

Study of the Near-shore Environment on the south shore of Lake Erie

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Near Shore Projects

- Development of wetlands to reduce *E coli* and P
- Rehabilitation of the Ottawa River
- Lake Erie Sensor Network – Carbon and Energy Fluxes
- Citizen Science aircraft to monitor Lake Erie.
- Agricultural BMP development from remote sensing

Improving Water Quality with Ecosystem Restoration

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Department of Environmental Sciences

University of Toledo



Maumee Bay State Park – Oregon, OH

MBSP has posted an average of 25 swim advisories during each recreational season (late May to early September) since 2010 at its lakeside beach due to elevated algal and bacterial densities

The image is a composite. The top half is an aerial photograph of Maumee Bay State Park, showing a large, sandy beach curving along the shore of Maumee Bay. The water is a deep blue, and the surrounding land is green with some developed areas. The bottom half is a map of the Maumee River watershed and its connection to Lake Erie. The map shows the river flowing from the south (Oregon, OH) towards the north (Toledo, OH). It includes various sampling points labeled M1 through M12 and Q1 through Q11. A legend on the right indicates 'Average E. coli Concentrations Water colonies/100 ml' with color-coded circles: red (5-20), orange (21-100), yellow (101-200), and green (201-620). Another legend indicates 'Bed Sediment MPN/gdw' with color-coded circles: red (11-30), orange (31-100), yellow (101-300), and green (301-800). A scale bar shows 0 to 1 mile. A north arrow is present. A legend at the bottom identifies symbols for 'Wastewater Treatment Plant' (star), 'Powerplant' (circle with 'i'), 'Confined Disposal Facility' (star with a dot), and 'Port Authority' (triangle). A list of ditches is provided: A = Heckman Ditch, B = Johlin Ditch, C = Big Ditch, D = Tobias Ditch, E = McHenry Ditch, F = Berger Ditch, G = Anderson Ditch.

Maumee Bay State Park – Oregon, OH

MBSP has posted an average of 25 swim advisories during each recreational season (late May to early September) since 2010 at its lakeside beach due to elevated algal and bacterial densities

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Average *E. coli* Concentrations
Water colonies/100 ml

- 5 - 20
- 21 - 100
- 101 - 200
- 201 - 620

Bed Sediment
MPN/gdw

- 11 - 30
- 31 - 100
- 101 - 300
- 301 - 800
- 801 - 1800

Legend:

- ★ Wastewater Treatment Plant
- ⓘ Powerplant
- ✱ Confined Disposal Facility
- ▲ Port Authority

Locations:

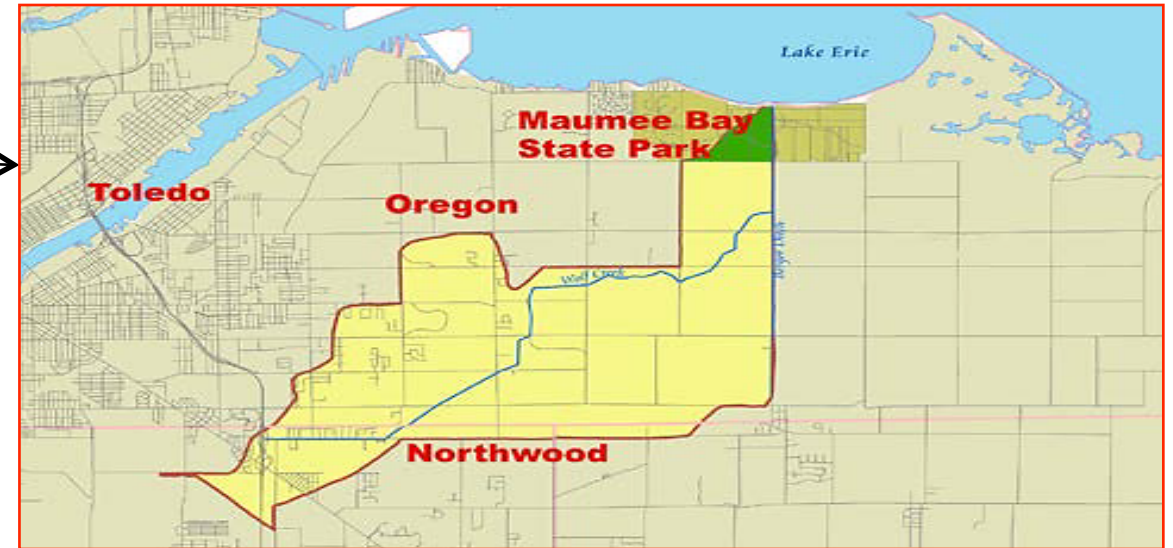
- A = Heckman Ditch
- B = Johlin Ditch
- C = Big Ditch
- D = Tobias Ditch
- E = McHenry Ditch
- F = Berger Ditch
- G = Anderson Ditch

Other Labels:

- Toledo
- OHIO
- Maumee River
- Shipping Channel
- Woodtick Is.
- Grassy Is.
- Lake Erie
- Maumee Bay
- Oregon
- Maumee Bay State Park



Wolf Creek Watershed and Maumee Bay State Park



- Size: 16 mi²
- Mostly Channelized Waterways
- Frequent Inputs from Agricultural Drain Tiles
- Mouth is Adjacent to Swimming Beaches at MBSP

Photo Courtesy: TMACOG



Demonstration Projects in the Wolf Creek Watershed

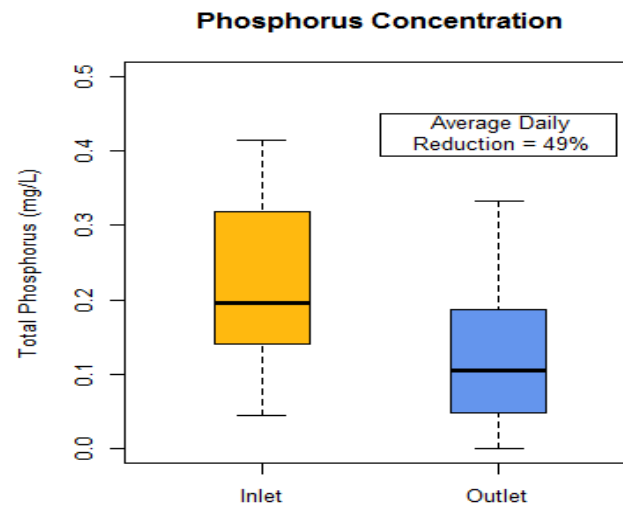
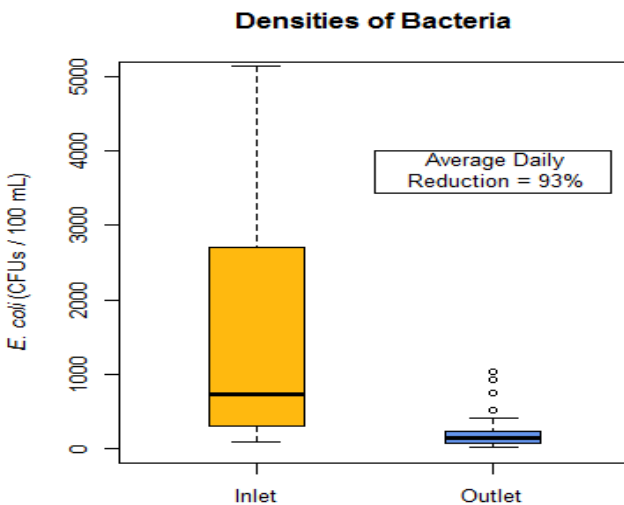
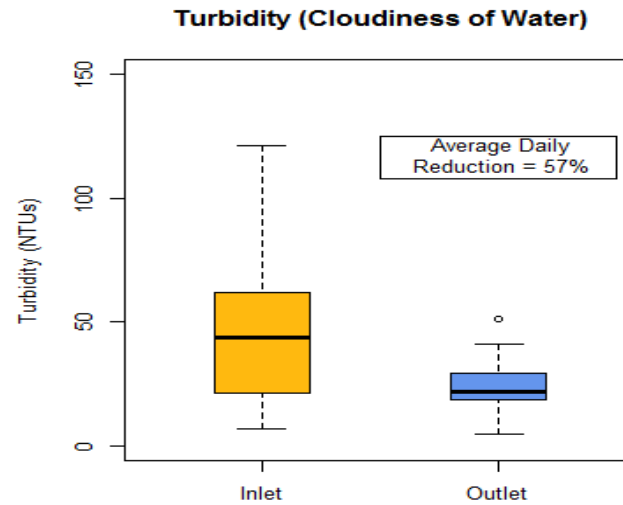
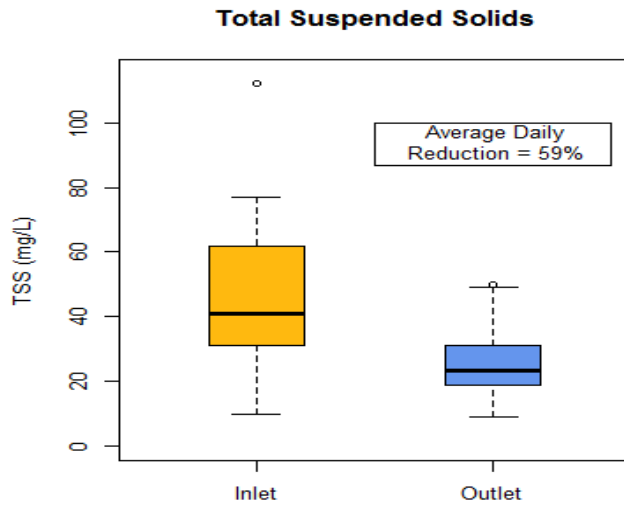
- **Goal:** Use Restored Riparian and Wetland Habitat engineered for concentrated removal of non-point source pollutants
- Strive to Delist BUIs:
 - Eutrophication
 - Beach Closings
 - Degradation of Aesthetics
 - Loss of Fish and Wildlife Habitat
- **First Project:** Sedimentation Pond
 - Accumulate Suspended and Bed Load Sediment
 - Approx. 40% of P and 70% of *E. coli* are attached to sediment
 - Restore Riparian Habitat
 - Increase Floodplain



