Committee on Government Reform
U.S. House of Representatives

Hearing on Progress in Safeguarding Chesapeake Bay
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Testimony of
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Chairman Davis and members of the Committee, I am pleased to have this opportunity to offer my perspectives on progress made in restoring the Chesapeake Bay.

That this opportunity comes at historic Fort Monroe is particularly meaningful for me. In 1968 I undertook my first independent scientific research with a study of the animals that live on the bottom of Hampton Roads. The publication of that research truly launched my career. In March 1970 I stood with my young wife in front of the Chamberlin Hotel as we watched a total eclipse of the sun over Willoughby Spit, an experience that overwhelmed us with awe for the natural world. Although a magnificent body of research has now demonstrated that human impacts on the Chesapeake Bay began well before I began studying it, regrettably its lapse into seriously poor health, with widespread oxygen depletion and disappearance of extensive seagrass meadows, mainly occurred since the 1960s—on my watch, so to speak. While none of us here today will live long enough to observe another solar eclipse from Fort Monroe, I certainly hope I can chronicle, and maybe even assist, the Bay's recovery to good health during my remaining tenure as a scientist.

I will do my best to address the charge of your invitation to assess the state of the Bay, progress that has been made in restoring it, and the appropriate use of modeling and monitoring in reporting progress. More importantly, I will offer some suggestions about what we can do to accomplish this mission while I am still standing watch.

Have Nutrient Loads Been Reduced?

As you know by now, a principal cause of the rapid degradation of the Chesapeake Bay ecosystem observed during the 1970s and 1980s was the multifold increase in loading the estuary with nutrients, particularly nitrogen. A substantial body of evidence indicates that the Chesapeake Bay Program has been successful in turning this trend around for the Bay as a whole since the 1980s. Nitrogen inputs from municipal wastewater discharges (point sources) have, in fact, been reduced by 23% since 1985—no mean feat because wastewater volumes have increased by 45%. Because of the phosphate detergent ban coupled with improved waste treatment, phosphorus discharges from wastewaters have declined by 80% since 1970. We have high confidence in these point-source reductions because they are directly measured and reported. In addition, for the large part of the watershed drained by rivers that are monitored by the USGS, concentrations of nitrogen and phosphorus in the river discharges have generally been declining. However, this is not uniformly the case; there is evidence that some rivers and Bay tributaries influenced mainly by coastal plain drainage may actually have experienced increasing nutrient inputs. While the watershed model obviously also estimates a downward trend in nutrient concentrations, the actual amount of decrease differs greatly between model and monitoring estimates. In my opinion, more detailed analysis is required before progress in reducing nonpoint source inputs can be confidently estimated based on observations consistent with model estimates.

Declining nutrient concentrations do not necessarily mean that the Bay has been receiving lower nutrient inputs. Even if nutrient concentrations decrease, high river inflow can mean that the amount of nutrients delivered to the Bay (what we call loading) actually increases. For example, the nutrient loads delivered by the major rivers in 2003 were the second highest since 1990 because of very high freshwater inflows last year. River inflows into the Bay have been unusually variable and, on average, higher than normal during the period we have been attempting nutrient reductions. Of the 11 years of record since 1992 only two fell within the normal range of annual river inflow to the Bay, while inflow was higher than the normal range for five years and below the normal range for four years. Despite the general decline in nutrient concentrations, the average annual total nitrogen loading from the four rivers with a suitably long monitoring record to allow comparison (Susquehanna, Potomac, Patuxent, and Choptank) was slightly greater (5%) since 1992 than it was for the period 1985-1992. With the reductions in point-source contributions factored in, the average annual loading of total nitrogen was essentially the same for the years before and after 1992. The same is true for phosphorus.

I would summarize, then, by saying that the average loadings of nutrients actually delivered to the Bay over the past decade or so were not less than during the beginning the Chesapeake Bay Program, largely because of the higher than normal freshwater inflows experienced over that period. It should not be surprising, therefore, that we have not seen much improvement in the symptoms of nutrient overenrichment in the Bay. Unqualified statements that nutrient inputs have been reduced by a certain stated amount based on a watershed model that assumes unvarying, normal flow conditions do not comport to the reality of a highly variable Chesapeake Bay. Nonetheless, generally declining nutrient concentrations at the fall lines, together with documented point-source reductions, indicate we are making progress in reducing nutrient sources, although the amount of progress remains difficult to quantify for nonpoint sources.

