National Aeronautics and Space Administration

Great Lakes Ecological Forecasting

Utilizing NASA Earth Observations to Monitor and Forecast the Spread of Phragmites australis in the Great Lakes Basin

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Phragmites

- *Phragmites australis* subsp. *australis*
- Common reed
- Worldwide
- Perennial wetland grass
- Invasive species
- Lowered biodiversity

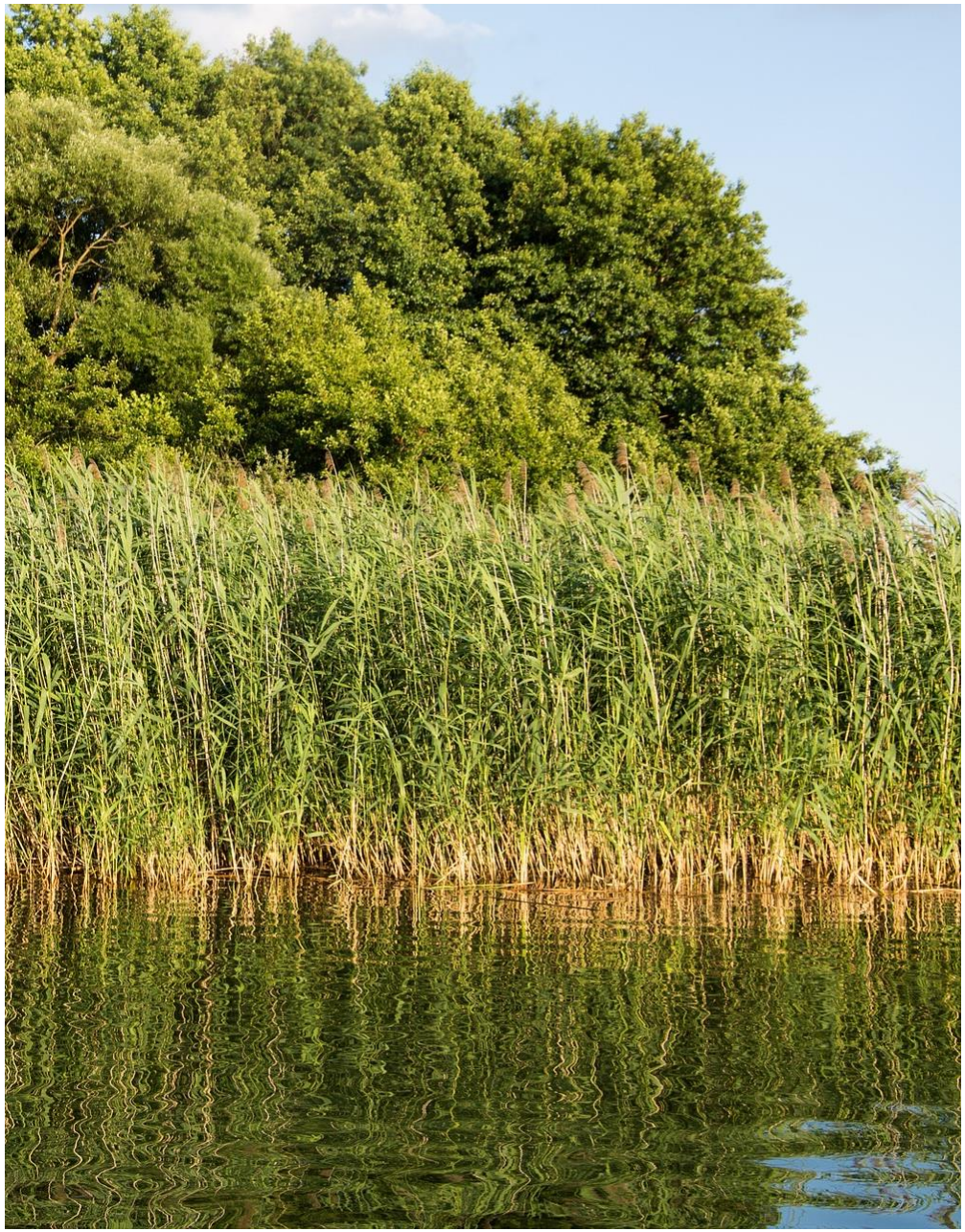


Image credit: Pixabay

Study Area

- Great Lakes Basin
- Canada & U.S
- 18% of worlds freshwater
- 90% of U.S freshwater
- 34 million people

Image credit: ESRI

Study Period

- 1985 – 2015
- Habitat suitability model for 2015 Phragmites extent
- Forecast for 2020

Image credit: Pixabay

Community Concerns

- High cost of management
- Hard to eradicate
- Lowers biodiversity
- Detriment to property value
- Rapidly expanding

Image credit: U.S. Fish and Wildlife Service

Partners

Great Lakes St. Lawrence Cities Initiative

- Member Cities in U.S & Canada
- Assist in policy making
- Provide updated Phragmites information

Michigan Tech Research Institute

- Experience in mapping Phragmites regionally
- Remotely sensed imagery

Image Credit: Neil Cornwall

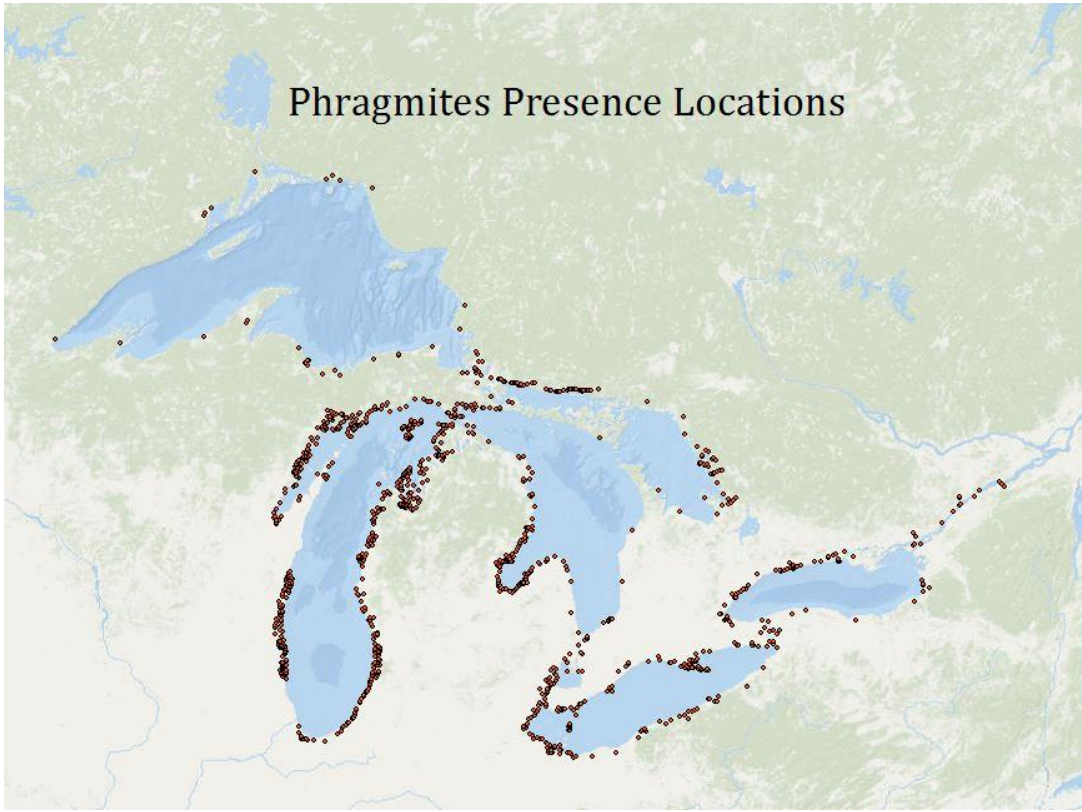
Objectives

- Assess the value of Earth observations in creating environmental variables
- Model a current risk map of Phragmites
- Model land change as driver variables for ecological forecasting
- Forecast a risk map of Phragmites for 2020

Image credit: Andreas Trepte

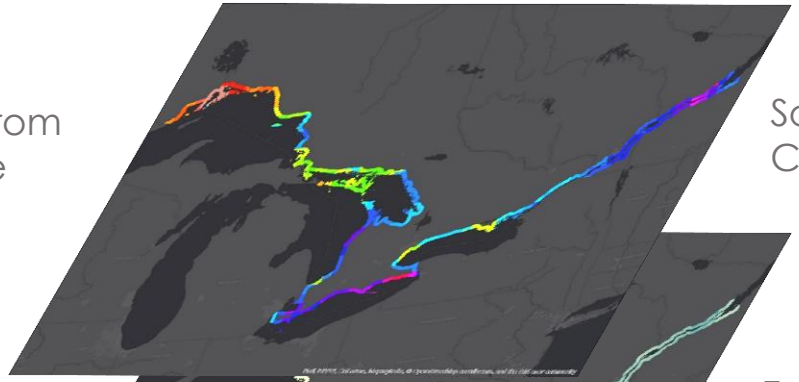
Data: Phragmites

- Early Detection & Distribution Mapping System
- MTRI Field Survey
- Global Biodiversity Information Facility
- Used for model training and validation
- n = 1,163

