

# The Secchi Dip-In technology and data evolution

Lisa Borre, Kathleen C. Weathers, Michael Forcella, Julie Chambers, Philip Forsberg, and Mark LeBaron

## A brief history of the Secchi Dip-In

Three scientists at Kent State University organized the “First Great American Secchi Dip-In” as a pilot study in 1994. In that first year, 800 volunteers in six states participated from Indiana, Illinois, Michigan, Minnesota, Ohio, and Wisconsin. Drs. Bob Carlson, Dave Waller, and Jay Lee expanded the program the following year across the US and into two Canadian provinces. At its peak under Dr. Carlson’s leadership, in 2001, the Dip-In had nearly 200 programs and 45 provinces and states participating. The program was designed as a way to get people involved and know what is changing in lakes.

By 2015, Dr. Carlson was ready to retire, and a long-term agreement was reached to transfer operation of the Dip-In program and management of the Dip-In database to NALMS. By then, participation had begun to decline (Figure 1), but an Access database had been created for volunteers to submit data, and volunteer monitoring programs could send their data in a spreadsheet format. It was still possible to mail or fax a paper form as in the early days, but most volunteers had shifted to entering data via an online form (Figure 2). Transfer of the Secchi Dip-In program to NALMS created a quandary with inheriting an out-of-date database. It was also an opportunity for a new data management system and new technologies to support the popular community science program (Figure 3).

## Data and technology partnership

In addition to upgrading the Dip-In database technology, NALMS and USEPA partners were interested in creating a mobile app for data entry. In 2015, staff at USEPA discovered that computer and environmental scientists of the Global

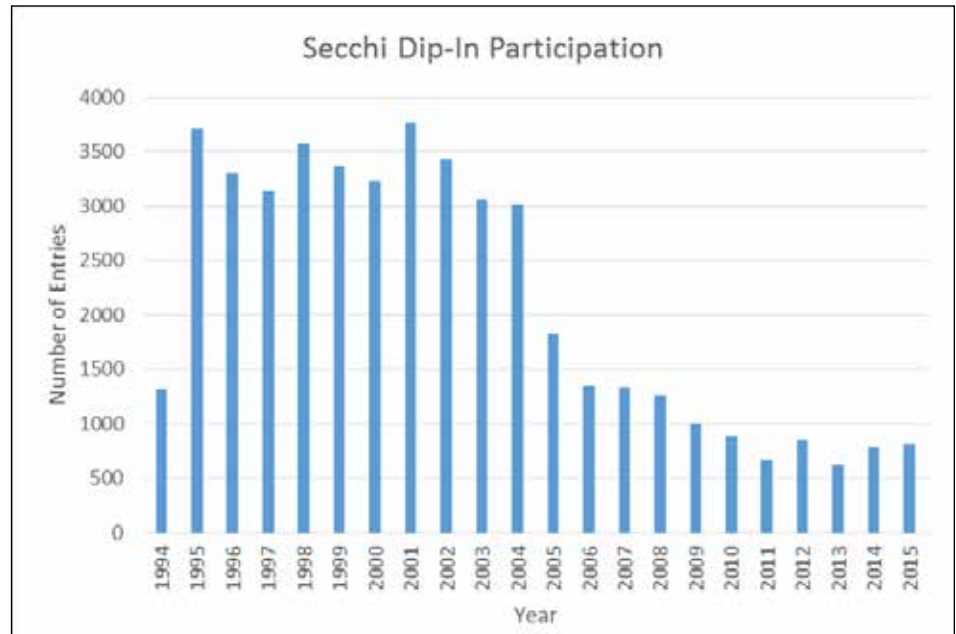


Figure 1. Secchi Dip-In participation under Dr. Carlson’s leadership, 1994-2015.

Lake Ecological Observatory Network (GLEON, [www.gleon.org](http://www.gleon.org)) had developed and were evolving the Lake Observer mobile app ([www.lakeobserver.org](http://www.lakeobserver.org)). A partnership was formed to explore whether existing data management tools and technologies among these three groups could be adapted or re-used to support the Dip-In. In addition to NALMS, four other partners began meeting regularly to migrate the Dip-In database to a new platform and conduct a pilot project to use Lake Observer:

- **EPA** manages the Water Quality Exchange (WQX), a national data format and mechanism for sharing water quality data used by state and federal agencies, Tribal water programs, local governments, universities and non-governmental organizations to share their monitoring information. Data submitted to WQX

is combined with data collected by USGS and made publicly available via the Water Quality Portal (WQP).

