



*Hypothesized Changes in Littoral Habitat with
Continued Water Level Decline in a Central
Wisconsin Seepage Lake*

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Onterra LLC
Lake Management Planning

Presentation Outline

- **Drivers of lake level fluctuations in Wisconsin's seepage lakes**
 - Central Sands Region
- **How do lake level fluctuations affect lake ecology?**
- **Pleasant Lake Study**
 - What we wanted to learn
 - Study Methods
 - Study Results

Lake Level Fluctuations in Seepage Lakes

- **What is a seepage lake?**
 - No tributary inlet or outlet (landlocked)
 - Relatively small drainage basin; lower nutrients
 - Occur when groundwater table meets land depression
 - Water levels are strongly tied to groundwater table

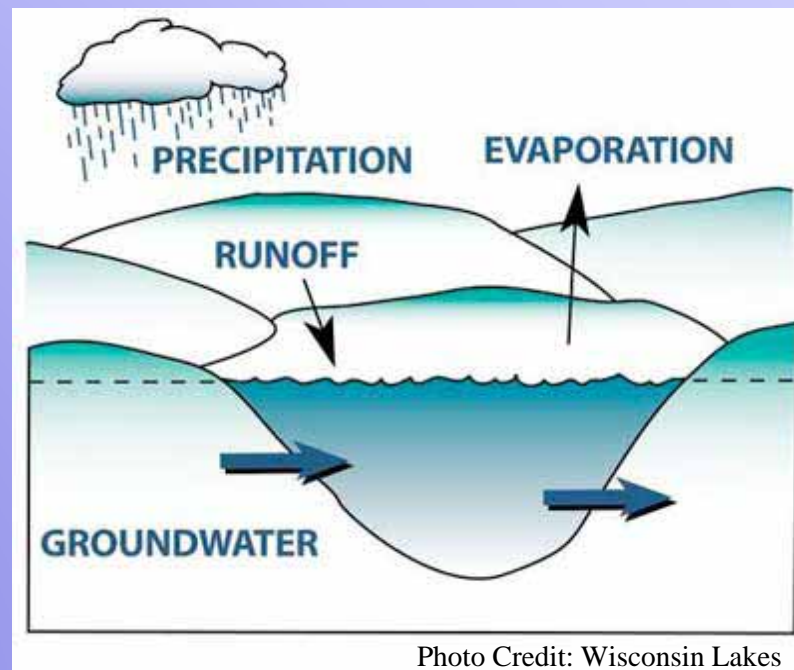


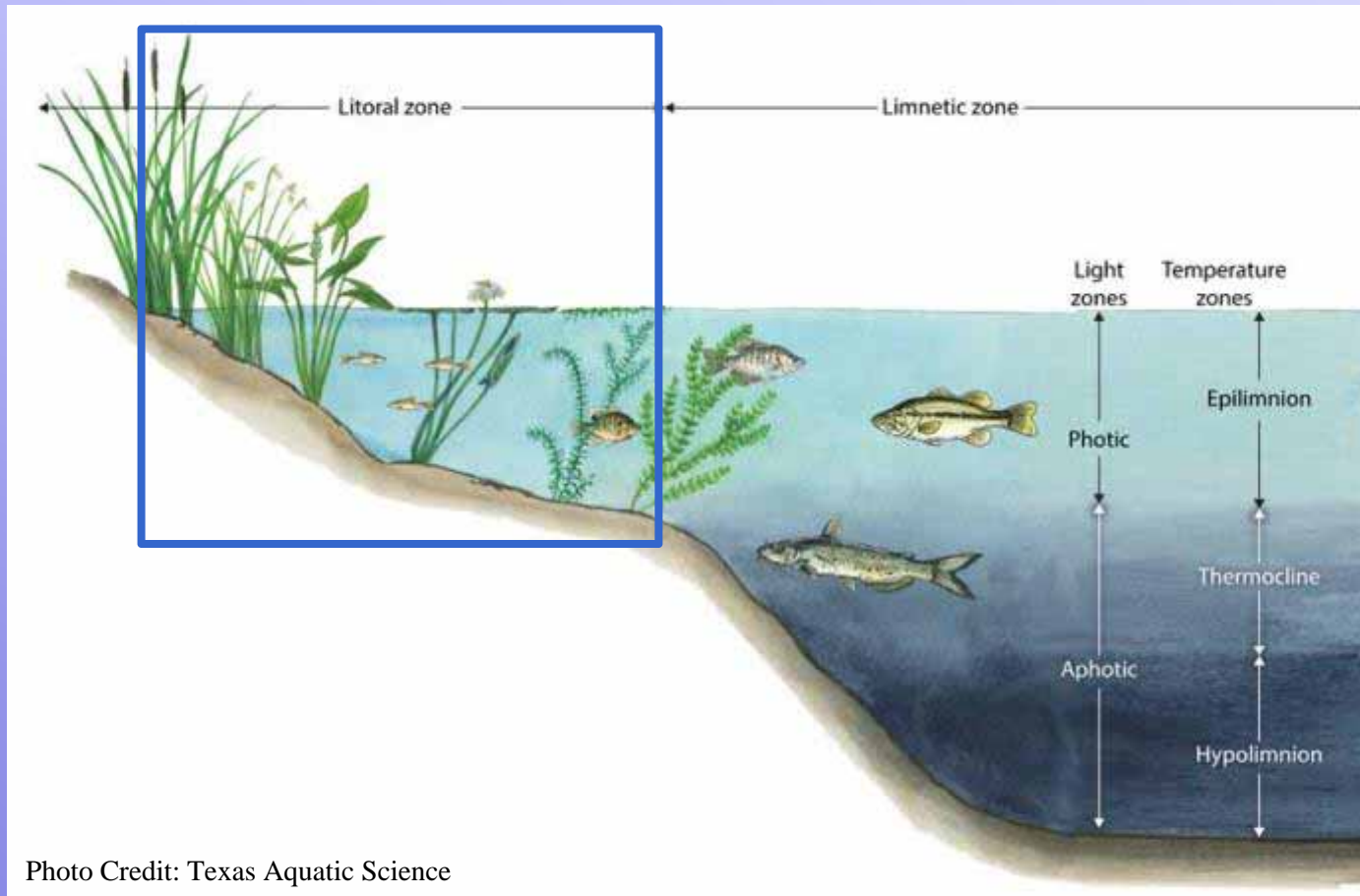
Photo Credit: Wisconsin Lakes

Lake Level Fluctuations in Seepage Lakes

- **What drives changes in groundwater table elevations and consequently lake levels?**
 - Difference between groundwater input and output
 - Natural Drivers
 - Local and regional climatic conditions
 - Lake levels fluctuate naturally at varying timescales (seasonal, decadal, etc.)
 - Anthropogenic Drivers
 - Land development (wetland destruction, impervious surfaces)
 - Groundwater removal (pumping)
 - Agriculture, industry, municipal, etc.
 - Global climate change

Lake Level Fluctuations in Seepage Lakes

- What do we know about the effect of water level fluctuations on lakes?

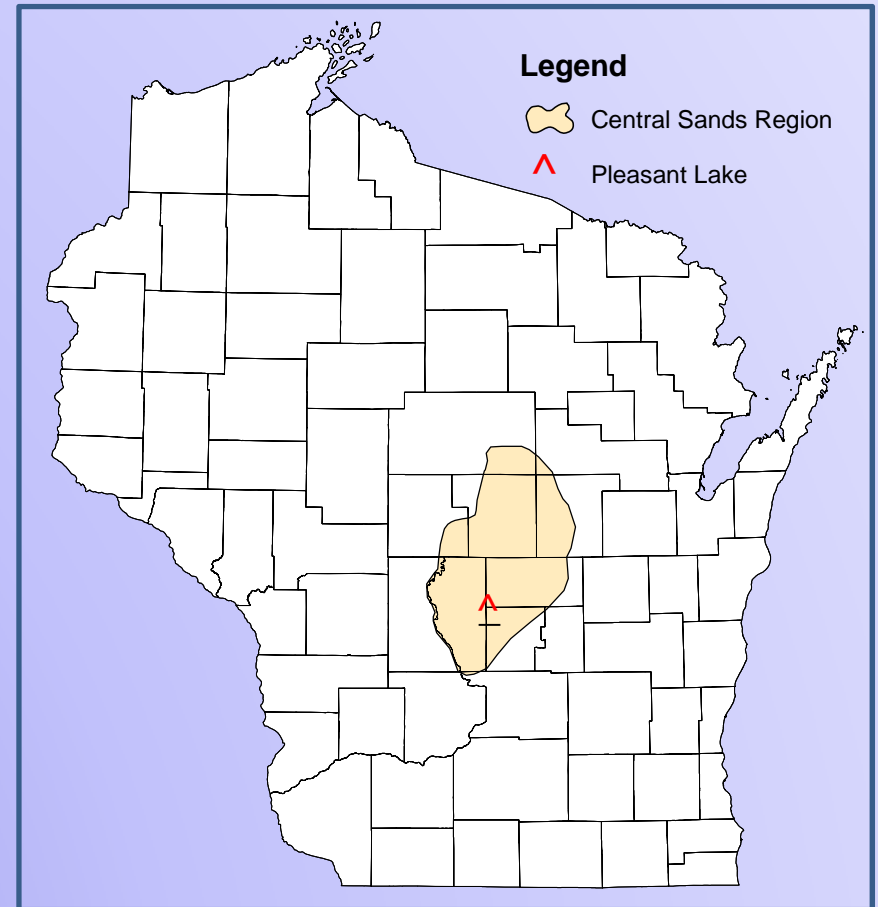


Lake Level Fluctuations in Seepage Lakes

- **What do we know about the effect of water level fluctuations on lakes?**
 - Naturally-driven fluctuations are healthy
 - Maintain species and habitat diversity
 - Many species require water level fluctuations to persist
 - Sediment consolidation
 - Deviations from natural fluctuations can have negative effects
 - Timing/Amplitude
 - Water level stabilization decreases species/habitat diversity
 - Sustained decline can cause littoral/riparian habitat loss
 - However, it's difficult to generalize lake response to water level decline

