# Tools of the Trade

## Lowering the barriers: How the NALMS SHINY APPS SERVICE is expanding access to powerful data tools

Jen Stamp, Tim Martin ,and Erik W. Leppo

For many water resource professionals, the mention of *R* is enough to end a conversation. It is often associated with dense code, steep learning curves, and technical expertise that feels out of reach. Yet behind that single letter lies a growing ecosystem of tools that is changing how data are processed, analyzed, visualized, and shared—often with no programming required from the end user.

At the center of this shift are **Shiny applications**. They are lowering barriers to advanced data workflows while helping biologists, analysts, and managers make better use of the data they already collect. And the **NALMS Shiny Apps Service** is making these apps available to more people.

### What is a Shiny App?

Shiny is an add-on package for the R statistical programming language that allows developers to turn R code into **interactive web applications**. These applications look and function like modern websites. Users click buttons, choose options from dropdown menus, upload files, and view results instantly.

The significance of Shiny apps is not only what they can do, but **who can use them**.

Users do not need to install R, download packages, or understand code. All that is required is an internet connection and intermediate level computer skills, such as navigating a web page and uploading or downloading files. For many water resource professionals, this turns advanced analyses from something theoretical into something practical.

Behind the scenes, Shiny apps rely on the same statistical and visualization tools that make R so powerful. But those details remain invisible to the user.

### A central hub for water resources tools

For several years, NALMS has hosted a growing collection of Shiny applications designed specifically for water resource management. These tools support activities such as:

- Processing and quality controlling continuous sensor data
- Analyzing and visualizing lake and water quality datasets
- Sharing monitoring protocols and technical resources
- Learning about Shiny applications

These tools are centralized on the **NALMS Shiny Apps Home Page** (Figure 1). In addition to apps hosted directly by NALMS, the site includes links to Shiny and nonShiny applications hosted elsewhere, along with related datasets, tools, and code repositories.

The goal is straightforward: **make useful tools easy to find and easy to use**.

### Why NALMS created a hosting service

Building a Shiny app is only part of the process. To be accessible, it must be hosted on a server so users can reach it through a standard web browser. That requirement presents a major challenge.

