2021 STATE OF THE LAKES REPORT

Lake Wingra (foreground), Lake Mendota and Lake Monona with Madison's Isthmus (background)
Photo courtesy Robert Bertera

2021 STATE OF THE LAKES

Clean Lakes Alliance envisions a future in which everyone realizes the lakes are the center of our community. Surrounded by water, Greater Madison thrives because these stunning natural amenities make us special and different from anywhere else. The lakes are also constantly changing and being impacted by the decisions we make. Like a living organism, the health of our waters reflects the quality of the surrounding environment that protects and nourishes them.

This annual *State of the Lakes Report* provides a window into how the lakes are doing each year. Additionally, it highlights the root causes of water quality challenges and casts a light on the status and effectiveness of cleanup efforts. We thank the many partners, scientific experts, and volunteer monitors whose contributions make these public reports possible. As stewardship action unfolds across a 485-square-mile watershed (Figure 1), knowing how the lakes are responding to ongoing change is the first step in charting a path toward their recovery.

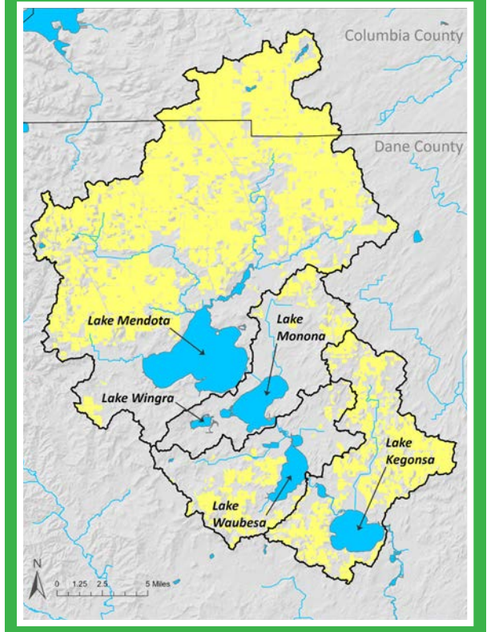


Figure 1: Yahara Watershed showing land areas that drain directly to each lake. Yellow denotes agricultural areas that comprise most of the watershed.

SUCCESSES AND SETBACKS

Conservation actions work. Thirty years of monitoring data from Lake Mendota's stream tributaries show these actions lead to declines in sediment and phosphorus concentrations in streamflow entering the lakes. That means practices like cover crops, low-disturbance tillage, and following farmland nutrient management plans are doing their jobs. According to Dane County Land & Water Resources (2019), if climate variations were held constant, models show that the amount of phosphorus delivered to Lake Mendota would have *decreased* by 36% over the last two decades. Those findings speak to the effectiveness of conservation actions as they get adopted across the watershed.

But a wetter climate and other factors are masking those impacts. Greater rainfall volumes and intensities combined with milder winters means more runoff and more algae-loving phosphorus entering the lakes. Today, all five Yahara lakes are classified as "impaired," mostly because of excess phosphorus. There are also 13 beaches already listed (9) or proposed to be listed (4) as impaired due to problems with *E. coli* bacteria. The failure of our lakes and beaches to meet basic standards of quality and usability is seen in water resembling thick green paint. It is experienced with every beach closure warning of toxic cyanobacteria or *E. coli* contamination. And it is the smell in the air as thick matts of algae wash to shore and rot. Conservation actions may be working, but the lakes tell us much more is still needed.

WHY THE FUSS ABOUT PHOSPHORUS?

Too much phosphorus harms water quality and turns the lakes green. It can be found in fertilizers (phosphorus fertilizers are banned in Dane County), soil, animal waste, and organic material. With one pound of phosphorus capable of generating up to 500 pounds of algae, every pound matters.

While phosphorus can enter the lakes in different forms and through various pathways, it is what we put on and do to the land surface that most impacts downstream waters.

FOLLOW THE WATER

The story of our lakes is written in the pathways of its water, beginning at the source. Data from the Dane County Regional Airport gauge show a total of 25.29 inches of precipitation fell across the watershed during the last "water year" (Oct. 1, 2020 – Sep. 30, 2021). Compared to the normal of 34.48 inches, the significantly drier conditions interrupt a trend of above-average rainfall. The lakes typically respond favorably to drier weather, with less runoff meaning fewer opportunities for pollutants to move from land to water.

Throughout the year, surface water steadily flows from north to south as it is funneled from the upper reaches of the watershed, through Yahara River stream tributaries, and down the chain of lakes before entering the Rock River. Monitoring data allow scientists to estimate the mass of phosphorus transported to the lakes over the year (called "loading"). Total loading can be highly variable, but long-term trends paint a picture that illustrates how climate and landscape interactions are impacting lake and stream quality.

A BELLWETHER FOR THE CHAIN

Perched at the top of the chain and receiving most of the watershed's drainage, the condition of Lake Mendota is a good indicator for how the downstream lakes will be impacted. Lake Mendota is also the largest lake with the greatest number of monitored streams and the most complete long-term dataset. The lion's share of phosphorus received by the lower lakes is through the outlet of Lake Mendota as it gathers from the northern headwater regions of the watershed and cascades down the rest of the system.

