Understanding Nutrient Dynamics on Delmarva

A summary from a series of workshops with diverse partners held in June 23-25, 2025

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DELMARVA LAND AND LITTER COLLABORATIVE

Introduction

Delmarva's mix of high-value working lands and diverse natural resources make the region both productive and ecologically important, as well as vulnerable to water quality challenges linked to agricultural production, development, and other nutrient sources. Agriculture does not operate in a vacuum and all parts of the system, including commercial and residential development and drainage systems, impact the health of the Chesapeake Bay.

Reports from the Chesapeake Bay Program and University of Maryland, however, have continued to identify agricultural runoff on Delmarva as the single largest regional source of nutrients reaching the Chesapeake Bay, even as farmers have invested in widespread agricultural conservation measures.

The table below summarizes nutrient load information provided from the Chesapeake Assessment Scenario Tool (CAST) for Delmarva's Chesapeake Bay watersheds for the years 2009-2023. This data indicates that nutrient management and conservation practices have resulted in significant reductions of nitrogen, phosphorus, and sediment on Delmarva, though more reductions are still needed.

Data provided from the Chesapeake Assessment Scenario Tool (CAST) including Best Management Practices (BMPs) reported to the Chesapeake Bay Program

Pollutant	Estimated Loads Without Any BMPs (pounds/year)	Estimated Loads Including BMPs (pounds/year)	Estimated Reductions Provided by BMPs (pounds/years)	Percent Reduction Provided by BMPs
Nitrogen	43,618,016	25,856,753	17,761,263	41%
Phosphorous	1,202,990	592,316	610,674	51%
Sediment	417,217,619	156,610,726	260,606,893	62%

CAST modeled agricultural reductions for the Delmarva Eastern Shore (Chesapeake Bay watershed only) provided by Devereux Consulting.

To improve our collective understanding around the relationships between conservation practices and water quality results, the Delmarva Land and Litter Collaborative (DLLC) planned and hosted a series of three workshops, all in Easton, Maryland.

The first of these workshops was held on June 23rd and included approximately 30 regional scientific experts. This group met to exchange and evaluate the best available science, monitoring data, and modeling related to nutrient dynamics on Delmarva, and to establish a shared set of hypotheses.

On June 24th, DLLC convened approximately 70 participants, including scientists, farmers, chicken producers, environmental advocates, federal and state managers, and technical service providers. The intent of this meeting was to bring together diverse interests and information sources, in order to

develop a more cohesive understanding around why, despite significant and prolonged investments in agricultural conservation practices in the region, watershed health has not responded as expected. Representatives from the scientific gathering attended the meeting on June 24th to share their consensus statements on main drivers impacting nutrient dynamics in the region.

On the third and final day of the workshop series, June 25th, DLLC's 30 members met to review this information and begin to summarize shared learnings. This document summarizes the major findings from these workshops.

Findings

Water Quality Monitoring

The discussions among participants helped the collaborative make the following findings about the current state of nutrient dynamics on Delmarva:

- The Nanticoke Watershed Alliance's monitoring indicates improvement in nitrogen in lower regions and declining or no improvement in all others. Increases in phosphorus were indicated across their monitoring region.
- ShoreRiver's monitoring indicates the mid-Shore region shows nitrogen and phosphorus are high upriver, but decline downriver. The Tuckahoe in particular has high phosphorus levels.
- Although water quality is not improving as desired across Delmarva, conservation efforts have helped slow degradation despite increased development, precipitation, crop productivity, and chicken manure in the region.
- The time it takes for nutrients in groundwater to reach surface water is highly variable. Average groundwater residence time in Delmarva is 29 years.
- While the Chesapeake Bay region is one of the most well-monitored water bodies in the country, river and stream monitoring stations are limited on Delmarva because tidal mixing in portions of many waterways makes it difficult to isolate and calculate the amount of nutrients transported solely by streams.
- In recognition of this challenge, USGS load-monitoring stations are located only in nontidal areas to avoid tidal influences that would make the pollutant load estimates less reliable. There is a general lack of long term water quality nutrient monitoring in southern Delmarva, particularly in Accomack County, Virginia as the area is almost all tidal.
- The 2023-2024 UMCES Report Card indicates moderate conditions for the Choptank River and Lower Eastern Shore and declining conditions for the Upper Eastern Shore.
- USGS monitoring from 2014 to 2023 indicates varying trends in nitrogen loads across Delmarva, including improvements at stations in Manokin Creek, Tuckahoe Creek, Chesterville Branch, and Morgan Creek. Degrading conditions have been recorded for Marshyhope Creek and Nanticoke River. The Choptank River site shows no significant trend. Phosphorus loads are shown to be increasing across all stations on Delmarva.

Scientific Hypotheses

Scientists who participated in the workshops presented the following four hypotheses to DLLC members and guests for why water quality monitoring in some areas does not show expected improvements in Delmarva.

1. Nutrient and conservation management plans that are not spatially and temporally targeted for maximum BMP effectiveness.
2. Lag times in groundwater nitrogen movement and soil phosphorus drawdown.

3. Increased variability in precipitation and increased temperatures.
4. Increased nitrogen fertilizer application seeking yield goals to balance phosphorus-based litter application.

DLLC Lessons Learned

Building from the findings above, DLLC members identified the following five priority areas that could explain why water quality monitoring in some areas does not show expected improvements in Delmarva.

1. **Effectiveness of conservation management efforts**
   Some areas of the watershed are more vulnerable to nutrient and sediment loss than other areas. There are opportunities to target conservation practices to these high-risk areas where they will have the greatest impact on water quality. Additionally, there may be opportunities to improve the effectiveness of conservation practices by focusing more on the implementation timing. For example, planting cover crops earlier and terminating them later, allows for increased biomass and nutrient uptake.

2. **Groundwater lag times**
   Groundwater in Delmarva has an average residence time of 29 years. Lag times in some areas of the Lower Shore are closer to 100 years. This means that nitrogen in groundwater from decades ago could be impacting water quality measurements taken today.

3. **Increased weather variability**
   Increased heat stress, drought, and rainfall intensity raise the risk of nutrient and sediment loss to surface waters. High intensity rainfall events can increase transport of nutrients and sediment to waterways and accelerate nitrate loss to groundwater. Depending on the timing, heat stress to crops and droughts can impact yields and fertilizer uptake, leaving applied fertilizer at risk of transport to water resources.

4. **Altered drainage systems**
   Some areas of Delmarva are characterized by flat, low-lying, poorly drained coastal plain soils. This has led to extensive ditching and tile drain systems to ensure land is suitable for agricultural and commercial use. The prevalence of ditching and tile drainage in Delmarva could increase nutrient transport and reduce natural processing services. Understanding system performance requires looking at the full picture, including agriculture, along with municipal infrastructure, septic systems, and commercial and residential activity, combined with ongoing population growth, especially around drainage networks and their management.

5. **Nutrient management and nutrient use efficiency**
   Across Delmarva, farmers adopt advanced nutrient management practices to improve nutrient use efficiency, boost crop yields, and reduce fertilizer losses to air and water. The region has also seen an increase in collaborative efforts to address nutrient loss, including programs that promote efficient fertilizer use, regulatory requirements such as the Phosphorus Management Tool, and public–private investments in manure transport. Scientists estimate nutrient losses by analyzing crop nutrient uptake, fertilizer and manure application rates, and yields to determine the quantity of nutrients that remain unused and reach surface waters. However, limited or conflicting data on poultry production, manure use, fertilizer sales, application practices, and in-field management make it difficult to accurately quantify agricultural nutrient losses.