

## WHAT CLOSED OUR BEACHES?

A look at beach closure data and the cause of closures

PG. 43

## LAKE BY LAKE REPORT

A breakdown of the state of each of the Yahara lakes

PG. 45 - 49



# 2019 STATE OF THE LAKES



Volunteer water quality monitor training on Lake Mendota

# STATE OF THE LAKES

WHAT HAPPENS ON THE LAND, IMPACTS THE LAKES



View of Wisconsin State Capitol over Lake Mendota

The Yahara River Watershed encompasses lakes Mendota, Monona, Wingra, Waubesa, and Kegonsa, and is home to a fast-growing population and some of the most productive farmland in the United States. The intersection of productive farms and growing urban areas presents unique challenges as we work to improve water quality.

Lake water quality is a reflection of the health of the landscape. Many of the decisions we make on the land impact the health of our lakes, from how we manage manure, to how much winter salt we use.

At Clean Lakes Alliance, we focus on curbing the biggest culprit of our water quality problems—phosphorus runoff that results in the excessive growth of potentially toxic cyanobacteria (also known as blue-green algae). Phosphorus that makes its way into our surface waters is found in leaves, soil, and animal waste. It is found at higher than natural levels in our lakes because of how we use and manage surrounding lands. The trend toward more frequent and intense rainstorms and winter snowmelt only exacerbates the situation by generating more runoff that carries phosphorus to our lakes. The total amount of phosphorus entering the lakes is called “loading.”

The following *State of the Lakes Report* shows the impact of phosphorus on lake water quality and beach closures in 2019. Each lake has a unique story, but overall, it was another challenging year for our lakes. Water clarity ranked “good” and phosphorus levels ranked “fair” for most of the lakes, according to Wisconsin Department of Natural Resources (DNR) criteria, and there were a comparatively

large number of beach closures. These conditions can be tied in part to wetter than normal weather. Large runoff events, especially in the late winter when the ground was frozen, contributed to the highest annual phosphorus loading since the 1990s. Overall, phosphorus loading was 40% higher than 2018 when we had massive flooding. 2019 also saw 146 days of beach closures, or 39 more closure days than the long-term median (2010-2019). Cyanobacteria blooms were the primary cause of the 2019 beach closures, and were likely made worse by invasive zebra mussels. Zebra mussels (see page 26) consume free-floating algae and zooplankton, but they leave cyanobacteria—which compete for the same nutrients and sunlight—largely untouched.

If land management surrounding our waters does not change to accommodate an increasingly wet climate with more extreme rain events, our lakes are likely to continue to experience poor water quality. These challenges are why Clean Lakes Alliance is advocating for and investing in individual and community actions through the Yahara CLEAN (Capital Lakes Environmental Assessment and Needs) Compact. This coalition of government, nonprofit, and industry association leaders is working together to update lake-improvement recommendations and accelerate the adoption of effective solutions. We also worked with partners to develop an at-home actions guide for improving the watershed (pg. 20 - 21), raised money to support conservation practices on farmland, and promoted leaf-free streets (the largest source of urban phosphorus pollution).

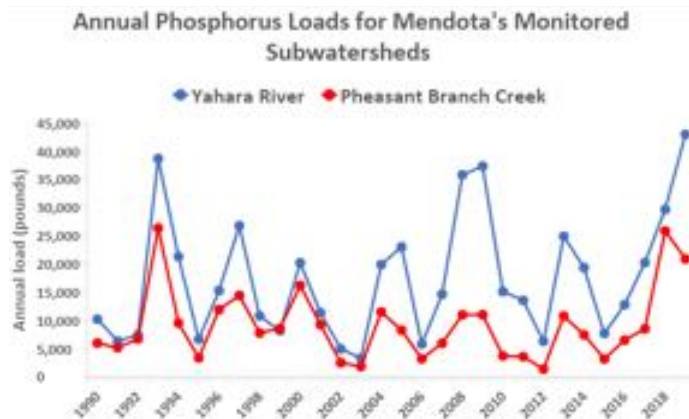


# YAHARA RIVER WATERSHED

THE STATE OF OUR LAKES IN 2019

## ABOUT THE WATERSHED

- » The Yahara River Watershed begins in the headwaters of the Yahara River in Columbia County, and encompasses lakes Mendota, Monona, Wingra, Waubesa, and Kegonsa throughout Dane County. The Yahara River then empties into the Rock River in Rock County.
- » Invasive species like zebra mussels and the spiny water flea are impacting the food web in the lakes, creating conditions that favor cyanobacteria blooms during hot, calm conditions.
- » Conservation practices and manure management on farmland and green infrastructure in urban areas (like rain gardens) help make our watershed more resilient while keeping phosphorus out of the lakes.



