Water Resources:
Water, Land & Life Research

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Critical Zone Hydrology

- **Dr. Hannes Bauser**
- Assistant Professor
- Department of Geoscience
- Email: hannes.bauser@unlv.edu
- Website: https://geoscience.unlv.edu/people/department-faculty/hannes-bauser/

Expertise

- Vadose Zone Hydrology and Soil Physics
- Hydrologic Modeling
- Data Assimilation
- Machine Learning

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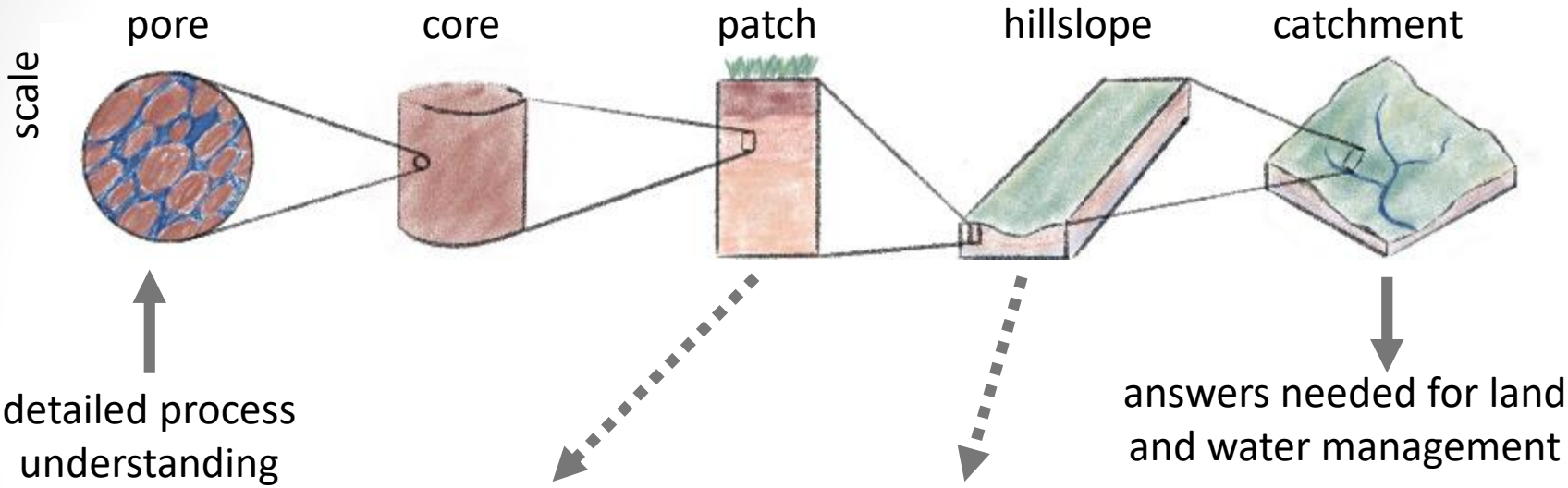
Hydrologic Scaling Challenge



Collaboration with the Desert Research Institute for access to the SEPHAS Lysimeters in Boulder City.

Collaboration with the University of Arizona for access to the Landscape Evolution Observatory at Biosphere 2.

How can we use data science (e.g., data assimilation, machine learning) to combine process understanding and data to solve the hydrologic scaling challenge?

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Dr. Dale Devitt
Professor
Director - Center for Urban Water Conservation
School of Life Sciences
Phone 702-895-4699

Expertise

Soil Plant Water Relations
Water Management
Evapotranspiration
Salinity

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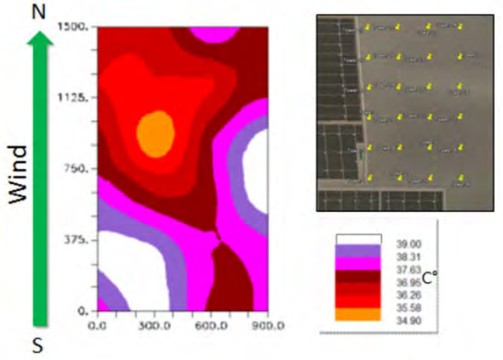
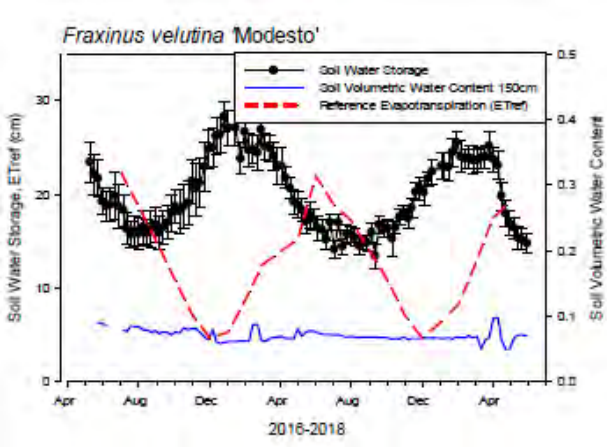
Current Research

- Assessing the impact of large scale solar development on desert ecosystems.



- Tree grass water use tradeoffs in urban landscapes



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10 acre research facility in North Las Vegas dedicated to conducting applied and basic water related research.

Response (growth, flower and seed production) of desert perennial shrubs to altered precipitation

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Aqueous Geochemistry and Astrobiology

- **Dr. Elisabeth (Libby) Hausrath**
- Professor
- Department of Geoscience
- Email: Elisabeth.Hausrath@unlv.edu
- Website: https://hausrath.faculty.unlv.edu/

Expertise

- Using laboratory experiments, field work, and modeling to interpret water-rock interactions and soil-forming processes on Earth and Mars
- Interpreting the signatures of past aqueous and biological impacts on minerals
- Participating Scientist on the Mars Science Laboratory Curiosity and the Mars2020 rover Perseverance and member of the Network for Life Detection (NFOLD) Steering Committee..

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Holes made by sampling soil on Mars

