DLLC brings together representatives from chicken companies, farming, regulatory agencies, academia, and environmental groups in a collaborative and mission-driven manner.

The complex challenges facing the integration of food production, environmental protection, rural economies and communities cannot be solved by single-faceted approaches. The challenges cross boundaries, and the solutions need to as well.

Learn more online: **https://delmarvalandandlitter.net**

Diverse Leaders at the Table

Chesapeake Bay Foundation
The Nature Conservancy
Mountaire Farms
J.R. Frazee Strategic Consulting
Eastern Shore Land Conservancy
DE and MD Soybean Boards
Sussex Conservation District
Old Mill Farms, Poultry Farmer
Delmarva Chicken Association
Alliance for the Chesapeake Bay
U.S. Environmental Protection Agency
VA Department of Environmental Quality
Horizon Farm Credit
Sustainable Chesapeake

DE and MD Association of Conservation Districts
University of Maryland Extension
Forever Maryland
Perdue Farms
Lower Shore Land Trust
Maryland Grain Producers Utilization Board
Nanticoke Watershed Alliance
Chesapeake Bay Commission
Harry R. Hughes Center for Agro-Ecology
Thomas Family Farms, Poultry/Grain Farmer
VIMS, Eastern Shore Lab
ShoreRivers
R&W Farms, Poultry/Grain Farmer
Maryland League of Conservation Voters
Delaware Center for Inland Bay

Ammonia Emissions from Poultry Production on Delmarva

Delmarva Land and Litter Collaborative members spent two years reviewing and synthesizing information related to the management of ammonia in the chicken houses, modeling of ammonia emissions and identifying where information gaps still exist. The culmination of this work is a publicly available document which summarizes what DLLC learned. It's information that is scientifically backed and thoroughly vetted by DLLC members and scientists who contributed to the process.

DLLC members primarily engaged in this process were Kristen Hughes-Evans (Sustainable Chesapeake), Alan Girard (CBF), Keven Cline (VA DEQ), Mike Levengood (Perdue), Bill Massey (Mountaire), Alex Echols (Keith Campbell Foundation), Holly Porter (DCA), and Richard Snyder (VIMS ESL)

Dr. Richard Snyder, Director of the Virginia Institute of Marine Sciences, Eastern Shore Laboratory, will be the presenter of this webinar. Dr. Snyder first became involved in poultry issues in 2015 when poultry industry expansion on the Eastern Shore of Virginia raised water quality concerns.

This presentation will provide highlights of the paper and allow for discussion of the contents.
Please enter your questions using the Q&A function at anytime and will be used to moderate a discussion after the formal presentation. We will attempt to answer as many questions as time allows.

The full paper can be found here:

https://delmarvalandandlitter.net/wp-content/uploads/2022/10/ammonia-paper-high-res-2.cdf

DELMARVA LAND AND LITTER COLLABORATIVE

The nitrogen cycle

and how does poultry fit in?

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N_2 gas in Atmosphere

↓

Inert gas (N_2), 87% of the earth's Atmosphere

Ammonia (NH_3)
Ammonium (NH_4^+)

Biologically active forms

<u>N_2 converted to biologically active forms by:</u>

Nitrogen fixing microorganisms on roots of plants (soybeans, locust, wax myrtle)

After 1913, industrial nitrogen fixation: Haber-Bosch process began the production of inorganic nitrogen fertilizers.

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N_2 gas in Atmosphere

Inert gas (N_2), 87% of the earth's Atmosphere

Ammonia (NH_3)
Ammonium (NH_4^+)

Biologically active forms

Ammonium (NH_4^+) and Ammonia (NH_3)

The balance between ammonium and ammonia depends on pH (acid or alkaline).

In acidic conditions, (below pH 7): ammonium (NH_4^+) dominates.

In basic/alkaline conditions (above pH 7): ammonia (NH_3) dominates.

Ammonium (NH_4^+) and Ammonia (NH_3)

Standard chemical tests do not distinguish between ammonia and ammonium

A single reporting number as ammonia nitrogen is typically presented and used to track environmental nitrogen processes, but these are very different chemicals.

Do model assumptions assume all ammonia (NH_3)?

Ammonium (NH_4^+) and Ammonia (NH_3)

Ammonia exists as a volatile gas, but also readily dissolves in water.

Ammonia gas is the form that is of concern in poultry litter emissions

Loss of ammonia gas from litter impairs bird health and reduces its fertilizer value.

In contrast, ammonium tends to be bound to organic matter and clays

N_2 gas in Atmosphere

Ammonia (NH_3)
Ammonium (NH_4^+)

Ammonia (NH_3) gas

Ammonia Emissions

Burning organic material and fossil fuels

Waste water treatment plants

Agriculture and urban fertilizer

Agriculture livestock and pets

Concentrated Animal Feeding Operations (CAFOs)

CAFO ammonia emissions have been relatively stable over time, but as other sources are being addressed, CAFO ammonia has become a target