**Figure 1:** Annual phosphorus loading to Lake Mendota from 1990-2019 as measured at the U.S. Geological Survey's monitoring stations on the Yahara River (at Windsor, WI) and Pheasant Branch Creek (at Parmenter Street in Middleton, WI). Loading was at record levels in 2019 largely due to an unusually large snowmelt in March of 2019. Source: T. Stuntebeck, U.S. Geological Survey & R. Lathrop, UW Center for Limnology

## WHAT HAPPENED IN 2019?

### RECORD LEVELS OF PHOSPHORUS FLOW INTO LAKE MENDOTA

- » 2019 was the 5th wettest year on record in the region, with greater than normal total precipitation and heavy rain events recorded at the Dane County Regional Airport. All the lakes were above their summer maximum water levels for a majority of the summer (May 1 - October 30).
- » Rivers and streams flowing into Lake Mendota carried phosphorus into the lake in record amounts, the highest levels since intensive monitoring began in the late 1980s, and more than double the long-term average (see Figure 1).
- » The majority of phosphorus loading to the lakes occurred during an unusually large snowmelt period in March.

### CONSERVATION PRACTICES ARE MAKING A DIFFERENCE

- » Separating out the effect of streamflow on water quality allows us to see the impact of watershed management, such as the adoption of conservation practices by landowners, over the past 30 years.
- » According to an analysis by Matt Diebel of Dane County Land & Water Resources Department, if weather-related streamflow had not increased and did not vary from year to year, estimated phosphorus inputs to Lake Mendota would have decreased by 36% during the period 1990-2019, suggesting conservation practices would have been effective in an unchanging climate.



Rain garden



Low-disturbance manure injector

## WHAT IMPACTS WATER QUALITY?

- » Phosphorus, a nutrient found in soil, manure, leaves, and organic matter, enters the lakes in runoff and fuels algal blooms. The amount delivered into the lakes can vary greatly from year to year due to variations in land use and runoff-producing weather events. Reducing phosphorus in the upper lakes (Mendota, Monona, and Wingra) is essential to reducing it in the lower lakes (Waubesa and Kegonsa) as phosphorus flows downstream and accumulates.
- » Late winter runoff events, when rain falls on frozen ground and cannot infiltrate into the ground, are when most of the annual phosphorus load reaches our lakes.
- » Fall precipitation creates a phosphorus-rich “tea” when leaves are left to decay in the street. Because Madison storm sewers lead directly to the lakes, leaves represent the biggest source of phosphorus from urban areas.
- » Invasive species, like zebra mussels, are changing the lake ecology and creating conditions that can worsen water quality.
- » A changing climate, projected to be warmer and wetter in southern Wisconsin, is working against efforts to improve water quality.

Although it seems there are many forces negatively impacting water quality, it is important to remember that the actions we take on the land can help improve it.

### YAHARA LAKES ICE DATES

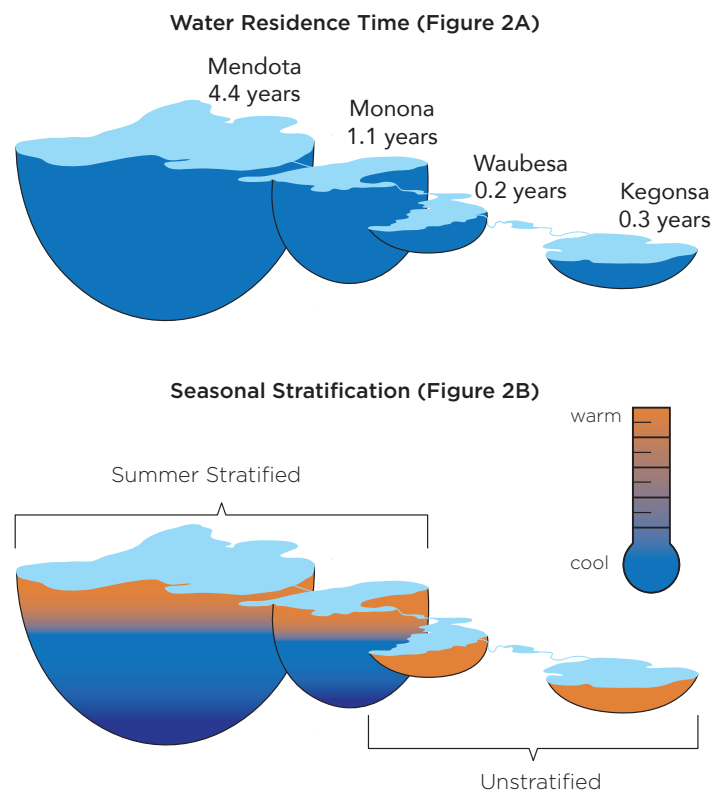
Lake ice can be an indicator of climate change. The median seasonal ice duration has decreased by about one month since the winter of 1852-53 when records began at the Wisconsin State Climatology Office. Scientists project one-third of winters will result in an ice-free Lake Mendota by the end of this century.

