Establishing a scientific framework for aquatic plant management in WI

Wisconsin Department of Natural Resources

Science Services Bureau

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WDNR Research Overview

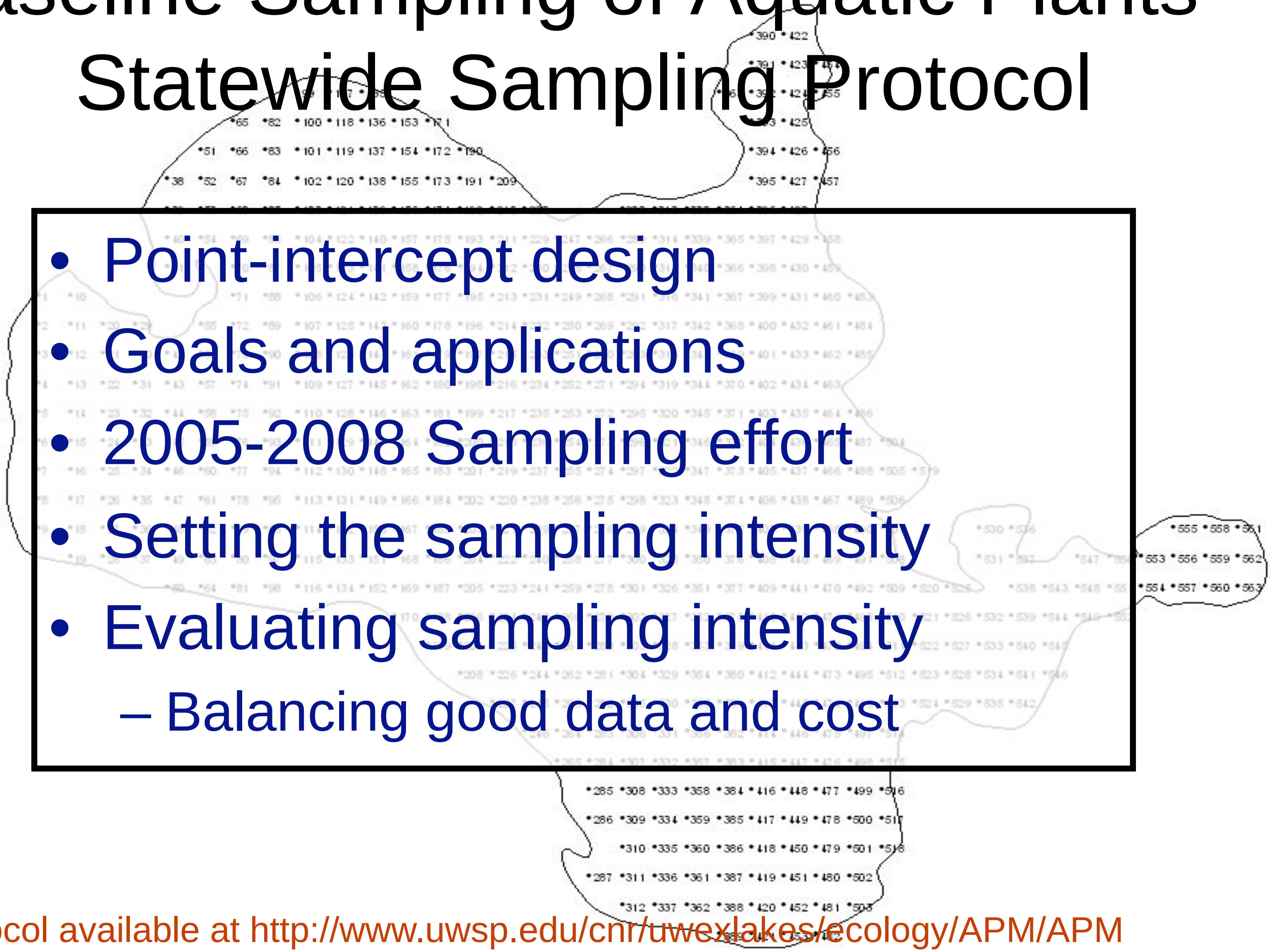
Theme: The importance of good data to inform management: providing science tools for you!

Talk outline:

1) Building and testing a good observation system

2) Using data to understand systems
   - What drives EWM abundance in lakes? 100 lake survey, long-term statewide surveys, 2,4-D experimental case studies

Baseline Sampling of Aquatic Plants - Statewide Sampling Protocol



- Point-intercept design
- Goals and applications
- 2005-2008 Sampling effort
- Setting the sampling intensity
- Evaluating sampling intensity
  - – Balancing good data and cost

Protocol available at http://www.uwsp.edu/cnr/uwexlakes/ecology/APM/APM%20Appendix.pdf

Baseline sampling of aquatic plants

Goals and Applications

1) In-lake ecology and management

-Snapshot of one lake today…

and over time

2) Regional and state-wide ecology and management

-Comparisons among many lakes today…

and over time

-Provides *CONTEXT*

3) State $ yield state “product”!

In-lake examples:

1) Summary statistics

Enterprise Lake, Langlade County

Size - 200 ha; Max depth - 8.2 m

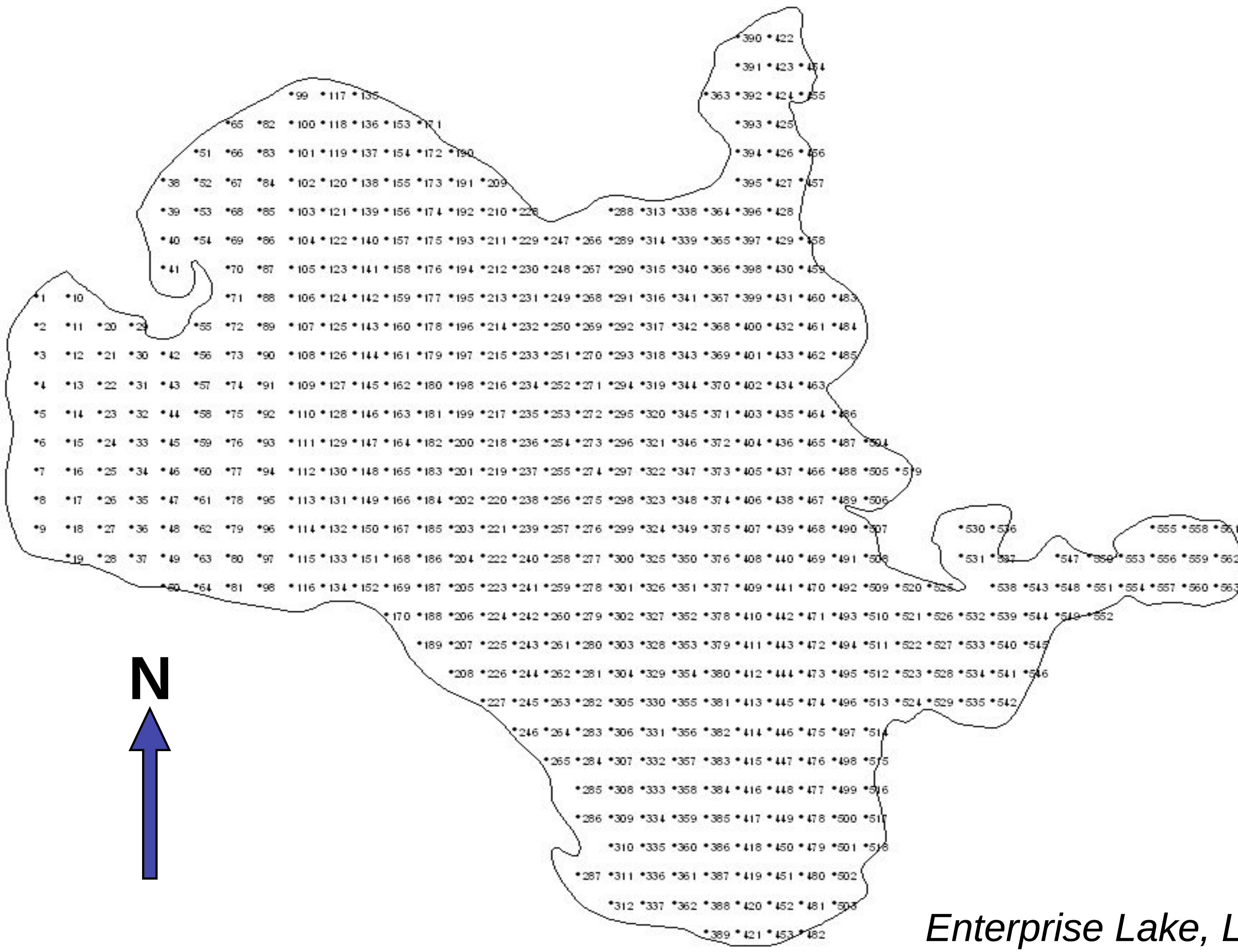
Summary Statistics	
Total lake points	563
Number of points with plants	178
Maximum depth of plants (m)	4.1
Littoral area (% of lake)	32
Mean # species/point	1.7
Species Richness	27
Simpson's Diversity Index	0.87

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

In-lake examples:

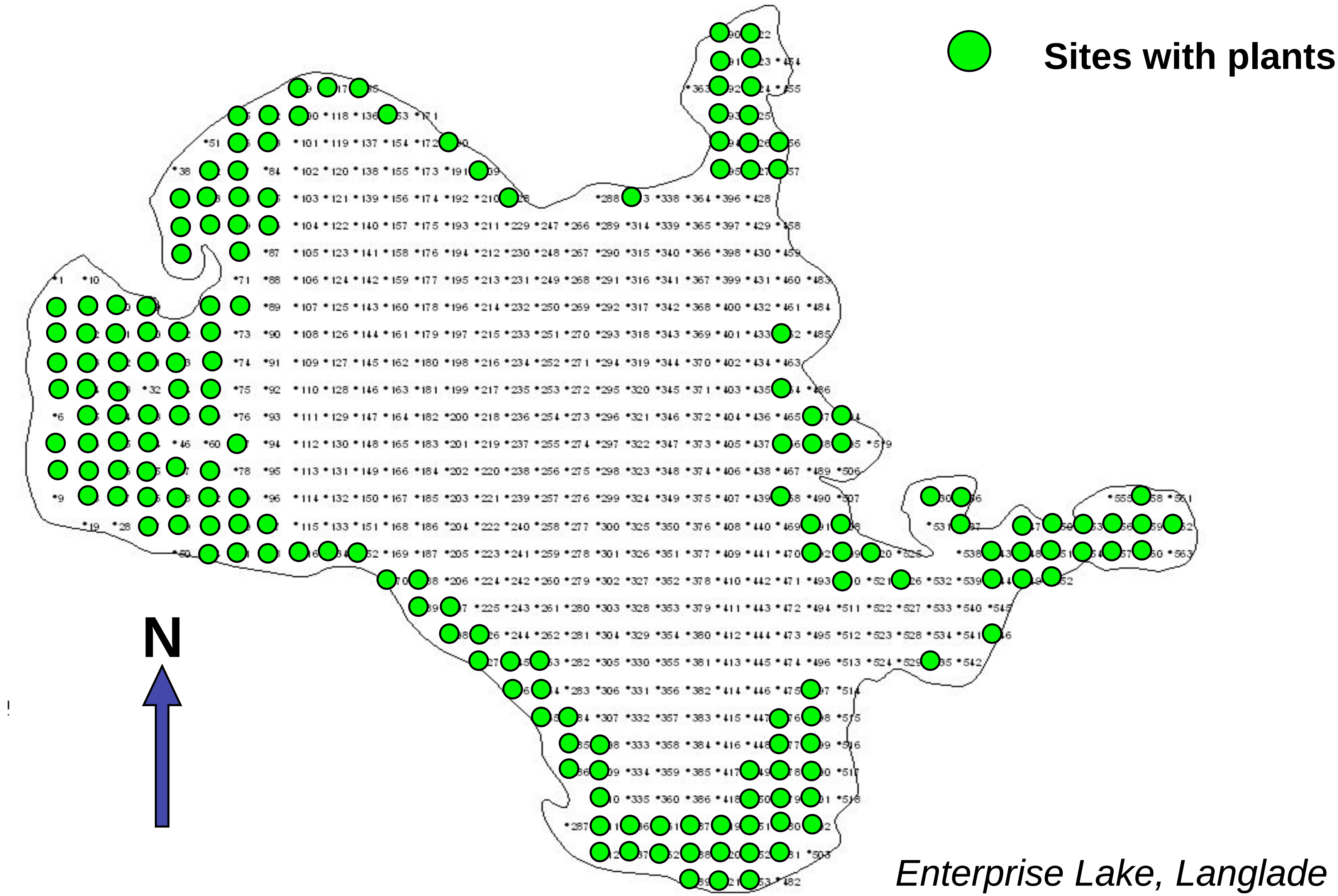
2) Maps of species distributions



Enterprise Lake, Langlade

In-lake examples:

Vegetated sites



Enterprise Lake, Langlade

2005-2008 - Sampling Maps Standardized by DNR Research

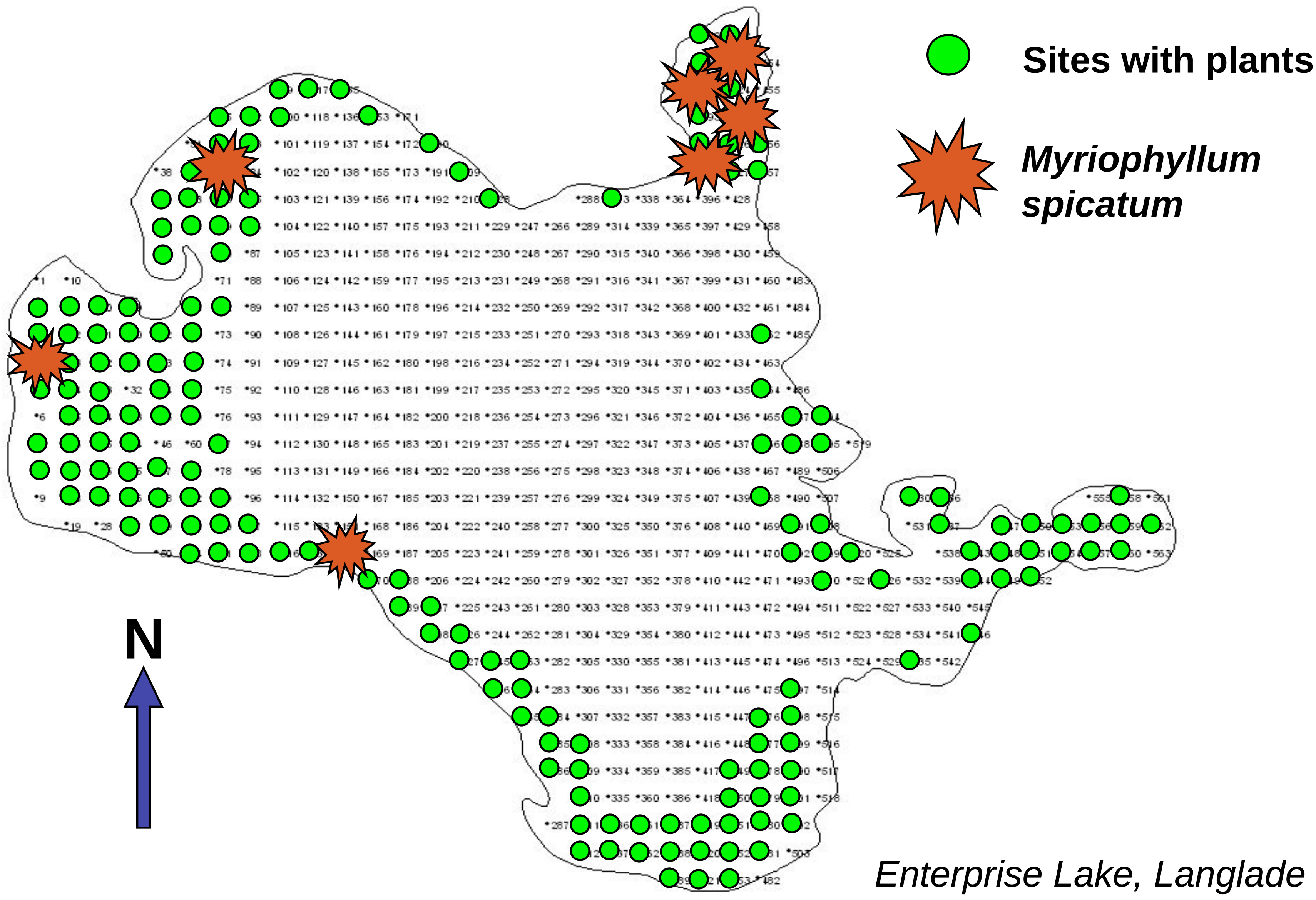
Request origination: DNR, municipalities, lake consultants, educational institutions

Aquatic Plant Sampling Maps (822 lakes)		
Variable	**Range**	**Mean**
Lake size (ha)	5-4000	115
Distance between points (m)	25-150	45
Total # sample points	40-4100	370

266 sampled by DNR Research crews = about 52,000 rake tosses!

