How accurately does CyAN represent cyanobacteria cell counts in Oregon Lakes?

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Research Questions and Objectives

1. Does CyAN accurately measure cell counts in Oregon Lakes?
2. How well can satellite-derived data compare with in situ measures of cyanobacteria harmful algal blooms (cyanoHABs)?
3. How well can time series analysis for early detection of cyanoHABs be applied to satellite data?

CyAN

The Cyanobacteria Assessment Network (CyAN) is an android mobile application created by the EPA (Figure 1). This app utilizes satellite imagery from European Space Agency Sentinel-3 satellite Ocean and Land Colour Instrument and SeaDAS software to calculate cyanobacteria cell counts (cells/mL). Limited verification has been done on the app, especially in Oregon. Schaeffer et al. (2018) performed a verification using CyAN reported cell counts and OHA cyanophAB advisories (Figure 2), however, there are no verifications of cell counts.

Limitations:
- Minimum surface area of 300m x 300m without shoreline (Schaeffer et al. 2018)
- Cloud coverage, smoke from wildfires, solar reflection can interfere with output
- Does not have the ability to detect toxin levels/species identification

Study Location

Figure 2. Schematic of how the CyAN application uses Sentinel-3 Ocean Land Colour Instrument (OCLI) data to calculate cyanobacteria abundance, using calculations in Schaeffer et al. (2018).

Spectral Shape (681nm)

Figure 1. Schematic of how the cyanobacteria index (CyCI) is calculated.

Materials and Methods

Field Verification

- Weekly grab samples taken and preserved from June 21st to September 21st for cell count enumeration and taxonomic identification
- Sondes placed in each lake, recording dissolved oxygen saturation, pH, temperature, and specific conductance, chlorophyll concentrations and phycocyanin as relative fluorescence (RFU)
- Monthly spatial and depth integrated analysis of both lakes

Early Warning Signal

Quickest detection method will be used for analyzing changes in lag-1 autocorrelation and standard deviation in 14 and 21 day rolling windows of chlorophyll a, phycocyanin RFU, and dissolved oxygen between the two lakes (Schaeffer et al. 2009; Carpenter et al. 2014; Wilkinson 2018).

Preliminary/Expected Results

Table 1. Comparison of the two study sites, Crescent Lake and Odell Lake.

<table>
<thead>
<tr>
<th>Area (km²)</th>
<th>Elevation (m)</th>
<th>Max Depth (m)</th>
<th>Land cover</th>
<th>Inlet</th>
<th>Outlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescent Lake (reference)</td>
<td>14.9</td>
<td>1,475</td>
<td>81</td>
<td>Evergreen Forest (83%) Developed</td>
<td>Summit Lake</td>
</tr>
<tr>
<td>Odell (experimental)</td>
<td>13.9</td>
<td>1,459</td>
<td>86</td>
<td>Evergreen Forest (80%) Developed</td>
<td>Trapper Creek</td>
</tr>
<tr>
<td>Cyanobacteria abundance (cells/mL)</td>
<td>1.0 x 10^16 + 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To change the cyanobacteria abundance results with presence/absence of an Oregon Health Authority Bloom advisory from Schaeffer et al. 2018.

Next Steps

Cyanobacteria Taxa Identification
- Identify and analyze taxa that are present in each lake
- Look for changes in community compositions before blooms
- Does CyAN favor a specific species?

Cyanobacteria cell counts
- Cell enumerations for samples at both lakes
- Statistical analysis/comparison to CyAN derived cell counts
- Early warning detection
- If cell counts are accurate, apply cell counts from CyAN to early warning detection method described in Wilkinson et al. (2018)
- If cell counts are not comparable, try using spectral shape or other satellite derived patterns
- Do historical cell counts from CyAN show the same patterns of detection?

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References


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