#### Yahara Lakes Ice Conditions (2019-2020 Season)

Ice Conditions (days)	Freeze dates	Ice off dates	Median freeze date	Median ice off date
Mendota	1/12	3/22	Dec. 20	Apr. 4
Monona	12/16, 1/12	12/30, 3/20	Dec. 15	Mar. 30
Wingra	11/12, 12/11	11/27, 3/12	Nov. 29	Mar. 25
Waubesa	11/16, 12/12	11/21, 3/20	N/A	N/A
Kegonsa	11/16	3/20	N/A	N/A

## WATER RESIDENCE TIMES & LAKE STRATIFICATION

- » Figure 2A shows the water residence time of each lake, which is the length of time it would take to completely “flush” its entire volume of water. Deeper surface waters like Mendota and Monona thermally stratify in the summer, meaning a warmer water layer lies on top of a substantially colder water layer. This leads to a reduction in the amount of nutrient-rich water at the bottom that mixes to the surface where it can fuel cyanobacteria growth. Stratified lakes tend to have better summer water quality compared to shallower, mixed lakes like Wingra, Waubesa, and Kegonsa (see Figure 2B).



**Figure 2:** Water residence times and summer stratification of lakes Mendota, Monona, Waubesa, and Kegonsa. Figure adapted from an original image created by Cory McDonald, research limnologist formerly with the Wisconsin DNR Bureau of Science Services.



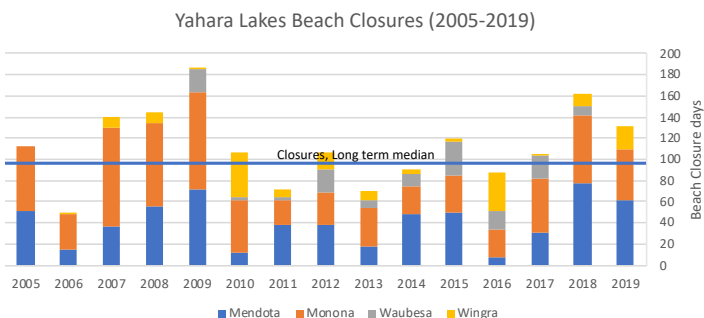
## WATER QUALITY GOALS

Once Yahara CLEAN phosphorus-reduction goals are realized, University of Wisconsin scientists have estimated that we will double the number of summer days when the lakes are clear and free of cyanobacteria blooms.

### BEACH CLOSURES

We experienced 146 beach-closure days in 2019 due to cyanobacteria and high *E. coli* levels from Memorial Day to Labor Day.

To put this into context, each beach offers 99 possible beach days from Memorial Day to Labor Day. Multiplying this by the number of beaches we include in this report, 17, we should have 1,683 total beach days per year.



**Figure 3:** Each lake has the following number of public beaches monitored by Public Health Madison Dane County for beach closures: Mendota (8); Monona (7); Waubesa (1); Wingra (1); Kegonsa (0).

## WHAT CAUSES BEACH CLOSURES?

- » Invasive aquatic organisms, like zebra mussels and spiny water fleas, alter native food webs and phosphorus availability, creating conditions that lead to cyanobacteria blooms, floating algal mats, and beach closures.
- » High *E. coli* bacteria levels at beaches can occur for several reasons. Commonly, rainstorms wash dog or bird feces into our lakes, allowing pathogens to enter our waters from nearby stormwater outfalls. Bacterial contamination can also come from manure runoff.
- » Cyanobacteria, also known as “blue-green algae,” is an aquatic photosynthetic form of bacteria that can take on different colors and appear as a paint-like scum on the water surface. Abundant phosphorus combined with hot, calm weather creates ideal cyanobacteria bloom-forming conditions. Wind can then push floating scums to downwind shorelines where it accumulates and rots, producing noxious odors. Public health officials close beaches when blooms are present because they are potentially toxic and can lead to various health concerns. Toxins can also poison fish and other water-dependent wildlife, and rob the lake of life-sustaining dissolved oxygen.