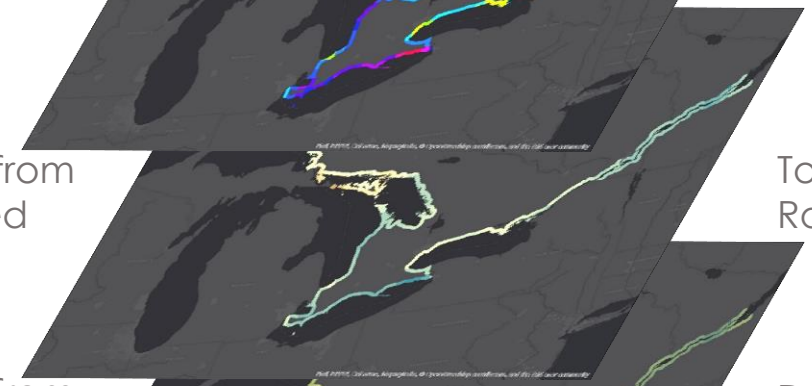


Driver Variables

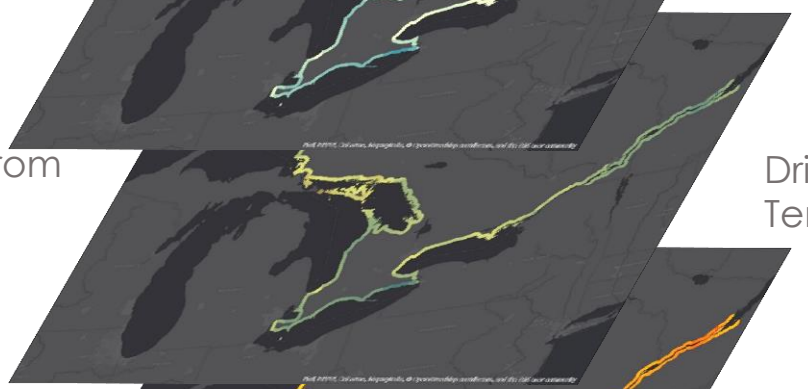
Distance from Agriculture



Distance from Developed

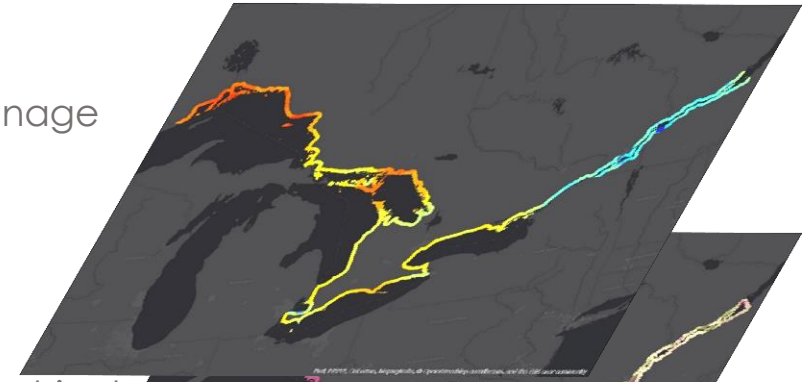


Distance from Roads



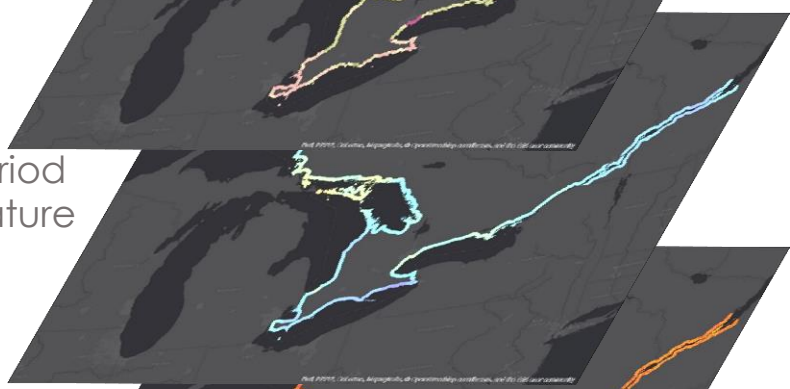
Coldest Quarter Precipitation

Soil Drainage Class



Topographical Roughness

Driest Period Temperature



Warmest Quarter Precipitation

Earth Observations - SRTM

- Shuttle Radar Topography Mission (SRTM)
- Slope
- Topographic Roughness
- 30m Digital Elevation Model

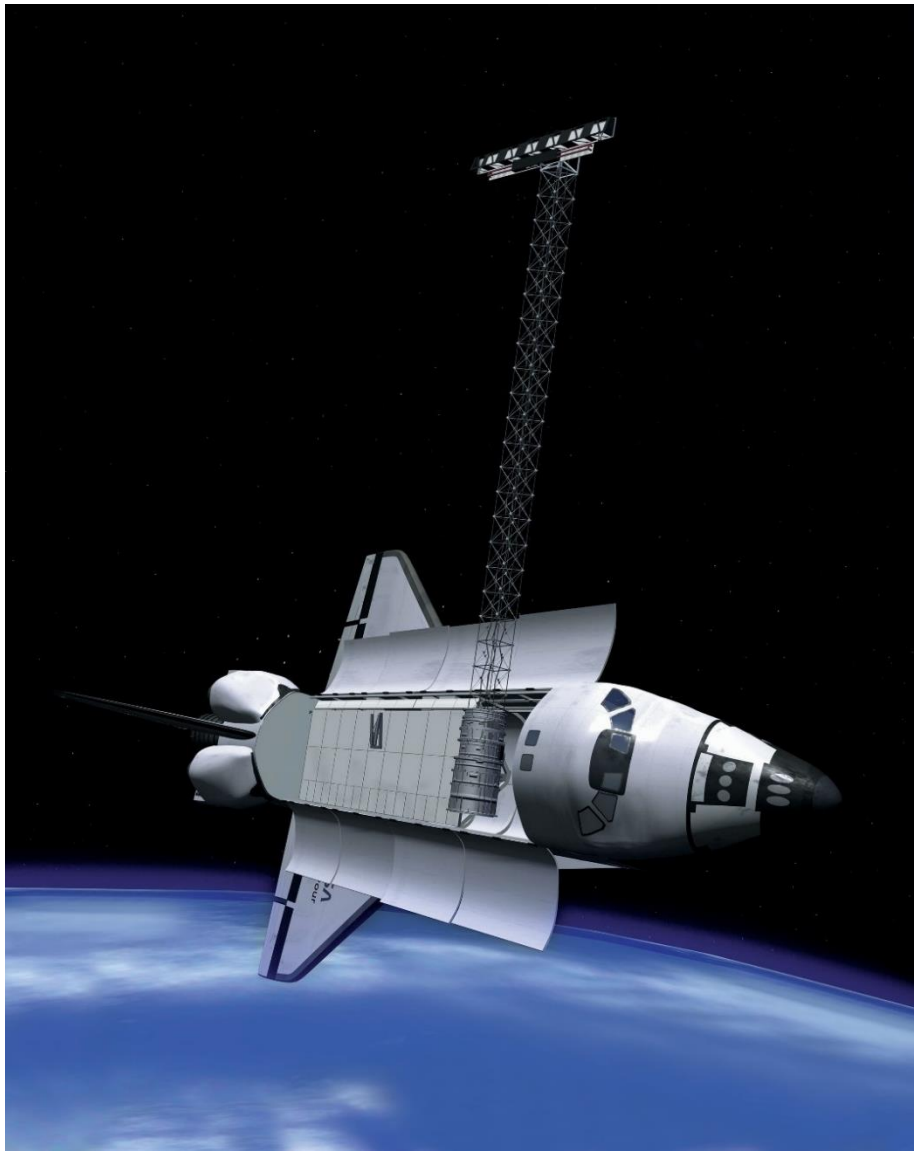
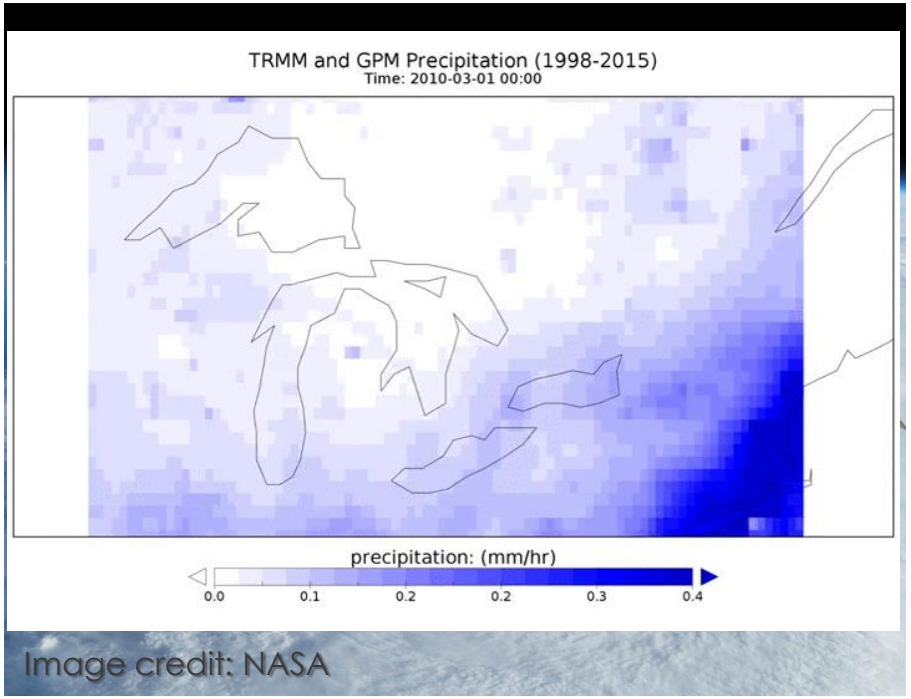


