Written testimony of

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Mr. Chairman and members of the Subcommittee. I am Donald M. Anderson, a Senior Scientist in the Biology Department of the Woods Hole Oceanographic Institution, where I have been active in the study of red tides and harmful algal blooms (HABs) for over 30 years. I am here to provide the perspective of an experienced scientist who has investigated many of the harmful algal bloom (HAB) phenomena that affect coastal waters of the United States and the world. I am also Director of the U.S. National Office for Harmful Algal Blooms, co-Chair of the National HAB Committee, and have been actively involved in formulating the scientific framework and agency partnerships that support and guide our national program on HABs. Today my testimony will briefly summarize HABs, their impacts and trends. I will also provide my perspective on the research, programmatic, and legislative needs for the reauthorization of the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA), and will offer some specific comments on the Discussion Draft of the bill.

BACKGROUND

An excellent background on marine HABs has been provided by Rob Magnien in his written testimony for this hearing, so I will be brief and cover aspects that I feel need to be emphasized or included.

Marine HABs. HABs are caused by algae – many of them microscopic. In the ocean, these species sometimes make their presence known through massive "blooms" of cells that discolor the water (hence the common use of the term "red tide"), sometimes through illness and death of humans who have consumed contaminated shellfish or fish, sometimes through mass mortalities of fish, seabirds, and marine mammals, and sometimes through irritating aerosolized toxins that drive tourists and coastal residents from beaches. Macroalgal or seaweed blooms also fall under the HAB umbrella. Excessive seaweed growth, often linked to pollution inputs, can displace

natural underwater vegetation, cover coral reefs, and wash up on beaches, where the odor of masses of decaying material is a serious deterrent to tourism.

With regard to human health, one major category of HAB impact occurs when toxic phytoplankton are filtered from the water as food by shellfish which then accumulate the algal toxins to levels that can be lethal or cause serious illness in humans and marine animals. These poisoning syndromes have been given the names paralytic, diarrhetic, neurotoxic, azaspiracid, and amnesic shellfish poisoning (PSP, DSP, NSP, AZP, and ASP). All have serious effects, and some can be fatal. A sixth human illness, ciguatera fish poisoning (CFP) is caused by biotoxins produced by dinoflagellates that grow on seaweeds and other surfaces in coral reef communities. Ciguatera toxins are transferred through the food chain from herbivorous reef fishes to larger carnivorous, commercially valuable finfish. Yet another human health impact from HABs occurs when a class of algal toxins called the brevetoxins becomes airborne in sea spray, causing respiratory irritation and asthma-like symptoms in beachgoers and coastal residents, typically along the Florida and Texas shores of the Gulf of Mexico.

With the exception of AZP, all of the poisoning syndromes described above are known problems within the U.S. and its territories, affecting large expanses of coastline. PSP occurs in all coastal New England states as well as New York, extending to offshore areas in the northeast such as Georges Bank, and along much of the west coast from Alaska to northern California. Overall, PSP affects more U.S. coastline than any other algal bloom problem. NSP occurs annually along Gulf of Mexico coasts, with the most frequent outbreaks along western Florida and Texas. Louisiana, Mississippi, North Carolina and Alabama have also been affected intermittently, causing extensive losses to the oyster industry and killing birds and marine mammals. ASP has been a problem for all of the U.S. Pacific coast states. The ASP toxin has been detected in shellfish on the east coast as well, and in plankton from Gulf of Mexico waters. Until recently, DSP was virtually unknown in the U.S., but a major outbreak was recently reported along the Texas coast, resulting in an extensive closure of shellfish beds in that area. CFP is the most frequently reported non-bacterial illness associated with eating fish in the U.S. and its territories, but the number of cases is probably far higher, because reporting to the U.S. Center for Disease Control is voluntary and there is no confirmatory laboratory test. In the U.S. Virgin Islands, it is estimated that nearly 50% of the adults have been poisoned at least once, and some estimate that 20,000 – 40,000 individuals are poisoned by ciguatera annually in Puerto Rico and the U.S. Virgin Islands alone. CFP occurs in virtually all sub-tropical to tropical U.S. waters (i.e., Florida, Texas, Hawaii, Guam, Virgin Islands, Puerto Rico, and many Pacific Territories). As tropical fish are increasingly exported to distant markets, ciguatera has become a problem for consumers far from the tropics. For example, poisonings of restaurant patrons in the Washington DC area and elsewhere were linked to fish caught in the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico south of Texas. The FDA subsequently issued a letter of guidance to seafood processors that recommends that certain fish species caught around that sanctuary should be avoided.

