



2022 STATE OF THE LAKES



Yahara River and agricultural land (foreground), Lake Kegonsa (background), October 2022
Photo courtesy Robert Bertera



2022 STATE OF THE LAKES

Initiated by Clean Lakes Alliance in 2013, the *State of the Lakes* provides an annual synopsis of conditions, trends, and water quality drivers affecting the five Yahara lakes (Mendota, Monona, Wingra, Waubesa, and Kegonsa). This yearly report distills the relevant science while drawing attention to major efforts reported by community partners working toward cleaner lakes and a healthier watershed.

While authored by Clean Lakes Alliance Deputy Director and Chief Science Officer Paul Dearlove, all findings and conclusions are a product of collaboration involving multiple governmental partners and scientific contributors. We especially thank the following organizations and individuals for their data and analytical contributions to this 2022 *State of the Lakes*: UW-Madison Center for Limnology (Richard Lathrop), UW-Madison Departments of Agronomy and Civil & Environmental Engineering (Eric Booth), U.S. Geological Survey (Todd Stuntebeck and Matthew Diebel), Dane County Land & Water Resources Department (Kyle Minks), Public Health Madison & Dane County, and Wisconsin Initiative on Climate Change Impacts.

Welcome to the 10-year-anniversary edition of the *State of the Lakes*. Along with the original release of the *Yahara CLEAN Strategic Action Plan for Phosphorus Reduction* (2012), Clean Lakes Alliance has brought key implementation partners together to collaborate on advancing recommended actions and tracking our collective progress. Yearly updates are then reported as part of this annual snapshot, raising public awareness about the health of our waters and the major factors driving those conditions.

A lot can happen over a decade: floods, droughts, major project completions, new research discoveries and understandings, technological advancements, land-use change, and even aquatic invasive species infestations (see pages 66-67 for a Clean Boats, Clean Waters program update). The list goes on and on. Like canaries in a coal mine, our lakes respond to these changes in good ways and bad, signaling what is working and where we might be falling short on the path to improvement. While some of these lake responses can unfold quickly, others can take years to materialize.

Now, after 10 years of implementing the action plan, a fully updated and amended version is steering our collective efforts. Called *RENEW THE BLUE: A Community Guide for Cleaner Lakes & Beaches in the Yahara Watershed* (2022), this latest body of work by the Yahara CLEAN Compact recalibrates the roadmap for achieving healthy waters. Its recent signing by the leaders of 19 partnering organizations is a credit to the power of shared values, science-based planning, and broadly inclusive participation in solution-making. (See page 56 for early examples of leadership around recommended actions.)



In 2022, the Yahara chain of lakes generally fared well. Comparatively less runoff and phosphorus pollution were aided by a span of unusually dry weather and the continued adoption of conservation practices across the watershed. These factors, along with others, contributed to mostly good water clarity, fewer cyanobacteria-bloom sightings, and a lower number of beach closures.

IMPACT ZONE

Our Yahara chain of lakes lies within the lower reaches of a 385-square-mile watershed, a land-drainage basin beginning at the southern edge of Columbia County and extending south through much of Dane County, including Wisconsin's capital city of Madison. Precipitation falling over this land area either soaks into the ground or runs off and into a network of streams or storm sewers toward the lower-elevation lakes.

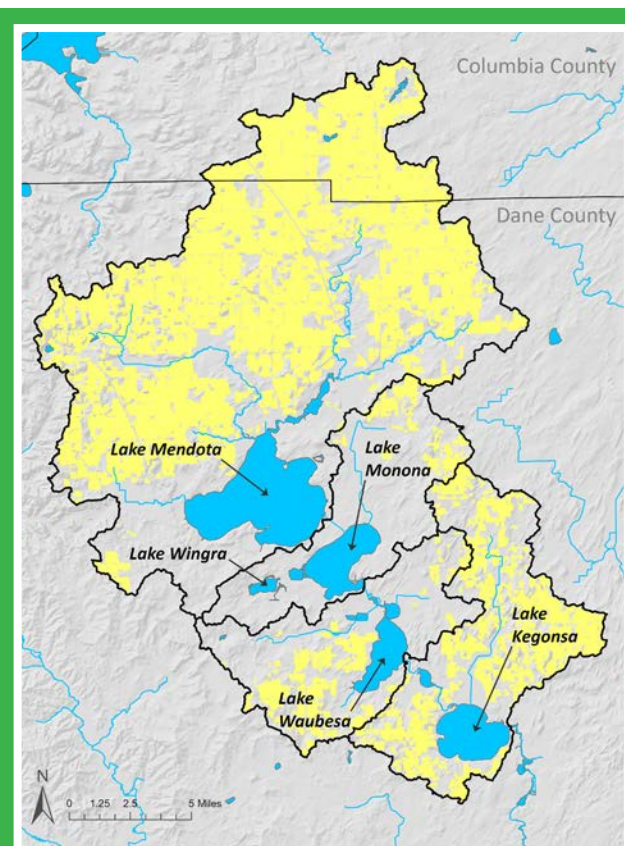


Figure 1: Yahara lakes watershed showing land areas that drain directly to each lake. Yellow denotes agricultural areas that comprise most of the watershed.

Water that is able to soak into the ground recharges groundwater which feeds springs, providing dry-weather “baseflow” to streams or direct springwater to the lakes. The lakes collect and temporarily hold the inflowing surface and ground water before it exits the Yahara lakes watershed and continues its journey through the Yahara River and into the Rock River near the southern edge of Dane County. The water then enters the Mississippi River where it is sent to the Gulf of Mexico.

The largest four of the five waterbodies—lakes Mendota, Monona, Waubesa, and Kegonsa (in downstream order)—are interconnected by the Yahara River. Figure 1 shows the Yahara lakes watershed divided into smaller subwatersheds, also called subbasins or direct drainage areas, that funnel water to a specific waterbody.

Lake Mendota's comparatively large, direct drainage area is predominantly agricultural while Lake Monona's is mostly urban. Lake Waubesa's is a mix of urban and agricultural, whereas Lake Kegonsa's is predominantly agricultural. The much smaller and shallower Lake Wingra, which drains east to Lake Monona, is contained within an entirely urbanized subbasin. Together, these subbasins gather and direct surface water that then moves from one lake into the next.

The time it takes each lake to completely cycle through its volume of water ranges from 4.3 years for deeper Lake Mendota to only 2.8 months for shallower, downstream Lake Waubesa. These flushing rates for each lake increase during wet, high-runoff years and decrease during drought years.

The five Yahara lakes have a complex relationship with their surrounding watershed. Much has been learned about this relationship and the land conditions needed to sustain it. But because many variables are at play (i.e., climate, geology, soil health, land cover, land use, lake ecology, etc.), teasing out the precise causes of water quality change can often prove complicated. And because the lakes themselves exhibit their own unique characteristics, each lake can behave somewhat differently in response to internal (in-lake) and external (watershed) influences.

ASSESSMENT METHODOLOGY

This report looks at five, interconnected areas of interest that represent vital pieces of the larger water quality puzzle (Figure 2). Progress-tracking metrics include a combination of outputs (i.e., actions taken, or areas affected) and outcomes (measured water quality responses), with phosphorus management as a central theme given its dominant role in generating algal growth. In general, we track phosphorus and its impact on algal abundance, water clarity, and beach closures, factors that influence the perception of water quality and the recreational suitability of the lakes.

WHY PHOSPHORUS?

Too much phosphorus harms water quality and turns the lakes green. It can be found in fertilizers (note: phosphorus lawn 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.

Whenever applicable, the 2022 condition status is described relative to a particular water quality goal or target. Status is also compared to historical findings to provide context and reveal potential trends. This allows us to make more informed judgements regarding lake conditions, the possible factors affecting those conditions, and the overall state of progress toward our goals. Finally, each of the five areas of analysis is assigned two, color-based “scores,” one for 2022 status and one for the longer-term trend.

