

# Living with Harmful Algal Blooms

May 15, 2014  
OTCO

Ryan Farmer  
Laboratory Scientist

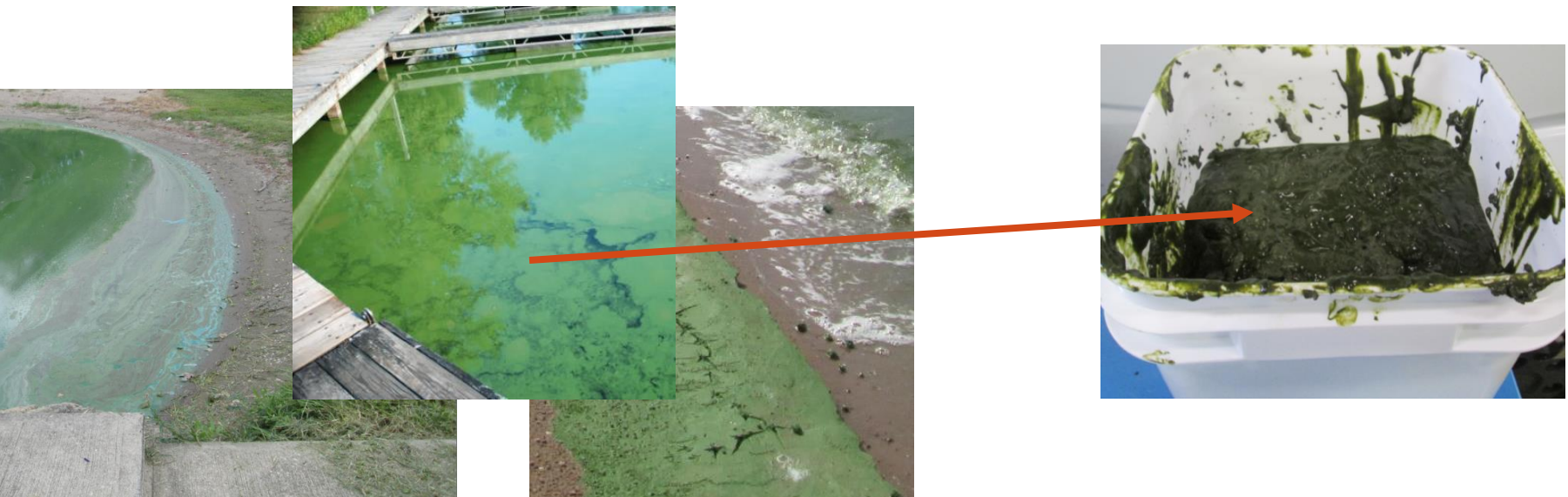


# Beagle's Business



*“We find out where conditions are the worst – the places where others are not going – and that's where we want to be.”*

- Nicolas de Torrente, Médecins Sans Frontières (Doctors Without Borders)



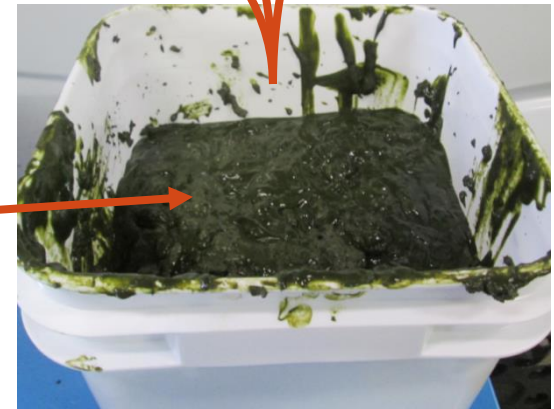
# Beagle's Business



Monitoring



Product Extraction



# Living with HABs

**Beagle**  
*Bioproducts Inc.*

- What are HABs
- The MIM Steps
  - Monitor
  - Identify
  - Measure
- Manage



# What are HABs



- Harmful
- Algae
- Bloom

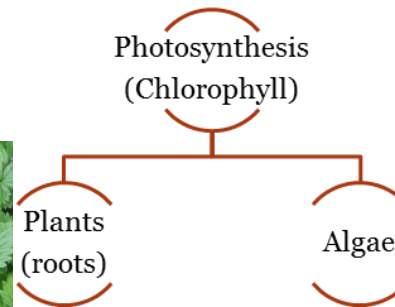
# HABs

- Harmful
- Algae
- Bloom
  - Overgrowth
    - Hot
    - Still
    - Fertilizer
      - $\text{PO}_4$
      - $\text{NO}_3$



