

# **Summarizing Threats to Lake Erie: Multi-Stressor Mapping to Assist Decision-Making**

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# Key Points

- Multiple stressors influence the Great Lakes
  - Vary in impact, vary spatially
  - The constellation of stressors differs among lakes and among locations within lakes
- The lakes provide multiple human benefits
  - Like stressors, benefits vary spatially
- Management plans vary in focus
  - Restoration, conservation, P abatement, ....
- How might a lake-scale effort to combine multiple data sets aid decision-making?

**GLRI Priority**



Runoff from land

**GLRI Priority**



Toxic chemicals

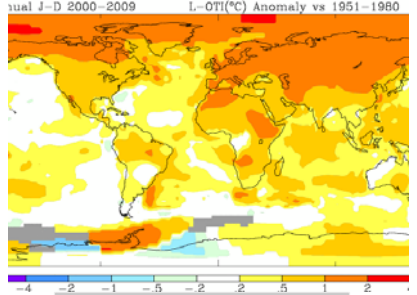
**GLRI Priority**



Invasive species



Fishing pressure



Climate change

**GLRI Priority**



Aquatic habitat loss



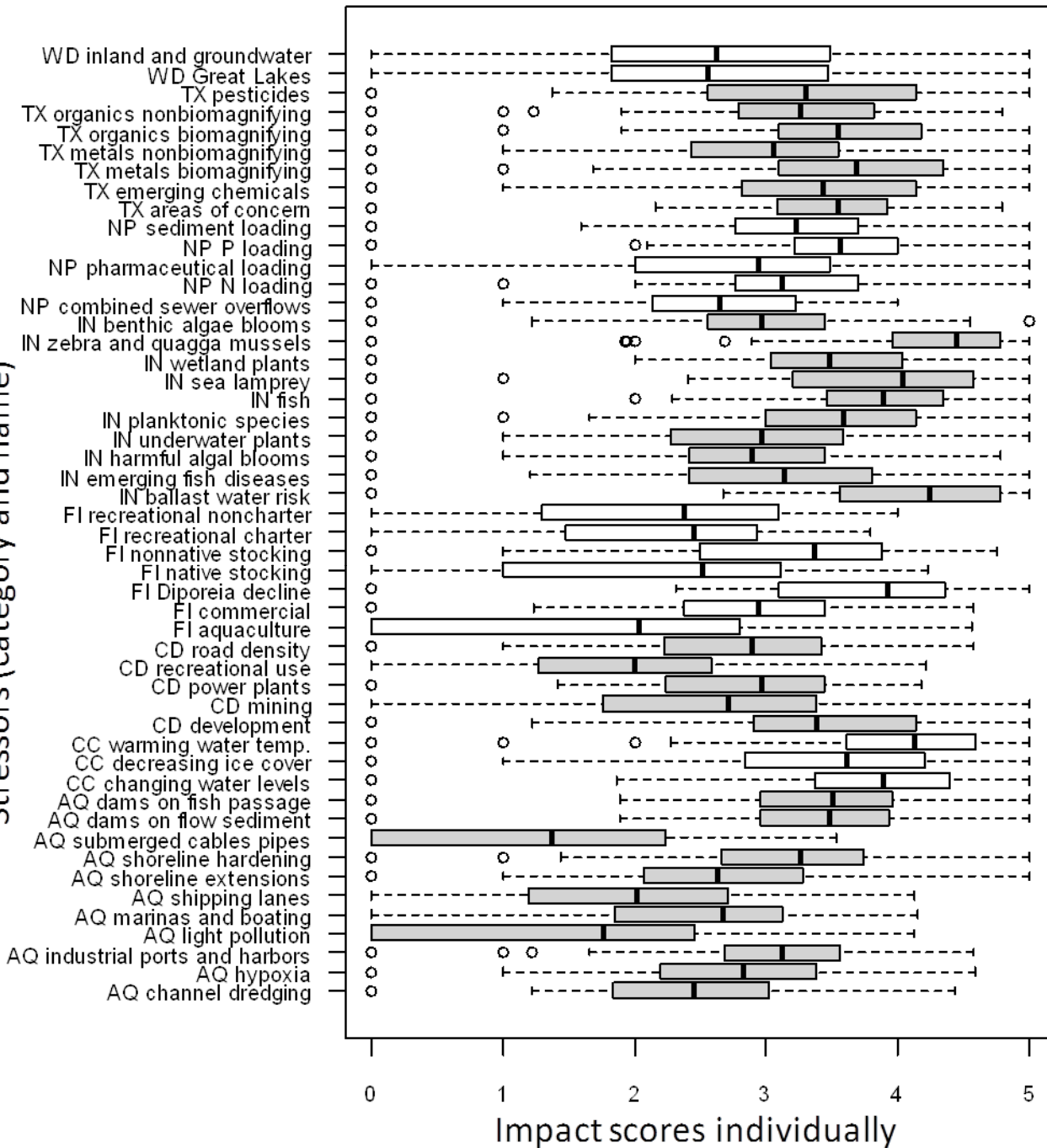
Coastal development



Water withdrawals



Stressors (category and name)



Importance of 8 categories of stressors from a survey of Great Lakes experts (n = 230 complete responses).

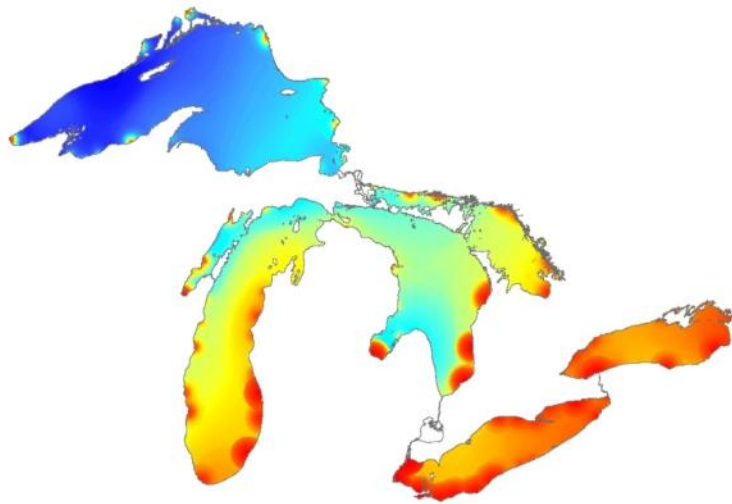
Abbreviations:

CC = climate change,  
 TX = toxic chemicals,  
 NP = nonpoint source pollutants,  
 AQ = aquatic habitat alterations,  
 CD = coastal development,  
 IN = invasive and nuisance species,  
 FI = fisheries,  
 WD = water withdrawals and diversions.

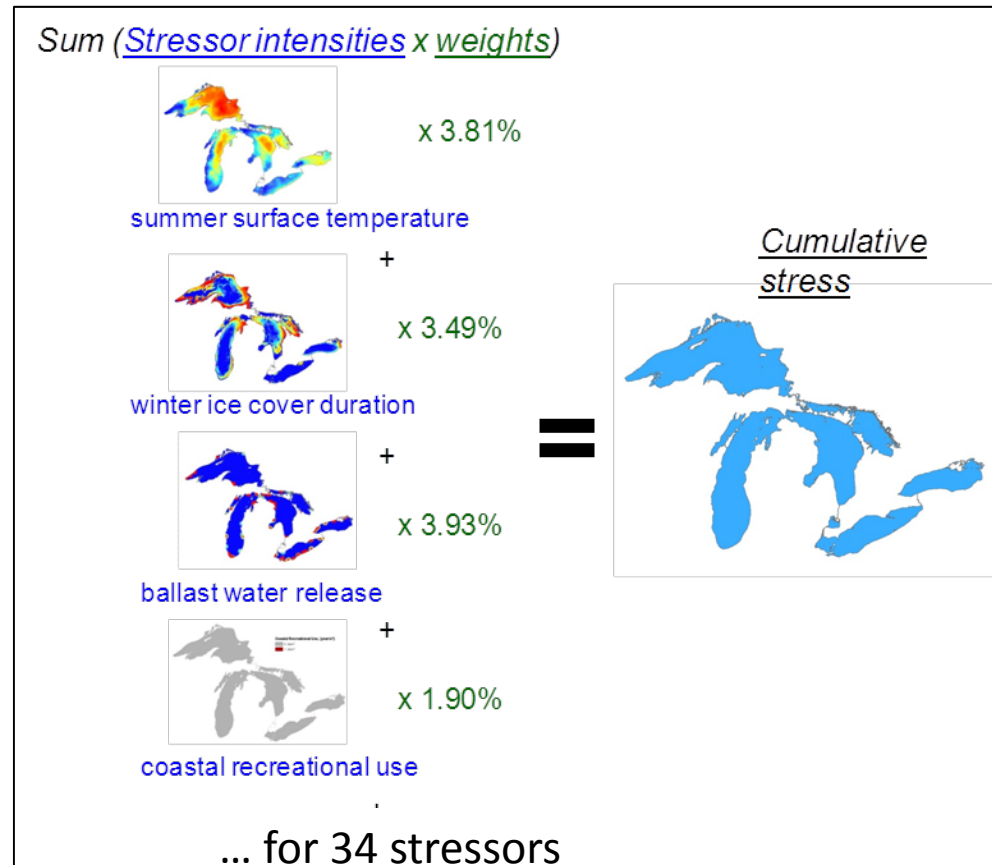
Smith et al., in prep.

