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Water Resources **Research Institute** 

Newsletter written and compiled by Nicole Damon

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### **RFPs**

If you have questions about submitting a NWRRI proposal, e-mail Amy Russell (Amy.Russell@dri.edu).

For current RFP information, visit the NWRRI website (www.dri.edu/nwrri).

### NWRRI - Desert Research Institute



# Director's Letter

We have wrapped up another year at Nevada Water News and I'm very impressed by the unique and varied projects that our researchers have undertaken. From evaluating the presence of emerging contaminates in Lake Mead, to assessing urban water use, to analyzing groundwater basins and paleo-hydroclimatic data, these projects are exploring innovative solutions to conserve Nevada's valuable water resources. I'm also proud that these projects have provided hands-on research opportunities for a variety of students to learn skills that will prepare them for careers in the field of water resources research.

The newly funded NWRRI project "Wastewater Reuse and Uptake of Emerging Contaminants by Plants" led by Drs. Kumud Acharya and Daniel Gerrity continues this innovative research. This project will evaluate the use of reclaimed water for agricultural irrigation. The benefit of using reclaimed water for agricultural irrigation is that it could help conserve valuable drinking water supplies. However, little is known about the potential uptake of emerging contaminants by edible plants. This project will irrigate tomato and spinach plants with potable water and reclaimed water



at several treatment stages in a greenhouse environment to evaluate the transport, persistence, and accumulation of emerging contaminants in edible plants.

In addition to the exceptional research that DRI faculty are conducting, DRI also supports advancements in water resources management and conservation statewide by partnering with programs such as WaterStart. WaterStart is a public-private, notfor-profit, joint venture that works to bring new water research, technology, and economic development opportunities to Nevada. Nevada's climate provides unique opportunities for studying

### (Director's Letter continued)

sustainable water management and finding solutions for conserving this valuable natural resource. WaterStart connects worldrenowned experts with partner organizations to provide water innovation services to management agencies, policy makers, and technology companies to support economic growth in Nevada's water sector. The goals of WaterStart are to support existing businesses and grow new business opportunities in Nevada through the group's unique capabilities and expertise, as well as to build an operational infrastructure and educate and train a highly skilled workforce.

I look forward to seeing what new research comes from our continuing projects and programs and what new advancements in resource conservation our researchers continue to make.

Sincerely, Jim Thomas ■

## An 8,000-year Paleoperspective of Hydroclimate Variability in the Southern Sierra Nevada

Climate impact assessments allow researchers to understand and anticipate the effects of climate change on the environment. However, being able to conduct accurate assessments requires understanding how and why climate changes have occurred. To do this, researchers need to be able to differentiate natural climate variability from human-induced climate changes. "Deciphering patterns of natural hydroclimate variability from underlying anthropogenic climate change is only possible by understanding the climate of the recent geologic past," explains Steven Bacon, the principal investigator of the project. "The goal of this study is to evaluate the sensitivity of the longest tree-ring record in North America, the Methuselah Walk bristlecone pine chronology from the White Mountains, to different components of the hydrologic system using a coupled watershed runoff and lake surface evaporation model for the Owens River-Lake system in California." This study is also part

of Bacon's PhD research and includes collaboration with his PhD advisor Dr. Rina Schumer of DRI, as well as Dr. Adam Csank of the University of Nevada, Reno.

The researchers will evaluate the sensitivity of the Methuselah Walk chronology by comparing historical ring widths to a variety of hydrologic outputs from the coupled water balance and lake evaporation model. The hope is to make confident correlations in order to develop an 8,000-year record of the southern Sierra Nevada hydroclimate, which will include the precipitation and temperature fluctuations in the region over that time period. "LaMarche (1974) demonstrated that the growth patterns of some annual tree-ring chronologies from moisture- and temperature-sensitive



A new layer of wood is added each growing season, which creates a growth ring. By analyzing the tree-ring chronologies of precipitation- and temperature-sensitive trees, researchers can evaluate changes in the hydroclimate.

> species show strong correlations with historical hydroclimate variability at watershed to regional scales," Bacon says. "Depending on the type of tree species analyzed,

### (Project Spotlight continued)

tree-ring chronologies are commonly compared to a wide range of instrumental records of the watershed's hydroclimatic system, such as precipitation, temperature, snow water equivalent, soil moisture, streamflow, lake water level, and drought indices. Ultimately, the goal of these analyses is to develop a hydroclimatic proxy dataset that could be used to infer paleoclimatic change over the length of the treering chronology."

