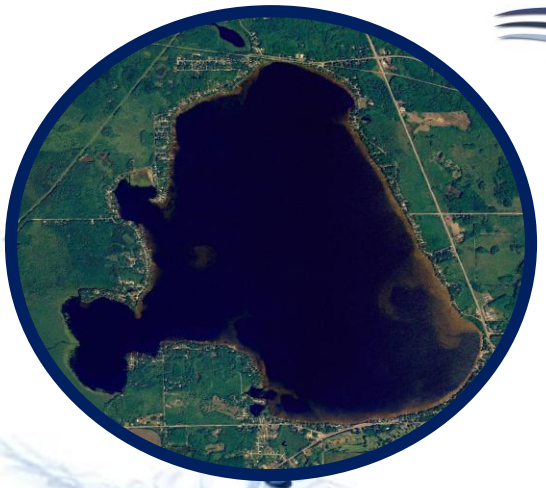


Lake Mitchell Improvement Plan

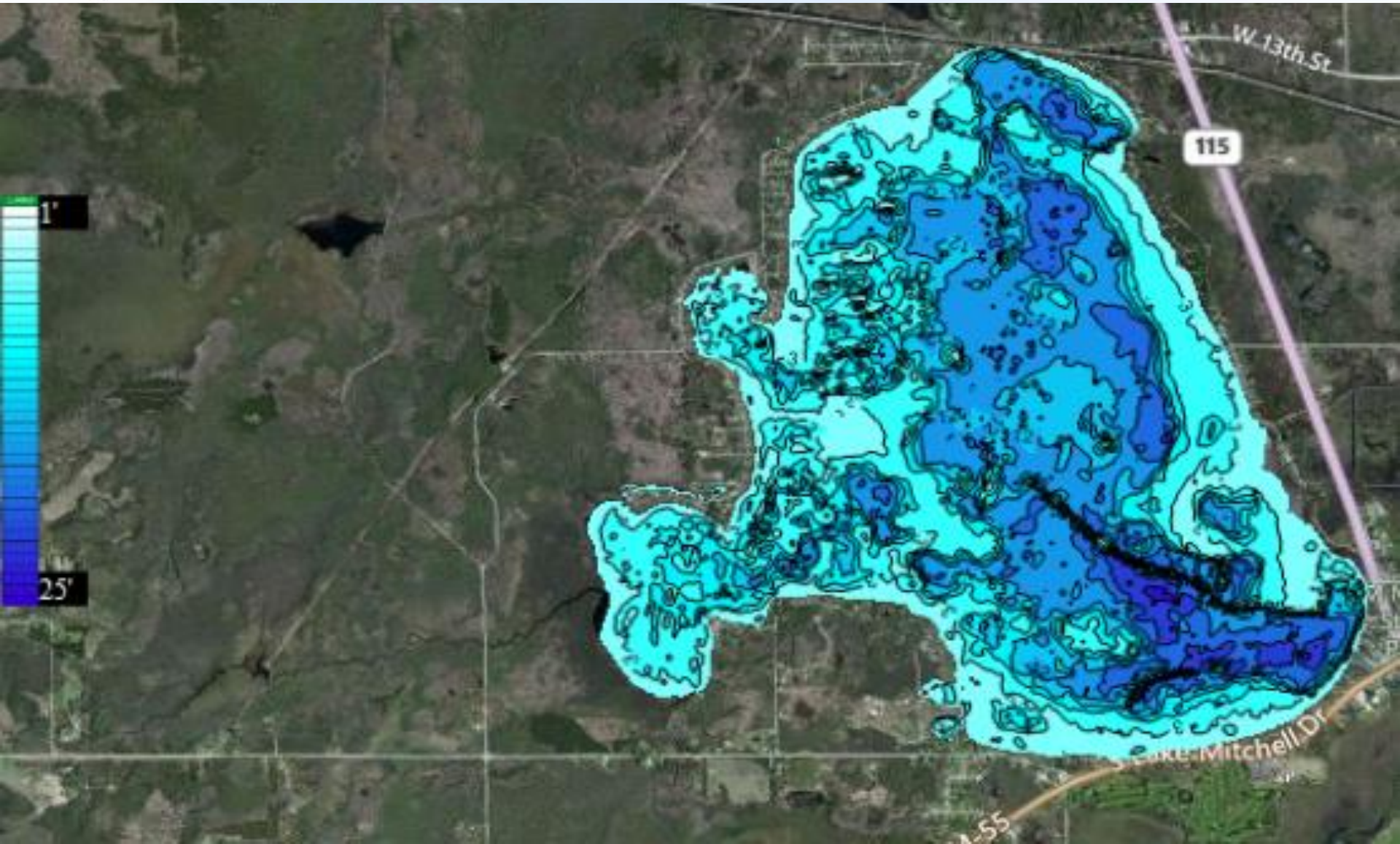
By: Restorative Lake Sciences

October 26, 2019

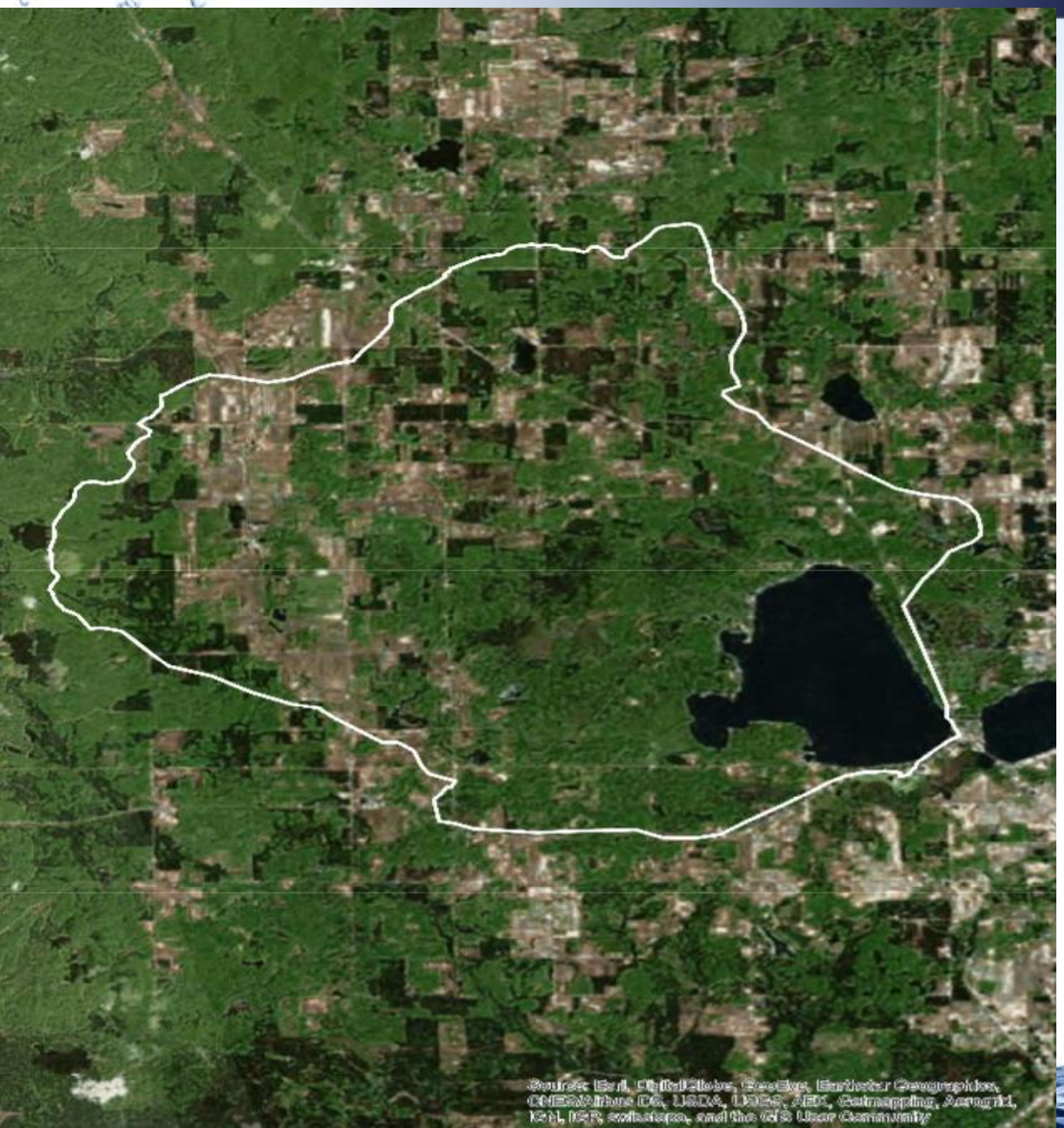
Lake Mitchell Physical Characteristics

- Shoreline Length: 10.5 mi
- SDF: 1.8
- Surface Area: 2,580 acres
- Elevation: 1,289 feet
- Mean Depth: 8.5 feet
- Max Depth: 22.0 feet
