Cysts and eggs of many HAB species can pass intact through the digestive tracts of commercially important bivalve species. This research is being examined for the first time in a new ECOHAB-supported project. The research team is assessing potential routes of algae introduction to determine the risk of transferring toxic algal cysts or clams during the transport of live bivalves between sites. The group will also evaluate ways to minimize these risks. They will determine: 1) if washing and purging shellfish intended for transfer can slow or eradicate the transfer of HAB species; 2) if algae species pass intact through the digestive tracts of commercially important bivalve species; and 3) how to design shells that would be suitable for transport following exposure to HAB species. This research will be valuable to aquaculture, shellfish harvesters, and public health managers and can assist in habitat management.

For More Information:

Readers can learn more about the projects in this publication at EPA’s National Center for Environmental Research’s Web site (http://www.epa.gov/cncr). Enter the grant number in the search box on the right, or to obtain a list of all STAR-sponsored ECOHAB projects, enter “Harmful Algal Blooms.”

The following Web sites provide comprehensive information about harmful algal blooms:

The Harmful Algae Page (http://harmfulalgaes.org/site/index): This site provides national reports, all ECOHAB abstracts, information on harmful algae, pictures, and links to other resources. It is supported by the NOAA Center for Sponsored Coastal Ocean Research Coastal Ocean Program.

HARMNESS - Harmful Algal Research and Response: A National Environmental Science Strategy 2005–2015 (http://www.noaa.gov/HARMNESS): This site offers the updated National Plan for Marine Biotoxins and Harmful Algae, designed to guide and reflect the community’s research and management of HABs. The following Web sites provide further information about ECOHAB efforts across the U.S.

ECOHAB Gulf of Maine (http://www.ecohabpm.org): This site provides information for predicting the safety of shellfish consumption.

ECOHAB Pacific Northwest (http://www.ecohonw.org): This site provides information on the HAB species affecting the West Coast. It describes domoic acid poisoning, paralytic shellfish poisoning, and technical challenges associated with detection and monitoring.

ECOHAB Alaska (http://www.ecohabalaska.org): This site provides information on HAB species affecting Alaska.

ECOHAB Northwest Fisheries Science Center Harmful Algal Bloom Program (http://www.nwfsc.noaa.gov/hab): This site provides information on the HAB species affecting the West Coast. It describes domoic acid poisoning, paralytic shellfish poisoning, and technical challenges associated with detection and monitoring.

ECOHAB ECOHAB Administrative Information:

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U.S. EPA Office of Research and Development
Washington, DC
Telephone: 202-501-8015
Perovich.Gina@epa.gov

REFERENCES


3 EcoLog and Oceanography of Harmful Algal Blooms (ECOHAB) Center for Sponsored Coastal Ocean Research (CSCOR), National Oceanic and Atmospheric Administration’s National Centers for Coastal Ocean Research - Current HAB Programs: ECOHAB (http://www.es.epa.gov/ncer/rfa). Enter the grant number in the search box on the right, or to obtain a list of all STAR-sponsored ECOHAB projects, enter “Harmful Algal Blooms.”

4 Fish & Wildlife Science, an online magazine from the Washington Department of Fish and Wildlife.


HARMFUL ALGAL BLOOMS: A NATIONAL AND GLOBAL CONCERN

Two decades ago, few people had heard of “red tides” or harmful algal blooms. Today, these terms have become all too familiar in the nation’s coastal areas, where populations of toxic algae have left shores lined with marine mammals, and resulted in shellfish poisoning among seafood consumers. While the term “toxic algae” is usually used when algae produce toxins, some HAB species produce toxins without being toxic. Often referred to as “red tide” for the color some algae turn affected waters, the blooms have grown in frequency, duration, and scale, becoming a significant threat to our coastal waters. In the U.S. alone, the cost of HABs has been reported to exceed $10 million per year, a conserve estimate that is largely based on fishing and tourism losses and public and environmental health expenses. The projected price tag associated with HABs is expected to exceed several billion dollars over the next several decades.

