SPECIAL EDITION

BENEATH THE SURFACE

DATA SUMMARY | **45** LAKES, **3** SUMMERS, **1** COUNTY

USE THIS **2023 REPORT** TO INVESTIGATE AND CLARIFY THE COMPLEX RELATIONSHIPS BETWEEN LAND, WATER, AND LIVING ORGANISMS IN KOSCIUSKO COUNTY.

LILLY CENTER FOR LAKES & STREAMS | GRACE COLLEGE

Dr. Nate Bosch
Director

You may notice this year's report is bigger than usual. Thanks to support by the K21 Health Foundation, we sampled an additional 31 lakes to conduct a checkup on Kosciusko County's waterways. That's a lot of sampling!

Just like our bodies need checkups, our lakes need checkups. We last conducted a county-wide research study in 2013- we call this year's study the **Decade Lake Study**. Beneath the Surface contains the data we collected and will equip you with the information that will give your family, organization, or agency the ability to help look after these incredible resources.

Special thanks to the Renda family and The Papers for making this publication possible!

Preventative care can help keep our bodies healthy. Likewise, this year's study will **guide the next ten years of our research, education, and collaboration**. This library of data shows patterns and differences in the health of our lakes, which in turn reveal specific management steps. After looking at the data, I encourage you to follow the action steps on page 48 and share them. You will find a digital copy at ***lakes.grace.edu/bts.***

We invite you to dive Beneath the Surface with us!

CONTENTS

RESEARCH

LAKE DATA

MISSION & VISION

The Lilly Center for Lakes & Streams uses research, education and collaboration to make the lakes and streams of Kosciusko County clean, healthy, safe, and beautiful.

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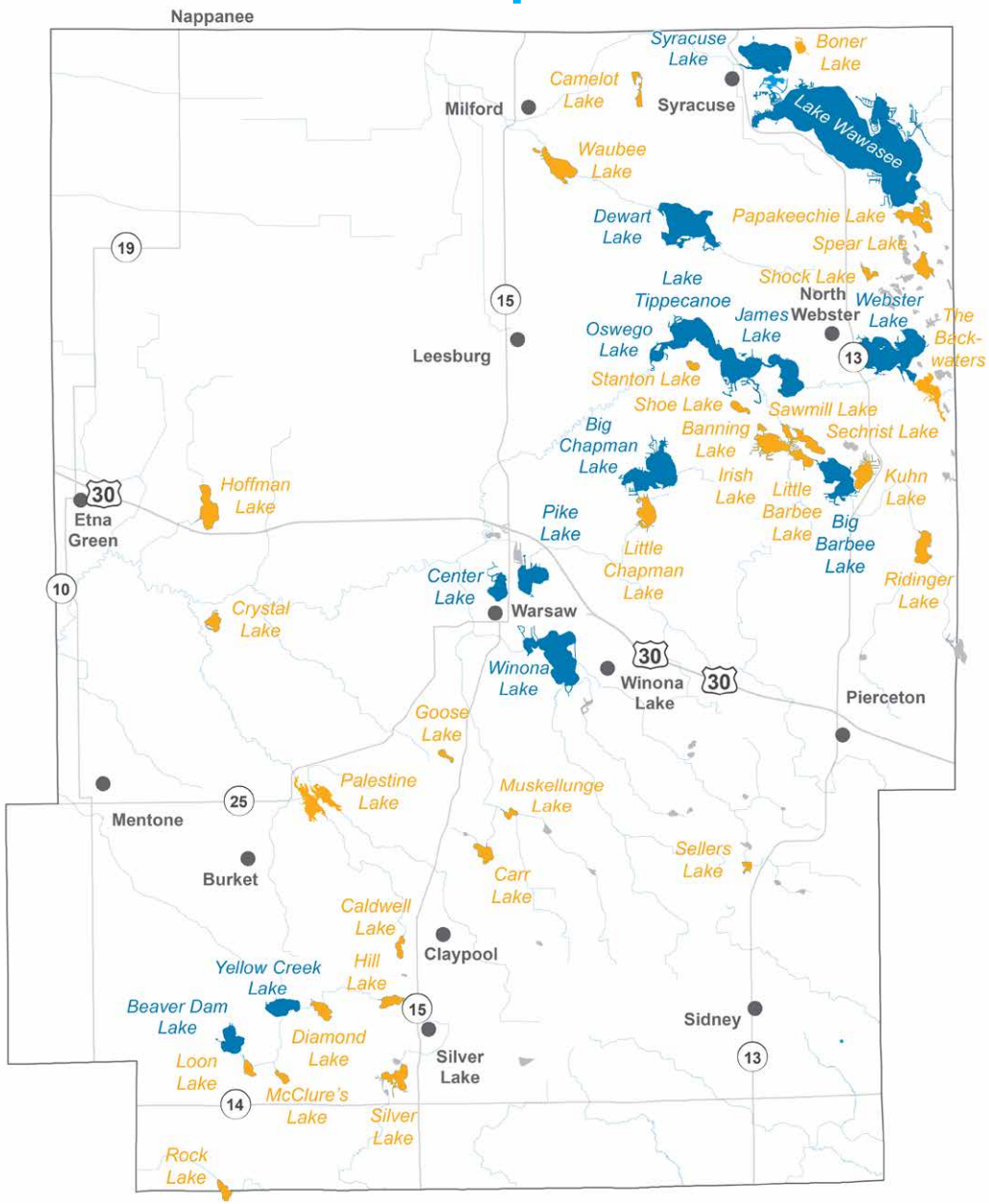


KEY: Standard Lakes Decade Lakes

What is *Beneath the Surface?*

Beneath the Surface is a condensed form of the data Lilly Center staff and students gathered on 14 lakes (**standard lakes**) during the summers of 2021-23 and an additional 31 lakes (**decade lakes**) in 2023. Reviewing several years of data helps us accurately compare and contrast data points and dissect any potential changes that may have occurred.

How should you use this report?

We want you to understand this data and use it to make the best decisions for your local lakes and their watersheds. That's what this report helps us do: **investigate and clarify the complex relationships between land, water, and living organisms**. The 45 lakes are organized by watershed, beginning on page 20.

How do we conduct lake research?

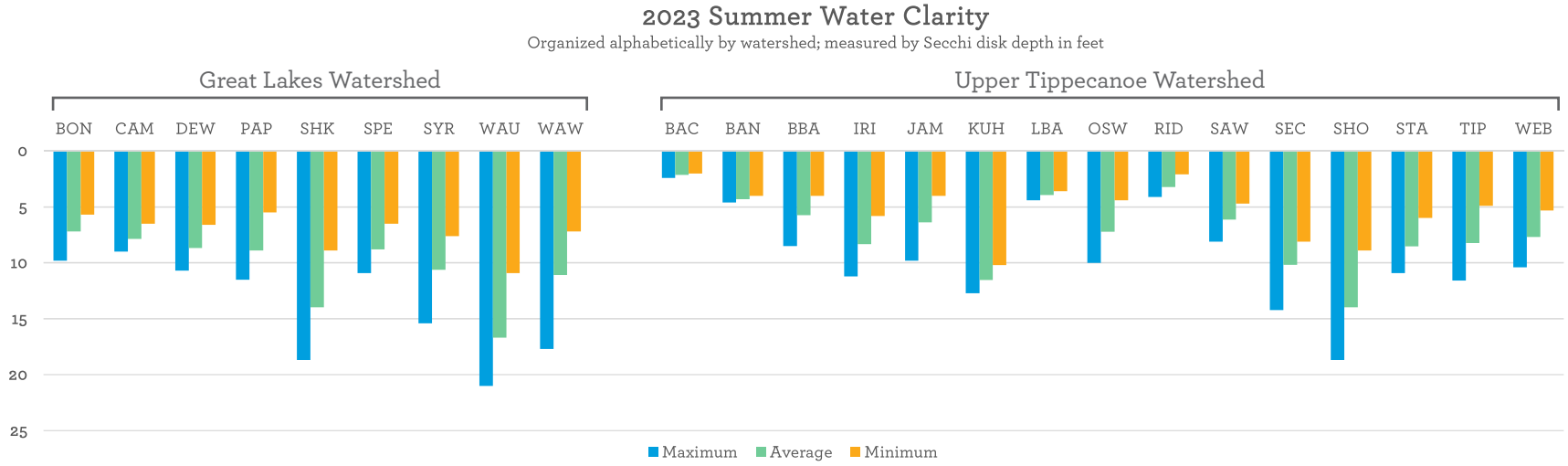
Every week from the beginning of June through the middle of August, the Lilly Center research team samples 12 all-sport lakes of Kosciusko County (since 2012), Center and Pike lakes, and seven public swimming beaches (since 2018). The research team collected samples from an additional 31 lakes during the summer of 2023 once a month during the same time frame.

Lakes are sampled at a lake's deepest point to get a full vertical profile of the lake's temperature, dissolved oxygen, pH, and conductivity. Nutrient samples are collected from one meter above the bottom and one meter below the surface to observe both distinct layers of lake water in the summer.

At all 45 lakes, we take **microcystin** (blue-green algae toxin) samples from the top six feet of open water and the top three feet at seven public beaches. Measurements and notes are also recorded on atmospheric conditions, past and present weather, resident observations, and recent management work. See page 10 for more information on blue-green algae!

WATER CLARITY

Secchi disk depth is a measure of water clarity, one of the first things you observe as you look down into a lake. The "stuff" suspended in the water, typically soil particles and algae, reduces water clarity. The size and content of the watershed, precipitation, and water temperature all influence how much particulate matter and algae are present in the lake and how clear or murky the water appears. Water clarity is measured with a tool called a Secchi disk. A Secchi disk is a frisbee-sized disk that is painted with a black-and-white pattern. The disk is attached to a rope and lowered into the lake until the black-and-white pattern is no longer visually distinct. Our research team records the depth where the disk disappears to measure the water's clarity.



Nutrients (learn more on **page 8**) can come from inflowing streams and the sediment at the bottom of a lake, stirred up by waves or boat propellers. These nutrients lead to increased algae growth, contributing to murky water.

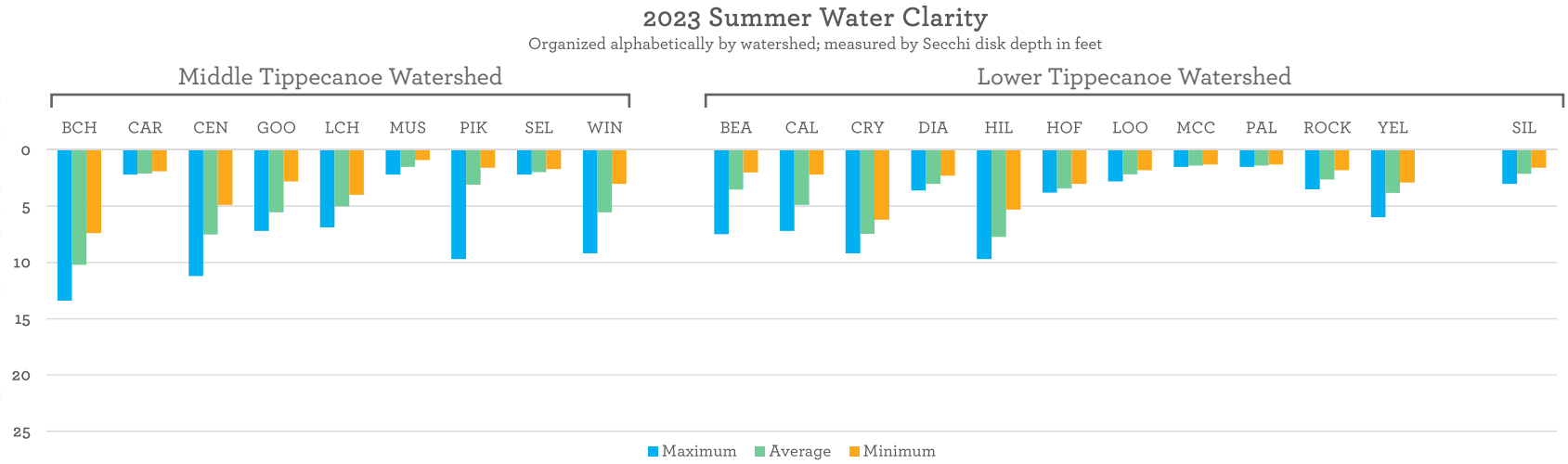
These Secchi disk graphs show the maximum, average, and minimum depths we observed at each lake during the summer of 2023. The average of all summer 2023 Secchi disk readings was **6.7 ft**. This average is similar to averages from

LAKE ABBREVIATIONS

These abbreviations will be used throughout Beneath the Surface.

The Backwaters.....BAC
Banning.....BAN
Beaver Dam.....BEA
Big Barbee.....BBA
Big Chapman.....BCH
Boner.....BON
Caldwell.....CAL
Camelot.....CAM
Carr.....CAR
Center.....CEN
Crystal.....CRY
Dewart.....DEW
Diamond.....DIA
Goose.....GOO
Hill.....HIL
Hoffman.....HOF
Irish.....IRI
James.....JAM
Kuhn.....KUH
Little Barbee.....LBA
Little Chapman.....LCH
Loon.....LOO
McClure's.....MCC
Muskellunge.....MUS

the 14 standard lakes in 2022 (**6.8 ft**) and 2021 (**6.4 ft**). Water clarity varied within each watershed and differed depending on where the watersheds drained into the Tippecanoe River. The clearest lakes were in the Great Lakes watershed. The average Secchi depths for these lakes was **10.3 ft** compared to **3.8 ft** in most southern lakes in the county in the Lower Tippecanoe watershed area. Silver Lake, which flows to the Eel River and eventually to the Wabash River, had an average Secchi depth of **2.1 ft**. Water clarity in the lakes of the Upper Tippecanoe watershed averaged **7.1 ft**, but lakes in the Middle Tippecanoe watershed averaged **5.7 ft**. This is a noticeable distinction in water clarity the further downstream these lakes are in the Tippecanoe watershed. Except for Beaver Dam and Yellow Creek, the lakes in the southern



part of the county are relatively shallow and appear more eutrophic than many other lakes in Kosciusko County. This difference in water clarity could be due to the type of land use, the amount and quality of wetlands, as well as conservation efforts targeted to reduce nutrient & sedimentation inputs into streams and lakes.

Scientists use water clarity to determine the age of a lake, also called its **trophic state**. Turn to **page 48** to learn how a lake ages and where your lake is in its aging process.

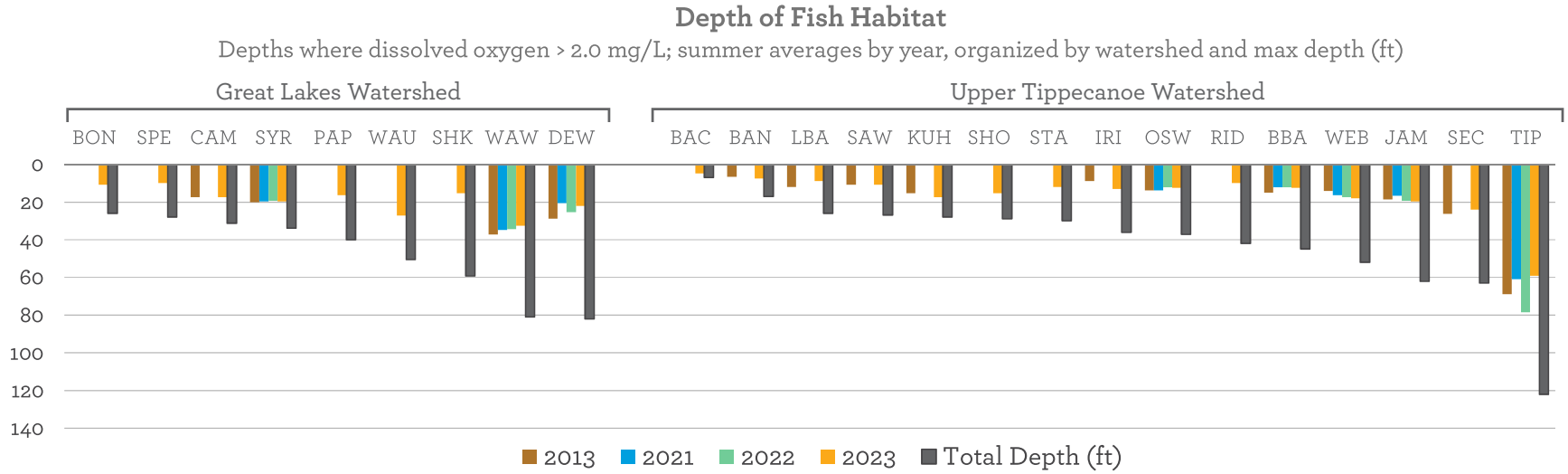
Oswego..... OSW
Palestine..... PAL
Papakeechie..... PAP
Pike..... PIK
Ridinger..... RID
Rock..... ROC
Sawmill..... SAW
Sechrist..... SEC
Sellers..... SEL
Shock..... SHK
Shoe..... SH
Silver..... SIL
Spear..... SPE
Stanton..... STA
Syracuse..... SYR
Tippecanoe..... TIP
Waubee..... WAU
Wawasee..... WAW
Webster..... WEB
Winona..... WIN
Yellow Creek..... YEL

DISSOLVED OXYGEN

We aren't the only ones interested in water quality. Fish rely on healthy lakes, and their habitat can be limited by a lack of oxygen in the water. Microbes, fish, and other organisms consume oxygen at the bottom of a lake, and as the lake warms in the summer, the oxygen near the bottom can run out.

Oxygen from the air cannot get all the way down to replenish the cool bottom layer of water. Only fish that can live in warm water near the surface get the oxygen they need. By reducing the amount of material decomposing at the bottom of a lake, we can hopefully slow that use of oxygen and make more room in the lake for fish to inhabit in the summer.

The lakes in this graph are organized from shallowest to deepest at their deepest point within their respective watersheds. Fish require a concentration of at least **2.0 mg/L of oxygen** in the water to survive, so the depth of habitat is where dissolved oxygen is greater than or equal to 2.0 mg/L of oxygen. That oxygen concentration is a bare minimum, however. Many fish species need three or more times that amount to thrive and produce healthy offspring.



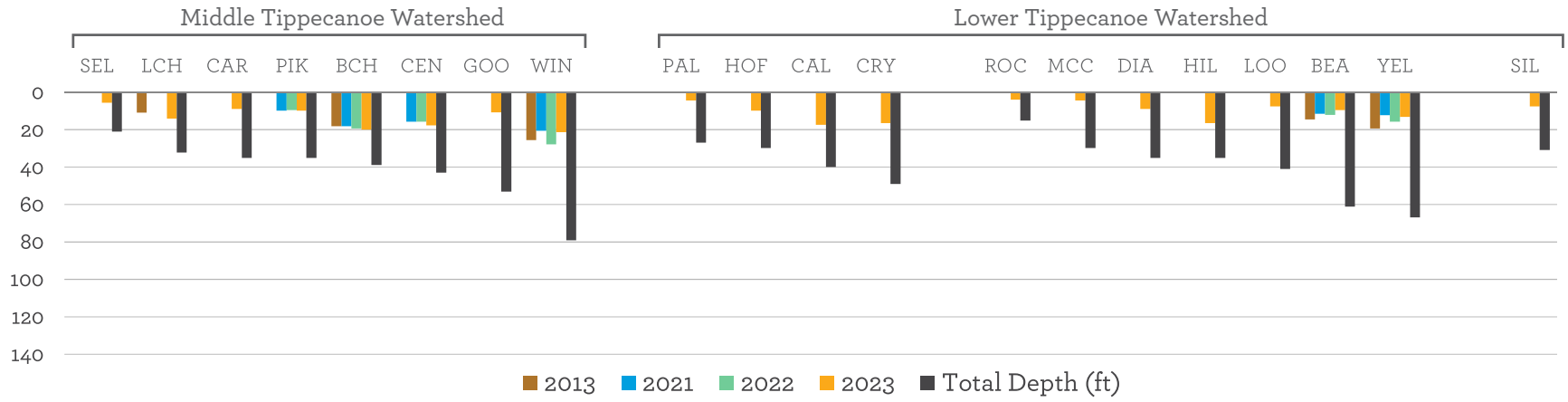
The depth of dissolved oxygen averaged **14.4 ft in 2023**. While dissolved oxygen depths do not vary much within each lake across years, dissolved oxygen depths differ between watersheds. The lakes in the Great Lakes watershed had the best dissolved oxygen levels with an average depth of **19.0 ft**. On the other hand, the more eutrophic lakes in the Lower Tippecanoe watershed further south in the coun-

ty exhibit an average fish habitat depth of only **9.1 ft**. Lakes in the Upper and Middle Tippecanoe watersheds showed depths of dissolved oxygen averaging **16.4 ft** and **12.4 ft**, respectively.

