Aquatic Plant Management Research Updates

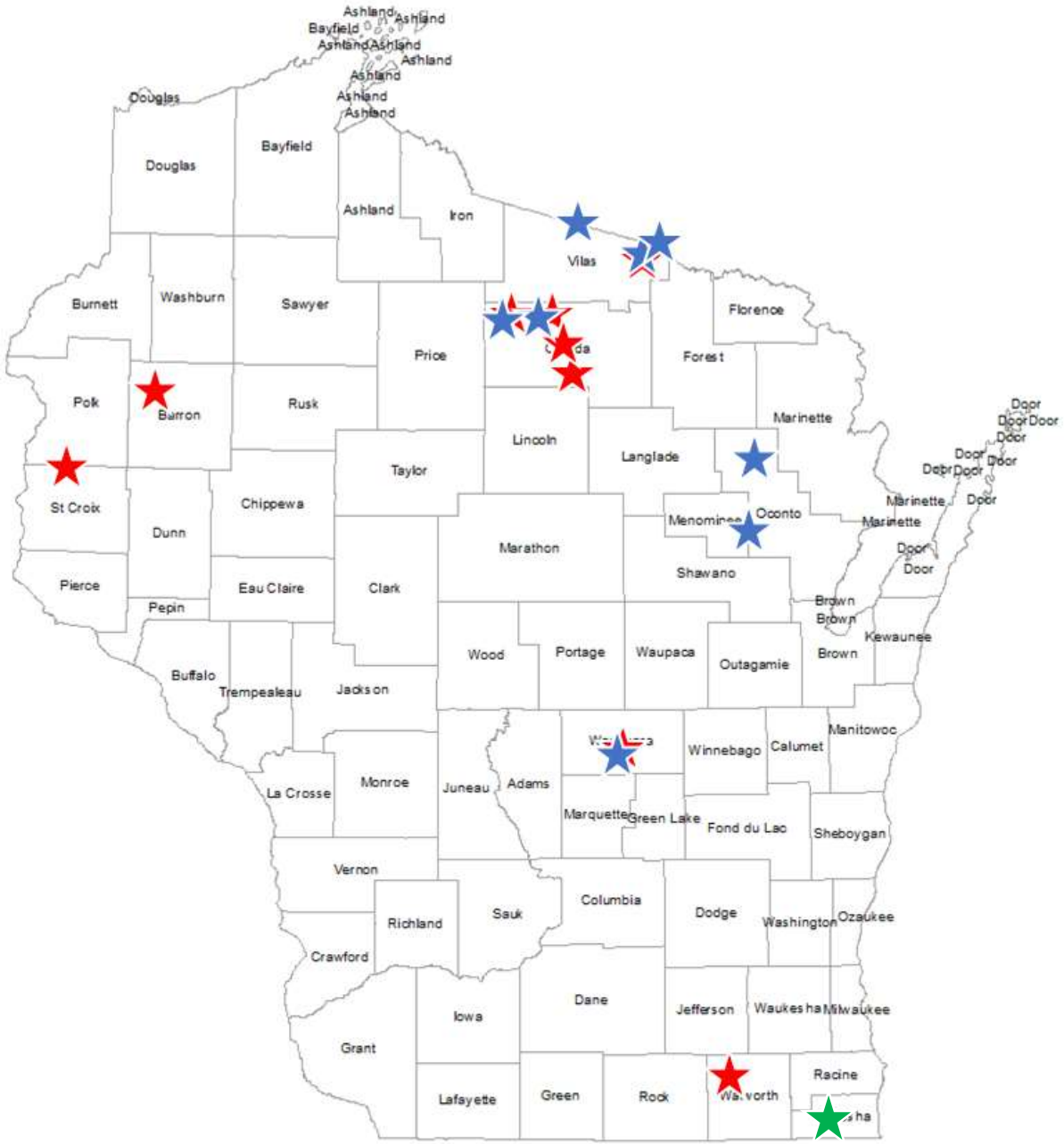
APM Industry Meeting

January 27, 2021

Research Topics

- ProcellaCOR (florpyrauxifen-benzyl)
- Ecological effects of EWM and large-scale treatments
- Limno-barrier curtains
- Starry stonewort
- Questions & feedback opportunity

ProcellaCOR Evaluation Projects in Wisconsin

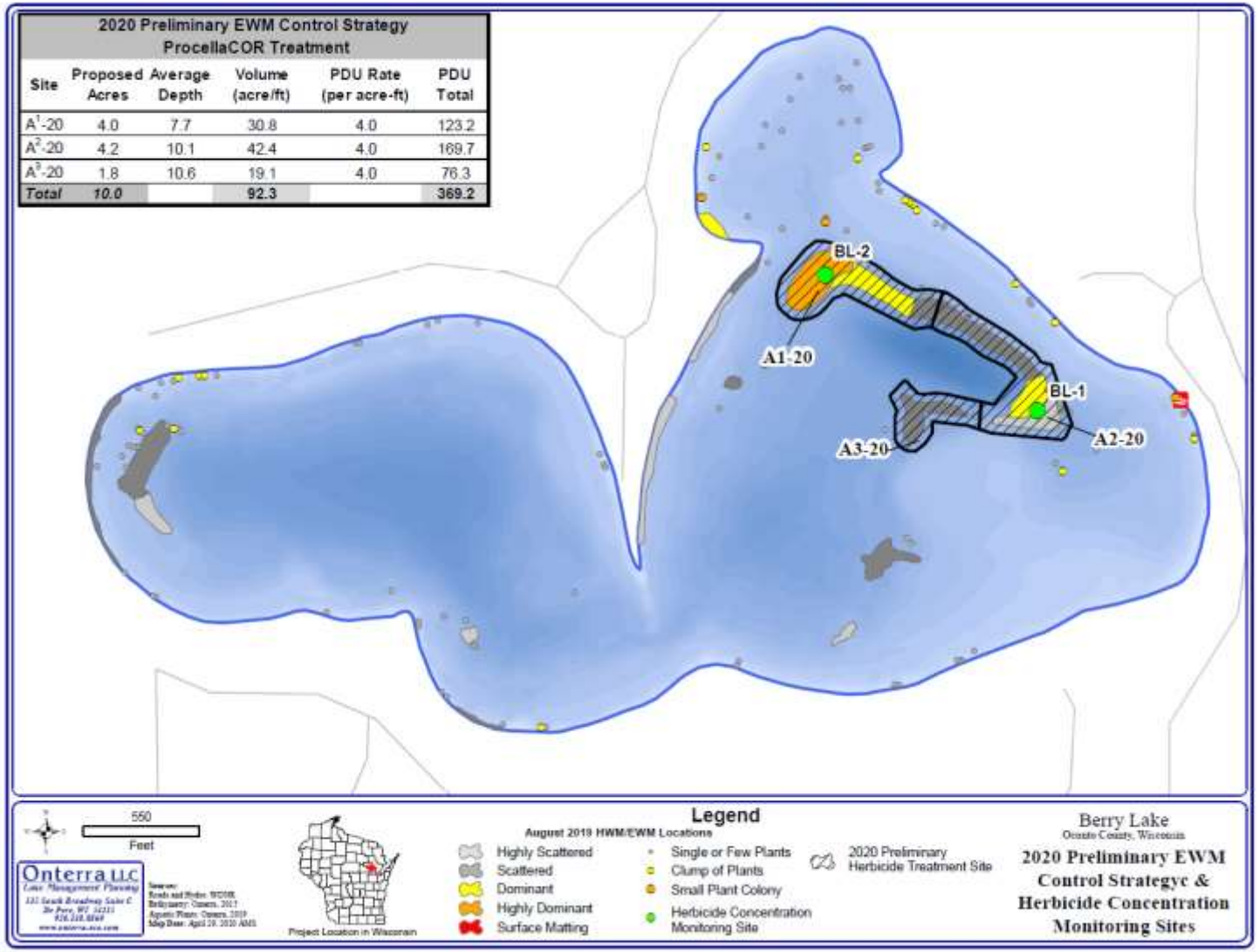


Case Studies (2020)

Lake	County	Date Treated	Treatment Area (acres)	Application Rate (PDU/ac-ft)	Application Rate (ppb)	Milfoil Genetics
(Big) Silver	Waushara	6/8/2020	11.6	3.5	6.7	HWM
Berry	Oconto	6/12/2020	10.1	4.0	7.7	HWM & EWM
Crooked	Oconto	7/6/2020	2.7 & 5.2	3.0 - 5.0	5.8 - 9.6	EWM
Minocqua	Oneida	6/15 & 6/30/2020	7.4, 10.2, 12.8 & 17.7	3.0 - 4.5	5.8 - 8.7	HWM & EWM
Kawaquesaga	Oneida	6/30/2020	12.9 & 15.2	3.5 - 5.0	6.7 - 9.6	EWM
North Twin	Vilas	6/17/2020	10	7.0	13.5	EWM
Long	Vilas	6/17/2020	15.9	4.0	7.7	HWM & EWM
Big	Vilas	6/25/2020	1.5	4.0	7.7	EWM
Little St. Germain	Vilas	6/12/2020	5.1, 11.1, & 15.9	3.0 - 4.0	5.8 - 7.7	EWM

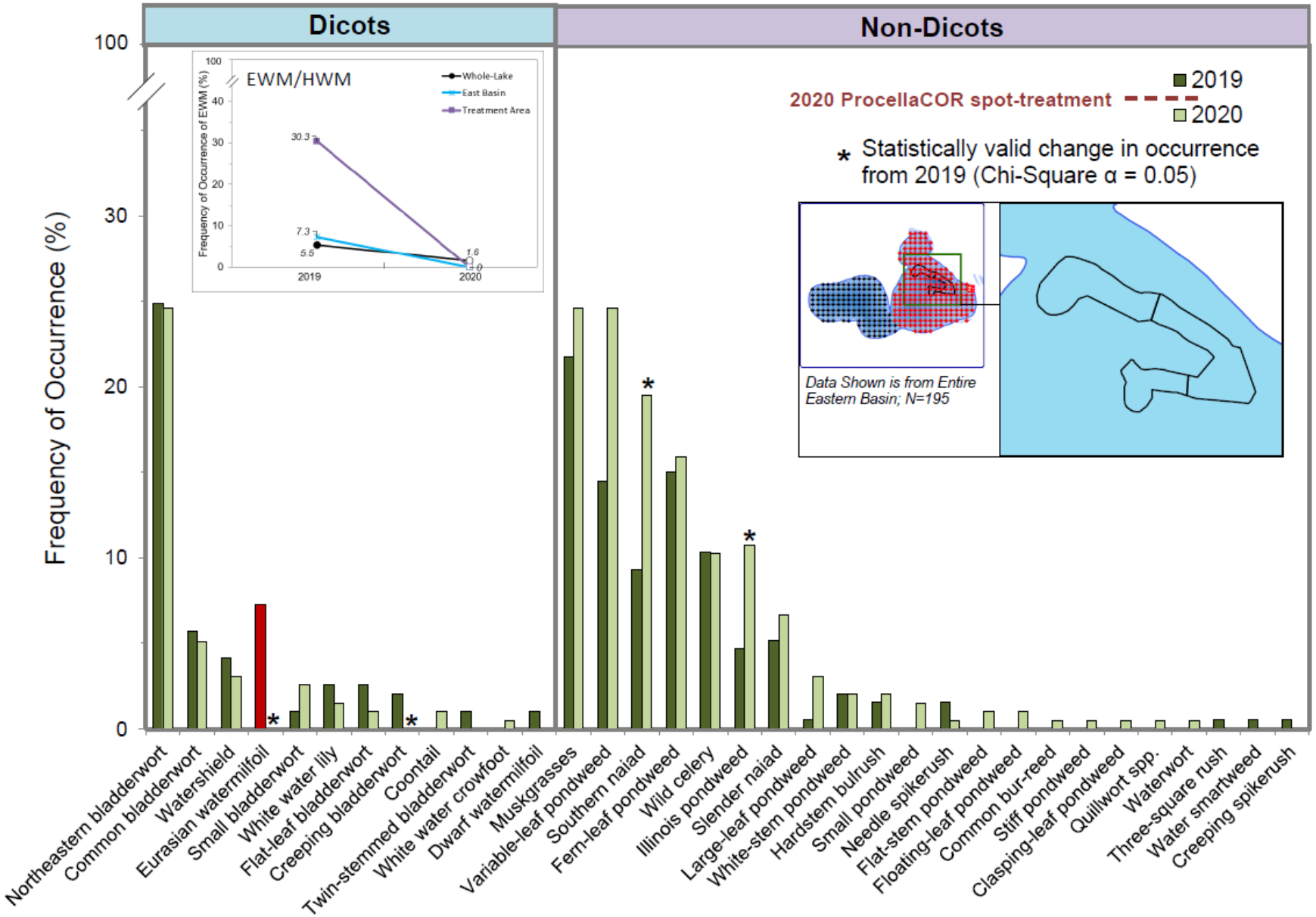
Berry Lake, Oconto Co.

- Treatment Date: June 12, 2020
- Acreage: 10.1 ac
- Applied Rate: 4.0 PDU/ac-ft



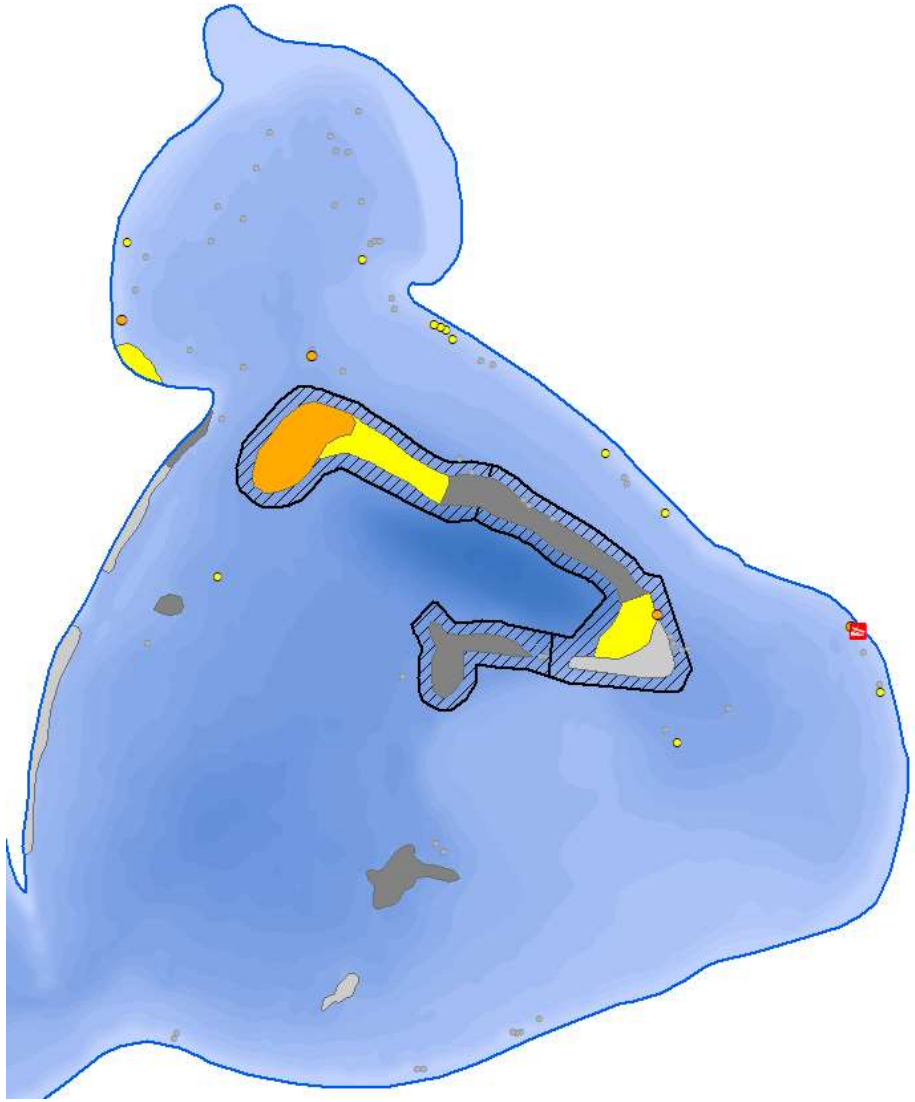
Data: Onterra, LLC

Berry Lake, Oconto Co.

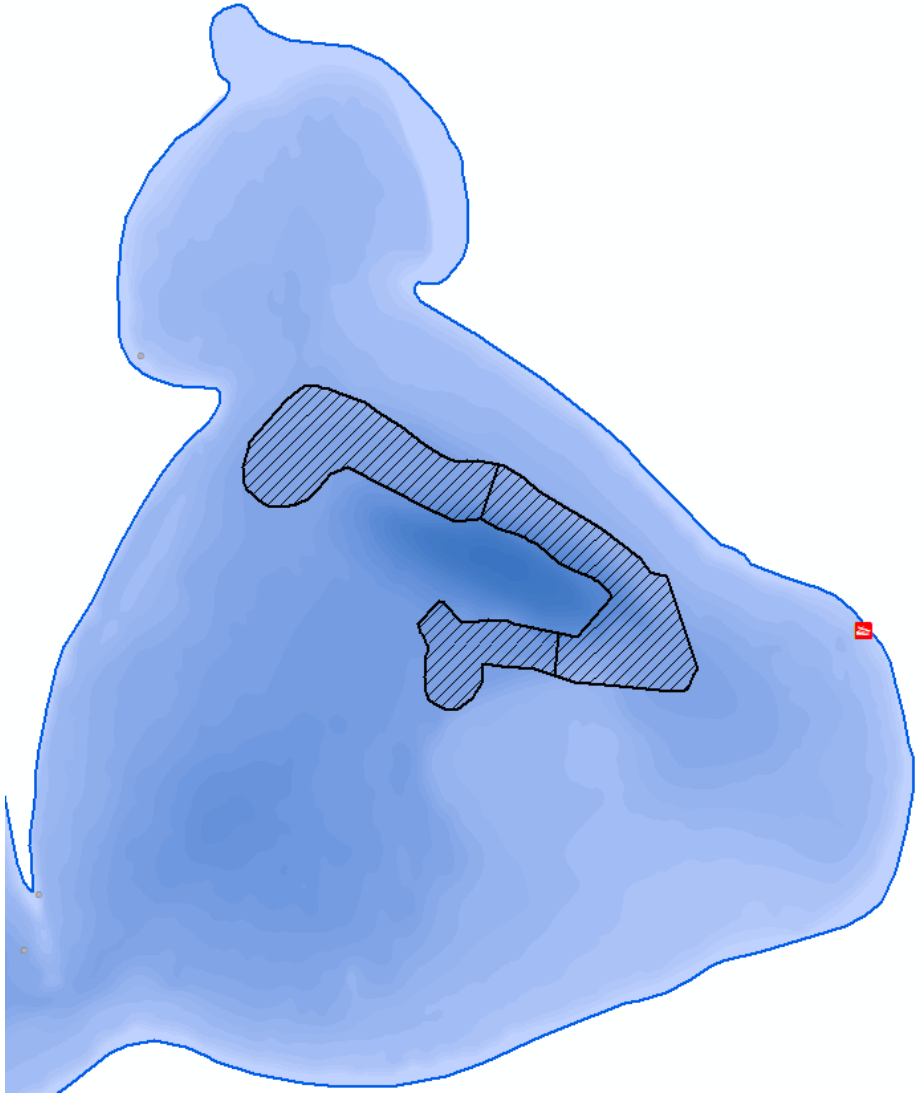


Data: Onterra, LLC

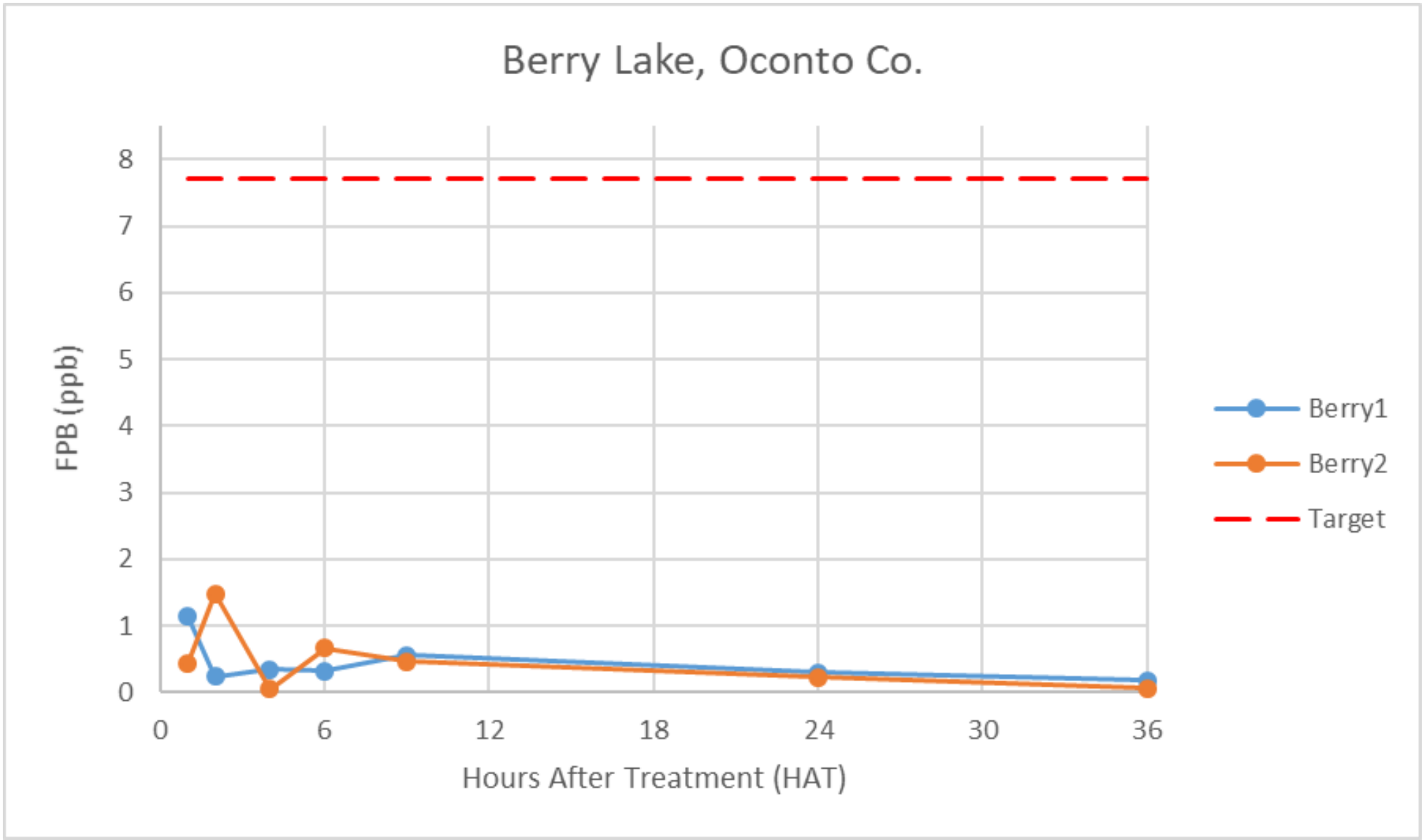
Berry, Oconto
Eastern Basin 2019 (pre)



Berry, Oconto
Eastern Basin 2020 (post)



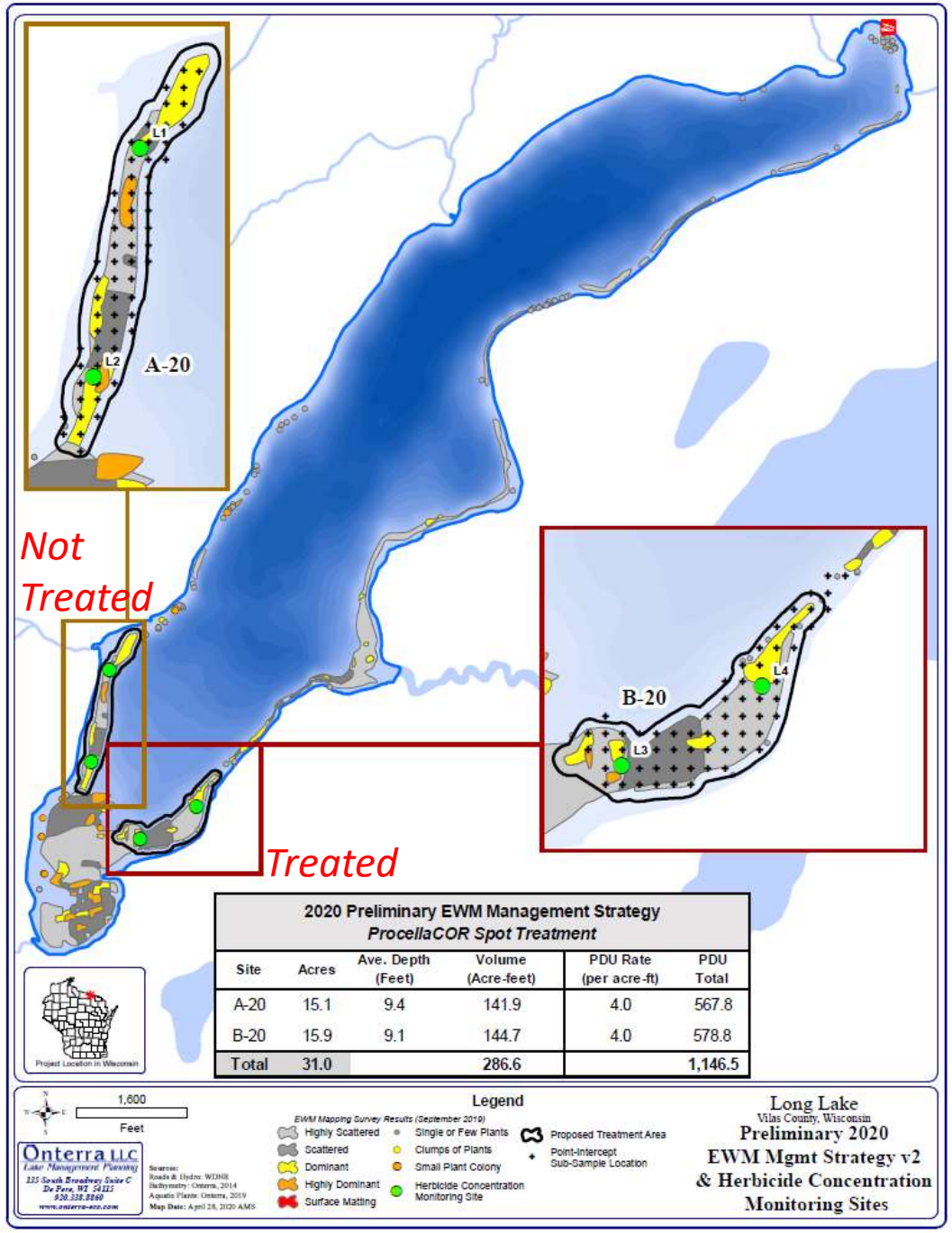
Berry Lake, Oconto Co.



Long Lake, Vilas Co.