Upland Sedimentation Pond



Sedimentation Pond - Preliminary Data



- Water Samples (Left): July 2014 – July 2015
- Sediment Accumulation (Bottom): Nov. 2014 – **Nov. 2015**
- Over 220 m³ of Sediment has Accumulated Over the Past Year
- Or, 300 metric tons!!
- Approx. 0.5 tons of phosphorus is attached to this sediment



Constructed Wetland at Wolf Creek

- Three-tiered design
- Acts as a “polishing step” to remove nutrients, bacteria, and fine sediment
- Primarily subsurface flow
- Limestone fill to improve treatment efficiency
- Different elevations and frequency of flooding provide appropriate habitat for a variety of emergent, wetland, and prairie plants

Treatment Wetlands

1. Stream or river water is discharged (from pump, gravity discharge, instream, *etc.*) into the top of the wetland.
2. Water flows (subsurface) through tiered wetland containing stone, gravel, soil and/or filtration media.
3. Contaminants, bacteria, sediment and nutrients (PP and DRP) are retained within the wetland media.
4. Native plants capture contaminants and consume nutrients.
5. Clean water flows back into the source surface water system.

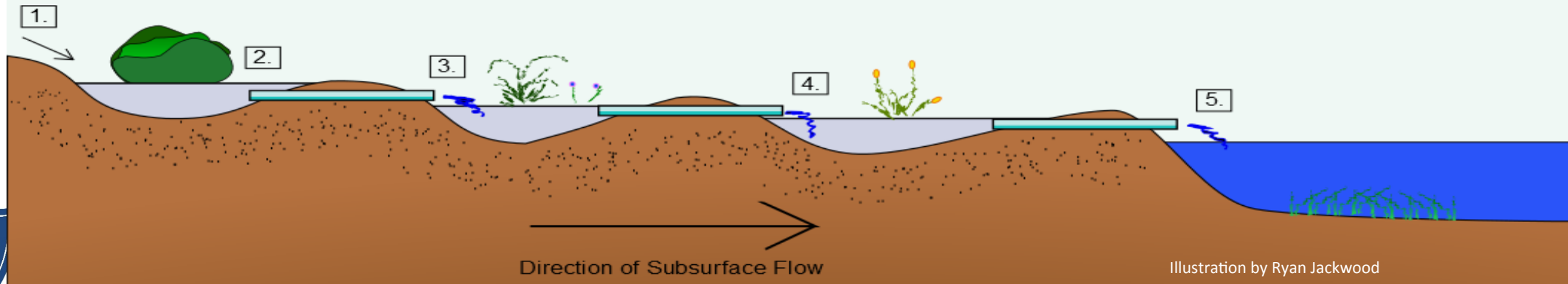
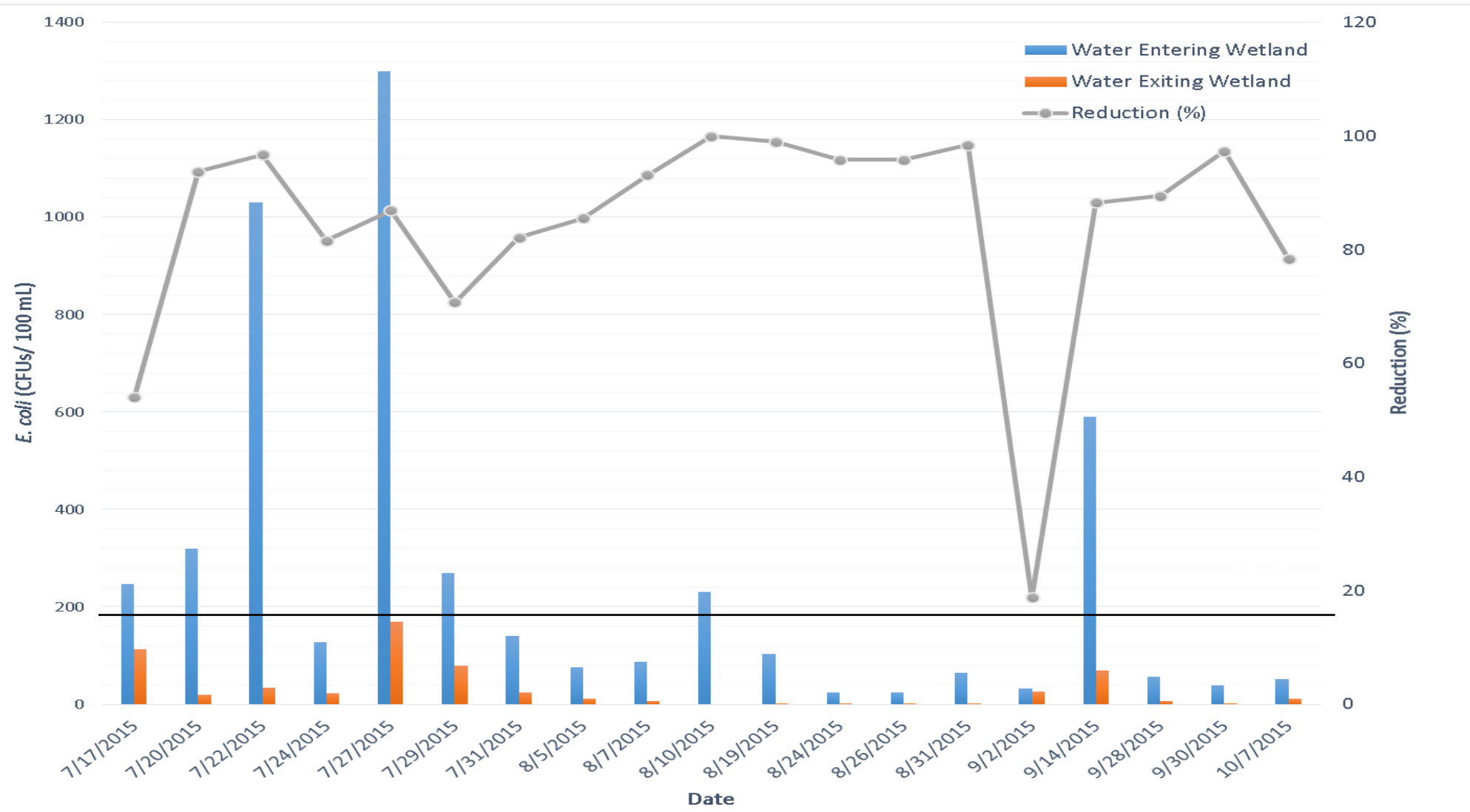
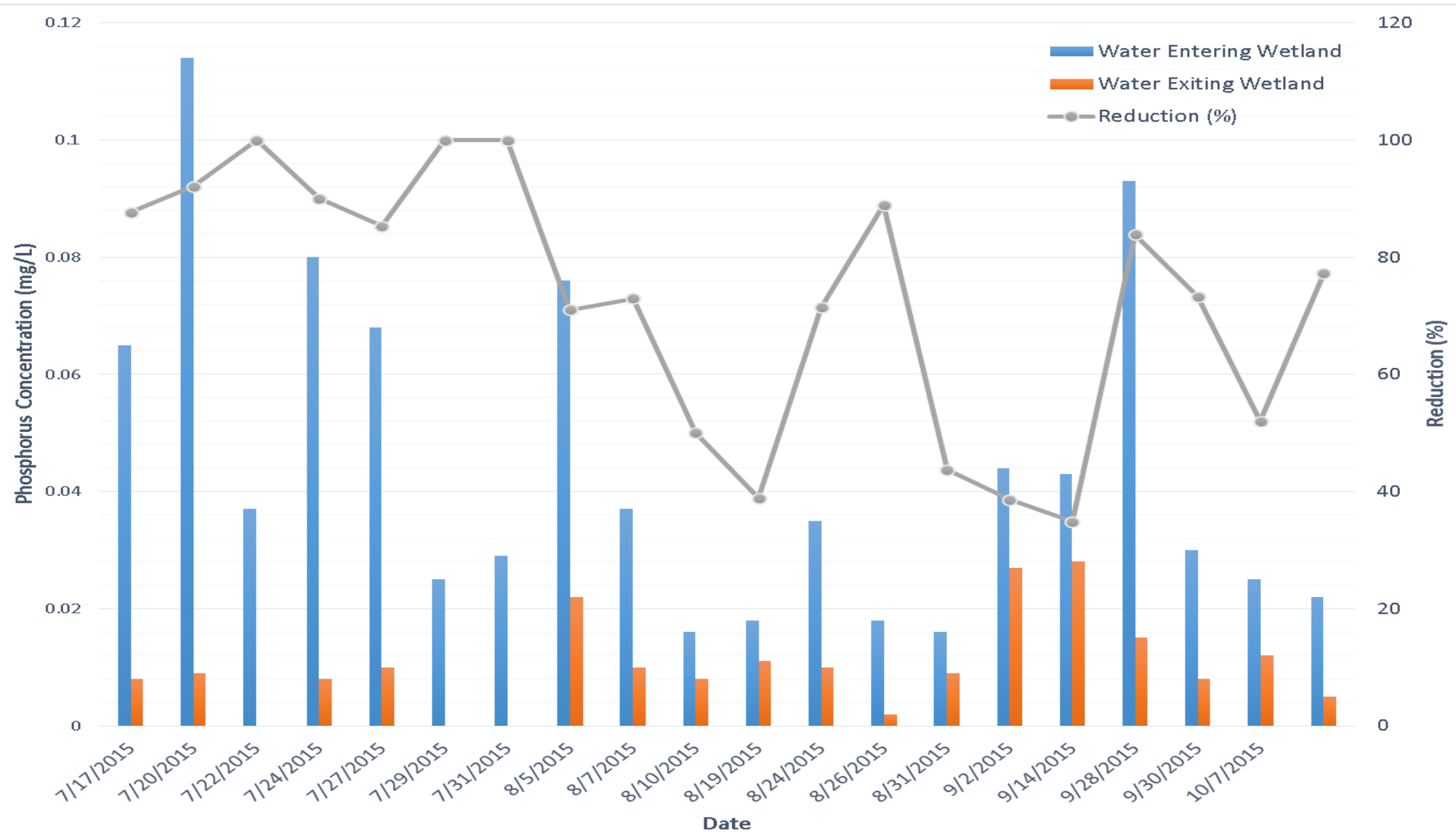


