

2025 ANNUAL REPORT



Utah Water Research Laboratory

UTAH STATE UNIVERSITY®



Bethany Neilson
UWRL Director

Water challenges affect everyone everywhere: from the kayaker headed toward a low head dam, to the grocery shopper concerned about contaminated lettuce, to those of us hoping to keep our lawns green.

Research to find solutions to these challenges must

be applicable to highly variable situations and people. Researchers at the Utah Water Research Laboratory take into account not only research needs and solutions, but figuring out how to communicate the results to people who need them.

This is the case with Brian Crookston's leading efforts on low-head dam safety. His toolbox can be used by anyone needing information about the risks surrounding a low-head dam in their area, and his work is supported by national efforts to increase awareness about these risks.

Other data-driven efforts at the UWRL are focused on the natural flow conditions of rivers and managed wetlands that deliver water to the Great Salt Lake. Belize Lane and her team want to know if, while tracking that water to the lake, we can also achieve environmental water management goals along the way, ensuring good fish habitat and improved water quality. Collaborating with the Utah Department of Natural Resources, Lane hopes to bring functional flows to the table of GSL decision making.

Microplastics in our drinking and irrigation water may be affecting people in Utah. Microplastics can be transported through wastewater treatment plants to downstream drinking water treatment plants or irrigation systems, impacting our drinking water, soils, and crops. Kyle Moor, Yiming Su, and Liyuan (Joanna) Hou are working on several separate projects focused on every stage of the microplastic problem from generation to transport and degradation.

As we collaborate with local and state officials on a myriad of water issues, we are dedicated to ensuring the knowledge we gain gets into the hands of those who can use it. Education and outreach efforts are central to the mission of the Utah Water Research Laboratory, so we are pleased to open our annual report with an overview of our outreach impact in the Bear River Basin.

The projects highlighted in this report are just a snippet of the full breadth and depth of research we do, but they are focused, as is all our work, on the real water needs of Utah and the world. The challenges affect everyone, and so it takes everyone—dedicated researchers, state and federal agencies, local water users, and more—to find and implement solutions. ■

For more information, please visit our website:

<http://uwrl.usu.edu/>



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Story photos courtesy UWRL

Bear River Basin Impact

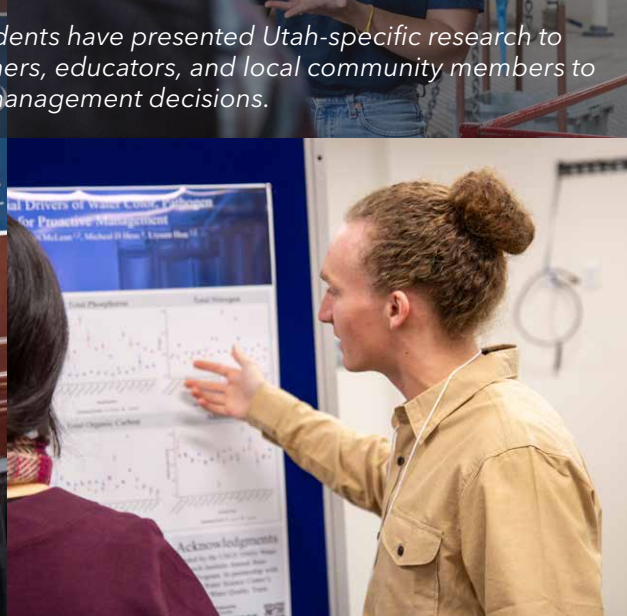


The Logan River Observatory joined the Bear River Commission to tour sites along the Bear River and discuss the importance of water measurement to managing sustainable growth





The Utah Water Research Laboratory is dedicated to not only the science and engineering work in the field and lab, but the outreach and education necessary to build bridges with water and environmental decision makers and future students. Data is only useful when it can be used to better the world. In the Bear River Basin, the UWRL has worked with community and educational programs to increase awareness of water research and solutions, including tours, presentations, and efforts to build connections.



Our faculty and students have presented Utah-specific research to legislators, researchers, educators, and local community members to help inform water management decisions.



Professor David Rosenberg brought together students, local officials, and the Bear River Watershed Council to explore Cutler Dam and discuss how water infrastructure and delivery in the Bear River system impact ability to get water to Great Salt Lake.

