TAHOE

A LEGACY OF RESEARCH, EDUCATION & OUTREACH

Profiles in research
Nevada research contributes to Tahoe science

Alumni profiles
Alumni dedicate their careers to preserving Lake Tahoe

Academy for the Environment
University of Nevada, Reno

DRI Desert Research Institute
Center for Watersheds and Environmental Sustainability

Compiled by: Mike Collopy, Jim Thomas, Wally Miller and Alan Heyvaert

2013

HARRY REID
NEVADA

MAJORITY LEADER

United States Senate

WASHINGTON, D.C. 20510

August, 2013

Dear Friends:

Lake Tahoe provides unmatched beauty within the Sierra Nevada Mountains and serves as a source of pride for Nevadans and Californians. As the stewards of this pristine lake, it is our responsibility to protect it for future generations.

The Lake Tahoe Summit was first convened in 1997 in an attempt to enhance awareness and increase federal involvement in preserving our national treasure. Since then, we have made incredible strides in restoring the health of the Tahoe Basin, as the recent trend of improved water clarity shows, but there is still important work ahead of us.

Rigorous scientific research is a vital component of the environmental improvements in the Tahoe Basin. I am proud of the continued efforts put forth by a variety of agencies, institutions, and individuals, including the faculty and students of the University of Nevada, Reno and the Desert Research Institute. Each August, their publication of this report, in conjunction with the Summit, provides us with an opportunity to mark our progress and plan our next steps.

Over the past 17 years, our joint efforts have served as a model for how to coordinate efforts of federal, state, and local agencies with the common goal of restoring this unique ecosystem and safeguarding our national heritage. While we have achieved significant success, climate change continues to be one of the greatest challenges of our time, and we must take steps to address its effects in the Lake Tahoe Basin. This is why it is vital to continue to support scientific research efforts through bi-partisan and bi-state proposals such as the Lake Tahoe Restoration Act.

One of the best legacies we can leave to our children is a clean environment and a history of preservation of our natural beauty and resources. I look forward to continuing to work with all of you to that end. My best wishes to you.

Sincerely,

HARRY REID
United States Senator for Nevada

DEAN HELLER
NEVADA
(202) 224-6244

United States Senate

WASHINGTON, DC 20510

COMMITTEES:
ENERGY AND NATURAL RESOURCES
COMMERCE, SCIENCE, AND TRANSPORTATION
SPECIAL COMMITTEE ON AGING

August 2013

Dear Friends and Colleagues:

I am honored to participate in this year's Lake Tahoe Summit. As in years past, I would encourage everyone to take this opportunity to reflect on the lake's history and to use the knowledge we have gained from the successes and challenges to build upon future restoration efforts in order to improve the long-term health of Lake Tahoe.

In spite of the continuing economic uncertainty facing our nation, and the status and changes to the funding stream for Lake Tahoe, I am encouraged by the continuing efforts to rehabilitate and protect the Basin. This is most certainly attributed to the strong public-private partnerships which resulted from the first Lake Tahoe Summit. I'm thrilled that the cooperation among entities continues to develop and expand. The collaborative efforts between Nevada and California are shining examples of what can be accomplished when we set our minds towards a common goal. I am certain that these relationships will continue to serve as a strong foundation in order to promote the health and well-being of the lake.

Lake Tahoe's resilience should not be taken for granted. We are all aware of the efforts to improve water clarity and stop the spread of invasive species. I am encouraged by the progress to combat the spread of Eurasian watermilfoil in Emerald Bay, as well as recent water clarity readings. This, combined with the intensive efforts to prevent the introduction of new invasive species, is especially reassuring.

Again, I am honored to be a part of this process and privileged to join the stakeholders who have come together in the spirit of collaboration for the benefit of Lake Tahoe. It is imperative that we continue to address the challenges facing the lake, so future generations are able to enjoy it as we do today. I look forward to continuing my work with all of you towards that goal.

Sincerely,

Dean Heller
United States Senator

Tahoe Research: Our common cause

President Marc Johnson

President Stephen Wells

Dear Friends,

Together, the Desert Research Institute and the University of Nevada, Reno have a proven record of collaboration at Lake Tahoe. We've helped provide this national treasure with needed science, program leadership and a plan for sustaining its health for the benefit of future generations.

It is interesting to note how far the Tahoe partnership between our two institutions has come since 1997, when President Bill Clinton and Vice President Al Gore, at the invitation of Nevada U.S. Sen. Harry Reid, convened the first Lake Tahoe Environmental Summit. The Lake Tahoe Presidential Summit held on July 26, 1997 (and preceded by several community events involving key cabinet members and what has been estimated at more than 1,000 cabinet and White House staff) brought about a resounding and exciting affirmation that teamwork, partnership and a common research vision would provide answers in saving Tahoe. Vice President Gore, hosting an event in a clearing of pine trees not far from Mount Tallac on Tahoe's south shore the day before President Clinton's arrival at Sand Harbor, spoke of a "consensus" of purpose that would include effort from all with a stake in Tahoe's future.

Said Sen. Reid of the impact of the first Lake Tahoe Summit: "It led to our turning around the environmental degradation of that great lake."

Since those heady days of 1997, our two institutions have joined forces with local, regional and national management agencies as well as other academic institutions, in an effort to strike that fine balance of consensus of purpose. Our institutions have helped lead the way in discoveries on nutrient loading, water quality and watershed ecology. Our scientists have helped develop innovative ways to monitor Tahoe's precious ecology and in finding management strategies for the air, land and water of Tahoe that help, not hinder, the overall health of this unique natural resource. Our students and researchers have helped the public develop a more in-depth understanding of why Tahoe is important, and why it is of the utmost importance that the work of the past 16 years must continue at its quick and productive tempo. Our approach will continue to be interdisciplinary and inter-institutional. Our pledge to Lake Tahoe remains firm: our two institutions work in common cause, so that the lake's heritage of beauty and clarity can be shared by our children's grandchildren and beyond.

Sincerely,

MARC JOHNSON
President
University of Nevada, Reno

STEPHEN WELLS
President
Desert Research Institute

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Prepared for the annual Lake Tahoe Summit, August 2013
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(www.unr.edu/art/photography)
Project management by Christina Clack

Photograph by Krissy Clark

Tom Albright

How do plants and animals fare in extreme conditions?

By Deanna Hearn

Photographs by Krissy Clark

Tom Albright is interested in the big picture. He wants to know how environmental change affects plant and animal communities. This can include changes ranging from heat waves and droughts to fires and hurricanes, plus much more. Proficient in Spanish and French, his work has taken him to many parts of the world, including China, Africa and the Caribbean.

As an assistant professor in the Department of Geography at the University of Nevada, Reno, Albright collaborates in his research with many different people to enable him to work on a broad scale analyzing data. That includes using a lot of citizen science data.