Illustration by Ryan Jackwood

E. Coli Removal in Wetland



Total Dissolved Phosphorus Removal in Wetland



Funding for Daryl Dwyer's Group



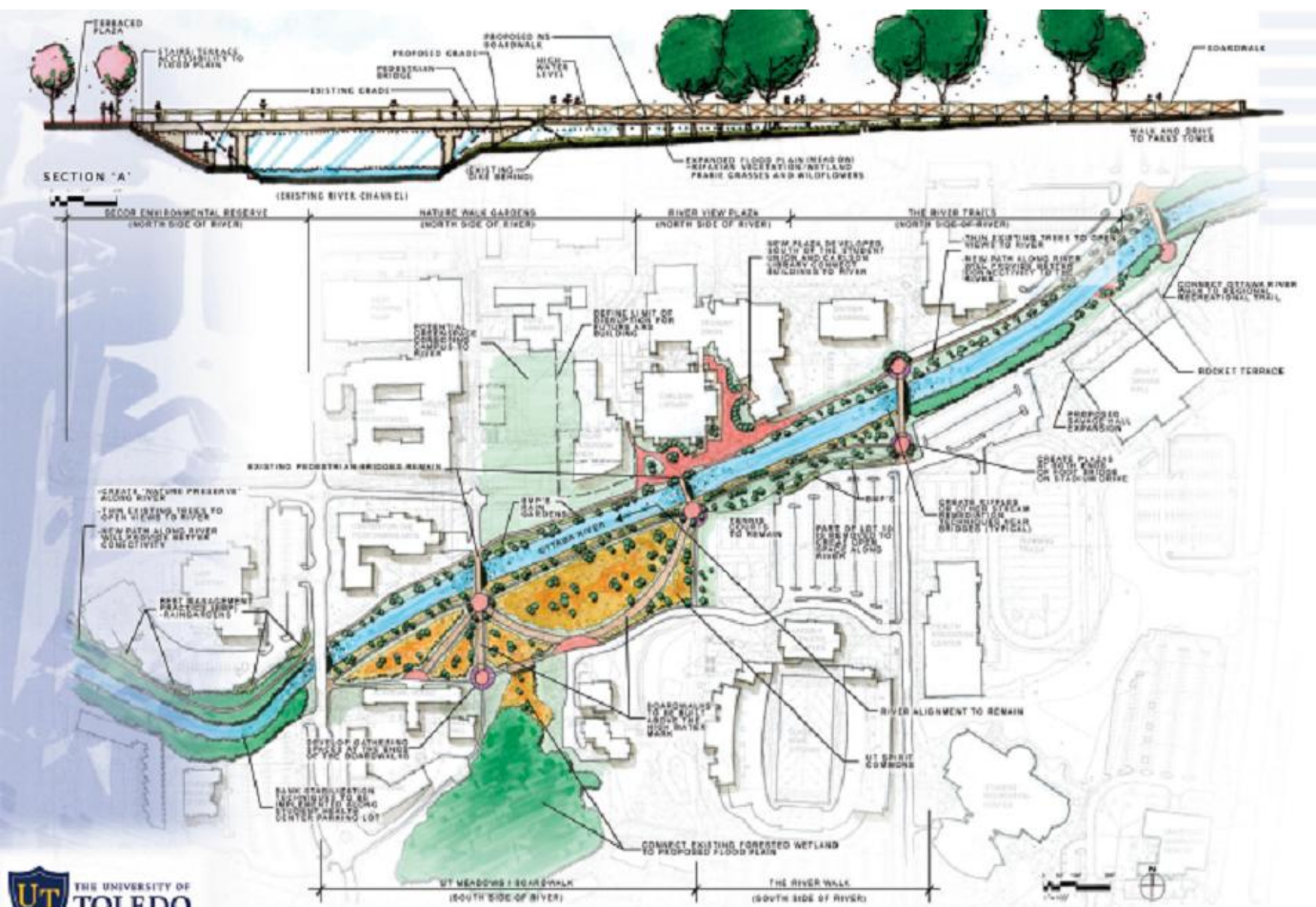
Rehabilitation of the Ottawa River on the University of Toledo campus: Initial Habitat and Fish Community Responses

Gottgens, J.F.¹, Lawrence, P.L.² and A.D. Svoboda³

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³ Ottawa County Health Department, Port Clinton, Ohio 43452



OTTAWA RIVER COMMISSION

DECEMBER 1, 2000 TOL NO. 101012

THE COLLABORATIVE INC





Lake Erie Center Environmental Sensor Network

J. Chen, C. Stepien, R. Becker, J. Gottgens, K. Czajkowski, T. Bridgeman



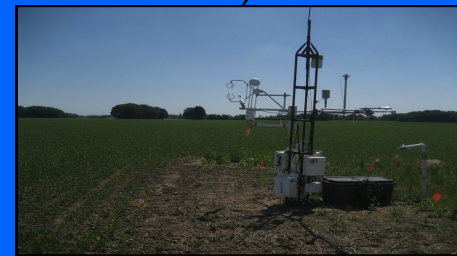
Station Locations



Western basin, Lake Erie
CO₂, H₂O, and energy fluxes of a freshwater lake ecosystem on top of the city of Toledo water intake crib.



Swanton, Ohio
The Oak Openings MetroPark is the sole *Ameriflux* tower site in Ohio. Measuring the carbon sequestration capacity of managed forest ecosystems.



Curtice, Ohio
CO₂, CH₄, H₂O, N₂O, and energy fluxes in an agricultural field are measured using an open-path eddy covariance and static chamber.



Port Clinton, Ohio
CO₂, CH₄, H₂O, and energy fluxes in a marshland ecosystem of Lake Erie shoreline.



Western basin, Lake Erie
CO₂, H₂O, and energy fluxes of a freshwater lake ecosystem on top of the U.S. Coast Guard's Toledo Light #2 light beacon.

