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Marine Harmful Algal Blooms (HABs): Background, Statutory Authorities, and Issues for Congress

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SUMMARY

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Eva Lipiec
Analyst in Natural Resources Policy

Marine Harmful Algal Blooms (HABs): Background, Statutory Authorities, and Issues for Congress

Experts agree that the widespread occurrence and effects of harmful algal blooms (HABs) have adversely affected humans and the environment and that they likely will continue to do so. HABs may affect human, animal, and ecosystem health, and they may have socioeconomic consequences. A range of stakeholders—including federal, state, local, and tribal governments, the private sector, and individuals—have supported actions to prevent, control, mitigate, and research aspects of HABs; Congress has considered and may continue to consider additional actions to address HAB events.

Algae are naturally occurring components of healthy fresh and marine water ecosystems. However, under certain environmental conditions, colonies of algae can grow excessively or can result in HABs. Several factors may influence the occurrence and prevalence of HABs, including nutrient concentrations, water temperature, availability of light, water pH, shape of the coastline, other organisms in the water, and water currents or circulation. Experts widely recognize excessive nutrients as one of the key causes of HAB formation. Studies have found that changes to several environmental conditions, such as water temperature and precipitation, from the effects of climate change may lead to additional HAB events. Dying and decomposing HABs also can lead to areas with low oxygen (*hypoxia*), further harming aquatic ecosystems.

Congress has taken action to address HABs primarily through the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA; P.L. 105-383, as amended) and its amendments. In provisions of other legislation and through annual appropriations bills and accompanying language, Congress also has directed various federal agencies to support specific HAB-related activities. In addition, Congress has instructed agencies to carry out activities to address factors that may contribute to HAB formation. A 2016 Government Accountability Office study found that multiple federal agencies reported HAB-related activities, with 12 federal agencies spending a total of $110 million on these activities over the course of FY2013-FY2015.

Congress has directed the National Oceanic and Atmospheric Administration (NOAA) to carry out the majority of HAB-related activities in marine waters. NOAA also has some responsibilities related to HABs in freshwater settings, such as the Great Lakes. These activities include coordination, research, monitoring, detection, forecasting, and mitigation. Congress also instructed NOAA to (1) release guidance on HABs and hypoxia events of national significance in coastal waters and (2) update national estimates of the socioeconomic impacts of HABs, among other tasks. NOAA reported that the agency spent $39.45 million on HAB-related activities between FY2013 and FY2015. Additional departments and agencies, such as the U.S. Army Corps of Engineers, U.S. Department of Agriculture, U.S. Environmental Protection Agency (EPA), and National Science Foundation, also have statutory responsibilities related to HABs, including authorities specific to marine HABs.

Congress has directed several federal agencies to participate in marine HAB-related interagency coordination efforts through a federal task force (the Interagency Task Force on HABs and Hypoxia established under HABHRCA) and regional efforts, such as a federal working group on the Gulf of Mexico. Currently NOAA, EPA, and the White House Office of Science and Technology Policy serve as cochairs of the Interagency Task Force on HABs and Hypoxia. Congress directed the Secretary of Commerce to lead many of the task force's activities; the Secretary delegated these responsibilities to NOAA. Federal agencies also coordinate their activities with nonfederal entities at the regional, national, and international levels. Several federal and nonfederal entities have identified research and policy needs to address HABs. Needs have centered on establishing strategies to prevent and control HABs and assess HAB exposure; understanding how multiple factors may contribute to HABs; evaluating the socioeconomic impacts of HABs; and assembling national datasets of environmental conditions before and during events.

Potential issues for congressional consideration may include an evaluation of federal marine HAB-related activity expenditures, an assessment of federal performance and coordination regarding marine HABs, the establishment of new or adjustment of existing marine HAB authorities and funding, and other concerns.

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Marine harmful algal blooms (HABs) have affected and likely will continue to affect U.S. coastal communities. HABs may affect human, animal, and ecosystem health and may have socioeconomic consequences. A range of stakeholders—including individuals; local, state, and tribal governments; the federal government; nongovernmental organizations; and the private sector—may have a role in preventing the development of HABs and mitigating their effects. Congress historically has supported a range of federal agency activities related to marine HABs.

This report concentrates on marine HABs, although there may be overlap between marine and freshwater HAB types in places where rivers meet the ocean.[1] The report provides background on marine HABs, including their effects, factors that may contribute to their development, and geographic incidence and trends. It then discusses federal agency, interagency, and interorganizational activities to address marine HABs. Finally, the report offers several issues for Congress to potentially consider, including an evaluation of federal marine HAB-related activity expenditures, an assessment of federal performance and coordination regarding marine HABs, the establishment of new or adjustment of existing marine HAB authorities and funding, and other concerns.

What Are Marine Harmful Algal Blooms?

Algae are naturally occurring photosynthetic organisms often part of healthy aquatic ecosystems. However, under certain environmental conditions, colonies of algae can grow excessively, or *bloom*, and produce toxins or have other harmful effects. These HABs may be caused by organisms of different sizes and types, including phytoplankton, cyanobacteria, benthic algae, or macroalgae, among other organisms.[2]

HAB species occur in waters of various salinities or may form only in waters of a specific salinity. Some HAB species can move from freshwater locations into areas with greater salinity, such as estuaries or the ocean, through the natural movement of water or via human activities.[3] Cyanobacteria, a type of photosynthetic bacteria, often cause algal blooms in freshwater and occasionally cause them in marine water, sometimes turning the water a bright blue-green color.[4] HAB species such as golden algae and brown tides may discolor brackish estuarine waters.[5] Dinoflagellates and diatoms, two types of phytoplankton, are the most common HAB species in marine and brackish waters;[6] these algae may cause the water to turn red and brown.

[1] For more information on harmful algal blooms that form in freshwater, see CRS Report R44871, *Freshwater Harmful Algal Blooms: Causes, Challenges, and Policy Considerations*, by Laura Gatz.

[2] National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, "Harmful Algal Blooms Frequently Asked Questions," at https://oceanservice.noaa.gov/hazards/hab/. Hereinafter cited as NOAA, "HABs FAQs." According to NOAA, phytoplankton are microscopic marine algae, benthic algae are associated with or occur on the bottom of a body of water, and macroalgae are algae that can be seen without the aid of a microscope (i.e., seaweed).

[3] Human activities may include, for example, increased flow of water from lakes and reservoirs to coastal areas during high-water episodes in highly managed systems.

[4] NOAA, "HABs FAQs."

[5] NOAA, "HABs FAQs."

[6] NOAA, "HABs FAQs."

Figure 1. Harmful Algal Bloom (HAB) Offshore of San Diego County, CA

Source: National Oceanic and Atmospheric Administration (NOAA), "Why Do HABs Happen?," at https://www.noaa.gov/what-is-harmful-algal-bloom.

HAB Effects

HABs may affect human, animal, and ecosystem health and may have socioeconomic impacts and costs.[7] HABs sometimes produce discolorations in the water that can appear as scums, paint-like slicks, clotted mats, or foam and may vary in color (i.e., light to dark green, yellow, red, or brown; **Figure 1**). HABs, in some cases, may wash up onshore and decompose, causing nuisance or harmful air-quality concerns. In addition to aesthetic concerns, HABs can contribute to poor water quality and ecosystem health numerous ways. For example, excessive algal growth may reduce water transparency (i.e., increase turbidity), clog the gills of fish and invertebrates, and change the biological community (e.g., smother corals and submerged aquatic vegetation).[8]

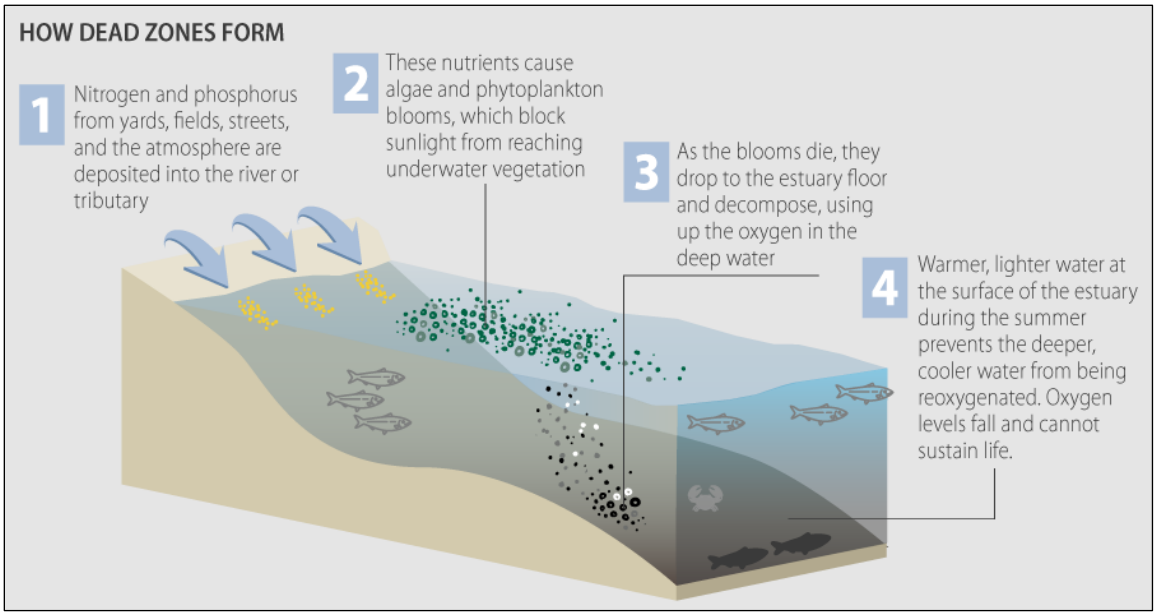
As algae dies, the decomposition process uses oxygen in the water. This process may leave waterways in a low-oxygen, or *hypoxic,* state, sometimes leading to the formation of *dead zones*—areas where aquatic life cannot survive (**Figure 2**). Hypoxic areas can suffocate and kill fish and bottom-dwelling organisms, such as crabs and clams. According to the U.S. Environmental Protection Agency (EPA), over 166 dead zones have been documented nationwide, including in the Chesapeake Bay and the Gulf of Mexico.[9]

[7] North Pacific Marine Science Organization (PICES), *GlobalHAB: Evaluating, Reducing and Mitigating the Cost of Harmful Algal Blooms: A Compendium of Case Studies*, PICES Scientific Report No. 59, November 2020, p. 95, at https://meetings.pices.int/publications/scientific-reports/Report59/Rpt59.pdf. Hereinafter cited as PICES, *Compendium of Case Studies*, 2020.

[8] NOAA, "Why Do HABs Happen?," at https://www.noaa.gov/what-is-harmful-algal-bloom.

[9] U.S. Environmental Protection Agency (EPA), "Nutrient Pollution, The Effects: Environment," at https://www.epa.gov/nutrientpollution/effects-environment.

Figure 2. How Dead Zones Typically Form



Source: CRS, adapted from National Science and Technology Council, Subcommittee on Ocean Science and Technology, *Harmful Algal Blooms and Hypoxia Comprehensive Research Plan and Action Strategy: An Interagency Report,* 2016, at https://cdn.coastalscience.noaa.gov/page-attachments/research/FINAL_HABs Hypoxia Research Plan and Action.pdf.

