

PRELIMINARY RESULTS ON WETLAND ADAPTIVE CAPACITY

Assessing and Enhancing the Resilience of Great
Lakes Coastal Wetlands
Information Sharing Meeting
March 12, 2020

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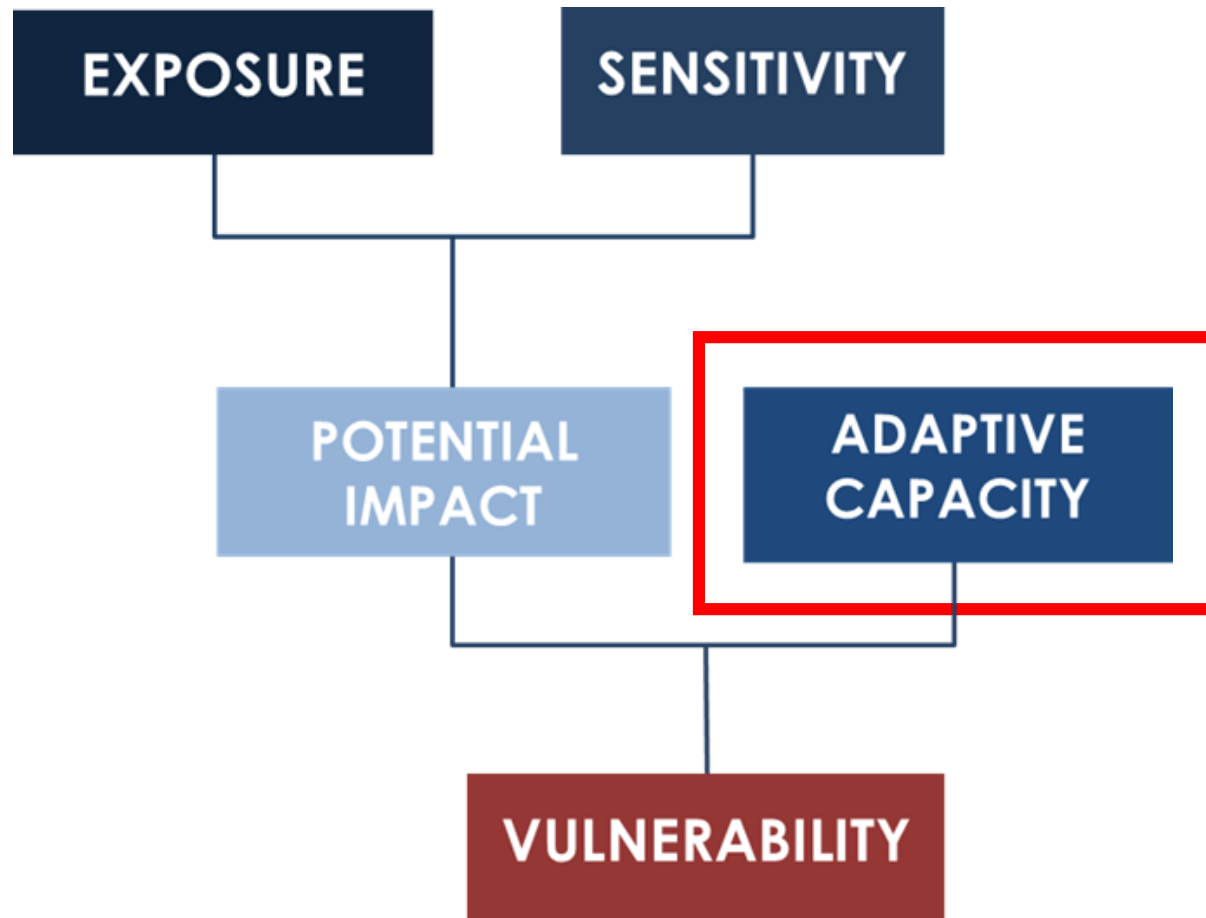
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Presentation Overview

1. Vulnerability Framework
2. Review of Indicators
3. Weighting and Combining Indicators
4. Preliminary Results
5. Next Steps in Analysis



Vulnerability Assessment Components



Adaptive Capacity (AC) - Operational Definition

Contemporary estimate of a wetland's ability to **persist** under changing conditions, **moderate** potential damages or to **cope** with consequences. This includes a wetland's capacity to adjust to climate change, including climate variability and extremes.



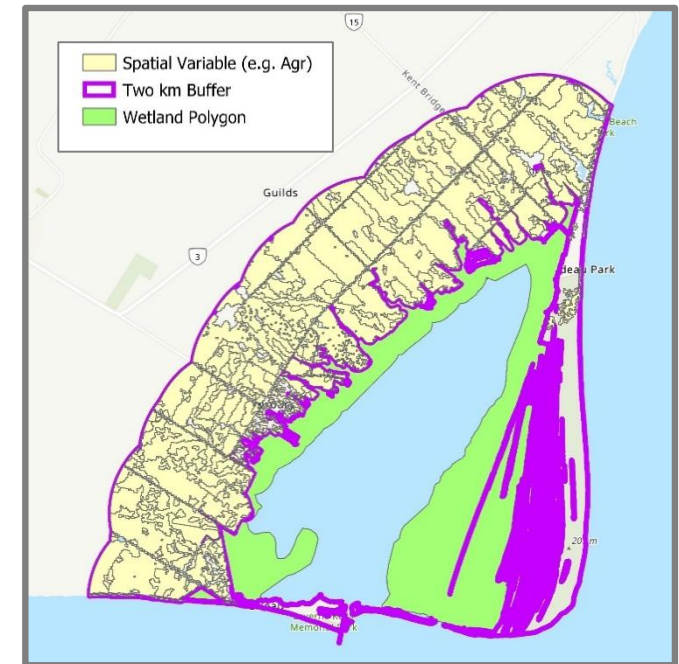
Adaptive Capacity Indicators



1. Landscape Condition

A measure of the broad land use types surrounding wetlands

- Measured as **percentage of urban, agricultural, and natural lands** within a buffered area
- Assumes that increased human land use surrounding a wetland will reduce adaptive capacity
- *Dataset:* Annual Crop Inventory Data and Crop Classification Data Base (2017)- AAFC



2. Invasive Species

A measure of the proportion of *Phragmites australis* surrounding a wetland

- *Phragmites* often create monocultures that lead to reduction in wetland biodiversity. Once present in a wetland, phragmites are difficult to eradicate often leading to additional disturbance (e.g. burning and application of pesticides)
- Data utilized is the Great Lakes Coastal Wetland and Land Use Map (Michigan Technological Research Institute; 2015)



3. Wetland Connectivity

A measure of the proportion of wetlands in the surrounding landscape



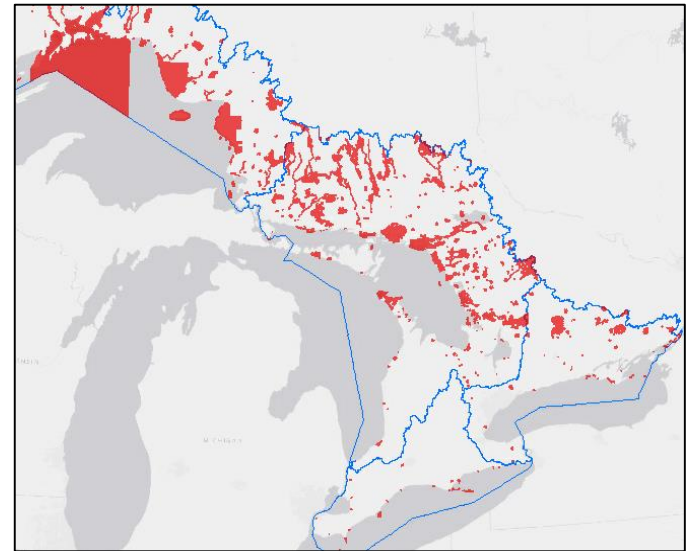
- Wetland connectivity allows for the movement of biotic and abiotic resources between wetlands
- Assumes that an isolated wetland will have a lower capacity to adapt to climate change due to a lack of wetland connectivity
- Data utilized is the Great Lakes Coastal Wetland and Land Use Map (Michigan Technological Research Institute; 2015)



