

A publication of the North American Lake Management Society

# LAKELINE

Volume 36, No. 4 • Winter 2016



## States of the Lakes

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# LAKELINE

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2016 NALMS Photography Contest entry  
– “September Storm” by Larry Butler

# From Bill Jones the Editor

## Who's Managing the Lakes

This issue's theme is a play on words. Our intent is not to answer the age-old question, "How are the lakes doing?" Instead, we explore how States (and one Canadian Province) assess and manage lakes in an era of decreased federal funding for such activities. We'll hear from Vermont, Wisconsin, Iowa, Texas, and Colorado in the States, and Ontario in Canada.

But first, let's step back to review federal funding for lake activities in the U.S. The U.S. Environmental Protection Agency (USEPA) was once the primary source of funding and guidance for education and in-lake assessment, diagnosis, and implementation through the Clean Lakes Program. The Clean Lakes Program was established in 1972 as Section 314 of the Federal Water Pollution Control Act, to provide financial and technical assistance to states in restoring publicly owned lakes. The program funded a total of approximately \$145 million of grant activities since its beginning in 1976 to address lake problems (<https://www.epa.gov/lakes/epas-clean-lakes-program>). Many young lake professionals have never worked in a time when federal funding for lake activities was this robust.

It is difficult to find annual funding levels for the Clean Lakes Program but I finally found a low-quality graphic in an old USEPA publication (Figure 1). Note that this funding came at a time when lake management science in the U.S. was starting to grow into a national effort. At its peak in 1980, the federal Clean Lakes Program annual appropriation was \$20 million. Coincidentally, 1980 was the year NALMS was officially formed. Clean Lakes Program support and activities were vitally important to the growth of

*LakeLine* encourages letters to the editor. Do you have a lake-related question? Or, have you read something in *LakeLine* that stimulates your interest? We'd love to hear from you via e-mail, telephone, or postal letter.

NALMS and of lake management science (Figure 1).

However, there have been no appropriations for the Clean Lakes Program since 1994. Instead, all the funding . . . and more went into the Section 319 Nonpoint Source Program (Figure 2). The 1987 amendments to the Clean Water Act (CWA) established the Section 319 Nonpoint Source Management Program. "Section 319

addresses the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319, states, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects" (<https://www.epa.gov/lakes/epas-clean-lakes-program>).

Interestingly, the \$314 Clean Lakes Program was reauthorized in September 2000 through 2005 as part of the Estuaries and Clean Water Act of 2000, but no funds were appropriated. The Clean Water Act does fund the National Lakes



Editor Bill Jones overlooking Lake Minnewanka outside of Banff, Alberta.

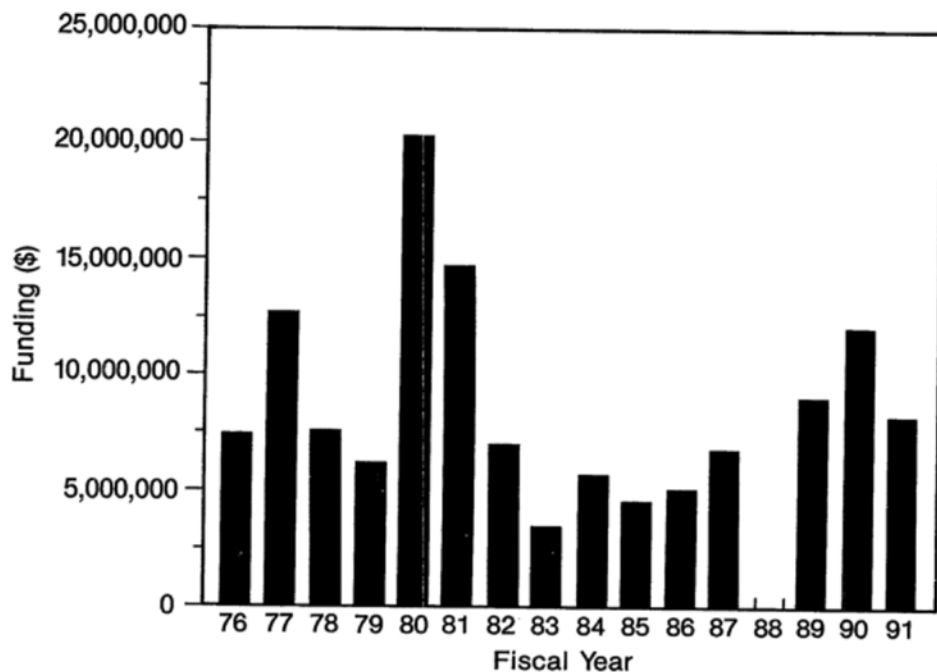


Figure 1. Total USEPA funding for Clean Lakes Program assistance from 1976 – 1991. Source: USEPA 1993.

Assessment, conducted every five years as a survey of the nation’s lakes.

The guidance EPA publishes for awarding Section 319 grants encourages the states, territories, and tribes to use “§319 funding for eligible activities that might have been funded in previous years under §314 (Clean Lakes) of the Clean Water Act” (<https://www.epa.gov/sites/production/files/2015-10/documents/319-guidelines-fy14.pdf>). However, there is no requirement for them to do so.

Understand that the §319 Nonpoint Source Program funds important work in watersheds but I could find no documentation of what proportion of the substantial §319 funds are used annually to fund lake activities previously funded by §314. An Internet search found two Phase I Diagnostic Feasibility Studies funded by § 319 (NJ and IL) but nothing more recent than 2007 and no Phase II Implementation projects. In a National evaluation of the CWA Section 319 Program for FY 2010, over 41 percent of the funds was used to fund state NPS program staff and only 7.3 percent was used to fund monitoring and assessment activities, some of which were likely used to assess lakes (<https://www.epa.gov/sites/production/files/2015-09/documents/319evaluation.pdf>).

In Indiana, the Department of Environmental Management (IDEM) uses

some of its annual 319 funds to contract with Indiana University to operate the Indiana Clean Lakes Program. A major effort of this program is conducting water quality assessments on approximately 80 lakes annually, which is used by IDEM to generate its 303(d) list of impaired waterbodies in Indiana.

We have another lakes program in Indiana called the Lake and River Enhancement Program (LARE) managed by the Indiana Department of Natural Resources. The LARE program funds

cost-shared diagnostic, engineering design, and implementation projects on lakes and streams, including in-lake activities such as aquatic plant management and selective sediment removal. This is funded by a portion of the state boat registration fee, which generates about \$3.5 million annually. Thus, Indiana found an alternative way to fund in-lake activities using a state funding source.

So this leads back to the main questions that drive this issue of *LakeLine*. What lake activities are being conducted by the states in this era of reduced federal funding of such activities? How are these activities funded? We will travel across the U.S. from east to west and then up into Canada to learn answers.

In our first article, **Susan Warren** and **Perry Thomas** tell us how Tropical Storm Irene became the impetus for a Shoreland Protection Act that provided additional tools for the Vermont Lakes and Ponds Program. NALMS past-president, **Lisa Conley**, then writes about changes in Wisconsin legislation and policies that are eroding some long-time lake protections of the past – a step backward indeed. Next, **Michelle Balmer** and **George Antoniou** describe a robust, state-funded Iowa Lake Restoration Program that does similar work that the original Section 314 Clean Lakes Program used to do.

With its many reservoirs, Texas manages surface waters within river basin

(from the Editor, continued on p. 5 . . .)

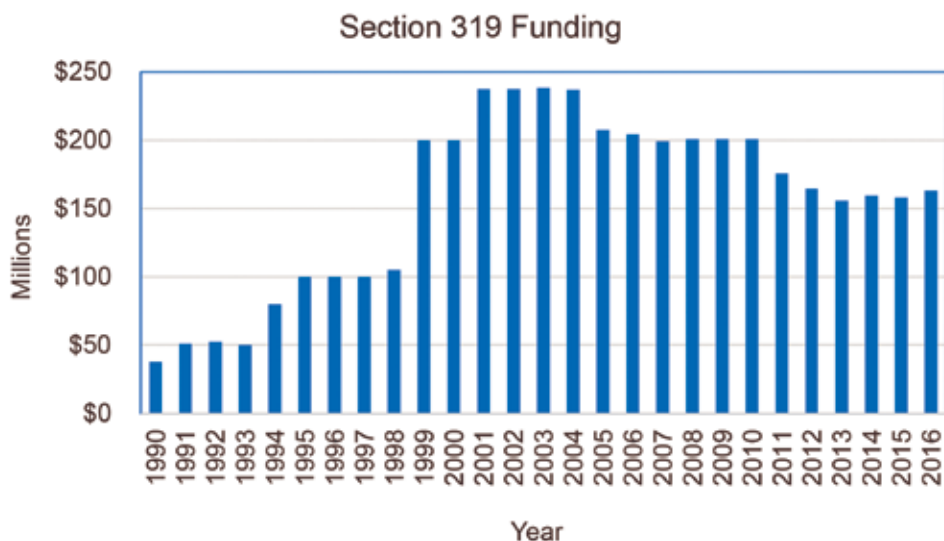


Figure 2. Annual funding of the Section 319 Nonpoint Source Program.

# From Frank Wilhelm **the President**

Welcome! It's my pleasure to write my first "From the President" column for *LakeLine* as your president. Having participated in NALMS since graduate school, I've always read *LakeLine*, often wondering what it takes to run an organization such as NALMS and the characteristics or training that qualified one for the position. Obviously, enough of you decided last year that I had the appropriate background and qualifications to take a turn – thank you.

I was especially thrilled to make the transition at the annual symposium in Banff this year, as it brought back fond memories from my time as a graduate student during which I had my first foray into the NALMS community back when the Alberta Lakes Management Society (ALMS) hosted the first Banff symposium. Thank you ALMS for hosting another wonderful symposium this year; you can read more about it later in the issue. If you've never attended a NALMS annual symposium, make it a goal to

join us in Denver, the local organizing committee of the Colorado Lake and Reservoir Management Association (CLRMA) is already hard at work planning the 2017 symposium details. It is an exhilarating week to be surrounded by so many like-minded folks willing to share their experiences, learn, and debate the best way to manage our lake and reservoir resources.

"Transition" is an appropriate word around which to write this column – as these are numerous. Internally at



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NALMS we have transitions with regards to activities of the Board of Directors (BOD); while externally there are large-scale transitions, such as those brought on by the change in season and the recent general election in the U.S.

The seasonal transition highlights the sharp contrasts in our lakes and reservoirs on a latitudinal and elevational gradient that cascades directly to our lake-related activities. While those at southern latitudes can experience an influx of visitors, both human and non-human, from northern climes at this time, those in the north or at high elevations experience water in solid form – ice – across the surface. This generally brings with it a lull in lake-related activities as many of us that are used to being out on the water bundle up inside to write reports and plan next year's open water activities. However, there is much that happens under the ice, and if you've never been out sampling through the ice, I strongly encourage it, it is a wonderful world – from pressure cracks and ridges in the ice, to the labor of just getting to some water. I contend that sampling through the ice is sometimes easier than sampling from a boat. No longer are you constrained by keeping things “in” the boat, you can just toss it on the ice next to you. Yes, one does need to be mindful of freezing lines, trigger mechanisms, nets, and the general chill that can creep into the bones. Still, if you've ever done any lake bottom coring, doing it from ice-cover is the way to go. Next time you visit family or a colleague in the north in winter, head out onto the frozen expanse and poke around. For hearty souls, I recommend building an igloo on the ice and spending the night – the liveliness of the ice with its booms and cracks on a cold night will amaze you.

With the U.S. general election behind us, there is a political transition as well. At NALMS, we should fully embrace our mission “to forge partnerships among citizens, scientists, and professionals to foster the management and protection of lakes and reservoirs for today and tomorrow.” Having participated on the board committee that has worked on transitioning our incorporation status from Maine to Wisconsin, it was abundantly clear that NALMS in general functions in an educational capacity – our symposium,


our journal, *LakeLine*, and our other materials and activities overwhelmingly point to educating ourselves and others to better manage our precious aquatic resources. The need for investment in water resource infrastructure was highlighted during the campaign period, which we should seize to move lake and reservoir science forward.

Recently the consortium of Aquatic Sciences Societies (CASS) sent a letter to president-elect Trump that summarizes a constructive approach forward. I encourage all of NALMS' members to take a look at it here: <http://aslo.org/news/wp-content/uploads/2016/11/CASS-Transition-Letter.pdf> and suggest that with our educational mission, we have much to offer in this changing political climate. This also presents a good backdrop for this issue's theme of the “States of the Lakes” as we review what's happening around the U.S. and Canada with regard to lake and reservoir science in our public institutions. As you read through the issue – ask yourself “what can I do to help at my lake or in my region?” By working together collectively and corroboratively we can affect change – a transition.

A couple of housekeeping notes to be aware of: Please check that you are receiving email messages from our office. NALMS regularly sends update notices via email, our main means of corresponding with members, which include renewal notices and directions to participate in the annual elections. This past year we discovered that nearly two-thirds of the election notice emails were never opened. This could be due to one of several reasons, such as an incorrect email address on file, but is most likely related to how your email client receives and deals with bulk mailings. We know that some firewalls, virus checkers, and the settings in the client (Thunderbird, Outlook, etc.) will automatically screen or direct such emails to special places (junk folder) where you wouldn't expect to look regularly. Please have a look at the settings in your software to ensure that you are receiving NALMS communications. As we approach the end of the year, please keep NALMS in mind when making those year-end donations. Thank you.

**Frank Wilhelm** is an associate professor of limnology at the University of Idaho in Moscow, Idaho, where he teaches courses in limnology and in the introductory sequence of natural resources course.



He has an active research program focused broadly on limnology including cyanobacteria, invasive species, nutrient cycling, and foodweb dynamics. He has been an active member of NALMS, having served on various committees and as Region 10 director previously. 

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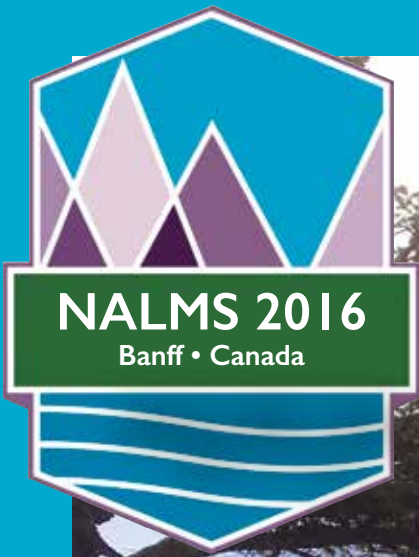
*(from the Editor, continued from p. 3 . . . )*

boundaries using assessed fees and state funds, and many cooperating partners. The Texas Commission on Environmental Quality is the lead agency. **Mark Ernst** tells us how it all works. Colorado surface water quality classifications and standards are also basin specific, as **Joni Nuttle** reports. The Department of Public Health and Environment – Water Quality Control Division is responsible for maintaining, restoring, and improving the quality of state waters. Lake management policy in Ontario started with the Ontario Water Resources Act in the 1950s. With hundreds of thousands of inland lakes, management has been a challenge. **Gord Miller** provides an overview of the Province's approaches to this.

At the beginning of this issue, we hear from new NALMS President, **Frank Wilhelm** of the University of Idaho. Frank accepted the gavel in Banff from outgoing president **Julie Chambers**. Our Banff Symposium coverage describes the technical program, awards, election results, and other activities that will be a fond memory for those in attendance and will make those who missed it sorry they did.

In our “Student Corner” we go all the way to The Netherlands and Ph.D. candidate **Thijs Frenken**. Thijs is studying the effects of parasites on cyanobacteria; a potential new tool for management.

