Subcommittee on fisheries Conservation, Wildlife and Oceans
House Committee on Resources

Oversight Hearing on the
Status of Ocean Observing Systems in the United States

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Testimony of
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Chairman Gilchrest and Members of the Subcommittee, thank you for the opportunity to speak with you concerning eutrophication and nutrient sources in Chesapeake Bay.

I am Thomas R. Fisher and a professor at the Horn Point Laboratory of the University of Maryland Center for Environmental Science. Besides enjoying sailing in the Chesapeake, I have been involved in scientific research on this lovely Bay since moving to the area in 1978, and I have worked with various national, state and local organizations. I am pleased to have been asked to provide my summary to you, and I offer the following testimony which I developed in consultation with my other colleagues listed above.

Summary

We want to put our main message right at the beginning. There are three main causes of eutrophication in Chesapeake Bay: agriculture, human waste disposal, and overfishing. Anthropogenic (human-derived) nitrogen (N) and phosphorus (P) from agriculture and human waste disposal have increased concentrations of N and P in rivers and caused increased algal growth in downstream waters of the Bay, including phytoplankton in the water and attached algae on plant and other surfaces. The greater algal growth reduces water visibility and shades submerged grasses which previously were common. Overharvesting of shellfish and fish has removed too many of the organisms which feed directly or indirectly on the algae, and much of the excess algal material settles to the bottom, where it is microbially degraded, contributing little to food chains and removing dissolved oxygen (O_2) from bottom waters. This process is particularly intense in warm summer months following large inputs of N and P during high flow periods in spring. We are, in effect, fertilizing the Bay and simultaneously removing the organisms which could benefit from the enhanced production. Chesapeake Bay may be viewed as an over-fertilized, under-grazed pasture, choking on its excess production..

This is the human footprint on the earth. We collect and produce food, and we dispose of our wastes after we eat the food. Human activities are the cause of the problems in the bay, and recognition of this will allow us to reduce the impact of our presence by providing ways to control the flow of N and P from land to water and to allow aquatic food chains to utilize effectively the anthropogenic N and P and enhanced production in the Bay. We have made some progress in reducing inputs of anthropogenic N and P to the Bay in some areas, but in general the reductions have not been large enough to create significantly better water quality. To illustrate this, we compare three regions: (1) the **Choptank** basin, where N and P inputs are dominated by agricultural activities (food production); (2) the **Patuxent** basin, where N and P inputs are dominated by human wastes (disposal of human waste after we eat the food); and (3) the **MD mainstem bay**, where agriculture in the Susquehanna basin (PA, NY) dominates the N and P inputs, with significant contributions from wastewater (e.g., Baltimore) and lateral tributaries such as the Patuxent and Choptank.

Choptank Basin

Dissolved nitrate in the Choptank River at Greensboro has continued to increase since monitoring began in the 1960s (Fig. 1). The cause is the increasing application of fertilizers to croplands, with a small contribution from septic systems associated with the increasing human population above the gauge site. The human populations in this area are low compared to other regions in the Bay's watersheds. This site is a USGS gauging station, one of the Bay Program's River Input Monitoring stations, with no significant point sources.

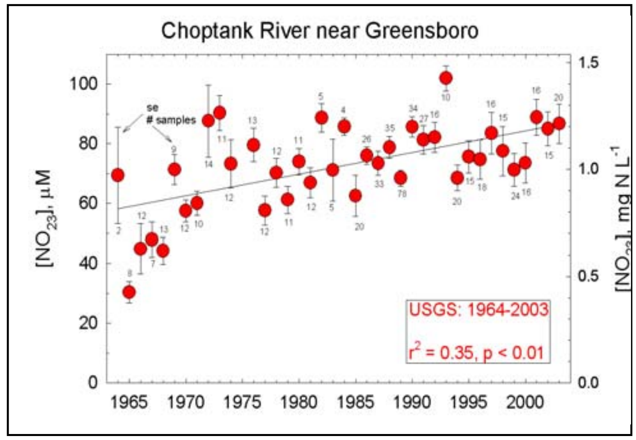

Figure 1. Annual average concentrations of nitrate at the USGS gauging station on the Choptank River at Greensboro MD (01491000).