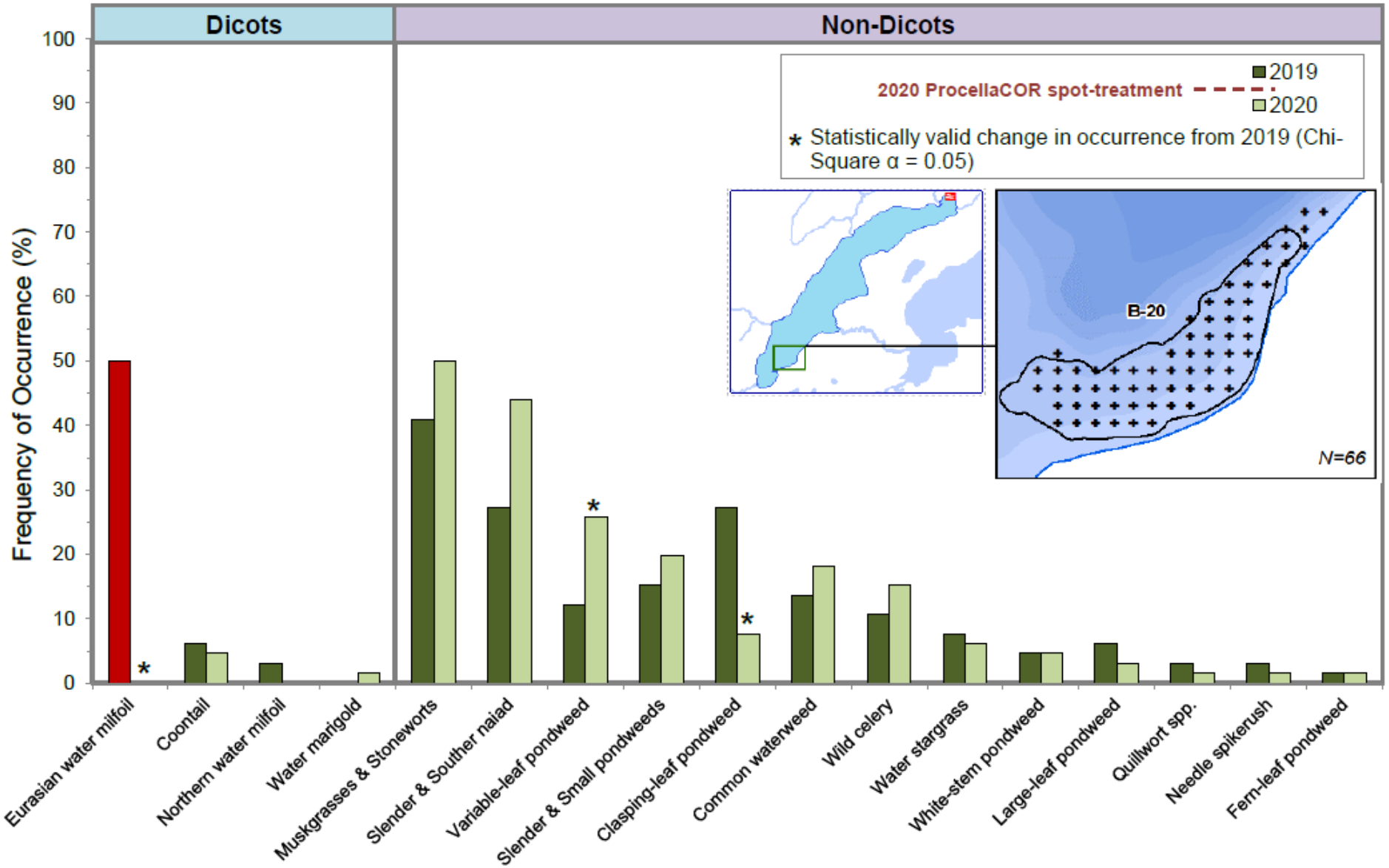
- Treatment Date: 6/17/2020
- Acreage: 15.9 ac
  - Site B-20 treated
  - Site A-20 not treated

    (monitored as reference)
- Applied Rate: 4.0 PDU/ac-ft



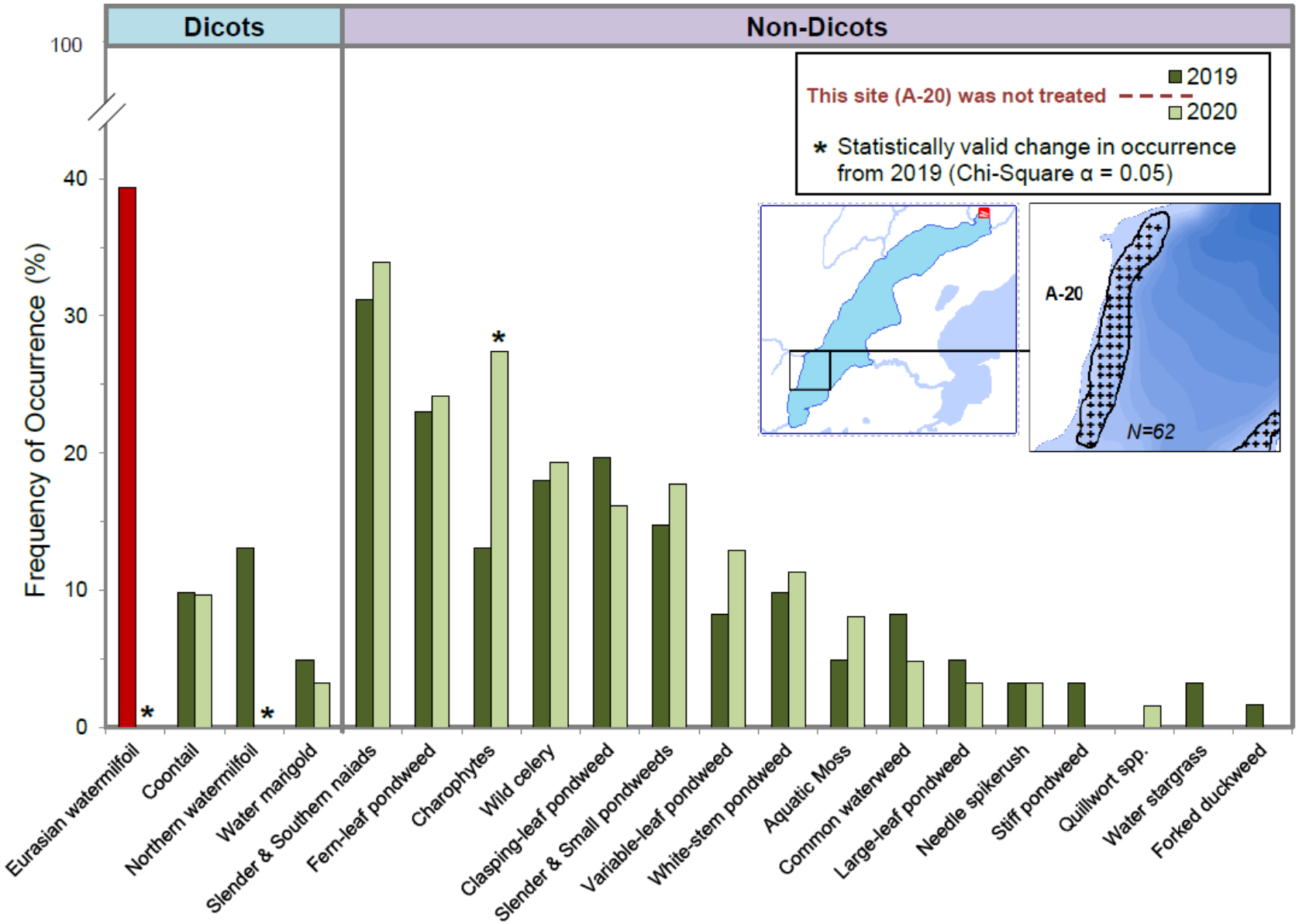
Data: Onterra, LLC

Long Lake, Vilas Co. (B-20: Treated)



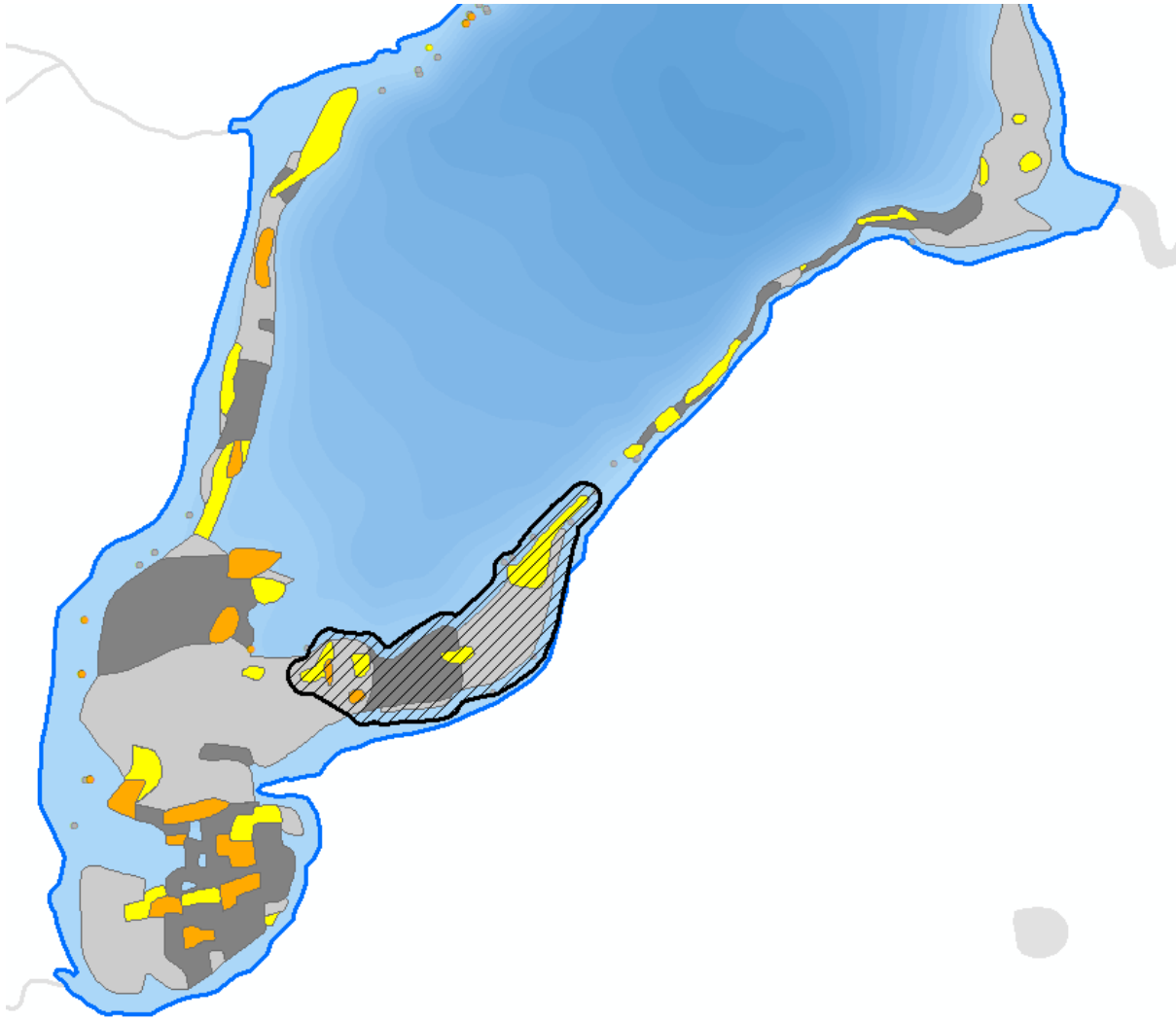
Data: Onterra, LLC

Long Lake, Vilas Co. (A-20: Untreated)

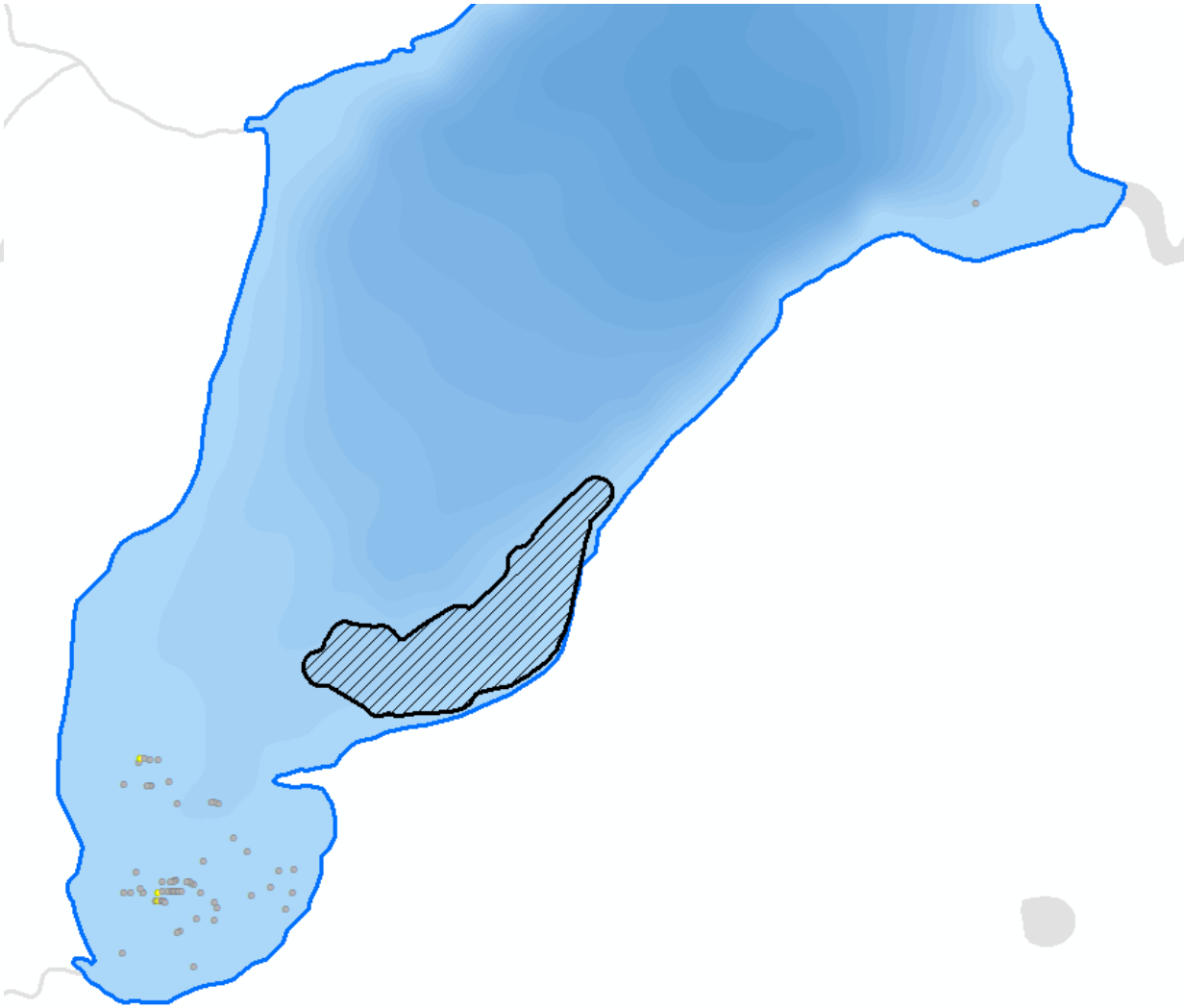


Data: Onterra, LLC

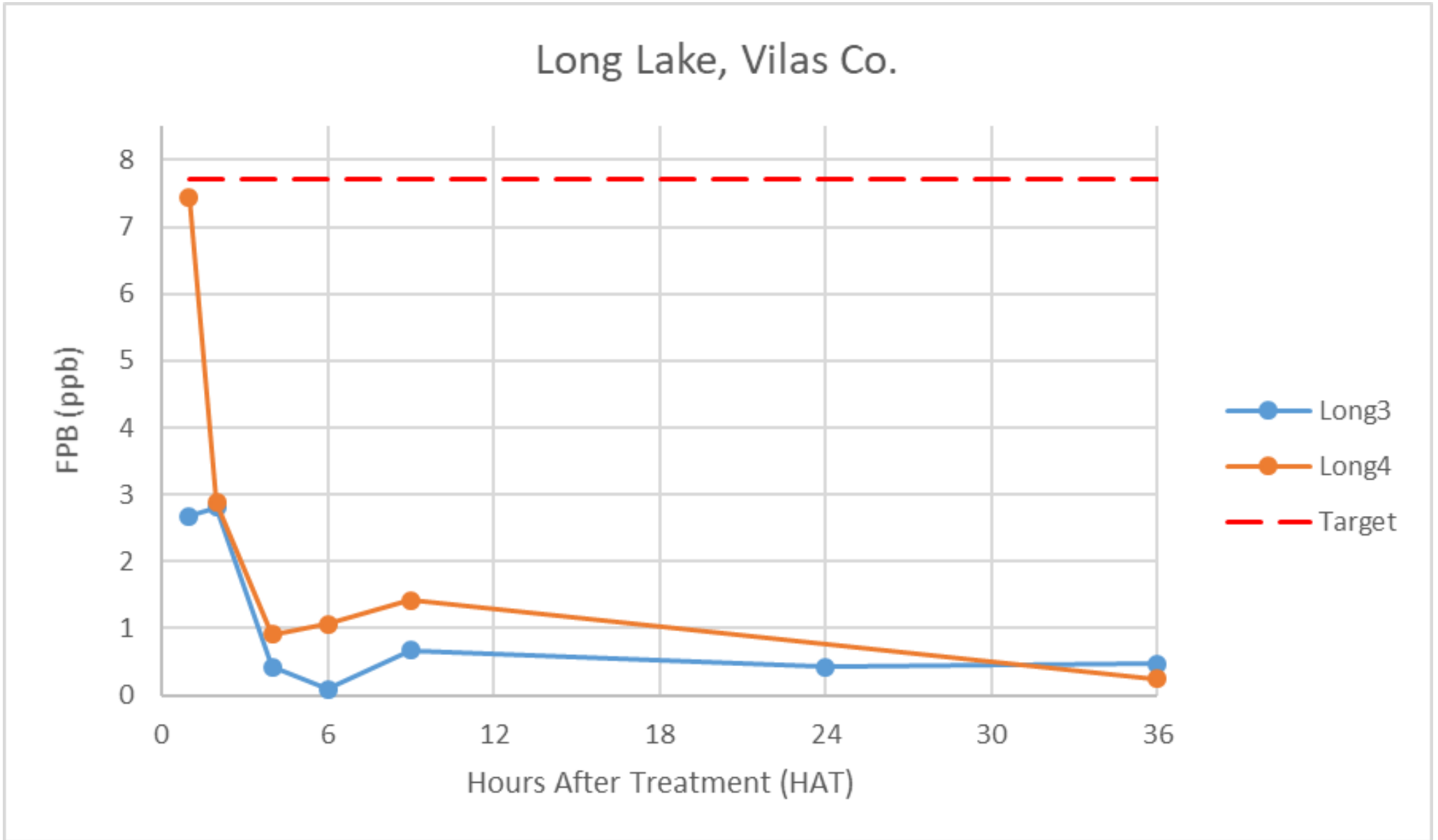
Long, Vilas
Southern Portion 2019 (pre)



Long, Vilas
Southern Portion 2020 (post)



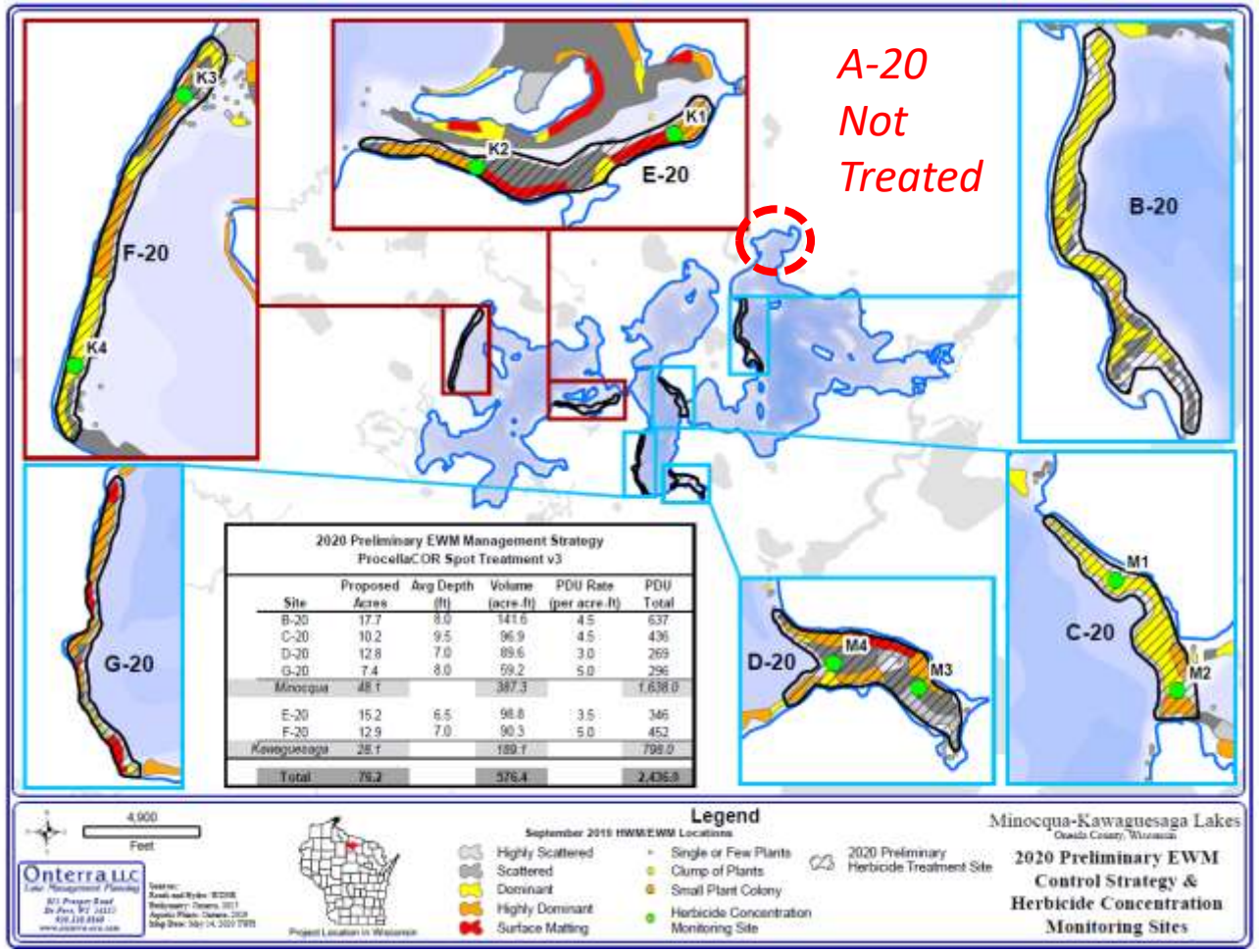
Long Lake, Vilas Co.



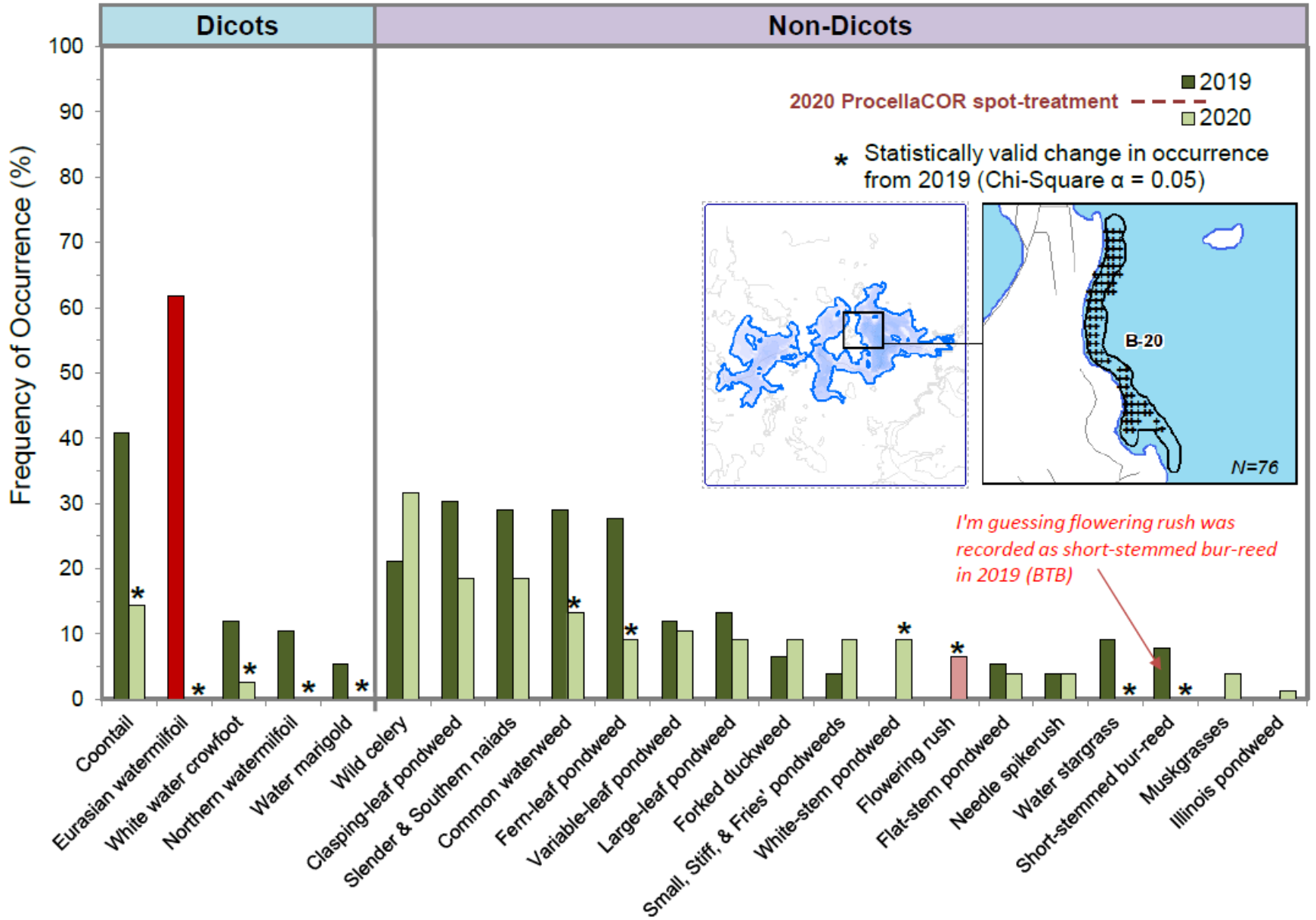
Lake Minocqua, Oneida Co.

- Treatment Date: June 15 & 30, 2020
- Acreage: 7.4, 10.2, 12.8 & 17.7 ac
  - Site A-20 not treated

    (monitored as reference)
- Applied Rate: 3.0 – 4.5 PDU/ac-ft

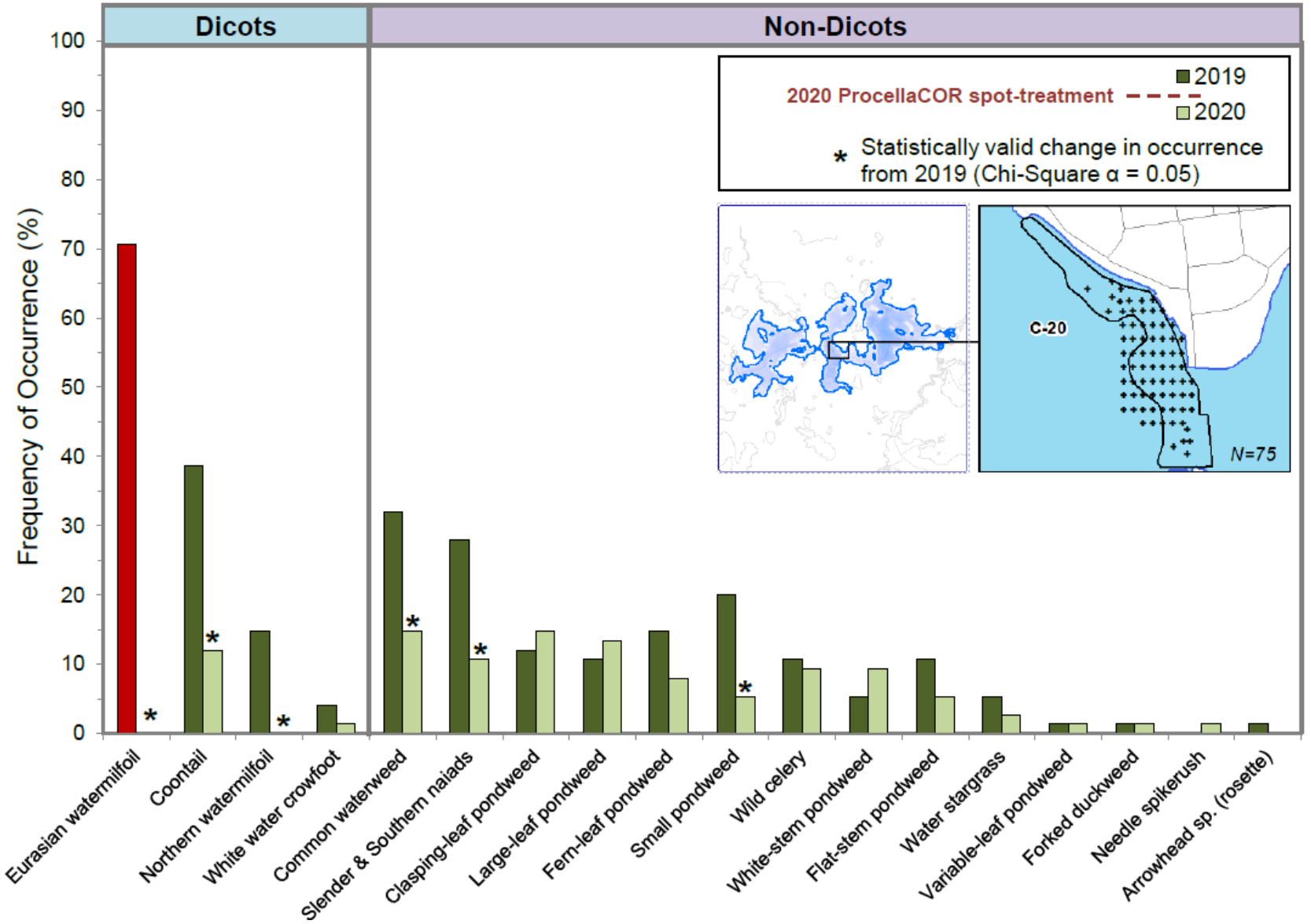


Lake Minocqua, Oneida Co.