Central Sands Region

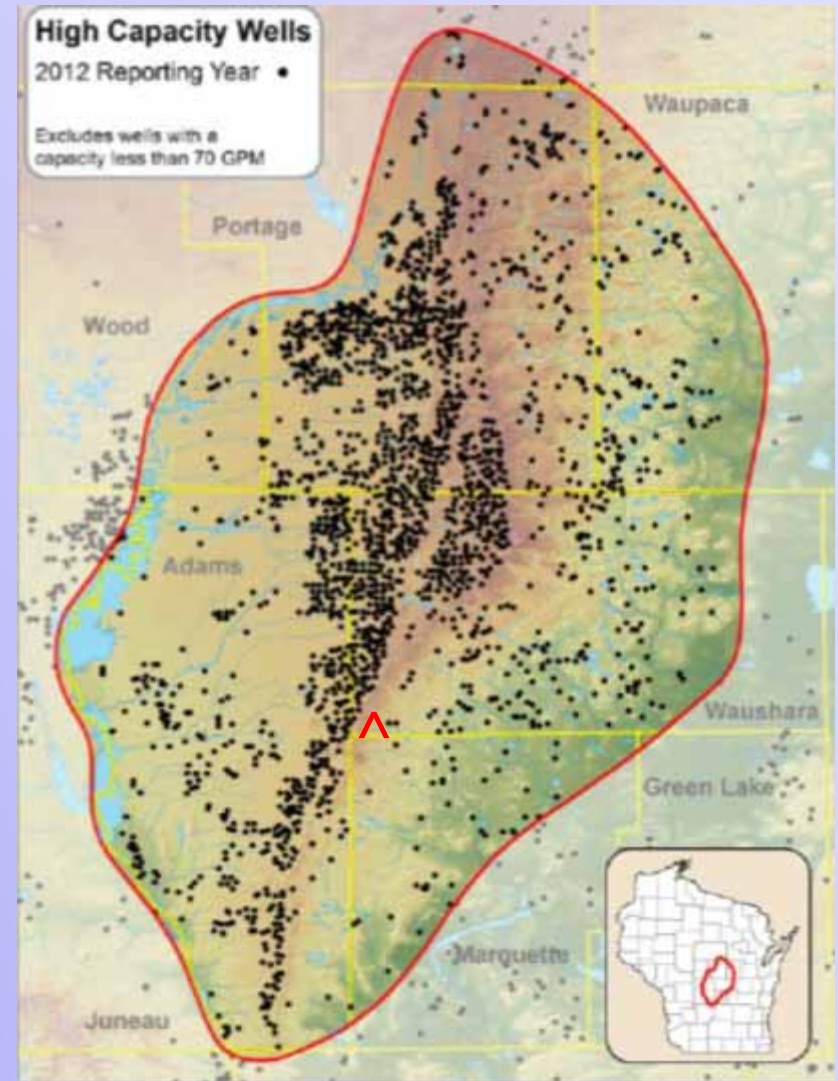
- Thick mantle of coarse, porous glacial material (>100 ft)
- Central Wisconsin Sand and Gravel Aquifer (1.75 million acres)
- >300 Lakes & 800 miles of trout streams
 - Highly dependent on groundwater



Central Sands Region

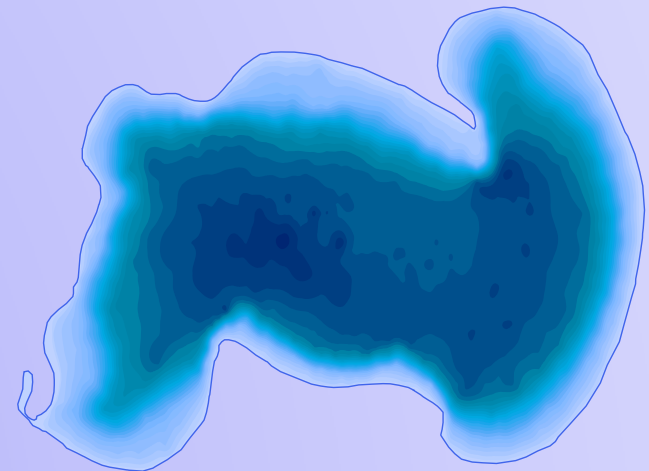
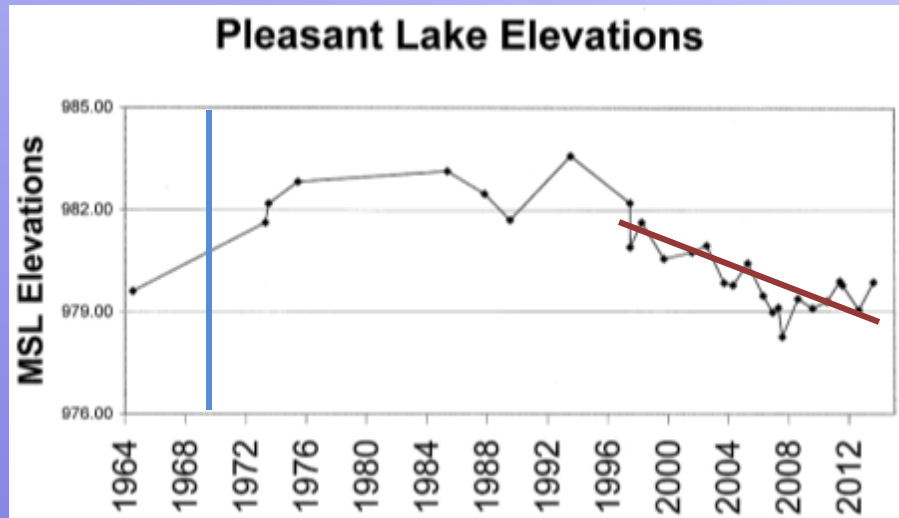
Kraft (et al. 2014)

- Highest Concentration of irrigation High Capacity Wells (HCW) in Wisconsin
- Groundwater & lake levels in irrigated areas have declined beyond what is explainable by climatic conditions



Pleasant Lake

- Deep Seepage Lake
 - ~131 surface acres; Max Z: 26'; Mean Z: 15' (2013)
- Mesotrophic, Hard Water Lake
- Water Levels
 - Measured intermittently since 1964
 - Maximum in 1994; Minimum in 2007 (difference of 5.5 feet)
 - Levels in a general decline since mid-1990s
 - 1.6 feet of decline attributed to pumping in 2013 (Kraft et al. 2014)



Waushara County Zoning and Land Conservation Department

Onterra, LLC

Lake Management Planning

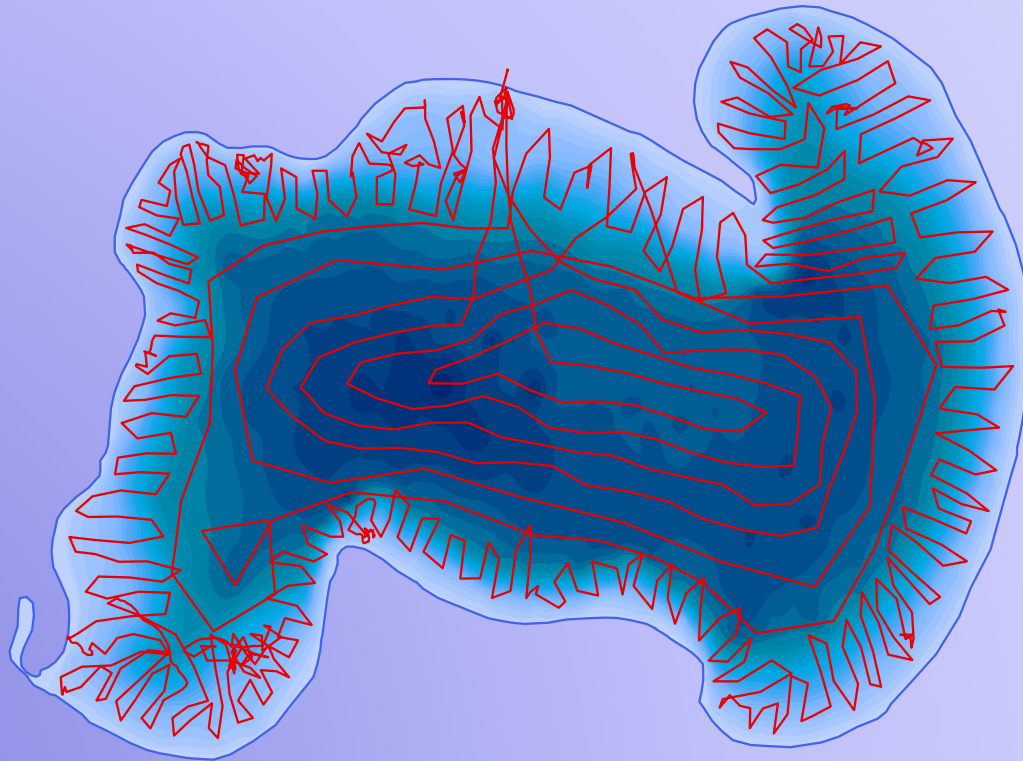
What We Wanted to Learn

- How does littoral area change with continued water level decline?
- How may structural habitat (aquatic plants & CWH) change with continued water level decline?
- What habitats/communities may be degraded? Decline threshold? Critical/sensitive habitats?



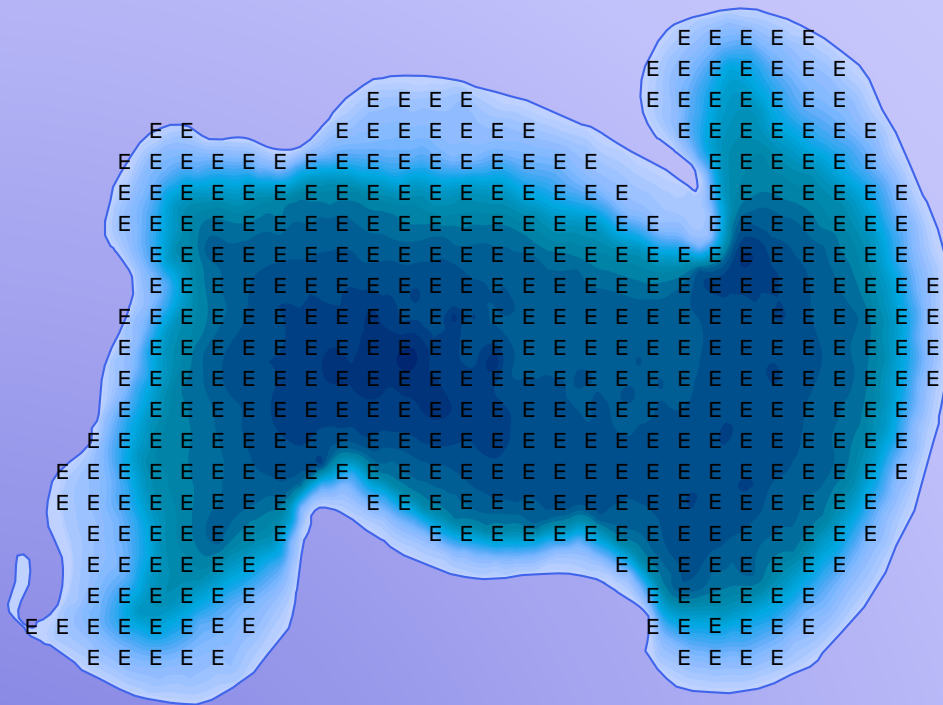
Study Design/Methods

- **Acoustic Survey (2013)**
 - Accurate bathymetry
 - Aquatic Plant Bio-Volume/Height
 - Substrate Hardness