He received a three-year NASA New Investigator in Earth Sciences award and has a particular interest in birds that began when he and his wife spent their honeymoon in her native country of Nicaragua. "We bought binoculars and found the birds to be so charismatic," he said.

"I think most people are natural scientists," Albright said. "One reason we have so much data on birds is because people love them, and they're happy to collect the information, which makes it easier for us to do the science with regard to avian conservation and biology."

Temperature and how it affects animals is one area of Albright's research. "We think of temperature at the airport as the official reading, but if we put temperature sensors all over we would find the Sahara Desert in a parking lot and the Pacific Northwest on a mountain slope. To understand what's going on, we need to understand how microclimates work. Animals can use microclimates for shade, water or as a refuge from something they're trying to avoid. That's why we put sensors throughout the area we're studying," Albright said.

Similar principles apply to the Lake Tahoe Basin according to Albright. "Tahoe has a rugged topography and huge environmental gradients from high to low elevations which are the kinds of situations I work with throughout Nevada."

In the NASA project, "Desert Birds in a Warming World: Characterizing Thermal Stress with Daily Earth Observation Data in Complex Terrain," Albright and his colleagues are researching the specific mechanisms and their conservation implications by which birds and other animals are affected by climate change and extreme weather. "One way we do this is by using remote sensing, sensor data and GIS to map physiological models of birds across landscapes," Albright said.

For example, researchers map the consecutive days a specific type of bird would experience thermally stressful and potentially lethal conditions. By looking at the averages and specific time periods, they can project into the future with climate models. "This should tell us when and where to expect die offs and when and where we expect birds to avoid certain areas," Albright said.

"We have found in our southern Nevada models that extreme heat waves can knock back ground nesting species by over 30 percent in a season. The species may be dispersing to other locations, the young may not be making it out of the egg stage and surviving, or maybe the birds are putting their resources into their own survival instead of reproduction and caring for their young. Some birds, even if they have access to water and shade, do not have the thermal tolerance to survive. That's why it's important to understand the physiological tolerances of birds and heat."

The educational portion of the NASA grant is called Project H.E.A.T. (hot environments, animals and temperature). Albright and Jacque Ewing-Taylor of the University's Raggio Research Center for STEM education, which promotes science, technology, engineering and mathematics education, held a two-week camp this past summer at the University to help middle school students learn about temperature, how it varies across space and time, how it's measured and analyzed, and how humans and animals deal with it. Coincidently, the camp, which will continue for two more summers, occurred during a historic heat wave.

Tom Albright

researches how birds and other animals are affected by climate change and extreme weather.

Photograph by Krissy Clark

Tim Brown

Smoke and weather: Using data to make better decisions

By Guia Del Prado

Lake Tahoe's environmental agencies often prepare for fire season by burning potential fuel like shrubs and grass. But before the U.S. Forest Service (USFS) can pack their gear and head deep into the basin's forests, they have to check the weather first.

Tim Brown, director of the Western Regional Climate Center (WRCC) and the Desert Research Institute's Climate, Ecosystem and Fire Applications program (CEFA), provides Lake Tahoe agencies with weather and climate information to lessen the impact that prescribed fires have on the air. Smoke particles can cause respiratory problems among Tahoe's residents or settle into the lake, dampening its clarity.

"In places like Tahoe, which is this giant bowl, it's easy for colder air to settle," Brown said. "If you have a fire going, what you don't want is for that smoke to settle with the colder air. Ideally, you want the smoke to rise and let upper level winds disperse it so it doesn't impact anybody."

For smoke to not settle into the basin, the mixing height, a lower layer of the atmosphere with rising air, needs to be high enough to where winds can scatter the smoke over a larger area. Brown generated maps from an atmospheric model to help understand the mixing heights' daily patterns. Environmental agencies can refer to these maps to strategically plan for burns.

"As a fire manager, what you want to do for planned burns is to reduce hazardous fuels and create a healthy forest and landscape environment," Brown said. "But in trying to meet these objectives, you also don't want to impact people by putting the smoke in their houses, schools or hospitals."

Brown and his team also work with the USFS to maintain online tools, which combine weather and smoke models. The USFS AirFire group developed a tool called Bluesky Playground that local agencies can use to plan burns. The agencies can enter information about their planned burn into the tool, including the fuel contents and how long the burn will last. The tool then estimates how much smoke to expect and, using the weather models that Brown developed, estimates how high and how far the smoke might go.

"You don't want to impact individuals or put out so much smoke that you're exceeding a regulatory threshold," Brown said.

Brown's modeling domain extends beyond the Lake Tahoe Basin and includes California and Nevada. As the director of the WRCC and the CEFA, he also monitors a nationwide network of climate information, remote weather stations and lightning strike centers. He provides climate, fire danger and smoke management information to agencies such as the USFS.

Brown believes in approaching environmental issues like fire and climate from different perspectives and with different data to better aid management agencies in solving complex issues. Decisions like conducting a prescribed burn on the wrong day could have repercussions in the environment and with local residents.

"In my view, you can't really talk about the physical aspects of fire without the societal aspects of fire," Brown said. "Some decisions could really have an impact on society, on health, safety and quality of life. There could also be a large economic component to these decisions."

Brown's interests in examining different perspectives of a problem using data may be a product of his background. He started college in meteorology, but eventually switched to astronomy, inspired by boyhood evenings scanning the skies with his grandfather on the family farm in Illinois. Now with a master's and doctoral degree in climatology, he's working to make fire climate and weather information useful to decision makers.

"A challenge for me was to learn about the fire management system, so I could combine the physical and societal aspects of fire and perform research with a more holistic viewpoint," he said.

Though he has been working on fire and climate issues since the 1990s, Brown knows there is still much more to learn. "Fire-climate didn't really become in vogue until this past decade. Now the conflating of climate change, fire and people are generating whole new areas of research and societal challenges."

Photographs by Krissy Clark

Tim Brown

provides climate, fire danger and smoke management information to agencies.

Photograph by Krissy Clark

Antony Chen

Ensuring environmental health with better air quality

By Guia Del Prado

Lake Tahoe's water clarity has historically served as a marker for the environmental health of the entire basin. But Lung-Wen "Antony" Chen, associate research professor at the Desert Research Institute's Atmospheric Sciences Division, says the air also interacts with the lake and land in ways that have long-lasting impact on the basin's health.

For Chen, gaining a better understanding of this dynamic begins with examining long-term trends in air quality while also getting down to the particle level. He has been analyzing air quality data dating back to the 1980s, which includes trends in airborne particle concentration, chemical composition, and distribution as well as atmospheric visibility conditions.

"Particulate matter in the atmosphere has an effect on the climate, human health and visibility," Chen said. "The Lake Tahoe area is such a pristine environment, even a small contamination can have a big impact."