- Volume: 21,321 acre-feet
- Retention Time: 1.06 yrs.
- Watershed: Lake: 22.6

Lake Mitchell Depth Contours



Lake Mitchell Immediate Watershed



- 58,256 acres
- Watershed is 22.6X lake size = large watershed = more pollution

Lake Mitchell Aquatic Vegetation Sampling Locations

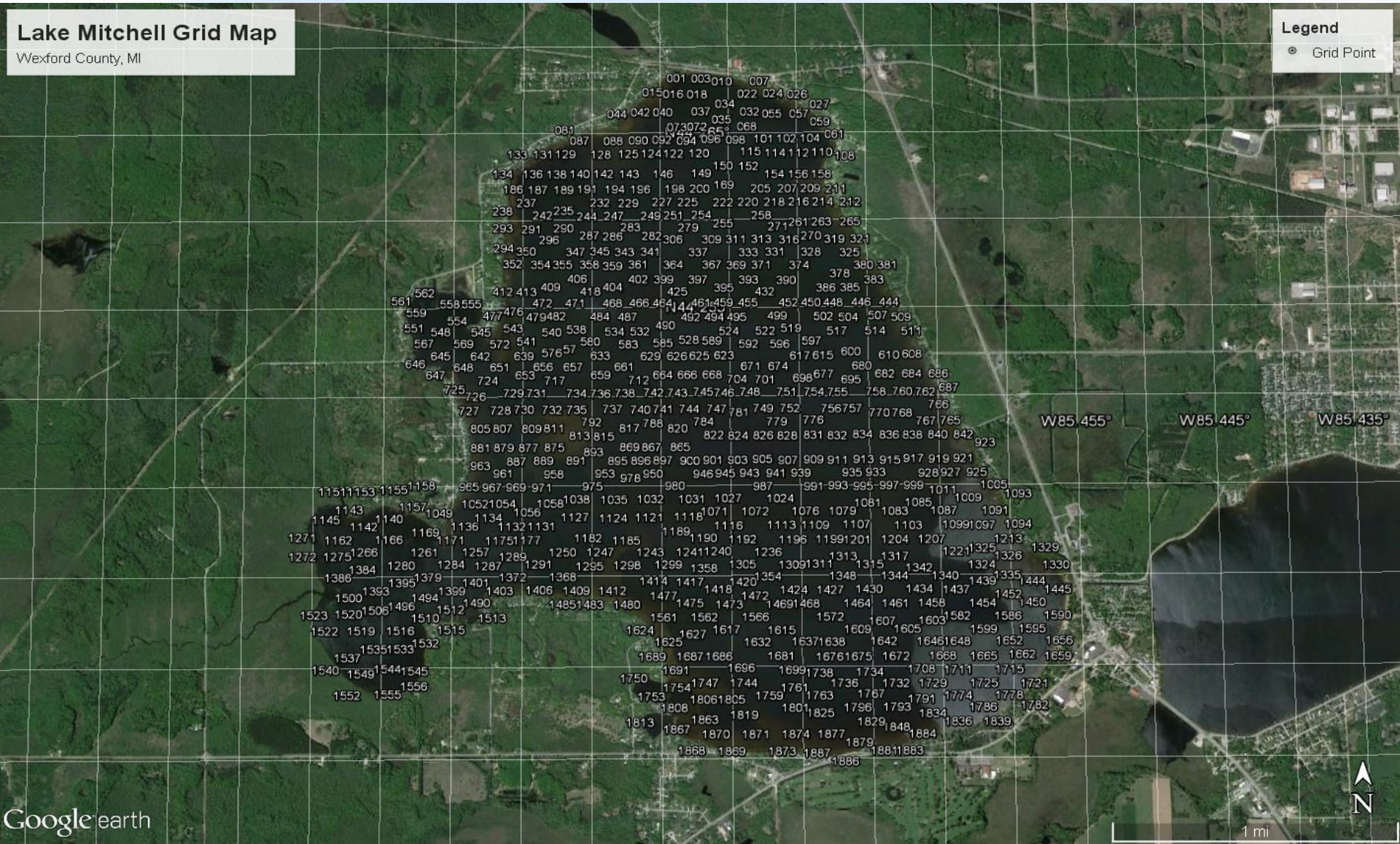
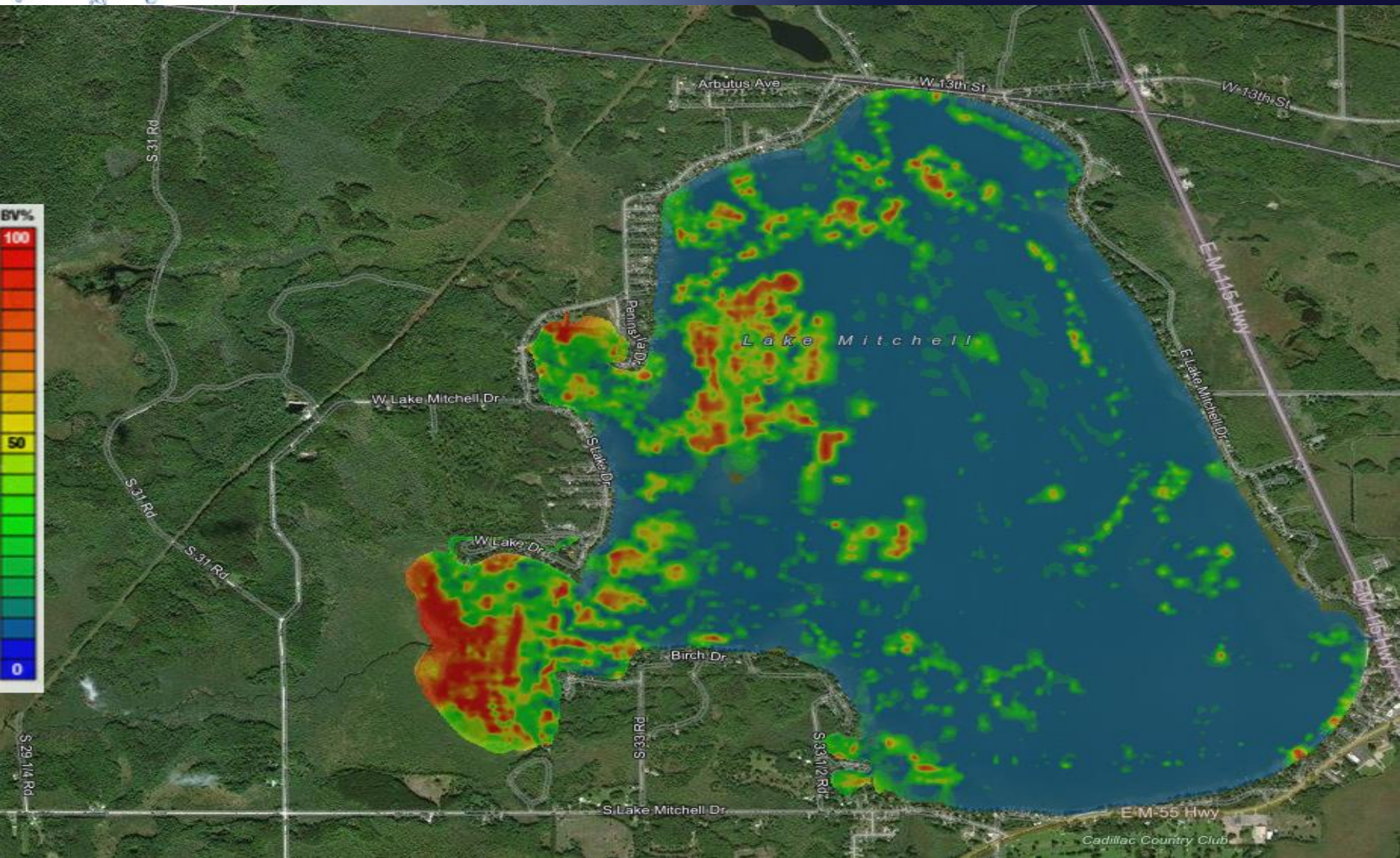