The consequences of HABs are multidimensional, affecting human health, the balance of aquatic ecosystems, and water quality. In the late 1990s, when Pfiesteria piscicida, a shapeless North Carolina, Maryland strain was implicated in fish kills and health problems among fishermen, the need for more information and better tools to cope with HABs became clear. At that time, no single federal agency had the resources or mandate to address the many facets of the issue. Thus, in 1997, an interagency program on the Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) was initiated to support scientific research on the causes of HABs, their detection, and cause fish kills.

The Northwest Fisheries Science Center Harmful Algal Bloom Program

One of a spurious problem, destruction of populations of algae, called Harmful Algal Blooms, was appear in every coastal state in the nation, affecting diverse on marine ecosystems and threatening public health. Research of Harmful Algal Blooms (ECOHAB) program is improving understanding of these blooms, providing early-detection tools to safeguard the public, and working towards environmentally friendly solutions to this rising problem.
Molecular Probes for Faster Detection of HABs

**Principal Investigator:** David Oldach, University of Maryland, Baltimore; Grant Number R827090

To protect the public, natural resources agencies need to be able to quickly and reliably detect the presence of harmful marine algae, or HABs, so that it leads to health concerns. However, in the late 1990s, when massive fish kills and coastal closures occurred, thousands of HAB occurrences among fishery were reported in North Carolina and Maryland, the algae causing the problem could not be identified readily using light microscopy. Researchers turned to molecular techniques for a solution. They developed a real-time test, a polymerase chain reaction (PCR) assay, that made it possible to identify HABs quickly and reliably. Using this assay, in surveys in Maryland and Delaware, the researchers determined in which rivers and which seasons HABs were most likely to occur. To further enhance the managers, the team also developed assays for other species of concern. The tests are now used by Maryland Department of Natural Resources, North Carolina Department of Environmental Management, and Delaware Department of Natural Resources. The researchers are now using PCR assays to be able to analyze samples in less than 24 hours to prevent public health hazards.

**Outcomes**

- The Maryland DNREC uses the PCR test to help determine the presence of problematic species.
- Researchers are correlating HAB events with human health conditions, for example, formation of domoic acid (a neurotoxin that can cause death). Studies are evaluating if the occurrence of domoic acid in shellfish is dependent on the occurrence of HAB species.
- The researchers added 113 HAB species to GenBank, the National Institutes of Health's genetic sequence database, for general scientific use.
- These methods are being used to assess the presence of harmful algal species in sediments and ship ballast water (funded by EPA and the National Institutes of Health's National Institute of Environmental Health Sciences and the Centers for Disease Control and Prevention). The results were published in the *International Journal of Environmental Research and Public Health*, 2016.

**Determining the Factors Behind Macroalgal Blooms**

**Principal Investigator:** Brian Lapointe, Harbor Branch Oceanographic Institution, Inc., Florida; Grant Number R827084

Not all harmful algal blooms produce toxins, and not all algal blooms involve local species. Over the past decade, coral reefs offshore of Southeast Florida have been devastated by a profusion of seaweeds (macroalgae). Most recently, these seaweeds have outperformed natural reef builders. In underwater surveys, researchers found that the macroalgal seagrass meadows were being consumed by the invasive species. To determine the factors driving the blooms, the scientists have been studying the role of nutrient inputs on algae growth on the PCBs in the Florida Keys. To determine the role of nutrient inputs on algae growth, they are using a combination of techniques, including measurements of nutrient concentrations, phytoplankton and algal community composition, and primary productivity. The researchers are investigating the role of nutrient inputs on the growth of algae to determine if reducing the nutrient inputs can help prevent future blooms.