4. Conservation Capacity

A measure of the of protected lands surrounding a wetland

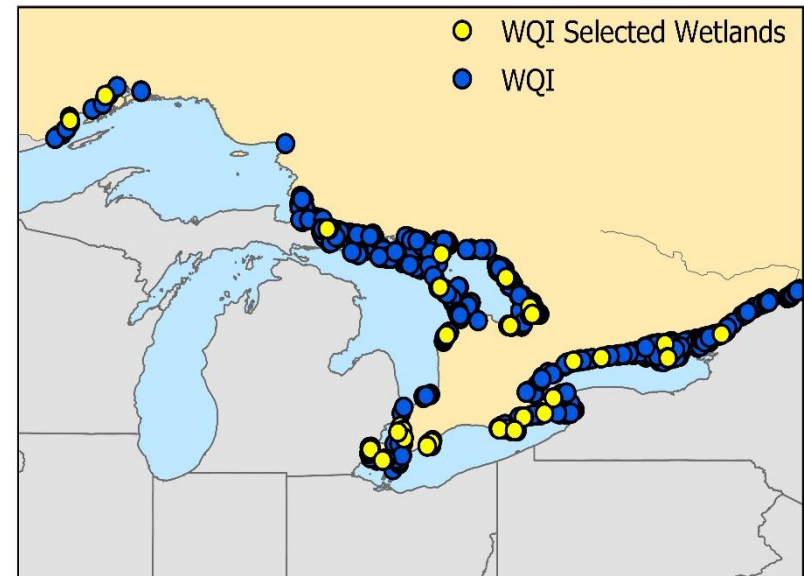
- Assumes that protected wetlands, or wetlands surrounded by protected lands will be better able to cope with climate change due to the greater potential for conservation management
- Currently, conservation capacity is measured using the Canadian Protected and Conserved Areas Database (2019)



5. Water Quality

A measure of physical and chemical properties of a wetland related to human-disturbance

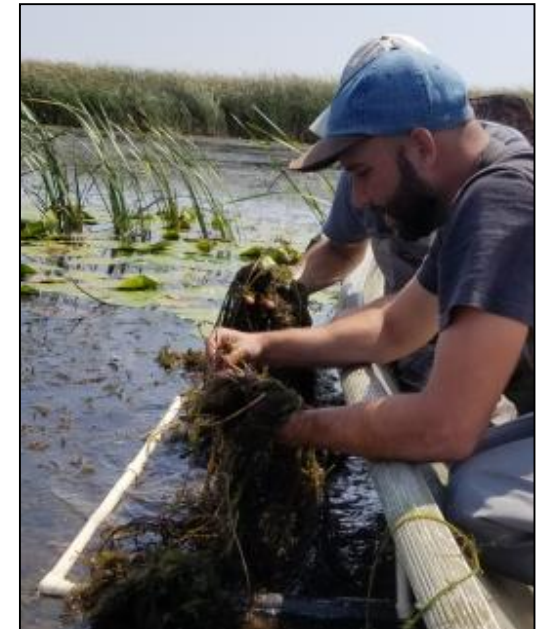
- To measure this indicator we will use the Water Quality Index (Chow-Fraser, 2006)
 - Turbidity, conductivity, temperature and pH
- Data Source: CHAMP and McMaster University



6. Wetland Condition

A measure of wetland health using Indices of Biotic Integrity (IBIs)

- IBIs are composite measures of biological variables weighted to reflect human disturbance
- Datasets available for use include:
 - Great Lakes Restoration Initiative (GLRI) – Sum Rank
 - Coastal Habitat Assessment and Monitoring (CHAMP) - Submerged Aquatic Vegetation Integrative Biological Indicator (SAV-IBI)



Wetland Condition Challenges



Four challenges exist in utilizing IBI data for a measure of wetlands condition:

1. Rotational sampling produces temporal variation
2. No consistent coverage with selected sentinel sites
3. Scaling up requires intensive sampling efforts to be conducted
4. Often a measure of disturbance is used to inform IBI. This includes landscape variables, water quality variables and/or invasive species presence



Wetland Condition - Challenges

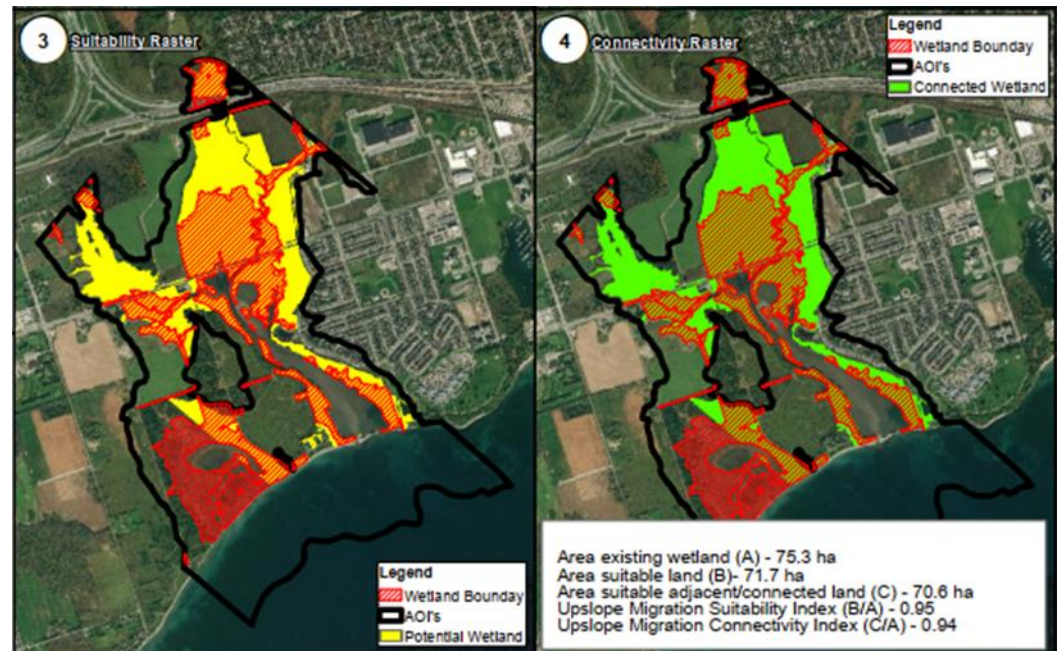
- Given the challenges associated with utilizing IBI Data, it has been proposed to remove this indicator from the Adaptive Capacity analysis
- This data may still prove useful for other aspects, including verification of Adaptive Capacity results



7. Potential to Migrate

A measure of suitable areas that a wetland may expand to in the future

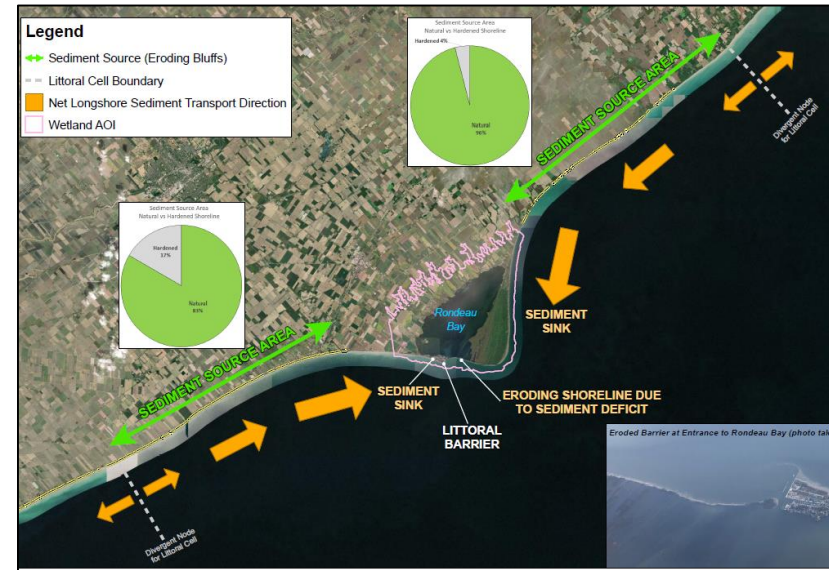
- Migration potential is a combination of suitable habitat and connectivity between suitable habitat
- Currently under development by a contractor and expect results this spring