Response and Biophysical regulation of Carbon Fluxes to Climate Variability and Anomaly in Contrasting Ecosystems



Housen Chu¹, J. Chen², J. Gottgens¹, R. Becker¹, K. Czajkowski³

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²Department of Geography, Michigan State University

³Department of Geography and Planning, University of Toledo

Site Information



Deciduous woodland

Red Oak (*Quercus rubra*) White Oak (*Q. alba*)

Black Oak (*Q. velutina*)

Red Maple (*Acer rubrum*)

Sandy mixed & Mesic

WT: -0.3 ~ -3.0 m

VWC: 17-25%



Conventional cropland

Soybean (*Glycine max*)

- 2011-2012/Sep

Wheat (*Triticum spp.*)

- 2012/Sep-2013

Silty Clay

WT: -0.3 ~ -3.0 m

VWC: 25-65%

Rain-fed, no irrigation



Freshwater marsh

Water Lily (*Nymphaea odorata*)

American Lotus (*Nelumbo lutea*)

Cattail (*Typha angustifolia*)

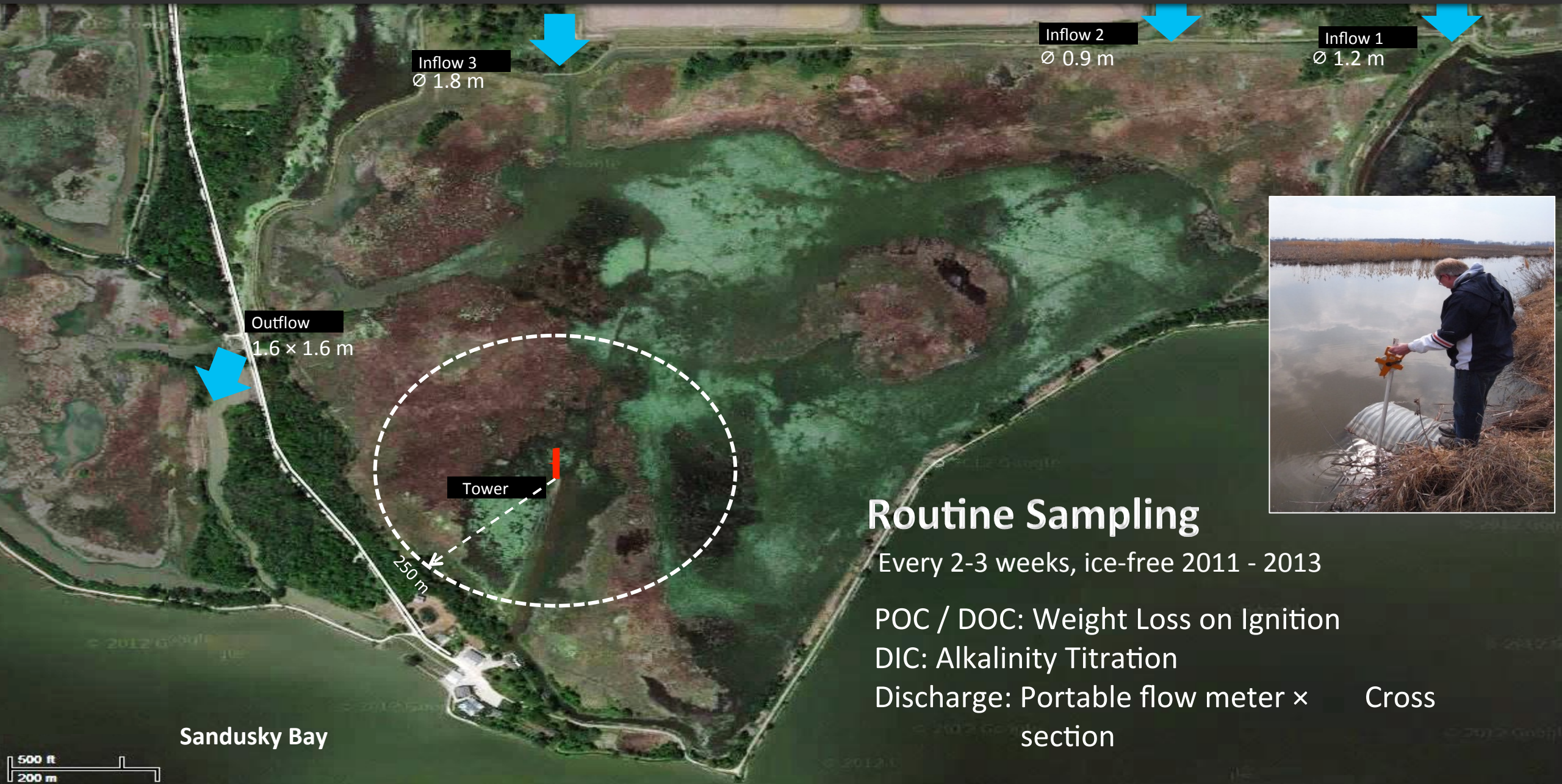
Rose Mallow (*Hibiscus moscheutos*)

Hydric (Permanent inundated)

WT: 0.2 ~ 1.0 m

Hydrologically connected to upstream croplands and downstream lake

Hydrologic Carbon Flux



Routine Sampling

Every 2-3 weeks, ice-free 2011 - 2013

POC / DOC: Weight Loss on Ignition

DIC: Alkalinity Titration

Discharge: Portable flow meter ×

Cross

section

Instrumentation & Methodology



Met, Soil & Water variables

Soil temperature (T_g)
Friction velocity (u_*)
Ground water level (WT)
Air temperature (T_a)
Vapor pressure deficit (VPD)

Precipitation, Water temperature, Soil water content (VWC)
Photosynthetically Active Radiation (PAR)

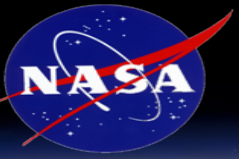
Vegetation index

MODIS – NDVI



Findings

- Freshwater marsh efficiently converted carbon to methane flux.
- Soil temperature influenced methane flux.
- Methane release from crops are much smaller than from the marsh.



Citizen Science Aircraft to Monitor Lake Erie

Citizen Science Pilot Project to Help Tackle Remote Sensing of Harmful
Algal Blooms

Rafat Ansari, PhD
NASA Glenn Research Center

APPROACH: Volunteer GA Pilots as Citizen Scientists

- 600,000 private pilots/200,000 GA aircrafts in the U.S.
- Use untapped resource to study land and aquatic systems.
- NASA did not pay for any pilot services, aircraft maintenance, hangar rent, fuel etc.



HAB Event (12mi east of Toledo)

Changes in Water Quality over Time –HAB Events



Photo credit: Marvin Smith, NASA

- HABs –Complex Phenomena
- Dynamic System –several orders of magnitude
- Timing is Everything

