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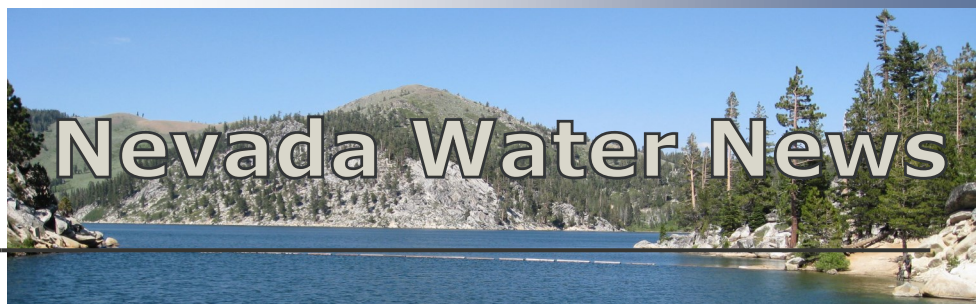
Desert Research Institute






Newsletter written and compiled by
Nicole Damon

**Inside this issue:**



## 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).

# *Director's Letter*

Greetings! As the new interim Director of the Division of Hydrologic Sciences (DHS) at Desert Research Institute, I'm pleased to be heading the Nevada Water Resources Research Institute (NWRRI).

Because Nevada is the most arid state in the United States, the research that DHS is conducting as the NWRRI provides valuable insights into managing and conserving Nevada's precious water resources. This research includes monitoring sensitive ecosystems—such as the research being done at Devils Hole that is featured in this issue—and finding innovative ways to conserve, restore, and repurpose valuable water resources.

This research is all the more important not only because of the past 16 years of ongoing drought that Nevada has experienced, but also because of the unknown effects that climate change could have on arid regions in the future. Desert Research Institute is taking an active role in conducting cutting-edge water resources research and providing opportunities for students to gain experience participating in these projects, which will train future generations of scientists.

I'm excited to learn more about the hydrologic research that DHS will be conducting in the coming years and how our researchers and students will be working to find the best ways to manage and conserve water resources in Nevada and throughout the United States and the world.

Sincerely,

Kumud Acharya ■

# *The Effects of Ecosystem Changes on the Devils Hole Pupfish Population*

Devils Hole is a unique aquatic environment located in the Mohave Desert that is home to the endangered Devils Hole pupfish. "The pupfish live in a system that's right on the edge of survivability in terms of both (high) water temperature and (low) dissolved oxygen," says Dr. Mark Hausner, who has been researching the Devils Hole aquatic ecosystem for nine years. "It also has a seasonal cycle of food availability." This delicate environment has undergone significant changes since it was first threatened by groundwater pumping in the late 1960s, which caused a sharp drop in the water level of Devils Hole. "Groundwater pumping for a ranching operation in Ash Meadows dropped the water level in the system by almost a meter, which almost completely dewatered the shallow shelf in Devils Hole," Hausner explains. "Although the water level began to rise once the groundwater pumping stopped in 1974, it never returned to the pre-pumping level."

Devils Hole was formed by a fissure in the rock connected to a groundwater aquifer and a series of ceiling collapses that created a water-filled cave that has a submerged shallow shelf (Riggs and Deacon, 2004). This shallow shelf is where the pupfish feed and spawn. A decrease in the water level over the shallow shelf also affects the water temperature, which in turn affects the survivability of pupfish eggs and juvenile fish, and consequently the overall pupfish population. "The Devils Hole pupfish population has an annual cycle, with spring lows and autumn highs," Hausner says. "The fish live just 10-14 months and although they spawn year-round, larvae only grow to adulthood when two conditions are met: the water is cool enough and there's enough food. This recruitment window occurs primarily in the spring, which causes a population increase from spring to fall."

Devils Hole as seen from above. The equipment shown is used to measure the water level.

In addition to water level changes, there have been other long-term environmental changes within Devils Hole. "Over the years, the dominant algae has shifted from green algae to cyanobacteria, one of the main species of ostracod that the pupfish prey on is no longer found in the system, and there has been an increasing abundance of riffle beetles and predaceous flatworms," Hausner says. "Although it's difficult to attribute the population decline to one particular change, the sum total of changes in the system appear to be moving toward a less friendly habitat."