Of the thousands of known algal species, more than 100 can produce toxins that are harmful to humans and wildlife.[10] The types of algae, the toxins they may produce, and the effects of these toxins vary from region to region.[11] Common toxins in marine HABs include brevetoxin, azpiracid, ciguatoxin, domoic acid, okadaic acid, saxitoxin, and dinophysistoxin.[12] Humans may be exposed to HAB toxins by consuming tainted drinking water, seafood, or foods watered with contaminated irrigation water; swimming or recreating in waters in which certain concentrations of toxins are present; or inhaling aerosolized toxins.[13] The toxins also can impact fish, shellfish, invertebrates, pets, and other animals. Exposure to the HAB-associated toxins can cause hepatic (liver-related), neurologic, respiratory, dermatologic, and other symptoms in humans, as well as in wildlife.[14] Symptoms may be acute or chronic, mild or severe, and in some cases may be fatal for both humans and animals.

[10] Øjvind Moestrup et al., "IOC-UNESCO Taxonomic Reference List of Harmful Micro Algae" at http://www.marinespecies.org/hab; and U.S. National Office for Harmful Algal Blooms, "HAB Species by Name," at https://hab.whoi.edu/species/species-by-name/.

[11] NOAA, "HABs FAQs."

[12] Centers for Diseases Control and Prevention (CDC), "Harmful Algal Bloom (HAB)-Associated Illness—Saltwater Algal Blooms," at https://www.cdc.gov/habs/illness-symptoms-marine.html.

[13] National Science and Technology Council (NSTC), Subcommittee on Ocean Science and Technology, *Harmful Algal Blooms; and Hypoxia Comprehensive Research Plan and Action Strategy: An Interagency Report*, 2016. Hereinafter cited as NSTC, *HABs Report*, 2016.

[14] NSTC, *HABs Report*, 2016; Hans W. Paerl, Timothy G. Otten, and Raphael Kudela, "Mitigating the Expansion of Harmful Algal Blooms Across the Freshwater-to-Marine Continuum," *Environmental Science and Technology*, vol. 52 (April 16, 2018), pp. 559-5529. Hereinafter cited as Paerl, Otten, and Kudela, "Mitigating HABs," 2018.

HABs may have socioeconomic effects, which differ based on the characteristics and magnitude of the HAB event.[15] Direct and indirect impacts of HABs may include costs related to recreation and tourism, commercial fisheries, public health, and monitoring and management costs.[16] According to some experts, there is a lack of consistent data on the socioeconomic impacts of marine HABs at the national and regional scales.[17] A 2006 report is the most recent comprehensive national evaluation of the average annual economic effects of HABs in the United States.[18] Using available information from 1987 through 2000, the report estimated an annual average of $82 million (2005 dollars) in economic effects associated with marine HAB impacts on public health, commercial fisheries, recreation and tourism, and monitoring and management.[19] More recent information about the economic impacts of marine HABs is available for certain regions and HAB events.[20] For example, NOAA reported that an HAB along the West Coast in 2015 caused a $97 million loss in the commercial Dungeness crab fishery, with an additional $40 million lost in tourism spending in Washington State.[21] In another study, 12 counties on Florida's west coast reported a total of $130.6 million in physical and economic damages due to red tide events between August and December 2018.[22]

Factors Contributing to Marine HAB Formation

Many factors may influence the occurrence and prevalence of HABs in marine waters, including nutrient concentrations, water temperature and pH, availability of light, shape of the coastline, other organisms in the water, and water currents or circulation.[23] Some scientists note that factors such as pollution, food-web alterations, and the introduction of HAB species into new regions due to international commerce and water-flow modifications also may contribute to HAB formation.[24]

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[15] PICES, *Compendium of Case Studies*, 2020, p. 95.

[16] Florida Sea Grant, "Understanding Florida's Red Tide," at https://www.flseagrant.org/news/2018/12/understanding-floridas-red-tide/.

[17] Isabella Sanseverino et al., *Algal Bloom and Its Economic Impact*, European Commission Joint Research Centre (JRC), JRC Technical Reports EUR 27905 EN, 2016, p. 22.

[18] Porter Hoagland and Sara Scatasta, "The Economic Effects of Harmful Algal Blooms," in *Ecology of Harmful Algae*, vol. 189 (2006). Hereinafter cited as Hoagland and Scatasta, "Economic Effects," 2006.

[19] The authors separated the economic effects into four categories: (1) public health related to the "costs of morbidities or mortalities that result from eating shellfish contaminated" by various toxins; (2) commercial fisheries related to closures of shellfisheries and aquaculture operations, mortalities of shellfish or fish in aquaculture operations, prohibitions on the commercial sale of recreational fish, untapped fishery resources, and other indirect effects; (3) recreation and tourism based on "incompletely documented economic impact estimates" for two events, in North Carolina and Washington, respectively; and (4) monitoring and management costs based on information from state governments, where available (Hoagland, and Scatasta, "Economic Effects," 2006, pp. 398-401).

[20] For additional examples of economic impacts, especially in other countries, see PICES, *Compendium of Case Studies*, 2020.

[21] NOAA lists several more estimates of economic losses due to HABs at NOAA, NOAA Fisheries, "Hitting Us Where It Hurts: The Untold Story of Harmful Algal Blooms," at https://noaa.maps.arcgis.com/apps/Cascade/index.html?appid=9e6fca29791b428e827f7e9ec095a3d7.

[22] Tampa Bay Regional Planning Council Regional Economic Analysis Program, *The Economic Ripples Effects of Florida Red Tide*, January 2019.

[23] NOAA, "Why Do HABs Happen?," at https://www.noaa.gov/what-is-harmful-algal-bloom.

[24] NSTC, *HABs Report*, 2016, p. 11; and U.S. National Office for Harmful Algal Blooms, "Recent Trends: National changes," at https://hab.whoi.edu/maps/regions-us-distribution/regions-us-recent-trends/. Hereinafter cited as U.S. National Office for HABs, "Recent Trends."

Excessive nutrients are widely recognized as one of the key causes of HAB formation.[25] Nutrients, such as nitrogen and phosphorus, are essential to plant growth and are natural parts of aquatic ecosystems. Although some sources of nutrients in water bodies are natural, many anthropogenic activities contribute nutrients to waterbodies from various sources, including the following:

- Municipal and industrial wastewater discharges
- Concentrated animal feeding operations
- Failing septic systems
- Atmospheric deposition of nitrogen from fossil fuel combustion
- Runoff from urban and suburban stormwater, fertilized cropland, and manure from cropland, pastures, and animal feeding operations[26]

Environmental conditions related to climate change also may affect marine HAB development. Some studies indicate that increased water temperatures and changes in rainfall frequency and intensity may favor HAB formation, as HABs generally proliferate in warmer waters.[27] Other studies have found that swings between flooding and drought also may enhance HAB formation. For example, if intense rainfall is followed by a drought, the nutrients washed into receiving coastal water bodies may remain in the water bodies for longer than average, increasing the potential for HAB development.[28]

Marine HAB Incidence and Trends

HABs have been found in all U.S. coastal marine states (**Figure 3**).[29] Coastal U.S. waters are home to most major HAB poisoning syndromes, such as paralytic shellfish poisoning, neurotoxic shellfish poisoning, amnesic shellfish poisoning, and ciguatera fish poisoning.[30]

Some experts assert that the frequency and distribution of HABs, the economic costs associated with them, the types of resources affected, and the number of toxins and toxic species all have increased in recent decades.[31] Several factors may contribute to greater incidence, including, in

[25] NSTC, *HABs Report*, 2016, p. 11; and EPA "Nutrient Pollution: Harmful Algal Blooms," at https://www.epa.gov/nutrientpollution/harmful-algal-blooms#cause.

[26] EPA "Nutrient Pollution: Sources and Solutions," at https://www.epa.gov/nutrientpollution/sources-and-solutions; EPA, Office of Water, *A Compilation of Cost Data Associated with the Impacts and Control of Nutrient Pollution*, EPA 820-F-15-096, May 2015, pp. IV-23; and NSTC, *HABs Report*, 2016, p. 11.

[27] Hans W. Paerl and Jef Huisman, "Climate Change: A Catalyst for Global Expansion of Harmful Cyanobacterial Blooms," *Environmental Microbiology Reports*, 1 (1) 2009, pp. 27-37 (Hereinafter cited as Paerl and Huisman, "Climate Change," 2009); Paerl, Otten, and Kudela, "Mitigating HABs," 2018; NSTC, *HABs Report*, 2016, p. 12; and U.S. Global Change Research Program, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, 2018.

[28] Paerl and Huisman, "Climate Change," 2009; and Paerl, Otten, and Kudela, "Mitigating HABs," 2018.

[29] NOAA, "What is a harmful algal bloom?" at https://www.noaa.gov/what-is-harmful-algal-bloom. Congress has defined the Great Lakes as coastal waters, however the Great Lakes contain fresh, rather than marine, waters. For more information on freshwater HABs see, CRS Report R44871, *Freshwater Harmful Algal Blooms: Causes, Challenges, and Policy Considerations*, by Laura Gatz.

[30] U.S. National Office for Harmful Algal Blooms, "Distribution of HABs in the U.S.," at https://hab.whoi.edu/maps/regions-us-distribution/.

[31] NSTC, *HABs Report*, 2016, pp. 10-11; and U.S. National Office for Harmful Algal Blooms, "Recent Trends."

some cases, better detection methods, increased observations, and other factors described in the section "Factors Contributing to Marine HAB Formation."[32]

Figure 3. Marine HAB Events in the United States Through 2020

Source: CRS from U.S. National Office for Harmful Algal Blooms, "Distribution of HABs in the U.S.," at https://hab.whoi.edu/maps/regions-us-distribution/. According to the Woods Hole Oceanographic Institution (WHOI), data were obtained from the Harmful Algae Event Database (HAEDAT) maintained by the International Council for the Exploration of the Sea, Science and Communications Center in Vigo, Spain. Graphic created by the National Office for Harmful Algal Blooms at WHOI.

Notes: ASP = amnesic shellfish poisoning; DSP = diarrhetic shellfish poisoning; HAB = harmful algal bloom; NSP = neurotoxic shellfish poisoning; PSP = paralytic shellfish poisoning; USVI = U.S. Virgin Islands. According to the U.S. National Office for Harmful Algal Blooms, "each 'Event' noted on the map is considered to be something that constituted a quarantine, closure or management decision where toxicity was detected exceeding regulatory limits."

Federal Activities to Address Marine HABs

Experts have identified various interventions that stakeholders (including federal, state, or local government; nongovernmental organizations; individuals; and others) may take to address HABS. See **Table 1** for some potential actions to prevent, control, understand, and reduce the impacts of *Karenia brevis*, or red tide, blooms in the Gulf of Mexico, for example.

Table 1. Potential Actions to Prevent or Address the Impacts of *Karenia brevis* in the Gulf of Mexico

Prevent or Control Blooms	Understand the HAB Event and Notify Stakeholders	Reduce Populations at Risk	Mitigate Illnesses
Set fertilizer ordinances	Monitor conditions	Visit substitute beaches	Self-medicate
Implement other nonpoint source pollution controls	Forecast HAB development	Remain indoors	Visit a physician

[32] U.S. National Office for Harmful Algal Blooms, "Recent Trends."

