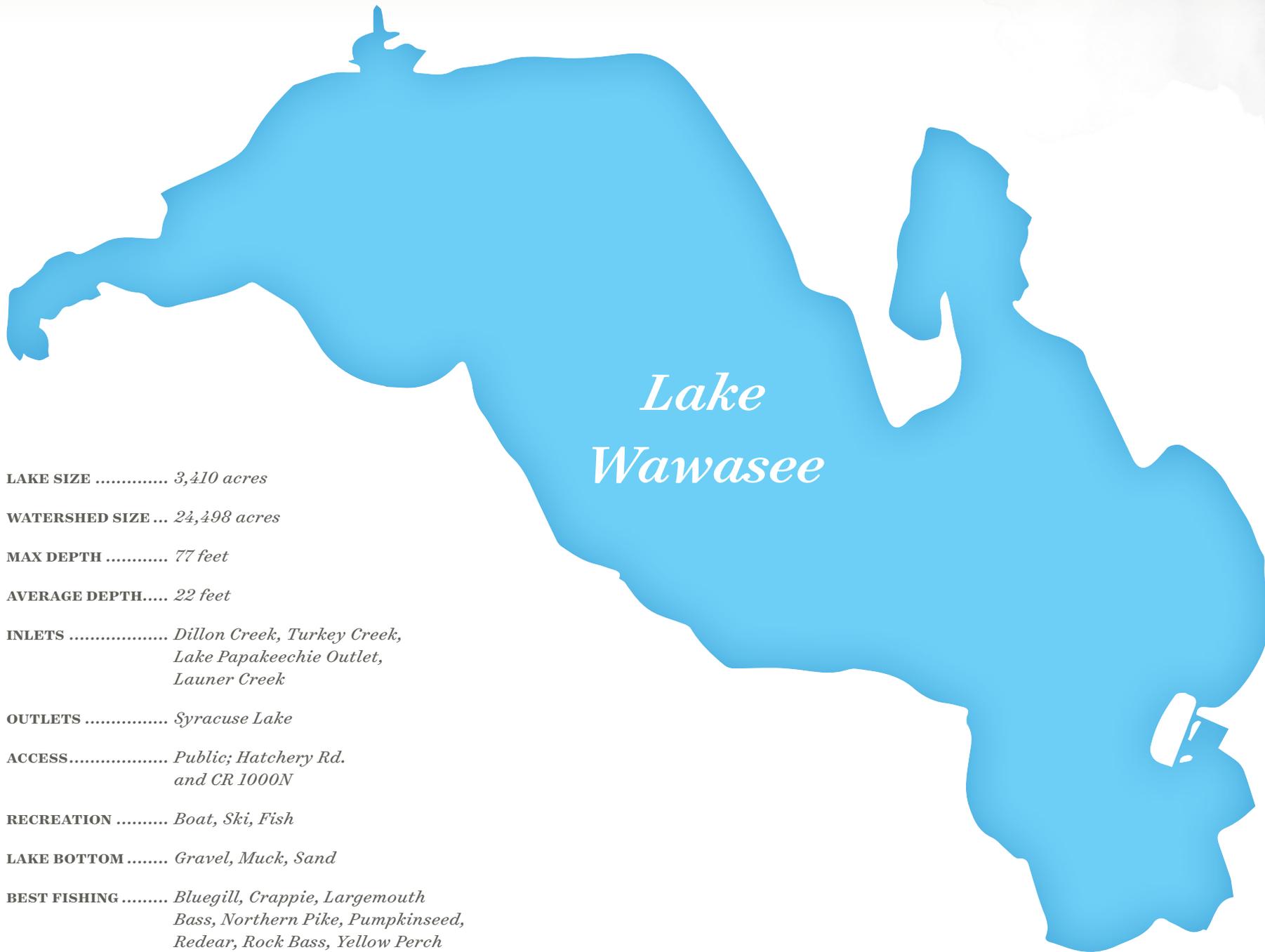


Lake Wawasee: Beneath the Surface
an investigation into your lake's health

CENTER FOR
**LAKES &
STREAMS**™



GRACE
COLLEGE



Lake Wawasee

LAKE SIZE 3,410 acres

WATERSHED SIZE ... 24,498 acres

MAX DEPTH 77 feet

AVERAGE DEPTH..... 22 feet

INLETS Dillon Creek, Turkey Creek,
Lake Papakeeche Outlet,
Launer Creek

OUTLETS Syracuse Lake

ACCESS..... Public; Hatchery Rd.
and CR 1000N

RECREATION Boat, Ski, Fish

LAKE BOTTOM Gravel, Muck, Sand

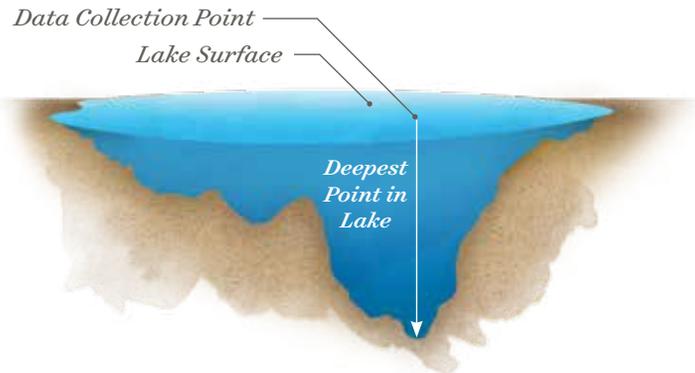
BEST FISHING Bluegill, Crappie, Largemouth
Bass, Northern Pike, Pumpkinseed,
Redear, Rock Bass, Yellow Perch

Your Lake, Your Home

At the Center for Lakes & Streams, we know that Lake Wawasee isn't just any body of water. It's part of your everyday life. It's where you share memories. It's where your kids (and their kids) play. In other words, it's home. For that reason, we committed to gathering important information to help keep your home safe. This report is a summary of that information, collected over our four-year study.

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Our Study

In 2010, the Center for Lakes & Streams launched an ambitious research project: Studying 44 of Kosciusko County's largest lakes to assess blue-green algae toxins. As we investigated, we collected data on water clarity, nutrients, dissolved oxygen and other parameters. After four years of research, this left us with a wealth of valuable information.