Poultry litter

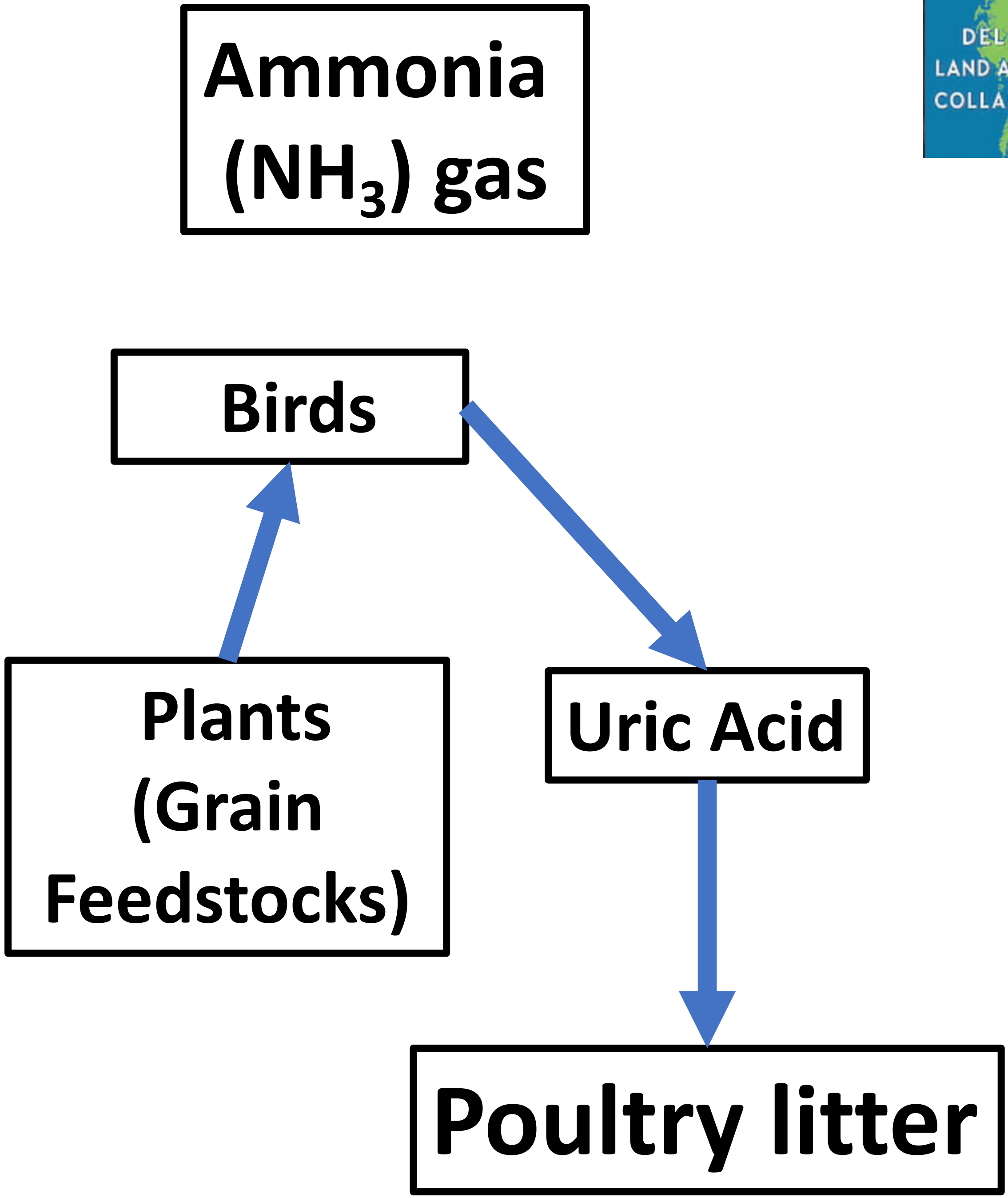
Growth efficiency:

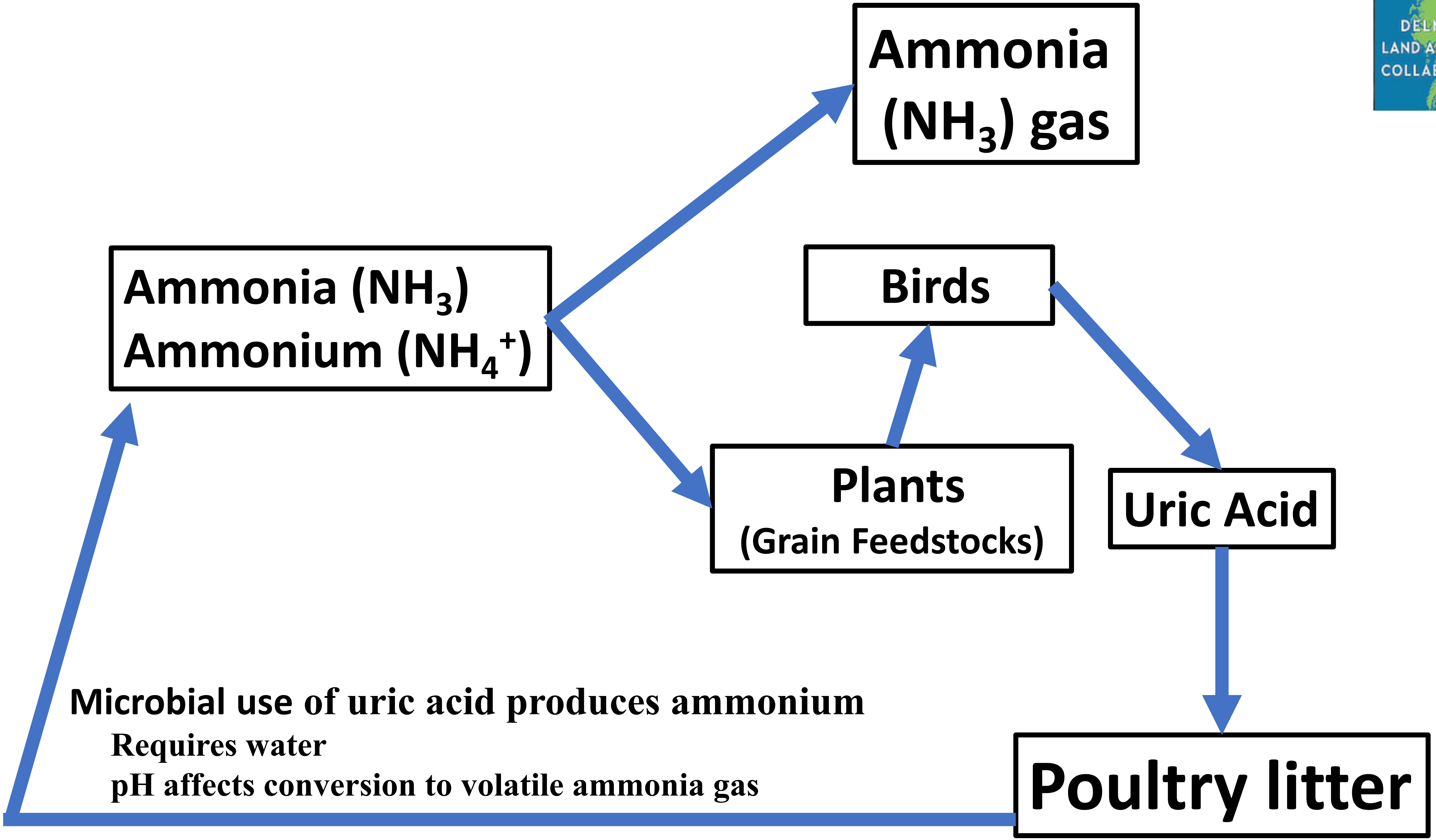
Only part of the N ingested is converted into chicken, the rest is excreted.

