Improving modeling and mitigation strategies for poultry ammonia emissions across the Chesapeake Bay Watershed

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Introduction

Current estimates are that roughly one-third of the nitrogen entering the Chesapeake Bay comes from atmospheric emissions. [1] Historically, about two-thirds of that was in the form of nitrogen oxides (NO_x) and one-third as ammonia.[2] Improvements in air quality have played a critical role in restoring the Chesapeake Bay. [3] Emissions of NO_x from power plants and vehicles have achieved substantial nitrogen reductions through the Clean Air Act.[4] In contrast, ammonia emissions, which are primarily from agricultural sources, have increased over time. Currently the contribution of NO_x and ammonia to the atmospheric load of nitrogen to the Chesapeake Bay are roughly equal, but in the future, the contribution from ammonia is expected to exceed that of NO_x[5,6]. A recent study estimating ammonia emissions and deposition from poultry operations on Maryland's Eastern Shore suggests contributions of nitrogen to local waters and the Chesapeake Bay could be substantial.[7] In addition to exacerbating eutrophication, ammonia is also toxic to highly sensitive freshwater mussels as evident by recently adopted EPA Criteria. Ensuring that our modeling approaches are accurately estimating this growing source of nitrogen and that mitigation strategies are explored and implemented are key to protecting water quality in the Chesapeake Bay and its tributaries.

Mitigation strategies

Poultry litter additives, (e.g., alum) which are principally applied to promote bird health, prevent nitrogen emissions from poultry houses. NRCS has historically provided incentives for the use of these additive but there is not a current pathway to crediting their use. Further CBP modeling efforts lack information related to how frequently these additives are used. While improving the effectiveness of litter additives remains an area of emerging research, scientific literature consistently suggests the capacity to dramatically reduced ammonia volatilization.[8]

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[1] Air Pollution | Chesapeake Bay Program
[2] http://www.chesapeake.org/pubs/atmosphericnitrogen.report.pdf
[3] Cleaner Air, Cleaner Bay (chesapeakebay.net)
[4] Eshleman, K. N. and R.D. Sabo. 2016. Declining nitrate-N yields in the Upper Potomac River Basin: What is really driving progress under the Chesapeake Bay restoration? Atmospheric Environment 146:280-289
[5] https://www.chesapeakebay.net/channel_files/25651/atmo_dep_webinar_draft_11-1-17.pdf SEE Page 47
[6] Campbell, Patrick C., Jesse O. Bash, Christopher G. Nolte, Tanya L. Spero, Ellen J. Cooter, Kyle Hinson, and Lewis C. Linker. "Projections of Atmospheric Nitrogen Deposition to the Chesapeake Bay Watershed." Journal of Geophysical Research: Biogeosciences 124, no. 11 (November 1, 2019): 3307–26.
[7] Baker, Jordan, William H. Battye, Wayne Robarge, S. Pal Arya, and Viney P. Aneja. "Modeling and Measurements of Ammonia from Poultry Operations: Their Emissions, Transport, and Deposition in the Chesapeake Bay." Science of The Total Environment 706 (March 1, 2020):
[8] Moore Jr, P. A., et al. "Evaluation of chemical amendments to reduce ammonia volatilization from poultry litter." Poultry Science 75.3 (1996): 315-320.

Pursuing litter additives as a management strategy has long been contemplated by the partnership. The *Chesapeake Bay Program Best Management Practice Reference Guide* suggested these "will be available in future editions." However, progress on quantifying these issues is unclear. Maryland and Delaware have set a specific goals to achieve litter treatment as part of their Phase III Watershed Implementation Plans and yet these practice still do not have the capacity to be credited. This workshop will advance these efforts.

Adequacy of the existing modeling framework

A variety of modeling tools are used to estimate livestock ammonia emissions, deposition and transport to local waters and the Chesapeake Bay. Wet deposition of ammonium is estimated using wet-fall concentration regression models for the Chesapeake Bay watershed [9] Regression parameters include precipitation, land-use information, and livestock emissions. The source of the landuse information is from the National Land Cover Database (NLCD) and for livestock emissions, the National Emissions Inventory (NEI). In both cases, the most recent data are from the 2011 versions of these databases and worth noting, is that the 2011 NEI uses livestock inventory data from the 2007 USDA Agricultural census.[10] Livestock and poultry production have increased in the region since 2007, raising a question of whether these increases are captured within the current modeling framework. In addition, some have questioned the adequacy of the emissions factors used in the model. [11] The Community Multi-Scale Air Quality (CMAQ) model integrates this information on wet deposition and combines it with other modeling approaches that include dry deposition of ammonia to estimate nitrogen deposition[6]. According to Campbell et al. 2019 "There is greater uncertainty in the characterization of agricultural sector NH_3 emissions in the 2011NEI platform compared to NO_x sources, due to fewer in situ observations and emissions monitoring data than exist for NO_x." One purpose of the proposed workshop is to bring together experts to discuss the current modeling approach for ammonia emissions from livestock, and determine whether model estimates are adequate or should be improved and if so, how.

