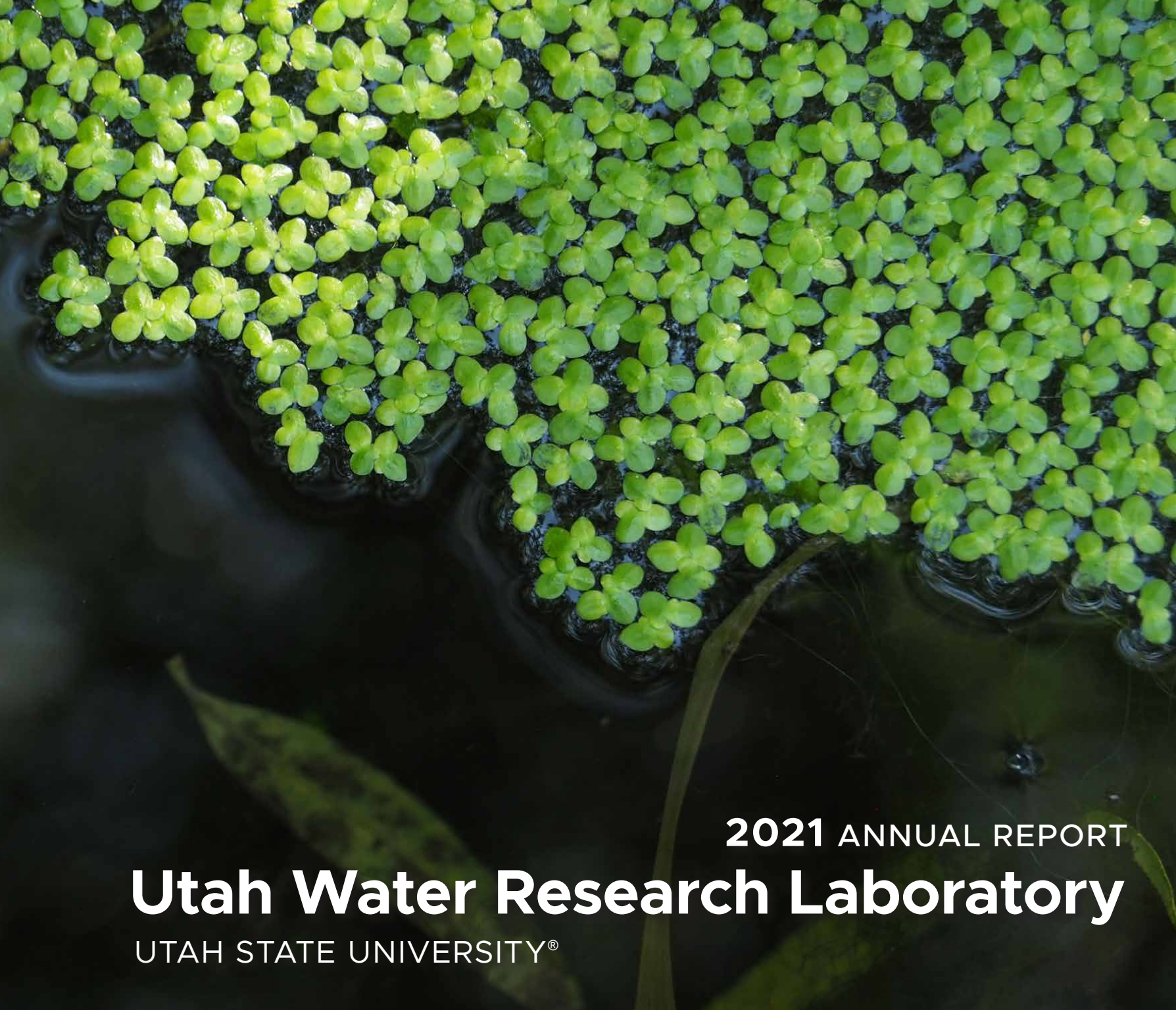

2021 ANNUAL REPORT

Utah Water Research Laboratory

UTAH STATE UNIVERSITY®

Message from the Director

David Tarboton
UWRL Director

2021 was a year of drought and fires in the western US. Both have important implications for water resources, and both are areas where the UWRL is doing research. In last year's annual report, we featured UWRL research on the Colorado River basin, and this research has only assumed greater importance in light of the ongoing drought. UWRL researcher Belize Lane has received National Science Foundation RAPID funding for post-wildfire monitoring of hydrologic response, and I am excited to see the results of this work in the near future.

2021 was one of the driest years on record in terms of the natural inflow to Lake Powell. Current (March 2022) snowpack is also low, which does not bode well for 2022. If one looks back 20 years, the average natural flow in the Colorado River at Lees Ferry has been 12.4 million acre feet per year, notably less than average consumptive use in the Upper and Lower Colorado River basins of 15 million acre feet per year. It is no wonder that Lakes Powell and Mead are at record low levels, and society is faced with the difficult problem of how to reduce water use to match available supply. It is through interdisciplinary understanding of all aspects of water problems that society will be able to face and resolve challenges such as this. In this report, we focus on some of the studies at the UWRL that cut across disciplines and advance integrative knowledge generation.

"Critical Zone" is a term used for the earth's outer skin, a thin layer from the tops of the trees to the bottom of the groundwater. The National Science Foundation's Critical Zone Collaborative Network is bringing together scientists studying the Critical Zone, where water processes are critically important for life on our planet. One feature in this report highlights how UWRL researchers are applying their expertise in hydrologic information systems and cyberinfrastructure to the Critical Zone Network Coordinating Hub.

Other work featured in this report includes the Logan River Observatory, a microcosm for investigating, understanding, and providing education on western water issues. Also featured is work to improve the hydraulics of urban flooding, along with a feature on cyanobacteria, the microorganisms responsible for what are called harmful algal blooms that plague some of our water resources.