Growth efficiencies 52-67%!

Mammals convert ammonium into urea that is excreted in urine.

Birds and reptiles convert ammonium into uric acid, which is excreted as the white part of the feces.




Ammonia (NH_3) gas
Ammonia (NH_3)
Ammonium (NH_4^+)
Birds
Plants
(Grain Feedstocks)
Uric Acid
Poultry litter
Microbial use of uric acid produces ammonium
Requires water
pH affects conversion to volatile ammonia gas

Poultry Litter

- Manures from animals and birds contain ammonium, nitrate, phosphorous, and potassium and micronutrients

- The amount of nitrogen in poultry litter that is immediately plant-available is estimated to be 18%.

- Most of the nitrogen in animal manure is bound in organic molecules.

5-3-2

$30/25lbs

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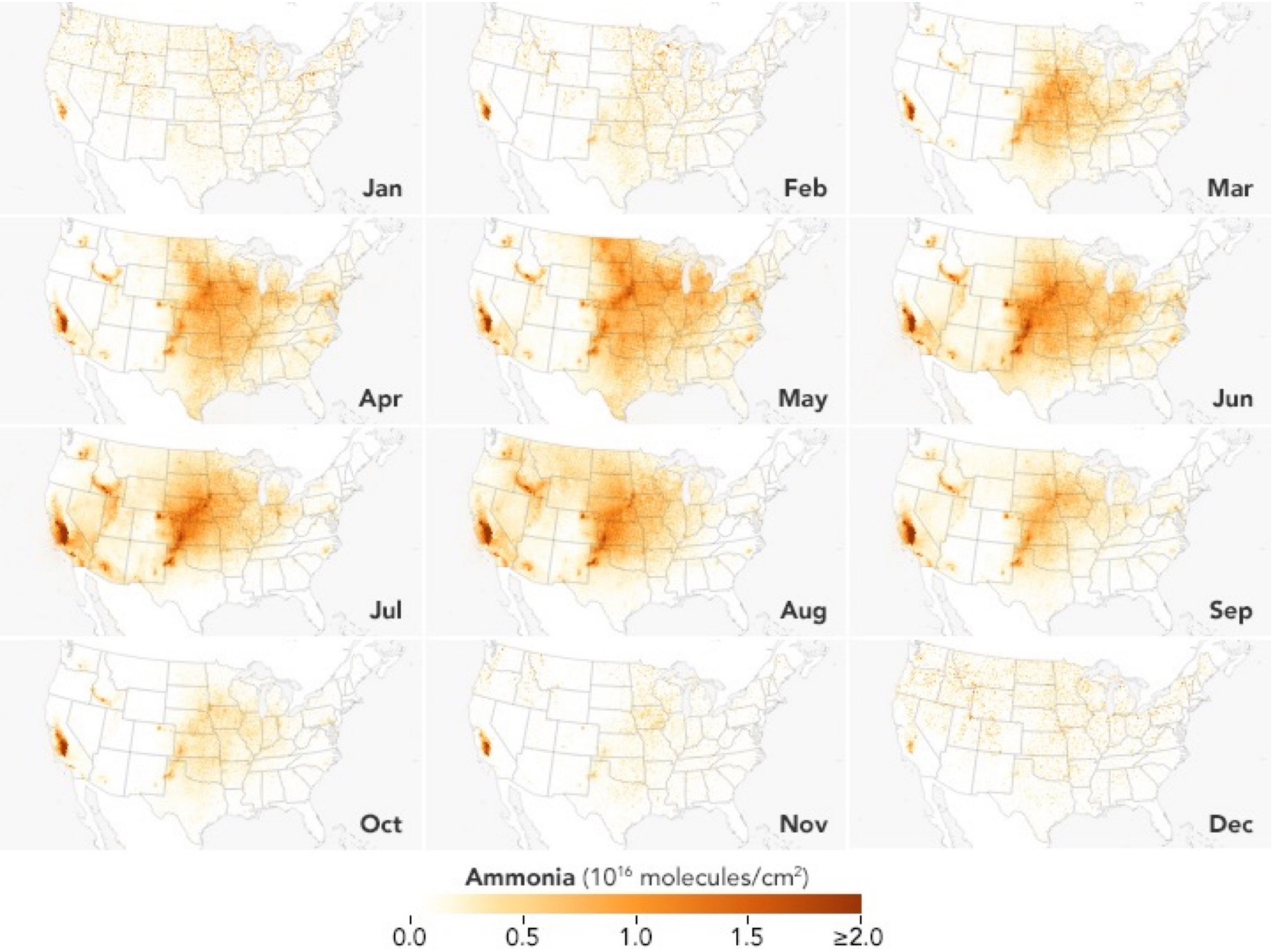
Ammonia Emissions: large scale