This is a summary of our results specific to your home: Lake Wawasee. It uses data collected in open water above the deepest point in the lake and compares Lake Wawasee to other Kosciusko County all-sports lakes.

A technical report of this data is available online at lakes.grace.edu.

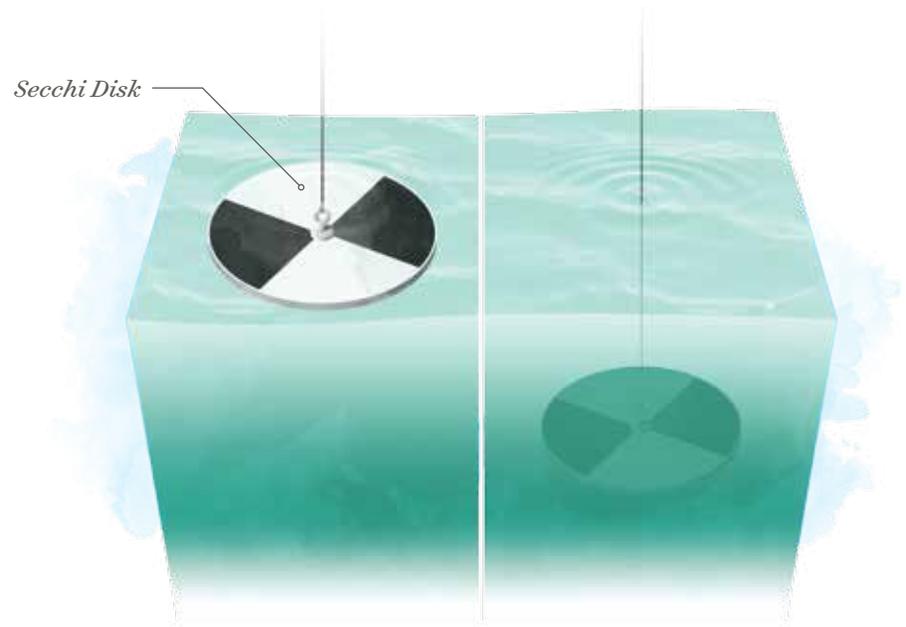
This research was funded by the K21 Health Foundation, Grace College and private donors.

WATER CLARITY

a measure of how far down light penetrates through water

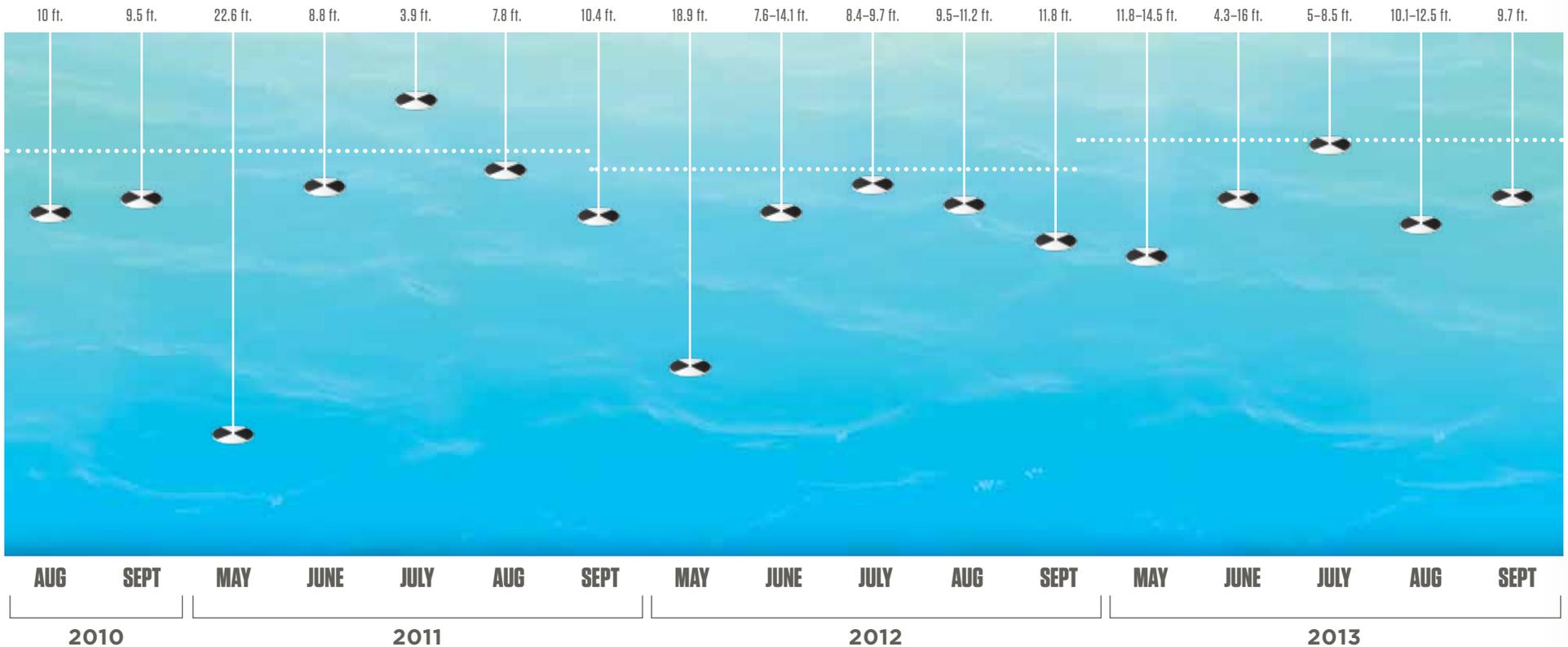
How clear is your water? Measuring water clarity is the first step in assessing the health of a lake. A clear lake is generally a healthy lake, but murky water is a sign that something may be wrong — such as too much sediment, pollution or an overgrowth of algae. Once the clarity of water is assessed, it is important to conduct more tests to find out what is affecting the lake's water.

How is water clarity measured? Water clarity is measured with a tool called a Secchi disk. A Secchi disk is a frisbee-sized metal disk that is painted with a black and white pattern. The disk is attached to a string and lowered into the lake water until the black and white pattern is no longer visually distinct. The depth of the disk is recorded as a measure of the water's clarity.



