

ENVIRONMENTAL monitor

FALL 2025

APPLICATION AND TECHNOLOGY NEWS FOR ENVIRONMENTAL PROFESSIONALS

HABITAT RESTORATION AND CONSERVATION



Source Water Monitoring
in Albany, New York

Three Decades of Research
at Acton Lake

Conservation in the
Great Bay Estuary

Welcome...

Welcome to the Fall 2025 edition of the Environmental Monitor, a collection of the best of our online news publications. In this issue, we highlight the importance of data collection and informed decision-making in habitat restoration and conservation efforts across the world.

From fish in Northwest Arkansas springs to orcas in New Zealand, this latest edition features stories from researchers who use environmental data to initiate, evaluate, and improve habitat restoration efforts in the smallest of streams to the world's largest oceans. These long-term monitoring projects collect critical data that kickstart initiatives to protect vulnerable ecosystems and wildlife that are on the brink of collapse.

Our writers also sought out science professionals dedicated to studying ecosystems of all sizes and collaborating with anglers, aquaculture managers, universities, and various agencies to collect data. This edition showcases how important continuous monitoring efforts are to creating and improving conservation and restoration efforts over time.

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ON THE COVER

Front: Water Department employees monitoring the Basic Creek Reservoir for harmful algal blooms from shore. Photo taken by Albany Water Department. (See Pg. 12)

Back: The HERO WEC being tested on the nearshore mooring at Jennette's Pier. Photo taken by John McCord / Coastal Studies Institute.

IN THE NEXT EDITION

Subscribe to read the next edition of the Environmental Monitor, focusing on *Innovation in Environmental Monitoring*. Stories will highlight unique and innovative applications of environmental monitoring equipment and systems.

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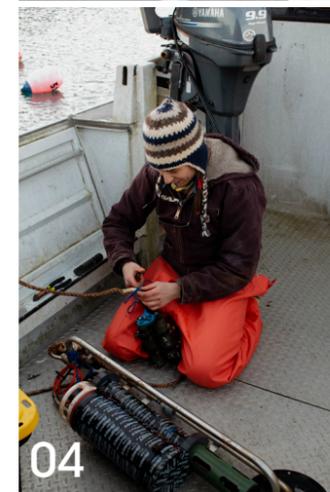
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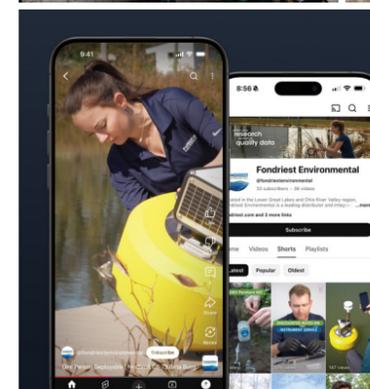
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when your
research
demands
quality data

On the Web



30 Minutes to Act: University City's Award-Winning Flash Flood Prediction System

Flooding is already the deadliest severe weather hazard in Missouri, and under high-emissions scenarios, the central US is predicted to emerge as a flash flooding hotspot. University City, a suburb of St Louis, Missouri, is frequently flooded by the River Des Peres. These events catalyzed the installation of real-time weather and water level monitoring equipment on the river, with the twofold aims of providing a historical record of rainfall and river level, as well as to act as a flood warning system.

New Buoy Boosts White Lake's Water Quality Monitoring and Conservation

In 1988, the White Lake Association (WLA) was founded by residents concerned about proposed development at the lake's northern end. Today, the WLA remains dedicated to maintaining and improving the quality of White Lake for the health of its aquatic wildlife and local communities through monitoring and education. A recent deployment of a NexSens XB-200 buoy at the lake's deepest point is collecting key data for researchers and lake visitors alike.



Flow Photo Explorer: Studying Flows in the Penobscot River Basin

In Maine, varying flows in the Penobscot River Basin have impacted the health of the ecosystem, water resource use, and habitat suitability for native species—topics of particular concern to the Penobscot Indian Nation, who have been protecting and managing the waterway for millennia. While the USGS stream gage network has monitored parts of the Penobscot Basin, many of the small streams found on tribal lands are not included. Angela Reed, Water Resources Planner for the Penobscot Indian Nation, is working with USGS collaborators to deploy additional stations and fill in some monitoring gaps over the next year.

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Monitoring Mariculture in the Gulf of Alaska

Greene is part of a team that maintains the network of arrays, visiting each site every couple of months to calibrate sensors and offload their data. "Then I work up all of that data to identify regional trends and differences between each site," states Greene.

In addition to the sondes managed by Greene, the farmers conduct their own water quality monitoring as partners of the project. Once a month, the farmers collect CTD casts to capture stratification and conditions throughout the water column. They also collect and filter water for inorganic nutrient samples.

Greene explains, "We have a lot of freshwater influence that's pretty different between each site. So, we're trying to see what the different bodies of water look like within each region because of this."

All of the collected data is used to generate reports for the farmers and also models to predict kelp and oyster growth at each site using all of the collected parameters. This data is then shared publicly through the Alaska Ocean Observing System (AOOS) network.

MONITORING CHALLENGES IN ALASKAN MARICULTURE OPERATIONS

When designing monitoring solutions for this project, organizers had to consider the unique environmental demands and data needs.

First, each site is remote and only accessible by boat, so instrumentation must be durable and capable of enduring a range of conditions. Some sites are situated in protected bays that are sheltered from storms but exposed to glacial runoff that can form ice sheets in the winter, while others are more exposed to larger waves and currents, but not likely to have the freshwater influence.

Second, mariculture in the Gulf is different from common aquaculture ponds that operate in a much smaller, more controlled area—these kelp and oyster farms are operated in open water, supported only by lines, anchors, and buoys.

The mariculture industry in the Gulf of Alaska has been steadily growing in recent years, guided by ongoing research to help refine farm location and cultivation practices. A subset of aquaculture, mariculture focuses on rearing organisms in the open ocean.

In Alaska, finfish farming is illegal, so most farms cultivate kelp, oysters, or a combination of the two. The first oysters farms were established in the early 20th century; however, state legislation enacted in the 1990s helped format the industry and provide a kickstart to commercial oyster farming. Kelp farming did not begin to catch on in the state until 2016.

Many of the coastal areas that have grown interested in mariculture are historically commercial fishing communities. However, in the past couple of decades, commercial fish stocks and the market around them have become less stable.

One event leading to the instability of the fishing industry in the central Gulf of Alaska was the 1989 Exxon Valdez oil spill. This event devastated the Gulf's fisheries, ecosystems, and the local economy.

In 2023, the Mariculture Research and Restoration Consortium, or MarRecon, for short, was started with the goal of studying the developing mariculture industry in the Gulf of Alaska, specifically

in areas impacted by the oil spill. The project looks at mariculture through the lens of ecological and economic restoration to these areas.

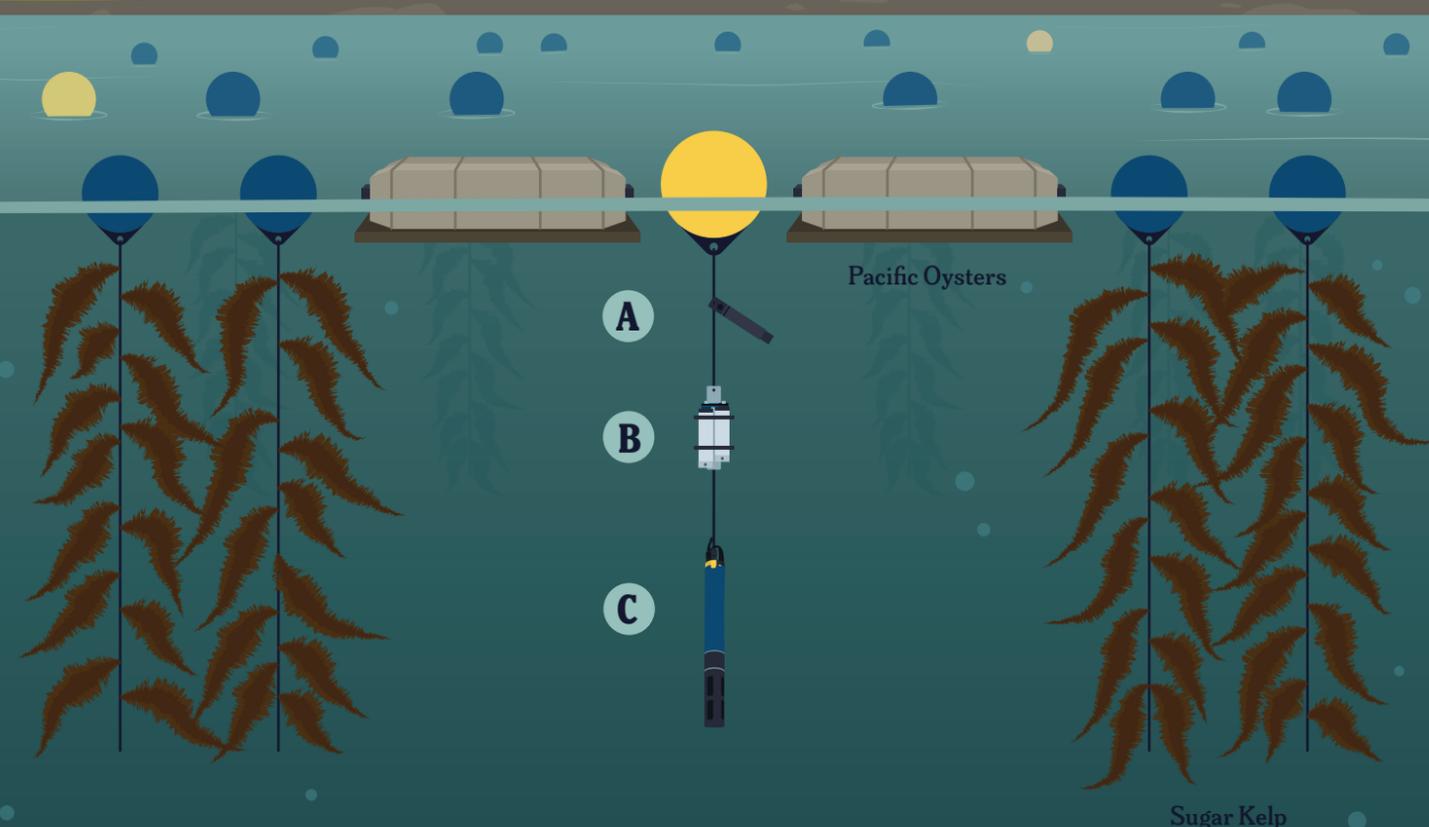
HOW MARICULTURE IS MONITORED

Sierra Greene is one of many researchers working to study and improve mariculture operations in the Gulf. MarRecon researchers study various aspects of mariculture, from its impact on fish and bird communities to crop cultivation and the economics of it. Greene's role is to study the oceanographic principles surrounding farms to help explain growth.

The program partnered with nine aquatic farms across the state in the Kodiak Archipelago, Prince William Sound, and Kachemak Bay. With the goal of monitoring water quality and correlating data to growth, Greene and her colleagues deployed "production arrays" on each farm.

These arrays are made up of lines and buoys that house oceanographic sensors, as well as grow kelp and oysters. The oceanographic monitoring sensors measure the temperature, salinity, dissolved oxygen, turbidity, and chlorophyll of each site. Sensor instrumentation at each site varies, though most are YSI EXO2 or EXO3 sondes deployed at about three to four meters down year-round.

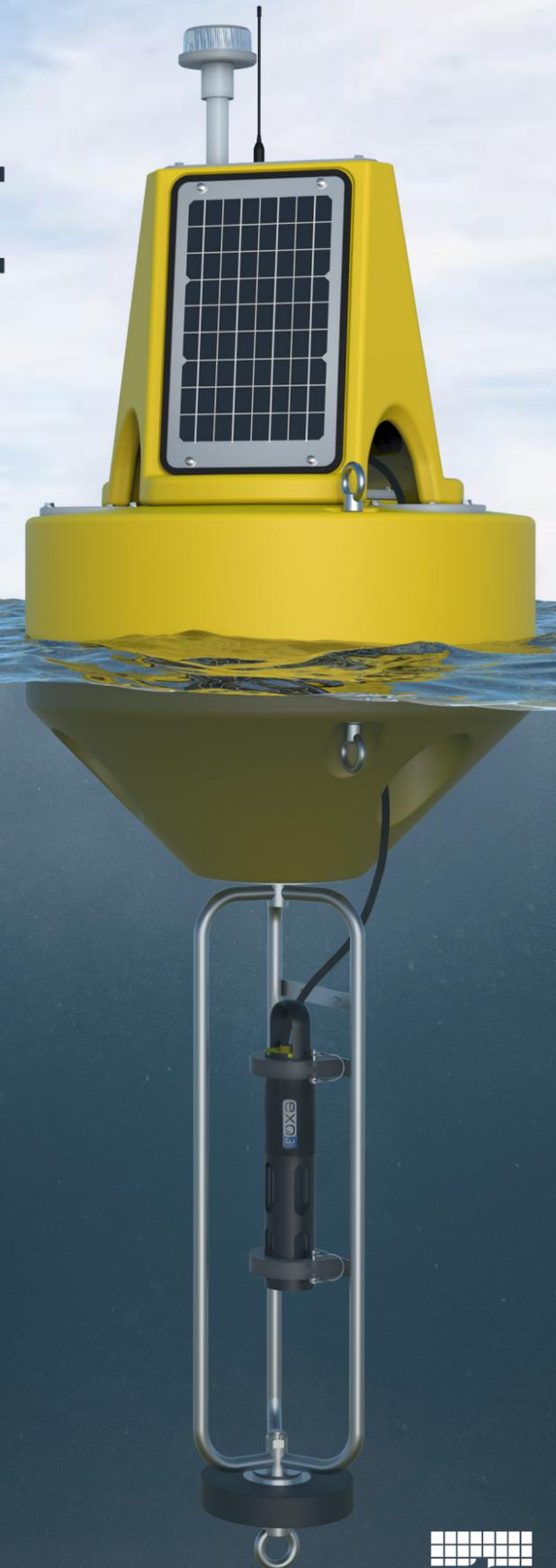
Illustration: Emma McCroskey / Fondriest Environmental, Inc.



- A** HOBO U24 Conductivity Logger
- B** PME miniPAR Logger
- C** YSI EXO Multiparameter Sonde



NEXSENS & YSI: AN UNBEATABLE COMBINATION



Building off this is the size of the Gulf of Alaska, which has made monitoring difficult, leading to limited knowledge of the coastal nearshore areas of the Gulf.

Greene explains, "The coastline of the Gulf of Alaska is just massive and each area is very different. [...] So, we're trying to collect more data on that in general, and then see which areas are best for growing kelp and which areas are best for growing oysters, and try to make similarities between different sites so that when new farmers want to get involved, they can have a better idea of where to look."

She continues, "For instance, would an area that has a lot of freshwater runoff be better or worse for growth? It would have lower salinity, but then also bring in more nutrients from land runoff. Or maybe it's a place that's more exposed to the open ocean? That could lack the shore-based nutrients, but maybe the phytoplankton bloom would occur earlier and provide more food for oysters farms."

“Everyone’s out there trying new things to push the industry forward and help understand what makes their farms tick.”

- Sierra Greene

MarRecon is currently funded for two more years, but Greene is hopeful that they will be able to secure funding for an additional five years for a total of ten years of monitoring mariculture in the Gulf of Alaska.

Being so new, the mariculture industry—and the associated necessary monitoring—is continuing to develop as farmers and researchers work together to refine practices.

Farmers are generally open to learning more about their farms through MarRecon and modifying their practices as they try out what works and what doesn't. This is an exciting time to be part of the industry.

As Greene explains, "There's not really any set plans for a farm, or how to run a mariculture small business, or what's the best way to do it. Everyone's out there trying new things to push the industry forward and help understand what makes their farms tick." ^{SB}

(Left to Right) Surface oysters growing on the production array at Kodiak Island Sustainable Seaweeds, in Kodiak Alaska. | Researcher, James Crimp, and farmer, Lindsay Olsen, measure kelp from the production array on Spinnaker Sea Farms in Kachemak Bay, AK. | Researcher, Sierra Greene, servicing the mooring located on the Native Village of Eyak research kelp farm in Prince William Sound. | Researcher, Arron Jones, flips the oyster cage to prevent fouling on Alaska Ocean Farms in Kodiak.

Photos: Jessica Whitney / Alaska Sea Grant; Allie Conrad / NOAA

Combine the NexSens XB-200 data buoy and X3 data logging technology with YSI multiparameter water quality sondes for reliable measurements, dependable performance, and robust wireless communication.

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ECOSYSTEM MONITORING

Dean Janiak deploys a YSI EXO2 at the dock outside the Smithsonian MarineGEO station in Fort Pierce, Florida. The sonde has been deployed at the site for over a decade, measuring dissolved oxygen, salinity, temperature, pH, turbidity, and chlorophyll every six minutes in order to track annual changes in water quality.

These changes influence the larger ecosystem, impacting species distribution and the overall health of key species in the region, from seagrass to oyster reefs to mangroves and manatees. The long-term data goes on to help inform state legislatures surrounding these species, including environmental restoration and conservation efforts that help preserve key habitats.

(See "From Florida to the World: How a Smithsonian Research Station is Bridging Gaps in Marine Biology," Pg. 20)

NexSens NX260

The NexSens NX260 Turbidity Sensor is an optical, self-cleaning sensor designed to measure turbidity in lakes, rivers, bays, and other freshwater or marine environments. The probe is ideal for construction sites, dredging projects, stormwater applications, and many other water quality monitoring settings where water clarity is a concern.

