

Northern Prairie Wetland Assessment at Multiple Spatial Scales

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Wetland losses substantial in Alberta

40 - 70% of marshes in the settled part of Alberta lost since European settlement



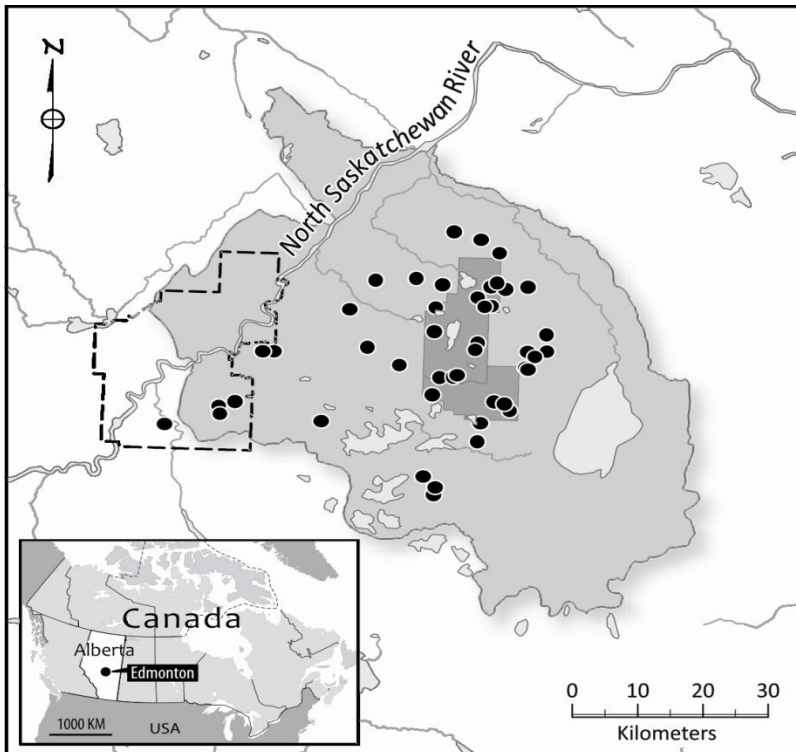
(Photo credit Parks Foundation Calgary 2003)

Outline

- Alberta wants to develop a new provincial wetland policy using function rather than area
- Developed indices of biotic integrity to assess wetland condition at site specific level
- Constructed wetlands are not adequate compensation for loss of natural wetlands
- Developed remote methods of estimating wetland condition to use in planning

Beaverhill subwatershed, Alberta Canada

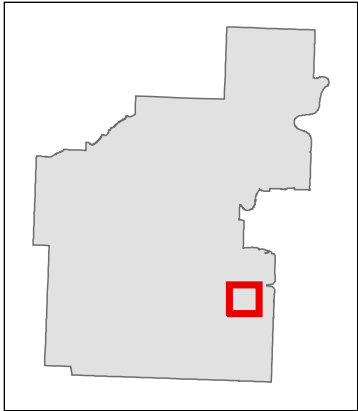
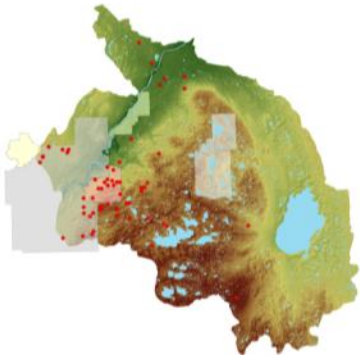
- Aspen parkland
- Northern limit of prairie potholes
- Reference – national and provincial parks
- Constructed – urban
- Restored – Ducks Unlimited



● Study sites ◻ Beaverhills watershed ◻ National or provincial park

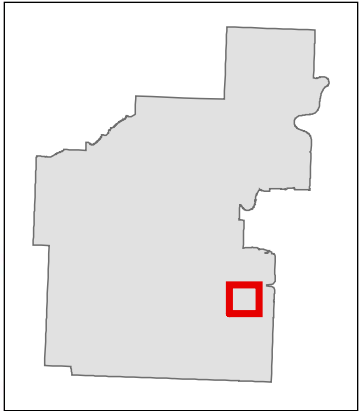
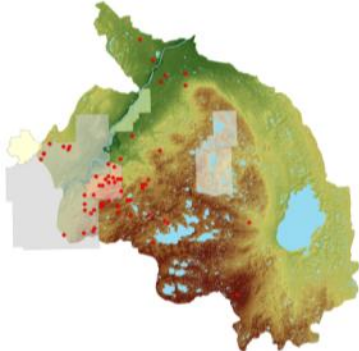
1993

NSWMF
Wetland



2009

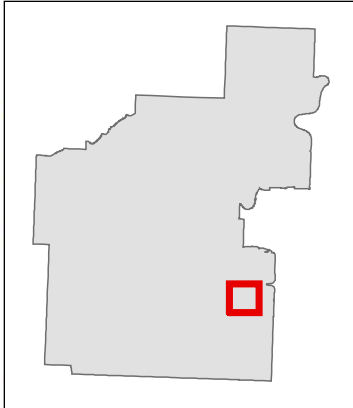
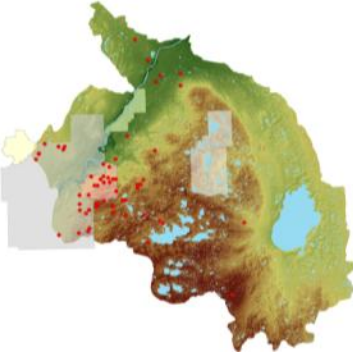
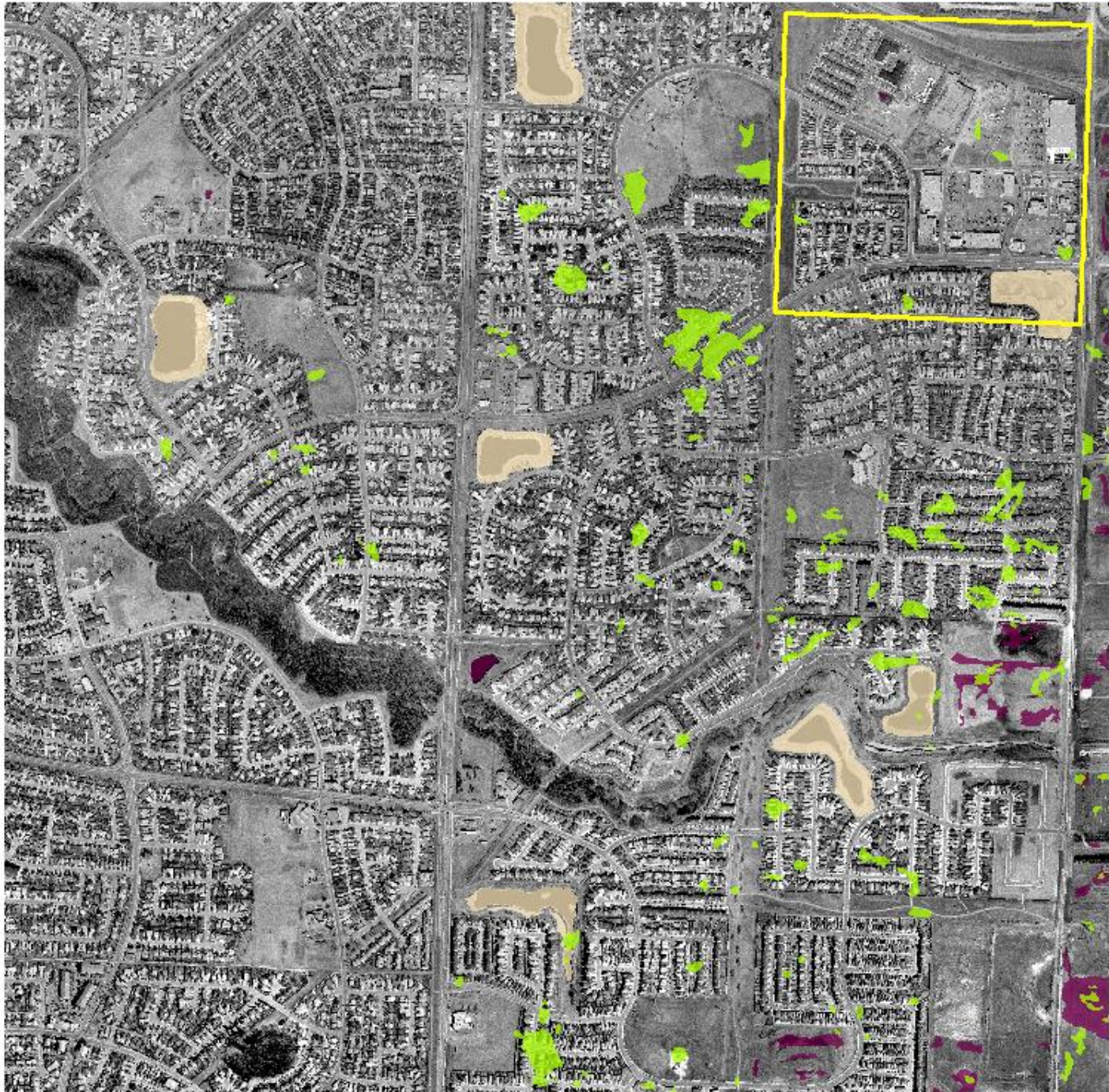
NSWMF
Wetland