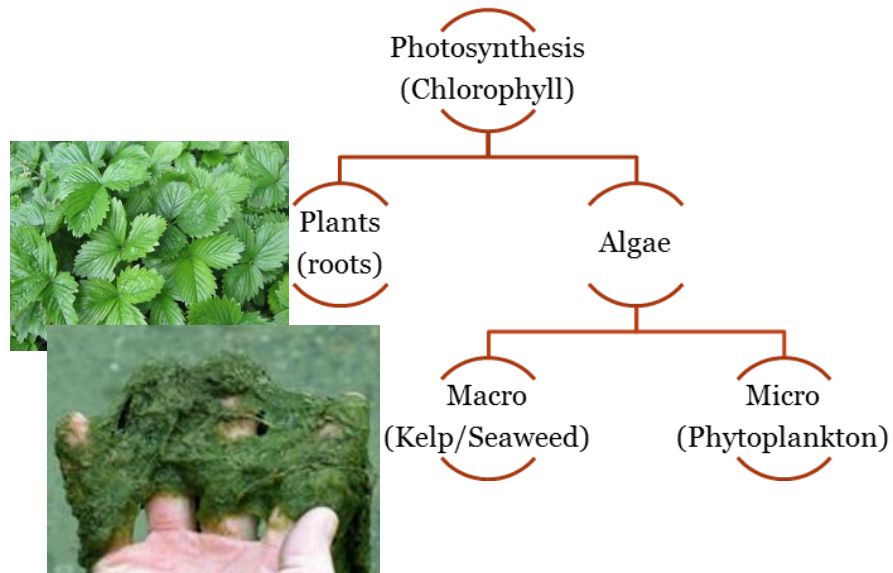
# HABs

- Harmful
- Algae
- Bloom
  - **Overgrowth**



# HABs

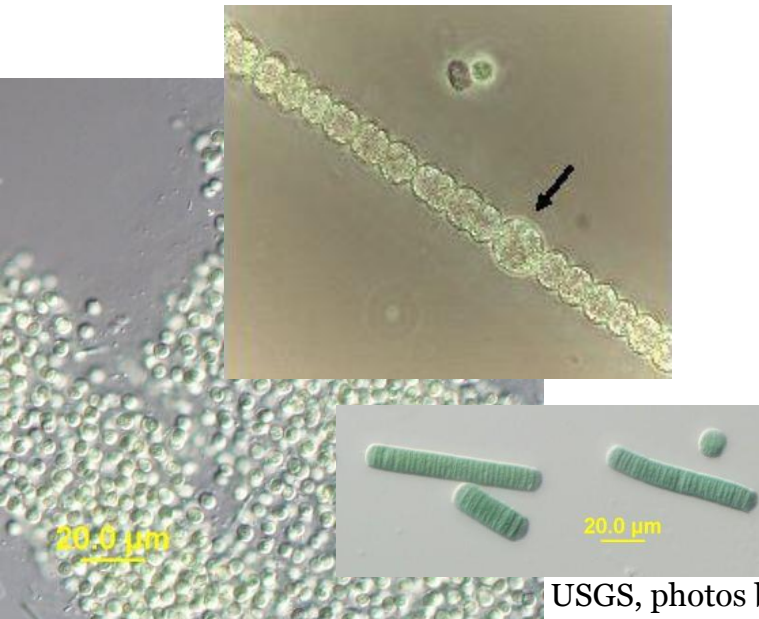
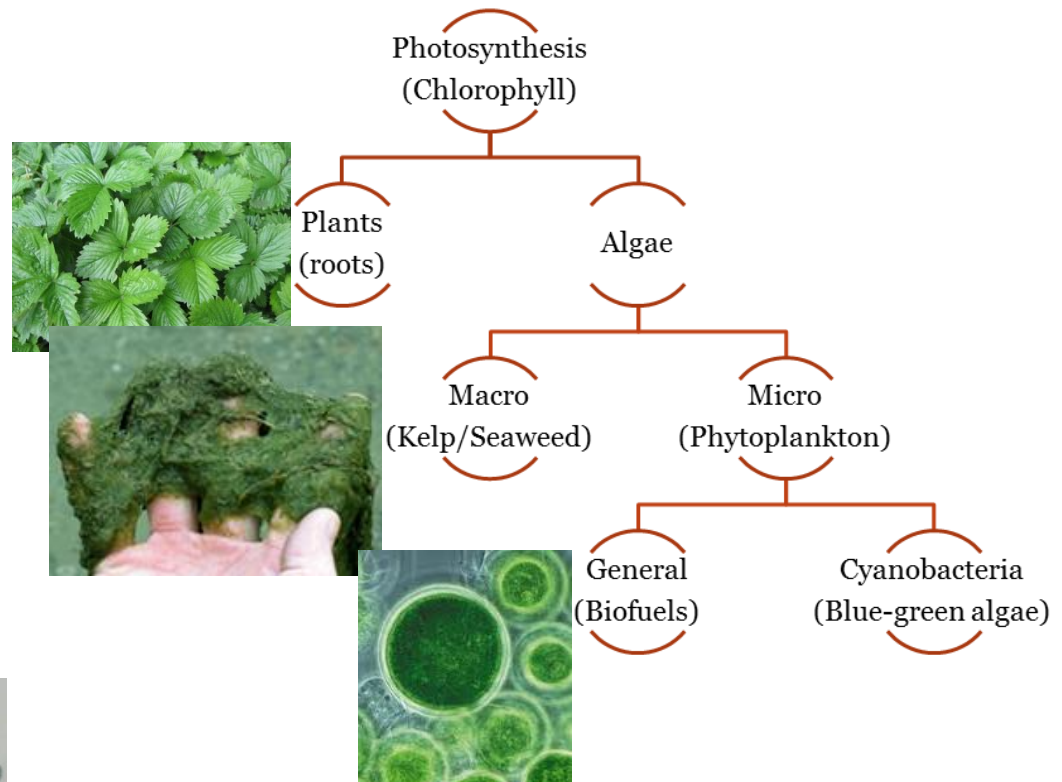
- Harmful
- Algae
- Bloom
  - **Overgrowth**





