Protecting your environment today for tomorrow.

Portage Lake
Lake Management Plan Review

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PLM Lake & Land Management Corp.

- Bre Grabill, Environmental Scientist
- Studied at Michigan State University with a focus in Limnology
- Senior Regional Manager- North, 20 years
- Focus on community outreach/education and working with municipalities, POAs, and individuals to form comprehensive programs with an ecological focus
- Mike Pichla, Environmental Biologist
- Studied at GVSU
- Northwest Lakes Manager- 8 years

MICHIGAN LOCATIONS

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1169 N Nottawa St.
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PLM Lake & Land Management Corp.

- 4 offices (soon to be 5 with a Manistee-area office) to better serve our clients
- Largest Aquatic Management Company in the State of Michigan.
- Full service firm with services to meet your needs:
  - Vegetation Assessment/Mapping
  - Water Quality Monitoring
  - Aquatic Invasive Plant and Algae Control
  - Fisheries Evaluation
  - Lake Depth and volume mapping
  - Fountain Installation and Maintenance
  - Phosphorus Mitigation
  - Plant Harvesting
  - Aeration
  - Shoreline Restoration

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Lake Facts

- Putting it in perspective
  - Michigan has ~11,037 lakes over 5 acres in size
    - Largest lake is Houghton, over 20,000 acres
  - 36,000 miles of streams, rivers and creeks
  - Never more than 6 miles from an inland lake or stream and never more than 85 miles from a Great Lake
  - Provides critical habitat for 154 freshwater fish species
  - Inland lakes generate ~15 billion dollars in direct and indirect economic activity annually

Facts By MLSA available at www.mymlsa.org

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The fight against Invasive Species

- ~$24 Million spent per year to control aquatic plants in Michigan
- ~$200 million lost per year in the Great Lakes Region due to the effects of ship-born invasive species on sport fishing, commercial fishing, wildlife watching and raw water usage
- ~$5.7 billion per year of Total Impact of AIS in the Great Lakes Region
- How many non-native aquatic organisms have colonized the Great Lakes since the 1800's?
  - 180+

Agenda

- Why share the above figures?
  - Important to keep in mind that the BMP's for EWM and various other nonnative plants are well established, peer reviewed and used as part of your annual management plan
- Lake Management
  - Integrated Pest Management Approach (IPM)
  - Riparian BMP's & Natural Shoreline/Nutrient abatement
  - Prevention
  - Monitoring- Planning/Evaluation
    - Survey Program
    - Water Quality Monitoring
  - Fishery
  - Management
    - Nonnative submersed Plants
    - Terrestrial Plants
    - Native Plant Diversity
    - Algae Management
- Lake Management Approaches
- Portage Lake
  - Survey Data
  - Lake Data & Maps
  - 2022 Treatment information
  - Herbicide information
  - Water Quality Data
  - Trophic Status
  - Budget

Photo courtesy of the Portage Lake Association. Photographer, Al Taylor.

Portage Lake
Lake Management Plan 2021

Prepared for Onekama Township and the Invasive Species Committee

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An Overall Plant Management Program

At PLM, our Plant Management Programs focus on preserving and protecting desirable plant life while controlling unwanted “weed” species through remediation services. In addition, these preventative programs strive to keep your site free from unwelcome plants that are known to be pests elsewhere in the region.

Under PLM’s Plant Management Program, we first evaluate and record your site goals. Next, we prescribe an individually developed management plan to control unwanted plant growth. After consultation with you, we then implement the agreed upon plan. Later, we assess the results and use the information to modify and improve our priorities, processes and plans- starting the cycle again.

The key to our success is our Plant Management program, which minimizes the total long-term impact of noxious aquatic and terrestrial vegetation. Our priorities include prevention of new infestations and management of existing plant growth, which provide the most value for your money while protecting our environment.

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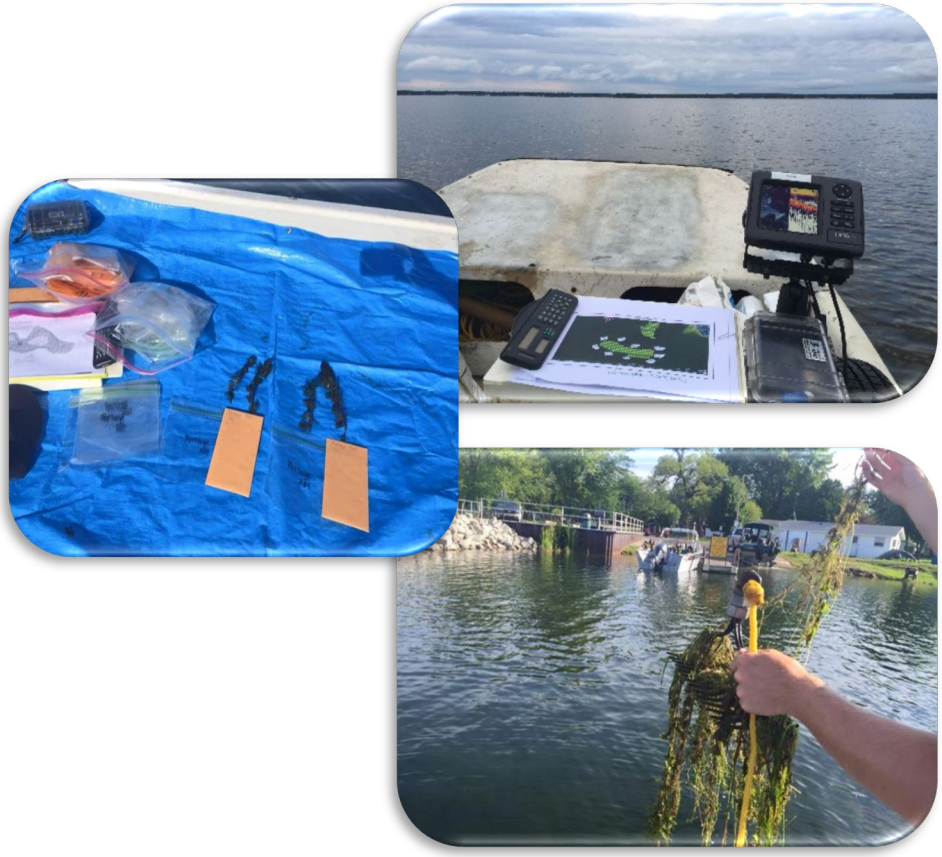
Integrated Pest Management (IPM)

- Emphasize spending more effort evaluating the problem, so that exactly the right control can be applied at just the right time to control the pest.
- Minimize management costs and minimizes the use of chemicals.
- Essential for long term success.
- Multi-faceted approach to review numerous control avenues.
- Allows for cost-benefit analysis as well as checks and balances over program.



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What can you do to help protect Portage Lake?

- **Do not rake leaves into the lake. Decomposing leaves produces more muck.**
- **Do not feed the ducks and geese.**
- **Remove dog, geese and duck droppings from lawns, docks, etc. Excess feces will increase nutrients within the lake.**
- **If you do fertilize make sure you are using Phosphorus free fertilizer. One pound of phosphorous may produce over 775 pounds of algae-"The slimy green stuff".**
- **Perforate lawn periodically and seed and mulch exposed soil (to prevent erosion).**
- **Remove aquatic plants, leaves/branches and other debris that washes up along the lakeshore so less decomposition occurs in or near the lake.**
- **Always use silt fences when building a new home or doing any yard-work that would cause erosion.**
- **Keep all burn piles and debris piles away from lake. Do not burn near the water. The ash is concentrated nutrients!**
- **Encourage the use of stone, brick and similar porous materials when building a landscape to minimize urban water collection.**
- **Create a natural buffer close to the water's edge.**
  - **A natural setting will filter excess nutrients from entering the water**
  - **Decreases erosion.**
  - **Deters geese from making a stop on your beach front. Geese do not like areas where they cannot see the predators coming towards them.**

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Natural Shoreline & Nutrient Abatement

- Lakeshore residents should also be encouraged to manage their waterside landscapes according to the recommendations outlined in publications on this topic available from the MSU Extension.
- Rooted plants derive most of their key nutrients from the sediments; thus, they respond slowly, if at all, to reductions in nutrient loading. In fact, if reductions in nutrient loading lead to improved water clarity, the growth of rooted plants will probably increase.
- If organic material (muck) accumulates to undesirable levels in shoreline areas, bacterial treatments should be considered as a way to alleviate the buildup.
- Shoreline development has led to habitat degradation and as lakes continue to become more and more developed, the impacts continue to be damaging to the lake ecosystem.
  - From mowed grass and sandy beaches, to seawalls and riprap and fertilizer, development has negatively impacted a lake in all ecological aspects.
  - Working to reduce the human footprint around the lake, the health of the lake will be improved.
  - Natural shoreline restoration is helpful from reducing nutrient loading and runoff to providing habitat for frogs and fish to naturally defending against Canadian geese congregating in your yard, it is important that action is taken to minimize development impact and restore natural features.
  - Maintaining a natural shoreline can greatly aid in the overall health of the lake.

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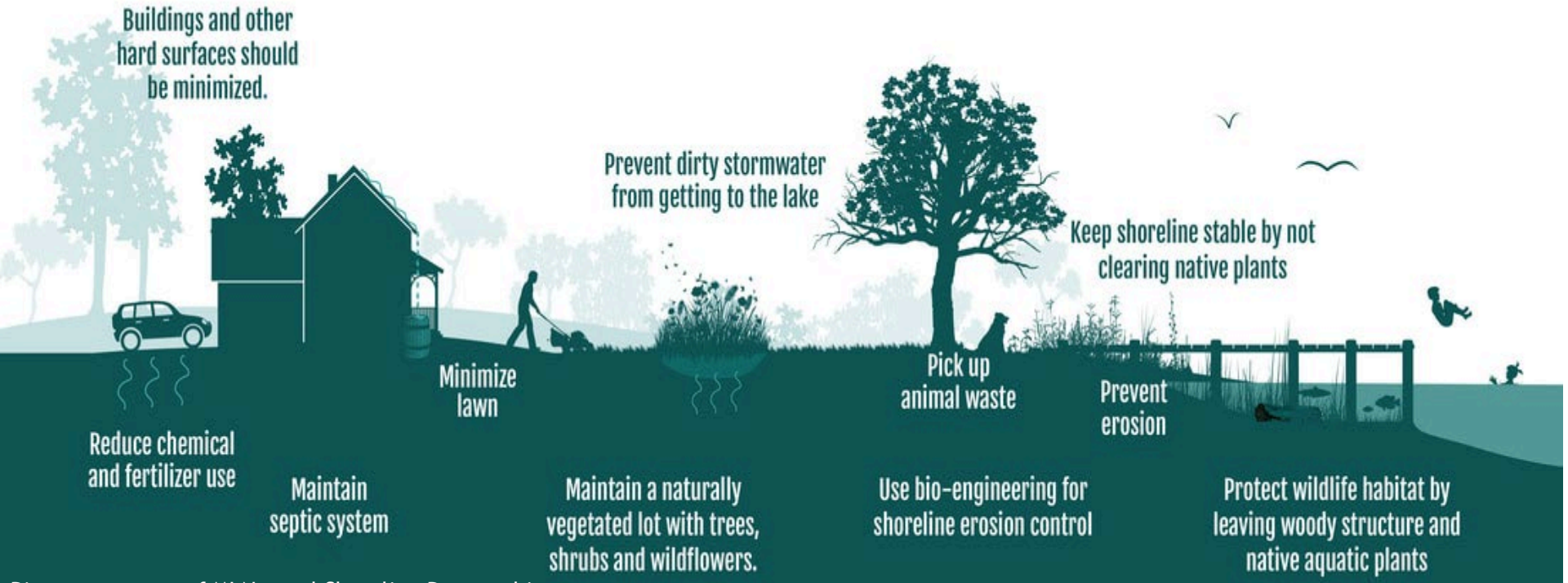
- Converting seawall shorelines back to natural vegetation; plants, trees and shrubs along the water's edge has many benefits for the lake.
  - Benefits include erosion control, nutrient and pollution absorption, increase in wildlife and fish habitat and reduction of nuisance geese on lawns.
  - If seawall removal is not feasible there are other options residents can do to improve and protect the lake.
  - Placing rip rap in front of a seawall will help reduce wave action thus reducing lake scour. Rip rap can also create a suitable shoreline for animals to access the land and provide places for aquatic insects and plants to grow.
  - Native vegetation can be planted within the rip rap, creating a more natural shoreline. Adding rip rap is an easy, affordable and effective way to help the lake.



Picture courtesy of MI Natural Shoreline Partnership

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Prevention

- Early detection and rapid response is key to a successful program.
- Community education and outreach is key to preventing introductions.
- More often than not, nonnative aquatic plants (exotic species) were possibly introduced by boats and/or boat trailers.
- Preventing their inadvertent introduction to your lake can significantly lower the cost of future lake management.
- Education can be an effective preventative measure.
  - Newsletter articles should alert lake residents to the threat from exotic nuisance plants and animals.
  - Warning signs should be erected at any public boat access sites, if applicable, that encourage boaters to clean boats and trailers when launching or removing watercraft from the lake.

STOP AQUATIC HITCHHIKERS!™
Be A Good Steward.
Clean. Drain. Dry.
StopAquaticHitchhikers.org

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Planning & Evaluation

- Survey Program
  - Surveys of the lake should be conducted frequently throughout the summer months
  - Management evaluation
  - Vegetation surveys determine the locations of target and non-target plant species.
  - Vegetation surveys also document the success of the prescribed management program.
- Mapping Program
- Water quality Testing

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Fishery

- Portage Lake has a diverse fishery including both cool and warm water species.
- Overall health of the lake's fishery is directly tied to many factors including:
  - Plant coverage
  - Water quality
  - Algae densities
- Managing nonnative plants, while maintaining native plants will promote a healthy fish community.
- Through proper management, a fishery can be maintained and restored.
- Independent fish study, in addition to DNR studies, options have been made available to the committee, both past and present.
- Highly recommend investment in a fish study in 2022
  - This should fall under the management program/SAD funding
  - Within the long term best interest of program support

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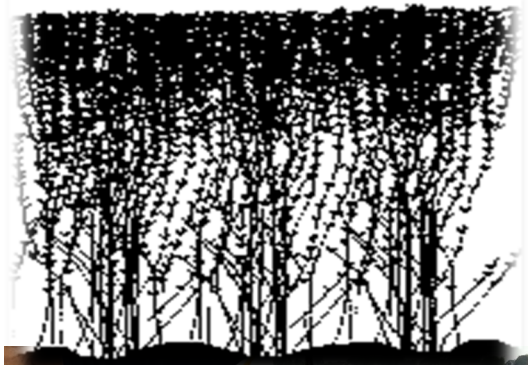
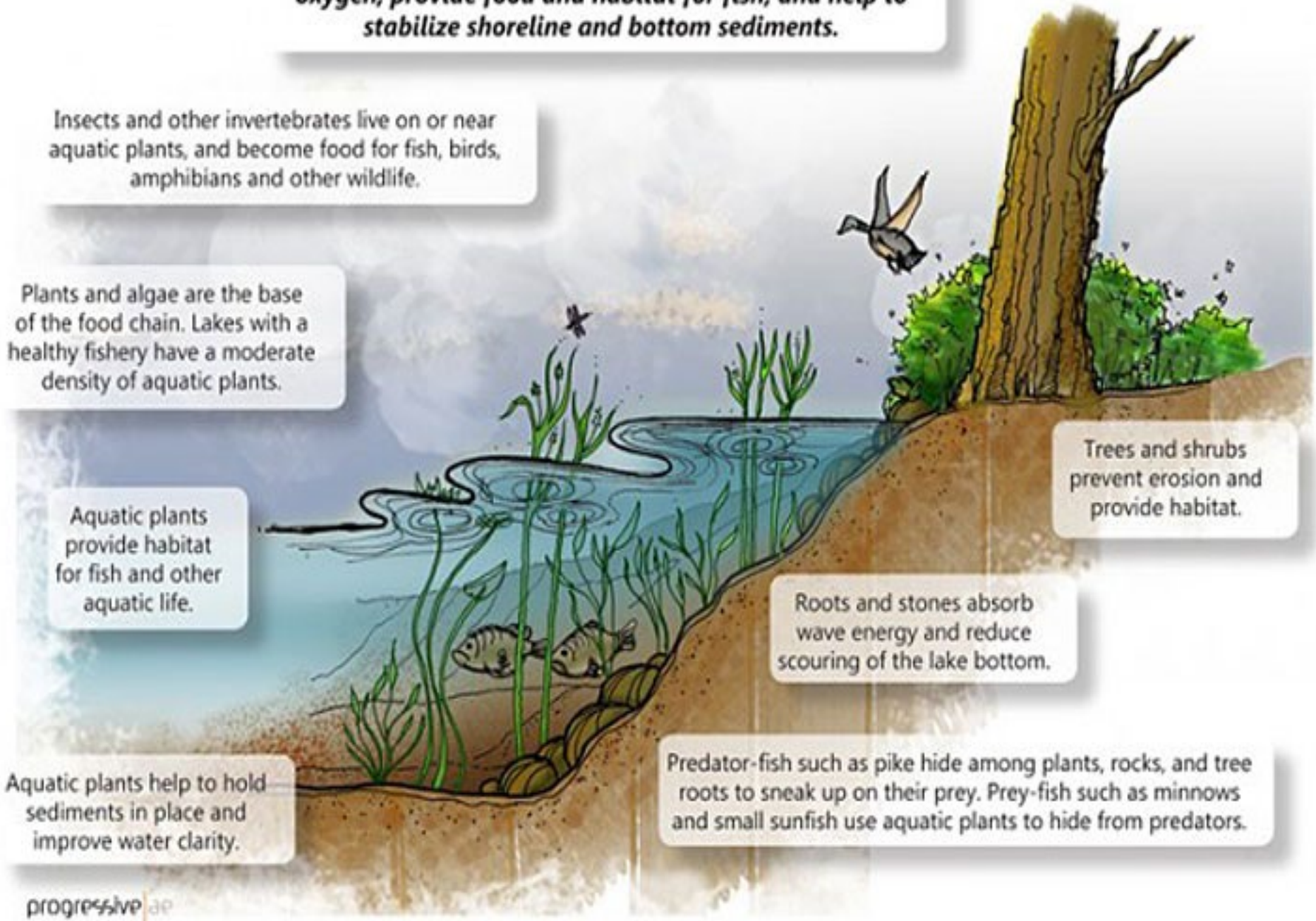
Plant Management

- Submersed nonnative plant management
  - On Portage Lake
    - Eurasian watermilfoil (EWM), Curlyleaf pondweed (CLP), Starry stonewort (SSW)
- Emergent nonnative plant management
  - On Portage Lake
    - Purple Loosestrife (PL), Narrowleaf cattail, Phragmites (Phrag), Japanese knotweed
- Native plant management
  - Not part of Portage Lake Plan
- Algae management
  - Advanced monitoring in place, reports of growing visual impacts, no control in place, other than SSW



Aquatic plants are part of a healthy lake. They produce oxygen, provide food and habitat for fish, and help to stabilize shoreline and bottom sediments.