# Estimating Cumulative Stress

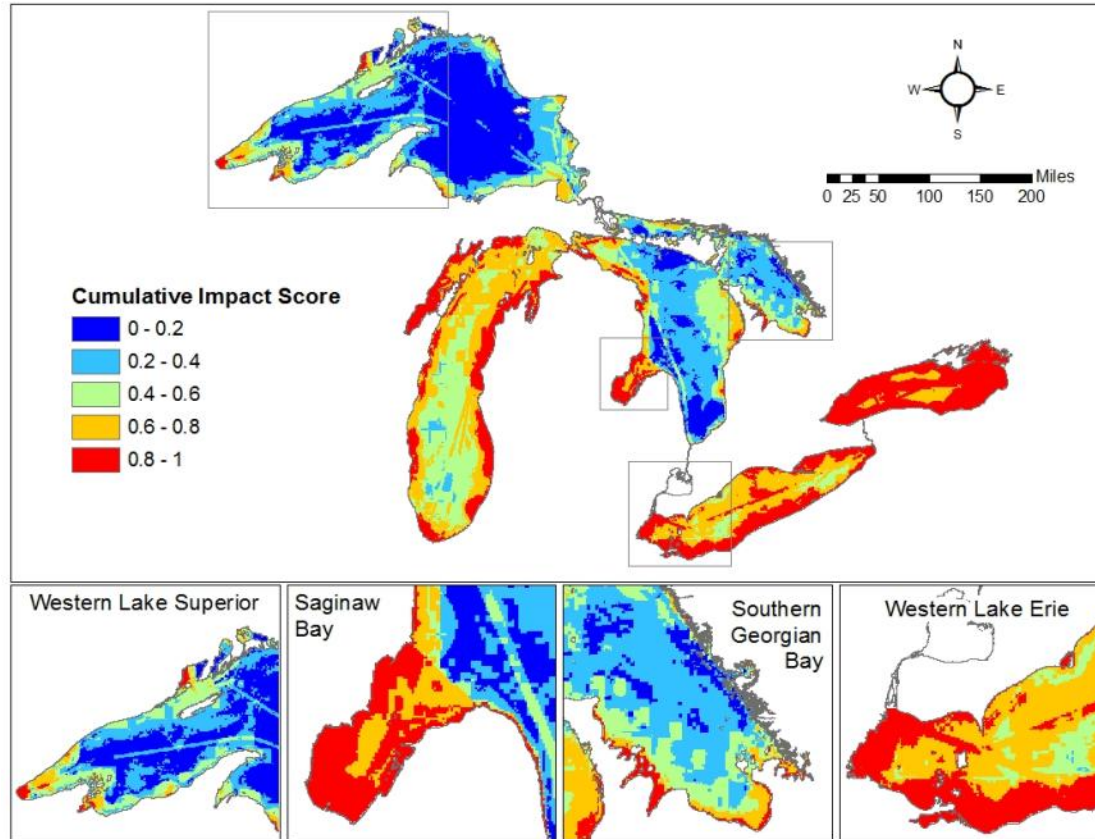
1. Develop maps of intensity of each individual stress
2. Develop a relative weight for each stressor (from survey)
3. Compute a weighted sum



Nitrogen load (tributary + atm)



# Cumulative Stress



Based on 34 stressors representing 7 themes: land runoff, contaminants, fishing pressure, invasive species, coastal development, aquatic habitat degradation and climate change.