Prevent or Control Blooms	Understand the HAB Event and Notify Stakeholders	Reduce Populations at Risk	Mitigate Illnesses
Improve wastewater treatment	Alert stakeholders	Travel away from the coast	Visit the Emergency department
Construct runoff holding ponds	Issue publications (media and scientific)	Reduce regional tourist visits	Admit for a hospital stay
Upgrade septic tanks	Support scientific research		
Use chemical/biological/ physical controls	Educate stakeholders		

Source: CRS, adapted from U.S. National Office for Harmful Algal Blooms, *Proceedings of the Workshop on the Socio-Economic Effects of Marine and Freshwater Harmful Algal Blooms in the United States*, March 2021, Figure 1, at https://cdn.coastalscience.noaa.gov/page-attachments/news/HABSocioeconomics_WorkshopProceedings.pdf.

Note: HAB = harmful algal bloom.

Congress has directed multiple federal agencies to support a range of activities to address marine HABs, including some of the activities listed in **Table 1**. In 2016, GAO identified 17 federal agencies that reported undertaking HAB-related activities between FY2013 and FY2015 (**Table 2**).[33] The GAO report identified federal agency activities related to HABs, such as research and analysis, forecasting, monitoring, outreach, and response.[34] GAO did not specify whether the activities were related to freshwater or marine HABs. Other stakeholders, such as state, local, and tribal governments, the private sector, and individuals, also may address aspects of marine HABs in these ways.

Table 2. Federal Departments and Agencies Supporting HAB-Related Activities

(identified by GAO in 2016)

U.S. Environmental Protection Agency	U.S. Department of Commerce • National Oceanic and Atmospheric Administration
Executive Office of the President • Council on Environmental Quality • Office of Science and Technology Policy	U.S. Department of Defense • Department of the Navy • U.S. Army Corps of Engineers
National Aeronautics and Space Administration	U.S. Department of the Interior • Bureau of Ocean Energy Management • National Park Service • U.S. Geological Survey
National Science Foundation	U.S. Department of Health & Human Services • Centers for Disease Control and Prevention • Food and Drug Administration • National Institutes of Health, National Institute of Environmental Health Sciences

[33] U.S. Government Accountability Office (GAO), *Environmental Protection: Information on Federal Agencies' Expenditures and Coordination Related to Harmful Algae*, GAO-17-119, October 2016, at https://www.gao.gov/assets/690/680457.pdf. Hereinafter cited as GAO-17-119.

[34] GAO-17-119, p. 16.

U.S. Department of Agriculture

- National Institute of Food and Agriculture
- Natural Resources Conservation Service

Source: U.S. Government Accountability Office (GAO), *Environmental Protection: Information on Federal Agencies' Expenditures and Coordination related to Harmful Algae*, October 2016, GAO-17-119, at https://www.gao.gov/assets/690/680457.pdf.

Notes: HAB = harmful algal bloom. The GAO report does not always distinguish whether federal agency activities relate to fresh or marine HABs.

Federal Agency Marine HAB Statutory Authorities

Congress has taken action to address marine HABs primarily through the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA; P.L. 105-383, as amended, **Table 3**). HABHRCA includes provisions that could apply to HABs in all water bodies, as well as provisions specific to marine HABs. Congress also has enacted other HAB-related laws that either do not specify the type of waterbody or are specific to marine HABs (**Table 3**).[35]

Federal agency activities authorized under the statutes listed in **Table 3** include HAB observations, monitoring, modeling, forecasting, management, and mitigation. The statutes also authorize activities related to HAB data management, information dissemination, federal coordination, and support of federal and nonfederal research to address HABs.[36] Congress has directed federal agencies to perform these activities both independently and in coordination with other federal and nonfederal entities. Congress also has directed various federal agencies to support HAB-related activities in annual appropriations language and associated committee reports and explanatory statements.[37]

[35] For more information on freshwater HABs, see CRS Report R44871, *Freshwater Harmful Algal Blooms: Causes, Challenges, and Policy Considerations*, by Laura Gatz.

[36] For more information on activities federal agencies may be performing under the authority of these statutes, see Interagency Working Group on Harmful Algal Bloom and Hypoxia Research and Control Act (IWG-HABHRCA), *Harmful Algal Blooms and Hypoxia in the United States: A Report on Interagency Progress and Implementation*, March 2018, at https://cdn.coastalscience.noaa.gov/page-attachments/research/FINAL_USEC%20signed%20-%20Progress%20and%20Implementation%20Report_HABHRCA.pdf (Hereinafter cited as IWG-HABHRCA, *Report on Interagency Progress*, 2018); and IWG-HABHRCA, *Harmful Algal Blooms and Hypoxia in the Great Lakes: An Interagency Progress and Implementation Report*, November 2020, at https://cdn.coastalscience.noaa.gov/page-attachments/research/FINAL_HABHRCA_GreatLakes_ProgressReport_November_2020.pdf. Hereinafter cited as IWG-HABHRCA, *Interagency Progress Report*, 2020).

[37] Provisions included in appropriations bills may be presumed temporary unless the bill explicitly indicates futurity or is of "general character bearing no relation to the object of the appropriation" (GAO, *Principles of Federal Appropriations Law, Chapter 2: The Legal Framework, Fourth Edition*, 2016, GAO-16-464SP, p. 2-86). For examples of congressional direction in appropriations bills or accompanying language, see section entitled "Federal Agency HAB Funding" or **Table A-1**.

Table 3. Enacted Legislation Regarding Marine HABs

(in force as of the date of this report, in alphabetical order by activity)

Activity	Statutory Authority	Summary of HAB-Related Provisions	Contains Provisions Potentially Applicable to HABs in All Types of Waters	Contains Provisions Specific to Marine HABs
Algal Toxin Risk Assessment and Management	Drinking Water Protection Act (P.L. 114-45; 42 U.S.C. §300j-19)	Directs the EPA Administrator to (1) develop and submit to Congress a strategic plan for assessing and managing risks associated with algal toxins in drinking water provided by public water systems and (2) publish information from federal agencies on algal toxins and public health concerns related to HABs, among other tasks	X	
Conservation Reserve Program	Agriculture Improvement Act of 2018 (P.L. 115-334; 16 U.S.C §3831)	Directs the Secretary of Agriculture to prioritize the implementation of practices on land that would help reduce HABs, among other issues	X	
Federal Ocean Acidification Research and Monitoring	Federal Ocean Acidification Research and Monitoring Act of 2009 (P.L. 111-11) and Coordinated Ocean Observations and Research Act of 2020 (P.L. 116-271) (33 U.S.C. §§3701-3708)	Directs the National Science and Technology Council Joint Subcommittee on Ocean Science and Technology to submit to Congress a report that identifies habitats vulnerable to multiple stressors, such as HABs, among other topics Directs the subcommittee to develop a strategic plan to include research to understand the "combined impact" of multiple ocean changes, such as HABs Requires the NSF Director to continue to carry out competitive research activities on the impacts of multiple stressors on ecosystems, including HABs, among other topics		X
Harmful Algal Bloom Demonstration Program	Water Resources Development Act 2020 (Division AA of P.L. 116-260; 33 U.S.C. §610 note)	Directs the Secretary of the Army to carry out a demonstration program to determine the causes of HABs and to implement measures to effectively detect, prevent, treat, and eliminate HABs associated with water resources development projects Program focus areas include the Great Lakes, New Jersey tidal and inland waters, Louisiana coastal and tidal waters, and waterways in the counties that comprise the Sacramento-San Joaquin Delta, among other locations Authorizes appropriations of $25 million to the Secretary of the Army for these activities, to remain available until expended	X	X

Harmful Algal Bloom and Hypoxia Research and Control	Harmful Algal Bloom and Hypoxia Research and Control Act, 1998 (P.L. 105-383); Harmful Algal Bloom and Hypoxia Amendments Act of 2004 (P.L. 108-456); Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014 (P.L. 113-124), Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2017 (P.L. 115-423) (33 U.S.C. §§4001-4010)	Establishes the Interagency Task Force on Harmful Algal Blooms and Hypoxia, chaired by the Department of Commerce and consisting of representatives from 10 federal departments or agencies, the White House's Office of Science and Technology Policy and Council on Environmental Quality, and "such other Federal agencies as the President considers appropriate" Requires the task force, in cooperation with nonfederal partners, to prepare reports assessing the ecological and economic consequences of HAB and hypoxia; alternatives for the reduction, mitigation, and control of HAB and hypoxia; and the social and economic costs and benefits of such alternatives Requires the President, in consultation with state chief executive officers, to develop and submit a report to Congress that describes and evaluates the effectiveness of measures to protect against environmental and public health impacts of HABs Directs the Secretary of Commerce, in coordination with the task force and appropriate state, tribal, and local governments, to provide for local and regional scientific assessments of HABs and hypoxia Requires the task force to complete a scientific assessment of hypoxia and marine and freshwater HABs at least once every five years Directs the task force to develop and submit to Congress a plan for a national research program to develop and demonstrate prevention, control, and mitigation methods to reduce impacts of HABs on coastal ecosystems (including the Great Lakes), public health, and the economy Requires the Secretary of Commerce to establish a research, development, demonstration, and technology transfer program Requires the Under Secretary of Commerce for Oceans and Atmosphere to submit to Congress a report that describes annual task force proceedings; activities and budget under the research, development, demonstration, and technology transfer program; progress made on implementing the action strategy; and any need to revise or terminate program research and activities Requires the task force to consult with nonfederal entities when developing assessments, reports, and plans Directs the Under Secretary of Commerce for Oceans and Atmosphere, through the task force, to maintain and enhance a national HAB and hypoxia program	X	X

Directs the task force to coordinate interagency review of the national HAB and hypoxia program, support implementation of the action strategy, and promote development of new technologies, among other tasks

Identifies NOAA as the lead federal agency with primary responsibility for administering the national HAB and hypoxia program

Directs the Under Secretary of Commerce for Oceans and Atmosphere, in administering the national HAB and hypoxia program, to promote the program; prepare work and spending plans to implement the action strategy; administer a competitive grant program; coordinate with nonfederal entities; coordinate with the Secretary of State to support international HAB and hypoxia activities; identify additional HAB and hypoxia needs and priorities; integrate, coordinate, and augment existing education and extension programs; facilitate and provide resources to train nonfederal resource managers, support regional efforts; and convene a task force meeting at least once a year, among other tasks

Directs the Under Secretary of Commerce for Oceans and Atmosphere to maintain and enhance existing HAB and hypoxia competitive programs at NOAA; carry out marine and Great Lakes HAB and hypoxia response activities; develop and enhance observations, monitoring, modeling, data management, information dissemination, and forecasts; enhance communication and coordination among federal agencies; leverage existing resources and nonfederal expertise; increase availability of nonfederal analytical facilities and technologies, forecasts, and research materials; use cost effective methods; and develop contingency plans for long-term monitoring of hypoxia, among other tasks

Directs the Under Secretary of Commerce for Oceans and Atmosphere to work cooperatively and avoid duplication of effort within NOAA and with federal and nonfederal entities

Directs the EPA Administrator, through the task force, to lead the freshwater aspects of the program

Requires the Under Secretary of Commerce for Oceans and Atmosphere, through the task force, to develop a comprehensive research plan and action strategy to address marine and freshwater HABs and hypoxia. Directs the Under Secretary to periodically review and revise the action strategy

Directs the EPA Administrator, through the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, to periodically report on the progress toward the goals of the Gulf Hypoxia Action Plan 2008

