Digitizing Great Lakes Coastal Wetlands: A Case Study of GIS Data Integration

Chris Hippensteel

Advisor: Dr. Benjamin Heumann

Center for Geographic Information Science and

Institute for Great Lakes Research,

Central Michigan University

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Objectives

1. Update Great Lakes Wetland Polygons using best available data
2. Use an analytical comparison to see how coastal wetlands have changed based on: area, perimeter, and fragmentation
   - Used to determine if the utilization of the latest GIS tools and remote sensing products changes how coastal wetlands are mapped

Great Lakes Coastal Wetlands?

- What are they?
  - Wetlands that share a hydrologic connection with a Great Lake

Image From: https://mnfi.anr.msu.edu

Great Lakes Coastal Wetlands?

- Why do we care?
  - They provide:
    - Essential spawning grounds for many species of fish (Watchorn et al., 2015)
    - Crucial habitat for fish, birds, reptiles, and amphibians (Cvetkovic & Chow-Fraser, 2011)
    - Sinks/storage areas for various nutrients and sediments (Watchorn et al., 2015)
    - Soil erosion buffers along exposed shorelines (Canadian Wildlife Service, 2002)
  - ~80% of all Great Lakes fish species use coastal wetlands for spawning or nursery habitat (Cvetkovic & Chow-Fraser, 2011), and sport fishing adds 4 billion dollars to the economy (NOAA)

Great Lakes Coastal Wetlands?

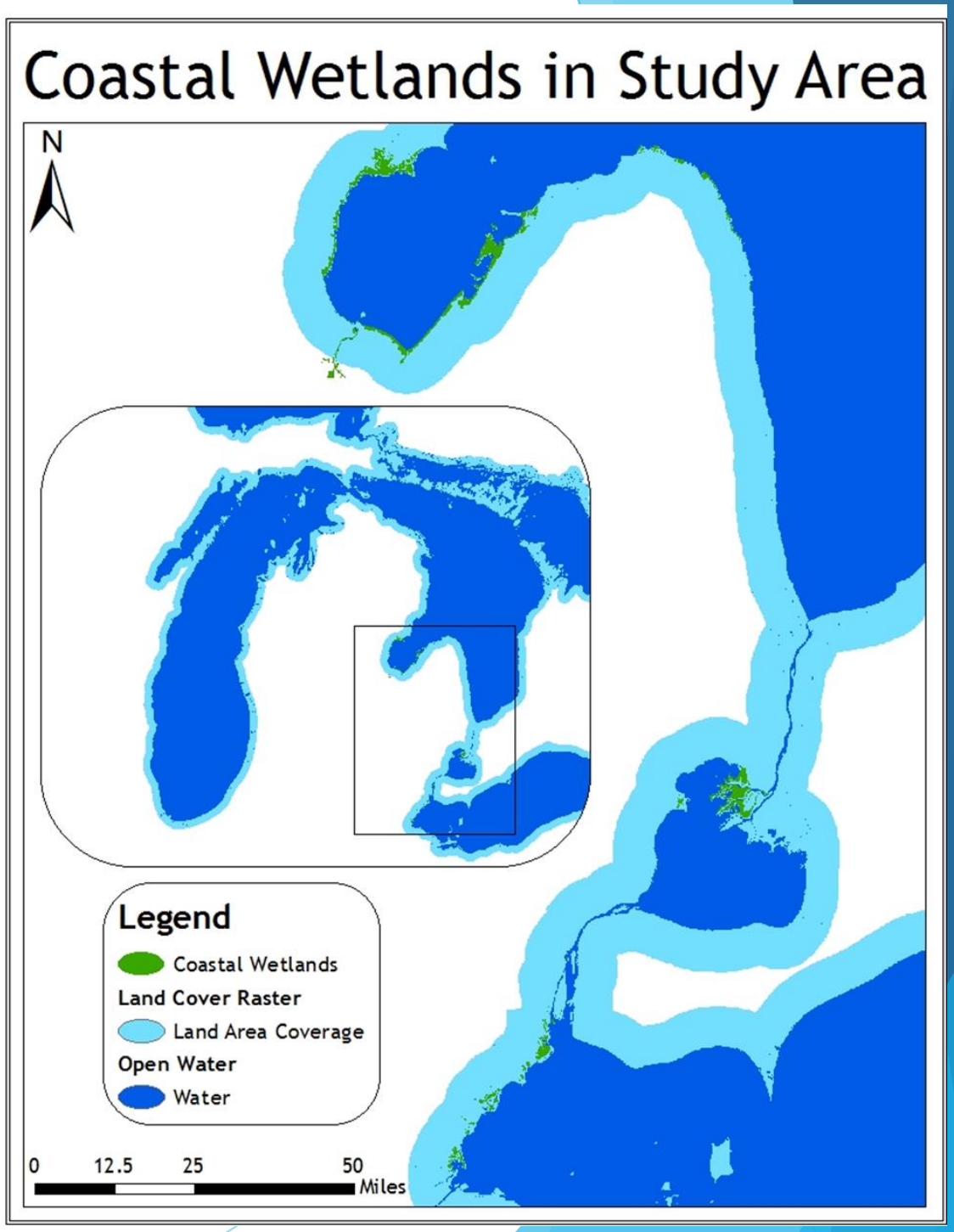
- Why study them?
  - Deteriorating since European settlers arrived and decline not stopping (Brazner, 1997)
  - Have been filled, dredged, drained, and fragmented (Mazzotta et al., 2002; Brazner, 1997) for farming and development
  - Western Basin of Lake Erie, for example, has lost an estimated 95% of its wetlands (Mitsch & Wang, 2000)

Why Update?

- Great Lakes Coastal Wetland Inventory completed in 2004
  - Data from a variety of sources but most based off of pre 2004 air photos and personal knowledge of field scientists
- Various newly available data:
  - True and false-color air photos
  - Detailed land cover classification
  - LiDAR bathymetry
  - Updated roads shapefiles
- Current wetland areas important for further data collection to aid in management decisions