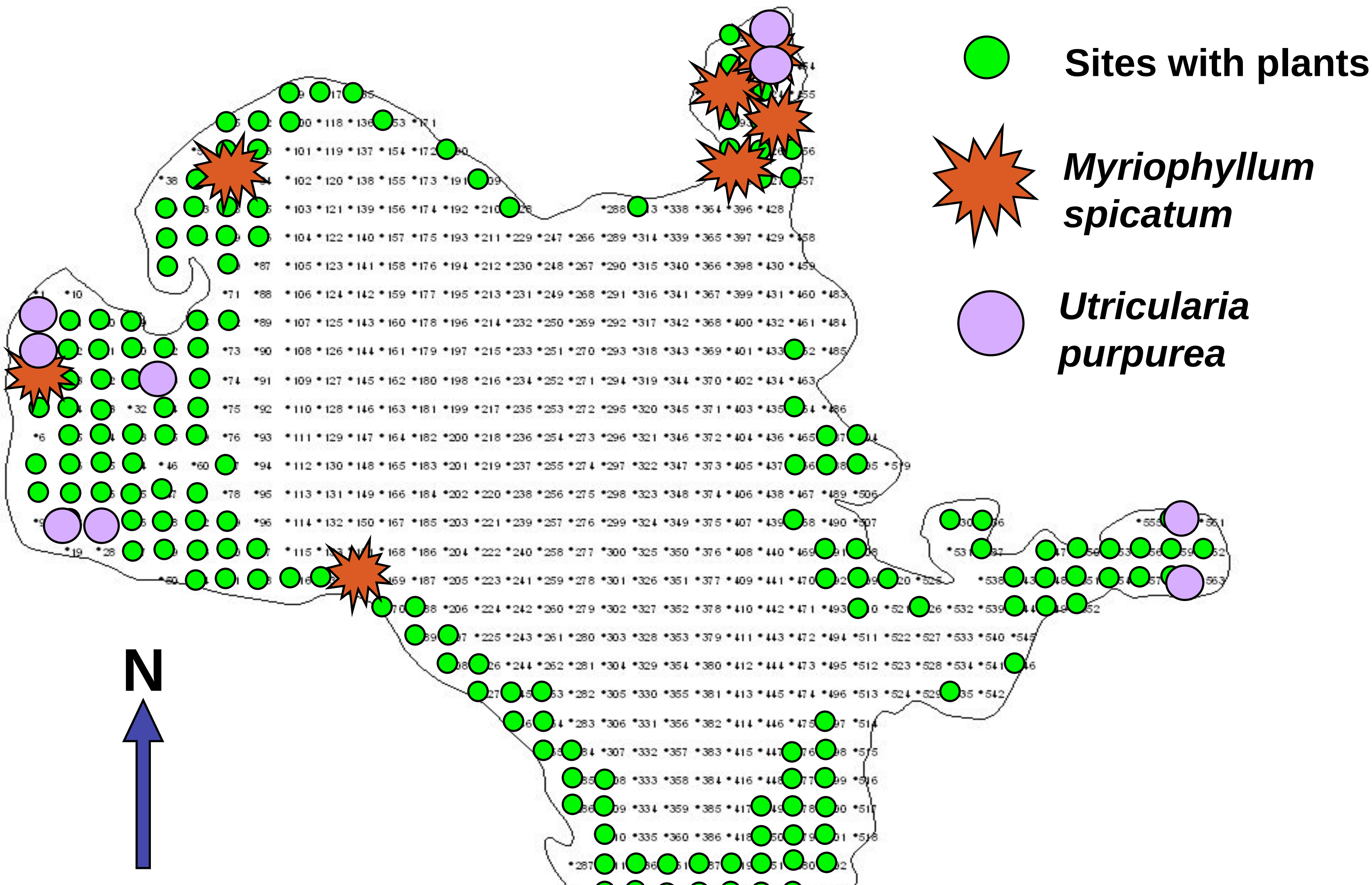
In-lake examples:

Distribution of Eurasian Watermilfoil



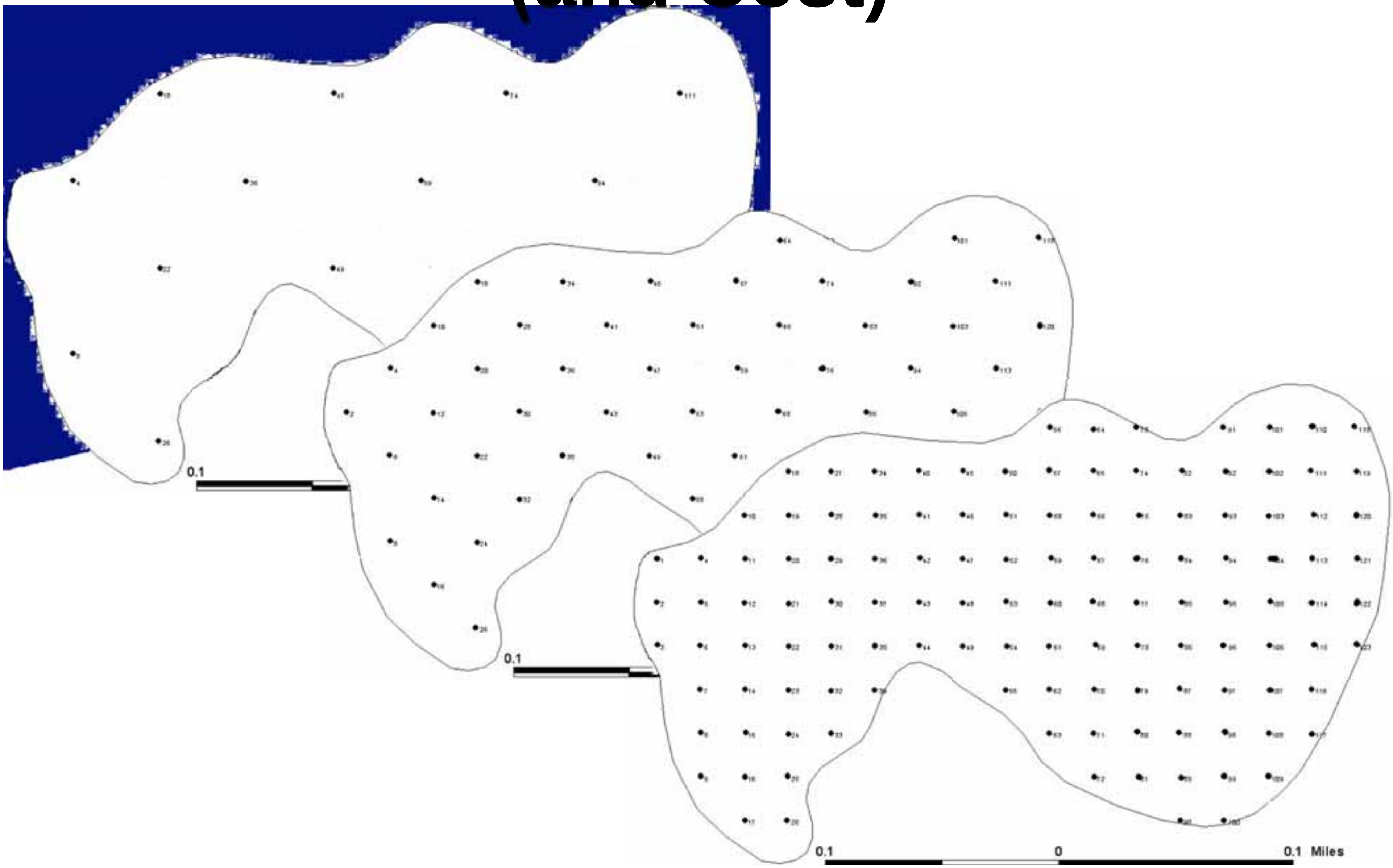
In-lake examples:

Species of Special Concern



Enterprise Lake, Langlade

Sample Size Affects Data Quality (and Cost)



Are We Collecting Good Data?

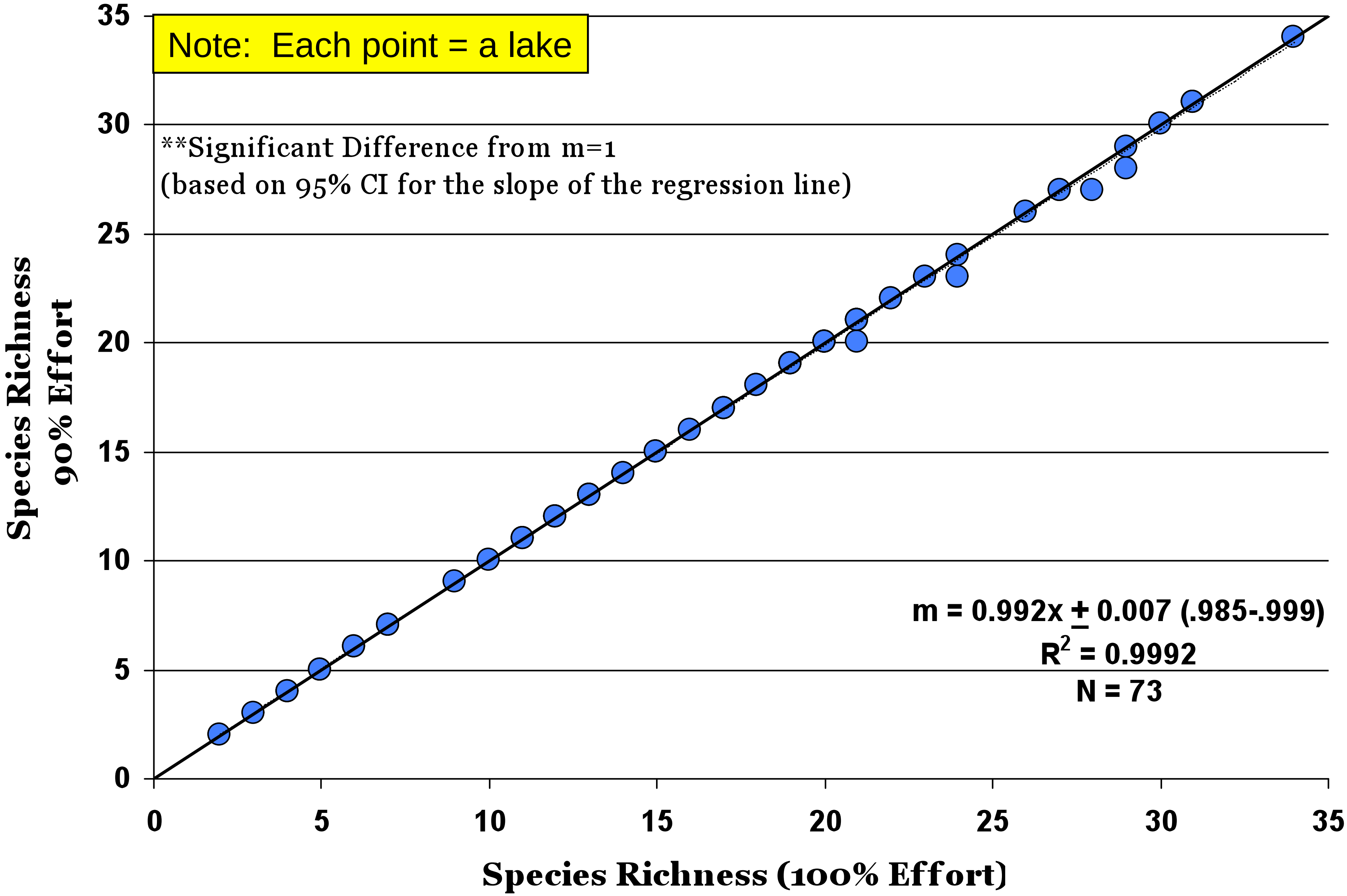
Must balance data quality with time and $!

- No guidance from literature
- We are working at maximum effort
- What happens when we decrease the number of points sampled?

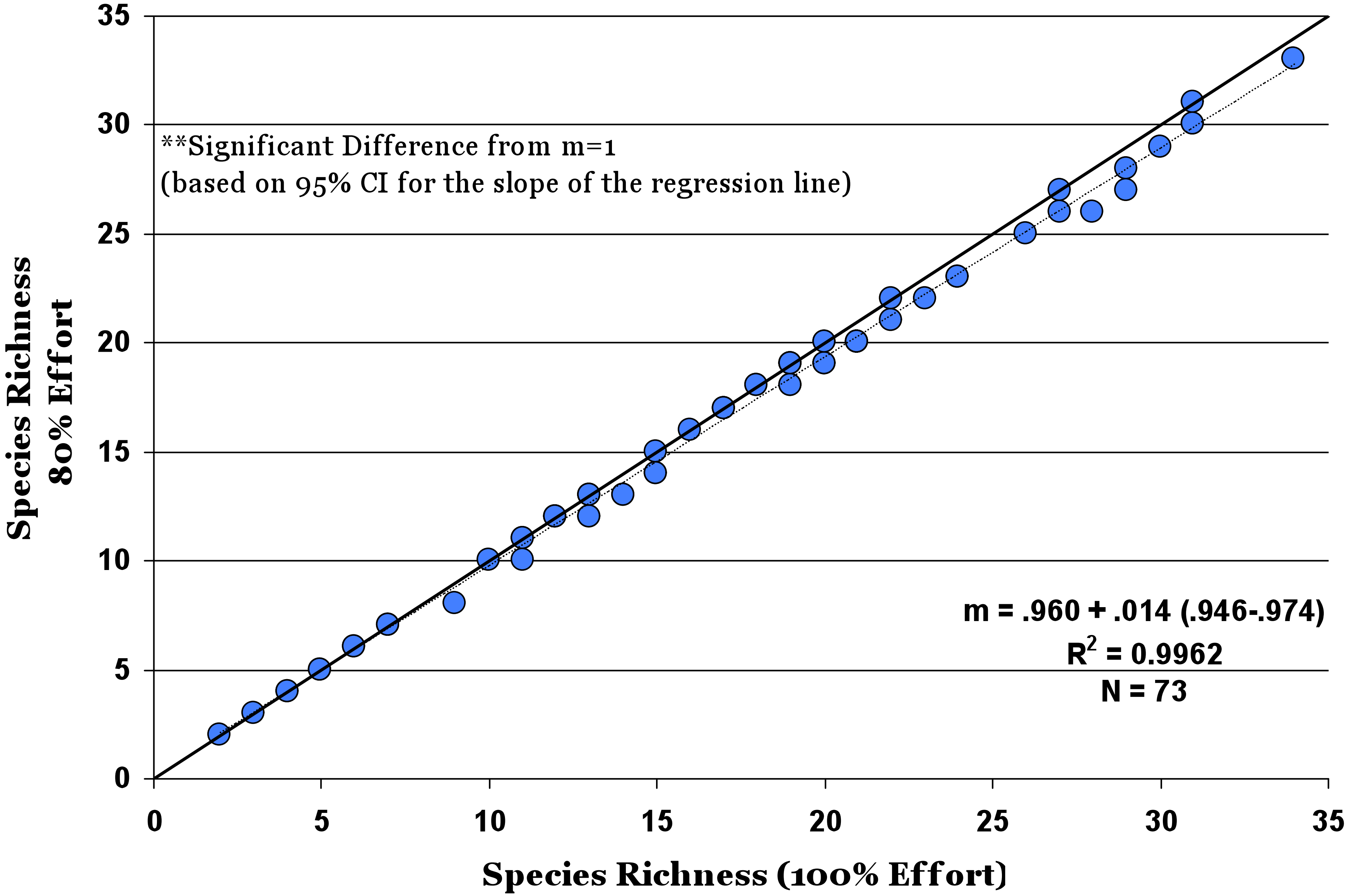
If we considered fewer sampling points…

- How does our sampled lake ‘change’?
  - Which parameters shift (total # species, frequency of occ. for given species, max depth plants, etc.)?
  - Which species are ‘lost’?
  - Post-hoc simulation

