Habitat Hotline Atlantic

Issues of Concern for Atlantic Marine Fish Habitat **September 2005, Volume XII, Number 3**

Harmful Algal Blooms:
A Growing Threat to People and Marine Ecosystems

You have all read the headlines: "Red Tide Blamed for Fish Kills in Florida ", "The Rise in Toxic Tides", "The Cells from Hell." Increasingly, we have become inundated with news about harmful algal blooms (HABs) and their impacts to fishing communities, fishery resources and the marine environment as a whole. While HABs are not necessarily a rare occurrence (early reports date back to biblical times), their increasing frequency worldwide is a mounting concern among fisheries managers and scientists. Where there once were only a few U.S regions impacted by HABs, now almost every coastal state is at risk by more than one harmful algal species (Figure 1). For example, there are neurotoxic shellfish poisoning outbreaks in North Carolina and Florida waters, brown tide outbreaks in New York, Rhode Island and Texas waters, and paralytic shellfish poisoning outbreaks in Georges Bank and Alaska waters.

Background

Marine algae are simple, aquatic plants that have a wide diversity of forms, ranging from single-celled microscopic organisms (microalgae) to larger, more complex macroalgae such as seaweed.

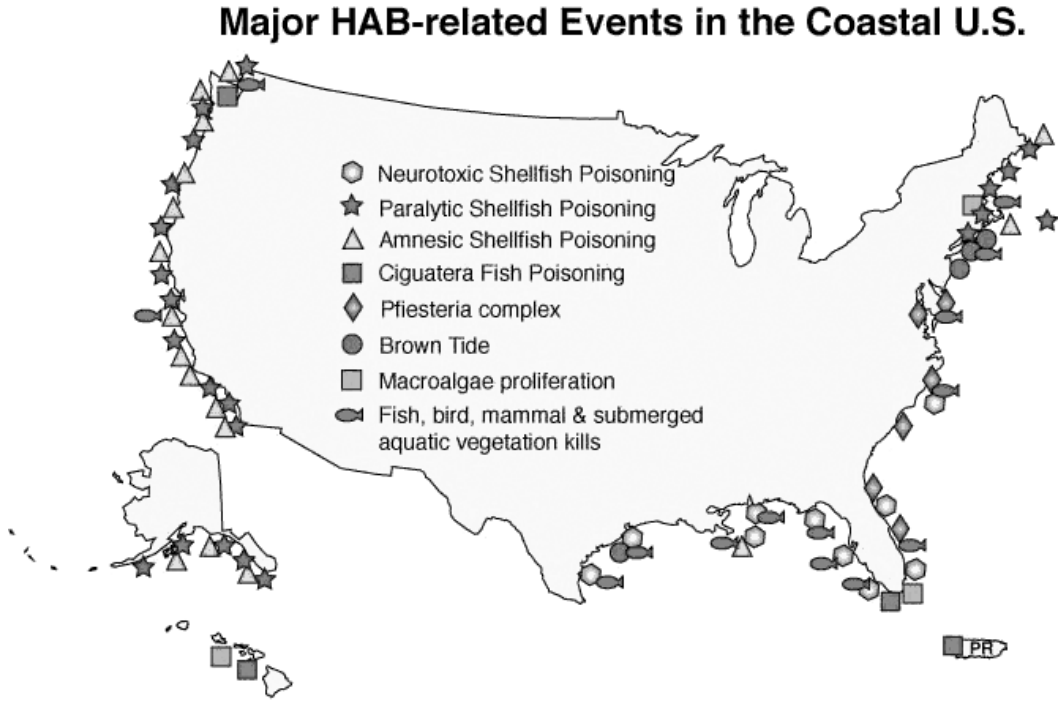

Figure 1. Major Harmful Algal Bloom-related events in U.S. coastal waters (Source: www.whoi.edu/science/B/redtide/index.html).

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Algae live within reach of sunlight, floating in the water column or attached to bottom substrates, including rocks, sediments, coral reefs, and even other plants. Algal blooms occur when populations of algae grow rapidly and produce high concentrations of algae (Figure 2).

Not all marine algae produce toxins. In fact, most do not produce any toxins and, for the few that do, the toxins are usually in such low concentrations that they do not cause any problems. But in high enough concentrations, as in the case of HABs, toxins can harm humans and wildlife, causing sickness and death in humans, wild and farmed fish, seabirds, shellfish and other marine animals. HABs often cause severe socioeconomic impacts to fisheries due to diminished sales of fish and shellfish products as well as lost marine recreational opportunities.