# PHOSPHORUS REDUCTION

## AN UPDATE ON OUR COMMUNITY'S PROGRESS

Yahara CLEAN Plan							
Actions	Target	2017	2018	2019	%	Comments	
Urban (pounds of phosphorus reduced)							
[1]	Improve leaf management	4,100	390	150	750	18%	Includes estimated phosphorus reductions from reported new or expanded collection programs, or from collections in excess of an established baseline.
[2]	Control construction erosion	3,600	910	760	290	8%	Most progress associated with City of Madison's Expanded Erosion-control Enforcement Program.
[3]	Maintain private permitted stormwater facilities	2,500	150	150	150	6%	Dane County inventories and issues notices of non-compliance. No additional facilities were brought into compliance in 2019.
[4]	Stabilize urban waterway banks	2,100	1,440	1,550	1,820	86%	Recent projects completed in Madison on heavily eroded waterway banks.
[5]	Reduce total suspended solids in municipal stormwater	1,100	810	900	980	89%	Recent projects in Madison and Village of DeForest, with assistance from Dane County's Urban Water Quality Grant Program, includes stormwater treatment ponds and green infrastructure.
	<b>Urban subtotal</b>	<b>13,400</b>	<b>3,700</b>	<b>3,500</b>	<b>4,000</b>	<b>30%</b>	
Rural (pounds of phosphorus reduced)							
[6]	Improve cropping, tillage, & in-field agricultural practices	14,800	7,360	10,060	11,230	76%	Farmers are adopting conservation measures to limit soil and phosphorus loss from fields. Recent progress mostly reported through Yahara Pride Farms and Dane County Land & Water Resources, and with funding from Yahara WINS and other assistance programs. Cover crops and low-disturbance manure injection were the biggest gainers.
[7]	Build community manure-processing facilities	7,700	1,660	1,660	1,660	22%	Two of the recommended five facilities have been built.
[8]	Recover additional phosphorus at digesters for export	5,100	0	0	0	0%	Dane County is in the process of installing a nutrient concentration system at one of the two manure digesters.
[9]	Manage manure and nutrients	2,100	1,850	2,140	2,560	122%	Biggest gains were from farm nutrient management planning and the headland stacking or composting of manure. The latter practice previously received funding support from Clean Lakes Alliance and other partners.
[10]	Stabilize rural waterway banks	1,000	0	0	10	1%	Recent project in Town of Westport funded through Yahara WINS and Clean Lakes Alliance.
[11]	Dredge drainage ditches	600	0	0	0	0%	Dane County's "Suck the Muck" project has removed legacy sediment from sections of Dorn and Token Creeks. Associated phosphorus reductions to the lakes have yet to be estimated.
[12]	Relocate or cover livestock facilities	600	0	0	0	0%	Dane County continues to identify high-risk facilities and advertise cost-share availability.
[13]	Harvest wetland plants	600	0	0	0	0%	Work is needed to identify suitable sites.
[14]	Restore critical drained wetlands	300	30	50	50	17%	Work is needed to identify additional restoration sites.
	<b>Rural subtotal</b>	<b>32,800</b>	<b>10,900</b>	<b>13,900</b>	<b>15,500</b>	<b>47%</b>	
	<b>Total</b>	<b>46,200</b>	<b>14,600</b>	<b>17,400</b>	<b>19,500</b>	<b>42%</b>	<i>Totals and subtotals rounded to nearest hundred</i>



# LAKE BY LAKE REPORT

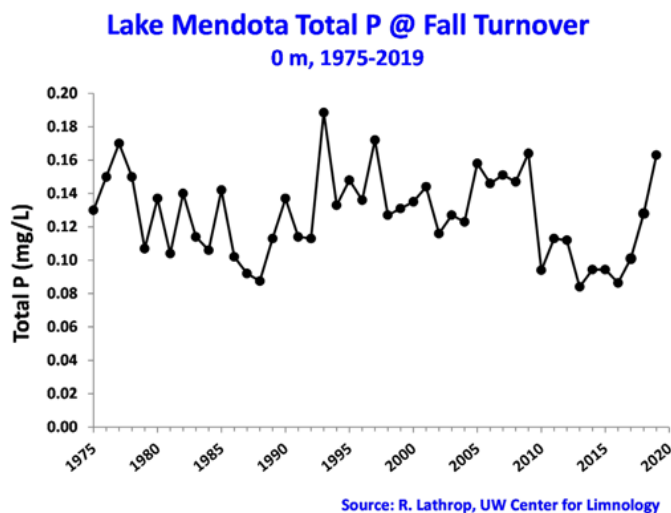
## HOW WAS THE WATER IN EACH OF OUR LAKES?

### LAKE MENDOTA [cleanlakesalliance.org/lake-mendota](http://cleanlakesalliance.org/lake-mendota)

Lake Mendota is the largest of the lakes in the Yahara River Watershed, located at the top of the chain. The lake has a 72,094-acre watershed that is primarily agricultural but with areas of rapid urban growth. There are eight beaches on 22 miles of shoreline. Water quality improvements in this lake will positively influence water quality in the downstream lakes of the chain.