**Outcomes**

- The destruction of coral reefs by invasive seaweeds has the potential to eliminate domoic acid and become safer for consumption.
- Predicting seafood safety is becoming more important as the demand for seafood increases. The researchers are investigating how to predict the presence of HABs in the seafood industry. They expect to better understand how to predict the presence of HABs in the seafood industry. They expect to better understand how long it takes for shellfish to eliminate domoic acid and become safe for consumption.
- The scientists are investigating the role of nutrient inputs on the growth of algae to determine if reducing the nutrient inputs can help prevent future blooms. They expect to better understand how long it takes for shellfish to eliminate domoic acid and become safe for consumption.
The control and mitigation of blooms remains a challenge. One of the more promising strategies investigated to date is the application of several blooms to flocculate and settle algae cells.\(^1\) Although effective, and in Japan and South Korea, chloride determination is logistical and environmental questions. What types of readily available clays would work best for the harmful algae species in the United States? Can toxins-laden clay farm bottom-shelving plants and animals? Will clay disperse increase nutrient levels in the water? Researchers in this ECOHAB project have assessed the effectiveness of regional clays for the mitigation of three HAB species, including the Florida red tide organism, Karenia brevis. In laboratory and contained field studies, the researchers determined which clays out of 25 different types were most efficient in removing algae from suspension. They also experimented with factors such as particle size, water flow, and salinity to improve removal and mortality of algae cells. They found that clays are effective, and in quick-sinking, are used to create a benthic (bottom-dwelling) habitat to sequester some dissolved algal toxins from the water column. However, the researchers also found that clays can absorb or release nutrients, depending upon different conditions in the water. Through successful experiments, the scientists reduced the release of nutrients by mixing clay with the chemical coagulant, polyaluminum chloride. Importantly, the PMO-Clay can be brought to select bottom-shelving (seabed) marine animals, and it increased the removal of algae cells from the water with ECOHAB funding through NOAA. For example, in calculations of effective removal and mitigation in the region.

Connecting Toxic Blooms to Urban River Discharge


dominating algal species found are problematic species. \(^2\) Researchers used their findings concerning the removal and mortality of algae cells to improve the effectiveness of their clay-based dispersions. \(^3\) Studies showed that the clay dispersal has the potential to quell algae blooms from the water column with minimal environmental ramifications.

Currently, EPA STAR grants are supporting ECOHAB research intended to advance knowledge of the conditions and processes that influence bloom formation, maintenance, and decline. These investigations will examine factors such as nutrient pollution and coastal eutrophication. It is anticipated that these projects will lead to improvements in the following areas:

- Laboratory and mitigation options for decision makers
- Bloom prevention strategies

Addressing Domoic Acid Poisoning

The present marine toxin, domoic acid, produced by the Pseudo-nitzschia alga, can cause neural damage, disorientation, short-term memory loss, and loss of life in vertebrates. Since first associated with the deaths of 100 flamingos and several pet dogs in California in 1991, these blooms have grown in frequency and severity. Several domoic acid-causing the poisoning in

Not all harmful algae blooms produce toxins, and not all blooms involve local species. Over the past decade, cold Pacific Northwest bloom events were most likely to have caused the loss of coastal shellfish fisheries for several years. For example, while most shellfish rapidly correct domoic acid, razor clam retain high toxin levels for months or even a year. A recent new ECOHAB-supported research project is investigating how shellfish incorporate domoic acid into their tissues and how they eliminate it. While investigating the exchange between two trophic levels—from razor clam to crab—the researchers are observing the processes of domoic acid absorption and elimination in these organisms. The model developed from their findings will be especially useful to federal managers who need to predict how long it takes for shellfish to eliminate domoic acid and become safe for consumption.

