Written Testimony, E&E House Subcommittee, June 1, 2011

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<u>Introduction</u>

I extend my appreciation to the Subcommittee Chair, Subcommittee members and staff, and agency administrators for this invitation to discuss the importance of HBHRCA re-authorization to mitigating the frequent and reoccurring blooms of harmful algae that now typify many of our nation's waters.

As my colleagues have just summarized, harmful algal blooms are a serious and recurring threat to human and domestic animal health, living resource viability, ambient dissolved oxygen levels in our eutrophic lakes, reservoirs, and coastal systems, and a substantial economic drain on our already stretched fiscal resources for local governments, states, and agencies responsible for safeguarding or nation's waters and its citizens.

I have prepared comments to outline the spectrum of mitigation options now or soon available for mitigating these recurrent algal proliferations and accumulations. There are some techniques that show high potential for reducing blooms in many systems and in some areas and other nations, are applied more frequently than we do in the U.S. Just as on the extremely productive US farmlands, the supply of nutrients to US waters governs all algal production, and thus reducing these inputs will have the greatest impact at limiting these 'events'. However, that focus area is not integral to HABHRCA but addressed in other legislation and existing Federal programs and agencies. HABHRCA <u>IS</u> critical to exploring the reasons for these recurring blooms, and most importantly 3 critical factors for reducing these recurring aquatic stresses locally to nationally.

<u>Mitigation and Prevention of Harmful Algal Blooms</u>

First, HABHRCA authorizes support for expanding prevention, control, and mitigation research for harmful algae, a recent US commitment long after a report from the community requested such a program more than a decade ago. Through HABHRCA, NOAA's Center for Sponsored Coastal Ocean Research now administers a Prevention, Control, and Mitigation competitive research program which funds research projects designed to develop and apply technologies to reduce harmful blooms in US waters. Based on research in freshwaters from China and saline waters from Korea, Japan, the Philippines, and Florida's western shelf in the Gulf of Mexico, an inexpensive but very efficient bloom mitigation technique employing sediment to bind with and remove bloom algae from the water column looks very promising as an operational technology for bloom removal. I am part of a recent award, focusing on removing blooms of toxic, dense surface scum algae *Microcystis aeruginosa*, common throughout the world. This bloom-former can produce the toxins known as microcystins, lethal to domesticated animals drinking from lakes, ponds, and tributaries containing *M. aeruginosa* blooms and induce liver tumors in humans and other animals through continuous lower level exposures over time. Our laboratory work over the past 3 years with an honors undergraduate research team at the University of Maryland indicates that laboratory grown and field collected blooms are rapidly removed from the water column on additions of mixtures of local sediments and a crab shell by-product (chitosan). We are now expanding that work to field blooms in a lake outside Denton, MD where blooms of the algae will be trapped in large containers and treated with sediment-chitosan mixtures to determine removal efficiencies for these field conditions and importantly fate of the settled bloom and its toxin. We believe that the technique will work very well, freeing the water from the cells and the toxin and thereby reducing toxin impacts on domestic animals drinking from the lake as well as citizens (such as Girl Scouts in the Girl Scouts of America camp surrounding the lake) using the lake for swimming, boating, and fishing. From these results, we anticipate moving to open water applications for eventual technique application as a standard protocol for state staffs deployed to remove blooms from Maryland's fresh and bay waters. HABHRCA enabled program initiation, selection of the project for support, and most likely use of this inexpensive procedure as a standard tool in protecting state waters in the next 5-10 years.

Authorization enables exploration of other mitigation procedures used in other systems and nations. For example, in freshwater systems with rapidly increasing depths from shores, aeration through bubbling or mixing of the water column has proven effective in reducing blooms of these dense surface 'scums' so common globally. Some chemical additives have also been used to remove developed blooms, such as copper sulfate or permanganate additions. The former is a concern, however, due to ancillary copper toxicity issues while permanganate additions must be used cautiously due to the bursting of bloom cells and release of internal toxins into the surrounding water or living resource mortalities if too much of the permanganate is added. In systems with higher salinity such as estuaries or coastal ocean areas, sediments can be added for removing cells as discussed above, using compounds other than chitosan to bind the sediments and algae. These approaches appear very promising but not without substantial effective outreach and education of local residents to the benefits of the additions versus the impacts of non-intervention (see social science needs below).

