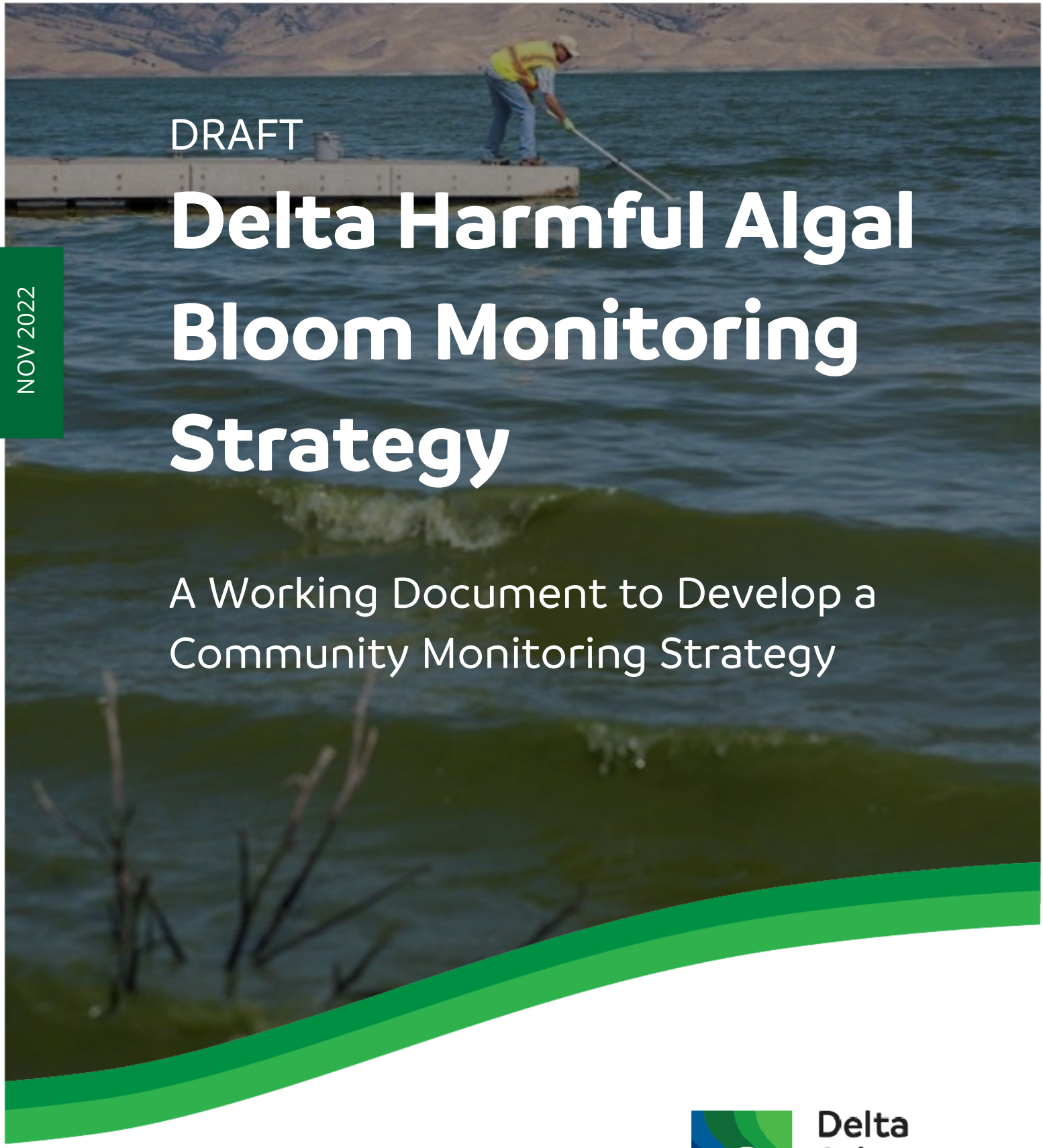

DRAFT

Delta Harmful Algal Bloom Monitoring Strategy

NOV 2022

A Working Document to Develop a Community Monitoring Strategy

Delta Science Program
DELTA STEWARDSHIP COUNCIL

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Introduction

Harmful algal bloom (HAB) monitoring efforts and targeted studies are growing in number and scope in the Sacramento-San Joaquin Delta (Delta), along with concerns that blooms will increase in frequency and severity. With the increased scientific and public attention to the issue, a need for increased coordination amongst the many groups that work on HABs in the Delta has been identified by scientists and managers alike. The intent of this monitoring strategy is to identify nexuses where HAB monitoring and other routine data collection can be optimized.

HABs and their associated toxins are increasingly a problem in the Delta and are expected to become more prevalent with climate change impacts fueling the conditions (e.g., low water flow, increased water temperatures) that lead to blooms. Toxins from HABs can harm aquatic life and humans and impact the water bodies California relies on for industry, drinking water, and recreational purposes. For more information see the HABs in the Delta document developed for the November 2022 Delta Science Program's Delta HAB Monitoring Workshop or visit https://mywaterquality.ca.gov/habs/what/index.html. For the purposes of this document, we will primarily focus on cyanobacterial HABs or cyanoHABs, which are the most prevalent HAB for the Delta.

Management Questions

The intent of this document is to provide a foundation that could be used to design a Delta HAB monitoring program. This strategy is not a monitoring program and does not have funding associated with it. However, it provides community-developed priorities for data collection to inform management questions. These management questions were developed by the workshop planning committee but support the implementation of Assembly Bill (AB) 834 (leginfo.legislature.ca.gov/) to protect water quality and public health from HABs and the Water Resilience Portfolio Action 8.1 (resources.ca.gov/) that calls for implementation of AB 834. This workshop will also support Science Action Agenda (scienceactionagenda.deltacouncil.ca.gov/) Science Action 2B "Develop a framework for monitoring, modeling, and information dissemination in support of operational forecasting and near real-time visualization of the extent, toxicity, and health impacts of HABs" and Science Action 5C "Determine how environmental drivers (e.g., nutrients, temperatures, water residence time) interact to cause HABs in the

Delta, identify impacts on human and ecosystem health and well-being and test possible mitigation strategies".

Primary Management Question

How can HAB monitoring efforts be collaboratively designed, facilitated, integrated, performed, and/or standardized to achieve status-and-trend monitoring objectives, and to fit the scale of management actions, timing of ecosystem processes, and climate change challenges?

- **Status** refers to the spatial extent of HABs and the magnitude/intensity of HABs
- **Trends** refers to the temporal extent of HABs both short term and long term to answer are the conditions improving or worsening
- What are the drivers of HABs in distinct areas of the Delta to inform management actions?

Collaboration

1. How will the HABs strategy communicate/link with existing strategies and efforts in the Delta?
2. What are the existing barriers to collaboration/cooperation and how can we overcome them?
3. How should safety/health risks for human and domestic animals be communicated?

Data Sharing

1. How can relevant HAB data be made accessible and available?
2. How can current barriers to data storage and access be overcome to support a comprehensive monitoring program?

Not Covered by this Strategy

This strategy is focused on the most pressing first steps in achieving consistent data collection to evaluate HABs drivers in the Delta. As such, this strategy does not cover:

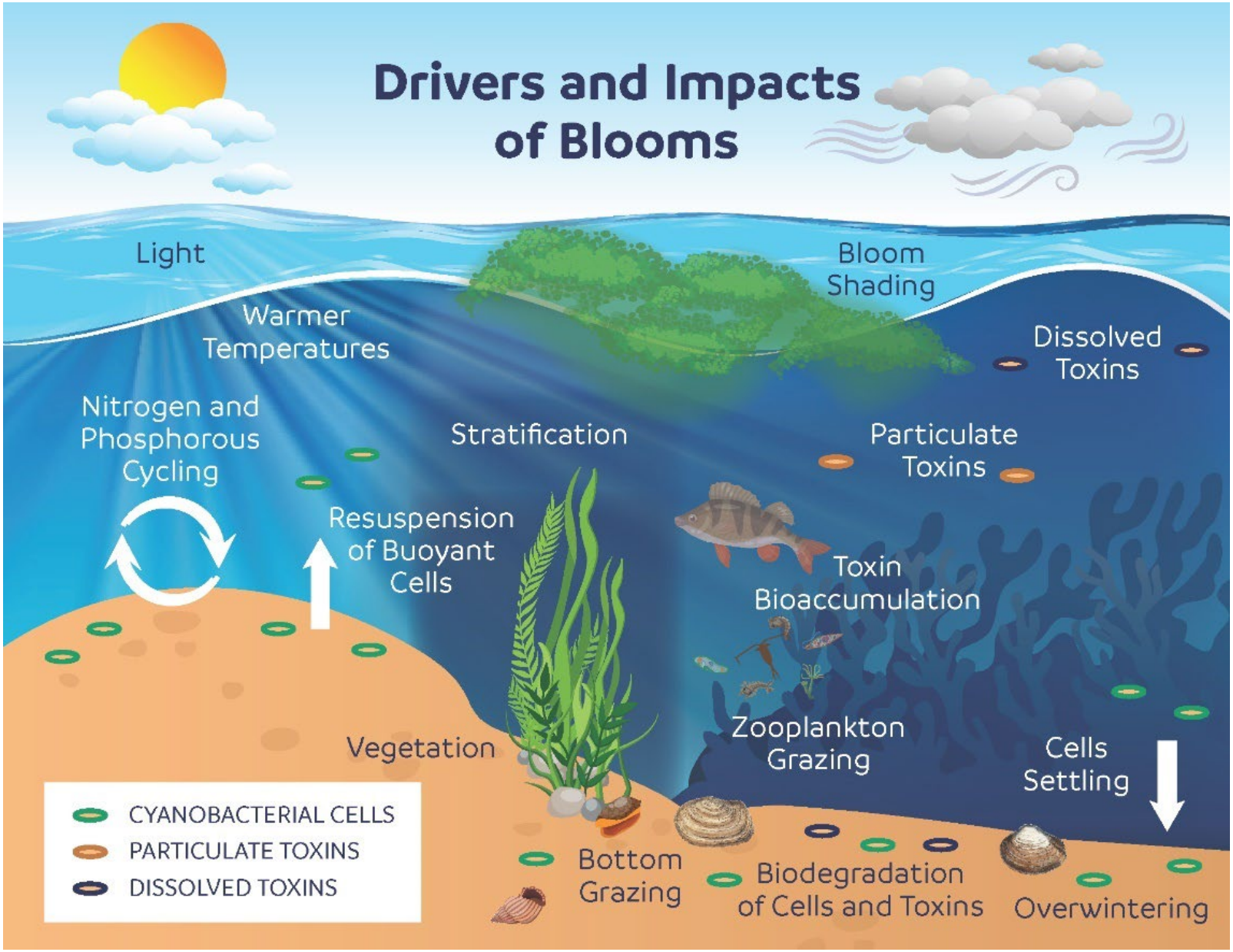
- Informing the development of thresholds of HAB toxins on drinking water or human food sources like fish,
- Impacts of HAB-contaminated water on in-Delta agriculture,