EXAMPLES OF ECOHAB-SUPPORTED RESEARCH

SAFEGUARDING THE PUBLIC AND AQUATIC RESOURCES:

- Laboratory and mitigation options for decision makers
- Bloom prevention strategies

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Preventing the Transport of Harmful Algae
Principal Investigator: Shenda Muenchow, University of Connecticut; Grant Number 833179

Cells and eggs of many HAB species can pass intact through the digestive tracts of bivalve mollusks. Because shellfish are harvested in large quantities, the potential for bivalves to introduce HAB species into new areas is significant. This research project is assessing how long it takes for bivalves to become safe through the digestive tracts of commercially important bivalve species and determining the risk of algae introduction to determine the risk of HAB species being introduced to new areas.

EPA ECOHAB Administrative Information:
Gina Perovich, Program Manager
U.S. EPA Office of Research and Development
Washington DC
ECOHB 2005 0503 0305 0203 0706
perovich.gina@epa.gov

For More Information:
Readers can learn more about the project in this publication at EPA’s National Center for Environmental Research’s Web site (http://es.epa.gov/ncer/nct). Enter the grant number in the search box on the site, or to obtain a list of all STAR-sponsored ECOHAB projects, enter “Harmful Algal Blooms.”

Preventing the Transport of Harmful Algae:

The following Web sites provide comprehensive information about harmful algal blooms:

http://www.cop.noaa.gov/stressors/extremeevents/hab/current/fact-ecohab.html
http://www.floridamarine.org/features/view_article.asp?id=24817

The following Web sites provide further information about ECOHAB efforts across the U.S.

NOAA Center for Sponsored Coastal Ocean Research - Current HAB Programs: ECOHAB
http://www.oca.noaa.gov/reports/echob/已经有了

The Northwest Fisheries Science Center Harmful Algal Bloom Program
http://www.nwfsfc.noaa.gov/hab/


The Northeast Fisheries Science Center Harmful Algal Bloom Program
http://www.nwfsc.noaa.gov/hab/sara.htm

ECOHAB Pacific Northwest
http://www.ecohabpns.org

ECOHAB Gulf of Maine (http://www生态海洋学/eco)

ECOHAB Photos (http://www.marinebio.org/figures/taxa_article.asp?dp=4817)

ECOHAB and the University of Maryland Center for Environmental Science
http://www.umbio.umd.edu/eco

EPA NRC Funded Project – ECOHAB overview

Highlights from the Interagency Research Program on the Ecology and Oceanography of Harmful Algal Blooms (ECOHAB)

One a sporadic problem, destruction of public health, called Harmful Algae Blooms, was appear in every coastal state in the nation, affecting on marine ecosystems and threatening public health. Research of Harmful Algae Blooms (HABs) program is improving understanding of these blooms, providing early-detection tools to safeguard the public, and working towards environmentally friendly solutions to this rising problem.

HARMFUL ALGAL BLOOMS: A NATIONAL AND GLOBAL CONCERN

Two decades ago, few people had heard of “red tide” or harmful algal blooms. Today, these terms have become all too familiar in the nation’s coastal areas, where profusion of toxic algae has left shores littered with dying fish, mammals, and resulted in shellfish poisoning among seafood consumers. While the term “toxic algae” is usually used when describing Harmful Algal Blooms (HABs), it is important to keep in mind that HABs are actually caused by a diverse group of organisms, including toxic and non-toxic phytoplankton, protozoa, cyanobacteria, harmful marine mammals, and macroalgae. Also, while many of these organisms produce toxins, some HAB species produce toxins without being toxic. Often referred to as “red tide” for the color some algae turn affected waters, the blooms have grown in frequency, duration, and scale, becoming a significant concern throughout the world. In the U.S., the cost of HABs has been reported to exceed $10 billion per year, with continuing and often emerging consequences that are largely based on fishing and tourism losses and public and environmental health expenses. The projected price tag associated with HABs is expected to exceed a billion dollars per year on the next several decades.