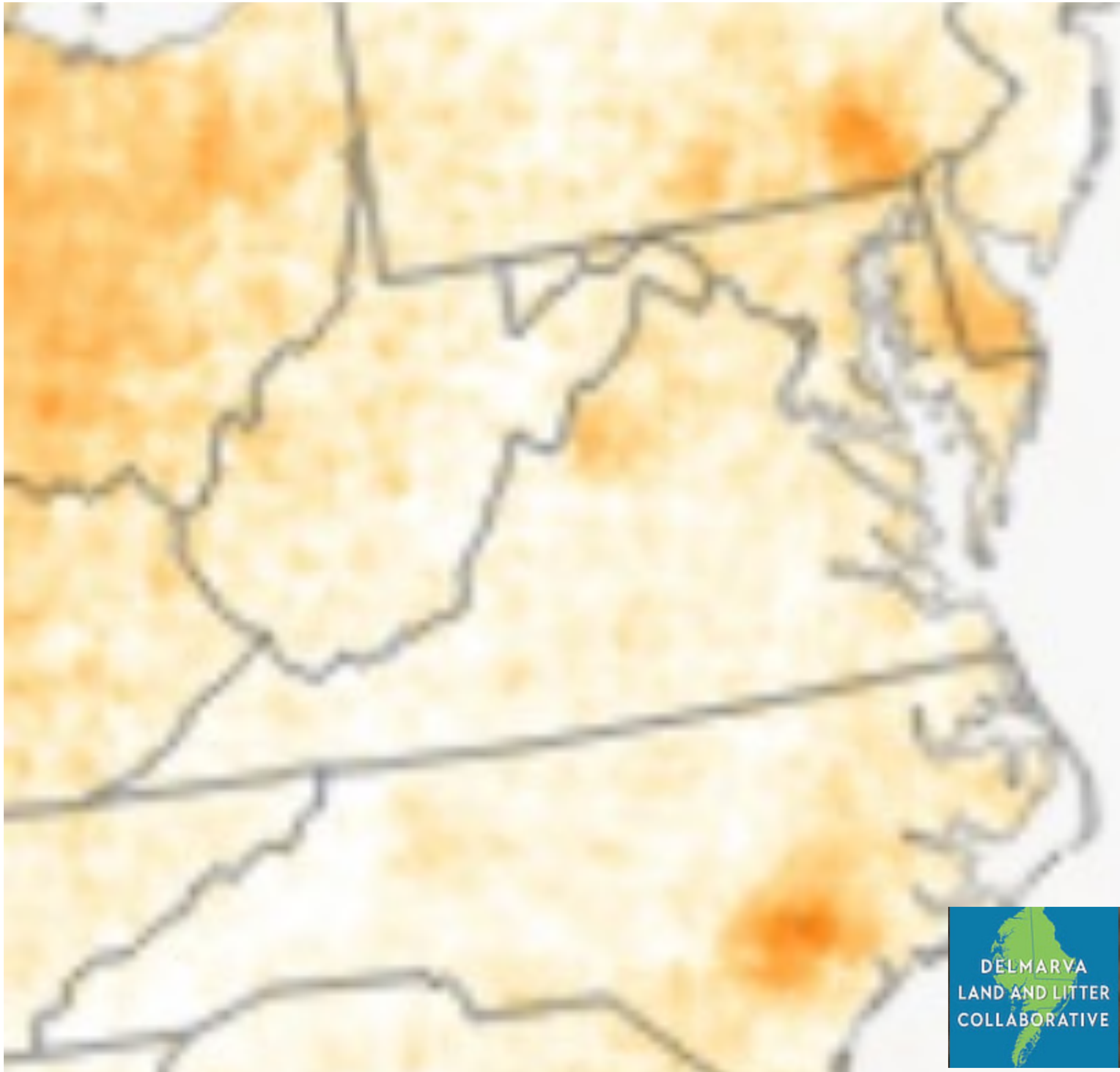


Nationwide, Ammonia emissions are seasonal

NASA Earth Observatory: https://earthobservatory.nasa.gov/images/144351/the-seasonal-rhythms-of-ammonia

Ammonia Emissions:
East Coast US June 2016

Chesapeake Bay vs Delaware Bay and Atlantic Ocean drainages



NASA Earth Observatory:
https://earthobservatory.nasa.gov/images/144351/the-seasonal-rhythms-of-ammonia

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Ammonia Emissions: distance, deposition, and dispersal

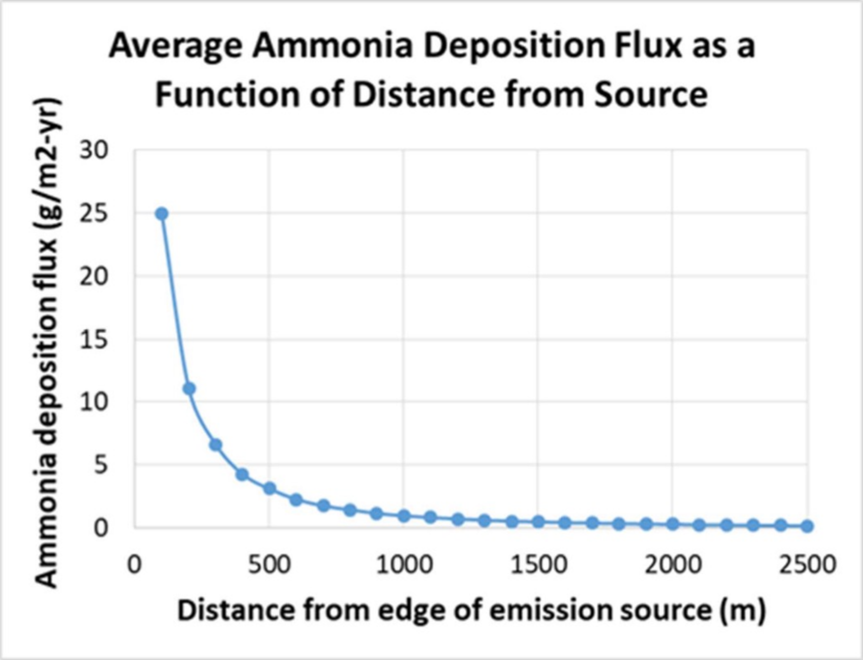


Figure 11. Average annual ammonia deposition flux (g $m^{-2}yr^{-1}$) as a function of distance (m) from an AFO source (for a deposition velocity of 2.4 cm/s), for a single poultry facility.