Combining the precipitationand temperature-sensitive tree-ring chronologies from the White Mountains will potentially allow the researchers to reconstruct the hydrologic system of the Sierra Nevada region. "The coupled watershed runoff and lake surface evaporation model we will use has three primary model parameters: precipitation, temperature, and solar insolation. If we can demonstrate strong correlations between the White Mountain treering chronologies and the historical modeled components of the hydrologic system in the watershed, then we could in turn use the associated precipitation and temperature reconstructions as input parameters in the coupled water balance model," Bacon says. "The accuracy of the modeled lake levels based on the tree-ring hydroclimatic reconstructions will be assessed by comparing them with the Holocene shoreline record of Owens Lake in combination with the paleotemperature depression record developed in the Sierra Nevada from glacial deposits."

The research for this study will also incorporate some novel techniques. This project will combine precipitation- and temperaturesensitive tree-ring chronologies to reconstruct a hydrologic system. The resultant chronology will be approximately 6,000 years longer than



Great Basin bristlecone pines are a long-lived species found in California, Nevada, and Utah. The Methuselah Walk bristlecone pine chronology from the White Mountains in Inyo County, California, is the longest tree-ring record in North America.

similar records in the western United States and potentially have the longest tree-ring-based reconstruction of runoff and lakelevel fluctuations in North America. "Tree-ring and other highresolution paleoproxies that are resolved to annual time scales allow the range of precipitation and temperature scenarios used in climate impact assessments to be extended," Bacon explains, "which could provide an extended perspective on the range in magnitude and duration of potential hydroclimatic variability that could be experienced under future climate change in eastern California and western Nevada."

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"If we can demonstrate strong correlations between the White Mountain tree-ring chronologies and the historical modeled components of the hydrologic system in the watershed, then we could in turn use the associated precipitation and temperature reconstructions as input parameters in the coupled water balance model." – Steven Bacon

### (Project Spotlight continued)

Additionally, this project will use variable estimates of solar insolation values over time in the evaporation component of the water balance model. "The total energy received by the Earth from the Sun changes with time, so the change in the magnitude of paleo-solar insolation needs to be included in a paleoclimate water balance model to accurately estimate evaporation from the water surface and evapotranspiration from the land surface," Bacon says. "Fortunately, previous work has computed the positions of Earth's orbit and rotation for the last 10 million years for paleoclimatic research. The resolution of this dataset is monthly insolation values for intervals of 10 degrees of latitude at 1,000-year time steps."

Although the project is still in its early stages, it has already produced some interesting results. "Our preliminary analysis and model results have confirmed that traditional statistical techniques yield problematic correlations to observed precipitation and temperature, which have also been found in previous dendrochronologic research of the White Mountain bristlecone pine tree-ring chronologies conducted by Hughes and Graumlich (1996) and Salzer *et al.* (2014)," Bacon explains. "These results are likely related to the bristlecone's harsh, upper montane to alpine mountainous environment and its short growing season and complex physiology. As a result, our ongoing research has primarily focused on finding which component of the hydrologic system and at what extent within the watershed the tree rings are recording."

The modeling techniques that the researchers are developing for this study could also benefit future watershed studies. "Although the watershed-scale modeling approach we are using is relatively similar in principle to the study of Saito et al. (2015) in the Sierra Nevada," Bacon says, "this project also includes lake surface evaporation and perennial snow/glacier accumulation elements that are calibrated to the shoreline record of Owens Lake and the glacial record in the watershed." If the researchers observe confident correlations between the observed precipitation and temperature and the other hydrologic system components, then they will be able to estimate

precipitation and temperature in the southern Sierra Nevada region for up to 8,000 years. The model could then be used to estimate the paleohydrologic surface conditions in closed Nevada basins. "With additional research, the results could possibly provide Holocene groundwater recharge estimates for these basins," he adds, "which could then be used to provide a paleohydrologic context of modern groundwater recharge rates used for water resources management."