AREAS OF ANALYSIS

- 1 Weather and climate drivers
- 2 Watershed phosphorus mass balance
- 3 Land conservation practices
- 4 Phosphorus delivery to the lakes
- 5 In-lake water quality responses

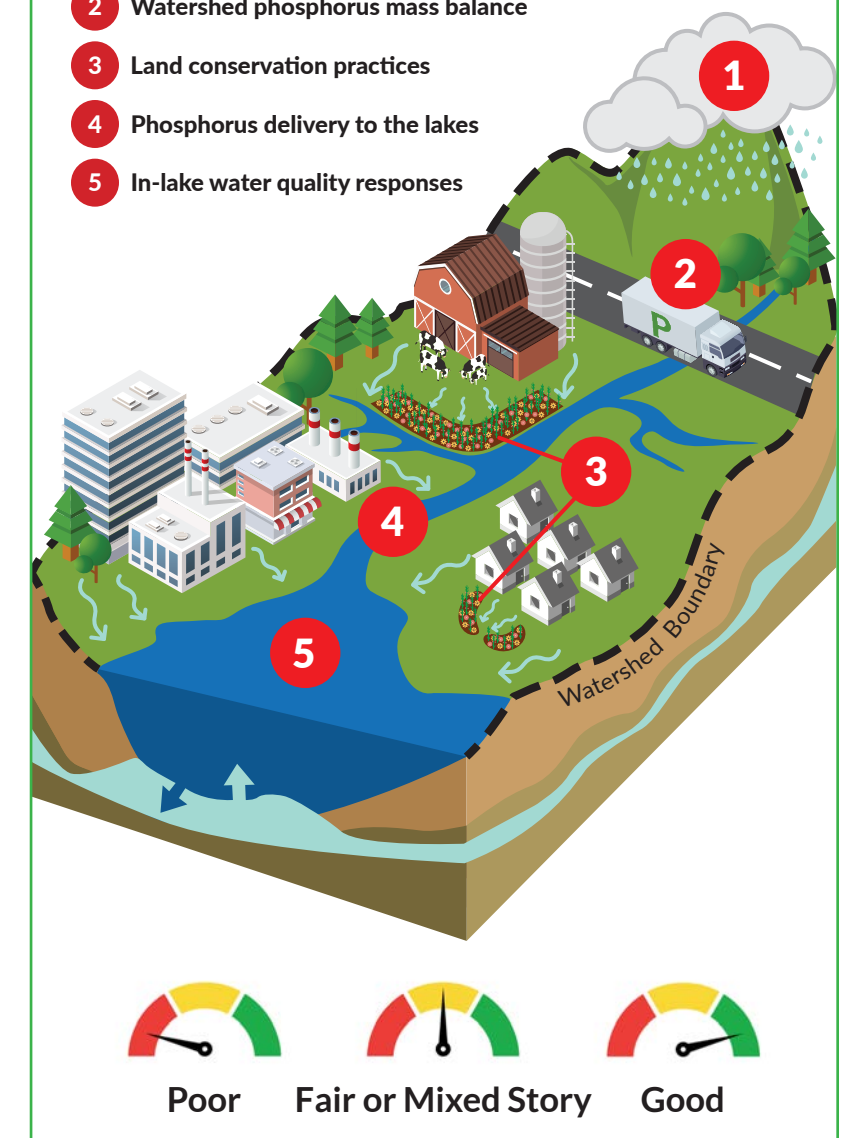
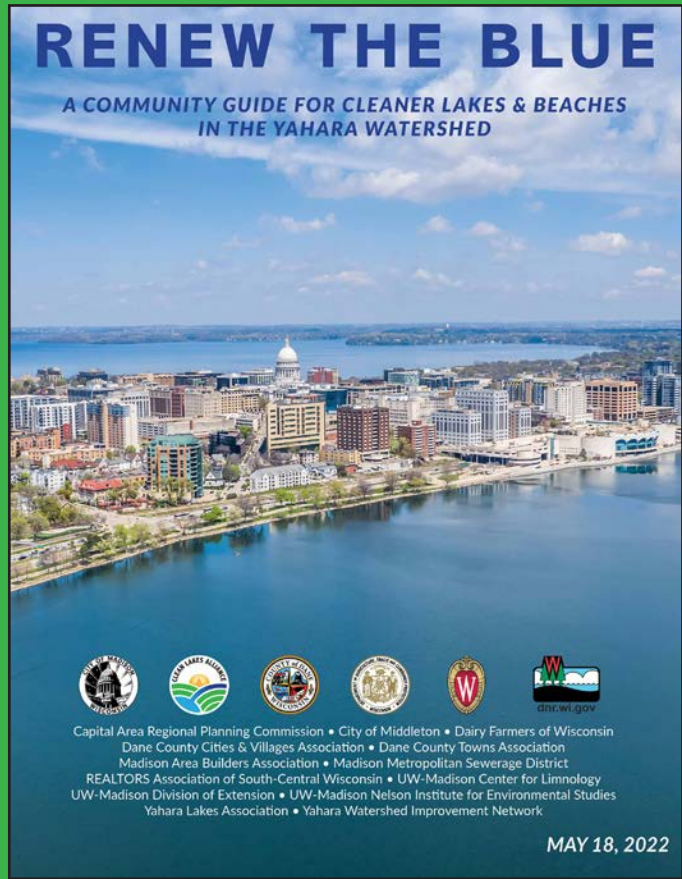


Figure 2: Cross-section illustration of an example watershed showing five areas of analysis. Example scoring dials represent condition status and trend for each area of analysis.



TOP DIRECT-IMPACT ACTIONS
1. Build additional manure-processing capacity. Support farmers in using existing manure-processing facilities or to build their own on-farm systems. Pilot a manure-collection and processing program targeting the critical January-March period with the highest overall phosphorus loading.
2. Increase the ability to handle and transport manure. Use composting and other processing techniques to allow for improved timing and targeting of applications. Minimize chemical fertilizer use by substituting with composted manure or other sources of crop nutrients generated within the watershed.
3. Increase farmland acres guided by a nutrient management plan. Use plans to improve operational decision-making, ensure the most efficient use of costly nutrient inputs, and reduce the risk of phosphorus loss.
4. Increase farmland acres under no-till (or reduced tillage) and continuous living cover. Limit soil disturbance and maintain a living root in the soil with cover/forage crops, harvestable buffer strips, overwintering hay, etc. to build better soil health and reduce erosion.
5. Increase municipal street-cleaning miles and frequency during fall. Regularly remove leaf litter from streets to prevent rainwater-leached phosphorus from entering storm sewer systems.
6. Protect internally drained lands and wetlands. Use closed depressions (accounting for an estimated 41% of the watershed) to naturally retain and absorb runoff. Maintain and restore wetland function to achieve similar benefits.
7. Increase green-infrastructure installations in parks, new developments, and on existing residential and commercial properties. Incorporate nature-based solutions such as rain gardens, bioswales, infiltration trenches, and permeable pavement to capture, absorb, and filter runoff. Use tools such as stormwater utility credits, rate adjustments, and recognitions to reward action.

Top direct-impact actions from *Renew the Blue* stakeholder-action guide

RENEW THE BLUE

As we move forward with *Renew the Blue*, several initiatives are already underway to improve our watershed.

DANE COUNTY

- Laying the groundwork to quadruple its manure-treatment capabilities (see story page 50)
 - Expanded the Door Creek Wildlife Area by 128 acres near Lower Mud Lake while budgeting another \$10M for future land acquisitions
 - Launched the next phase of “Suck the Muck” to excavate legacy phosphorous from area streambeds, removing an estimated 25,000 tons of sediment from Sixmile Creek north of Lake Mendota
- ## CITY OF MADISON
- Adopted a first-of-its-kind ordinance requiring that excessive residual salt be removed from public sidewalks (not specifically addressed in *Renew the Blue*, but important for protecting vulnerable aquatic life)
 - Created its third, permeable-pavement street near Midvale Elementary School to better infiltrate runoff
 - Increased native plant diversity in stormwater-treatment systems, improving runoff infiltration and pollinator habitat

YAHARA WATERSHED IMPROVEMENT NETWORK (YAHARA WINS)

- Significantly increasing financial support to farmer-led groups working to grow participation and the cost sharing of eligible conservation practices like manure composting

TOWN OF WESTPORT

- Strengthened its stormwater and erosion-control ordinance following *Renew the Blue* guidelines
- Purchased and permanently protected 105 acres of conservation land stretching from Governor Nelson State Park to State Highway 113 on the north side of Lake Mendota

