Sevilleta LTER

Arid and semi-arid ecosystems cover more than 40% of Earth's land surface and are expanding in extent. Due to their fluctuating nature, drylands are excellent settings to investigate the ecological consequences of environmental variability. The Sevilleta (SEV) LTER site represents the convergence of six major North American dryland ecosystems – pinon-juniper woodlands, juniper savannas, riparian cottonwood forests, plains grasslands, and Chihuahuan Desert grasslands and shrublands. Combined, these ecosystems create a powerful opportunity to test how ecosystem structure and function respond to environmental variability and change.

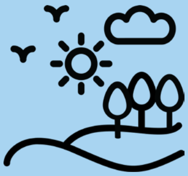
The SEV LTER program spans 30 years of long term data, experiments, specimen archives, and theory. Sevilleta LTER researchers are developing new theories to predict the consequences of environmental variability over space, time, and biological scales and generating the long term data needed to test these predictions. Current research is focused on the question: How do long term trends in climate variability drive the dynamics of dryland ecosystems and transitions among them?

Between 2008-2018:

73 investigators

33 institutions represented

48 graduate students



Mixed Landscape

Principal Investigator:

Jennifer Rudgers

University of New Mexico

Est. 1989

Funding Cycle:

LTER VI

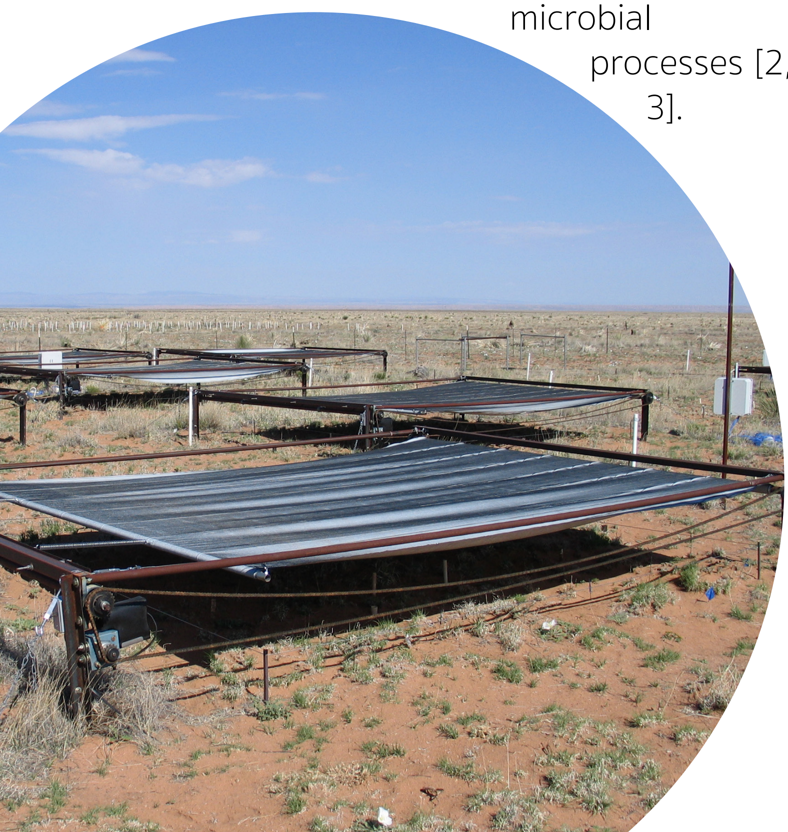
NSF Program:

Biological Sciences / Division of Environmental Biology

Key Findings

Climate variability interacts with average weather conditions. The climate of SEV LTER ecosystems has become drier and more variable during the past 100 years. SEV LTER research is gaining new insight into the biological consequences of these dual climate changes. For instance, increased climate variability has benefitted desert grassland during dry periods but reduced its productivity in wet periods, while plains grassland has been more sensitive to variability during droughts. [Product 1].

Challenging the pulse-reserve paradigm. Pulse-reserve theory has been a dominant conceptual framework for drylands since the 1970s. Detailed long term observations and experiments at the SEV LTER revealed that individual rainfall pulses rarely produce significant reserves and that many ecosystem processes do not "pulse" on the same time scales. SEV LTER researchers have improved pulse-reserve theory with the Threshold Delay Nutrient Dynamics model, which incorporated microbial processes [2, 3].