Figure 2 shows the total pounds of phosphorus delivered from Lake Mendota's monitored streams during the 2021 water year compared to prior years. During the 2021 water year, the 28,160 pounds of phosphorus loading to Lake Mendota was 48% below the long-term average (1990-2021).

Maintaining an annual average loading of 32,600 pounds is a Yahara CLEAN target recommendation. If attained, the number of days our lakes are clear and free of algal-blooms each summer should double. Yet an increasingly wetter climate makes reaching this target more challenging, and monitoring data show a widening gap between annual average loading and the desired target level. According to *Renew the Blue: A Community Guide for Cleaner Lakes & Beaches in the Yahara Watershed (2022)*, a 57% reduction from current conditions is now needed to reach water quality goals (Table 1).

Figure 2 also shows total precipitation by water year and how it relates to loading. While yearly totals can be telling, it is the timing, intensity, and frequency of rainfall and snowmelt that ultimately offer the best predictors of runoff and phosphorus-loading conditions. For example, runoff events when the ground is frozen can have a disproportionately large impact regardless of yearly totals. This is evidenced by high ammonium concentrations in winter runoff samples. These findings link the land spreading of manure to high phosphorus loads observed during the January-March period (Figure 3). On average, phosphorus loading during that period accounts for 54% of the annual total.

SCREENING FOR LAKE HEALTH

In-lake clarity and phosphorus data are collected by UW-Madison's Center for Limnology as part of its Long-Term Ecological Research (LTER) program. Because of the COVID-19 pandemic and its impacts on personnel availability, center-of-lake summer phosphorus concentrations were not obtained for lakes Monona, Wingra, Waubesa, and Kegonsa in 2020, and lakes Waubesa and Kegonsa in 2021.

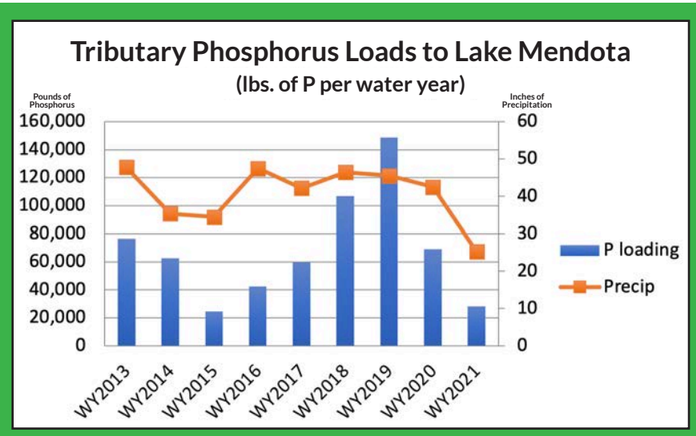


Figure 2: Phosphorus loads (in pounds) delivered to Lake Mendota through its monitored stream tributaries by water year. Also shown is total precipitation (in inches) during these time periods. Loading data source: T. Stuntebeck, USGS

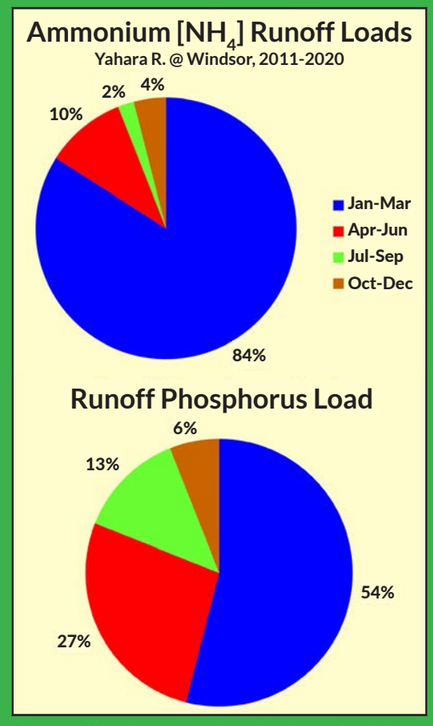
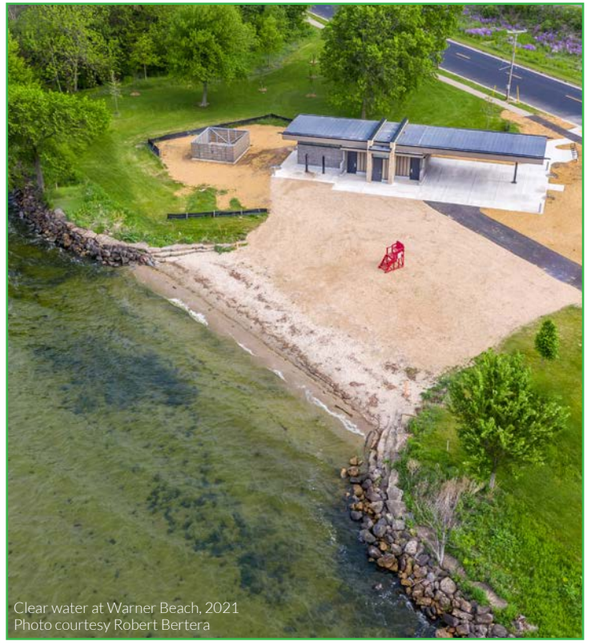