Downstream of this monitoring station, small towns (Denton, Easton, Cambridge) continue to grow, with increasing **wastewater flows from sewage systems (point sources)**. Several tertiary treatment additions have been recently completed or are underway, and good management of the plants has decreased N and P concentrations in treated sewage (Fig. 2). Flux of N or P is flow * concentration, and the decreasing concentrations have been balanced by increases in flow due to increasing human populations. Continuing increases in human populations have the potential to offset the gains made by decreasing concentrations, and there have been few or no significant decreases in N and P inputs from wastewater plants. Because inputs from agricultural areas continue to increase (Fig. 1), overall inputs are either stable or increasing in rural areas such as the Choptank.

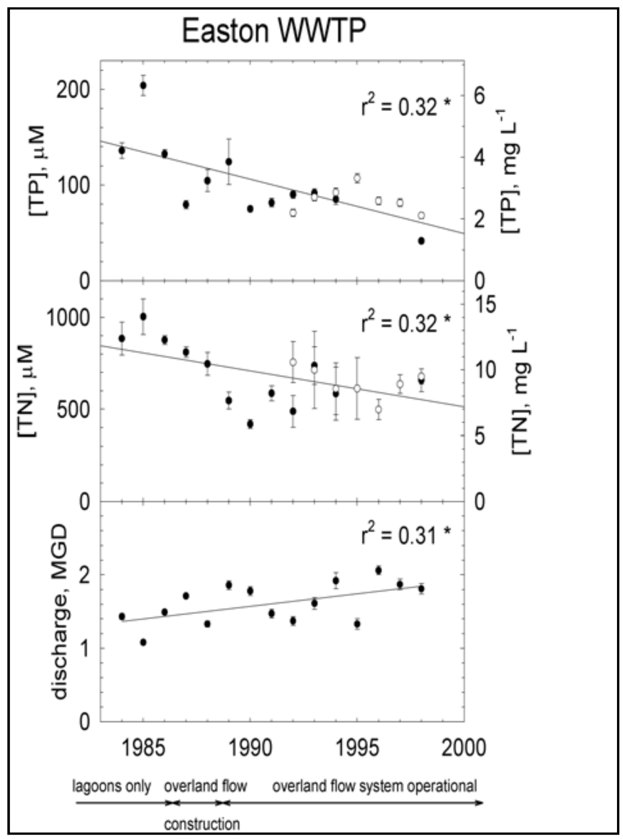

Figure 2. Increasing flows and decreasing concentrations of N and P at the Easton WWTP (MD).

In response to increasing agricultural inputs (Fig. 1), **water quality is degrading** at the Bay Program monitoring station ET5.2 (Rt. 50 bridge) in the Choptank (Fig. 3). The annual average phytoplankton (algae) populations in surface waters (measured as chlorophyll-a) are increasing, and water transparency (measured as Secchi depth and total suspended solids) is decreasing. Furthermore, in bottom waters summer O_2 is decreasing (upper panel of Fig. 4). If the present trends continue for another decade, oxygen in the bottom waters of the Choptank will be routinely lower than the minimum requirement for fish. At that point, fishing in the Choptank will become similar to that of the oxygen-poor Patuxent (lower panel of Fig. 4), where fish cannot live in bottom waters in summer.

Recommendations:

1. Agriculture needs to do more to reduce N and P inputs (winter cover crops, more stream buffers, better animal waste management). Current trends are not promising.
2. Caps (maximum fluxes of N and P) are needed for wastewater plants. Fluxes are flow x concentrations, and growth in towns (= increased wastewater flow from plants) needs to be matched by increased treatment to reduce concentrations to stay below the maximum allowed fluxes. New developments in growing areas should include the costs of the increased treatment.
3- The Choptank is P-limited in spring, N limited in summer, and inputs of both N and P should be reduced to avoid even lower bottom water dissolved oxygen in summer. Concentrations of oxygen too low for fish will occur within a decade if no action is taken (Fig. 4, top panel).

