Sources and Inputs of Nutrients to the Chesapeake Bay Watershed, 1950-2012

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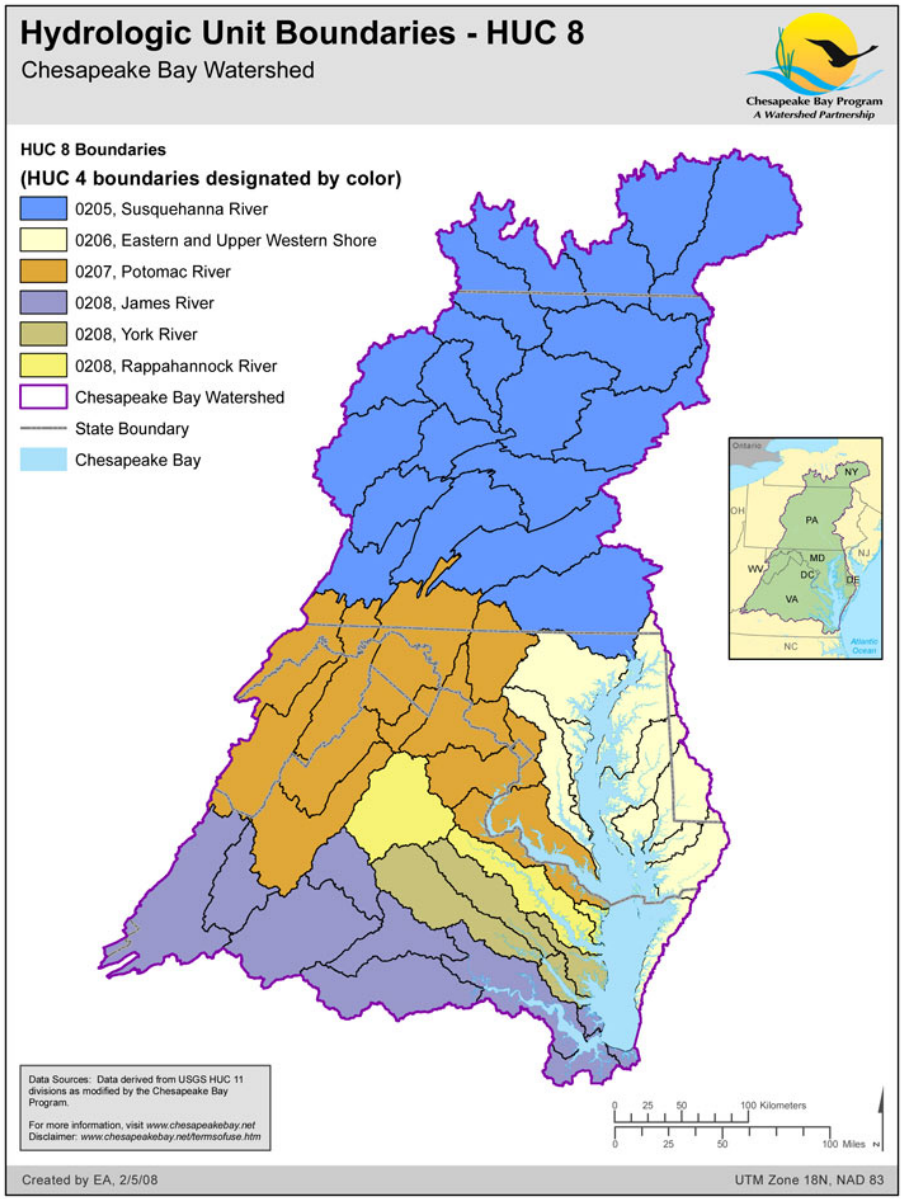
Relating Nutrient Inputs, Sources, and BMPs