The consequences of HABs are multidimensional, affecting human health, the balance of aquatic ecosystems, and water quality. In the late 1990s, when Pfiesteria piscicida was found in North Carolina, Maryland, and Virginia, the blooms were implicated in fish kills and health problems among fishermen, the need for more information and better tools to cope with HABs became clear. At that time, no single federal agency had the resources or mandate to address the many factors of the issue. Thus, in 1997, an interagency research program on the Ecology and Oceanography of Harmful Algae Blooms (ECOHAB) – was initiated to support scientific research on the causes of HABs, their detection, and causes of HABs, their detection, and cause fish kills. Pfiesteria piscicida and other similar protist species were implicated in fish kills and health problems among fishermen, the need for more information and better tools to cope with HABs became clear. At that time, no single federal agency had the resources or mandate to address the many factors of the issue. Therefore, in 1997, an interagency research program on the Ecology and Oceanography of Harmful Algae Blooms (ECOHAB) was initiated to support scientific research on the causes of HABs, their detection, and cause fish kills. Pfiesteria piscicida and other similar protist species were implicated in fish kills and health problems among fishermen, the need for more information and better tools to cope with HABs became clear. At that time, no single federal agency had the resources or mandate to address the many factors of the issue. Therefore, in 1997, an interagency research program on the Ecology and Oceanography of Harmful Algae Blooms (ECOHAB) was initiated to support scientific research on the causes of HABs, their detection, and cause fish kills.

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http://www.cop.noaa.gov/stressors/extremeevents/hab/current/fact-ecohab.html

The Northwest Fisheries Science Center Harmful Algal Bloom Program
http://www.nwfsfc.noaa.gov/hab/sara.htm

ECOHAB Pacific Northwest
http://www.ecohabpns.org

ECOHAB Gulf of Maine (http://www生态海洋学/eco)

ECOHAB Photos (http://www.marinebio.org/figures/taxa_article.asp?dp=4817)

ECOHAB and the University of Maryland Center for Environmental Science
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EPA NRC Funded Project – ECOHAB overview

HARMFUL ALGAL BLOOMS: A NATIONAL AND GLOBAL CONCERN

Two decades ago, few people had heard of “red tide” or harmful algal blooms. Today, these terms have become all too familiar in the nation’s coastal areas, where profusion of toxic algae has left shores littered with dying fish, mammals, and resulted in shellfish poisoning among seafood consumers. While the term “toxic algae” is usually used when describing Harmful Algal Blooms (HABs), it is important to keep in mind that HABs are actually caused by a diverse group of organisms, including toxic and non-toxic phytoplankton, protozoa, cyanobacteria, harmful marine mammals, and macroalgae. Also, while many of these organisms produce toxins, some HAB species produce toxins without being toxic. Often referred to as “red tide” for the color some algae turn affected waters, the blooms have grown in frequency, duration, and scale, becoming a significant concern throughout the world. In the U.S., the cost of HABs has been reported to exceed 10 billion per year, with continuing and often emerging consequences that are largely based on fishing and tourism losses and public and environmental health expenses. The projected price tag associated with HABs is expected to exceed a billion dollars per year on the next several decades.

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Molecular Probes for Faster Detection of HABs
Principal Investigator: David Oldach, University of Maryland, Baltimore; Grant Number R830414

To protect the public, natural resource agencies need to be able to rapidly identify harmful algal blooms (HABs) to lead to health concerns. However, in the last 10 years, many marine fish kills and coastal illnesses have occurred among fishermen were reported in North Carolina and Maryland, the algae causing the problem could not be identified readily using light microscopy. Researchers turned to molecular techniques for a solution. They developed a real-time test, a polymerase chain reaction (PCR) assay, that made it possible to identify Pseudo-nitzschia species. Using this assay in surveys in Maryland and Delaware, the researchers determined that made it possible to identify the dominant organism at two coral reefs from the southeast coast of California in 1991, these blooms have grown in frequency, especially along the West Coast. The control and mitigation of blooms remains a challenge. One of the most promising strategies investigated to date is the application of clays to flocculate and settle algal cells.3,4 Although effective, and in Japan and South Korea, clay dispersion has increased logistical and environmental questions. What types of readily available clays would work best for the harmful algal species in the United States? Can toxin-laden clay harm bottom-dwelling plants and animals? Will clay dispersion increase nutrient levels in the water?