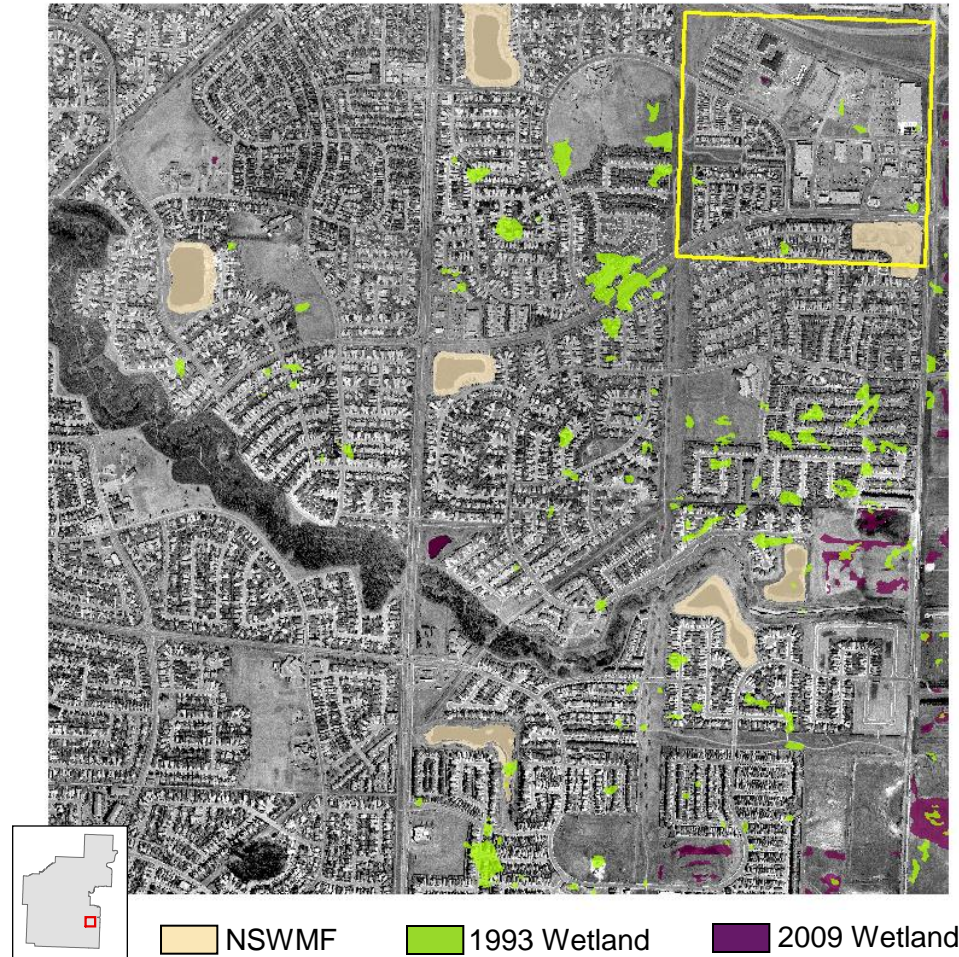


1:15:000

2009

- NSWMF
- 1993 Wetland
- 2009 Wetland





Wetland extent

1993: 15.4 ha

2009: 6.6 ha

= **57%** absolute loss
of wetlands (8.8 ha)

➤ **94%** of those lost
lacked an approval

Despite a wetland compensation policy, Alberta is losing wetlands in both urban and agricultural areas

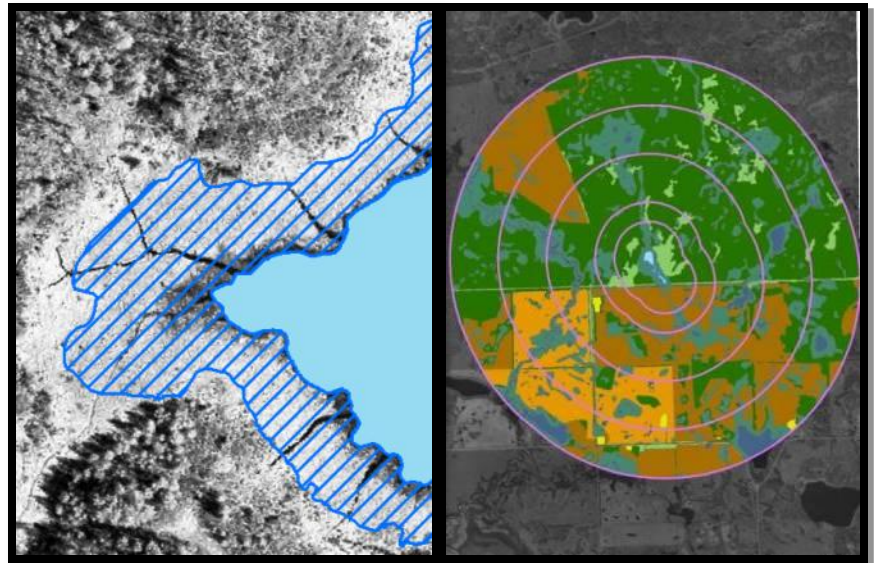
Are compensation wetlands in good condition?

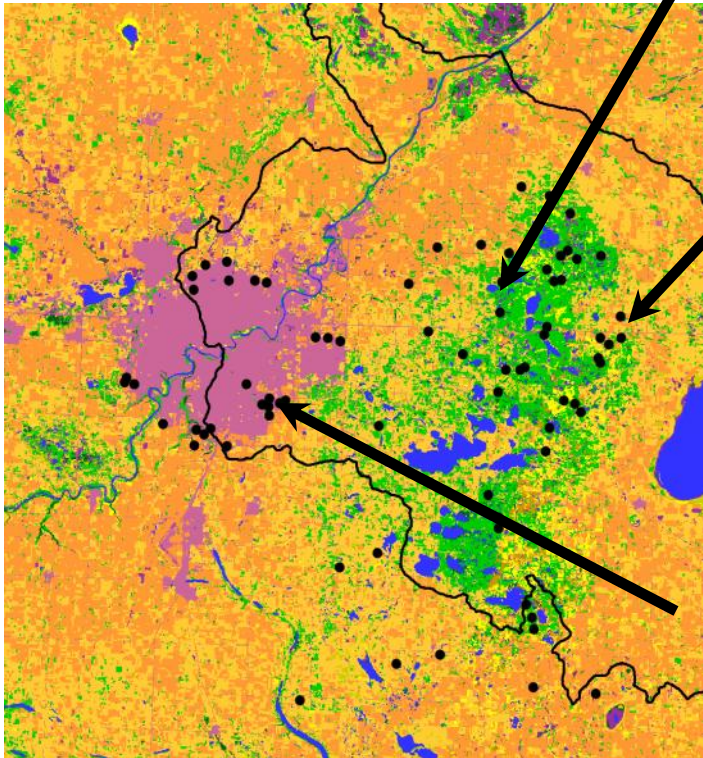
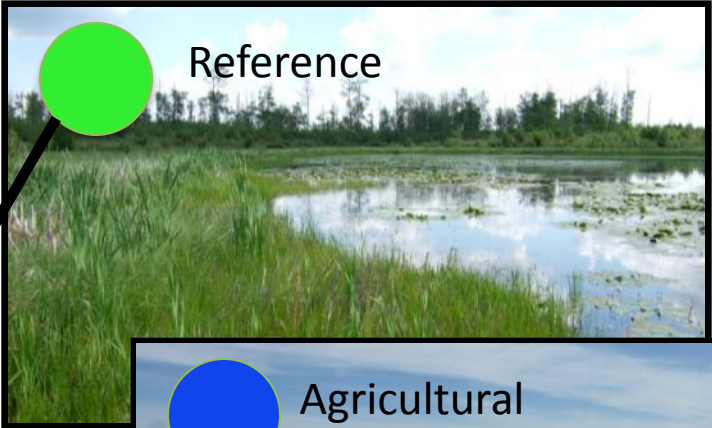
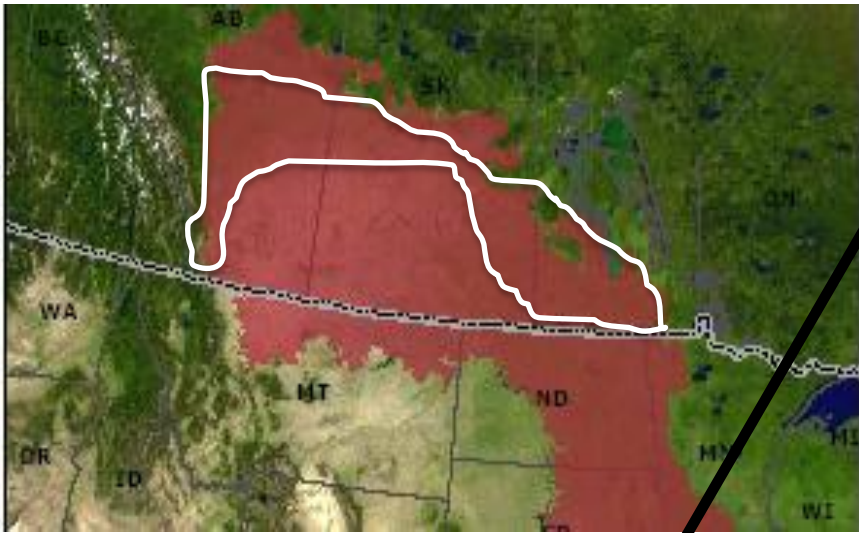
- Permitted losses require compensation
- Function?
- Area?





Tools to assess wetlands

- Field-based tools
 - Environmental stress
 - Plant community
 - Bird community
- Remotely sensed tools
 - Scaled up measures of field tools
 - Land use affects wetland condition





-  Naturalized Stormwater pond
-  Stormwater pond

Stress gradient

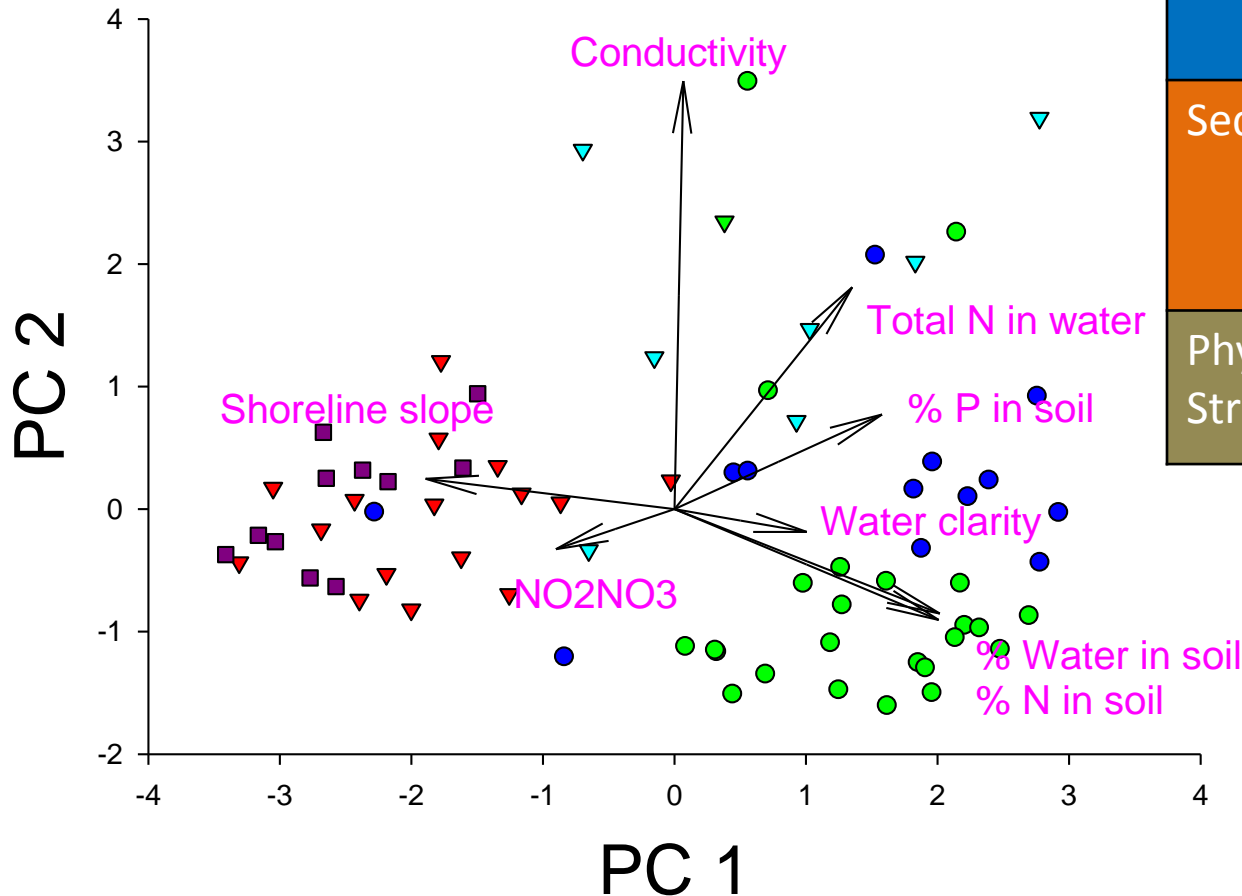
How healthy is the wetland: phys./chem. conditions?