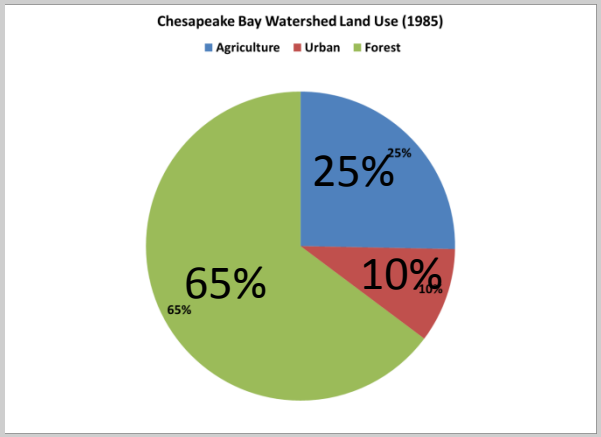


Questions

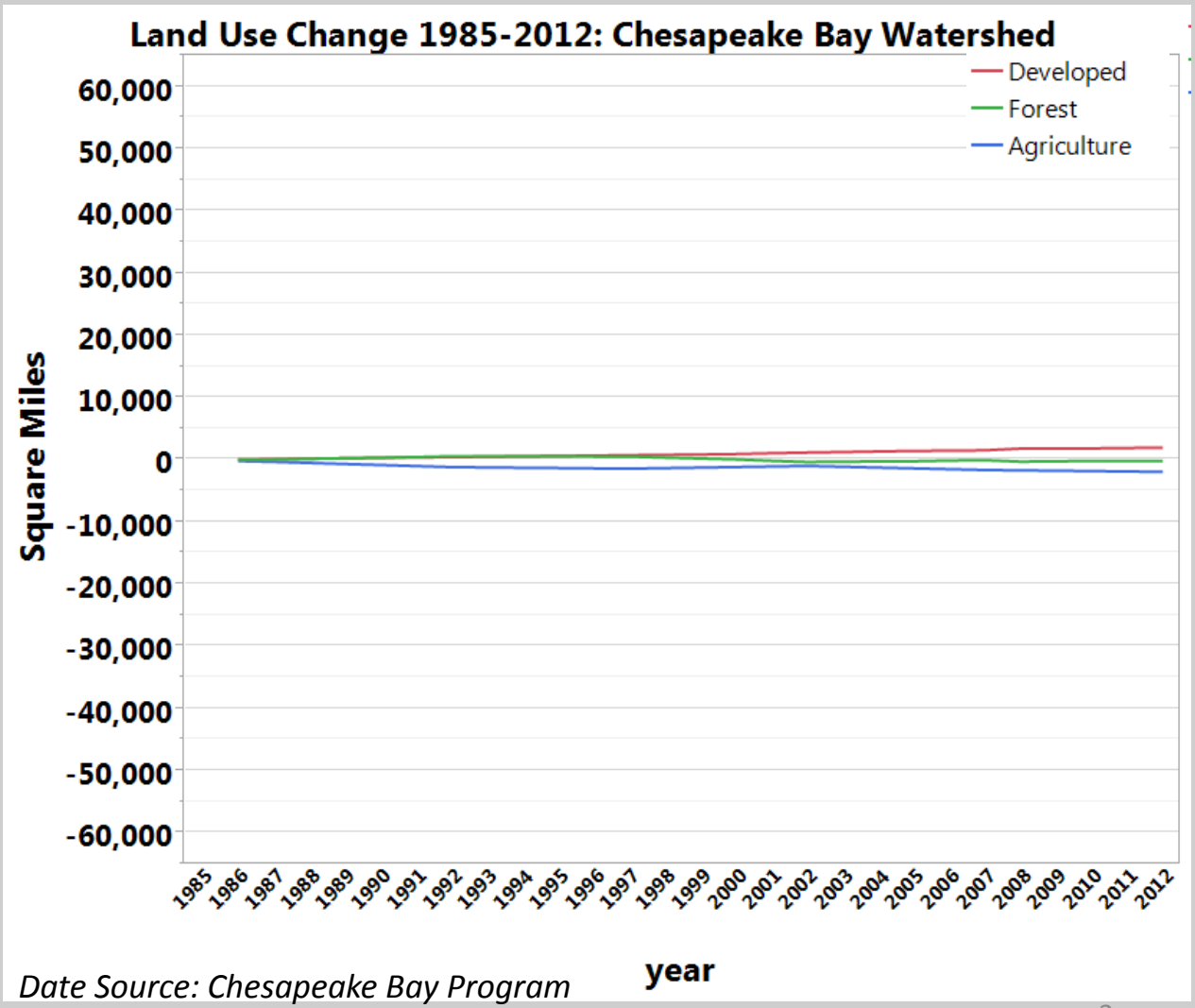
- How have nitrogen and phosphorus inputs and their sources changed over time in the Chesapeake Bay Watershed?
- What has driven observed changes?
- How are inputs and their sources distributed across the watershed?
- What is the expected effect of best management practices (BMPs) on nutrient inputs?