Freshwater HABs. Freshwater HABs are primarily caused by cyanobacteria (blue-green algae), although other organisms such as golden algae also cause destructive and dangerous freshwater blooms in many midwestern states. Cyanobacteria are found in virtually all ecosystems, but are primarily a problem (termed cyanoHABs) in fresh to brackish waters. Their blooms generally consist of dense mats or aggregations of cells floating on the water surface or suspended in the water column. These huge masses of organic material create serious problems for humans and

aquatic ecosystems in two ways. The first is that the biomass of the blooms reduces water transparency, resulting in light limitation that can inhibit the growth of suspended and bottom-dwelling plants. As blooms collapse, decomposition processes deplete oxygen in the water column, killing fish and other organisms that are unable to escape to oxygenated waters. Repeated bloom cycles may irrevocably alter aquatic ecosystems, extinguishing biota that contribute to healthy ecosystems, while creating conditions for continued cyanoHAB bloom dominance.

The second and more serious problem is that many cyanobacteria produce cyanotoxins, some of the most potent natural toxins known to man. Freshwater HABs thus pose serious risks for human and animal health, aquatic-ecosystem sustainability and economic vitality (Dodds et al., 2009; Falconer, 2008; Hudnell, 2008; Lopez et al., 2007; Stewart et al., 2008). From the public health perspective, an unquantified but significant amount of human morbidity and mortality result from exposure to high levels of cyanoHAB toxins during recreational activities and lower doses in drinking water. Health effects can be acute, as might occur after **s**wallowing a mouth full of contaminated water, leading to serious illness or death due to respiratory arrest or organ failure. Lower level exposures cause a multi-system, flu-like illness. Every year there are multiple reports of animal deaths in the U.S. due to cyanotoxin exposure, and occasionally there are reports of human deaths. Most non-lethal cases of acute cyanotoxin poisoning recover within day or weeks. However, an unknown percentage of susceptible individuals continue to suffer neurological and other symptoms for many months or years. The scientific literature also contains reports of chronic illness following acute exposure or repeated, low-level exposure to cyanotoxins. Little is known about the effects of repeated, low-level exposures, but cancer and neurodegeneration are outcomes implicated in the scientific literature. For example, laboratory studies indicate that microcystins are a cause and promoter of liver, colon and other cancers. Microcystin levels in drinking water are potentially linked to liver cancer incidence in Chinese epidemiological studies. Other studies indicate that cylindrospermopsin and other cyanotoxins also may be carcinogenic.

The toxins also affect freshwater ecosystems, where fish, zooplankton, macro-invertebrates, wading birds and aquatic vertebrates suffer further lethal and sub-lethal effects. For example, data from Florida show strong correlations between *Cylindrospermopsis* and cylindrospermopsin concentrations and alligator death rates.

Another important freshwater HAB problem is caused by the "golden algae" *Prymnesium parvum* which blooms in reservoirs, rivers, and lakes, and causes extensive fish kills. These blooms have killed millions of fish in Texas year after year, and have also impacted Arizona, New Mexico, Colorado, Wyoming, North Carolina, South Carolina, Oklahoma, and Nebraska.

Recent Trends. The nature of the HAB problem has changed considerably over the last three decades in the U.S. Virtually every coastal state is now threatened by harmful or toxic marine algal species, whereas 30 - 40 years ago, the problem was much more scattered and sporadic. In inland states, HABs in rivers, lakes, reservoirs, and other water freshwater bodies have increased as well. Overall, the number of toxic blooms, the economic losses from them, the types of resources affected, and the number of toxins and toxic species have all increased dramatically in recent years in the U.S. and around the world (Ramsdell et al., 2005).

