Eutrophication

- Characterized by an enrichment of nutrients (N and P), increased primary production, and excessive algal or plant growth

Oligotrophic

- Natural stage in late lake succession

Mesotrophic

- Accelerated by human activities
    - "Anthropogenic/Cultural Eutrophication"

Eutrophic

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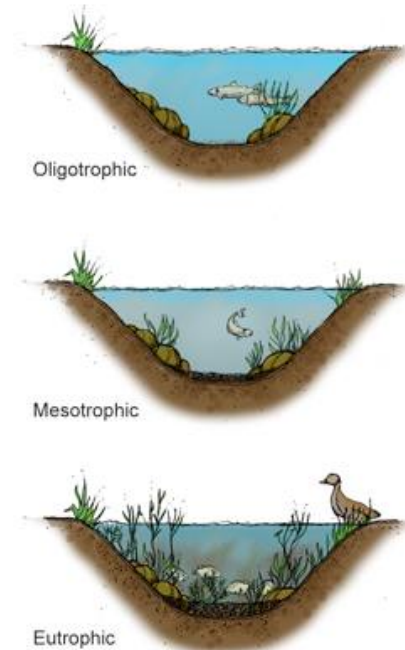
Cultural Eutrophication Realized

- "America's Sewage System and the Price of Optimism" *TIME* Magazine, 1969

Clean Water Act

Point Sources

Non-Point Sources

Finding a Balance

- Primary Production
  - fuels an ecosystem
  - provides oxygen
  - sequesters carbon
- Maintain high quality waters

Consequences

- Hyperproductivity can cause:
  - human and animal health effects
    - Increased pathogen growth
    - **Increased occurrence of toxic algae blooms**
  - Decreased aesthetics/recreational opportunities
  - Dissolved O_2 crashes and fish kills
  - Higher treatment operating costs
 - Shortened lake lifespan

Huffingtonpost.com

Harmful Algal Blooms

- Cyanobacteria
  - Specialized to dominate under certain conditions
  - Toxin producers
  - Challenges in predicting occurrence and toxin production

Freshwater Cyanotoxins	Type of Toxin	Causative Organism
Anatoxin-a	Neurotoxin	Anabaena spp.
Anatoxin-a (s)	Neurotoxin	Aphanizomenon spp. Planktothrix spp.
Cylindrospermopsin	Hepatotoxin	Cylindrospermopsis raciborskii, Aphanizomenon ovalisporum
Lyngbyatoxin	Dermal Toxin	Lyngbya spp.
Microcystins	Hepatotoxin	Microcystis aeruginosa Anabaena spp. Planktothrix spp.
Saxitoxins	Neurotoxin	Anabaena circinalis Lyngbya wollei

Algal Toxins

- Symptoms include:
  - Gastrointestinal distress
  - Paralysis
  - Liver and kidney damage
  - Respiratory failure
  - Dermatitis
- Susceptible populations
  - Children
  - Livestock
  - Wildlife
  - Pets
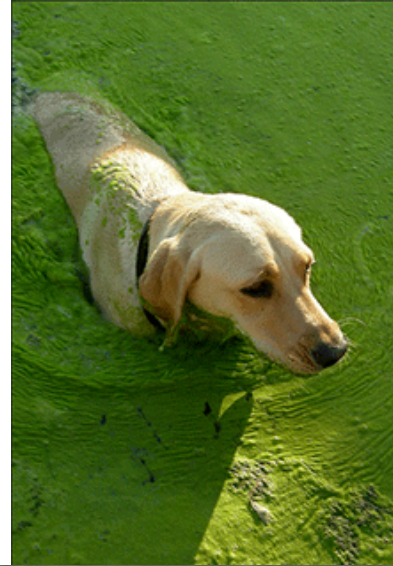
©2013 Nature Education Photo by Jannie Coetzee.

A Real Threat

- Saxitoxins (Paralytic Shellfish Poisoning)
  - One of the most potent known toxins on Earth
  - Lethal effects as low as 1 mg
- Microcystins (liver toxins)
  - Liver damage and cell death within minutes
  - Cause of 52 human deaths in Brazil
  - Domestic animal deaths reported in 7 states including OK

This common summer problem can kill your dog in
30 TO 60 MINUTES!