Is Hypoxia Getting Better?

The short answer to this question is that there is no convincing evidence that the extent of serious oxygen depletion of Bay bottom waters during the summer has been reduced since 1985. Again, we have to keep in mind the highly variable freshwater inflows in recent years. Higher flows not only deliver more nutrients, but also intensify the density stratification of Bay waters that is also an important contributing factor to hypoxia. On the other hand, drought years such as 2001 and 2002, are characterized by much less severe hypoxia. So, deducing trends over this highly variable period is tricky business at best. Moreover, strong wind events can mix Bay waters, causing a shrinking of the volume of hypoxia during any part of the summer.

EPA analysts have found no significant trends in the summertime (June-September) volume of moderate hypoxia (dissolved oxygen <2 mg/l) and anoxia (<0.2 mg/l or virtually no dissolved oxygen) between 1985 and 2002.[1] In many areas around the world, including the famous Gulf of Mexico Dead Zone, the 2 mg/l concentration of dissolved oxygen is used to delimit harmful hypoxia because, in general, mobile animals such as fish and crustaceans are seldom found when the concentrations dip below this level. The EPA analysts did report a significant decreasing trend in the volume of water with dissolved oxygen levels less than 5 mg/l (a concentration reflecting some oxygen depletion but that is generally not lethal) during this same period, but remember the unusually dry years of 1999, 2001 and 2002, with predictably lower extent of hypoxia, occurred at the tail end of that record. The inclusion of 2003 in this analysis produced a problematic outcome because it was a high flow year with extremely extensive, moderate-to-severe hypoxia during the first half of the summer, which was alleviated somewhat by mixing from storms during the later part of summer. In conclusion, I would have to say that the claim of "recent indications of improving trends since 1985" on the Bay Program website was premature and failed to consider the confounding effects of flow variability and weather.

Another analysis of trends in hypoxia was recently published by my colleagues James Hagy and Walter Boynton[2]. It covers a longer period, from 1950 through 2001. Their study showed convincingly that little or no anoxia occurred prior to our solar eclipse in 1970, except in unusually high river flow years, but has since become a regular feature of the Bay, even during drought years. An analysis of the long-term statistical trend showed that the volume of moderate hypoxia has increased almost three-fold for an average flow year. The complex multiple linear regression technique used suggests that hypoxia continued to grow through the 1990s, however if just the period after 1985 was examined, there was no significant trend up or down. Therefore there is no inconsistency in the findings of the University of Maryland scientists and the EPA: there is no statistical evidence that the volume of anoxia or moderate hypoxia (2 mg/l) has decreased or increased since 1985.

In their work, my colleagues uncovered an intriguing and very troubling relationship between nutrient loading and the volume of hypoxia in the Bay, namely that the extent of hypoxia for a given level of nitrogen loading seems to have increased. That is to say, the Bay appears to have lost some of its ability to assimilate nutrients without becoming seriously hypoxic. While we do not understand the reasons for this—it could be related to longer-term effects on the benthic community—this diminished resilience probably means that we simply have to accomplish much more reduction in nutrient loading before we see greatly reduced hypoxia.

What About Other Indicators?