WATER CLARITY *in* LAKE WAWASEE

☞ Lake Wawasee All-Sports Lakes in County (yearly average)



Observations:

- Water clarity was often lowest in the middle of the summer
- Lake Wawasee's water clarity was higher than other all-sports lakes in the county

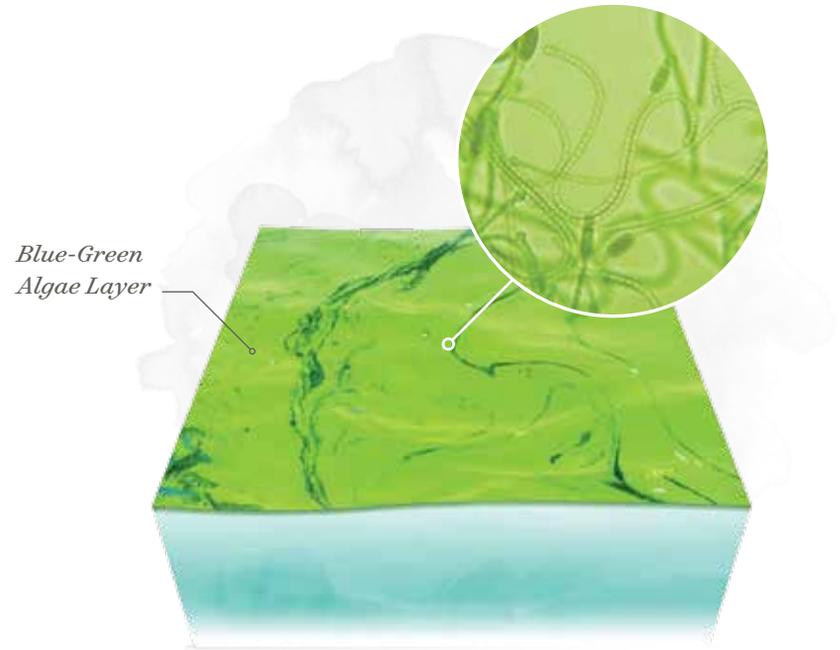
DATA SUMMARY: Lake Wawasee's water clarity was typically worse in the middle of the summer. This decreased clarity is partially caused by nutrients (phosphorus and nitrogen) making more algae grow in the middle of summer. Additional factors might include increased boat activity in shallow areas stirring up the lake bottom or dirty stream water coming into the lake after summer thunderstorms.

BLUE-GREEN ALGAE

also cyanobacteria; a specific group of microscopic organisms that typically live in water and use light for photosynthesis

Why analyze algae? You have probably seen green or brown “scum” on the surface of the lake before. That is most likely algae. Algae can also be mixed down into the water, changing the color of the lake. Our research focused specifically on blue-green algae because it is the type of freshwater algae capable of producing health-threatening toxins.

What is Blue-Green Algae? A type of algae distinguishable from other algae by its paint-like or “pea soup” appearance. This algae is actually a kind of bacteria that is often blue-green in color but can also be blue, green, reddish-purple or brown.



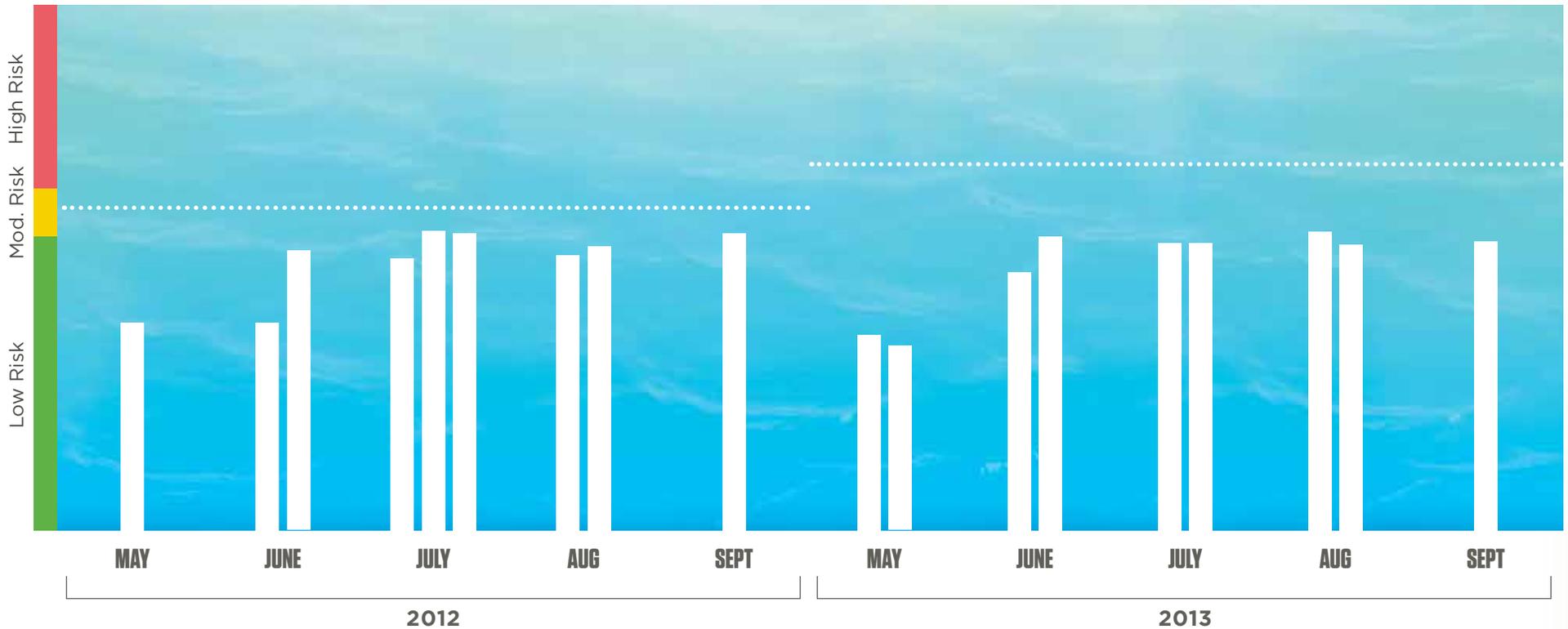
HEALTH RISKS BASED ON BLUE-GREEN ALGAE LEVELS