Relative scaling:  
highest 20% = red,  
lowest 20% = blue

Beaches



Parks



Sport Fishing



Birding



Drinking water



Power plants



# The Benefits of the Great Lakes

Commercial Fishing

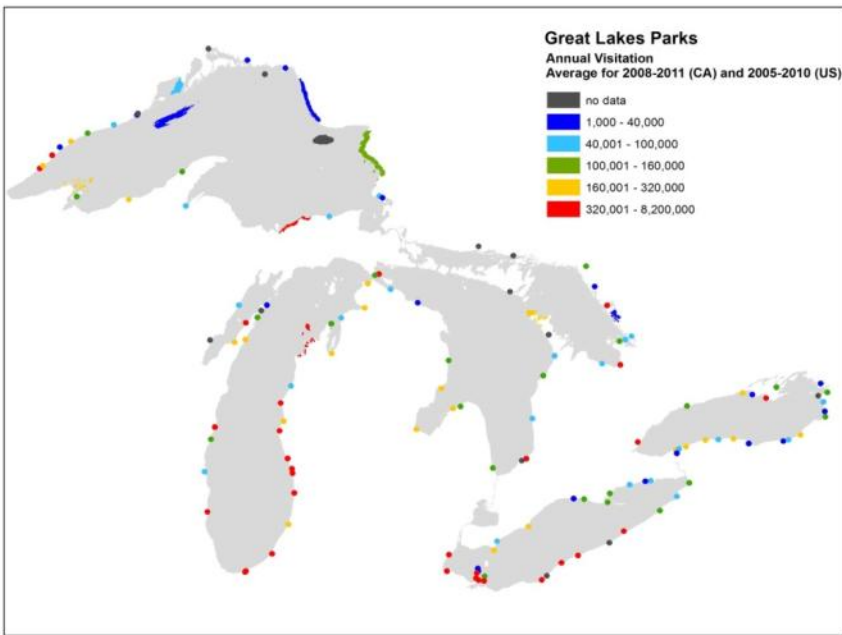


Boating

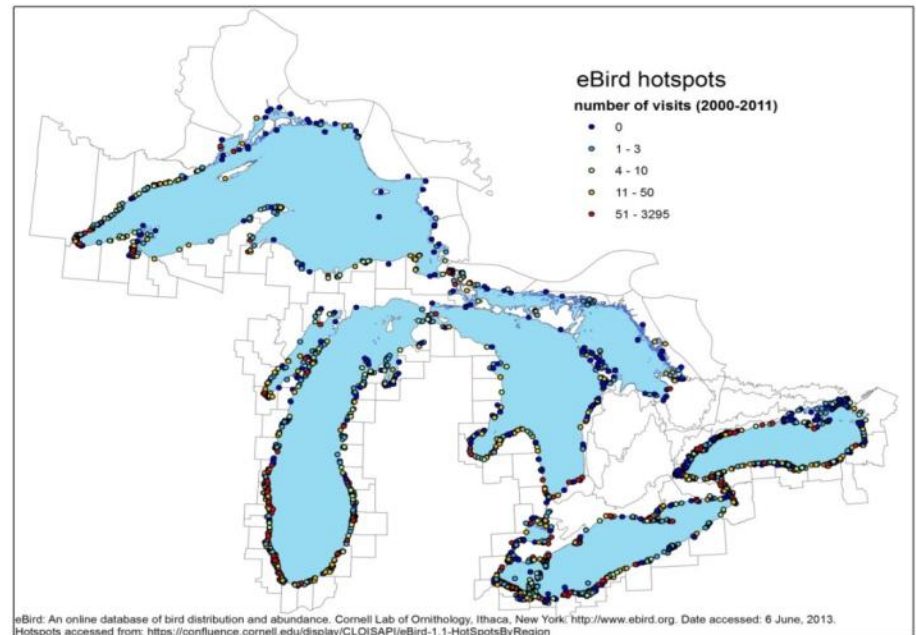


Shipping

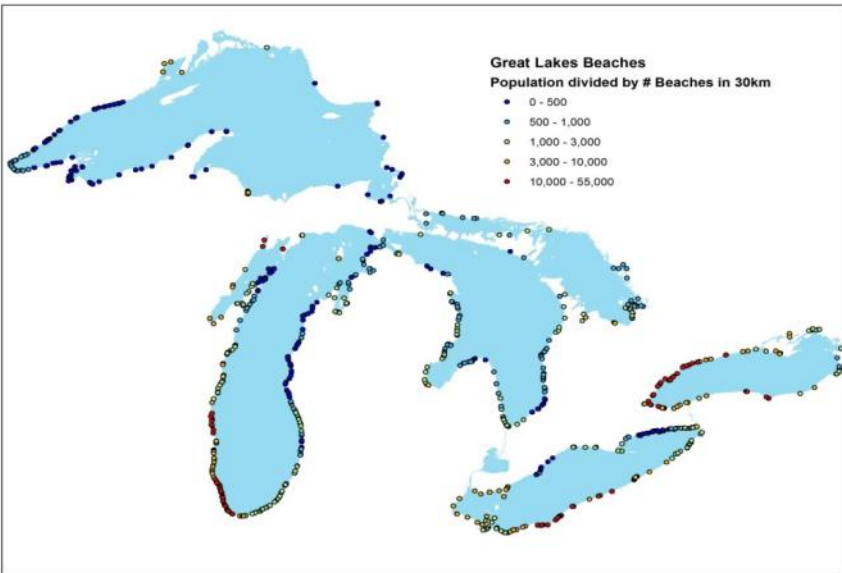




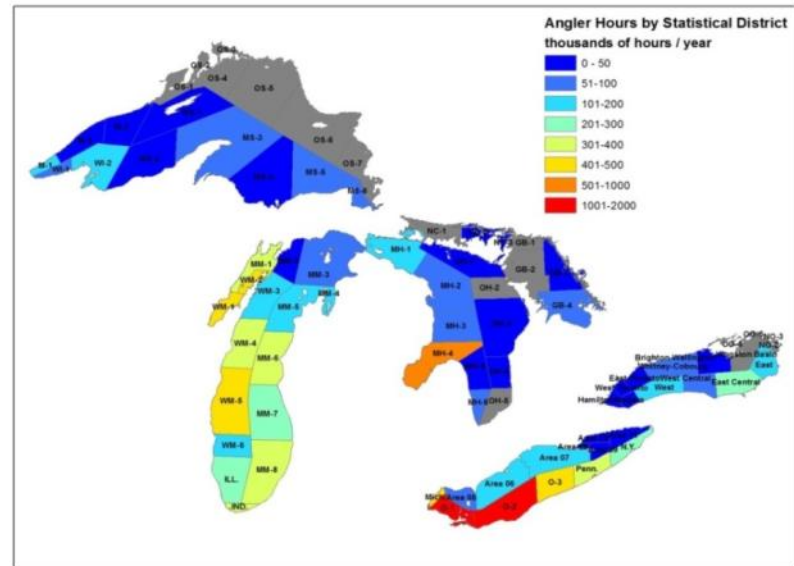
The 139 state, provincial and national parks located within 5 km of the Great Lakes shoreline



Birding activity located within 5 km of the shoreline in the Great Lakes



854 public-access beaches in the Great Lakes

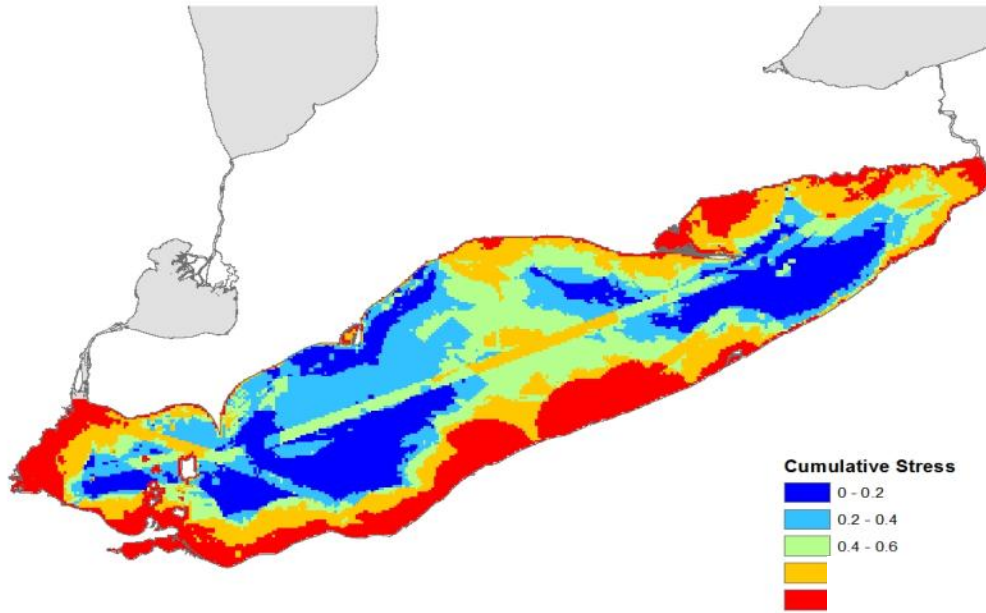


Great Lakes sportfishing (effort as angler hours) averaged for 2009-2011



# Focusing on Lake Erie....



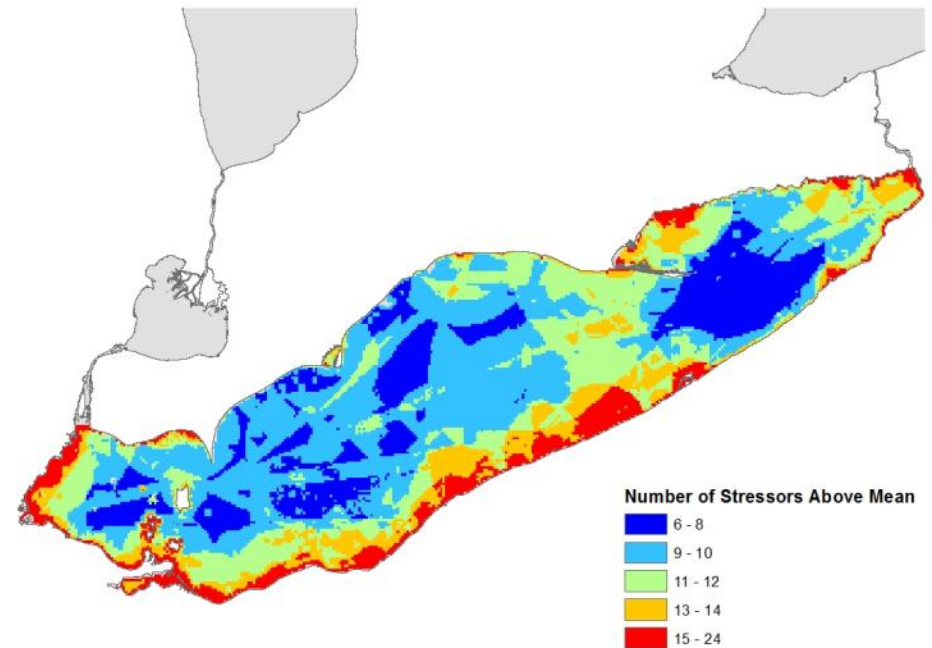


Lake Erie shows high cumulative stress (top left) and a substantial number of stressors above the basin-wide mean (bottom right).