Table 5. Native aquatic plants found in Lake Mitchell in 2018.

Aquatic Plant Species Name	*Aquatic Plant Common Name*	*Aquatic Plant Growth Form*	*% Coverage of Lake (2018)*
Chara vulgaris (macroalga)	Muskgrass	Submersed; Rooted	9
Potamogeton pectinatus	Sago Pondweed	Submersed; Rooted	11
Potamogeton robbinsii	Fern-leaf Pondweed	Submersed; Rooted	62
Potamogeton gramineus	Variable-leaf Pondweed	Submersed; Rooted	19
Potamogeton praelongus	White-stem Pondweed	Submersed; Rooted	47
Potamogeton richardsonii	Clasping-leaf Pondweed	Submersed; Rooted	2
Potamogeton illinoensis	Illinois Pondweed	Submersed; Rooted	24
Potamogeton amplifolius	Large-leaf Pondweed	Submersed; Rooted	16
Myriophyllum sibiricum	Northern Watermilfoil	Submersed; Rooted	6
Ceratophyllum demersum	Coontail	Submersed; Non-rooted	8
Elodea canadensis	Common Waterweed	Submersed: Rooted	6
Utricularia vulgaris	Common Bladderwort	Submersed; Non-rooted	27
Utricularia minor	Mini Bladderwort	Submersed; Non-rooted	2
Najas guadalupensis	Southern Naiad	Submersed; Rooted	22
Najas flexilis	Slender Naiad	Submersed; Rooted	17
Myriophyllum tenellum	Leafless Watermilfoil	Submersed; Rooted	69
Potamogeton pusillus	Small-leaf Pondweed	Submersed; Rooted	10
Megalodonta beckii	Water Marigold	Submersed; Rooted	4
Nymphaea odorata	White Waterlily	Floating-leaved	12
Nuphar variegata	Yellow Waterlily	Floating-leaved	10
Brasenia schreberi	Watershield	Floating-leaved	11
Lemna trisulca	Star Duckweed	Floating-Leaved; Non-rooted	1
Pontedaria cordata	Pickerelweed	Emergent	13
Typha latifolia	Cattails	Emergent	11
Schoenoplectus acutus	Bulrushes	Emergent	28
Decodon verticillatus	Swamp Loosestrife	Emergent	10
Eleocharis acicularis	Spike rush	Emergent	14

Lake Mitchell Aquatic Vegetation Biovolume



Lake Mitchell Exotic Aquatic Plants

Hybrid Watermilfoil

Purple Loosestrife

Figure 4. A photograph of White-stem Pondweed (*Potamogeton praelongus*)

Figure 5. A photograph of Bladderwort (*Utricularia vulgaris*)

Figure 8. A photograph of a *Chara* family plant

Figure 9. A photograph of Illinois Pondweed (*Potamogeton illinoensis*)

Figure 6. A photograph of Wild Celery (*Vallisneria americana*)

Figure 7. A photograph of Northern milfoil (*Myriophyllum sibiricum*)

Figure 10. A photograph of Southern Naiad(*Najas guadalupensis*)

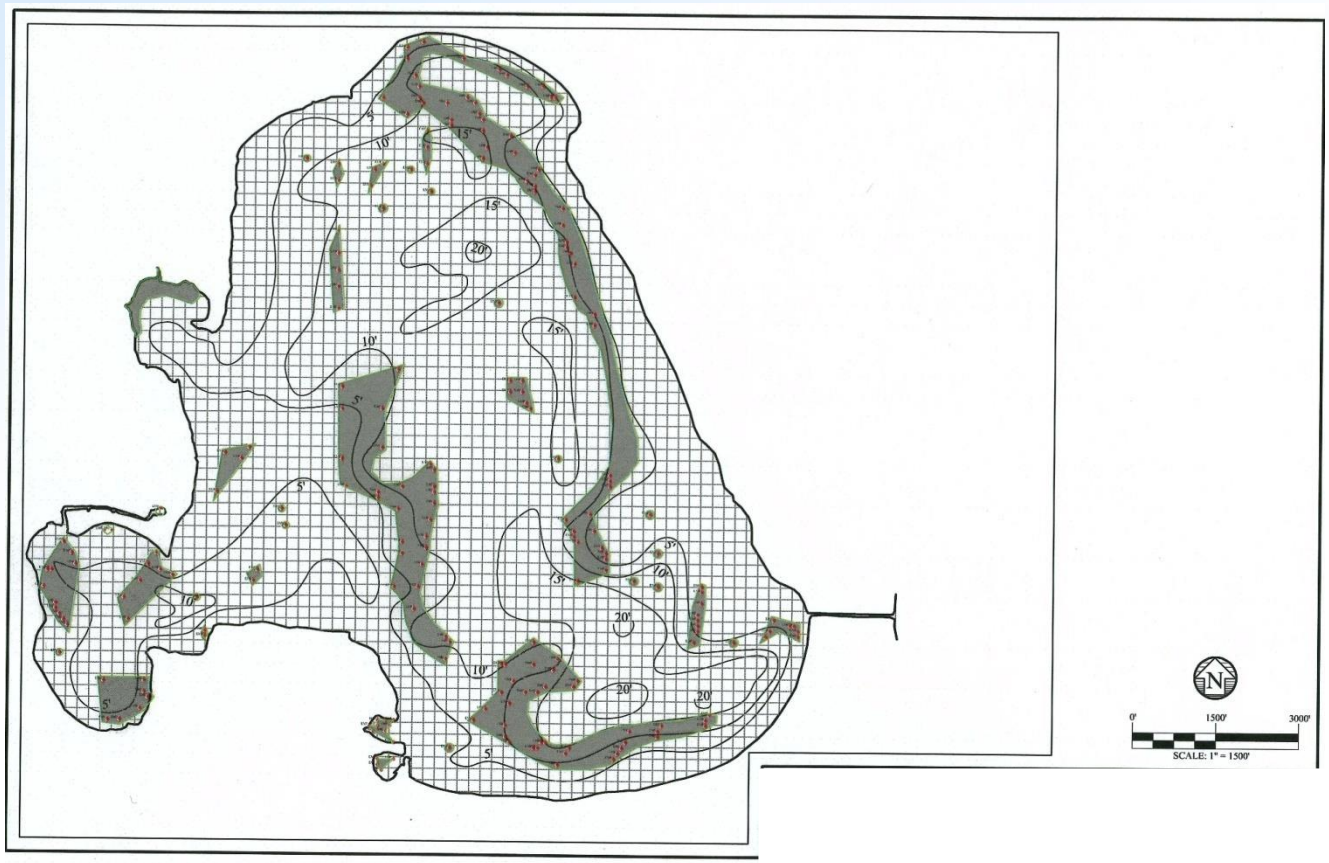
Figure 11. A photograph of Variable-leaf Pondweed (*Potamogeton gramineus*)