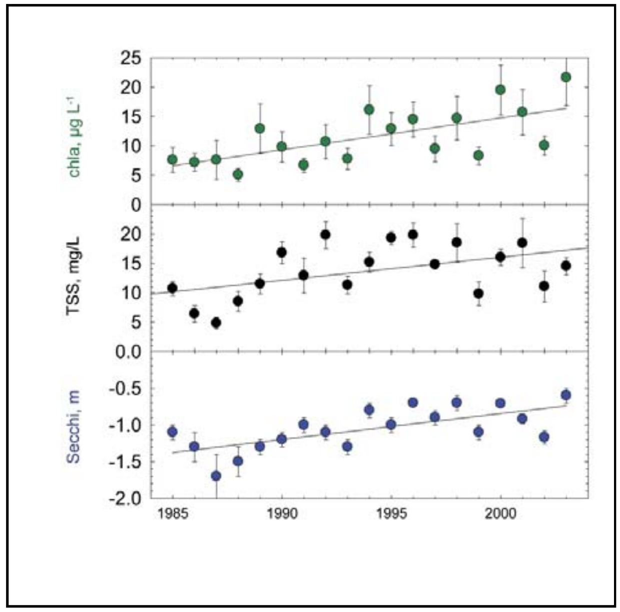

Figure 3. Increases in chlorophyll a (=algal abundance) and water turbidity (total suspended solids or TSS and Secchi depth) at the ET5.2 station on the Choptank River.

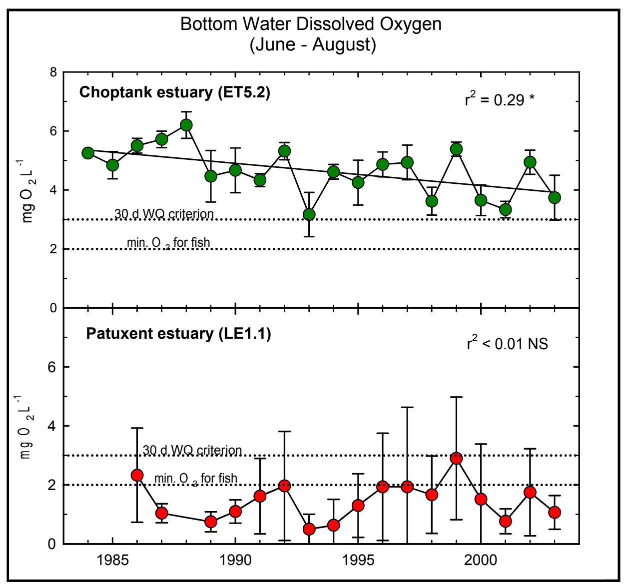

Figure 4. Long term trends in summer oxygen concentartions in bottom waters of the Choptank (upper panel) and Patuxent (lower panel) relative to living resource requirements.

Patuxent Basin

Increases in human populations in the Patuxent basin in the latter half of the 20th century have been responsible for large increases in sewage inputs to the Patuxent (Fig. 5). These inputs from wastewater dominate the nutrient budgets of the Patuxent, although diffuse sources from the atmosphere and agriculture also make contributions.

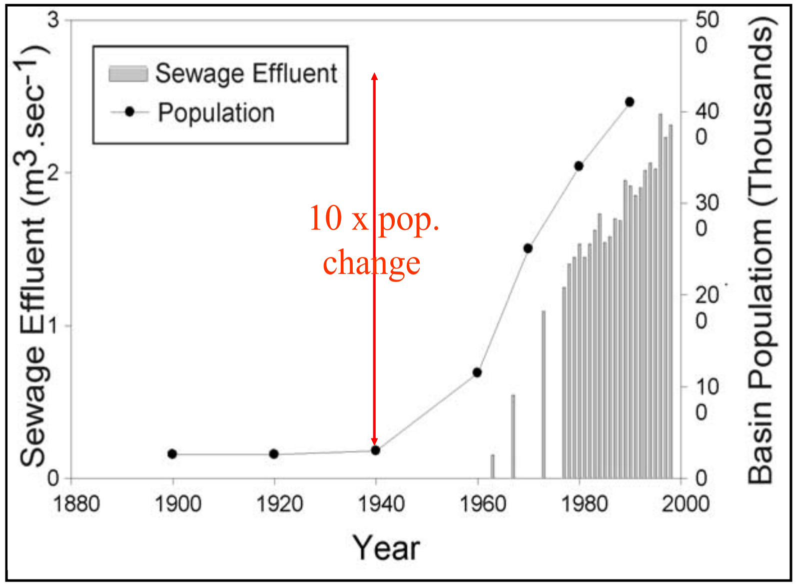

Figure 5. Human populations and wastewater volumes in the Patuxent basin in the 20th century.