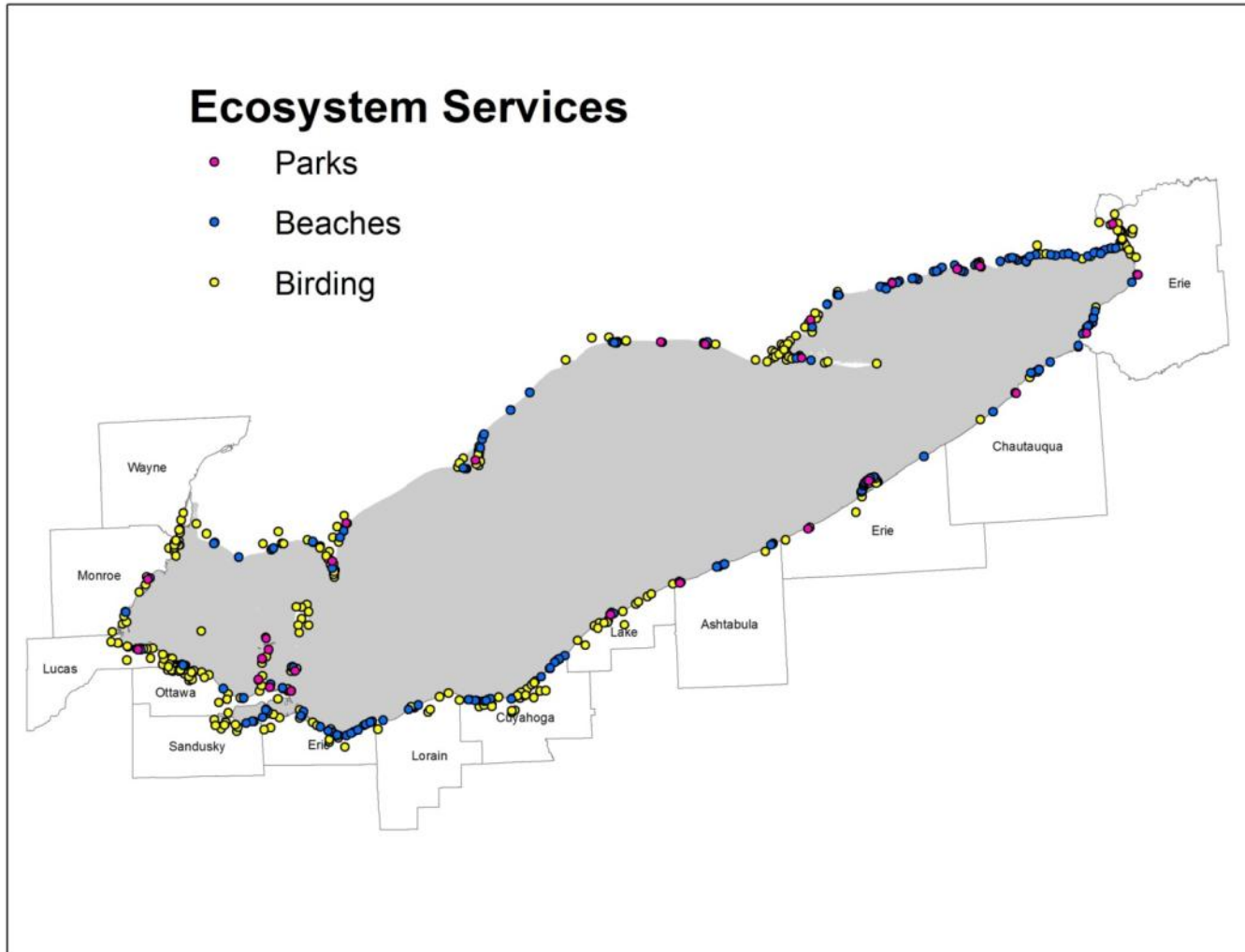
The greatest stress is in near-shore waters

HABs and Cladophora not included, due to inability to obtain consist data across all five lakes - A limitation of the basin-wide approach.

Hypoxia was included – but ranked only as a middling threat overall.



# Are Ecosystem Services Clustered?

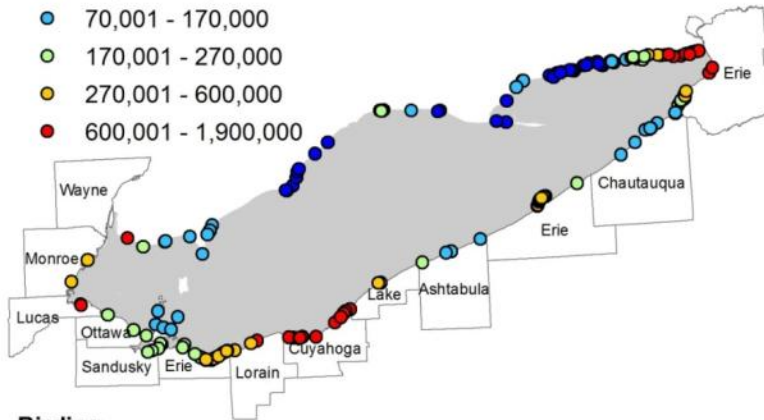


# How do Services Vary in Use?

## Beaches

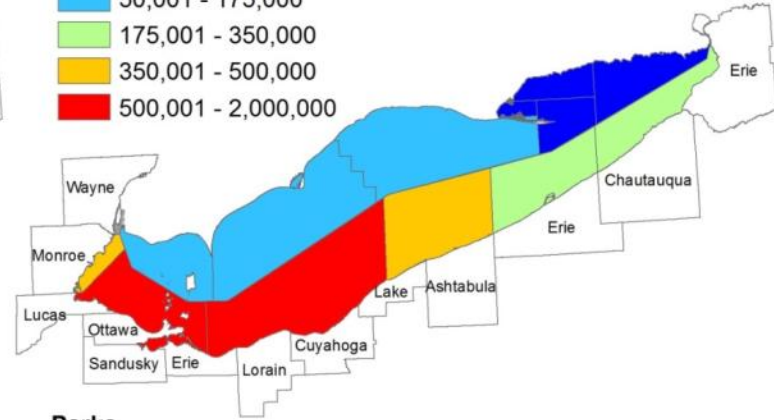
### Population within 30km

- 26,000 - 70,000
- 70,001 - 170,000
- 170,001 - 270,000
- 270,001 - 600,000
- 600,001 - 1,900,000



## Recreational Fishing Effort (2010, hrs)

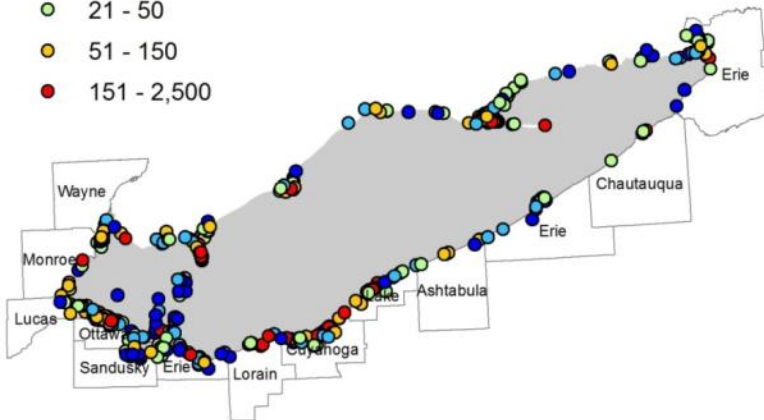
- 40,000 - 50,000
- 50,001 - 175,000
- 175,001 - 350,000
- 350,001 - 500,000
- 500,001 - 2,000,000



