TESTIMONY
OF
DR. RICHARD GREENE
CHIEF
ECOSYSTEM DYNAMICS AND EFFECTS BRANCH
GULF ECOLOGY DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

HEARING ON
THE HARMFUL ALGAL BLOOMS AND HYPOXIA RESEARCH AND CONTROL AMENDMENTS ACT OF 2011
BEFORE THE
U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
June 1, 2011

Good afternoon Chairman Harris, Ranking Member Miller, and other members of the Subcommittee. My name is Richard Greene, with EPA's Office of Research and Development (ORD). For the last 13 years, I've served as Chief of the Ecosystem Dynamics and Effects Branch at the Gulf Ecology Division, within the National Health and Environmental Effects Research Laboratory. I have a Ph.D. in Oceanography and over the last 10 years have been the ORD lead for Gulf of Mexico hypoxia research and estuarine nutrient research in the Gulf. Although I serve in an ecology research Division along the Gulf of Mexico, this testimony addresses programs across EPA offices and laboratories relevant to the focus of this hearing. It is a pleasure to be here with you today to discuss the EPA's research relating to harmful algal blooms and hypoxia.

HARMFUL ALGAL BLOOMS AND HYPOXIA – THREATS TO HUMAN HEALTH AND ECOSYSTEMS

Toxic or otherwise harmful algal blooms and hypoxia, or low dissolved oxygen, represent significant and continuing threats to freshwater, estuarine and coastal ecosystems, aquatic life and human health. Scientific understanding of the causes and impacts of harmful algal blooms and hypoxia on aquatic ecosystems and human health has progressed over the last 5-10 years. However, there is still much to be learned to improve our ability to predict when and where those

events will occur, the specific impacts they will have on human health and aquatic ecosystems, and how best to prevent, control or mitigate those problems. We know that by-and-large many HAB and hypoxia events are inextricably linked to nitrogen and phosphorus pollution. However, we need to improve the science supporting the development of sustainable solutions for controlling and reducing nutrient pollution, HABs and hypoxia, and protecting water resources and human health. EPA, working with NOAA, and other federal, state, and private sector partners, is committed to that goal.

Nationally, nitrogen and phosphorus pollution is one of the top causes of water quality impairments. EPA's National Aquatic Resource Surveys (NARS) show that of the stressors assessed, nitrogen and phosphorus are the most pervasive in the nation's wadeable streams, with more than 200,000 stream miles showing high concentrations (those greater than 95 percent of the regionally-relevant least-disturbed reference condition)[1]. The NARS also report that an estimated four million lake acres showed high concentrations of phosphorus, and 1.9 million acres showed high concentrations of nitrogen[2]. Streams and lakes with high levels of nitrogen and phosphorus were about two times more likely to have poor biological health[3]. For streams, biological health was determined by evaluating the health of macroinvertebrate communities compared with least-disturbed, regionally-relevant, reference conditions. In lakes, biological condition was determined by analyzing the condition of zooplankton and phytoplankton communities using an observed/expected model. The ecological impacts of excess nutrients on our waters includes harmful algal blooms. The recent NARS lakes assessment found microcystin (an algal toxin that can harm humans, pets, and wildlife) present in about one-third of lakes and at levels of concern in one percent of lakes based on World Health Organization

[1] Wadeable Streams Assessment: A Collaborative Survey of the Nation's Streams
EPA 841-B-06-002 December 2006. Chapter 2 – see page 35 -
http://water.epa.gov/type/rsl/monitoring/streamsurvey/upload/2007_5_9_streamsurvey_05_chap2a_5-2-07.pdf

[2] Note – The NLA reported information as the number and/or percent of lakes. See - U.S. Environmental Protection Agency (USEPA). 2009. *National Lakes Assessment*: *A Collaborative Survey of the Nation's Lakes.* EPA 841-R-09-001. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C. See Chapter 3 - http://water.epa.gov/type/lakes/upload/nla_newchapter3.pdf

To make the lake statement more consistent with the streams statement (e.g., using miles and acres rather than miles and percent of lakes), ORD-Corvallis calculated the area associated with the % of lakes presented in the NLA document on page 26. The area figures were emailed by Steve Paulsen, EPA-ORD to Sarah Lehmann, EPA-OW on 2-16-2011.

