WHITE LAKE Property Owners Association Preservation Project

This is the annotated version of a webinar presented on April 17, 2021 under the auspices of Watersheds Canada. This webinar was meant to inform on the current state of White Lake and to explain why and how existing water quality conditions were reached and what we can do to make things better.

Slide 1: The title of this webinar is meant to communicate that it is our responsibility to assure the preservation of White Lake. It will only be by our individual and collective actions that this lake can be handed down in good condition to the next and future generations.

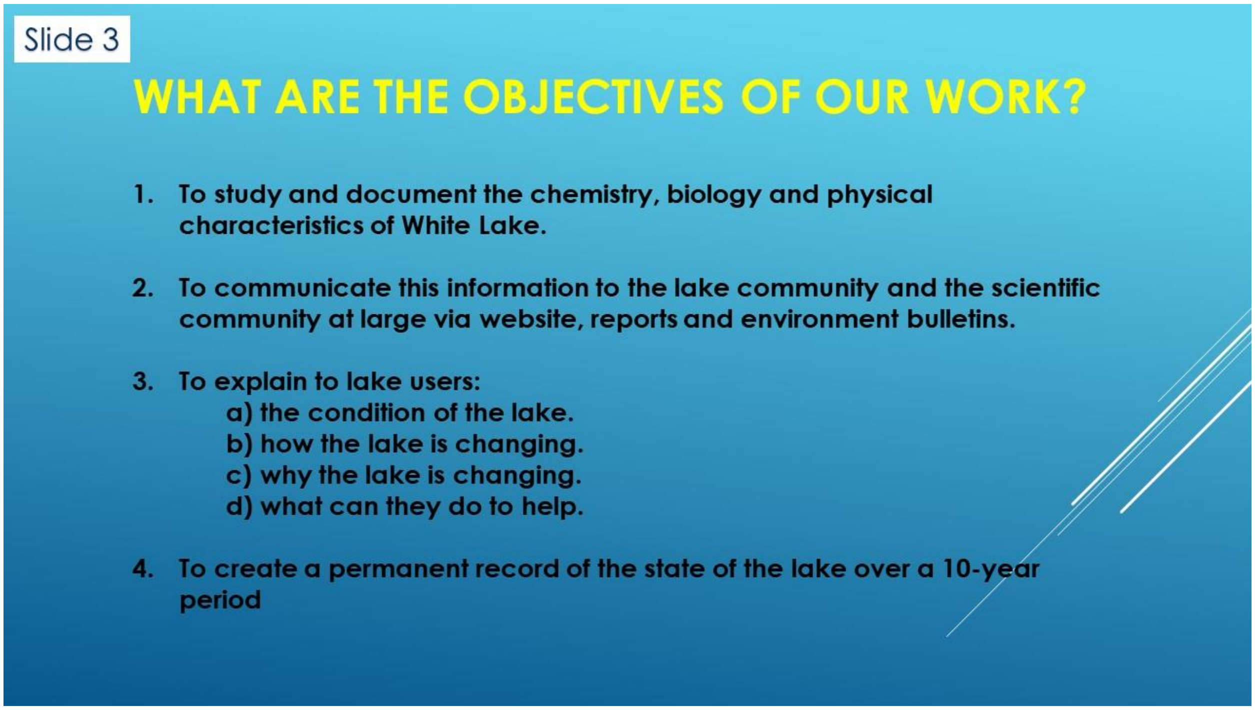
Slide 2: We were motivated to study the chemistry and biology of White Lake by the appearance of lake-wide blue-green algal blooms starting in 2013. It is true that algal blooms are not new to White Lake. In fact, they occurred relatively frequently in the past, but mostly resulting from the maintenance of excessively high-water levels done so at the request of cottagers.

Since the mid-1970s, a more moderate water level regime has been adopted, which has resulted in relatively stable water quality conditions, while at the same time maintaining the local bass and pickerel fishery.

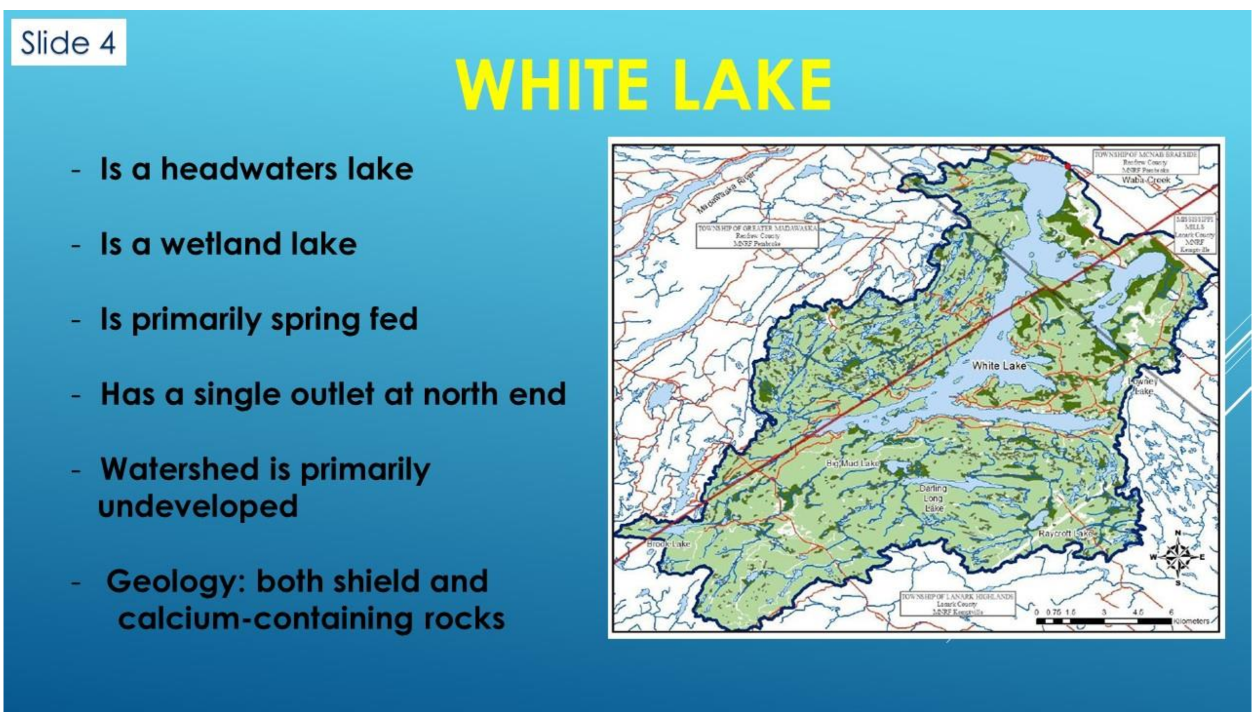
This equilibrium was lost in 2013 when White Lake began showing signs of stress from multiple sources, as will be discussed below. Green and toxic blue-green algal blooms began to appear after a hiatus of over 30 years.

As part of designing a research program for the study and monitoring of White Lake, we created the White Lake Science and Information Website. This website contains all available published information on all aspects of White Lake including government reports, geological and physical characteristics and information on its history dating back to 1822. It now also contains all of the reports and bulletins we have written as a result of our research.

We also became part of the Ministry of the Environment's Lake Partner Program (LPP), through with we received valuable support in the form of chemical analyses of the hundreds of samples we have collected during the last eight years.



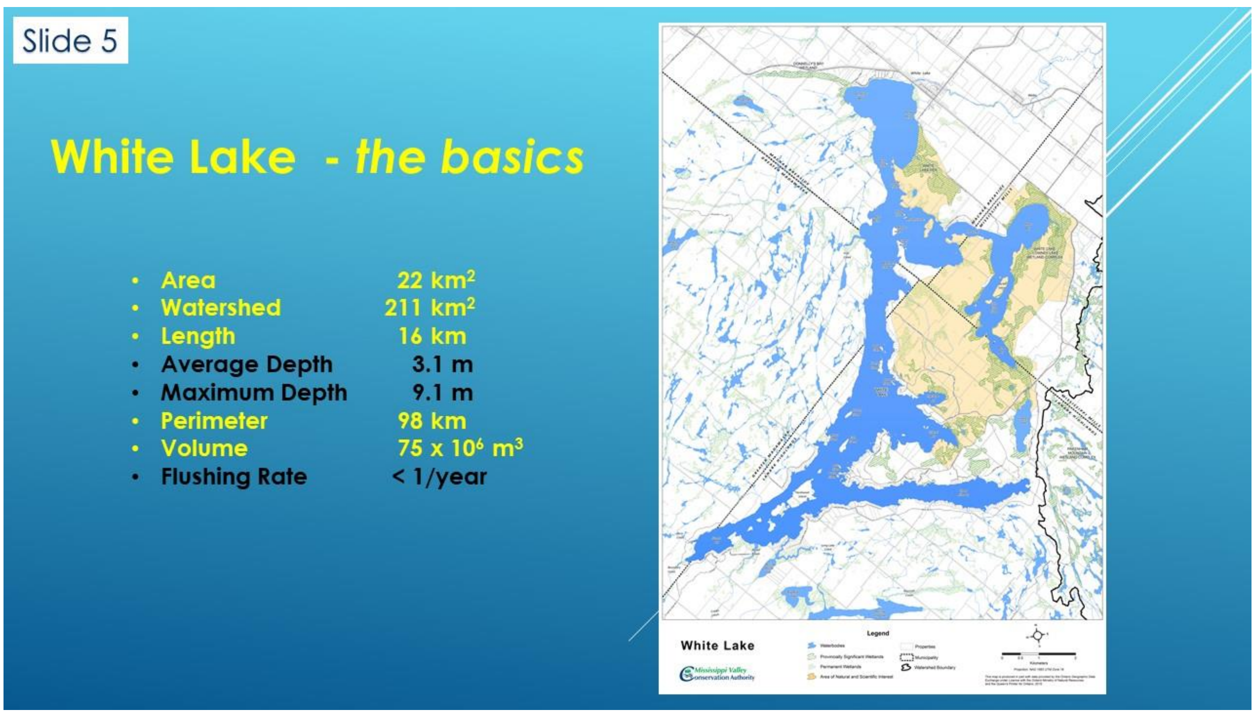
Slide 3: The objective of our work was to bring to light the many aspects of lake science which explains our detailed observations of White Lake water quality. An equal challenge has been to convey this information to concerned citizens in a clear and forthright manner. Our goal is to educate and persuade individuals to make choices so that together we can preserve White Lake over the long-term.



