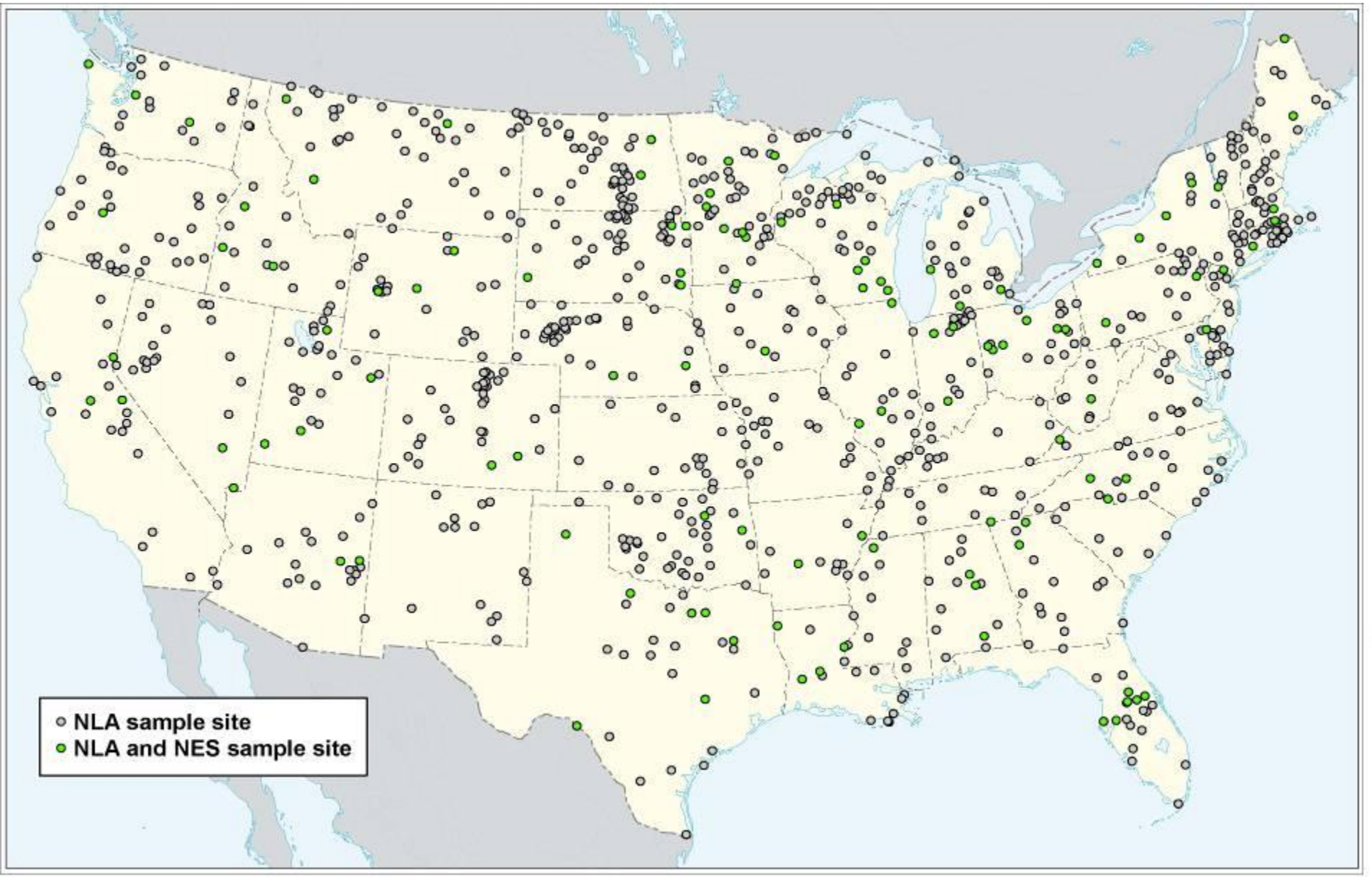
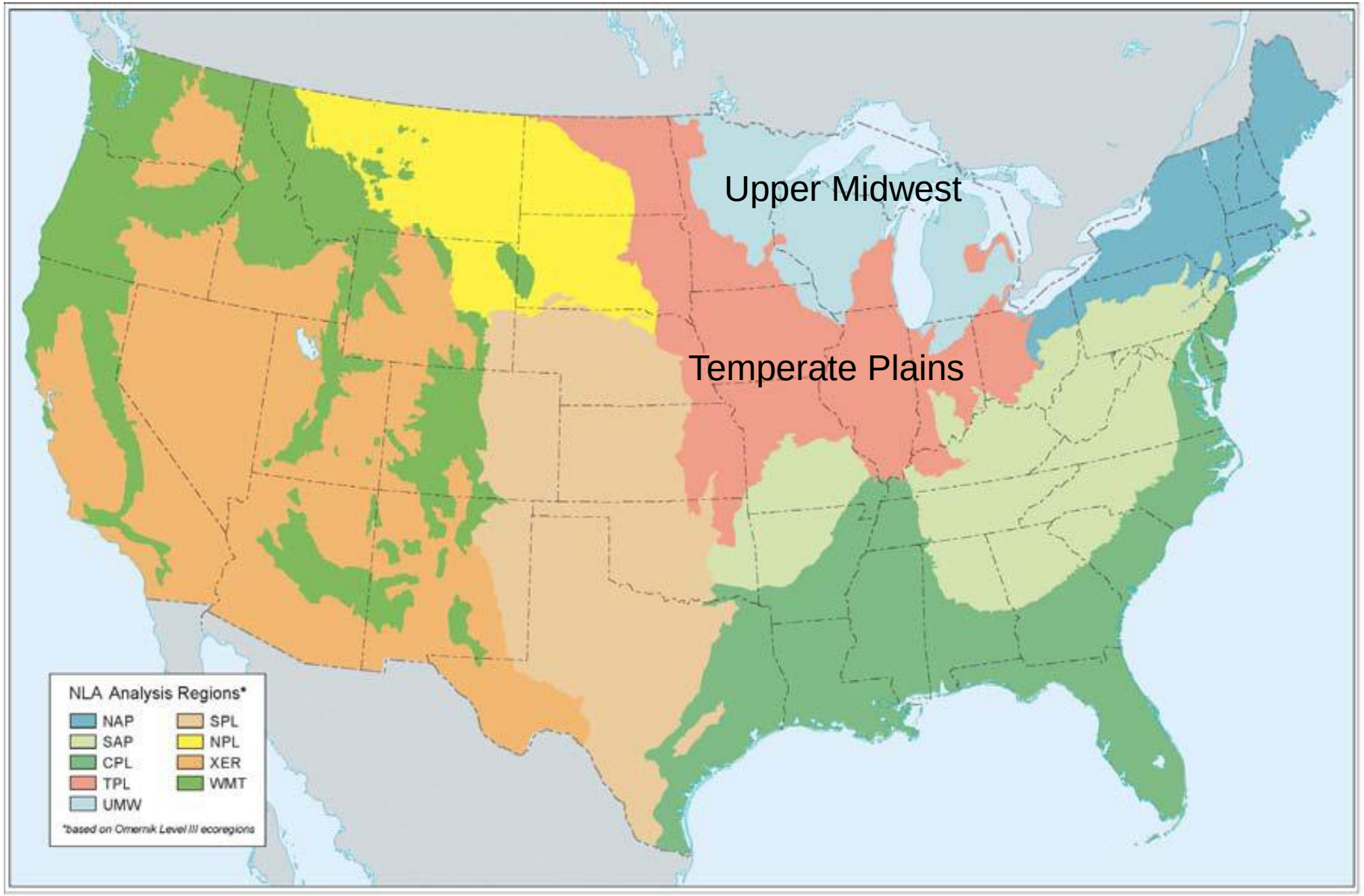
EPA National Lake Assessment: Wisconsin's Approach and Findings

Map of Survey Lakes



Two Ecoregions

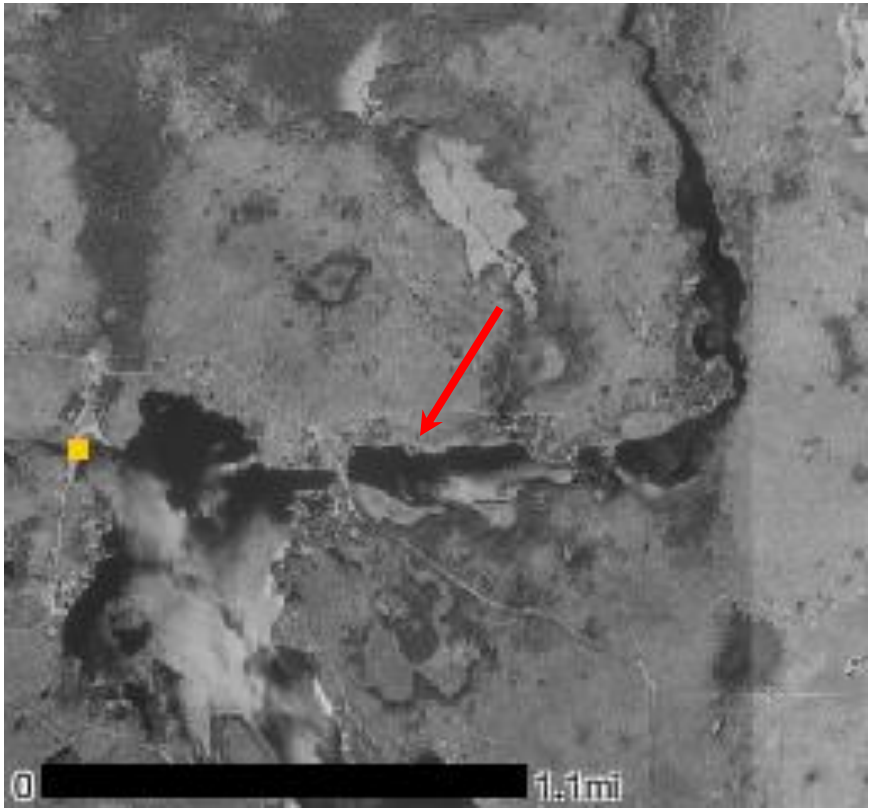


WI Site ReCon Status

Lake or wetland?

Unnamed pond in Polk Co.

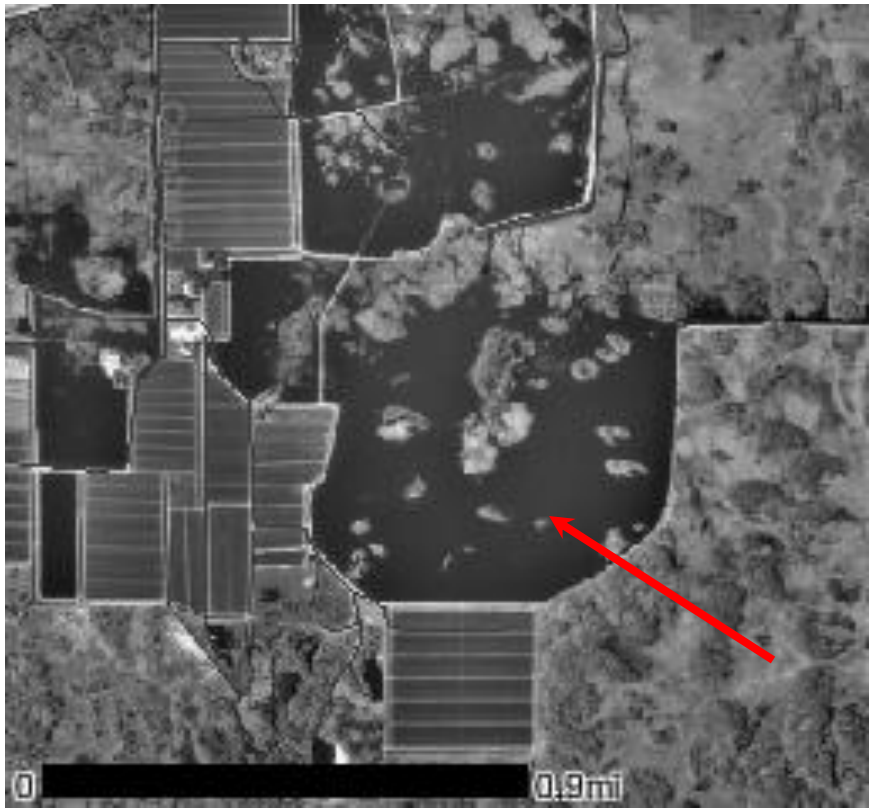
Lake or river?



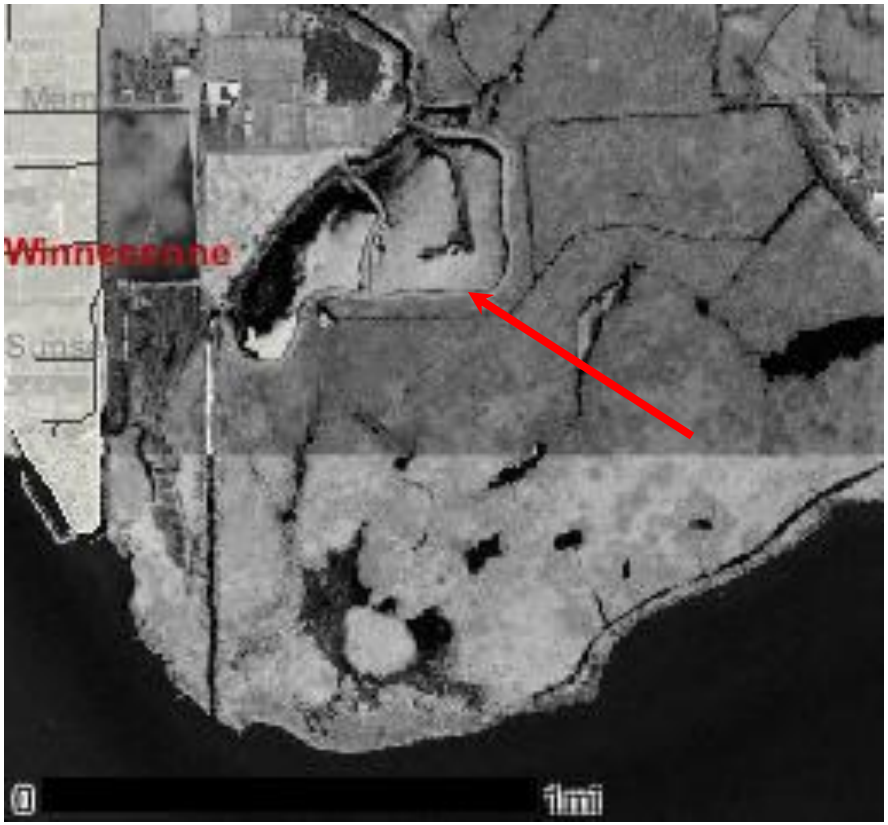
West Fork of Chippewa River

WI Site ReCon Status

Rejects



Cranberry Bog



Dugout for waterfowl production

USEPA National Lake Assessment:

Wisconsin's 29 Lakes

Nov. 5, 2007

Name	Cty	WBIC	Lake Class	Area (acres)	Max Depth (ft)
Buckskin Lake	Florence	584600	5	11	6
Unnamed	Polk	2658800	1	13	4
Marl Lake	Waupaca	264100	2	17	59
Fox Lake	Iron	1849500	6	43	23
Unnamed	Washburn	2698300	1	48	
Little Elkhart Lake	Sheboygan	46000	6	52	25
McLeod Lake	Vilas	1619600	1	54	7
Echo Lake	Lincoln	1488400	1	57	10
Spring Lake	Barron	1882800	6	63	67
Round Lake	Polk	2616400	2	67	26
Crystal Lake	Vilas	1842400	6	80	67
Price Lake	Price	2234600	4	87	27
Haskell Lake	Vilas	1538000	2	91	50
Half Moon Lake	Polk	2621100	4	120	60
Schnur Lake	Price	2284000	2	153	27
Atkins Lake	Bayfield	2734000	2	175	80
Berry Lake	Oconto	418300	6	206	27
Blueberry Lake	Sawyer	1835700	6	300	29
Arrowhead Lake (Manchester)	Adams	1377700	4	306	30
Plum Lake	Vilas	1592400	4	323	57
Swan Lake	Columbia	179800	4	453	82
Oconomowoc Lake	Waukesha	849600	4	778	62
Chequamegon Waters Flowage	Taylor	2160700	4	911	22
Tichigan Lake	Racine	763600	4	1209	65
Wapogasset Lake	Polk	2618000	4	1427	32
Kegonsa, Lake	Dane	802600	4	3196	31
Willow Reservoir	Oneida	1528300	4	4399	30
Green Lake	Green Lake	146100	4	7672	236
Winnebago, Lake	Calumet	131100	4	133404	21

Wisconsin's Approach

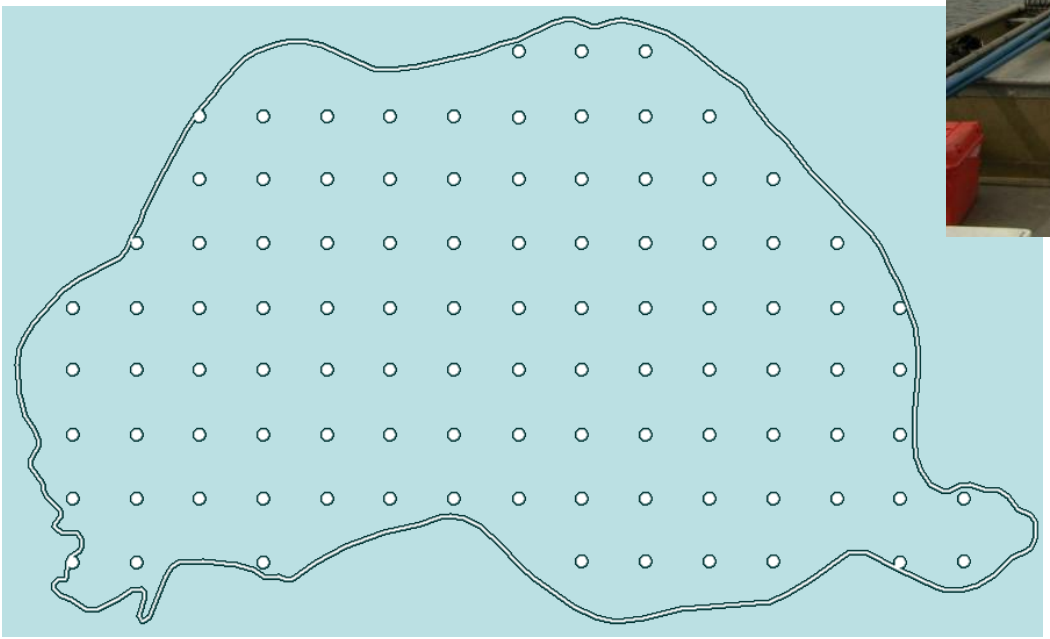
- USGS conducted the pelagic (index station) sampling.
- WDNR conducted the littoral habitat assessment, and collected benthic and pathogen samples.
- DNR Science Services completed aquatic plant surveys on target lakes less than 500 acres
- DNR Science Services analyzed sediment core (top and bottom, dating and diatoms) and zooplankton samples.
- State Laboratory of Hygiene analyzed some water chemistry and all phytoplankton samples.
- Full water chemistry, algal toxins, pathogens, and benthic invertebrates sent to centralized laboratories.

Wisconsin Add-ons

- Point intercept (PI) aquatic plant survey on NLA lakes, as well as reference lakes
- Additional info on shoreline habitat and human influence
- Sediment cores and water quality from additional 30+ lakes
- Mercury (Hg) sample from water column

Aquatic Plant Survey

- Point-intercept method
- Two headed rake throws
- Species list and distributions for each lake
- Density rating for exotics (1,2,3): EMW and CLP



Supplemental Data: Lakeshore Habitat

- Plot expanded to 45 m
- 3 plant rake throws
- Woody debris transects
- Additional invasives:
  - Japanese stiltgrass
  - Reed canary grass
  - Phragmites
  - Hybrid cattail
  - Yellow iris

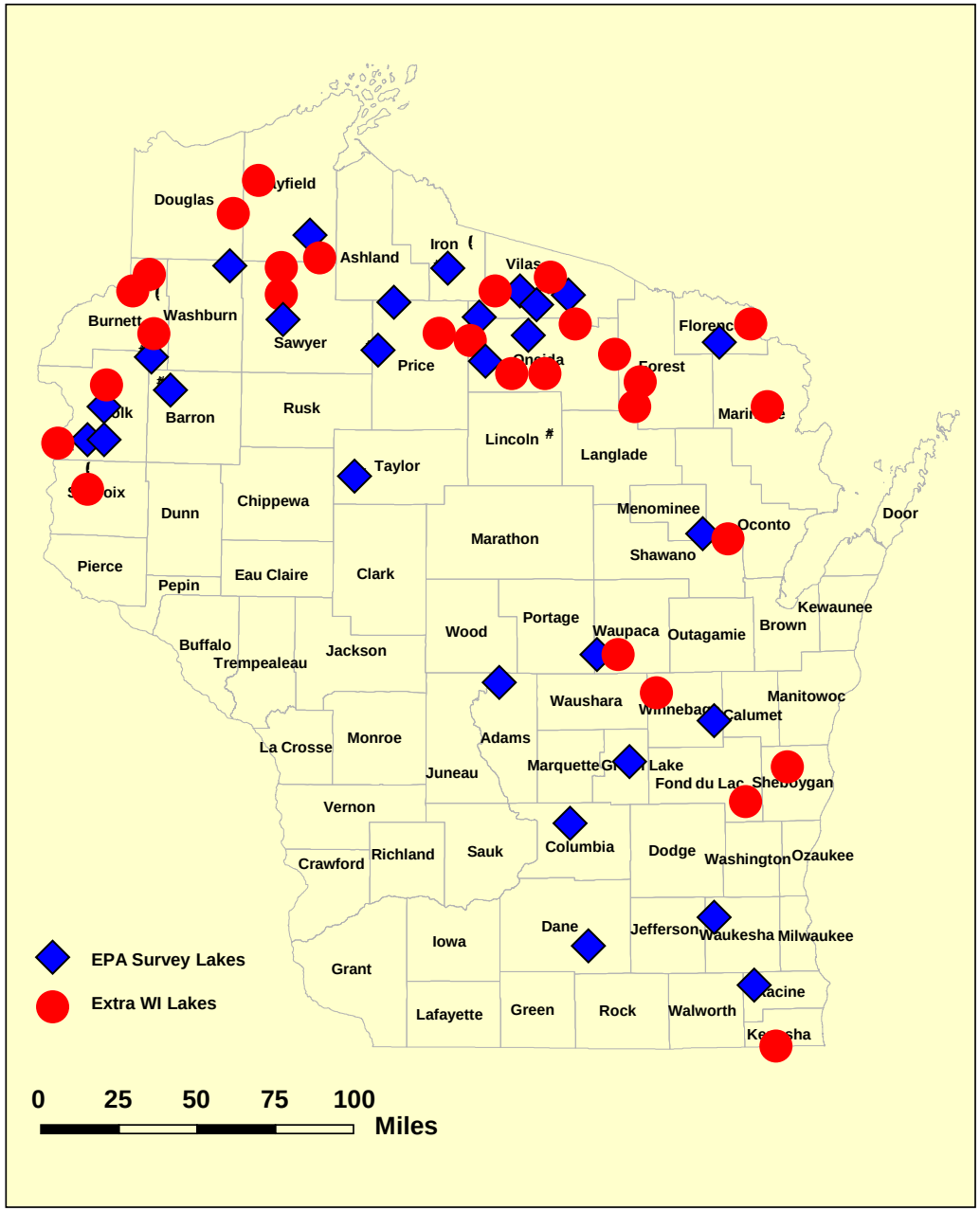
Supplemental Data: Human Development

Quantified %:

- Seawall & riprap
- Artificial beach
- Lawn
- Pavement

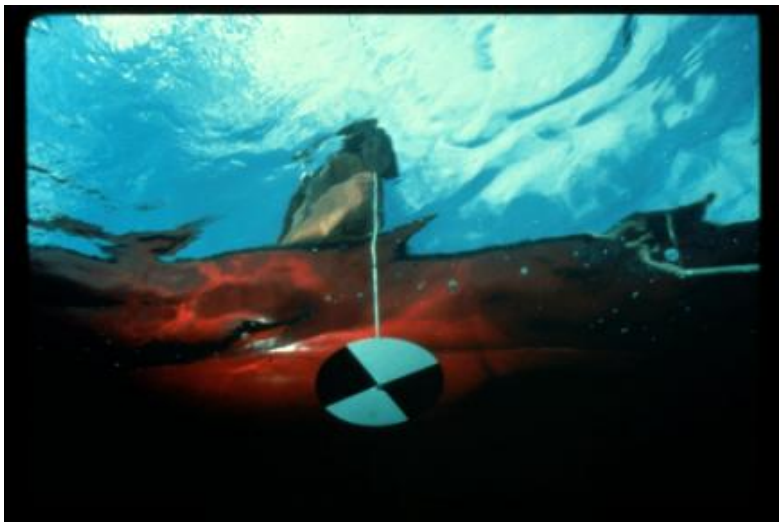
Counted:

- Residences
- Commercial buildings
- Structures
- Docks
- Boat lifts
- Swim rafts


Douglas
Ashland
Iron
Vilas
Florence
Burnett
Washburn
Sawyer
Price
Forest
Barron
Rusk
Lincoln
Langlade
Taylor
Chippewa
Dunn
Menominee
Oconto
Door
Marathon
Shawano
Pierce
Pepin
Eau Claire
Clark
Kewaunee
Brown
Portage
Wood
Waupaca
Outagamie
Buffalo
Trempealeau
Jackson
Waushara
Manitowoc
Calumet
Adams
La Crosse
Monroe
Marquette
Lake
Juneau
Fond du Lac
Sheboygan
Vernon
Columbia
Richland
Sauk
Dodge
Washington
Ozaukee
Crawford
Dane
Jefferson
Waukesha
Milwaukee
Iowa
Grant
Racine
Lafayette
Green
Rock
Walworth
EPA Survey Lakes
Extra WI Lakes
0
25
50
75
100
Miles

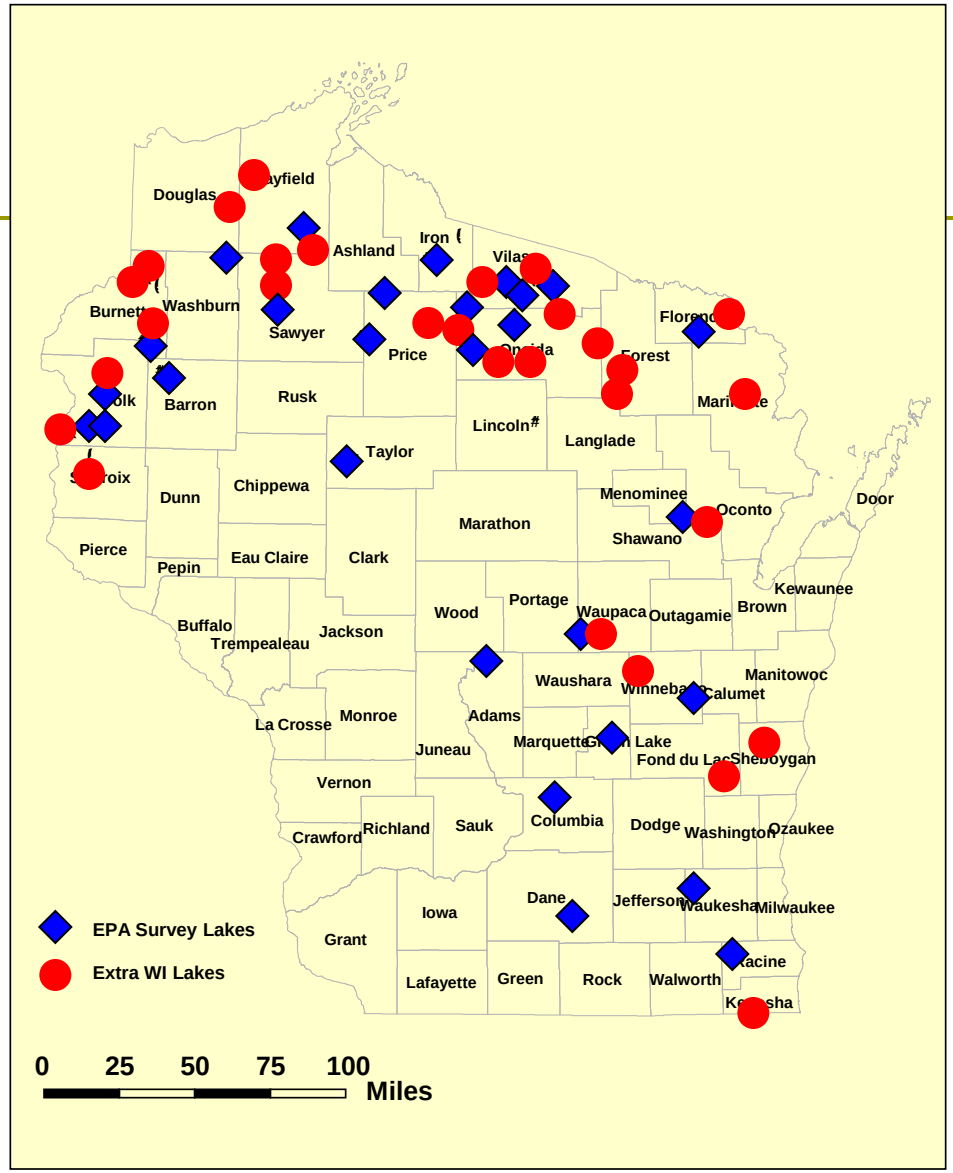
WI Findings

- Water clarity
- Trophic Status
- Algal toxins (microcystin)
- Sediment cores
- Mercury (Hg)
- Plant data
- Shoreland habitat and development



Algal toxins (Microcystin LR)

- 16 of 35 samples had detectable levels
- 15 of 33 lakes
- Highest concentration was 4.5 ug/L (well below WHO guideline for risk)
- Samples collected in the middle of the lake!


Douglas
Ashland
Iron
Washburn
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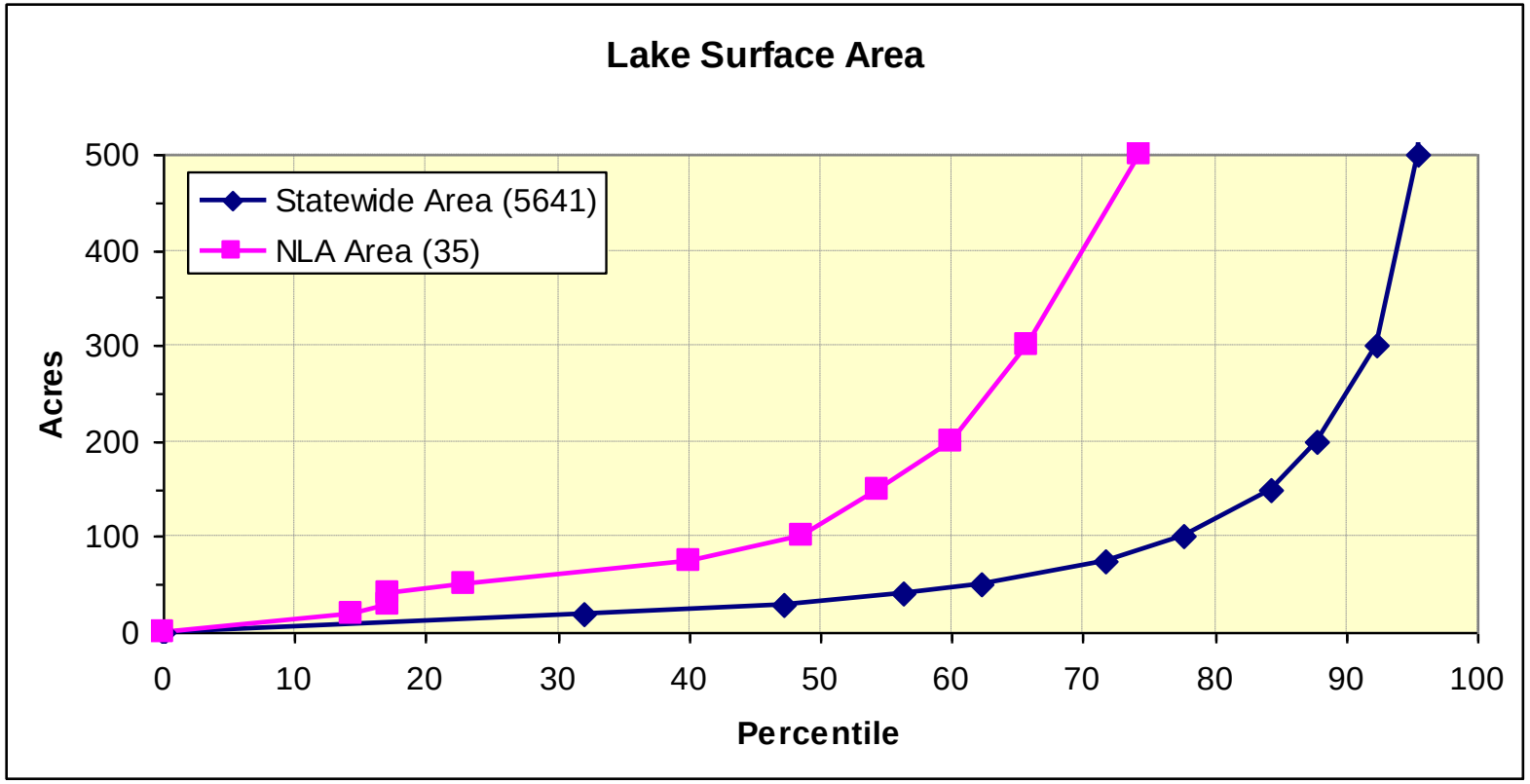
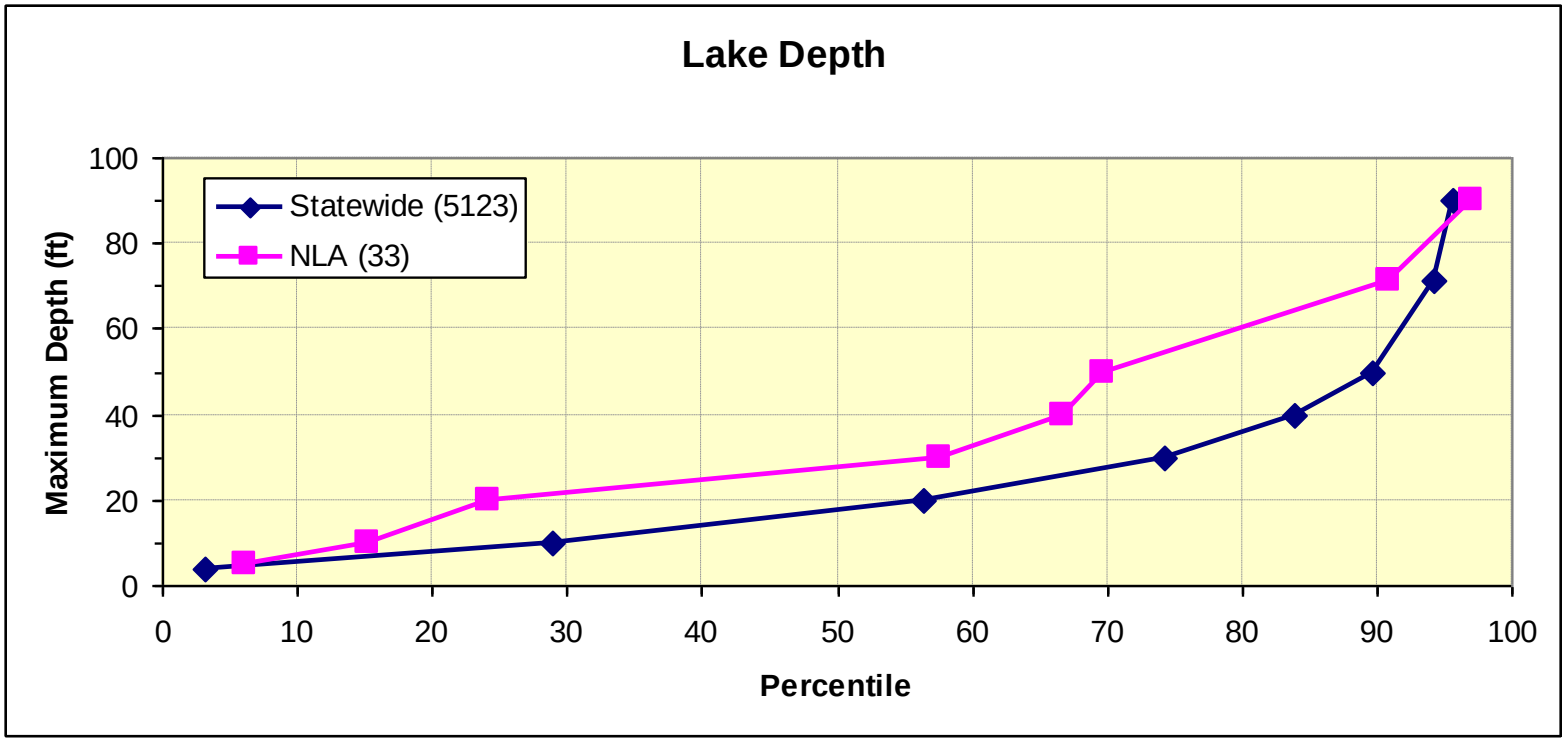
Florence
Forest
Barron
Rusk
Taylor
Lincoln
Langlade
Marinette
Dunn
Chippewa
Menominee
Oconto
Door
Marathon
Shawano
Pierce
Pepin
Eau Claire
Clark
Kewaunee
Portage
Wood
Waupaca
Outagamie
Brown
Buffalo
Trempealeau
Jackson
Waushara
Manitowoc
Calumet
La Crosse
Monroe
Adams
Juneau
Marquette
Fond du Lac
Sheboygan
Vernon
Columbia
Dodge
Washington
Ozaukee
Crawford
Richland
Sauk
Dane
Jefferson
Waukesha
Milwaukee
Iowa
Grant
Racine
Lafayette
Green
Rock
Walworth
EPA Survey Lakes
Extra WI Lakes
0
25
50
75
100
Miles

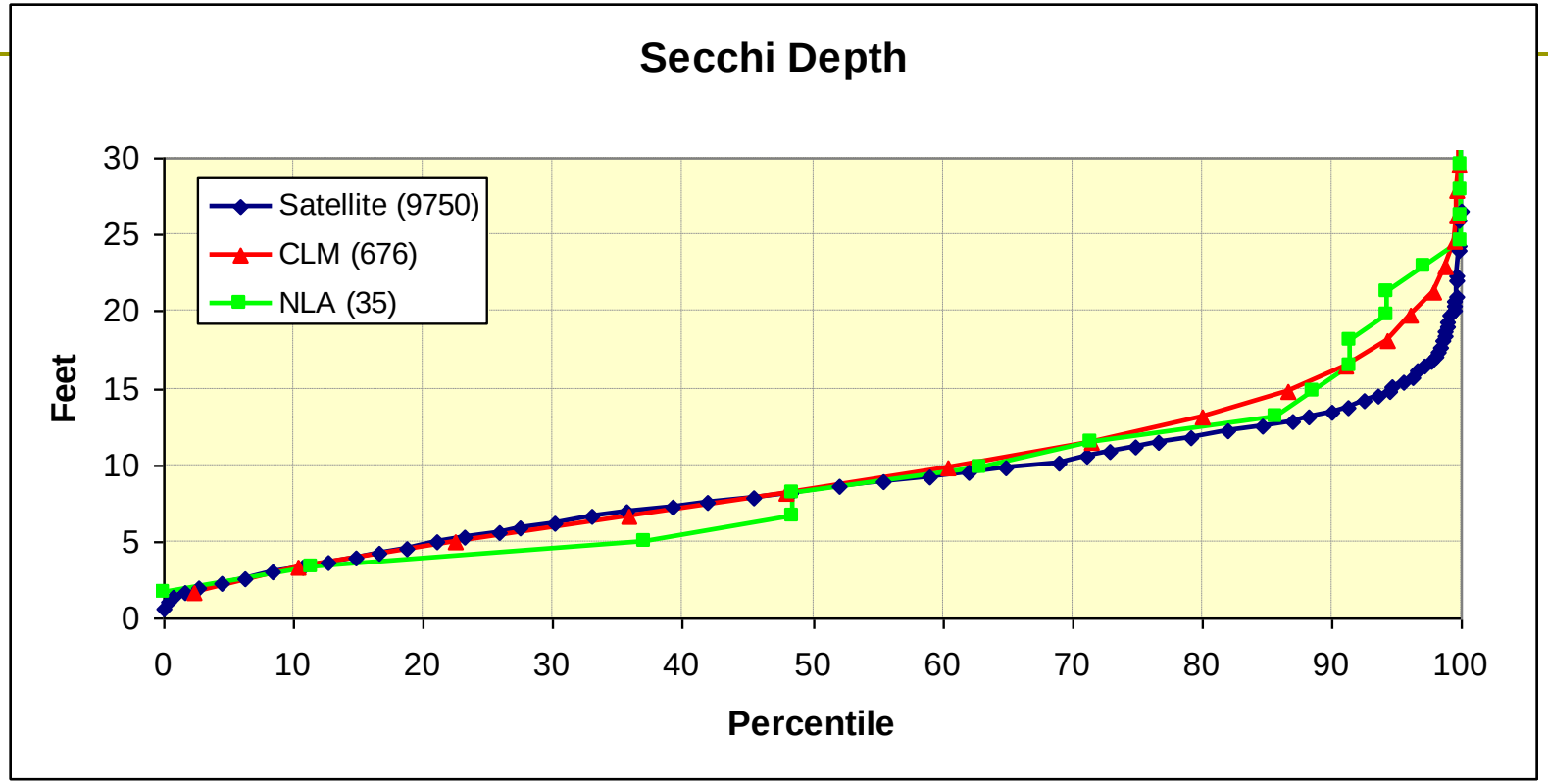
LAKE AREA FREQUENCY DISTRIBUTION



LAKE DEPTH FREQUENCY DISTRIBUTION



SECCHI DEPTH FREQUENCY DISTRIBUTION



For Citizens's Lake Monitoring

Best Secchi:	**31.5 ft**	**Black Oak L. Vilas Co.**
Worst Secchi	**0.7 ft**	**Lake Sinissippi, Dodge Co.**

NLA FREQUENCY DISTRIBUTIONS

	Color	Secchi	DOC	Chl-a	TP	TN	Cl	SO4
	PCU	ft	mg L^{-1}	µg L^{-1}	µg L^{-1}	µg L^{-1}	mg L^{-1}	mg L^{-1}
Min	0	2.6	2	1	2	197	0.1	2
10th	3	3.3	3	2	6	307	0.3	5
25th	7	4.1	5	3	8	521	0.9	21
50th	10	8.5	6	5	13	654	3.6	61
75th	21	11.9	9	14	40	903	17.6	164
90th	28	15.1	13	32	64	1300	42.4	197
Max	125	23.8	27	149	161	1824	127.2	252

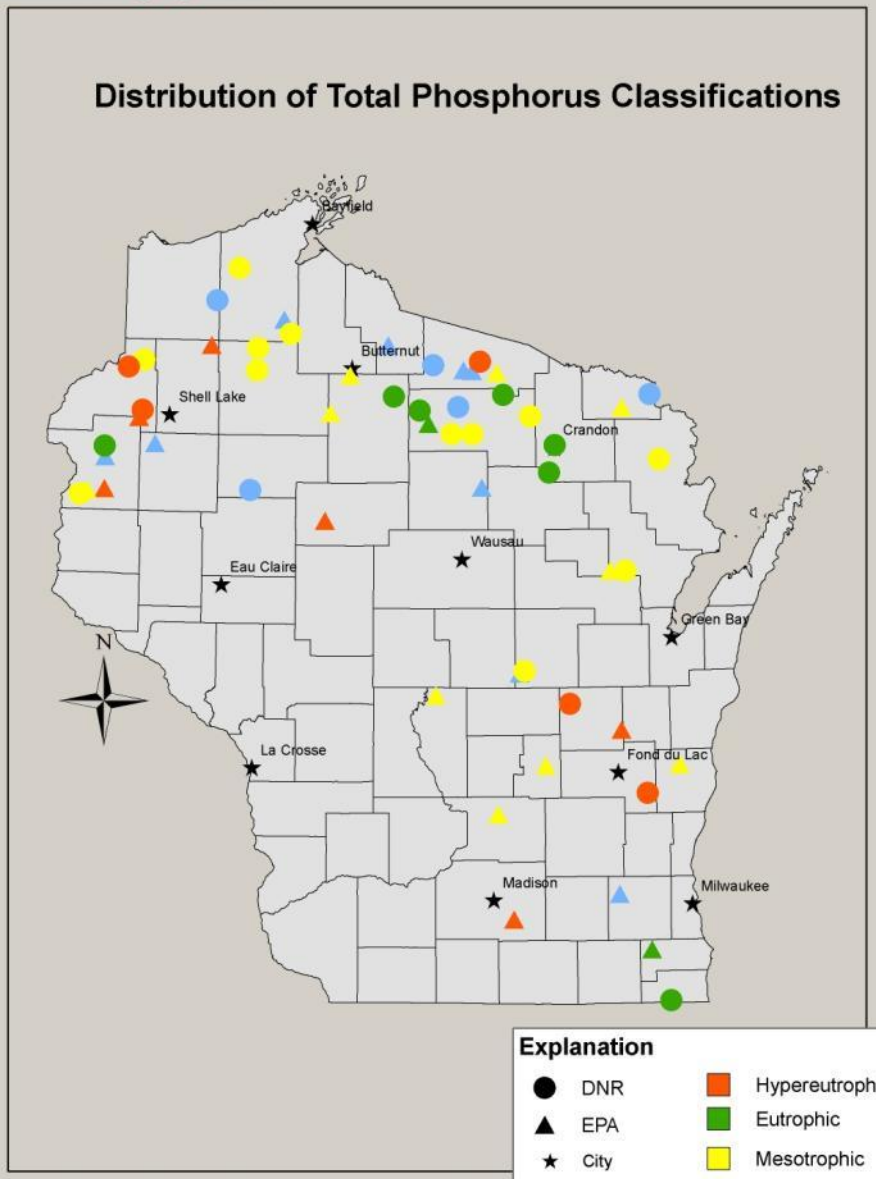
NLA IQ range for Secchi comparable to statewide assessment

