Preview of Award 1235828 - Annual Project Report

Cover

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Accomplishments

* What are the major goals of the project?

Chihuahuan Desert landscapes exemplify the ecological conditions, vulnerability, and management challenges in arid and semi-arid regions around the world. The goal of the Jornada Basin Long Term Ecological Research program (JRN LTER) established in 1982 is to understand and quantify the key factors and processes controlling ecosystem dynamics and patterns in Chihuahuan Desert landscapes. In collaboration with the Jornada Experimental Range (USDA ARS), studies initiated in 1915 have been incorporated into the JRN LTER program. Previous research focused on desertification, a state change from perennial grasslands to woody plant dominance that occurs globally. Based on findings from growing long-term databases, the breadth of studies in LTER-VI was expanded to include four additional state changes that occur in dryland systems worldwide: (1) a reversal to grassland states, (2) transitions among different states dominated by woody plants, (3) invasion by non-native grasses leading to novel states, and (4) transitions to human-dominated states. Processes of interest include water mediated plant-soil feedbacks, patch-scale contagion, landscape context, and time lags that are manifested as nonlinear dynamics and threshold behavior. The overall goal of Jornada LTER-VI (2012-2018) is to understand and quantify the mechanisms that generate alternative natural and human-dominated states in dryland ecosystems, and to predict future states and their consequences for the provisioning of ecosystem services. A modified conceptual framework and integrated research plan in LTER-VI is being used to: (1) test specific elements by coupling existing long-term studies of patterns with new experiments aimed at elucidating processes, (2) integrate data from long-term studies in novel ways to address new questions, both at the JRN and in the surrounding region, and (3) forecast alternative future landscapes and consequences for ecosystem services under a changing environment. The proposed research is organized around two major geomorphic units that characterize the Chihuahuan Desert, and that contain on-going long-term studies and a sensor network. Long-term studies are being combined with new mechanistic experiments designed to identify dominant processes and drivers with a focus on pattern-process relationships that transcend scales. The generality of this framework is being assessed with cross-site and regional studies. Simulation modeling is being used to synthesize and integrate data, both to understand current patterns and to predict future dynamics. New socio-economic studies and scenarios based on the Ecosystem Millennium Assessment are placing Jornada research into a broader socio-economic-ecologic context. Proposed research is resulting in five major products: (1) new understanding of state changes, in particular in drylands, that lead to theory development, testable hypotheses, and new experiments; (2) accessible data and visualization tools applicable at multiple scales; (3) explanatory and predictive relationships between drivers, patterns, and processes that can be used to (4) develop scenarios of alternative human- and natural-dominated states with assessments of their impacts on ecosystem services; and (5) usable information transfer to a broad audience including K-12 students and teachers, and NGO and government agency land resource managers.

The major goals of our project are:

1. To provide new understanding of state changes within geomorphic units at the Jornada

2. To compare state change transitions among different geomorphic units at the Jornada

3. To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert

4. To provide education and outreach programs across a range of scales, from local to global

5. To enhance the accessibility of Jornada data to a broad range of users.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

GOAL 1. To provide new understanding of state changes within geomorphic units

Grassland to shrubland transitions

(i) We tested the hypothesis that fragmentation of large grass patches to medium and then small patches creates a harsh environment for grasses, thereby producing a positive feedback that accelerates change to a barren state (Svecjar et al. submitted).

(ii) As grass cover is reduced, increasingly large and interconnected bare gaps occur which increase the transport of sediment by wind and water. We conducted an experiment aimed at understanding sediment transport in landscapes undergoing shrub-to-grass transition using rare earth elements as tracers of this sediment movement (Rachel et al. submitted).

Shrubland to grassland transitions

(i) We used long-term datasets (1993-2010) to examine the processes underlying relationships between aboveground net primary production (ANPP) and precipitation in wet and dry rainfall periods (Peters et al. in review).

(ii) In arid ecosystems, current-year precipitation often explains only a small proportion of ANPP. We explored five hypotheses regarding the magnitude of legacies, two possible mechanisms, and the differential effect of previous dry or wet years. We used a 3-year manipulative experiment with five levels of rainfall in the first two years (-80% and -50% reduced PPT, ambient, +50% and +80% increased PPT), and reversed treatments in year 3 (Reichmann et al 2013).

(iii) Variability of ANPP displays a closer association with precipitation when considered across space than through time. We tested hypotheses about legacies of wet and dry years to explain space vs. time differences in ANPP-precipitation relationships using 16 long-term datasets (Sala et al 2012).

(iv) We used a long-term (13 year) pulse-perturbation experiment featuring heavy grazing and shrub removal to determine if critical thresholds can be demonstrated in Chihuahuan Desert grasslands (Bestelmeyer et al. 2013).

Shrubland to shrubland transitions

(i) A mixed shrubland in the Jornada bajada geomorphic unit was instrumented with three coordinated sensor arrays: (1) a watershed water balance network, (2) an eddy covariance footprint network and (3) a COSMOS (cosmic-ray neutron) sensor (Templeton et al. [2013, in review]). Datasets derived from field measurements are being used for simulations with the Triangulated Irregular Network-based Real-time Integrated Basin Simulator (tRIBS)[Vivoni et al. 2013].

(ii) Monitoring land-atmosphere exchange of carbon, water, and energy and biophysical factors is ongoing in a creosotebush shrubland. Site infrastructure includes an eddy covariance tower; phenocam network; robotic tram system that measures surface hyperspectral properties; a micrometeorological sensor; and plant phenology. Monitoring infrastructure and protocols align with national and international networks.

Transitions to novel states Changing precipitation patterns can affect the geographic distribution of invasive species with consequences for alternative states. We are using a model of soil water dynamics (SOILWAT) to simulate establishment of two grasses from South Africa (Lehmann lovegrass, buffelgrass) at the Jornada across a range of soils and climatic conditions.

GOAL 2: To compare transitions among different geomorphic units

(i) We quantified the relationship between vegetative change and geomorphic units: (1) a landform map of the Jornada Basin LTER area was overlain on long-term vegetation maps (1859-1998) and (2) a geopedological classification map was developed, and overlain on the most recent vegetation maps.

(ii) In 2003, we established livetrapping grids to determine if rodent community dynamics differ among ecosystem states. We are adding a new effort using non-invasive camera traps to provide density estimates of lagomorphs and mammalian carnivores. We also initiated an investigation to compare carnivore activity and rates of herbivory along an urbanization gradient.

(iii) We are continuing a manipulation of resources at the patch scale that consists of small Connectivity Modifiers (ConMods) placed within bare gaps in shrublands to reduce the movement of resources. Amount of material trapped behind each ConMod and plant recovery is estimated using image analysis of aerial and ground-based photos.

GOAL 3: Regional dynamics

(i) Interactions between biophysical factors and land use are a primary driver of regional and global change. We combined ownership data for public land ranches surrounding the Jornada with biophysical data obtained from soil survey and other GIS data to explore relationships among them.

(ii) A survey of public land ranchers in southwestern New Mexico was completed

(Parry 2012). Results identify ranch planning and management challenges related to proximity to the U.S.-Mexico border, multiple-use issues, public perception, intergenerational transfers, economic and regulatory issues.

(iii) Data collected from the US Forest Service and General Land Office-Grazing Service records housed in the National Archives in Denver document early (circa 1905-1925) vegetation conditions in southwestern New Mexico and southeastern Arizona, as well as the dates of construction of major range-related improvements.

GOAL 4: Education and outreach programs

Education

Education activities for K-12 students, teachers, and other adults have been developed over the past 15 years by a collaborative team of scientists and educators from the JRN and the Asombro Institute for Science Education (AISE), a nonprofit in Las Cruces, New Mexico. Major activities include:

Schoolyard Science Studies (Schoolyard Desert Discovery Program), Field Trips, Classroom / Schoolyard Programs, Teacher Workshops, Family Education Events, Desert Data Jam, Graduate Student Participation in K-12 Education.

