

Colin W. Bell, Ph.D.

Research Ecologist

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Professional Preparation:

Ph.D., Department of Biology completed 12/2009

Texas Tech University

Ph.D. Dissertation: Long-term responses of soil microbial community structure and function to changes in precipitation in a Chihuahuan Desert Grassland: Implications toward understanding global climate change

Master's Program, Department of Microbiology 06/2004-12/2007

Texas Tech University (transferred to Ph.D. Program in 2007)

B.A., General Studies completed 05/1998

Texas Tech University

Appointments:

Natural Resource Ecology Laboratory, Colorado State University

Postdoctoral Research Associate 08/2011 – PRESENT

USDA-Agriculture Research Services, Cropping Systems Research Laboratory

Biological Scientist- GS-11 01/2011 – 08/2011

USDA- Forest Service, Rocky Mountain Research Station

Postdoctoral Research Associate 06/2010 – 12/2010

Department of Biological Sciences, Texas Tech University

Adjunct Research Faculty 01/2011 – present

Post-Doctoral Research Associate 01/2010 – 12/2010

Graduate Teaching Assistant 09/2004 - 05/2009

CH Robinson Worldwide Logistics

Branch Sales Manager 01/2000-05/2003

Logistics Operations Associate 07/1998-12/1999

Research Focus:

My research focuses primarily on soil microbial taxonomic and functional responses to climate variability. Long-term research efforts include soil microbial responses to increased precipitation variability in the Chihuahuan desert grasslands in BBNP. I have also conducted long-term studies in agroecosystems in the Texas High Plains in order to assess crop-sustainability issues regarding soil-functional responses to different cropping-management practices. More recent efforts have focused on understanding how changes in precipitation may offset the C-balance of Piñon-Juniper woodlands in the northern Chihuahuan Desert region at the Sevilleta LTER site. I have most recently joined the collaborative research efforts at the PHACE experimental site in Wyoming. The goal of this project is to characterize the effects of elevated temperatures and atmospheric CO₂ on the metabolic and physiological characteristics of rhizosphere-associated microbes and plant communities in this mixed grass prairie. My primary research over the past eight years has involved a long-term multidisciplinary study, in which biological, chemical, and physical characteristics of soils were measured to elucidate soil-microbial and plant responses to climate variability in a mid-elevation Chihuahuan Desert grassland watershed ecosystem in Big Bend National Park. More specifically, my research efforts focused on determining the long-term impacts of climate change (i.e. changes in precipitation frequency and timing) on soil microbial biodiversity and ecosystem functional dynamics. These data are critical to elucidate how changes in precipitation and soil temperature may alter critical land-management decisions in Big Bend. I am also extremely interested in expanding my research efforts into woodland, lotic (i.e. biotic and physical-habitats of streams), and agro-ecosystems in response to climate change. I look forward to engaging in research determining how differing ecosystems will respond to climate change for purposes of developing more sustainable restoration and management practices.

Publications:

1. Arnosti, C., **C. Bell**, D.L. Moorhead, R.L. Sinsabaugh, A.D. Steen, M. Stromberger, M. Wallenstein, and M.N. Weintraub, Extracellular enzymes in terrestrial, freshwater, and marine environments: perspectives on system variability and common research needs. *Biogeochemistry*, 2013: p. 1-17.
2. **Bell, C.**, Y. Carrillo, C.M. Boot, J.D. Rocca, E. Pendall, and M.D. Wallenstein, Rhizosphere stoichiometry: Are C:N:P ratios of plants, soils, and enzymes conserved at the plant species-level? . *New Phytologist*, 2013. in press.

