Impact of environmental policies on the adoption of animal waste management practices in the Chesapeake Bay Watershed

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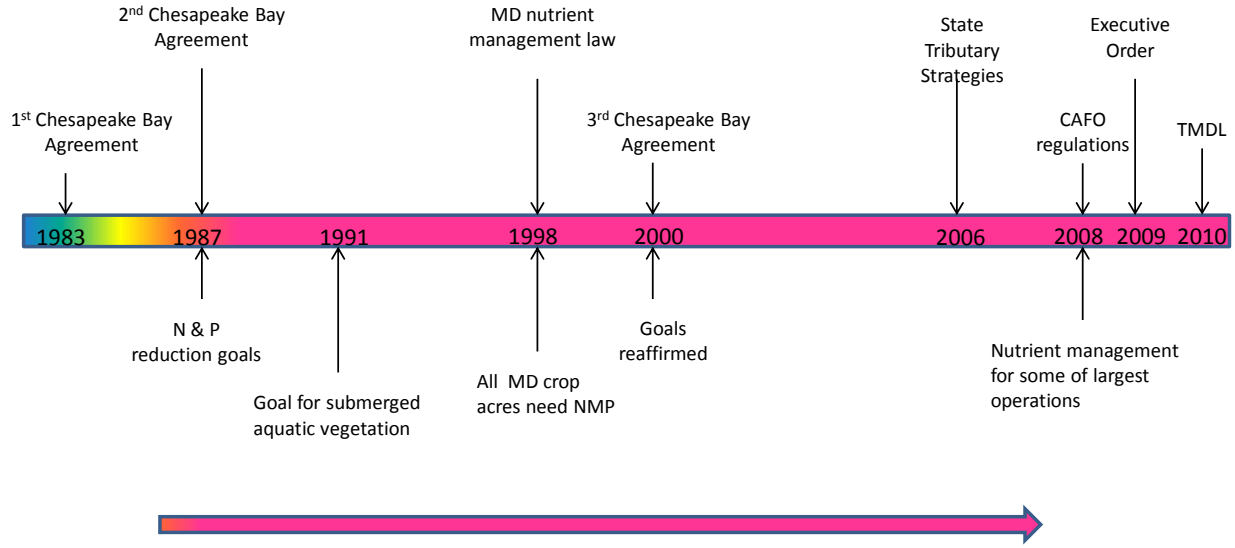
Introduction

The Chesapeake Bay is North America's largest and most biologically diverse estuary. However, its water quality has declined significantly since the 1970's due to increased urbanization and intensive agricultural production, resulting in a broad decline in aquatic resources. Starting in the 1980's the Bay watershed has been a focal point of federal and state initiatives to reduce nutrient pollution from agriculture and other sources.

In response to the Bay's decline, various management initiatives have been undertaken for Bay restoration since 1983, culminating in 2010 with the establishment of the Chesapeake Bay Total Maximum Daily Load (TMDL). The TMDL sets a pollution "diet" for the watershed, calling for loading reductions of 25 percent for nitrogen (N), 24 percent for phosphorus (P), and 20 percent for sediment. Pollution limits are allocated to jurisdictions (Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia) and major river basins based on modeling, monitoring data, peer-reviewed science, and collaboration with watershed stakeholders.

Nonpoint source pollution from the agricultural sector is exempt from regulation under the Clean Water Act (CWA). Since its inception in 1983, Chesapeake Bay Program (CBP) efforts to curb pollution from agricultural sources have relied on largely voluntary approaches (education, technical assistance, financial assistance) to encourage producers' voluntary adoption of agricultural best management practices. Increasing pressure to meet water quality goals and an expectation that future regulations are coming may be pushing producers, especially operations with confined animals, to proactively adopt best management practices. Evidence suggests that agricultural producers may respond to intense and focused policy scrutiny by adopting best management practices, with and without assistance, in order to get ahead of any potential regulations (Ribaudo and Johansson, 2007; Key et al., 2011). The monitoring and modeling that led to the development of a TMDL also provide evidence of links between agriculture and water quality, which could raise farmers' awareness of their impacts on water quality and potentially accelerate the adoption of water quality-protecting practices (Baumgart-Getz et al., 2012).

