Preview of Award 1832194 - Annual Project Report

Cover

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Accomplishments

*** What are the major goals of the project?**

In LTER-VII, we will explore how the heterogeneity inherent in an underlying soil-geomorphic template is amplified or dampened by a complex of spatial-temporal interactions, connectivity-mediated feedbacks, and disturbance histories. We will address the critical need for integration of long-term observations into an evolving conceptual and predictive framework for drylands. We propose to expand our landscape linkages framework to fill this critical need, and contribute to emerging ecological theory on: (a) alternative states, (b) ecosystem sensitivity under global change, and (c) cross-scale interactions. Our recent activities have positioned us to conceptually and numerically integrate data and knowledge that will allow Jornada results to be translated to other locations in the Chihuahuan Desert and to drylands globally.

Obj. 1: to quantify the role of multiple triggers and connectivity-mediated feedbacks interacting with patches and soil-geomorphic patterns on the rate and nature of state transitions

Obj. 2: to explain and predict multi-scale spatial heterogeneity in alternative states

Obj. 3: to apply new analytical concepts and tools developed at the Jornada to broader extents (regional to global) and examine consequences for ecosystem services through our collaborations

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

Obj. 1 to quantify the role of multiple triggers and connectivity-mediated feedbacks interacting with patches and soil-geomorphic patterns on the rate and nature of state transitions

A. Grassland to shrubland transitions
A2: The NEAT Experiment: The NEAT biocrust restoration project is now ongoing. A site survey, including phototrophic biomass determinations and microbial community composition has been completed. Cyanobacterial isolations provided over 20 isolated strains and biomass scale up has begun. Site surveys for pathogenic agents have been completed. Infected and healthy biocrusts have been collected for analysis of the impact of pathogens on cyanobacterial community composition.

A3: Ecotone study: In Year 1 we continued our long-term monitoring of small mammal consumers via live-trapping and their mammalian predators with camera traps across shrub cover gradients. We also measured precipitation and aboveground primary production at each sites. This approach will allow us to test hypotheses regarding the relative importance of top-down and bottom-up processes for controlling consumers across state transitions and during wet and dry periods. We also completed data collection and analysis to quantify the landscape of fear for desert lagomorphs so we can assess how perceived predation risk affects their activity and herbivory potential across state transitions.

B. Shrubland to grassland transitions
B1: We initiated a long-term manipulative experiment in Year 1 to determine how reduced connectivity triggers grass establishment through nonlinear responses to precipitation. A rainfall-connectivity factorial experiment was established in a mesquite dune-field with minimal grass cover (TRIGGER). We will manipulate rainfall in zones between shrubs (ambient and -80%, -50%, +50%, + 80% of ambient; per Gherardi and Sala 2013). Plots were divided into paired treatments with ConMods present (at a density of 0.8 m-2) or absent. ANPP and plant density by species will be measured annually, and UAV photogrammetry (SfM) to quantifying litter cover, vegetation structure, and biomass. Soils were sampled at T0, and will be sampled every 3y to determine effects of treatments on soil nutrients, texture, and seed bank.

B2: In Year 1 we initiated long-term experiments on a site cleared of vegetation in 1996, yet with grass recovery following the 2004-08 wet period, to examine the importance of feedbacks between aeolian processes and climate drivers to future transitions. We separated the area into two parts: a downwind section where mesquite plants were killed to allow grass recovery to be measured, and a smaller upwind section where mesquite plants remained intake to allow dune development to be measured. In both sections, we installed permanent: TDR rods to measure soil water availability at two depths (10, 30 cm), 10m x 30 m biodiversity plots, BSNE dust collectors, and a series of transects for plant cover by species estimates. Measurements were obtained prior to and following shrub removals in 2019.

B3: We completed a pilot study to evaluate the effectiveness of Connectivity Modifiers (ConMods) to modify resource redistribution by water or wind and influence fine-scale patterns in grass recovery (Rachal et al. 2015). We continued a long-term multi-scale experiment to address two questions: (a) at what spatial scales and weather conditions do fine-scale processes propagate to produce broad-scale impacts and grass recovery? (b) at what spatial scales do broad-scale drivers (drought or extended wet periods) overwhelm fine-scale processes?

B4: We are continuing long-term monitoring of NPP at 15 locations across the Jornada Basin following the recent sequence of wet years (2004-2008) to examine the legacy effects of the wet period, and to examine the spatial and temporal variability in grass response in different shrubland ecosystems (mesquite-, creosotebush- or tarbush-dominated).

C. Shrubland to shrubland transitions

C1: Shrub demographic experiment: We initiated a study of the population dynamics of dominant shrub species of the Jornada Basin (Prosopis juliflora, Larrea tridentata, Floruensia cernua) to determine primary bottlenecks to establishment and likely mechanisms, environmental and edaphic drivers of shrub encroachment. Year 1 focused on characterization of key demographic parameters of seed viability and germination rate, seedling establishment and survival subject varying soil type, water availability and the presence/absence of soil microbial communities. These greenhouse experiments used seed and soil collected from the Jornada with factorial soil and watering treatments to study germination, seedling establishment/survival, and sapling growth/survival rates.

C2: Shrub mapping and connectivity: In Year 1 we published a new map of shrub cover for the Jornada Basin, with shrubs identified at very high resolution (~1 m) and aggregated to shrub cover at ~1 ha scale. These data facilitated analysis of shrub canopy cover and size patterns across the Basin, relationship to soil type, water availability and the emergence of competitive density dependence. We began UAV-based monitoring to develop methods for assessment of patch-scale connectivity to wind and water as influenced by different plant functional types (woody, herbaceous). We established baseline aerial surveys to derive 3-D point-clouds at the 15 long-term NPP sites where Aeolian transport of sediments is measured. Analysis will focus on analysis of different metrics of connectivity (including woody and herbaceous density and height distributions) as correlates of sediment flux.

C3: Bajada watershed studies: In Year 1 we deployed a disdrometer at the Jornada and a comparative site in Mesa, AZ to measure rainfall intensity, rainfall drop size distribution and kinetic energy. We deployed four hillslope runoff plots to measure overland flow generated during storm events, with two plots north-facing and two south-facing. Their locations will allow estimation of contributions to channel runoff and differences due to variations in plant and bare soil composition. Continuous rainfall, runoff and event-based sediment measurements are underway.

Obj. 2 to explain and predict multi-scale spatial heterogeneity in alternative states

We are expanding the Jornada long-term quadrat monitoring dataset to include data not previously compiled or analysed, including 1243 previously un-scanned long-term vegetation monitoring quadrat charts that were scanned and 1,126 of them were georeferenced. Digitization of plant cover is in progress with each time series involving up to 64 chart quadrats spanning 1915-2016. In addition, new soil and climate datasets linked to 123 quadrat locations were assembled.