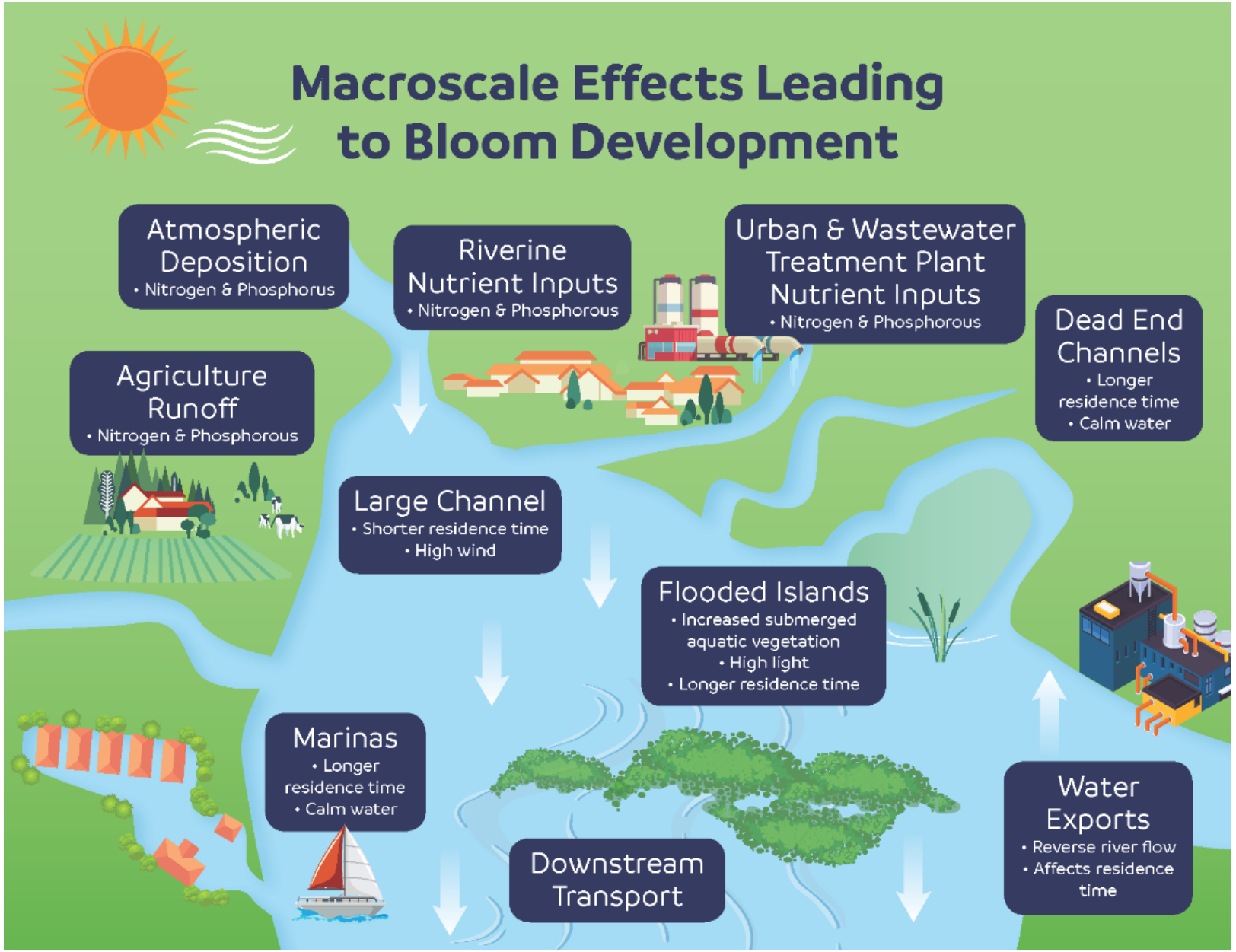
- Marine HABs,
- The impacts of HABs on food web dynamics, and
- Public health epidemiology as a result of acute or chronic HAB exposure.

However, we recognize that these research areas are very important for understanding HABs impacts on communities and call for future work beyond the 3–5-year horizon of this strategy that addresses these knowledge gaps after initial coordinated HABs monitoring has been established.