The sensor emits light that scatters off suspended particles in the water, and the reflected intensity is measured by a photodetector at 90 degrees. An internal microprocessor applies calibration coefficients and outputs turbidity measurements in FNU. The integrated wiper cleans the optical lens prior to each measurement, ensuring accurate readings and reducing maintenance requirements.

The sensor is housed in a corrosion-resistant titanium body with a marine-rated connector and scratch-resistant sapphire lens. No wiring or programming is required to integrate the sensor with NexSens X-Series data loggers. Connection to other data loggers is available using RS-485 Modbus-RTU protocol or SDI-12 with an optional converter. NexSens CONNECT Software is used for configuration, calibration, and sensor verification.

NX260 Turbidity Sensor Features

- Integrated wiper to reduce biofouling and extend deployment times
- Corrosion-resistant titanium housing with marine-rated connector
- Smart sensor supports multi-point calibrations via graphical user interface



The device is designed with Type 316 stainless steel, shock-mounted electronics, and redundant seals to withstand extreme wave action, floods, and underwater deployment up to 100m.



Pair the NX260 with NexSens data buoys and loggers for real-time turbidity measurement in fresh and saltwater environments.



Source Water Monitoring in Albany, New York: Tracing Water Quality throughout Tributaries

Thousands of US cities pull their drinking water from natural source waters like reservoirs, rivers, and streams, making overall watershed health a key consideration for water providers. In Albany, New York, the Albany Department of Water and Water Supply delivers drinking water to over 100,000 residents as well as monitors and manages the larger drinking water supply watershed.

Hannah Doherty, Environmental Specialist at the Albany Department of Water and Water Supply, spends her days working with a small team to monitor the drinking supply and the connected water bodies.

Doherty explains, "We're the first to encounter the water that ends up being the drinking water. And I'm responsible for monitoring that water quality before it goes to the treatment plant and communicating potential issues with the plant to make adjustments to intake levels and how they might have to process the water based on the conditions."



MONITORING SOURCE WATER RESOURCES

With a background in invasive species removal, wetland restoration, and reforestation, Doherty has the opportunity to study the entire watershed through multiple lenses while working to provide clean drinking water to the region she grew up in.

Doherty's main job is to monitor the drinking water reservoirs, their tributaries, and the greater watershed to identify water quality issues early on, work with landowners to fix those issues, and inform the filtration plant. During these source water monitoring excursions, Doherty also gathers data and observations that assist her team in evaluating the success of ongoing restoration efforts.

If issues are detected, the team works together to trace the source of the issue back through the watershed and troubleshoot strategies to resolve the issue through outreach and educating land owners or large-scale restoration projects, depending on the source of the issue. Whatever solution is decided upon, the team will continue to monitor the source waters and the problem area to document progress.

A YSI ProDSS is used at 21 monitoring sites—seven across the two reservoirs and fourteen in the tributary—to measure turbidity, conductivity, temperature, dissolved oxygen, and pH, and evaluate overall water quality.

"We make in-field decisions about what strategically makes sense to sample—for example, upstream and downstream of a potential source of pollution," states Doherty.

Since the backup reservoir experiences an occasional harmful algal bloom, with even more rare occurrences in the main reservoir, the team also measures chlorophyll in a laboratory.

Consistent data collection establishes a baseline of conditions in the source water reservoirs and makes identifying changes and issues easier. While this applies to any water quality issue, harmful algal blooms are a growing concern in many freshwater lakes.

Frequent data collection before, during, and after blooms helps make identifying the onset of blooms easier in the future and can help identify possible causes, such as excess nutrients, throughout the watershed. It also helps keep the treatment plant informed so they don't take water during a bloom that impacts the intake area, and they are prepared to treat water depending on current conditions.

In addition to requiring special treatment to remove the toxins from source water experiencing a harmful algal bloom, algal blooms—both harmful and non-harmful—can clog filters and disrupt operations, leading to improperly sanitized water and possible shortages. Therefore, Doherty's work is key to minimizing disruptions and keeping drinking water clean.

Knowing that she plays a role in ensuring continuous access to safe drinking water for the residents of Albany and working with a dedicated team are some of the most rewarding parts of the work for Doherty.

She explains, "Having clean drinking water is such a privilege, and something I never thought of much before joining this department, and now I feel it's very rewarding that I, and the people of Albany, get to benefit from the work that I do every time I turn on my tap."

"Working with a diverse team of people who all have their own expertise but are working together to accomplish the same goal of improving water quality is really energizing and fulfilling," adds Doherty.

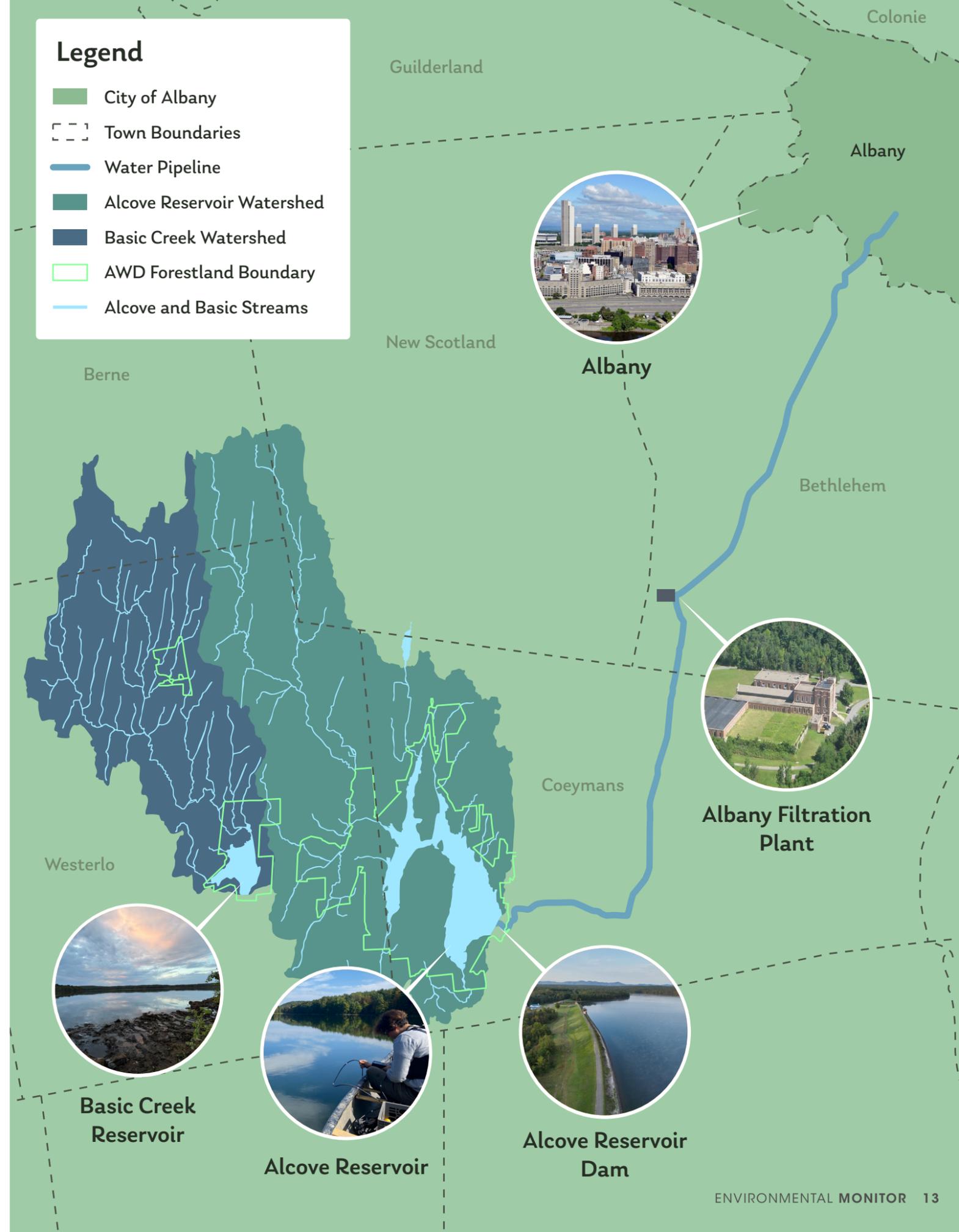
As a member of this team, Doherty has the opportunity to engage with the watershed on a much larger scale than just the drinking water reservoirs, understanding our source waters and improving the natural environment. 

Albany Water Department employee collecting water samples from a beaver pond.

Legend

-  City of Albany
-  Town Boundaries
-  Water Pipeline
-  Alcove Reservoir Watershed
-  Basic Creek Watershed
-  AWD Forestland Boundary
-  Alcove and Basic Streams

Photos: Albany Water Department; Map: Albany Water Department, Emma McCroskey / Fondriest Environmental





LANCASTER COUNTY MAKES THE SWITCH TO REAL-TIME WATER QUALITY MONITORING SYSTEMS



Continuous data collection in Lancaster County, Pennsylvania, started about 5 years ago, and the county will be making a major upgrade over the next year—switching from relying solely on the internal storage of water quality sondes to telemetry units that enable real-time data viewing.

TELLING LANCASTER COUNTY'S STORY THROUGH DATA

Since the Lancaster County Conservation District started monitoring county waterways, the goal has remained the same, according to Amanda Goldsmith, Watershed Specialist for the Watershed Department.

"Our goal is to tell our own story as we try to restore Lancaster's streams through restoration and other best management practices," states Goldsmith.

Because Lancaster is predominantly an agricultural county with about 5000 farms and a lot of urban development, according to Goldsmith, there is a lot of conflicting land use in the county that makes reducing outputs difficult.

However, the department works with county, state, and federal groups to respond to non-point source pollution by working with farms, land owners, and construction companies to implement specialized best management practices and reduce influxes of contaminants.

At the same time, the Lancaster County Conservation District oversees and manages stream restoration projects that improve waterway health via the installation of forested riparian buffers and targeted habitat restoration projects.

Monitoring efforts help establish a baseline of conditions in the waterways before, during, and after restoration and implementation of best management practices. Current efforts will contribute to a future data pool that allows operators to see the history of the county in water health.

Presently, the data collected helps the Lancaster County Conservation District measure outputs from county waterways to the Chesapeake Bay. In the Bay Watershed in Pennsylvania, Lancaster alone is tasked with reducing 21% of nitrogen and 23% of phosphorus loads.

Switching to telemetry units is just the next step in improving the department's data collection and building a better data pool for future use.



SWITCHING TO TELEMETRY IN LANCASTER

The small water quality monitoring team of Goldsmith, Noelle Cudney (Data Coordinator), and Tyler Keefer (Watershed Resource Specialist) manage a network of 15 YSI EXO2 sondes throughout Lancaster County. The sondes continuously measure turbidity, pH, conductivity, temperature, total dissolved solids, and dissolved oxygen at various stations in the county.

While the team has historically relied on the internal storage of the sondes to hold data, this approach led to data gaps when instrumentation failed in the field without the team knowing. Since the team is so small, sites are typically only visited every seven weeks to collect data and calibrate sondes, meaning that a failure could lead to days or weeks of lost data.

Thanks to funding from the Lancaster County Commissioners through American Rescue Plan Act (ARPA) dollars, the Lancaster County Conservation District purchased 15 NexSens X3 data loggers in 2024 to be added to their existing sonde deployments. The addition of the telemetry units will allow the team to view water quality data at any time, removing the need for site visits to download data.

The use of NexSens' WQData LIVE platform also allows the team to set up alerts for when water quality conditions are above or below an allotted threshold or if data collection has been paused for any reason.



"Our goal is to tell our own story as we try to restore Lancaster's streams through restoration and other best management practices."

- Amanda Goldsmith

Only five have been installed so far, with plans to deploy five more over the winter into early spring and the remaining five before the end of 2025. The team has already benefited from the change as they were alerted of a sonde failure due to battery life on the Little Conestoga, allowing the team to respond quickly and minimize interruptions.

Future site updates will depend on agreement from landowners as several of the systems are located on private property and will build on existing and future conservation efforts in the county.

Though the county's monitoring program is relatively new compared to older programs in the region, like the Susquehanna River Basin Commission and US Geological Survey, the program is important and ties back into the bigger picture of improving Lancaster streams.

Goldsmith explains, "We're not going to see these trends right away, but knowing that my work now, decades later, will finally start to show improvements, is really important."

She continues, "In Lancaster, we're starting to see tiny changes. They're not huge—they're not dramatic. We have a huge goal to reach... but we're seeing little changes. We're seeing fish communities improve, and that's from decades of work prior. It's rewarding to know we are contributing to that bigger picture and improving our local and downstream community." ^{SB}

Photo: Amanda Goldsmith / LCCD

Photos: Dawn Rise Ekdahl; Tyler Keefer, LCCD

(Left Page) Tyler Keefer installing an X3 telemetry unit along the upper Conestoga River. (Top Left) Amanda Goldsmith, Noelle Cudney, and Grace Chamberlain conduct an electrofishing survey along the Conestoga River. (Top Right) Amanda Goldsmith, Noelle Cudney, and Grace Chamberlain checking for fish in the Conestoga River. (Circle) Amanda Goldsmith at a recently planted riparian buffer on Mill Creek.



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Monitoring Habitat Suitability and Water Quality in Northwest Arkansas Springs

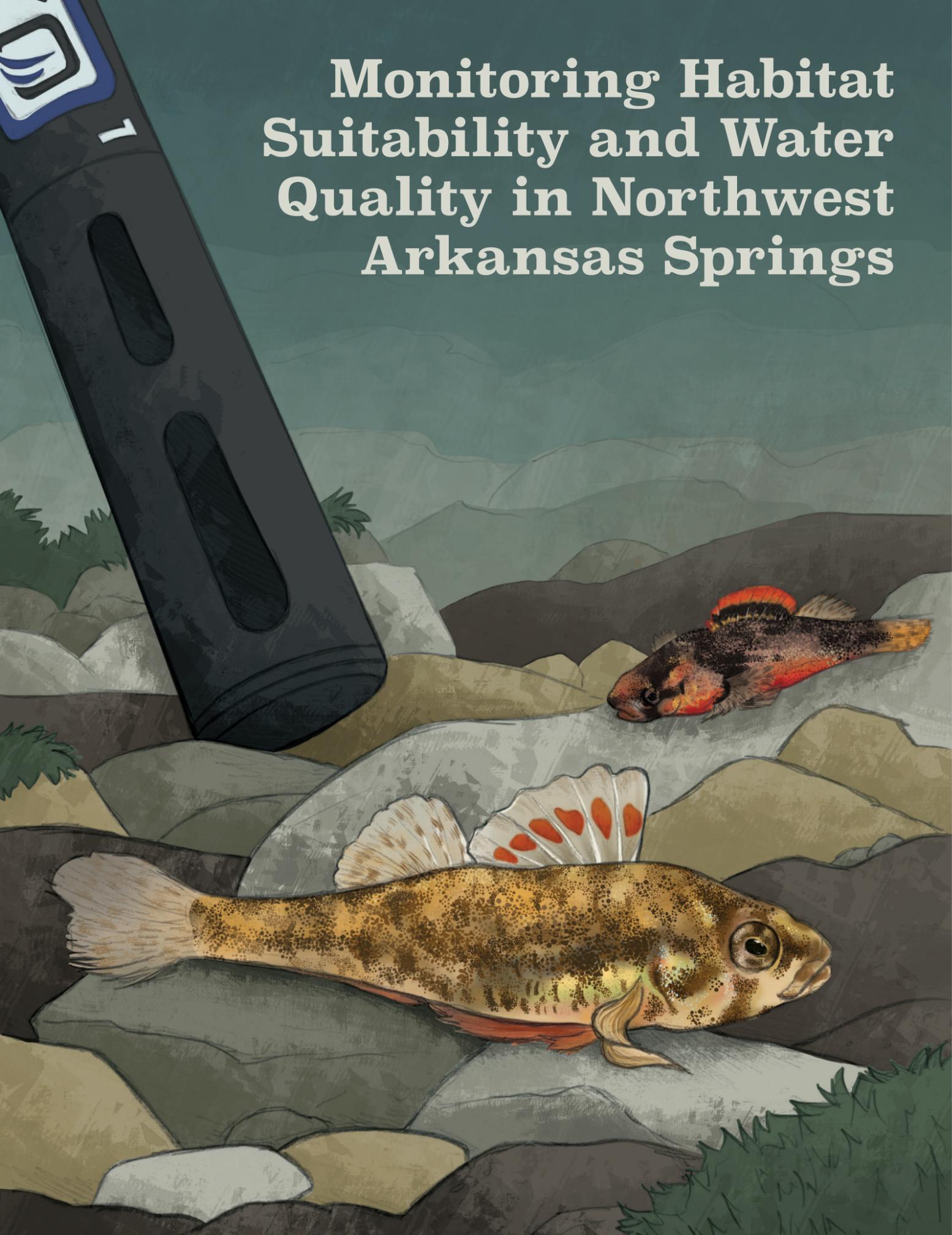


Illustration: Emma McCroskey / Fondriest Environmental, Inc.; Photos: Zach Moran

Northwest Arkansas has seen an economic, industrial, and population boom in recent years as a result of expanding businesses, which have created thousands of jobs in the region and the mass migration of employees and construction companies. However, with this growth has come rapid urbanization and the degradation of the natural landscape, specifically the freshwater springs that can be found throughout the region.

These springs are critical habitat centers for native wildlife, home to threatened and endangered fish, as well as those that have yet to be listed. Zach Moran, Assistant Professor of Fisheries Science at Arkansas Technical University, is working to help monitor these habitats and provide key data that will hopefully inform future development in the region.

