NOAA Phytoplankton Monitoring Network - A Citizen Scientist Program

Promoting a better understanding of Harmful Algal Blooms by way of volunteer monitoring.

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Marine Biotoxins Program

http://www.chbr.noaa.gov/pmn/
Train citizen scientists to:
• identify algal species
• analyze water samples for HAB toxins
• identify temporal and geographic HAB trends

PMN started in 2001 as part of Marine Biotoxins Program.

Over 100 active sites in 12 coastal states.

To educate the public on harmful algal blooms (HABs) while expanding the knowledge of phytoplankton that exist in coastal waters through research based monitoring.
**Phytoplankton Monitoring Network**

Network that monitors distribution of harmful algae and species composition throughout the coastal US. Observations and samples by PMN monitors assist the research that is being done by the Marine Biotoxins program.

**Analytical Response Team**

Provides rapid and accurate identification and quantification of marine algal toxins in suspected harmful algal blooms, marine animal mortality events and human poisonings.

Identification and analytical capability provides support for management agencies that can then make timely and informed decisions impacting stakeholders involved in coastal wildlife, human health and commerce.
Two-tiered approach to analysis

Rapid screen by toxin class-specific assays

- ELISA
- Receptor Binding Assay
- Protein Phosphatase Inhibition Assay
- Neuroblastoma 2A Assay
- General Cytotoxicity Assay
- Surface Plasmon Resonance
- Radioimmunoassay

Confirmation of toxin by analytical methods

Liquid chromatography-tandem mass spectrometry (LC-MS/MS)
- Brevetoxins (PbTx)
- Saxitoxins (STX)
- Ciguatoxins (CTX)
- Domoic Acid (DA)
- Microcystins
- Okadaic Acid (OA)
- Azaspiracids (AZA)
Program Goals

- Monitor and maintain an extended survey area along coastal waters throughout the year
- Create a comprehensive list of harmful algal species inhabiting coastal marine waters
- Promote an increased awareness and education to the public on HABs
- Identify general trends where HABs are more likely to occur
- Isolate areas prone to harmful algal blooms (HABs) for further study by researchers in effort to assist state managers in mitigating the affects of HABs
- Create a working relationship between volunteers and researchers
- Increase the public's awareness of research conducted by federal workers on HABs
Harmful algal blooms (HABs)
Cyanobacterial Harmful Algal Blooms (cyanoHABs)

**Cyanobacteria**, formerly called blue-green algae, are a type of photosynthetic bacteria.

When environmental conditions are ideal, cyanos can grow rapidly, or ‘**bloom**’, forming thick surface scum layers.

**SOME** species are potentially harmful, and can produce toxins that can impact drinking and recreational waters.
Cyano Harmful Algal Blooms (cyanoHABs)

Mounting evidence indicates global climate changes support increased frequency and geographic extent of HABs.

Each year the desire to live at lakeside and the reliance on large surface waters for recreation and drinking water puts more people and animals at risk for exposure to HABs and the toxins they can produce.
Harmful Effects of CyanoHABs

- **Block the sun**
  - Kills other aquatic plants, reducing oxygen production

- **Remove oxygen from water when bloom dies off**
  - Kills other organisms like fish

- **Produce Toxins**
  - Can cause illness/death in animals and humans

*Cyanobacteria have been linked to human and animal illnesses around the world, including North and South America, Africa, Australia, Europe, Scandinavia, and China.*
## CyanoToxins

<table>
<thead>
<tr>
<th>Toxin Type</th>
<th>Primary Organ Affected</th>
<th>Toxin-Producing Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcystins</td>
<td>Liver</td>
<td>Anabaena Microcystis</td>
</tr>
<tr>
<td>- <em>hepatotoxin</em></td>
<td></td>
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</tr>
<tr>
<td>Anatoxins</td>
<td>Nervous system</td>
<td>Anabaena Aphanizomenon</td>
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<tr>
<td>- <em>neurotoxin</em></td>
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</tr>
<tr>
<td>Saxitoxins</td>
<td>Nervous system</td>
<td>Anabaena Aphanizomenon Cylindrospermopsis</td>
</tr>
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Why the PMN?