Researchers in this ECOHAB project have assessed the effectiveness of regional clays for the mitigation of three HAB species, including the Florida red tide organism, Karenia brevis. In laboratory and contained field studies, the researchers determined which clays of different textures were most efficient in removing algae from suspension. They also experienced with factors such as particle size, water and salinity to improve removal and mortality of algal cells. They found that clays are effective, and in quick, short-term tests, can reduce algal cell counts to below detection levels. They also found that clays can absorb or release nutrients, depending on different conditions in the water. In the winter and spring months, the researchers found that the removal of nutrients by clays would be beneficial to the aquatic environment, thus reducing the algal blooms in the water column. From their findings, the researchers found that algal blooms can be mitigated to improve the quality of the water and improve environmental conditions.

Outcomes
- The Maryland DNR uses the PCR test funded by this grant to determine the presence of problematic species.
- Researchers are correlating HAB events with human health conditions in collaboration with the Centers for Disease Control and Prevention and the North Carolina Department of Health and Human Services.
- The researchers added 113 HAB species to GenBank, the National Institutes of Health’s genetic sequence database, for general scientific use.
- These methods are being used to assess the presence of harmful algal species in coastal sediments and ship ballast wastewater.

Determining the Factors Behind Microalgal Blooms

Microalgal Blooms
Principal Investigator: Brian Lapointe, Harbor Branch Oceanographic Institution, Inc.; Florida; Grant Number R830424

Not all harmful algal blooms produce toxins, and not all blooms involve local species. Over the past decade, coral reefs around Southeast Florida have been devastated by a proliferation of seaweeds (macroalgae). Most recently, these seaweeds have outperformed natural reef plants and animals. In underwater surveys, researchers found that the dominant seaweed species offshore of Los Angeles, California in 1991, these blooms have grown in frequency, especially along the West Coast. The control and mitigation of blooms remains a challenge. One of the most promising strategies investigated to date is the application of clays to flocculate and settle algal cells.3,4 Although effective, and in quick, short-term tests, can reduce algal cell counts to below detection levels. They also found that clays can absorb or release nutrients, depending on different conditions in the water. In the winter and spring months, the researchers found that the removal of nutrients by clays would be beneficial to the aquatic environment, thus reducing the algal blooms in the water column. From their findings, the researchers found that algal blooms can be mitigated to improve the quality of the water and improve environmental conditions.

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- Researchers used their findings concerning the removal and mortality of algal cells to improve the effectiveness of their clay-dispersion apparatus.
- Studies showed that clay dispersed the potential to reduce algae from the water column with minimal environmental restrictions.

Developing Bloom Control Techniques

Principal Investigator: Michael Worden, WHOI Oceanographic Institution; Grant Number R830250

The proliferation of harmful organisms that dominate the water column is a global problem that affects both marine life and human health. The rapid and accurate detection of harmful algal blooms (HABs) is critical for the protection of public and aquatic resources. The control and mitigation of blooms remain a challenge. One of the most promising strategies investigated to date is the application of clays to flocculate and settle algal cells.3,4 Although effective, and in quick, short-term tests, can reduce algal cell counts to below detection levels. They also found that clays can absorb or release nutrients, depending on different conditions in the water. In the winter and spring months, the researchers found that the removal of nutrients by clays would be beneficial to the aquatic environment, thus reducing the algal blooms in the water column. From their findings, the researchers found that algal blooms can be mitigated to improve the quality of the water and improve environmental conditions.