Building a Low-Head Dam Safety Toolbox

In any one year, fifteen to thirty people drown at low-head dams in the US. In general, the public is unaware of the drowning potential of the rotating current, known as a reverse roller, immediately downstream and just beneath the surface. Individuals overturning in a kayak, trying to rescue a family pet, and even participating in carefully prepared training exercises by search and rescue have all been victims.

Although recreation is an important function of many rivers in the US, a lack of knowledge of low-head dams and the deadly reverse roller presents a very real risk for those who point their paddles downstream.

"If you're recreating and you're traveling downstream, it can be almost impossible to see the drop of the low head dam, so you're basically on top of it when you see it," said professor Brian Crookston from the Utah Water Research Laboratory.

Crookston is developing a toolbox with Professor Rollin Hotchkiss at Brigham Young University (BYU) to help those involved in public safety to analyze the risk of reverse rollers at low-head dams. The rotating current that traps people is a function of river discharge and stage. If the water elevation

below the dam is high, like after a rainstorm, the reverse roller can form.

"People might go out kayaking on a Sunday and everything is safe," Crookston said. "But then you might get a half inch of rain overnight and suddenly the reverse roller is there. People who are familiar with the dam may not know how quickly conditions can change and that there is a new danger."

He hopes his safety assessment tools will help with risk assessments and public safety improvements.

The work began as a volunteer effort five years ago. No funding, no one asking for the data, just researchers and engineers at Utah State University, BYU, and other organizations passionate about the work. Thankfully professional organizations such as USSD, ASCE, and ASDSO were supportive.

Through crowdsourcing efforts where individuals would spend time over their weekend scanning Google Earth and recreators using apps to geolocate and take pictures of low-head dams, a nation-wide database was formed to identify all of these structures in the lower forty-eight states. Advanced tools were developed to automate this

process, such as a recent MS project at USU by Caitlin Arnold. This collaborative, crowdsourced effort became the foundation for Crookston to work with BYU and the Federal Emergency Management Agency (FEMA) to get the data needed to improve safety and public information at these dams.

To build a toolbox useful at any of these structures in the database, Crookston partnered with UWRL's AggieAir to get LiDAR scans of topography by rivers, augmented by ADCP boat measurements to see what's beneath the water surface at a low-head dam. The field data was used to create example models. Crookston said UAVs are a great way to scan the river and get the most accurate data needed for effective modeling so stakeholders can consider site-specific conditions.

The data, the example models, and all the other information the researchers have about low-head dams, reverse rollers, and risk assessments are being packaged into a single plain-language toolbox intended to be picked up and used by anyone.

"If a stakeholder says, 'I know of this low-head dam, but I don't know if it's dangerous,' then they can download

our toolbox that will walk them through the danger, the data needed, and the modeling efforts.”

Crookston said stakeholders using this toolbox can showcase the data as justification when pursuing grants to improve the safety of the dams.

The national database of low head dams will be hosted by the US Army Corps of Engineers, who already have a database for large dams. The researchers’ efforts have resulted in a low-head dams safety month and increased public awareness like the Association of State Dam Safety Officials’ 2026 campaign. More members of the academic community are also becoming involved, extending the network of experts working on this important issue.

“For me personally,” Crookston said, “it’s really rewarding to work on a safety aspect. It’s nice to be helping with awareness and connecting others to the problem.”

Crookston looks forward to conducting more UAV flights and gathering data on Utah rivers to expand knowledge on the state’s low-head dams and contribute to efforts to prevent further drownings. ■



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Go with the Flow: a framework to support river and wetland ecosystem functions in the Great Salt Lake Basin

The terminal Great Salt Lake basin is a complex water system comprising rivers, wetlands, and Great Salt Lake. Meeting water needs requires collaboration among researchers and water managers to coordinate efforts to facilitate deeper understanding of systems while accounting for all the water users in the basin.

One important 'user' is the environment itself. River and wetland ecosystems throughout the basin rely on water at certain times, with specific magnitudes, to support all the species that call them home. However, many places don't have the data required to fully understand the relationship between streamflow and wetland and river ecosystem health.

