing human dimension variables using BLM allotment data and correlating them to ecological site and state characteristics. We have several allotment clusters we are using that feature different soils and probably have different histories.

10. Geomorphic influences on desertification and grass survival [Monger]. We initiated a new landscape-wide study to determine the landforms that have experienced the least vegetation change since 1858. We are using historic vegetation and soil maps with current landform maps to determine the influence of geomorphology on grassland resistance to shrub invasion. Fine-scale landforms, such as alluvial fans, lake terraces, and playas, are being examined for the relative resistance of perennial grasses through time based on persistence. We are creating a “resistance map” for the Jornada that can be used when stratifying future experiments. The map will also be used to interpret vegetation dynamics within the context of spatially and temporally variable drivers (wind, rainfall) compared with landforms.

B. Animal population dynamics

1. Animal-animal interactions [Fredrickson]. In 2007, we initiated new studies on livestock-prairie dog interactions in an extensive area in northwestern Mexico with current flora and faunal assemblages similar to the Jornada Basin in the mid to late 1800’s. We are examining: differences in breed habitat and foraging preferences, the importance of physical factors in affecting herd hierarchies and movements, and livestock – prairie dog interactions, including the possible formation of “grazing associations” that may prevent desertification by affecting prairie dog distribution and shrub establishment. We found strong seasonal associations between livestock and black-tailed prairie dogs that affect each species distribution. A successful eradication effort during the last century in New Mexico and Arizona is thought to be one factor leading to desertification in the northern Chihuahuan Desert. Our studies will elucidate mechanisms of livestock-prairie dog interactions that may have led to historic desertification patterns, and will provide information needed for the re-introduction of prairie dogs in the Southwestern US. We continued this study in 2008.

<u>2007-08</u>
2. Animal studies evaluation.
Led by B. Bestelmeyer, we conducted a thorough evaluation of our ongoing animal population studies to determine which studies should be continued, and which ones should be modified, and

the ones that should be discontinued. Many of our long-term animal monitoring studies were started in the 1980s, and data have been faithfully collected since that time. However, for several datasets, the data had not been examined for quality or suitability for publication or, in some cases, the scientific questions were missing, unknown, or forgotten when the original PI left the project. Because of limited resources, we decided it was time to conduct this evaluation. We plan on conducting a similar evaluation for our core plant datasets in 2008-09. Below is the document approved by the JRN Executive Committee on June 10 (2008) and approved at the PI mtg on July 14 (2008).

Changes to Jornada Basin LTER Animal Population studies

Submitted by Brandon Bestelmeyer, 1 May 2008; approved by the JRN Executive Committee June 10, 2008; approved by all PIs in attendance at PI mtg July 14, 2008

JRN LTER work will be refocused on the following studies, given existing resources and the involvement of PIs willing to oversee the studies and produce publications from them. Here are the new core studies:

1) Rodent population responses to spatio-temporal heterogeneity across ecotones associated with desertification (RES study). LTER techs trap 3 ecotones (9 sites) and measure NPP twice/year at those sites. This amounts to about 5 weeks of work. Gary Roemer and Brandon will, as often as possible, additionally trap the 2 other ecotones. This study already has 5 years of data. This can also serve as a platform for other studies in the future, including Jeremy Klass's work and was used by Leticia Rios to sample ants.

2) Population dynamics of lagomorphs in desertified and undesertified landscapes. This is the same as the ongoing study except changes in the design. This will take about 4 days of LTER time.

3) Bird population responses to desertification and exurban development. This study will be directed by Laura Burkett using help from whoever is available, and will involve point counts in and around the JER on the East Mesa. An M.S. student will be involved at the start. The amount of LTER time has not yet been determined.

4) Long-term monitoring of rodent-exclosures in grassland. This is the SMES study re-recorded on a 5 year interval, but only the grassland sites.

Below is the rationale for ending, modifying, and adding studies to the core JRN animal project.

Completion of studies

1. End the lizard monitoring study. Rationale: Discussions with past and present LTER techs, including Andrea Campanella, John Kuehner, Clayton (Clay) Crowder, as well as John Anderson indicates that the sampling design is flawed. Traps were allowed to collect sediment leading to reduced capture rates of certain (especially large) species. Inspection of the data by Clay and Brandon confirmed this pattern. Further, the low overall capture rates seem to preclude an evaluation of habitat effects for most species. Brandon approached a graduate student of Blair Wolf (Biology, UNM) who had independently observed the trapping array and the student noted he would have no interest in the data given the design. Clay concluded that the data are essentially a study of population dynamics of a common, small, and easily-trapped generalist lizard Uta stansburiana. Furthermore, it is not clear what interesting patterns are evident in the data after 17 years (data summarized by Clay). The lack of a key question, specific rationale for a focus on this taxon, PI interest, and design problems limits the relative value of extending this data set. Furthermore, the data have not yet produced any significant insights or publications in 18 years. The traps have not been sampled for 1 year.

2. End the arthropod monitoring study. Rationale: This study has not produced any particularly interesting insights. Although the design appears not to be flawed, inspection of the data revealed that 1) for some

reason, many more individuals were recorded in LTER II compared with LTER III (and most species have very low capture rates from 1996-2001) and 2) there appears to be a backlog of species identifications at UNM. The data on the tenebrionid beetles may be the best use of this data set, but the time investment, low capture rates, the need for species identifications, and the problems inherent in quality control of species designations that are "outsourced" reduces the utility of this data set. While a recent used some of these data, there is no interest by any local scientists in directing this study.

3. End maintenance of the creosotebush Small Mammal Exclusion Study (SMES) exclosures. Rationale: The location of the exclosures on an active alluvial fan has created high maintenance costs due to debris accumulation and erosion/deposition of sediment. Furthermore, the atypical nature of the Summerford bajada (most others are relict piedmont landforms with distinct parent materials and vegetation) limits the generality of inference that can be drawn to similar "creosotebush shrublands" elsewhere on the JER/CDRRC. The high maintenance costs associated with this treatment are not balanced by scientific insights that have been (or could be) generated relative to other projects.

4. End responsibility for SMES web sampling. Rationale: The primary rationale is limited resources; we need to free up tech time to sample rodents as part of the Rodent Ecotone Study (RES; see below). The loss of the SMES creosotebush exclosures negates the related need for background rodent abundances near those sites. There may still be a need for rodent abundances as explanatory variables for the SMES grassland sites, however. This could be achieved by using the grassland rodent grid from the nearby Pasture 9 ecotone to gauge yearly changes in abundance, and temporal overlap between SMES and RES sampling allows us to evaluate this option and calibrate future comparisons.

Modification of existing studies

1. Maintain black grama (Pasture 9) SMES exclosures and sampling on a 5 year basis. Rationale: The location of this treatment is adequate and the experiment addresses an important question regarding rodent effects on vegetation in an area of generally high rodent densities. There are, however, concerns about the design of this study as well. The 5 year cycle (as opposed to annual sampling) will maintain our ability to detect long-term directional changes in vegetation and free up resources for other work. In order to justify further expenditure on this project by the JRN, however, the resulting data should be controlled directly by current JRN PIs.

2. Evaluate methods and potentially redesign lagomorph routes. Rationale: As noted above, the Summerford bajada does not adequately represent the shrubland types for us. Furthermore, detectability is very low so this route has been essentially producing a handful of recorded animals (John Kuehner). Consequently, the methods need to be re-evaluated and routes reconsidered. We should consider a new design that intersperses segments of shrubland and grassland that allows replication and blocks to control for rainfall heterogeneity. We also need more total routes to get higher numbers. Right now, it is not clear that we can ever publish the existing data.

New studies

1. Initiate LTER tech support for the Rodent Ecotone Study. Rationale: This study was initiated in 2002/2003 and has been run by Andrea Campanella as part of his doctoral research. Publications will be produced in 2008 and there is potential for us to test and publish on other, long-term hypotheses. Currently, 16 x 6 (10 m spacing) trapping grids are placed in 3 positions across grassland/middle/shrubland ecotone positions in 5 replicate ecotones. Productivity measurements are gathered in 32 1m2 quadrats/grid 2 times each year. The study directly addresses the consequences of desertification and shrub encroachment for rodent populations and, coupled to exclosure studies, to feedbacks on black grama dominance. If some of the ecotones are indeed dynamic in the future, we can test if the grassland grid converges with the shrubland portions in terms of species composition and energy flux. LTER techs will sample rodents in 3 ecotone grids with NPP measurements, requiring 3.5 weeks of field time in fall beginning and one week in spring beginning in 2008.

2. Initiate a new bird monitoring study: Rationale: Birds have experienced documented, interpretable, and significant changes in the Southwestern US, but a mechanistic understanding of the changes are lacking. The population and community responses of birds integrate ecological variables across a variety of

scales, and most notably the broad scales of landscape-to-regional patterns and processes. Birds are uniquely positioned to provide information on the broad and diffuse impacts of regional vegetation change, climate change, and exurban development. Birds are widely used as indicators of the biotic consequences of land conversion and development, so data from the JRN would complement many such studies. We will design a study testing the combined consequences of desertification and suburban development by arraying a system of point count locations from the East Mesa into grassland and shrubland habitats (some of which will be coupled to the RES grids) on the JER. We would test the hypothesis that suburban development on the East Mesa in conjunction with climate change and desertification leads to increasing homogenization of the avifauna, and that suburbanization effects will extend away from the centers of development into adjacent wildlands. We can also take advantage of previous studies on JRN as older baseline data, dating to the IBP period (e.g., Raitt and Pimm 1976). While the sampling is relatively simple, the major challenge would be to train techs to recognize bird species. Fortunately, Laura Burkett is an expert birder and would direct this project in collaboration with other PIs, and a number of volunteers may be available.

C. Transport processes, fluxes, and biogeochemistry of soil resources

Continuing activities (2007-)

1. Hydrologic connectivity [Parsons, Wainwright]. We developed a conceptual and numerical model for emergent behavior of semi-arid vegetation based upon the concept of landscape connectivity and the role of water, wind and animals in exploiting connectivity to redistribute resources and propagules within the landscape. We also continue to collect water and sediment samples from the interrill and rill samples, stock ponds, and the North and South watershed.