**Problem:** Very few government or private institutions have the capacity or capability to monitor thousands of lakes (and reservoirs), from the Great Lakes to small residential lakes annually impacted by HABs.

**Solution:** *Engage local citizens* in environmental monitoring of potentially harmful cyanobacteria to aid NOAA scientists and others in their research.
PMN and EPA

• Entered into a collaboration to create a freshwater citizen science program to monitor CyanoHABs
  - FY15 included a pilot program in EPA Region 5 and Region 8

• Use previously established PMN methods with modifications for freshwater habitats.
Freshwater Phytoplankton Monitoring Network (PMN)

Promoting a better understanding of Cyano Harmful Algal Blooms by way of volunteer monitoring.

Volunteering
Volunteer Requirements:

1) **Collect sample** at least once every two weeks during the sampling season (Ice Out – Ice In)
2) **Analyze sample** identifying target algae
3) **Take** digital pictures to send into the PMN
4) **Input** data into the PMN database
5) **Preserve** sample and ship to PMN when water is visibly green
Volunteer Equipment

Volunteers are loaned all sampling equipment

• Thermometer
• 5 gridded slides
• Cover slips
• 125 mL bottles
• 30 mL of Lugol’s solution for sample preservation
• Pre-paid overnight shipping label and shipping envelopes

*Region specific volunteer manual

*Identification sheets for target species
Tools for cyanoHAB training & identification

PHYTO app

WebEx training sessions

- Done remotely to make training more convenient when on-site is not possible
- Allows NOAA scientists to observe real samples online with volunteers

http://youtu.be/ItzxoB06De0
Target Freshwater Algae

Anabaena spp.

Aphanizomenon spp.

Cylindrospermopsis spp.

Microcystis spp.

Oscillatoria spp.

Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring, and management, World Health Organization, 1999
When a Bloom is reported

Managers
Stakeholders
Bloom Events (2001-2013)
NOAA Phytoplankton Monitoring Network

Total Blooms: 250  Non-toxic: 205  Toxic: 45
A bloom of *Pseudo-nitzschia* was observed by students of First Flight High School and preserved samples sent to the Marine Biotoxins Program were positively identified using scanning electron microscopy as *Pseudo-nitzschia multiseries*, and shown by LC-mass spectrometry to produce domoic acid. The identification of *P. multiseries* in North Carolina’s waters is another example were a volunteer monitoring program is useful in developing a species list and record of distribution patterns, as well as alerting NOAA scientists to the presence of potentially harmful species.

**PMN Findings Help Lead to the...**

**First time Identification of Domoic Acid in Marine Mammals in Southeastern U.S Waters**

Domoic acid was detected exclusively in *Kogia spp.* stranding in the absence of observed HAB activity. The frequency of occurrence and concentrations of domoic acid suggests potential chronic animal exposure in a region with virtually no history of HABs.
FPMN 2010 in Review (with CDC)

- 2 states involved - Minnesota & Wisconsin
- 12 lakes sampled
- 34 sampling sites
- > 40 people monitored
- > 305 samples collected and analyzed
  - 96% contained at least 1 target algae
  - 74% contained Microcystis
- 6 Microcystis blooms reported with NO HEALTH AFFECTS
  - 3 in July, 3 in August
- 3 Oscillatoria blooms reported
  - 1 in June, 1 in July, 1 in August
- NO human health affects reported during sampling season
Freshwater Phytoplankton Monitoring Network

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2015 Pilot Project Sampling Season
FY 2015

Region 8:
Colorado (1 site)
Montana (1 site)
Utah (5 sites)

Partners include:
• Weber-Morgan Health Dept.
• UT DEQ-DWQ
• TriCounty Health Dept.
• EPA
FY 2015

Region 5:
Ohio (2 sites)
Michigan (1 site)

Partners include:
• Imagination Station
• Knabusch Math & Science Center
Persistent *Microcystis* bloom in western Lake Erie

Photos by Tom Green
Conclusion

• Volunteer Phytoplankton Monitoring Networks are a proven key asset in the detection of harmful algal blooms.

• Data generated by volunteer citizen scientists is very useful in many aspects of HAB research and management decisions.
Funding

NOS/NCCOS/CCEHBR

EPA- Office of Water