Atmospheric Nitrogen Deposition to the Chesapeake Bay

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Virginia State Air Advisory Board
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Outline

- Brief Background on the CBP
- Air Deposition Commitments
- Sources of Nitrogen Loads to the Bay
- Inputs to the Watershed vs. Delivered Load to Water
- Benefits of CAA Regulations to Reduce N Loads
- Going beyond CAA?
- CAA and Clear Skies
- Uncontrolled N Emissions

Chesapeake Bay Program

Unique regional partnership focusing on restoration of the Chesapeake Bay (A WATER-BASED PROGRAM)

The Program partners included:

- MD, PA, VA, DC
- Chesapeake Bay Commission (tri-state legislative body)
- U.S. EPA (representing the federal government)
- Participating advisory groups

But NOW it also includes DE, WV and NY.

Chesapeake Bay…

- Largest estuary in the U.S.
- One of the most productive in the world
- First estuary in U.S. targeted for restoration and protection.
- Highest priority has been the restoration of the Bay's living resources

- Three major areas requiring attention:
  - nutrient over-enrichment
  - Loss of underwater Bay grasses
  - toxic pollution.

Air Commitments under Water Quality Goals

1987 Chesapeake Bay Agreement:

"Quantify the impacts and identify the sources of atmospheric inputs on the Bay system."

Air Commitments under Water Quality Goals

1992 Amendments:

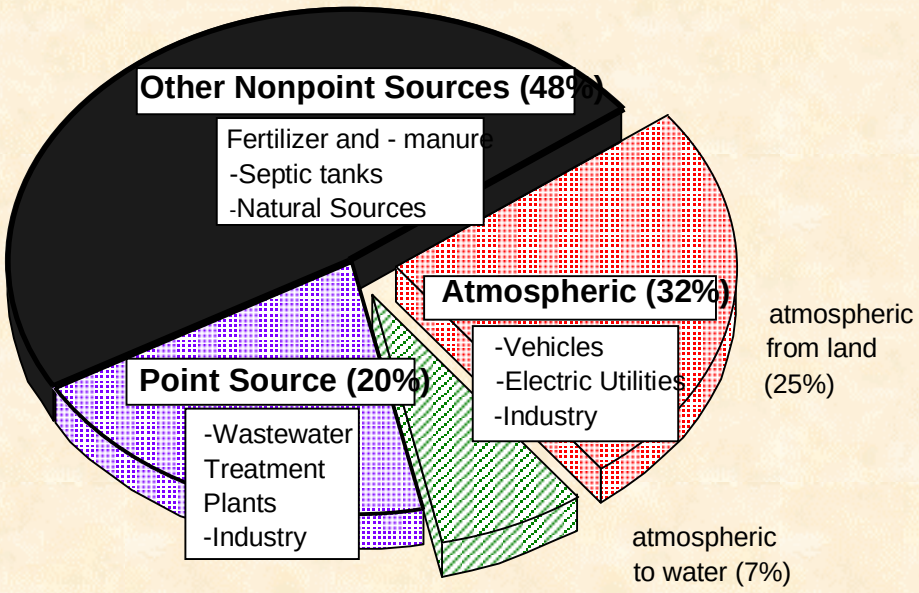
"To incorporate into the Nutrient Reduction Strategies an air deposition component which builds upon the federal Clean Air Act and explores additional implementation opportunities to further reduce airborne sources of nitrogen entering Chesapeake Bay and its tributaries."

Air Commitments under Water Quality Goals

Chesapeake 2000 Agreement:

"By 2003, assess the effects of airborne nitrogen compounds and chemical contaminants on the Bay ecosystem and help establish reduction goals for these contaminants."

Sources of Nitrogen Loads to the Bay



305 million lbs. in 2000

Estimating Atmospheric N Load

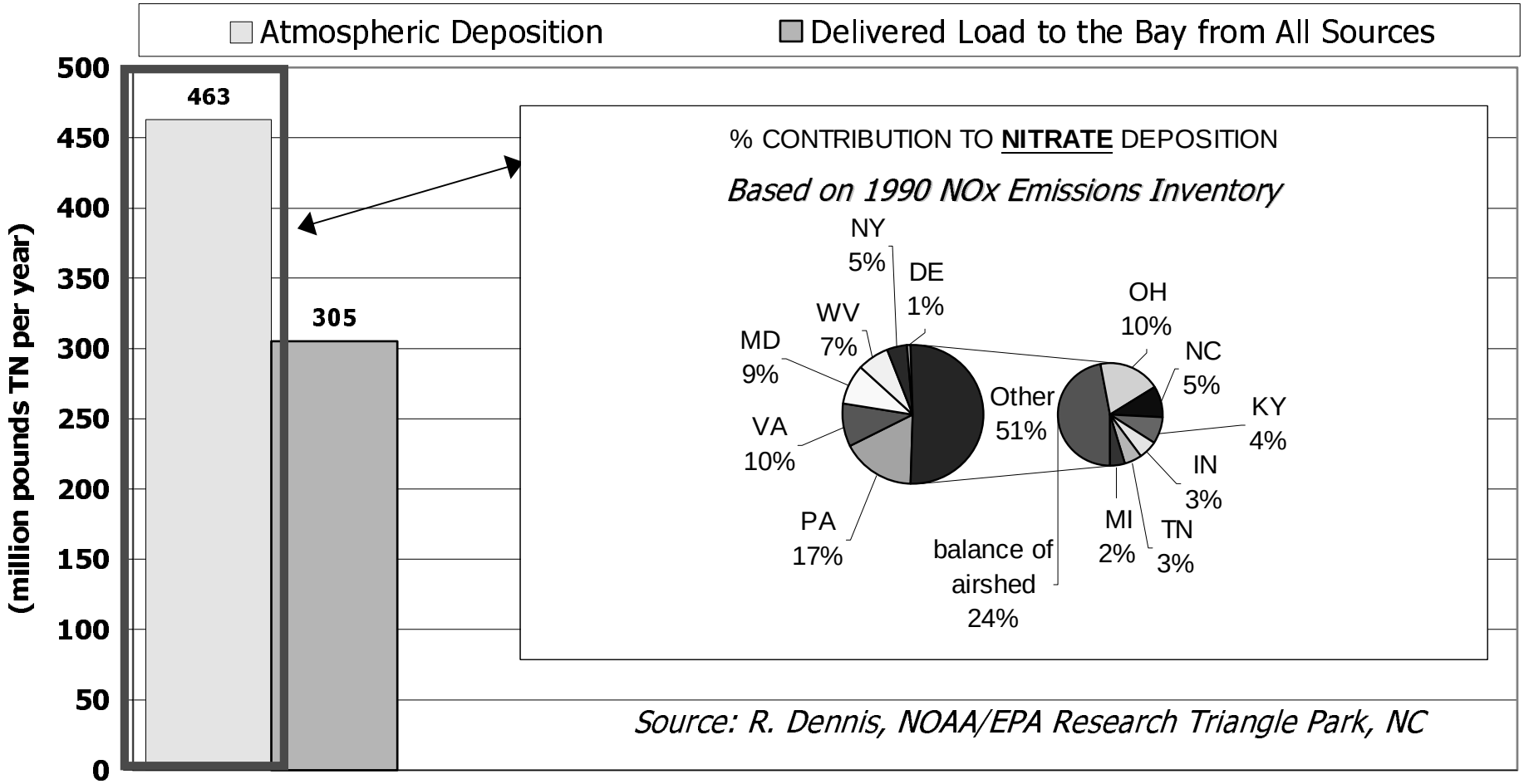
First, Let's Look at the Atmospheric Input…

Estimating Atmospheric N Load

3 sources of information are used to derive atm. load:

- Regression analysis using dissolved inorganic nitrogen (NO_3 + NH_4) from selected NADP monitoring data;
- RADM estimates of wet:dry for nitrate and ammonium (<u>no ammonia</u>);
- Literature estimates of organic nitrogen.