Figure 3: Ammonium runoff loads compared to phosphorus loads by season as measured between 2011-2020 from samples collected at the Yahara River at the Windsor stream gage. Loading data source and graphic: R. Lathrop, UW-Madison Center for Limnology

DIRECT DRAINAGE P LOAD	MENDOTA	MONONA	WAUBESA	KEGONSA	TOTAL
1976 - 2008 Average[1]	65,300	16,500	4,600	8,800	95,200
1990 - 2020 Average	75,500[2]	19,100[3]	5,300	10,200[3]	110,100
Target[1]	32,600	8,300	2,300	4,400	47,600

Table 1: Summary of average annual phosphorus (P) loads and targets (pounds/year) for the Yahara lakes.
(1 - Lathrop & Carpenter, 2014. 2 - Sum of measured tributary loads plus estimates of ungauged areas (14%). 3 - 1976-2008 average multiplied by ratio of 1990-2020 to 1976-2008 averages for Lake Mendota.) Table credit *Renew the Blue: A Community Guide for Cleaner Lakes & Beaches in the Yahara Watershed*



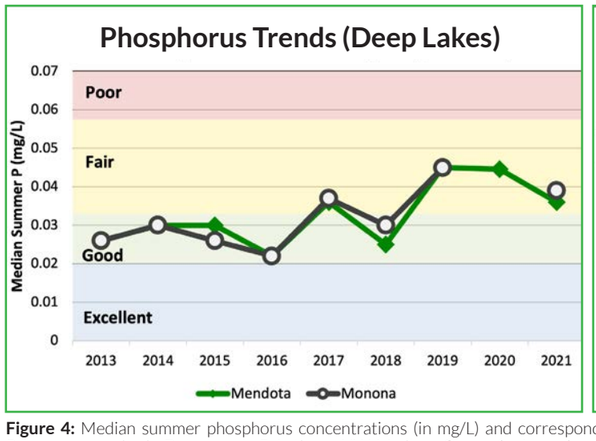
Clear water at Warner Beach, 2021
Photo courtesy Robert Bertera

Figure 4 shows summer median total phosphorus concentrations for 2021 compared to recent years. For deeper lakes Mendota and Monona, phosphorus levels are considered "fair" by Wisconsin Department of Natural Resources standards. For shallower Lake Wingra, conditions are considered "good." No LTER phosphorus data were available for the lower lakes, Waubesa and Kegonsa.

Figure 5 shows summer median water clarity readings for 2021 compared to recent years. Values represent the depth to which a transparency-measuring device, called a Secchi disk, can be seen when lowered from the water surface. Clarity readings hover between "good" and "fair" conditions for lakes Mendota, Monona, and Wingra. The much smaller and shallower Lake Wingra continues to exhibit water quality benefits from carp removal in 2008. Carp are known to stir up lake bottoms through their feeding behavior. For Lake Waubesa, conditions are considered "fair," while Lake Kegonsa experienced an "excellent" year for water clarity.

THE LAKE USER EXPERIENCE

Ultimately, we want our lakes to be safe and swimmable, and free of the cyanobacteria blooms and *E. coli* contamination that can close beaches and pose public-health risks. Thanks to the dedication of Clean Lakes Alliance's all-volunteer monitoring network, a record 85 reporting stations were active across all five lakes during the 2021 season (Figure 6). Trained monitors contributed 2,105 LakeForecast condition reports from approximately Memorial Day to Labor Day.



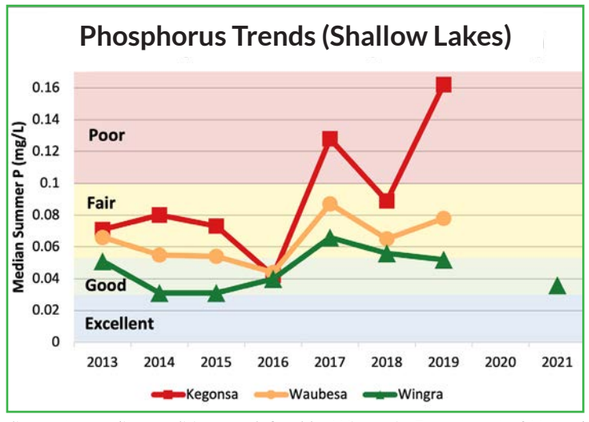
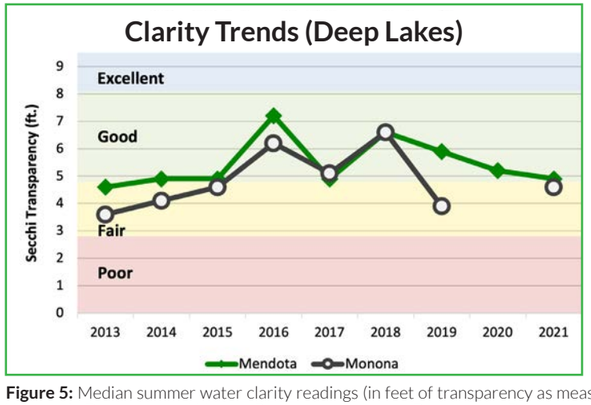