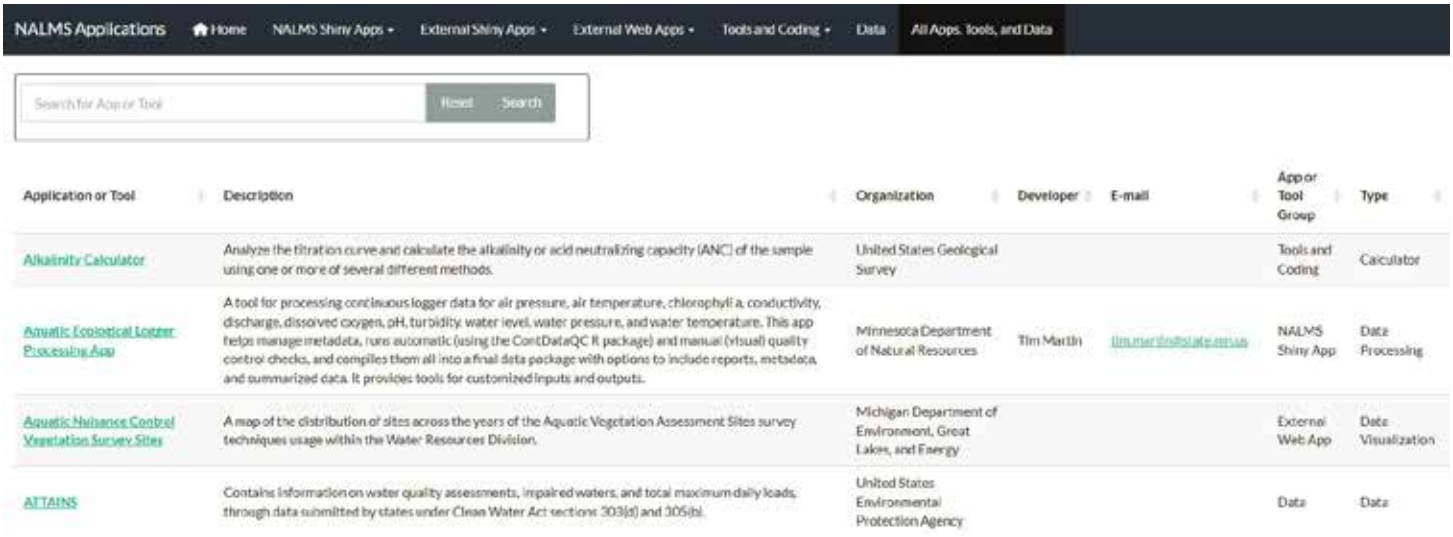


*Figure 1. Screenshot of the 'All Apps, Tools and Data' page on the NALMS Shiny Apps server:* https://nalms.shinyapps.io/NALMS_Shiny_Home/

Many agencies face IT restrictions, security concerns, or funding limitations that make hosting Shiny apps difficult or impossible. Even when hosting is allowed, individual developer accounts on commercial platforms often come with usage limits that restrict how widely an app can be shared.

As a result, many well-designed tools never reach the audience they were created for.

The NALMS Shiny Apps Service addresses this gap by providing a **neutral, independent platform** capable of hosting applications without the constraints common within government agencies. At the same time, it serves as a curated repository, allowing NALMS to bring together tools developed by different organizations in one location.

## Sensor data as a catalyst

The need for this service became clear through work on the Regional Monitoring Networks (RMNs) and the Minnesota Sentinel Lakes Program. Both initiatives rely heavily on continuous sensor data (Figure 2), which pose unique challenges related to quality control, data volume, and long-term management.

Many partners collecting sensor data struggled to keep pace. They needed tools that could standardize workflows, reduce manual effort, and quickly visualize results. Spreadsheet-based approaches were no longer sufficient.

In response, Erik Leppo of Tetra Tech, with support from EPA ORD, developed the **ContDataQC** R package and accompanying Shiny app (Pennino et al. 2025) to support automated and visual quality control of continuous data. Building on that foundation, Tim Martin, who works for the Minnesota Department of Natural Resources (MN DNR), developed the **Aquatic Ecological Logger Processing App**, integrating QC, metadata collection, and data visualization into a single workflow.

While these tools proved effective, sharing them broadly remained difficult. They turned to NALMS with a request for help to distribute them widely. As an independent organization bound by fewer constraints, NALMS agreed to fund a shinyapps.io subscription, enabling the creation of what is now the **NALMS Shiny Apps Service**.

*Figure 2. MN DNR field crews preparing to deploy a sensor array in one of Minnesota's sentinel lakes.*

## A non-programmer's perspective

Jen Stamp of Tetra Tech, who served as overall coordinator of the RMNs (with support from EPA ORD), describes her role as a User Interface (UI) tester who articulates needs to programmers like Erik and Tim, who then write the code. "I tell programmers like Erik what I want, and they make it happen. It's like magic!"

She has seen both the challenges and the benefits of Shiny apps firsthand.

"Some people dismiss Shiny apps immediately because they associate them with R code and assume they will be beyond their comfort level and skill set," she says.

She is quick to clarify that programming experience is not required. For those who prefer working directly in R, she notes that the underlying code for many apps is available and can be run offline once the necessary packages are installed.

From her perspective, the impact of Shiny apps has been substantial.

"They have been a real game changer, at least in the realm that I operate in," Jen says. "They put the power in biologists' and scientists' hands. Having the ability to put apps on the NALMS Shiny App server improves accessibility and helps break down IT barriers."

## A programmer's perspective

Tim Martin and Erik Leppo are currently maintaining the NALMS Shiny Apps Service in a volunteer capacity. They approach Shiny from different paths but share similar conclusions about its value.

When Tim joined the Sentinel Lakes Program, he inherited a backlog of more than nine years of raw sensor data, with new data continuing to arrive each year. The processing demanded a more efficient system than traditional spreadsheets.