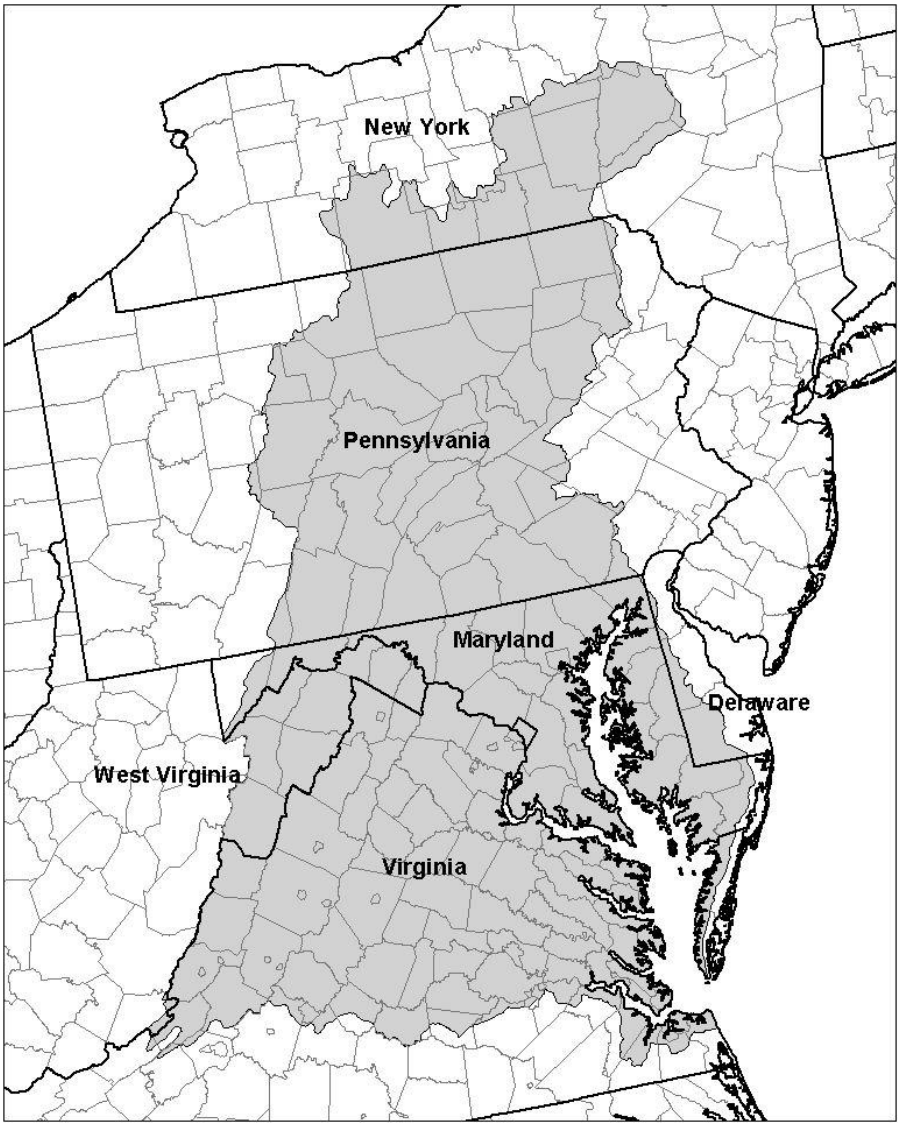
Timeline of Major Chesapeake Bay Program Components



Increasing pressure to meet water quality goals

Objective

We examined adoption of water-quality best management practices on animal feeding operations, both in states within the Chesapeake Bay Watershed and outside the watershed. Greater adoption within the watershed would indicate that pressure to meet water quality goals is encouraging practice adoption in advance of potential regulations.



Chesapeake Bay Watershed

Data and Methodology

We assess current nutrient management practices using data from USDA's Agricultural Resource Management Survey (ARMS) collected from broilers (2006), hogs (2009), dairy (2010), and cow/calf (2008) operations.

For each animal type we compared the manure management indicators of farms in the six Bay states (DE, MD, NY, PA, VA, WV) with farms in states outside the watershed but east of the Mississippi River. We also disaggregated the data by operation size, to the extent possible, given the number of observations. For each animal type/size class we estimated adoption of practices related to protecting water quality from animal waste. These include such things as the density of animals per cropland acre, the percentage of waste moved off the farm, the use of feed additives for reducing the nutrient content of manure, and the use of a comprehensive nutrient management plan (CNMP) for applying waste to fields.

