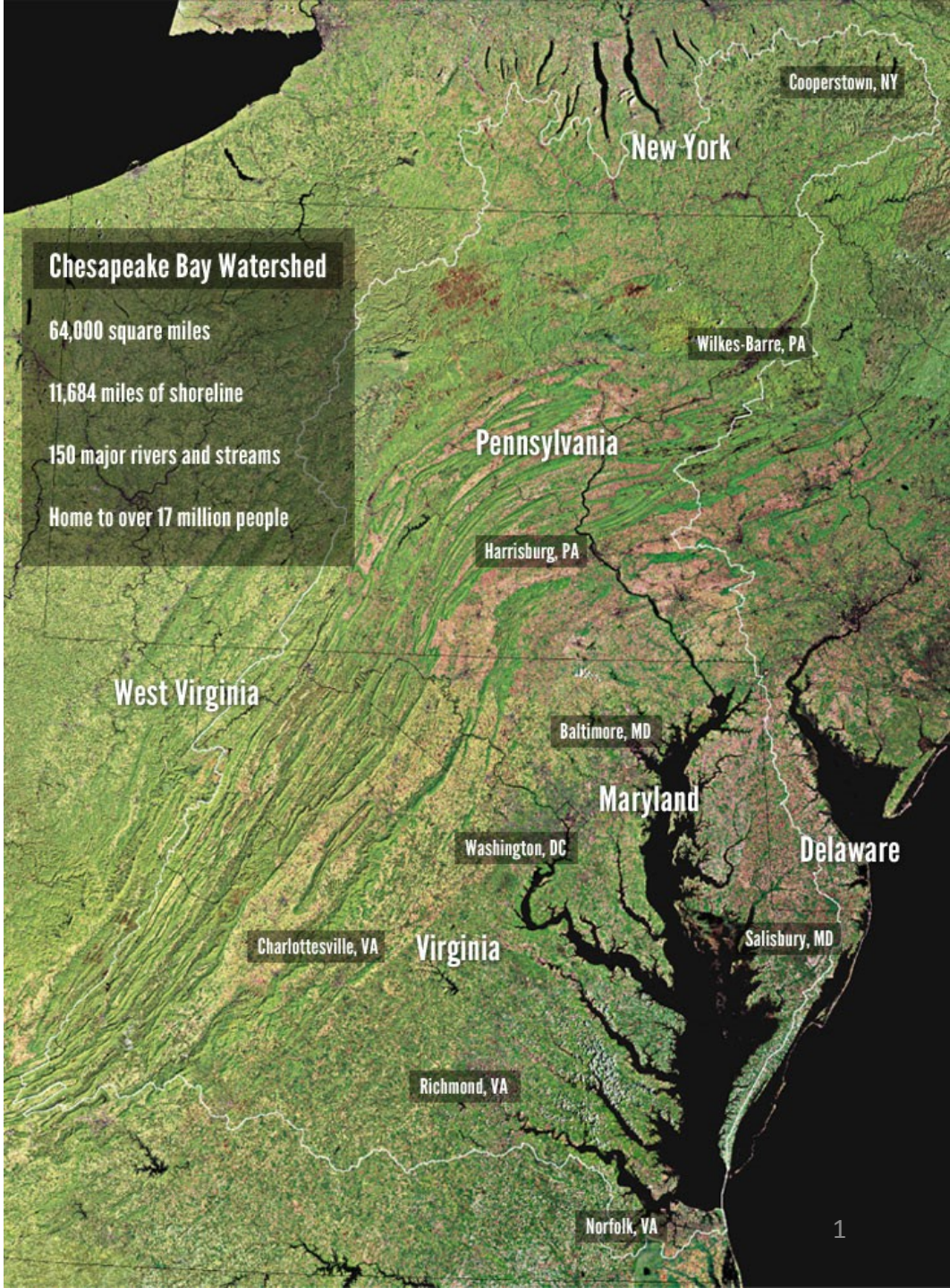
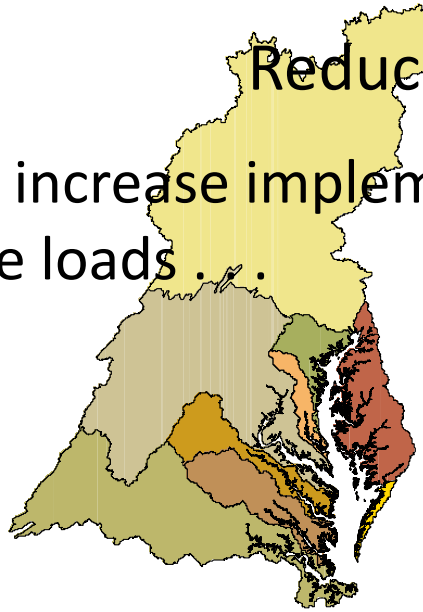
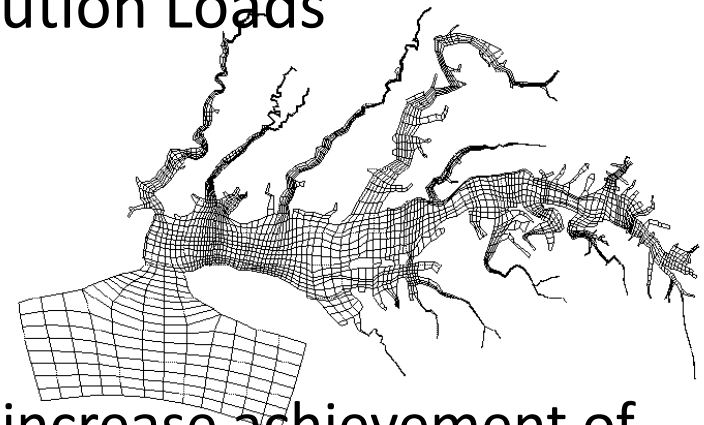
Sources of Nitrogen to the Chesapeake Bay