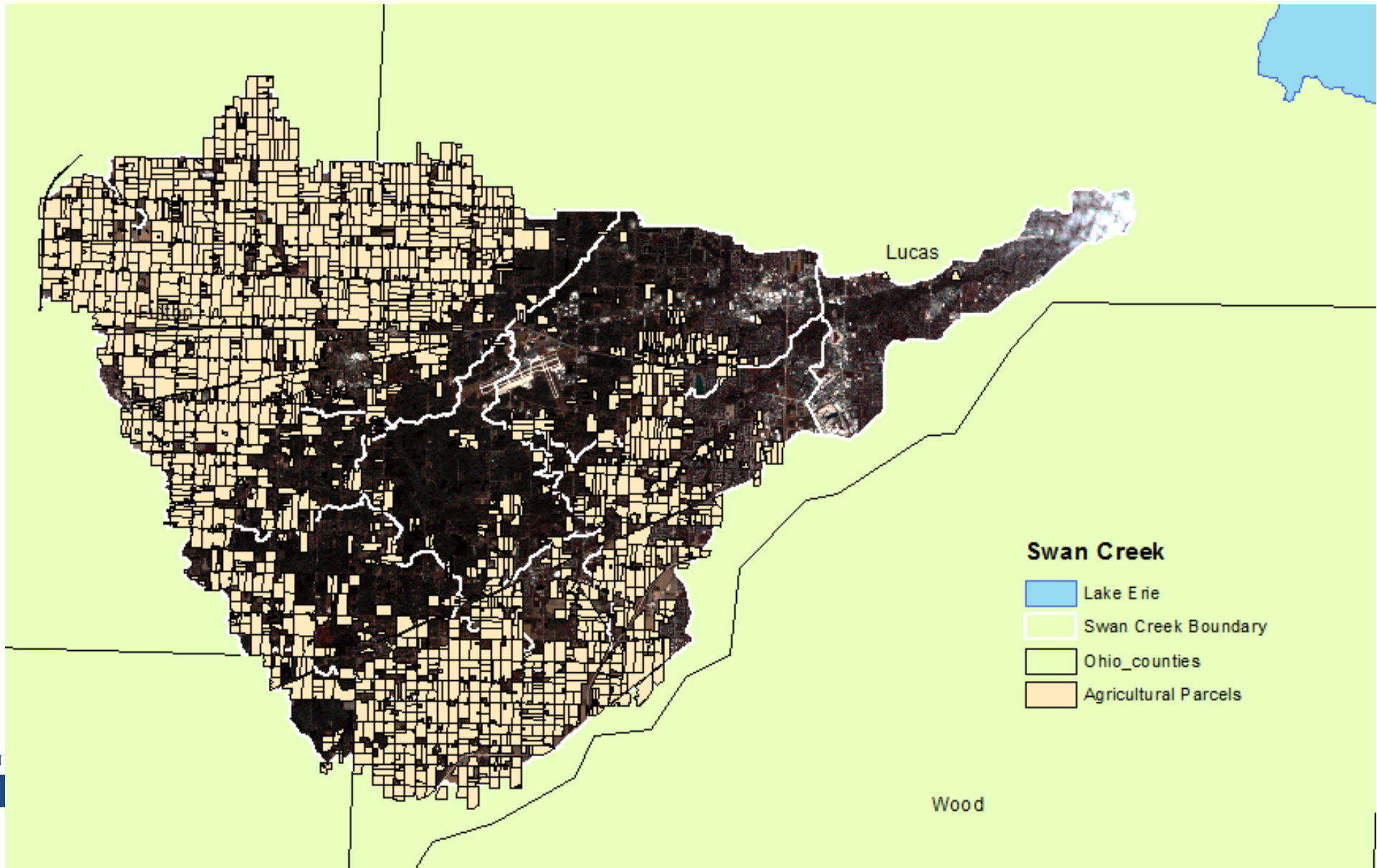
Conclusions

- GA pilot volunteers and citizen scientists can provide a vital data in efforts to monitor and maintain water quality standards
- We demonstrated an early warning system of an ensuing algal bloom is possible via a volunteer aerial network
- Near real-time data can be available for water quality science
Valuable for:
 - Scientists to study the issues related to HABs
 - Water quality managers' to use in decision making
 - Students to use in advance learning and image processing via open-source free software
- Citizen science aerial data can be a “no to low”- cost tool to help assess water quality

BMP Development for Swan Creek Watershed: Pilot

Kevin Czajkowski, April Ames, Yitong Jiang, Kimberly Panozzo, Brinda Athreya
University of Toledo

BMP Mapping Pilot: Swan Creek Watershed

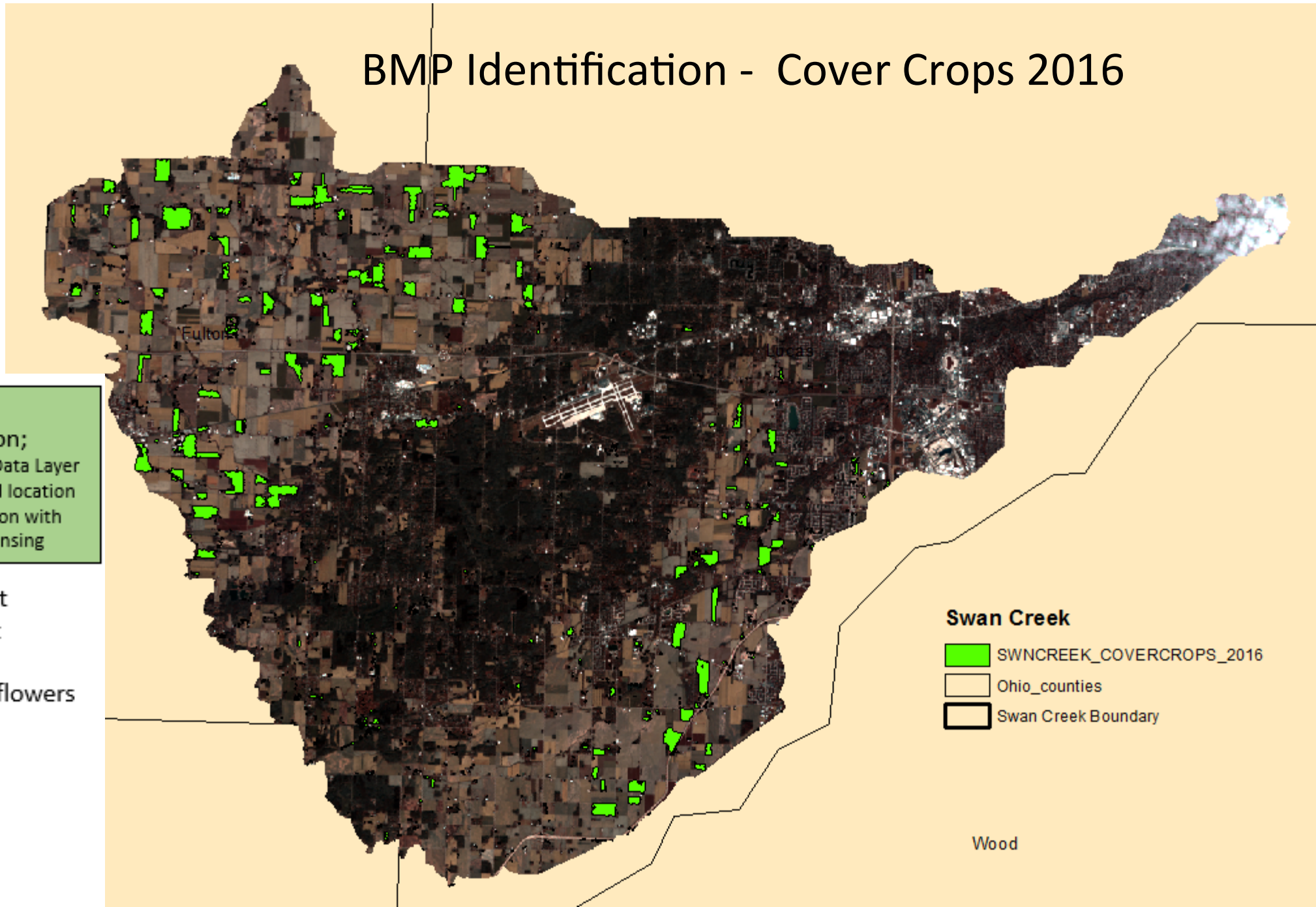


Agricultural practice (BMPs) identification

The following agriculture practices will be identified in this project:

- Cover Crops (types and periods)
- Tillage (no till, conservation tillage, traditional tillage)
- Buffer Strips (forest and grass)
- Wetlands (woody and herbaceous)
- Tile Drainage (location and density)

BMP Identification - Cover Crops 2016



Cover Crop Identification;

- Cropland Data Layer
- In situ field location
- Classification with Remote Sensing

