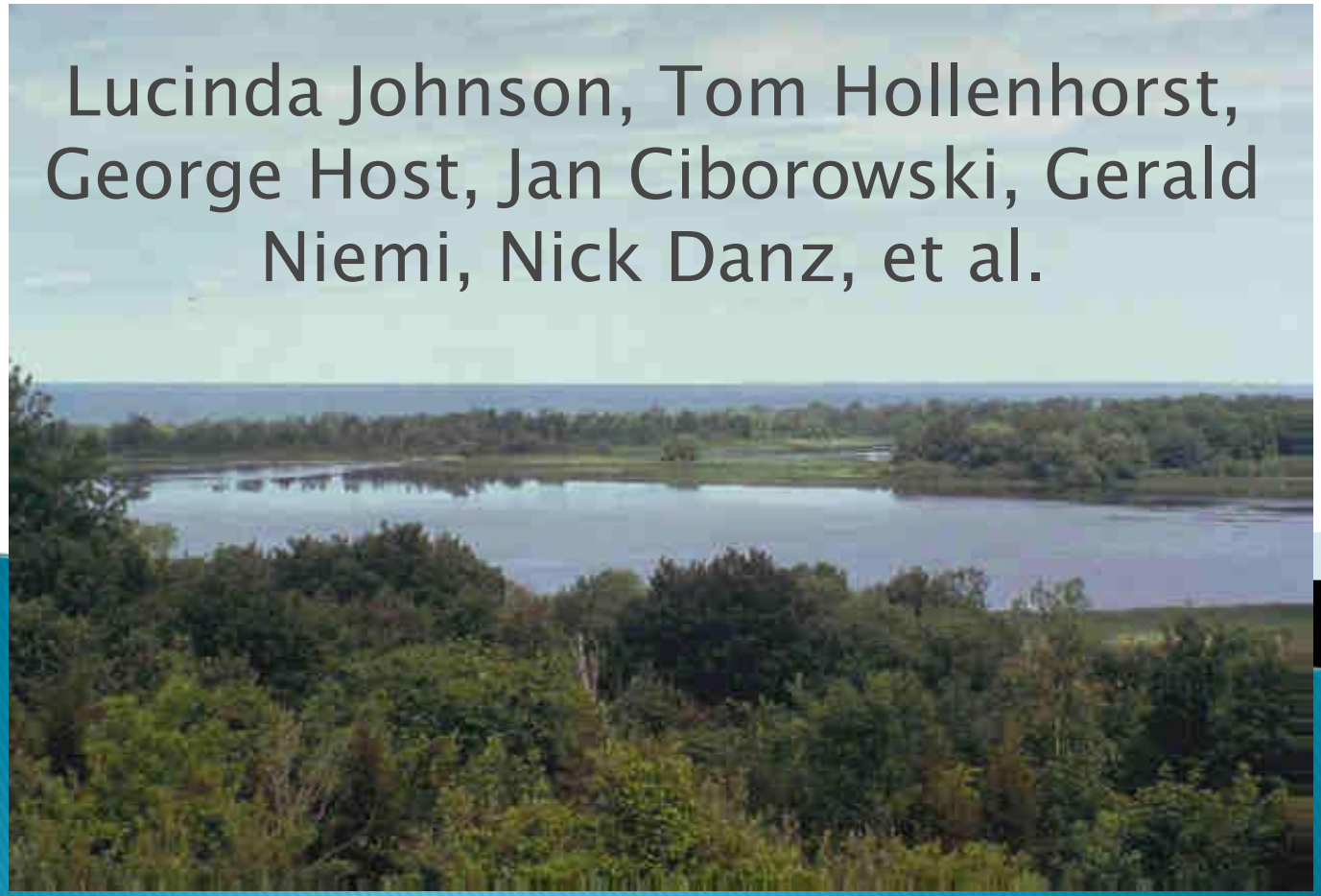
Multivariate summary of loadings & watershed weightings

Lucinda Johnson, Tom Hollenhorst, George Host, Jan Ciborowski, Gerald Niemi, Nick Danz, et al.

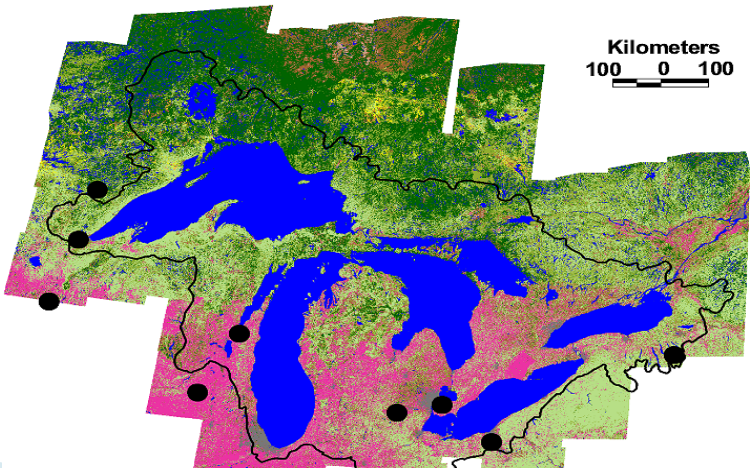


Great Lakes Environmental Indicators Initiative

Go What indicators can effectively, efficiently, and economically measure and monitor the condition of the Great Lakes coastal region as well as point to causes of impairment?

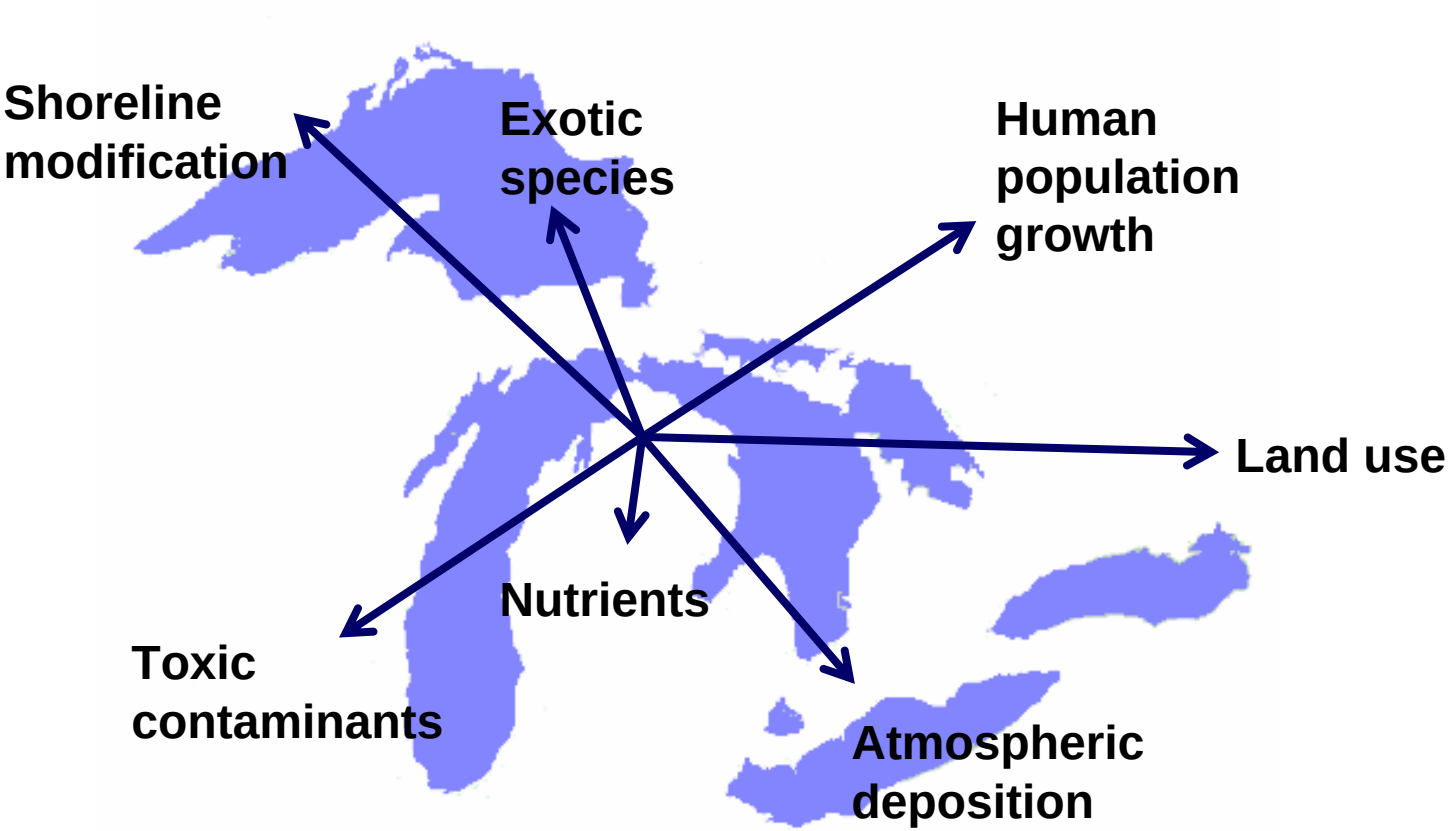
Objectives

1. Identification of potential and useful environmental indicators
2. Comprehensive examination of **relationships between stress and responses** to provide a diagnosis for causes of impairment
3. Recommend a suite of hierarchically-structured indicators that are useful for making informed management decisions