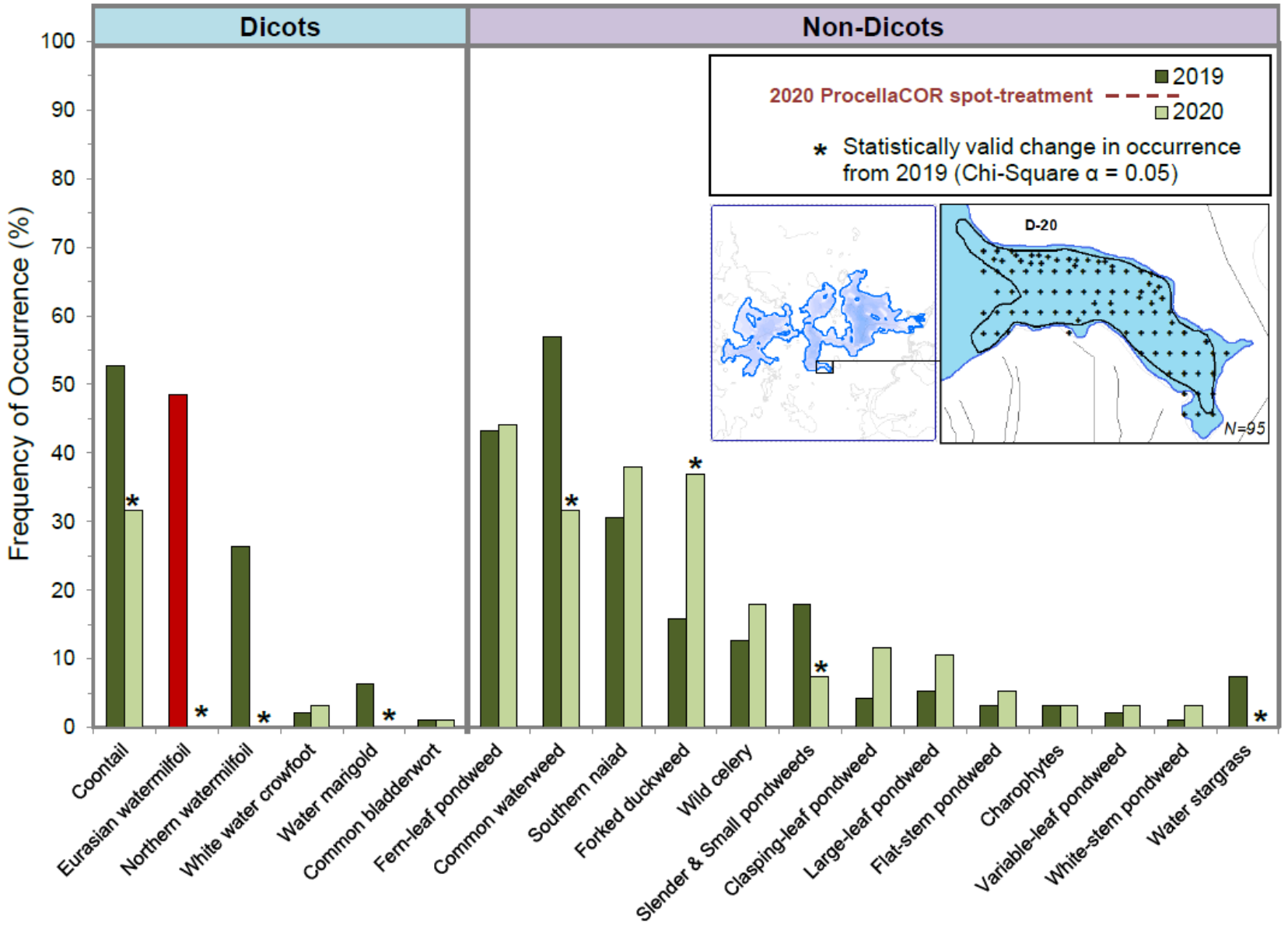
Data: Onterra, LLC

Lake Minocqua, Oneida Co.



Data: Onterra, LLC

Lake Minocqua, Oneida Co.



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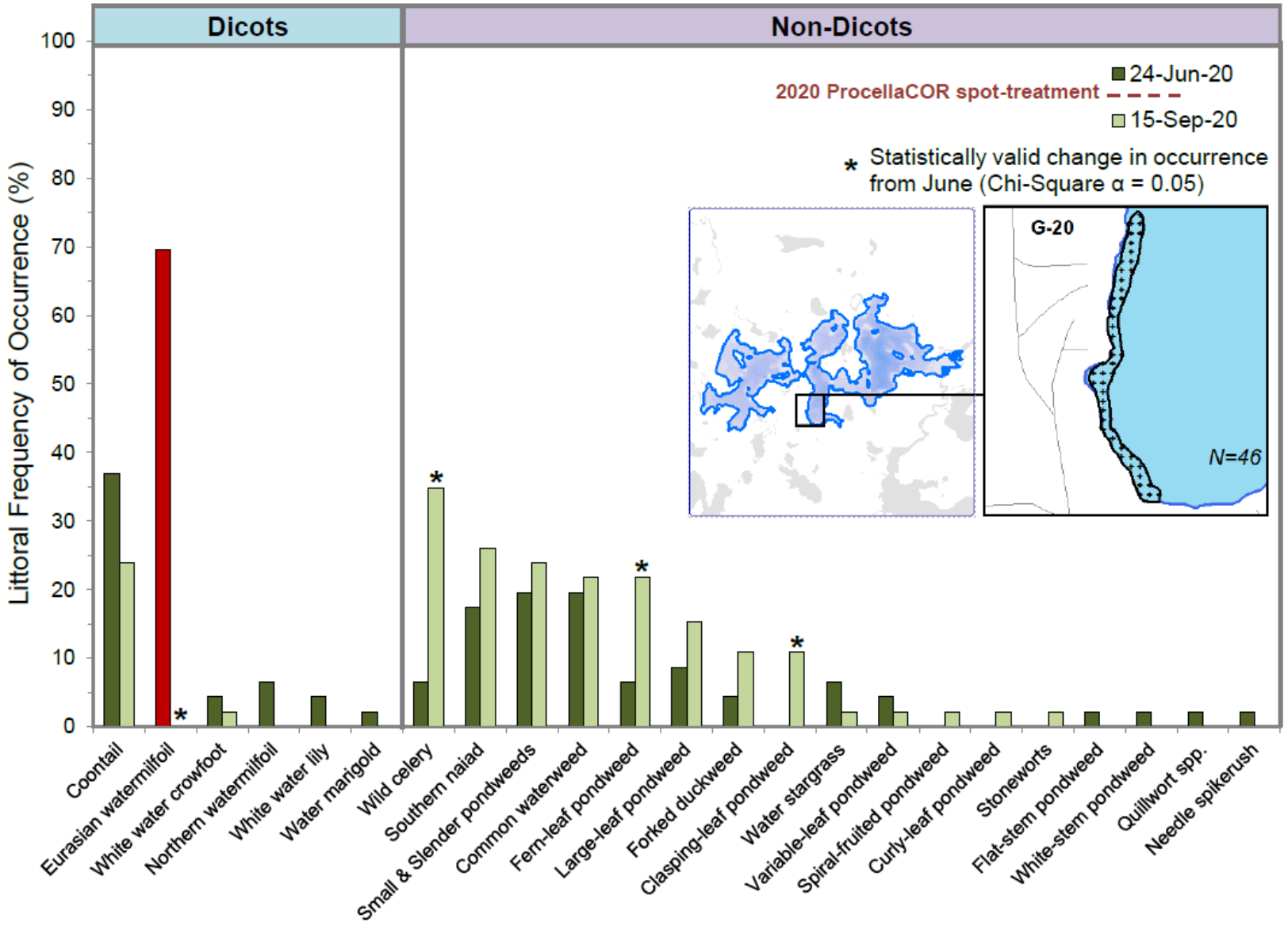
Lake Minocqua, Oneida Co.



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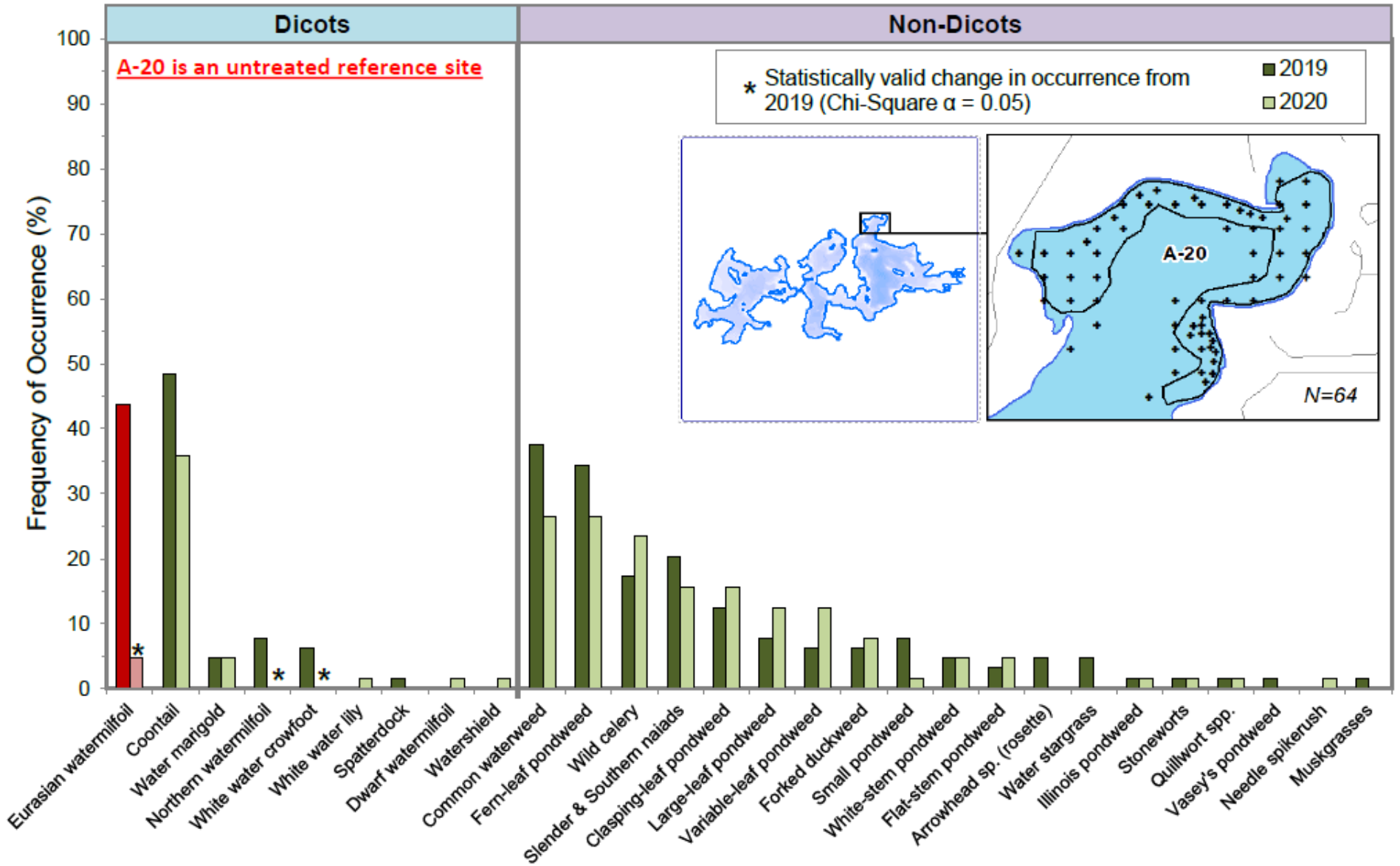
Lake Minocqua, Oneida Co.



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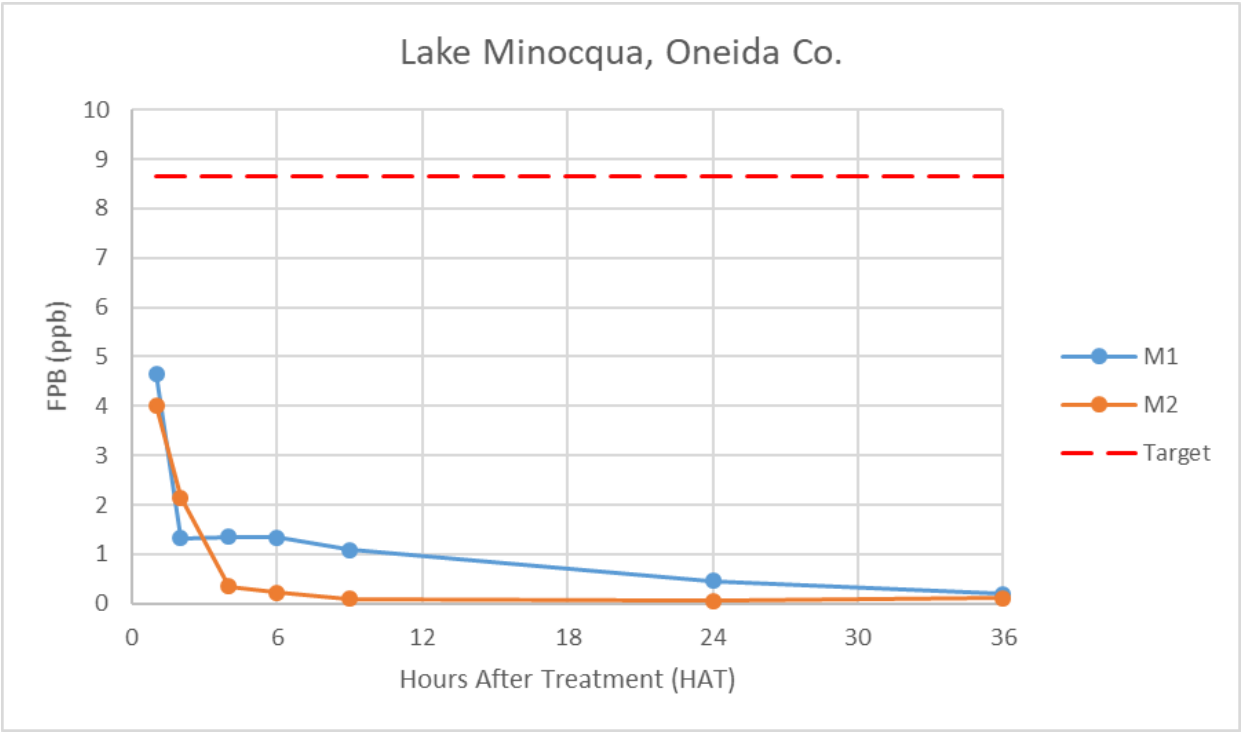
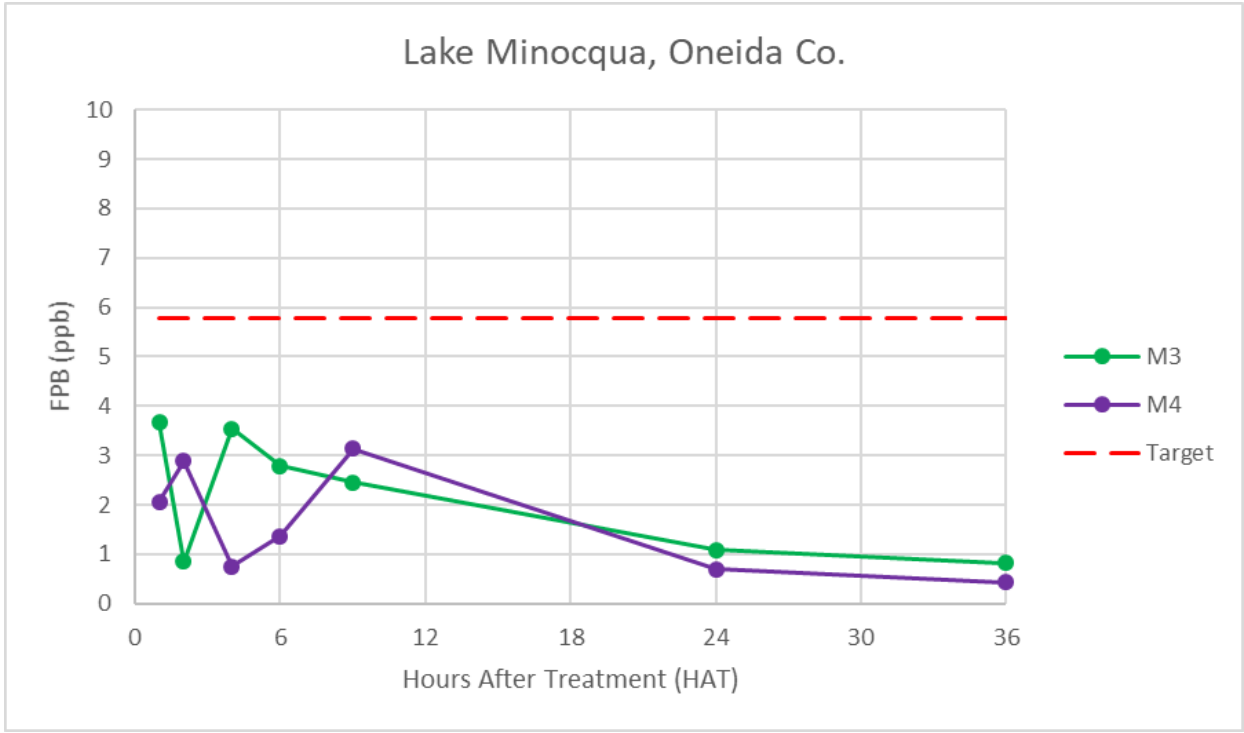
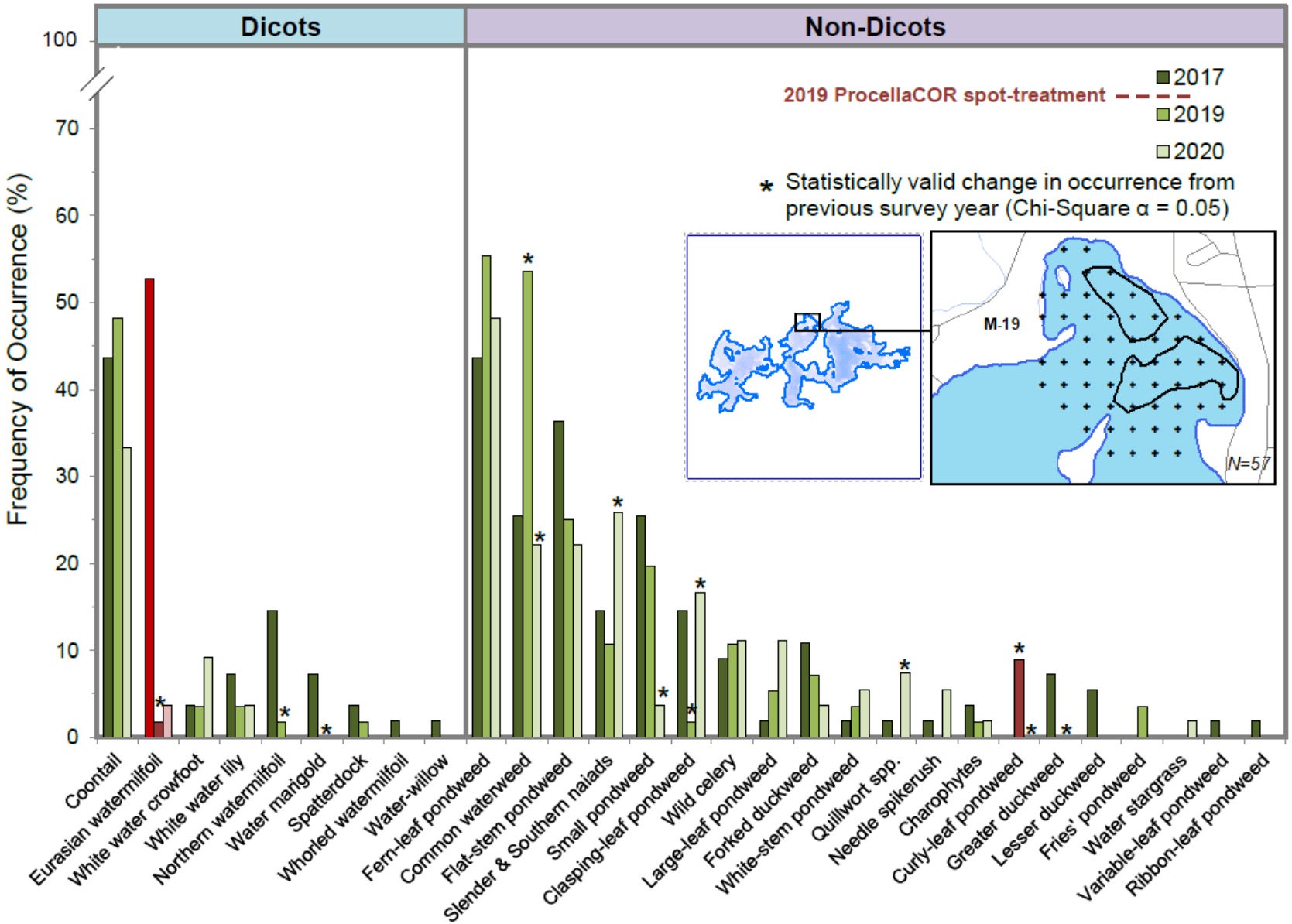
Lake Minocqua, Oneida Co.





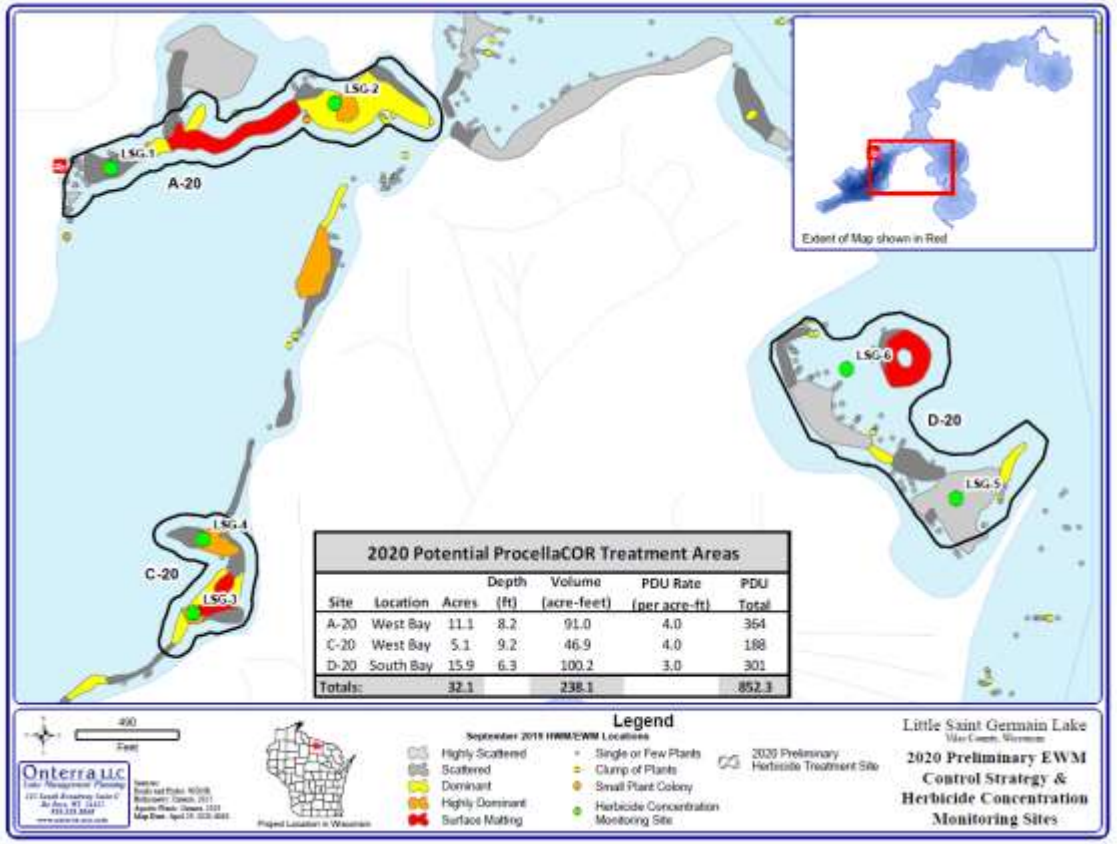
Lake Minocqua, Oneida Co. (M-19)



Data: Onterra, LLC

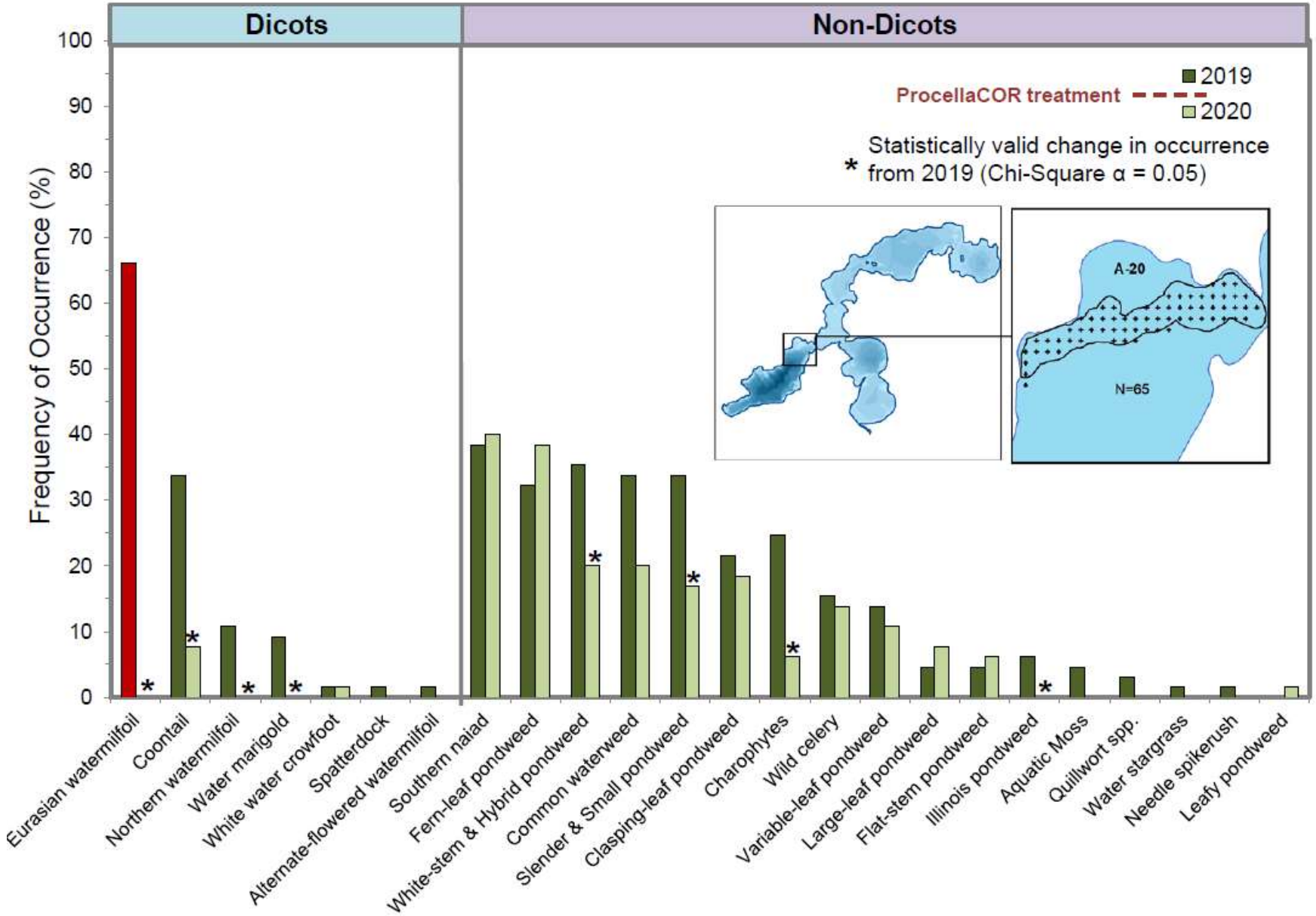
Little St. Germain Lake, Vilas Co.