- **Gold Systems**, a software development company, developed the Ambient Water Quality Monitoring System (AWQMS), a water quality database now part of their GS Elements software package. EPA also contracts with Gold Systems to manage WQX.
- **Cary Institute of Ecosystem Studies** ([www.caryinstitute.org](http://www.caryinstitute.org)), a nonprofit research organization, coordinates GLEON and leads the Lake Observer app project.
- **Oklahoma Water Resources Board** (OWRB) uses the AWQMS software application and has become Oklahoma’s largest supplier of environmental data to WQX. OWRB has worked in close partnership with





Figure 3. Secchi Dip-In event with members of the Pennsylvania Lake Management Society (PALMS).

With a direct connection to a publicly accessible, federal database, Dip-In data are now available for research, monitoring, and even ‘ground truthing’ remote sensing data. Data entry can be done online with forms provided or by creating custom data import configurations when adding data for a volunteer monitoring program.

**Lake Observer’s evolution: “We need an app for that!”**

Unrelated to the Secchi Dip-In, development of an Android data collection app for the Lake Sunapee Protective Association began in 2010 as a student side-project of a National Science Foundation grant, led by Kathleen Weathers and Kenneth Chiu, a computer scientist at Binghamton University, in collaboration with community scientists at Lake Sunapee, which is a GLEON research site. Project partners were interested in supporting

Community Science and crowdsourcing efforts on the lake (Figure 5). At the time, nearly two-thirds of Americans owned a smartphone, and researchers wanted to capitalize on what is becoming a common tool. They also recognized that a mobile app could conveniently capture time, date, and location information automatically, and thus have the potential for increasing the spatial extent and frequency of data collection. Data could then be captured in a publicly accessible, online database.

Research scientists and computer scientists were involved in the project team. They identified a short list of specifications: (1) record data normally collected by citizen scientists, (2) easy to use for field observations, (3) store data for later submission if offline, and (4) data storage and retrieval possible from the app.