Study Design/Methods

- **Aquatic Plant Point-Intercept Survey (2012 UWSP)**
 - Abundance and locations of specific plant species



Pleasant Lake

34-meter resolution

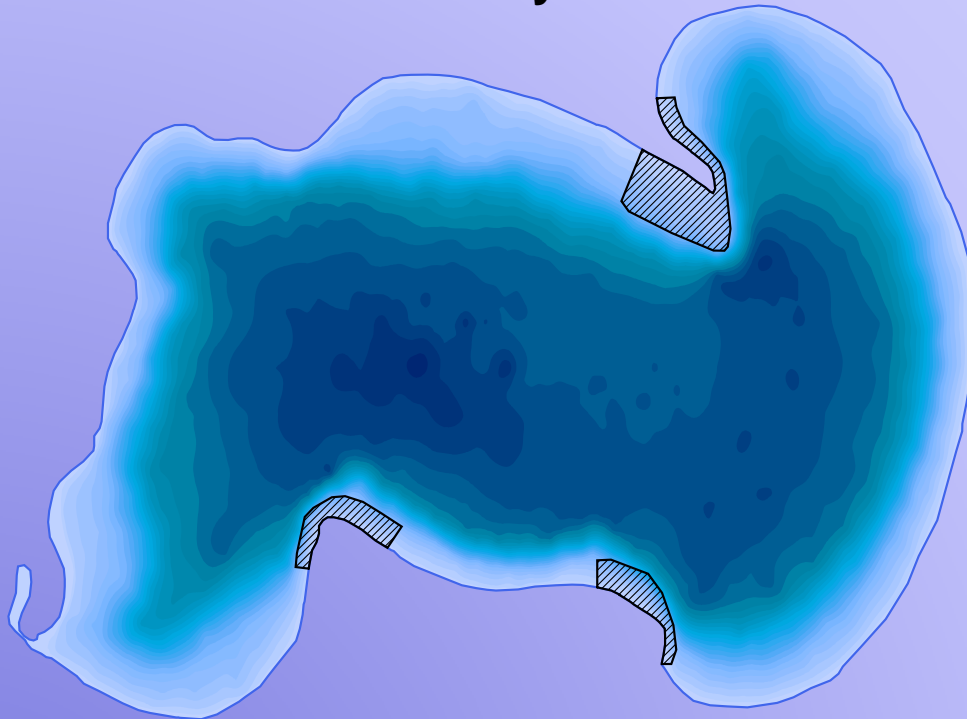
419 total points



Study Design/Methods

- **Freshwater Mussel (*Unionidae*) Survey (2013)**
 - Snorkel Transects

Mussel Survey Areas



Study Design/Methods

- **Coarse Woody Habitat Survey**
 - Classified Based on Size
 - 2-8 Inches in Diameter
 - >8 Inches in Diameter
 - Classified Based on Branching Complexity
 - No Branches
 - Minimal Branches
 - Moderate Branches
 - Full Canopy

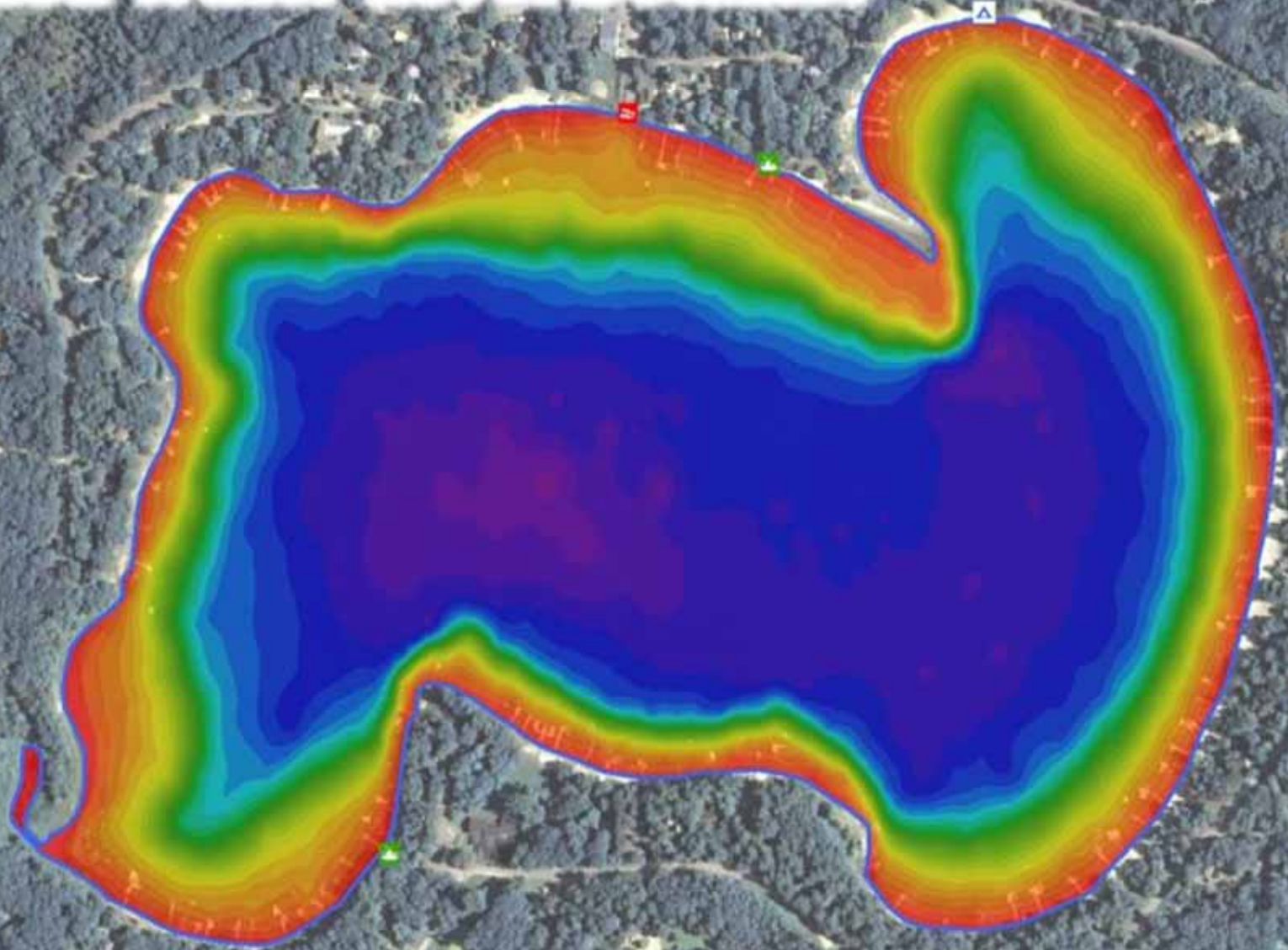


An underwater photograph showing a dense, vibrant green algal bloom. The water is slightly turbid, and the light is diffused, creating a soft, ethereal atmosphere. The algae appear as numerous thin, needle-like or hair-like structures extending upwards from the bottom. The word "Results" is superimposed in the center of the image in a bold, italicized, black font with a white outline.

Results



How Does Littoral Area Change with Continued Water Level Decline?

2013 Contour (feet)

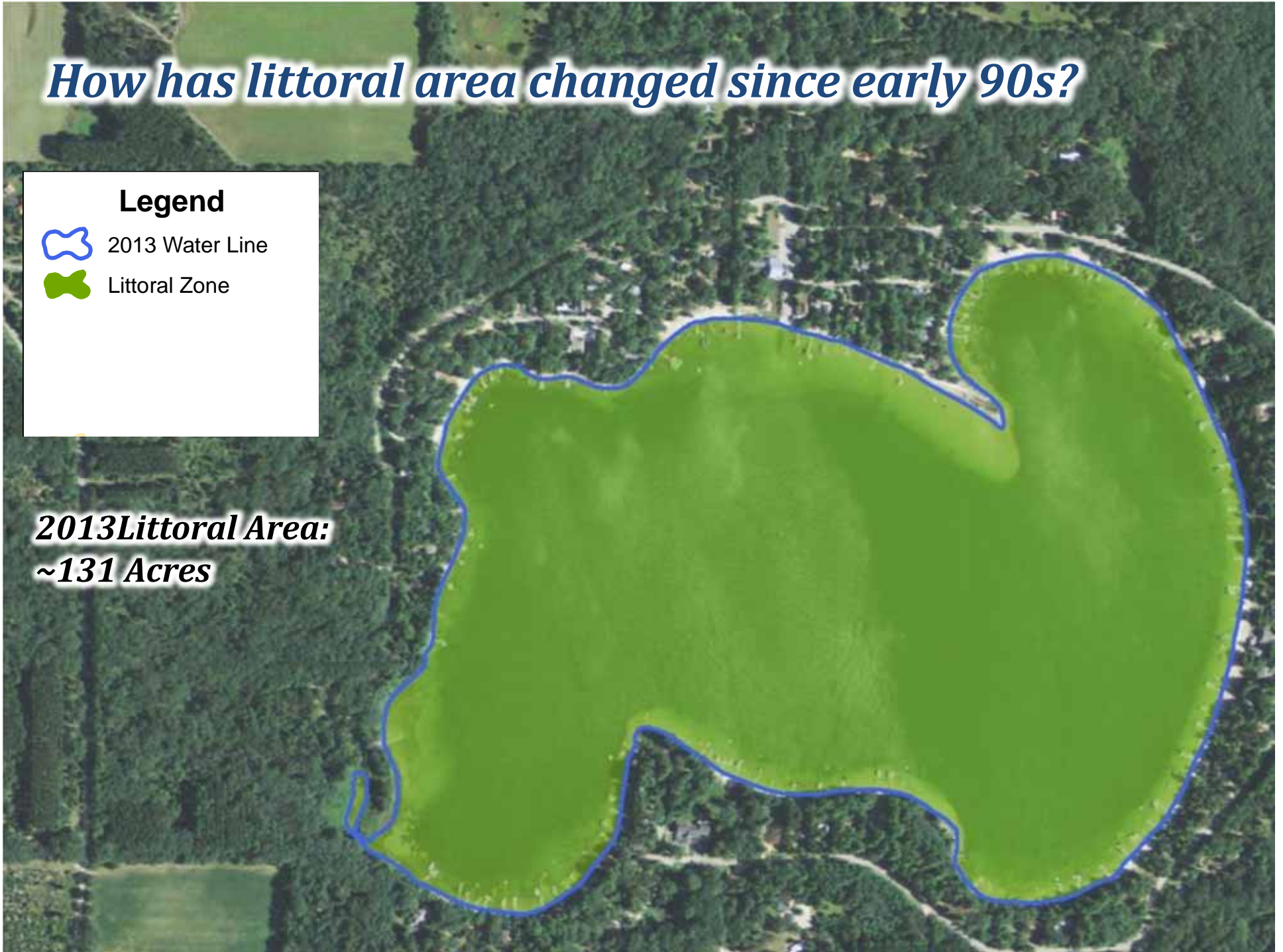


How has littoral area changed since early 90s?