Improvements in wastewater treatment in the Patuxent basin reduced P inputs in the 1980s and seasonally reduced N inputs in the 1990s (Fig. 6, top and middle panels). Although decreases in P inputs were large, the decreases in N inputs are only during the warm season, and peak fluxes in winter continue to increase because flows continue to increase (Fig. 6, bottom panel) due to increasing population (Fig. 5).

The estuary has responded to the reductions in wastewater inputs. Long-term (multi-year) averages of total N and total P have decreased somewhat (10-40%, see Fig. 7), but not enough to significantly improve water quality in the lower estuary. Water column algal biomass (chlorophyll a, see Fig. 8) and bottom water dissolved oxygen (Fig. 4, lower panel) have not changed because N and P were present in such abundance prior to the reductions. The estuary is responding (Fig. 7), but the reductions in N and P from human waste are not yet large enough to make significant improvements and the changes in total N and total P are only detectable in multi-year averages. In addition, human populations in the Baltimore - Washington corridor (upper Patuxent watershed) continue to increase (Fig. 5), which will only reverse the small gains already made.

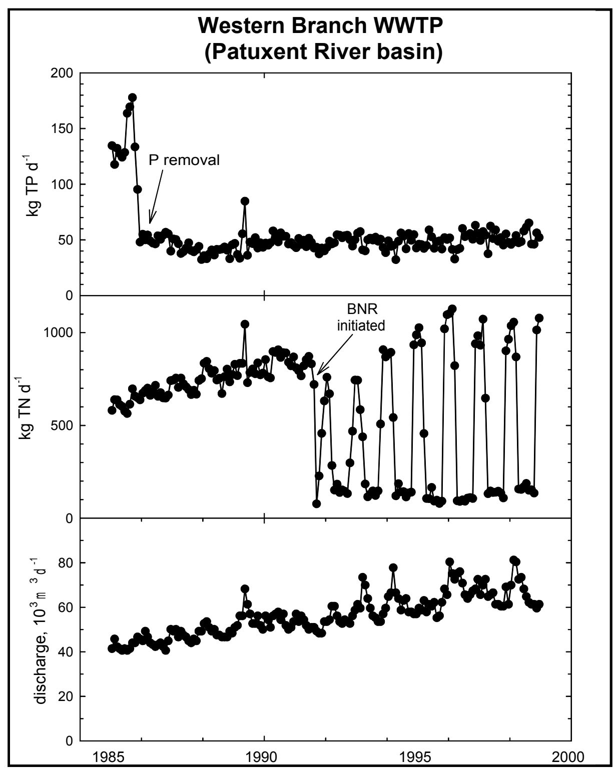

Figure 6. History of discharge and fluxes of N and P at Western Branch wastewater treatment plant in the Patuxent Basin.

Recommendations:

1. Improvements to sewage treatment have helped, but the reductions are not big enough compared to the magnitude of the inputs to a small system of limited volume. More advanced treatment will be required to improve water quality in the Patuxent estuary. In order to keep up with the increasing human population, even further reductions in wastewater concentrations will be required. As in the Choptank, quotas for wastewater N and P should be set, with concentration reductions compensating for increasing flows.
2. In this estuary, the focus should be on N inputs, as this system is primarily P-saturated from sewage and is nearly continuously N-limited.