Baker, J, WH Battye, W Robarge, SP Arya, and VP Aneja. 2020. Modeling and measurements of ammonia from poultry operations: their emission, transport, and deposition in the Chesapeake Bay. *Science of the Total Environment* 706: 135290

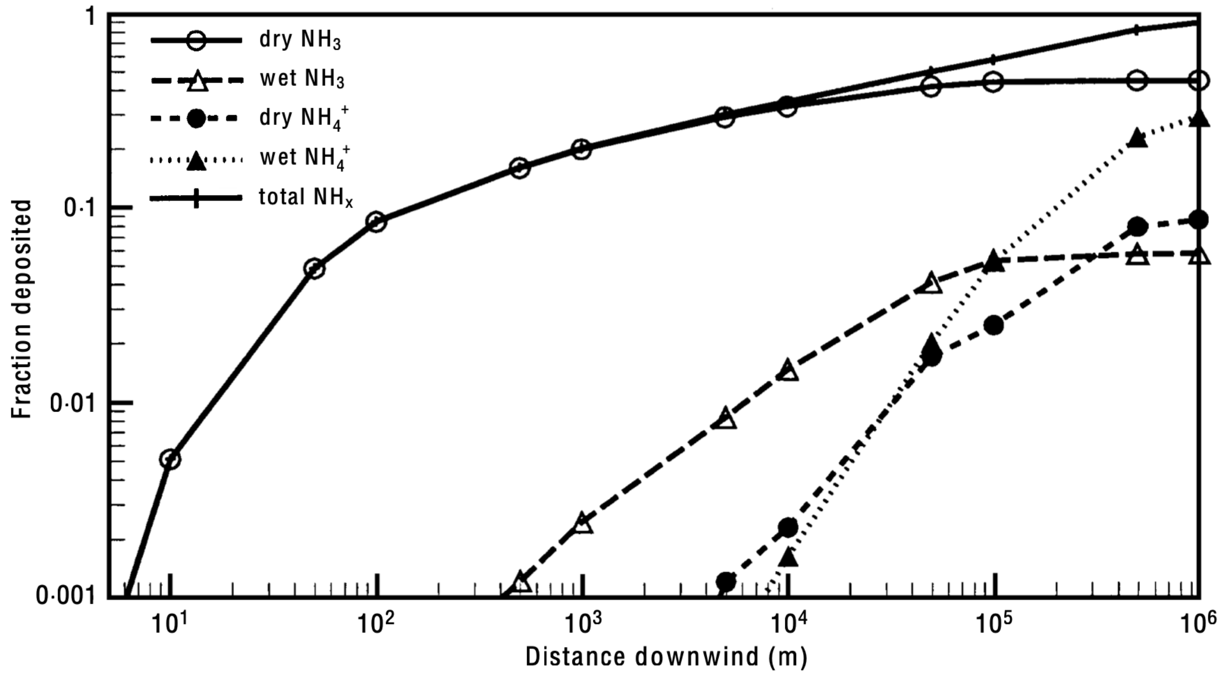


Figure 8. Fate of atmospheric NH_3 emissions: cumulative deposition of different forms as a function of downwind distance from a 1-m-high point source. The deposition is integrated over all wind directions and is expressed as a fraction of the NH_3 emission. The calculations are based on Dutch climatology and surrounding land being rough grassland with an estimated R_c of 30 s m^{-1}. (Reprinted from Asman & van Jaarsveld (1992). Copyright 1992, with kind permission from Elsevier Scientific, UK).

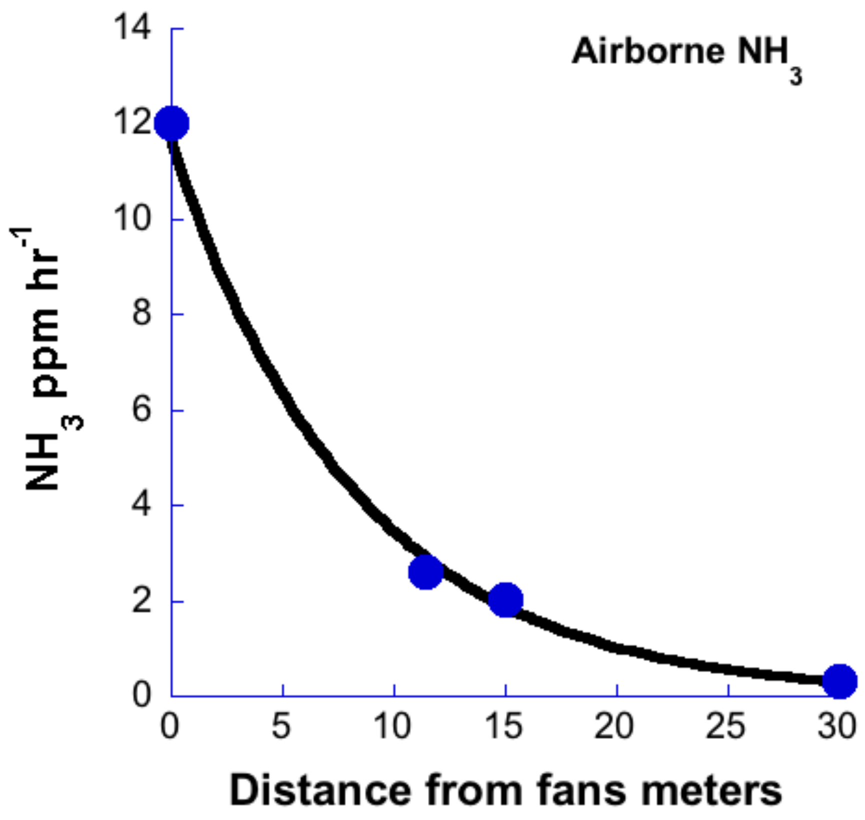
Asman, WAH, MA Sutton, and JK Schjorring.1998. Ammonia: emission, atmospheric transport, and deposition. *New Phytol*. 139:27-48.

Vegetative Buffers

Ammonia emissions are adsorbed (onto) and absorbed (into) planted vegetative buffers and natural vegetation.