Drivers

Many drivers and impacts of HABs have been identified in the Delta (see Kudela et al., in press), and are illustrated in the following conceptual models:


Drivers and Impacts of Blooms
Light
Warmer Temperatures
Bloom Shading
Dissolved Toxins
Nitrogen and Phosphorous Cycling
Stratification
Particulate Toxins
Resuspension of Buoyant Cells
Toxin Bioaccumulation
Zooplankton Grazing
Vegetation
Cells Settling
CYANOBACTERIAL CELLS
PARTICULATE TOXINS
DISSOLVED TOXINS
Bottom Grazing
Biodegradation of Cells and Toxins
Overwintering


Macroscale Effects Leading to Bloom Development
Atmospheric Deposition
• Nitrogen & Phosphorus
Riverine Nutrient Inputs
• Nitrogen & Phosphorous
Urban & Wastewater Treatment Plant Nutrient Inputs
• Nitrogen & Phosphorous
Dead End Channels
• Longer residence time
• Calm water
Agriculture Runoff
• Nitrogen & Phosphorous
Large Channel
• Shorter residence time
• High wind
Flooded Islands
• Increased submerged aquatic vegetation
• High light
• Longer residence time
Marinas
• Longer residence time
• Calm water
Downstream Transport
Water Exports
• Reverse river flow
• Affects residence time

Risks

Human exposure to HABs often occurs through contact with contaminated water such as when recreating in waterbodies where a bloom has occurred. Additional areas of potential public health risks include consumption of fish taken from waterbodies with HABs, drinking contaminated water, or exposure to aerosolized toxins. These exposure pathways can disproportionately impact subsistence fishing communities and the carrying out of traditional rituals in tribal communities. Recurring HABs have detrimental effects on recreation, the local economy, and communities relying on tourism. Pets and livestock can also suffer lethal or sublethal effects when they come in contact with a contaminated water body. See HABs in the Delta informational sheet for more detail.

Monitoring

Cyanobacteria and algae can be detected by satellites and other remote sensing instruments because they contain pigments (e.g., chlorophyll-*a*) that interact with light. Algorithms use the color of water to estimate the density of cyanobacteria or chlorophyll-a in a water body. Remotely sensed data from satellites covers large spatial extents that would be impractical to sample using field-based methods. However, limitations of satellites include an inability to collect data through clouds, reduced accuracy during certain other atmospheric conditions, and pixel size and data frequency that may not meet all monitoring needs.

Discrete

Discrete sampling for potential indicators for HAB development as well as for harmful algae and toxins is carried out by state and federal agencies, community-based organizations, and academic researchers. See the Surface Water Ambient Monitoring Program's standard operating procedures for more information.

Continuous

Continuous, real-time sampling for water quality parameters including temperature, salinity, dissolved oxygen, and chlorophyll occurs at a variety of locations across the Delta. The maps here show where certain water quality parameters are collected and could be monitored for indication of HAB development.

Workshop Focus Areas

Workshop Day 1 – Creating a Coordinated Partner Monitoring Strategy

Coordination must be established across Delta programs and integrate with other strategies and efforts. For a list of other entities working in HABs in the Delta, please see the Delta HABs Monitoring information sheet developed for the workshop. Day 1 of the workshop will facilitate discussions on creating a coordinated partner monitoring strategy.

Workshop Day 2 – Data Sharing and Integration

Day 2 of the workshop will expand the discussion surrounding data collection, accessibility, and hosting.

Next Steps

Information gleaned from the workshop will be incorporated into a complete Delta HABs Monitoring Strategy and will provide recommendations based on experiences shared through the workshop. Expected release of the strategy is spring 2023.

References

Howard, M. D. A., Smith, J., Caron, D. A., Kudela, R. M., Loftin, K., Hayashi, K., Fadness, R., Fricke, S., Kann, J., Roethler, M., Tatters, A., Theroux, S. 2022. Integrative monitoring strategy for marine and freshwater harmful algal blooms and toxins across the freshwater-to-marine continuum. Integrated Environmental Assessment & Management, doi: 10.1002/ieam.4651.

Kudela, R.M., Howard, M.D.A., Monismith, S., Paerl, H. In Press. Status, trends, and drivers of harmful algal blooms along the freshwater to marine gradient in the San Francisco Bay Delta system. San Francisco Estuary and Watershed Sciences.

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