[3] Wadeable Streams Assessment: A Collaborative Survey of the Nation's Streams
EPA 841-B-06-002 December 2006. See Chapter 2 – page 49.
http://water.epa.gov/type/rsl/monitoring/streamsurvey/upload/2007_5_14_streamsurvey_06_chap2b_5-2-07.pdf

recreational exposure guidelines[4]. Although there are relatively few documented cases of severe human health effects , exposure to cyanobacteria or their toxins may produce allergic reactions such as skin rashes, eye irritations, respiratory symptoms, and in some cases gastroenteritis, liver and kidney failure, or death. The most likely exposure route for humans is through accidental ingestion or inhalation during recreational activities, though cyanotoxins are also potentially a cause for concern in drinking water.[5]

Under Section 303(d) of the Clean Water Act, states develop lists of impaired waters every two years and are then required to develop clean-up plans, also known as Total Maximum Daily Loads (TMDLs), for those waters. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. Currently, more than 15,800 waters have nitrogen- or phosphorus-related impairments. States or EPA has developed more than 8,000 nitrogen- or phosphorus-related TMDLs for more than 5,000 of these waters.

Grand Lake St. Marys stands out as one recent example of the potentially significant and far-reaching costs associated with the human health, economic, recreational and ecosystem impacts of nitrogen- and phosphorus-contaminated waters. Grand Lake St. Marys, Ohio's largest inland water body, has suffered from increasing nitrogen and phosphorus loading from farm runoff, failing septic systems, and fertilizer applied to lawns. As a result, the lake has experienced massive blooms of toxic cyanobacteria, which have led to the death of fish, birds, and dogs, and illnesses of at least seven people. The State of Ohio has issued fish consumption, recreational use, and health warnings, including "no contact" and "algal bloom" advisories.[6]

---

[4] U.S. Environmental Protection Agency (USEPA). 2009. *National Lakes Assessment*: *A Collaborative Survey of the Nation's Lakes.* EPA 841-R-09-001. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C. See Chapter 4 - http://water.epa.gov/type/lakes/upload/nla_newchapter4.pdf

[5] IBID

[6] Spencer Hunt, New Tests find Grand Lake St. Marys Safe, The Columbus Dispatch, 30 Oct. 2010. One Algal Toxin Advisory Removed; Others Continue, Ohio EPA. 29 Oct. 2010. Ohio EPA http://www.epa.state.oh.us/pic/glsm_algae.aspx

In addition to Grand Lake St. Marys, freshwater HABs or the cyanoHABs have now been documented in at least 35 states and at least 18 states now have some type of CyanoHAB research or response program.

EPA continues to evaluate the human health implications of cyanoHABs and the toxins they produce in drinking water. Cyanotoxins have been included in all three Candidate Contaminant Lists (CCL) published so far pursuant to the Safe Drinking Water Act. EPA must periodically publish this list of contaminants and decide whether to regulate at least five or more contaminants on the list. A drinking water CCL is the primary source of priority contaminants from which EPA makes decisions about whether regulations are needed. The contaminants on the list are known or suspected to occur in public water systems but are currently unregulated by existing drinking water standards. The Agency included cyanotoxins as a group in the most recent CCL (CCL 3, October 8, 2009) and focuses research and data collection on three algal toxins: Anatoxin-a; Microcystin-LR; and Cylindrospermopsin.