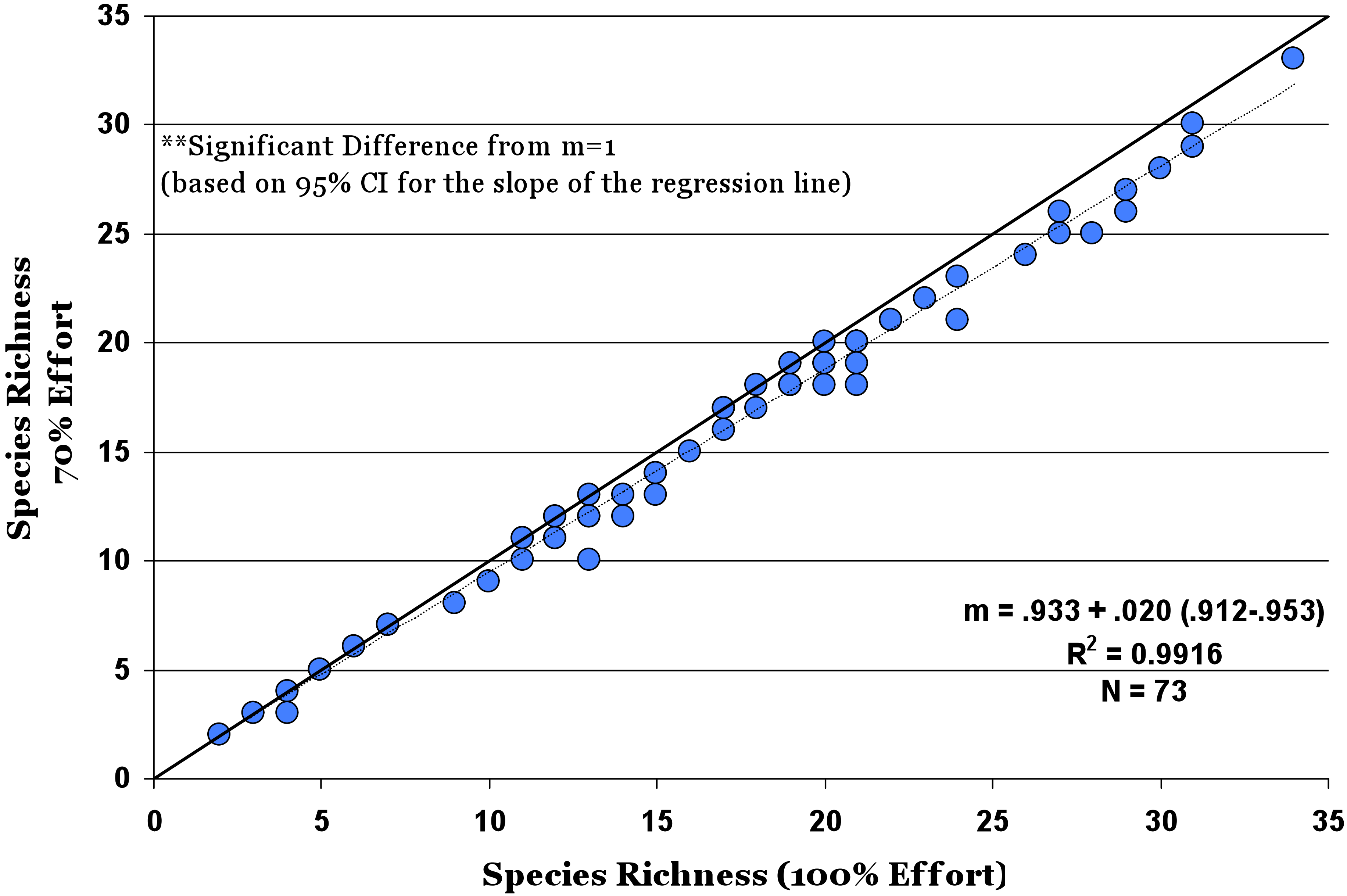
Richness: Full dataset vs. 90%



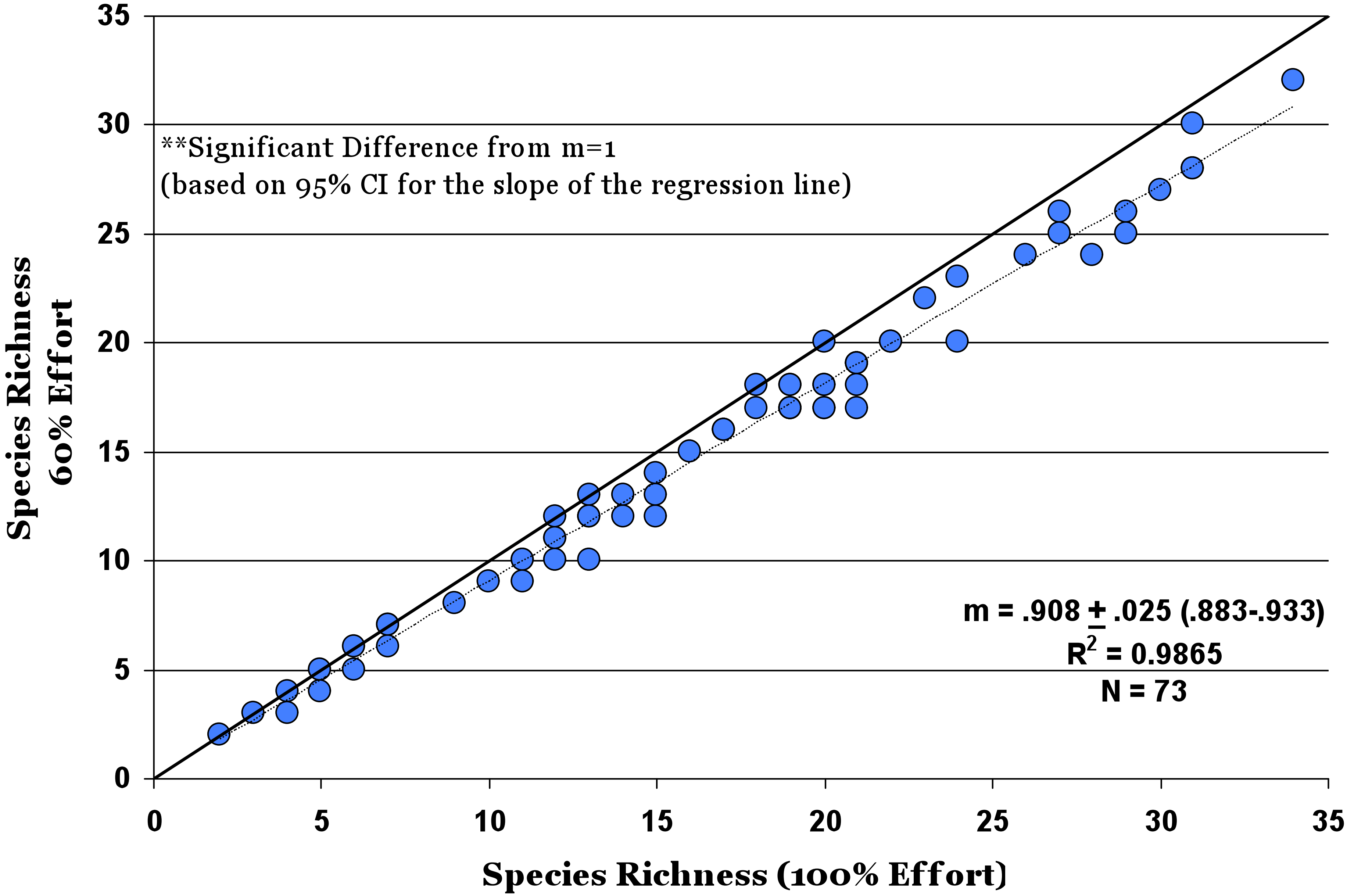
Richness: Full dataset vs. 80%



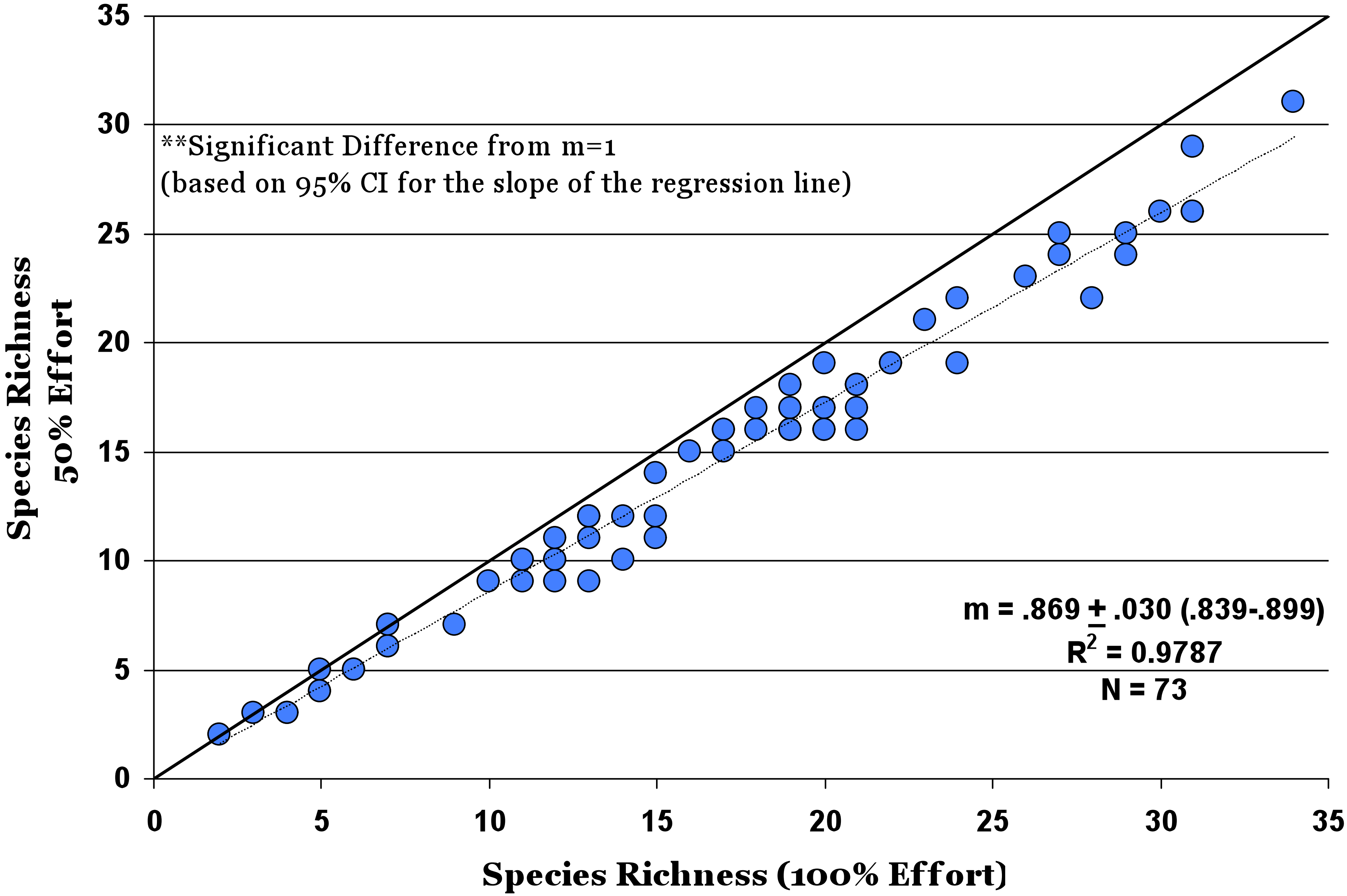
Richness: Full dataset vs. 70%



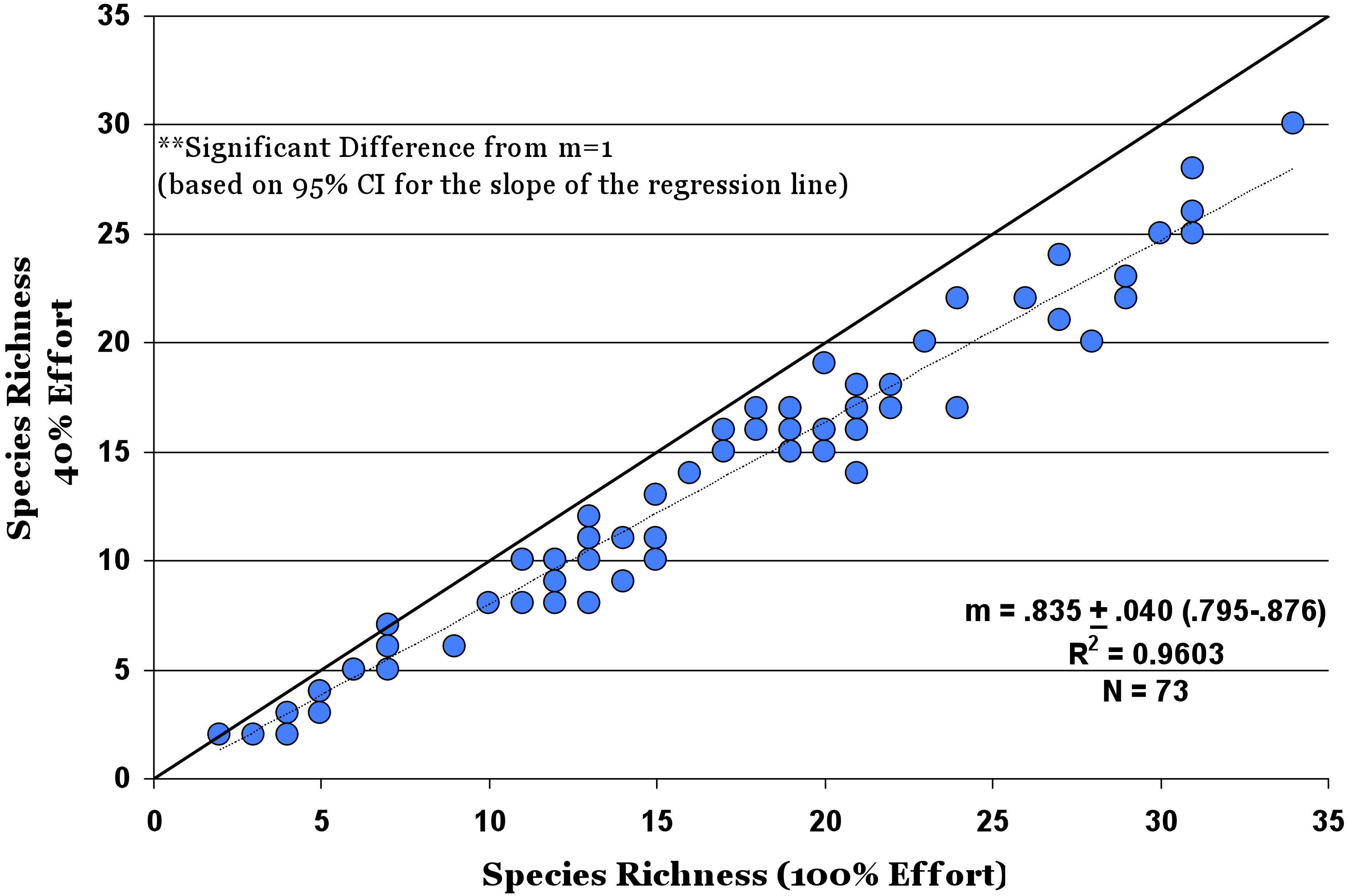
Richness: Full dataset vs. 60%



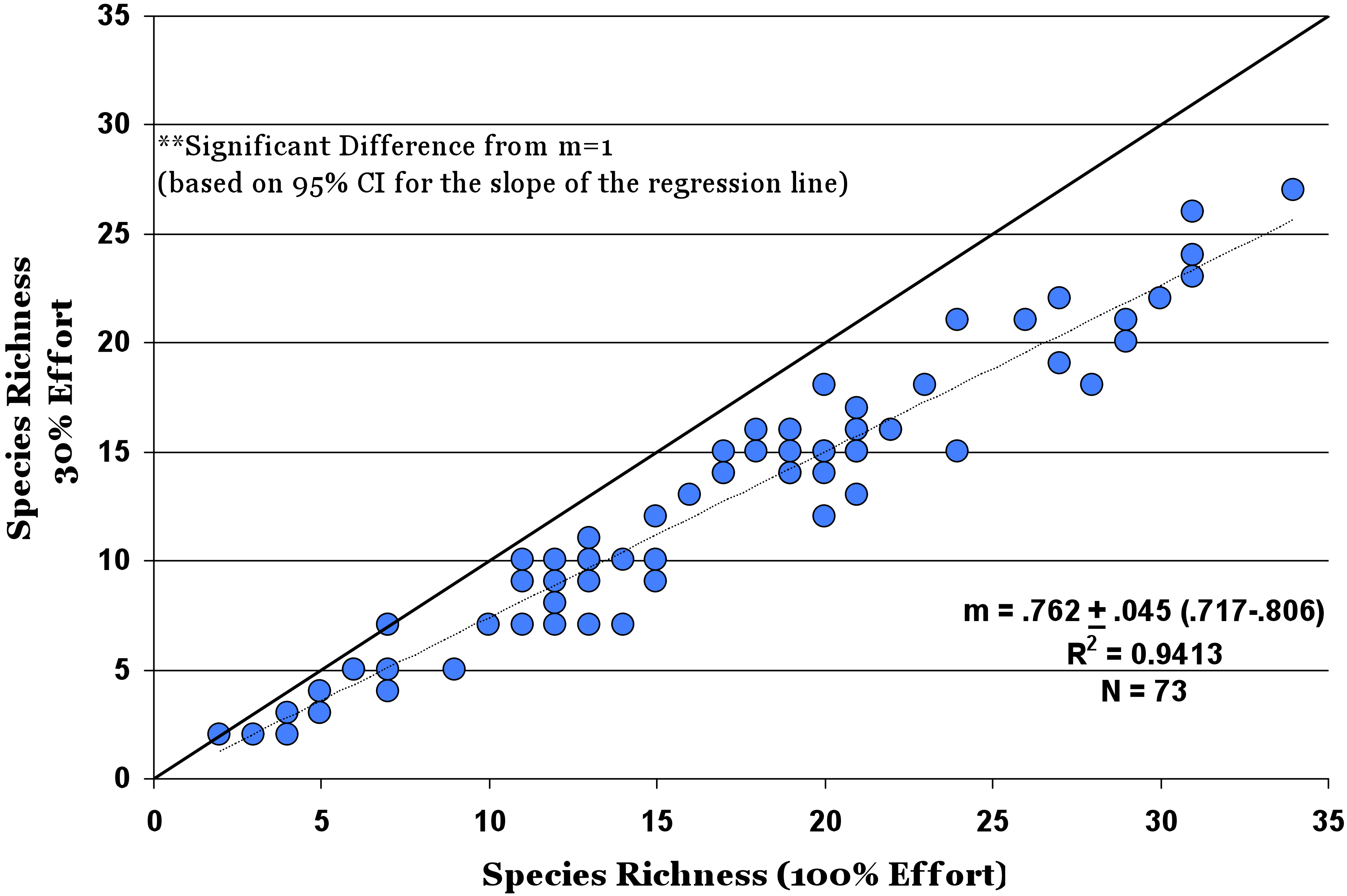
Richness: Full dataset vs. 50%



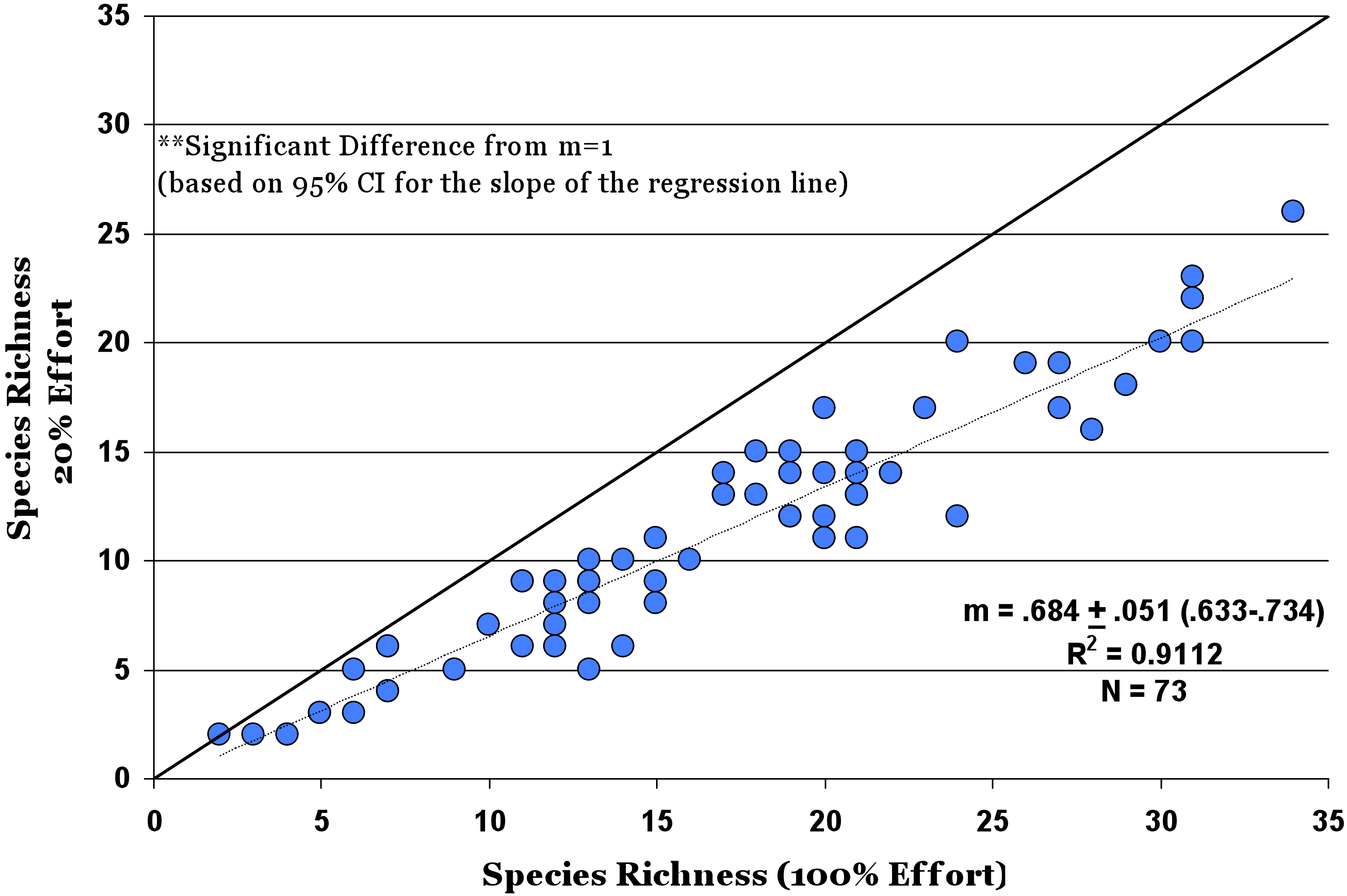
Richness: Full dataset vs. 40%



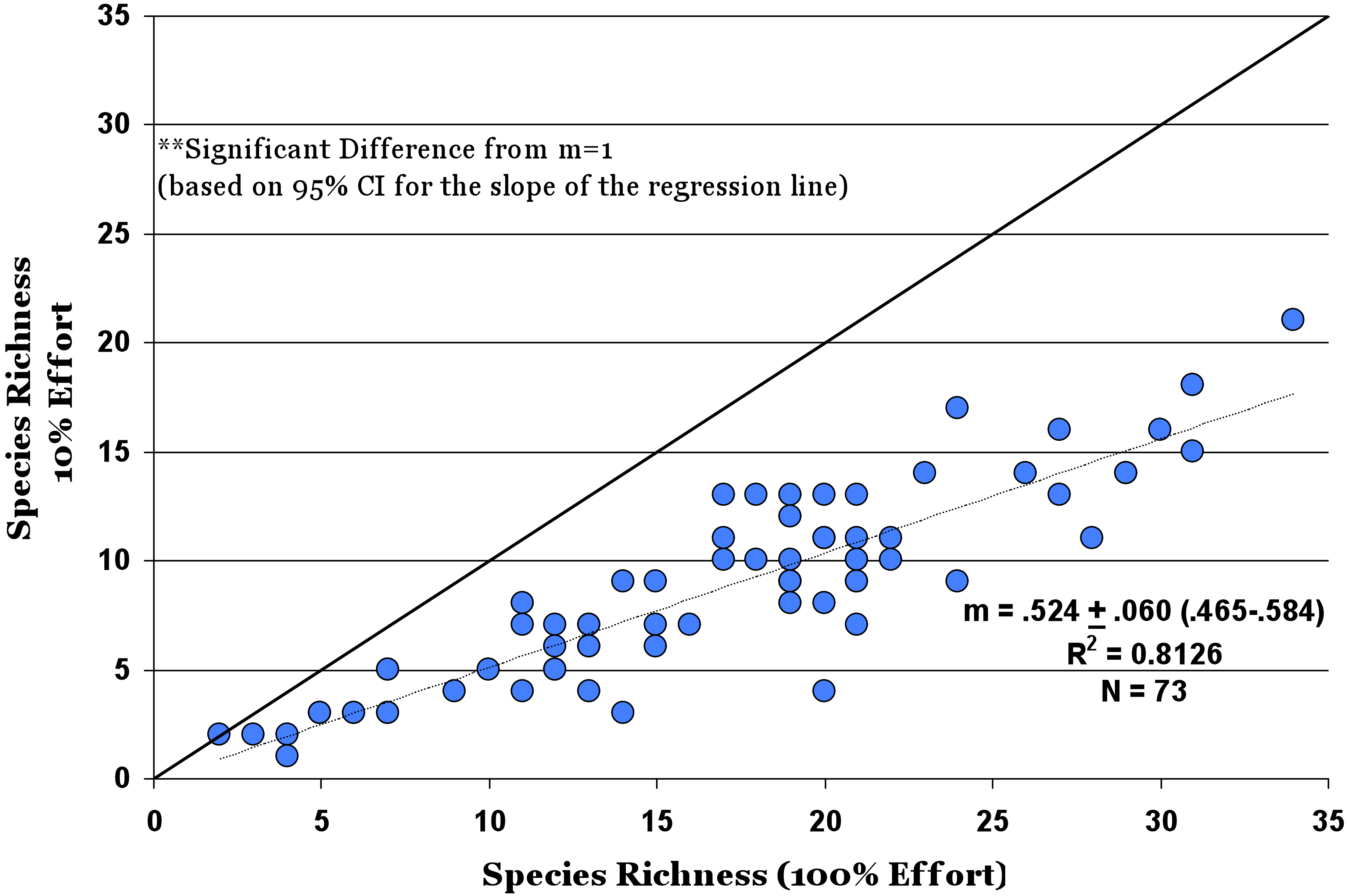
Richness: Full dataset vs. 30%



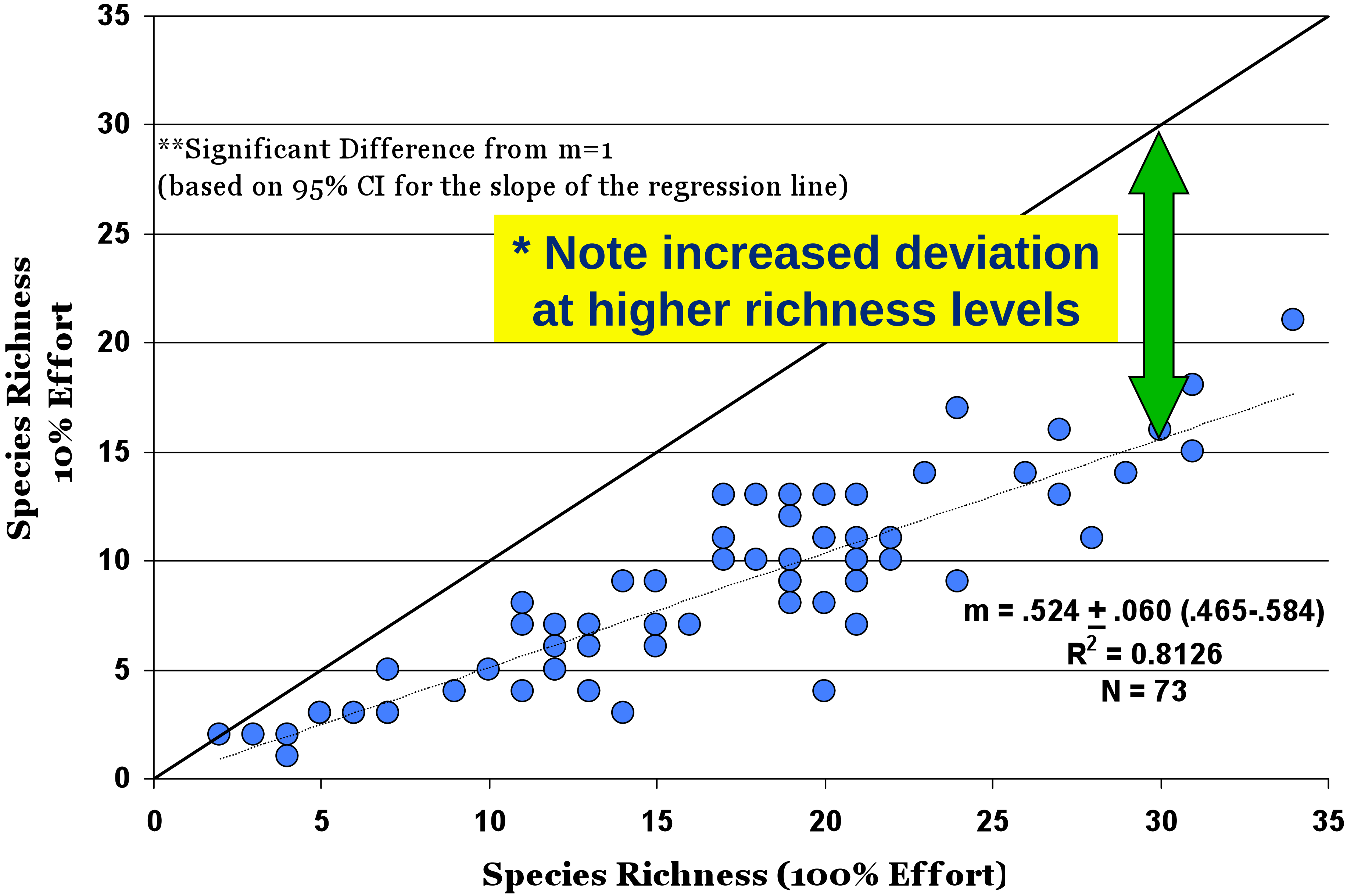
Richness: Full dataset vs. 20%



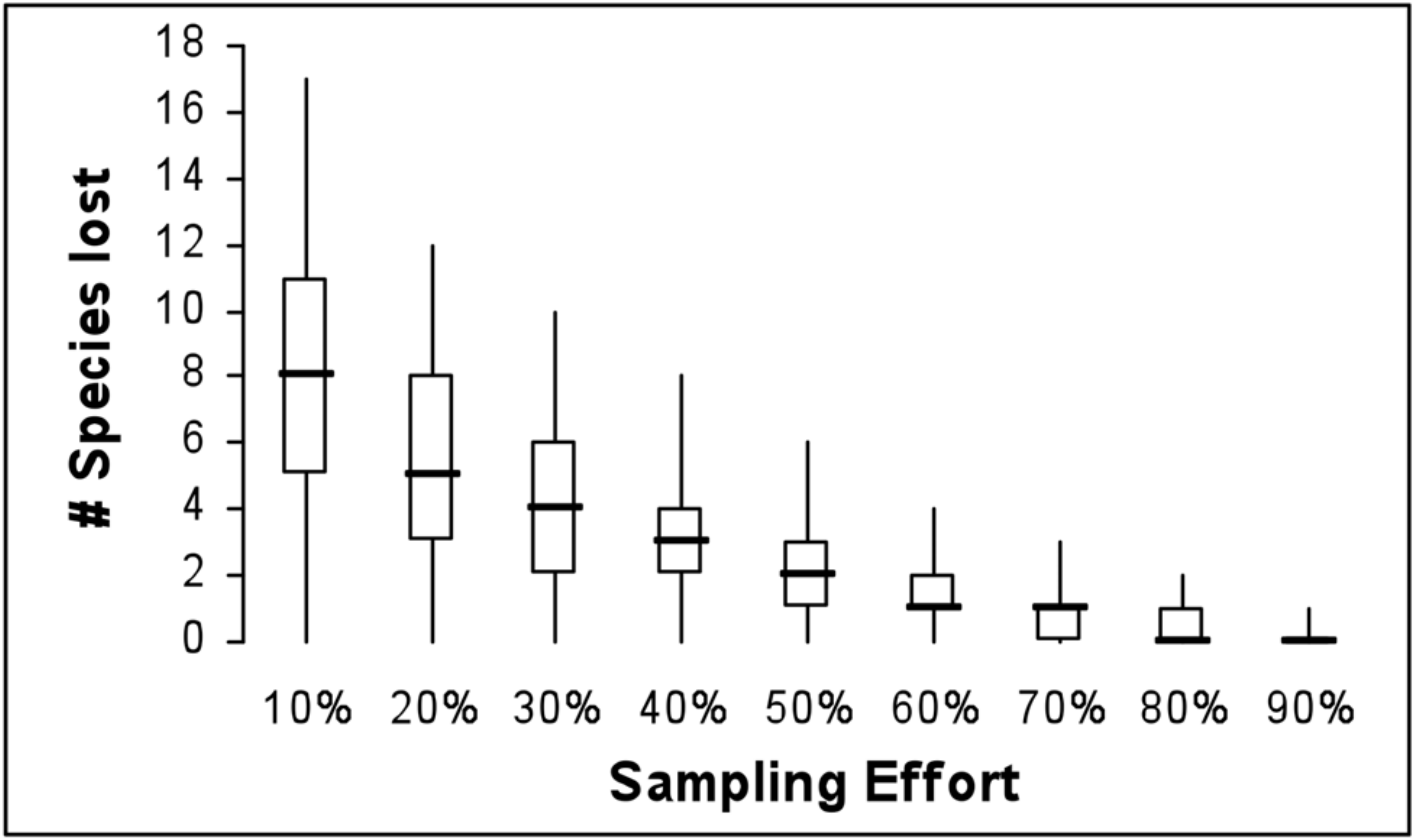
Richness: Full dataset vs. 10%



Richness: Full dataset vs. 10%

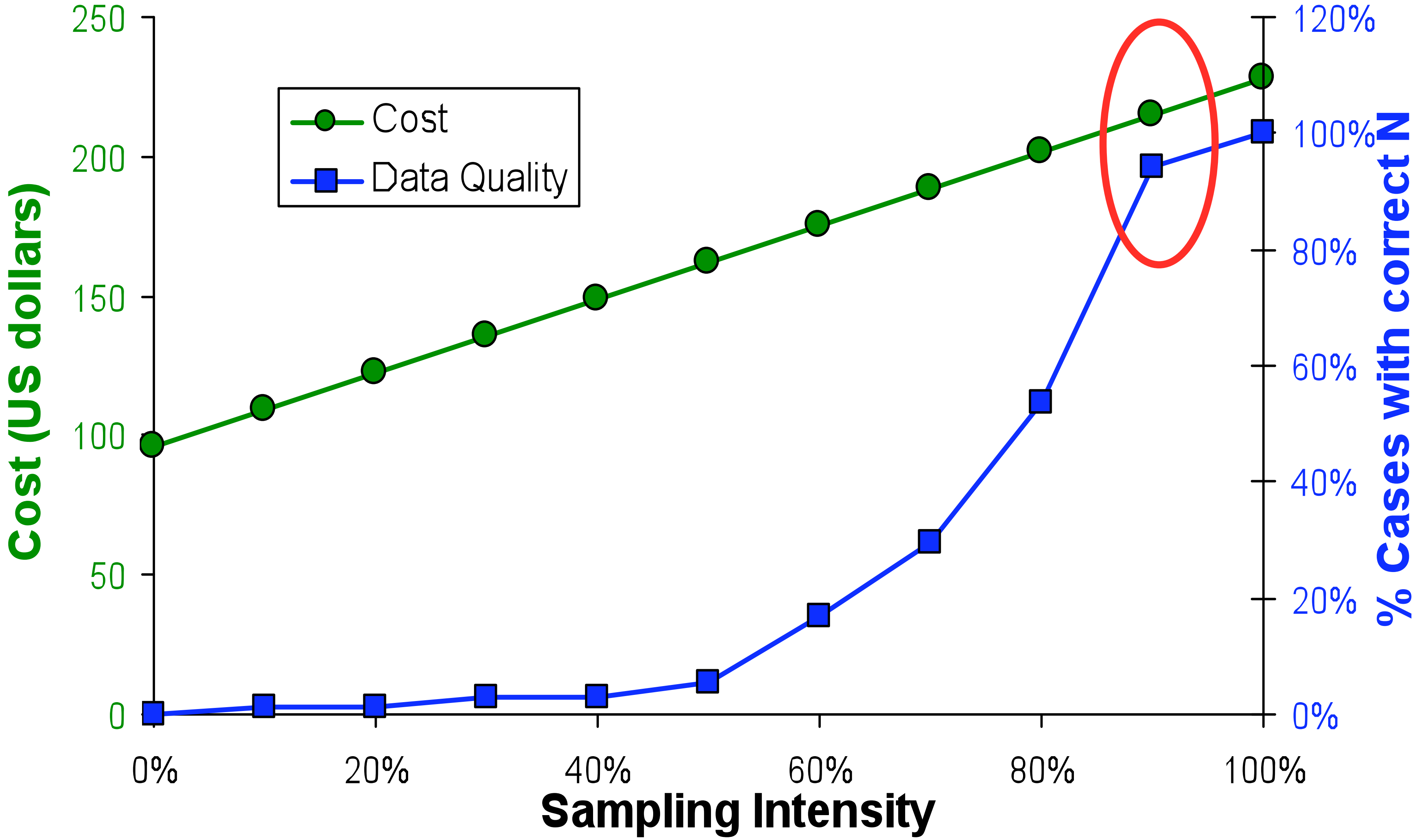


Increase in Accuracy
Decrease in Variability



Accurate estimates in 94% of lakes tested

Cost-Benefit Analysis



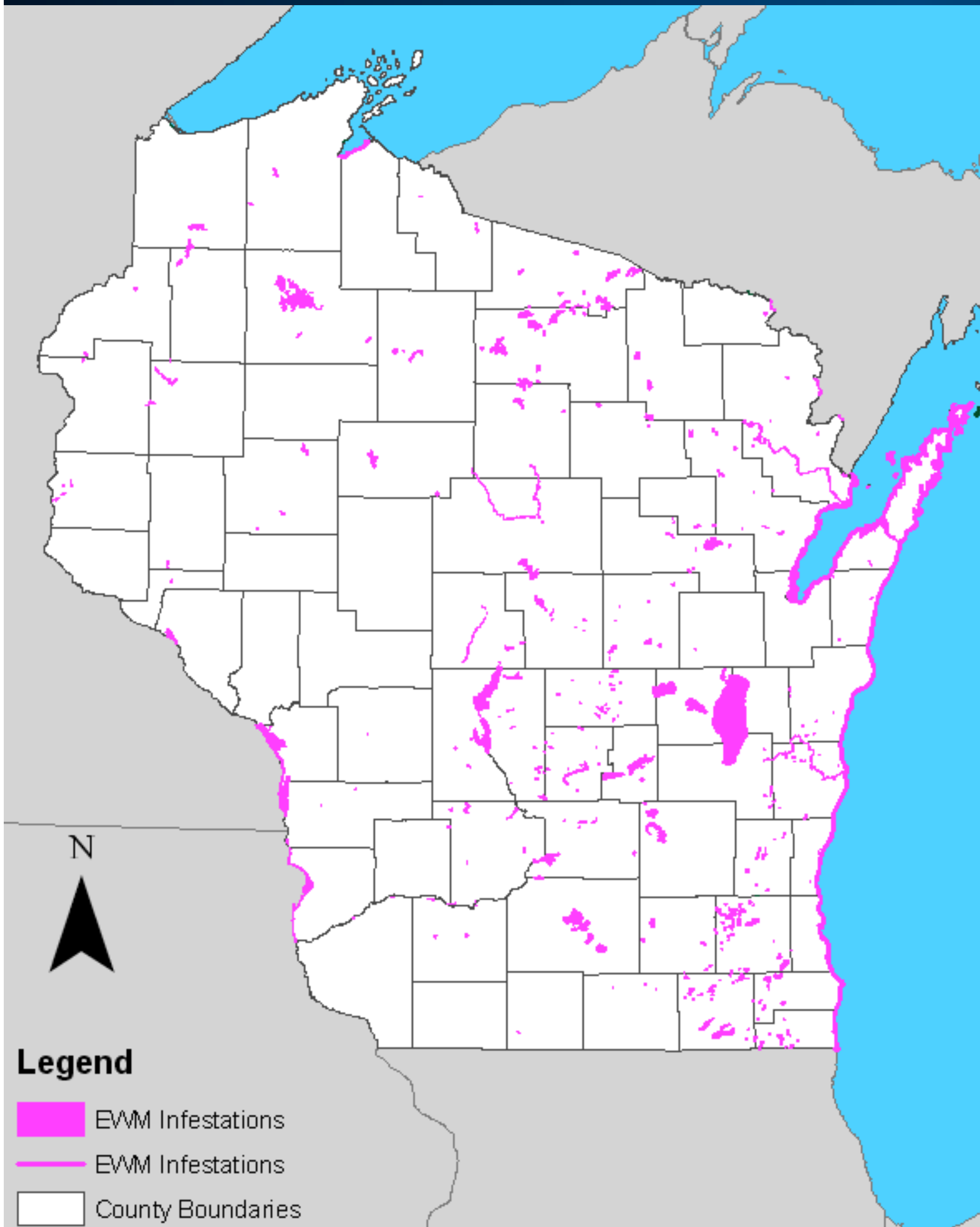
Summary

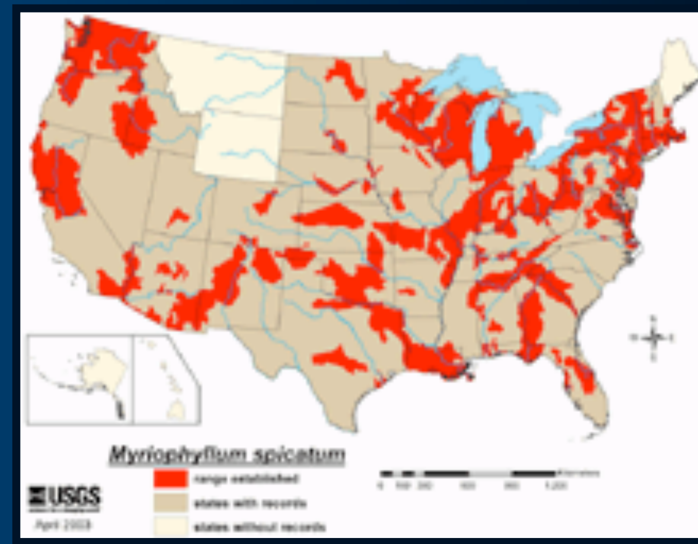
- Our picture of the lake is sensitive to reducing sampling intensity
- We are representing plant community characteristics accurately
- By quantitatively testing the “success” of our survey methodology, we know that we are collecting good data to guide management
- Now on to addressing AIS problems…