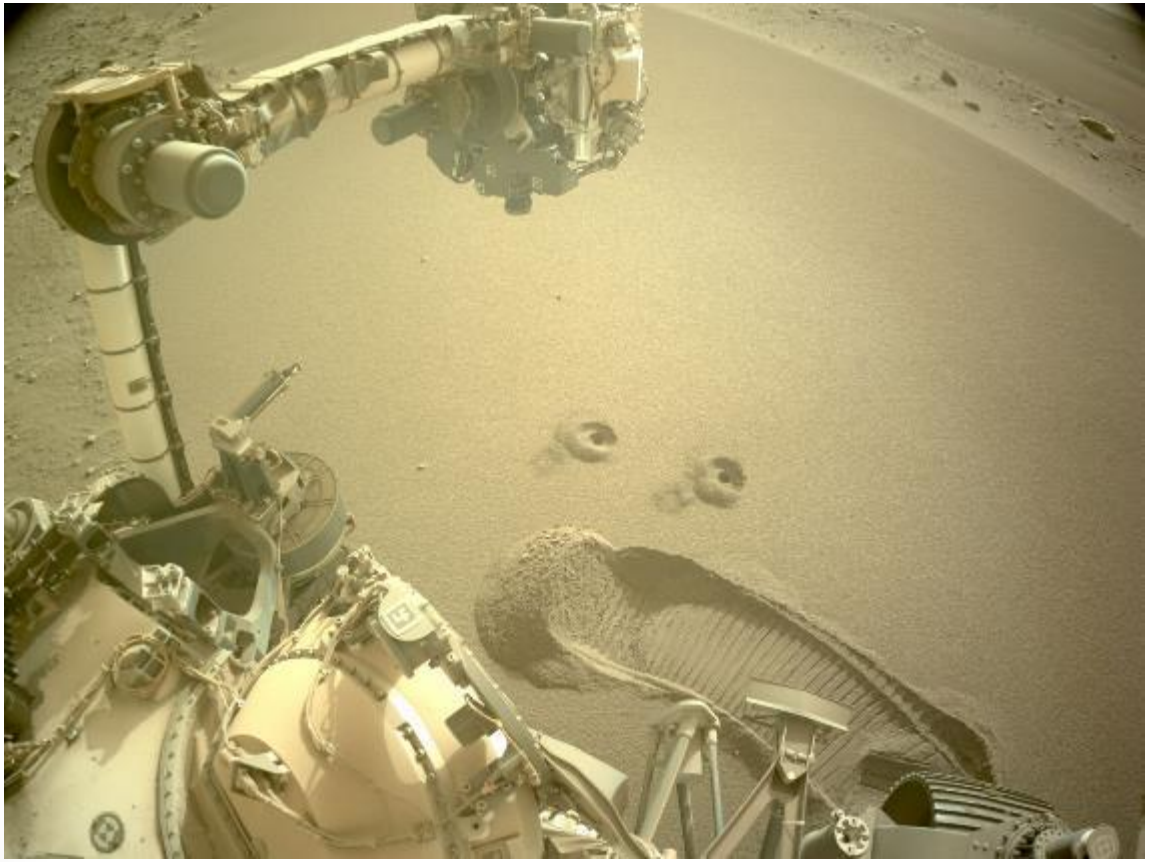

Image credit: NASA/JPL-Caltech

https://mars.nasa.gov/news/9311/nasas-perseverance-rover-gets-the-dirt-on-mars/#:~:text=The%20mission's%20first%20two%20samples,prepare%20for%20future%20missions%20there.

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Sedimentary Geology

Dr. Ganqing Jiang
Professor
Department of Geoscience
Phone: (702) 895-2708
Email: Ganqing.Jiang@unlv.edu

Expertise:
Sequence and chemostratigraphy
sedimentology
Carbonate diagenesis

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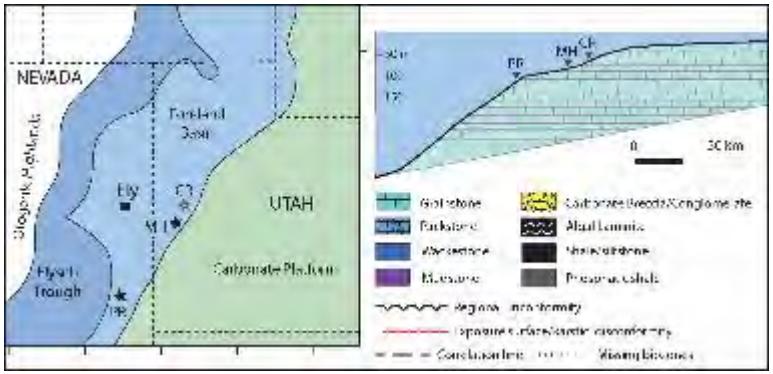
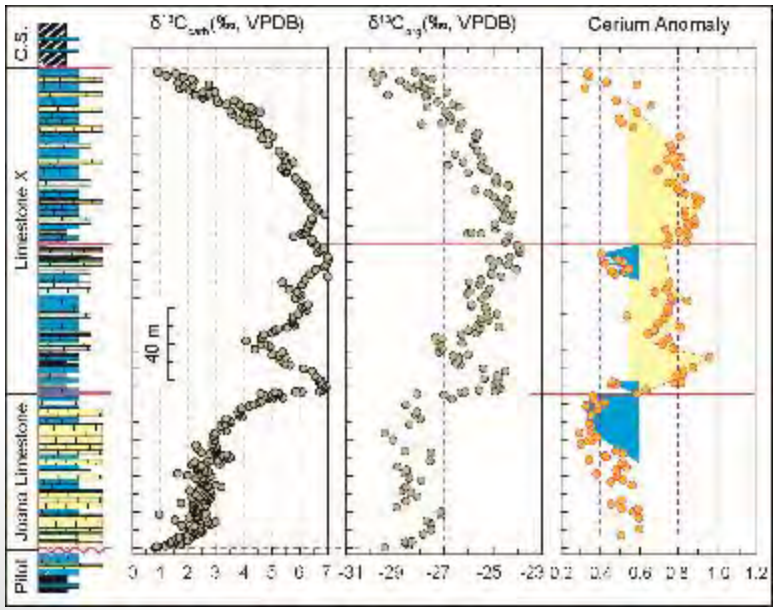
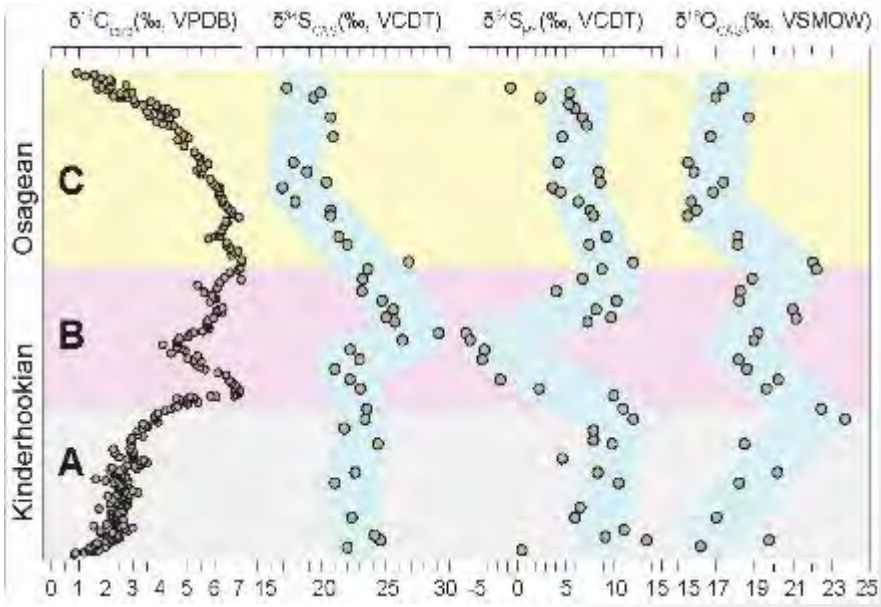
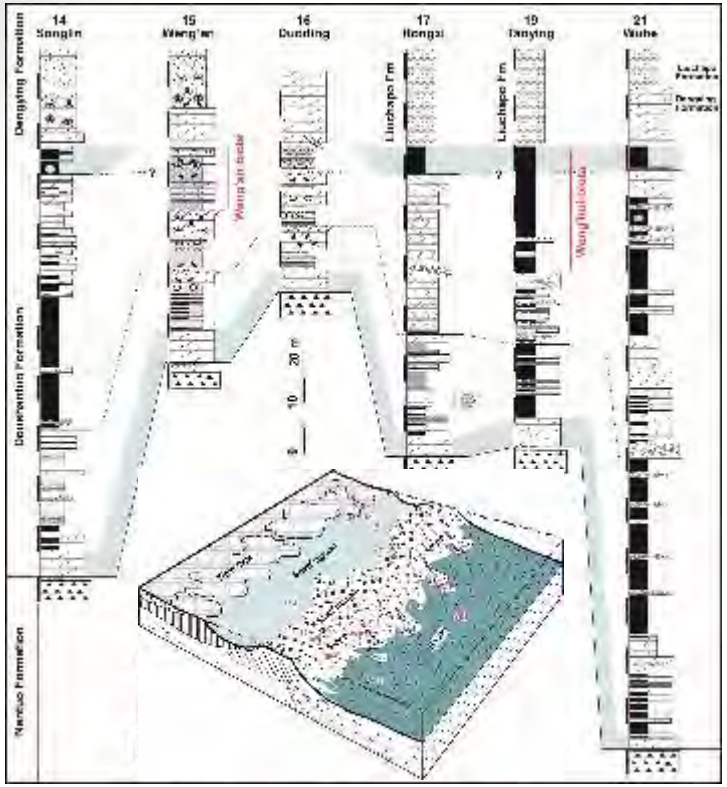
- Sequence and chemostratigraphy
- Paleogeographic reconstruction
- Applications of stable isotopes and rare earth elements
- Paleoenvironmental change across major perturbations of the carbon cycle and mass extinctions