- Treatment Date: June 12, 2020
- Acreage: 5.1, 11.1, & 15.9 ac
- Applied Rate: 3.0 - 4.0 PDU/ac-ft
  - No herbicide conc. samples



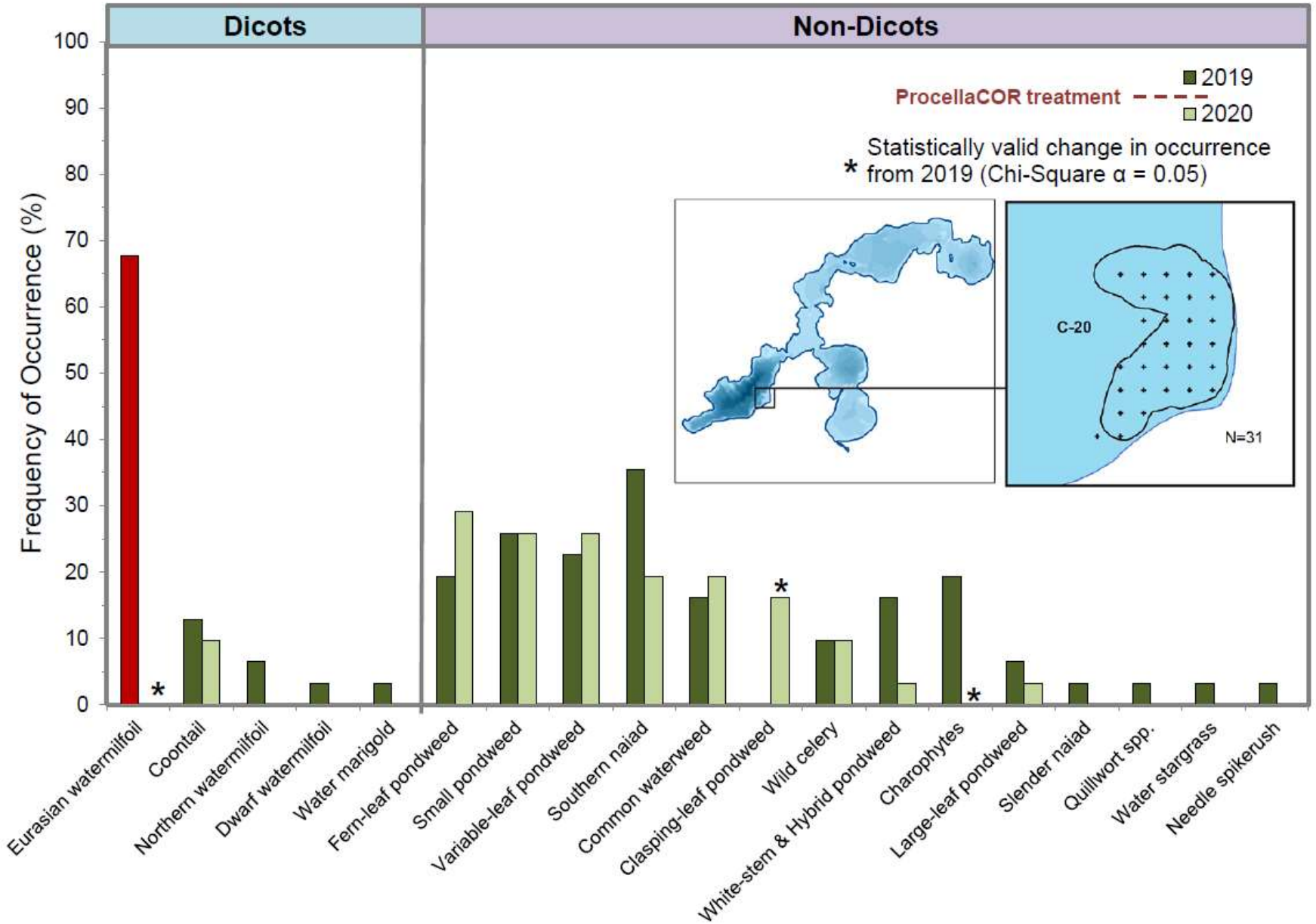
Data: Onterra, LLC

Little St. Germain Lake, Vilas Co.



Data: Onterra, LLC

Little St. Germain Lake, Vilas Co.



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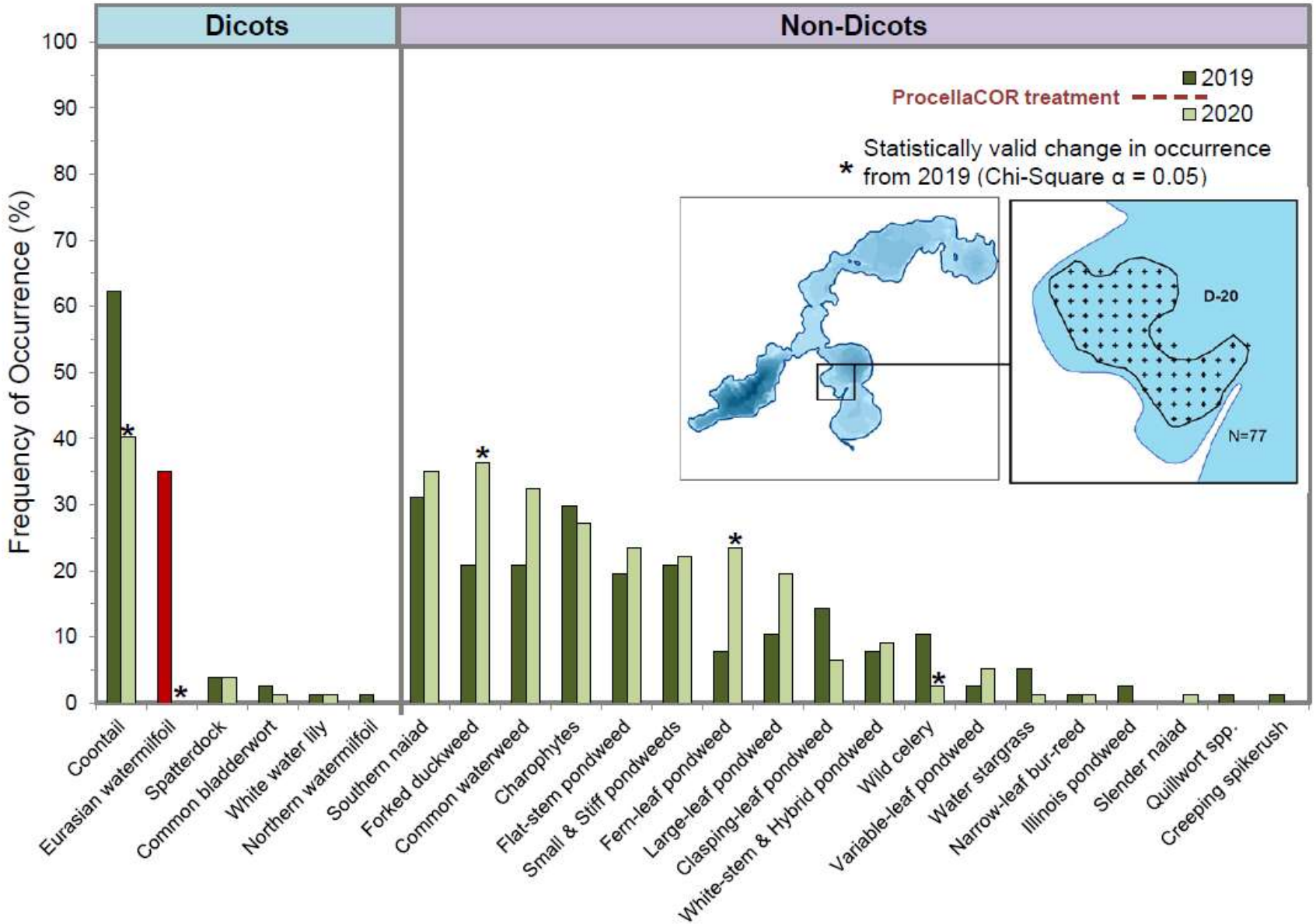
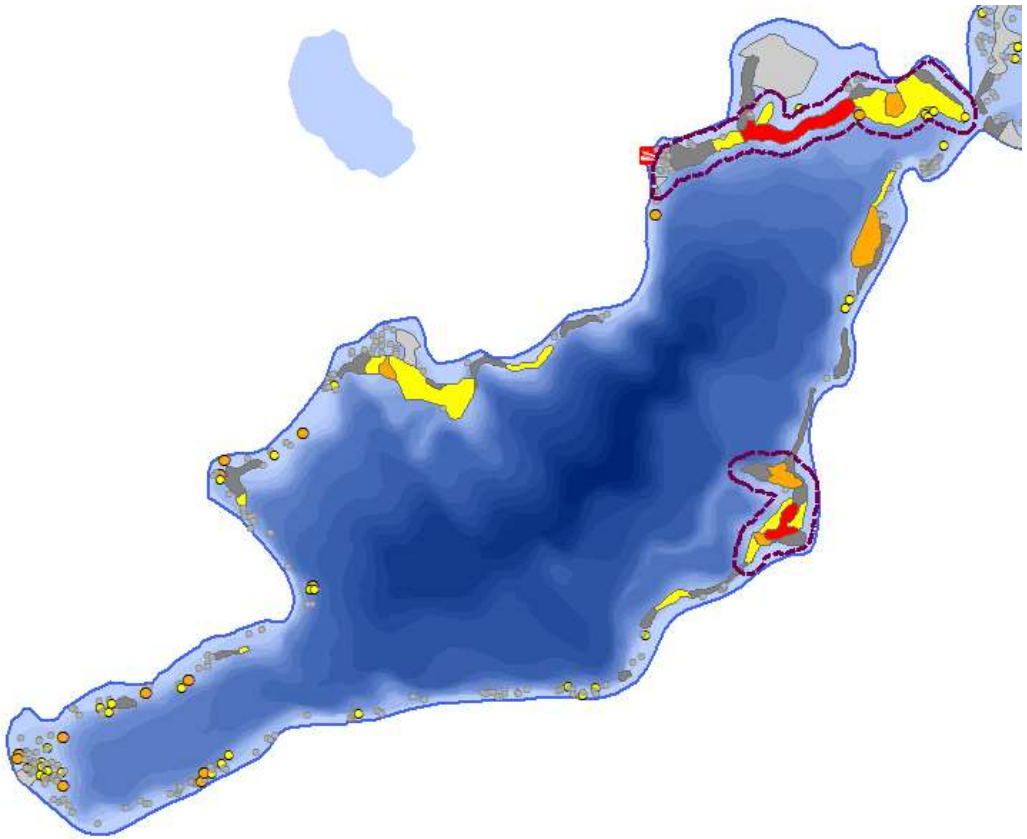
Little St. Germain Lake, Vilas Co.

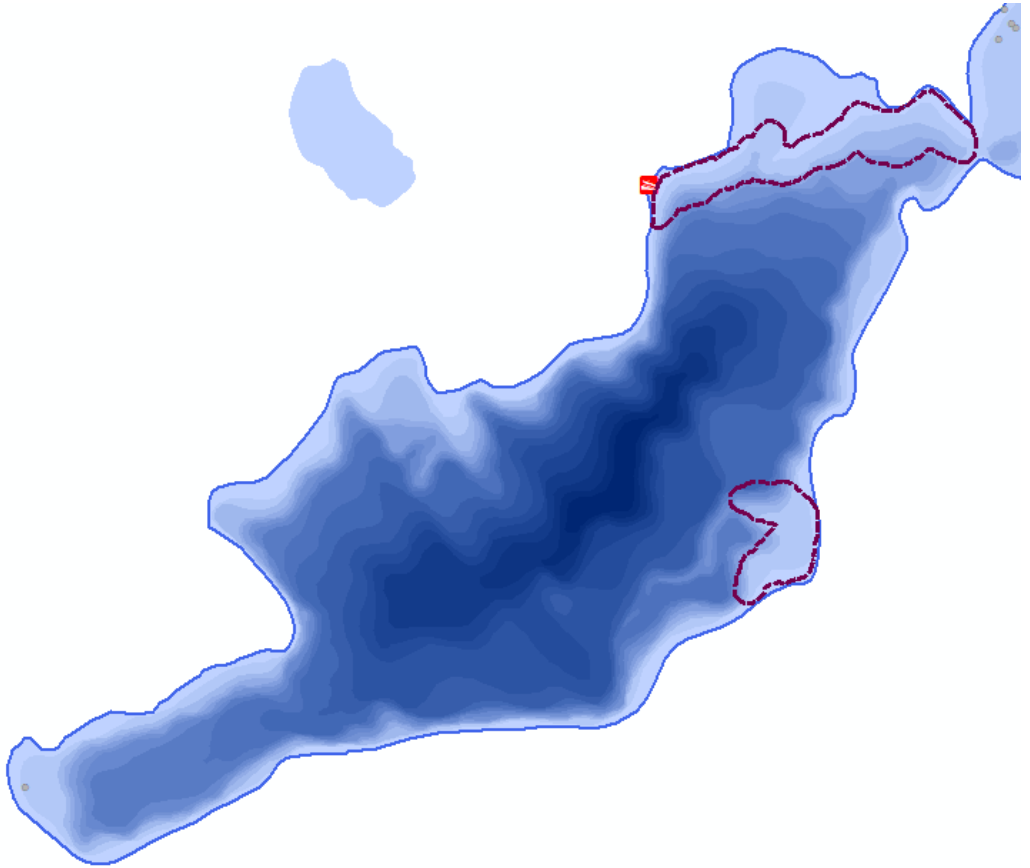


Data: Onterra, LLC

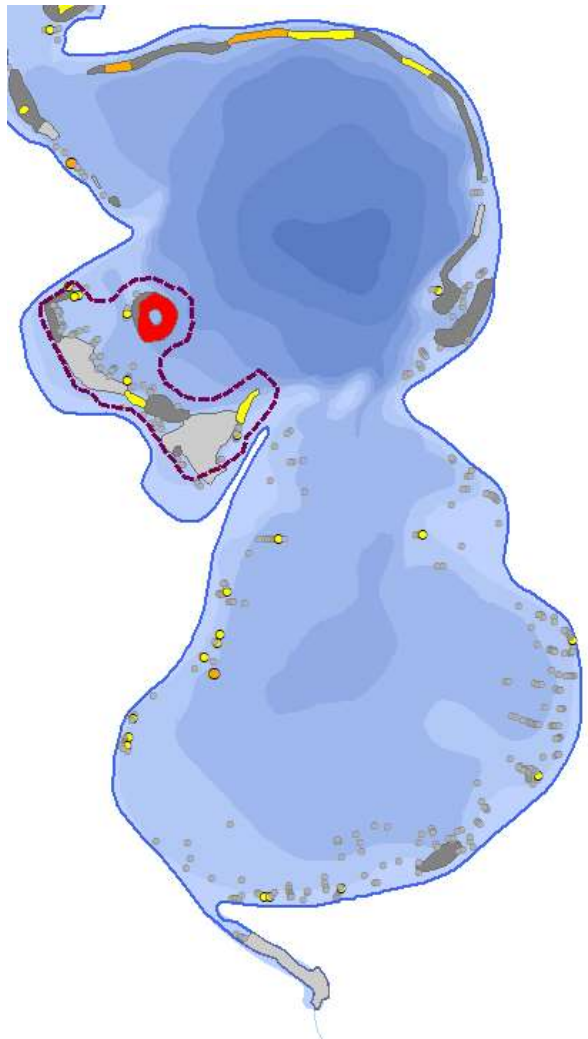
Little Saint Germain, Vilas
West Bay 2019 (pre)



Little Saint Germain, Vilas
West Bay 2020 (post)



Little Saint Germain, Vilas
South Bay 2019 (pre)



Little Saint Germain, Vilas
South Bay 2020 (post)

Preliminary Conclusions

- Statistically significant non-native watermilfoil control was achieved during year of treatment in many, but not all ProcellaCOR case studies monitored to date.
- Additional data on milfoil control efficacy collected at one YAT on a small sub-set of lakes observed sustained reductions in non-native milfoil on the majority of the waterbodies, with some limited milfoil re-growth observed.
- Field evaluation efforts in 2020 also provided some evidence which suggests that the observed impacts following these localized ProcellaCOR treatments may have potentially extended to areas beyond the immediate treatment areas. This observation supports conducting additional research to better understand the actual scale of impact following ProcellaCOR treatments which are permitted at a localized scale.
- Statistically significant declines were observed with some native plant species, particularly several dicots (i.e., native watermilfoils, water marigold, white water crowfoot, etc.), while other native plant species did not exhibit any statistical changes.
- Additional data on native plant selectivity collected at one YAT on a small sub-set of lakes observed sustained reductions in the native plant species which exhibited initial declines following treatment.

WISCONSIN
DEPT. OF NATURAL RESOURCES

PRIORITIZING MANAGEMENT AND PREVENTION

for Eurasian watermilfoil

PART ONE

UNDERSTANDING INVADER IMPACTS

Not all non-native species are created equal

https://allthatsinteresting.com/invasive-species

Killer Fish And Man-Eating Snakes: Nine Invasive Species That Are Destroying America

Image Source: National Geographic Channel

Image Source: http://www.startribune.com/leaping-fish-why-asian-carp-must-be-stopped/217839421/

Image Source: NBC News

Image Source: The Sacramento Bee

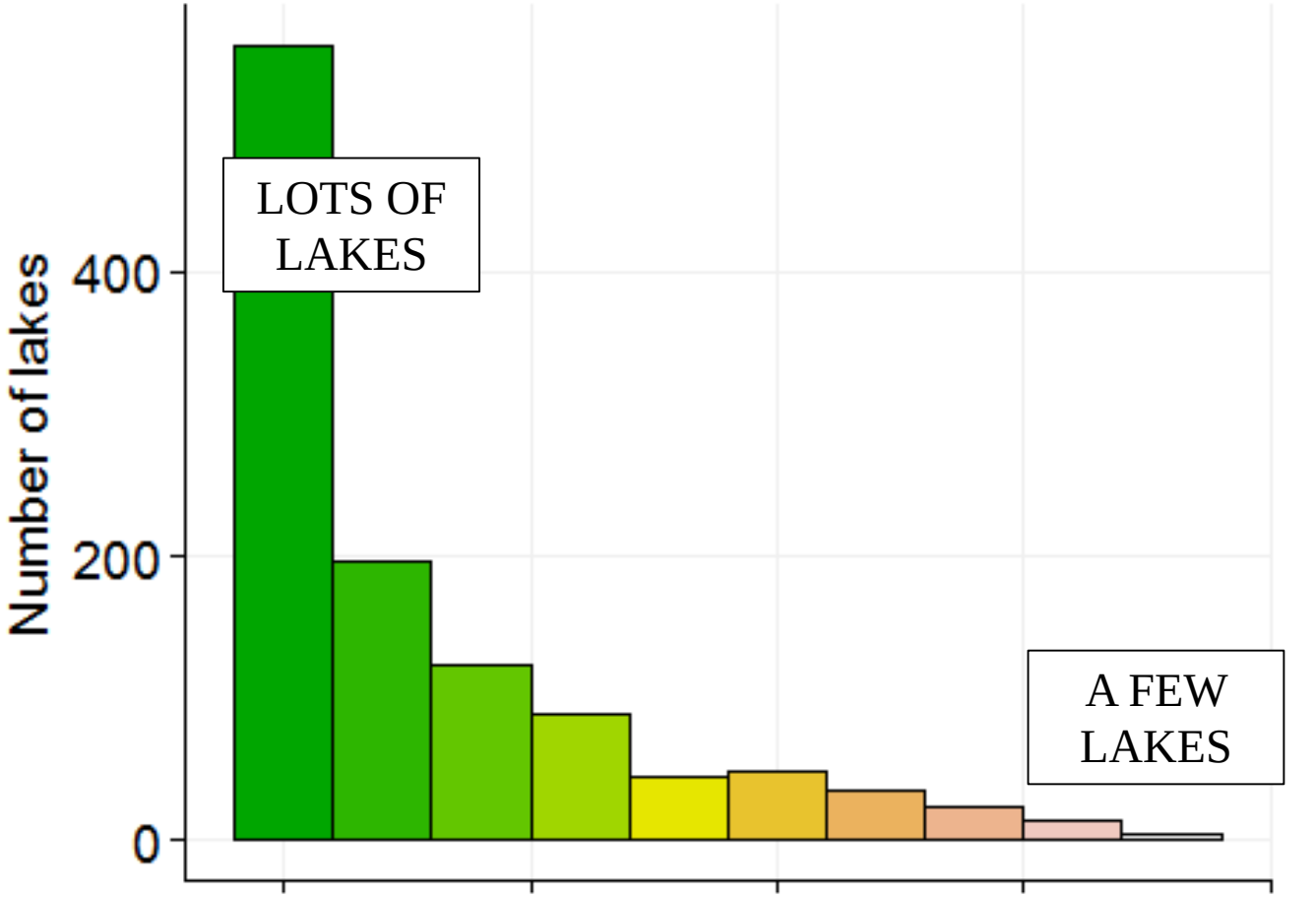
SOME, BUT NOT ALL INVADERS HAVE LARGE IMPACTS

Table 2. Total number and percentage of alien species known to have an ecological or economic impact for different taxonomic groups in Europe*

Taxonomic group	*Total*	*Ecological impact (%)*	*Economic impact (%)*
Terrestrial plants	5789	326 (5.6)	315 (5.4)
Terrestrial invertebrates	2481	342 (13.8)	601 (24.2)
Terrestrial vertebrates	358	109 (30.4)	138 (38.5)
Freshwater flora and fauna	481	145 (30.1)	117 (24.3)
Marine flora and fauna	1071	172 (16.1)	176 (16.4)

*DAISIE database search at 12 Feb 2008

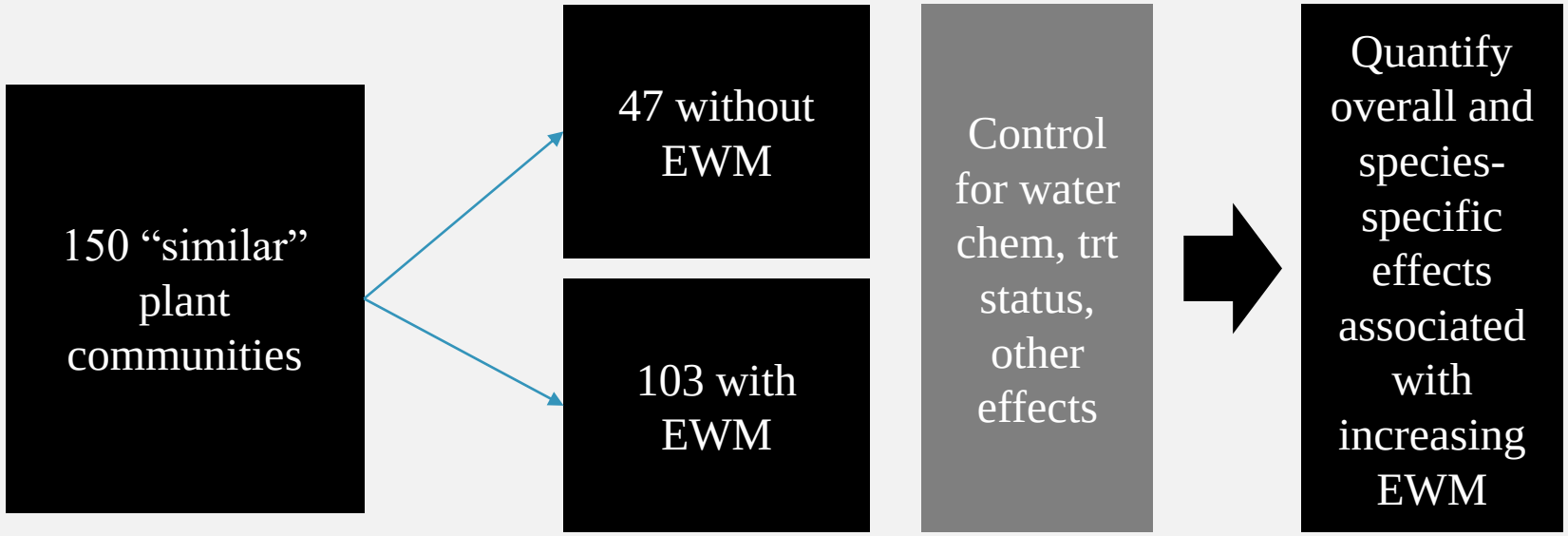
WE TEND TO FIXATE ON “INFESTATIONS” BUT NON-NATIVE SPECIES OFTEN DON’T TAKE OVER.



CONTRADICTIONS IN THE LITERATURE?

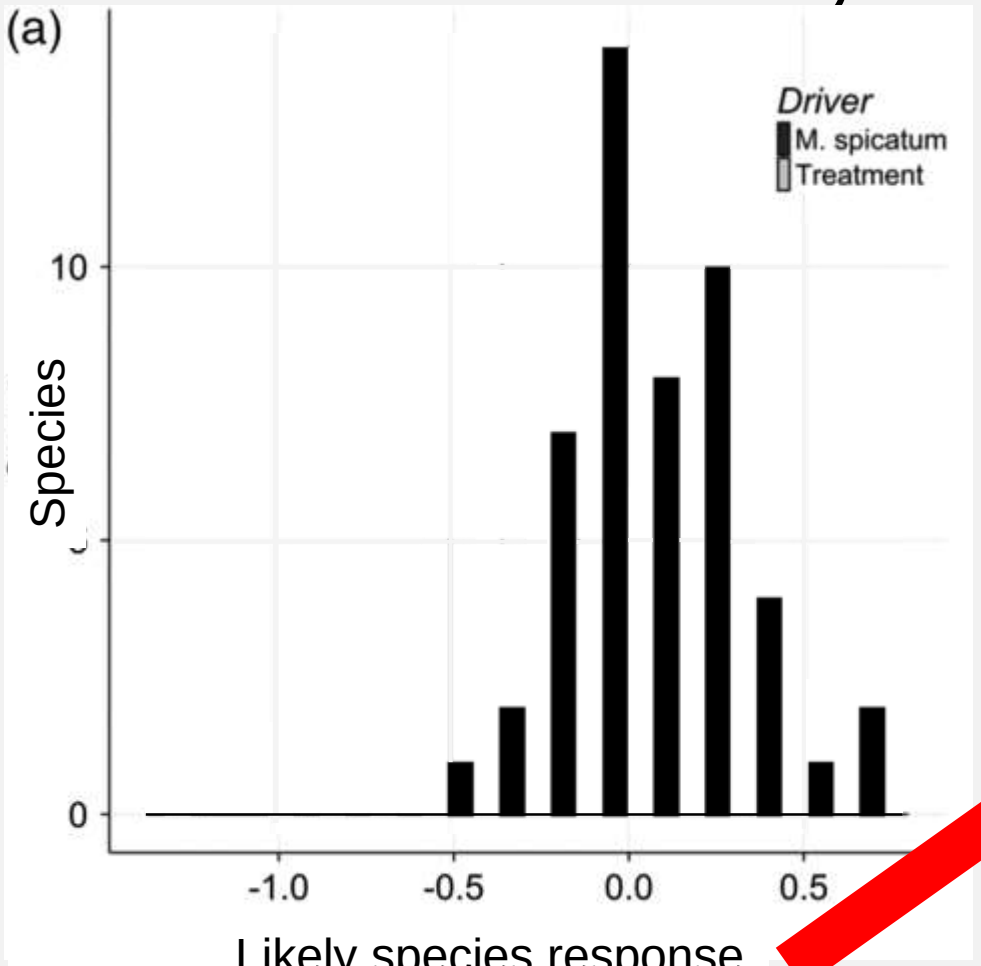
- Studies that focus on 1 or a handful of systems report **negative effects of EWM.**
  - E.g. Boylen et al. 1999; Madsen et al. 1991
- Large-scale studies with a landscape focus report **neutral or positive effects of EWM**.
  - E.g. Trebitz and Taylor 2007; Grafe 2014; Muthukrishnan et al. 2018

WISCONSIN DEPT. OF NATURAL RESOURCES



Y since intro
Min = 1y
Max = 54y
Mean = 16yr

WHEN EWM ABUNDANCE INCREASES, SPECIES RESPONSE WAS VARIABLE, OFTEN POSITIVE



Surprising result?

Native and non-native species *alike* are probably responding to underlying, uncaptured variation in local conditions that are "good for plants"

Other native species were associated with bigger, more negative effects than EWM.

At this landscape scale, negative abundance associations are relatively infrequent.