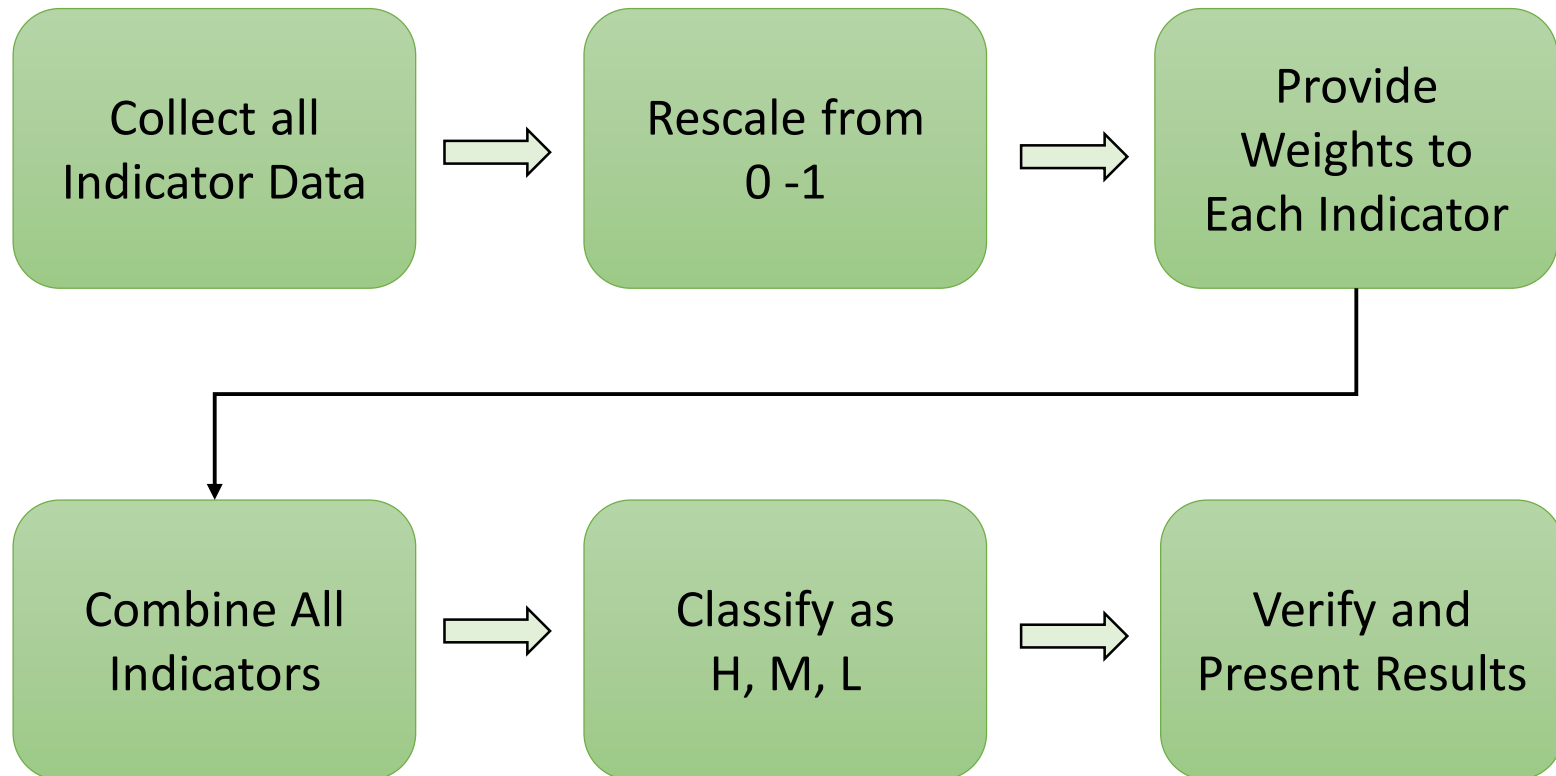
8. Sediment Dynamics

A measure of sediment budgets and erosion

- Reductions in sediment supply to barrier beaches, barred river mouths, and sandspits can result in the loss of protective features and increase wave exposure in wetlands
- This indicator is currently under development by Zuzek Inc.



Scoring and Scaling of Indicators



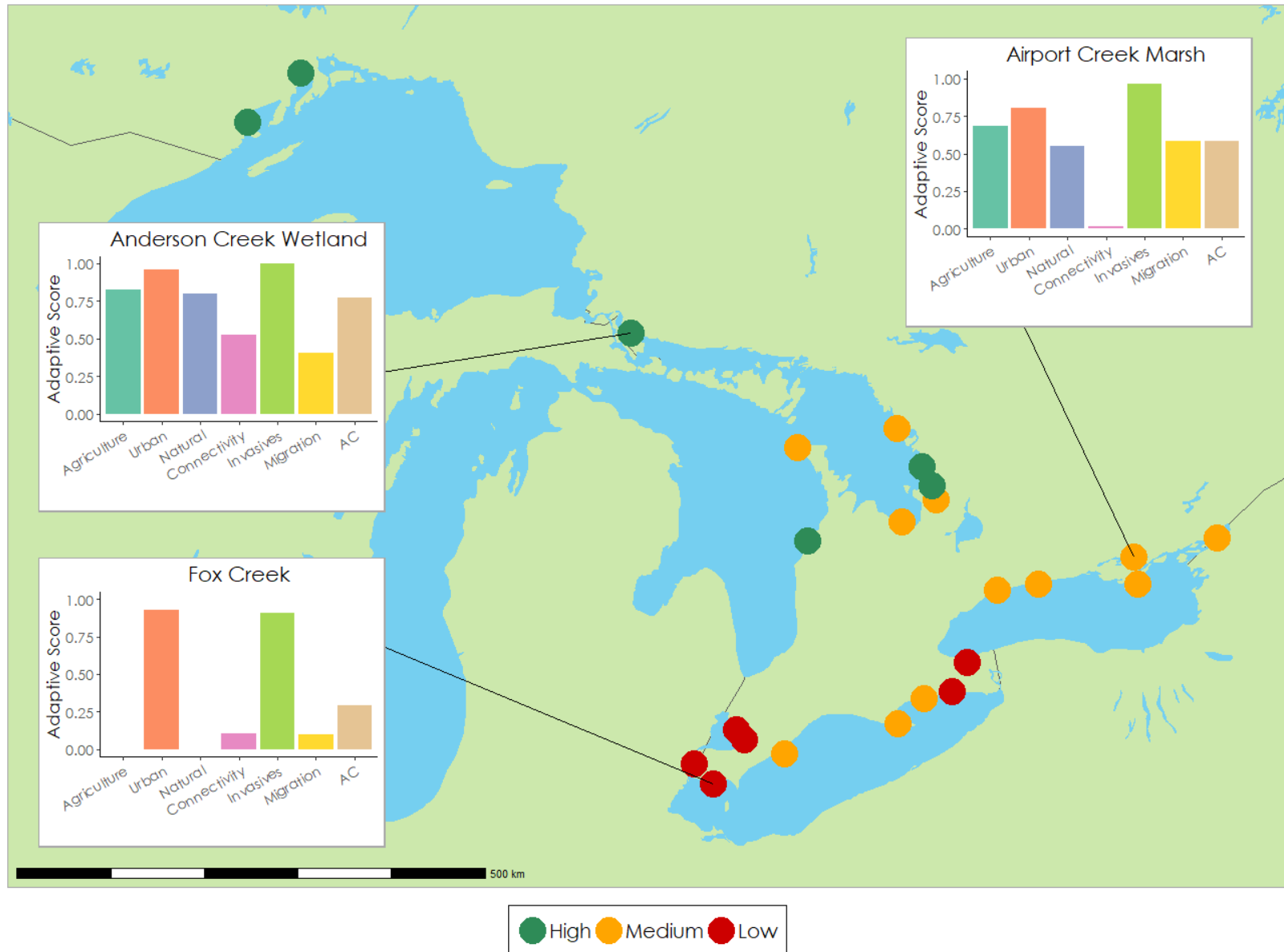
Preliminary Results

- Four indicators are currently available: Landscape Condition, Invasive Species, Connectivity, and Landward Migration
- All indicators have been rescaled (0 – 1) to reflect their Adaptive Score
 - A high Adaptive Score = Good
 - A low Adaptive Score = Bad
- All indicators are **equally weighting**



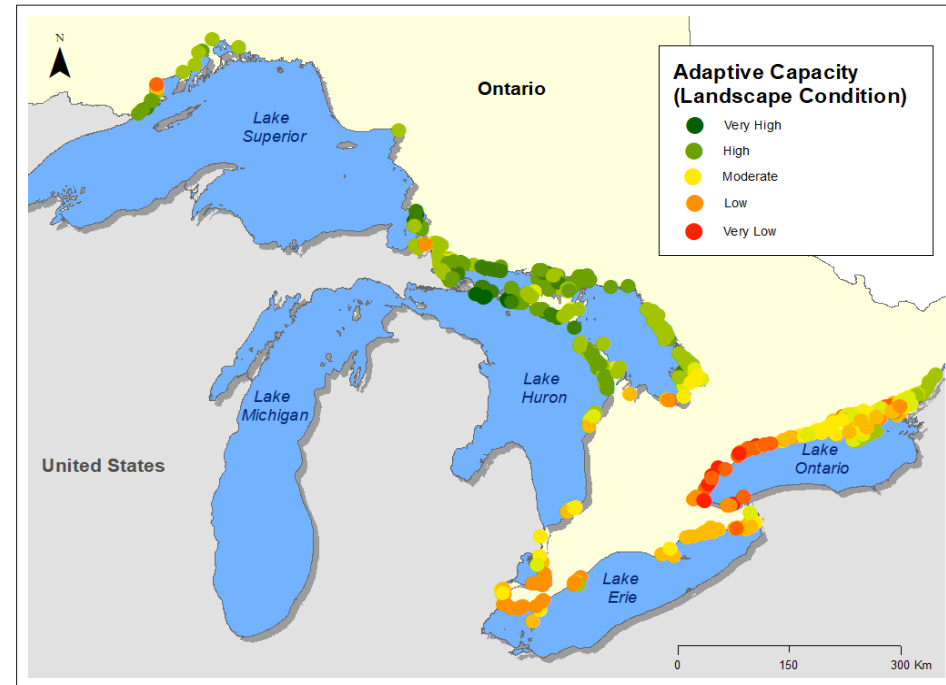
Great Lakes Wetland Adaptive Capacity

Indicators



Next Steps in Adaptive Capacity Analysis

- Many indicators utilized in determining AC are obtained using spatial analysis therefore, there is potential to scale up the analysis to more wetlands across the Great Lakes Basin
- Several Indicators are under development or require updated datasets



The image is a horizontal collage of three nature photographs. The left panel shows a pond with large green lily pads and submerged reeds. The middle panel is a close-up of tall, thin reeds in water. The right panel shows a white canoe on a rocky shore next to a pond with lily pads. The text "THANK YOU" is centered across the middle panel in a large, white, sans-serif font.