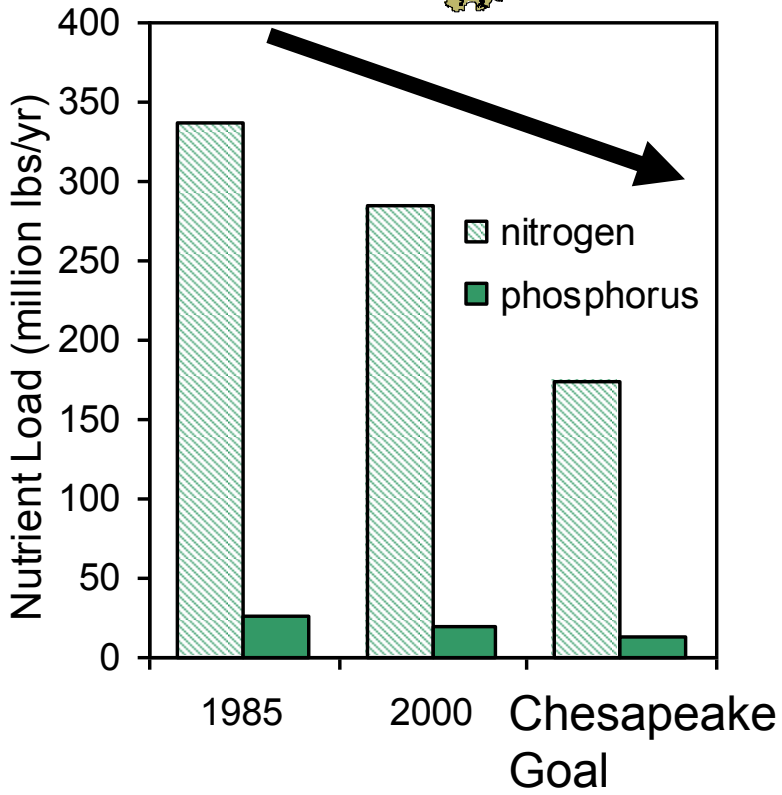
Reduce Nutrient Pollution Loads

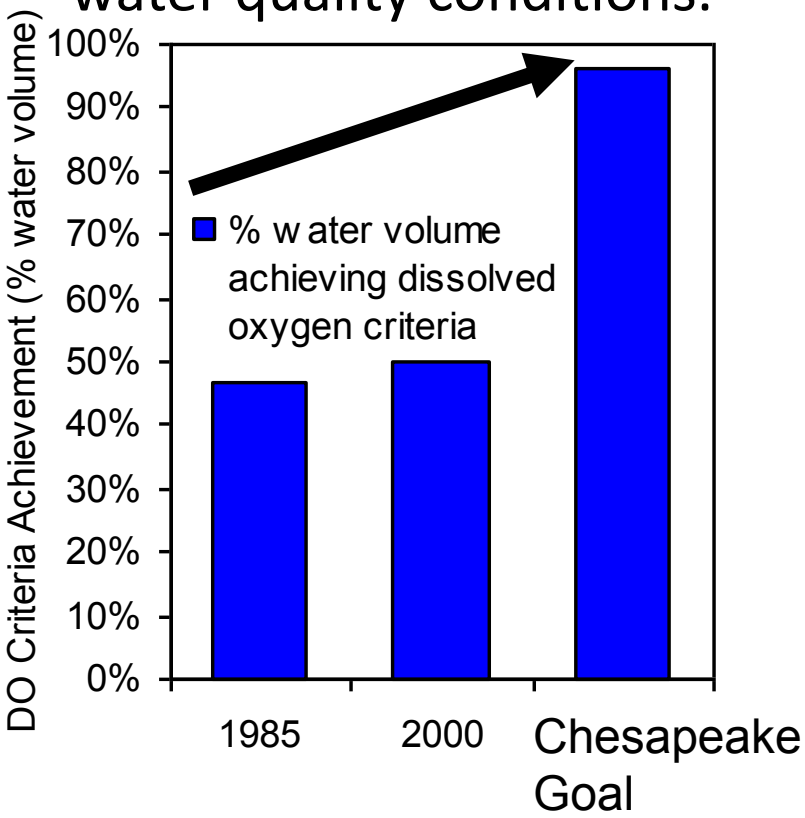
As we increase implementation, we reduce loads . . .



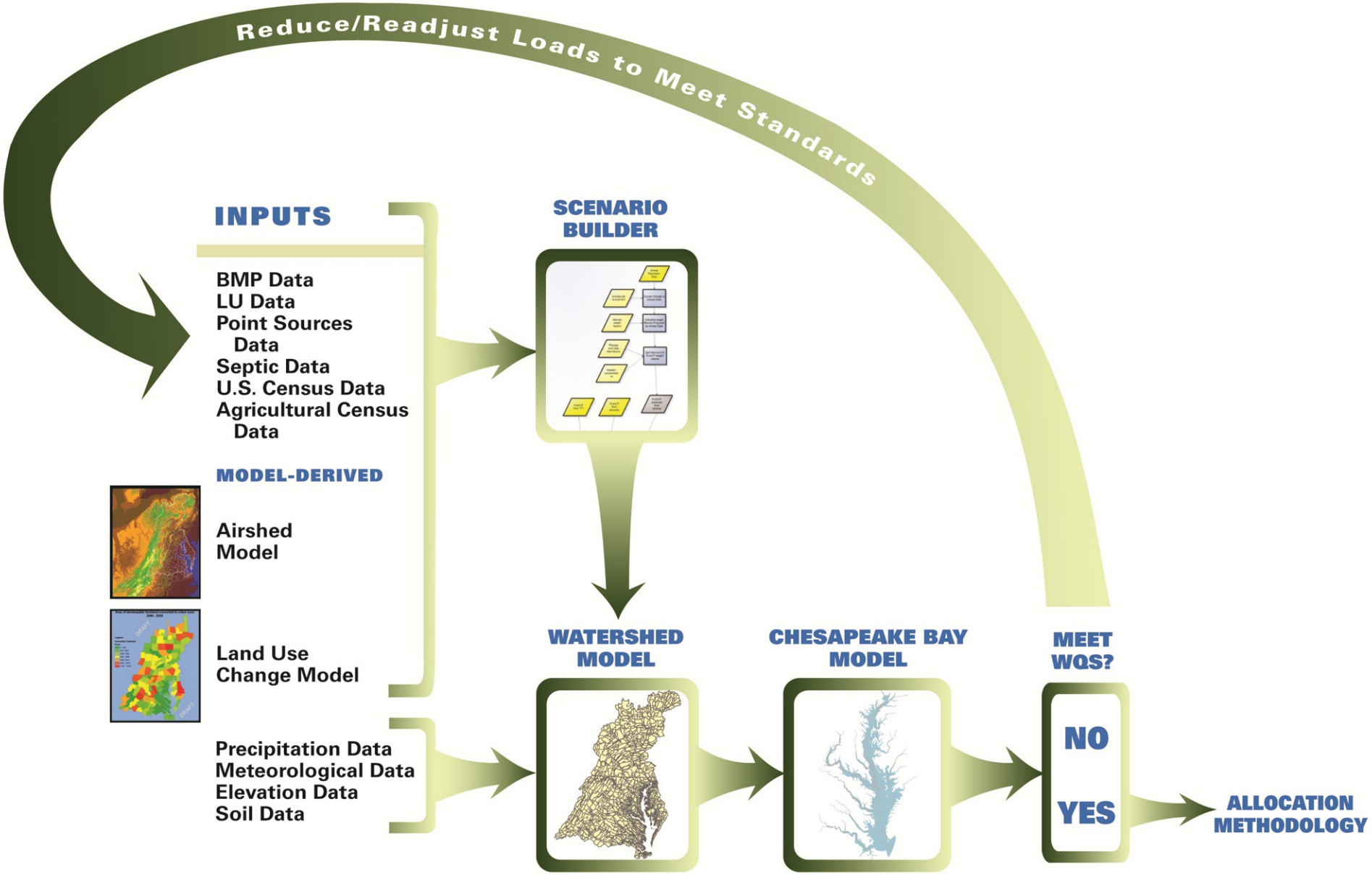


. . . we increase achievement of water quality conditions.





Chesapeake Bay Partnership Models



CBP Modeling Tools

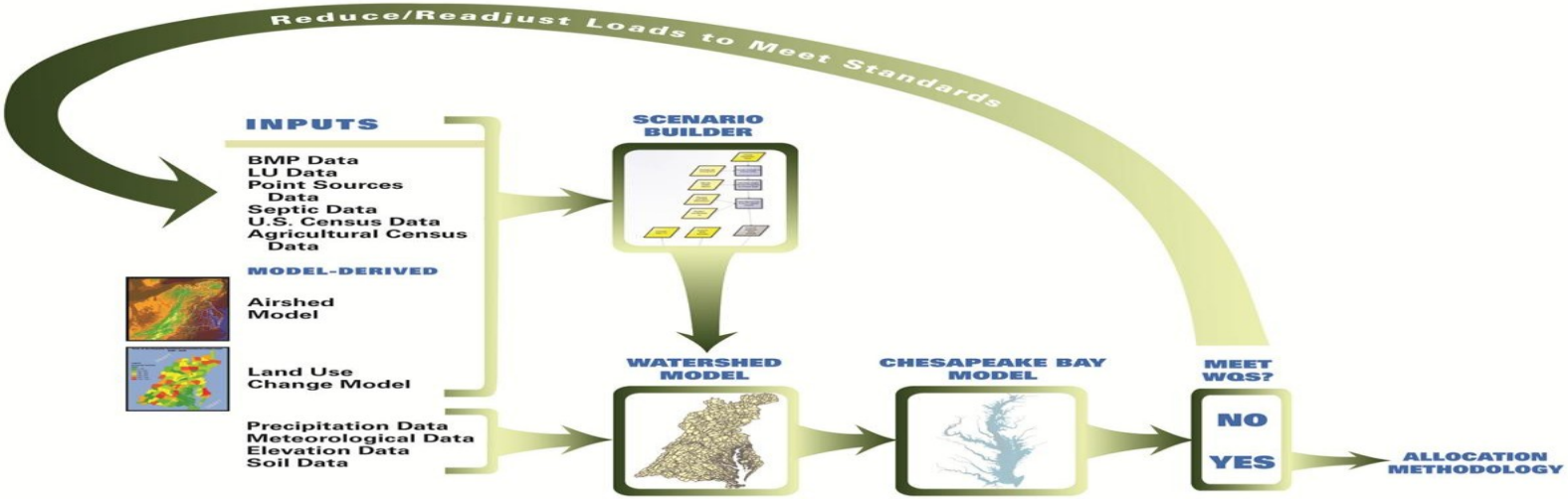
Interaction Tools

NEIEN
Environmental Information eXchange Network

CAST

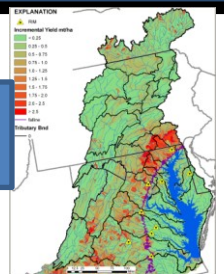
ChesapeakeStat
BayTAS
Chesapeake Bay TMDL Tracking and Accounting System