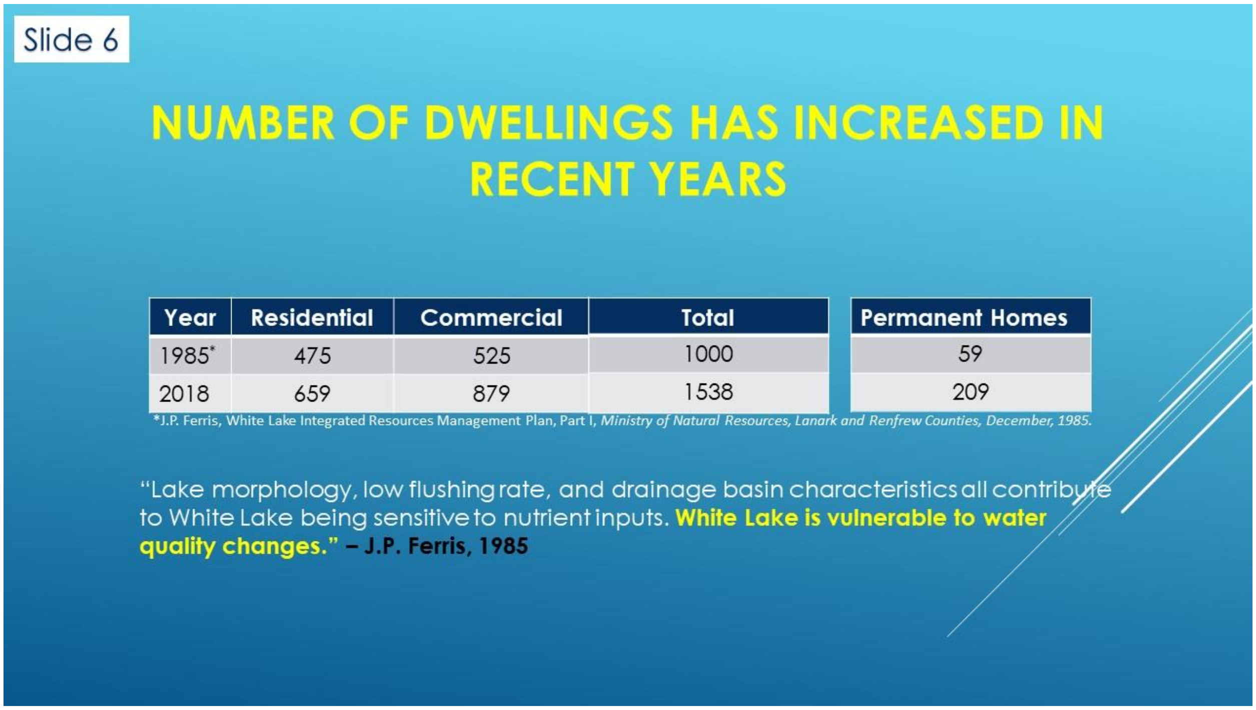
Slide 4: White Lake is a headwaters lake, meaning that it is not part of a chain of lakes or a river system. An advantage is that we are not receiving unwanted pollutants from other sources upstream. The watershed, which is about 10 times the area of the lake itself, is relatively undeveloped, but not pristine.

An important aspect of the lake is that it is a wetlands lake with approximately 25% of its surface area covered by marshes, swamps and wetlands. These wetlands are critical to the health of the lake because they provide the effective purification of incoming surface waters. They should be protected.

Because of its shape and geological setting, about 80% of the water entering the lake is from springs and water table flow. This gives us another important reason to protect the lands surrounding the lake which in turn provide much of the water in the lake. The single outlet at the northern end of the lake allows easy control of water levels, but also determines the direction of flow of water out of the lake.

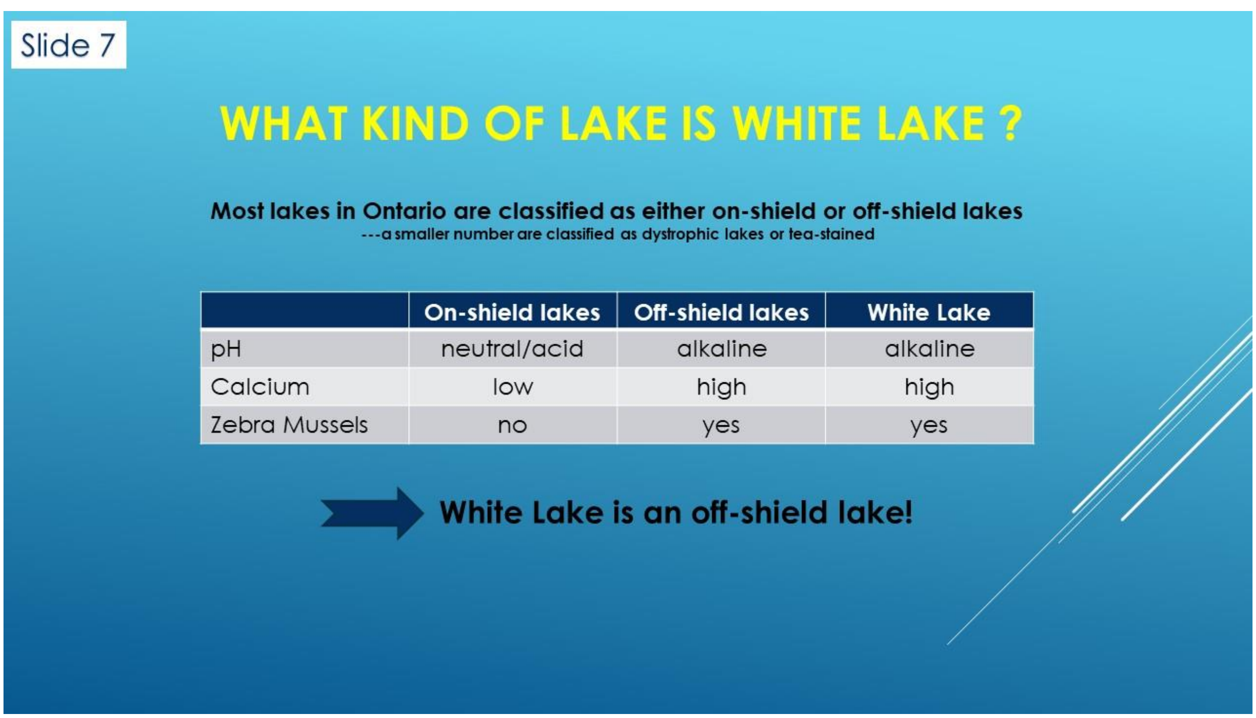


Slide 5: The sensitivity of White Lake to nutrient inputs is partly due to the fact that White Lake is a very shallow lake. Another very important fact is the flushing rate of the lake which is less than one volume per year. This means that much of what enters the lake stays in the lake. Lakes with higher flushing rates are better at removing excess nutrients and other unwanted chemical components.



Slide 6: White Lake has been used for recreational purposes for more than 100 years. Over the past 33 years, the number of cottages and recreational sites have increased by over 50%. Also, the number of permanent homes has increased by 350%, a trend which is likely continuing at the present time.

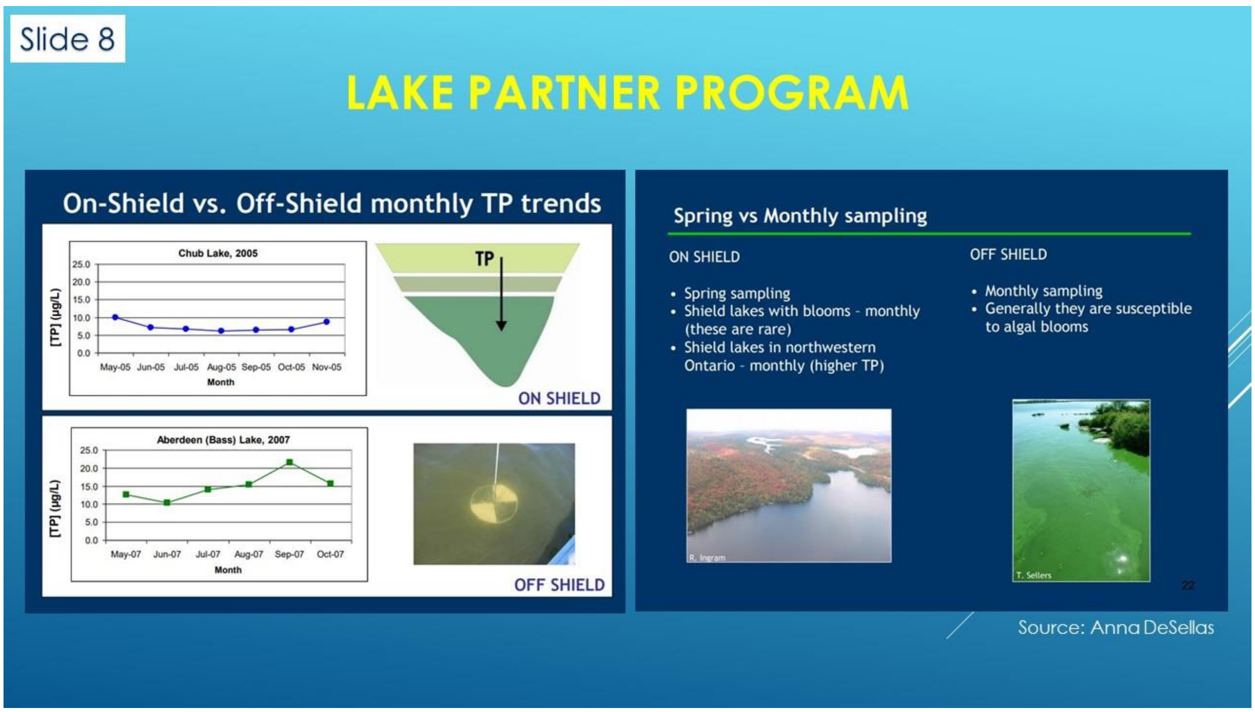
Government scientists studying White Lake during the 1980s warned of 'cultural eutrophication', a term which denotes the acceleration of the process which effects the rate at which the lake is filling up.



Slide 7: When studying water quality, it is important to know the type of lake being studied. This is because there are different ways to collect data and calculate results which are specific to the lake type being studied.