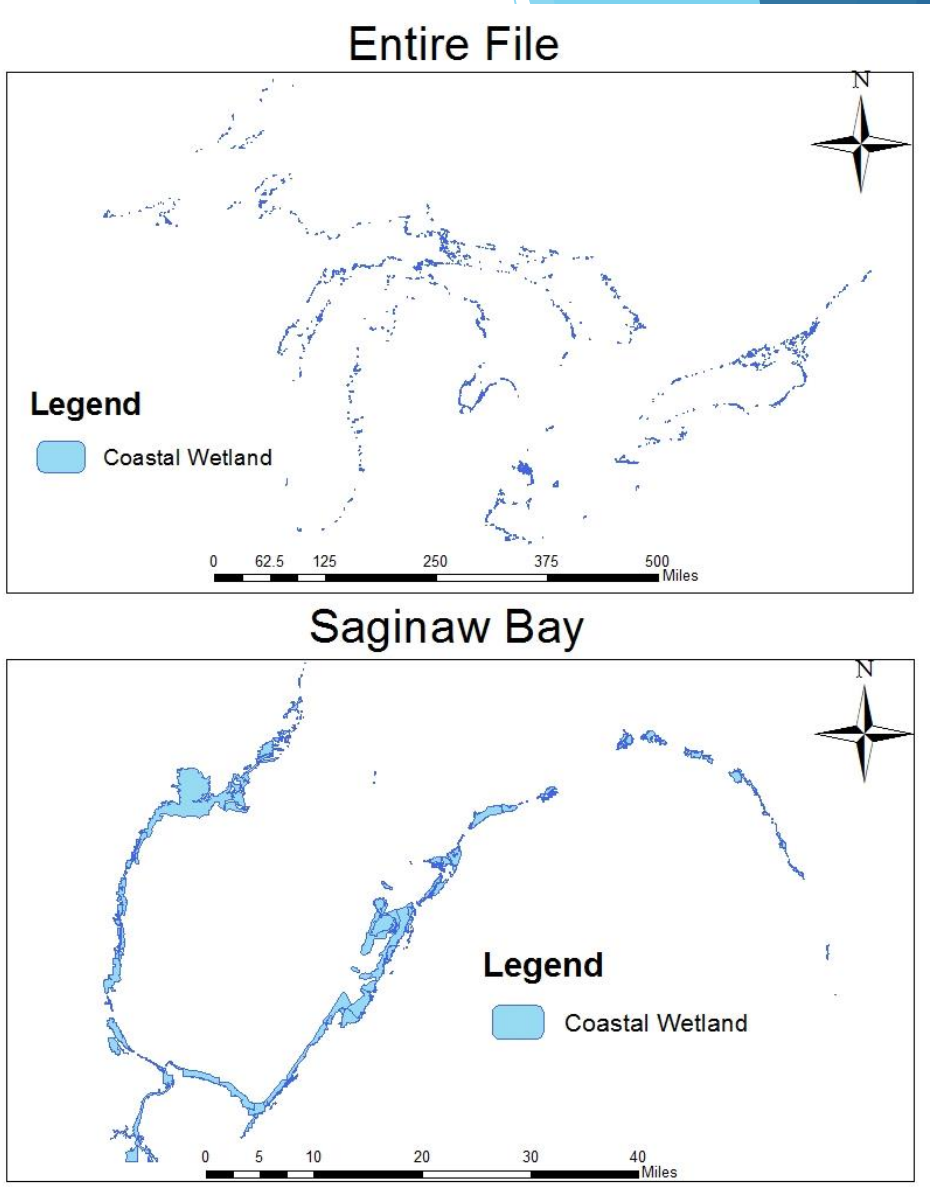
Study Area

- Michigan only
- Northern part of Saginaw Bay
- Southwest basin of Lake Erie
- Includes Lake St.Clair
- 73 Coastal Wetlands:
  - Lake Huron: 41
  - Lake St. Clair: 11
  - Lake Erie: 21



Data (1 of 5)

- Great Lakes Coastal Wetland Inventory, 2004
  - Created By:
    - Michigan Natural Features Inventory
    - Environment Canada, Canadian Wildlife Service - Ontario Region
    - U.S. Geological Service, Water Resources Discipline
    - Ontario Ministry of Natural Resources
  - Can obtain from: http://glc.org

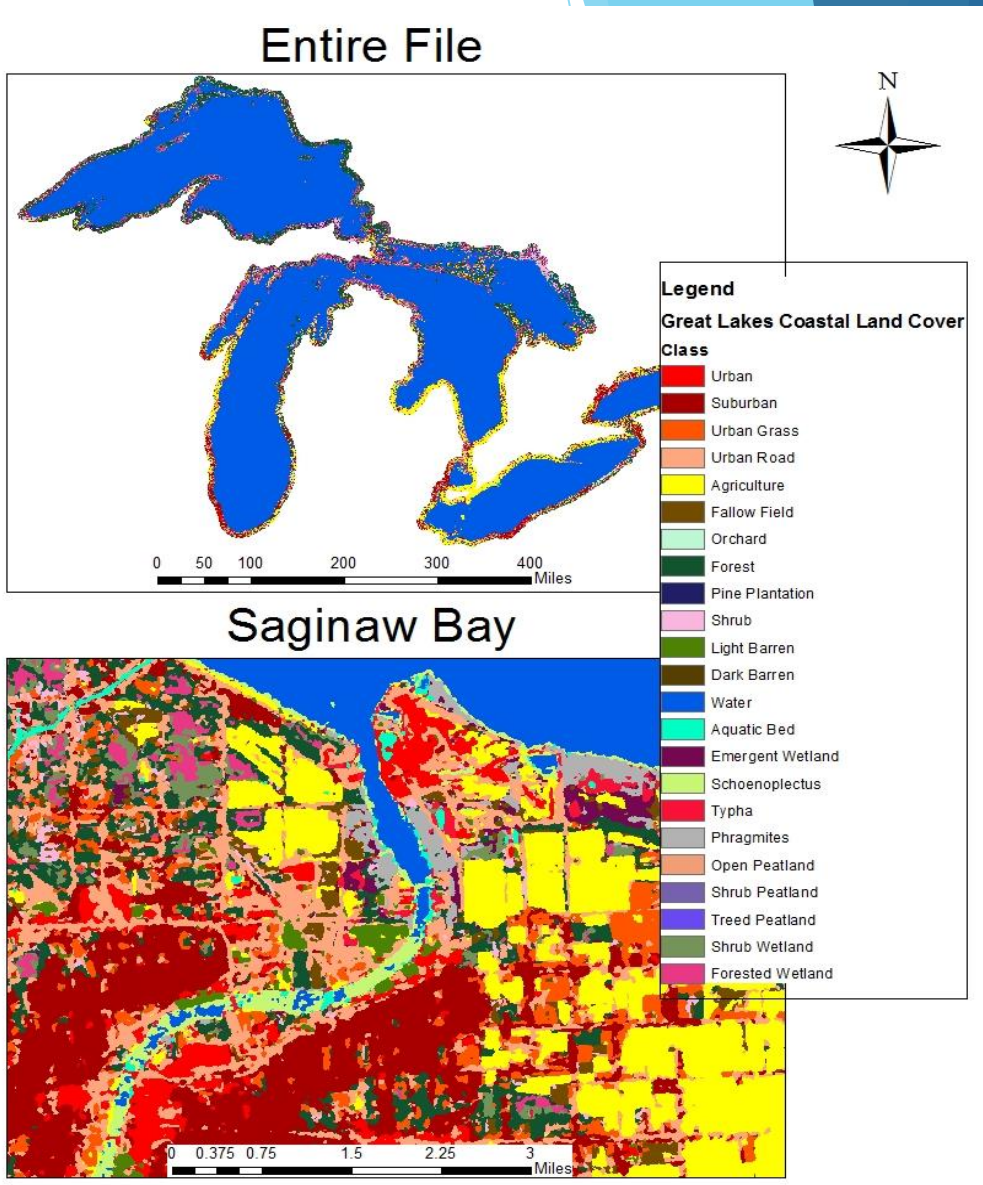


Data (2 of 5)