Figure 4: Median summer phosphorus concentrations (in mg/L) and corresponding water quality conditions as defined by Wisconsin Department of Natural Resources standards. Data source: R. Lathrop, UW-Madison Center for Limnology



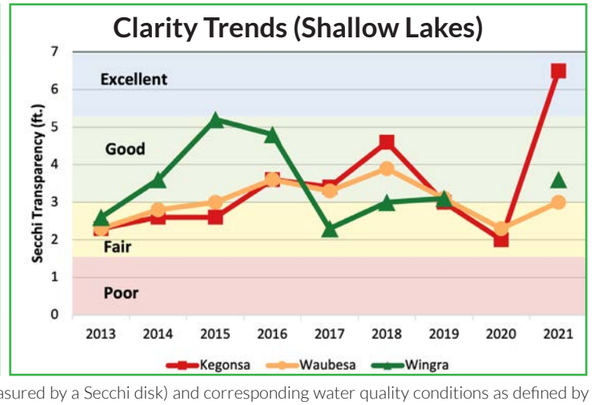


Figure 5: Median summer water clarity readings (in feet of transparency as measured by a Secchi disk) and corresponding water quality conditions as defined by Wisconsin Department of Natural Resources standards. Data source: R. Lathrop, UW-Madison Center for Limnology

LAKEFORECAST & VOLUNTEER WATER QUALITY MONITORING

Volunteer water quality monitor, Jeff Koziol, tests for microcystins

We've come a long way since Clean Lakes Alliance's pilot monitoring program was initiated in 2013. Back then, only two beaches were monitored by a handful of volunteers. Now, we have more than 100 volunteers, 85 unique locations, 100% beach coverage, and the unique data dissemination tool: LakeForecast. Where we are today is thanks to the hard work of our volunteers and partners, who made this program a leading example in bringing critical information together and inspiring curiosity about our lakes.

LakeForecast is a free-to-use website and app that provides real-time water quality information at locations around all five Yahara lakes. LakeForecast bridges the data gap between nearshore water quality and the greater community that interacts with and enjoys the lakes. Potentially harmful algal blooms (HABs) and the toxins they can produce are a significant public health challenge that need to be communicated clearly and frequently. HAB occurrences and other water quality parameters are reported by dedicated volunteers throughout the summer and provide lake users information to make informed decisions about when and where to enjoy the lakes safely. Lake conditions are dynamic and can change rapidly, making the frequent reporting by our volunteers all the more valuable.

The strength and success of the LakeForecast initiative can be attributed to its amazing volunteer network and its many partnerships. Bringing together beach closures issued by Public Health Madison Dane County, in-lake water conditions from the UW-Madison Center for Limnology Lake Mendota research buoy, and frequent reporting from our volunteer network has created a dynamic tool that provides a voice for the lakes. The data collected can help us identify long-term trends necessary to assess the state of our lakes and community progress toward cleaner water.

Figure 6: 2021 LakeForecast monitoring sites

LakeForecast volunteer monitoring equipment
Photo courtesy Robert Bertera

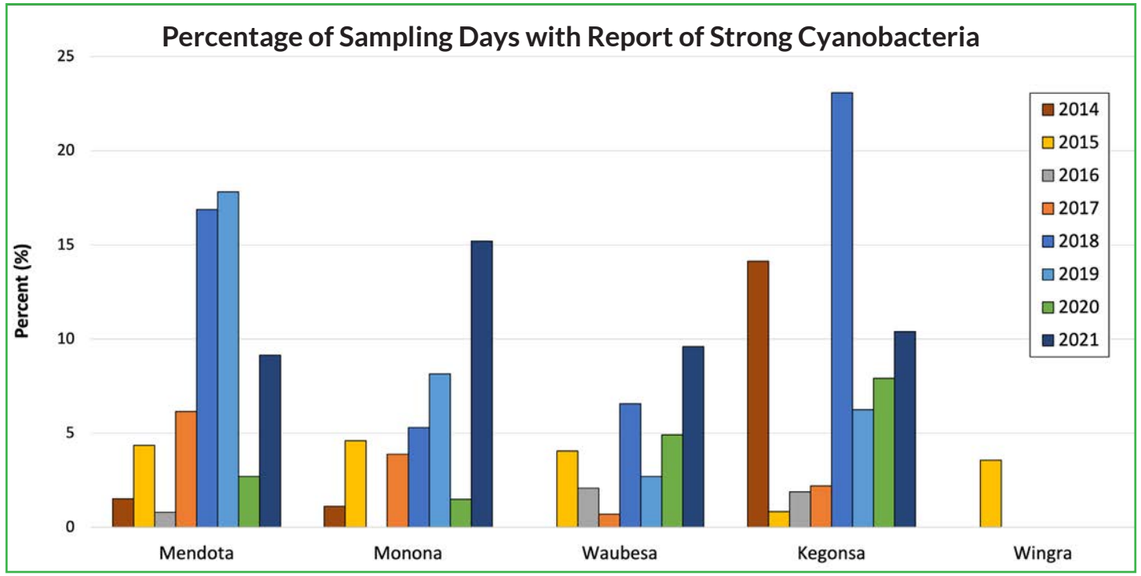


Figure 7: LakeForecast nearshore monitors reporting "strong evidence" of a cyanobacteria bloom represented as a percentage of total sampling days