Establishing a scientific framework for Eurasian watermilfoil management in Wisconsin

Photo by John Madsen, Aquatic Plant Management Society

Eurasian watermilfoil





Present in 479 lakes in WI

Historically more problematic in SE WI

Despite good tracking of EWM populations in WI (✓yes if present):

- How much? Where in the lake? What will the lake look like in the future?

-different lake types, different outcome?
-different location, different outcome?
-different management, different outcome?

Translates to poor ability to educate the public on potential outcomes and management

Questions about EWM

1) EWM ecology

-What are the possible outcomes when EWM is introduced to a lake?

-What factors contribute to different outcomes?

-Interannual variation (with and without management)?

2) EWM management

-Past management (non strategic) outcomes = short term nuisance relief?

-Future management (strategic) outcomes = restoration?

Goals of Statewide EWM Research in WI

1) Within a given lake - gain background data on EWM lakes to manage today and track future changes

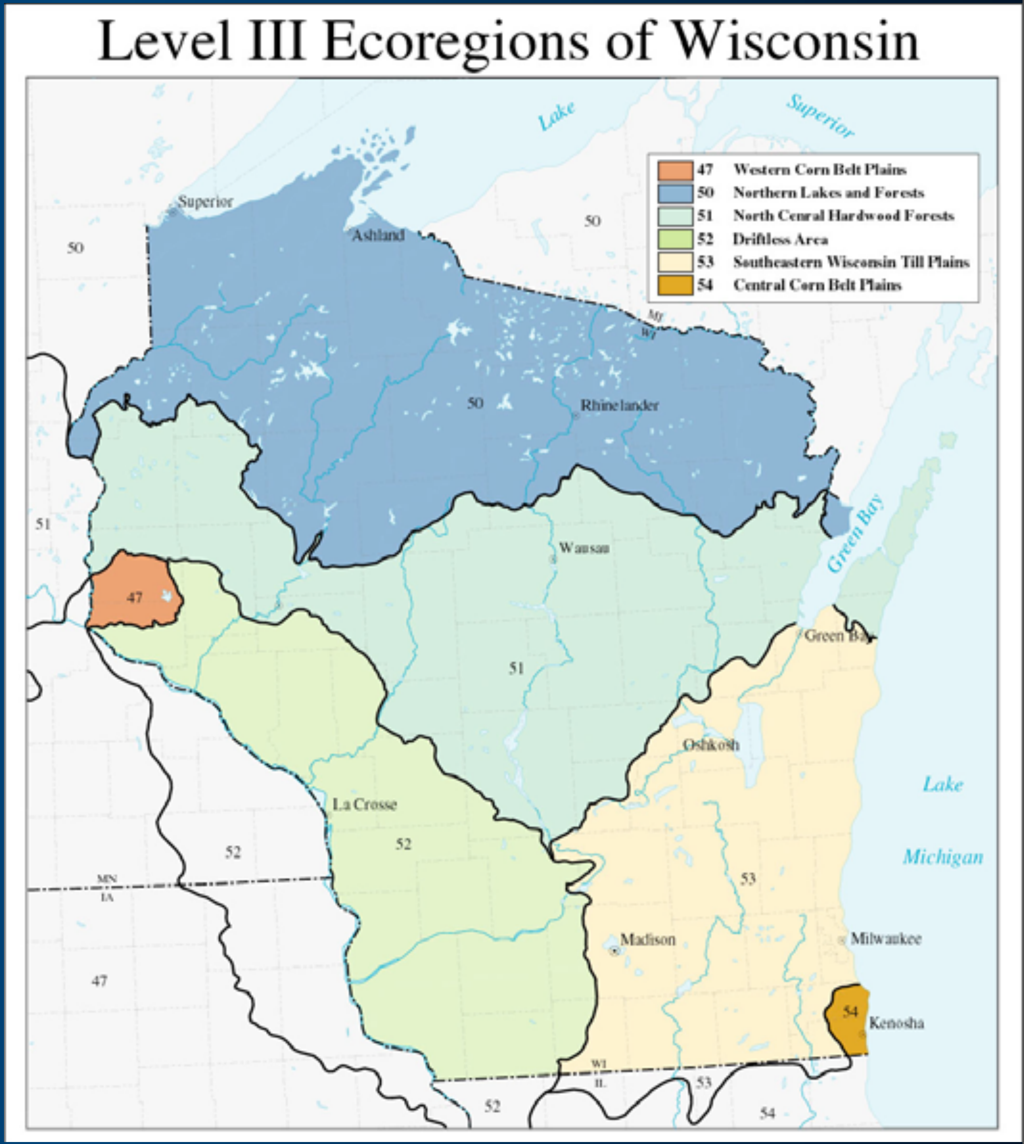
2) Across lakes statewide - understand the factors that control EWM abundance and time course in lakes

Approach – survey as many milfoil lakes as possible!!!