The UWRL is also happy to welcome new faculty member Sierra Young who comes to us from North Carolina and has a focus on the use of robots and drones for sensing agricultural and natural systems. We also welcome Lore Clark as business manager. These are just a few of the projects and activities ongoing at the lab. I encourage you to read on and visit our website to learn more about UWRL research making an impact in so many different ways, at home and abroad.

http://uwrl.usu.edu/

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Critical Zone Collaborative Network Hub:
building the cyberinfrastructure for interdisciplinary critical zone research

The critical zone is the relatively thin layer surrounding our planet that supports all life and regulates many of Earth's characteristics. It reaches from the tops of the trees to the lowest bedrock where groundwater circulates—it's where life happens on our planet.

The Critical Zone Collaborative Network (CZNet) is a research program funded by the National Science Foundation (NSF) that brings together scientists studying the physical, chemical, biological, atmospheric, geological, and hydrological processes happening in the critical zone and how human interactions are impacting those interconnected processes. All that science creates and requires vast amounts of data, and that's where UWRL researchers Jeff Horsburgh and David Tarboton are making a valuable contribution.

These researchers are part of a collaborative team working to improve the data management, data sharing, and communication tools used by the engineers and scientists who study the earth's critical zone. The team is working to create the Critical Zone Collaborative Network Coordinating Hub.

This research is another contribution within the UWRL's general hydroinformatics research focus that seeks to advance hydrologic information systems in support of water-related problem solving and knowledge generation.

The Critical Zone Collaborative Network

CZNet is the latest phase of the NSF's Critical Zone research program. Building on the outcomes of earlier Critical Zone Observatories, CZNet consists of nine Thematic Cluster projects, each of which is focused on a scientific "theme" related to the critical zone. The Cluster themes address research topics in nine broad categories: Bedrock, Big Data, Coastal, Critical Interfaces, Drylands, Dust, Dynamic Water, Geomicrobiology, and Urban.

CZNet addresses interdisciplinary scientific questions at regional and national scales to better understand how different facets of critical zone processes interrelate and how they respond to the pressures of human impact. At the same time, the network seeks to increase understanding and connection between CZ scientists. Exchange of data and information is built into each project, and that exchange is facilitated by the CZNet Coordinating Hub.

The Coordinating Hub

The Hub ensures that the data created by the network of thematic cluster projects are standardized, archived and accessible for broad reuse. The Hub also facilitates outreach, connection, participation, and collaboration in the CZ community. Horsburgh and Tarboton are leading the Hub's Cyberinfrastructure Team,

and USU will receive $1.1 million over five years for their work on the Hub.

"The Hub is coordinating several aspects of the Collaborative Network's Thematic Cluster projects, but our main job is to help facilitate data sharing across the network." says Horsburgh. "We are building tools to help the data managers from the Thematic Cluster projects submit their data to reputable repositories to ensure that the data are Findable, Accessible, Interoperable, and Reusable (FAIR)."

Their goal to provide a robust cyberinfrastructure for FAIR data from the CZ network Thematic Clusters is not without challenges:

- CZ research is interdisciplinary, with researchers representing a broad spectrum of scientific expertise.
- CZ data and research products reflect this diversity.
- Existing data repositories have good functionality but are not coordinated.
- No single repository meets the needs of all CZ scientists
- The best repository to use for data or other research products is not always clear.
- Finding and accessing data shared within multiple repositories is challenging.

Their solution is a distributed architecture that links existing data facilities and services (e.g., HydroShare, EarthChem, SESAR, Zenodo, and other repositories) via a central hub with services for easy data submission, integrated data discovery and access, and linked computational resources that can enhance the shareability and reproducibility of scientific analyses.

The Hub also aims to grow the CZ community to include non-Cluster scientists, and enable more forward-looking data analysis, synthesis, cross-site comparisons, modeling, and the development of conceptual and theoretical unifying frameworks through integrative strategies for formally sharing and curating CZ data.

"The data being collected by the projects in this network are a tremendous resource to scientists studying the Critical Zone—not just those funded by NSF or the CZNet projects," continued Horsburgh. "Ensuring that the data being collected are made available using FAIR data principles ensures that they become a resource for the larger Critical Zone science community."

"Increasingly, scientific advances require large team efforts that combine information from multiple sources," added Tarboton. "It's gratifying to have our expertise in hydrologic information systems and data management recognized and included in this coordinated national effort. We are pleased to be part of this project." ■

CZNet Coordinating Hub team:

Jared Bales - *Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)– Lead Institution*

Jeff Horsburgh - *Civil and Environmental Engineering and Utah Water Research Laboratory, Utah State University*

Kerstin Lehnert - *Lamont Doherty Earth Observatory, Columbia University*

Chris Calloway - *Renaissance Computing Institute, University of North Carolina Chapel Hill*

Elizabeth Boyer – *Pennsylvania State University*

Jill Baron – *United States Geological Survey's John Wesley Powell Center for Analysis and Synthesis*

David Tarboton - *Civil and Environmental Engineering and Utah Water Research Laboratory, Utah State University*

CZNet
Critical Zone Network

https://criticalzone.org/hub

The Critical Zone Network Hub Structure

CRITICAL ZONE THEMATIC CLUSTERS

Scientists: Collect data • Aggregate data • Control and assure quality of data • Manage data locally • Create metadata • Submit data to the CZNet Coordinating Hub

DATA SUBMISSION PORTAL

Metadata templates • Data format standards • Controlled vocabulary • Data upload templates • Sample registration • Unique identifier management • User/data curation support • Documentation

LINKS TO EXISTING DATA REPOSITORIES

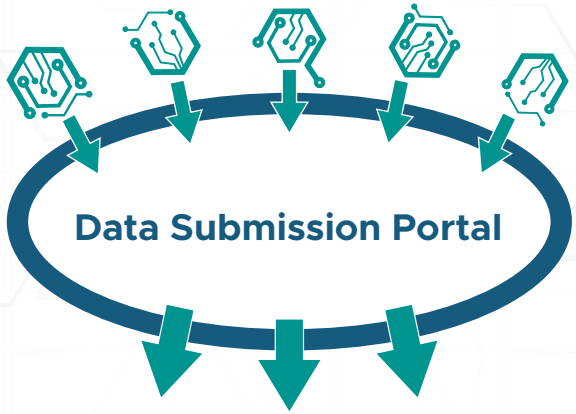
Permanent data archival and publication • Access control for embargoed data • Open access for public datasets • Citable data