State: 5 – 12 ug L^{-1}
NLA: 4 – 12 ug L^{-1}

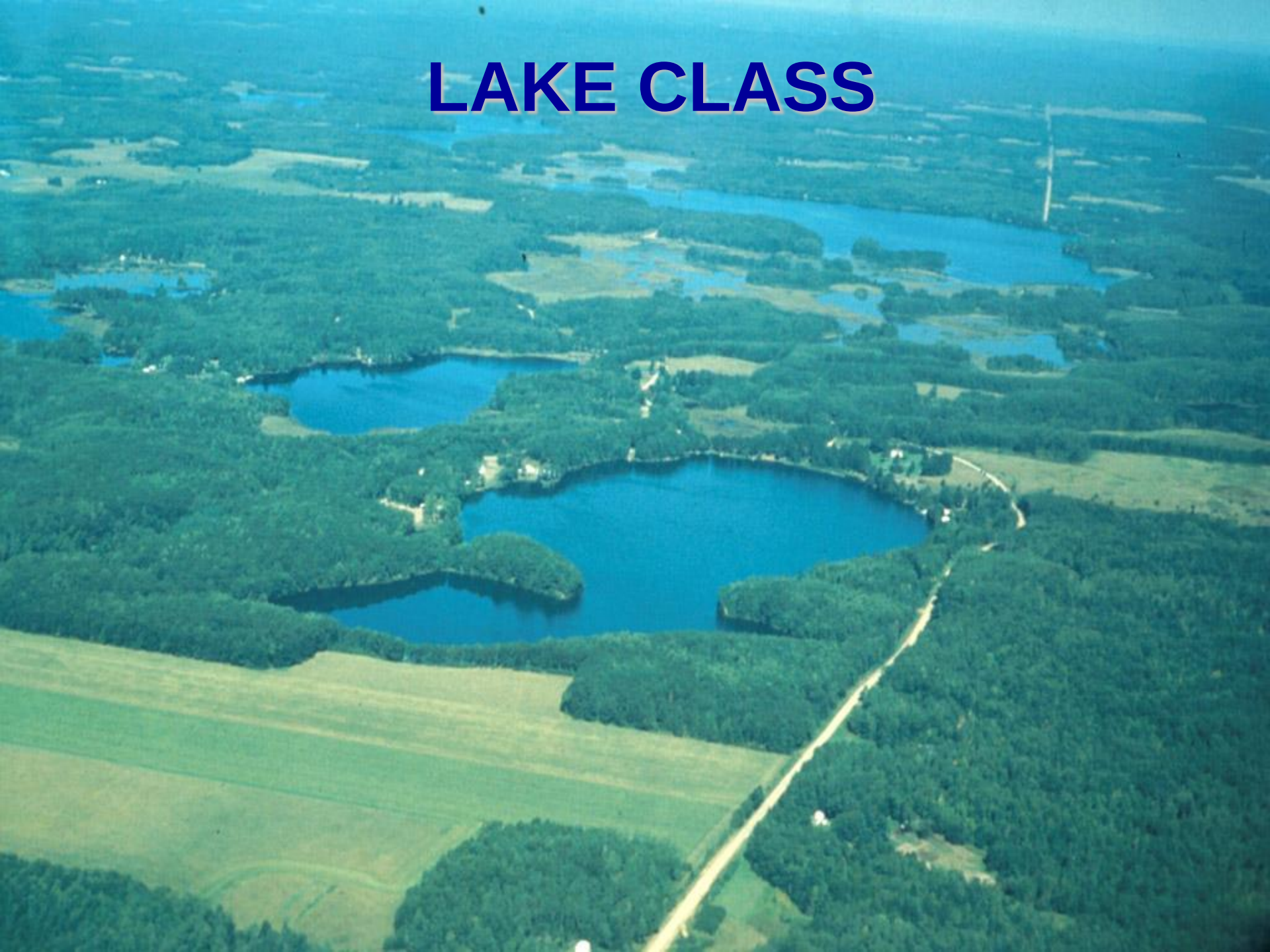
NLA IQ range for TP comparable to statewide assessment

State: 11 – 31 ug L^{-1}
NLA: 8 – 40 ug L^{-1}

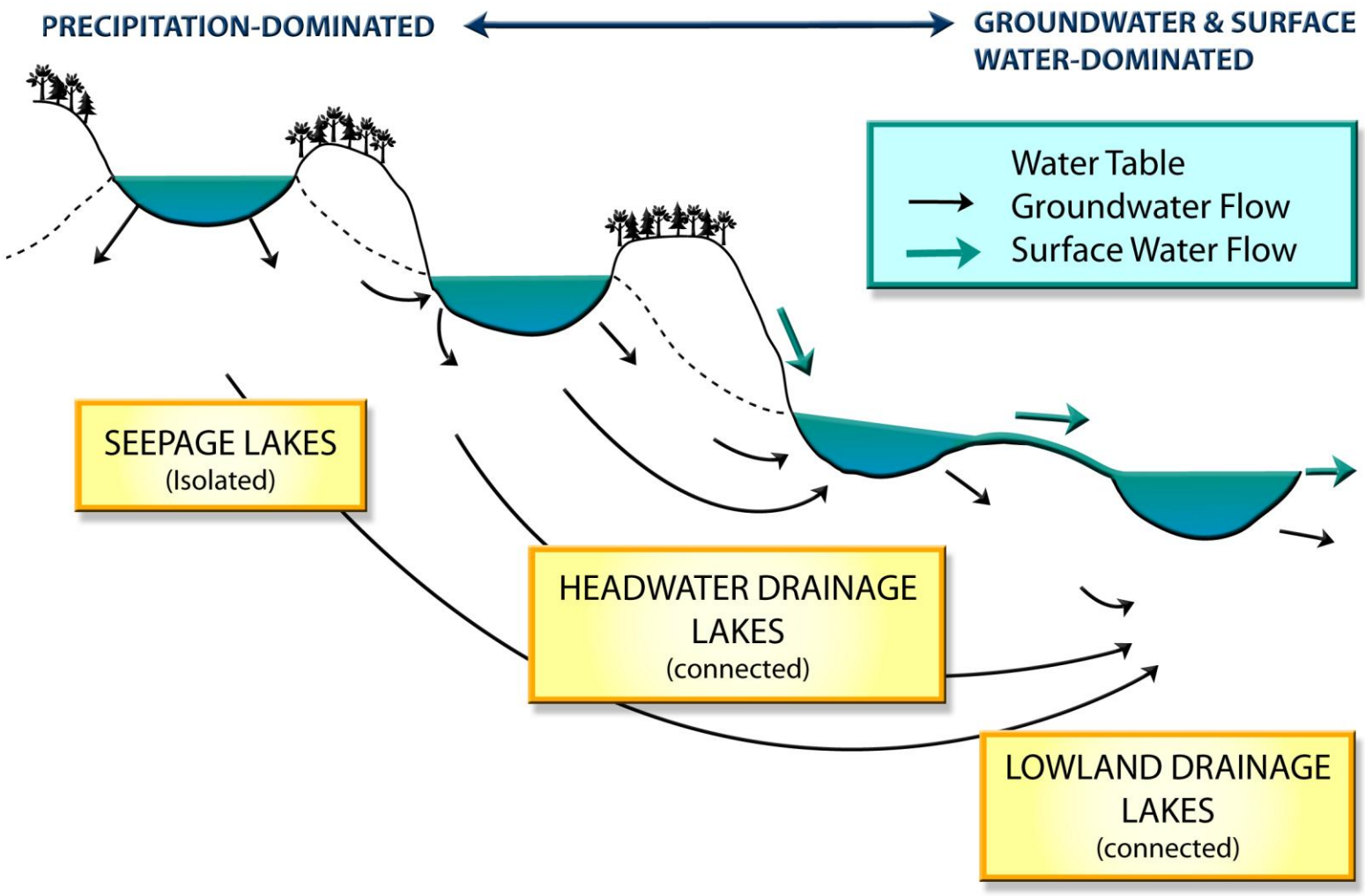
USGS
science for a changing world

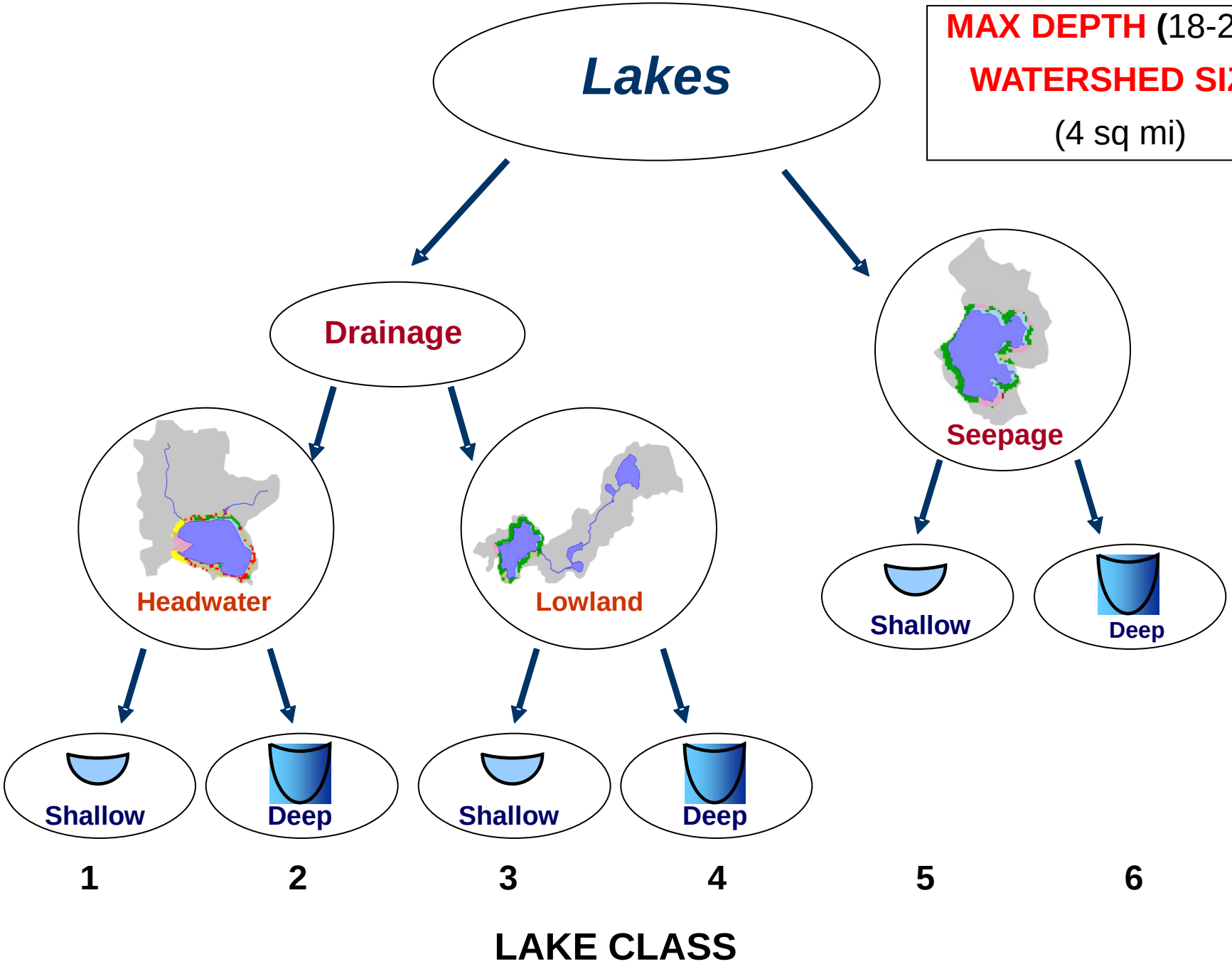


LAKE CLASS

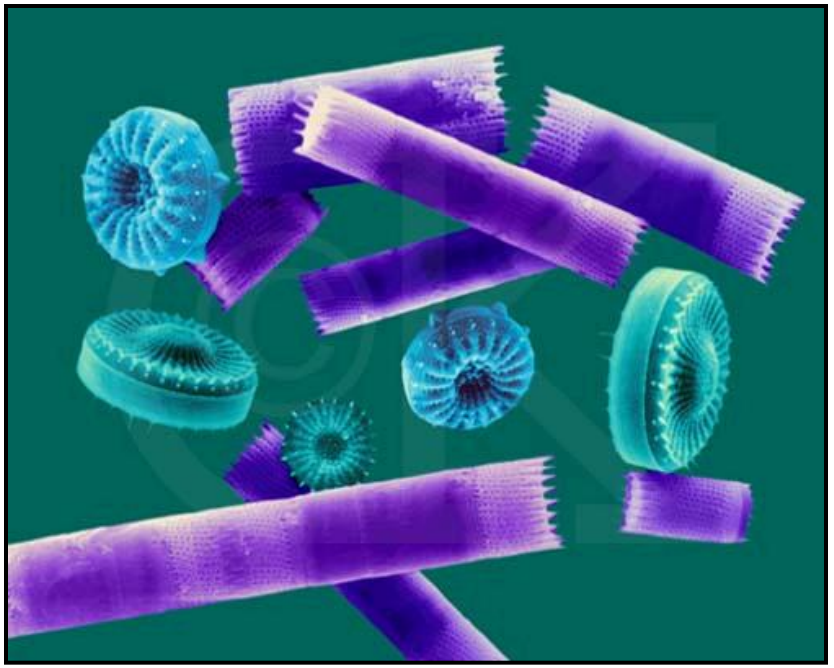


LANDSCAPE POSITION

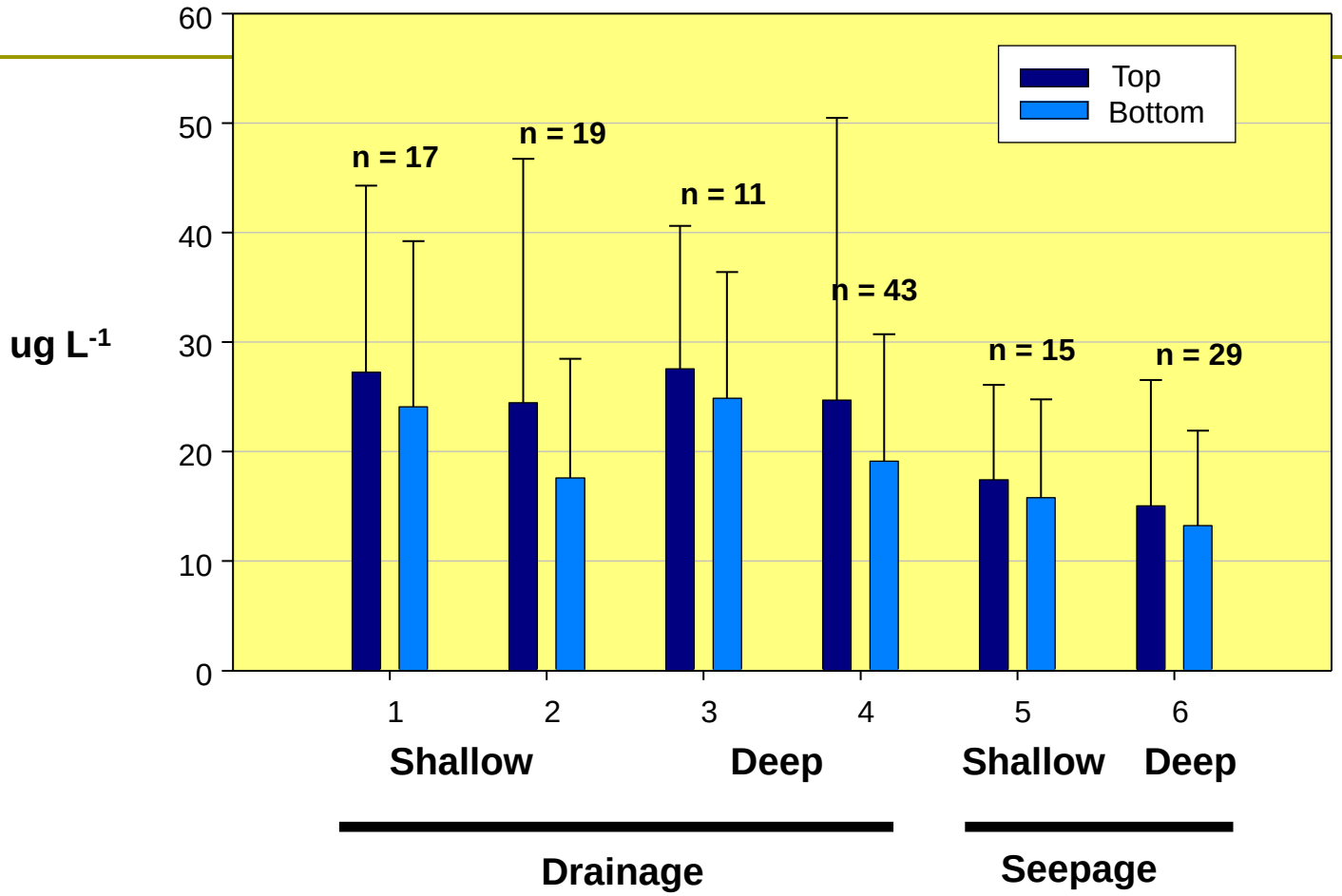



MAX DEPTH (18-20 ft)
WATERSHED SIZE
(4 sq mi)
Lakes
Drainage
Seepage
Headwater
Lowland
Shallow
Deep
Shallow
Deep
Shallow
Deep
1
2
3
4
5
6
LAKE CLASS