- Quantify abiotic stress at the site, and test sensitivity of biotic (functional) indicators
- Identifies stress/disturbance gradient among sites
- Minimizes ‘best professional judgment’
- Rooney & Bayley (2010) *Ecol. Indic.* 10: 1174-1183

Are constructed wetlands are under greater environmental stress?

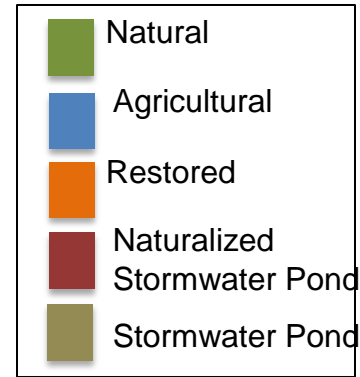
Only 8 environmental variables



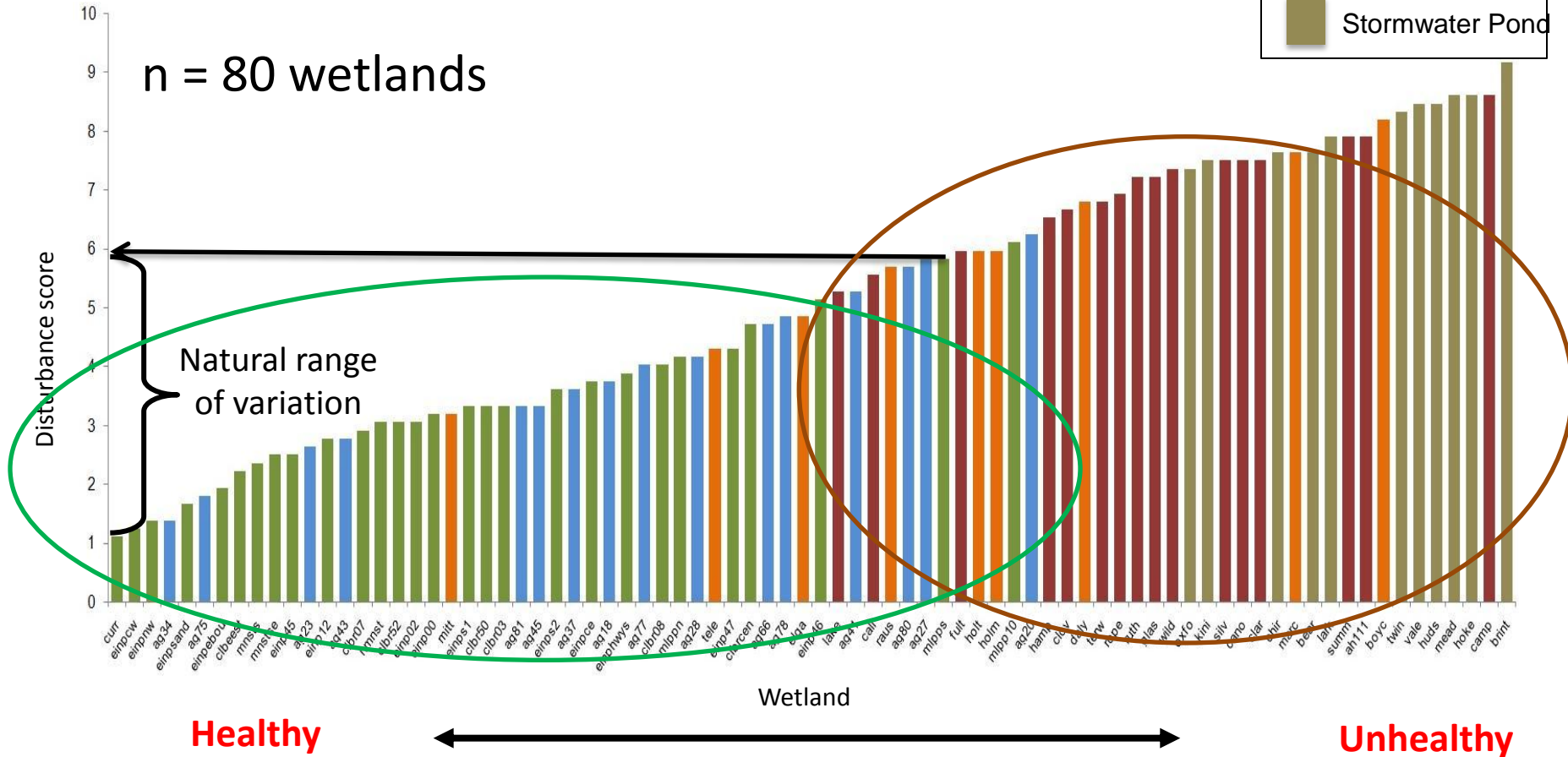
Water	Total Nitrogen
	NO ₂ NO ₃
	Conductivity
Sediment	% Phosphorous
	% Nitrogen
	% water content
Physical Structure	Shoreline slope
	Proportion Secchi

Stress gradient

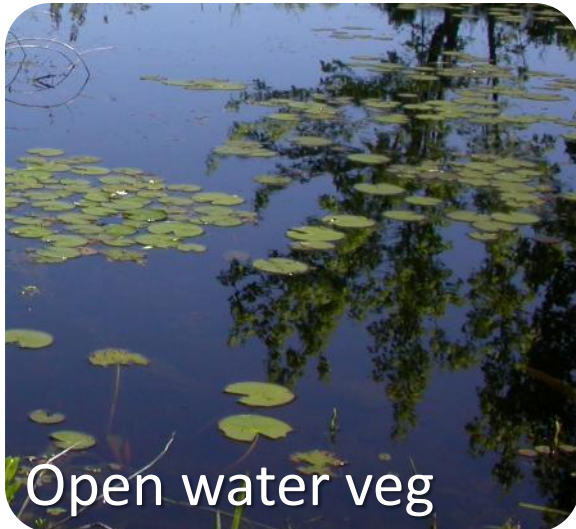
- Secchi depth
- Shoreline slope
- Water NO₃, TN, conductivity
- Sediment water content
- Sediment P & N



n = 80 wetlands



Six main bioindicator assemblages



All 6 bioindicators affected by same environmental variables

Most important environmental variables

- Area of wet meadow zone
- Area of emergent zone
- Shoreline slope
- Water TDN, DOC, & K conc
- Sediment water content
- Sediment C & N conc

Abundance and diversity of biological communities

- Open-water vegetation
- Emergent vegetation
- Wet meadow vegetation
- Macro-invertebrates
- Waterfowl
- Wetland-dependent songbirds

Field-based tools: biota

- If all 6 bioindicators are sensitive to the same environmental variables, can we use biota to evaluate wetland health?
 - Plant-based Index of Biotic Integrity
 - Bird-based Index of Biotic Integrity



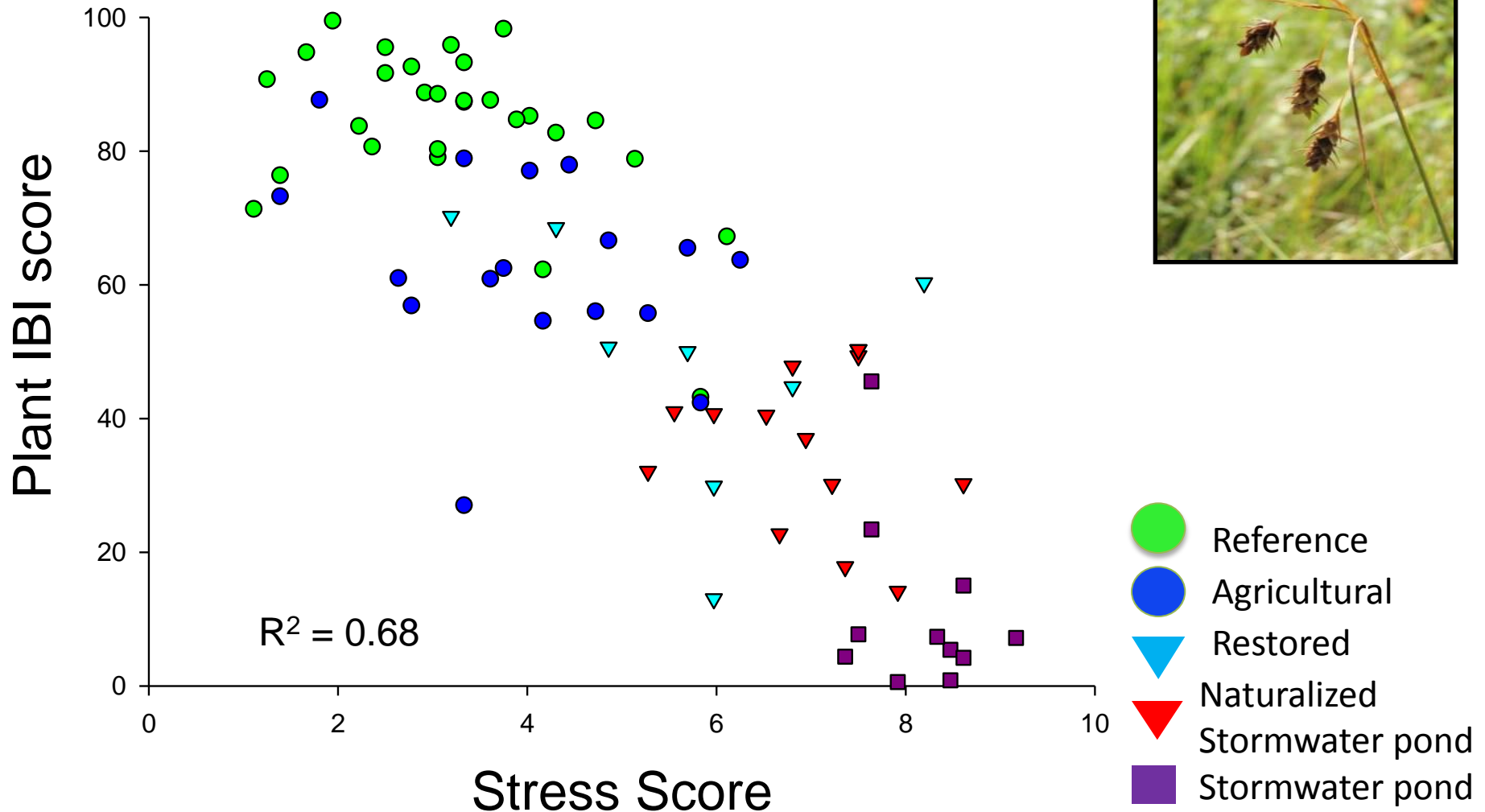
Plant-based IBI uses 4 metrics to estimate biological health