Outreach

Outreach activities include pedoderm pattern class workshops, rangeland health workshops, BLM Assessment, Inventory and Monitoring (AIM) program, Malpai Borderlands Geoportal, and United Nations University Land Restoration Training Course.

GOAL 5: To enhance the accessibility of Jornada data Improving data discovery, accessibility, and the synchronization of data and associated metadata within site and network data catalogs and portals is being met by leveraging website and application development to minimize costs and maximize efficiency and productivity. We continue to improve and optimize our computer networks, centralized storage, databases, websites, applications, and web services to meet the needs of many users. We populated all long-term Jornada data and metadata into Drupal Ecological Information Management System (DEIMS), which powers the new Jornada Data catalog. We developed views in Drupal to create the new Jornada data catalog (http://jornada.nmsu.edu/data-catalogs/jornada) and long-term datasets (http://jornada.nmsu.edu/data-catalogs/long-term) web page. After the long-term data and associated metadata were loaded into DEIMS, we began updating and optimizing the Jornada computational infrastructure. The current data catalog and image gallery were migrated to separate websites and integrated with the Jornada website using HTML iFrames in preparation for migrating the remainder of the web content to Drupal 7. We also implemented a 3-tier public key infrastructure (certificate authorities) for the website, computers, servers, applications, and users. This will support integration of authentication and authorization for Jornada network resources and will support single sign in for the website and applications. All of these efforts have been informed by LTER requirements and best practices. All long-term data and associated metadata have been uploaded to the current LTER data portal and the Jornada EML metadata generated from the data catalog are Metacat compliant. Once DEIMS 2 has been deployed at the Jornada, all long-term datasets will then be PASTA compliant and the remaining short-term datasets will be uploaded to DEIMS 2.

Specific Objectives: **GOAL 1. To provide new understanding of state changes within geomorphic**

units

Grassland to shrubland transitions

(i) To compare the production of reproductive parts and reproductive success of *B. eriopoda* plants across a range of patch sizes.

(ii) To understand sediment transport using rare earth elements as tracers.

Shrubland to grassland transitions

(i) To determine the timing of seed availability and successful recruitment in the three rainfall periods (no trend, dry, wet). To determine processes driving the relationship between each ecosystem response with precipitation or number of sequential wet years.

(ii) To explore five hypotheses regarding the magnitude of the legacies, the mechanisms leading to legacies, and the differential effect of previous drier or wetter years relative to current year on the magnitude of legacies.

(iii) To develop a theory of the controls of ANPP through space and time, and its mechanisms.

(iv) To evaluate evidence for threshold models using acute defoliation of perennial grasses (especially *Bouteloua eriopoda*) by cattle grazing within a shrub-invaded grassland that represents a precarious condition between grassland and eroding shrubland states.

Shrubland to shrubland transitions

(i) To determine spatial distribution of topography, vegetation species and soil properties within the shrubland. To compare estimates of soil moisture and evapotranspiration from different methods and to determine which method best informs best the hydrologic characteristics of the watershed. To integrate various field measurements and UAV image products into a spatially-distributed model to explore effects of transitions on ecohydrology of the bajada under historical, present and future (climate change) conditions.

(ii) To determine biophysical controls of land-atmosphere fluxes of carbon, water, and energy over multiple spatial and temporal scales; to compare the best optical remote sensing properties for determining component fluxes; to develop new cyberinfrastructure to advance these studies.

Transitions to novel states To determine precipitation and temperature requirements for seedling establishment of two invasive grasses (lovegrass, buffelgrass) at the Jornada

GOAL 2: To compare transitions among different geomorphic units

(i) To determine which landform was most resistant to shrub invasion and which was least resistant.

(ii) To quantify relationships between precipitation, ANPP, and herbivore abundances (rodents and lagomorphs) across shrubland-grassland ecotones directly and with time lags; to determine if variation in herbivore abundances not explained by rainfall and productivity is related to carnivore distribution and abundances across ecological states; to test the “urbanization-herbivory hypothesis”.

(iii) To determine how flux of materials by wind or water can influence vegetation recovery in bare gaps between shrubs.

GOAL 3: Regional dynamics

(i) To examine relationships between ownership variables such as allotment turnover rates and inter-family transfers and biophysical variables.

(ii) To examine relationships between impermanence syndrome, biophysical, and ranch ownership turnover variables.

(iii) To examine relationships between range improvements, vegetation conditions, and ranch ownership and turnover.

GOAL 4: Education and outreach programs

Education

To increase science literacy and ecological understanding by K-12 students and teachers; to provide opportunities for learning about the local ecosystem; to increase science understanding and foster interest in science careers by underrepresented groups; to decrease stereotypes students have of science and scientists.

Outreach

To increase awareness and understanding of landscape processes and connectivity at multiple spatial scales for developing, implementing and assessing and monitoring the impact of management on ecosystem services; to provide land managers with appropriate tools and training to support evidence-based decision-making.

GOAL 5: To enhance the accessibility of Jornada data To develop applications to allow users to easily access and manipulate maps and data from the Jornada web site; to modify the Jornada web site and underlying database to improve accessibility to a general audience.

Significant Results:

GOAL 1. To provide new understanding of state changes within geomorphic units

Grassland to shrubland transitions

(i) Mean counts of stolons, ramets, and rooted ramets for focal black grama plants were higher in medium (M) than in large patch interiors (L(I)) and small patches (S) (Fig. 1). L(E) and M did not differ in mean counts of ramets and RRs, but M had more stolons. L(E) and L(I) did not differ, but they generally had greater counts of reproductive structures than S, driven by strong differences from August 2010-April 2011. Over the relatively dry spring/summer period from April to October 2011, counts of ramets and RR in S increased while it decreased in other classes, after which differences between S, L(E), and L(I) were reduced.

Shrubland to grassland transitions

(i) In grasslands, ANPP was linearly related to precipitation regardless of rainfall period, primarily as a result of stolon recruitment by black grama. A lag in responses suggests the importance of legacies associated with stolon density. In shrublands, ANPP was only related to rainfall in the wet period when it increased nonlinearly as the number of wet years increased (Peters et al. 2012). Seed availability by mesa dropseed increased in the first wet year (2004), and seedling establishment occurred two to four years later (2005-2008). Increases in biomass, litter, and simulated transpiration beginning in the third year corresponded with increases in ANPP (Peters et al. in review).

(ii) Legacies of previous two years, which were dry or wet, accounted for a large fraction (20%) of inter-annual variability in production in year three. Legacies in ANPP were similar in absolute value for both types of precipitation transitions, and their magnitude was a function of the difference between previous and current-year precipitation. Tiller density accounted for 40% of legacy variability, while nitrogen and carry-over water availability showed no effect. Understanding responses to changes in inter-annual precipitation will assist in assessing ecosystem responses to climate change-induced increases in precipitation variability.

(iii) Legacies occur across all ecosystem types from deserts to mesic grasslands. Previous-year precipitation and ANPP control a significant fraction of current-year production. The relative importance of current- versus previous-year precipitation changes along a gradient of mean annual precipitation (MAP) with the importance of current-year PPT decreasing whereas the importance of previous-year PPT remains constant as MAP increases. Our results suggest that ANPP will respond to climate-change driven alterations in water availability and, more importantly, that the magnitude of the response will increase with time.

(iv) Contrary to expectations, winter grazing had a greater impact on black grama compared to summer grazing. Mesquite presence slowed grass recovery in the nongrazed treatment, but did not exacerbate grass reductions in the grazed treatments. There were no differences among grazing or shrub removal treatments in the recovery of black grama cover after the perturbation.