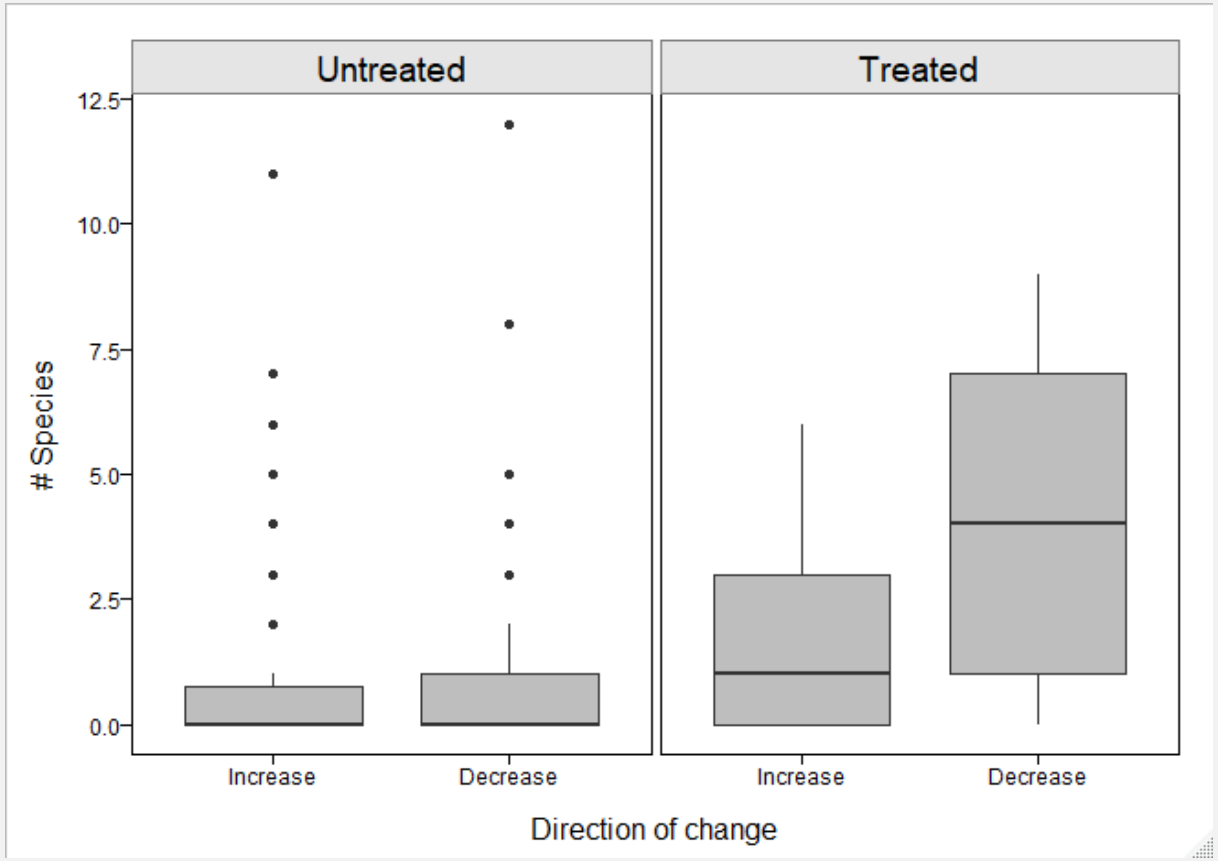
WHAT IS THE EFFECT OF LAKEWIDE MANAGEMENT?

Single system

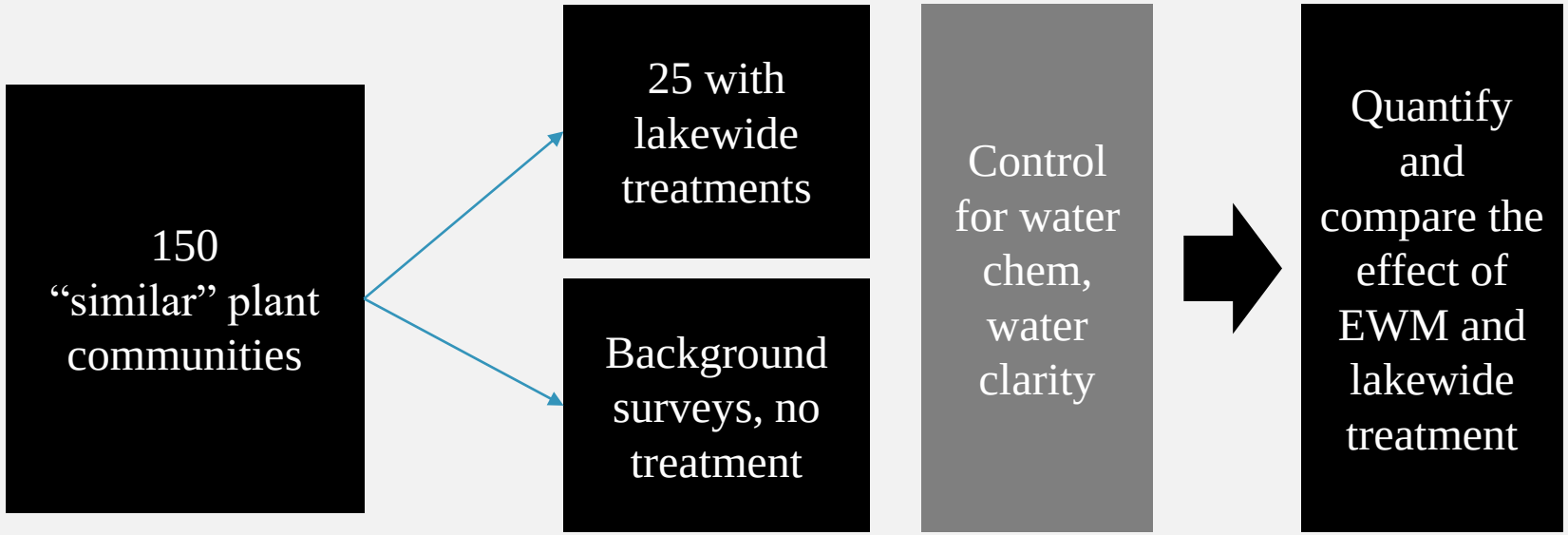
Set of case studies

Landscape-scale study

FOR EWM, LAKEWIDE HERBICIDE TREATMENTS ARE OFTEN ASSOCIATED WITH BIG CHANGES FOR NATIVE PLANTS

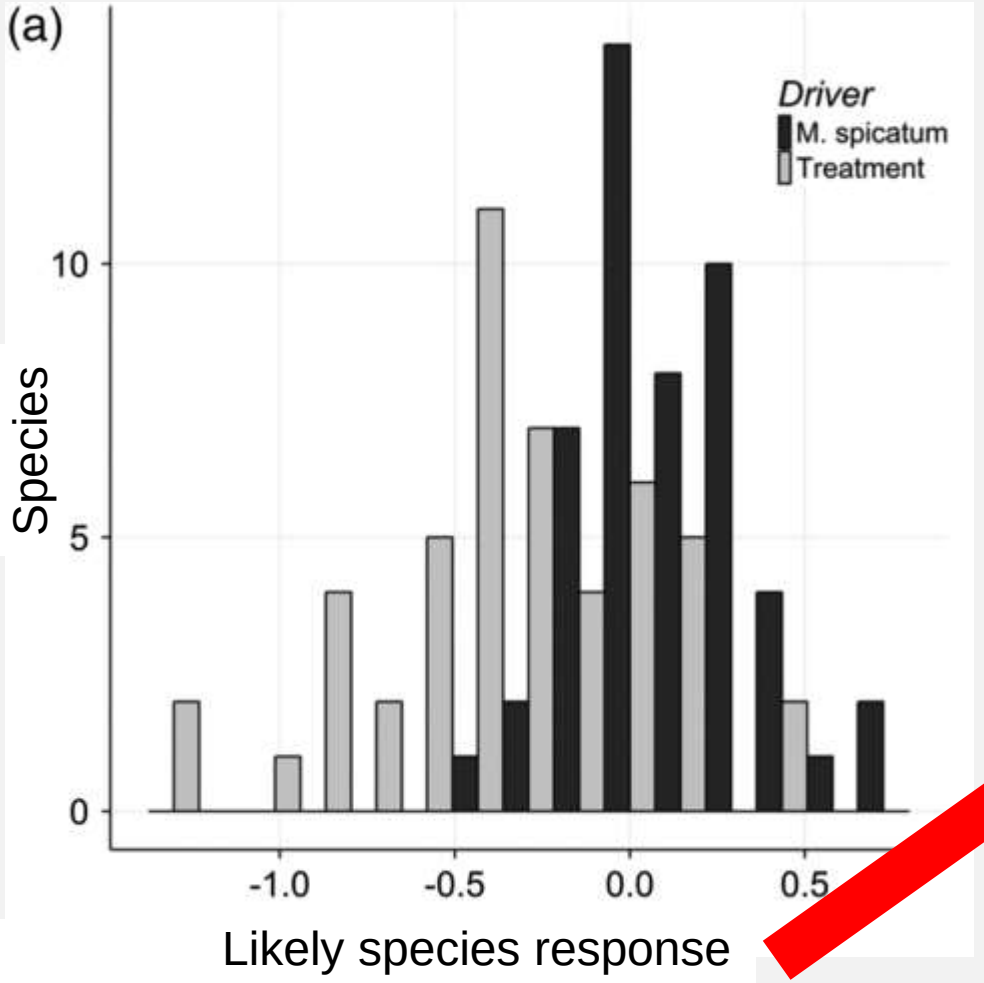


BUT IF EWM IMPACTS ARE BIGGER, THE COST COULD BE WORTH IT



Various treatment strategies, all designed to have lakewide effects

OTHER DRIVERS, INCLUDING SOME NATIVE SPECIES, WATER CHEM, AND TREATMENT HAD A LARGER EFFECT



Variability in species-specific response was greater and more often negative for treatment than EWM.

Lakewide treatments were associated with bigger shifts in community composition.

Lakewide treatments may potentially favoring some species over others.

IMPORTANT CAVEATS

Could these responses to treatment be temporary?

Yes! But we lacked data from 3, 4, & 5 years after treatment without additional management interventions. This made “community recovery” difficult to study.

Other literature shows that certain native species rebound following treatment, but so does EWM, leading to additional management intervention

We can reason based on the findings, that repeated lakewide treatments are likely to have cumulative effects worth considering, and which may interfere with recovery.

Looking at long-term responses would be a great idea for future research.

IMPORTANT CAVEATS

So is lakewide treatment *never* a good idea?

Not necessarily. What this work tells us is **not** that lakewide treatment is never appropriate, just that lakewide herbicide treatments should be used judiciously, reserved for situations where the adverse effects of EWM are clear.

Ecological effects are just one reason to manage EWM – the recreational effects and other impacts are still important to consider. This study shows us that if your main goal is to protect the native plant community…

PREVENTION IS IMPORTANT, CONTROL CAN HELP, CARE IS KEY.

TREATMENTS CAN HAVE A COST TOO.

MAIN FINDINGS

In summary,

- Management solutions are never one-size-fits-all
- Lakewide herbicide treatments are effective for EWM control, but they can have negative effects too.
- For the most part, EWM and native species show more positive associations than negative
- Lakewide herbicide treatments should be used judiciously, reserved for situations where the adverse effects of EWM are clear.

Mikulyuk et al. 2020. Is the cure worse than the disease? Comparing the ecological effects of an invasive aquatic plant and the herbicide treatments used to control it. *FACETS. 5(1)*

https://www.facetsjournal.com/doi/full/10.1139/facets-2020-0002

SO WHAT?

After a new introduction, it's appropriate to act early, but appropriately.

Does that mean we need to see the future?

PART TWO

PREDICTING WHERE AND HOW TO ACT

Focus on the most vulnerable lakes first

VULNERABLE LAKES: WHERE EWM CAN ARRIVE, SURVIVE, AND THRIVE

Lake-specific vulnerability has three parts

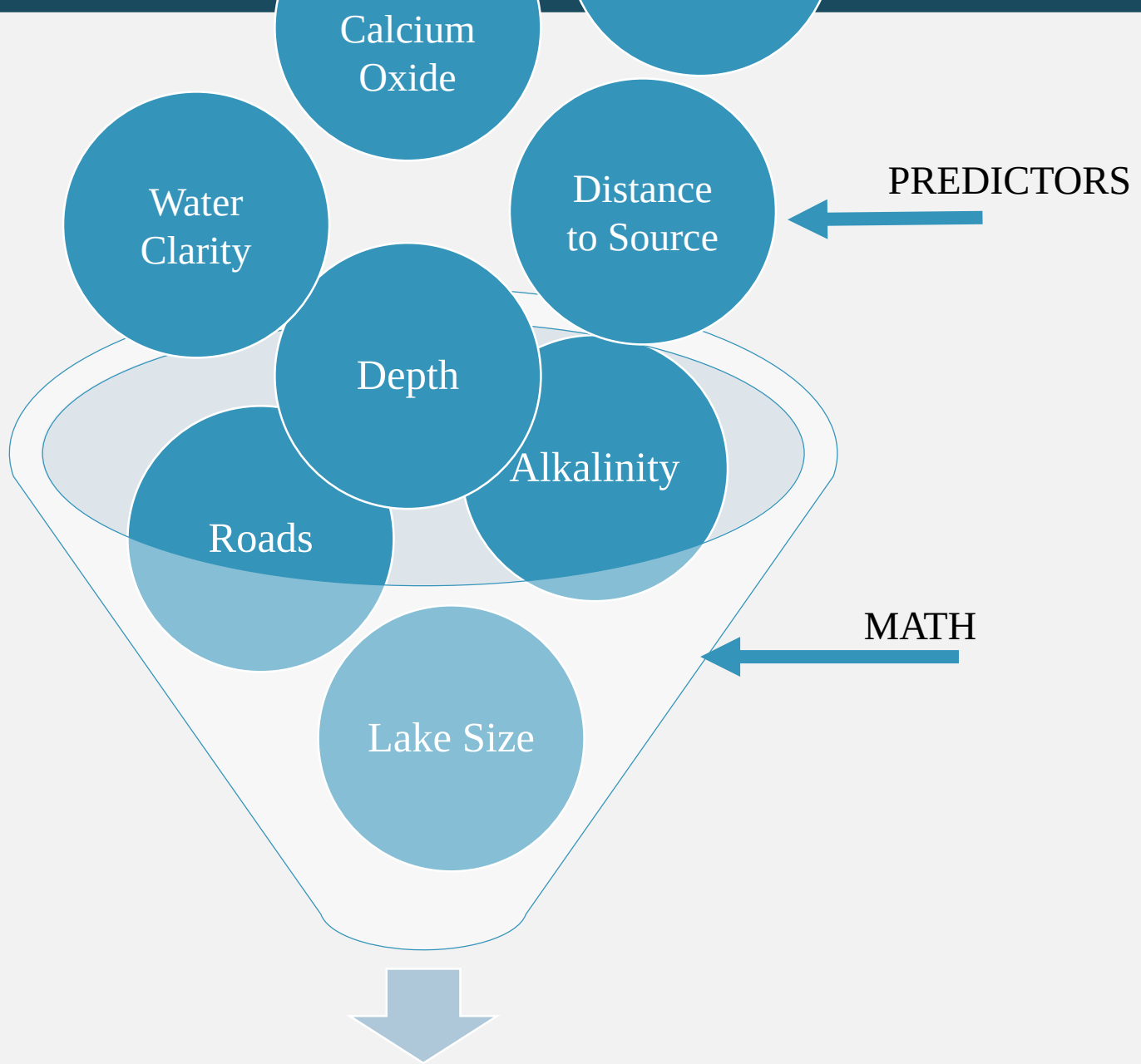
Where will it occur?

- Consider movement across the landscape and lake characteristics
- Where will it **arrive** and **survive**?

Where will it be abundant?

- Consider lake characteristics
- Where will it **thrive**?

USE WHAT WE KNOW ABOUT TRANSPORT AND HABITAT PREFERENCES TO PREDICT VULNERABLE LAKES

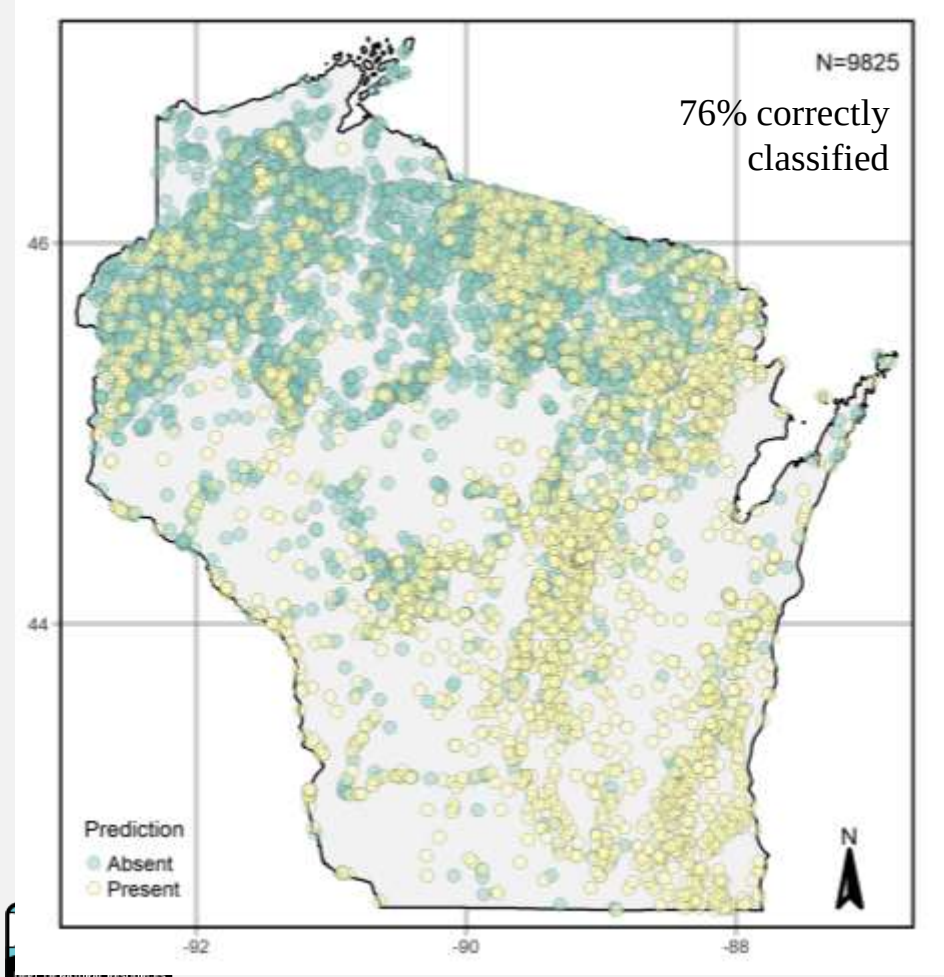

Calcium Oxide
Water Clarity
Distance to Source
PREDICTORS
Depth
Alkalinity
Roads
MATH
Lake Size

EWM MAPS

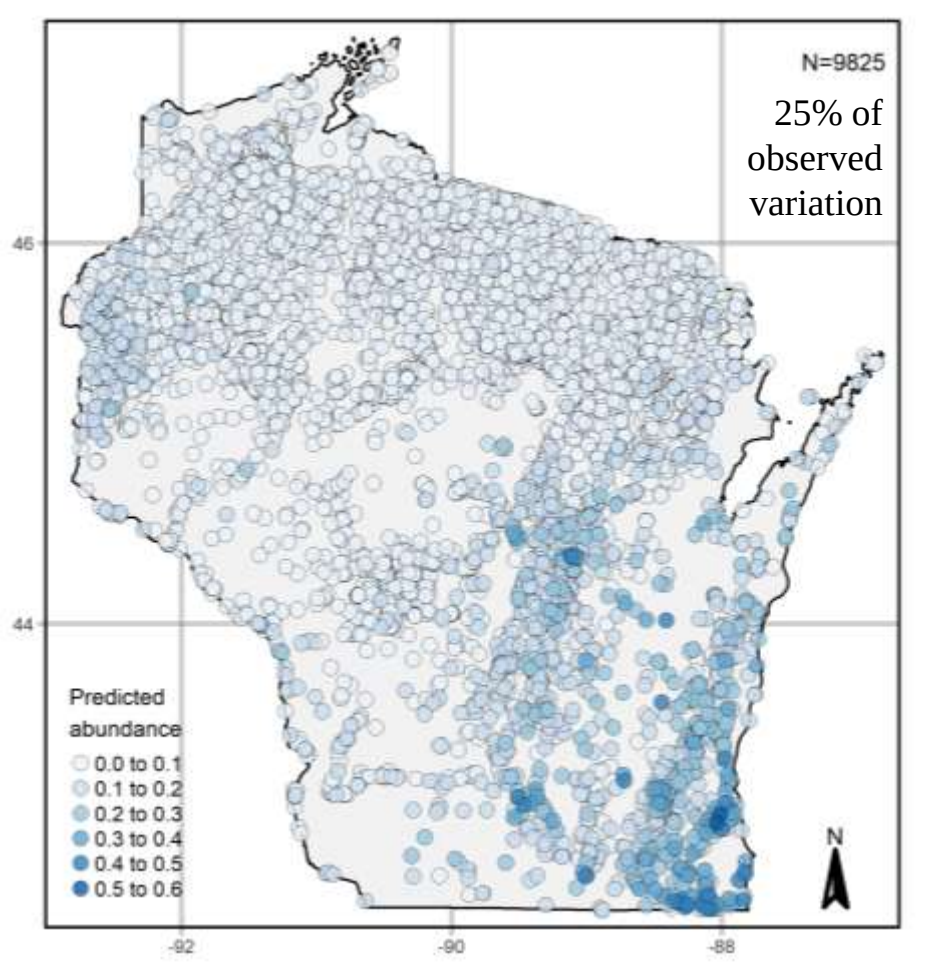
RESULTS: EWM MAPS

https://www.mdpi.com/1424-2818/12/10/394

PREDICTED OCCURRENCE



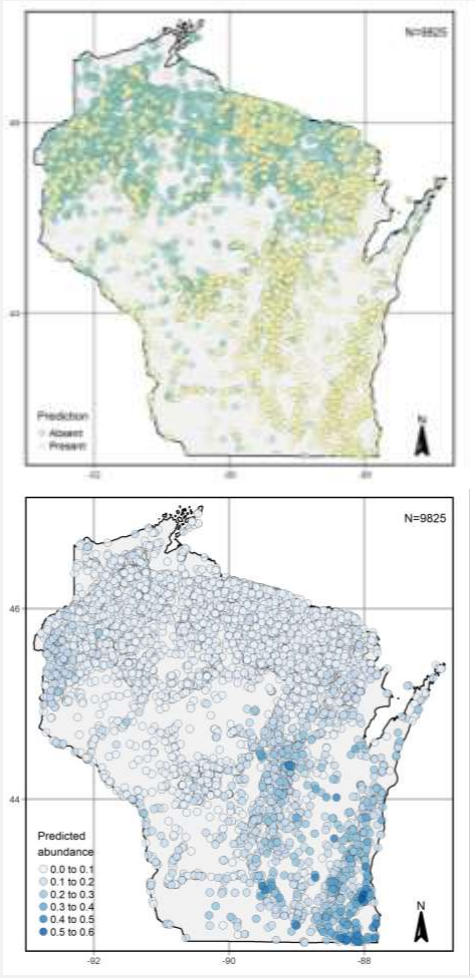
PREDICTED ABUDANCE

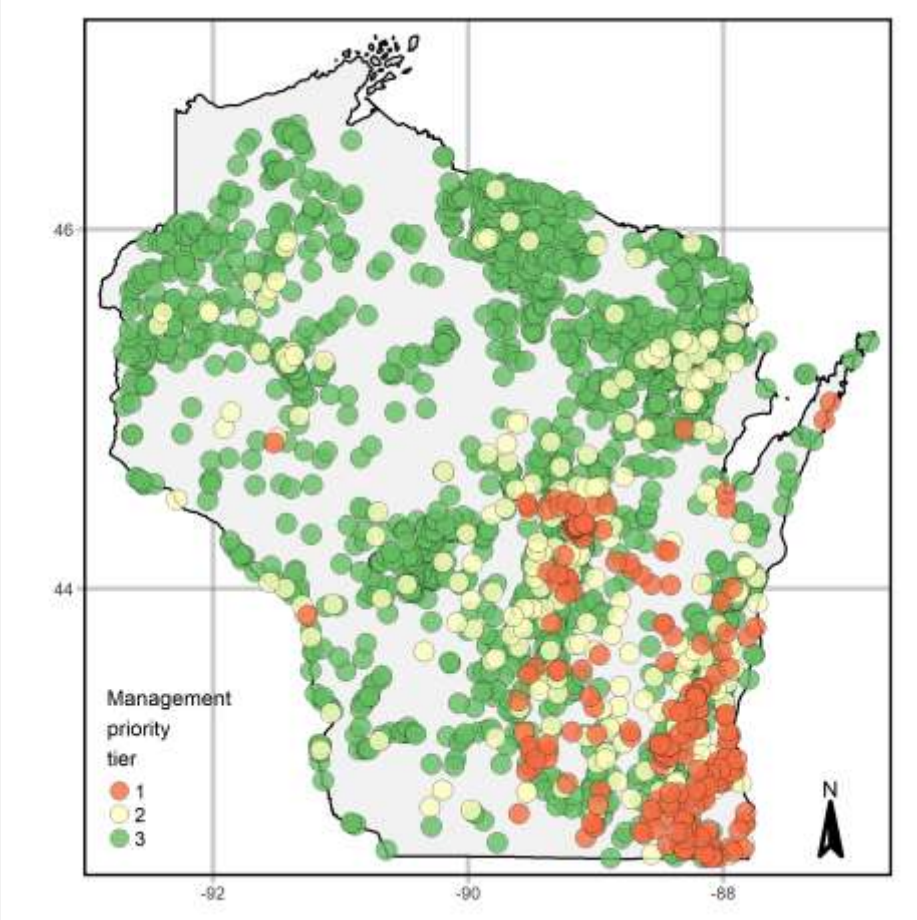


RESULTS: MANAGEMENT PRIORITY

PREVENTION and CONTROL:

focus on likely introductions and large populations





WISCONSIN DEPT. OF NATURAL RESOURCES

TAKEHOMES

Understanding lake-specific vulnerability can inform management decisions

- Even though EWM has been present since the 1960s, there are still many lakes where EWM hasn't been verified
- Most lakes are not likely to support high abundance
- Prioritize prevention where introduction is likely
- Abundance risk may help inform future management planning
- This is a model: its better than guessing, but isn't perfect:
- Work in progress!