RESHAPING THE NORTHWEST ARKANSAS LANDSCAPE & THREATS TO FRESHWATER SPRINGS

The transformation of the historically rural lands into bustling cities with popular businesses, restaurants, grocery stores, and industry has transformed what was a fairly untouched environment into an expanding urban center.

The unintended consequence of such rapid growth is the loss of biodiversity, declines in water quality, and other environmental degradation.

Runoff from construction sites and outputs from industry contaminate the groundwater and nearby rivers, streams, and springs, making habitats that used to be ideal for native wildlife inhospitable.

Moran explains, "Up there, it's the most rapidly developing area in Arkansas [...]. And that whole Northwest Arkansas area is karst topography—this limestone, Swiss cheese geology. It's full of water, and the rock up there is very porous. And when it comes to the surface, it creates these really pretty springs."

He continues, "And these spring habitats—they are home to an amazing diversity of fish, crayfish, plants, all sorts of really neat aquatic life, and they're very special little ecosystems. But what is happening is the spring habitats... they are being destroyed in response to all this development."

Moran recalls a particular spring that was destroyed by construction and damming in order for a business to be built on the spring. While the spring could have been integrated into the design of the building, the ecosystem and the attached creek were destroyed.

"That story is happening over and over and over again," warns Moran. "And so that is why we're doing this. We're just trying to provide some data that can help protect these ecosystems."

*(Left Page) An illustration depicting a Least Darter (*Etheostoma microperca*) and a Sunburst Darter (*Etheostoma mihilize*) in an stream monitored by a YSI EXO1 sonde. (Top) A popular grocery store construction impacting Osage Spring. (Bottom) Frida Martinez (left) and Brianna Winchester (right) sampling water quality in a stream.*



MEASURING THE IMPACT OF CHANGING LAND USE ON NORTHWEST ARKANSAS SPRINGS

Moran is leading a group of researchers who are monitoring the water quality of these springs and identifying the fish that reside there. The project is a continuation of a previous study conducted by Dr. Sue Colvin, which focused on fish assemblage identification and crayfish assemblage identification.

The goal of Moran's work is to document the current water quality and species concentrations and then document changes as development in the region continues. "It's a very neat ecosystem, and I'm pretty pumped about being able to study it," states Moran.

Discrete sampling is conducted on a quarterly basis using a YSI EXO1 sonde to measure dissolved oxygen, pH, turbidity, and conductivity, which are all key parameters connected to aquatic life. By the end of the study, the 25 springs included will be sampled four times, totaling 100 data points with the sonde.

A total of six HOBO MX801 loggers are also planned to be deployed in springs known to be habitats for threatened and endangered species like the Arkansas Darter/Least Darter, and measure dissolved oxygen and temperature continuously. Data is stored internally in the loggers and then downloaded on a quarterly basis.



Data from these springs are then compared to HOBO logger measurements from a spring where these species have been extirpated.

USING DATA TO PROTECT AQUATIC ECOSYSTEMS

The data from both monitoring efforts are sent to the Arkansas Game and Fish Commission to inform them when wildlife in the springs is under threat due to poor water quality. In cases where a threatened or endangered species is going to be impacted by the development, the only way to truly protect the lands is by purchasing the spring and the surrounding area.

Still, the AGFC, Arkansas Natural Heritage Commission, and Arkansas Department of Transportation are working hard to protect these springs, sponsoring the work of researchers like Moran to conserve these critical ecosystems and the species found in them.

The springs without threatened and endangered species are still important to protect as rich hubs of biodiversity. According to Moran, most people understand and appreciate these springs, but there is a need for more public involvement and action to protect these ecosystems.

While it may be hard to see the value in slower or more environmentally conscious development, connection to nature and the value it brings to the public means more than the dollars spent trying to protect these environments.

Moran shares that even developers contributing to the loss of these ecosystems see the beauty of the springs, but there is a disconnect between the work that now dominates Northwest Arkansas and the historic springs that have dotted the region for centuries.

Moran's work helps make this connection. He explains, "You take your family to the park that's next door to the spring, and your kids get to enjoy playing in the fresh, clean water. They get to see the really cool crayfish and vegetation that grows around there. They get to experience being out in nature."

He continues, "You can't quantify that monetarily. It's more spiritual [...]. I can contextualize why these ecosystems are important and the reason why you're doing this is not only just for one or two dinky little fish, it's for everything." ^{SB}

(Top Left) Frida Martinez (left) and Brianna Winchester (right) collecting water quality samples from Osage Springs.

(Top Right) A Ringed Crayfish (Faxonius neglectus).

(Bottom Left) Healing Springs.

(Bottom Right) (From left to right) Arkansas Tech students Frida Martinez, Brianna Winchester, and Savannah Wise collect water quality data from Elm Spring.

Photos: Zach Moran

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From Florida to the World

How a Smithsonian Research Station is Bridging Gaps in Marine Biology

In the early 2000s, along the coast of northern California, where the redwoods dominate the forests, and the Pacific Ocean shapes shorelines, a Humboldt University undergraduate student took the first steps into a lifelong love of marine biology.

Dean Janiak accepted an invitation to help a graduate student with fieldwork in rocky coastal tide pools, and so began a journey that led him from California to Connecticut to Florida and eventually to the world, where he has facilitated research in communities across the globe.

While finishing up his masters of Oceanography from the University of Connecticut, Janiak continued researching fouling communities—marine life that live on hard, often artificial surfaces such as docks—at the Smithsonian Environmental Research Center.

After his supervisor retired, he decided to take his research to the Florida coast, specifically to the newly created Smithsonian MarineGEO Station. As part of a larger network, the program brings together many branches within the Smithsonian to promote coastal climate change research.

It was in the Sunshine State, where marine research is as prevalent as the oceans, lagoons, and rivers that define its landscape, that Janiak began to realize the global impact he and his research projects could have. Now a biologist and lead researcher at the station, Janiak and his colleagues study marine biodiversity and coastal climate change, but approach it differently than most.

"No matter how big or how small a plant or animal is, it's having some sort of function in a system," Janiak says. "[...] so what MarineGEO does is we're studying this on a global scale."

Located next to the Indian River Lagoon along the Atlantic coast, where the ocean, inland water bodies, and human-dominated landscapes intertwine, this area may seem primed for complex ecological experiments and research. While Janiak spends time monitoring fouling communities in the lagoon and using a YSI ProSolo handheld dissolved oxygen meter to track water quality, the work at MarineGEO extends well beyond Florida's waters.

Janiak explains that while science is often conducted on local scales, it may not always be the best method for a rapidly changing natural world. A practiced scientific communicator, he likens this train of thought to how we often only understand what's right in front of us without accounting for the full picture.

"You know what's in your backyard. You know the plants there, you know the animals there, you know how it changes from season to season, but you don't know what's in my backyard," Janiak explains.

"So that's how science has been done, classically, for as long as it has been done. We know our [own] backyards really, really well, but we don't know how our backyards are connected or how they differ," he continues.

MARINE RESEARCH ON A GLOBAL SCALE

One way that MarineGEO is working to disseminate crucial ecological information on broader scales is by creating standard protocols. From how seagrass is changing to researching the complexity of coral reefs to investigating the impact of artificial habitat on fouling communities, it is believed that by standardizing these protocols, researchers across the world can identify common stressors to ecological issues.

Rather than hyper-focusing on local issues, Janiak and his colleagues hope that the knowledge of how oceans, coastlines and marine ecosystems are changing can be more easily understood on global and regional scales. And they achieve this by facilitating research projects from Florida to coastlines around the world.

The difference between these research projects, however, and the more common local research is their simplicity. Remote communities or those without adequate funding don't have the resources to conduct complex research.

So, MarineGEO steps in by not only coordinating projects with these communities but also providing lessons on proper research techniques and taxonomic identification as well as taking on the heavy lifting in terms of data analysis.

"If you're doing it locally, it's going to be a lot more complicated," Janiak says. "And so by scaling up we can really minimize the amount of work we actually have to do, which is really nice. So these experiments are really impactful at [understanding fundamental mechanisms]."

(Left) Janiak measuring dissolved oxygen off the side of the dock outside of the MarineGEO station. (Right) Fish congregating under a dock, which provides habitat for the fish and fouling communities on the poles.



FROM OCEAN TRASH MOVEMENT TO FOULING PREDATION PATTERNS

MarineGEO has coordinated a project where participants simply identify and pick up trash on the beach. The difference is that this occurred at hundreds of sites across the world. After participants determine the characteristics such as material, ability to float, and presence or absence of animals attached, MarineGEO takes on the analysis.

Using ocean current data, MarineGEO modeled the paths this trash has taken, using it to find where it originated from, what types of trash travel farthest, and if they are carrying invasive species. While such projects use citizen scientists, MarineGEO also works with other research institutions and universities.

For example, Janiak recently helped students at the University of the Virgin Islands determine their graduate project. After sharing his knowledge and the resources that MarineGEO can provide, the students decided to focus on monitoring fouling communities. Janiak sees this as a win-win, as he guides these students in their academic endeavors while MarineGEO gains more partners and another monitoring site.

Some of their large-scale projects aim to test some of the most prevalent theories in ecology, all with minimal logistical and technical difficulties. Once again connecting back to his roots, Janiak is currently wrapping up a project observing predator and fouling interactions. One of the largest he has taken on, he pulled it off using the same idea of simple methods across great distances.

Although he had dozens of research sites up and down the East and West Coast, the work he coordinated with partners involved caging a fouling community, protecting it from predation, and observing how it changed in response. A simple experiment led to profound results, which will be shared in a scientific paper coming out later this year.



Photos: Dean Janiak



"We looked at how as you move from the poles down to the equator, predation becomes more intense, and so it changes the way the communities look more rapidly," Janiak says. "[...] but it got into Science. And that might be the only time I'll ever get my name in a Science paper because it's so hard and it's so prestigious, but it's just something simple that we did in collaboration with a lot of people, and I think it shows the power of network science."

MONITORING IN THEIR OWN BACKYARD

Ultimately, MarineGEO staff take the knowledge from their global projects to continue protecting their backyard, the Indian River Lagoon. As they understand the world's backyards, they use it to help improve monitoring in lagoon habitats.

Janiak and the team at MarineGEO use a YSI EXO2 sonde, stationary at their dock, to measure dissolved oxygen, salinity, temp, pH, turbidity, and chlorophyll every six minutes. Their goal is to track annual changes in water quality with changes in important species, from seagrass to oyster reefs to mangroves and manatees, helping to inform state legislature through their work.

Janiak finds himself at local meetings, using the communications skills he has gained from participating in global projects to share MarineGEO's work with Florida residents. Their data on the health of some of Florida's most precious and unique ecosystems continues to drive marine biology and conservation.

Yet behind it all is the knowledge that MarineGEO is just one part of a much larger picture, a network of interconnected researchers, students, and citizen scientists working together to push science forward. While challenges from funding, legislative restrictions, and engagement subsist, the team at MarineGEO sees the ultimate value in their work.

"We have knowledge from all over, and it could be relatively helpful, if you want to restore a local area, [to know] how those techniques work in different parts of the world," Janiak explains. "I think having a scope as large as we do, that helps predict patterns and change." ^{SN}



(Left) Janiak and his team monitor oyster reefs in the Indian River Lagoon. (Right) Janiak shows interns different species in their annual MarineGEO monitoring of fouling communities. (Bottom) Janiak measuring dissolved oxygen off the side of the dock outside of the MarineGEO station.

Photos: Dean Janiak



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Expanding the Port Everglades

Real-Time Monitoring of Water Quality Conditions from Planned Dredging Operation



A CB-950 and CB-25 deployed on site at Port Everglades. The sensor buoys are protected by white buoys on the sides to prevent collisions with boats in the area. (Bottom) The bottom package is ready to be deployed. The instruments are wrapped in special tape to prevent biofouling accumulation.

The Port Everglades in Broward County, Florida, serves large trade vessels and cruise liners, as well as incoming and outgoing recreational boaters. However, as cargo ships become larger, the port must expand.

A dredging project led by the US Army Corps of Engineers will substantially deepen and widen the port's navigation channel to accommodate larger Panamax cargo ships and modern cruise liners.

As a result of this project, a large amount of sediment will be displaced into the water column. This suspended sediment may settle outside of the project area, burying benthic organisms like corals, and possibly carrying harmful particulates to other regions.

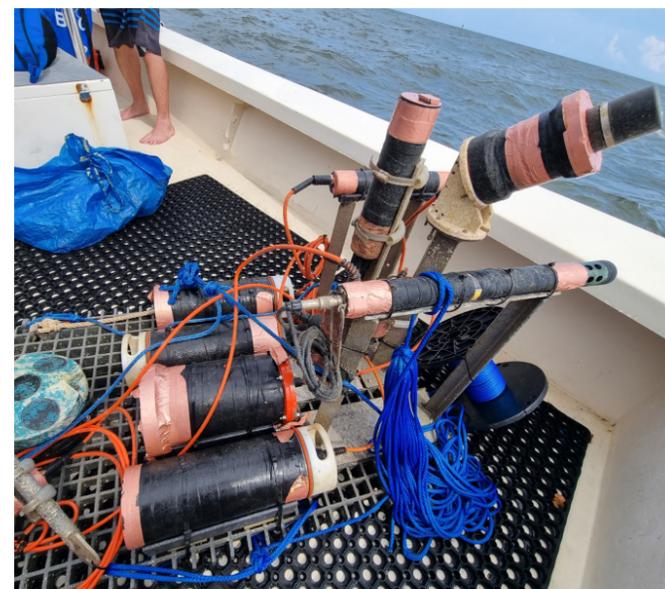
SEDIMENT PLUME MONITORING DURING DREDGING OPERATIONS

Due to the size and potential impact of the Port Everglades dredging project, NOAA and the US Army Corps of Engineers have been tasked with monitoring the Port before, during, and after the channel expansion.

Dr. Enrique Montes, Associate Scientist of the University of Miami Cooperative Institute for Marine and Atmospheric Studies (CIMAS) affiliated to NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML), oversees near real-time monitoring systems collecting water quality conditions off the channel of the Port.

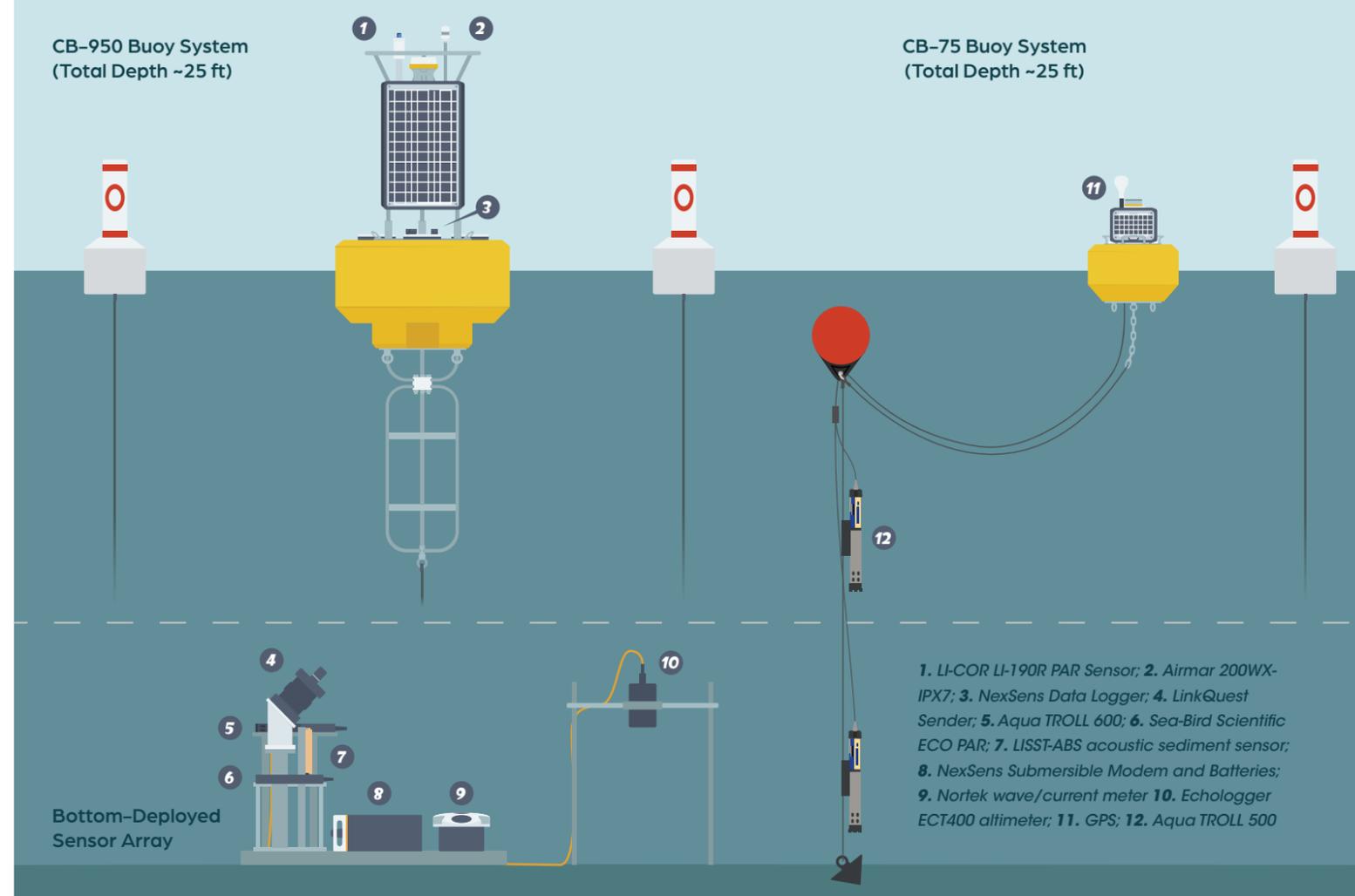
Montes explains, "During dredging operations, sediment plumes should be monitored to mitigate harmful effects on the benthos and minimize possible coral disease outbreaks that have previously been associated with dredging projects like the ones observed in the Florida Keys."