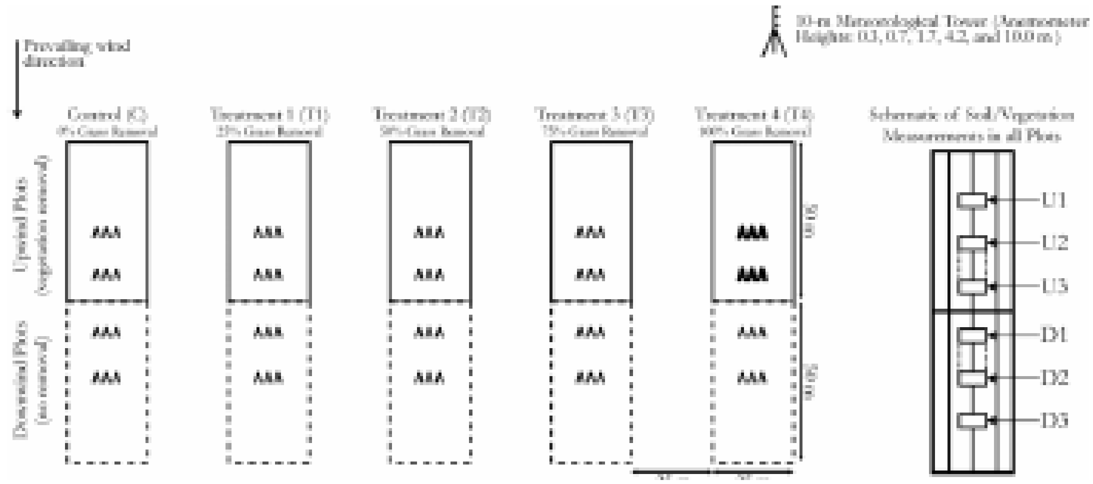
2. Soil water dynamics in the profile [Herrick]. Soil profiles were characterized at each of the 15 NPP sites and soil texture data were collected in association with the NPP access tube locations. These data released in 2008, together with a separate calibration study relating neutron probe counts to volumetric and plant available water, will be used to interpret long-term NPP soil water data. We are nearing completion of these calibrations in 2008 such that a manuscript can be written on the relationship between soil water content, and plant biomass and production.

3. Soil carbon dynamics [Monger, Throop]. In 2007, we initiated a new study using carbon isotopes to compare C_4/C_3 vegetation changes in the arid vs semiarid regions of the Jornada Basin. We are also developing methods for measuring $CaCO_3$ formation/dissolution and its isotopic composition for recording relative abundances of C_3 vs C_4 plants. Through an REU student in 2007 (Ebbs), we assessed spatial patterns of soil organic carbon (SOC) distribution on mesquite coppice dunes. We performed fine-scale soil sampling on dunes of different sizes to determine the influence of dune size on SOC distribution. Additional data collection and analyses are being conducted in 2008. This works parallels work in Sonoran Desert grasslands that suggests sub-canopy SOC pools are strongly a function of shrub size and sub-canopy location. This work will increase our ability to generate landscape-scale estimates of shrub encroachment impacts on C sequestration. Ebbs will write an honors thesis on this work in 2008-09, and we expect to submit a manuscript for publication in spring 2009.

4. Atmospheric deposition [Anderson]. 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. Collections of atmospheric (wet and dry) deposition continue to be monitored seasonally. These measurements will provide (coupled with emission data) a measure of the net loss/deposition of soil nutrients by wind in the Jornada.

5. Wind erosion-deposition [Throop, Archer, Okin]. In 2007, we initiated an experiment to test the rate of redistribution of mesquite leaf litter by wind in landscape positions that differ in vegetation patch structure and connectivity. We hypothesize that decomposition rates will be greatest in areas where flux rates are greatest. Litterbags were deployed in 2007; data collection on the first phase of this 4-year project were completed in May 2008, we expect a manuscript to be submitted for publication in 2008. A related project was recently funded by NSF (see H. Associated Grants below) that will explore how interactions between solar radiation and soil transport influence decomposition rates.

[Okin] We continue to collect data from a large-scale wind erosion experiment established at the JER in 2003. To our knowledge, this experiment is the *only* vegetation manipulation in existence 1) aimed at investigating feedbacks between aeolian processes and vegetation, 2) of a large size, and 3) in natural vegetation. The study was initially funded as an NSF award to Okin (DEB 0316320); the LTER is now assisting with plot maintenance and data collection. The wind erosion experiment consists of three blocks (replicates). Each block consists of four treatments and a control oriented perpendicular to the direction of the prevailing wind. Each treatment consists of an upwind portion where vegetation has been manipulated and a downwind portion where no vegetation manipulations have occurred. Vegetation manipulation on the upwind portion of the treatments consisted of removal of 25%, 50%, 75%, and 100% of the grasses, forbs and small shrubs such as *Gutierrezia sarothrae* in an area of 25 m x 50 m. Shrub cover (*P. glandulosa*) was low in the sites at the beginning of the experiment and was not removed. No vegetation was removed in the control. Because annuals are typically dead by the beginning of the windy season, annual cover is ignored, although each March we determine whether any removal of annuals is necessary. Maintenance (vegetation removal) on the site was last done in March, 2007 and 2008 following significant establishment in summer, 2006. Several recent papers have resulted from this study (Li et al. 2007, 2008) with additional manuscripts being prepared for submission.



Schematic of an individual block in the wind erosion experiment. BSNE collectors are indicated by ^^^. Meteorological stations are installed in Blocks 1 and 3. The right figure shows the layout of sampling locations in each treatment. There are a total of six 5 x 10m soil sampling plots (U1, U2, U3 upwind and D1, D2, D3 downwind). There are six 50-m line-intercept transects for vegetation monitoring (3 upwind, 3 downwind). There are also 10m x 20m plots upwind and downwind where the location of every plant > 2 cm wide has been mapped.

D. Linked socio-economic-natural systems

2007-08

1. Adjudication maps [Skaggs, Wright]. In 2008, we started working with the BLM to digitize the 1930s Las Cruces District allotment adjudication maps that were only available in paper format. There are ca. 230 double-sided 18” x 24” original map documents in generally good condition that we are digitizing and creating an accurate key. BLM personnel in the Las Cruces Office know of at least two retired former BLM employees who can likely provide insight into the map key development; we will consult these individuals as required. The NMSU Geography Department Geospatial Lab supervised by Jack Wright and Mr. Quinn Korbulic is responsible for scanning and digitizing the maps, and developing the map key.

2. Relationships between Socio-Economic & Ecological Processes in Rangeland Landscapes [Skaggs, Bestelmeyer] In 2008, we started compiling socio-economic data from BLM allotment files in order to link to LULLC data. Previous surveys of individuals involved in cattle production throughout the US point to significant variation in motivations, objectives, and cattle management practices. However, previous research has not explored the linkages between this variation and variation in the land they use for livestock production. Furthermore, previous socio-economic research has been aspatial in nature and fixed in time. Thus, while we have some sense of the types of ranchers throughout the country, we have little knowledge of the dynamic spatial and temporal relationships between ranchers’ socio-economic characteristics and biophysical data. Individual BLM grazing allotment records contain data which provide insight into the human agents which control and manage rangelands management, decision making, and outcomes. We recently began building a data set to characterize socio-economic variables and processes for allotments located in Southern New Mexico. Some of the data pertain to the individuals and households which have managed spatially distinct rangeland units since the 1930s. The human agent behavior and characteristics data are linked to spatial data (i.e., grazing allotments). Other data are a function of broad scale trends, events, and shocks which have affected the region's rangelands as well as the people who live and work on them. Some allotments and households have been directly affected by these events (e.g., transfer of land to military reservations during WWII), while other allotments and households may have been indirectly affected as a result of impermanence fears.

Our first step in data collection has been to develop timelines of major events in the "life" of an allotment. These data show differences in allotments which may have had significant effects on LULCC and ecological conditions. The management and ownership differences are qualitative, and also have a temporal dimension. Data collection for BLM rangeland allotments in the study region currently involves establishment of a timeline since the late 1930s for each allotment, development of a brief narrative describing significant socio-economic processes which have impacted the allotment over time, the creation of binary variables to indicate the socio-economic processes. Examples of binary variables being developed include: active manager vs. absentee permittee; agency assessment of permittee management of allotment; commercial rancher vs. hobby rancher; high vs. low ownership turnover; orderly vs. messy transfers or turnovers; evidence or lack of evidence of permittee financial stress; contentious vs. non-contentious relationship between permittee and agency; presence or absence of impermanence factors such as urban area proximity, vandalism, Wilderness Study Area, endangered species, actual or potential military takeover, etc.; presence or absence of significant recreation use; and presence or absence of actual or potential transportation corridors.

Clearly, the data being developed to characterize the georeferenced socio-economic processes on BLM rangeland allotments in the study area involve a certain degree of expert judgment. When the data are complete they will be linked with biophysical data, and provide previously unavailable insight into the relationships between socio-economic and ecological processes in rangeland landscapes.

3. Landuse-land cover change in Dona Ana County [Wright]. Maps are being used to evaluate historic and potential future changes in the number and distribution of residences, and spatial variation in these changes. Results of the modeling exercise are being used to predict the spatial distribution of residences and population density in the future.

E. Cross-site research

1. Small mammal impacts on recruitment of perennial grasses [Bestelmeyer, Peters]. We continue to sample vegetation responses in plots set up in 2000 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. 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 were installed in 2001, and response variables have been measured annually during peak plant growth. We are monitoring black grama basal diameters and assessing plant growth and colonization of all species within each plot. We also monitor small mammal abundance along these ecotones using mark and recapture trapping procedures. Rabbit population studies were conducted by an REU student in 2004.

2. Small mammal exclosure study: Field work and analysis continue for the cross-site project examining the role of small mammals in desert grassland 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. Annual vegetation responses were completed in 2004, although we plan on sampling vegetation every 5 years into the future. Rodent trapping has occurred yearly as part of our animal monitoring studies. This study was initiated by D. Lightfoot (UNM) and is now part of our core studies with management by B. Bestelmeyer and J. Anderson.

3. Monitoring manual [Herrick]. The “Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems” published in 2005 continues to be used in training workshops held throughout the western US, Mexico, and more recently in Mongolia. This document integrates much of the LTER research and applies it to indicator selection and interpretation. A number of US agencies have adopted these methods, including the NRCS, USGS, BLM, and The Nature Conservancy.

4. Hydrology [Parsons, Wainwright]. In 2004-2005, we initiated hydrology studies at the Sevilleta LTER to coordinate cross-site comparisons. Fieldwork at the Sevilleta is being conducted by a graduate student who is sampling spatial characteristics of the physical and chemical properties of soils.

5. Ecotone studies [Peters]. Field work continues to compare grass-shrub ecotones at the JRN and Sevilleta. This research started in 1995 and integrates long-term removal plots at the Sevilleta with the ecotone studies started at the JRN in 2001 (E.1) and the recent connectivity – drought pilot study being initiated at both sites.

F. Network-related activities

2006-07

We continue to remain active at the network level. We initiated the EcoTrends project in 2004 and continue to lead this effort (Peters, Laney, Ramsey). We participated in the LTER GIS survey and the Remote Sensing survey that resulted in articles in Databits (Nolen). We attended the annual LTER Information Managers meeting in San Jose (Nolen, Ramsey, Laney). We co-chair the Network Information Systems Advisory Committee (Peters) and have another member on this committee (Ramsey). We attended a course on “Sensing Technology for the Soil Environment” held at the Center for Embedded Networked Sensing, Riverside, CA and the workshop “ Phenology Across the LTER Network” sponsored by LTER Network Office at Sevilleta, NM (Anderson). In addition, Peters was on the LTER Executive Committee until her term expired this spring.

2007-08

We continue to lead the EcoTrends and P2ERLS Projects (see I. Synthesis activities). We submitted a proposal to the Advances in Biological Informatics Program at NSF to expand EcoTrends and P2ERLS in three ways: (1) to include more sites and databases through an automated procedure, (2) to allow statistical analyses of the long-term data combined with spatial databases, and (3) to allow visualization of original data and derived data products in time and space.