Shrubland to shrubland transitions

(i) Classification of the vegetation in the mixed shrubland watershed using UAV imagery yielded unexpected results. First, the dominant shrub mariola and not creosotebush or mesquite (Templeton et al. [2013, in review]). Each sensor has a different footprint within the landscape which contribute to the aggregation of information measured by the device. Because these regions are relatively close together, they would traditionally be assumed to have similar vegetation cover. However, variations occurred in the percentage of each vegetation type and in the dominance of individual species. Creosote and mesquite tend to grow on relatively flat deep soils whereas Mariola tends to grow on steeply sloping hillslopes with shallow soils.

(ii) The creosote shrubland site is a net carbon sink; there are strong seasonal trends to land-atmosphere fluxes, and net ecosystem exchange of CO_2 has a bimodal distribution with peaks in late spring and in late summer corresponding to the onset of the monsoon; interannual variability in fluxes is best explained by soil moisture and a freeze event that occurred in early 2011, which delayed vegetation greenup in the following spring.

GOAL 2: To compare transitions among different geomorphic units

(i) Grasslands were most susceptible to shrub expansion on sandy landforms and bajadas, and most resistant to shrub invasion on ephemerally flooded playas (Rachal et al. 2012). Alluvial fan collars and mountain uplands also were relatively resistant to shrub invasion because they receive run-off and nutrient inputs from adjacent slopes or they have favorable soil water properties resulting from deep bedrock fissures. Mesquite is dominant on the basin floor when the parent material is siliceous sand, but biological soil crust becomes dominant in the basin floor when the parent material is gypseous. Creosotebush is dominant on rocky soils of the piedmont slopes regardless of parent material. Grasslands become dominant on the bajadas upslope regardless of bedrock type (Michaud et al. 2013).

(ii) Abundances of desert rodents were similar among habitats in years when abundances were low. In contrast, when rodent abundances were high, shrubland and mixed habitat had higher rodent abundances than grasslands. Decoupling of rodent populations from available resources may be associated with years of high predator densities. The camera-trap system was tested successfully on 18 sites (grassland and shrubland) during fall 2012. Experimental results from 2012 support the "urbanization-herbivory hypothesis" in that herbivory rates of seedlings were greater in high-density urban areas compared to low-density urban areas and undeveloped areas.

GOAL 3: Regional dynamics

(i) We detected significant spatial autocorrelation in ownership variables that may be structured by biophysical variables.

(ii) Survey data show strong impermanence perceptions among the ranching population of southwestern New Mexico. Our research suggests negative ranch management impacts and increased ranch ownership turnover result from perceived impermanence threats.

GOAL 4: Education and outreach programs

Education

(i) Schoolyard Science Studies (Schoolyard Desert Discovery Program) – The new biodiversity activities were created, tested, and refined. Eight teachers took Science Investigation Kits to their schools to use with their students. (ii) *Field Trips* – We hosted 21 full-day field trips to the JRN and/or Chihuahuan Desert Nature Park for 1,490 students. (iii) *Classroom / Schoolyard Programs* – A total of 531 one-hour classroom/schoolyard programs were delivered to 13,363 students at schools throughout southern New Mexico and west Texas. (iv) *Teacher Workshops* – We hosted five one-day workshops and one two-week workshop for 148 teachers. (v) *Family Education Events* – Five family education events allowed 422 people to visit field sites to learn about butterflies, nightlife of the desert, and desert ecology. (vi) *Desert Data Jam* – The 2013 competition culminated in the final competition in May 2013. Forty projects were submitted by 65 students from 5 regional high schools. (vii) *Graduate Student Participation in K-12 Education* - We gave a presentation as part of the ecology short-course for LTER graduate students in June 2013. Five graduate students have contributed > 40 hours of service to assist with staffing.

Outreach

Over 500 individuals were trained in the application of Jornada-developed or co-developed assessment and monitoring tools in 2013. Regional geoportal developed based on understanding of landscape-scale processes.

GOAL 5: To enhance the accessibility of Jornada data We completed the iPad application and beta-tested it as part of the field trip with the LTER Science Council in May. We are completing our modifications to the EcoTrends web site.

Key outcomes or Other achievements:

GOAL 1. To provide new understanding of state changes within geomorphic units

Grassland to shrubland transitions

(i) Understanding effects of patch fragmentation on grass reproduction will help provide a clearer view of how grassland-shrubland transitions are initiated and therefore how to detect and mitigate them in management.

Shrubland to grassland transitions

(i) Understanding the processes underlying ecosystem dynamics in multi-year dry or wet periods is expected to improve predictions of ANPP under directional increases or decreases in rainfall that could alter state transitions.

(ii) Experimental approaches to understand the nature of threshold dynamics, specifically whether critical thresholds exist at moderate levels of grass cover, are needed to predict state changes in managed ecosystems.

Shrubland to shrubland transitions

(i) Characterizing the watershed characteristics using field and UAV-based techniques to incorporate spatial patterns into distributed hydrologic simulations. Utilizing the sensor arrays to quantify ecohydrologic states and fluxes and compare across different techniques. Relate the landscape properties to the land-atmosphere interactions occurring over different seasons, with an emphasis on the phenologically-active summer period.

(ii) We have amassed among the most comprehensive multi-parameter datasets in the desert southwest for identifying and documenting spatiotemporal impacts of biophysical factors controlling land-atmosphere fluxes of carbon, water, and energy.

GOAL 2: To compare transitions among different geomorphic units

(i) Understanding locations more susceptibie to grass loss and shrub expansion can be used to target sites for management efforts.

(ii) Past research on desert herbivores has focused on bottom-up effects driven by variability in precipitation. Our long-term monitoring indicates much unexplained variation and a potential role for top-down effects. Likewise, our initial investigations of predator-prey interactions across an urbanization gradient highlight the likely importance of trophic cascades within alternative states in the Chihuahuan Desert.

GOAL 3: Regional dynamics

The results of these studies will advance our understanding of how social-ecological interactions impact the trajectories of Chihuahuan Desert landscapes and this case will contribute a mechanistically-detailed study of a coupled human-natural system.

GOAL 4: Education and outreach programs

Education

(i) 14,918 K-12 students with increased knowledge of desert ecology and the process of science as well as decreased stereotypes about scientists

(ii) 148 teachers with experience teaching desert ecology and the resources needed for hands-on science activities in their classrooms and schoolyards

(iii) A cadre of JRN LTER graduate students with an appreciation for the joy and challenges of working with the K-12 community to promote broader impacts from their own research

(iv) 422 members of the general public with knowledge about the local ecosystem and current LTER research

Outreach

(i) The pedoderm pattern class tool has been adopted by the National Cooperative Soil Survey for national application.

(ii) The rangeland health assessment protocol is nationally applied by both BLM and NRCS, and the results are used to inform national policy as well as local land management decisions.

(iii) Regional ranchers have a greater understanding of the extent and impacts of landscape-scale disturbances.

GOAL 5: To enhance the accessibility of Jornada data

Data and metadata are accessible and will be PASTA ready.

* What opportunities for training and professional development has the project provided?

1. We provided $5000 each summer fellowships to five graduate students from three universities:

Below are short reports from each student as to how the funding supported their research.

Nathan Pierce, University of Arizona

The Jornada Basin LTER Graduate Research Fellowship Program (GRFP) provided my financial support for conducting fieldwork for the Nutrient and Ecosystem impacts of Aeolian Transport (NEAT) experiment and for my dissertation research during June-August, 2013. This report summarizes my activities during this time frame and highlights how significant finding from this year's data collection will be used in my dissertation. Under supervision of Dr. Greg Okin, my goals were to update ongoing, long-term data sets and collect soil samples that will be analyzed for nutrient content at a later date in Dr. Okin's lab at UCLA. In early June, I re-marked the corners of the subplots with rebar pins to replace the deteriorated wooden stakes previously in place. In July, I repeated the soil sampling in the 5 m x 10 m subplots that had last been conducted by Dr. Junran Li in 2006. Fifty soil samples were taken to a depth of 5 cm in subplot 2 of each plot (total 1,500 samples). All samples were shipped to Dr. Okin in early August, and a metadata file describing the methods has been submitted to John Anderson. Overall, this fellowship enabled me to continue my dissertation research at the JRN while simultaneously gaining research experience in areas new to me, and leveraging synergies between my dissertation research and some of the research being geared up in LTER VI.