3. **Bell, C.**, D.T. Tissue, M.E. Loik, M.D. Wallenstein, V. Acosta - Martinez, R.A. Erickson, and J.C. Zak, Soil microbial and nutrient responses to seven years of seasonally altered precipitation in a Chihuahuan Desert grassland. *Global Change Biology*, 2013. in press.
4. **Bell, C.W.**, B.E. Fricks, J.D. Rocca, J.M. Steinweg, S.K. McMahon, and M.D. Wallenstein, High-throughput fluorometric measurement of potential soil extracellular enzyme activities. *J. Vis. Exp.*, 2013. doi: 10.3791/50961.
5. Nie, M., E. Pendall, **C. Bell**, C.K. Gasch, S. Raut, S. Tamang, and M.D. Wallenstein, Positive climate feedbacks of soil microbial communities in a semi-arid grassland. *Ecology Letters*, 2013. 16(2): p. 234-241.
6. Nie, M., E. Pendall, **C. Bell**, and M.D. Wallenstein, Soil aggregate size distribution mediates microbial climate change feedbacks *Soil biology & biochemistry*, 2013. in press.
7. Wallenstein, M., M. Stromberger, and **C. Bell**, Bridging the gap between modelers and experimentalists. *Eos Trans. AGU*, 2012. 93(32).
8. Acosta-Martínez, V., **C.W. Bell**, B.E.L. Morris, J. Zak, and V.G. Allen, Long-term soil microbial community and enzyme activity responses to an integrated cropping-livestock system in a semi-arid region. *Agriculture, Ecosystems & Environment*, 2010. 137(3-4): p. 231-240.
9. Acosta-Martínez, V., S.E. Dowd, **C.W. Bell**, R. Lascano, J.D. Booker, T.M. Zobeck, and D.R. Upchurch, Microbial Community Composition as Affected by Dryland Cropping Systems and Tillage in a Semiarid Sandy Soil. *Diversity*, 2010. 2(6): p. 910-931.
10. **Bell, C.W.**, V. Acosta-Martinez, N. McIntyre, S. Cox, D.T. Tissue, and J.C. Zak, Linking microbial community structure and function to seasonal differences in soil moisture and temperature in a Chihuahuan Desert grassland. *Microbial Ecology*, 2009. 58(4): p. 827-842.
11. Patrick, L., K. Ogle, **C.W. Bell**, J.C. Zak, and D.T. Tissue, Physiological responses of two contrasting desert plant species to precipitation variability are differentially regulated by soil moisture and nitrogen dynamics. *Global Change Biology*, 2009. 15(5): p. 1214-1229.
12. Robertson, T.R., **C.W. Bell**, J.C. Zak, and D.T. Tissue, Precipitation timing and magnitude differentially affect aboveground annual net primary productivity in three perennial species in a Chihuahuan Desert grassland. *New Phytologist*, 2009. 181(1): p. 230-242.

13. **Bell, C.W.**, N.E. McIntyre, S.B. Cox, D.T. Tissue, and J.C. Zak, Soil Microbial Responses to Temporal Variations of Moisture and Temperature in a Chihuahuan Desert Grassland. *Microbial Ecology*, 2008. 56(1): p. 153-167.

Ph.D. Dissertation:

TITLE:

Long-term responses of soil microbial community structure and function to changes in precipitation in a Chihuahuan Desert Grassland: Implications toward understanding global climate change (Supervised by Dr. John Zak, Department of Biological Sciences; Texas Tech University)

ABSTRACT:

Global climate models predict increased temperature and precipitation variability in arid regions throughout southwestern North America within the next century, resulting in fewer rain events of greater magnitudes and longer periods between rain events. Longer inter-pulse periods coupled with increased air temperature can greatly reduce soil moisture availability. Few efforts have directly assessed the role of precipitation-pulse shifts in regulating long-term functional- and structural soil-microbial community responses over more than a couple of years. This research examined soil microbial and edaphic responses to climate model predictions of 25% increased seasonal rainfall applications over a 7-year period between 2002-2008 to determine long-term soil microbial responses to climate change with respect to variable rainfall in a Chihuahuan Desert Grassland at Big Bend NP. We hypothesized that over time, these minor but realistic increases in moisture would produce a measurable accumulative change in microbial, biogeochemical, and edaphic properties. We used 454 molecular pyrosequencing and fatty acid methyl ester techniques, in which microbial communities were classified as bacterial (gram-negative, gram-positive, and actinomycetes) and fungal (saprophytic fungi and arbuscular mycorrhiza) to characterize the soil microbial community structure in this desert grassland. Microbial functional responses were characterized using carbon substrate utilization and enzymic activities. By the fourth year of this study, increases in moisture (25% additions based on climate change predictions) produced cumulative changes in soil microbial, biogeochemical, and edaphic properties; as the relative abundances of saprophytic fungi, AM fungi, and gram negative bacteria, and soil exoenzymes β -Glucosidase (responsible for cellulose degradation) and

Phosphodiesterase (responsible for phosphorus mineralization) displayed elevated levels in the summer + winter watering plots. Once microbial responses were elicited in response to increased moisture, changes in microbial community structure and function persisted throughout the duration of the study (2006-2008), irrespective of ambient rainfall variability over the succeeding years. In conclusion, as soil microbes encounter altered precipitation amounts and timing along with increased soil temperatures predicted for this region, the ability of the soil microbial community to maintain functional resilience may be drastically altered in this Chihuahuan Desert ecosystem. However, these results may suggest that although different components of the soil-microbial community respond differently to seasonal temperature and precipitation, they may be able to facilitate similar ecosystem functional roles.