We collaborated with four LTER grassland sites (CAP, SEV, SGS, KNZ) to submit a coordinated LTER social sciences supplement that was funded in 2008. This supplement will allow cross-site social science studies to be conducted and will further develop the JRN social science database. In addition, we are using these ideas to develop a coordinated effort towards a regional ULTRA submission that would include Phoenix, Albuquerque, and Las Cruces.

We participated in the cross-site grassland symposium held at the University of New Mexico July 11-12. We had a total of 18 attendees (8 PIs, 4 staff, 6 graduate students and postdocs) with two presentations (Peters, Monger), and 11 posters. One of the working groups at the meeting discussed the upcoming ULTRA competition, and links among sites in their social sciences research.

G. Information Management

1. Ongoing Activities
We continue to perform ongoing tasks of data documentation, collection, archive, and backup for all research data archived within the Jornada Information Management System (JIMS). We continue planning how to effectively integrate geographic information system (GIS) data layers and research site locations with research data and associated metadata to enhance the quality and availability of all JRN data and to generate more detailed and precise EML documentation. We also continue to provide GPS of research site locations and production of new GIS layers, to provide GIS and GPS support to researchers and students including training and map production. We continue to administer NMSU site licenses for GIS and remote sensing software (Nolen). We continue to populate the JIMS database with research project and associated dataset metadata to support EML generation and the data catalog for all Jornada Basin LTER (JRN) datasets.

2. File Server
<u>2006-2007</u>
The USDA ARS Jornada Experimental Range (JER) purchased a new database server and the JIMS' databases and Trends administrative databases have been migrated to the new server, which required upgrading from Microsoft SQL Server 2000 to 2005. During this process we discovered that Xanthoria (CAP LTER product) would not work on SQL Server 2005. This required that we develop a customized EML creation solution from metadata stored with JIMS. New style sheets have been developed that generate EML level 3 from the JIMS database.

<u>2007-2008</u>
JRN is purchasing a new file server using the LTER site supplement this year. The operating system for the new server will be Novell Open Enterprise Server on SUSE Linux Enterprise Server. Upgrading the operating system from Netware 6.5 will give us the capability to organize

our data easier as our volume size limit will be increased from 2TB to 16 TB per volume; e.g., our image archive is currently spread out over 6 volumes on the old file server.

3. GIS/Image Archives and Services Integrating
2006-2007
The GIS metadata in xml will be used to generate EML documentation for all JRN GIS layers stored within JIMS, which includes geographic bounding coordinates within EML documents describing research datasets.

JRN purchased a new server to support ESRI ArcGIS Server and ArcGIS Image Server software to allow JRN researchers to query and access the JRN data, GIS layers, and imagery. We also attended the Annual ESRI International User Conference in San Diego, CA to gather technical information necessary to develop and serve the GIS services on the new GIS Server. The new GIS Server will support the following GIS Services:

- query and access to aerial photograph archive
- access research site locations (Intranet)
- online shapefile production to support research site location selection and approval
- Jornada Interactive Map (2D) on website
- Jornada Interactive Map (3D) using ArcGIS Explorer

Deployment of ESRI ArcGIS Explorer is being evaluated to support interaction with the globe services and research site locations and their associated data and metadata as well as GIS thematic layers such as vegetation, soils, and base maps.

2007-2008
We are working closely with JRN users of imagery to improve organization of and access to JRN GIS and remote sensing (RS) data. With the growing quantity of imagery at the Jornada, consistent organization, use of naming conventions, processes for adding and acquiring GIS and RS data, and search interfaces and map services for gaining access to the image archives is critical. We are also exploring new methods for backup of imagery to minimize the backup window and reduce impacts on the local area network (LAN). We are preparing to connect 2 imagery users to the SAN to demonstrate the speed and performance of the SAN versus traditional local disk storage to our imagery users. Backup of the SAN is much faster than LAN-based backups of desktop computers and does not impact LAN performance. We deployed ESRI ArcGIS Server for Java and ArcGIS Image Server on the new GIS server and have begun to develop and deliver map services and web mapping applications for research projects. We attended the Annual ESRI International User Conference in San Diego, CA again this year to gather more detailed technical information necessary to develop search interfaces for the aerial photographs (> 5,000) and other image archives and to stay current on advances in ESRI software.

4. Jornada Website
2006-2007
The new web server (purchased by JRN) has been installed and configured to support the new Jornada website currently in beta testing. The new website will include a new XML-based data catalog and data cart that will enforce the JRN data access policy by requiring user registration

and authentication prior to download of JRN data. Users that download data will be required to supply an intended use statement upon download. Users will provide contact information, affiliation, and acknowledgement of the JRN data policies when they register with JIMS. When the beta testing of the new website is completed, the new server will be renamed and replace the web server that currently serves the Jornada website.

2007-08
The new web server has been deployed. The new data cart will be deployed soon and will enforce the JRN data access policy by requiring user registration and authentication prior to download of JRN data. We will be phasing in the data cart in a prioritized manner; ongoing, long-term dataset first, followed by climate and all remaining datasets. Prior to deployment of the new server, the website was updated. The new website has the familiar look and feel of the old website, but under the hood, site authentication now uses the JRN LDAP directory and XML configuration files for dynamic web page creation. The LDAP integration also supports the new user registration and data cart systems.

5. Storage Area Network
2007-2008
The Jornada Experimental Range (JER) purchased a new storage area network (SAN), a fiber channel switch, network attached storage (NAS) server, and fiber channel tape library. This storage solution gives JRN nearly 24 TB of storage capacity with the ability to add 28 TB by adding 1 TB hard drives.

H. Education and Outreach

1. Education [S. Bestelmeyer].

The Jornada Basin sLTER is run through a unique collaboration that links the Jornada Basin LTER, the USDA-ARS Jornada Experimental Range, and the nonprofit Asombro Institute for Science Education (home of the Chihuahuan Desert Nature Park). Since its inception in 1998, the program has become a model used by regional school districts (El Paso Independent School District), other NSF-funded programs (e.g., GK12 program at the University of Texas El Paso), and statewide initiatives (New Mexico's NSF EPSCoR). The program's success highlights the need for inquiry-based science education opportunities for underrepresented students in this border region where approximately 70% of the students are Hispanic.

During the 2007/08 year, staff continued and/or improved all four components of the program. In doing so, staff directly reached more than 12,000 individuals (8,923 students, 80 teachers, and 3,078 other adults) in southern New Mexico and western Texas. Specific accomplishments for each project component are listed below.

Field trips – 2,735 kindergarten through 12th grade students attended 38 day-long field trips where they participated in hands-on activity stations to learn about LTER scientists' latest research. Teachers used pre- and post-field trip activities available through the Asombro Institute for Science Education's web site (www.asombro.org) to prepare students for the field trip and then extend the learning back into the classroom.

Classroom programs and schoolyard studies – Asombro Institute staff members brought exciting, hands-on science programs into classrooms as well. Staff gave 162 hour-long classroom programs to 3,751 students. Most of the activities for these classroom programs come from the Jornada Basin Schoolyard LTER's 400-page handbook containing 35 inquiry-based activities that are done in the schoolyard and/or classroom. Activities are divided into seven categories that overlap with LTER research: weather, microclimates, soil, water, vegetation, arthropods, and vertebrates. Each activity includes teacher instructions, background information, sample graphs, reproducible student pages in English and Spanish, and alignment with state standards. Each topic area (e.g., weather, arthropods) has an associated Science Investigation Kit containing all of the equipment and consumable supplies needed to do the activities. Teachers borrowed these kits for use in their classrooms throughout the 2007/08 school year.

Teacher workshops – During the project year, staff presented nine daylong teacher workshops for 80 teachers from three school districts. During workshops, teachers learned and practiced the schoolyard activities.

Programs for the general public – Focus was also placed on increasing science learning opportunities for the general public through the presentation of 52 public programs attended by 2,437 students and 3,078 adults. Programs took place at the Asombro Institute's 960-acre Chihuahuan Desert Nature Park as well as at other venues throughout the region.

While maintaining the components above, staff also added two new classroom programs (one for elementary students and one for middle school students). These programs were specifically designed for teachers with limited science backgrounds; handouts allow teachers to use project activities and borrowed equipment to continue data collection and analysis with their students following the programs given by Asombro Institute staff members.

Finally, project staff began working with a program evaluator from the University of Texas at El Paso to develop evaluation instruments that can assess students' and teachers' gains in understanding following participation in sLTER programs. Instruments are being pilot tested during the fall of 2008.

2. Outreach: local to national.

2006-2007

Based on a synthesis of our research results together with other studies and in cooperation with the NRCS, we developed a protocol for improving ecological site and ecological site. The NRCS is now promoting the national adoption of this protocol. We also served with an interagency team (USGS, BLM and NRCS) to provide three week-long workshops to over 150 land managers on an ecological process-based rangeland assessment protocol in Colorado, Oregon and Wyoming. This protocol, much of which is supported by Jornada LTER research, is already being nationally applied by NRCS and BLM. Participants in the 2006-2007 workshops including a number of USFS and DoD managers.

2007-08

In addition to numerous oral and poster presentations at local to national meetings, we highlight the following invited talks:

Herrick presented the invited talk "Prioritizing responses to desertification" at the United Nations Commission on Sustainable Development (CSD-16) in May 2008 in New York, NY.

Sala presented the talk "Sustainability without stability: new goals for a world in flux" at the American Association for the Advancement of Science annual meeting in Boston, MA.

Monger hosted the Soil Geomorphology Institute, March 4-20, 2008. The workshop consisted of 35 participants mainly from the NRCS with others from BLM and USDA-APHIS. The objective was to provide training to soil scientists on pedology and geomorphology using a combined classroom and field training approach.

Monger chaired two symposia (Geology and Biomineralogy; Human Influences on the Stratigraphic Record) at the joint 2008 meeting of the Geological Society of America and Soil Science Society of America meetings.

Rango established formal links with the Physical Science Lab at NMSU for the JRN to become part of their UAV facility.

Peters will give the key note talk at the annual meeting of the New Mexico Native Plant Society on 26 September 2008 in Las Cruces, NM. Her talk, entitled "The past as a lens to the future: crossroads in time and space" will feature JRN LTER research results.

Peters was elected to the Board of Directors of NEON as a member representative. She attends three NEON board meetings each year as part of her duties in her 3-year term.

2006-continuing

We continue to publish the Jornada Trails newsletter twice a year with a mailing list of > 350, and we organize the Jornada Symposium with a combined on-site and web-based audience of over 200. Because of our participation in the grassland cross-site symposium in 2008, we did not have the Jornada Symposium for the first time in 14 years. This symposium will continue in 2009.

3. Outreach: international.

2006-07

Herrick: With support from an international supplement, we initiated the development of a network of sites in Mexico designed to examine the role of extreme events in Chihuahuan Desert dynamics. A workshop was held in Zacatecas, Mexico in April, 2005. The workshop resulted in the development of a set of standardized site characterization protocols. These protocols were subsequently applied at 18 locations distributed among 7 sites in Mexico. As part of this pilot project, over 20 Mexican scientists and students were trained in the protocols during workshops held in 2006. A database was developed that will facilitate the characterization of additional sites that can be used in the future for extreme events and other long-term research. The database was transferred to the GRACILIS network, which is part of the new Mexican LTER network and is based in San Luis Potosi.

