

Ammonia and The Nitrogen Cycle

Making the air-water quality connection

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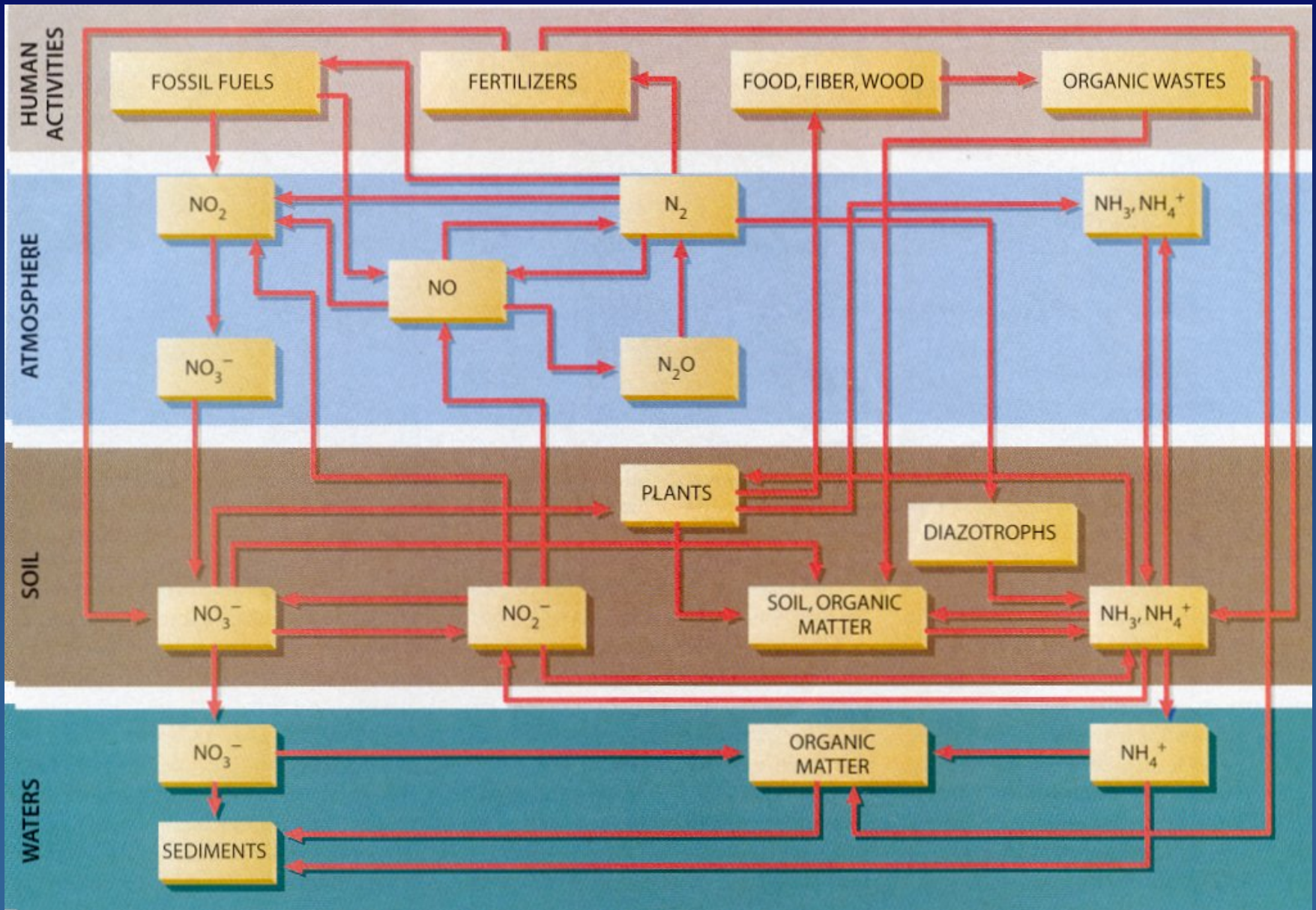
Mid Atlantic Agricultural Ammonia Forum
Woodstock, VA March 16, 2004