Search for patterns across meaningful gradients…

Project Design

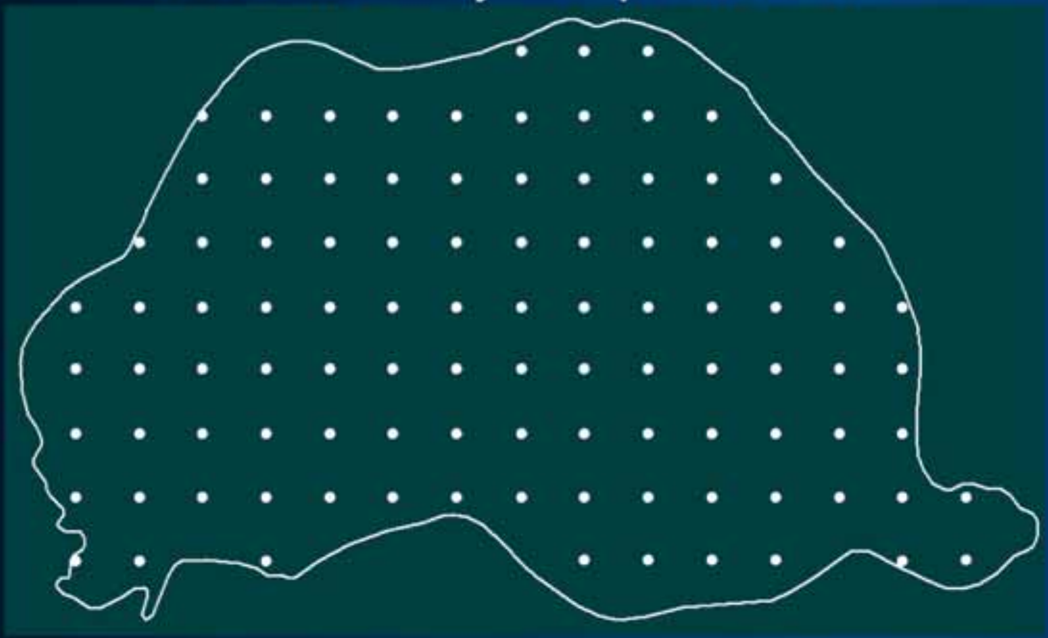
- Major factors:
  - –Ecoregion
  - –Lake Type
- Gradients of:
  - –Size (up to 500 acres)
  - –Depth
  - –Date reported present
  - –Management histories



Omernick et al. 2000

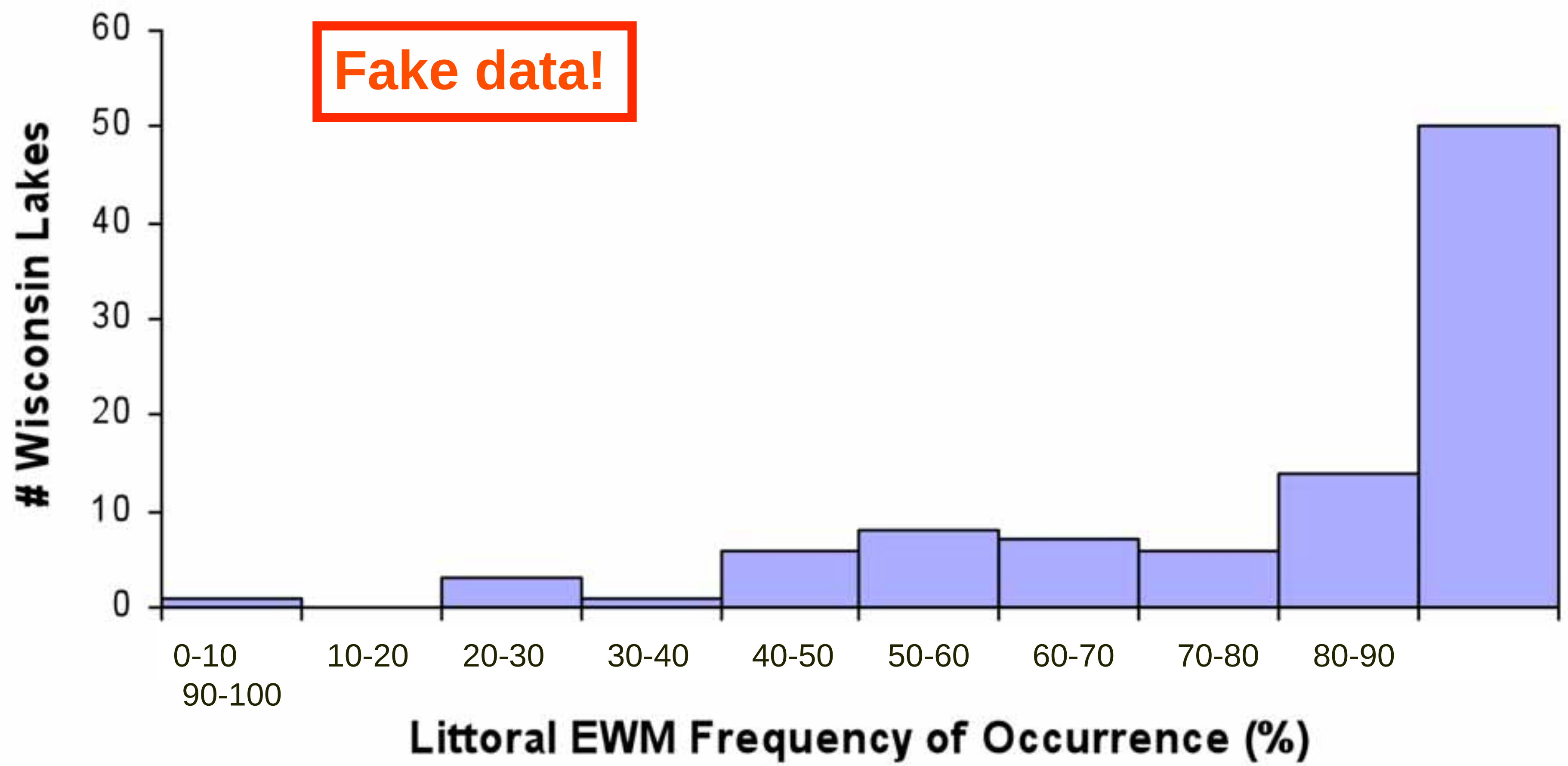
Data Collection

- Point-intercept method
- 100 EWM lakes
- 30-70 m resolution
- Species list and distributions for each lake
- Density rating for exotics (1,2,3): EWM and Curly-leaf pondweed

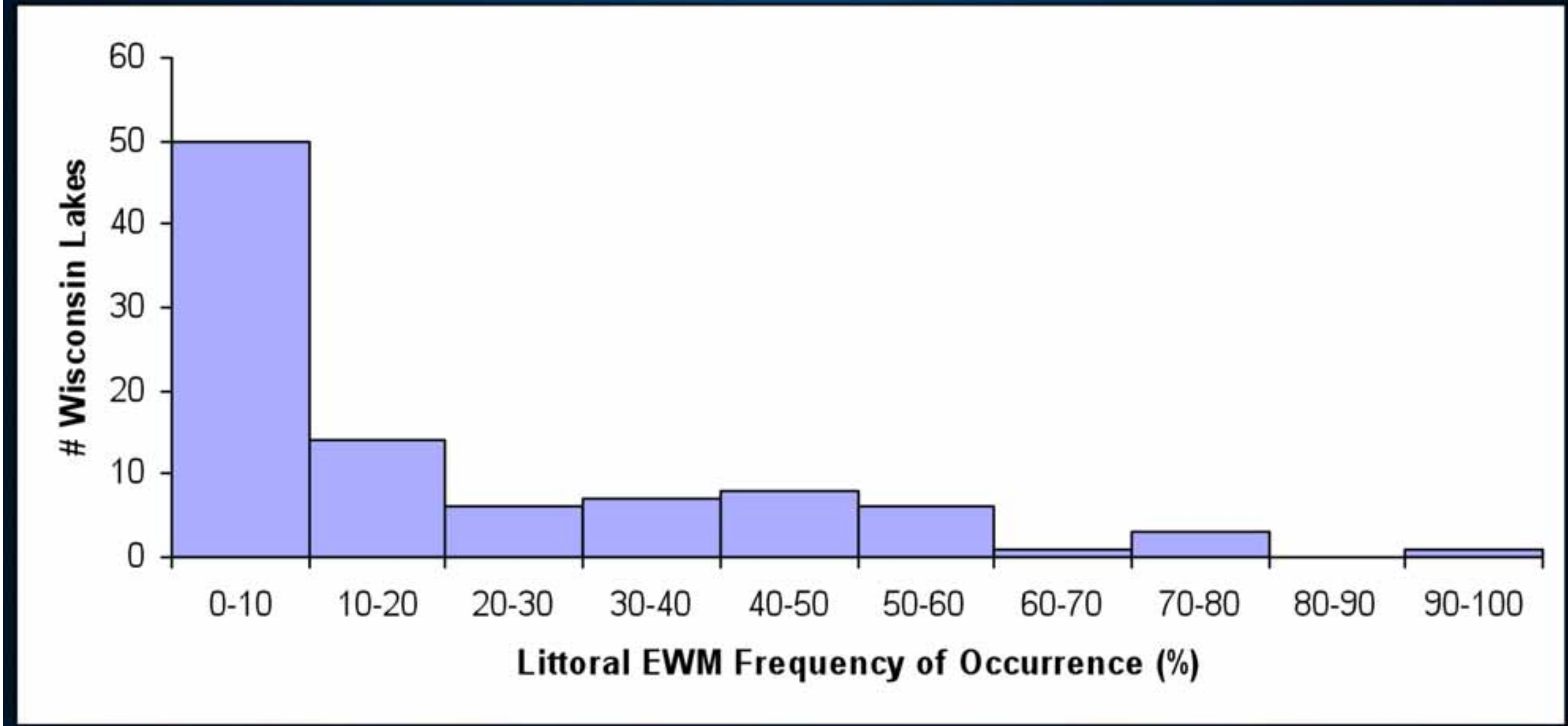


EWM frequencies across state…

PERCEPTIONS



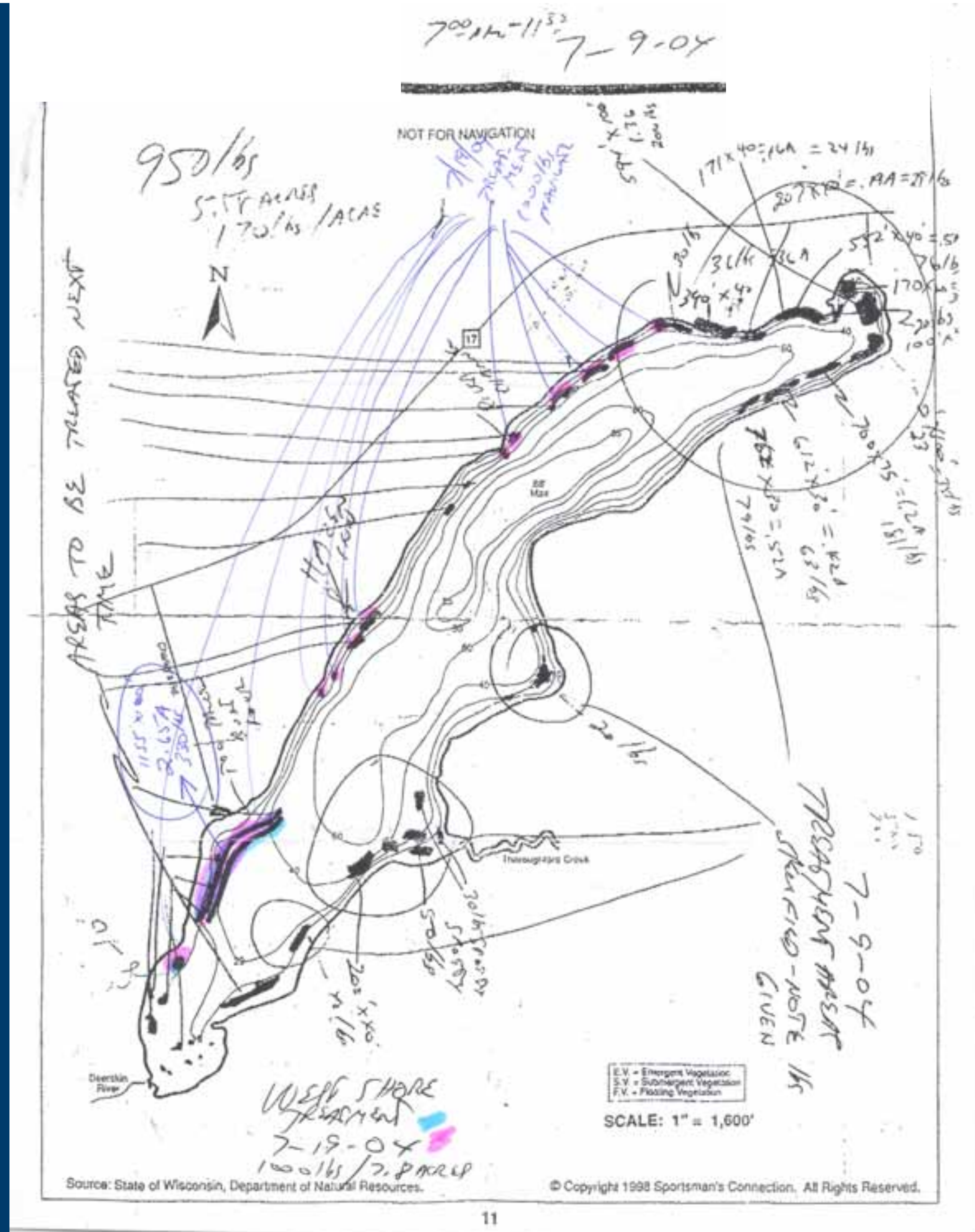
EWM frequencies across state… REALITY!



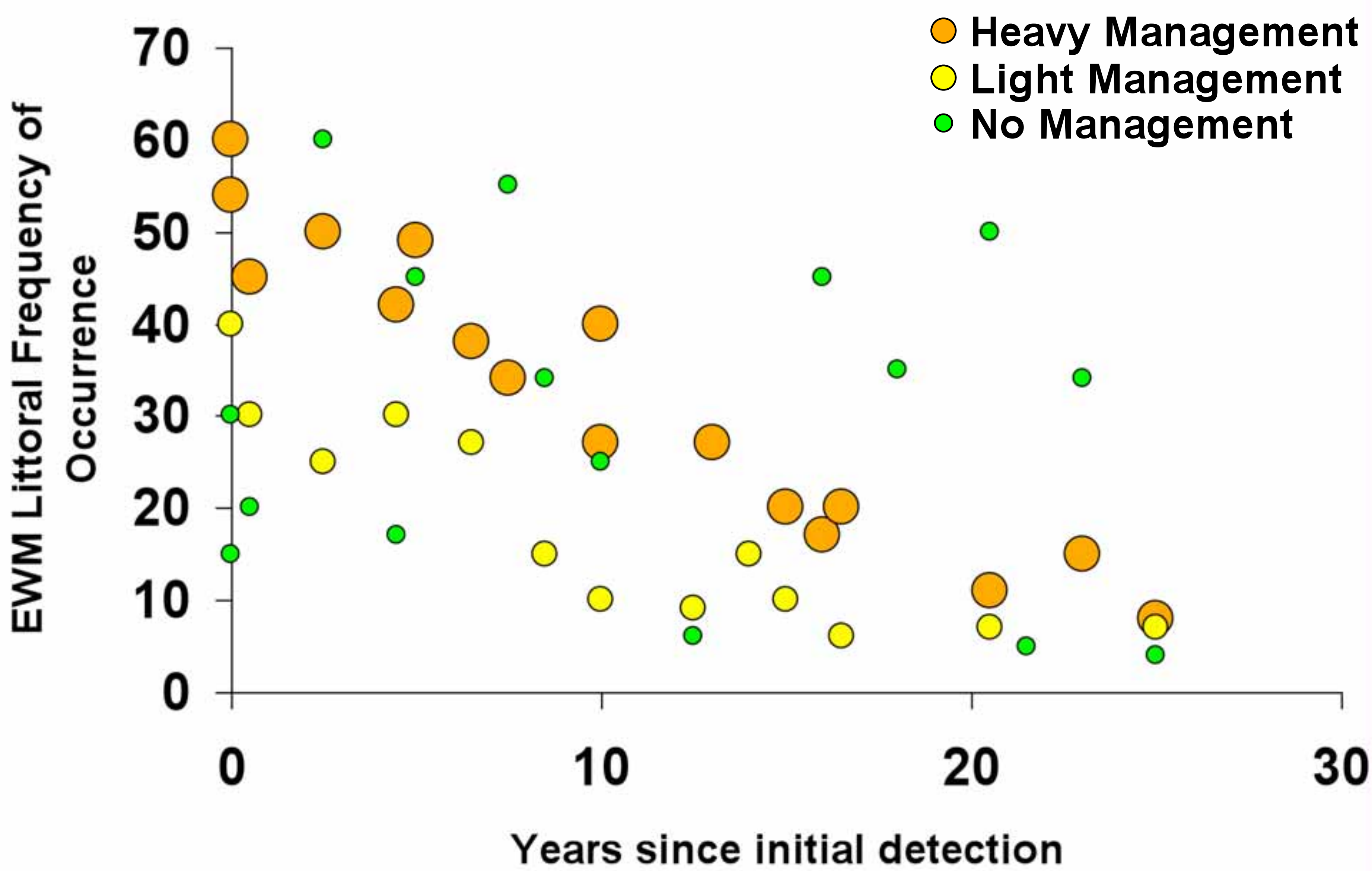
-Most EWM littoral frequencies are <10%... Variation?

