East Alaska Lake, Wisconsin

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The Path to a Successful Lake Restoration

Beginning the Process with Baseline Studies and Creating a Management Plan

East Alaska Lake is a 53-acre drainage lake located less than 1.5 miles from the shores of Lake Michigan in Kewaunee County, WI. In the late 1990s, spurred on by poor lake health as shown by frequent and severe algal blooms, the Tri-Lakes Association was created by a group of concerned citizens. Within a year of its creation, the association teamed with town officials, hired a consultant, and successfully applied for a Wisconsin Lake Management Planning Grant to help fund the creation of a management plan for East Alaska Lake. The management planning project, which focused upon the lake's water quality, aquatic plants, and watershed, was completed in 1999 (NES 1999).

The studies associated with that first planning project confirmed the concerns over poor water quality raised by East Alaska Lake stakeholders, including eutrophic conditions brought on by high nutrient levels that resulted in frequent pelagic and filamentous algae blooms (Figure 1). Documentation of the lake's poor water quality conditions continued into the 2000s with summer phosphorus levels often exceeding 0.030 mg/L, which is higher than the median value of 0.017 mg/L for deep, headwater drainage lakes in Wisconsin (WDNR 2009).

While Wisconsin is home to some of the most beautiful lakes in the world, it is also known as the *Dairy State* for a reason. So, finding an unnaturally productive lake in one of Wisconsin's farm-rich eastern counties is about as easy as finding a dairy cow in that same area. In fact, Kewaunee County is second only to its neighbor, Brown County, for supporting more concentrated animal feeding operations (CAFOs) than any county in the state. With intense agriculture comes high levels of nutrient loading to lakes, rivers, and streams; therefore, the easy answer to East Alaska Lake's water quality woes must have been agricultural runoff – right? Well, this really wouldn't be much of a story if it were just that easy.

While dairy-related agriculture unquestionably played a role in the deterioration of East Alaska Lake over the years, run-off from agricultural lands was not the primary source of nutrient pollution, like so many other lakes in this area of Wisconsin. In fact, during the late 1990s when the first planning studies were being conducted, less than 15 percent of the land in the lake's 325-acre watershed was in agricultural row crops. Furthermore, all of that acreage drained through the upstream West Alaska Lake, reducing the phosphorus content through sedimentation, before it reached East Alaska Lake.

The 1999 studies suggested that East Alaska Lake's unexpectedly high phosphorus concentrations were not only brought on by external sources that were impacting the lake at the time, but also by the latent affects of historical sources,

Figure 1. Algae bloom on East Alaska Lake. Photo by Patrick Robinson.

many of which were curbed years before. One intense impact was runoff from a sizeable farm's feedyard that drained directly to the lake for decades and was finally diverted to a concrete manure storage facility in 1995. An additional significant phosphorus source impacting the lake until approximately 1960 was wash water and whey discharge from an adjacent cheese factory that entered the lake only after flowing through an inline settling tank and gravel filter. And during the mid-1990s, county staff investigated many of the private onsite wastewater treatment systems (POWTS) on East Alaska Lake. Of particular interest were 16 homes along the southern basin of the lake, the majority of whose POWTS were found to be failing. With the exception of two, all of these systems were replaced with a holding tank within five years.

The 1999 management plan contained four water quality-related recommendations; (1) divert two stormwater discharge pipes draining a section of county highway to an adjacent ditch and downstream wetland, (2) create a nutrient and pesticide management plan for a golf course partially draining to the lake, (3) create a sedimentation basin to intercept and treat water being discharged to the lake by an agricultural drain tile, and (4) investigate the significance of internal loading on the lake's phosphorus budget. The latter recommendation was prompted by the historical nutrient loading impacts to the lake, the lake's long retention time of just over a year, and high hypolimnetic phosphorus values exceeding 300 µg/l.