There are many reasons for this expansion, some of which involve human activities. Some new bloom events likely reflect indigenous populations that have been discovered because of better

detection methods and more observers rather than new species introductions or dispersal events. Other "spreading events" are most easily attributed to dispersal via natural currents, while it is also clear that man may have contributed to the global HAB expansion by transporting toxic species in ship ballast water. The U.S. Coast Guard, EPA, and the International Maritime Organization are all working toward ballast water control and treatment regulations that will attempt to reduce the threat of HAB species introductions worldwide.

Of considerable concern, particularly for coastal resource managers, is the potential relationship between the apparent increase in HABs and the accelerated eutrophication of coastal waters due to human activities (Anderson et al., 2002). Some HAB outbreaks occur in pristine U.S. coastal waters with no influence from pollution or other anthropogenic effects, but in other areas, linkages between marine HABs and eutrophication have been noted (Anderson et al., 2008). Coastal waters are receiving massive and increasing quantities of industrial, agricultural and sewage effluents through a variety of pathways. Just as the application of fertilizer to lawns can enhance grass growth, algae can grow in response to various types of nutrient inputs. Shallow and restricted coastal waters that are poorly flushed appear to be most susceptible to nutrient-related algal problems in marine systems. Nutrient enrichment of coastal waters often leads to eutrophication and increased frequencies and magnitudes of phytoplankton blooms, including HABs.

The prevalence and duration of harmful algal blooms in freshwater is also rapidly expanding in the U.S. and the world. In part, this reflects rising temperatures, as some HAB species, notably the cyanobacteria, thrive under warmer temperatures. But the main stimulus has come from growing nutrient inputs into our water bodies. Recent assessments by the U.S. Environmental Protection Agency indicate that 44% of river and stream miles and 64% of lake and reservoir acres are impaired pursuant to section 303(d) of the U.S. Clean Water Act (EPA, 2009). Eutrophication, the processes through which the flux of growth-limiting nutrients from watersheds to receiving waters stimulates freshwater HABs, continues to increase (Hudnell 2010). Analyses of data from EPA's first eutrophication survey in 1972 indicated that 10-20% of all U.S. lakes and reservoirs were eutrophic (Gakstatter and Maloney 1975). The Agency recently reported that over 50% of all U.S. lakes and reservoirs are now eutrophic or hypereutrophic (EPA, 2009a). This alarming rate of increase supports my view that a national program on freshwater algal blooms is urgently needed and should be included in the HABHRCA legislation, as detailed below.

Economic and Societal Impacts. HABs have a wide array of economic impacts, including the costs of conducting routine monitoring programs for shellfish and other affected resources, short-term and permanent closure of harvestable shellfish and fish stocks, reductions in seafood sales (including the avoidance of "safe" seafoods as a result of over-reaction to health advisories), mortalities of wild and farmed fish, shellfish, submerged aquatic vegetation and coral reefs, impacts on tourism and tourism-related businesses, and medical treatment of exposed populations. A conservative estimate of the average annual economic impact resulting from marine HABs in the U.S. is approximately $82 million (Hoagland and Scatasta, 2006). Cumulatively, the costs of HABs exceed a billion dollars over the last several decades. These estimates do not include the application of "multipliers" that are often used to account for the manner in which money transfers through a local economy. Furthermore, individual bloom events can approach the annual average, as occurred for example in 2005 when a massive bloom of *Alexandrium* species along the New England coast closed shellfish beds from Maine to

southern Massachusetts. A recent study estimated the direct and indirect costs of the 2005 outbreak at nearly $50 million for Massachusetts and $23 million for Maine. Furthermore, a one-week state-wide closure in Maine (soft-shell clams, mahogany quahogs, and mussels) is estimated to cost the state ~$1.2 M in lost harvester sales and a total economic loss of $2.9 M. Typical duration of harvesting closures in Maine range from 4 to 16 weeks.

There is no national estimate of the economic and social impact of freshwater HABs, but the impacts are certainly significant. For example, a single golden algae outbreak in Texas in 2001 caused an estimated $18 million loss to local economies; these blooms and their associated fish kills are near annual occurrences. Another example is the closure of Grand Lake St. Marys in Ohio last summer due to toxic cyanoHAB blooms. That cost the local community an estimated $200M in lost tourism income. In addition, countless fish, waterfowl, and pets were sickened and killed by the lake's toxic conditions, and the state of Ohio confirmed seven lake toxin-caused illnesses with 21 others possibly linked to lake exposure, including a case in which an individual was temporarily blinded.