Reducing the amount of nutrients in a lake reduces the amount of algae, which in turn increases the amount of oxygen available for fish. Lawn clippings, tree leaves, and lawn fertilizer are just a few of the common ways nutrients enter our lakes. You can learn more about how to minimize the nutrients entering your lakes - and improve the fishing- on **page 49**.

Depth of Fish Habitat

Depths where dissolved oxygen > 2.0 mg/L; summer averages by year, organized by watershed and max depth (ft)



The data presented in Beneath the Surface must have a home: a research database. We are grateful to the following individuals for their gifts toward this project. Learn more about the research database on our website: lakes.grace.edu/field-notes.

Patrick Appenzeller, Keith & Tammy Denlinger, Jeff & Carrie Herdrich, Max & Jan Kendall, James Leman, Dr. Frank & Kristen Levinson, Rick & Belinda Russell, Dr. Rick & April Sasso, John & Kristine Schlagenhauf, Amb. Randy & Deborah Tobias, Dr. Terry & Dr. Sandra Tucker, David & Peggy Wihebrink.

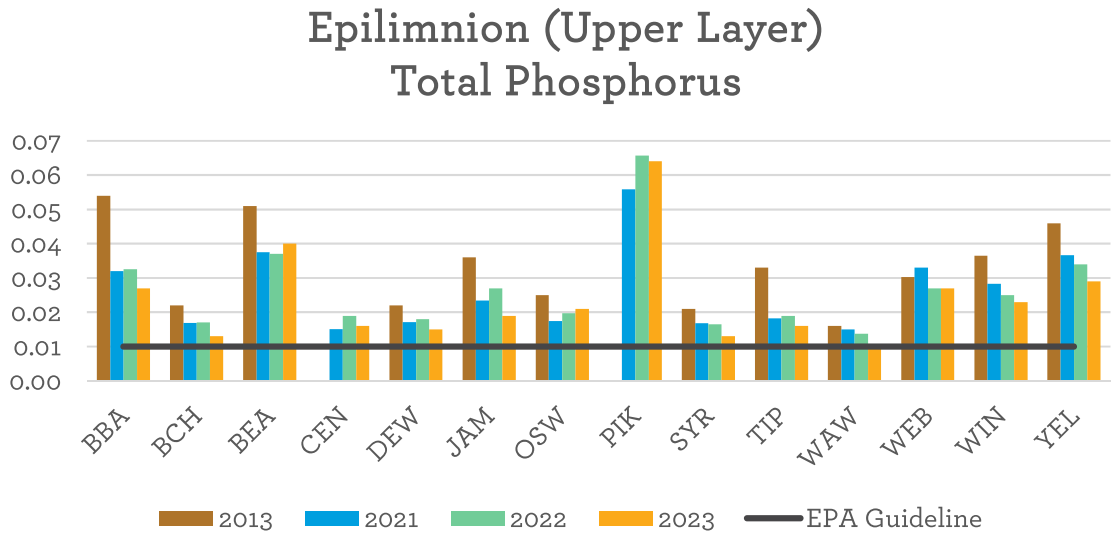
TOTAL PHOSPHORUS, TOTAL NITROGEN

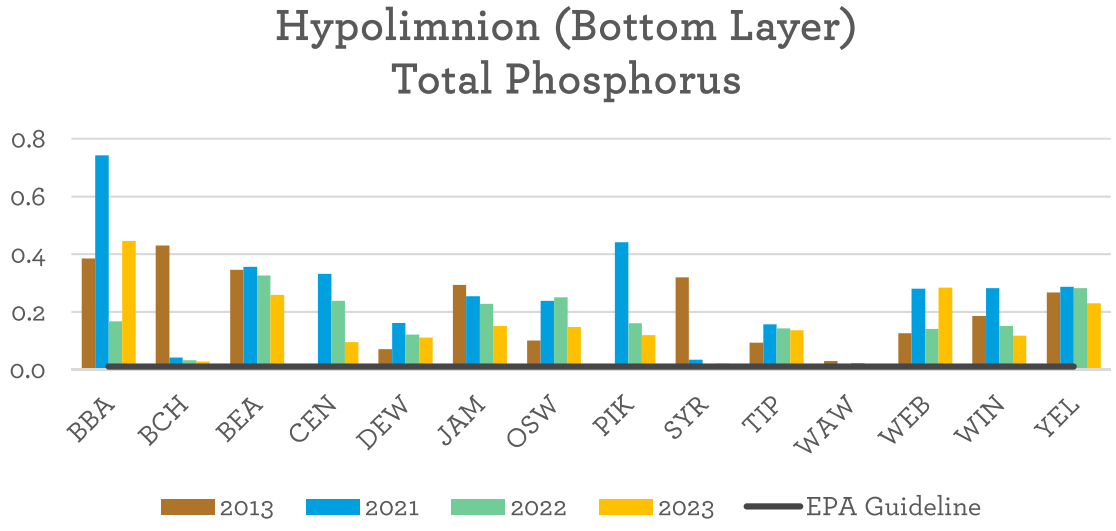
These four graphs show two nutrients – phosphorus and nitrogen – in two parts of the lake; the **epilimnion** is the top layer of water, and the **hypolimnion** is the bottom layer. (Epi- meaning "over," and hypo-, "under") These layers do not mix in the summer, so we take a sample of both to gain a complete picture of each lake's nutrient levels.

Phosphorus and nitrogen are two of our **most important chemical parameters for lake health**. They are both critical nutrients for supporting aquatic life, specifically rooted plants (weeds) and phytoplankton (algae) that make up the foundation of the food chain. But just as eating too much of the wrong food can negatively impact our health, too much of these nutrients can take a toll on our lakes and their inhabitants.

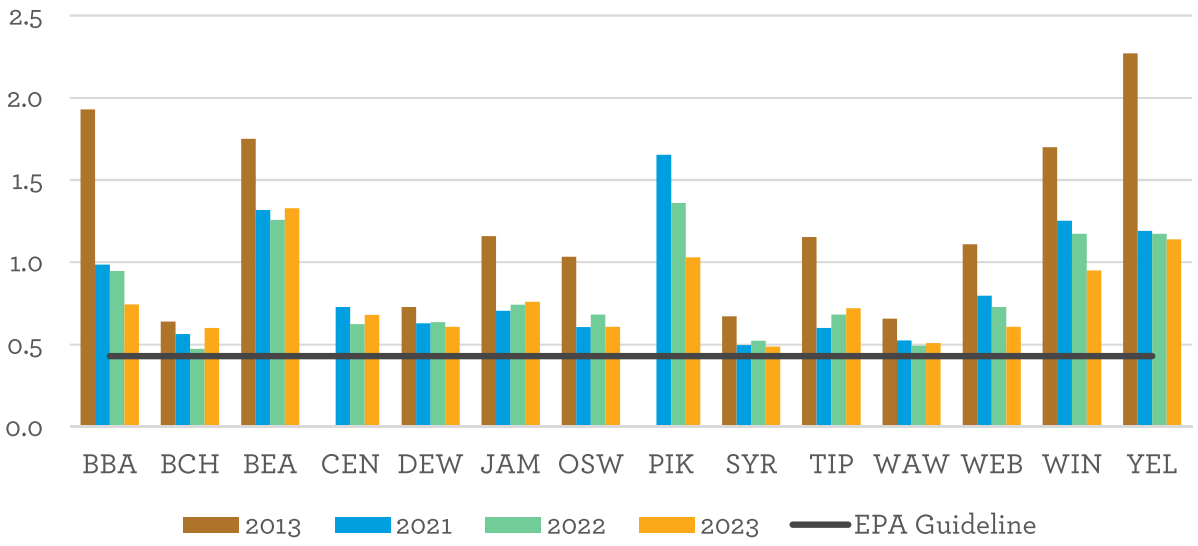
The black bar on each nutrient graph marks the EPA water quality guideline for a minimally impacted lake in our ecoregion. It is a low bar, which means it is a high goal! All of our lakes need help to reduce the amount of nutrients coming in to increase water clarity and the depth of fish habitats.

Note that the scales on these graphs are different, highlighting the fact that there are typically more nutrients in the hypo-

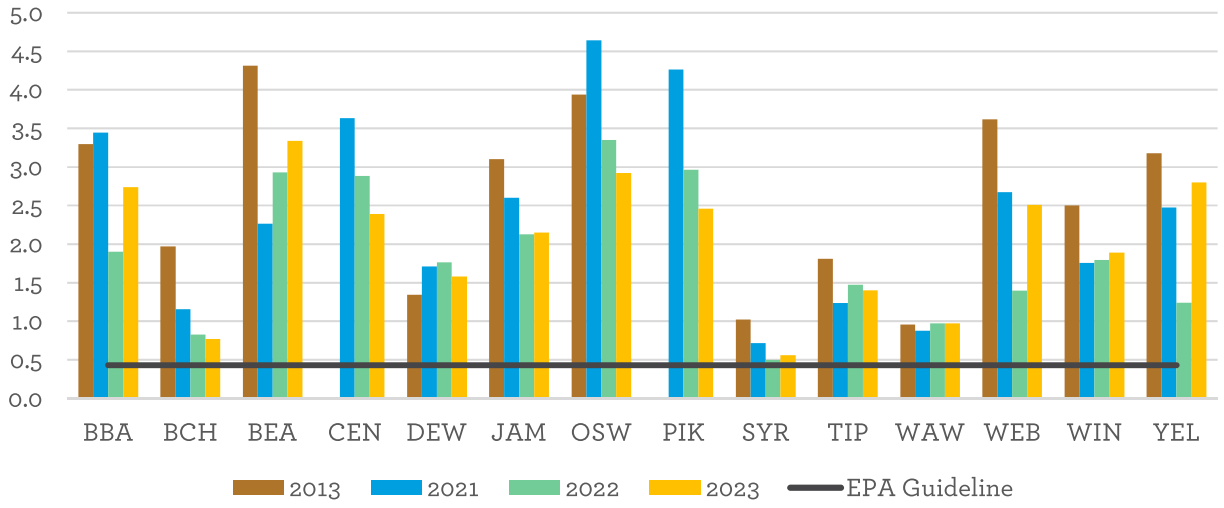




Epilimnion (Upper Layer) Total Nitrogen



Hypolimnion (Bottom Layer) Total Nitrogen



limnion than epilimnion in our lakes. That indicates that nutrients are coming from the bottom sediments of the lakes in addition to inflowing streams.

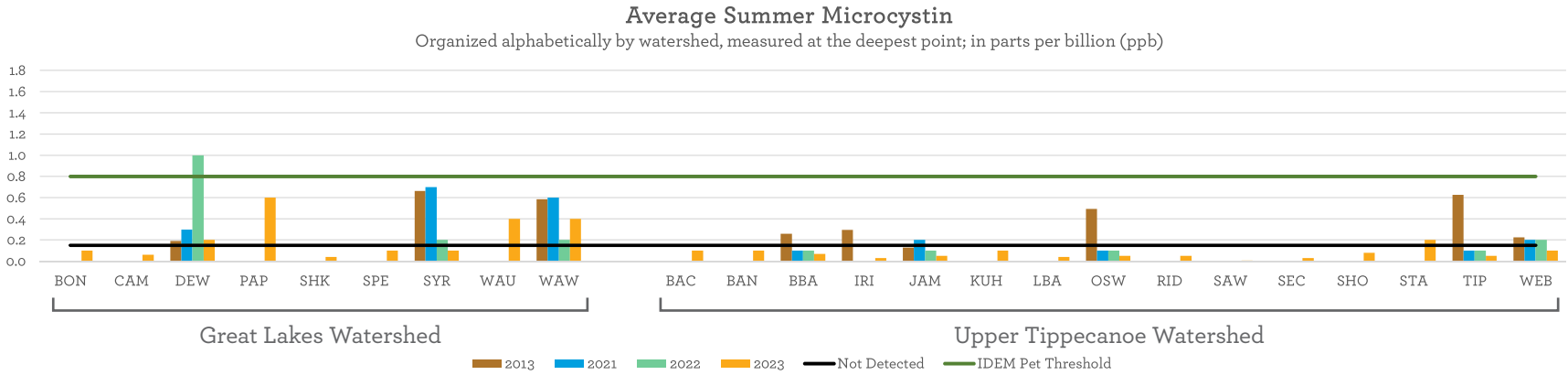
You can observe that Big Chapman, Syracuse, and Wawasee lakes have relatively low total phosphorus concentrations in the hypolimnion, indicating less nutrient loading from the sediments in these lakes.

The EPA guideline for total phosphorus is **0.010 mg P/L**. The average total phosphorus across all 2023 epilimnion samples was **0.024 mg P/L**, while the hypolimnion was **0.154 mg P/L**. The EPA total nitrogen guideline is **0.43 mg N/L**. The 2023 overall average total nitrogen was **0.77 mg N/L** in the epilimnion and **2.034 mg N/L** in the hypolimnion.

Current levels of phosphorous and nitrogen in the epilimnion appear to be substantially lower than those observed in 2013 at several lakes. However, 2013 was an extremely wet year compared to the last three years, and the abundant precipitation likely increased nutrient input into the lakes. Additionally, 2017 and 2019 nutrient levels were similar to 2013. Nutrient levels in the epilimnion in 2023 were among the lowest in the last ten years but similar to concentrations in 2015 and 2016. The Lilly Center will **continue to monitor these results for potential trends.**

BLUE-GREEN ALGAE

Blue-green algae (BGA) are a photosynthesizing, increasingly-prevalent, potentially toxin-producing family of bacteria natural to freshwater. The "potentially" part of "potentially toxin-producing" works in two ways: not every species of BGA creates toxins, and the toxin-producing species do not always produce toxin. Though BGA is abundant in our lakes, data from the past three years shows that microcystin toxin averages are usually below levels of concern for pets (**0.8 ppb**). While our BGA is capable of producing higher levels, such as in concentrated scums during a bloom, typical levels do not approach IDEM's guideline for human health concern (**8.0 ppb**).



Indiana Department of Environmental Management's (IDEM) microcystin exposure thresholds

Human Recreation Caution
8.0 ppb

Dog Recreation Prohibited*
0.8 ppb

**State lakes & ponds*

What we learned

This summer, the Lilly Center sampled 45 lakes from around the county. At these lakes, microcystin concentrations at open water locations (i.e., a lake's deepest point) exceeded IDEM's pet safety threshold in 7 samples at five lakes. Carr Lake and Silver Lake had two microcystin readings above the pet safety threshold. Papakeechie, Waubee, and Wawasee each had one

Did you receive our weekly microcystin update emails this summer? These data are just a taste of what we discovered while sampling. Stay in the loop when you follow this QR code and sign up for weekly microcystin updates, or visit lakes.grace.edu/blue-green-alge to learn more.

measurement above 0.8 ppb. Overall, **less than 4%** of all the samples (open water and shore) resulted in microcystin concentrations above the pet safety threshold. Microcystin levels in the last three years never approached IDEM's safety threshold for people. Unsafe levels in past years mean the Lilly Center will stay proactive in monitoring this threat.

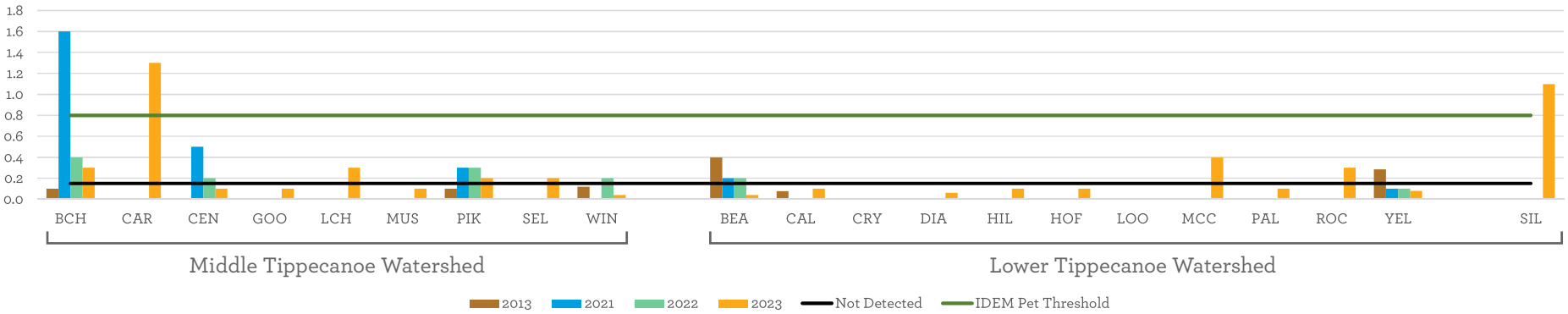
Average percent of algae population that is BGA to date

Summer microcystin samples over the dog threshold (0.8)

Percent of identified BGA species that can produce toxins

Average Summer Microcystin

Organized alphabetically by watershed , measured at the deepest point; in parts per billion (ppb)



BGA Look-alikes

Can you identify a blue-green algae bloom? Reporting blooms to the Lilly Center activates a quick response to test the bloom for toxins. Call **574-372-5281** or email **lakes@grace.edu** to report a bloom sighting.