Mikulyuk et al. 2020. Prioritizing Management of Non-Native Eurasian Watermilfoil Using Species Occurrence and Abundance Predictions. *Diversity.12*, 394.

https://www.mdpi.com/1424-2818/12/10/394

THANK YOU

Alison Mikulyuk

✉ *Alison.Mikulyuk@Wisconsin.gov*

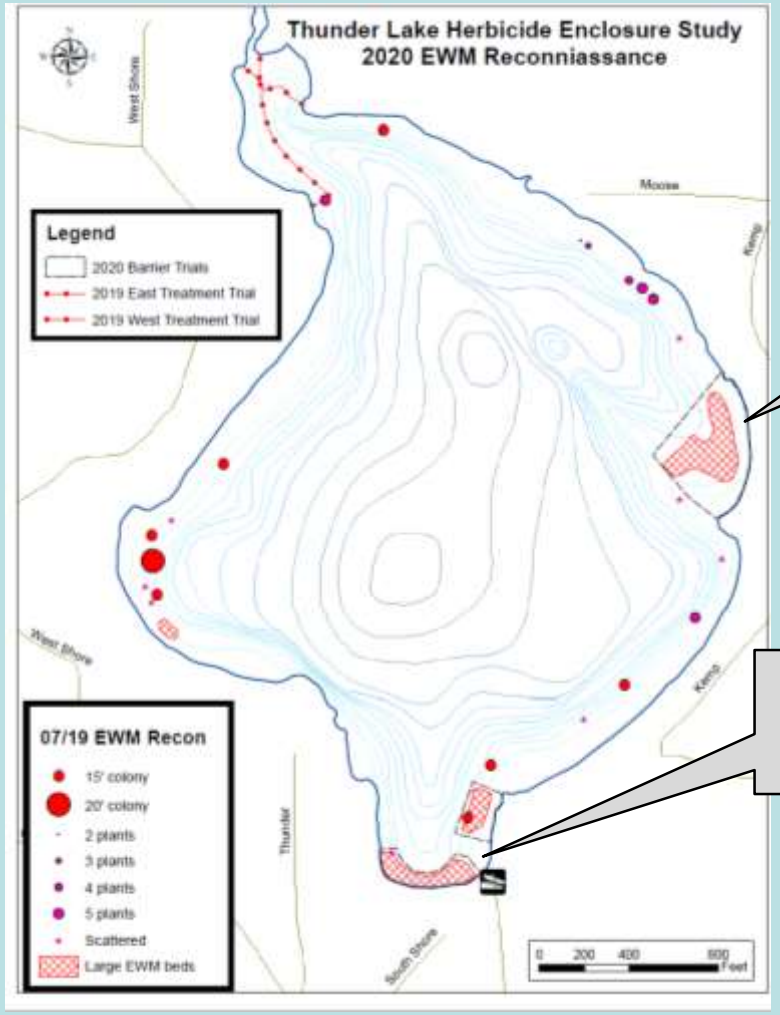
🔗 *https://dnr.wisconsin.gov/aid/SurfaceWater.html*

Small-Scale Limno-Barrier Treatments

Photos:
Marinette Co. LWCD

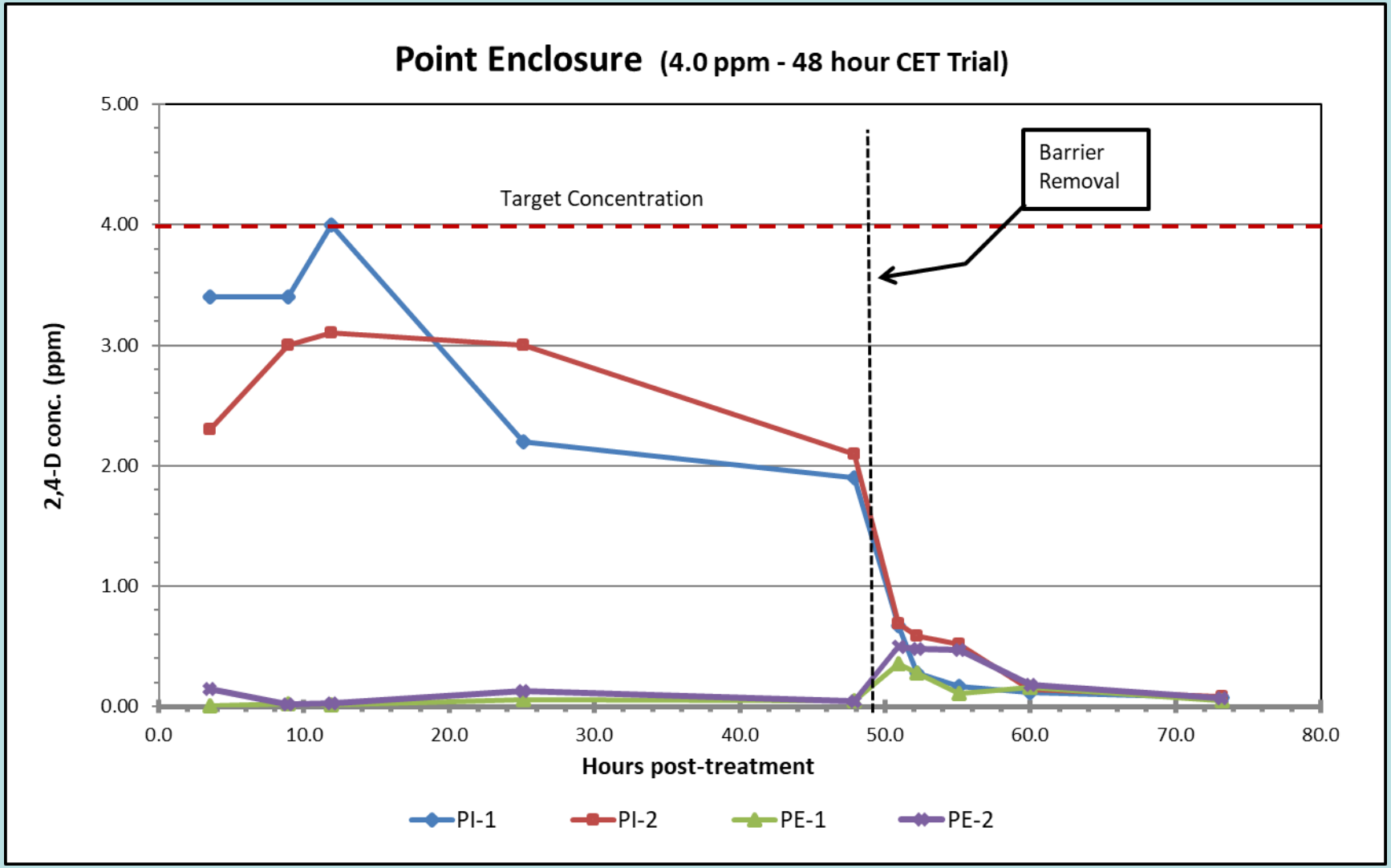
Limno-Barrier Treatments

- Thunder Lake, Marinette Co.
- Deployed a limno-barrier to surround two small (0.9 & 2.9 acre) areas of dense EWM.
- Liquid 2,4-D applied within limno-barriers at 4.0 ppm.
- Barriers were removed at 48 hrs.
- Herbicide concentration analysis following treatment through the Wisconsin State Lab of Hygiene.
- Pre- and post-treatment sub-PI monitoring to evaluate efficacy and selectivity.



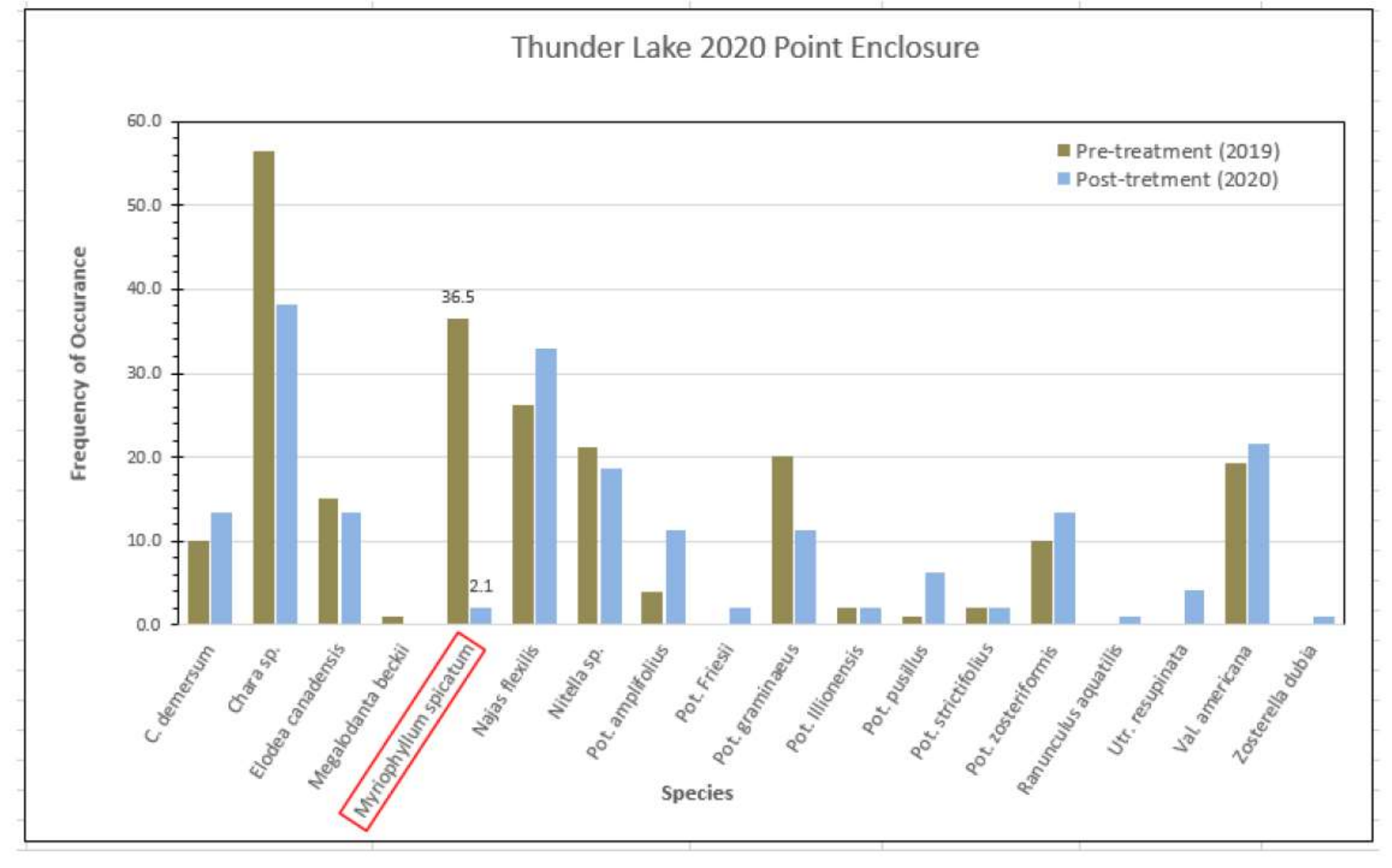
Courtesy of Marinette Co. LWCD

Limno-Barrier Treatments



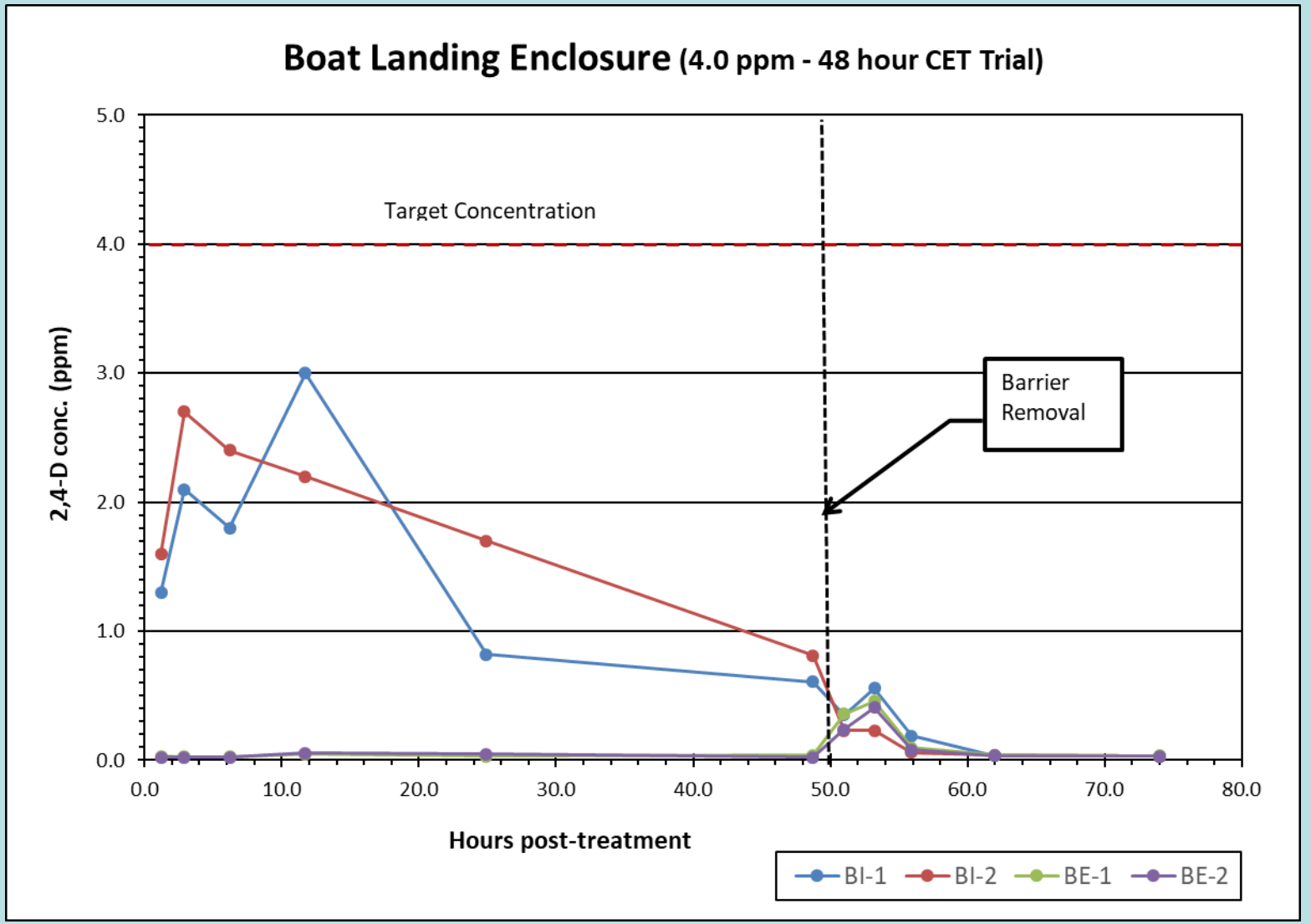
Courtesy of Marinette Co. LWCD

Limno-Barrier Treatments



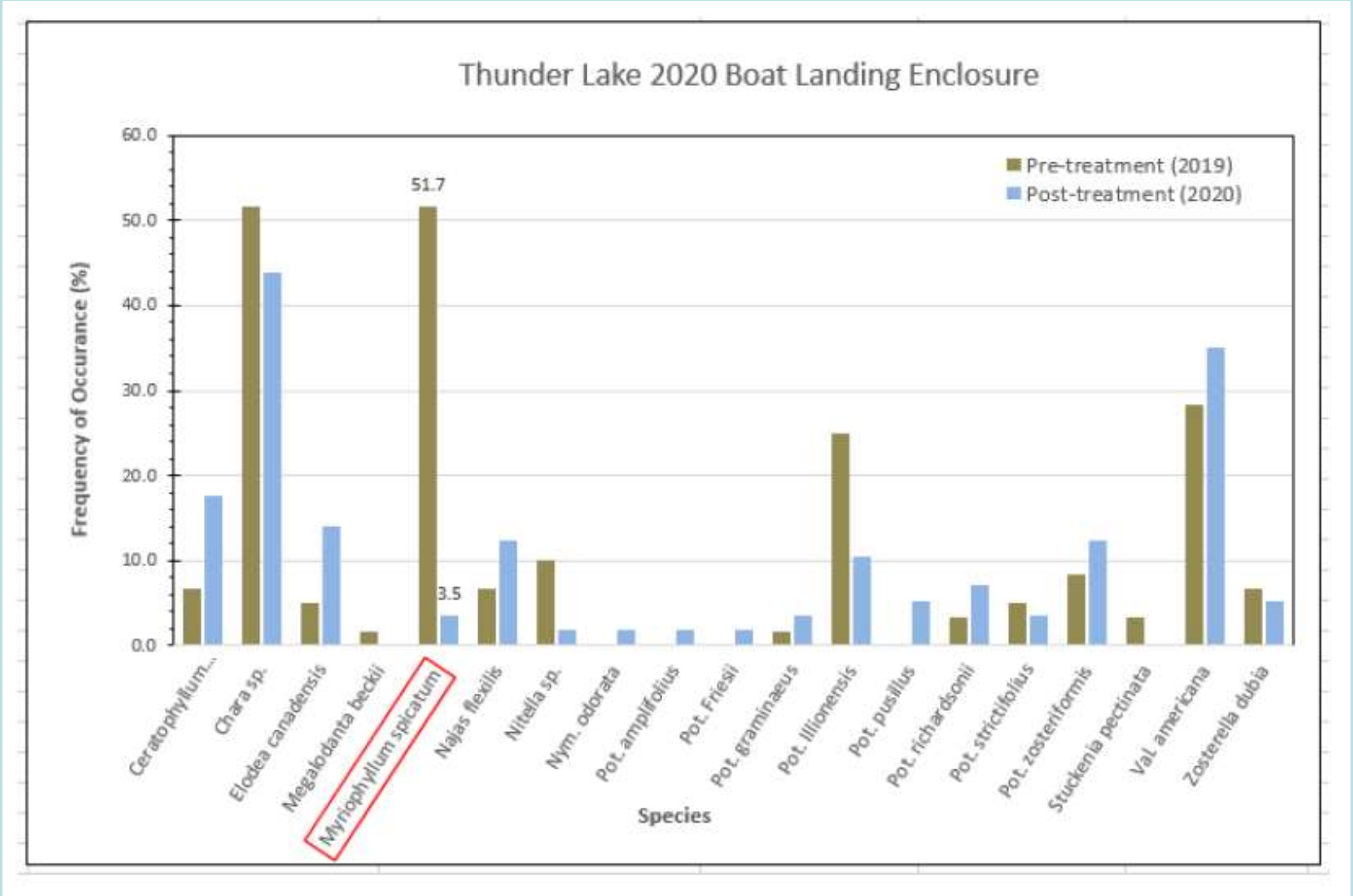
Courtesy of Marinette Co. LWCD

Limno-Barrier Treatments



Courtesy of Marinette Co. LWCD

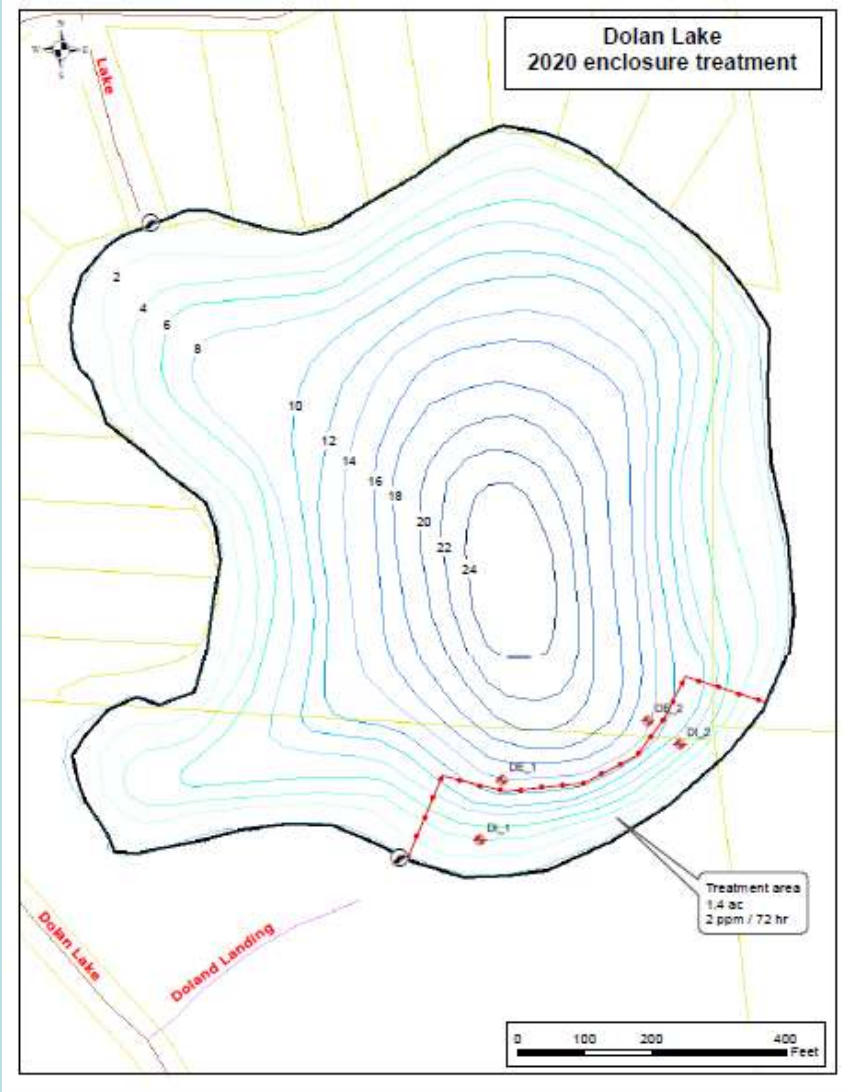
Limno-Barrier Treatments



Courtesy of Marinette Co. LWCD

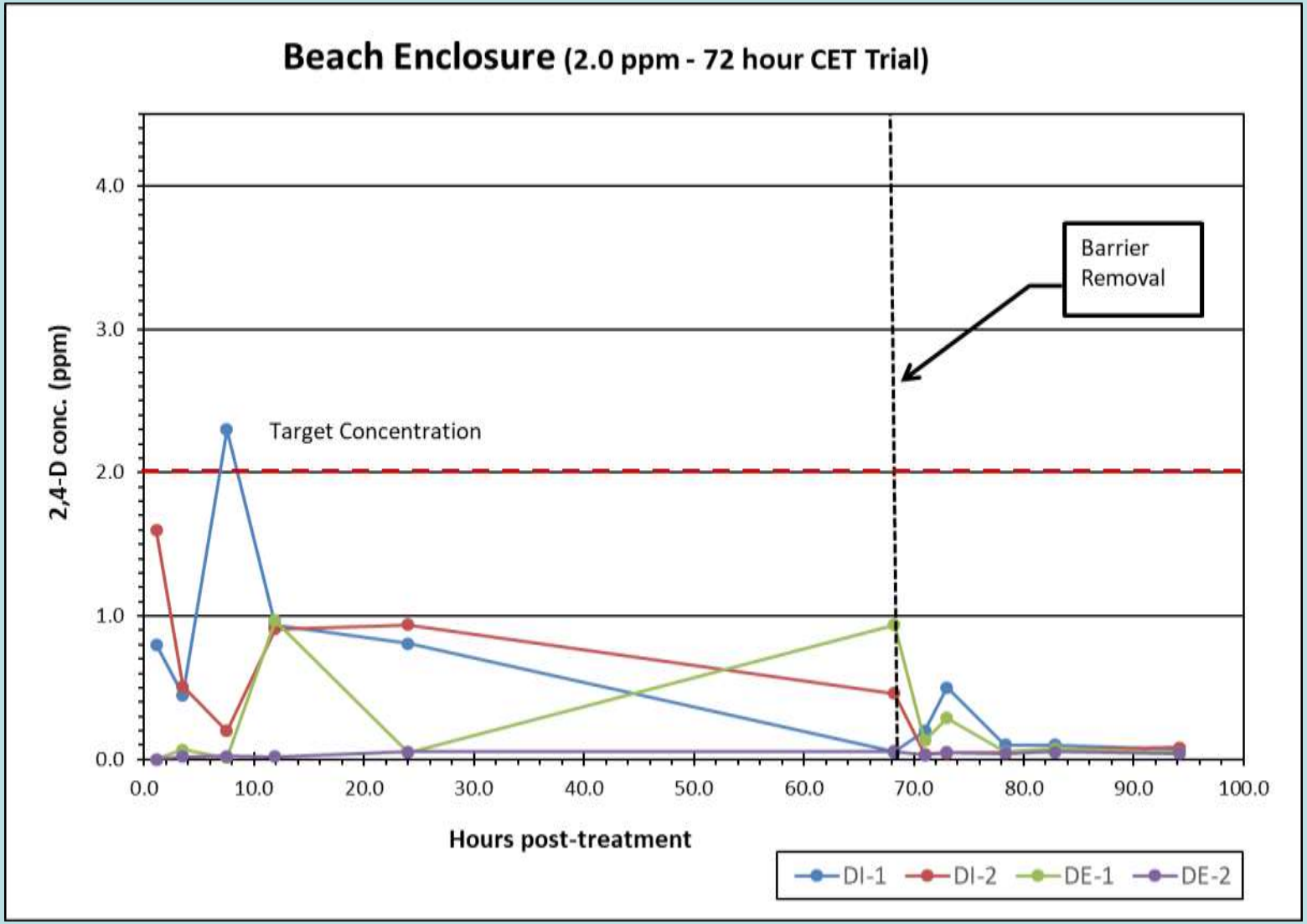
Limno-Barrier Treatments

- Dolan Lake, Marinette Co.
- Deployed a limno-barrier to surround one small (1.4 acre) area of localized EWM.
- Liquid 2,4-D applied within limno-barrier at 2.0 ppm.
- Barrier was removed at 72 hrs.
- Herbicide concentration analysis following treatment through the Wisconsin State Lab of Hygiene.
- Pre- and post-treatment sub-PI monitoring to evaluate efficacy and selectivity.



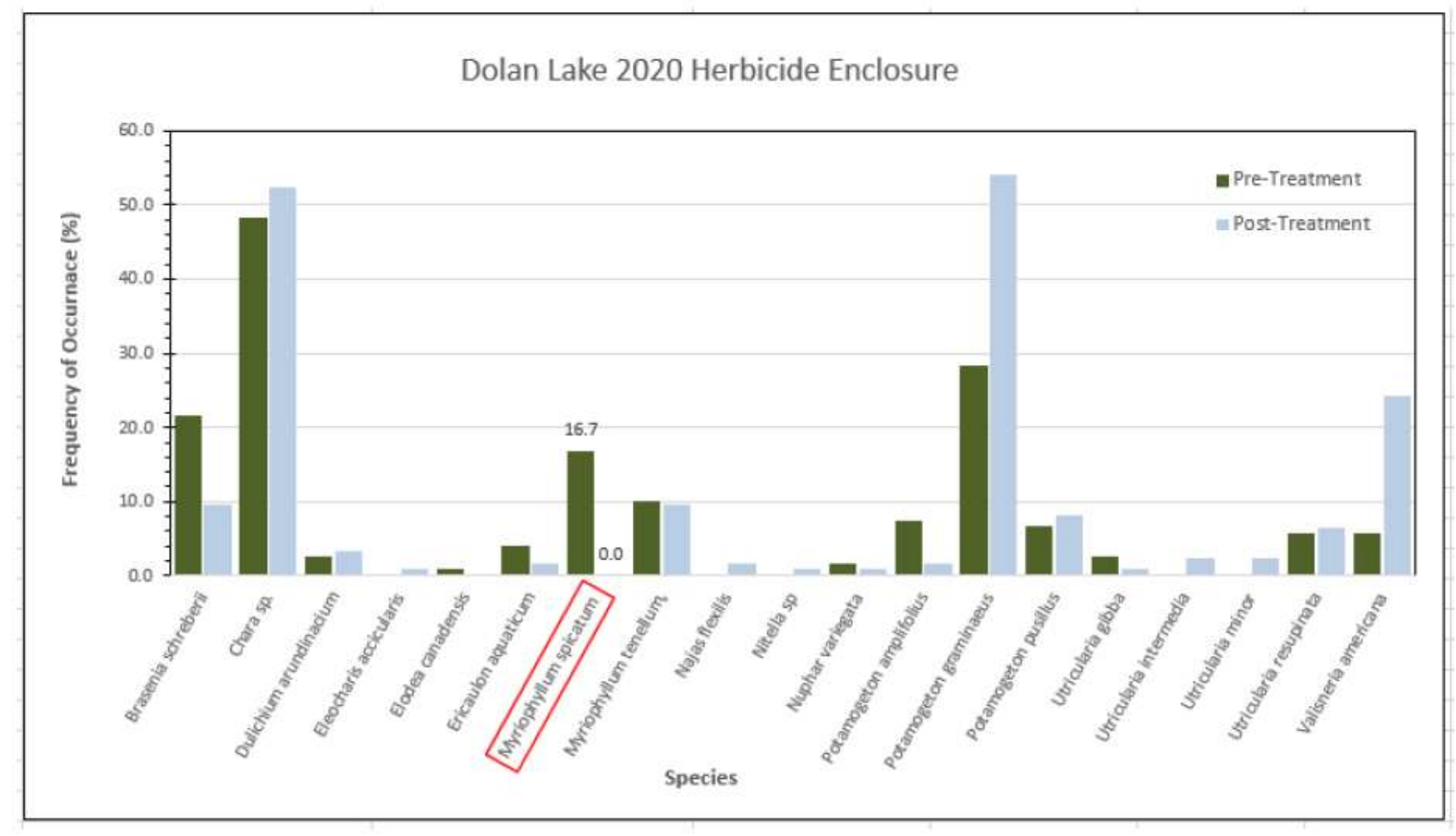
Courtesy of Marinette Co. LWCD

Limno-Barrier Treatments



Courtesy of Marinette Co. LWCD

Limno-Barrier Treatments

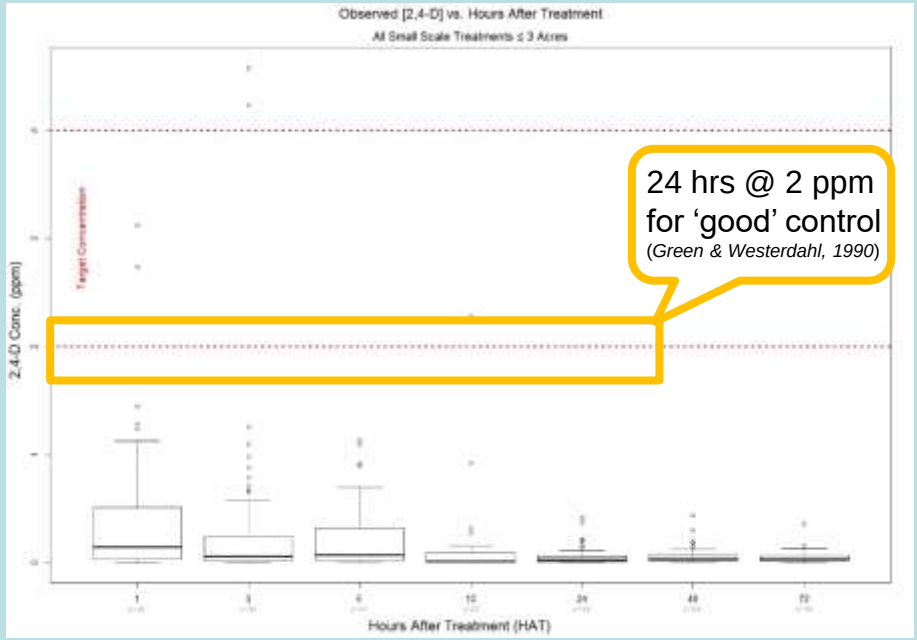


Courtesy of Marinette Co. LWCD

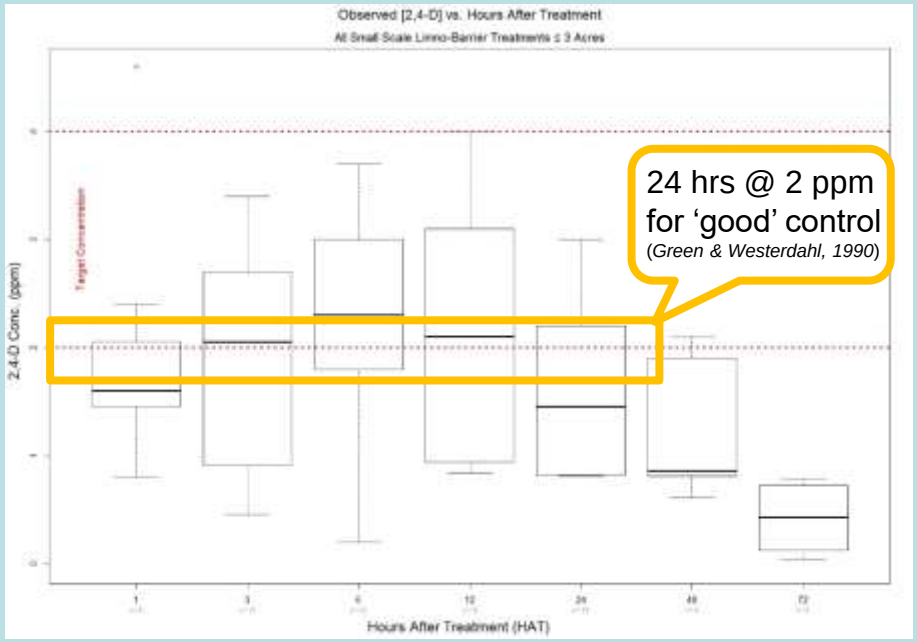
Limno-Barrier Treatments

2,4-D Treatments ≤3 Acres

No Barrier [open water]