Though air quality has slowly improved over time, particle concentration in recent years has spiked on the haziest days. These increases coincided with wildfire activities, including the Angora fire of 2007.

"These big spikes can actually cause the trend to go upward," Chen said. Climate change can also contribute to worsening air quality, he said, since warmer temperatures result in more fires.

Close attention should also be paid to prescribed burns to minimize adverse effects on air quality, Chen said. Prescribed burns dispose of bushes and grasses that can serve as fuel for potential wildfires. The burns are usually small and planned for days that minimize impacts, but they could have small, cumulative effects, on the air and also on the lake water through deposition.

Recent studies estimate that 15 percent or more of the pollutants that lead to diminishing water clarity, such as particles and nutrients, fall into the lake directly from the air. Still, Chen said, much uncertainty surrounds those estimates. Previous deposition studies focused on ambient concentrations. In order to arrive at a better estimate, Chen is measuring the particle deposition directly around the lake everyday, as well as examining the particles themselves.

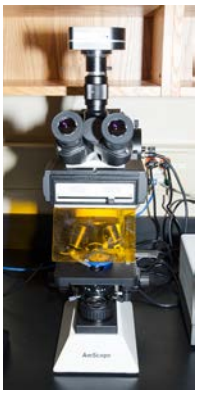
"If you really want to assess the source of particles and their impact on lake clarity, you need to have information on the particle's size and chemical composition," he said.

Though water and air quality have been improving over the past 30 years, Chen said detailed studies could help prevent air and water quality from worsening. Chen and his colleagues work closely with local groups like the Tahoe Regional Planning Agency and the U.S. Forest Service to advise them on how prescribed burning and other activities might impact the air quality and the lake.

"The long-term goal is to mitigate the human influence and return the basin to its natural condition as much as we can," he said. "We want to maintain the lake for the next generation. We have a responsibility to do that."

This desire to do work that has a larger impact is evidenced by Chen's body of research, even before he joined DRI in 2002. When Chen was a graduate student at the University of Maryland, he was given the choice to study pollution issues or create semiconductors for smartphones. Chen knew the answer was obvious.

"I like my research to have an impact on the well-being of mankind," he said. "The challenge we face in our generation is climate change. I hope that I can make some contributions that help solve the problem."



Photographs by Krissy Clark

Photograph by Krissy Clark

Antony Chen

examines long-term air quality trends along with directly measuring particle deposition around the lake.

Photograph by Krissy Clark

Peter Goin

Using photographs to blend art and science

By Deanna Hearn

Photographs by Krissy Clark

Most artists don't think about using their work in a scientific way, but Peter Goin does. Goin is a Foundation Professor of Art, as well as the chair of the Department of Art at the University of Nevada, Reno. He's been using his photographs and those of others to research the visual history of Lake Tahoe for 25 years.

Published in 1992, *Stopping Time: A Rephotographic Survey of Lake Tahoe* is one of Goin's 16 books. He uses a variety of 19th century photographs and more than 50 comparative photographs to document how the Tahoe Basin landscape evolved over time.

"That project really started a process of looking at the Tahoe Basin more critically," Goin said. "I realized the fundamental problems in the basin are really a microcosm of a larger ecological picture. Lake Tahoe is like the canary – gentle, fragile and beautiful – that serves as an early warning sign. If the canary goes, how much longer before we go? My work at Tahoe is about the integrity of the ecological environment in which we live. This is our world, where our health is woven together with biotic communities in a shared environment, and it is so clearly evident at Tahoe."

"Artists are often seduced by the beauty of the lake. They fail to look beyond the beauty into the complexity and history of the landscape," Goin explained, which is why he has tackled a major project to build a comprehensive archive of photographs. Working in collaboration with donors, the archive will ultimately create a public record and make the photographs accessible to anyone in the scientific community as well as the general public.

"The visual history of Tahoe precedes scientific research at the lake by some 60 years," Goin said. "Within this broad range of time, there are some important visual images of the pre-scientific era of Tahoe."

As the photographs keep streaming in from private collectors, Goin and his small crew of paid and volunteer students continue to scan and catalog the images. From the ever-expanding archive come a number of Goin's publications.

"The books serve as a conversation, a way to do focused study," Goin said. "They allow me to do serious research, particularly on the comprehensive visual history of Lake Tahoe."

Goin and his collaborator, Paul Starrs, who teaches cultural and historical geography, have been working for a number of years to produce a large, significant environmental history of Lake Tahoe from 1957 to modern day. Starrs is a Foundation Professor of Geography and also the chair of the Department of Geography at UNR. They hope the book, which is about two years out, will have the contemporary stature of E. B. Scott's two-volume pictorial history published in 1957, *Saga of Lake Tahoe*, that traces Tahoe's development from 1857 to 1957.

Yet another element of Goin's research is a photographic look at the changes in the landscape after the 2007 Angora fire southwest of South Lake Tahoe. Now in its sixth year, the study ultimately will cover 10 years of photographing in 10 specific sites. Scott Hinton is the project's coordinator of photographic research.

A number of other books are in the works for Goin including a much larger rephotographic history of Lake Tahoe, a richly illustrated book designed to create a contemporary photographic view that is very close to the historical view.

"I'm trying to find the same or relatively similar vantage point for the historical camera and standardizing my photographs so, in the future, if someone wants to go back, they can exactly duplicate the images," Goin said.

Recently the University honored Goin as the 2013 Outstanding Undergraduate Research Faculty Mentor. He was also named the Outstanding Researcher of the Year in 2007.

Peter Goin

works to expand the visual history of Lake Tahoe by building a comprehensive archive of photographs.

Photograph by Krissy Clark

Darko Koracin

Scientist tracks ozone and particulate matter in the Tahoe Basin's atmosphere

By Guia Del Prado

Photographs by Krissy Clark

After a series of California air quality violations, Lake Tahoe researchers are shifting their attention to air quality problems in the basin. Desert Research Institute (DRI) research professor Darko Koracin is applying his expertise in advanced air quality modeling for complex terrain to unravel the complex air quality issues in one of the country's most pristine environments.

Though the states of California and Nevada continually work together to solve Lake Tahoe's environmental concerns, the fact that the basin straddles the Californian border often complicates these issues. The amount of ozone in the Tahoe Basin violated California's air quality standards several times between 2006 and 2010. California's air standards rank as one of the strictest in the country. Still, the violations exposed the lack of research and management being done on the Tahoe Basin's air quality.

To address the issue, Koracin and his research partners started an air quality modeling project this year, utilizing DRI's HPC (high performance computing) data center and expert integrated computer systems for modeling extremely large datasets, to track the amount of ozone and particulate matter in the Tahoe basin.

Koracin said ozone is what's called a secondary pollutant, meaning other pollutants must interact to create it. The Environmental Protection Agency tracks ozone closely, as it can be detrimental to plants and harmful to humans.