## Birding

### Total Visits (1999-2012)

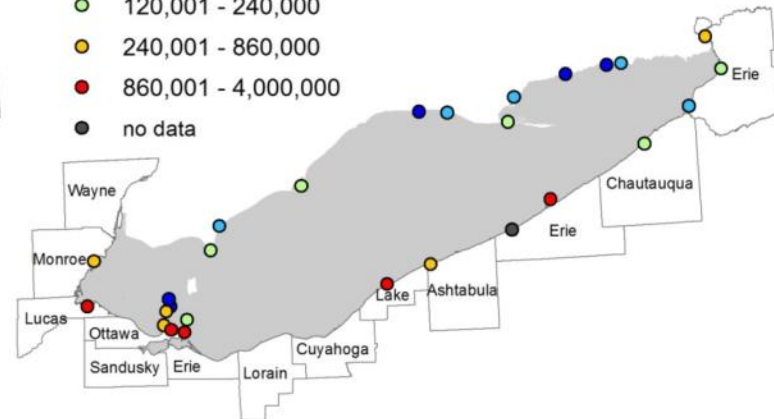
- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 150
- 151 - 2,500



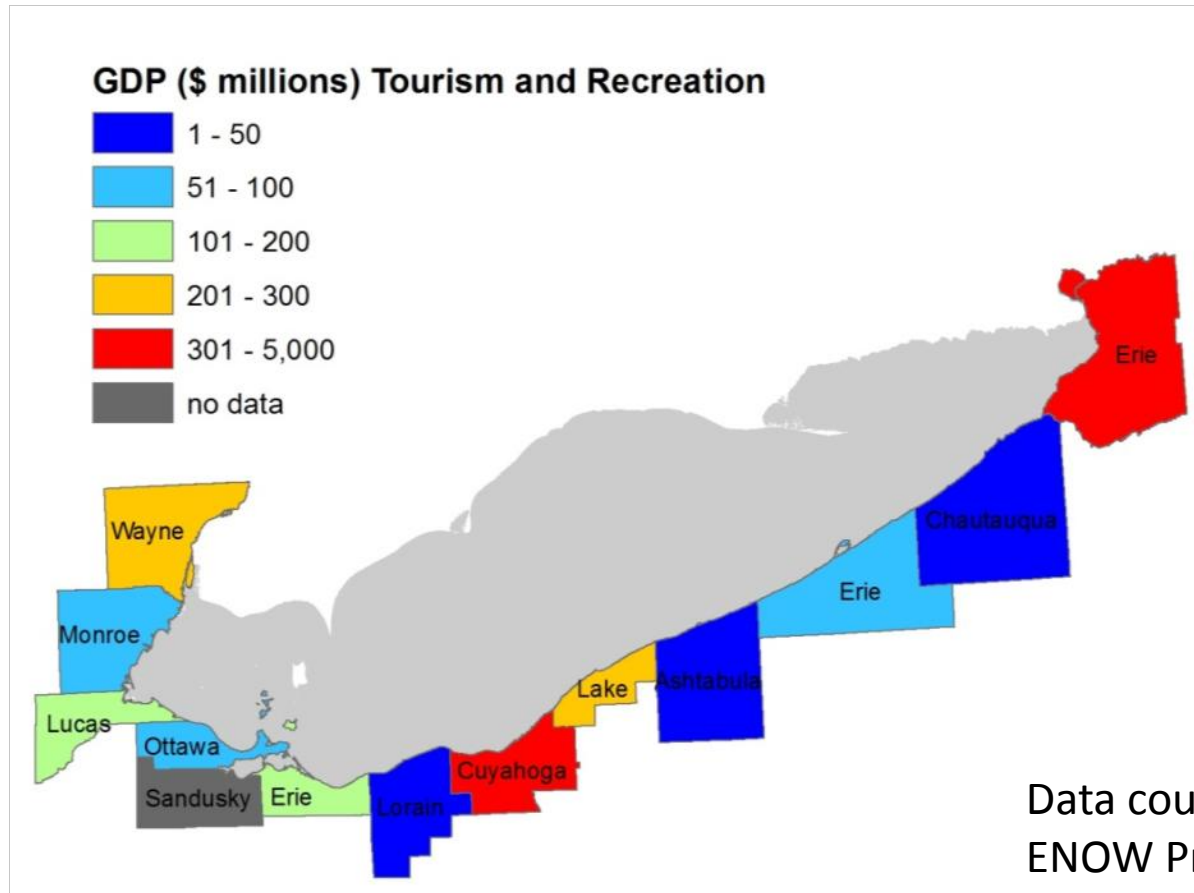
## Parks

### Average Annual Visits (2005-2010)

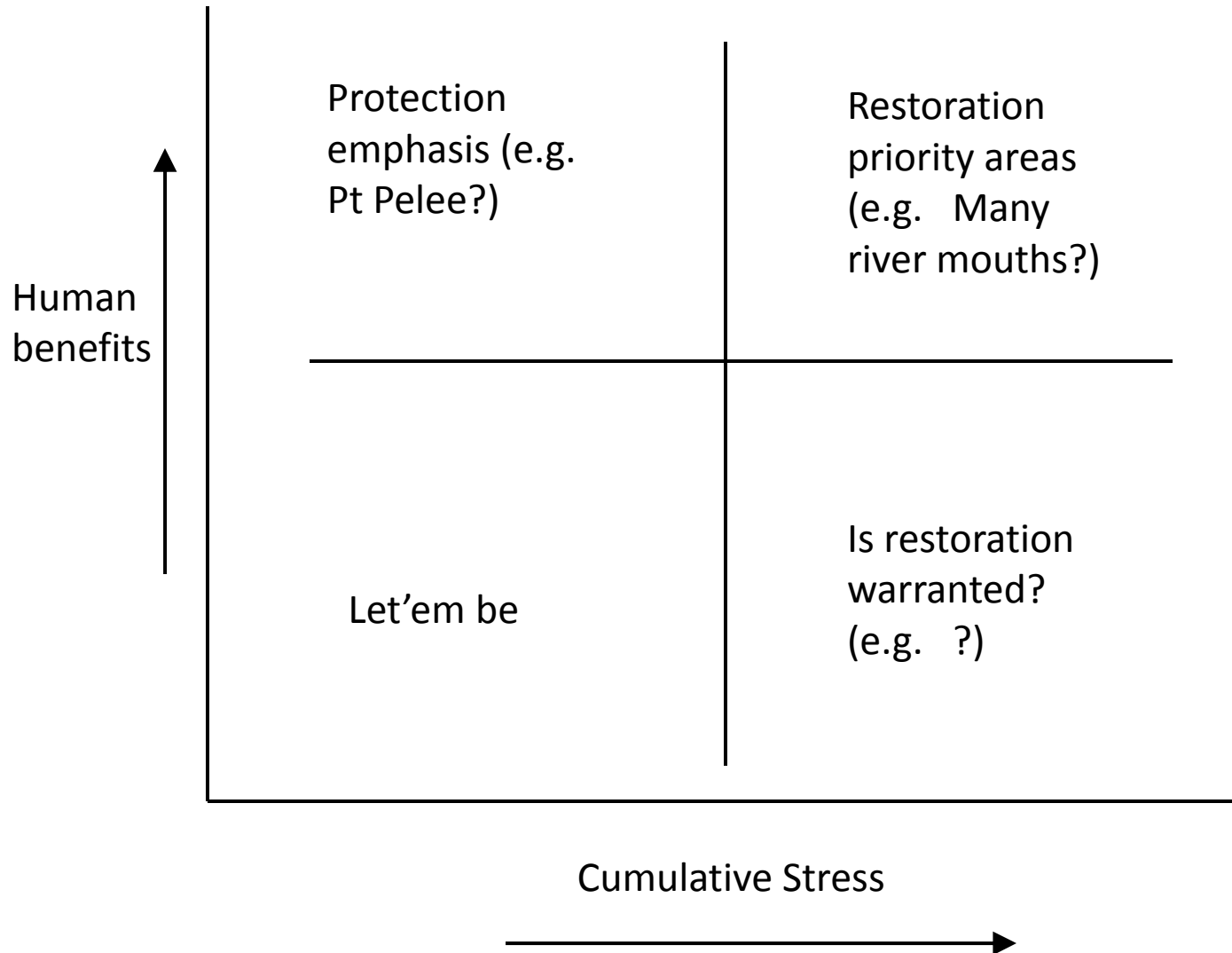
- 1,300 - 60,000
- 60,001 - 120,000
- 120,001 - 240,000
- 240,001 - 860,000
- 860,001 - 4,000,000
- no data



# Relationship with Economic Indicators?



# Joint Analysis of Stressors and Services



# Spatial Analysis to Assist Management

- How can we use this information for holistic spatial planning of new activities?