Although the western shore of White Lake abuts on rocks derived from the Precambrian Shield, the characteristics of the lake water itself is governed by the rock underlying the lake and forming most of the rest of the shoreline. These are rocks high in calcium such as limestone and calcite.

The table in slide 7 clearly shows that White Lake is an off-shield lake, which in turn dictates when and how often water should be collected and how the resulting analytical data should be treated.



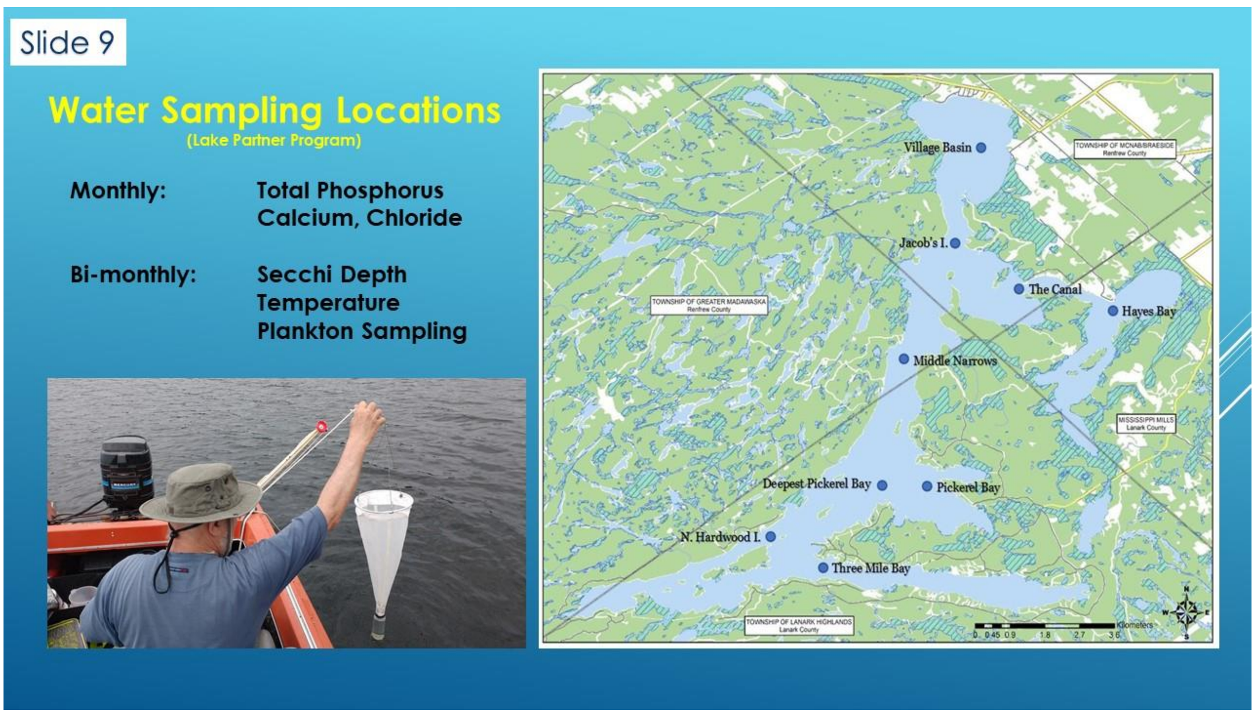
Slide 8: The Ministry of the Environment's Lake Partner Program is a volunteer-based program which monitors the health of over 600 lakes in Ontario. Slide 8 was prepared by the current director of the LPP and shows how on and off-shield lakes differ when it comes to total phosphorus measurements.

The top left panel on Slide 8 shows that for on-shield lakes, total phosphorus values are at their highest early in the spring and there is little change during the summer months. Evaluation of water quality is done using the earliest and highest total phosphorus concentration according to MOE guidelines.

The lower left panel shows total phosphorus data for off-shield lakes like White Lake. For these lakes, the total phosphorus concentration is lowest in early spring and then rises during the summer months, followed by a decline as the weather grows colder. Prior to the introduction of zebra mussels, the total phosphorus concentration increased by a factor of three during the ice-free season. In order to find the maximum total phosphorus concentration for water quality evaluation, the Lake Partner Program prescribes that samples be taken once per month rather than just once per year as is done for on-shield lakes.

Slide 9: The map below shows the nine separate sites the Environment Volunteers sample every two weeks during the ice-free season. In addition to monthly samplings for total phosphorus, calcium and chloride, bi-weekly sampling is done for plankton as well as are measurements of temperature and water clarity (Secchi depth). Duplicate samples are taken at each site as part of the Lake Partner Program quality assurance protocol.

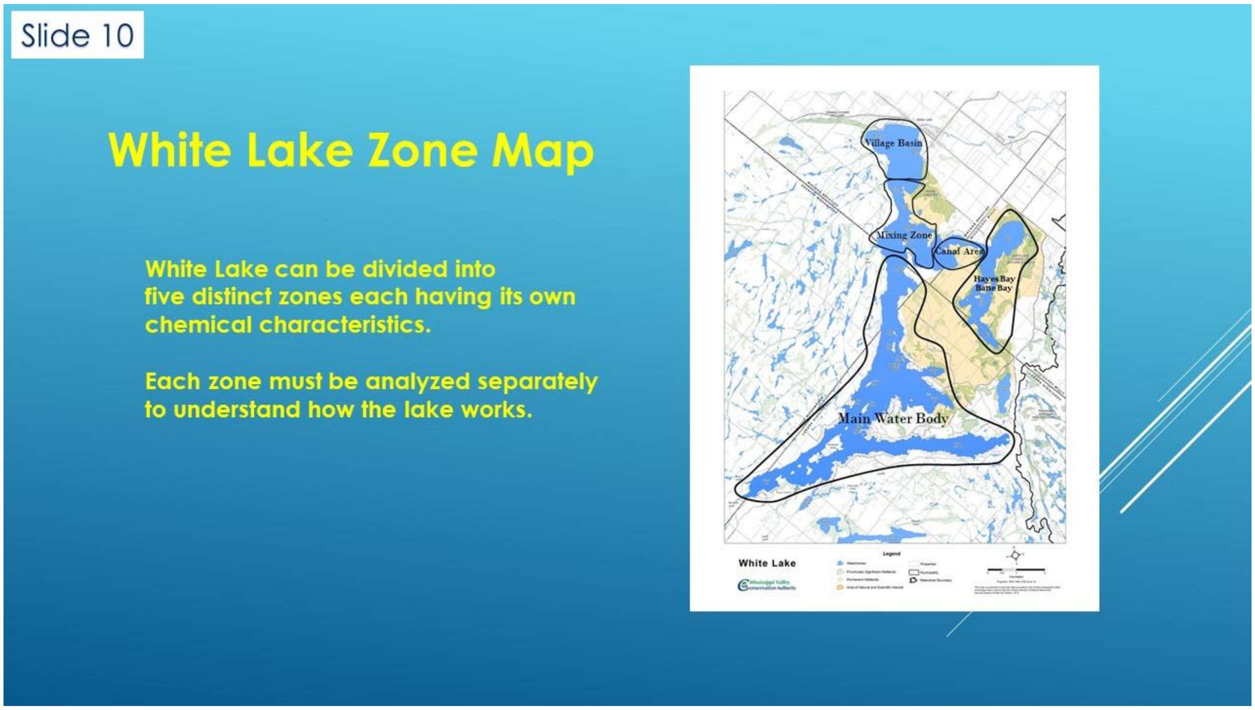
Over the past 8 years, the Environment Volunteers have collected over 700 water samples for analysis of total phosphorus, calcium and chloride.

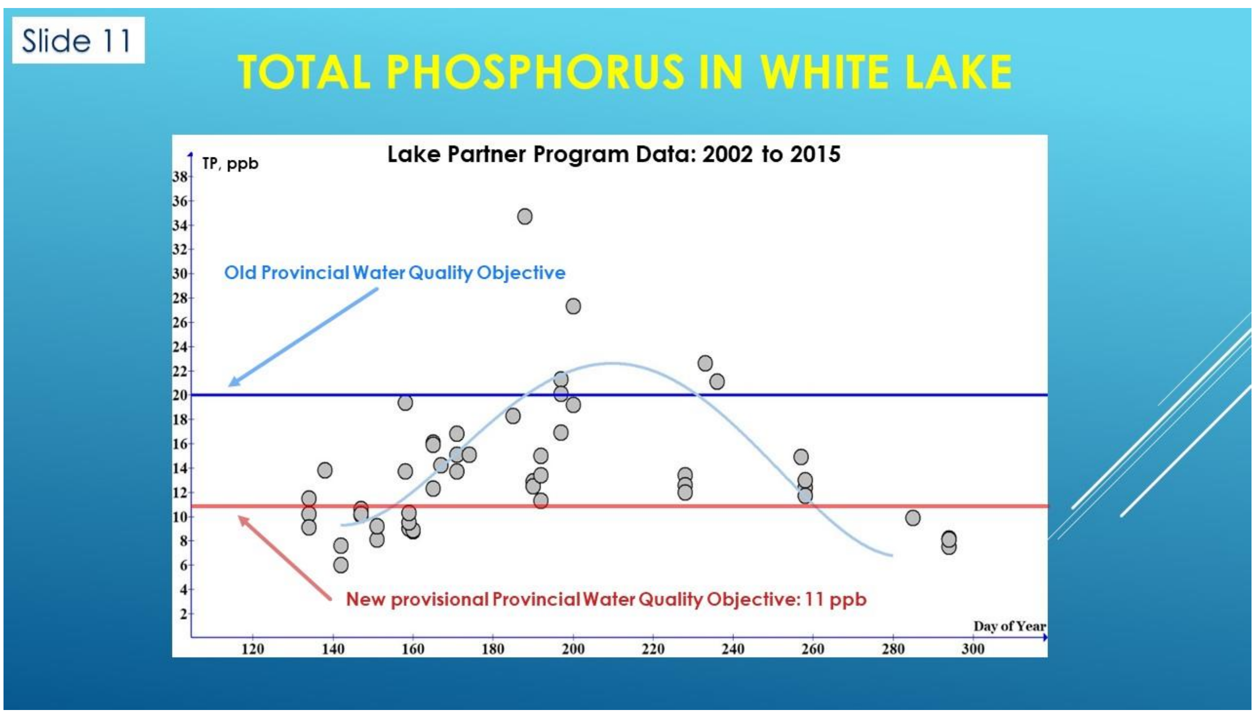


Slide 10: White Lake is a complex lake and different parts of the lake show different chemical, physical and biological characteristics. Our studies have shown that the lake can be divided into five separate zones. These zones are shown in slide 10 below.