"The most dominant sources are vehicle emissions, which are not easy to control," Koracin said. "Some chemicals also don't directly make ozone but are important to the ozone cycle."

Although local sources like cars contribute to the amount of ozone in the basin, wind can also transport it from distant locations. This added complication makes ozone difficult to address locally. In order to create accurate models, Koracin will have to determine how much of the ozone comes from industrial sources in California and its Central Valley.

Particulate matter can also be harmful to the water and affect visibility in the basin. Particulate matter comes from the fumes and smoke created by cars, boats and fires. Though the current project will only focus on the warmer months of the year; Koracin said the next step is to model the air's particulate matter content during the winter. Residents using wood-burning stoves in the colder months may add a significant amount of particulate matter in the air.

"For the ozone part of the study, there is a good correlation with high temperatures," Koracin said. "But particulate matter is often a winter problem."

Koracin, who has more than 20 years of experience investigating weather and climate phenomena and creating atmospheric pollutant models at DRI, is well suited for the challenge of maintaining air quality standards in the Tahoe Basin. In addition to his research, Koracin also teaches and mentors students. He divides his time in the lab, teaching at the University of Nevada, Reno and lecturing about air quality at other colleges, including his alma mater, the University of Croatia, Zagreb.

The air quality project is one of his first projects at Lake Tahoe, but Koracin had always recognized the need for more research there.

"Lake Tahoe is one of the most beautiful areas in the U.S.," he said. "There's a big concern about the trends in air quality from the residents and tourist agencies to the federal and local agencies. A lot of work is being done and will continue to be done to preserve its pristine properties and air and water quality."

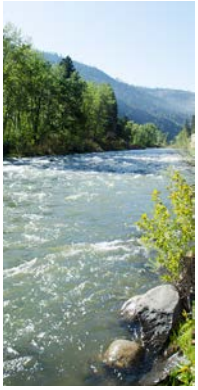
Darko Koracin
started a modeling project to track the amount of ozone and particulate matter in the air.

Photograph by Krissy Clark

Laurel Saito

Attracting students and helping agencies with water quality modeling

By Deanna Hearn



Photographs by Krissy Clark

Talk to Laurel Saito about ecohydrology, an emerging science to study the interactions between water and ecosystems, and she can't contain her enthusiasm for the University of Nevada, Reno's undergraduate ecohydrology major, the only bachelor of science degree program of its kind in the country.

"The University is unique in offering undergraduate ecohydrology. We have students transferring in because they want to do something that matters. I think it's important students have the opportunity to get interested in water and ecology at the undergraduate level." said Saito, director of the graduate hydrologic sciences program and adviser for the ecohydrology program in the Department of Natural Resources and Environmental Science.

Saito, an associate professor with an extensive background in water resources and interdisciplinary water modeling in the College of Agriculture, Biotechnology and Natural Resources, does most of her research on water quality as opposed to water quantity. That work has taken her to many locales including the Tahoe Basin for a study after the Gondola fire in July 2002 near the Nevada-California border at Lake Tahoe's south shore and the Truckee River.

In a study commissioned by the Truckee Meadows Water Authority (TMWA), Saito and one of her students looked at the issues surrounding a possible contaminant spill in the river from either a train or vehicle accident along the I-80 corridor.

"TMWA wanted some guidelines for the treatment plant operators if a spill occurred," Saito said. "They needed a way to figure out how much time they had until a spill would reach the water intakes and how long they would need to remain offline until the spill passed. We were able to model that for them."

Saito's team collaborated with the U.S. Geological Survey to conduct a dye study in the river and measure at various locations the times it took the dye to travel downstream and how much it spread in the river as it dispersed. This also allowed the researchers to determine dispersion equations for the first time on the Truckee River, something that is included in the manuscript to be published in the *Journal of Water Resources Planning and Management*.

Because Truckee River flows are highly regulated, they ran different flow scenarios through the model with simulated spills and set up a tool with various options for TMWA operators. Based on a number of factors, including the time of the spill and where it occurred, the tool can estimate the concentration of the spill, how long the contaminant would be present in the water above a certain level, when the plant should be shut down and when it could be turned back on.

"We provided time estimates that were conservative, best estimate and a liberal estimate to help the operators plan for such an occurrence," Saito said. "If a spill occurs at Boca Bridge, for example, they will have some idea when to get their equipment out there and start monitoring."

In another Truckee River paper published last summer, "Understanding perceptions of successful cooperation on water quality issues: A comparison across six western U.S. interstate watersheds," Saito worked with a student who was interested in whether or not people involved with watershed issues in the West thought working collaboratively was helping them better manage various water quality issues.

"There have been a lot of studies on interstate water with regard to the management of water quantity but not water quality," Saito said. "We conducted 48 surveys in six interstate watersheds, including the Truckee River. Meetings received the highest score for people's perception of success. There were higher marks for grassroots efforts rather than those who were required to work together because of river compacts or federal mandates.

"This relates to the Truckee River because the study found a wide range of cooperative activities in the Truckee River Basin, and people seem to be willing to work together and may be inspired by successes elsewhere. It is possible successful cooperation might spread to others."

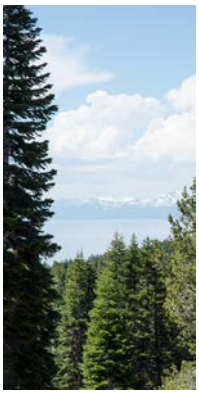
Laurel Saito
provides valuable information to agencies with water quality modeling.

Photograph by Krissy Clark

Rina Schumer and Hal Klieforth

Scientists collaborate to find new use for vast data collection

By Guia Del Prado



Photographs by Krissy Clark

After every storm and during every winter from 1965 to the 1996, Desert Research Institute (DRI) scientist Harold Klieforth collected snowpack samples at different sites scattered throughout the Tahoe Basin. In collecting this regional weather data, Klieforth established a network of precipitation monitoring bases that covers 1,000 square miles of the Truckee River watershed, which includes Lake Tahoe. His work for the Bureau of Reclamation's cloud seeding project resulted in the most comprehensive collection of precipitation data for the Tahoe Basin.

"To my knowledge, these records are unique," he said. "I believe that no other such series of measurements and observations have been made after every storm during such a long period over such a large region of mountainous terrain."

Now 30 years after he began collecting data, DRI scientist Rina Schumer is using the data to validate climate models that predict freezing levels and snowpack. Schumer first became interested in Klieforth's vast data collection while reading the many studies on the impact of changing Sierra snowpack on California water supply.

"The hydrology of the western and eastern Sierra Nevada are very different because the mountain range causes a rain shadow." Schumer says, adding "Hal's data give us a detailed look at whether the snowpack that supplies much of the water supply for Northeastern Nevada changed over three decades."