- National Agricultural Imagery Program (NAIP) Mosaic, 2014
  - USDA-FSA-APFO NAIP
  - 1 meter resolution
  - Downloaded for each county in study area
  - Data Available from: USDA Geospatial Data Gateway

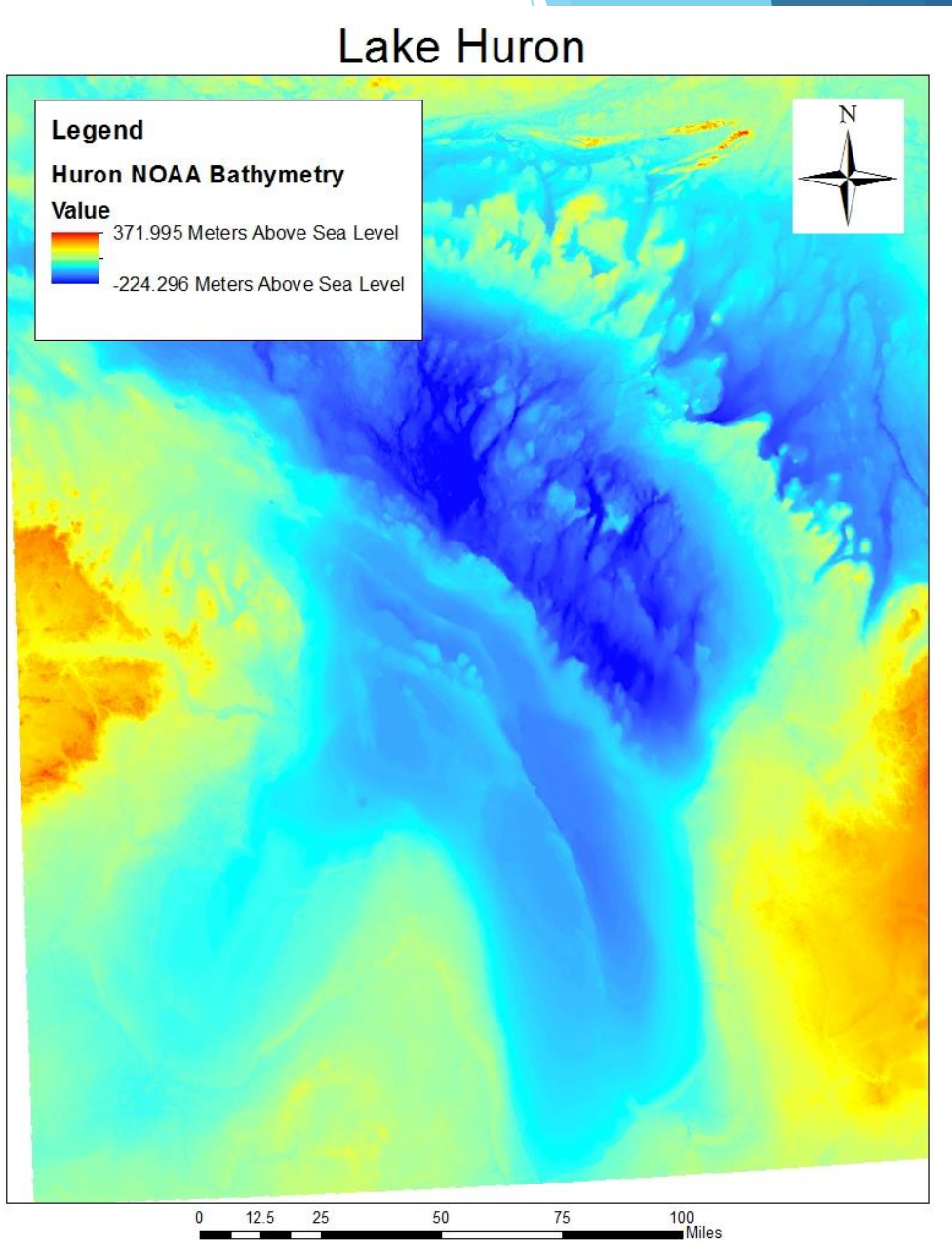
Data (3 of 5)

- Great Lakes Land Cover Raster, 2011
  - Created By:
    - Michigan Tech Research Institute & Environmental Protection Agency (EPA)
  - 12.5 meter resolution
  - Recognizes 23 difference land cover classes
  - Most accurate Land Cover for Great Lakes available
  - Raster Format (not Polygon)
  - Data Available from: http://www.mtri.org/coastal_wetland_mapping.html



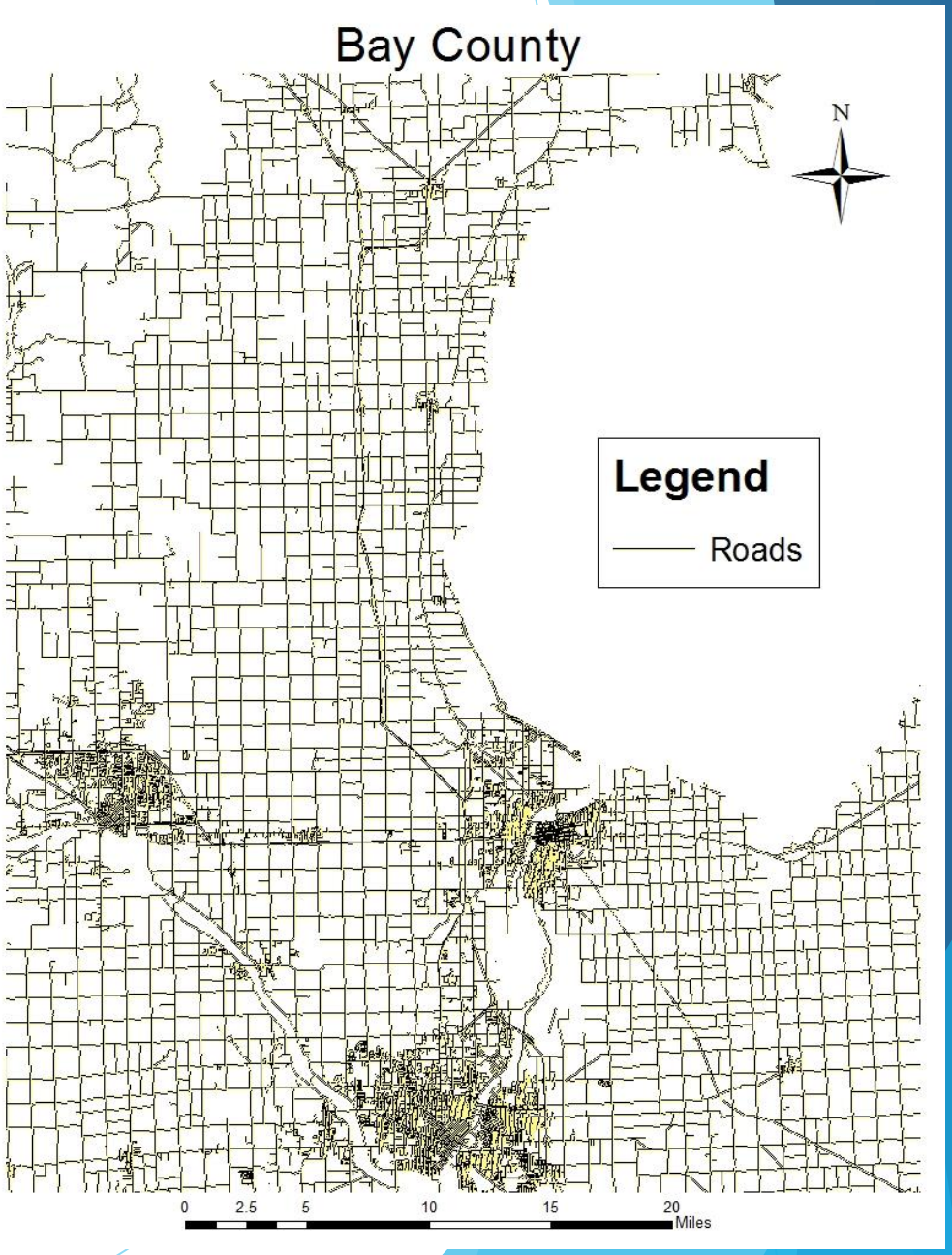
Data (4 of 5)