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Connecting Toxic Blooms to Urban River Discharge

Principal Investigator: David Caron, University of Southern California; Grant Number R831703

Not all harmful algal blooms produce toxins, and not all blooms involve local species. Over the past decade, coral reefs around Southeast Florida have been devastated by a proliferation of seaweeds (macroalgae). Most recently, these seaweeds have outperformed natural reef plants and animals. In underwater surveys, researchers found that the dominant seaweed species offshore of Los Angeles, California in 1991, these blooms have grown in frequency, especially along the West Coast. The control and mitigation of blooms remains a challenge. One of the most promising strategies investigated to date is the application of clays to flocculate and settle algal cells.3,4 Although effective, and in quick, short-term tests, can reduce algal cell counts to below detection levels. They also found that clays can absorb or release nutrients, depending on different conditions in the water. In the winter and spring months, the researchers found that the removal of nutrients by clays would be beneficial to the aquatic environment, thus reducing the algal blooms in the water column. From their findings, the researchers found that algal blooms can be mitigated to improve the quality of the water and improve environmental conditions.

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Addressing Domoic Acid Poisoning

Principal Investigator: Irvin Schultz, University of Washington; Grant Number R831370

The present marine toxin, domoic acid, produced by the Pseudo-nitzschia longa, can cause neural damage, disorientation, short-term memory loss, and long term memory loss. State organizations and EPA are using information from this study to address problems associated with domoic acid in California in 1991, these blooms have grown in frequency, especially along the West Coast. The control and mitigation of blooms remains a challenge. One of the most promising strategies investigated to date is the application of clays to flocculate and settle algal cells.3,4 Although effective, and in quick, short-term tests, can reduce algal cell counts to below detection levels. They also found that clays can absorb or release nutrients, depending on different conditions in the water. In the winter and spring months, the researchers found that the removal of nutrients by clays would be beneficial to the aquatic environment, thus reducing the algal blooms in the water column. From their findings, the researchers found that algal blooms can be mitigated to improve the quality of the water and improve environmental conditions.

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NEW RESEARCH: CAUSES, PREVENTION, AND CONTROL

Currently, EPA STAR grants are supporting ECOHAB research intended to advance knowledge of the conditions and processes that lead to HAB formation, maintenance, and decline. These investigations will examine factors such as nutrient pollution and coastal upwelling. It is anticipated that these projects will lead to improvements in the following areas:
- HAB forecasting ability
- Control and mitigation options for decision makers
- Bloom prevention strategies

EXAMPLES OF ECOHAB-SUPPORTED RESEARCH

Focusing on the role of sewage discharge into coastal water has fueled interest in testing new management strategies and mitigation technology that could diminish the impact of harmful algal blooms. In laboratory and contained field studies, the researchers determined that algal blooms can be mitigated to improve the quality of the water and improve environmental conditions.

Outcomes
- The control and mitigation of blooms remains a challenge. One of the most promising strategies investigated to date is the application of clays to flocculate and settle algal cells.3,4 Although effective, and in quick, short-term tests, can reduce algal cell counts to below detection levels. They also found that clays can absorb or release nutrients, depending on different conditions in the water. In the winter and spring months, the researchers found that the removal of nutrients by clays would be beneficial to the aquatic environment, thus reducing the algal blooms in the water column. From their findings, the researchers found that algal blooms can be mitigated to improve the quality of the water and improve environmental conditions.
- Researchers used their findings concerning the removal and mortality of algal cells to improve the effectiveness of their clay-dispersion apparatus.
-Studies showed that clay dispersed the potential to reduce algae from the water column with minimal environmental restrictions.

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- Studies showed that clay dispersed the potential to reduce algae from the water column with minimal environmental restrictions.
Once a sporadic problem, destruction of alpha-gal, called Harmful Algal Blooms, was apparent in every coastal state in the nation, inflicting damage on marine ecosystems and threatening public health. Research of Harmful Algal Blooms (ECOHAB) program is improving understanding of these blooms, providing early-detection tools to safeguard the public, and working towards environmentally friendly solutions to this rising problem.