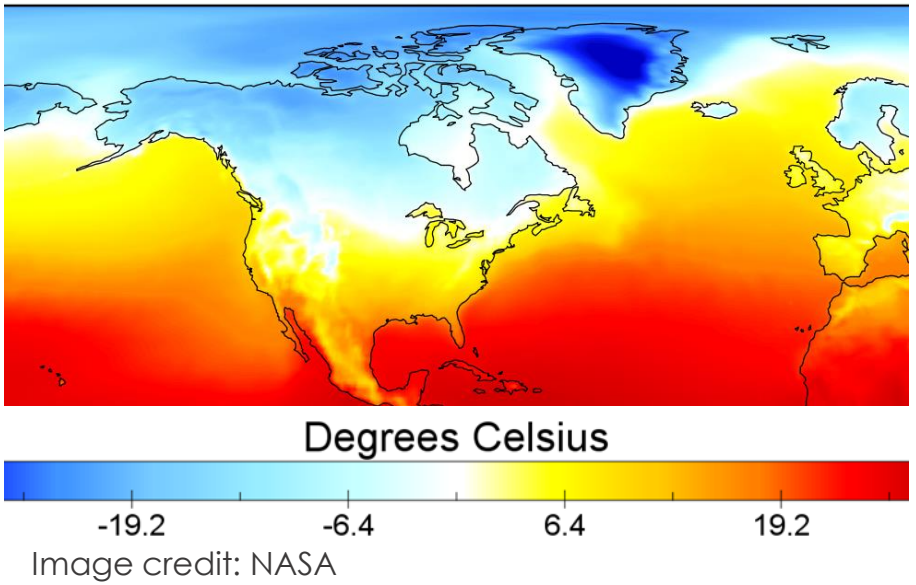
Image credit: NASA

Earth Observations
TRMM + GPM

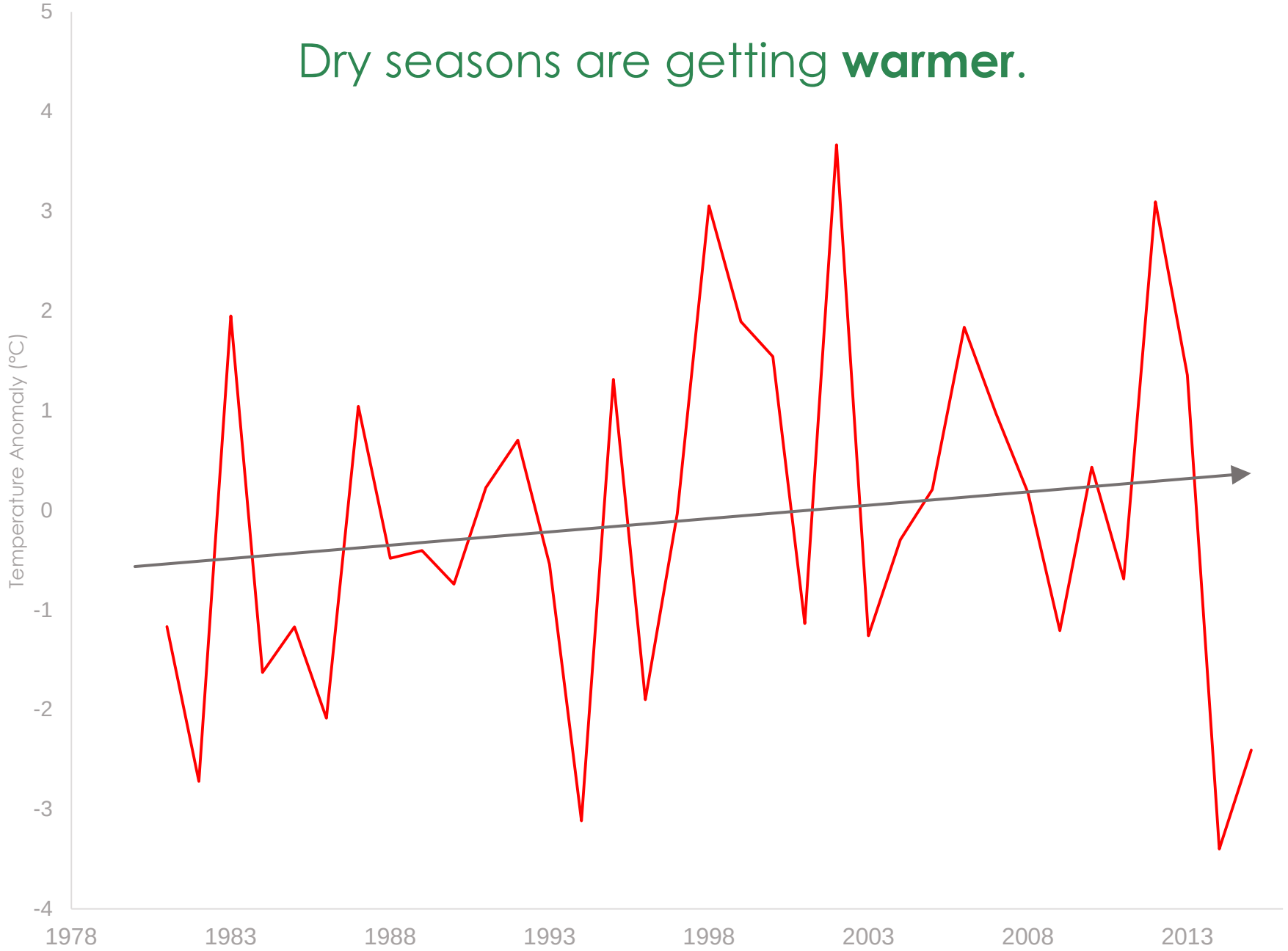
- Precipitation
  - TRMM (Tropical Rainfall Measuring Mission)
  - GPM (Global Precipitation Measurement)



- Temperature
  - MERRA-2 (Modern-Era Retrospective Analysis for Research and Applications-2)



Dry seasons are getting **warmer**.