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Algae Management

- **Why monitor Algae?**
- An over abundance of algae is an indicator that there is an excess amount of nutrients within the water column/lake, causing the waterbody to become overly productive.
- Algae are very beneficial in a lake ecosystem and can be thought of as the base of the food chain. Therefore, some algae is required.
- However, when an algae reaches the point of hindering the use of the lake, control measures are available:
  - Actions should be taken within the watershed to promote a healthy lake ecosystem and decrease nutrient loading, etc. However, no immediate change will be seen with these actions but play a critical role in protecting the lake for future generations.
  - Phosphorus Mitigation Options
  - Direct control options – again not part of the Portage Lake Plan
- 3 types of algae to be familiar with:
  - **Filamentous, Planktonic, Macroalgae**
- **Macroalgae** includes three types, Chara, Starry stonewort and Nitella.
  - Chara
    - Grows like a plant on the bottom (carpet), is a natural water filter and is excellent for fish bedding
    - This is a #1 species in Portage Lake and should continue to be protected!
    - Chara is the most dominate “plant” in Portage Lake 36% (found in 119/130 sections!)
  - Starry stonewort- the enemy of Chara and Portage Lake

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Algae

- **Planktonic algae**
  - Microscopic, often referred to as "water bloom". Typically Blue-green algae species
  - In large number, the algae can cause water to appear green, brown, yellow, or even red.
  - Can form toxins (not always)
  - Dealing with the source is often preferred over treatment.
- **Filamentous algae**, commonly called "pond scum"
  - Typically green algae or diatoms
  - Form raft-like masses over the water surface.
  - Vulnerable to winds and currents
  - Filamentous algae can grow attached to the lake bottom, weeds and docks. Frequently detach from the lake bottom and form floating mats.

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Lake Management Approaches

Main highlights listed (expanded points in LMP)

Aeration

- Adding oxygen into lake
- Permits almost impossible to get, many misused systems
- Not appropriate for Portage Lake

Bacteria Augmentation

- Optional for lake frontages with high organic content
- Not appropriate for lake wide management on Portage Lake

Benthic barriers

- One of oldest technologies in aquatics
- Mats placed to prevent light pentation
- Not selective, can impact spawning, securing issues, potential navigational hazard
- Requires permit and if used, avoid areas with mixed beds for less impact on native plants

Biological control

- Purple loosestrife beetles have been used successfully, access to new beetles was limited with covid.
- EWM weevils or beetles are no longer being produced, very expensive with irregular results
  - Control was typically limited to top few inches, overwintering issues, fish impacts

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Lake Management Approaches

Main highlights listed (expanded points in LMP)

Chemical control

- Highly regulated by State of Michigan, EPA (Requires state and federal permits)
- Can be selective, expensive, requires professional contractor
- “Negative” view point of chemicals

DASH

- Suction hoses by diver to vacuum out plants (native and/or nonnative)
- Impacted by bottom sediments, easily stirred up, small areas, very expensive
- Fragmentation can occur
- Permits, deposal sites

Harvesting

- Fragments plants
- Should be used for only non fragmenting plants and typically for native plant control
- Expensive, per hour rate, slow, dump site

Phosphorus mitigation

- New technology to help prevent/repair lakes from impairment and phosphorus pollution
- Becoming an interest to many lake residents to manage long term, not a band aid approach

Swimmers Itch

- Snails/water fowl
- Limited management options

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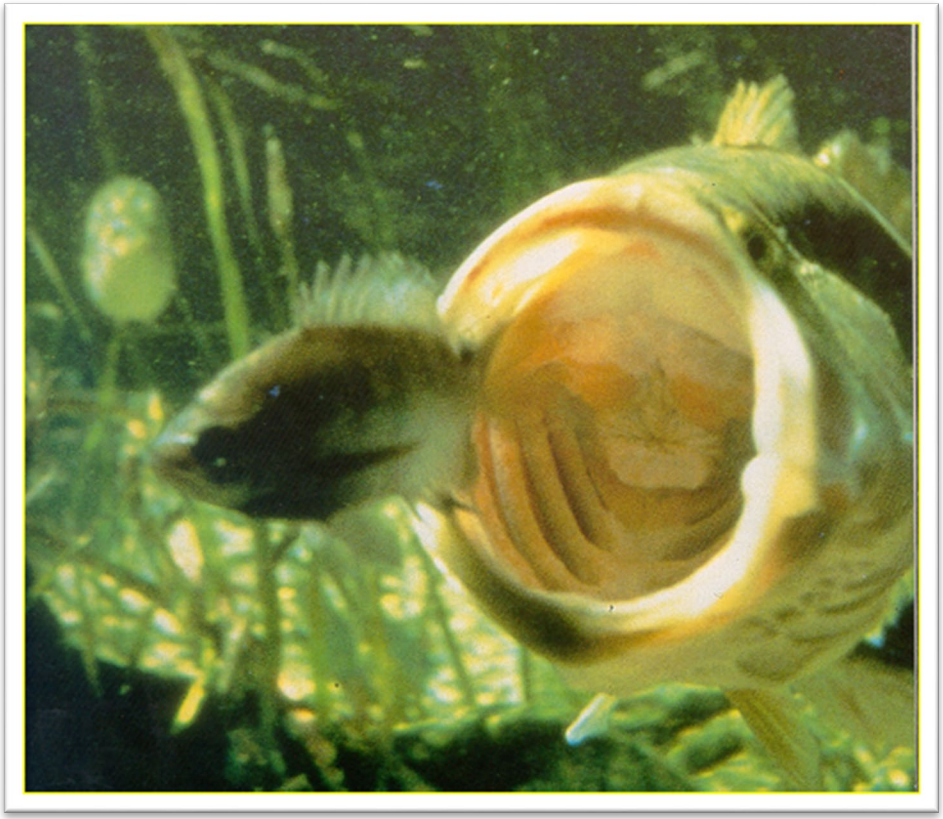
Goals of Aquatic Plant Management

Control Exotic Species

- Promote a Balanced and Diverse Native Plant Community
- Improve Fisheries
- Maintain Property and Recreational Values

Native Plant Species

- Fundamental component of aquatic ecosystems
- Perform important functions
  - Stabilizing sediments
  - Support aquatic insects
  - Maintaining Oxygen
  - Provide forage and refuge areas for fish



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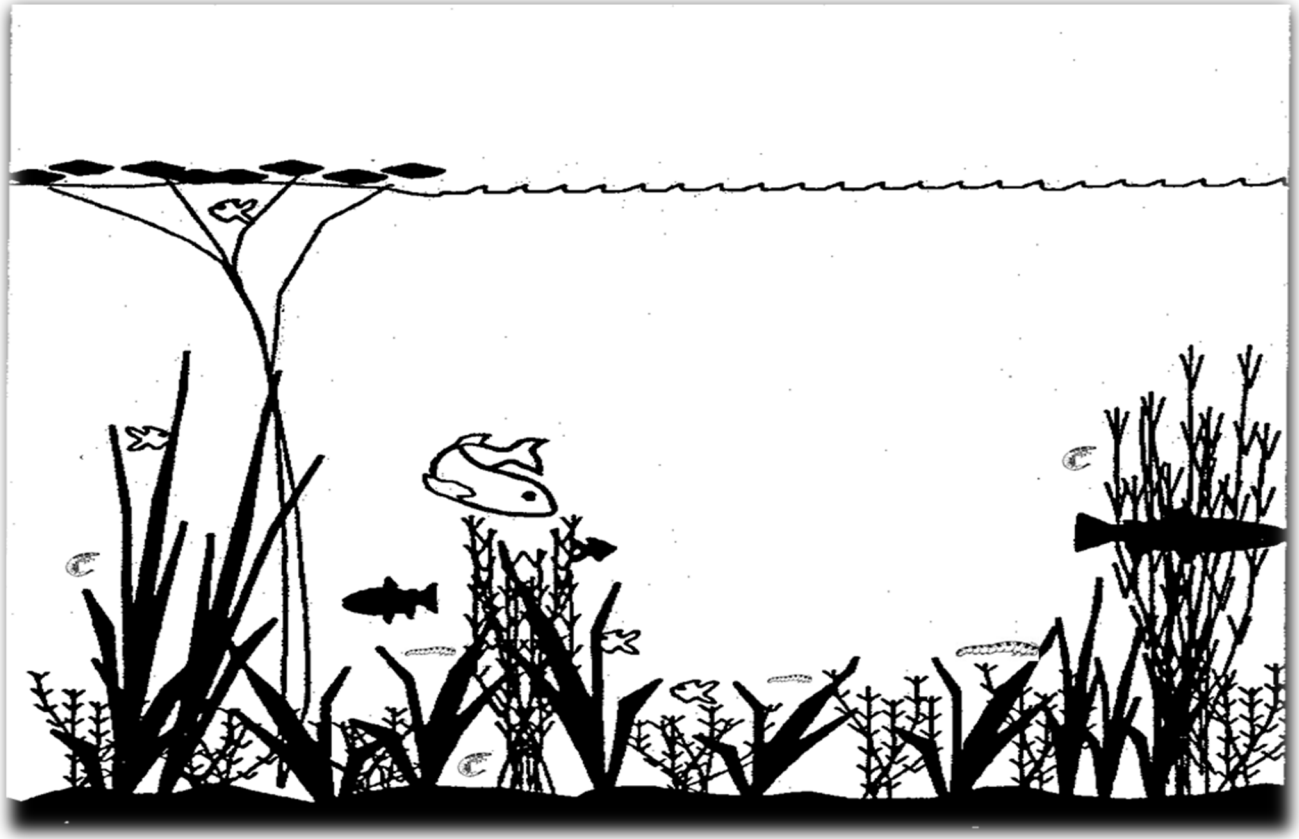
Diverse, Native Plant Community



The goal of Aquatic Plant Control: A healthy & diverse plant community.

Impacts of Exotic Species

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Portage Lake Survey Program

- Numerous surveys each summer including:
  - Two AVAS Surveys
    - GPS shoreline map, 130 segments
    - State standard survey method
  - Pre/post treatment surveys
    - Includes GPS mapped areas for applicator
  - Biobase mapping done historically, as needed
    - Included vegetation and sediment density maps
  - In 2021, 7 separate surveys were completed
  - Independent genetic testing completed numerous times during AVAS survey
  - 2022- adding in additional offshore grid points for additional comprehensive review
- Score the shore
  - CLMP Survey program for overall lake health
    - Great for determining health of lake shoreline (erosion, % of natural shoreline, ID various plants, working with residents for improvement)
    - Citizen scientists

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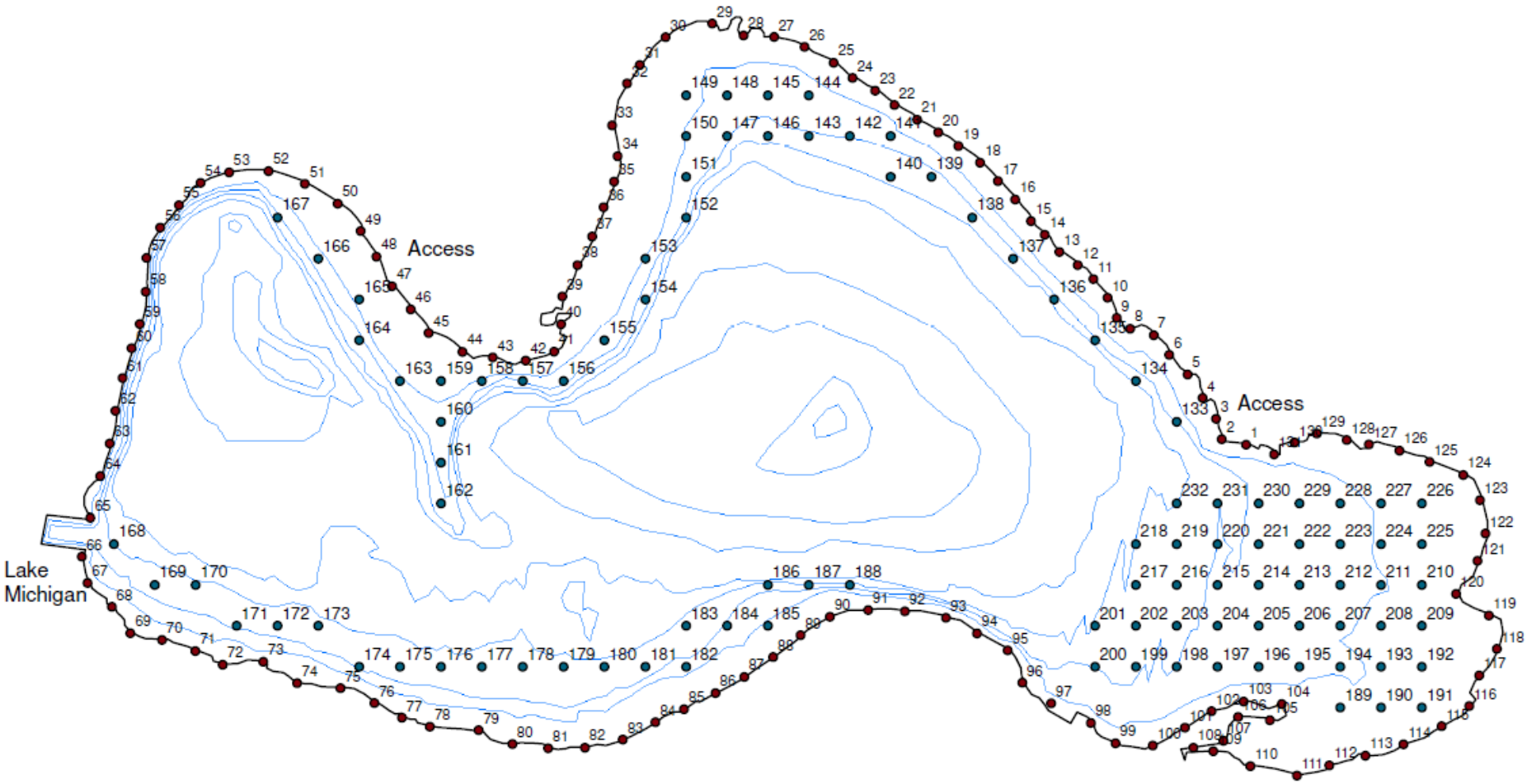
2022 Combination AVAS/Grid Survey Map



AVAS Code	Common Name	Scientific Name	% Cumulative Cover June 2021	% Cumulative Cover October 2021
	Submerged- Exotic			
1	Eurasian watermilfoil	Myriophyllum spicatum	2.74	1.98
2	Curlyleaf pondweed	Potamogeton crispus	2.41	0.08
29	Starry stonewort	Nitellopsis obtusa	0.00	0.08
	Submerged- Native			
3	Muskgrass	Chara	24.46	36.08
4	Thinleaf pondweed	Potamogeton spp.	2.74	7.46
5	Flatstem pondweed	Potamogeton zosteriformis	1.55	2.93
6	Robbins pondweed	Potamogeton robbinsil	0.00	0.00
7	Variable leaf pondweed	Potamogeton gramineus	2.29	4.54
8	White stem pondweed	Potamogeton praelongus	1.26	4.08
9	Richardsons pondweed	Potamogeton richardsonii	3.05	7.95
10	Illinois pondweed	Potamogeton illinoensis	5.35	13.62
11	Largeleaf pondweed	Potamogeton amplifolius	2.31	1.62
14	Water stargrass	Zosterlia dubia	0.00	0.23
15	Wild Celery	Vallisneria Americana	0.56	19.57
17	Northern milfoil	Myriophyllum sibiricum	0.09	0.08
20	Coontail	Ceratophyllum demersum	1.17	7.25
21	Elodea	Elodea Canadensis	0.31	2.88
22	Bladderwort	Utricularia valgaris	0.55	0.67
24	Buttercup	Ranunculus longirostris	0.77	0.23
25	Naiad	Najas flexilis	3.95	7.12
27	Sago pondweed	Potamogeton pectinatus	0.32	9.75
45	Variable leaf watermilfoil	Myriophyllum heterophyllum	0.03	0.69
48	Water marigold	Megalodenta beckii	0.00	0.00
	Emergent- Native			
30	Water lily	Nymphaea odorata	0.00	0.00
37	Pickerelweed	Pontederia cordata	0.00	0.31
39	Cattail	Typha spp.	11.88	15.37
40	Bulrush	Scirpus spp.	10.47	15.65
42	Swamp loosestrife	Dianthera americana	0.00	0.00
	Emergent - Exotic			
43	Purple loosestrife	Lythrum salicaria	0.00	0.00
44	Common reed	Phragmites	0.00	0.08*
	Total		79.21	161.21