ADDITIONAL TOXIN TESTING

This summer, the Lilly Center tested for an additional four cyanobacterial toxins. This aligns with the research the Lilly Center conducted in 2015. Cylindrospermopsin was nearly nonexistent in our lakes this summer. It was only detected in Waubee Lake below the level deemed safe for pets and people. Anatoxin appeared to be prevalent in 2015 but was rarely detected in samples from 2023. Hoy's Beach in Syracuse Lake was the only loca-

**nd = not detected*

Great Lakes Watershed

		Boner Open Water	Boner Shore	Camelot Open Water	Camelot Shore	Dewart Open Water	Dewart Shore	Papakeechie Open Water	Papakeechie Shore	Shock Open Water	Shock Shore	Spear Open Water	Spear Shore	Syracuse Open Water	Syracuse Comm. Center Beach	Syracuse Hoy's Beach	Waubee Open Water	Waubee Shore	Wawasee Open Water	Wawasee Shore
Anatoxin	2015 Max.			1.23	1.37	0.68		0.72		0.38		0.17	0.74	0.36	0.76		0.34	1.50	0.91	
	2015 Avg.			1.11	1.13	0.47		0.48		0.20		0.59	0.62	0.18	0.65		0.20	1.05	0.72	
	2023 Max.	nd	nd	nd	nd	0.28		nd	nd	nd	nd	nd	nd	nd	nd	0.44	nd	nd	nd	
	2023 Avg.	nd	nd	nd	nd	0.05		nd	nd	nd	nd	nd	nd	nd	nd	0.06	nd	nd	nd	
BMAA	2015 Max.			5.60	nd	nd		nd		nd		nd	nd	nd	nd		5.90	nd	nd	
	2015 Avg.			2.80	nd	nd		nd		nd		nd	nd	nd	nd		3.80	nd	nd	
	2023 Max.	nd	5.89	5.77	19.51	16.13		nd	nd	nd	6.26	15.70	18.69	nd	nd	nd	nd	nd	nd	
	2023 Avg.	nd	1.96	2.81	8.01	2.19		nd	nd	nd	2.53	5.23	6.29	nd	nd	nd	nd	nd	nd	
Saxitoxin	2015 Max.			nd	nd	1.30		nd		nd		nd	nd	nd	nd		nd	nd	nd	
	2015 Avg.			nd	nd	0.60		nd		nd		nd	nd	nd	nd		nd	nd	nd	
	2023 Max.	nd	nd	nd	0.03	0.02		0.04	0.05	0.03	0.10	nd	0.20	0.02	0.02	0.02	nd	0.03	0.02	
	2023 Avg.	nd	nd	nd	0.02	0.01		0.01	0.02	0.02	0.05	nd	0.01	0.01	0.01	0.01	nd	0.01	0.01	
Cylindro.	2015 Max.			nd	nd	0.20		nd		0.20		nd	nd	nd	nd		nd	nd	nd	
	2015 Avg.			nd	nd	0.10		nd		0.01		nd	nd	nd	nd		nd	nd	nd	
	2023 Max.	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.07	nd	
	2023 Avg.	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.01	nd	

Upper Tippecanoe Watershed

		Banning Open Water	Banning Shore	Big Barbee Open Water	Big Barbee Shore	Irish Open Water	Irish Shore	James Open Water	James Shore	Kuhn Open Water	Kuhn Shore	Little Barbee Open Water	Little Barbee Shore	Oswego Open Water	Oswego Shore	Ridinger Open Water	Ridinger Shore	Sawmill Open Water	Sawmill Shore	Sechrist Open Water	Sechrist Shore	Shoe Open Water	Shoe Shore	Stanton Open Water	Stanton Shore	Tippecanoe Open Water	Tippecanoe Shore	Webster Open Water	Webster Beach	Backwater Open Water	Backwater Shore
Anatoxin	2015 Max.			0.87	0.95		0.78	1.42	0.84		0.73		0.39	0.80	0.74		0.59		0.69		1.19		0.87		0.45	0.98	0.47	0.40	0.65		0.85
	2015 Avg.			0.69	0.53		0.56	0.98	0.42		0.46		0.36	0.67	0.56		0.30		0.41		0.81		0.67		0.23	0.73	0.24	0.20	0.53		0.67
	2023 Max.	nd	nd	nd		nd	nd	nd		nd	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd	nd	nd
	2023 Avg.	nd	nd	nd		nd	nd	nd		nd	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd	nd	nd
BMAA	2015 Max.			nd	nd		nd	nd	nd		nd		nd	nd	nd		nd		nd		nd		nd	nd	nd	nd	nd		nd
	2015 Avg.			nd	nd		nd	nd	nd		nd		nd	nd	nd		nd		nd		nd		nd	nd	nd	nd	nd		nd
	2023 Max.	nd	nd	122.7		15.17	nd	5.76		nd	nd	nd	nd	nd		7.08	nd	nd	nd	nd	5.38	nd	6.78	nd	nd	nd		8.37	5.15	nd	nd
	2023 Avg.	nd	nd	13.70		6.05	nd	1.56		nd	nd	nd	nd	nd		2.49	nd	nd	nd	nd	2.08	nd	3.53	nd	nd	nd		2.96	1.99	nd	nd
Saxitoxin	2015 Max.			nd	0.02		0.02	nd	nd		nd		0.03	0.02	0.02		nd		0.02		nd		nd		nd	nd	0.04	0.02	0.03		nd
	2015 Avg.			nd	0.01		0.01	nd	nd		nd		0.01	0.02	0.02		nd		0.01		nd		nd		nd	nd	0.03	0.01	0.03		nd
	2023 Max.	0.02	0.02	0.03		0.02	0.03	0.04		0.02	0.02	0.03	0.03	0.04		0.03	0.02	0.03	0.03	0.04	nd	nd	nd	0.02	0.03	0.03		0.03	0.05	0.02	0.03
	2023 Avg.	0.02	0.02	0.02		0.02	0.03	0.02		0.02	0.02	0.02	0.03	0.02		0.02	0.01	0.02	0.03	0.02	nd	nd	nd	0.02	0.02	0.02		0.01	0.03	0.01	0.02
Cylindro.	2015 Max.			nd	nd		nd	nd	nd		nd		nd	nd	nd		nd		nd	nd	nd	nd	nd		nd	nd	nd	nd	nd		nd
	2015 Avg.			nd	nd		nd	nd	nd		nd		nd	nd	nd		nd		nd	nd	nd	nd	nd		nd	nd	nd	nd	nd		nd
	2023 Max.	nd	nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd	nd	nd
	2023 Avg.	nd	nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd	nd	nd

tion where anatoxin was above the pet threshold of **0.4 ppb**. Saxitoxin was detected much more frequently in 2023 than in 2015. However, only nine of the 45 lakes had levels above the pet threshold of **0.05 ppb**. BMAA (beta-methylamino-L-alanine) is a toxin most often associated with eating shellfish - not an activity associated with Kosciusko County lakes. At the time of publication, the Indiana Department of Environmental Management does not issue a safety threshold for BMAA. Although BMAA concentrations were more common and higher than other toxins this summer than eight years ago, more research is needed to understand this toxin.

Middle Tippecanoe Watershed

			Big Chapman Open Water	Big Chapman Shore	Carr Open Water	Carr Shore	Center Open Water	Center Beach	Goose Open Water	Goose Shore	Little Chapman Open Water	Little Chapman Shore	Muskellunge Open Water	Muskellunge Shore	Pike Open Water	Pike Beach	Sellers Open Water	Sellers Shore	Winona Open Water	Winona Beach
Anatoxin	2015	Max.	0.52	0.71		1.05		0.84		0.60		1.67		0.64		0.48		1.24	1.19	0.96
		Avg.	0.44	0.70		0.62		0.75		0.48		1.30		0.42		0.41		0.95	0.67	0.48
	2023	Max.	nd		0.19	0.16	nd	nd	nd	nd	nd	nd	nd	0.18	nd	nd	0.16	nd	nd	0.25
		Avg.	nd		0.01	0.09	nd	nd	nd	nd	nd	nd	nd	0.10	nd	nd	0.10	nd	nd	0.05
BMAA	2015	Max.	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd	5.30
		Avg.	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd	2.60
	2023	Max.	nd		nd	nd	nd	7.95	nd	nd	nd	nd	11.38	9.55	25.04	8.55	nd	7.59	nd	10.76
		Avg.	nd		nd	nd	nd	1.38	nd	nd	nd	nd	4.45	4.41	6.33	2.50	nd	3.41	nd	1.63
Saxitoxin	2015	Max.	nd	nd		nd		nd		0.02		nd		nd		0.03		0.02	nd	nd
		Avg.	nd	nd		nd		nd		0.01		nd		nd		0.01		0.01	nd	nd
	2023	Max.	0.02		0.02	0.02	0.02	0.02	0.19	0.16	0.06	0.05	0.02	nd	0.09	0.07	0.03	0.04	0.03	0.03
		Avg.	0.91		0.01	0.01	0.00	0.01	0.14	0.12	0.03	0.03	0.01	nd	0.03	0.02	0.03	0.02	0.01	0.02
Cylindro.	2015	Max.	nd	nd		nd		nd		nd		nd		nd		nd		nd	nd	nd
		Avg.	nd	nd		nd		nd		nd		nd		nd		nd		nd	nd	nd
	2023	Max.	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.05
		Avg.	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.01

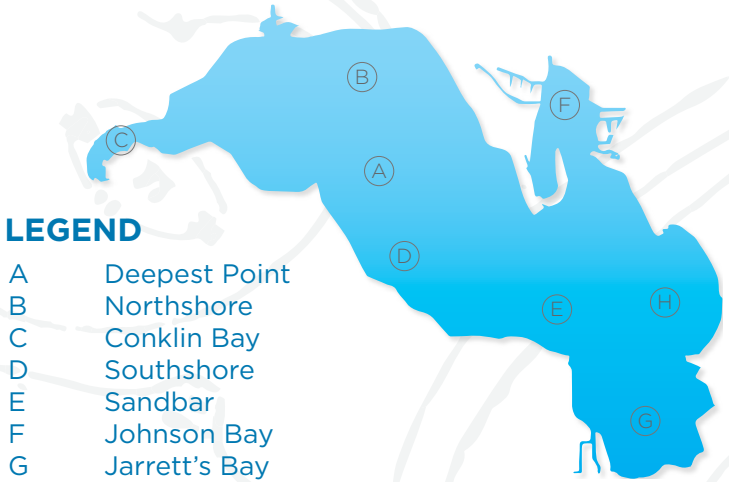
Lower Tippecanoe Watershed

			Beaver Dam Open Water	Beaver Dam Shore	Caldwell Open Water	Caldwell Shore	Crystal Open Water	Crystal Shore	Diamond Open Water	Diamond Shore	Hill Open Water	Hill Shore	Hoffman Open Water	Hoffman Shore	Loon Open Water	Loon Shore	McClure's Open Water	McClure's Shore	Palestine Open Water	Palestine Shore	Rock Open Water	Rock Shore	Yellow Creek open water	Yellow Creek shore	Silver Open Water	Silver Shore
Anatoxin	2015	Max.	0.47	0.56		0.39		1.19		0.24		0.84		0.50		0.79		0.79		0.68		0.56	0.67	1.35		1.60
		Avg.	0.47	0.56		0.19		1.08		0.21		0.78		0.45		0.40		0.50		0.60		0.47	0.66	1.02		0.80
	2023	Max.	0.15		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.20	0.20	nd	0.15	nd	nd	nd		0.20	0.20
		Avg.	0.06		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.12	0.11	nd	0.12	nd	nd	nd		0.11	0.09
BMAA	2015	Max.	nd	nd		nd		nd		nd		nd		nd		nd		nd		nd		nd	nd	nd		nd
		Avg.	nd	nd		nd		nd		nd		nd		nd		nd		nd		nd		nd	nd	nd		nd
	2023	Max.	10.76		6.70	14.62	nd	nd	9.46	nd	nd	nd	6.55	nd	nd	nd	nd	nd	nd	5.06	6.62	8.80	25.15		nd	nd
		Avg.	2.04		2.83	5.58	nd	nd	4.86	nd	nd	nd	2.21	nd	nd	nd	nd	nd	nd	1.69	2.55	3.24	3.99		nd	nd
Saxitoxin	2015	Max.	nd	nd		nd		nd		nd		nd		nd		nd		nd		nd		0.03	nd	nd		nd
		Avg.	nd	nd		nd		nd		nd		nd		nd		nd		nd		nd		0.03	nd	nd		nd
	2023	Max.	0.09		0.02	0.02	nd	nd	0.02	0.02	0.02	0.01	0.02	nd	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02		0.04	0.05
		Avg.	0.02		0.02	0.02	nd	nd	0.02	0.02	0.01	0.01	0.01	nd	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.01		0.03	0.03
Cylindro.	2015	Max.	nd	nd		nd		nd		nd		nd		nd		nd		nd		nd		nd	nd	nd		nd
		Avg.	nd	nd		nd		nd		nd		nd		nd		nd		nd		nd		nd	nd	nd		nd
	2023	Max.	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd
		Avg.	nd		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd

SPATIAL VARIABILITY STUDY

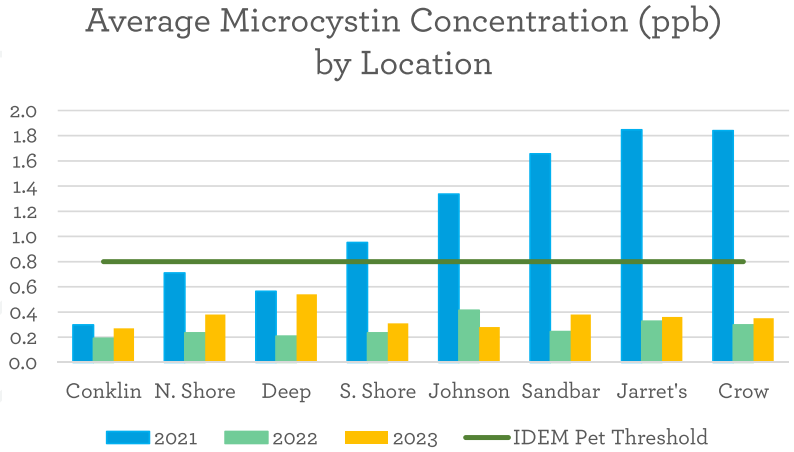
Lake Wawasee, Indiana's largest natural lake, provides unique opportunities for research thanks to its size. The primary question in the third year of this spatial variability study is, "Do the microcystin levels vary across the lake?" We began by sampling seven additional sites in 2021 and repeated the research plan in 2022 and 2023.

The data we collected this summer was similar to the observations we recorded last year. There appeared to be little evidence that suggests spatial variability of microcystin levels among the eight sampling sites. Microcystin concentrations average **0.3 ppb** and **0.4 ppb** in 2022 and 2023, respectively. The average Secchi depths between the two years were 9.6 ft



LEGEND

A	Deepest Point
B	Northshore
C	Conklin Bay
D	Southshore
E	Sandbar
F	Johnson Bay
G	Jarrett's Bay
H	Crow Bay



in 2022 and 8.8 ft in 2023. Despite little evidence of spatial variability in 2022 and 2023, data from 2021 show conspicuous differences in microcystin levels among the sampling locations. In 2021, the average microcystin concentration at these locations was substantially higher (**1.2 ppb**) and ranged from 0.3 ppb at the western-most location to 1.8 ppb at the eastern-most location. In the last two years, microcystin concentrations ranged from 0.2 ppb to 0.5 ppb; those levels were relatively consistent across the sampling locations. It appears any potential spatial variability **may depend on higher levels of microcystin** in Lake Wawasee. If microcystin levels become elevated in the future, it will be instructive to observe concentrations across the sampling sites.

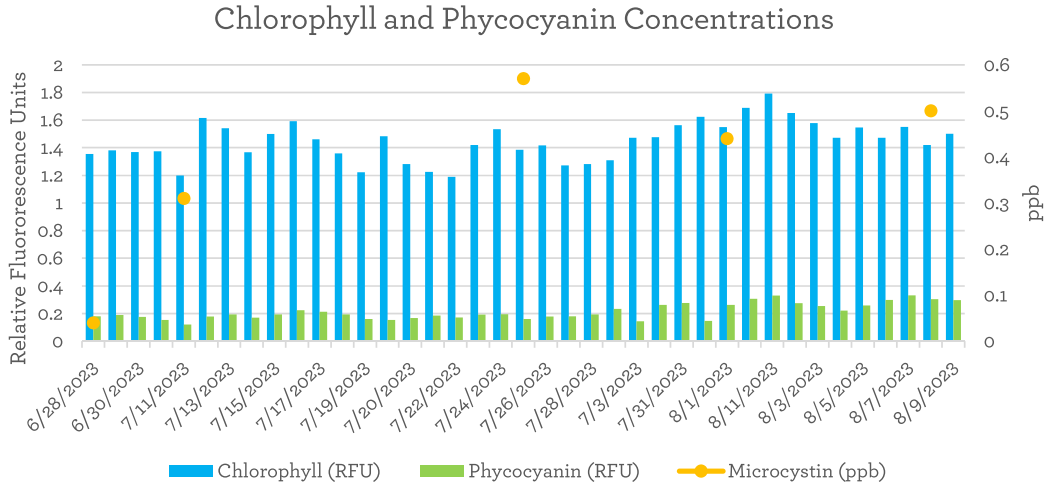
We will continue to report future findings in next year's Beneath the Surface - stay tuned!

Thanks to the support of two generous Lake Wawasee families, the Finches and the Herdrichs, as well as generous support by the K21 Health Foundation, the Lilly Center was able to sample these seven additional sites on Lake Wawasee. The additional data from this study provides insight about potential management steps on other lakes as well.

LAKE WAWASEE RESEARCH BUOY

Now in its second year, the Lake Wawasee research buoy in Crow Bay continues to be an important addition to our blue-green algae research. The sensor array beneath the buoy gathers hundreds of data points each day in 15-minute intervals. It uses a process called fluorescence to distinguish between harmless green algae and potentially toxic blue-green algae.

The research team maintains the buoy



Indiana Department of Environmental Management's (IDEM) microcystin exposure thresholds

Human Recreation Caution
8.0 ppb

Dog Recreation Prohibited*
0.8 ppb

**State lakes & ponds*

Both chlorophyll and phycocyanin increased slightly from the end of June to the beginning of August, but observations were variable during this time. Chlorophyll relative abundance ranged from **1.2 RFUs** to **1.8 RFUs**, whereas phycocyanin levels were between **0.12 RFUs** and **0.33 RFUs**. Despite the minimal increase in levels of both pigments, microcystin concentrations exhibited a more positive trend. The microcystin level on June 28th was **0.04 ppb** and then increased to **0.3 ppb** two weeks later. The toxin level increased again at the end of July to **0.57 pbb** and then tapered off to **0.5 pbb** on August 8th. Like last year's results, there does not appear to be an obvious relationship between microcystin levels and chlorophyll and phycocyanin relative abundance recorded at the buoy's location. As with the spatial variability study, more data is needed to see how microcystin levels respond to measured changes in chlorophyll and phycocyanin.

The research buoy was inspired by conversations with Alex Levinson and Alan Tehan. It was financially supported by the Levinson family and installed thanks to the help of the Herdrich family, especially Jeff and Bob. Thanks to the engineering department at Grace College and Dr. Fred Wentorf for developing the buoy. Their help and support are key to providing quality data and deepening our understanding of our lakes, all in pursuit of a safe place to live and play.

STREAM SENSORS

The health of Kosciusko County's lakes is directly connected to the health of its streams. Since 2014, the Lilly Center has studied the major streams surrounding six all-sport lakes. In 2023, we installed a **13th remote stream sensor at Deeds Creek** upstream of Pike Lake. This sensor joins others at inflows and outflows around Winona, Wawasee, Syracuse, Tippecanoe, Oswego, and James Lakes.

At right, you can observe Jed Harvey, Lilly Center research technician, and Kyle Kaminski of Xylem, a water solution company, installing the new stream sensor in Deeds Creek. The solar-powered sensors consist of two main parts: **the sensor** that sits in the stream and **the box** mounted outside the stream that receives and sends out data. Harvey and Kaminski create a profile of the stream bed that they upload to the stream sensor. The sensor uses this information to calculate the volume of water and its speed moving through the stream. The sensor can also measure other properties like water, air temperature, and the total depth of the stream.