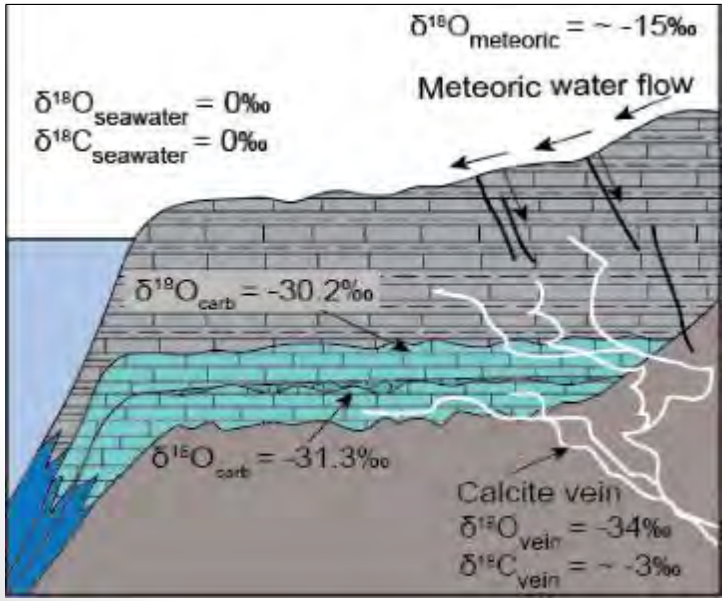








- Basin analyses and paleoceanography
- Fluid migration and carbonate diagenesis
- Tracing fluid migration in sedimentary basins using stable isotopes and trace elements
- Carbonate aquifer



Climate Science and Paleoclimatology

Matthew S. Lachniet

Professor

Department of Geoscience

Phone 702-895-4388

Matthew.Lachniet@unlv.edu

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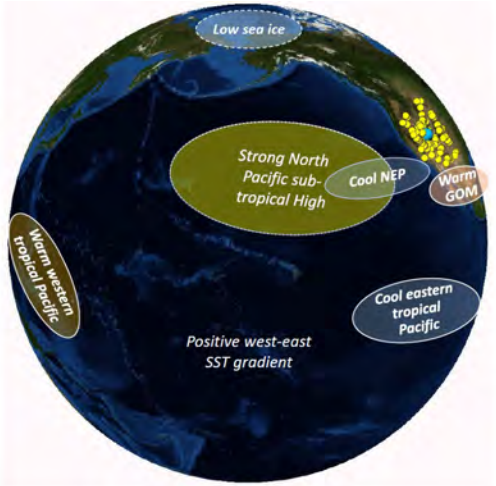
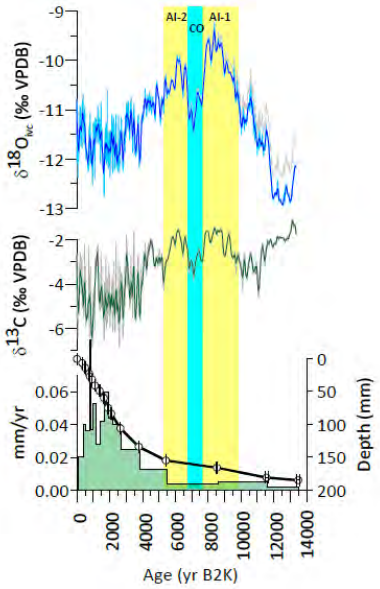
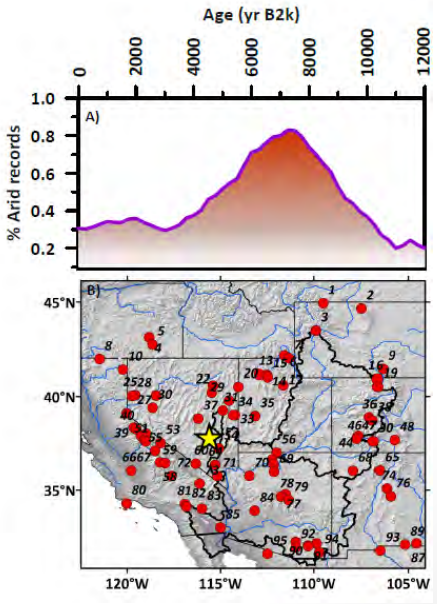
Paleoclimatology

- Study of the causes, timing, and consequences of climate change on timescales ranging from decades to millennia
- Cause of aridity in the Great Basin and Western United States
- Influence of ocean temperatures on precipitation in Nevada
- Cave archives of past climate with sites in Nevada, Mexico, Central America, and elsewhere







Hydrology

Dr. Michael Nicholl
Department of Geoscience
Phone: (702) 895-4616
Email: michael.nicholl@unlv.edu

Expertise:
Unsaturated zone hydrology
Fractured rock hydrology
Environmental fluid mechanics

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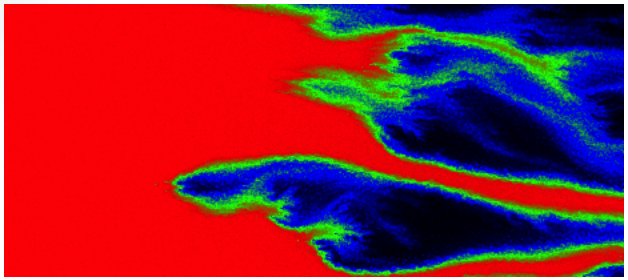
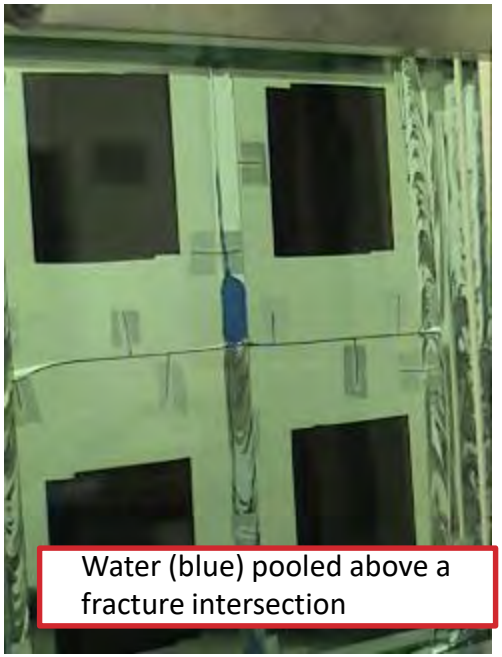
Fractured Rock Hydrology



False color image of a miscible displacement experiment in a single fracture



Water (blue) pooled above a fracture intersection

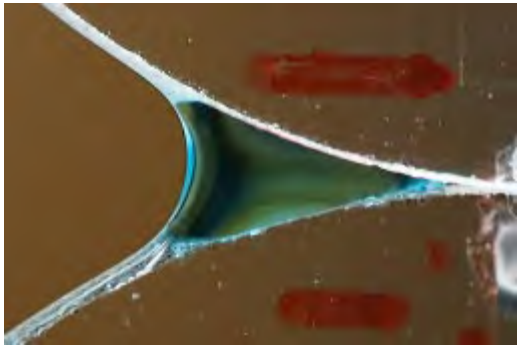
Field mapping of fracture networks
blue dye (right foreground) is from an infiltration test

Isothermal flow across a single rock fracture (matrix-to-matrix flow)

- Two-phase flow and transport in fractured rock
- Laboratory experimentation, field mapping, numerical simulations
- Contaminant transport, geothermal energy, enhanced petroleum recovery