Vegetation can also disperse ammonia into the air.

This BMP can be effective in capturing ammonia emissions as particulate matter and gas



Exponential loss of airborne ammonia with distance from poultry house fans. Trees were planted at 11.4 and 15 m and the samples taken within the trees. Data for this graph and curve taken from Adrizl et al. (2008).

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Ammonia Emissions: Monitoring

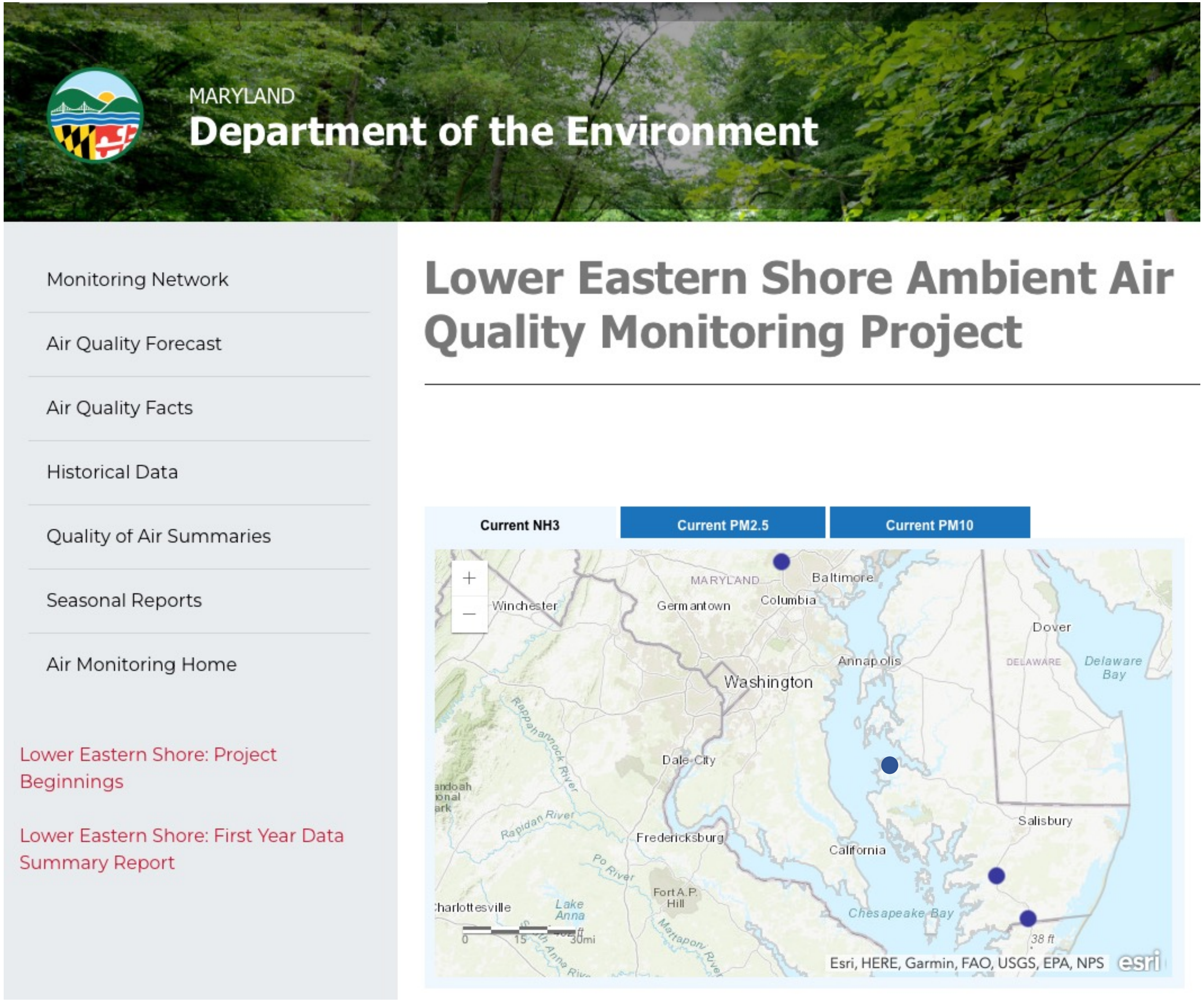
Maryland Department of the Environment (MDE)

Keith Campbell Foundation for the Environment

Delmarva Chicken Association (DCA)

University of Maryland Eastern Shore

https://mde.maryland.gov/programs/Air/AirQualityMonitoring/Pages/Lower-Eastern-Shore-Monitoring-Project.aspx



