Perhaps the greatest motivation for HR 3480 is to evaluate Best Management Practices (BMPs) - management practices that could ameliorate agricultural runoff and reduce its impact on lakes and rivers. They include conservation tillage, grass stripping, riparian zone buffer strips, contour plowing and terracing, and wetlands restoration. While most scientists believe that BMPs are what is needed to solve the problem of nonpoint pollution, they have precious little data to prove it. Some BMP practices are already in place, and a coordinated public-private program of monitoring and modeling could help to analyze their effectiveness. Local, state, and federal water quality monitoring and modeling efforts need to be joined to obtain a comprehensive picture. Eventually we will need to control nonpoint sources of pollution in the most cost-effective manner. We are embarking on a massive undertaking, but Americans deserve nothing less than clean water for drinking, fishing, recreation, and beautiful, functioning ecosystems.

One mantra in business is, "If we can measure it, we can manage it. If we can manage it, we should be able to improve it." That is the impetus for the Upper Mississippi River Basin Protection Act. It should be accomplished by the highest qualified professionals, subjected to rigorous peer review, and results should be published in the freely available literature. I believe that HR 3480 provides such a study. It addresses a very serious national problem, protection of water quality and a natural resource treasure.

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Congressional Testimony Featured in this Issue

In this issue of *EHSRC Update* we feature testimony given by Dr. Jerald L. Schnoor to the U.S. House of Representatives Subcommittee of Water and Power in support of HR 3480, the Upper Mississippi River Basin Protection Act. This testimony describes the connection between agricultural practices in America's heartland and the expanding dead zone in the Gulf of Mexico. It also points to the need for data showing which agricultural land management practices most effectively reduce runoff of contaminants into surface water. HR 3480 was voted into law on April 9, 2002 on a unanimous voice vote.

Schnoor Testifies on Mississippi River Protection Act

Good morning, Chairman Calvert and members of the Subcommittee. Thank you for the invitation to discuss the water quality of the Mississippi River and HR 3480, the Upper Mississippi River Basin Protection Act. I have prepared remarks on the need to monitor, model, and reduce nutrient and sediment loads in the Upper Mississippi River Basin. Together with Congressman Kind, I co-chaired a workshop on this subject in January 2001, sponsored by the Water Science and Technology Board of the NRC. I have authored a textbook related to this subject, *Environmental Modeling: Fate and Transport of Pollutants in Water, Air, and Soil* (John Wiley and Sons, New York, 1996), and performed research on water quality issues for almost 30 years. I am born and reared in Davenport, Iowa, on the Mississippi River, and I have observed the river all my life.

Permit me to tell a fish story. When I was ten years old, my uncle ran a smoke-house and small grocery store near Muscatine, Iowa, on the banks of the Mississippi River. He taught me to fish for large white sturgeon, a strange prehistoric-looking fish, but a true delicacy when smoked and savored. Unfortunately, the river has changed considerably over the past decades. It's no longer possible to catch sturgeon – they have been largely extirpated from the river, the victims of soil erosion, over-fertilization, and wastewater discharges. This tension between humans and their environment is neither inevitable nor completely irreversible. We must find ways to protect the environment while developing a strong economy. A healthy economy and a clean environment *can* go hand-in-hand. To do this, we must understand fully the environment, technologies for improvement, and human social systems.

The Upper Mississippi Protection Act seeks to develop a coordinated public-private approach to reducing nutrient and sediment losses in the Upper Mississippi River Basin. It is sorely needed. The first steps are to establish a water quality monitoring

network and mathematical models of the basic processes for pollutant fate and transport in the river basin. By cross-comparisons of sub-basins, it will allow scientists and engineers to decipher what management approaches are cost-effective in reducing sediment and nutrient loads to the river. This is a critical need in the nation's effort to improve water quality, impacted to a large extent by nonpoint source runoff from the land.

Since pre-settlement days (circa 1850), land cover and land use have changed dramatically. In Iowa, for example, 90% of the land is now in agriculture. This agriculture is the lifeblood of the economy, but we need to find ways to harmonize it better with the environment and to sustain quality ecosystems. Since 1850, we have cleared about two-thirds of the forestland, drained 95% of the wetlands, and replaced 99% of the native prairies. Such drastic change in land cover is bound to influence water quality. Streams have become clogged by soil erosion, critical habitat for fish spawning has been covered, and species have been lost. Changes in land cover, together with the introduction of locks and dams and channelization, have destroyed prime habitat for native aquatic organisms.