Legend




-  2013 Water Line
-  Littoral Zone

***2013 Littoral Area:
~131 Acres***



How has littoral area changed since early 90s?

Legend

-  2013 Water Line
-  Littoral Zone
-  1993 Water Line

***2013 Littoral Area:
~131 Acres***




***1993 Estimated
Littoral Area: 140 Acres***

Reduction of 9 Acres



How will littoral area change with continued water level reduction?

Legend

-  2013 Water Line
-  Littoral Zone
-  1993 Water Line

*Littoral Area
2013: 131 Acres*



How will littoral area change with continued water level reduction?

*1' Below 2013 Water Line
(5.4 feet Below 1993 Water Line)*

Legend

-  2013 Water Line
-  Littoral Zone
-  1993 Water Line
-  Scenario Water Line
-  Exposed Lakebed






2013 LA: 131 Acres
1' Decline: 127 (4 net loss)



How will littoral area change with continued water level reduction?

**2' Below 2013 Water Line
(6.4 feet Below 1993 Water Line)**

Legend

-  2013 Water Line
-  Littoral Zone
-  1993 Water Line
-  Scenario Water Line
-  Exposed Lakebed

2013 LA: 131Acres

1' Decline: 127 (4 net loss)






2' Decline: 123 (8 net loss)



How will littoral area change with continued water level reduction?

*3' Below 2013 Water Line
(7.4 feet Below 1993 Water Line)*

Legend

-  2013 Water Line
-  Littoral Zone
-  1993 Water Line
-  Scenario Water Line
-  Exposed Lakebed

2013 LA: 131 Acres

1' Decline: 127 (4 net loss)

2' Decline: 123 (8 net loss)






3' Decline: 117 (14 net loss)



How will littoral area change with continued water level reduction?

***4' Below 2013 Water Line
(8.4 feet Below 1993 Water Line)***

Legend

-  2013 Water Line
-  Littoral Zone
-  1993 Water Line
-  Scenario Water Line
-  Exposed Lakebed

2013 LA: 131 Acres

1' Decline: 127 (4 net loss)

2' Decline: 123 (8 net loss)

3' Decline: 117 (14 net loss)






4' Decline: 112 (19 net loss)



How will littoral area change with continued water level reduction?

*5' Below 2013 Water Line
(9.4 feet Below 1993 Water Line)*

Legend

-  2013 Water Line
-  Littoral Zone
-  1993 Water Line
-  Scenario Water Line
-  Exposed Lakebed

2013 LA: 131 Acres

1' Decline: 127 (4 net loss)

2' Decline: 123 (8 net loss)

3' Decline: 117 (14 net loss)

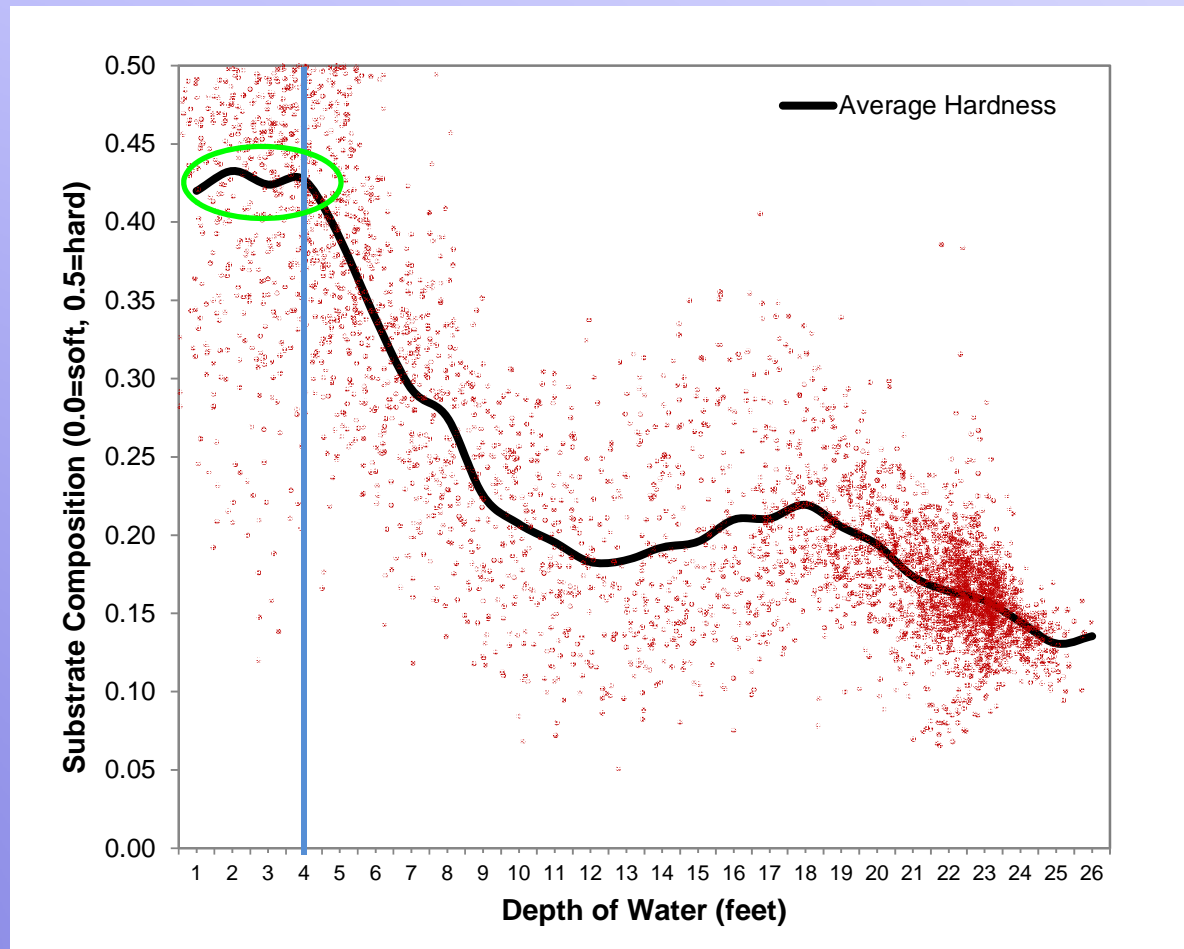
4' Decline: 112 (19 net loss)

5' Decline: 106 (25 net loss)



Substrate Hardness

- Majority of hard substrates (sand/rock) located ≤ 4 feet of water
- Continued water level decline may reduce this habitat type