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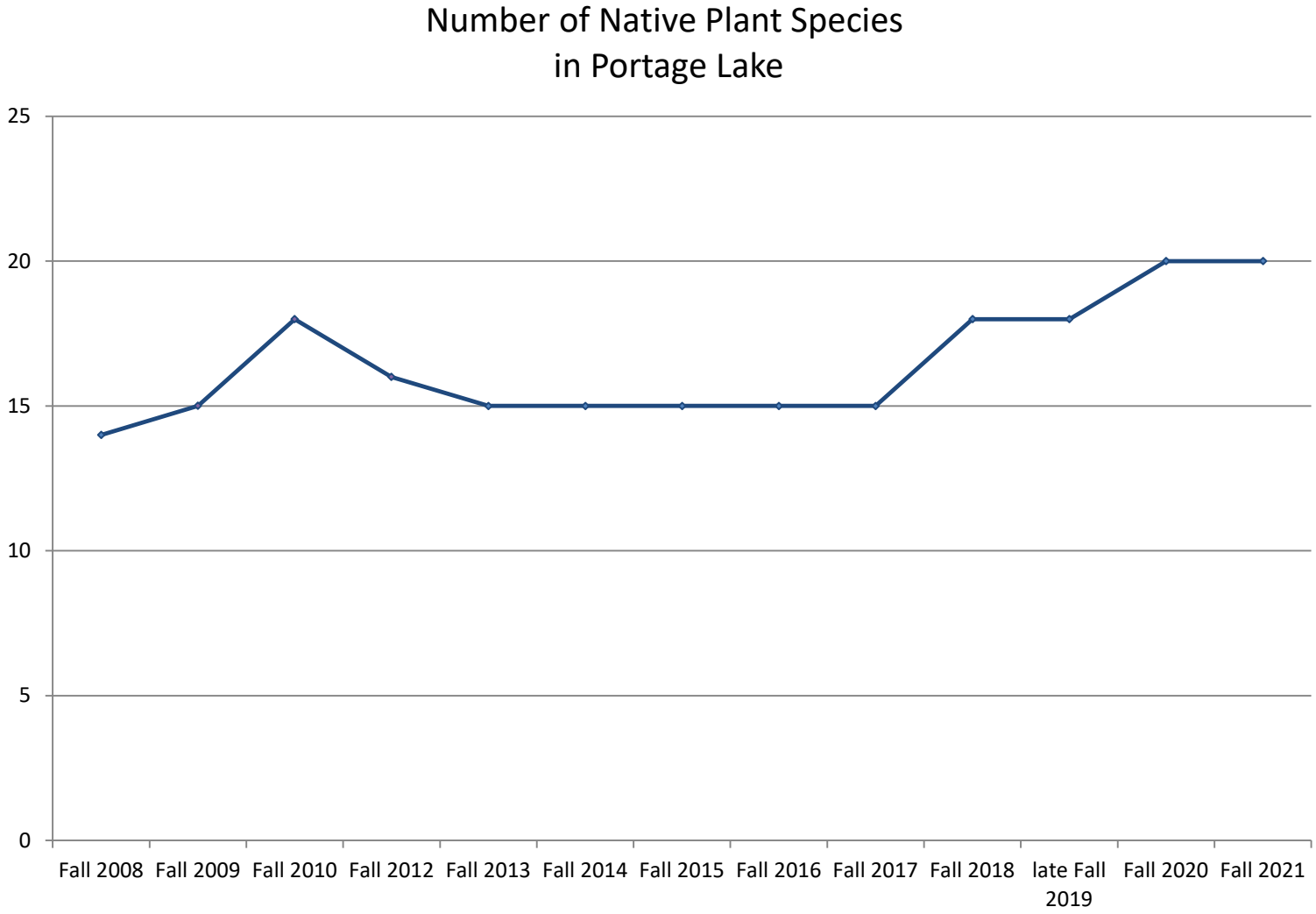
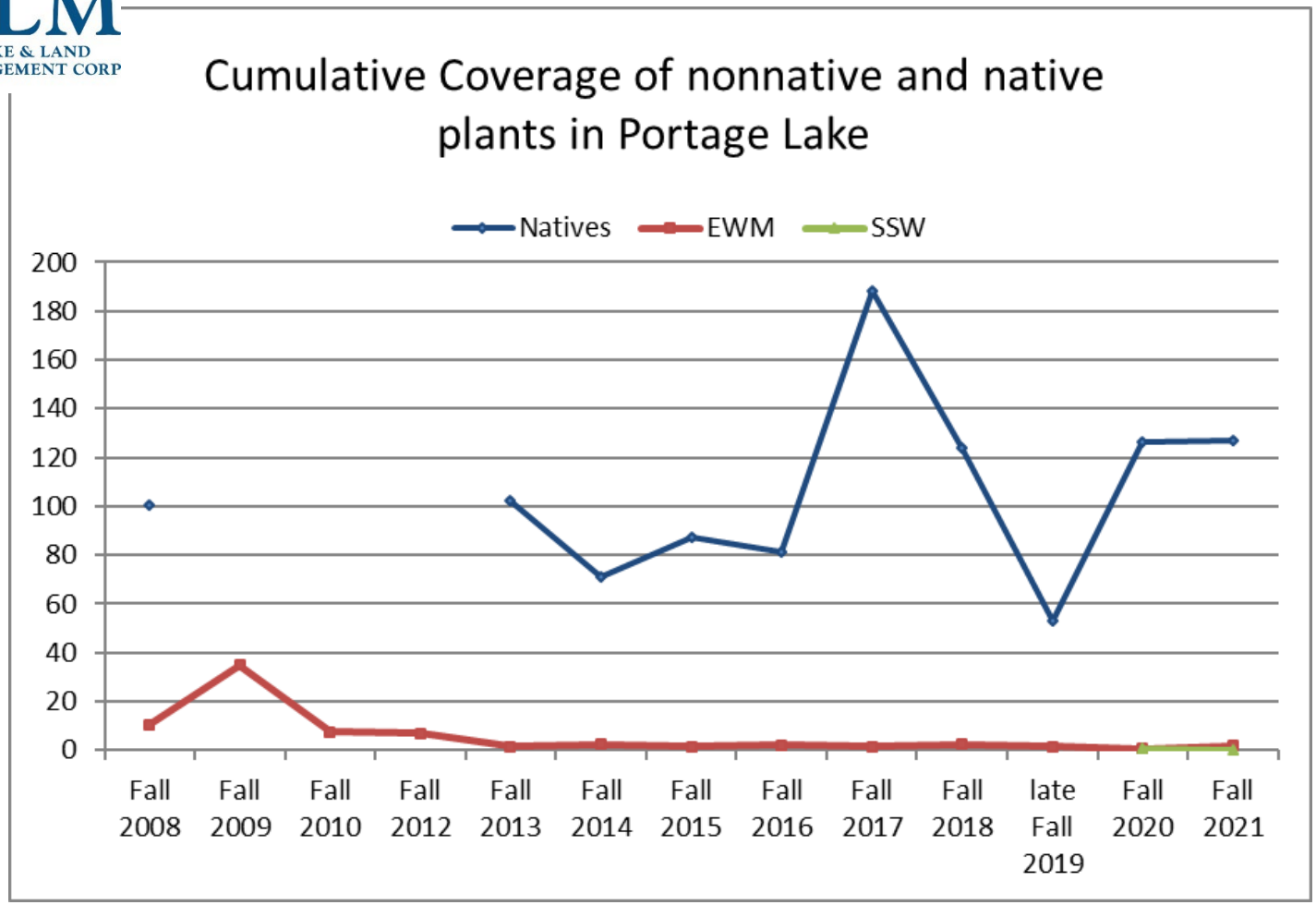
AVAS Data Graph





This graph shows the cumulative coverage of EWM, SSW & Native plants from 2008-2021. The overall decline in the presence of EWM from the start of the management program shows the success of the program and that the population is currently being maintained at very low levels. The 2019 survey found great diversity but lower density, likely contributed to the weather patterns and a cooler September than the previous few years when increases in plant growth were found. As thought in 2019, the 2020 densities increased, with a warmer fall and earlier survey. The native plant population will naturally vary from year to year based on weather, water depth and many other factors; but has been maintained during the management of EWM.

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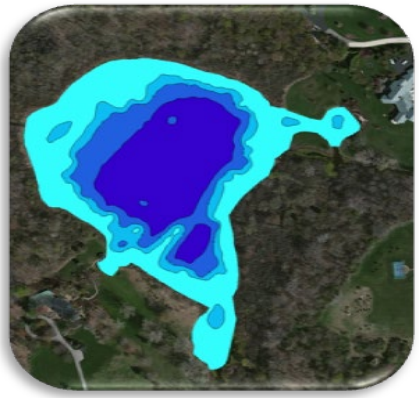
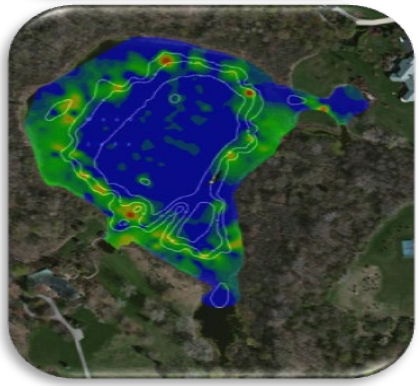
Biobase Mapping





- Mapping of the lake offers different interpretations of plant coverage
- Portage Lake has had numerous Biobase surveys completed, by citizen scientists in the past
  - Included to educate on previous work compiled as part or program
- Ability to quickly collect precise
  - Bathymetry (depth contours)
  - Vegetation Biovolume
  - Bottom Hardness

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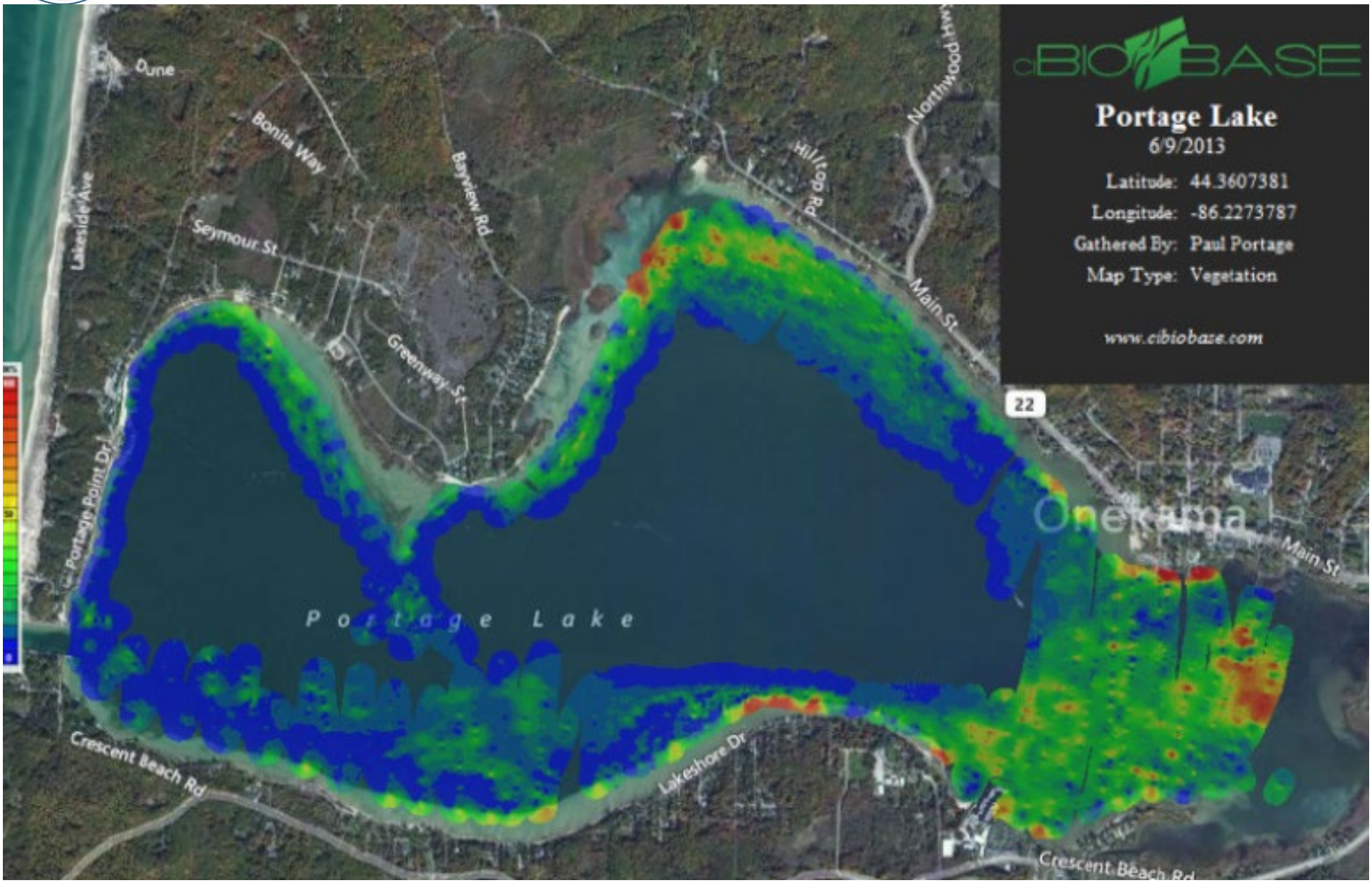

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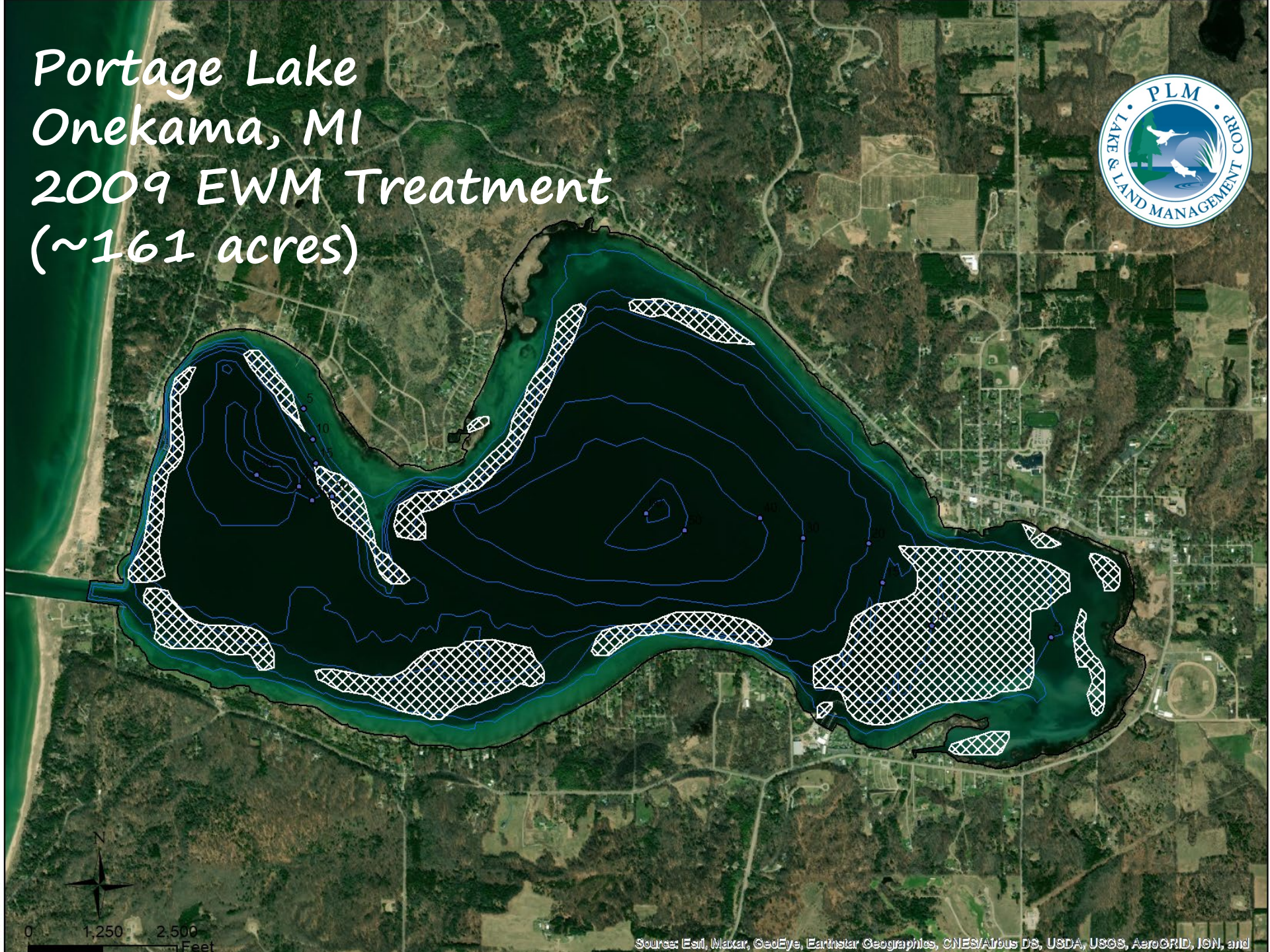
Portage Lake Treatment Areas