Laureano A. Gherardi, Arizona State University

The fellowship supported my research during the summer 2013 allowing me to (1) maintain and sample my dissertation experiment, (2) develop collaborations, (3) attend the Jornada summer course, (4) analyze and present results at the annual ESA meeting, and (5) participate in education activities in collaboration with the Asombro Institute. The fellowship allowed me to focus in all these interesting and productive activities and advance with my dissertation, collaboration and education activities.

Kristen DaVanon, New Mexico State University

I am investigating the effects of urbanization on the state-change from a grassland to a shrubland in the Chihuahuan Desert in regards to predator-prey interactions. The predators looked are mammalian predators, including coyotes and bobcats. The prey include small rodents, as well as rabbits and hares. I spent this summer working on the design of my experiment and starting research. I located twelve sites around Las Cruces. These sites were divided into three treatments: four low-density areas, four high-density areas, and four wildland areas. I conducted small-mammal trapping at all twelve sites to look at rodent occupancy. The same two species of rodent were caught at every site. These were Merriam's kangaroo rat (*Dipodomys merriami*) and the Chihuahuan pocket mouse (*Chaetodipus eremicus*). I also placed out wildlife cameras at every site from July to August. The pictures obtained from the cameras will be looked at to observe predator and lagomorph occupancy. I conducted two studies this summer to look at herbivory rates. The first used sunflower seedlings that were grown in a greenhouse and then placed in transects at each location. These seedlings were observed every day for ten days. The results from this study showed that there was significantly higher herbivory rates at the high density locations than the low density or wildland locations. The low density and wildland locations were not significantly different from each other. The second herbivory study is still ongoing. The natural recruitment of seedlings are being observed in transects at all locations. These seedlings are currently being observed throughout the monsoon season in order to monitor herbivory on the natural plants of the community. The funding provided through the Jornada Basin LTER fellowship allowed me to start my research. It provided money for supplies, salary, and gas.

Cody Anderson, Arizona State University

The two major undertakings were field equipment maintenance and soils analysis. Maintaining our group's field equipment was my primary purpose for applying for the fellowship and residing at Jornada for the summer. My project—analyzing the connection between atmospheric fluxes and land surface states through monitoring the footprint of eddy covariance towers—revolves around two sets of instruments: the eddy covariance tower and a network of continuous soil probes. The next steps include relating these vegetation coverages to the evapotranspiration (e.g. does an increase in bare coverage correlate to an increase in evapotranspiration?), testing the connection of soil moisture and temperature with overlying vegetation and soil properties (is soil texture the main control on soil moisture? does this change with wet or dry times?), and suggesting how much monitoring is necessary to adequately capture the dynamics within the footprints of eddy covariance towers (can one soil probe location give us reasonable estimates of the land surface state as a whole?).

Owen McKenna, Arizona State University

As a Jornada Summer fellow, I worked to process soil samples from 2012, helped set up and maintain long-term precipitation variability experiments, participated in the desert ecology short course, collected sediment and water samples, and presented research at the Ecological Society of America annual meeting. This summer I continued my investigation of the geomorphic and ecological controls over organic carbon and nitrogen stocks in the playas of the Jornada Basin. I also helped another Jornada fellow Laureano Gherardi, and NSF-REU student Josh Haussler in the field for a couple of weeks. In July I participated in and presented at the desert ecology shortcourse at NMSU/ Jornada Experimental Range. This was a great experience to learn more about the depth and breadth of Jornada LTER research. As a fellow I also have been working with Stephanie Bestlemeyer at the Asombro Institute. I am working with them to develop a new student activity regarding soil texture classification. I will also be helping Anna from Asombro film a youtube video highlighting my research in the playas.

2. We provided 12-month ($23,017) fellowships to two graduate students. These students started August 15 (2013) so they do not have results to report yet.

Adam Schreiner-McGraw (ASU, Ph.D.); Savitoz Singh Sidhu (NMSU, M.S.)

3. We provided a summer training program for two undergraduates as part of our REU Program:

Veronica Garcia (NMSU) and Corinne Fox (NMSU)

These students were trained under John Anderson, our LTER site manager. They learned vegetation, soils, and small animal sampling techniques, preparation and maintenance of plant herbarium samples, and data acquisition and management techniques. We chose to broadly train these students in many of our standard measurement protocols given their interests and expertise. They are planning a poster presentation of their most interesting results for the 2014 Jornada Summer Symposium.

4. We conducted our first annual Desert Ecology course. This 3-day course was organized by Curtis Monger, and consisted of PI led-talks and discussions about their research, followed by a field trip to visit experimental sites. Nine graduate and two undergraduate students participated in this course. All students receiving Jornada fellowship support are required to participate in the course. We plan on offering the course each summer, and rotating appearances by PIs to keep the topics fresh and up-to-date.

* How have the results been disseminated to communities of interest?

Our primary web site for all of our projects is shared with the USDA Jornada Experimental Range (jornada.nmsu.edu). From this home page, there are links to a number of web sites for specific applications and information, include the Jornada LTER (http://jornada.nmsu.edu/lter), EcoTrends (www.ecotrends.info), our schoolyard LTER program (www.asombro.org), NEON (www.neoninc.org), the LTAR network (jornada.nmsu.edu/ltar), the Landscape Toolbox for spatial analysis (http://www.landscapetoolbox.org/), and our monitoring and assessment (http://jornada.nmsu.edu/monit-assess) and Ecological Site Description tools (jornada.nmsu.edu/esd).

* What do you plan to do during the next reporting period to accomplish the goals?

GOAL 1. To provide new understanding of state changes within geomorphic units

Grassland to shrubland transitions

We are planning the establishment of the Dune Development Study discussed in the LTER VI proposal. This large-scale experiment will allow us to observe how plants and soils respond to increased aeolian transport. Our goal in this experiment is to kick-start the formation of a coppice dune system and to observe changes in soil, vegetation, and litter as this transition occurs. This is the type of research that can only be conducted in a long-term context.

Shrubland to grassland transitions

(i) We are comparing the nonlinear increase in perennial grasses with time during the 2004-2008 wet period with a previous wet period (1984-1988). We are testing hypotheses about factors controlling similar responses in the two wet periods (Peters et al. 2013. ESA abstract). We are also examining factors that led to the mortality of perennial grasses following the 1988 wet period. We will continue to reuse long-term data from multiple datasets and studies at the Jornada as we test additional hypotheses.

(ii) We are continuing to investigate potential mechanisms responsible for initiating grass loss using the same patch framework discussed above. This next reporting period, we will test if plant-soil-ecohydrologic feedbacks differ among the various grass-patch settings. Response variables will include plant physiological status following rain events (net photosynthesis, stomatal conductance, and leaf water potential) and soil water content (5-10 cm depth). Relationships between plant metrics, soil water, and patch size will be analyzed using generalized linear mixed-effects models.

Shrubland to shrubland transitions

(i) We are collecting additional datasets from the coordinated network for long-term comparisons of the various ecohydrological methods. A sapflow sensor array for a sample of different mixed shrubs will be installed and used to aid in the partitioning of total evapotranspiration into shrub transpiration (by species) and soil evaporation. Through the MS thesis of Cody Anderson (to be completed by November 2013), an in-depth exploration of the relation between turbulent fluxes and footprint moisture and temperature conditions will be conducted for publication. We will be testing the ability of the watershed soil moisture sensors to capture the spatially-aggregate measurement from COSMOS and the usefulness of this new technique for updating the states of the tRIBS hydrologic model. Model simulations will be tested against the observations network and a range of different shrubland-to-shrubland transition scenarios constructed.

