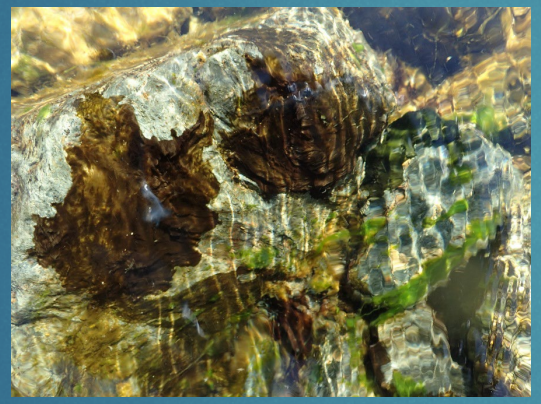
US EPA BENTHIC HABS DISCUSSION GROUP WEBINAR

April 6, 2023, 10:00am – 11:30am Pacific Standard Time

Webinar registration:

https://zoom.us/webinar/register/WN_axPFfA3BQHuojGAzf7fIxw

GUEST SPEAKERS:

DR. ALYSSA CALOMENI, ENGINEER RESEARCH & DEVELOPMENT CENTER (ERDC), UNITED STATES ARMY CORPS OF ENGINEERS (USACE)

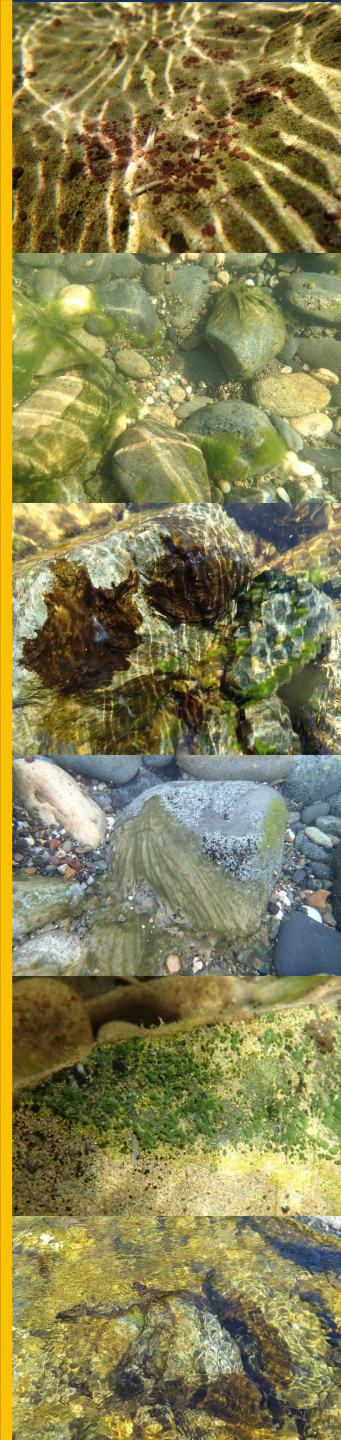
RICH FADNESS, CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

I. AGENDA

I **Welcome, Agenda Overview, Introductions, and Announcements**
Margaret Spoo-Chupka and Eric Zimdars

II **Presentation: Identification and preventative management of overwintering cyanobacteria in sediment**
Guest Speaker – Dr. Alyssa Calomeni

III **Presentation: A request to reevaluate available benthic monitoring data to inform guidelines for posting benthic cyanobacteria signage to protect public health**
Guest Speaker – Rich Fadness



I. INTRODUCTIONS

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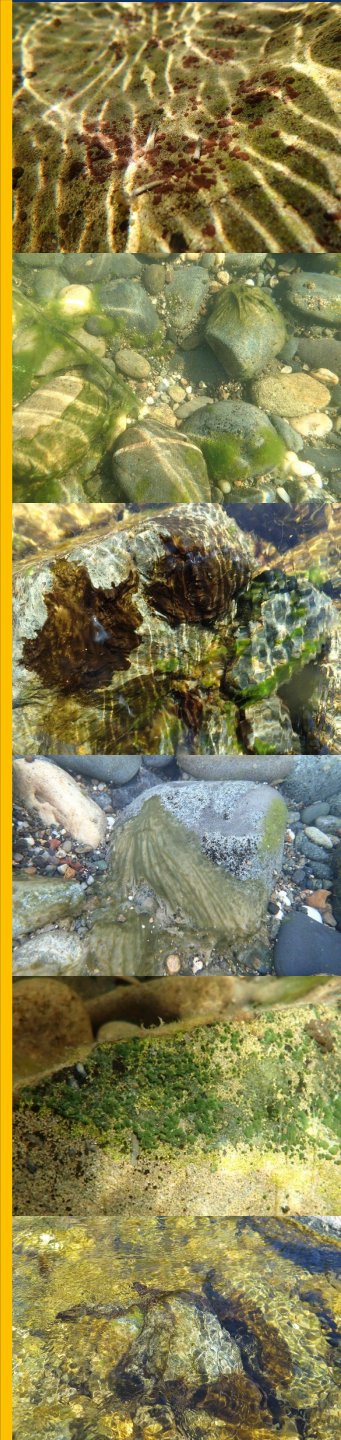
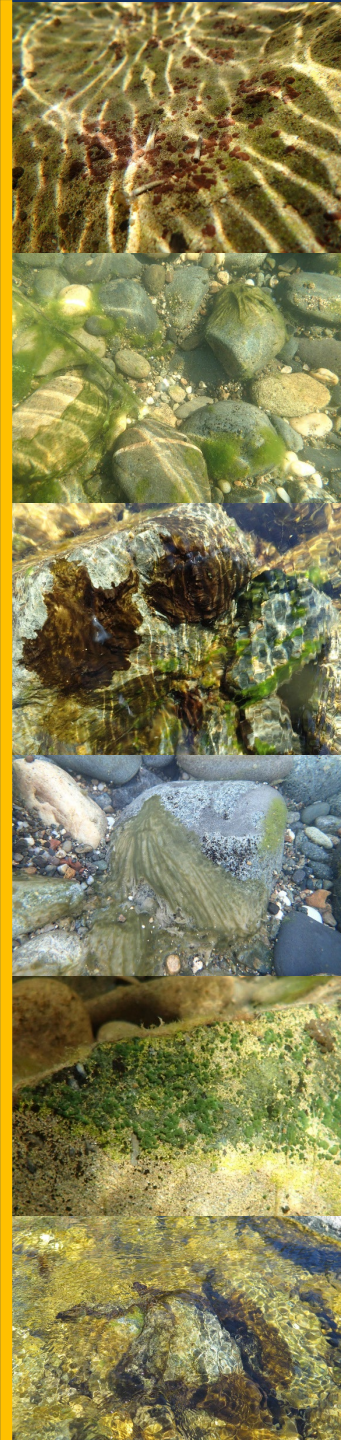


I. ANNOUNCEMENTS

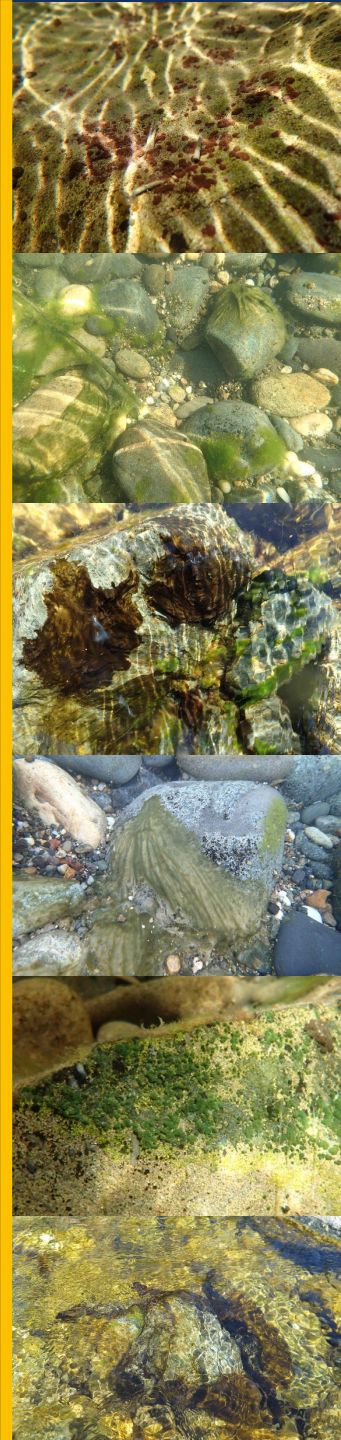
- Upcoming Meetings
  - National Water Quality Monitoring Council: 13th National Monitoring Conference, April 24-28, Virginia Beach, Virginia
- Recent Papers
  - Valadez-Cano et al., 2023, *Genomic characterization of coexisting anatoxin-producing and non-toxigenic Microcoleus subspecies in benthic mats from the Wolastoq, New Brunswick, Canada*.
  - Robichon et al., 2023, *Relative effect of hydraulics, physico-chemistry and other biofilm algae on benthic cyanobacteria assemblages in a regulated river.*



ITEM II

GUEST PRESENTATION: Identification and preventative management of overwintering cyanobacteria in sediment

DR. ALYSSA CALOMENI, ENGINEER RESEARCH AND DEVELOPMENT CENTER (ERDC), U.S. ARMY CORPS OF ENGINEERS (USACE)