THANK YOU

PRELIMINARY RESULTS ON WETLAND ADAPTIVE CAPACITY

Supplementary Slides

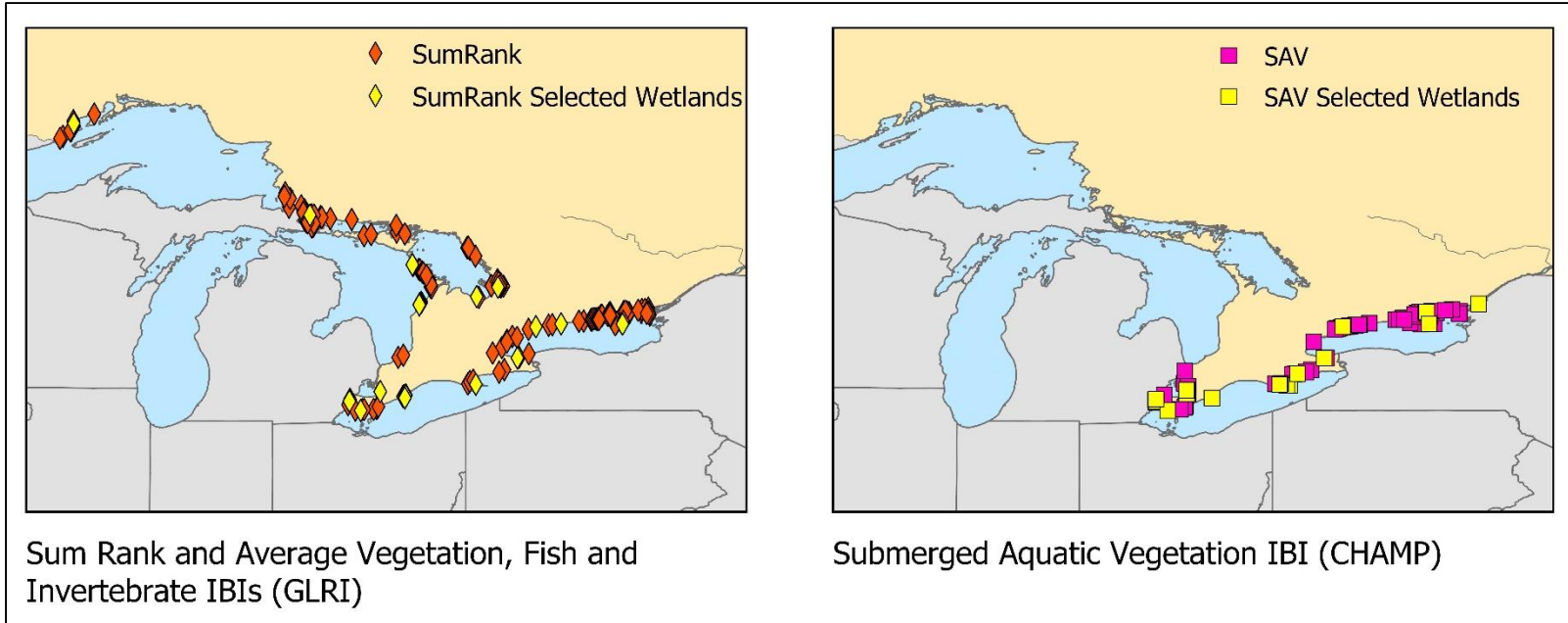


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Wetland Condition – Challenges: Coverage

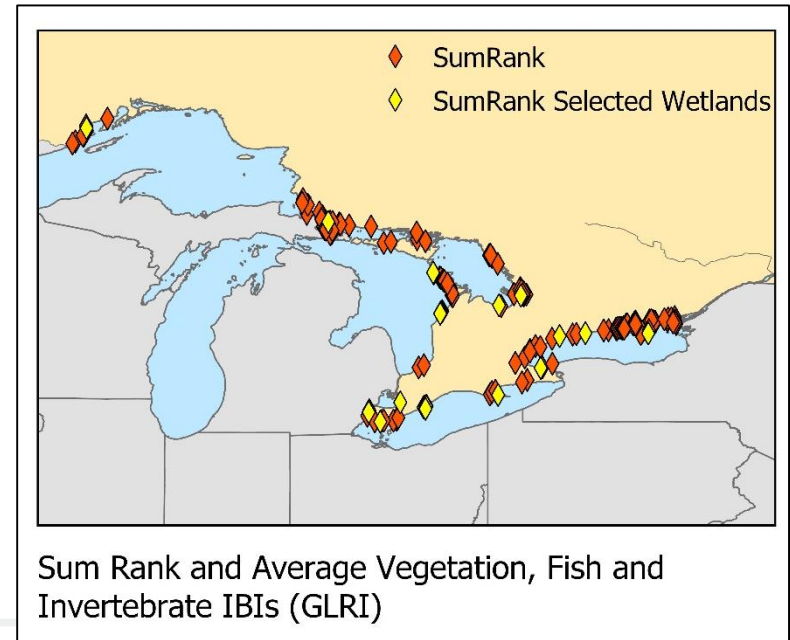


- Not all sentinel wetland sites have IBI data
- Sum Rank is missing 15 sites, SAV only covers Lake Erie and Lake Ontario



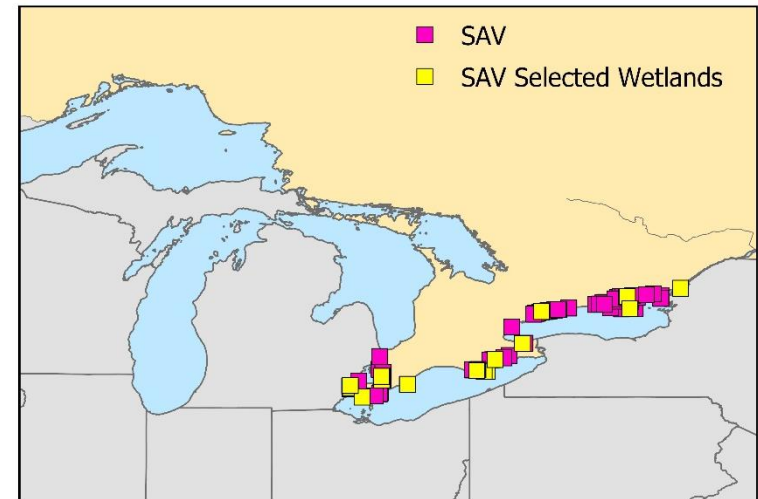
Wetland Condition Challenges: IBIs Measures Disturbance

- The purpose of the Sum Rank Disturbance Gradient Indicator (Uzarski et al., 2016) was to determine which biological indicators could be used to identify wetlands with **anthropogenic disturbance**
- Where disturbance was measured using
 - Chemical data – **temperature**, chlorophyll, **conductivity**, solids, dissolved oxygen, and **pH**
 - Physical data – **land cover** at 1 and 20 km