Hybrid Watermilfoil (Eurasian Watermilfoil + Native Watermilfoil)

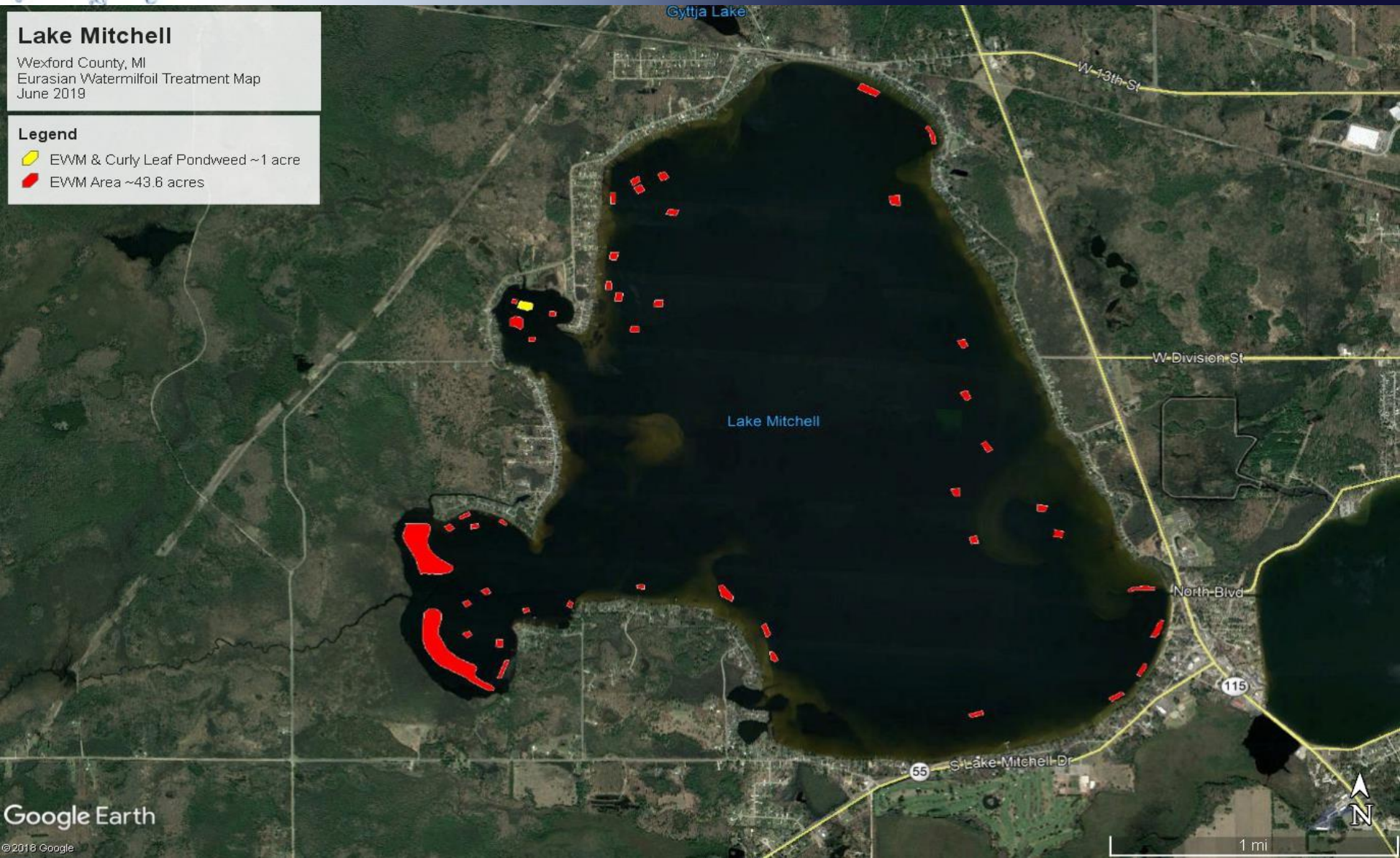
Grows thicker, wider, faster than EWM and is VERY TOLERANT to herbicides!

EWM Overgrowth in Other Lakes:

M. Spicatum Distribution in Lake Mitchell (Spring, 2009)



Lake Mitchell Milfoil Distribution (June, 2019)



Lake Mitchell Milfoil Distribution (August, 2019)

New Herbicide: ProcellaCOR®

- New systemic herbicide used for local control of hybrid EWM
- Dosed in “prescribed dose units” PDU’s
- Used in Big Cove (June, 2019) with excellent results!
- Used in Houghton Lake in 2018 with excellent results
- Requires additional EGLE surveys but good for site-specific data

What Happens if We Kill Too Much Vegetation ?

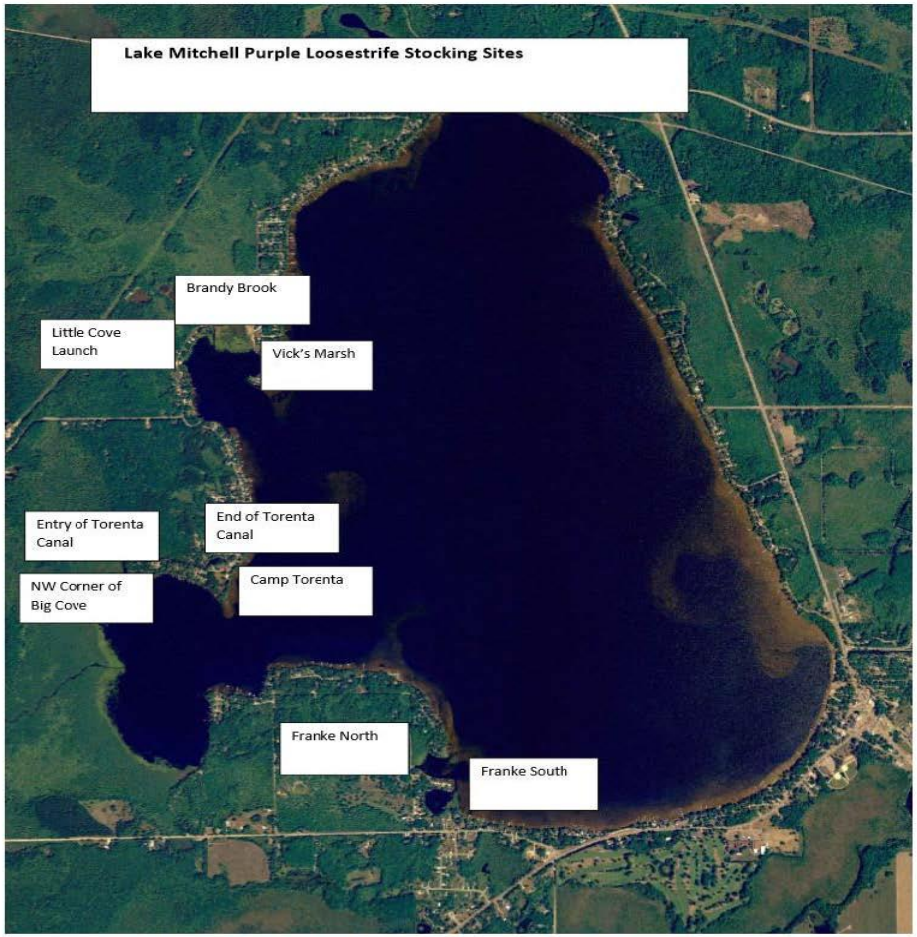
Toxic Blue-green algae bloom, Spring Lake, Ottawa County, MI