HAB PROGRAM DEVELOPMENT

In addition to providing background information on HABs, I was asked to provide my perspective on the research, programmatic, and legislative needs for the reauthorization of HABHRCA. To accomplish this, I will first provide some background on the development of the suite of activities, facilities, and funding programs that constitute our national strategy for dealing with this significant problem in both marine and fresh waters.

Our national marine HAB "program" or strategy is viewed by many colleagues in other disciplines as a model program that has succeeded because of its organization, structure, and planning. As recently as 25 years ago, this was not the case, however, as there was very little research on HABs, and that being conducted in the academic community was scattered and unfocused. To rectify this problem, we formulated a *National Plan for Marine Biotoxins and Harmful Algae* (Anderson et al., 1993) that guided activities in this field for the next 10-15 years. The *National Plan* was broadly based, encompassing ecology, physiology, toxicology, human health, economics, ecosystem health, and many other topics. This breadth exceeded the mandate and resources of any single agency or program, however, and thus for implementation purposes, it was necessary to break the plan into a series of programs on complementary topics. The first thematic area was the "*Ecology and Oceanography of HABs*", which was addressed by the ECOHAB program. This was followed by MERHAB (*Monitoring and Event Response of HABs*), and then by *Ocean and Human Health* (OHH) programs. The latter began with a partnership between the National Institute of Environmental Health Sciences (NIEHS) and the National Science Foundation (NSF), who have supported four *Centers for Oceans and Human Health* that conduct significant HAB research and outreach activities. NOAA then created an *Oceans and Human Health Initiative* (OHHI) that supports extramural research and focused activities at three federal OHH centers.

The 1993 *National Plan* provided the guidance and perspective that led to the creation of several multi-agency partnerships and individual agency initiatives on this topic. Together, ECOHAB and MERHAB have funded over $100 million in marine and freshwater (Great Lakes) HAB research since the programs began in 1996 and 2000, respectively. Significant funding has also been provided by the COHH and OHHI programs. After more than 10 years of strong program growth and diverse research activities, the 1993 National Plan became outdated, however, and thus was replaced by *HARRNESS* (*Harmful Algal Research and Response: A National*

Environmental Science Strategy 2005-2015; Ramsdell et al., 2005). Several hundred scientists and managers, from a wide array of fields, contributed to the knowledge base on which this new national science and management strategy is based. *HARRNESS* is the plan that will guide U.S. HAB research and monitoring well into the future, and is one that I enthusiastically support.

At the conceptual level, *HARRNESS* is a framework of initiatives and funding programs that identify and address current and evolving needs associated with HABs and their impacts. In this context, the existing programs should continue to function, and new ones added to address important gaps. In the former category, ECOHAB is a critical, core program that is needed to address the fundamental processes underlying the impacts and dynamics of HABs. ECOHAB's research results have been brought into practical applications through MERHAB, a program formulated to transfer technologies and foster innovative monitoring programs and rapid response by public agencies and health departments. MERHAB should also continue under the future national plan.

Two relatively new programs (the Centers for Oceans and Human Health (COHH) initiative of NIEHS and NSF and NOAA's OHHI) should also continue as we move forward. They fill an important niche by creating linkages between members of the ocean sciences and biomedical communities to help both groups address public health aspects of HABs. The COHH focus is on HABs, infectious diseases, and marine natural products, whereas the NOAA OHHI Centers and extramural funding include these subjects in addition to chemical pollutants, coastal water quality and beach safety, seafood quality, sentinel species as indicators of both potential human health risks and human impact on marine systems. The partnership between NIEHS, NSF, and NOAA clearly needs to be sustained and expanded in order to provide support to a network of sufficient size to address the significant problems under the OHH umbrella. This is best accomplished through additional funds to these agencies, as well as through the involvement of other agencies with interests in oceans and human health, including, for example, EPA, NASA, FDA, and CDC.

A number of the recommendations of *HARRNESS* are not adequately addressed by existing programs, however. As a result, the HAB community needs to work with Congressional staff and agency program managers to create new programs, as well as to modify existing ones, where appropriate. Specific recommendations are given below in this regard.