#### References

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### **Upcoming Events**

2017 UNR/NWRA Dinner Forum April 19, 2017 Sparks, NV www.nvwra.org/2017unr-nwradinnerforum

2017 Spring AWRA Specialty Conference Connecting the Dots: The Emerging Science of Aquatic System Connectivity April 30-May 3, 2017 Snowbird, UT www.awra.org/meetings/Snowbird2017/ Truckee River Tour May 4 & 5, 2017 Reno, NV www.nvwra.org/truckee-river-tour

Long Canyon Mine Tour May 9 & 10, 2017 Elko, NV www.nvwra.org/2017-long-canyon-mine-tour

# PI Spotlight: Steven Bacon

Steven Bacon first became interested in water resources research while he was working on his master's degree in geology at Humboldt State University in California. "The watershed hydrology and fluvial processes classes that I was taking for my degree initially sparked my interest in the field," Bacon says. "I also used to perform geologic hazard assessments for dams and related water conveyance facilities along the western Sierra Nevada, which exposed me to the engineering aspect of water resources." His interest in water resources research has also inspired him to pursue a PhD in hydrology at the University of Nevada, Reno.

The NWRRI project "An 8,000-year Paleoperspective of Hydroclimate Variability in the Southern Sierra Nevada" is part of Bacon's PhD research, and it has given him a new understanding of the complex dynamics of hydrologic systems. "Developing a watershed runoff and lake evaporation model for paleoclimatic research that is process based and calibrated by Holocene and late Pleistocene shoreline and glacial geomorphic records has been fascinating," Bacon says. "In developing this model, I have learned a lot about the complexity of hydrologic systems

in snowmelt-dominated arid and semiarid basins."

In addition to conducting hydrologic modeling of the Southwest to evaluate hydroclimate variability, Bacon's recent research includes geomorphic mapping of alluvial, fluvial, and lacustrine depositional environments; characterizing alluvial fan environments for flood hazard assessments; conducting analyses of sequence stratigraphy and soils; and geomorphic-based terrain modeling of dust emission hazards in desert regions. As he continues in his research, Bacon hopes to incorporate more of his geological expertise in future water resources studies. "Because I have a background in geomorphology and engineering geology, it would be interesting to use some the governing principles of process geomorphology to better understand the connection between surface water and both unconfined and confined groundwater systems," he adds.

When it comes to working in the lab or being out in the field, Bacon's preference is for fieldwork. "It's a chance to be where the air is fresh, the light is natural, and dirt is underfoot," he



says. If he had six months with no obligations or financial constraints, Bacon would spend the time traveling with his family to multiple countries so that they could visit the mountains to play in the snow and tropical beaches to relax in the sun. When asked what he would want to have with him if he were shipwrecked on a desert island, Bacon answered, "I would want a machete and a fire starter. I've seen the movie Cast Away, and if Tom Hanks had these two items with him, he would have had more time to relax on the beach and figure out how to brew coconut beer."

"Developing a watershed runoff and lake evaporation model for paleoclimatic research that is process based and calibrated by Holocene and late Pleistocene shoreline and glacial geomorphic records has been fascinating. In developing this model, I have learned a lot about the complexity of hydrologic systems in snowmelt-dominated arid and semiarid basins." – Steven Bacon

# Postdoc Interview: Kelly Gleason

We asked Maki Postdoctoral Fellow Dr. Kelly Gleason about her current research and her continuing research plans. Here's what she had to say:

# 1) What sparked your interest in water resources research?

I became interested in water resources research because it is the primary mechanism by which climate influences ecosystems and society. Water is the conduit that connects upland montane headwater ecosystems to lowland natural resource users and policy makers.

### 2) What do you find most interesting about water resources research, particularly working in an arid/semiarid environment such as Nevada?

In the semiarid western United States, most annual precipitation falls as snow, although rising temperatures are reducing snowpack storage. I find snow hydrology particularly interesting because the biophysical interactions of water, climate, and ecosystem disturbances have profound consequences on water resource availability across multiple scales in space and time.

### 3) What kinds of research are you currently working on and what have you learned so far from this research?

Currently, I'm researching snow and ice processes in mountain environments, disturbance hydroclimatology, and waterclimate-forest interactions using a suite of tools, including integrated hydroclimate modeling, surface energy balance modeling, remote sensing of land cover change, spatiotemporal statistics, and geoanalytics.

My primary research is focused on how forest fires affect snow hydrology and subsequent water resources across the Colorado River Basin. Burned forests shed black carbon, burned debris, and other light absorbing impurities that deposit in the snowpack during winter and concentrate on the snow surface during snowmelt. By increasing the transmission of sunlight through the canopy, decreasing the emission of longwave radiation by the canopy, and reducing snow surface shortwave albedo, forest fire disturbance accelerates snowmelt rates and advances the date of snow disappearance for many years following a fire.