Belize Lane, an associate professor at the Utah Water Research Laboratory, is leading a research effort with USU professors Michelle Baker in the Department of Biology and Sarah Null from the Department of Watershed Sciences. Together, they are working to leverage ongoing GSL water conservation efforts to also support river and wetland ecosystem health throughout the GSL basin. A Functional Flows Framework has been developed for the GSL basin to

characterize how often, how much, for how long, and where flow is necessary to support aquatic ecosystem health.

Functional Flows Framework

Five metrics are used to describe natural streamflow: frequency, magnitude, duration, timing, and rate of change. These are all pieces of a streamflow hydrograph (or streamflow over time). Streamflow changes naturally with the seasons, and this variability supports specific river processes, including biogeochemical, geomorphic, and ecological processes.

In highly seasonal climates like Utah, many aquatic organisms are adapted to the natural seasonal and interannual variability in hydrologic patterns. Fish like the Bonneville cutthroat trout are cued to the timing and rate of change in streamflow that tells them when to move upstream to spawn. The flows upstream provide the best habitat conditions for spawning and rearing.

The functions a river provides depend on the flow, but when it comes to managing water to protect these functions, water managers don't always have the data they need for a specific site. This is particularly important where diversions or dams

have altered streamflows and ecological processes are no longer natural.

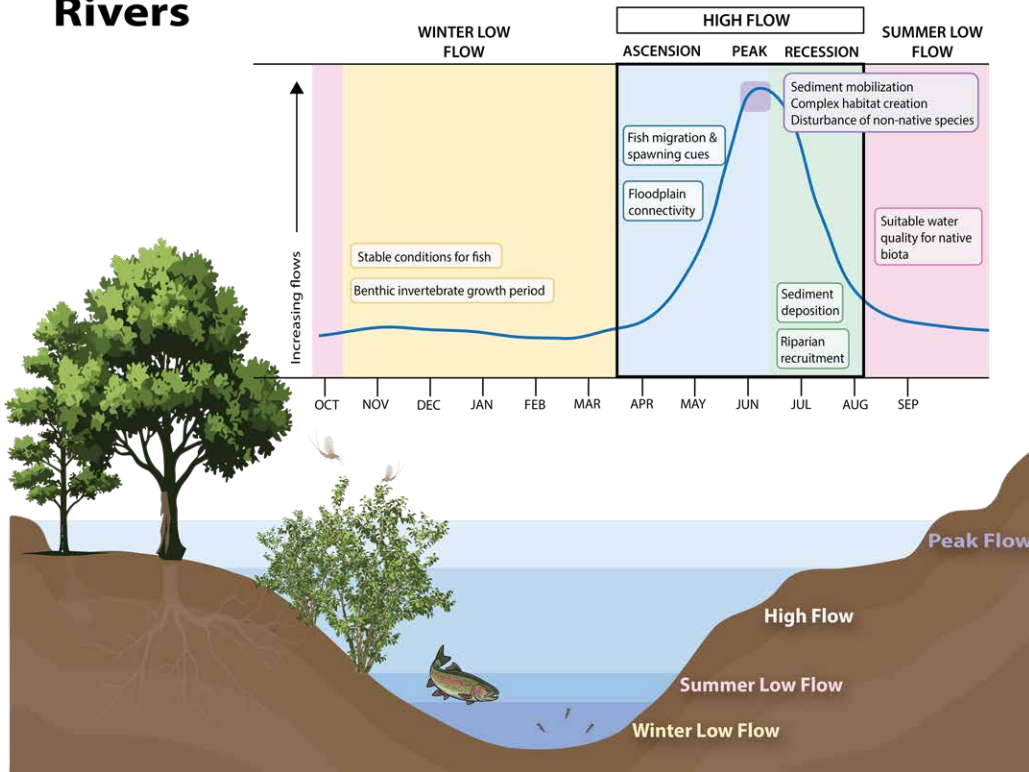
"The idea of functional flows is that, if we can summarize which parts of the flow hydrograph are most important for keeping ecosystems healthy, we can set management goals in the absence of more detailed, intensive studies," Lane said.

Lane and her team began by meeting with stakeholders across federal, state, and local groups invested in environmental water management. They laid out their proposed framework and asked for feedback. Then they developed algorithms to calculate the annual functional flow metrics from gages that measure natural flow regimes over a range of wet to dry years.