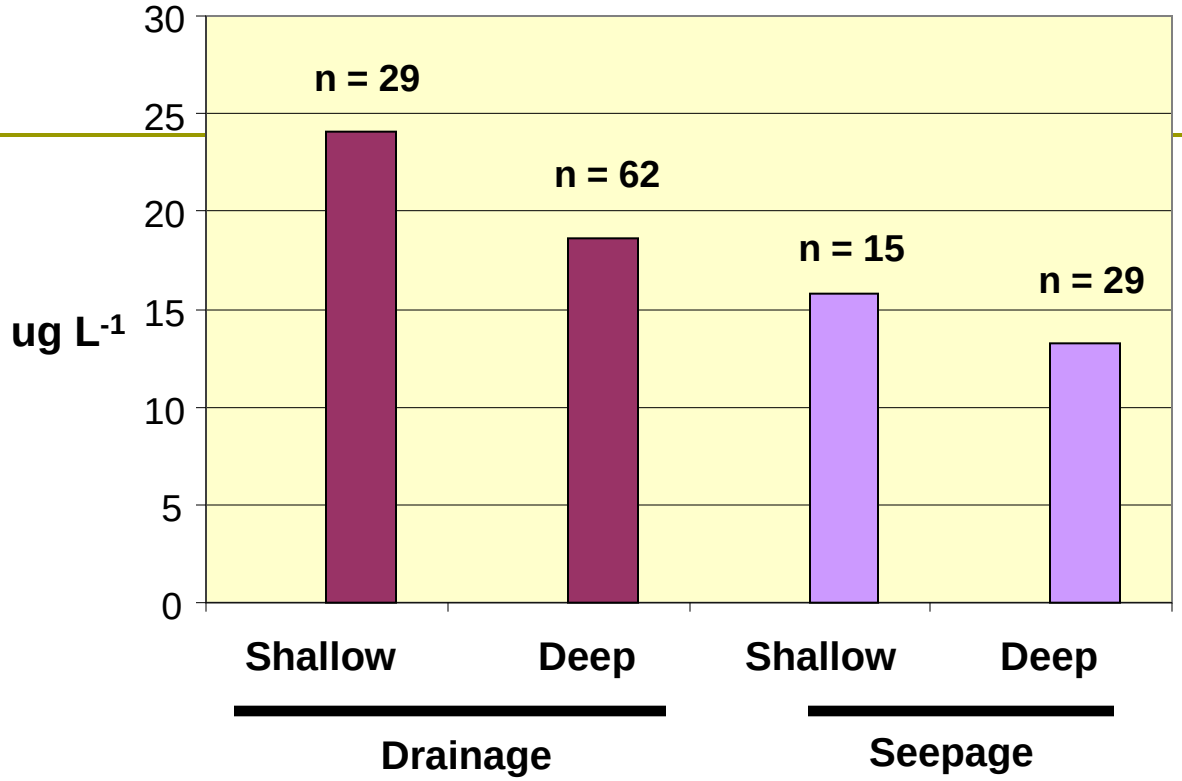
REFERENCE CONDITIONS



SUMMER PHOSPHORUS

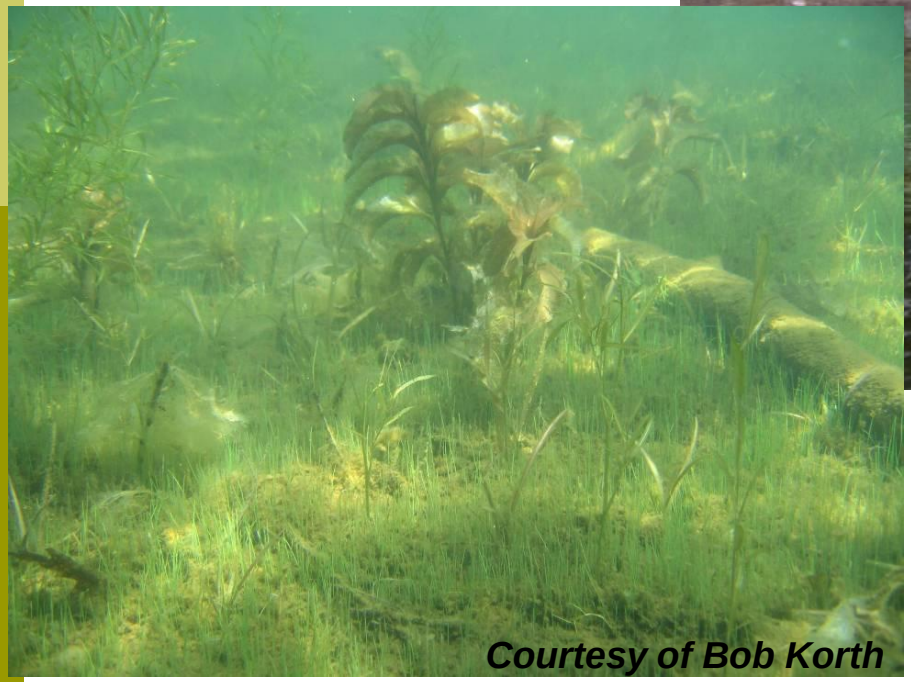


Summer Phosphorus



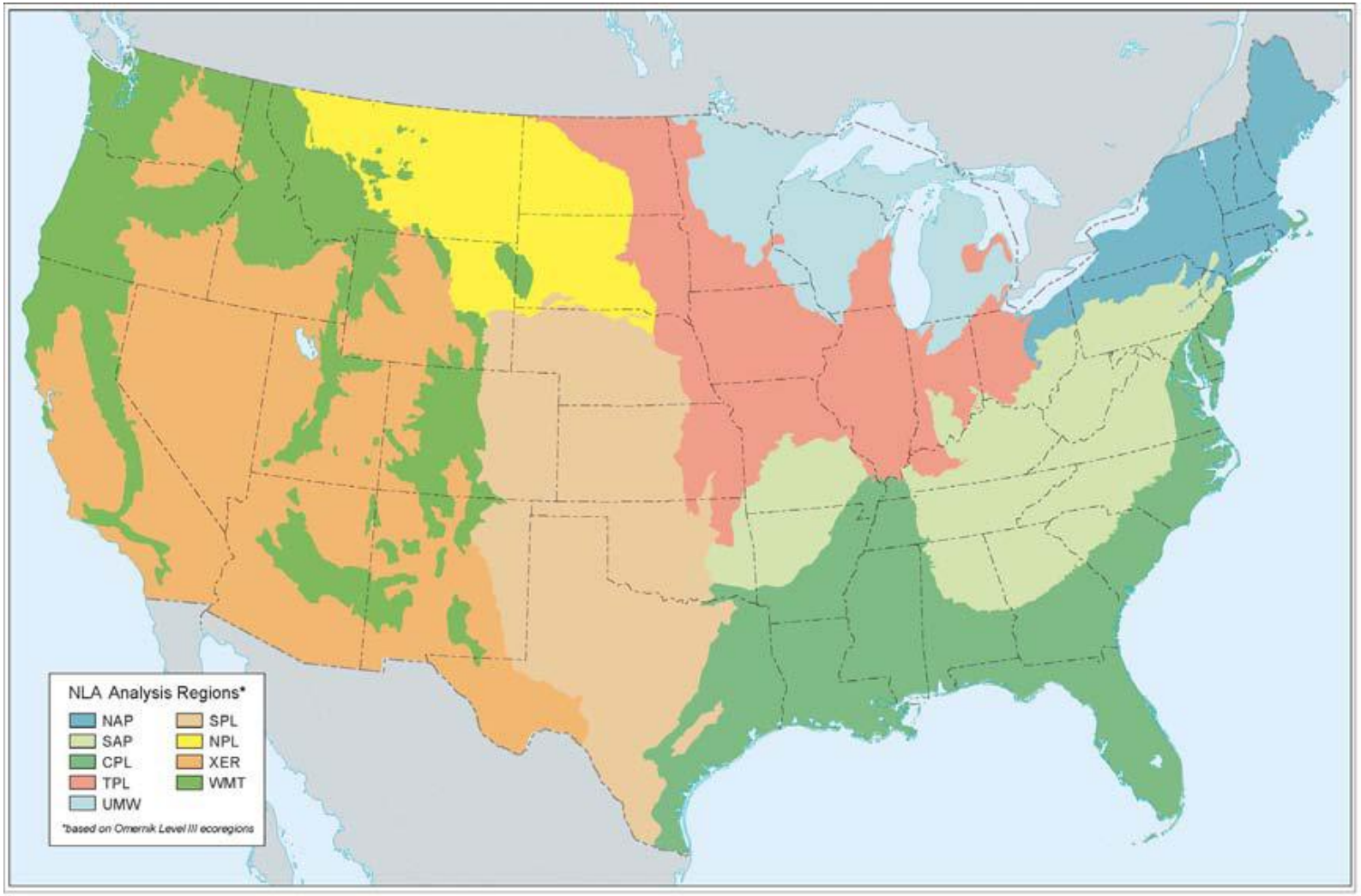
CLASS	Phosphorus (ug/L)
Drainage Lakes	
1,3 (Shallow)	**24**
2,4 (Deep)	**19**
Seepage Lakes	
5 (Shallow)	**16**
6 (Deep)	**13**