MADISON METROPOLITAN SEWERAGE DISTRICT

- Deploying low-disturbance biosolid injection to better protect soils while limiting erosion and phosphorus runoff on participating farms

NATIONAL, STATE, AND LOCAL REALTORS' ASSOCIATIONS

- Financially contributing to a Clean Lakes Alliance-commissioned study quantifying the economic value and impact of the Yahara lakes (important for building awareness and action)

FRIENDS OF LAKE KEGONSA SOCIETY (FOLKS)

- Initiated expanded phosphorus monitoring around Lake Kegonsa to help pinpoint problem areas
- Continued fall leaf vacuuming around the lake in cooperation with the City of Stoughton, Town of Dunn, and Town of Pleasant Springs



Flooding at Governor's Island on Lake Mendota in 2018

1. WEATHER & CLIMATE DRIVERS



Weather variability and longer-term climate trends impact our lakes in many ways. For example, the timing and intensity of rainfall and snowmelt largely dictate how much runoff reaches the lakes and what it can carry along the way. Rain during a mild winter over frozen ground produces more runoff than if the rain fell during the summer when plants are actively growing. And while wetter years can transport more pollutants as surface runoff through the watershed’s drainage system and into the lakes, droughts will have the opposite effect.

Long-term climatological data show a region that is getting wetter and warmer. According to the Wisconsin Initiative on Climate Change Impacts (WICCI), the last two decades have been the warmest on record, and the past decade has been the wettest, with average annual precipitation increasing 17 percent (about five inches per year) since 1950.

Increasing rainfall volume and intensity represent an unwelcome trend that can negatively affect the performance of many conservation practices. In addition, warmer winters are leading to greater runoff and phosphorus delivery as liquid precipitation falls across frozen soils, especially where winter manure spreading occurs. The longer-term precipitation trend finally broke in 2021 and the first half of 2022. As a result of this short drought period, less surface runoff occurred, causing total phosphorus delivery to be lower than normal. This contributed to lake conditions that were generally more favorable. It speaks to the lakes’ responsiveness to reduced, external (watershed-sourced) phosphorus inputs and the rationale behind reduction goals.

2. WATERSHED PHOSPHORUS MASS BALANCE



Calculating the difference between the mass of phosphorus entering (imported into) and leaving (exported from) the watershed tells us whether the net balance is trending in the right direction. The goal is to attain a negative balance, indicating more phosphorus is being exported than imported on an annual basis. This situation reduces the overall availability and potential of phosphorus to reach area waterways.

Conversely, a positive balance points to an annual net accumulation of phosphorus in the watershed, usually leading to its gradual buildup in area soils. Phosphorus-saturated soils subject to erosion from farm tillage or a lack of protective, year-round plant cover can eventually end up at the bottom of nearby lakes and streams. Phosphorus is also more easily “leached” (or released in dissolved form) from such soils when in contact with rainwater and snowmelt. Dane County’s stream-dredging project, commonly referred to as “Suck the Muck,” is designed to remove this sediment-bound phosphorus that has accumulated in stream channels.

According to Eric Booth, author of *Phosphorus Flows and Balances for the Lake Mendota and Yahara River Watersheds: 1992-2017*, there was a notable decline in annual net phosphorus accumulation over the study period, but with plenty of room for continued improvement (Figure 3). The study looked at how much phosphorus in animal feed, fertilizer, and other phosphorus sources was imported annually into each watershed compared to how much phosphorus was leaving through the export of crops, livestock products, manure compost, and stream outflow. The difference between inputs and outputs is the change in storage or mass balance for the given watershed.

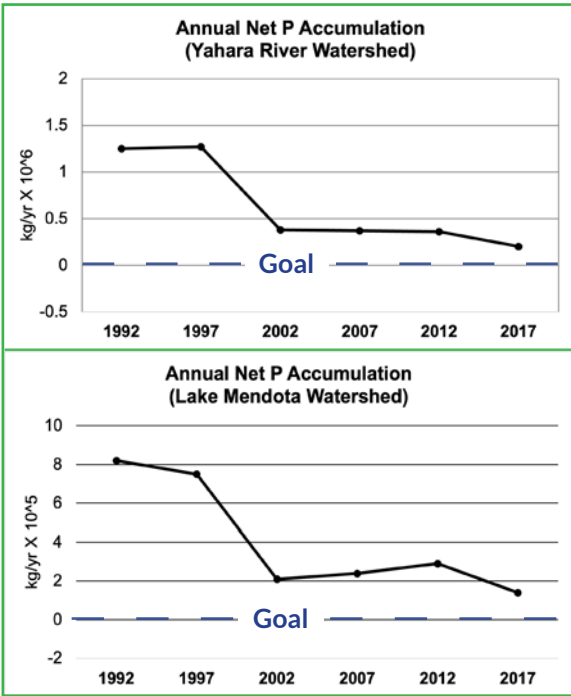


Figure 3: Watershed phosphorus mass balances in the Yahara River (top) and Lake Mendota (bottom) Watersheds. See Figure 1 for the Lake Mendota Watershed, located in the northern portion of the larger Yahara lakes watershed. Research credit: Eric Booth, Ph.D., Associate Scientist, UW-Madison Department of Agronomy and Department of Civil & Environmental Engineering

The most precipitous decline, observed between 1997 and 2002, is attributed to a decrease in imported commercial fertilizer and less phosphorus-containing feed supplements consumed by livestock. However, a growth in livestock numbers and milk production beginning in 2002 caused earlier declines to flatten or reverse, even masking the positive effects of advanced phosphorus-management and removal strategies implemented by the Madison Metropolitan Sewerage District. While bans on phosphorus-containing lawn fertilizers (2005) and household detergents (2007) helped to moderate these livestock-production impacts, it was the start of Dane County-subsidized manure digestion and associated compost export (2012) that saw accumulation rates begin to once again trend downward for both watersheds.

Booth explains that not all phosphorus accumulation is the same. The amount of risk depends on where it is accumulating and how "slippery" it is on land. He points out that the watershed is a leaky system and phosphorus tends to move around. "Reducing the transport of that slippery phosphorus from land to water is a key strategy. While many are working diligently on this through various conservation practices, we also need to treat the strategy of reducing phosphorus accumulation as an equal complement," said Booth. "If phosphorus accumulation is not addressed, it will pose a long-term risk to water quality and can frustrate future efforts."

3. LAND CONSERVATION PRACTICES



According to the Wisconsin Initiative on Climate Change Impacts (WICCI), the combination of warmer winters, wetter springs, and extreme weather events is impacting agricultural production throughout the state and overwhelming conservation practices designed to keep soil in place and protect water quality. WICCI's latest report recommends regenerative adaptations that build landscape resiliency. Examples include preserving and increasing grasslands and natural vegetation by limiting their conversion to row-crop production or urban development; planting more cover crops on farm fields; and raising livestock on rotationally-grazed pastures.

Considerable progress has been achieved to-date with the adoption of conservation practices throughout the watershed, including among many of those listed on page 56. Thanks to the ongoing leadership and support of many governmental, nonprofit, and private-sector partners, the cumulative effect of these actions is largely holding the line against several growing headwinds described in this report.

One example of a practice making a big difference comes from Kyle Minks of the Dane County Land & Water Resources Department. He reports the continued increase of farmland acreage under nutrient management plans. This tool is used by agricultural producers to understand how on-farm operational decisions can improve efficiencies while minimizing soil and phosphorus loss. Based on landowner records filed with the County (an under-representation of the total amount of watershed acres under nutrient management planning), 40,547 out of roughly 97,000 agricultural acres in the Yahara lakes watershed were mapped as



Highland Spring Farm in Oregon, WI uses rotational grazing with its Scottish Highland cattle

having a nutrient management plan in 2021 – a 25% increase over numbers mapped in 2016. Dane County is also actively working to significantly expand manure-processing capacity in the watershed, among other water quality-improvement initiatives. If successful, the increased manure treatment will help address a primary source of phosphorus pollution to the lakes, especially during late winter and early spring when manure spreading is most susceptible to runoff.