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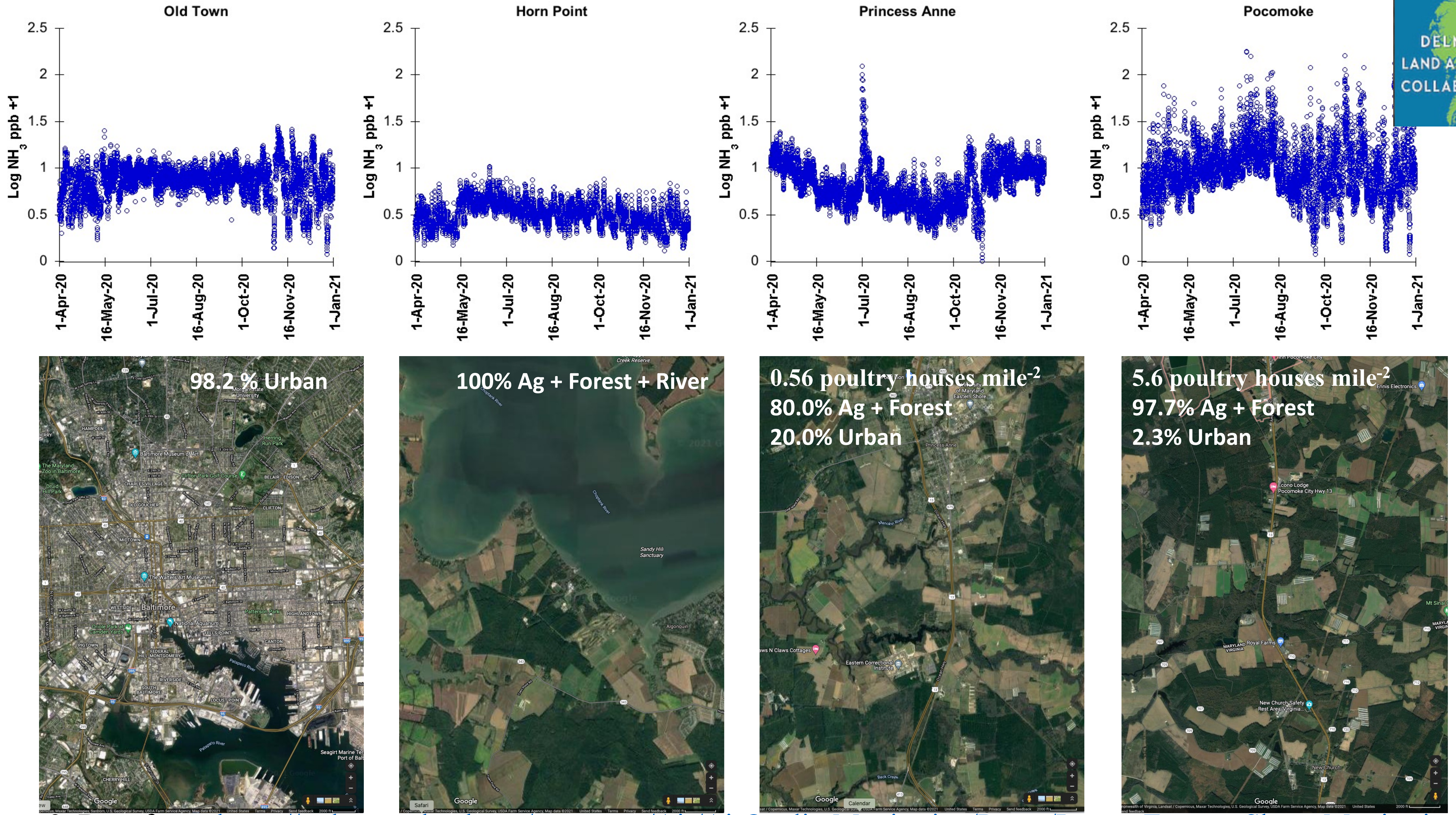


Figure 2. Data from: https://mde.maryland.gov/programs/Air/AirQualityMonitoring/Pages/Lower-Eastern-Shore-Monitoring-Project.aspx. Houses per square mile were calculated from the number of houses in a 2 mile radius around the sensors.

Ammonia Emissions: Monitoring

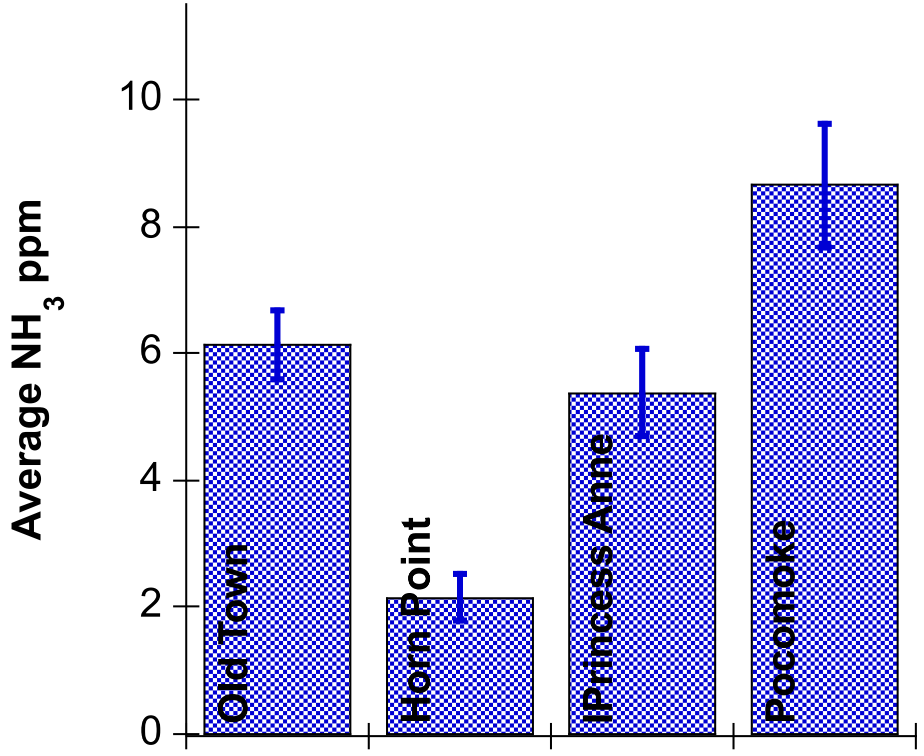
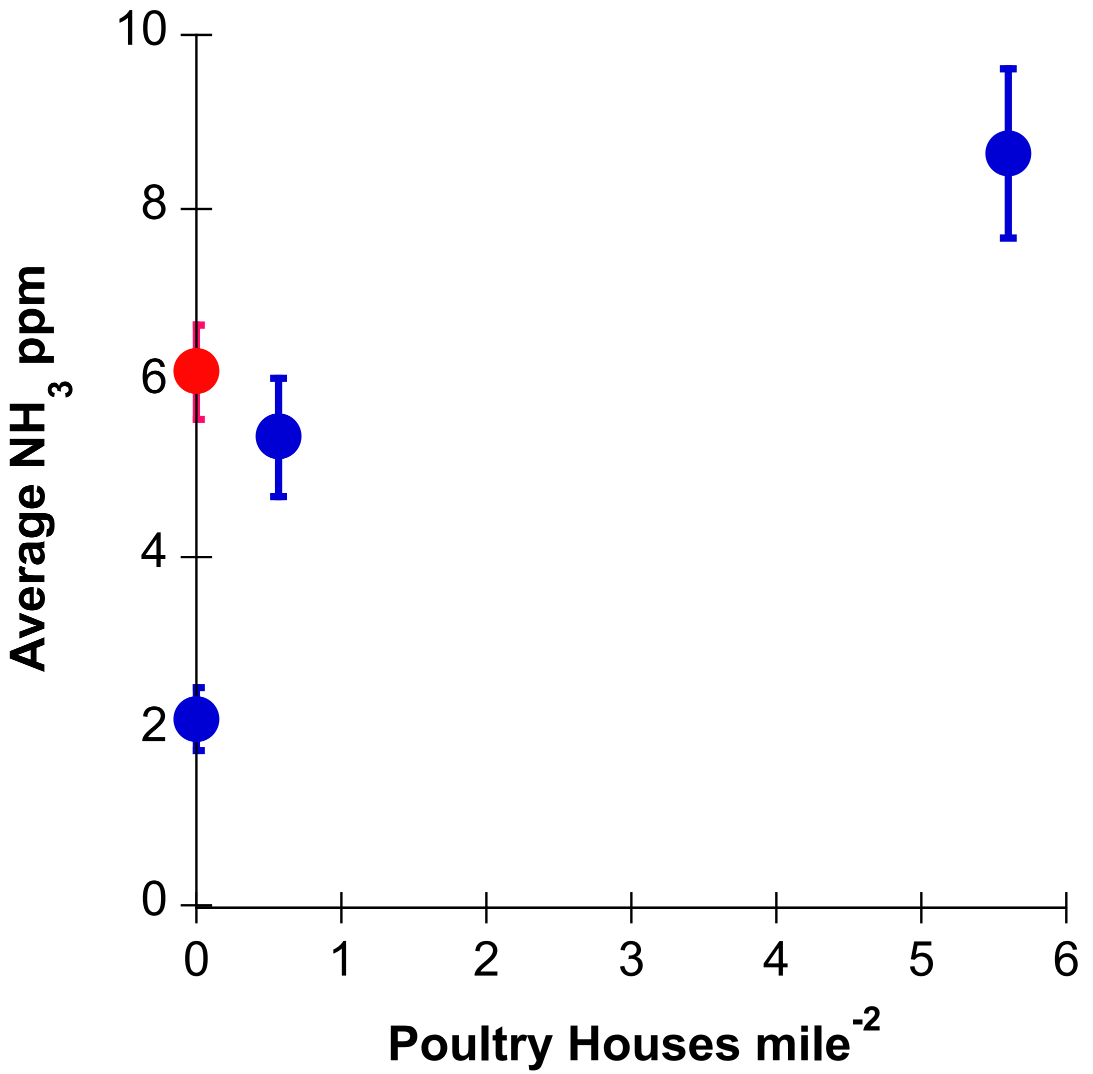