(ii) We plan to sustain the environmental monitoring and infrastructure described above. Further emphasis will be placed on characterizing sampling footprints, developing new algorithms for spatiotemporally extrapolating ecosystem traits, and comparing findings with other studies ongoing in the US desert southwest.

(iii) In FY 14, we will switch from using the Bat 3 to the larger Bat 4 UAS, fly more frequently, and determine the optimum density of phenocams and their reliability. We will also try to assess whether mariola, the dominant shrub in the study area, has a significant role to play in the bajada hydrology and ecology that we have yet to identify.

GOAL 2: To compare transitions among different geomorphic units

(i) We plan on comparing 2013 data collected by the network sensors to test the hypothesis that meteorological conditions are significantly different across the basin. We are testing the hypothesis that desertified areas have lower infiltration and, therefore, less soil moisture, higher soil temperatures, and lower soil respiration than neighboring non-desertified zones. We are also examining animal-vegetative and wind-vegetative feedbacks for the major plant types.We will continue to analyze vegetative, erosional, and depositional patterns spatially and temporally to generate hypothesis that will increase our understanding of mechanisms.

(ii) For the animal ecology studies, we will establish an array of camera traps in conjunction with the Ecotone study during fall 2013 so that we can simultaneously measure precipitation, ANPP, herbivore abundances, and mammalian carnivore densities. We will expand our investigation of urbanization and trophic cascades by sampling additional sites across the gradient.

GOAL 3: Regional dynamics

A post-doc has been hired to advance the data analysis for current and past ecological sites and states in the study region in relation to landownership and range improvement practices.

GOAL 4: Education and outreach programs

Education

We will continue support for schoolyard science studies, field trips, and classroom/schoolyard programs. We will plan and host at least one teacher workshop on Schoolyard Desert Discovery activities and four family education events. We will host the 2014 Desert Data Jam competition in May and continue to work with LTER-funded graduate students on K-12 and public outreach opportunities. We will begin development of a new field trip activity station and family education event focused on the use of remote sensing in ecology.

Outreach

We will continue to actively pursue opportunities to integrate understanding of landscape processes into policy and management decisions. We will continue to support the development of new tools, and training for existing tools, that facilitate evidence-based decision-making.

GOAL 5: To enhance the accessibility of Jornada data

We are currently migrating the Jornada website (http://jornada.nmsu.edu) from Drupal 6 to 7. After migration to the new Drupal 7 based DEIMS is completed, we will be generating fully PASTA compliant attribute level EML that can be used to populate the new LTER Data Portal with all long-term Jornada datasets. The timing of the Information Managers Meeting could not have been better. Ken was able to learn more about deploying and migrating to DEIMS 2. Once the migration from Drupal 6 to 7 is completed, the next priority will be to finish loading long-term data files into the enterprise geodatabase and to expose data tables in the geodatabase to DEIMS 2 which will provide live data query capabilities for all long-term Jornada data.

Products

Journals

Alvarez, LJ, Epstein HE, Li J, and Okin GS (2012). Aeolian process effects on vegetation communities in an arid grassland ecosystem.. *Ecology and Evolution*. 2 809.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/ece3.205

Barnes, PW, Throop HL, Hewins DB, Abbene ML, and Archer SR (2012). Soil coverage reduces photodegradation and promotes the development of soil-microbial films on dryland leaf litter. *Ecosystems*. 15 311.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10021-011-9511-1

Bestelmeyer, BT, Duniway MC, James DK, Burkett LM, and Havstad KM (2013). A test of critical thresholds and their indicators in a desertification-prone ecosystem: more resilience than we thought. *Ecology Letters*. 16 339.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/ele.12045

Browning, DM, Duniway MC, Laliberte AS, and Rango A (2012). Hierarchical analysis of vegetation dynamics over 71 years: soil–rainfall interactions in a Chihuahuan Desert ecosystem. *Ecological Applications*. 22 909.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Duniway, MC, Karl JW, Schrader S, Baquera N, and Herrick JE (2012). Rangeland and pasture monitoring: an approach to interpretation of high-resolution imagery focused on observer calibration for repeatability. *Environmental Monitoring and Assessment*. 184 3789.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10661-011-2224-2

Eldridge, DJ, Koen TB, Killgore A, Huang N, and Whitford WG (2012). Animal foraging as a mechanism for sediment movement and soil nutrient development: Evidence from the semi-arid Australian woodlands and the Chihuahuan Desert. *Geomorphology*. 157-158 131.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.geomorph.2011.04.041

Kidron, GJ, Monger HC, Vonshak A, and Conrod W (2012). Contrasting effects of microbiotic crusts on runoff from desert surfaces. *Geomorphology*. 139-140 484.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.geomorph.2011.11.013

Klass, JR, Peters DPC, Trojan JM, and Thomas SH (2012). Nematodes as an indicator of plant–soil interactions associated with desertification. *Applied Soil Ecology*. 58 66.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.apsoil.2012.03.005

Lee, H, Rahn T, and Throop HL (2012). An accounting of C-based trace gas release during abiotic plant litter degradation. *Global Change Biology*. 18 1185.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/j.1365-2486.2011.02579.x.

Lightfoot, DC, Davidson AD, Parker DG, Hernįndez L, and Laundre JW (2012). Bottom-up regulation of desert grassland and shrubland rodent communities: implications of species-specific reproductive potentials. *Journal of Mammalogy*. 93 1017.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1644/11-MAMM-A-391.1

Michaelides, K, Lister D, Wainwright J, and Parsons AJ (2012). Linking runoff and erosion dynamics to nutrient fluxes in a degrading dryland landscape. *Journal of Geophysical Research*. 117 G00N15.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1029/2012JG002071

Monger, HC, Buck BJ, Hawley JW, and Rachal DM (2012). Geochronology of the Bolson sand sheet, New Mexico and Texas, and its archaeological significance: Discussion. *Geological Society of America Bulletin*. 124 1552.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1130/B30517.1.

Peters, DPC, Belnap J, Ludwig JA, Collins SL, Paruelo J, Hoffman MT, and Havstad KM (2012). How can science be general, yet specific? The conundrum of rangeland science in the 21st century. *Rangeland Ecology and Management*. 65 613.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.2111/REM-D-11-00178.1

Peters, DPC, Yao J, Sala OE, and Anderson JP (2012). Directional climate change and potential reversal of desertification in arid and semiarid ecosystems. *Global Change Biology*. 18 151.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/j.1365-2486.2011.02498.x.

Rachal, DM, Monger HC, Okin GS, and Peters DPC (2012). Landform influences on the resistance of grasslands to shrub encroachment, Northern Chihuahuan Desert, USA. *Journal of Maps*. 8 507.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1080/17445647.2012.727593

Sala, OE, Gherardi LA, Reichmann L, Jobbįgy E, and Peters DPC (2012). Legacies of precipitation fluctuations on primary production: theory and data synthesis. *Philosophical Transactions of the Royal Society B*. 367 3135.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1098/rstb.2011.0347

Smith, JG, Eldridge DJ, and Throop HL (2012). Landform and vegetation patch type moderate the effects of grazing-induced disturbance on carbon and nitrogen pools in a semi-arid woodland. *Plant and Soil*. 360 405.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s11104-012-1288-2

Throop, HL, Archer SR, Monger HC, and Waltman S (2012). When bulk density methods matter: Implications for estimating soil organic carbon pools in rocky soils. *Journal of Arid Environments*. 77 66.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.jaridenv.2011.08.020

Throop, HL, Reichmann LG, Sala OE, and Archer SR (2012). Response of dominant grass and shrub species to water manipulation: an ecophysiological basis for shrub invasion in a Chihuahuan Desert Grassland. *Oecologia*. 169 373.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s00442-011-2217-4

Vivoni, ER (2012). Spatial patterns, processes and predictions in ecohydrology: integrating technologies to meet the challenge. *Ecohydrology*. 5 235.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/eco.1248

