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Hearing on Non-point Source Pollution: The Impacts of Agriculture on Water Quality
2165 Rayburn House Office Building

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Professional qualifications and experience:

Howarth is a biogeochemist and aquatic ecosystem scientist. He is an expert on the global alteration of nutrient cycles, climatic influences on nutrient fluxes from large river basins, the sources of nutrients that reach estuaries and coastal oceans, and the consequences of coastal nutrient pollution. Howarth earned a BA in biology from Amherst College (1974) and a Ph.D. in biological oceanography jointly from MIT and the Woods Hole Oceanographic Institution (1979). He was on the staff of the Marine Biological Lab in Woods Hole, MA, from 1979-1985, and has been on the faculty of Cornell University since 1985. Since 1993, he has held an endowed professorship at Cornell: the David R. Atkinson Professor of Ecology & Environmental Biology. Since 2000, Howarth also has served as an Adjunct Senior Scientist at the Marine Biological Lab in Woods Hole.

Howarth is President Elect of the Estuarine Research Federation, the largest professional society in the world for scientists and managers who work in estuaries and coastal oceans; he will serve as President for 2 years beginning in the fall of 2007. Howarth also represents the State of New York on the Science and Technical Advisory Committee of the Chesapeake Bay Program. He is serving on the EPA Hypoxia Advisory Panel (a group charged with determining what new science has become available since the CENR "dead zone" assessment of 1999, and how this new science should influence policy). From 1998-2000, Howarth chaired the National Academy of Sciences' Committee on Causes and Consequences of Coastal Nutrient Pollution. He was the lead author on the nutrient pollution chapter of the 2005 Millennium Ecosystem Assessment. From 1994-2002, Howarth co-chaired the International SCOPE Nitrogen Project, and just this winter has been appointed chair of a new international SCOPE project on the environmental impacts associated with biofuels such as ethanol; both of these are efforts of the International Council of Science (ICSU), and both in part address nutrient pollution. Howarth runs an active research program on coastal nutrient pollution, with funding from NSF, NOAA, EPA, and the USDA. He directs the Agricultural Ecosystems Program at Cornell, a program working to identify sources of and solutions for nutrient pollution in the Chesapeake watershed. He is the Founding Editor of the journal *Biogeochemistry*, and served as Editor-in-Chief from 1983-2004. Last fall, Howarth gave an invited briefing to White House staff in the Office of Science and Technology Policy and Office of Management and Budget on coastal nutrient pollution.

Testimony of Robert W. Howarth:

Thank you for the opportunity to address you today, and I am delighted by the Committee's interest in agricultural impacts on water quality. My statement, which focuses on nutrient pollution in estuaries and other coastal marine waters of the United States, is based heavily on several national reports over the past 7 years, including the National Academy of Sciences (2000) Clean Coastal Waters report, the Pew Oceans Commission report (2003), and the report of the US Commission on Ocean Policy (2004). I will particularly focus on nitrogen pollution, since this is generally the larger problem in coastal waters, although phosphorus pollution is also of concern. My testimony represents my best professional judgment. It should not be considered an official position of Cornell University or any other institution or organization with which I am affiliated.

Human alteration of the nitrogen cycle is one of the most dramatic aspects of global change. During my lifetime, the rate at which human activity creates reactive nitrogen – the nitrogen that can lead to water pollution – has increased 7-fold. Synthetic fertilizer is the biggest component of this increase globally, and half of the synthetic nitrogen fertilizer that has ever been used on Earth has been applied in the last 15 years. Fertilizer use and agricultural sources are by far the largest problem contributing to the nitrogen flux down the Mississippi River to the "dead zone' in the Gulf of Mexico. Thus, it is appropriate that this hearing today focus on agricultural sources of pollution. However, agriculture is only part of the story of change in the nitrogen cycle. Municipal wastewater plants are significant sources of nitrogen pollution to some coastal ecosystems, such as Long Island Sound. More importantly in many areas, deposition of nitrogen from the atmosphere can also play a role in polluting coastal waters. This nitrogen, which also contributes to acid rain, comes from burning fossil fuel for transportation, electric power generation, and other uses, and also from volatilization from agricultural sources, particularly animal wastes. Overall in the United States, my research has suggested that 40% of the nitrogen pollution reaching coastal waters comes from atmospheric deposition, an amount almost equal to the direct runoff from agricultural fields (municipal wastewater contributes 16%). The most recent estimates for the input of nitrogen to Chesapeake Bay also indicate roughly equal contributions from agriculture and from atmospheric deposition, although there is tremendous uncertainty in such estimates.