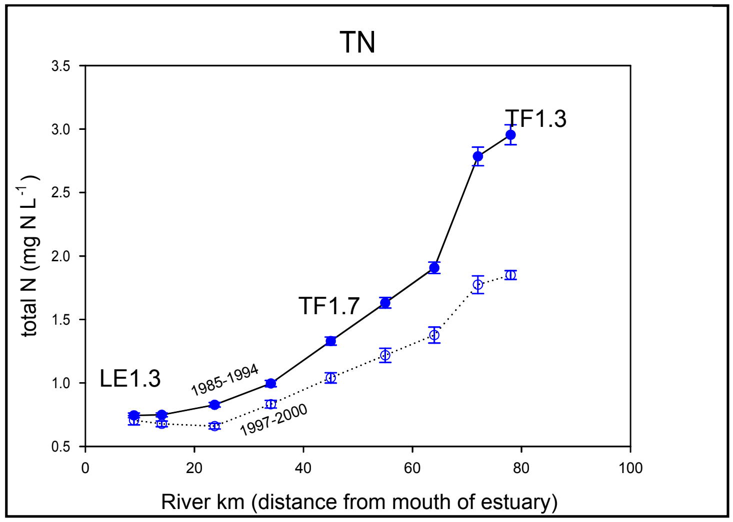

Figure 7. Long term changes in total N concentrations along the length of the Patuxent estuary resulting from reductions in sewage inputs.

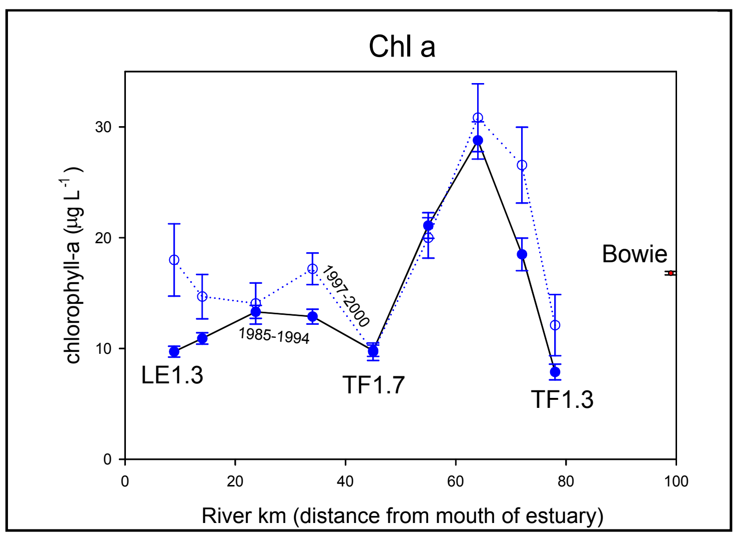

Figure 8. Long-term changes in chlorophyll a (algal biomass) along the length of the Patuxent estuary.

Main Bay

Historically, the main bay has experienced **increases in phytoplankton and decreases in water transparency** due to increased loading from both point and diffuse sources in the basin (Fig. 9). These sources in the Susquehanna River basin are similar to those shown above for the Choptank and Patuxent basins.

However, the Susquehanna River at Conowingo has had **decreasing N trends** since approximately 1985 (Fig. 10). These changes are probably due to management actions in PA or trapping by dams in the river, but concentrations remain more than ten times higher than N concentrations in streams draining forested regions. Despite the decreasing concentrations of TN at the river, there have been no parallel decreases in chlorophyll a or water turbidity downstream because the changes have been too small. However, there have been increases in the **annual index of N limitation** derived from bioassays at the main bay monitoring station CB4.3 (Fig. 11). This station is off the mouth of the Choptank, 40 km downstream from the Susquehanna River. This is an early indication of response to decreasing N inputs, but other sources to the bay in MD may have partially offset the decreases from the Susquehanna River.

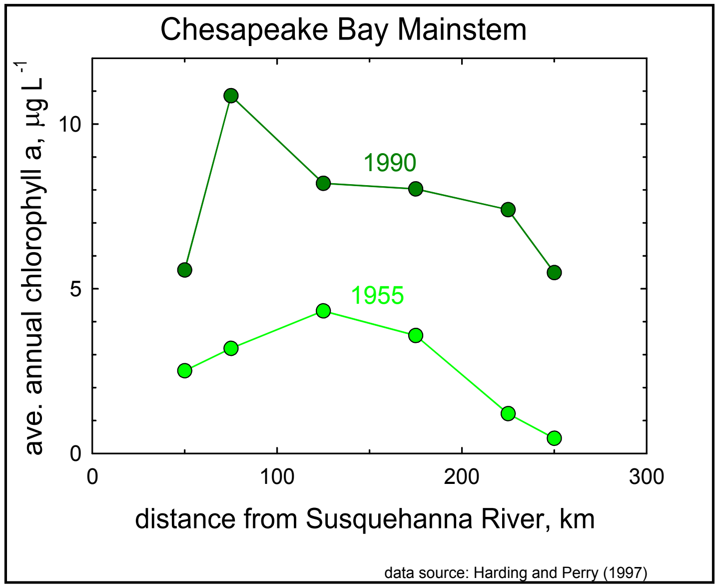

Figure 9. Historical changes in phytoplankton abundance (chlorophyll a) in the mainstem of Chesapeake Bay.