Obj. 3 to apply new analytical concepts and tools developed at the Jornada to broader extents (regional to global) and examine consequences for ecosystem services through our collaborations

Additional vegetation and soil data were gathered in support of a long-term monitoring program to evaluate the conditions promoting success of shrub removal and grazing management on grassland restoration in public lands of the southwestern USA. A dataset is now complete for analysis and publication, but plots will continue to be monitored. Another year of Mongolian monitoring data involving 1550 plots was incorporated into our data management system and analyses are being conducted that will test for state change across 5 years.

Specific Objectives:

Significant Results:

Obj. 1 to quantify the role of multiple triggers and connectivity-mediated feedbacks interacting with patches and soil-geomorphic patterns on the rate and nature of state transitions

A. Grassland to shrubland transitions

A2: The NEAT Experiment: The site survey of the NEAT 2 experimental plots indicates low levels of cyanobacterial biomass. Six sampling sites were analyzed and chlorophyll *a* levels, a proxy for phototrophic biomass, indicate cyanobacteria can be found in higher numbers under plants and lower numbers in plant interspaces (Figure 1). Across all sampling sites *Microcoleus vaginatus* made up a majority of the cyanobacterial community and in 5 of the 6 cases was > 90% of the composition (Figure 1). Observational surveys of 2 sandy soil and 2 silty soil sites show widespread symptomology of an infectious agent. Microbial community composition was analyzed and confirmed the presence of a bacterial infectious agent in the family Chitinophagaceae in 2 of the 4 sites, including the NEAT site.

A3: Ecotone study: Results for bottom-up effects on small mammal consumers indicate biomass of desert rodents reflects an interaction between summer precipitation and shrub cover and is partly mediated by dynamics of transient species. Analysis is ongoing to examine if and when predators affect consumer biomass. A structural equation model indicates desert lagomorphs perceive shrubby habitatd to be safer from predators than grasslands, but the mechanisms differ among species.

B. Shrubland to grassland transitions

B1: Nothing to report (new study)

B2: Nothing to report (new study)

B3: An experimental treatment was imposed to manipulate connectivity of resources by wind or water on different geomorphic surfaces to study effects of plant-soil feedbacks vs precipitation. Results show that Connectivity Modifiers (ConMods) were most effective on sandy soils where wind is the dominate vector, resulting in grass recovery within six years after plant-soil feedbacks developed to overwhelm effects of precipitation (aeolian location; Figure 2). Shrub removals alone resulted in growth of perennial forbs whereas patch-scale redistribution of resources by ConMods alone resulted in growth of annual grasses. Gravelly soils on stable surfaces with low sediment movement by water had the least potential for grass recovery (alluvial-stable). Grass cover on cover plots was related to precipitation for all geomorphic surfaces.

B4: Perennial grass responses had the largest response on sandy soils dominated by mesquite, and least response on rocky soils with low water-holding capacity that are dominated by creosotebush. Perennial grass recovery in degraded shrublands has historically been thought to be nearly impossible. Recent results from our cross-scale experiment and long-term monitoring plots show that perennial grass response in degraded shrublands can occur following a combination of shrub mortality and patch-scale redistribution of resources that modify plant-soil water feedbacks or during wet periods that consist of very high pulses of precipitation in individual years (2006, 2008).

C. Shrubland to shrubland transitions

C1: Shrub demographics experiment: Studies on seed viability and germination rate and seedling/sapling survival probabilities show great diversity in the demographic constraints on establishment across the three main species. Mesquite and creosote both produce copious amounts of viable seed, but tarbush viability is extremely low. Seedling survival probabilities depend on rainfall during the 2-10 weeks following germination and survival rates interact with soil texture and the presence/absence of soil microbial communities.

C2: Shrub mapping and connectivity: Shrub canopy cover across the entire Jornada Basin is rarely >35% at 1 hectare scales, but in locations with high shrub cover most landscapes show signs of self-thinning, suggesting competitive suppression of neighbors in high density situations (Ji et al., 2019).

C3: Bajada watershed studies: Data analyses for disdrometer and hillslope runoff plots have commenced, with on-going automated data collection and site maintenance for the multiple types of hydrologic observations in the study watershed,

including micrometeorological sensors, flumes, soil moisture transects, rain gauges, phenological cameras, etc. Analysis using a distributed ecohydrological model and varying scenarios for future climate and degree of woody plant encroachment (WPE) indicate that shrub encroachment is a critical component of the hydrological response, with increased WPE associated with reduced deep water (water table) recharge (Figure 3).

D. Transition to novel ecosystems

D1: A field experiment quantifying Lehmann love grass germination and early establishment ('recruitment') was completed. We found a strong interaction between growing season precipitation (PPT) and grazing, wherein recruitment increased with increasing PPT, but more so on plots where native grasses were clipped (to simulate livestock grazing), with the clipping effect increasing with increasing PPT. Recruitment was nil when growing season PPT was < 30 mm. Recruitment was also promoted in plots with rodent/lagomorph access, suggesting disturbances associated with small mammal activities will promote recruitment on this non-native grass.

We addressed lovegrass competition with blue grama through a replacement series experiment and found lovegrass to be a superior competitor at the seedling stage in a well-watered greenhouse setting, producing 341% more biomass than blue grama when planted in equal proportions. Drought effects in rainout experiments did not become apparent in the first two years of our experimental treatments, with mature plants of black grama and Lehmann lovegrass suppressed equally. Black grama, however, consistently retained higher percent cover than Lehmann lovegrass under all treatments across all years.

Obj. 2 to explain and predict multi-scale spatial heterogeneity in alternative states

Our analysis focus will be on patterns in recent data that have not yet been analyzed and published. This year, we discovered that our foundation grass species, *Bouteloua eriopoda* (BOER4), has increased in abundance over the past 10 years due to the establishment of new ramets (Figure 4).

Obj. 3 to apply new analytical concepts and tools developed at the Jornada to broader extents (regional to global) and examine consequences for ecosystem services through our collaborations

We measured vegetation in two plots that were burned 5 years ago as a pilot to test the effectiveness of fire as a management tool in relatively productive soils in a public lands setting. Results indicate that fire precipitated desertification. (Figure 4)

Key outcomes or Other achievements:

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

1. K12 Education and Outreach:

K12 Education and Outreach Activities: The Jornada LTER education and outreach program is spearheaded by our partner the Asombro Institute for Science Education. The primary goals of the K12 program are to increase the ability of local school districts to help students improve ecological understanding, including understanding the causes and potential impacts of climate change on local ecosystems (Schoolyard LTER program). We also provide support to other LTER sites interested in adopting and adapting strategies developed in cooperation with JRN, including Data Jams (Asombro Institute). During Year 1 of the LTER-7 project we ran a flexible science education program for K-12 students and teachers, including field trips, classroom/schoolyard science lessons, and teacher workshops based on JRN research. We hosted the eighth annual Desert Data Jam competition for middle school students in New Mexico, shared the Data Jam model with Education and Outreach coordinators across the LTER network, and provided materials and advice to educators at BES, LUQ, and NES who subsequently hosted four Data Jams in Maryland, Massachusetts, New York, and Puerto Rico.