Metrics	R ²
Vegetation width of wet meadow	0.65
Floristic Quality Index	0.43
% Carex spp.	0.44
% Native perennials	0.42

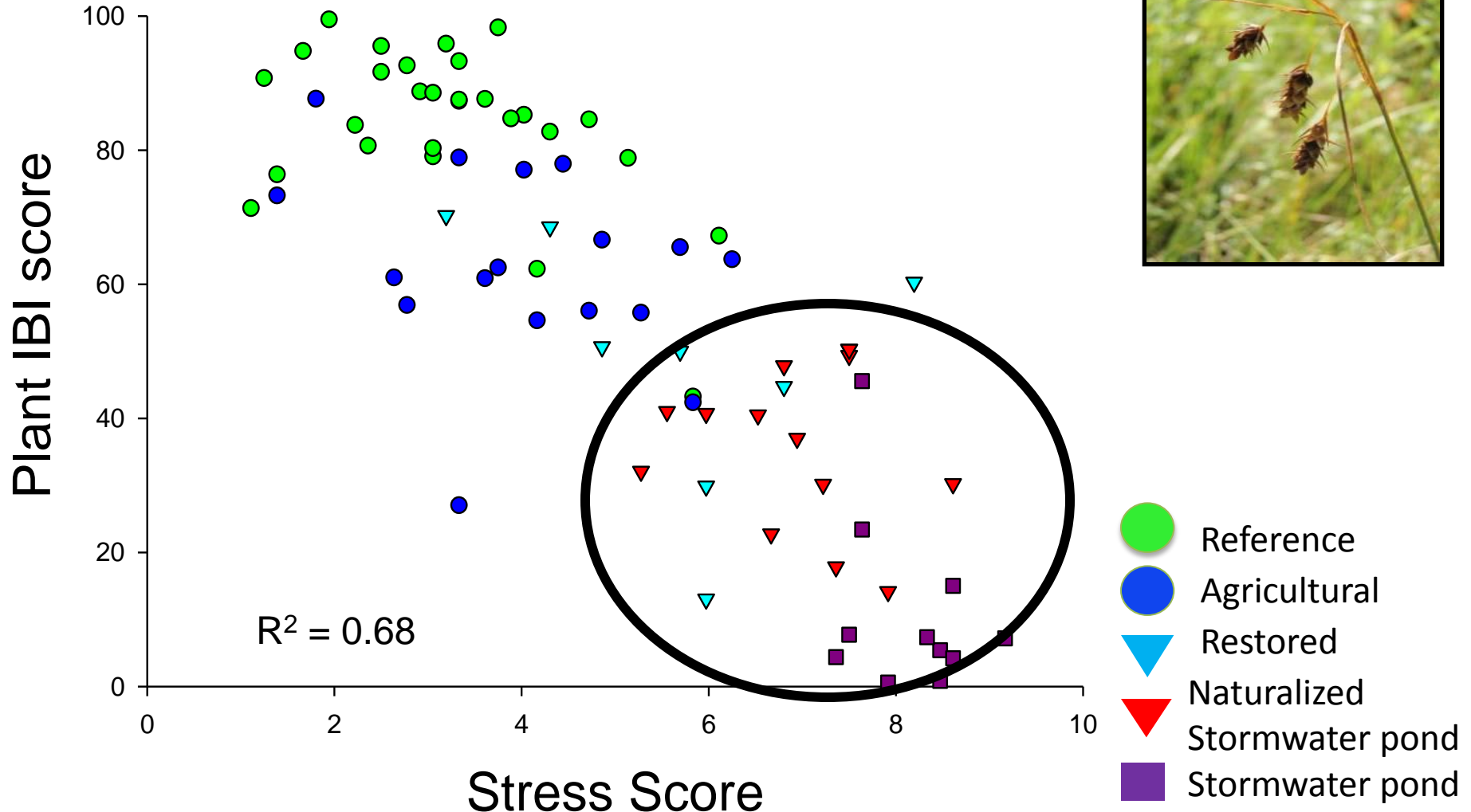
} IBI score



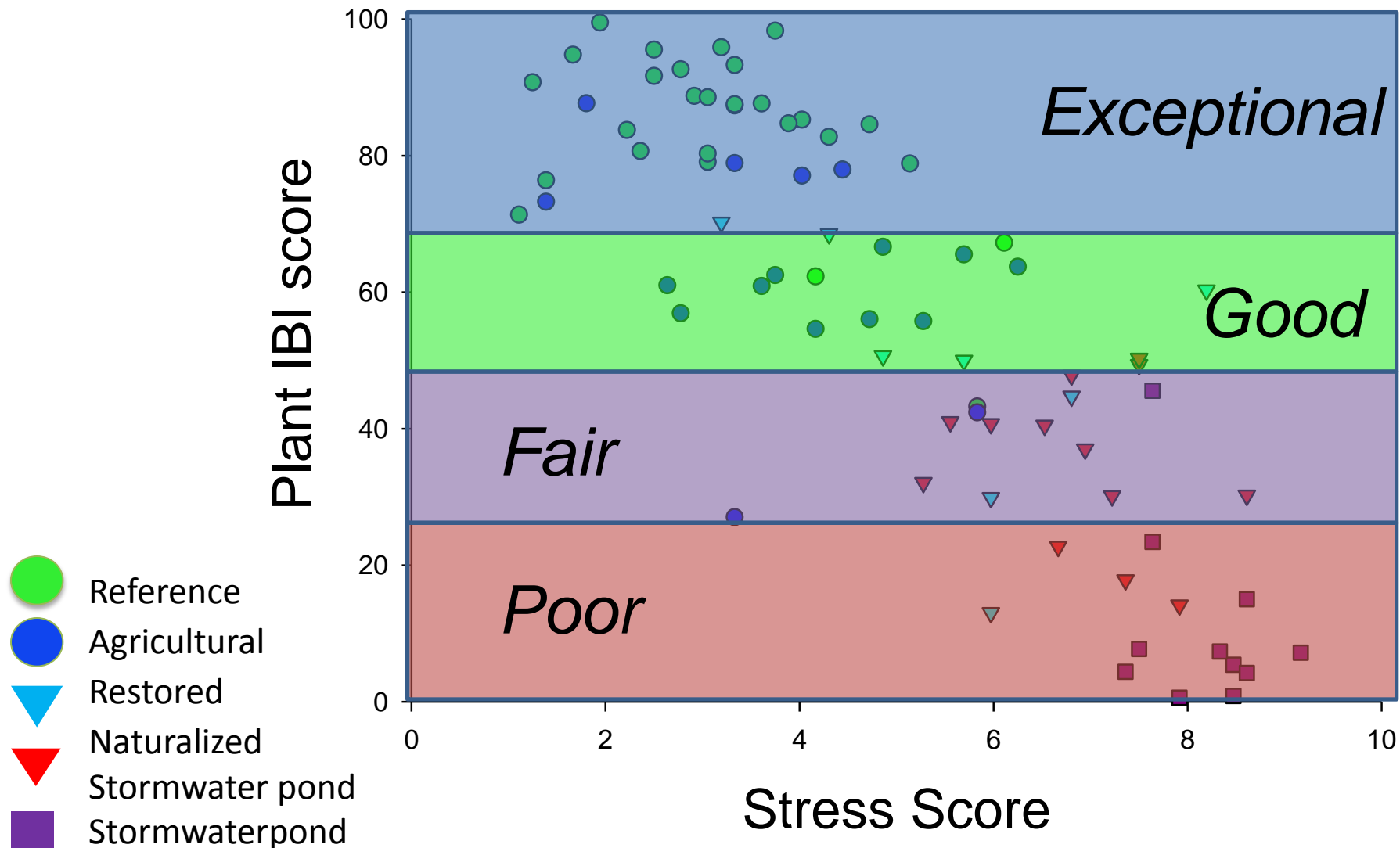
Constructed wetlands have poor condition