With funding from a National Science Foundation grant supplement, GLEON

**Secchi Dip-In Proposed System**

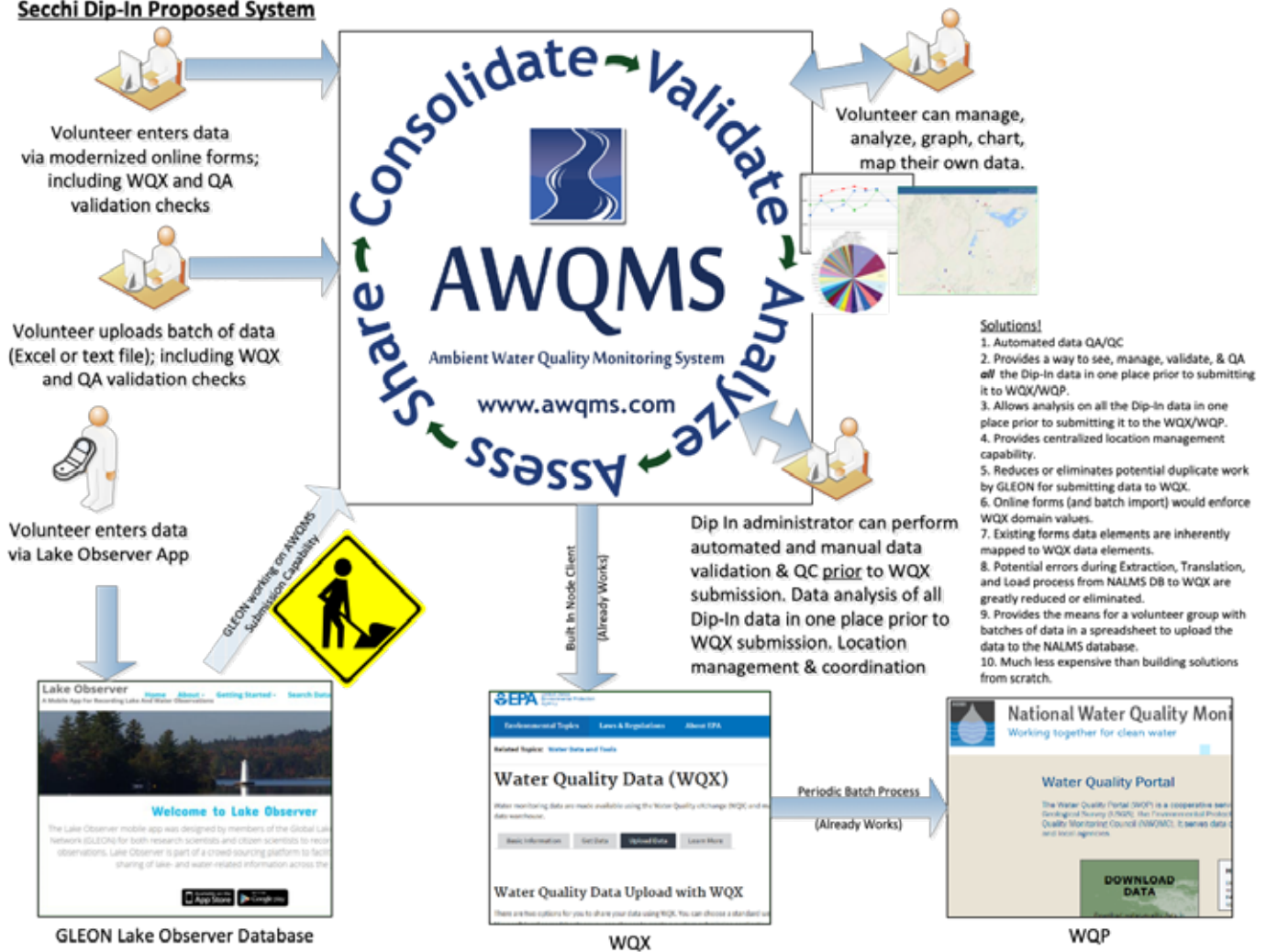


Figure 4. Diagrams showing current and proposed data management system in 2018 for the Dip-In after a pilot project was conducted (Source: Mark LeBaron, Gold Systems).



Figure 5. Work on the Lake Observer app began as a community science project on Lake Sunapee in New Hampshire. Photo courtesy of M. Eliassen.

researchers, including Weathers, Chiu, Holly Ewing at Bates College, and students began development of the current version of Lake Observer in 2014. The goal was to develop native Android and iOS versions of the app and a backend MySQL database. All initial programming was done by students. Now one of those former students, Michael Forcella, is a senior app developer at Cary Institute where he continues to work on Lake Observer and helps NALMS manage the Dip-In database. In addition to serving as a tool for Dip-In, Lake Observer is part of a crowd-sourcing platform to facilitate the collection and sharing of lake- and water-related information across the globe. Lake Observer App development continued through the pandemic years with generous support from an anonymous donor (Figures 6 and 7).

Lake Observer now has 27 active projects monitoring 312 waterbodies. Users have collected 69,490 water quality and related observations, including 5,308 Secchi Depth measurements.

### Current status and next steps

NALMS' Secchi data collection program is now known as the Robert Carlson Secchi Dip-In, in memory of Dr. Carlson. Serendipity, partnerships and financial support were key in making the transition of the program from its founder

to NALMS and in upgrading data entry and management systems.

Participants in the Secchi Dip-In now have the option of submitting current and historical data directly to AWQMS via batch data import tools and manual data entry forms or by using the Lake Observer mobile or web app to submit water quality observations and bulk data uploads. All Dip-In data are then flowed to WQX and WQP databases. The various options provide tools for individuals, lake

associations, or larger volunteer water monitoring programs to participate in the program and share data through publicly accessible government databases.

As of the end of March 2026, NALMS has sent over 400,000 water quality observations from 287,000 sampling activities to WQX, including 193,000 Secchi depth results from more than 250 individual users and 650 conducting organizations (Figure 8).