The most well-known HABs are red tides, caused by microscopic algae called dinoflagellates. Under bloom conditions, the high concentration of dinoflagellates can color the water red. However, not all red tides are toxic; toxicity varies from species to species. Diatoms are another type of microscopic algae that form blooms, however, only one species of diatoms (*Pseudonitzschia*) is known to produce toxins. Brown tides are caused by yet other kinds of microscopic algae (*Aureococcus* and *Aureoumbra)*.

Algae do not have to produce toxins to be harmful. Blooms of non-toxic micro- and macroalgae can also cause adverse impacts. For example, when any algal bloom dies, bacteria use available oxygen during decomposition and can produce anoxic conditions (very low to no oxygen). This oxygen depletion can result in the widespread death of fish, shellfish and invertebrates.

Human Impacts

Humans are exposed to HAB toxins mainly through eating contaminated shellfish and fish. Four human-related illnesses are related to the consumption of toxin-contaminated shellfish in the United States (paralytic shellfish poisoning, neurotoxic shellfish poisoning, diarrheic shellfish poisoning, and amnesic shellfish poisoning). These diseases generally cause gastrointestinal and/or neurological symptoms. Paralytic, neurotoxic, and diarrheic shellfish poisonings are caused by dinoflagellates. Amnesic shellfish poisoning is caused by diatoms. Ciguartera, another HAB toxin, is produced by dinoflagellates associated with many coral reef communities. By consuming contaminated reef fish, humans can develop Ciguatera fish poisoning which causes gastrointestinal, neurological and cardiovascular symptoms. Of the approximately 5,000 species of microscopic algae, less than 80 produce potent toxins.

Increasing HABs

Scientists suggest several possible explanations for the phenomenon of increasing HABs. Nutrient enrichment of coastal waters by human activities and increased aquaculture activities may be encouraging growth of harmful algae. Storms, currents and other natural mechanisms may be dispersing harmful algae more widely. Exotic HAB species may be transported and dispersed from ship ballast water or shellfish seeding activities. Long-term climate change (temperature, wind speed, or exposure to the sun's rays) may encourage HABs. Increased scientific and regulatory scrutiny of coastal waters and fisheries products may be revealing more HABs. Improved chemical analytical capabilities may be detecting new toxins and toxic events.

In some cases, the cause of a HAB can be determined. In 1987, a neurotoxic shellfish poisoning event in North Carolina occurred as a result of a Florida bloom being carried by the Gulf Stream up to North Carolina waters, a natural phenomenon with no linkage to human activities. Similarly, a massive paralytic shellfish poisoning bloom in 1972 in Maine was responsible for introducing dormant cysts of the toxin-producing dinoflagellate, *Alexandrim fundyense,* to southern New England waters, where it still persists (see Figure 2). In spring 2005, favorable conditions helped produce the largest *Alexandrim* bloom since 1972. This year's bloom resulted in massive shellfish closures throughout New England. The identification of amnesic shellfish poisoning along the West Coast after 1991 was attributed to increased communication among scientists and improved detection capabilities leading to the identification of the toxin.

Some scientists believe there is a strong link between increasing HABs and coastal pollution, where increased nutrients or changes in the proportion of key nutrients serve to stimulate growth of some species over others, thus, altering the normal species composition of algae. An example where increased amounts of nitrogen and phosphorus have been linked to a HAB is the dinoflagellate, *Pfiesteria.* Discovered in 1988, it has been associated with fish lesions and fish kills in coastal waters from Delaware to North Carolina. In addition, since 1988, *Pfiesteria*-like organisms have been found to occur from Delaware to the Gulf of Mexico. However, determining the exact role that nutrients and other factors may play in promoting toxic outbreaks of *Pfiesteria* is still an active area of research.

Research

States affected by HABs are taking action. Monitoring programs, public education, and outreach efforts are underway. Some states have established hotlines to report fish with lesions and fish kills. State and federal agencies are working together to protect public health and better understand HABs. The U.S. Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), Centers for Disease Control and Prevention (CDC), and the National Institute of Environmental Health Services are just a few of the federal agencies cooperating to address the HAB problem. State coastal zone, public health and natural resource agencies are also contributing to research and monitoring programs.