Monger: We hosted the Desert Project Soil-Geomorphology Tour, May 21-25, 2007. This tour brought together geomorphologists, soil scientists, ecologists, and archaeologists from 15 states, Washington DC, Nepal, Puerto Rico, and India. The tour had an attendance of 85 participants from 16 university, 5 federal agencies, and 6 consulting companies.

2007-08

Herrick co-led one week long "Interpreting and Measuring Indicators of Rangeland Health" workshops in Las Cruces (May 2008; 45 participants), Worland, WY (June 2008; 35 participants), and Xilinhot, Inner Mongolia, China (June 2008; 60 participants). Workshop participants in the US included representatives from BLM, NRCS, DoD, NM State Lands, TNC, university faculty, and consultants. This internationally applied protocol is based on our LTER research.

Bestelmeyer presented the invited talk "The regional ecology of alternative states and thresholds: strategies for ecological site descriptions" at the International Rangeland Congress in Hohhot, Inner Mongolia, China.

Bestelmeyer presented the invited talk "Thresholds in rangelands: the scales of social-biophysical interactions" at CSIRO Rangelands and Savannas stations on Alice Springs, Darwin, Townsville, and Canberra, Australia.

Fredrickson will participate in the Sister Park Meeting between White Sands National Monument and Cuatrocienegas Protected Area in Mexico 3-5 September 2008. Ed will lead a tour of the Jornada and will discuss JRN LTER approaches to understanding and remediating arid and semi-arid landscapes. He has extensive experience working in Mexico, and is involved in efforts to form a biosphere reserve in the Janos grasslands and is working with the Sta. Elena Protected area. He also has active research projects in Chihuahua, Mexico on prairie dog-cattle-vegetation interactions, and is mentoring graduate students from the Universidad de Chihuahua and the Universidad Nacional de Mexico.

I. Associated Grants

Funded

Bhattacharya, A., Cook, J., Bailey, D., Jeffery, C., **Peters, D**. CRI: Infrastructure for networked sensor information technology. NSF. Division of Computer and Network Systems. Program for Computing Research Infrastructure. $498,000. 2006-2009.

Peters, D. LTER V. Site Supplement. NSF. $72,150. 2007.

Peters, D. LTER V. EcoTrends Supplement. NSF. $149,800. 2007.

Peters, D. LTER V. Supplement. NSF. $206,707. 2008.

Bestelmeyer, B. and **Archer, S**. A hierarchical, geospatial approach to predicting and mitigating shrub invasion in the southwestern US. USDA-NRI Biology of Weed and Invasive Species in Agroecosystems. $400,000. 2008-2011.

Archer, S. and **Throop, H.** (collaborative with D. Breshears, P. Barnes, R. McCulley). Decomposition in drylands: soil erosion and UV interactions. NSF Ecosystem Science Cluster. $1,108,000. 2008-2012.

Barger, N., Miller, M, **Herrick, J**. Development of a science-based decision making model for restoration of pinyon-juniper ecosystems. USDA-NRI Forest and Rangeland Ecosystems. $499,650. 2008-2011.

Dougherty, L., **Peters, D**., and **Havstad, K**. Construction of a multi-user facility at the Jornada Experimental Range Field Station. NSF. Division of Biological Infrastructure. Field Station Program. $238,000. 2008-2010.

Peters, D.P.C., and W. Sheldon. Workshop to promote synthesis products from the EcoTrends project. LTER Network Working Group Proposal. $24,500. 2008-09.

Submitted

Peters, D. and **Bestelmeyer, S**. Collaborative research: Ecological Connectivity Analysis Toolkit (ECAT) to transform global change research. NSF. Division of Biological Infrstructure. Program for Advances in Biological Informatics. Collaborative with Evergreen (Cushing), UNM (Brunt, Servilla), and UTEP (Tweedie). $564, 708. 2009-2012. Submitted.

Okin, G., Peters, D., and Rundel, P. Impacts of wind erosion on state change in the Chihuahuan Desert. NSF. Division of Environmental Biology. Ecological Biology Cluster. $764,312. 2009-2012. submitted.

Sala, O., and Peters, D. Precipitation controls of carbon and nitrogen cycles in semi-arid ecosystems. NSF. Division of Environmental Biology. Ecological Biology Cluster. $799,052. 2009-2012. submitted.

JRN LTER FINDINGS

A. Vegetation dynamics

A1. Deb Peters (ARS), **Curtis Monger** (NMSU, Plant and Environmental Science), **Jeff Herrick** (ARS), and **Greg Okin** (UCLA) are using simulation models to examine effects of environmental conditions on perennial grass recruitment following shrub invasion. State changes from perennial grasslands to shrub-dominated systems characterize much of the arid regions of the world, including the American Southwest. This conversion is often difficult to reverse as a result of soil degradation and low grass seed availability. Additional recruitment processes that can limit the return of grasses are seed germination and seedling establishment, processes that are affected by both soil properties and vegetation structure. We conducted simulation model analyses in 2007 to compare the probability of recruitment of the perennial grass, *Bouteloua eriopoda* (black grama), in 1858 and at present. We used a simulation model of daily soil water dynamics (SOILWAT) to simulate recruitment probabilities of black grama for the variation in conditions found at the Jornada Basin. Vegetation and landform maps combined with soils, vegetation, and weather data were used to parameterize the model. In general, simulated recruitment probabilities were higher in 1858 when the Jornada was dominated by grasslands compared with the present, shrub-dominated system (Fig. 1a, b). Changes in recruitment probabilities were dependent on location-specific changes in soil properties and vegetation cover (Fig. 1c). Our results were used to identify the locations and conditions where recruitment of black grama is still possible; these areas can then be targeted for remediation efforts. We also identified the locations where remediation efforts of this grass species will fail without significant modifications to soil properties and vegetation cover. This approach to stratifying landscapes by recruitment potential can be used for other invasive species.

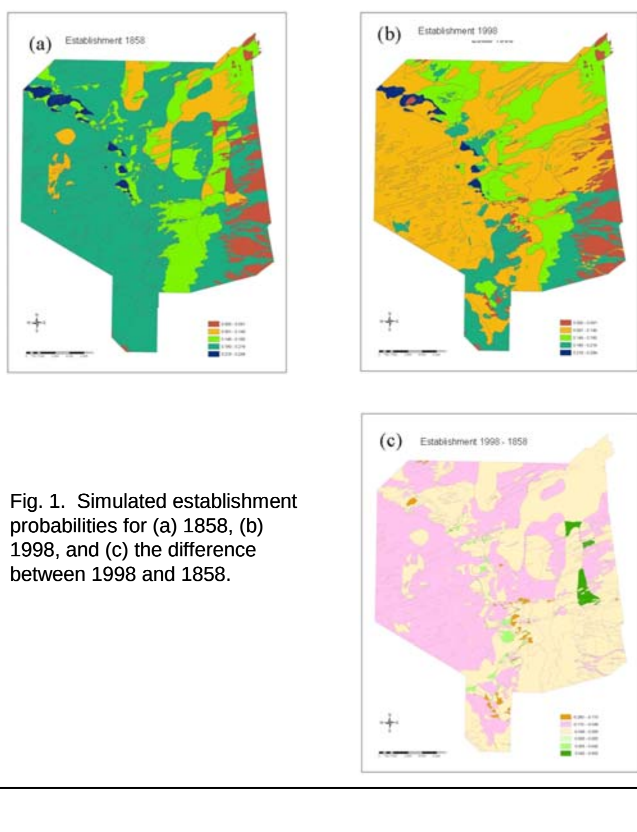


Fig. 1. Simulated establishment probabilities for (a) 1858, (b) 1998, and (c) the difference between 1998 and 1858.

<u>2007-2008</u>

We conducted additional simulations in 2008 using a variable soil layer structure that occurs following either the erosion or deposition of sand during shrub encroachment. Simulated recruitment probabilities were higher where near-surface water-holding capacity (low sand content) was higher, and for sites with higher ANPP. Model results were most sensitive to the addition of 5-15 cm of sand, comparable to soil changes observed over the past 100 years (Fig. 2). Establishment probabilities decreased with the addition of 5 cm sand, and increased with the addition of 15 cm sand; largest increases were found on the most productive sites and largest decreases on the least productive sites.

Removal of surface soil resulted in little change in probability of establishment. Our results show that spatial variation in erosion-deposition patterns combined with patterns in ANPP are needed when planning restoration efforts in dynamic arid landscapes.

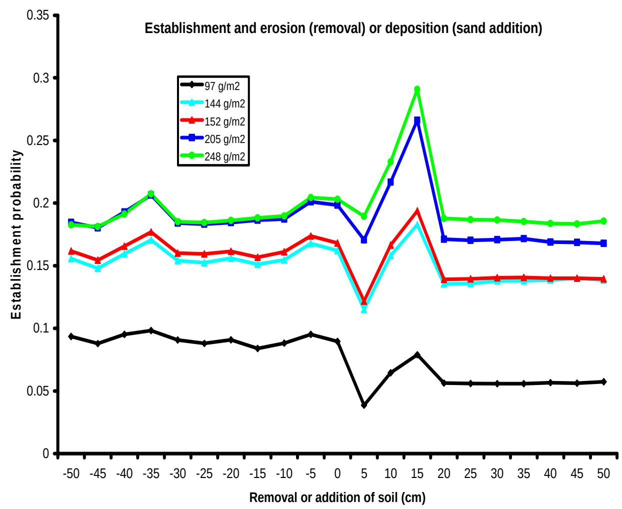
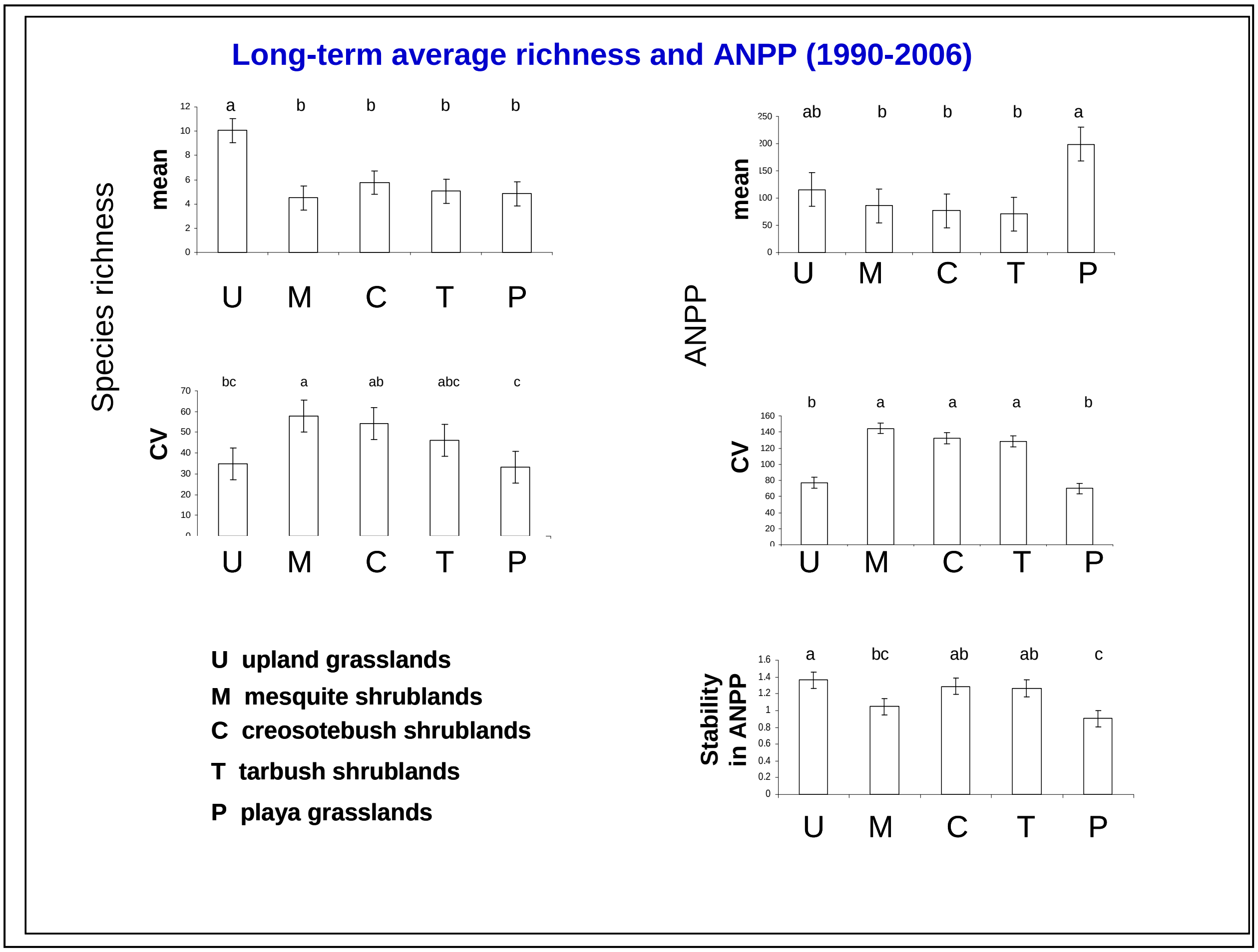