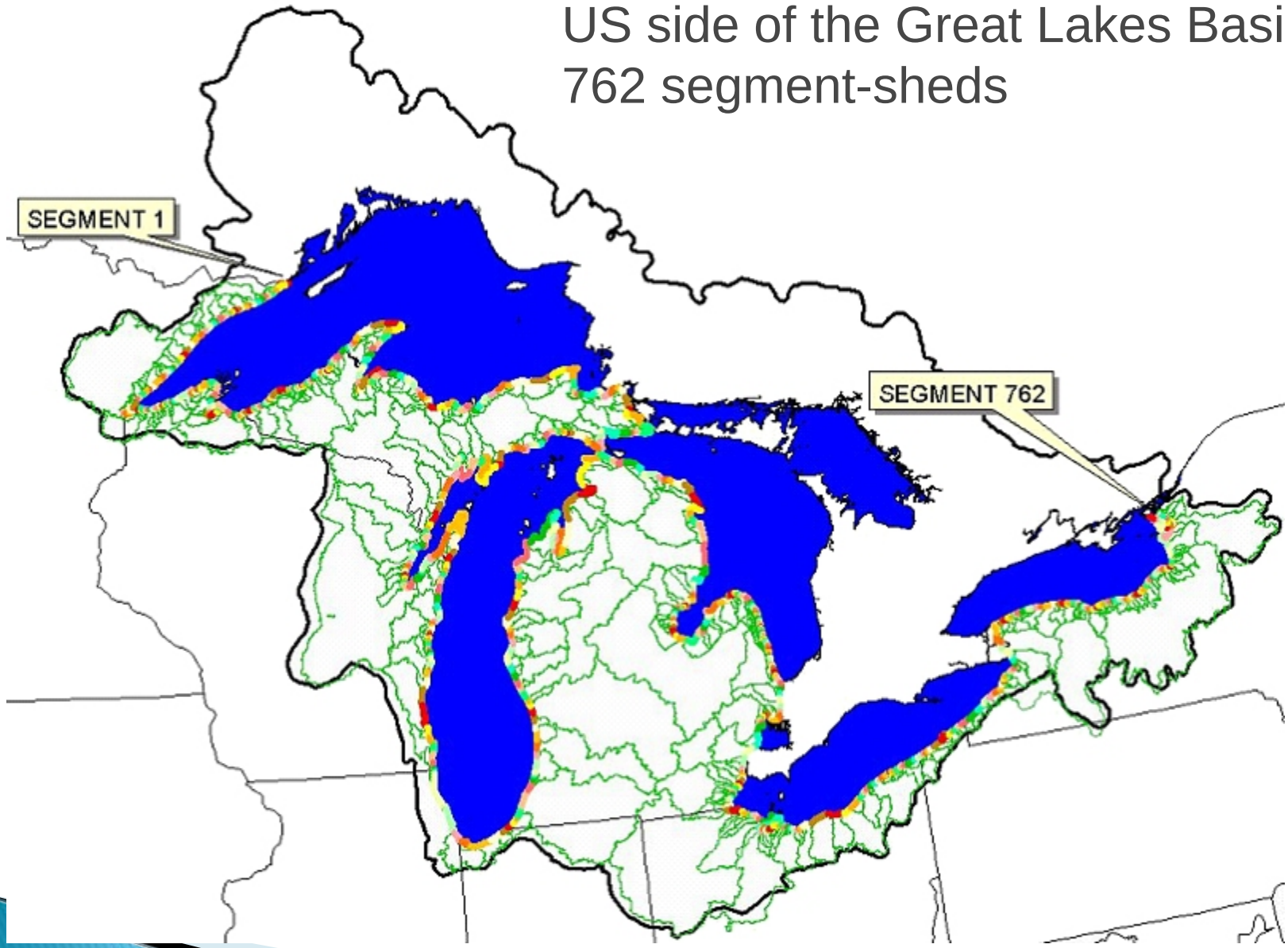


US Great Lakes Stressor Gradient

- large geographic extent (> 6500 km of coastline; > 750 wetlands)
- many important human disturbances – overlapping in space and time



Sampling Domain:
US side of the Great Lakes Basin,
762 segment-sheds

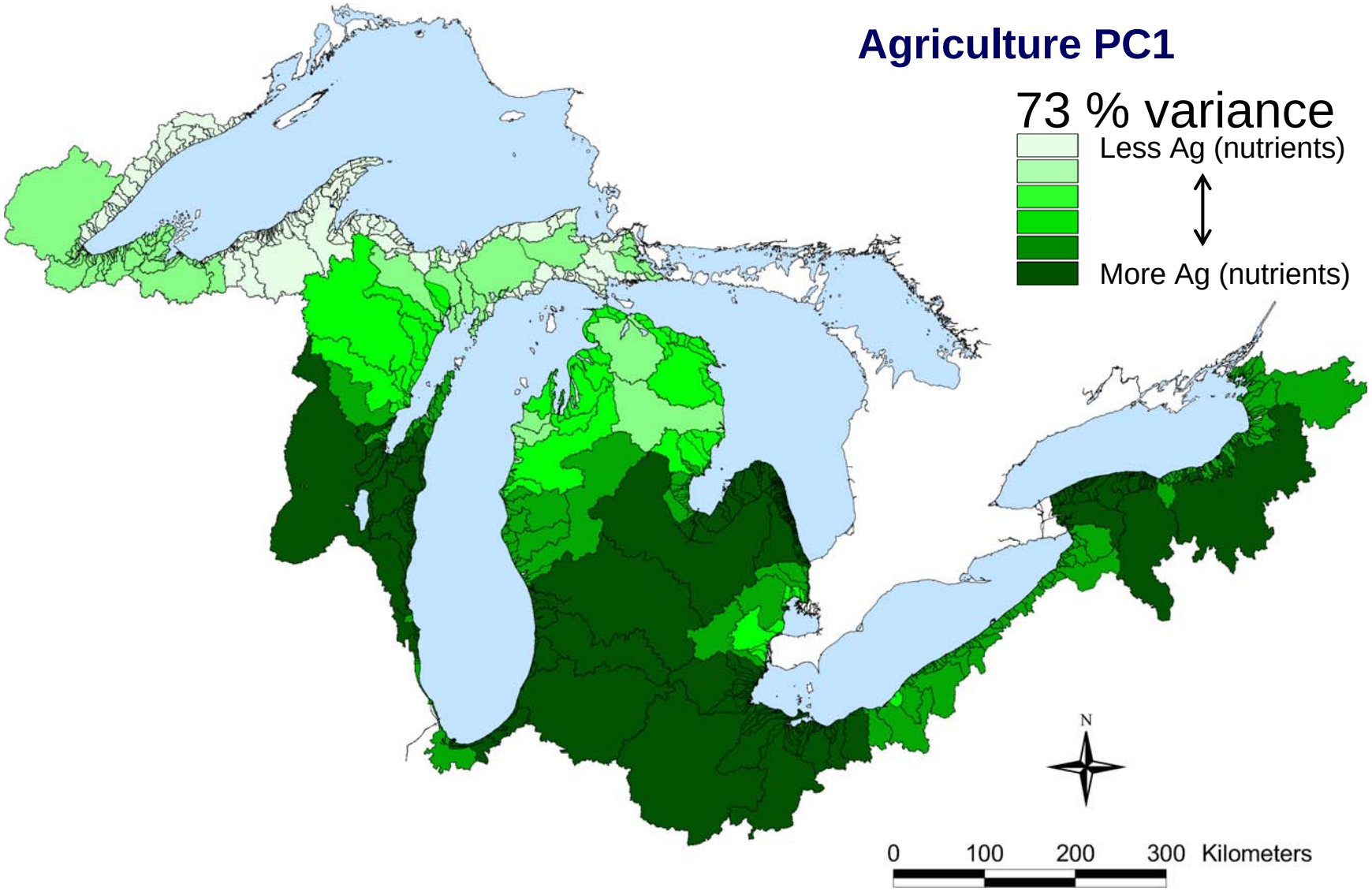


Categorize GIS variables by type of human disturbance and soils (accounting for natural variation in landforms)

Categories	*n* Variables
Agricultural / Ag. Chemical	21
Atmospheric Deposition	11
Land Cover	23
Human Population / Development	14
Point and Non-point Pollution	79
Shoreline Protection	6
Soils	53
Total	207

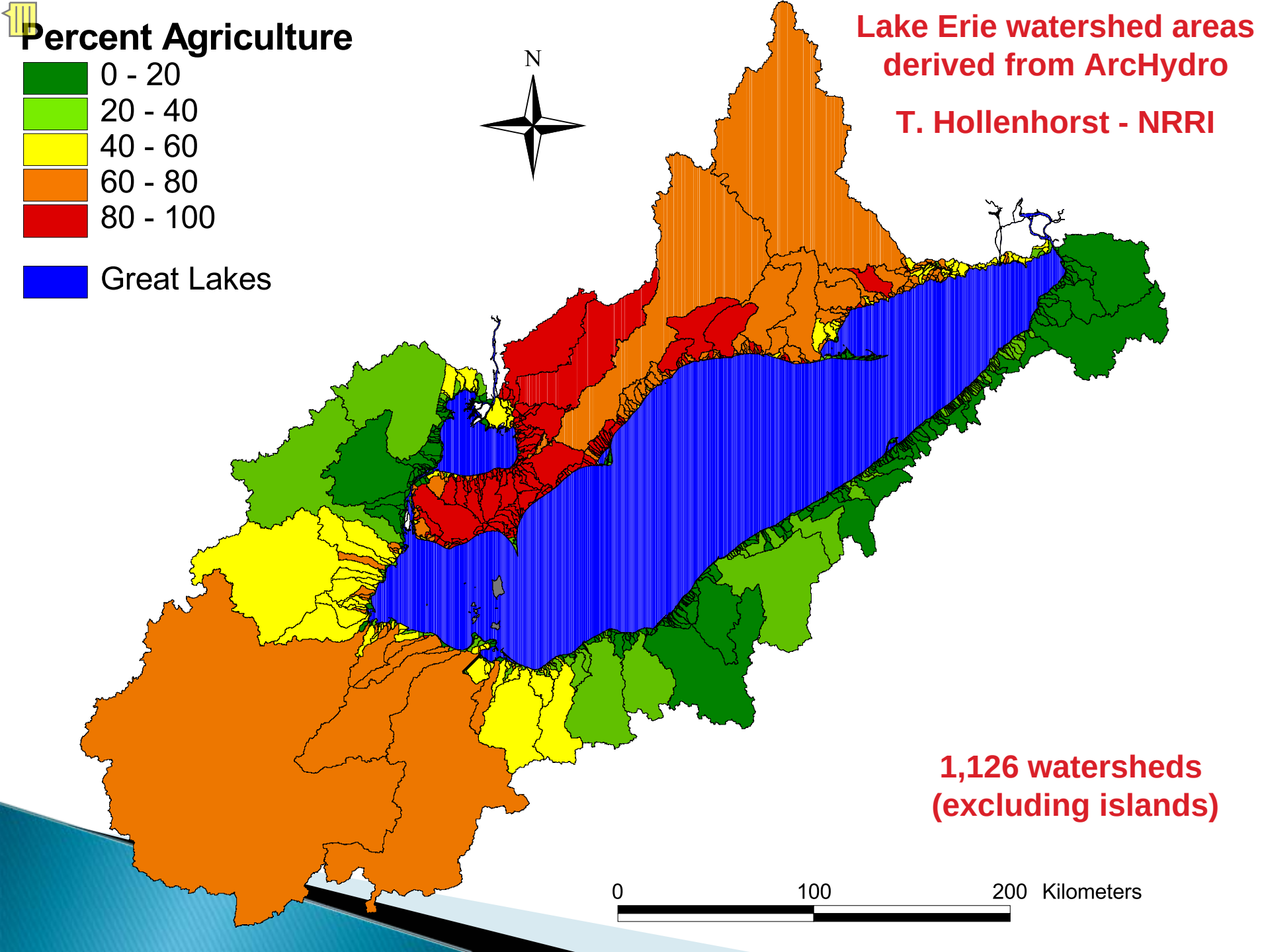
Danz et al., (2005)
Env. Monit. Assess.