Wetland Condition Challenges: IBIs Measures Disturbance

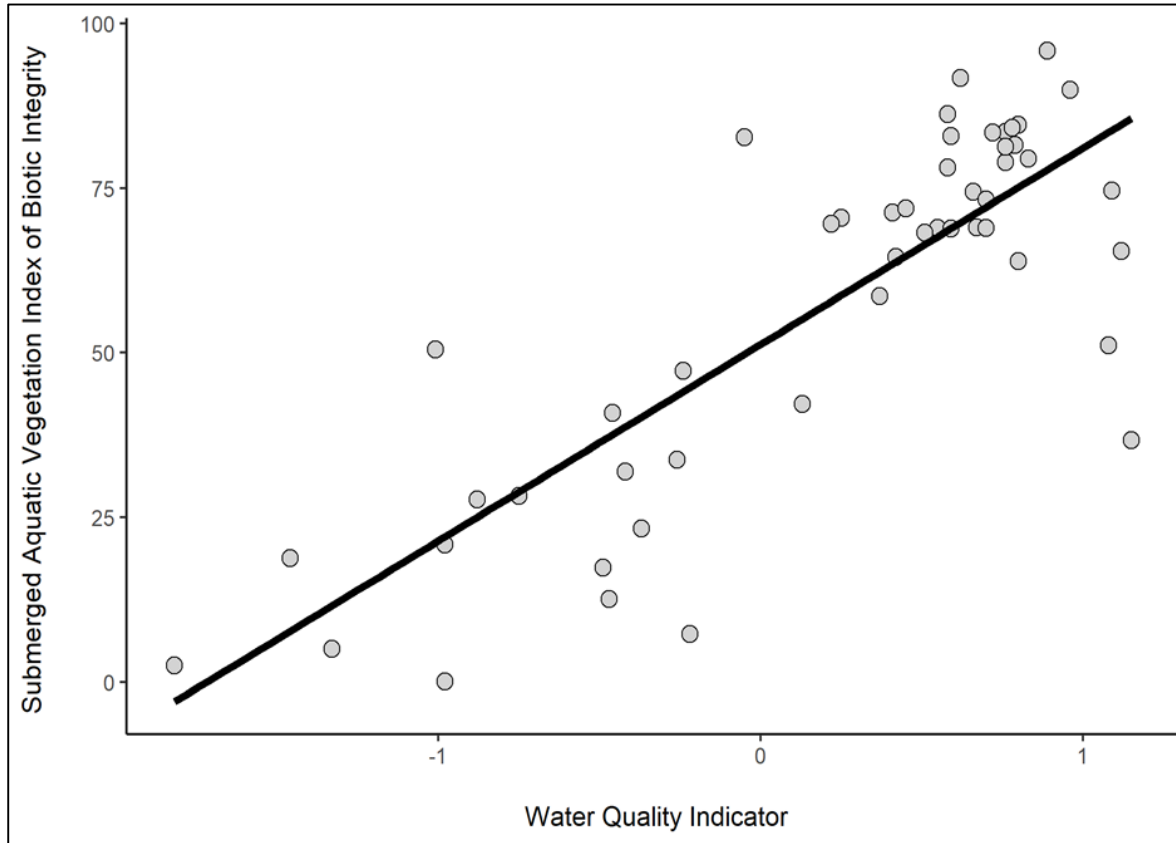
- Submerged Aquatic Vegetation Integrative Biological Indicator (SAV-IBI) developed by Greg Grabas (2012)
 - Used water quality index (Chow-Fraser, 2006) as a measure of disturbance to inform SAV-IBI



Submerged Aquatic Vegetation IBI (CHAMP)

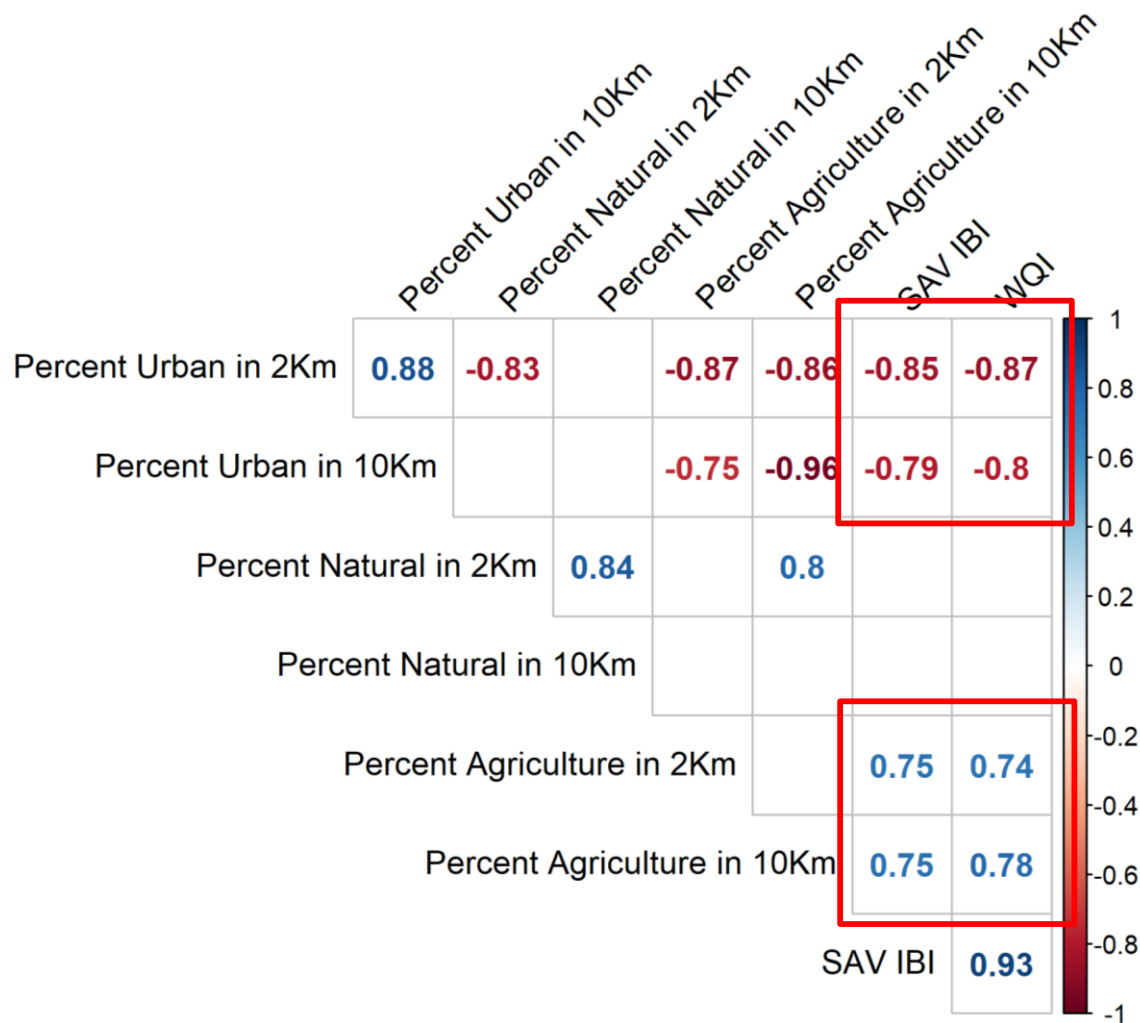


Wetland Condition Challenges: IBIs Measures Disturbance



- Comparison of WQI and SAV-IBI data for 2017 showed a significantly high correlation between the variables ($p < 0.001$, $r = 0.93$)





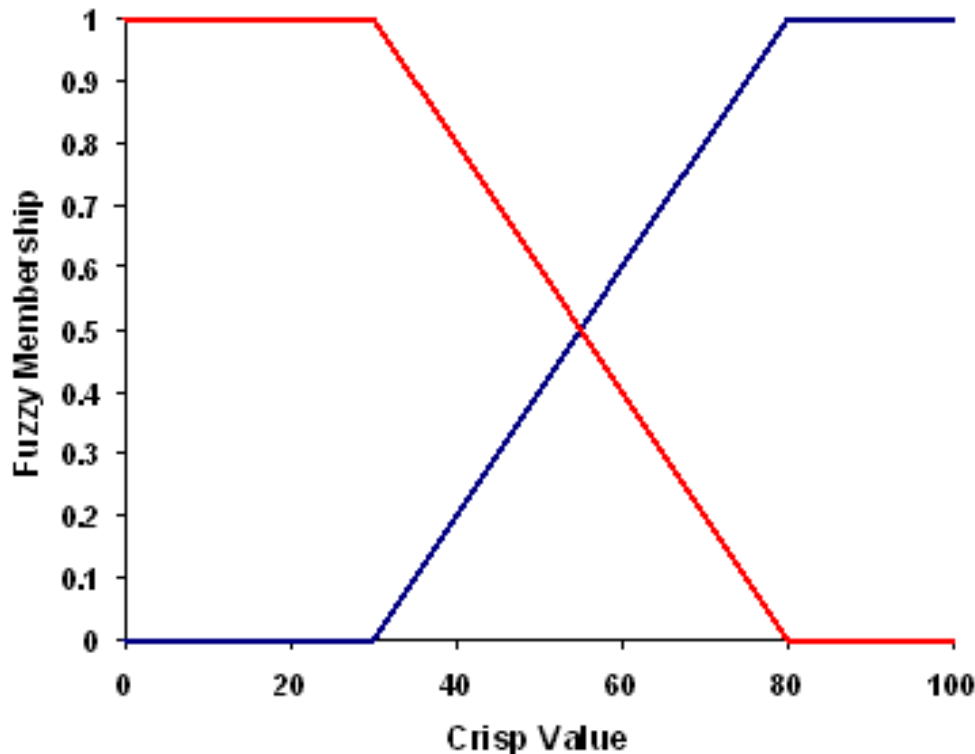
General take away:

- High significant correlation between urban land use and SAV-IBI/ WQI, and;
- High significant correlation between agricultural land use and SAV-IBI/ WQI

Spearman pairwise correlation matrix comparing SAV IBI, WQI, and land use (urban, agriculture, and natural) at two buffer scales (2km, and 10km).