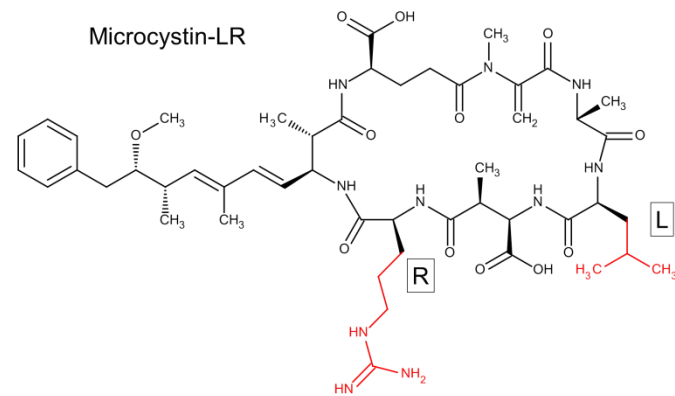
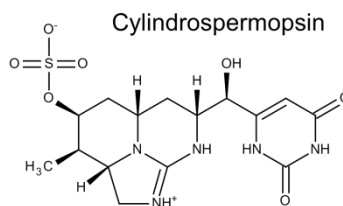
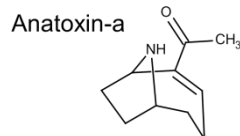
# HABs

- Harmful
- Algae
  - Cyanobacteria
- Bloom
  - Overgrowth



# HABs

- Harmful
  - Toxic
  - O<sub>2</sub> depletion
  - Taste and Odor
  - Economic Losses
- Algae
  - Cyanobacteria
- Bloom
  - Overgrowth



## Algae update: Fixing bad-tasting drinking water already expensive

It's anyone's guess just how bad the algae blooms might be this year, but the city already is dealing with a related problem: bad-tasting drinking water

By [Dean Narciso](#)

*The Columbus Dispatch* • Saturday May 10, 2014 6:55 AM

The city of Columbus has spent \$97,000 since early February to get rid of the off-taste and unpleasant odor of drinking water pulled from Hoover Reservoir. But the battle against the toxic algae causing the problems — which so far has cost \$820,000 and generated 1,700 customer complaints — might not be over.

# Living with HABs



- What are HABs
  - Harmful cyanobacteria
- The MIM Steps
  - Monitor
  - Identify
  - Measure
- Manage

## Why Monitor

- Prepare treatment options
  - Proactive Management
- Protect public safety



# MIM - Monitoring



- Eyes



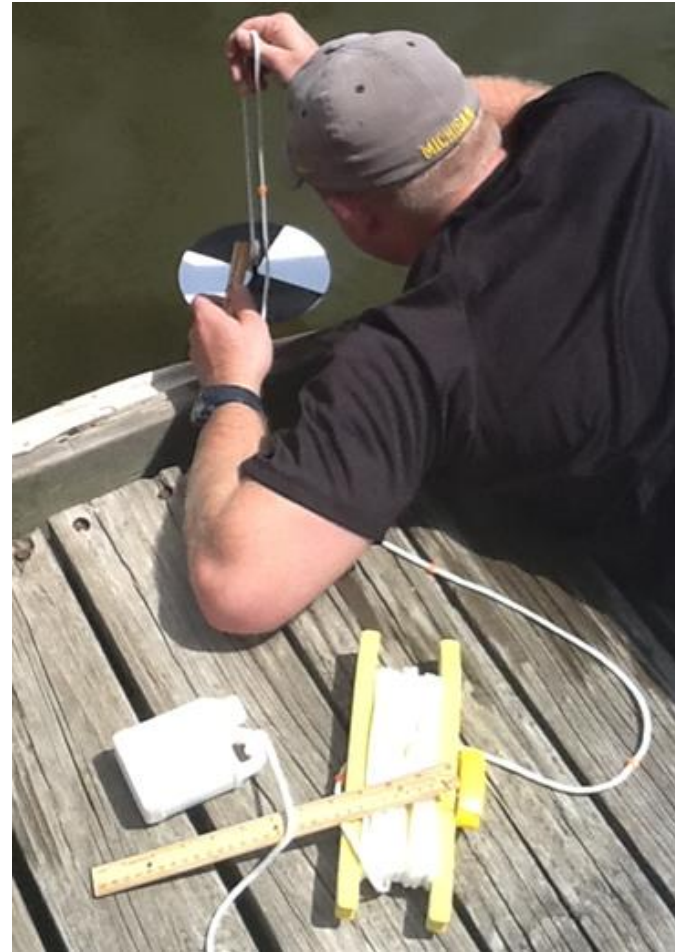
A cow killed by Cyanobacteria (W. Carmichael)