HARMFUL ALGAL BLOOMS: A NATIONAL AND GLOBAL CONCERN

Two decades ago, few people had heard of “red tide” or harmful algae blooms. Today, those terms have become all too familiar in the nation’s coastal areas, where profusion of toxic algae has left shores littered with dying fish, and resulted in shellfish poisoning among seafood consumers. While the term “toxic algae” is usually used when referring to Harmful Algal Blooms (HABs), it is important to keep in mind that HABs are actually caused by a diverse group of organisms, including toxic and noxious phytoplankton, some protists, cyanobacteria, harmful; in fact, algae are essential to a productive oceanic food web.

Harmful algal blooms, also known as red tides, are transplanted during normal aquaculture and shellfish harvesting, and can assist in habitat management. Our efforts will be valuable to aquaculturists, shellfish harvesters, and other valuable to aquaculturists, shellfish harvesters, and other.

Preventing the Transport of Harmful Algae

The following Web sites provide further information about ECOHAB efforts across the U.S.

The Harmful Algae Page (http://www.hpl.umces.edu/ecohab): This site provides national reports, all ECOHAB abstracts, information on harmful algae, pictures, and links to other resources. It is supported by the NOAA Center for Sponsored Coastal Ocean Research Coastal Ocean Programs. HARRINESS - Harmful Algal Research and Response: A National Environmental Science Strategy 2005–2015 (http://www.noaa.gov/HARRINESS): This site offers the updated National Plan for Marine Botulism and Harmful Algae, designed to guide and reflect the science community’s research and management of HABs. The following Web sites provide further information about ECOHAB efforts across the U.S:

The Northwest Fisheries Science Center Harmful Algal Bloom Programs (http://www.nwfsc.noaa.gov/hab): This site provides information on harmful algae, pictures, and links to other resources. It is supported by the NOAA Center for Sponsored Coastal Ocean Research Coastal Ocean Programs. HARRINESS - Harmful Algal Research and Response: A National Environmental Science Strategy 2005–2015 (http://www.noaa.gov/HARRINESS): This site offers the updated National Plan for Marine Botulism and Harmful Algae, designed to guide and reflect the science community’s research and management of HABs.

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NOAA Center for Sponsored Coastal Ocean Research - Current HAB Programs: ECOHAB (http://www.hpl.umces.edu/esources/esources/hab/current/facilities.html)

U.S. EPA Office of Research and Development
Washington DC
EPA/600/S-06/005
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For More Information:
Readers can learn more about the projects in this publication at EPA’s National Center for Environmental Research/Environmetal Science Technology Office (NCER/ESTO). Enter the grant number in the search box on the right, or to obtain a list of all STAR-sponsored ECOHAB projects, enter “Harmful Algal Blooms.”


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ECOHAB and the University of Maryland Center for Environmental Science. (http://www.umd.edu/)

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6 NOAA Center for Sponsored Coastal Ocean Research - Current HAB Programs: ECOHAB (http://www.hpl.umces.edu/esources/esources/hab/current/facilities.html)

7伤害有害藻类在海洋中的作用，特别是有害赤潮。1997年，海藻学家加入到有害藻类研究中，提出了对于HABs的定义。2001年，美国环境保护局成立了HABs项目，以支持科学研究在有害藻类的检测、影响，以及控制。ECOHAB目前涉及环境保护局（EPA），海洋与大气海洋学研究所（NOAA），国家海洋和大气组织（NOAA），海上研究基金会（NRF），美国海洋航运研究组织（NSF）。

8 The following Web sites provide further information about ECOHAB efforts across the U.S:

9 The Northwest Fisheries Science Center Harmful Algal Bloom Programs (http://www.nwfsc.noaa.gov/hab): This site provides information on harmful algae, pictures, and links to other resources. It is supported by the NOAA Center for Sponsored Coastal Ocean Research Coastal Ocean Programs.

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