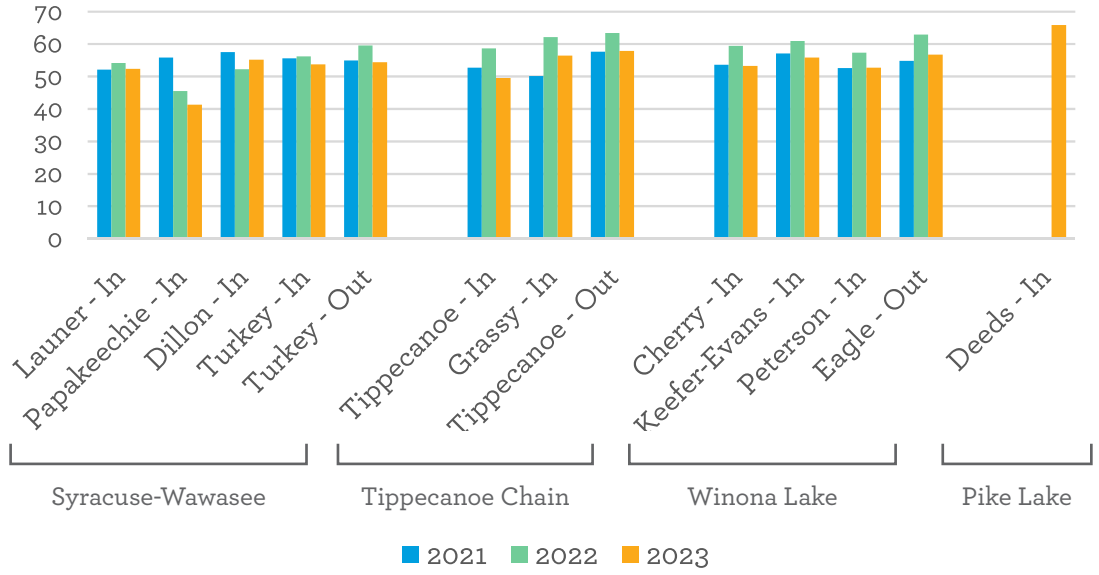
Average stream water temperatures decreased from last year but were similar to temperatures observed in 2021. Likewise, stream flows were higher last year compared to 2021 and 2022. Except for a high average flow at Tippecanoe River

Left: Stream sensors use solar power to operate. Right: Jed Harvey attaches the remote cable to the sensor, the portion of the system that sits in the water.

Above: Harvey, assisted by Kyle Kaminski, measures the depth of Deeds Creek in order to create a profile of the stream. This profile is uploaded to the stream sensor.

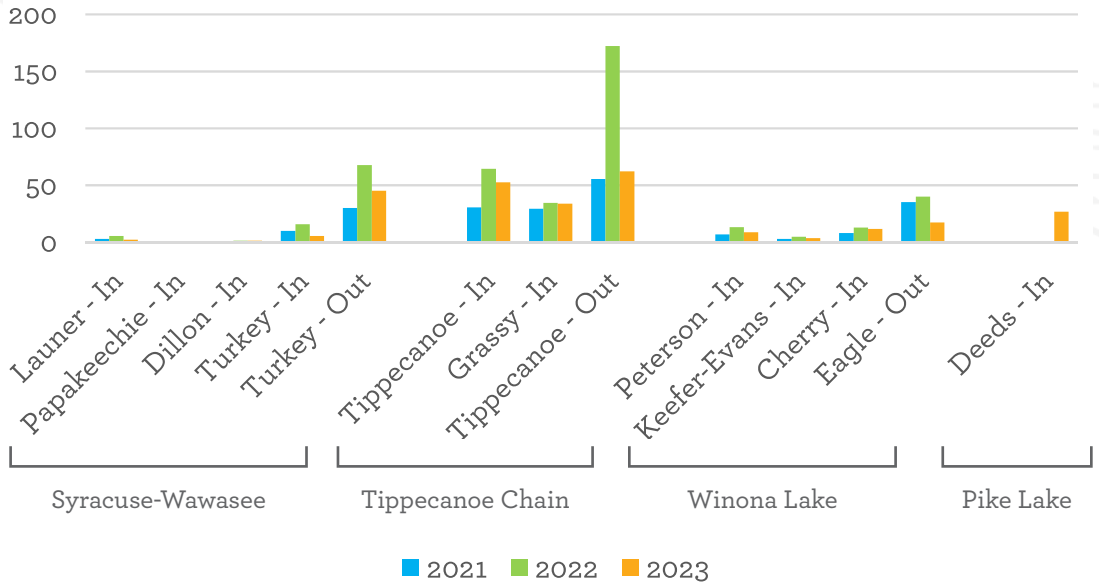
Average Water Temperature

Measured in degrees Fahrenheit (F)



Average Water Flow

Measured in cubic feet per second (cfs)



outflow last year, there is little variability in the streamflows or water temperatures at these stream sites. While this data may not seem exciting on its own, the ability to collect information 24/7, 365 days a year regarding daily streamflow is a powerful tool. The stream sensors allow us to gather detailed long-term data that we can couple with other data to help us **detect trends in water quality** around the watershed. Pairing our stream sensor data with nutrient samples collected in the field allows us to create nutrient budgets for our lakes.

Nutrient budgets can help us identify how many nutrients are entering our lakes and where they are coming from. Using a long-term dataset like this can help us monitor changes in the watershed and potentially measure the impacts of agricultural best management practices, wetland restoration projects, and other projects aimed at improving water quality.

Not only do our efforts to improve quality mean safer lakes and fewer harmful algae blooms, but they also improve property values and encourage tourism, which in turn drives our economy. Turn to **page 49** for practical ways you can decrease the amount of nutrients entering your lakes and streams.

LILLY CENTER PARTNERS

We work with each of these organizations to analyze or provide relevant data. We also co-host events, provide lake-focused presentations, and collaborate on other activities within the county's watersheds. It is a privilege to work with dozens of individuals and businesses, including many more not on this list!

LAKE ASSOCIATIONS

Consider becoming a member of your local lake association to participate in the work that is already being done to protect your lake.

BARBEE LAKES PROPERTY OWNERS ASSOCIATION
North Webster, IN | barbeelakes.org

BEAVER DAM & LOON LAKE CONSERVATION CLUB
Claypool, IN

CENTER LAKE CONSERVATION ASSOCIATION
Warsaw, IN

CHAPMAN LAKES CONSERVATION ASSOCIATION
Warsaw, IN | chapmanlake.com

DEWART LAKE PROTECTIVE ASSOCIATION
Syracuse, IN | dewartlake.org

DIAMOND LAKE CONSERVATION CLUB
Silver Lake, IN

LAKE TIPPECANOE PROPERTY OWNERS ASSOCIATION
Leesburg, IN | ltpo.org

PALESTINE LAKE PROPERTY OWNERS ASSOCIATION
Palestine, IN

PIKE LAKE ASSOCIATION
Warsaw, IN

RIDINGER LAKE ASSOCIATION
Pierceton, IN

SILVER LAKE ASSOCIATION
Silver Lake, IN

SYRACUSE LAKE ASSOCIATION
Syracuse, IN

WAUBEE LAKE ASSOCIATION
Milford, IN

WAWASEE PROPERTY OWNERS ASSOCIATION
Syracuse, IN | wawaseepoa.org

WEBSTER LAKE CONSERVATION ASSOCIATION
North Webster, IN | lakewebster.net

WINONA LAKE PRESERVATION ASSOCIATION
Winona Lake, IN | winonalakepreservation.com

YELLOW CREEK LAKE CONSERVATION CLUB
Claypool, IN

GOVERNMENTAL & CONSERVATION ORGANIZATIONS

Searching for an expert on local environmental efforts or ongoing statewide projects? Reach out to one of these organizations!

CITY OF WARSAW STORMWATER UTILITY
Warsaw, IN | warsaw.in.gov/301/stormwater-utility

U.S. ENVIRONMENTAL PROTECTION AGENCY
epa.gov

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
Indianapolis, IN | in.gov/idem

INDIANA DEPARTMENT OF NATURAL RESOURCES
Indianapolis, IN | in.gov/dnr

KOSCIUSKO COUNTY CONVENTION, RECREATION AND VISITORS COMMISSION
Warsaw, IN | visitkosciuskocounty.org

KOSCIUSKO COUNTY SOIL AND WATER CONSERVATION DISTRICT
Warsaw, IN | kosciuskoswcd.org

THE WATERSHED FOUNDATION
North Webster, IN | watershedfoundation.org

WAWASEE AREA CONSERVANCY FOUNDATION
Syracuse, IN | wacf.com

K21 HEALTH FOUNDATION

Warsaw, IN | k21foundation.org

Several years ago, the K21 Health Foundation provided the initial funding for the Lilly Center's cyanobacteria (blue-green algae) research. They share our vision for healthy communities around healthy waterways and continue to provide invaluable support. Most recently, they invested over $300,000 into the Lilly Center's research. Their support also provides equipment for in-house water testing and toxin analysis and will provide resources for continued development and proactive measures to protect public health.

GRACE COLLEGE

Winona Lake, IN | grace.edu

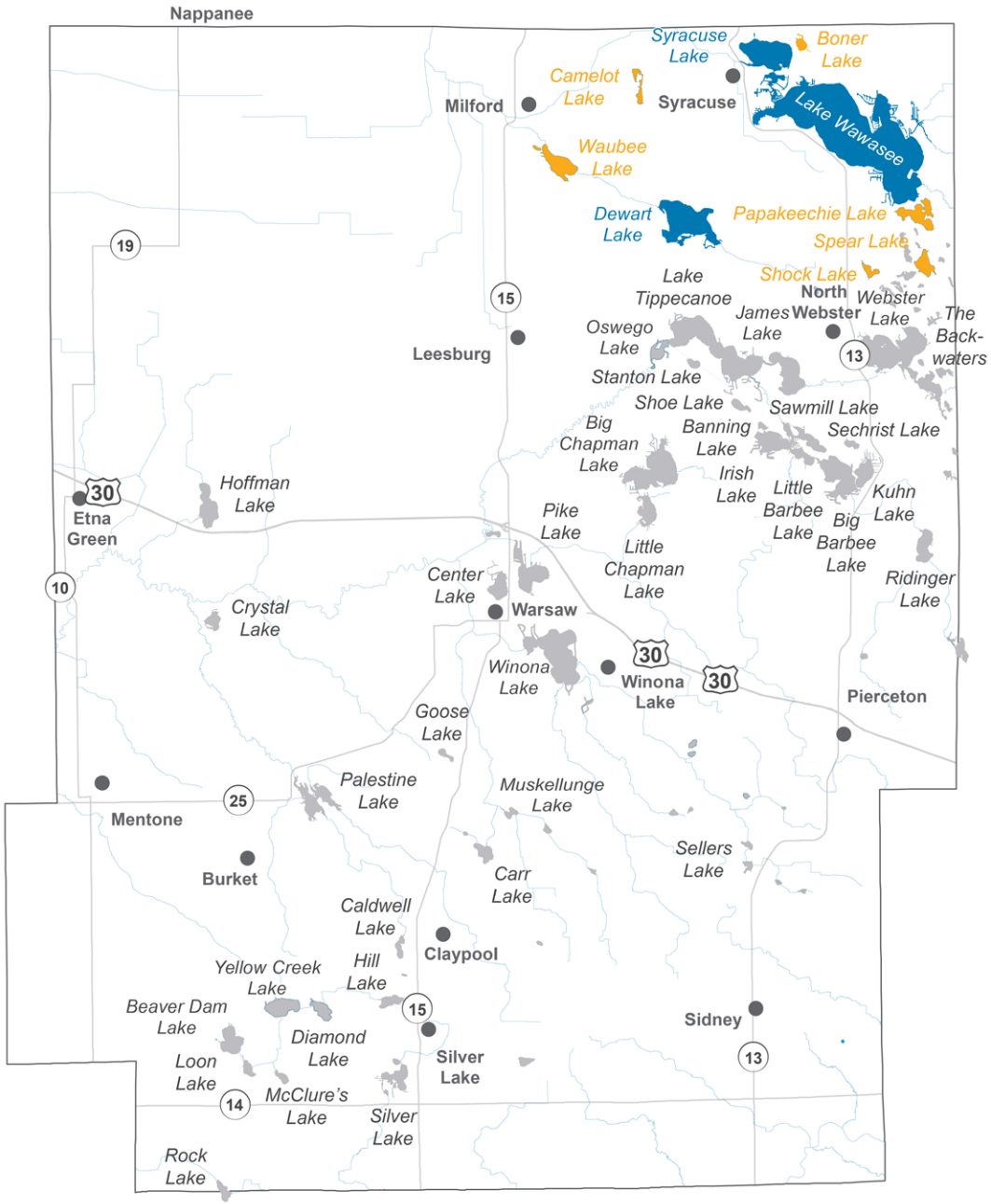
The Lilly Center was founded and is based at Grace College. Over the years, our connection with the School of Science and Engineering has proven exceedingly valuable; the Lilly Center's research would be incomplete without the expert insight of the department's professors. The Lilly Center also works closely with the School of Education and other departments on campus, drawing from a seemingly endless supply of resources and knowledge.

great lakes
WATERSHED

Did you know that a north-south continental divide runs through Kosciusko County? A plaque on State Road 13, near North Webster, reminds us that our county is home to this special feature. Any water north of the continental divide finds its way into Lake Michigan through the Saint Joseph River.

LAKES:

Camelot Lake
Boner Lake
Dewart Lake
Papakeechie Lake
Shock Lake
Spear Lake
Syracuse Lake
Waubee Lake
Lake Wawasee



KEY: Standard Lakes Decade Lakes


Boner Lake, taken in 2021.

boner & spear
papakeechie & syracuse
shock & wawasee

Tucked into the northeast corner of Kosciusko County, these lakes revolve around Lake Wawasee, Indiana's largest natural lake. It has a surface area of over 3,000 acres and a watershed reaching well into Noble County.

BON

Surface area	40 acres
Max. depth	26 ft
Watershed	175 acres

PAP

Surface area	228 acres
Max. depth	40 ft
Watershed	3,301 acres

SHK

Surface area	32 acres
Max. depth	59 ft
Watershed	1,125 acres

SPE

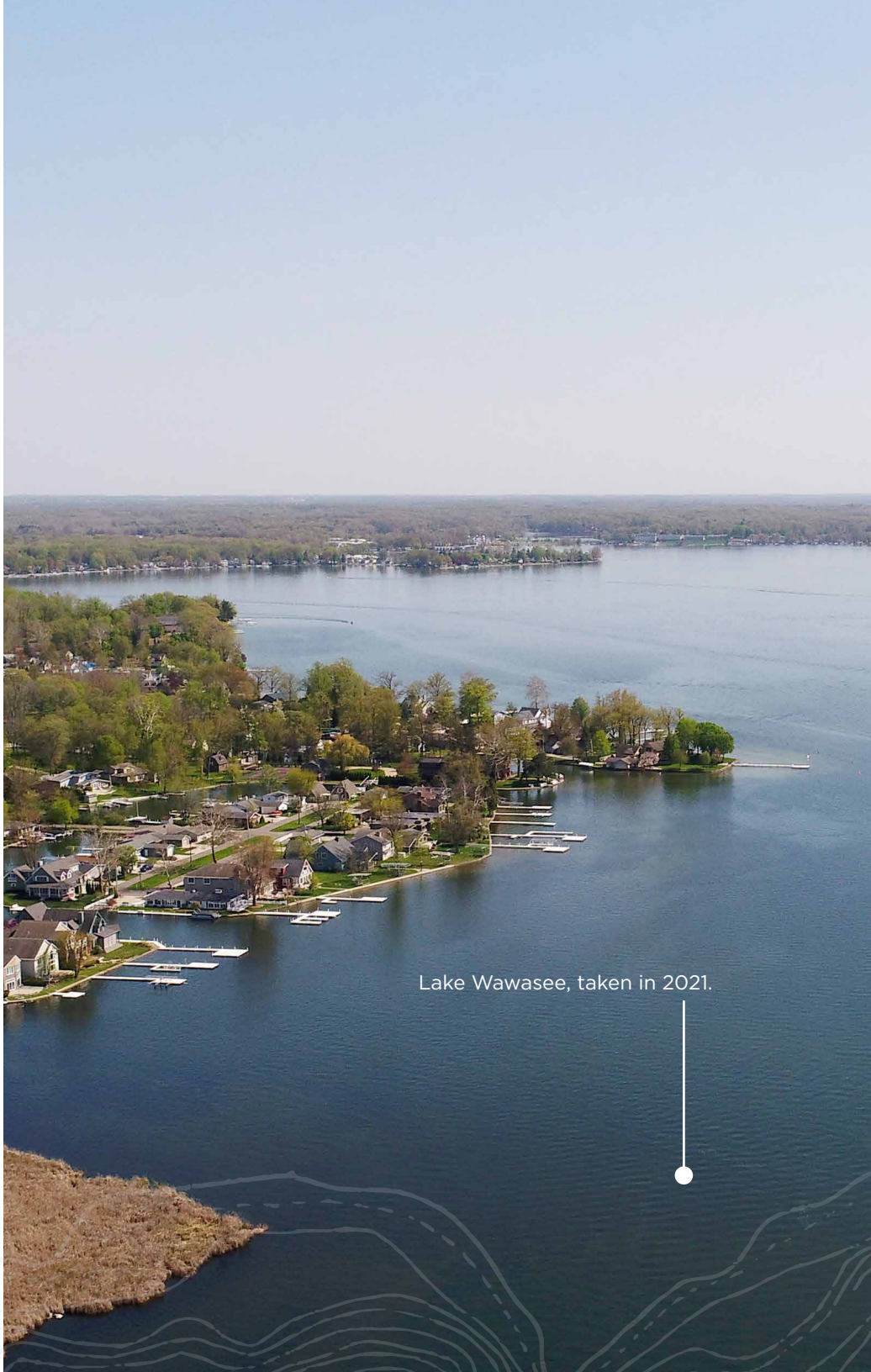
Surface area	40 acres
Max. depth	28 ft
Watershed	2,570 acres

SYR

Surface area	411 acres
Max. depth	34 ft
Avg. depth	13 ft
Watershed	24,498 acres

WAW

Surface area	3,006 acres
Max. depth	81 ft
Avg. depth	22 ft
Watershed	24,448 acres



Lake Wawasee, taken in 2021.

MICROCYSTIN

Microcystin levels continue to vary yearly, but overall concentrations of this blue-green algae toxin remain relatively low. Only three samples at these 12 locations were above IDEM's pet safety threshold of 0.8 ppb. The open water sites on Wawasee and Papakeechie each had one measurement that exceeded 0.8 ppb. Syracuse Community Center Beach also had a microcystin concentration of 1.6 ppb - twice that of the pet safety threshold. Compared to the 2013 results, 2023 microcystin concentrations were, on average, similar to or slightly lower. None of the microcystin results from these lakes approached the IDEM's human safety level of 8.0 ppb.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Boner Open Water	max.		0.2
	avg.		0.1
Boner Shore	max.	0.2	nd
	avg.	0.2	nd
Papakeechie Open Water	max.		1.3
	avg.		0.6
Papakeechie Shore	max.	0.4	0.7
	avg.	0.4	0.4
Shock Open Water	max.		nd
	avg.		nd
Shock Shore	max.	0.3	0.2
	avg.	0.2	0.2
Spear Open Water	max.		0.2
	avg.		0.1
Spear Shore	max.	nd	nd
	avg.	nd	nd

WATER CLARITY

Water clarity on Wawasee was similar to 2022 measurements but better than what we observed in 2021. The average Secchi disk depth has increased each year on Syracuse. In 2021, Secchi depths averaged 8.4 ft and then increased to 9.5 ft in 2022 and 10.6 ft in 2023. The water clarity for most of these lakes averages 8 to 10 feet. Shock Lake in the Tri-County Fish & Wildlife Area was the lake with the highest average water clarity, with an average Secchi depth of 14.0 ft.