In 1972, the Federal Water Pollution Control Act (Clean Water Act), P.L. 92-500, sought a goal of "swimmable and fishable" waters. After spending billions of dollars each year, the nation has benefited significantly from secondary treatment of point source discharges (municipal and industrial wastewater treatment). The Act established the National Pollutant Discharge Elimination System (NPDES) in which approximately 70,000 permits have been issued to enforce water quality standards. The water quality of the nation's inland waters improved greatly during the next 20 years. Unfortunately, those improvements have, for the most part, run their course, and we are still short of our goal. In the U.S., we have 21,000 waters that are not expected to meet their intended uses, even with permitted discharges. Many of these stream and lake segments are in the Upper Mississippi River Basin, primarily impacted by sediments, nutrients and fecal coliform bacteria. *What went wrong?*

Nothing really went wrong. It is simply an ongoing effort in adaptive management. Congress recognized the need in 1972 to address nonpoint source pollution, but data for proper assessment and modeling purposes did not exist. Ever since then, we have been moving towards assessment of the problem and a new program, Total Maximum Daily Loads (TMDL). This program requires the states to perform a new waste load allocation *and* a load allocation for nonpoint source pollution with a margin of safety to recognize uncertainties. Basin-wide implementation plans will be required and new permits will eventually be issued, a process that may take 10-15 years. I believe monitoring of the nation's waters is critically under-funded and slows this process – the states are perplexed by how to implement a program without enough data to fulfill modeling needs and perform defensible

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TMDLs. The Upper Mississippi River Basin Protection Act will help to gather this data and construct computer models for one of the most ecologically and economically important waters in the Nation. Trends in the water quality of the Upper Mississippi River over the past 30 years are difficult to delineate with so little data, but some general observations can be stated. Nitrate concentrations are getting worse in some highly agricultural areas, probably due to increased applications of nitrogen fertilizers. Fertilizers are applied at rates greater than the crops can assimilate, resulting in nitrogen runoff valued at more than $300 million per year. The trend towards greater density of animals in concentrated animal feeding operations (CAFOs) is also accelerating. It is difficult for operators to apply manure onto the land in an acceptable manner when the density of animals and sheer volume of the manure is so great. On the other hand, conservation tillage practices on farms have really taken hold, and there is some evidence that silt and total phosphorus concentrations may be decreasing (improving).

That the Upper Mississippi River still fails to meet the goals of the Clean Water Act and its intended uses is undeniable. Spawning areas are covered with silt by soil erosion, nitrate concentrations exceed drinking water standards in many locations, bathing beaches are closed due to fecal coliform bacteria in the water, and algae choke many waterways due to eutrophication (the excessive rate of addition of nutrients). Furthermore, the problems are multiplied by the transport of sediments and nutrients downstream, creating a conundrum for the Gulf of Mexico.

"Gulf Hypoxia" refers to a zone of low dissolved oxygen in the Gulf of Mexico that has grown to 17,000 square kilometers since 1985, roughly the size of Massachusetts. It is probably caused by the build-up of nutrients in sediments from algal blooms over the past 50 years or so. Remember, we said that the nation's inland waters had, for the most part, improved during the period 1972-1990s because of the Clean Water Act and its amendments. But our nation's coastal waters have not improved similarly. We do not understand fully why, but it seems there is a time lag associated with sediment anoxia that has grown steadily worse due to development of coastal zones and the cumulative build-up of nutrients and silt from riverine transport. Thus, the problems in the Gulf of Mexico are, to a large extent, the problems of the Upper Mississippi River Basin transported downstream. It is thought that about 31% of the nutrient loadings to the Gulf come from the Upper Mississippi River Basin alone, mainly from agricultural runoff. Although it is difficult to document damages in the Gulf at the present time, continued growth of the hypoxic zone will eventually result in the loss of important fisheries.

Economic impacts already can be documented in the Upper Mississippi River Basin. Dredging of sediments in the navigation channel costs over $100 million each year. The loss of aquatic habitat and beach closings threatens the river's $1.2 billion recreation and $6.6 billion tourism industries. The fishing industry, both commercial and recreational, has changed substantially in the past 50 years, but it is difficult to allocate damages among the many causes of soil erosion, agricultural runoff, municipal and industrial wastewater discharges, over-fishing, and invasive species. Invasive species are one of the thorniest problems nation-wide, a serious by-product of global commerce. Zebra mussels, *Dreissena polymorpha*, were introduced by ballast water to the Great Lakes in 1986. They entered the Upper Mississippi River Basin a few years later, clogging water intake structures and out-competing native mussels for habitat. So far, costs of control and eradication have exceeded $138 million. They are not the only problems: several carp species have been introduced since the 1970s by aquaculture.