The number of days when one or more monitors reported "strong evidence" of a cyanobacteria bloom is summarized for each lake in Figure 7. By comparing the number of 'algal days' to the total number of unique sampling days for each lake, a percentage can be generated that better represents the number of blooms witnessed each year. This method eliminates overreporting in situations when different monitors report the same algal bloom.

Compared to the prior year, 2021 saw more "strong evidence" of cyanobacteria blooms on the four primary lakes, with Monona and Waubesa at their highest reported levels compared to the last six years. Lake Wingra remained consistent with no reports of strong cyanobacteria blooms.

There was significant variability in algal days across each lake. Generally, the highest number of strong cyanobacteria blooms are reported in June and July, followed by a sharp decline in August. May and September often have fewer strong reports of cyanobacteria. This is because fewer monitors are active, and the typically cooler weather does not support the rapid algal growth seen during warmer months.

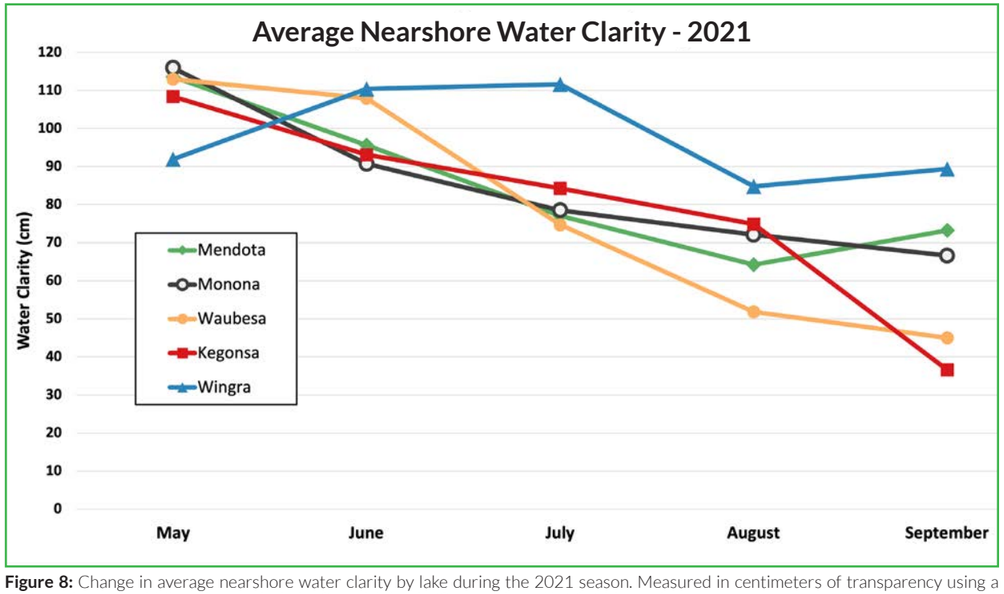


Figure 8: Change in average nearshore water clarity by lake during the 2021 season. Measured in centimeters of transparency using a 120-centimeter turbidity tube; murky is 0-50 cm, fair is 50-80 cm, and good is 80-120 cm of transparency.

Clarity reports did not reveal any consistent trends across the five lakes when compared to 2020. Lake Kegonsa and Lake Wingra demonstrated an improvement in water clarity, while Mendota, Monona, and Waubesa saw moderate reductions when compared to the previous year. These observations also hold true when compared to the long-term median water clarity measurement for each lake. Except for Lake Wingra, overall water clarity in 2021 for the Yahara lakes was relatively poor when compared to previous years.

As depicted in Figure 8, average clarity for most lakes decreased throughout the summer with a peak decline in August. Lake Kegonsa deviated from this trend as clarity readings were at a season low in September. The shallower depths of Lake Kegonsa, combined with its low-elevation position within the watershed and chain of lakes, likely contributed to the lower clarity readings.

Observations from the 2021 monitoring season demonstrate the difficulty in identifying whole lake trends in water clarity and algal presence. Despite an unusually dry year, water quality conditions were generally poor when compared to historical LakeForecast data. The data highlights the fact that the complex interactions of multiple variables affect water quality. There can also be long lag times between watershed actions that reduce phosphorus and lake response. The data collected by LakeForecast volunteers offer a valuable tool to help us better understand cause-and-effect relationships as they apply to ever-changing lake conditions.