Activity	Statutory Authority	Summary of HAB-Related Provisions	Contains Provisions Potentially Applicable to HABs in All Types of Waters	Contains Provisions Specific to Marine HABs
		Requires the Interagency Task Force on Harmful Algal Blooms and Hypoxia to complete an integrated assessment of and plan to address hypoxia and HABs in the Great Lakes Defines terms, such as *United States coastal waters* to include the Great Lakes Authorizes appropriations of $20,500,000 for each of FY2014-FY2023 to the Under Secretary of Commerce for Oceans and Atmosphere to implement the national HAB and hypoxia program, research plan, and action strategy. Requires the Under Secretary to allocate a "substantial portion of funds" to extramural research activities In the case of an HAB or hypoxia event of national significance, directs the Under Secretary of Commerce for Oceans and Atmosphere or the EPA Administrator, respectively, to make funds available to affected state or local governments for assessment and mitigation of HAB effects		
Harmful Algal Bloom Technology Demonstration	America's Water Infrastructure Act of 2018 (P.L. 115-270; 33 U.S.C. §610 note)	Requires the Secretary of the Army to implement a five-year HAB technology development demonstration program to identify and develop strategies for early detection, prevention, and management techniques and procedures to reduce the occurrence and effects of HABs in the nation's water resources and to ensure said technologies have the ability to scale up	X	
Integrated Coastal and Ocean Observation System	Integrated Coastal and Ocean Observing System Act of 2009 (P.L. 111-11) and Coordinated Ocean Observations and Research Act of 2020 (P.L. 116-271) (33 U.S.C. §§3601-3611)	Directs the NOAA Administrator to work with users and regional associations to develop products to enable real-time data-sharing related to HAB forecasting, among other issues Directs the Integrated Ocean Observation System Advisory Committee to advise NOAA and the Interagency Ocean Observing Committee on national mapping networks to address HAB forecasting and detection, among other priorities		X

Activity	Statutory Authority	Summary of HAB-Related Provisions	Contains Provisions Potentially Applicable to HABs in All Types of Waters	Contains Provisions Specific to Marine HABs
Interagency Oceans and Human Health Research Program	Consolidated Appropriations Act, 2005, as amended (P.L. 108-447; 33 U.S.C. §3101)	Directs the White House National Science and Technology Council to coordinate and support a national research program on the ocean's role in human health, including activities related to HABs and hypoxia (in coordination with the Interagency Task Force on Harmful Algal Blooms and Hypoxia)		X
National Estuary Program	To Amend the Federal Water Pollution Control Act to Reauthorize the National Estuary Program, and for Other Purposes (P.L. 114-162; 33 U.S.C. §1330)	Directs the EPA Administrator to award competitive grants to address recurring HABs in coastal areas, among other issues	X	X
National Sea Grant College Program Competitive Grants	National Sea Grant College Program Amendments Act of 2008 (P.L. 110-394); and National Sea Grant College Program Amendments Act of 2020 (P.L. 116-221) (33 U.S.C. §1131)	Authorizes the Secretary of Commerce to use $6.0 million for competitive grants to university research on the biology, prevention, and forecasting of HABs, among other topics, for each of FY2021-FY2025	X	
Oceans and Human Health Initiative	Consolidated Appropriations Act, 2005, as amended (P.L. 108-447; 33 U.S.C. §3102)	Authorizes the Secretary of Commerce to establish the Oceans and Human Health Initiative, including the support of centers of excellence focused on areas such as HABs and hypoxia		X

Source: CRS, using Congress.gov.

Notes: EPA = U.S. Environmental Protection Agency; HAB = harmful algal bloom; NOAA = National Oceanic and Atmospheric Administration; NSF = National Science Foundation

This table does not include descriptions of provisions within each act that do not potentially apply to marine HABs nor does it include legislation pertaining solely to freshwater HABs. For more information on freshwater HABs, see CRS Report R44871, *Freshwater Harmful Algal Blooms: Causes, Challenges, and Policy Considerations*, by Laura Gatz.

In addition, Congress has directed federal agencies to perform activities that may indirectly address marine HABs. Some legislation authorizes federal agencies to address factors that may contribute to HAB formation, such as excessive nutrient runoff.[38] Other legislation requires multiple federal agencies to support the conservation or restoration of habitats or species, which may indirectly help to prevent HAB formation.[39] In some cases, Congress also has provided some federal agencies with broad authorities related to environmental health and public health prevention and research under which some agencies support activities related to marine HABs.[40]

Federal Agency HAB Funding

Congress typically appropriates funding to agencies to support HAB-related activities through multiple budget line items that may or may not explicitly focus on HABs. Congress has directed several agencies to support HAB-related activities primarily through explanatory statements and committee reports accompanying appropriations bills in recent fiscal years (FY2019-FY2021). For example, in language accompanying the FY2021 appropriations act, Congress included extensive directives to several federal agencies (e.g., Centers for Disease Control and Prevention [CDC], EPA, NOAA, U.S. Army Corps of Engineers [USACE], the U.S. Department of Agriculture's [USDA's] Agricultural Research Service, and U.S. Geological Survey [USGS]) to support HAB-related activities (see **Table A-1**).[41] Congress encouraged the agencies to use appropriations to support research, work with federal and nonfederal stakeholders, establish pilot projects, develop models, and improve monitoring and detection. Congress directed these and other agencies (e.g., USDA's Natural Resources Conservation Service) to address HABs in language accompanying FY2019 and FY2020 appropriations acts, as well. The accompanying reports and statements directed agencies to support work internally and to fund nonfederal partners to prevent, research, monitor, model, forecast, control, and mitigate HABs and their effects.[42] The congressional guidance did not always distinguish whether federal agency activities were related to HABs in fresh or marine waters.

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[38] For example, the Clean Water Act (33 U.S.C. §§1251 et seq.) authorizes the U.S. Environmental Protection Agency (EPA) and states to address water quality concerns associated with HABs, including nutrient pollution. For more information on federal regulations related to nutrients and HABs, see CRS Report R44871, *Freshwater Harmful Algal Blooms: Causes, Challenges, and Policy Considerations*, by Laura Gatz.

[39] For example, under the Coastal Zone Management Act (16 U.S.C. §§1451 et seq.), NOAA may provide funds to coastal states to conserve or restore coastal habitats, such as wetlands, that may serve to filter excessive nutrients from surface water runoff before the runoff enters waterways, among other benefits.

[40] For instance, some federal agencies, such as National Institute of Environmental Health Sciences or CDC (especially the National Center for Environmental Health), have broad missions related to environmental health. Existing CDC HAB-related activities include the One Health HAB System (OHHABS), under which CDC supports the voluntary collection of information on HABs in fresh, marine, and brackish water and HABs' health effects on humans and animals (CDC, "Harmful Algal Bloom (HAB)-Associated Illness—One Health Harmful Algal Bloom System (OHHABS)," at https://www.cdc.gov/habs/ohhabs.html).

[41] U.S. Congress, House Committee on Appropriations, *Committee Print on H.R. 133/Public Law 116-260 Book 1 of 2*, committee print, 117th Cong., 1st sess., March 2021 and U.S. Congress, House Committee on Appropriations, *Committee Print on H.R. 133/Public Law 116-260 Book 2 of 2*, committee print, 117th Cong., 1st sess., March 2021.

[42] U.S. Congress, House Committee of Conference, *Making Further Continuing Appropriations for the Department of Homeland Security for Fiscal Year 2019, and for Other Purposes*, Conference Report to Accompany H.J. Res. 31, 116th Cong., 1st sess., February 13, 2019, H.Rept. 116-9, pp. 563, 614, 725, 726, 737, and 739; U.S. Congress, House Committee on Appropriations, *Committee Print on H.R. 1158/ Public Law 116-94*, committee print, 116th Cong., 2nd sess., January 1, 2020, p. 509 and U.S. Congress, House Committee on Appropriations, *Committee Print on H.R. 1865/Public Law 116-94* committee print, 116th Cong., 2nd sess., January 1, 2020, pp. 103, 310, 437, 602, and 615.

Few resources provide information about HAB-related expenditures at federal agencies. GAO released the most recent analysis on federally funded HAB-related activities in 2016.[43] The study found that 12 selected federal agencies spent approximately $101 million from FY2013 through FY2015 on various HAB-related activities.[44] Of the 12 agencies, NOAA reported the largest expenditures, at $39.4 million over the three-year period.[45] The report did not distinguish between spending on freshwater and marine HABs. According to GAO, each of the agencies "had its own methods for collecting HAB-related expenditure data," making comparisons between the agencies difficult. Two additional federal agencies could not provide HAB-related expenditure data, and two other federal agencies provided "expenditure data that [GAO] determined were not sufficiently reliable" for the report.[46]

NOAA HAB Authorities

Congress has charged either the Department of Commerce (DOC) or NOAA, directly, with implementing the majority of marine HAB-related statutory provisions and congressional guidance (**Table 3** and **Table A-1**). DOC typically delegates HAB-related responsibilities to NOAA. Congress has provided NOAA with additional HAB-related direction under broad statutes that mention HABs as a program focus among other issues. Congress also has authorized DOC and/or NOAA HAB-related activities in certain freshwater systems, such as the Great Lakes. As presented in **Table 3**, statutory language and congressional guidance do not always distinguish whether activities are related to HABs in fresh or marine waters; therefore, the sections below describe NOAA's HAB-related activities without distinguishing between fresh or marine waters.

Activities under HAB-specific and broader authorities include coordination, research, monitoring, detection, forecasting, and mitigation. NOAA's HAB-related statutory responsibilities are not fulfilled by one program; rather the agency fulfills its requirements through various line offices and programs. NOAA is administratively organized into six line offices. NOAA identified HAB-related activities in at least three of these line offices: the National Ocean Service (NOS), Office of Oceanic and Atmospheric Research (OAR), and Office of Marine and Aviation Operations (OMAO).[47] Programs with HAB-related efforts under these three line offices include the National Centers for Coastal Ocean Science, National Sea Grant College Program, and Integrated Ocean Observing System, among others.[48] Programs and activities under National Centers for Coastal Ocean Science include the HAB monitoring system; HAB forecasting in certain areas (see **Figure**

[43] The report was in response to a congressional directive in P.L. 114-45, §2(b).

[44] GAO-17-119, p. 16. The agencies included CDC, Department of the Navy, EPA, Food and Drug Administration, National Aeronautics and Space Administration (NASA), National Institute of Environmental Health Sciences, National Institute of Food and Agriculture, National Park Service, National Science Foundation, NOAA, U.S. Army Corps of Engineers, and U.S. Geological Survey (USGS).

[45] GAO-17-119, p. 16.