Near real-time systems can help with measuring turbidity at the top and bottom of the water column, and alert operators and overseers of the project to pause or slow dredging to prevent sediment plumes and minimize impacts.



Photos: Jhon Mojica / CIMAS-UM

Illustration: Emma McCroskey / Fondriest Environmental, Inc.



"The idea is to deploy a whole array of sensor packages on the seafloor and data buoys at the surface that will be collecting data every 15 minutes and transmitting data with near real-time capability so that we can track major changes in turbidity and water quality conditions that may harm the coral reef as a result of sediment plumes coming out of the dredging area," he continues.

A bottom-deployed sensor array equipped with an Echologger ECT400 altimeter, Aqua TROLL 600 (In Situ), acoustic modem, NexSens data logger, Nortek wave/current meter, an ECO-PAR sensor that measures photosynthetically active radiation—specifically the light levels crucial for photosynthesis, and LISST-ABS acoustic sediment sensor continuously monitor sediment dynamics.

The bottom sensor package is powered using alkaline battery packs that are swapped out when needed. Site visits are conducted on a monthly basis and include sensor cleaning, battery replacement, and any other necessary maintenance or troubleshooting.

The NexSens logger collects and stores data from the sensor package, and then the acoustic modem transfers the data through the water column to a CB-950 data buoy on the surface.

Data is then logged by a NexSens data logger on the surface buoy and then transferred to the cloud, where the data can be viewed via WQData LIVE. In addition to the bottom sensor package's data, the buoy is equipped with a suite of surface water sensors.

An Airmar multiparameter weather station and LI-COR PAR sensor measure climate conditions. Additionally, smaller Nexsens data buoys (CB-25 and CB-75) equipped with surface and bottom Aqua TROLL 500 sensors attached to the mooring line will be deployed in the area to measure temperature, salinity, chlorophyll-a, and turbidity.

The buoys are all equipped with solar panels, which makes the surface systems more self-sufficient compared to the bottom array and limits the need for intervention.

Currently, only one bottom sensor array and a surface buoy have been deployed to establish a baseline of conditions and document natural sediment plume formation from climate conditions.

This early monitoring will help to identify and troubleshoot challenges, aid in collecting baseline data to characterize the natural variability in turbidity conditions, develop algorithms that trigger early-warning alerts transmitted via email and cell phone messaging, and eventually inform management once dredging begins.



“The data that we’re collecting is going to be really important to help us to at least mitigate, to some extent, the level of damage that is going to be caused by dredging in this area.”

– Enrique Montes

Prior to the first dredging operation, three additional bottom sensor packages will be deployed in the Port Everglades, along with 12 smaller NexSens buoys.

While the bottom sensors will remain the same, the smaller surface buoys will include a Nexsens data logger and two Aqua TROLL 500s. One of the Aqua TROLLs will be positioned just below the surface, and the other will be a few feet above the seafloor.

MINIMIZING ECOLOGICAL IMPACTS INSIDE AND OUTSIDE OF THE PORT EVERGLADES

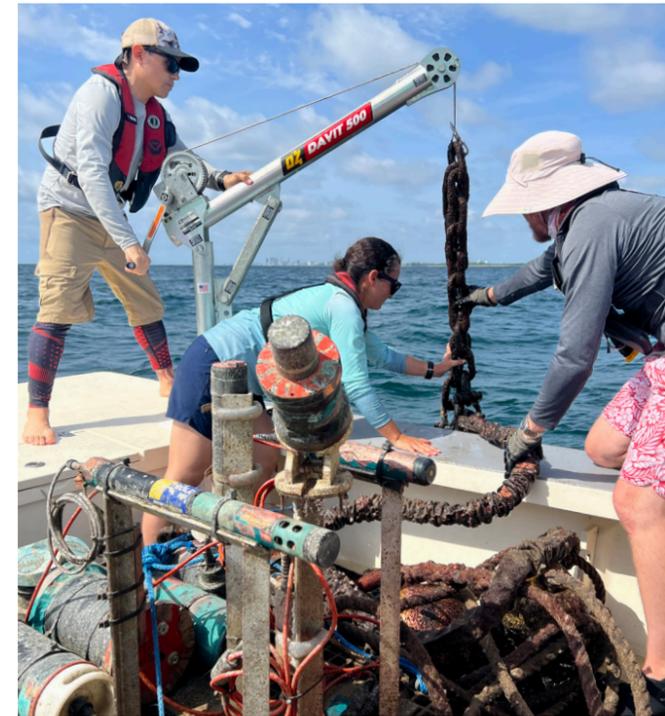
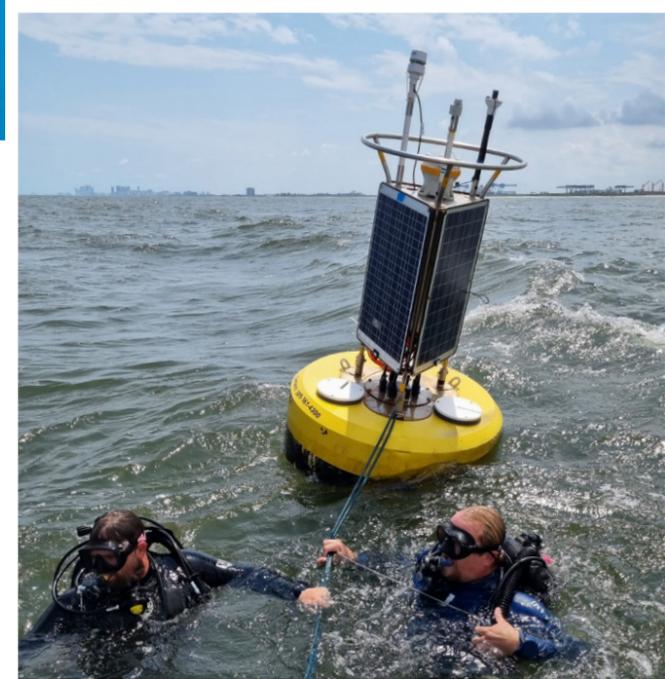
Corals and other benthic species are critical components of marine ecosystems, serving as habitat and food sources for other species, including humans. These organisms will be the most impacted by the project as the sediment they live on is removed.

“This is going to be a massive project that will entail transplanting big corals from one location to another, assessing and characterizing benthic habitats—there are certain areas of conch aggregation reproduction that may be affected by these activities, and we’re in the process of figuring out how to monitor turbidity conditions in these aggregation sites,” states Montes.

Early research and monitoring will help inform translocation efforts and protect these key species during dredging operations. Paired with continuous sediment plume monitoring of the project, Montes is hopeful that the project can be completed with minimum impacts on marine life.

He explains, “The data that we’re collecting is going to be really important to help us to at least mitigate, to some extent, the level of damage that is going to be caused by dredging in this area.” ^{SB}

(Top) Divers servicing the surface buoy by cleaning the sensors to eliminate biofouling accumulation. (Middle) Scuba divers attaching the surface buoy to the bottom anchors using lines and chains. (Bottom) The bottom package being recovered for a full service (cleaning and communication checks) using a davit.



Photos: Jhon Mojica / CIMAS-UM

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Reintroducing Historically Native Fish in America's Largest Wilderness



Among the dozens of publicly protected national parks, hundreds of wilderness areas, and thousands of state parks in the contiguous US, none are larger than the Adirondack Park, a 6 million-acre wilderness area that spreads across upstate New York.

With 3,000 lakes and ponds and 30,000 miles of rivers and streams, the waterways of the Adirondacks are enormous. Diverse aquatic habitats and ecosystems abound, along with bountiful recreational opportunities.

Nearly half of this land is owned by the state of New York and managed through the New York State Department of Environmental Conservation (NYSDEC) as a forest preserve to return the wilderness to its "presettlement" state.

When early European settlers came to the region in the early 1600s, they introduced multiple non-native fish species, beginning a problem that has plagued waterways across the US for centuries.

Rob Fiorentino, a NYSDEC Regional Fisheries Manager in the Eastern Adirondacks region, is one of the many scientists and conservationists working to combat this problem. Fiorentino explained that as settlers began pushing further into the wilderness, they brought fish as a food source, introducing them to ponds, lakes, and rivers along the way.

HISTORICALLY NATIVE AND GENETICALLY DISTINCT ADIRONDACK FISH SPECIES

Despite the size of Adirondack Park, it does not boast a diversity of historically native species. According to the NYSDEC, after the last ice age, climate and rugged geography restricted fish movement upstream, limiting what species became established.

Since then, brook trout and round whitefish have been the two species that survived, even developing "heritage" strains unique to certain watersheds in the region. Thousands of years without competition from other fish species meant that non-native species complicated a relatively simple ecosystem when they were introduced.

While species such as invasive bass, perch, and crappie are known to harm native populations, Fiorentino does not believe one single species can be blamed, but rather, that sudden competition in the ecosystem led to population declines.

"It's not that it's any one specific or particular fish species," Fiorentino says. "It's just the change in the fish community often makes it not as good as it was before."

As a result of the changing ecosystem, round whitefish are now listed as an endangered species, and many brook trout populations have dramatically declined, with some of the heritage strains having gone extinct. Therefore, re-establishing these populations is extremely important to Fiorentino and others in the NYSDEC's Division of Fish and Wildlife.

(Left) NYSDEC Fisheries Biologist Nicole Balk and Fish and Wildlife Technician Megan Beckwith stocking Atlantic salmon into a net pen in Lake Champlain in 2023.



Fish and Wildlife Technician, Dustin Dominesey, in the bow and Fish and Wildlife Technician, Adam Kosnick, in the back of the boat, conducting a reclamation on Murphy Lake in 2021.

Unfortunately, it is difficult to define what is native, given that there are so few fish species but many distinct genetic strains in the Adirondack region. To combat this, Fiorentino explains that he and his team look at the historical pre-settlement presence and community of fish in a certain body of water before deciding on a management plan.

"They're native to New York State. They're native to waters within the state, to watersheds within the Adirondacks," Fiorentino says. "But they might not necessarily be exactly native to that specific single water[body] that you're talking about."

UNIQUE FISH, UNIQUE MANAGEMENT

When managing Adirondack waterways, the NYSDEC adheres to the idea of returning them to their presettlement state, which often involves completely removing non-native species. This method is known as pond reclamation.

Fiorentino explains that since the 1950s, the NYSDEC has used pond reclamation to bring back brook trout ponds. According to their website, reclamation begins by adding rotenone to a pond or lake, a natural toxin that degrades to carbon dioxide and water. After this step, a local heritage strain of brook trout is stocked, and the ecosystem is allowed to recover.

Rotenone is ideal as it has minimal impact on brook trout and round whitefish, and does not harm wildlife that use the pond as a food or drinking source. However, there are limits to which ponds can be reclaimed with this method.

Pond size, the abundance or presence of certain wetlands, and the likelihood of non-native fish returning to the pond via outlets may inhibit pond reclamation. Nonetheless, over 100 ponds have been reclaimed in the Eastern Adirondacks.

BALANCING RECREATION AND CONSERVATION IN ADIRONDACK PARK

The Adirondacks are a popular fishing region, and regulations have been placed to limit the spread of non-native species. For both reclaimed and non-reclaimed bodies of water, the NYSDEC has taken steps to inform anglers of the problems in Adirondack waterways and how to avoid worsening them.

"At our boat launch sites, we have kiosks that have information in them, telling how you should treat your bait fish, what you should do with them, the proper way to dispose of them," Fiorentino explains.

Along with bait fish, non-native species can spread by water vessels. With many waterways in the region, Fiorentino explains that it is common for people to bring their boats to multiple locations and unintentionally bring unwanted guests along with them.

Similar to regulations on bait fish, the NYSDEC has used kiosks, posters, and informational campaigns to educate anglers about how non-native species spread. The NYSDEC requires self-certification from boat owners to certify that they have cleaned and dried their boats when moving them between different waterways.

"When that first came out, that really wasn't well understood," Fiorentino says. "And I'm sure some people didn't appreciate it because now they have to take more time away from their recreational activity and make sure [the boat is] both clean and dry."

As the NYSDEC continues to learn how invasive species spread, it continues to carry out management efforts and educate the public. Despite some initial confusion on the purpose of regulations, cases of invasive species causing damage to their local waterways have made the public more receptive. Invasive plants, insects, and other aquatic species have also damaged local water bodies and tourism.

For example, invasive zebra mussels have spread to some Adirondack waterways, impacting water filtration for local villages. Fiorentino explains that such instances increase people's appreciation for the steps being taken to reduce all non-native species.

"Taking that moment to do the right thing by just making sure your equipment is clean doesn't take a lot away from your personal recreation, but there's a potential there that you could really impact a lot of other people's," Fiorentino says.

It is an uphill battle with delicate ecosystems and fish species. Still, conservation and educational successes give Fiorentino and the NYSDEC hope about preserving the ecologically important and pristine waterways of America's largest wilderness. 



NYSDEC Regional Fisheries Manager, Rob Fiorentino, and NYSDEC Fisheries Biologist, James Pinheiro, on Lake Placid, conducting a lake trout survey.

Photos: NYSDEC

The NexSens XB-200 data buoy deployed in Acton Lake.
(Credit: Josh Pene / DreamBox Studio)

Three Decades of Research at Acton Lake

A multi-disciplinary team at Miami University, Ohio, has been studying the environmental change at Acton Lake for over three decades. Using three different NexSens buoys over this time, the team has an incredible archive of data that is helping build a picture of Acton's past, present, and future.

Until recently, a NexSens CB-50 buoy was used alongside other environmental monitoring at Acton Lake. In May 2025, the Miami team deployed a new XB-200 buoy, future-proofing their ongoing monitoring using real-time buoy systems.

Acton Lake, a small hypereutrophic reservoir in Southwest Ohio, covers 2.4km² and has a maximum depth of about 8m. The dam was built in 1956, and the lake has a large agricultural watershed. Historically, erosion of soil—mainly from farmland—has washed vast amounts of sediment into Acton Lake, causing it to slowly fill.

In 1992, the United States Department of Agriculture Soil Conservation Service developed a watershed management plan encouraging conservation tillage through economic incentives for farmers, aiming to reduce sedimentation in the lake.

Mike Vanni, Professor Emeritus at Miami University, has worked on Acton Lake since the 1990s. He explains, "From 1990 to 2000, the amount of conservation tillage in the watershed more or less quadrupled from around 15% to 60% of cropland area and that's been pretty stable since then. And those trends mirror regional trends all over the Midwest."

DEVELOPING MONITORING AT ACTON LAKE

A variety of environmental monitoring methods are used at Acton Lake to track its changing ecosystem.

Around 2010, the Miami University team deployed their first NexSens buoy, the MX-300, which was later replaced by the CB-50 buoy. Positioned close to the dam at the south end of the lake, it measures oxygen concentration and temperature through the water column, forming the foundation of much of the team's long-term monitoring.

During its service, the buoy has transmitted real-time data via cell and hosted various additional sonde configurations, including conductivity, temperature, chlorophyll, and turbidity. Across the duration of monitoring, sondes have been added, removed, and replaced from the buoy—something made easy by the system's flexibility.

As well as the buoy, there is a longstanding weather station at Acton Lake, with new ones planned for installation this year.



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Hydrological monitoring efforts in the rivers that drain into Acton Lake use simple methods, including pressure transducers in wells to measure water level and automated water samplers that collect samples every seven hours. Manual grab samples requiring lab analysis remain an important part of the team's monitoring efforts.

EMERGING TRENDS AT ACTON LAKE

Vanni states that over the last two decades, research has focused on "how the lake and streams are responding to changes in agriculture—mostly a change in tillage."

Before this, research monitored fluvial inputs and lake health, but didn't focus on longer-term changes related to agriculture.

The shift that catalyzed the beginning of the long-term monitoring program was "fortuitous," as Vanni highlights, "We didn't really think we'd see any change, because we know how noisy environmental data are. And we didn't know how successful the movement towards conservation tillage would be."

"But we just happen to notice these changes in the streams and then in the lake. After about six or eight years, when we were monitoring the streams, we noticed that the concentrations of sediment and phosphorus were declining in the way you'd predict, consistent with less tillage. So that set the stage for doing this long term study," he explains.

In 2002, the Miami team secured funding from the US National Science Foundation's Long Term Research in Environmental Biology (LTREB) Program for a long-term project exploring the impact of changes on streams and Acton Lake. Since that initial grant, the project has continued to receive LTREB funding.

LONG-TERM MONITORING BEGINS

The Acton Lake ecosystem is shaped by complex, interlinked factors. Agricultural land use affects sediment, phosphorus, and nitrogen levels, while precipitation determines stream water input.

In the first decade after conservation tillage began in the watershed, environmental changes were clearly observed. While suspended sediment decreased as expected, some surprising trends emerged.

Although conservation tillage was expected to reduce phosphorus and algal blooms, Vanni notes that Acton Lake had the "exact opposite response" and actually became "much greener" in the first 10-12 years.

The team hypothesized this was because of gizzard shad, a fish that feeds on bottom sediment containing nitrogen and phosphorus, and excretes them into the water.