IDENTIFICATION AND PREVENTATIVE MANAGEMENT OF OVERWINTERING CYANOBACTERIA IN SEDIMENTS

Alyssa Calomeni PhD, USACE-ERDC

Andrew McQueen PhD, USACE-ERDC

Ciera Kinley-Baird PhD, Aquatic Control

Tony Clyde PhD, USACE-Tulsa District

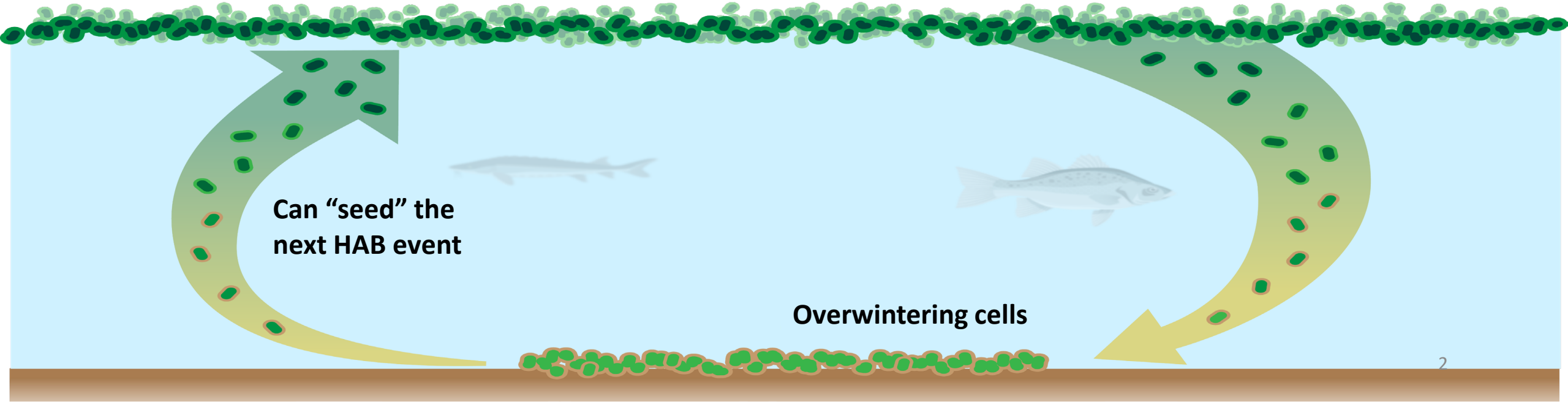
6 April 2023

Introduction

Overwintering cells:

- Cyanobacteria that remain viable under non-ideal conditions
- **Akinetes** (e.g., *Dolichospermum*)
- **Vegetative cells** (e.g., *Microcystis*)

- **Overwintering** cyanobacterial cells in sediments **can contribute** to harmful algal blooms **(HABs)**
- **Limited data** on the preventative treatment of overwintering cells



Introduction

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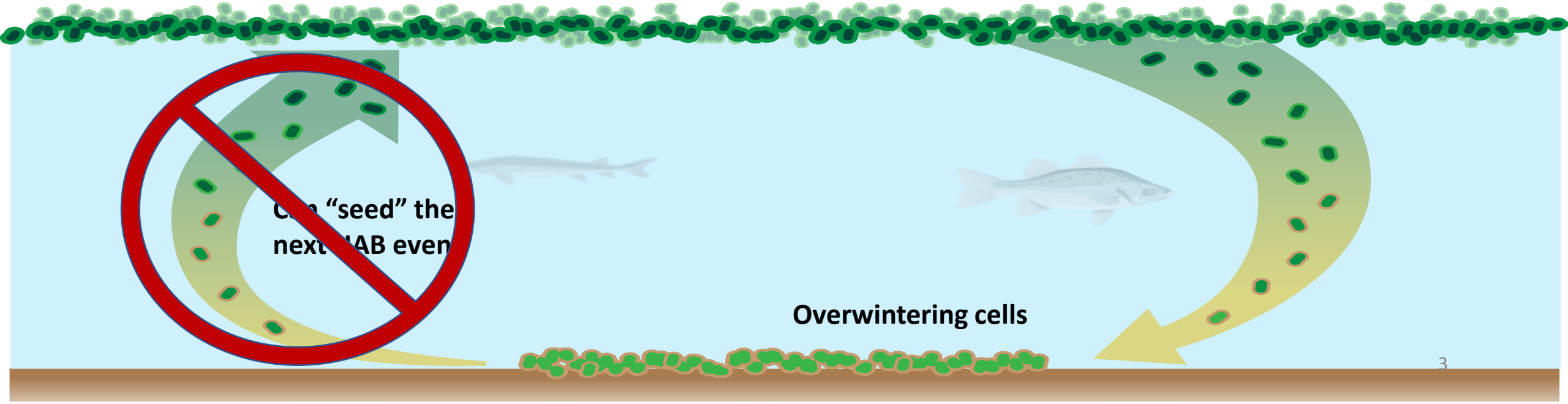
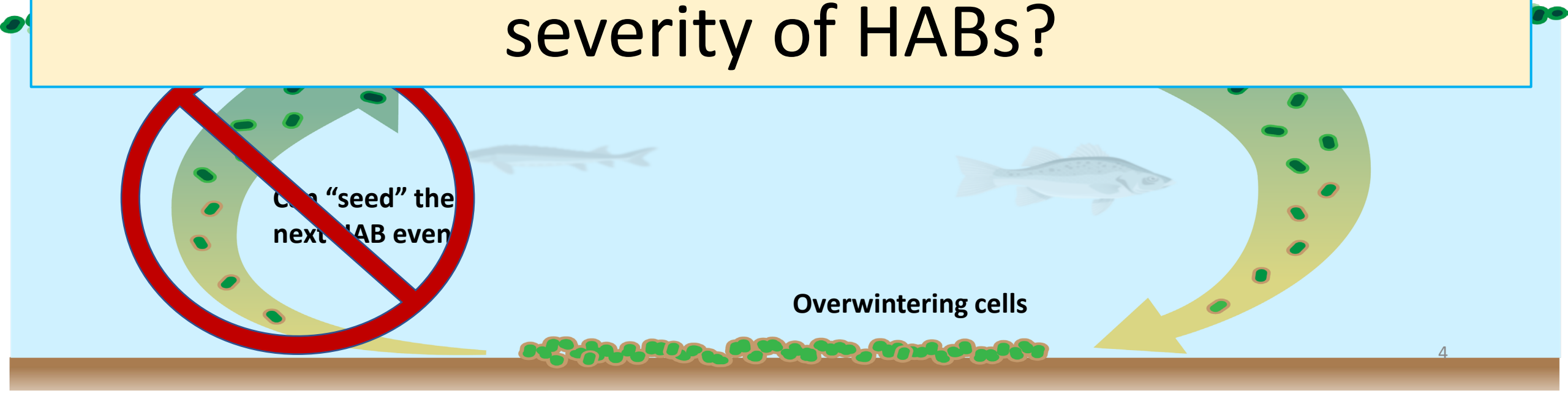


Introduction

Can preventative algaecide treatments applied to overwintering cyanobacteria in sediments delay the onset and decrease the severity of HABs?

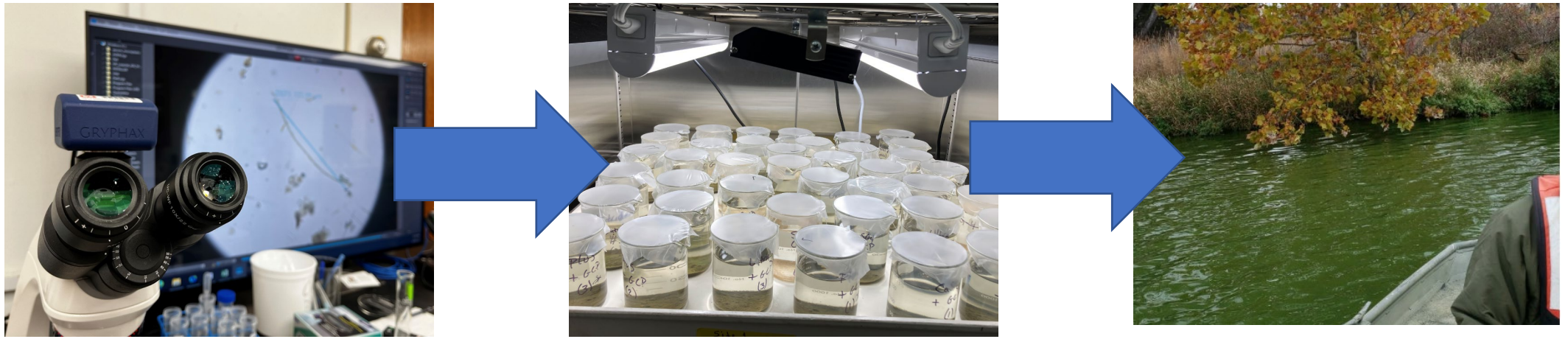


Objectives

1) **Literature review** to identify and inform overwintering cell response measurements and site selection

2) **Bench-scale testing** to evaluate analytical detection methods for overwintering cells and measure responses of cells to candidate algaecide exposures