Decision Models/ Databases



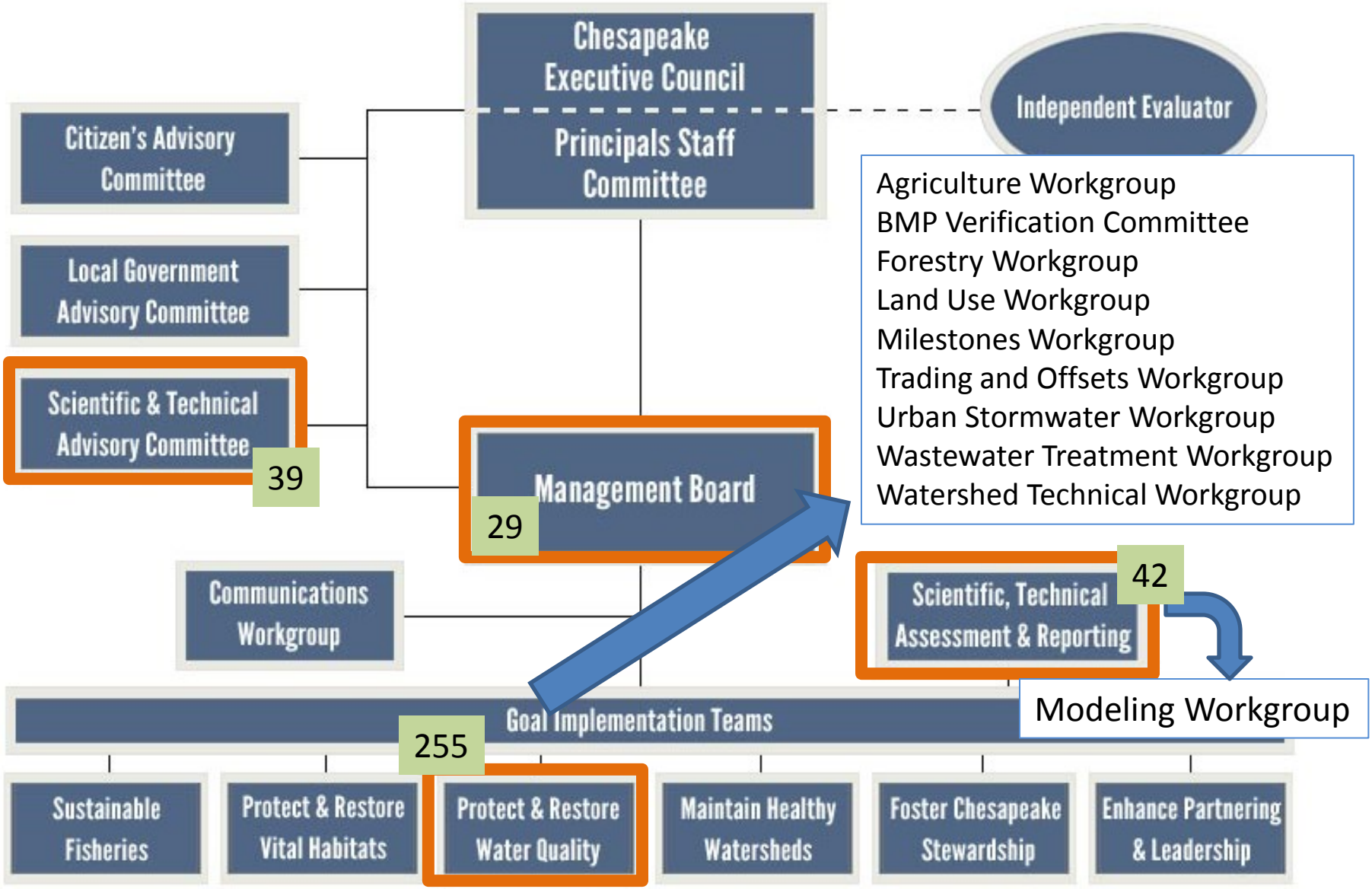
Related Tools

sparrow



Model related Membership as of 7/2013 – 365 individuals

Chesapeake Bay Program Partnership



Expert Review Panels; Planned and Active

Agriculture

- Nutrient Management
- Poultry Litter
- Conservation Tillage
- Cover Crop Panel
- Manure Treatment Technologies
- Animal Waste Storage Systems
- Manure Injection/Incorporation
- Cropland Irrigation Management

Urban

- Urban Retrofits
- Performance Based Management
- Stream Restoration
- LID and Runoff Reduction
- Urban Fertilizer Management
- Erosion and Sediment Control
- Illicit Discharge Elimination
- Impervious Disconnect
- Floating Wetlands
- MS4 Minimum Management Measures

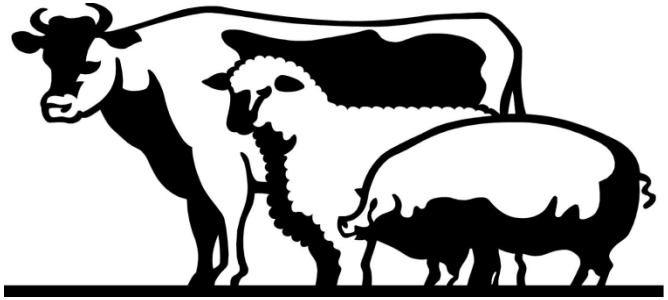
Forestry

- Riparian Buffers
- Urban Tree Planting
- Forest Management
- Urban Filter Strips and Upgraded Stream Buffers