EPA RESEARCH

Freshwater HABs

EPA's National Aquatic Resource Surveys are beginning to contribute significant information necessary to evaluate the extent and impact of harmful algae, nutrients, and other key indicators on ecological condition and potential human health risks. The 2009 report on the National Lakes Assessment included three indicators with respect to the condition and safety of recreational water use: 1) microcystin - a common algal toxin, 2) cyanobacteria - the group of unicellular or filamentous algae, some of which produce algal toxins, and 3) chlorophyll-a - a measure of all algae present. The study reported that microcystin was present in about 30% of lakes and at levels of concern in about 1% of lakes, based on World Health Organization thresholds of risk. While the survey results are a good start in our understanding, much more is to be learned about algal toxins in lakes. For example, it is currently unknown how well microcystin occurrence correlates with the occurrence of other classes of cyanotoxins that were not measured, or the associated human health risks. In addition, there are relatively few documented cases of severe human health effects associated with exposure to cyanobacteria or their toxins.

In addition, ORD is conducting a pilot study to assess human exposure and effects, and potential developmental toxicity associated with the cyanotoxins microcystin, cylindrospermopsin and anatoxin-a in drinking water systems in the southeastern United States. The pilot study is to determine whether a new blood serum assay for microcystin exposure can reliably detect low levels of human exposure to the toxin. A second study of developmental toxicity uses human placenta cells in culture to determine whether microcystins disrupt normal placental formation for pregnancy maintenance.

Gulf of Mexico Hypoxia

ORD coordinates and collaborates research in the northern Gulf hypoxia zone with NOAA and other federal, state and academic organizations. ORD has ongoing research and modeling efforts in the northern Gulf of Mexico to assess and predict: the relationships between nutrient loads and hypoxia; the physical, chemical, and biological processes regulating dissolved oxygen dynamics in the Gulf; and the effects of nutrient load reduction scenarios on hypoxia. ORD has partnered with Naval Research Laboratory modelers to develop integrated water quality simulation modeling tools that will improve our ability to evaluate the effectiveness of nutrient load reductions on Gulf hypoxia. The research and modeling efforts underway fill important research gaps identified in 2007 by EPA's Science Advisory Board state-of-the science evaluation regarding Gulf hypoxia and are critical to the information needs and goals of the Mississippi River/Gulf of Mexico Watershed Nutrients Task Force (Gulf Hypoxia Task Force).

In 2009, ORD published research on multiple regression models that described the size of the Gulf hypoxic zone based on river discharge and nitrogen and phosphorus concentrations. Those results supported the need for a dual nutrient management strategy - reductions in both nitrogen and phosphorus loads - to achieve the goal of reducing Gulf hypoxia. Equally significant were results of model predictions demonstrating that substantial and sustained nitrogen and phosphorus reductions will be needed before it will possible to discern statistically significant reductions in hypoxic area against the background of natural variability.

ORD scientists, as well as NOAA and NOAA-funded academic groups are working on parallel efforts to develop multiple 3D numerical simulation models for the northern Gulf system that link nutrient inputs, physical circulation processes, and ecological and water quality responses.

EPA, NOAA and the scientific community consider the development of multiple models and modeling approaches as offering many advantages compared to a single model or modeling approach for addressing complex problems like the Gulf of Mexico hypoxia. All the research groups met recently in Mississippi at a NOAA-sponsored workshop to report on progress of the modeling efforts. The groups are about a year or two away from being able to run 3D model simulations and examine the effects of nutrient load reduction scenarios on dissolved oxygen dynamics and ultimately, the size, frequency, and duration of hypoxia in the northern Gulf.

EPA PATICIPATION IN INTERAGENCY TASK FORCES AND WORKGROUPS

Harmful Algal Bloom and Hypoxia Task Force

ORD is an active participant in the Interagency Working Group on HABs, Hypoxia, and Human Health (IWG-4H) within the National Ocean Council, which is led by NOAA and which, among other responsibilities, implements the reporting requirements of the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA) of 2004. In these efforts, ORD staff were co-authors on the **Scientific Assessment of Hypoxia in U.S. Coastal Waters**, released in 2010, and the **Scientific Assessment of Freshwater Harmful Algal Blooms**, released in 2008, through IWG-4H

EPA has had a long-standing collaboration with NOAA through the Interagency Ecology and Oceanography of Harmful Algal Blooms Program, authorized by HABHRCA in 1998 and 2004. A Memorandum of Understanding allowed the participating agencies, EPA, NOAA, NSF, NASA, and ONR, to fund competitive research on the causes and impacts of HABs and to develop methods of detection, prevention and control. EPA funded nearly 30 projects between 1997 and 2006 several of them joint efforts with NOAA.