CATALOG SERVICES

Connection to research products that are Findable, Accessible, Interoperable, and Reusable (FAIR) • Cross-repository view of CZ data products • Search functionality by author, keyword, geographic area or cluster • Schema.org metadata implementation

CZ Thematic Cluster Network Scientists

submit data and research products



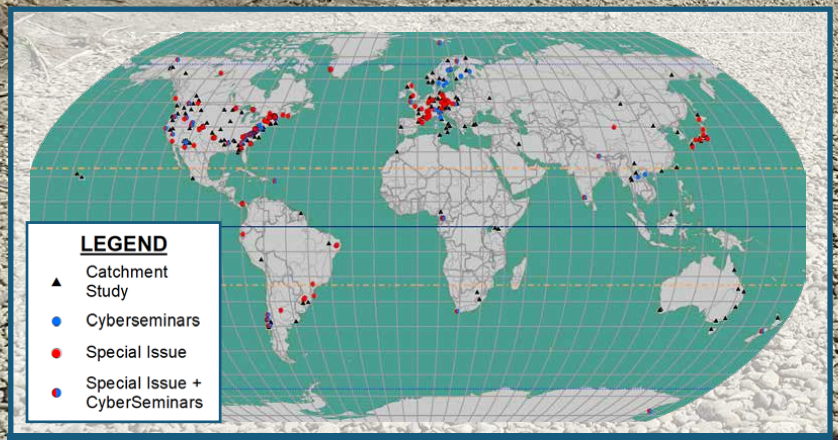
Automated submission to existing data repositories

- API Earth Chem
- API HydroShare
- API Zenodo
- API SESAR & Others

Catalog Services

Connects users with FAIR research products

Logan River Observatory:
information, education, understanding



The LRO is part of a worldwide effort to generate and maintain long-term hydrologic and water quality data to facilitate informed, sustainable water resources management around the world, now and in the future.

(map courtesy S. Sebestyen, published in "Research and observatory catchments: Promoting the sites behind the rich legacy of knowledge, discovery, and innovation." Earth and Space Science Open Archive)

During summer 2021, almost the entire State of Utah and much of the western US experienced extreme to exceptional drought conditions. In a state where much of our water supply depends on runoff from melting yearly snowpack, the water available for agricultural, municipal, industrial, ecological, hydropower, and other uses can vary significantly year to year.

This variability in streamflow, along with increasing demand and decreasing overall water availability, is deeply concerning for water managers. Because prior data inform their decisions, access to accurate, long-term data and a clear understanding of processes that control flow variability are vital to supporting sustainable water management decisions.

A Worldwide Challenge

The story is the same all across the world—decision makers need long-term data that will unravel and identify the interconnected nature of different aspects of the hydrologic cycle as they work to ensure sufficient water will be available for communities, nations, and ecosystems to thrive. This highlights the need for hydrologic observatories that represent various regions worldwide. Although each observatory may address local concerns and contribute to local solutions, together these observatories are part of a broader worldwide network, like pieces in a giant water puzzle, that bring our collective understanding into focus.

Logan River Observatory

The Logan River Observatory (LRO) in northern Utah is one such piece that is critical to understanding and planning for Utah's water needs. The LRO has been collecting aquatic (streamflow and water quality) and climate data throughout the Logan River watershed since 2014. This complex watershed features highly diverse hydrology, topography, and geology spanning relatively pristine mountainous areas that drain into the lower valley, supporting both agricultural and urban water uses.

The LRO is funded through partnerships with educational, community, and local and state government entities, including direct appropriations from the Utah Legislature through the Utah Division of Water Resources.

"The State of Utah clearly recognizes the value of this ongoing water related data and research," says Bethany Neilson who leads the LRO efforts. "The state funding for the LRO is

Neilson's LRO presentation at the CUAHSI 2021 Winter Cyberseminar Series: Research and Observatory Catchments: the Legacy and the Future (Week 7) focused on collaborating in agricultural and urban landscape catchments. The seminar brought together scientists involved in experimental catchment research at sites around the globe.

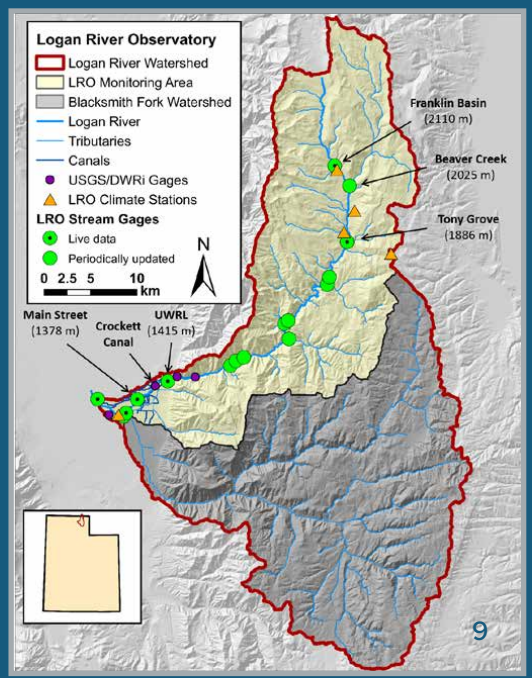
Information

The LRO is one of the most highly instrumented watersheds in the western US:

- **14** streamflow gaging stations
- **14** water quality stations
- **6** climate stations

Real-time and quality controlled data available at:

LROdata.usu.edu



Education

LRO data and research support learning from grade school to grad school, and from government to communities:

- Supporting graduate and undergraduate student research
- Providing an outdoor laboratory and data source for USU water-related courses and senior design projects
- Educating K-12 STEM teachers
- Increasing public awareness of human, landscape, and water connections
- Supporting stakeholder decision making

essential to the continuity of data streams that gives local and state leaders and water managers the information they need to make informed state-wide decisions about our limited water resources."