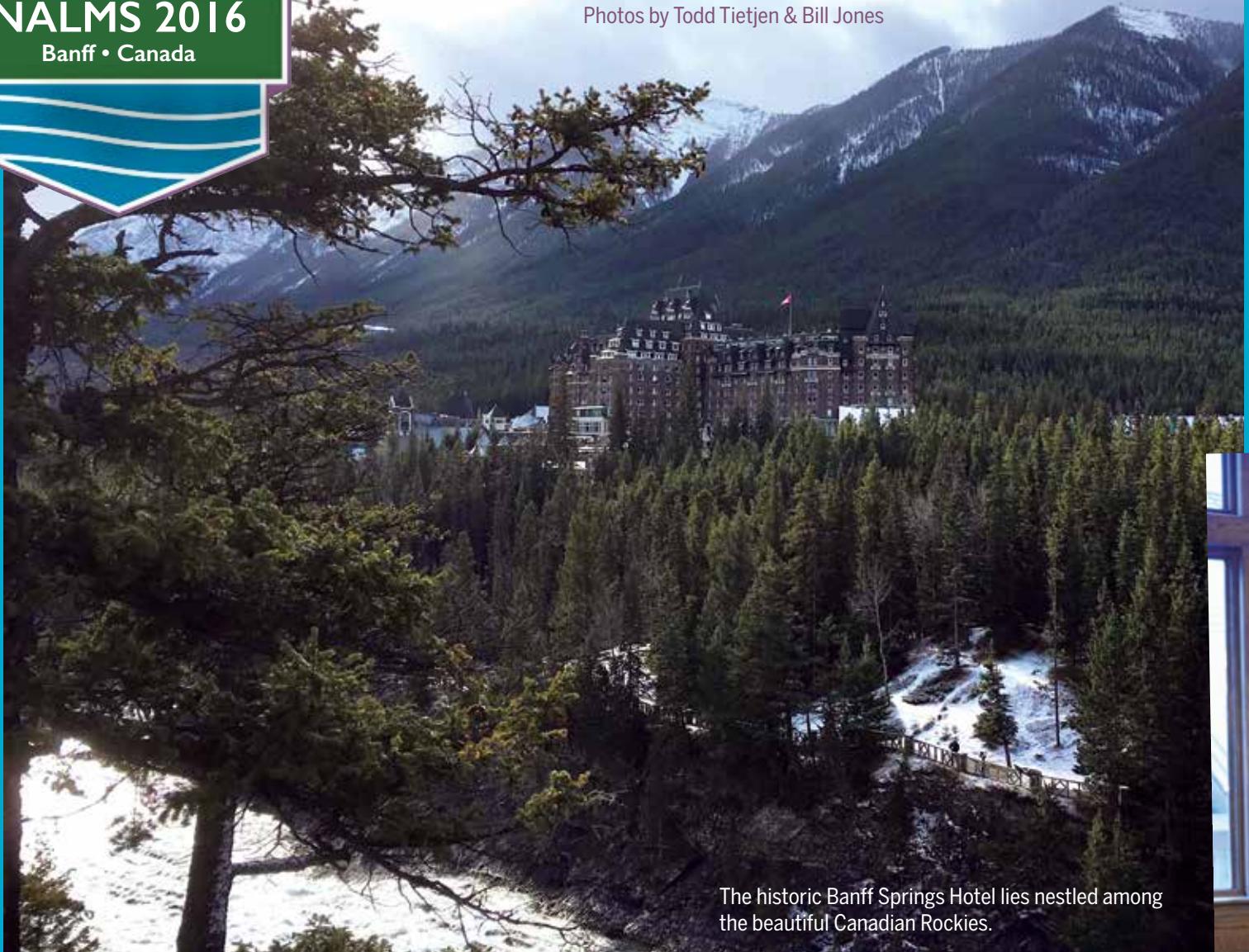
We conclude, as usual, with “Literature Search.” Enjoy.



# Symposium Summary

Philip Forsberg & Bill Jones

Photos by Todd Tietjen & Bill Jones



The historic Banff Springs Hotel lies nestled among the beautiful Canadian Rockies.

NALMS and the Alberta Lake Management Society (ALMS) welcomed more than 500 attendees from throughout Canada, the U.S., and nine other countries to Banff, Alberta, Canada, November 1–4, for NALMS' 36th International Symposium.

The historic Banff Springs Hotel provided a magnificent setting for the 2016 NALMS Symposium. The meeting and dining facilities were first rate with plenty of old world charm. The winding hallways provided an adventure around every corner with plenty of places to sit and relax or talk with old (and new) friends. Incidentally, many new friends were made by the boisterous crowd cheering on the Chicago Cubs in their World Series final.

The local Host and Program Committees worked for more than a year to insure that things ran smoothly for all of the activities.

The week started with seven workshops on a variety of lake management topics. Newcomers this year included workshops on citizen science (hosted by Living Lakes Canada) and a workshop by Campbell Scientific on their dataloggers and water quality sensors. Attendees raved about the Lakes of Banff National Park field trip. The day-long trip explored the glacial lakes of the Canadian Rockies, including Lake Minnewanka, Lake Louise, and Bow Lake.



Host Committee Co-chair Ron Zurawell and Chair Arin MacFarlane Dyer welcome attendees to Banff.



Plenary Speaker John Smol.



Plenary Speaker Hugh MacIsaac.



Exhibitors add greatly to the symposium experience.



A relaxed immediate Past-President Julie Chambers and NALMS Director of Programs and Operations, Philip Forsberg, talk with attendees during a break.

The opening plenary session featured presentations by Dr. John Smol of the Paleocological Environmental Assessment and Research Lab (PEARL) at Queen's University and Dr. Hugh MacIsaac of the Great Lakes Institute for Environmental Research at the University

of Windsor. Smol's talk focused on PEARL's research investigating the effects of multiple stressors on lake ecosystems using paleolimnological approaches, while MacIsaac spoke about how changes in global shipping regulations are leading to changes in the

mix of aquatic invasive species found in systems like the Great Lakes.

The three-day technical program included approximately 180 oral presentations and 25 poster presentations on topics including aquatic invasive species, in-lake treatment, cyanobacteria

and fisheries, among others. A special session was convened to discuss the recent discovery of whirling disease in Alberta.

Thirty-two exhibitors filled the exhibit area with a variety of the most current technology and services for lake and watershed scientists and managers. Refreshment breaks and meals were served in the large hall with the exhibits.

The annual awards banquet featured a great meal, the debut of Dana Stephens as MC and, more importantly, the Society recognized the accomplishments and contributions of its members to lake management. The Secchi Disk Award, the Society's most prestigious award, given to a member who has made extraordinary contributions to the goals and objectives of the Society was bestowed upon Jack Jones.

We also took a moment to look ahead to the 2017 NALMS Symposium. For 2017, we'll stay in the Rockies as we travel about 900 miles south to Denver, Colorado. Kelly Close from the Colorado Lake and Reservoir Management Association, our hosts for 2017, gave us a preview of next year's symposium.

Thank you to all who attended this year's symposium! We look forward to seeing you next November in Denver for NALMS 2017!



NALMS Conference Advisory Chair, Jeff Schloss, and his wife, Annette, relax during the Awards Banquet.

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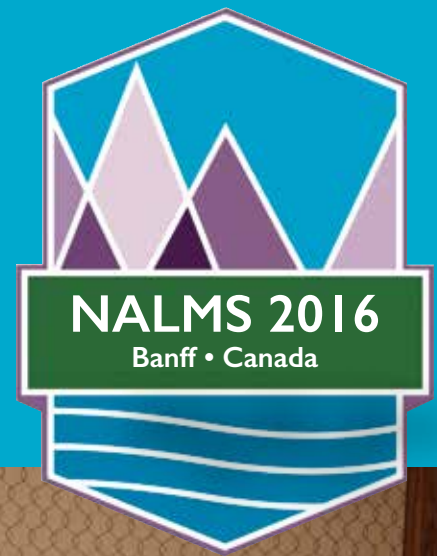
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# The 2016 NALMS Awards

Dana Stephens, Awards Committee Chair

Photos by Todd Tietjen



Amidst the lovely mountains of Banff, Canada, NALMS was honored to recognize individuals and organizations for their contribution to lake and reservoir management and NALMS at the 36<sup>th</sup> annual symposium. Congratulations again to our 2016 recipients!

**N**ALMS sincerely recognizes all outgoing officers and directors. These individuals devoted countless hours to enhance NALMS' mission and efforts. Thank you again, 2016 outgoing officers and directors (Figure 1).

Below, abbreviated nominations are listed for each award. Full nominations are available on the NALMS website. Also, please mark your calendars to submit nominations for the 2017 NALMS Awards. The deadline is August 15, 2017. Specific nomination details are listed on the NALMS website.

## OUTGOING OFFICERS AND DIRECTORS

### Officers

Reed Green, Past-President  
Sara Peel, Secretary

### Directors

Wendy Gendron, Region 1  
Nicki Bellezza, Region 3  
Melissa Laney, Region 5  
Todd Tietjen, Region 9  
Ted Harris, Student-at-large



Figure 1. Outgoing Board members present in Banff: Reed Green, Melissa Laney, Wendy Gendron, Nicki Bellezza, Sara Peel, and Ted Harris.

## NALMS AWARDS

### Leadership and Service Award-Education and Outreach

Awards individuals or teams for design, facilitation, or performance of exceptional education and outreach activities supporting community understanding and appreciation of lake and reservoir management.

### *Beaver Watershed Alliance is the 2016 recipient!*

Award accepted by John Pennington (Figure 2)  
Nomination by Brad Hufhines, Robert Morgan, Reed Green, and Byron Winston

Over its five-year history, Beaver Watershed Alliance (BWA) has proven itself as an extraordinary organization for design and delivery of effective outreach and education programming regarding the volunteer protection of Beaver Lake, Northwest Arkansas's sole source of drinking water. Their outreach and education efforts are comprehensive in communication and programming methodology, and are producing impressive outcomes through enabling public and private landowners to take actions necessary to protect the watershed. The BWA effort is assuring the region of a long-term source of quality drinking water and other designated lake uses such



Figure 2. John Pennington

as recreation. They are a benefit to our community.

BWA's outreach and education efforts have culminated in results such as:

- Buy-in and participations of landowners who own 200,000 acres (25 percent) of the watershed
- Implementation of over 800 water quality best management practices, measured increases in learning
- Developed a volunteer army of thousands of people, which have planted 7 miles of riparian buffers and removed over 60,000 pounds of trash from 100 miles of waterway

What went into these outcomes? There were 394 education and stewardship programs, 340 property visits with landowners, 20 board members, 10,000 program participants, and 3,000 volunteers . . . all with three paid staff.

Overall, BWA has effectively developed strong relationships with landowners and built local environmental stewards.

### Lake Management Success Stories

Awarded to individuals or organizations accomplishing successful lake management efforts. Nominees must show demonstrable improvements in lake conditions through lake and watershed management.

#### *Ducks Unlimited-Iowa is a 2016 recipient!*

Award accepted by Mike Shannon (Figure 3)  
Nomination by George Antoniou

Ducks Unlimited Living Lakes Initiative team has contributed to a variety of Iowa and southern Minnesota shallow lake and wetland restoration projects. The Living Lakes Initiative was

established by Ducks Unlimited to focus conservation work on large marshes and shallow lakes throughout the Prairie Pothole Region of Iowa and Minnesota. Their long-term commitment has resulted in the protection and improvement of Iowa's and Minnesota's shallow lakes and enhancement of extensive wetland habitat. Contributions include innovative engineering solutions for carp control and water level management capabilities, in-kind support from their staff, and partnering with resource agencies to obtain federal grants.

Ducks Unlimited-Iowa has an extensive achievement record including successes such as:

- Facilitated North American Wetlands Conservation Act grants from U.S. Fish and Wildlife Service focused on protection of wetland habitat and shallow lakes in Iowa.
- Partnered with U.S. Department of Agriculture Natural Resources Conservation Service to execute Wetlands Reserve Program focused on habitat restoration on private lands.
- Enhanced over 1,000 acres of wetland habitat within the Barringer Slough/Blue-wing Marsh complex (2,200-acre lake and one of Iowa's top recreation and tourism destinations).
- Surveyed and designed series of water control structures and fish barriers allowing managers to focus on creating productive habitat.
- Surveyed and designed lake enhancement projects including innovative water control structure, water pumps, and fish barriers.



Figure 3. Mike Shannon accepts the award from Dana Stephens



Figure 4. Nick Spinelli

Overall, Duck Unlimited's long-term commitment resulted in protection and improving Iowa and Minnesota's shallow lakes and enhancement of extensive wetland habitat.

**Lake Wallenpaupack is a 2016 recipient!**

Award accepted by Nick Spinelli (Figure 4)

Nomination by Nicki Bellezza

Lake Wallenpaupack (PA) Watershed Management District's mission is to affect a cultural and societal change in the way people think about the lake and its watershed by fostering a responsible and balanced conservation ethic, educating lake residents and visitors, pursuing funding for projects and research, and leading by example in managing what happens in our watershed.

Built in 1926 as a hydroelectric dam, Lake Wallenpaupack is 5,700 acres in area and has become a popular tourism destination in the PA-NY-NJ Tri-state region.

In 2011, the Lake Wallenpaupack Watershed Management District, a non-

profit organization, created the Cost-share Program. The Cost-share Program maximized water quality improvement efforts by leveraging program dollars against other funds... consequently, the program successfully build relationships with homeowners, commercial entities, community associations, and farmers to reduce nutrient input to the lakes.

To date, the program has:

- Completed 16 shoreline stabilization projects.
- 10 storm water improvement projects.
- 3 stream rehabilitation projects.

or discovering innovative or improved methods, technologies, or processes for achieving lake or watershed management outcomes. Outcomes are safer, more affordable, and contribute to the science of lake and reservoir management.

**Harvey Harper, Environmental Research and Design, Inc. is the 2016 recipient!**

Award accepted by Harvey Harper (Figure 5)

Nomination by Dick Osgood

Development of Walt Disney World in Orlando triggered larger-scale development, leading to critical lake impairments in Central Florida by the 1980s. Increased phosphorus loading from untreated runoff sustained lake pollution. Remedies for poor water quality were needed.

Harvey Harper of Environmental Research and Design, Inc. stepped up. Harvey has a track record spanning decades of aggressive, effective, and innovative solutions to Central Florida's water quality challenges.

- 1 agricultural runoff control structure.
- Reduced phosphorus loading to Lake Wallenpaupack as recommended in a 2005 TMDL, resulting in a delisting of the lake from the Impaired Waters List in 2016.

Overall, Lake Wallenpaupack Watershed Management District has demonstrated improvements in the condition of Lake Wallenpaupack and its surrounding watershed in a cost-effective manner.

**Advancements in Lake Management Technologies**

Awarded to individuals or organizations refining, developing,



Figure 5. Harvey Harper

To solve these problems, Harvey developed alum treatment systems employing sound engineering principles and validated with rigorous field validation. Dozens of these systems have been implemented achieving impressive pollution removals, typically:

- 90 percent for total phosphorus
- 95 percent for TSS
- 40-50 percent for total nitrogen
- 60-90 percent for metals

Pollution removal has been achieved at a fraction of the cost (20- to 200-times less costly/pound) compared to other watershed management practices.

Harvey's innovative technological solutions and scientifically rigorous evaluation, especially as they have been implemented to achieve meaningful and measurable improvements in lakes, has clearly advanced lake management.

#### **Friends of NALMS Award**

Awarded to individuals or corporations making major contributions to NALMS. Recipients do not need to be NALMS members and contributions extend beyond monetary donations.

#### ***Pennsylvania Lake Management Society is a 2016 recipient!***

Award accepted by Nick Spinelli (Figure 4)

Nomination by Nicki Bellezza

Pennsylvania Lake Management Society (PALMS), a NALMS affiliate, is a statewide authority focused on lake and watershed management and restoration. Annually, PALMS organizes successful lake and watershed conferences with 100-150 attendees, in addition to routinely sponsoring and participating in regional workshops throughout the Commonwealth.

PALMS demonstrates major contributions to NALMS with their program that effectively address lake management through education, funding, and hands-on technical assistance.

PALMS is part of a program known as C-SAW (Consortium for Scientific Assistance to Watersheds). Through this program, PALMS provides technical assistance to lake associations within Pennsylvania. They also help with public education of lake and watershed management.

PALMS's efforts have measurable outcomes such as:

- Administers Mini-Grant Program through PA's DEP
- Funded small projects aimed at improving water quality and recreational value of the Commonwealth's lakes.
- Since 2010, PALMS awarded 25 mini-grants to lake associations in the amount of \$533,000 – provided shoreline stabilization and erosion control, aquatic invasive plant management, native shoreline/riparian buffers, and installation of 3-floating wetland islands.

#### ***SUNY Oneonta Biological Field Station is a 2016 recipient!***

Award accepted by William Harman (Figure 6)

Nomination by Nancy Mueller

For over a decade, the SUNY Oneonta BFS has supported the nomination and subsequent election of its staff members to serve as NALMS Region 2 Directors. Three outstanding individuals have now held the position: Matthew Albright, Holly Waterfield, and (currently) Kiyoko Yokota. Their support of NALMS, and particularly student activities, has been further manifested by the continued presence of many SUNY Oneonta students at NALMS conferences each year both as attendees and as presenters.