As Director Hanmer has pointed out to you, the Chesapeake Bay Program employs many other indicators to track progress in Bay restoration in addition to estimating nutrient

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[1] Communication from Marcia Olson, August 12, 2004.
[2] Hagy, J.D., W.R. Boynton, C.W. Keefe, and K.R. Wood. 2004. Hypoxia in Chesapeake Bay, 1950-2001: Long-term change in relation to nutrient loading and river flow. *Estuaries* 27:634-658.

concentrations and loadings and the extent of hypoxia. Some of these indicators, for example populations of striped bass, shad and waterfowl and riparian forest buffers, have been on the upswing. Some of the needles on the gauges have barely moved at all, while some, such as oyster populations and nontidal wetlands, have been moving in the wrong direction. An important biological indicator of water quality, the areal extent of submerged grasses (commonly referred to as SAVs) that provide such a critical habitat, has increased slightly from the start of the Bay Program in the early 1980s, but has leveled off during the 1990s, far below our restoration goals. The annual surveys provide encouragement during dry years as we find more grasses and discouragement during high flow years, when the grasses retreat. I don't know if we should claim much credit for the expansion in acreage that did occur. This took place between 1984 and 1989, when our efforts to control nitrogen from wastewaters and agriculture were just beginning had not yielded any appreciable results, and may have just represented longer term recovery after the devastation of Tropical Storm Agnes in the 1970s. However, we have seen some encouraging signs of SAV recovery in localized areas that are likely the result of reduction of nutrient pollution.

What Are the Appropriate Uses of Modeling and Monitoring?

The Chesapeake Bay Program has the benefit of the most comprehensive and powerful models of the watershed and estuary of their kind and a very extensive and competent environmental monitoring program. Scientists in my institution and their colleagues in Virginia and Pennsylvania have contributed extensively to both the modeling and monitoring programs and agency managers have every right to be proud of them.

Bay Program models have been designed to answer "what if" or, more appropriately, "what will it take" questions important in setting Program goals. They are strategic, not tactical. The recent application of the watershed and estuary models to determine the new Chesapeake 2000 nutrient reduction goals was exemplary in the inclusion of scientific expertise and peer review. Because of the openness and rigor of the process, there is a strong scientific consensus that achieving those nutrient reduction goals will achieve the desired outcomes. The current controversy regarding estimating progress to date should in no way undermine public confidence in the use of these models for setting achievable goals.

However, it is clearly misleading to state that nutrient loading has actually been reduced by a certain amount based on watershed model estimates of accomplishments, even if various elements of the model have been calibrated with field measurements. There are obviously uncertainties about the efficiencies and levels of implementation of management practices as well as inescapable imperfections in how well the model itself mirrors nature. Furthermore, lag times, which delay the effect of pollution reduction actions for several years, and interannual variation in river flow, which can result in atypically large or small inputs of nutrients, are not represented in the present watershed model. They will be incorporated in the next generation of the model currently under development.

I suspect that the Program espoused model-based estimates of progress that are over-simplified because of the natural human tendency of managers to look on the bright side, promote optimism and encourage future progress. That said, I would hope that the current controversy would: (1) make managers and policy makers more aware of the uses and limitations of both modeling and monitoring; (2) prompt them to promote a scientific culture of organized skepticism; (3) strengthen its efforts in environmental monitoring and interpretation of monitoring results; (4) develop and employ models that are appropriate for addressing interannual variability and event-scale processes (e.g. storms); and, most importantly, (5) advance the thorough integration of modeling and monitoring in order to better achieve the requirements of adaptive management[3]. The Chesapeake Bay region is endowed with the largest and most accomplished community of estuarine scientists in the world. From both the governmental and university sides, we need to work to ensure that their extraordinary intellectual and material resources are fully engaged in advancing knowledge and critical assessment to advance Bay restoration goals.

What It Will Take To Restore The Bay?

All of the witnesses here today agree on at least two things: (1) the Chesapeake 2000 goals are worthy and (2) we are seriously behind schedule in meeting the water quality restoration goals by 2010 and need to accelerate our efforts. There is close agreement between the nutrient reduction targets developed through the strategic use of Bay Program models and the more empirical estimates by Drs. Hagy and Boynton of what it would take to eliminate anoxia as a recurring problem. The attainability analyses performed by the Bay Program and the Scientific and Technical Advisory Committee's *Chesapeake Futures* report[4] both demonstrate that we have the ability to meet these targets. Yet, we are nearly three-quarters into the game begun in 1987 with the first commitment for reductions in nutrient loading and, even if one accepts the model estimates of progress, we are only about one-third of the way toward the nitrogen reduction goal. More aggressive public policies and investments are clearly required.