The next step involved machine learning to predict functional flow metrics at all the stream reaches in the GSL basin. The purpose is to get estimates in places where data or gages aren't in place.

By linking ecological processes to the natural flow, the project connects water quality, water quantity and wildlife. This will help managers assess tradeoffs among ecological and societal needs as water makes its way to the lake.

Rivers



The five generalized functional flows include winter low flow, high flow ascension, peak flow, recession flow, and summer low flow.

"I think it's one of those amazing opportunities in research where there is real potential to achieve a win-win," Lane said.

Real Numbers for Real Wildlife Needs

One of those wins comes from a fisheries lens. "As a fisheries biologist,

we can do all sorts of habitat work. We can go out and sample and monitor the populations, but without water, we don't have a fishery," said Paul Thompson, the assistant chief of habitat with the Division of Wildlife Resources.

Many times, he goes to the table with water managers knowing the fisheries need more water but not knowing how

much. "This project will actually identify the flow amounts in all of the streams in the Great Salt Lake basin considering different aspects of the hydrograph," Thompson said. "This will allow water managers to understand what amounts are needed to maintain healthy fisheries."

Utah fisheries play an important role in both the statewide and local economy. Blue ribbon or destination fisheries bring in millions of dollars, according to Thompson. He also emphasized the importance of maintaining healthy native fish populations.

"If we can work cooperatively with these numbers that the functional flow project is going to generate for us, we can highlight fish needs as well and try to maintain adequate water to maintain healthy populations," Thompson said.

The data from the functional flows framework will show water needs from all different areas of the GSL basin's ecosystem, which excites Thompson. "A lot of times when water decisions are made, wildlife are not part of the consideration. So, we're trying to highlight that a little bit more."

Building on the Framework

The project is a result of many heads and hands coming together across Utah State University campus and state agencies, including the Utah Department of Natural Resources and Division of Water Quality.

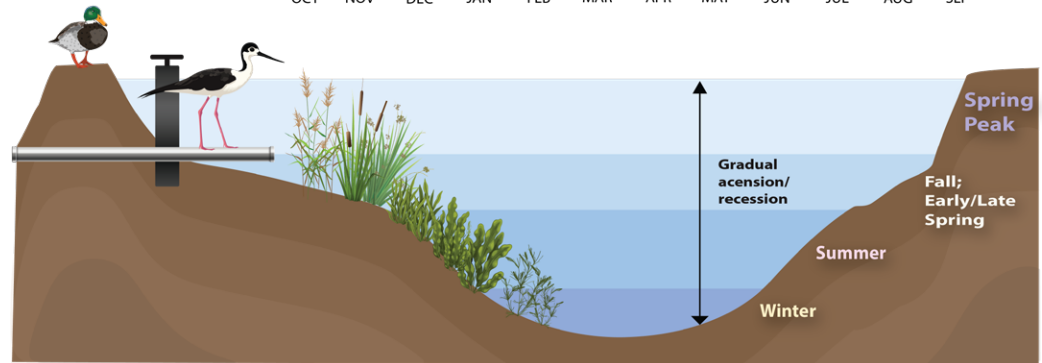
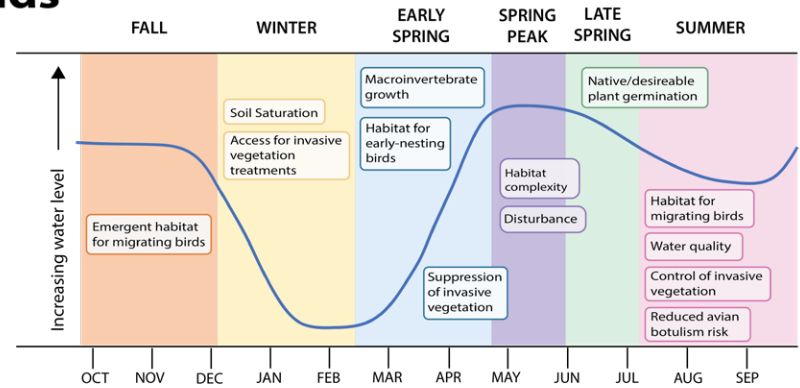
Wetlands

This collaboration is vital to achieving water management goals. Thompson emphasized the importance of discussing state needs with university experts. "Without partners," Thompson said, "none of us in the state system would be successful in doing our jobs."