K12 Education and Outreach Accomplishments: A total of 24,322 K-12 students, 729 teachers, and 218 other adults participated in 18 field trips, 975 one-hour classroom/schoolyard lessons, 5 teacher workshops, and 29 family events, where they learned about JRN research by participating in inquiry-based activities. Six graduate students contributed more than 30 hours to help provide background information and assist with classroom lessons. The Desert Data Jam competition was held in April 2019. In total, 615 middle school students from southern New Mexico participated. The top projects from each school (68 projects total) participated in the final competition from April 23 - 25. JRN staff also assisted other LTER educators, who subsequently hosted 2019 Data Jam competitions in Maryland, Massachusetts, New York, and Puerto Rico.

2. LTER-VII Graduate Fellows: The JRN-LTER solicits graduate proposals for summer (3 month) and annual (12-month) fellowships that are reviewed by an ad-hoc committee of JRN investigators each Spring. In 2019 we supported 10 summer fellowships and 2 12-month fellowships for graduate students pursuing both master's and PhD research focused on dryland ecology at the Jornada LTER site.

3. LTER-VII REU: The JRN-LTER also supported summer research experience for undergraduate (REU) fellowships this year, for a student from NMSU and a student from ASU. Both students were paired with graduate student and faculty mentors and presented posters on their research as part of the Desert Ecology Short-Course held at the Jornada in July.

4. Jornada Desert Ecology Short-Course: the Jornada Desert Ecology Short-Course takes place during the second week of July each year. In 2019 the short-course included field demonstrations, student talks, poster sessions, professional development and both formal and informal networking and team building elements. The 2019 short-course was attended by a total of 33 participants (undergraduate students, graduate students and postdocs).

5. Other training and outreach:

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

Science results have been communicated through scientific meetings, and publications in high impact journals (see Products Report).

We have continued to share updated LTER results with US land management agency and other natural resource managers through our co-leadership of the "Interpreting and Managing Indicators of Rangeland Health" (IIRH) course that is conducted three times/year in locations throughout the western US, and an additional 4+ annual BLM "Assessment, Inventory and Monitoring" (AIM) trainings. The new version of the training manual for the IIRH course (Version 5) includes updated sections on landscape connectivity which were informed by LTER research. The results are also being communicated through global outreach and training associated with the Land-Potential Knowledge System app, which is experiencing exponential growth in use (see https://landpotential.org). The app now includes direct links to the new "Ecosystem Dynamics Interpretive Tool" (EDIT) developed by the Jornada (https://app.edit.jornada.edu/).

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

Obj. 1 to quantify the role of multiple triggers and connectivity-mediated feedbacks interacting with patches and soil-geomorphic patterns on the rate and nature of state transitions

A. Grassland to shrubland transitions

A2: The NEAT Experiment: Scale-up of biocrust inoculum, using whole community and mixed isolate approaches, is planned for spring of 2020 as part of the NEAT2 experiment. Preparation and inoculation of experimental plots is planned for June 2020. Sampling for phototrophic biomass and microbial community composition will occur initially and 6 months after (June and December 2020). Whole community inoculum will be monitored during inoculum production for symptomology of infectious agents during spring 2020. Analysis of shifts in cyanobacterial community composition, in locations where infectious agent symptomology was documented will be done in spring 2020.

A3: Ecotone study: We will continue our long-term monitoring of small mammal consumers, precipitation, plant cover, and net primary production. These data have been collected since 2004 and represent our core animal consumer study. We will also extend sampling of mammalian carnivores with camera traps to our seventh year. A paper will be submitted to a special feature on Dynamic Deserts in Ecosphere on the landscape of fear of desert lagomorphs and its ties to herbivory potential.

B. Shrubland to grassland transitions

We are continuing our long-term experiments; (1) to examine rainfall and connectivity as triggers of grass recovery, (2) effects of shrub presence or absence on grass recovery, and (3) cross-scale effects of shrub mortality, patch-scale redistribution of resources, and cover of grasses or shrubs on grass recovery. (4) We will continue to monitor ANPP on 15 locations for 5 ecosystem types at 3 sites each. These seasonal data have been collected since 1989 and remain a critical part of our long-term data.

C. Shrubland to shrubland transitions

C1: Shrub demographics experiment: The initial seedling germination and sapling survival experiments are being analyzed to assess bottlenecks to shrub establishment. In Year 2 we will repeat and braoden these experiments to examine the range of factors potentially involved in shrub population release and/or limitation relative to climate, soils, and microbial interactions.

C2: Shrub mapping and connectivity: The very high resolution data available using UAV imagery will be used to explore the metrics of woody and herbaceous vegetation cover that best correlate with long-term sediment transport rates. The high resolution UAV data will further be examined with airborne NAIP (1 meter) imagery to assess information loss associated with measurement scale and the potential for wider assessment of connectivity time-series at Basin and regional scale, given NAIP imagery is available at ~annual intervals for all of the SW USA).

C3: Bajada watershed study: We are conducting a retrospective analysis of the carbon dioxide flux measurements (2011-2019) from the eddy covariance tower. The goal is to link the event, seasonal and inter annual variability of the carbon fluxes to the periods of hydrologic activity (soil moisture pulses, runoff events). This analysis will be submitted to the special issue on Dynamic Deserts in Ecospheres.

Obj. 2 to explain and predict multi-scale spatial heterogeneity in alternative states

We will submit a data paper featuring initial analyses of the expanded Jornada quadrat dataset.

Obj. 3 to apply new analytical concepts and tools developed at the Jornada to broader extents (Regional to global) and examine consequences for ecosystem services through our collaborations

We will submit a paper analyzing the 5 and 10 year responses of “Restore New Mexico” monitoring data with respect to climoedaphic context and management variables.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
LTER-7_Year-1_Report_Final_Figures.pdf	Figures 1-4 showing recent JRN-LTER results	Niall Hanan	11/03/2019

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers
View all journal publications currently available in the NSF Public Access Repository for this award.

The results in the NSF Public Access Repository will include a comprehensive listing of all journal publications recorded to date that are associated with this award.