For the last few years, the SUNY Oneonta BFS has collaborated with NALMS and its leaders in the development of the first M.S. in Lake Management degree program in the country. Graduates of

the program have earned the NALMS Certified Lake Manager distinction and have become professional lake managers in their own right. We now find them in the exhibit area at NALMS conferences as well as on the program.

The continued commitment of the SUNY Oneonta BFS means that the future of NALMS, through the development of young lake management professionals, is in good hands.

#### **Jim Flynn Award**

Awarded to an organizational member to have contributed the most to NALMS's goal. Recipient must be a NALMS Corporate member.

#### ***Abraxis, Inc. is the 2016 recipient!***

Award accepted by Dave Deardorff (Figure 7)

Nomination by Ann St. Amand

Abraxis has been instrumental at NALMS conferences for over 10 years. They have always been available for any help NALMS or its members might



Figure 6. Bill Harman



Figure 7. Dave Deardorff

need in respect to understanding and implementing toxin testing via a variety of methods.

Abraxis has been developing, manufacturing, and marketing rapid environmental algal toxin tests (both strip and ELISA) for over 20 years, representing innovative methods including the only strip tests for Anatoxin a and cylindrospermopsin on the market. Many of their products are validated/verified by agencies such as USEPA, USDA, USGS, FDA, Japanese Ministry of the Environment, and WHO.

Abraxis has sponsored event after event at our conferences, always offering to be as flexible as possible with their sponsorship dollars, even providing gratis materials to other workshops opposite their own workshop. For many years, Abraxis has provided free strip test kits to the Algal ID workshop, with Dave Deardorff often graciously demonstrating the kits himself, despite the pressure and time crunch to set up his own exhibitor booth. In addition, I have never asked a question or submitted an inquiry, which didn't get a kind, accurate, quick

response, no matter the time of year, or what was going on during the conference.

Abraxis is a model supporter of NALMS, contributing to the ability of a wide range of individuals to responsibly manage their water resources in real time for algal toxins.

**Jim LaBounty Award**  
*Lake and Reservoir Management* selects the best paper published in 2016 in the *Journal of Lake and Reservoir Management*.

**Smeltzer et al. are the 2016 recipients!**  
Eric Smeltzer, Neil C. Kamman, and Steven Fiske. 2016. Deriving nutrient criteria to

to NALMS in the 35 years since its inception. He has (1) worked internally to promote NALMS through his activities as the NALMS International Committee Chair (1993-1996) and as a member of the Board of Directors (2002-2005), (2) elevated the impact factor of *Lake and Reservoir Management (LRM)* by serving as an associate editor for nearly 20 years (1991-2010), and (3) increased the visibility of the NALMS organization in the aquatic sciences by publishing at least 30 authored articles in *LRM*, some of which are among the highest cited articles in the journal. Jack's impressive publication rate in *LRM* was recognized by NALMS in 2003 when he was awarded the Best Peer-Reviewed Paper award.

Jack thoroughly embodied the NALMS vision throughout his research career. He attended more than half of the annual NALMS meetings since 1980, given 15 first author oral presentations and co-authored a multitude of presentations, covering a wide range of topics that include, but are not limited to: volunteer monitoring, international

minimize false positive and false negative water use impairment determinations. 32(2): 182-193.

**Secchi Disk Award**  
Award recognizes an individual member considered to have contributed the most to the achievement of NALMS' goal.

**John "Jack" R. Jones is the 2016 recipient!**  
Award accepted by Jack R. Jones (Figure 8) Nomination by Ted Harris and Jennifer Graham

Jack attended the first NALMS meeting in Portland, ME in 1980, and has made numerous and substantial contributions

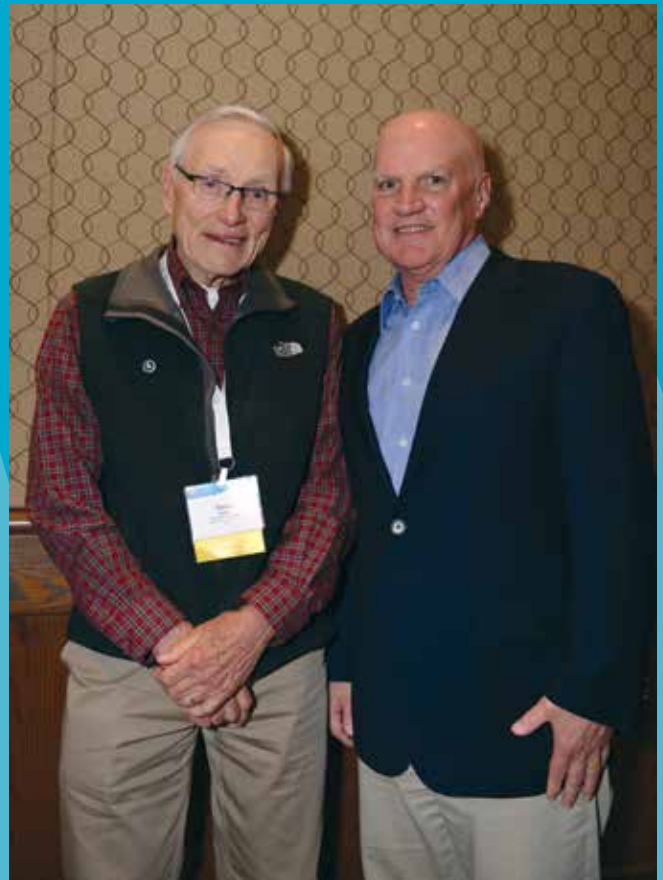


Figure 8. Jack Jones (r) and presenter, Gene Welch (l)

lake management, and cyanotoxins. His received the NALMS Outstanding Research Technical Merit Award in 2011.

Jack consistently encouraged his students and staff to join and contribute to NALMS and publish articles in *LRM*. For more than three generations Jack's students have (1) presented at NALMS and the National Water-Quality Monitoring conference, (2) served as committee chairs (e.g., Graham – Inland HAB, Harris – Student Program), (3) served on the NALMS Board (e.g., Hoyer – President, Graham – Region VII Director, and Harris – Student Director) and (4) won the Secchi Disk award (Hoyer 2013). Jack's students have also increased the visibility of *LRM* and *LakeLine* in the field of aquatic sciences by producing highly cited publications. In *LRM*, these include, but are not limited to, first author publications by Knowlton (8; numbers indicate number of first author publications in *LRM*), Graham (3, including guest editing an issue dedicated to algal toxins), Harris (3), LePerriere (2), and Obrecht (1). For *LakeLine*, these include Graham (4, including Guest Editing 3 issues dedicated to harmful algal blooms), Harris (1), and Hoyer (numerous). In addition to publishing in *LRM* and *LakeLine*, Jack's students have also served as associate editors and reviewers for *LRM* and guest editors for both publications. Jack's students have gone on to have careers that directly involve the management of water resources, a testament to his passion and dedication to the field of lake and reservoir management.

For the past 35 years Jack Jones has gone above and beyond to grow NALMS into the organization it has become today. Jack's NALMS legacy includes not only his own contributions to the society, but also the contributions of those he has mentored. Jack had a personal role in the careers of multiple well-recognized NALMS scientists and leaders who will perpetuate the NALMS vision for generations to come.

#### Jody Connor Student Awards

By Frank Browne, Student Awards Committee Co-Chair

Each year NALMS presents student awards to the best student presentation

and best student poster at the annual NALMS symposium. The awards are sponsored by Water Quality Solutions. The NALMS Board renamed the student award as the Jody Connor Student Award in memory of Jody Connor, a long-time friend of NALMS who was active on the Education Committee and participated in the reviews of student presentations and posters.

The first-place winner receives a check for \$200 and a plaque. Honorable mention or second-place winners receive a plaque. The Student Awards Committee is co-chaired by Alex Horne and Frank Browne. Members of the committee include Amy Smagula, Harry Gibbons, Holly Waterfield, Jennifer Graham, Ann St. Amand, Matt Albright, and Guy Foster. The awards are based on scientific merit, research design, visual aids, clarity, and presentation.

The 2016 first-place winner of the student presentation award was Ted Harris from the University of Kansas for his paper *Comparing Predictive Modeling Techniques for Cyanobacterial Abundance, Microcystin and Geosmin in a Eutrophic Midwestern USA Drinking*

*Water Supply Reservoir*. The second-place winner was Zophia Taranu from the University of Ottawa for her paper *Spatio-Temporal Dynamics of Microcystin Congeners in Response to Environmental Change: Potential Impact on the Bioamplification of Cyanotoxins*.

The first-place winner of the student poster award was Kimberly Gilmour from the University of Saskatchewan for her poster *Cold Spots and Cold Moments: The Potential for Sediment Freezing to Depress Denitrification in Wetland Sediments*. The second-place winner of the student poster award was Carolyn Greenough from Plymouth State University for her poster *Understanding How Stakeholders Value Scenic Views and Incorporate Viewshed Management into Environmental Decision Making: Lessons from the Lakes Region and White Mountains of New Hampshire*.

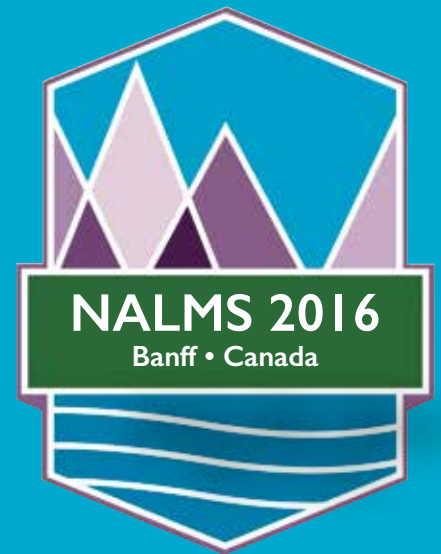
Students are encouraged to present scientific papers and posters at the NALMS symposium; it provides an excellent way to present research data and maybe win an award. We thank Water Quality Solutions for sponsoring the student awards.

### NALMS 2016 By the Numbers



- 521 Final number of attendees
- 142 Number of attendees from Alberta
- 9 Number of Canadian provinces and territories represented
- 39 Number of US states and districts represented
- 11 Number of countries represented
- 13,069 km (8,121 mi) Furthest distance traveled – by Robert Schuitema, Nigel Traill, and Andrew Winks from Sydney, Australia
- 49 Number of technical sessions
- 181 Number of oral presentations
- 25 Number of poster presentations
- 32 Number of exhibitors
- 40 Number of competitors in the Clean Lakes Classic
- 1,400 m (4,600 ft) Elevation of Banff, Alberta
- 1,609 m (5,280 ft) Elevation of Denver, Colorado, site of the 2017 NALMS Symposium

# The 2016 NALMS Photo Contest



The annual NALMS Photo Contest showcases not only many beautiful lakes from around North America but also the talents of our member photographers. Eleven photographers submitted entries this year. The annual photo contest is sponsored generously by Water Resources Services, a Massachusetts consulting company owned by Ken Wagner. We award a \$250 prize to each winner in two categories:

1. People's Choice – as voted on by delegates attending the Annual NALMS Symposium
2. Editor's Choice – chosen by *LakeLine* Editor-in-Chief Bill Jones and *LakeLine*

Production Editor Cynthia Moorhead for the entry that would make the best cover for *LakeLine*. We considered composition, image quality and color quality, and general aesthetics.

We thank all the great photographers who submitted this year: Larry Butler, Sarah Burnet, Clint Calhoun, Bev Clark, Denise Clark, Mark Howarth, Chris Mikolajczyk, Dick Osgood, Sara Peel, Jason Smith, Jeff Spence, and Ken Wagner. We encourage all NALMS members to keep their cameras with them as they work, recreate, and travel on and around lakes in 2017.

This year's winning photos are pictured below.



People's Choice First Place – "Turtle Trio" by Clint Calhoun



Winning photographers  
Clint Calhoun and  
Mark Howarth



At right: Editor's  
Choice – "Peaceful  
Foggy Morning" by  
Mark Howarth

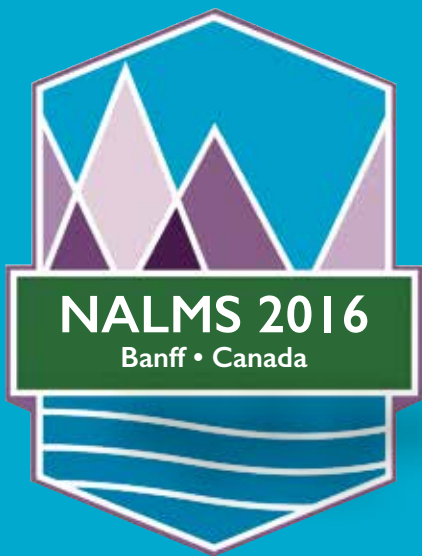


People's Choice Second Place – "Dream Lake" – Rocky Mt. National Park by Jeff Spence



People's Choice Third Place – "Winter Chairs" by Dick Osgood

# The 2016 Election Results



The annual election for officers and directors is an important way for NALMS members to provide input in the management of the Society. Our officers and directors are all volunteers who serve without pay. Thank you to all the candidates for their dedication to NALMS and thank you to all NALMS members who participated in this year's election!



## *President-elect – Frank Browne*

Dr. Frank Browne, P.E., received his doctorate from the University of Florida. He is president of F.X. Browne, Inc., an environmental consulting firm specializing in lake and watershed management. Frank was a member of the 11-person committee that founded NALMS. He has attended every NALMS meeting from the first organizing meeting in Portland, Maine in 1980. Frank has been active in NALMS, serving on several planning and financial committees; he was a NALMS Board member and also served as NALMS secretary. He is a member of the NALMS Education Committee. He is co-chair of the NALMS Student Awards Committee. Frank has over 35 years of experience in lake and watershed management. He wrote major sections of the EPA Clean Lakes Manual. He also wrote a chapter in the *NALMS Lake and Reservoir Restoration Handbook*. Frank created the Pennsylvania Lake Management Society (PALMS), and

was its first president. Frank is also an adjunct professor at Villanova University where he teaches graduate courses in lake and stream ecology and stormwater management.



## *Secretary – Amy Smagula*

Amy Smagula is a limnologist with the New Hampshire Department of Environmental Services, where she coordinates the Exotic Species Program. Amy has an undergraduate degree in natural resources as well as a Master of Science in water resources management, both from the University of New Hampshire. Amy has over 18 years of experience in field and laboratory limnology, aquatic plant and algae identification and management, lake and watershed assessment and management, lake related policy-making, wetland inspection and permitting, and shoreland protection.



## *Region 1 Director – Perry Thomas*

Perry Thomas has been Lakes and Ponds Program Manager with the Vermont Department of Environmental Conservation since February 2015. Previously, she worked as a faculty member and dean at Sterling College in Craftsbury Common, Vermont. She and her students protected and restored waters across the Northeast Kingdom, working closely with state and federal partners. She also volunteered time with conservation organizations, including stints as president of the Lake Eden Association, Federation of Vermont Lakes & Ponds, and Memphremagog Watershed Association. She earned a B.A. in biology from Dartmouth College and Ph.D. in aquatic ecology from Northern Arizona University.



***Region 3 Director – Lisa Borre***

Lisa Borre has worked on lake conservation and management for more than 25 years. She is currently a senior research specialist at the Cary Institute of Ecosystem Studies. She was coordinator of the Lake Champlain Basin Program from 1990 to 1997 and co-founded LakeNet, a world lakes network that was active from 1998 to 2008. She is now an active member of the Global Lake Ecological Observatory Network (GLEON) and an associate investigator with the SAFER Project: Sensing the Americas' Freshwater Ecosystem Risk from Climate Change. As a contributor to *National Geographic's* Water Currents blog, Lisa writes about global lake topics. Lisa has a B.A. from the University of Vermont and an M.E.S. from Yale University.

and OSU's Lake Erie-based biological field station, F.T. Stone Laboratory. He is a past president of the Ohio Chapter of the American Fisheries Society and the Ohio Lake Management Society (OLMS) and continues to serve the governing boards of those organizations, the Water Management Association of Ohio, and several others. He also represents Ohio on the Mississippi River Basin Panel of the national Aquatic Nuisance Species Task Force and previously served on the International Joint Commission's Council of Great Lakes Research Managers and grant-making committee of the Lake Erie Protection Fund.



***Student At-large Director – Sarah Burnet***

Sarah Burnet is pursuing her Ph.D. at the University of Idaho, where she completed an M.S. in the spring of 2016. She received a B.S. from Western Washington University. Her Ph.D. research is focused on internal loading of phosphorus to reservoirs. Specifically, she is interested in understanding the relationships between sediment type, particle size, the availability of iron, and dissolved oxygen in the release of P. This builds on her M.S. research, which focused on measuring the seasonal internal phosphorus load as part of a mass balance for Willow Creek Reservoir in Oregon. Sarah's previous work experience includes sampling and analysis on all five Great Lakes with Cornell University as well as collecting data and samples after the BP Deepwater Horizon Oil spill. Sarah has been a member of NALMS since 2014.