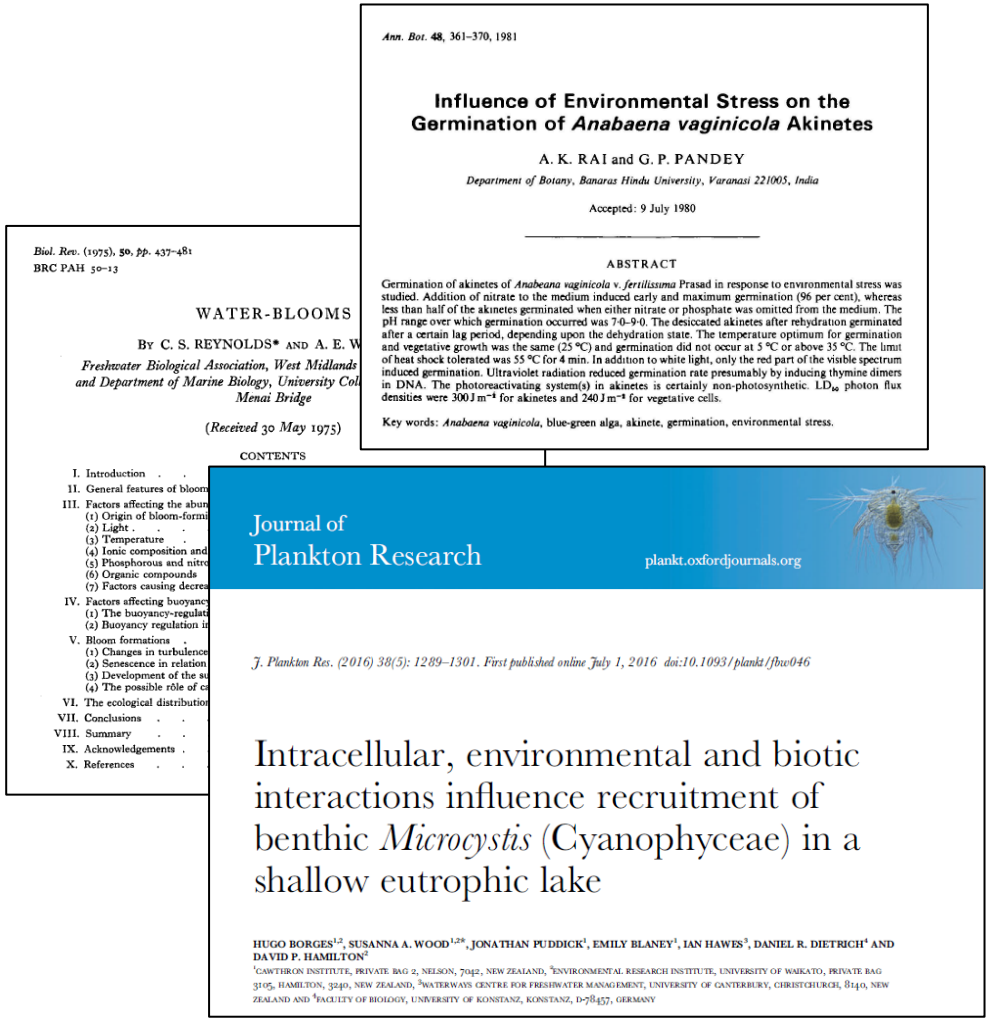
3) **Field site demonstration** of efficacy in location with known HAB history and confirmed overwintering cells in sediments



Methods – Focused Literature Review

Criteria for inclusion of study data

- Unconfounded setting – laboratory and mesocosm
- Akinetes
  - Germination can be identified microscopically by cell emerging from envelope - Could be measured at one point in time
- Vegetative Overwintering Cells
  - Growth measured over time/ multiple points in time
  - Focused on overwintering cells
  - Common HAB producing genera



Ann. Bot. **48**, 361–370, 1981

Influence of Environmental Stress on the Germination of *Anabaena vaginicola* Akinetes

A. K. RAI and G. P. PANDEY

Department of Botany, Banaras Hindu University, Varanasi 221005, India

Accepted: 9 July 1980

ABSTRACT

Germination of akinetes of *Anabaena vaginicola* v. *fertilissima* Prasad in response to environmental stress was studied. Addition of nitrate to the medium induced early and maximum germination (96 per cent), whereas less than half of the akinetes germinated when either nitrate or phosphate was omitted from the medium. The pH range over which germination occurred was 7·0–9·0. The desiccated akinetes after rehydration germinated after a certain lag period, depending upon the dehydration state. The temperature optimum for germination and vegetative growth was the same (25 °C) and germination did not occur at 5 °C or above 35 °C. The limit of heat shock tolerated was 55 °C for 4 min. In addition to white light, only the red part of the visible spectrum induced germination. Ultraviolet radiation reduced germination rate presumably by inducing thymine dimers in DNA. The photoreactivating system(s) in akinetes is certainly non-photosynthetic. LD_{50} photon flux densities were 300 J m^{-2} for akinetes and 240 J m^{-2} for vegetative cells.

Key words: *Anabaena vaginicola*, blue-green alga, akinete, germination, environmental stress.

Biol. Rev. (1975), **50**, *pp.* 437–481
BRC PAH 50–13

WATER-BLOOMS

BY C. S. REYNOLDS* AND A. E. W

Freshwater Biological Association, West Midlands and Department of Marine Biology, University Col Menai Bridge

(*Received* 30 *May* 1975)

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Journal of Plankton Research

plankt.oxfordjournals.org

J. Plankton Res. (2016) 38(5): 1289–1301. First published online July 1, 2016 doi:10.1093/plankt/fbw046

Intracellular, environmental and biotic interactions influence recruitment of benthic *Microcystis* (Cyanophyceae) in a shallow eutrophic lake

HUGO BORGES[1,2], SUSANNA A. WOOD[1,2*], JONATHAN PUDDICK[1], EMILY BLANEY[1], IAN HAWES[3], DANIEL R. DIETRICH[4] AND DAVID P. HAMILTON[2]

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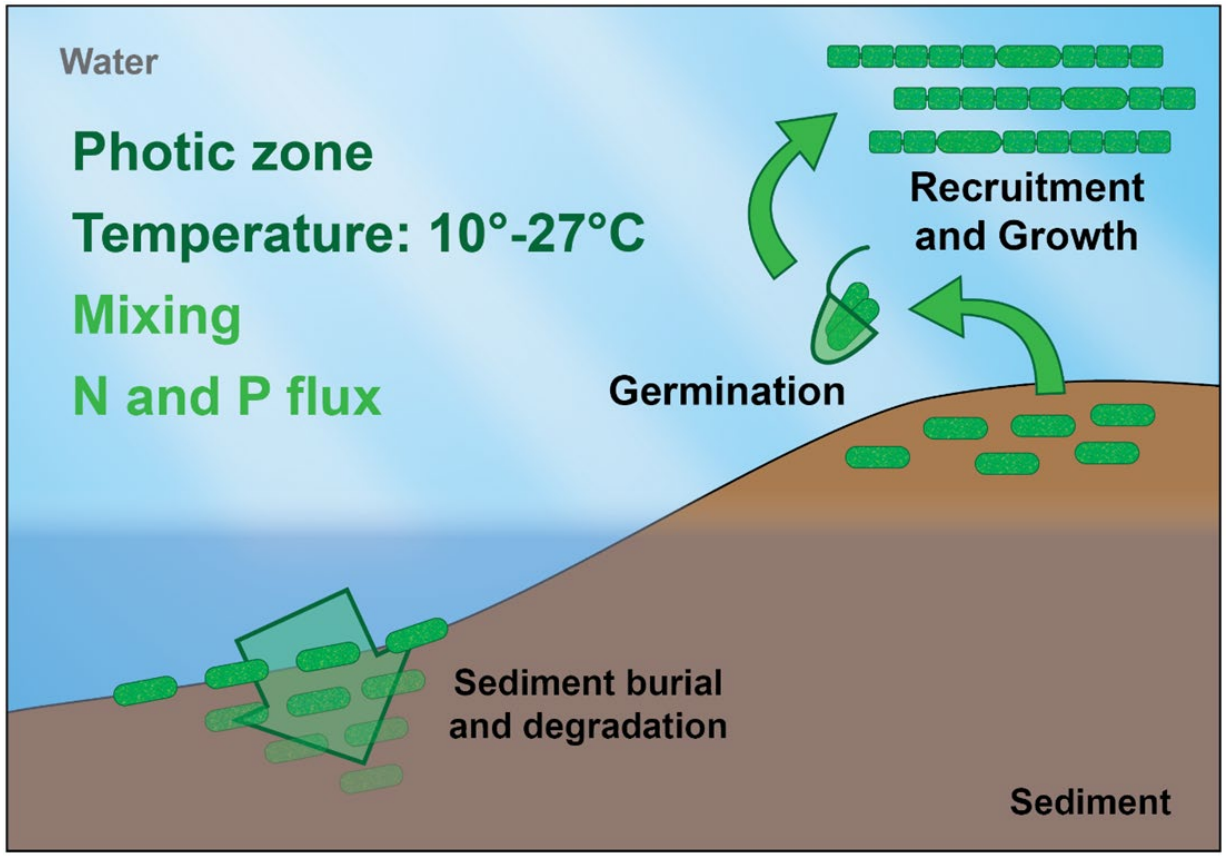
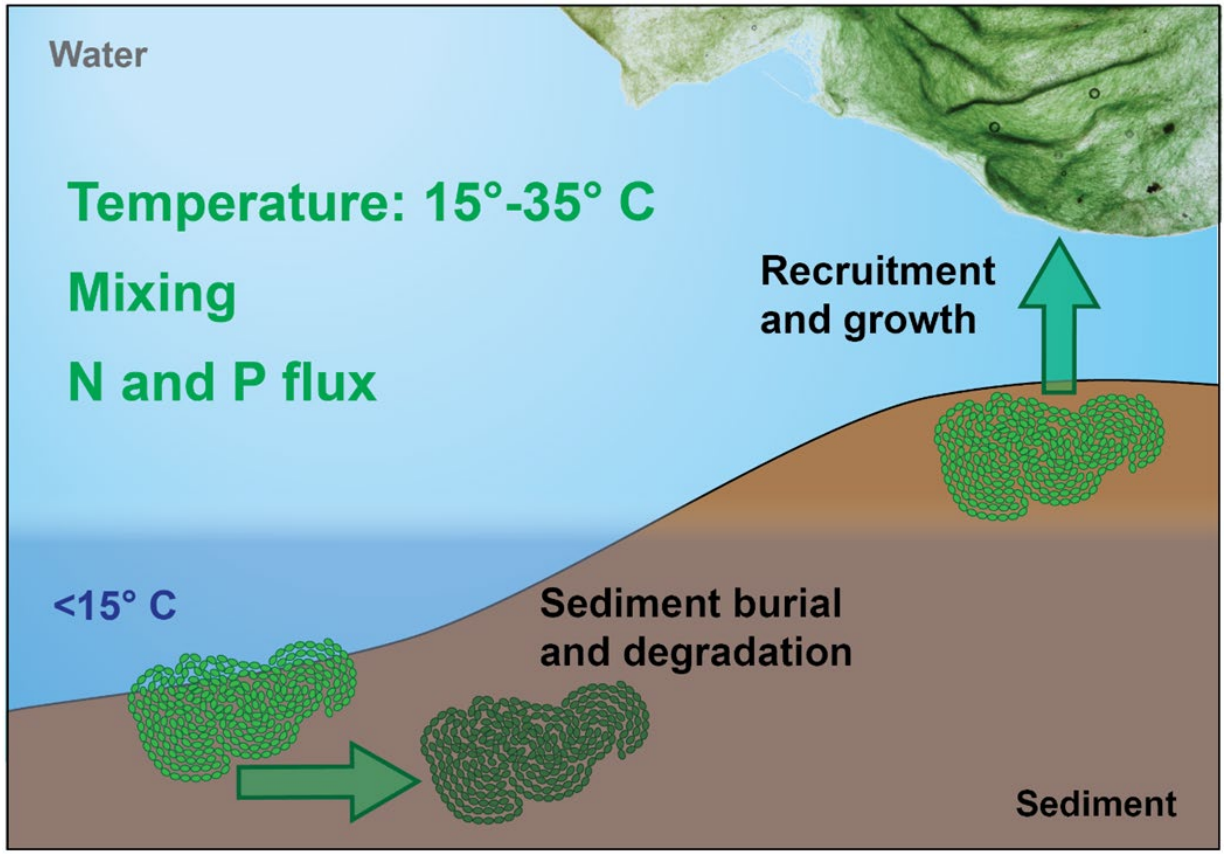
Literature Review for Cell Responses