Freshwater HABs. With the exception of the Great Lakes, which fall under NOAA's jurisdiction, freshwater systems that are impacted by HABs have not been comprehensively addressed in ECOHAB, MERHAB, or the OHH HAB programs. This is because NOAA's mandate includes the Great Lakes and estuaries up to the freshwater interface, but does not include the many rivers, ponds, lakes, and reservoirs that are subject to freshwater HAB problems.

The reauthorization of HABHRCA in 2004 expanded the Act to include blooms in all U.S. freshwaters. The Act mandated an assessment of freshwater HABs (Lopez et al., 2008), leading to an interagency monograph that described science and research needs (Hudnell, 2008). This effort to address freshwater HABs at the national level was hampered because the Act did not contain a mandate or funding authorization for the EPA, which is the appropriate Agency to establish and maintain such a plan. All U.S. freshwaters are within the purview of the EPA, as defined in the Clean Water Act (2002) and the Safe Drinking Water Act (2002). The Agency acknowledges its mandate for safe and clean water in Goal 2 of the 2006-2011 EPA Strategic

Plan (EPA, 2008), "Ensure drinking water is safe. Restore and maintain oceans, watersheds, and their aquatic ecosystems to protect human health, support economic and recreational activities, and provide healthy habitat for fish, plants, and wildlife". Although the EPA recognizes the need for a National Research and Control Plan for Freshwater HABs (Lopez et al., 2008), the Agency has not begun development of a plan primarily due to the lack of clear Congressional direction and funding.

I believe it is imperative that the reauthorization of HABHRCA contain an EPA mandate and funding authorization for freshwater HABs. I make specific recommendations on this below.

Prevention, Control, and Mitigation of HABs. The 2004 HABHRCA Reauthorization authorized the establishment of three national programs on HABs. Of these, two existed (ECOHAB, MERHAB), but the third did not. This was to be "a peer-reviewed research project on management measures that can be taken to prevent, reduce, control, and mitigate HABs." (HABHRCA Sec. 605 (3)). In response, NOAA has since established the Prevention, Control, and Mitigation of Harmful Algal Blooms (PCMHAB) Program.

Guidelines for the PCMHAB are given in the Congressionally requested *National Scientific Research, Development, Demonstration, and Technology Transfer Plan on Reducing Impacts from Harmful Algal Blooms* (RDDTT Plan; Dortch et al., 2008). This plan includes PCMHAB, but has two other essential components as well. These are: 1) a comprehensive national HAB Event Response program: and 2) a Core Infrastructure program. Together with the PCMHAB component, these are interdependent and critical for improving future HAB research and management, and I therefore urge the Committee to include these as specific, named programs in the legislation. Justification for this programmatic emphasis is as follows.

Prevention, control, and mitigation (PCM) of HABs has always been a priority within Congress. PCM issues were included in the original HABHRCA in 1998, and were included in the 2004 reauthorization. Further rationale for this program is that much of the focus of past HAB research has been on fundamental aspects of organism physiology, ecology, and toxicology, so less effort has been directed towards practical issues such as resource management strategies, or even direct bloom suppression or control (Anderson, 1997). Progress in the area of bloom suppression or control has been slow, but is now increasing due to the new PCMHAB program. Among the impediments to progress is that scientists often choose to focus more on less controversial, and therefore more easily funded lines of work. Societal concern about bloom control strategies that might involve the use of chemicals or engineered or non-indigenous organisms is significant, and therefore it has been difficult to move research from the laboratory to the field. In the case of my own laboratory's work on the use of clay dispersal to control blooms, we have seen that a few vocal opponents can raise environmental concerns that delay or stop field applications, even though this method is environmentally benign in comparison to the damage from the HAB itself, and that this same bloom control strategy is used routinely elsewhere in the world to protect fish farms (e.g., Korea).

Yet another impediment is that for many years, there was no specific funding specified for PCM research. As a result, PCM proposals competed with ECOHAB and MERHAB submissions for funds. Given the controversial nature of many PCM strategies, it is not surprising that peer reviews of the proposals were variable and sometimes negative, and that more conservative projects on bloom dynamics, toxin chemistry, or other topics were selected. **I therefore strongly**

recommend that specific wording be inserted in the draft HABHRCA legislation to sustain a national program on Prevention, Control and Mitigation of HABs, and that specific funds be authorized for that program.