Constructed wetlands have poor condition

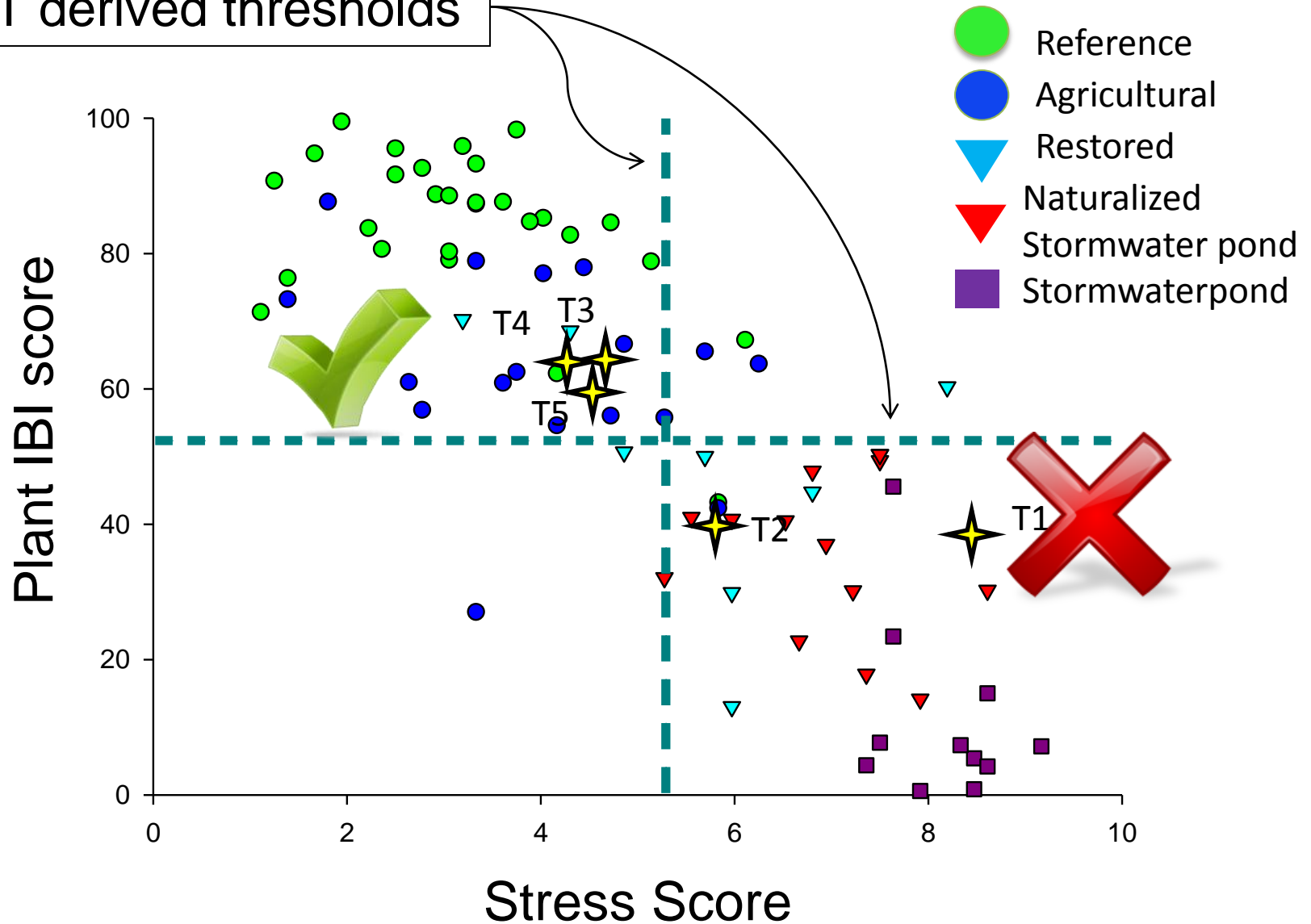


Thresholds for determining compensation ratios: CART analysis

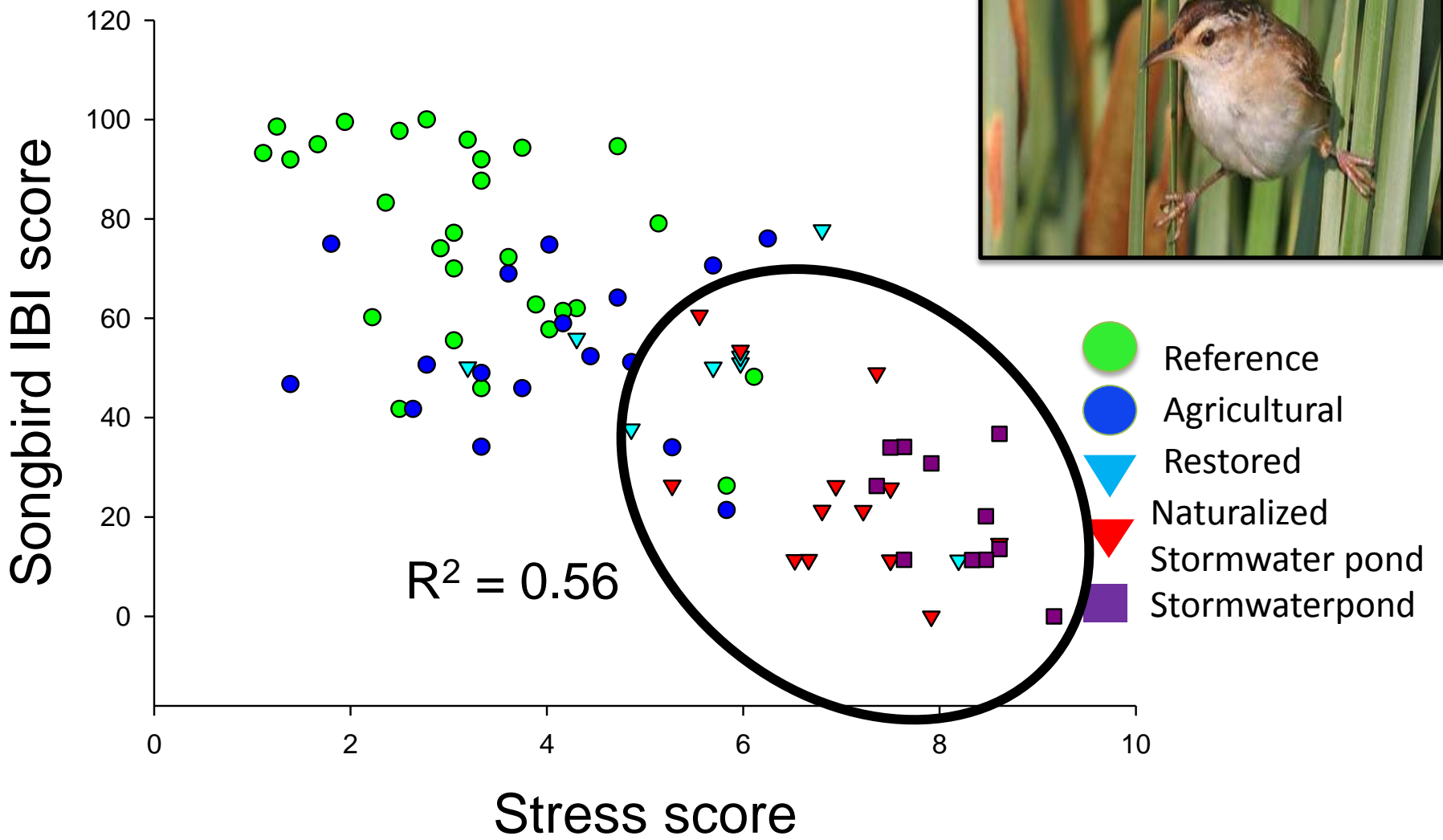


Tools to monitor restoration success

CART derived thresholds



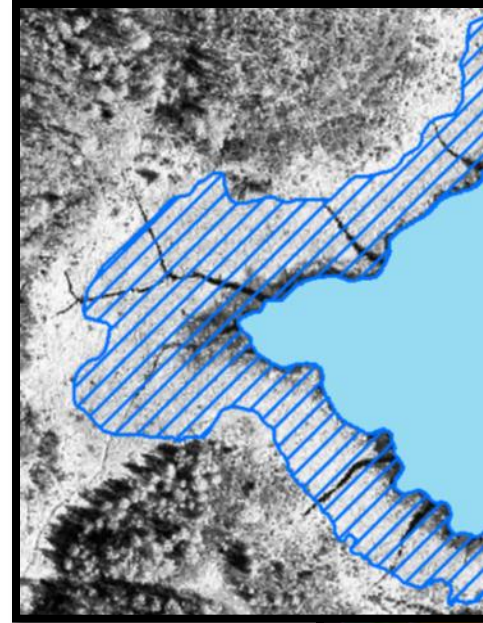
Bird-based IBI: 5 metrics to estimate biological condition



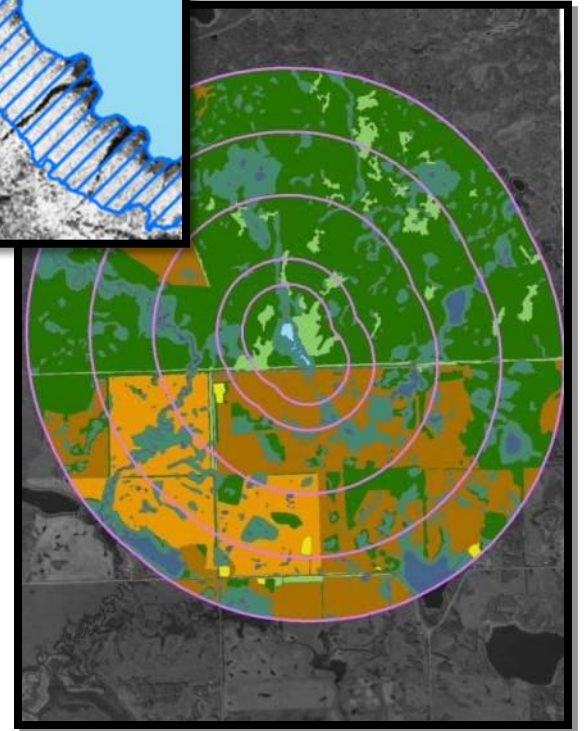
Two approaches to remote estimates of wetland condition