***Region 9 Director – Ellen Preece***

Ellen Preece, Ph.D., is a limnologist with Robertson-Bryan, Inc. in Elk Grove, California. Ellen's research is focused on cyanobacterial harmful algae blooms (CyanoHABs) and the accumulation of associated toxins in seafood that humans consume. For the past six years, she has conducted research on the transfer of cyanotoxins from inland lakes to nearshore marine areas. Ellen was actively involved in the NALMs affiliate group WALPA for five years, where she served as secretary and president and is now a CALMS director. Ellen possesses a B.S. in resource economics from University of New Hampshire and her M.S. and Ph.D. in environmental sciences from Washington State University.



***Region 5 Director – Eugene Braig***

Eugene Braig MS – fisheries management – is Aquatic Ecosystems Program Director with Ohio State University (OSU) Extension and past assistant director of the Ohio Sea Grant College Program

# Tropical Storm Irene & the Passage of Vermont's Shoreland Protection Act

Susan Warren and Perry Thomas

In late August 2011, Tropical Storm Irene dropped more than seven inches of rain over parts of Vermont. Waterbury, base of operations for the Department of Environmental Conservation (DEC), was one of the many communities hit hard by the storm. DEC lost much of its infrastructure to flooding, and all employees working in central office buildings were displaced. In the face of such devastation, members of DEC's Watershed Management Division might have thrown in the towel; instead, they rallied to make the most of a teachable moment.

Not long before Irene, in the spring of 2011, the Agency of Natural Resources published a white paper describing predictions of climate change models and how impacts could affect Vermont's waters (Pealer and Dunnington 2011). Increased storm intensity and frequency were among the predictions. Restoring and protecting shorelands were described as important ways to improve lake resiliency. An intense storm hit central Vermont just after this report was released, leading the Agency of Natural Resources to establish a flood resilience program during summer 2011. Then Irene arrived. Two high-intensity storms, happening in the same year, reinforced the need for flood resilience. Images of sediment transport into lakes helped point toward improved land management practices across Vermont's watersheds (Figure 1).

As floodwaters receded, one of the Watershed Management Division programs that seized on the opportunity to build upon lessons learned was the Vermont Lakes and Ponds Management and Protection Program. Created in 1975, in the wake of the Federal Clean Water Act, the Vermont Lakes and Ponds



Figure 1. Aerial view of Otter Creek delivering a sediment plume to Lake Champlain in Ferrisburgh, VT (A), and the Ferrisburgh shoreline shows the lawn-to-lake pattern that we strive to change through legislation and outreach (B). Photos: Staci Pomeroy, DEC.

Program served as home for a range of lake-focused projects: (1) monitoring and assessment of the state's lakes, (2) regulation of aquatic nuisance control and lake encroachment (below mean water level), (3) aquatic invasive species management, (4) education and outreach about lake protection, and (5) lake watershed management. By building and maintaining this diverse set of initiatives, funded through various sources, the Lakes Program grew and thrived. As of 2011, however, shoreland regulations were absent from the Program's toolkit. In Irene's aftermath, we sought to fill this gap.

### **A Shoreland Bill**

After decades of development with few shoreland protections in place across Vermont, most people agreed lake shorelands needed better management. There were several key factors that we believe resulted in successful legislation. Perhaps most critical was the support of the leaders of the Agency of Natural Resources and the Department of Environmental Conservation who agreed to take on the issue where before it had been perhaps viewed as too controversial. The administration included it in their post-Irene legislative agenda and assigned key personnel to promote it.

Fortunately, the Vermont legislature is a very open and approachable body. Citizens can easily attend committee meetings and get on the agenda to speak. Legislators are easy to reach at home and pay attention to every comment they receive from constituents. During the legislature's consideration of the shoreland bill, Agency staff could sit in on all committee discussions. Committee members regularly referred to staff with questions even when we were not specifically testifying. The legislature respected Lakes Program staff and appreciated when we were available to provide information.

We were often asked by the legislature, "Why not just educate people about good shoreland management?" Although we had offered active outreach programs on shoreland management for many years and found education to be an essential component of all our efforts, we knew that education alone was not going to protect the shores. We provided

social science research supporting this contention.

The legislature was keen to see that every standard addressing natural vegetation or runoff was supported by science. Perhaps most importantly, Vermont had new data showing how shoreland clearing and the associated runoff resulted in a substantially degraded littoral habitat (Merrell et al. 2009). This research was critical in gaining legislative support.

### **Vermont's Shoreland Protection Act**

In 2013, the Vermont Legislature passed the Shoreland Protection Act, establishing a permit program that focuses on protection of existing natural vegetation within 100 feet of the water and minimization of stormwater runoff. The legislature and agency worked hard to produce a bill that addressed some of the specific concerns voiced by the public. These now include:

- existing shoreland property owners are not required to change how their land is currently being managed, only a new project of a certain size (e.g., building an addition onto a camp) triggers a permit requirement;
- some "*de minimus*" projects are allowed that would not require a permit, such as building a small storage shed within the 100-foot buffer area;
- the permit application process is relatively simple and landowners do not need to hire an engineer to comply;
- the state works closely with associated permit programs (e.g. septic systems and wetlands) to ensure a coordinated permit process;
- we have developed a voluntary contractor training program in coordination with contractor trade groups to support the new permit program; and
- towns may adopt a protective shoreland ordinance and, after approval by the state, residents of that town do not also need a state shoreland permit.

The Vermont Lakes program is grateful for the support of the agency

and legislature in enacting the Shoreland Bill. Going forward we are pursuing a three-pronged approach to shoreland management. First, the new permit program enables us to ensure shoreland development proceeds with little new impact on the lake resource. Second, we continue to consider education and outreach a crucial part of shoreland management. Recently, Vermont's outreach program was substantially revamped in the form of Lake Wise, and shoreland owners across the state are receiving it enthusiastically. It allows us to work with the existing owners of shoreland properties who are interested in reducing their impact on the lake (Picotte 2012). And third, we continue to monitor and assess the in-lake water quality and habitat conditions.

### **Monitoring Lake Resilience**

Ongoing monitoring and assessment have allowed us to demonstrate clear connections between shoreland management practices and littoral habitat health. By participating in the EPA's National Lake Assessment (NLA) we not only continue to track habitat changes within Vermont lakes but also assess lake health in a national context. A comparison of lakeshore disturbance rates across Vermont, the ecoregion, and the nation revealed that Vermont lagged behind other states in protecting lakeshores. A separate study comparing Vermont lakes with those in Maine (where shoreland regulations have been in place since the 1970s) reinforced the importance of protecting shoreland vegetation (Merrell et al. 2013).

The research supporting enactment of Vermont's shoreland protection measures was supported through Vermont's Performance Partnership Agreement with USEPA Region 1. Field work and laboratory analyses were funded in large part thru that agreement, tied specifically to the EPA Office of Water's "Monitoring Initiative" set-aside funds. These funds are provided by EPA from each state's Section 106 allocation, subject to the stipulation that the funds enhance state water quality monitoring programs. Vermont has effectively used Monitoring Initiative funds to address management needs.

## Shoreland Protection and Lake Resilience

In their pre-Irene white paper, Pealer and Dunnington emphasized the value of riparian and shoreland vegetation in providing shade for aquatic habitat, thereby directly mitigating the effect of increased water temperatures. This kind of local action to protect lakes from climate change is receiving increasing attention nationally and globally, as lake managers and policy makers recognize the need to provide specific, local recommendations for improving the resiliency of lake ecosystems (e.g., Borre et al. 2016). Faced with dire predictions from climate change experts and natural disasters consistent with those predictions, communities can become overwhelmed to the point of inaction (Scheffer et al. 2015).

When specific, doable projects are proposed as ways to protect local ecosystems from the impacts of climate change, people are encouraged to take action – making small changes that together have big impacts (Figure 2). In Vermont, as we continue to rebuild communities five years after Tropical Storm Irene, our new shoreland regulatory team is working closely with the voluntary Lake Wise Program to provide the information and tools shoreland property owners need to protect their lakes. Fees from permit applications and support from state funding sources such as the Ecosystem Restoration Program make these complementary programs possible.

### Acknowledgments

We wish to acknowledge the Vermont DEC's Watershed Management Division for contributions to the work described above. Many, many thanks to staff members of the Lakes and Ponds Management and Protection Program for dedicating their considerable energy and talents to the shoreland protection cause. Thanks also to Neil Kamman and the Monitoring Assessment and Planning Program for supporting lake monitoring efforts and for contributing to this article.

For more information, visit the following websites:

<http://dec.vermont.gov/watershed/lakes-ponds/permit>

<http://dec.vermont.gov/watershed/lakes-ponds/lakeshores-lake-wise>



Figure 2. This shoreland on Lake Eden was restored by simply allowing succession of natural vegetation on an area that was once maintained as bare sand. Photo: Perry Thomas.

<https://www.epa.gov/water-pollution-control-section-106-grants/monitoring-initiative-grants-under-section-106-clean>

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**Susan Warren** worked in the Lakes and Ponds Program for 32 years before retiring in 2014. She feels fortunate to have been able to help shepherd Vermont's Shoreland Bill through the legislature. Susan now spends her time making and selling pottery.



**Perry Thomas** has been Lakes and Ponds Program Manager since February 2015. Previously she served as a faculty member and dean at Sterling College in Craftsbury Common, VT. When Tropical Storm Irene hit, she was president of the Federation of Vermont Lakes and Ponds.



# Wisconsin Lake Management, Programs, Policy, and Litigation

Lisa Conley

Wisconsin is a state with a long history of strong protections of its natural resources, including its 15,000 lakes. Spread across the state, with heaviest concentrations in the northern tier of counties and least prevalent in the unglaciated Driftless Area of southwest Wisconsin, Wisconsin's lakes range in size from glacial kettles smaller than an acre to 132,000-acre Lake Winnebago. Natural lakes are found more often in the north, while impoundments are more common in the southeast.

The Department of Natural Resources (DNR) holds primary jurisdiction over lakes, with authority conferred mostly through the state constitution's Public Trust Doctrine, which says the waters of Wisconsin are held in trust for the people of the state, and should be managed for their protection. The exact nature of that protection is determined by the state legislature, which in turn, delegates authority to the DNR. DNR also holds authority over water quality issues through a delegation of federal Clean Water Act powers from the Environmental Protection Agency.

Unfortunately, while there is still some good news to report, much of what is happening in Wisconsin right now is not good, but bad, and some is downright ugly.

## The Bad

I deeply regret to report that recent legislation and state policies have rolled back important laws that protected Wisconsin's waters in the past.

- The state minimum standards for shoreland zoning are now the state maximum, undoing the work that 43 counties have done to enact and enforce stricter standards for waters needing

more protection than that minimum. Our Lake Classification grants helped counties establish larger lot sizes, greater setbacks, and wider shoreland buffers needed to protect the most sensitive and pristine lakes of our state. These ordinances are no longer valid.

- Destructive policies, including this shoreland zoning change, have been tucked into the budget bill in the middle of the night with no opportunity for public debate.
- The ability of local communities to decide what is needed to protect their local resources and the health of their citizens has been undermined. The Legislative Audit Bureau found that 128 pieces of legislation have passed that restrict local control, including the shoreland zoning changes.

- The Attorney General has ruled that the DNR cannot consider cumulative impacts when giving out high-capacity well permits, allowing for the overuse of groundwater, regardless of impacts to local waterbodies. This even though lakes and streams in Wisconsin are already being drawn down or even pumped dry by over-pumping of local groundwater (Figure 1). Recently, Clean Wisconsin has filed suit to overturn nine of the most egregious high capacity well permits granted this summer that threaten surface waters.
- It is now easier to disturb and develop wetlands thanks to a bill that allows mitigating of the destruction of wetlands in one location by building wetlands elsewhere in the state, not necessarily in the same watershed.



Figure 1. Long Lake drawn down by over-pumping of local groundwater. Photo by Kate Golden/Wisconsin Center for Investigative Journalism.

- The 2013-15 state budget directed the DNR to sell 10,000 acres of public land by mid-2017 to help pay down debt in the agency's land stewardship program. Pristine northern lakefront property has been sold to a political donor.
- DNR staff and funding have been cut continuously over the past years. In the last budget, the Bureau of Scientific Services had a 31-percent budget cut. The DNR lost 16 scientists and 11 educators. This translates into the loss of experienced staff and the resources to continue research projects critical to resource management.
- Capacity grants have been eliminated that supported DNR partnerships with The Wisconsin Lakes Association, the River alliance of Wisconsin, and many others. As a result, nonprofit staff has been lost that supported citizen education and outreach positions.
- Wisconsin has one of the most concentrated areas of dairy cows in the world – and this on thin soils over fractured bedrock. Citizens' wells are being polluted on a huge scale in Keweenaw County and others. State enforcement and permitting are inadequate. The Legislative Audit Bureau reported that DNR's pollutant regulators failed to follow their own policies regarding violators of water pollution laws more than 90 percent of the time.

Now Midwest Environmental Advocates has made a formal request, a Petition for Corrective Action, to the EPA, on behalf of Wisconsin tribes and water organizations. The EPA has been asked to act to correct the ways in which Wisconsin is not following federal water pollution laws. EPA staff are now in Wisconsin conducting an investigation. I can't believe all this is happening in the state that used to be so well known for taking such excellent care of its beautiful, healthy lakes and environment.

### The Ugly

- The secretary of the DNR, appointed by the governor, owned and operated a home construction business. She had no experience in natural resources or environmental management or experience administering a huge, multifaceted agency – or even a

college degree. The DNR declared that "Wisconsin is open for Business." The stated goal was job creation, but years later Wisconsin has lagged way behind other states in this area.

- I have served on a number of state rule writing committees regarding non-point programs, lake use, pesticide use, forestry BMPs, manure management, etc. Around the table was always a balance of industry, non-profits, and DNR, ag, and or forestry staff. The results were a compromise, and no one got their wish list, but it was always better to have a chance to get some progress and understand the needs of all around the table. Now many of the rules and laws we worked on have been re-written behind closed doors and the mining companies, dairy industry, developers, realtors, and road builders have access and consideration from our elected officials not granted to groups dedicated to protecting the environment we all depend on.
- Access time to the documents we must testify on is much shorter that it used to be, giving environmental groups much less time to study the bills or coordinate responses.
- Redistricting has greatly increased the chances for keeping the current legislative majority in power.
- Limits for campaign contributions have doubled.
- The Government Accountability Board was eliminated.
- The Environmental Education Board was eliminated.
- Voter ID laws have passed aimed at disenfranchising minority and student voters.
- Acrimony between the two political parties has made civil discussion and compromise much less likely.

A few really bad ideas did fail to pass in the last legislative session, such as allowing Wisconsin's water utilities to be privatized or allowing lake residents to dredge three truckloads of sediment from their lakeshore annually.

### The Good

- Despite all this, the Wisconsin Lakes Partnership continues to do great work.

You read about some of our newer programs in the last issue of *LakeLine*. Our collective belts have tightened, and Wisconsin lakes and The River Alliance of Wisconsin now share office space – and an opportunity for greater collaboration.

- Our Lake and River grant programs will continue. We still have nearly \$8 million in funding from the motorboat gas tax (the Water Resources Account) that supports our lake and river grant programs, DNR and UWEX lakes staff, equipment and training for our 1000+ volunteer lake monitors, aquatic invasive species grants, and support staff. This is the segregated funding that the Wisconsin Association of Lakes worked to set aside decades ago and has defended over the years. The surface water grants leverage an additional \$2 million a year from local partners to protect and improve water quality and aquatic habitat.
- Our UWEX Lake Leaders Institute continues to graduate, educate, and inspire a growing cadre of citizens to get active in many ways to improve our state's waters and water policies.
- We have \$200K federal 319 funding for 303(d) water restoration Lake and River Protection Grants to local lake organizations and communities.
- EPA mandated TMDLs are progressing in the Rock River and the Milwaukee River Watersheds, with strong local partnerships working towards implementation. Yahara WINS, the Rock River Coalition, and Milwaukee Riverkeeper are key partners (Figure 2).
- Adaptive management plans in several Wisconsin communities, including Madison and Oconomowoc, are allowing sewage treatment plants to implement mandated phosphorus reduction by funding upstream non-point projects. This is real community building and a promising way to achieve measurable results, as well as provide much-needed funds for non-point projects. Yahara WINS and the Oconomowoc Watershed Protection Program are prime examples. Agricultural nonpoint efforts are having success with a focus on soil health that resonates better with producers than a water protection focus alone. Promising

farmer-led coalitions for watershed action are forming as a result.