Atmospheric Nitrogen Deposition And Delivered Loads

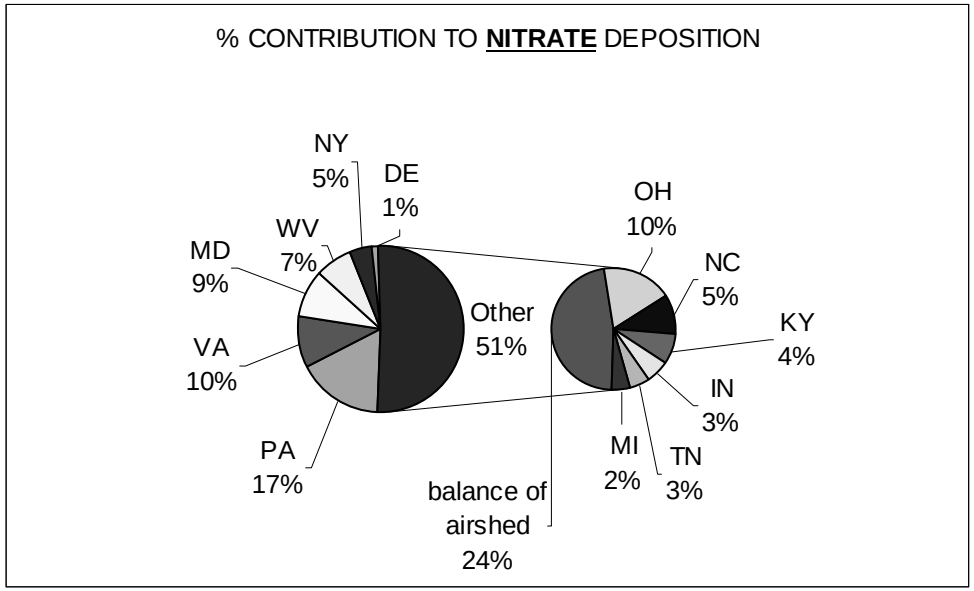


2000 Baseline

Nitrogen Deposition = NO3, NH4, Org N

% Contributions are Relative to 37-State Air Modeling Domain.

Based on 1990 NOx Emissions Inventory



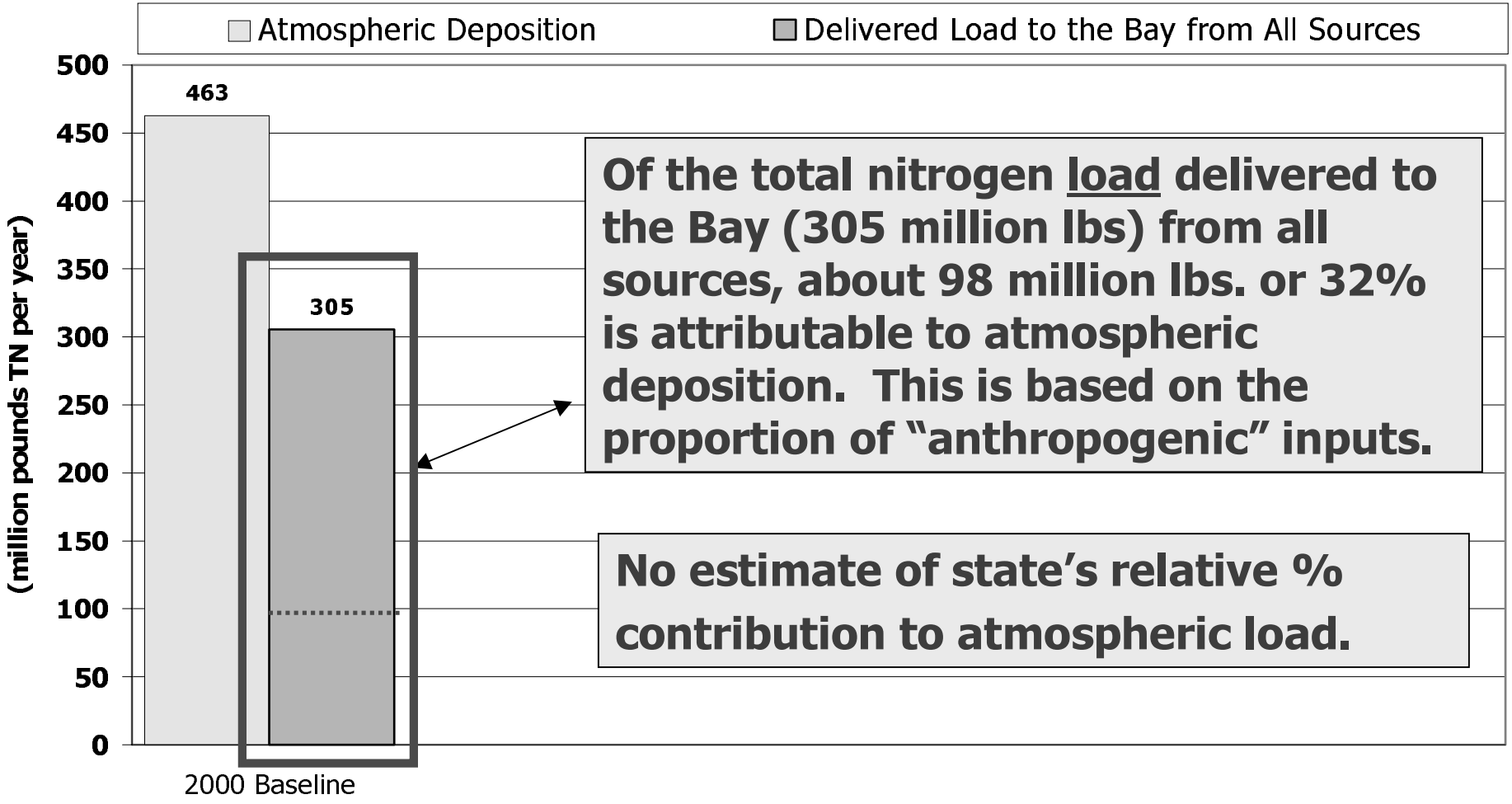
Source: R. Dennis, NOAA/EPA Research Triangle Park, NC

Basin States (6) contribute almost half (49%) of nitrate deposition.

Signatory States (3) contribute roughly 36%.

****Can be broken out by major tributary basin and by source sector.**

Atmospheric Nitrogen Deposition And Delivered Loads



Of the total nitrogen <u>load</u> delivered to the Bay (305 million lbs) from all sources, about 98 million lbs. or 32% is attributable to atmospheric deposition. This is based on the proportion of "anthropogenic" inputs.

No estimate of state's relative % contribution to atmospheric load.

Benefits of Clean Air Act Regulatory Programs

What the scenarios say:

"If these emissions reductions forecasted for 2010/2020 were realized today (2000 land uses), deposition and loads to the Chesapeake Bay would be . . . "*

For all scenarios, landuses, fertilizer applications, point sources, septic, and BMP implementation are held constant at 2000 levels - only atmospheric deposition varies.

Atmospheric Deposition Scenarios

NOx SIP (2007/2010)

This model run is the Basic 1990 Clean Air Act projected for the year 2010.

This scenario includes regulations that have passed.

2007 non-utility and area source emissions.

2007 mobile source with Tier II tail-pipe standards on light duty vehicles.