Lake may not be able to break down plant matter fast enough

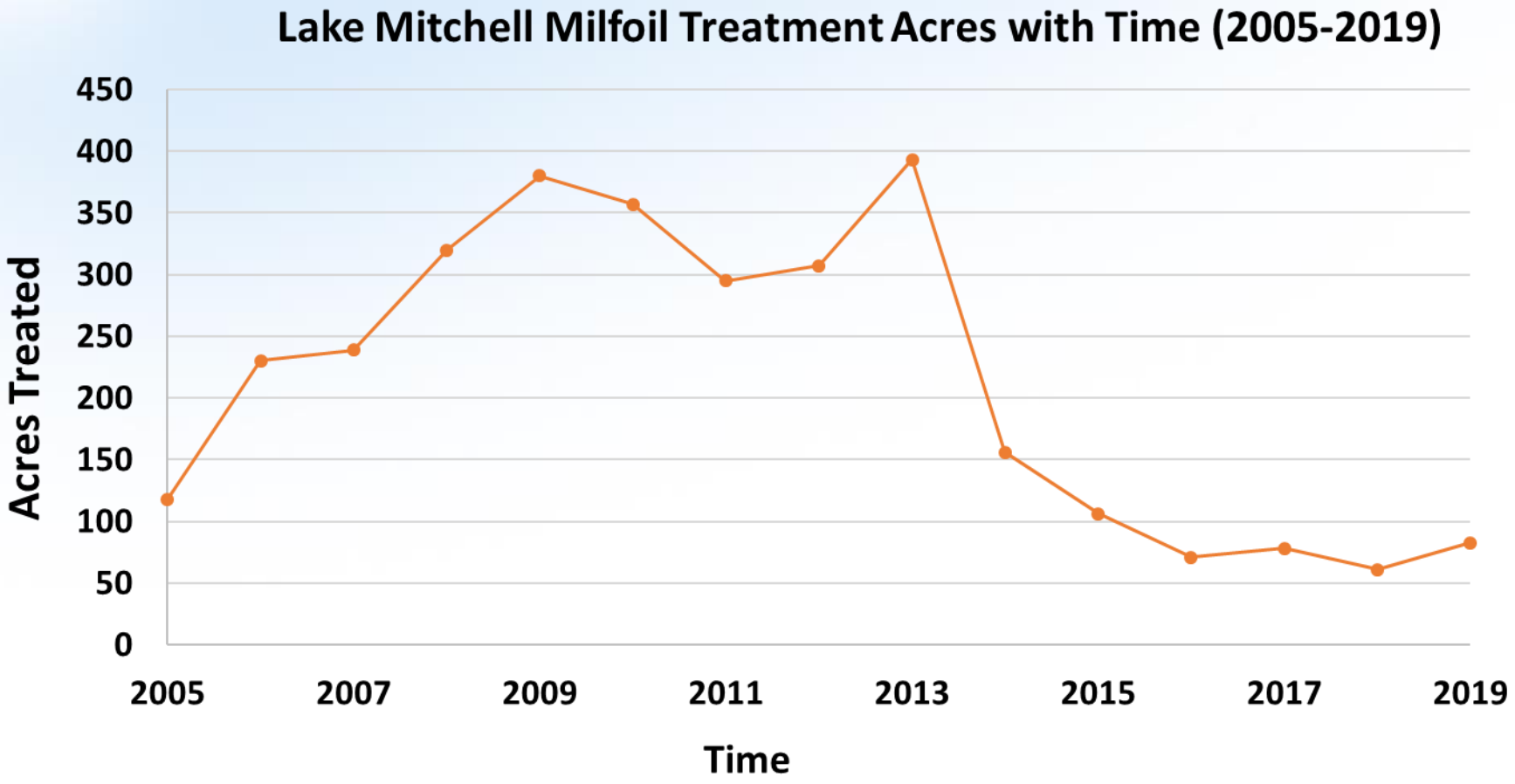
What Will Happen If We Do Nothing?

- EWM will displace native aquatic plant species
- Fishery will decline in quantity and quality
- Excessive die-off of massive EWM beds will cause major declines in water quality parameters
- Hydrilla or other species may invade and further destroy the lake

Lake Mitchell Loosestrife Beetle Stocking Locations



Lake Mitchell Improvement Cost Savings-EWM Acres Treated to Date



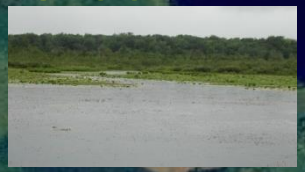
Lake Mitchell Deep Basin & Water Quality Sampling Locations