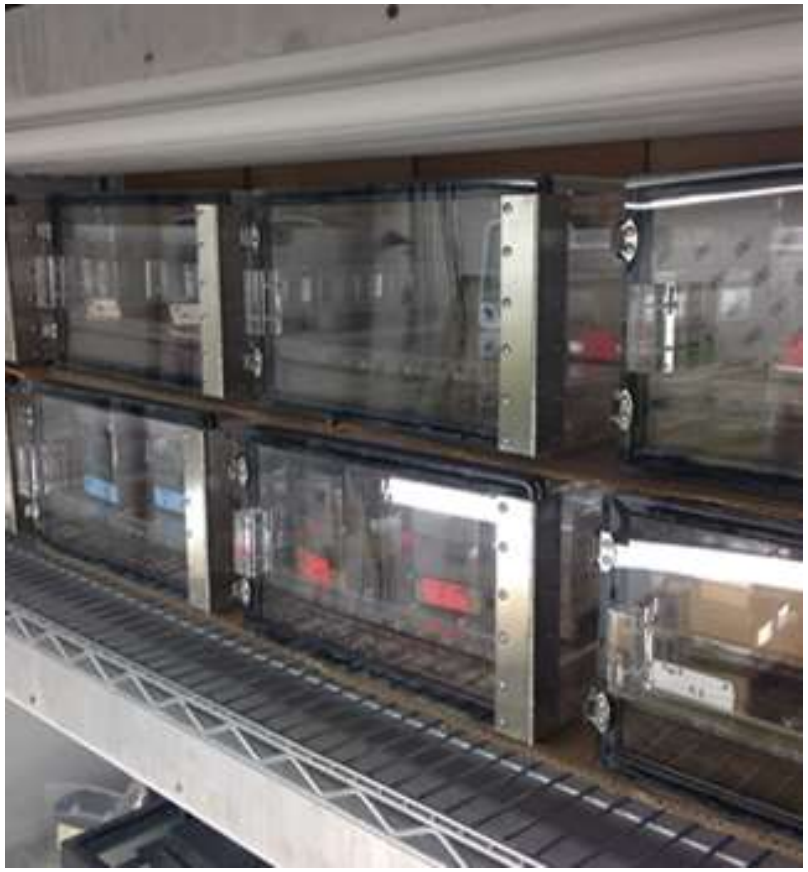
Limno-Barrier [enclosed]



Data: Marinette Co. LWCD & WDNR

Preliminary Conclusions

- Utilizing a limno-barrier curtain in conjunction with a small-scale herbicide treatment results in a much higher probability of both achieving the intended target concentration, as well as maintaining that concentration over time, which increases the likelihood on an effective treatment.
- Additional data is being collected to better understand longevity of observed EWM control.
- The building and utilization of limno-barrier curtains is being considered for use on several other Wisconsin lakes in the future, and these efforts will be similarly evaluated and analyzed.



Starry Stonewort Research

What is starry stonewort?

- Starry stonewort (*Nitellopsis obtusa*) is a macroalgae in the Characeae family.
- Not a vascular plant like most our aquatic plant species.
- Native to Europe & Asia; rare in portions of its range (endangered species in the United Kingdom and Japan).
- First documented in St. Lawrence River in 1970s; likely transported to U.S. via international ballast water.
- Can survive in a wide range of habitats.
- Primarily reproduces via asexual bulbils.

Verified Starry Stonewort Populations

2014
- Little Muskego

2015
- Big Muskego
- Long
- Pike
- Silver

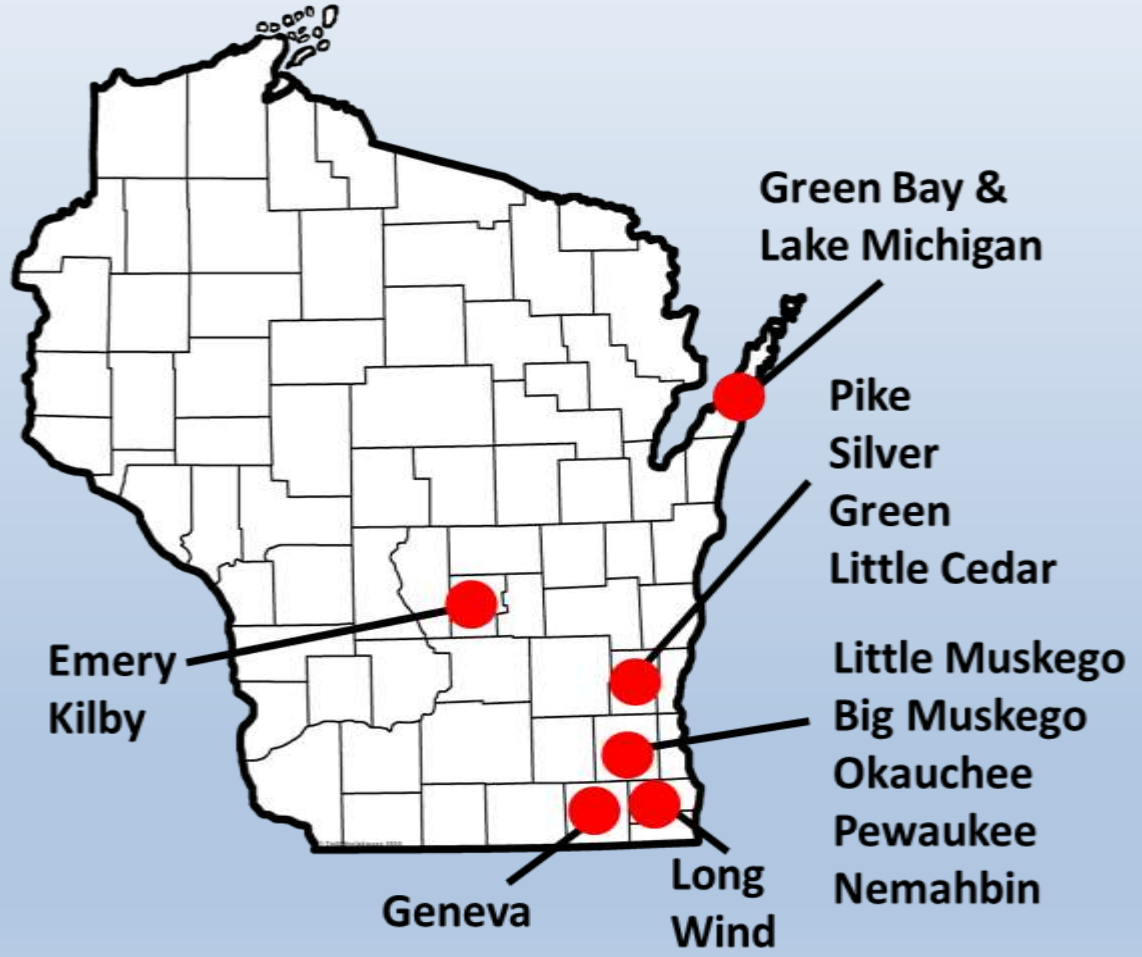
2016
- Green
- Lake Michigan/Green Bay

2017
- Wind

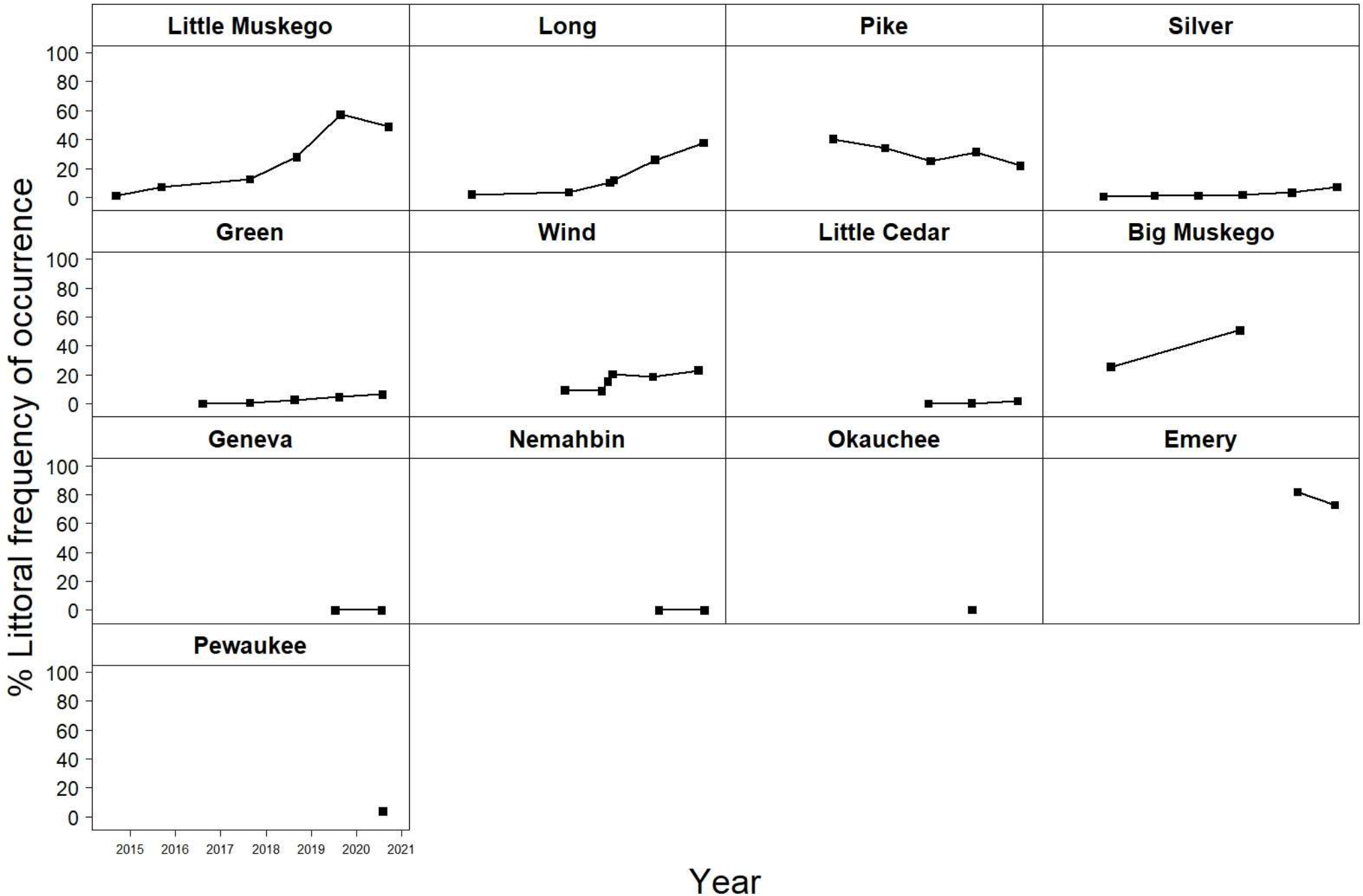
2018
- Geneva
- Little Cedar

2019
- Okauchee
- Pewaukee
- Nemahbin
- Emery

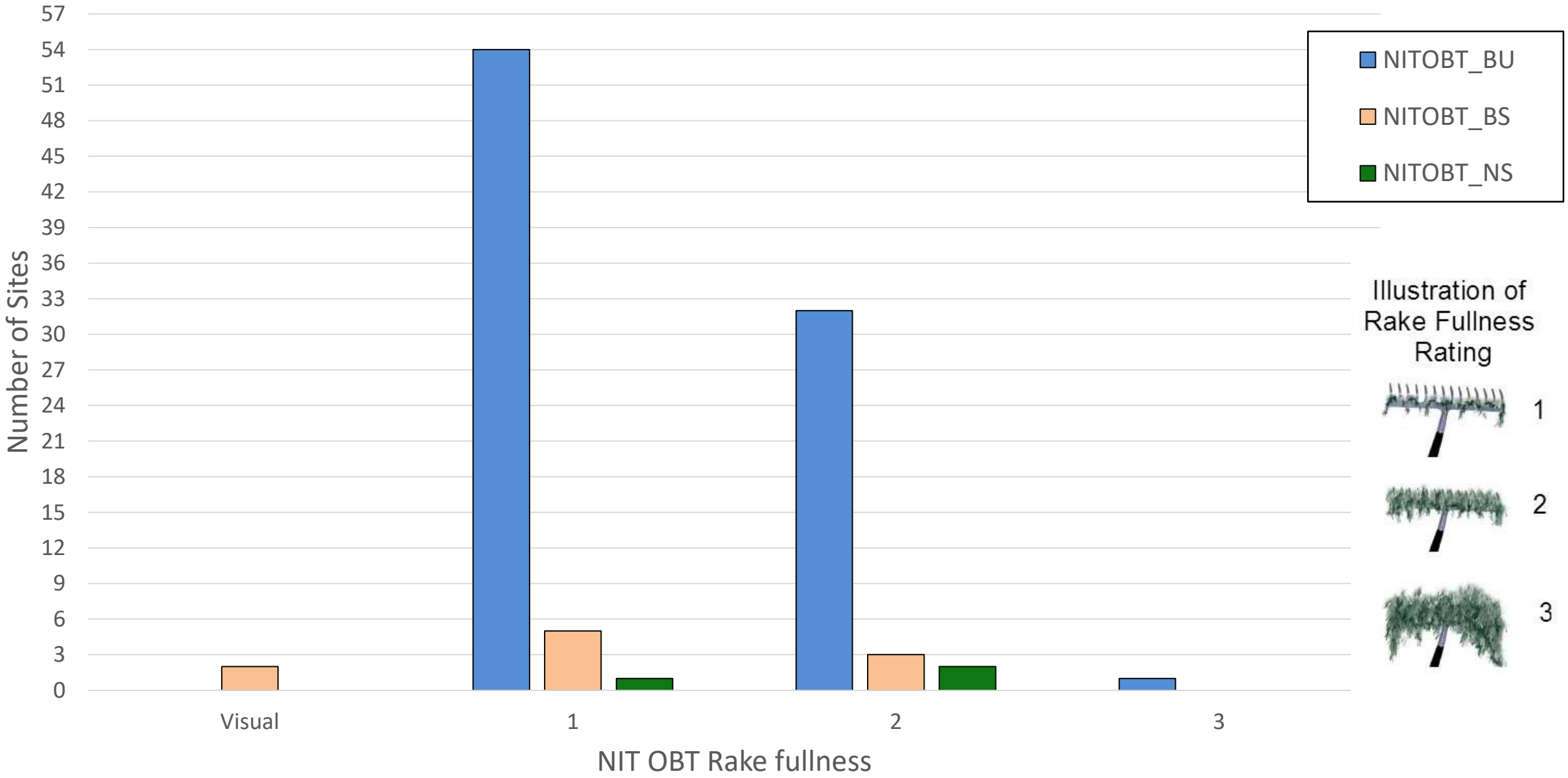
2020
- Kilby

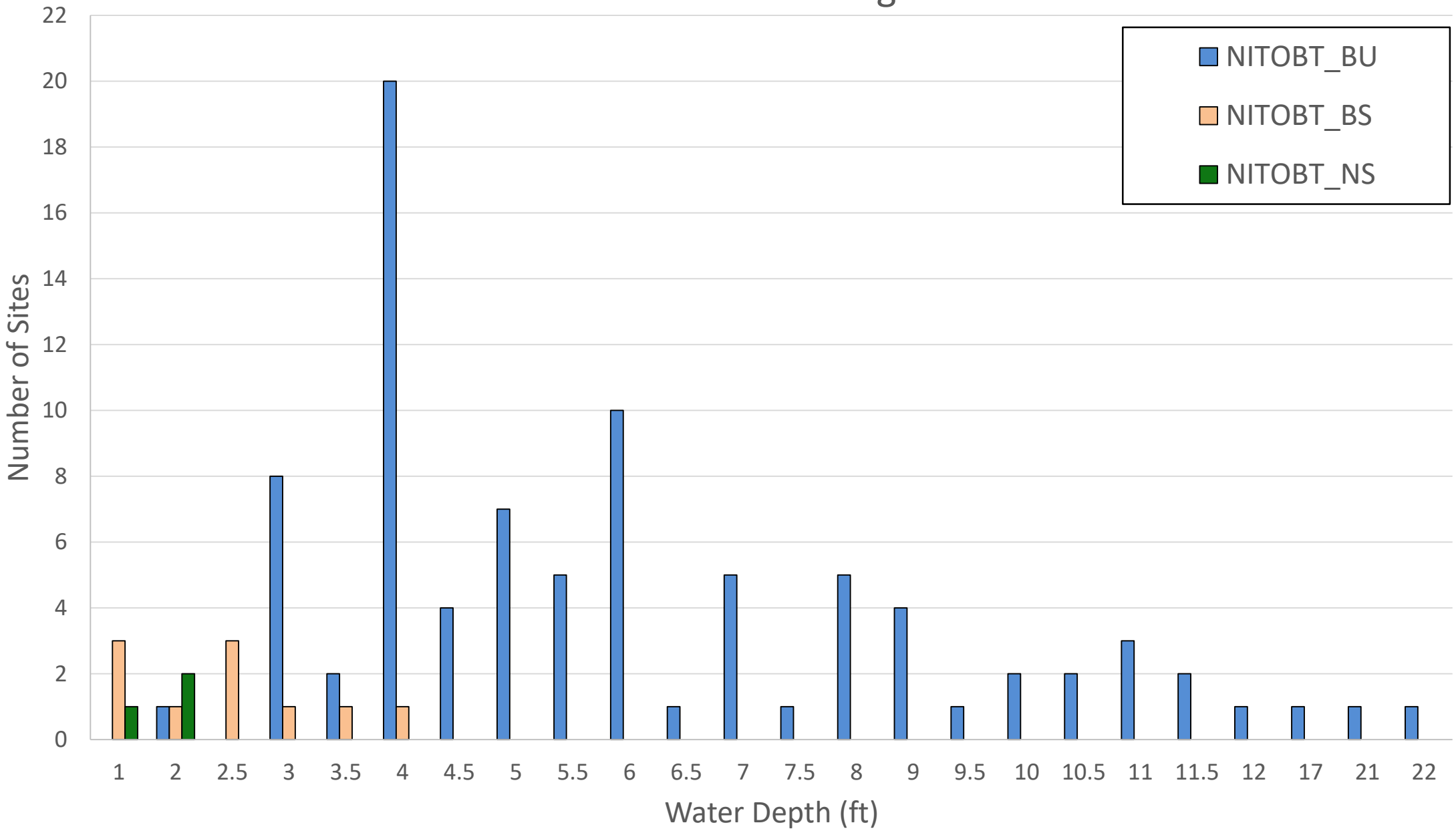


Starry Stonewort % Frequency

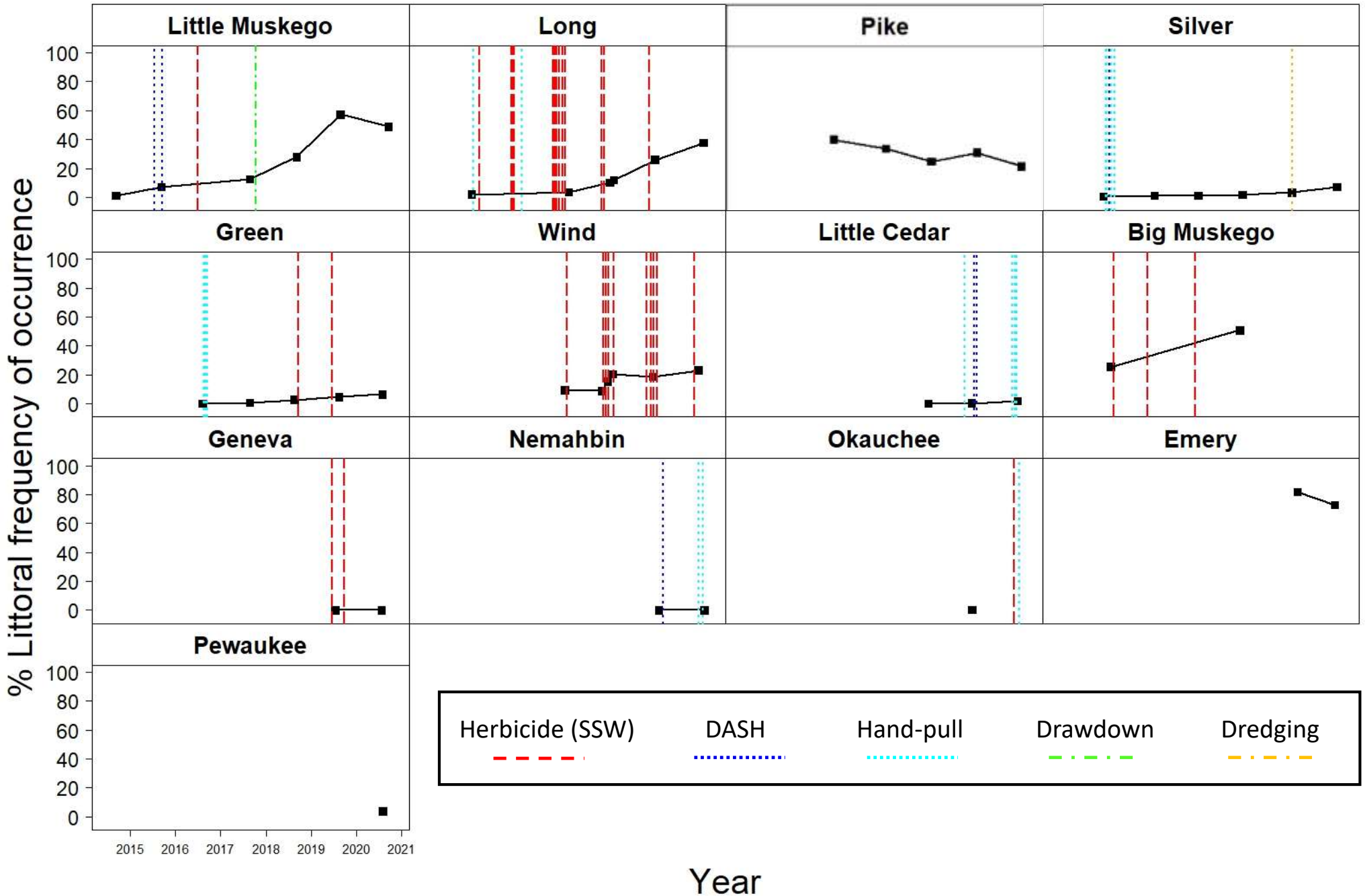


Nitellopsis obtusa
"Nuisance" Ratings



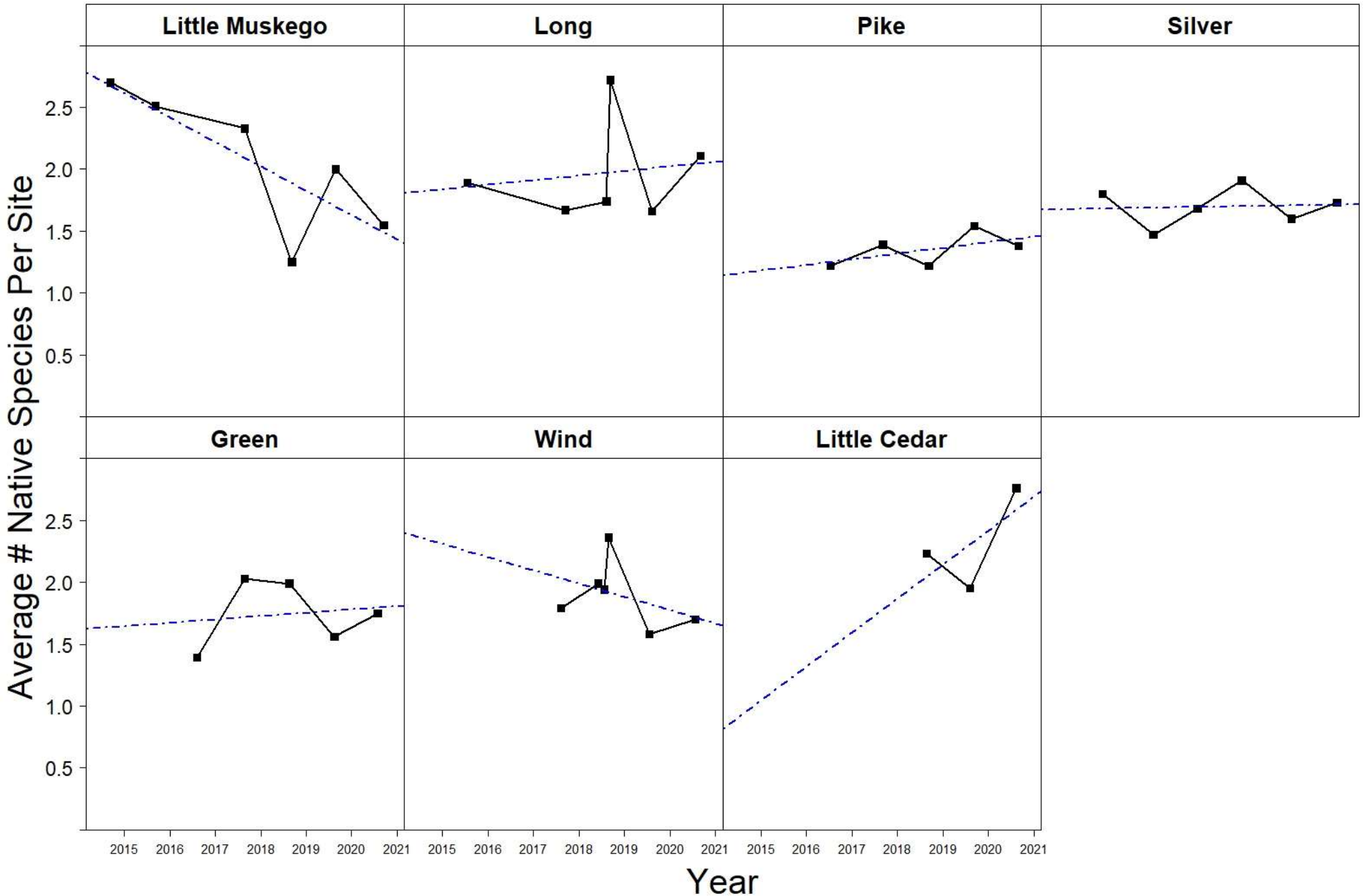

Nitellopsis obtusa
"Nuisance" Ratings
NITOBT_BU
NITOBT_BS
NITOBT_NS
Number of Sites
0
2
4
6
8
10
12
14
16
18
20
22
1
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
9
9.5
10
10.5
11
11.5
12
17
21
22
Water Depth (ft)