- U.S. Great Lakes Bathymetry
  - Created By:
    - National Oceanic and Atmospheric Administration (NOAA)
  - Obtained files for Lakes Huron and Erie
  - Data Available from: NOAA - Great Lakes Bathymetry



Data (5 of 5)

- U.S. All Roads, 2010
  - Created By:
    - U.S. Department of Commerce
    - U.S. Census Bureau, Geography Division
  - Data Available from: https://catalog.data.gov



- Imagery
- Wetlands
- Land Cover
- Bathymetry
- Roads
- Update

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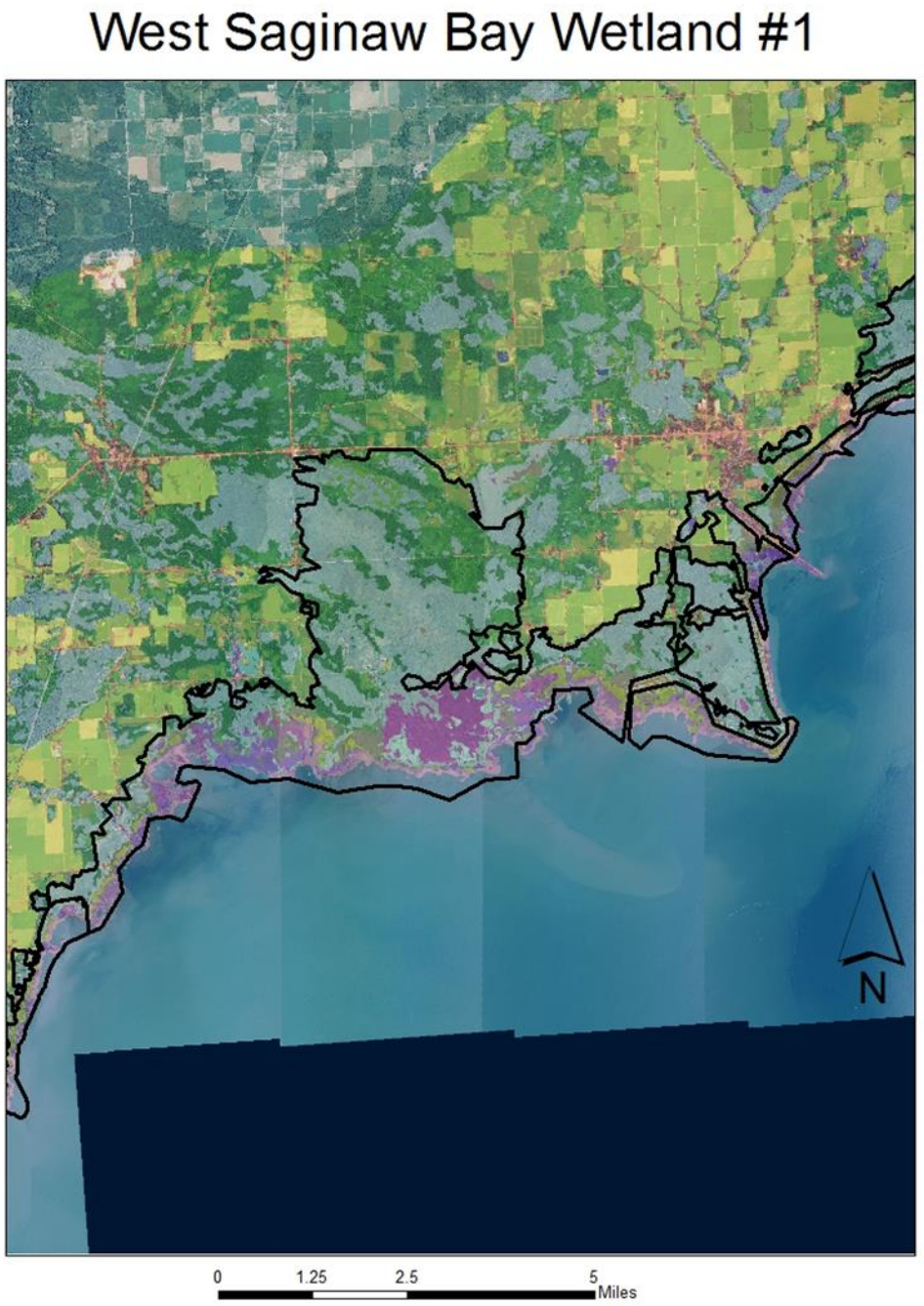