Akinetes



***Microcystis* Overwintering Cells**

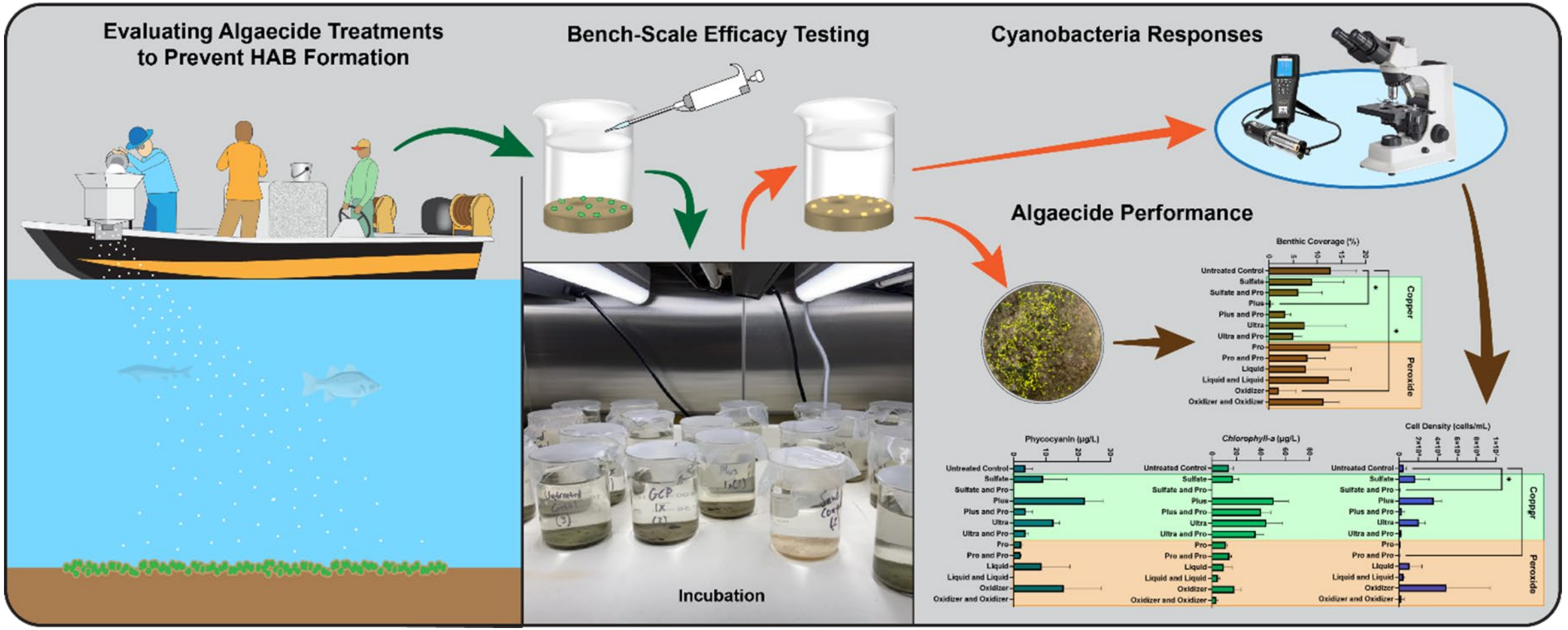


Discussion - Incubation Studies

- **Conducted to determine areas with viable overwintering cells**
  - Pre- and post-management
  - Identify areas with viable overwintering cells in field – potential HAB inoculum

Environmental Condition	Akinetes	*Microcystis* Overwintering Cells
Light	1,200 – 3,000 LUX	Sufficient to support planktonic growth 2,000 – 4,000 LUX
Temperature	10 – 27 ℃	15 – 35 ℃
Water	Filtered site water	
Sediment	Site collected sediment containing overwintering cell	

Bench-scale Efficacy Testing



Methods – Bench-scale Efficacy Testing

- **Algaecide Trials**

1 Algaecide Treatment

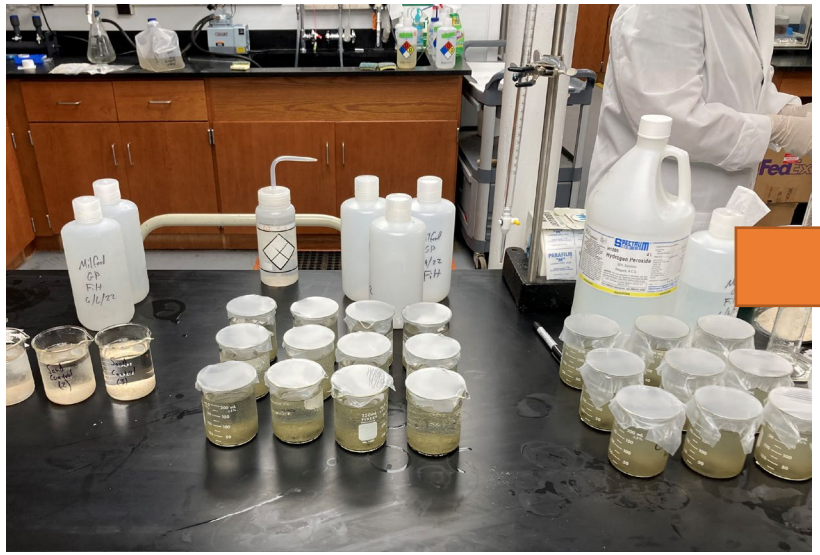
- **12 exposure scenarios total**
- Copper-based (n=3) (1x, 2x)
- Peroxide-based (n=3) (1x, 2x)