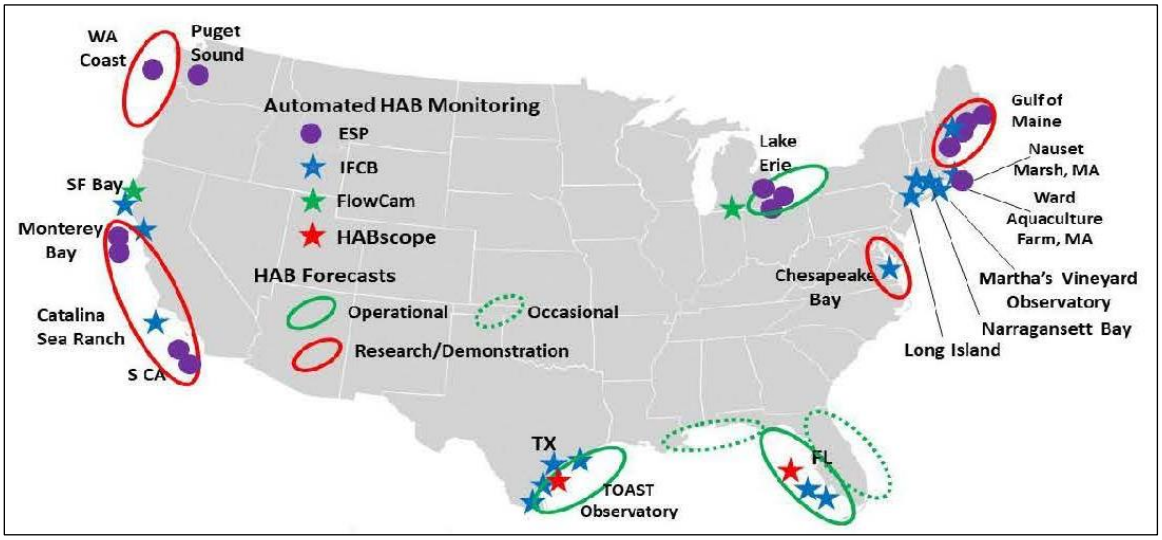
[46] GAO-17-119, p. 16.

[47] NOAA Office of Legislative and Intergovernmental Affairs (OLIA), *NOAA HABHRCA (HAB and Hypoxia) Expenditures (in Millions) FY2010-FY2019*, provided August 2018 (Hereinafter cited as NOAA, *HABHRCA Expenditures FY2010-FY2019)*; NOAA OLIA, *NOAA HABHRCA (HAB and Hypoxia) Expenditures (in Millions) FY2016-FY2020*, provided April 2019 (Hereinafter cited as NOAA, *HABHRCA Expenditures FY2016-FY2020)*; and NOAA OLIA, *NOAA HABHRCA (HAB and Hypoxia) Expenditures (in Millions) FY2017-FY2021*, provided March 2021 (Hereinafter cited as NOAA, *HABHRCA Expenditures FY2017-FY2021)*. NOAA's other line offices are the National Environmental Satellite, Data, and Information Service; the National Marine Fisheries Service; and the National Weather Service.

[48] NOAA, *HABHRCA Expenditures FY2017-FY2021*.

4 for a 2020 map of coastal HAB monitoring instruments and forecasts in the United States); the Ecology and Oceanography of HABs (ECOHAB) program; the Phytoplankton Monitoring Network (PMN); the Monitoring and Event Response for HABs (MERHAB) research program; the Prevention, Control, and Mitigation of HABs (PCMHAB) program; and rapid response programs.[49]

Figure 4. Coastal HAB Monitoring and Forecasting



Source: CRS, adapted from NOAA, National Centers for Coastal Ocean Service and U.S. Integrated Ocean Observing System, *Framework for the National Harmful Algal Bloom Observing Network: A Workshop Report*, December 18, 2020, p. 28.

Notes: ESP = environmental sample processor; FL = Florida; HAB = harmful algal bloom; HABscope = harmful algal bloom scope; IFCB = Imaging FlowCytobot; MA = Massachusetts; NOAA = National Oceanic and Atmospheric Administration; S CA = Southern California; SF = San Francisco; TOAST = Texas Observatory for Algal Succession Timeseries; TX = Texas; WA = Washington.

The automated HAB monitoring legend provides information about the instruments used in each region.

According to NOAA, operational forecasts are those that are conducted consistently, whereas occasional forecasts may be conducted sporadically in response to bloom dynamics. The efforts are "supported primarily with research funding."

Congress also has directed NOAA to implement two additional HAB-related activities: responding to HAB events of "national significance" and estimating the socioeconomic impacts of HABs.

HAB and Hypoxia Events of National Significance

In January 2019, Congress directed the Under Secretary of Commerce for Oceans and Atmosphere to make funds available to affected state or local governments for assessment and mitigation of HAB and hypoxia effects if an event in marine and coastal waters is determined to be an "event of national significance."[50] In July 2019, NOAA published a notice of intent to develop a policy for determining HAB and hypoxia events of national significance in marine and

[49] NOAA, National Centers for Coastal Ocean Science (NCCOS), "Stressor Impacts & Mitigation," at https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/.

[50] P.L. 115-423, 33 U.S.C. §4010. Congress also directed the EPA Administrator to make funding available for events of national significance in freshwaters.

coastal waters.[51] The public comment period on the notice closed in September 2019. In February 2021, NOAA indicated the draft policy was under review by NOAA and DOC.[52] The agency has not yet released the policy. The statute does not include an authorization of appropriations, and Congress has not appropriated funding to NOAA to support implementation of the provision.[53]

Socioeconomic Impacts of HABs

Congress provided appropriations to NOAA in FY2020 to update the estimated annual economic impacts from marine and freshwater HABs in the United States. Congress specified that the study should include

> impacts related to public health, drinking water treatment, commercial fisheries, property values, recreation and tourism, and monitoring and management. The study shall also include an assessment of the estimated annual economic impacts in those U.S. States and territories most impacted by HABs.[54]

According to NOAA, as of May 2021, the agency is supporting numerous activities to estimate annual economic impacts from HABs. These activities include grants for research projects assessing specific economic impacts, a workshop on the socioeconomic effects of marine and freshwater HABs in the United States,[55] updates to a map of national HAB economic impacts,[56] and a new program to fund research that will provide data for an updated assessment.[57]

NOAA HAB Expenditures

NOAA uses appropriations to support both HAB-related intramural efforts at the agency and grants to nonfederal entities. In the 2016 GAO report, NOAA reported that it spent $39.45 million on HAB-related activities between FY2013 and FY2015 (**Figure 5**).[58] According to GAO, several line offices, including NOS, OAR, and OMAO, supported these activities. According to the information NOAA provided to the Congressional Research Service, the agency has spent or estimates it will spend approximately $168.48 million on HAB-related activities between FY2013 and the end of FY2021 (**Figure 5**).[59] NOAA notes that the majority of its HAB-related spending occurs through programs within NOS.[60] Congress has provided NOAA the authority to support

[51] NOAA, "Notice of Intent to Develop a Policy for Determining Harmful Algal Bloom (HAB) and Hypoxia Events of National Significance in Marine or Coastal Waters," 84 *Federal Register* 35854, July 25, 2019.

[52] Email correspondence with NOAA, OLIA, February 26, 2021.

[53] NOAA, NCCOS, "HAB/Hypoxia Events of National Significance," at https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/habhrca/hab-hypoxia-events-of-national-significance/.

[54] U.S. Congress, House Committee on Appropriations, *Committee Print on H.R. 1158*/P.L. 116-93, committee print, 116th Cong., 2nd sess., January 1, 2020, p. 509, and H.Rept. 116-101, p. 23.

[55] See the text box entitled "Identified Research and Policy Needs to Address Harmful Algal Blooms" for recommendations from the workshop.

[56] NOAA, "Hitting Us Where It Hurts: The Untold Story of Harmful Algal Blooms," at https://noaa.maps.arcgis.com/apps/Cascade/index.html?appid=9e6fca29791b428e827f7e9ec095a3d7.

[57] Email correspondence with NOAA, OLIA, May 18, 2021.

[58] GAO-17-119, p. 62.

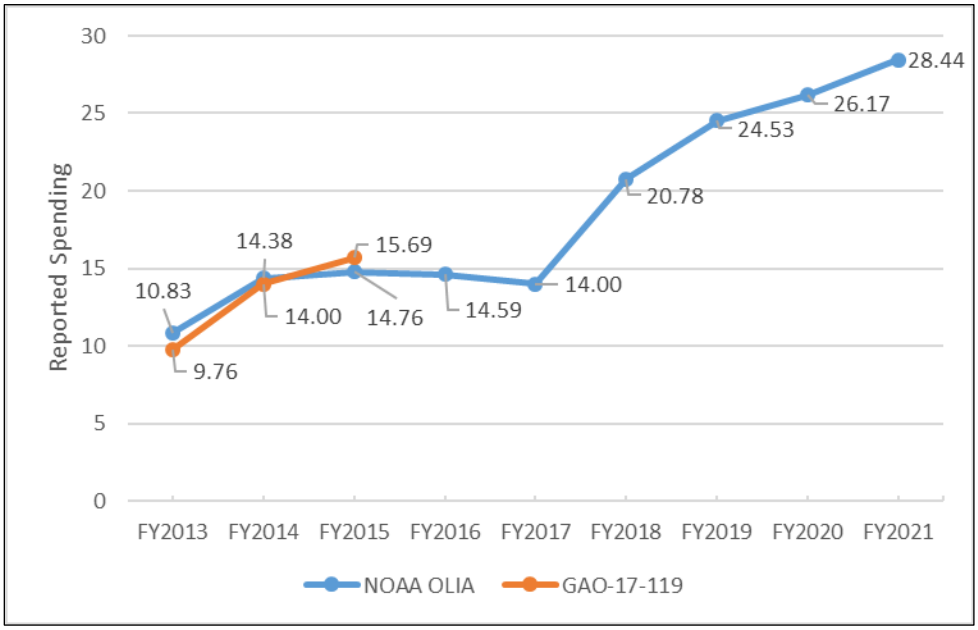
[59] NOAA, *HABHRCA Expenditures FY2010-FY2019*; NOAA, *HABHRCA Expenditures FY2016-FY2020*; and NOAA, *HABHRCA Expenditures FY2017-FY2021*. NOAA indicated that the FY2021 amount is an estimate and that "final amounts depend on final spend plan, budget allocation and results of the competitive review process." The numbers in the GAO report may "differ from those reported to Congress in NOAA's 'HABHRCA Spending 2010-2015' table, which includes hypoxia work" (GAO-17-119, p. 57).

[60] NOAA, *HABHRCA Expenditures FY2017-FY2021*.

activities related to both freshwater and marine HABs; therefore, NOAA's HAB-related expenditures support activities in both settings.

Figure 5. NOAA Reported HAB-Related Final and Estimated Expenditures, FY2013-FY2021

(in millions of nominal $)



Sources: NOAA, OLIA, NOAA HABHRCA (HAB and Hypoxia) Expenditures (in Millions) FY2010-FY2019, provided August 2018; NOAA, OLIA, NOAA HABHRCA (HAB and Hypoxia) Expenditures (in Millions) FY2016-FY2020, provided April 2019; NOAA, OLIA, NOAA HABHRCA (HAB and Hypoxia) Expenditures (in Millions) FY2017-FY2021, provided March 2021; and GAO, Environmental Protection: Information on Federal Agencies' Expenditures and Coordination Related to Harmful Algae, October 2016, GAO-17-119, p. 62.

Notes: GAO = Government Accountability Office; HAB = harmful algal bloom; HABHRCA = Harmful Algal Bloom and Hypoxia Research and Control Act (P.L. 105-383, as amended); NOAA = National Oceanic and Atmospheric Administration; OLIA = Office of Legislative and Intergovernmental Affairs.

As noted in GAO-17-119, the numbers in the report "differ from those reported to Congress in NOAA's 'HABHRCA Spending 2010-2015' table, which includes hypoxia work."