Project partners (Figures 9 and 10) continue to collaborate to maintain the AWQMS database, Lake Observer app, and data submissions to WQX and WQP. If you are interested in learning more or getting help to sign up or submit data, send a message to [secchidipin@nalms.org](mailto:secchidipin@nalms.org).

**Lisa Borre** is a Senior Research Specialist and Development Officer at Cary Institute of Ecosystem Studies where she coordinates GLEON and is part of the Lake Observer app development team. She is



a past president (2021), board member (2016-2019), and member of the Robert Carlson Secchi Dip-In program team for NALMS. She has a BA from the University of Vermont and an MES from Yale University.

**Kathleen C. Weathers** is a Distinguished Senior Scientist at Cary Institute of Ecosystem Studies, Millbrook, NY, where she studies how ecosystem

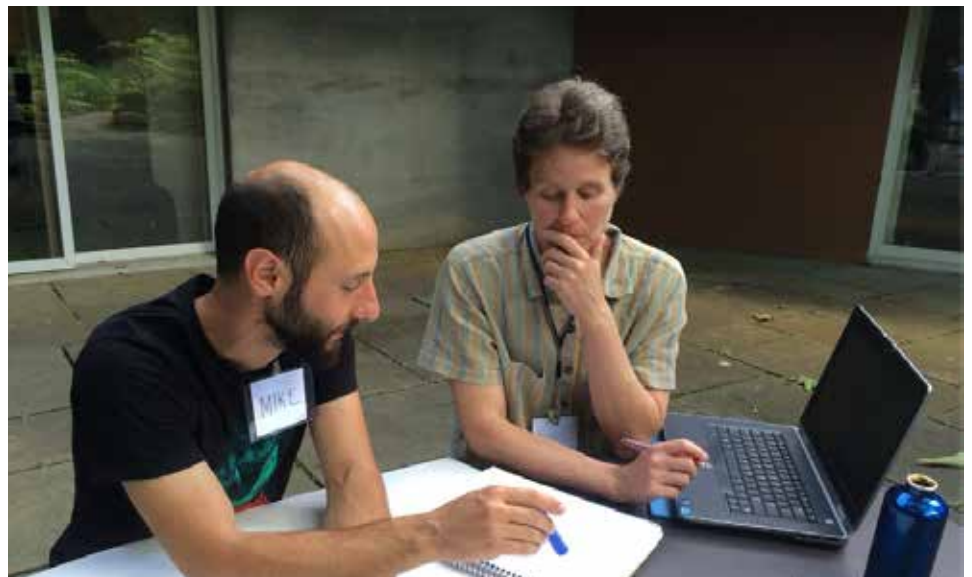


Figure 6. Michael Forcella (on left), now senior programmer for the Lake Observer app, and Holly Ewing, a member of the app development team, in a workshop at Cary Institute.



Figure 7. Lake Observer app in use.

### Secchi Dip-in and Lake Observer App Timeline

- 1994 – Secchi Dip-In pilot study in 6 states
- 1995 – Dip-In expanded across U.S. and to 2 Canadian provinces
- 2010 – GLEON partners begin development of the Lake Observer mobile app
- 2015 – Dip-In operations and database transferred to NALMS
- 2016 – Current Data and technology partnership forms
- 2018 – EPA grant awarded to upgrade the database to AWQMS and use Lake Observer app
- 2020 – Data submitted and managed via AWQMS and Lake Observer
- 2023 – Renamed “The Robert Carlson Secchi Dip-In” in memory of Dr. Carlson

processes are affected by global changes within and among aquatic, airborne, and terrestrial systems. She is co-chair emerita of the Global Lake Ecological Observatory Network (GLEON) Steering Committee and Volunteer Research Director for the Lake Sunapee Protective Association. She has a PhD from Rutgers University and an MFS from Yale University.