Vanni explains that in summer, when stream input is low and fish populations are high, "more phosphorus comes from the fish than the streams."

The correlation between increased fish populations and lake greening led the team to conclude that "there's more light and more fish, and we're getting more algae because of that."

Indeed, this 15-year study showed that gizzards supported an average of 18% of primary production during the phytoplankton growing season, and about 30% during summer (July-September) when algal biomass is highest, though there was significant variation inter- and intra-annually.

BENEATH THE SURFACE AT ACTON LAKE

Lesley Knoll is an Acton Lake local and Assistant Professor of Biology at Miami University who has been studying the lake since the beginning of her academic career.

Now working with an extensive 31 years of data, Knoll's work focuses on long-term trends and dissolved oxygen (DO) in the deepest parts of the lake.

A global trend in decreasing lake-bottom DO has been linked to factors such as an increase in productivity, decomposition of organic matter, and rising temperatures, which exacerbate temperature stratification.

At Acton, Knoll's research has uncovered that the lake's "anoxic factor"—which takes into account the spatial and temporal trends of hypoxic events—has not changed over time.

But, she highlights, "What's interesting is that it does seem like the amount of suspended sediments in the water is playing a role in the oxygen dynamics"—an area often overlooked in research.

She continues, "If you have more suspended sediments in the water there's less anoxia. When you have more suspended sediments, you have less algae. If you don't have as much algae, you don't have as much fuel for decomposition."

Knoll emphasizes that research is still very much in progress to untangle the complex, transboundary relationships of DO at Acton. "There seems to be a relationship between what's going on in the watershed with the erosion from the farm fields and the oxygen," she notes.

ACTON LAKE INPUTS

Miami University's approach to studying Acton Lake has been cross-departmental, allowing for a more holistic interpretation of data and a deeper understanding of the complex interconnectedness of the lake and its environment.

Bartosz Grudzinski is a hydrologist and geomorphologist at Miami University interested in factors influencing water quality and hydrology in the rivers that feed Acton Lake.

He explains that changes in hydrological and meteorological patterns are impacting the watershed. Although there hasn't been a significant change in total precipitation, there has been a shift in seasonality, more intense flooding, and temperature increases.

Grudzinski remarks that there have been "plenty of surprises" unearthed from the data collected. For example, there is variability in the response of streams to extreme flooding, an unexpected difference considering their close geographical proximity.

One study explored how water quality changes as water flows through a state park—a pocket of forest that contains natural vegetation on untilled soil—hemmed in by agricultural land.

Grudzinski says, "When water flows through that park, we're noticing that nutrient levels significantly decrease within several streams that drain into the lake."

He continues, "We cleared out all the forest to allow agriculture to expand, but we still have some pockets of forest. Hopefully we'll conserve more in the future, and that could have benefits to water quality."

THE FUTURE OF MONITORING AT ACTON LAKE

At the beginning of May 2025, the Miami University team deployed a new NexSens XB-200 buoy, which will improve the spatial resolution of data collection at Acton Lake.

With a temperature string and YSI EXO2 multiparameter sonde on board, real-time data is transmitted via the X3 data logger.

The data from the new buoy will supplement the existing dataset and contribute to a fuller environmental picture—something particularly important in the context of climate change.

"If you have a wet year now, we're probably going to get more sediment coming into the lake than we did in a dry year in the 90s, even though the concentrations of sediment are lower. Basically, weather overwhelms agricultural management," Vanni says.

THE BENEFITS OF BETTER DATA

One of the immense benefits of the long-term data at Acton Lake is that it has enabled a whole variety of applications—some unexpected—and offered windows into multiple research areas.

Despite the already extensive continuous dataset and its many applications, Knoll notes, "I think we need more data. [...] We're finding that 31 years [of data] might not be enough for some of these things, because there's so much variability year to year."

The long-term dataset from Acton Lake has already provided significant scientific value and shed light on an ecosystem in flux—with sometimes surprising results. Looking to the future, it's exciting to consider what the team might discover with a new buoy on the water. ^{SA}



Photos: Josh Pene / DreamBox Studio

(Left Page) Aerial view of the dam adjacent to Acton Lake.
(Right Page) Joseph Davidson assisting the Miami University team with the deployment of the XB-200 data buoy.



WILDFIRE PREVENTION IN THE SIERRA NEVADA REGION WITH THE YUBA WATERSHED INSTITUTE

Though recent wildfires have sparked new conversations about wildfire management and response, groups like the Yuba Watershed Institute have been monitoring the forests and water resources of the Sierra Nevada region for decades, managing approximately 5,000 acres of land with the Bureau of Land Management (BLM) and about 7,000 acres in private land partnerships.

The goal of the Institute is to work with local communities and land agencies to improve watershed and forestry management through informed practices and public outreach. The goals of the Yuba Watershed Institute are three-fold:

1. Improve the ability of fire suppression agencies like the California Department of Forestry and Fire Protection (CAL FIRE) and the US Forest Service.
2. Improve safety for nearby residents by working within the wildland-urban interface.
3. Improve the resilience of areas outside of the wildland-urban interface.

MIMICKING WILDFIRES AND MINIMIZING IMPACTS

Historically, the Sierra Nevada region experienced smaller-scale wildfires every 10-15 years, but there hasn't been a major fire in most of the Yuba River watershed in over 100 years, leaving the ecosystem out of balance and increasing the risk for even more severe burns.

As a result, the Yuba Watershed Institute's goal is to go into these areas and remove excess fuels and vegetation in the same way a wildfire might in order to minimize the extent and severity of future burns.

Chris Friedel, Executive Director of the Yuba Watershed Institute, explains, "We're trying to get in and mimic wildfire and, where we can, re-establish a more natural fire regime to try to open up the forest and make it more resilient."

Fuel removal techniques fall under two categories: understory fuels reduction and stand management.

Understory fuel reduction includes removing many small-diameter trees and shrubs, with a focus on removing shade-tolerant species like incense cedar and Douglas fir, as these species would not be present in most areas under a normal fire regime.

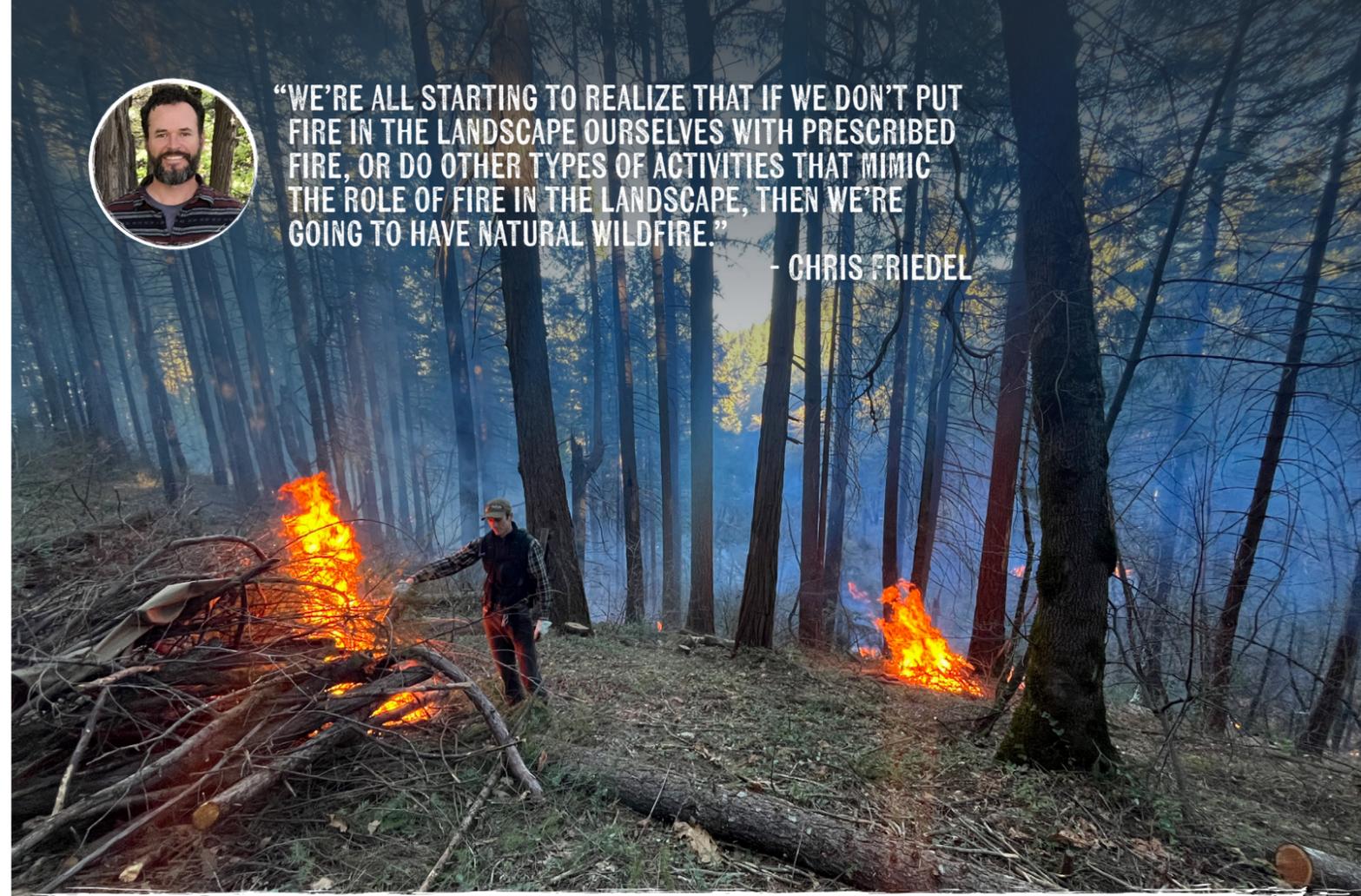
Most of these removals are done through manual treatments like chainsaws, burn piles, prescribed fire, chipping, or through mechanical mastication.

(Left) A spring prescribed burn to control the invasive plant Scotch broom. (Right) A local prescribed fire crew (First Rain Land Stewardship) burning piles of the Yuba Watershed Institute's Little Deer Creek Landscape Resilience Project.



"WE'RE ALL STARTING TO REALIZE THAT IF WE DON'T PUT FIRE IN THE LANDSCAPE OURSELVES WITH PRESCRIBED FIRE, OR DO OTHER TYPES OF ACTIVITIES THAT MIMIC THE ROLE OF FIRE IN THE LANDSCAPE, THEN WE'RE GOING TO HAVE NATURAL WILDFIRE."

- CHRIS FRIEDEL



In contrast, stand management involves looking at the overstory of the forest, reducing overall canopy density, and removing suppressed, diseased, dead, and dying trees, which helps reduce the risk of crown fires. Once removed, the Yuba Watershed Institute works with BLM to sell the removed logs.

The Institute is also looking into prescribed herbivory, which involves the use of goats or sheep to reduce fuels in certain areas, as well as controlled use of herbicides in some areas.

"It's really kind of all the tools in the toolbox, and I think that's what makes us different. We're really trying to do it in a way that balances this type of treatment with protection of biodiversity," states Friedel.

He continues, "We've had a focus on biodiversity since the founding of the organization, and so we try to be really sensitive to things like wildlife, habitat, special status species, soil impacts, and other unintended consequences of this type of work."

IDENTIFYING AREAS FOR TREATMENT

Before any of these treatments can begin, the Yuba Watershed Institute identifies areas for treatment. Most of their work starts from the ground up, with someone from a community contacting them due to concerns about local land management, or a local/regional fire agency like CAL FIRE will ask for assistance from smaller groups for help on a project.

An example of one of these CAL FIRE partnerships is the South Yuba Rim Hazardous Fuels Reduction project, which covers about 9,000 acres of federal and private lands. The project is a collaboration between the Yuba Watershed Institute and the Nevada County Office of Emergency Services.

The group is currently reviewing various platforms that might identify gaps in treatment areas, as well as various modeling tools like the Forest Services, LandFire data set, and mapping services like USGS LIDAR data.

"There's just a wealth of information that you can get from those LIDAR data sets that helps us understand the land form and what types of equipment and access can happen where," states Friedel.

He continues, "We can also get some vegetation information from the LIDAR. We can create a canopy height model, which allows us to understand the different vegetation types that are out there, as well as some information on fuel densities, so that's been incredibly helpful for me when I plan projects."

Once the overall area in need of intervention is identified, Friedel's team uses a Juniper Geode to map out the public land for treatment. BLM-managed lands are normally isolated parcels surrounded by private land, which the institute may not have access to for treatment.

Photo: Tim Van Wagner

Photos: Yuba Watershed Institute; Jesse Gruenberg



(Top) First Rain Land Stewardship crew removing invasive Scotch broom from BLM lands near a local school.
 (Bottom) A local contractor (GP Land Development and Clearing) chips cut material at the Yuba Watershed Institute's Little Deer Creek Landscape Resilience Project.



The sub-meter accuracy of the Geode allows the team to accurately map out the treatment zone and ensure they aren't infringing on private property. Some areas included in the project have dense canopies or are located in canyons where other GNSS receivers the team has used have struggled, but the Geode offers more consistent and accurate data.

Aside from drawing out the property lines, the team also flags different unit boundaries, riparian areas, equipment limitation zones, and maps completed treatments. Treatment data is reported to funding agencies, and the Yuba Watershed Institute makes internal notes of rare plant species locations and the presence of invasive species, improving their existing wetland and stream corridors maps.

"We build a data set for every project that allows us to make sure we're protecting resources and implementing the project in the right way," states Friedel.

He continues, "We're really trying to figure out some best management practices for our area—and our work is definitely not happening in isolation. We're part of a loose network of different agencies, municipalities, private companies, and nonprofit organizations that are all working on the same types of issues."

A key part of figuring out these best practices is moving toward a data-center approach to identifying treatment areas, which the CAL FIRE partnership offers the opportunity to work with various data sources and test different strategies to improve land management.

THE PUBLIC COMPONENT OF WATERSHED MANAGEMENT

According to Friedel, in the Sierra Nevada and California region, it's not a question of if fire is going to happen—it's a question of when. Knowing how severe these fires can be without the appropriate intervention, collaboration with other fire prevention and response agencies to develop informed management practices and minimize the risk of wildfires is essential.

"We're all starting to realize that if we don't put fire in the landscape ourselves with prescribed fire, or do other types of activities that mimic the role of fire in the landscape, then we're going to have natural wildfire, and it's probably going to have effects that are not what we want to see," explains Friedel.

He continues, "The goal—even though this is very hard sometimes to actually accomplish—is to try to have either prescribed fire or some other kind of fuels reduction activity happen every 5 to 10 years in all these areas that we're managing [...] and how we get there and whether there's enough funding, and whether the funding matches up with the timeline that we want, that's another question."

Without intervention, millions of residents in the area would be impacted, and so listening to their concerns about land use and developing a culture of stewardship for the watershed is a key component of the Institute's work.

Part of fostering this culture of stewardship is in sharing projects with the public and hosting public events that allow them to engage more deeply with various parts of the watershed, from the flora and fauna that live there to the landscape itself.

"People are very understandably concerned and afraid of a large-scale uncontrolled wildfire and what kind of effects it would have on this community. [...] We are playing a part in helping to make our community more safe and resilient," states Friedel. 

Photos: Tim Van Wagner; Ben Hout

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Have You Heard?

AI Buoys Revolutionizing Marine Mammal Monitoring in Whangārei Harbor, New Zealand

In one history, Whangārei Harbor, nestled in the lush hills of New Zealand's North Island, gets its name from the Māori, "waiting for the breastbone of the whale." It seems fitting, then, that it's now home to state-of-the-art acoustic monitoring buoys listening for marine mammals around the clock.

In September 2024, a team from Auckland-based underwater acoustics firm Cetaware Ltd installed NexSens buoys in Northport, a major commercial port at the entrance to the Whangārei Harbor.

The first buoys to be installed by Cetaware in a permanent setting running 24/7, they use real-time artificial intelligence (AI) models to passively sense Delphinidae—from common dolphins to orcas.

Dr. Matt Pine, Director at Cetaware explains that for a busy shipping hub like Northport, data is key, stating, "People can, in real-time, obtain really important and accurate data on the presence of marine mammals in the waterways, data on soundscapes or vessel movements, 24/7 day or night, which can be used to inform real-world environmental management decisions."



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EVOLVING MONITORING IN WHANGĀREI HARBOR

Initially installed for a three-month pilot, Pine explains that the technology was the natural evolution of monitoring systems in Whangārei Harbor.

"Since 2020, the port has maintained several hydrophones around their operational zones to monitor the presence of cetaceans," he says. The hydrophone systems needed regular maintenance to deal with problems like batteries running out and memory cards filling up.

They also recorded rather than transmitted, causing analysis bottlenecks as data was only obtained once the loggers had been retrieved. These problems are all solved in the new, real-time Cetaware system.

DEPLOYING THE NEW CETAWARE BUOY SYSTEMS IN WHANGĀREI HARBOR

Building and deploying a bespoke system housed in a NexSens buoy was straightforward. According to Pine, "NexSens provided the dimensions for the lid, which we had made up here locally. As soon as the buoy arrived, we could essentially just put the lid in because it's all standardized. So whether it's the 450s or the 1250s or the 950s, the lids are the same."

Utilizing the Northport harbor team's knowledge of tides and currents, moorings were built for the Cetaware buoys. The crane at the container terminal was used to hoist the buoys into the water before being towed to their permanent locations.

The buoys use edge processing, meaning data is processed inside the buoy and only transmits when it identifies sounds it has been told to listen for.