## Potential Inputs:

- threats locations (and what/how many threats)
- services locations (and how threats align with services)
- current plans and activities
- local knowledge

## Potential Outputs:

- decision support, such as threats to tackle at different locations and new locations
- more synthetic view of actions and possibilities
- Specific recommendations that are spatially explicit within a lake-wide analysis

# With the help of many!

- Core Working Group
- Key team members
  - S. Smith, P. McIntyre, C. Dickinson, C. Joseph, A. Marino, A. Prusevich
  - Students: R. Biel, J. Olson, K. Hanson
- Data providers
  - Dozens of staff from state agencies, OMNR, GLERL, USGS, Environment Canada, USFWS, TNC, GLFC, IFR, GLEI, NFHAP
  - Academic scientists from USA & Canada

Suggestions or Data to Share?

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<http://www.greatlakesmapping.org>



Fred A. and Barbara M.  
Erb Family Foundation



**WATER CENTER**  
UNIVERSITY OF MICHIGAN



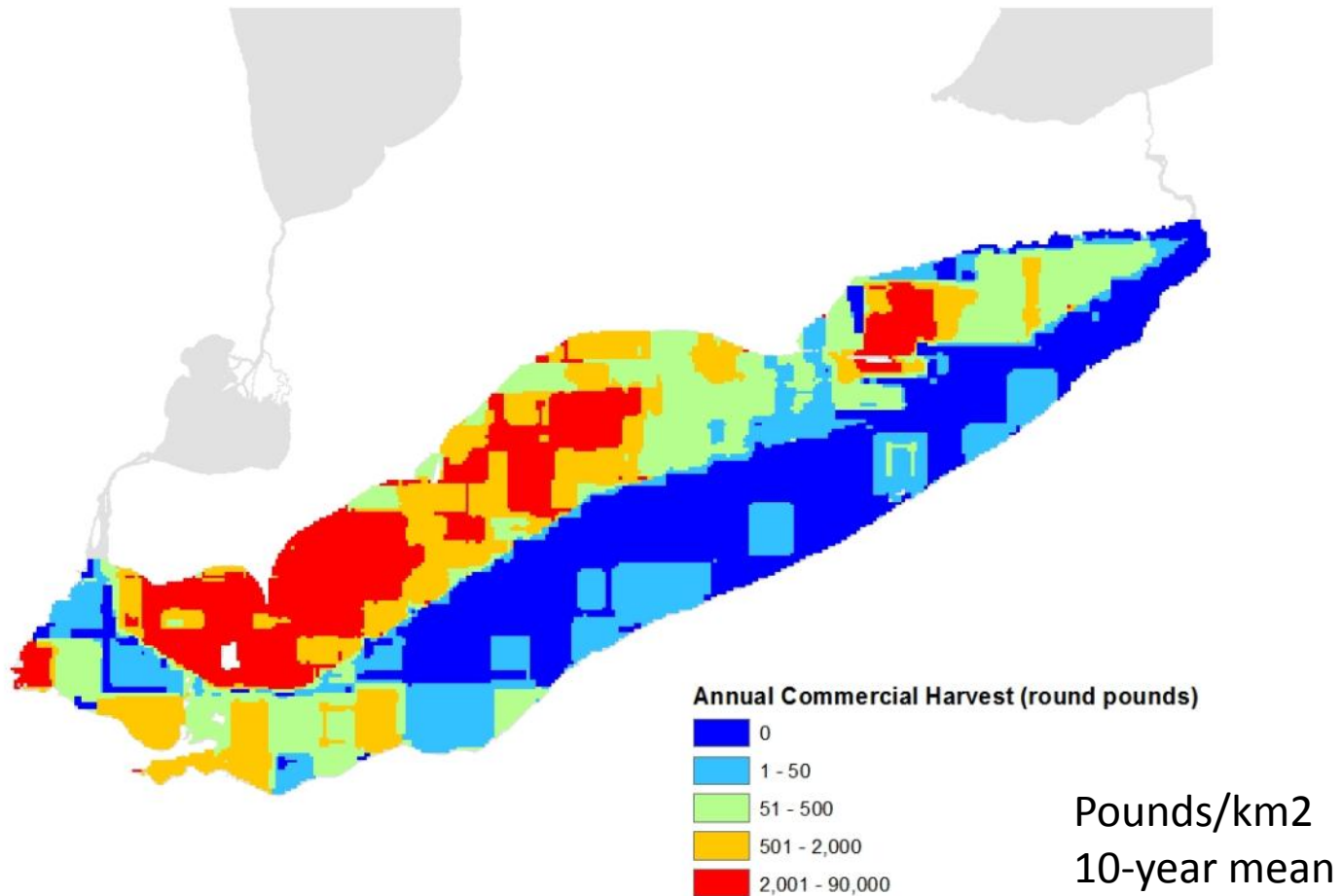


Extra slides

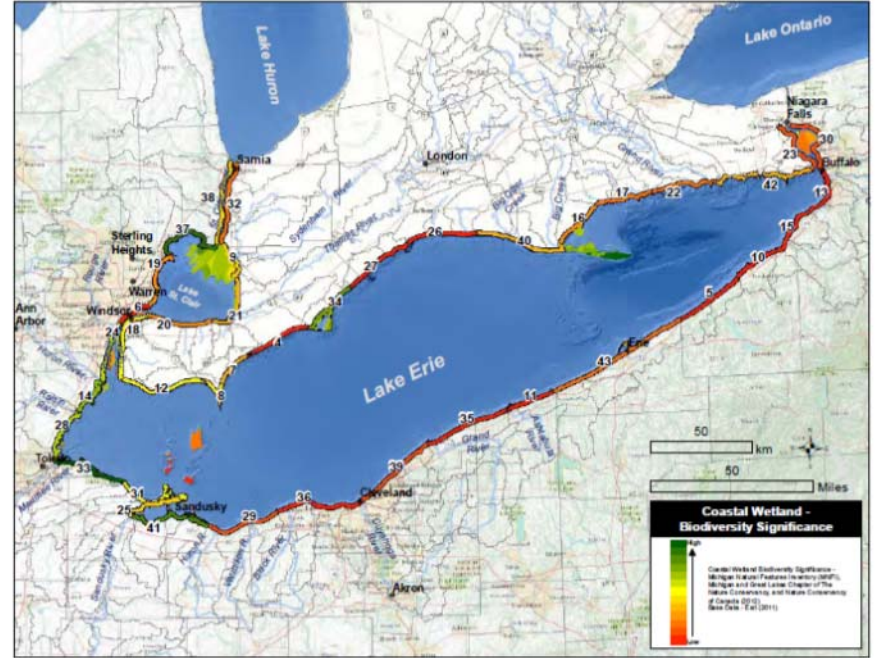
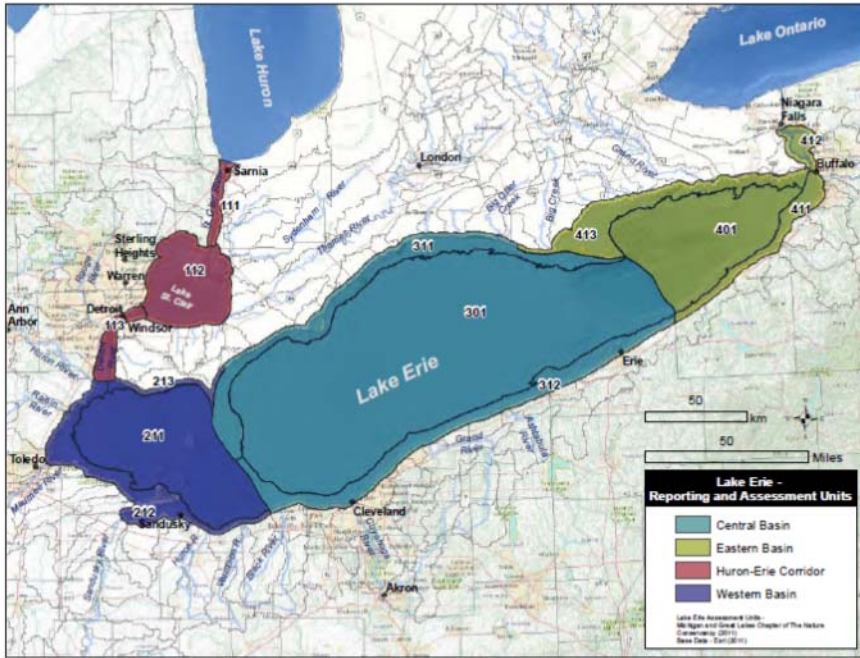
# Lake Erie Frameworks