Wisconsin Shoreline Habitat

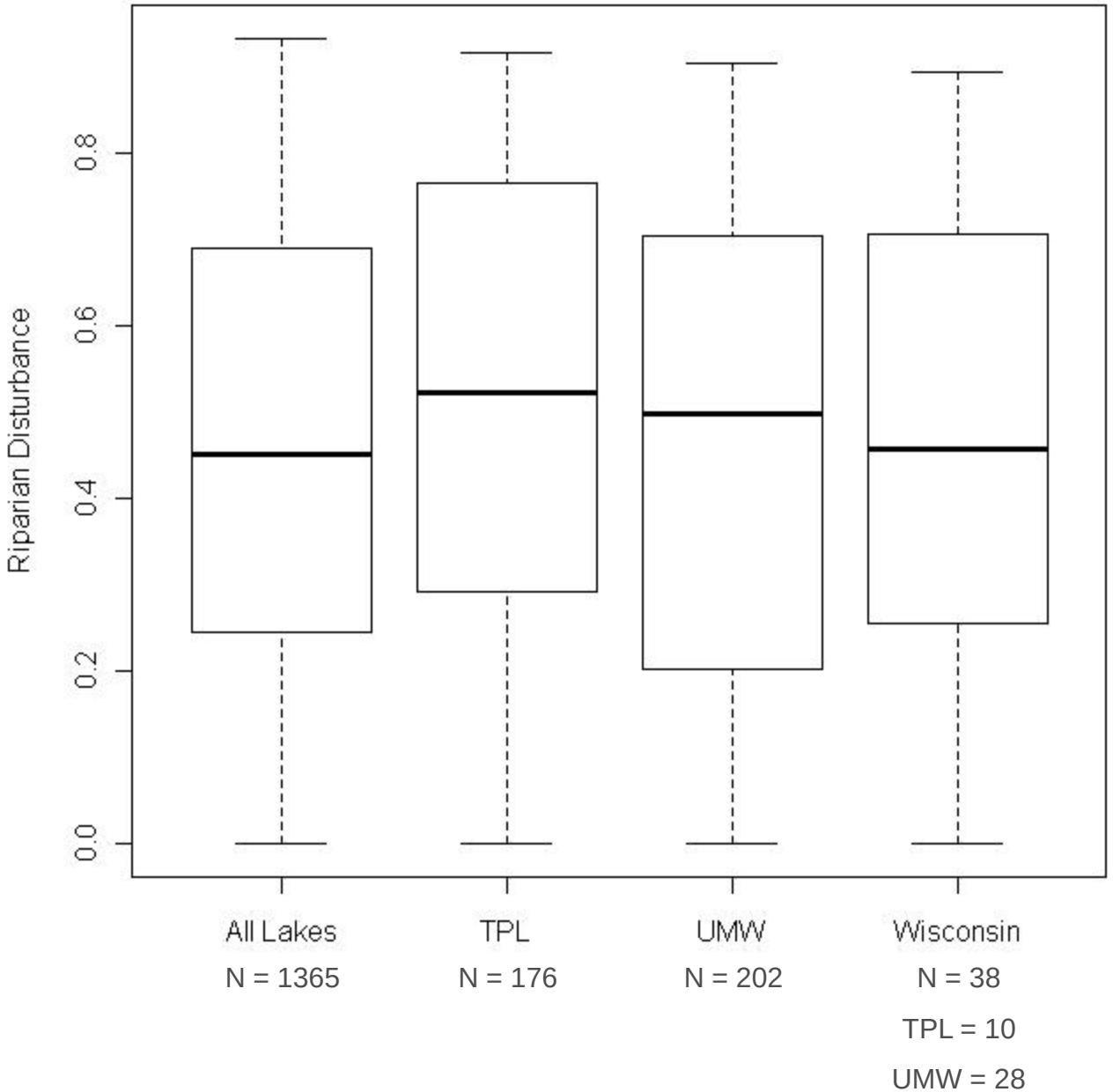


Courtesy of Bob Korth

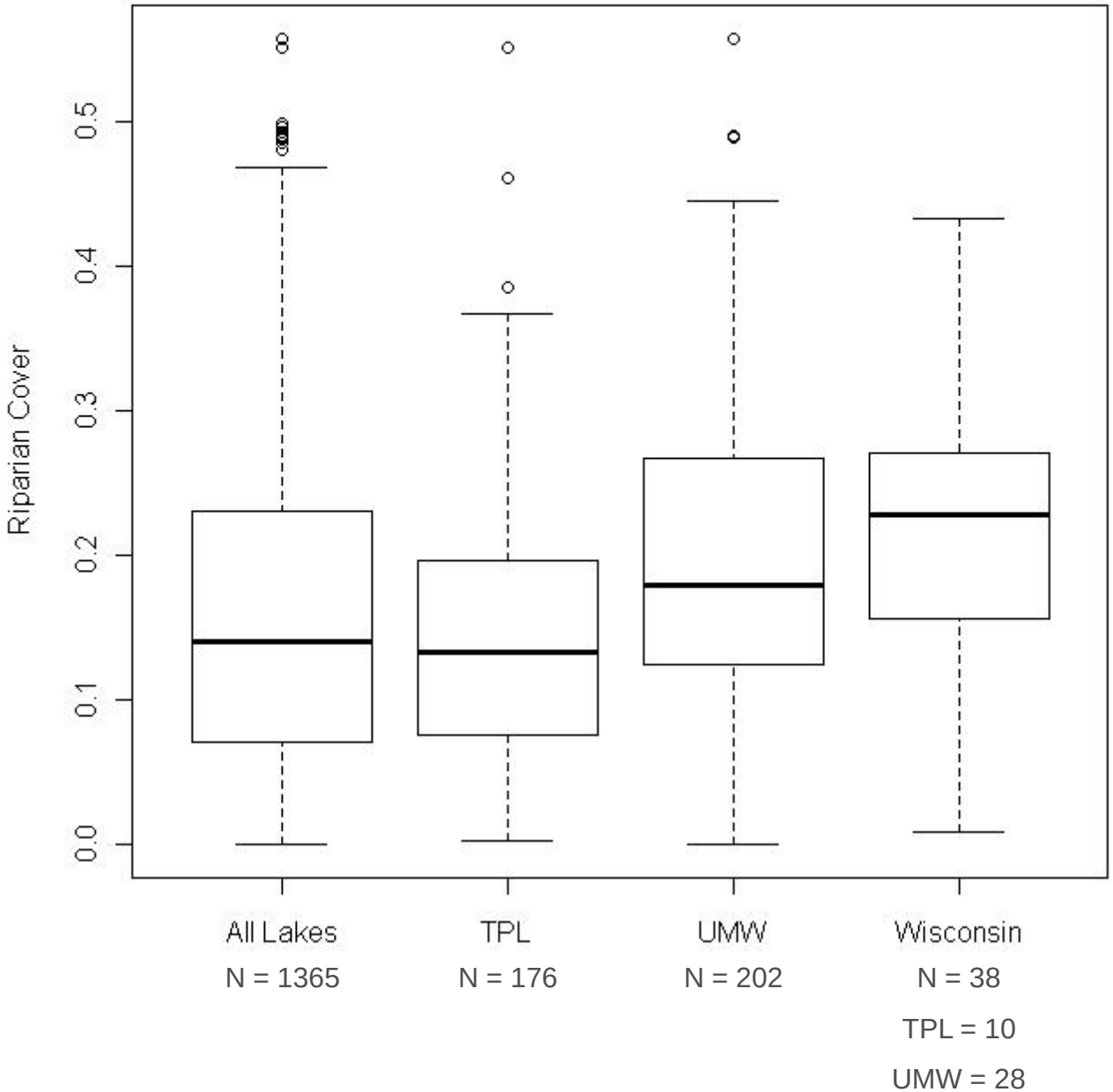
Level III Ecoregions



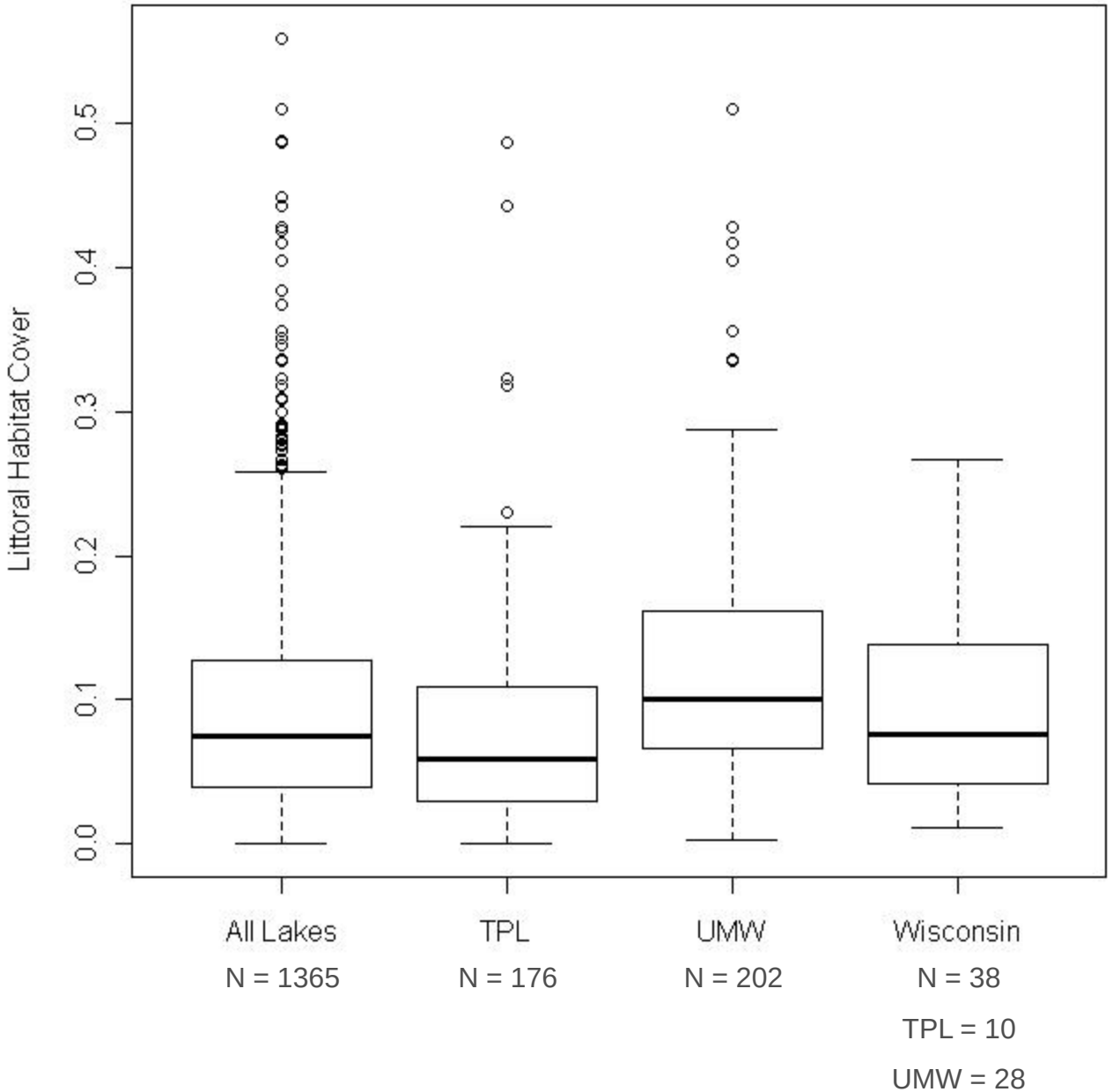
Shoreline Disturbance



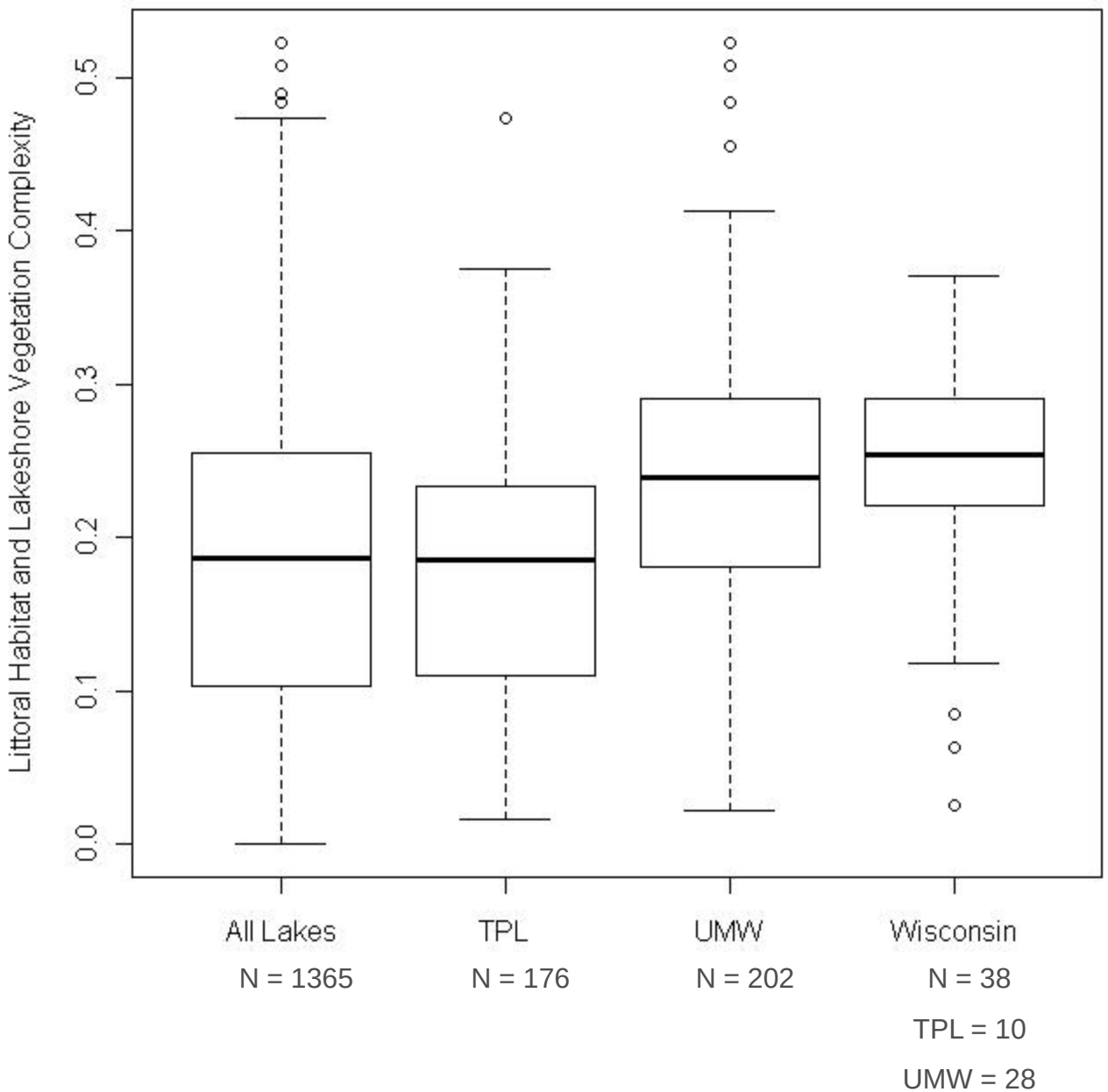
Riparian Vegetation



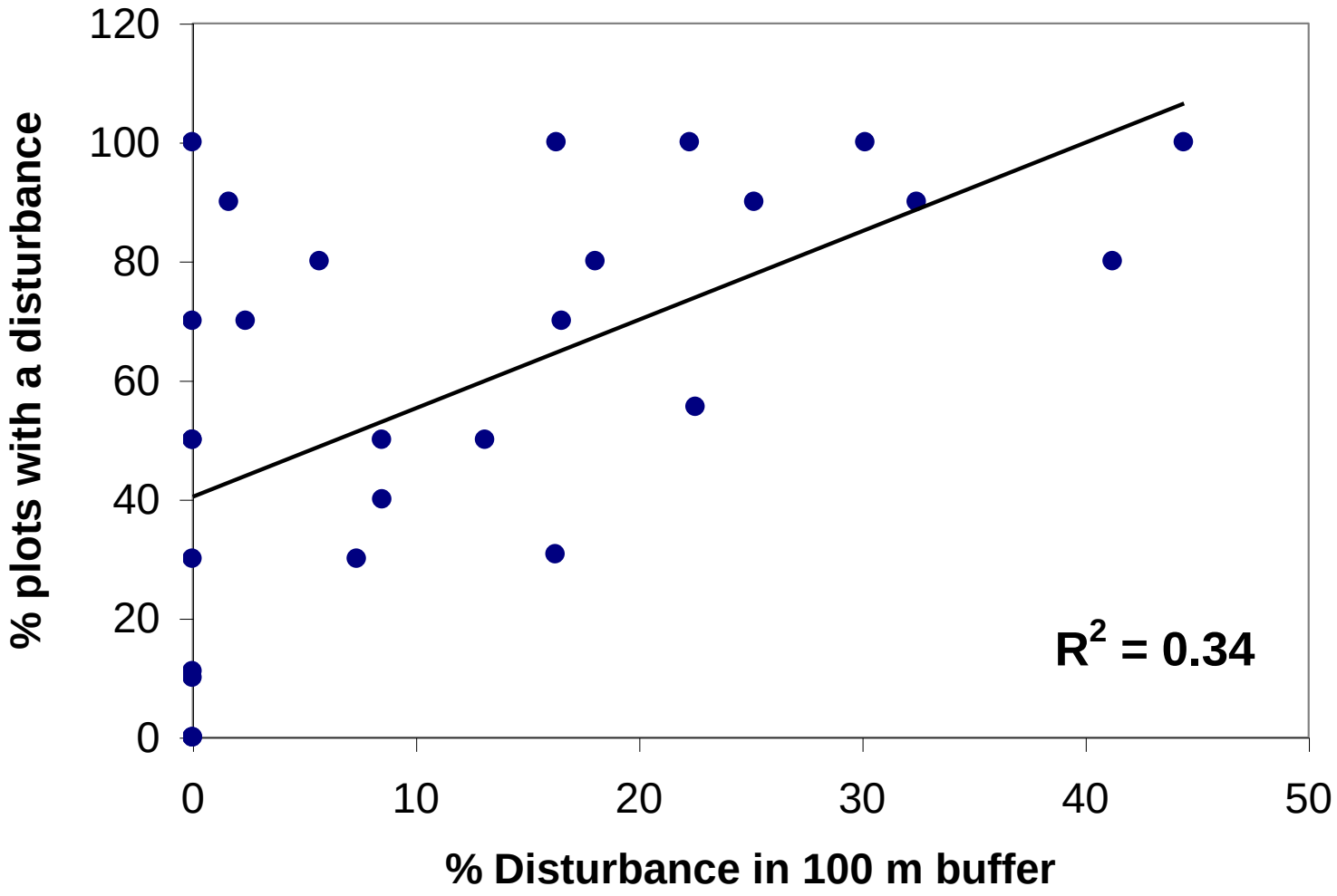
Littoral Zone Habitat



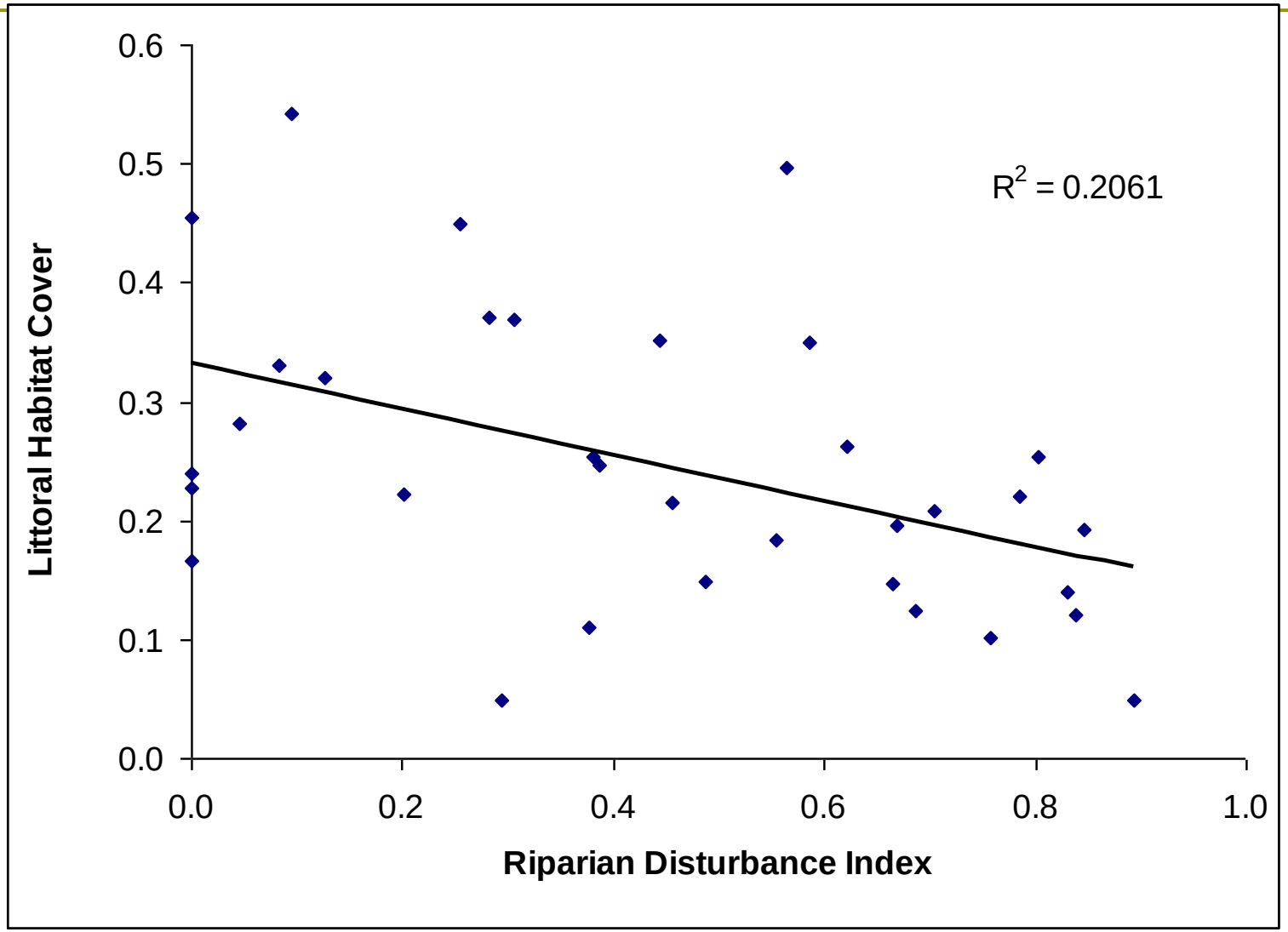
Shoreland and Shallows



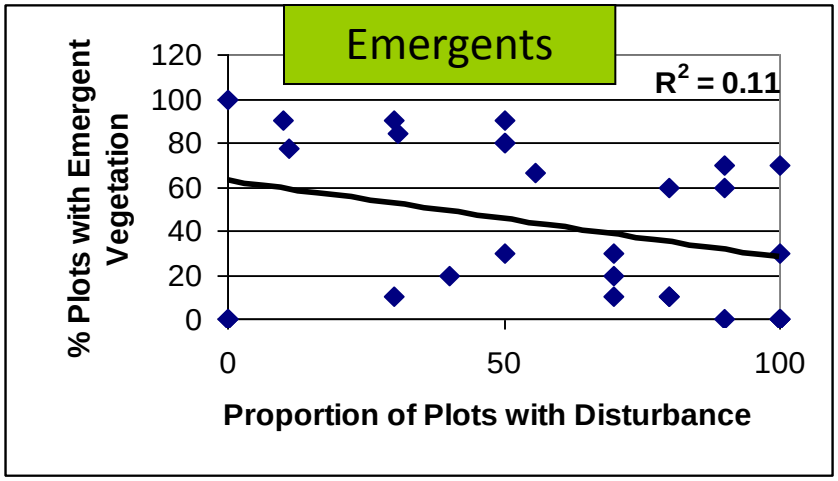
Ground-truthing is needed.

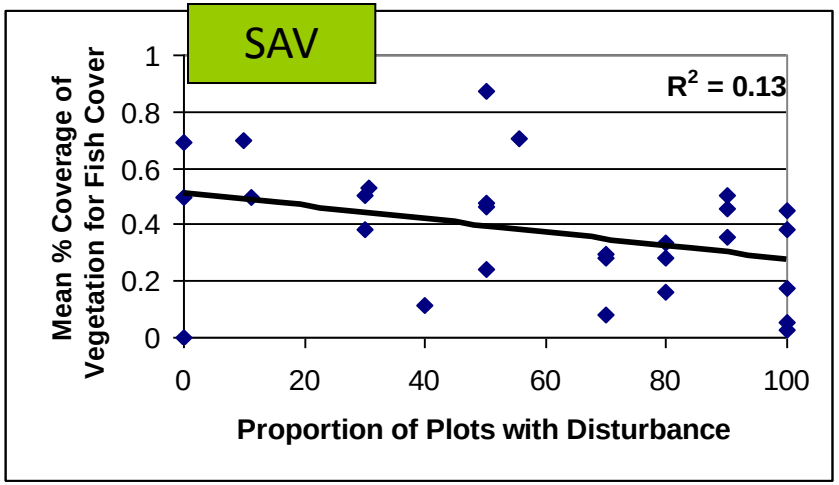


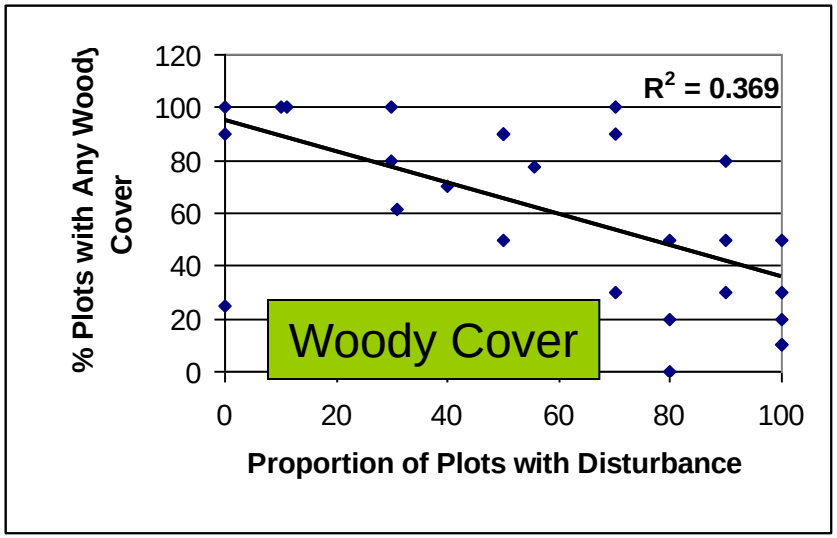
We affect the shallow water habitat.

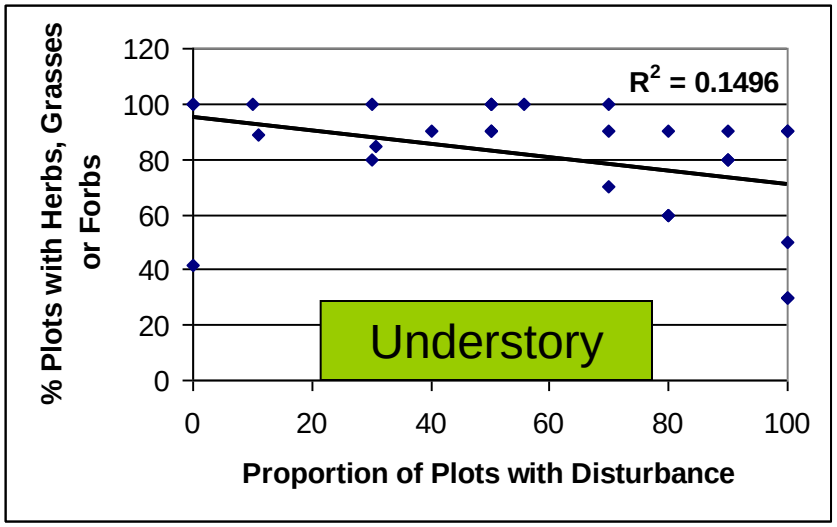


Human Influences on Habitat



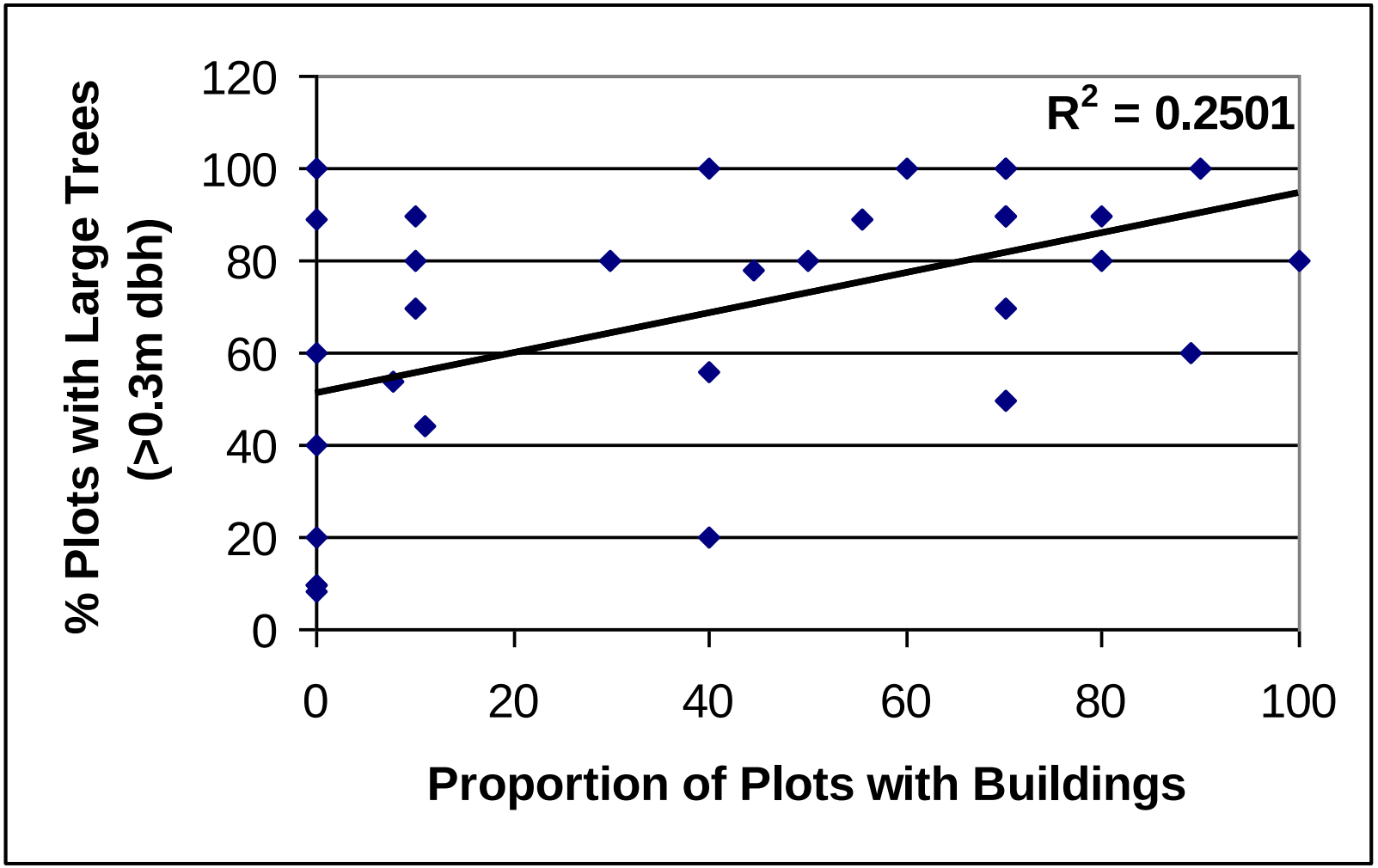






Proportion of Habitat Plots with Disturbance (%)

Do large trees have aesthetic appeal?



National Lakes Assessment

Aquatic Macrophyte Surveys

Michelle Nault, Alison Mikulyuk,
Scott Van Egeren, Jen Hauxwell

WISCONSIN
DEPT. OF NATURAL RESOURCES

Recommended Baseline Monitoring of Aquatic Plants in Wisconsin:

Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications

Jennifer Hauxwell, Susan Knight, Kelly Wagner, Alison Mikulyuk, Michelle Nault, Meghan Porzky and Shaunna Chase

March 2010

Document citation:
Hauxwell, J., S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky and S. Chase. 2010. Recommended baseline monitoring of aquatic plants in Wisconsin: sampling design, field and laboratory procedures, data entry and analysis, and applications. Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010. Madison, Wisconsin, USA.

WISCONSIN DEPT. OF NATURAL RESOURCES

Protocol available at:

http://wiatri.net/ecoatlas/ReportFiles/Reports2/1757AquaticPlantReport.pdf

http://www.uwsp.edu/cnr/uwexlakes/ecology/APM/Appendix-B.pdf

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Testing a methodology for assessing plant communities in temperate inland lakes

Alison Mikulyuk[1,*], Jennifer Hauxwell[1], Paul Rasmussen[1], Susan Knight[2], Kelly I. Wagner[1], Michelle E. Nault[1] and Daryl Ridgely[1]

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[2]University of Wisconsin Trout Lake Research Station, 10810 County Hwy N, Boulder Junction, WI 54512

Abstract

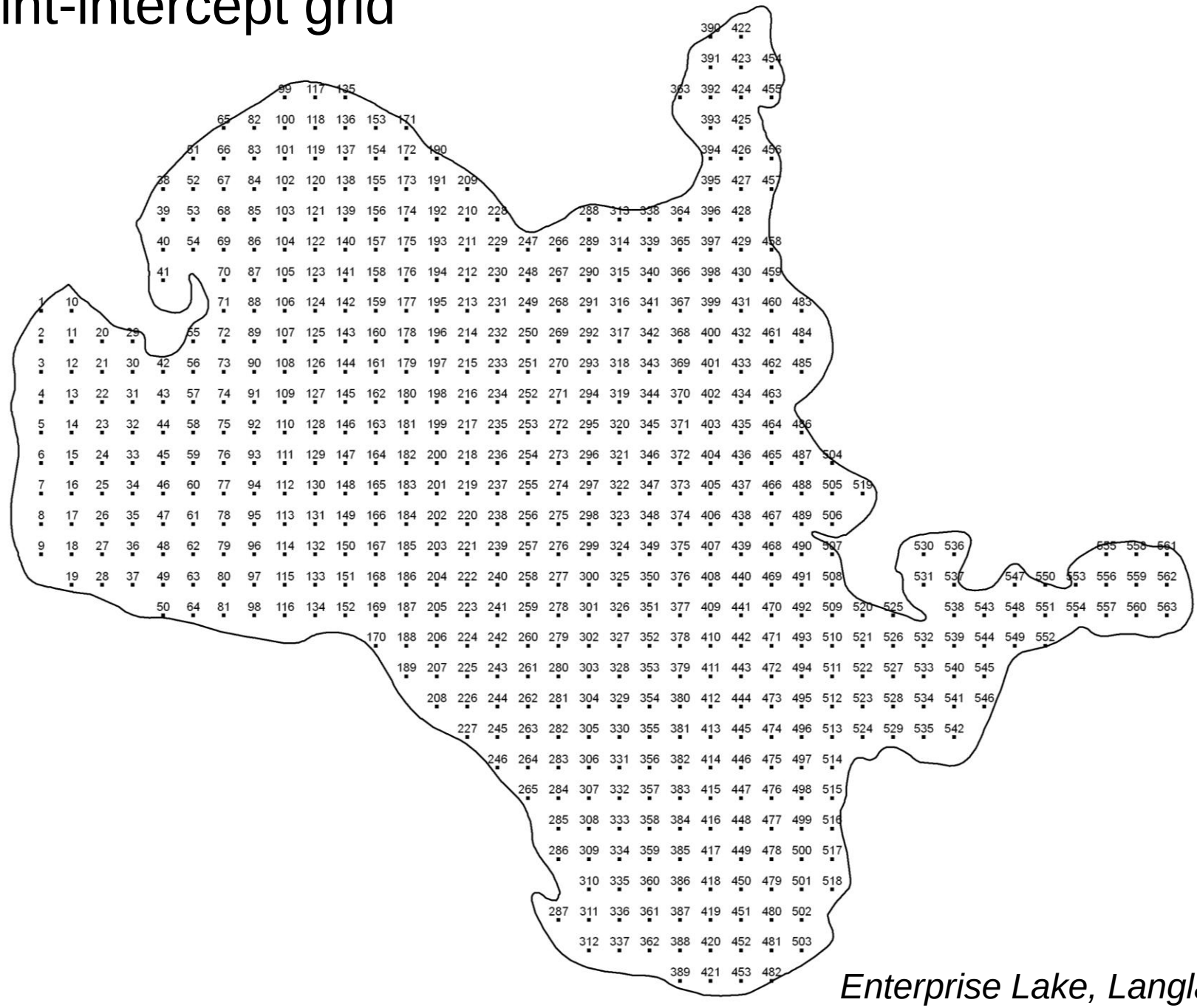
Mikulyuk A, Hauxwell J, Rassmussen P, Knight S, Wagner KI, Nault ME, Ridgely D. 2010. Testing a methodology for assessing plant communities in temperate inland lakes. Lake Reserv Manage 26:54–62.

We outline and test an aquatic plant sampling methodology designed to track changes in and make comparisons among lake plant communities over time. The method employs a systematic grid-based point-intercept sampling design with sampling resolution adjusted based on littoral area and lake shape. We applied this method in 72 Wisconsin lakes ranging from 6.5–245 ha in size, recording species presence–absence and depth at approximately 20,000 unique sample points. To assess how reductions in sampling effort might affect data quality, we used Monte Carlo simulations (100 iterations at each of 9 levels of sampling intensity) to reduce total lake sample points by 10% through 90% using a stratified random selection approach. Species accumulation curves were fit using the Michaelis-Menten 2-parameter formula for a hyperbola, and the predicted asymptote was similar to observed species richness. In a subset of lakes, oversampling (200% effort) did not yield significant increases in species richness. However, even a modest reduction (10–20%) in sampling effort affected species richness, while frequencies of occurrence of dominant species and estimations of percent littoral area and maximum depth of plant growth were less sensitive to sampling effort. In addition, we provide results of a power analysis for detecting changes in plant communities over time. Future applications of this protocol will provide information suitable for in-lake management and for assessing patterns in aquatic plant communities state-wide related to geographic region, hydrological characteristics, land use, invasive species and climate.

Key words: aquatic macrophytes, Monte Carlo, sampling effort, species richness estimation

***Mikulyuk et al., 2010. Lake and Reservoir Management*, 26:54–62.**

Point-intercept grid



Enterprise Lake, Langlade Co.