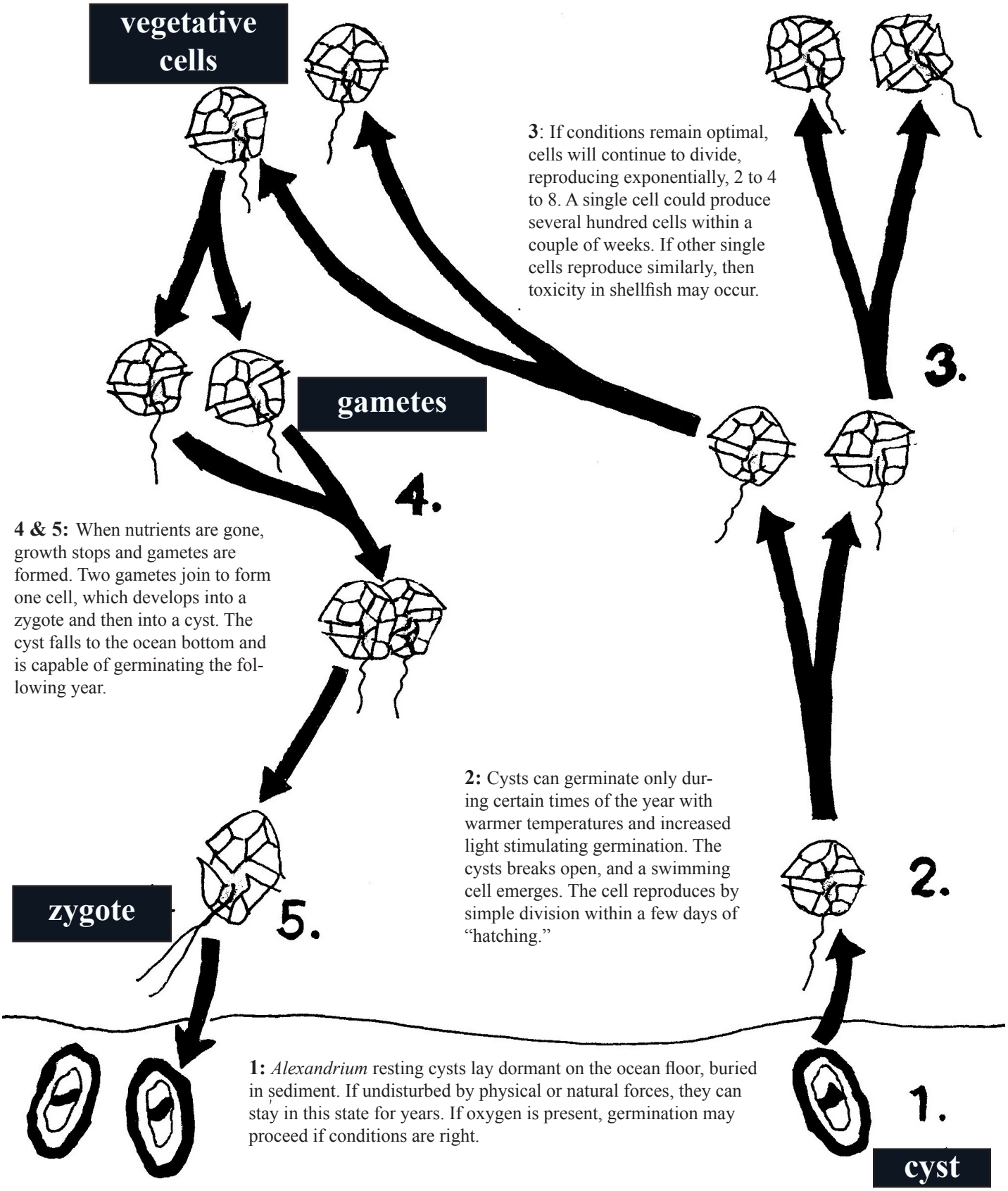


Figure 2. How a toxic algal bloom occurs, the life cycle of one Alexandrium cell (Source: www.whoi.edu/science/B/redtide/index.html)

Efforts are underway to synthesize available information known about HABs and provide it to managers in real time. A successful example of this is the spring 2005 red tide of *Alexadrium* in New England. Oceanographic sampling and modeling were used to measure and predict bloom conditions, and management was able to use the information to make decisions in a timely manner about opening and closing shellfish beds for harvest.