Lane's project is part of the Great Salt Lake Basin Integrated Plan, which was created by the Utah Division of Water Resources to understand the human and ecosystem water needs throughout the GSL basin, including rivers and wetlands.

She hopes the outcomes from this project can encourage managers to think about the timing and rate of water releases to GSL so additional environmental benefits to rivers and wetlands can be achieved along the way.

"By considering water for the environment as another important water user," Lane said, "We could do a huge amount of additional good with the same resource." ■



Hypothetical hydrographs show flow/water characteristics and important associated ecological functions for both rivers (left) and managed wetlands (above).

Further Reading:

Research Links

Utah Division of Water Resources
Great Salt Lake Integrated Plan
<https://water.utah.gov/gsl-basin-integrated-plan/>

Research Publications

Developing a Functional Flows Framework (FFF) for the Great Salt Lake Basin
<https://uwrl.usu.edu/files/pdf/research-projects/developing-a-functional-flows-framework.pdf>



Breaking Down Solutions to Plastic Pollution

The journey of a plastic bottle is a well-worn tale. Bought from a convenience store or snatched from a cafeteria, this little petroleum-based container is quickly emptied and thrown away, but its travels don't end there. Plastic in its myriad forms travels from trash bin to landfill, often skipping that journey altogether to land on the side of the road or in a stream. Wherever its final resting place, it is neither final nor resting. Weathering from wind and water and sun exposure slowly break down plastic into microplastics and eventually nanoplastics, leaching chemicals into water, soil, and air.

Plastics aren't sustainable, but use over decades have woven them into society.

As long as we use plastics, they will always be breaking down and turning into the tiny particles that harm the health of both the environment and humans. This means solutions are needed not only to clean up the microplastic problem already upon us but also to find new alternatives to the toxic chemicals involved in production. The UWRL is conducting research at every stage of the plastic problem, from generation to degradation, to support a cleaner future.

Generation

One of the ways plastics degrade and break down into harmful micro- and nanoplastics is through exposure to ultraviolet (UV) light from the sun. UV

light can make plastic brittle or yellowed and more prone to breaking or leaching chemicals. To prevent this, plastics constantly exposed to the sun, like a car's headlights or dashboard, have additives mixed in. These UV stabilizers keep those headlights looking new for years, but when they do eventually break down into the environment, they can impact human health.

"Plastics aren't sustainable, but the plastic additives that are in use are also not sustainable," said assistant professor Kyle Moor. As plastics breakdown, the UV stabilizers enter soils and surface waters and then can disrupt human endocrine systems and harm natural ecosystems. To address this problem

in plastic creation, Moor is looking for safer alternatives for these additives.

Moor's alternative takes a leaf out of the plant book. Plants, like car headlights, are exposed to UV light, and they have protection of their own in the form of flavones. Like the molecule quercetin in parsley, these flavones protect the plant from UV damage, and Moor believes they can be used in plastic production.

"The idea is we can replace those more harmful chemicals with ones that are found in plants that we consume through our diet already," Moor said. Using lasers to simulate UV exposure, Moor and his team are exploring how flavone chemistry controls its ability to act as a UV stabilizer.

Moor emphasized sustainable chemistry as the idea behind all of his work. "As we're looking toward these new solutions, they need to be grounded in sustainable chemistry concepts to make sure we're not impacting the environment or human health by these new materials or new additives we might be using."

Transport

As assistant professor Yiming Su said, "Plastics are everywhere." They're in our kitchen utensils and our favorite sweaters. They form containers and tools and grocery store packaging. And once they're out in the environment, broken down into tiny plastic particles, they can start to pop up in unexpected places.

Su's work on plastic focuses on its transport through water and soil, particularly the pieces that are too small to be filtered out. These are called nanoplastics, and they are less than one micron in size.

Su said we don't really know the significance of plastic particles to human health, but the things attached to the plastics, like additives, per- and polyfluoroalkyl substances (PFAS), or heavy metals, can and do have health effects. This highlights the motivation to study the movement of plastics through our water, soil, and air.