Topics

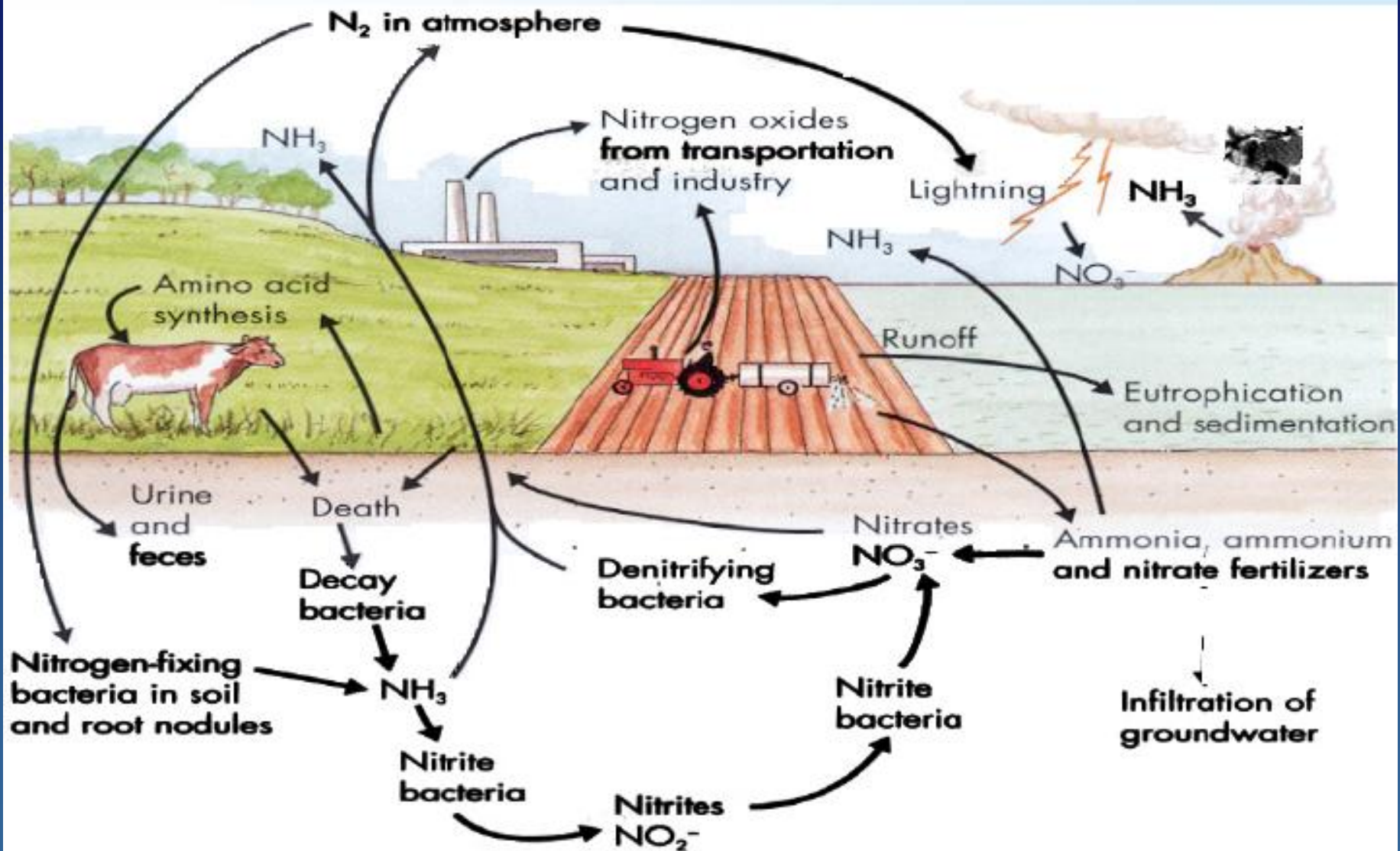
- Review of global nitrogen pools
- Review of the nitrogen cycle
- Forms of nitrogen found in the agro-eco system
- Inputs of Nitrogen into the soil system
- Losses of Nitrogen from the soil system
- Factors for agricultural Ammonia losses, volatilization
- Ammonia generation from non agricultural sources