Weems, SL and Monger HC (2012). Banded vegetation-dune development during the Medieval Warm Period and 20th century, Chihuahuan Desert, New Mexico, USA. *Ecosphere*. 3 art21.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1890/ES11-00194.1

Whitford, WG and Steinberger Y (2012). Effects of seasonal grazing, drought, fire, and carbon enrichment on soil icroarthropods in a desert grassland. *Journal of Arid Environments*. 83 10.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.jaridenv.2012.03.021

Whitford, WG., Ginzburg O, Berg N, and Steinberger Y (2012). Do long-lived ants affect soil microbial communities?. *Biology and Fertility of Soils*. 48 227.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s00374-011-0619-4

Williamson, JC, Bestelmeyer BT., and Peters DPC (2012). Spatiotemporal patterns of production can be used to detect state change across an arid landscape. *Ecosystems*. 15 34.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10021-011-9490-2

Chalcraft, DR (2013). Changes in ecological stability across realistic biodiversity gradients depend on spatial scale.. *Global Ecology and Biogeography*. 22 19.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/j.1466-8238.2012.00779.x

Hewins, DB, Archer SR, Okin GS, McCulley RL, and Throop HL (2013). Soil-litter mixing accelerates decomposition in a Chihuahuan Desert grassland. *Ecosystems*. 16 183.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10021-012-9604-5

Li, J, Okin GS, Herrick JE, Belnap J, Miller ME, Vest K, and Draut AE (2013). Evaluation of a new model of aeolian transport in the presence of vegetation. *Journal of Geophysical Research - Earth Surface*. 118 288.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Michaud, GA, Monger HC, and Anderson DL (2013). Geomorphic-vegetation relationships using a geopedological classification system, northern Chihuahuan Desert, USA. *Journal of Arid Environments*. 90 45.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.jaridenv.2012.10.001

Monger, HC, and Cooke PH (2013). Soil micromorphology and the Anthropocenecross-scale connections and technology trends. *Spanish Journal of Soil Science*. 3 1.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.3232/SJSS.2013.V3.N2.01

Ponce-Campos, GE, Moran MS, Huete A, Zhang Y, Bresloff C, Huxman TE, Eamus D, Bosch DD, Buda AR, Gunter SA, Scalley TH, Kitchen SG, McClaran MP, McNab WH, Montoya DS, Morgan JA, Peters DPC, Sadler EJ, Seyfried MS, and Starks PJ (2013). Ecosystem resilience despite large-scale altered hydroclimatic conditions. *Nature*. 494 349.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1038/nature11836

Reichmann, LG, Sala OE, and Peters DPC (2013). Water controls on nitrogen transformations and stocks in an arid ecosystem. *Ecosphere*. 4 article 11.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: abs/10.1890/ES12-00263.1

Throop, HL, Lajtha K, and Kramer M (2013). Density fractionation and 13C reveal changes in soil carbon following woody encroachment in a desert ecosystem. *Biogeochemistry*. 112 409.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10533-012-9735-y

Turnbull, L, Parsons AJ, Wainwright J, and Anderson JP (2013). Runoff responses to long-term rainfall variability in a shrub-dominated catchment. *Journal of Arid Environments*. 91 88.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.jaridenv.2012.12.002

Reichmann, LG, Sala OE, and Peters DPC (2013). Precipitation legacies in desert grassland primary production occur through previous-year tiller density. *Ecology*. 94 435.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1890/12-1237.1

Templeton, RC, Vivoni ER, Méndez-Barroso LA, Pierini NA, Anderson CA, Rango A, Laliberte AS and Scott RL (2013). High-resolution characterization of a semiarid watershed: implications on evapotranspiration estimates. *Journal of Hydrology*. .

Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Books

Peters, DPC, Laney CM, Lugo AE, Collins SL, Driscoll CT, Groffman PM, Grove JM, Knapp AK, Kratz TK, Ohman MD, Waide RB, and Yao J (2013). *Long-term trends in ecological systems: a basis for understanding responses to global change.* U.S. Department of Agriculture.

Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Book Chapters

Bestelmeyer, BT (2012). Is the historical range of variation relevant to rangeland management?. *Historical Environmental Variation in Conservation and Natural Resources Management: Past, Present, and Future* Wiens JA, Hayward GD, Safford HD, and Giffen CM. John Wiley & Sons, Ltd. Chichester, UK. .

Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/9781118329726.ch21.

Monger, HC., and Rachal DM (2013). Soil and landscape memory of climate change: how sensitive, how connected?. *New Frontiers in Paleopedology and Terrestrial Paleoclimaology: Paleosols and Soil Surface Analog Systems* Driese SG and Nordt LC. Society for Sedimentary Geology (SEPM). Tulsa, Oklahoma, USA. 63.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes ; ISBN: 978-1-56576-322-7.

Peters, DPC, Archer SR, Bestelmeyer BT, Brooks ML, Brown JR, Comrie AC, Gimblett HR, Goldstein JH, Havstad KM, López-Hoffman L, Monger HC, Okin GS, Rango A, Sala OE, Tweedie CE, and Vivoni ER (2013). Vulnerability of ecosystem services to cumulative threats that result in desertification. *Vulnerability of ecosystems to climate* 4. Seastedt TR and Suding KN. Elsevier. 239.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Rango, A, Vivoni ER, Anderson CA, Pierini NA, Schreiner-McGraw A, Saripalli S and Laliberte A (2013). Application of high resolution images from unmanned aircraft systems for watershed and rangeland science. *American Geophysical Union Monograph on Remote Sensing of the Terrestrial Water Cycle* American Geophysical Union. .

Status = UNDER_REVIEW; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Thesis/Dissertations

Goolsby, DP. *Heterogeneity in ecological state transitions at multiple spatial scales in the northern Chihuahuan Desert*. (2012). New Mexico State University.

Acknowledgment of Federal Support = Yes

Klass, JR. *Plant-soil interactions associated with desertification of the Chihuahuan Desert*. (2012). New Mexico State University.

Acknowledgment of Federal Support = Yes

Parry, SF. *Impermanence factors and rangeland management in the desert southwest*. (2012). New Mexico State University.

Acknowledgment of Federal Support = Yes

Rachal, DM. *Tracing the lateral movement of sediment through an arid landscape at seasonal, centennial, and millennial scales*. (2012). New Mexico State University.

Acknowledgment of Federal Support = Yes

Svejcar, LN. *Quantitative approaches to state-and-transition models at fine and broad spatial scales*. (2012). New Mexico State University.

Acknowledgment of Federal Support = Yes

Hewins, DB. *Exploring the role of soil-litter mixing on decomposition in dryland ecosystems*. (2013). New Mexico State University.