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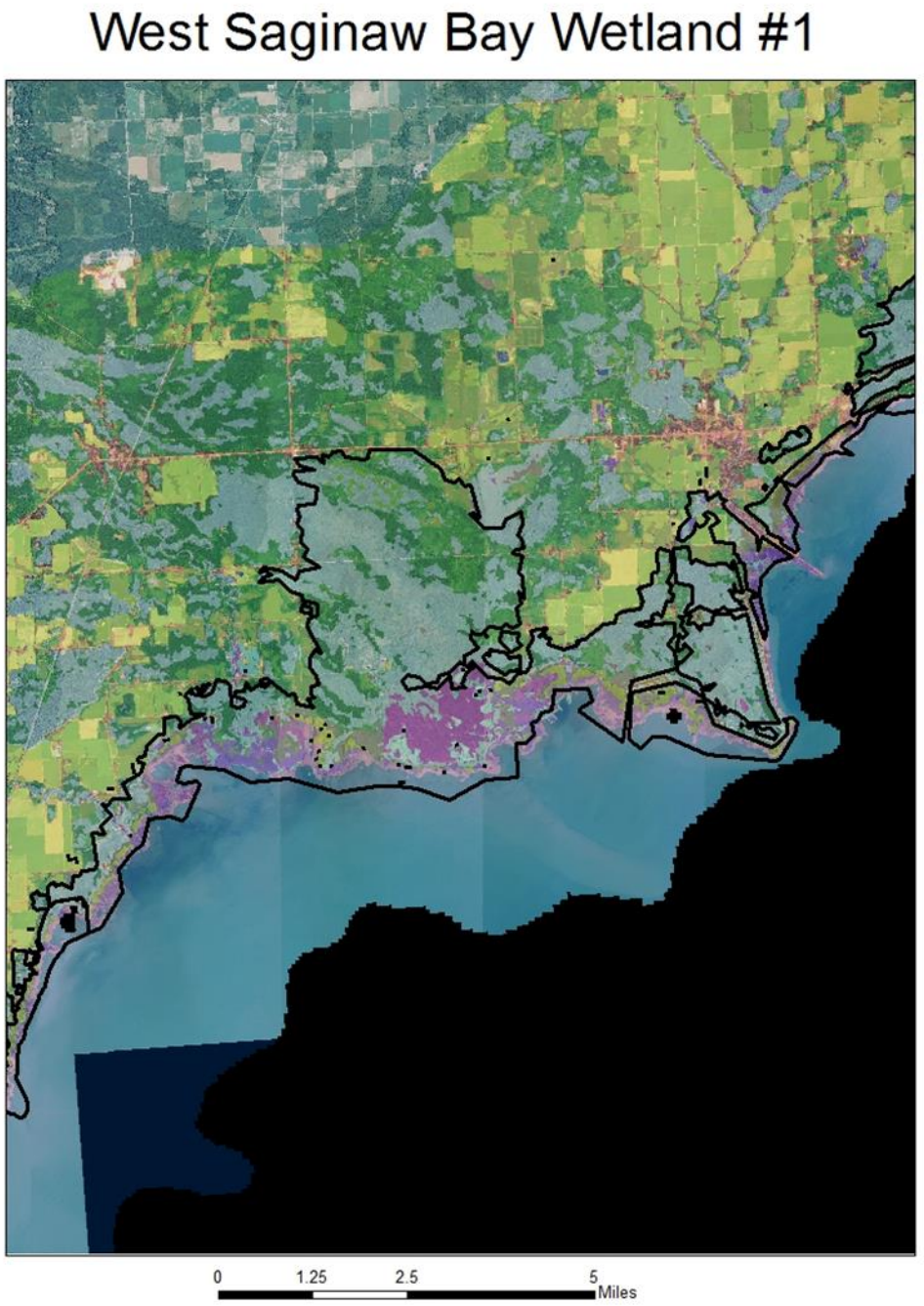

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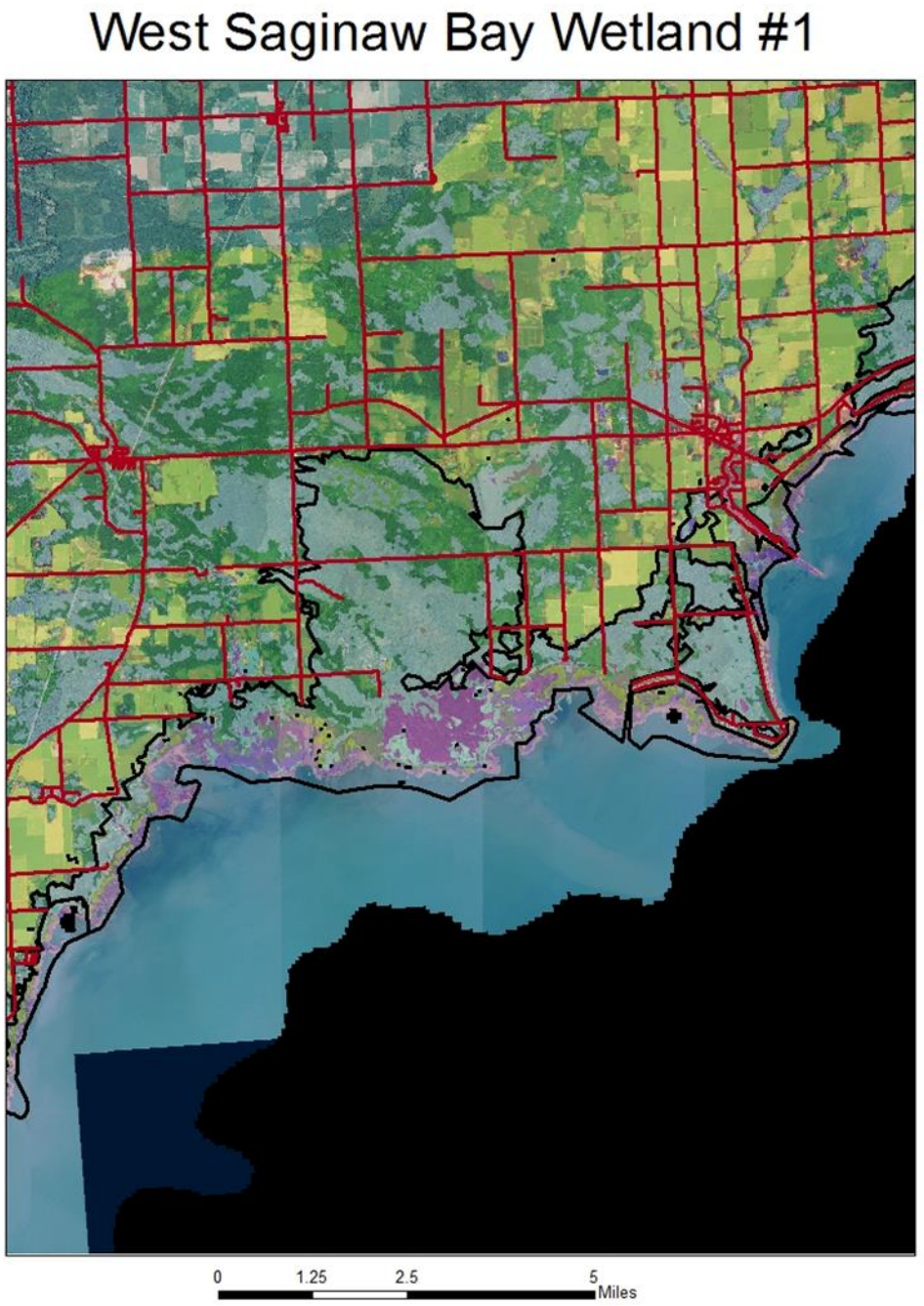