Scenario Builder – model of nutrient inputs

Manure storage practice

Livestock



Crops

Pasture

Fertilizer

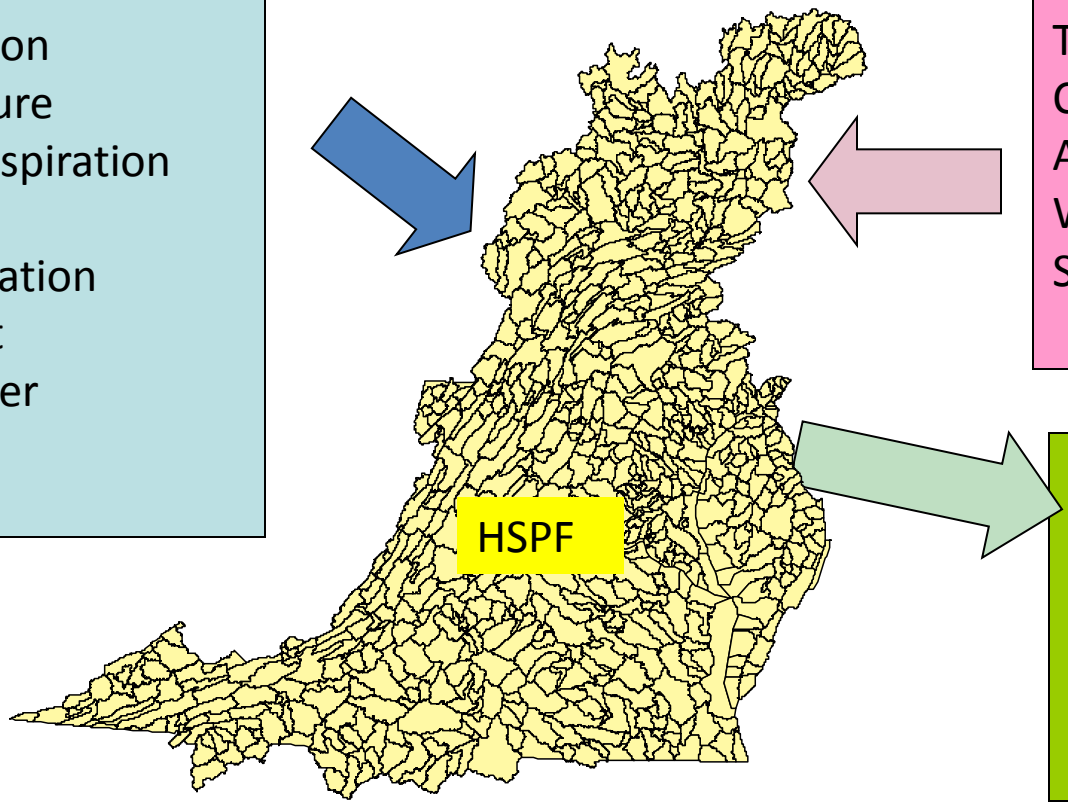
Image Credits
https://utextension.tennessee.edu/lincoln/4-H/Pages/Livestock-Skillathons-%28Beef,-Sheep-and-Swine%29.aspx
Rebelwoodsranch.com
Seaburst.com
http://pubs.ext.vt.edu/442/442-308/442-308.html

Describe Change in Load due to Actions

Hourly or daily values of Meteorological factors:

Precipitation
Temperature
Evapotranspiration
Wind
Solar Radiation
Dew point
Cloud Cover

CBP Partnership Watershed Model



Constant values of anthropogenic factors:

Land Use Acreage
BMPs
Fertilizer
Manure
Tillage
Crop types
Atmospheric deposition
Waste water treatment
Septic loads

Run for 1984-2000
Average 1991-2000
For 'flow-normalized average annual loads'

Home | ChesapeakeStat

stat.chesapeakebay.net

States | Basins | Segments | Permitted Facilities

Go to: State, zip, address, etc. Go

Streets | Imagery

Phase II WIP Planning Targets

Show Original TMDL Allocations

Click on a map or chart feature or select from options below to view information by State.

Select: Watershed-Wide

Nitrogen | Phosphorus | Total Suspended Solids

Watershed-Wide

Total 2025 Planning Target for Nitrogen:

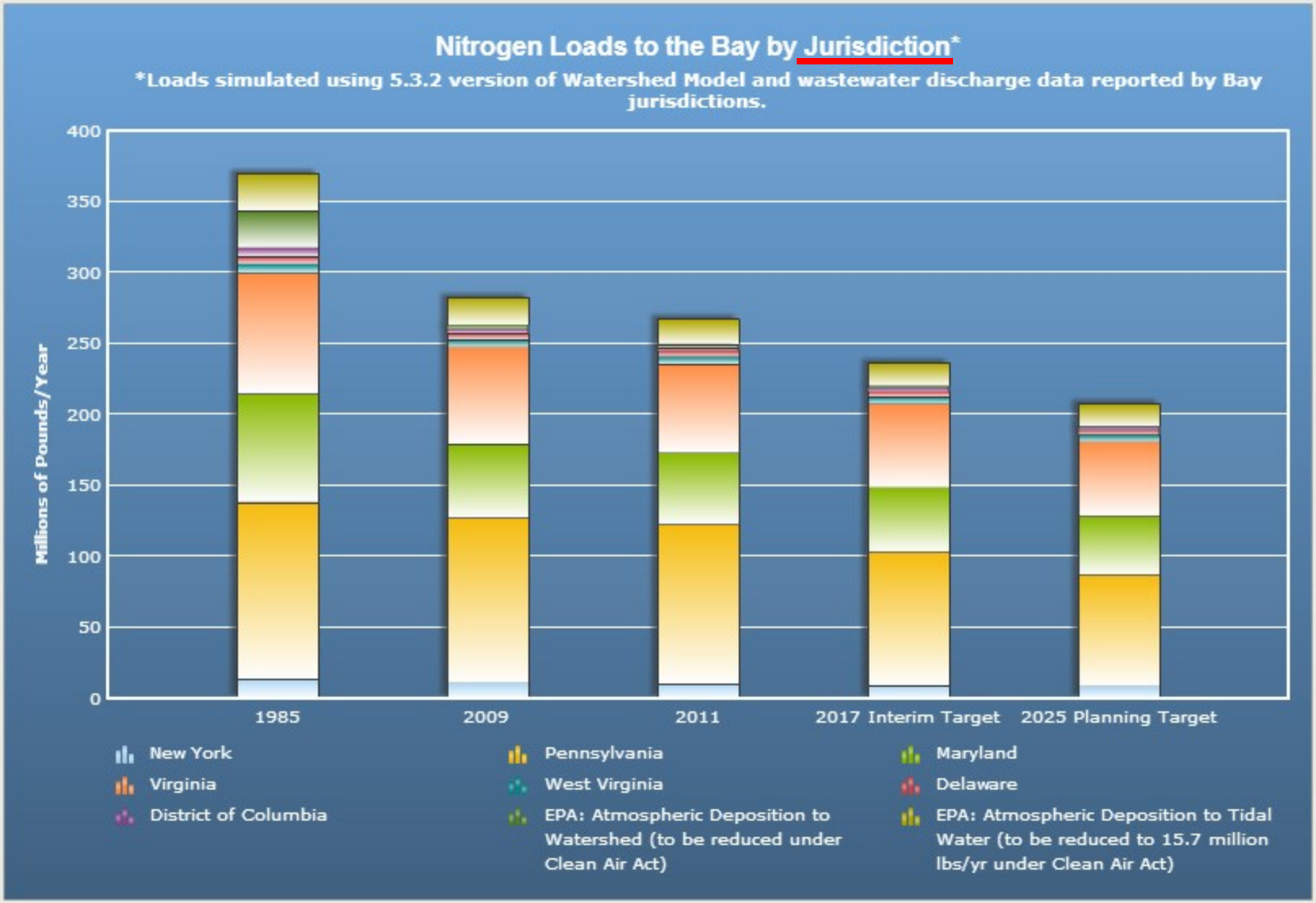
208,071,430 lbs/year

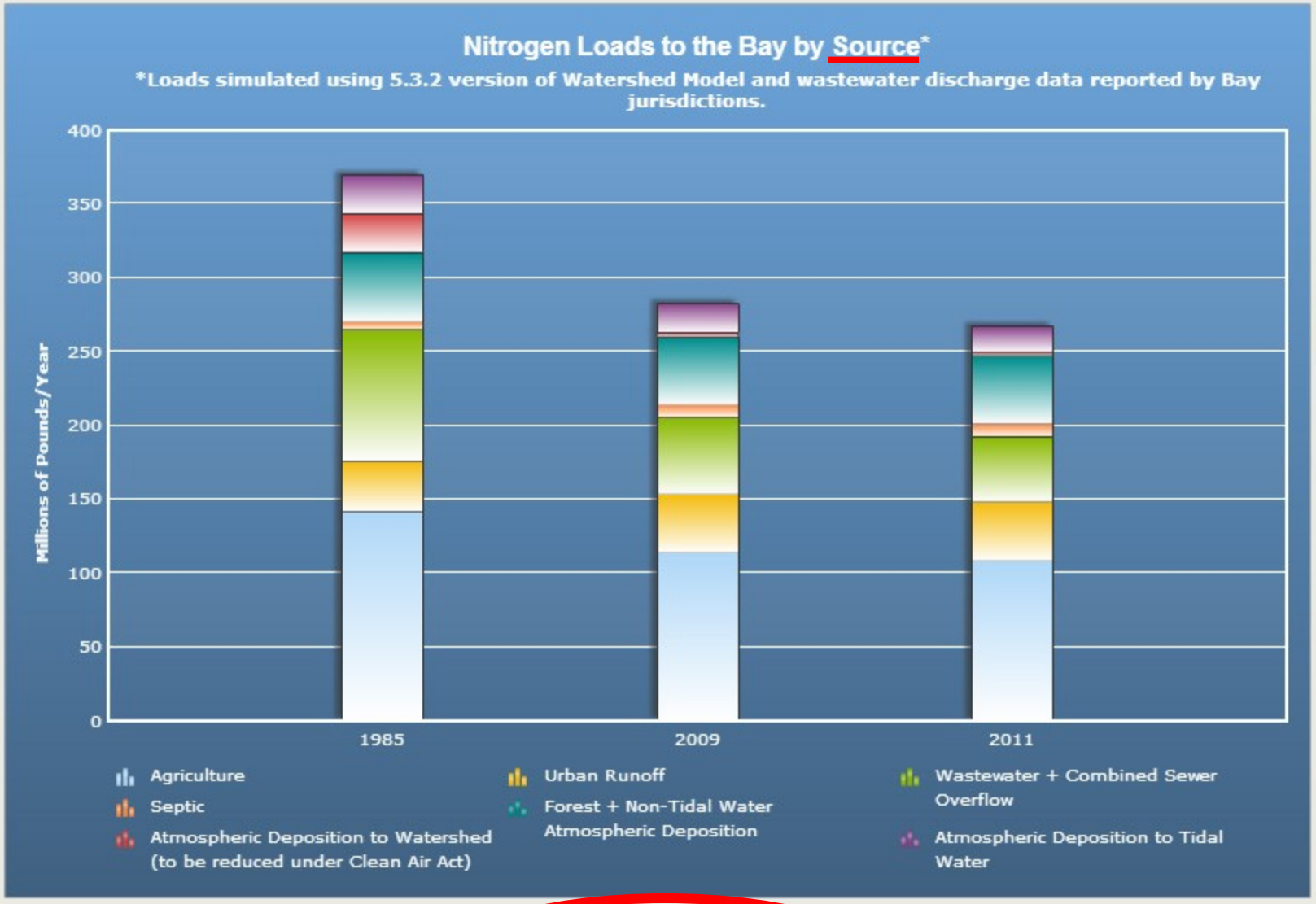
Download Data

Total Nitrogen 2025 Planning Target by Sector:

Loads simulated using 5.3.2 version of Watershed Model and wastewater discharge data reported by Bay jurisdictions.

Lake Ontario
Toronto
Buffalo
Rochester
Lake Erie
Cleveland
Allentown
Philadelphia
Baltimore
Washington
Dover
Newport News
Virginia Beach
Norfolk
Chesapeake
Charlotte
Pamlico
300 km
100 mi
bing


Nitrogen Loads to the Bay by Jurisdiction*
*Loads simulated using 5.3.2 version of Watershed Model and wastewater discharge data reported by Bay jurisdictions.
Millions of Pounds/Year
400
350
300
250
200
150
100
50
0
1985
2009
2011
2017 Interim Target
2025 Planning Target
New York
Pennsylvania
Maryland
Virginia
West Virginia
Delaware
District of Columbia
EPA: Atmospheric Deposition to Watershed (to be reduced under Clean Air Act)
EPA: Atmospheric Deposition to Tidal Water (to be reduced to 15.7 million lbs/yr under Clean Air Act)

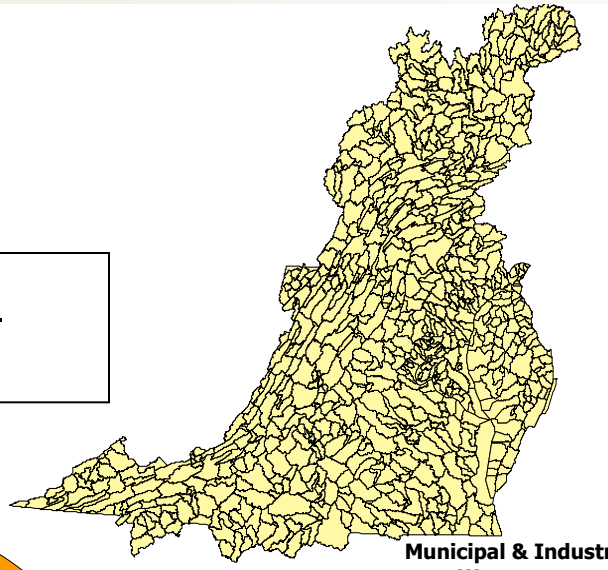


Download Data (114.55 KB)

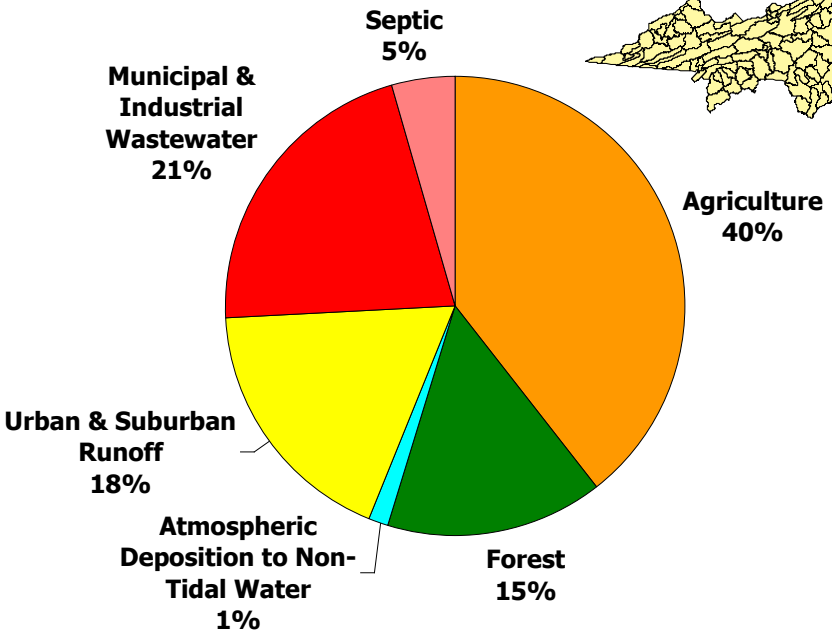
Analysis & Methods (127.5 KB)

Watershed Model Uses

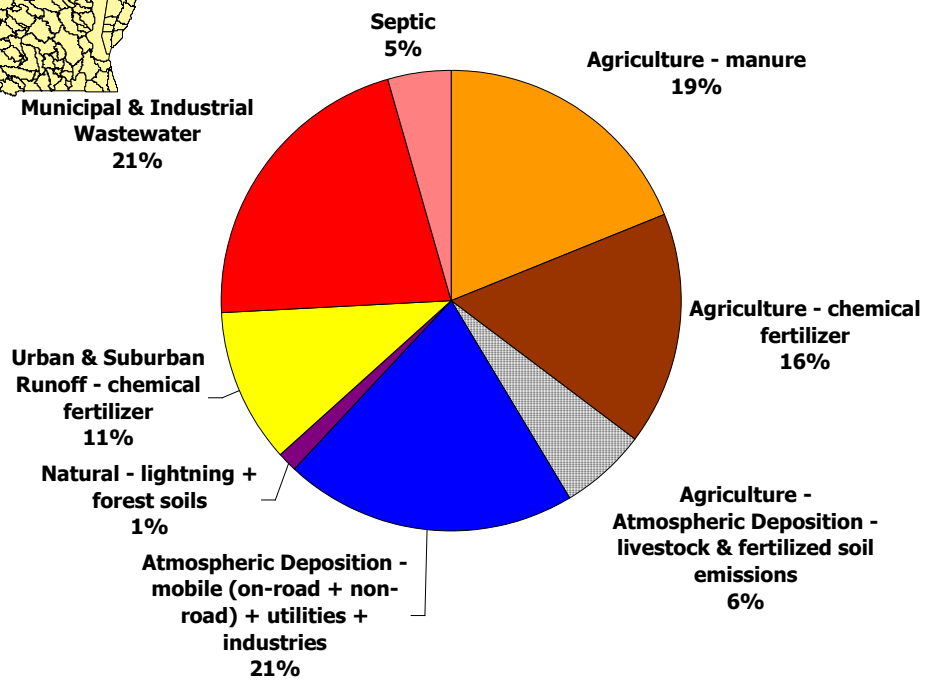
Divide loads into contributing areas and sources