For recreational waters as outlined by the World Health Organization

	LOW RISK LEVELS	MODERATE RISK LEVELS	HIGH RISK LEVELS
Possible Health Problems	Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	Potential for acute poisoning Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness
Typical Actions	Post on-site risk advisory signs Inform relevant authorities	Watch for scums or conditions conducive to scums Discourage swimming and further investigate hazard Post on-site risk advisory signs Inform relevant authorities	Immediate action to control contact with scums; possible prohibition of swimming and other water contact activities Public health follow-up investigation Inform public and relevant authorities

ALGAE LEVELS *in* LAKE WAWASEE

 Lake Wawasee
  Select All-Sport Lakes in County (yearly average)



Observations:

- Algae levels were in the "moderate risk" zone multiple times
- Lake Wawasee's algae levels were lower than other all-sports lakes studied in the county

DATA SUMMARY: Algae populations in Lake Wawasee were often above blue-green algae guidelines for human health even though the microcystin toxin levels (see toxins on next page) remained low at those times. The algae populations in Lake Wawasee may be producing less toxin than anticipated, or they are producing different toxins that were not tested for in this study.

MICROCYSTIN TOXIN

a common toxin produced by blue-green algae that primarily targets the liver but is also a skin, eye and throat irritant

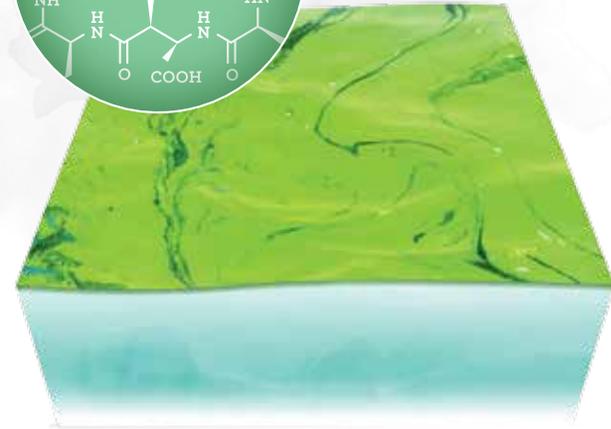
Blue-Green Algae and Toxin Levels

In addition to measuring the amount of blue-green algae in the lake, we also measured toxins produced by the algae. Both measurements are important because it is not yet understood what causes blue-green algae to release toxins. A lake may have a lot of blue-green algae but not much toxin. The ratio of blue-green algae to toxin is not consistent, so it is important to investigate both.

What is Microcystin? Microcystin is the most commonly studied toxin produced by blue-green algae. At high levels, microcystin can cause a variety of health problems (see chart below).



Sometimes blue-green algae can produce toxins



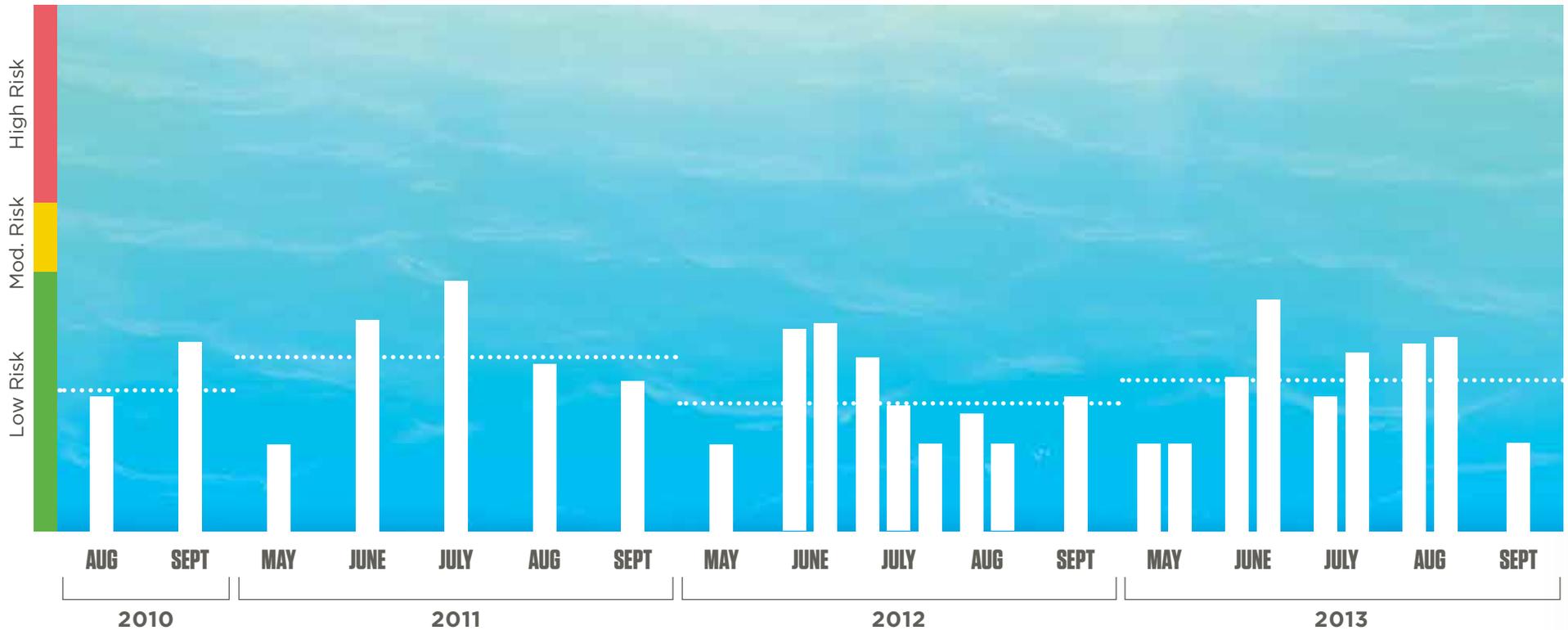
HEALTH RISKS BASED ON MICROCYSTIN LEVELS