#### HOW WAS THE WATER?

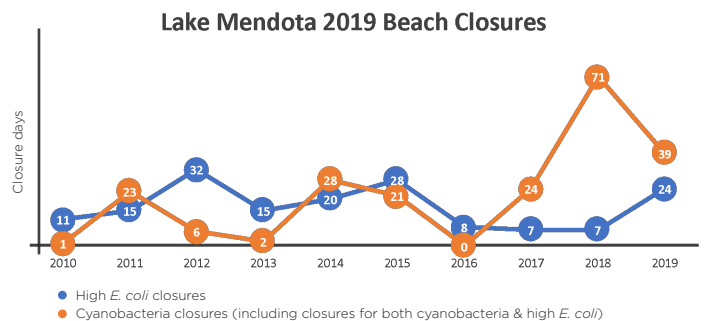
- » A reproducing population of zebra mussels was first confirmed in the lake in 2015. Zebra mussels filter out small forms of free-floating algae (phytoplankton), making the water clearer at the center of the lake, but prefer not to eat cyanobacteria, helping this organism proliferate near the shoreline. They are most likely contributing to increases in cyanobacteria blooms, beach closures, and the accumulation of algal mats that wash up on downwind shorelines.
- » 2019 average (July – August) water clarity ranked "good" and phosphorus concentrations ranked "fair," according to Wisconsin DNR criteria for deep lakes.



**Figure 4:** Lake Mendota Total Phosphorus at Fall Turnover (surface measurement, 1975-2019). Fall turnover is when the lake mixes from top to bottom due to temperature changes in the water. This is the time when phosphorus concentrations are most uniform in the lake. Concentrations were low during 2010-2017. Concentrations went up in both 2018 and 2019 due to high phosphorus loading from the lake's major tributaries.

#### COMMUNITY PROJECTS & INITIATIVES

- » **City of Middleton** repaired damage to the Donna Drive Pond, including reinforcing the embankment, improving the outlet system, and enlarging the pond to provide more flood-storage capacity.
- » **Friends of Pheasant Branch Conservancy** is continuing to work with the **City of Middleton** and **Dane County** to repair and restore the Pheasant Branch Creek corridor after it was impacted by the devastating floods of August 20-21, 2018.
- » **Dane County** provided funding for a new "Continuous Cover Program" to offer small family farms an incentive to convert lands from annual row crops into perennial grasses to improve water quality and reduce flooding.
- » **Town of Westport** completed a project to control bank erosion along Six Mile Creek, a Lake Mendota tributary stream.
- » **Village of DeForest** constructed five bio-retention basins at the Conservancy Place Athletic Complex. Wetland restorations continued at the Marvin and Marie Schweer's Natural Area and along the Upper Yahara River Trail.



**Figure 5:** Lake Mendota beaches were closed 63 times during the summer of 2019, primarily due to cyanobacteria blooms or both cyanobacteria and high *E. coli* (64%). A total of eight Lake Mendota beaches are monitored.

# LAKE MONONA [cleanlakesalliance.org/lake-monona](http://cleanlakesalliance.org/lake-monona)

Lake Monona is the second lake in the Yahara River chain. There are seven beaches on 13 miles of shoreline. The lake has a 61,643-acre watershed that is primarily urban. Efforts to keep streets leaf-free and reduce construction erosion will help reduce phosphorus runoff into the lake.

## HOW WAS THE WATER?

» 2019 average (July – August) water clarity and phosphorus concentrations both ranked "fair," according to Wisconsin DNR criteria for deep lakes.

