UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Silver Spring, Maryland 20910

APR 11 2002

Admiral James D. Watkins, USN (Ret.)
Chairman, U.S. Commission on Ocean Policy
1120 20th Street, N.W.
Washington, D.C. 20036

Dear Chairman Watkins:

Enclosed is my response to the question you posed on March 7, 2002 as a follow up to my testimony at the Commission's Charleston meeting.

Your question was:

> The Commission heard quite a bit about airborne, non-point-source pollution (nitrates); over 25% of nitrate loading in Chesapeake Bay is airborne. Is this airborne chemical synoptically monitored/modeled?

Yes. The national air quality models (Models-3/CMAQ), developed by the Environmental Protection Agency and the National Oceanic and Atmospheric Administration (NOAA), synoptically model nitrogen. However, modeling inter-annual variability of the dynamics of nitrogen transport and transformation needs to be improved to better understand the impacts of nitrogen deposition on marine environments.

Monitoring airborne nitrogen, on the other hand, is not synoptic but site specific (see attached information on the National Atmospheric Deposition Program). Nitrogen and other chemical compounds can be synoptically monitored if there is good spatial coverage and samples are collected daily. This data then can be coupled with meteorological models. This has been demonstrated with the Atmospheric Integrated Research Monitoring Network (AIRMoN), a sub-network of the National Atmospheric Deposition Program managed by NOAA, which uses a daily wet deposition sampling protocol. However, there are only a few AIRMoN stations in the U.S.-- primarily located in the east. Enclosed is more complete information on nitrogen deposition for your review.

I would like to thank you again for inviting me to testify and assure you that the Department remains committed to assisting the Commission in its work.

Sincerely,

for Margaret A. Davidson
Acting Assistant Administrator for
Ocean Services and Coastal Zone Management

Enclosure
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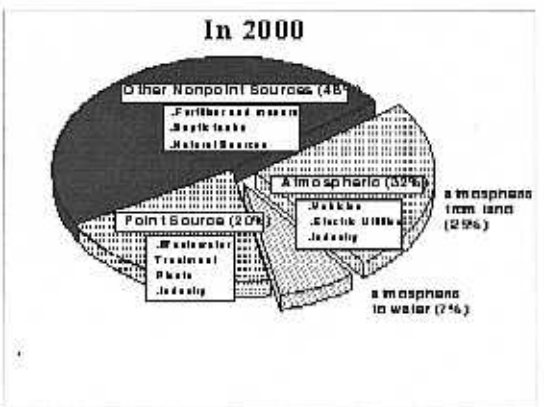
There is growing awareness of the ecological problems associated with nutrient over enrichment, specifically nitrogen, in coastal and estuarine waters worldwide. Symptoms include enhanced algal growth, geographic expansion and increasing frequencies of harmful algal blooms, oxygen depletion, fish kills, and the disappearance of seagrasses. Recent watershed and regional-scale studies point to atmospheric nitrogen deposition as a highly significant, and growing source of nitrogen entering the coastal zone. Over the past century, atmospheric nitrogen deposition (most of it from fossil fuel combustion and agricultural activities) has increased by 10-fold and now accounts for 20 to >40 percent of the "new" nitrogen loading to east coast estuarine and coastal waters (Valigura, et al 2000; Paerl, 2001). On global scales, atmospheric nitrogen deposition is the greatest source of new nitrogen input to the ocean environment, accounting for ~40 Tg N y^{-1}, compared to ~30 Tg N y^{-1} from runoff and riverine discharge, ~10 Tg N y^{-1} for groundwater, and ~15 Tg N y^{-1} from biological fixation (Prospero et al , 1996; Paerl, 2001). In the Chesapeake Bay, for example, atmospheric nitrogen is estimated to contribute roughly 32 percent of the total nitrogen load to the Bay and tidal rivers (Chesapeake Bay Program, 2001).

Atmospheric Nitrogen Loads to Chesapeake Bay



Loads to Bay = 284.7 million lbs. N
Source: CBP Phase 4.3 Watershed Model
2000 Progress Scenario

Atmospheric nitrogen deposition is 32% of the total nitrogen load to the Bay. (7% of which is deposited to the Bay's water surface and 25% is transported from the surrounding land after deposition).

For the Chesapeake Bay, the atmospheric nitrogen [nitrate, ammonium, and organic N] loading estimate (in lbs of N/year) is derived from the following pieces of information:

- a regression model of the distribution of wet inorganic nitrogen (nitrate+ammonium) deposition over the Bay and its watershed;
- modeled estimates of dry nitrate deposition (dry ammonia is unknown at this time); and
- literature-derived estimates of organic nitrogen.