For recreational waters as outlined by the World Health Organization

	LOW RISK LEVELS	MODERATE RISK LEVELS	HIGH RISK LEVELS
Possible Health Problems	Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	Potential for long-term illness Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	Potential for acute poisoning Potential for long-term illness Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness
Typical Actions	Post on-site risk advisory signs Inform relevant authorities	Watch for scums or conditions conducive to scums Discourage swimming and further investigate hazard Post on-site risk advisory signs Inform relevant authorities	Immediate action to control contact with scums; possible prohibition of swimming and other water contact activities Public health follow-up investigation Inform public and relevant authorities

TOXIN LEVELS *in* LAKE WAWASEE

▮ Lake Wawasee ···· All-Sports Lakes in County (yearly average)



Observations:

- Microcystin levels were consistently in "low risk" zone but highly variable
- Lake Wawasee's microcystin levels were higher than other all-sports lakes in the county

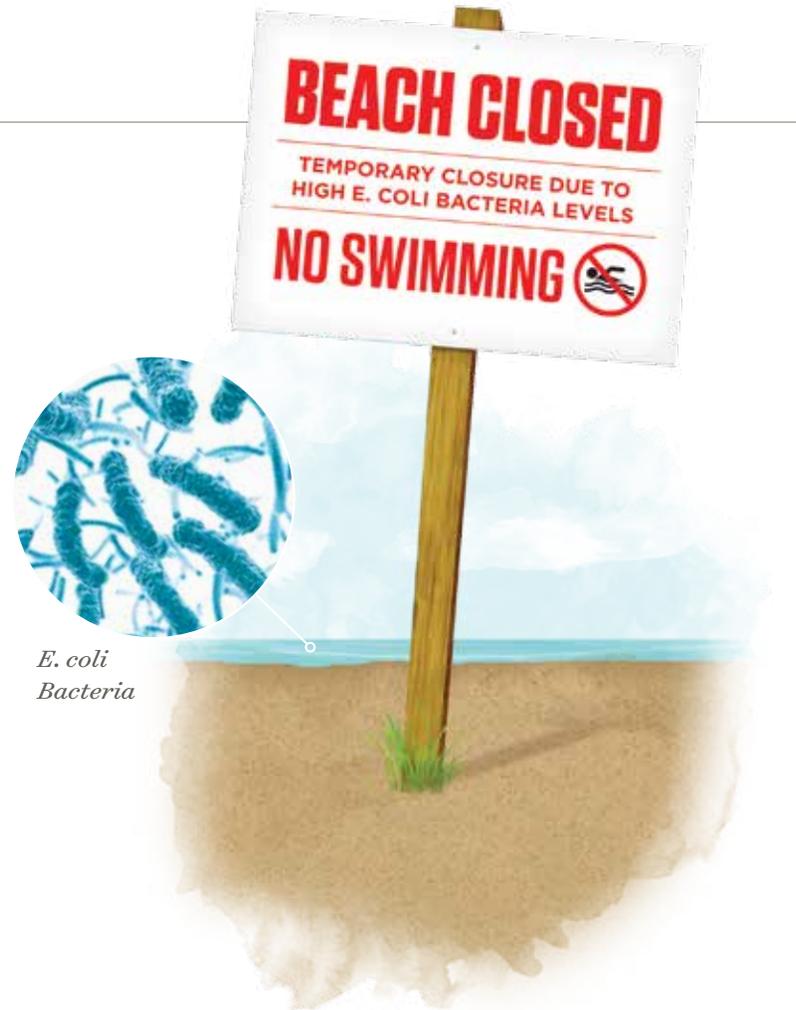
DATA SUMMARY: Even though Lake Wawasee's microcystin toxin levels were consistently below guidelines for human health, the high variability of these levels indicates strong potential for future risk. Under the right conditions, such as high nutrient levels and warm temperatures, blue-green algae could produce microcystin toxin levels above human health guidelines in Lake Wawasee.

E. COLI

Escherichia coli (E. coli) is a bacteria that normally lives in the intestines of people and animals

You have probably heard of public beaches being shut down because of *E. coli*. This bacteria is closely monitored by health officials and others because it is a common problem with water. There are many pathways through which *E. coli* can enter and contaminate lakes, including combined sewer overflows, neglected septic systems, wildlife, and urban/agricultural runoff.

Beach Closure. In public health, *E. coli* levels are used as an indicator of fecal pollution in water. If the levels of *E. coli* in water are too high, the beach is deemed unsafe and the beach is closed. The public beach closure guideline for *E. coli* is established by the Indiana Department of Environmental Management and enforced by local health departments.