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Gallardo, Antonio and García-Velázquez, Laura and Sala, Osvaldo E. and Abades, Sebastián R. and Alfaro, Fernando D. and Berhe, Asmeret A. and Bowker, Matthew A. and Currier, Courtney M. and Cutler, Nick A. and Hart, Stephen C. and Hayes, Patrick E. and Hseu, Zeng-Yei and Kirchmair, Martin and Peña-Ramírez, Victor M. and Pérez, Cecilia A. and Reed, Sasha C. and Santos, Fernanda and Siebe, Christina and Sullivan, Benjamin W. and Weber-Grullon, Luis and Fierer, Noah. (2019). Changes in belowground biodiversity during ecosystem development. *Proceedings of the National Academy of Sciences*. 116 (14) p. 6891-6896. Status = Deposited in NSF-PAR doi:10.1073/pnas.1818400116 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

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Franco, André L. and Gherardi, Laureano A. and de Tomasel, Cecilia M. and Andriuzzi, Walter S. and Ankrom, Katharine E. and Shaw, E. Ashley and Bach, Elizabeth M. and Sala, Osvaldo E. and Wall, Diana H.. (2019). Drought suppresses soil predators and promotes root herbivores in mesic, but not in xeric grasslands. *Proceedings of the National Academy of Sciences*. 116 (26) 12883 to 12888. Status = Deposited in NSF-PAR doi:10.1073/pnas.1900572116 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Peters, Debra P and Burruss, N Dylan and Rodriguez, Luis L and McVey, D Scott and Elias, Emile H and Pelzel-McCluskey, Angela M and Derner, Justin D and Schrader, T Scott and Yao, Jin and Pauszek, Steven J and Lombard, Jason and Archer, Steven R and Bestelmeyer, Brandon T and Browning, Dawn M and Brungard, Colby W and Hatfield, Jerry L and Hanan, Niall P and Herrick, Jeffrey E and Okin, Gregory S and Sala, Osvaldo E and Savoy, Heather and Vivoni, Enrique R. (2018). An Integrated View of Complex Landscapes: A Big Data-Model Integration Approach to Transdisciplinary Science. *BioScience*. 68 (9) 653 to 669. Status = Deposited in NSF-PAR doi:10.1093/biosci/biy069 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Bestelmeyer, Brandon T and Peters, Debra P and Archer, Steven R and Browning, Dawn M and Okin, Gregory S and Schooley, Robert L and Webb, Nicholas P. (2018). The Grassland–Shrubland Regime Shift in the Southwestern United States: Misconceptions and Their Implications for Management. *BioScience*. 68 (9) 678 to 690. Status = Deposited in NSF-PAR doi:10.1093/biosci/biy065 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Browning, Dawn M. and Crimmins, Theresa M. and James, Darren K. and Spiegal, Sheri and Levi, Matthew R. and Anderson, John P. and Peters, Debra P.. (2018). Synchronous species responses reveal phenological guilds: implications for management. *Ecosphere*. 9 (9) e02395. Status = Deposited in NSF-PAR doi:10.1002/ecs2.2395 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Schooley, Robert L. and Bestelmeyer, Brandon T. and Campanella, Andrea. (2018). Shrub encroachment, productivity pulses, and core-transient dynamics of Chihuahuan Desert rodents. *Ecosphere*. 9 (7) e02330. Status = Deposited in NSF-PAR doi:10.1002/ecs2.2330 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Duniway, Michael C. and Petrie, Matthew D. and Peters, Debra P. and Anderson, John P. and Crossland, Keith and Herrick, Jeffrey E.. (2018). Soil water dynamics at 15 locations distributed across a desert landscape: insights from a 27-yr dataset. *Ecosphere*. 9 (7) e02335. Status = Deposited in NSF-PAR doi:10.1002/ecs2.2335 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Okin, Gregory S and Sala, Osvaldo E and Vivoni, Enrique R and Zhang, Junzhe and Bhattachan, Abinash. (2018). The Interactive Role of Wind and Water in Functioning of Drylands: What Does the Future Hold?. *BioScience*. 68 (9) 670 to 677. Status = Deposited in NSF-PAR doi:10.1093/biosci/biy067 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Koerner, Sally E. and Smith, Melinda D. and Burkepile, Deron E. and Hanan, Niall P. and Avolio, Meghan L. and Collins, Scott L. and Knapp, Alan K. and Lemoine, Nathan P. and Forrestel, Elisabeth J. and Eby, Stephanie and Thompson, Dave I. and Aguado-Santacruz, Gerardo A. and Anderson, John P. and Anderson, T. Michael and Angassa, Ayana and Bagchi, Sumanta and Bakker, Elisabeth S. and Bastin, Gary and Baur, Lauren E. and Beard, Karen H. and Beever, Erik A. and Bohlen, Patrick J. and Boughton, Elizabeth H. and Canestro, Don and Cesa, Ariela and Chaneton, Enrique and Cheng, Jimin and D'Antonio, Carla M. and Deleglise, Claire and Dembélé, Fadiala and Dorrough, Josh and Eldridge, David J. and Fernandez-Going, Barbara and Fernández-Lugo, Silvia and Fraser, Lauchlan H. and Freedman, Bill and García-Salgado, Gonzalo and Goheen, Jacob R. and Guo, Liang and Husheer, Sean and Karembé, Moussa and Knops, Johannes M. and Kraaij, Tineke and Kulmatiski, Andrew and Kytöviita, Minna-Maarit and Lezama, Felipe and Loucougaray, Gregory and Loydi, Alejandro and Milchunas, Dan G. and Milton, Suzanne J. and Morgan, John W. and Moxham, Claire and Nehring, Kyle C. and Olff, Han and Palmer, Todd M. and Rebollo, Salvador and Riginos, Corinna and Risch, Anita C. and Rueda, Marta and Sankaran, Mahesh and Sasaki, Takehiro and Schoenecker, Kathryn A. and Schultz, Nick L. and Schütz, Martin and Schwabe, Angelika and Siebert, Frances and Smit, Christian and Stahlheber, Karen A. and Storm, Christian and Strong, Dustin J. and Su, Jishuai and Tiruvaimozhi, Yadugiri V. and Tyler, Claudia and Val, James and Vandegehuchte, Martijn L. and Veblen, Kari E. and Vermeire, Lance T. and Ward, David and Wu, Jianshuang and Young, Truman P. and Yu, Qiang and Zelikova, Tamara Jane. (2018). Change in dominance determines herbivore effects on plant biodiversity. *Nature Ecology & Evolution*. 2 (12) 1925 to 1932. Status = Deposited in NSF-PAR doi:10.1038/s41559-018-0696-y ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Pierce, Nathan A. and Archer, Steven R. and Bestelmeyer, Brandon T. and James, Darren K.. (2019). Grass-Shrub Competition in Arid Lands: An Overlooked Driver in Grassland–Shrubland State Transition?. *Ecosystems*. 22 (3) 619 to 628. Status = Deposited in NSF-PAR doi:10.1007/s10021-018-0290-9 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Svejcar, Lauren N. and Bestelmeyer, Brandon T. and James, Darren K. and Peters, Debra P.C.. (2019). The effect of small mammal exclusion on grassland recovery from disturbance in the Chihuahuan Desert. *Journal of Arid Environments*. 166 (C) 11 to 16. Status = Deposited in NSF-PAR doi:10.1016/j.jaridenv.2019.04.001 ; Federal Government's License = Acknowledged. (Completed by Hanan, Niall on 10/17/2019) Full text Citation details