4. PHOSPHORUS DELIVERY TO THE LAKES



When phosphorus accumulates in the watershed, it is easier for it to build up in area soils where it puts local waterways at risk. Most phosphorus is delivered to the Yahara chain of lakes through tributary streams that collect and channel upland-generated runoff as it moves downhill. How much is transported depends on multiple factors. The seasonal timing and intensity of runoff events, the location and availability of major phosphorus sources, and measures taken to contain those sources and manage runoff all affect the delivery process.

Stream monitoring may be used to evaluate the effectiveness of conservation practices by tracking phosphorus loading. Loading describes the total mass of phosphorus delivered to a specific location in a stream over time. In our case, we characterize loading in pounds of phosphorus (calculated by multiplying in-stream concentrations by streamflow) delivered through Lake Mendota's monitored stream tributaries in a given water year (Oct. 1 – Sep. 30).

**LAKE MENDOTA:
BELLWEATHER 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 outlets of the upper lakes as it cascades through the system.



Pheasant Branch Creek flowing into the west side of Lake Mendota, courtesy Robert Bertera

Figure 4 shows the change in stream-monitored phosphorus loading to Lake Mendota since 2013. Total precipitation is also plotted in orange to distinguish between wet and dry years. In both 2021 and 2022, phosphorus loading to Lake Mendota significantly declined. This was largely due to recent drier weather after years of above-average precipitation, reducing the amount of runoff and phosphorus delivery.

Based on the most recent 10 years of phosphorus loading data, there is a 56% gap between the annual average load to Lake

Mendota over this period and the goal of 32,600 pounds per year. Scientists estimate a doubling of summer days when the lakes are clear and free of algal blooms if this lower average loading goal can be achieved. However, this objective remains elusive due to the increasing volume of runoff and streamflow from a wetter climate that is bringing more phosphorus into the lakes.

"The good news is that if runoff and streamflow volumes had not changed, modeling indicates a significant decline in phosphorus loadings would have occurred over the last 30 years. This is due,

in part, to increased adoption of conservation practices that have decreased the concentration of phosphorus in runoff," said Matt Diebel of the U.S. Geological Survey and former chair of the Yahara CLEAN Compact's scientific advisory committee. In other words, the long-term trend of wetter weather and increased runoff is counteracting the positive effects of these practices under their current rate of adoption.

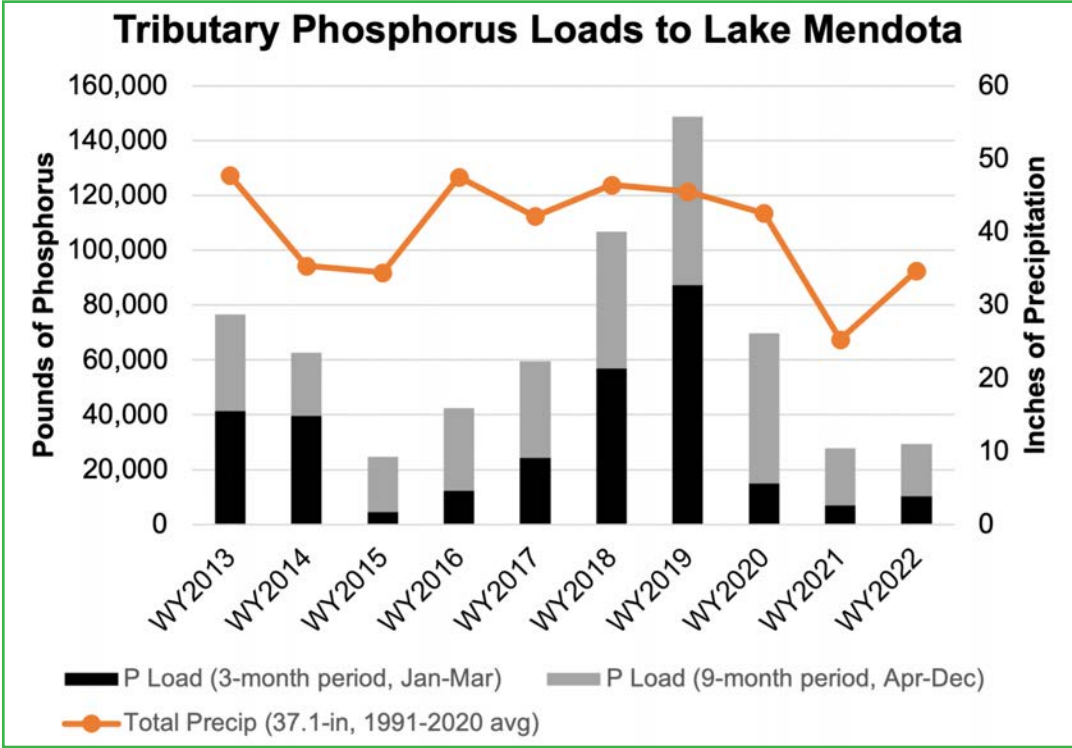


Figure 4: Phosphorus loading through Lake Mendota's monitored stream tributaries relative to total precipitation. Monitored streams include Pheasant Branch Creek, Dorn Creek, Sixmile Creek, and Yahara River at Windsor. January to March (shown as black bars) is historically the 3-month period of highest phosphorus delivery to the lakes. Phosphorus-loading data credit: Todd Stuntebeck, U.S. Geological Survey. Precipitation data credit: NOAA Regional Climate Center, Dane County Regional Airport

5. IN-LAKE WATER QUALITY RESPONSES



Several in-lake metrics are used to assess overall lake health and track changes over time. Those metrics include water clarity, phosphorus concentration, presence of cyanobacteria (blue-green algae) blooms, and beach closures. Each is summarized below. Generally, most of the lakes fared relatively well in 2022. Lake Kegonsa, the shallowest and most downstream lake in the chain, was the exception with respect to median phosphorus concentration, nearshore clarity, and cyanobacteria bloom sightings.

Mid-Lake Clarity & Phosphorus Concentrations

Water clarity readings are taken by lowering a Secchi disk from the surface over the deepest point in each lake. The depth at which the disk can no longer be seen is known as its Secchi transparency. As shown in Figure 5, summer median clarity values in 2022 were indicative of "good" water quality conditions in lakes Monona, Wingra, and Kegonsa. Summer clarity was borderline "good" in Lake Mendota and "fair" in Lake Waubesa.

Because the amount of algal growth in the lakes is usually influenced by the availability of phosphorus as its main fuel source, clarity changes often mirror changes in phosphorus concentrations. In the case of Lake Wingra, the continuation of favorable water clarity may likely be attributed to a major carp-removal effort in March of 2008. The non-native carp stir up the lake bottom and uproot aquatic plants through their feeding behaviors.

In 2022, summer median phosphorus concentrations were indicative of "good" to "excellent" conditions for lakes Mendota, Monona and Wingra (Figure 6). The lakes lower in the chain did not fare as well, with Waubesa classified as "fair" and Kegonsa as "poor." According to Richard Lathrop of the UW-Madison Center for Limnology, "Lake Kegonsa's concentrations were very high with dissolved phosphorus elevated way above analytical detection. This means summer algal growth in the lake was not limited by how much phosphorus was available. In contrast, the upstream lakes, including shallow lakes Wingra and Waubesa, had undetectable levels of dissolved phosphorus as algae effectively utilized available supplies."

Recent drought years continue to have a positive effect on in-lake phosphorus concentrations. Lake Mendota's concentrations after

fall turnover hit a record low in 2022, a consequence of less runoff and external phosphorus loading (Figure 7). Turnover occurs when deeper lakes cool to the point where the water column can completely mix, usually around early November. This seasonal phosphorus index is thought to offer a better estimate of Lake Mendota's phosphorus status. During turnover, high phosphorus concentrations accumulating in the lake's bottom waters are mixed throughout the lake.

Fall turnover phosphorus concentrations were also low in 1988 and 2012 following those extended droughts. "This is good evidence that Lake Mendota's phosphorus status declines when external loads are low with benefits that should cascade down through the lower Yahara lakes," said Lathrop. He says this shows the lakes can respond quickly and positively when phosphorus inputs are reduced. In addition, he points to 2008 and 2018-19 as high-loading years after which Lake Mendota's phosphorus status quickly recovered. This reveals that internal (in-lake) loading does not continue to maintain the lake's high phosphorus concentrations.