Acknowledgment of Federal Support = Yes

Conference Papers and Presentations

Bestelmeyer, S, Somerday R, Harper P, Haan-Amato S, and Keener A (2012). *Jornada Basin Schoolyard LTER: inquiry-based ecology education for the K-12 community*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Browning, D, Anderson JP, and Peters DPC (2012). *Long-term reproductive phenology in the Chihuahuan Desert linking legacy and contemporary datasets*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Duniway, MC, Monger HC, Anderson JP, and Herrick JE (2012). *Long-term soil water dynamics across a desert basin: broad-scale climatic drivers and local heterogeneity*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gherardi, L and Sala OE (2012). *Effects of interannual precipitation variability on aboveground net primary production in the Chihuahuan desert*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Haussler, J, Sala OE, Gherardi L, Easter S, Reichmann L, Smith J, Throop HL, and Archer SR (2012). *Water-nitrogen effects on fine-root production in a Chihuahuan Desert grassland*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Jaimes, A, Laney C, Litvak M, Peters DPC, and Tweedie CE (2012). *Improving the understanding and scaling of land-atmosphere carbon, water and energy exchange in a Chihuahuan Desert shrubland at the Jornada Experimental Range, Southern New Mexico.*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Lajtha, K and Throop HL (2012). *Density fractionation and 13C reveal changes in soil carbon following woody encroachment in a desert ecosystem*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McKenna, O and Sala OE (2012). *Geomorphic controls over nutrient cycling in playa wetlands*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Monger, HC (2012). *Soil memory: a tool for understanding vegetation change during the Anthropocene*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Nieto, B, Pierce N, Archer SR, and Throop HL (2012). *Fine root production and belowground soil processes across a dryland ecotone*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Peters, DPC, Havstad KM, Monger HC, Bestelmeyer BT, Archer SR, Duniway MC, Herrick JE, Sala OE, Rhonda Skaggs, Throop HL, and Enrique V (2012). *Jornada Basin LTER: landscape linkages and state changes across spatial and temporal scales*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Peters, DPC and Havstad KM (2012). *Science in the time of big data: what happens when Google meets the Jornada LTER?*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Peters, SL, Yao J, Peters DPC, and Bestelmeyer S (2012). *The EcoTrends Project: long-term data provide ecological insights to scientists and non-scientists*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Peterson, M, Duarte LC, Bravo-Garza MR, and Throop HL (2012). *Understanding litter decomposition in drylands: is litter abrasion an important abiotic factor?*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Pierce, N, Archer SR, and Bestelmeyer BT (2012). *Grass-shrub interactions in a Chihuahuan Desert ecosystem: can vegetation structure predict state-transitions?*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Pillsbury, F, Peters DPC, Okin GS, Duniway MC, Anderson JP, Sala OE, Vivoni E, Herrick JE, and Havstad KM (2012). *Identifying thresholds in pattern-process relationships: a new cross-scale interactions experiment at the Jornada Basin LTER*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Ratajczak, Z, Demarco J, Nippert JB, Collins S, D'Odorico P, Throop HL, Barger N, Ladwig L, Shiflett S, Bissett S, and McCulley R (2012). *Widespread abrupt shifts of grasslands to a wooded state: woody encroachment in a stable-state and socio-economic framework*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Smith, JG and Throop HL (2012). *Greenfall production by animals in the Chihuahuan Desert influences decomposition by altering litter quality and distribution*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Sylvain, Z, Diana HW, Karie LC, Peters DPC, Sala OE, and Reichmann LG (2012). *Soil animal community structuring along an LTER cross-site moisture gradient*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Yao, J and Peters DPC (2012). *How does precipitation control primary production at Jornada Basin LTER?*. Long Term Ecological Research All Scientists Meeting. Estes Park, CO, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Anderson, CA, Vivoni E, Pierini N, Robles-Morua A, Rango A, Laliberte A, and Saripalli S (2012). *Characterization of Shrubland-Atmosphere Interactions through Use of the Eddy Covariance Method, Distributed Footprint Sampling, and Imagery from Unmanned Aerial Vehicles*. American Geophysical Union falll meeting. San Francisco, CA, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Peters, DPC, Yao J, Duniway MC, Peters SL, and Huang H (2012). *Deciphering landscape complexity to predict (non)linear responses to extreme climatic events*. American Geophysical Union fall meeting. San Francisco, CA, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Rango, A, Vivoni E, Anderson CA, Perini NA, Saripalli S, and Laliberte A (2012). *Application of high resolution images from unmanned aerial vehicles for hydrology and rangeland science*. American Geophysical Union falll meeting. San Francisco, CA, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Throop, HL (2012). *Ghosts of vegetation past: biogeochemical legacy effects in changing drylands*. American Geophysical Union fall meeting. San Francisco, CA, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Bestelmeyer, BT, Havstad KM, Svejcar LN, Duniway MC, Okin GS, and Peters DPC (2013). *Critical thresholds and recovery of Chihuahuan Desert grasslands: insights from long-term data*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Duniway, MC, Monger HC, Herrick JE, and Anderson JP (2013). *Climate change insights from long-term soil-moisture data collected across a desert basin*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gherardi, LA, and Sala OE (2013). *Effects of interannual precipitation variability on plant-species diversity in the Chihuahuan Desert*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gillan, J, Karl JW, Barger NN, Duniway MC, and Elaksher A (2013). *Using high-resolution aerial photogrammetry to 3-dimensionally model soil erosion in rangeland ecosystems.*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Herrick, JE (2013). *Becoming a scientist-practitioner or practitioner-scientist – advice to students and people that care about them*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Herrick, JE (2013). *Challenges and opportunities for increasing the impact of soil biodiversity science on global sustainability*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McKenna, OP, and Sala OE (2013). *Geomorphic controls over nitrogen and carbon stocks in desert playas*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Peters, DPC, Yao J, Browning DM, Duniway MC, Pillsbury F, Anderson JP, and Havstad KM (2013). *Climatic modoki and abiotic contingency: drivers of ecosystem response to extreme events*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Peters, SL, Peters DPC, Havstad KM, Monger HC, Blumenthal DM, Derner JD, Kronberg SL, Northup BK, Okin GS, Sanderson MA, and Steiner J (2013). *Ecological catastrophes: threshold responses to climate, soil, and land use drivers of the Dust Bowl*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Yao, J and Peters DPC (2013). *Critical soil water period for primary production in Chihuahuan Desert ecosystems*. Ecological Society of America annual meeting. Minneapolis, MN, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Browning, DM, Tweedie CE, and Rango A (2013). *Bridging estimates of greenness in an arid grassland using field observations, phenocams, and time series Umanned Aerial System (UAS) imagery*. American Geophysical Union fall meeting. San Francisco, CA, USA.

Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Rango, A, Browning DM, Vivoni E, Anderson CA, and Laliberte A (2013). *Utilization of unmanned aerial vehicles for rangeland resources monitoring in a changing regulatory environment*. American Geophysical Union fall meeting. San

Francisco, CA, USA.

Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Rango, A, Elias E, Steele C, Mejia J, and Fernald A (2013). *Potential impacts of climate warming on runoff from snowmelt: a case study of two mountainous basins in the Upper Rio Grande*. American Geophysical Union fall meeting. San Francisco, CA, USA.

Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Elias, E, Steele C, Rango A, and MeJia J (2013). *Assessing climate change impacts on water availability of snowmelt dominated watersheds of the Upper Rio Grande*. American Geophysical Union fall meeting. San Francisco, CA, USA.

Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Vivoni, E, Pierini N, Schreiner-McGraw A, Anderson C, Saripalli S, and Rango A (2013). *Fusing unmanned aerial vehicle imagery with high resolution hydrologic modeling*. American Geophysical Union fall meeting. San Francisco, CA, USA.

Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Herrick, JE and Toevs G (2013). *Practical tools for monitoring and assessment of DLDD for economic assessments*. UNCCD 2nd Scientific Conference Programme and Short Abstracts. Bonn, Germany.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Herrick, JE and Toevs G. (2013). *Adapting to climate change and disaster risk reduction through sustainable land management: experiences in Tajikistan, East Africa, US, Argentina and Mongolia*. UNCCD 2nd Scientific Conference Programme and Short Abstracts. Bonn, Germany.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Herrick, JE, Urama KC, Boos J, Karl JW, and Kosnik C (2012). *The land potential knowledge system (LandPKS): increasing land productivity and resilience.*. African Technology Policy Studies (ATPS) Annual Conference & Workshops. Addis Ababa, Ethiopia.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Browning, DM, Miura T, Rango A, and Peters DPC (2013). *Integrating phenology and patterns in spatial autocorrelation to delineate perennial grass cover using Landsat: a case study in a southwestern U.S. arid ecosystem.*. Spatial Statistics meeting. Columbus, OH, USA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Vivoni, ER, Pierini NA, Anderson CA, Schreiner-McGraw A, Robles-Morua A, Mendez-Barroso LA and Templeton RC (2013). *Watershed-scale ecohydrological studies of woody plant encroachment in Sonoran and Chihuahuan Desert landscapes*. American Geophysical Union Meeting of the Americas. Cancun, Mexico.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Other Publications

Perry, A (2012). *Climate change may help restore arid grasslands*. Agricultural Research, pp 4-5. Washington, DC: USDA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Technologies or Techniques

Nothing to report.