The regression model, developed in 1994 by NOAA Air Resources Laboratory for the Chesapeake Bay Program (CBP), is based on the basic logarithmic relationship between amount of precipitation (taken from NOAA hourly precipitation datasets) and selected nitrogen concentration data taken from National Atmospheric Deposition Program-National Trends Network (NADP/NTN*) sites within or near the Bay watershed. The output from the regression model is a daily estimate of spatially allocated wet deposition across the Bay and its watershed. The regression design included latitudinal [north – south] and seasonal components. It does not characterize other factors (e.g., complex terrain) that contribute to the variation in deposition. Also, the nitrogen concentration data used to calibrate the Bay model were from the period 1984-1992. The CBP is in the process of improving this regression analysis.

*The NTN is a weekly wet deposition collection network, originally designed to address acid rain. For this purpose, the NADP intentionally positions stations away from polluted source regions (e.g., urban centers and concentrated animal agriculture areas) and from coastal sea salt influences. Therefore, the CBP estimates of atmospheric nitrogen loadings may be significantly underestimated. For the purposes of better understanding the effects of atmospheric nitrogen deposition on marine environments, more monitoring sites (ideally daily collection) are needed in strategic locations throughout the watershed and over water surfaces.

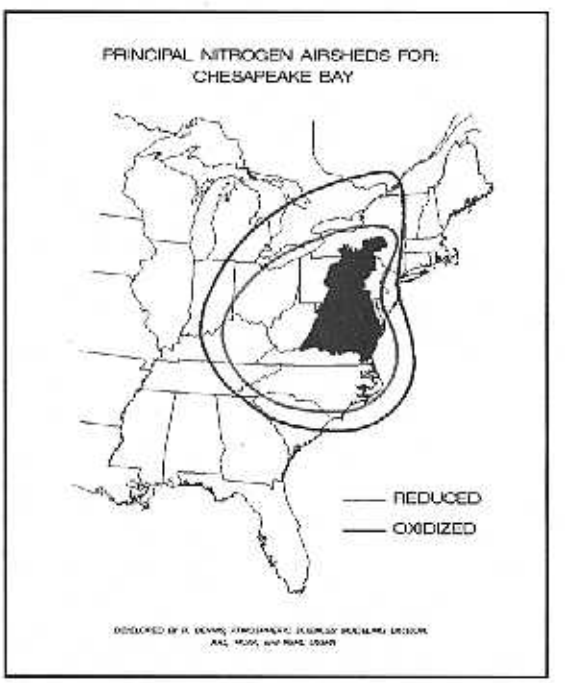
Unlike wet deposition, there is no simple method for measuring dry deposition. Artificial collection surfaces (plates, buckets, etc.) don't yield the same answers as are relevant for natural surfaces, because the properties controlling dry deposition rates are usually surface-specific. Dry deposition is an area where additional research is needed to accelerate the development of measurement technologies. For now, dry deposition estimates are derived from modeling conducted by NOAA and EPA and updated as models are advanced.

At this time, there is considerable uncertainty in the measurements and sources of organic nitrogen and debate on methods of collection and analyses. For now, literature estimates are used.

Chesapeake Bay Nitrogen Airsheds

In the mid 1990s the Regional Acid Deposition Model (RADM–an advanced Eulerian model) was used to develop an estimate of the primary airshed of nitrogen oxide (NOx) emissions that contribute to the nitrate deposition to the Chesapeake Bay and its watershed. The Chesapeake Bay NOx airshed, and more recently the ammonia airshed, were developed by the Atmospheric Sciences Modeling Division of NOAA/EPA. This model has since been replaced by a third generation modeling system called Models-3/CMAQ (http://www.epa.gov/asmdnerl/models3/CMAQ/index.html).

The boundaries of the Bay's airsheds were defined as the contiguous areas whose emission sources contribute nitrogen (via deposition) to the Bay and its watershed in a meaningful way. The NOx emissions within the airshed (larger outline in blue) account for roughly 76% of the nitrate deposition to the Bay and its watershed. The remaining 24% of the deposition is from sources outside the airshed. The ammonia emissions within the airshed (smaller outline in red) account for roughly 57% of the ammonia/um deposition to the Bay and its watershed. The remaining 43% is from sources outside the airshed.