Agriculture PC1



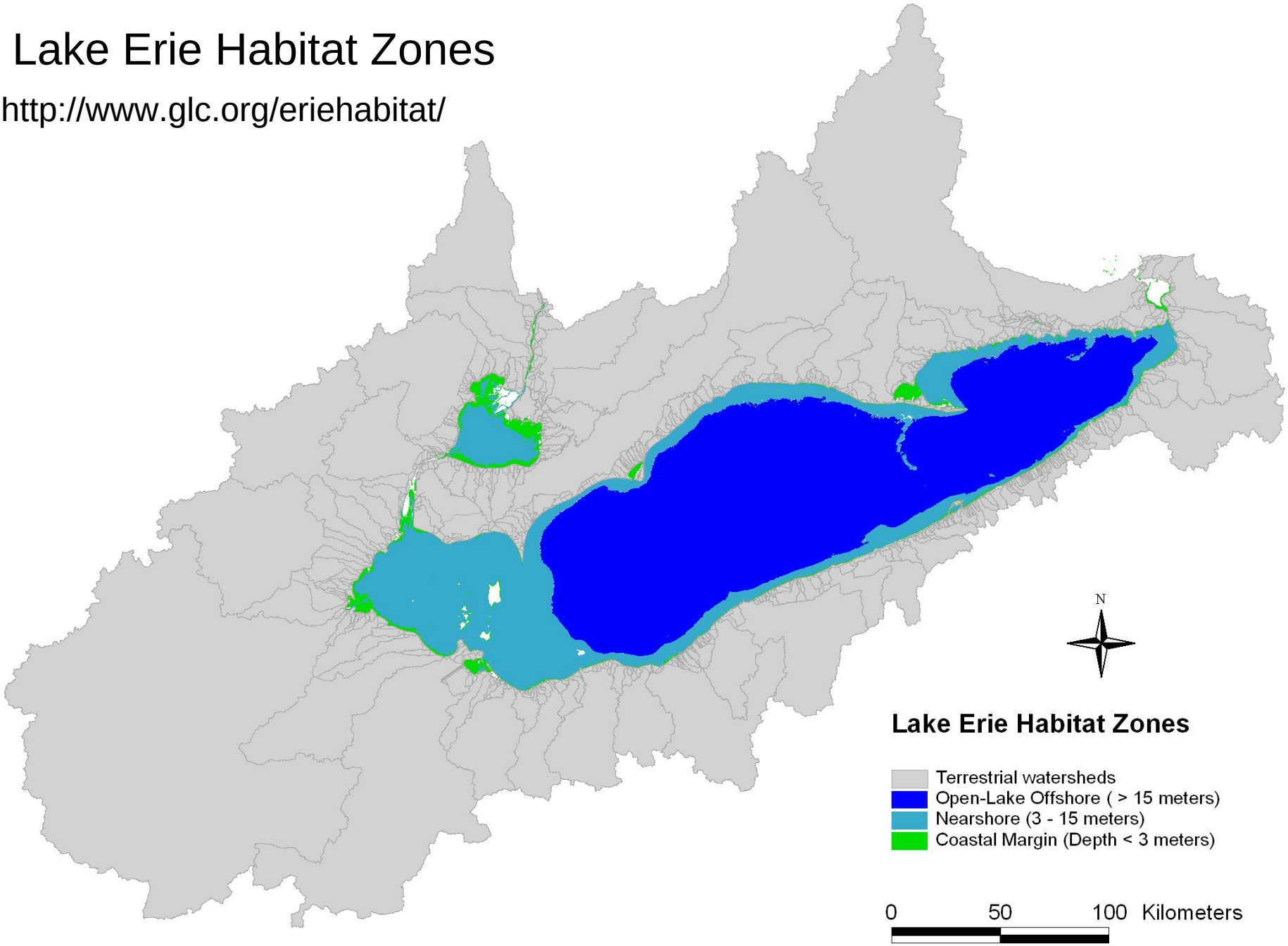
Danz et al., (2005) Env. Monit. Assess.

GLEI

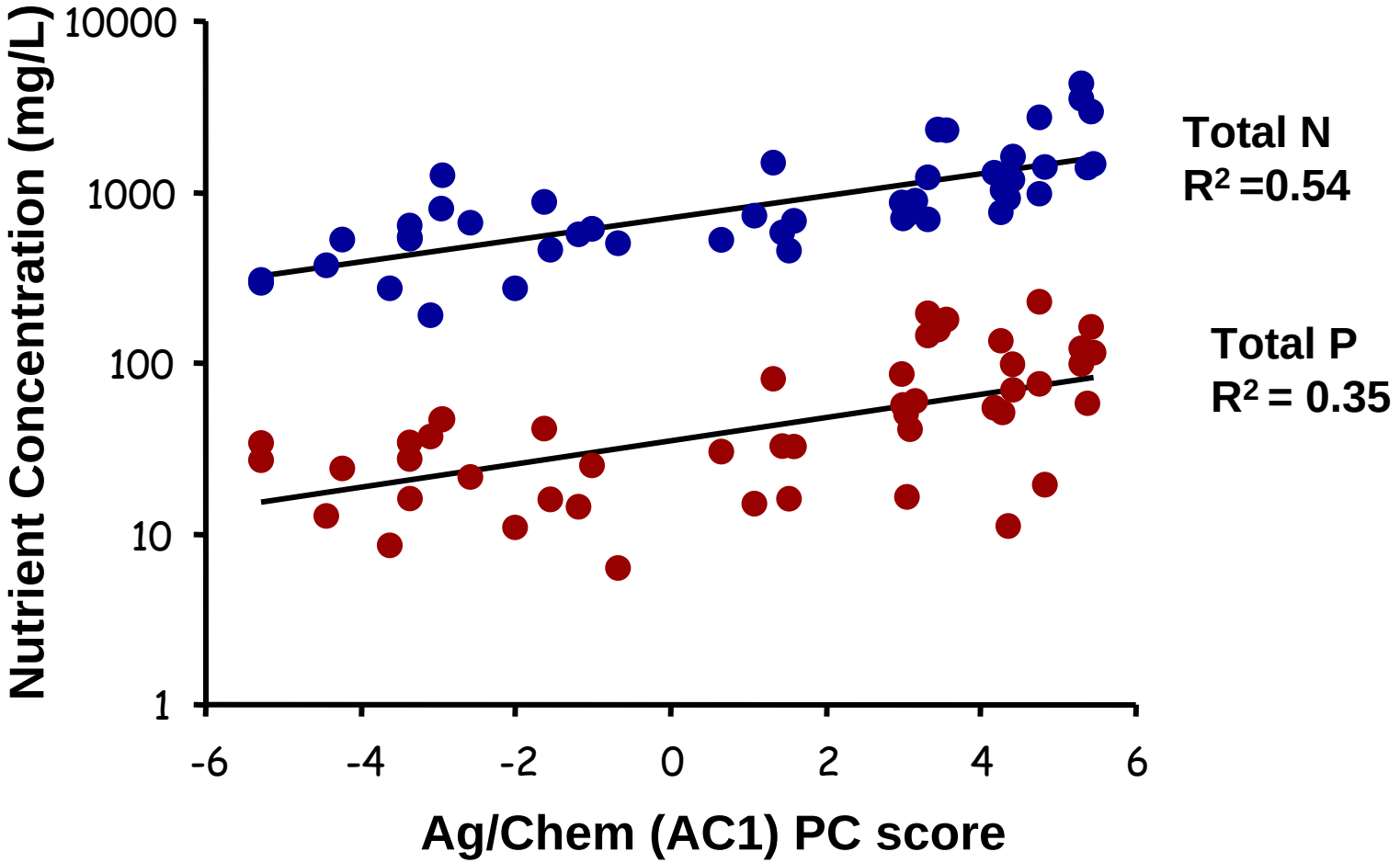

Percent Agriculture
0 - 20
20 - 40
40 - 60
60 - 80
80 - 100
Great Lakes
N
Lake Erie watershed areas
derived from ArcHydro
T. Hollenhorst - NRRI
1,126 watersheds
(excluding islands)
0
100
200 Kilometers

Lake Erie Habitat Zones

http://www.glc.org/eriehabitat/



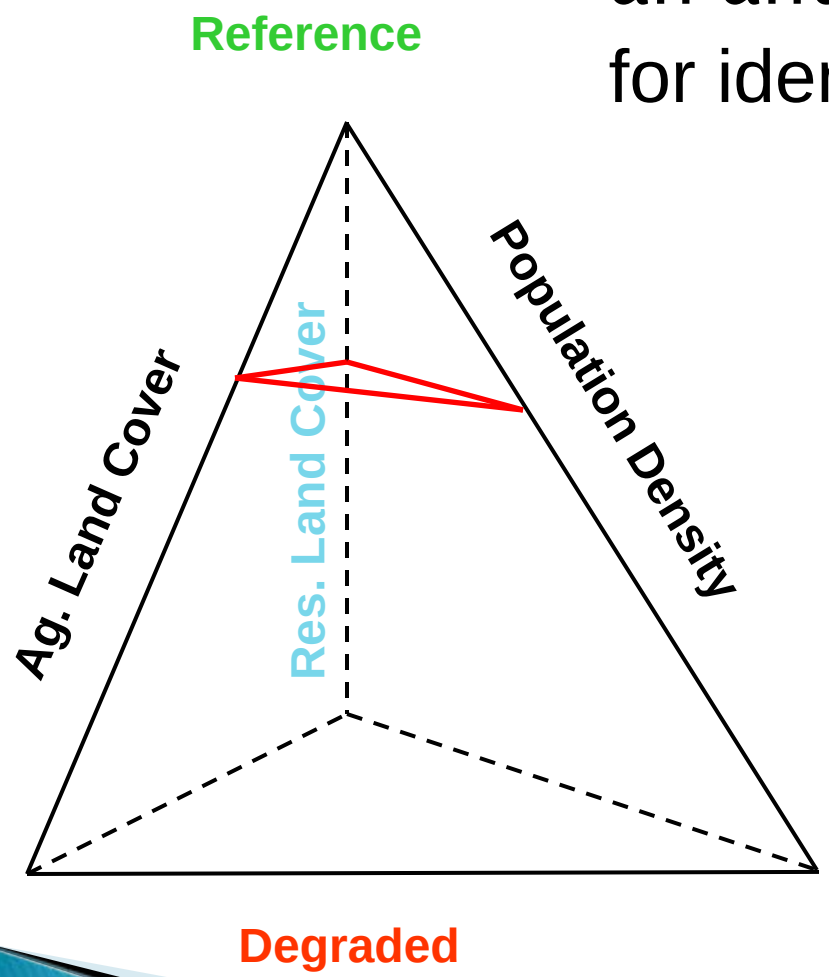
Nutrient concentrations in Great Lakes coastal wetlands



Morrice et al.,
In preparation

Axis of Anthropogenic Stress:

an anthropogenic stress model for identifying reference conditions



Objective:

Identify habitats with minimum anthropogenic pressure values across multiple stress axes

Host et al. IJRS 2006

Integrating across stressors: Calculating "MaxRel" & "SumRel"

MaxRel = Max(Agriculture, Residential, Population, Roads, NPDES)

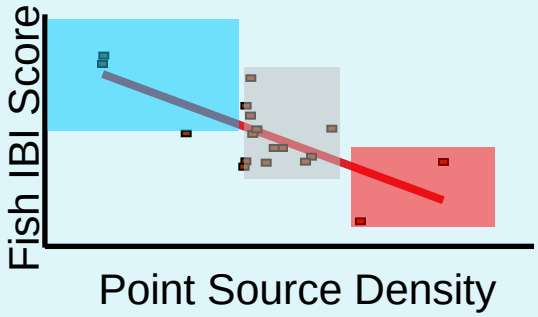
SumRel = Sum(Agriculture, Residential, Population, Roads, NPDES)

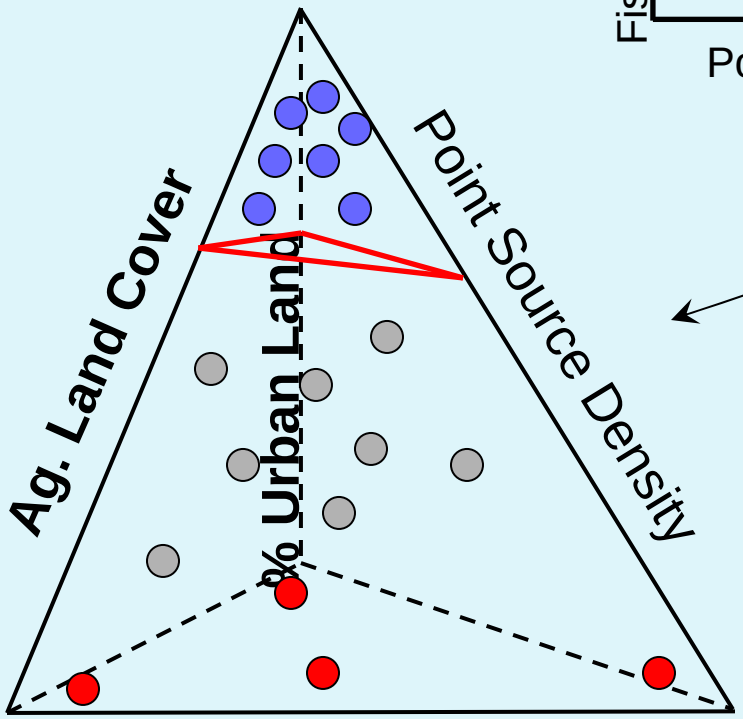
Watershed Summary		Scaled Value	Score for Pixel/Polygon
Ag	125	0.352	0.352
Res	96	0.254	
Pop	.306	0.156	
Roads	1.6	0.187	
NPDES	5159	0.089	