Implementing the Plan and Learning More

The first two recommendations were implemented immediately following the completion of the lake management plan, while the second two, being more complicated and costly, took a bit more time. In 2004, the Tri-Lakes Association received a second and a third grant from the State of Wisconsin to complete studies to quantify the phosphorus loading to the lake through its inlet from West Alaska Lake, the agricultural drain tile described above, and internal nutrient loading (Onterra 2005). The project design was essentially an alum treatment feasibility study for East Alaska Lake. These studies indicated that while both the inlet and the drain tile each delivered approximately 57 lbs of phosphorus to the lake annually, the impact of the drain tile was more severe because basically no flushing of the lake was associated with the drain tile phosphorus input as it discharged only 6 percent of the flow delivered by the inlet. Mass-balance modeling of spring, summer, and fall in-lake phosphorus concentrations indicated that the lake could potentially be receiving over 280 lbs of phosphorus annually via internal loading. While this estimate was believed to be an exaggeration, it was still considered a strong indication that internal loading was a significant source of phosphorus fueling the lake's production.

Although the 2004 studies confirmed internal loading to be significant in East Alaska Lake, the resulting report stopped short of recommending an alum treatment because of the unchecked drain tile load and continued uncertainties associated with impacts of lakeshore POWTS. Instead, it recommended additional septic system inspections and reiterated the need for a sedimentation basin for the treatment of the agricultural drain tile discharge.

The Tri-Lakes Association followed through on the recommendations stated in the report and in 2006, with assistance from Kewaunee County and the US Fish and Wildlife Service, completed construction of a 1-acre sedimentation basin on the lake's west shore to treat water entering the lake from the agricultural draintile. Furthermore, in 2007 the association prompted the county to inspect all POWTS around the lake, with the inspections resulting in 11 corrective actions.

Over the course of a decade, the Tri-Lakes Association, with help from private consultants and town, county, and state agencies, discovered that the lake's poor water quality was not only brought on by existing external loads, but also by the on-going affects of historical external loads that had been shut off years earlier. The association worked to minimize the remaining external loads and by the mid-2000s, had met its objective, leaving only internal phosphorus loading as the primary culprit impacting the lake's health. At that point, the association set out to implement an alum treatment on the lake.

An Alum Treatment Plan is Developed

Following the minimization of external loads the Tri-Lakes Association, in 2010, applied for and received its fourth grant from the State of Wisconsin to fund the development of an alum treatment plan for East Alaska Lake to inactivate sediment phosphorus. The project entailed the extraction of sediment cores to develop an alum dosing plan for the lake, the creation of a cost estimate for the alum application and subsequent water quality monitoring, the presentation of the plan to the association and surrounding community, documentation of their support, and development of a fifth and final grant application to fund the treatment.

During the summer of 2010, Wisconsin Department of Natural Resource (WDNR) researchers extracted sediment cores from eight locations within East Alaska Lake (Figure 2). The sediment cores were delivered to Bill James of the U.S. Army Corps of Engineers Eau Galle Aquatic Ecology Laboratory in Spring Valley, Wisconsin and were analyzed for different fractions of sediment phosphorus. The core analysis results indicated that under anaerobic conditions, all of the sites released phosphorus to the overlaying water with the rates ranging from 0.7-11.5 mg/m^2-day. The sediments from the northern basin had the greatest release rates, yet the sites in the southern basin also exhibited significant release. The alum treatment would target two fractions of phosphorus found within the sediment: loose-P, and Fe-P. Loose-P is essentially phosphorus that is loosely bound to other chemicals or particulate matter. Fe-P is iron-bound phosphorus. Together, these two phosphorus fractions are considered Redox-P, or the phosphorus fraction that is susceptible to being released from the sediment into overlaying waters during anoxia.

Based upon the sediment core analysis, the application plan was to dose the areas of the lake with depths equal to and greater than 10 feet (33.0 acres) at a rate of 132 g/m^2 Al. Following advice provided by Sweetwater Technologies, the contractor chosen to complete the alum application, the treatment area was expanded to include the bottom area between the depths of 5-10 feet (7.6