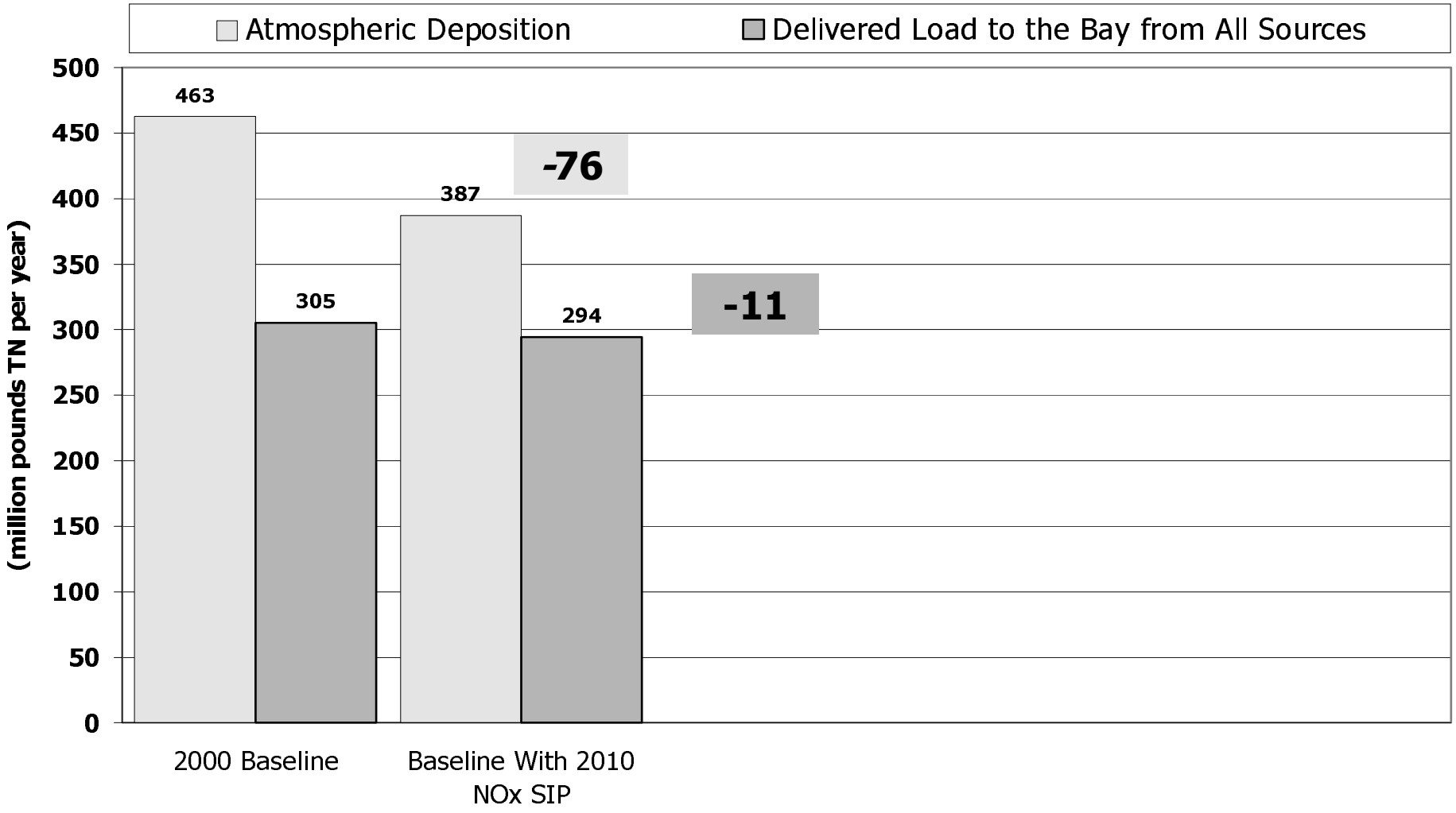
2010 utility emissions: Title IV (Acid Rain Program) fully implemented;

the 20-state NOx SIP call reductions @ 0.15#/MMbtu. Ozone-season (May to September) controls only.

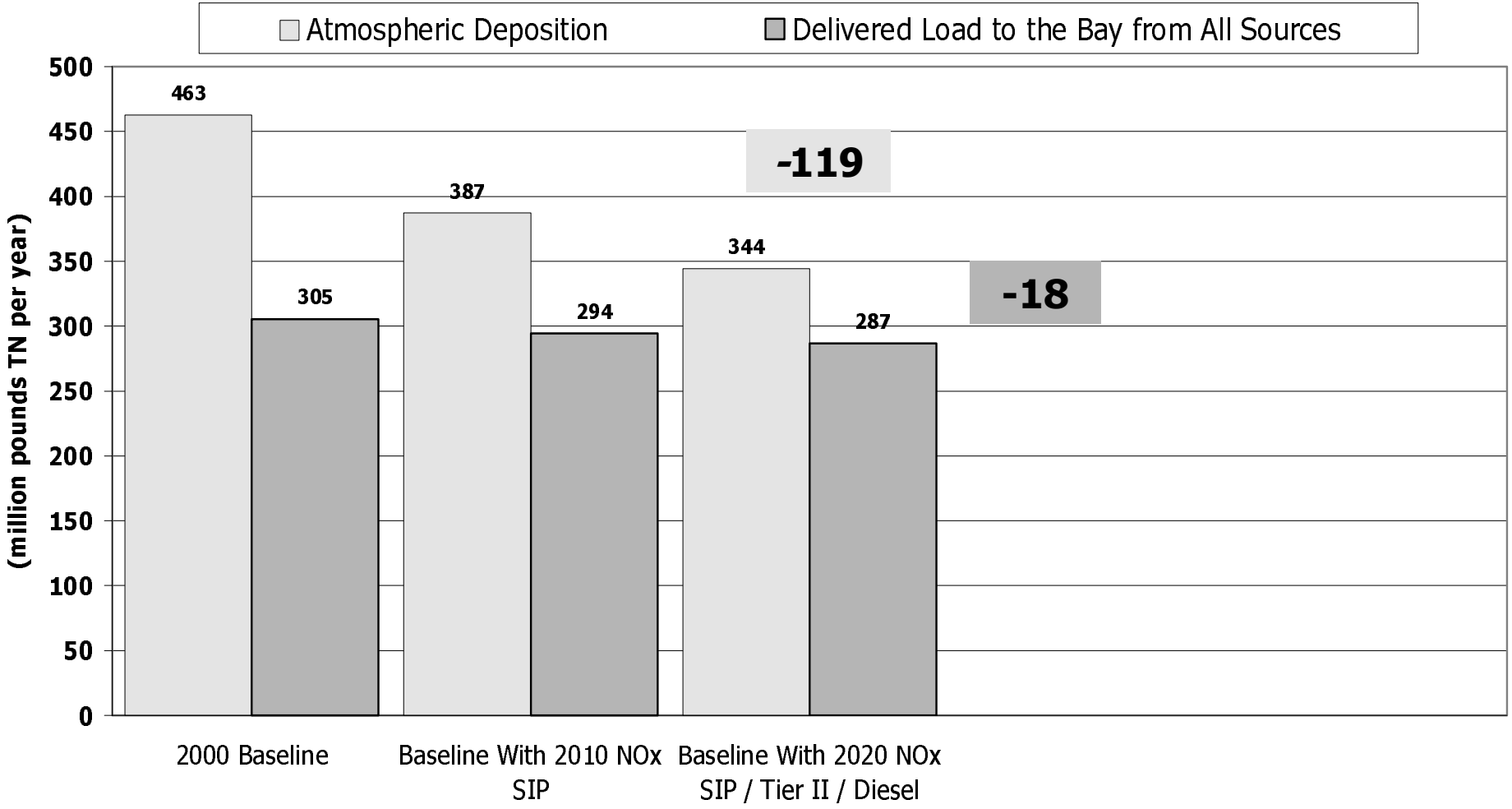
Tier II (2020)

This model run includes the scenario above PLUS new heavy duty diesel regulations by 2020.

Atmospheric Nitrogen Deposition And Delivered Loads



Atmospheric Nitrogen Deposition And Delivered Loads



Going Beyond the Regulations ?

Aggressive Controls (2020)

This scenario includes regulations (NOx SIP, Tier II, HDDV) that have passed PLUS utilities go to 0.10#/MMbtu, and year-round controls.