In the case of the Cetaware buoys in Whangārei Harbor, they're listening for frequencies above 1 kHz—the vocalizations of dolphins, orcas, and potentially humpback whales. When a vocalization is detected, audio is transmitted to a mobile device in real-time.

For Pine, the passive nature of this type of monitoring makes it special. "There's something I really like about the idea of when an animal comes into a bay and it vocalizes, it's made its presence known on its terms."

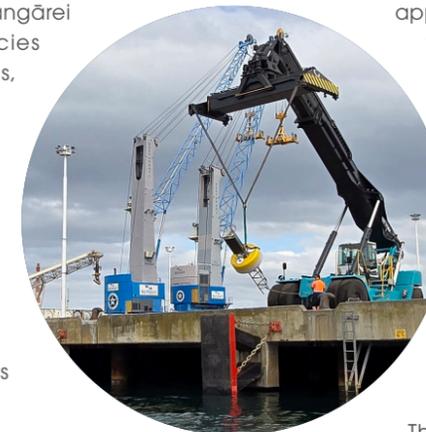
"It [the buoy] doesn't interact with the animal. It doesn't have any impact on them. It just sits passively, and they're providing information to you in a way. If it doesn't vocalize, I don't know what's there—that's the caveat to passive acoustics," he says.

REAPING THE BENEFITS OF REAL-TIME MONITORING SYSTEMS

Compared to manual loggers, the new real-time buoy system is more cost-effective, reducing labor, maintenance, and operational costs.

Pine explains that the buoys can be left out on the water for several months: "The NexSens buoys are pretty insensitive to fouling on the floats themselves, so it's just knocking it over to its side and then getting the weeds off the hydrophone element."

Furthermore, the buoys' connectivity makes pushing software upgrades as easy as "a few keyboard strokes." With systems like the NexSens CB-1250, the ability to remotely access the buoy means updating its models, troubleshooting issues, and applying upgrades can be done from anywhere in the world.



"Because it's sending data back to our servers here on land, we can retrain those models periodically on the data obtained from it, and then during its midnight handshakes, ping it back. Then, when the sun rises, it's running a whole new model. So as the technology evolves, as AI models change [...] you don't need the buoy back, we can push updates out to sea," Pine explains.

This flexibility enables scalability. With multiple buoys across New Zealand running AI models, they can all improve using data from the Cetaware buoys, and vice-versa.

APPLICATIONS OF ACOUSTIC MONITORING DATA

Real-time data gathered by Cetaware's system has already shed light on the behavior of marine mammals and is being practically applied.

"Port companies can better manage ship movements in and out of their ports. Pilots can slow vessels down if whales or dolphins are inside the harbor at the same time as their large ship is moving through the area, thereby affording those cetaceans more protection than they may have had otherwise," Pine highlights.



(Left Page) Buoys listening for marine mammals in Whangārei Harbor. (Top) A crane lifts a buoy into the water as the first stage of deployment begins. (Bottom) A pair of orcas.

Photos: Cetaware Ltd

**"THE MOST EXCITING THING ABOUT IT IS YOU'RE LINKING HUMANS WITH THE OCEAN."
- MATT PINE**



Additionally, triangulation using three or four hydrophones means it's possible to locate a vocalizing animal's location. Pine explains that since deployment, there's been a lot of activity recorded, and a surprising finding has been discovering how many marine mammals enter Whangārei Harbor at night.

The buoys can also monitor noise levels, creating a valuable archive that maps humans' acoustic impact on the marine world.

The team hopes that data from the Cetaware system can contribute to the Department of Conservation's sighting database, a key source used by decision-makers to determine whether an area is important for marine mammals.

The 24/7 data from the buoys helps build a more complete picture of animal activity in this area, free from the sampling bias commonly seen in datasets solely compiled from human observations.

Despite the limitations to observations, sightings remain important and—alongside corroboration from other sensors—are how the Cetaware system is being validated. Through this, the team now knows that the buoys can reliably hear Delphinids within 2km.

(Above) Orcas passing a buoy in Whangārei Harbor.

WHAT'S NEXT FOR ACOUSTIC MONITORING OF MARINE MAMMALS?

The trial of the Cetaware real-time system has been so successful that the team is removing the sea floor-mounted hydrophones in early 2025 and transitioning to fully live, buoy-based monitoring.

When asked what's next, Pine answers unequivocally, "More nodes." The team has already earmarked sites at Queen Charlotte Sound and Kaikoura for new buoys. Alongside expanding the network, upgrading the technology in the buoys will be an ongoing task, as AI models develop and software upgrades are implemented.

The future is bright for these buoy systems, which are already contributing to the global understanding of marine mammals and helping to shape more sustainable interactions for Northport.

Pine captures the essence of the project, "The most exciting thing about it is you're linking humans with the ocean."

He continues, "Knowledge is power, and so if you better understand your environment and what the animals are doing when they're there, then it naturally leads to better environmental outcomes. It's the balance between development, economic growth and progression with protecting the environment and that's very important to us in New Zealand." SA

Photo: Ingrid Visser / Orca Research Trust

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DATA-DRIVEN ADVOCACY ON THE LOWER DESCHUTES RIVER



(Left) Algae blooms in Lake Billy Chinook in a popular swimming area. (Right) Field Equipment used by the DRA. YSI EXO2 sonde, NexSens X2 data logger, and field cables.

Like many freshwater environments, the Deschutes River in Oregon is under pressure from development, pollution, and climate change. Many rivers, streams and lakes in the Deschutes Basin do not meet Oregon water quality standards—where state water quality monitoring assesses levels of bacteria, pH, dissolved oxygen, temperature, and fine sediment.

Hannah Camel is the Water Quality Coordinator for the Deschutes River Alliance (DRA), a non-profit organization that focuses on the health of the lower 100 miles of the Deschutes River—the area most affected by human intervention.

As a data-driven organization, the DRA has benefited from the installation of three NexSens X2 data loggers. Camel explains that these have given the team “better data and more scientifically credible data,” adding weight to their work advocating for colder, cleaner water, healthy ecosystems, and the recovery of fish life in the Lower Deschutes River (LDR).

THE LOWER DESCHUTES RIVER

The 252-mile-long Deschutes River originates from Little Lava Lake, Oregon, on the eastern slope of the Cascade Mountains, and empties into the Columbia River. It is the basis of most of Central Oregon’s economic and recreational activities.

In the mid-20th century, the Deschutes River was fragmented by the Pelton-Round Butte Hydroelectric Project. The three-dam complex comprises Round Butte Dam, Pelton Dam, and a final, re-regulation dam.

The LDR begins at the tailrace of the downstream-most dam and runs 100 miles north to its confluence with the Columbia. It is an Oregon Scenic Waterway and Federal Wild and Scenic River, world-renowned for its fly fishing, and visited by thousands of people each year.

THE IMPACT OF HUMAN INTERVENTION ON THE LOWER DESCHUTES

The hydroelectric facilities on the LDR are the only ones in the United States jointly owned by a utility company—Portland General Electric—and a tribe—the Confederated Tribes of Warm Springs. Following relicensing in 2005, the groups committed to working together to restore fish passage.

Consequently, in 2009, a Selective Water Withdrawal (SWW) tower was built in Lake Billy Chinook, the main reservoir in the system, and held behind Round Butte Dam.

The SWW Tower is engineered to help migrating smolts find their way through the lake and hydroelectric complex. Operators can release up to 100% of surface water at any time and for an unlimited duration—doing so generates surface currents that attract the fish to a collection facility.

While the SWW has successfully increased the number of anadromous fish leaving the hydroelectric complex, it has also had significant negative side effects.

Photos: DRA



The SWW Tower draws water from Lake Billy Chinook, a reservoir fed by three tributaries—the Metolius River, Middle Deschutes, and Crooked River.

Notably, the Metolius brings very cold, very clean water, and the Crooked River brings very warm, nutrient-laden water from nearby agricultural hotspots—it’s estimated that the Crooked River accounts for 86% of Lake Billy Chinook’s dissolved nitrates. The difference in water temperature in these tributaries leads to stratification in the lake.

Camel explains, “Now they’re drawing this warm nutrient-rich Crooked River water from the surface, combining it with the bottom water, and we’re seeing huge water quality issues downstream because of that.”

A CHANGING AQUATIC ECOSYSTEM

Changes to water quality were noted by the DRA almost immediately after the SWW Tower began operation. Camel outlines, “We have seen an increase in temperatures and pH in the lower river. We’ve seen issues with dissolved oxygen.”

A 2023 study found that “temperature predominantly drives daily DO [dissolved oxygen] dynamics in the contiguous United States,” highlighting the potential ecosystem damage the release of warm water could cause in the LDR.

“The overarching issue that we’re seeing is a huge increase in nutrients and algae in the lower river [...]. This non-usable form of algae is proliferating and pushing out all the species that are usable by our benthic communities,” Camel continues.

While the negative impact on water quality was immediately apparent, Camel warns that “we’re just now starting to see a lot of those effects on wildlife. We are seeing shifts in hatch timing of insects, and some insect species are almost gone entirely. It is speculated that this could affect the timing of our Redband Trout spawning.”

**"WE PUSH FOR SCIENCE-DRIVEN POLICY CHANGES,
NOT JUST POLICY CHANGES." – HANNAH CAMEL**



Camel is clear that the DRA isn't outright against the SWW Tower, instead advocating for a measured, data-driven approach that balances supporting fish migration without harming the LDR's fluvial ecosystem.

She states, "We're pushing for more cold bottom water being released into the lower Deschutes River for the majority of the year—versus how it is now, where it's a majority surface water being dumped in. With the exception of peak out migration to encourage smote capture, but releasing that water at night so it's already cooler."

A NEW WAY TO MONITOR THE LOWER DESCHUTES RIVER

Robust scientific data is fundamental to the DRA's mission and provides a vital record of the changes unfolding in the LDR. However, until 2016, the team used resource-intensive manual monitoring systems.

"We were doing a lot more grab sampling with manual temperature loggers," states Camel. "All they can monitor is temperature and you have to physically be there to plug them in to download the data. They have a really short capacity."

In 2016, the DRA team installed a NexSens X2 data logger about a half mile below the final dam, added a second data logger 50 miles below the dam in 2024, and in 2025 added a third logger near LDR's confluence with the Columbia. The real-time data provided by these loggers complements the team's ongoing grab samples and targeted studies.

Camel explains that the DRA "focuses on long term monitoring of temperature, dissolved oxygen, pH, and nutrients, to give us a picture of how operation changes at this [hydroelectric] complex have affected the lower river's ecosystem."

She highlights that the X2 water quality systems—which integrate the X2 data logger, mounting kit, and solar power pack—have proved to be an effective solution. "They're very durable and reliable. We're in a challenging ecosystem in the high desert, it's extremely hot, it's extremely cold, and we've had no issues with them," states Camel.

The DRA uses the YSI EXO data sondes, which are easily plugged into the X2 data logger. "They've integrated extremely well with our existing equipment," she adds. "We've had zero issues putting them together and making this system, which saves us time and money and effort."

TRANSFORMING MONITORING ON THE LOWER DESCHUTES RIVER

Better data has been transformative to the organization's work. Camel explains, "The more intensive monitoring has been done since 2016 and that's allowed us to build this really big, long-term data set."

"We're able to log every 10 minutes. I'm able to be at home and see how my sensors are running. It lets us respond in real time and then push those messages out immediately. Rather than having to wait six or eight months to process all this data, we're able to put it out to the public and say we just saw a huge change in the lower river."

Photos: DRA

Having high-quality, high-resolution, continuous data like this is rare. "No other group has a long-standing data set over the course of 10 years, and this has really helped us inform our advocacy efforts. We push for science-driven policy changes, not just policy changes," elucidates Camel.

The data the DRA collects feeds into broader monitoring efforts, including data published by the Oregon Department of Environmental Quality.

Camel notes, "Because no one else is doing this monitoring in the lower river, we submit a lot of our data to them, and then they make it available for the entire United States."

THE FUTURE OF MONITORING

Camel argues that more data is needed to deepen understanding of the environmental changes unfolding in the LDR, and the impact of the SWW Tower is one element in a complex patchwork of environmental flux, including climate change, industry, and development.

"We added a third monitoring location this year," she says. "We put it right by where the mouth is with the Columbia so we can really get a big picture along the entire length of the river and understand exactly how dam operation affects it immediately downstream and all the way up to the mouth."

"We also are in the process of developing a new algae monitoring initiative. We want to assess biomass, species composition, and nutrient impacts on the lower river, and we want to build this data set now so if and when operational changes are made, we can start looking at how operation will change the nuisance algae community," she continues.

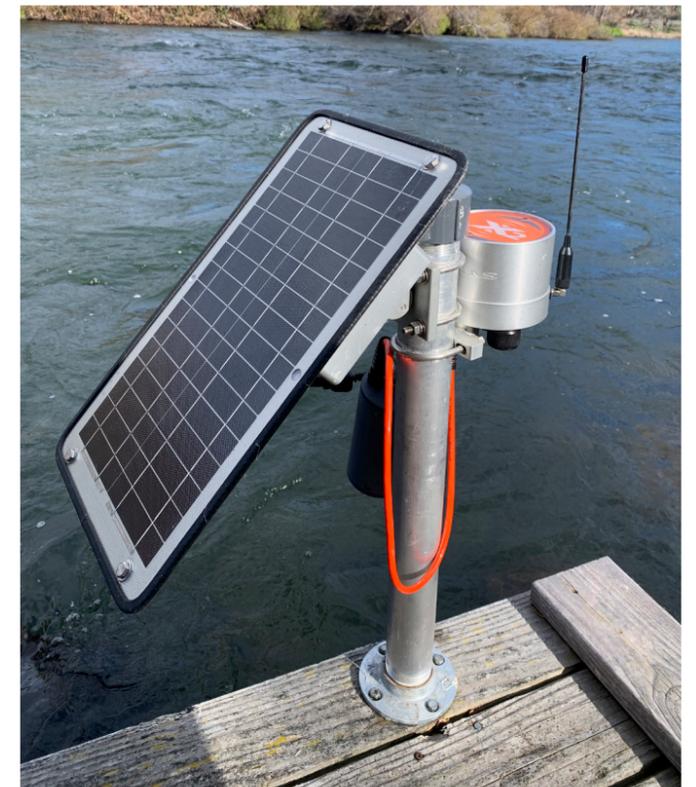
Thinking bigger, the DRA has ambitions of monitoring at a watershed-wide level. "We understand the health of that river is the sum of its tributaries," Camel notes. "We want to begin monitoring more of the tributaries that flow into the lower Deschutes to better understand how they influence the river's health and to identify strategies—like targeted restoration—to improve their condition."

ADVOCATING FOR A HEALTHIER DESCHUTES

Like many rivers in the US and around the world, the LDR is experiencing accelerated change, in large part because of human activity. It is certain that data collected by the DRA—which contributes to wider monitoring efforts—will continue to be integral to informing and observing positive environmental change.

"There's an issue going on, and we wouldn't be arguing for change if the data didn't show that," Camel concludes. 

(Left Page) Selective Water Withdrawal Tower on Round Butte Dam. (Top) Raft on Lower Deschutes River. The LDR is a popular destination for recreation from fly fishing to multiday rafting trips. (Middle) NexSens X2 data logger setup. (Bottom) Algae blooms in Lake Billy Chinook in a popular swimming area.





Clendenen and Brenner collecting two samples at each site.

Watershed Stewardship in Minnesota Protecting Valley Creek in the Land of 10,000 Lakes

The Saint Croix Watershed is home to dozens of lakes, rivers, and streams that host an abundance of aquatic life from its tributaries. Valley Creek, a tributary of the St. Croix River, is a designated trout stream and while it is a pristine waterway, ongoing monitoring and stewardship establish a baseline of conditions and protect the creek.

Don Wendel and Dilon Clendenen, Minnesota Master Naturalists, Liberal Arts majors, and retired college teachers, are two members of the wetlands research team based out of the Science Museum of Minnesota's St. Croix Watershed Research Station that monitors Valley Creek throughout the year.

They are joined by two other researchers, Jeffery Brenner, with the Inorganic Chemistry Unit, Minnesota Department of Health, and Lisa Peterson, a former chemistry professor retired from the University of Minnesota.

FROM BOGS TO CREEKS: WETLAND RESEARCH IN VALLEY CREEK

After spending several years researching the causes of flora change in Bernie's Bog at Warner Nature Center, Wendel and Clendenen moved to Belwin Conservancy in Afton, Minnesota, in the spring of 2020. There, they were given space to establish their own laboratory, which gave them more rigorous control over research protocols.

While their research originally started in Metcalf Marsh, the group quickly determined that a more comprehensive study of the Valley Creek stream system was the best way to establish a definitive study.

Currently, the team oversees six sites starting where Valley Creek exits from Metcalf Marsh, through the confluence of the north and south branches, and close to the area where Valley Creek flows into the St. Croix River.

The team monitors the waterways to ensure that the ongoing development of the surrounding area does not impact the health of the watershed. The purpose of the monitoring is to establish a database that profiles typical artifacts for determining water quality.

"There are roads, homes, farms, and businesses around Valley Creek, and we were concerned that over time, there might be more development in the area. That development might affect the quality of Valley Creek, which is a designated trout stream and maintains five different kinds of trout in it," states Wendel.

Valley Creek also sustains wildlife in the area. Otters, foxes, bears, birds, deer, and many other animals in the area would be impacted by deterioration of the creek.

He continues, "The goal of the monitoring program is to create a database against which we could measure any kind of dramatic change. For the few years we have been studying Valley Creek streams we have noticed an increase in the level of nitrate in the south branch of Valley Creek."