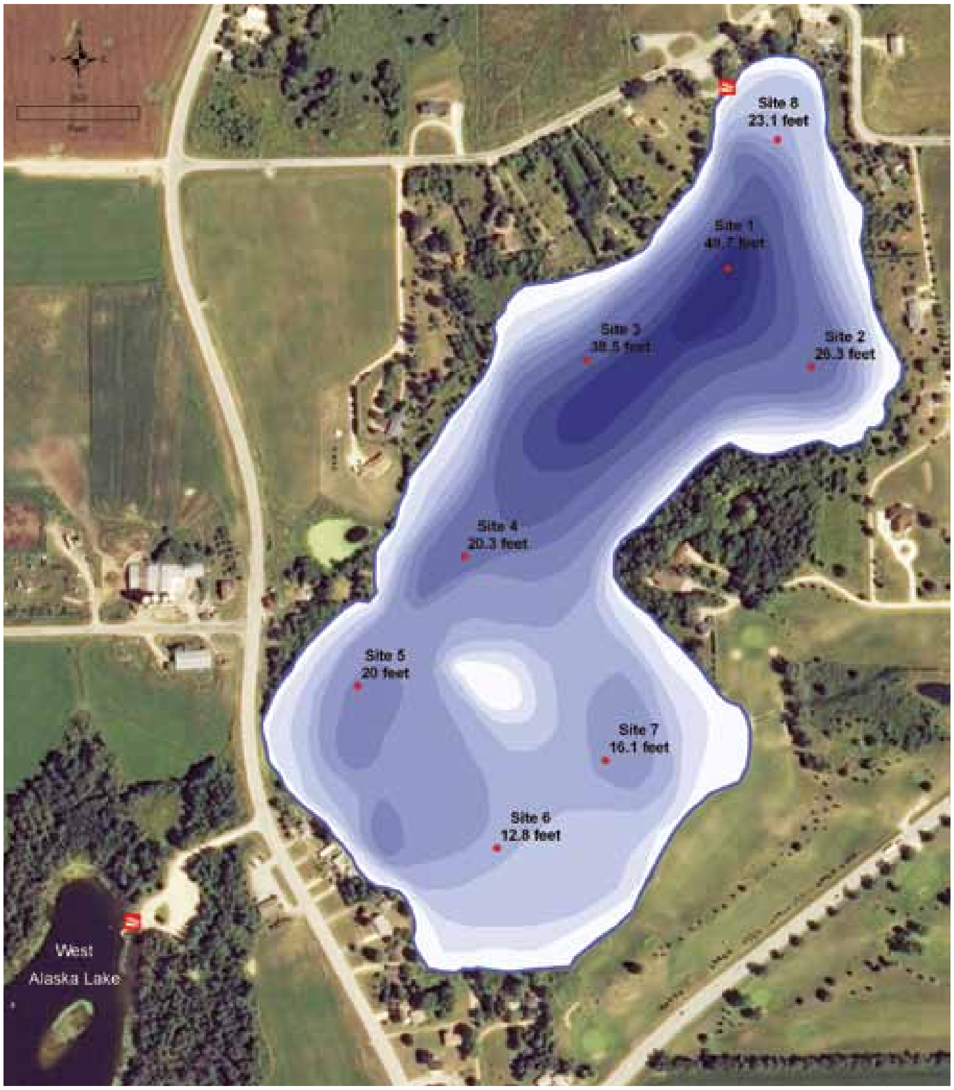


Figure 2. Sediment coring sites at East Alaska Lake. The results of the phosphorus fraction analysis on the core samples lead to the determination of the alum dose used to restore the lake.

acres) at a moderate dose of 40 g/m^2. The treatment of depths between 5-10 feet was selected in order to reduce filamentous algae growth, which frequently reaches nuisance levels in East Alaska Lake and is a primary concern of lake stakeholders.

In early spring 2011, the alum treatment plan and cost estimate of $165,000 was presented to the members of the Tri-Lakes Association and interested members of the community. However, before that meeting, two press releases were published in local papers describing the issues on East Alaska Lake, disclosing the possible use an alum treatment and announcing the public meeting. In addition to the newspaper exposure, area residents were provided with a factsheet outlining the risks of implementing an alum treatment and how those risks would be minimized if the treatment were to move forward on East Alaska Lake. As a result, the community was prepared for what they were going to hear at the meeting and achieving their buy-in was assured.