- Phosphorus (No. 1 stressor) focus
  - IJC's LE Ecosystem Priority, Ohio LE P Task Force, LAMP
- Biodiversity focus
  - The Nature Conservancy' Biodiversity Conservation Strategies
- Multi-stressor focus
  - GLEI, GLEAM
- Plans and Conferencing
  - Great Lakes Restoration Initiative (GLRI) action plan (2010, USEPA)
  - United States Great Lakes Regional Collaboration (2005, United States)
  - State of the Great Lakes report (SOLEC, 2009, binational)
  - International Joint Commission (IJC) Biennial Report on Great Lakes Water Quality (2011, binational)
  - The Biodiversity Conservation Strategy (Blueprint) projects led by The Nature Conservancy and Nature Conservancy of Canada

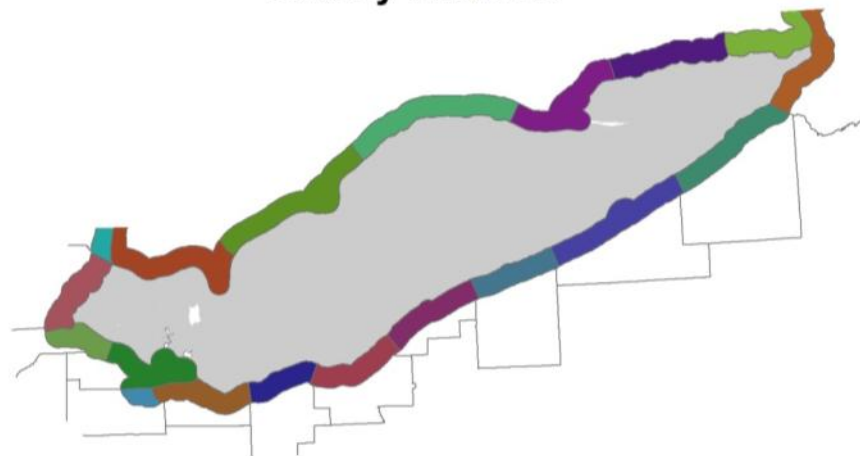
# Lake Erie Commercial Harvest



# Lake Erie Biodiversity Conservation Strategy - TNC

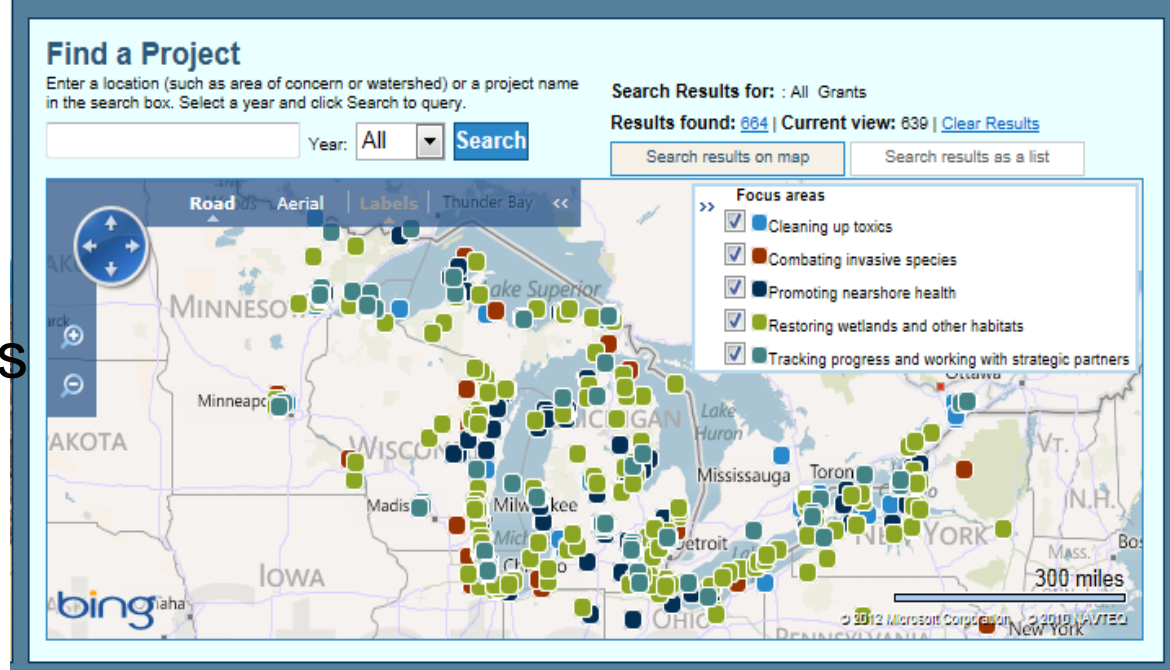


## County Ribbons



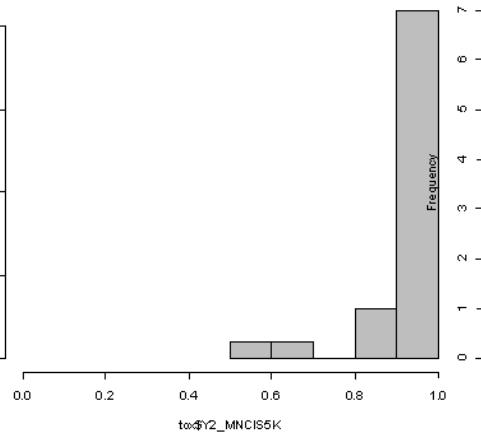
# GLRI

<http://greatlakesrestoration.us/>



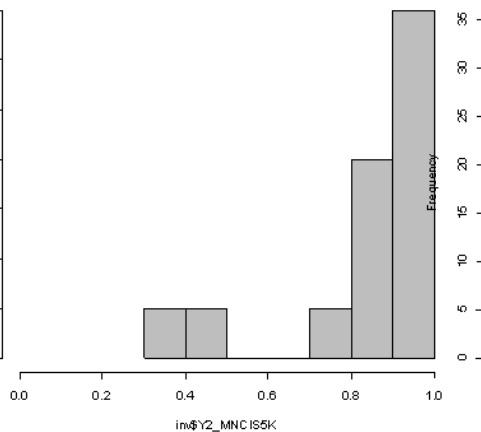
Toxics (n=26)

Histogram of tox\$Y2\_MNCIS5K



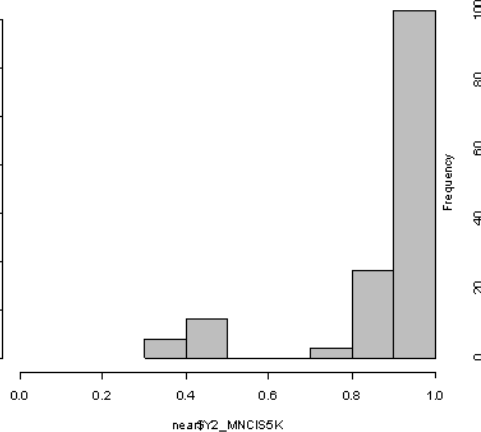
Invasives (n=14)