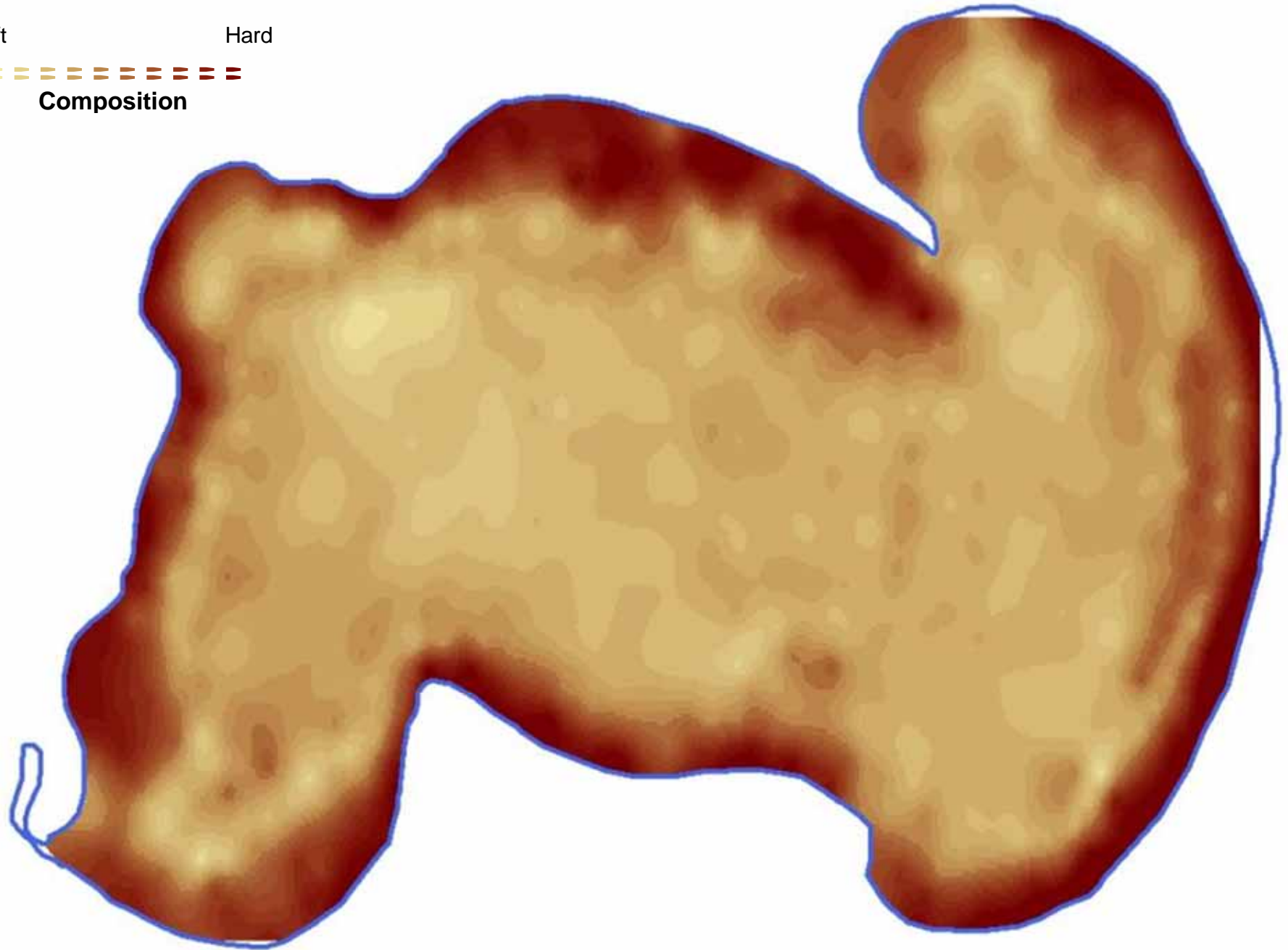
2013 Substrate Hardness

Soft

Hard



Composition



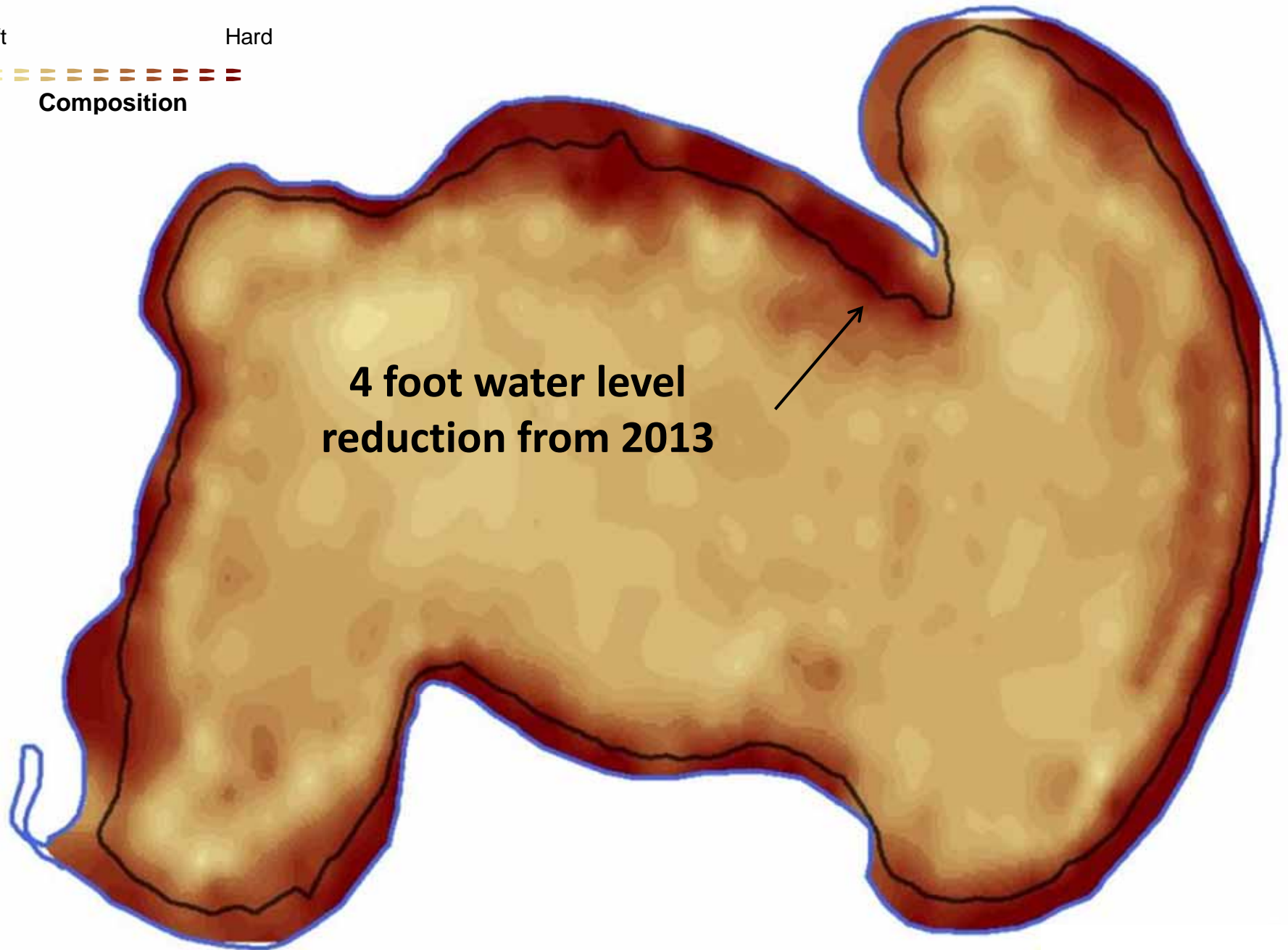
2013 Substrate Hardness

Soft

Hard

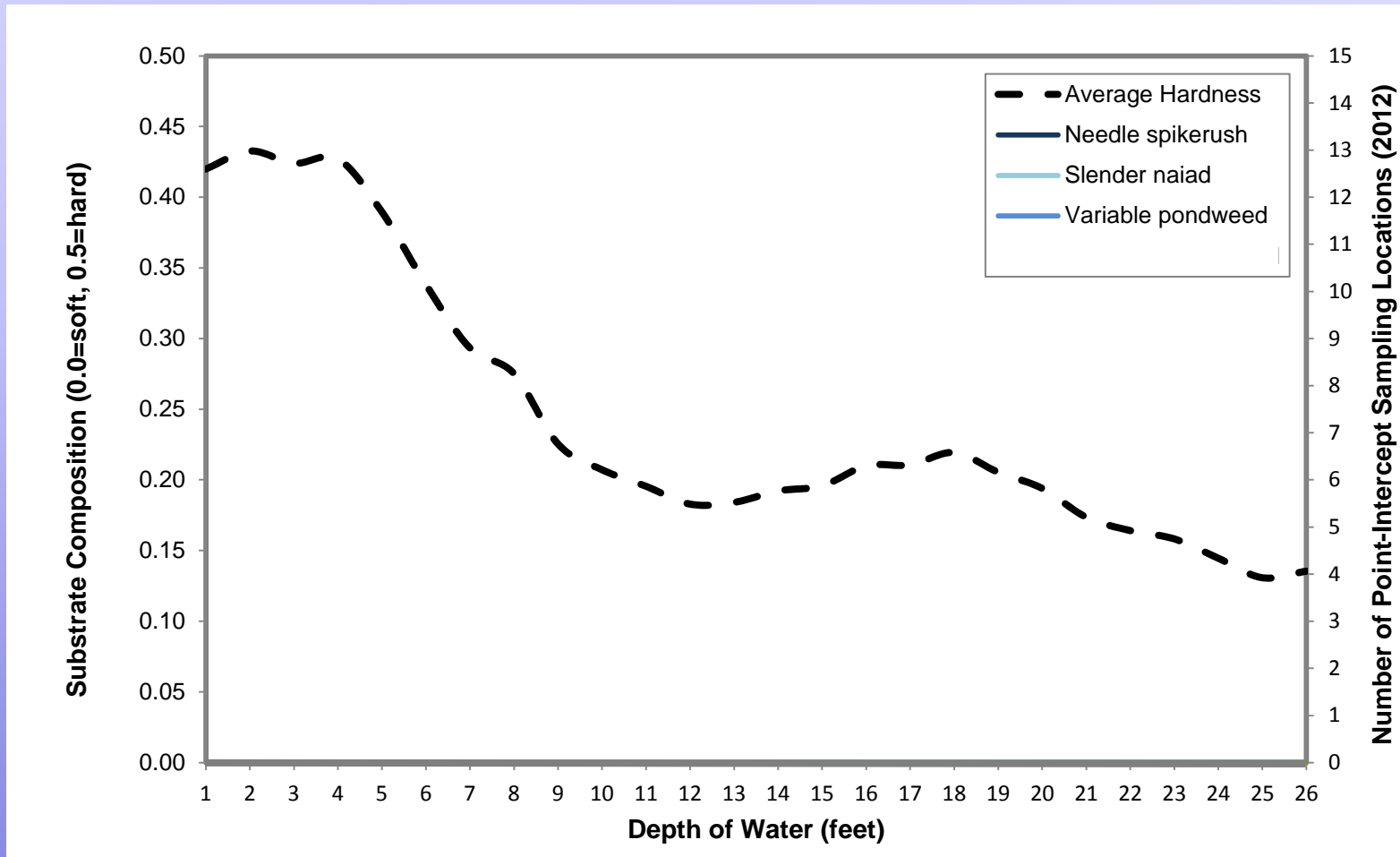


Composition

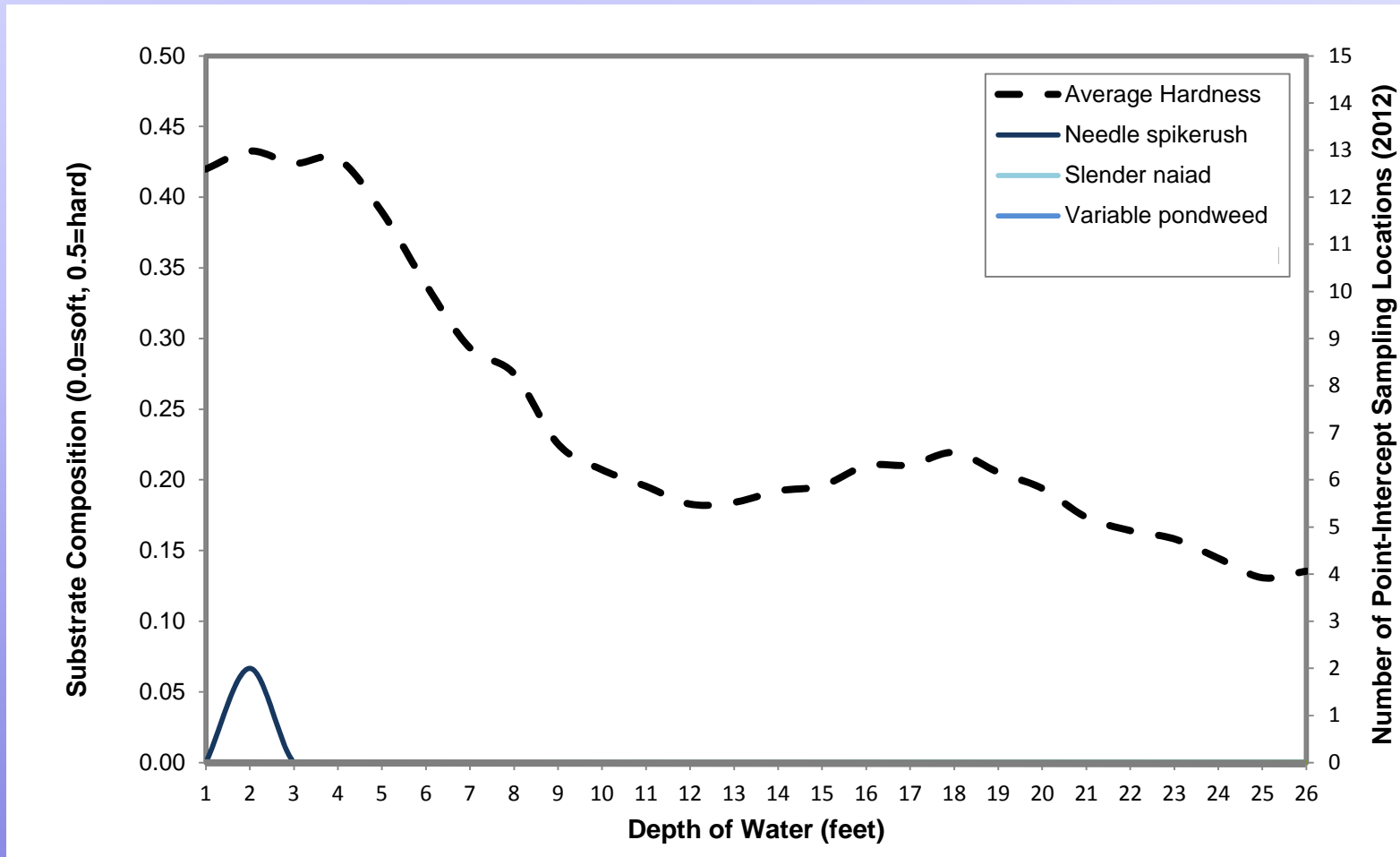


**4 foot water level
reduction from 2013**