Missing values represent correlation coefficients where $p > 0.01$

Scoring and Scaling of Indicators - Rescaling



- Apply fuzzy membership function
- High and low values can be determined using sentinel wetland sites or expert knowledge
- Apply either a positive or negative relationship depending on variable



Scoring and Scaling of Indicators - Scoring

Traditional Indicator Calculation:

$$y_j = \sum_{i=1}^d w_i x_{ji}, \quad j = 1, 2, \dots, n$$

$$I_i \neq w_i$$

Consider that importance of indicator does not equal weight of indicator

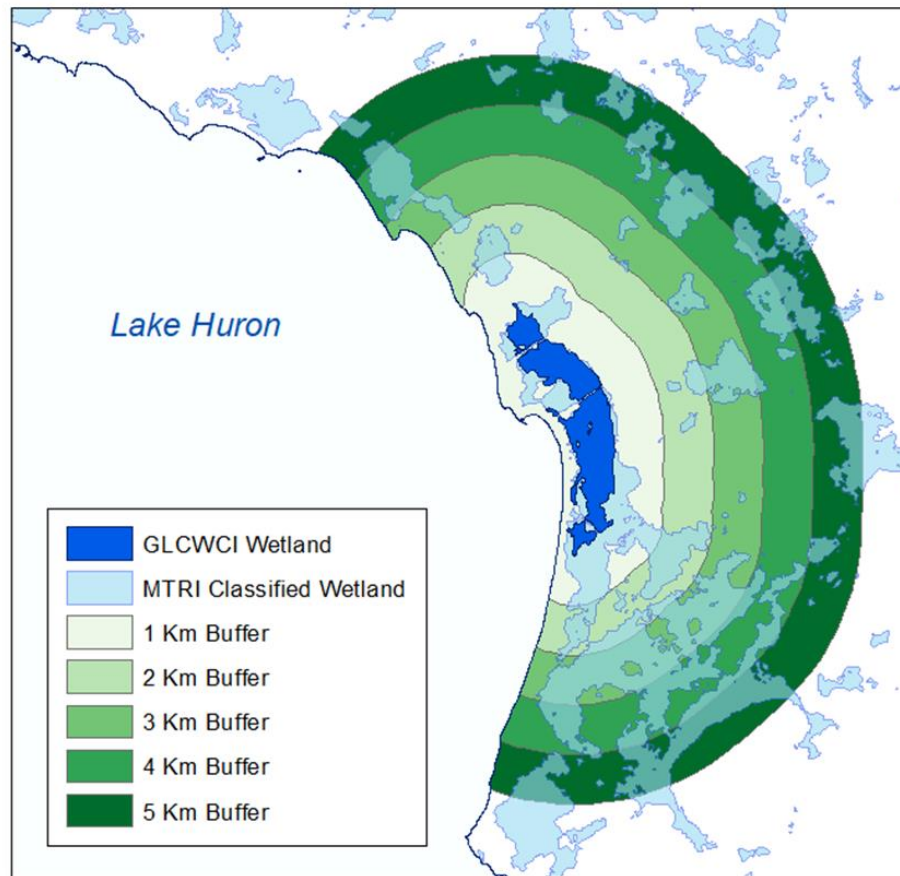
Worthwhile to consider PCA for weighting of variables

Pro: Allow for more variation in data to be captured

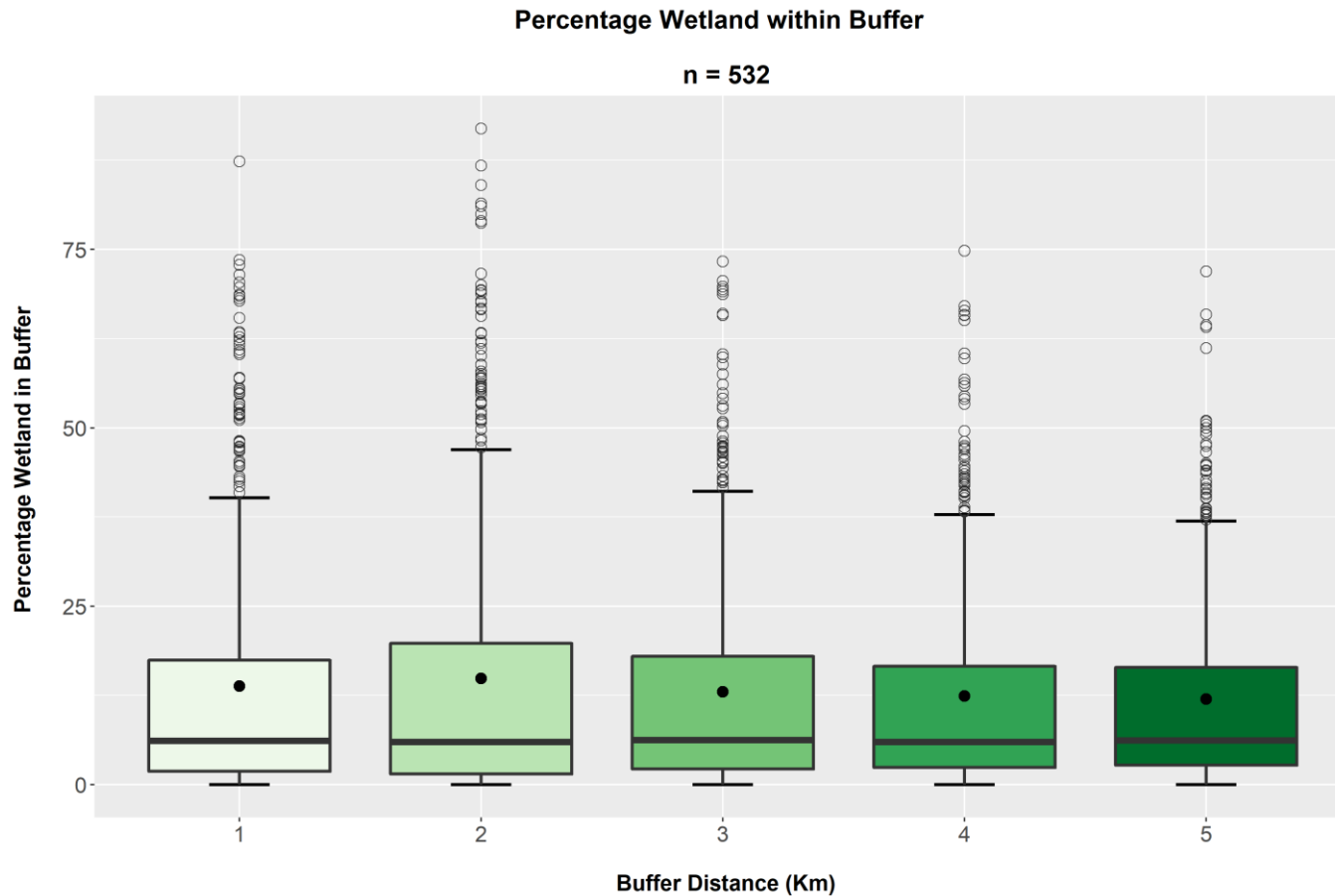
Con: May reduce interpretability and therefore adaptive management