Variables are transformed, normalized and scaled from 0-1

Reference / Degraded Ecosystems

Reference

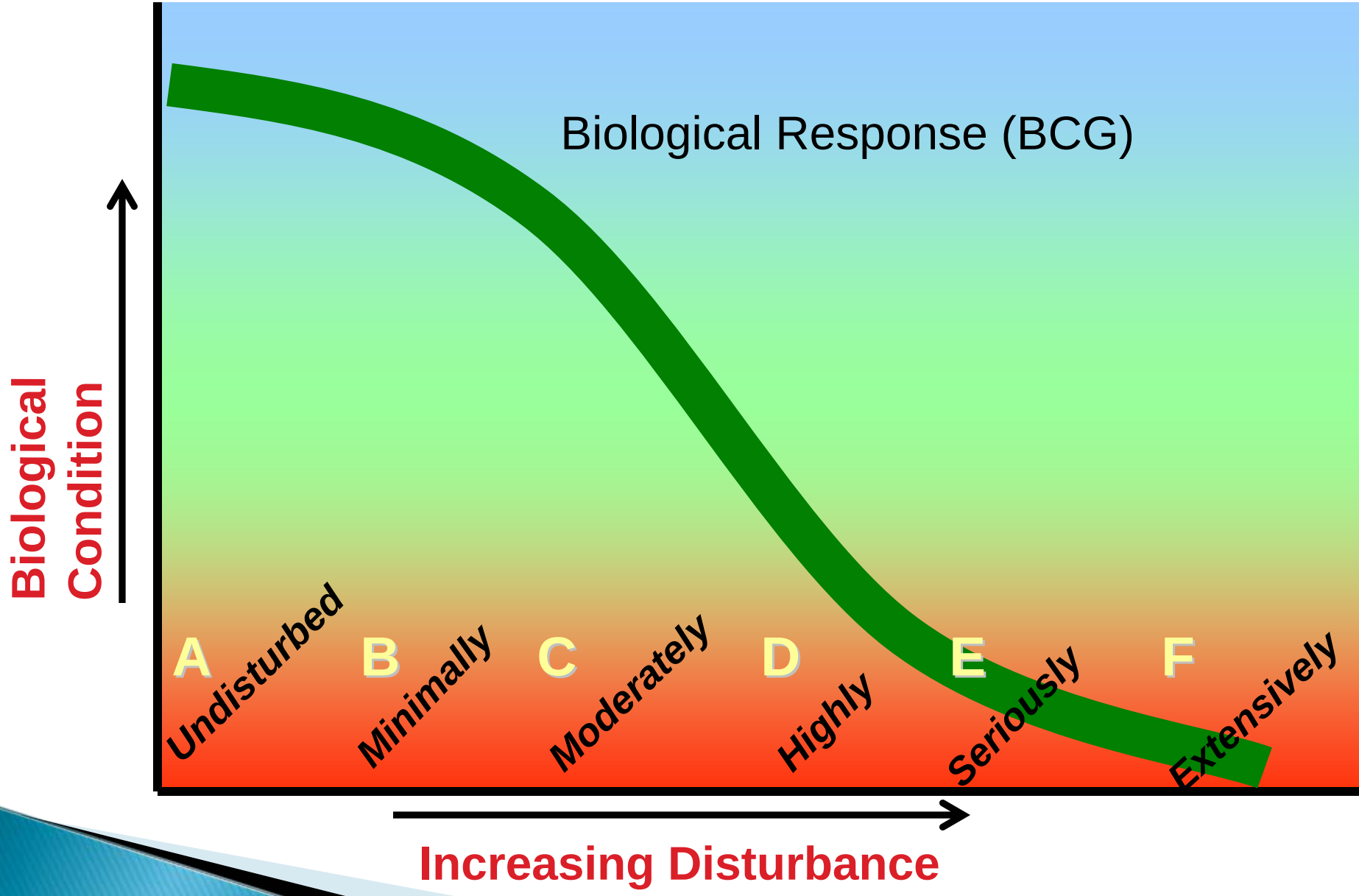


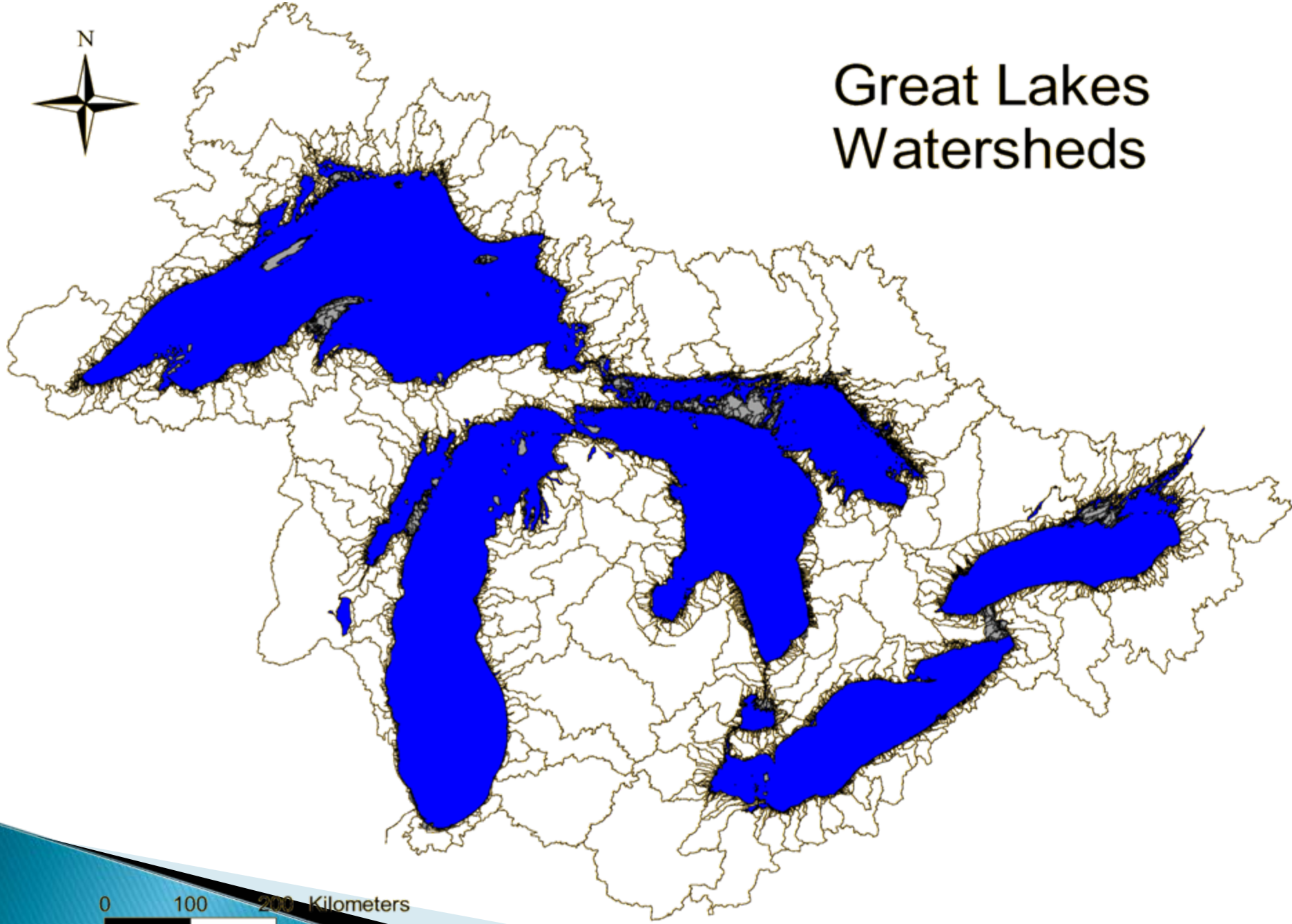


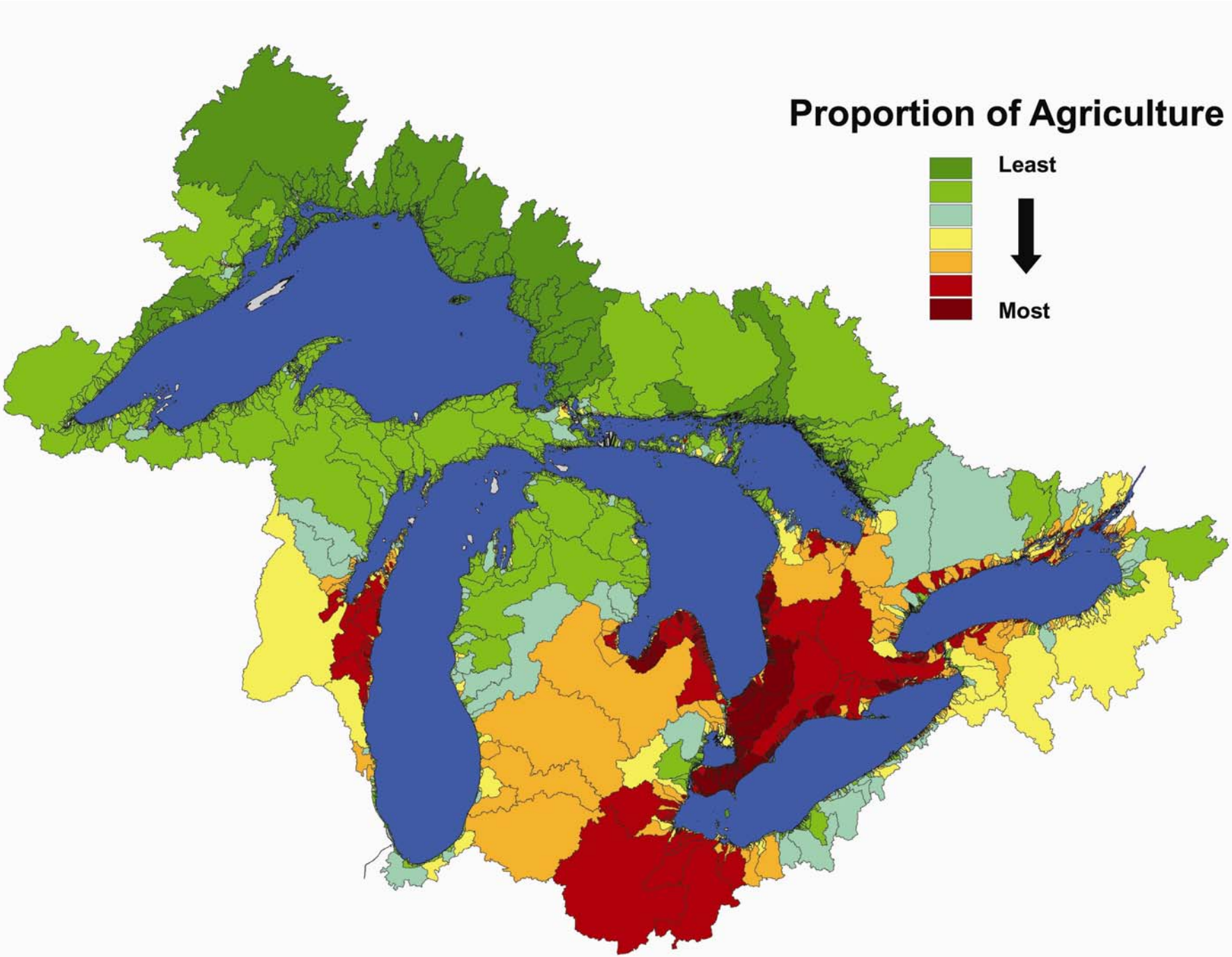
Degraded

Ciborowski, et al., in Prep.