**Michael Forcella** is a Senior Research Support Specialist and Data Scientist at Cary Institute of Ecosystem Studies. With a BS in Biology from SUNY New Paltz, Michael worked for several years as a

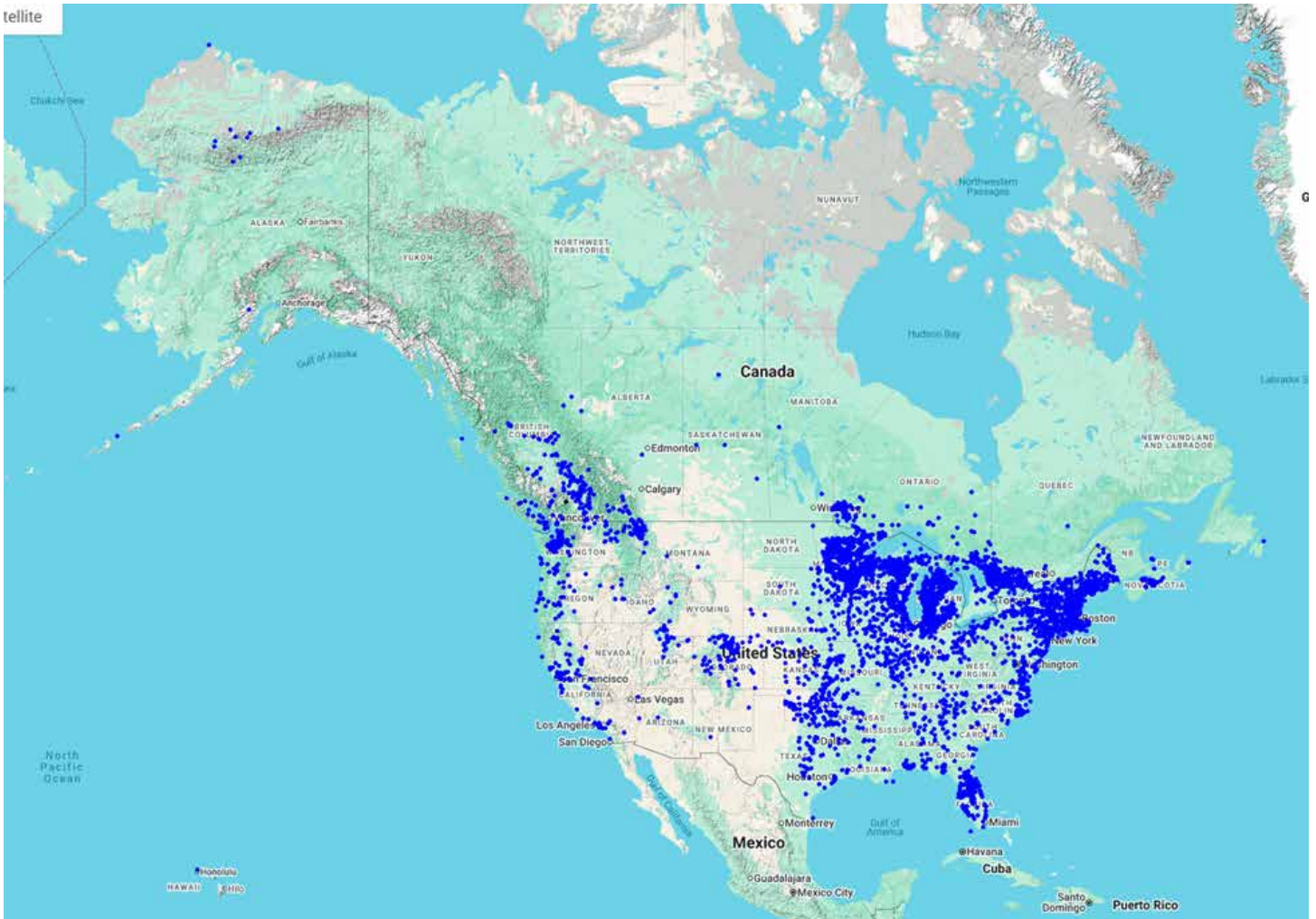


Figure 8. Map of Secchi Dip-In sampling locations in north America (Credit: AWQMS).



Figure 9. Mark LeBaron (L) and Philip Forsberg meeting over coffee at the NALMS symposium where a “back of the envelope” concept to upgrade the Dip-In database turned into a multi-year project to re-use existing tools.