After three years of digitizing Klieforth's notebooks, Schumer, along with graduate student Hal Voepel, can document the strong correlation between snowfall volume and variability in winter temperatures. "The key is to separate natural variation in temperature from those caused by human activities. Northern Nevada relies on mountain snowpack to store water until we need it in the irrigation season," she said. "Changes in regional snowpack could affect local water management strategies."

Schumer also thinks about how pollutants like mercury or nutrients such as nitrogen and phosphorus contained in the Tahoe Basin snowpack make their way to the lake. These nutrients can have a damaging effect on the lake's ecosystem and water clarity. "There is great interest in excess nutrients entering the lake," Schumer said. "But there have been few studies focused on nutrients entering the lake from the snowpack that builds up on the mountains around the lake during the winter."

Schumer collaborates with fellow DRI scientist Daniel Obrist and graduate student Chris Pearson to collect samples from snowpack on the ground and snow falling from the sky. Using chemical data and measurements of snowfall like Klieforth's, they intend to make estimates of the pollutants held in the snowpack each year.

Schumer, along with many DRI colleagues, is carrying on the climate research that Klieforth began three decades ago. Schumer is currently the associate director of the graduate program of hydrology at the University.

Klieforth, now 86, joined DRI in January 1965 and is Professor Emeritus at both the University and DRI. He splits his time between his two homes in Reno and Bishop, Calif. Klieforth still finds time to hike and explore the Sierra Nevadas, the area that sparked his interest in how weather interacts with vegetation and wildlife continues to fire his scientific curiosity. Having grown up in Marin County, Calif., Klieforth found himself naturally drawn to Lake Tahoe and the surrounding region.

"Lake Tahoe and its environs were in the same climate regime as Marin County," he said. "They experienced the same storms and seasons. They were all part of my backyard, my background, and my life."

Rina Schumer (left)
with graduate student, Chris Pearson, (right) combines current and historical samples to model snowpack trends in the Tahoe Basin.

Photograph by Krissy Clark

Tom Jackman
utilizes 3-D technology to humanize data visualization.

Photograph by Quincy Shanks

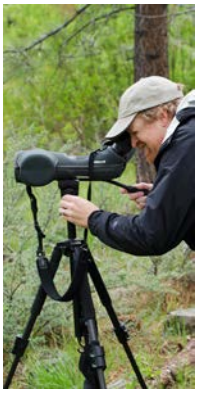
Will Richardson and Kirk Hardie

Bringing the natural wonders of Tahoe to the people

By Deanna Hearn

Loaded with expertise, passion and vision, Will Richardson and Kirk Hardie have a big dream. They want to build a world-class interpretive nature center, an evolving natural history museum that features ongoing research, education and community involvement on a scale not seen before in the Lake Tahoe Basin.

They've been laying the foundation for their ultimate dream since April 2010 when they formally created the Tahoe Institute for Natural Science (TINS), a member-supported nonprofit organization with the express purpose of advancing the natural history, conservation and ecosystem knowledge of the Tahoe region.



Photographs by Krissy Clark

Having felt the lure of Lake Tahoe for years, and armed with recent graduate science degrees from the University of Nevada, Reno, they combined their extensive teaching and research experience to foster greater appreciation, understanding and stewardship of Tahoe's natural resources.

"It's surprising there isn't a comprehensive nature center here," Richardson said. "With over three million visitors a year, it's a great way to reach out to the public with an extensive natural history clearinghouse that features education and ecological, applied and conservation-based research."

While they pursue the nature center, Richardson and Hardie continually expand TINS' extensive educational and citizen science offerings as well as the opportunities for adults and children to participate in hands-on nature experiences. They work collaboratively through research to help public and private land managers answer questions that support management decisions.

Richardson's research includes short-term studies and long-term monitoring in areas such as fall bird banding, bird monitoring at various locations and biological monitoring at the 2007 Angora fire site in the basin's southwestern corner. He's conducting a study of Tahoe's three primary species of rabbits and hares which have largely been ignored despite their important ecological role between vegetation and predators.

Designed to awaken students' curiosity of the natural world and engage them in responsible environmental citizenship, TINS educational programs bring nature to the classroom in schools in the Tahoe Basin and surrounding region. TINS also provides summer day camps and field trips.

"We had more than 4,500 student contacts ranging in age from kindergarten to high school in 2012," Hardie said.

Bugs, Bats and Birds is an in-school science program that runs from kindergarten through 5th grade. "Each year it builds on concepts and teaches students about their surroundings and what's happening in their own backyards," Hardie said. "We focus on the entire basin and take a comprehensive approach instead of just looking at certain parts of the lake."

Summer is a busy time with the Junior Entomologists camp (also known as Bug Camp) and a multitude of field trips and other summer camps where students learn about the forests, water and wildlife while they explore different parts of the basin through activities such as hiking and kayaking.

"There's great demand for our adult events such as bird hikes or a weekend dedicated to dragonflies. Our hikes fill up. We try to make them free and accessible and often do them in partnership with other organizations," said Richardson.

Although citizen science is heavily used at Tahoe for things such as water sampling, TINS helps people observe living things. They coordinate events such as butterfly counts and the local Christmas bird count which has been sponsored by the National Audubon Society for more than 100 years and is regarded as one of the largest and oldest citizen-science projects in the world.

The organization's education and citizen-science focus is broader than strictly water-related issues. "We found people were a lot more interested in bobcats and butterflies than in total dissolved solids and pH," Richardson said.

It's a busy life for both men, but as Hardie explains, "We enjoy the work. I got an email from a grandparent who told me the camp her grandson attended last summer made a huge difference in the boy's life. It's an "aha" moment for me when I can share something about the natural world that people never knew existed. Making that connection is our passion."

Will Richardson (right) and Kirk Hardie (left) *share their passion with the Tahoe community and facilitate collaboration with citizen scientists.*

Photograph by Krissy Clark

Marion Bisiaux

Alumna educates public about global warming using her own research experience

By Guia Del Prado

Photographs provided by Marion Bisiaux

Scientists are currently building on the discoveries that one University of Nevada, Reno alumna began along with her Desert Research Institute (DRI) mentors. Now Marion Bisiaux is using her expertise on pollutants to bring environmental issues to the forefront of the public's attention.

Bisiaux studied black carbon and ice cores as part of her postgraduate research in hydrology. Her work at Lake Tahoe, which focused on how pollutants harmful to water clarity enter the lake, comprised only a third of her dissertation. But the discoveries she made led to questions that had never been asked about water clarity issues until then. Bisiaux and her DRI research partners, Ross Edwards and Alan Heyvaert, found that black carbon, a type of particle created by combustion such as in car engines or fires, could enter Lake Tahoe from storm drains on the roads in great quantities. Although these particles do not seem to affect water clarity directly, Bisiaux's research suggested that other pollutants associated with urban pollution might also be carried to the lake along with black carbon.