Even as a relatively young observatory, the LRO continues to build a valuable knowledge base to inform water management and hydrologic understanding. Through data sharing and new discoveries, the LRO is not only helping to find solutions to local water issues, but the data collected, knowledge gained, education offered, and processes developed are transferrable much more broadly to state and regional water problems.

Important Locally and Transferrable Globally

Effectively anticipating future conditions is critically important for the Logan River watershed as it is the primary drinking water supply for Logan City and for both residential and agricultural irrigation. The following representative research examples illustrate the importance of ongoing data collection, locally and beyond.

Streamflow gains and losses

One recent LRO publication (Neilson et al., 2021) shows the importance of collecting streamflow timeseries throughout watersheds that span diverse land cover and varied human influences. Such data can help identify when and where water is added to or taken from the river. In the mountainous portion of the Logan watershed, many seasonal springs and tributaries flow with varying amounts year to year based on prior snowpack. Additionally, groundwater can be added to the river, or river water can be lost to groundwater throughout the basin. In the valley, there many irrigation diversions take water from the river, but water is added to the river via urban and agriculturally sourced inflows.

Using flow timeseries data from LRO gaging stations, periodic streamflow measurements, and water chemistry samples in different reaches of the river, researchers have gained insight into gain and loss patterns throughout the basin (Tennant et al., 2021). They have also been able to distinguish water sources, helping establish how different conditions such as intense rains, changing snow dynamics, drought, and additional human influences may alter these exchanges in the future.

For example, future modifications to management practices in response to changes in climate, water availability, and/or continued development could diminish or eliminate inflows from urban and agriculturally influenced areas. This can be critical because these inflows are often the primary source of instream flow downstream of large irrigation diversions during the spring and summer months.

2021 LRO outcomes:

- **13** faculty at **3** institutions
- **6** journal publications
- **7** conference presentations
- **9** funded research projects
- **4** new research proposals
- **17** graduate students used LRO data for research or worked on Logan River watershed projects

Snowmelt driven karst groundwater systems

Neilson is one of several western researchers to be collectively awarded $700,000 from the National Science Foundation to study the Logan River watershed and its mountainous, snowmelt-driven, karst groundwater system, and the LRO is central to this effort. They are developing models to establish connections between snowpack variability and availability of groundwater and streamflow. This will offer insight into how water quantity from the Logan and other watersheds with similar characteristics might change under future climate conditions, including persistent drought (Xu et al., 2022).

These and many other LRO activities are contributing to a better understanding of local water-related management concerns as well as a broader understanding of how complex watersheds and semi-arid environments respond to changing conditions.

Added Value

"The research and long-term data are teaching us about hydrologic processes and the connectedness of groundwater and streamflow in snow driven watersheds, from source to useable water. At the same time, the LRO is about much more than research," says Neilson. "It creates connections with local and state entities, it's an outdoor classroom for students who will become our future water leaders, and it gives real people and decision makers valuable tools they need to manage water well, particularly during very dry years."

From gathering the long-term data to solve local water challenges along the Logan River, to providing an outdoor classroom for community members, students, and future water experts, to unravelling the ways snow-driven watersheds react to climate pressures, the LRO is a vital piece in a worldwide puzzle that is gradually revealing a clearer picture of what it will take to manage water more sustainably, now and in the future. ■

For more information on LRO activities and publications:

LRO.usu.edu

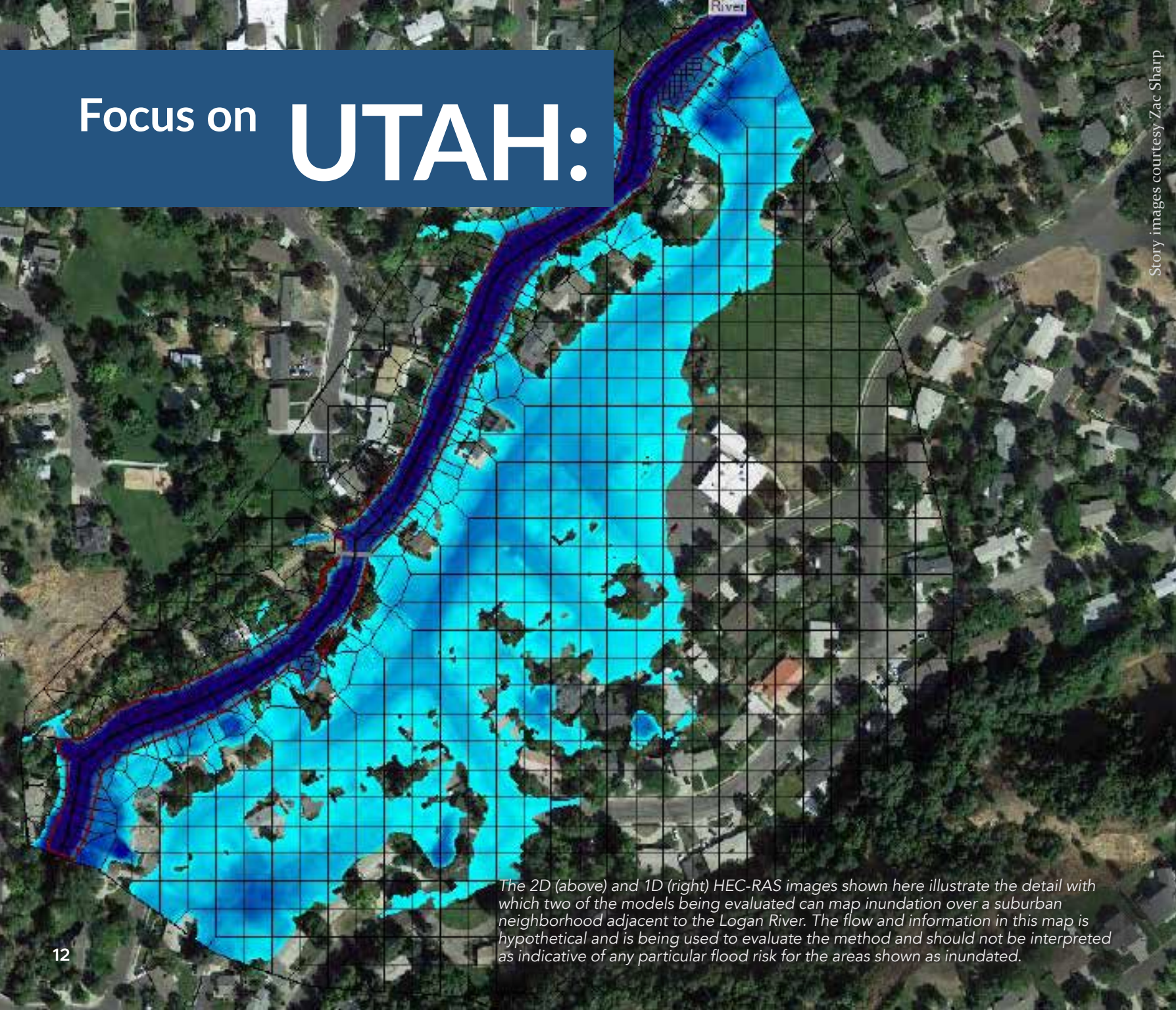
Story photos courtesy Bethany Neilson

In addition to core data and instrumentation, LRO supports further data collection, analyses and research products:

- **MONITORING** detailed river temperature, stormwater, and microplastic/dust
- **MEASURING** detailed river and canal flow
- **ANALYZING data** for local water-related decision making (Logan River Task Force, Cache Water District)
- **MODELING** temperature, river hydraulics, and snow distribution
- **MAPPING** springs and other key watershed attributes

Understanding

Focus on UTAH:



Story images courtesy Zac Sharp

The 2D (above) and 1D (right) HEC-RAS images shown here illustrate the detail with which two of the models being evaluated can map inundation over a suburban neighborhood adjacent to the Logan River. The flow and information in this map is hypothetical and is being used to evaluate the method and should not be interpreted as indicative of any particular flood risk for the areas shown as inundated.

Improving the Hydraulics of Urban Flooding

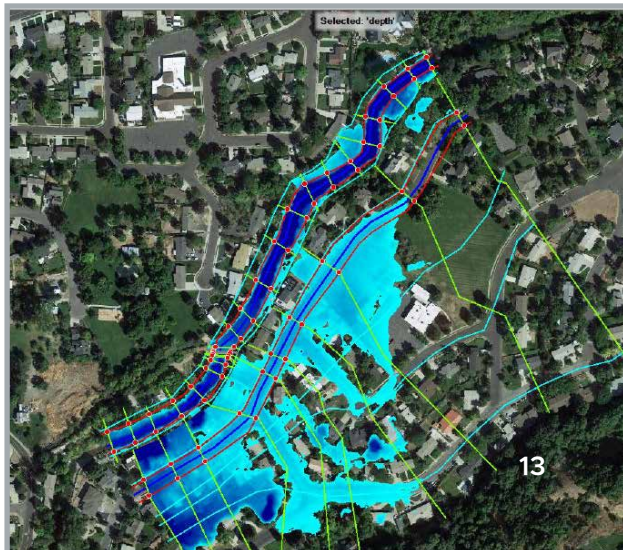
Mapping and mitigating flooding in the areas near to rivers subject to flooding impacts lives and property. This is an important problem as urban development occurs adjacent to rivers and urban structures alter natural flow paths. It is thus important that inundation be modeled and mapped accurately. UWRL Research assistant professor Zac Sharp and MS student Taylor Keslor are investigating how improving the detail in inputs to hydraulic models of flood prone areas and increasing the sophistication of the modeling approach improves the accuracy of model predictions. They have selected a reach of the Logan River to use as a case study to evaluate how limitations in current practice 1D HEC-RAS models due to choke points and other flow control structures can be improved using 2D HEC-RAS models, and further improved using a full 3D computational fluid dynamics (CFD) model.

1D HEC-RAS models are accurate and efficient for long river reaches. However, a limitation of a 1D model is in predicting the flow through control structures and other choke points in the river that may cause flooding. To accurately model control structures or other choke points in urban rivers with a 1D model, the modeler must know a rating curve for the choke point. Without that information the model can become inaccurate. A 2D HEC-RAS model is an improvement to the 1D model. It allows the user to let the model calculate the rating curve at control structures. The 2D model is also efficient and, in some instances, accurate for predicting the rating curves of choke points. Further improvement can be achieved using a full 3D computational fluid dynamics (CFD) model which can provide accurate rating curve information for all kinds of structures and choke points in urban rivers.