E. coli
Bacteria

E. COLI AND YOUR HEALTH

Why monitoring E. coli levels is important

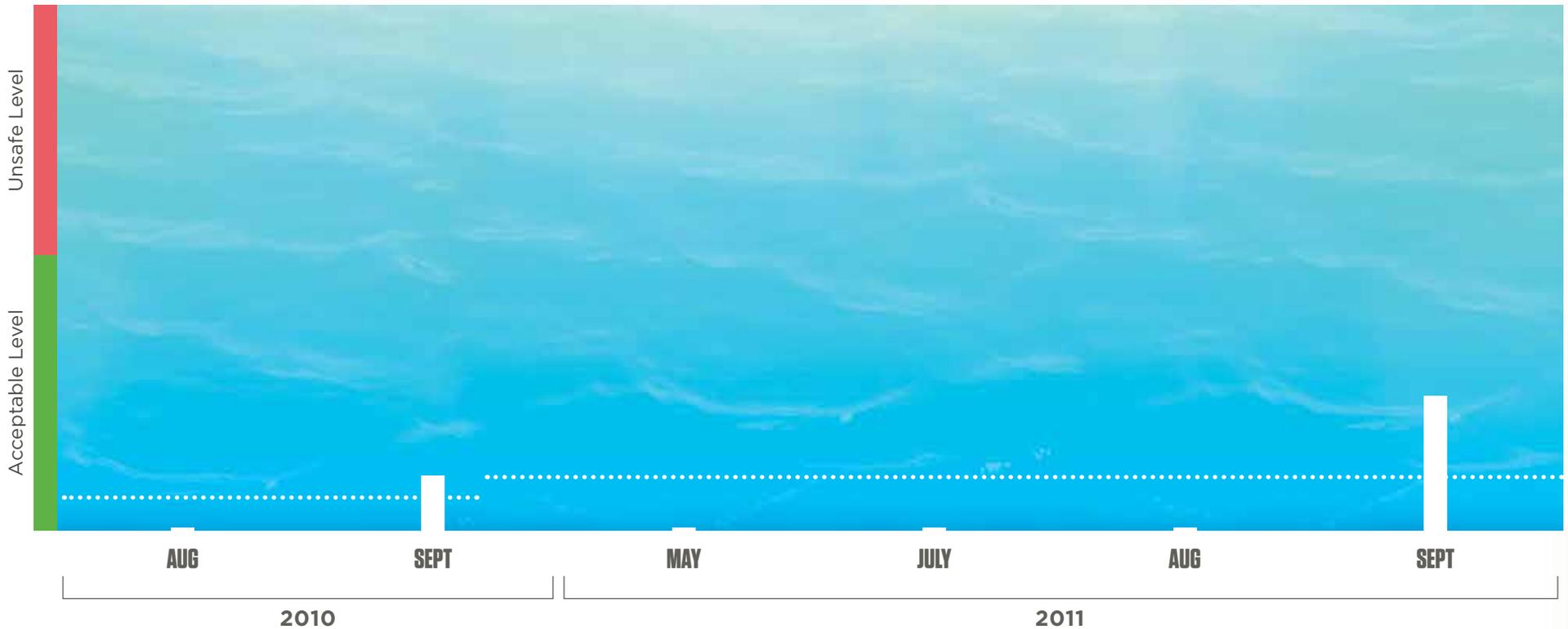
If *E. coli*-contaminated water is ingested, it can cause infections and various other health issues:

UNSAFE *E. COLI* LEVEL

Possible Health Problems	Gastroenteritis, which can cause a variety of symptoms, including nausea, vomiting, abdominal cramps and pain, diarrhea, headache and fever Ear, eye, nose and throat infections
Typical Actions	Close beaches

E. COLI LEVELS *in* LAKE WAWASEE

■ Lake Wawasee All-Sports Lakes in County (yearly average)



Observations:

- E. coli levels were well below the health guideline
- Lake Wawasee's E. coli levels were similar to other all-sports lakes in the county

DATA SUMMARY: In the open lake areas of Lake Wawasee, *E. coli* levels were well below the health guideline, though this study did not include extensive sampling of various shoreline areas, where *E. coli* levels are often higher.

NUTRIENTS

soluble minerals plants need to grow

Too Much of a Good Thing. Nutrient-packed fertilizers are good for lawns and gardens. But when they enter the lake in the form of fertilizers, human and animal waste, or yard waste, they make aquatic plants and algae grow too much.

Two of the most important nutrients to study are phosphorus and nitrogen. They are responsible for a majority of plant and algae growth in the lake.