Unsaturated Porous Media

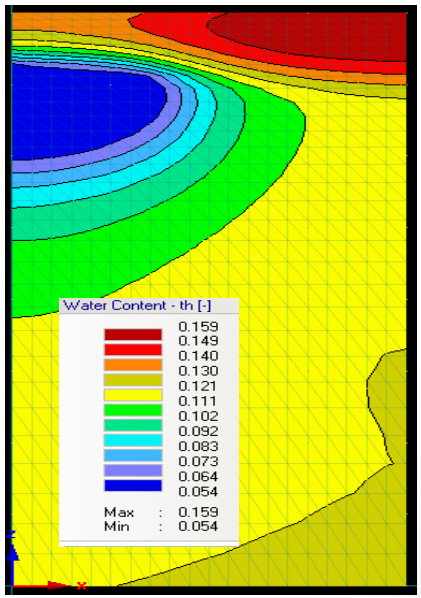
Seepage through gravel-sized capillary barrier materials



Millimeter-scale transport experiment

Hydraulic conductivity of a rock slab

Sampling Chloride as a proxy for root-driven horizontal flow



2D simulation of root-driven transport

- Challenging existing conceptual models for unsaturated and two-phase flow
- Design and execution of critical laboratory/field/numerical experiments

Environmental Geochemistry

Dr. Zach Perzan

- Assistant Professor
- Department of Geoscience
- Email: zach.perzan@unlv.edu
- Website: https://zperzan.github.io/

Expertise

- Environmental geochemistry
- Surface water-groundwater hydrology
- Machine learning
- Uncertainty quantification
- Managed aquifer recharge

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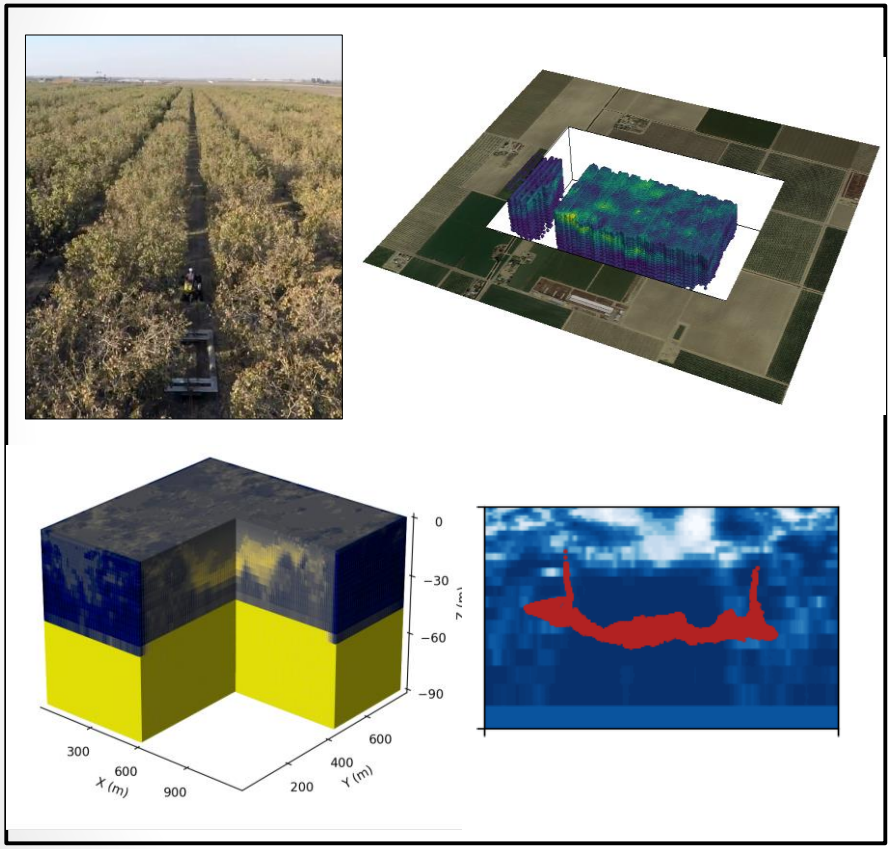
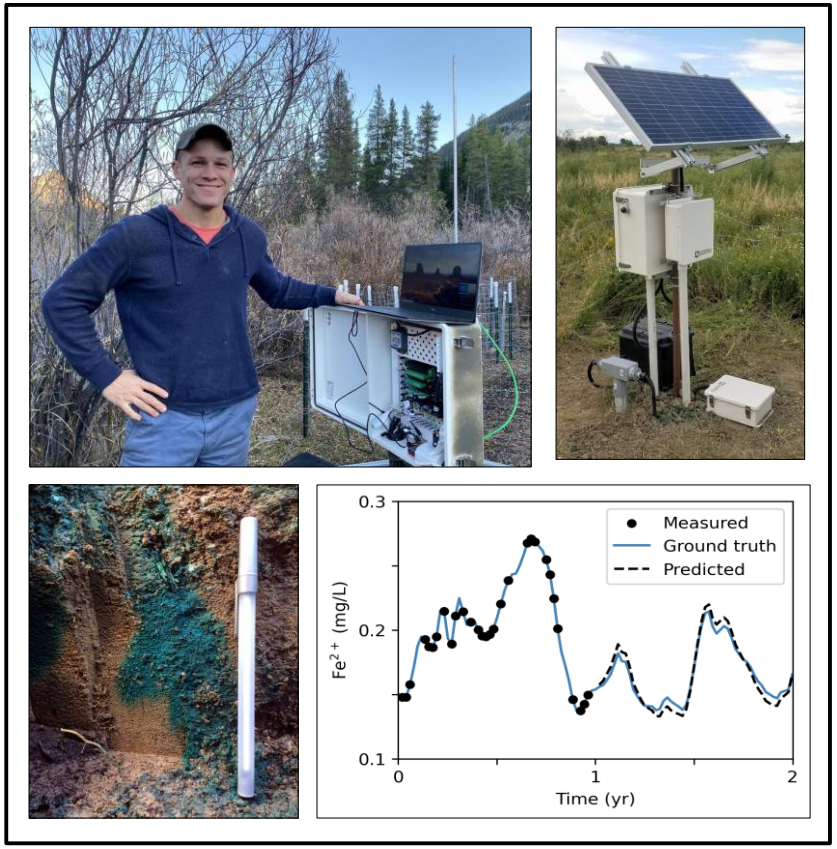
Understanding how hydrologic extremes (droughts and floods) impact water quality

Managed aquifer recharge



Geophysical surveys (top left) give us a 3D image of the distribution of sand, silt and clay within the subsurface (top right). We can then use hydrologic and geochemical models to understand how water (bottom left) and contaminants (bottom right) move through these sediments during a flood.

Floodplain biogeochemistry



Sensor arrays deployed in Colorado (top left) and Wyoming (top right) allow us to monitor sudden changes in water quality during floods. By pairing these with field experiments – such as tracer tests (bottom left) – we can develop data-driven water quality forecasts (bottom right).