# MIM - Monitoring



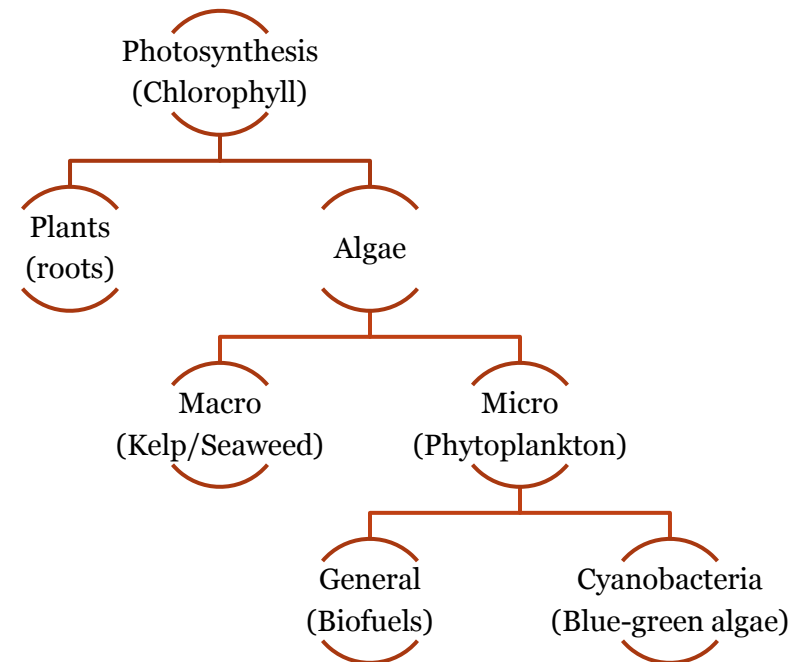
- Eyes
- Tools to Assist
  - Nonspecific
    - Secchi disks
    - Temperature
    - Dissolved O<sub>2</sub>
    - Lab tests for nutrients



# MIM - Monitoring



- Eyes
- Tools to Assist
  - Nonspecific
    - Secchi disks
    - Temperature
    - Dissolved O<sub>2</sub>
    - Lab tests for nutrients
  - HAB focused
    - Fluorometers
      - All Microalgae
      - Cyanobacteria (HABs)



# MIM - Monitoring



## Fluorescence

### Part I: absorption

- Energy (light) is absorbed
  - Has to go somewhere
    - Destructive
    - Heat
    - Light

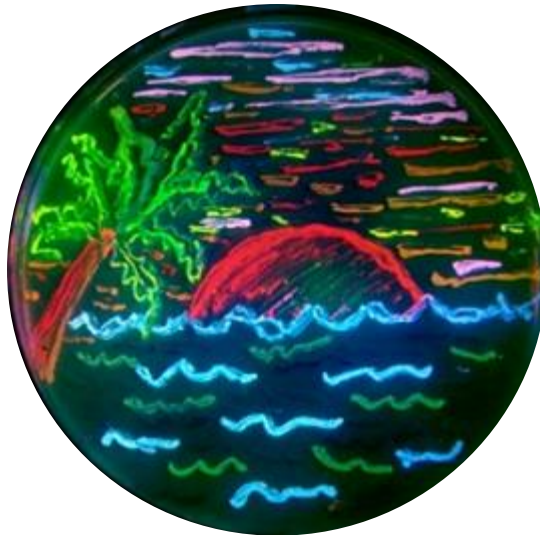
# MIM - Monitoring



## Fluorescence

### Part I: absorption

- Energy (light) is absorbed
  - Has to go somewhere
    - Destructive
    - Heat
    - Light



### Part II: Emission

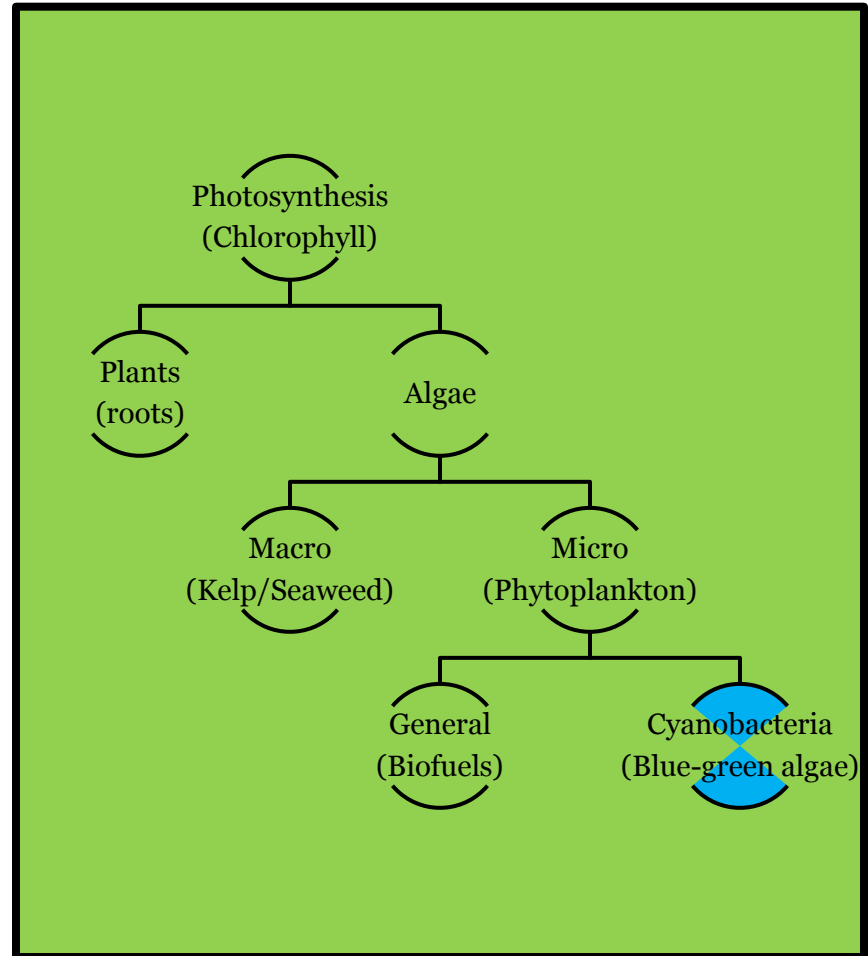
- Light is released
  - Glow
    - Highlighters
    - Blacklights
  - Some energy lost as heat
  - Emitted light  $\neq$  Absorbed light
    - Each molecule is different