NUTRIENTS, PLANTS AND ALGAE

*This figure shows
how nutrients affect
a lake's plant life*



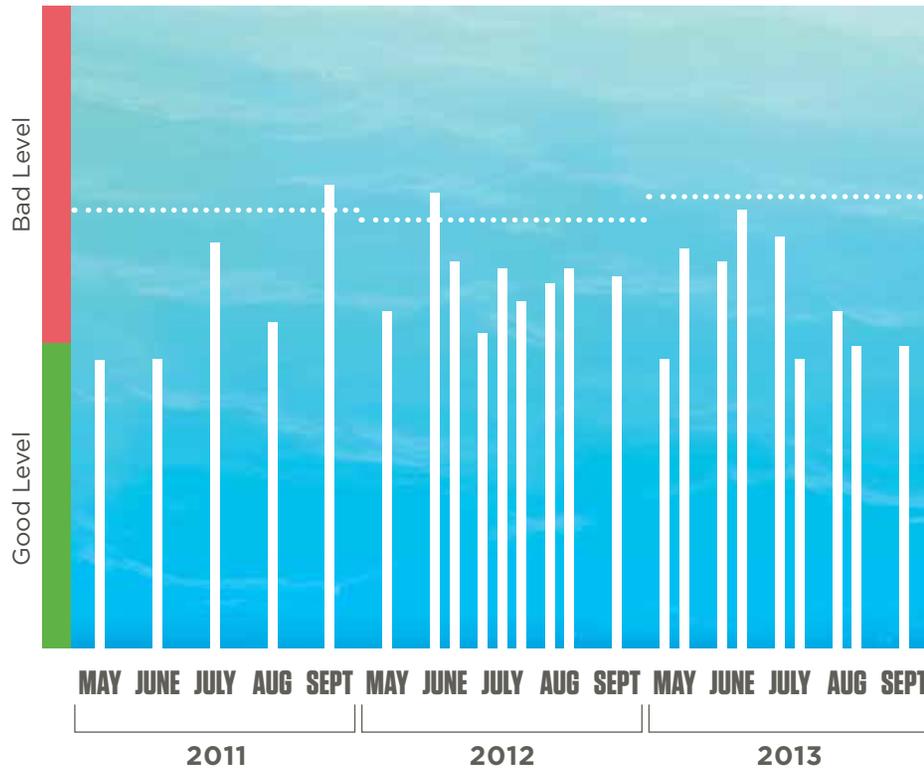
Few Nutrients

Optimum Nutrient Levels

Nutrient Overload

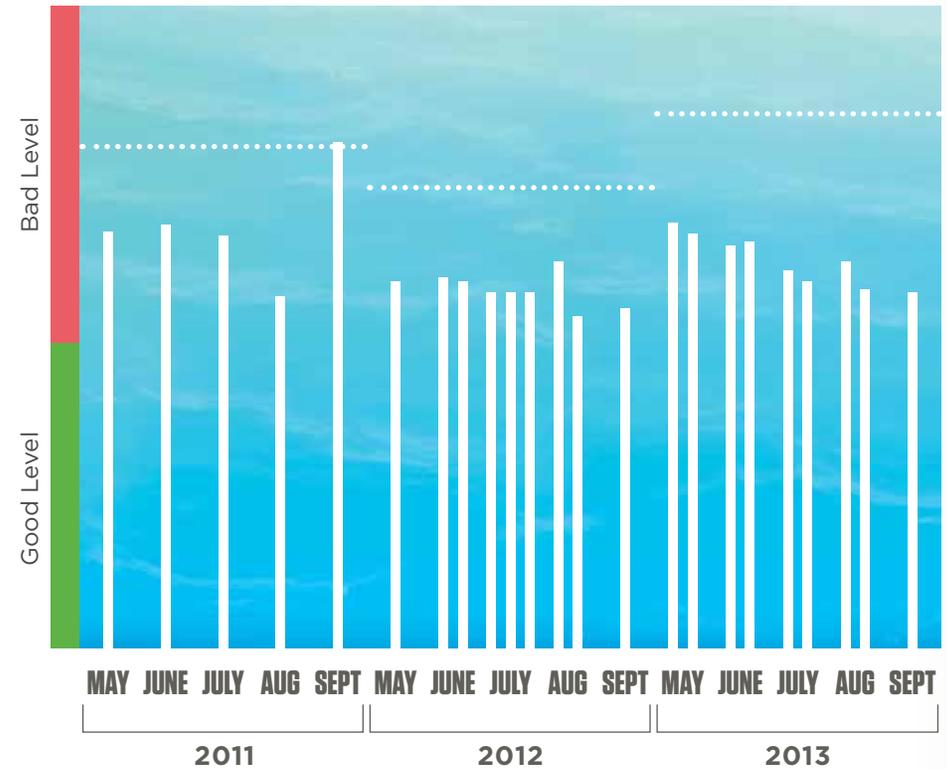
PHOSPHORUS LEVELS *in* LAKE WAWASEE

|| Lake Wawasee All-Sports Lakes in County (yearly average)



NITROGEN LEVELS *in* LAKE WAWASEE

|| Lake Wawasee All-Sports Lakes in County (yearly average)



Observations:

- Phosphorus and nitrogen levels were mostly higher than the recommended guidelines
- Lake Wawasee's phosphorus and nitrogen levels were lower than other all-sports lakes in the county

DATA SUMMARY: Both phosphorus and nitrogen levels in Lake Wawasee were consistently well above the Environmental Protection Agency recommended guidelines. Nutrients feed harmful algae and reduce water clarity. These high levels often decreased over summer months, indicating nutrients sinking to the lake bottom.

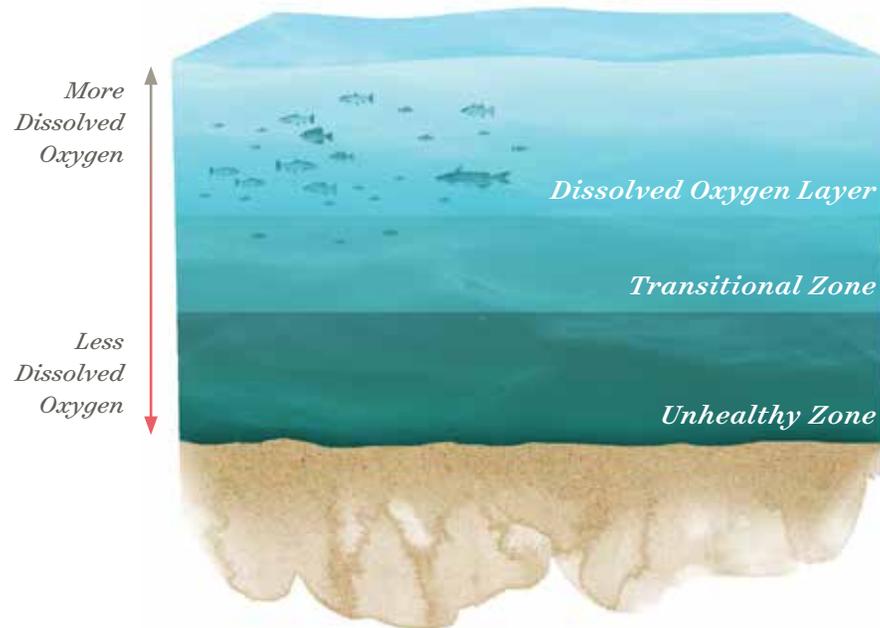
DISSOLVED OXYGEN

gaseous oxygen in water and available to aquatic organisms for respiration

The Effects of Dissolved Oxygen. Dissolved oxygen is the major factor that determines where organisms can survive in an aquatic system. During the summer, many lakes become layered based on temperature – and the bottom layer is often depleted of oxygen. This is because of chemical reactions that occur when dead plants decay on the bottom. Since this layer does not mix with the other layers, it is not able to replenish its oxygen through mixing of lake waters. Oxygen depletion also occurs in the winter when surface ice keeps oxygen from entering the water from the atmosphere.