Winter wheat
Spring wheat
Alfalfa
Clover / wildflowers
Rye
Triticale
Speltz

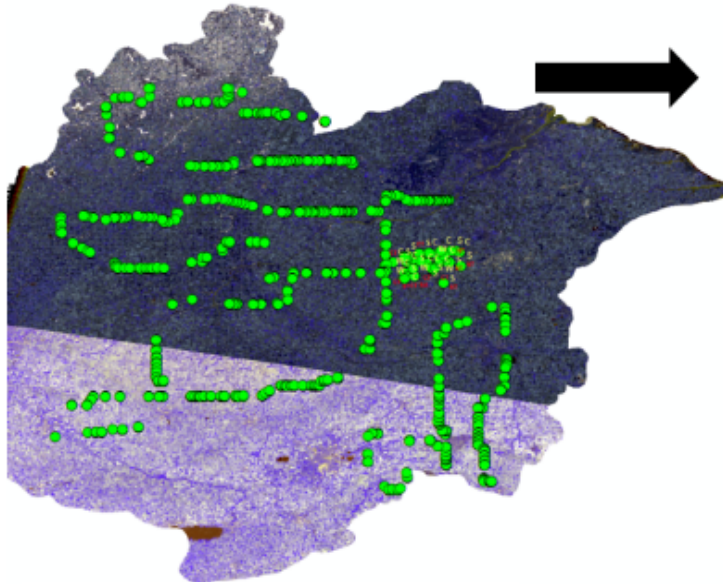
Swan Creek

-  SWNCREEK_COVERCROPS_2016
-  Ohio_counties
-  Swan Creek Boundary

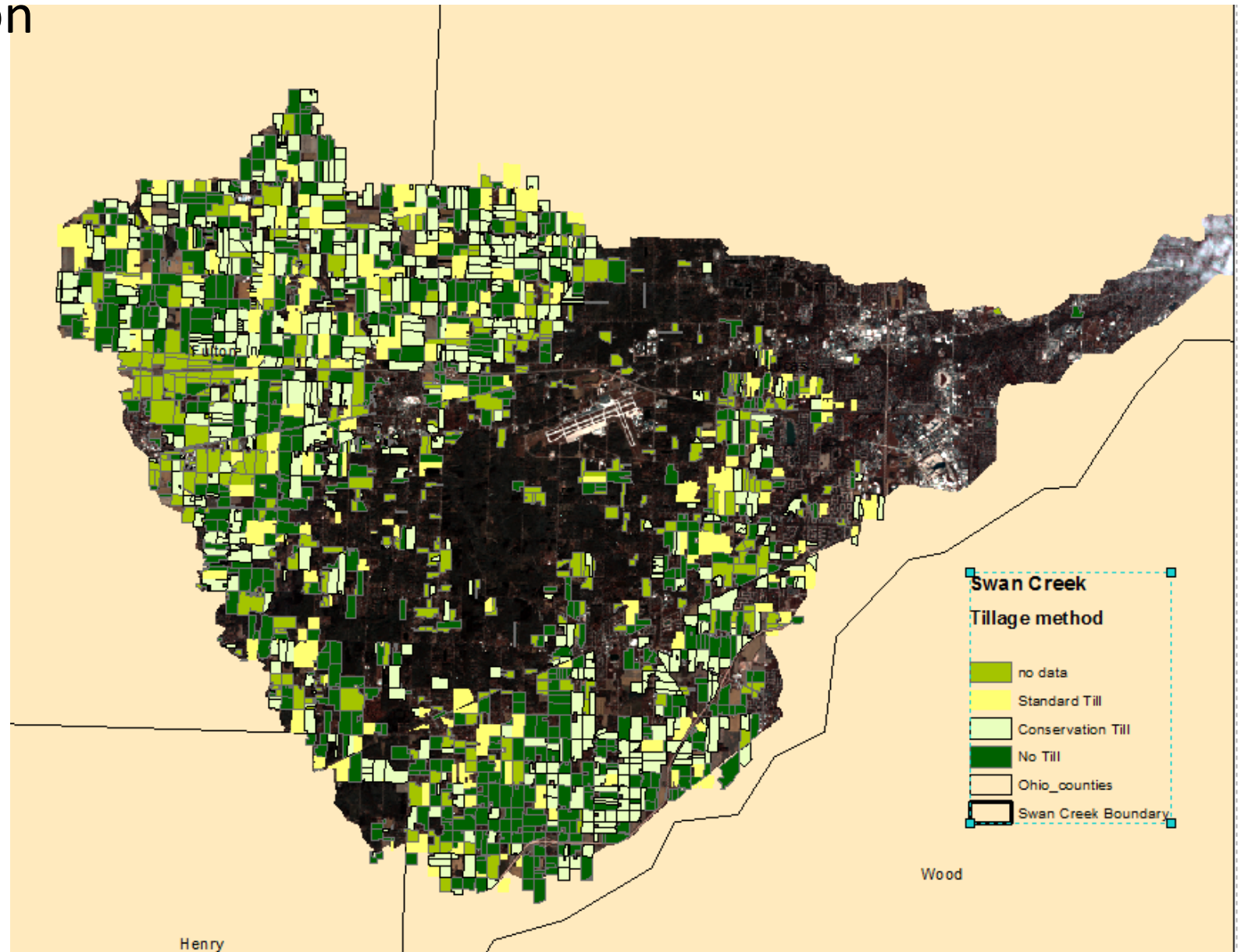
Wood

Tillage Practice Identification

- CONSERVATION TILL
- NO TILL
- STANDARD TILL



Field Observations



BMP Identification – Buffers (CDL)

Grass Buffers

Forested Buffer Strips

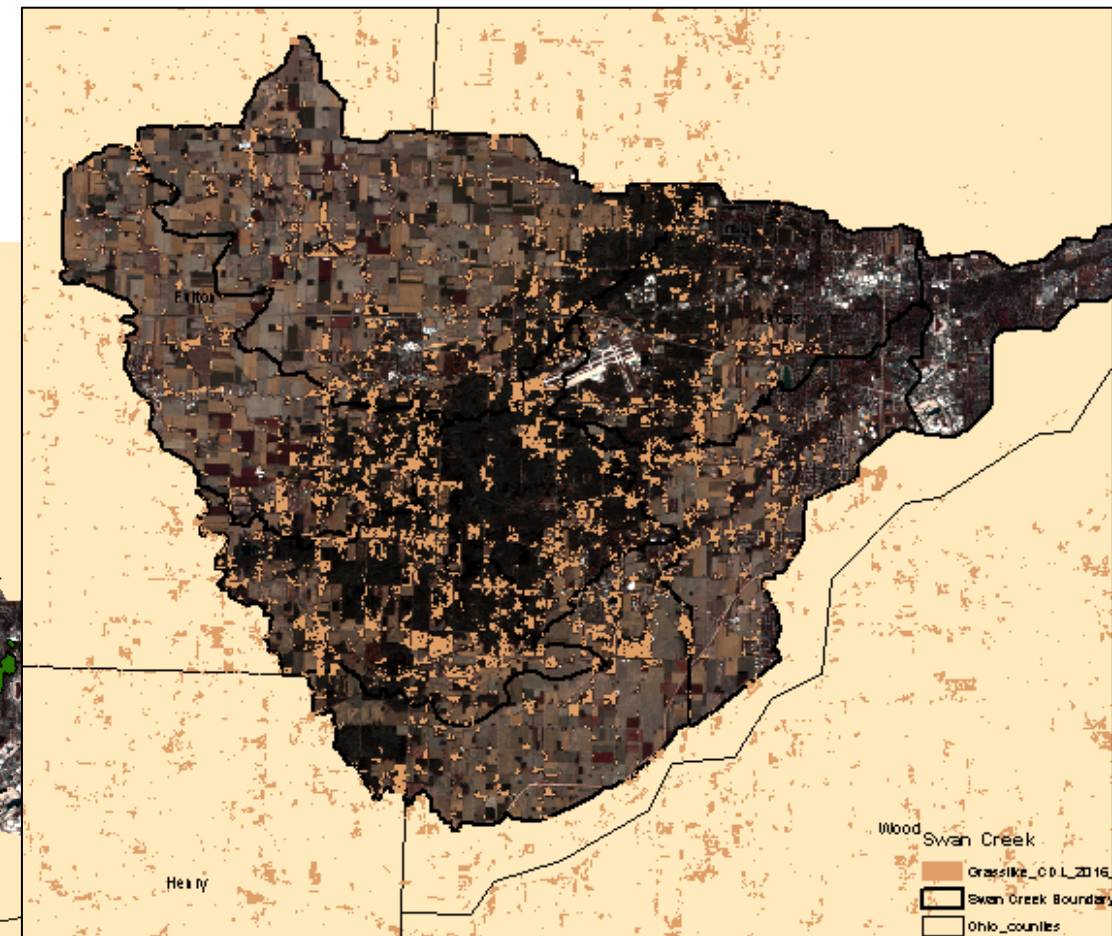
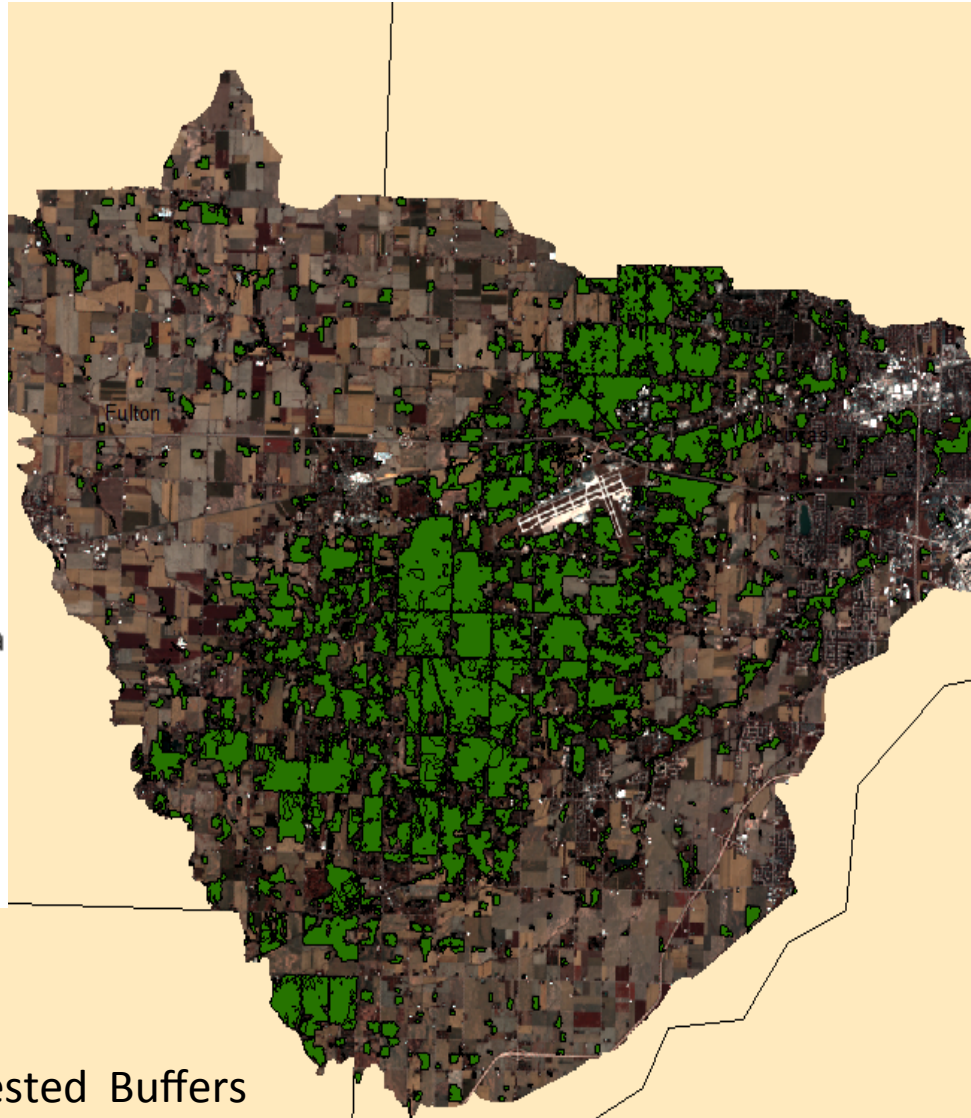
- Cropland Data Layer
- Areal image identification
- HWCD images