Dryland ecology, hydrology and climate dynamics

Dr. Matthew Petrie
Assistant Professor
School of Life Sciences
ph: 702-895-5844
e: matthew.petrie@unlv.edu

Expertise:

Vegetation ecology and near-surface hydrology
Forest regeneration
Climate dynamics and climate change forecasting
Extreme events
Landscape ecology
Manipulative field experimentation

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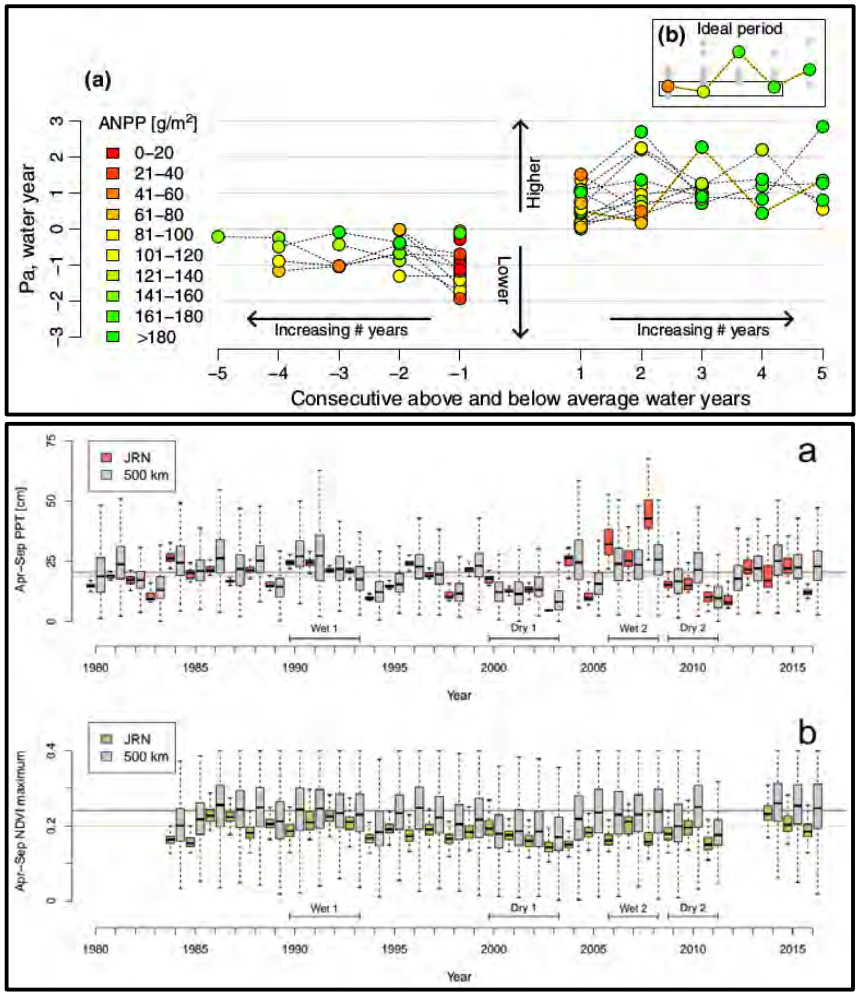
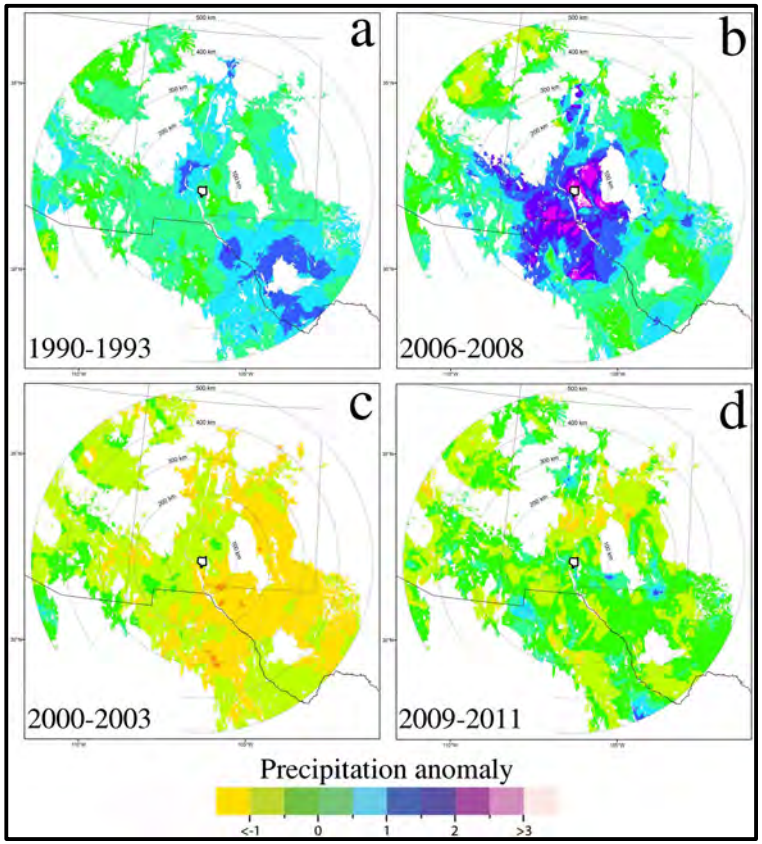
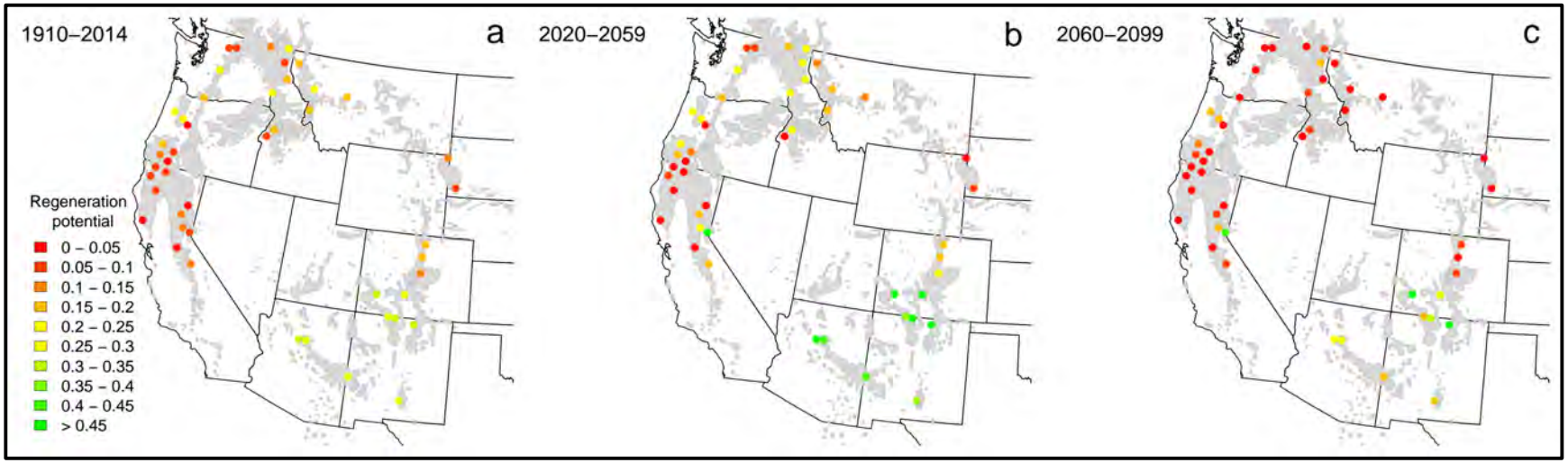
Linking extreme climate events and ecological dynamics across space and time

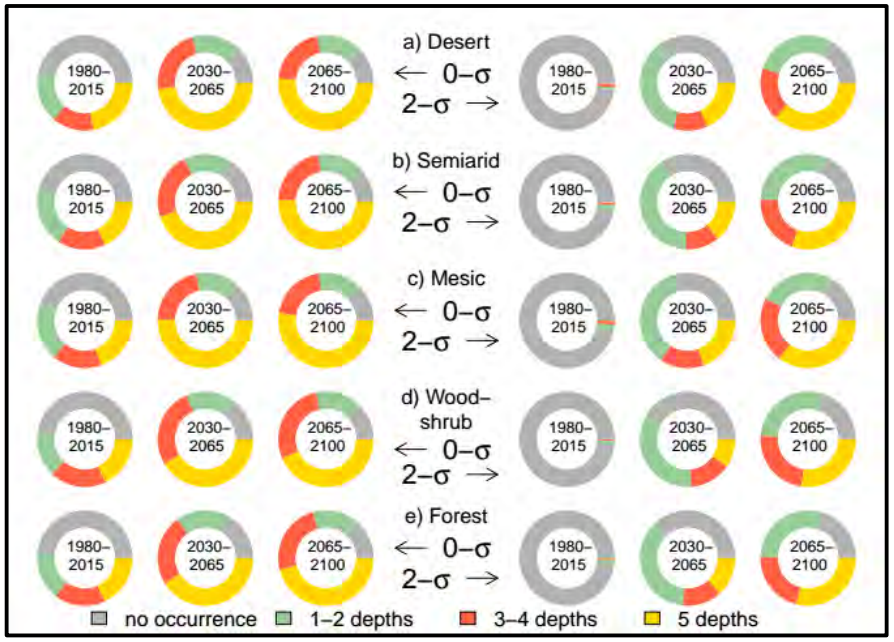




Above: Disentangling locally- and regionally-observed ecological responses to multiyear high and low rainfall periods. Multiyear periods are a key component of understanding climate impacts to arid and semiarid regions. Our research focuses on the physical mechanisms that shape ecological responses, providing a foundation for understanding the effects of local and regional extreme events in a changing climate.