Wetland Connectivity



Wetland Connectivity Buffer Comparison

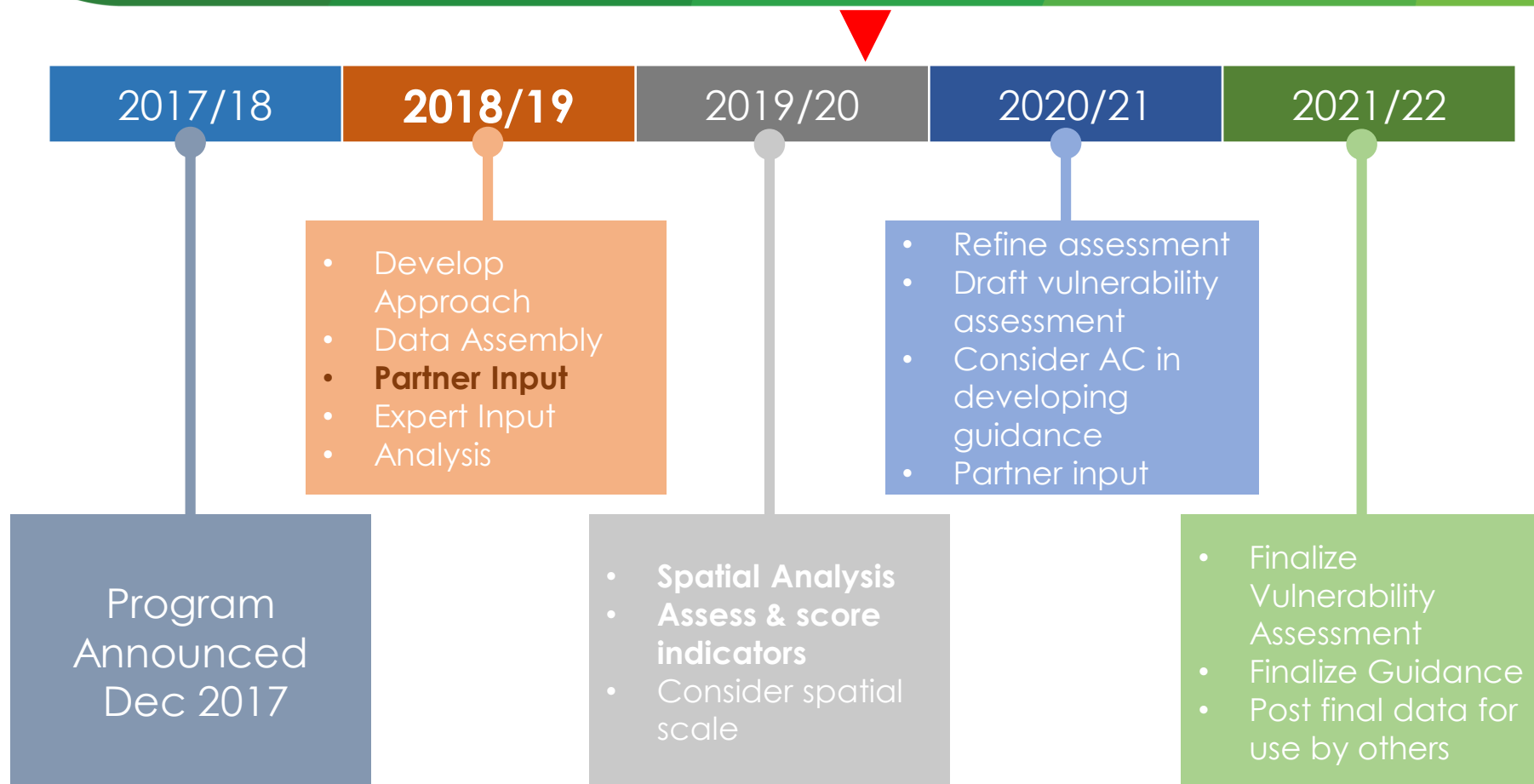


Wetland Within Buffers is Highly Correlated

	1 Km	2 Km	3 Km	4 Km	5 Km
1 Km	1.00	0.94	0.90	0.86	0.84
2 Km		1.00	0.97	0.94	0.92
3 Km			1.00	0.98	0.96
4 Km				1.00	0.99
5 Km					1.00