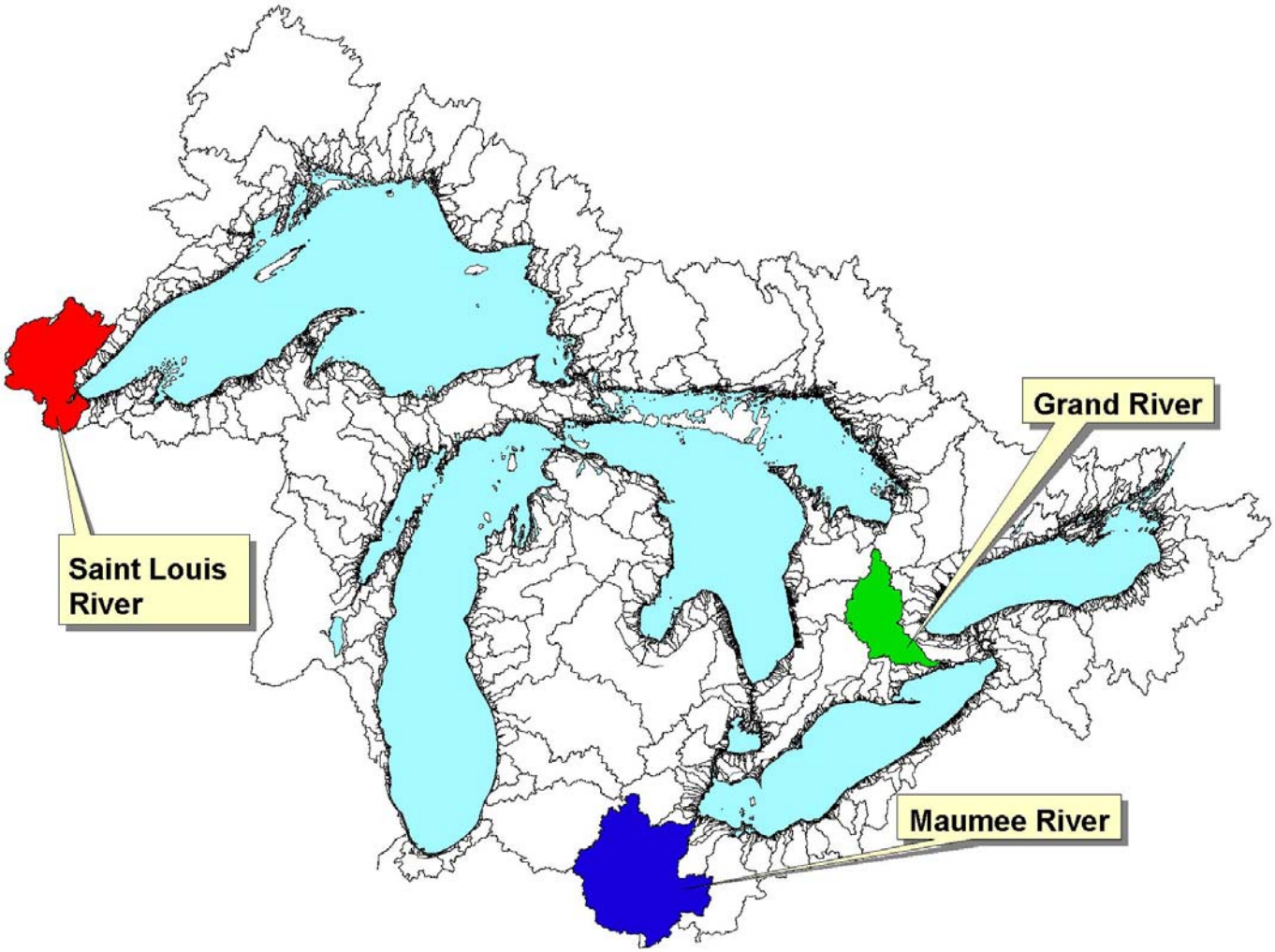
Narrative Model: The HDG

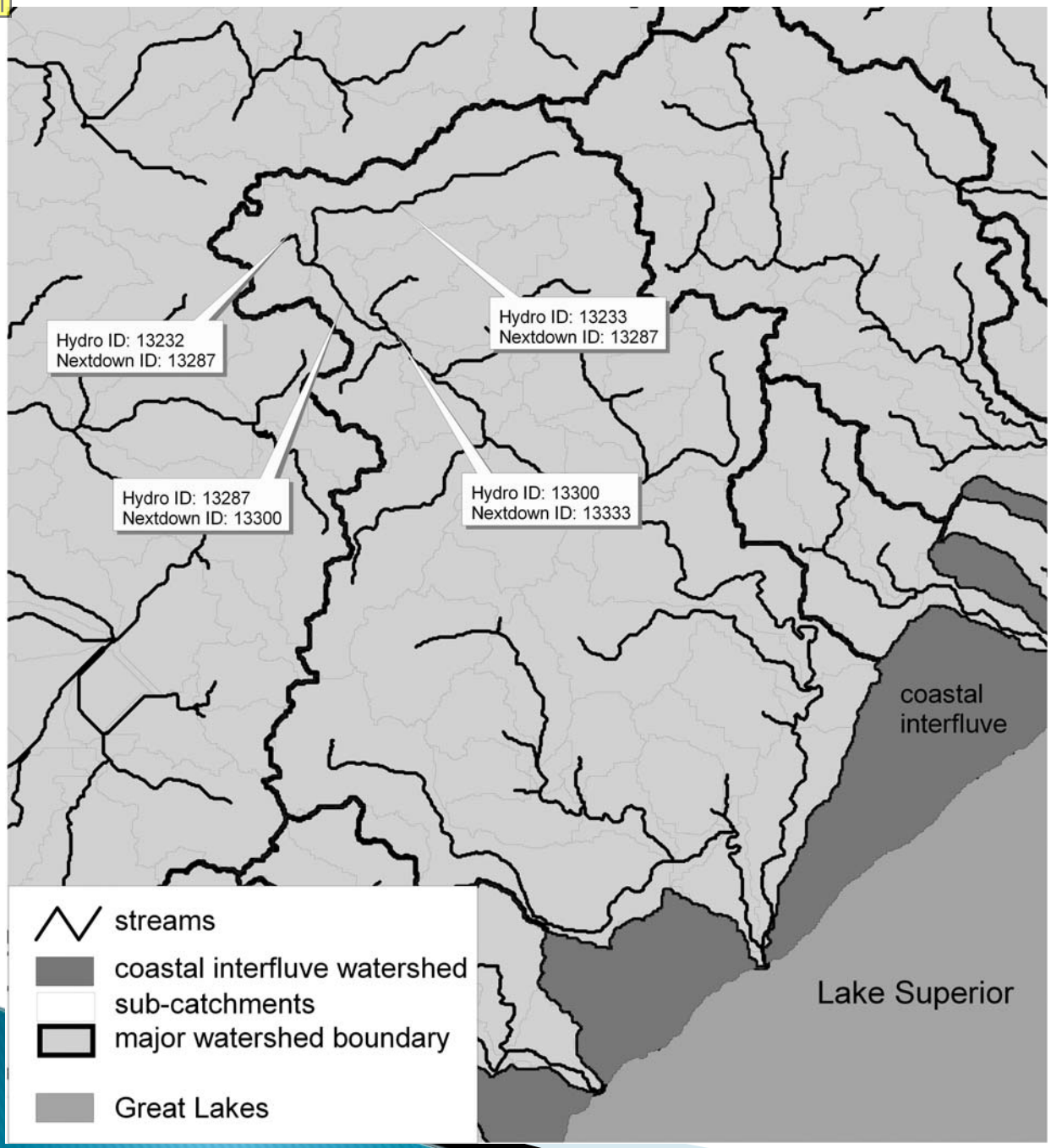



N
Great Lakes
Watersheds
0
100
200 Kilometers


Proportion of Agriculture
Least
Most

Detailed ArcHydro Delineations

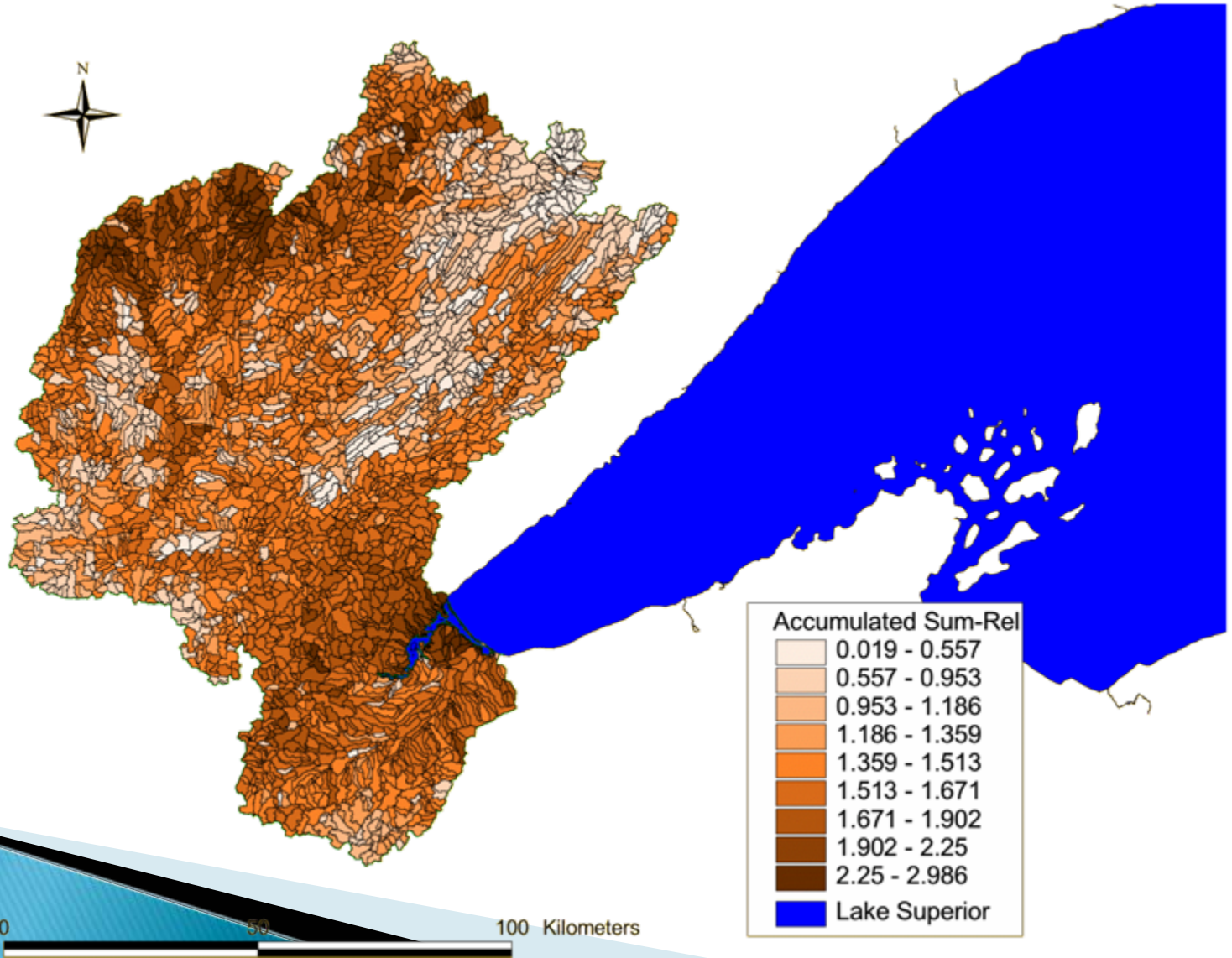




Network connectivity of ArcHydro catchments.

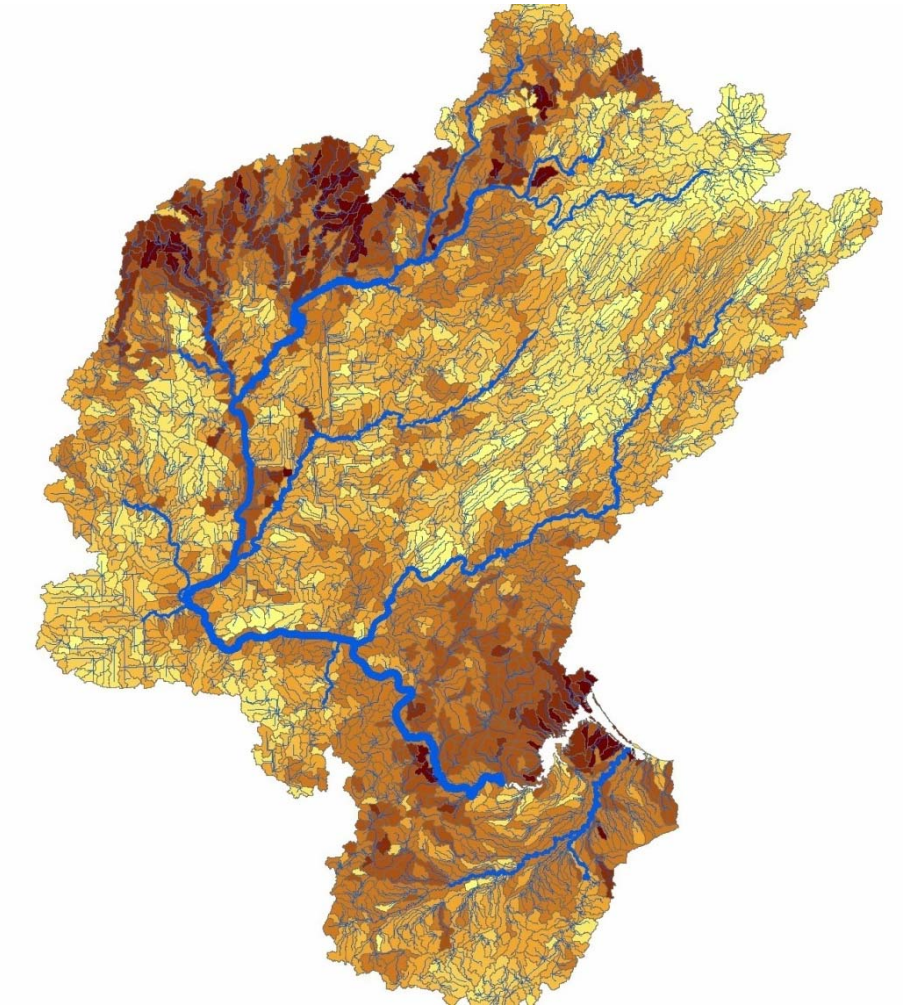
(Hollenhorst et al. 2007)