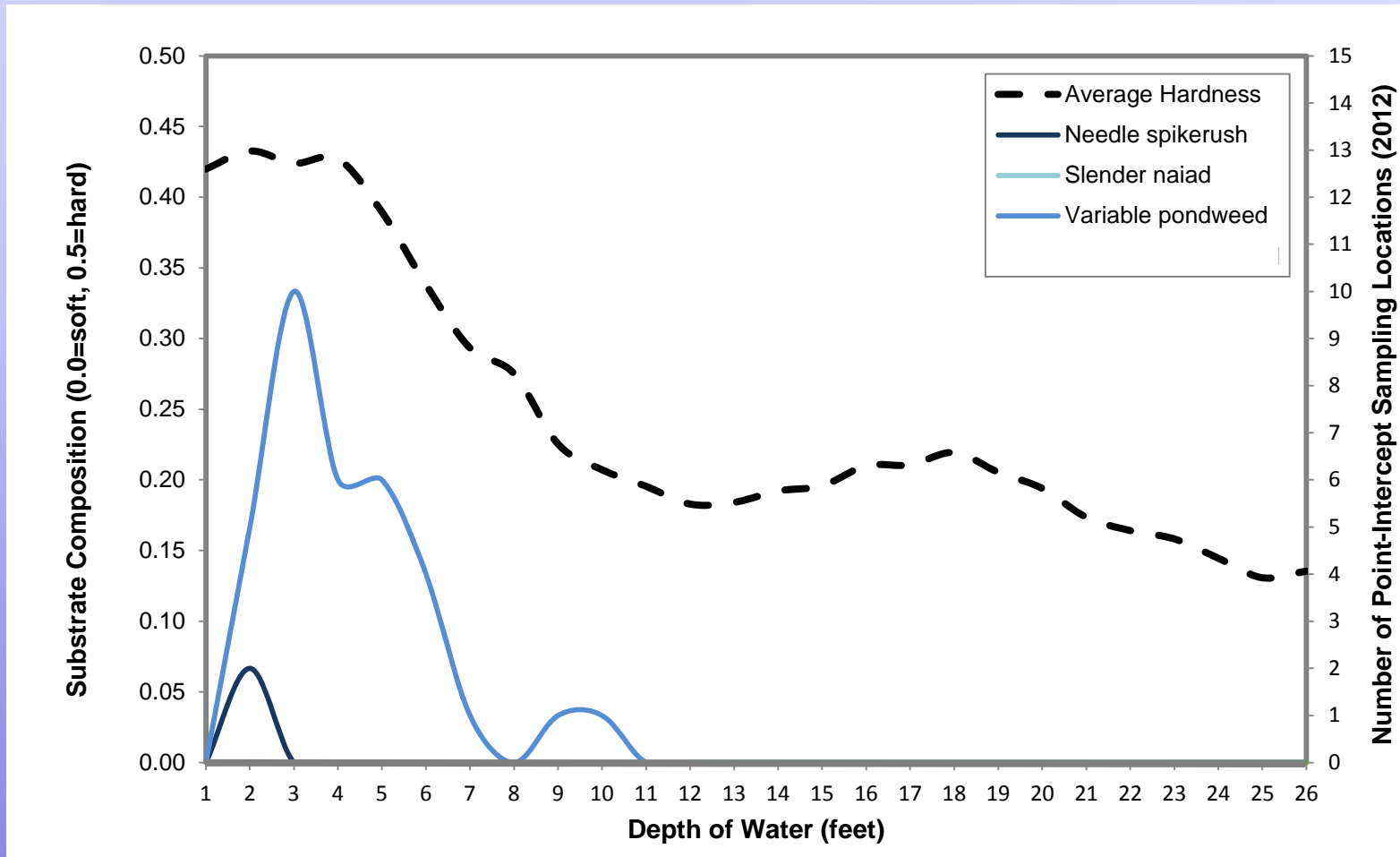
Response of Individual Submersed Plant Species



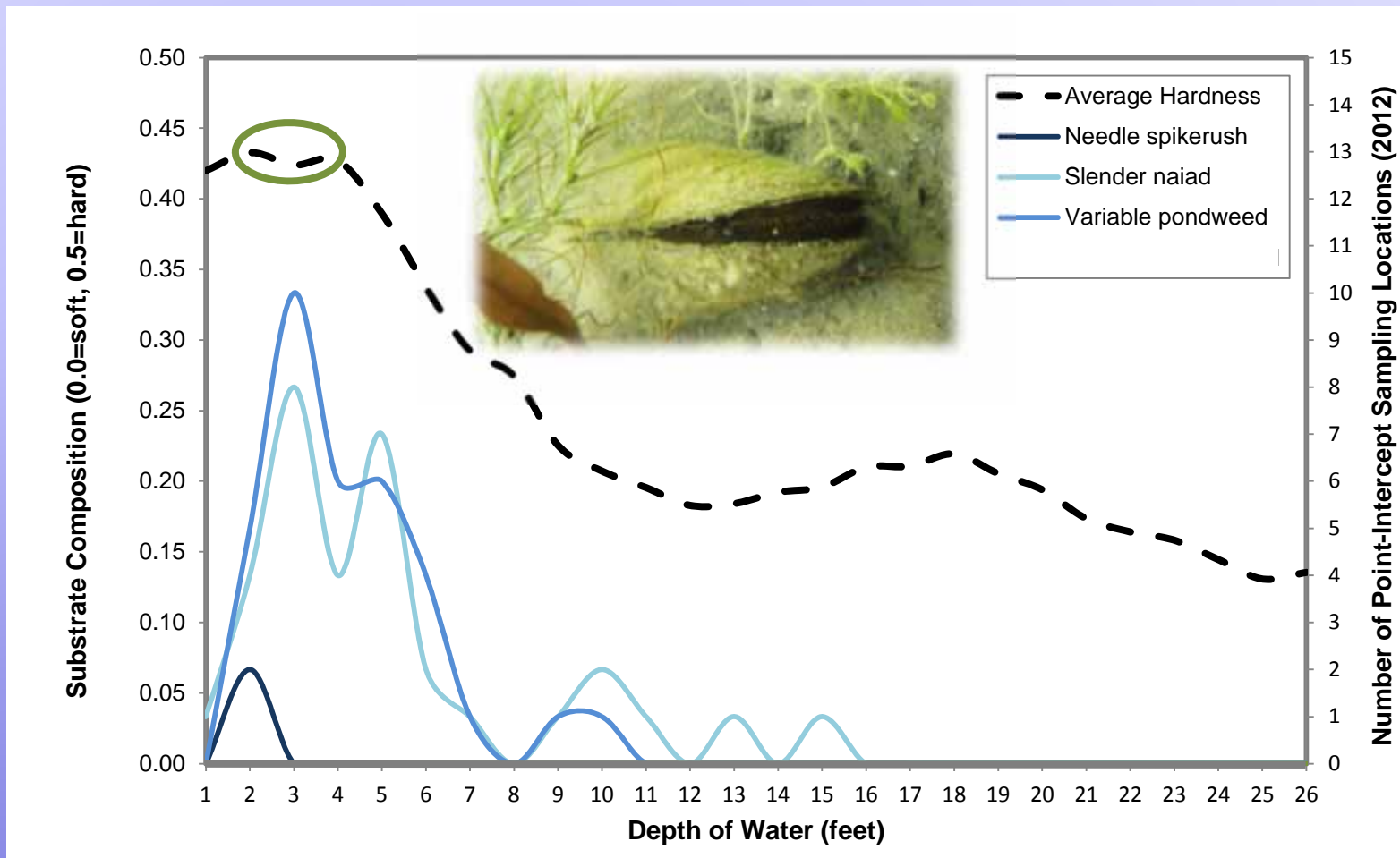
Response of Individual Submersed Plant Species



Response of Individual Submersed Plant Species



Response of Individual Submersed Plant Species



2013 Freshwater Mussel Locations



Giant Floater
(*Pyganodon grandis*)