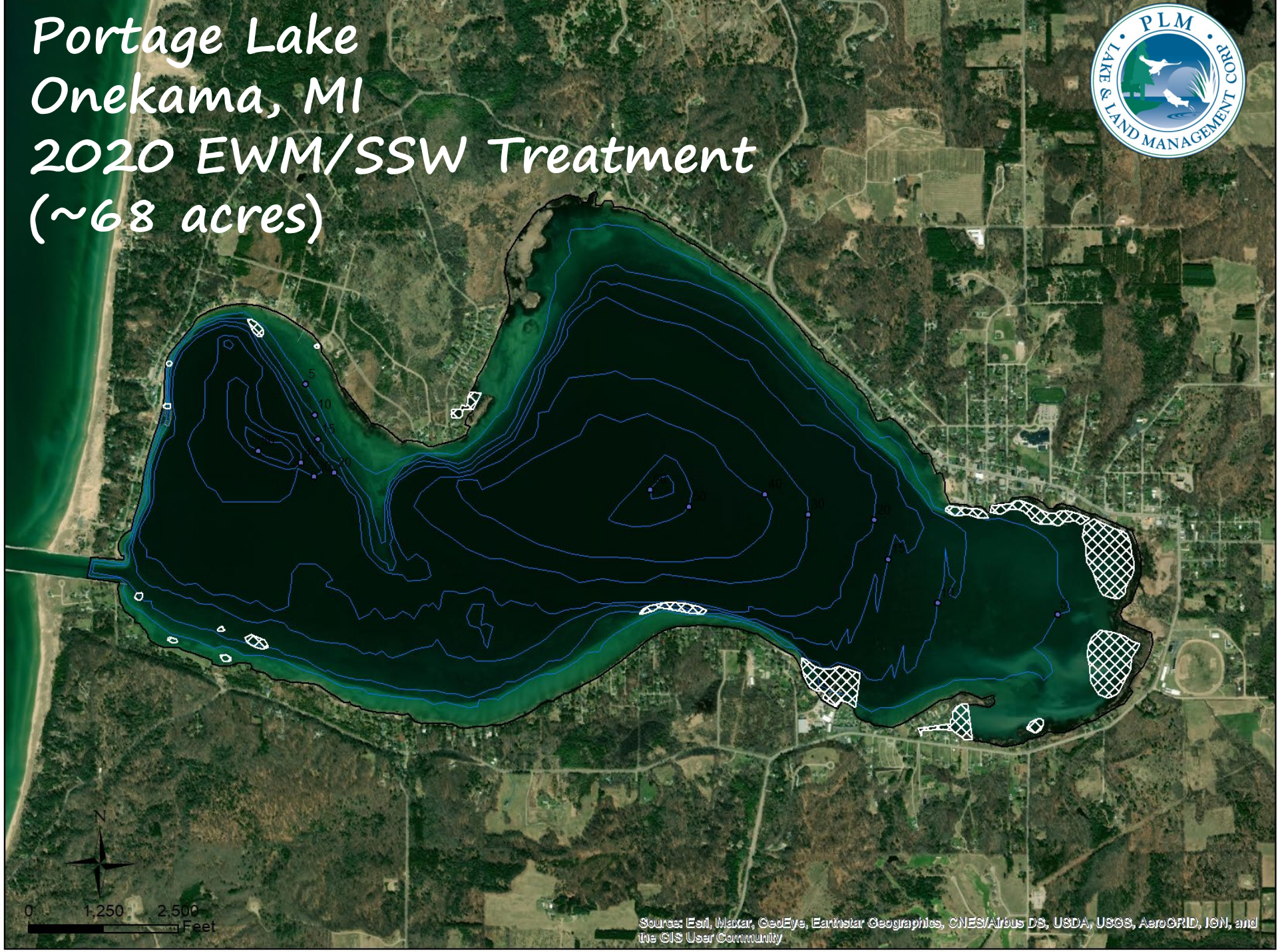
- Historical overview of treatment maps
- Original infestation from 2009
- 10 years later - 2018 treatment areas
- Latest maps: 2020 and 2021
- Beneficial for reviewing areas of concern and changes in the coverage of EWM within the lake

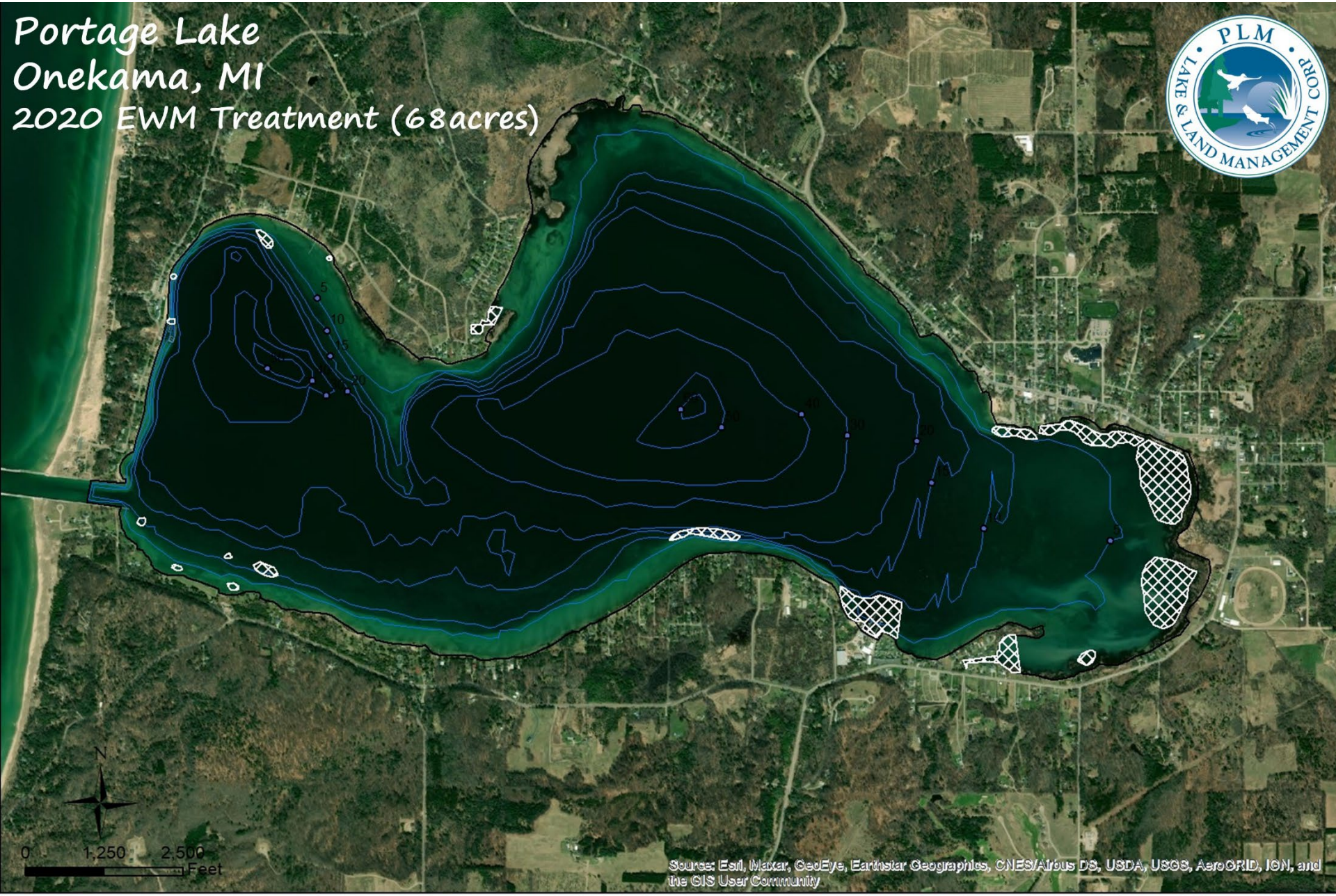
Portage Lake
Onekama, MI
2009 EWM Treatment
(~161 acres)



Portage Lake
Onekama, MI
2018 EWM Treatment (49.5 acres)

Portage Lake
Onekama, MI
2020 EWM/SSW Treatment
(~68 acres)




Portage Lake
Onekama, MI
2020 EWM Treatment (68acres)
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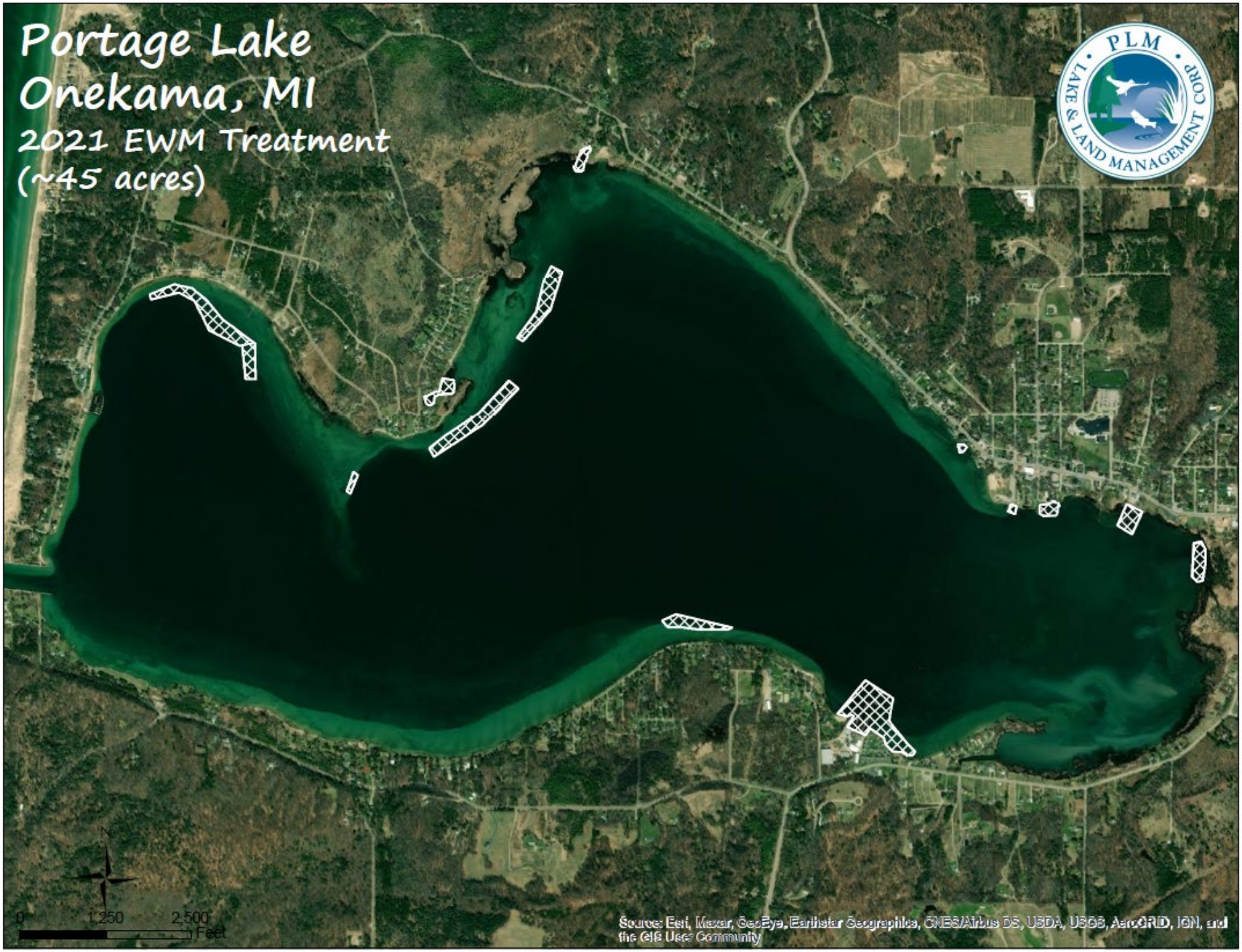
N
0
1,250
2,500
Feet
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Portage Lake
Onekama, MI
2021 EWM Treatment
(~45 acres)
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N
0
1,250
2,500
Feet
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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2022 Treatment Breakdown

- 50.65 acres of EWM/SSW Treated
- Less than 1/10 acre of Phrag
- Less than 2.5% of lake treated in 2022
  - Most years under 4%, most ever is still under 9%
  - In comparison to hundreds of other Michigan lakes, this is very small treatment program
- EWM treatment utilizes a new technology for EWM control, ProcellaCOR
  - ProcellaCOR has a reduced risk EPA rating, uses a new mechanism of plant absorption and designed as a selective herbicide for EWM control
- SSW treated with SeClear G
  - SeClear G is an algaecide to target and control SSW
    - Found to be most effective algaecide to control SSW
  - Has the ability to precipitate out Phosphorus as well, helping remove the food for algae growth.
    - Binds phosphorus in the water column, making it unavailable - phosphorus mitigation

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2022 Treatment Breakdown – in more depth

- Product weight/pounds/gallons is not “active ingredient”
- Sculpin G (2,4d) is 20% active with 80% inert (clay to help it sink) ingredients
- ProcellaCOR is 2.7% active
- Rates have increased with time due to hybrid plants
- Rates dependent on depth, various other factors.
- Total spent in 2022 (including management): $48,565.50 ($83,600) ~58%

	Product	Rate lbs/Acre	Acres	Total Product	% active ingredient	Total active used	Price	Total Price
17-Jun	Aquathal K	1gal	6.5	6.5gal	40.30%	2.6195gal	$9,286.75	
12-Aug	ProcellaCOR/Diquat	4pdu/1gal	1.5	6pdu/1.5g	2.7%/ 37.3%	0.51ou/0.55gal	$862.50	
	ProcellaCOR/Diquat	5pdu/1gal	16	80pdu/16g	2.7%/ 37.3%	6.84ou/5.96gal	$10,800.00	
	Sculpin G	300lbs	22.4	6720lbs	20%	1344lbs	$18,480.00	
	SeClear G	50lbs	4.25	212.5lbs	58.90%	125.16lbs	$1,275.00	$40,704.25

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Inert and/or proprietary ingredients

- To attain USEPA registration on a product, under FIFRA (Federal Insecticide, Fungicide and Rodenticide Act)
  - USEPA highly reviews all components of a product, sources of components and how/where it is made
  - This is listed on the CSF (confidential statement of formula) that is summitted with the registration process
  - QAQC (quality assurance/quality control) standards met with every batch
- State Registrations, especially in MI, provide many more levels of scrutiny
  - MDARD (Michigan Department of Agriculture and Rural Development) and ANC EGLE (Aquatic Nuisance Control Department of Environment, Great Lakes and Energy) each independently reviews the product including the CSF which is transparent of all ingredients, including proprietary ones
- In the case of SeClear G, it is further and separately reviewed and certified as to NSF (National Science Foundation) ANSI (American National Standards Institute) standard 60 certification (drinking water) by the Water Quality Association to support it's use in potable water supplies
  - This entity also knows all propriety ingredients, sources and how it is made.
  - Annual inspections of facilities where product is made to ensure no contamination is occurring.
- What this means
  - All components are highly reviewed and scrutinized
  - So why aren't all components listed on the label then?
    - To protect intellectual property from generic and copycat companies – especially ones that may not use the same standard of production

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Understanding herbicides

- Ideally, herbicides would not be required
- Products are re-registered every 10 years, costing millions of dollars each time
- Aquatics has a very small market and very few products as compared to agriculture
- Michigan has its own approval process for each specific product, not just active ingredient, but each trade name (this procedure in itself can take months to years)
- MDARD oversees applicators in addition to EGLE Permits/oversight
- Herbicides are designed to attack the chlorophyll of the plant (the green part that makes it grow). Only plants have chlorophyll.

EPA Registration Process: By the Numbers

- **8 to 10 years** – average duration of entire development and testing process for each new pesticide
- **$150 to $185 million** – average cost of testing, evaluation, EPA registration, and label approval
- **1 in 140,000** – number of potential products that successfully makes it from the lab to the market

The Label is the Law

- EPA oversees label development for each registered product
- Label contains explicit directions for use
- Additional tests and re-registration are required
- Use of a product in a manner not specified on the label is <u>against the law</u>

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The Dose Makes the Poison

- Prescription drugs (antibiotics) are therapeutic if taken in small doses, but can be dangerous if abused or taken in overdose proportions.
- Pesticides, like antibiotics are effective when used in the right circumstances, but can become a threat to the environment or even human health if improperly used.