Subdividing the lake into different zones allows us to understand more clearly how the lake works and how different parts of the lake react to changes in nutrient concentrations and other stressors.

As well as the chemical qualities of the different parts of the lake, the composition of bottom sediments was also an important factor in the process of defining different zones.



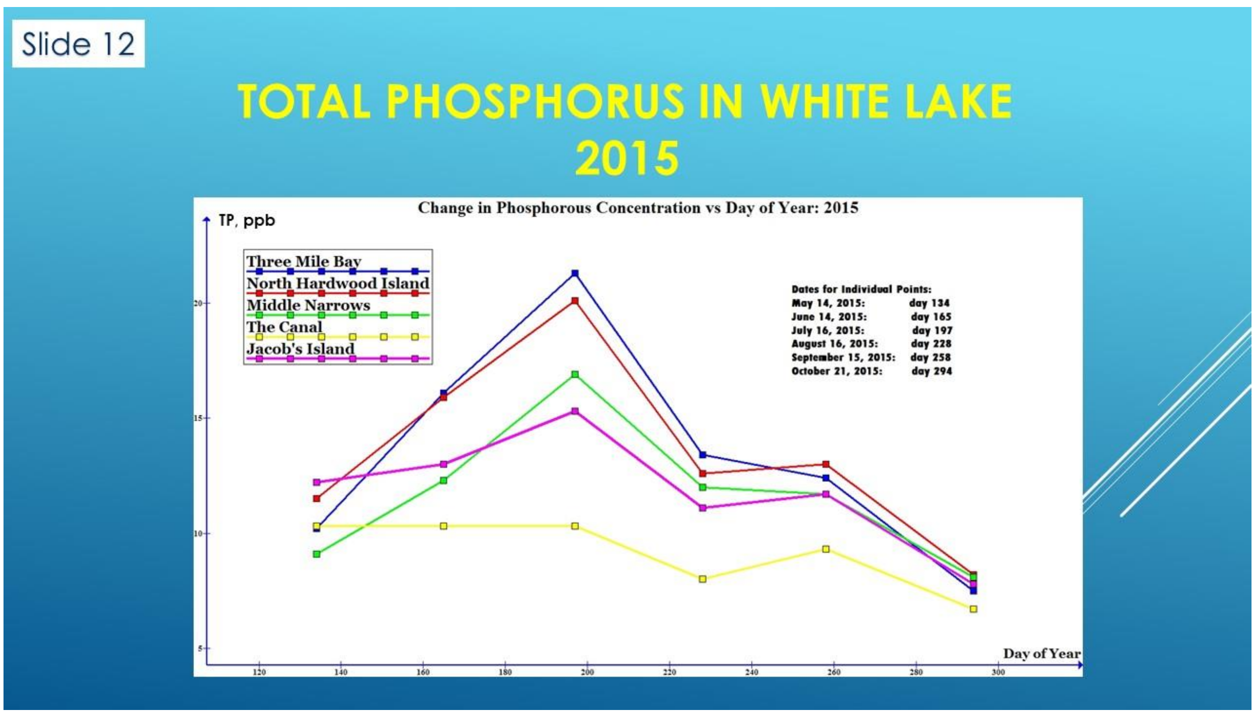


Slide 11: The above slide shows the change in concentration of total phosphorus during the ice-free season. All of the points on the graph are for LPP data taken from 2002, when the current more accurate and precise analytical methods were implemented, and 2015, the last year White Lake water chemistry was not affected by the zebra mussel infestation.

The graph shows that total phosphorus concentrations were about 8 parts per billion (ppb) in May and rose to as high as 35 ppb later in the year. The light blue line through the data is a best-fit curve for the available data. This line shows that for about 40 days during summer, total phosphorus concentrations in White Lake exceed the old Provincial Water Quality objective of 20 ppb.

The 20 ppb Provincial water quality objective is currently under review as it is believed by lake scientists that this concentration level is too high and does not reflect what is actually happening in the lake, such as algal blooms.

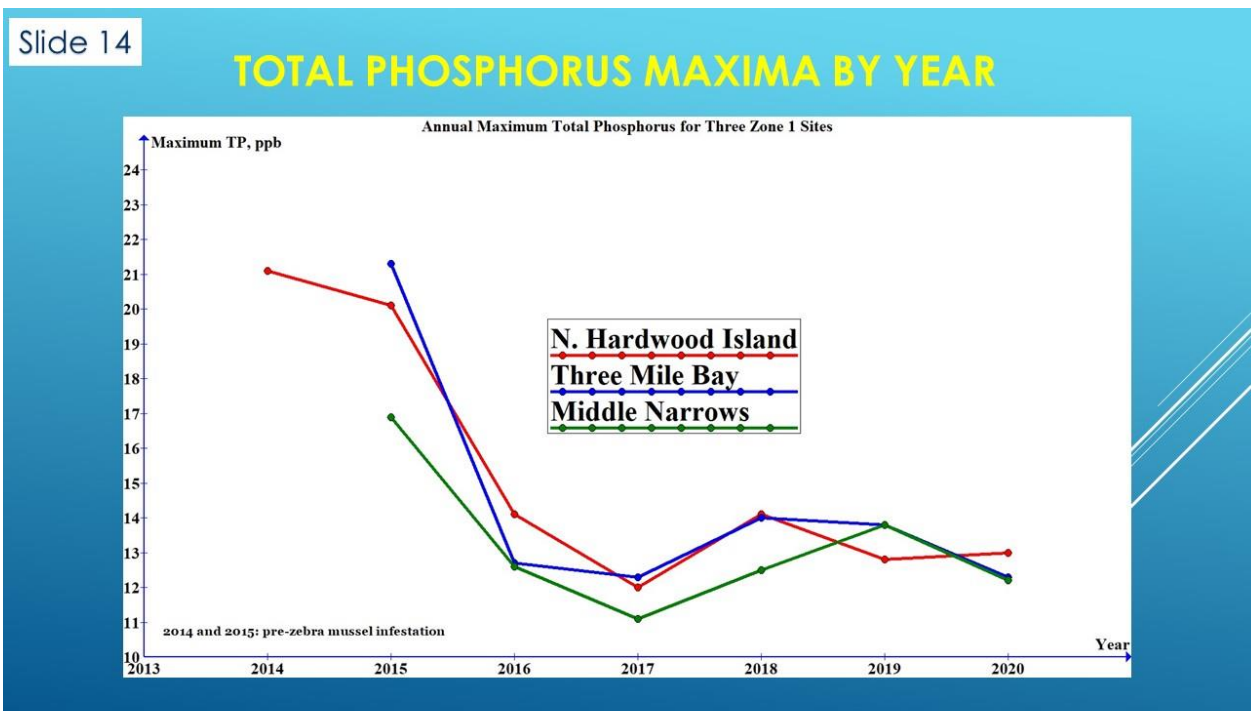
Instead, Provincial (MOE) scientists are proposing that the revised total phosphorus level limit be equal to the concentration of total phosphorus in the lake prior to the arrival of Europeans plus 50%. For White Lake, this means that the total phosphorus concentration representing the limit for nutrient input should be 11.3 ppb. Reference to the above graph shows that White Lake currently greatly exceeds this limit for most of the ice-free season.



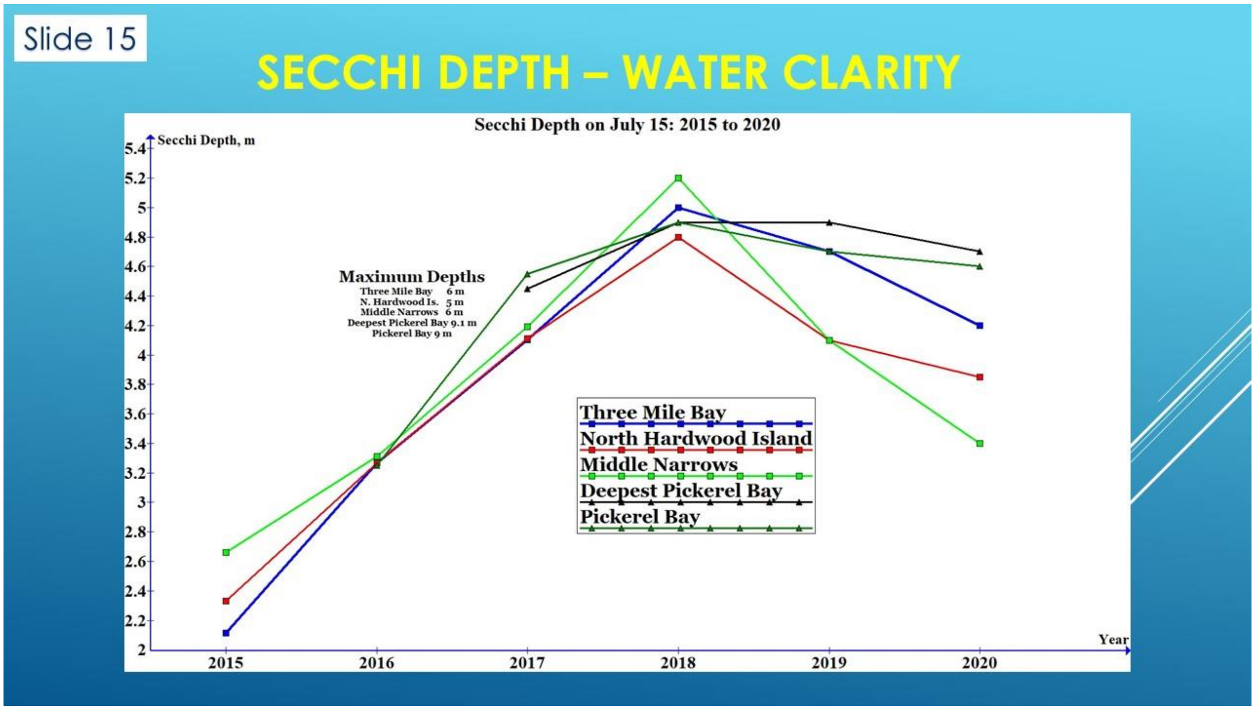
Slide 12: The slide above shows 2015 total phosphorus data for 5 sites on White Lake. Note that the total phosphorus concentrations are not the same at all sites in different parts of the lake. The yellow line is for samples taken at The Canal, where a special type of sediment occurs which actually occludes phosphorus and partially removes it from waters flowing from springs into the lake.