- Several top former DNR staff are now working in a very public way for nonprofits and are a powerful and eloquent voice for protecting our waters.

Hope for the future: I am so very grateful for the good science generated by NALMS members and the outstanding work of our Wisconsin Lake Partnership. A great example is Bob Kirschner's work to restore the shorelines of the Chicago Botanical Gardens (Figure 3). This camaraderie and collaboration has given us all a better understanding of what can be done to take good care of our lakes. There are so many good, dedicated people I have worked with over the years, and together we carry on. Thanks to all.

For more details, check out these sources:

**Wisconsin Lakes page** – [www.wisconsinlakes.org/](http://www.wisconsinlakes.org/)

**UW Extension Lakes page** – <http://www.uwsp.edu/cnr-ap/UWEXLAKES/Pages/default.aspx>

**DNR Lakes program** <http://dnr.wi.gov/lakes/>

**Petition to the EPA** <http://midwestadvocates.org/pca/>  
**Clean Wisconsin** <http://www.cleanwisconsin.org/>



**Lisa Conley** is retired from the nonprofit world, having served as president or chair of the Lac La Belle Management District, Oconomowoc River Priority Watershed Task Force, Wisconsin Association of Lakes, NALMS, Rock River Coalition, and Town and County RC&D. She has been a volunteer monitor for Lac La Belle for over 25 years. She loves sailing, paddling, photography, throwing pots, her very patient husband, and



*Figure 2. Monitoring the Rock River by Kayak – Professor Eric Compass, UW-Whitewater, and board member of the Rock River Coalition, led a kayak expedition the entire length of the Rock River. Samples of D.O., temperature, pH, and conductivity were taken every 10 seconds, and uploaded to a live feed. Photo by Lisa Conley.*



*Figure 3. Bob Kirschner teaching about shoreline restoration. Photo by Lisa Conley.*

being a grandma. She is having more fun going to protests than going to hearings lately, but goes anyway. The pendulum must swing. (Family Photo – Bob, Lisa and Castan Conley – by Rob Conley) 📷

# Lake Restoration in Iowa: Building Partnerships for Success

Michelle Balmer and George Antoniou

It's a typical summer evening on North Twin Lake in Iowa – the sun is shining, the cicadas are buzzing, and there are a few boats bobbing around the lake – except that tonight local residents, state officials, scientists, and other advocates for conservation are sitting together at a public meeting to discuss the future of North and South Twin Lakes. Twin Lakes, like many other lakes in the State of Iowa, have degraded and currently are plagued with poor water quality, frequent algae blooms, and an underperforming sport

fishery dominated by rough fish. The goal of this meeting, and the many meetings to come, is to learn about the two-year Diagnostic and Feasibility Study that was recently completed and to synthesize a comprehensive restoration plan for the lakes that will result in improved water quality and better recreational opportunities.

Iowa, located in the mid-western United States, was dominated by prairies, oak savannas, and pothole wetlands until European settlement in the 1800s. With

the invention of the plow, prairie was transformed to agriculture. Today, over 97 percent of the landscape in Iowa has been altered, and less than 1 percent of the land in the state is publicly owned (Figure 1). Therefore, protecting public resources are an integral part of environmental stewardship and recreational opportunities in Iowa. Throughout the 20<sup>th</sup> century, public entities invested heavily in constructing small reservoirs and impoundments around the state for recreation. Most of these publicly

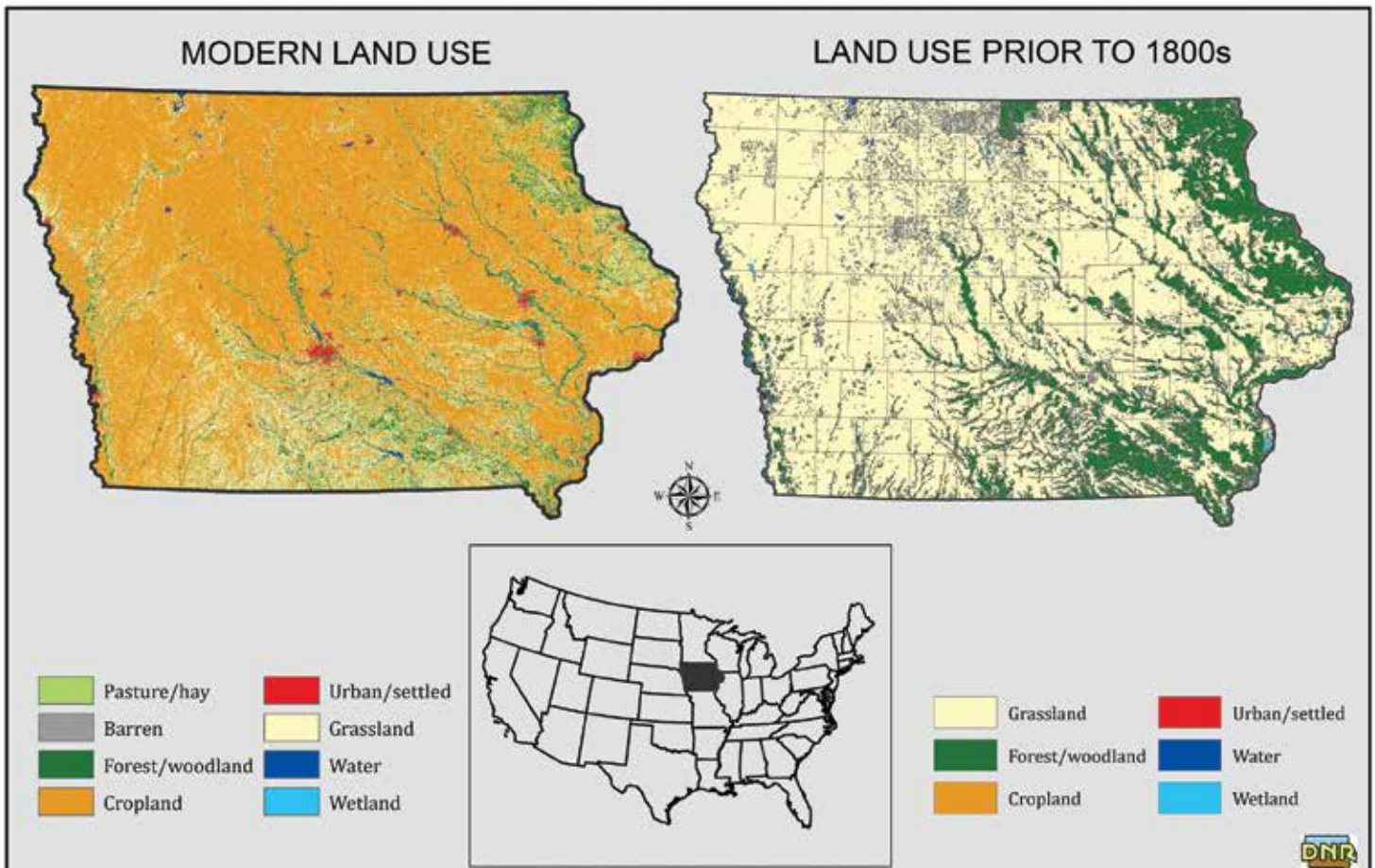


Figure 1. Historic and Modern Land Use in the State of Iowa.

owned lakes are the centerpiece of city, county, and state parks. Being in a highly altered landscape, restoration and maintenance work on our lakes and reservoirs is extremely important for the longevity of these resources. Many of the reservoirs have also experienced high rates of sedimentation and nutrient loading since they were built. Shoreline erosion, loss of lake volume, and aging infrastructure has plagued many of these ecological and recreational hotspots. Today, approximately 70 percent of the monitored lakes in the state are listed as impaired.

As a response to these challenges, the Iowa Legislature introduced a bill in 2006 to create a state-funded Lake Restoration Program (LRP) that would be administered by the Department of Natural Resources (DNR) to protect and restore publicly-owned lakes around the state. Funding since the program's inception has averaged \$8.3 million annually (Figure 2). Monies are appropriated annually to the program for the development and completion of in-lake and watershed restoration projects. Program guidelines have allowed the state to prioritize lakes using a science-based approach and implement complex, multi-phase projects with a variety of partners. On average, there is about a 35 percent cost-share match to LRP funds, which is critical for accomplishing the program's goals.

Iowans love their lakes, and they are an important part of the state's economy. Approximately 60 percent of all Iowans visit lakes each year, and those who visit typically make eight single-day trips per year (CARD Survey). Additionally, about 22 percent of all Iowans make overnight trips to visit Iowa's lakes annually. In 2014, Iowans spent an estimated \$1.2 billion visiting public lakes in the state. Protecting, restoring, and investing in these resources remains an important goal for the state.

### Program Goals and Directives

The Lake Restoration Program (LRP) focuses efforts on Iowa's significant publicly owned lakes and shallow lakes. Lakes are eligible for inclusion in the program if they meet the following criteria:

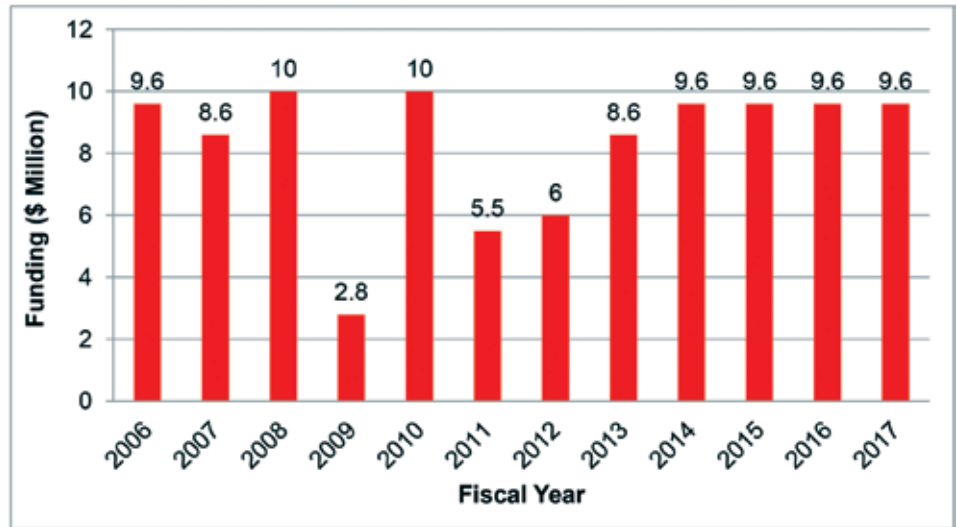


Figure 2. State Fiscal Year Funding for the Iowa Lake Restoration Program.

- Greater than ten acres
- Capable of supporting multi-use recreation
- Have a watershed to lake area ratio of less than 200 to 1
- Are owned by a city, county, or the state, and have public access
- Shallow lakes are also eligible for the program if they meet the above criteria and also have a mean depth of less than 4.5 feet

Through the legislative language establishing the program, a number of specific goals were developed for improving Iowa's lakes. The following goals were established for the program:

- Ensure a cost-effective, positive return on investment for the citizens of Iowa
- Ensure a local community commitment to lake and watershed protection
- Ensure significant improvement in water clarity, safety, and quality of Iowa's Lakes
- Provide for a sustainable, healthy, functioning lake system
- Result in the removal of lakes from the impaired waters list

The LRP is actively working on 22 projects throughout the state, and has completed projects at about 24 lakes in the state. Additionally, the program has prioritized an additional ~13 lakes for restoration and is currently working with

local partners to establish restoration plans for these lakes and watersheds (Figure 3).

### How a Lake Becomes a Candidate for Restoration – Prioritization Begins with a Need

Given the legislative intent of the program, the Iowa Department of Natural Resources (DNR) developed a science-based approach for classifying lakes based on water quality, potential for public benefit, and feasibility for restoration. Three measures are used to determine if a lake is a good candidate for the program:

1. *Feasibility* – The feasibility score is based on a combined rank of the watershed to lake area ratio and the Revised Universal Soil Loss Equation for the watershed (RUSLE).
2. *Potential for Public Benefit* – Lake visitation data collected through periodic statewide surveys are used to assess the potential for public benefit and potential economic impacts of restoration. According to the 2014 survey, the median visitation at Iowa lakes each year is about 37,000 visits.
3. *Lake Status* – The program currently uses a water quality index developed using statewide ambient monitoring data from the last 15 years of monitoring to rank lakes based on several important parameters for restoration success and water quality perception.

Scores for all three metrics are used to rank lakes. Systems with high scores

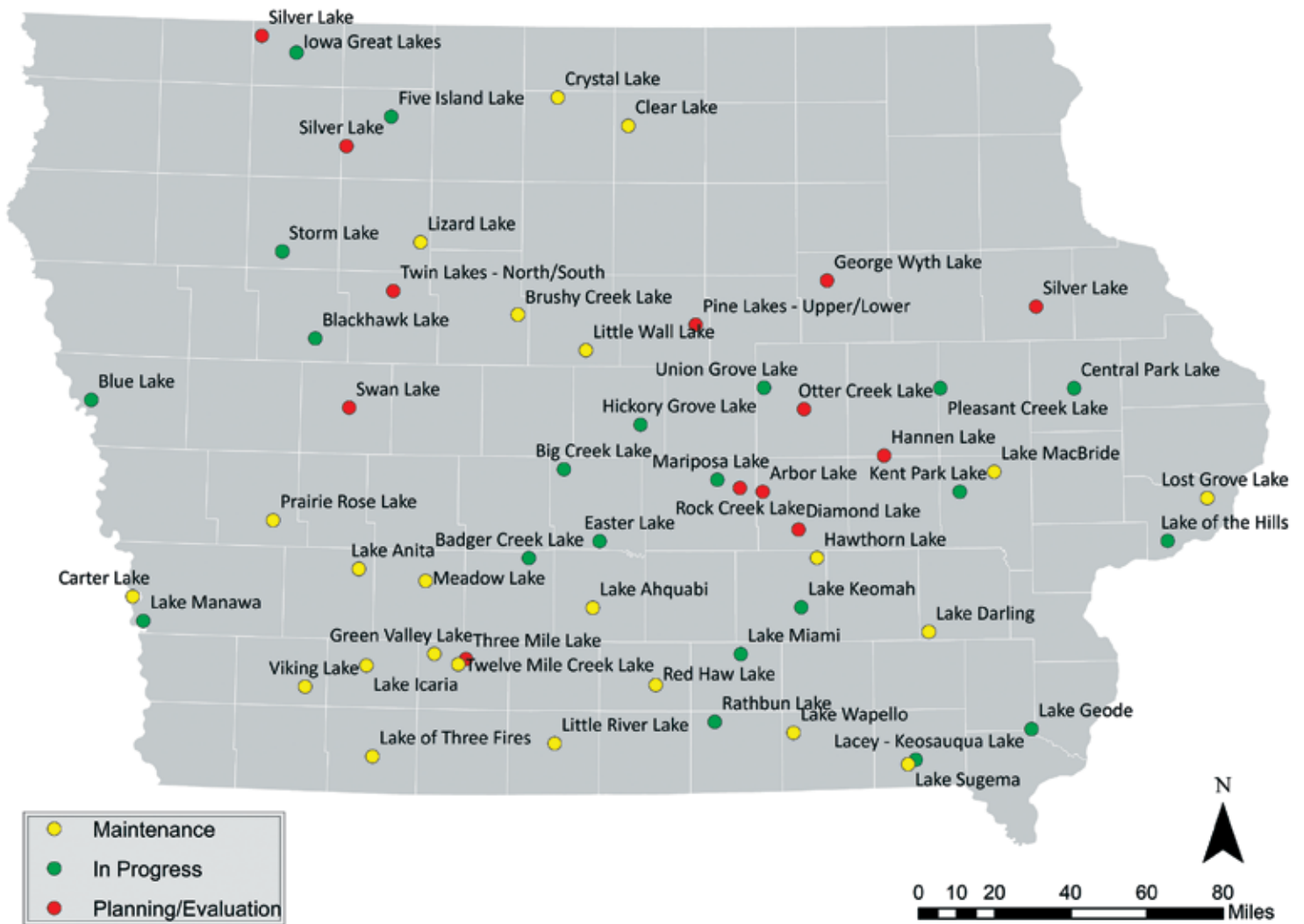


Figure 3. Map of Lake Restoration Projects.

are given preference for restoration. Lakes are identified in one of two ways to be prioritized for funding: (1) A need is identified by local resource managers and verified through the program’s science-based approach or (2) a community petitions the director of the DNR to be included in the program (Figure 4). Once a lake is prioritized within the ten-year plan, planning work begins on the project.