Bisiaux also found high rates of black carbon in samples taken from the center of the lake. In particular, she tested samples taken shortly after the 2007 Angora Fire, which showed a spike in black carbon particles throughout the water column.

"Black carbon shouldn't have reached these depths in the middle of the lake so quickly," she said. "It was quite surprising."

She and her colleagues hypothesized that the pollutants fell into the water directly from the air, attached to other larger particles and settled toward the bottom of the lake."

Bisiaux said more work is needed to learn how pollutants behave in the lake's water and to assess the role prescribed fires and wildfires may or may not have on declining water quality.

Bisiaux finished her postdoctoral appointment in hydrology in 2011. During her last year in the program, she returned to her hometown of Grenoble, France, and began applying her expertise in ice cores and black carbon by collaborating with the Laboratory of Glaciology and Geophysical Environment (LGGE). Still, her idealism and drive to do better left her wanting more.

Bisiaux took six months off to travel and help a friend write a book about ice cores. When she returned, she knew she had to try something else. She thought back to her time as a student at the University when she taught a class about the cryosphere, the totality of ice and glaciers in the world.

"I got to talk with different people in different environments about different issues, not just the cryosphere," she said as she realized that one of the problems plaguing environmental scientists is the challenge of communicating the threat of global warming and the intricacies of scientific research.

"I'm sorry to say I was reaching a point where it felt like I was doing things that were so small that it wouldn't change anything for anybody," she said. "Even with all the global warming stories, some parts of science are really difficult to talk about properly."

She left her job and enrolled in a science communication program at Stendhal University. Bisiaux graduated from the program this past June. She is currently organizing a meeting for scientists where laypersons would have an opportunity to speak with scientists directly.

Bisiaux acknowledges that her work will be more like a hobby at first, but she plans to eventually start a nonprofit that would help scientists communicate their expertise to the public in ways that can change how people think of the environment and how they affect it.

Marion Bisiaux

returned to her hometown of Grenoble, France, during the last year of her postdoctoral program.

Photograph provided by Marion Bisiaux

Air quality in the Tahoe Basin
10 key questions and answers

Photographs by Krissy Clark

Overall, the air in the Lake Tahoe Basin is still much clearer than major urban areas, according to Alan Gertler, vice president of research and chief science officer at the Desert Research Institute. However, because Tahoe is visited by millions of people each year and considered by many as one of the few remaining pristine environments in the West, Gertler knows how critical air quality and visual range are to the future of the basin.

With more than 35 years of air quality research experience at Tahoe and around the world, Gertler shared his expertise to help answer 10 of the most common questions about air quality.

1 Why should we care about air quality in the Tahoe Basin?

When we look around Tahoe, the air usually looks clean, but it is one of the few areas in the region where ozone is increasing. It is now at a point where it will likely violate ambient air quality standards. Research also shows that air is a significant source of pollutants that lead to declining water clarity. If we want to reverse this trend, we need to consider making some atmospheric changes.

2 What air pollutants should we be concerned about?

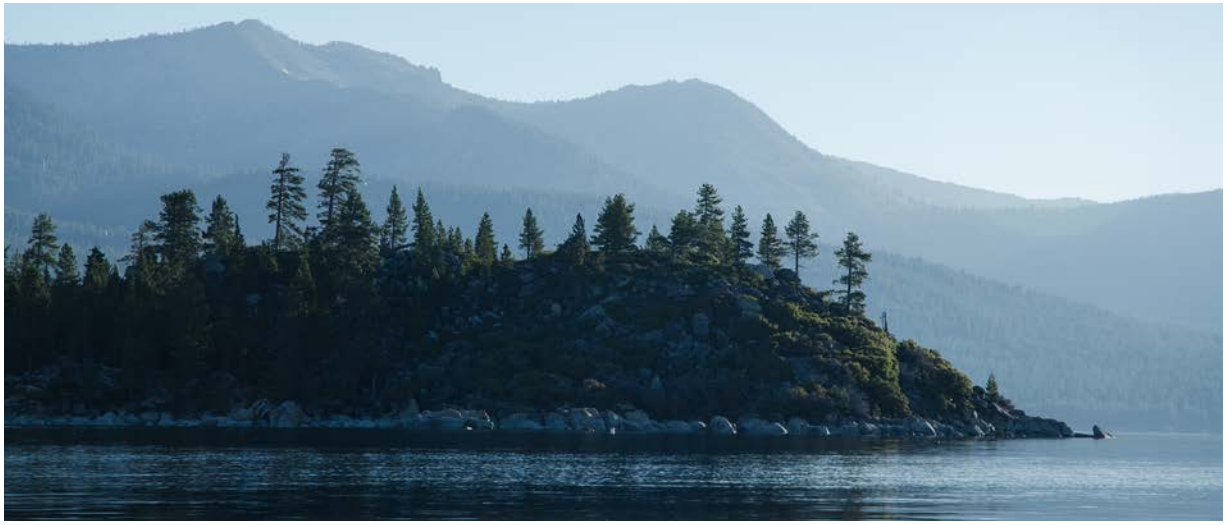
Both nitrogen and phosphorus lead to algae growth in the lake. We should also consider particulate matter because it, too, can deposit in the lake and reduce the clarity of the lake and its surrounding basin. A hazy day is caused by particulate matter. We're also concerned about ozone because of the negative effects it has on human health and the ecosystem.

3 What are the sources of the pollutants?

Particulate matter comes from road dust or soil, wood burning and emissions from cars, trucks and boats. Nitrogen is also from cars, trucks and boats, while phosphorus is from the soil and wood burning. Ozone is completely formed by chemical reactions in the atmosphere. The sources that are precursors to ozone formation include the mobile sources and the natural emission of hydrocarbon from trees.

4 Are these air pollutants from inside or outside the basin?

Studies have shown that a large majority of the pollutants come from sources inside the basin, as opposed to being transported from areas such as the Sacramento Valley or Bay Area. Since the wind tends to blow from west to east, the primary sources are also not from other locales in northern Nevada.



Photograph by Krissy Clark

5 Is wood burning a significant source of the pollutants?

Clearly, it is. There are three major sources of wood burning: fireplaces, prescribed burns and wildfires. We're not necessarily able to control wildfires, but we can control fireplaces and prescribed burns. In the future, we need to consider the weather conditions and air quality prior to scheduling prescribed burns. In winter, greater consideration should be given to controlling the use of fireplaces.

6 How important is road dust as a pollutant?

It's surprisingly important in terms of contributing to the decline in water quality. Large particles kick up and get scattered in the lake, they reduce visibility, and they contain phosphorus from the soil that leads to the growth of algae in the lake.

If we look at the two factors that lead to declining water quality, algae growth and sediment deposition, current estimates show that 55 percent of nitrogen and 15 percent of phosphorus that deposit into the lake come from atmospheric sources.