Harmful algal blooms are of concern in the Great Lakes and other waters because of their toxicity and impact on human and ecosystem health. A particularly toxic species is present in Western Lake Erie and Saginaw Bay (Lake Huron) -- two areas of the Great Lakes that typically have significant cyanobacterial blooms. These blooms cause fouling of the beaches and shoreline, economic and aesthetic losses, taste and odor problems in drinking water, and direct risks to human, fish and animal health. EPA's Great Lakes National Program Office funds research on harmful algal blooms research and coordinates with NOAA's Center of Excellence

for Great Lakes and Human Health (CEGLHH). Grants associated with nutrient related controls, management, and restoration have been a significant area of emphasis in the Great Lakes Restoration Initiative. Restoration related activities are under way as part of grant-funded projects at several sites across the Great Lakes.

Mississippi River/Gulf of Mexico Watershed Nutrients Task Force

In addition to EPA's participation in the Federal interagency Task Force on HABs and Hypoxia, EPA OW co-chairs the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Gulf Hypoxia Task Force) which is comprised of 17 state and federal agencies. The Gulf Hypoxia Task Force provides a forum for state water quality and agriculture agencies to partner on local, state, and regional efforts to mitigate nutrient loading, encouraging a holistic approach that takes into account upstream sources and downstream impacts. The Task Force's goal of reducing the size of the Gulf hypoxic zone to a five-year running average of 5,000 km^2 is a very challenging commitment.

In its most recent *Gulf Hypoxia Action Plan* (2008), the Gulf Hypoxia Task Force emphasized its commitment to work with states to develop nutrient reduction strategies and increase accountability, and both remain top priorities of the current Gulf Hypoxia Task Force leadership. To facilitate nutrient strategy development, the Gulf Hypoxia Task Force produced a State Nutrient Reduction Strategy Report in September 2010 that identifies essential strategy components and potential federal funding sources. As recommended in that report, Gulf Hypoxia Task Force federal and state members, including EPA, have assisted in organizing and providing technical and funding support for two nutrient reduction strategy workshops, the second of which is occurring in mid-June in Columbus, Ohio. A Gulf Hypoxia Task Force working group is developing a proposed set of "indicators of progress" to measure progress towards addressing nitrogen and phosphorus pollution in the Mississippi and Atchafalaya River Basin (MARB) and reducing the size of the Gulf hypoxic zone.

More broadly, EPA has asked interested and willing states to join the Agency, other federal partners, and stakeholders and work collaboratively to achieve substantial near-term reductions of nitrogen and phosphorus pollution, using a transparent and accountable action framework,

while some states continue to develop numeric criteria for nitrogen and phosphorus pollution to provide a clearly measureable and objective basis for longer-term reduction strategies.[7]

ORD provides technical support to OW for Gulf Hypoxia Task Force activities and also participates in the Task Force Coordinating Committee. ORD collaborates and coordinates with NOAA and other organizations thru the Gulf of Mexico Hypoxia Research Coordination Workshop series (sponsored by NOAA) which seeks to coordinate monitoring and modeling activities in the Gulf hypoxic zone.

CONCLUSION

In conclusion, EPA has made progress in understanding and addressing harmful algal blooms, hypoxia, and the broader issues of nutrient pollution in the U.S., and there is much more to do. EPA programs are targeting the causes and their impacts, working with states and federal partners to identify and protect healthy watersheds and their receiving waters and restore impaired waters. These efforts will improve management of nutrients, HABs and hypoxia, and help create safe and sustainable water resources for the future generations. We look forward to working with the Committee in the future.

Thank you for the opportunity to be here today, and I will be happy to answer your questions.

[7] N. Stoner, March 16, 2011. Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutreint Reductions. U.S. Environmental Protection Agency, Washington D.C. See http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/memo_nitrogen_framework.pdf