NOAA indicated that the FY2021 amount is an estimate and that "final amounts depend on final spend plan, budget allocation and results of the competitive review process."

Federal Interagency and Other Coordination

Congress has directed several federal agencies to participate in marine HAB-related interagency coordination efforts through a federal task force and regional efforts.[61] Federal agencies also

[61] In some cases, federal agencies may form partnerships between two or more agencies to collaborate on HAB issues (GAO-17-119, p. 22). In its 2016 report, GAO identified several of these federal partnerships, such as the Cyanobacteria Assessment Network Project, which includes participants from EPA, USGS, NASA, and NOAA (GAO-17-119, pp. 98-99).

coordinate their science and research activities with nonfederal entities at the regional, national, and international levels.[62]

Interagency Task Force on Harmful Algal Blooms and Hypoxia

Congress established the Interagency Task Force on HABs and Hypoxia (also known as the Interagency Working Group on HABHRCA) in 1998.[63] Congress has amended the task force's membership and responsibilities several times since its establishment. **Table 4** lists the federal agencies and departments currently required to participate in the task force. Other federal agencies are allowed to join the task force "as the President considers appropriate" (see the notes in **Table 4** for information about other federal agencies that have joined the task force).[64]

Table 4. Statutorily Required Departments and Agencies on the Interagency Task Force on HABs and Hypoxia

(as of the date of this report)

Department of Commerce (chair)[a]
Environmental Protection Agency
Department of Agriculture
Department of the Interior[b]
Department of the Navy
Department of Health and Human Services[c]
National Science Foundation
National Aeronautics and Space Administration
Food and Drug Administration
Office of Science and Technology Policy
Council on Environmental Quality
Centers for Disease Control and Prevention[d]
U.S. Army Corps of Engineers

Source: 33 U.S.C. §4001(a).

Notes: The Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA; P.L. 105-383, as amended) states that the task force also shall include "such other Federal agencies as the President considers appropriate."

As of the date of this report, other agencies in the task force include the Bureau of Indian Affairs, U.S. Coast Guard, and U.S. Fish and Wildlife Service. Additionally, the Environmental Protection Agency and the Office of Science and Technology Policy serve as cochairs, alongside the National Oceanic and Atmospheric Administration (NOAA; see NOAA, National Centers for Coastal Ocean Science, "Harmful Algal Bloom and Hypoxia Research and Control Act," at https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/habhrca/).

a. Responsibilities delegated to NOAA.

b. Responsibilities delegated to the Bureau of Indian Affairs, National Park Service, U.S. Fish and Wildlife Service, and U.S. Geological Survey.

[62] GAO-17-119, p. 22.

[63] P.L. 105-383 and NOAA, NCCOS, "Harmful Algal Bloom and Hypoxia Research and Control Act," at https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/habhrca/.

[64] 33 U.S.C. §4001(a)(14).

c. Responsibilities delegated to the National Institute of Environmental Health Sciences.
d. The Centers for Disease Control and Prevention are part of the Department of Health and Human Services.

Task Force Responsibilities

Under statute, the Interagency Task Force on HABs and Hypoxia is responsible for numerous reports, including assessments of HABs and hypoxia and plans to reduce their impacts.[65] Congress also required the Under Secretary of Commerce for Oceans and Atmosphere, through the task force, to develop a "comprehensive research plan and action strategy to address marine and freshwater HABs and hypoxia.[66] In 2016, the task force released its research plan and action strategy, which recommended several federal actions to address HABs and hypoxia (**Table A-2**).[67] In 2018, the task force released a report on interagency progress in implementing the research plan and the action strategy, which included a discussion of research needs (see the text box entitled "Identified Research and Policy Needs to Address Harmful Algal Blooms").[68] Both the 2016 and the 2018 reports discuss HABs (freshwater and marine) and hypoxia, with recommendations and actions that often may apply to HABs in both types of waterbodies. Under statute, the task force is required to periodically review and revise the action strategy, "as necessary."[69]

In addition to chairing the task force and other HAB-related responsibilities, Congress directed the Secretary of Commerce (who historically has delegated to NOAA) or the Under Secretary of Commerce for Oceans and Atmosphere to lead several task force-related activities, including the following:

- Support, to the extent funds are available, coastal states, Indian tribes, and local governments with measures to protect environmental and public health from the impacts of HABs[70]
- Provide, to the extent funds are available, for local and regional scientific assessments of hypoxia and HABs as requested by states, Indian tribes, and local governments, or for affected areas as identified by the Secretary of Commerce[71]
- Establish a research, development, demonstration, and technology transfer program on methods to prevent, control, and mitigate HABs[72]

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[65] 31 U.S.C. §4001(b)-(g). For example, see the *National Assessment of Harmful Algal Blooms in U.S Waters*, *An Assessment of Coastal Hypoxia and Eutrophication in U.S. Waters*, and *Harmful Algal Bloom Management and Response: Assessment and Plan*, *Scientific Assessment of Marine Harmful Algal Blooms*, and *Scientific Assessment of Freshwater Harmful Algal Blooms* at NOAA, NCCOS, "Harmful Algal Bloom and Hypoxia Research and Control Act," at https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/habhrca/.

[66] 33 U.S.C. §4003.

[67] IWG-HABHRCA, *Harmful Algal Blooms and Hypoxia Comprehensive Research Plan and Action Strategy: An Interagency Report*, February 2016. Hereinafter cited as IWG-HABHRCA, *2016 Research Plan and Action Strategy*.

[68] 33 U.S.C. §4001(i)(4) required the Under Secretary of Commerce to submit a progress report on implementation of the action strategy within two years of the strategy's release. See the progress report at IWG-HABHRCA, *Harmful Algal Blooms and Hypoxia in the United States: A Report on Interagency Progress and Implementation*, March 2018 (Hereinafter cited as IWG-HABHRCA, *Report on Interagency Progress*, 2018). See **Table A-2** for a comparison of the 2016 strategy and 2018 actions, and see the text box entitled "Identified Research and Policy Needs to Address Harmful Algal Blooms" for information on research needs as identified in the 2018 report.

[69] 33 U.S.C. §4003(f).

[70] 33 U.S.C. §4001(d)(4).

[71] 33 U.S.C. §4001(e).

[72] 33 U.S.C. §4001(h)(3).

Identified Research and Policy Needs to Address Harmful Algal Blooms

Several federal and nonfederal entities have identified multiple needs to address HABs. In 2018, the Interagency Task Force on HABs and Hypoxia (for more information about this group, see "Interagency Task Force on Harmful Algal Blooms and Hypoxia") identified several needs, including the following:

- Strategies for effective prevention, suppression, and control of HABs within watersheds and affected waterbodies.
- A rapid-response strategy for assessing HAB exposure
- A greater understanding of the influence of climate change, atmospheric deposition of nutrients, and other factors that may affect the occurrence, frequency, and severity of HABs and hypoxia
- An evaluation of the economic and socioeconomic impacts of HABs and hypoxia and the costs of mitigation
- National datasets on human exposure and cyanobacterial blooms monitoring
- Continued and improved conservation, implementation, and agricultural management practices to reduce nutrients and sediment losses from agricultural lands

A 2019 workshop of international experts identified several categories of research needs related to evaluating the socioeconomic costs of HABs. The categories centered on the need for datasets of environmental conditions before and during HAB events over the long term and over multiple geographic areas, as well as the development of ways to appropriately quantify indirect impacts of HABs.

In 2020, the U.S. National Office for Harmful Algal Blooms held a workshop to develop a national research agenda on the social and economic effects of HABs in the Great Lakes and U.S. marine waters. The workshop attendees developed several sets of recommendations. One set of recommendations would create a socioeconomic assessment framework, with actions related to federal agency coordination, regional or national data sharing and collaboration, collection of baseline information, and engagement of nonacademic communities, among other activities. The other set of recommendations focused on a socioeconomic research agenda with an emphasis on community surveys, transferable research approaches, social impacts, communication methods, cost-benefit analyses, and the costs of social impacts, among other needs.

Individual federal agencies also have identified specific needs related to addressing HABs. For example, the National Oceanic and Atmospheric Administration has recognized the need for a national HAB observing network in coastal regions and the Great Lakes to "efficiently and effectively integrate local, state, regional, and federal HAB observing capabilities and deliver products operationally."

Sources: Interagency Working Group on Harmful Algal Blooms and Hypoxia Research and Control Act, *Harmful Algal Blooms and Hypoxia in the United States: A Report on Interagency Progress and Implementation*, March 2018; North Pacific Marine Science Organization (PICES), *GlobalHAB: Evaluating, Reducing and Mitigating the Cost of Harmful Algal Blooms: A Compendium of Case Studies*, PICES Scientific Report No. 59, November 2020; U.S. National Office for Harmful Algal Blooms, *Proceedings of the Workshop on the Socio-economic Effects of Harmful Algal Blooms in the United States*, March 2021; and National Oceanic and Atmospheric Administration, National Centers for Coastal and Ocean Science and U.S. Integrated Ocean Observing System, *Framework for the National Harmful Algal Bloom Observing Network: A Workshop Report*, December 2020.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

Some federal interagency coordination of HAB-related activities focuses on certain regions, such as the Gulf of Mexico. In 1997, EPA established the interagency Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, also known as the Mississippi River/Gulf of Mexico Hypoxia Task Force.[73] According to its charter, the task force was created to "understand the causes and effects of eutrophication [the process of excessive plant and algal growth due to high levels of nutrients] in the Gulf of Mexico, to coordinate activities to reduce the size, severity and duration of this phenomenon, and to ameliorate its effects."[74] The task force includes

[73] EPA, "History of the Hypoxia Task Force," at https://www.epa.gov/ms-htf/history-hypoxia-task-force.

[74] EPA, *Charter of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force*, May 2018, at

representatives from federal agencies (including DOI, EPA, USACE, USDA, and NOAA), state agencies, and tribes. NOAA and EPA have continuously monitored the Gulf of Mexico hypoxic zone extent since 1985, and NOAA has developed operational hypoxia forecast models.[75] The Gulf of Mexico experiences a variety of HABs in addition to hypoxia.[76]

In 2014, Congress directed the EPA Administrator, through the task force, to submit biennial reports to Congress on progress toward the goals of a 2008 Gulf of Mexico hypoxia action plan.[77] Action plan goals included activities to "accelerate the reduction of nitrogen and phosphorus" and to "advance the science, track progress and raise awareness."[78] The most recent publicly available progress report is from 2017.[79] In the 2017 report, the task force described the actions it had implemented since 2008 and made recommendations moving forward. Recommendations included continuing to implement the 2008 action plan, revising the action plan's coastal goal and committing to accelerated and new actions to reduce nutrients, and tracking environmental results.[80]

The federal agency members of the task force also periodically update and release a strategy on federally focused actions to implement the 2008 Gulf of Mexico hypoxia action plan. The strategy highlights the assistance federal members provide to task force states for developing and implementing their nutrient reduction strategies. The most recent strategy, released in 2016, continued to focus on federal actions related to seven areas: monitoring; decision-support tools; modeling; permitting and regulatory program support; outreach, education, and partnerships; financial and technical assistance; and other initiatives.[81]

U.S. National Office for Harmful Algal Blooms

Congress has directed the Secretary of Commerce for Oceans and Atmosphere to "enhance communication and coordination among Federal agencies carrying out marine and freshwater harmful algal bloom and hypoxia activities and research" and to "work cooperatively and avoid

https://www.epa.gov/sites/production/files/2015-03/documents/2008_9_10_msbasin_tfcharter_revised.pdf; and NOAA, National Ocean Service, "What Is Eutrophication?," at https://oceanservice.noaa.gov/facts/eutrophication.html.