Chesapeake Bay Watershed Land Use/Land Use Change

The Chesapeake Bay Watershed covers about 64,000 square miles across 7 jurisdictions from New York to Virginia

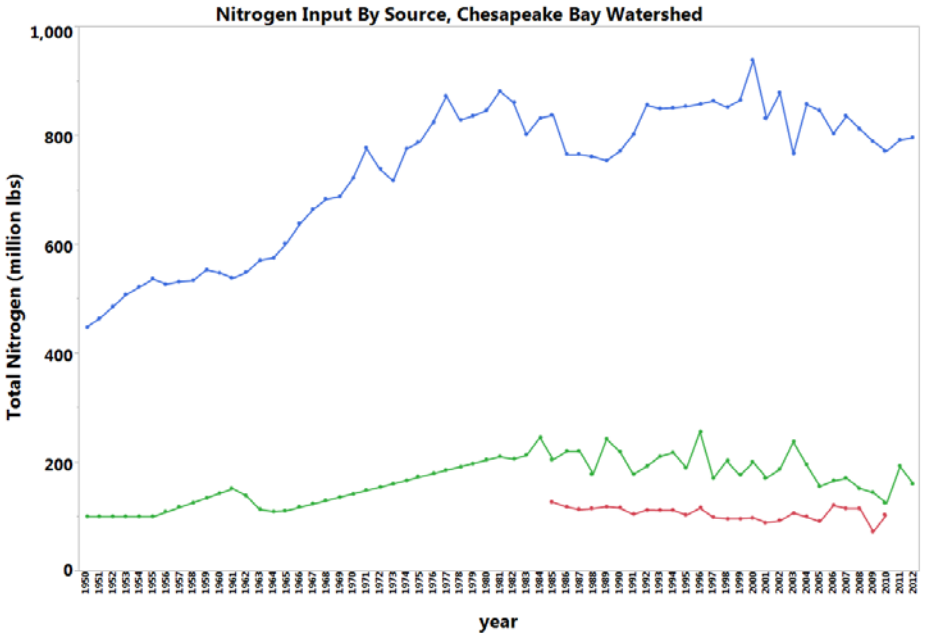


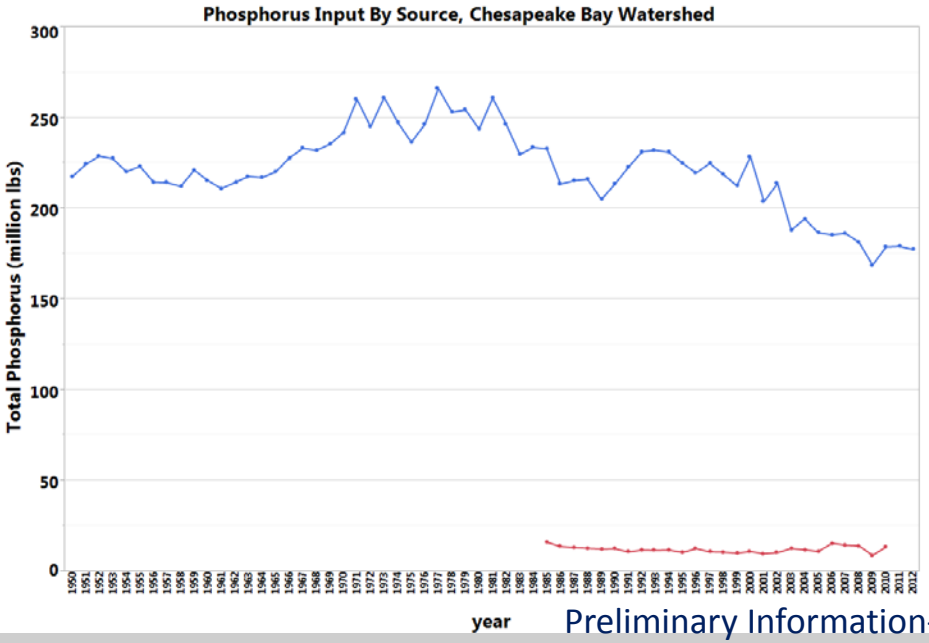
- About 2000 square miles (3%) of the watershed was developed from 1985-2012*.