Forecasting climate change impacts





Above: Natural forest regeneration may decline substantially throughout the western US in the 21st century. We study how climate, landscape properties, and the stress tolerance of tree populations will shape the future of western forests.

Left: Forecasts for increasing belowground extreme temperature events in a changing climate. We use downscaled climate model projections to forecast the increasing occurrence of moderate (0-σ) and very high (2-σ) extreme temperature events throughout multiple depths in the soil profile for ecosystems of the central and western US.

Dryland microbes and soil ecology

Dr. Nicole Pietrasiak

- Associate Professor of Sustainability in Arid Lands
- School of Life Sciences
- Email: nicole.pietrasiak@unlv.edu

Expertise

- Soil Microbiology and Ecology
- Biological Soil Crusts
- Phycology and Cyanobacteria/Algae Culture Collection
- Soil Science
- Dryland Ecology
- Biogeomorphology

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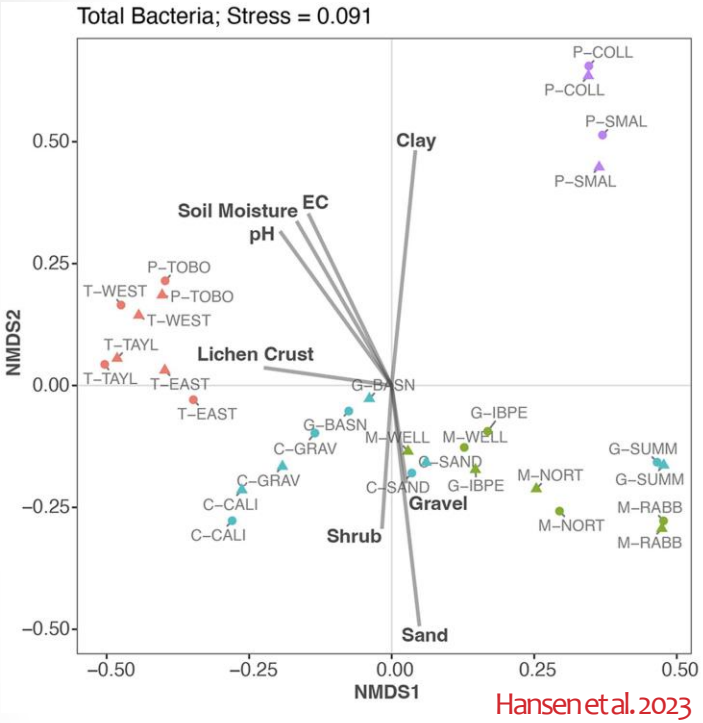
In our lab we investigate what shapes the diversity, abundance, and distribution of desert microbes



Hansen et al. 2023

Landscape and soil properties select for unique microbiomes

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DOI: 10.1111/jpy.12887

WHEN IS A LINEAGE A SPECIES? A CASE STUDY IN *MYXACORYS* GEN. NOV. (SYNECHOCOCCALES: CYANOBACTERIA) WITH THE DESCRIPTION OF TWO NEW SPECIES FROM THE AMERICAS[1]

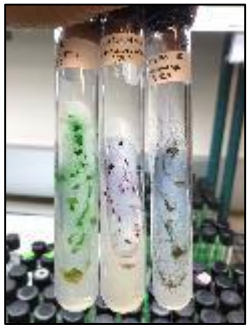
Nicole Pietrasiak[2]
Plant and Environmental Sciences Department, New Mexico State University, 945 College Drive., Las Cruces, New Mexico 88003, USA

Karina Osorio-Santos
Department of Comparative Biology, Faculty of Science, Universidad Nacional Autonóma de México, Coyoacán, Distrito Federal 04510, México

Sergei Shalygin
Plant and Environmental Sciences Department, New Mexico State University, 945 College Drive., Las Cruces, New Mexico 88003, USA

Michael P. Martin
Department of Biology, John Carroll University, University Heights, Ohio 44118, USA

and Jeffrey R. Johansen
Department of Biology, John Carroll University, University Heights, Ohio 44118, USA
Department of Botany, Faculty of Sciences, University of South Bohemia, Branišovská 31, České Budějovice 370 05, Czech Republic



We also describe species and genera new to science and society.

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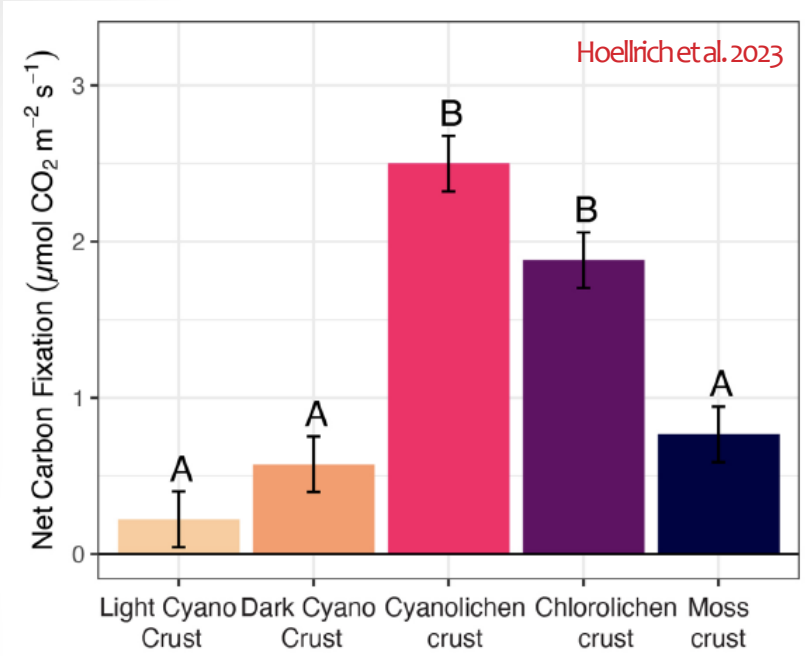
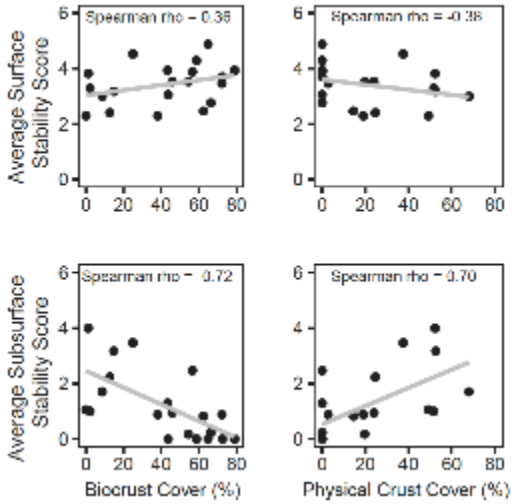
And we identify and quantify the roles microbes play in dryland ecosystem functioning and soil health



Dryland microbes are crucial for maintaining sustainable arid lands.



Stovall et al. 2023

Microbes are part of our dryland biodiversity. They prevent soil loss, increase soil fertility, control nutrient cycling, and contribute to carbon sequestration.