Methodology

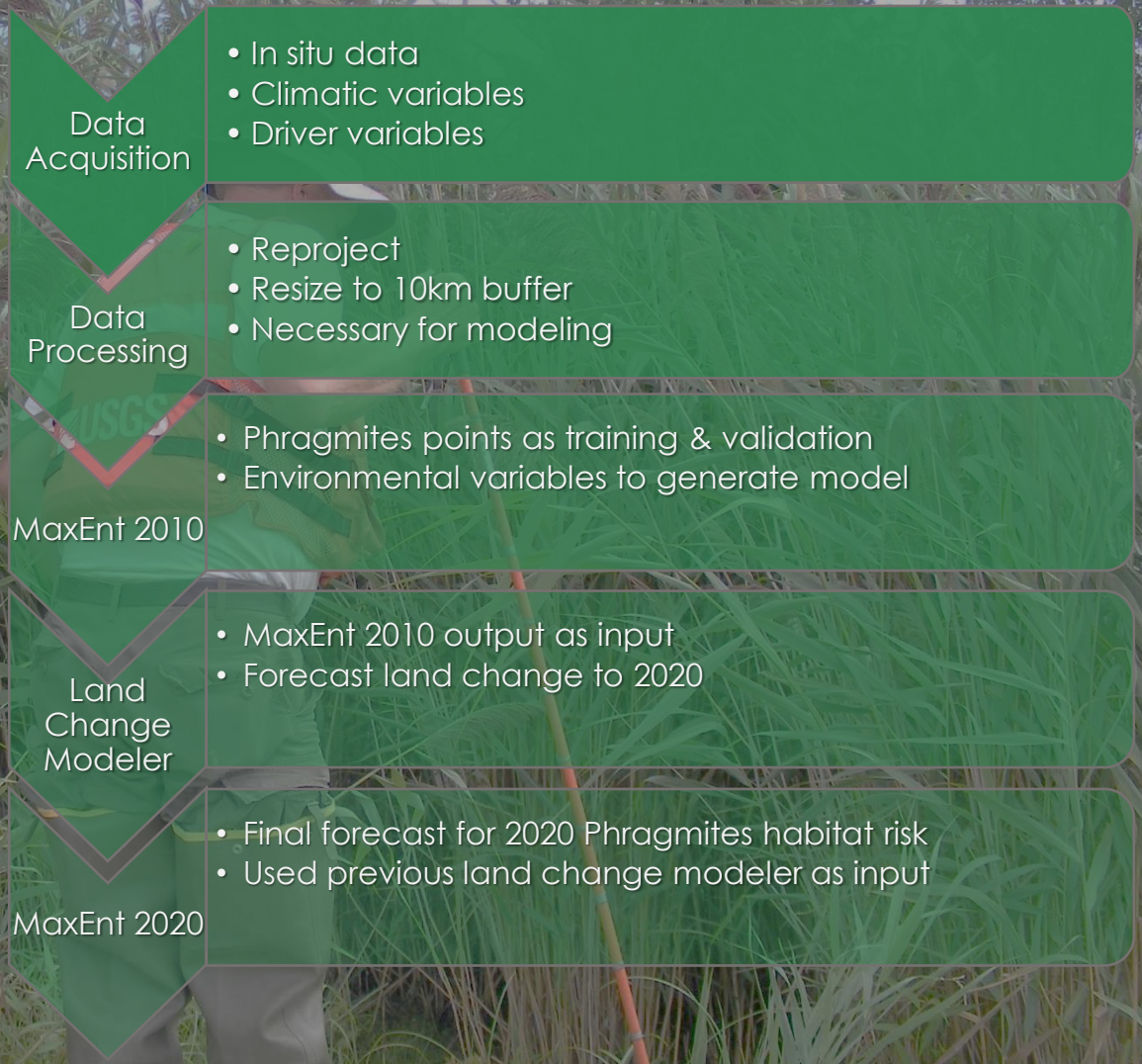
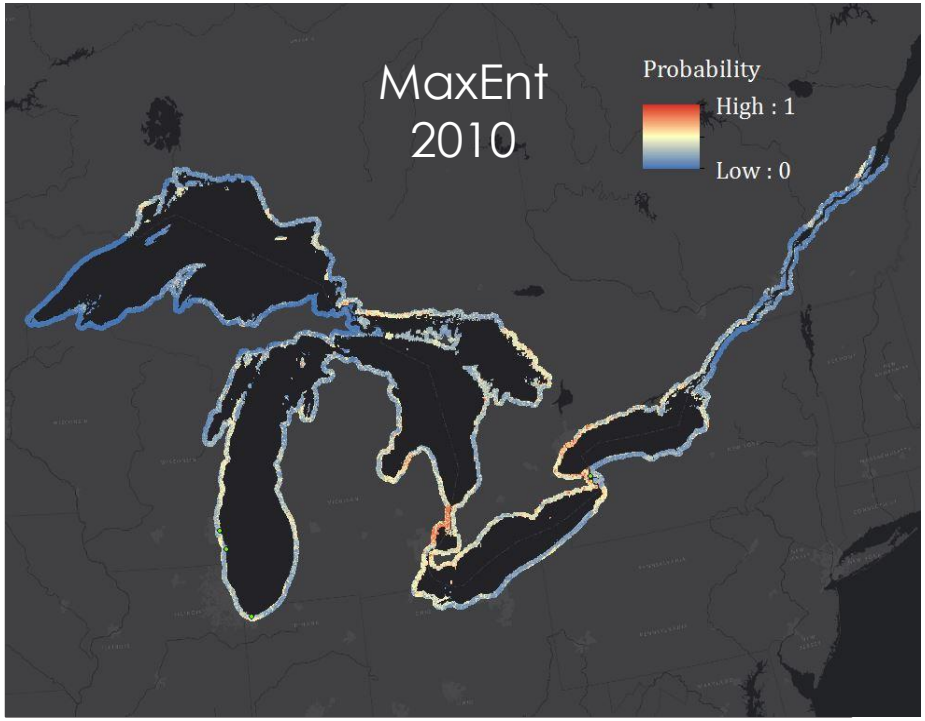


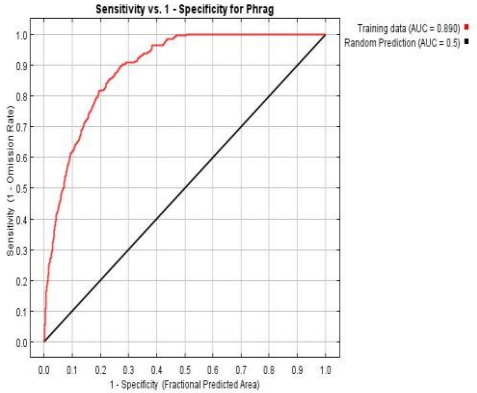
Image Credit: Kurt Kowalski, USGS

Results – MaxEnt 2010

Variable contributing most to model	Percent contribution
Topographic roughness	28
Driest season temperature	17.7
Soil drainage	13
Distance from agriculture	12.5
Distance from developed	4.6

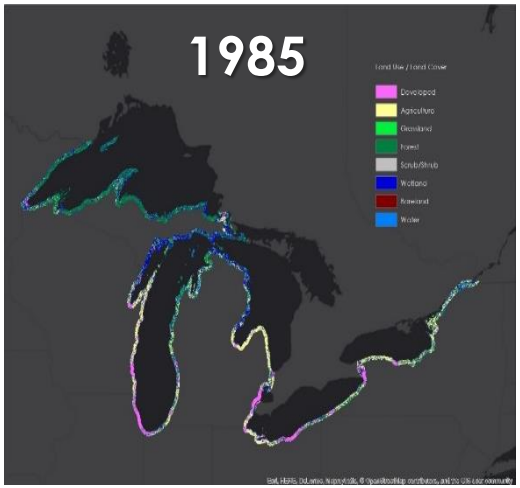
- Coldest season precipitation

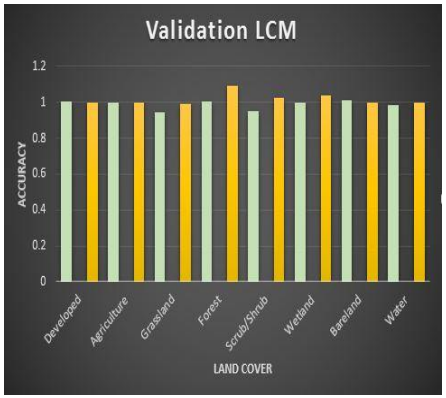


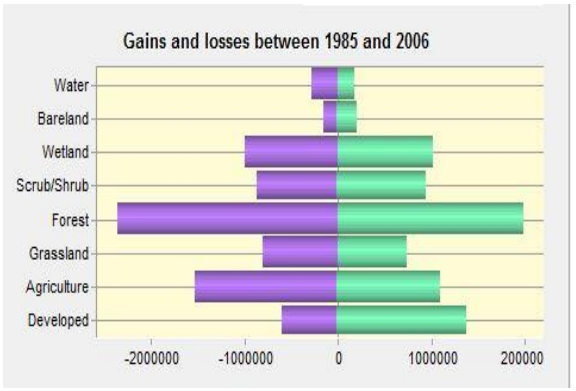


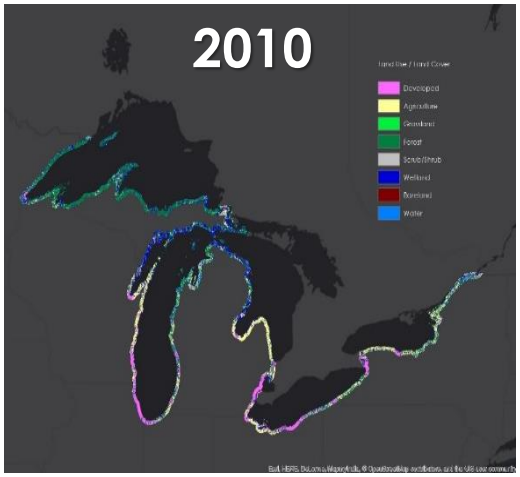
Variable	Percent contribution	Permutation importance
maxent_US_TR_ASCII	28	22.1
maxent_US_DryTemp_2010_ASCII	17.7	34.4
maxent_US_ColdTemp_2010_ASCII	17.1	2.6
maxent_US_SoilDrainage_ASCII	13	8.2
maxent_Dist_2_Agr_2010_USA_ASCII	12.5	11.8
maxent_Dist_2_Dev_2010_USA_ASCII	4.6	11.2
maxent_US_DJF_2010_2011_ASCII	3.2	6.2
maxent_Dist_2_Roads_USA_ASCII	2.2	2
maxent_US_JJA_2010_2011_ASCII	1.7	1.4