# MIM - Monitoring



- Eyes
- Tools to Assist
  - Nonspecific
  - Fluorometers
    - All Algae
      - Chlorophyll – green
    - Cyanobacteria (HABs)
      - Chlorophyll – green
      - Phycocyanin – blue



# MIM - Monitoring



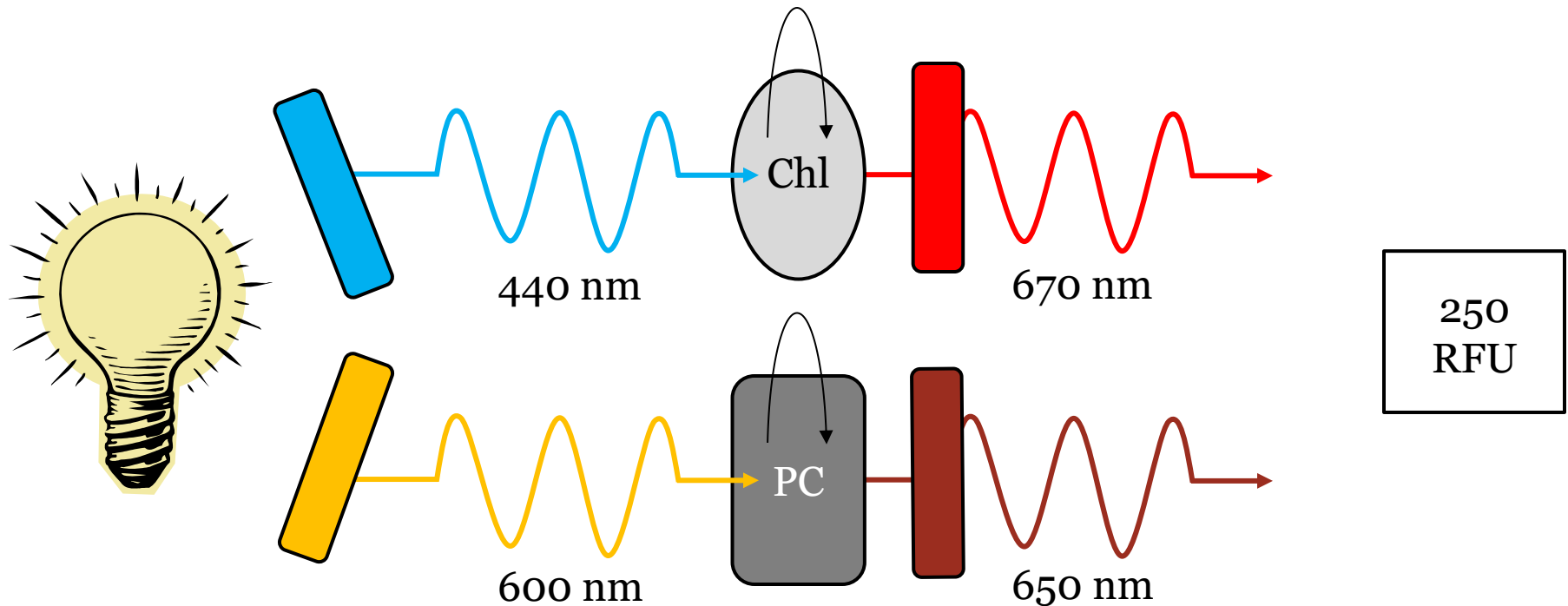
## Measuring Fluorescence

### Part I: Supply light

- Filter to specific type

### Part II: Detect light

- Filter to specific type



# MIM - Monitoring



## Measuring Fluorescence

Google image search  
“handheld fluorometer”



- Take sample
- Measure sample
- Internal data storage

Google image search  
“submersible fluorometer”



- Submerge probe
- Leave probe
- Internal data storage

# Living with HABs



- What are HABs
  - Harmful cyanobacteria
- The MIM Steps
  - Monitor
    - Water Quality
    - Fluorometers
  - Identify
  - Measure
- Manage