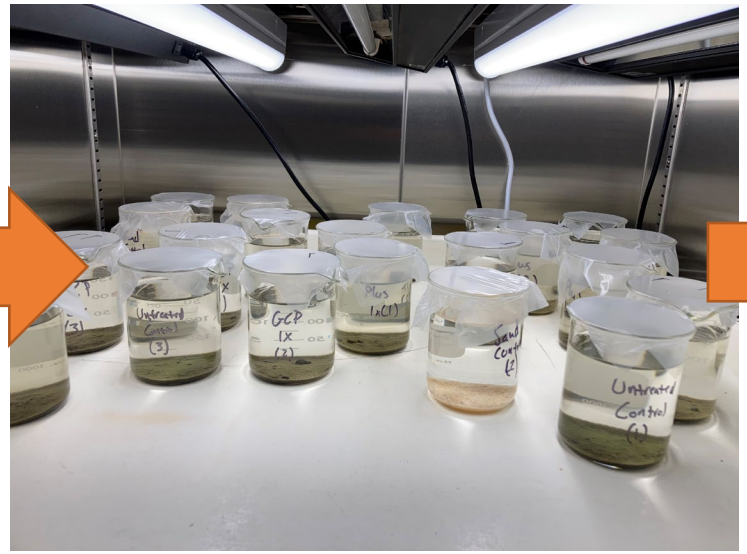
2 Incubation

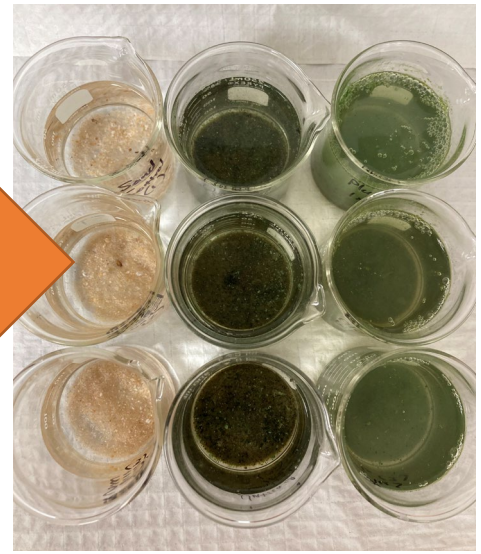
- 14-d duration
- 25° C
- 3,200 LUX

3 Cyanobacteria Responses

- Cell density, pigment,% cover

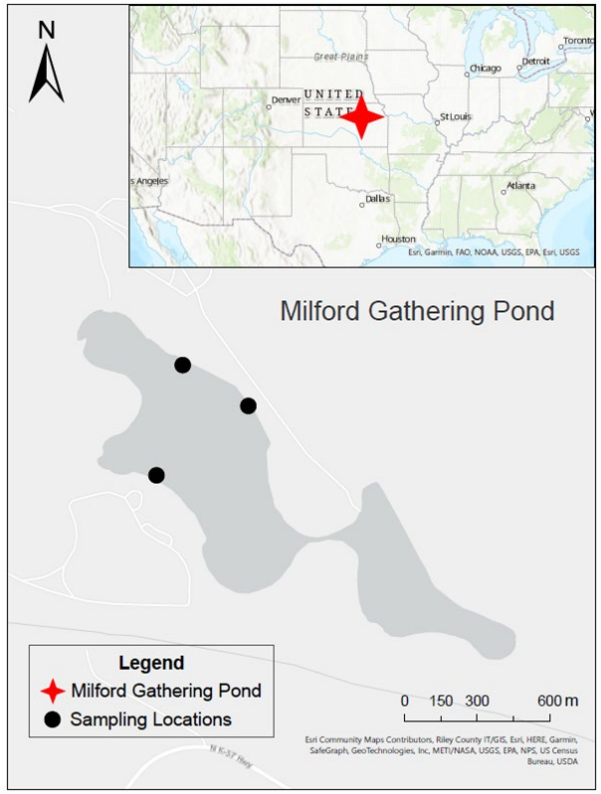






Methods – Bench-scale Efficacy Testing

- **Sediment** collected from **Milford Gathering Pond, KS**
- **400 µg/L microcystin**
- In 2019 **microcystin toxin >50 times over** USEPA recreational ambient water quality criterion (KDHE, 2019; USEPA, 2019)
- **Representative** HAB cyanobacteria across USA
- **Akinetes** and other **overwintering cyanobacteria** in sediments were monitored from 2021 - 2022
  - 58,000 to 327,000 cells/ g wet sediment.

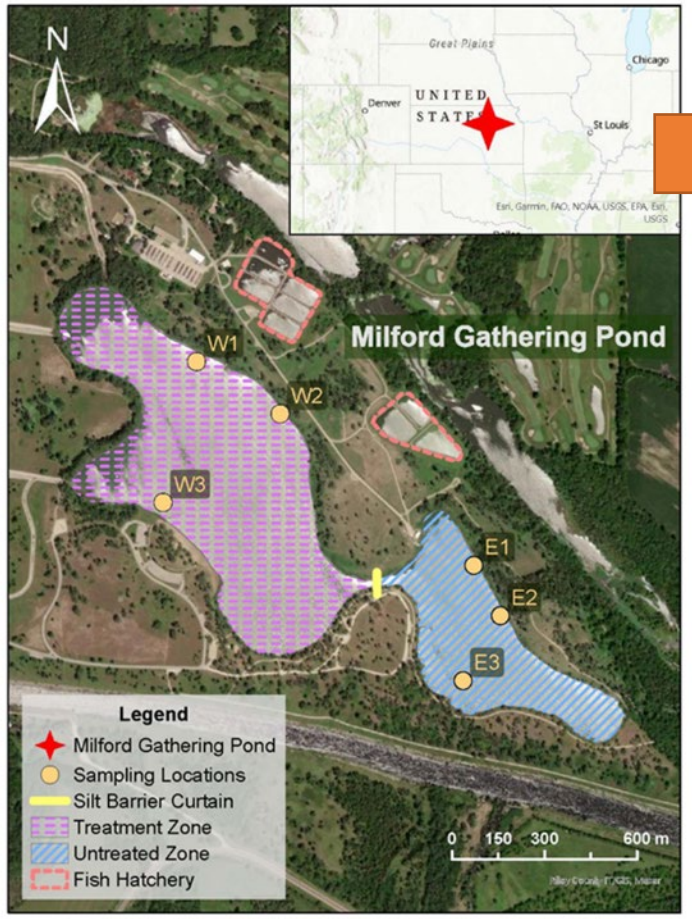


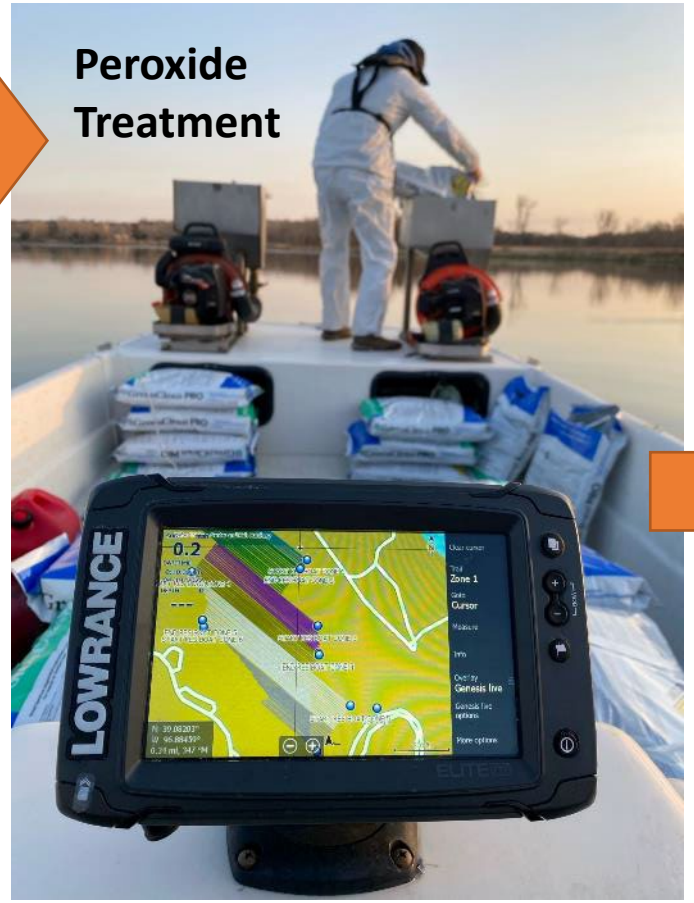
Results – Bench-scale Efficacy Testing

- **Target Algal Assemblage:**
  - *Aphanizomenon, Dolichospermum*, *Microcystis, Nostoc*, and *Planktothrix*
- **Sodium carbonate peroxyhydrate** (PeroxiSolid) most effective algaecide evaluated
- Most effective treatments **copper sulfate+PeroxiSolid and PeroxiSolid applied twice**
- **5 of the 12** treatments **decreased** planktonic **cell density** by **≥ 50%**

Treatments[a]	Percent Control	Response Relative to Untreated Control
CuSulfate + PeroxiSolid	91	Significantly less ($p \leq 0.05$)
PeroxiSolid 2x	91	
PeroxiSolid	72	Greater than 50% decrease[b]
CuAdjuvant + PeroxiSolid	57	
PeroxiLiquid 18%PAA 2x	54	
CuChelated + PeroxiSolid	36	Relatively small decrease[b]
PeroxiLiquid 5%PAA 2x	4	
PeroxiLiquid 5%PAA	-128[c]	Greater cell density[b]
CuSulfate	-246[d]	
CuAdjuvant	-325[d]	
CuChelated	-645[d]	
PeroxiLiquid 18%PAA	-919[c]	