Fig. 2. Simulated establishment probability of black grama for 5 sites with different ANPP, and different amounts of sand added or removed from the soil surface.

A2. Vince Gutschick (NMSU, Biology) and his students completed a study of N dynamics in the co-dominant shrub, *Larrea tridentata.* In 2007, we completed final analyses of data obtained in 2004-2006. Tissue N contents were analyzed by combustion elemental analysis. Thirty mature plants were labeled with 15N-enriched KNO3 and then partially or wholly defoliated (or left as controls) in order to induce N remobilization. The disposition of the 15N label was traced using isotope-ratio mass spectrometry. In the complete data analyses completed in 2006-2007 we found extremely large tissue N pools, which frustrated compartmental analysis of N transfers but revealed the unexpectedly great magnitude of these pools (far exceeding pool sizes of comparable mesic plants). Coarse roots, very high in N (2%), are the largest N pool, by a considerable margin. We also found 10-fold variation in relative labeling intensities, with leaves being exceptionally responsive, and stem and root-crown wood being minimally responsive. Soil nitrate levels were measured in 2007 by flow-injection analysis. The measurements confirmed earlier reports that soluble mineral N pools are extremely high (> 100 mM as soil solution) at 1-2 m depths in these desert soils. We developed hypotheses for the role of these very high N contents, favoring the interpretation of their value as osmotica in the recurring intense water stresses and disfavoring their value in interplant competition for N for N-based defenses (apparently lacking in the species), and other aspects. A manuscript has been drafted, merging these results with 10 years of our data on leaf gas exchange plus a considerable number of studies by other researchers. The manuscript is complete except for additions to figures on stable isotopic ratios in soil and in stem wood.

A3. Laurie Abbott (NMSU, Range Science) continues to study effects of fine-scale redistribution on remediation of grasses following shrub invasion. In 2003, we initiated an experiment to determine the integrated effects of vegetation manipulation treatments on mesquite control and grassland restoration at the Jornada. Treatments tested were herbicide application (Triclopyr and Clopyralid), and creation of microcatchments, followed by reseeding in June or August; the experiment was repeated in 2004 using a randomized complete block design. Growing season (July-September) precipitation was highly variable: plots received 22%, 110%, 37%, and 310% of average growing season precipitation in 2003 – 2006. In 2006, perennial grass cover, mesquite cover and bare ground were affected by herbicide treatment ($p < 0.001$), but no effects of microcatchments or planting date were detected ($p > 0.05$). Herbicide treated plots had 35% perennial grass, 2% mesquite, and 38% bare ground cover, compared to 2% perennial grass, 20% mesquite and 70% bare ground cover on unsprayed plots. Plant establishment in 2006 indicates that the seedbank persisted through at least 2 growing seasons. Observations of perennial grass establishment under mesquite canopies and in interspaces, and lack of microcatchment effects suggest that controlling mesquite was more important than altering microsites for revegetation success.

A4. **<u>2007-08</u>**
Deb Peters (ARS) and **Osvaldo Sala** (Brown) in collaboration with **Jin Yao** (Adams State College) in 2008 analyzed the long-term ANPP and biodiversity data from our 15 NPP sites.

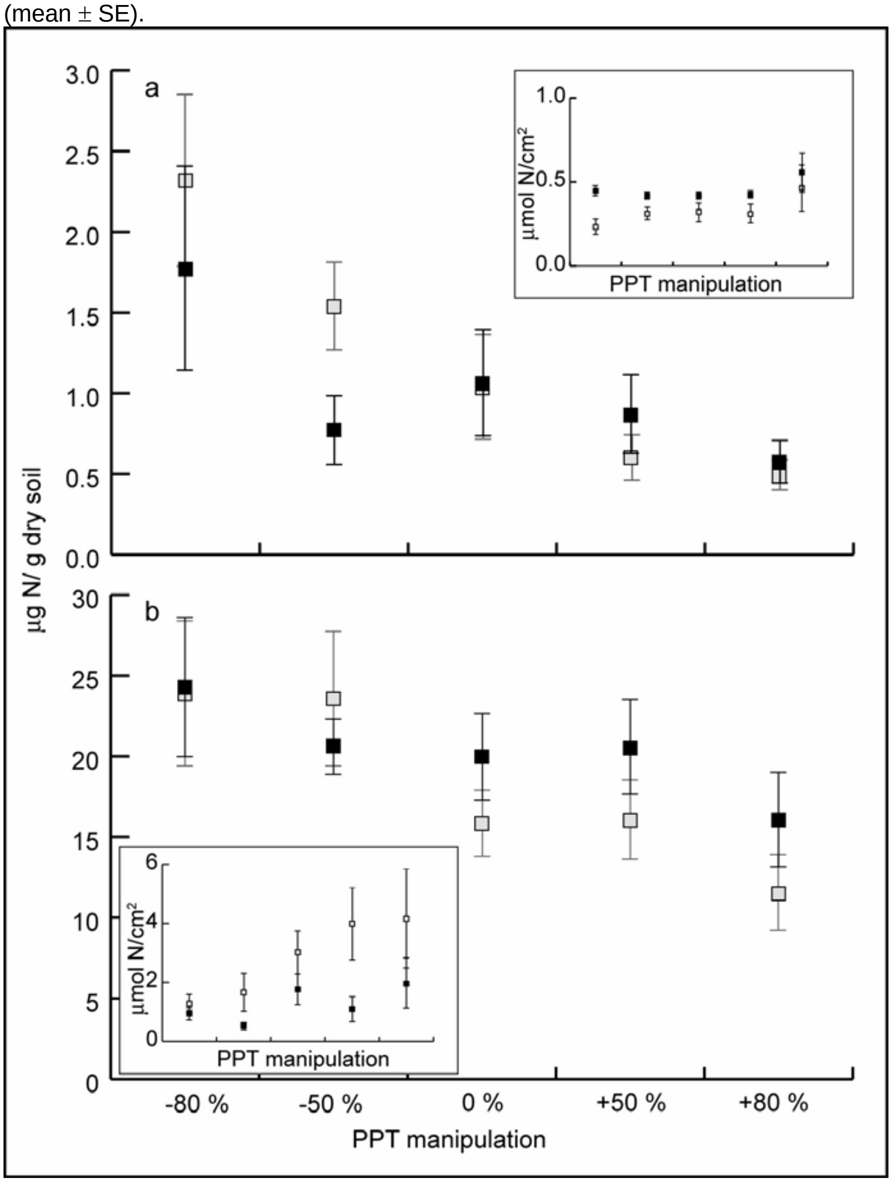


These data have been collected three times a year for 5 sites from each of three vegetation types (upland and playa grasslands; mesquite, creosotebush, and tarbush shrublands) since 1989. Average species richness and ANPP decreased from upland grasslands to shrublands, the most common conversion on the JRN LTER site. Shrubland richness and ANPP were more spatially variable than shrublands (based on the CV). However, playas had the highest variability in ANPP through time. We expect to submit several manuscripts based on these data in fall (2008).

A5. Osvaldo Sala (Brown) and **Deb Peters** (ARS) continue to collect carbon and nitrogen response data following rain addition and removal studies in a mesquite-black grama location.

The central question is: Is water availability the most important factor limiting ecosystem function in arid and semiarid systems? We hypothesize that water availability is indeed the most important limiting factor, but there are indirect mechanisms associated with biotic and biogeochemical constraints that create lags in ecosystem response to changes in precipitation that mask the production-precipitation relationship. Predicting the response of arid and semiarid systems to climate change requires an understanding of these indirect mechanisms. We are testing three hypotheses related to: (1) the effect of meristem density constraints on production, (2) the effect of biogeochemical constraints on production, and (3) the asymmetric response of production to increases or decreases in precipitation from one year to the next and its consequences on production under more variable precipitation.

Soil inorganic N content for different experimental rainfall and N manipulation treatments. **a**. No N addition. **b**. Fertilized with 10 g N-NH_4NO_3. m^{-2}. The insets show inorganic N concentration in resin capsules buried at 10 cm depth for the same rainfall manipulation treatments (August through October 2007). Open squares, N-NO_3; filled squares, N-NH_4 (mean ± SE).