For each variable we test the hypothesis

Statistical tests for two independent samples were used to assess whether the samples were drawn from the same population. Criteria for choosing a test are the validity of the test, and the power and efficiency of the test. Parametric tests are the most powerful when all of the test's assumptions are met. Nonparametric tests are most appropriate if the sample size is very small. We based the choice of statistical test on the following conditions from Siegel and Castellan:

1. *t* test
    a. When the statistical power of the *t* test is at least 0.80

For tests of means:

2. Robust rank-order test
    a. When the statistical power of the *t* test is less than 0.80

For tests of proportions:

3. Fisher exact test:
    a. When $N \leq 20$.
    b. When N is between 20 and 40, and the expected frequency of at least one outcome is less than 5

4. χ^2 test corrected for continuity
    a. When $N > 40$, use χ^2 corrected for continuity

Results

Practice adoption for dairy operations in the watershed vs. dairy operations outside the watershed

Practice/measure	Small operations	Medium/Large operations
Intensity (AU/Acres)	0[2]	—[1]
Percent manure removed from operation	0[2]	0[2]
Percent waste incorporated	0[1]	0[2]
Follow CNMP	0[4]	+[3]
Tested manure	0[4]	0[4]
Adjust fertilizer to account for manure nutrients	0[4]	0[4]
Feed management to reduce N	+[2]	0[4]

0 = no statistical difference
— = statistically smaller in the watershed
+ = statistically greater in the watershed
Superscripts 1-4 indicate statistical test used (see above)

Practice adoption for hog operations in the watershed vs. hog operations outside the watershed

Practice/measure	Small operations	Medium operations	Large operations
Intensity (AU/Acres)	—[1]	—[1]	—[1]
Percent manure removed from operation	0[2]	0[2]	+[2]
Percent waste incorporated	0[2]	0[2]	0[2]
Follow CNMP	0[4]	0[3]	0[3]
Tested manure	—[1]	—[4]	0[3]
Adjust fertilizer to account for manure nutrients	+[3]	+[3]	+[3]
Feed management to reduce P	0[3]	0[3]	0[3]

0 = no statistical difference
— = statistically smaller in the watershed
+ = statistically greater in the watershed
Superscripts 1-4 indicate statistical test used (see above)

Practice adoption for broiler operations in the watershed vs. broiler operations outside the watershed

Practice/measure	Small operations	Medium operations	Large operations
Intensity (AU/Acres)	0[3]	─[1]	─[2]
Percent manure removed from operation	+[1]	+[1]	+[2]
Percent waste incorporated	0[2]	0[2]	0[2]
Follow CNMP	+[1]	+[1]	+[1]
Tested manure	+[3]	+[1]	+[1]
Adjust fertilizer to account for manure nutrients	0[3]	0[1]	+[1]
Feed management to reduce P	0[4]	+[1]	+[4]

0 = no statistical difference
─ = statistically smaller in the watershed
+ = statistically greater in the watershed
Superscripts 1-4 indicate statistical test used (see above)

Practice adoption for cattle-calf operations in the watershed vs. cattle-calf operations outside the watershed

Practice	All operations
Fencing	+[4]
Riparian buffers	+[3]

0 = no statistical difference
— = statistically smaller in the watershed
+ = statistically greater in the watershed
Superscripts 1-4 indicate statistical test used (see above)

Discussion

Confined livestock and poultry operations in the Chesapeake Bay watershed appear to be responding to increasing pressure for improved water quality performance by adopting best management practices, even though regulations were generally not in place at the times the surveys were conducted. In cases where there was a statistical difference, animal operations in the Bay watersheds states almost always exhibited a greater degree of protection of water resources from animal waste than operations in states outside the watershed.

- Animal intensity (animal units per acre of cropland) was consistently lower on operations in the watershed states, across animal types and size classes.
- A greater percentage of manure was moved off the farm on broiler operations in watershed states.
- A higher percentage of hog and broiler operations in the watershed states tended to have comprehensive nutrient management plans.
- Cow/calf operations in the watershed states had higher adoption rates of both fencing and riparian buffers.
- A greater percentage of dairy and broiler operations in the watershed states utilized feed management practices that reduced the nutrient content of manure
- A greater percentage of hog and broiler operations adjusted commercial fertilizer applications to account for manure nutrients

While there has been some progress in the voluntary adoption of practices to protect water quality, much more needs to be accomplished. The threat of regulation has been strongest for confined animal operations. A "carrot/stick" approach that mixes voluntary adoption with prospects of regulations for crop production as well as confined animal operations may contribute to an overall strategy for meeting the TMDL.

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