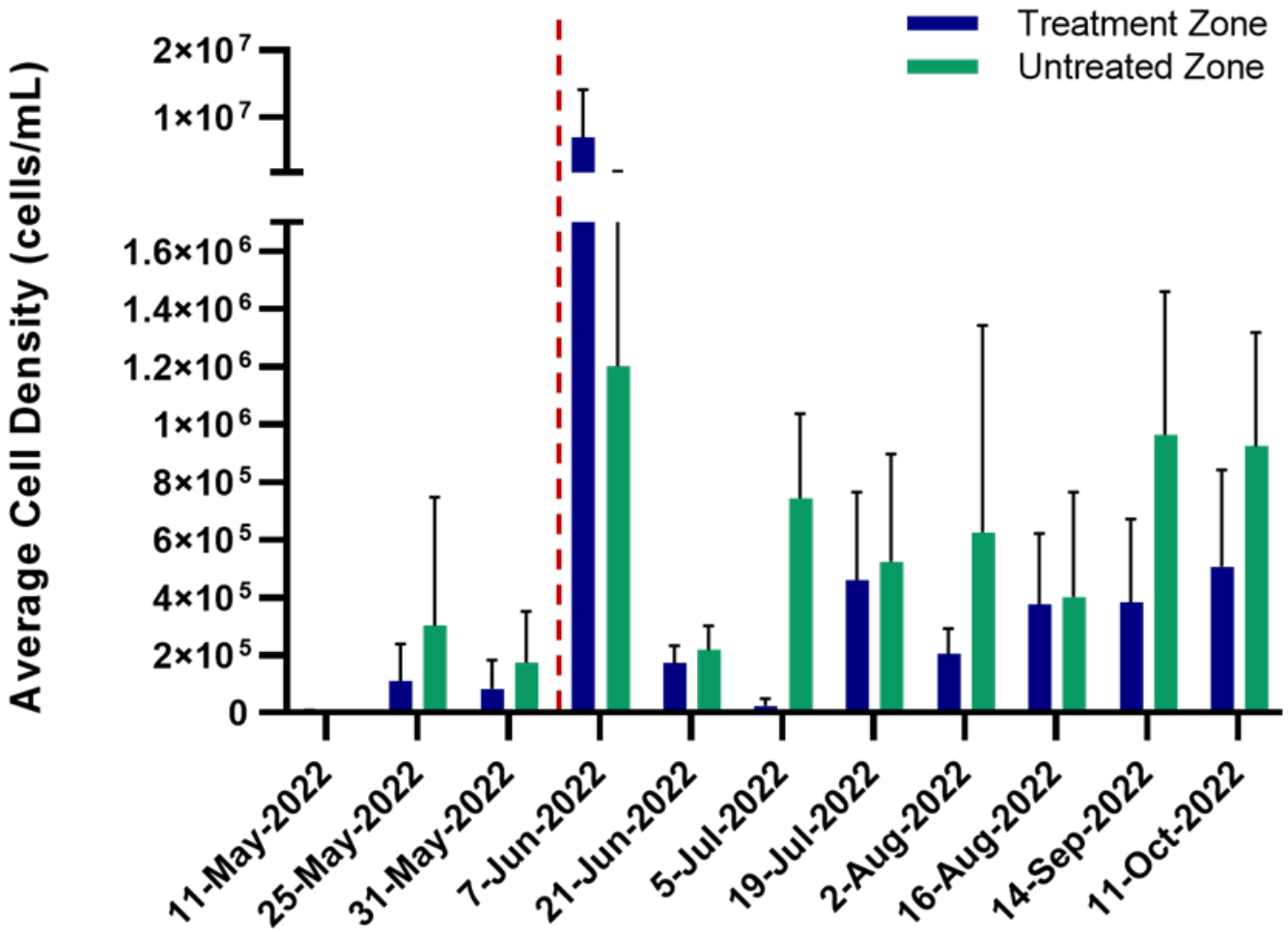
Field Demonstration





Results – Field Demonstration

- **Target Algal Assemblage:** *Dolichospermum*, *Microcystis*, and *Raphidiopsis*
- **9 of 11 (81%) post-treatment timepoints** had lower average **cell densities** (as compared to untreated zone)
- **Initial field evidence** that preventative treatments were effective for decreasing overwintering cell viability



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Results/Takeaways

- Developed methods to **identify candidate sites, inform field treatments** and **measure treatment success**
- **Initial field** evidence that preventative treatments were effective for decreasing overwintering cell viability
- **Second field demonstration** - ongoing

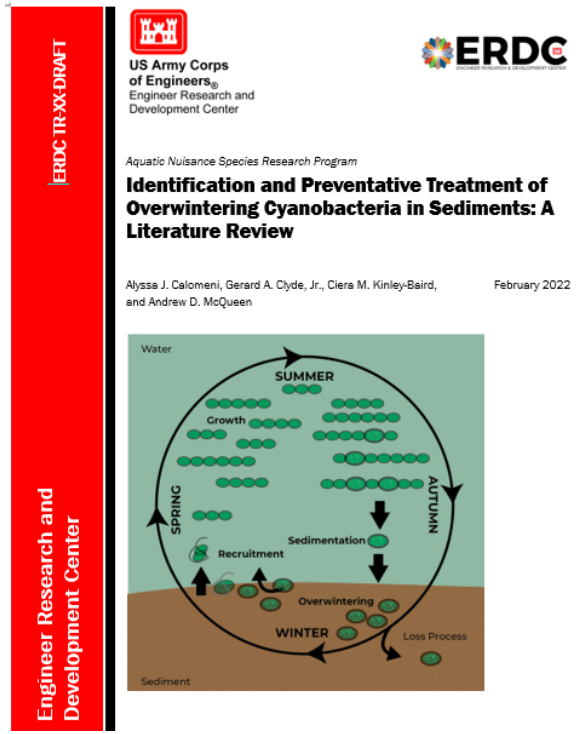
Photo credit: Liz Smith (KDHE)

Resources

➢ **USACE ERDC Technical Report**

➢ **Coming Soon:**

- Identification of Overwintering Cells and Environmental Conditions Causing Germination – *Journal of Applied Ecology*
- Identification and Prioritization of Sites for Targeted Overwintering Cyanobacteria Management: a Preventative Approach – *Journal of Aquatic Plant Management*
- Efficacy of algaecides for the preventative treatment of overwintering cyanobacteria – *Ecotoxicology and Environmental Safety*
- Evaluation of preventative algaecide treatments for cyanobacterial resting cells in sediments of a central USA lake – *Lake and Reservoir Management*



Acknowledgements

- **Research Team**
  - Liz Smith, Katelynn Decker, Benjamin Growcock - Kansas Department of Health and Environment (KDHE)
  - Marvin Boyer – USACE Kansas City District
  - Schad Hampton – Wyandotte County Administration

- **Funding**
  - HAB Congressional Interest
  - USACE Aquatic Nuisance Species Research Program (ANSRP)

Photo credit: Liz Smith (KDHE)

Photo credit: Liz Smith (KDHE)

THANK YOU!

QUESTIONS?

Contact Information

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Research Biologist
USACE ERDC

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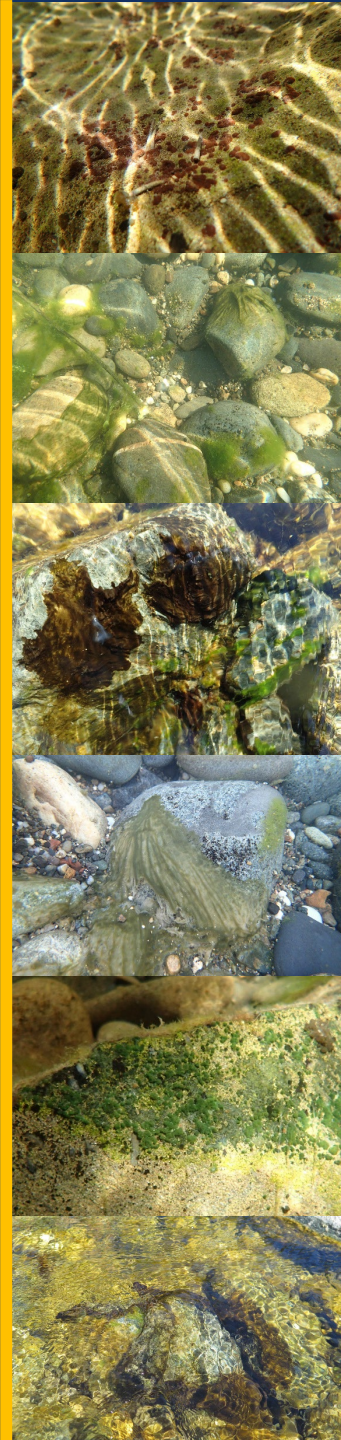
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

ITEM III

GUEST PRESENTATION: A request to reevaluate available benthic monitoring data to inform guidelines for posting benthic cyanobacteria signage to protect public health

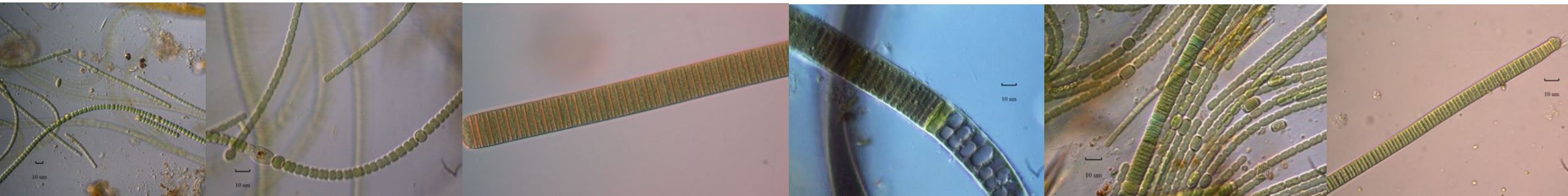
RICH FADNESS, CALIFORNIA STATE WATER RESOURCES CONTROL BOARD



Reconvening CCHAB Benthic HABs Guidance Subcommittee

California Water Boards SWAMP Program: Rich Fadness
California Water Boards FHAB Program: Mike Thomas, Carly Nilson, Marisa Van Dyke