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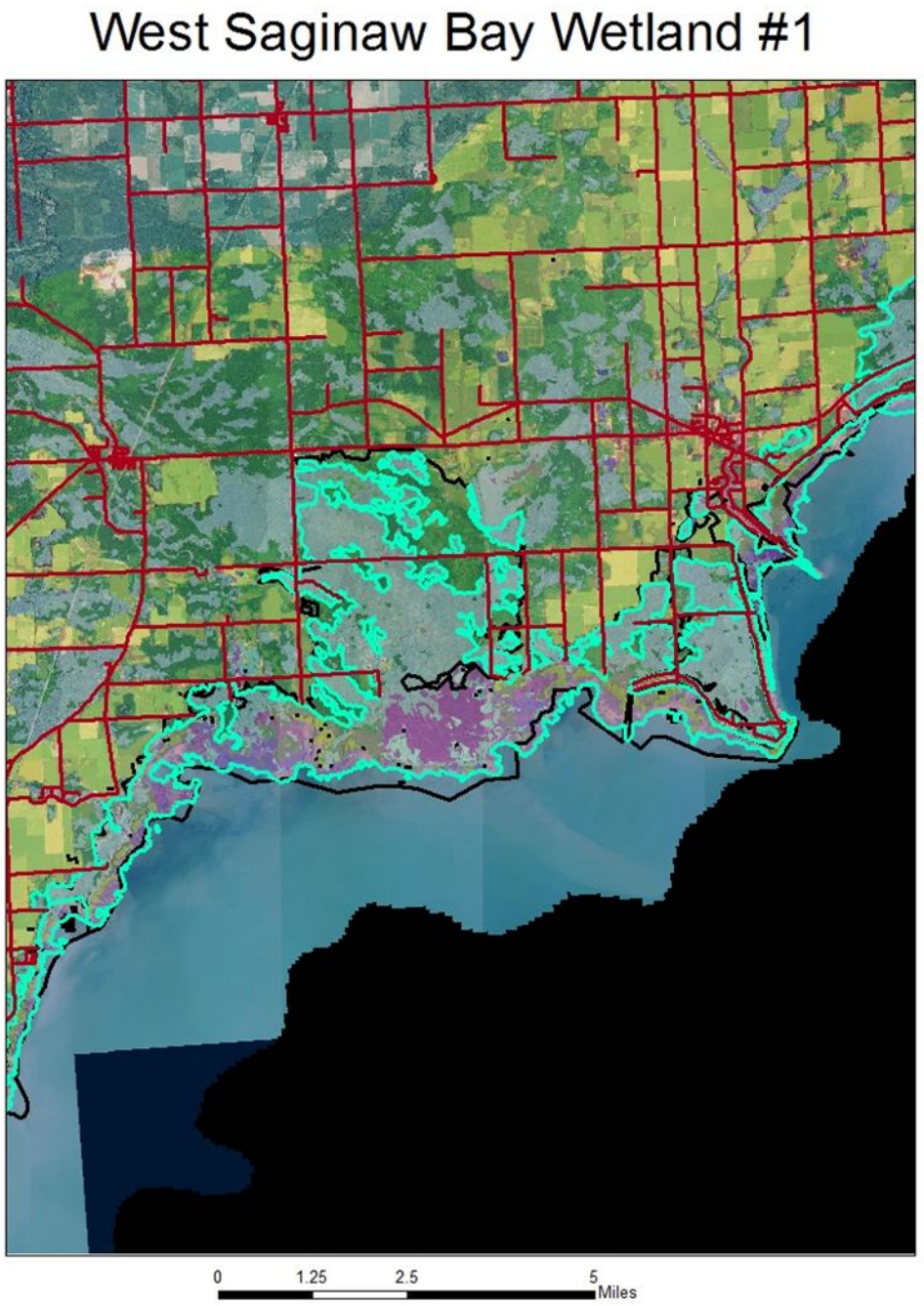
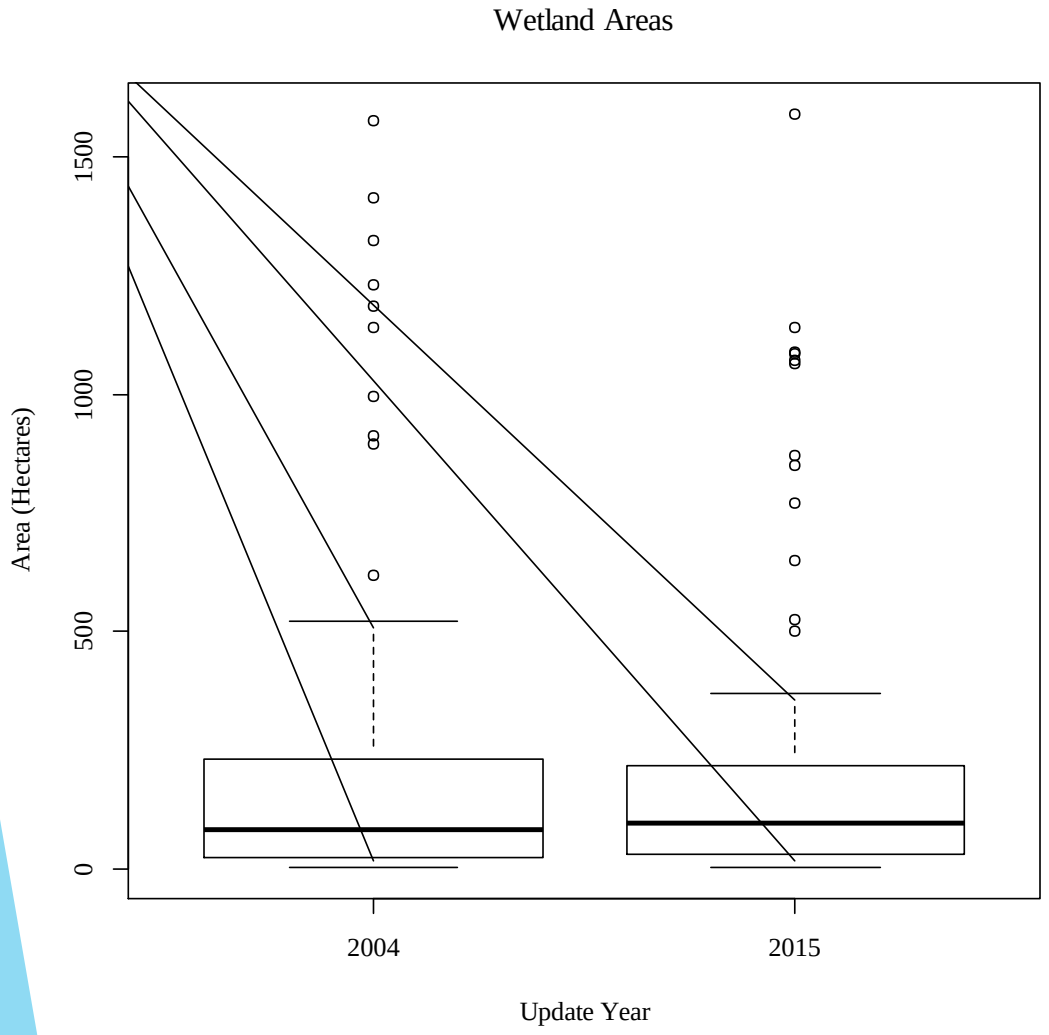
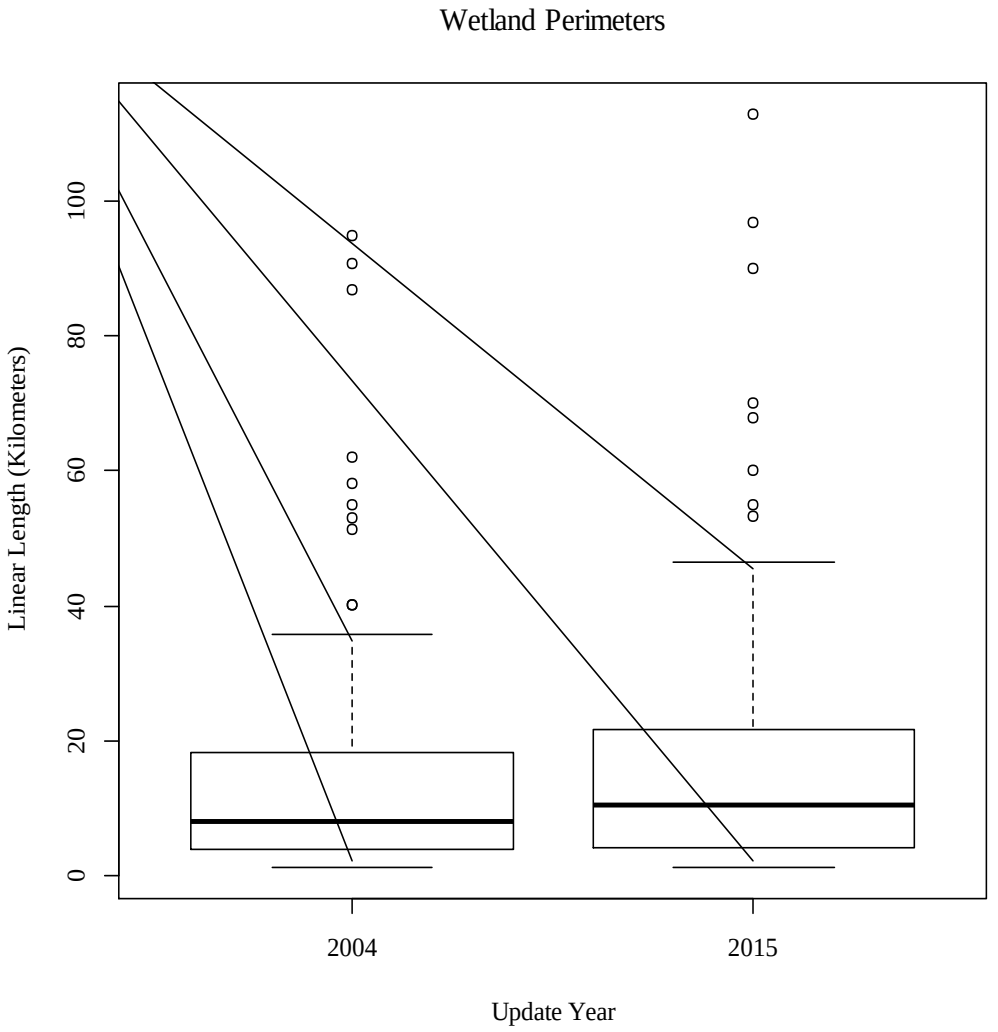