In addition, efforts are also underway to direct and coordinate research to improve our knowledge and understanding of HABs (see ECOHAB side article). A 1992 workshop produced Marine Biotoxins and Harmful Algae: A National Plan, a document that identifies 28 major impediments to effective management of fisheries, public health, and ecosystem problems related to marine biotoxins and harmful algae. A second workshop, held in 1994, developed a national research agenda to guide activities in the specific area of HAB ecology and oceanography. The resulting plan, The Ecology and Oceanography of Harmful Algal Blooms: A National Research Agenda, outlines research priorities intended to guide agencies in the efficient allocation of resources targeted to HAB issues, and to help them formulate new, multidisciplinary HAB initiatives.

Future Conferences

The Third Symposium on Harmful Algae in the United States is scheduled for October 2-7, 2005, in Asilomar, California. For more information about this symposium visit the website http://www.whoi.edu/redtide/3rdsymposium/index.html. A special session on HABs is scheduled during the 2006 Ocean Sciences Meeting, February 20-24, in Honolulu, Hawaii. The session will present current scientific research aimed at developing reliable approaches to forecast bloom development, persistence, and toxicity. For more information about this symposium see the website http://www.whoi.edu/science/B/redtide/announcements/special_session_OS080.html.

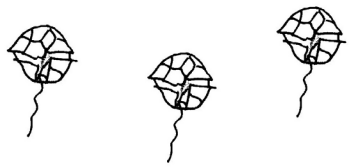
For more information about HABs, visit the HAB website at http://www.whoi.edu/science/B/redtide/index.html.

Sources:

HAB website at http://www.whoi.edu/science/B/redtide/index.html

NOAA Coastal Ocean Service website at http://www.oceanservice.noaa.gov/topics/coasts/hab/welcome.html

National Research Council. 1999. **From Monsoons to Microbes: Understanding the Ocean's Role in Human Health (Chapter 3 Harmful Algal Blooms).** National Academy Press. pp. 59-70. (available online at http://www.nap.edu/books/0309065690/html/59.html)



ECOHAB

ECOHAB is a multi-agency partnership that includes NOAA's Center for Sponsored Coastal Ocean Research (CSCOR), the National Science Foundation, the EPA, NASA, and the Office of Naval Research. The partnership works to combine long-term regional studies and short-term targeted studies to produce new, state-of-the-art detection methodologies for HABs and their toxins. The partnership also hopes to understand the causes and dynamics of HABs, to develop forecasts of HAB growth, transport, and toxicity, and to predict and ameliorate impacts on higher trophic levels and humans. Research results are used to guide management on how to reduce HAB development, impacts, and future threats. Projects are subject to an external peer-review process and include a mix of investigators from academic, state, federal, and non-profit institutions. Regional projects have helped develop new detection methodologies that are already being used in state monitoring programs. The projects have also increased our understanding of the role of human activities in stimulating HABs, determined the movement of toxins through the food web, found natural and developed new control mechanisms that may be useful in mitigation and control, investigated the causes, and impacts of newly emerging HAB problems, and summarized the economic impacts of HABs.

Around the Coast: Spotlight on North Carolina's Coastal Habitat Protection Program

North Carolina, with its wealth of coastal resources, is leading the way towards integrated coastal habitat protection, with the release of its Coastal Habitat Protection Plan (CHPP). In the late 1990s, the North Carolina General Assembly recognized that cooperation and collaboration among disparate state agencies was critical for successful protection of coastal resources. So in 1997 the General Assembly passed the Fisheries Reform Act of 1997. The law required the Environmental Management, Coastal Resources, and Marine Fisheries commissions to adopt a plan to protect and restore critical coastal resources. The resulting Coastal Habitat Protection Plan (CHPP) was started in 1999 and completed in early 2005. The plan describes the six major fish habitats found in coastal waters of North Carolina and provides information on their functions and contributions to the ecosystem. The plan also identifies threats to each habitat and various goals the state wants to achieve that will enhance each type of fish habitat.

The plan is a landmark step forward for the management of fish habitat in North Carolina. North Carolina has 2.9 million acres of estuarine and marine waters, the largest amount of any state on the Atlantic Coast. These habitats are critical not only for resident fish, but also for species that migrate along the coast between Florida and Maine. North Carolina supports billion dollar commercial and recreational fishing industries that rely on state agencies to maintain habitats that can support the fisheries they fish on.