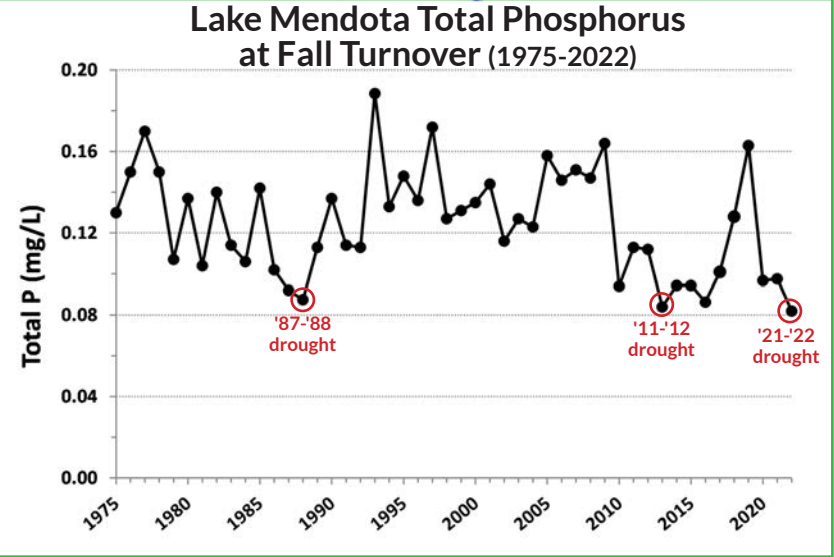


Figure 7: Lake Mendota total phosphorus concentrations at fall turnover measured at the lake surface. Credit: Richard Lathrop, UW-Madison Center for Limnology

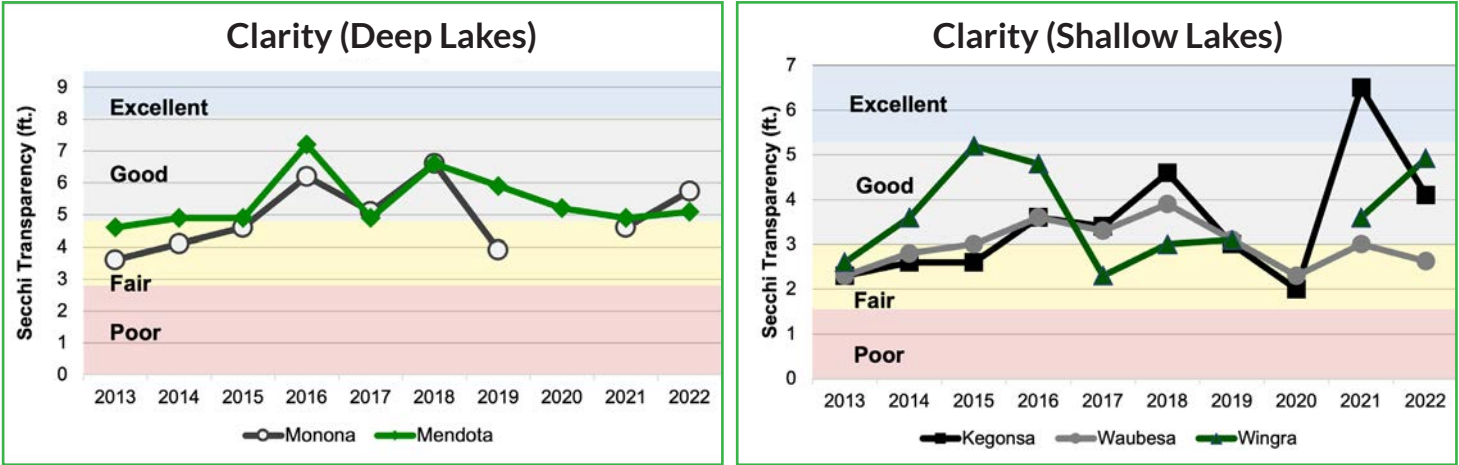


Figure 5: Median summer (Jul-Aug) water clarity readings and corresponding water quality classifications by lake type. Notes: Water clarity information was not available for Lake Monona and Lake Wingra in 2020. Water quality classifications based on Wisconsin Department of Natural Resources' criteria. Data credit: Richard Lathrop, UW-Madison Center for Limnology

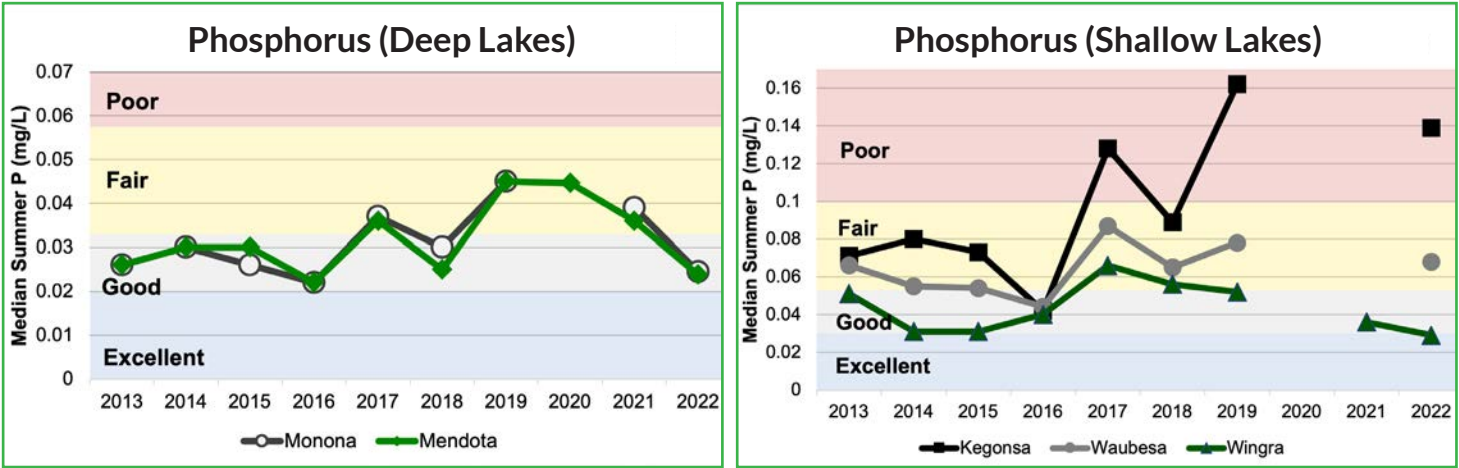


Figure 6: Median summer (Jul-Aug) phosphorus concentrations and corresponding water quality classifications by lake type. Notes: Phosphorus sampling was not performed in lakes Kegonsa, Waubesa, and Wingra in 2020, and in lakes Kegonsa and Waubesa in 2021. Water quality classifications based on Wisconsin Department of Natural Resources' criteria. Data credit: Richard Lathrop, UW-Madison Center for Limnology



Clear water on the southeast shoreline of Lake Monona shows a lake-mixing phenomenon known as langmuir circulation. The windrows of white foam show where upwelling is occurring as a result of wind-driven mixing.

LAKEFORECAST MONITORING

Clean Lakes Alliance’s volunteer water quality monitoring program continues to thrive as we enter our 11th year of water sampling. This program relies on the power and passion of trained volunteers to submit real-time water quality information to our free app, LakeForecast, so lake users can be informed about the conditions of their favorite beaches across the five Yahara lakes.

In 2022, Clean Lakes Alliance utilized 96 monitors to cover 87 nearshore and seven offshore locations throughout the watershed, including all 25 public beaches in the area.

Volunteers begin every summer with training on how to measure turbidity (an indicator of water clarity), water temperature, waterfowl presence (a source of *E. coli* bacteria), and perhaps most important, the presence of cyanobacteria (blue-green algae). Cyanobacteria can have detrimental effects on human and pet health, as well as aquatic life.