### Planning for Success

This phase of the process focuses on determining what types of work (both in the watershed and in the lake) will be most effective for improving water quality. The LRP partners with others to complete (or use already completed) watershed improvement plans to target watershed best management practices (BMPs). If needed, additional assessment work is completed through a Diagnostic

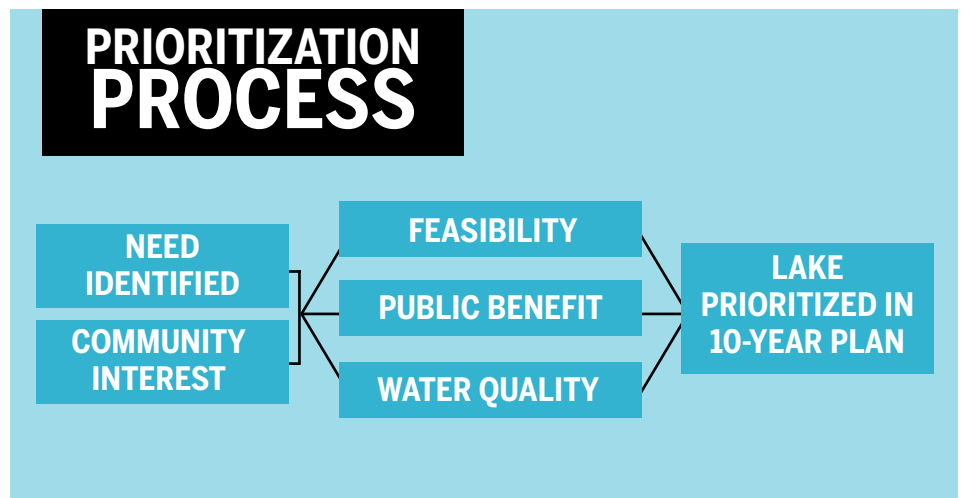


Figure 4. Prioritization for inclusion within the LRP is based on community interest and an individual lake’s ranking for feasibility, public benefit, and water quality scores.

and Feasibility Study. The result of all initial planning is tentative watershed BMPs design and placement, as well as rough cost estimates for construction of watershed practices (Figure 5).

Final planning includes complete engineering design and contracting for construction of watershed work. An important component of this part of the plan is continuous outreach with land

# PLANNING PROCESS

## INITIAL PLANNING:

- Diagnostic and Feasibility Studies
- Initial engineering/project cost estimates
- Identifying project partners and additional funding sources

## FINAL PLANNING:

- Develop comprehensive watershed and in-lake restoration plan
- Additional design work completed
- Develop education and outreach plan
- Continue to work with project partners to identify cost share opportunities

# IMPLEMENTATION PROCESS

## WATERSHED IMPLEMENTATION

- Final engineering design for watershed projects
- Work with project partners to treat watershed before in-lake work begins
- Construct BMPs on public and private lake in the watershed
- Examples include: terraces, ponds, and forest restoration
- Continue education and outreach with the community

## IN-LAKE IMPLEMENTATION:

- Final engineering design and permitting for in-lake projects
- Complete in-lake work as watershed projects wrap-up
- Examples of in-lake work include: shoreline armoring, dam repair, and targeting dredging
- Continue to work with project partners to education and interact with the community

Figure 5. Planning and implementation includes extensive research about an individual lake's watershed and in-lake challenges and the development of a comprehensive plan to address those challenges and improve water quality.

owners and the community to engage those around the lake with the project.

### Implementing Restoration Projects

Watershed work is usually completed before in-lake work begins; however, there is often some overlap between the two phases of projects. The project culminates with in-lake construction, and if needed, fishery and habitat enhancement. Community and stakeholder groups are actively involved during the construction phase for both in-lake and watershed work. Partnerships are vital to the success of every project, and public education remains a key piece of the program's success.

Key components of the process include:

- Community involvement throughout the project. This includes steering committee meetings, public presentations, and partnering with a variety of local groups to achieve a common goal of improved water quality.
- Active partnerships to leverage costs. The LRP works in concert with other federal, state, county, and local agencies to tackle components of a project and share costs for various watershed practices and in-lake work.
- Addressing the watershed before working in the lake. The LRP works to address problems in the watershed for several years before tackling in-lake work. We want to ensure that restoration efforts completed in

the lake will have a long lifespan. We rely heavily on our partners to help us identify and implement best management practices that will significantly reduce pollution to the lake. Using the most robust data available, the LRP works to target in-lake practices that will be the most beneficial for improving water quality and increasing recreational opportunities at the lake. We frequently partner with other DNR bureaus to address myriad issues as we restore the lake.

### Success Stories

Because of the partnerships and work completed around the state, many of the lakes that have undergone or are currently undergoing restoration are showing measurable water quality improvement, increased visitation, and better recreational opportunities for diverse user groups. In many lakes, water clarity has improved substantially, and subsequently, aquatic macrophytes are being observed for the first time since the 1930s. Following restoration, angling opportunities are improving through better sport fisheries and increased access for both shoreline and boat anglers. Many projects spark additional in-park improvements. Following restoration, local communities have invested in public cabins, nature centers and lodges, and bike trails to enhance visitors' experiences.

**Easter Lake** – Located in an urban area (Des Moines, IA) with over 500,000 residents within 15 miles of the lake, Easter Lake has the potential to be one of the most visited lakes in the state. However, since the lake was built in the 1960s, this 178-acre reservoir has lost over 20 percent of its original volume and has a poor sport fishery and very high turbidity. Easter Lake is an excellent example of how partners come together to work towards better water quality and recreational opportunities.

The project at Easter Lake began in 2008 with a study to better understand where nutrients and sediment were coming from in the watershed and what suite of restoration alternatives could be used to reach water quality goals. In 2012, a (Section 319) federally funded

watershed project was initiated to install BMPs throughout this urban watershed and stabilize Yeader Creek (the primary in-flow for the lake). A local steering committee and technical advisory team was formed to draft a long-term restoration plan for the lake and connect partners and leverage funds from the county, city, state, and local homeowners to improve the lake and watershed. Together, over 61 practices have been installed in the watershed since 2012 to reduce phosphorus and nutrients being delivered to the lake. In 2015 work in the lake began, with the installation of sediment detention ponds, a fish rearing pond, and fish barriers to benefit the sport fishery at the lake. Dredging was completed throughout the summer of 2016 to restore the reservoir's original volume. Shoreline armoring and a fishery renovation will be completed in the coming years to further improve water

quality. Additionally, the city and county have invested millions of dollars installing a bike trail around the perimeter and making a number of other park upgrades to enhance recreation at the park.

**Black Hawk Lake** is a 922-acre natural lake in northwest Iowa that has experienced near constant blue-green algae blooms and extremely high phosphorus levels since monitoring data has been collected at the lake. Water clarity in the summer never exceeded 0.5 m. To better understand where nutrients and sediment were coming from and how to best restore the lake, a diagnostic and feasibility study was completed in 2010. A watershed project was also initiated in 2012 to help reduce nutrient and sediment loading from the watershed to the lake. To date, the watershed project has helped cut phosphorus and sediment inputs to the lake by about ten percent. Because

Black Hawk Lake is a shallow natural lake, internal loading was also a concern for this lake. To reduce internal loading, the fishery was chemically renovated in 2012, capitalizing on a historic drought and very low water levels. Prior to the renovation, the fishery was dominated by common carp and other rough fish that constantly disturbed the bottom sediments in the lake. Shoreline armoring was also completed in 2012 to protect the lake from shoreline erosion. Finally, fish barriers were constructed to prevent re-encroachment of rough fish into the lake and inlet wetland complex (see overall restoration timeline, Figure 6).

Following the fishery renovation, water clarity improved substantially (Figure 7). For the first time since the 1930s, macrophytes were documented in the lake. In addition to the fishery renovation, fish barriers, and shoreline protection work, an extensive dredging

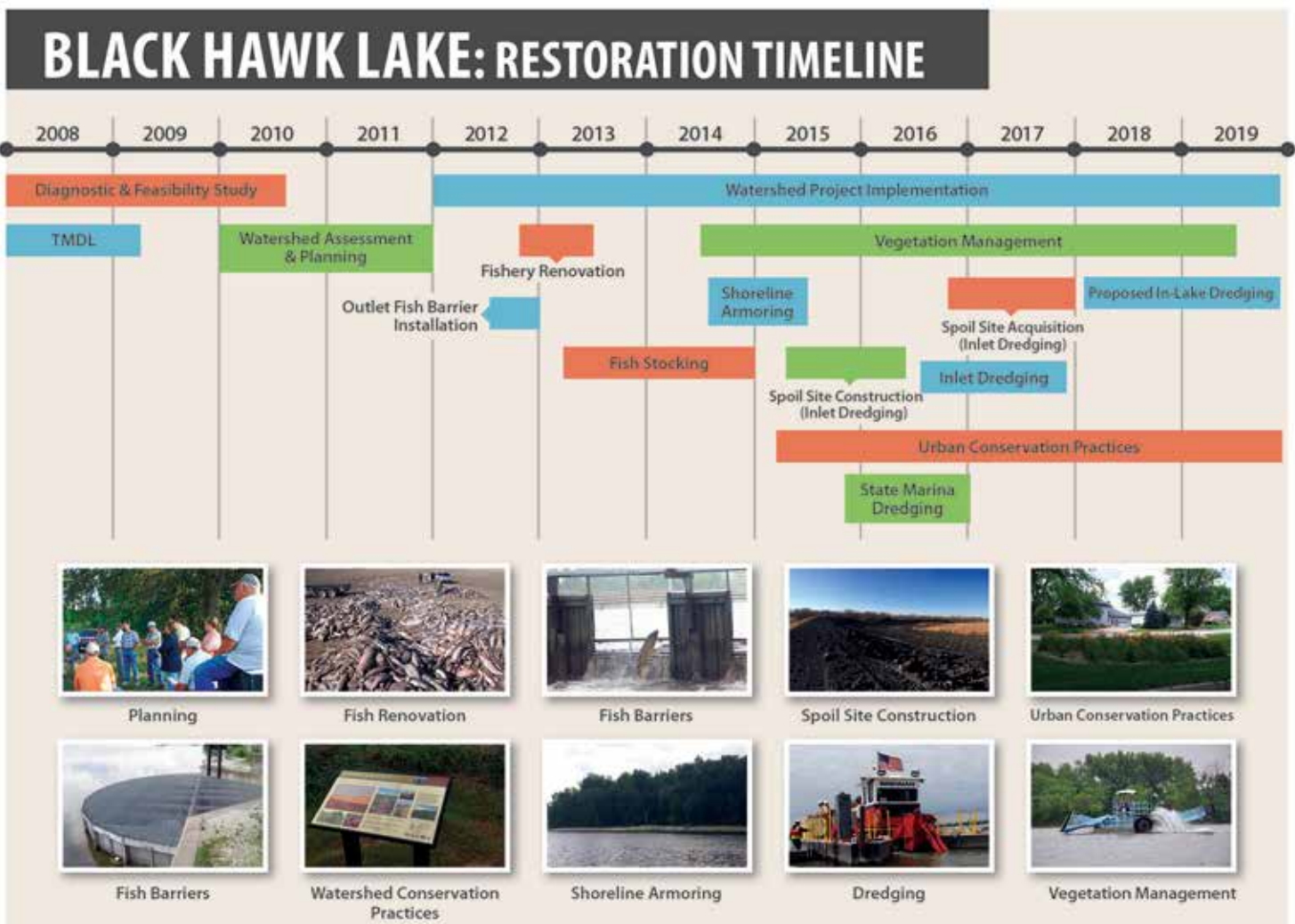


Figure 6. Restoration timeline for Black Hawk Lake



Figure 7. Pictures from the summers of 2012 (pre-renovation, top) and 2013 (post-renovation, below) at Black Hawk Lake.

project is underway to restore functionality and depth to the 162-acre wetland/inlet that is immediately upstream of the lake. By enhancing the wetland, it is estimated that the total annual phosphorus load to the lake will be reduced by 65 percent.

For additional information see:

Iowa's Lake Restoration Program: <http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Lake-Restoration>

CARD Lake Valuation Project: [http://www.card.iastate.edu/ag\\_policy\\_review/f15-lakes/#85](http://www.card.iastate.edu/ag_policy_review/f15-lakes/#85)

**Michelle Balmer** is an Environmental Specialist Senior with the Iowa Department of Natural Resources (IDNR) where she helps administer the Lake Restoration Program. She joined the IDNR in 2012 as the Lake Monitoring Coordinator and joined the Lake Restoration Program in 2015. She loves working at the intersection of applied science and community action to improve Iowa's waters for current and future generations. For questions about the program, you can reach Michelle at [michelle.balmer@dnr.iowa.gov](mailto:michelle.balmer@dnr.iowa.gov).



**George Antoniou** has been a Program Coordinator with the Iowa Department of Natural Resources in Des Moines, Iowa, since 2007. He is responsible for the administration of the Lake Restoration Program including identification of priority projects and working with local, state and federal agencies to implement restoration activities. George develops and oversees lake restoration projects that ensure a cost-effective investment for the State of Iowa; foster a community commitment to lake and watershed protection; and provide significant improvement to the quality of Iowa lakes. 🌱



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# Top-Down Water Quality Approach in Texas

Mark Ernst

In Texas, the lead water quality agency is the Texas Commission on Environmental Quality (TCEQ). It is responsible for standards, assessments, permitting, and TMDLs. The TCEQ used to do all the monitoring of designated water bodies, but in 1991 the Texas Legislature set up the Clean Rivers Program (CRP) with the goal of assessing and improving the state's water resources.

The Act authorizes the TCEQ to levy fees on wastewater and water rights permits to cover the expense of the program. Typically, the most developed and populous areas of the state, such as the Dallas/Fort Worth Metroplex, contribute substantial funding to the CRP. TCEQ then contracts with river authorities or regional entities to perform specific tasks within each river basin, mostly involving water quality. Fifteen regional water authorities (12 river authorities, 1 water district, 1 council of governments, and an international water commission) have contracts with the TCEQ to conduct water quality monitoring, assessment, and stakeholder outreach in the 23 major river and coastal basins of Texas. The Texas CRP program was allotted \$8.5 million (of State funds) for the FY16/17 biannual budget cycle. The CRP Steering Committee for each authority or entity serves as its guiding body, and suggestions from its members serve as the genesis for many of the special studies conducted within each river basin.

For example, in the Trinity River basin, the Trinity River Authority (TRA) serves as the contractor for this program and is funded by a grant from TCEQ with a FY16/17 biannual budget of \$786,500. Because of the size and breadth of the Trinity basin, TRA sought out partners to provide data for the CRP, which makes up the vast majority of the data used for the

biannual TCEQ water quality assessment. These partners work with the TRA to collect and submit quality controlled sampling data for reservoirs, rivers, and streams to the state's database. Last year, TRA field staff were responsible for adding approximately 1,700 discrete results to the database, while TRA's partners were responsible for more than 26,000 discrete results. The combination of the TCEQ, TRA, and partners allows for reasonable sampling coverage of all the designated segments in the basin.

One major partner is the Tarrant Regional Water District. The District owns four large reservoirs and uses three more in the north Texas area to supply raw water to numerous cities for them to treat and distribute to nearly two million people. The District has had a monitoring program for over 30 years that has served its mission of protecting and understanding its water sources, but since the initiation of the CRP, it has gone under the CRP's QAPP, added a few parameters and sites, and transferred data regularly to the TRA for review and submittal to the TCEQ for the statewide database. Participation in the CRP has been valuable to the District through data management, data quality control, some data analysis and graphing and the biannual assessment by TCEQ. Special projects funded by the CRP, such as a nutrient bioassay study, have also been useful. Annually the District spends about \$250,000 monitoring its reservoirs and major tributaries.

TRA hosts an annual coordinated monitoring meeting each spring to ensure that each of the assessments units within the Trinity River Basin are covered with monitoring and to ensure that multiple entities are not sampling the same locations. This allows for a pooling of

resources and sharing of data across entities. Additionally, TRA provides field and documentation training to ensure that the data is collected using approved, standardized methodologies so that data are comparable across entities.

For more information about the water-related duties of the Texas Commission on Environmental Quality, see: <https://www.tceq.texas.gov/waterquality/>.