Legend



Mussel Snorkel Survey Transect Area



Live *Pyganodon grandis*



Non-Live *Pyganodon grandis*

2013 Freshwater Mussel Locations

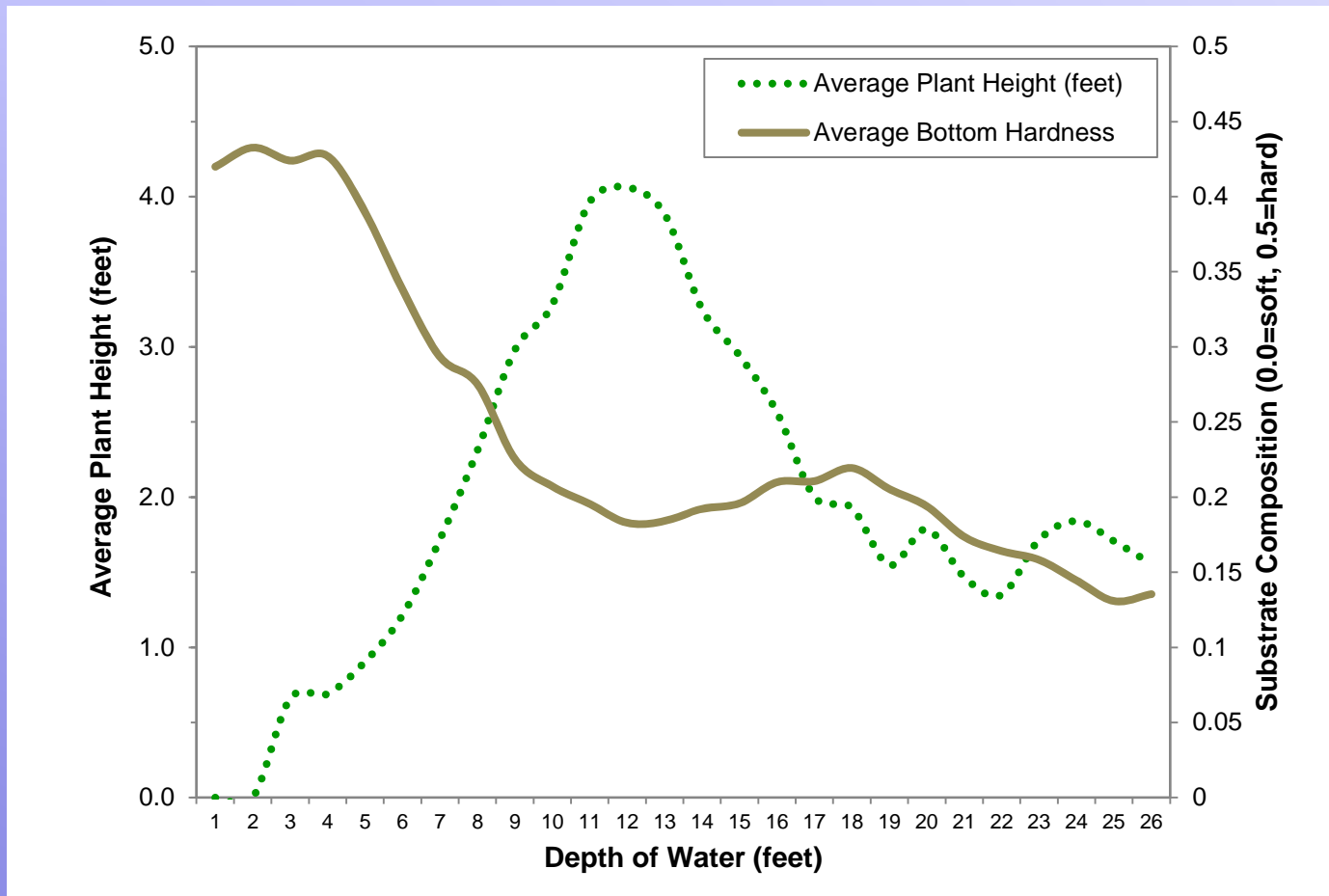
3' Decline from 2013

Legend

- (Live *Pyganodon grandis*
- (Non-Live *Pyganodon grandis*

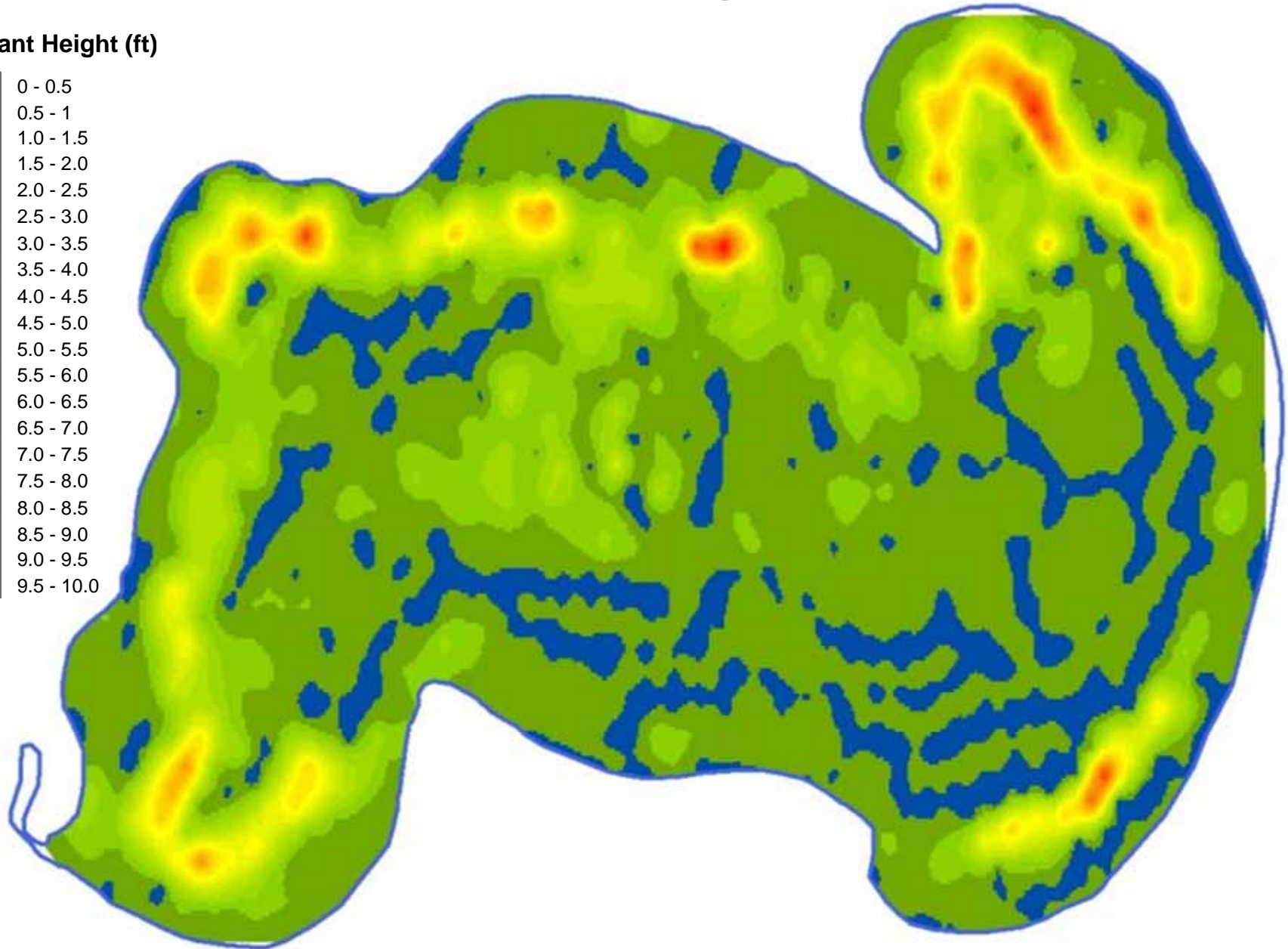
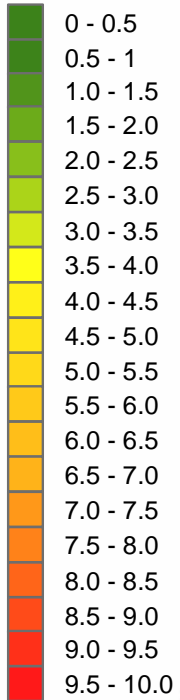


Average Plant Height & Substrate Hardness



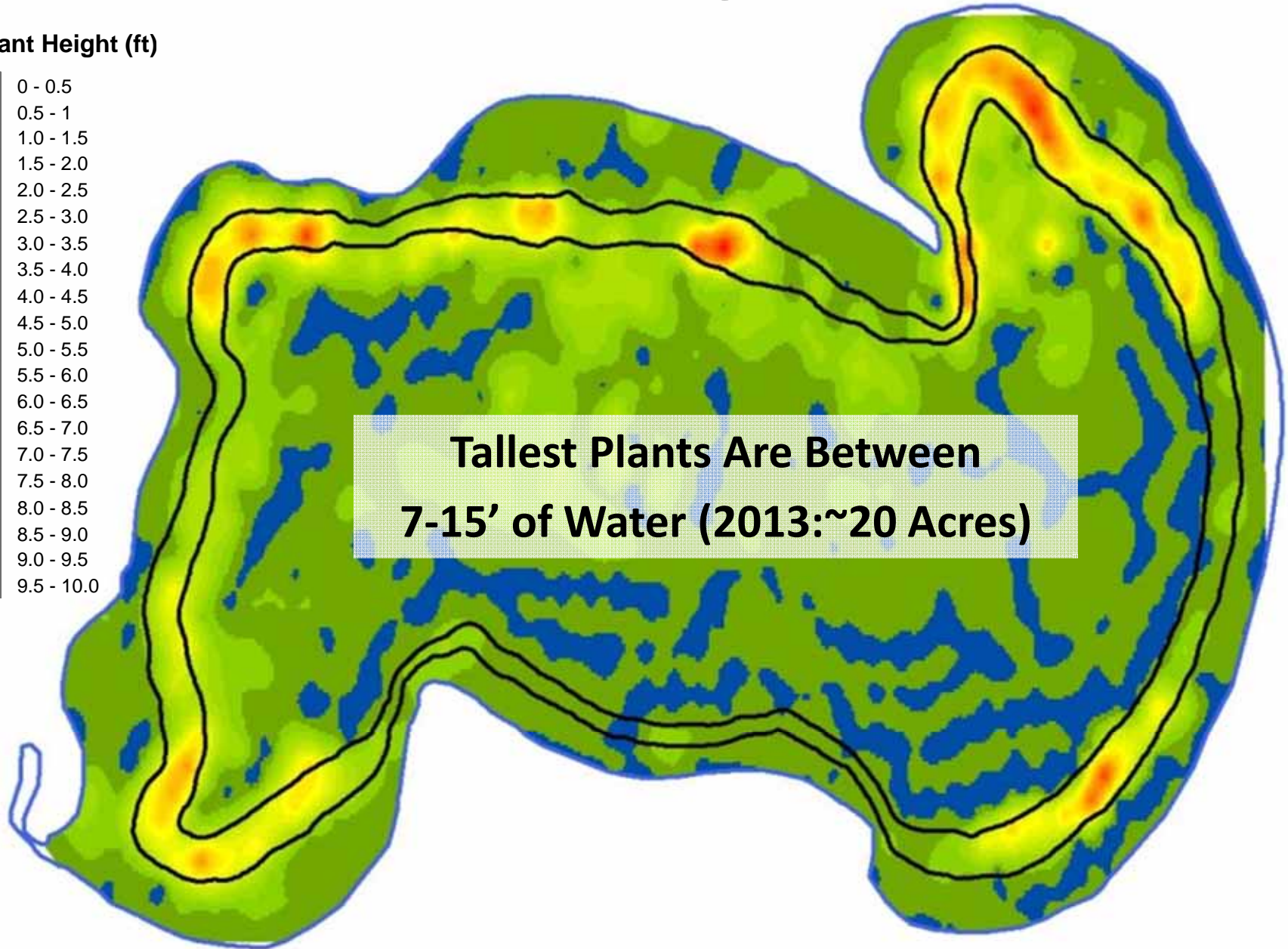
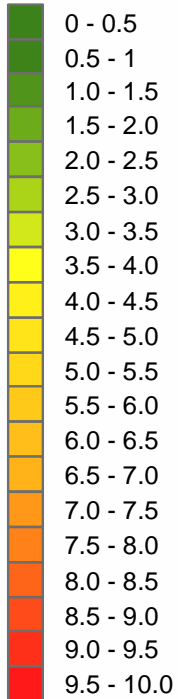
2013 Aquatic Plant Ave. Height