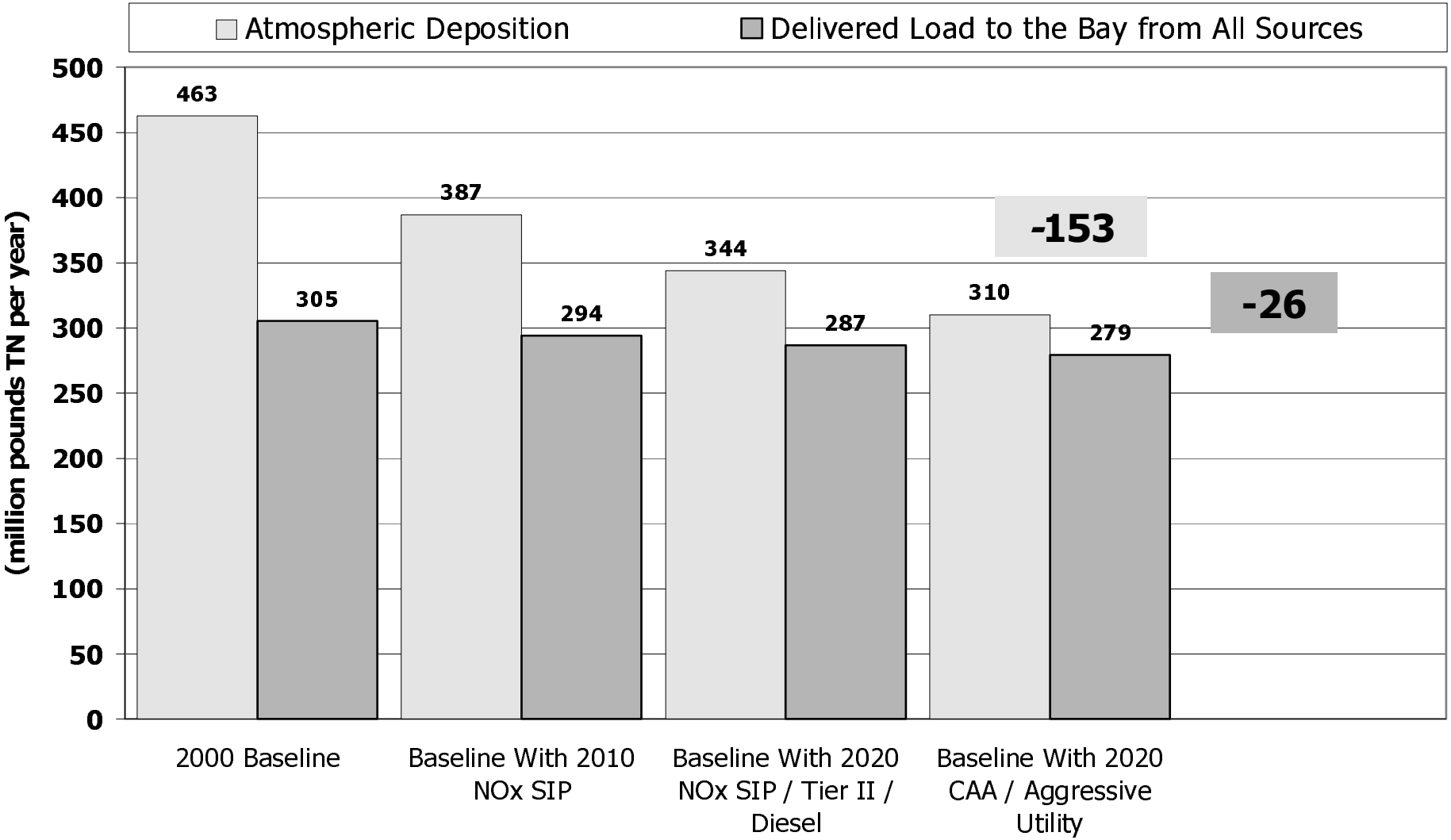
Limit of Technology (2020)

This model run includes the scenario above PLUS

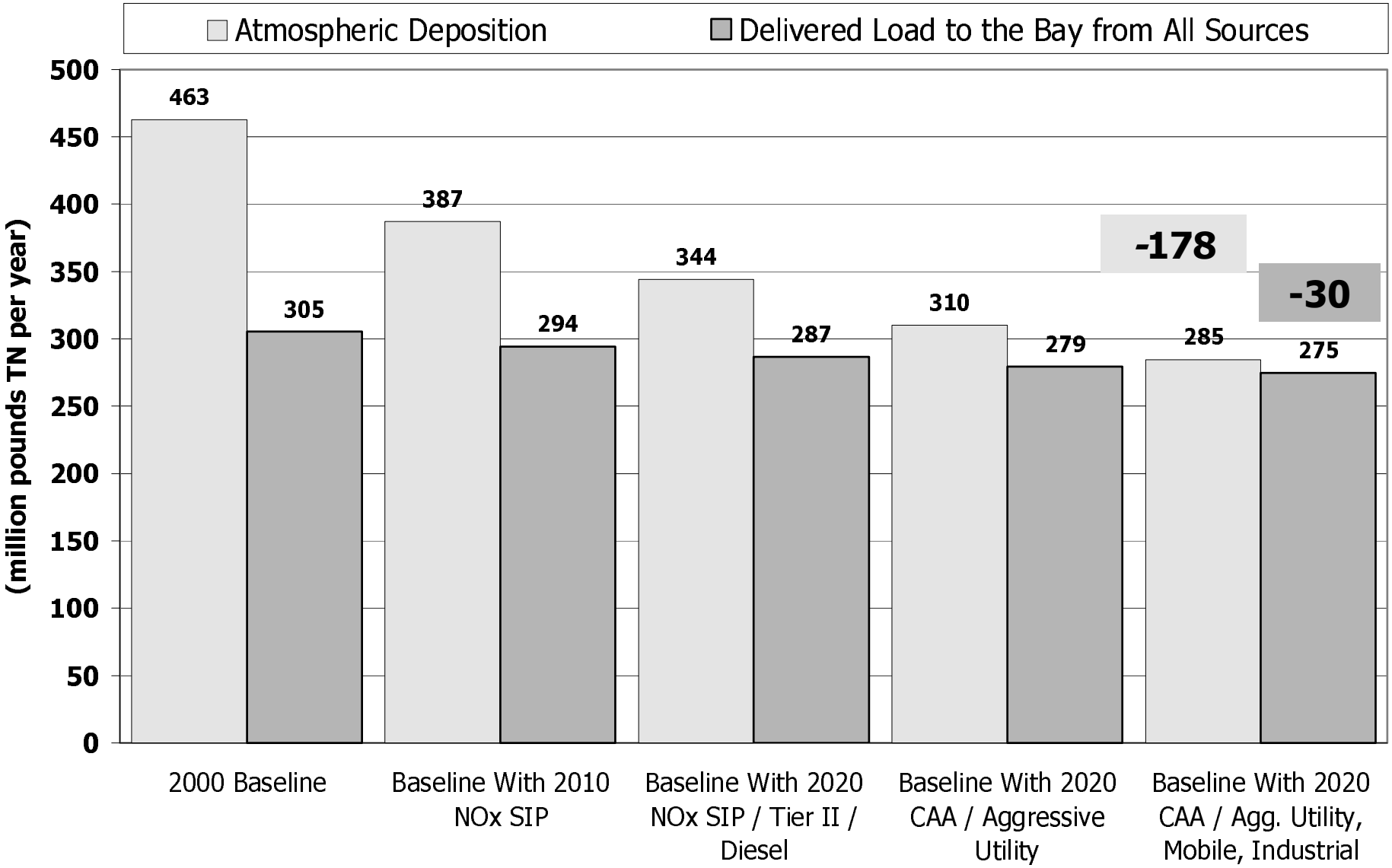
Non-utility (industrial) point emissions cut almost in half for both SO_2 and NOx.