Less Toxic	**LDC/50 mg/kg**
Fluridone	10,000
Glyphosate	5,600
Table Salt	3,000
Triclopyr	2,574
Aspirin	1,000
2,4-D	300 – 1,000
Copper Sulfate	300
Diquat	230
Caffeine	192
Nicotine	53
Sodium Cyanide	6.4
Most Toxic	

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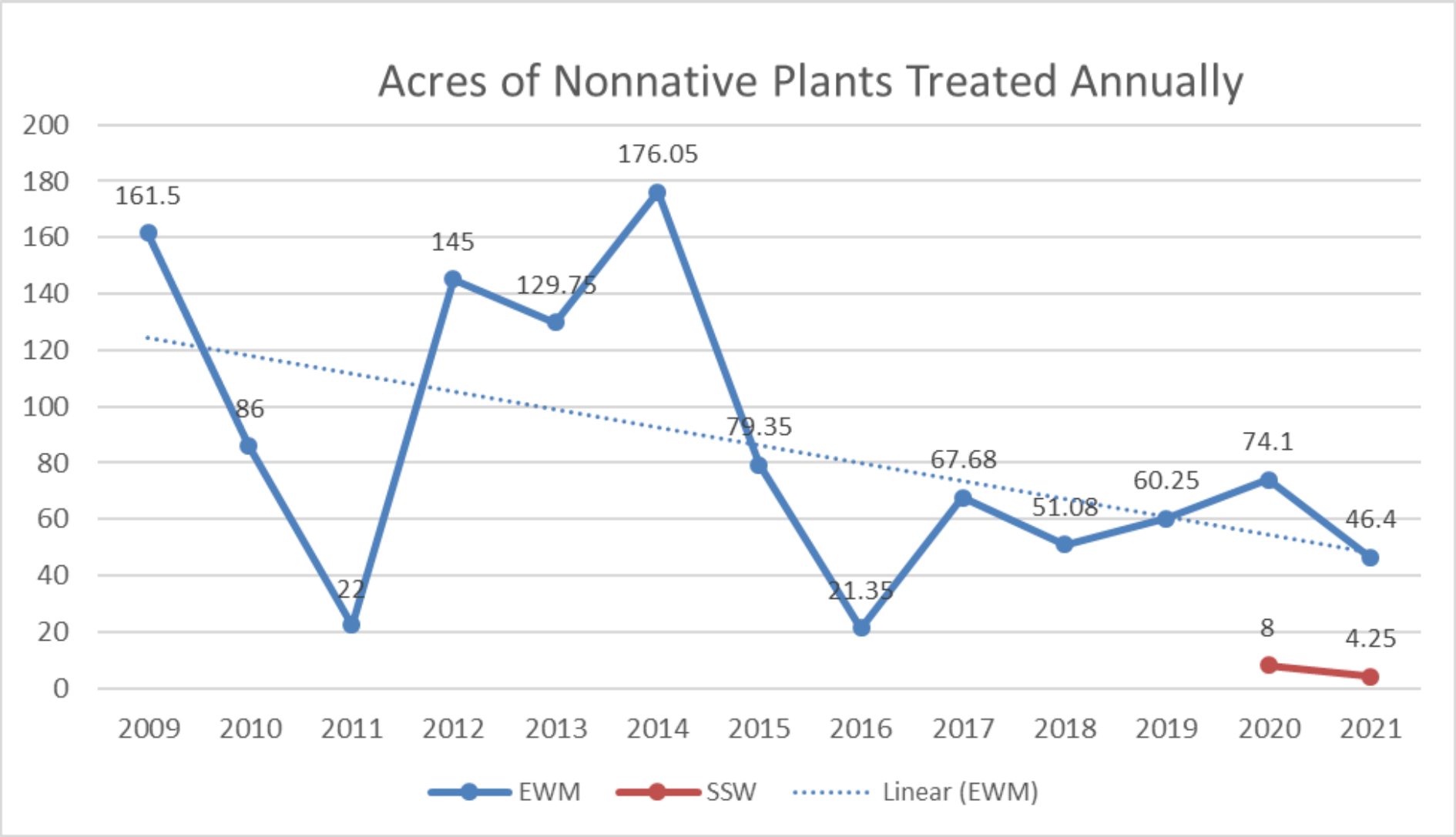
Portage Lake

A look back at the acreage treated annually



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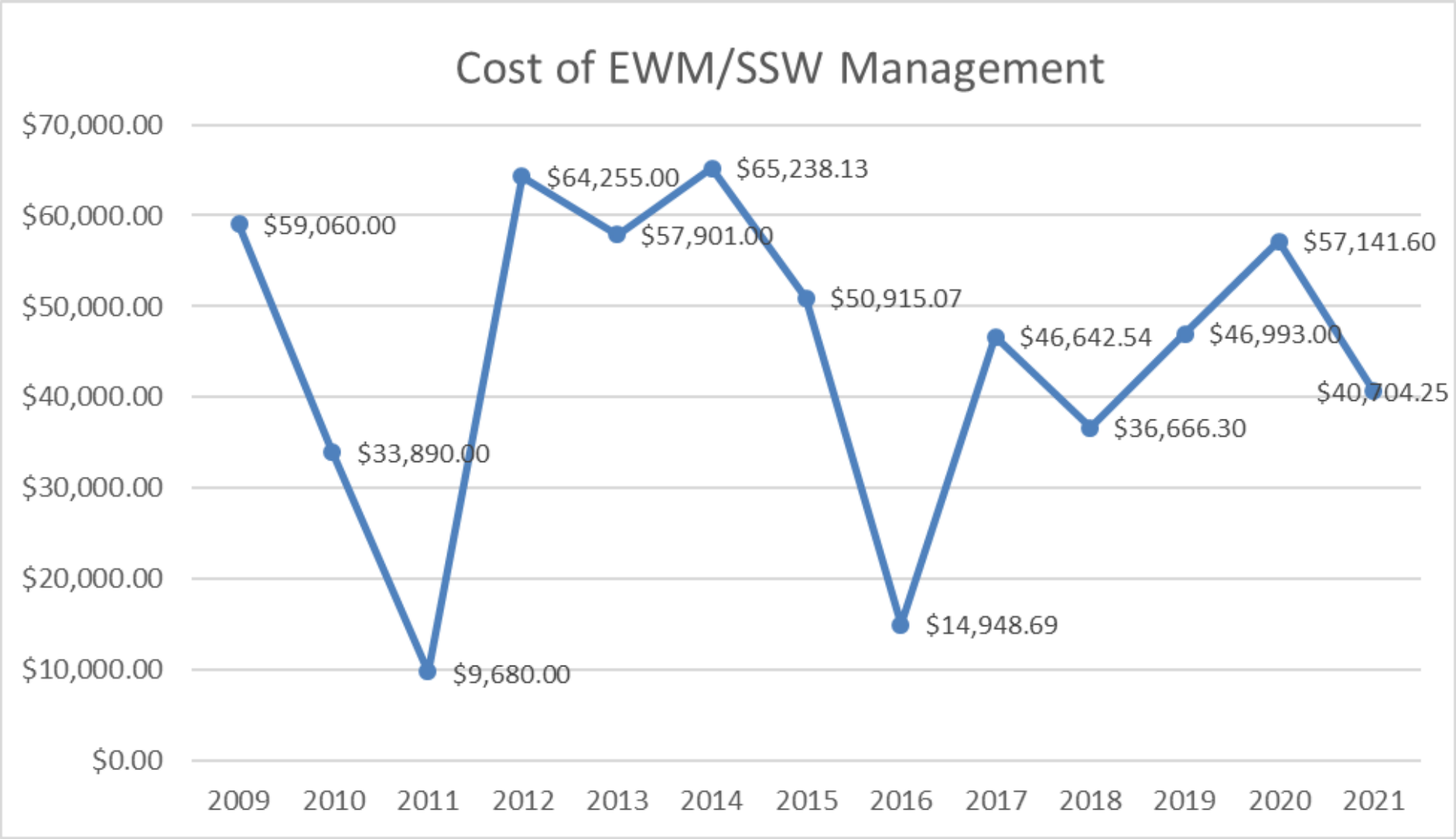
Portage Lake

A look back at the cost of treatment annually



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Portage Lake Water Quality

- Portage Lake has one of the most advanced water quality programs in the State of Michigan
- Designed by Dr. Herb Lennon, limnologist with assistance from numerous other limnologist and consultants/consulting firms
- Has been modified some in recent years and is always open for new direction
- Important in making management decisions and understanding the impacts of human interaction on the lake (watershed) and why and how the lake is changing.
- Program
  - Tributary testing - 7 sites (2x/year)
  - Storm Drains - 4 sites (1x/year)
  - Deep holes – 2 sites (3x/year)
  - Shoreline sites – 3 sites (3x/year)
  - E.coli- ~5 sites/year in addition to Health Dept. testing
  - Numerous parameters tested
  - All raw data is in the LMP! Graphs next of top paramaters

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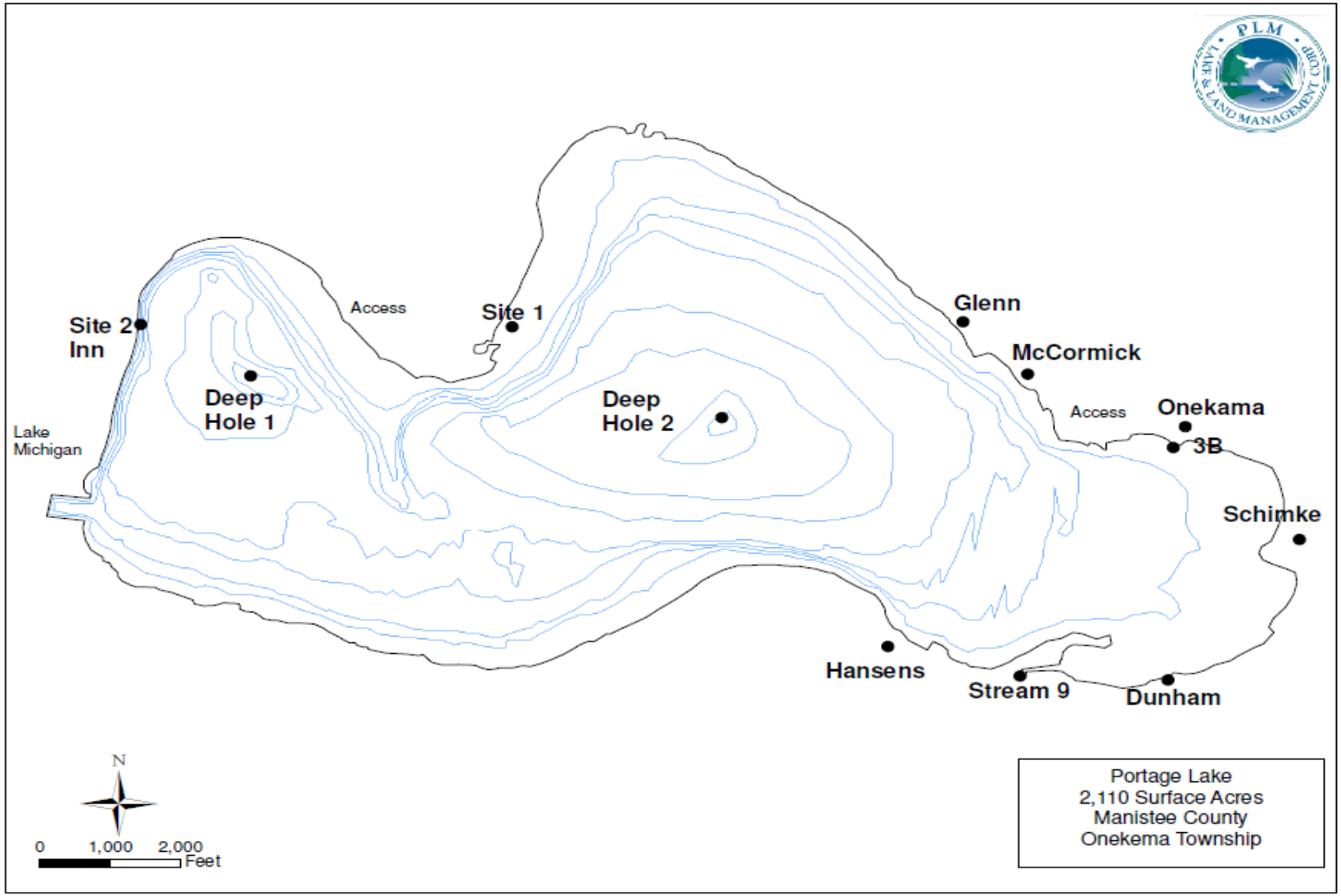
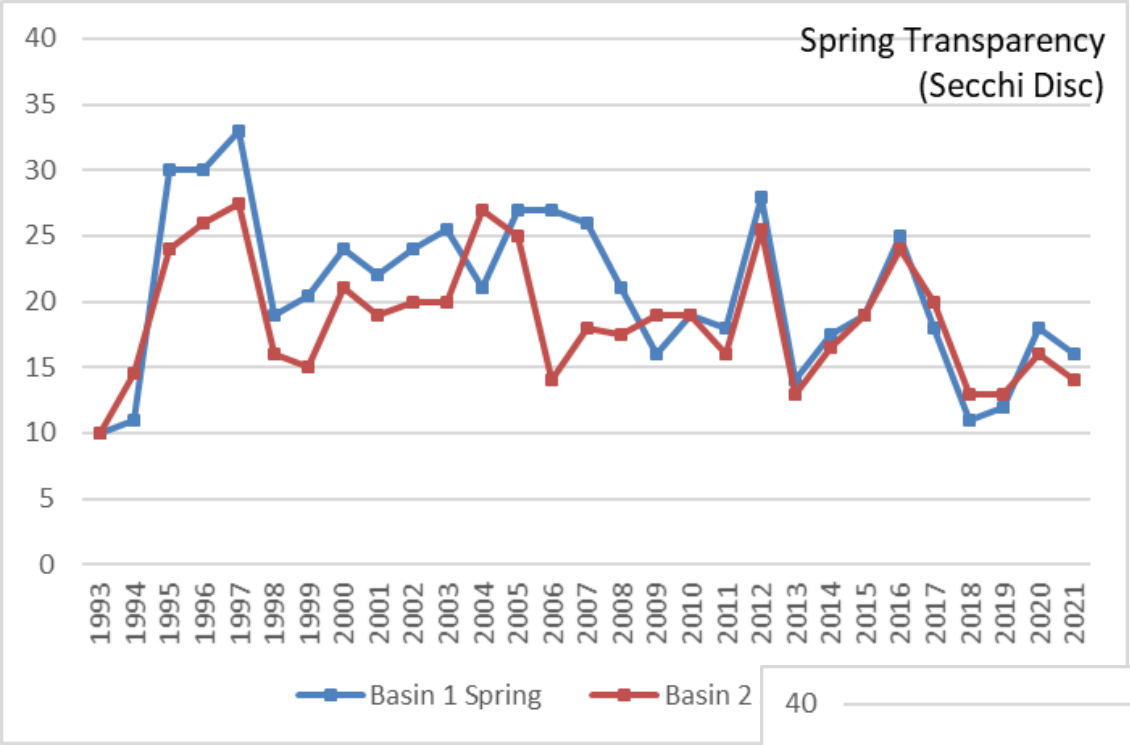
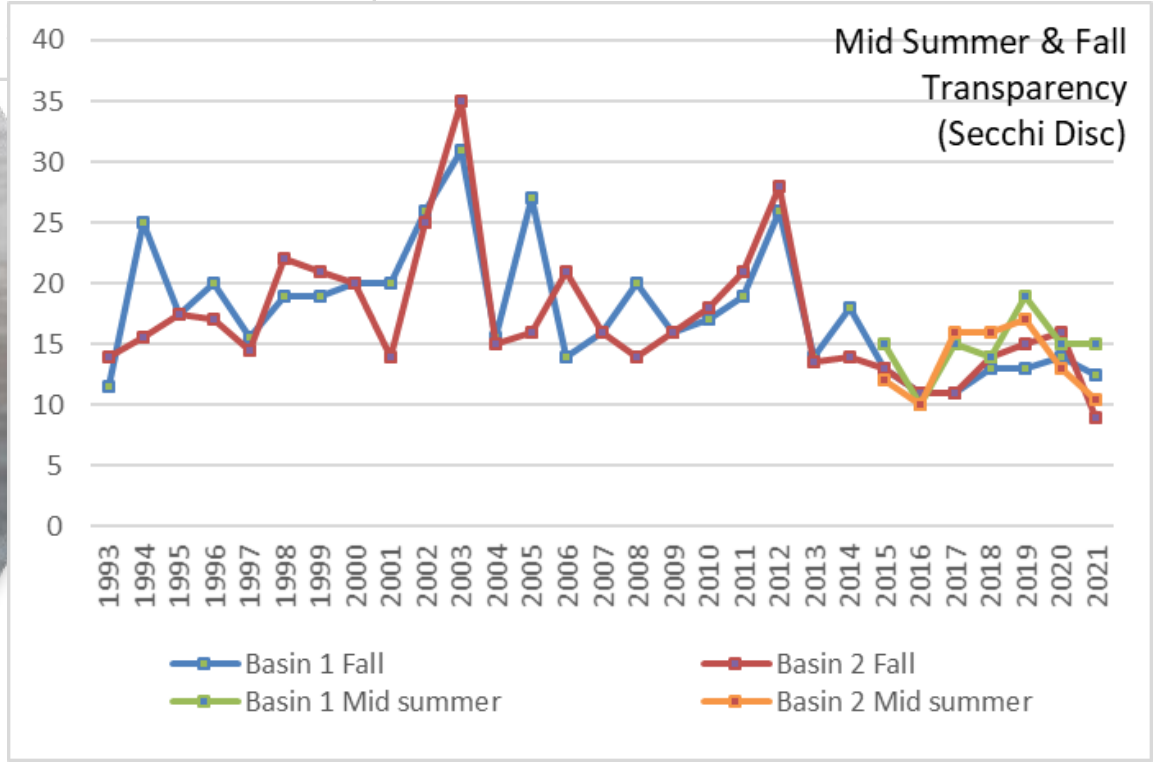
Portage Lake Water Quality Map



Secchi Disc



- Numbers can vary daily/weekly
- Basin 2 more impacted by lake fetch (wind)
- Huge variance since 1993, relatively consistent recently



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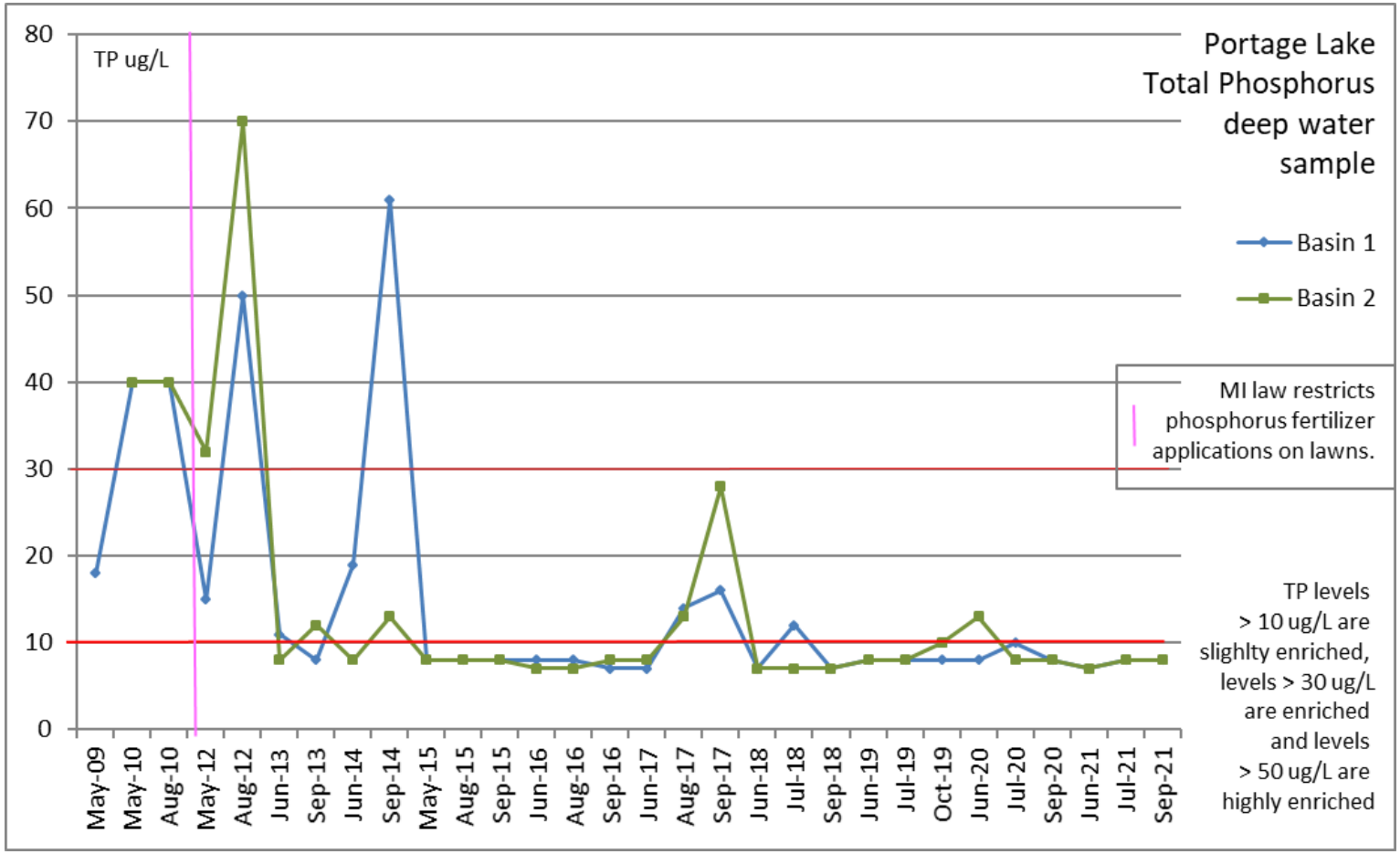
Total Phosphorus

Total phosphorus measures the total amount of phosphorus in the water. Phosphorus is an important plant nutrient (i.e., fertilizer) and the nutrient most likely to limit algal growth. Phosphorus levels are not only related to internal loading of nutrients but also from external sources. Elevated phosphorus inputs to lakes caused by human activities are a major cause of cultural eutrophication. Readings above 10 µg/L are considered slightly enriched while readings over 30 µg/L are considered enriched.