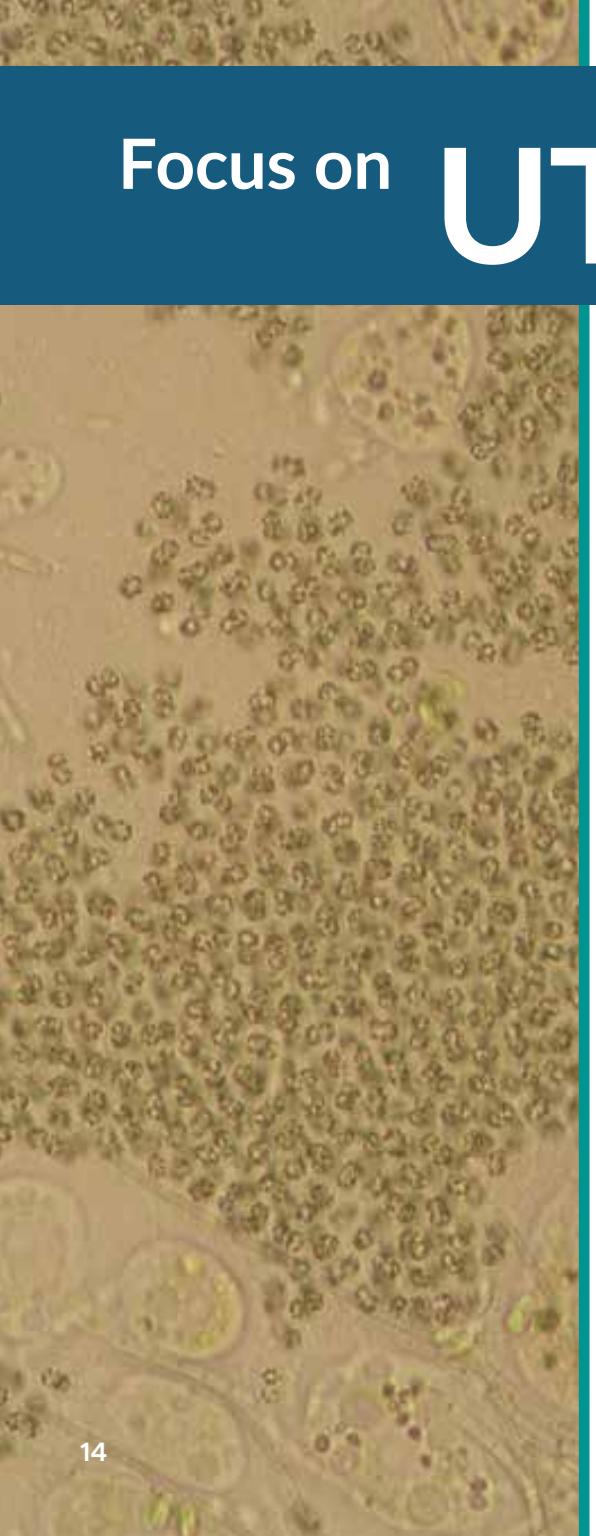
This work is important in Utah because, while we are in a dry state, climate change is altering the balance between rain and snow, and the rapidity of snowmelt events increasing the potential for flooding. Hydrologic models are increasingly improving their ability to predict the flows associated with such events, but translating these flows into flood inundation maps requires accurate hydraulic models, such as those investigated in this project. Improved flood prediction can help eliminate flood damage in a number of ways.

- First, with a proper warning, river managers and property owners can implement flood mitigation efforts to keep flow in the riverbanks.
- Second, with proper warning, people and animals can be evacuated and stay safe.
- Third, if identified early enough, the portion of the river (or structure, culvert, bridge, etc.) that causes the flooding may potentially be fixed and actually prevent flooding in that area.

Being able to more accurately locate and mitigate flood risks before they happen could provide safety, economic and societal benefits to citizens and communities across the state. While this study is helping Logan City particularly to address one of their most sensitive flood zone areas, this new approach could help other areas in Utah to improve their flood maps and be better prepared for potential future flooding. ■



This material is based upon work supported by the U.S. Geological Survey under Grant/Cooperative Agreement No. G21AP10623



Story photos courtesy David Stevens

Focus on UTAH:

What's in the Water?

Tracking cyanotoxin in Utah surface waters

They may be small, but cyanobacteria are getting a lot of attention lately. These microscopic organisms are abundant in Utah lakes and reservoirs with excess phosphorus, especially in late summer and autumn.

Cyanobacteria are so called because they contain chlorophyll and a blue pigment. Many are phototrophic—they harvest sunlight for the energy needed to grow. Many can take nitrogen straight from the atmosphere. Warming climates and higher nutrient levels (such as nitrogen and phosphorus) from human activities are creating increasingly favorable conditions for yearly "blooms" in more Utah's surface waters.

Many cyanobacteria can also produce chemicals called cyanotoxins that are among the more potent natural poisons that affect nervous system and liver functions in humans and other mammals, including dogs and livestock. Some evidence suggests links between cyanotoxins and neurological disorders such as Lou Gehrig's disease.

Thus, it is no surprise that state water administrators recently listed cyanotoxins as one of their top three concerns in drinking water systems nationwide.

Facing the Challenges

To address this growing concern, UWRL researchers David Stevens and Joan McLean are collaborating with the Utah Division of Water Quality (DEQ), Utah Division of Drinking Water (DEQ), and the Bear River Health Department (BRHD) to monitor for cyanotoxins at several Utah lakes and reservoirs and conduct laboratory-controlled studies to better understand the environmental conditions that affect cyanobacterial growth and toxin release.

"The importance of this issue to drinking water quality cannot be overstated," says project lead David Stevens. "Utah also prides itself on its exceptional outdoor recreation and quality of life. The threats cyanobacteria and their toxins pose to these resources is difficult to pin down, but in this project we are working to clarify how to predict where and when the threats need to be addressed."

The Research

After an extensive literature review of existing mathematical models of cyanobacteria growth and cyanotoxin production, the team is now:

- monitoring and assessing key selected Utah drinking water utilities to identify cyanobacteria and levels of toxins in Utah recreational waters and drinking water supplies.
- performing initial laboratory and kinetic modeling work to evaluate the various factors, such as light, nutrient inputs, and temperature, that stimulate cyanobacteria to grow and produce toxins.
- coordinating with drinking water utilities to determine the need for and establish programs that monitor and assess cyanotoxin risk.
- determining the data needed to effectively establish and maintain those programs.

Results

Based on samples of cyanobacterial blooms provided by the DEQ's extensive monitoring program at many Utah reservoirs and lakes, the researchers have been able to isolate three individual cyanobacterial species.

These are now being grown into feed cultures for upcoming growth and toxin-production experiments. Set volumes of these cultures will be added to water from each of the lakes from which initial cultures were found (Matt Warner Reservoir, Scofield Reservoir, and Pineview Reservoir) and nutrient, temperature, and other environmental conditions will be varied to determine the impacts those conditions have on the growth of cyanobacteria and the likelihood of toxin production.

Toxins anatoxin-a, microsystins, and cylindrospermopsin have been found in samples from Utah lakes and reservoirs. Most locations were below the detection limit, but several showed levels that cause concern.