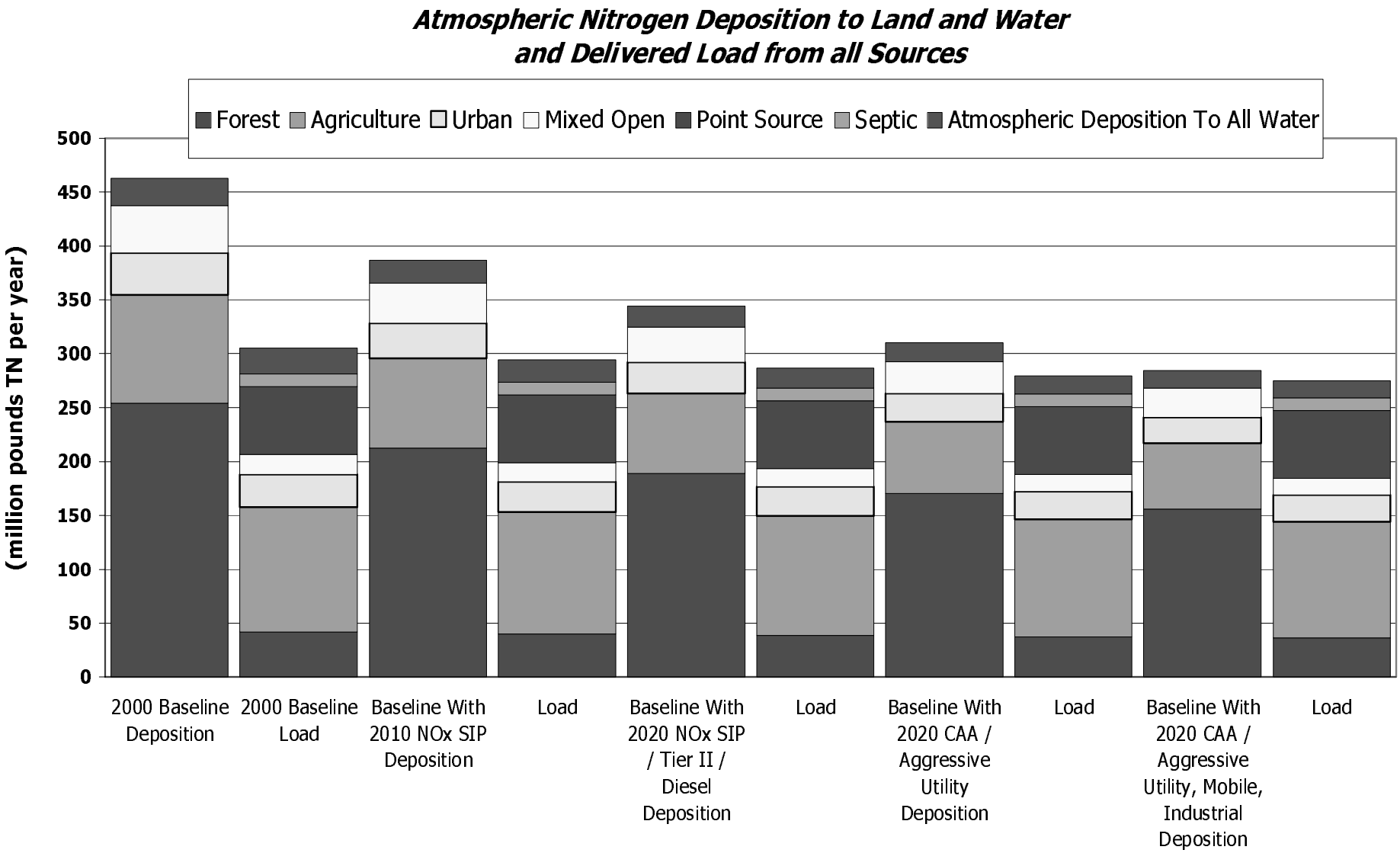
Super ultra-low emission vehicle assumed for light duty vehicles.

Atmospheric Nitrogen Deposition And Delivered Loads



Atmospheric Nitrogen Deposition And Delivered Loads




Atmospheric Nitrogen Deposition to Land and Water
and Delivered Load from all Sources
Forest
Agriculture
Urban
Mixed Open
Point Source
Septic
Atmospheric Deposition To All Water
(million pounds TN per year)
500
450
400
350
300
250
200
150
100
50
0
2000 Baseline Deposition
2000 Baseline Load
Baseline With 2010 NOx SIP Deposition
Load
Baseline With 2020 NOx SIP / Tier II / Diesel Deposition
Load
Baseline With 2020 CAA / Aggressive Utility Deposition
Load
Baseline With 2020 CAA / Aggressive Utility, Mobile, Industrial Deposition
Load

The Clean Air Act and Clear Skies

Project Description

- *Estimate and compare the benefits of nitrogen emissions reductions associated with the existing Clean Air Act and the Clear Skies on water quality (in terms of delivered nitrogen loads to the Chesapeake Bay).*
  - *does not address benefits to human health, air quality, visibility, forest health, etc.*
- *The source of the deposition data is EPA Headquarters.*
  - *Deposition of nitrogen species to the Chesapeake Bay watershed came from REMSAD/MM-5, which varied greatly from deposition estimates from RADM.*
  - *To compensate for disparate models, correction factors were determined from the two models' deposition rates for the like-year 1996 and applied to all Clean Air Act and Clear Skies scenarios.*

Clear Skies and the Clean Air Act

Chesapeake Bay Watershed Model Scenarios

- *Four scenarios were simulated:*
  - ***2010 CAA*** *– 2010 projected emissions with existing Clean Air Act controls ⇒ seasonal NOx SIP call, Acid Rain controls, Tier II tailpipe rules, and Heavy Duty Diesel Engine standards.*
  - ***2010 CAA with Clear Skies*** *– 2010 projected emissions with Clear Skies-enhanced Clean Air Act controls ⇒ with Clear Skies caps on utilities, Acid Rain controls, Tier II tailpipe rules, and Heavy Duty Diesel Engine standards*

  - ***2020 CAA*** *- 2020 projected emissions with existing Clean Air Act controls*
  - ***2020 CAA with Clear Skies*** *- 2020 projected emissions with Clear Skies-enhanced Clean Air Act controls ⇒ more stringent caps on utilities than 2010 Clear Skies*

Clear Skies and the Clean Air Act

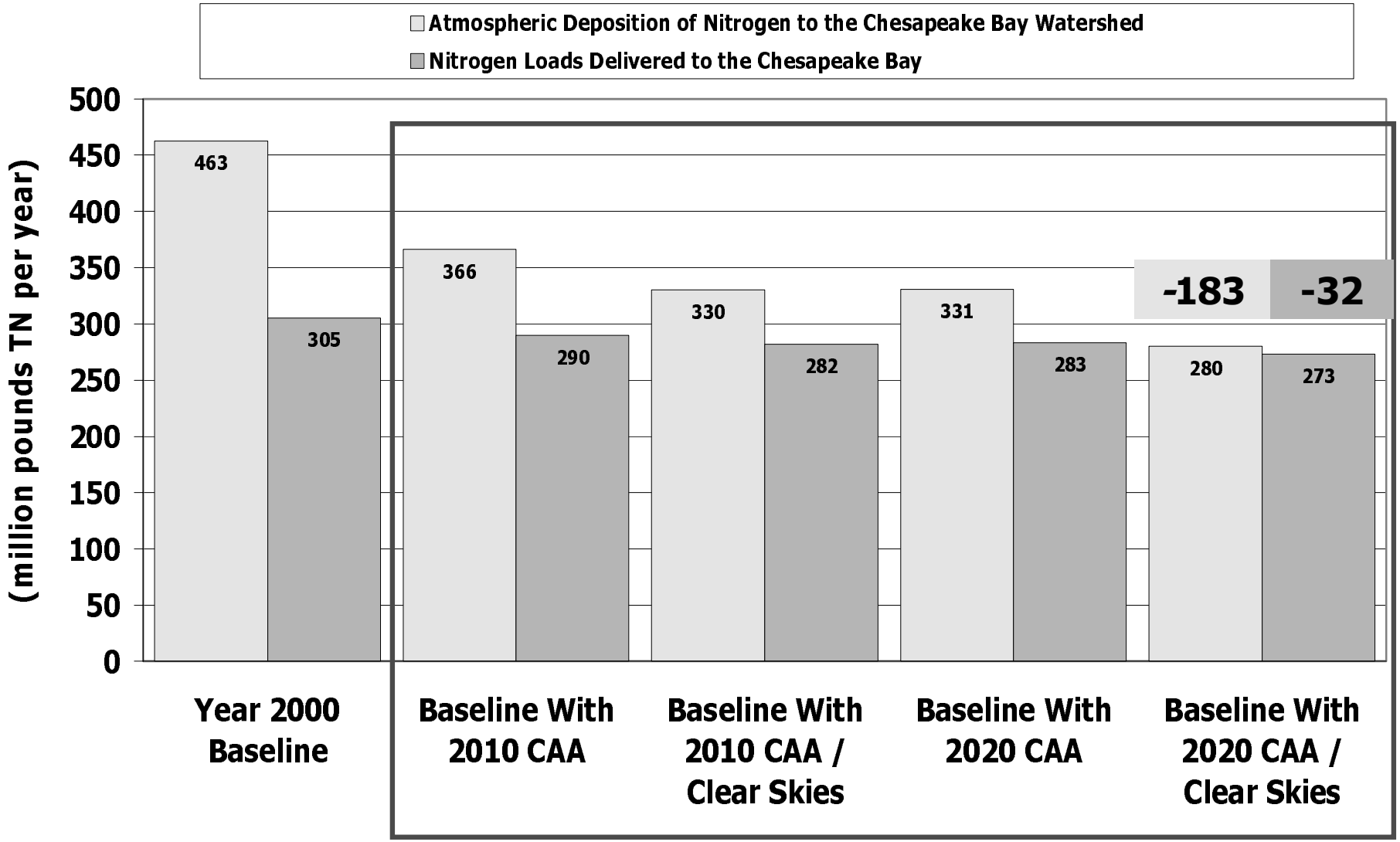
Model Scenarios

- *All scenarios are compared to a Year 2000 baseline.*
- *Reported results include nitrogen deposition to the watershed and direct load to the tidal waters.*
- *For all scenarios, landuses, fertilizer applications, point sources (POTW and industrial discharges), and BMP implementation levels were held constant . Only atmospheric deposition varied.*