- There have been a few spikes in TP over time but generally speaking, the bottom waters of Portage Lake are not classified enriched based on the sampling in recent years.
- Note: Basin 2 May 2009 sample is not graphed as the reading of 340 ug/L is an extreme outlier and not reflective of the overall lake results.

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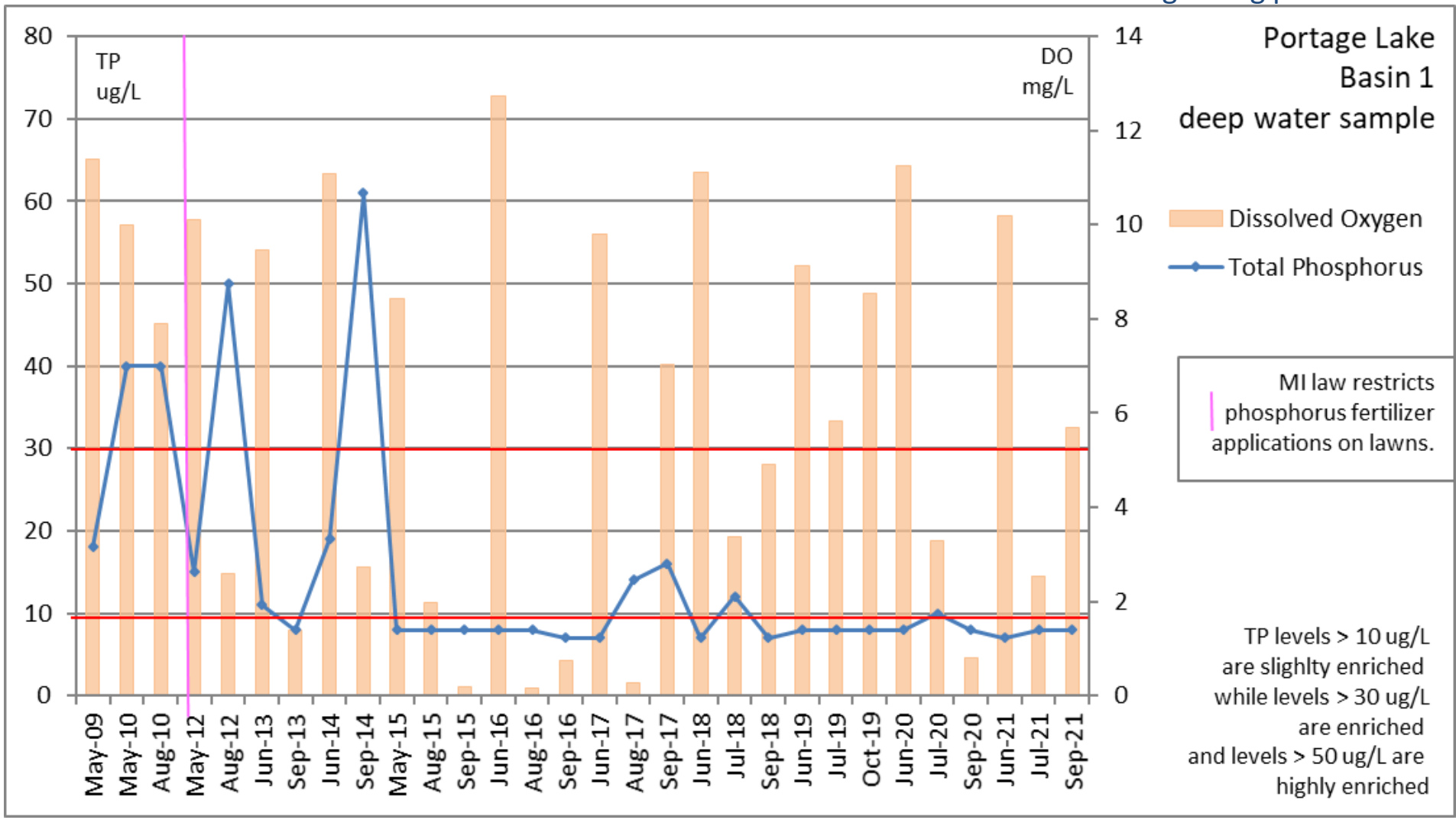
Basin 1 Total Phosphorus with Dissolved Oxygen

Looking at the trend line, Basin 1 has higher DO levels during mid to late summer months than Basin 2. Higher DO levels are better. Internal loading (spikes in TP) can take place when DO levels decrease. There is no indication of internal loading taking place.



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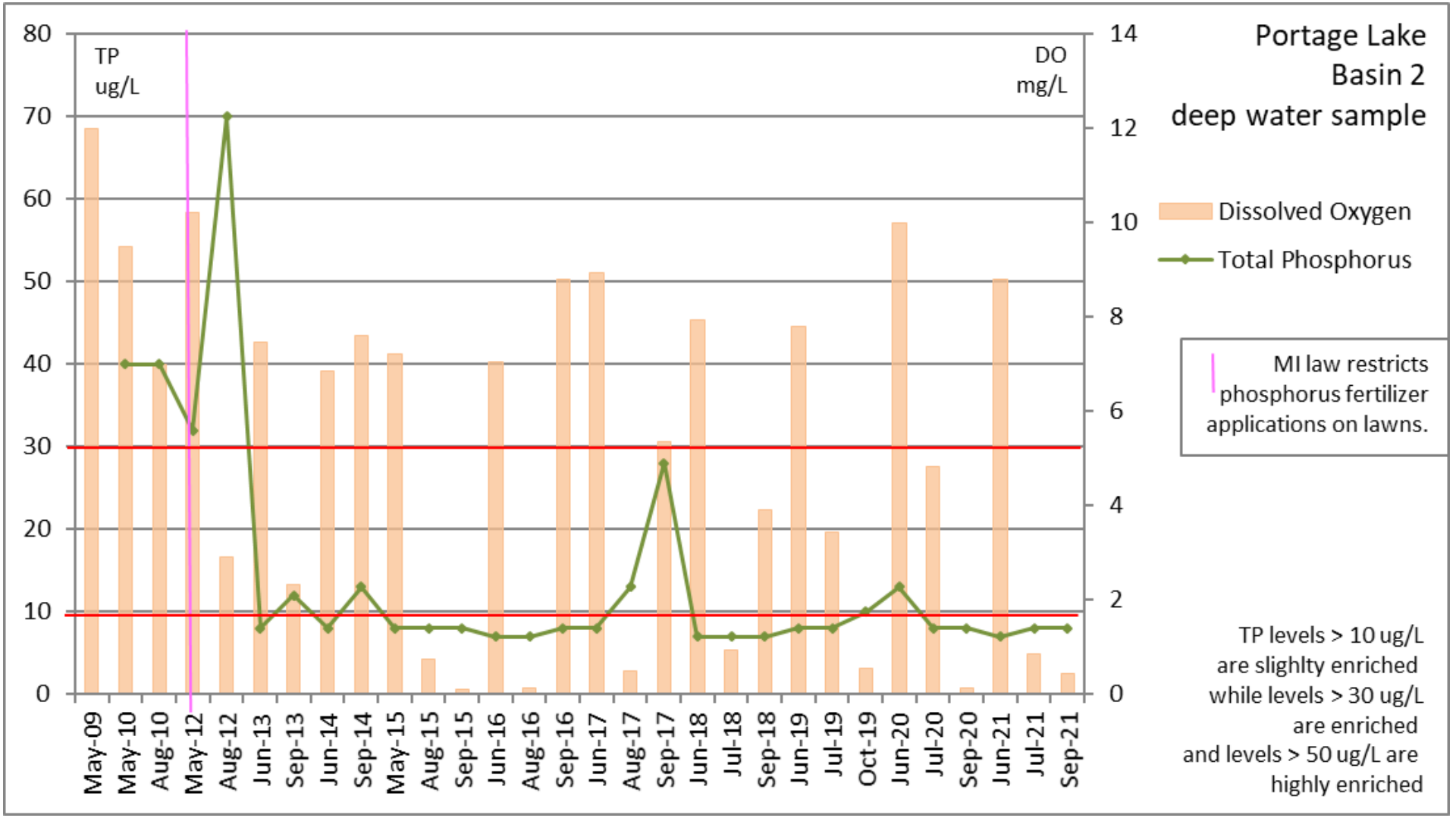
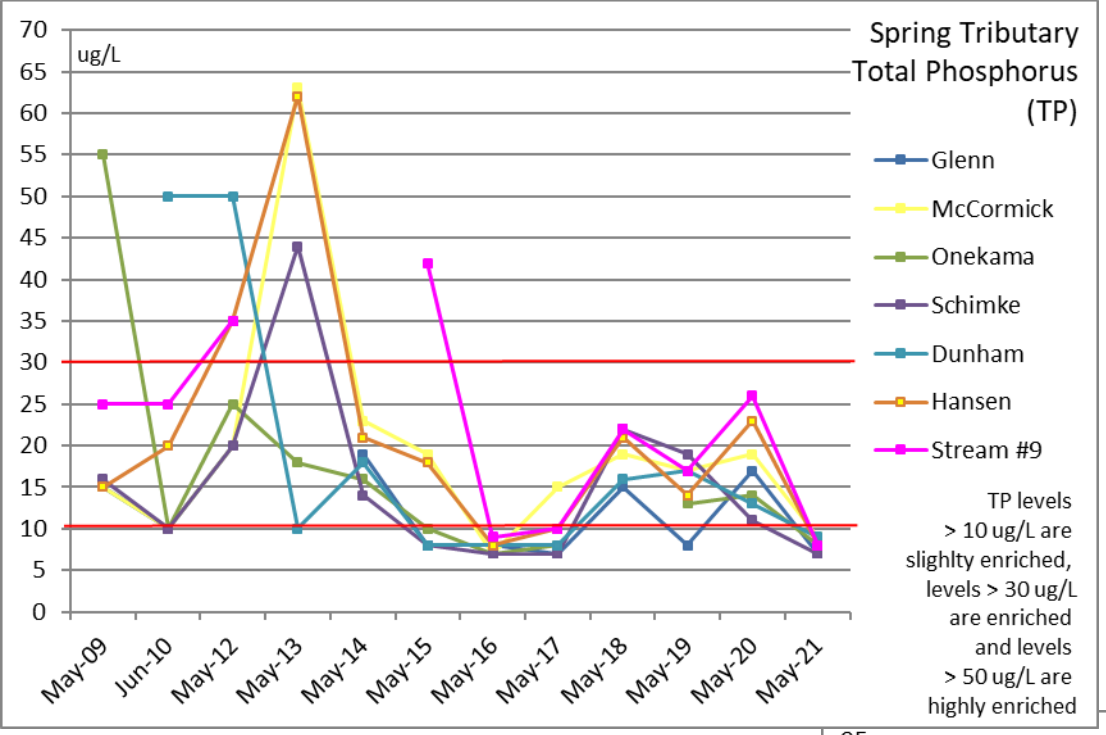
Basin 2 Total Phosphorus with Dissolved Oxygen

Looking at the trend lines, DO has consistency declined in the mid to late summer months, leading to anoxic conditions. However, TP levels have stayed low; which is an excellent sign. There is no indication of internal loading in Basin 2.





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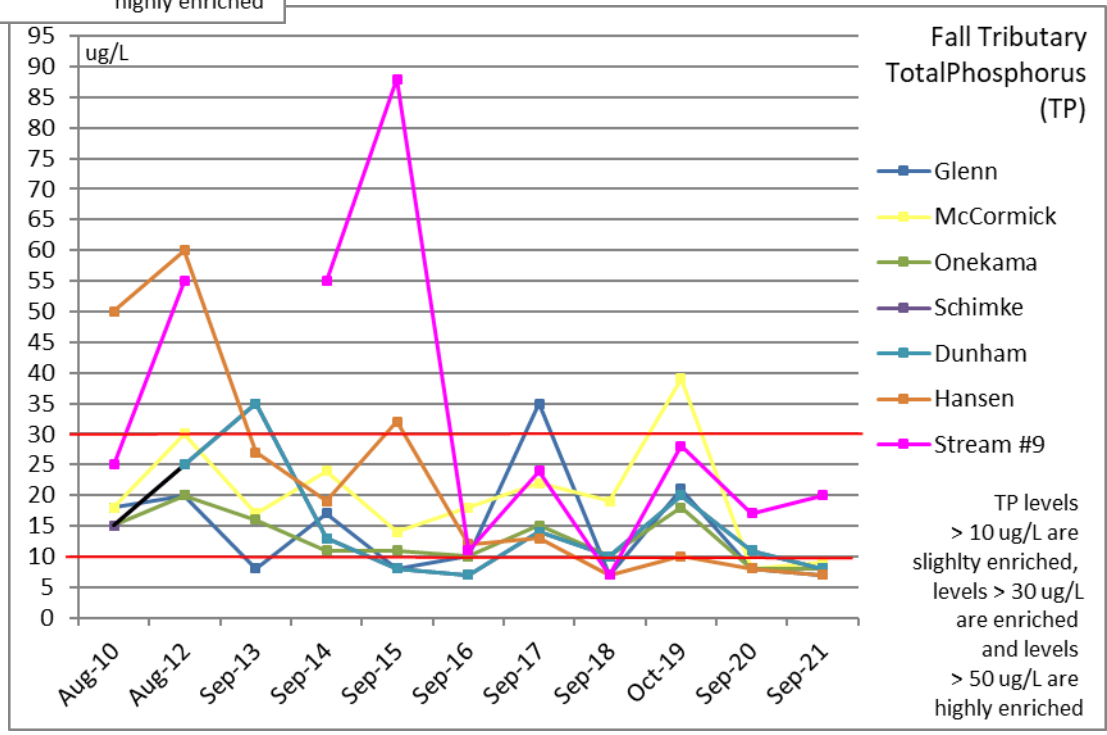
Tributary Total Phosphorus

As these graphs illustrate, there are fluctuations between the creeks over time.

Glenn Creek May 2013 sample was removed from this graph as an extreme outlier, likely from a contaminated sample. Stream #9 was not sampled in 2013.



