Pigment Monitoring
Why Pigments?

Why algae love them

• Harvest light for photosynthesis
• Can regulate pigment levels
Why Pigments?

Why algae love them
• Harvest light for photosynthesis
• Can regulate pigment levels

Why we love them
• Fluorescent molecules that we can detect in situ

Excitation
• Absorbs light energy of a specific wavelength

Emission
• Releases light of a longer wavelength, but lower energy
Why Pigments?

Why algae love them
• Harvest light for photosynthesis
• Can regulate pigment levels

Why we love them
• Fluorescent molecules that we can detect *in situ*

Why you should love them, too
• Early detection of HABs
Chlorophyll is the most common tool for assessing algal population growth. 

*In situ* or *in vitro*

Caution comparing lab and field

Phycocyanin is critically important for monitoring PTOX blue-green algae blooms in freshwater

Phycoerythrin is used for blue-green algae in marine environments, bloom dynamics

*Trichodesmium with Karenia*
YSI’s EXO and ProDSS TAL Sensors

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Phycocyanin</th>
<th>Chlorophyll</th>
<th>Phycoerythrin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex (\lambda)</td>
<td>590 ± 15 nm</td>
<td>470 ± 15 nm</td>
<td>525 ± 15 nm</td>
</tr>
<tr>
<td>Em (\lambda) (meas.)</td>
<td>685 ± 20 nm</td>
<td>685 ± 20 nm</td>
<td>685 ± 20 nm</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 100 RFU; 0 to 100 (\mu g/L) PC</td>
<td>0 to 100 RFU; 0 to 400 (\mu g/L) Chl</td>
<td>0 to 100 RFU; 0 to 280 (\mu g/L) PE</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.01 RFU; 0.01 (\mu g/L) PC</td>
<td>0.01 RFU; 0.01 (\mu g/L) Chl</td>
<td>0.01 RFU; 0.01 (\mu g/L) PE</td>
</tr>
<tr>
<td>Detection Limit</td>
<td>0.01 (\mu g/L) PC</td>
<td>0.01 (\mu g/L) Chl</td>
<td>0.01 (\mu g/L) PE</td>
</tr>
</tbody>
</table>
Why Pigments?

- Oregon, OH raw water (not finished water!)
- EXO TAL-PC
- Microcystin by ELISA
- Lake Erie has fairly consistent blooms of *M. aeruginosa*
- Thank you Ed Verhamme of Limnotech
Why Pigments?

TAL-PE sensor on EXO

http://api.kilroydata.org/public/

Thank you to Michael Corbet and ORCA!
Why Pigments?
Why Pigments?

ORCA Algal ID and Enumeration Report
Prepared: March 22, 2018
Prepared By: GreenWater Laboratories

Samples: 1 (Collected on 3/2/18)
1. Sykes Creek

Sample 1: Sykes Creek
Total algal cell numbers in the Sykes Creek sample collected on 3/2/18 were 3,487,986 cells/mL. Pelagophytes (Pelagophyceae; 3,447,871 cells/mL) were the dominant algal group in the sample in terms of cell number accounting for 98.8% of total cell numbers. Other algal groups in the sample were diatoms (Bacillariophyceae; 3,927 cells/mL), green algae (Chlorophyta; 8,272 cells/mL), blue-green algae (Cyanobacteria; 23,562 cells/mL), dinoflagellates (Dinophyta; 10 cells/mL) and unknown flagellates and unicells (Miscellaneous; 4,345 cells/mL). The dominant alga in the sample was the brown-tide pelagophyte *Aureocynbria lagunensis* (3,447,871 cells/mL; Fig. 1).