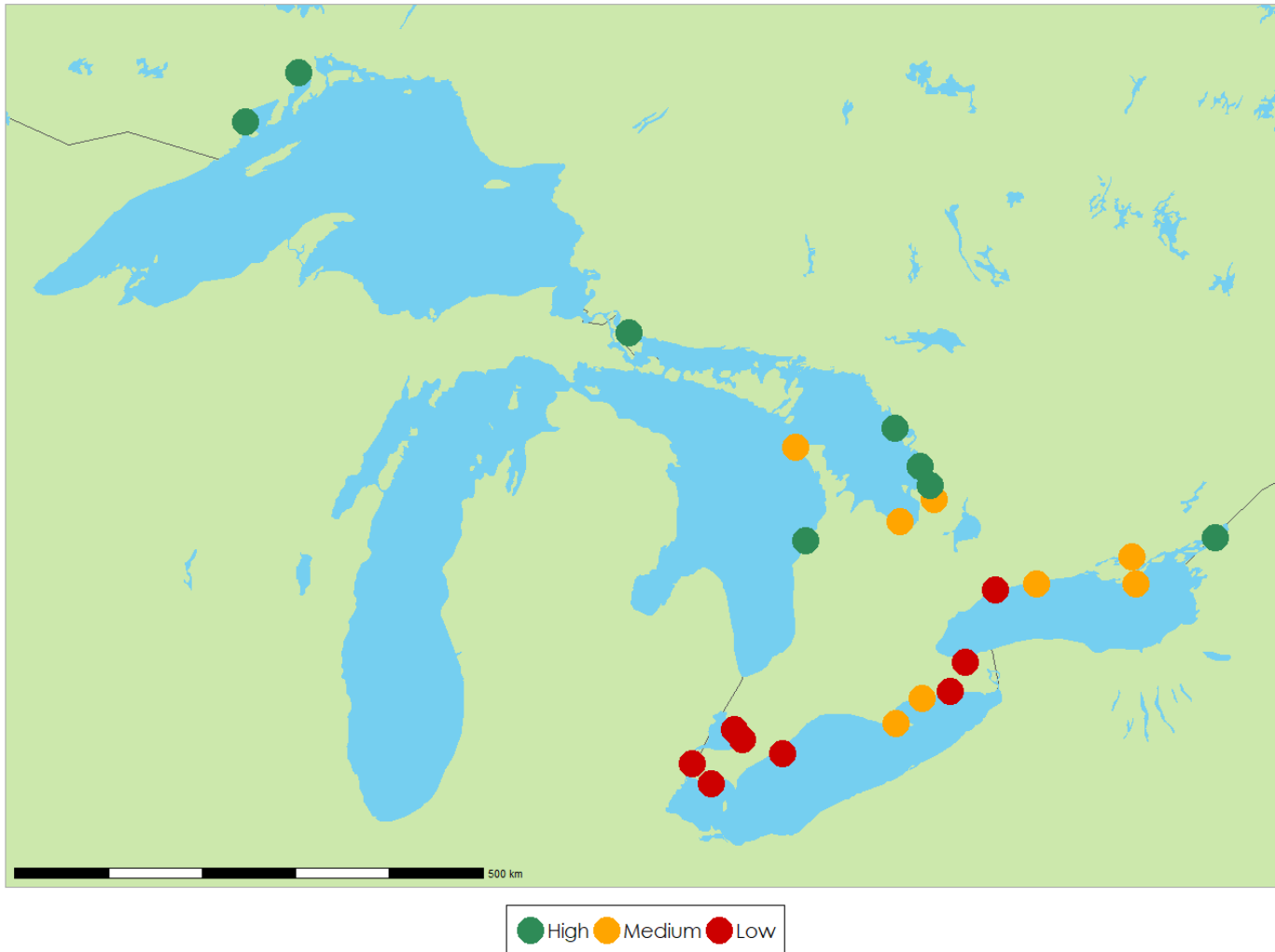


Timelines



Great Lakes Wetland Adaptive Capacity

Landscape Condition Weighted X3

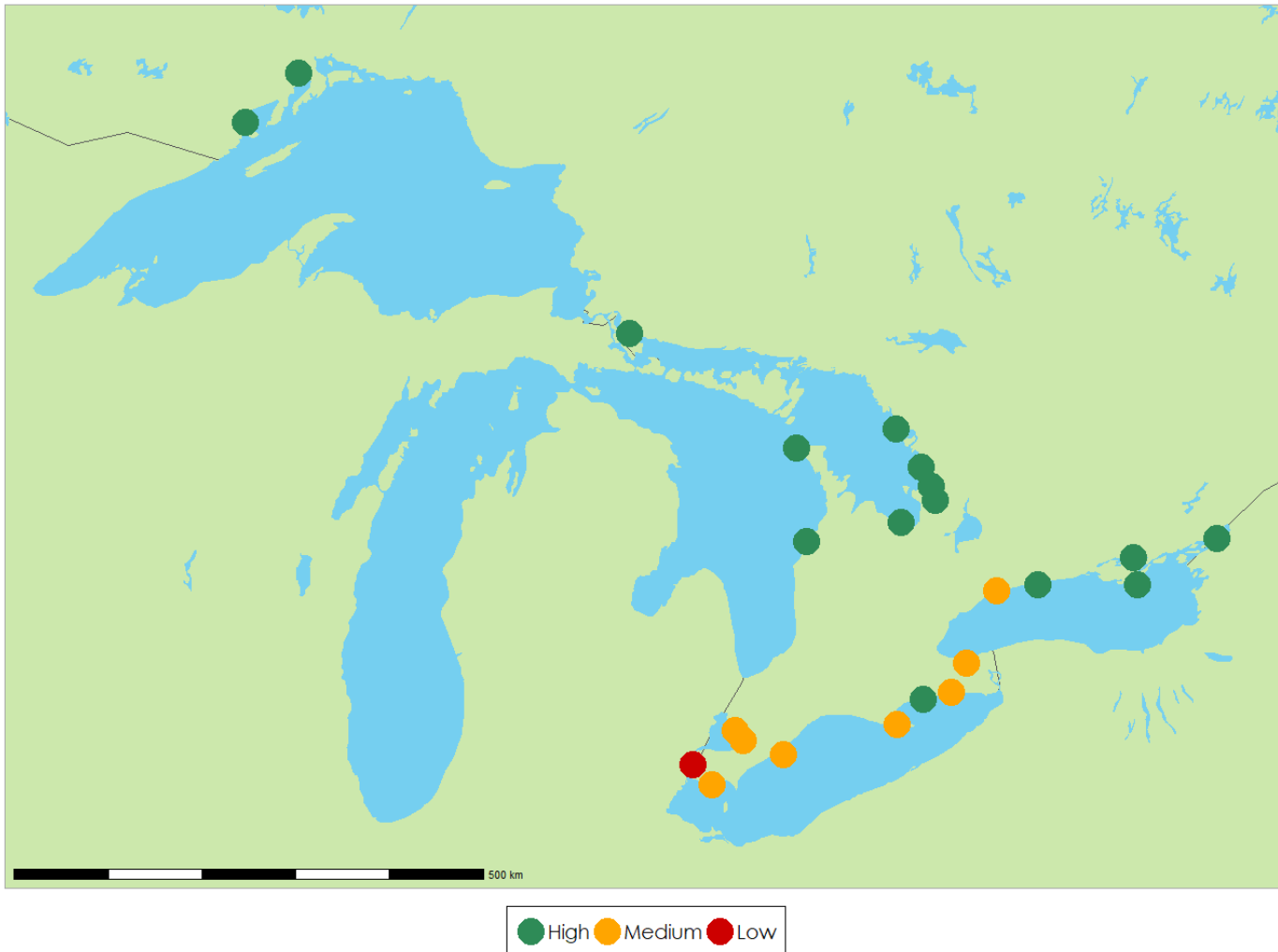


Great Lakes Wetland Protection Initiative • Data Not Finalized

LANDSCAPE CONDITION – URBAN, AGRICULTURE, AND NATURAL

Great Lakes Wetland Adaptive Capacity

Invasives Weighted X3

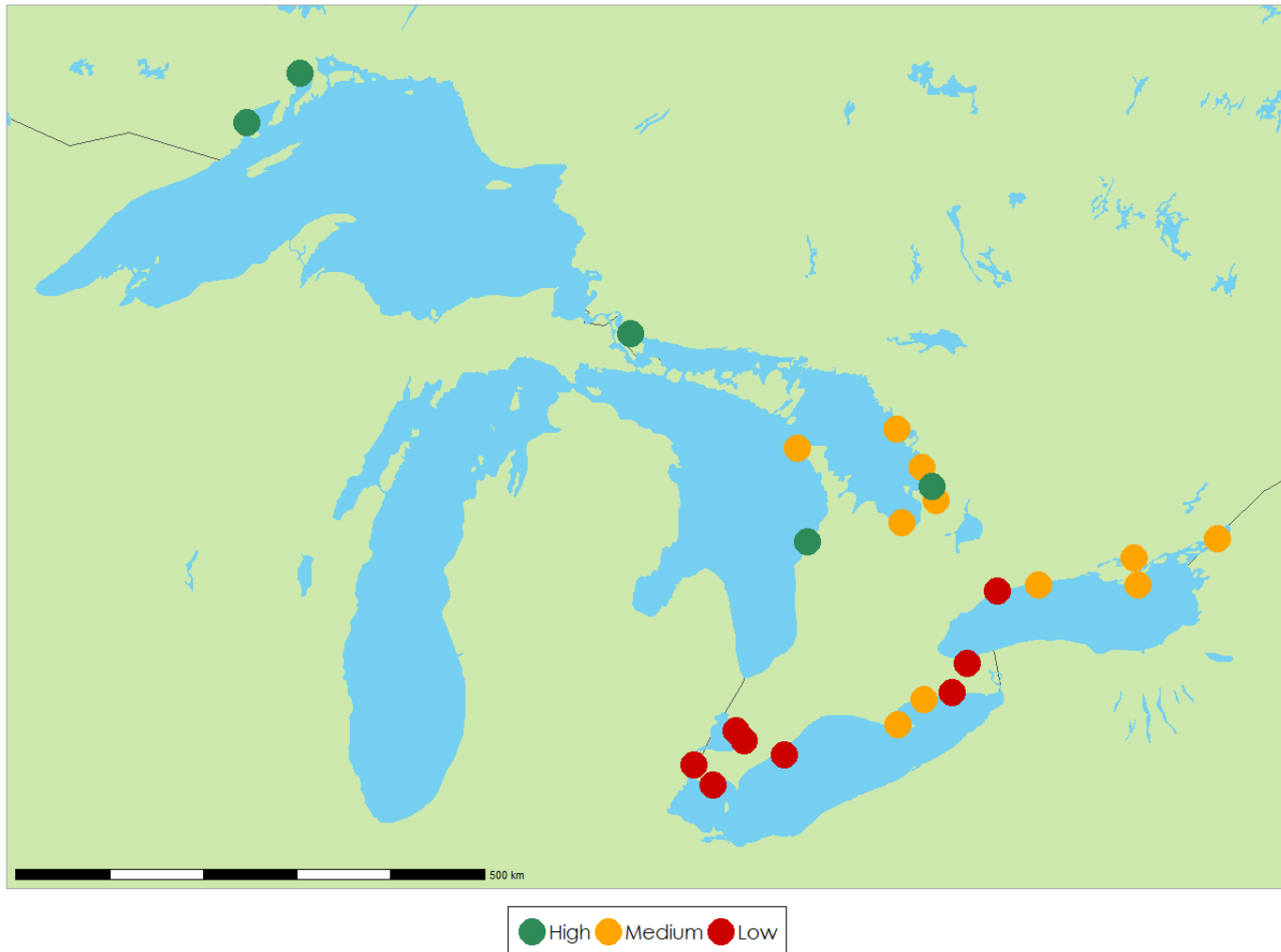


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INVASIVE SPECIES

Great Lakes Wetland Adaptive Capacity

Connectivity Weighted X3

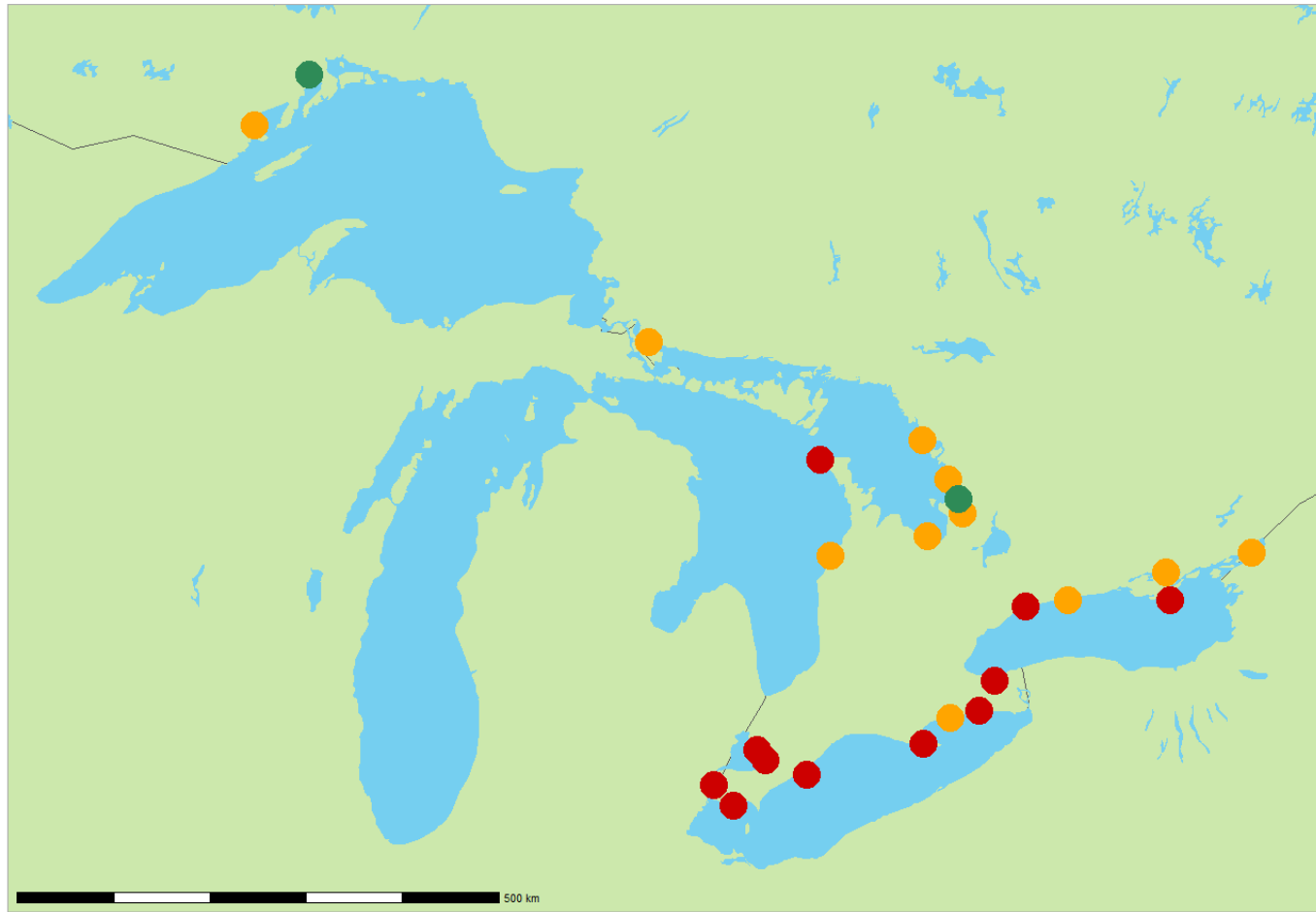


Great Lakes Wetland Protection Initiative • Data Not Finalized

CONNECTIVITY

Great Lakes Wetland Adaptive Capacity

Migration Weighted X3



Great Lakes Wetland Protection Initiative • Data Not Finalized

WETLAND MIGRATION

Great Lakes Wetland Adaptive Capacity

Spatial Indicators • 2 km Buffer