Gyttja Creek

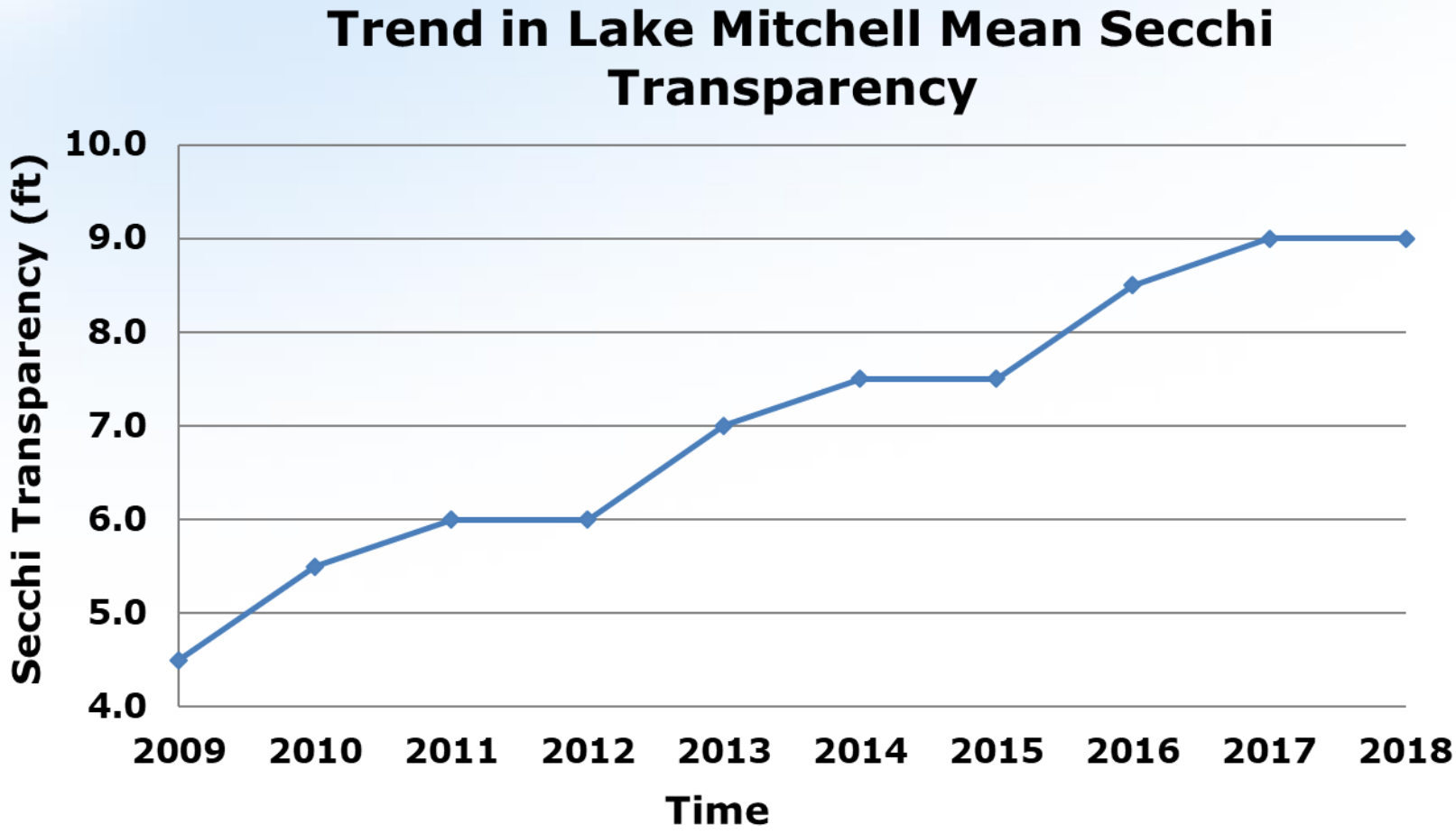
DB #1

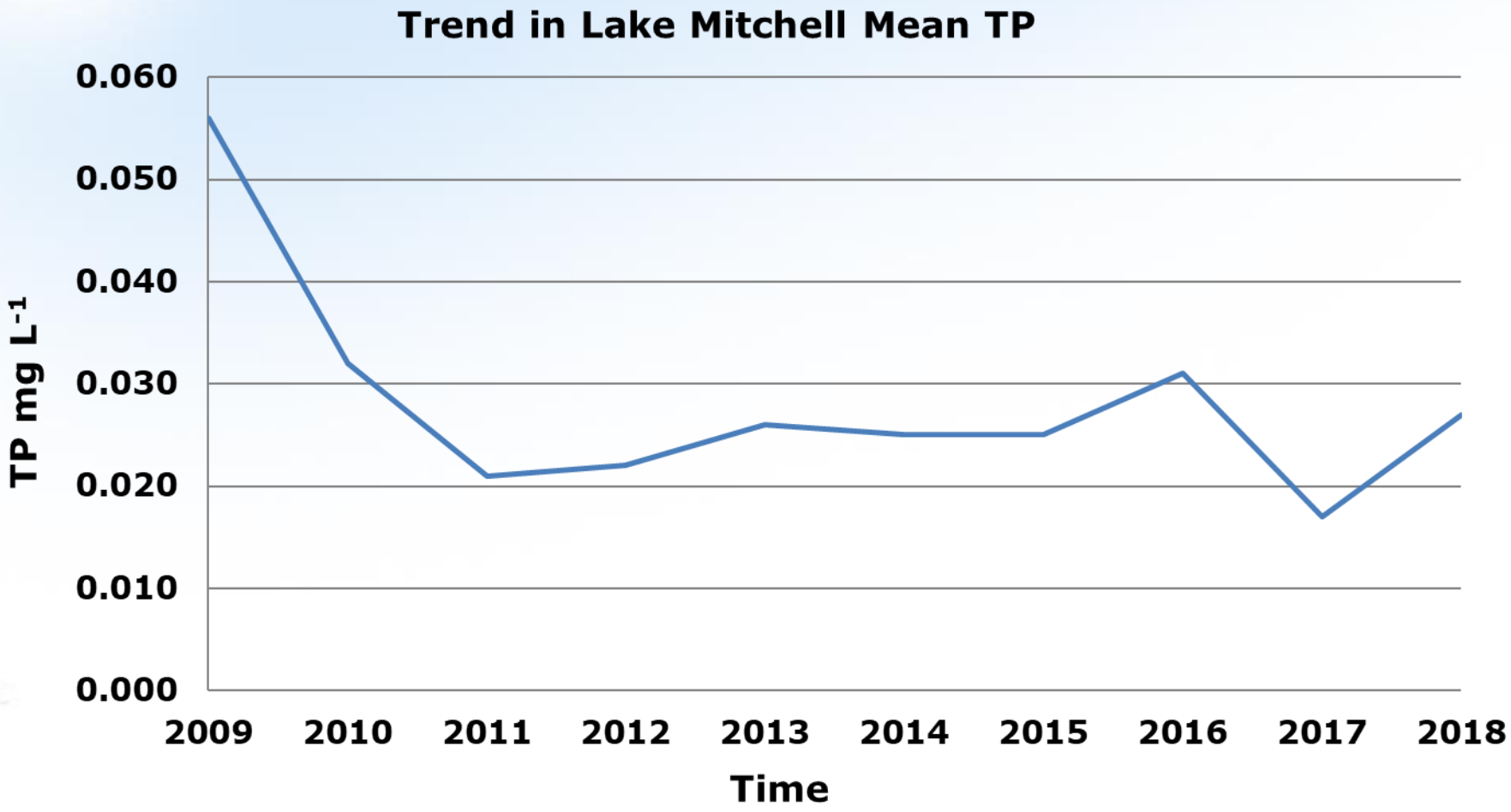
Brandy Creek

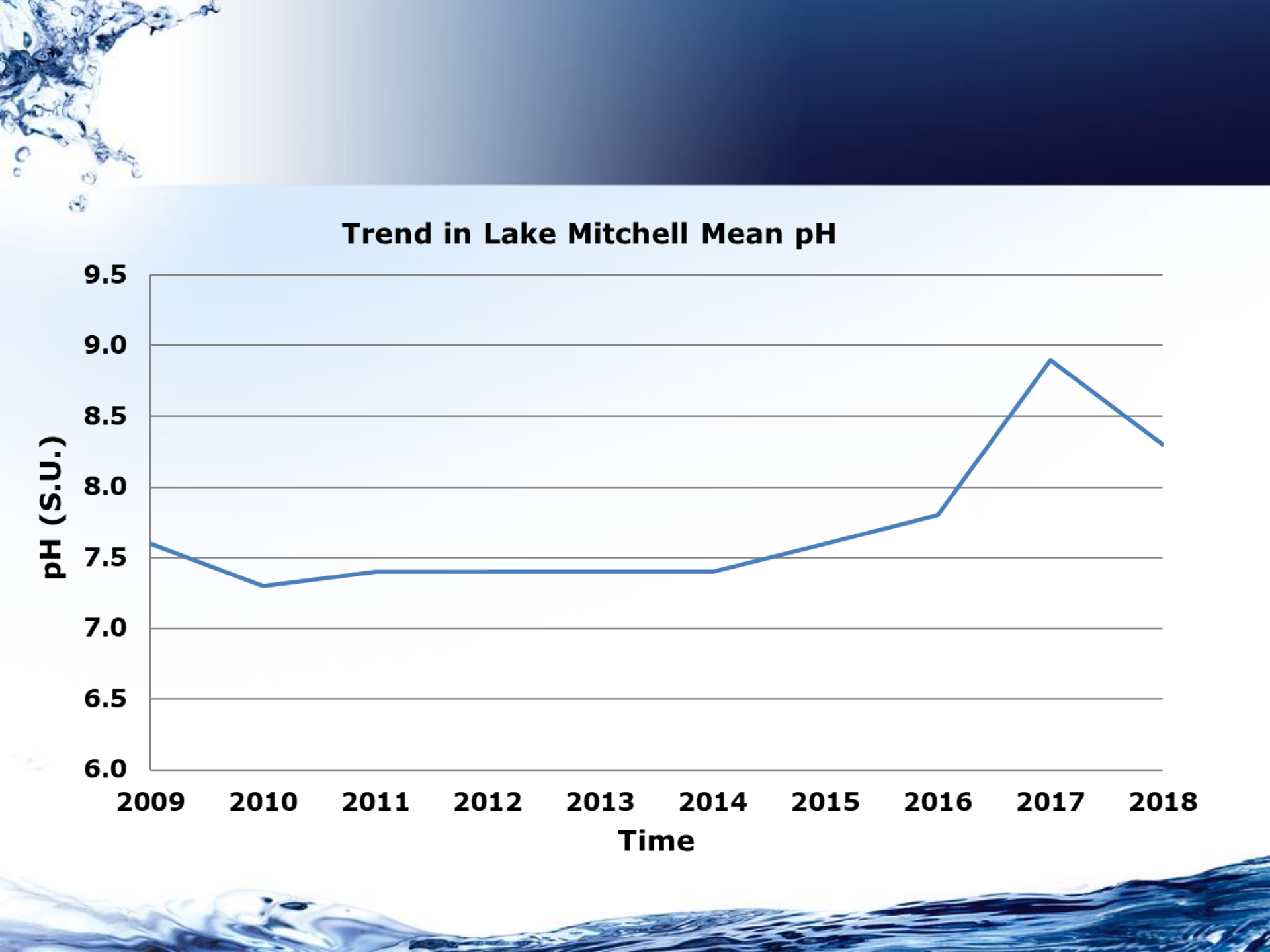
Mitchell Creek

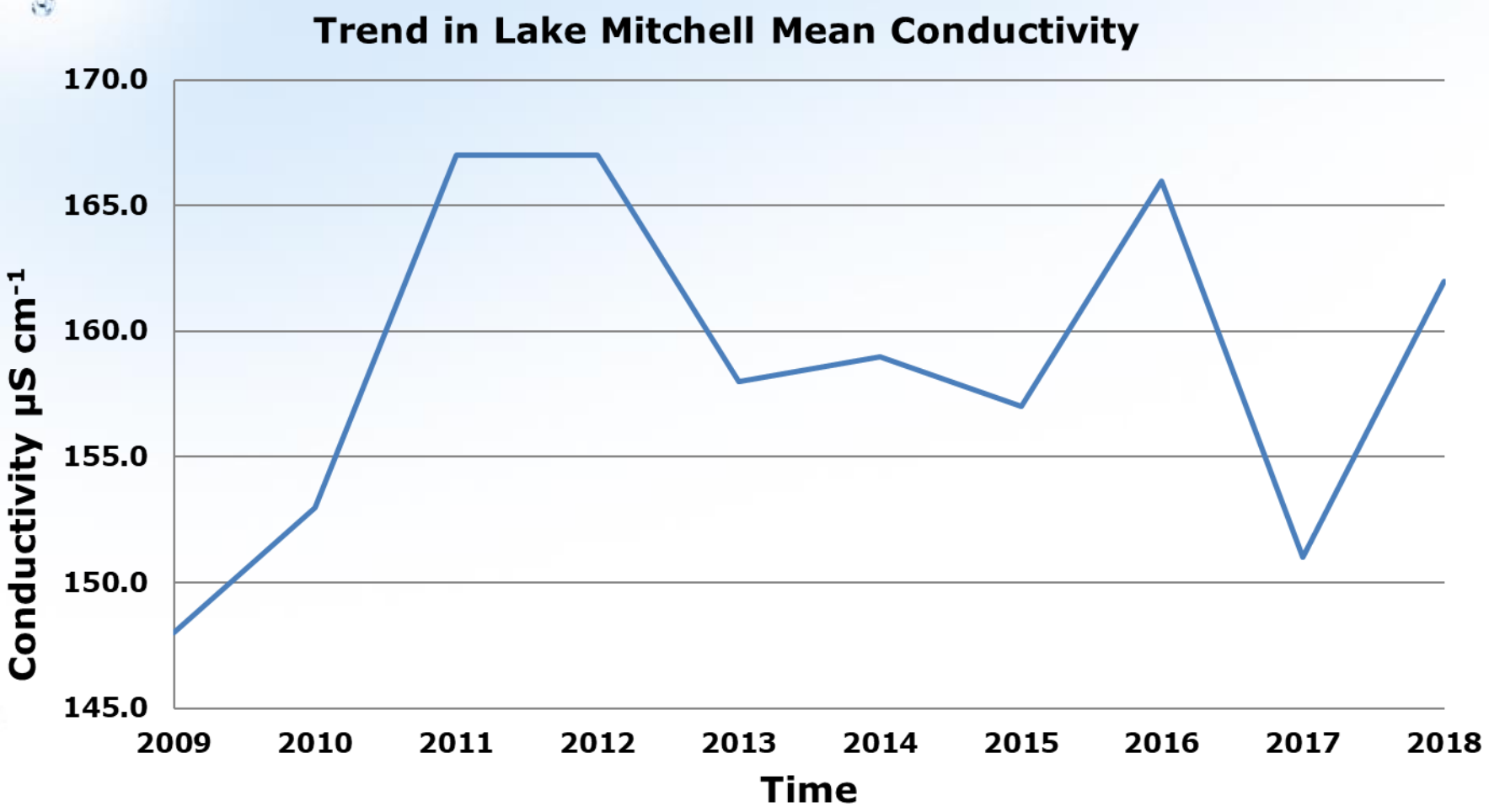


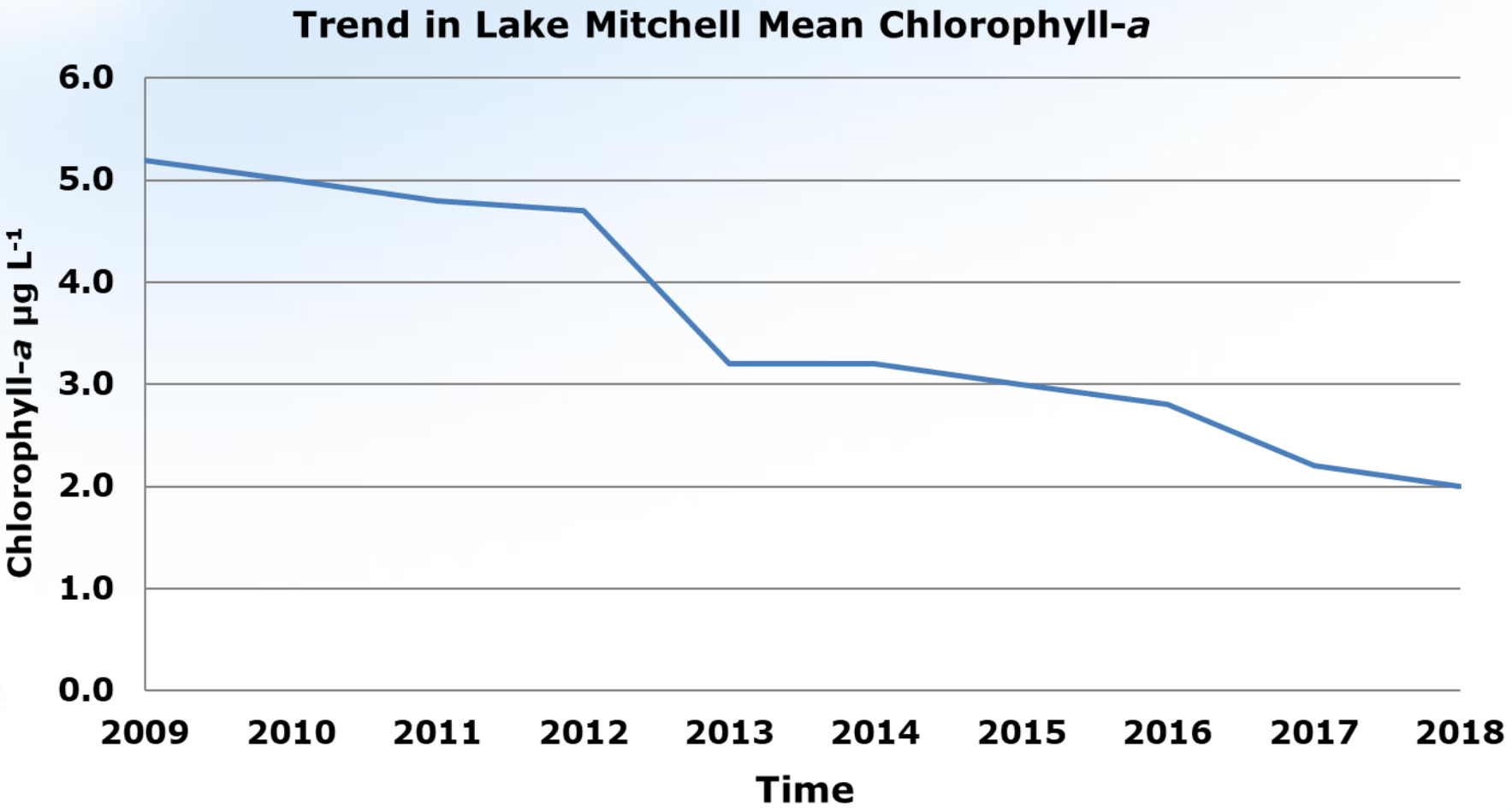
DB #2


Trend in Lake Mitchell Mean Secchi Transparency
Secchi Transparency (ft)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Time


Trend in Lake Mitchell Mean TP
0.060
0.050
0.040
0.030
0.020
0.010
0.000
TP mg L-1
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Time


Trend in Lake Mitchell Mean pH
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH (S.U.)
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Time


Trend in Lake Mitchell Mean Conductivity
170.0
165.0
160.0
155.0
150.0
145.0
Conductivity µS cm-1
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Time


Trend in Lake Mitchell Mean Chlorophyll-a
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Chlorophyll-a µg L-1
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Time

Mechanical Harvesting