![Indian River Lagoon, 2017 Photo: St. John’s River Watershed Management District](image)

Fig. 1 *Aureocynbria lagunensis* 400X (scale bar = 5μm)
Are Pigments all that matter?
Multiparameter Monitoring
## Multiparameter Monitoring: Meteorological

<table>
<thead>
<tr>
<th>Monitor this…</th>
<th>Because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature</td>
<td>High temperatures favor cyanobacteria</td>
</tr>
<tr>
<td>Barometric pressure</td>
<td>Affects dissolved gases at water’s surface</td>
</tr>
<tr>
<td>Wind</td>
<td>Blooms can migrate with wind patterns, and wind impacts mixing</td>
</tr>
<tr>
<td>PAR</td>
<td>Photosynthetically Active Radiation—energy source for growth</td>
</tr>
<tr>
<td>Rainfall</td>
<td>Can stimulate nutrient introduction into waterways</td>
</tr>
</tbody>
</table>
### Multiparameter Monitoring: Water Quality

<table>
<thead>
<tr>
<th>Monitor this…</th>
<th>Because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Monitor for optimal growth temperatures in water</td>
</tr>
<tr>
<td>pH</td>
<td>( \uparrow ) pH with ( \uparrow ) photosynthetic CO(_2) consumption</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Proxy for increased biomass; runoff events that feed algae</td>
</tr>
<tr>
<td>dO(_2)</td>
<td>( \downarrow ) as blooms die off (anoxia); ( \uparrow ) with high photosynthetic activity</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Freshwater incursions and mixing, growth thresholds</td>
</tr>
<tr>
<td>fDOM</td>
<td>DOM role in bloom dynamics, especially red tides</td>
</tr>
</tbody>
</table>
Multiparameter Monitoring: Estero Bay, FL

• Florida Department of Environmental Protection
• Thank you, Rebecca Flynn and FL DEP

Dolphin at Estero Bay
Source: Estero Bay Buddies
http://www.esterobaybuddies.org/ebb-boat-trip-6/

Manatee at Estero Bay
Source: Kelsey Lang (staff), Florida DEP
https://floridadep.gov/fco/fco/media/estero-bay-aquatic-preserve-dep-staff-kelsey-lang-manatee

Estero Bay
Source: Florida DEP
https://content.govdelivery.com/accounts/FLDEP/bulletins/ca2606
Estero Bay Monitoring Sites
Multiparameter Monitoring: Estero Bay, FL

- Fish Trap Bay
- Lat/Long 26.354972, -81.844528
- Sonde affixed to manatee caution sign in center of Big Hickory Bay
- Avg. depth 1.7 m
- Salinities fluctuate daily with tides, wind, rain, and freshwater discharge
Multiparameter Monitoring: Estero Bay, FL

January Temperature

July Temperature
Multiparameter Monitoring: Estero Bay, FL

### January Salinity

- **Salinity (ppt)**
- Data points for dates: 12/26/17 to 1/30/18
- **Dates**: 12/26/17 0:00 to 02/4/18 0:00

### July Salinity

- **Salinity (ppt)**
- Data points for dates: 6/29/18 to 8/3/18
- **Dates**: 6/29/18 0:00 to 8/3/18 0:00
Multiparameter Monitoring: Estero Bay, FL

January Dissolved Oxygen

July Dissolved Oxygen
NOAA HAB Bulletin, Lake Erie

July 19, 2017 ➔ July 24, 2017
## Multiparameter Monitoring: Lake Erie

<table>
<thead>
<tr>
<th>Site</th>
<th>pH</th>
<th>DO % sat</th>
<th>Chlorophyll RFU</th>
<th>Phycocyanin RFU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gibraltar</td>
<td>8.7</td>
<td>97.7%</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Sandusky</td>
<td>9.3</td>
<td>108.2%</td>
<td>1.7</td>
<td>6.4</td>
</tr>
<tr>
<td>Cedar Point</td>
<td>9.5</td>
<td>134.6%</td>
<td>1.3</td>
<td>2.8</td>
</tr>
</tbody>
</table>

*Figure 1. Cyanobacterial index from NASA MODIS-Aqua & Terra data collected 20 August, 2017 at 13:07 EST. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/mL.*
Non-pigment water quality parameters can provide important information regarding bloom dynamics.

How the water responds to the algae, and how the algae respond to the water

In all cases, *understanding baseline behavior for a system is paramount to using multiparameter monitoring successfully*
Questions?

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