### 4) What do you hope to learn more about from the research you are doing?

I hope to learn more about the combined effects of light absorbing impurities (i.e., black carbon, dust, and burned woody debris) on snow hydrology and



water resources across the western United States and beyond under past, current, and future climate conditions.

### 5) Do you have a preference for lab work or fieldwork, and if so, why?

As a snow hydrologist and physical geographer, I use a combination of fieldwork, lab work, numerical modeling, and remote sensing to investigate the interactions of water, climate, and ecosystems. This provides me with a good seasonal balance of working in the field during the winter and conducting analyses in the lab during the summer.

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"My goal in water resources research is to develop a world-class eco-hydro-climatology research group that investigates mechanistic biophysical drivers of earth surface processes and water resource availability in snow-dominated ecosystems." – Kelly Gleason

#### (Postdoc Interview continued)

6) What are some of your other research interests? Do you have any goals for incorporating those interests into your work as you continue in your career?

I am broadly interested in interactions and feedback of water, climate, and ecosystems under a changing climate system and across multiple scales in space and time. My goal in water resources research is to develop a world-class ecohydro-climatology research group that investigates mechanistic biophysical drivers of earth surface processes and water resource availability in snow-dominated ecosystems.

### 7) If you had six months with no obligations or financial constraints, what would you do with the time?

I would hike the Pacific Crest Trail with skis.

8) Cake or Pie?

Sweet potato pie.

### **Events continued**

2017 GSA Cordilleran Section: 113th Annual Meeting May 23-25, 2017 Honolulu, Hawai'i www.geosociety.org/Sections/cord/2017mtg/

SeriesSEE Workshop June 19, 2017 Reno, NV www.nvwra.org/seriessee

Well Regulations Workshop June 19, 2017 Reno, NV www.nvwra.org/2016-wellregs-workshop

Well Design, Construction & Rehab Workshop June 20, 2017 Reno, NV www.nvwra.org/well-design

Well Rehabilitation Workshop June 21, 2017 Reno, NV www.nvwra.org/well-rehab

Borehole Geophysical Logging Workshops June 22 & 23, 2017 Reno, NV www.nvwra.org/2017borehole-geophysical-loggingworkshop

2017 AWRA Summer Specialty Conference Climate Change Solutions June 25-28, 2017 Tysons, VA www.awra.org/meetings/Tysons2017/

2017 AWRA International Conference September 10 & 11, 2017 Tel Aviv, Israel www.awra.org/meetings/Israel2017/

AEG 2017 Annual Meeting September 10-16, 2017 Colorado Springs, CO aegweb.site-ym.com/events/EventDetails.aspx? id=593893&group=



Pressing Water Quality Issues in Nevada Workshop September 26, 2017 Reno, NV www.nvwra.org/waterquality

NWRA Fall Symposium September 27 & 28, 2017 Reno, NV www.nvwra.org/2017fallsymposium

2017 ASA, CSSA, and SSSA International Annual Meeting Managing Global Resources for a Secure Future October 22-25, 2017 Tampa, FL www.acsmeetings.org/

GSA 2017 October 22-25 Seattle, WA community.geosociety.org/gsa2017/home

2017 Annual AWRA Conference November 5-9, 2017 Portland, OR www.awra.org/meetings/Portland2017/

AGU Fall Meeting December 11-15, 2017 New Orleans, LA fallmeeting.agu.org/2017/

### NWRRI - Desert Research Institute

Success and the dedication to quality research have established the Division of Hydrologic Sciences (DHS) as the Nevada Water Resources Research Institute (NWRRI) under the Water Resources Research Act of 1984 (as amended). As the NWRRI, the continuing goals of DHS are to develop the water sciences knowledge and expertise that support Nevada's water needs, encourage our nation to manage water more responsibly, and train students to become productive professionals.

Desert Research Institute, the nonprofit research campus of the Nevada System of Higher Education, strives to be the world leader in environmental sciences through the application of knowledge and technologies to improve people's lives throughout Nevada and the world.

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www.dri.edu/nwrri

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- Page 2: Diagram of secondary growth in a tree showing idealized vertical and horizontal sections, by Chiswick Chap - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/ index.php?curid=35580681
- Page 3: Great Basin bristlecone pine in the White Mountains, Inyo County, California, by Dcrjsr - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=11040152
- Events list, page 7: Red Rock Canyon National Conservation Area, Nevada, by Fred Morledge - Self-photographed, CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=22419840