Starry Stonewort % Frequency



		COPPER							ENDOTHALL	FLUMIOXAZIN		DIQUAT	
LAKE	YEAR	Cutrine Ultra	Komeen Crystal	Captain XTR	Cutrine Granular	Cutrine Plus	Komeen	Nautique	Hydrothol 191	Clipper	Clipper SC	Tribune	Reward
Little Muskego	2016		0.5 ppm										
Big Muksego	2015	0.8 ppm							0.17 ppm				
Big Muksego	2016	0.8 ppm							0.17 ppm				
Big Muksego	2015									0.2 ppm			
Big Muksego	2016				0.4 ppm								
Big Muksego	2017				0.4 ppm								
Big Muksego	2016	0.8 ppm							0.17 ppm				
Long	2015			0.78 ppm						0.1548 ppm			
Long	2016			0.8 - 0.95 ppm									
Long	2016			0.825 ppm						0.1505 ppm			
Long	2016		0.97 - 1.0 ppm				0.8 - 0.86 ppm		0.29 ppm				0.35 - 0.5 ppm
Long	2017		0.93 ppm										
Long	2017		0.99 ppm	0.79 ppm							0.147 ppm		
Long	2017		0.97 - 0.99 pm										
Long	2017		0.99 - 1.0 ppm	0.79 - 0.83 ppm						0.15 - 0.156 ppm			
Long	2017		0.98 - 1.0 ppm										
Long	2017		0.99 - 1.0 ppm	0.84 ppm						0.195 ppm			
Long	2018		0.97 ppm										
Long	2018			0.8 ppm							0.150 ppm		
Long	2019		0.99 ppm	0.76 - 0.78 ppm							0.148 - 0.152 ppm		
Green	2018	0.8 ppm							0.17 ppm				
Green	2019	0.8 ppm							0.17 ppm				
Wind	2017	0.8 ppm							0.17 ppm				
Wind	2018	0.8 ppm							0.17 ppm				
Wind	2018	0.8 ppm							0.17 ppm				
Wind	2018	0.8 ppm							0.17 ppm				
Wind	2018	0.8 ppm										1.5 - 1.75 gal/acre	
Wind	2019	0.8 ppm										1.5 gal/acre	
Wind	2019	0.8 ppm										1.5 gal/acre	
Wind	2019	0.8 ppm										1.0 - 1.5 gal/acre	
Wind	2019	0.8 ppm										1.0 - 1.5 gal/acre	
Wind	2020					0.8 ppm			0.3 ppm				
Geneva	2019					0.6 ppm			0.2 ppm				
Geneva	2019					1.0 ppm				0.3 ppm			
Okauchee	2020							1.0 ppm	0.3 ppm				

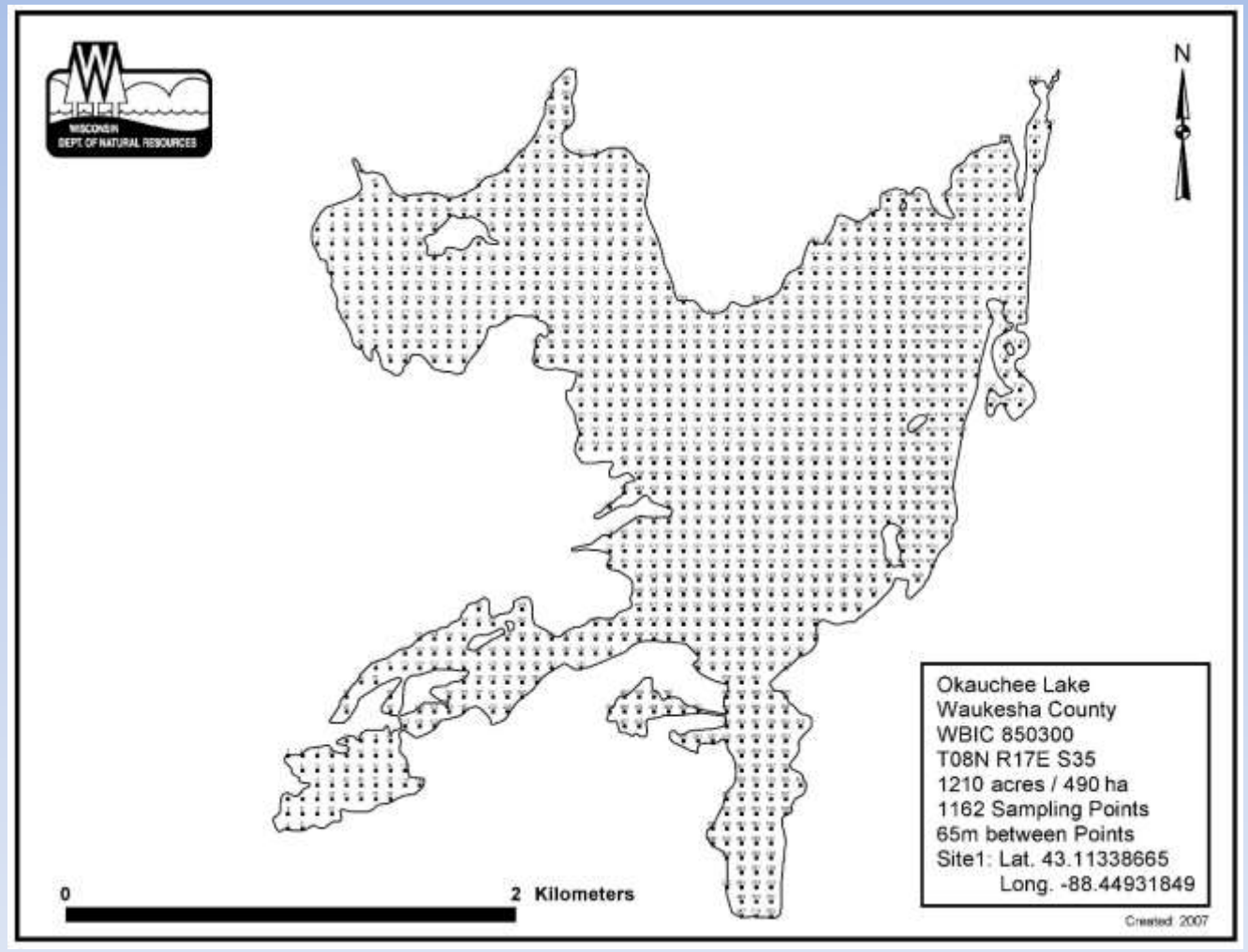
Average # Native Species Per Site



Okauchee Lake, Waukesha Co.

- Management Approach: Chemical Control w/ Limno-barrier

- 1210 acre drainage lake
- 90 feet max depth
- SSW discovered in July 2019 near boat access
- WDNR Early Detection & Response Grant funding obtained to help support monitoring and control efforts



Okauchee Lake

Management Approach: Chemical Control w/ Limno-barrier

- Localized area of SSW near boat access & marina
- Goal: Apply herbicide within a barrier to increase time plants are exposed to chemical with the hope of achieving greater control of SSW
- Barrier treatment: July 14, 2020
- Chemically treated ~0.4 ac with Nautique (1.0 ppm) & Hydrothol 191 (0.3 ppm)

Okauchee Lake

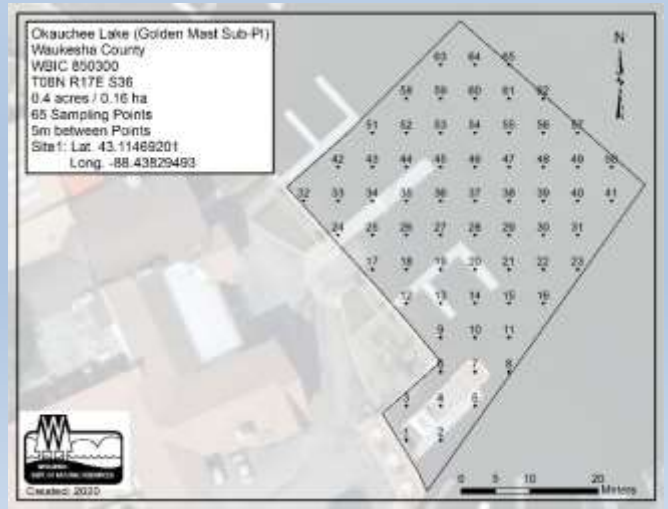
Management Approach: Chemical Control w/ Limno-barrier

Herbicide Concentration Monitoring

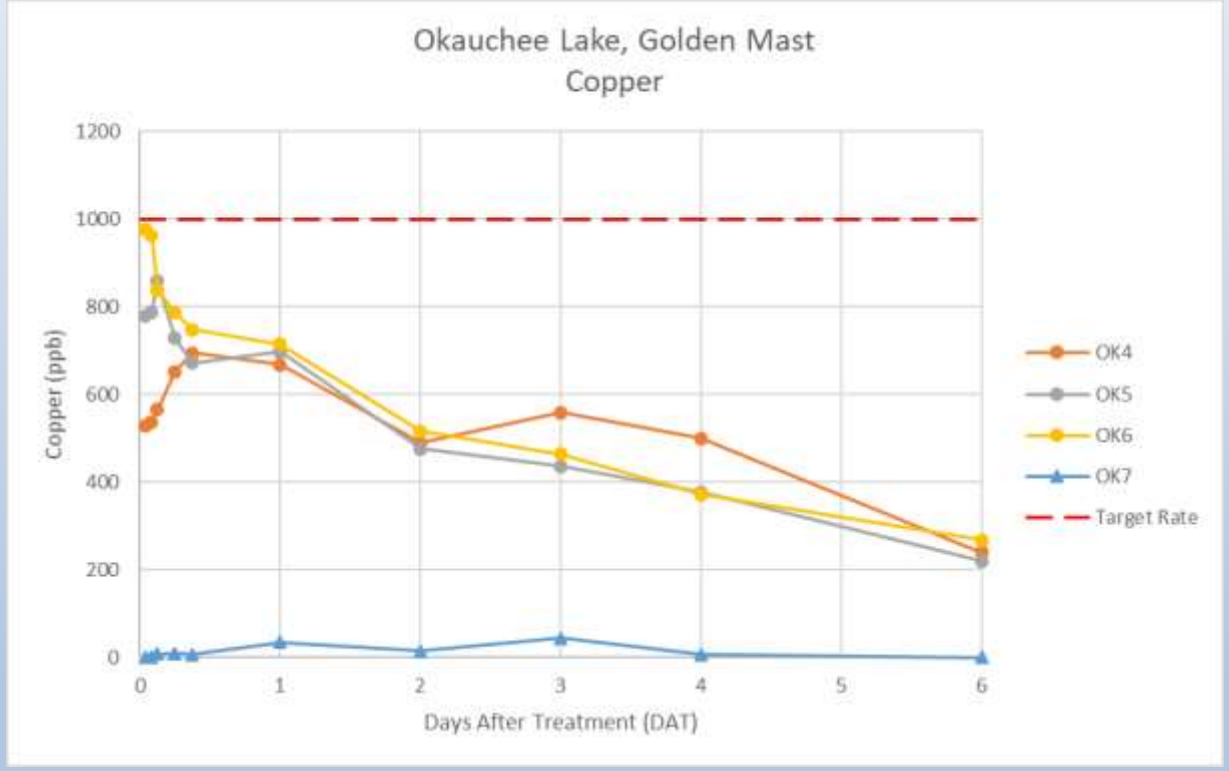
- Sites: OK4, OK5, OK6, & OK7
  - Water samples collected at: 1, 2, 3, 6, 9, 24, 48, 72, 96, & 144 HAT
- Analyzed at WSLH for copper and endothall

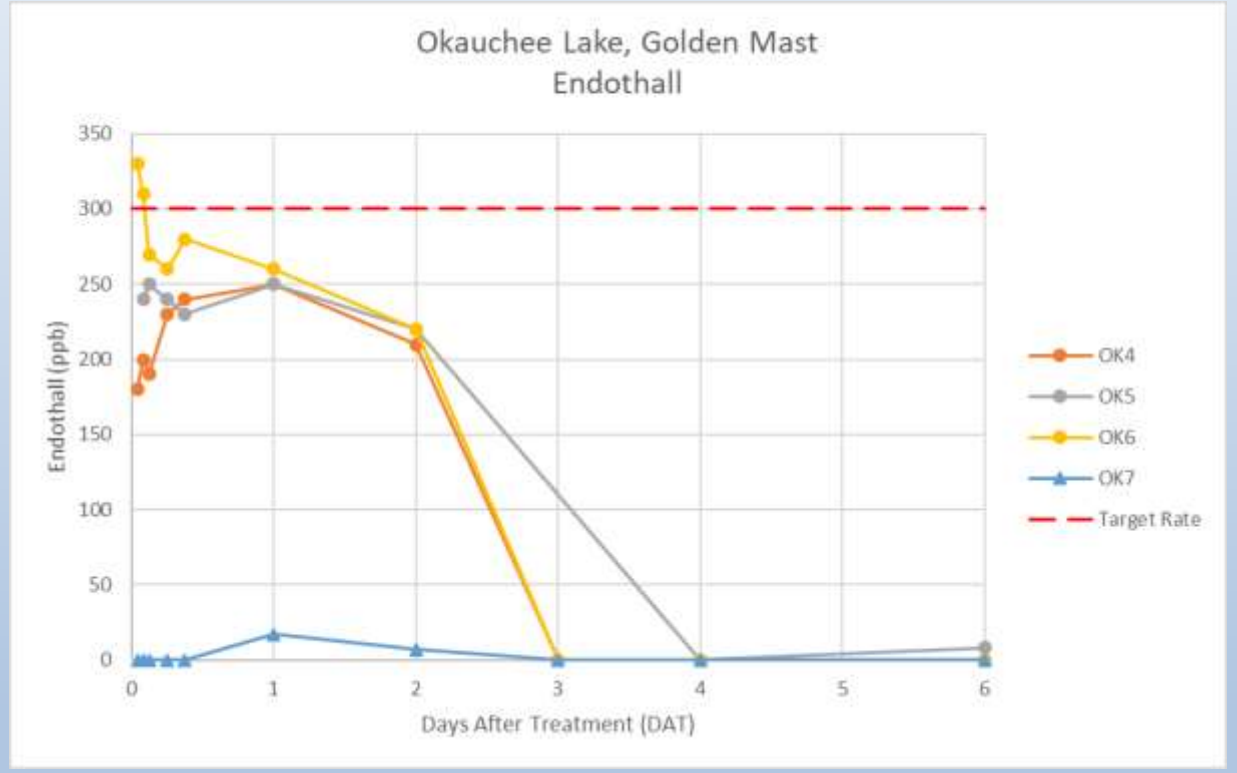
Aquatic Plant Monitoring

- Pre- and Post-Treatment sub-PI plant surveys
  - Late June, Aug, & Sept 2020
  - Conducted at Golden Mast (treated) & Bridge (untreated reference).



Okauchee Lake

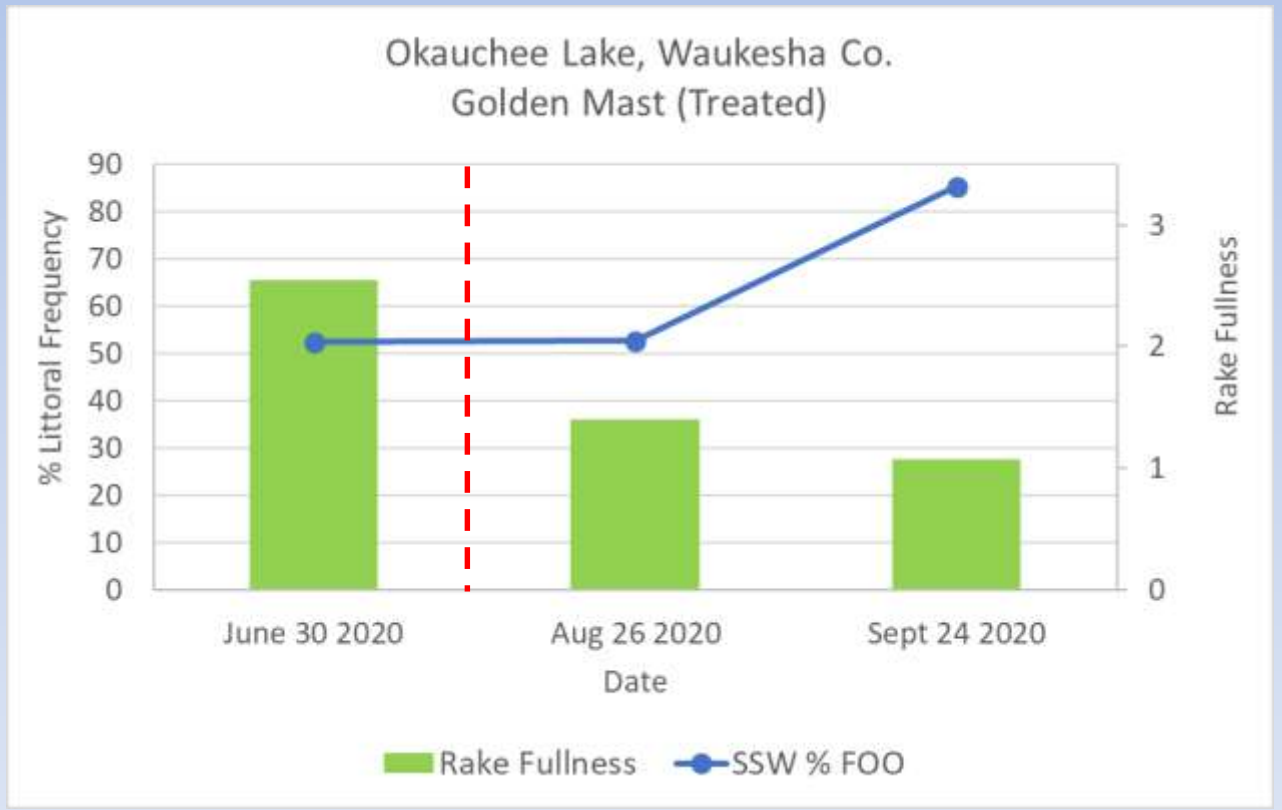




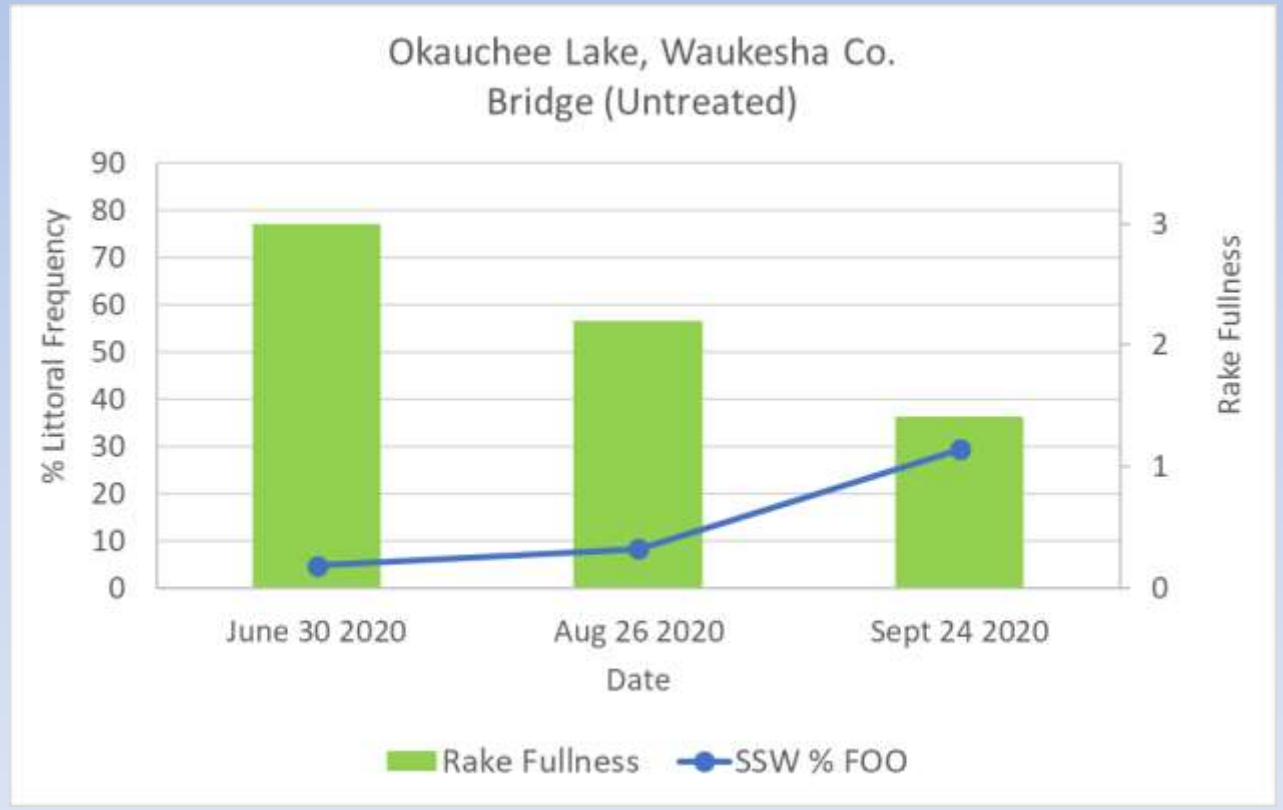
Okauchee Lake

- Management Approach: Chemical Control w/ Limno-barrier

Golden Mast (treated)



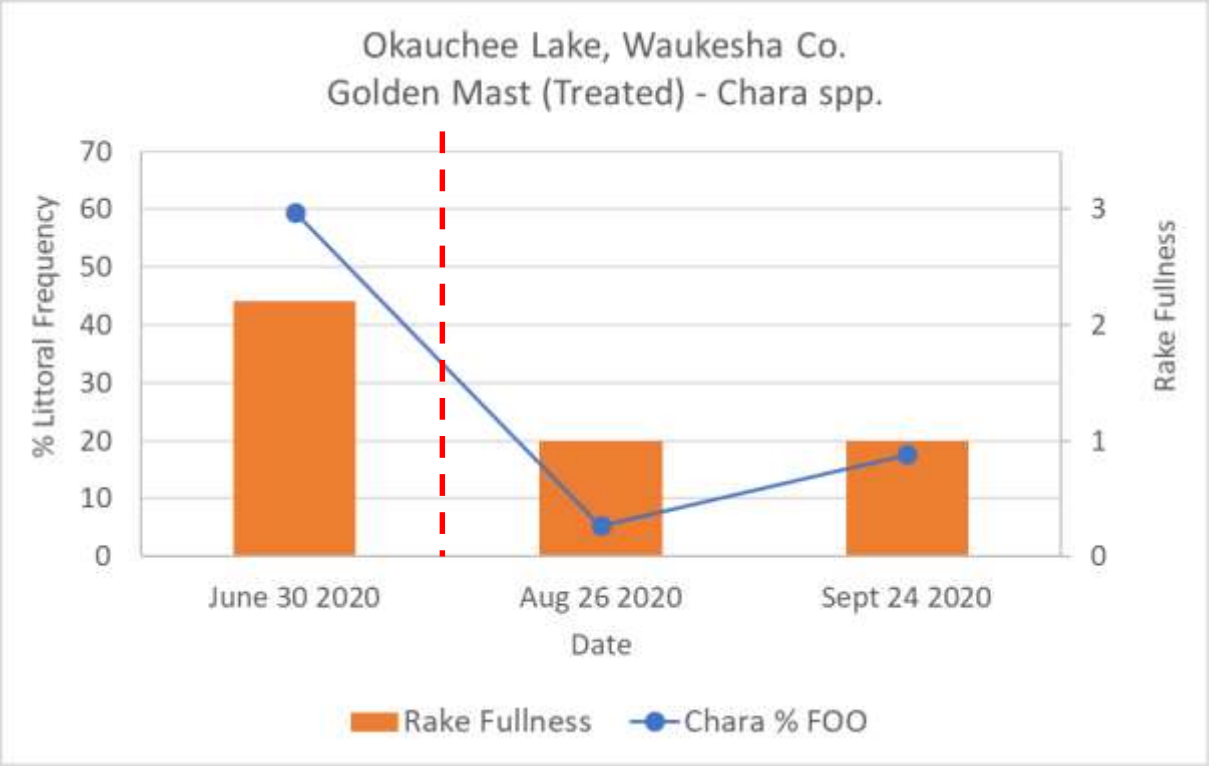
Bridge (untreated)



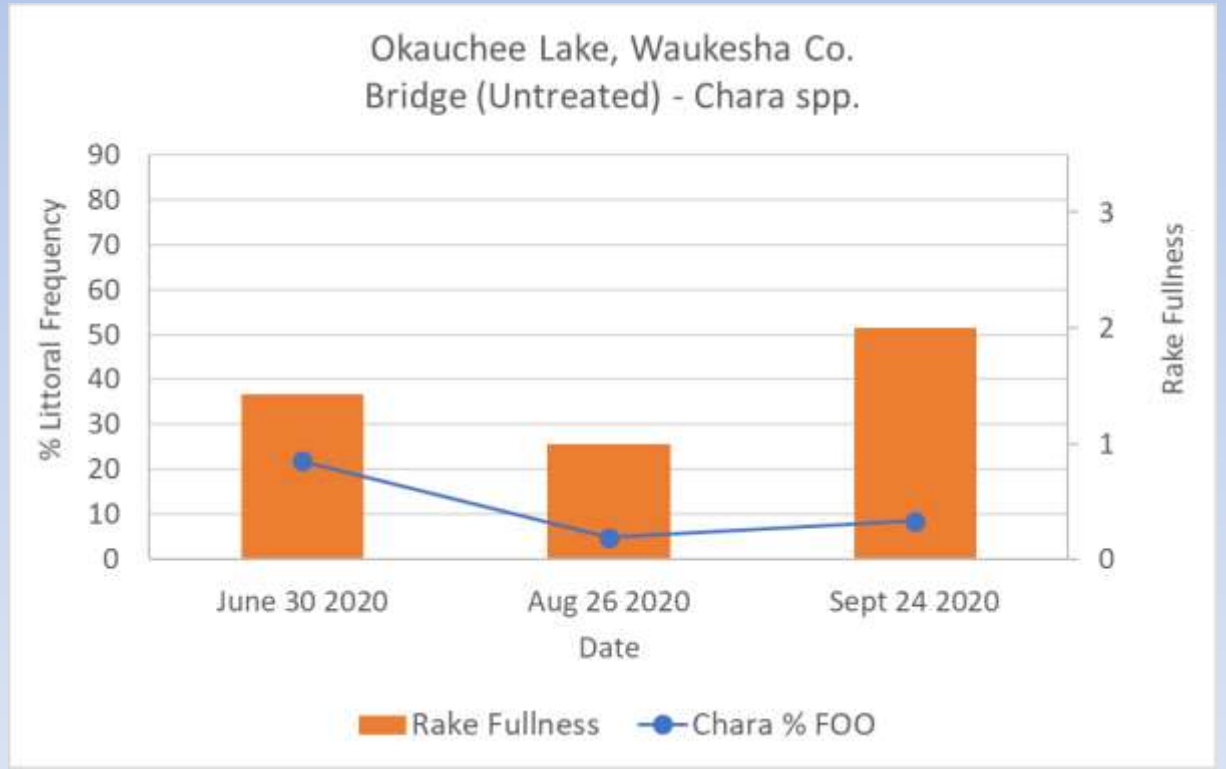
Okauchee Lake

- Management Approach: Chemical Control w/ Limno-barrier

Golden Mast (treated)



Bridge (untreated)



Preliminary Conclusions

- Evaluation of pre- and post-treatment data from several lakes utilizing chemical control methods (primarily copper/hydrothol) has not resulted in control or eradication of starry stonewort
- The use of barrier curtains in conjunction with chemical applications was able to keep the herbicide concentration higher and prevent diffusion off site, however this did not result in better control of starry stonewort
- Pre and post treatment data for lakes utilizing DASH, hand removal and/or dredging for control of starry stonewort is currently being evaluated
- The Department is continuing to work with other regional and national partners (US ACOE, University of Minnesota, University of Indiana, New York Botanical Garden) to evaluate management techniques for the control and prevention of starry stonewort

Michelle.Nault@Wisconsin.gov
608-513-4587