Benefits of Harvesting

- Removes some plant debris and associated organic nutrient
- Can reduce need for herbicides but is generalist
- Should not be used on species that fragment

Limitations of Harvesting

- Can increase biomass of fragment-producers
- Does not exclude need for treatments in “high-maintenance” lakes
- Can create floating debris
- May need to be repeated in single season due to re-growth

Chemical Herbicides

- Applied to both exotic and native aquatic plants
- Most commonly used: 2,4-D, Reward, Triclopyr, Fluridone, Aquathol-K, $CuSO_4$, Flumioxazin
- Requires MDEQ permit; residue sampling may be required (i.e. Triclopyr, Fluridone)
- Shallow well restrictions, swimming restrictions, watering restrictions-Notifications required

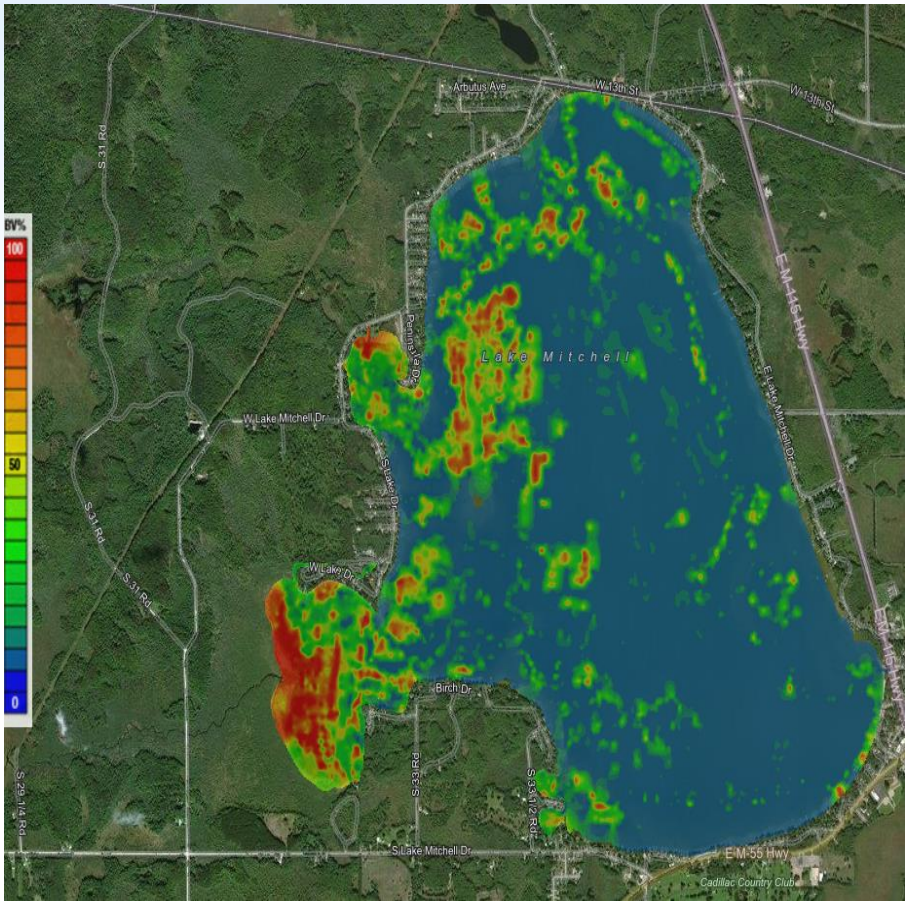
Management Recommendations

- Spot-treatments with systemic herbicides for long-term control of Hybrid Eurasian Watermilfoil
- Mechanical harvesting for coves and canal if needed
- Biological controls for Purple Loosestrife