Licenses

Other Conference Presentations / Papers

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Svenja Wagner. *Effects of Water Holding Capacity and Precipitation on Above Ground Net Primary Production*. (2019). Arizona State University. Acknowledgement of Federal Support = Yes

Websites

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Peters, Debra	PD/PI	1
Bestelmeyer, Brandon	Co PD/PI	1
Hanan, Niall	Co PD/PI	1
Archer, Steve	Co-Investigator	1
Bestelmeyer, Stephanie	Co-Investigator	6
Brown, Joel	Co-Investigator	1

Name	Most Senior Project Role	Nearest Person Month Worked
Browning, Dawn	Co-Investigator	1
Brungard, Colby	Co-Investigator	1
Garcia-Pichel, Ferran	Co-Investigator	1
Herrick, Jeffrey	Co-Investigator	1
Monger, H.	Co-Investigator	1
Okin, Gregory	Co-Investigator	1
Pietrasiak, Nicole	Co-Investigator	1
Sala, Osvaldo	Co-Investigator	1
Schooley, Robert	Co-Investigator	1
Tweedie, Craig	Co-Investigator	1
Vivoni, Enrique	Co-Investigator	1
Giraldo-Silva, Ana	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Ji, Wenjie	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Meredith, Christy	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Savoy, Heather	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Schreiner-McGraw, Adam	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Maurer, Gregory	Other Professional	6
Ramirez, Geovany	Other Professional	12
Anderson, John	Technician	12
Chepsongol, Roxanne	Technician	12
Gename, Kyle	Technician	12
Golgani-Amirkhiz, Reza	Technician	3
Hall, Seth	Technician	12
Harrison, Charlene	Technician	6
Nelson, Conrad	Technician	12
Omari, Haneen	Technician	6
Burruss, Nathan	Statistician	12
Darren, James	Statistician	3
Currier, Courtney	Graduate Student (research assistant)	3
Escoto, Eric	Graduate Student (research assistant)	3
Fischella, Michael	Graduate Student (research assistant)	3
Hoellrich, Mikaela	Graduate Student (research assistant)	3
Jordan, Samuel	Graduate Student (research assistant)	3
Keller, Zachary	Graduate Student (research assistant)	12
Nelson, Corey	Graduate Student (research assistant)	12
Perez-Ruiz, Eli	Graduate Student (research assistant)	3
Rakes, Julie	Graduate Student (research assistant)	3
Scroggs, Stacey	Graduate Student (research assistant)	2
Toth, Caroline	Graduate Student (research assistant)	3
Turk, Tyler	Graduate Student (research assistant)	3
Vidaurre, Grace	Graduate Student (research assistant)	3

Name	Most Senior Project Role	Nearest Person Month Worked
Weber-Grullon, Luis	Graduate Student (research assistant)	3
Wojcikiewicz, Robert	Graduate Student (research assistant)	3
Young, Katherine	Graduate Student (research assistant)	3
Treminio, Ronald	Undergraduate Student	3
Vera, Elizabeth	Undergraduate Student	3
Stickel, Paul	Research Experience for Undergraduates (REU) Participant	3
Taylor, Hansen	Research Experience for Undergraduates (REU) Participant	3

Full details of individuals who have worked on the project:

Debra P Peters
Email: deb.peters@ars.usda.gov
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Lead PI responsible for vision and project direction, NSF reporting and representing the ARS

Funding Support: This award

International Collaboration: No
International Travel: No

Brandon Bestelmeyer
Email: Brandon.Bestelmeyer@ars.usda.gov
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Co-PI responsible for state-and-transition model development and representing the ARS

Funding Support: This award

International Collaboration: No
International Travel: No

Niall P Hanan
Email: nhanan@nmsu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Co-PI working on landscape and regional scale shrub dynamics, population demographics, and remote sensing.

Funding Support: This award

International Collaboration: No
International Travel: No

Steve Archer
Email: sarcher@ag.arizona.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Grass-shrub interactions at individual plant scale with a focus on demography and physiology

Funding Support: this award

International Collaboration: No
International Travel: No

Stephanie V. Bestelmeyer
Email: stephanie@asombro.org
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 6

Contribution to the Project: K-12 Education and Outreach

Funding Support: this award

International Collaboration: No
International Travel: No

Joel Brown
Email: Joel.Brown@lin.usda.gov
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Rangeland ecology, application of state and transition models to rangelands, rangeland soil carbon dynamics, shrub invasion, grazing systems, effects of climate change on rangelands, adoption of management practices on rangelands.

Funding Support: NRCS

International Collaboration: No

International Travel: No

Dawn Browning
Email: dawn.browning@usda.gov
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Plant ecology, remote sensing, spatial statistics, landscape ecology, and range management

Funding Support: ARS

International Collaboration: No
International Travel: No

Colby Brungard
Email: cbrung@ad.nmsu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Soil and geomorphological processes

Funding Support: this award

International Collaboration: No
International Travel: No

Ferran Garcia-Pichel
Email: ferran@asu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Biocrust and microbial communites

Funding Support: this award

International Collaboration: No
International Travel: No

Jeffrey E. Herrick
Email: jeff.herrick@ars.usda.gov
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Qualitative assessment and quantitative monitoring tools

Funding Support: ARS

International Collaboration: No
International Travel: No

H. Curtis Monger
Email: Curtis.Monger@lin.usda.gov
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Soil and geomorphological processes

Funding Support: NRCS

International Collaboration: No
International Travel: No

Gregory S. Okin
Email: okin@ucla.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Dust and aeolian dynamics, field studies and simulation modeling

Funding Support: this award

International Collaboration: No
International Travel: No

Nicole Pietrasiak
Email: npietras@ad.nmsu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Biocrust and microbial communites

Funding Support: this award

International Collaboration: No
International Travel: No

Osvaldo E. Sala
Email: osvaldo.sala@asu.edu

Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Biodiversity, sustainability, and biogeochemistry of grasslands and shrublands

Funding Support: this award

International Collaboration: No
International Travel: No

Robert L. Schooley
Email: schooley@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Small animal population dynamics and metapopulations

Funding Support: this award

International Collaboration: No
International Travel: No

Craig E. Tweedie
Email: ctweedie@utep.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Cyberinfrastructure (hardware, software) technologies for new uses in ecology

Funding Support: this award

International Collaboration: No
International Travel: No

Enrique R. Vivoni
Email: vivoni@asu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Ecohydrology and dynamics of watersheds

Funding Support: this award

International Collaboration: No
International Travel: No

Ana Maria Giraldo-Silva
Email: amgirald@asu.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 2

Contribution to the Project: iocrust cultivation experiments with Ferran Garcia-Pichel