The changes that have occurred in Devils Hole raise concerns about the potential effects of climate change on its ecosystem. Devils Hole is already experiencing higher water temperatures earlier in the year, which shortens the period of ideal water temperature and food availability on the shallow shelf. "Modeling shows that the current recruitment window is approximately ten percent shorter than the historical window, and simulations based on long-term climate projections point toward a continued shortening through the end of this century," Hausner explains. "That's what we've seen for the annual climate projections, but there has also been an increase in the

*(Research Spotlight continued)*

day-to-day climate variability, which is something that we'll be looking at in the future."

Although recent increases in the pupfish population seem encouraging, Hausner cautions that it's too early to determine what this signifies for the long-term. Although the spring population count increased from 80 fish in 2015 to 115 fish in 2016, it is still much lower than the spring counts of 220 fish in the late 1980s and early 1990s. The 2016 fall count of 144 fish also showed an increase, but it was still much lower than the fall counts from 30 years ago that averaged 400 to 500 fish. "We can't say for sure if the population will continue to rise," says Hausner. "We're learning more about the system all the time, but we don't have a lot of information about the ecosystem from the late 80s to early 90s, when it was relatively stable. We are getting better at managing the ecosystem, but we don't yet know if that's enough for the pupfish to survive."

The effects of human-induced changes to Devils Hole show the importance of proactive research, monitoring, and planning, especially for endangered populations. "In the simplest possible terms, humans 'broke' Devils Hole by mining the groundwater that the ecosystem depends on," Hausner says. "From my perspective, that means we have the responsibility to try to remedy the problems we caused."

A variety of management practices have been implemented at Devils Hole to encourage a more hospitable environment for the pupfish. Cover packets were installed on the shallow shelf to provide additional shade and protect juvenile fish from being eaten by adult fish. Material deposited from overland flows onto the shallow shelf is occasionally removed to maintain the depth of the shallow shelf, which is necessary to prevent increases in peak water temperatures that damage pupfish eggs and interfere with recruitment. Ongoing ecosystem monitoring is also integral to developing effective management plans. "In 2009, a long-term ecosystem monitoring plan (LTEMP) was finalized for Devils Hole to provide regular, systematically collected observations of a number of different ecosystem parameters," Hausner explains. "Having this baseline dataset for comparison when something happens is a valuable resource."

The Devils Hole pupfish depend on the shallow shelf in Devils Hole for both feeding and spawning (photo by Olin Feuerbacher/U.S. Fish and Wildlife Service).

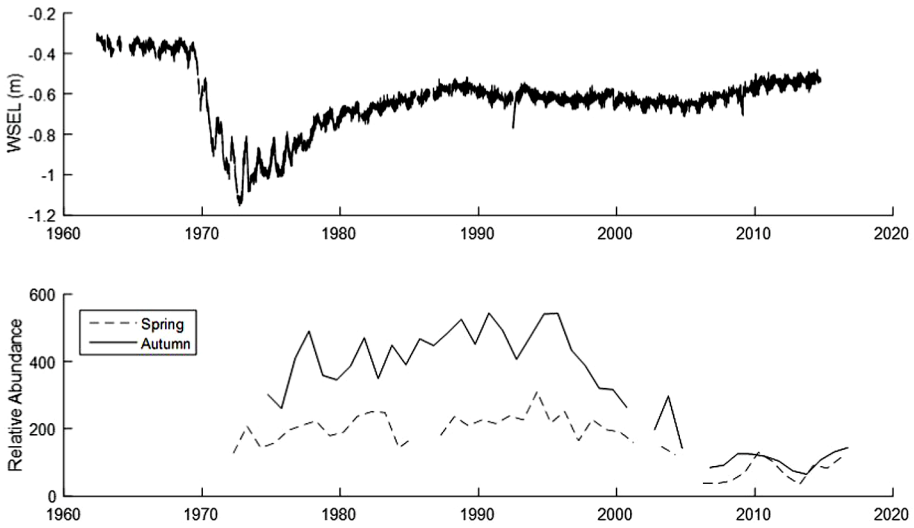
One of the more controversial management practice is the supplemental feeding program, which began in 2006. "The spring 2006 survey was just 38 fish and by December of that year, the few observable fish appeared to National Park Service (NPS) staff to be emaciated," Hausner explains. "The NPS staff were worried about a possible extinction, so they began providing additional food over the winter months. In the long term, the goal is to stop the supplemental feeding, but not until managers are confident that the fish can survive without it."