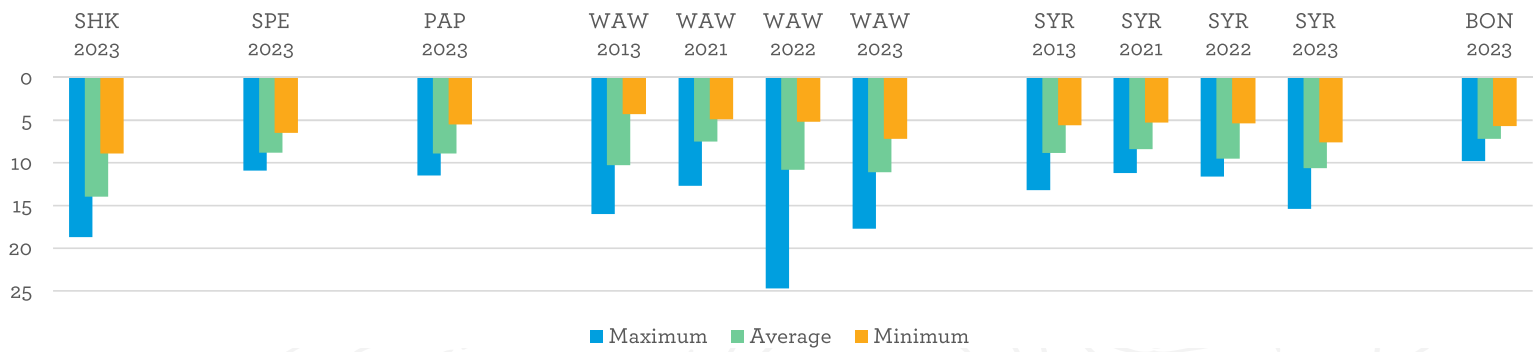
Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
Wawasee Open Water	max.	2.1	1.3	0.7	2.2
	avg.	0.6	0.6	0.2	0.4
Syracuse Open Water	max.	5	2.0	0.5	0.2
	avg.	0.7	0.7	0.2	0.1
Syracuse Community Center Beach	max.		1.8	0.3	1.6
	avg.		0.7	0.2	0.3
Syracuse Hoy's Beach	max.	3.8	1.9	0.6	0.4
	avg.	1.0	0.6	0.3	0.2

Measured in parts per billion (ppb)
nd - no toxin detected

Shock, Spear, Papakeechie, Wawasee, Syracuse, and Boner Water Clarity

Measured by Secchi disk depth in feet



LIMIT of FISH HABITAT

BON	10.8'	SPE	9.8'
PAP	16.4'	SYR	19.7'
SHK	15.4'	WAW	32.5'

WATER CLARITY

BON	7.2'	SPE	8.8'
PAP	8.9'	SYR	10.6'
SHK	14.0'	WAW	11.1'

AVERAGE TEMPERATURE

BON	81.3˚F	SPE	75.7˚F
PAP	79.3˚F	SYR	76.3˚F
SHK	77.0˚F	WAW	74.5˚F

ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

camelot & dewart waubee

Although most of Kosciusko County's lakes are kettle lakes, lakes formed by retreating glaciers, Camelot Lake is a large man-made lake. Teams of competitive water skiers call Camelot Lake home and go on to regional success.

CAM

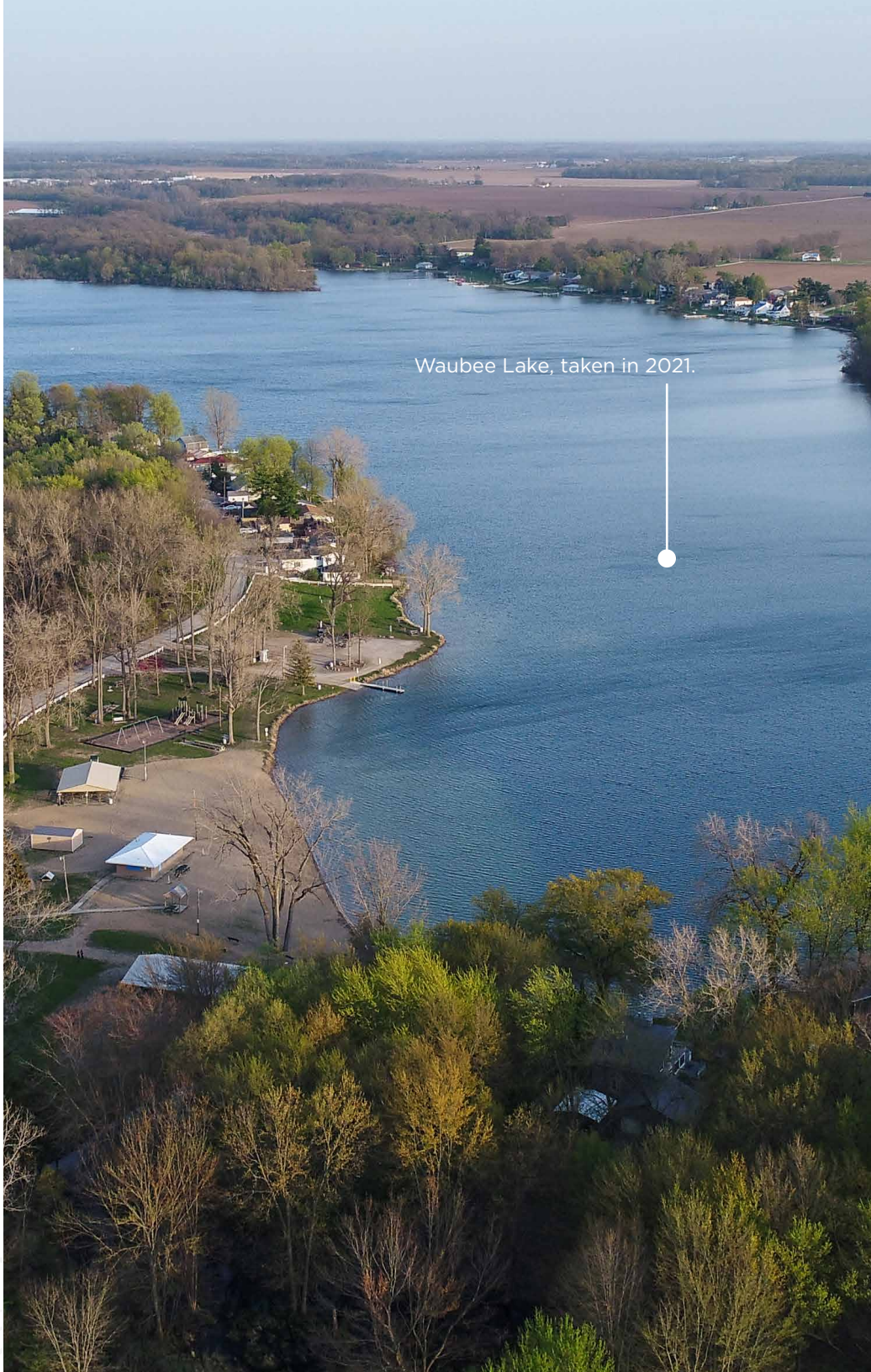
Surface area	30 acres
Max. depth	30 ft
Watershed	unkown

DEW

Surface area	554 acres
Max. depth	82 ft
Avg. depth	16 ft
Watershed	5,059 acres

WAU

Surface area	187 acres
Max. depth	51 ft
Watershed	9,370 acres



Waubee Lake, taken in 2021.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Camelot Open Water	max.	nd	nd
	avg.	nd	nd
Camelot Shore	max.	nd	nd
	avg.	nd	nd
Waubee Open Water	max.		0.8
	avg.		0.4
Waubee Shore	max.	0.4	1.9
	avg.	0.4	0.6

Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
Dewart Open Water	max.	1.3	0.7	1.7	0.5
	avg.	0.2	0.3	1.0	0.2

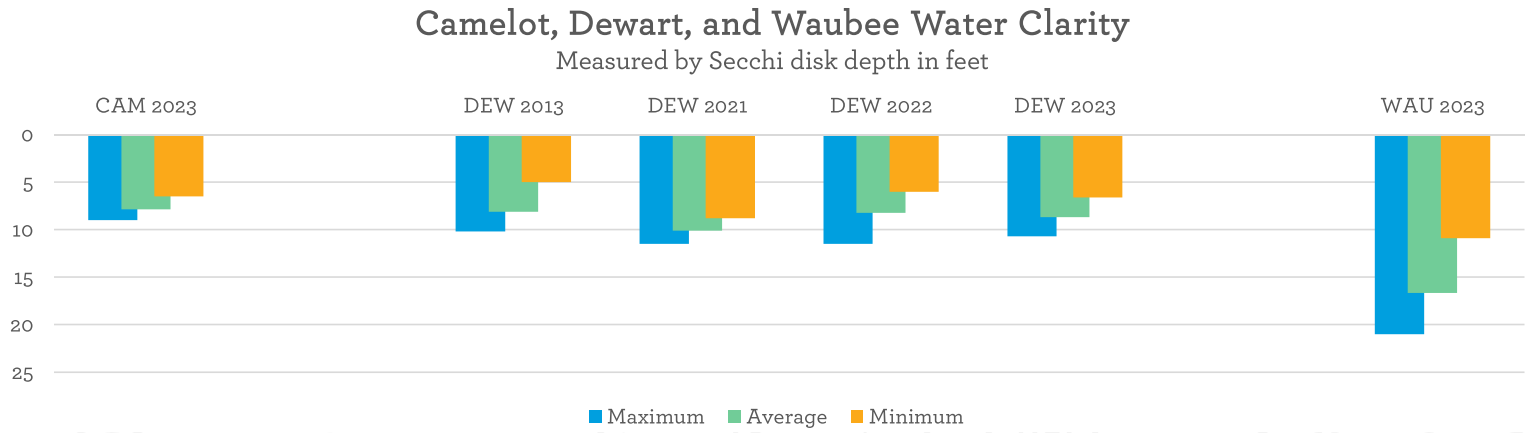
Measured in parts per billion (ppb)
nd - no toxin detected

MICROCYSTIN

We observed no detectable levels of microcystin at either the open water or shore location at Camelot. This man-made lake with limited access is sheltered from the outside influence of inflowing waters from upstream lakes and aquatic hitchhikers typically carried by boats from other locations. Waubee open water and shore samples each had at least one microcystin measurement that met or exceeded the pet safety threshold. Despite being one of the county's most clear lakes, Waubee has a higher microcystin concentration than most other lakes. Dewart's microcystin concentrations were lower this year compared to 2021 and markedly lower compared to 2022.

WATER CLARITY

In the last three years, Dewart Lake's water clarity was best in 2021 when Secchi disk measurements averaged 10.1 ft. Clarity decreased in 2022 (8.2 ft) and rebounded slightly this year (8.7 ft). Water clarity in 2021 and 2022 was similar to what was recorded in 2013 (8.1 ft). Waubee Lake's average Secchi depth this summer was 16.7 ft, the clearest lake observed in 2023. Water clarity on Camelot averaged 7.9 ft, better than the average of 6.7 ft among all lakes in 2023.



LIMIT of FISH HABITAT

CAM 17.4'
DEW 22.0'
WAU 27.2'

WATER CLARITY

CAM 7.9'
DEW 8.7'
WAU 16.7'

AVERAGE TEMPERATURE

CAM 77.4 °F
DEW 75.7 °F
WAU 74.5 °F

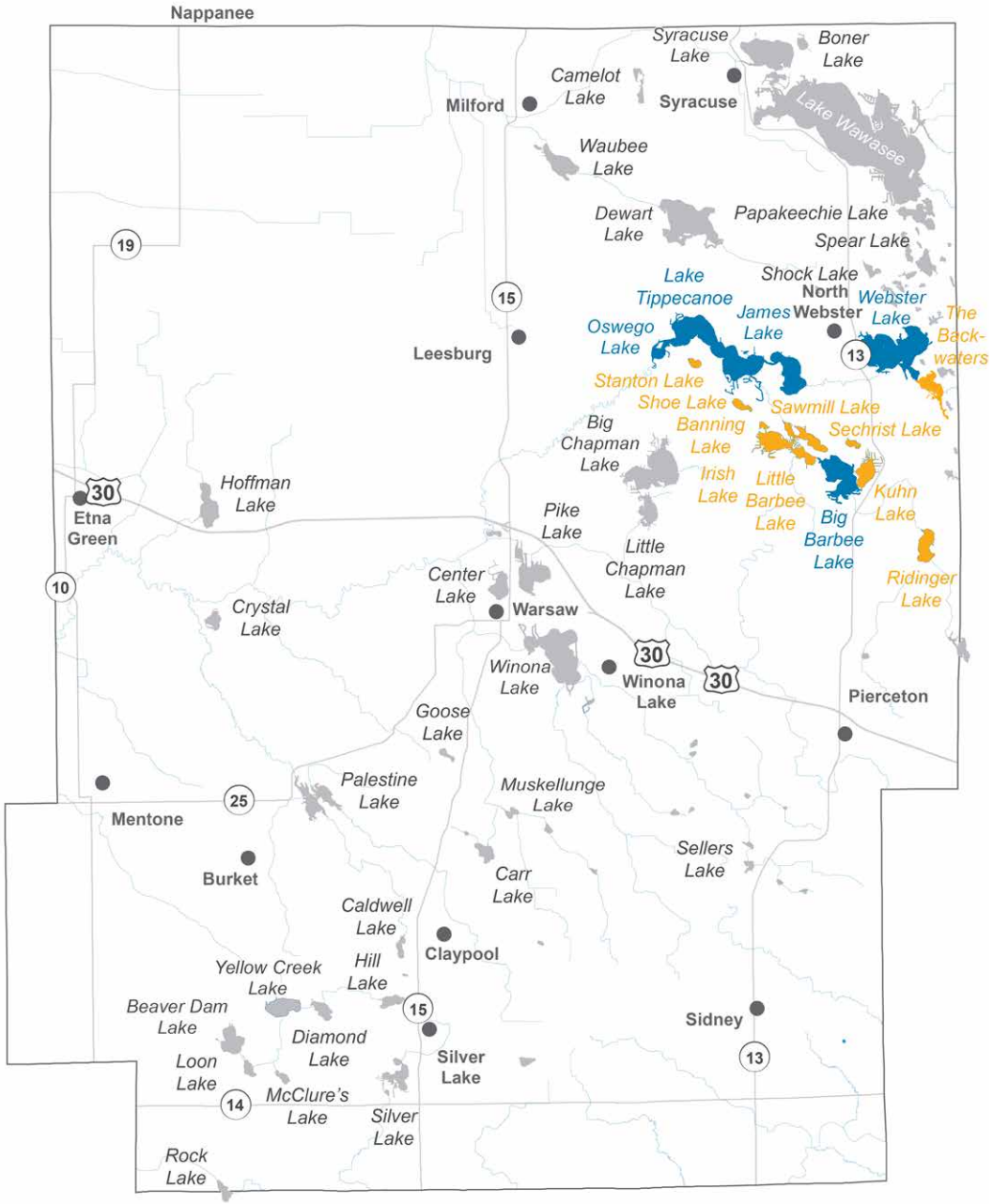
ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

upper tippecanoe
WATERSHED

Water that flows from the Upper Tippecanoe watershed mixes with water from lakes further south. Together, they make their way to the Mississippi River and, after a long journey, to the Gulf of Mexico. The lakes and streams in this region are called the headwaters. In other words, this area is the source of the major rivers further south.

LAKES:

The Backwaters
Banning Lake
Big Barbee Lake
Little Barbee Lake
Irish Lake
James Lake
Kuhn Lake
Oswego Lake
Ridinger Lake
Sawmill Lake
Sechrist Lake
Shoe Lake
Stanton Lake
Lake Tippecanoe
Webster Lake



KEY: Standard Lakes Decade Lakes

Kuhn Lake, taken in 2021.

james oswego & tippecanoe stanton

A truly unique and beautiful feature of Indiana, the Tippecanoe River feeds into and flows from the Tippecanoe lakes chain. James (Little Tippy), Tippecanoe, and Oswego lakes are connected, so their health and water quality are, too. Stanton Lake, inside the chain's "elbow," is affected by the same land practices as the main lake chain.

JAM

Surface area	278 acres
Max. depth	62 ft
Avg. depth	27 ft
Watershed	35,776 acres

OSW

Surface area	78 acres
Max. depth	37 ft
Avg. depth	13.7 ft
Watershed	72,847 acres

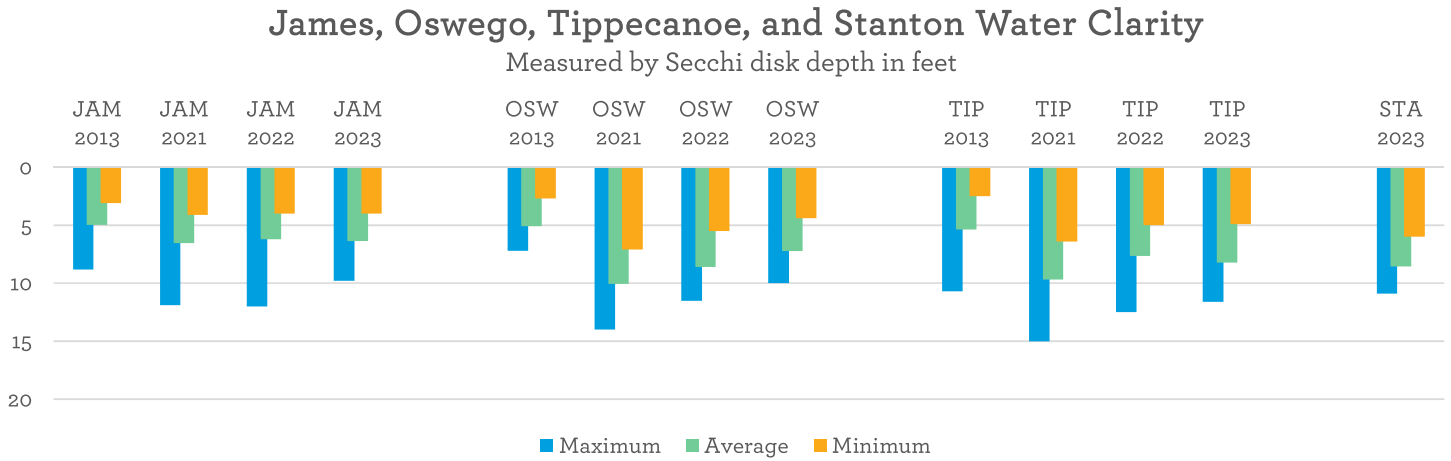
STA

Surface area	30 acres
Max. depth	30 ft
Watershed	215 acres

TIP

Surface area	876 acres
Max. depth	122 ft
Avg. depth	37 ft
Watershed	72,847 acres

Tippecanoe Chain, taken in 2020.



WATER CLARITY

The Tippecanoe Lake chain's average Secchi depth for this summer was 7.3 ft. This depth is greater than the all-lake average of 6.7 ft. Water clarity on James Lake has been consistent since 2021 ranging between 6.2 ft and 5.5 ft. On the other hand, Oswego shows a decrease in clarity over the past three years. In 2021, Oswego's Secchi depth averaged 10.1 ft. That measurement dropped to 8.6 ft in 2022 and then again in 2023 to 7.2 ft. Although not as pronounced, water clarity on Lake Tippecanoe dropped by 1.5 feet in the last three years. Average Secchi depth dropped two feet from 2021 to 2022 but rebounded in 2023 to 8.2 feet. Despite these recent decreases, water clarity at both Oswego and Tippecanoe is considerably higher than observations from 2013. Water clarity on James has been consistent during the last three years, ranging from 6.2 ft (2022) to 6.5 ft (2023). Stanton Lake's clarity (8.5 ft) was slightly better than James, Tippecanoe, and Oswego.

MICROCYSTIN

Microcystin levels on the Tippecanoe Lake chain have been relatively low over the past three sampling seasons. Concentrations of microcystin in 2023 were lower than observed in 2013 and 2022. We recorded no microcystin levels that exceeded the IDEM pet threshold in James, Tippecanoe, or Oswego over the last three years. Oswego and Tippecanoe microcystin levels were down substantially from the last decade. Stanton Lake open water samples average 0.2 ppb. Microcystin concentrations from Stanton shore samples from this year were similar to those recorded in 2013.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Stanton Open Water	max.		0.7
	avg.		0.2
Stanton Shore	max.	0.2	0.2
	avg.	0.1	0.2

Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
James Open Water	max.	0.2	0.5	0.3	0.2
	avg.	0.1	0.2	0.1	<0.1
Oswego Open Water	max.	1.5	0.2	0.3	nd
	avg.	0.5	0.1	0.1	nd
Tippecanoe Open Water	max.	3.4	0.2	0.1	nd
	avg.	0.6	0.1	0.1	nd

Measured in parts per billion (ppb)
nd - no toxin detected

LIMIT of FISH HABITAT

JAM	19.7'
STA	12.1'
TIP	59.1'
OSW	12.5'

WATER CLARITY

JAM	6.4'
STA	8.5'
TIP	8.2'
OSW	7.2'

AVERAGE TEMPERATURE

JAM	77.0 °F
STA	79.2 °F
TIP	76.5 °F
OSW	77.5 °F

ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

& barbee lake chain ridinger shoe

The Barbee Lake chain is a complex system of big and small lakes whose health is directly connected. Many lakes presented here were part of the Lilly Center's DNR-funded sewer impact study in 2021. You can read the full report on our website: lakes.grace.edu.