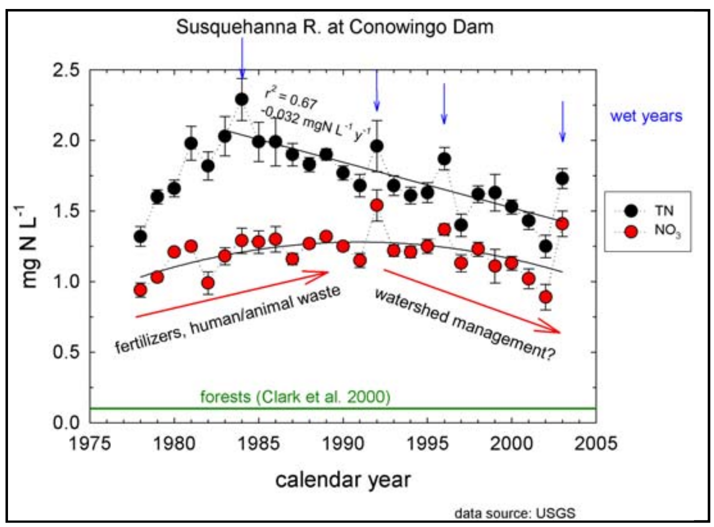

Figure 10. Recent changes in totalN concentrations in the Susquehanna River at Conowingo. With the exception of the record rainfall year in 2003, N has been falling since ~1985.

In the main bay, summer anoxia became widespread in the 1960s, and has gotten worse annually. Despite the trend in Fig. 10, the large inputs of freshwater, N, and P in 2003 resulted in record hypoxia in the bay's bottom waters in summer. Further reductions in nutrient inputs to the main bay from the Susquehanna River and from areas adjacent to the Bay (e.g., Baltimore) will be required to make significant reductions in chlorophyll-a and turbidity in surface waters and significant increases in oxygen in the bottom waters of the main bay.

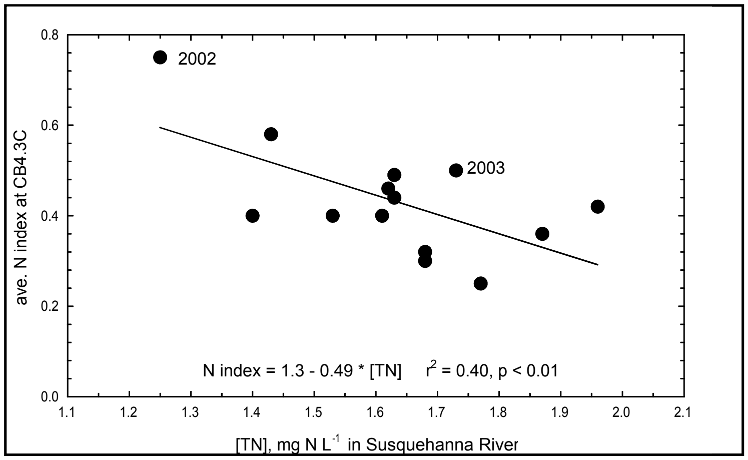

Figure 11. Correlation of the annual index of N limitation at the main bay station CB4.3C with Susquehanna River total N concentrations. Decreasing TN in the river makes the phytoplankton populations more N-limited.

Recommendations:

1. Decreases in N inputs from the Susquehanna River have helped improve water quality in the main stem of Chesapeake Bay. However, the decreases have been small, and further decreases in N concentrations will be needed to meet the Bay Program's goals.
2. More P reductions in sewage discharges into the main bay (e.g., Baltimore) will also reduce the magnitude of the annual spring bloom, which is primarily limited by P from March-May. In summer, under N-limitation, decreasing N from the Susquehanna River will reduce the size of algal populations and increase the survival of pockets of submerged grasses.