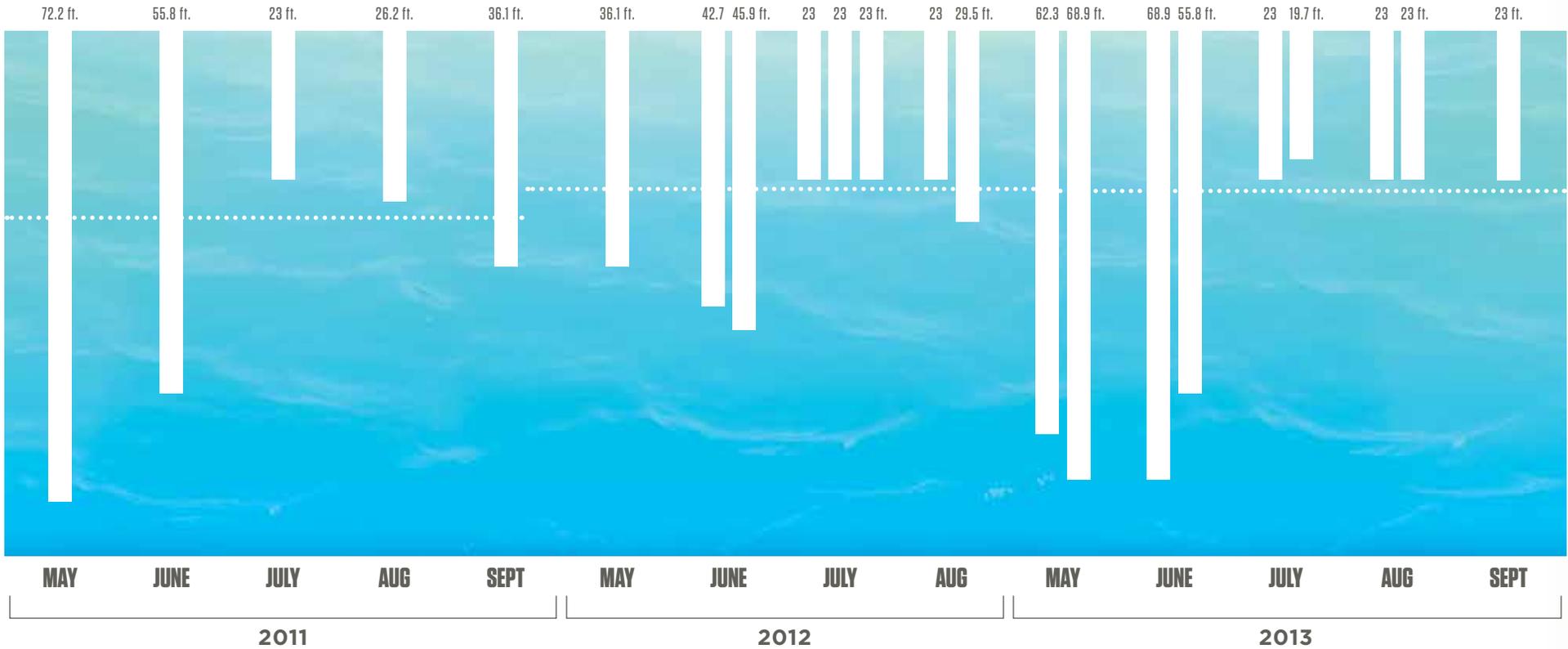
DISSOLVED OXYGEN LAYER

How far down fish and other aquatic species have enough oxygen to survive



OXYGEN LAYER DEPTH *in* LAKE WAWASEE

 Lake Wawasee
  All-Sports Lakes in County (yearly average)



Observations:

- The oxygen layer was often thinnest in the middle of the summer
- The oxygen layer varied widely among all-sports lakes in the county (partially depending on lake depth), but Lake Wawasee's was usually thicker

DATA SUMMARY: When Lake Wawasee's oxygen layer gets thinner through the summer, fish get squeezed into a warmer and smaller area. The resulting lack of oxygen makes it difficult for these fish and their food sources to survive. This lack of oxygen is caused by too many nutrients in the lake.



TAKE ACTION

Help Keep Lake Wawasee a Great Place to Live. Research is a great start, but we need your support to keep the waters of Lake Wawasee at healthy and safe levels. Here are a few of the most effective ways that we can all do our part.

What you can do to help

Reduce fertilizer usage on your lawn and garden (especially close to the lake) to save yourself some money and keep extra nutrients out of Lake Wawasee. If you want to know exactly how much nutrients your lawn or garden needs, the Center for Lakes & Streams can help you with soil testing resources.

Add beautiful vegetation along your shoreline to filter out nutrients as water carries them toward the lake. Native plants (those plants that occur naturally in our region) are best because they cut down on your maintenance costs and provide the best filtration. The Center for Lakes & Streams has information to help you get started.

Avoid yard waste entering the lake. Leaves, grass clippings or other yard waste have nutrients which increase algae growth, reduce water clarity and lead to less oxygen for fish. Use this yard waste as compost in your garden to further reduce your fertilizer use or have it removed from your property. If you would like to start composting and need some direction, the Center for Lakes & Streams can help.

What we can do together

Expand collaborative relationships and projects with non-lake residents. Water flows downhill, so neighborhoods, industries, farmers and businesses in areas surrounding Lake Wawasee all influence the lake. Your support and participation has allowed the Center for Lakes & Streams to pursue these efforts, and we look forward to working with you to expand them.

Provide financial support toward research to solve the identified challenges facing Lake Wawasee. Our center samples inflowing and outflowing streams and can use this data to start quantifying nutrient sources. This will help us navigate future efforts toward efficiently reducing these nutrient sources. We could also study boating activities and additional algae toxins to make appropriate recommendations based on science.

Engage our lake neighbors and our non-lake community members in educational programs that inform them about how to best take care of Lake Wawasee. You might consider helping as a volunteer for the Northern Indiana Lakes Festival or financially supporting one of our K-12 programs.



Making our lakes and streams clean, healthy, safe and beautiful

The Center for Lakes & Streams at Grace College conducts important research, engages and educates residents, and collaborates with other organizations to make the lakes and streams of Kosciusko County cleaner.

We have the expertise and tools to conduct guiding research. Led by a professor of freshwater science and outfitted with the necessary equipment, our center can perform high-quality research at a local level, focusing on the lakes and streams of Kosciusko County.

We have the capacity and competency to provide resources. Our website is a clearinghouse of data, tools and other resources pertaining to Kosciusko County lakes and streams. Our offices house educational and scientific resources we make available to local communities.

We have the background and talent to engage and educate residents. Our staff is experienced at national and local levels with operating K-12 and community outreach programs. Our Grace College student

interns and volunteers give us the personnel we need to effectively and efficiently conduct our education programs.

We have the infrastructure and positioning to lead collaborative efforts among local organizations.

Our Grace College facilities accommodate meetings, workshops and other gatherings. With countywide perspective we help create working partnerships and facilitate exchanges of knowledge and expertise.

We want our lakes and streams to be something we can all be proud of, to be clean, healthy, safe and beautiful.

By supporting the Center for Lakes & Streams you're ensuring that every effort is being made to make the lakes and streams of Kosciusko County cleaner.





CENTER FOR
LAKES
& **STREAMS**™

GRACE
COLLEGE

200 Seminary Drive | Winona Lake, IN 46590

574-372-5100, ext. 6445

lakes.grace.edu