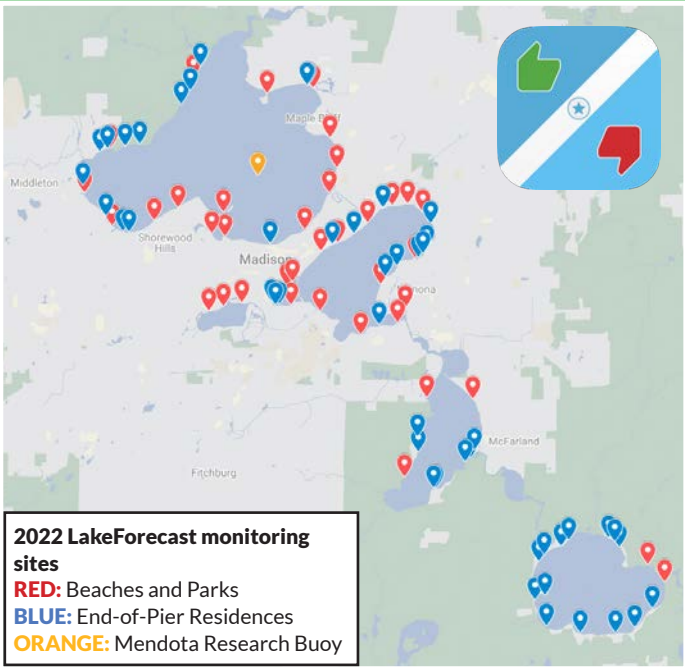
The purpose of the LakeForecast water quality monitoring program is not only to gather useful information on the state of our lakes, but also to let community members know when our lakes are safe to enjoy through beach-closure reports. Learn more about what Clean Lakes Alliance is doing to gather more data specifically on cyanobacteria blooms below.

BLOOMOPTIX

There are certain visual clues that indicate a cyanobacteria bloom: murky, sometimes stinky, floating scum that looks like paint spilled across the surface of the water. But it is incredibly difficult to determine what specific strains and concentrations of bacteria are causing the blooms just by looking at it with the naked eye. For that, microscopes and lab analysis are needed which can be cumbersome, time sensitive, and costly.

To make this process more accessible, companies like BloomOptix are working to create software that use microscopic images taken of harmful algal blooms (HABs) to determine what types of cyanobacteria are present in a more timely, cost-effective manner. Clean Lakes Alliance partnered with BloomOptix in the summers of 2021 and 2022 to be a part of their HABAlert Pilot Program to grow their stock of algal bloom images that helps the software to fine-tune itself.

Clean Lakes Alliance-trained volunteers from our LakeForecast program used pocket-sized microscopes to take photos of algal blooms they noticed at their monitoring sites. These images were then uploaded to the BloomOptix app to determine what strains and quantities of bacteria were present during various algal bloom events. This information is helpful as lake managers, researchers, and other interested parties look to find solutions. The HABAlert Pilot Program aims to be a resource for any entity wanting to learn more about their local blooms. The more information we can gather, the more we can move forward in mitigating these beach-closing phenomena in the first place.



Lake	2015	2016	2017	2018	2019	2020	2021	2022	Median (2015-2022)
Mendota	84.7	95.7	89.7	95	92.4	92.9	80.7	87.8	92.4
Monona	94.5	100.6	100	102.8	82.5	92.6	84.1	101.6	94.5
Wingra	107.3	102.8	70.5	81.5	75.1	100.9	102	111.3	100.9
Waubesa	90.4	95.5	91	99	85.5	86.2	80	82.35	90.4
Kegonsa	85.7	77.5	85.6	78.6	84.7	67.7	79.2	78.9	79.2

Table1: Average nearshore clarity on each lake relative to the eight-year median.
Note: Units shown in centimeters as measured by a 120-cm turbidity tube.

Nearshore Clarity & Cyanobacteria Blooms

Clean Lakes Alliance trains and coordinates a network of volunteer monitors who also track water quality changes as part of its LakeForecast program (page 62). In 2022, monitors submitted 2,094 lake-condition reports. The bulk of these reports provide real-time information on the status of nearshore areas where most people interact with the water. Clarity, water temperature, and cyanobacteria bloom evidence are among the water quality parameters evaluated. The data complement center-of-the-lake measurements, painting a more complete picture of how conditions can vary over time and space.

Volunteer monitor reports indicated a relatively good year for the lakes for nearshore clarity and cyanobacteria bloom evidence, except for Lake Kegonsa that had an above-average number of bloom sightings (Figure 8). Lakes Mendota, Monona, and Waubesa had some of the lowest reports of strong cyanobacteria blooms since LakeForecast monitoring began in 2013. For the first time since 2014, Lake Mendota lasted the entire season without a single

report of a strong cyanobacteria bloom. Lake Wingra had only one day of strong cyanobacteria presence reported in early July. In stark contrast to the other Yahara lakes, Lake Kegonsa volunteers reported strong blooms on 31% of all sample days (May-September).

Compared to 2021, all lakes except Kegonsa showed improvement in average nearshore water clarity and were representative of "good" conditions as defined by Clean Lakes Alliance (Table 1). Lakes Monona and Wingra reported particularly high average clarity that was greater than their respective long-term medians. Lake Kegonsa, despite increased cyanobacteria bloom sightings, reported similar average clarity to 2021 and only slightly less than the 2015-2022 median. The lake's shallower depth and its low-elevation watershed position likely contribute to its lower nearshore clarity readings. Water clarity for most lakes generally decreases throughout the summer with a peak decline in August. Lakes Monona and Wingra deviated from this pattern by exhibiting relatively high clarity readings throughout the monitoring season (Figure 9).

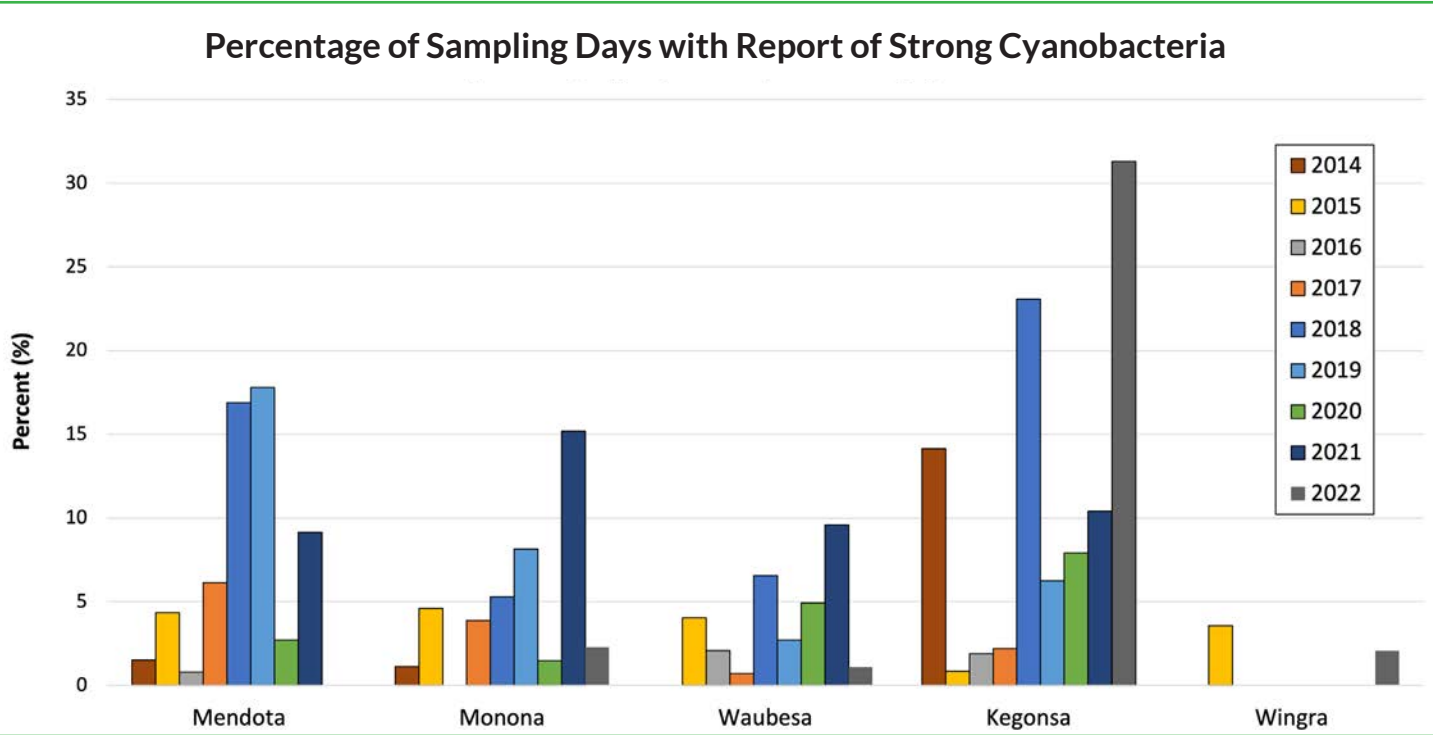


Figure 8: Percentage of sampling days with report of strong evidence of cyanobacteria shown by lake and year