As for beach closures, there were 267 total "closure days" documented during the 2021 summer-recreation season (Figure 9). Closure days represent the number of days each monitored beach had to be closed due to unsafe water conditions. These unsafe conditions are most often due to the presence of elevated and potentially harmful levels of *E. coli* and/or toxin-producing cyanobacteria. For historical comparison, the long-term median closure rate (2005-2021) is 107 days lost per season.

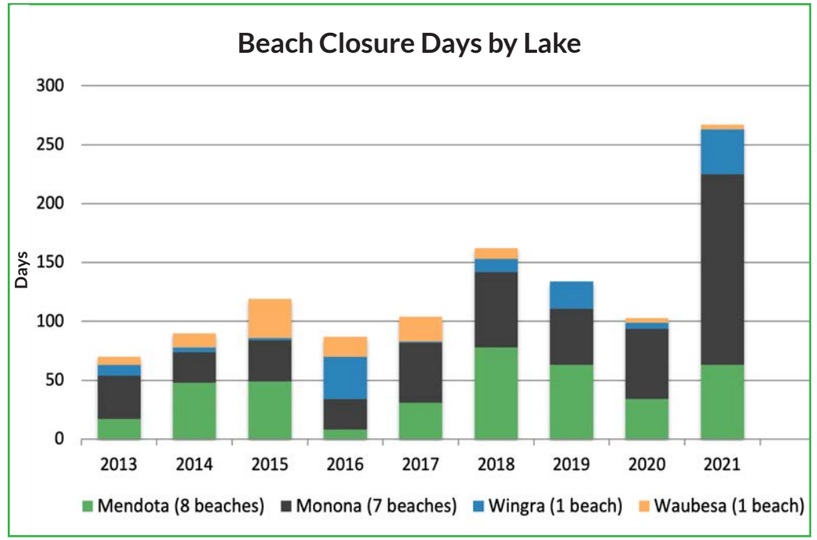


Figure 9: Beach closure days by lake from 2013-2021. Data source: Public Health Madison & Dane County

ENJOYING OUR FROZEN ASSETS

In winter, the lakes freeze over and become our largest public parks. Ice fishing, cross-country skiing, snowshoeing, ice boating, ice skating, and other activities are enjoyed during the coldest months. The winter of 2020-2021 was relatively warm, with Lake Mendota freezing for 77 days, only seven days longer than the previous year when it froze for 70 days. For reference, the median duration of ice cover on Lake Mendota is 104 days measured over the last 165 seasons.

A warmer winter can significantly shorten opportunities for cold-season recreation. It also leads to warmer water temperatures earlier in the year, creating a longer growing season for algae and aquatic plants while impacting the life stages of ice-cover-dependent organisms.

Lake Waubesa, winter of 2020-2021
Photo courtesy Robert Bertera

CLEAN BOATS, CLEAN WATERS

Aquatic invasive species (AIS) are a major threat to natural and cultural resources, ecosystem services, recreation, and tourism in the Yahara Watershed. AIS disrupt the ecological balance of our lakes. They can also decrease water quality and increase cyanobacterial growth. The impacts of AIS are not only costly to our lake health, but also to our economy. AIS cause millions of dollars in damages to our lakes, and our ability to enjoy them. If you have ever visited the Yahara lakes, you have likely experienced the effects of AIS, from stepping on sharp zebra mussel shells while swimming, to seeing large algal blooms, created in part by the spiny water flea.

Clean Lakes Alliance is committed to establishing measures to protect our lakes and mitigate the threats of AIS. We strive to raise awareness of AIS in our watershed through watercraft inspection, outreach, and education at boat launches. In 2022, in partnership with the Wisconsin Department of Natural Resources and Dane County, Clean Lakes Alliance will expand AIS efforts by participating in the Clean Boats, Clean Waters program. This statewide initiative places inspectors at boat landings to educate boaters about aquatic invasive species and the steps they can take to prevent their spread. This spring and summer, keep an eye out for staff and volunteers leading these efforts at boat landings in Babcock, Fish Camp, Marshall, Olbrich, Olin, and Warner parks.

Everyone has a part to play in keeping our lakes healthy and preventing the spread of AIS. The goal of Clean Lakes Alliance is to raise the profile of AIS in our lakes and empower the community to take action. To make this vision a reality, we would like to see AIS inspection programs at every boat landing in the Yahara Watershed, clear and effective signage about AIS prevention, and increased resources for boaters, including more boat washes, cleaning tools, and educational materials.

Zebra mussels - an aquatic invasive species

Inspecting a boat for aquatic invasive species (AIS)
Photo courtesy Stephanie Boismenue, Wisconsin Department of Natural Resources

EMERGING CONCERNS

Clean Lakes Alliance has long focused on building capacity and partnerships around phosphorus reduction, seeking to apply maximum pressure to what is arguably the lakes' single largest driver of water quality problems. This laser focus allows us to direct the public's attention to where it is most needed, and has produced many notable wins, including leading the Yahara CLEAN Compact's work in producing a *Renew the Blue* stakeholder guide to cleaning up our lakes and beaches. A community unveiling and official launch of the *Renew the Blue* initiative begins in May of 2022 as part of a culminating public event. (Pages 8-12)

However, many other factors affect water quality conditions. They include over-salting during the winter months, the introduction and spread of aquatic invasive species like zebra mussels, and contamination by largely unregulated PFAS/PFOS "forever chemicals" that threaten human health (Figure 10) – to name a few. Clean Lakes Alliance will continue to raise awareness about these concerns while either leading or supporting actions that confront these challenges head on. That includes advocating for needed policies and bringing "Clean Boats, Clean Waters" watercraft inspectors to several busy boat landings in partnership with Dane County and the Wisconsin Department of Natural Resources.