The plans' specific recommendations are organized under four major goals. The first goal is, "to improve effectiveness of existing rules and programs protecting coastal fish habitats." To achieve this goal, the CHPP suggests agencies work together to ensure that water quality, physical conditions in coastal habitats, and monitoring of fisheries is a coordinated effort. The CHPP recommends expanding education and outreach on the value of fish habitat, the threats from human activities, and the management process. This step is critical to ensuring public support for CHPP activities. Finally, the CHPP calls for coordinated rulemaking and law enforcement among the various regulatory agencies and commissions. Coordination among regulators is important to ensure that all aspects that contribute to healthy fish habitat are protected. Goal 1 will help North Carolina agencies build upon existing management rules and processes that work and streamline processes that are ineffectual at coordinating the management of coastal resources.

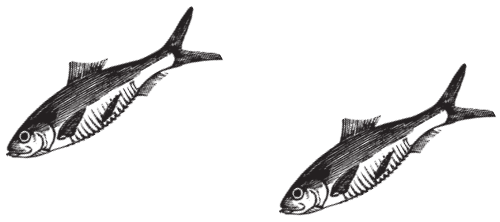
The second goal outlined in the CHPP calls for the identification, designation, and protection of strategic fish habitat. What this means is that North Carolina agencies are asked to use ecologically based criteria to identify and designate habitat areas that are important for the protection of fishery resources. These important habitat areas are called strategic habitat areas. Commissions and agencies will then use existing rules or propose new rules to protect the strategic habitat areas.

Goal Three is, "enhance habitat and protect it from physical impacts." The CHPP identifies various activities that damage or change fish habitats such as dredging or filling. Physical impacts can be reduced, mitigated, and often restored. Thus the CHPP suggests that restoration of degraded habitats be expanded.

The final goal of the CHPP is to protect water quality. In North Carolina and many states, water quality is not managed by habitat or fisheries agencies, but by environmental protection agencies. The intent of the CHPP is to encourage coordination among agencies so that the concerns of fisheries and habitat managers are addressed in water quality standards and laws. For example, the CHPP makes specific recommendations on how to address non-point source pollution, point source pollution, and other activities that affect water quality. Pollution and other water quality issues, although not managed by fisheries and habitat agencies, are critical components. Coordination and cooperation between agencies will tremendously benefit all resources and the agencies themselves.

The CHPP is one of few documents that specifically calls for integrated management with the ultimate goal of protection and enhancement of coastal resources. The CHPP is a strong foundation for North Carolina to continue building upon their dedication to the protection and enhancement of fishery and coastal resources. Federal and other agencies will be able to use the CHPP for guidance in cooperation and integration of management when discussing ecosystem approaches to management of fisheries and other resources.

For more information or to download the CHPP, please visit the web site at: http://www.ncfisheries.net/habitat/index.html



In the News

Six northeast states have filed a lawsuit in federal court against the U.S. Environmental Protection Agency (EPA) claiming the EPA's rules on power plants' water use will cause fish kills and environmental harm. Rhode Island, Connecticut, Delaware, Massachusetts, New York and New Jersey joined in the law suit. The states say the power plants take in too much water and that many aquatic organisms cannot survive in the warm water discharged by the plants.
Source: Associated Press

On July 8, 2005, NOAA announced it awarded $90,000 to the Florida Department of Environmental Protection (FDEP) to restore fishery habitat. Specifically, the funds will be used to speed the recovery for seagrass beds affected by boating activity. When boat propellers hit the fragile seagrasses, the groundings result in holes in the seagrass beds. The funds will be used to restore two boat grounding sites and the scars associated with the groundings.
Source: NOAA press release

On September 9, 2005, U.S. Commerce Secretary Carlos Gutierrez announced a formal determination of a fishery failure in the Gulf of Mexico due to the devastation following Hurricane Katrina. Fishing has virtually been shut down in the affected areas from Pensacola, Florida to the Texas border and in the Florida Keys due to major flooding, damage to fishing boats and fishing ports, waterways clogged with debris and closed processing facilities. The determination makes federal relief funds available under the Magnuson-Stevens Fishery Conservation and Management Act to assess the impacts, restore the fisheries, prevent future failure and assist fishing communities' recovery efforts after a natural disaster. Through the Inter-jurisdictional Act, funds will also be made available to fishermen to alleviate harm resulting from the natural disaster. Gutierreez said the Administration will work with with Congress and affected states to identify needs and develop an emergency plan to meet those needs. Once funds are in place for the disaster assistance plan, fishermen will be notified with information about how to apply for relief.
Source: NOAA press release

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