In this context, Congressional oversight may be needed to establish an agency mandate for control of marine and freshwater nuisance species. Unlike the Agricultural Research Service of the USDA, which has a mandate for control of terrestrial plant pests, there is no federal agency with this responsibility for marine waters. This is an area where the growing concern about invasive species could be of great help to the HAB field, as technologies, regulations, policies, and environmental concerns are common to both fields. I can see a great deal of value in the convening of a meeting to in which HAB investigators would meet with those working on control strategies for invasive species, insects, aquatic vegetation, other pest infestations, as well as with those working on bioremediation strategies used for oil spill and pollution events.

Event Response. A major HAB outbreak in the Gulf of Maine in 2009 highlighted the need for an Event Response program as part of the national HAB program. During this event, virtually the entire coastline of the state of Maine was closed to shellfish harvesting due to dangerous levels of toxicity. The same was true for New Hampshire, and for portions of Massachusetts. Government officials, resource managers, and the general public were anxious for information on the offshore extent of the bloom, and it's potential duration, yet there were no research programs ongoing to provide such information. Senator Snowe made a direct request to NOAA to provide this type of information, resulting in a scramble to find funding for ships and research personnel on short notice. Had there been a national HAB Event Response Program, as described in the RDDTT report (Dortch et al., 2008), the response would have been significantly more comprehensive, rapid, and efficient.

This is but one example of the need for rapid response to HABs that occur throughout the U.S. In some cases, local resources are sufficient, but in unexpected events, or those that are more significant and dangerous than normal, additional resources are needed that can be rapidly mobilized and used to protect the public health and fisheries resources. **It is therefore my recommendation that specific wording for a national HAB Event Response program be included in the HABHRCA legislation, and that specific funds be authorized for that program.**

Infrastructure. Researching and implementing new PCM strategies and improving event response will not be possible without certain types of infrastructure, including chemical analytical facilities, reference and research materials, toxin standards, HAB culture collections, tissue banks, technical training centers, and databases. At the present time, many of these facilities or resources are maintained by individual investigators or laboratories, with no centralized coordination or support. Personally, I maintain a culture collection of HAB species that exceeds 400 strains, yet I do not receive targeted funding for its expenses. This has become a significant financial burden that has made me begin culling cultures from the collection. For other infrastructure needs, the necessary resources to not exist, and therefore funds are needed to provide these to the HAB community. For example, analytical standards for some HAB toxins are not available, severely restricting research and management progress. Likewise, molecular probes that allow the accurate and rapid identification of HAB species are also not universally available.

The RDDTT report (Dortch et al., 2008) identifies and prioritizes infrastructure needs for the national HAB program. **What is needed is the Congressional recognition of the need for such a program, and therefore I recommend that specific wording for a national HAB infrastructure program be included in the HABHRCA legislation, and that funds be authorized for this specific program.**

The support provided to HAB research through ECOHAB, MERHAB, Sea Grant, and other national programs has had a tremendous impact on our understanding of HAB phenomena, and on the development of management tools and strategies. Since HAB problems facing the U.S. are diverse with respect to the causative species, the affected resources, the toxins involved, and the oceanographic systems and habitats in which the blooms occur, we need multiple teams of skilled researchers and managers distributed throughout the country. This argues against funding that ebbs and floods with the sporadic pattern of HAB outbreaks or that focuses resources in one region while others go begging. **I cannot emphasize too strongly the need for an equitable distribution of resources that is consistent with the scale and extent of the national problem, and that is sustained through time.** This is the only way to keep research teams intact, forming the core of expertise and knowledge that leads to scientific progress. To achieve this balance, we need a scientifically based allocation of resources, not one based on political jurisdictions. This is possible if we work within the guidelines of *HARRNESS* and with the inter-agency effort that has been guiding its implementation. It is also critical that appropriations be increased to include these new areas of effort. The current programs are effective, and the new ones (PCMHAB, Event Response, and Infrastructure) are needed to complete the coverage of this diverse and widespread problem.

COMMENTS ON THE DRAFT LEGISLATION

I offer the following comments on specific aspects of the HABHRCA Discussion Draft.