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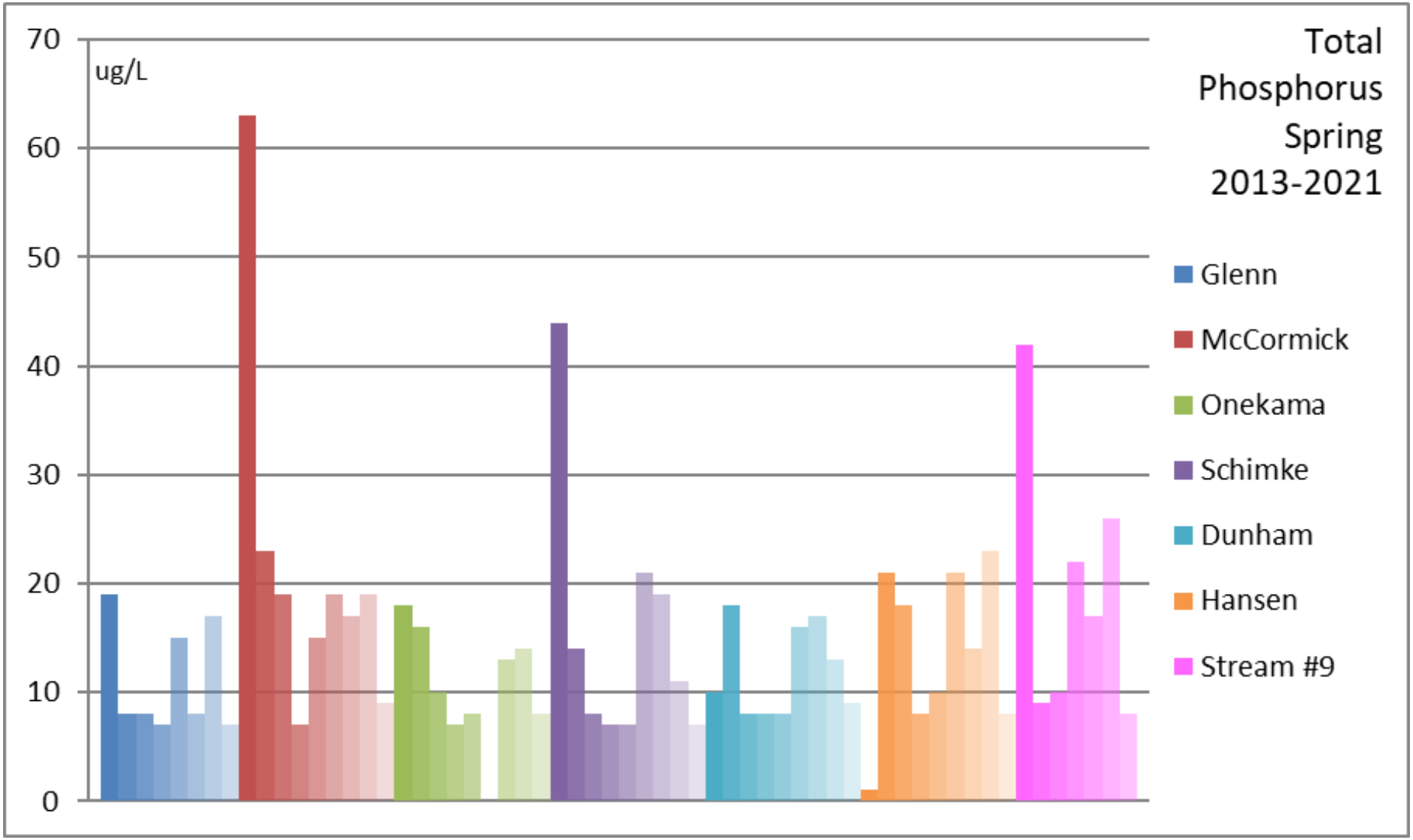
Tributary Total Phosphorus



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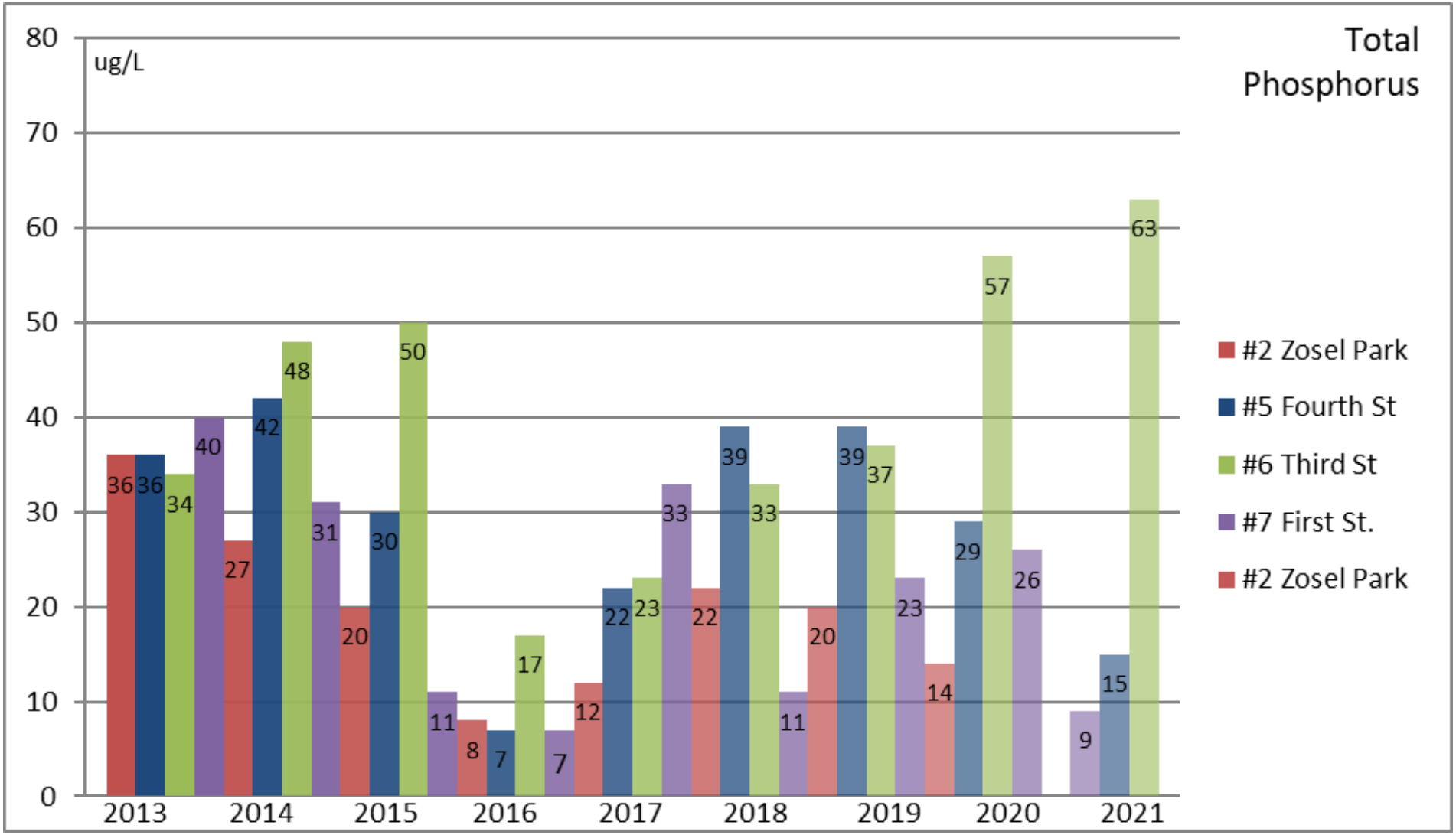
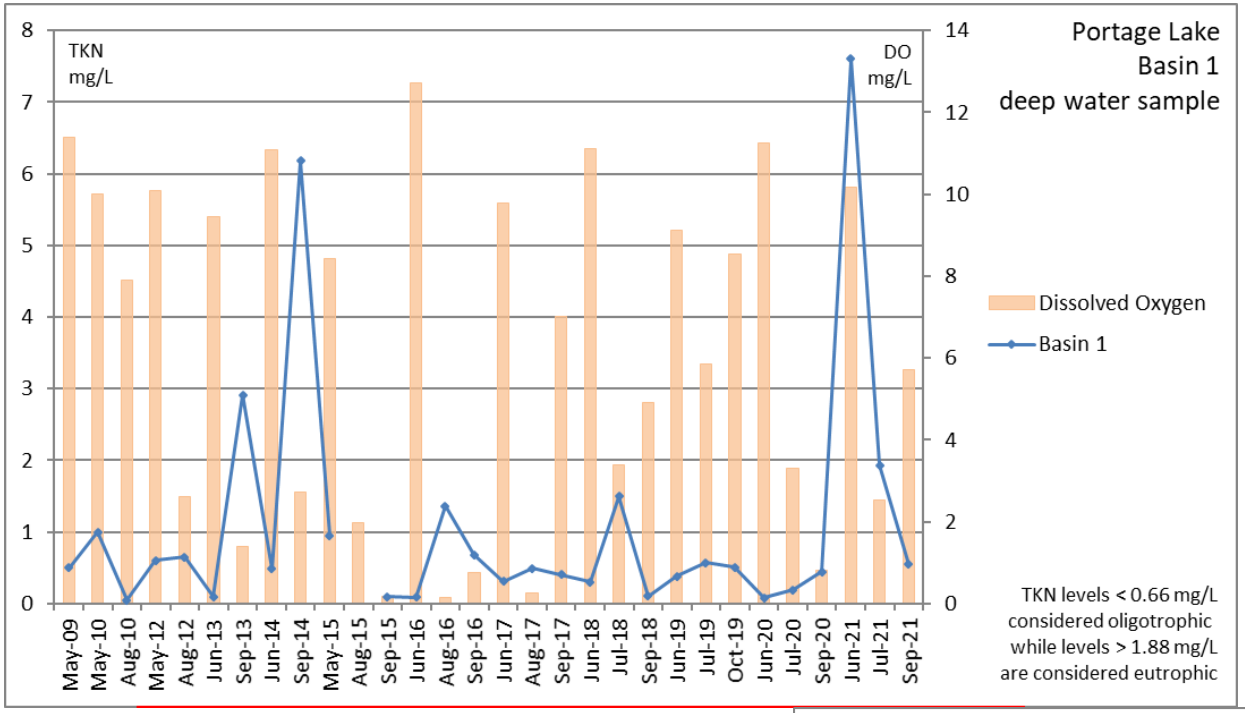
Storm Drain Total Phosphorus



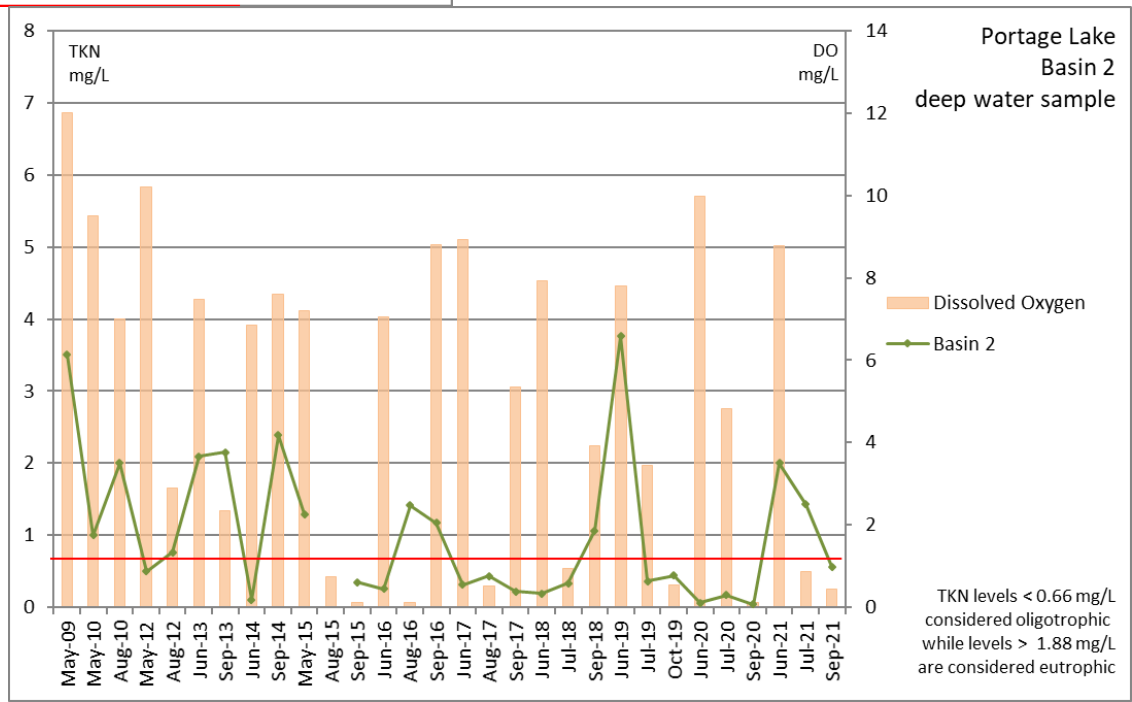
Total Kjeldahl Nitrogen (TKN)

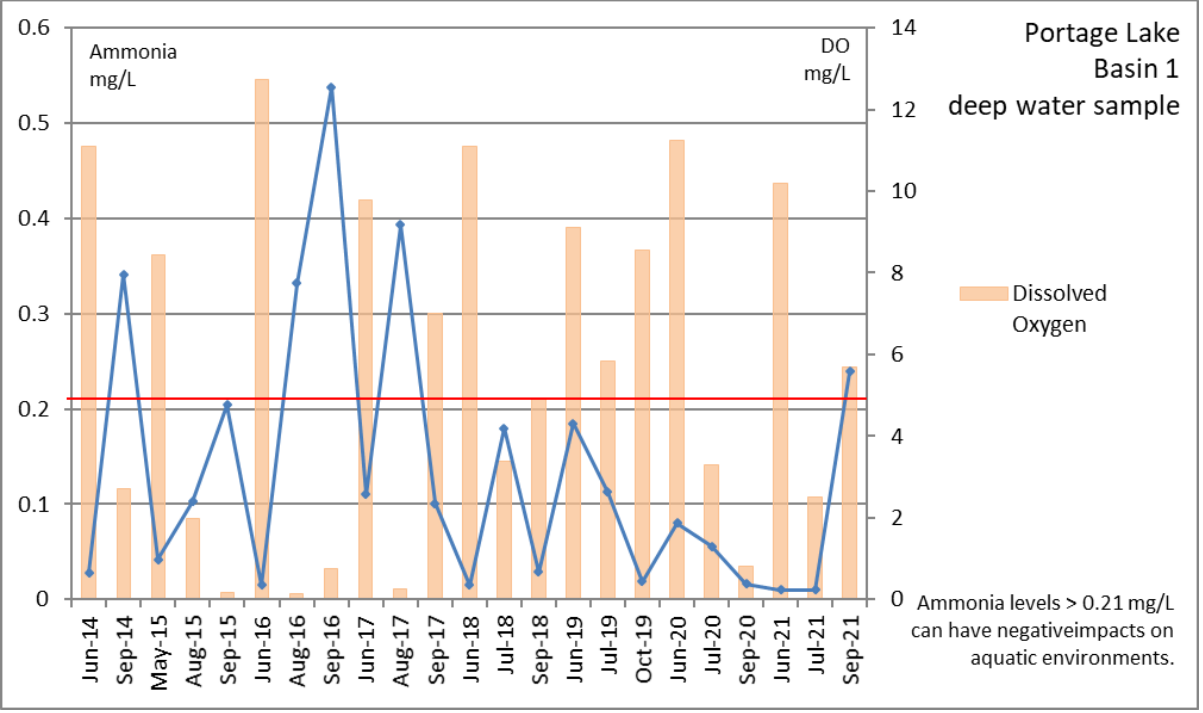


- Lakes with a TKN value of 0.66 mg/L or less are typically classified as oligotrophic lakes (having fewer nutrients, less productivity).
- Lakes with TKN values above 1.88 mg/L may be classified as eutrophic (highly productive and nutrient rich).

TKN measures the total organic amount of nitrogen (nitrate and nitrite) and ammonia in the water. Nitrogen is the plant nutrient most likely to control the amount of rooted plant growth in lakes. Most Midwestern lakes have more nitrogen and more rooted plant growth than is desirable, so lower values are generally considered better. The major sources of nitrogen in lakes are from agriculture (animal waste, fertilizer) and atmospheric emissions (fossil fuel).

Nitrates do not accumulate very much in the bottom waters during the summer because when nitrate is void of oxygen it turns into ammonia. Therefore, ammonia testing is an excellent way to determine internal loading of nitrogen.





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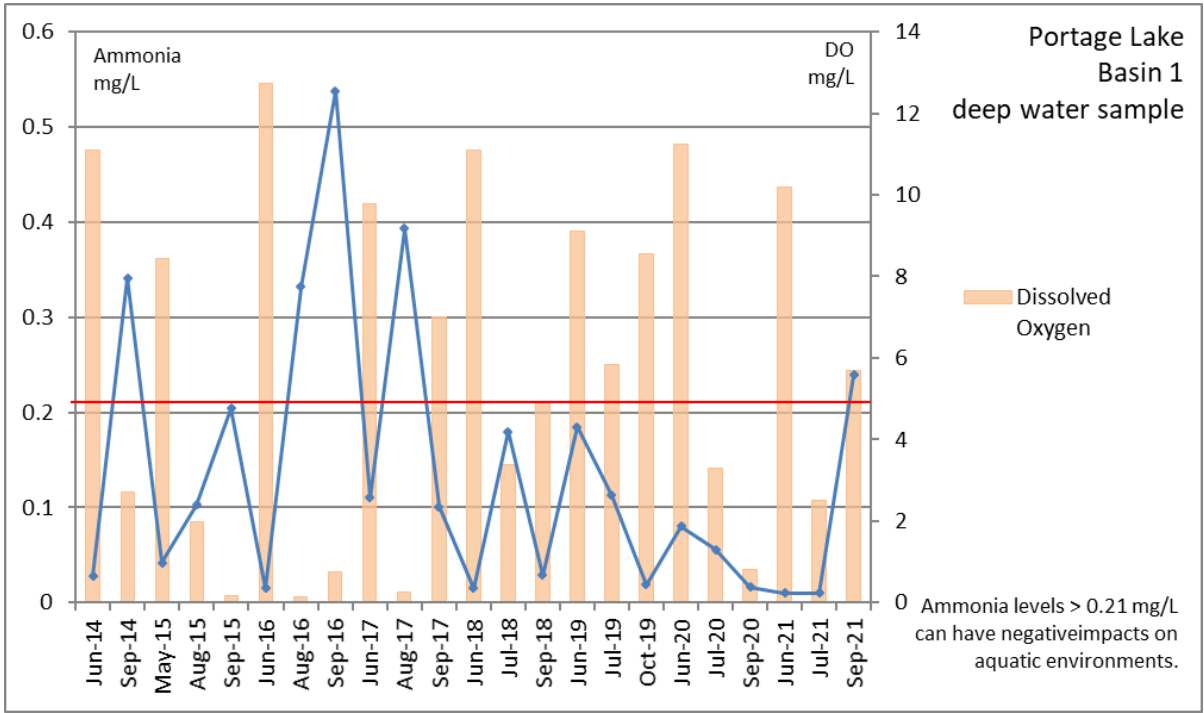
Ammonia

Ammonia is a form of nitrogen found in organic materials, sewage, and many fertilizers. It is the first form of nitrogen released when organic matter decays. Also, when ammonia degrades it consumes oxygen, which worsens already existing anaerobic conditions. However, ammonia can be used by most aquatic plants and is therefore an important nutrient. When oxygen is present in a lake ecosystem, ammonia will convert to nitrates.