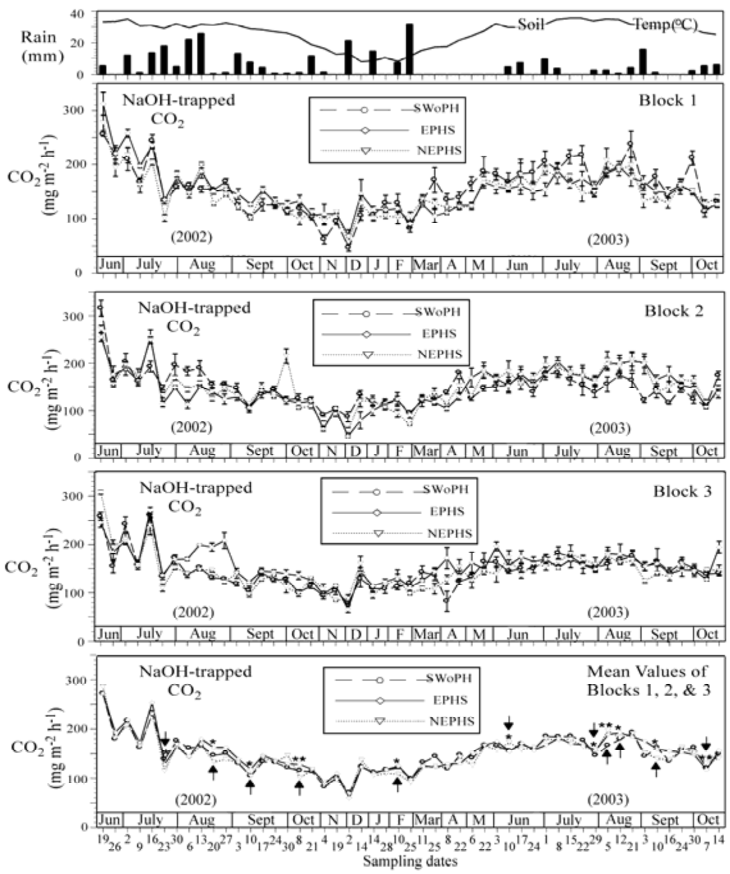


2007-08

Results from 2008 showed that water and fertilization treatments affected N loss and immobilization in different ways, but did not affect N net mineralization. Soil mineral N increased 2.4 times in the drought treatments compared to irrigated plots leading to an accumulation of both forms of inorganic N. Moreover, nitrate was the most abundant ion in both water interception treatments. The addition of ammonium nitrate interacted with water availability to increase nitrate loss at a depth of 0-10cm due to leaching.

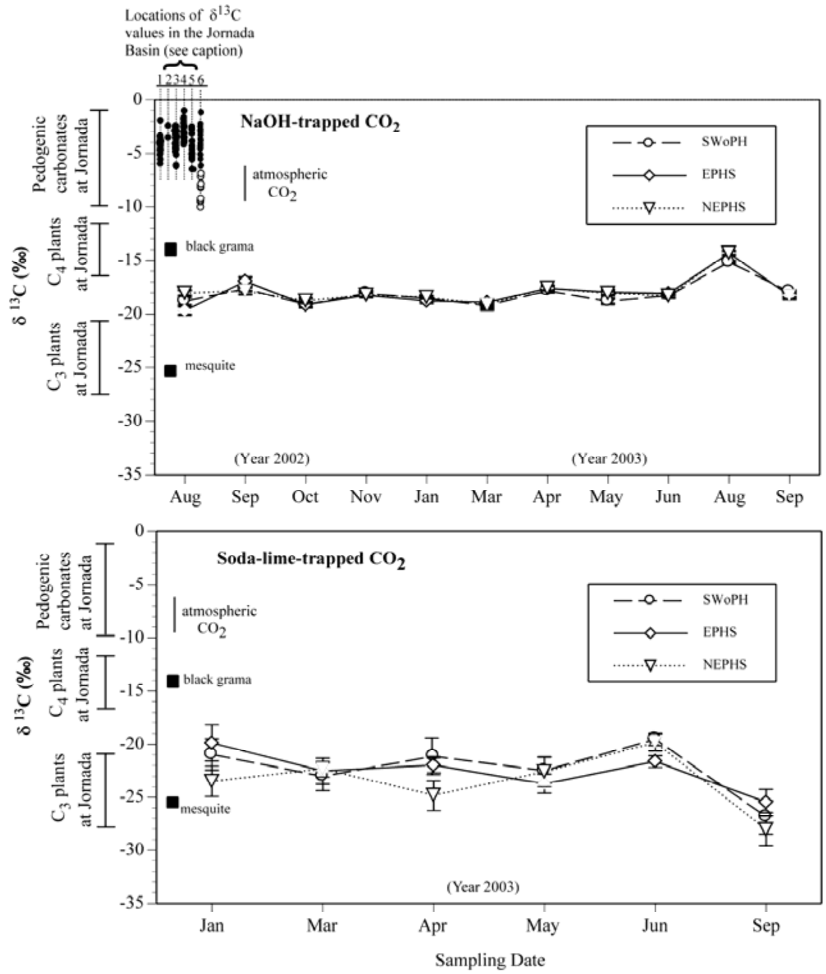
B. Soil carbon dynamics

B1. Curtis Monger (NMSU) conducted a study in 2007 of CO_2 emissions from soils with and without petrocalcic horizons. Carbon has been studied at the landscape scale by several investigators. Our researched focused on the source of CO_2—respiration versus carbonate dissolution—by testing the hypothesis that soil type 1 (eroded Aridisols with exhumed petrocalcic horizons) will emit more CO_2 than soil type 2 (non-eroded Aridisols with petrocalcic horizons) or soil type 3 (Entisols formed in sandy, noncalcareous sediments). We found no statistical difference in CO_2 emissions from the three soil types at the $\alpha = 0.05$ level. New studies will build on these results by setting up experiments that measure $CaCO_3$ development and dissolution as a function of soil depth.



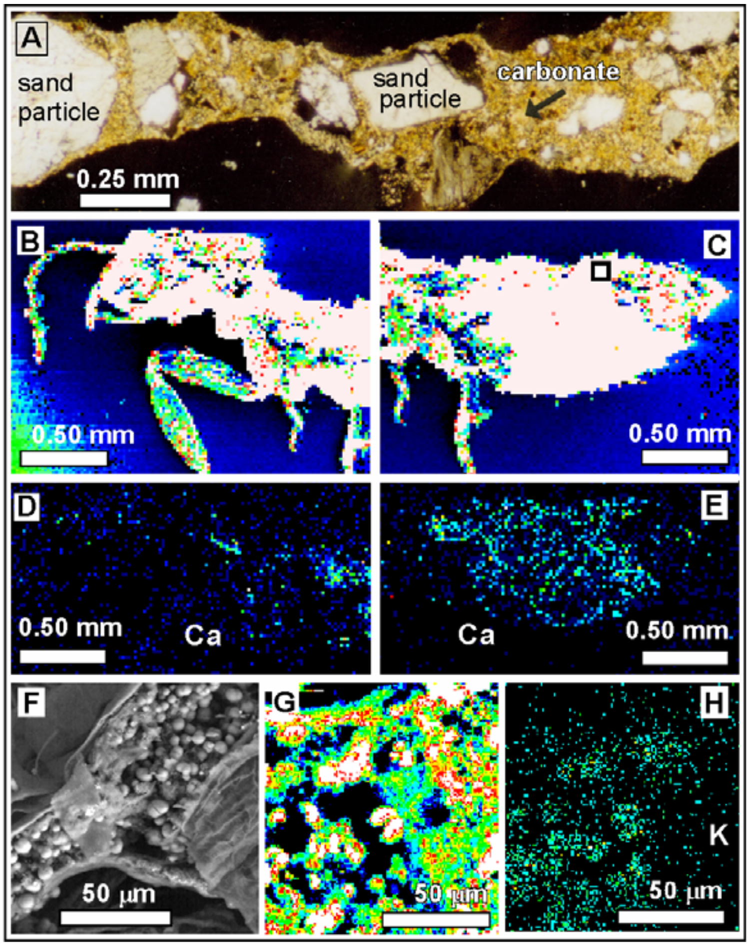
Soil CO_2 emissions for three sampling blocks across the basin floor. SWoPH=Soil without petrocalcic horizons, EPHS=Eroded petrocalcic horizon soil, NEPHS=Non-eroded petrocalcic horizon soil. Means with ** are different at $\alpha = 0.05$. Means with * are different at $\alpha = 0.20$. Arrows pointing up signify times when EPHS is higher than at least one of the other two soil types. Arrows pointing down signify times when EPHS is lower than at least one of the other two soil types. (Serna-Perez et al. 2006).

B2. Curtis Monger (NMSU) conducted a study in 2007 to identify the source of soil-respired CO_2 at the landscape scale through carbon isotopes. Using a randomized complete block design, we found that the isotopic values of soil-respired CO_2 did not match the isotopic values of pedogenic carbonate, nor were there any statistical differences ($\alpha = 0.05$) in $\delta^{13}C$ of CO_2 among the three soil types. We conclude, therefore, that exhumed petrocalcic horizons are not actively emitting CO_2 at a rate significantly greater than adjacent soils, and thus carbon stored in petrocalcic horizons can be considered a recalcitrant reservoir within the decadal timeframe. In LTER V, we will continue ^{13}C studies of soil CO_2 with the goal of increasing our knowledge about how accurately $Ca^{13}CO_3$ records the relative amounts of C_4 vs C_3 plants growing on the landscape.



Carbon isotopic values ($\delta^{13}C$) of CO_2 emissions. Each point is the mean of n = 12 (i.e., 4 reps in each plot times three plots per soil type). Range of C_4 black grama and C_3 mesquite, shown with black boxes, are from Connin et al. (1997a) and Monger (2003). Values for pedogenic carbonates shown in upper left of top figure are from the following areas in the Jornada Basin: 1. Stressor site. 2. Mayfield well. 3, 4 and 5 Liu (2002). 6. Connin et al. 1997a, b. Open circles are stage I pedogenic carbonates formed in coppice dunes. (Serna-Perez et al. 2006)

B3. Curtis Monger (NMSU) conducted a study in 2007 dealing with carbon at the landscape scale that tested the hypothesis that termites can biomineralize calcium carbonate. Based on (1) field surveys, (2) $^{13}C/^{12}C$ ratios, (3) x-ray diffraction, (4) petrographic thin sections, (5) scanning electron microscopy, and (6) x-ray mapping, we concluded that carbonate in termite galleries originated from upward transport rather than biomineralization, and that this transported $CaCO_3$ plays a less active role in short-term carbon sequestration than it would have otherwise played if it had been biomineralized directly by termites. New studies will investigate biomineralization by mesquite and other plants to better understand inorganic carbon sequestration in arid and semiarid environments.



Microscopy of termite gallery and termites used to test the hypothesis that termites biomineralize calcium carbonate for gallery construction. (A) Petrographic thin section of effervescent termite gallery showing carbonate matrix. (B-C) Composite x-ray image of termite of which Ca concentration is shown below in D-E. (F) Scanning electron micrograph of crystals concentrated along the edge of termite body, located by square in C. (G) Composite x-ray image of crystals shown in SEM image to left. (H) Chemical map of image to left showing that potassium, rather than Ca, exists in greatest abundance. (Liu et al. 2007).