**Mark Ernst** has worked for Tarrant Regional Water District in Fort Worth, Texas for 26 years. Maintaining a consistent surface water quality monitoring program on seven reservoirs covering over 100,000 surface acres has been the main priority. This effort has led to a good understanding of water quality trends, central tendencies and what can cause a change in water quality that might affect the boater/fisherman, water supply entity, or fish and wildlife. 🐟



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# An Overview of Lake Monitoring and Management in Colorado

Joni Nutle

## Introduction to Colorado Lakes

Lakes and reservoirs are important economic and aesthetic resources in Colorado. The state is home to more than 2,000 lakes and reservoirs. Approximately 75 percent are publicly owned and many of these provide recreational opportunities such as fishing and swimming and other public benefits such as drinking water supplies.

Colorado's topography varies greatly; lakes and reservoirs are found at elevations from 3,560 to greater than 12,000 feet above sea level. Lakes and reservoirs have many different characteristics, most notably natural vs. man-made origins. Natural lakes tend to be smaller and most are found at elevations above 9,000 feet (Nelson 1970). In Colorado, there are only 11 natural lakes larger than 50 surface acres. Reservoirs tend to be larger and are found at all elevations. Reservoirs have been constructed for water management since the 1880s, initially for irrigation storage and then for municipal uses (Knopf and Scott 1990). Many natural lakes have been modified to increase storage capacity and thus are managed more like reservoirs. Most waterbodies greater than 50 acres are reservoirs. Grand Lake, Shadow Mountain Reservoir, and Lake Granby, a lake and two reservoirs that are part of the Colorado Big Thompson Project are some examples of larger highly managed reservoirs (Figure 1). Many lakes and reservoirs are located in Colorado's 42 state parks. Approximately 150 lakes are located in Rocky Mountain National Park. Sprague Lake and Bear Lake are an example of the popular lakes in the national park (Figures 2 and 3). For the remainder of this article, "lake" will refer to both lakes and reservoirs.



Figure 1. Grand Lake Area, Colorado. Photo: used under license from Shutterstock, ©H. Sadura.

## Colorado's Regulatory Framework

The Colorado Department of Public Health and Environment – Water Quality Control Division (Division) is responsible for maintaining, restoring, and improving the quality of state waters. The agency implements and enforces regulations adopted by the Water Quality Control Commission (Commission) and assesses water quality of the state's surface waters. The Division provides technical expertise to the Commission for rulemaking and policy-setting activities. The Division administers state programs to implement the Federal Clean Water Act. The Clean Water Act protects the quality of Colorado's ambient water bodies – rivers, streams, lakes, reservoirs, and ground waters.

The Commission is the administrative agency responsible for assigning use classifications and adopting water quality standards that protect beneficial uses of

state waters. In addition, the Commission also adopts various regulations aimed at achieving compliance with the classifications and standards. Use classifications assigned to lakes and reservoirs include water supply, recreation, aquatic life, and agriculture. Lakes must be managed to protect all uses assigned. The Commission regulations and policies can be found at: [www.colorado.gov/cdphe/water-quality-control-commission-regulations](http://www.colorado.gov/cdphe/water-quality-control-commission-regulations).

The Division performs duties to protect Colorado surface waters. The environmental data unit provides surface water quality status and reporting services. The standards unit provides information, scientific analysis, and policy recommendations to the commission. The restoration and protection unit provides financial and technical support, collaboration, and planning services to support implementation strategies that



Figure 2. Otis, Hallett and Flattop Mountains seen from Sprague Lake in Rocky Mountain National Park, Colorado. Photo: used under license from Shutterstock, ©Kamenskiy.



Figure 3. Sunset at Bear Lake in Rocky Mountain National Park, Colorado. Photo: used under license from Shutterstock, ©cvm.

protect, improve and restore water quality. The Division's website can be found at: [www.colorado.gov/cdphe/categories/services-and-information/environment/water-quality](http://www.colorado.gov/cdphe/categories/services-and-information/environment/water-quality).

Colorado surface water quality classifications and standards regulations are basin-specific. That is, each set of

regulations addresses waterbodies in specific river basins (i.e., Arkansas River basin, Rio Grande River basin, etc.). These waterbodies include lakes, reservoirs, streams, and rivers.

In addition to surface water regulations, from 1984-1992 Colorado also adopted watershed protection control regulations for four reservoirs – Dillon

Reservoir (1984), Cherry Creek Reservoir (1985), Chatfield Reservoir (1989), and Bear Creek Reservoir (1992). Three of these reservoirs, Cherry Creek Reservoir, Chatfield Reservoir, and Bear Creek Reservoir are located in the Denver metro area. Dillon Reservoir (Figure 4) is located in the mountains of Summit County, Colorado. The control regulations for these reservoirs are essentially water quality implementation plans targeted at controlling eutrophication of the reservoir. Eutrophication results when excess nutrients enter a lake and stimulate a drastic increase in algae (algal bloom) that can lead to oxygen depletion when the algae die and decay, which can lead to fish kills and other problems. The strategy in the control regulations is to curtail algal growth by controlling nutrient loading to the reservoir. The control regulations grew out of USEPA Clean Lakes Program studies conducted during the 1980s. The Clean Lakes Program supported efforts by states to restore publicly-owned lakes. These reservoirs were considered to be at risk of eutrophication due to urban development and population growth.

Each control regulation is implemented by an active stakeholder association. Members of each association include cities, counties, and permitted point sources dischargers including wastewater treatment plant dischargers, and regulated stormwater dischargers. The Cherry Creek Basin Water Quality Authority implements the Cherry Creek Reservoir Control Regulation. The Chatfield Basin Authority implements the Chatfield Reservoir Control Regulation. The Bear Creek Watershed Association implements the Bear Creek Watershed Control Regulation and the Summit Water Quality Committee implements the Dillon Reservoir Control Regulation. Members of each association include cities, counties, and permitted point sources dischargers such as wastewater treatment plant dischargers and regulated stormwater dischargers.

These control regulations have been revised over the years. Initially, three of the four control regulations were based on numeric standards for total phosphorus. The Bear Creek Control Regulation was based on a narrative standard. Subsequently, the Water Quality Control Commission has adopted a numeric



Figure 4. Dillon Reservoir in autumn. Photo: used under license from Shutterstock, ©SNEHIT.

total phosphorus standard on Bear Creek Reservoir. The Commission also adopted numeric chlorophyll-*a* standards for all of these reservoirs.

In addition to the watershed control regulations lakes, several other lakes have active watershed groups working to protect water quality. For Barr Lake and Milton Reservoir, the Barr Milton Watershed Association implements TMDLs. A diverse stakeholders group worked to develop the Clear Creek/Standley Lake Watershed Agreement in 1993 that focuses on watershed water quality as it affects Standley Lake. Grand Lake, Shadow Mountain Reservoir and Lake Granby have many watershed stakeholders. Colorado is fortunate to have numerous water quality partners to address water quality in lakes and rivers.

### Colorado's Lake Monitoring and Assessment Program

The division maintains a lake monitoring program to support water quality assessment. The division spends approximately \$35,000 on the program annually. This represents 6.3 percent of the total surface water monitoring budget. Most of the surface water monitoring program money is spent on water quality analysis. Remaining money is spent on equipment maintenance. Information on the lake monitoring

program can be found at: [www.colorado.gov/cdphe/lakes-monitoring](http://www.colorado.gov/cdphe/lakes-monitoring).

The lake monitoring program produces data used for several purposes. The division determines if lakes are meeting their designated uses and standards by comparing water quality measurements against applicable water quality standards. If standards and uses are not met, a lake is identified as

impaired on the state's 303(d) List of Impaired Waters. Seventy-seven lakes are on Colorado's 303(d) list (Figure 5).

For impaired lakes, already identified on the 303(d) list, monitoring data are used to validate the listing or to support de-listing. The state is required to develop Total Maximum Daily Loads (TMDLs) for waterbodies on the 303(d) list and monitoring data support the development of TMDLs. The lake monitoring program also provides data to evaluate the trophic status of Colorado lakes. Finally, monitoring data are used to develop new water quality standards (e.g., nutrient criteria), or help anticipate needs for new standards (e.g., emerging contaminants).

The lake monitoring program operates on a five-year rotation with sampling focused in the river basins of one quadrant of the state for a given year. No distinction is made between lakes and reservoirs in the design of the sampling program. Lakes are prioritized for the following reasons: (1) if the lake provides insight into water quality trends in the basins, (2) if the lake is on the monitoring and evaluation list, and (3) if the division has little or no data from a lake. The division then selects approximately ten lakes from the basins of focus to sample three times each during the growing season of July to September. Additionally, in late August, the division conducts one sampling event on 10-15 lakes from the

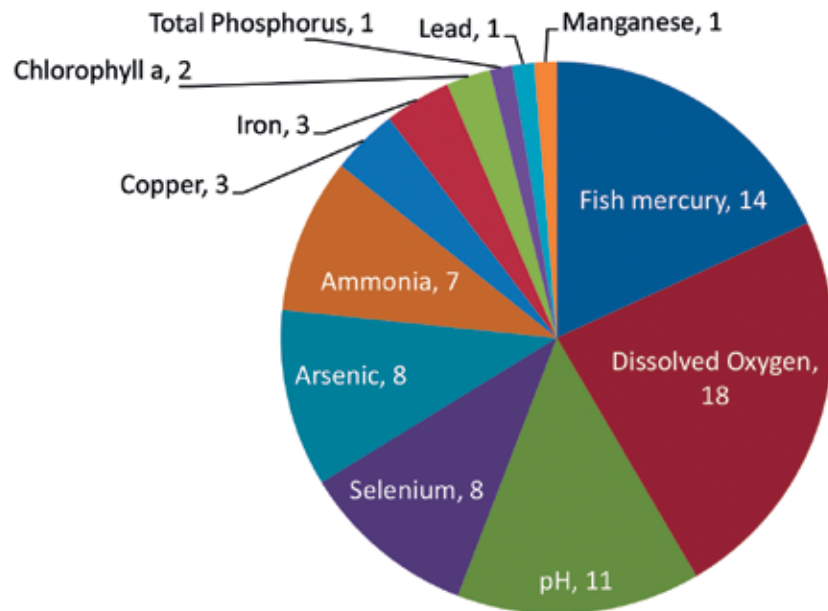


Figure 5. Number of lakes listed as impaired by parameter (Colorado 303[d] List of Impaired Waters).

basins in the next quadrant to help with site selection the following year. The fifth year is used to collect supplementary data from lakes across the state where water quality issues are suspected and provide time to focus on special projects.

The monitoring program collects several kinds of data from each lake. Vertical profiles of temperature, dissolved oxygen, pH, and specific conductance are measured at one-meter intervals. Water quality samples are collected from near the surface and near the bottom. These samples are analyzed for a suite of chemical parameters including nutrients, metals, and inorganics. The surface sample is also analyzed for chlorophyll-*a* content and phytoplankton composition. The Division collaborates with EPA to conduct limited cyanotoxin testing.

The division also assesses water quality data collected through partner monitoring programs. These partners represent water providers, municipalities, watershed-based water quality authorities, associations, forums, and other state and federal agencies. There are various other entities that conduct routine monitoring of publicly owned reservoirs including the U.S. Geological Survey, the U.S. Army Corps of Engineers, Denver Water, and others such as cities, regional councils of governments and river basin associations. Many are members of Colorado Lake and Reservoir Management Association (CLRMA) and the North American Lake Management Society (NALMS).

As reported in Colorado's 2016 Integrated Water Quality Monitoring and Assessment Report, Colorado has assessed 59 percent of its lake acres for at least one use. Over the past 20 years, Colorado has monitored 98 lakes.

### Colorado Funding Assistance Program


There is no targeted funding program for lakes in Colorado. However, Colorado has a Nonpoint Source (NPS) Program that provides funding, primarily from Federal Section 319 grants, for watershed planning, targeted TMDL development, best management practices (BMPs) implementation, and specific monitoring activities, all of which help to evaluate and control nonpoint sources of pollution. For many years, these funds have played an important role in addressing nonpoint source impacts to lakes throughout the

state. For example, nonpoint source funds were used to develop watershed plans for Chatfield Reservoir, Barr Lake, and Milton Reservoir. These plans prioritized nonpoint source actions necessary to help protect and restore lake water quality. Nonpoint source funds also supported development of a TMDL for Barr Lake, and Milton Reservoir and the funds were used for mercury monitoring on Horsetooth and Elkhead Reservoirs in support of statewide mercury TMDL development. TMDLs are foundational for understanding the pollutant reductions necessary to ensure lakes meet water quality standards. NPS funds have also been used for BMP implementation to address nonpoint source pollution impacts to lakes from impaired waterbodies in watersheds throughout the state. These funds also support monitoring in National Water Quality Initiative watersheds that are impacted by nutrients. In particular, NPS Program funds have helped increase understanding about the effectiveness of agricultural conservation practices in reducing nonpoint sources of nutrients impacting DeWeese Reservoir.

Colorado division staff and lake management partners will be happy to discuss Colorado lakes at the 2017 North American Lake Management Society Symposium in Denver, Colorado.

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## LAKE and RESERVOIR MANAGEMENT

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# Lake Management in Ontario

Gordon Miller

Ontario is a large jurisdiction in North America that spans terrain of vastly different bedrock and surficial geology and includes hundreds of thousands of inland lakes. These lakes are generally of excellent water quality and have a high recreational value to Ontario citizens and the many visitors they draw each year. Managing these lakes has always been a challenge due to the magnitude of the task but sincere and largely successful efforts have been made over the last 60 years and continue. This article will attempt to summarize and characterize those efforts.

Ontario also has watershed responsibility on the Canadian side of four of the five Great Lakes, but management of the Great Lakes involves quite a different and more complex ecology and policy structure. Management decisions are influenced by authorities in two federal governments, two provinces, and eight states. As a result, Ontario's role in Great Lakes management will not be discussed here.

## Lake Management Policies in Ontario

Lake management policy started with the Ontario Water Resources Act (OWRA) in the 1950s, which created the first clear prohibition of water pollution and established policy authority to regulate water takings. As our understanding of watersheds and aquatic ecosystems developed, a more comprehensive approach to environmental management was needed. That came with the passing of the Environmental Protection Act (EPA) in 1972. Originally the intention was to replace the OWRA with the EPA but powerful wording in the pollution prohibition that had been

included in the OWRA during optimistic post-war years could not be duplicated in the more wary legislature of the 1970s so both statutes remain in effect to this day.

Those two pieces of legislation still form the foundation of the policies and programs that are in place relating to the management of lakes in Ontario. Periods of austerity have resulted in contractions and setbacks over the years but the long-term trend has been toward increased sophistication. Much of the enhancement of the policy regime over the years usually has been focused on a particular environmental problem or a challenged geographic area.

Examples of the former include the Nutrient Management Act that regulates the management of agricultural manure and other residues, the ban on residential and municipal use of cosmetic pesticides, and the Toxics Reduction Act, which focuses on reducing the industrial use of toxic substances. All of these policies seek to limit or remove the opportunity for polluting substances to find their way into watercourses.

Water quality challenges in various geographic areas of the province have arisen over the years as recreational and more recently residential development encroaches on the watersheds of inland lakes. There have been various responses in land use planning and environmental policy but state-of-the-art in Ontario is represented by the comprehensive and sophisticated approach to protecting and remediating Lake Simcoe. Decades of monitoring and attempts at watershed management have evolved into the Lake Simcoe Protection Act and the Lake Simcoe Protection Plan.

In addition to these policy approaches, The Clean Water Act requires communities to protect the quantity and quality of their drinking water sources through science-based source water protection plans. For communities drawing drinking water from lakes this results in certain restrictions and prohibitions in land use in the proximity of the intake.

## Overview of Assessment Activities

Monitoring and assessment of the water quality of the vast number of lakes in Ontario has always posed an almost insurmountable challenge. Wide-scale monitoring has been going on for more than 50 years, but despite these efforts knowledge of the state of the lakes overall is limited. Although much of the populated south has been well studied, data in the lakes of the Canadian Shield are spotty and only in recent years has there been an attempt to develop baseline water quality and environmental information in what is termed the Far North ahead of industrial development. The Far North includes the great stretches of peat lands in the lowlands draining to Hudson and James Bay.

The solution to this conundrum of an unmanageable number of lakes has been to form a variety of partnerships and work on two geographic scales. At the broad scale, the Ministry of the Environment and Climate Change (MOECC) through its Dorset Environmental Science Centre (DESC) coordinates many monitoring partnerships involving the federal government, other provincial ministries, conservation authorities, municipalities, academic institutions, cottage and

environmental organizations, industry, First Nations, and volunteers. The best known is the Lake Partners Program, which has run for many decades and currently samples nearly 550 recreational lakes across Ontario.