The global alteration of the nitrogen cycle has been uneven, and some regions have seen much greater changes than others. Human activity has probably increased nitrogen fluxes down the Mississippi River by 5-fold or more. The change has been even greater in the northeastern United States, and coastal systems such as Chesapeake Bay have likely seen nitrogen increases of up to 10-fold due to human activity.

As a result of this increase in nutrient inputs over the past few decades, nutrients are now the largest pollution problem in the coastal marine waters of the United States, and one of the greatest threats to the ecological integrity of these ecosystems. Unfortunately, there is no national monitoring program for this problem, and so we have significant uncertainty over the full magnitude and consequences. Nonetheless, the best available evidence is that one third of the nation's coastal rivers and bays are moderately degraded from nutrient pollution; another one third are severely degraded. This finding by a team of NOAA-led scientists was endorsed by the Clean Coastal Waters report in 2000 from the National Academy of Sciences Committee on Causes and Management of Coastal Eutrophication. That Academy report also stressed the urgent need to develop a national monitoring system, but that has not yet happened.

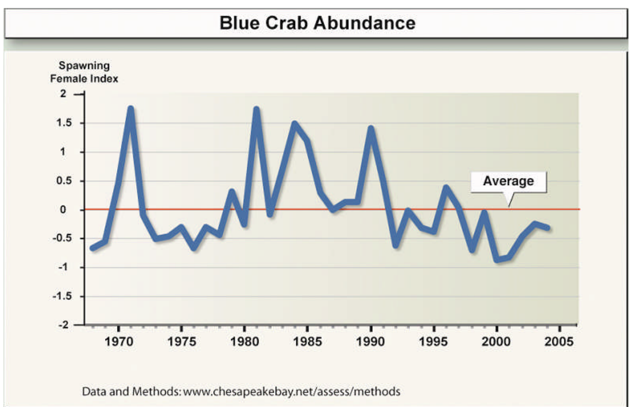
What are the effects of nutrient pollution? Nutrients are defined as substances that nourish, and so carry a positive connotation. But just as excessive consumption of food leads to obesity and a host of health issues, excess nutrients over-fertilize coastal waters and can lead to a variety of deleterious effects. These include:

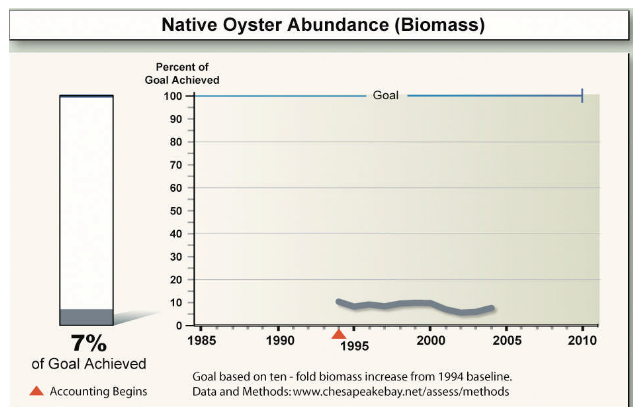
- Creation of "dead zones," or regions of the ocean where bottom waters are devoid of oxygen (anoxic) or have levels of oxygen so low as to not support the ability of most animals to live (hypoxic);
- Loss of biodiversity;
- Change in ecological structure and degradation of habitat quality, potentially leading to loss of fish and shellfish resources and damage to endangered species such as sea turtles even where "dead zones" do not develop;
- Increased cloudiness of water, and greater odors from water;
- Loss of seagrasses and other ecologically valuable submerged aquatic vegetation;
- Decline of coral reefs;
- Decreased production of commercially important fish and shellfish;
- Increased frequency, duration, and extent of harmful algal blooms, with risk to human health and great damage to marine mammals;
- Increased transmittance of some human diseases such as cholera.