B4. 2007-08

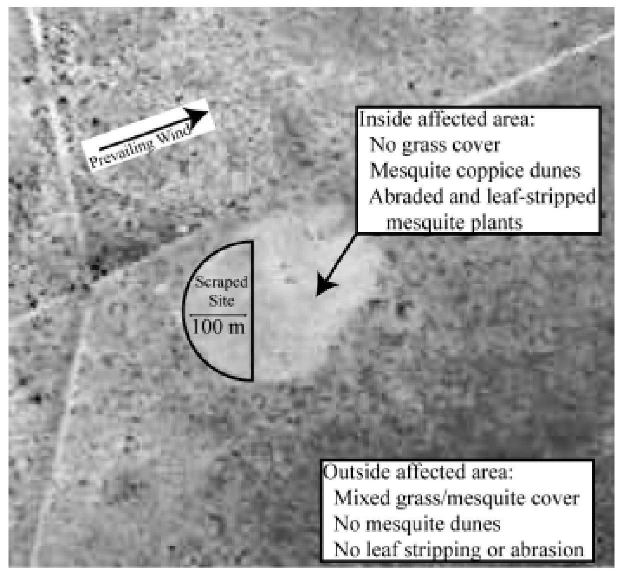
Heather Throop (NMSU, biology) in collaboration with **Curtis Monger** (NMSU), and Kate Lajtha and Phil Sollins (Oregon State University)) used sequential density fractionation with sodium polystungstate to density fractionate Jornada soil samples that differed in parent material and vegetative cover. Fractionation was completed in 2008, and we are currently performing physical and chemical analyses of the samples. The work complements similar research at other sites to allow cross-site comparisons. Initial analyses indicate very different patterns of carbon storage in density fractions from patterns found at more mesic sites with proportionally greater carbon stored in heavy density fractions at the Jornada.

C. Transport processes, fluxes, and biogeochemistry of soil resources

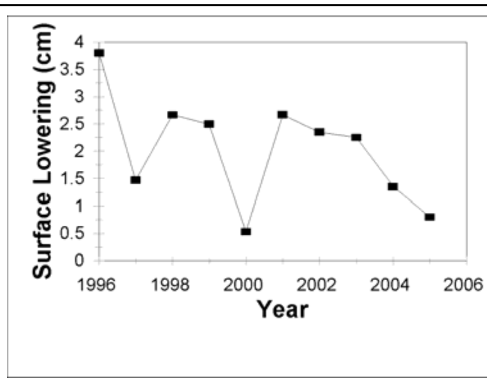
C1. Jeff Herrick (ARS) and **Mike Duniway** (NMSU, graduate student) characterized soil water properties of petrocalcic horizons in 2007. Analyses in 2008 showed that petrocalcic horizons have a higher plant available soil water holding capacity and retain plant available water longer than soils without these horizons. This study resulted in a PhD dissertation by Duniway, and has altered the traditional view of calcic horizons as impermeable layers to dynamic layers containing plant available water.

In 2008, soil profile characteristics associated with plant available soil water holding capacity were determined for the 15 NPP sites. These profiles were found to vary widely among sites. These results have implications for runon-runoff relationships for these sites.

C2. Dale Gillette (NOAA) completed a study in 2007 of dust emissions from all 15 NPP sites that was initiated in 1997. Results show that sandy soils dominated by mesquite have the highest sediment flux by wind compared to the other vegetation types. We will continue to monitor sediment flux at these sites as part of the LTER following Dale's retirement in 2007. We will also continue to monitor sediment flux from the "scrape site" – a 100 m-diameter semicircle cleared of vegetation in 1990. This site has experienced a nonlinear loss of soil through time, and is often used as a severe treatment to compare with other studies. The wind erosion experiment (See Activities) was initiated to study downwind sediment fluxes that occurred unexpectedly as a result of the complete removal of vegetation.



The "scraped site" in a 1999 low-altitude airborne visible/infrared spectroradiometer (AVIRIS) image with ca. 5m resolution.



Surface height at the scraped site through time.

C3. <u>2007-2008</u>

Greg Okin (UCLA) continues to monitor vegetation and soil changes through time following experimental removal of herbaceous plants. Results from 2008 show that blowing sand from an upwind treated site experiencing erosion can influence community composition on an adjacent, downwind, non-erosional site. Significant decreases in grass cover observed on downwind sites were likely a result of sandblasting caused by erosion from the upwind treated sites. We will continue to monitor these treated and adjacent areas connected by wind erosion-deposition dynamics.

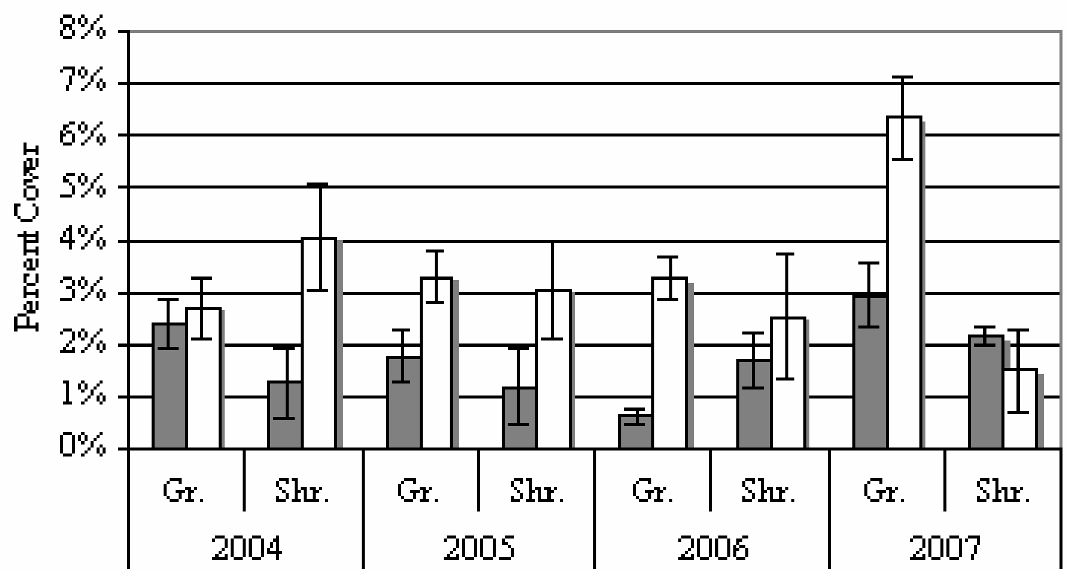
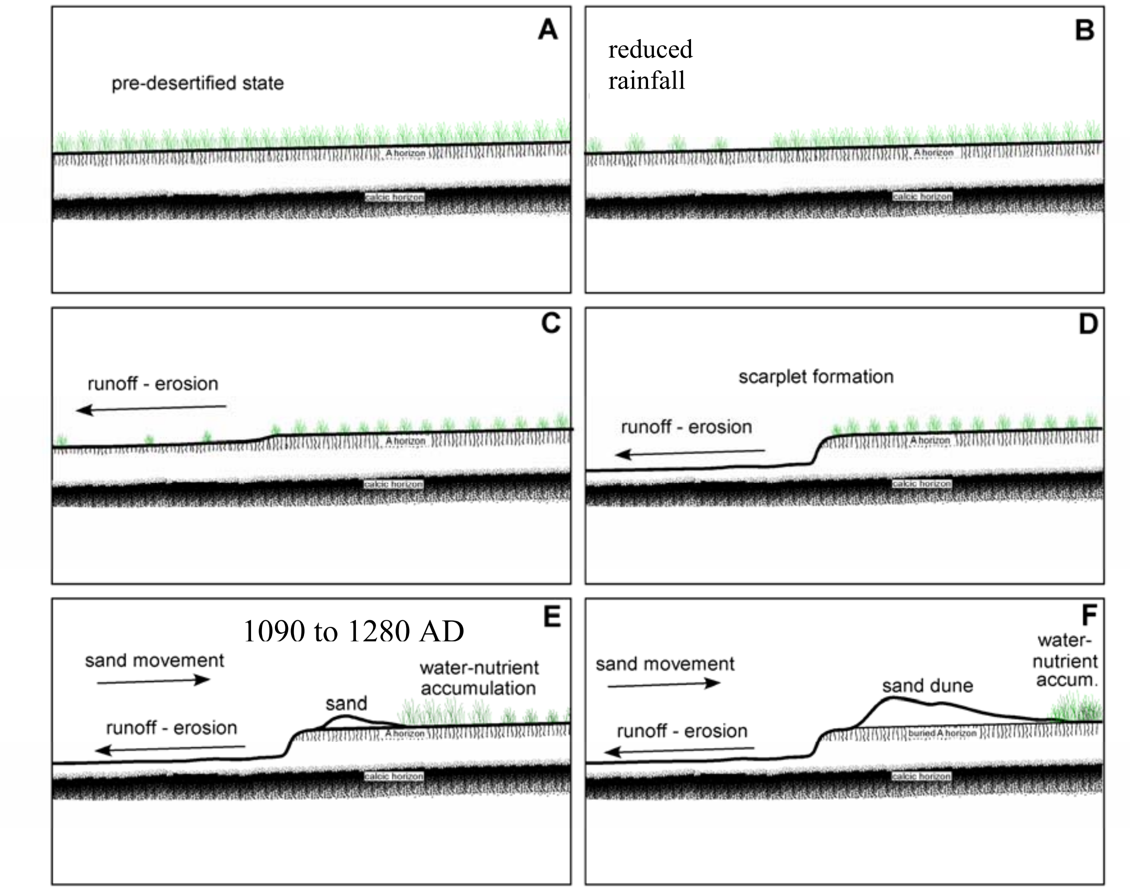


Figure 2. Average percent cover of grass (Gr., primarily *Sporobolus* spp.) and Shrubs (Shr., *P. glandulosa*) on treatments with high sand flux (shaded) and control (white) in June from 2004 to 2007. Late summer, 2006 and spring, 2007 saw exceptionally high rainfall, resulting increases in 2007. Note that the regrowth of grass as of Jun, 2007 for the treatment is less than the control).

D. Vegetation-soil interactions

D1. Curtis Monger (NMSU) and **Stacey Weems** (NMSU, graduate student) conducted a study in 2007 to determine the time frame and mechanisms for the formation of banded vegetation. This vegetation type has been little studied at the Jornada, yet it occurs across much of the east central part of the basin. At the Jornada, dense strips of tobosa grass parallel sinuous sand dunes that in turn parallel erosional scarplet less than 1 meter high to create banded vegetation. The erosional scarplets and the bare ground associated with them downslope are the most barren and desertified areas on the Jornada, in contrast to the dense bands of tobosa grass which have some the greatest biomass at our site. We undertook a study to determine how and when these features formed. The illustration below shows the steps involved. Based on charcoal and fossil leaf dates, the sand began accumulating between 1090 and 1280 AD during the Medieval Warm Period. Results from this study will help us place the current rate of erosion into a long-term context.

Jeff Herrick (ARS) sampled cesium and fine-scale elevation data to show that although these features are old and persistent, significant erosion and deposition continues to occur.



Model of the formation of banded vegetation associated with erosional scarplets and linear sand dunes. Illustrations A to D depict the progressive formation of the scarplet, while E and F show the accumulation of sand that acts as an obstacle to overland flow. This creates a resource sink that leads to the dense tobosa grasslands. (Weems 2007).