1. Scale-up field-based metrics directly

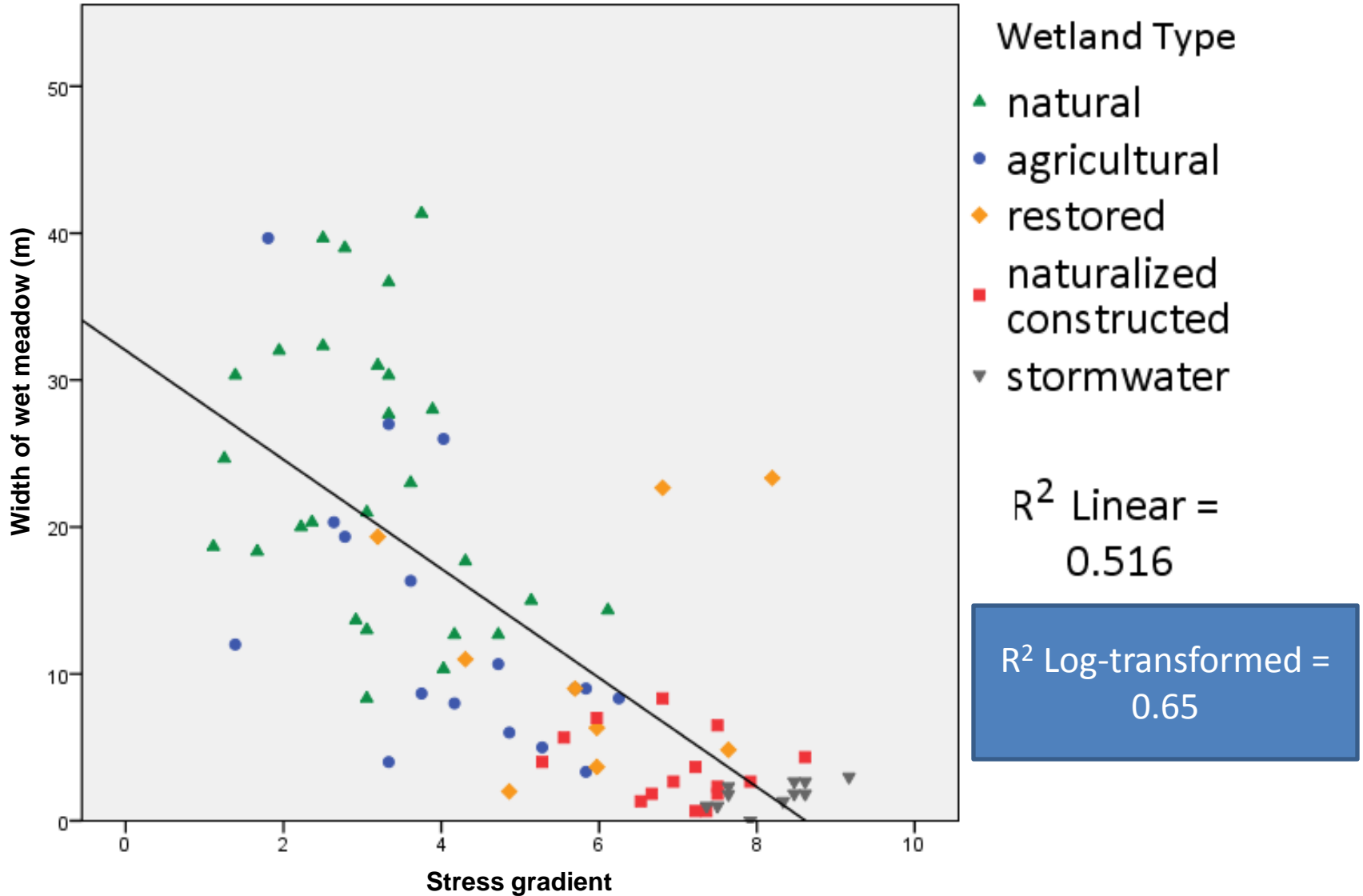
E.g. Marsh zone width



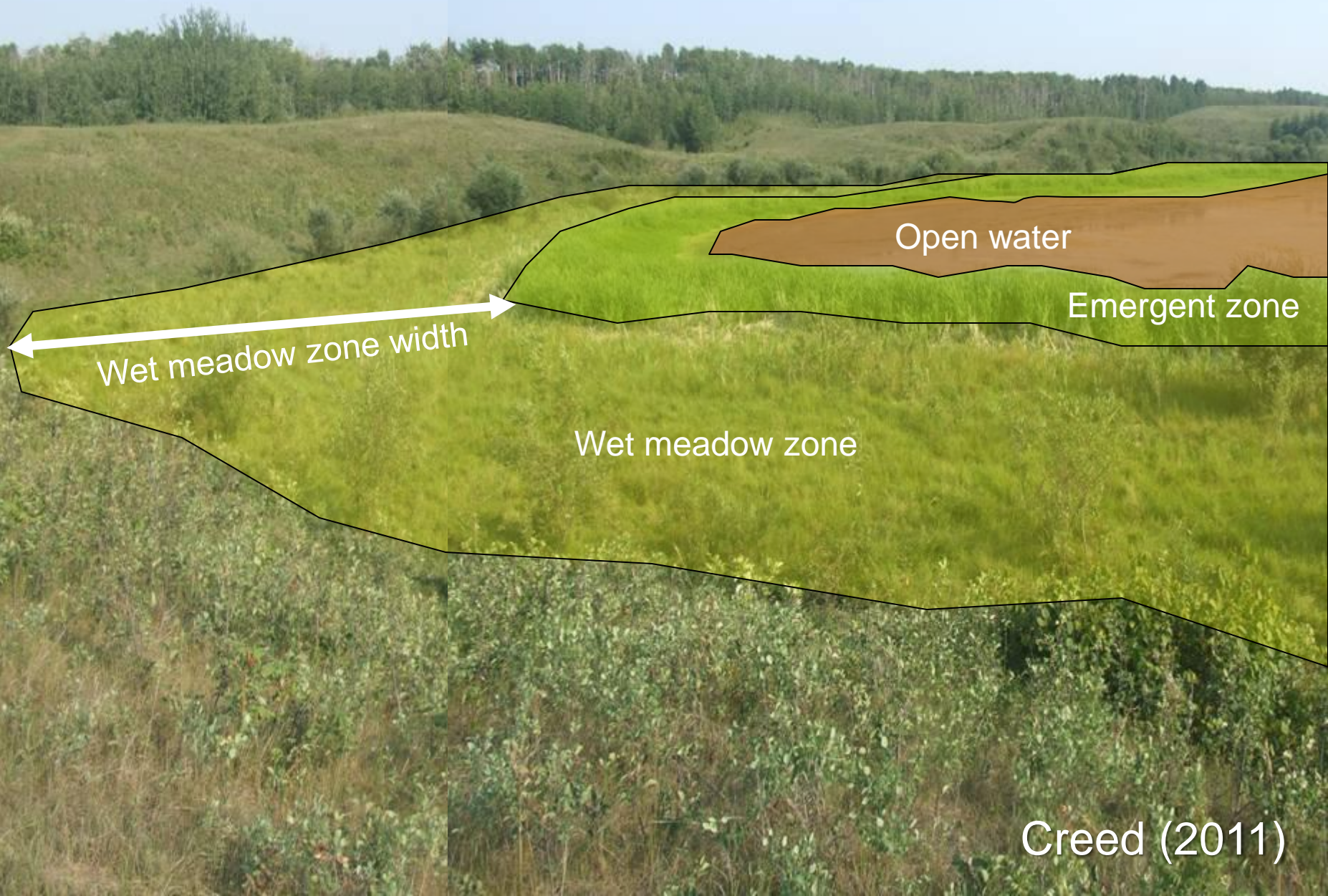
2. Use land use/ land cover models to estimate IBI



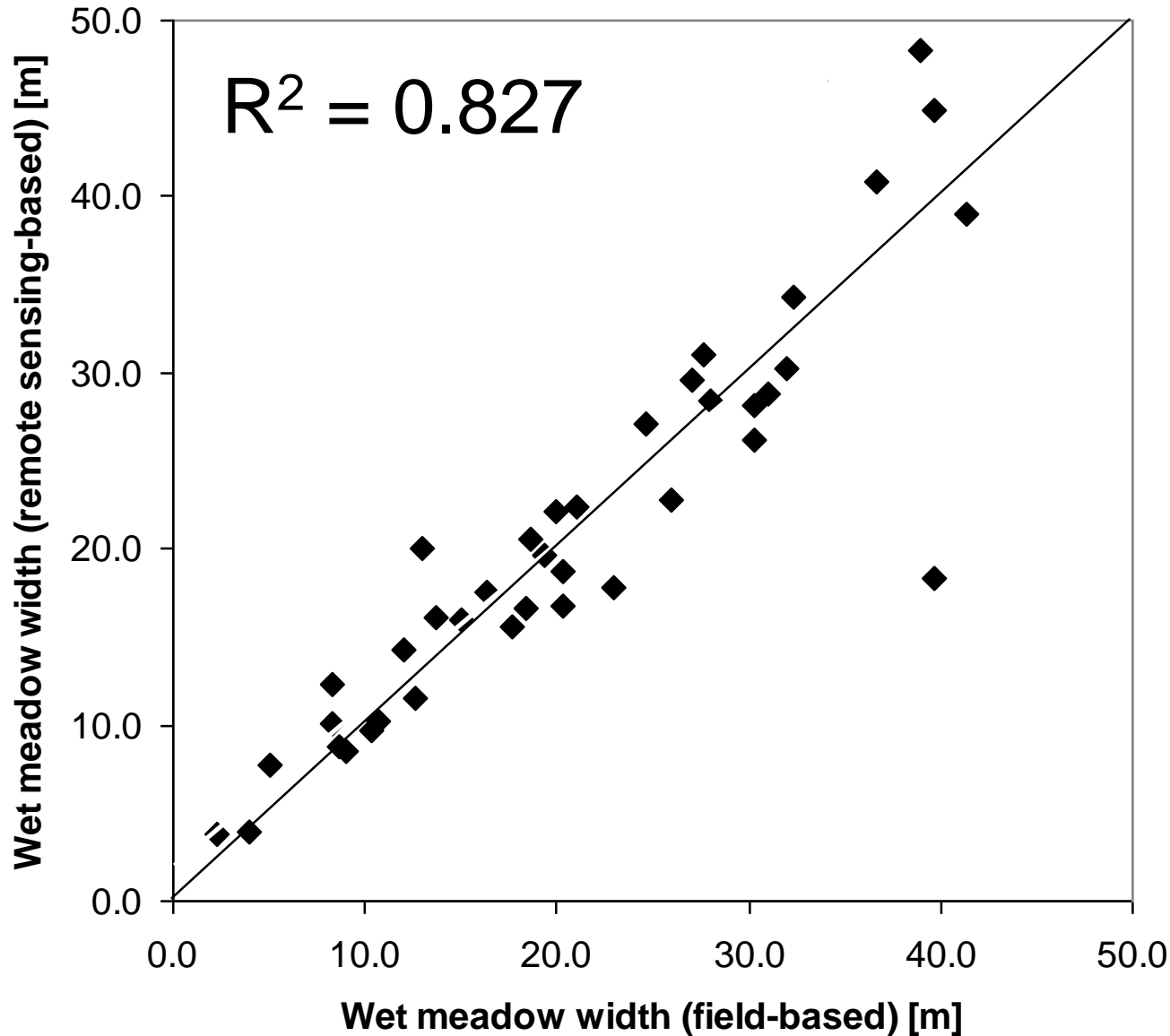
Relationship between stress gradient and width of wet meadow zone