For sampling sites in the main body of the lake, such as those at Three Mile Bay and N. Hardwood Island, it is clear that maximum total phosphorus levels exceed even the old Provincial Water Quality Objective of 20 ppb.

Slide 13: In the fall of 2015, zebra mussels were first reported in most parts of White Lake. Veligers, which are the larval stage of the mussel, were first detected in 2008. In 2016, the population of zebra mussels exploded with total numbers estimated to be near one billion. The presence of such large numbers of an invasive species such as the zebra mussel resulted in a permanent change in White Lake water chemistry. The cycling of phosphorus, a key nutrient in any water body, changed and applied stresses to White Lake helping to cause annual green and blue-green algal blooms.



Slide 14: The above slide shows the change in the maximum total phosphorus concentration at three sites located in the main water body. Data for 2014 and 2015 are for pre-zebra mussel conditions. Starting in 2016, the total phosphorus concentration changed by about 50% and, has changed little since then.



Slide 15: The above slide shows the change in water clarity since the arrival of zebra mussels. Water clarity, as expressed as a Secchi depth, more than doubled once zebra mussels established themselves in the lake. The data presented in this graph are Secchi depths measured annually on July 15, at five locations in the main part of the lake (Zone 1). There has been a small decrease in water clarity since 2019, which was not accompanied by any corresponding change in total phosphorus concentrations.

Slide 16: The slide below shows the transformation from barren rock in White Lake, to rocks completely covered in zebra mussels. The scientific literature reports that it is common to have zebra mussel densities exceed 500,000 individuals per square metre. And since each mussel can produce up to 50,000 surviving offspring per year, it is no surprise to learn just how fast a lake can become saturated with zebra mussels, as White Lake did in 2016.

Zebra mussels are filter feeders and each adult mussel can filter 1 litre of water per day. Taking in account the total volume of White Lake and the estimated number of mussels present, it is easy to calculate that the entire volume of the lake can be filtered in about two months.

Slide 17

WHAT HAPPENS WHEN ZEBRA MUSSELS INVADE A LAKE

Published Literature Predicts	White Lake Observations
Marked decrease in total phosphorus levels	Decrease in TP by about 50%
Significant increase in water clarity	Water clarity more than doubled
Density and extent of aquatic plants along shoreline will increase	Marked increase in density of aquatic plants along shoreline
Shoreline water will become very clear especially in calm weather (no waves)	Where zebra mussels are present, water becomes crystal clear along shoreline
Microcystis blue green algae favored over Anabaena blue green algae	2018 White Lake experiences first two recorded Microcystis algal blooms
Toxic algal blooms will occur at relatively low TP concentrations	2018 toxic (25 ppb toxins)* algal bloom in Sept. when TP was ~10 ppb
Filamentous green algae will increase significantly	Filamentous green algae blooms are now common and extensive

*Drinking water limit: 1.5 ppb; Recreational limit: 20 ppb

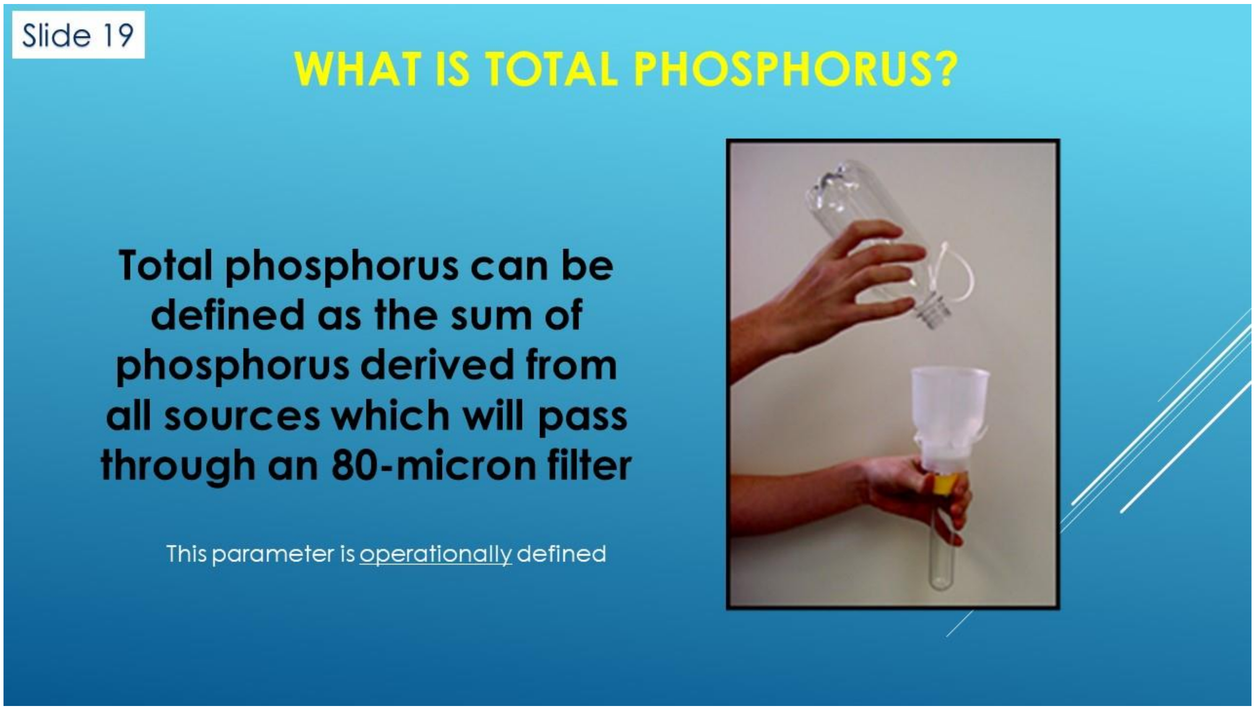
Slide 17: The Scientific literature contains tens of thousands of published articles on zebra mussels and their effects on lakes and rivers. The left-hand column on the above table shows the predicted effect that zebra mussels can have on a lake. The right-hand side of the table shows the effects observed in White Lake. All of the effects which we have observed are commonly reported for other water bodies around the world. Zebra mussels have been in Canada for about 50 years and the scientific literature from Canadian sources continues to grow at a rapid rate.

Slide 18: One of the more unfortunate effects of zebra mussel infestation is the facilitating of green and blue-green algal blooms. For several years White Lake has been experiencing algal blooms both in early summer and fall. Photographs of two such blooms are shown in the above slide.

An important aspect of these algal blooms is that they occur at very low total phosphorus concentrations. In each case above, the concentration of total phosphorus was about 10 ppb, which is well below the old 20 ppb Provincial water quality objective and even below the new provisional level of 11.3 ppb.

It is important to understand the reason why we see algal blooms at such low total phosphorus concentrations and why we can expect these to continue into the future.

To see a summary of documented algal blooms occurring on White Lake from 2013 to 2020, please read the algal bloom report from the White Lake Science and Information Website.

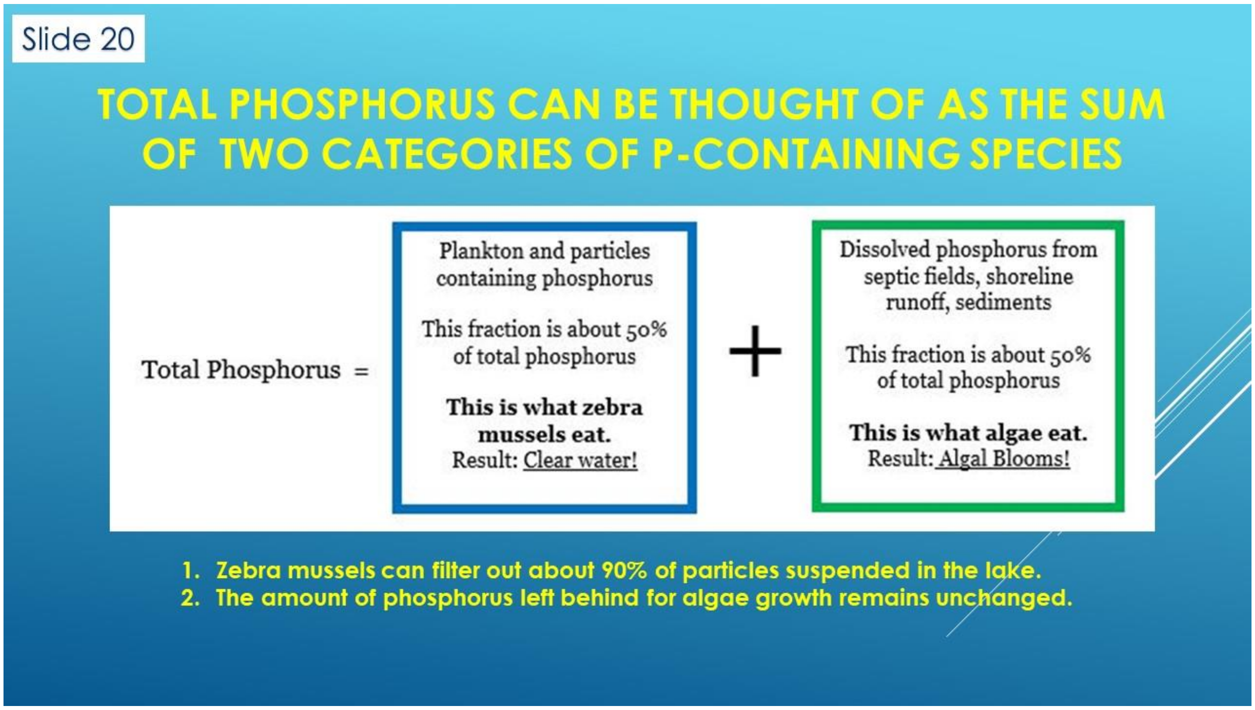


Slide 19: Before going further into explaining how zebra mussels have changed the cycling of phosphorus in the lake, it is instructive to first consider what, in fact, total phosphorus is and how its concentration is obtained.