LOOKING AHEAD

Starting with the next *State of the Lakes Report*, readers will be introduced to a new progress-reporting dashboard. The new dashboard will follow guidance set forth in *Renew the Blue: A Community Guide for Cleaner Lakes & Beaches in the Yahara Watershed*, and offer a more accurate and comprehensive representation of our collective progress. As in past reports, the focus will be on celebrating successful partner efforts and to maintain transparency and accountability as our work together proceeds.

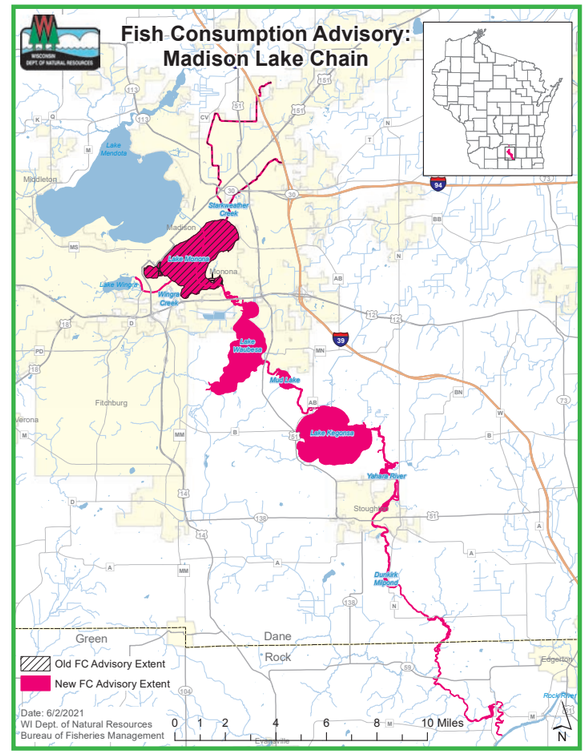
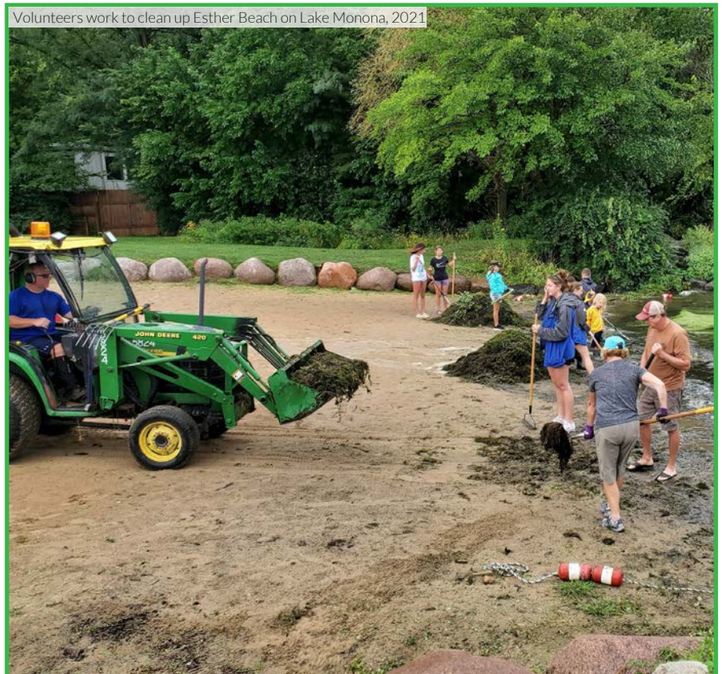


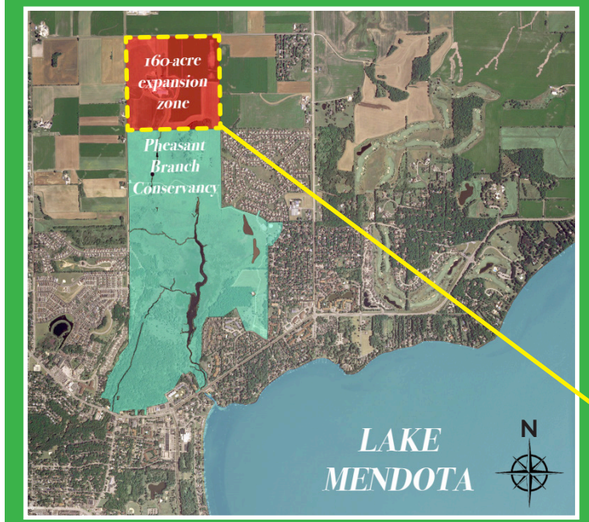
Figure 10: Fish-consumption advisories due to elevated levels of PFAS and PFOS. Credit: Wisconsin Department of Natural Resources



Volunteers work to clean up Esther Beach on Lake Monona, 2021

Overuse of sidewalk salt in the winter

PHEASANT BRANCH CONSERVANCY RESTORATION



In 2019, Dane County purchased 160 acres of land on the north end of the Pheasant Branch Conservancy. Formerly a dairy farm, this purchase was the largest conservation investment for land acquisition in the county's history.