Another conservation effort is the establishment of a refuge population at the Ash Meadows Fish Conservation Facility (AMFCF), which is operated by the U.S. Fish and Wildlife Service. The AMFCF is a full-scale replica of the uppermost six meters of Devils

*(Research Spotlight continued)*

Hole made up of a 100,000 gallon tank and aquaria for rearing juvenile pupfish and invertebrates. The conservation facility supports a backup population of 50-100 Devils Hole pupfish. Pupfish eggs are collected from Devils Hole each winter, when they are likely to be viable but unlikely to survive until adulthood. The eggs are then transferred to the refuge tank, which helps maintain genetic diversity at the facility. "The facility also houses hybrid pupfish that are used for research purposes in a separate building," Hausner adds. "These are Devils Hole pupfish hybridized with Ash Meadows Amargosa pupfish in a previously established refuge. Researching the behavior and physiology of the hybrid pupfish, as well as various aquiculture techniques, has helped inform a number of management actions in Devils Hole, such as the use of cover packets and the formulation of the supplemental food."

Monitoring practices not only allow researchers to learn more about the pupfish, but they could also provide insight into the potential effects of climate change on arid environments in general. "Environmentally, the Devils Hole pupfish is like a canary in a coal mine," Hausner says. "Devils Hole is thought to be the smallest complete habitat for any vertebrate species in the world. Therefore, this limited habitat will respond quickly to stressors." The stressors that Devils Hole is it is currently experiencing—climate change, drastic temperature fluctuations, and shifting communities—are anticipated to be global environmental stressors in the future. "Ash Meadows National Wildlife Refuge (which surrounds Devils Hole) is just 23,000 acres, but it is home to three other endangered species of fish: the Ash Meadows Amargosa pupfish, Warm Springs pupfish, and Ash Meadows speckled dace," Hausner says. "The other two pupfish species are the closest relatives to the Devils Hole pupfish and they will likely respond to the same stresses in similar ways. The more we understand the response of the Devils Hole ecosystem to stress, the better we'll be able to manage and mitigate the impacts of those stresses on other endangered species." ■




The top plot shows the change in the water surface elevation (WSEL) over time. The bottom plot shows the spring (dashed line) and fall (solid line) pupfish population surveys. Although the population has increased since 2013 (when the spring survey counted just 35 fish), the current numbers are still far less than they were 25-30 years ago.

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***– Mark Hausner***

**Reference:**

Riggs, A.C., and J.E. Deacon, 2004. "Connectivity in Desert Aquatic Ecosystems: The Devils Hole Story." In *Conference Proceedings, 2002, Spring-Fed Wetlands: Important Scientific and Cultural Resources of the Intermountain Region, May 7–9,2002,* edited by D.W. Sada and S.E. Sharpe. DHS Publication No. 41210. Desert Research Institute. https://www.dri.edu/images/stories/conferences_and_workshops/spring-fed-wetlands/spring-fed-wetlands-riggs-deacon.pdf.

# *Postdoc Interview: Tihomir Kostadinov*

We asked postdoctoral fellow Dr. Tihomir Kostadinov about his current research and his continuing research plans. Here's what he had to say:

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

I have been interested in Earth and life sciences since I was very young. In college, I majored in biology with an emphasis in botany and I took an oceanography class, which I found fascinating and it sparked my interest in science related to water resources. I also took a GIS class, which I enjoyed. I went on to do ocean color remote sensing for my MA and PhD degrees, so I've been an oceanographer for a while. Later, at the University of Richmond, I had a collaborator who was interested in snow, so I branched out into snow remote sensing, which is what I am currently doing at DRI. Overall, I'm fascinated by the multiple critical roles water plays in climate and life on our planet.

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

Water on Earth and electromagnetic energy from the Sun are the two most important factors for sustaining life on our planet. Water is crucial for climate formation and freshwater on land is vital for humanity's existence. I am fascinated by all the intricate relationships between life and the Earth's systems that involve water, from the hydrologic cycle to the carbon cycle to climate feedbacks. When it comes to arid systems such as Nevada, I find it fascinating that such a variety of life calls this area home despite the extreme lack of precipitation (except this year!), especially in the growing season. It is also fascinating how dependent arid regions are on wintertime snowfall. Accurately quantifying the hydrologic cycle in such places, for example by using innovative techniques for the remote sensing of snow, is one of my key interests and that is what brought me here.