Data Collection

- Point-intercept method (Hauxwell *et al*., 2010)
- Species list and distributions for each lake
- Density rating for each species (1,2,3)

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

In-lake examples:

Summary statistics

Enterprise Lake, Langlade County

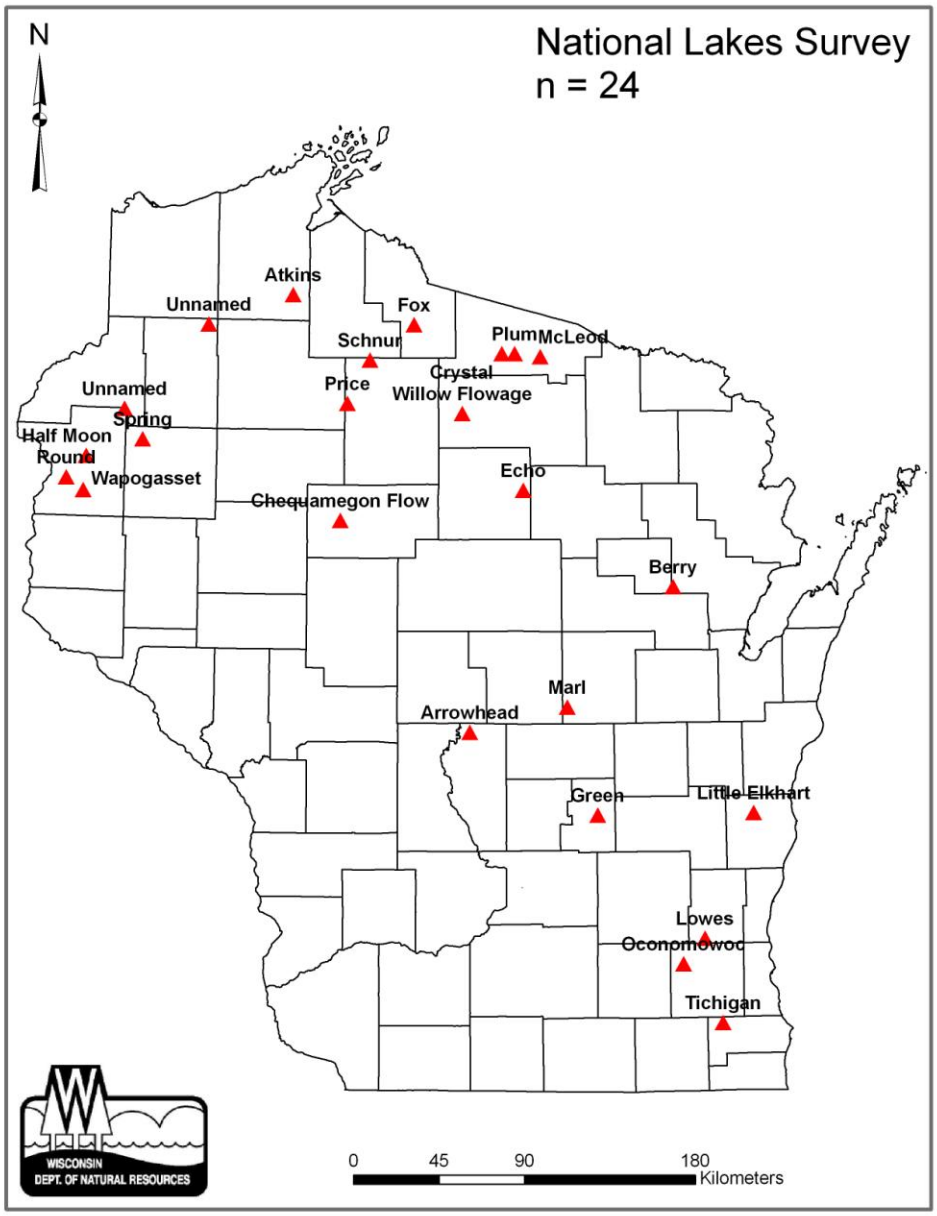
Size - 200 ha; Max depth - 8.2 m

Summary Statistics	
Total lake points	**563**
Number of points with plants	**178**
Maximum depth of plants (m)	**4.1**
Littoral area (% of lake)	**32**
Mean # species/point	**1.7**
Species Richness	**27**
Simpson's Diversity Index	**0.87**

Species	Frequency of occurrence (%)	Species	Frequency of occurrence (%)
E. canadensis	48.1	*M. tenellum*	1.9
Nitella spp.	26.4	*Chara* spp.	1.9
V. americana	14.3	*Isoetes* spp.	1.9
C. demersum	12.0	*P. amplifolius*	1.6
N. flexilus	11.6	*M. beckii*	1.6
P. pusillus	11.2	*E. acicularis*	1.2
N. gracillima	8.1	*N. odorata*	1.2
P. richardsonii	4.7	*P. strictifolius*	1.2
S. fluctuans	4.7	*E. palustris*	0.8
P. robbinsii	3.9	*M. heterophyllum*	0.8
U. purpurea	3.9	*N. variegata*	0.4
M. spicatum	3.5	*P. crispus*	0.4
P. spirillus	3.1		
B. schreberi	2.3		

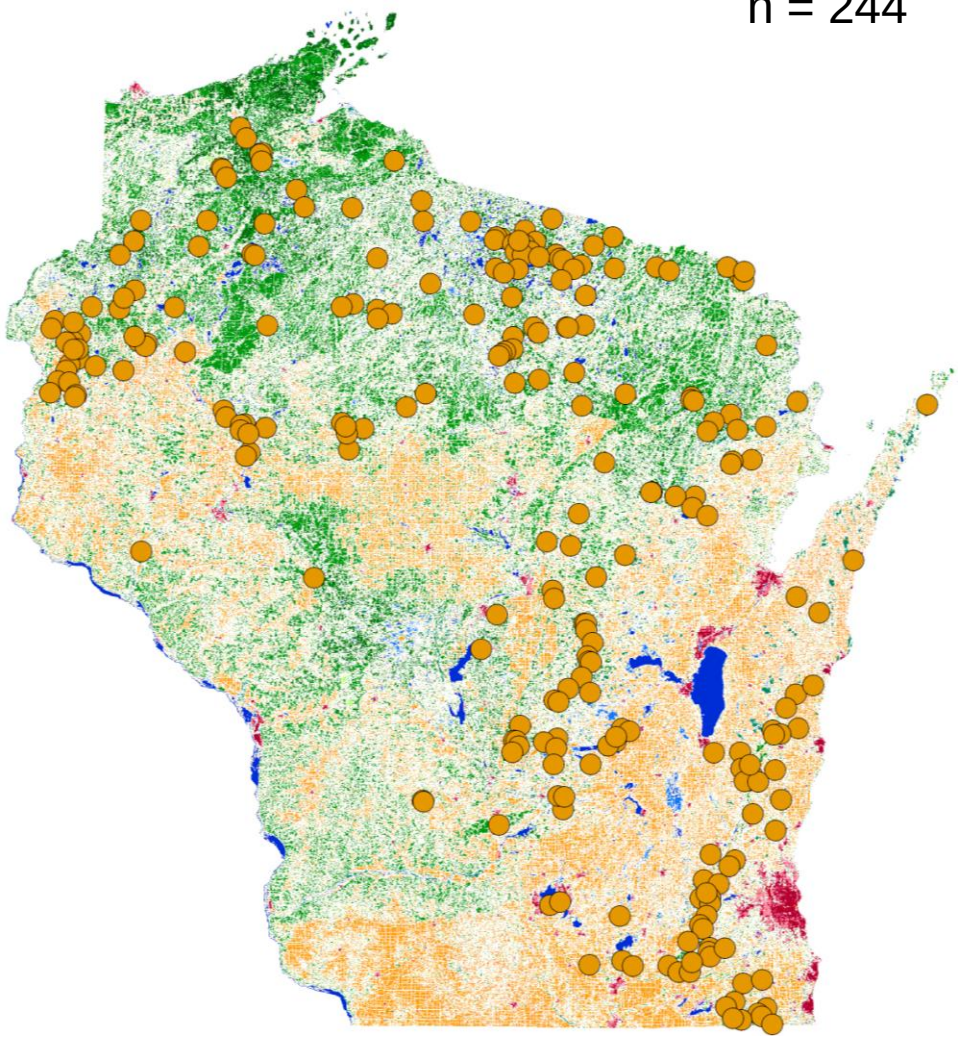
Enterprise Lake, Langlade Co.

Lakes Surveyed



Statewide Lake Surveys

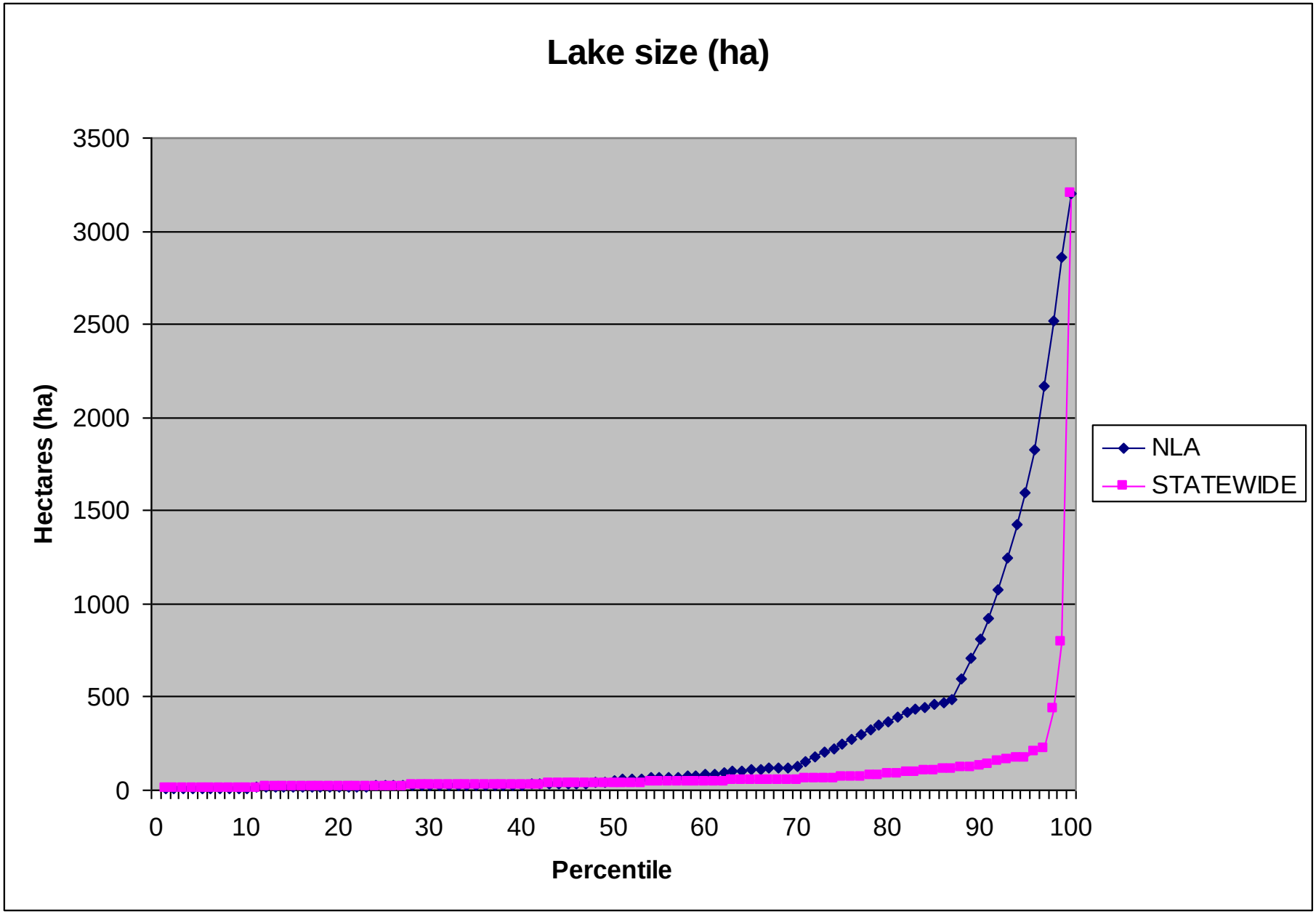
n = 244

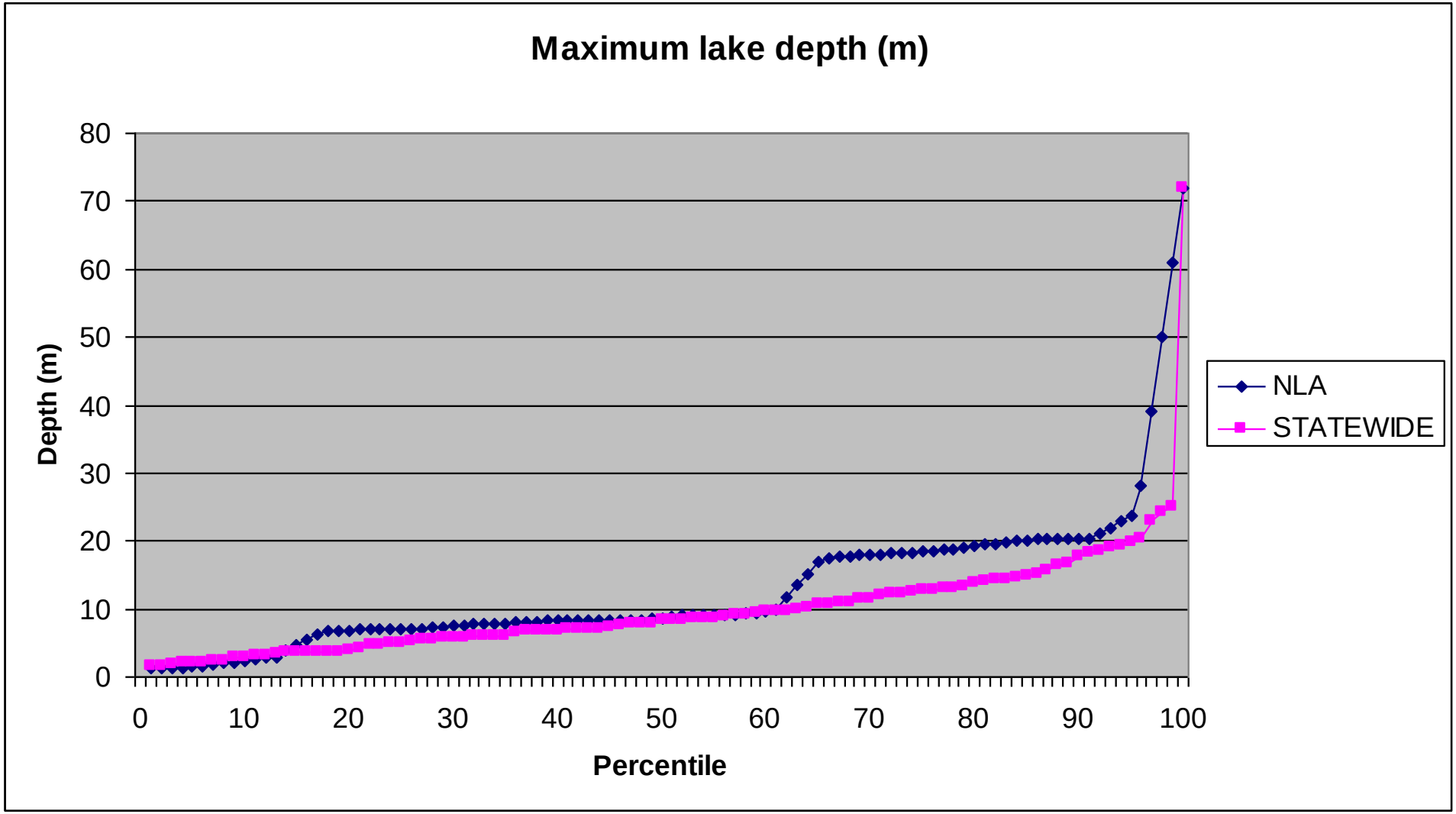


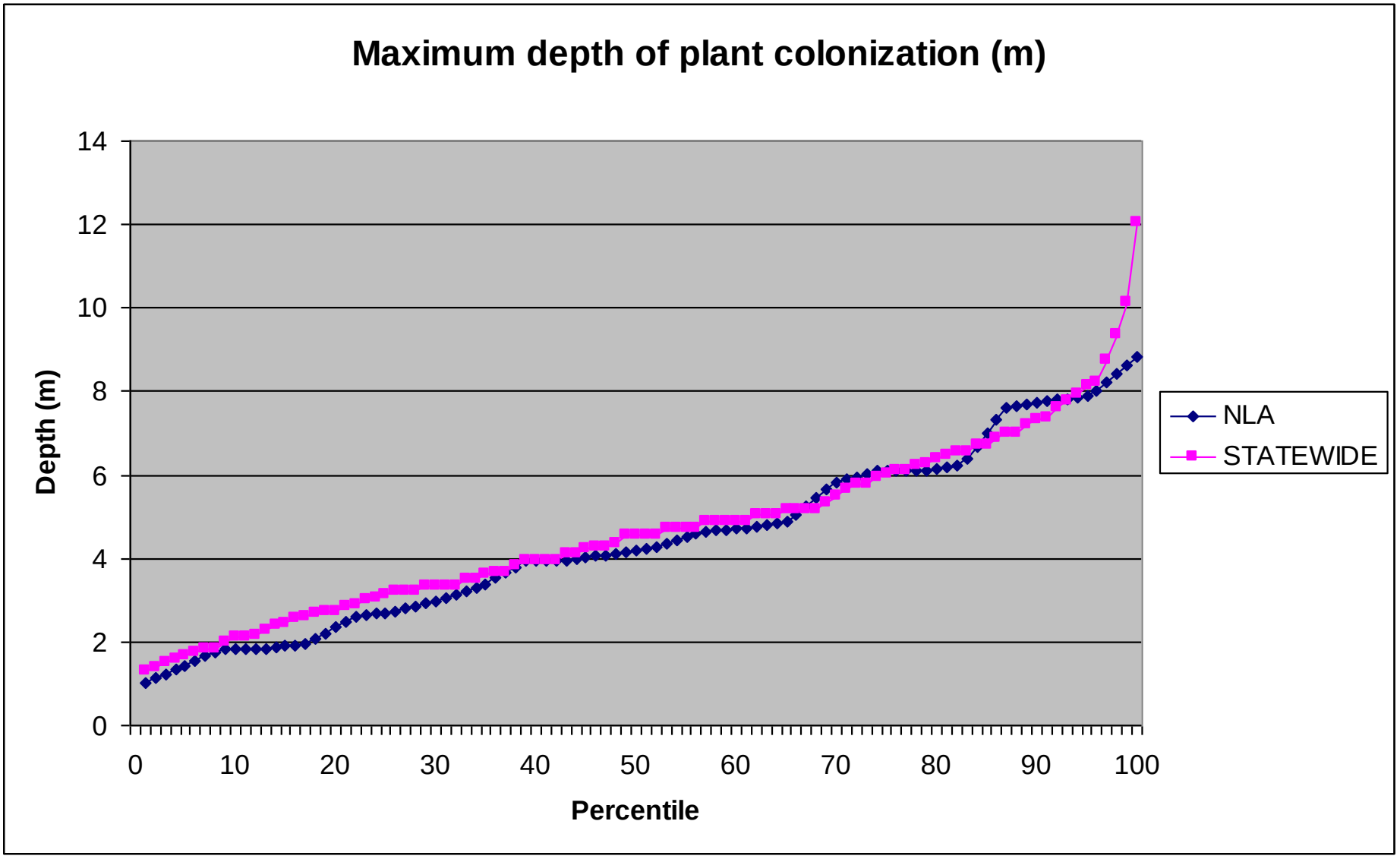
National Lakes Survey Summary Results

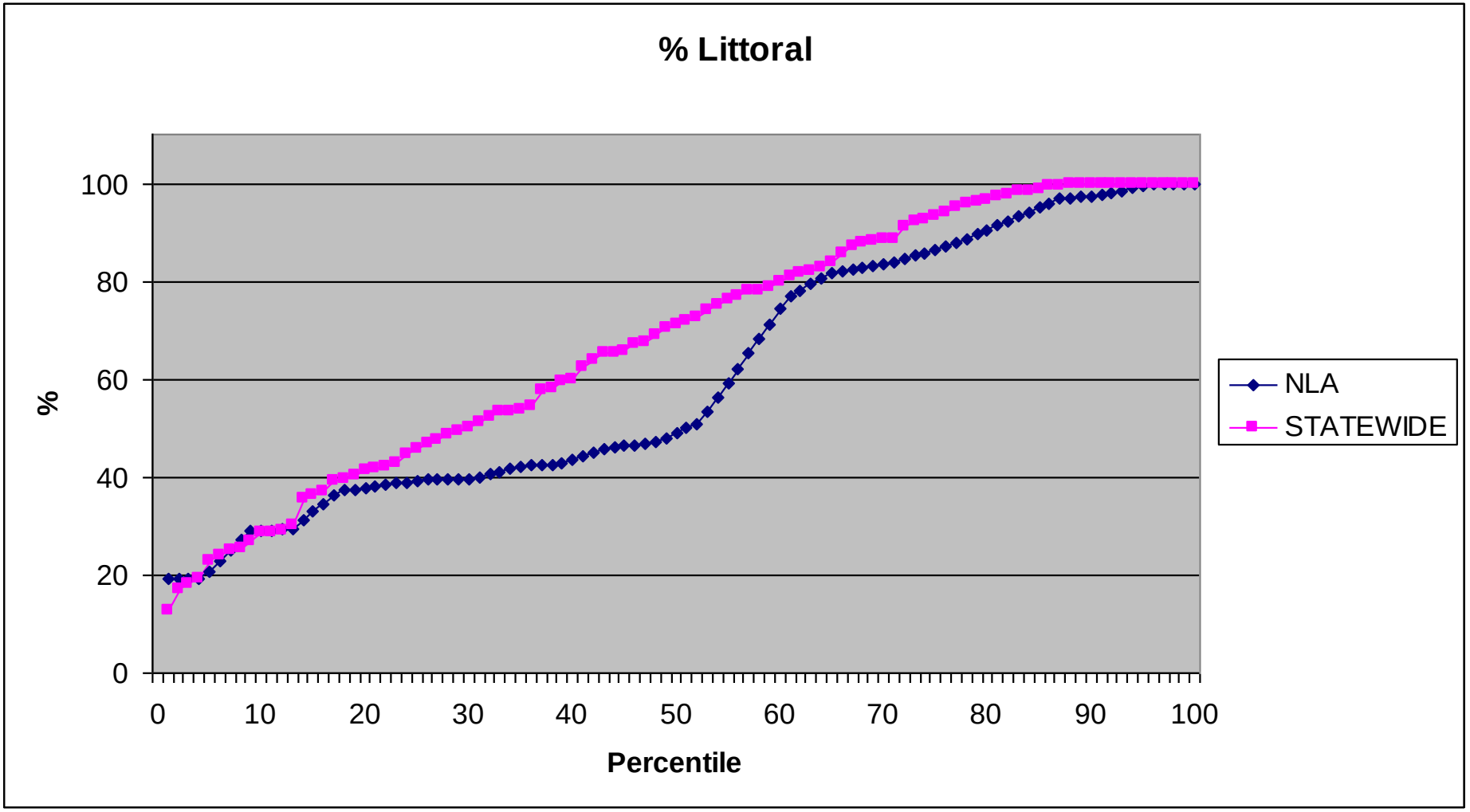
	NLA Lakes (n = 24)			Statewide (n = 244)		
Parameter	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Lake size (ha)	5	3205	334.4	5	3205	80.1
Max depth (m)	1.2	71.9	13.6	1.2	71.9	9.5
MDC (m)	0.9	8.8	4.4	0.3	12	4.6
% Littoral	19	100	60	9	100	67
% Vegetated	5	100	43	2	100	52
% Littoral vegetated	25	100	69	5	100	74
Simpsons' diversity	0.37	0.93	0.8	0	0.94	0.79
Native species / vegetated site	1.25	3.95	2.30	1	4.92	2.16
Species richness	5	31	17.6	1	42	16.7
FQI	13.8	34.8	25.0	0	42.5	24.1
AMCI	33	62	51.3	11	68	51.0
Secchi (m)	0.5	8.5	3.5	0.3	8.8	2.9

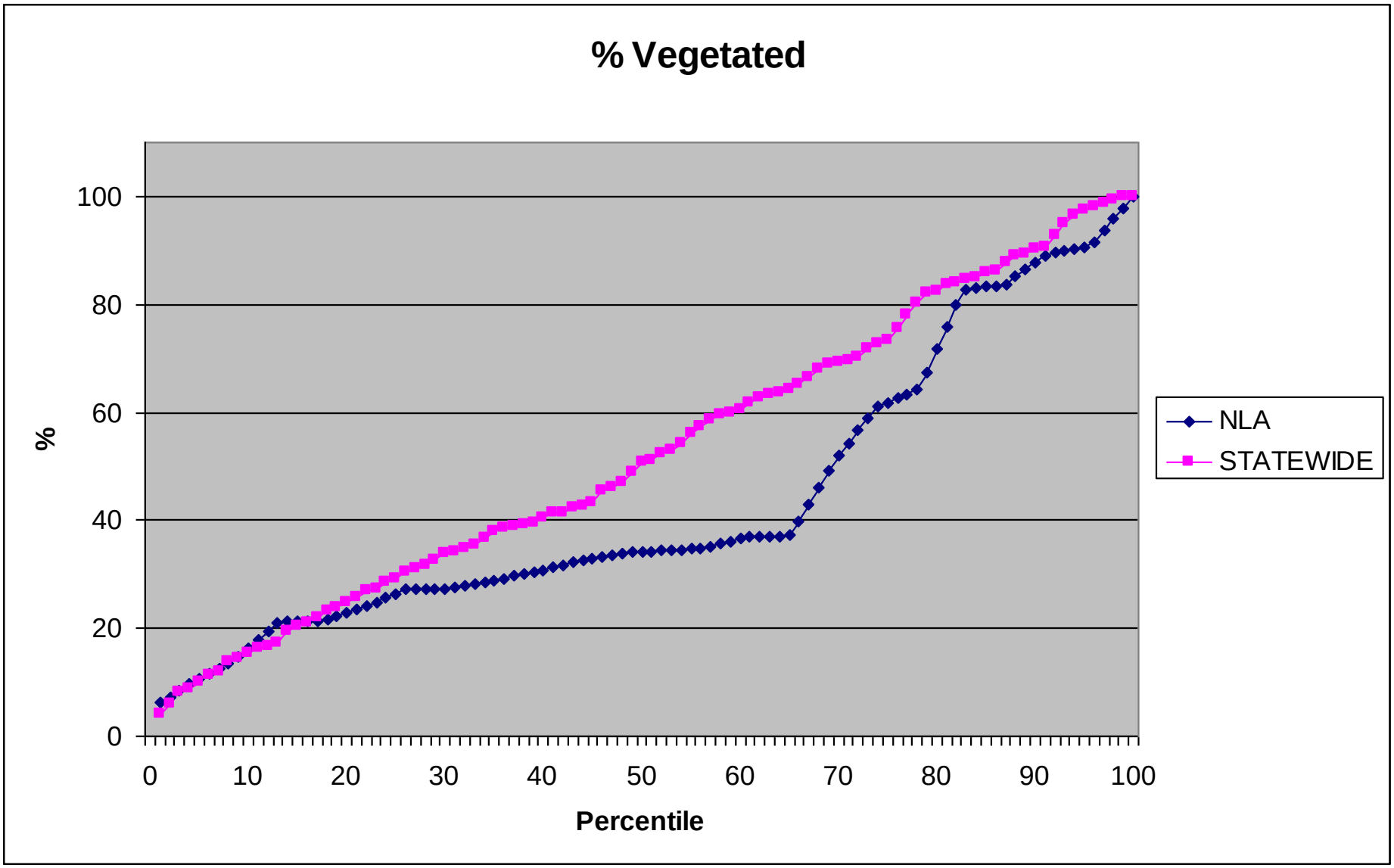
244 sampled by DNR Research crews = about 50,000+ rake tosses!