Devastating toxic algae bloom plagues Florida's Gulf Coast

by TAMARA LUSH, Associated Press | Sunday, August 12th 2018

ENVIRONMENT
Toxic algal blooms found in more than 80 New York waterways

Associated Press Sep 8, 2018

Harmful algae found in central Wyoming reservoir

Aug 6, 2018

Harvesters donates bottled water to Kansas town where toxic algae has impacted water supply

POSTED 6:57 AM, JUNE 25, 2018, BY AP

Gillham Lake Swim Beach Closed Temporarily Due to Algae Bloom

Posted: May 24, 2018 03:53 PM CDT

Harmful Lake Erie Algae Bloom Expected This Summer

By Pam Wright · July 13 2018 10:45 AM EDT · weather.com

Southern California coast emerges as a toxic algae hot spot

August 21, 2018, University of Southern California

Toxic algae blooms becoming more common across US

By Associated Press
June 22, 2018 | 4:02pm

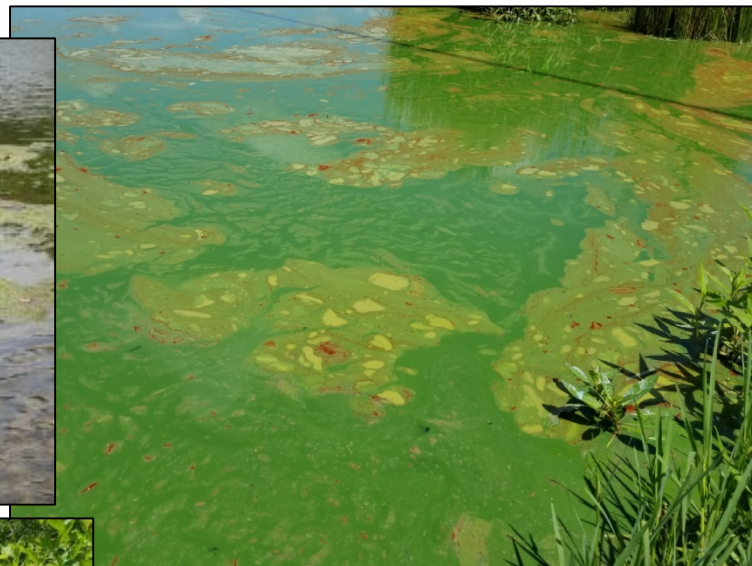# Oregon's not alone: Algae blooms happening more often

By: AP
Posted: Jun 22, 2018 12:45 AM PDT

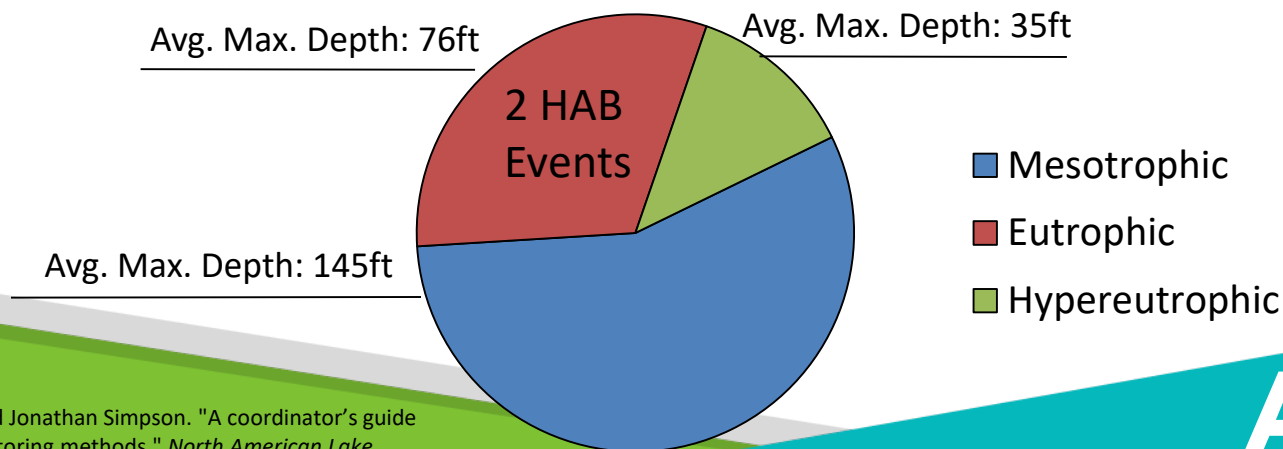# Maine expanding shellfish closure in wake of harmful bloom

By - Associated Press - Tuesday, September 19, 2017

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Cyanobacterial Blooms in Arkansas

Water Quality and Productivity Sampling on AR Lakes

- Small reference lakes

- 2011 – present: Quarterly sampling
  - 16 lakes
    - SA: 1,300 – 45,152 acres
    - Max Depth: 34 – 200 ft
    - Trophic State (based on Chl α)[1]

Avg. Max. Depth: 76ft

Avg. Max. Depth: 35ft

Avg. Max. Depth: 145ft

2 HAB Events

- Mesotrophic
- Eutrophic
- Hypereutrophic

[1]Carlson, Robert E., and Jonathan Simpson. "A coordinator's guide to volunteer lake monitoring methods." *North American Lake Management Society* 96 (1996): 305.