What the scenarios say, for example, is:

"If Clear Skies emissions reductions, projected to occur by 2020, were realized today (2000), loads to the Chesapeake Bay would be . . . "

Chesapeake Bay Watershed
Atmospheric Nitrogen Inputs And Delivered Loads
Clear Skies and the Clean Air Act



Clear Skies and the Clean Air Act

Results

- *Full implementation of Clear Skies by 2020, lowers nitrate deposition to CB by about 183 million pounds per year from current atmospheric inputs.*

- *This is roughly 51 million pounds per year (15%) more than what is projected to be achieved under the existing CAA by 2020.*

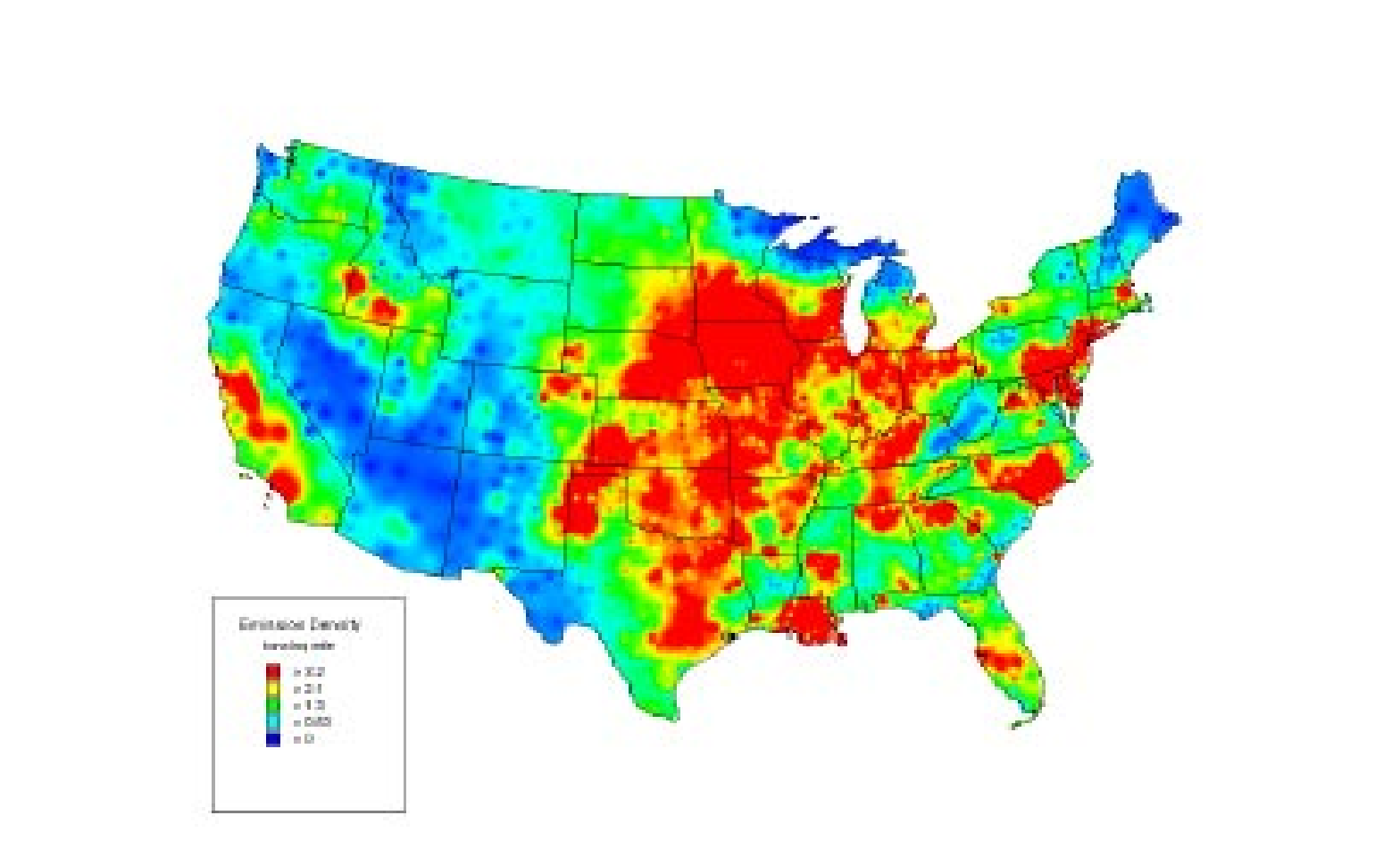
- *Assuming today's land use/cover, this deposition reduction lowers nitrate loads to the Bay by approx. 32 million pounds per year from current levels, or 10 million pounds per year (4%) beyond what is anticipated under the existing CAA.*

Uncontrolled Nitrogen Emissions

What About Ammonia?

Density Map of 1998 Ammonia Emissions by County

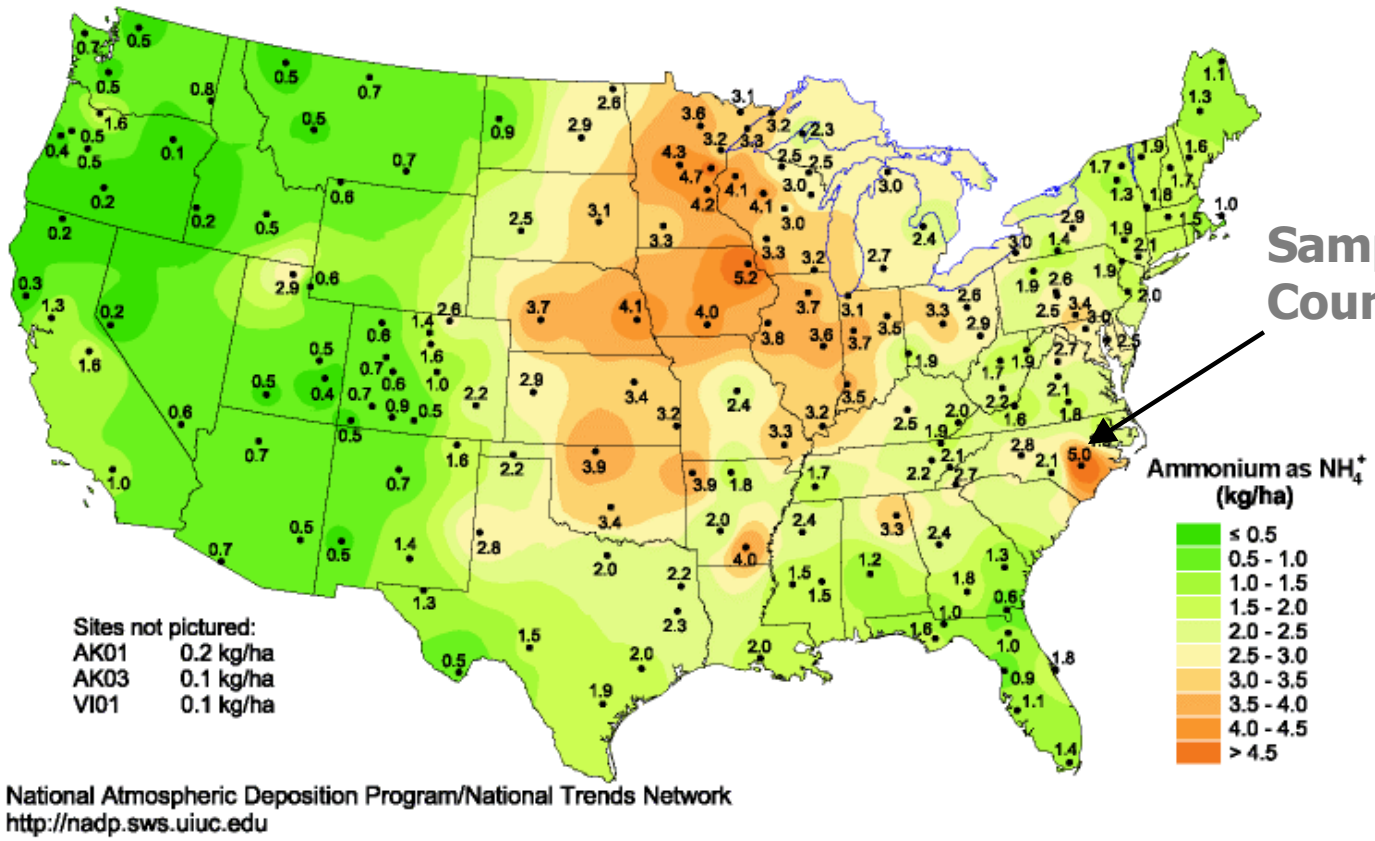
From EPA's Report: National Air Pollutant Emissions Trends, 1900-1998