# Fluorometers

**Beagle**  
*Bioproducts Inc.*

- Calibrate
- Measure
- Retrieve



# Fluorometers



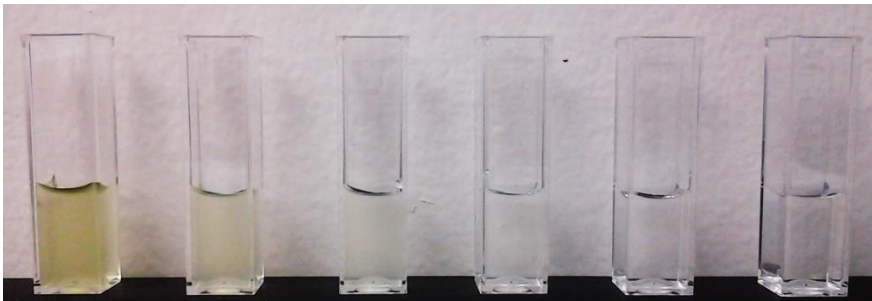
- Calibrate
  - Procedure
    1. Prepare blank
    2. Prepare standard
    3. Set value
  - Uncalibrated
    - Relative units
      - Measure trends
    - No drift correction
  - Calibrated
    - Standard of known concentration
    - Units same as standard
    - Remeasure standard for drift



# Fluorometers

**Beagle**  
Bioproducts Inc.

- Calibrate
  - Standard Value
- Measure
  - Choose either Chl or PC
  - Fill sample tube
    - (Dilute)
  - Measure



Too Dense | OK →



# Fluorometers



- Calibrate
  - Standard Value
- Measure
  - Fill tube
- Retrieve
  - On Fluorometer
  - On Computer
    - USB connection