Cyanobacteria bloom spotted on Lake Monona near the Monona Terrace Community & Convention Center in 2022. Photo courtesy Robert Bertera

Beach Closures

Beach closures prompted by observed and measured water quality concerns are another useful indicator of general lake health. Clean Lakes Alliance looks at closure data provided by Public Health Madison & Dane County for 17 beaches (Figure 10). Covering four of the five Yahara lakes, these tested public beaches were selected due to the consistency of tracking data over the prior 10-year period. Results are reported as total closure days recorded for each season, roughly running from Memorial Day to Labor Day. For example, if two beaches on a given lake are closed for a total of five days each, 10 closure days would be reported for that lake.

Closures are most often the result of high cyanobacteria and/or *E. coli* bacteria levels, with closure rates strongly influenced by timing

and frequency of testing. Most beaches are tested once per week and then daily for beaches with a closure in effect. Cyanobacteria blooms, which are generally a product of high lake fertility, can be dangerous due to their potential to release toxins that can harm people, pets, and wildlife. High *E. coli* bacteria concentrations, on the other hand, indicate the presence of human or animal fecal matter that often carries pathogens that can cause illness.

In 2022, there were 91 beach-closure days reported, which is below the long-term median. Closures were relatively split between cyanobacteria and *E. coli* as the causes. This follows a year with a record 267 closures, with most occurring on Lake Monona.

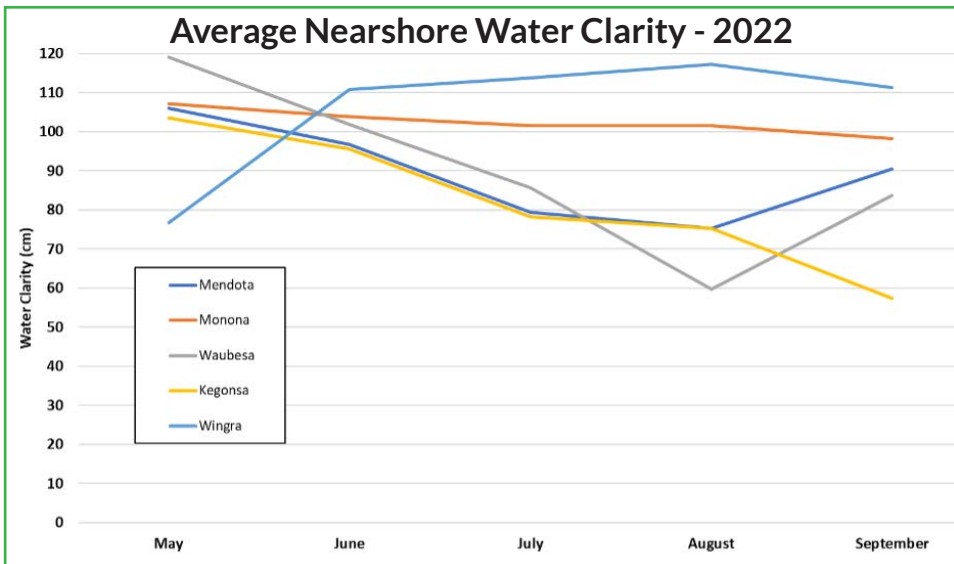


Figure 9: 2022 average water clarity by month for each lake using a 120-cm turbidity tube

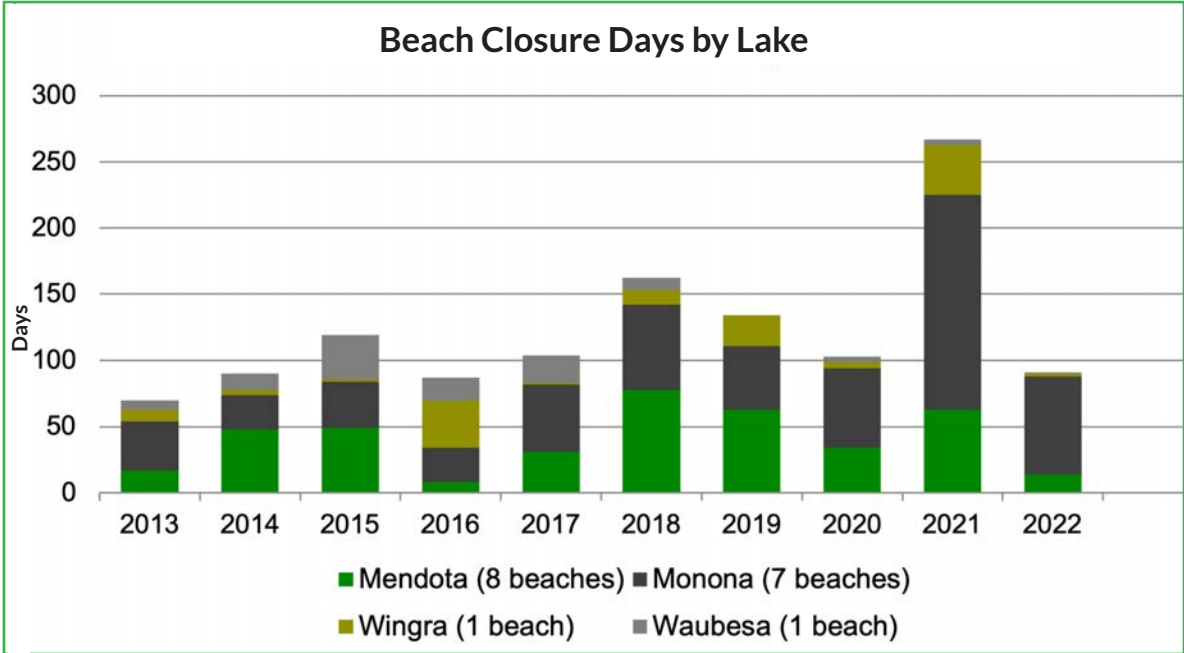
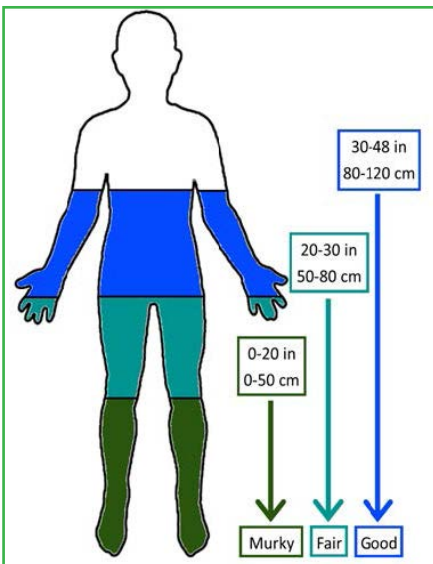


Figure 10: Beach closure days by lake. Includes beaches consistently monitored since 2013. Lake Mendota: Governor Nelson, Warner, Mendota County, James Madison, Memorial Union (pier), Marshall, Tenney, and Spring Harbor; Lake Monona: B.B. Clarke, Bernie's, Brittingham, Esther, Hudson, Olbrich, Olin; Lake Wingra: Vilas; Lake Waubesa: Goodland County; Lake Kegonsa: None. Data credit: Public Health Madison & Dane County

TALE OF TWO WATERSHEDS

The path to recovery rarely follows a straight line and disconnects sometimes happen between celebrated action versus how and when the lakes might respond. There will be successes and setbacks, good times and bad, and progress that elicits both hope and disappointment. All in all, the lakes belong to a watershed community that cares, collaborates, and acts. We value the health of our lands and waters. We also possess the knowledge and motivation to be effective stewards. Only time will tell if we are headed in the right direction through our investments and actions – a reality that can often lead to frustration among the people working toward cleaner lakes.