Nitrogen Reservoirs

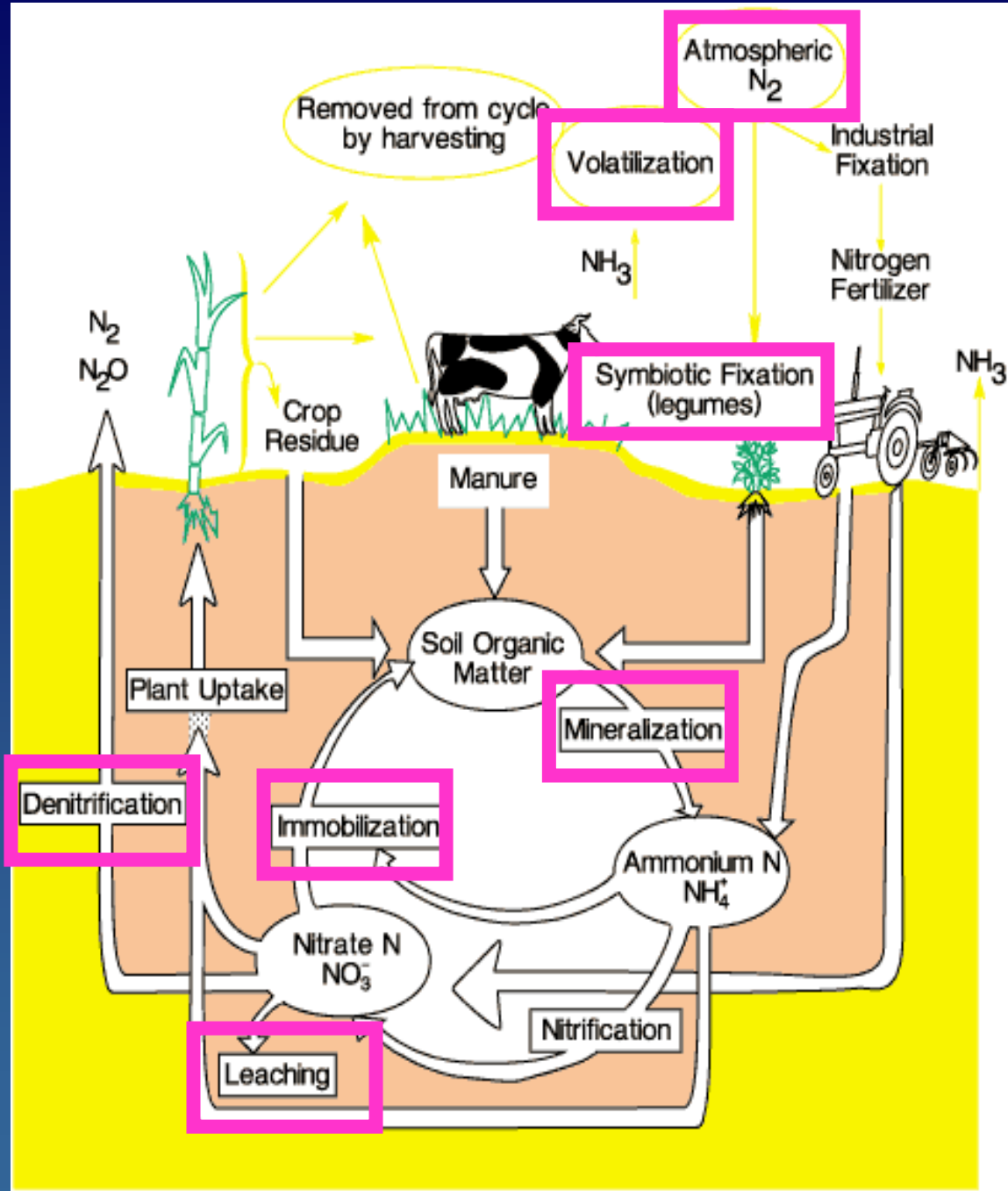
Scientific American, July 1997



The Nitrogen Cycle



Nitrogen Cycle



Important forms of N

- Nitrogen gas
 - N_2
- Nitric Oxide
 - NO
- Nitrous Oxide
 - N_2O
- Nitrogen dioxide
 - NO_2
- Nitrate
 - NO_3^-
- Nitrite
 - NO_2^-
- Ammonium
 - NH_4^+
- Ammonia
 - NH_3

Nitrogen Inputs

Organic N

- Amino acids $\langle \text{--}\underline{\text{N}}\text{H}_2 \rangle$ in manures and crop residues

Inorganic N (fertilizer)

- $\underline{\text{N}}\text{O}_3^-$ Nitrate
- $\underline{\text{N}}\text{H}_4^+$ Ammonium
- $\underline{\text{N}}_2$ (79% of atmosphere)



Other inputs



- Atmospheric deposition??
 - Ammonia, NO_x ~ 6 lbs N/acre
 - Lightning ~ 5 lbs N/acre

Other inputs

- N in irrigation water??
 - An “acre-inch” of irrigation water has about one-quarter lb. of N for each ppm.
 - 10 ppm, 13 inches of irrigation ~ 30 lbs N

N Losses From the Soil

- N most mobile plant nutrient, subject to greatest losses from soil–plant system
- Best recovery of N from cropping system is 66%
- Mineral forms of N will not remain very long in a moist soil
- 5 channels of N loss, Bacterial Denitrification, Chemodenitrification, NH_3 Volatization, Leaching and Erosion