Land Use Source
Total Nitrogen

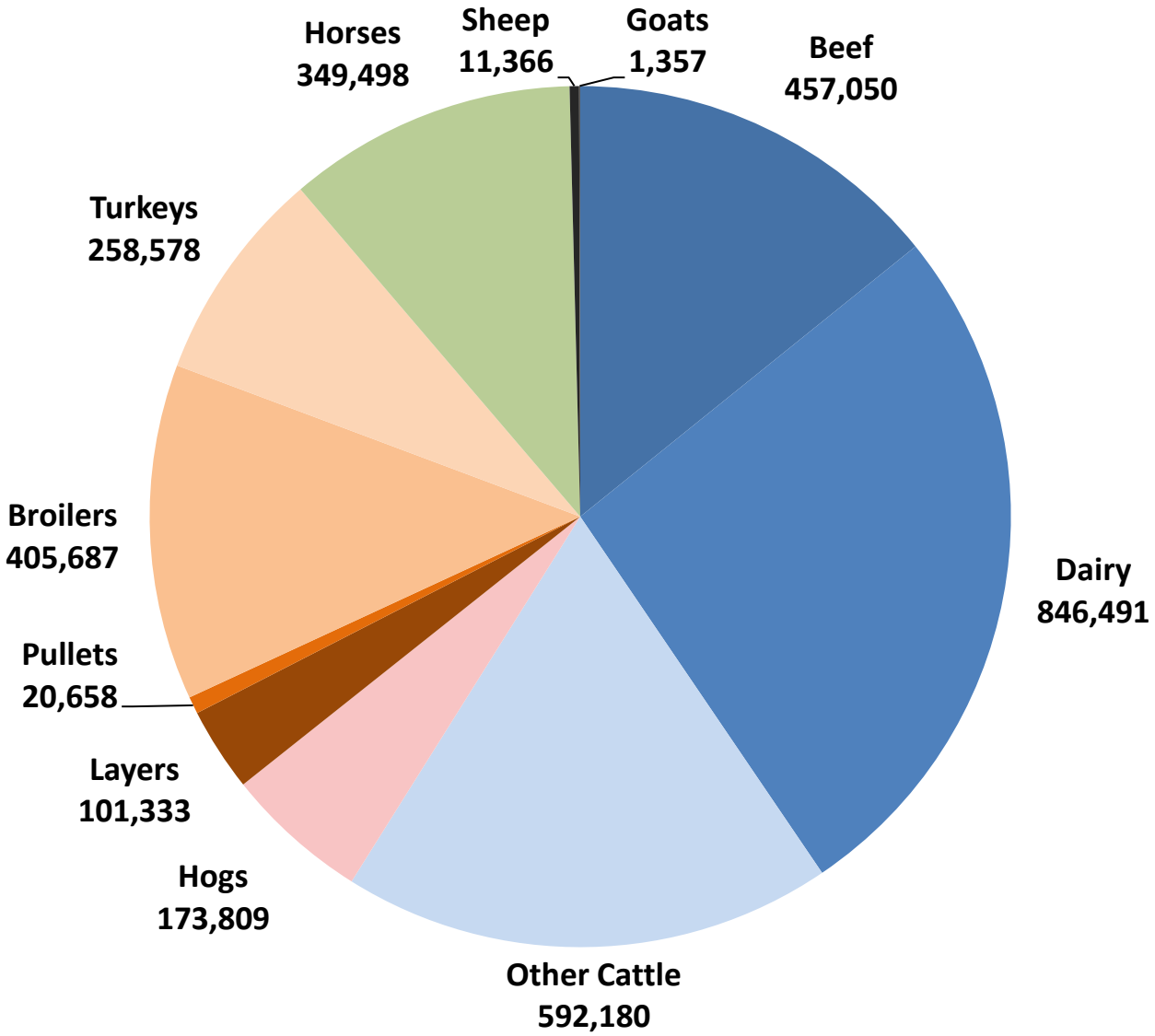


Ultimate Source
Total Nitrogen

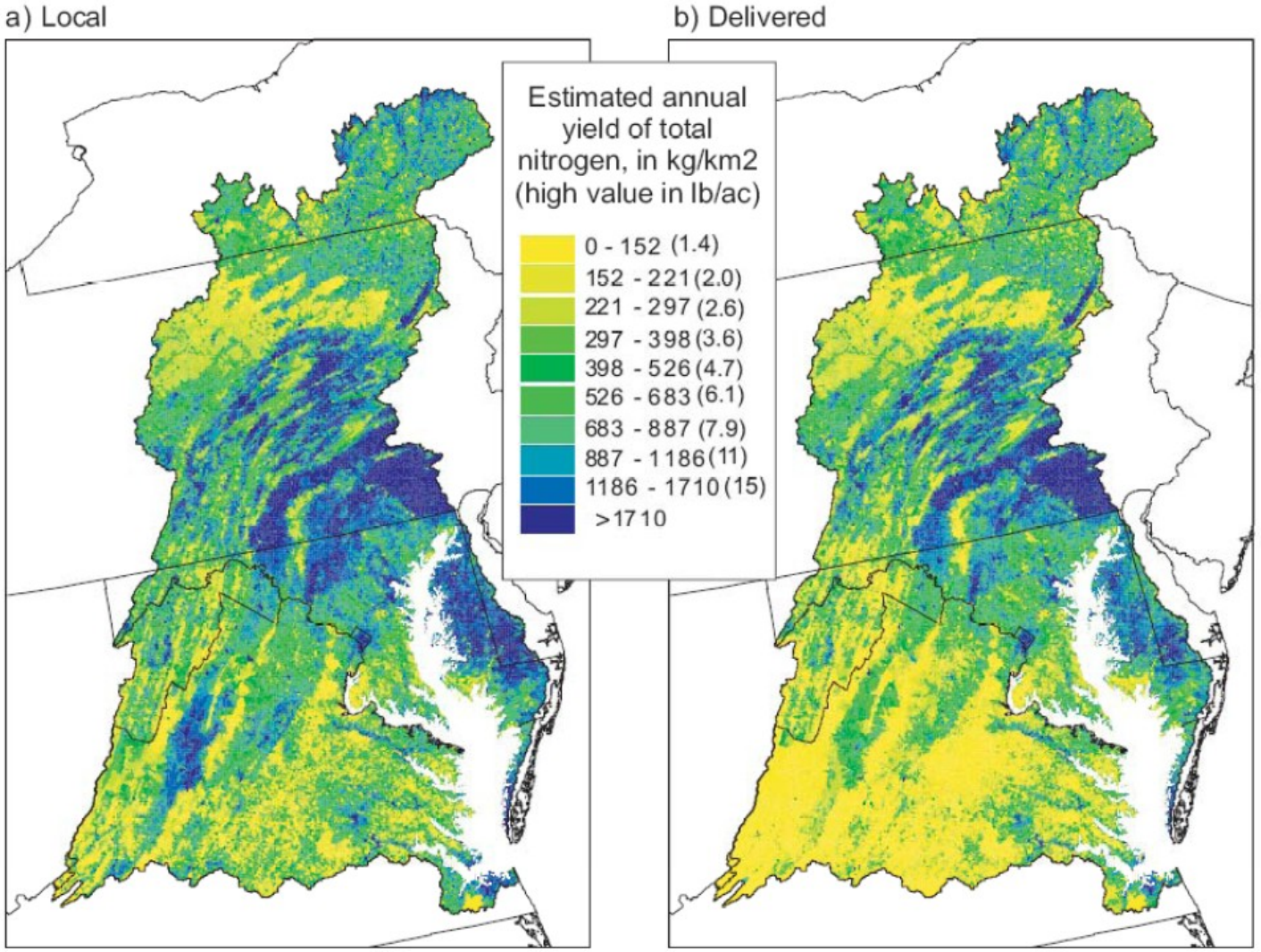


Example from previous model version

Animal Units in the Chesapeake Watershed 2010

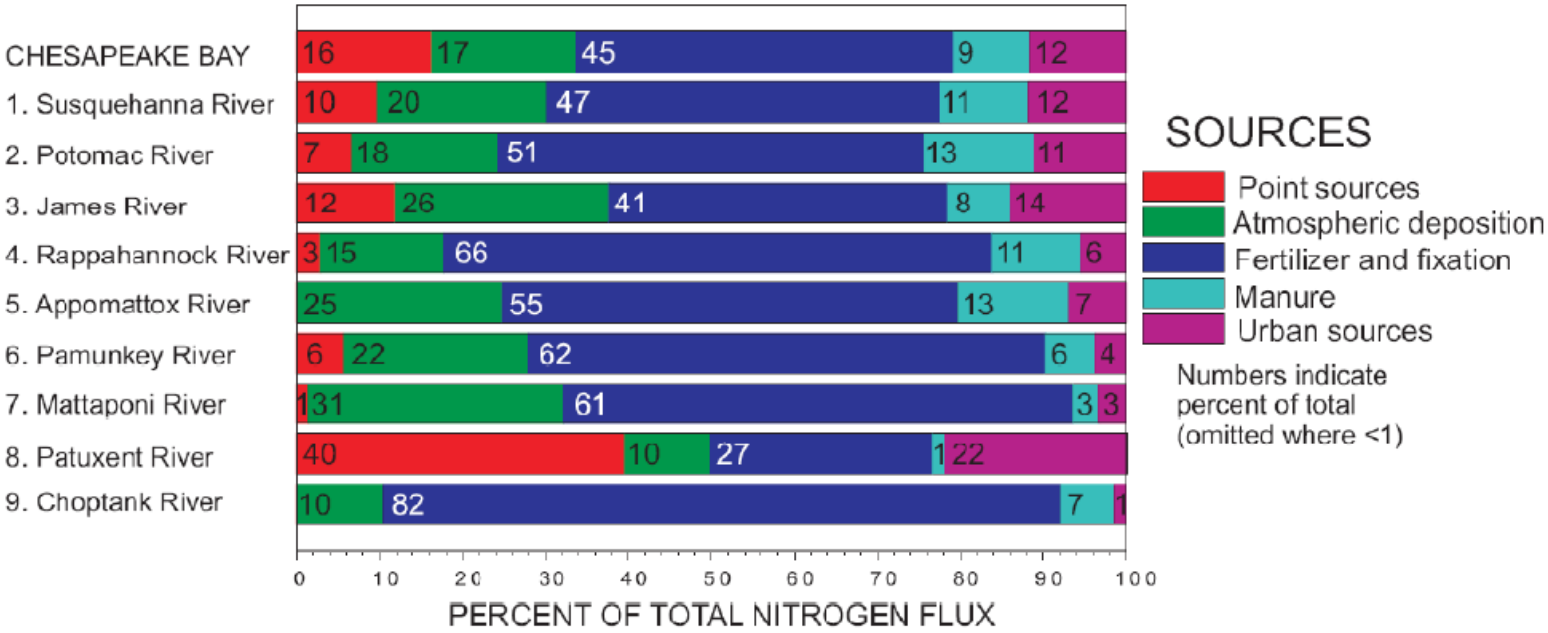


USGS – Sparrow
Spatial Model of Nitrogen Sources



Ator and others, USGS SIR 2011-5167

Nitrogen Source Shares



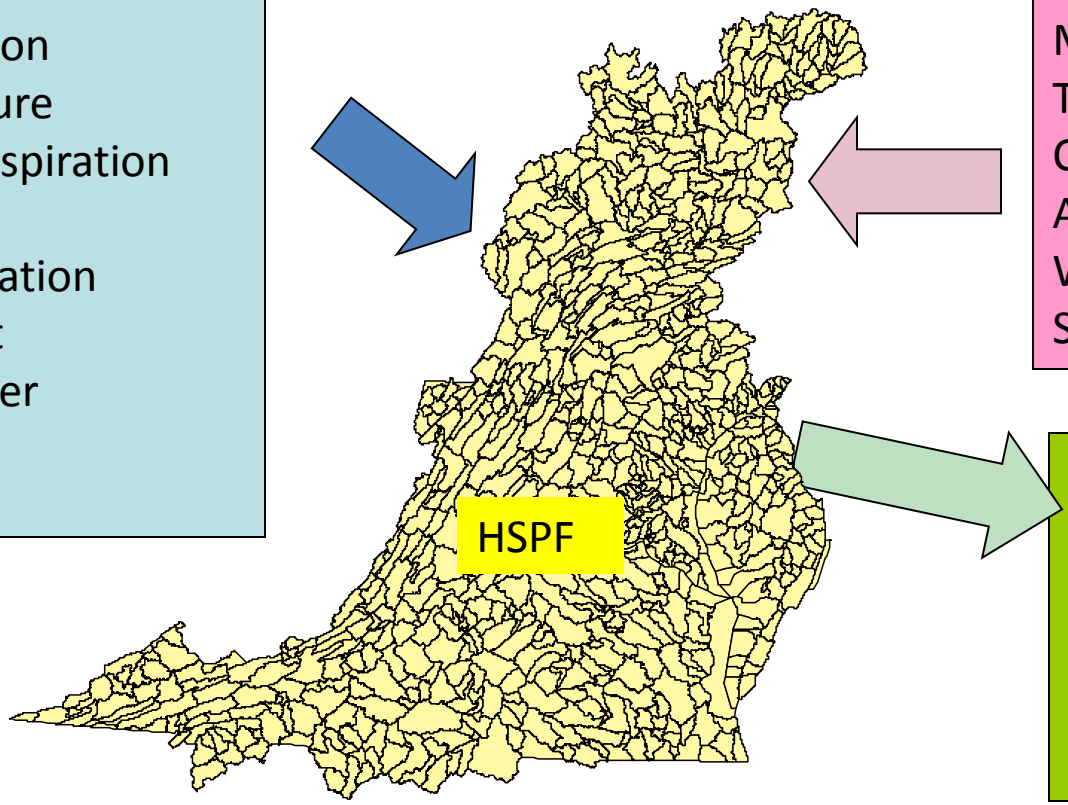
Ator and others, USGS SIR 2011-5167.

How the Watershed Model Works

Calibration Mode

Hourly or daily values of Meteorological factors:

Precipitation
Temperature
Evapotranspiration
Wind
Solar Radiation