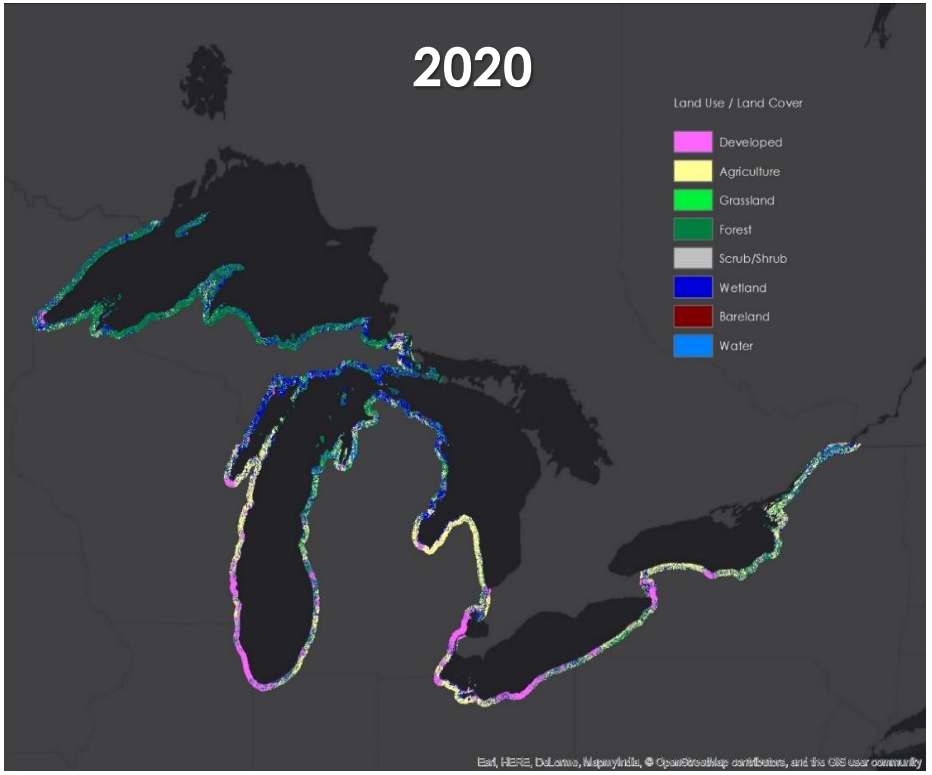
Results - Land Change Modeler



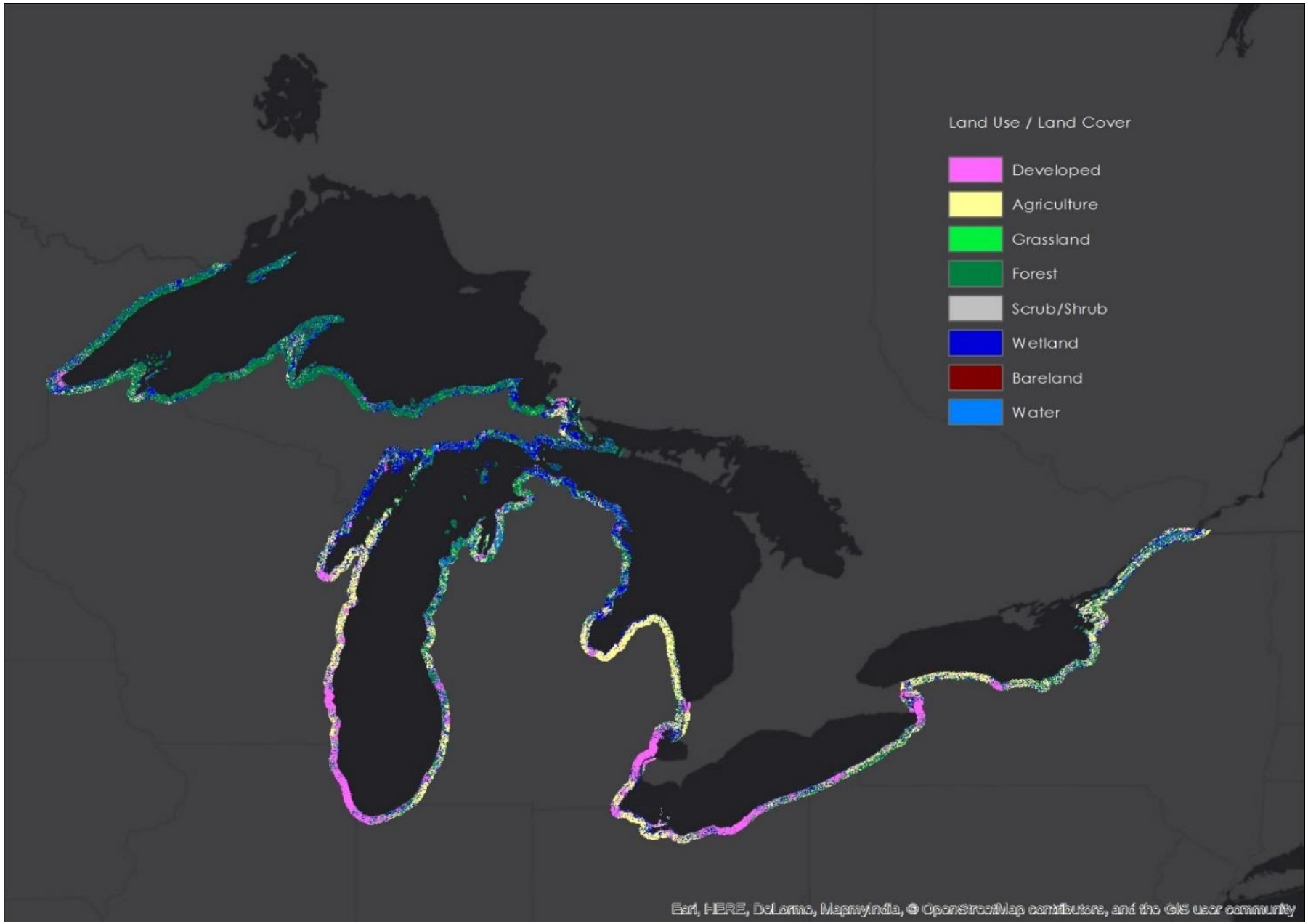




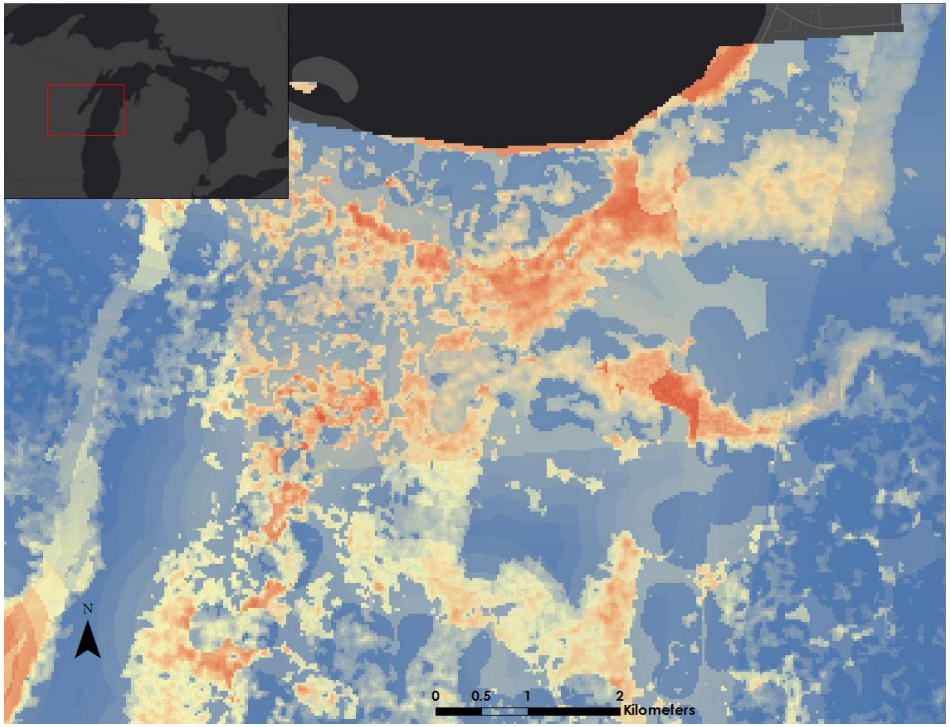


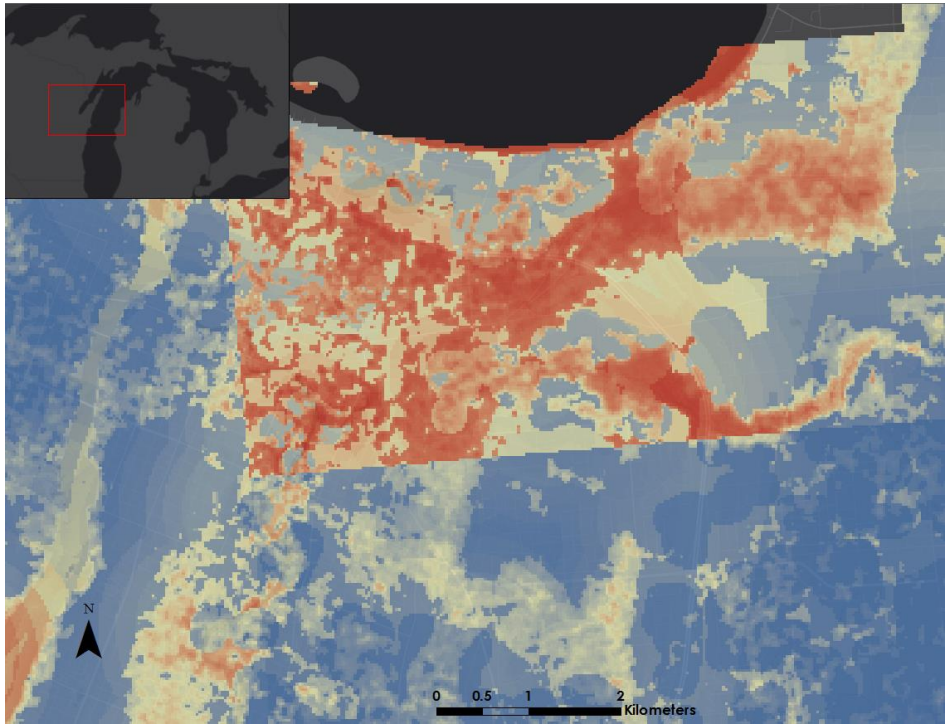


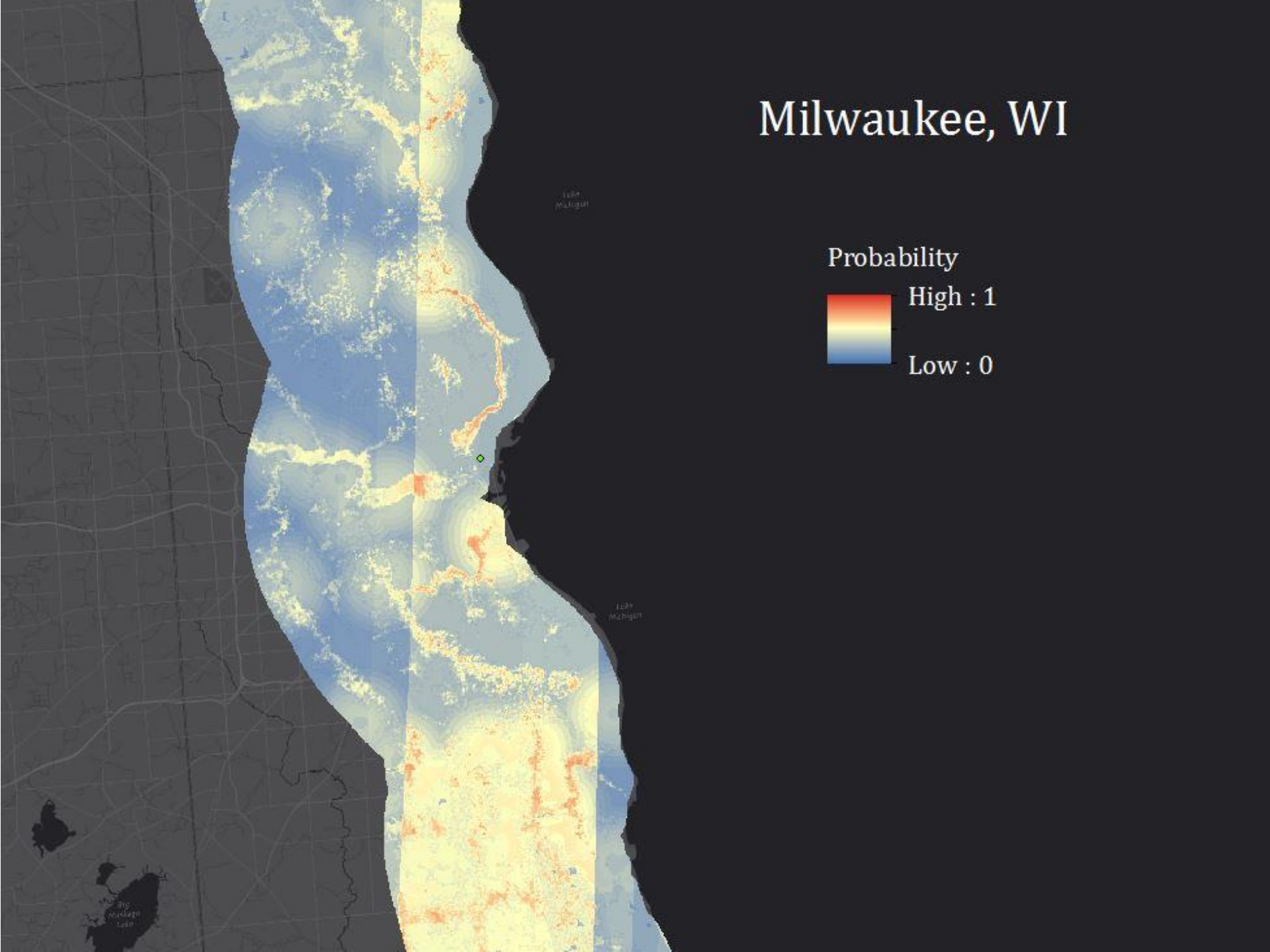
Land Change Modeler – Predicted 2020

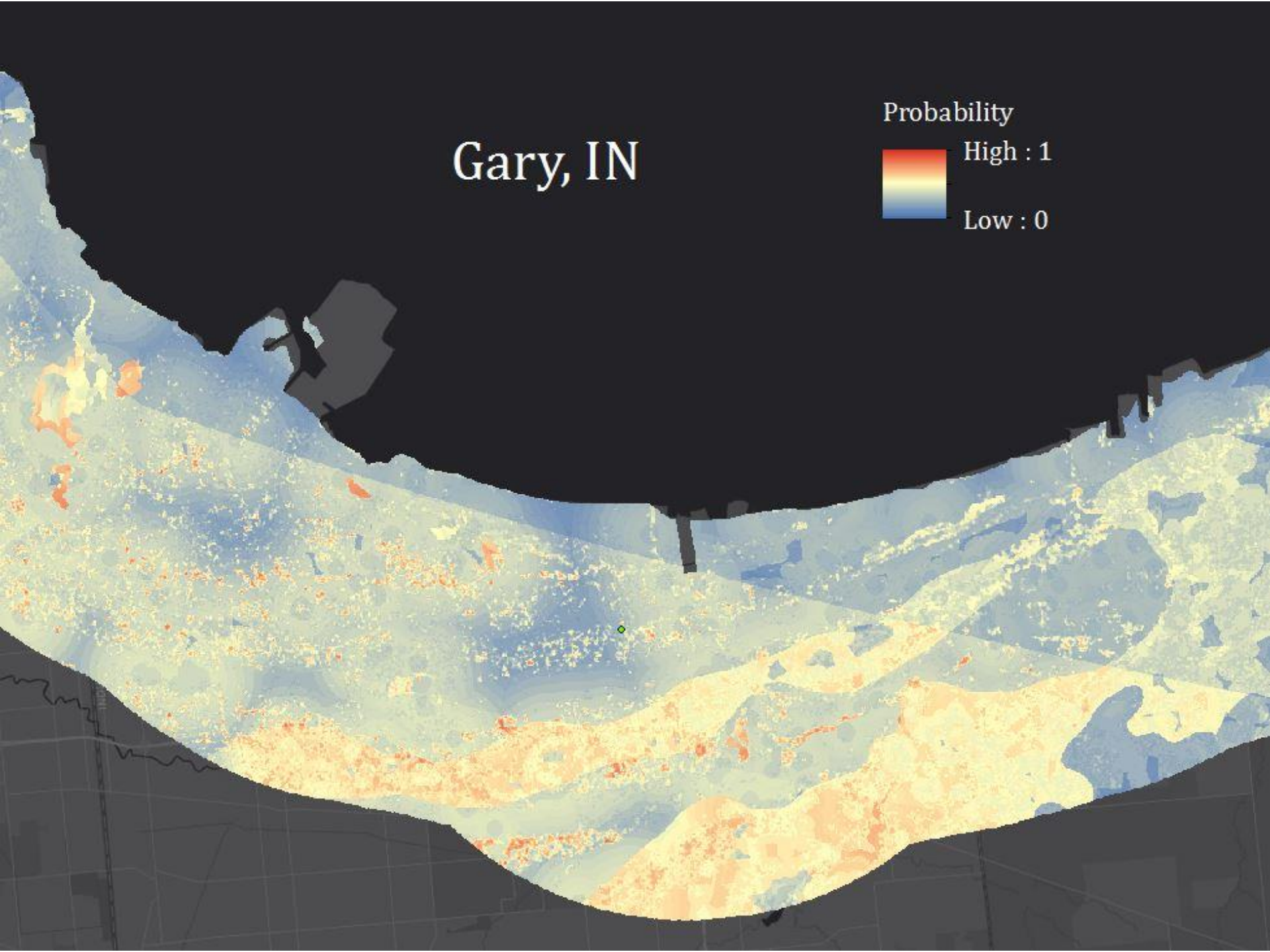


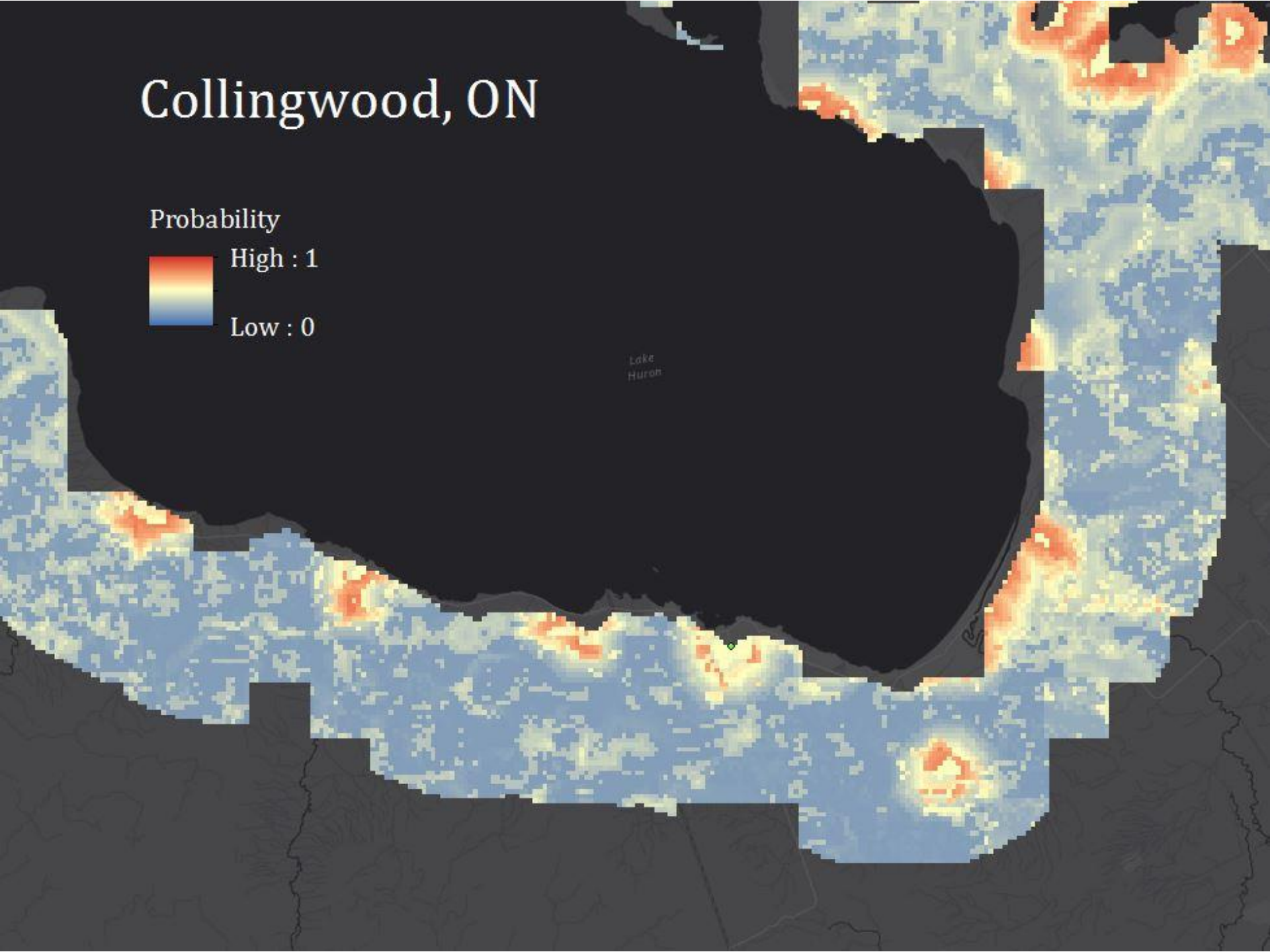