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Computational biology and the physiology of plants

Dr. Paul J Schulte
Associate Professor,
School of Life Sciences
Email: paul.Schulte@unlv.edu

Expertise

- Plant water relations and transport processes
- Computational fluid dynamics
- Anatomy of transport tissues in plants

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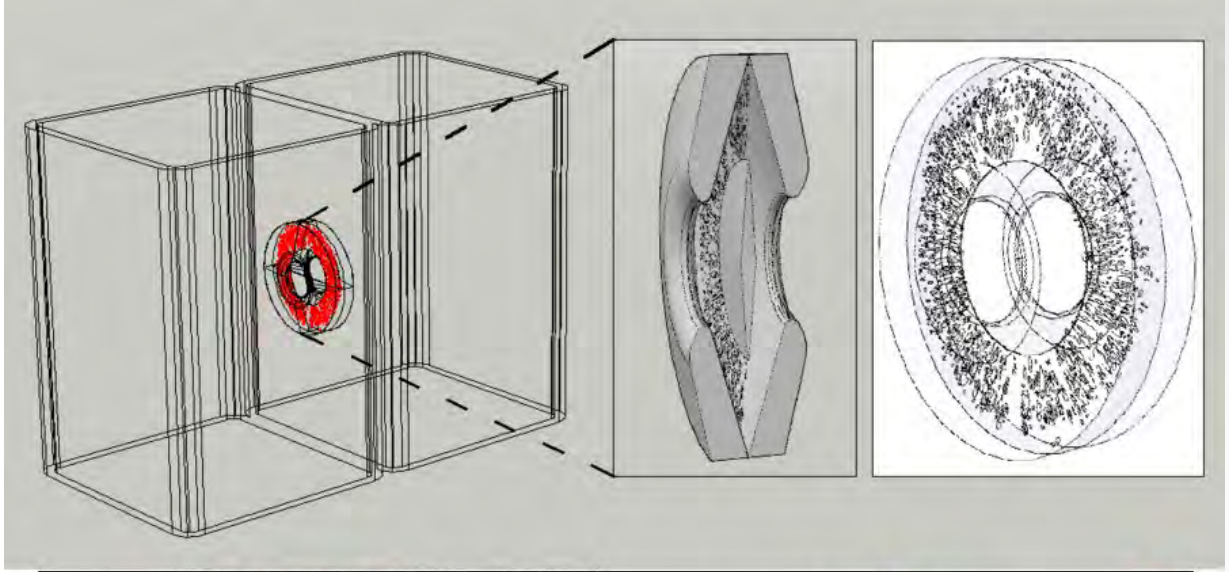
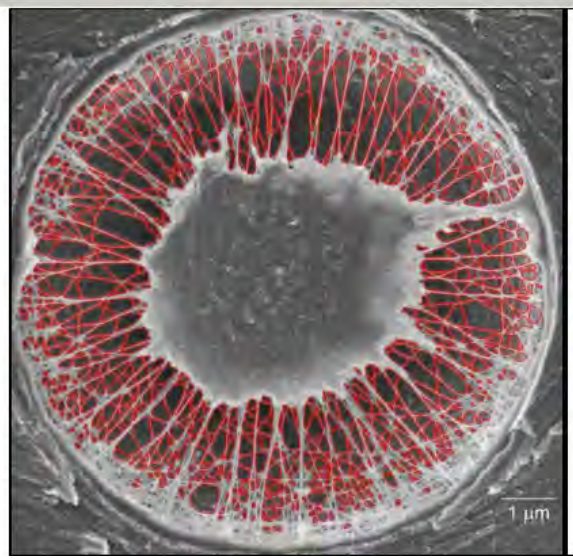
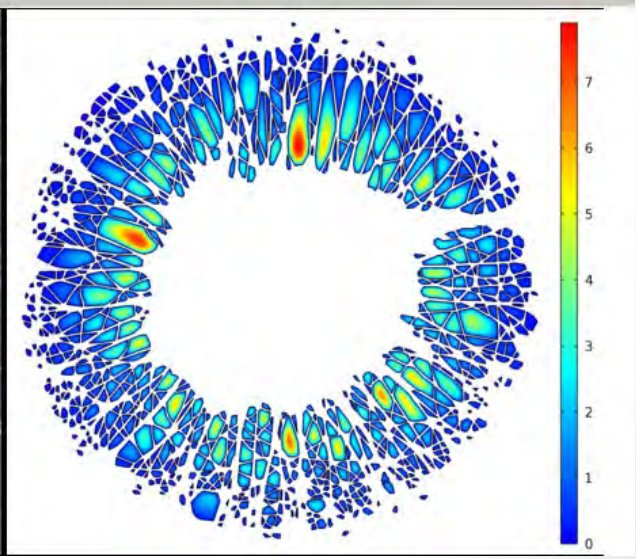
Fluid dynamics of flow between cells

Computer models and mathematical approaches to studying transport processes can help us understand the roles that these structures play in the flow of water from roots to the leaves of tall trees.

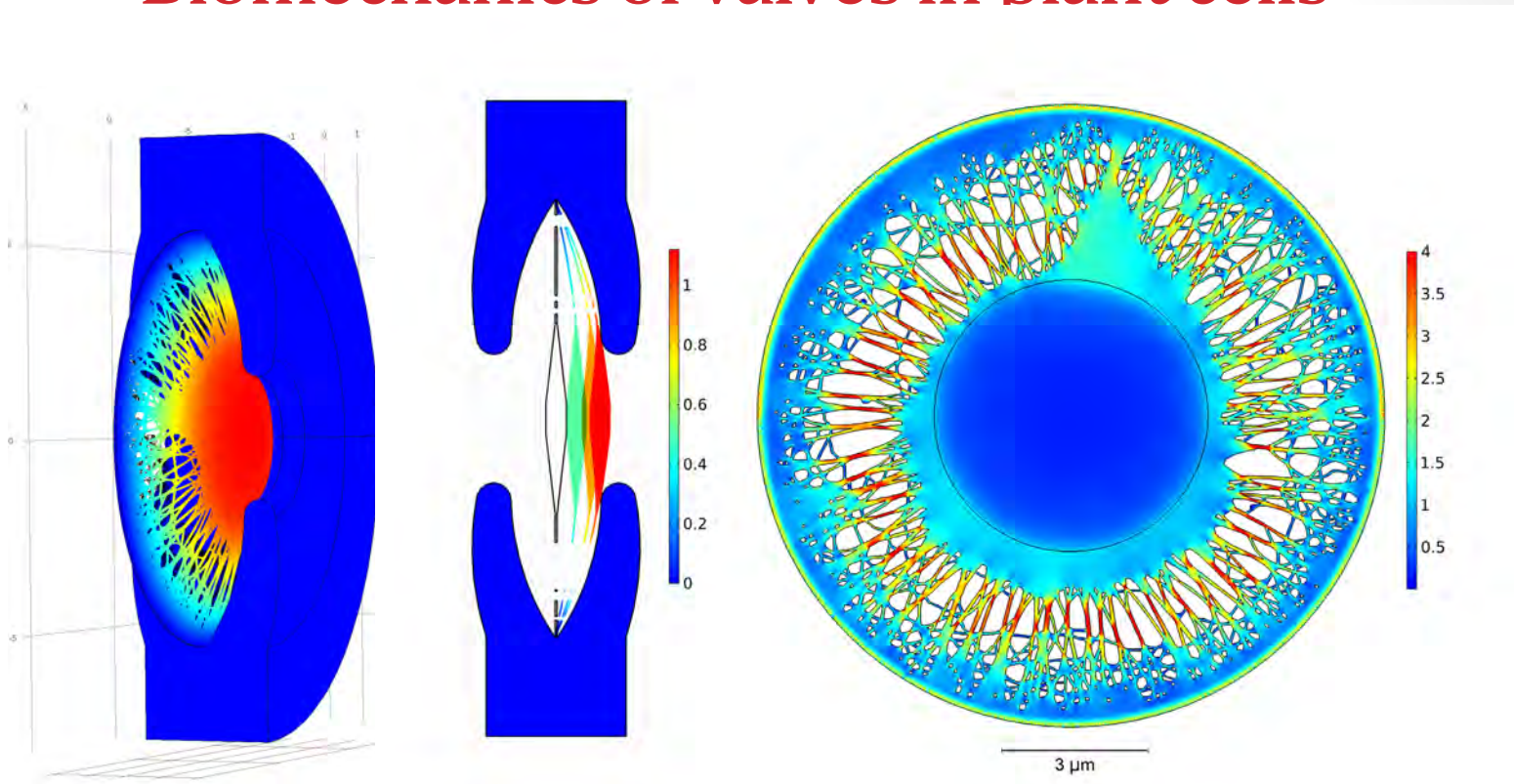
These images show work based on a computational fluid dynamics approach to flow through pits in conifer tracheids.