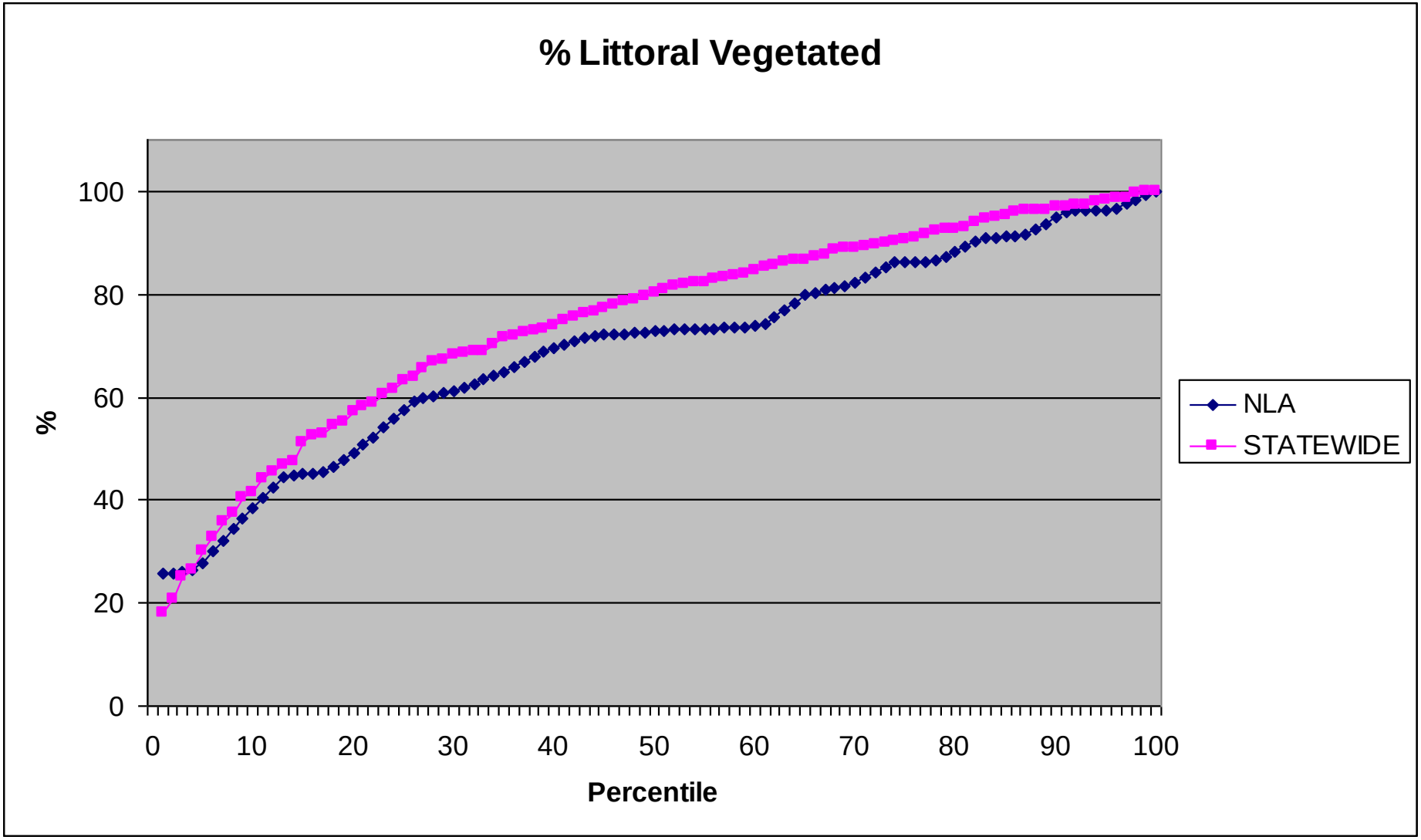

Lake size (ha)
Hectares (ha)
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE

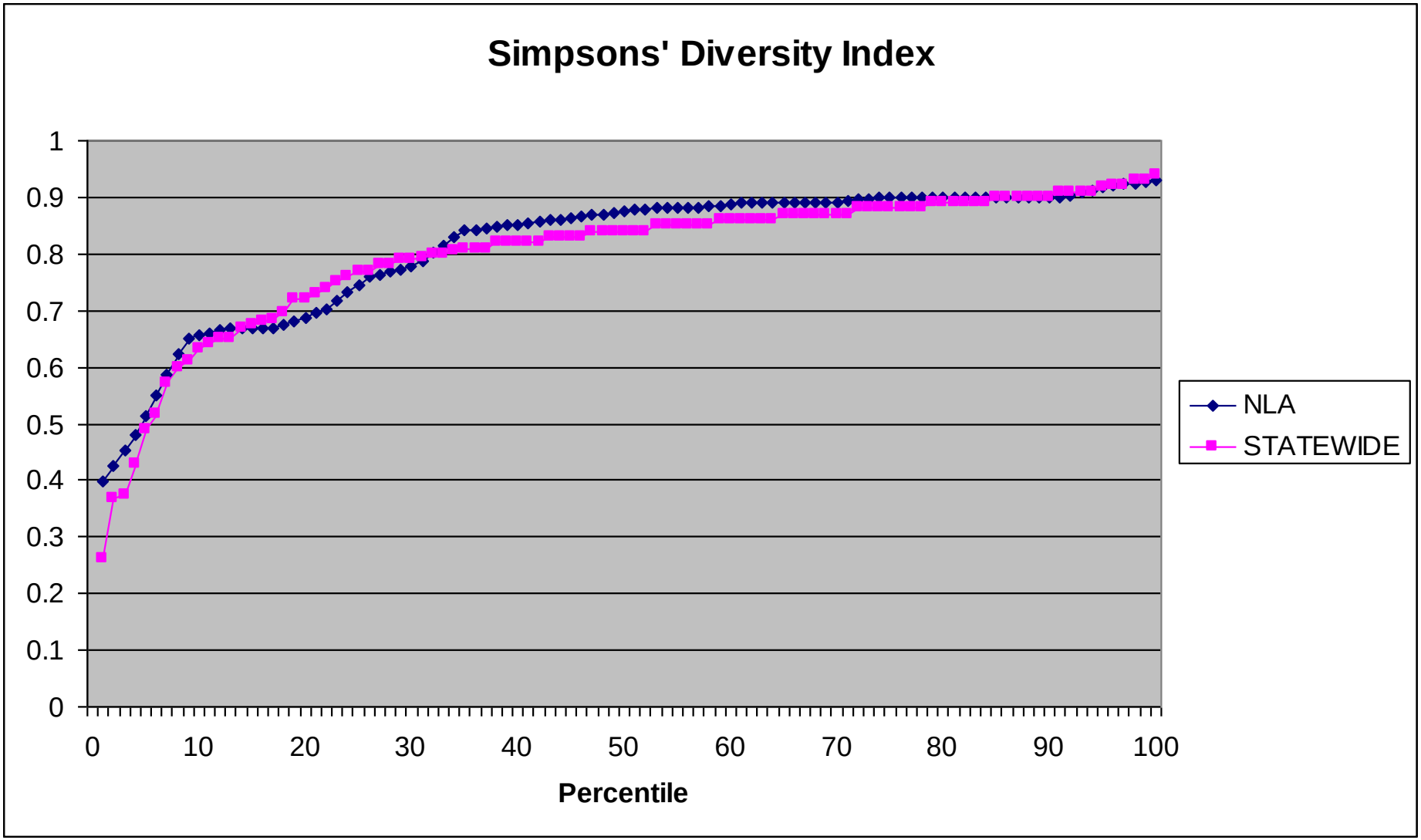

Maximum lake depth (m)
Depth (m)
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE

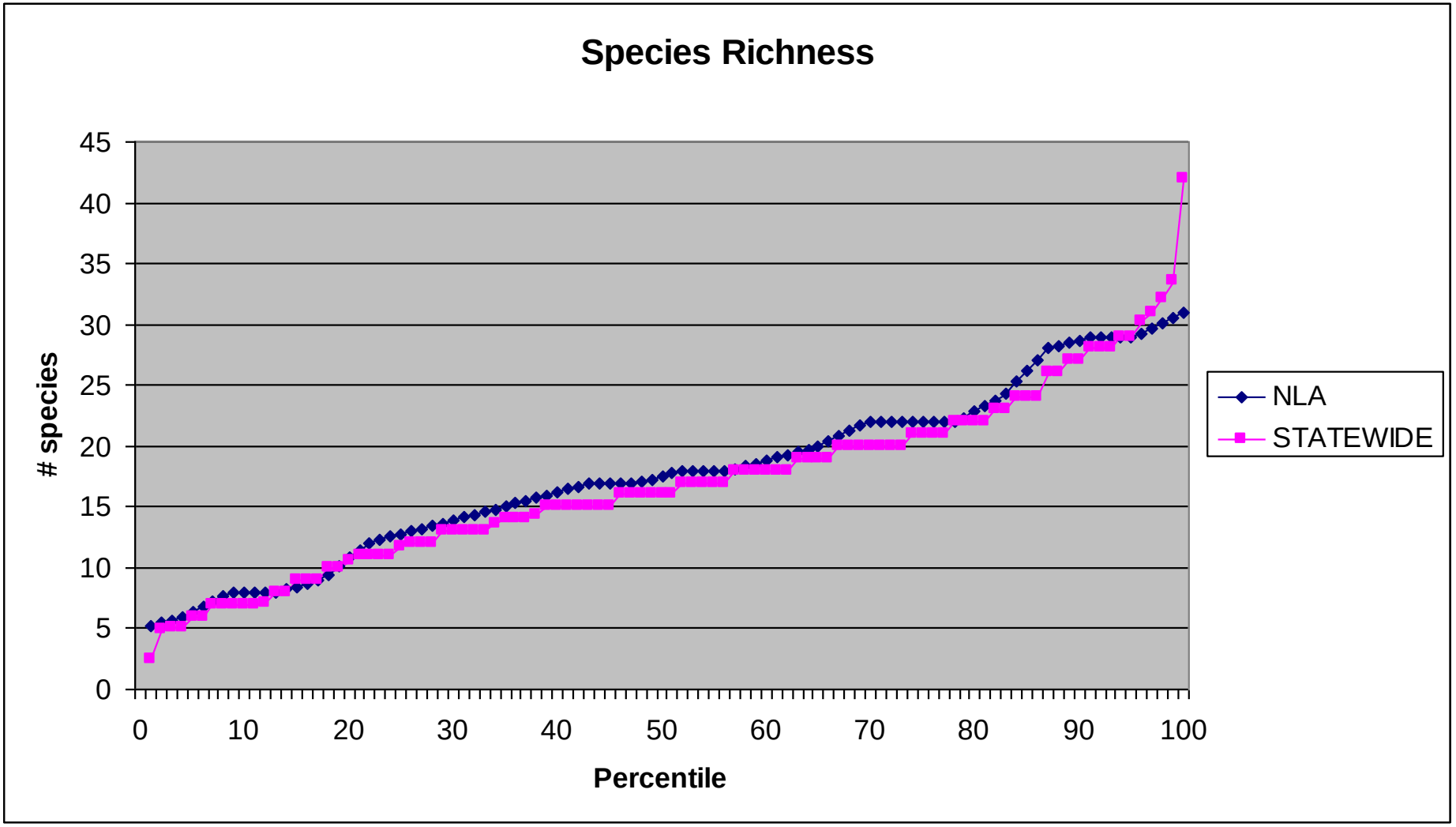

Maximum depth of plant colonization (m)
Depth (m)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE

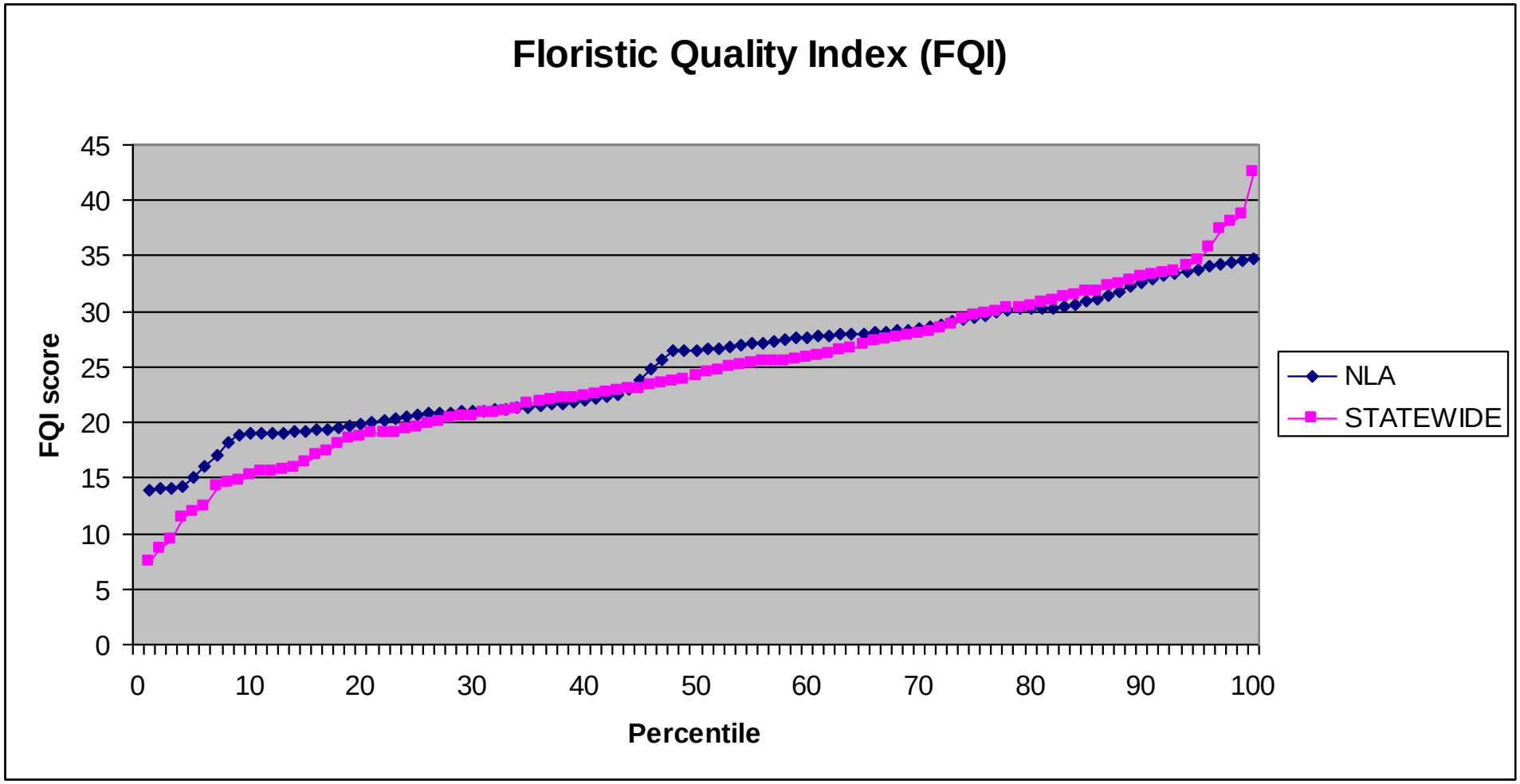

% Littoral
100
80
60
40
20
0
%
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE

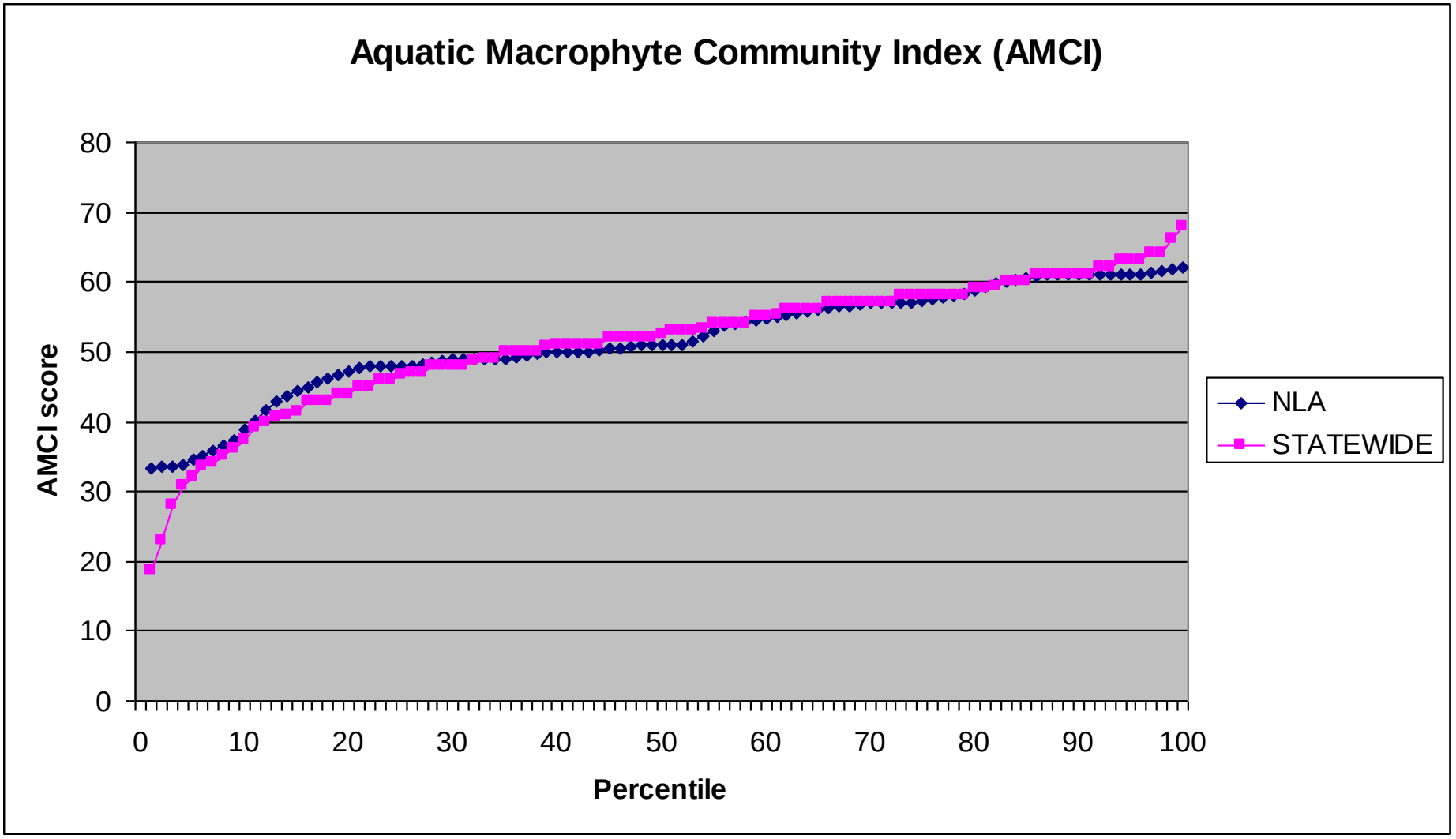

% Vegetated
100
80
60
40
20
0
%
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE


% Littoral Vegetated
100
80
60
40
20
0
%
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE


Simpsons' Diversity Index
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE


Species Richness
species
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE


Floristic Quality Index (FQI)
FQI score
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE


Aquatic Macrophyte Community Index (AMCI)
AMCI score
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
Percentile
NLA
STATEWIDE

Conclusions

- NLA dataset overestimates “true” Wisconsin distribution of lakes based upon size and depth
- NLA dataset underestimates % littoral and vegetated compared to statewide dataset
- However, NLA dataset concurs with most general trends seen in statewide dataset
- Extremes (lower and upper percentiles) better represented in larger, statewide dataset

DISCUSSION

Questions?

Comments?