Systems, Inc. in Salt Lake City, UT. Mr. LeBaron has been instrumental in implementing and supporting several environmental data management and analysis systems for the EPA, states, tribes, and volunteer groups. He has a B.A. from Utah State University in Business Information Systems and an M.S. in Data Analytics from Western Governors University.



**Philip Forsberg** is the Executive Director of NALMS and a member of the Robert Carlson Secchi Dip-In program team. He started his career with NALMS as an intern in 1997 and has since held several positions with the organization and performed many disparate tasks from graphic design to accounting to grant management to conference planning. Philip earned a BS in Natural Resources and Environmental Management from Ball State University and an MS in Urban and Regional Planning from the University of Wisconsin.

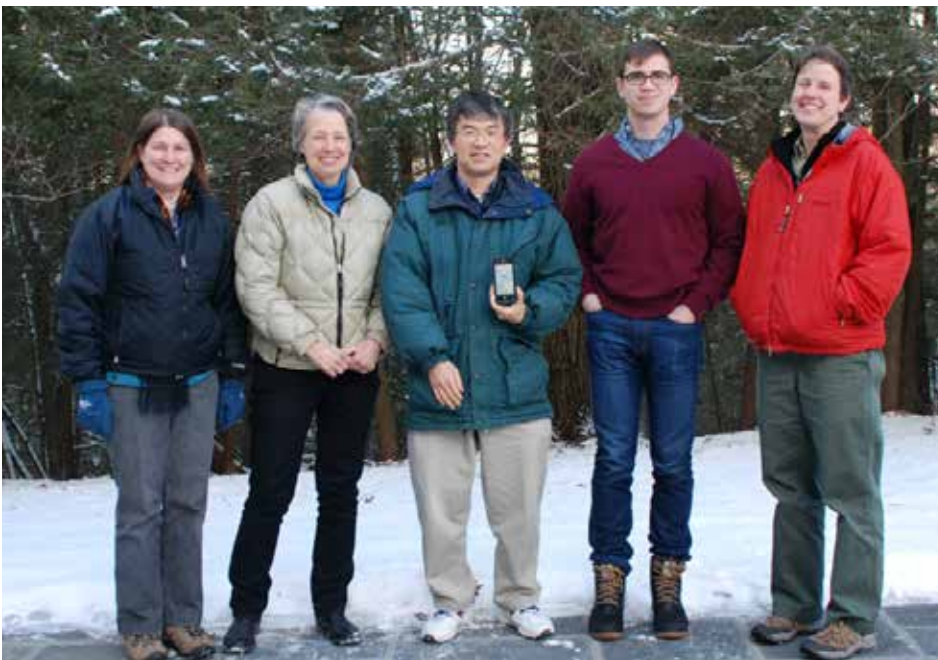


Figure 10. Lake Observer app development team at Cary Institute (L to R): Lisa Borre, Kathleen Weathers, Ken Chiu, Benjamin Chrobot, and Holly Ewing.

**Julie Chambers** leads the Oklahoma Water Resources Board's Beneficial Use Monitoring Program (BUMP) Lake Monitoring section. She has 25 years of experience in statewide water quality management, from program design through data collection, management, reporting, and dissemination of information. Over the last 22 years her program has thrived and is responsible for conducting water quality studies, assessments, and bathymetric surveys on reservoirs across Oklahoma, as well as managing lake and wetland projects funded through federal grants and other contracts. Julie serves on the water quality steering committee for the EPA's National Lake Assessment as well as on several state technical workgroups focused on the assessment of lakes and field protocol development. Julie has been an active member of The North American Lake Management Society (NALMS) for 20 years serving on various committees and representing as past president since 2016. 🌟



forestry technician in Wyoming. He later returned to New York to pursue a Master of Science in Computer Science and spent time working alongside aquatic ecologists to deploy environmental sensors. He has been the lead developer for the Lake Observer web and mobile app since 2017.

**Mark LeBaron** works as a Senior Information Systems Analyst and Project Manager for Gold

**Links to more information and resources:**

- <https://www.nalms.org/secchidipin/>
- <https://www.lakeobserver.org/>
- <https://gleon.org/>
- <https://www.caryinstitute.org/>
- <https://goldsystems.com/>
- <https://www.epa.gov/waterdata/water-quality-data>