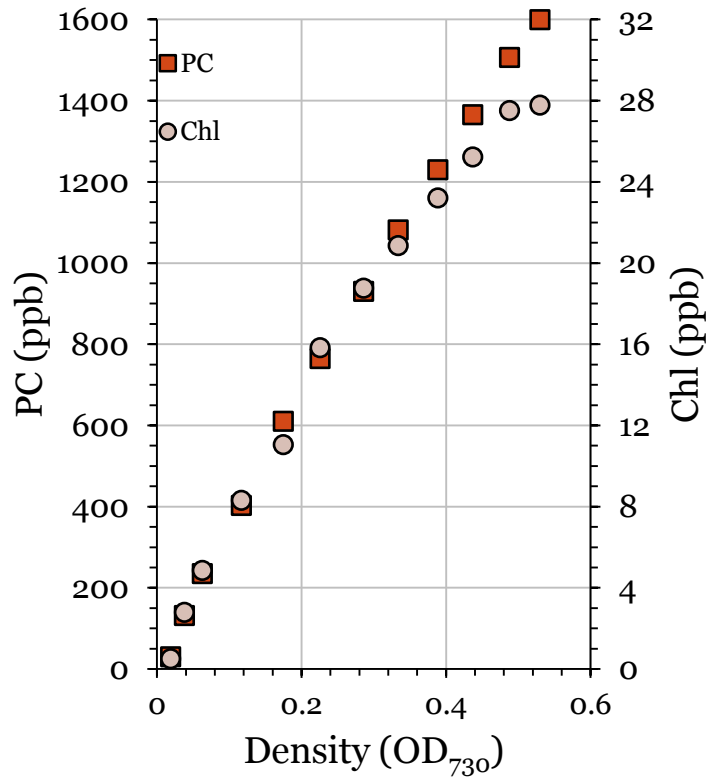




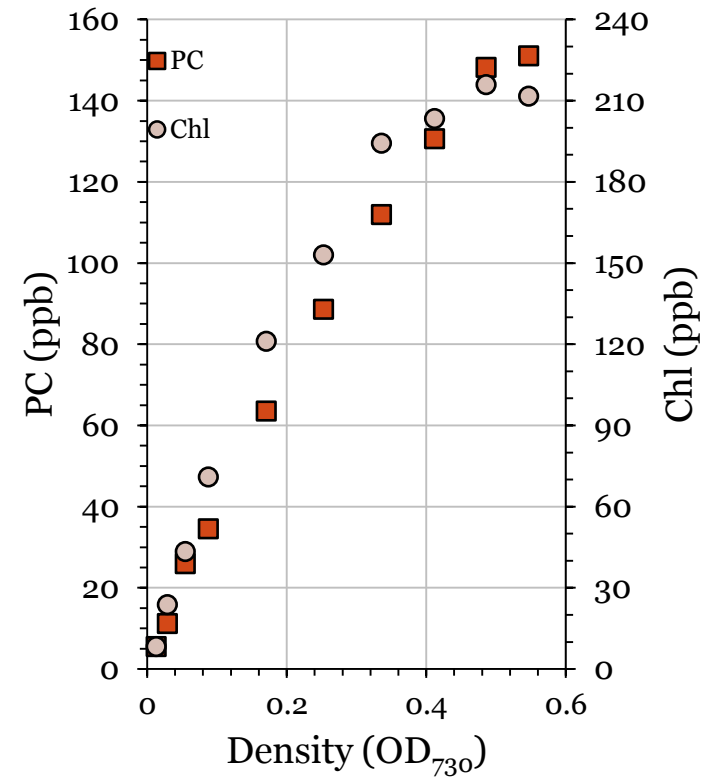
# Fluorometers



## *M. aeruginosa* (cyanobacteria)



## *S. dimorphus* (green algae)



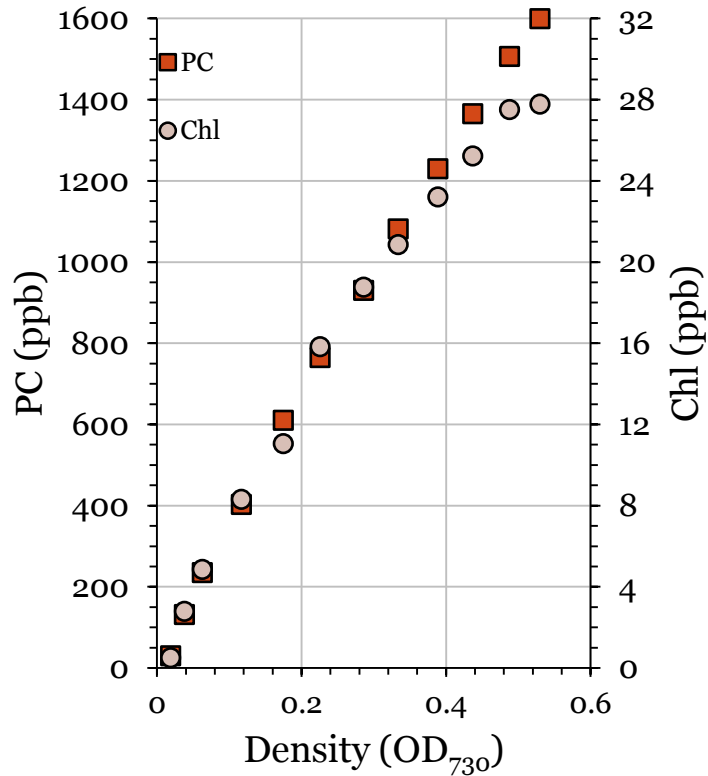
Turbidity  
Not linear @ high

Phycocyanin  
 $Ma = 10 * Sd$

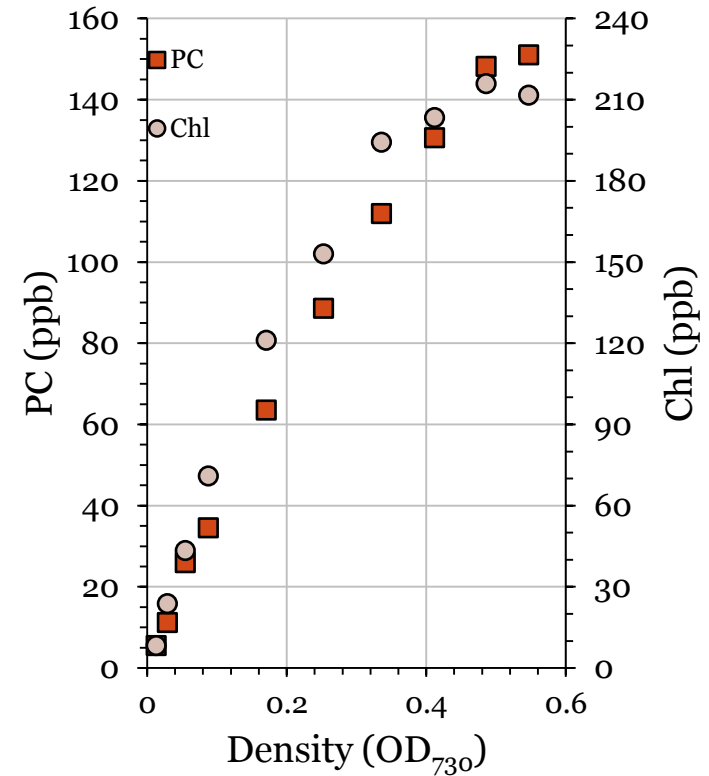
Chlorophyll  
 $Ma = 0.12 * sd$

# Fluorometers

## *M. aeruginosa* (cyanobacteria)



## *S. dimorphus* (green algae)



Density = 0.170

PC (ppb)

- ~50 → Sd
- ~200 → Mix
- ~500 → Ma

# Fluorometers



## Mixed Cultures

<b>Actual:</b>	<b>Measured:</b>		<b>Calculated:</b>
<b>Ratio of Ma: Sd</b>	<b>PC (ppb)</b>	<b>Chl (ppb)</b>	<b>Ratio of Ma: Sd</b>
<b>Pure Ma</b>	<b>574.10</b>	<b>13.66</b>	<b>-----</b>
<b>2:1</b>	<b>400.00</b>	<b>47.13</b>	<b>2.08 : 1</b>
<b>1:1</b>	<b>318.90</b>	<b>63.73</b>	<b>1.03 : 1</b>
<b>1:2</b>	<b>223.06</b>	<b>79.73</b>	<b>1 : 2.06</b>
<b>Pure Sd</b>	<b>57.84</b>	<b>104.03</b>	<b>-----</b>

- If only 2 organisms, then can quantify
- Increase in PC when cyanobacteria becoming dominant
- Chl levels can decrease

# Living with HABs



- What are HABs
  - Harmful cyanobacteria
- The MIM Steps
  - Monitor
    - Water Quality
    - Fluorometers
      - Semi-quantitative
      - Monitor trends
  - Identify
  - Measure
- Manage