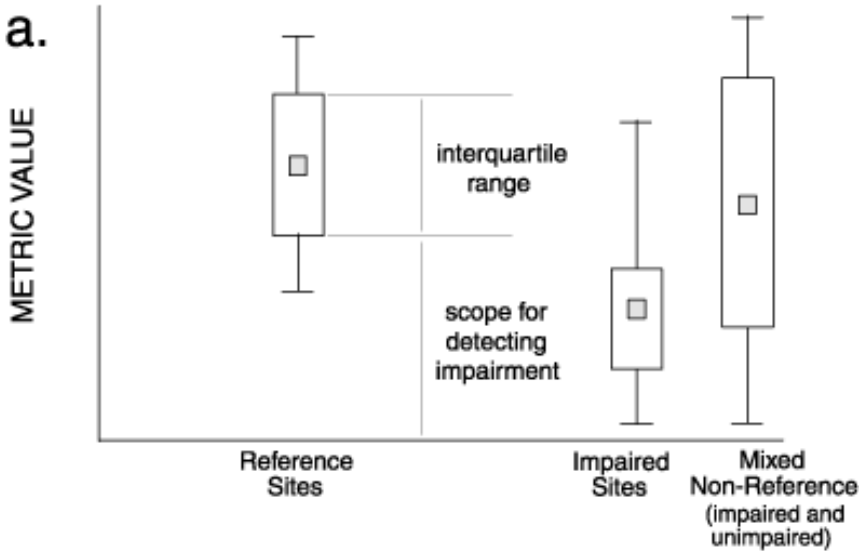
michelle.nault@wisconsin.gov

Opportunities for WI lakes

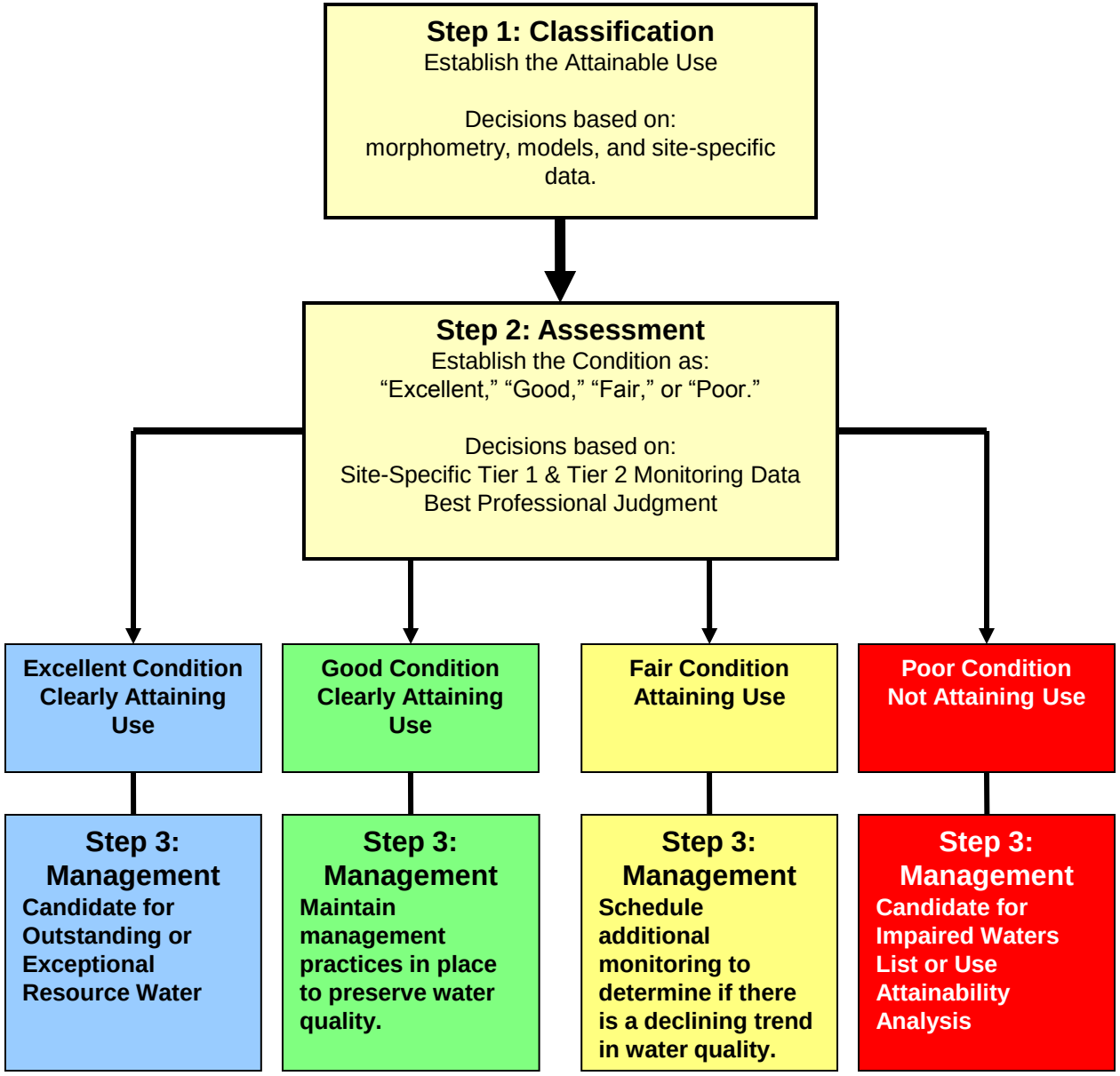
- Test habitat assessment protocols
- Tie into existing WDNR Lakes Monitoring (addition of PI plant survey and reference lake sampling)
- Build up database of sediment core information (up to 60 more lakes) for Lake Assessment
- Broader context for citizen monitoring and satellite TSI
- Leverage dollars with lake grants

Statewide Lake Assessment

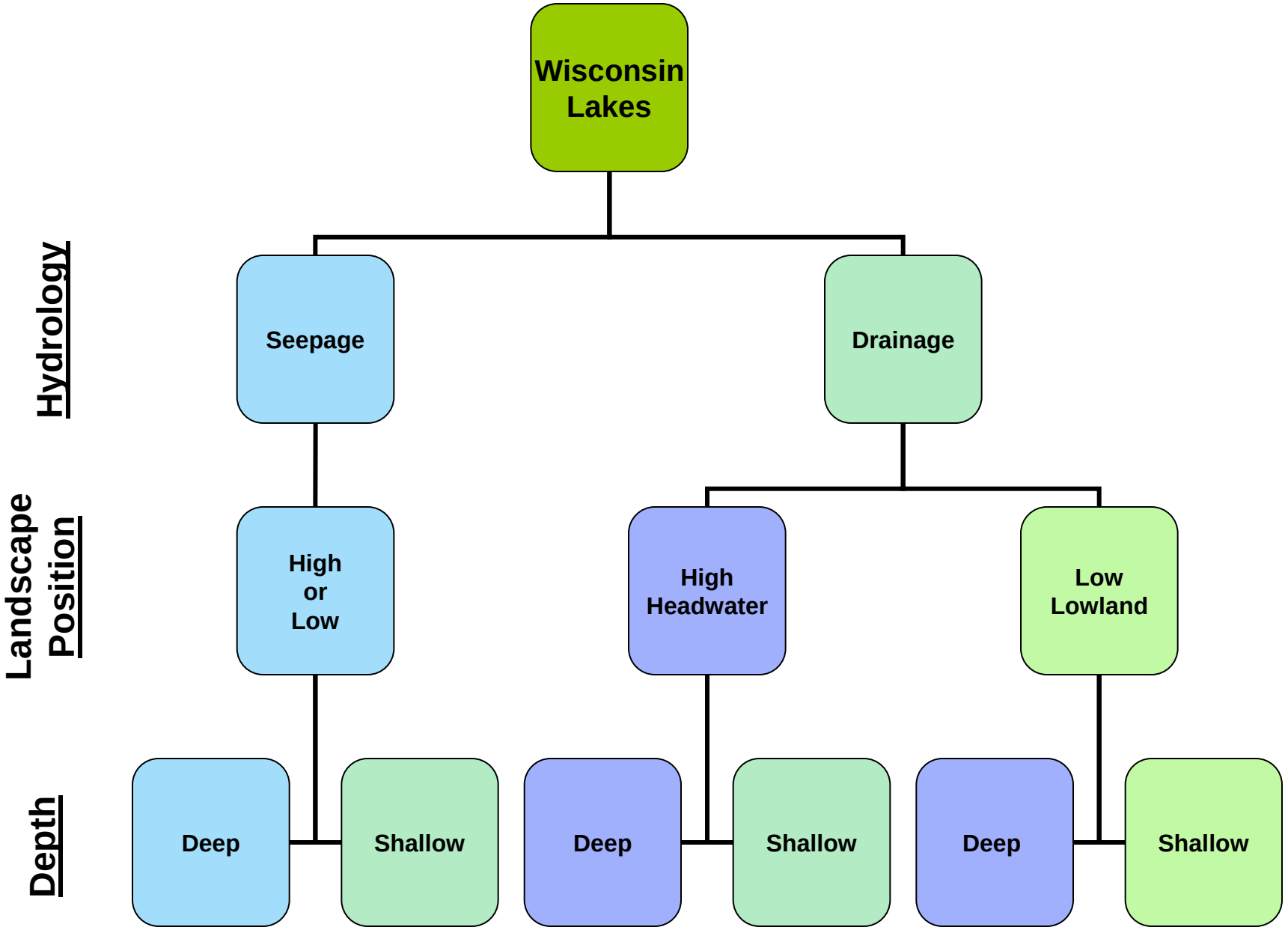
- Reference TSI conditions for WI lakes (sediment core dataset)
- Reference lakes for aquatic plants and development of impairment metrics
- Methodologies for statewide AIS monitoring



Process Diagram for Assessment of Lakes, Rivers, and Streams



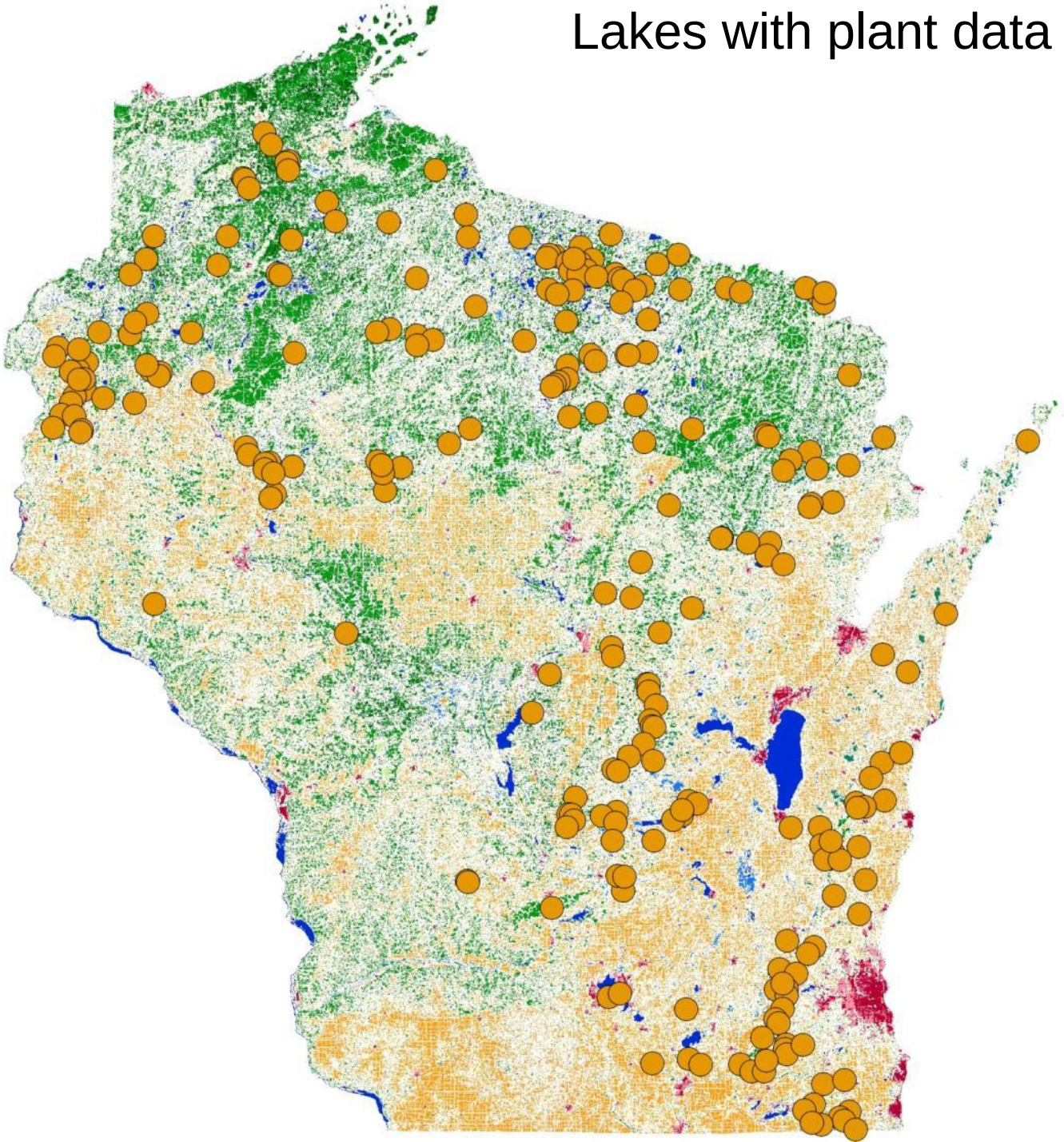
Wisconsin Lake Classification



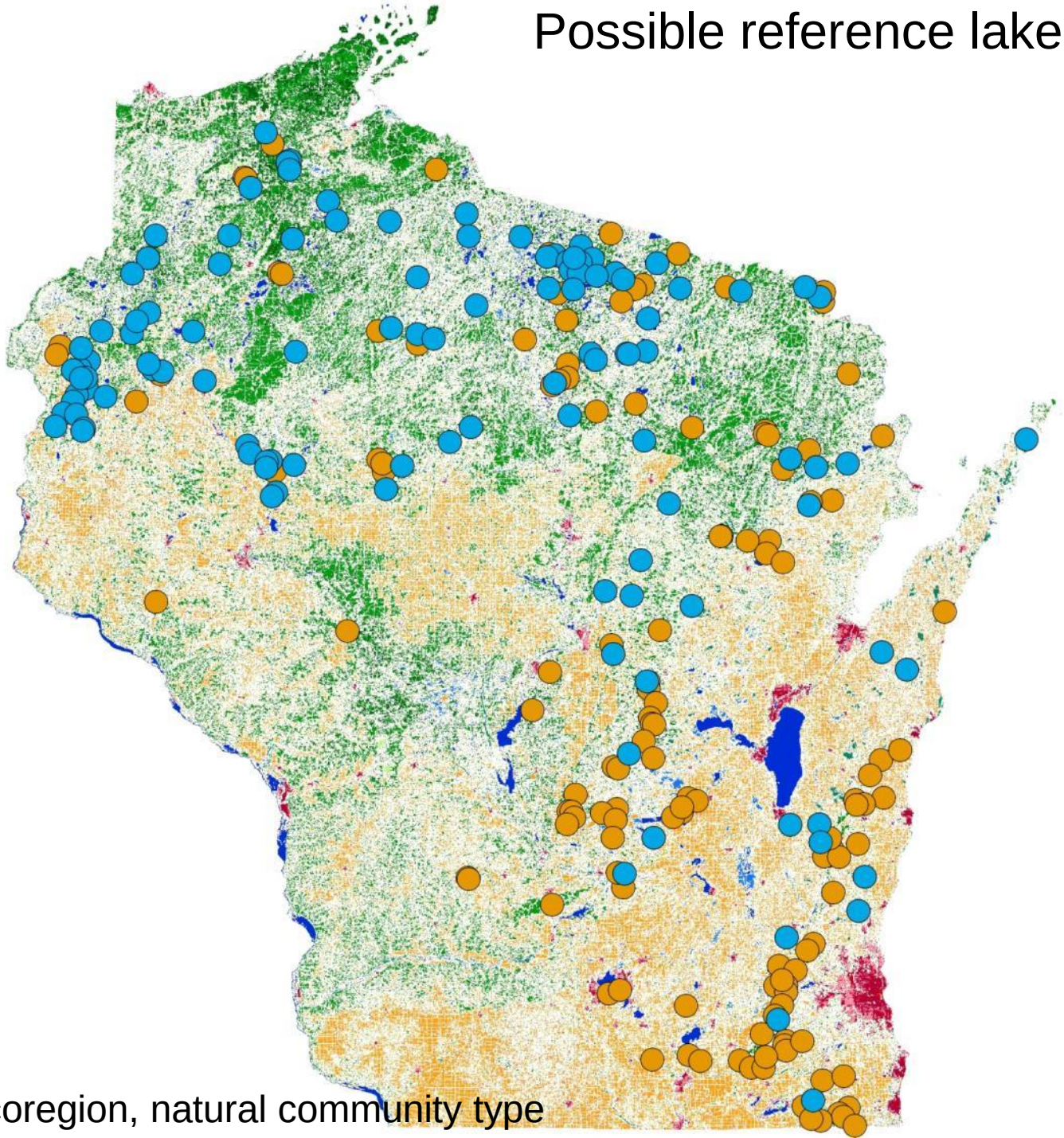
TSI Thresholds By Natural Lake Community

Condition Level	Shallow			Deep			
	Headwater	**Lowland**	**Seepage**	**Headwater**	**Lowland**	**Seepage**	**Two-Story**
Excellent	< 45	< 49	< 39	< 47	< 46	< 44	< 44
Good	45 – 57	49 – 59	39 – 54	47 – 54	46 – 53	44 – 52	44 – 47
Fair	58 – 70	60 – 70	55 – 70	55 – 62	54 – 62	53 – 62	48 – 52
Poor	≥ 71	≥ 71	≥ 71	≥ 63	≥ 63	≥ 63	≥ 53

Lakes with plant data



Possible reference lakes



Stratify by ecoregion, natural community type

Refining shoreland assessment tools

Develop standard methodology for statewide lake assessment down to the lakeshore property-owner or parcel-based scale to:

1. Assess shoreland development and habitat loss in a meaningful way
2. Provide a good template for success [like methodology for apm work]
3. Present an effective tool for partners to identify priority restoration areas over time
4. Weave this shoreline assessment tool into lake management planning grants for partners
5. Provide some erosion severity measure along the way

Will you help Pat Goggin?

- Identify a subgroup of reviewers to help get this template perfected for wide use: lake coordinators; researchers; grant administrator; county zoning/lwcd; lake groups/WAL; UWEX; service providers; GIS technician; volunteer monitoring representative; others?

- Get your input on a process for feedback and moving forward a template for use

Partnerships

- Berry Lake – leveraged lake planning grants and heightened awareness of water quality changes and AIS in community
- Price Lake – baseline information and educational opportunity for lake residents
- Tribal lakes – shared information and analytical resources, better working relationships

Berry Lake, Wisconsin

An online community resource serving the Berry Lake area

Home
Newsletter
Calendar of Events
Berry Lake Photos
BLPO
Marketplace
BL Blog

Visit Creators

PO BOX 492 GILLETT, WI 54124
berrylakewi@gmail.com

updated 03-27-10

ICE OFF 2010 - MARCH 26TH!

No one guessed March 26th for ICE OFF, however 2 Berrylakers gu
25th which is the next closest date. Congratulations to the Swans
Jill DePrey for coming the closest to this year's ICE OFF date of Ma

Wisconsin Department of Natural Resources

2007 National Lake Survey - Wisconsin Results

In the summer of 2007, Wisconsin's lakes got a checkup as part of a national study to assess the percentage of lakes in g fair, or poor condition. The EPA-sponsored 2007 National Lake Survey examined ecological, water quality, and recreation indicators for lakes across the country. This site explains the purpose of the survey and what researchers in Wisconsin measured. You can also view the data for each visited lake as they become available.

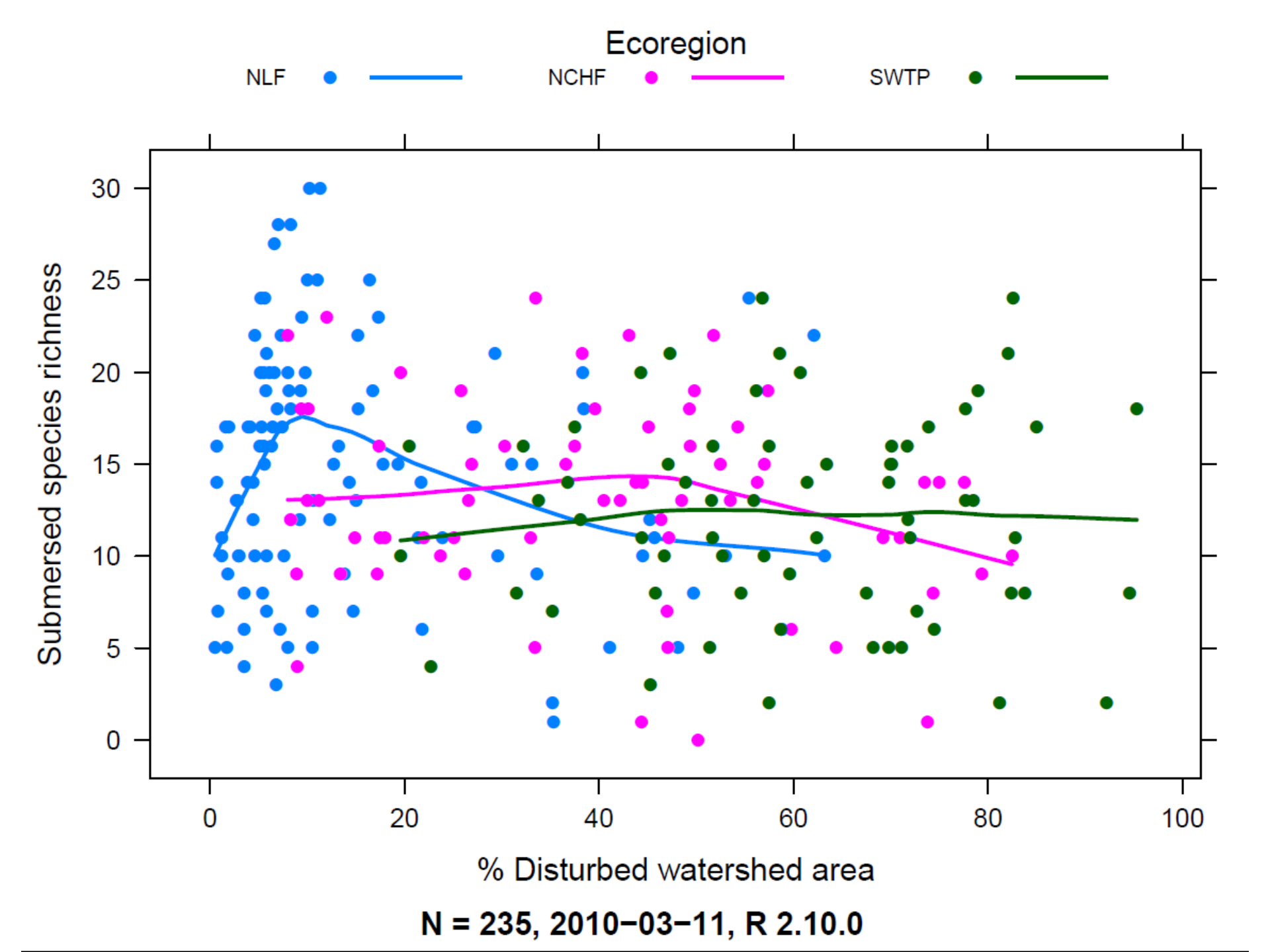
What was the Survey's Purpose?

The purpose of the Survey was to assess the percentage of lakes throughout the country in good, fair, or poor conditio ecological integrity, and recreational value. Researchers also looked at the relative importance of key stressors such a lakeshore development, and pathogens on lake conditions.

An additional goal was to establish a sound baseline to compare future surveys in lake health over time. Last, the EPA's a state, tribal, and interstate monitoring programs by encouraging more efficient use of resources, expanding accessibility a partnerships.

Discussion questions

- What can we apply from the NLA to our own statewide, regional, and local lake monitoring and assessment efforts?
- What would we like to see in the 2012 National Lake Assessment?


Ecoregion
NLF
NCHF
SWTP
Submersed species richness
0
5
10
15
20
25
30
0
20
40
60
80
100
% Disturbed watershed area
N = 235, 2010−03−11, R 2.10.0