Funding Support: Separate funding

International Collaboration: No
International Travel: No

Wenjie Ji
Email: wenjieji@nmsu.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: Postdoc with Hanan on shrub community structure and dynamics

Funding Support: NMSU

International Collaboration: No
International Travel: No

Christy Meredith
Email: csm5@nmsu.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: Worked for Deb Peters as LTER project manager

Funding Support: this award

International Collaboration: No
International Travel: No

Heather Savoy
Email: hsavoy@nmsu.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: Worked for Deb Peters to model landscape and broadscale patterns of disease as part of the ARS-funded VSV Grand Challenge Project

Funding Support: ARS

International Collaboration: No
International Travel: No

Adam Schreiner-McGraw
Email: adam.schreiner-mcgraw@ucr.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 1

Contribution to the Project: Ecohydrology and hydrology of desert landscapes

Funding Support: Separate funding

International Collaboration: No
International Travel: No

Gregory Maurer
Email: gmaurer.jrn.lter@gmail.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 6

Contribution to the Project: Information manager

Funding Support: this award

International Collaboration: No
International Travel: No

Geovany Ramirez
Email: georam@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Programmer, data analyst

Funding Support: this award

International Collaboration: No
International Travel: No

John Anderson
Email: janderso@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: LTER site manager responsible for data collection, QA/QC, interactions with scientists and visitors on data issues

Funding Support: this award

International Collaboration: No
International Travel: No

Roxanne Chepsongol
Email: rofranke@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: LTER field technician

Funding Support: this award

International Collaboration: No
International Travel: No

Kyle Gename
Email: kgename@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: LTER field technician

Funding Support: this award

International Collaboration: No
International Travel: No

Reza Golgani-Amirkhiz
Email: rgoljani@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 3

Contribution to the Project: Geospatial technician with Debra Peters quantifying grass recovery on wind eroded soils

Funding Support: this award

International Collaboration: No
International Travel: No

Seth Hall
Email: sethahall08@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: LTER field technician

Funding Support: this award

International Collaboration: No
International Travel: No

Charlene Harrison
Email: charhrsn@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: Office support, budget and travel support

Funding Support: NMSU

International Collaboration: No
International Travel: No

Conrad Nelson
Email: cwnelson@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: LTER field technician

Funding Support: this award

International Collaboration: No
International Travel: No

Haneen Omari
Email: hanomari@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: Information management and data QA/QC

Funding Support: NMSU

International Collaboration: No
International Travel: No

Nathan Dylan Burruss
Email: dylanb@nmsu.edu
Most Senior Project Role: Statistician
Nearest Person Month Worked: 12

Contribution to the Project: Statistician modeling alternative state dynamics

Funding Support: this award

International Collaboration: No
International Travel: No

James Darren
Email: darren.james@ars.edu
Most Senior Project Role: Statistician
Nearest Person Month Worked: 3

Contribution to the Project: Information management and statistics

Funding Support: ARS

International Collaboration: No
International Travel: No

Courtney Currier
Email: Courtney.Currier@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Osvaldo Sala

Funding Support: this award

International Collaboration: No
International Travel: No

Eric Escoto
Email: Eric.Escoto@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Osvaldo Sala

Funding Support: Separate NSF fellowship

International Collaboration: No
International Travel: No

Michael Fischella
Email: mfischella@g.ucla.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Gregory Okin

Funding Support: this award

International Collaboration: No
International Travel: No

Mikaela Hoellrich
Email: Mikaela.Hoellrich@rockets.utoledo.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Nicole Pietrasiak

Funding Support: this award

International Collaboration: No
International Travel: No

Samuel Jordan
Email: sam.jordan@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graudate student with Osvaldo Sala

Funding Support: this award

International Collaboration: No
International Travel: No

Zachary Keller
Email: ztkeller@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Graduate student with Enrique Vivoni

Funding Support: this award

International Collaboration: No
International Travel: No

Corey Nelson
Email: cnelso22@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Graduate student with Ferran Garcia-Pichel

Funding Support: this award

International Collaboration: No
International Travel: No

Eli Perez-Ruiz
Email: eperezru@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Enrique Vivoni

Funding Support: Fullbright, Prodep, and CONACYT fellowships

International Collaboration: No
International Travel: No

Julie Rakes
Email: jabethan@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Ferran Garcia-Pichel

Funding Support: this award

International Collaboration: No

International Travel: No

Stacey Scroggs
Email: stpeters@nmsu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 2

Contribution to the Project: Worked for Deb Peters on the analysis of cross-scale connectivity experiment data

Funding Support: this award

International Collaboration: No
International Travel: No

Caroline Toth
Email: ctoth@nmsu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Hanan on shrub community dynamics

Funding Support: this award

International Collaboration: No
International Travel: No

Tyler Grace Turk
Email: Tyler.Turk@colorado.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Akasha Faist

Funding Support: this award

International Collaboration: No
International Travel: No

Grace Smith Vidaurre
Email: gsmithvi@nmsu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Worked for Deb Peters as geospatial technician and app developer as part of the ARS-funded VSV Grand Challenge Project

Funding Support: ARS

International Collaboration: No
International Travel: No

Luis Weber-Grullon
Email: Luis-Weber@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate sutdent with Osvaldo Sala

Funding Support: this award

International Collaboration: No
International Travel: No

Robert Wojcikiewicz
Email: rwojciki@nmsu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Graduate student with Niall Hanan

Funding Support: this award

International Collaboration: No
International Travel: No

Katherine Young
Email: kiy761@nmsu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Worked for Deb Peters on the analysis of above-ground net primary production

Funding Support: this award

International Collaboration: No
International Travel: No

Ronald Treminio
Email: rstremin@nmsu.edu

Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: Worked for Deb Peters to model disease distribution as part of the ARS-funded VSV Grand Challenge Project

Funding Support: ARS

International Collaboration: No
International Travel: No

Elizabeth Vera
Email: emvera@nmsu.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: Worked for Deb Peters supporting the publication of scientific articles and posters

Funding Support: this award

International Collaboration: No
International Travel: No

Paul Stickel
Email: pstickel@email.arizona.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: REU student working with Archer and Hanan

Funding Support: this award

International Collaboration: No
International Travel: No
Year of schooling completed: Junior
Home Institution: University of Arizona
Government fiscal year(s) was this REU participant supported: 2019

Hansen Taylor
Email: tahansen@nmsu.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: REU student working with Hanan and Prihodko

Funding Support: this award

International Collaboration: No
International Travel: No
Year of schooling completed: Junior
Home Institution: New Mexico State University
Government fiscal year(s) was this REU participant supported: 2019

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Arizona State University	Academic Institution	Tempe, AZ
Asombro Institute	Other Nonprofits	Las Cruces, NM
USDA ARS, Jornada Experimental Range	Other Organizations (foreign or domestic)	Las Cruces, NM
University of Arizona	Academic Institution	Tucson, AZ
University of California-Los Angeles	Academic Institution	Los Angeles, CA
University of Illinois	Academic Institution	Urbana-Champaign, IL
University of Texas-El Paso	Academic Institution	El Paso, TX

Full details of organizations that have been involved as partners:

Arizona State University

Organization Type: Academic Institution
Organization Location: Tempe, AZ

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: ASU provides office and lab facilities for Garcia-Pichel, Sala and Vivoni and their students

Asombro Institute

Organization Type: Other Nonprofits
Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Asombro leads JRN K-12 education and outreach programs and operates the Jornada Basin schoolyard LTER program

USDA ARS, Jornada Experimental Range

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Jornada Basin LTER office and several PI offices are housed in the USDA bldg on the NMSU campus. The ARS Experimental Range is the primary location for JRN-LTER field work.

