Preventative Measures for Cyanobacterial HABs in Surface Water

Preventative measures are the preferred approach to managing the occurrence of cyanobacterial blooms. The most effective preventative measures are those that seek to control anthropogenic influences that promote blooms such as the leaching and runoff of excess nutrients. Management practices for nutrients, specifically nitrogen and phosphorus, should have the goal of reducing loadings from both point and nonpoint sources, including water treatment discharges, agricultural runoff, and stormwater runoff. Devices that result in the mixing of lakes (for example, by air bubbling) enhance vertical mixing of the phytoplankton, which minimizes the formation of surface blooms of buoyant cyanobacteria. Also, increasing the water flow through lakes or estuaries reduces water residence time and inhibits cyanobacteria blooms; however, these efforts can be expensive and are best suited to small affected water bodies.

Various preventive measures target external nutrient input from point sources (which may include discharges from municipal and industrial wastewater treatment plants, concentrated animal feeding operations (CAFOs), Municipal Separate Storm Sewer Systems (MS4s), stormwater associated with industrial activity, and other) and non-point sources (which may include diffuse runoff from agricultural fields, roads and stormwater). In addition to external sources, nutrients exist internally within the sediment layer and cycle through the water column periodically (internal loading) to contribute towards the formation of HABs.

The table provides a summary of common measures to prevent HABs in surface waters.

DISCLAIMER: U.S. EPA does not endorse any of the measures presented on this page.

Waterbody Management Measure to Prevent HABs Example link	Description	Benefits	Limitations
Biological Measures			

Waterbody Management Measure to Prevent HABs Example link	**Description**	**Benefits**	**Limitations**
Floating Treatment Wetlands (FTW) <https://www.floatingislandinternational.com/>	Consists of emergent wetland plants growing on floating mats on the water's surface. The plant's roots provide enough surface area to filter and trap nutrients. FTWs also encourage biofilm processes that reduce cyanobacteria levels. Periodic harvesting of mature plants is conducted to prevent stored nutrients from re-entering the aquatic ecosystem, mitigating risk of HABs by keeping nutrient levels in balance.	Assimilates nutrients and encourages particle adsorption. Covered surface area minimizes light penetration and limits opportunity for algae growth. Able to tolerate fluctuations in water depth. Utilizes natural processes with minimal technical attention required.	Often dependent upon the amount of input (i.e., the number of plants and mats). Excessive coverage can lead to de-oxygenation of the water. Plants only have access to nutrients in the water column and not ones in sediment.

Waterbody Management Measure to Prevent HABs Example link	Description	Benefits	Limitations
Riparian Vegetation	Vegetated zones (trees, shrubs, and other plants) adjacent to surface waters serve as a buffer between the water and point/non-point sources of pollution.	Intercept nutrients and other pollutants from entering surface waters. Provides shade from sunlight, which helps to reduce higher temperatures that can cause HABs. Long-term sustainability. Little maintenance and upkeep once installed.	Feasibility and effectiveness largely depend on geographic characteristics of water body and surrounding land mass.
Physical Measures			

Waterbody Management Measure to Prevent HABs Example link	Description	Benefits	Limitations
Aeration <https://www.midmichiganponds.com/pages/pond-management>	Aerators pump air throughout the water column to disrupt stratification. Many operate by pumping air through a diffuser near the bottom of the water body, resulting in the formation of plumes that rise to the surface and create vertical circulation cells as they propagate outwards from the aerator.	Limits the accessibility of nutrients to the surface. Disrupts the behavior of cyanobacteria to migrate vertically. Reduces competitive advantage of cyanobacteria by maintaining healthy levels of dissolved oxygen.	Individual devices have limited range; areas further away may remain stratified and provide a suitable environment for growth. De-stratification of the water column may harm aquatic habitats that rely on colder bottom temperatures.

Waterbody Management Measure to Prevent HABs Example link	**Description**	**Benefits**	**Limitations**
Mechanical Circulation	Mechanical circulators operate by pumping water from the surface layer downwards or draw water up from the bottom to the surface layer. Similar to aerators, mechanical mixers interfere with stratification of the water column, intercepting conditions ideal for HABs to occur.	Limits the accessibility of nutrients to the surface. Disrupts the behavior of cyanobacteria to migrate vertically. Reduces competitive advantage of cyanobacteria by maintaining healthy levels of dissolved oxygen.	Individual devices have limited range; areas further away may remain stratified and provide a suitable environment for growth. Certain algae prefer an unstable environment and are benefitted by circulation.
Hypolimnetic Oxygenation <https://www.tandfonline.com/doi/abs/10.1080/07438149909354124>	To increase oxygen concentrations in the hypolimnion layer. Mechanisms include submerged oxygen chambers, side stream oxygenation and direct oxygen injection.	High oxygen delivery rates reduce potential for sediment to release nutrients. Minimizes impact to hypolimnion by maintaining water column structure and temperature (thermocline, pycnocline, etc.).	Techniques are relatively expensive. Requires a significant understanding of system in order to operate.

Waterbody Management Measure to Prevent HABs Example link	Description	Benefits	Limitations
Chemical Measures			

Waterbody Management Measure to Prevent HABs Example link	**Description**	**Benefits**	**Limitations**
Alum, ferric salts, clay (Coagulation and Flocculation) <https://ecology.wa.gov/water-shorelines/water-quality/freshwater/freshwater-algae-control>	Alum, ferric salts, or clay can be applied to the water body as coagulants that cause cyanobacteria to settle down away from the top layer of the water body. When applied to water, alum forms an aluminum hydroxide precipitate called a floc. As the floc settles, it removes phosphorus and particulates (including algae) from the water column. The floc settles on the sediment where it forms a layer that acts as barrier to phosphorus. Phosphorus, released from the sediments, combines with the alum and is not released	Injection of aluminum compounds can be effective at reducing phosphorus levels in the water body.	Effectiveness varies with amount of alum added and depth of water body. The addition of aluminum can impact pH levels of the water body. Best suitable for well-buffered hard water. Buffering soft water lakes with either sodium aluminate or carbonate type salts to prevent undesirable pH shifts that can be toxic to biota may be needed.

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	into the water to fuel algae blooms.		
Barley Straw <https://njaes.rutgers.edu/fs1171/>	Barley straw, when exposed to sunlight and in the presence of oxygen, produces a chemical that inhibits algae growth. Barley straw bales are broken apart and placed in a buoyant net deployed around the perimeter of the water body to facilitate the necessary chemical reactions and natural processes that prevents algae growth.	A low cost method to preventing HABs.	Amount used depends on size of water. Does not kill existing algae, but inhibits the growth of new algae. May take anywhere from 2 to 8 weeks for the barley straw to begin producing active chemical. Potential to cause fish kills through the deoxygenation of the water body due to decay.

To learn more about ways to prevent blooms and protect water resources visit:

- Preventing Eutrophication: Scientific Support for Dual Nutrient Criteria Fact Sheet (pdf) <https://epa.gov/sites/default/files/documents/nandpfactsheet.pdf> (269.87 KB, February 2015, EPA 820-S-15-001)
- Great Lakes Water Quality Agreement, Nutrient Annex 4- Recommended Binational Phosphorus Targets to Combat Lake Erie Algal Blooms <https://binational.net/annexes/a4/>
- US EPA Watershed Framework Approach <https://epa.gov/watershedacademy/watershed-approach-framework>
- US EPA Watershed Analysis and Management (WAM) Guide for States and Communities <https://epa.gov/watershedacademy/watershed-management-publications>

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