The Tri-Lakes Association voted unanimously to proceed with the alum treatment. By mid-summer, the association was notified that their fifth grant application was successful and they would receive 75 percent funding from the State of Wisconsin to complete the alum application and post treatment monitoring.

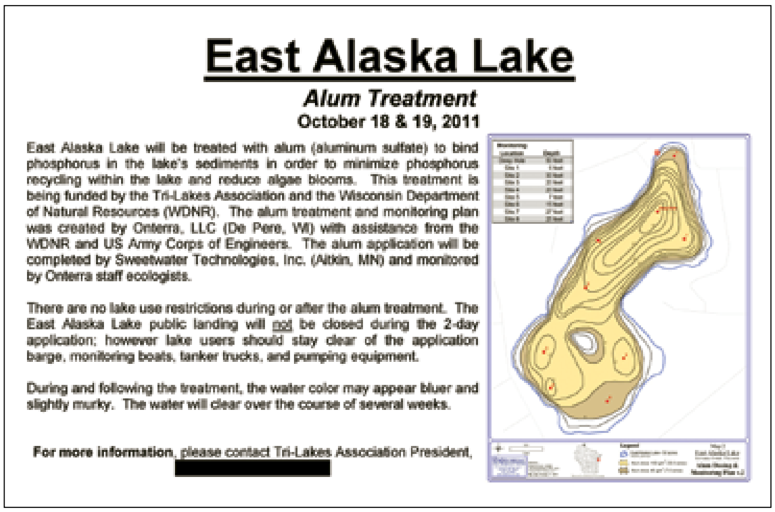
The Alum Treatment is Implemented

After 20-plus years of study and planning, the East Alaska Lake alum treatment was implemented in mid-October 2011 and included the application of nearly 84,000 gallons of aluminum sulfate over a two-day period (Figure 3). It is quite a spectacle to have a 24-foot stainless steel barge with a 60-foot boom span sweep back and forth across a 53-acre lake. Add in a constant convoy of tanker trucks bringing aluminum sulfate to the lake's small landing and the characteristic milky turquoise appearance of the lake water during application (Figure 4) and you have something people are likely to go out of their way to see.

In anticipation of this possibility, the WDNR notified local news outlets

Figure 3. Barge applying alum to East Alaska Lake during October 2011.

Figure 4. Treatment monitoring crew on East Alaska Lake. Notice the milky turquoise water resulting from the alum treatment occurring that day.



East Alaska Lake

Alum Treatment

October 18 & 19, 2011

East Alaska Lake will be treated with alum (aluminum sulfate) to bind phosphorus in the lake's sediments in order to minimize phosphorus recycling within the lake and reduce algae blooms. This treatment is being funded by the Tri-Lakes Association and the Wisconsin Department of Natural Resources (WDNR). The alum treatment and monitoring plan was created by Onterra, LLC (De Pere, WI) with assistance from the WDNR and US Army Corps of Engineers. The alum application will be completed by Sweetwater Technologies, Inc. (Aitkin, MN) and monitored by Onterra staff ecologists.

There are no lake use restrictions during or after the alum treatment. The East Alaska Lake public landing will not be closed during the 2-day application; however lake users should stay clear of the application barge, monitoring boats, tanker trucks, and pumping equipment.

During and following the treatment, the water color may appear bluer and slightly murky. The water will clear over the course of several weeks.

For more information, please contact Tri-Lakes Association President, [redacted]

Figure 5. Informational sign posted at East Alaska Lake boat landing two weeks prior to treatment.

Figure 6. East Alaska Lake summer (June, July, and August) near-surface total phosphorus concentrations from 2002-2012. The alum treatment occurred during October 2011.

and Onterra, the consultant managing the project, mailed a notice to area residents describing the upcoming treatment and what to expect. Further, a sign was posted at the landing two-weeks prior to the treatment to alert transient users (Figure 5).