Stevenson, 1986

Volatilization

✓ Low

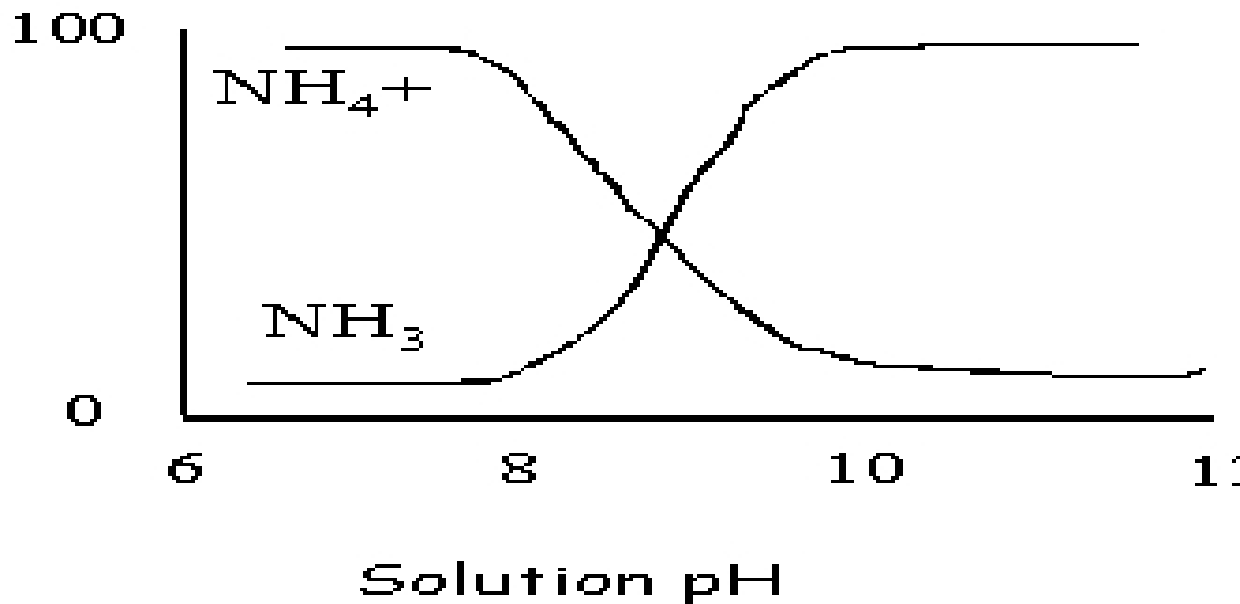
Ammonium Volatilization and pH

✓ Factors

➤ H₂O

➤ NH₄⁺

➤ T



Major Pathway for NH₃ Loss

NH₃

Ammonia

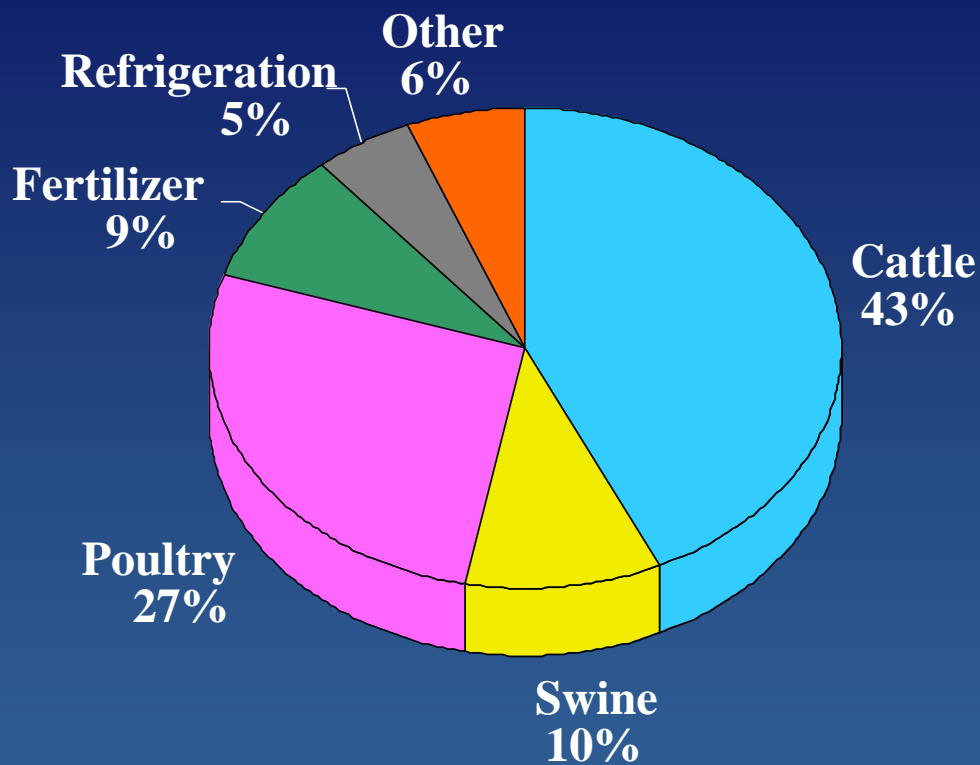
Heat and Wind

Soil or Manure

Temperature: Urease activity doubles for each 10 degree increase in temperature between 50 and 110 F

Sims and Gartley- DE
Non-incorporated poultry litter; lost 56% of NH₃ in 3 days

Ammonia Sources: U.S.