<u>Workshop questions and product deliverables</u>

I. Evaluating the threat:
   a. What evidence do we have suggesting overlooked environmental impacts from poultry houses?
   b. How could overlooked impacts from poultry emissions limit our ability to meet our Bay restoration goals (i.e., hypotheses/conceptual models that communicate how poultry operations influence air and water quality)?
   c. What information is missing to assess these threats? What can we apply from research on other types of CAFO operations?

II. Evaluating the Adequacy of the Current Regulatory Framework:
   a. How does the CBP watershed model evaluate impacts from animal operations? What are the estimated cumulative effects of various animal operations on water and air quality relative to other ag impacts? What are the sources of uncertainty?
   b. Do these algorithms adequately capture or describe risk from poultry operations (i.e., reflect the conceptual models shared in Session I)? What information is missing?
   c. Does the model adequately represent BMP benefits? Are changes needed to emissions factors animal inventories or other modeling parameters to improve model estimates?

III. What are the most effective mitigation strategies?

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[9] Grim, J. 2017. Extension of Ammonium and Nitrate Wet-Fall Deposition Models for the Chesapeake Bay Watershed FINAL REPORT found here: CAST - Model Documentation (chesapeakebay.net)

[10] NEI2011v2_TSD_12aug2015_jbh suggestions 081215 (epa.gov) Page 82.

[11] Ammonia-Report.pdf (environmentalintegrity.org)

a. Summarize Current and emerging technologies including (1) In-house bedding and treatments (2) Waste treatment (3) Off-site mitigation strategies
b. What other factors are important at controlling emissions?
c. What mitigation strategies exist for other animals, e.g., dairy cows?

IV. Stakeholder Engagement and Practice Adoption
a. Do we have an understanding of Current BMP adoption rates?
b. What are the current incentives? Co-Benefits? How much has the partnership invested in these?
c. What is the cost-effectiveness of this strategy set relative to other ag BMP's?
d. Strategies to improve information sharing and support to agriculture?

Expected Deliverables:

1. Summarize best estimates of ammonia deposition and identify important knowledge gaps for the partnership to address.
2. Summarize efficacy of mitigation strategies and identify important knowledge gaps.
3. Summarize CBP modeling of ammonia emissions, identify important knowledge gaps and recommend strategies to improve.
4. Identify obstacles to implementation of BMPs and provide recommendation to improve adoption.

Management Relevance, Fit for STAC Workshop, and Urgency

This represents the first STAC proposal by this collective group although several members have substantial history working with the Bay Program and STAC. Further, this effort brings experts to the table that have not historically been involved in the partnership, helping to broaden diverse and constructive dialogue on Bay issues. The result of this workshop will directly inform a variety of groups including the Water Quality Goal Implementation Teams; government partners at local, state and federal level that may consider incentives related to mitigation techniques and the Agricultural workgroup. Deliverables produced will provide recommendations on how the partnership can improve modeling and increase incentives for the most beneficial practices.

Logistics, Timeline and Budget

The steering committee will meet monthly to discuss objectives and identify important resources leading up to a remote meeting to address the questions at hand. The committee will look to take advantage of a virtual format by considering a series of several short meetings rather than focusing on a single event. This enhance our ability to facilitate focused discussions and to have opportunities to synthesize those discussions between meetings. The steering committee will also hold several conference calls following the workshop while developing the final products. We request a budget of **$ 10,000** which will largely consist of financing a facilitator. We are also exploring the possibility of private funder to offset any additional costs associated with the workshop. The timeline for the workshop is flexible.

Spring 2021: Hold steering committees to plan agenda, presentations, Finalize guest lists
Summer 2021: Hold series of meeting (1. modeling and underlying science, 2. Mitigation strategies, 3. Stakeholder engagement); synthesizing
Fall 2021: Monthly steering committee meetings to draft and finalize report.