SPATIAL PATTERNS OF HARMFUL ALGAL BLOOMS IN LAKE BLOOMINGTON AND EVERGREEN LAKE

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WHAT ARE ALGAL BLOOMS?
A rapid increase in the concentration of algae in a water body

Harmless and Harmful Algal Blooms

Harmful algal blooms (HABs) produce toxins
WHY ARE THEY A PROBLEM?

HABs can cause harmful effects to;

- Freshwater - taste and odor problems in drinking water, depletion of oxygen levels
- Humans and wildlife - skin irritation, diarrhea, vomiting, stomach pains, death
- Aquatic life - Create dead zones in the water and cause fish die off
- Industries that depend on clean water - Raise treatment costs for drinking water
Lake Erie in Toledo
Monitoring Algal Blooms
Field Sampling

- It is expensive
- It is time consuming
- It is difficult for the whole lake area to be sampled
Remote Sensing

- It is inexpensive
- Less time consuming
- More lake areas can be sampled
Research Questions

1. What is the spread behavior of Algal Blooms in lakes?
   - I expect to see algal blooms spread from the edges of the lakes to the middle of the lake

2. What are the conditions that influence and facilitate spread?
   - Spread influenced by Nutrients and Temperature

3. What are the effects of Algal Blooms on water properties?
   - Water properties quality decrease with increasing algal bloom population
Objectives

- To predict algal blooms spatial patterns using remote sensing
- To understand conditions that influence and facilitate this spread
- To determine the effects of algal blooms on water properties
Study Site

The study area for this project is Lake Bloomington and Evergreen Lake.

**EVERGREEN LAKE**—15 miles North of Bloomington IL. 925 acres. Average depth of 19.7’. Maximum depth is 50ft

**LAKE BLOOMINGTON**—15 miles North of Bloomington IL. 635 acres and 18.5 miles of shoreline. Average depth is 14.5ft
Methods

- Field and historical water quality data analysis
- Remote Sensing
- Statistical Analysis
Field Sampling

EXO SONDE

Sonde with Probe Guard and Calibration Cup
## EXO Smart Sensors

<table>
<thead>
<tr>
<th>Cond / Temp</th>
<th>pH / ORP</th>
<th>Optical Dissolved Oxygen</th>
<th>Turbidity</th>
<th>Total Algae (Chl &amp; BGA-PC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Cond / Temp Sensor" /></td>
<td><img src="image2" alt="pH / ORP Sensor" /></td>
<td><img src="image3" alt="Optical Dissolved Oxygen Sensor" /></td>
<td><img src="image4" alt="Turbidity Sensor" /></td>
<td><img src="image5" alt="Total Algae Sensor" /></td>
</tr>
</tbody>
</table>
Collection and interpretation of information about an object without being in physical contact with the object
Landsat 8

Operational Land Imager (OLI)
Thermal Infrared Sensor (TIRS)

<table>
<thead>
<tr>
<th>Band</th>
<th>Band Name</th>
<th>Spectral range (nm)</th>
<th>Use Of Data</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New Deep Blue</td>
<td>433-453</td>
<td>Aerosol/Coastal zone</td>
<td>30m</td>
</tr>
<tr>
<td>2</td>
<td>Blue</td>
<td>450-515</td>
<td>Pigments/scatter/Coastal</td>
<td>30m (TM heritage Bands)</td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td>525-660</td>
<td>Pigments/Coastal</td>
<td>30m</td>
</tr>
<tr>
<td>4</td>
<td>Red</td>
<td>630-680</td>
<td>Pigments/Coastal</td>
<td>30m</td>
</tr>
<tr>
<td>5</td>
<td>NIR</td>
<td>845-885</td>
<td>Foliage/Coastal</td>
<td>30m</td>
</tr>
<tr>
<td>6</td>
<td>SWIR1</td>
<td>1560-1660</td>
<td>Foliage</td>
<td>30m</td>
</tr>
<tr>
<td>7</td>
<td>SWIR2</td>
<td>2100-2300</td>
<td>Minerals/Litter/no scatter</td>
<td>30m</td>
</tr>
<tr>
<td>8</td>
<td>PAN</td>
<td>500-680</td>
<td>Image sharpening</td>
<td>15 m</td>
</tr>
<tr>
<td>9</td>
<td>SWIR</td>
<td>1360-1390</td>
<td>Cirrus Cloud Detection</td>
<td>30 m</td>
</tr>
<tr>
<td>10</td>
<td>TIRS1</td>
<td>10060-11190</td>
<td>Surface Temperature</td>
<td>100*(30)</td>
</tr>
<tr>
<td>11</td>
<td>TIRS2</td>
<td>11500-12510</td>
<td></td>
<td>100*(30)</td>
</tr>
</tbody>
</table>

Overpass time: 16 days
Flow chart For Methods

Lake Sampling

Lab Analysis

Input

Remote Sensing

Processing Landsat image

Linear Regression Model

Remote Sensing

f(x)

Predict water quality

WATER QUALITY

REMOTE SENSING
Preliminary Test
Path No - 23
Row No - 32
12 images in total for the time frame
9 used

These Images have been altered to appear brighter
Lake Bloomington

![Graph showing remote sensing DN values for different bands and months.]
Preliminary Conclusions

- Raw, unprocessed remote sensing data suggests that
  - Lake Bloomington has a lot of spatial variation
  - Evergreen Lake has less spatial variation but shows a seasonal trend.
- These patterns are generally similar to what is seen in the Volunteer Lake Monitoring Program Secchi disk data.
- Potential for use of remote sensing exists
Next steps

- Field Sampling in the summer 2018 to create relationships between remote sensing and chlorophyll, Secchi, turbidity

- Use of reflectance values

- Other processing approaches
  - Band ratios
  - Adding up bands
Thank you....

Questions?