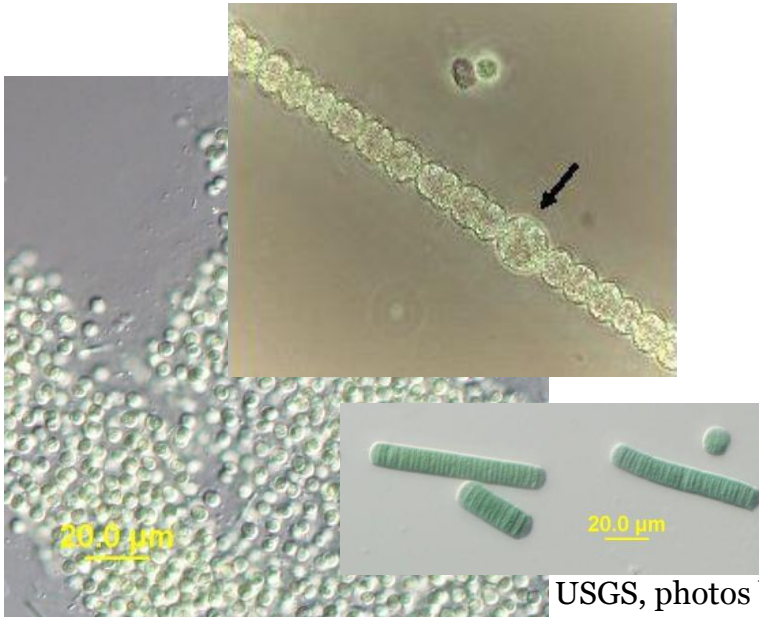
# Identification



- Collect sample
- Preserve sample
  - Refrigeration
  - Lugol's solution
- Microscopy



NOAA, Great Lakes Environmental Research Laboratory



USGS, photos by Barry Rosen

# Living with HABs



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  - Measure
- Manage



# Measure



- Toxin groups
  - Microcystin
  - Nodularin
  - Cylindrospermopsin
  - Anatoxin
  - Saxitoxin
- Procedure
  - Sample
  - $\pm$  lyse cells
    - Various efficiencies
- Laboratory Tests
  - ELISA – group level ID
  - LC-MS – congener level ID



# Living with HABs



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    - Fluorometers
      - Semi-quantitative
      - Monitor trends
  - Identify
    - Microscopy
  - Measure
    - ELISA
- Manage

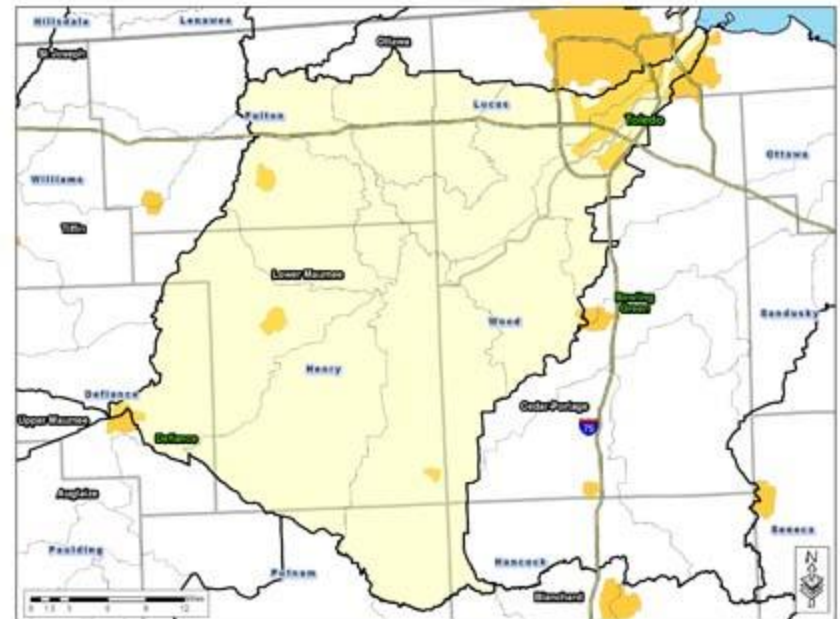




# Manage



- Small scale
  - Additives
    - Cu
    - Peroxide
  - Nutrient removal
    - $\text{PO}_4$  sedimentation
    - Plant competition
  - Aerators
- Large scale
  - Watershed management
    - Limit fertilizer runoff

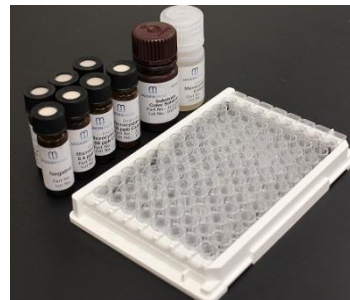
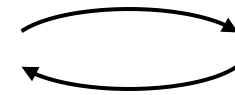


NW Ohio Lower Maumee Watershed

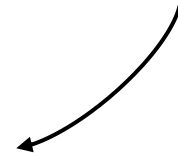
# Living with HABs

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Bioproducts Inc.

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  - Harmful cyanobacteria
- The MIM Steps
  - Monitor
    - Water Quality
    - Fluorometers
      - Semi-quantitative
      - Monitor trends
  - Identify
    - Microscopy
  - Measure
    - ELISA
- Manage
  - Various



Management Strategy



The logo for Beagle Bioproducts Inc. features a stylized black and white dog head profile on the left, which forms the letter 'B'. To the right of this graphic, the word 'Beagle' is written in a large, black, serif font. Below 'Beagle', the words 'Bioproducts Inc.' are written in a smaller, red, italicized serif font.

**Beagle**  
*Bioproducts Inc.*