Biomechanics of valves in plant cells



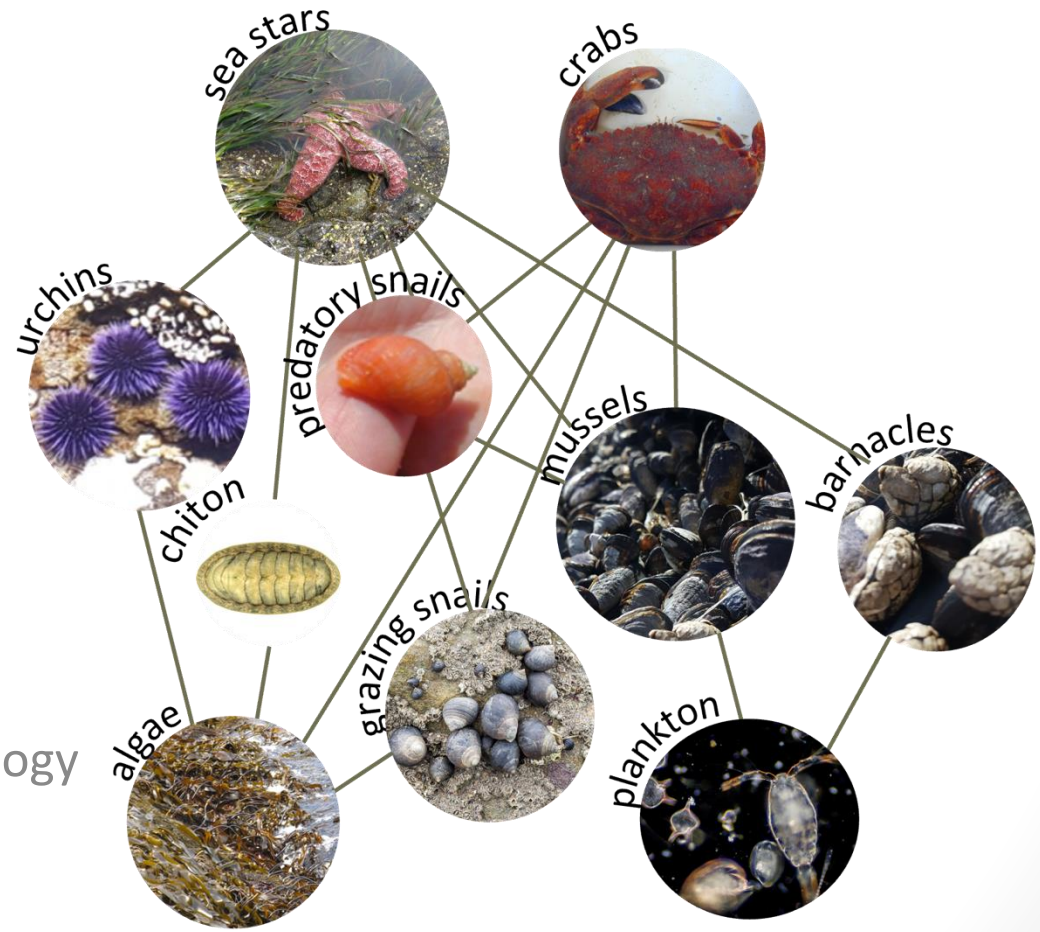
Water flows along the xylem in conifer trees from cell-to-cell through small openings called pits. The pits in many species contain structures that appear to act as valves that prevent air from spreading and blocking the transport system. The above figures show results from solid mechanics modeling of the pressures that are required to deflect the valve and seal the pit.

Paleoecology

- **Dr. Carrie L. Tyler, Ph.D.**
- Assistant Professor
- Department of Geoscience
- Email: carrie.tyler@unlv.edu
- Website: www.carrietyler.com

Expertise

- Marine invertebrates
- Taphonomy
- Food webs
- Conservation Paleobiology
- Predation



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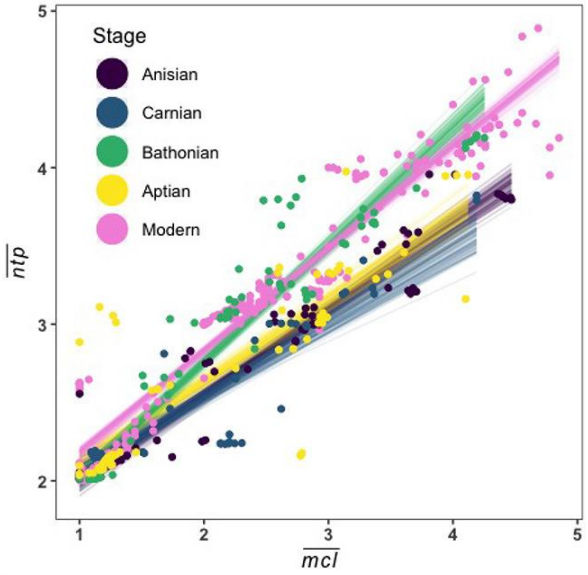


Marine food web structure from the Bathonian Stage (168 mya) resembles a modern Jamaican reef, but not the ecosystem before or after it.

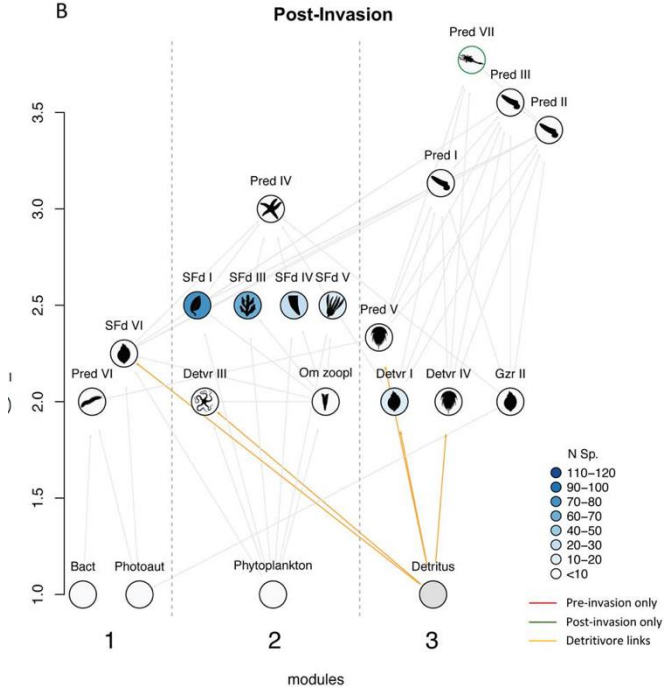
A better understanding of trophic position is needed for restoration planning, as communities may be so severely altered that restoring species or interactions may no longer be possible.

Banker *et al.* 2022 https://doi.org/10.3389/fevo.2022.983374

Fossil food webs before and after an invasion show changes in ecosystem dynamics, and invaders destabilized the ecosystem.

Conservation efforts may need to focus on preserving functional diversity if more diverse ecosystems are not inherently more stable.

Kempf *et al.* 2020
https://doi.org/10.1017/pab.2020.26



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