7 What can we do to control road dust?

Much of the dust comes from the sand and salt used on the roads during the winter snows. From a safety standpoint, we need to use it. However, what we could do instead is to increase the use of street sweepers and liquid de-icers, both of which would reduce soil on the road that can be re-suspended.

8 What role does fire play in air quality?

Fires are important from the standpoint of visibility in the basin. We want to be able to see across the lake, and fires greatly reduce the visual range. It's important the air be as clear as possible for many reasons, including aesthetics, yet there are no federal standards regarding visibility. The Tahoe Regional Planning Agency, however, does have a visibility standard.

9 What can we do to control sources of pollutants?

The most important sources we have to control are boats and the mobile sources, cars and trucks. Those sources provide the precursors to forming ozone, and they are also a significant source of particulate pollution.

10 How were the sources of the pollutants determined?

Two types of studies were conducted to determine the most important sources of pollutants: a bottom-up approach and a top-down approach. The bottom-up approach involved developing an emissions inventory that counted all activity from traffic, burning and other sources. What we see is that the largest sources of nitrogen are cars, trucks and boats. We also found that major sources of hydrocarbons in the basin are from the mobile sources as well as natural sources such as trees.

In the top-down approach, we conducted source-receptor modeling to establish where particulates were coming from. We wanted to determine the significance of road dust and emissions from wood burning and mobile sources.

Photographs by Peter Goin

Photograph by Scott Hinton

The role of fire in the Tahoe Basin
10 key questions and answers

Photographs by Scott Hinton

Soil scientists Wally Miller and Dale Johnson, professors emeriti in the College of Agriculture, Biotechnology and Natural Resources at the University of Nevada, Reno, have studied the impact of wildfires in the Tahoe Basin for many years. Their study of the 2002 Gondola wildfire near the Nevada-California border at the south shore of Lake Tahoe has led to new soils management strategies in the basin.

With more than six decades of combined experience and extensive work in forestry, biogeochemical cycling and fire ecology, Miller and Johnson shared their expertise to help answer 10 of the most common questions about the role fire and forest management play in the runoff of nutrients into the upper watershed that feeds into Lake Tahoe, ultimately affecting water quality.

1 How has the upper watershed been affected by historic fire management strategies?

Prior to the 20th century, wildfire was a natural part of Sierran ecosystems. It created forests that were less dense, structurally more diverse, had larger trees with less ladder fuels, sparse undergrowth and greatly reduced dead and decaying downed timber. These conditions have been altered by fire suppression over the last 100 years.

2 What has changed in today's forest landscape in the upper watershed?

The buildup of fuels from falling litter and plant life growing beneath the forest canopy has increased the potential for stand-replacing wildfires and resulted in the accumulation of much thicker, nutrient-rich organic residues that can release more available nutrients into runoff and percolating solutions that can reach Lake Tahoe.

3 What are the potential effects of wildfire on nutrients in the forest floor?

Wildfire was found to induce an immediate mobilization of inorganic nitrogen and phosphorus, both of which can affect water quality. Although this effect seems to diminish rapidly over time, a wildfire followed by a high water year within the first season after the fire would likely have a much greater impact on water quality than a wildfire followed by a low runoff water year.

4 What other fire management strategies are available?

The most commonly applied alternative to total fire suppression is fuel reduction by either mechanical thinning, prescribed burning or a combination of both.

Photographs by Peter Goin

5 What are the long-term forest health consequences of repeated prescribed burning as opposed to mechanical treatment?

Repeated burning is likely to cause greater nitrogen removal than mechanical thinning, perhaps causing reductions in regenerative growth.

6 What are the long-term water quality consequences of repeated prescribed burning as opposed to mechanical treatment?

Repeated burning is likely to cause greater nitrogen removal than mechanical thinning, which may help improve water quality.

7 What are the long-term forest health consequences of controlling post-wildfire brush?

Eliminating post-wildfire brush may preclude nitrogen fixation, the natural process by which nitrogen is converted to forms plants can use, and thus not allow replenishment of nitrogen lost during the wildfire. However, leaving brush may preclude the re-establishment of forest vegetation for many decades, creating quite a dilemma.

8 What are the long-term water quality consequences of controlling post-wildfire brush?

Thus far, we see no negative water quality effects of the most common nitrogen-fixing species, *Ceanothus velutinus*, a species of shrub with the common names of snowbrush, redroot and tobacco brush, native to western North America. Water quality effects should be minimal.

9 What are the effects of combining mechanical thinning and prescribed burning on water quality?

Prescribed burning in conjunction with mechanical harvest may potentially improve runoff water quality by reducing nitrogen and phosphorus litter mass pools and improving the overall health of forest ecosystems without the danger of a stand-replacing wildfire.

10 Is climate change important?

Absolutely. The fate of these forest ecosystems in a changing climate will have a direct impact on forest health, fire hazard, biomass mitigation strategies and water quality.

Photographs by Peter Goin

Photographs by Peter Goin

Lake Tahoe to Pyramid Lake: Summer Research Experience in the Arid West

Project outcomes report

By Michael Collopy

Photographs by Scott Hinton

Research combines creativity with a thorough understanding of a subject, as well as the quantitative, analytical and writing skills needed to effectively convey findings to your target audience. In order to build a future generation of talented researchers, it is crucial to give young students an opportunity to partake in the research process so that they may experience the challenges and rewards associated with research. During the past three summers (2010-2012), our National Science Foundation grant, "Lake Tahoe to Pyramid Lake: Summer Research Experience in the Arid West" has supported 27 nationally-recruited undergraduate students to conduct research during an intensive summer research experience for undergraduates or REU program. The overarching goal of our program was to explore the intersections between disciplines in the socioeconomic and natural sciences that inform adaptive watershed management. We also aimed to provide undergraduate students with a comprehensive research experience under the guidance of a faculty mentor in the student's field of interest.

Over the course of a 10-week program each summer, undergraduate students worked closely with their University of Nevada, Reno, faculty mentor in the following disciplines: fine art, landscape, plant and wildlife ecology, business, hydrology, history, geography, tourism, conservation biology, resource economics, limnology and political science, to develop and implement an array of projects that addressed current issues regarding natural resource management within the watershed. Throughout the summer, students were exposed to local natural resource management issues through a series of lectures and discussions with local managers and scientists designed to highlight the complexity of balancing policy and science to make informed management decisions.

Our program expanded students' knowledge of a specific topic related to natural resource management in the Lake Tahoe-Truckee River-Pyramid Lake watershed while allowing them to participate in all aspects of the research process. Our research program culminated in an undergraduate research poster session where students presented the findings of their projects to their peers, faculty and the general public. All projects contributed to an increased scientific and/or socioeconomic understanding of regional conservation issues in an applied context.