The greatest risk of environmental harm resulting from an alum treatment is when pH values fall below 5.5. Below that level, dissolved aluminum concentrations can reach toxic levels to fish and other wildlife. This risk was explained to the community during the alum treatment planning process along with the fact that pH levels would likely not drop below 6.0 due to the lake's high alkalinity, which often exceeds 200 mg/L as $CaCO_3$. The alkalinity works to buffer the lake against the pH drop associated with the hydrolysis of aluminum sulfate during the application. Still, to lessen public concern, Onterra staff monitored pH and dissolved oxygen values at numerous sites on East Alaska Lake during the two-day application. The lowest value recorded during the application was 6.3, with most sites remaining at 6.5 or higher. Two days following the treatment, pH values rebounded to 7.1 and greater throughout the lake.

East Alaska Lake – One Year Post-Treatment

A single growing season's data have been collected at East Alaska Lake post alum treatment. Casual observations throughout the summer were positive as no filamentous algae was noted and near surface total phosphorus values were lower than previously measured (Figure 6). During early fall 2012, a core was extracted from the deep hole where the full dose rate of 132 g/m^2 was applied, a distinct layer was found near the surface of the sediment, indicating a substantial barrier to sediment phosphorus flux had been created (Figure 7). A phosphorus profile collected during the same October visit is also strong evidence of the success of the treatment, especially when compared to profiles collected the two previous years (Figure 8). During the two years prior to the treatment, total phosphorus concentrations in the anoxic hypolimnion ranged from 0.1 to 1.24 mg/L, while the post treatment samples spanned from 0.040 to 0.088 mg/L.

Figure 7. Bottom core extracted from the deepest location in East Alaska Lake approximately one year after the alum treatment. The white section is the alum layer that has settled approximately two inches into the soft bottom sediments.

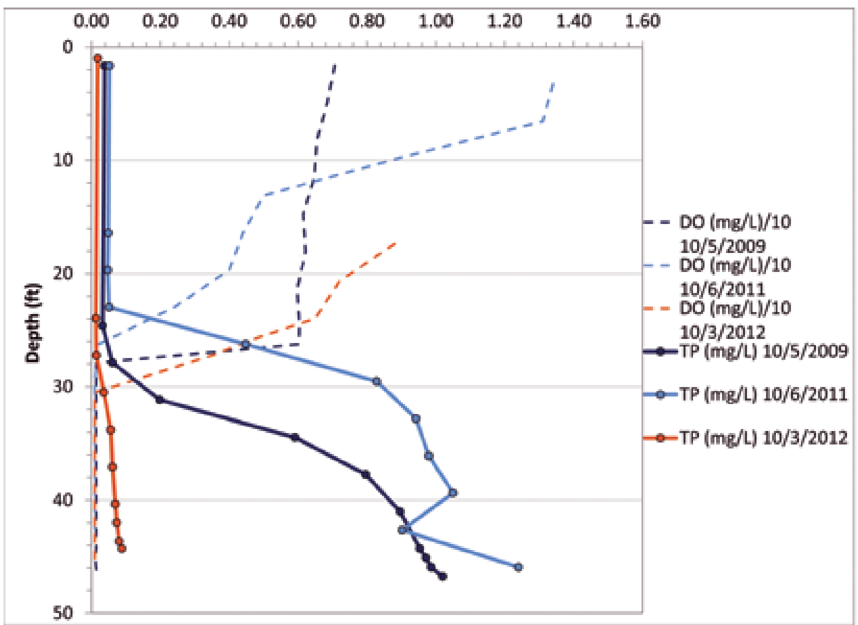


Figure 8. Total phosphorus and dissolved oxygen profile results from October 2010, 2011, and 2012. The alum treatment occurred after the October 2011 samples were collected.

While the environmental data are great to see, especially for a professional limnologist that has worked on the lake for over a decade, the most satisfying evidence was when long-time Tri-Lakes Association President, Bill Iwen, called to say, "People are actually swimming in East Alaska Lake again!"

The Future of East Alaska Lake

The one-year post treatment results certainly look promising for East Alaska Lake; however, time will tell if the treatment effects last for the 20 or more years for which the Tri-Lakes Association hopes. After the professional water quality monitoring ends in 2013, volunteers will be relied upon to collect samples through Wisconsin's Citizen Lake Monitoring Network. Data resulting from that program will be useful in determining the longevity of the alum treatment; therefore, it is essential that the association be consistent in providing volunteers to collect the samples.

Acknowledgments

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