Causes and consequences of ecosystem state transitions. Groundbreaking interdisciplinary work by SEV LTER researchers has documented biophysical feedbacks at ecosystem boundaries. Key differences in the mechanisms of drought tolerance explained the conversion of pinon woodlands into juniper savannas. Creosote bush promoted nighttime warming that can favor its seedling establishment at grassland-to-shrubland ecotones. State transitions have important consequences for ecosystem climate sensitivity and carbon sequestration. During the past decade, SEV biomes ranged from carbon (C) sources to the atmosphere (~400 g C m^{-2}, desert grassland) to sinks (~1500 g C m^{-2}, pinon-juniper woodland). [4-6]

Conceptual and empirical advances in desert microbial ecology. Researchers at SEV LTER led efforts to characterize fungi and bacteria in drylands and document their responses to environmental change. SEV LTER pioneered new assays of microbial function, including carbon use efficiency and ecoenzymatic stoichiometry. They quantified how microbes in roots maintain plant species coexistence and temporal stability in plant communities and how biological soil crusts affect community and ecosystem dynamics. [7]

Photo credits: Mike Friggens (left), Erika Zambello/U.S. LTER (top and bottom right)

Synthesis

Expanding the range. As one of the few dryland nodes in the Nutrient Network Project, SEV LTER extends the range of inference for understanding relationships among nutrients, biodiversity, and productivity. [8]

Streams and rivers retain nitrogen. SEV LTER researchers studied streams and rivers in central New Mexico as sinks for bioavailable nitrogen. Collaborative work established relationships among nitrate, denitrification, and ecosystem photosynthesis and respiration that are generalizable across biomes. [9]

Long term experiments to improve prediction. Synthesis of chronic resource manipulations at SEV LTER and elsewhere launched a novel, hierarchical conceptual framework for predicting the ecological consequences of global environmental change. [10]

Partnerships

Sevilleta National Wildlife Refuge | Los Alamos National Laboratory | Sandia National Laboratory | University of New Mexico (UNM) | UNM Sevilleta Field Station | UNM Civil, Construction and Environmental Engineering | New Mexico Museum of Natural History and Science | Bosque Ecosystem Monitoring Program

Photo credits: Will Pockman (top); Bosque Ecosystem Monitoring Program (bottom)

Data Accessibility

Sevilleta LTER information management provides high quality, well documented, easily accessible data through the Environmental Data Initiative, with 219 data packages. Partnership with the Museum of Southwestern Biology has established a DNA repository for monitoring long term evolutionary change. Ongoing projects are building new interfaces with genomic and museum databases as well as publicly accessible model and statistical code.

Broader Impacts

STEM workforce development. Sevilleta LTER recruits and trains a diverse STEM workforce through activities such as distributed graduate seminars and a data analysis course, course-based undergraduate research modules, collaborative teaching with the Southwestern Indian Polytechnic Institute, and an REU Site program.

Partnering with federal land managers. Sevilleta LTER partners with the Sevilleta National Wildlife Refuge, which receives 13,000 visitors per year. Collaboration with land managers occurs at local, regional, and national levels and informs prescribed fire, climate forecasts, disease outbreaks, and wildlife management.

Schoolyard data informs land and river management. Sevilleta LTER partners with the Bosque Ecosystem Monitoring Program (BEMP) to reach 9,000-10,000 participants each year (55% Hispanic, 11% Native American). Combining long term scientific research with educational outreach, BEMP engages K-12 students and their teachers in hands-on monitoring of the riparian forest (or bosque) of the Rio Grande. Data collected by K-12 and university students are used by federal and state agencies, including the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, City of Albuquerque Open Space, and Mid Rio Grande Stormwater Quality Team to inform multimillion dollar management decisions.

Top Products

1. Rudgers, JA et al. 2018. Climate sensitivity functions and net primary production: A framework for incorporating climate mean and variability. **Ecology.** doi: 10.1002/ecy.2136
2. Thomey, ML et al. 2011. Effect of precipitation variability on net primary production and soil respiration in a Chihuahuan Desert grassland. **Global Change Biology.** doi: 10.1111/j.1365-2486.2010.02363.x
3. Collins, SL et al. 2008. Pulse dynamics and microbial processes in arid ecosystems. **Journal of Ecology.** doi: 10.1111/j.1365-2745.2008.01362.x
4. McDowell, N et al. 2008. Mechanisms of plant survival and mortality during drought. **New Phytologist.** doi: 10.1111/j.1469-8137.2008.02436.x
5. Turnbull, L et al. 2008. A conceptual framework for understanding semi-arid land degradation: ecohydrological interactions across multiple-space and time scales. **Ecohydrology.** doi: 10.1002/eco.4
6. Anderson-Teixeira, KJ et al. 2011. Differential responses of production and respiration to temperature and moisture drive carbon balance across a climatic gradient in New Mexico. **Global Change Biology.** doi: 10.1111/j.1365-2486.2010.02269.x
7. Sinsabaugh, RL et al. 2008. Stoichiometry of soil enzyme activity at global scale. **Ecology Letters.** doi: 10.1111/j.1461-0248.2008.01245.x
8. Adler, PB et al. 2011. Productivity is a poor predictor of plant species richness. **Science.** doi:10.1126/science.1204498
9. Mulholland, PJ et al. 2008. Stream denitrification across biomes and its response to anthropogenic nitrate loading. **Nature.** doi:10.1038/nature06686
10. Smith, MD et al. 2009. A framework for assessing ecosystem dynamics in response to chronic resource alterations induced by global change. **Ecology.** doi:10.1890/08-1815.1

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