D2. **<u>2007-08</u>**

Jeff Herrick (ARS) and Nicole Hansen (NMSU graduate student) completed a study in 2008 of soil erosion following encroachment by mesquite (*Prosopis glandulosa* Torr.) and other desert shrubs into the desert grasslands. Processes associated with vegetation shifts are still poorly understood. One such example of vegetation shift is the replacement of tobosa (*Pleuraphis mutica* Buckley) grasslands by mesquite dunelands on the Red Lake playa, an ephemeral lake in the northwest corner of the Jornada. The objective of this project is to define the probability of grass-shrubland transitions for vegetation patches based on soils and spatial context. We used aerial photos from 1942 and 1973 and a digital orthophoto quarter quadrangle from 1996 to define changes in the mesquite dominated area since 1942. We used the 1996 photos to compare GIS-based mesquite canopy intercept measurements with line-point intercept measurements completed in 2005. The next phase of GIS work consisted of using a 2004 QuickBird satellite image to identify current vegetation community patches based on vegetation and soil type and the spatial distribution and density of plants and bare ground within each patch. Plots were then established in the field within these patches to characterize the soils and vegetation of the site and create highly-detailed soil and vegetation maps of the site. After the initial characterization, the field data and 2004 satellite image were compared against the older imagery and past vegetation and soil maps to identify areas requiring more extensive soil and vegetation measurements. Major findings include: (1) sand deposition on fine-textured soils does not facilitate mesquite encroachment, (2) the texture, electrical conductivity, and gypsum content of soils may affect the rate of mesquite encroachment but the extent of colonization, (3) inter-canopy gaps are influenced more by vegetation type than by wind or water erosion, and (4) the formation of coppice dunes led to the loss of landscape integrity.

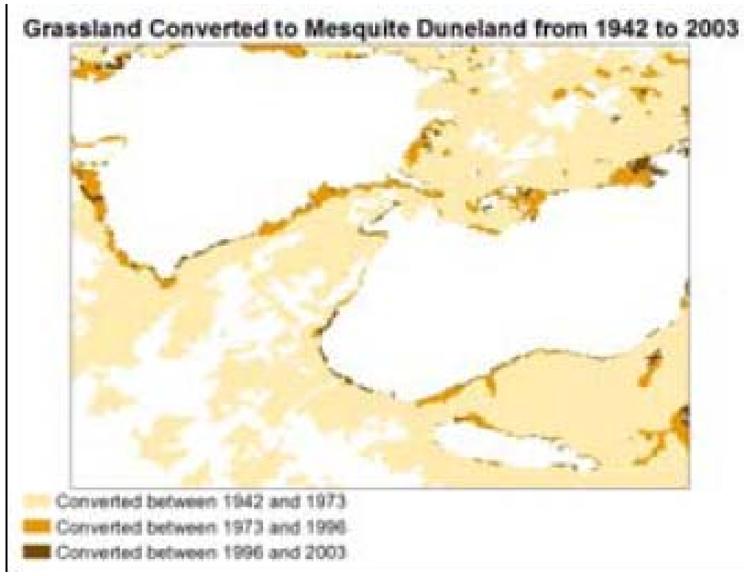


Image analysis showing change from grassland to mesquite duneland likely associated with sand deposition.

D3. **2007-08**
Jeff Herrick (ARS) and Noemi Baquera (NMSU graduate student) conducted GIS analyses to determine the long-term (decades) effects of runoff modification using low dikes on vegetation cover, composition, and spatial structure, and how they vary across the landscape. Preliminary results show increased vegetation is associated with dikes on some soil-geomorphic units.

E. Disturbances

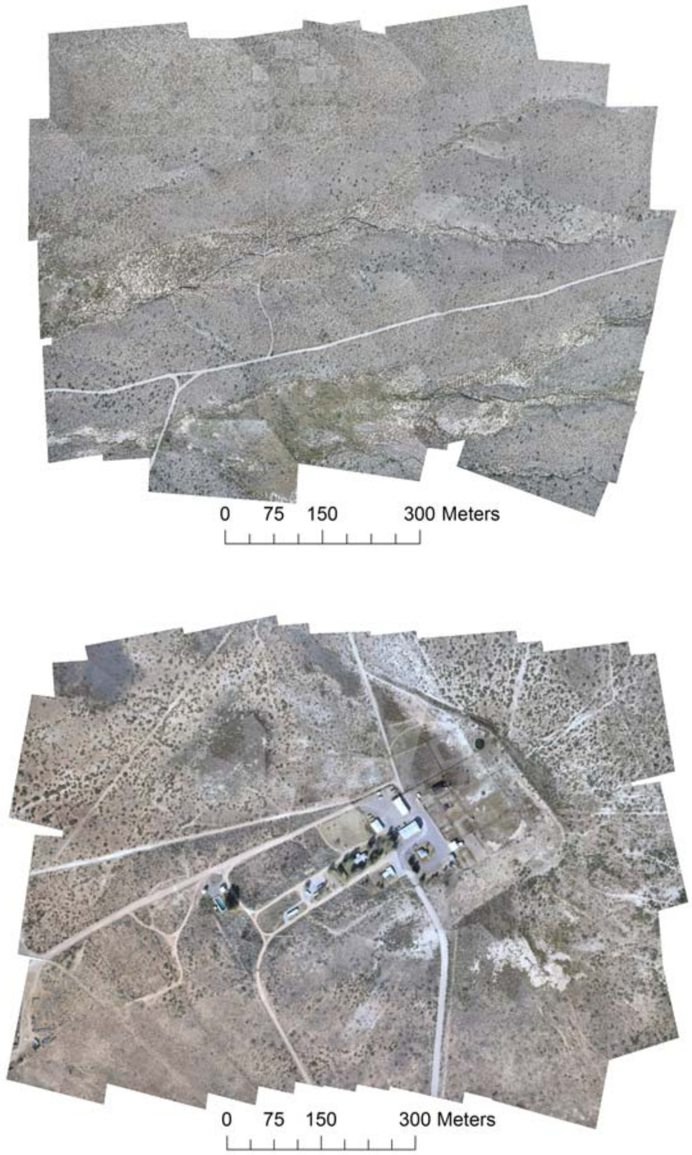
E1. Jeff Herrick (ARS) completed analyses of 7 years of post-disturbance data on each of the five sites. In 1997, a study was initiated under non-LTER funding to apply several types of surface disturbance to desert soils and monitor recovery of soil properties. Surface disturbance plots established in tarbush and creosote plant communities were re-measured and half of each plot was re-disturbed in 2001. In 2007, we completed 10 year measurements. Results show that both resistance and resilience vary with both soil and disturbance type. Results also suggest that drought sensitivity may be affected by past disturbance on some soils, but not on others.

F. Remote sensing

F1. <u>2007-08</u>

Al Rango (ARS) is using a combination of different remote sensor systems and ground truth to provide comprehensive monitoring of patterns in vegetation and soil properties. ASTER and Landsat images provide 15-30 m resolution data to determine uniform landscape units. 1 m or less satellite or aircraft data can be used to assess the pattern of ecological states. 5 cm UAV images can easily measure vegetated and bare soil patch sizes as well as percentage bare soil and vegetation cover for determining rangeland status.

Aerial photography (0.25-1.0m resolution) is being used in the development of long-term databases to be used for assessment of vegetation and land cover changes through time. Image collection started in the 1930s and continues to present. This continuity of data collection makes these images extremely useful for LTER studies. We currently have 5144 aerial photos in our Jornada database. Digital scanning, documentation, storage, and a searchable database are being created to allow easy access to historical photos.



UAV mosaic of images for our connectivity pilot study (top) and field station (bottom).

An object-based image analysis approach was used to classify very high resolution digital ground photography to effectively estimate fractional cover of vegetation and soil for separating green and senescent vegetation. This method showed high correlation with ground-based line-point intercept approaches with less time and labor. The permanent photo plots can also be used to detect vegetation change over time.

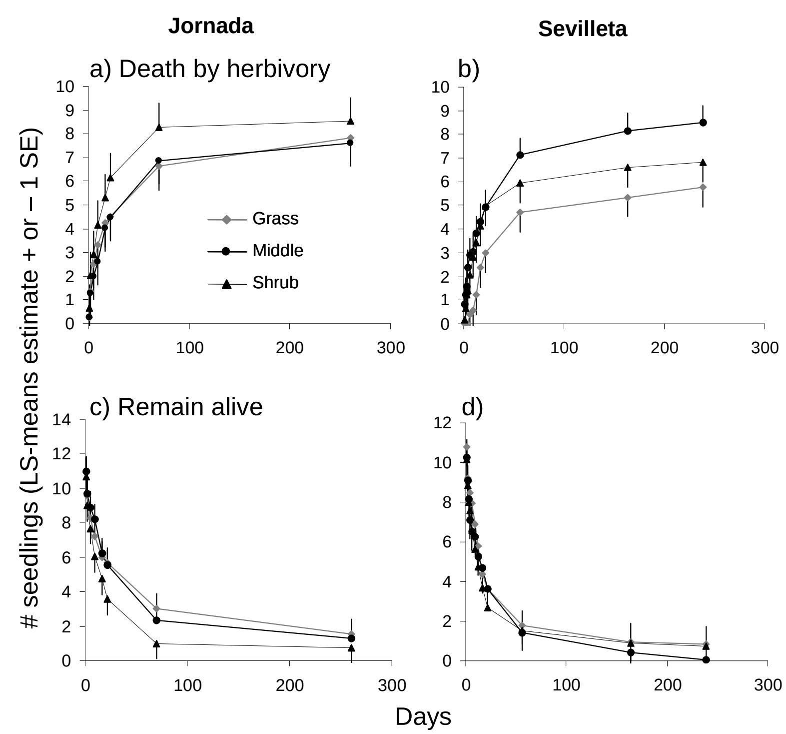
Our UAV team is trained and capable of acquiring hyperspectral data anywhere over the LTER site at 5 cm resolution. Over 5000 UAV images have been acquired in the past two years. For example, UAV data were acquired in 2008 to assist in the selection of locations for our new connectivity experiment in various landscape positions, and a mosaic was created of our field station.

G. Cross-site studies

G1. Brandon Bestelmeyer (ARS) and **Deb Peters** (ARS) conducted a study of the effects of small mammals on grass recruitment for grassland-shrubland ecotones at the Jornada and Sevilleta. Results show that seedlings were killed by small mammals in greater numbers in shrubland than in grassland or middle ecotone positions at the Jornada with large herbivore populations. At the Sevilleta low herbivore numbers, however, most seedlings were killed in middle ecotone positions. The abundance patterns of herbivores did not parallel patterns of seedling herbivory across the ecotones or between sites. We conclude that seedling herbivory is an important process and is related to vegetation composition, but the mechanisms underlying the relationship are not clear. We speculate that variation in small mammal foraging behavior may contribute to seedling herbivory patterns. We support the idea that grassland restoration strategies in the Chihuahuan Desert need to account for the abundance and/or behavior of native herbivores. This study is being continued at the Jornada as part of our long-term monitoring of rodent populations.

2007-08

Leticia Rios (postdoc) completed an ant study in 2008 using these ecotones.



Highest seedling mortality occurred in the shrublands at the Jornada with large herbivore populations. At the Sevilleta, highest mortality occurred in the ecotone locations.