Forested buffers

- Evergreen
- Deciduous

Grass buffers

- Fallow
- Grass/pasture
- Other hay/ non alfalfa
- Shrub land
- Sod/grass coverage



Grass Buffers

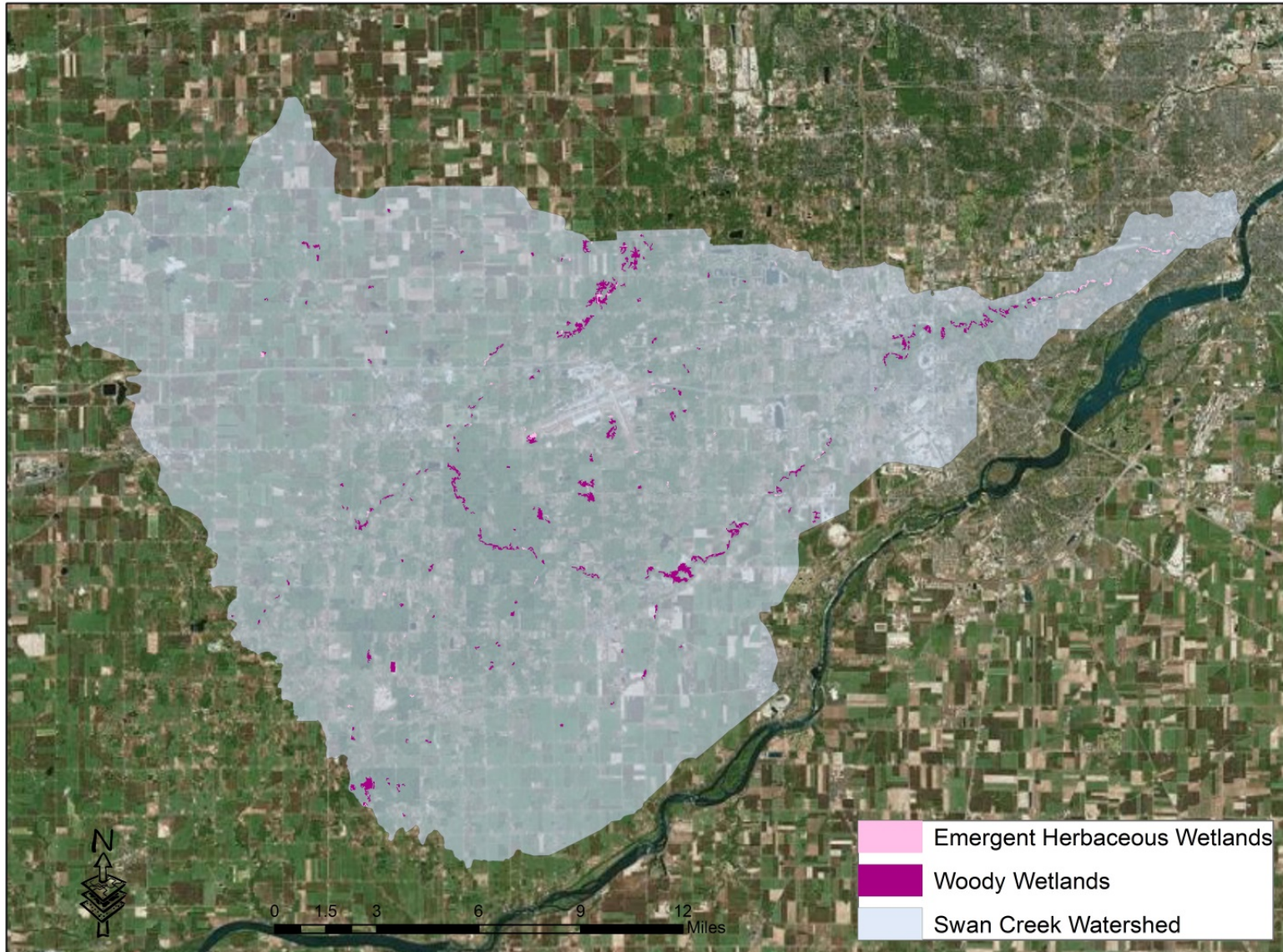


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Forested Buffers

187

Wetlands Layer from National Land Cover Data Set (NLCD)



Tile Drain Identification



Areal Images



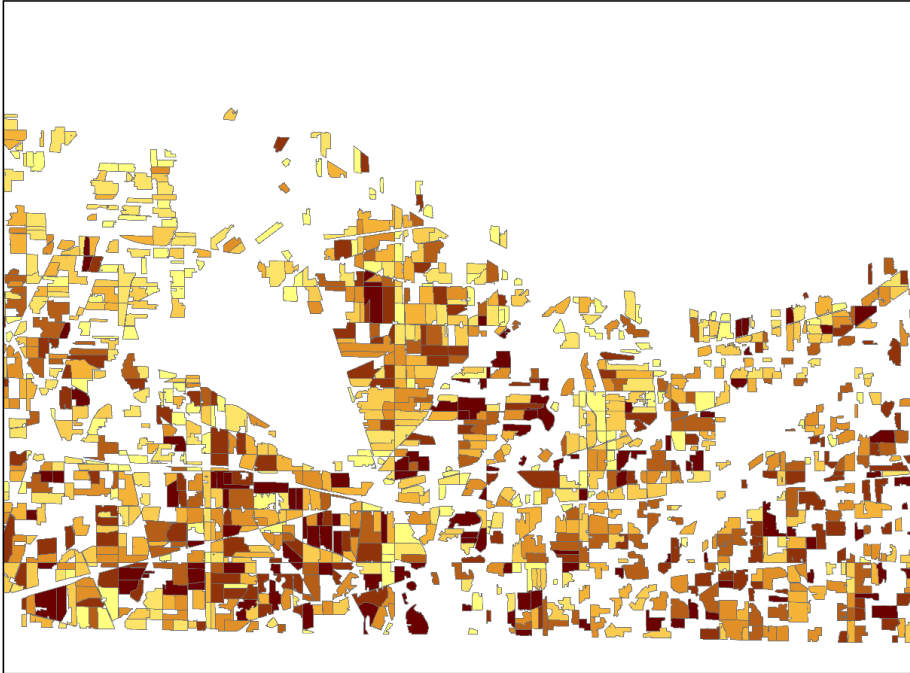
Heads up Digitization



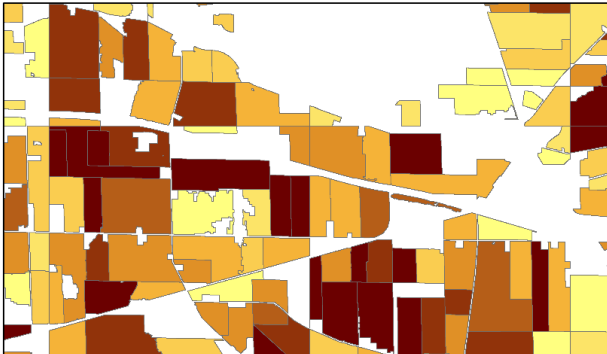
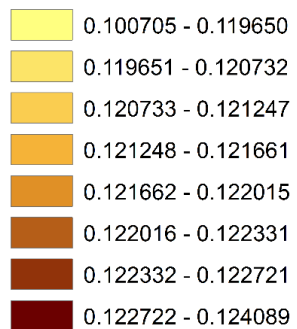
Automated Approach