Other techniques propose to harvest the bloom biomass from bloom areas and concentrate the algal cells for harvest and biofuel/compost production. Large filtration devices or multiple screens can be deployed in the water, concentrating bloom biomass for removal and processing. This technique, however, is expensive and can be used in small bloom areas only, or if implemented in very large blooms, is hardware and labor intensive and therefore requires very large fiscal commitments. Preventative technologies can also be used to create chemical conditions in receiving waters that favor beneficial algae rather than the harmful species. One alternative is to divert waters known to support algal blooms across fine meshes on gently sloped land and allow the natural flora to colonize the mesh and remove nutrients supporting expected recurring blooms, yielding attached algae for harvest, processing, and biofuel production. These 'algal turf scrubbers' (ATS) have been used effectively in multi-acre systems in Florida and Texas and been used in demonstration projects in the Chesapeake Bay watershed. Similarly, filling large translucent floating 'bags' with bloom-supporting water followed by enrichment with rapidly growing high lipid-containing algae can result in high nutrient uptake by the 'preferred alga', reducing the likelihood for growth of the harmful species. Harvest of the lipid-rich algae can, in turn, yield biofuels. A third option is the introduction of materials that bind available nutrients, with one commercial product Phoslock® very effective at binding available phosphorus in the water as well as in loads entering waters treated with the compound. It will continue to bind phosphorus, the nutrient that favors the proliferation of freshwater cyanobacteria generally, as long as the binding sites of the Phoslock remain available. All three of these preventative measures, however, are costly. ATS systems require land and initial construction across several acres but continuous algae harvest and returns from the production of butanol, omega-3 fatty acids, compost, and carbon and nutrient credits make long-term profit probable; additionally nutrients in river discharges are also continuous, insuring a likely permanent source of nitrogen and phosphorus to produce the algae in the ATS and reduce the likelihood for harmful algae production in natural waters.

<u>The Importance of Social Sciences from HABHRCA</u>

Outreach and education are critical to future application of research results to societal problems in US waters and hence social science outlined in HABHRCA insures effective and continuous dialog with citizens and stakeholders directly or indirectly tied to harmful algal bloom impacts or intervention. It is currently a required component of the Prevention, Control, and Mitigation Program administered by NOAA, a direct result of HABHRCA. The public is deeply concerned about the proliferation of blooms in local waters, and informing the community on the detrimental aspects of blooms versus the benefits to local health, healthy ecosystems, and local livelihoods on bloom removal is now integral to NOAA's research commitment. In the program, researchers on the blooms, their fate, and aspects of toxin removal now actively collaborate with social scientists to work with citizens and other stakeholders to outline the bloom problem, potential impacts on the local community and the waters they use, and modes of intervening in reducing these threats to local-to-regional citizens and user groups. An example of this interaction of science and citizens is embedded in our current Denton, MD project where natural and social scientists will meet with citizens next month to encourage discussion, communication, and cooperation in reducing the bloom effects in the local lake. Without this comraderie and understanding, no matter how efficient the technique is in removing a local bloom, citizen anxiety of 'interfering with mother nature' could prevent any routine mitigation in state waters, effectively preventing protection of citizens and their animals and health, perpetuating the *status quo* of dying animals and threats to citizen health from toxin exposure. Social science research and subsequent citizen-scientist cooperation arising from HABHRCA are critical to future success in routinely mitigating blooms in our very productive national waters.

<u>National Integration, Coordination, and Reporting of Harmful Algal Bloom Management, Research, and Prevention, Control, and Mitigation</u>

An effective collaboration of scientists and non-scientists must be informed and facilitated by strong Federal leadership, so I encourage continued support of intramural NOAA staffing to meet this national need. National workshops must be held to collect needed expert opinion of on-going and emerging harmful algal issues, draft reports required by Congress and agency leaders, and provide career opportunities for students entering the field to protect future citizens from these expanding blooms and toxins. NOAA's Center for Sponsored Coastal Ocean Research staff have provided this excellence in the past 15 years, but excellence requires support so HABHRCA re-authorization and subsequent agency appropriations for intramural coordination, integration, and reporting in NOAA and would insure continued national leadership for the excellent research needed (supported in NOAA-administered competitive peer-reviewed extramural research for the Ecology and Oceanography of Harmful Algal Blooms (ECOHAB), Monitoring and Event Response of Harmful Algal Blooms (MERHAB), and Prevention, Control, and Mitigation of Harmful Algal Blooms (PCM HAB)), communication with scientists and users of that science, and implementation of mitigation procedures most effective at reducing threats to our citizens and ecosystems.

<u>Re-Institution of EPA Leadership for Freshwater Harmful Algal Bloom Research, Response, and Prevention, Control, and Mitigation</u>

One more point needs to be made: previous HABHRCA language identified EPA as a leader in Freshwater Harmful Algal Bloom research and the language is missing in this year's re-authorization. Freshwaters are beyond NOAA's mandate and hence it is important to re-institute the EPA lead role in Freshwater Bloom Research as EPA has a strong and historic commitment to freshwater health, so EPA is a natural lead for specific harmful algae research and mitigation. This is beyond its identified role in water pollution and nutrients, and re-authorization should re-install the requirement for EPA leadership in specific algal bloom research efforts.

<u>Concluding Remarks</u>

I appreciate the opportunity to the subcommittee of the importance of re-authorizing HABHRCA for safe-guarding our nation's waters from toxins and bloom-induced losses to our economies and health of our citizens, their animals, and our important and productive aquatic ecosystems.