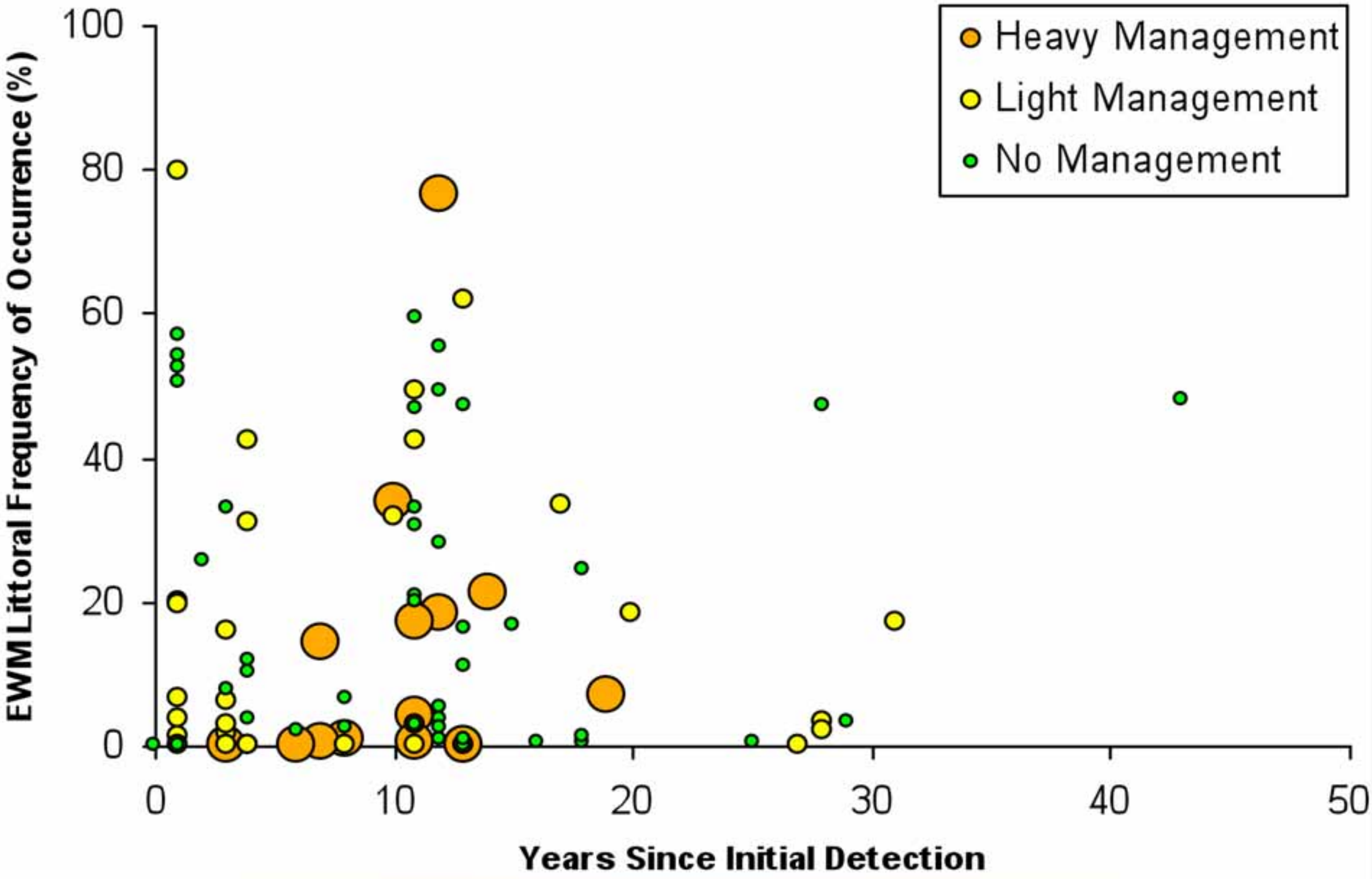
Management history in WI

- Acreage of EWM
- Acreage of EWM treated
- Chemical used
- Amount used
- When
- Where



What would we like to see?





No patterns! Other sources of variation seem to be more important than past (non-strategic) management

Eurasian watermilfoil

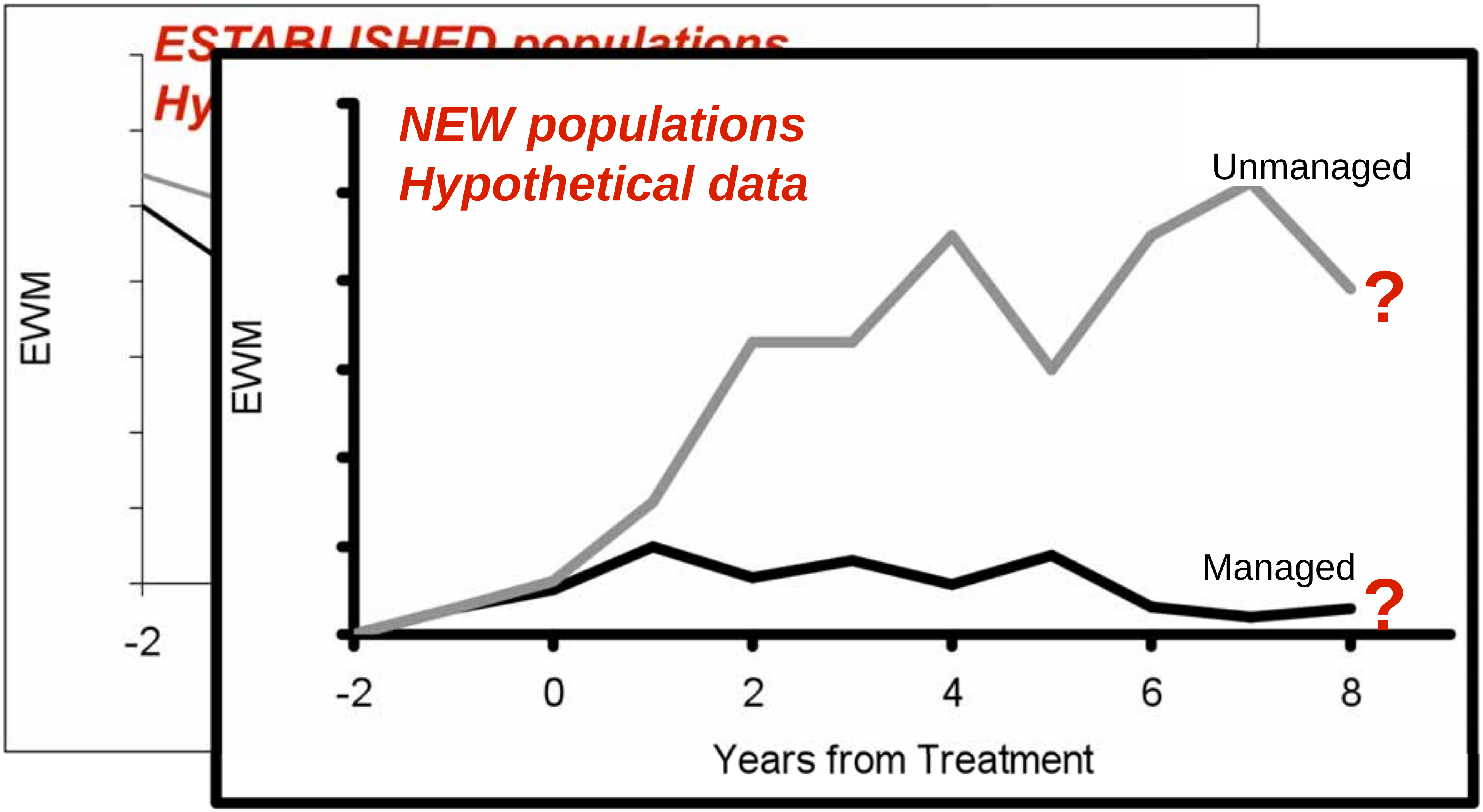
Long-term EWM management study

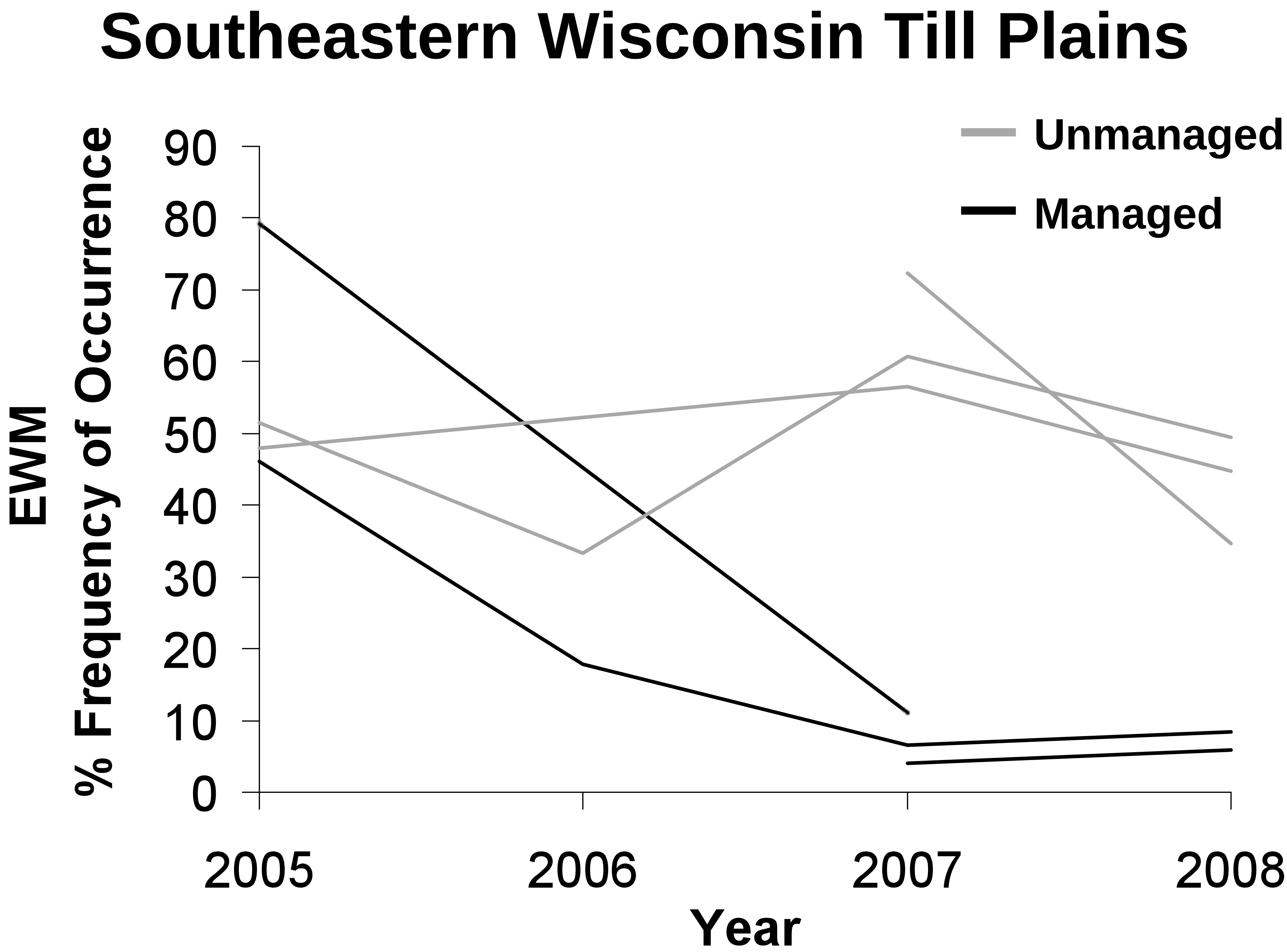
- Track results of STRATEGIC management
  - Annual PI survey and biomass collection
  - Control for region and time since detection
- Management effect in preliminary data

-How does *strategic* management affect long-term EWM population levels?

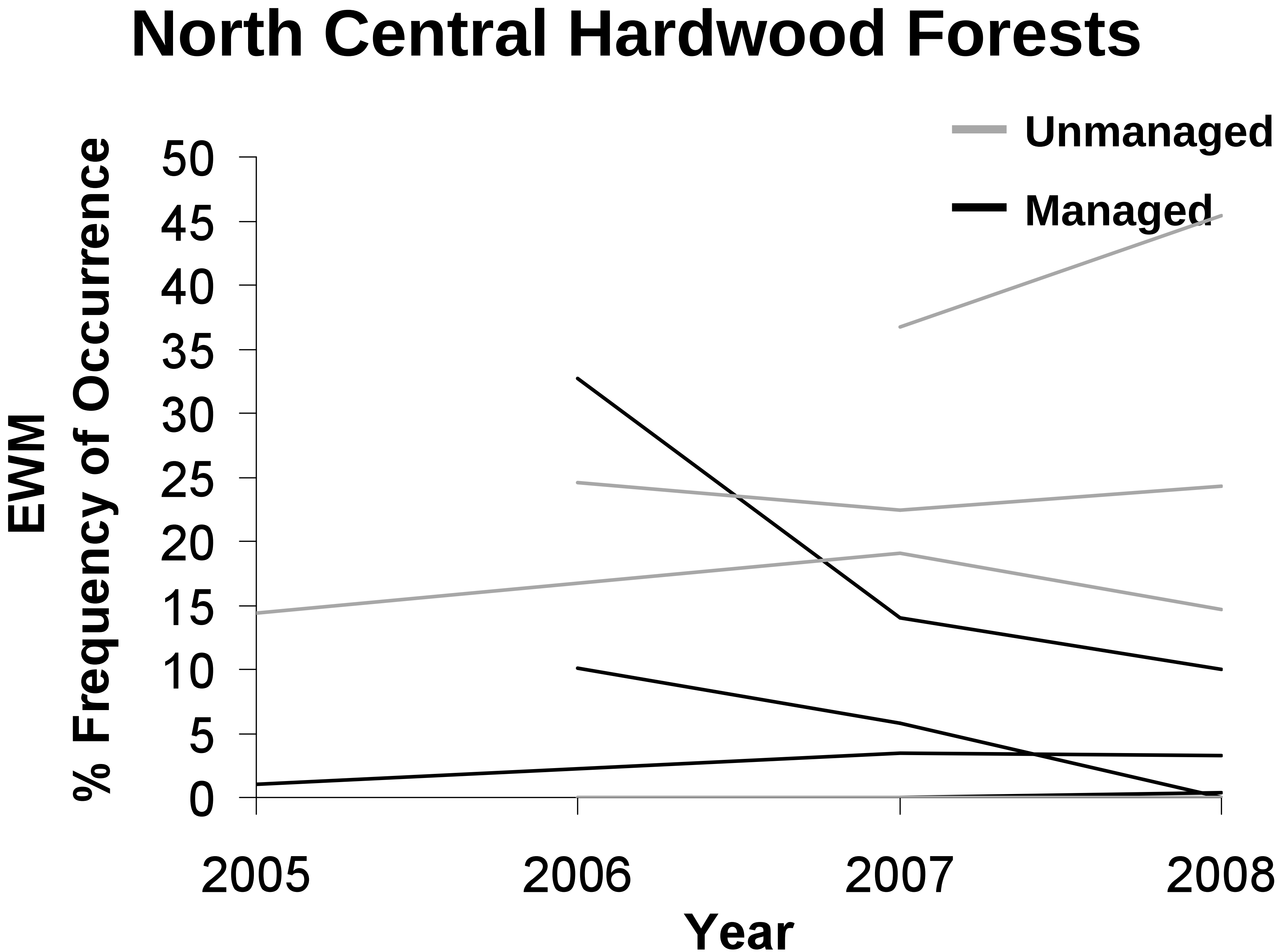
Tracking 24 lakes over time, ongoing

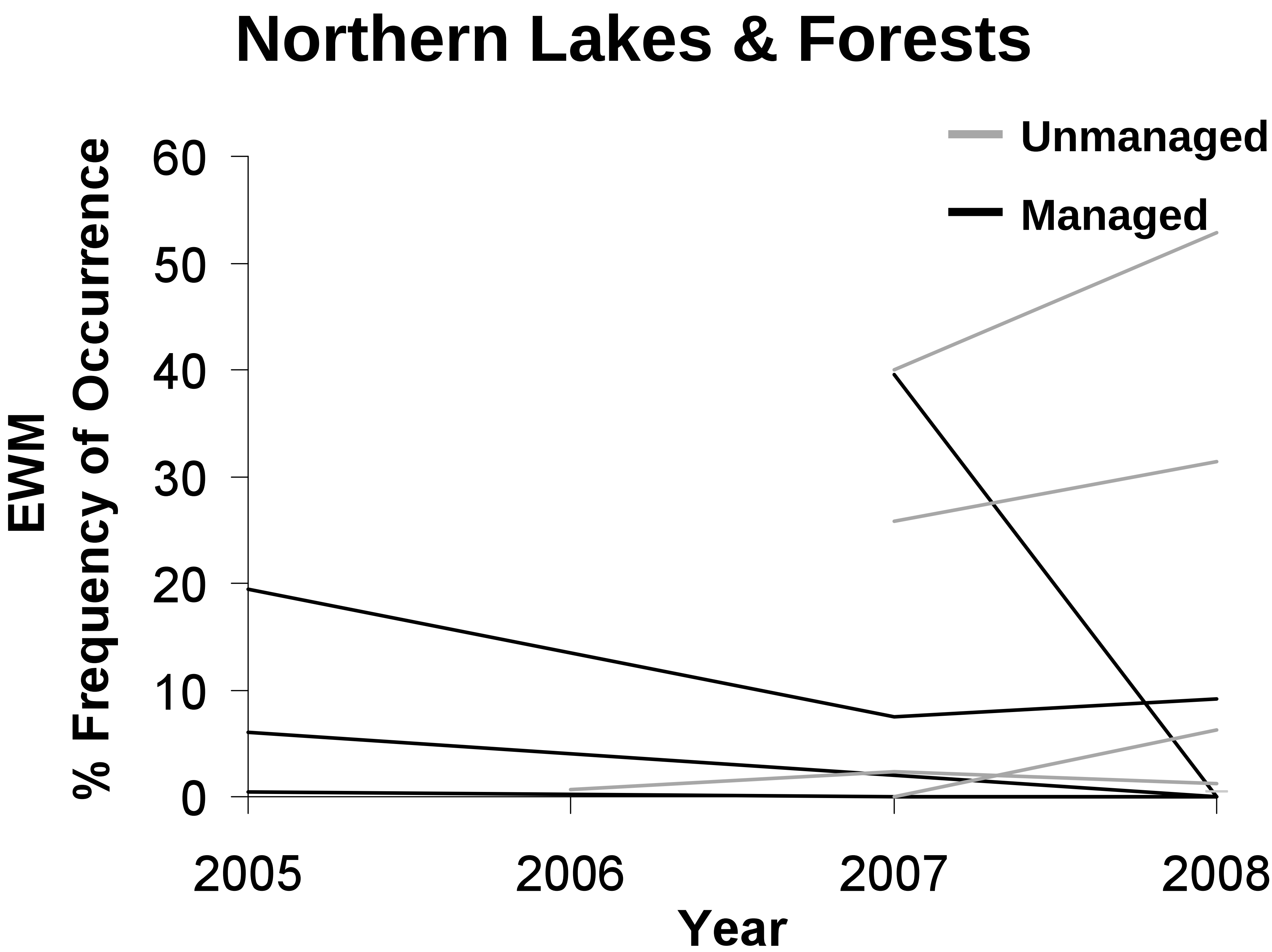
3 regions, established and new, managed and unmanaged





Southeastern Wisconsin Till Plains
Unmanaged
Managed
EWM
% Frequency of Occurrence
0
10
20
30
40
50
60
70
80
90
2005
2006
2007
2008
Year


North Central Hardwood Forests
Unmanaged
Managed
EWM
% Frequency of Occurrence
50
45
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
Year


Northern Lakes & Forests
Unmanaged
Managed
EWM
% Frequency of Occurrence
60
50
40
30
20
10
0
2005
2006
2007
2008
Year

Summary

- Baseline data on EWM lakes
- Continue to track new and established populations in managed and unmanaged systems
- Be able to inform the public about reasonable expectations for EWM on individual lakes