Tile outflow

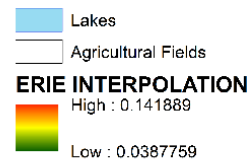
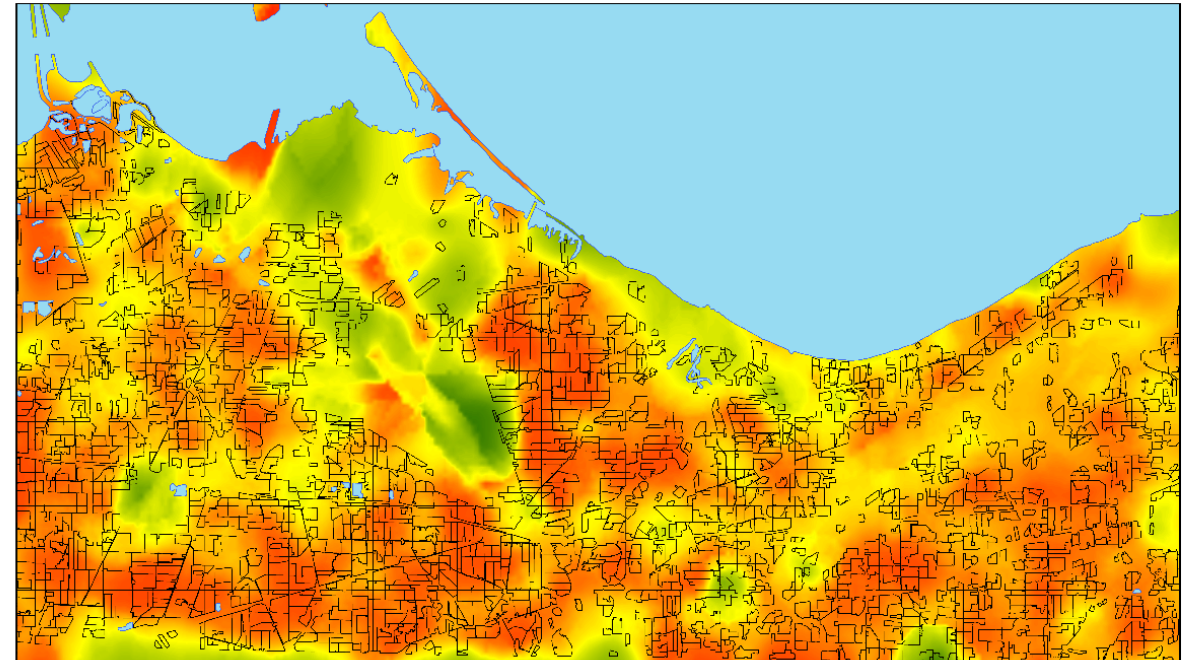
Erie County Tile Drain Output



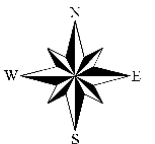
Erie County Tile Outflow Estimations



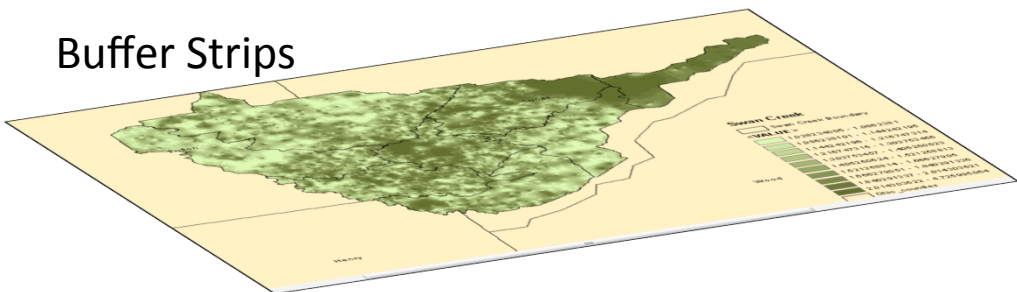
Tile Line Density



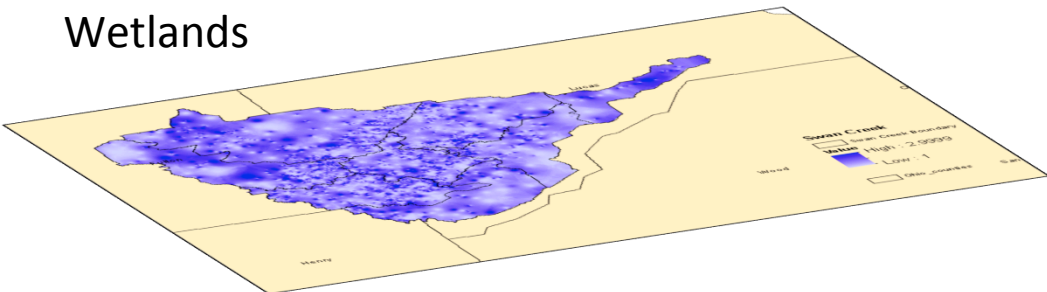
Interpolation results of eCognition lines and Agricultural Fields in Erie County, Ohio.
NAD83_HARN_Ohio_North_ftUS Projection: Lambert_Conformal_Conic
Cartographer; Kimberly Panozzo University of Toledo, 2016



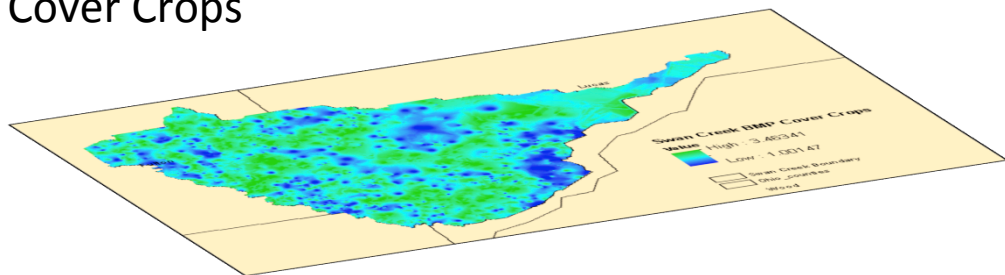
Buffer Strips



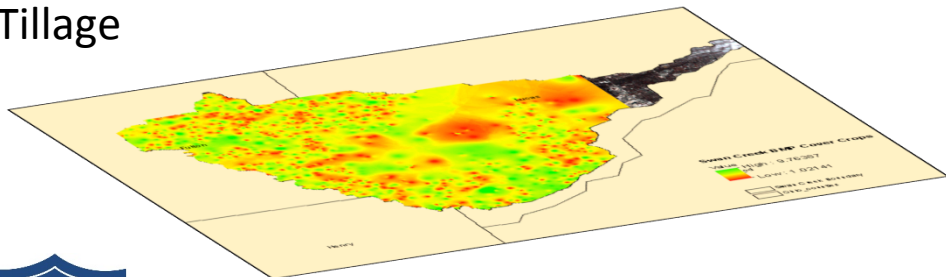
Wetlands



Cover Crops

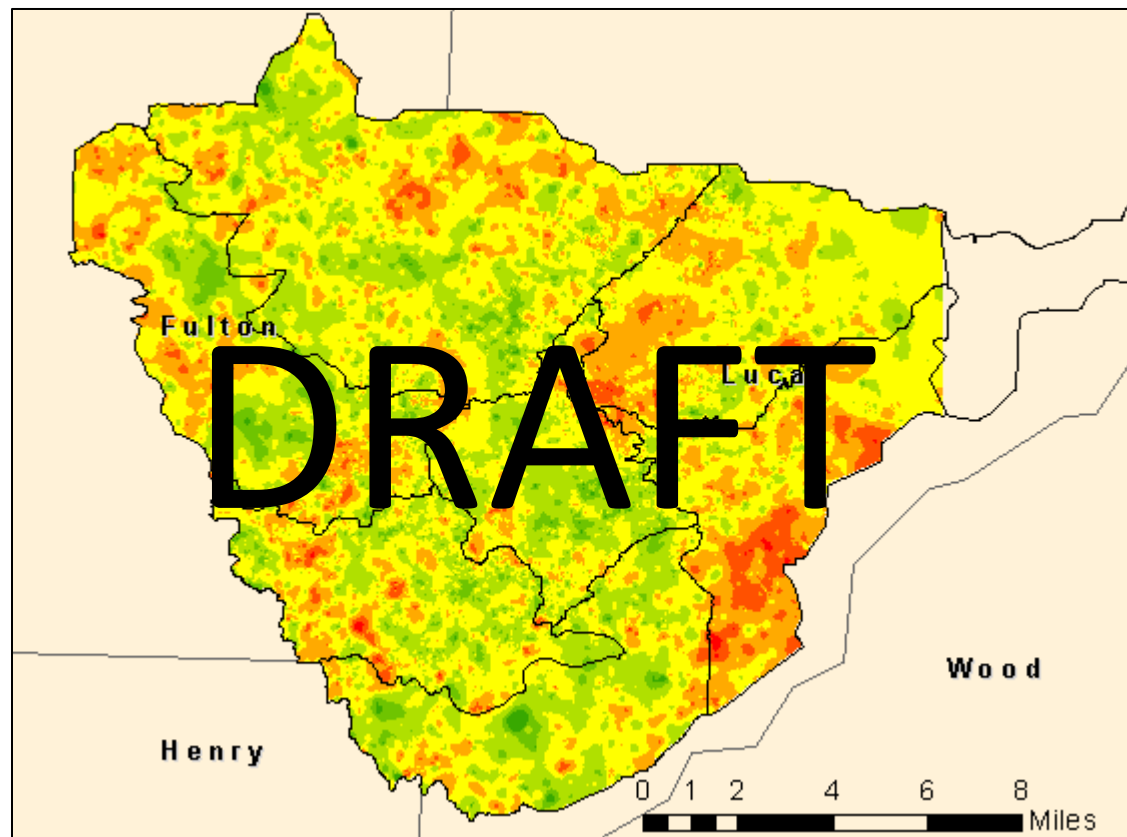


Tillage



Best Management Practices

(Buffer Strips, Wetlands, Tillage and Cover Crops)



Thank You

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