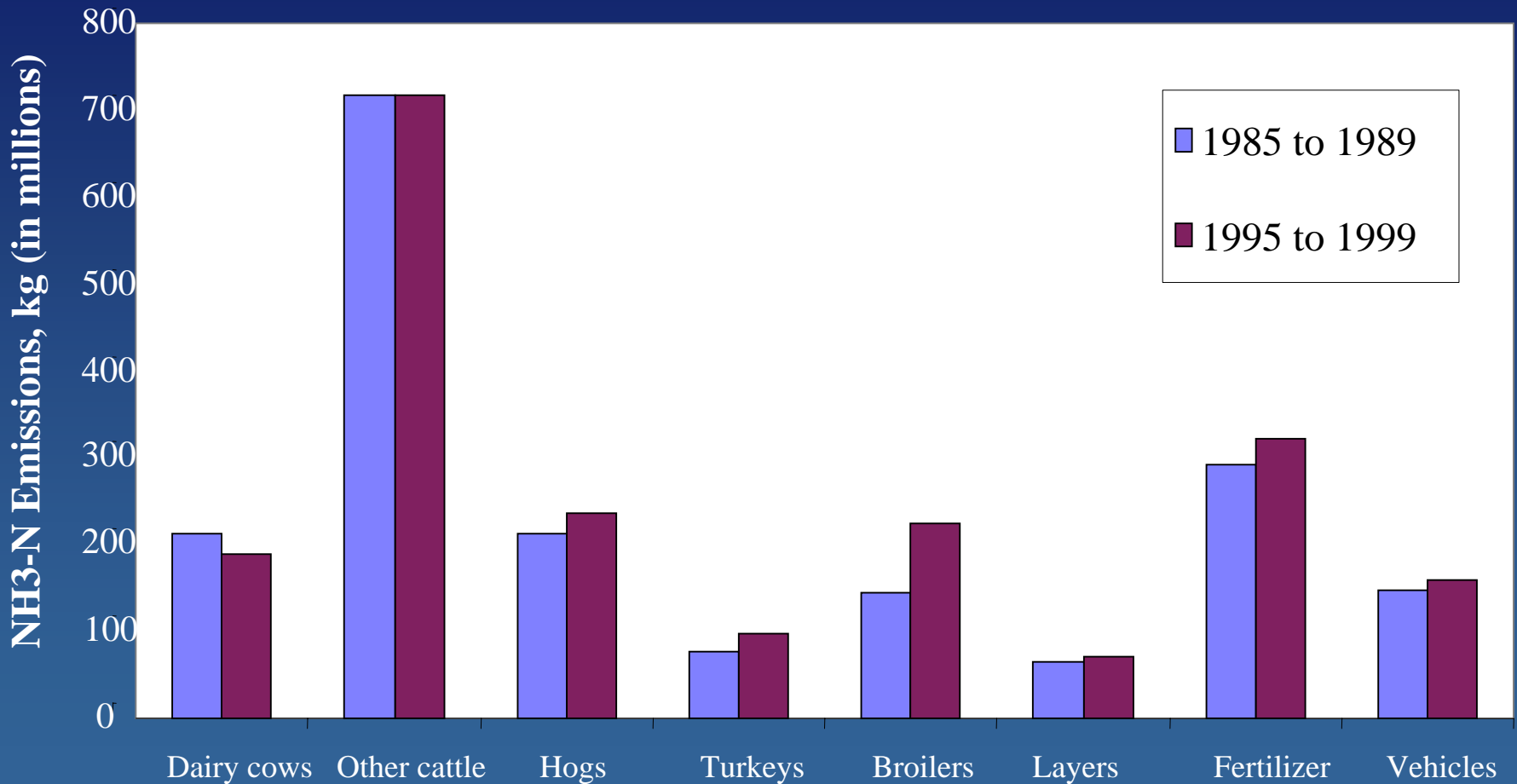


National Ammonia Inventory

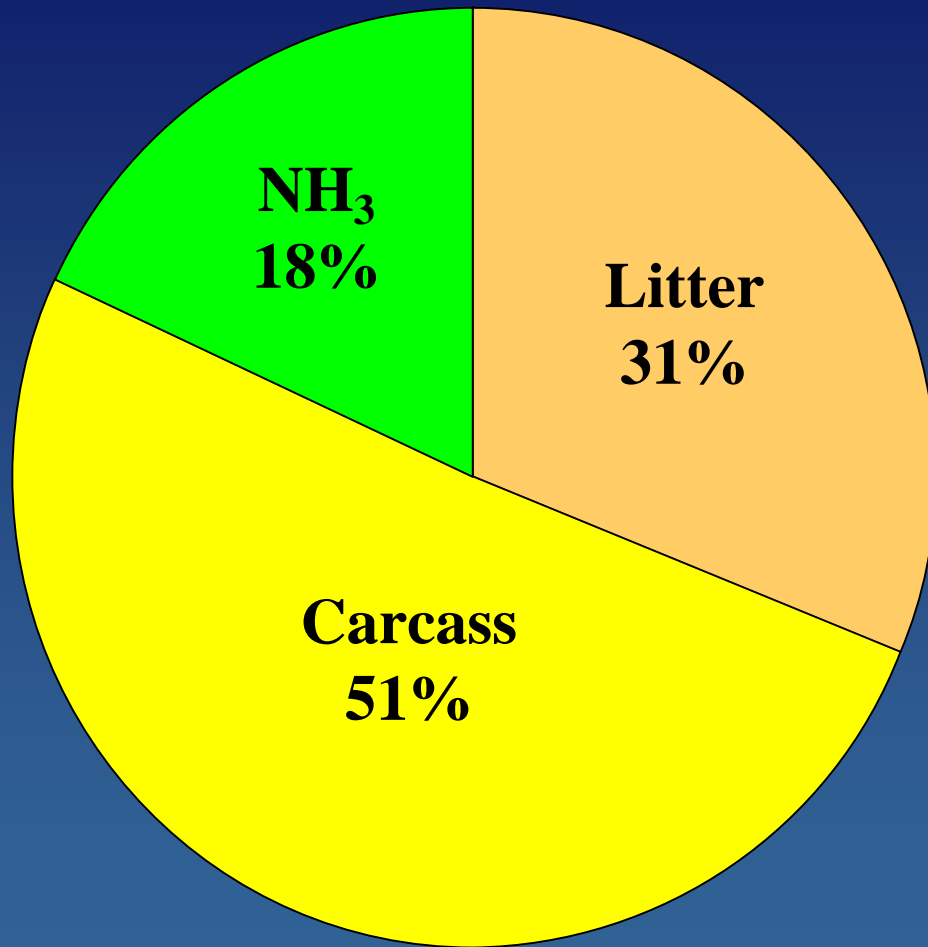
(Battye, 1994)

Other includes industry (<0.1%), humans (1%), Combustion (2%), Sheep (1%), and POTWs (2%)

Changes in NH3 by Source



Example from Broilers



N Fed to Broilers

- Assuming a 25,000 bird flock and 19.7 lbs NH₃ per 1000 birds this is nearly 500 lbs NH₃ per flock!
- BUT: Probably much higher