After the purchase, the property was split into four quadrants – with the plan of seeding one section per year, starting in 2021. The goal was to achieve a "Platinum Prairie" by planting at least 100 different plant species in each quadrant.

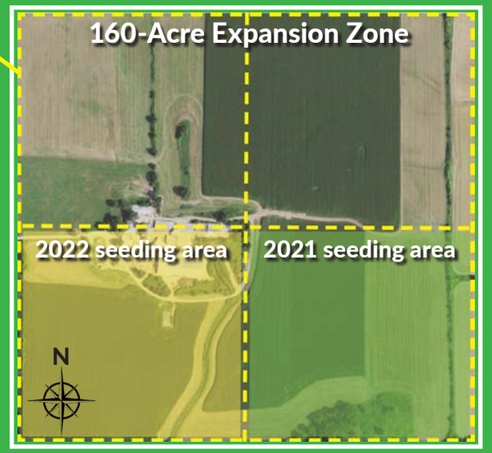
Clean Lakes Alliance received an initial donation of $100,000 from the Alliant Energy Foundation to help restore prairie and wetland areas. Additionally, the Friends of Pheasant Branch Conservancy raised $25,000 for the first, second, and third years of planting.

The first quadrant of prairie was seeded in March of 2021 with 174 different plant species. Donated funds helped increase the seeding density from 80 to 100 seeds per square foot.

Earlier this year, the second quadrant was seeded with 203 different species. Dane County Parks was able to collect 139 species from volunteer collection programs and purchase an additional 64 species with funds from Clean Lakes Alliance and the Friends of Pheasant Branch Conservancy.

Seeding takes place in the late winter or early spring because light snow cover holds the seeds in place, and as it melts, the seeds embed into a softening soil.

Over the next several years, Dane County Parks will mow these new prairies to combat annual and biannual weed seed production. The final, bloomed prairie should be noticeable in each quadrant a few years after initial planting.



Collecting seeds from native plants at Pheasant Branch Conservancy to be used in the future, October 2021


Clean Lakes Alliance Executive Director James Tye participates in ceremonial seeding of second quadrant, March 2022

RENEW THE BLUE STAKEHOLDERS

RENEW THE BLUE
Renew the Blue seeks to spur collective action among those who live and work within the Yahara Watershed. Creating a legacy of clean lakes for this and future generations is a shared responsibility, and it will take motivated and empowered community members to make it happen. The following stakeholder groups were identified because they either own or control land within the watershed, or they are responsible for setting policy and allocating funding related to water quality improvement.

AGRICULTURE
This group includes farmers and landowners involved in agricultural production and processing. This group also includes farmer-led conservation groups and agricultural advisors and suppliers. After government, agriculture is the second most influential stakeholder group based on its ability to directly impact water quality.


Creating buffer strips on agricultural lands


Construction site beside waterbody

BUILDERS & DEVELOPERS
These stakeholders are land-development companies and builders involved in new development or redevelopment. The actions taken by this group are typically governed by ordinances and policies adopted by the local municipality in which a project is located. Some recommendations involve incentives to encourage going above and beyond standard regulatory requirements.

GOVERNMENT
This is the most influential of the five groups due to its capacity and authority to affect broad-scale change. Comprised of towns, villages, cities, counties, and state government, the largest number of priority actions apply to this group, especially those that involve policies, ordinances, or regional guidelines. Government also has the greatest ability to raise and allocate funds or commission research on behalf of water quality efforts.


Aerial view of Madison's Isthmus
Photo courtesy Robert Bertera


B.B. Clarke Beach Park on Lake Monona

PARKS & OPEN SPACE MANAGERS
This group includes department personnel at the municipal, county, and state levels whose responsibilities include designing, maintaining, improving, retrofitting, or adding new parks and open spaces. This group also includes land-conservation stewards and other nonprofit entities involved in management or recreational program offerings. Priority is given to actions targeted to lands located directly adjacent to lakes and streams.

RESIDENTIAL & COMMERCIAL LANDOWNERS
This group is comprised of the greatest number of potential participants. While those belonging to this group may not always feel that their individual actions have an impact, cumulative action can result in significant and meaningful impacts. As more individuals implement changes at their homes and places of business, the more likely they will advocate for policies, incentives, and funding models that will help support and sustain the overall effort.


Homeowners create a more resilient landscape

LEARN MORE
To learn more about these groups and how they fit into *Renew the Blue*, please read the plan's executive summary on pages 8-12.