Red = >3.2 tons/sq. mile; **yellow = >2.1 tons/sq. mile**

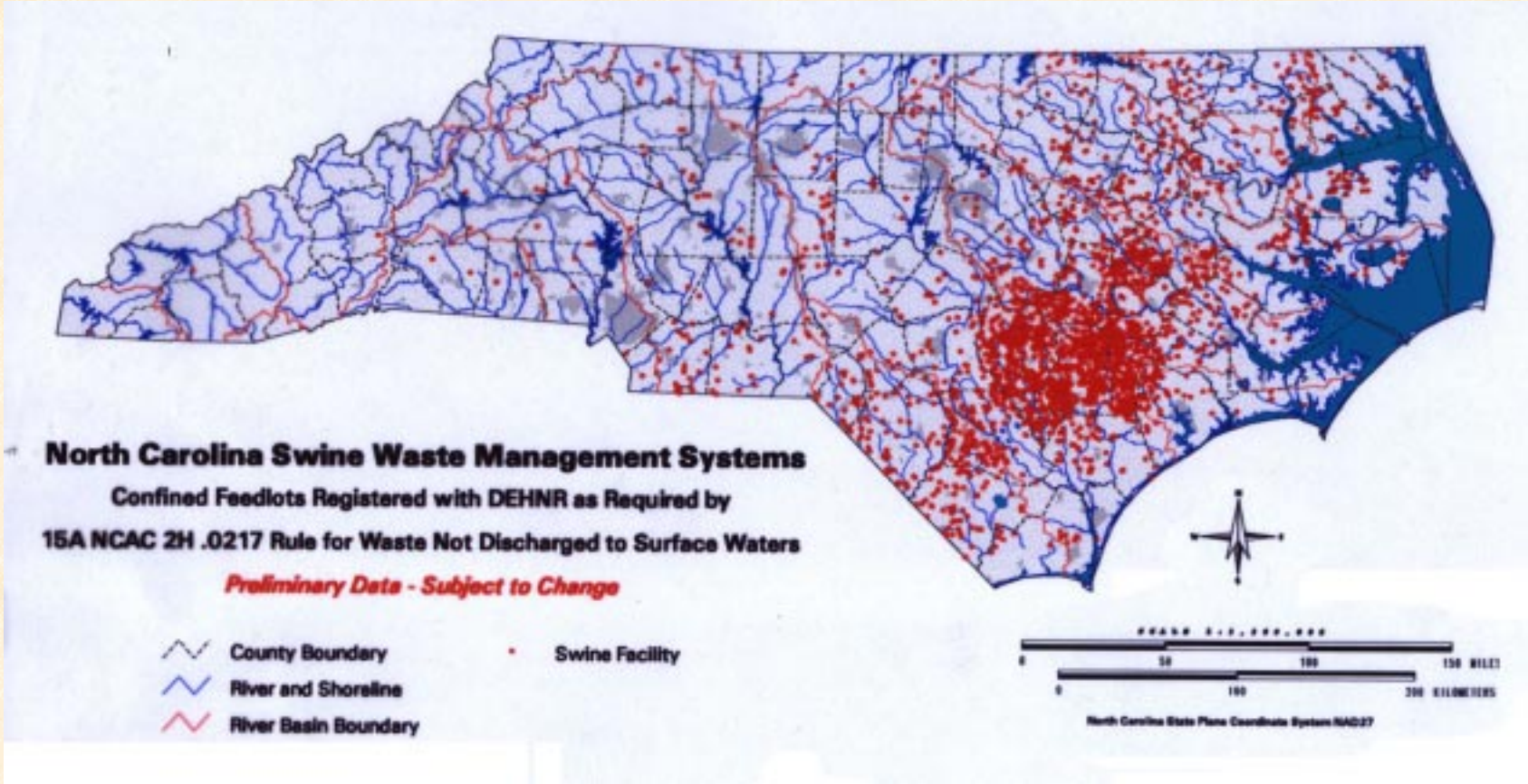
Green = >1.3 tons/sq. mile; **light blue = >0.83 tons/sq. mile**