In another broad-scale monitoring program, the DESC analyzes water samples collected from over 800 lakes as part of a fisheries management initiative of the Ministry of Natural Resources and Forestry (MNR). The sampled lakes range from being within 100 km of Lake Erie in the south to the same distance from Hudson Bay in the north resulting in the most representative data set to characterize Ontario lakes overall. Frequency graphs of these data for total phosphorus, dissolved organic carbon, calcium, and chloride are publicly available.

Another well-known broad-scale monitoring program is the *Guide to Eating Ontario Fish*, which has been published annually since 1977 by the MNR and MOECC. Although marketed as a public health service, the data from fish tissue samples collected in hundreds of lakes provide a long-term monitoring of metals and organic contaminants that bioaccumulate through the food chain.

To supplement the information provided by broad-scale monitoring, more geographically focused and frequent monitoring and more advanced scientific analysis is conducted in a number of areas of the province. At the center of these efforts is the DESC, which has for 40 years, intensely monitored lakes in central Ontario, including some fully calibrated watersheds where detailed geochemical modelling was undertaken. DESC is perhaps best known for its trailblazing acid precipitation research during the 1980s, but it continues to be a leading scientific center for lake research and limnology.

The aforementioned Lake Simcoe Protection Plan is another excellent example of focused lake management. Lake Simcoe has been the center of concern for many years because of eutrophication primarily from agriculture and loss of its lake trout fishery due to water quality, over-exploitation, and invasive species. But the recent encroachment into the watershed of urban sprawl from the south has given rise to the political will and available

funding to implement a serious effort at rehabilitation, which includes a Lake Simcoe Phosphorus Strategy with a target to reduce phosphorus levels by 40 percent.

In the far west of Ontario there is a multi-agency and civilian collaboration regarding the water quality of the Rainy River/Lake of the Woods basin. The coordinated monitoring and research is published in *State of the Basin Reports*. The pooling of expertise and resources allows for much more comprehensive analysis of watershed issues, including the ongoing effects of climate change.

Another collaboration facilitating lake monitoring and research is the Muskoka Watershed Council in south-central Ontario. The partnership pools the resources of the District Municipality of Muskoka and the DESC and produces a Muskoka Watershed Report Card that reports broadly on environmental conditions in the watersheds of a large area of the granitic Canadian Shield. A limnological problem of particular concern in this area is the decline in calcium concentrations to critical levels due to acid deposition, timber harvesting, and timber regrowth.

The Experimental Lakes Area in northwestern Ontario is well known for its pioneering research in the role of phosphorus in eutrophication, acid rain and lake acidification, and the deposition and movement of mercury in watersheds among other accomplishments. For many decades it was operated by the federal government of Canada, but in 2012 the government of the day defunded and attempted to close the facility. The Province of Ontario intervened with funding along with private donors and the facility was placed in the control of the International Institute for Sustainable Development. It is one of few locations that allow for whole-lake experimentation to be carried out in controlled conditions.

### **Funding of Watershed and Lake Management**

Because of the collaborative and decentralized approach that has developed in watershed and lake management in Ontario it is difficult to provide information on expenditures made to support this activity. The MOECC spends approximately \$8.5 M per year on lake management. This includes activities such

as the monitoring of water quality, biota, and land use activities to assess aquatic ecosystems, as well as management initiatives, and volunteer partner programs to assess water quality. However, there is no spending estimate for the significant contributions other ministries and other agencies and volunteers as the costs of their participation is distributed throughout various parts of their operations.

There are no formal provincial level programs for shoreland protection, aquatic weed control, sediment control, and watershed best management practices but those activities are often undertaken locally by watershed management organizations known as Conservation Authorities (CAs), of which there are 36 in Ontario. The CAs are chartered by provincial legislation but most of their funding comes from the municipalities in the watersheds they manage. Periodically, provincial or federal grant money is made available for local lake or watershed initiatives subject to application and review.

### **Website Citations to Program Information and Data**

The numerous studies and information sources referred to in this article are summarized in further detail along with links to reports and websites in the MOECC report entitled *Water Quality in Ontario 2014 Report* (<https://www.ontario.ca/page/water-quality-ontario-2014-report>).

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## Top-down Regulation of Algal Blooms: Pathogens as a Potential Whole Lake Biological Control Measure?

### Background

Phytoplankton are responsible for over half of Earth's primary production and thereby play an important role in the cycling of carbon and nutrients in both marine and freshwater ecosystems. Traditionally, grazing has been seen as the most important phytoplankton mortality factor. Although already observed and documented some decades ago (Van Donk and Ringelberg 1983), it is only recently that parasites are being generally acknowledged for having a share in plankton mortality as well. Parasitism is the most common lifestyle on earth, but only in recent times there has been a call for the inclusion of these infectious disease agents in food web research and models (Lafferty et al. 2008). For phytoplankton, the most common pathogens are fungal parasites (chytrids) and viruses, which can infect up to 90 percent of the total host community, and are the most common biological agents in both freshwater and marine ecosystems. In the field, chytrids and viruses can reach densities between 1 and 10 billion counts per litre. Here, I will focus on the potential role of chytrids, a common fungal parasite in phytoplankton communities, in controlling algal blooms.

### The Role of Chytrids in the Food Web

Hilda Canter-Lund, one of the pioneers in plankton research, frequently encountered planktonic diatoms infected by chytrids when performing algal counts. Actually, most of the planktonic diatoms she came upon were found to be infected by these host-specific parasitic fungi. This indicates that most species potentially have a parasite able to infect them. Chytrids have been shown to be highly

infective and extremely virulent. The free-swimming zoospores are the main dispersive agent of the fungus (Van Donk and Ringelberg 1983), which actively searches for new hosts using chemical cues released by the phytoplankton. Once a host is found and infected, a sessile stage (sporangium, Figure 1) is formed in which new zoospores are produced. Chytrid infections in most cases kill their hosts. Thereby they can control host populations, delay timing and size of the phytoplankton bloom, and lead to an altered seasonal species succession (Van Donk and Ringelberg 1983; Frenken et al. 2016). Research has shown that fungal zoospores are an excellent food source for *Daphnia*, and upon zooplankton grazing, fungal infections

can be significantly decreased. When large celled phytoplankton species are infected by chytrid parasites (Figure 2), nutrients within host cells are transferred to zooplankton via the fungal zoospores (Kagami et al. 2007).

### Global Warming and Eutrophication

In the scope of global warming and eutrophication, available evidence indicates that ecological changes are expected to amplify infectious diseases. Earlier studies have outlined the existence of a disease-free window of cold water in winter that creates an opportunity for phytoplankton to build up a bloom when chytrid development is still inhibited by the low lake water temperatures ( $<3^{\circ}\text{C}$ ). During cold conditions, not only is



Figure 1. Example of a chytrid infection, with sporangia at both ends of a filament of *Planktothrix rubescens* (scale bar length equals 50  $\mu\text{m}$ ).

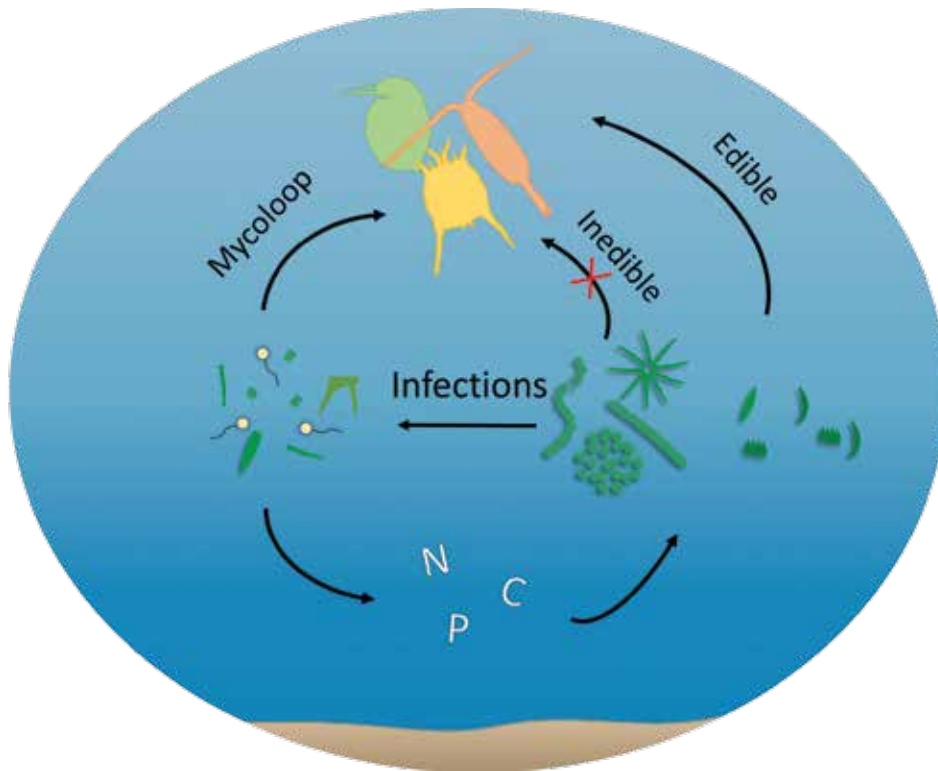


Figure 2. The mycoloop: grazing by higher trophic levels on fungal zoospores liberated after infection of large celled phytoplankton species.

chytrid development time increased, also its expected lifetime is reduced. Due to global warming, the periods in which water temperatures remain low will be less frequent, decreasing the window of opportunity for uninfected growth (Ibelings et al. 2011). Additionally, warming is known to accelerate fungal parasite infections, which have been shown to terminate algal blooms (Frenken et al. 2016).

Regarding cultural eutrophication, usually the ratio between nutrients in catchment runoff is unbalanced. This ultimately forces phytoplankton growth into a limitation by nitrogen or phosphorus. These changes in the availability of nutrients will lead to a change in the nutritional quality of phytoplankton, and can change the availability of nutrients to the chytrids as well. Because chytrids are very susceptible to phosphorus limitation (Bruning 1991), nutrient-limited environments might impede chytrid proliferation. Overall, we can expect that top-down pressure by parasites is expected to increase in the future as a result of global warming and eutrophication.

### Biological Control

The goal of biological control is to reduce or mitigate pests. In the case of algal blooms, the goal is to eliminate large-scale blooms using natural enemies of the target species. Because chytrids are very efficient at reducing host populations, they could represent a novel way to mitigate harmful and/or noxious algal blooms. However, practical applications may be hampered for several reasons. One reason can be host specificity of the chytrids. Chytrids can be highly host- (or genotype-) specific. Because most blooms consist of a mixture of genotypes from the same host or of different species, the efficiency of using chytrids in this scenario might be limited. Yet, some chytrids have a very broad host range. Thus, when the amount of host genotypes in a bloom are limited or chytrids with a broad spectrum are used for infection, applying chytrids might be a feasible biological treatment to control algal blooms. In lakes with high densities of zooplankton, the potential for using chytrids as a biological control might be limited, because zooplankton could graze away the fungal zoospores of the parasite. Therefore, in lakes with high densities of

planktivorous fish, the potential for using chytrids as a biological control measure might be highest, because zooplankton populations can be controlled by the presence of fish.

Besides chytrids, viruses and pathogenic bacteria also might have a potential to be used as biological control measures to mitigate blooms. But, managers will need to find efficient ways to produce large amounts of pathogens first to enable the application of pathogen treatments on a whole lake basis. The amount of experiments testing the possibility to use pathogens of phytoplankton to control blooms is currently limited to laboratory studies and a large-scale mesocosm experiment. In my research, I focus on how eutrophication affects the infection mechanisms of chytrids, and test if their success rate changes during different nutrient loading scenarios. This might help us to predict the presence and behaviour of chytrids in the future, when nutrient loading of aquatic systems will change. Also, experiments are currently being performed where zooplankton are exposed to either healthy or infected cultures of phytoplankton, from which we can conclude the indirect effect of chytrid infections on the reproduction and population growth of zooplankton.

### A Large-scale Mesocosm Case Study on the Termination of Algal Blooms by Pathogens

In 2007, a Chinese research group, Central China Normal University\*, isolated pathogenic bacteria (Actinomycetes) that produces chemical compounds that are able to kill the notorious bloom-forming blue-green algae *Microcystis*. These pathogens were cultured in a relatively large-scale (~10,000 Litre) fermentation tank, where after they were dried and applied as a powder to a 1,000 m<sup>3</sup> enclosure in lake Dian-Chi, famous for its noxious *Microcystis* blooms. The bloom was ended three days after the single-dose treatment (Figure 3). This shows that it may be possible to use pathogens to control cyanobacterial blooms.

\*For more information, contact Dr. Kai Cheng at [chengkaicn@163.com](mailto:chengkaicn@163.com).



Figure 3. Enclosures in lake Dian-Chi, China. On the left, a control enclosure, and on the right, an enclosure to which the pathogen was added.

### Synthesis

To our knowledge, chytrids have never been used as a biological control measure. Before applying these pathogens to natural systems, much more research is needed to fully understand their infection mechanisms and how these interact with other trophic levels in aquatic systems. Experiments that investigate effects of pathogens usually focus on the host-parasite interaction, and not on the effects on the rest of the ecosystem and other organisms therein. Although we expect that the upcoming role of pathogens in controlling algal blooms will intensify, the practical applicability with our current knowledge is still limited.

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## Next Issue – Spring 2017 *LakeLine*

The theme of our spring 2017 issue will be “PAH Sources to Lakes”. Polycyclic aromatic hydrocarbons are a group of chemicals created by heating or burning material that contains carbon. The many sources of PAHs to the environment include asphalt, tire particles, used motor oil, and especially coal-tar-based sealcoat. PAHs are an environmental concern because many cause cancer, mutations, birth defects, or death in fish, wildlife, and invertebrates.



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June 2016—Semi-automated Analysis with 48 hr. turnaround



# 37<sup>th</sup> Annual Symposium of the North American Lake Management Society



# Finding Balance

November 6 – 9, 2017 - The Westin Westminster



After 26 years, Colorado welcomes NALMS back to the headwaters state. Colorado is home to thousands of both natural alpine lakes and reservoirs. We are proud of our mountains and appreciate the importance of our lakes and reservoirs.

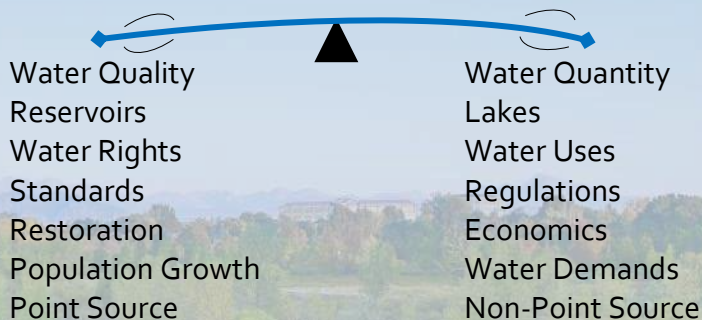
Water in Colorado is used for fishing, drinking, farming, rafting, camping, mining, ranching, boating, brewing, and much more. All of these uses are supported with a stateside annual average rainfall of just 17 inches. The lakes and reservoirs throughout the West and the Rockies provide the resources to meet these diverse needs. Finding balance in how we manage them is important.

**Finding Balance** is key to managing our lakes, watersheds, and even day-to-day relationships with people. Come to Colorado in 2017 to, hear fascinating lake talks, drink great beer, see the Rocky Mountains, and to achieve balance in managing your lakes and reservoirs.

## Potential Topics

- |                             |                      |
|-----------------------------|----------------------|
| Reservoir Management        | Harmful Algal Blooms |
| Drinking Water Treatment    | Beer-sheds & Brewing |
| Arid West Issues            | Invasive Species     |
| Inter-basin Water Transfers | Western Water Law    |
| Watershed Management        | WQ Monitoring        |
| Climate Change Impacts      | Citizen Science      |
| Storm Water Impacts         | Agricultural Uses    |
| Wildfire Impacts            | Case Studies         |

## Finding Balance



Propose a session or topic that interests you! Call for papers will be available at [nalms.org](http://nalms.org) January 2017



For sponsorship or general information, contact NALMS: [nalms.org](http://nalms.org), 1-608-233-2836  
For other details, contact conference co-chairs Steve Lundt or Jean Marie Boyer at [ColoradoLRMA@gmail.com](mailto:ColoradoLRMA@gmail.com)