Accumulated stressor scores based on next-down ID

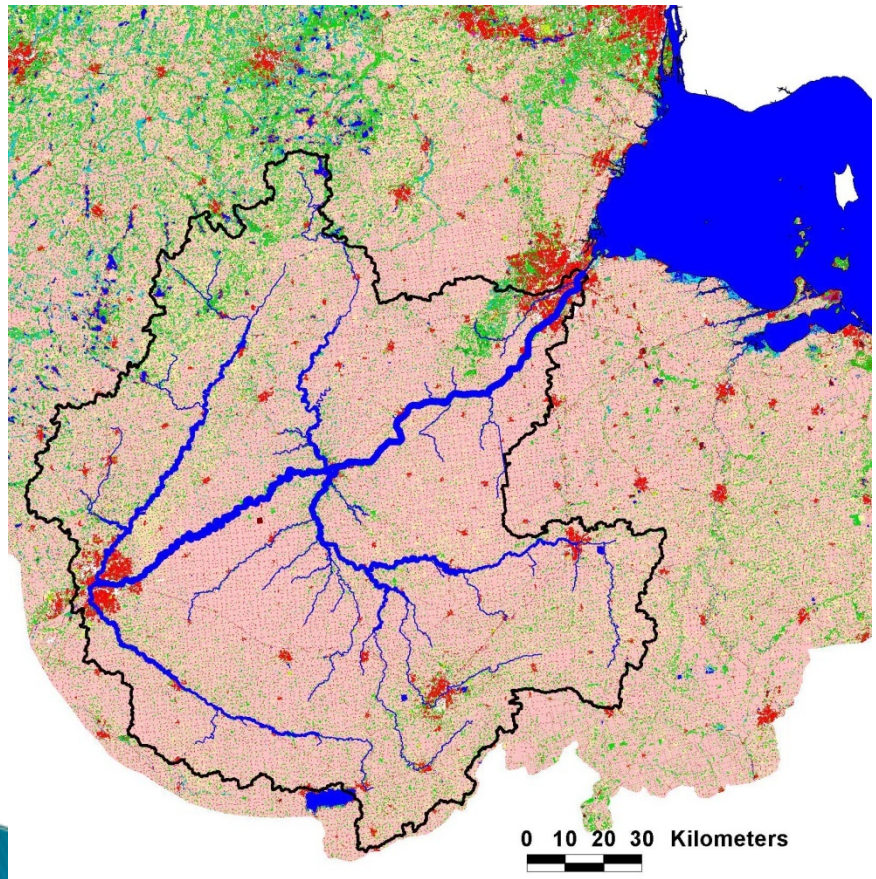


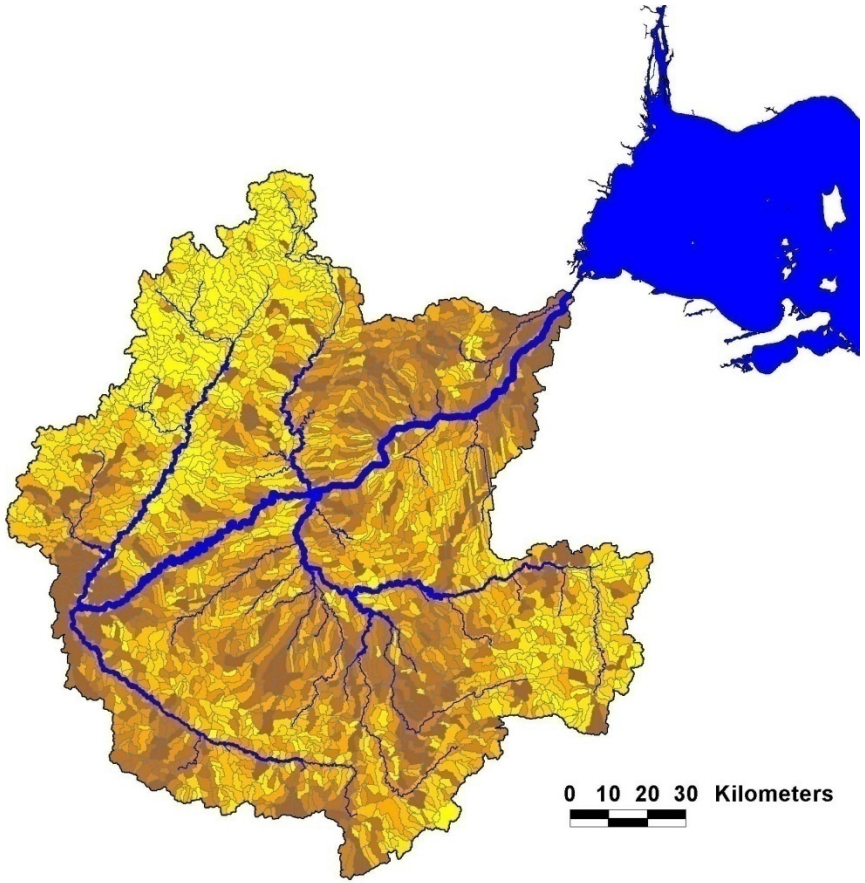
Stressor scores (SumRel) for watersheds

- Composite score based on cumulative scores for:
  - % Agricultural land use
  - Population density
  - Road density
  - Point source density