Dew point
Cloud Cover



Annual, monthly, or daily values of anthropogenic factors:

Land Use Acreage
BMPs
Fertilizer
Manure
Tillage
Crop types
Atmospheric deposition
Waste water treatment
Septic loads

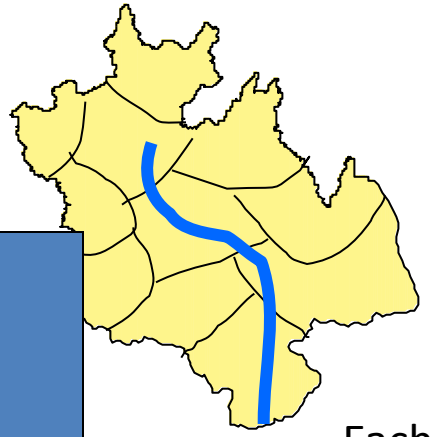
Daily flow, nitrogen, phosphorus, and sediment compared to observations over 21 years

How the Watershed Model Works

Each segment consists of 30 separately-modeled land uses:

- Regulated Pervious Urban
- Regulated Impervious Urban
- Unregulated Pervious Urban
- Unregulated Impervious Urban
- Construction
- Extractive
- Combined Sewer System
- Wooded / Open
- Disturbed Forest