- Continued education of all riparians; emphasis on local & affordable watershed management strategies
- Annual WQ monitoring of lake and inlets for nutrients and investigation of long-term BMP’s

Lake Mitchell Improvement Cost Estimates

Proposed Lake Mitchell Management Improvement Item	*Estimated 2020 Cost*	*Estimated 2021-2024 Cost*[5]
Herbicides (2,4-D/ Triclopyr) for Hybrid Watermilfoil[1]@$585 and $744 per acre (plus MDEQ permit fee)	$98,000	$98,000
Weed Pickup	$8,000	$8,000
Professional Limnologist Services (limnologist surveys, contractor oversight, education)[2]	$18,500	$19,000
Attorney Fees	$5,000	$5,000
Assessment Appeals	$3,000	$3,000
Purple Loosestrife Control	$2,000	$2,000
Website Newsletter	$2,000	$2,000
Newsletter Preparation	$800	$800
Audit, Bond, Insurance	$1,400	$1,400
Professional Membership	$100	$100
Mailings, Publication	$800	$800
Contingency (15%)[3]	$20,400	$20,400
TOTAL ANNUAL ESTIMATED COST	$157,500	$157,500
APPROX. ANNUAL COST PER UNIT OF BENEFIT[6]	$196.88	$196.88

Questions ?



Lake Mitchell: Yours to Protect!