Synergistic Activities:

Workshop Co-Organizer (05-10/2013): Enzymes in the Environment RCN and TerraGenome RCN joint Workshop: held at the 5th Annual Argonne Soil Metagenomics Meeting, October 2–4, 2013

Guest Editor (10/2012-present): Biogeochemistry special issue: Incorporating Enzymes and Microbial Physiology into Biogeochemical Models,

Organizational committee (01/2013-present): 4th Annual Summer Soil Institute at Colorado State University, July 7-20, 2013

Workshop Co-Organizer and Director (01-05/2012): 2nd International Enzymes in the Environment RCN workshop focused on “Incorporating Enzymes and Microbial Physiology into Biogeochemical Models, May 15-18, 2012

Professional Conference Presentations:

1. Plant species-specific stoichiometry of soil nutrients and extracellular enzymes in a semi-arid grassland ecosystem; Ecological Society of America, Minneapolis, MN, 08/2013
2. Plant rhizosphere species-specific regulation of extracellular enzyme and microbial community stoichiometry; American Geophysical Union, San Francisco, CA, 12/2012
3. Long-Term Responses of Soil Microbial Community Structure and Function to Changes in Precipitation in a Chihuahuan Desert Grassland: Impacts Towards Understanding Soil Responses to Global Climate Change; Ecological Society of America, Pittsburgh, PA, 08/2010
4. Linking microbial community structure and function to seasonal differences in soil moisture and temperature in a Chihuahuan Desert grassland; Implications toward understanding the effects of Global Climate Change; Ecological Society of America, Albuquerque, NM, 08/2009
5. Microbial functional response to variable soil moisture inputs as predicted by GCM's in the Sotol Grasslands of Big Bend National Park; Soil Ecology Society Biannual Meeting, Moab, UT, 05/2007
6. Microbial carbon and nitrogen mineralization dynamics in desert grassland soils of Big Bend NP as influenced by Global Climate Change; Ecological Society of America, Memphis, TN, 08/2006
7. Soil microbial functional responses to increased precipitation in the Sotol Grasslands of Big Bend National Park; Soil Ecology Society Biannual Meeting, Argonne National Laboratories, 05/2005
8. Microbial responses to Global Climate Change scenarios of increased precipitation in the Sotol Grasslands of Big Bend National Park; Fourth Annual Texas Tech Graduate Student Research Poster Competition, 04/2005
9. Microbial responses to increased precipitation as predicted by GCM's in the Sotol Grasslands of Big Bend National Park; Sixth Symposium on the Natural Resources of the Chihuahuan Desert Region, Sul Ross State University, 10/2004

Funding (Grant Proposals and Student Fellowships):

Current

- TITLE: Identifying and assessing the impacts of nitrogen deposition in Big Bend National Park
 - Source of Support: Air Resources Division, NPS; Total Award Amount: \$90,000; Total Award Period: 09/01/2011 – 08/31/2014 (Co-PI)
- TITLE: Plant-microbe interactions: Visualizing plant species – specific effects on soil microbial communities
 - Source of Support: WCNR-CSU; Total Award Amount: \$10,000; Total Award Period: 01/01/2012 – 12/31/2012, (PI)

Pending

- TITLE: Reverse-engineering the rhizosphere: Can plant-microbe-soil feedbacks be exploited to restore degraded ecosystems and prevent invasion by Cheatgrass (*Bromus tectorum*)?
 - Source of Support: DoD; Total Award Amount: \$1.4M; Total Award Period: 09/01/2013 – 08/31/2016, (Postdoctoral Research Personnel)
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- TITLE: Enabling science to assist stakeholders and decision-makers in managing water resources in a changing world: an integrated approach – WSC Category 1
 - Source of Support: NSF; Total Award Amount: \$149,733; Total Award Period: 09/01/2010 – 08/31/2011, (Co-PI)

Past

- TITLE: Helen-DeVitt Jones Graduate Fellowship
 - Source of Support: Helen-DeVitt Jones Foundation; Total Award Amount: \$3500/yr., Total Award Period: 09/2008- 08/2010

Areas of Research Interest:

Quantification of Ecosystem Function Dynamics in Response to Climate Change

- Soil Microbial and Plant Biodiversity Responses to Climate Variability
- Biogeochemical Cycling
- Plant-Microbe Interactions
- Riparian and Lotic Responses to Climate Variability

Laboratory Experience:

Natural Resource Ecology Laboratory	08/2011-Present
USDA ARS, Soil Microbiology and Biochemistry Lab	01/2005-082011
Department of Microbiology, Texas Tech University	01/2004-05/2010

- Measurement of the microbial biomass C and N to provide indices of soil microbial population size in soils from different regions under different management.
- Characterization of the microbial community structure in soils from different regions using fatty acid methyl ester (FAME) methods.
- Characterization of microbial functional diversity using Biolog (GN2) and Fungilog (SFN2) microplates (redox technology) for heterotrophic microbial community structure characterization in soils according to the C source utilization patterns among soil samples.
- Assay methods to determine several enzyme activities involved in C, N, P, and S cycling in soils
- Analytical methods to study the chemistry and biochemistry of N, S and P reactions and transformations in soils.
- Analyses of soil C and N using different chemical methods, or instrumentation such as the Carlo Erba NA 1500 (carbon and nitrogen content of soil).