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Applying the Data

- Predictive regional model
  - Screening and prioritization tool
    - LULC
    - Lake Morphometry
    - **Water Quality/Productivity**
  - Utilize existing resources
    - Regional Model for HABs in the Pacific NW from Rose et al., 2019

$$CB = a * (Developed-Open\ Space)$$
$$+ b * (Evergreen\ forest) + c * (Scrub\ shrub)$$
$$+ d * (Grassland\ herbaceous) + e * (Pasture\ hay)$$
$$+ f * (TN) + g * (TP) + h * (Chl\text{-}a)$$
$$+ j * (Drainage\ area),$$

Rose, Vanessa J., et al. "Catchment characteristics, water quality, and cyanobacterial blooms in Washington and Oregon Lakes." *Lake and Reservoir Management* (2019): 1-13.

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Data limitations

- Resource limited
  - 2 staff members dedicated to lake sampling and analysis

- Lake diversity limited
  - Historic data on larger, more mesotrophic reservoirs

- Parameter limited
  - Chl a is the only metric directly measuring productivity/HABs

Beginning to Bridge Data Gaps

- 2340 named lakes in Arkansas - water quality routinely collected on 16 (<1%)

- What do HAB prone lakes look like?

- Utilize the network of aquatic knowledge we have in AR
  - Natural Resource Agencies
  - Universities
  - Private Industry
  - Non-profit Organizations
  - Community Groups

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Beginning to Bridge Data Gaps

- Recruiting partners
  - Our benefits
    - Partnerships allow for better analytical, spatial, and temporal data
    - Localize effort and knowledge
  - Partner benefits
    - Get to know the primary productivity/water quality side of your lake
    - Contribute to a statewide database used to make human health and management decisions

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What we're missing to inform our model can likely be found in a bucket of water

Alkalinity	Bromide	Flouride	Orthophosphate	TDS
Aluminum	Cadmium	Hardness	Potassium	TKN
Ammonia – nitrogen	Calcium	Inorganic nitrogen ($NO_2 + NO_3$)	Selenium	TOC
Antimony	Chloride	Iron	Silica	TP
Arsenic	Chlorophyll α	Lead	Silver	TSS
Barium	Chromium	Magnesium	Sodium	Turbidity
Beryllium	Cobalt	Manganese	Sulfate	Vanadium
Boron	Copper	Nickel	Thallium	Zinc

Pilot Project

- Summer 2018 – 2019 HAB Monitoring Initiative Fund (MIF)
  - Target lakes for HAB sampling
- Collect 1 – 2 buckets of water and aliquot into specified containers
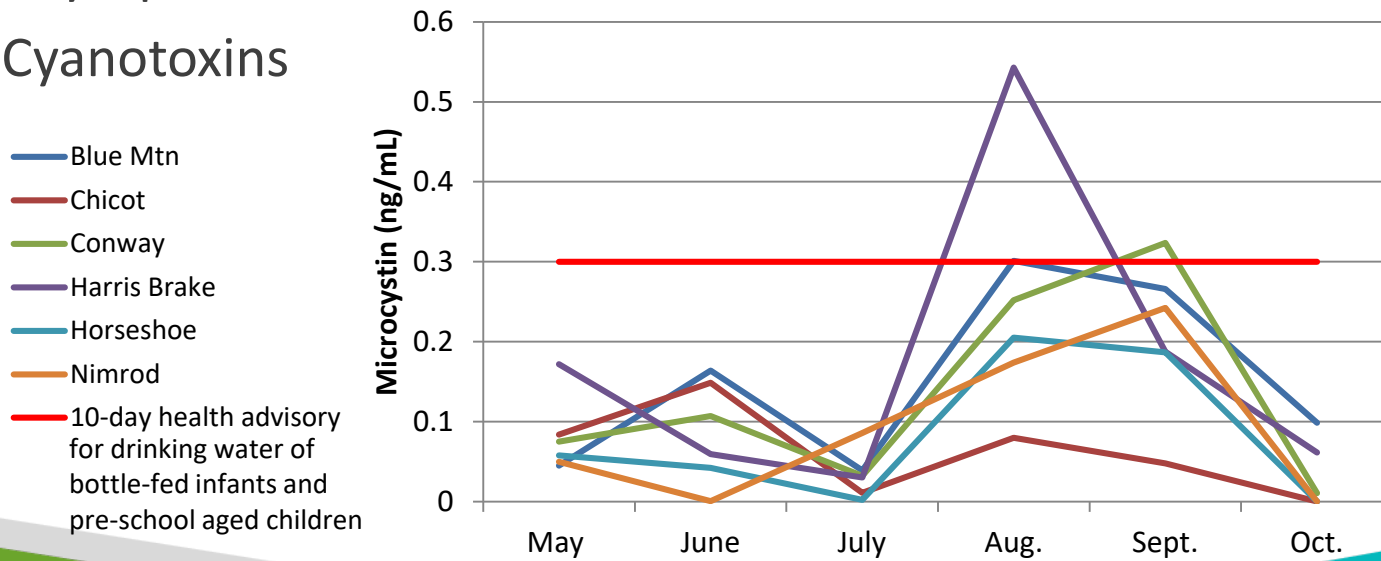- Collect *in situ* parameters if possible