Total phosphorus is what scientists call an ‘operationally defined’ parameter. This means that the method used to determine total phosphorus includes a step which, in this case, is the filtration of the lake water samples through an 80-micron (millionth of a metre) filter. Lake scientists have agreed to use this step so that they can better compare their results.

Phosphorus exists in lake water as dissolved compounds and also in particle form such as plankton, decaying vegetation, algae, etc. The filtration step used is designed to remove the larger solid particles because they can seriously affect the final analytical result. For example, the presence of a single daphnia, a relatively small microorganism, can increase the total phosphorus result by as much as 35 ppb, roughly three times the concentration we are now reporting for White Lake. Without the filtration step, results would be skewed higher and give more erratic results which would be difficult to interpret. This is also why we do not use any total phosphorus results obtained before the filtration step was officially implemented in 2002.

So, although we call our result ‘total phosphorus’, it is not really that, but only a part of the actual total of all phosphorous-bearing particles in the water column.



Slide 20: Continuing with the discussion on total phosphorus, we can say that the total phosphorus we are measuring is the sum of two broad categories of phosphorus-containing species: dissolved phosphorus and particulate phosphorus.

Two important facts to consider: 1) algae feed only on the dissolved fraction of phosphorus; 2) zebra mussels feed only on the particulate fraction of phosphorus containing species.

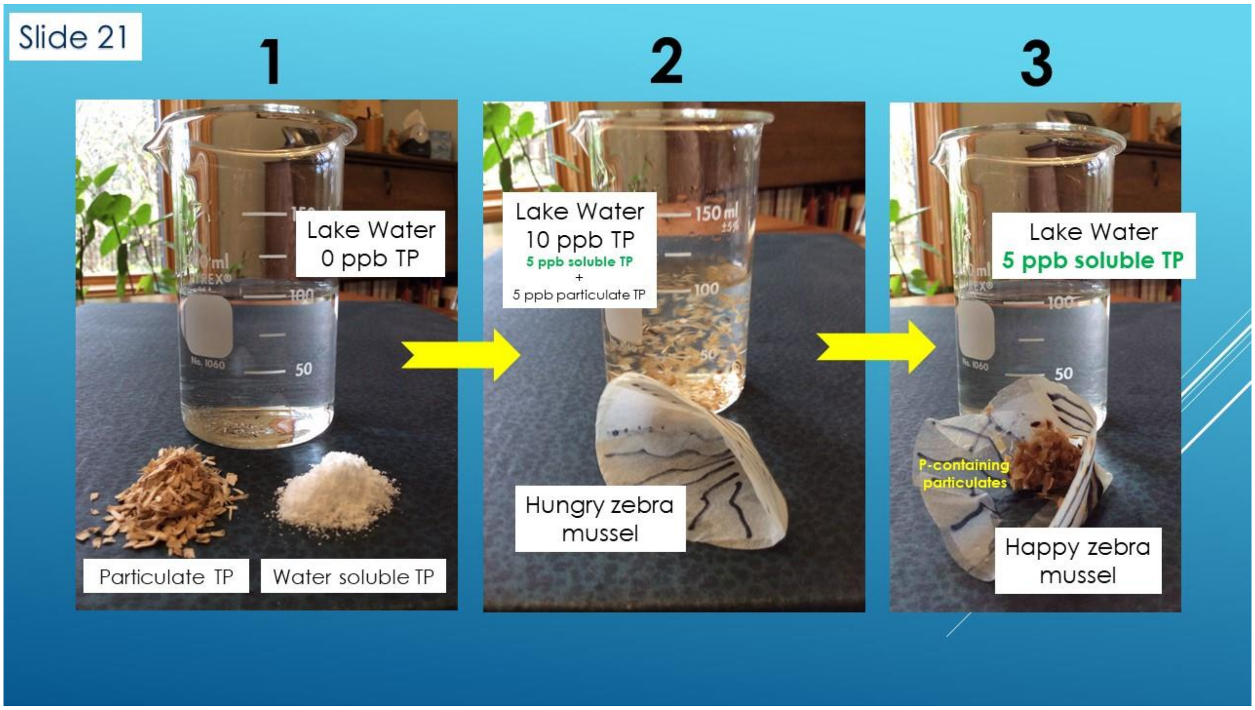
This means that while zebra mussels are busy filtering out any particles down to a few microns in size, as well as all other particles (even those larger than 80 microns), algae do not have their food supply diminished at all.

We now have a scenario which explains why water clarity has doubled, and total phosphorus values have halved since zebra mussels invaded White Lake.

This also explains why, even with low apparent total phosphorus values, the potential for algal blooms has not changed.

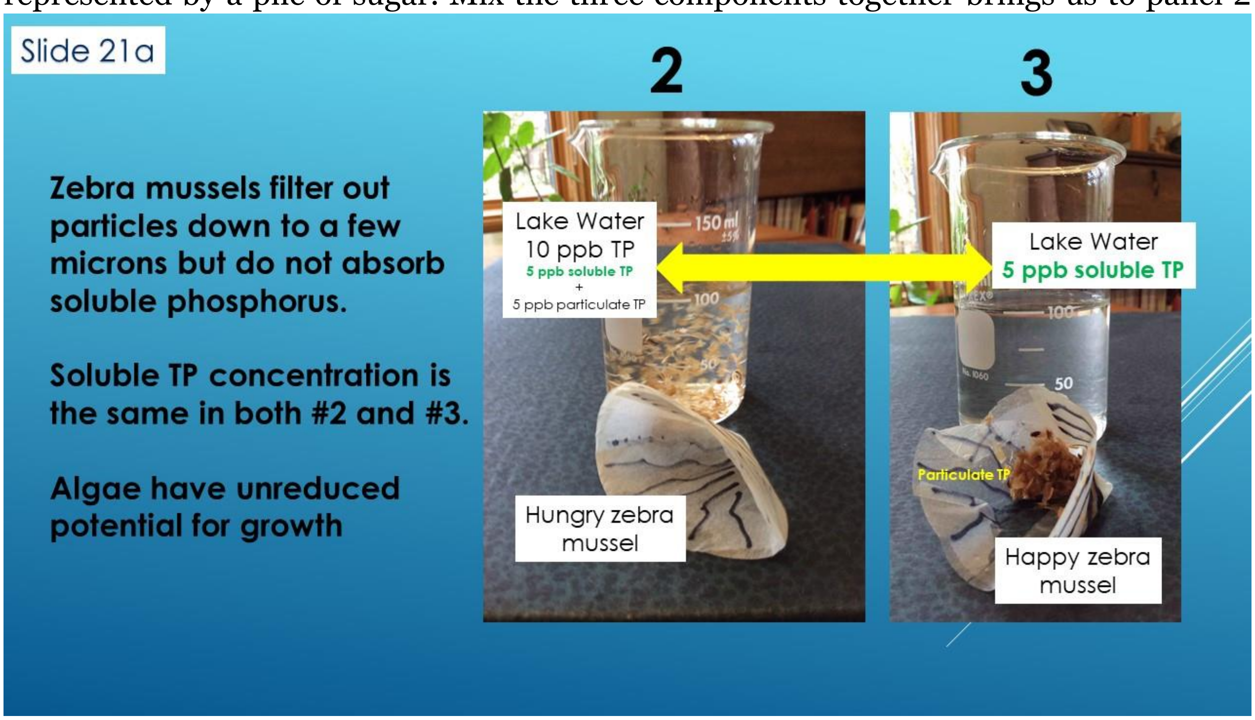
As will be discussed below, the net effect of the action of zebra mussels is to change the fate of particle-based phosphorus. Rather than these particles eventually settling to the bottom of the lake, they (and their phosphorus content) are now being concentrated along the shoreline where zebra mussels live.

An equally important fact is that zebra mussels can selectively promote the growth of potentially toxic blue-green algae, blooms of which are now occurring in White Lake.



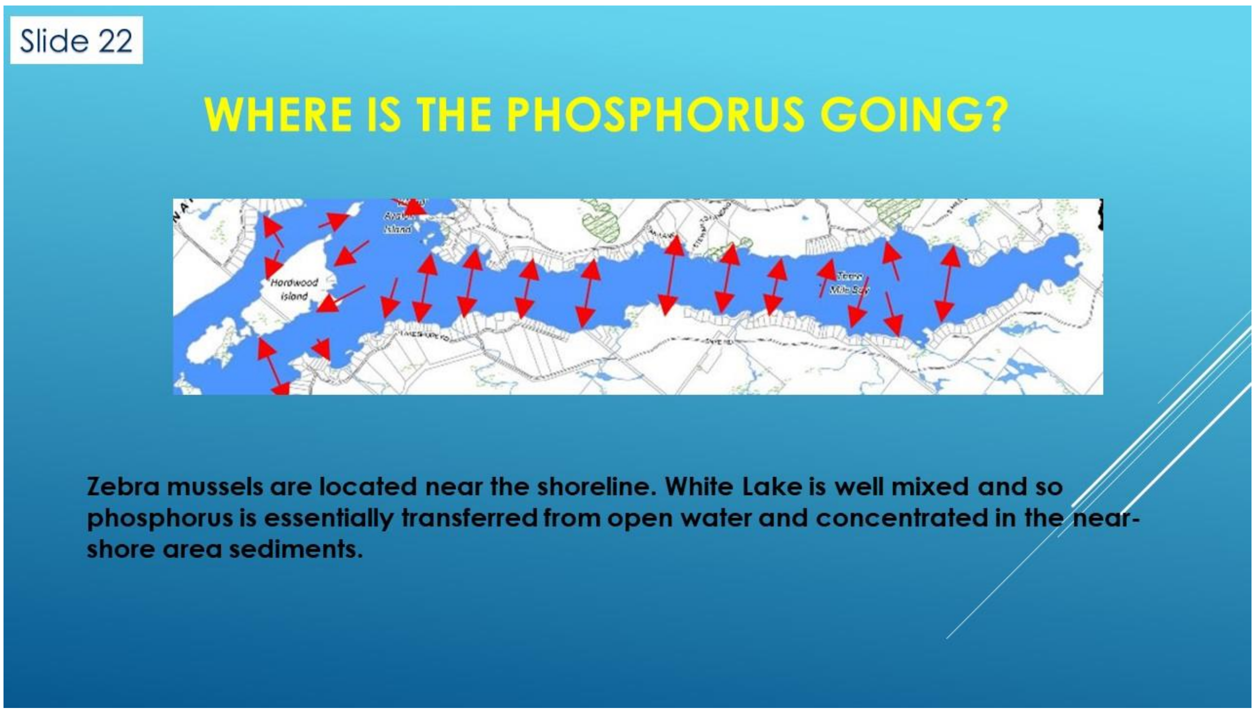
Slide 21 and 21a: The points made in the previous slide are so important to this discussion that we would like to present them again in a different format to benefit those who learn better by using a more visual example.