A recent article from Adam Hinterthuer at the UW-Madison Center for Limnology addressed this frustration, responding to an exasperated resident who wrote in to say they were sick of all the studies with no better water quality.

Hinterthuer began his post by quoting Victor Hugo – "Science says the first word on everything and the last word on nothing."

He then continued, "Yes, science can tell us about the current state of our lakes and explain how they got that way and offer suggestions

for how we head in a different direction. But that's where science stops. It rarely gets the final say. It's up to society to take it from there. Policymakers, resource managers, business leaders, and (perhaps the biggest agent of change) concerned citizens, are the actors that then get involved. When it comes to informed decision making, science provides the info. Society makes the decision."

The "last word" is up to us. While annual *State of the Lakes* findings may at times send mixed messages, significant inroads are being made by many people and groups working for cleaner lakes. The guidance and tools are there, and we as stakeholders are called upon to play a positive role and leverage what is already working. If that happens, the days of consistently clear water, open and safe beaches, and a thriving lake community will certainly lie ahead and not behind us.

The *Renew the Blue* plan gives us hope that this is possible. As pointed out in Chapter 2 of that plan (State of the Science), "Even gradual change may produce noticeable improvements in water quality before the [phosphorus loading] target is met." A welcome conclusion in a world full of uncertainty.



Paddling near Brittingham Boats on Monona Bay with members of Madison Magnet and Out Professional Engagement Network (OPEN)



CLEAN BOATS, CLEAN WATERS

In 2022, Clean Lakes Alliance received funding from the Wisconsin Department of Natural Resources to participate in its first season of the Clean Boats, Clean Waters (CBCW) program. CBCW is a state-wide aquatic invasive species (AIS) prevention program aimed at increasing awareness among boaters, anglers, and general lake users on best practices to prevent the further spread of AIS at our local boat landings.

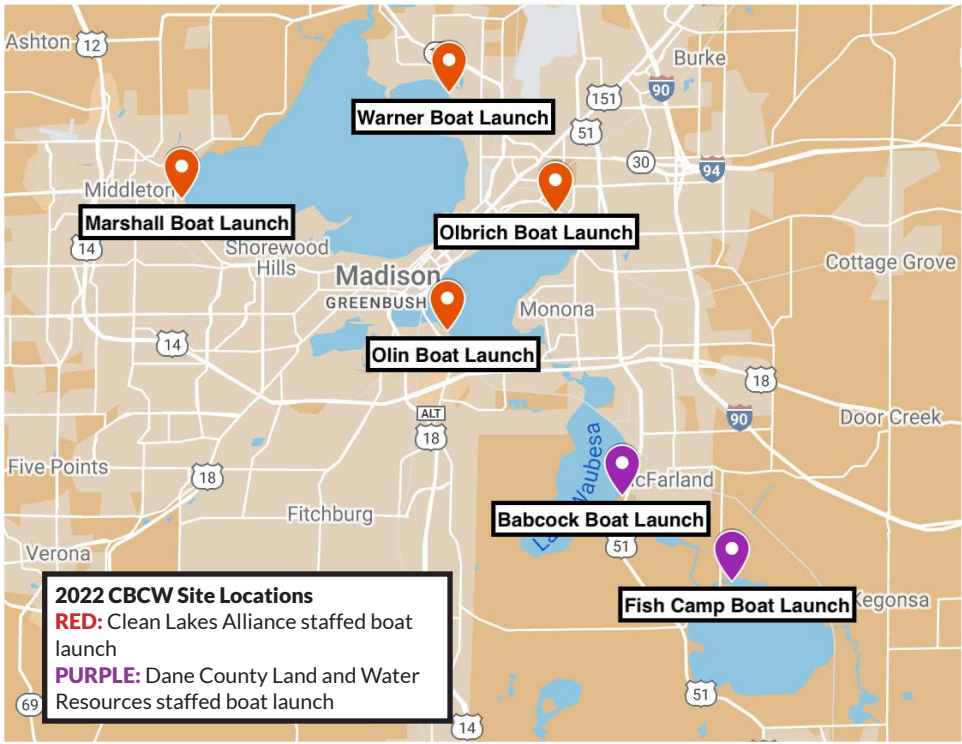
Aquatic invasive species can have broad and detrimental effects on our lakes. Their presence comes with severe economic and ecological impacts: spiny water flea populations worsen algal blooms; Eurasian watermilfoil reduce dissolved oxygen levels in the water; and zebra mussels alter food webs and damage lake infrastructure. Many AIS can move to new water bodies by “hitchhiking” on watercraft and surviving inside undrained live wells. To address the issue, trained inspectors offered courtesy boat and trailer inspections on the Yahara lakes at four of the busiest boat launches: Olin, Olbrich, Marshall, and Warner. Clean Lakes Alliance also coordinated with the Dane County Land and

Water Resources Department which covered two additional locations on Lake Waubesa (Babcock Boat Launch) and Lake Kegonsa (Fish Camp Boat Launch).

The CBCW program's courtesy watercraft inspections serve as a front-line defense to the threat of emerging AIS. Educating lake users on how to identify and report AIS, as well as how to implement best management strategies when moving watercraft between water bodies, provides additional safeguards for the lakes when it comes to harmful invasives.

2022 HIGHLIGHTS

- Hired and trained 3 watercraft inspectors
- Staffed 4 boat landings
- Invested 433 inspection hours from Memorial Day to Labor Day
- Interacted with 3,615 lake users



The CBCW program utilizes the guidelines established in NR 40 (a DNR invasive species rule making it illegal to possess, transport, transfer, or introduce certain invasive species in Wisconsin without a permit) to prevent the spread of invasive species. The rule establishes “preventive measures” to highlight what actions boaters can take to slow AIS spread. For all boaters, paddlers, and anglers, the following rules apply:

- INSPECT your boat, trailer, and equipment
- REMOVE any attached aquatic plants or animals (before launching, after loading, and before transporting on a public highway)
- DRAIN water from boats, motors, and equipment
- NEVER MOVE live fish away from a waterbody
- DISPOSE of unwanted bait in the trash
- BUY minnows from a Wisconsin bait dealer

Below is a table summarizing AIS currently found within the Yahara lakes, highlighting the importance of measures to prevent their spread or introduction. The data collected from inspectors showed that 10% of boaters using Lake Mendota or Lake Monona boat launches had used their watercraft on another waterbody within the last 5 days. Many AIS species can survive on watercraft, trailers, motors, live wells, and equipment for several days after you leave the boat launch.

LEARN MORE: cleanlakesalliance.org/clean-boats-clean-waters



AQUATIC INVASIVE SPECIES IN THE YAHARA LAKES

	Spiny Water Flea	Zebra Mussel	Chinese Mystery Snail	Banded Mystery Snail	Eurasian Water-milfoil	Curly Leaf Pondweed	Purple Loose-strife	Water Lettuce	Aquatic Forget-me-not	Yellow Iris
Lake Mendota	✓	✓			✓	✓		✓		
Lake Monona	✓	✓	✓	✓	✓	✓				
Lake Wingra					✓	✓	✓		✓	✓
Lake Waubesa	✓	✓	✓		✓	✓	✓			
Lake Kegonsa	✓	✓			✓	✓				

Source: Wisconsin Department of Natural Resources

WHAT DID YOU ENJOY MOST ABOUT BEING A WATERCRAFT INSPECTOR?

“I enjoyed how much I learned about invasive species management, and also the specific issues that face the Yahara Watershed. I’m someone who likes to learn and then be able to effectively communicate with others about these types of issues, and the CBCW program gave me the information to do that.” – Chloe Czachor



“Getting to interact with the public and converse about scientific concepts was the most enjoyable part for me. It was great practice talking about AIS while making them more understandable to a wider audience. I also enjoyed being able to go to different boat landings and enjoy the fresh air and the environment.

Lastly, I enjoyed understanding how the public connected with the lake and, time permitting, have a great talk about their time on the lake – whether it be fishing or just casual boating.” – Pharaoh Graham

“I enjoyed being able to work outside for my summer. I think working outside, or even being outside for long periods of time in nature is something that is getting harder for people to do as time goes on.” – Alyssa Martin