<u>AGFC Partners</u>

- Conway (Mayflower)
- Harris Brake (Mayflower)
- Horseshoe (Brinkley)

<u>ADEQ Staff</u>

- Blue Mountain
- Chicot
- Nimrod

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Summer 2018 HAB MIF Lakes

- 6 lakes from May to Oct
  - SA: 1300 – 6700 acres
  - Max Depth: 15 – 36 ft
  - Trophic State (based on Chl α)[1] – 100% hypereutrophic
  - Phytoplankton
  - Cyanotoxins

Legend:
- Blue Mtn
- Chicot
- Conway
- Harris Brake
- Horseshoe
- Nimrod
- 10-day health advisory for drinking water of bottle-fed infants and pre-school aged children

[1]Carlson, Robert E., and Jonathan Simpson. "A coordinator's guide to volunteer lake monitoring methods." *North American Lake Management Society* 96 (1996): 305.

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2018 HAB Season

- 5/18/18 - Gillham Lake
  - 273 mi^2 watershed
  - ~10% developed or pasture
  - Cyanobacterial cell count ~88,000 cells/mL
  - Microcystins < MDL
- 7/13/18 - Lake Bennet
  - 3.33 mi^2 watershed
  - ~50% developed or pasture
  - Cyanobacterial cell count ~90,000 cells/mL
  - Microcystins < MDL
- 8/14/18 - Brewer Lake
  - 36.3 mi^2 watershed
  - ~43% developed or pasture
  - Cyanobacterial cell count ~170,000 cells/mL
  - Microcystins = 0.633 ng/mL

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Summer 2019 HAB MIF Lakes

- Add lakes with blooms reported in 2018
  - Gillham
  - Bennet
  - Brewer
- Introduce another analyte (phycocyanin)
- **Increase HAB reporting**

https://www.adeq.state.ar.us/complaints/forms/harmful_algae_complaint.aspx

Harmful Algae Bloom Complaint Form

The information you submit will be forwarded to ADEQ environmental enforcement personnel. If you send a complaint to the wrong division, it will be referred to appropriate staff.
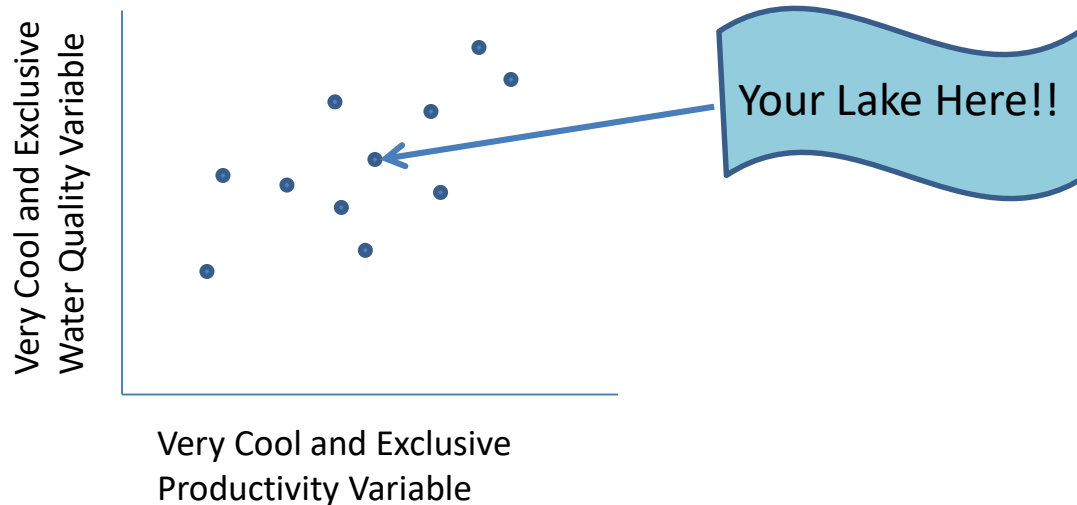
ADEQ's Mobile App - Pollution Complaints
Get our app and start sending complaints from your phone.

Download on the App Store   ANDROID APP ON Google play

Closing remarks

- We don't want to have to pay the potential price of HABs

- By working together, we can improve efforts to protect aquatic ecosystems

Acknowledgements

- Thank you to our partners from AGFC
  - Matt Schroeder
  - Matt Horton
  - Justin Homan
  - Micah Tindall
- EPA for funding

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