Patents
Nothing to report.

Inventions
Nothing to report.

Licenses
Nothing to report.

Websites

Title: Jornada Basin LTER
URL: http://jornada-www.nmsu.edu
Description: Link to the home page of the Jornada Basin LTER Program

Title: EcoTrends home page
URL: http://www.ecotrends.info
Description: Home page of the EcoTrends web site

Title: Asombro Institute for Science Education
URL: http://asombro.org
Description: Home page of our schoolyard LTER program

Title: USDA Jornada Experimental Range home page
URL: http://jornada.nmsu.edu
Description: Home page of our main partner, the Jornada Experimental Range.

Other Products
Nothing to report.

Participants

Research Experience for Undergraduates (REU) funding

How many REU applications were received during this reporting period? 6

How many REU applicants were selected and agreed to participate during this reporting period? 2

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Steve Archer	Co-Investigator	1
Michael C. Duniway	Co-Investigator	1
Jeffrey E. Herrick	Co-Investigator	1
Robert L. Schooley	Co-Investigator	1
Craig E. Tweedie	Co-Investigator	1
Albert Rango	Co-Investigator	1

Enrique R. Vivoni	Co-Investigator	1
Gregory S. Okin	Co-Investigator	1
Heather L. Throop	Co-Investigator	1
Nathan F. Sayre	Co-Investigator	1
Rhonda Skaggs	Co-Investigator	1
Osvaldo E. Sala	Co-Investigator	1
Michaela Buenemann	Other Professional	1
Joel R. Brown	Other Professional	1
Donovan Bailey	Other Professional	1
Karen Mabry	Other Professional	1
Sam Fernald	Other Professional	1
Dawn Browning	Other Professional	1
John Anderson	Technician	12
Kenneth Ramsey	Technician	12
Roxanne Chepsongol	Technician	12
James Lenz	Technician	6
Bernice Gamboa	Technician	1
Valerie LaPlante	Technician	1
Theodore Scott Schrader	Technician	1
Yanhua Feng	Technician	12
Stacey Scroggs	Statistician	2
Charlene Harrison	Technician	6
Laureano Gherardi	Graduate Student (research assistant)	3

Nate Pierce	Graduate Student (research assistant)	3
Owen McKenna	Graduate Student (research assistant)	3
Cody Anderson	Graduate Student (research assistant)	3
Kristen DaVanon	Graduate Student (research assistant)	3
Adam Schreiner-McGraw	Graduate Student (research assistant)	3
Savitoz Singh Sidhu	Graduate Student (research assistant)	3
Veronica Garcia	Research Experience for Undergraduates (REU) Participant	3
Corinne Fox	Research Experience for Undergraduates (REU) Participant	3
Debra P Peters	PD/PI	1
Hugh C Monger	Co PD/PI	1
Kris M Havstad	Co PD/PI	1
Brandon T. Bestelmeyer	Co PD/PI	1
Stephanie V Bestelmeyer	Co PD/PI	2
Jin Yao	Staff Scientist (doctoral level)	12
Lauren Svejcar	Graduate Student (research assistant)	6
Aline Jaimes	Graduate Student (research assistant)	12
Christine Laney	Graduate Student (research assistant)	12
Anna Ortiz	Graduate Student (research assistant)	12
Geovany Ramirez	Graduate Student (research assistant)	12
Stephanie Haan-Amato	Other Professional	3
Paul Harper	Other Professional	3
Anna Keener	Other Professional	3

Marianne Somerday	Other Professional	3
Tayeen AbuSaleh	Technician	6
Naomi Luna	Undergraduate Student	3
Gesuri Ramirez	Technician	3
Lindsey Howard	Undergraduate Student	3
Monica McAllister	Undergraduate Student	3
Bojun Wu	Undergraduate Student	3

What other organizations have been involved as partners?

Name	Location
Arizona State University	Tempe, AZ
Asombro Institute for Science Education	Las Cruces, NM
Bureau of Land Management	Las Cruces, NM
Center for Applied Remote Sensing in Agriculture, Meteorolog	Las Cruces, NM
Institute for Natural Resource Analysis and Management	Las Cruces, NM
US Geological Survey	Moab, UT
USDA ARS, Jornada Experimental Range	Las Cruces, NM
USDA NRCS	Las Cruces, NM
University of Arizona	Tucson, AZ
University of California-Berkeley	Berkeley, CA
University of California-Los Angeles	Los Angeles
University of Illinois	Urbana-Champaign
University of Texas-El Paso	El Paso, TX

Have other collaborators or contacts been involved? N

Impacts

What is the impact on the development of the principal discipline(s) of the project?

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 can exacerbate patchiness in soil resources and provide a positive feedback to continued shrub dominance has stimulated research at the Jornada and other sites globally. More recently, our landscape linkages framework expands on the plant-interspace model to explicitly include a range of interacting spatial scales with a focus on transport processes that connect patches. This framework has been used to explain historic patterns that were unaccounted for by the single scale plant-interspace model of Schlesinger et al. (1990). The framework has also been applied to grass recovery in desertified shrublands following a 5-year wet period, and to explain long-term grass dynamics and threshold behavior following drought. The application of this cross-scale approach to broader scales has implications for continental-scale ecology and the development of environmental observatories and networks to address broad-scale questions.

What is the impact on other disciplines?

Jornada LTER research on state changes has promoted an understanding by soil scientists about the properties of soils in aridlands that influence their resilience and resistance to future disturbance. LTER research has been particularly important in allow geomorphologists, ecohydrologists, and soil scientists to explore the feedbacks between soil properties and vegetation cover across a range of temporal and spatial scales. Range managers are using LTER research findings to develop state-and-transition models for millions of acres of land in the western US and globally. The identification of early indicators of state changes for diverse terrestrial, aquatic, and marine ecosystems is being aided by Jornada long-term data and analyses.

Jornada research is contributing to the development of Earth System Science and the understanding of phenomena that link ecosystems to global environmental change. Specific examples include interactions between desertification and the generation and export of dust to the atmosphere that feeds back to terrestrial ecosystem processes. Recent research on inorganic carbon at the Jornada is increasing knowledge of the carbon cycle at the global scale.

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

What is the impact on the development of human resources?

The Jornada program supports graduate and undergraduate students from numerous institutions, and attracts postdocs and visiting scientists from around the world. NMSU, UTEP, ASU, and UA are all minority, Hispanic-serving institutions, and we routinely include minority and female students in our program. In addition, Jeff Herrick has been an active mentor of the ESA SEEDS program for many years. This program recruits and supports students of color in ecology.

What is the impact on physical resources that form infrastructure?

The Jornada Program has been succcessful in receiving resources to build additional facilities at the research site because of the use of the site, both locally and by visiting scientists and classes.

What is the impact on institutional resources that form infrastructure?

The Jornada as a large research program on the campus of NMSU is able to have input on future faculty hires and expansion by the university.

What is the impact on information resources that form infrastructure?

The Jornada was the co-founder of the EcoTrends Project where the goal is to make long-term data and derived data products from many sites easily accessible and usable by others. The Jornada maintains and upgrades the EcoTrends web site, and has focused on making the long-term data easily used by high school students.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

LTER research findings have been used in the development of assessment and monitoring methods to evaluate the status of arid and semiarid land, and the ability of this land to provide food and fiber to humans. Much of the American West is composed of these lands, thus there is substantial debate about the appropriateness of particular land uses and their impacts on ecosystem and economic sustainability. Our applications provide tools that are needed by regulatory and land management agencies as well as by private land owners.

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

Our highly successful schoolyard LTER program is 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 a largely poor, minority population - Las Cruces public schools 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.

Changes

Changes in approach and reason for change

Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.