Looking to the Future

These monitoring and laboratory studies will ultimately result in an improved kinetic model for growth and toxin production that will provide the following benefits to drinking water managers:

- The guidance necessary for developing long-term cyanotoxin monitoring programs
- Preliminary data collection and database development for cyanotoxin-related information
- An assessment of the current cyanotoxin risk in water supplies that also identifies problem supplies at risk of increasing cyanotoxin presence

"Controlling the threat posed by cyanobacteria and their toxins comes down to controlling nutrient inputs to Utah lakes and reservoirs," says Stevens. "Wastewater discharges and other contributions from natural and human activities are significant and expensive to manage. With a better understanding of specific threats, managers can target specific locations and times, resulting in greater overall savings." ■

Cyanobacteria in Utah

- **Cyanobacteria blooms have been reported in several Utah reservoirs used for drinking water supplies, including Scofield (Carbon County), Mantua (Box Elder County), and Pineview (Weber County) reservoirs. Others have noted cyanobacteria blooms in late summer and fall in their source waters.**
- **A USEPA lake survey as early as 2007 found that samples from 8 out of 28 Utah reservoirs showed a moderate to high risk for exposure to cyanotoxins.**
- **One well-publicized cyanobacteria bloom in Utah Lake in fall 2014 resulted in the death of a swimming dog.**

Awards & Achievements*

Faculty Awards

Ryan Dupont

2021 Cazier Professor Lifetime Achievement Award

R. Ryan Dupont recently received one of USU's most prestigious honors: the 2021 Cazier Professor Lifetime Achievement Award, which recognizes senior faculty members who have demonstrated more than 20 years of consistent excellence in their academic careers.

Belize Lane

UCOWR 2022 Early Career Award for Applied Water Research

The University Council on Water Resources has awarded UWRL assistant professor Belize Lane the 2022 Early Career Award for Applied Water Research for her research on arid, water-limited regions in the western US, interdisciplinary communication skills, and student support.

Mac McKee

2021 Warren A. Hall Medal

Former UWRL Director Mac McKee was recently selected to be a recipient of the 2021 Universities Council on Water Resources Warren A. Hall Medal for his exceptional accomplishments in water resources over the course of his 40-year career.

Student Awards

Kevin Plaizier won first place in an international drone design contest established by actor Terrence Howard.

Shelby Bulkley received this year's American Water Works Association Intermountain Section, Undergraduate Scholarship.

Kailey Jorgensen recieved this year's American Water Works Association Intermountain Section, Eva Nieminski Graduate Scholarship.

Emma Lyon and **Caitlin Arnold** presented their research at the Association of State Dam Safety Officials Conference.

New Grant Awards

New I-GUIDE Institute

USU faculty members David Tarboton, Jeff Horsburgh, and Courtney Flint are part of a large multi-disciplinary team collaborating within the University of Illinois Urbana Champaign's newly formed Institute for Geospatial Understanding through an Integrative Discovery Environment (I-GUIDE). This $15 million, 5-year project is part of the NSF Harnessing the Data Revolution initiative. The USU team is creating tools to better understand the global impact of climate change and other disasters.

Research on Water Markets

A $10 million grant from the USDA, has researchers from USU and a cohort of other institutions exploring ways to make regional water management more resilient to change. The team includes experts in climate, water resources, economics, modeling, institutional design, transdisciplinary research,

*These are just a few of the many achievements at the UWRL in FY 2021

education and actionable outreach, including UWRL researchers Niel Allen, David Rosenberg, and Alfonso Torres-Rua, along with USU's Sara Null (project lead, Watershed Sciences), and Matt Yost (Plants, Soils, and Climate).

Other News

ISO/IEC 17025 Certification

The UWRL hydraulics laboratory received this accreditation recognizing excellence and quality in the laboratory testing industry.

Land, Water, Air Report

Several UWRL faculty contributed to USU's first report to the Governor on Utah's Land, Water, and Air by the new Janet Quinney Lawson Institute for Land, Water, and Air.

L. Douglas James Memorial Scholarship

UWRL alumna Zhida Song-James established this endowed scholarship in memory of her late husband, L. Douglas James, who served as UWRL director from 1976 to 1992. The scholarship will support undergraduate students to do water-related research at the UWRL.

Welcome to the UWRL

Sierra Young

Assistant Professor

Expertise: *Employing ground, aquatic, and aerial vehicles and developing new sensing mechanisms and autonomous methods to better understand agricultural and natural systems.*