Ammonia concentrations below 1 mg/L (or 1000 ug/L) are generally considered suitable for healthy fisheries; however, Ammonia concentrations can have impacts on aquatic organisms at lower levels. Michigan EGLE includes standards in part 4 (Water Resources Protection, Water Quality Standards) that ammonia shouldn't exceeded the Aquatic Maximum Value (AMV) threshold of 0.21 mg/L (210 ug/L) in which they feel negative impacts can occur in aquatic communities. Further, the Final Acute Value (FAV) shouldn't exceed a concentration of 0.42 mg/L (or 420 ug/L) where short term exposure can lead to negative impacts on aquatic organisms. Ammonia concentrations usually do not become elevated until water is void of oxygen and the nitrates are converted. Therefore, concentrations of Ammonia do not become elevated until anaerobic conditions are present, typically mid-summer.



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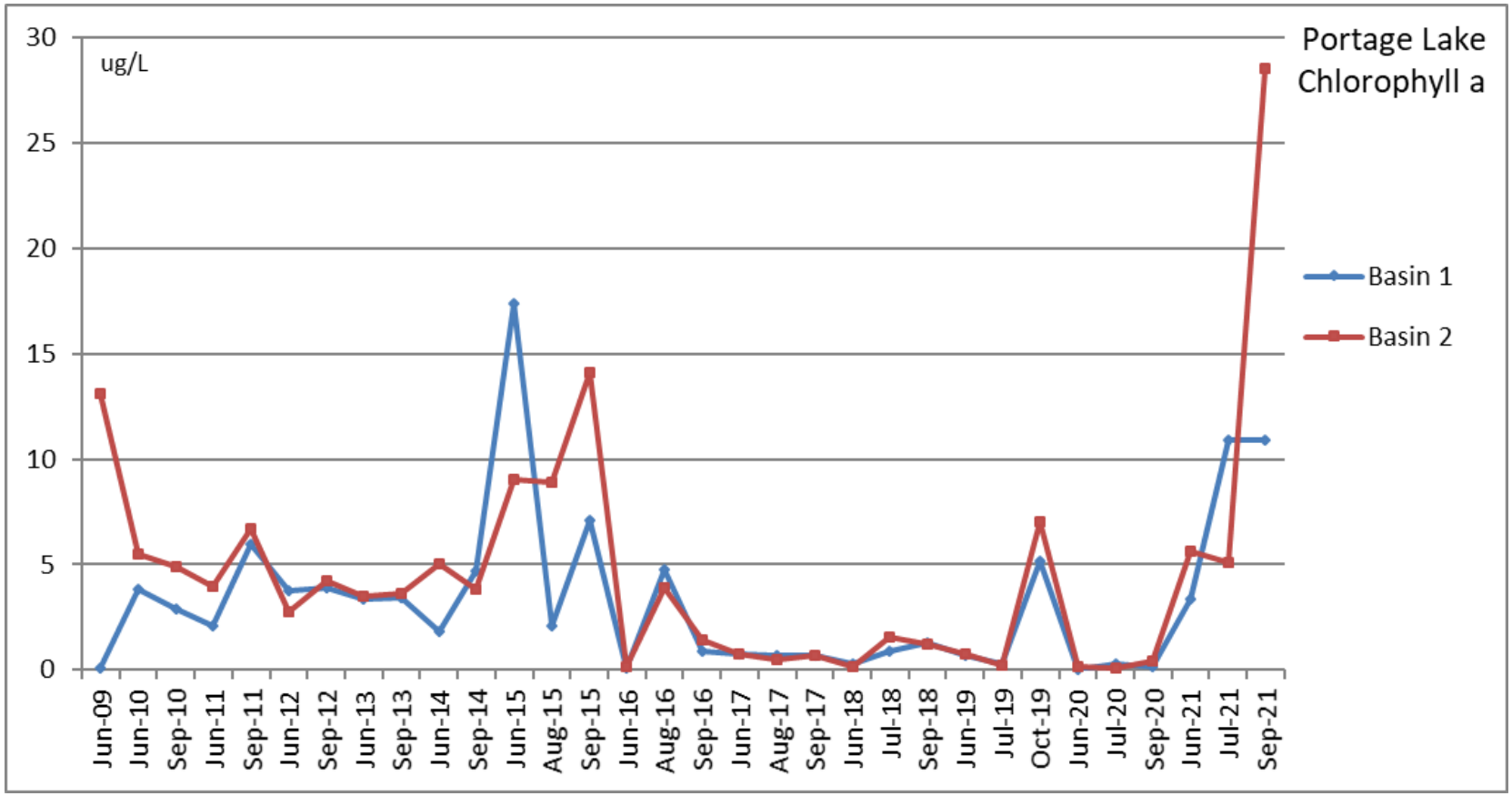
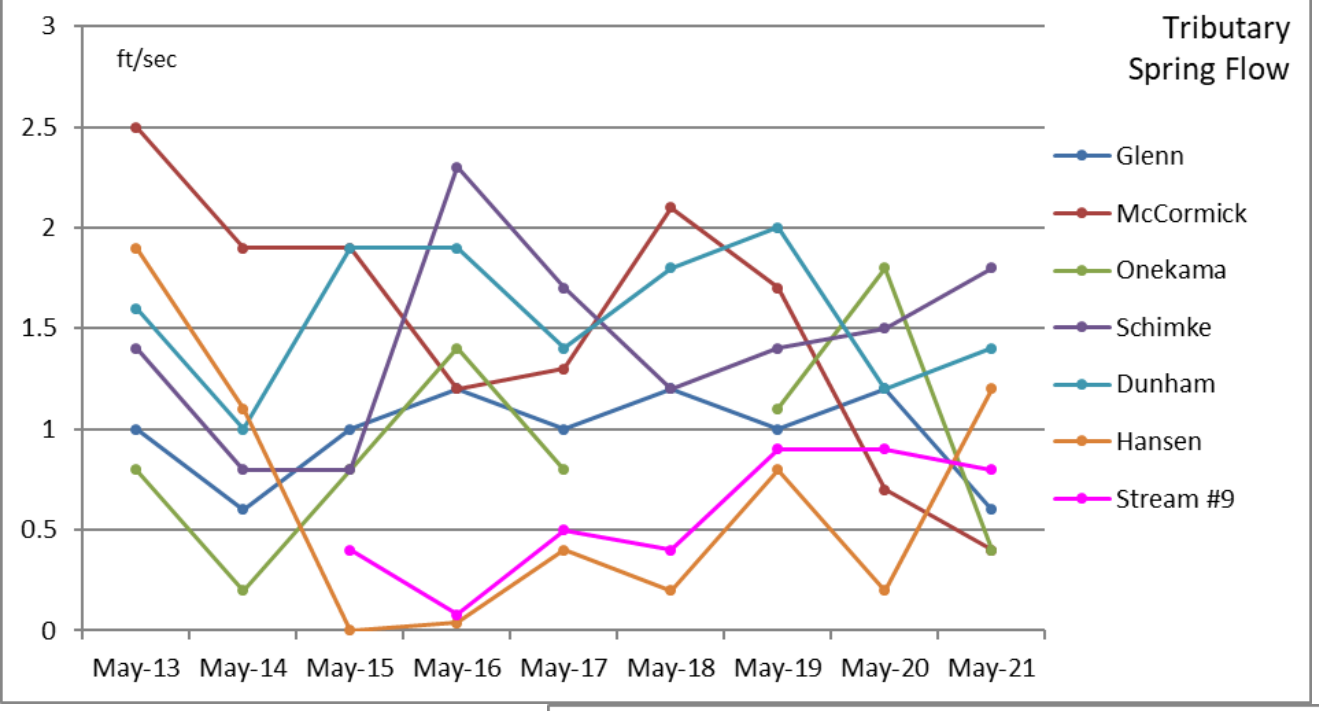
Chlorophyll

Chlorophyll measures the amount of plankton (green algae) in the water. Some plankton or algal growth is essential to support the growth of other organisms (e.g., zooplankton, fish) in the lake, but human activities and natural eutrophication often lead to excessive algal growth; thus, lower concentrations of chlorophyll are usually considered desirable.



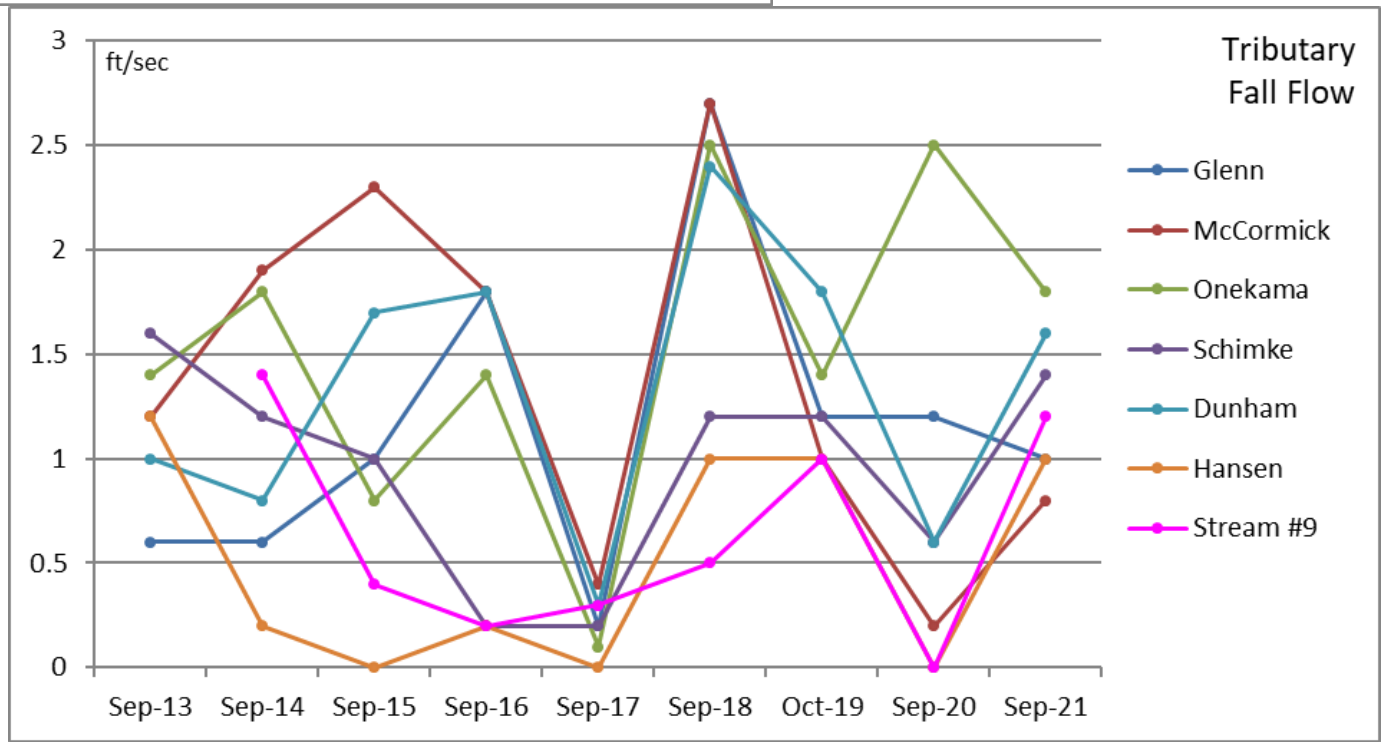
Overall, chlorophyll levels have varied some in recent years and were much higher in 2021. Additional sampling is recommended and over time, sampling technology has improved as well.



Tributary Flow/Total Phosphorus

Historically, these graphs illustrate that there is a decline in flow rate at the end of the summer versus the beginning of the summer. Typically, higher flows in spring will increase nutrient inputs in the spring and they decrease in the fall. This is standardly due to snow melt and spring rain.

Generally speaking, the flow in 2022 and 2021 had a higher range and overall higher average. This likely correlated with high water levels in the watershed. High water levels in the watershed could be having impacts on other parameters including nutrient levels as well as plant growth.



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Eutrophication

- Lakes naturally progress from oligotrophic to eutrophic, a process called eutrophication.
- Human activities dramatically speed this process by increasing input of nutrients (phosphorus and nitrogen) and sediment
- Prevention is far easier and less expensive than restoring lakes already damaged
  - Monitor phosphorus and nitrogen concentrations
  - Encourage BMP – Phosphorus free fertilizer, buffers, soil erosion, leaves, debris out of lake
  - Evaluate sources entering lake (Watershed study)

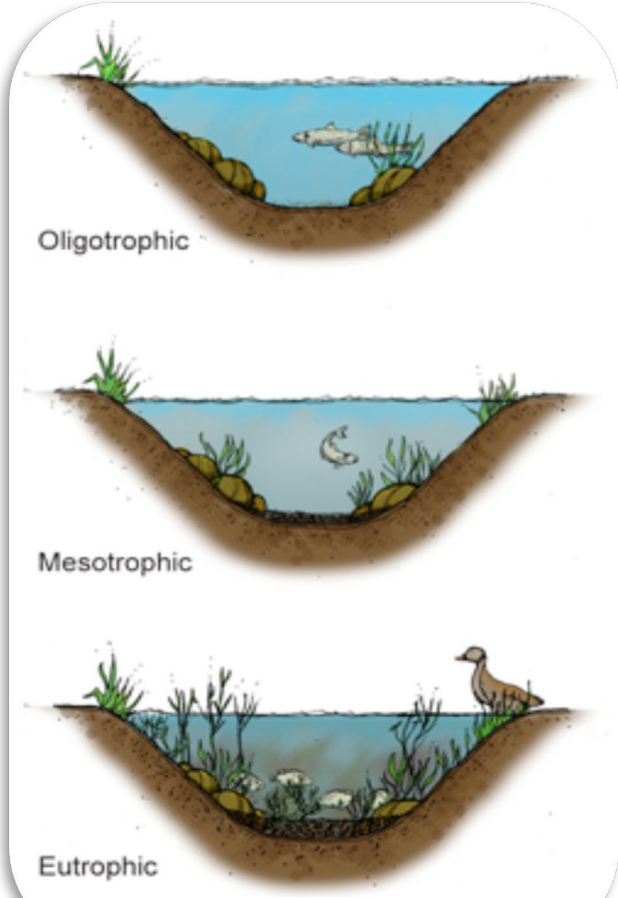

Photo curiosity Progressive AE

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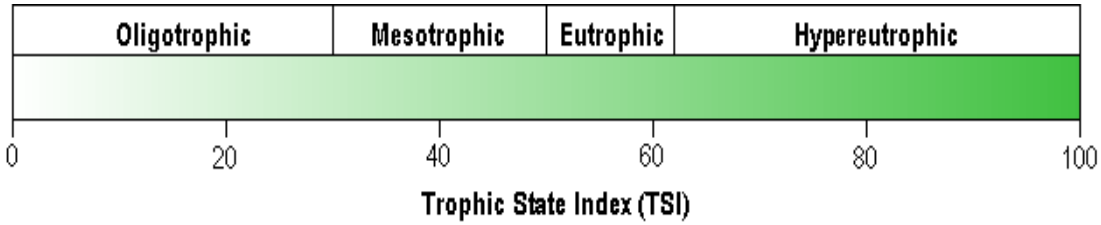
Trophic status



- June data between 28 and 39
- Late July data between 30 and 43
- September data between 30 and 48
- All of these values are considerable higher than 2020 results.
- In general, these values rate Portage Lake as mesotrophic.

Site	Secchi Depth	Total Phosphorus	Chlorophyll a
Basin 1 – June	37	28	28
Basin 2 – June	39	30	30
Basin 1- July	38	30	30
Basin 2- July	43	30	30
Basin 1 – Sept.	41	58	58
Basin 2 – Sept.	45	30	30

Characteristics associated with oligotrophic to meso-oligotrophic lakes are

- low nutrient levels
- clear water
- low productivity.
- High dissolved oxygen levels typically occur and survival of cold water fish is possible.

Mesotrophic lakes tend to have

- moderate nutrient levels
- clear water
- moderate productivity.
- Rooted plants are abundant and the lake can still support a cold water fishery.

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Characteristics Typical of Different Trophic States

	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic
Water Clarity	excellent	Good	fair-poor	very poor
Nutrients	low	Moderate	high	very high
Algae	few	Moderate	blooms likely	severe blooms probable
Plants	few	Moderate	abundant	few, in shallows
Fishery	cold water possible	cold water possible	warm water only	rough fish often dominate

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Current budget

The Recommended Management Schedule for 2022:

- A spring and fall vegetation survey (to evaluate conditions in the lake).
- Exotic plant management/treatment, as required
- Pre and post implementation surveys as required, in addition to a mid-summer survey
- Extensive water quality monitoring throughout season
- Late summer/fall Phragmites Control
- Community Education/outreach activities
- Fish Study

Proposed/ Estimated Budget	2022
Emergent Control	2,000
EWM/SSW Control	47,400
Permit	1,600
Lake Management/Fish Survey	25,000
Contingency Funds	7,600
Total	83,600

STOP AQUATIC HITCHHIKERS!

Prevent the transport of nuisance species.
Clean all recreational equipment.
www.ProtectYourWaters.net

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THANK YOU, QUESTIONS!

- Know your environment, what is around you
- Ask questions
- Communicate
- Prevention is key
- Early detection, rapid response
- We can all do our part!
- Let's work together to protect your Lake!

Bre Grabill
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800-382-4434 ext.2200