Figure 3. Averages of ammonia air concentrations recorded by Maryland Department of the Environment (MDE) at the stations in Figure 2. Averages are of log transformed data. Data from: https://mde.maryland.gov/programs/Air/AirQualityMonitoring/Pages/Lower-Eastern-Shore-Monitoring-Project.aspx.

Ammonia Emissions: Monitoring



Average ammonia concentrations from air sensors relative to the density of poultry houses within a 2-mile radius of the sampling sites. The red dot is the average from the Old Town Baltimore sampling location. Data from: https://mde.maryland.gov/programs/Air/AirQualityMonitoring/Pages/Lower-Eastern-Shore-Monitoring-Project.aspx

More data points are needed to define an equation describing ammonia emissions as a function of poultry house density.

The non-profit group Socially Responsible Agriculture Project (SRAP) has received a grant ($495,328; 11/3/22) from US EPA to establish additional stations.

What has been done?

- Reduced ammonia concentrations in house for bird health
- Improved chicken growth efficiency = less N to litter
- Improved control of water to limit litter moisture
- Improved house ventilation management
- Vegetation buffers
- Covered litter composting sheds and pads
- Improved litter management for field fertilizer use

(The Littr. app is available at https://littr.io)

Defining and modeling ammonia emissions and their fate is a complex problem.

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- **Ammonia deposition is increasing in the bay watershed and nationally.**
- **Food production ammonia emissions tend to follow a seasonal pattern, with greater emissions in the warm seasons.**
- **Ammonia leaving chicken houses as emissions to air and in litter reaches the Chesapeake Bay, Delaware Bay, and the Atlantic Ocean and retained in the uncultivated terrestrial landscape.**
- **The Chesapeake Bay Program (EPA) uses modeling assumptions to simulate ammonia deposition and track ammonia under the Chesapeake Total Maximum Daily Load (TMDL) regulations for water quality.**
- **The model estimates ammonia from production house litter, litter storage, application, losses to soil, groundwater, stormwater runoff and biota.**
- **Model estimates can be validated by real data, but isolating the poultry contribution is difficult**

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How can modeling be improved?

- **Ammonia emissions from poultry increases with the size of birds. Poultry houses are not continually full of birds, and most ammonia is emitted in the last 2 weeks of flocks.**

- **Have current litter management practices been incorporated?**
    - **Built up vs new litter, amendment use, composting, transport, and field application practices**

- **Where is ammonia deposited relative to sources? What fraction goes to Delaware Bay and Atlantic Ocean vs Chesapeake Bay?**

- **Are vegetative buffers adequately incorporated?**

- **How much ammonia is incorporated into Delmarva natural forests, grasslands, flooded woodlands, swamps, and wetlands and internally recycled, stored, or denitrified to N_2 gas versus ammonia that is transported to surface waters?**

- **How much litter nitrogen applied to fields offsets inorganic fertilizer N incorporated into grains and recycled as poultry feed?**

What's next?

- **Chesapeake Bay Foundation's Science and Technical Advisory Committee (STAC)**
- **Opportunities for research providing data to tune modeling assumptions**
- **Continued public education**

Discussion

Many thanks for backbone and communications support to DLLC from:
Green Fin Studio
https://greenfinstudio.com

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