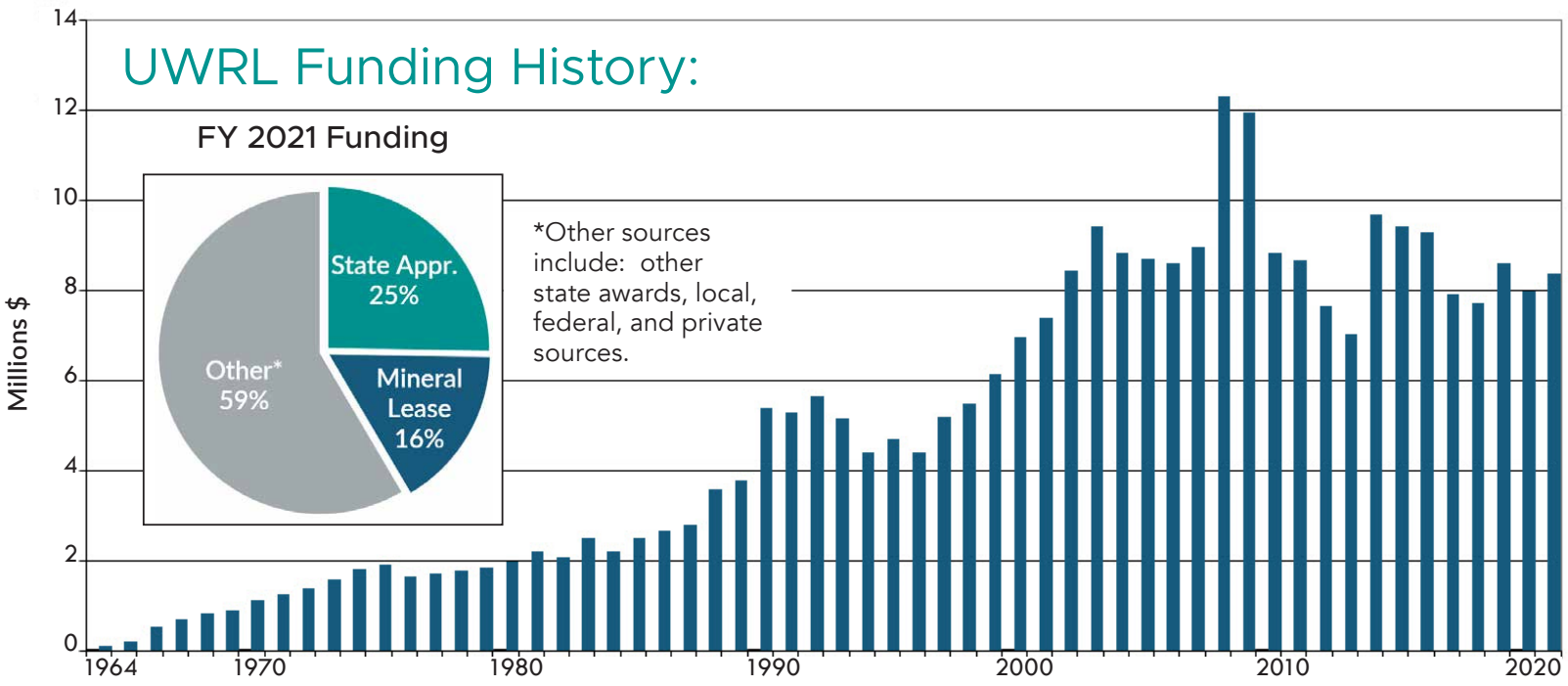
Sierra Young recently joined the UWRL/CEE faculty at USU. Young earned a bachelor's degree from Cornell University and a master's and PhD from the University of Illinois at Urbana-Champaign, all in civil and environmental engineering. Before coming to USU, Young worked as a visiting scholar in the Agricultural and Biosystems Engineering Department at Iowa State University and then as an assistant professor in the Biological and Agricultural Engineering Department at North Carolina State University. Her current research includes using aquatic surface vehicles and aerial vehicles to improve water quality monitoring and using remote sensing and drones to monitor soil moisture. She loves fieldwork and looks forward to collaborating with researchers from different departments and programs and bridging the gap between agriculture and environmental engineering. ■

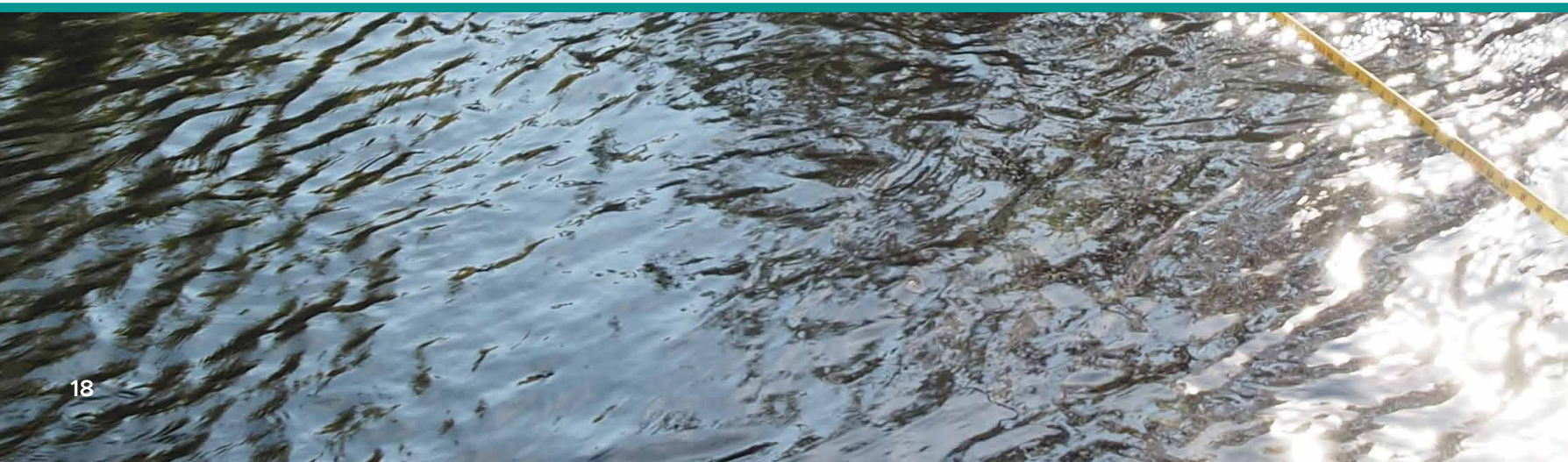
Lore Clark

UWRL Business Manager

Lore Clark recently joined the UWRL community as our new business manager to oversee Business Services Office functions, coordinate with other business-related campus departments, and handle financial reporting and grant management. While originally from Logan, Lore has also lived in Montana, Ohio, Michigan, and Florida. Although she graduated from Rocky Mountain College in Billings, MT, in 2017 with a degree in Business Administration and an emphasis in Managerial Accounting, she has spent most of her career creating, running, and refining businesses in various fields. Since returning to Utah, Clark has previously worked in USU's Scholarships, Advising, and Student Affairs offices. ■

FY 2021 Financial/Academic Summary





Research and Training Products:

176
Active projects

72
Scholarly presentations at professional conferences

68
Scholarly publications in peer reviewed journals

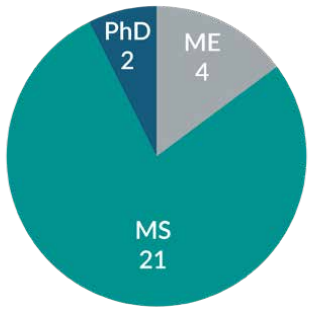
34
Short courses & trainings

Student Outcomes:

63
Graduate research assistantships funded

47
Undergraduate students supported

27
Graduate degrees granted



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Publication writer/editor, Carri Richards; cover photo courtesy of Bethany Neilson