SCCWRP FACT SHEET

Protecting ecosystems and humans from harmful algal blooms

Environmental managers are developing strategies, monitoring programs and modeling tools to gain the upper hand on managing HABs, especially those that produce toxins

Harmful algal blooms (HABs) are overgrowths of algae and cyanobacteria that reduce water quality and harm ecosystems. Although algae and cyanobacteria are part of a balanced ecosystem, too much algal growth can block sunlight and reduce oxygen levels, causing events like mass fish deaths. A major consequence of HABs is the potent toxins HABs can produce; these toxins can sicken and kill animals, contaminate food webs, and cause illness in humans who drink or swim in contaminated waters. In California, both freshwater and coastal marine waters are being affected by HABs. Researchers are working to help environmental managers understand:

- When, where and why toxin-producing HABs are occurring
- How to more accurately forecast when and where HABs will produce toxins

Photo credit: San Diego Regional Water Quality Control Board

A field crew collects samples during a HAB event in the San Dieguito River in northern San Diego County. HABs can turn water vibrant shades of green, blue and red.

How HAB toxins manifest in Southern California

HABs often pose a seasonal threat, forming in late spring or early summer and dissipating by fall. However, blooms can occur year-round, and HAB toxins can persist in water bodies for months after the blooms have disappeared. The most common types of toxin-producing HABs in Southern California are:

Marine environments

» ***Pseudo-nitzschia* blooms**: The diatom *Pseudo-nitzschia* can produce a neurotoxin known as domoic acid that can trigger mass strandings and deaths of sea lions and other marine mammals and birds. When humans consume contaminated seafood, domoic acid can cause gastrointestinal illness and short-term memory loss. Domoic acid can persist in seafloor sediments and sediment-dwelling organisms for months to years after a bloom, extending the time it can affect both wildlife and humans.

Photo credit: Channel Islands Marine & Wildlife Institute

A rescue team tends to a sea lion believed to have been poisoned by domoic acid.

» **Red tides**: Some species of dinoflagellates and raphidophytes turn marine and estuarine waters shades of red or brown during events known as red tides; some red tides are bioluminescent. While some red tides are benign, others produce toxins that cause widespread fish kills and contaminate shellfish consumed by humans.

Photo credit: Scripps Institute of Oceanography

Red tide at a La Jolla beach in San Diego County

Freshwater environments

» **CyanoHABs**: Blooms of cyanobacteria in lakes, streams and other freshwater and estuarine environments are known as cyanoHABs. They form thick mats along the surface or bottom of water bodies, and can produce cyanotoxins that harm wildlife, dogs and humans. Cyanotoxins can travel to coastal marine waters via streams and runoff, extending their impact across the land-sea interface.

Cyanobacteria bloom in a Southern California lake

HAB monitoring programs in California

Three statewide HAB monitoring programs are helping managers to better understand bloom dynamics, enable early detection and forecasting, and inform management responses:

» ***California HAB Monitoring and Alert Program (HABMAP)***: Founded in the mid-2000s, HABMAP provides weekly HAB monitoring at 10 coastal marine stations statewide.

» ***California Freshwater and Estuarine HAB (FHAB) Program***: The FHAB program was formalized by the Water Boards in 2020 to coordinate monitoring and assessment of inland HABs statewide.

» ***Shellfish Biotoxin Monitoring***: Launched in the 1990s, biotoxin monitoring is California's longest-running HAB monitoring program. It focuses on protecting humans from HAB toxins when they consume coastal shellfish and other seafood.

HAB studies via Bight regional monitoring

Since 2008, the Southern California Bight Regional Monitoring Program has been conducting foundational regional studies illuminating where, when and why algal blooms are occurring. In 2018, Bight '18 found that HAB toxins were detected in 54% of all seafloor sediment in the Southern California Bight. For Bight '23, the program is documenting the degree to which HAB toxins and other contaminants may have contaminated local shellfish that humans consume.