- Familiar with most methods and equipment (HPLC, IC, GC) used in microbiology, soil chemistry, and soil biochemistry research.
- Culture based microbiological techniques for bacteria and fungi (staining techniques, aseptic techniques, biochemical tests for identification of bacteria, fungal taxonomy, etc).
- Analyses of soil pH, soil organic matter, N mineralization *in vitro* incubation methods under aerobic incubation.
- Experience with the application and statistical analysis of molecular biological techniques for soil microbial characterization: DNA extraction, PCR, DGGE, and 454 pyrosequencing.

Research Experience:

- **Prairie Heating and CO₂ Enrichment (PHACE) Experiment** 08/2011 - PRESENT
 - Microbial response to climate change; plant microbial interactions
 - Lab: Matt Wallenstein, Natural Resource Ecology Laboratory - CSU
 - Role: Postdoctoral Research Associate
- **Pinion-Juniper Core Site LTER**; 06/2010 – 12/2010
 - Ecophysiology / Ecosystem carbon budget analysis
 - Lab: Mike Ryan, USFS-RMRS
 - Role: Postdoctoral Research Associate
- **Pine Canyon Experimental Watershed**, BIBE, TX: 10/2003 – 12-2010
 - Soil Microbial and Plant Ecosystem Functional Responses to Climate
 - Lab: John Zak, Texas Tech University
 - Role: Postdoctoral Research Associate
- **Canyonlands National Park, UT**: 09/2009
 - Long-term Biodiversity Assessment of Soil Microbial Crusts and Plant Communities
 - Lab: Jayne Belnap, USGS Biological Research Division
 - Role: Volunteer

- **Verde Watershed, Camp Verde AZ: 10/2009**
 - Lab: Anne Brasher, USGS Water Resources Division
 - Complete Biotic and Abiotic Assessment of Verde River Watershed
 - Role: Volunteer

Teaching Experience:

Texas Tech University - Department of Biological Sciences

Graduate Teaching Assistant

01/2004-12/2009

- BIOL 1403 (General Biology for majors):
 - Enrollment as a freshman requires a minimum composite SAT reading plus math total of 1100, or a minimum composite ACT score of 24, or a minimum AP Biology score of 3. Fundamentals of molecular biology, cell biology, genetics, and evolutionary theory. First semester of an integrated course recommended for students majoring in biological sciences or related disciplines. Partially fulfills Core Natural Sciences requirement. (Writing Intensive)
- MBIO 3400 & 3401 (Microbiology for non-majors and majors):
 - Prerequisite 3400: 3 hours of introductory biology. Introduction to the morphology, physiology, and activities of bacteria, fungi, and viruses. Primarily for students of agriculture, food and nutrition, animal science, secondary education, nursing, and others seeking an advanced science elective. May not be applied to degree requirements for biological sciences majors
 - Prerequisite 3401: BIOL 1401 and 1402 or BIOL 1403 and 1404; CHEM 3305 as pre- or co-requisite. Advanced morphology, physiology, and classification of microorganisms
- MBIO 4401 (Microbial Ecology):
 - Prerequisite: MBIO 3401 and BIOL 3309. An examination of the population and community ecology of bacteria and fungi, and the roles of these organisms in ecosystem processes

Professional Organizations:

American Society of Microbiology ASM	01/2004-PRESENT
Ecological Society of America ESA	01/2005- PRESENT
Soil Ecology Society SES	01/2005- PRESENT
Texas Branch of the American Society for Microbiology	01/2004- PRESENT
▪ President, Lubbock Chapter	01/2007-01/2008
▪ Student Organization Representative	01/2006-01/2007
Texas Tech University Association of Biologists TTUAB	09/2004-08/2005
Gold Key International Honor Society	09/2009- PRESENT

Past Professional Experience & Training:

Branch Sales Manager - CH Robinson Worldwide Logistics (01/2000-05/2003)

Logistics Management Associate (06/1998-12/1999)

- Tasks Performed: Management: Branch Sales Manager for a Fortune 500 company; Sales: Outside and inside sales, operations, and training; Marketing: Market research, annual business plan, annual budget; Leadership: Outside sales, sales trainer, new employee trainer, etc.; Presentations, annual budgets, customer correspondence