Case studies - Early season 2,4-D Application Timing/Phenology

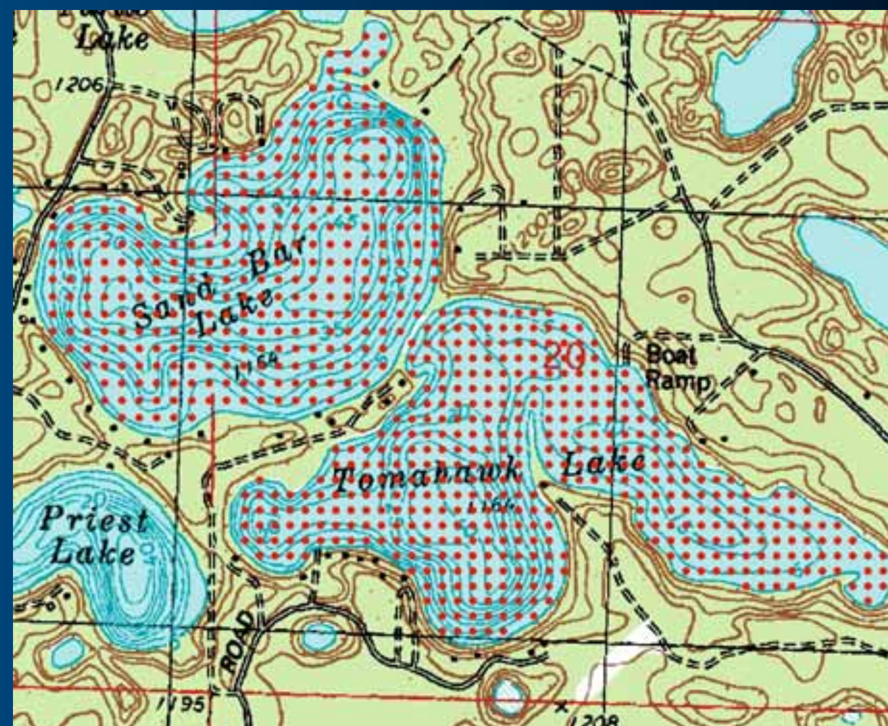
Blackhawk Lake, Eagan, MN

- **Exotic species small and most vulnerable**
- **Native species are dormant**
- **Minimal microbial degradation**

Case Studies – Early season control

Sandbar,
▼ Tomahawk
Early season 2,4-D treatment

Turville Bay ▲
Early season harvesting and 2,4-D treatment



Tomahawk & Sandbar: Study design

- **Tomahawk – early season low dose 2,4-D (0.5 mg/L ae) treatment to whole lake (May 20, 2008)**
- **Sandbar – reference lake**
- **PI Surveys conducted on Tomahawk: 2006-2008**
- **PI Surveys conducted on Sandbar: 2007-2008**
- **Biomass collected in 2007 & 2008 surveys**

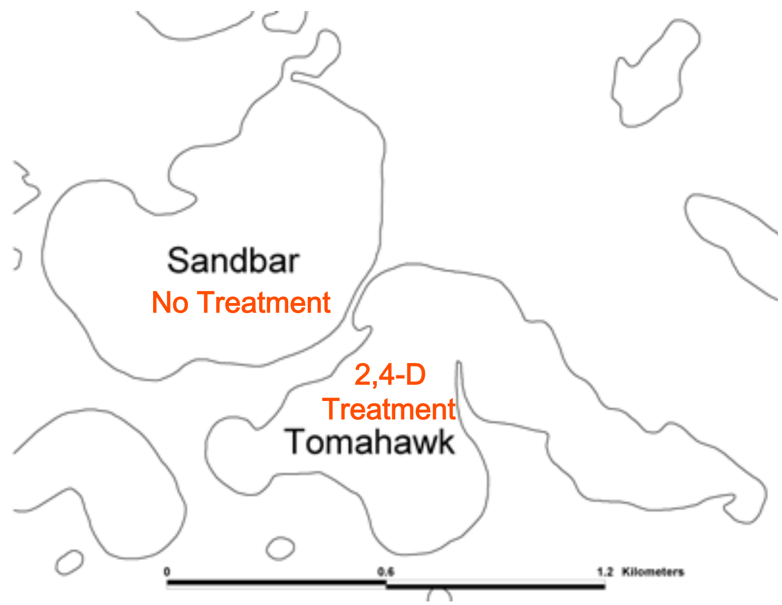
Case studies

Sandbar/Tomahawk; Town of Barnes, Bayfield County, Army Corps of Engineers, WDNR

1) What are the effects of early season 2,4-D on Eurasian watermilfoil?

2) What are the effects of early season 2,4-D on native plants?

Approach: Monitor annual changes in plant communities in experimental lakes (herbicide or reference)

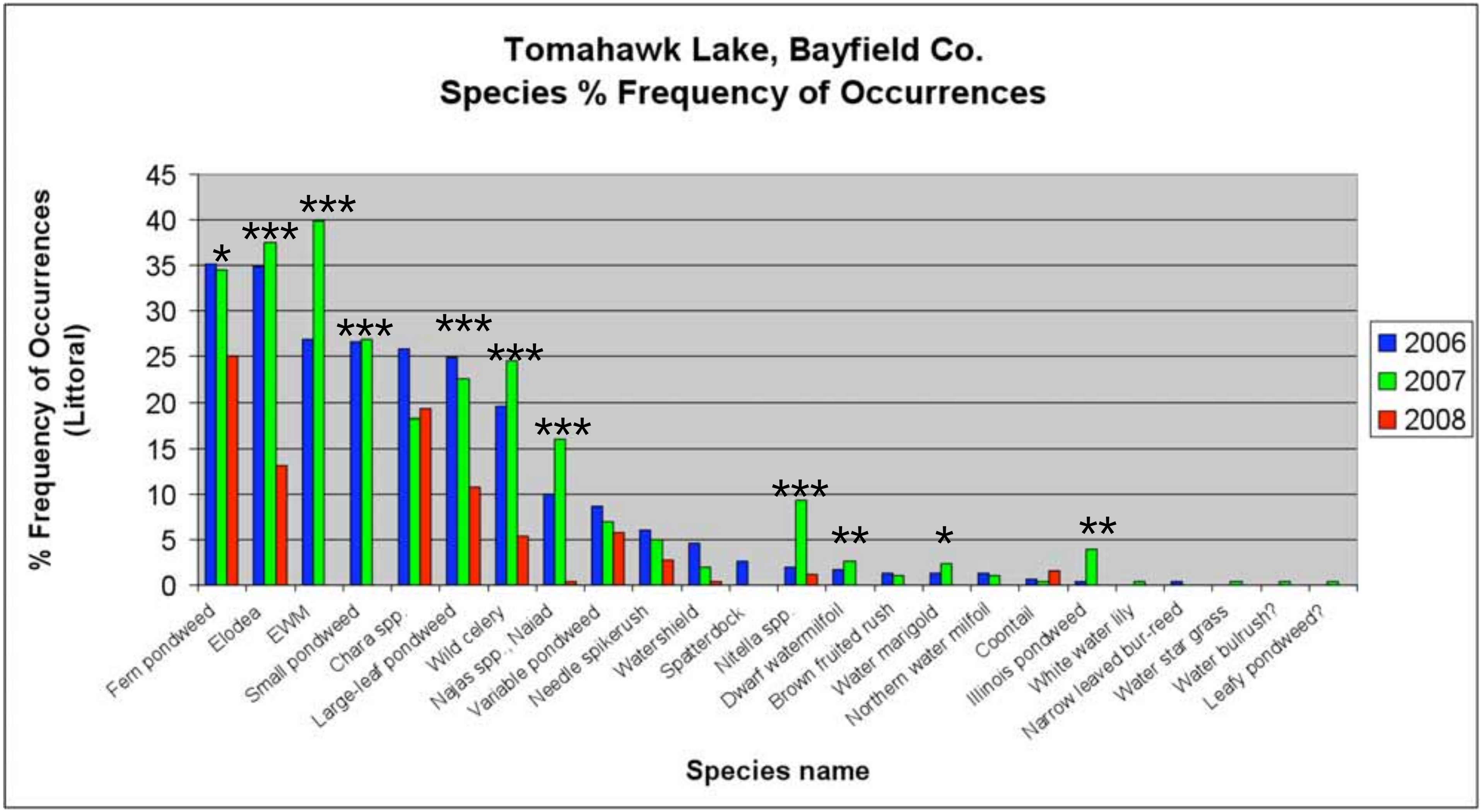


Tomahawk Lake, Bayfield Co.
2006 - 2008 Summary Stats

2,4-D Treatment

	Pre-treatment		Post-treatment
	2006	2007	2008
# points sampled	315	313	299
# of sites with vegetation	256	260	141
littoral FOC	85.1	86.4	54.2
simpsons diversity	0.89	0.90	0.81
avg. # species per site (littoral)	2.4	2.6	0.9
avg. # species per site (vegetated sites)	2.8	3.0	1.6
avg. # natives per site (littoral)	2.1	2.2	0.9
avg. # natives per site (vegetated sites)	2.5	2.7	1.6
species richness	20	22 (2 unverified)	11
species richness (+ visuals)	25	25	13

2,4-D Treatment



* = p ≤ 0.05

** = p ≤ 0.01

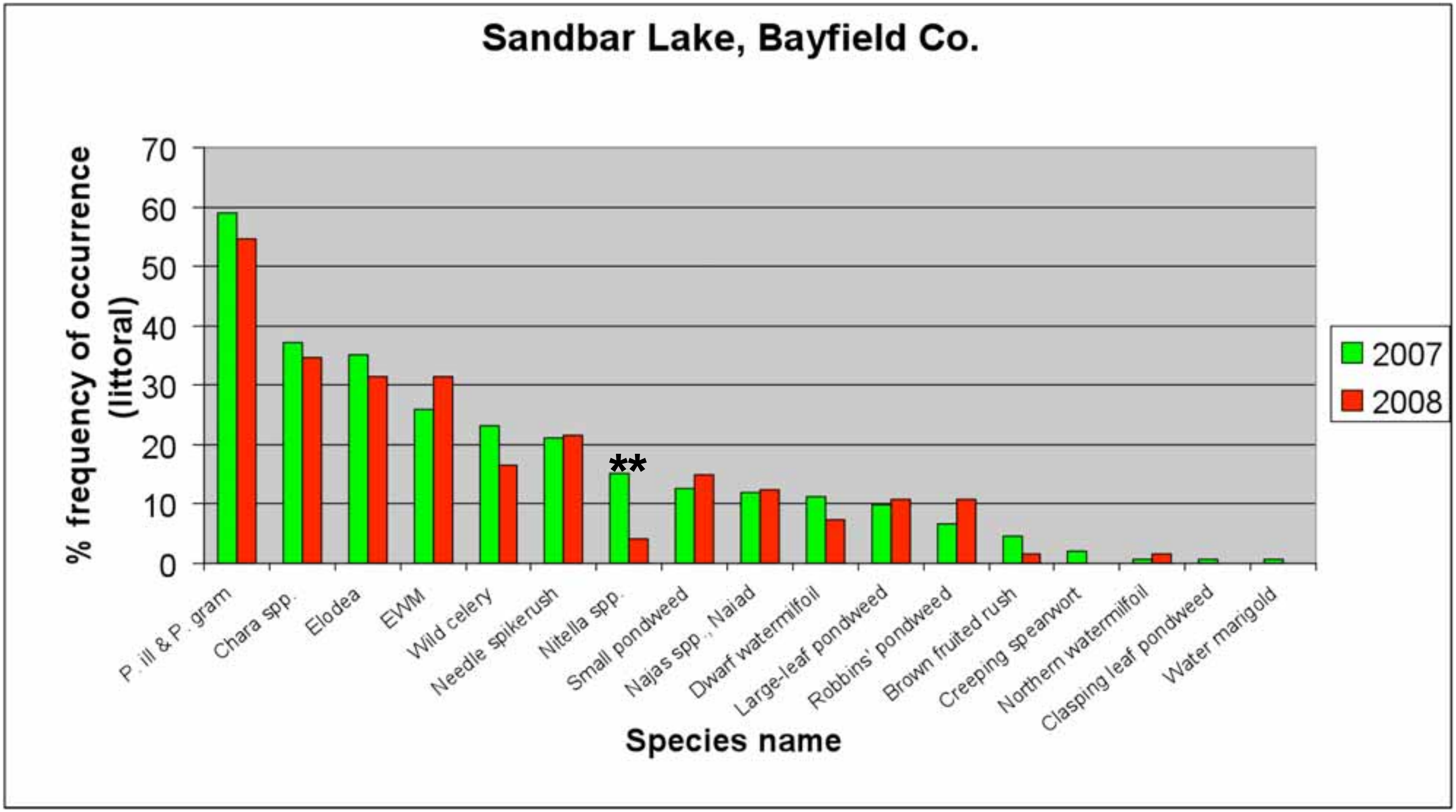
*** = p ≤ 0.001

Sandbar Lake, Bayfield Co.
2007 - 2008 Summary Stats

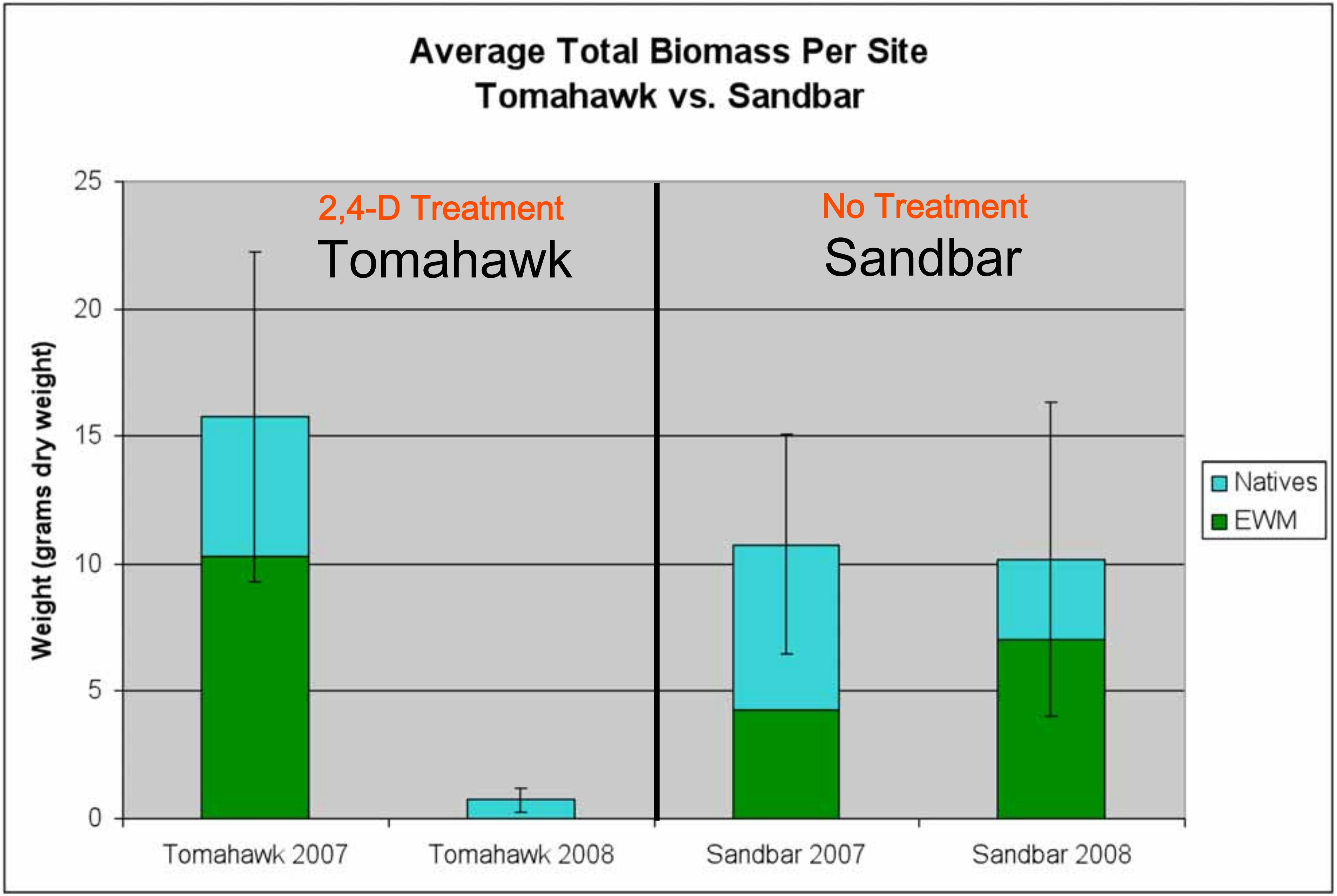
No Treatment

	2007	2008
# points sampled	190	125
# of sites with vegetation	131	107
littoral FOC	86.8	88.4
simpsons diversity	0.89	0.88
avg. # species per site (littoral)	2.8	2.5
avg. # species per site (vegetated sites)	3.2	2.9
avg. # natives per site (littoral)	2.5	2.2
avg. # natives per site (vegetated sites)	2.90	2.6
species richness	17	14
species richness (+ visuals)	19	14

No Treatment



* = p ≤ 0.05
** = p ≤ 0.01
*** = p ≤ 0.001



Average Total Biomass Per Site
Tomahawk vs. Sandbar
2,4-D Treatment
Tomahawk
No Treatment
Sandbar
Weight (grams dry weight)
25
20
15
10
5
0
Natives
EWM
Tomahawk 2007
Tomahawk 2008
Sandbar 2007
Sandbar 2008

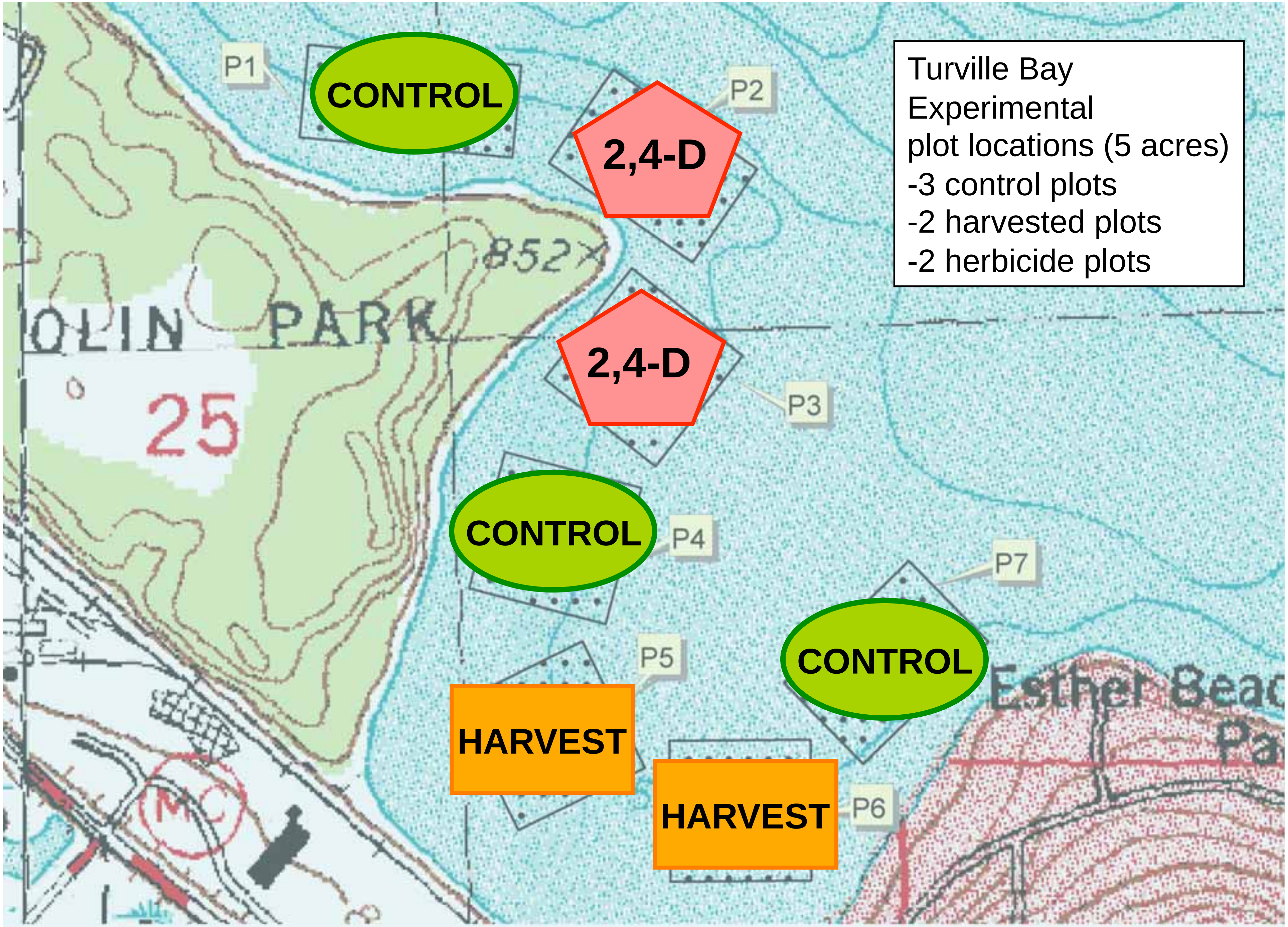
Case studies

Turville Bay, Lake Monona; Dane County, Army Corps, WDNR

1) What are the effects of early season 2,4-D, early season harvesting, and no-management on Eurasian watermilfoil?