NADP/NTN Isopleth Map

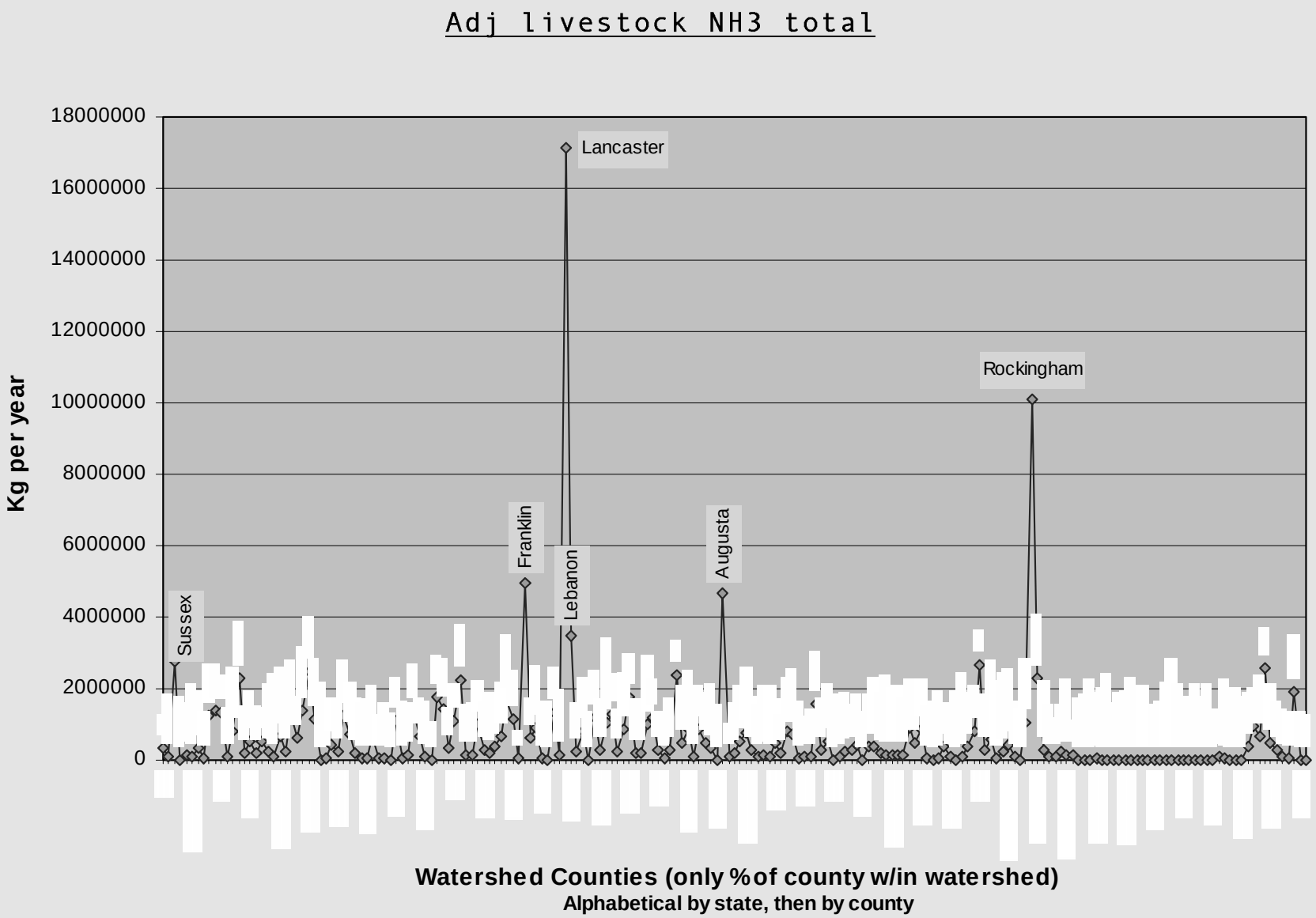


Sampson County, NC

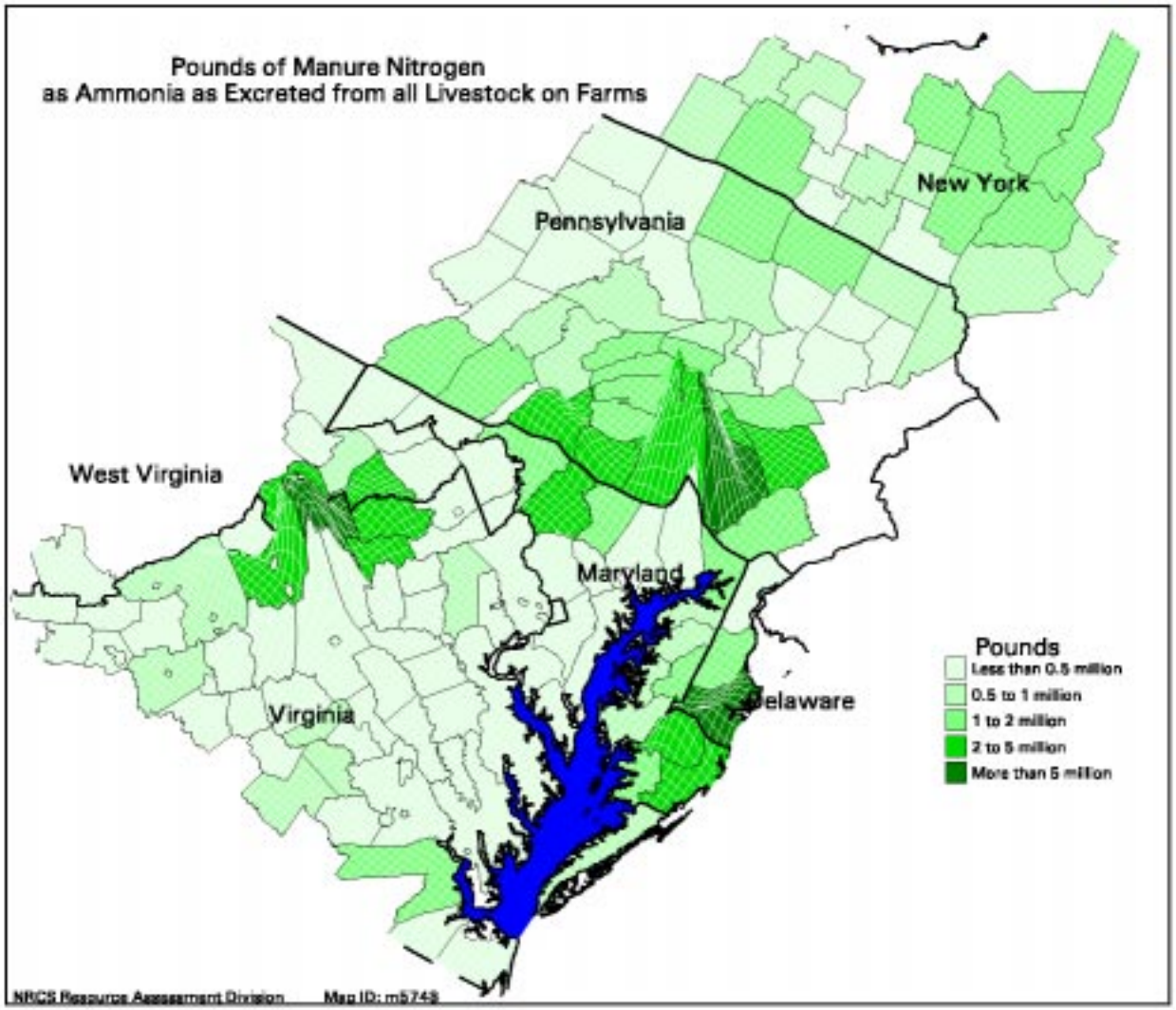
North Carolina Swine Map



Using the Carnegie Mellon University Analysis

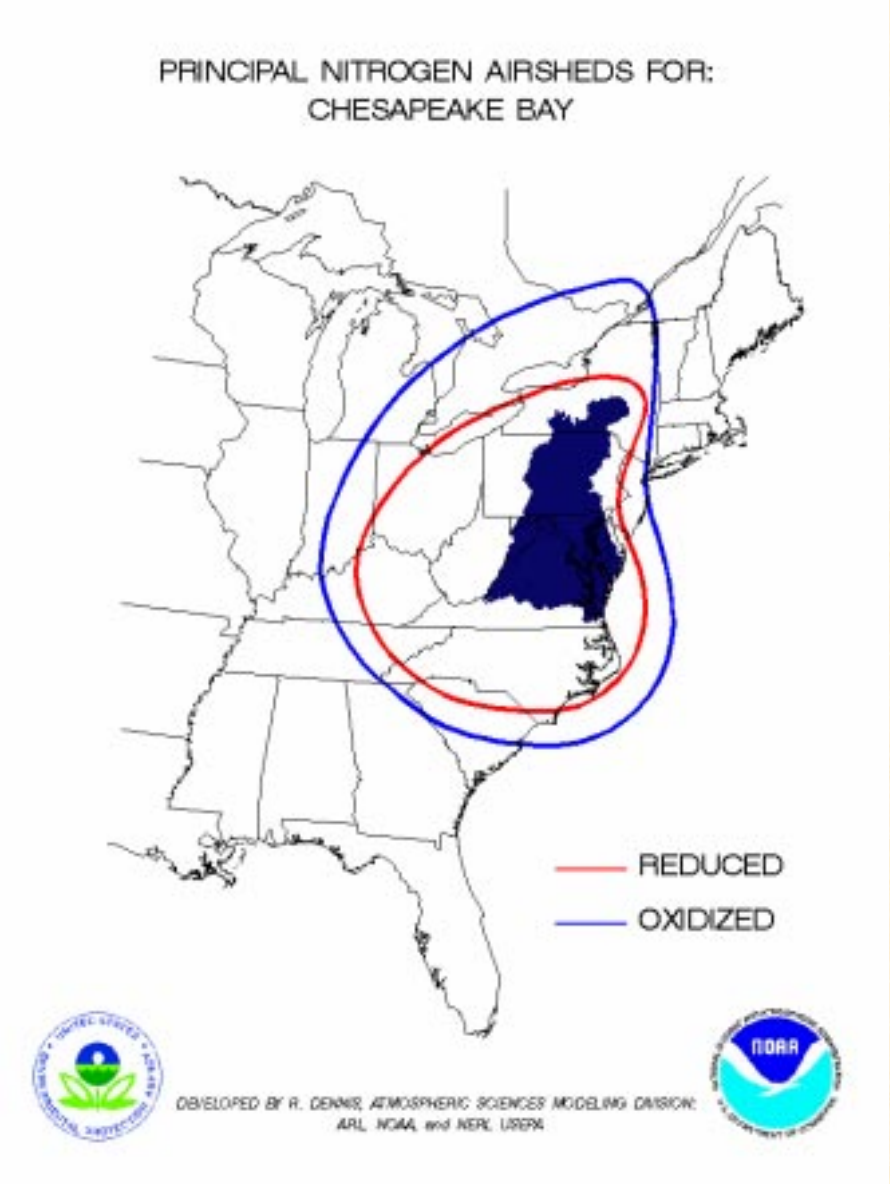


Using the USDA Analysis



Uncontrolled Nitrogen Emissions

- Focus on Ammonia "hotspots"
- Collaborative Multi-year Research (U of MD, U of DE, USDA, NOAA)
- Model Ammonia
- Conduct Ammonia Workshops

<u>NOx Airshed</u> is 6.5 times size of watershed; accounts for ~76% of nitrate deposition; and includes roughly 13 states.

<u>NHx airshed</u> is 4 times size of watershed; accounts for ~47% of ammonia/um deposition; and includes roughly 12 states.