Atmospheric Inputs

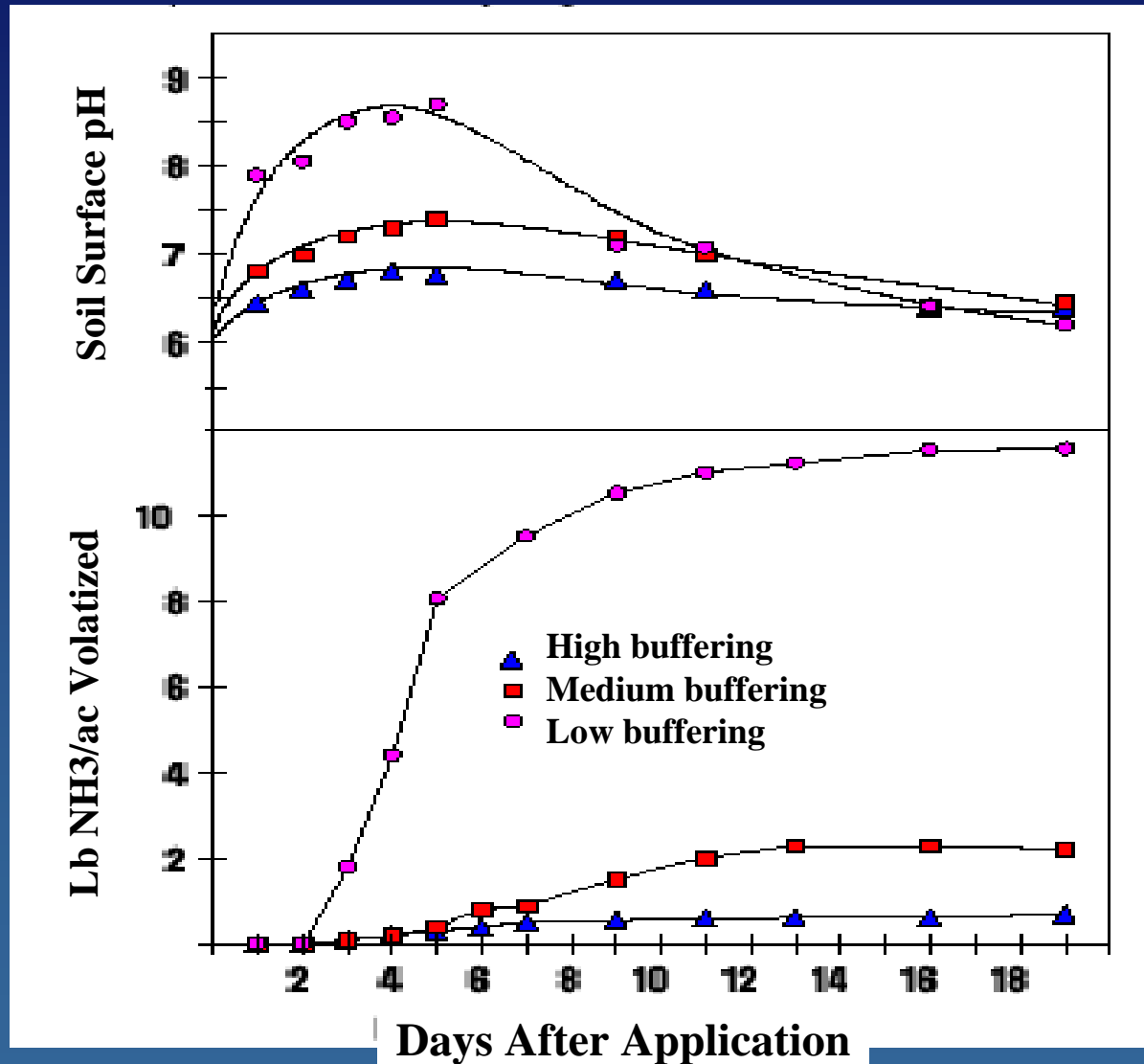
	<u>Coastal Waters</u>	<u>% N from atmosphere</u>
1. Atmospheric ammonium inputs to Delaware Inland Bays have increased >60% in past 20 years	Chesapeake Bay	25
	Delaware Bay	14
	Narrangansett Bay	12
2. This increase parallels the increase in poultry production	Long Island Sound	20
3. Poultry houses may be a major source of atmospheric N	Tampa Bay	28
	Albermarle-Pamlico Sounds	44

Skudlark, 2001

What about land- application of fertilizer and manure?

- Effects of fertilizer (or manure) type, timing of application, and method of application

Soil Buffer Capacity Effect



Non Agricultural Ammonia Losses

- Most smokestack industries regulated to control NH_3
- Automobiles fitted with Catalytic converters found to be a source of NH_3
- Nitrogen oxides are produced from internal combustion then the Catalytic Converters reduce NO_x to NH_3
- California researchers estimate 1 teaspoon NH_3 per 100 miles traveled per car
- How many cars in the Mid Atlantic? How many miles traveled?

Baum, 2000

Conclusions

- NH_3 is an important N loss channel in Agriculture
- Automobiles are part of the NH_3 problem but may be easier to fix
- NH_3 “down wind” contributes to soil acidification, forest soils
- About 10% of NH_3 is oxidized to nitric oxide, a significant greenhouse gas. Duxbury, 1994
- Improved farm management and technology can reduce losses from this part of the N cycle