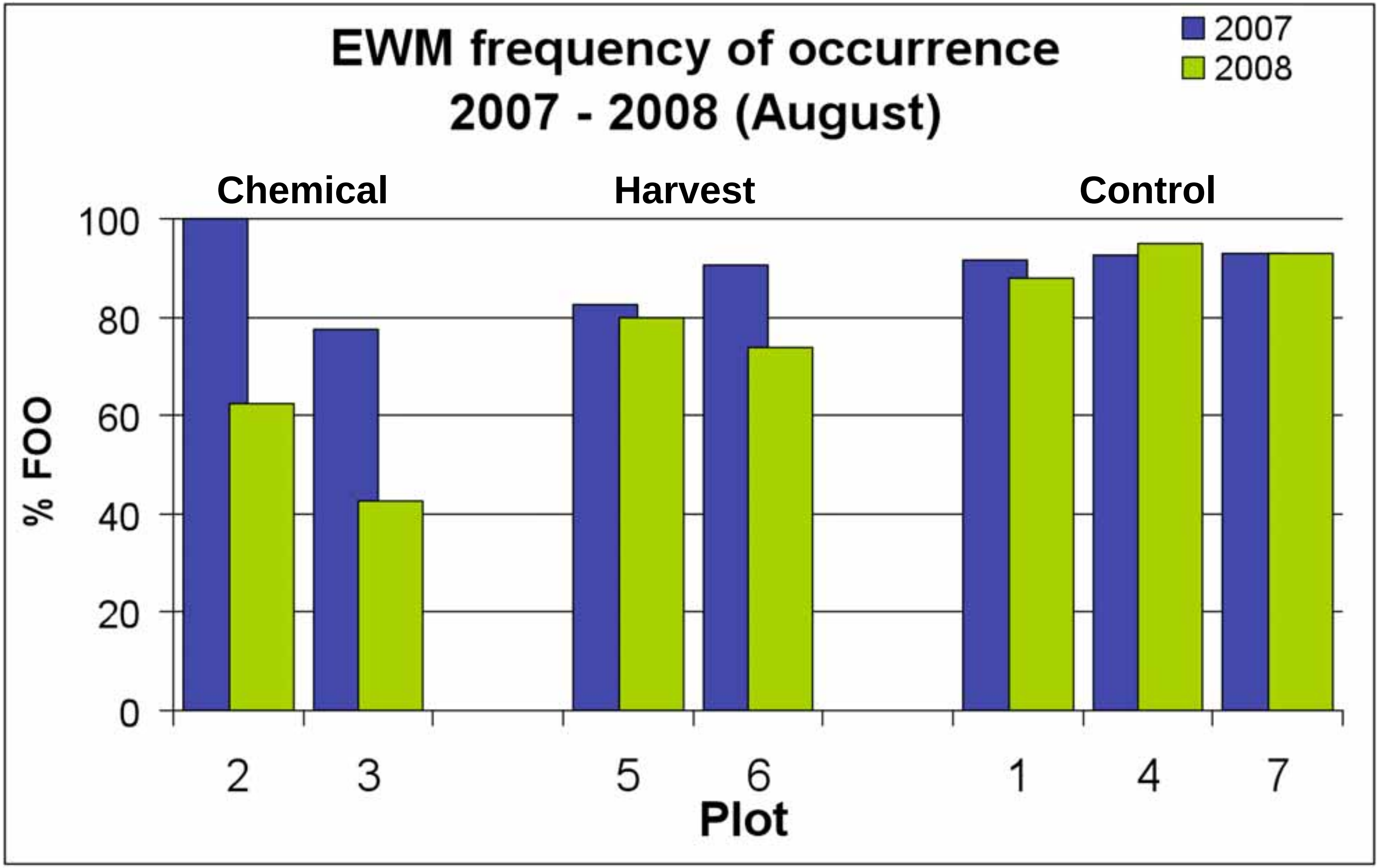
2) What are the effects of early season 2,4-D, early season harvesting, and no-management on native plants?

Approach: Monitor annual changes in plant communities in experimental plots (herbicide, harvested, control plot replicates = 7 total plots)


Turville Bay
Experimental
plot locations (5 acres)
-3 control plots
-2 harvested plots
-2 herbicide plots
P1
CONTROL
P2
2,4-D
2,4-D
P3
CONTROL
P4
P5
HARVEST
P7
CONTROL
HARVEST
P6
OLIN PARK
25
852
Esther Beac
Pa

Methodology

- 4 survey dates
  - June and August, 2007 – 2008
- ~40 points per plot
  - Rake sampler employed
    - Species ID, fullness rating, depth, substrate
- Biomass collection at each point
- Statistical Analysis
  - ANOVA to assess treatment effect
  - Chi-square to assess changes in frequency of occurrence by plot



*** SIGNIFICANT TREATMENT EFFECT 2007 – 2008 (ANOVA, $p = 0.005$)

EWM Treatment Demo Project

- Significant treatment effect
  - EWM frequency of occurrence
- Non-significant treatment effect
  - Total Biomass
  - Native Biomass
  - Exotic Biomass
  - Coontail frequency of occurrence

Eurasian Watermilfoil

- Looking forward:
  - Continue annual monitoring
    - Sandbar/Tomahawk
    - Turville Bay
    - Long-term statewide management project

What can science do for you?

- Save money!

  -Don’t want to spend unwisely without knowing the facts

  -Want to be able to invest wisely
- Set reasonable expectations

  -Data provides objective information to base decisions on

  -Helps to weigh the benefits of management with the potential risks

Fluridone Overview

- Marketed as Sonar® and Avast!®
- Systemic herbicide
- Kills plants in 60-90 days (6 ppb)
- Whole-lakes or coves,
  partial treatments possible
- Semi-selective control of Eurasian Watermilfoil and Hydrilla

Q: So what's the big deal with fluridone?

A: Spatial scale!

Whole lake treatment = Whole ecosystem manipulation

Why do we care?

Plants = nutrient uptake, erosion control, fish habitat

Too much algae = poor water clarity, aesthetics (odors), health, affect fish

Fish = important component of ecosystem, important to WI economy and legacy

Questions

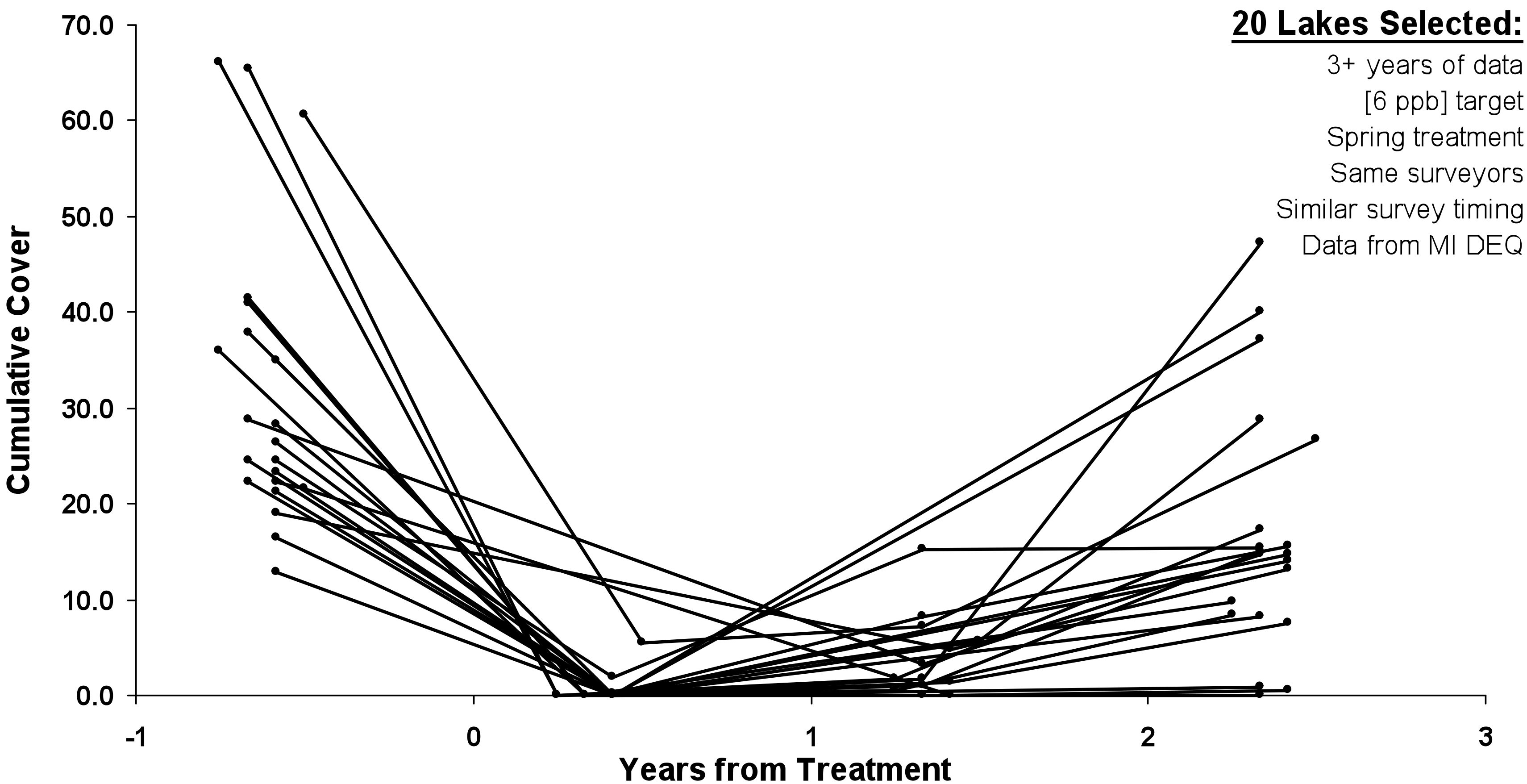
1) What are the primary and secondary ecological effects (both intended and unintended)?

-Vegetation (exotic and native)
-Water quality (algae)
-Fisheries

2) What has been done already to address those questions?

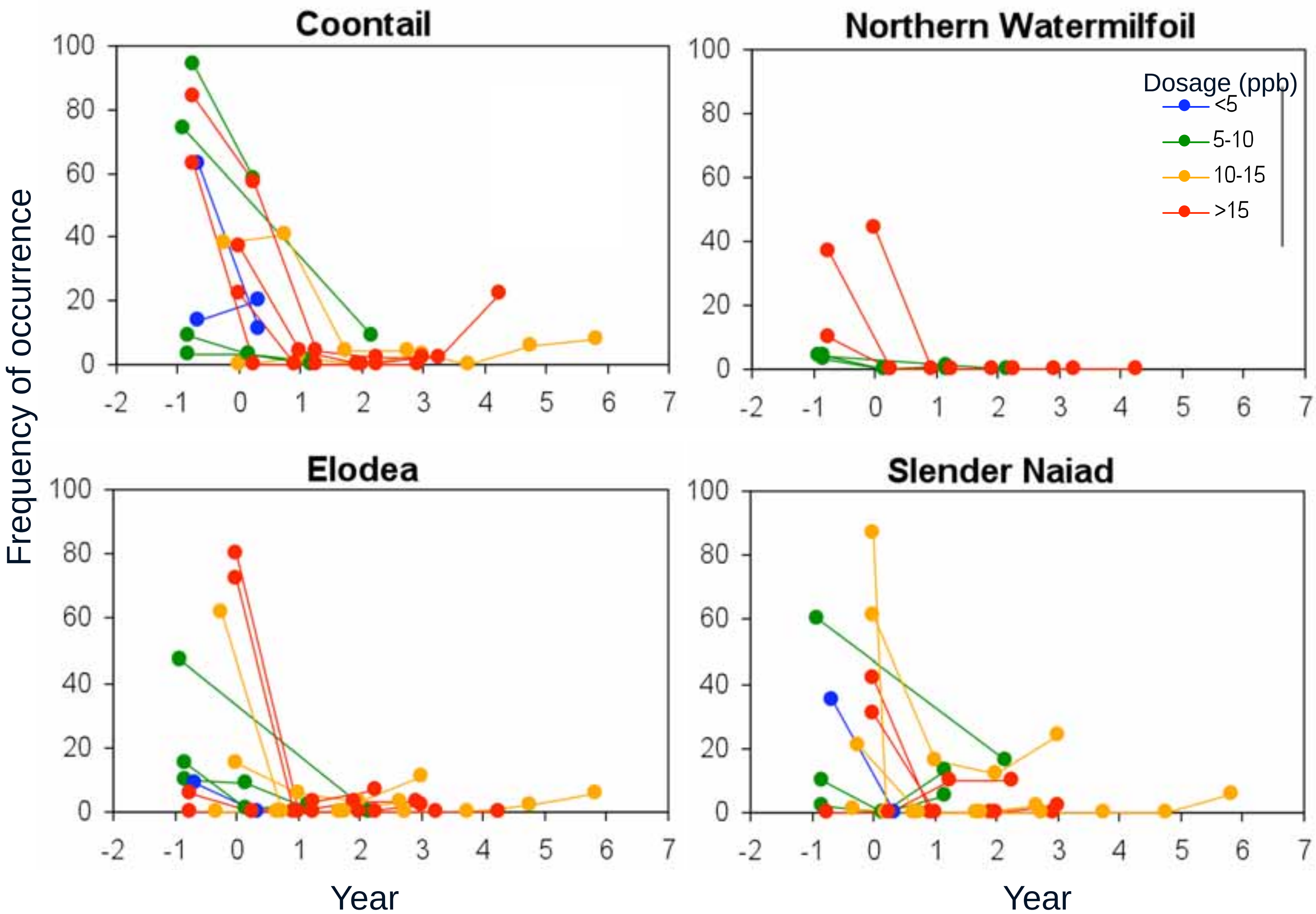
Anecdotal accounts → **Technical review of DATA**
N > 1, generalize effects

Long-term effects on EWM (3+ year data sets):



*Cumulative cover – indicates coverage and density of plants in lake

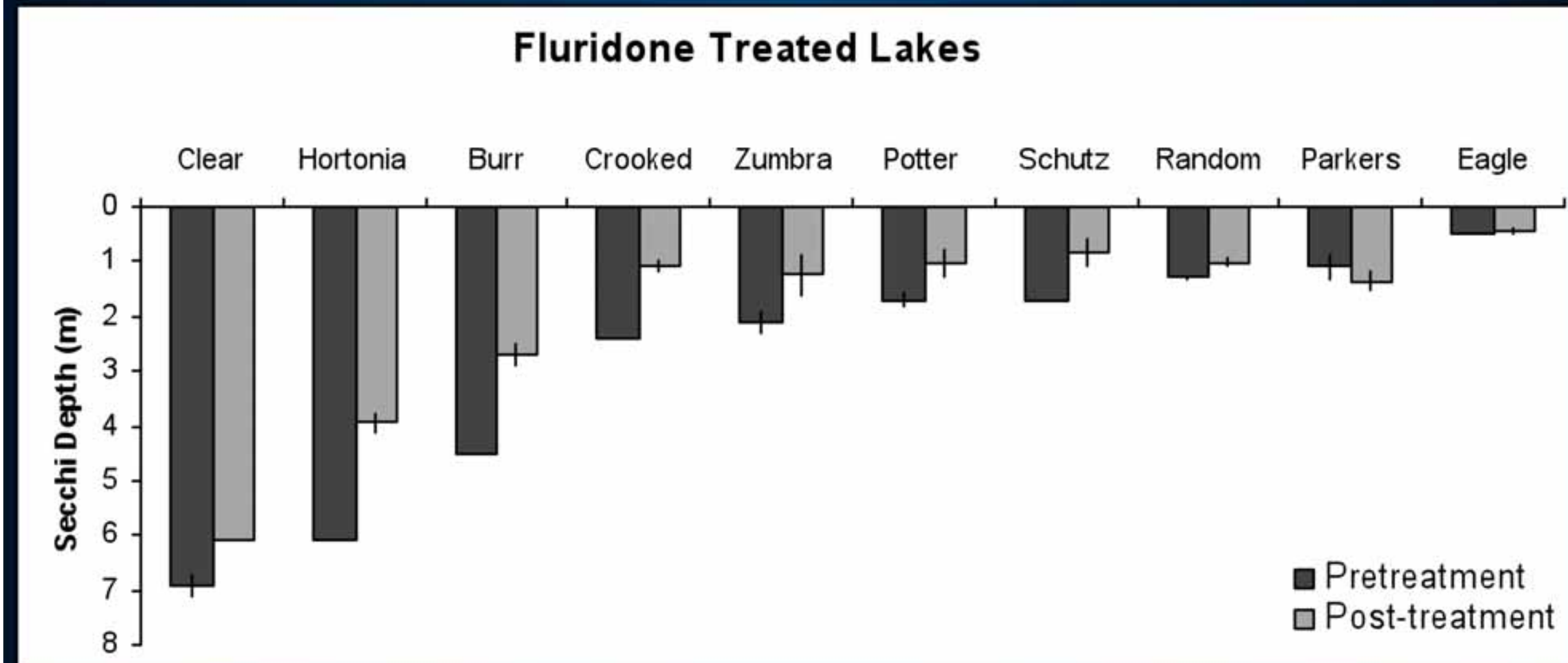
Long-term effects on susceptible native plants:



-Potential large decreases, regardless of dosage

Effects on Algae / Water Clarity

-Since they compete for nutrients, trade-off between plants and algae
-Plant decay also provides nutrients for algal growth



Reductions in secchi depth in 80% of treated lakes (*P* = 0.003) due to increased algae (late summer samples, 1 yr pretreatment vs averaged year of treatment and 1 year post)


Potter Lake 9/30/05

Overall effects on algae/water clarity:

Depends on the lake:

- Biomass of susceptible vegetation
- External and internal nutrient loads
- Morphology and bathymetry of lake (% of lake area that is vegetated)

Shallow, eutrophic lake with high biomass of EWM, coontail, and elodea throughout

VS

Deep, oligotrophic lake with some EWM, and high biomass of tolerant natives

Summary

Deciding whether a whole-lake treatment is appropriate:

1) *Quantify the perceived problem! Data, data, data…*

2) *Set reasonable expectations (ecological and economical)*

-Whole lake treatments generally do not eradicate EWM repeat treatments would probably be requested

-Usually provide 2 seasons of nuisance relief, need to manage in interim

-Can incur unintended ecological effects – need to evaluate data **lake by lake** (physical features, plants, algae/water clarity, fisheries)

3) *Weigh the benefit with the risks*

4) *Recognize that managing invasives is a long-term commitment with any tool (action based on data)*