University of Arizona

Organization Type: Academic Institution
Organization Location: Tucson, AZ

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: UA provides office and lab support and salary for Archer and his students

University of California-Los Angeles

Organization Type: Academic Institution
Organization Location: Los Angeles, CA

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: UCLA provides office and lab support and salary for Okin and his students

University of Illinois

Organization Type: Academic Institution
Organization Location: Urbana-Champaign, IL

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: University of Illinois provides office and lab support and salary for Schooley and his students

University of Texas-El Paso

Organization Type: Academic Institution
Organization Location: El Paso, TX

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: UTEP provides office, lab, and salary support for Tweedie and his students

What other collaborators or contacts have been involved?
Nothing to report

Impacts

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

The Jornada Basin LTER project continues to advance understanding and theory of dryland ecosystem functioning, relevant to management, and theory relevant to broader ecological theory. In particular, understanding of state transitions and alternative stable states in practice for drylands and in theory for ecology more broadly.

What is the impact on other disciplines?

Jornada Basin LTER results are directly relevant to livestock and range management across the southwestern USA and other grazing lands globally. JRN collaborations and outreach include impact in a variety of US and international, tropical and temperate drylands.

What is the impact on the development of human resources?

Student training and mentoring opportunities in dryland ecology in Year 1 has included direct support for 12 graduate students and 2 REU students, and participation of a larger number of students attending the Desert Ecology shortcourse and conducting research at the JRN with support from their JRN advisors, home universities, etc. Postdoctoral training and professional development is an integral part of the JRN-LTER program, developing next generation ecological and STEM researchers.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?

Year 1 focus on completion, updating and uploading JRN-LTER datasets has markedly increased visibility and accessibility of JRN-LTER historical and new datasets.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?

Our K-12 outreach program reaches every child in the local school districts and many children in school districts across southern New Mexico and west Texas. Field and classroom programs increase awareness and understanding in the general public with major long-term benefits for environmental and STEM literacy. During Year 1 of the project, 24,322 K-12 students gained increased understanding of the Chihuahuan Desert and research being conducted by LTER scientists. More than 600 students gained skills interpreting and communicating long-term datasets through the Desert Data Jam. 54% of anonymous survey respondents (n=39) said Data Jam participation increased their interest in college studies and/or careers in science.

Changes/Problems

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.

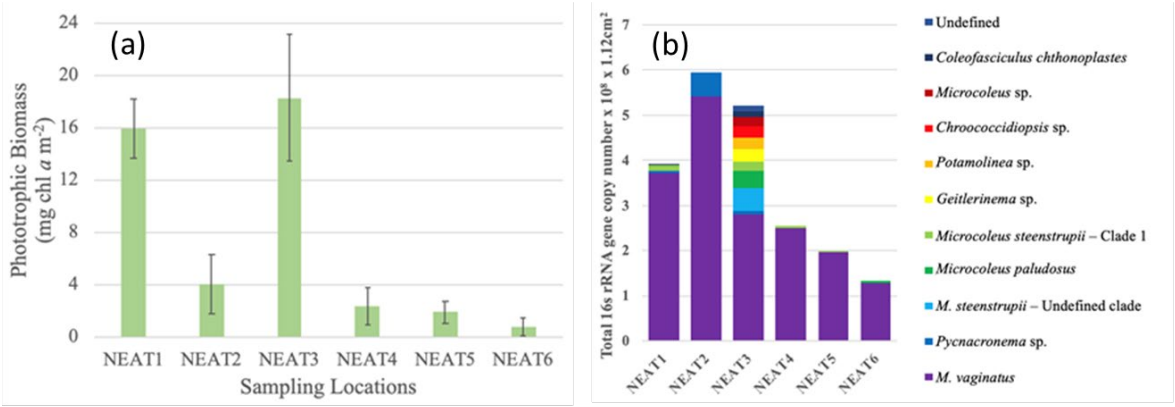

Figure 1: Characterization of remnant biocrust communities at the NEAT experimental site. (a) chlorophyll a concentration in surface crusts, (b) cyanobacterial abundance and community composition (determined using rRNA coupled to q-PCR analysis.

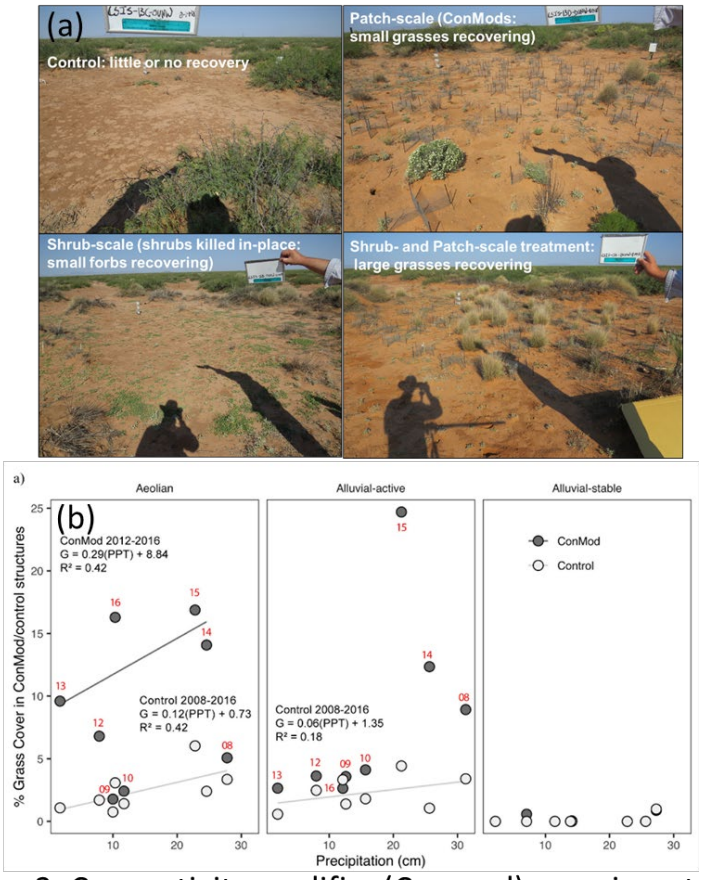

Figure 2: Connectivity modifier (Conmod) experimental results (a) photographs of control, conmod, shrub removal and conmod+shrub removal. (b) impact of conmods in landscapes with contrasting Aeolian and alluvial sediment transport