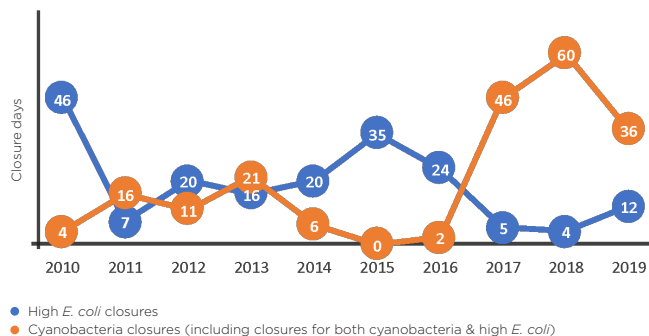
## COMMUNITY PROJECTS & INITIATIVES

- » **City of Madison** improved stormwater management at Nautilus and Jacobson Fury Ponds, and made streambank repairs along Daley Drive and Tree Lane. The City also restored natural areas by planting pollinator prairies along Inner Drive and established native plants around Dondee Pond. The City collected approximately 1,600 additional tons of leaves compared to the five-year average, and continued its Expanded Erosion-control Enforcement Program.
- » **City of Monona** dredged North Winnequah Park Lagoon, stabilized the lagoon's shoreline, installed new fish-habitat features, and expanded an adopt-a-storm drain program. In total, the City has had 110 drains adopted by volunteers to keep them free of leaves and dirt.
- » **Friends of Starkweather Creek** began working with the **Capital Area Regional Planning Commission** on a Starkweather Creek Watershed chloride study, collaborated with partners to maintain the rain garden at Washington Manor Park, and removed invasive vegetation from along the creek corridor.

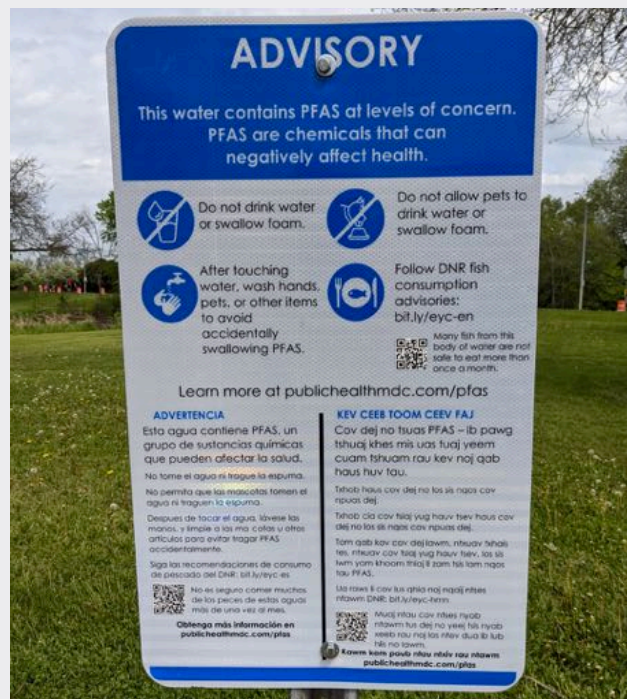


Jacobson Fury Pond

## Lake Monona 2019 Beach Closures



**Figure 6:** Lake Monona beaches were closed 48 times during the summer of 2019, primarily due to cyanobacteria blooms or both cyanobacteria and high *E. coli* (75%). A total of seven Lake Monona beaches are monitored.



Per- and poly-fluoroalkyl substances (PFAS) were found in high concentrations at Truax Field and in nearby Starkweather Creek in 2019. The Wisconsin DNR issued a fishing advisory on Lake Monona to limit consumption of and exposure to the contaminant.





## LAKE WINGRA [cleanlakesalliance.org/lake-wingra](http://cleanlakesalliance.org/lake-wingra)

Lake Wingra is a small shallow lake located in the City of Madison and connects to Lake Monona via Wingra (Murphy) Creek. The lake has a 3,456-acre watershed that is primarily urban but also includes the UW-Madison Arboretum. Water quality challenges include phosphorus and road salt pollution from urban runoff.

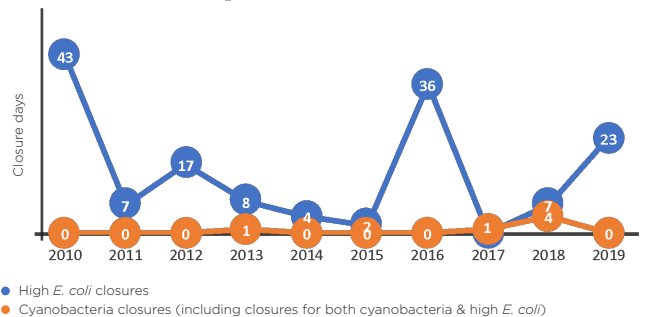
### HOW WAS THE WATER?

- » Lake water quality continues to benefit from a carp-removal project in 2008. Reducing carp numbers in small shallow lakes can be an effective strategy to improve water quality because non-native carp uproot submerged aquatic plants and stir up lake bottom sediment when foraging for food.
- » 2019 average (July – August) water clarity and phosphorus concentrations both ranked "good," according to Wisconsin DNR criteria for shallow lakes.