In Maryland, our General Assembly recently passed, and even expanded, Governor Ehrlich's bold proposal for levying statewide user fees (the so-called "flush tax") to fund sewage treatment improvements that would reduce nitrogen concentrations in wastewater to 3 mg/l. If other states took similar steps, perhaps assisted by some strategic federal assistance, we would greatly reduce point-source nutrient inputs and have capacity of handling growing wastewater streams without degrading the Bay.

Significant reductions in nitrogen loading can also be achieved if we aggressively implement the existing Clean Air Act. That would significantly reduce atmospheric deposition that accounts for at least 25% of nitrogen loading to the Bay.

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[3] Please see the report of a National Research Council panel I recently chaired on adaptive management: National Research Council. 2004. *Adaptive Management for Water Resources Project Planning*. National Academy Press, Washington, DC.

[4] Boesch, D.F. and J. Greer (eds.). 2003. *Chesapeake Futures: Choices for the 21st Century*. STAC Publication 03-001. Chesapeake Research Consortium, Edgewater, MD.

Reductions of urban nonpoint sources of nutrients will require expensive retrofitting of stormwater management systems. However, these sources are still a small slice of the nutrient pie and can be dealt with incrementally. The biggest challenge regarding urban nonpoint sources is, of course, continued urban, suburban and exurban sprawl, which threatens to undo gains made in reducing nutrients from other sources. Our *Chesapeake Futures* report depicts three scenarios representing present development trends, smart growth and smarter growth to show the importance of our future growth decisions on whether a healthy Bay can be achieved and sustained.

The most daunting obstacle to reducing nutrient loading to the point where the Bay can be “delisted” as an impaired water body remains agriculture. The tipping point for the health of the Bay, and in many other coastal ecosystems around the world, was clearly associated with the dramatic increase in the use of manufactured fertilizers in the 1960s and 1970s. Agriculture remains the largest source of both nitrogen and phosphorus for the Bay. Reductions in agricultural nonpoint sources have been difficult because of limitations in the effectiveness of management practices and economic constraints. However, *Chesapeake Futures* identified existing and emerging technologies and policies that could accomplish nutrient source reduction objectives. We need to fully and vigorously implement practices we can apply today (nutrient and animal waste management, cover crops, etc.), bring to implementation emerging practices and approaches (diet modification, precision agriculture, manure treatment, etc.), and adapt future agricultural production systems that have less impact on water quality (alternative crops, bio-energy/carbon sequestration, etc.).

These will require alignment of national agricultural and environmental policies and this is where you as Members of Congress can help. The 2002 Farm Bill provided many of the tools needed to reduce nutrient impacts from current crop and animal production systems as well as offering opportunities for long-term adaptation. Funding for the Environmental Quality Incentive Program (EQIP) increased five fold but needs greater targeting to nutrients and water quality issues in regions like the Chesapeake and Mississippi River basins. The Conservation Security Program (CSP) would pay incentives to farmers for increasing levels of conservation. The CSP was authorized at $7.7 billion but the Administration’s FY 2005 budget request is only $205 million, with only one small watershed in Pennsylvania eligible. The CSP could replace production subsidies with conservation subsidies in the long term and thereby be the answer to World Trade Organization objections to current production subsidies while providing a major tool in water quality improvement. A regional CSP pilot program for the Bay watershed could provide a tool we need in the short term and help the Department of Agriculture refine the program for broad national implementation. Finally, two years ago the Governors of the Bay states submitted a five year, $100 million dollar proposal to the Secretary of Agriculture for funding through the Partnership and Cooperation Program in which conservation programs can be bundled to support innovative regional partnerships. However, the USDA has not acted on this proposal. This is an immediate step that could be taken to reduce agricultural impacts on the Bay and the regional Congressional delegation should urge the Secretary to support implementation of this already authorized program.

Mr. Chairman, thank you again for the opportunity to speak with you. I know that the restoration of the Chesapeake Bay can be achieved on my watch. I hope that we have the will to seize the opportunities before us to make that happen.