[75] Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, *2017 Report to Congress*, August 2017, pp. 12 and 15, at https://www.epa.gov/sites/production/files/2017-11/documents/hypoxia_task_force_report_to_congress_2017_final.pdf. Hereinafter cited as Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, *2017 Report to Congress.*

[76] NOAA, National Ocean Service, "Gulf of Mexico/Florida: Harmful Algal Blooms," at https://oceanservice.noaa.gov/hazards/hab/gulf-mexico.html.

[77] 33 U.S.C. §4004. For more information on the action plan, see Mississippi River Gulf of Mexico Watershed Nutrient Task Force, *Gulf Hypoxia Action Plan 2008 for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico and Improving Water Quality in the Mississippi River Basin*, 2008, at https://www.epa.gov/sites/production/files/2015-03/documents/2008_8_28_msbasin_ghap2008_update082608.pdf. Hereinafter cited as Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, *Gulf Hypoxia Action Plan*, 2008.

[78] Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, *Gulf Hypoxia Action Plan*, 2008, pp. 31 and 42.

[79] EPA, "Mississippi River/Gulf of Mexico Hypoxia Task Force: Hypoxia Task Force Reports to Congress," at https://www.epa.gov/ms-htf/hypoxia-task-force-reports-congress.

[80] Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, *2017 Report to Congress*, p. 108.

[81] Mississippi River Gulf of Mexico Watershed Nutrient Task Force, *Looking Forward: The Strategy of the Federal Members of the Hypoxia Task Force*, December 2016, at https://www.epa.gov/sites/production/files/2016-12/documents/federal_strategy_updates_12.2.16.pdf.

duplication of effort with other offices, centers, and programs within [NOAA], other agencies on the Task Force, and States, tribes, and nongovernmental organizations."[82]

NOAA coordinates with federal and nonfederal entities partly through the U.S. National Office for Harmful Algal Blooms.[83] The office's primary objective is to "facilitate an open exchange of scientific information and advance the state of knowledge and research efforts" on both marine and freshwater HABs.[84] The office also provides governance and administrative support for the National HAB Committee,[85] described below.

In 2005, a group of federal and nonfederal experts at the Ecological Society of America identified the need for a National HAB Committee.[86] The committee's mission is "to facilitate coordination and communication of activities for the U.S. HAB community at a national level," among other functions.[87] The committee currently comprises individuals from federal and nonfederal entities, including representatives from CDC, EPA, National Institutes of Health, NOAA, National Science Foundation, USACE, and USGS, who serve as ex officio members.[88]

International Coordination

Several regional coordination efforts may support the observation, monitoring, and prediction of HABs. These efforts include the Integrated Ocean Observing System and the Great Lakes Collaborative, among others.[89] Internationally, representatives from federal agencies have participated in several efforts related to HABs research. For instance, NOAA scientists have been part of proceedings of the Intergovernmental Oceanographic Commission's Intergovernmental

[82] 33 U.S.C. §4002(f) and 33. U.S.C. §4002(g).

[83] U.S. National Office for Harmful Algal Blooms, "About the U.S. National Office for Harmful Algal Blooms," at https://hab.whoi.edu/about/.

[84] U.S. National Office for Harmful Algal Blooms, "About the U.S. National Office for Harmful Algal Blooms," at https://hab.whoi.edu/about/.

[85] Email correspondence with NOA, OLIA, May 18, 2021.

[86] Ecological Society of America (ESA), *HARRNESS Harmful Algal Research and Response: A National Environmental Science Strategy 2005-2015*, 2005, p. 59, at https://www.whoi.edu/cms/files/HARRNESS_high-res_18190_23046.pdf. Hereinafter cited as ESA, *HARRNESS*, 2005.

[87] U.S. National Office for Harmful Algal Blooms, "National HAB Committee–Mission," at https://hab.whoi.edu/national-hab-committee/.

[88] U.S. National Office for HABs, "National HAB Committee–Membership," at https://hab.whoi.edu/national-hab-committee/membership/.

[89] Integrated Ocean Observing System, "About Us," at https://ioos.noaa.gov/about/about-us/; and Great Lakes Commission, "HABs Collaborative," at https://www.glc.org/work/habs.

Panel on HABs (IOC IPHAB),[90] GlobalHAB,[91] and the International Council for the Exploration of the Sea (ICES) and its ICES-IOC Working Group on HAB Dynamics,[92] among others.[93]

Potential Issues for Congress

Congress may consider several issues under its legislative and oversight responsibilities to address recurring HABs. For example, Congress may consider whether to amend existing federal agency authorities or provide new authorities related to marine HABs, and/or whether to adjust appropriations for agencies to carry out programs under those authorities. Congress also may examine how effective current coordination activities are in addressing HABs, deliberate whether to alter existing coordinated efforts, or require new forms of coordination between federal or federal and nonfederal entities on marine HAB-related issues.

Federal Marine HAB Expenditures

According to GAO, "federal agencies do not generally receive appropriations dedicated specifically for HAB-related activities, [therefore] the extent and nature of their HAB-related expenditures are not readily available to Congress or the general public."[94] Congress may be interested in better understanding spending on federal marine HAB activities, which could require an annual report or crosscut budget on the subject. For example, in the past, Congress has directed the Office of Management and Budget to submit interagency crosscut budgets with certain information about Chesapeake Bay and Great Lakes restoration.[95] If considered in regard to marine HABs, Congress could direct a federal agency to collect information on activities of interest and associated spending within the agency or across federal agencies.

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[90] Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, Harmful Algal Bloom Programme (IOC HAB Programme), "IPHAB-XV Provisional List of Participants," March 18, 2021, at http://hab.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=27969. In March 2021, the group reported progress on several priorities set in 2019, including facilitating further development of early detection, warning and forecasting of HABs and completing the *Global HAB Status Report* and databases overviews, among other activities (IOC HAB Programme, "Executive Summary of the Fifteenth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms," March 23-25, 2021, at http://hab.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=28008).

[91] IOC HAB Programme, *SCOR-IOC GlobalHAB: Progress Report 2020-2021*, March 18, 2021, at http://hab.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=27958 (Hereinafter cited as GlobalHAB, *Progress Report 2020-2021*). GlobalHAB is a working group of international scientists who share information on HABs across the freshwater-to-marine continuum and the effects of HABs on humans The program received funding from several federal sources in 2020-2021, including the National Science Foundation and NOAA (GlobalHAB, *Progress Report 2020-2021*, p. 21).

[92] The International Council for the Exploration of the Sea (ICES) is governed by a council of representatives from its 20 member countries, including the United States (ICES, "Who We Are - Member countries," at https://www.ices.dk/about-ICES/who-we-are/Pages/Member-Countries.aspx). Various groups within ICES include representatives from U.S. federal and nonfederal entities, such as the ICES-IOC Working Group on HAB Dynamics (ICES, "Members," at https://www.ices.dk/community/groups/Pages/Members.aspx?Acronym=WGHABD).

[93] For information on other international agencies and programs with interest in HABs, see ESA, *HARRNESS*, 2005, p. 28.

[94] GAO-17-119, p. 5.

[95] 33 U.S.C. 1267 Note and 33 U.S.C. 1268a. For example, see Office of Management and Budget, *Chesapeake Bay Restoration Spending Crosscut, Report to Congress*, November 2020, at https://www.chesapeakebay.net/documents/2020-ChesapeakeBay-Crosscut.pdf; or Office of Management and Budget, *Great Lakes Restoration Crosscut, Report to Congress*, November 2020, at https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/11/2020-Great-Lakes-Crosscut-Report.pdf.

Federal Performance and Coordination on Marine HAB-Related Activities

As described above, Congress has directed federal agencies to work together in certain ways and has proposed additional coordinated activities in the 116th and 117th Congresses.[96] Congress may be interested in the performance of existing coordination efforts. Few, if any, evaluations of federal interagency coordination exist. For instance, the 2016 GAO report on federal HAB coordination did not evaluate agency performance or provide recommendations. An evaluation may help Congress consider potential questions such as (1) whether federal HAB-related activities are duplicative or appropriately coordinated across agencies; (2) how well federal agencies are providing appropriate information and services to nonfederal stakeholders; (3) whether and how information on marine HABs from nonfederal stakeholders is incorporated into federal agency activities; and (4) whether nonfederal entities need additional financial and technical support from federal agencies, among other questions.

New and Existing Federal Marine HAB Authorities

Congress has primarily tasked NOAA and EPA with specific marine HAB activities (see **Table 3**). Other agencies support HAB-related efforts under other authorities. Congress may consider whether to change existing federal agency authorities or direct additional federal agencies to fulfill specific roles in marine HAB activities. For example, in the 116th Congress, some Members proposed legislation that would have directed federal entities to support research on certain marine HAB-related topics (i.e., interactions between HABs and other environmental stressors).[97] Other bills would have directed federal entities to modify their operations, support demonstration programs, or develop plans to address HABs in certain locations.[98]

As noted, various stakeholders, such as experts from federal agencies and academic institutions, have identified multiple research and policy needs to address HABs.[99] In some cases, Congress has enacted or proposed legislation that directs federal agency activities to support some of the stakeholder recommendations. For example, Congress directed NOAA in FY2020 to update the estimated annual economic impacts from HABs in the United States.[100] In the 117th Congress, some Members have reintroduced legislation that would direct NOAA to report to Congress baseline information, trends, and climate change effects on the number, duration, size, location, and causes of HABs, among other phenomena, on a biennial basis.[101] Congress may consider establishing new authorities or amending existing authorities (and funding) to support other stakeholder-identified needs, such as establishing a national HAB observing network in coastal and Great Lakes regions.

[96] For example, in the 116th Congress, see provisions in H.R. 335/S. 10 (reintroduced as H.R. 565/S. 66 in the 117th Congress), H.R. 1237, H.R. 3596, H.R. 8632, and S. 914.

[97] For example, in the 116th Congress, see provisions in H.R. 729, H.R. 1237, H.R. 6738, S. 2699, and S. 2802.

[98] For example, in the 116th Congress, see provisions in H.R. 133, H.R. 335/S. 10, H.R. 729, H.R. 3324, H.R. 7575, H.R. 8632, S. 523/H.R. 1243, S. 1811, S. 2802, S. 3591, and S. 5056.

[99] See the text box entitled "Identified Research and Policy Needs to Address Harmful Algal Blooms."

[100] For more information, see section entitled "Socioeconomic Impacts of HABs."

[101] See H.R. 3764, §1403, in the 117th Congress and H.R. 8632, §1503, in the 116th Congress.

New and Existing Federal Marine HAB Funding

Congress also may consider whether to change appropriations amounts or support new types of funding mechanisms for marine HAB activities at federal agencies, depending on an updated assessment of past expenditures, an assessment of federal agency performance, or other information. The funding could support existing marine HAB activities; needs identified by the federal and nonfederal scientific community; emerging issues, such as HAB events of national significance, or other priorities.