Simplified Rules/Processes

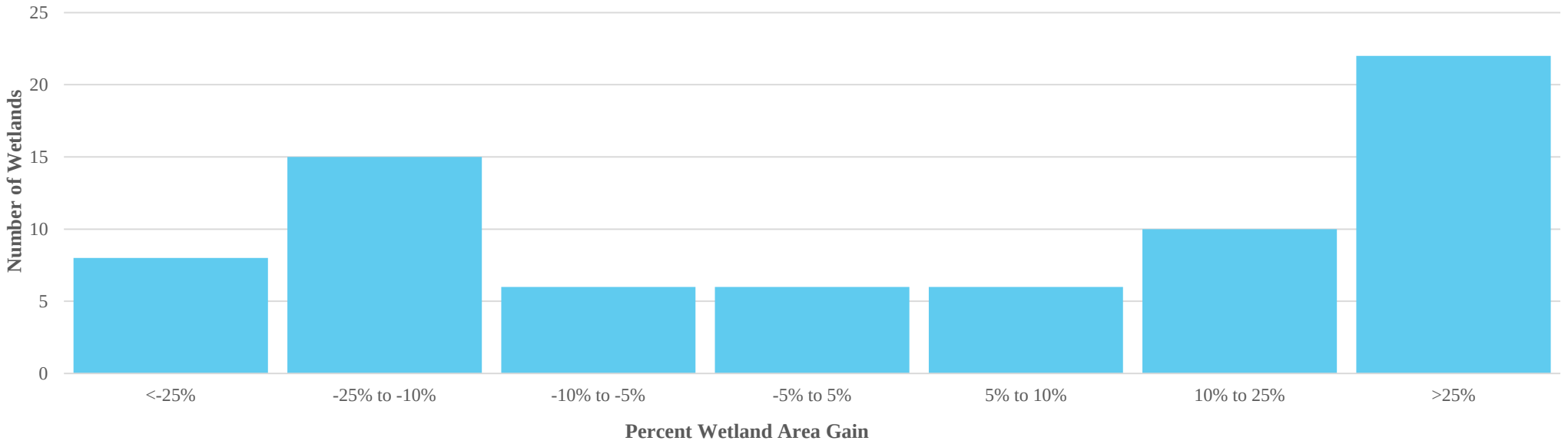
- Select wetland to update
- Zoom in to 1:3000 scale
- Identify any conflicts between polygon boundary and datasets
- **Need to justify every polygon adjustment**
  - If it does conflict:
    - Examine Land Cover and Aerial Imagery
    - Interpret new boundary
      - Edit vertices by hand
    - **If new boundary can't be interpreted, leave the existing boundary alone!!**
- Once the boundaries are updated we can move on to the second objective, analytical comparisons