Ave. Plant Height (ft)



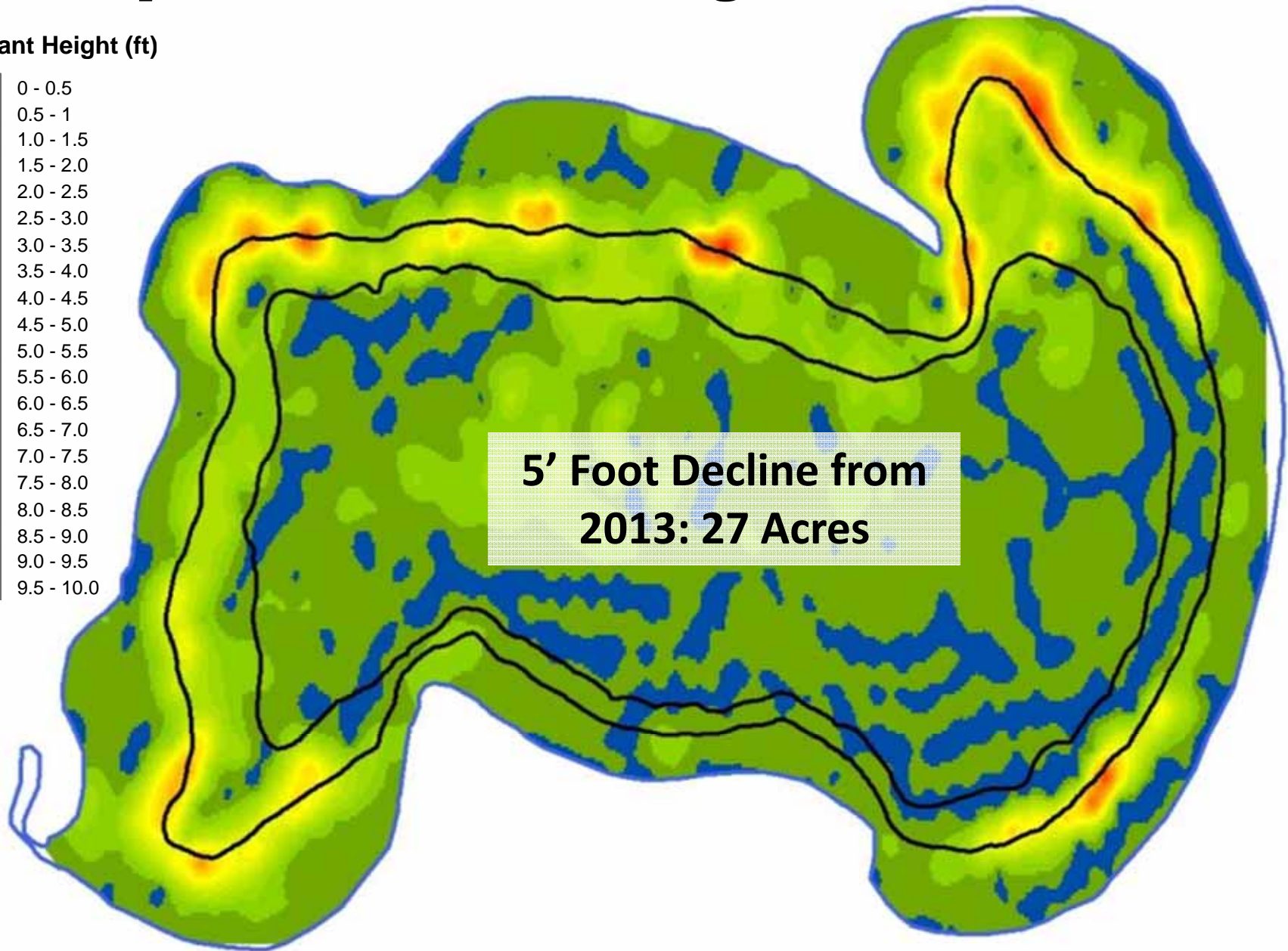
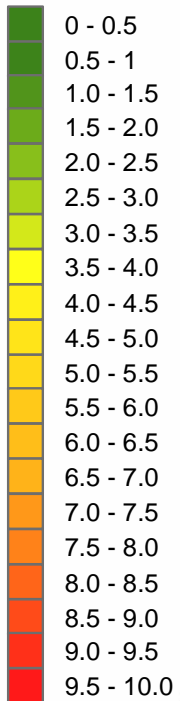
2013 Aquatic Plant Ave. Height

Ave. Plant Height (ft)



2013 Aquatic Plant Ave. Height




Ave. Plant Height (ft)

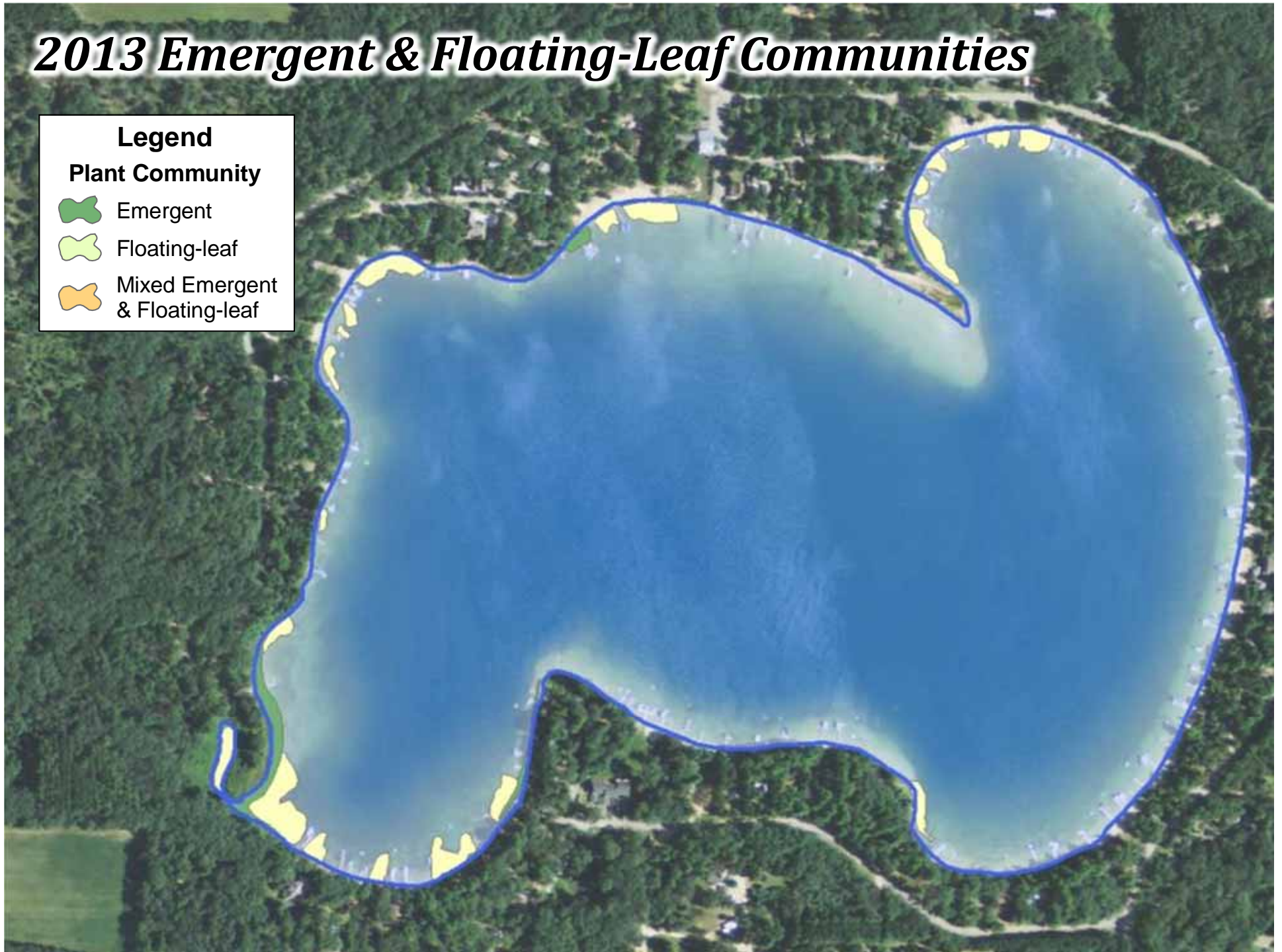


2013 Emergent & Floating-Leaf Communities

Legend

Plant Community




-  Emergent
-  Floating-leaf
-  Mixed Emergent & Floating-leaf



2013 Emergent & Floating-Leaf Communities

Legend

Plant Community

-  Emergent
-  Floating-leaf
-  Mixed Emergent & Floating-leaf



Critical/Sensitive Habitat Areas

Turtle Bay Wetland



Ecological Studies Documented:

- Diverse amphibian & reptile populations (2 special concern)
- Diverse plant community
- Only location of common bladderwort within the lake

Critical/Sensitive Habitat Areas

Turtle Bay Wetland



6 Anuran Species

- 2 Special Concern (American bullfrog & Northern Leopard Frog)

2 Reptile Species

- Snapping & Western Painted Turtles

Effects on Fisheries

- David Bartz (WDNR Fisheries Biologist)
 - Uncertain how fisheries will respond with continued water level decline
- WDNR is focusing on enhancing coarse woody habitat
- Banded Killifish (*Fundulus diaphanus*)
 - Special concern species in Wisconsin
 - Prefers clear water of bays and quiet backwaters over areas with sparse vegetation over gravel, sand, silt, marl, clay, detritus, or cobble
 - Healthy population as of 2012



An underwater photograph showing several thin, brownish stems of aquatic plants rising from the bottom. The stems are topped with small, dark, bell-shaped flowers. The water is a deep, murky green color. The word "Conclusions" is written in a large, bold, black serif font with a white outline, centered over the lower half of the image.

Conclusions

Conclusions

- Hypothesized Changes to Littoral Habitat
 - Littoral area (lake area) will decline ~4-6 acres with every 1' of water level decline
 - ~25 acres of littoral area (19% of 2013 lake area) would be exposed with 5' decline
 - Course substrate habitat & associated communities may be impacted with continued decline
 - Area with highest plant diversity in terms of species and structural complexity would expand by ~7 acres with 5' decline
 - Likely expansion of hybrid watermilfoil and curly-leaf pondweed
 - Turtle Bay Wetland would likely disappear with >2' decline
- Every lake is going to respond differently

Thank You



Wisconsin
Lakes
Partnership

LW
Extension



University of Wisconsin
Stevens Point

Onterra, LLC

Lake Management Planning

**Pleasant Lake
Management
District**