For example, the pipes that bring water to a city can be either metal-based or plastic-based PVC pipe. In a joint study with professor Steve Barfuss, Su looked for the release of nanoplastics from PVC walls as water rushed through them, simulating the drinking water supply system. Anything larger than twenty microns can be effectively removed during drinking water treatment, but Su's process allowed him to detect anything down to 100 nanometers.

His results showed no significant release of microplastics or nanoplastics—good news for PVC in drinking water systems.

But pipes aren't the only avenue for plastic transport into our homes. Many plastics find their way into irrigation and drinking water systems from wastewater treatment plants. The plastic fibers of our clothing come off

in the washing machine; the frayed edges of our plastic cooking utensils scour away in the dishwasher.

"Most of that will be removed in the sludge," Su said, speaking of the wastewater treatment process, "but there is still quite a bit of plastic in the effluent after treatment."

Wastewater effluent can be used as an irrigation water source downstream. To study how the microplastics in wastewater effluent can impact crops, Su and his students are growing lettuce in the lab.

Nanoplastics, which, again, are smaller than a single micron, can be taken up by plants. To simulate this, Su created nanoplastics and plated them with palladium as a tracer. Then he grew lettuce with the recycled water used on agriculture fields. After a month of exposure, he and his student analyzed the lettuce for palladium to see how much plastic the lettuce absorbed.

Su said he sees more nanoplastics in older leaves, so a preventative action for consumers is to strip those outer, older leaves before preparing food. He is also researching biochar as a possible soil amendment to keep nanoplastics in the soil and out of the plants. His research shows promising results with significantly lower nanoplastic levels in lettuce with biochar added to the soil.

Throughout his research, Su emphasized the importance of using precise and



innovative methods to find the tiny plastic particles escaping treatment and working their way into our food and water.

Getting his research to the public to inform action is a core part of Su's work. After a study detecting nanoplastic particles on the shores of Bear Lake in Utah, the Bear Lake community came together to host a plastic collecting event to lower the amount of microplastics released at the popular recreation spot. These are the kinds of outcomes Su hopes come from his projects, and he looks forward to future action on plastic pollution.

Degradation

Assistant professor Joanna (Liyuan) Hou started her research on plastics seven years ago on the heels of the New York City plastic bag ban. She saw how plastics broke down into microplastics and persisted in the environment, never degrading entirely. Hou didn't see any

way to end the story of plastics because we as humans are always using them. "So how can we deal with it?" she asked.

With her expertise in environmental engineering and microbes, Hou started to look at the communities of microbes on microplastics in wastewater, surface water, ocean water, and soil to understand their role in biodegradation.

Wastewater in particular holds interest because of how the presence of microplastics can affect treatment. Hou saw that some pathogens and microbes could escape treatment by hiding under microplastics, using them like an umbrella. "I felt this is important to look at," Hou said. "Who is escaping and taking a ride?"

By identifying the specific microbes escaping treatment and how microplastics affect their fate, we can control harmful microbes in wastewater. But not all microbes are

harmful. "Different microbes can actually provide benefits," Hou said.

One of Hou's many microbe-microplastic interaction projects involves a graduate student using machine learning to identify microbes that can actually degrade plastic.

"I'm trying to understand which microbes are on microplastics, what their role is, and how we can use the benefits of their metabolism pathways to make plastic finally biodegradable," Hou said. She and her team collected data from published papers about plastic-associated biofilms and analyzed them to look for plastic-degrading bacteria. They used three representative studies for wastewater, three for surface water, and three for ocean water to understand the diversity of microbes in different environments.

After comparison, they noticed consistent potential plastic-degrading bacteria had the highest concentrations in wastewater.

Plastic-degrading bacteria are linked with certain non-plastic-degrading bacteria, meaning that the different types help each other survive on the surface of plastics. When the plastic degraders chew the long polymers into short pieces, they leave behind organic matter byproducts for non-plastic degraders to use as an energy source, turning the whole piece of plastic into CO₂ and leaving behind an empty dinner plate.

These bacteria, already at work, can be used to help the plastic pollution problem. "If we can see more plastic-degrading bacteria, maybe in the future we can take advantage by isolating those bacteria from wastewater to do the degradation," Hou said.