"I needed a way to standardize the process and make it repeatable," Tim says. "Shiny allowed me to do that."

By wrapping existing R code in a graphical interface, Tim created tools that could be used consistently across users without requiring them to understand the underlying calculations.

"I was largely self-taught," he adds. "If you're familiar with R and basic web design, you can learn how to use Shiny"(Figure 3).

Erik's entry into Shiny also began with a practical need.

"I started working with Shiny apps in 2017 when we needed to modify an existing app and make it more general," he says. "I had the programming background, but I was new to Shiny."

For Erik, Shiny's strength lies in its efficiency and reach.

"The development timeline is much shorter, and the app stays close to the original R code," he explains. "You can get tools to far more people, and all they need is a web browser."

Tim notes that Shiny's potential extends beyond data processing.


*Figure 3. One of the features that sets Tim Martin's **Aquatic Ecological Logger Processing App** apart is an interactive time series plot with data points color-coded by flag test results (pass, suspect, fail).*

"I've used Shiny for displaying and analyzing data, learning about lakes, storing and distributing documents, and even quizzing people on aging fish structures," he says.

### Hosting, linking, and sharing tools

Not all tools listed on the NALMS Shiny Apps Home Page are hosted directly by NALMS. Some are hosted by partner organizations and simply linked from the site. One example is the **EPA's TADA app**, which supports analysis of discrete water quality data and is located on the EPA Shiny server.

For developers with their own hosting solution, inclusion in the NALMS repository is straightforward. Sharing a link along with basic metadata allows an app to be added without transferring hosting responsibility. This approach allows the repository to grow while remaining flexible.

### An invitation to the community

The NALMS Shiny Apps Service is open to the broader water resources community – for both using existing tools and contributing new ones.

Submitting nonShiny content, such as links to external web applications, tools, datasets, or code repositories, is simple. Requests can be sent to **shinyapps@nalms.org**. Requirements for hosting Shiny apps directly are outlined on the NALMS Shiny Apps Home Page.

Jen hopes increased visibility will allow more people to benefit.

"We have this great resource but not many people know about it," she says. "We really need people to help spread the word. These free tools could be a big difference maker for some water resource programs. They can help improve efficiencies and elevate data analyses and reporting to a new level."

Erik has seen the community evolve since he first began working with Shiny.

"Early on, it was hard to convince people to implement Shiny apps," he says. "Now there's far more interest and collaboration, and many people are eager to share their tools."

You do not need to be a programmer to benefit from these applications. And if you are not a programmer but see an opportunity, finding a programmer to partner with can open new doors. Whether you actively use the tools or simply help spread the word, the NALMS Shiny Apps Service depends on community awareness to reach its full potential.

### References

Pennino, M. J., Stamp, J., Leppo, E., Gibbs, D., & Bierwagen, B. G. 2025. ContDataQC: An R package and Shiny app for quality control of continuous water quality sensor data. *SoftwareX*, 30, 102124. https://doi.org/10.1016/j.softx.2025.102124

**Jen Stamp** is an aquatic ecologist and data scientist at Tetra Tech with more than 20 years of experience in water resources science. She has played a key role in designing and coordinating long-term Regional Monitoring Networks (RMNs) in streams and lakes, serving as overall coordinator while conducting technical analyses and facilitating national and regional meetings, trainings, and workshops.

**Tim Martin** is a data and water resources scientist working for the Sentinel Lakes Program in the Fisheries section of the Minnesota Department of Natural Resources. He is responsible for processing, managing, analyzing, and distributing data collected for this program at many trophic levels, ranging from water temperature up to fish. Through this work he creates data tools and applications and develops analytical methods that utilize the breadth of the Sentinel Lakes' large datasets.

**Erik W. Leppo** is a data and environmental scientist at Tetra Tech with over 30 years of experience applying data analysis, visualization, and custom tools to environmental applications. His work focuses on turning complex environmental data into interactive tools that support water quality and ecological decision-making.