Impact of Land Use on Watershed Health in the Western Basin of Lake Erie

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Outline

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  • Study Area
  • Watershed Assessment
• Goals and Objectives
• Methods
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  • Workflow
  • Analysis
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• Discussion
Western Basin of Lake Erie

- Historic Problems with Algal Blooms
- Increased Blooms in Recent History
- Ecological Shift
- Water Processing

Number of severe algal blooms in Lake Erie to double, forecast says

December 12, 2015 by Fox Fred Carter

[Image: Harmful algal bloom as seen from the research docks of The Ohio State University's Stone Laboratory on Gibraltar Island in Lake Erie in 2015. Credit: Jeff DeBoer, courtesy of Ohio State University]
Study Area

- Maumee River Basin
- Largest Watershed in Great Lakes
- Major Contributor to Lake Erie
Land Cover

- Dominantly Agriculture
- Fertile land from Great Black Swamp
- Limited Riparian Vegetation
Watershed Assessment

- Health Metrics
- Chemistry Short Term
- Biological Long Term
Ohio Bioassessment

- Very well supported
- Large Database, records since 1974
- Ohio Credible data program
Goals and Objectives

Goal
- to support management efforts and to preserve freshwater in the Western Basin of Lake Erie

Objectives
- Quantifying watershed health
- Analyzing land use within sample site zones
- Performing multiple regression analysis to determine impact of land use on IBI ratings
Methods

- Delineate Catchment Basins, Riparian buffer zones and local (1 km circle buffer)
- Calculate IBI values
- Summarize land use according to each sample point extraction zones
- Perform stepwise multiple regression to determine significant factors
Sample Points

20 Years

10 Years
IBI Calculation

- Calculated according to 12 Ohio EPA metrics
- Ranked on a score of 5-60
- Attainment classes

<table>
<thead>
<tr>
<th>Variable Measured</th>
<th>Type of Site</th>
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<tr>
<td>1. Total Number of Species</td>
<td>H W B</td>
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<tr>
<td>2. Number of Darter Species</td>
<td>H W</td>
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<tr>
<td>Percent Round-bodied Suckers</td>
<td>B</td>
</tr>
<tr>
<td>3. Number of Sunfish Species</td>
<td>W B</td>
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<tr>
<td>Number of Headwater Species</td>
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<tr>
<td>4. Number of Sucker Species</td>
<td>W B</td>
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<tr>
<td>Number of Minnow Species</td>
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<td>5. Number of Intolerant Species</td>
<td>W B</td>
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<tr>
<td>Number of Sensitive Species</td>
<td>H</td>
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<tr>
<td>6. Percent of Tolerant Species</td>
<td>H W B</td>
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<tr>
<td>7. Percent of Omnivorous Species</td>
<td>H W B</td>
</tr>
<tr>
<td>8. Percent of Insectivorous Species</td>
<td>H W B</td>
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<tr>
<td>9. Percent of Top Carnivores</td>
<td>W B</td>
</tr>
<tr>
<td>Percent of Pioneering Species</td>
<td>H</td>
</tr>
<tr>
<td>10. Number of Individuals</td>
<td>H W B</td>
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<td>11. Percent of Hybrids</td>
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<tr>
<td>Number of Simple Lithophilic Species</td>
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<td>12. Percent of DELT Anomalies</td>
<td>H W B</td>
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Catchment Basins and Buffer zones

- 3 Zones examined
  - Catchment
  - Riparian Buffer
  - Local 1km Buffer
- All water flowing into sample point across landscape
- Calculated based on DEM processing
NHDplus

DEM

FDR & FAC
Analysis

- Determine impact of land use within catchment basins compared to IBI
- Exploratory ANOVA to examine variance
- Correlation Assessment
- Stepwise Multiple Regression
## Results

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1st Quartile</th>
<th>Mean</th>
<th>2nd Quartile</th>
<th>Max</th>
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<td>58</td>
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<td>Water %</td>
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<td>Dev %</td>
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<td>Wetld %</td>
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ANOVA

- Exploratory ANOVA to examine variance.
- Performed on catchment basins and riparian buffer zones.

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<th>Catchment</th>
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<th>Riparian Buffer</th>
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<td></td>
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<td>P Value</td>
<td>F Value</td>
<td>P Value</td>
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<tr>
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<tr>
<td>Dev %</td>
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Correlation Assessment

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<th>CGrubPot</th>
<th>CHarbPot</th>
<th>CAgPot</th>
<th>CWet4Pot</th>
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</table>
Stepwise Multiple Regression

- **Catchment Basins**
  - $IBI \sim \text{DevelopedLand} + 40\% \text{Impervious} + \text{Herbaceous} + \text{Wetland} + 80\% \text{Impervious}$

- **Riparian Buffer Zone**
  - $IBI \sim \text{DevelopedLand} + \text{Wetland} + \text{Herbaceous} + \text{Shrub} + 20\% \text{Impervious} + 40\% \text{Impervious}$

- **Local Buffer Zone**
  - $IBI \sim 100\% \text{Impervious} + \text{Wetland} + \text{Barren} + \text{Agricultural}$
Discussion

- Developed land within catchment basin strongest negative influence on IBI scores
  - For both catchment and riparian buffer
  - Unlikely in local buffer
- Wetland strongest positive influence on IBI scores
  - Highly significant at all levels
  - Possibly less disturbance
- Agriculture not identified as significantly impacting IBI
  - Possibly hidden due to overwhelming majority
  - Additional stream interactions may be hidden.
Further Studies

- Further Research
- Addition elements
- Stronger Predictive Models
- Preservation of Lake Erie
Acknowledgements

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Questions?

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References