Alongside Hou's microbial solutions, Moor is also working on projects at the tail of plastic pollution, exploring the role of UV light exposure in plastic degradation,

specifically the fate of agricultural mulch films after season-long UV light exposure.

Mulch films are the long black plastic sheets laid on the fields of specialty crops like strawberries. New biodegradable mulch films are designed to replace polyethylene films (made of the same material found in grocery store bags) that release micro- and nanoplastics into soils. The new mulch films are intended to be tilled into the soil at the end of the growing season to naturally degrade, but Moor wants to see how season-long UV light exposure impacts the breakdown process. UV light generates a complex mixture of dissolved organics from plastic or plastic additives that could affect soil microorganisms, nearby surface waters from runoff, or the crops themselves.

Both Moor and Hou hope that, through research, we can solve the problem and finally give the plastic degradation story a period.

Not a Never-ending Story

Plastics are pervasive and invasive in their impact on the environment. Every stage of the life cycle of a piece of plastic requires research to improve the design and disposal processes and mitigate negative effects.

The professors at the Utah Water Research Lab are acutely aware of the cycle and are working to break it.

Different applications for plastics require different solutions to the pollution problem, but the start is to reduce and reuse. From personal decisions to state action to national and global efforts, each step taken, each new discovery, is a step toward a sustainable future. ■

Story photos by Alyssa Regis





Featured Events

Advancing PFAS Research and Collaboration in Utah

The Utah Water Research Laboratory hosted a half-day event this fall focused on strengthening collaboration and advancing understanding of PFAS issues across Utah. Organized by the UWRL's Environmental Quality Laboratory, the gathering brought together utility operators and managers from northern Utah to explore current needs, concerns, and strategies related to PFAS monitoring and management.

PFAS (Per- and polyfluoroalkyl substances) are a class of synthetic compounds widely used in products like food packaging, building materials, cosmetics, and clothing. These chemicals are a growing concern, in Utah and globally, because they persist in the environment and are linked to health risks.

The event opened with a summary of ongoing PFAS research projects, highlighting the capabilities and expertise of the Environmental Quality Laboratory. Participants then toured the laboratory facilities to see firsthand the methods and technologies being used to investigate and address PFAS contamination.

A key focus of the day was open discussion facilitated by College of Engineering Associate Dean Christopher Fox, as participants shared their challenges and priorities, and the lab team outlined how their research and testing capabilities can support utility planning and statewide water quality goals.

"Our goal in organizing this event was to create a space for open dialogue between utilities, regulators, and researchers on PFAS and other emerging contaminants," said Liyuan (Joanna) Hou, assistant professor at the UWRL and lead organizer of the event. "The insights shared underscore the importance of collaborative, science-based solutions for protecting Utah's water resources."

By bringing together these stakeholders, the UWRL hopes to help lay the groundwork for coordinated, science-driven approaches to addressing PFAS concerns across the state. ■



Photo by Matt Jensen



Photo by Alyssa Regis

The Utah Water Research Laboratory is celebrating 60 years!

Since the building was dedicated in 1965, the UWRL has been at the forefront of water and environmental research in Utah and beyond.

Over the decades, the UWRL has advanced innovative solutions through major projects addressing drinking water, contaminated soils, Great Salt Lake, ozone remediation, dam construction, and more. Our faculty have guided the next generation of water experts through these pivotal research efforts. As a result, UWRL graduates have emerged as prominent leaders in the water and engineering community.

We celebrated our diamond anniversary with USU's annual Spring Runoff Conference and Northern Utah Water Users Conference in 2025, and our website hosts new virtual tour videos highlighting the types of work done at the lab.