In the slide above, panel 1 shows the three components of White Lake water: 1) water; 2) particulate total phosphorus (TP) represented by a pile of sawdust; 3) water-soluble TP represented by a pile of sugar. Mix the three components together brings us to panel 2



where one can see a hungry zebra mussel (folded filter paper) standing by for a meal. Once being fed (panel 3) the now satisfied zebra mussel leaves behind a water sample containing as much soluble total phosphorus as was added to the beaker in panel 2.

For the sake of clarity, slide 21a summarizes the results of this experiment and the main point that although zebra mussels remove an important fraction of phosphorus sources from lake water, they do not alter the amount of phosphorus available to algae for growth and, at times, uncontrolled growth in the form of an algal bloom.

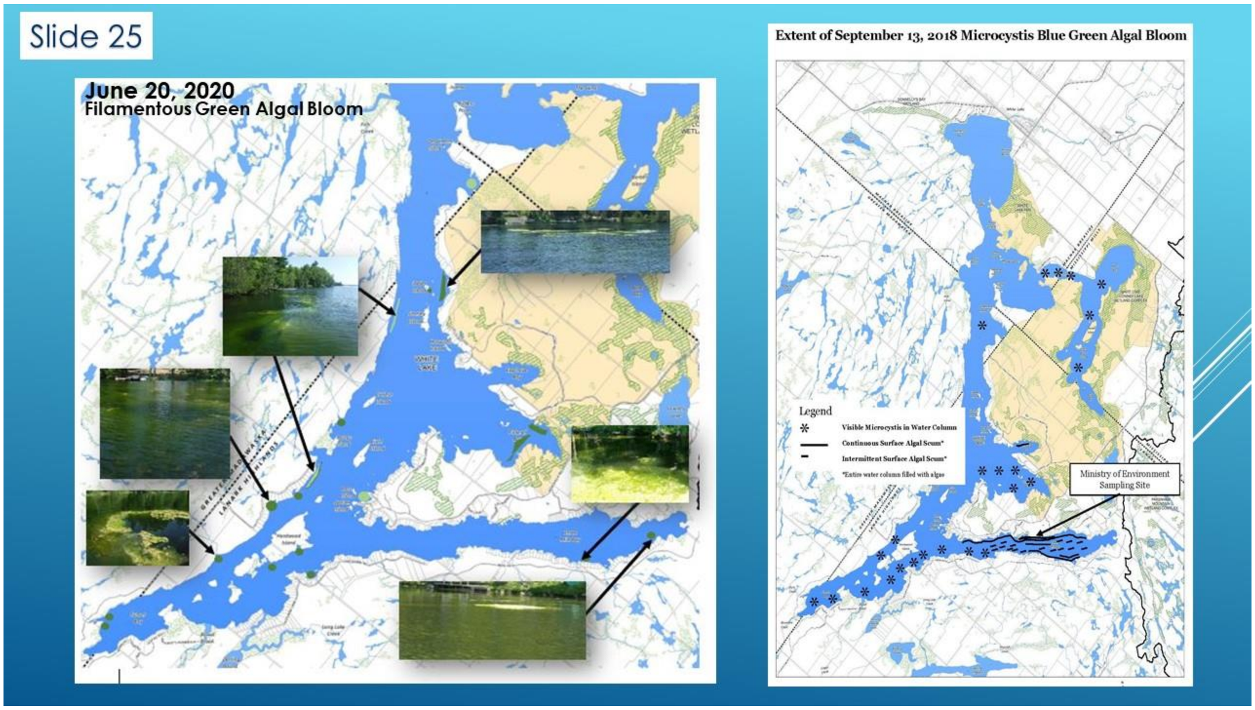


Slide 22: The arrows shown on Three Mile Bay illustrate the point made in the above slide that particulate phosphorus that is normally more equally distributed in the entire volume of the lake is now being concentrated along the near-shore areas where zebra mussels live. This process is occurring in all parts of the lake and not just Three Mile Bay.

Slide 23: Slide 23 below illustrates the fact that there are other inputs of nutrients coming from the land and reaching the lake. These nutrients include not only phosphorus, but also other compounds such as nitrates in the form of fertilizers and a wide array of pollutants including plastics and pesticides, etc.

These sources of nutrients impact the same area where zebra mussels are found and contribute (along with zebra mussels) to the accelerated growth of aquatic plants.

Slide 24: The slide below illustrates the combined effects of the concentration of phosphorus to the near shore areas by zebra mussels with the added contribution of cottage/home owners. This results in the creation of a new unwanted 'zone of life' located where we like to swim, fish and recreate at our dock sites. The arrows do not spotlight any specific property, but rather illustrate the point of multiple nutrient sources and their effects.



Slide 25: The two maps shown in the above slide illustrates the extent and intensity of algal blooms in White Lake.

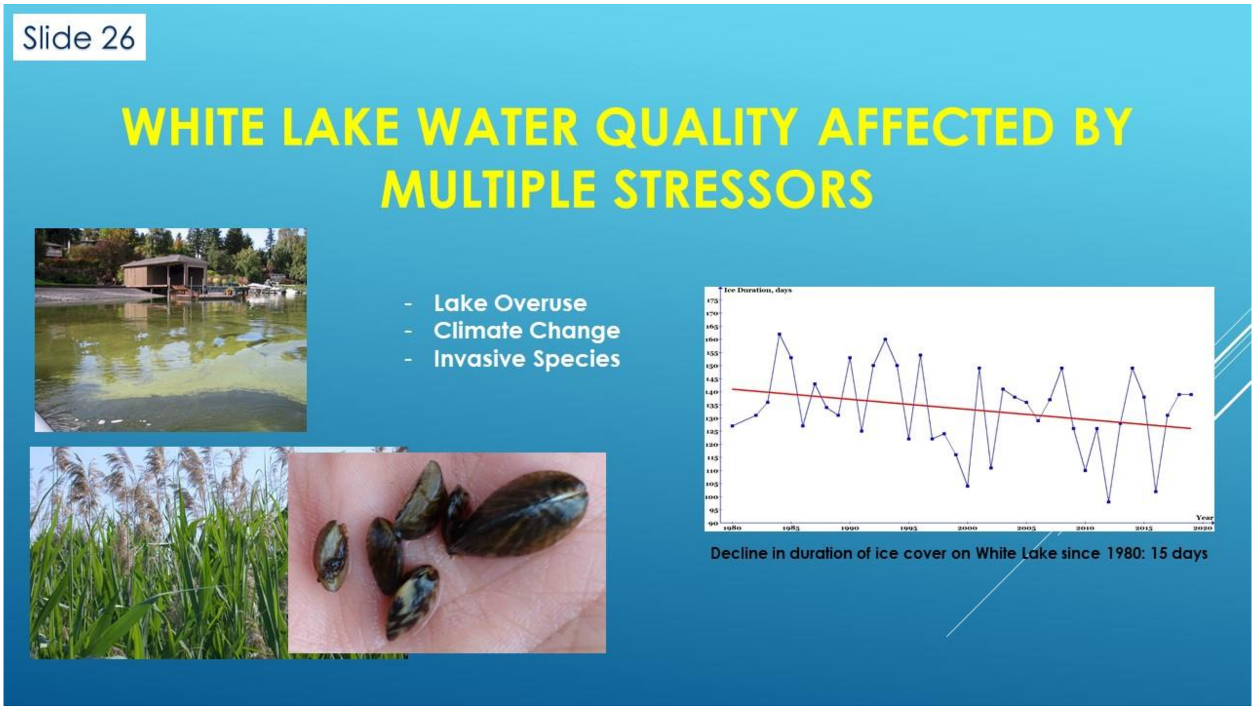
The map on the left shows that the early summer filamentous green algal blooms are extensive and can be found along the shoreline in many parts of the lake. This map also shows that the largest and most intense of these blooms can be found at locations where lots have been deforested or where shorelines have been stripped of vegetation, or where there has been recent landscaping activities.

The map on the right shows the distribution of a microcystis blue-green algal bloom which occurred in September of 2018. Although this algal bloom did produce dangerous toxins (microcystin), the intensity of the bloom has been variable from year to year depending on weather conditions.

An important observation, which is clearly shown on the map, is that the location of microcystis blue-green algal blooms is closely associated with the most densely populated areas of the lake.

For both algal bloom types, it is evident that human activity greatly influences the occurrence and intensity of these blooms. The presence of zebra mussels and their ability to concentrate nutrients in the near-shore area serves only to amplify the impact of humans on White Lake water quality.

Slide 26: At the present time, many lakes in Ontario are suffering from multiple stressors. It is important to recognize this because the effects of a single stressor, such as lake overuse, can be amplified by a second stressor such as climate change. White Lake is no exception.



There are at least three stressors currently effecting water quality in White Lake. These are lake overuse, climate change, and the presence of invasive species, both plant and animal.

The resurgence of algal blooms starting in 2013 (prior to the zebra mussel invasion) is an indication that What Lake has reached a level of nutrient input which is not sustainable.