Feedback from students was very positive. Of the 27 students that participated in our REU program during 2010-2012, 89 percent indicated this was their first undergraduate research experience. As a learning experience, 52 percent rated the REU program as "fantastic-this is a great way to learn"; the remaining 48 percent indicated they "learned a lot." Students reported their overall experience with mentors was excellent or good (89 percent), with 88 percent indicating their overall research experience met or exceeded their expectations. When asked if their REU experience changed their perspective on continuing their education, 44 percent of the students indicated they already planned to go to graduate school and still did, while 52 percent reported that our REU program increased their interest in going to graduate school.

Photograph by Scott Hinton

"By far, the best research experience I have ever had...The skills I've mastered and the experiences encompassed within this REU will definitely help pave the way towards the life I want to lead."

2012 NSF REU recipient

Photograph by Scott Hinton

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291 Country Club Drive
Incline Village, NV 89451

Tel (775) 881-7566
Fax (775) 832-1673
www.tahoescience.org

August 19, 2013

Dear Presidents Johnson and Wells,

On behalf of the Tahoe Science Consortium, I would like to recognize and thank researchers from the University of Nevada, Reno and DRI for their outstanding contributions to the Tahoe Science Program. Your scientists have worked on many projects over the last eight years to help provide a scientific basis to understand, protect and restore Lake Tahoe and its ecosystems. Scientists from the University and DRI worked in collaboration with researchers from the University of California, Davis, the U.S. Geological Survey, the U.S. Forest Service, Tahoe resource agencies and other organizations around the country to deliver data and expert advice to environmental policy makers, regulators and managers.

The Tahoe research community has advanced our knowledge of mountain aquatic ecosystems and provided the basis for science-based management of Lake Tahoe, a critical and unique national ecological treasure. They have pioneered work to understand nearshore ecology, reduce the impact of aquatic invasive species, model the production and transport of ozone and other pollutants in the Tahoe Basin, improve lake clarity, and restore stream environment zones. They worked diligently to protect special status species, reduce the risk of catastrophic wildfires, understand the impacts of climate change, quantify the impacts of the built environment on Tahoe's ecosystems, determine the value of ecosystem services, and evaluate the risk of extreme events.

In addition to conducting scientific research, Tahoe scientists have served as subject matter expert advisors to federal and state management agencies and educated the next generation of environmental scientists, engineers, artists and policy makers about the importance of sustainable environmental stewardship. Your researchers have been integral to restoring and protecting Lake Tahoe and sharing this knowledge with similar communities around the world.

Thank you for these outstanding and continuing contributions.

Sincerely,

Maureen McCarthy
Executive Director

DRI Desert Research Institute
University of Nevada, Reno
USGS science for a changing world
UC DAVIS TAHOE ENVIRONMENTAL RESEARCH CENTER

Photograph by Krissy Clark

Contact Information

University of Nevada, Reno
1664 N. Virginia Street
Reno, NV 89557
(775) 784-1110
www.unr.edu

Media contact
Jane Tors
(775) 784-1880

Desert Research Institute
2215 Raggio Parkway
Reno, NV 89512
(775) 673-7300
www.dri.edu

Media contact
Greg Bortolin
(775) 673-7465

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University of Nevada, Reno

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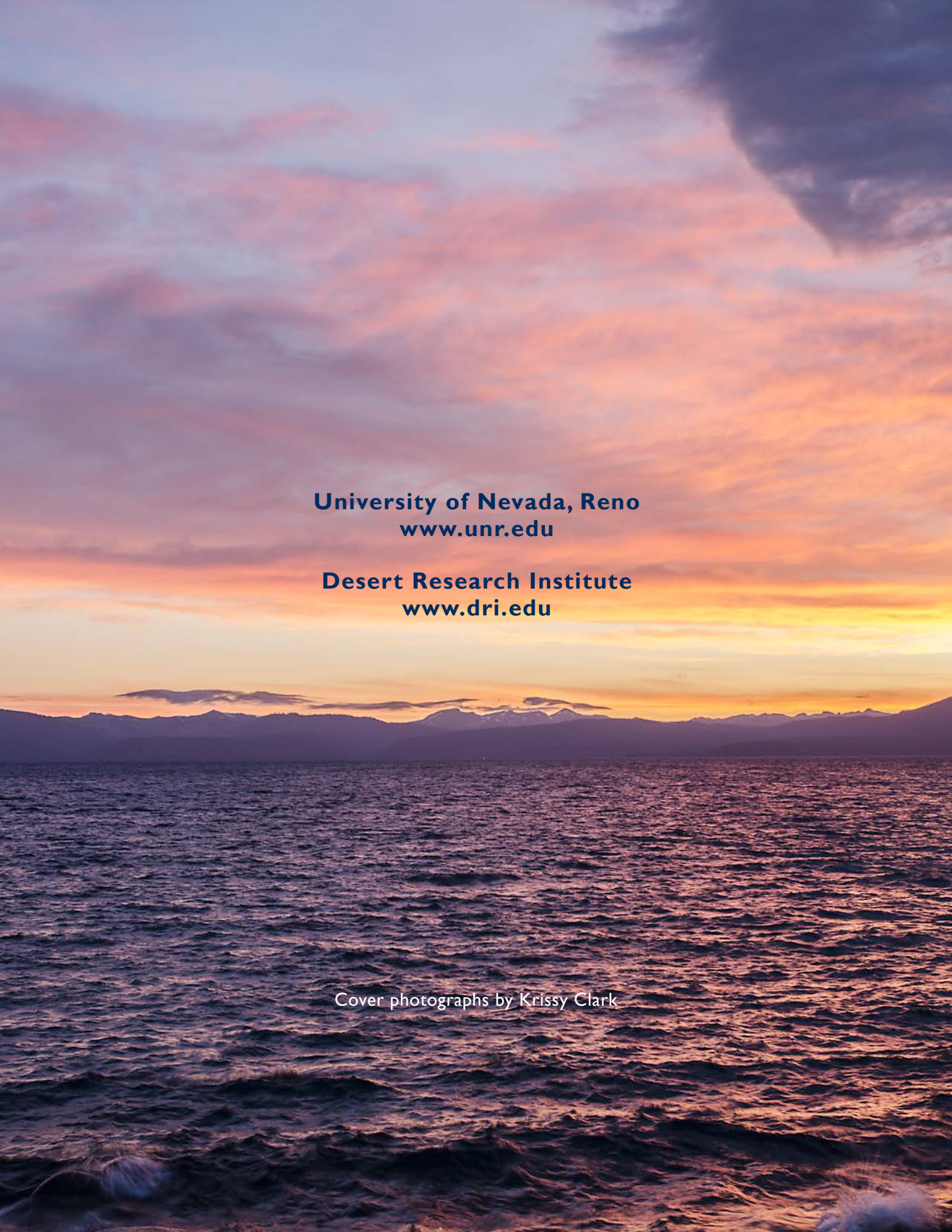

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