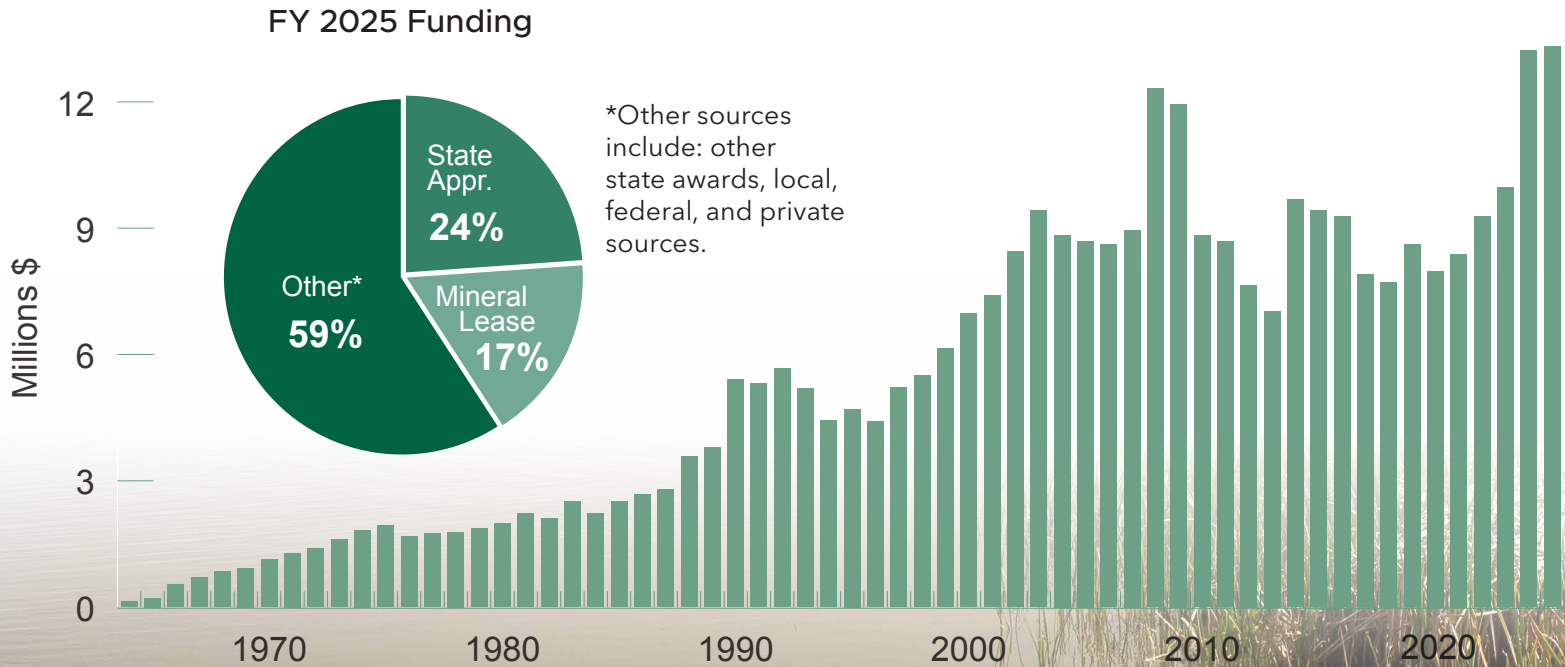
As the UWRL charts its course for the next 60 years, we continue to envision a sustainable water and environmental future for Utah and the world. In a state as dry as Utah, water will always be a critical research need, particularly as we grow and change.

Looking forward, the UWRL mission remains the same: conducting collaborative water and environmental research in Utah and throughout the world to advance innovative solutions, promote scientifically informed policy and management decisions, and train tomorrow's leaders. ■



FY 2025 Financial/Academic Summary

UWRL Funding History:



\$13,308,850

Total Annual Expenditures FY 2025

Research and Training Products:

219

Active projects

62

Scholarly publications in
peer-reviewed journals

39

Short courses &
training activities

80

Scholarly presentations at
professional conferences

Student Outcomes:

70

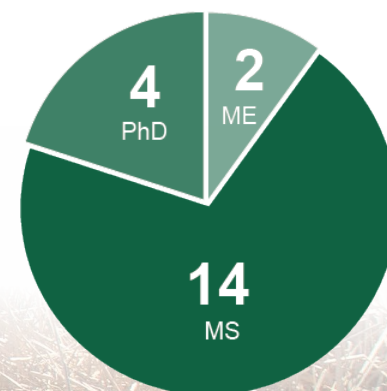
Graduate research
assistantships funded

67

Undergraduate students
supported

20

Graduate degrees
granted



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