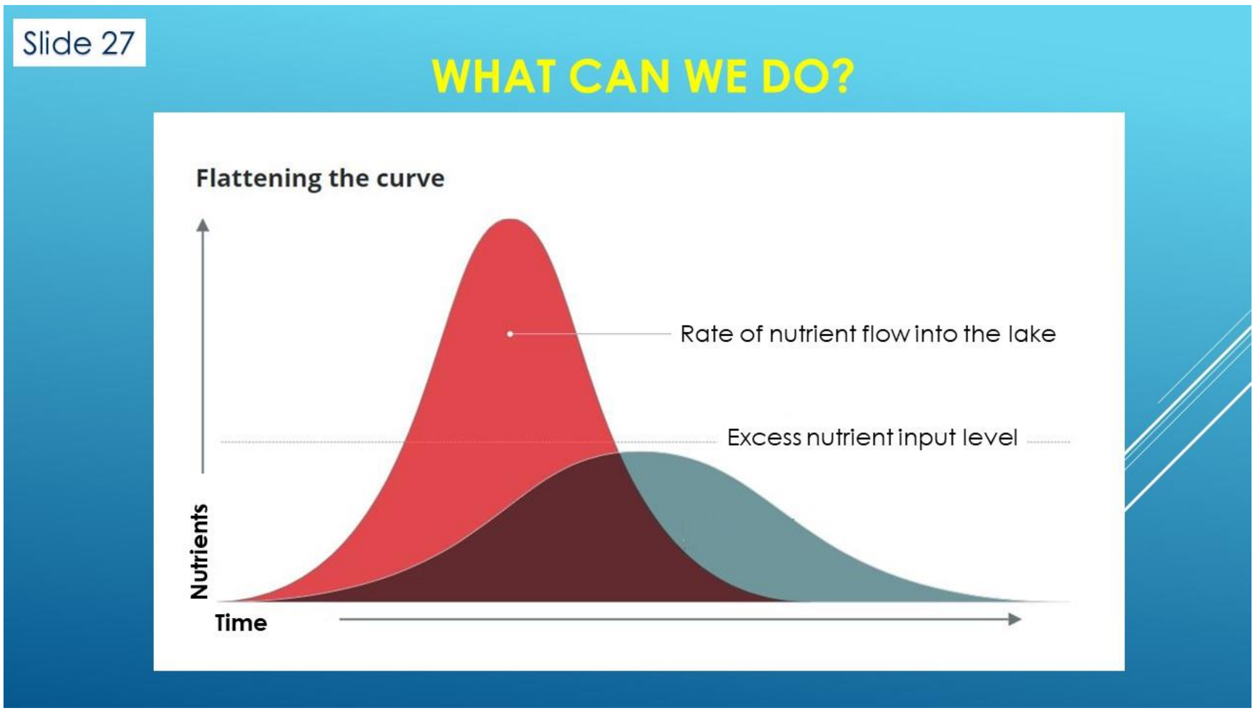
The arrival of zebra mussels has changed the way phosphorus and other nutrients are cycled in the lake. Phosphorus is now being concentrated in the near-shore area rather than be distributed more evenly in the lake. Zebra mussels also convert the phosphorus they process into forms which favour aquatic plant growth and the propagation of blue-green algae capable of producing toxins dangerous to human health.

Other invasive species such as the European common reed (phragmites) threaten to destroy wetlands and change how they function in filtering water and providing homes for wetland species as well as spawning locations for certain fish.

The White Lake Property Owners Association has been keeping track for over thirty years of the duration of annual ice-free periods for White Lake. These data show that during that time, the ice-free period has grown in excess of two weeks. This means that there are now two more weeks for boating, fishing, etc. as well as two more weeks of plant and algal growth.

An additional consequence of increased algae and aquatic plants in lakes is the depletion of available dissolved oxygen in the lake. This could adversely affect fish species such as pickerel, but also encourage the release of stored phosphorus from sediments.

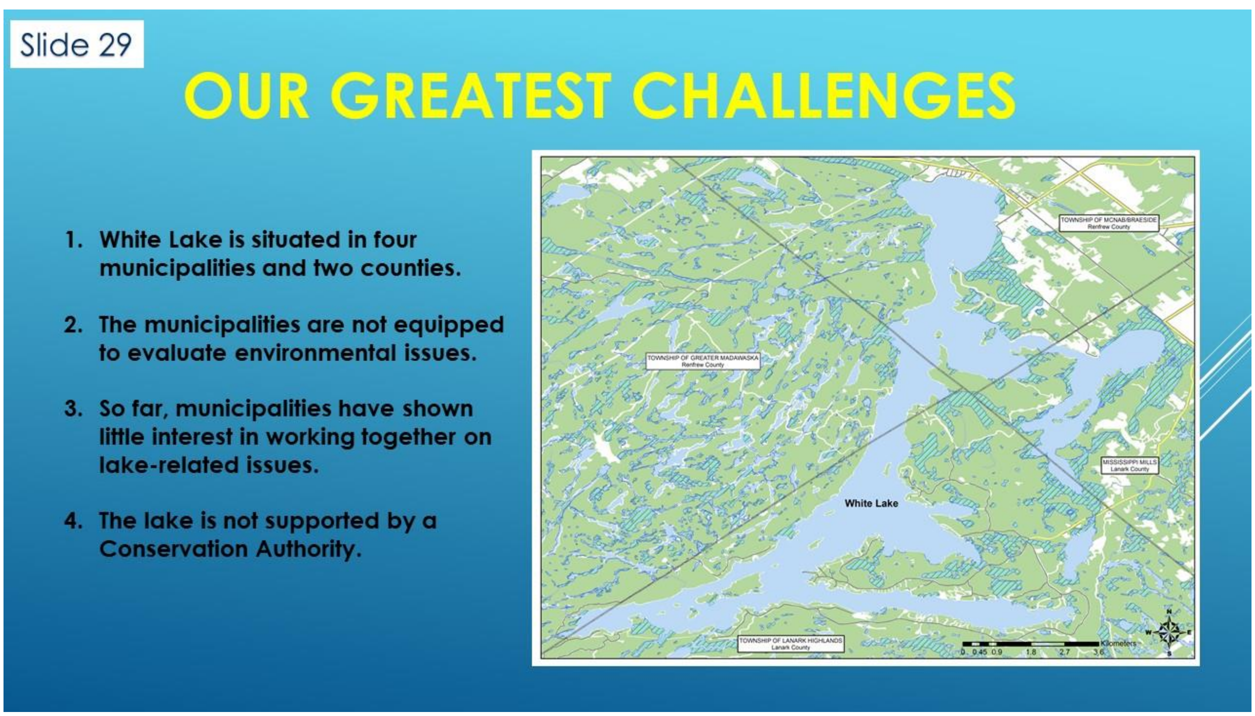
The concentration of phosphorus in lake sediments is about 200,000 times greater than in the water column above. The release of phosphorus from sediments is called ‘internal loading’ and White Lake has always had an internal load, but at a level that the lake could handle. Increased phosphorus from sediments intensifies both plant growth and algal blooms making worse a cycle resulting from the presence of multiple stressors on White Lake water quality.



Slide 27: We are in Covid times and the figure above may be familiar to many. The diagram shows the advantage of slowing the spread of the virus in order to avoid overwhelming the medical system. When it comes to nutrient inputs into the lake, the same concept applies.

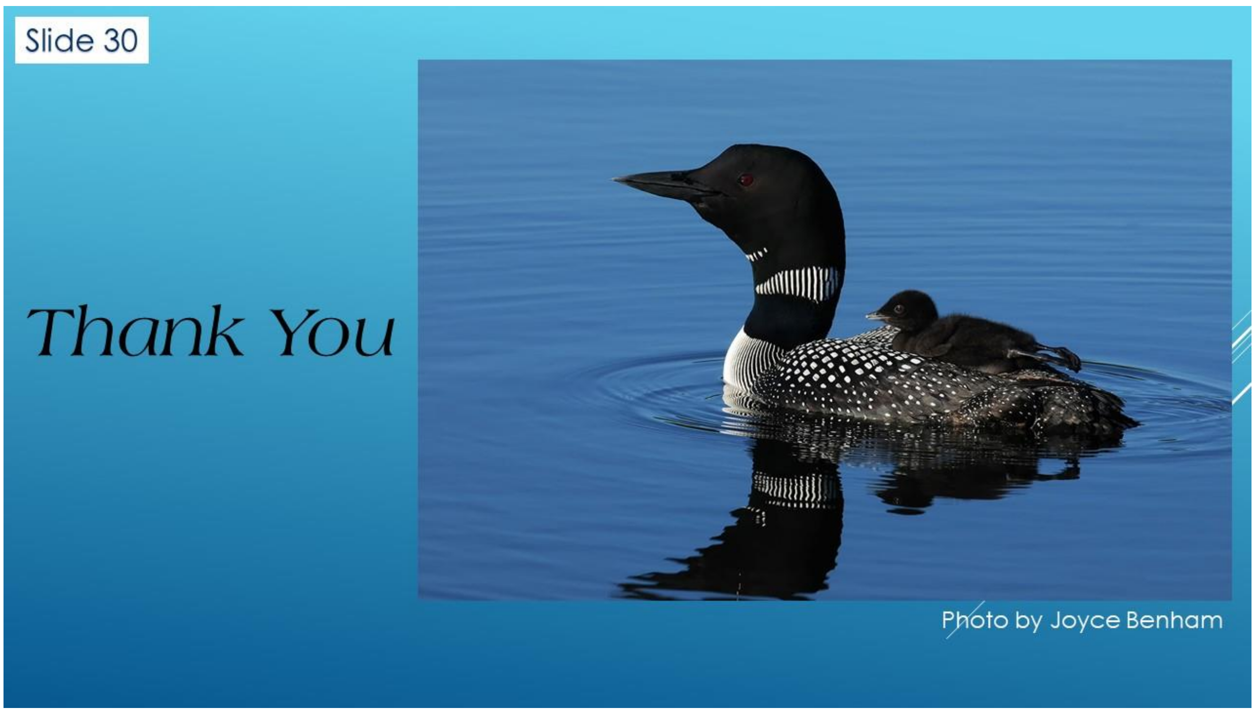
If we all do our part, we can slow the flow of nutrients into the lake resulting from human activity. Our goal must be to keep nutrient inputs below the ‘excess nutrient level’ for White Lake. Doing this will limit the frequency, extent and duration of unwanted algal blooms as well as the excessive growth of aquatic plants.

Slide 28: There are ample resources available to guide us in improving how we manage water quality in White Lake. [The Lake Protection Workbook]() is a good place to start. Further assistance can be obtained from organization like [Watersheds Canada](), who have specialized programs to asses and improve residential and cottage shorelines.



Slide 29: White Lake is located less than an hour from a city of over one million people. It is clear that over time, the lake will receive more and more visitors as well as the increase of conversions of three-season cottages to permanent homes.

It will be a challenge to manage the lake so as to preserve it for future generations. Because of the complexity of the political landscape and the absence of a Conservation Authority, we believe that management of the lake, at least in the near term, will have to be done by ourselves. Becoming an active member of our lake association (White Lake Property Owners Association) is a first step. In this way we can organize a political voice which can be directed to our elected officials in all four municipalities in an effort to engage them to work together in managing White Lake.



Slide 30: We have a beautiful lake which needs our attention and efforts to preserve it for future generations, not only for people, but also for the wildlife that make its shores and forests home.

July, 2021