Results

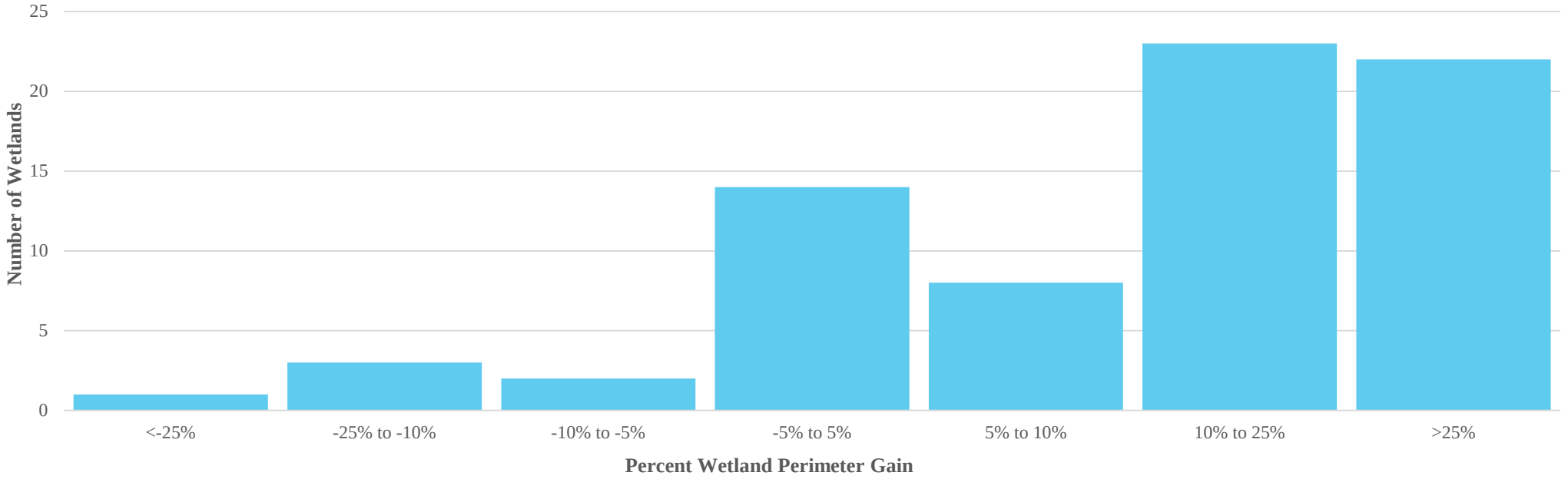

Wetland Areas
Area (Hectares)
0
500
1000
1500
2004
2015
Update Year


Wetland Perimeters
Linear Length (Kilometers)
0
20
40
60
80
100
2004
2015
Update Year

Number of Wetlands Within Each Percent Area Gain Class



Number of Wetlands Within Each Percent Perimeter Growth Class



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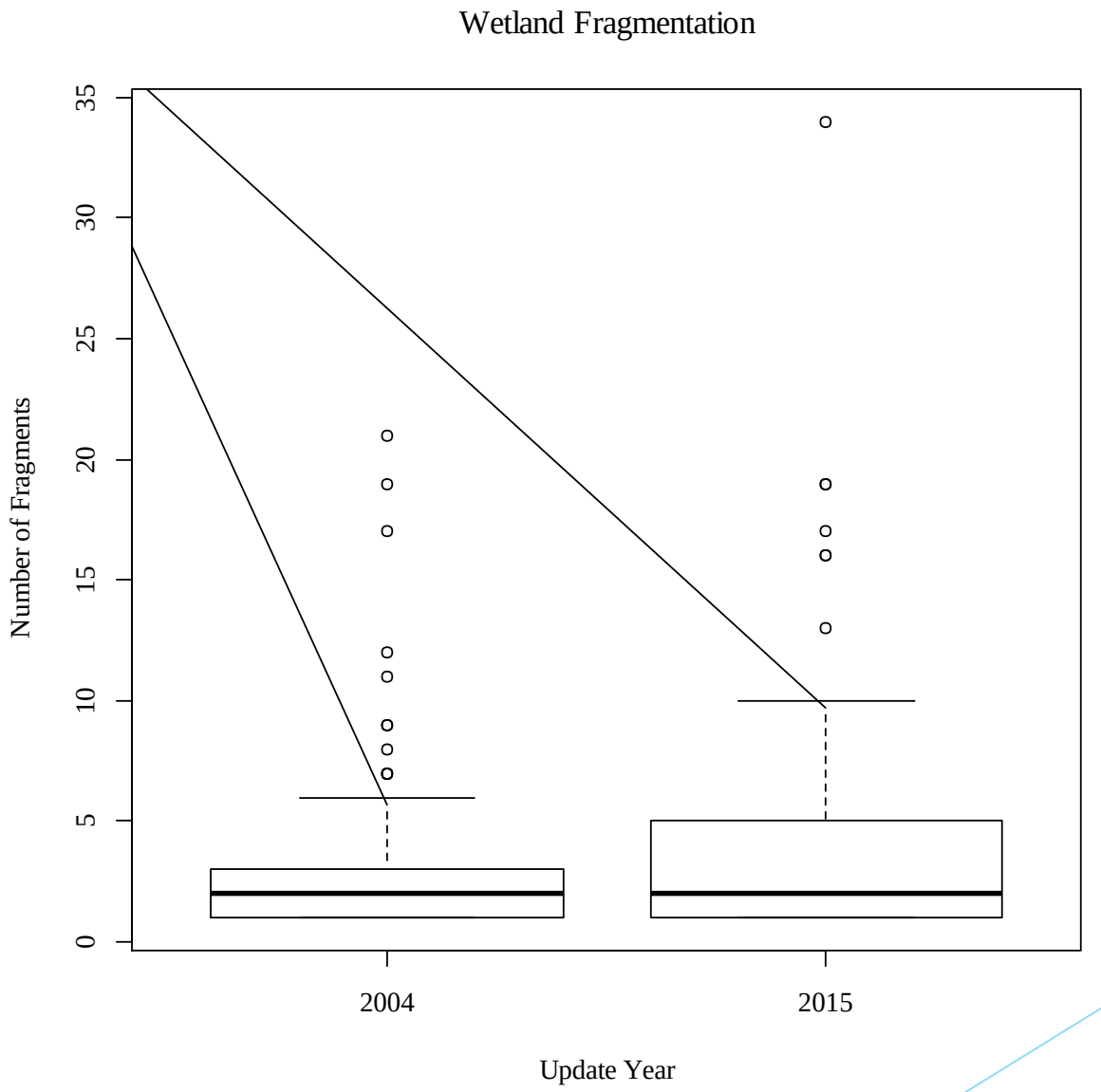
Wetland Fragmentation
Number of Fragments
0
5
10
15
20
25
30
35
2004
2015
Update Year

Discussion

- What caused the 11% decrease in area, 20% increase in perimeter, and 24% increase in fragmentation?
  - Likely 3 reasons:
    - Natural water level fluctuations
      - Great Lakes water levels can fluctuate over 1.5 meters from a wet year to a dry year (Mitsch & Wang, 2000)
    - Human development and agriculture
      - Less likely due to numerous state and federal laws
    - Differences in data while using conservative estimates

Conclusions

- Great Lakes coastal wetlands from Saginaw Bay to Lake Erie are changing
- The 11.2% decrease in area across the study area is a statistically significant change
- As a whole, these coastal wetlands are decreasing in size and becoming more fragmented
- Decreased habitat area and increased isolation can greatly influence species diversity in both plants and animals (Wettstein and Schmid, 1999)

Future Work

- Updated Great Lakes coastal wetland file enables the calculation and collection of various attributes that could aid in coastal wetland management
- Currently completing:
  - Nearby human population densities
  - Accessibility
  - Land ownership
  - Watershed land cover
  - Biodiversity
- All information gathered will undergo comparative analysis

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Thanks for Your Time!

Any Questions?