The frequent monitoring helps establish a highly granulated baseline of conditions at each site, and if any deterioration is recorded, the continuous sampling conducted by the team can help identify when, where, and why the change happened.

In order to create the database, the team goes out to the field twice a month and uses a Hach HQ2200 portable multimeter with dedicated probes to measure temperature, pH, conductivity, salinity, TDS, dissolved oxygen, and ORP.

For testing nitrate, nitrite, and orthophosphorus, a Hach DR900 colorimeter is used. Depending on the time of year and road conditions, the team will also use strips to test for chloride concentrations that might seep into the creek from road salt runoff.

Discharge of the river is also measured at each of the sites using a Global Water Flow Probe, and water clarity is measured using a Secchi tube.

The team also monitors precipitation as runoff from development could negatively impact water quality. Clendenen manages the precipitation equipment that continuously collects rain and snow over time, which can then be measured at a later site visit.

LIMITATIONS AND CHALLENGES

While the team has been able to collect a significant pool of data over the years, there are limitations to expanding their work as well as daily challenges. Site visits can be disrupted due to weather events that present safety risks to fieldwork, and staffing has historically been an issue for the program.

Including Clendenen and Wendel, the ideal staff size of the program would be six people—however, the team is currently operating with only three full-time members.

Clendenen oversees the precipitation monitoring and analysis component of their research and also serves as Belwin's contact for the program. She handles recruiting, schedules volunteers, and works in and out of the lab throughout the year.

Wendel manages the experimental aspects of the program. He monitors the experimental design, controls lab inventory, enters and analyzes data, and works with Clendenen to establish standard methods of sampling and analysis. Peterson and Brenner do both sample collection and testing. They also offer technical guidance when issues arise.



Matrix used for testing samples from the six sites.

For analytes, like orthophosphorus, nitrite, and nitrate, the team tests against standards and seeks to test against a resulting standard that comes within 10% of true value of a standard. However, unstable standards, like the nitrate test, are a challenge for Wendel as they make results less reliable.

"We need to assure that our data gives an accurate profile of the health of Valley Creek if our program is to have credibility," states Wendel.

FUTURE POTENTIAL OF THE VALLEY CREEK PROGRAM

A larger staff would help things run more smoothly and allow for the program to expand its capabilities.

Clendenen's precipitation monitoring, in particular, could be expanded on with some additional help. An extra researcher could assist with the data analysis, coordinating the precipitation data with what's happening in the stream and noting any nutrient spikes or changes following weather events.

Wendel adds, "If we had the staffing, we could set up a program to better examine temperature changes in and during the various seasons."

"There's also concern PFAS may have polluted some of the groundwater. So, we could—if we had the money—we could expand our study of that and see how the creek has been affected by PFAs," he continues.

The work being done by the wetlands research team is an essential part of protecting Valley Creek and the larger St. Croix watershed. The program is a key component of building consciousness about water quality in the surrounding region and better managing the area.

Clendenen explains, "Water is necessary for all life on our planet, and the quality of our water is degrading due to many factors, including, just for example, climate change and pollution."

"We are working to monitor one pristine trout stream and ensure its continued positive impact on Valley Creek watershed and the St. Croix watershed into which its waters flow. We need to do all we can to protect the health of our climate. This is my reward," she concludes.

In the grand scheme of things, the team's work is only being conducted in one part of the watershed. However, both Clendenen and Wendel are hopeful that their work in Valley Creek will inspire other programs in the watershed.

"We would like to think that what we're doing is a model and that somebody else could emulate that [elsewhere], and we would be happy to help them try to do that," states Wendel. ^{SB}

If you are interested in joining the Valley Creek monitoring team or creating a program elsewhere in the St. Croix watershed, please contact Dilon Clendenen at dilonac@hotmail.com or Don Wendel at don_wendel@msn.com

Photos: Don Wendel / St. Croix Watershed Research Station

Monitoring Aquatic Ecosystems

How Science Drives Waterway Management in Northwest Georgia

The University of Georgia is home to multiple labs that focus on monitoring aquatic ecosystems and organisms across the state. The River Basin Center connects these monitoring efforts with external partners, including government agencies and NGOs, to inform management and restoration of the state's waterways.

Phillip Bumpers is a Postdoctoral Associate in the Rosemond lab and the Wenger lab at the Odum School of Ecology and an affiliate of the River Basin Center. An aquatic ecologist, Bumpers' research focuses on quantifying how environmental variability shapes aquatic ecosystems and understanding the drivers of these trends.

MONITORING AQUATIC ECOSYSTEMS IN NORTHWESTERN GEORGIA

Recently, Bumpers and Dr. Seth Wenger have been monitoring ecosystems in the Northwestern part of Georgia, collecting water quality data and conducting fish surveys in Holly Creek and the Conasauga and Etowah Rivers. This data is used to establish a baseline of conditions in the waterways, documenting interactions within the ecosystem.

While all three waterways are monitored, the Holly Creek data has a slightly different goal. Holly Creek has undergone some remediation and restoration in recent years, along with some land use reform, making it the ideal environment to test the success of these changes.

Four continuous monitoring stations are set up along Holly Creek, monitoring dissolved oxygen and temperature using a PME miniDOT, water level using a HOBO U20L level logger, and specific conductance using a HOBO U24 conductivity logger. Measurements are performed every 15 minutes and stored internally on each device for download at a later date.

Across each of the lab's focused waterways, dissolved oxygen, temperature, water level, and conductivity spot measurements are collected using a YSI ProQuatro.

In addition to water quality monitoring, Bumpers' team samples fish in all three rivers annually, quantifying occupancy and measuring abundance for all species encountered during these outings.

Data is added to the long-term database in order to track abundance trends over time. Mussels are also sampled via similar means by project partners in Holly Creek exclusively.

DATA-INFORMED MANAGEMENT OF GEORGIA'S WATER RESOURCES

All three of the monitored waterways, which are located in the Mobile River Basin, are home to at least six species of endemic fish, all of which are considered imperiled. Finding out what makes these ecosystems tick is a key part of protecting these species.

For example, agricultural runoff, which can lead to increased algal production and potentially reduced dissolved oxygen caused by increased respiration, is common in some areas of the rivers and could be contributing to declines in several species.

Identifying these trends could inform management, such as the creation of riparian buffer zones and other strategies to minimize nutrient loading.

Water quality and aquatic species data are then sent to the River Basin Center's funders as well as other outside organizations and groups to help inform management actions in the watershed.

The Center's long-term monitoring efforts have been ongoing for 28 years, and the large data pool assists with trend spotting as well as documenting conditions in the waterways before, during, and after management.

The long-term monitoring was started by Dr. Bud Freeman, an ichthyologist at the Odum School, to monitor Amber Darter populations in response to water extraction and land use change.

This dataset may inform how well management policies are protecting aquatic ecosystems, which helps improve water resource management throughout the region.

In addition to guiding management, the data collected by Bumpers and his team will help improve existing understanding of Georgia's rivers and streams, particularly in pulling apart what is really threatening aquatic ecosystems.

Bumpers explains, "These rivers are highly biodiverse, it's important to understand what is happening to these systems so that we can keep these fish, several of which live nowhere else in the world, around for future generations. The threats that rare species are facing are myriad, and it's important to shed light on how these organisms are faring."



Photo: Sara Buckleither / River Basin Center, University of Georgia

Photos: River Basin Center, University of Georgia

He continues, "We are monitoring the temporal trends in these species, but we can also understand drivers of population variability—how aquatic organisms respond to variation in their environment, such as streamflow or temperature."

Though time-consuming, Bumpers stresses that this work is essential to protecting the aquatic ecosystems in the region. Fortunately, he has a motivated group of students helping to lead the way.

With an ever-changing environment, understanding drivers of change in aquatic ecosystems is essential to protecting organisms and water resources. Because watershed management is so multi-faceted, research topics can vary from the fish that inhabit these systems to larger physical processes.

Studying each of these variables and building a comprehensive understanding of them is essential to making informed management decisions and protecting aquatic ecosystems as effectively as possible.

"This can help us make predictions about how aquatic systems or particular species may respond to future management actions or changes in their environment," states Bumpers. ^{SB}

(Left Page) Researchers at the University of Georgia's River Basin Center seining for fish in the Etowah River, GA. (Top) A research technician at the University of Georgia, checking on sensors in Holly Creek. (Bottom) A Mobile Logperch in the Etowah River. Mobile Logperch are native to the Mobile River basin.

No Red Herrings:

Data Driving the Largest Salt Marsh Restoration in the NE USA

The Herring River system encompasses around 1,000 acres in the Towns of Wellfleet and Truro, Massachusetts. In 1909, the Chequessett Neck Road dike was built at the river's mouth, drastically limiting tidal flow. Today, it's one of the most restricted estuaries in the Northeastern United States.

As a result, the area has suffered environmental decline, including poor water quality, hypoxia, lower pH, and salt marsh degradation. In 2023, the Town of Wellfleet received \$14.7 million from NOAA's Office of Habitat Conservation to fund the Herring River Restoration Project (HRRP).

Francesco Peri, President and CEO at Charybdis Group LLC, uses a network of NexSens data loggers to monitor water level and water quality on the Herring River. Access to good data before, during, and after restoration is critical to understanding and managing an environment in flux.

THE HERRING RIVER RESTORATION PROJECT

The HRRP aims to restore the salt marsh at the Herring River mouth by replacing the dike and culvert with a bridge. The bridge will be fitted with 17 motorized gates, controlled by trained operators.

These gates will allow the gradual reintroduction of tidal exchange—currently the Herring River has an approximate tidal range of 0.5m, compared to around three meters in the harbor—with the exact amount guided by one of several adaptive management plans, ranging from less to more conservative.

The process balances marsh recovery with the protection of nearby properties and infrastructure as this change takes place.

After a period of up to a decade—depending on the management plan selected—the gates will be removed entirely, leaving just the bridge. Culverts and road crossings in the Herring River floodplain are also being removed to help restore fish ecosystems.

Peri explains that accurate data are "essential for managing the return of tidal flow and ensuring each step stays within the modeled parameters."

A SYSTEM IN FLUX

Peri emphasizes the long history of monitoring the Herring River. "We've collected roughly four years of baseline data ahead of bridge construction. Continuous monitoring during and after construction helps us identify and respond to any unforeseen changes."

Indeed, with work now underway, construction has caused "noticeable sediment redistribution"—driven by a change in the location, rather than volume, of tidal flow—and "unintentional modifications to the flow."

These changes are the latest in the history of a system in flux.

After more than a century of diking, the salt marsh has been heavily impacted. The natural tidal range of approximately three meters once brought in sediment during the flood tide, allowing the marsh to sustain and build. However, with the tidal range cut to less than 20% of pre-diking levels, the marsh has drained and collapsed.

Exposure to air decomposes marsh soils, releasing sulfuric acid into the ground and carbon dioxide into the atmosphere—an estimated 730,000 metric tons since diking happened.

With less saltwater influence, the marsh has shifted to a freshwater system, losing halophytic—or salt-loving—flora and fauna.

Named after the once-abundant river herring, the Herring River supported a thriving fishery until the early 1900s. The dike blocked passage upstream, reducing the herring population by about 90 percent. Some species, like brook trout, have vanished entirely.

Oxygen levels in the water have dropped, threatening wildlife. High pollutant and bacteria levels near the river mouth have shut down productive shellfish beds upriver of the dike.

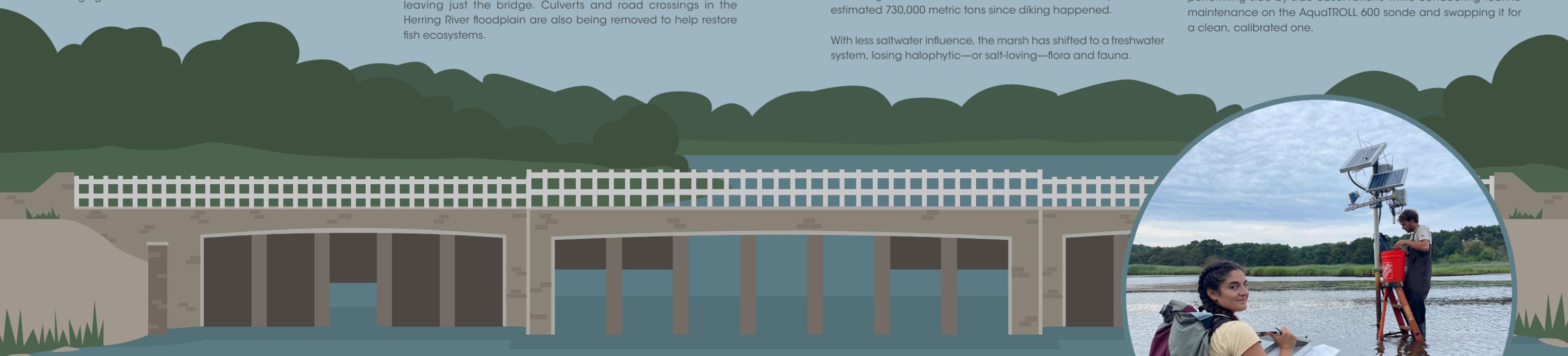
ENVIRONMENTAL MONITORING IN THE HERRING RIVER FOR BETTER DATA

The HRRP's environmental monitoring system uses NexSens technology, with upgrades underway to the latest X2 and X3 data loggers—user-friendly systems that "work out of the box."

Currently, four X3 loggers are deployed. Two more will replace existing, older models in 2025, and one new station is planned.

Each logger connects to an In-Situ AquaTROLL 600 multiparameter water quality sonde that measures temperature, conductivity, salinity, dissolved oxygen, pH, pressure, turbidity, and water level. One station measures air temperature, wind speed, and wind direction using the Vaisala WXT536 Multi-Parameter Weather Sensor.

The team also uses the YSI EXO2 sonde as a reference instrument, performing side-by-side observations while conducting routine maintenance on the AquaTROLL 600 sonde and swapping it for a clean, calibrated one.



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(Graphic) Illustration of how the bridge gates will open gradually over time, releasing water at a controlled rate. (Credit: Emma McCroskey / Fondriest Environmental, Inc.) (Right) The sondes at the Chequessett Neck Road dike get their routine maintenance. (Credit: Francesco Peri)

Construction of the new bridge that will replace the tidally-restrictive Chequesseff Neck Road dike is underway. Initially, the bridge will have motorized gates. Based on environmental data, tidal flow will be controlled via these gates, to ensure the sustainability of gradual ecosystem restoration. Eventually, these gates will be removed.



“Continuous monitoring during and after construction helps us identify and respond to any unforeseen changes.”
— Francesco Peri

“Water level is the essential parameter we’re measuring as we reintroduce tidal exchange,” highlights Peri. Water level is calculated via measurements of salinity—to account for water density—and hydrostatic pressure.

The sonde also measures turbidity to track suspended sediment. “We have one of the most flourishing shellfish industries on the Cape,” Peri notes. “They grow oysters on the flats just downstream of the dike and they are very worried about their oyster beds getting buried by sediment due to this transformation.”

Water chemistry is another critical focus. As tidal flow returned, dying freshwater plants released nutrients, altering soil chemistry.

“There is a lot of iron oxide in the system,” Peri says. “We pull out our sensors and they are completely rusted over, and the pH is very low. [...] seawater pH is around eight, but we’ve seen pH down to 5.5—something that has implications for wildlife.”

REAL-TIME DATA FOR VITAL INSIGHTS

Peri uses WQData LIVE, NexSens’ online dashboard, to access HRRP data remotely and in real-time.

Data is primarily used by the National Park Service, enabling “active management of the gates of the new bridge structure,” but it is also made publicly available.

With multiple stakeholders and landowners involved, Peri says the dashboard is accessed “all the time” and has already proven valuable.

For instance, a local golf club has to pump water off low-lying areas during spring tides—high tides that occur monthly. During one such tide amid preliminary bridge work, the water didn’t recede.

Peri explains, “The instrumentation that we had in place clearly demonstrated that the whole tidal oscillation had shifted up by about a foot. It’s an example of the importance of the data and the immediate repercussions to stakeholders on-site.”

EVOLVING METHODS

Monitoring methods on the HRRP are continually evolving. Around three years ago, waves breached the sandbar at Duck Harbor.

“Every spring tide, there is overflow from Duck Harbor into the system,” Peri says. “That creates a little bit of confusion because you have an unexpected second tidal input.” A new monitoring station is being set up there in response.

Two buoy systems have been deployed to replace an X-Series submersible logger in the intertidal zone, which could only transmit data at low tide. “The pressure sensor is attached with the anchor of the buoy,” Peri explains. “It is at the same location as before, but now we have the data logger in the buoy, so it can telemeter at all times.”

(Top Right) The Herring River downstream of the Chequesseff Neck Road dike. (Bottom Right) The team conducts an elevation survey at one of the real-time monitoring stations.

Photos: Francesco Peri



The buoy also houses an Airmar 200WX-IPX7 Ultrasonic Weather Station with integrated GPS and Inertial Measurement Unit.

Peri is also installing microwave radar transducers at existing stations. These non-contact sensors measure water level by distance, enabling year-round monitoring—even through the harsh Massachusetts winter.

These systems operate alongside a swathe of other environmental monitoring, including terrestrial LiDAR scans and direct sediment monitoring using altimeters.

A BETTER ENVIRONMENT BUILT ON BETTER DATA

The HRRP aims to improve water quality, restore rare species habitat, revive failing fisheries, and boost recreation. It’s also expected to aid the fight against climate change—healthy salt marshes absorb carbon dioxide and methane, and serve as natural flood defenses.