Scaling-up with remote sensing

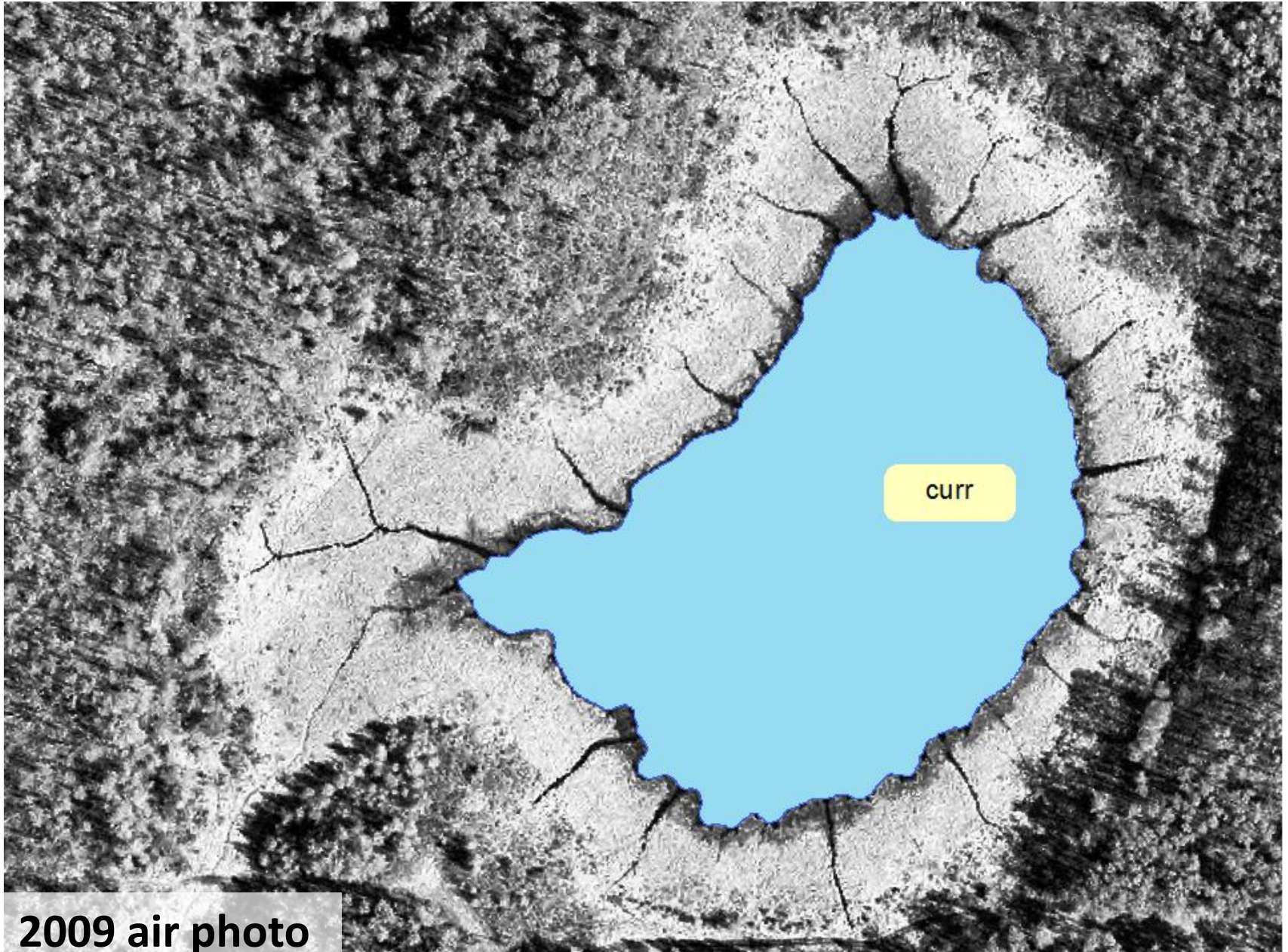


Agreement between field-measured wet meadow zone width and remote estimates of marsh width



Creed and
Bayley (2012)

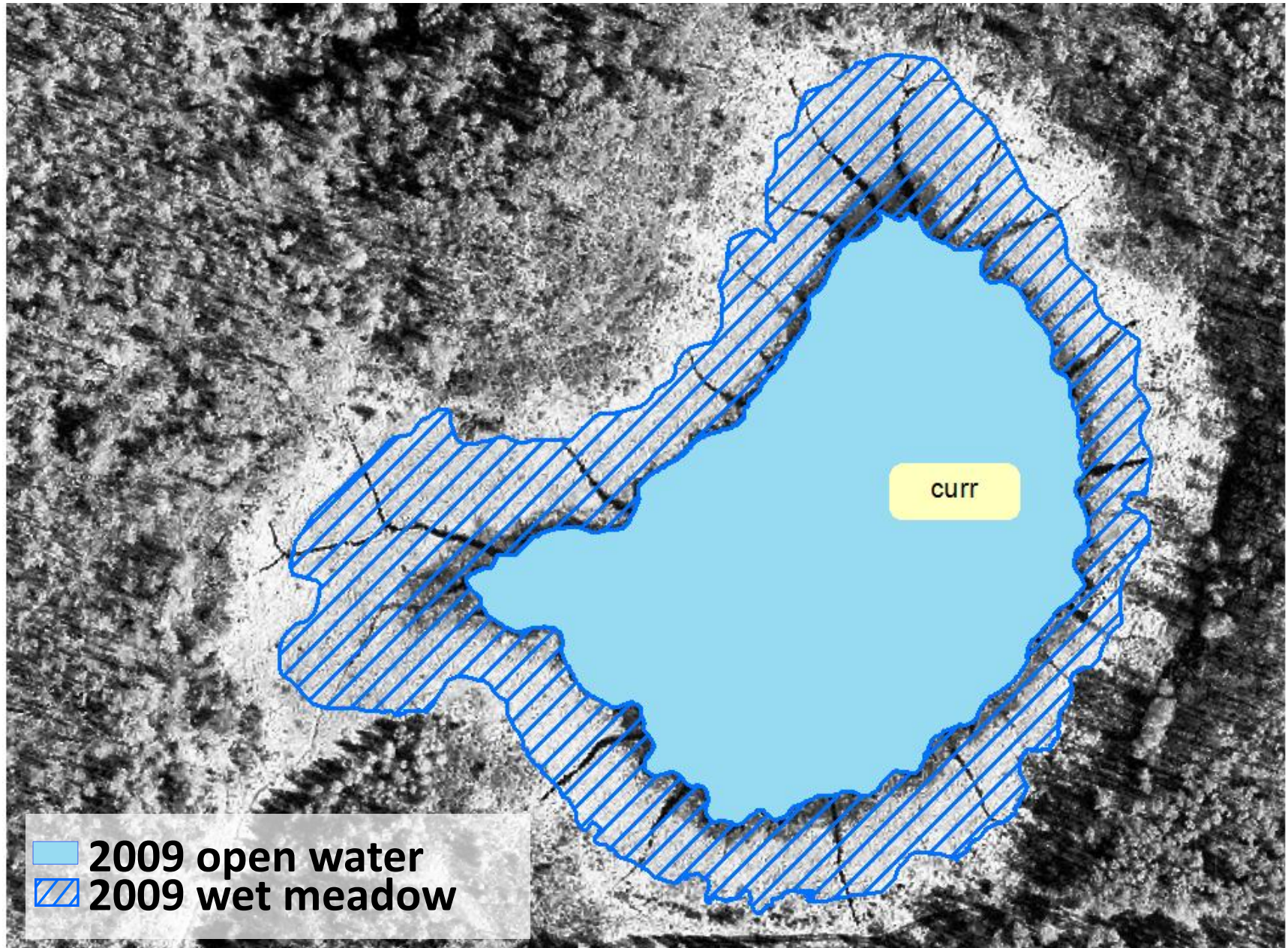
Calculating marsh width remotely



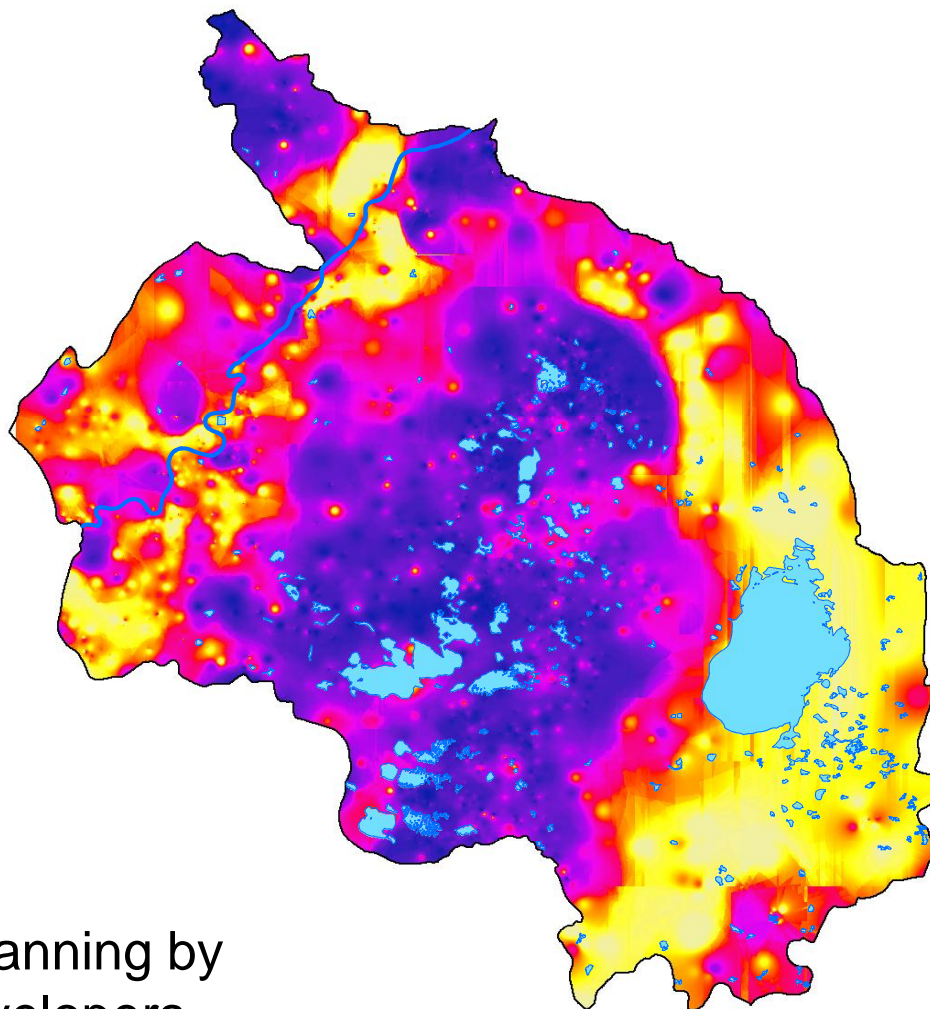
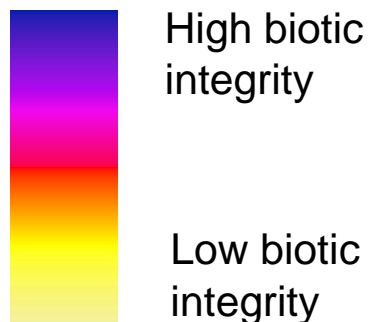
curr