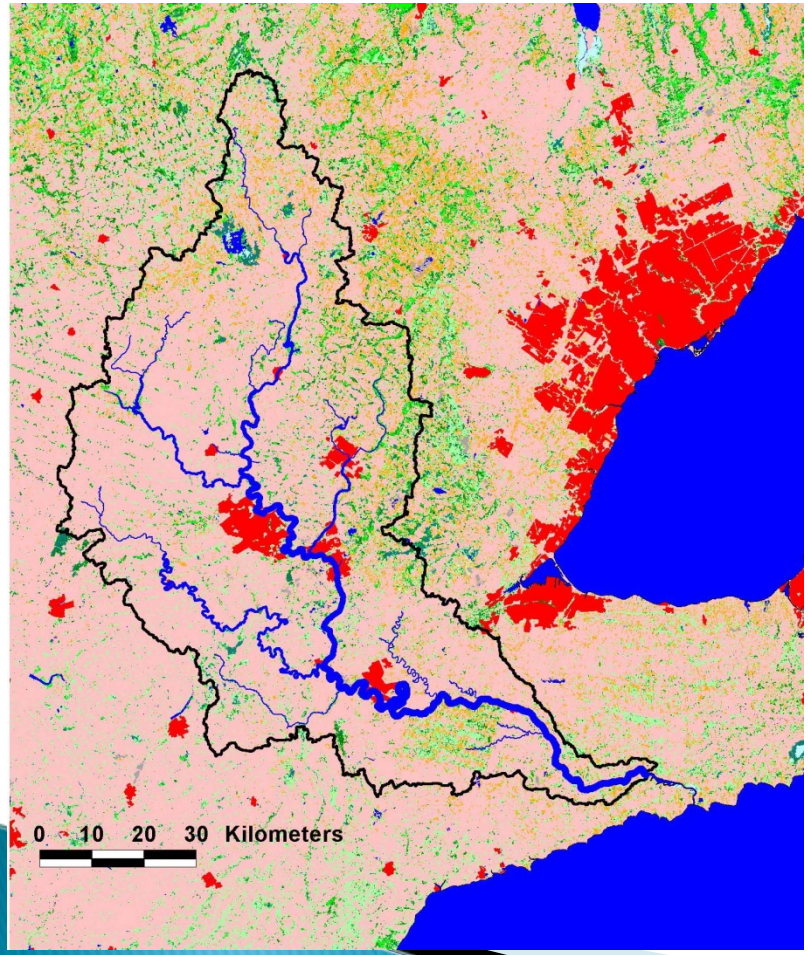


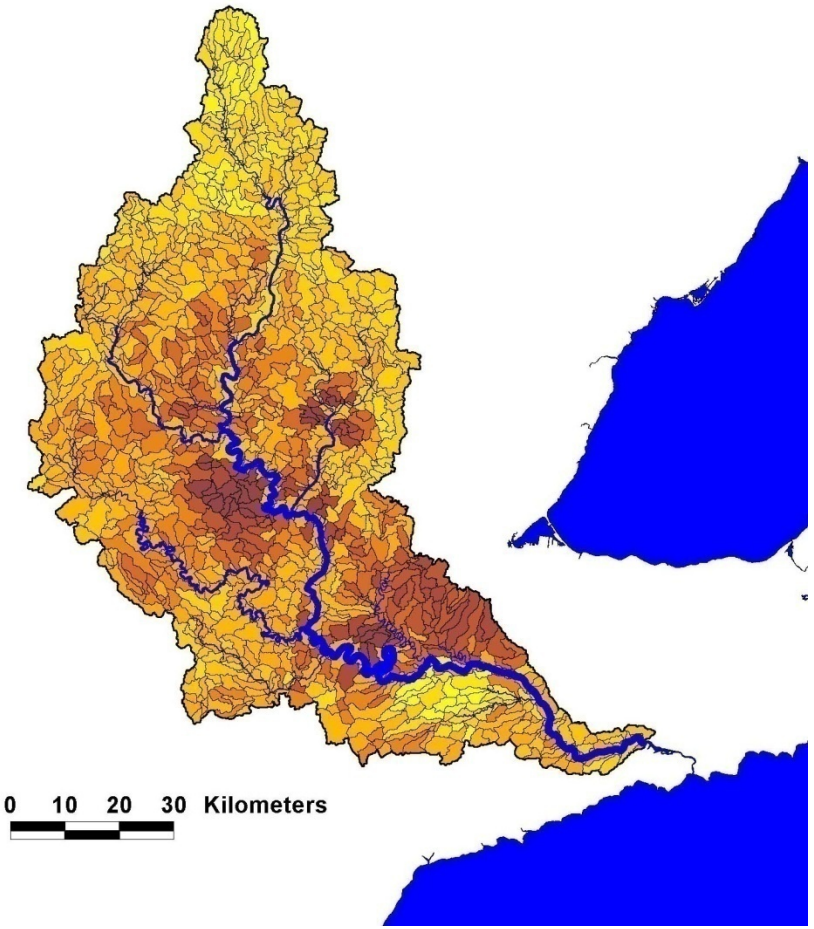
Maumee River, Ohio



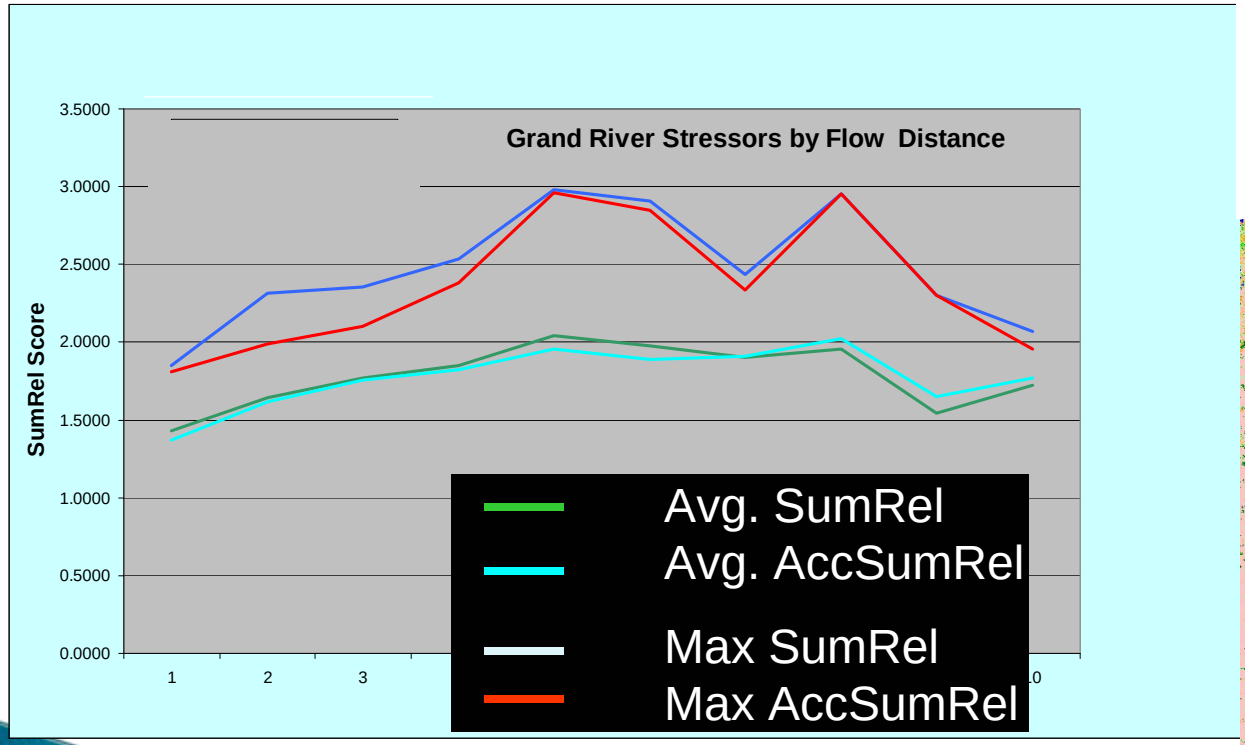


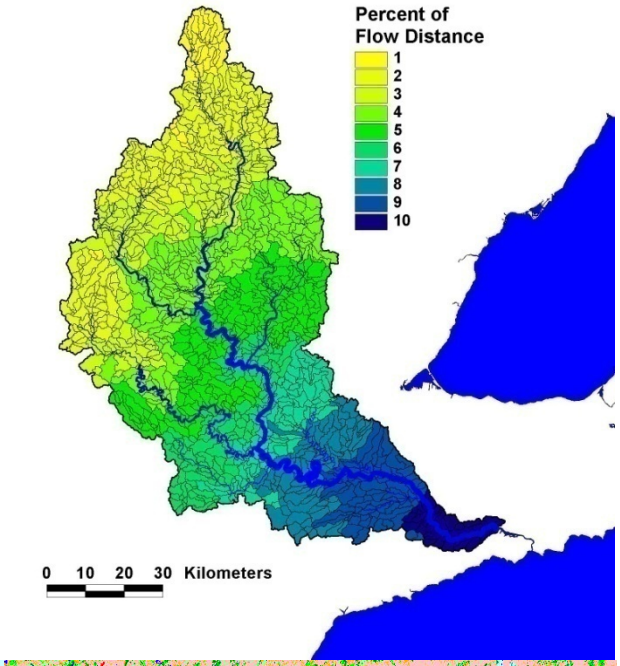
Grand River, Ontario

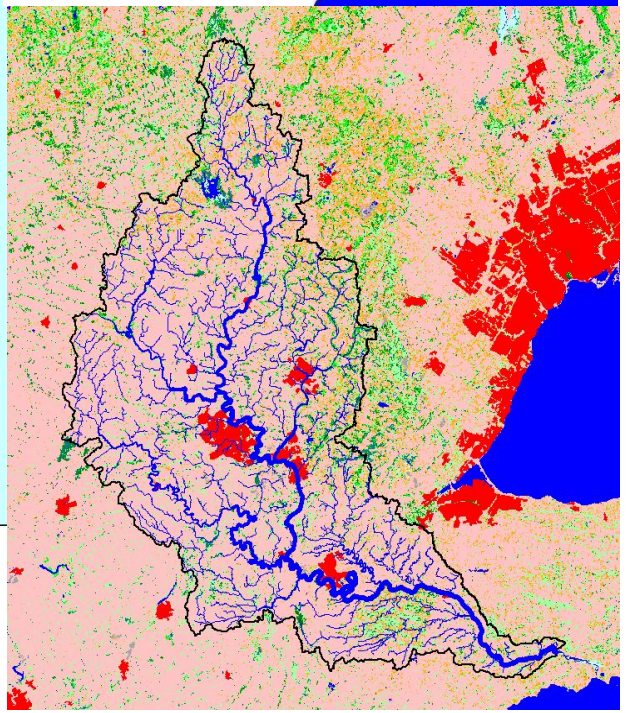




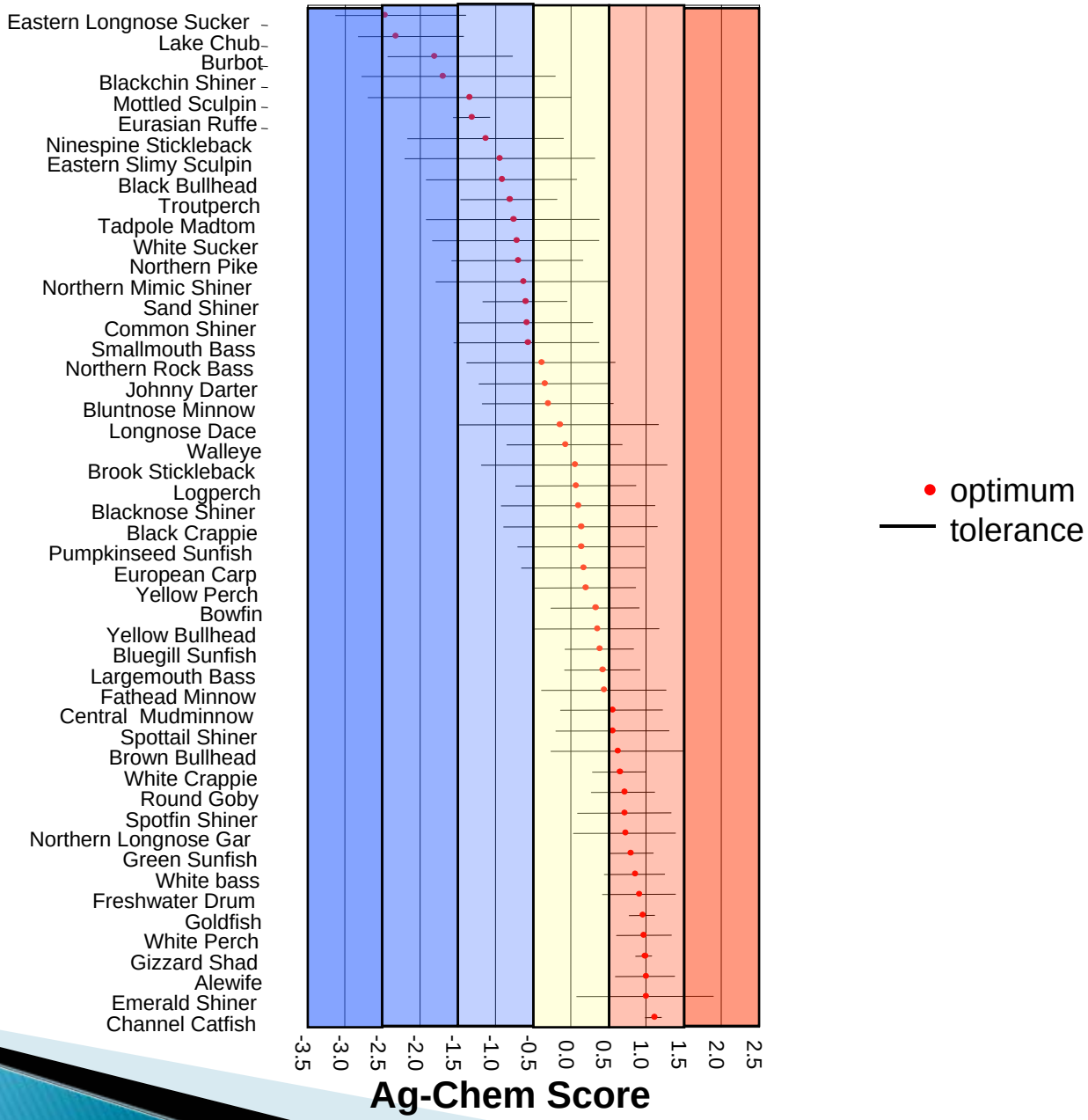
Stressor Summaries by Watershed Position







Fish species tolerances with respect to Agricultural Stressor

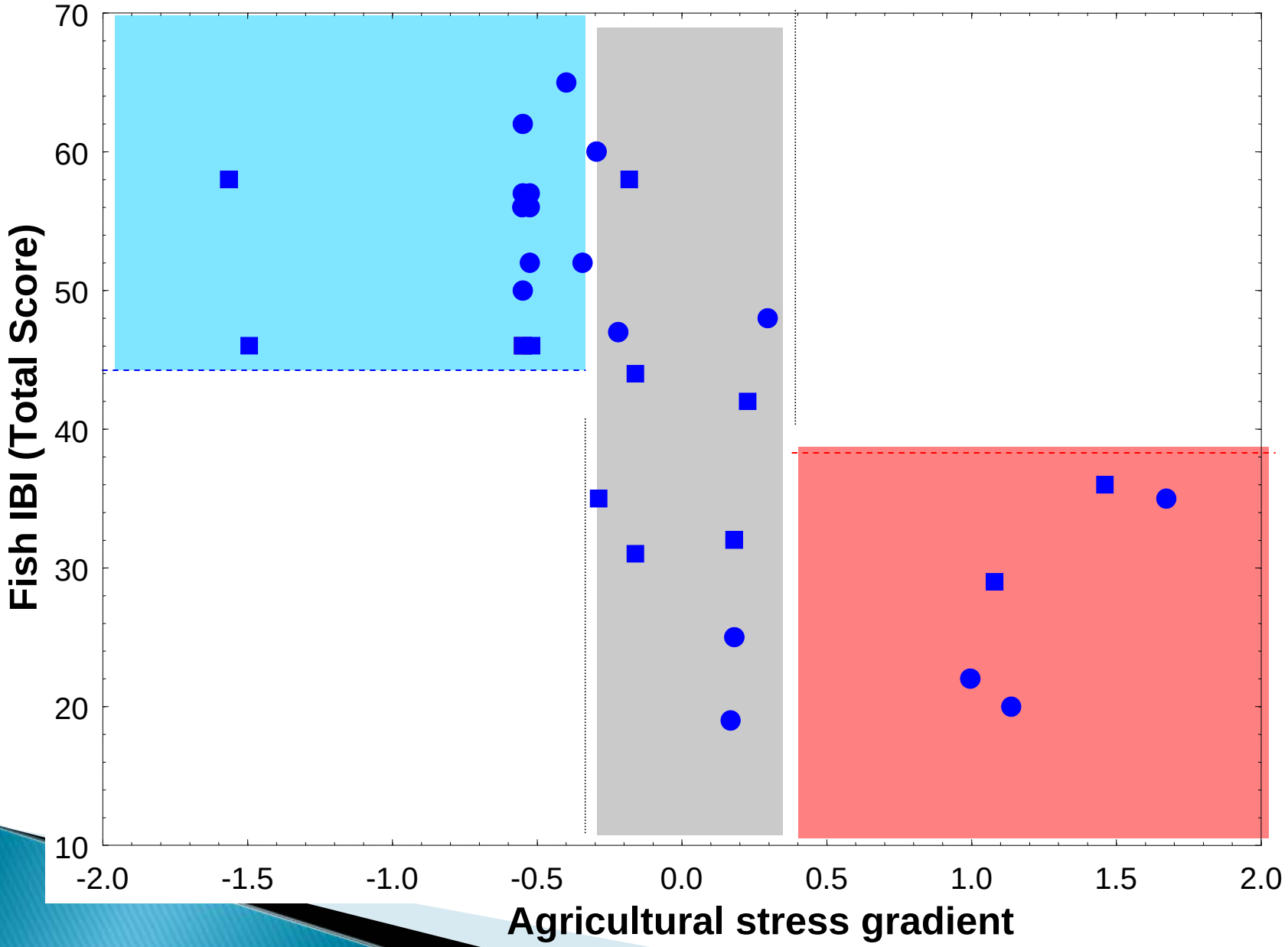


Fish IBI Correlations with Pressures

GLEI Land Pressure	Wetland Type: Typha	Wetland Type: Scirpus
Agriculture	0.02	**-0.64**
Land cover: Forest loss	-0.38	0.15
Population/development	**-0.70**	-0.21
Point source discharge	-0.09	**-0.57**
Atmospheric deposition	0.60	0.04
Shoreline modification	-0.24	-0.13

Bhagat et al. (in review)

Fish IBI: *Scirpus* sites



Predicting Loading: Data Needs

- High resolution watershed delineations
  - 10 m DEM
- Surficial geology / SURGO Soils
- Updated land use and land cover
  - Nearshore habitat
  - Wetland classification
  - Tile drainage
- Cross-walked classifications for US, CA
- Contemporary (and future) climate data in an accessible form.

Acknowledgements

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National Fish and Wildlife Foundation

Dedicated to the conservation of fish, wildlife and plants, and the habitats on which they depend.

NASA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Environnement Canada

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