Not all of the consequences of nutrient inputs are bad, and at low to moderate levels, increased nutrient inputs to marine ecosystems can lead to increased fish production and little deleterious effects. However, further inputs lead to degradation and loss of resources. The sensitivity of ecosystems to nutrient pollution – that is the amount of nutrient input necessary to cause serious ecological damage -- varies greatly among systems, for reasons we only partially understand. For example, Chesapeake Bay is far more sensitive than is New York Harbor, and San Francisco Bay has an intermediate sensitivity to nutrient pollution. Unfortunately, we do not yet know how to recognize the tipping point for any particular coastal ecosystem, where further nutrient inputs lead to serious ecological and economic damage, until we reach that point in that particular ecosystem. We also do not know how reversible damage is, once it occurs, although the best available evidence suggests that recovery may be difficult once we push an ecosystem beyond the tipping point. Given our current level of uncertainty, good management calls for caution to avoid even approaching these ecosystem tipping points.

Determining the full impact of nutrient pollution on fish and shellfish resources and on economic value has proven difficult, even for highly impacted ecosystems such as Chesapeake Bay.

Chesapeake Bay is the largest estuary or semi-enclosed bay in the United States, and also one of the most productive. Economists struggle to put value on ecosystems such as Chesapeake Bay, including the value of "clean water" and a healthy environment as well as the direct and indirect values of commercial and sport fishing. According to Rebecca Hanmer, the director of the Chesapeake Bay Program, the last attempt at a comprehensive economic analysis of Chesapeake Bay was made almost 20 years ago and put the value at $678 billion (1986 dollars). How has nutrient pollution affected the Bay's resources and value? As the figures below from the web site of the Chesapeake Bay Program illustrate, blue crabs have been in decline for at least the last 15 years, and the native oyster is in serious trouble with populations only a tiny fraction of what they once were. In the past, these were the most valuable harvests from Chesapeake Bay.





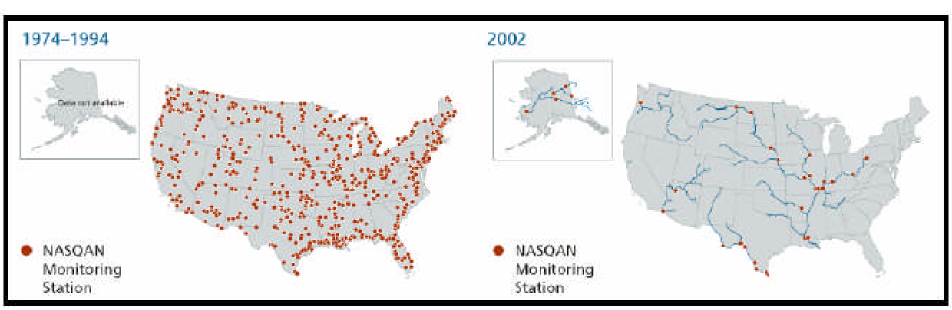
These declines undoubtedly are due in part to nutrient pollution, but other factors such as over-fishing and shellfish diseases have also played a role. Increasingly, climate change may also contribute to degradation of resources in ecosystems such as Chesapeake Bay. Teasing apart the relative contribution of these factors to ecological decline is not an easy task, and has not been done successfully in Chesapeake Bay. A growing number of scientists believe that rather than trying to isolate the causes of decline, we should be examining how the various causes interact in ways that may aggravate one another. For example, decline of oyster populations from over-fishing probably aggravates the problems of nutrient pollution, leading to further decline of oysters. And stress from nutrient pollution may well make oysters more susceptible to diseases.