The Oxidized (NOx) airshed is roughly 6.5 times larger than the Bay's watershed; the Reduced (ammonia) airshed is about 4 times larger than the Bay's watershed.

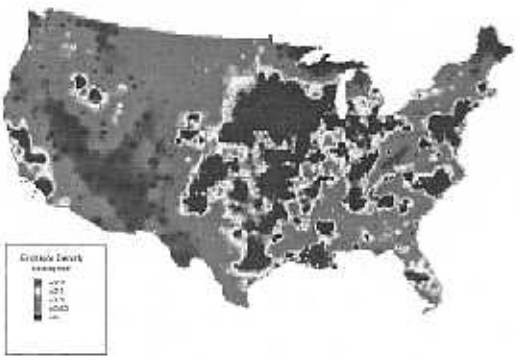
Atmospherically deposited nitrogen is primarily in the inorganic forms of oxidized nitrogen (particulate nitrate plus nitric acid gas) and reduced nitrogen (particulate ammonium plus ammonia gas). Approximately 2/3 of the deposited nitrogen is in the oxidized form; 1/3 is in the reduced form.

NOx emissions are largely a result of fossil fuel combustion (cars/trucks, industry, electricity generation). Ammonia emissions are dominated by agriculture (animal operations and commercial fertilizers), but are also from people, automobiles, and commercial and industrial activities. At this time, there are no controls on ammonia emissions.

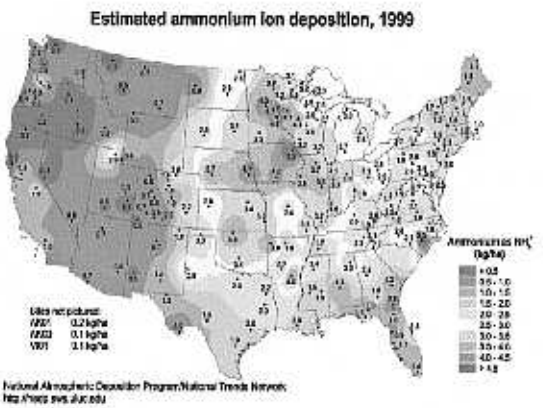
The airshed is not as firmly defined as the watershed; there are not clear boundaries to the flow of chemicals in the atmosphere as there are for the flow of surface and ground waters in watersheds. The absolute influence that an emission source has on deposition to an area continuously diminishes with distance. In other words, the airshed represents the area that encompasses emissions that would contribute most to the deposition across a watershed should all emission sources be equal. The airshed accounts for only 30% of the NOx emissions generated; 70% is generated by sources outside the airshed.

Models predict that existing Clean Air Act (CAA) regulations on NOx emissions will reduce nitrate deposition to the Bay and its watershed by 74 million pounds/year by 2010. That translates to about a 14 million pound reduction in nitrate load to the Bay.

Recent analyses of national monitoring data, however, show there is no decline in wet nitrate deposition in the U.S. This may be partially a reflection of the fact that CAA NOx emissions controls have not been fully implemented yet. Ammonium deposition, on the other hand, has dramatically increased in certain parts of the U.S., largely as a result of increasing human and animal populations. Ammonia also plays a key role in the formation of fine particulate matter , which can cause adverse human health effects and visibility degradation.



Density Map of 1998 Ammonia Emissions by County...From EPA's Report: National Air Pollutant Emissions Trends, 1900-1998



Monitoring Nitrogen Deposition

At present, there is one national deposition monitoring network operating in the U.S.–the National Atmospheric Deposition Program/National Trends Network (NADP/NTN). This program uses a weekly sampling protocol with the goal to assess trends and spatial patterns of acidic deposition. For this purpose, monitoring sites historically have been rural by design. Consequently, there is little data collected in polluted areas (high emission areas such as urban and concentrated animal agriculture) and coastal regions. Also, due to the weekly protocol, data can not be readily coupled with meteorological models or used in process-oriented studies. To improve upon these limitations, the Atmospheric Integrated Research Monitoring Network (AIRMoN), a sub-network of NADP managed by the National Oceanic and Atmospheric Administration (NOAA), uses a daily sampling protocol, with a special focus on concentrated emission regions and coastal regimes. However, due to funding constraints, there are only few monitoring stations in areas where data are required for studies of atmospheric nitrogen loadings to marine environments. Clearly, more monitoring is needed in populated coastal areas where the effects of nitrogen emissions are likely to be the greatest.