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

I am currently working on remote sensing of snow in the Sierra Nevada. Specifically, I am focusing my efforts on multi-platform data sets that have been collected over the Sierra Nevada and the Sagehen Creek watershed in particular. These include airborne hyperspectral imager overflights; light detection and ranging (LIDAR) data, which is essentially radar with lasers instead of radio frequencies; and ground-based distributed temperature observations, which have all been collected over the last few years. These multi-platform contemporaneous observations offer a unique opportunity to develop new methods to improve our capabilities to quantify snow in complex, forested terrain from space. Snowpack acts differently under forest canopies, which also make the snow hard to see with optical satellites. What I have learned so far is that although the same physical principles apply to ocean color and land/cryosphere remote sensing, the challenges facing the two fields, the terminology, and the approaches

*(Postdoc Interview continued)*

used are substantially different. I have also seen how valuable hyperspectral satellite sensors (i.e., imagers that measure at many finely resolved light wavelength channels to provide a fully resolved spectrum) can be for remote sensing. A fully resolved spectrum contains more information about the environment compared with most of the current satellite imagers that only measure a few wavelength channels. This underscores the importance of using hyperspectral instruments in future satellite missions.

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

I hope to learn more about the principles and techniques of land remote sensing, particularly in relation to the cryosphere and vegetation. I am also looking forward to learning more about using LIDAR data. One of my goals is to establish new scientific collaborations to become a better and more versatile scientific programmer and analyst. I am also looking forward to doing more fieldwork with different instruments.

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

I enjoy fieldwork, especially when there are lots of real-time measurements to collect. I also believe it is very important to actually spend time in the systems we are studying and get hands-on experience conducting measurements. I've done fieldwork both on research vessels at sea and on land in the mountains of the western United States, and I have enjoyed both. That said, I do enjoy lab work as well, which in my case is primarily modeling and analyses. I particularly enjoy solving challenging technical issues and programming tasks that are mathematical in nature, producing maps/visualizations of data, and calibrating and testing the field instruments.

**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'm an interdisciplinary scientist and I'm interested in many aspects of Earth science, but particularly remote sensing, oceanography (and water in general), planetary habitability, and the physical basis and controls on climate and climate change. I am interested in the Milankovitch cycles of Earth's orbital parameters and their effect on climate (i.e., the astronomical theory of climate). I also have an interest in positional astronomy and solar energy. I definitely aim to incorporate more of my interests in my future career as I have done in the past (e.g., branching out from ocean color to snow remote sensing).

**7) What is one of your favorite movies or books and why?**

I like a lot of books that deal with the relationship between humans and the natural environment. Here's four outstanding examples: *How to Find a Habitable Planet* by James Kasting; *The Omnivore's Dilemma* by Michael Pollan; *Guns, Germs, and Steel* by Jared Diamond; and *Sapiens* by Yuval Noah Harari.

***"Water is crucial for climate formation and freshwater on land is vital for humanity's existence. I am fascinated by all the intricate relationships between life and the Earth's systems that involve water, from the hydrologic cycle to the carbon cycle to climate feedbacks."***
***– Tihomir Kostadinov***

**8) Do you have a favorite dish that you like to make and why is it your favorite?**

I like to make a dish called *banitsa*, which is layers of phyllo dough with a mix of feta cheese, plain yogurt, and eggs layered between the dough that is then baked. It's a staple dish from Bulgaria (where I'm from) and the surrounding regions. I've grown up on it and always liked it. ■

# Upcoming Events

2017 Legislative Updates with Nevada State Engineer, Jason King, P.E.
July 26, 2017
Reno, NV
www.nvwra.org/2017legislativeupdates

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=

Environmental Geochemistry Workshop
September 25, 2017
Reno, NV
www.nvwra.org/geochemistry

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

Independence Lake & Perazzo Meadows Tour
September 29, 2017
Independence Lake, California (depart from Reno)
www.nvwra.org/2017-independence-lake-tour

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
www.geosociety.org/meetings/2017/

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/

*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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