As noted, through recent report language accompanying appropriations bills, Congress has directed several agencies to use FY2019, FY2020, and FY2021 appropriations to support HAB-related activities.[102] Several Members in the 116th Congress also introduced legislation that would have provided appropriations for additional HAB-related work at federal agencies (e.g., research into the mechanisms that result in HAB toxins and the impacts of HABs on human health).[103] Other bills in the 116th Congress would have authorized appropriations to fund efforts at nonfederal entities.[104] Some Members in the 116th Congress also proposed the establishment of other funding mechanisms for marine HABs activities, including public-private innovation prizes and revolving loan funds, among others.[105] Some of the legislation proposed in the 116th Congress has been reintroduced in the 117th Congress.[106]

Additional Considerations

Congress has directed federal agencies to carry out certain marine HAB-related activities in annual appropriations bills. Provisions included in appropriations bills are presumed temporary unless a provision explicitly indicates futurity or is of "general character bearing no relation to the object of the appropriation."[107] Congress, as it has in the past, may provide further policy guidance within report or explanatory statement language associated with a bill; however, these provisions are nonbinding. To direct federal activities related to marine HABs in the long term, Members may deliberate whether to introduce and enact provisions previously included only in appropriations bills or as language accompanying appropriations bills.

[102] For more information, see section entitled "Federal Agency HAB Funding".

[103] For example, in the 116th Congress, see provisions in H.R. 21 or H.Amdt. 284 to H.R. 2740.

[104] For example, in the 116th Congress, see provisions in H.R. 414, H.R. 729, H.R. 2405, H.R. 4160, H.R. 6738, and S. 2429.

[105] For example, see S. 933/H.R. 3548 and H.R. 3531.

[106] For example, see H.R. 74, S. 66/H.R. 565, and S. 140.

[107] GAO, *Principles of Federal Appropriations Law, Chapter 2: The Legal Framework, Fourth Edition*, 2016, GAO-16-464SP, p. 2-86.

Appendix. Harmful Algal Blooms: Related FY2021 Appropriations Provisions and Federal Strategy Recommendations and Progress

Table A-1. Summary of HAB-Related Provisions in Explanatory Statement and Committee Reports Accompanying the FY2021 Appropriations Act (P.L. 116-260)

Department/ Agency	Summary of Provisions
U.S. Department of Agriculture/ ARS	Directs ARS to support extramural and intramural research at FY2020 levels or greater for multiple topics, including HABs
Department of Commerce/ NOAA	Directs NOAA's National Ocean Service to use certain amounts of appropriations to • Support federal-nonfederal partnerships to monitor coastal areas for HABs and hypoxia • Work with stakeholders to improve the transition of HAB operational data to operational use • Continue and expand the IOOS pilot program, which monitors and detects HABs through the IOOS regional associations • Establish a pilot IOOS Gulf of Mexico HAB monitoring and detection test bed • Support grants for nonfederal entities for HAB research, prioritizing development of methods to prevent, mitigate, and control HAB events in fresh and marine waters with additional attention in certain areas and the impacts of nutrient pollution in coastal areas on HABs timing, duration, and toxicity • Submit a report to the House Committee on Appropriations on deployed capabilities and prior scope of work on the monitoring and management of nutrient runoff and its associated effect on HABs and on coordination with other federal agencies in the HABHRCA task force[a] • Explore methods to increase monitoring and detection of HABs in freshwater systems with academic stakeholders with expertise in unmanned aircraft systems
Department of the Army/USACE	Directs USACE to use certain amounts of appropriations to • Supplement activities related to HABs in freshwater ecosystems • Work with academic stakeholders to address HAB formation, detection, and remediation in U.S. water resources • Develop "next generation" ecological models to maintain inland and intracoastal waterways • Submit to the House Committee on Appropriations a report on the above activities[b] • Develop a "comprehensive research plan" to address HAB-related research needs and brief the House and Senate Committees on Appropriations on the plan status[c] • Support HAB-related activities including research on methods to mitigate HABs; investigate HABs across multiple regions; develop strategies for early detection, prevention, and management of HABs in water resources; work with academic stakeholders to assess impacts of environmental triggers in riverine systems; and improve early warning capabilities, including through the use of unmanned systems Directs USACE to brief the House Committee on Appropriations on its role in responding to HABs and on its role in the Interagency Task Force on HABs and Hypoxia,[d] and encourages USACE to continue its participation in the task force

Department/ Agency	Summary of Provisions
Department of the Interior/USGS	Directs USGS to use certain appropriations funding to • Support HAB research, including the prevalence of cyanobacteria and toxins in stream and wetland ecosystems and associated health impacts, as well as sediment and nutrient pathways that may result in HABs • Support HAB research under a national water quality program
EPA	Directs EPA to use certain appropriations funding to • Support research to prevent, monitor, predict, characterize, and control HABs, and investigate adverse health effects from HABs and cyanobacteria toxins • Assess the impact of HABs on certain areas in South Florida • Support HAB work under a water quality protection program
Department of Human Health Services/CDC	Directs CDC to use certain appropriations funding for HAB work as part of broader work on emerging and zoonotic infectious diseases

Sources: U.S. Congress, House Committee on Appropriations, *Committee Print on H.R. 133/Public Law 116-260 Book 1 of 2*, committee print, 117th Cong., 1st sess., March 2021, pp. 71, 213-214, 855-856, and 858; U.S. Congress, House Committee on Appropriations, *Committee Print on H.R. 133/Public Law 116-260 Book 2 of 2*, committee print, 117th Cong., 1st sess., March 2021, pp. 1369, 1373, 1393, 1396, 1398, and 1603; U.S. Congress, House Committee on Appropriations, *Report together with minority views to accompany H.R. 7667*, 116th Cong., 2nd sess., July 16, 2020, H.Rept. 116-455, pp. 29-31; U.S. Congress, House Committee on Appropriations, *Report Together with Minority Views to Accompany H.R. 7613*, 116th Cong., 2nd sess., July 15, 2020, H.Rept. 116-449, p. 66; U.S. Congress, House Committee on Appropriations, *Report Together with Minority Views to Accompany H.R. 7612*, 116th Cong., 2nd sess., July 14, 2020, H.Rept. 116-448, pp. 42-43, and 86; and U.S. Congress, Senate Committee on Appropriations, *Report to Accompany S. 2580*, 116th Cong., 1st sess., September 19, 2019, S.Rept. 116-123, p. 77.

Notes: ARS = Agricultural Research Service; CDC = Centers for Disease Control and Prevention; EPA = U.S. Environmental Protection Agency; HAB = harmful algal bloom; HABHRCA = Harmful Algal Bloom and Hypoxia Research and Control Act (P.L. 105-383, as amended); IOOS = Integrated Ocean Observing System; NOAA = National Oceanic and Atmospheric Administration; USACE = U.S. Army Corps of Engineers; USGS = U.S. Geological Survey.

a. The report is due to the committee within 180 days of the bill's enactment. According to NOAA, the report had been drafted and was in review on May 18, 2021 (email correspondence with NOAA Office of Legislative and Intergovernmental Affairs, May 18, 2021).

b. The report is due within 90 days of the bill's enactment. According to USACE, the agency briefed the congressional appropriations committees on research related to next generation ecological modeling on February 16, 2021 (email correspondence with USACE, May 21, 2021).

c. A status update on the report was due within 90 days of the bill's enactment, with the plan due within 180 days of the bill's enactment. According to USACE, the topic was covered in the February 2021 briefing, and the plan is in review (email correspondence with USACE, May 21, 2021 and USACE Invasive Species Leadership Team, "Harmful Algal Bloom Ownership-Agency Responsibility and Reporting," September 14, 2021, Powerpoint Presentation).

d. A briefing is due within 120 days of the bill's enactment. According to USACE, the topic was covered in the February 2021 briefing (email correspondence with USACE, May 21, 2021).

Table A-2. Federal HAB and Hypoxia Action Strategy Recommendations and Progress in Implementation

2016 Recommended Actions	Implemented Actions as of 2018 (Agency)
Add to and improve scientific understanding of HABs and hypoxia as well as their causes and effects, and improve testing and research methods	• Developed certified reference materials and other standardized and validated detection and analysis methods for HAB toxins (multiple agencies) • Conducted studies on toxins in food and on toxin mixtures (EPA) • Developed lower-cost, more effective HAB suppression and control methods that have minimal environmental effects (NOAA and USACE) • Examined the influence of climate change, atmospheric deposition of nutrients, and other factors that may affect the occurrence, frequency, and severity of HABs and hypoxia (EPA) • Developed case definitions for the spectrum of HAB-related illnesses and produced clinical therapeutic guidance for the spectrum of illnesses associated with exposure to HAB cells and toxins (CDC)
Strengthen and integrate new and existing monitoring programs	• Strengthened long-term HAB and hypoxia monitoring activities (multiple agencies) • Integrated new monitoring technologies into emerging U.S. and global ocean-observation systems (multiple agencies) • Developed a rapid-response strategy for assessing HAB exposure (FDA, NOAA, and EPA)
Improve predictive capabilities by developing and enhancing HAB and hypoxia modeling programs, and improve disease surveillance for human and animal exposure, illness, and death	• Developed, improved, and validated HAB and hypoxia models and remote sensing (EPA, NASA, NOAA, and USGS) • Developed enhanced surveillance for human and animal exposure, illnesses, disease, and death resulting from HAB toxins (CDC, EPA, and FDA)
Improve stakeholder communications, including having more effective and more readily available public advisories, stronger connections with susceptible communities, and a better understanding of the socioeconomic and health-related impacts of HABs and hypoxia	• Improved communication and coordination among health and environmental agencies so reports of HAB-associated animal poisonings are used as indicators of potential human-health risk (multiple agencies) • Developed science-based guidelines for cyanotoxins (EPA) • Identified susceptible populations at higher risk for HAB-associated adverse health effects (CDC and EPA) • Expanded stakeholder engagement (multiple agencies) • Evaluated socioeconomic impacts of HABs and hypoxia, as well as the costs of mitigation (NOAA and CDC)

Continue and expand collaborations in research, management, and policy-related arenas	• Continued and expanded relevant research, management, and policy collaborations (USDA and EPA) • Developed guidelines and tests for HAB toxins in drinking and recreational water and improved toxin removal during drinking water treatment (EPA)

Sources: Interagency Working Group on Harmful Algal Bloom and Hypoxia Research and Control Act (IWG-HABHRCA), *Harmful Algal Blooms and Hypoxia Comprehensive Research Plan and Action Strategy: An Interagency Report*, February 2016, pp. 3-4, at https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/NSTC/final_habs_hypoxia_research_plan_and_action.pdf; and IWG-HABHRCA, *Harmful Algal Blooms and Hypoxia in the United States: A Report on Interagency Progress and Implementation*, March 2018, pp. 14-26, at https://cdn.coastalscience.noaa.gov/page-attachments/research/FINAL_USEC%20signed%20-%20Progress%20and%20Implementation%20Report_HABHRCA.pdf.

Notes: Agencies or departments that worked on the implementation of each action are noted in parentheses.

CDC = Centers for Disease Control and Prevention; EPA = U.S. Environmental Protection Agency; FDA = Federal Drug Administration; HAB = harmful algal bloom; NASA = National Aeronautics and Space Administration; NOAA = National Oceanic and Atmospheric Administration; USACE = U.S. Army Corps of Engineers; USDA = U.S. Department of Agriculture; USGS = U.S. Geological Survey.

Author Information

Eva Lipiec
Analyst in Natural Resources Policy

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