Data is key to guiding the transition to full, natural tidal exchange on the Herring River and providing a quantitative basis for key decision-making, both in the day-to-day operation of the new bridge’s tide gates and longer-term management plans.

Peri concludes, “We know the importance of monitoring data, and most importantly, we know the importance of real-time monitoring. It gives us the immediate ability to go and make further observations when needed, and see things which otherwise might not be observed or missed altogether.” SA



Research in the Reserve:

Promoting Interdisciplinary Conservation at the Great Bay National Estuarine Research Reserve



On an early winter day in 1973, a helicopter buzzed over Durham, New Hampshire, just a few miles from the Atlantic Ocean. One of the helicopter's guests, oil magnate Aristotle Onassis, owner of Olympic Refining, looked east of town and saw what he hoped would become the world's largest oil refinery. Instead, he saw the Great Bay; thousands of acres of green coastal forest, mud flats, salt marshes, and estuarine tidal waters stretching over the land toward New Hampshire's small Eastern coastline.

Onassis likely also saw a group of Durham residents staked out on the bay's coast, ready for him to pass overhead. While out of place in the natural setting, an obvious message was spelled out in red paper: "Not Here."

Those words took hold in the small community, as townspeople banded together to oppose the construction of an oil refinery on their local land and waters. Just a few months after that helicopter ride, despite overwhelming support from the state and various media outlets to build the refinery, residents of Durham voted resoundingly to ban the construction of oil terminals and rezone their town to allow oil production.

Olympic left New Hampshire without its grand oil refinery, and the town of Durham left the interaction victorious in protecting its Great Bay. But residents were wary of future approaches to their land and water, and soon after, created the Great Bay System Estuarine Conservation Trust.

This was just the first step, and in 1989, the Great Bay achieved even more protection. That year, it earned status as a National Estuarine Research Reserve (NERR), a system created by the National Oceanic and Atmospheric Administration (NOAA).

The Reserve is a state-federal partnership between NOAA and the New Hampshire Fish and Game Department (NHFG). Day-to-day management is run by NHFG while NOAA continues to support the Reserve with funding, technical assistance, and links to the national network. It has remained under protection since 1989 and looks quite similar to the view from that nearly-fateful helicopter ride over 50 years ago.

THE CURRENT STATE OF THE GREAT BAY

Christopher Peter is a research coordinator at the Great Bay National Estuarine Research Reserve, where he has been since 2017. Having previously worked nearby at the University of New Hampshire, Peter knew of the sprawling 10,000-acre reserve. Yet, once he started working on the ground in Great Bay, he began appreciating the many hats the Reserve was wearing, which include education, land management, and environmental stewardship.

"We spread our resources...[some] labs are just focused on researchers, or some of these centers are focused on education," Peter says. "And we do all of that."

Recreation in and around the Reserve involves land and water, where people can hike, hunt, fish, and go birding, connecting visitors to protected natural resources. As a collaboration between state and federal protection, all of the lands in the Reserve are Wildlife Management Areas. Some of this land is managed for research and visitor use, and some areas are managed to benefit wildlife.

(Left) A teachers' workshop focused on water quality monitoring with data sondes like the YSI EXO2. (Right) Great Bay Reserve staff photo.

Another long-standing tradition at the Reserve is education, which occurs at the Great Bay Discovery Center in Greenland, New Hampshire. According to Peter, thousands of local school children visit the Reserve each year on field trips to learn about estuarine ecosystems. The Reserve also offers programming for young families and teacher training workshops, as well as sharing scientific information with the local community.

Much of the research Peter and his colleagues carry out is used to directly inform educational programs. Under the NERR system, collaboration between the different focus areas of a Reserve is heavily encouraged.

"I can start generating a science project that has a management application, and then have an education component too," Peter explains. "It's like a pipeline. It's not just one facility."

RESEARCH IN THE ESTUARINE RESERVE

Peter and his colleagues recently wrapped up a decade-long project in the estuary investigating how salt marshes are impacted by climate change, specifically how sea level rise is changing their habitat. A decade of data was analyzed, and the project came to a grim realization: salt marshes aren't doing well.

"Marshes are changing. They're basically drowning out now, because we're facing unprecedented levels of sea level rise," Peter says. "So we're likely to see less marshes in the future unless we take some action."

According to Peter, Great Bay has lost about half its seagrass beds, 90% of its oyster reefs, and has experienced significant marsh degradation. Some of this land has been replaced by subtidal mud flats, which now dominate the estuarine reserve.

Another key part of the Reserve is the coastal forest. Being above the water line, Peter explains that emphasis is placed on protecting these lands, although all parts of the Reserve work together to create its unique ecosystem.

Climate change is also bringing new fish and wildlife into the Great Bay. The arrival of Atlantic blue crabs, which are usually found further south in warmer climates, has brought Peter a new dynamic to investigate. He explains that the Gulf of Maine, which is bordered by Cape Cod in the south, the New Hampshire and Maine Coasts, and Nova Scotia to the north, is rapidly warming. In fact, it is in the 99th warming percentile worldwide.

As the climate warms, Peter believes the crabs are extending their northern limit and migrating into New Hampshire and Maine. He sees at the same time that lobsters in the estuary are migrating north out of Great Bay in search of cooler waters.

"So we've been working on understanding how much [of] their population is here, and trying to find all the parts of the life cycle," Peter says.

"[Do] they come here and then they die over the winter, or [do] they come and stay and reproduce?" he questions, with his current project revolving around understanding the crab's diet in Great Bay.

However, Peter's and his colleague's work doesn't just inform in-house management and education—another component of the Reserve is training engagement. This involves bringing the research conducted at Great Bay to conferences, workshops, and more, using what they have learned to aid in research projects and management decisions across the country.

Photo: Christopher Peter

Photo: Melissa Broglio



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UNIQUE STATUS IN NERR

This is especially useful when collaborating with other estuarine reserves under NOAA, which Peter sees as one of the great benefits of joining the national NERR system.

"I think that's one of the two biggest strengths of the Reserve system, is the integration of management, education, [and] research," Peter says. "And then the other biggest strength is we can amplify our efforts nationally, within our system."

Currently, Great Bay is working with scientists from the University of New Hampshire and several other reserves to catalog the biodiversity and communities in these estuaries. Components involve filtering DNA from water samples and looking at fish diversity across habitat types, salinity levels, and latitude. Understanding the diversity that estuaries harbor is key to predicting how they may change, or resist change, in the face of an ever-shifting planet.

Fortunately, not all is bleak for Great Bay and other estuarine reserves. Peter says that because land management and community engagement are such large parts of running the reserve, restoration and conservation are always ongoing.

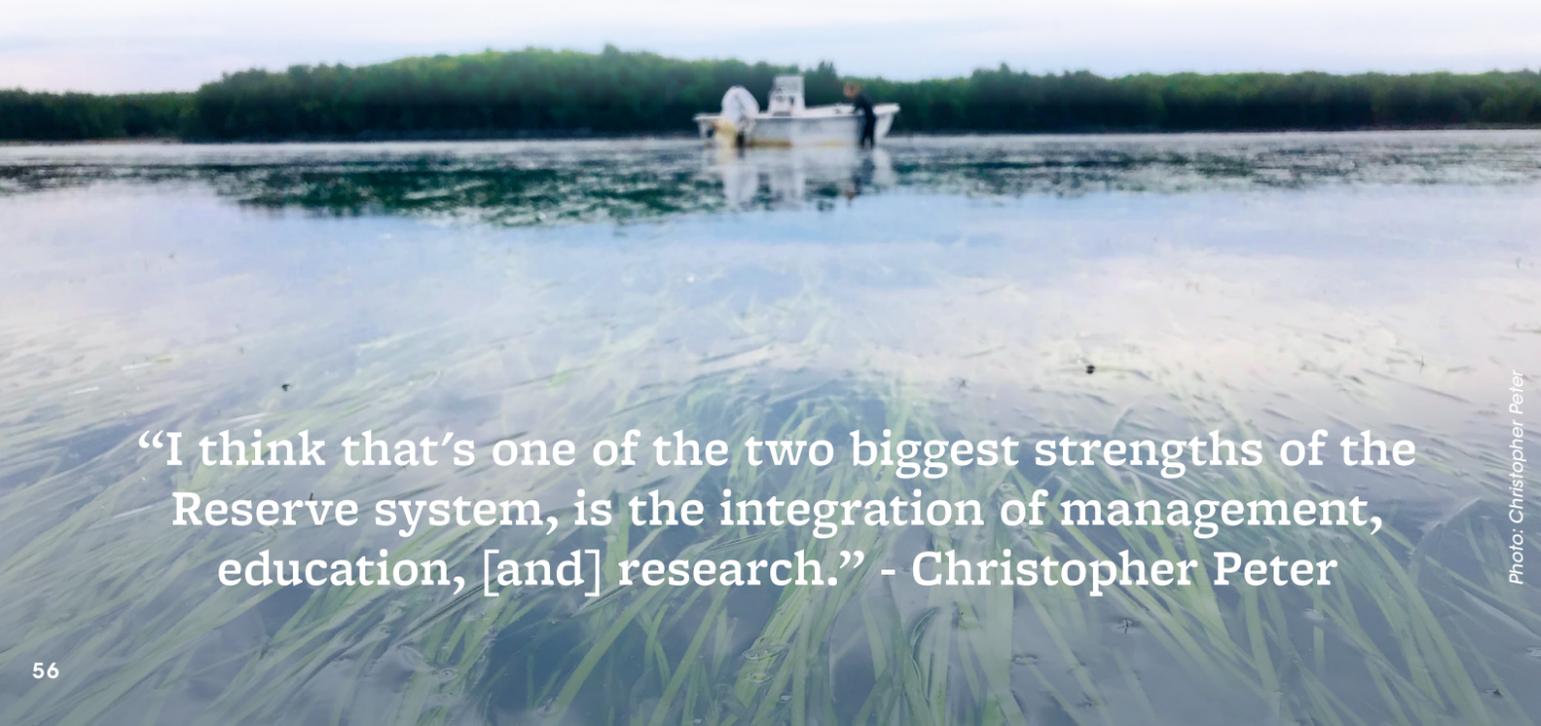
Great Bay is buying adjacent land, providing science to decision makers to help add further layers of protection to improve the water quality in a bay home to so many vital plants and wildlife.

"We focus on science to management," Peter explains. "We are buying and protecting land because they act as buffers to prevent nutrients from getting into the Great Bay."

They also partner with other conservation organizations and volunteers to bring back lost habitat, in the hope that future visitors may experience the natural landscape that locals fought so hard to preserve all those years ago.

"[It's] not just science for the sake of science," Peter says. "There's a lot of efforts here to try to restore lost habitats and prevent future lost habitats." 

(Left) Examining how seagrass meadows in Great Bay denitrify the sediment using the push-pull method (Aoki & McGlathery 2017). (Right) Crab monitoring on Great Bay. (Bottom) Eelgrass monitoring- this time looking at how they impact the nitrogen concentration of water by monitoring dissolved nitrogen and eelgrass cover.



"I think that's one of the two biggest strengths of the Reserve system, is the integration of management, education, [and] research." - Christopher Peter

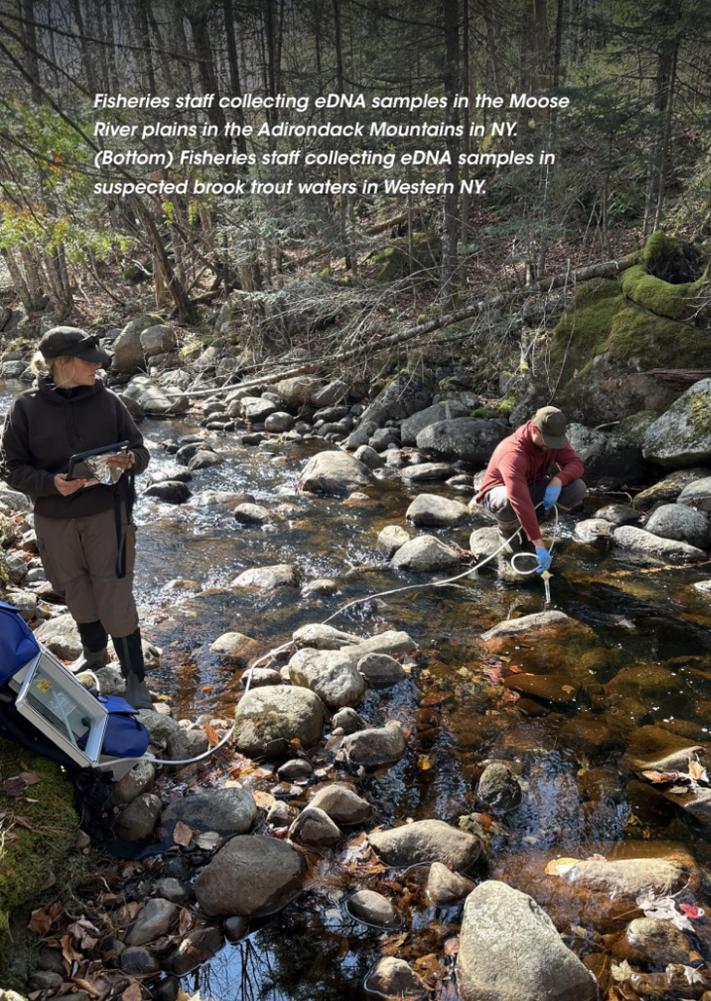
Photo: Christopher Peter



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Fisheries staff collecting eDNA samples in the Moose River plains in the Adirondack Mountains in NY. (Bottom) Fisheries staff collecting eDNA samples in suspected brook trout waters in Western NY.



Monitoring and Facilitating Habitat Restoration Efforts in the Great Lakes

While human infrastructure, urbanization, and industrialization have advanced human societies, the natural environment has suffered due to constructed impediments and deteriorating architecture. In order to combat this degradation, habitat restoration programs across the US work to remove impairments and improve damaged waterways.

HABITAT RESTORATION EFFORTS IN THE GREAT LAKES

Tom Hoffman, aquatic habitat restoration biologist in the Lower Great Lakes basin, directs restoration efforts within tributaries to Lake Erie, Lake Ontario, and the St. Lawrence River with local partners.

Hoffman's group receives funding through the Great Lakes Restoration Initiative (GLRI) to oversee and lead habitat restoration efforts that usually focus on one or multiple priority species that are impacted by various types of infrastructure like culverts and dams. The leading goal is to develop partnerships in the region and improve aquatic habitat.

The office works with local partners and agencies who are looking to remove a dam or culvert (or replace a culvert) and steps in to help provide funding for more fish-friendly infrastructure as well as restoring the waterway.

"When you have a stream that's not functioning properly, either eroding banks or it has been straightened or channelized, we go in and we fix them. In many situations, reasons for the streams not functioning properly are human caused. So we go in to try to restore them to natural function as much as we can," explains Hoffman.

Habitat restoration approaches vary and depend on the goals and objectives of partners and the needs of the priority species, such as freshwater mussels, brook trout, landlocked Atlantic salmon, and American eel.

For example, in cases where erosion has led to a loss of vegetation in a habitat, root wads, rocks, or large pieces of wood can be installed to provide complexity for fish and other aquatic species' habitats.

Most of the projects Hoffman's team takes on involve the removal of problematic culverts that are either deteriorating or too small for the waterway they output into. Beyond covering the removal and a possible upgrade cost, the office also oversees restoration efforts.



(Top Left) Installation of large wood fish habitat into Oatka Creek which is a tributary to the Genesee River. (Top Right) Restoration staff sampling brook trout in a tributary to the Genesee River in NY. (Bottom) Before and after a barrier removal on Rice Creek, which is a tributary to Lake Ontario.

Hoffman elaborates, "What we will sometimes do is bring additional money to say, 'Okay, we're going to replace this anyways. Let's add in some stream habitat restoration—be it cover, an undercut bank, some boulders or wood structure installation for example.'"

"So what we'll try to do is two-fold, definitely make the issue better—being an undersized culvert—but also, try to incorporate some fish habitat in the solution," adds Hoffman.

MONITORING STREAM RESTORATION EFFORTS

Because Hoffman oversees such a large area, the use of internal logging instruments and GPS/GIS equipment simplifies data collection and site viewing.

Internal loggers like the Solinst Barologger 5 Barometric Pressure Logger, WLTS vented water level & temperature sensor, and Onset HOBO Tidbit temperature logger allow for sensing equipment to be deployed and retrieved at varying intervals, depending on the needs of their partners.

Data from the loggers can be integrated with site maps created using GPS/GIS equipment and help identify key habitat locations for species.

For example, brook trout are an exclusively cold water species, and in the summer, they will stay in pockets of the water body that stay relatively cool.

"Identification of these cold water patches is very, very important in preserving brook trout populations," states Hoffman.

In addition to the loggers and GPS/GIS units, eDNA sampling and testing have also become an essential piece of Hoffman's work as the ability to easily identify the presence of a priority species saves some time in the field walking miles of river habitat.

Standard surveys are still conducted following the restoration, during which the team can see the results of their hard work.

"You have a stream that's degraded, you go in and you fix it, and if you've done it right, it should be there longer than I am here. When you fix a culvert, you can go back and see that it's fixed, and you can prove that aquatic organisms are passing through it," explains Hoffman.

He continues, "It's very rewarding to see what you're doing—it's something very tangible. You can go to a restoration site, you can observe it. You know that it's going to be there for a while." ^{SB}

Photos: Zachary Eisenhauer; Kyle Glenn / Trout Unlimited

Photos: Thomas Hoffman; Cody Anderson; Gian Doolici

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