What can we say about the fishery and economic consequences of the "dead zone" in the Northern Gulf of Mexico off the mouth of the Mississippi River? I know of no attempt at a full economic valuation of this region, but the direct value of the commercial harvest is huge. According to the most recent data from NOAA, the direct landing value of the commercial fish harvest in the Gulf of Mexico is approximately $670 million per year, with more than half of this due to shrimp harvests. In Louisiana alone the shrimp landings in 2004 were worth $140 million. The multiplier effect through the economy greatly increases these values. Further, the Gulf has a very valuable recreational fishery. In 2004, almost 5 million person-days of recreational fishing occurred in the coastal waters of Louisiana. The evidence for damage to these resources from nutrient pollution is not strong, although fishing on brown shrimp appears to have been adversely affected. A non specialist may conclude that lack of strong evidence for adverse affects indicates a clean bill of health for the Gulf, but this is far from the case. Confounding factors in the analysis include the lack of adequate monitoring, the inherent natural variation in fish and shellfish populations over time and space, and other stresses such as climate change and over-fishing that can lead to population declines. A further complication is that "dead zones" may actually make it easier to commercially fish for a while, as fish and mobile shellfish congregate at the edges of the oxygen-depleted waters and become easier targets for fishing vessels; this practice is not sustainable, and the increased vulnerability of fish and shellfish populations from the targeted fishing may further aggravate an eventual population decline. What we definitely can conclude is that a large area in the Northern Gulf of Mexico – over 20,000 km^2 in most recent summers – is severely impacted from nutrient pollution from the Mississippi River. The effects include oxygen depletions, excessive algal growths, and loss of bottom-dwelling animal populations in this region. If the area has not yet experienced large fishery losses as a result, we have every reason to believe we are moving towards that tipping point where this could occur. The question is, how close are we to that point? We lack the science base to answer this question. Clearly the conservative approach would be to follow the recommendations of the 1999 CENR Assessment and move towards significantly lower nutrient fluxes down the Mississippi River.

Some general recommendations on critical research and monitoring needs:

- As recommended by the 2000 Clean Coastal Waters report of the National Academy of Sciences, the nation should develop a nationally consistent approach to monitoring the consequences of nutrient pollution in coastal marine ecosystems. No such system exists, which greatly limits our ability to understand the extent, trends, or likelihood of ecological damage, including damage to commercially valuable resources. Good management requires the support of a strong monitoring program to determine if policies and practices are actually working as intended.

- National monitoring programs on nutrient fluxes in surface waters have been curtailed dramatically over the past decade, as illustrated in the figure below from the US Commission on Ocean Policy (2004) for one key USGS program. These programs must be rebuilt, strengthened, and extended into tidal waters if we are to understand whether or not the nation is making progress in reducing nutrient pollution in coastal waters.



- National monitoring programs for sources of nutrient pollution in the landscape have also been greatly curtailed over the past decade. Key programs measuring trends in atmospheric deposition such as the National Atmospheric Deposition Program and CASTNet have seen their funding cut consistently, and are now faced with further drastic cutbacks. These programs too should be rebuilt and expanded, if we are to better understand the relative contribution of various sources such as atmospheric deposition and agriculture to the nation's water quality problems.
- We have a sufficient knowledge base to move forward as a nation more aggressively in solving our water pollution problems. However, improved understanding through focused research can lead to better targeting of problems and more cost-effective solutions. Building on the National Academy of Sciences 2000 Clean Coastal Waters report, an interagency research program towards this end was designed in 2003 by NOAA, EPA, USGS, NSF, and USDA with significant engagement of the academic community (Howarth, R. W., R. Marino, and D. Scavia. 2003. Priority Topics for Nutrient Pollution in Coastal Waters: An Integrated National Research Program for the United States. National Ocean Service, NOAA, Silver Spring, MD). The program was endorsed by many scientific societies, which together had 230,000 members. The plan should be fully implemented.

A critical issue cross cutting all monitoring is the need for sustained effort over long periods of time. The variability of process and fluxes in nature is great from year-to-year, and only by evaluating data collected over periods of many years can we adequately detect trends – either positive or negative – in nutrient fluxes and in the consequences of water pollution. The need for continued high-quality monitoring becomes even greater as we move into the future, since long-term trend data are <u>essential</u> to evaluate how climate change is interacting with other stresses to affect water quality and ecological health.

Finally, I feel compelled to mention the current national expansion of producing ethanol from corn. Much of the problem with agriculture as a source of nutrient pollution comes from growing corn, and while this pollution can be lessened through management practices such as planting winter cover crops, corn is essentially a "leaky" crop when it comes to nitrogen. Thus, an increase in acreage growing corn to try to meet the needs of ethanol plants is of concern. Further, the brewers grain waste from ethanol plants can be used as an animal feed, and due to the economics of transporting this waste, ethanol plants can serve as magnets for new confined animal feedlot operations. These operations can also create significant water quality problems. All of the water-quality scientists I know across the country are greatly disturbed by the rush for this corn-ethanol expansion. Producing more ethanol from corn needs much more analysis and careful consideration of the full range of environmental and economic impacts before the country proceeds further down this potentially dangerous path.