BAN

Surface area	12 acres
Max. depth	17 ft
Watershed	132 acres

BBA

Surface area	311 acres
Max. depth	45 ft
Avg. depth	15.6 ft
Watershed	28,737 acres

LBA

Surface area	74 acres
Max. depth	26 ft
Watershed	28,737 acres

IRI

Surface area	182 acres
Max. depth	36 ft
Watershed	32,250 acres

KUH

Surface area	137 acres
Max. depth	28 ft
Watershed	2,460 acres

RID

Surface area	141 acres
Max. depth	42 ft
Watershed	22,144 acres

SAW

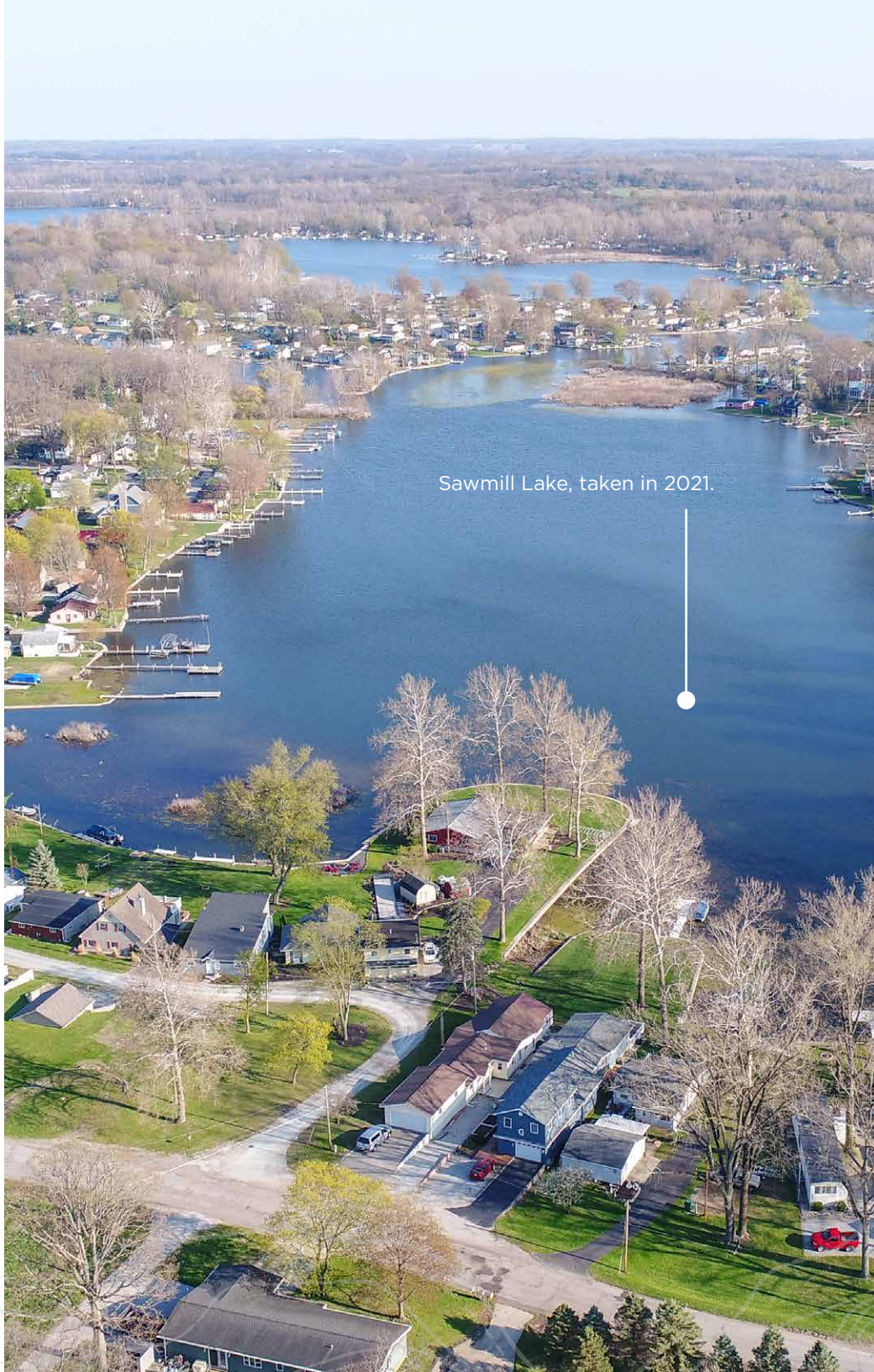
Surface area	36 acres
Max. depth	27 ft
Watershed	33,460 acres

SEC

Surface area	105 acres
Max. depth	63 ft
Watershed	361 acres

SHO

Surface area	43 acres
Max. depth	29 ft
Watershed	184 acres



Sawmill Lake, taken in 2021.

Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
Big Barbee Open Water	max.	0.3	0.2	0.4	nd
	avg.	0.3	0.1	0.1	nd

Measured in parts per billion (ppb)
nd - no toxin detected

MICROCYSTIN

The lakes of the Barbee chain experienced very low microcystin concentrations in 2023. Only Kuhn (open water and shore locations) and Banning (open water) had detectable levels of this cyanobacterial toxin this summer. The microcystin concentrations on these lakes averaged 0.2 pbb or less, and the maximum values (0.4 ppb) were well below the IDEM pet threshold of 0.8 ppb. No microcystin was detected in Ridinger Lake (open water and shore) or Shoe Lake (open water). We observed a low microcystin concentration in the shoreline samples from Shoe Lake.

WATER CLARITY

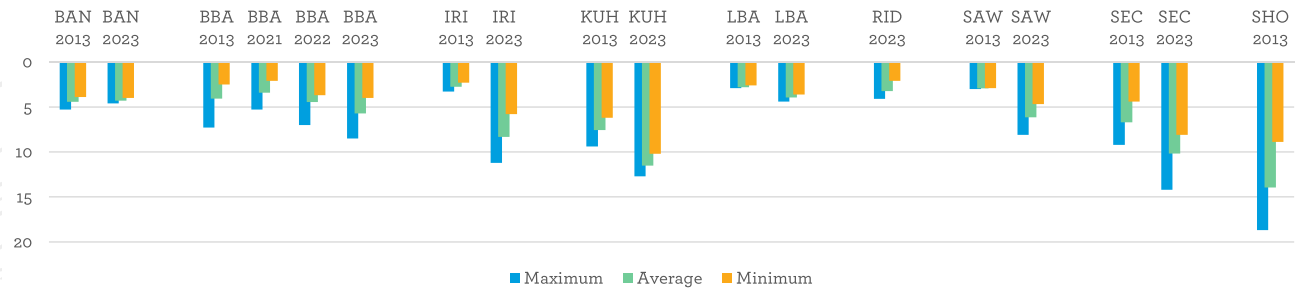
Water clarity appears to be on the rise in Big Barbee Lake. Secchi depth measurements on Big Barbee increased by 2.7 ft over the last three years. Since 2013, water clarity increased substantially on Kuhn, Little Barbee, Sawmill, and Sechrist. Shoe Lake Secchi depth averaged 14.0 ft in 2023, while Ridinger water clarity was only 3.2 ft.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Banning Open Water	max.		0.2
	avg.		0.1
Banning Shore	max.		nd
	avg.		nd
Irish Open Water	max.		nd
	avg.		nd
Irish Shore	max.	0.6	nd
	avg.	0.2	nd
Kuhn Open Water	max.		0.4
	avg.		0.1
Kuhn Shore	max.	1.4	0.4
	avg.	1.0	0.2
Little Barbee Open Water	max.		nd
	avg.		nd
Little Barbee Shore	max.	0.2	nd
	avg.	0.1	nd
Ridinger Open Water	max.		nd
	avg.		nd
Ridinger Shore	max.	0.2	nd
	avg.	0.1	nd
Sawmill Open Water	max.		nd
	avg.		nd
Sawmill Shore	max.	1.9	nd
	avg.	0.7	nd
Sechrist Open Water	max.		nd
	avg.		nd
Sechrist Shore	max.	0.3	nd
	avg.	0.2	nd
Shoe Shore	max.	0.4	0.2
	avg.	0.2	0.1
Shoe Open Water	max.		nd
	avg.		nd

Barbee Lake Chain, Ridinger and Shoe Water Clarity

Measured by Secchi disk depth in feet



LIMIT of FISH HABITAT

BAN	7.5’	RID	9.8’
BBA	12.5’	SAW	10.8’
LBA	8.9’	SEC	24.0’
IRI	13.1’	SHO	15.4’
KUH	17.4’		

WATER CLARITY

BAN	4.3’	RID	3.2’
BBA	5.7’	SAW	6.1’
LBA	3.9’	SEC	10.2’
IRI	8.3’	SHO	14.0’
KUH	11.5’		

AVERAGE TEMPERATURE

BAN	76.6˚F	RID	75.4 ˚F
BBA	75.9˚F	SAW	78.4˚F
LBA	77.9˚F	SEC	79.2˚F
IRI	79.0˚F	SHO	78.1˚F
KUH	76.1˚F		

ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

backwaters & webster

Webster Lake and The Backwaters are some of the most influential lakes in the Tippecanoe River's journey through Kosciusko County. The wetlands surrounding these lakes are key to filtering any water before it reaches the lakes and, eventually, the Tippecanoe River.

BAC

Surface area	186 acres
Max. depth	7 ft
Watershed	27,890 acres

WEB

Surface area	653 acres
Max. depth	52 ft
Avg. depth	12.5 ft
Watershed	31,459 acres

The Backwaters, taken in 2021.

Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
Webster Open Water	max.	0.5	0.4	0.5	0.2
	avg.	0.2	0.2	0.2	0.1
Webster Beach	max.	nd	0.2	0.3	0.2
	avg.	nd	0.2	0.2	0.1
Backwater Open Water	max.				0.2
	avg.				0.1
Backwater Shore	max.	0.3			nd
	avg.	0.1			nd

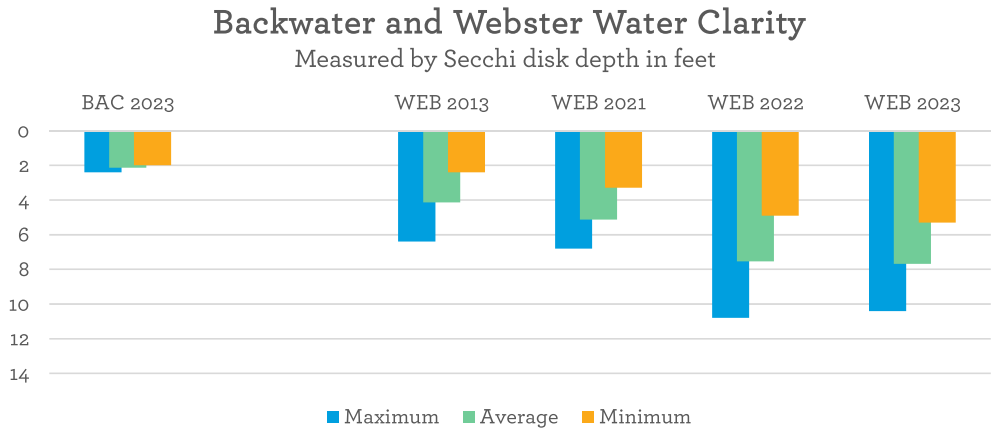
Measured in parts per billion (ppb)
nd - no toxin detected

MICROCYSTIN

Microcystin concentrations on Webster Lake and at the beach were lower this summer than the previous two years. Likewise, levels this year were lower than those recorded in 2013. The Backwaters microcystin levels were similar to Webster's this year and slightly lower than those observed in 2013.

WATER CLARITY

Water clarity in Webster appears to be moving in a positive direction. The average Secchi depth this summer measured 7.7 ft compared to 5.1 ft in 2021 and 7.5 in 2022. The Backwaters Secchi depth was only 2.1 ft. This is not uncommon for an extremely shallow and productive lake.



The Lilly Center relies on volunteer captains to facilitate strategic lake research. Some boat captains provide snacks for our team or bring their dogs for extra loving! Thank you to the following boat captains for their investment in their lake:

Fran Allen, Philip Baumgartner, Chuck & Cathy Brinkman, Paula & Larry Brown, Brett Burch, Jim Casper, Tim Creighton, Jack Dabler, Mark & Cindy Deister, Tammy & Keith Denlinger, Garry England, Ron England, Jane & Harry Finch, Lynn Gonzales, David Hamrick, Orville Haney, Phil Harshman, Steve & Leslie Hepler, Nathan Hooley, Julie Jose, Anna Leuer, Max Mock, John O'Neill, Greg Platt, Diane Quance, Vickie & Gifford Ried, Dustin Robbins, Duane Schlabach, Lon & Laura Sloan, Scott Smith, Kathryn Stanley, Jack & Kathy Sutton, Butch and Wanda Troke, Mike & Nancy Tynan

LIMIT of FISH HABITAT

BAC 2.1'
WEB 18.0'

WATER CLARITY

BAC 2.4'
WEB 7.7'

AVERAGE TEMPERATURE

BAC 77.0 °F
WEB 76.3 °F

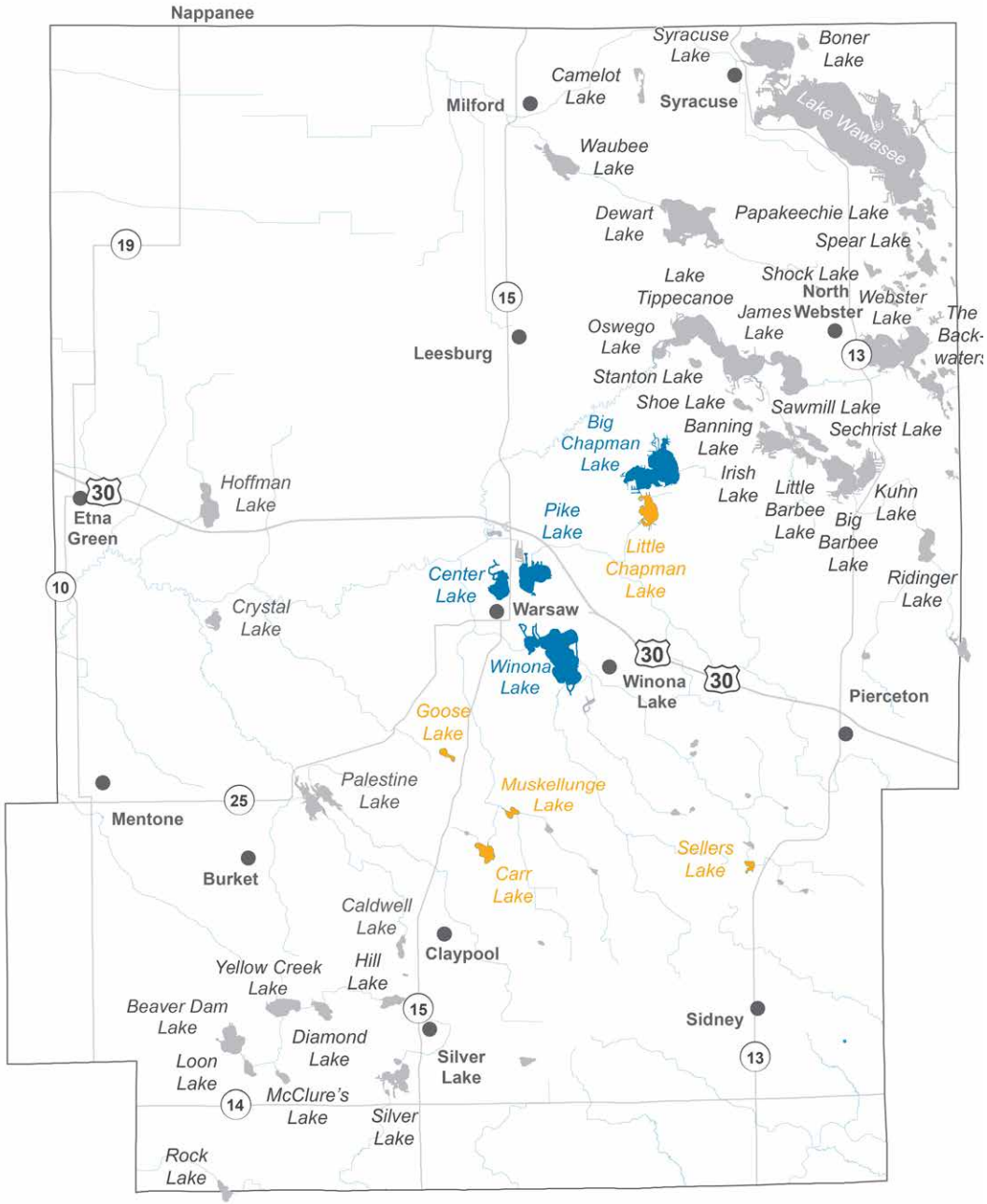
ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

middle tippecanoe
WATERSHED

This area of the Tippecanoe watershed contains the highest urban density found in Kosciusko County. By studying lakes across a region together, we can observe trends and differences that will inform specific practices and procedures based on their context.

LAKES:

Carr Lake
Center Lake
Big Chapman Lake
Little Chapman Lake
Goose Lake
Muskellunge Lake
Pike Lake
Sellers Lake
Winona Lake



KEY: Standard Lakes Decade Lakes

Big Chapman Lake, taken in 2021.

center & pike & winona

Center, Pike, and Winona lakes can be found within a 3-mile radius of each other. These lakes are the most-visited lakes within Warsaw and Winona Lake. They are freely accessible for public swimming, fishing and boating.