### COMMUNITY PROJECTS & INITIATIVES

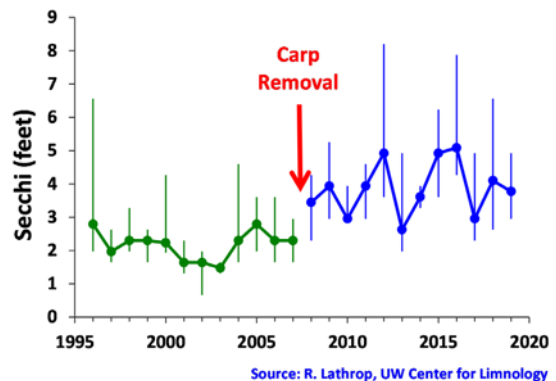
- » **Friends of Lake Wingra** worked with homeowners in the Vilas and Greenbush neighborhoods as part of a leaf-collection pilot with the **City of Madison**.
- » **City of Madison** launched the Vilas Park master planning process in 2019. Clean Lakes Alliance began serving on the advisory committee, advocating for green infrastructure and lake-friendly design concepts.

### Lake Wingra 2019 Beach Closures



**Figure 7:** A reported high number of geese at Vilas Beach likely contributed to the 23 closures due to high *E. coli*. One Lake Wingra beach is monitored.

### Lake Wingra Water Clarity June-August, 1996-2019



**Figure 8:** Lake Wingra water quality conditions are linked to the success of the March 2008 carp removal from the lake. Prior to the carp removal, during 1996-2007, median summer clarity was 2.0 feet. After the carp removal, during 2008-2017, median clarity was 3.7 feet, a major improvement for the shallow lake.

# LAKE WAUBESA [cleanlakesalliance.org/lake-waubesa](http://cleanlakesalliance.org/lake-waubesa)

Lake Waubesa is the third lake in the chain as the Yahara River flows south. The lake has a 28,160-acre watershed that is a mix of urban and rural lands. Action to improve agricultural practices, remove fall leaf debris from streets, and minimize construction erosion will help improve water quality. In addition, efforts to reduce the sources of upstream runoff will reduce the amount of phosphorus entering the lake via the Yahara River outlet (83% of the average annual phosphorus load).

## HOW WAS THE WATER?

- » 2019 average (July – August) water clarity ranked “good” and phosphorus concentrations ranked “fair,” according to Wisconsin DNR criteria for shallow lakes.

## COMMUNITY PROJECTS & INITIATIVES

- » **Town of Dunn** passed an assessment to allow for the purchase of development rights for the purpose of preserving agricultural land and natural areas.
- » **Town of Dunn** partnered with **Lake Waubesa Conservation Association** and **Dane County Parks** to offer a new leaf-collection site at Goodland County Park. This allowed an additional 780 cubic yards of leaves to be collected, bringing the total to 6,000 cubic yards of leaves for the 2019 season.
- » **Friends of Capital Springs Recreation Area** received a Foundation for Dane County Parks grant to develop educational and interpretive resources for an outdoor space at the Lussier Family Heritage Center.

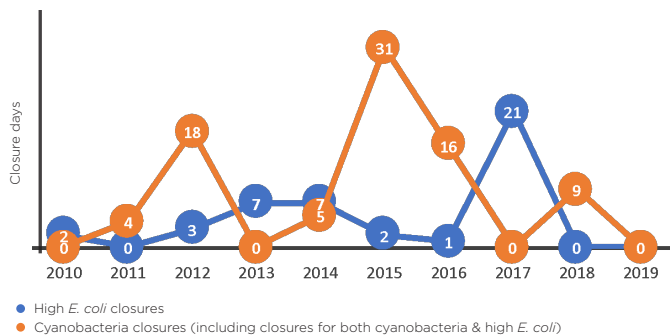


Piers on Lake Waubesa



Leaf collection at Goodland County Park  
Photo Credit: Lake Waubesa Conservation Association

## Lake Waubesa 2019 Beach Closures



**Figure 9:** The beach at Goodland County Park was open all summer, likely due to the enclosure maintained by Dane County in 2019 to enhance the water quality at the beach. One Lake Waubesa beach is monitored.



## LAKE KEGONSA [cleanlakesalliance.org/lake-kegonsa](https://cleanlakesalliance.org/lake-kegonsa)

Lake Kegonsa is the fourth and southernmost lake in the chain. The lake has a 34,560-acre watershed that is primarily agricultural. Most of the phosphorus comes from the upper lakes. Action to improve agricultural practices and fall leaf management will have a positive impact on water quality. In addition, efforts to reduce sources of upstream runoff will reduce the amount of phosphorus entering the lake via the Yahara River outlet (76% of the average annual phosphorus load to the lake).

### HOW WAS THE WATER?

- » The beach at Lake Kegonsa State Park was closed 11 times in 2019, nine times for cyanobacteria and two times for high *E. coli* bacteria levels.
- » 2019 average (July – August) water clarity ranked “good” and phosphorus concentrations ranked “poor,” according to Wisconsin DNR criteria for shallow lakes.