Histogram of inv\$Y2\_MNCIS5K



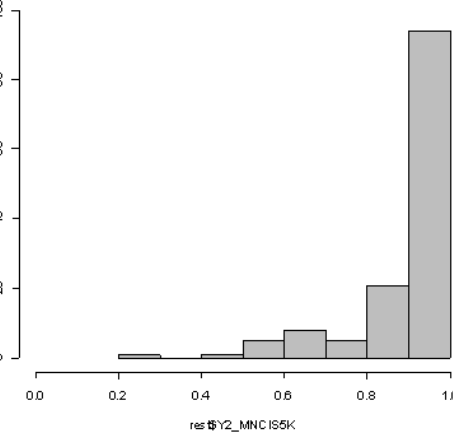
Nearshore (n=52)

Histogram of near\$Y2\_MNCIS5K

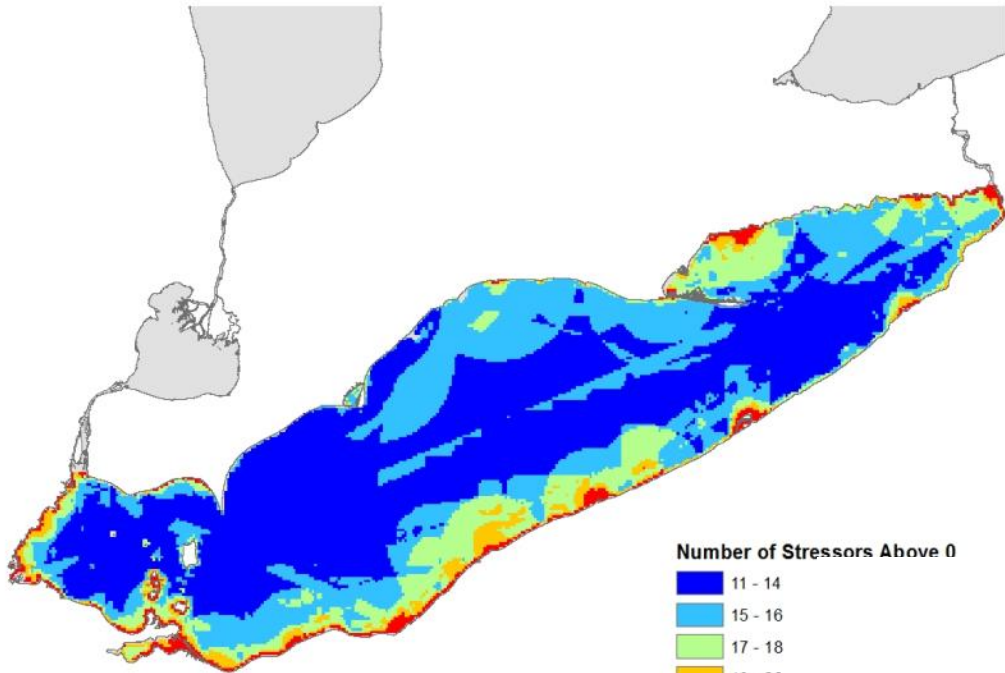


Restore (n=135)

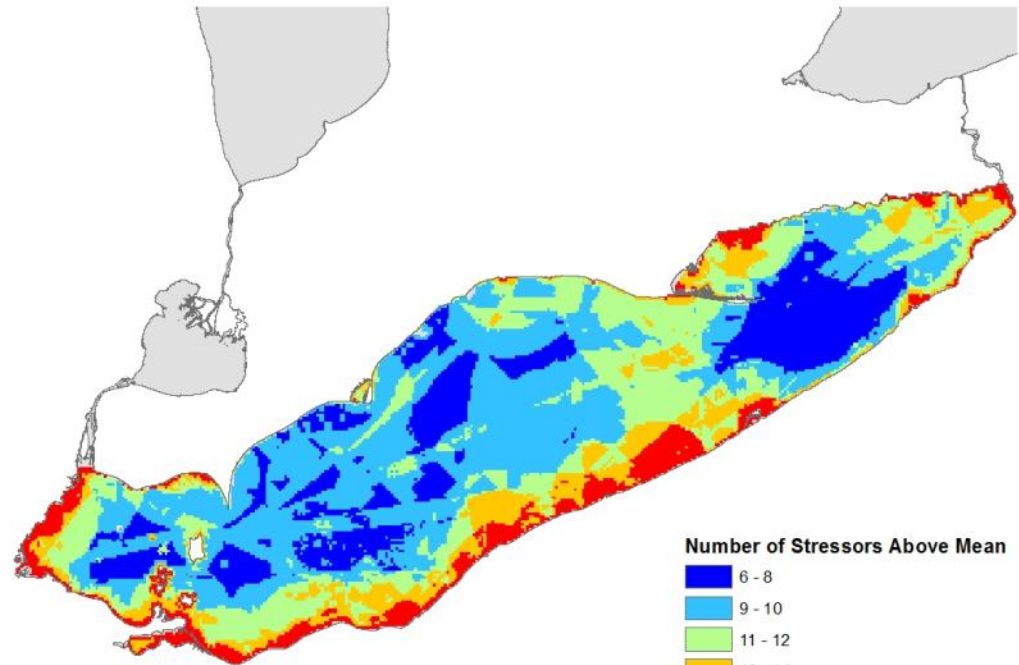
Histogram of rest\$Y2\_MNCIS5K



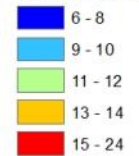
Full names: Cleaning up toxics, Combating Invasive Species, Promoting nearshore health, Restoring wetlands and other habitats



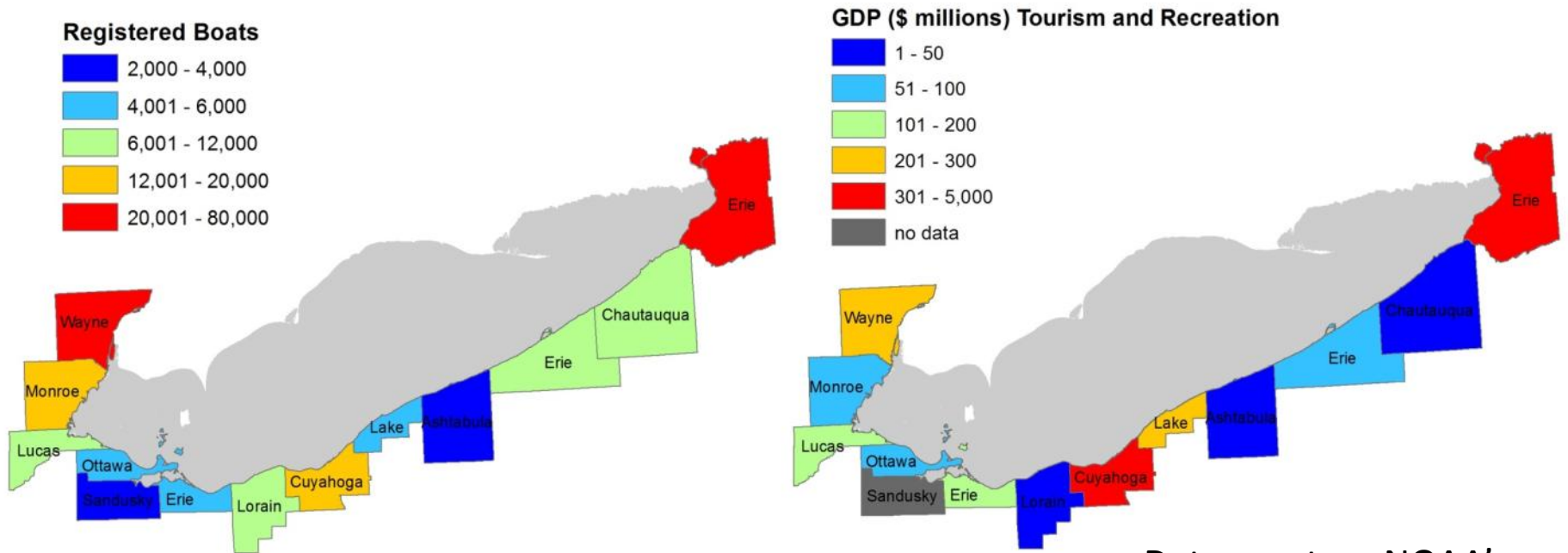
Number of Stressors Above 0



Number of Stressors Above Mean



# Relationship with Economic Indicators?



Data courtesy NOAA's ENOW Program