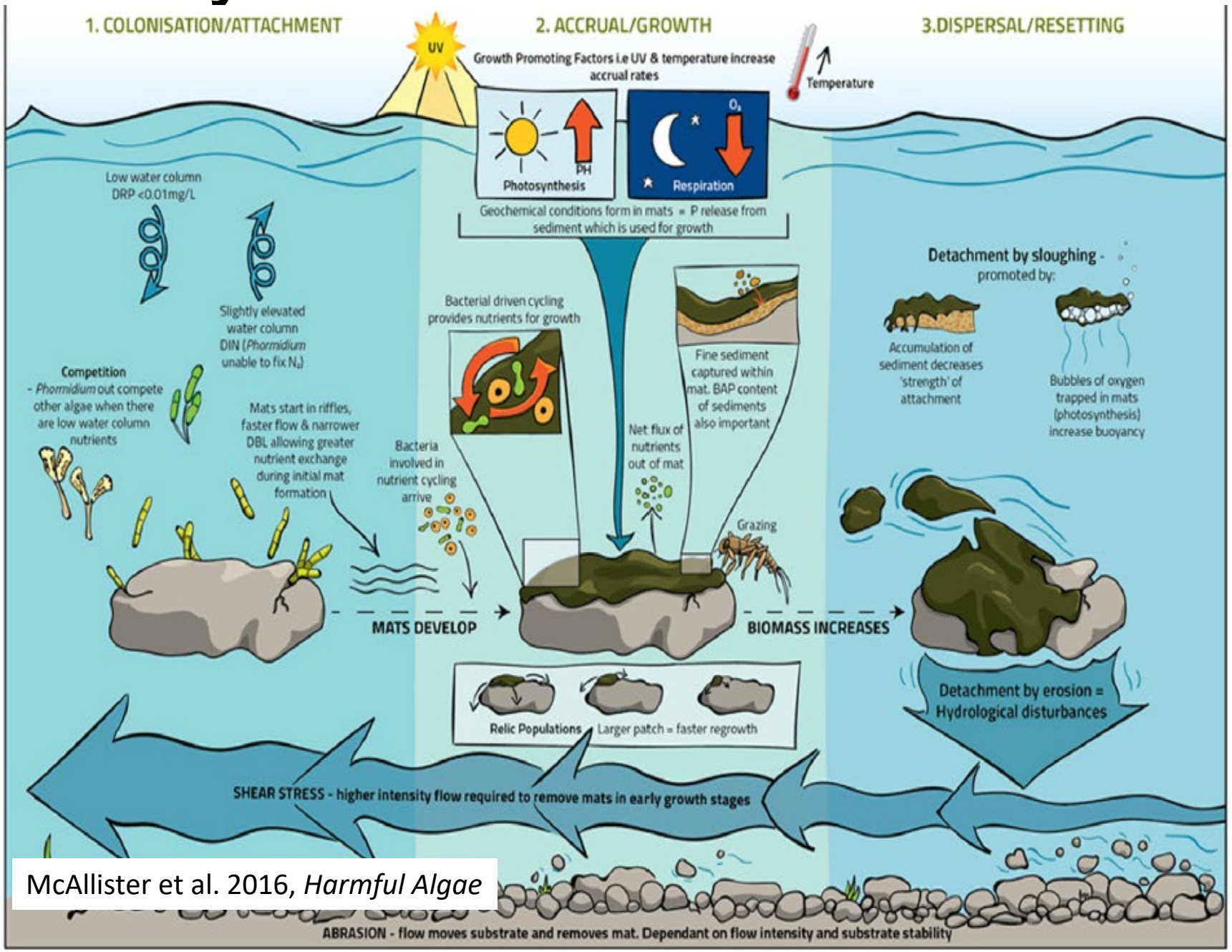
Benthic HABs Discussion Group | April 6, 2023



Outline

- **Convening the CCHAB Network Benthic Guidance Workgroup (2019)**
- Overview of the existing CCHAB Network benthic guidance
- Overview of the North Coast Regional Water Board Program
- Purpose for reconvening the CCHAB Network Benthic Guidance Workgroup (2023)
- Q/A

Life cycle of a benthic mat



McAllister et al. 2016, *Harmful Algae*

Three phases

1. Colonization
2. Growth
3. Detachment / Stranding

Convening the CCHAB Network Benthic Guidance Subcommittee (2019)

- Prior to 2019
  - No criteria, guidance, or signage in existence
  - Planktonic signage was utilized and posting of planktonic signs were based on water column concentrations.
  - In the absence of water concentration data, We used best professional judgement to prompt the local health departments to post signage
  - We petitioned the CCHAB to create a Benthic Guidance Workgroup with the purpose of developing guidance for posting signs aimed at protecting the recreating public.
- In 2020,
  - Developed signs and guidance for postings that were specific to benthic cyanobacteria.

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Advisories - narrative

Considerations

- Children and dogs most at risk
- Focus on primary exposure route, ingestion of mat material
- Challenges of mixed assemblages (algae and cyanos) and patchy distribution
- Little information about impacts of mat toxins on shellfish and fish
- Limited space on the signs

Full written report

CCHAB benthic algal mat signage design

Do NOT let children or adults touch, eat, or swallow any algal mats.

Do NOT let dogs eat algal mats or drink from the water.

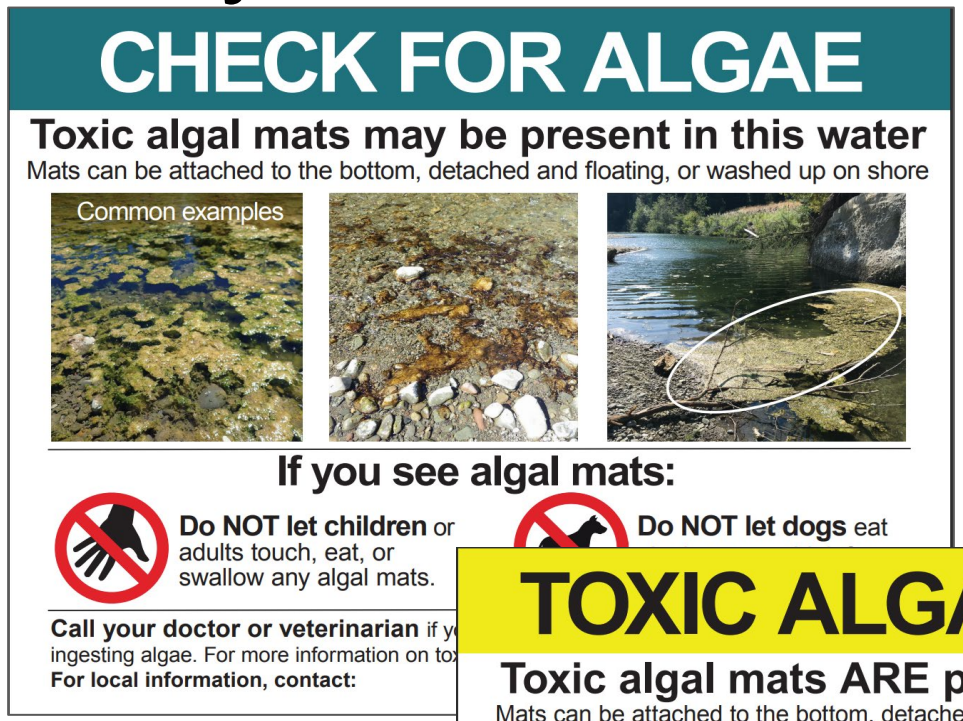
Development of Benthic Cyanobacteria Signage

2 Signs:

- **General Awareness**
- **Trigger Level Sign**

Sign objectives

1. inform people that benthic algal mats may be or are present,
2. provide them with information for how to identify algal mats, and
3. advise people on preventative practices to reduce the risk of exposure to algal mats (advisories).



Postings

General awareness sign

- **Purpose:** to post at waterbodies where benthic mats may be an issue
- **Trigger level:** none
- Can be used seasonally or year round
- Planktonic signage includes similar sign type
- Can be placed with CCHAB planktonic signs
- **De-posting:** N/A see above

Guidance document and flow-chart available on CA HABs Portal

Trigger level sign (advisory)

- **Purpose:** to post at waterbodies where benthic mats are confirmed
- **Trigger level:** visual confirmation of potentially toxigenic benthic mats OR detection of cyanotoxins within mat material (not overlying water).
- **De-posting:** when visual indicators are gone
- Can be placed alongside General Awareness signs