### COMMUNITY PROJECTS & INITIATIVES

- » **City of Stoughton** converted a bioswale to a wet detention basin in Industrial Park South to better protect water quality. The City collected leaves three times in April and at least seven times in October and November.
- » **Friends of Lake Kegonsa Society (FOLKS)** continued efforts to harvest carp by offering incentives to commercial anglers. Carp stir up bottom sediments, which resuspends phosphorus and contributes to poor water quality. In 2019, commercial harvesters removed 162,135 pounds of carp. FOLKS also continued to pilot leaf vacuuming with the **Town of Dunn**, **Town of Pleasant Springs**, and **City of Stoughton**, and maintained a native shoreline garden at Fish Camp County Park.



# MAKING PROGRESS

Clean Lakes Alliance has increased efforts to reduce phosphorus runoff and empower individual action to protect and improve our lakes. We accomplished a lot for our lakes in 2019, but there is still more work to do.

## WHAT DID WE ACCOMPLISH IN 2019?

Last year, Clean Lakes Alliance's work was focused on actions that increased community engagement and reduced phosphorus runoff into the lakes. Below are highlights of what Clean Lakes Alliance accomplished in 2019 with the dedication and support of our boards, committees, donors, volunteers, staff, and partners.

- » Recruited partners and collaborators to sign on to a **Yahara CLEAN Compact** Letter of Intent, pool resources, and begin the work of updating our lake cleanup plan. Began working with appointed Compact designees to affirm goals, build on recent progress, and create an inclusive decision-making framework for charting future action.
- » Created a **Protect, Restore, Preserve Fund** to raise money for critical land acquisitions and restoration work. Secured a \$100,000 challenge grant from Alliant Energy for the fund to help Dane County restore newly-purchased property adjoining Pheasant Branch Conservancy.
- » Funded a **manure composting pilot** led by Yahara Pride Farms, and invited leadership to speak about agricultural successes at Yahara Lakes 101 lecture series.
- » Graduated 23 watershed captains from the **Yahara Watershed Academy** and continued to support a growing network of graduates as they take action for the lakes.
- » Completed 30 different cleanup and restoration projects around the watershed, with volunteer events hosted every week from April through October. Led 538 **Renew the Blue Volunteer Day** participants in removing dozens of truckloads of invasive plants and trash from our lakeside parks and restoring native vegetation.
- » Activated weekly reporting at 72 nearshore **water quality monitoring** stations, including all 25 public beaches, to share water quality and beach data with the public through LakeForecast.org.

For an expanded list of our accomplishments last year, visit [cleanlakesalliance.org/2019-achievements](https://cleanlakesalliance.org/2019-achievements)

Aerial photo near Schluter Beach on Lake Monona  
Courtesy of Robert Bertera





## ACKNOWLEDGMENTS & REFERENCES

Collaborators: Dr. Jake Vander Zanden and Dr. Richard Lathrop at UW-Madison Center for Limnology, Dane County Land & Water Resources Department, United States Geological Survey

Contributors: City of Madison, City of Middleton, City of Monona, City of Stoughton, Town of Dunn, Village of Shorewood Hills, Village of DeForest, Village of Windsor, Friends of Lake Kegonsa Society, Friends of Starkweather Creek, Friends of Lake Wingra, UW-Madison Lakeshore Nature Preserve, Yahara Pride Farms

- » UW Center for Limnology – R. Lathrop, UW-Madison Center for Limnology. Data WDNR (1975-1994), NTL-LTER (1995-2019)
- » Dane County Land & Water Resources – lake levels, aquatic plant harvesting, phosphorus projects
- » Yahara Lakes Association – historic lake level highs
- » Public Health Madison & Dane County – beach closure data
- » Department of Natural Resources, beaches advisory report for lakes Mendota & Kegonsa - beach closure data
- » Wisconsin State Climatology Office – ice-on/off data for lakes Mendota, Monona, & Wingra, climate data
- » Christy’s Landing – ice-on/off for Lake Waubesa
- » Friends of Lake Kegonsa Society – ice-on/off for Lake Kegonsa
- » United States Geological Survey – preliminary data on phosphorus loading; rain monitoring data on Pheasant Branch Creek
- » Lathrop & Carpenter, Phosphorus Loading and Lake Response Analyses for the Yahara Lakes, unpublished report prepared for the Yahara CLEAN project, 2011
- » McDonald, C.P. & Lathrop, R. (2016), Aquatic Sciences, Seasonal shifts in the relative importance of local versus upstream sources of phosphorus to individual lakes in a chain
- » Potter, K. (2020), Landuse, Climate Change, and Yahara Lakes Flooding