CEN

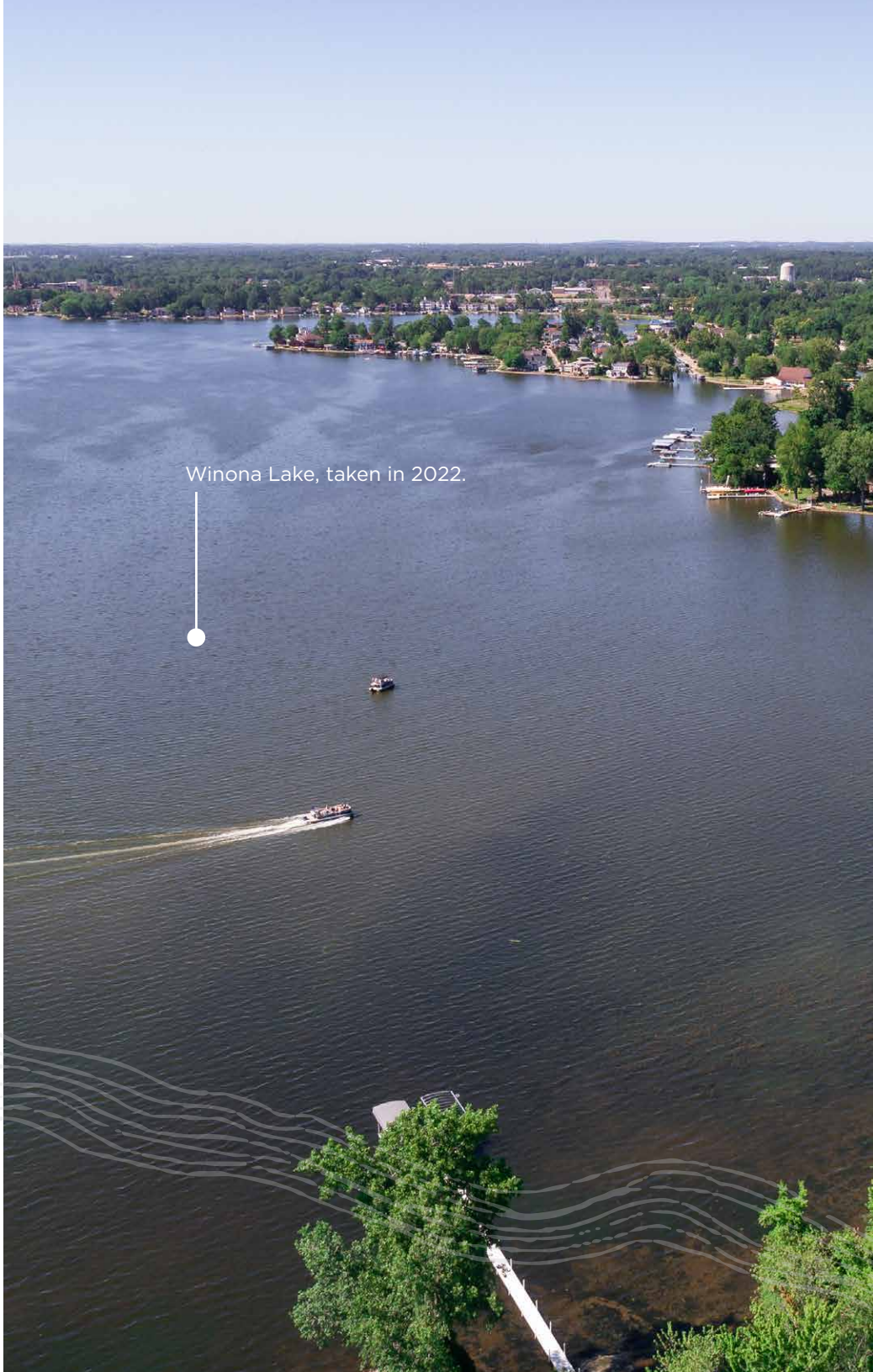
Surface area	120 acres
Max. depth	43 ft
Avg. depth	16.5 ft
Watershed	9,611 acres

PIK

Surface area	228 acres
Max. depth	35 ft
Avg. depth	14 ft
Watershed	23,405 acres

WIN

Surface area	571 acres
Max. depth	79 ft
Avg. depth	30 ft
Watershed	18,730 acres



Winona Lake, taken in 2022.

Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
Center Open Water	max.		2.5	0.3	0.3
	avg.		0.5	0.2	0.1
Center Beach	max.	1.1	1.7	0.3	0.2
	avg.	0.3	0.4	0.2	0.1
Pike Open Water	max.		0.6	0.6	0.5
	avg.		0.3	0.3	0.2
Pike Beach	max.	0.3	0.6	0.4	0.4
	avg.	0.1	0.3	0.3	0.2
Winona Open Water	max.	0.3	nd	1.3	0.2
	avg.	0.1	nd	0.2	<0.1
Winona Beach	max.	0.3	0.2	0.2	nd
	avg.	0.2	0.1	0.1	nd

Measured in parts per billion (ppb)
nd - no toxin detected

MICROCYSTIN

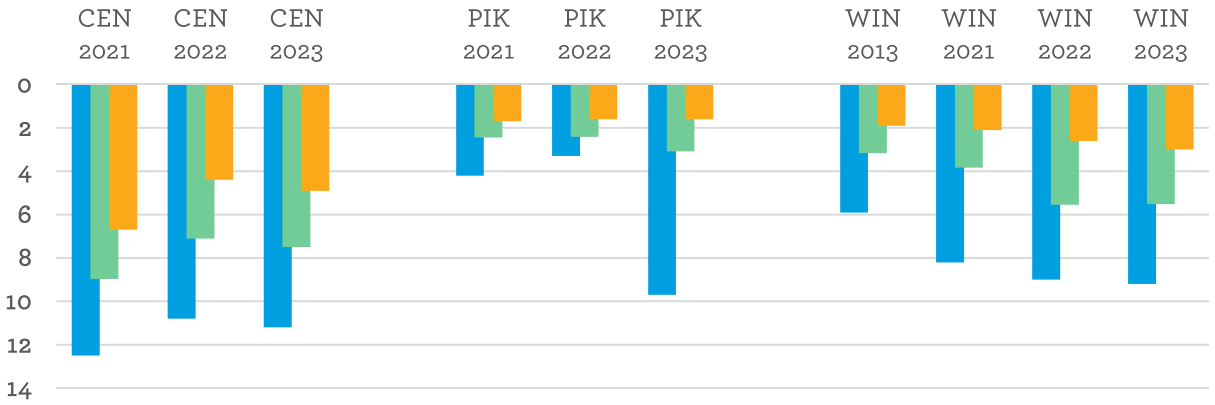
Microcystin levels at Center and Pike Lakes and their beaches were lower in 2023 compared to the previous two years. Winona Lake beach also had lower microcystin levels than in years past. In fact, no microcystin was detected at the Winona Lake beach, and we observed lower levels of microcystin in 2023 than in 2022, but not 2021. Microcystin levels at Center, Pike, and Winona beaches and Winona Lake open-water sites were higher in 2013 than in 2023.

WATER CLARITY

Water clarity at Center, Pike, and Winona continues to differ despite their proximity. This summer, Secchi depths at Pike Lake averaged 3.1 feet and have been relatively similar over the last three years. Secchi depths in Winona increased from 2021 to 2022 and remained the same as we moved into 2023. Water clarity in Winona averaged 5.5 ft this summer. Center Lake shows a decrease in water clarity from 2021 (9.0 ft) to 2022 (7.1 ft). After this nearly two-foot drop in water clarity, Secchi depths in 2023 averaged 7.5 feet.

Center, Pike, and Winona, Water Clarity

Measured by Secchi disk depth in feet



LIMIT of FISH HABITAT

CEN	17.7’
PIK	9.8’
WIN	21.3’

WATER CLARITY

CEN	7.5’
PIK	3.1’
WIN	5.5’

AVERAGE TEMPERATURE

CEN	75.6 ˚F
PIK	75.2 ˚F
WIN	76.1 ˚F

ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

big & little chapman

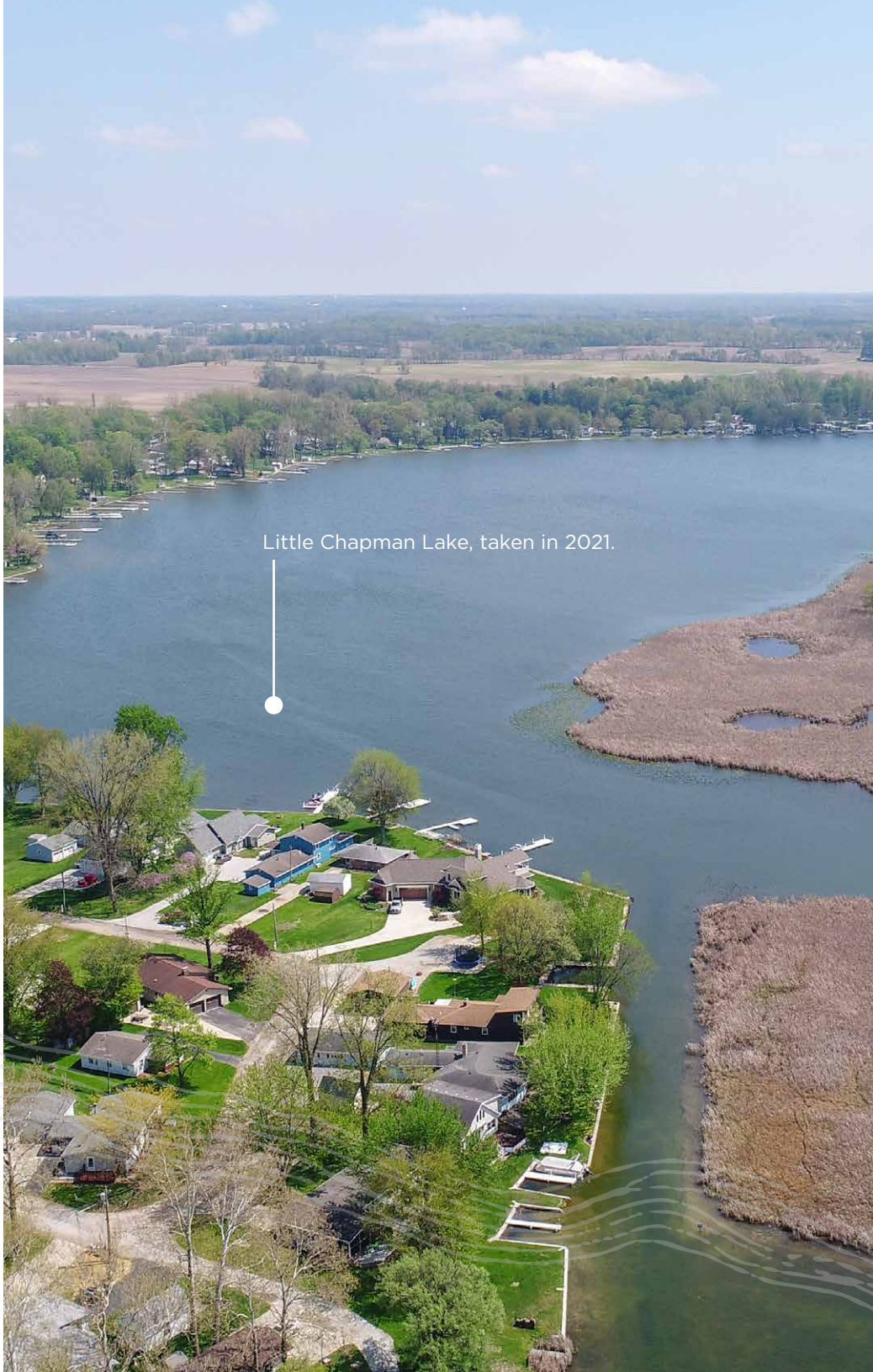
Like the Barbee lakes chain, Big Chapman and Little Chapman lakes were studied as part of the Lilly Center's sewer impact study, completed in 2021. The Chapman lakes are also home to a species of exotic freshwater jellyfish. You can learn more about jellyfish on our website: lakes.grace.edu/field-notes.

BCH

Surface area	504 acres
Max. depth	39 ft
Avg. depth	12.5 ft
Watershed	4,500 acres

LCH

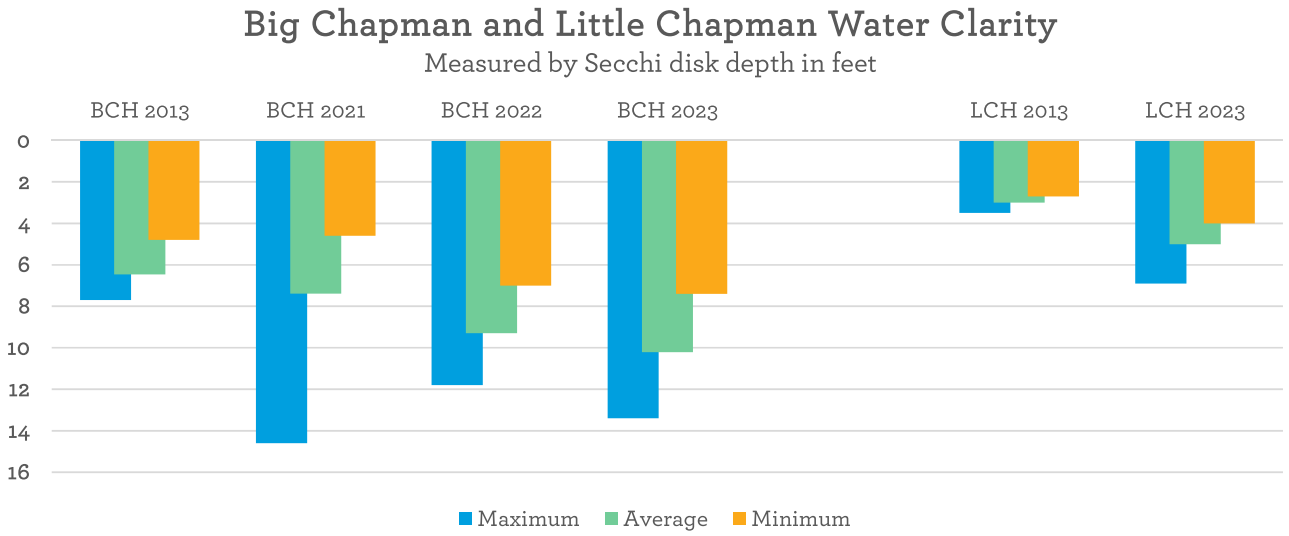
Surface area	177 acres
Max. depth	32 ft
Watershed	4,500 acres



WATER CLARITY

Water clarity has improved substantially at Big Chapman since 2021. Average Secchi depth readings increased nearly three feet over the last three years and over 3.5 ft since 2013.

Clarity on Little Chapman Lake averaged 5.0 ft this summer compared to the recorded clarity of 3.0 ft in 2013.



MICROCYSTIN

Contrasting the increase in water clarity, microcystin levels on Big Chapman have declined over the last few years. For the first time in three years, we observed no microcystin levels in Big Chapman that exceeded IDEM's threshold for pet safety. Microcystin levels in 2023 were also lower than those from 2013. Little Chapman microcystin concentrations were nearly identical to Big Chapman this year. Little Chapman shore samples showed a slight increase in microcystin levels compared to 2013.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Little Chapman Open Water	max.		0.5
	avg.		0.3
Little Chapman Shore	max.	0.4	0.5
	avg.	0.2	0.3

Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
Big Chapman Open Water	max.	1.3	3.8	0.9	0.5
	avg.	0.1	1.6	0.4	0.3

Measured in parts per billion (ppb)
nd - no toxin detected

LIMIT of FISH HABITAT

BCH 20.0'
LCH 14.1'

WATER CLARITY

BCH 10.2'
LCH 5.0'

AVERAGE TEMPERATURE

BCH 76.5 °F
LCH 77.5 °F

ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

carr & muskellunge goose & sellers

Although these four lakes do not appear to share much in common, their downstream impact converges in Walnut Creek and eventually in the Tippecanoe River. As the name suggests, these lakes lie within the smaller Walnut Creek watershed that includes Winona Lake.

CAR

Surface area	79 acres
Max. depth	35 ft
Watershed	1,340 acres

GOO

Surface area	70 acres
Max. depth	35 ft
Watershed	753 acres

MUS

Surface area	32 acres
Max. depth	21 ft
Watershed	7,700 acres

SEL

Surface area	32 acres
Max. depth	21 ft
Watershed	3,224 acres

Muskellunge Lake, taken in 2023.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Carr Open Water	max.		2.7
	avg.		1.3
Carr Shore	max.	3.5	4.5
	avg.	1.3	2.8
Goose Open Water	max.		0.2
	avg.		0.1
Goose Shore	max.	nd	nd
	avg.	nd	nd
Muskellunge Open Water	max.		nd
	avg.		nd
Muskellunge Shore	max.	1.6	0.3
	avg.	0.4	0.2
Sellers Open Water	max.		0.2
	avg.		0.2
Sellers Shore	max.	nd	0.2
	avg.	nd	0.2

Measured in parts per billion (ppb)
nd - no toxin detected

MICROCYSTIN

Despite poor water clarity, microcystin concentrations at Muskellunge and Sellers were low and similar to most of the other lakes we sampled in 2023. Shore samples collected this year at Muskellunge exhibited microcystin levels below those recorded in 2013. Goose Lake (open water and shore) samples were also similar to most of the other lakes in the county and well below the threshold for pet safety.

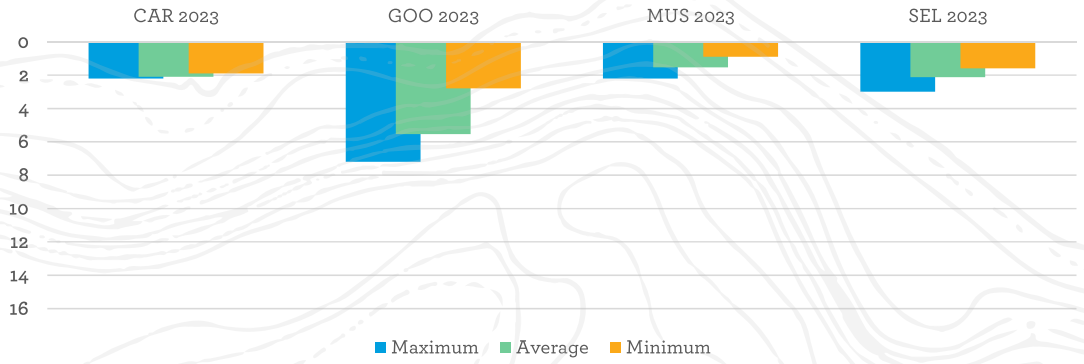
This was not the case at Carr Lake. A total of six microcystin samples were collected from Carr Lake in 2023 - three from a shore location and three from the open water. Five of the six samples were above IDEM's pet safety threshold of 0.8 ppb. Shore microcystin concentrations averaged 2.8 ppb and ranged from 0.8 ppb to 4.5 ppb. Although the open-water observations were not as high, two of the three samples had microcystin concentrations of 1.2 ppb and 2.7 ppb.

WATER CLARITY

Carr, Muskellunge, and Sellers lakes are all shallow, productive lakes. Muskellunge and Sellers are only 21 ft deep, and Carr has a maximum depth of 35 ft. Average Secchi depths at these three lakes are well below the overall average for the 2023 sampling season. Water clarity this summer averaged 2.1 ft at Carr and Sellers and only 1.5 ft at Muskellunge Lake. Goose Lake is a bit different from these other three lakes. Goose has a maximum depth of 53 ft, and its average Secchi depth (5.5 feet) was much closer to the all-lake average of 6.5 ft.