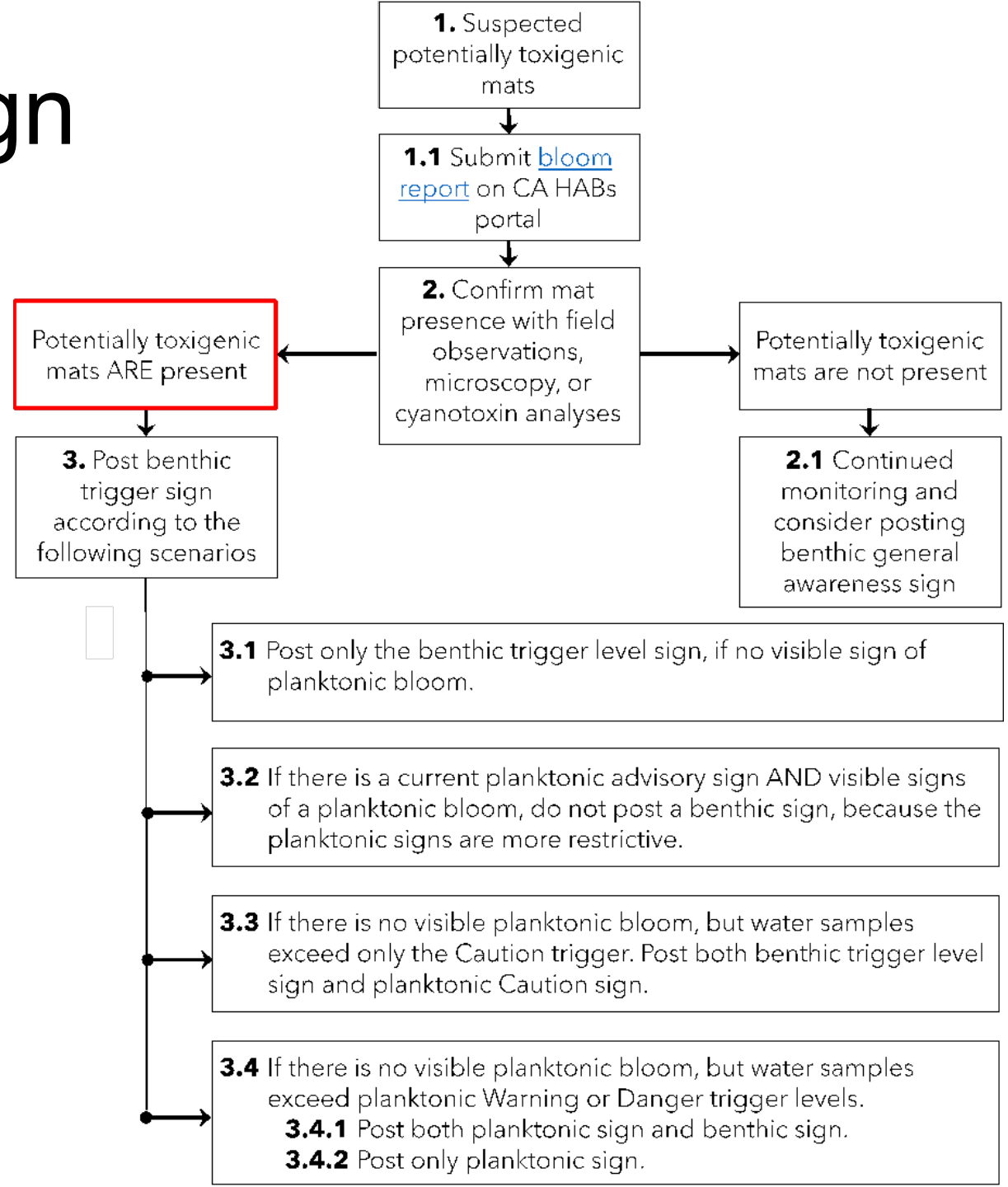
Trigger for advisory sign

Excerpt for Guidance

- *There are two triggers for posting this sign, 1) presence of potentially toxigenic benthic mats, floating mat material, **or** stranded mats on the shoreline at a site, or 2) detection of cyanotoxins or cyanotoxin genes within mat material.*
- *Either trigger can result in a signage posting and this sign does not require cyanotoxin detections prior to posting*

Documented concerns with triggers

- SPATT deployments with toxin detection trigger posting
- No consistent procedure to collect algal mats for toxin testing (grab vs. composite)
- Trigger sign alarming messaging compared to planktonic equivalent sign
- Consider incorporating spatial coverage survey and trigger level
- Consider toxin concentration trigger level



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North Coast Regional Water Board

Benthic Research and Public Health Monitoring

- The Regional Board has researched benthic HABs since 2016 and developed two reports in 2022:
  - *Benthic Cyanobacteria and Cyanotoxin Monitoring in Northern CA Rivers, 2016-2019*
  - *Cyanotoxin Monitoring with SPATT Passive Samplers in Northern CA Rivers, 2019*
- The Regional Board previously presented to the Benthic HABs Discussion Group on portions of this work in 2018 and on multiple occasions to the California CyanoHAB (CCHAB) network.
- Key Findings:
  - Toxigenic cyanobacteria of concern in northern California rivers
  - Temporal growth pattern of cyanobacteria in these systems
  - Using SPATTs as sentinel screening tools for cyanotoxins
  - Mostly no detections in discrete water grab samples
  - Appropriate use and deployment lengths for SPATTs

Tiered Monitoring in Northern California Rivers

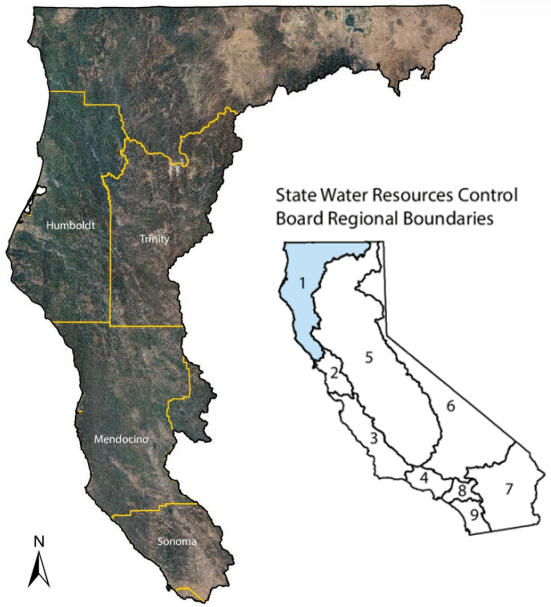
- Tiered monitoring recommendations from report findings:
  1) Deploy SPATTs to document when cyanotoxins are increasing in the system.
  2) When cyanotoxins increase in SPATTs, conduct visual assessments to confirm toxic mat-forming cyanobacteria are present.
  3) Conduct algal mat sampling to confirm toxicity of mat-forming cyanobacteria.
- SPATT trends provide more "qualitative" information on benthic cyanobacteria biomass and toxicity
- Visual observations and/or toxin testing of algal mats will trigger postings
- SPATT monitoring is not included in the current Posting Guidelines for Benthic Mat Signs

Outline

- Convening the CCHAB Network Benthic Guidance Workgroup (2019)
- Overview of the existing CCHAB Network benthic guidance
- Overview of the North Coast Regional Water Board Program
- **Purpose for reconvening the CCHAB Network Benthic Guidance Workgroup (2023)**
- Q/A

Purpose of Reconvening the CCHAB Network Benthic Guidance Subcommittee (2023)

- Public and partner feedback received in the North Coast Region:
  - Sign fatigue and public distrust due to over-posting
  - Economic impacts to local communities and businesses
  - Strained relationships with local partners
- Implement research findings in the North Coast Region and incorporate SPATTs as screening tool in the *Posting Guidelines for Benthic Mat Signs*
- Present findings to CCHAB Network and collaborate with the group to determine if an update to the *Guidelines* would be warranted



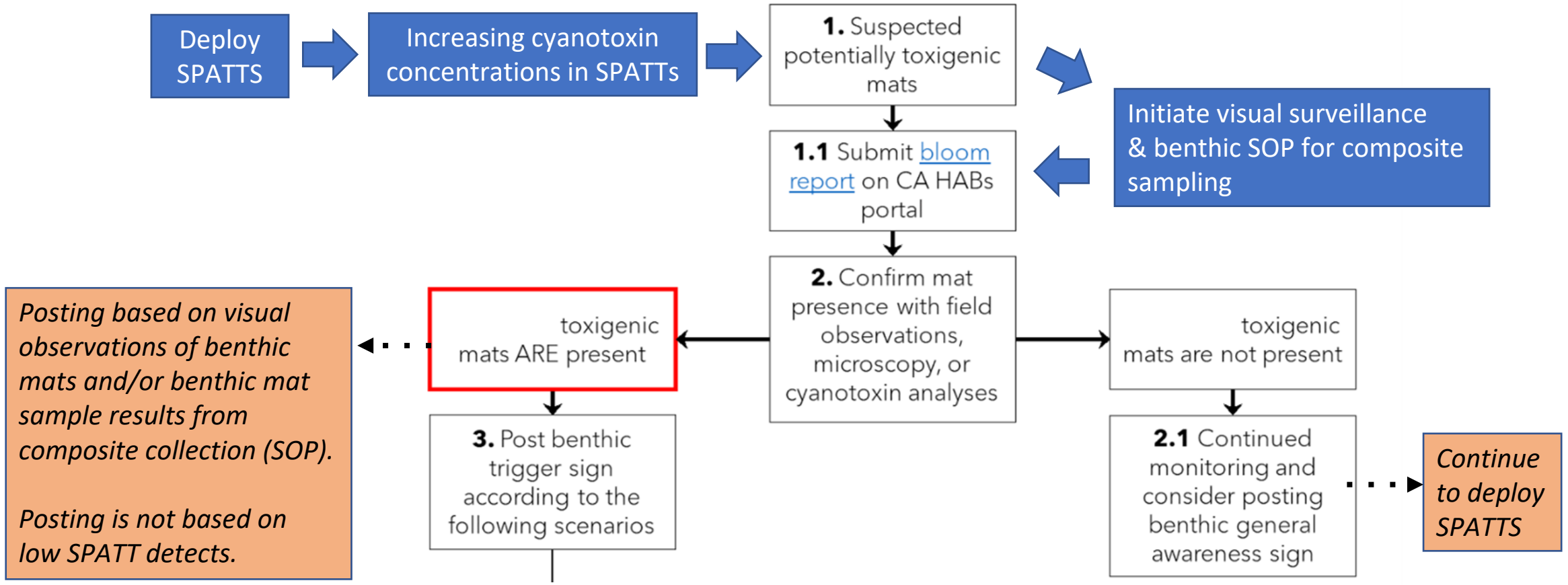
Timelines

- First meeting to review North Coast Regional Waterboard's Monitoring Plan
- Monthly workgroup meetings - October 2023-Spring 2024
- Review data and develop revised guidance as applicable for CCHAB Network to review
- Finalized revised guidance for adoption by CCHAB Network - ~March 2024

Questions?

Thank you

Incorporating North Coast Region Recommendations into the Current Benthic Guidance



THANKS FOR ATTENDING TODAY'S MEETING!