Comparison – MaxEnt 2010 vs. 2020

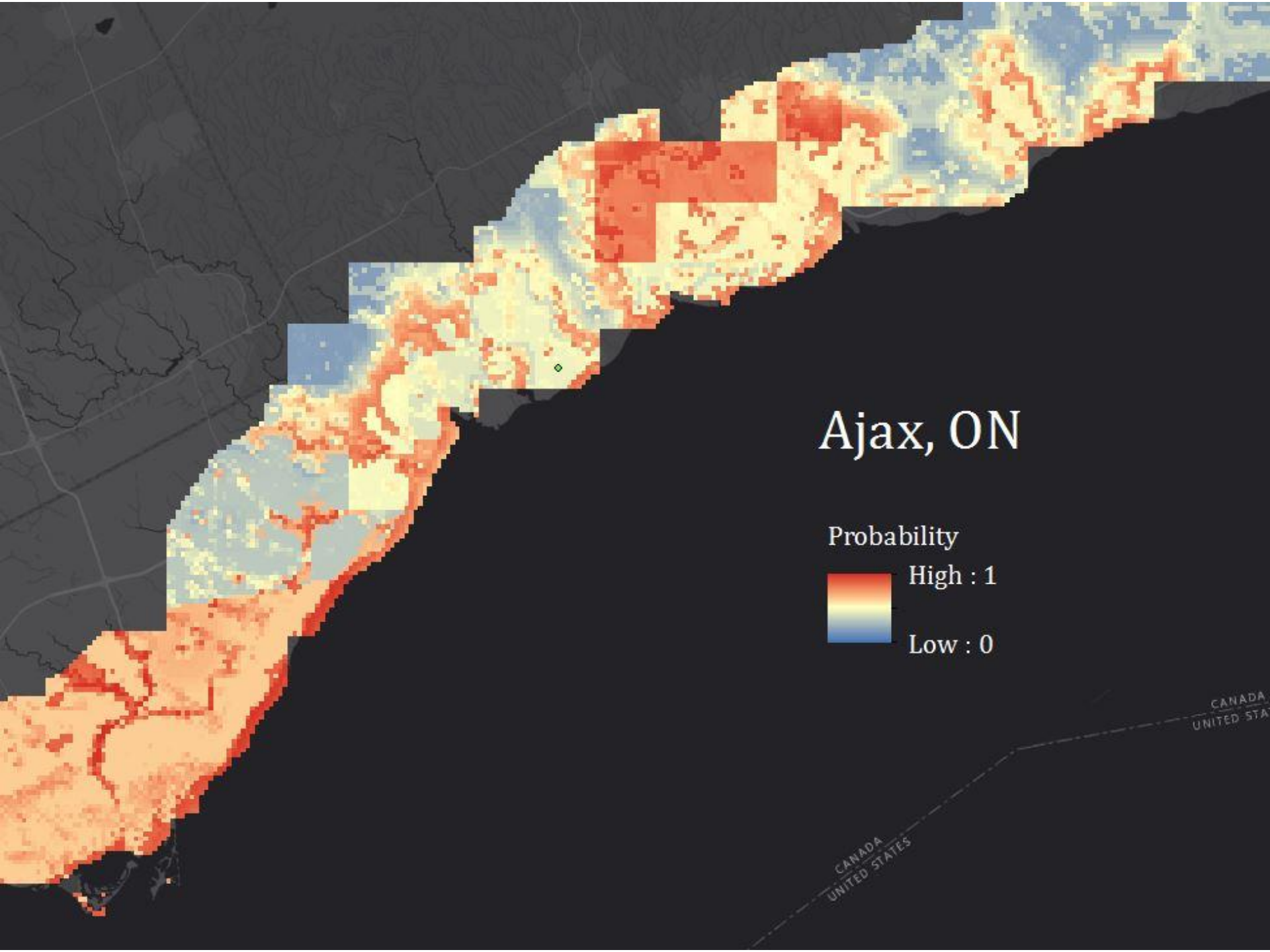


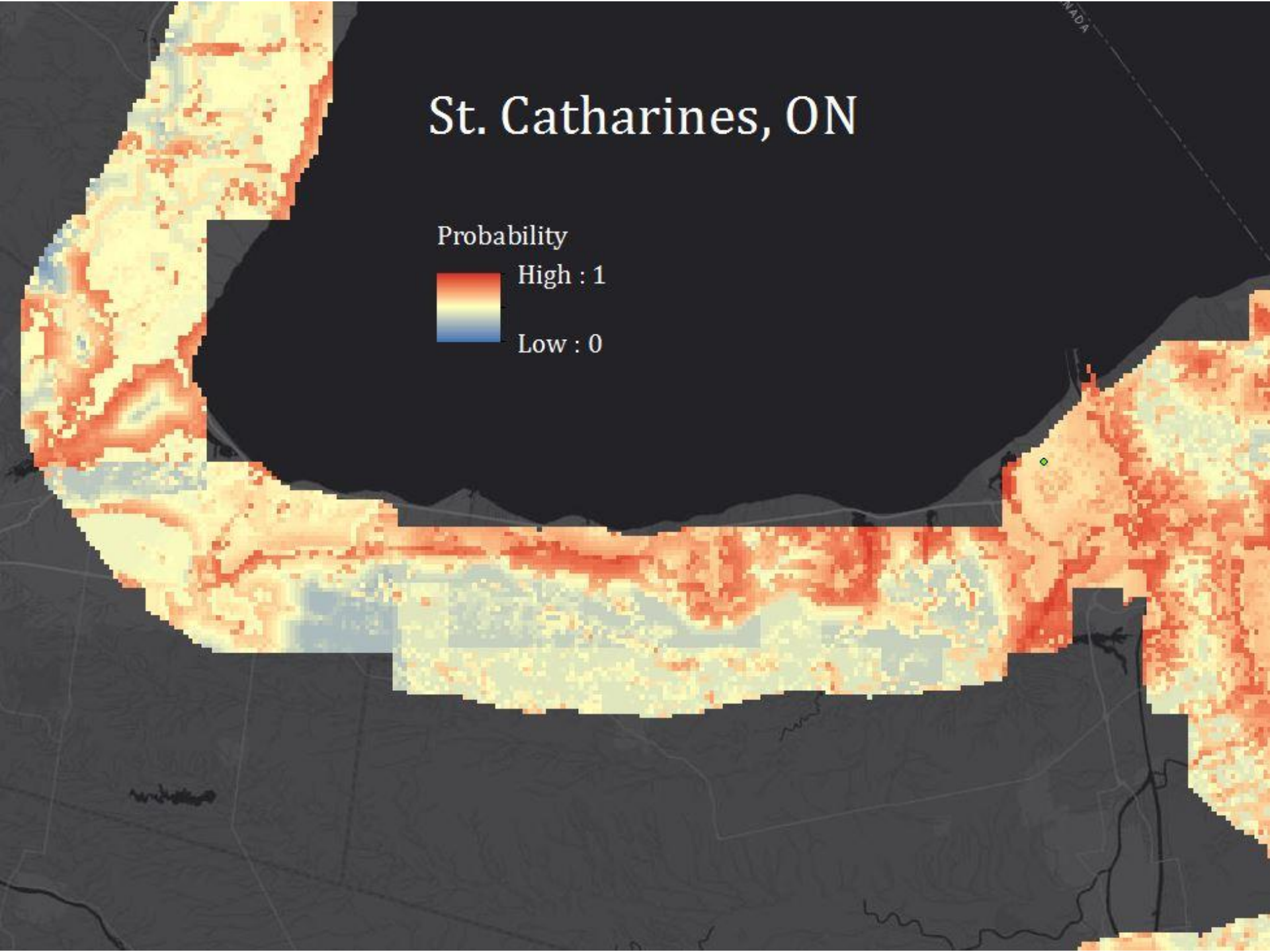


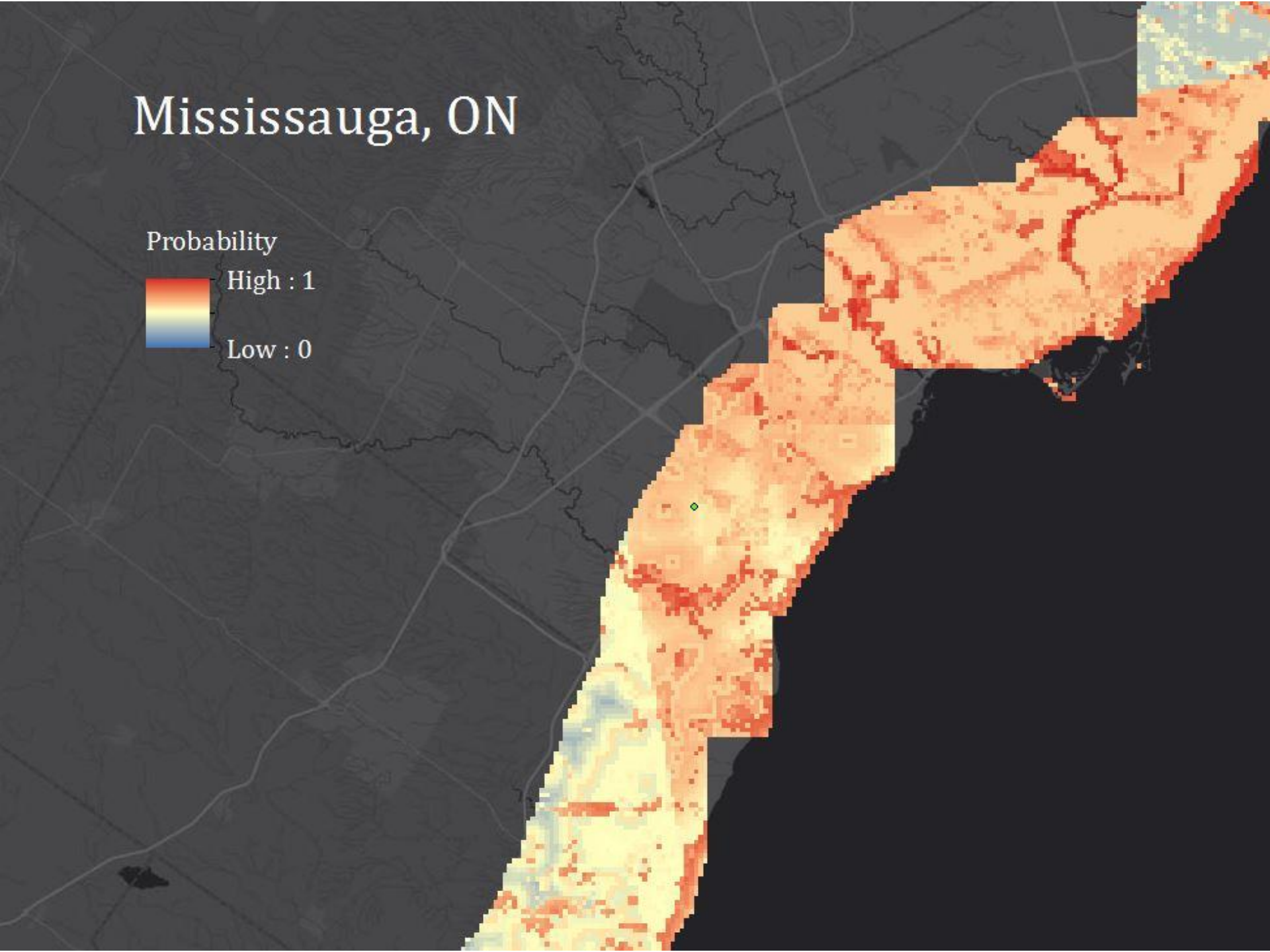

Milwaukee, WI
Probability
High : 1
Low : 0


Gary, IN
Probability
High : 1
Low : 0


Collingwood, ON
Probability
High : 1
Low : 0
Lake
Huron


Ajax, ON
Probability
High : 1
Low : 0
CANADA
UNITED STATES
CANADA
UNITED STA


St. Catharines, ON
Probability
High : 1
Low : 0


Mississauga, ON
Probability
High : 1
Low : 0

Future Work & Limitations

- Increased Phragmites data points
- Normalize spatial resolution
- Fine tune model
- Update land cover maps

Image credit: Sunghwan Yoon

Conclusions

- Phragmites risk areas growing (LCM Habitat Growth)
- Phragmites closest to agriculture, development, roads
- Trend: Human interaction leads to Phragmites increase
- Climate: trending towards increasing Phragmites growth

Acknowledgements

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Simon Belisle, Great Lakes and St. Lawrence Cities Initiative

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