Freshwater HAB program. HABHRCA, as enacted and re-authorized, did not contain a mandate or funding authorization for freshwater HABs, other than those covered by NOAA's mandate, which includes the Great Lakes. The freshwater HAB problem is huge, and includes every inland state, as well as those on the coast, which are also faced with marine HAB problems. The EPA is the appropriate Agency to establish such a plan. The 2010 bill to reauthorize HABHRCA contained the EPA mandate, a modest funding authorization, and direction for the Agency to use those funds to support research and control projects for freshwater HABs by becoming a partner with NOAA in the three existing NOAA grant programs (ECOHAB, MERHAB, and PCMHAB). That bill passed in the House with bipartisan support, but did not come up for a vote in the Senate. **I urge this Committee to include the EPA mandate, funding authorization, and direction to participate in existing national HAB funding programs in the current effort to reauthorize HABHRCA.** A National Research and Control Plan for Freshwater HABs will protect our citizens and industries, and ensure that they have a sustainable supply of usable freshwater into the future.

National HAB Program within NOAA. In Section 4, the Discussion draft states that ". . . the Undersecretary, through the Task Force established under section 603(a), shall maintain a National Harmful algal Bloom and Hypoxia Program pursuant to this section". The implication of this sentence is that a formal HABs and Hypoxia Program exists within NOAA, but this is not the case. The program exists as a competitive research activity under the National Center for Coastal Ocean Science (NCCOS). **The wording should be changed to ". . . shall establish and**

maintain . . . .". There are significant benefits to having a formally recognized and congressionally mandated HABS and Hypoxia program within NOAA. This simple wording change will make a huge difference to the way our program is viewed, supported, and managed within NOAA.

Named Programs and Authorizations. In Section 7 of the Discussion draft, the authorization details are not provided. As I stated earlier, Congress has requested that the national HAB research and monitoring effort be expanded to include several new program areas such as prevention, control, and mitigation of blooms, event response, and infrastructure. These enhanced responsibilities and needs will require modest increases to authorization levels.

I have been told very clearly by managers within NOAA that the congressional mandate for HABs and hypoxia provided through HABHRCA is a critical factor in deciding priorities for funding, staffing, and other resource allocations within NOAA. The same holds for individual programs – if they are congressionally recognized and mandated, their longevity and support are assured. **Accordingly, I recommend that the individual programs (e.g., ECOHAB, MERHAB, PCMHAB, Event Response, Infrastructure) be named specifically in the bill**.

Regional Research Action Plans. As emphasized above, HAB phenomena are diverse throughout the U.S., and therefore impacts and research needs will vary across regions. I therefore support the congressional directive to create regional research action plans through a series of meetings involving managers, scientists, government officials, industry, and other stakeholders. My concerns here are the timescale and costs for these meetings. Having participated in a very successful meeting of this type in Florida, I know that a significant cost is involved (at least $250 - 300K), and that considerable time is needed to plan, convene, and then report on the results of such a meeting. Given the inclusion of "freshwater" regions involving inland states, of which there may be many, I can envision NOAA HAB program officials struggling to organize and run a large number of meetings in a short period of time, and having to commit significant funds that would otherwise be directed to research. **I would thus recommend a more gradual approach to the regionalization**.

SUMMARY AND RECOMMENDATIONS

The diverse nature of HAB phenomena and the hydrodynamic and geographic variability associated with different outbreaks throughout the U.S. pose a significant constraint to the development of a coordinated national HAB program. Nevertheless, the combination of planning, coordination, and a highly compelling topic with great societal importance has initiated close cooperation between officials, government scientists and academics in a sustained attack on the HAB problem. Progress thus far has been excellent, as the U.S. HAB program is seen as a model for other scientific disciplines in the U.S. and the world. The rate and extent of progress from here will depend upon how well federal agencies work together, and on how effectively the skills and expertise of government and academic scientists can be targeted on priority topics that have not been well represented in the national HAB strategy. The opportunity for cooperation is clear, since as stated in the ECOHAB science plan (Anderson, 1995), "*Nowhere else do the missions and goals of so many government agencies intersect and interact as in the coastal zone where HAB phenomena are prominent*." The HAB community in the U.S. has matured scientifically and politically, and is fully capable of undertaking the new challenges inherent in an expanded national program. This will be successful only if a coordinated interagency effort

can be implemented to focus research personnel, facilities, and financial resources to the common goals of a comprehensive national strategy.