Carr, Goose, Muskellunge, and Sellers Water Clarity

Measured by Secchi disk depth in feet



LIMIT of FISH HABITAT

CAR 8.9'
GOO 10.8'
MUS 5.6'
SEL 5.6'

WATER CLARITY

CAR 2.1'
GOO 5.5'
MUS 1.5'
SEL 2.1'

AVERAGE TEMPERATURE

CAR 75.6 °F
GOO 75.7 °F
MUS 77.9 °F
SEL 79.2 °F

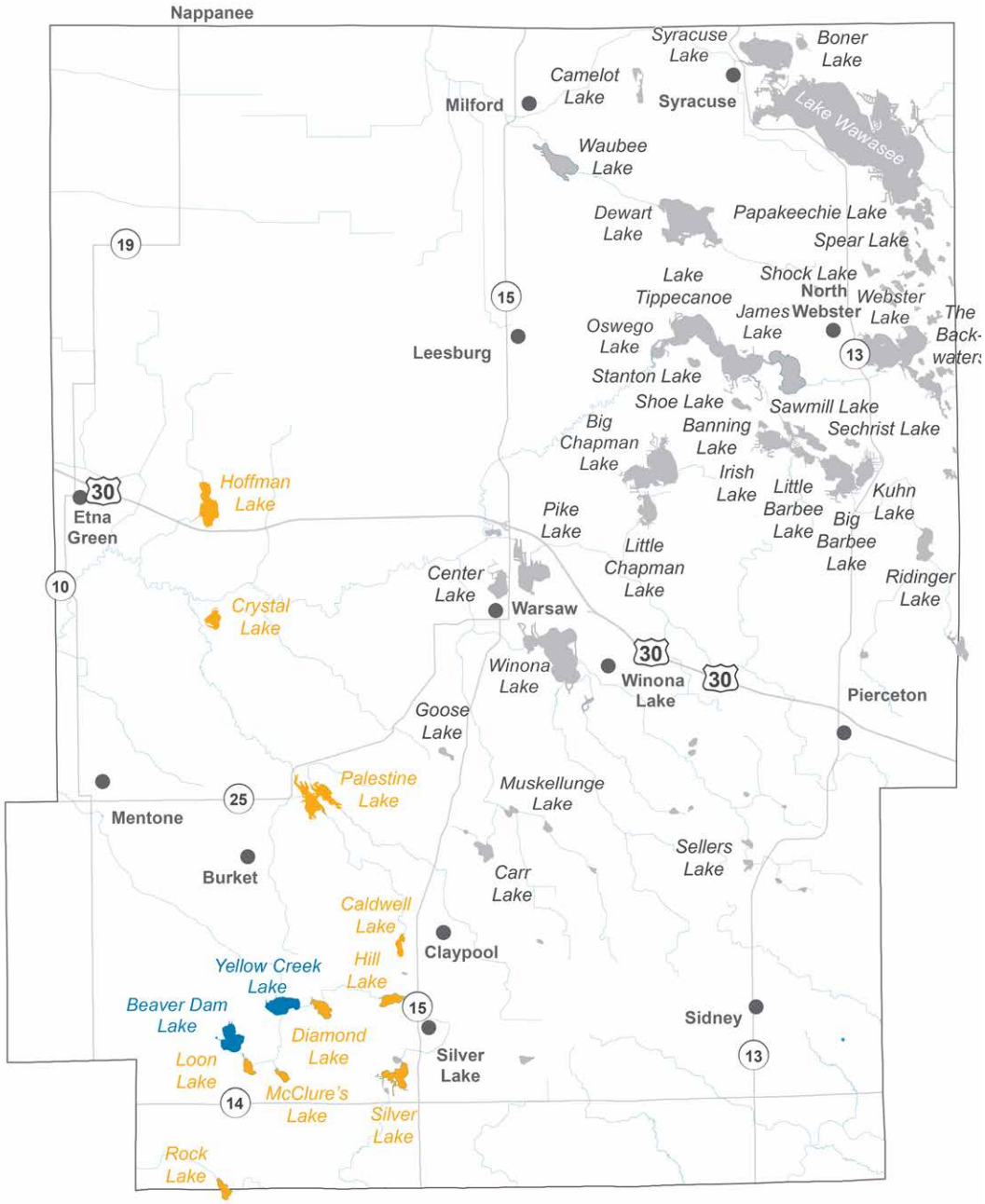
ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

lower tippecanoe
WATERSHED

One of these lakes is not like the other. Unlike the other lakes we study in the area, water from Silver Lake first flows into the Eel River before eventually making its way to the Gulf of Mexico. The land surrounding the lakes in the lower Tippecanoe watershed is a mix of agricultural and residential, much like the upper Tippecanoe watershed.

LAKES:

Beaver Dam Lake
Caldwell
Crystal Lake
Diamond Lake
Hill Lake
Hoffman Lake
Loon Lake
McClure's Lake
Palestine Lake
Rock Lake
Silver Lake
Yellow Creek Lake



KEY: Standard Lakes Decade Lakes

Loon Lake, taken in 2023.

caldwell & hoffman crystal & palestine

Known as the Trimble Creek watershed thanks to the creek that connects three of these lakes, Trimble Creek flows into the Tippecanoe River within a few miles of Hoffman Lake's outlet. Understanding how our actions can impact water quality downstream will help us care for our lakes for future generations. Learn more about what you can do on page 49.

CAL

Surface area	45 acres
Max. depth	40 ft
Watershed	1,290 acres

CRY

Surface area	68 acres
Max. depth	40 ft
Watershed	561 acres

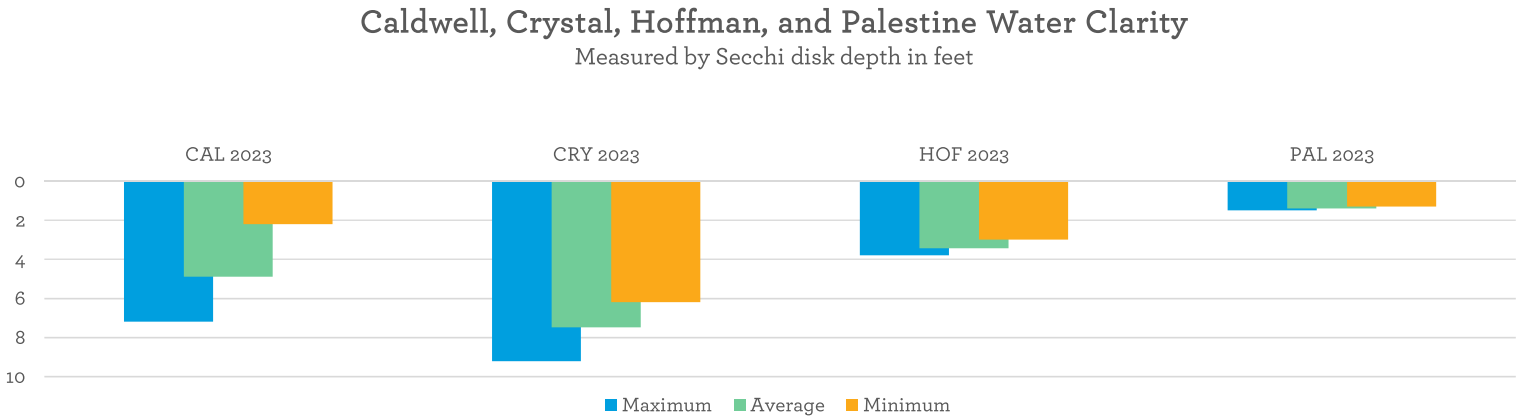
HOF

Surface area	180 acres
Max. depth	30 ft
Watershed	5,532 acres

PAL

Surface area	290 acres
Max. depth	27 ft
Watershed	20,815 acres

Crystal Lake, taken in 2021.



WATER CLARITY

This group of decade lakes had variable water clarity measurements. Crystal Lake water clarity averaged 7.5 ft this summer, one foot deeper than the all-lake average of 6.4 ft. Palestine Lake had one of the poorest water clarities recorded this summer at only 1.4 ft. Caldwell (4.9 ft) and Hoffman (3.4 ft) Secchi depths were also relatively low compared to the all-lakes average.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Caldwell Open Water	max.		0.2
	avg.		0.1
Caldwell Shore	max.	0.2	0.2
	avg.	0.1	0.1
Crystal Open Water	max.		nd
	avg.		nd
Crystal Shore	max.	nd	nd
	avg.	nd	nd
Hoffman Open Water	max.		0.2
	avg.		0.1
Hoffman Shore	max.	0.5	nd
	avg.	0.2	nd
Palestine Open Water	max.		0.2
	avg.		0.1
Palestine Shore	max.	nd	nd
	avg.	nd	nd

Measured in parts per billion (ppb)
nd - no toxin detected

MICROCYSTIN

None of the microcystin samples collected at these four lakes resulted in concentrations greater than IDEM's pet safety threshold of 0.8 ppb. The highest level we observed at these lakes this summer was 0.2 ppb. Results for this summer were similar to those recorded in 2013. Microcystin levels at Hoffman Lake were down from 10 years ago.

LIMIT of FISH HABITAT

CAL 17.4'
CRY 16.4'
HOF 9.8'
PAL 4.3'

WATER CLARITY

CAL 4.9'
CRY 7.5'
HOF 3.4'
PAL 1.4'

AVERAGE TEMPERATURE

CAL 79.0 °F
CRY 76.5 °F
HOF 76.5 °F
PAL 79.3 °F

ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

beaver dam & diamond & hill & loon & mcclure's & rock & silver & yellow creek

Apart from Silver Lake, which flows into the Eel River to the south, this group of lakes is tightly connected. Their separation from the rest of the county's lakes provides unique ways to measure and compare the impacts of blue-green algae to other lakes in the county.

BEA

Surface area	155 acres
Max. depth	61 ft
Avg. depth	15.6 ft
Watershed	1,266 acres

DIA

Surface area	79 acres
Max. depth	35 ft
Watershed	2,780 acres

HIL

Surface area	70 acres
Max. depth	35 ft
Watershed	753 acres

LOO

Surface area	40 acres
Max. depth	41 ft
Watershed	2,640 acres

MCC

Surface area	33.5 acres
Max. depth	30 ft
Watershed	835 acres

ROC

Surface area	56 acres
Max. depth	15 ft
Watershed	1,870 acres

SIL

Surface area	102 acres
Max. depth	31 ft
Watershed	3,300 acres

YEL

Surface area	155 acres
Max. depth	67 ft
Avg. depth	31.6 ft
Watershed	2,160 acres

Hill Lake, taken in 2023.

MICROCYSTIN

We observed no detectable microcystin levels at Beaver Dam Lake in 2023, a decrease compared to the average of 0.2 ppb in 2021 and 2022. Microcystin concentrations averaged 0.6 ppb in 2013 with a maximum of 2.0 ppb. Yellow Creek Lake followed a similar trend and exhibited lower microcystin than in 2013. Microcystin concentrations in the smaller lakes had higher concentrations compared to Beaver Dam, Yellow Creek, and small lakes to the north. McClure's, Rock, and Silver Lakes had average microcystin concentrations of at least 0.3 ppb and maximum values that ranged from 0.4 ppb to 2.7 ppb. Samples collected at Silver Lake averaged 1.1 ppb and 1.3 ppb, and only two of the six samples tested were below the pet safety threshold of 0.8 ppb. The results of shore samples recorded in 2023 were similar to those observed in 2013. Open water samples from Silver Lake were substantially higher in 2023 compared to ten years ago.

Summer Microcystin Concentrations

Sampling Location		2013	2023
Diamond Open Water	max.		nd
	avg.		nd
Diamond Shore	max.	0.3	nd
	avg.	0.2	nd
Hill Open Water	max.		0.2
	avg.		0.1
Hill Shore	max.	0.2	0.2
	avg.	0.1	0.2
Loon Open Water	max.		nd
	avg.		nd
Loon Shore	max.	1.7	nd
	avg.	0.5	nd
McClure's Open Water	max.		0.7
	avg.		0.4
McClure's Shore	max.	4.2	0.5
	avg.	1.0	0.3
Rock Open Water	max.		0.4
	avg.		0.3
Rock Shore	max.		0.4
	avg.	0.5	0.3
Silver Open Water	max.	0.3	2.2
	avg.	1.1	1.1
Silver Shore	max.	3.0	2.7
	avg.	1.3	1.3

WATER CLARITY

Except for Hill Lake, the average water clarity for this group of lakes is considerably lower than the all-lakes Secchi depth average of 6.7 ft. This group of lakes exhibited an average Secchi depth of only 3.5 ft. Hill Lake's Secchi depth averaged 7.7 ft in 2023. Water clarity was relatively consistent over the last three years at Beaver Dam and Yellow Creek. Water clarity measurements at these two lakes in 2013 were similar to those recorded in the last three years. McClure's Lake had the poorest water clarity and only averaged 1.4 ft during 2023.

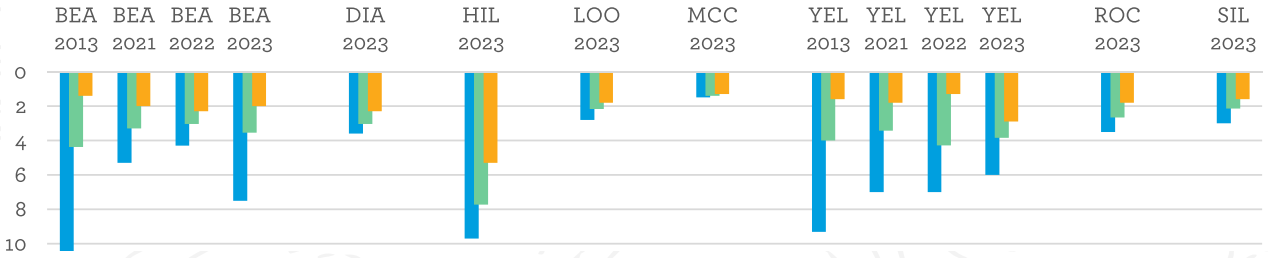
Summer Microcystin Concentrations

Sampling Location		2013	2021	2022	2023
Beaver Dam Open Water	max.	2	0.6	0.5	nd
	avg.	0.6	0.2	0.2	nd
Yellow Creek Open Water	max.	1.8	0.2	0.1	0.2
	avg.	0.3	0.1	0.1	<0.1

Measured in parts per billion (ppb)
nd - no toxin detected

Beaver Dam, Diamond, Hill, Loon, McClure's, Yellow Creek, Rock, and Silver Water Clarity

Measured by Secchi disk depth in feet



LIMIT of FISH HABITAT

BEA	9.5'	MCC	4.3'
DIA	8.9'	ROC	3.9'
HIL	16.4'	SIL	7.5'
LOO	7.5'	YEL	13.1'

WATER CLARITY

BEA	3.5'	MCC	1.4'
DIA	3.0'	ROC	2.7'
HIL	7.7'	SIL	2.1'
LOO	2.2'	YEL	3.8'

AVERAGE TEMPERATURE

BEA	77.0˚F	MCC	74.5 ˚F
DIA	78.1˚F	ROC	76.1˚F
HIL	77.4˚F	SIL	75.7˚F
LOO	74.3˚F	YEL	76.8˚F

ALL NUMBERS IN THIS SIDEBAR ARE AVERAGES FROM 2023 RESEARCH

HOW A LAKE AGES

Did you know that lakes age? Much like our own bodies, the things we feed them, the way we use them, and the passing of time all cause lakes to change in several important ways. Our actions can either speed up or stabilize the process. Overall, this aging process is known as **eutrophication**. All our local lakes can be categorized into one of these three stages – oligotrophic, mesotrophic, and eutrophic. A lake's natural aging process would likely take hundreds, if not thousands, of years if left alone. Find your lake in the list on the right. These designations are based on research from 2023 but may change year over year.

OLIGOTROPHIC LAKE

Lakes typically begin as oligotrophic lakes with **few nutrients** and few aquatic weeds and algae in the water. With minimal plant production, there is little sediment buildup at the bottom of the lake, and the water is very clear.

MESOTROPHIC LAKE

In the next stage, called a mesotrophic lake, there are **more nutrients** in the lake, which leads to more plant production. More sediment on the bottom of the lake creates a shallower and warmer habitat. Water clarity decreases thanks to algae in the water.

EUTROPHIC LAKE

A eutrophic lake is the final stage in the aging process. This lake is characterized by **intense weed and algae growth**. Sediment builds at the bottom of the lake quickly, eventually becoming a wetland. As a result, the water clarity is minimal.

OLIGOTROPHIC LAKES:

Shock Lake
Shoe Lake
Waubee Lake

MESOTROPHIC LAKES:

The Backwaters
Big Chapman Lake
Boner Lake
Camelot Lake
Center Lake
Crystal Lake
Dewart Lake
Hill Lake
Irish Lake
Kuhn Lake
Oswego Lake
Papakeechie Lake
Sechrist Lake
Spear Lake
Stanton Lake
Syracuse Lake
Lake Tippecanoe
Lake Wawasee
Webster Lake

EUTROPHIC LAKES:

Banning Lake
Beaver Dam Lake
Big Barbee Lake
Caldwell Lake
Carr Lake
Diamond Lake
Goose Lake
Hoffman Lake
James Lake
Little Barbee Lake
Little Chapman Lake
Loon Lake
McClure's Lake
Muskellunge Lake
Palestine Lake
Pike Lake
Ridinger Lake
Rock Lake
Sawmill Lake
Sellers Lake
Silver Lake
Winona Lake
Yellow Creek Lake

Because many lakes in Kosciusko County are surrounded by agricultural or residential areas, they can age more quickly than lakes that are left to themselves. See **page 49** for tips on small changes that will help keep lakes healthy for generations to come.

BEST PRACTICES TO TRY AT HOME

Having the information is one thing; how can you act on what you have learned? The answer will look a little different for every lake. At the Lilly Center, we make sure every research project we do has a local application. Consider joining your lake association (page 18) to share in the efforts happening on your shoreline.

PRACTICE MINDFUL BOATING

Boating with the health of your lake in mind keeps nutrients trapped in the lake floor, reducing the chances of harmful algae blooms. Here's the bottom line: look for at least 10 feet of water depth before creating a wake.

USE NATIVE PLANTS ON YOUR SHORELINE

Try native plants in your landscaping, especially along the shores of lakes and streams. Roots absorb nutrients from runoff and bind soil to prevent erosion. Look back at pages 8-9 to see current phosphorus and nitrogen levels in the 14 lakes that the Lilly Center samples annually!

DON'T PUT YARD WASTE IN YOUR LAKE

Collect your leaves, branches, and grass clippings for removal according to your local guidelines. Also, be sure not to sweep them into the street and cause them to clog storm drains. As the leaves decompose, they release extra nutrients that algae and plants can use to flourish.

Do you learn best with hands-on education? Lilly Center events are a great way to learn about best management practices by rubbing shoulders with other like-minded individuals. Visit the Lilly Center's Facebook page (**@centerforlakes**) or **lakes.grace.edu/events** to see what events are on our community event calendar so you can experience your lake in a new way!

LILLY CENTER PROJECTS

These current and ongoing research projects are part of the Lilly Center's mission to help you make informed decisions for your lake's future. You can read blog posts and studies about each of these and other research projects on our website: **lakes.grace.edu.**

Cyanobacteria like this lyngbya are prevelant in our lakes.

STREAM SENSORS

Stream sensors help us find potential patterns between the presence of cyanobacteria and its toxin on the lakes and identify where unique strategies may be required. The Lilly Center can monitor the "diet" of the lakes: what nutrients enter, leave, and get stored up, and in what amounts. By simultaneously gathering stream data from multiple lakes, our researchers can make insightful comparisons like identifying unique threats or shared opportunities. Learn more about stream sensors on **page 16**.

STUDENT FELLOWSHIPS

The educational programs and scientific research run by the Lilly Center would not be possible without the 40+ interns who join the team every year. These students come from various backgrounds and come together with one purpose: to make our lakes clean, healthy, safe, and beautiful. By investing in current college students for the duration of their college careers, we can launch future environmental professionals into our region. Learn more about Lilly Center interns at **lakes.grace.edu**.

RESEARCH MICROSCOPES

Understanding the aquatic life beneath the surface of our lakes starts with algae. Our algae research team, led by Dr. Joe Frentzel, uses research-grade microscopes to count the algae in your lake. Interns identify and count up to 100 different species of green algae and blue-green algae in each water sample collected during the summer. Tracking algae populations allows us to better understand the health of Kosciusko County's lakes and better predict emerging threats. Learn more about our research at **lakes.grace.edu/research**.

Sign up for our monthly e-newsletter

Get curated environmental news and local lake research delivered to your inbox. Scan the QR code or follow the link to sign up.

lakes.grace.edu/get-involved

Join us at an event

Start by visiting our Events page to see what webinars, workshops, and Expeditions are up next.

lakes.grace.edu/events

Make an investment

It takes a team to make research, education, and collaborative efforts possible. Use the QR code to see giving options, or go to **lakes.grace.edu/give.**

Visit Clearly Kosciusko

What better way to support your community than to join a community-wide brand? Register your business or organization for free!

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LILLY CENTER FOR

LAKES & STREAMS

GRACE COLLEGE

OUR MISSION & VISION

The Lilly Center for Lakes & Streams conducts research, provides resources, engages and educates residents, and collaborates with local organizations to make the lakes and streams of Kosciusko County clean, healthy, safe, and beautiful.

THE LILLY CENTER FOR LAKES & STREAMS | 1 LANCER WAY, WINONA LAKE, IN, 46590

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