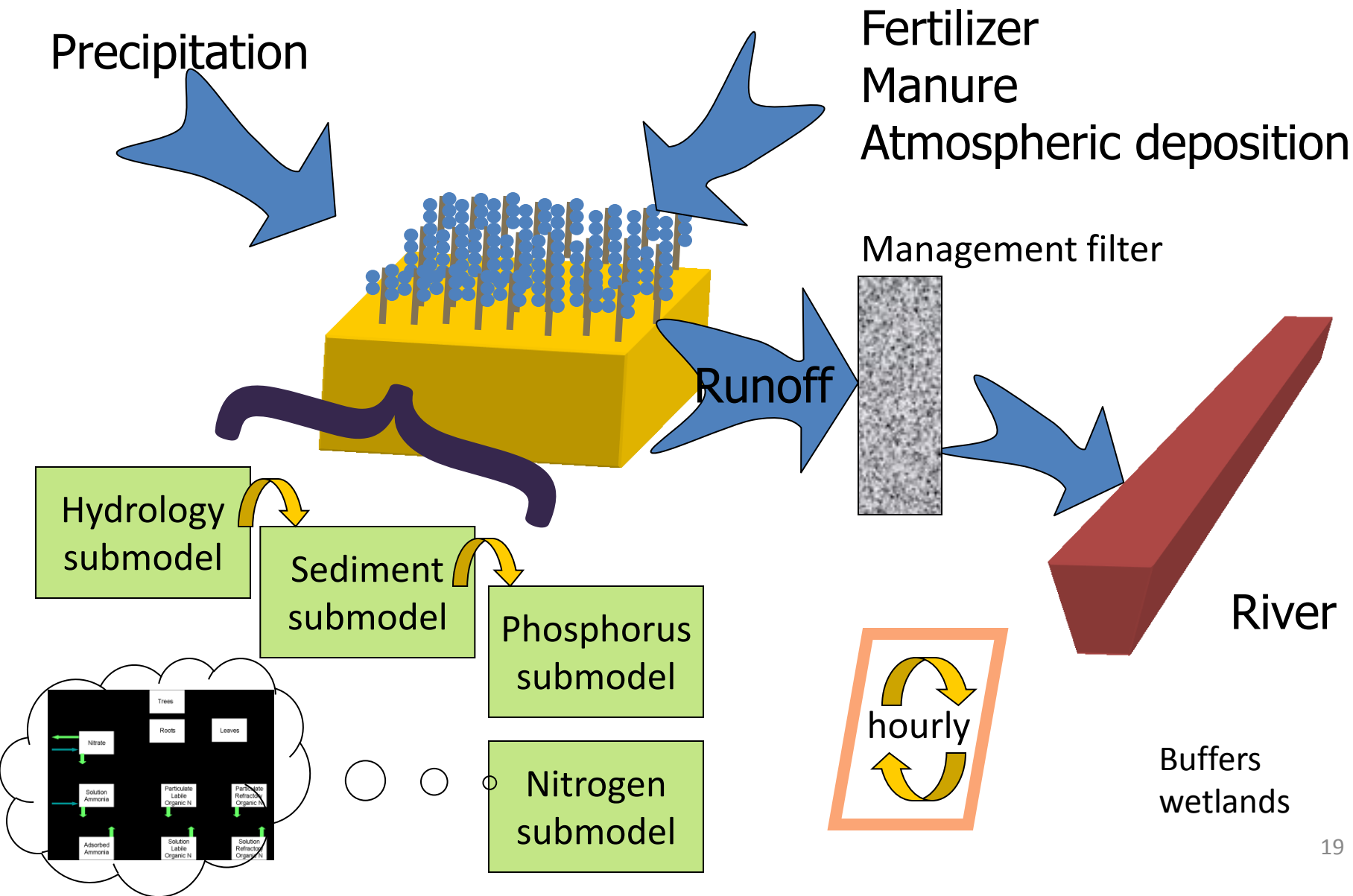
- Corn/Soy/Wheat rotation (high till)
- Corn/Soy/Wheat rotation (low till)
- Other Row Crops
- Alfalfa
- Nursery
- Pasture
- Degraded Riparian Pasture
- Afo / Cafo
- Fertilized Hay
- Unfertilized Hay
  - Nutrient management versions of the above



Plus: Point Source and Septic Loads, and Atmospheric Deposition Loads

Each calibrated to nutrient and Sediment targets

How the Watershed Model Works



Nitrogen SPARROW

RMSE=0.2892,
R^2=0.9784,
yieldR^2=0.8580
N = 181

- Sources: On average:
  - 1,090 kg/km^2 of N from Urban areas reach the stream
  - 24% of N from fertilizer and fixation reaches streams
  - Only 6% of N in manure reaches streams
  - 27% of N from atmospheric deposition reaches streams

Nitrogen Model	Estimate	p
Sources		
Point sources (kg/yr)	0.774	0.0008
Urban land (km^2)	1090	<0.0001
Fertilizer/fixation (kg/yr)	0.237	<0.0001
Manure (kg/yr)	0.058	0.0157
Wet atmospheric (kg/yr)	0.267	<0.0001
Land to Water Transport		
Ln(mean evi)	-1.70	0.0039
Ln(mean soil AWC)	-0.829	0.0016
Ln(GW recharge (mm))	0.707	<0.0001
Ln (% Piedmont carb)	0.158	0.0018
Aquatic Decay		
Small streams (<122 cfs)	0.339	0.0118
Lg Streams, T > 18.5 C	0.153	0.0030
Lg Streams, T< 15.0 C	0.013	0.431
Impoundments	5.93	0.0424

Ator and others, USGS SIR 2011-5167.

Nitrogen SPARROW

RMSE=0.2892,
R^2=0.9784,
yieldR^2=0.8580
N = 181

- Fate and transport:
  - Delivery to streams is greater in areas of greater groundwater flow, particularly in the Piedmont carbonate
  - Delivery to streams is less in areas with reducing conditions or greater plant uptake
  - In-stream losses are greater in smaller streams
  - In-stream losses in larger streams are greater in warmer areas
  - Losses in impoundments are likely due mainly to denitrification

Nitrogen Model	Estimate	p
Sources		
Point sources (kg/yr)	0.774	0.0008
Urban land (km^2)	1090	<0.0001
Fertilizer/fixation (kg/yr)	0.237	<0.0001
Manure (kg/yr)	0.058	0.0157
Wet atmospheric (kg/yr)	0.267	<0.0001
Land to Water Transport		
Ln(mean evi)	-1.70	0.0039
Ln(mean soil AWC)	-0.829	0.0016
Ln(GW recharge (mm))	0.707	<0.0001
Ln (% Piedmont carb)	0.158	0.0018
Aquatic Decay		
Small streams (<122 cfs)	0.339	0.0118
Lg Streams, T > 18.5 C	0.153	0.0030
Lg Streams, T< 15.0 C	0.013	0.431
Impoundments	5.93	0.0424

Ator and others, USGS SIR 2011-5167.

Phosphorus SPARROW

RMSE=0.4741
R^2=0.9510
yieldR^2=0.7300
N = 184

- On average, less than 5% of applied P in fertilizer and manure reaches streams
- Urban areas yield 49 kg/km^2
- Natural mineral sources are significant
- Delivery to streams is greater where runoff is more likely and in the Coastal Plain, possibly due to legacy applications or saturation
- Significant losses occur in impoundments

Phosphorus Model	Estimate	p
Sources		
Point sources (kg/yr)	0.877	<0.0001
Urban land (km^2)	49	<0.0001
Fertilizer (kg/yr)	0.0377	0.0014
Manure (kg/yr)	0.0253	0.0002
Siliclastic rocks (km^2)	8.52	<0.0001
Crystalline rocks (km^2)	6.75	0.0009
Land to Water Transport		
Soil erodibility (k factor)	6.25	0.0002
Ln(% well drained soils)	-0.100	0.0019
Ln(precipitation (mm))	2.06	<0.0237
Coastal Plain (% of area)	1.02	<0.0001
Aquatic Decay		
Impoundments	54.3	0.0174

Ator and others, USGS SIR 2011-5167.