Mr. Chairman, that concludes my testimony. Thank you for the opportunity to offer information that is based on my own research and policy activities, as well as on the collective wisdom and creativity of numerous colleagues in the HAB field. I would be pleased to answer any questions that you or other members may have.

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Summary points and recommendations

- Marine HABs are a serious and growing problem in the U.S., affecting every coastal state; freshwater HABS are an equally significant problem in inland states. HABs impact public health, fisheries, aquaculture, tourism, and coastal aesthetics. HAB problems will not go away and will likely increase in severity.
- HABs have a wide array of economic impacts, including the costs of conducting routine monitoring programs for shellfish and other affected resources, short-term and permanent closure of harvestable shellfish and fish stocks, reductions in seafood sales (including the avoidance of "safe" seafoods as a result of over-reaction to health advisories), mortalities of wild and farmed fish, shellfish, submerged aquatic vegetation and coral reefs, impacts on tourism and tourism-related businesses, and medical treatment of exposed populations. Cumulatively, the costs of marine HABs exceed a billion dollars over the last several decades. There is no national estimate of the economic and social impact of freshwater HABs, but the impacts are truly significant. For example, the closure of Grand Lake St. Marys in Ohio last summer due to toxic cyanoHAB blooms cost the local community an estimated $200M in lost tourism income.
- A coordinated national HAB Program was created over 15 years ago and partially implemented. That *National Plan* has been updated with a new plan called *HARRNESS* that can guide the next decade or more of activities in HAB research and management. Research and management programs such as ECOHAB, MERHAB, and the Oceans and Human Health initiatives have been highly successful and productive, but new programs are needed to cover gaps such as prevention, control and mitigation of blooms, event response, and core infrastructure.

Recommendations:

- Sustain and enhance support for the national HAB plan called *HARRNESS*.
- Sustain and enhance support for the ECOHAB, MERHAB and OHH programs, and authorize new programs. In the latter context, a separate program on the practical aspects of HAB prevention, control and mitigation (PCMHAB) needs to be authorized, as it was in past HABHRCA legislation, and two new programs (HAB Event Response and HAB Infrastructure) should be authorized as well, each with specific funding lines to insure that resources are indeed directed to these programs by NOAA and EPA.
- Recognize that NOAA will require funds for operations in support of HAB management, such as HAB forecasting; authorize these activities with specific language, and specific funding allocations. This could fall under the Event Response or Infrastructure programs.
- Encourage interagency partnerships, as the HAB problem transcends the resources or mandate of any single agency.
- Freshwater HABs are an important focus but are generally not comprehensively addressed in ECOHAB, MERHAB, or the OHH HAB programs. EPA should therefore be included in the HABHRCA legislation. Clear direction should be provided so that EPA and NOAA move this program forward in a productive and efficient manner. One way to accomplish this is to require EPA to participate in the established or anticipated NOAA programs like ECOHAB, MERHAB, PCMHAB, Event Response, and

Infrastructure.

- The ECOHAB, MERHAB, PCMHAB, HAB Event Response, and HAB Infrastructure programs should be named in the HABHRCA legislation.
- The wording **i**n Section 4 of the Discussion draft should be changed to read that ". . . the Undersecretary, through the Task Force established under section 603(a), shall establish and maintain a National Harmful Algal Bloom and Hypoxia Program pursuant to this section". There are significant benefits to having a formally recognized and congressionally mandated HABS and Hypoxia program within NOAA. Currently, this does not exist.
- The schedule for reports for program implementation, status updates, and multiple regional research action plans is very tight and demanding on NOAA's limited staff. This will also drain considerable resources from the research budget unless separate appropriations are made explicitly for these reports. The schedule could be relaxed, possibly reverting to the 5-year cycle of status reports that was required by the original HABHRCA
- Recommend appropriations that are commensurate with the scale of the HAB problem in both marine and fresh waters. The national HAB program is well established and productive, but it needs additional resources as new topics, responsibilities and tasks are added through new legislation. Research should be peer-reviewed and competitive, and should take full advantage of the extensive capabilities of the extramural research community.

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