2009 air photo

Calculating marsh width remotely



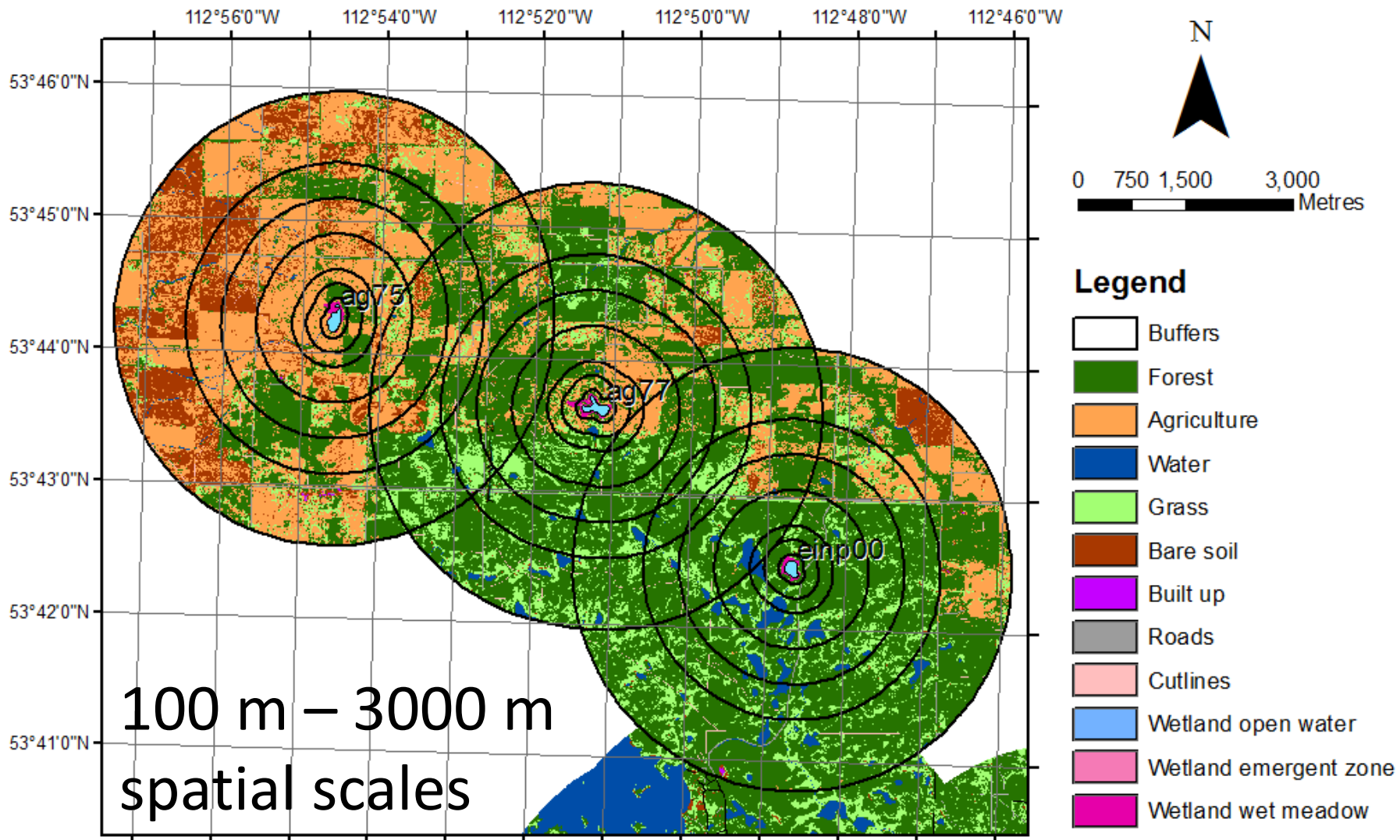
Scale up: extrapolate marsh width to estimate IBI scores for the subwatershed



Can be used to support planning by governments and land developers

Creed and Bayley (2012)

Landscape context: land cover models



Rooney, Bayley, Creed, and Wilson (in press) *Landscape Ecology*.

Landscape context: relationships between land cover and IBI

7 spatial scales

12 land cover types

Models:

IBI = land cover + road density



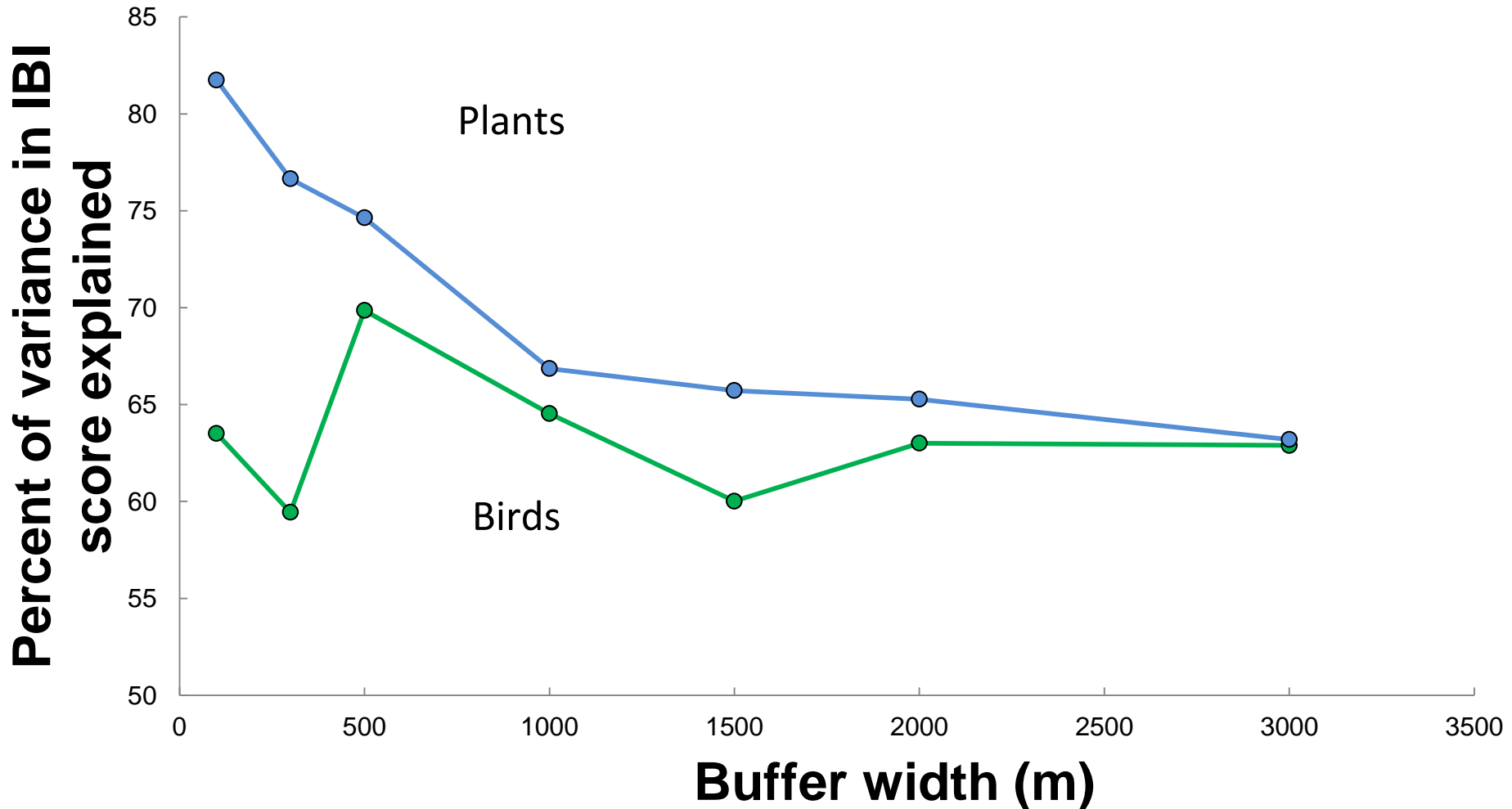
Rooney, Bayley, Creed, and Wilson (in press) *Landscape Ecology*.

Common themes among all models

- Models predicting plant and songbird biotic integrity all included
 - Roads or road density
 - % agriculture & % urban, or % forest



Optimal buffer width varied with biotic assemblage



Rooney, Bayley, Creed, and Wilson (in press) *Landscape Ecology*.

Scaling-up vs. modeling

- Scaling up marsh zone width
 - **Direct** measure of field-based metric related to stress
- Land cover models
 - **Indirect** measurement of stress due to human activity in the surrounding landscape

	Plant-based IBI	Bird-based IBI
% variance explained by marsh zone width	57%	52%
% variance explained by optimal land cover model	82%	70%

Potential applications of tools

1. Improved planning at multiple scales

- Remote sensing allows for landscape level planning in advance of site-specific impacts
- Can “rank” wetlands according to their health, allowing for prioritization
- Identify potential restoration sites

2. Standardized assessment methods

- Allows for direct comparisons between wetlands
- Ability to compare impact and compensation sites

3. Scientific basis for calculating compensation ratios

- Ratios based on scientific quantification of selected metrics of wetland function

Acknowledgements

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Thank you