Reasons for increases in toxin-producing HABs

HABs are becoming more intense, more widespread and longer-lasting – a consequence of changing environmental conditions associated with climate change and a range of local human activities. Leading causes of increases in HABs include:

» **Nutrients**
Excess nutrients in freshwater and marine water bodies can fuel increased algae growth. The excess nutrients can come from land-based activities as well as natural processes. In the coastal ocean, for example, nutrient-rich waters rise to the surface via a natural seasonal process known as upwelling.

» **Water stagnation**
When water is still for extended periods, it may lead to inadequate flushing that can prevent dilution of algae growing in the system – a particular problem in many inland water bodies.

» **Water temperature**
Warmer water temperatures enable certain HAB species in both marine and freshwater settings to grow rapidly and dominate microbial communities.

HAB toxin thresholds for protecting human health

California routinely monitors marine shellfish and fish for HAB toxin levels that exceed regulatory action levels established by the federal Food and Drug Administration. In inland waters, the California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network has developed a voluntary, three-tiered trigger system for recreational exposure to three common cyanotoxins to help managers make informed decisions for protecting public health.

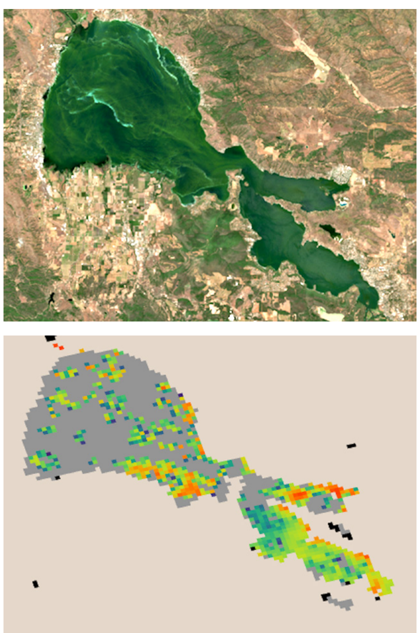
Next-generation tools for monitoring and modeling HABs

To take effective actions to combat and prevent HABs, managers rely on data that comes from a combination of monitoring and modeling.

HAB monitoring

Traditional HAB monitoring involves collecting and analyzing water samples one by one. Researchers also are piloting multiple additional ways to collect comprehensive HAB monitoring data, including:

- **Satellite remote sensing**: HABs in oceans, lakes and rivers can be monitored by satellites from space. Specialized satellite sensors identify and track unique signatures for algal and cyanobacterial pigments across broad areas.
- **Automated underwater imaging**: Special instruments can be submerged underwater to capture a continuous stream of images of individual algae cells in water, providing near real-time insights about HABs.
- **eDNA identification**: Researchers can use the DNA from algae – known as environmental DNA, or eDNA – to detect and quantify specific HAB taxa or HAB toxin genes. The method is more sensitive than traditional identification under a microscope, enabling HABs to be detected earlier.



Clear Lake in Northern California, which was captured in a satellite image (top), shows visual signs of a potential cyanobacterial bloom. The image can be analyzed using a computer algorithm (bottom) that differentiates cyanobacteria from other algae and non-biological matter to produce an estimate of overall algal abundance.

HAB modeling

Researchers are developing computer models for predicting when and where blooms – and toxins in particular – will occur, including two types of models for marine HABs in California coastal waters:

- **Operational forecasting**: Researchers are developing the California Harmful Algae Risk Mapping (C-HARM) model to provide an early warning of HABs in coastal marine waters. The model can forecast the likelihood of production of domoic acid, a neurotoxin, in coastal waters three days into the future.
- **Mechanistic modeling**: Researchers are developing mechanistic models to better understand the influence of natural and human factors in the development of domoic acid-producing blooms.

Models have been developed for many inland waters, but more HAB models are needed.

Developing water-quality standards that incorporate HAB toxins

The California State Water Resouces Control Board is developing water-quality standards to protect the biological integrity of streams and other water bodies from the adverse effects of eutrophication and other stressors. Known as the Biostimulation, Cyanotoxins, and Biological Condition Provisions, the policy is expected to use multiple indicators of eutrophication – including cyanotoxins – to establish consistent, statewide water quality standards.

More information

California Freshwater HAB Monitoring Strategy

Report a HAB

HAB Reports Map

CCHAB Network

Pets and HABs

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