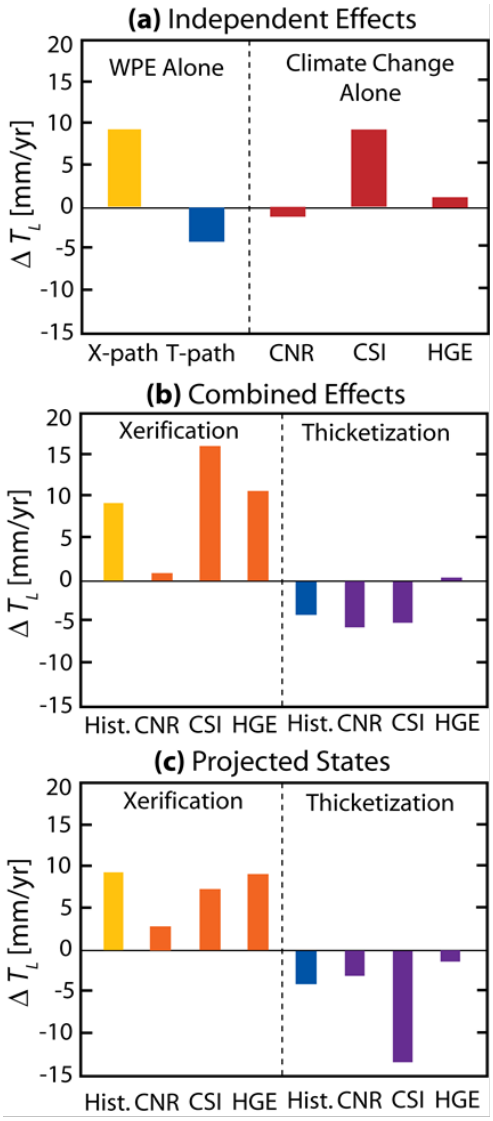

Figure 3. Combined impacts of climate change and woody plant encroachment (WPE) on hydrological transmission losses: Model simulations, using a distributed ecohydrological model in the Tromble Weir watershed that considers both WPE and climate change, to assess impacts in late 21st century. Results indicate that changes in focused channel recharge are determined primarily by the WPE pathway and not by climate change. (a) The difference in the average annual channel drainage term (T_L) between a historical grassland and an encroached shrubland forced with historical climate (left) and grassland under future climate (right). The X-path is the xerification pathway and the T-path is the thicketization pathway, with 3 GCM model (CNRM-CM5 ('CNR'), CSIRO Mk.3.6.0 ('CSI'), or HadGEM2-ES ('HGE')). (b) The difference in the average annual T_L between a historical grassland and two shrubland states forced with historical climate based on NLDAS-2 data ('Hist.') or one of 3 climate change projections, (c) The difference in the average annual T_L between shrubland and grassland when both vegetation states use the same meteorological forcings for historical conditions ('Hist.') or one of the 3 climate change projections.

Schreiner-McGraw et al.,. Woody Plant Encroachment has a Larger Impact than Climate Change on Dryland Water Budgets, *Science Advances*, (In Review).

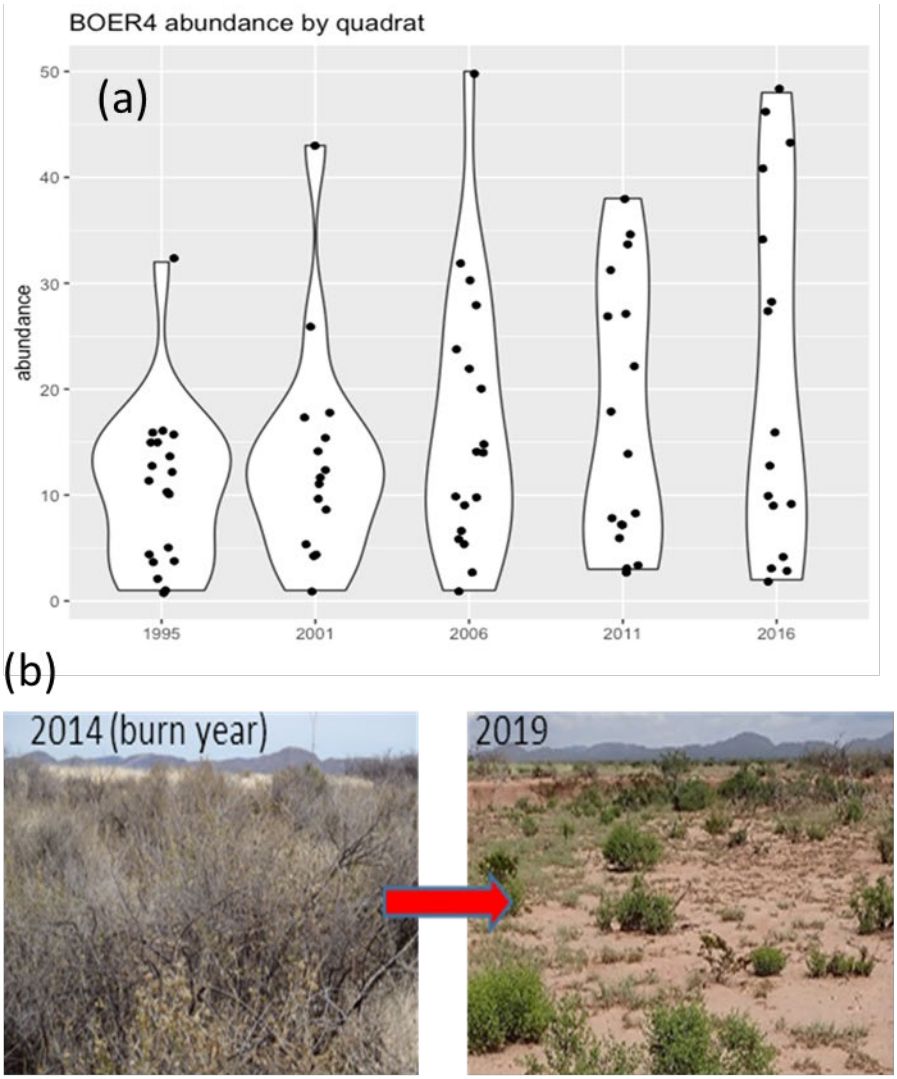

Figure 4: Grassland recovery and restoration approaches in southwest USA grasslands (a) Signs of regional recovery in Black grama (Bouteloa eriopoda) recovery in southwest regional grassland sites. (b) Significant loss of vegetation cover and risk of Aeolian erosion following experimental burn treatments for shrub control.