Date Source: Chesapeake Bay Program

Nutrient Inputs To Watershed By Source



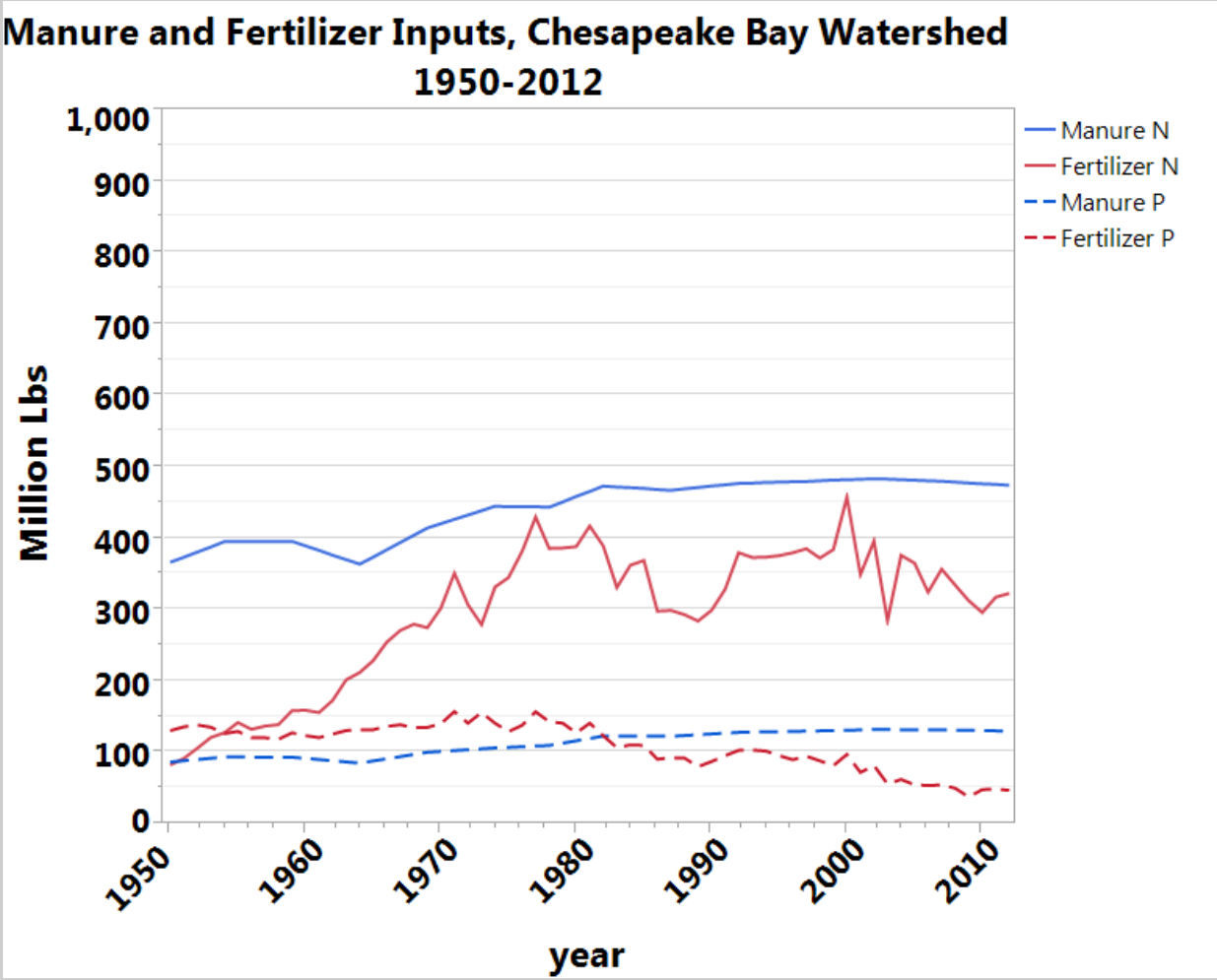


- **Fertilizer (both manure and commercial fertilizers) is the dominant source of N and P inputs watershed-wide**
- **The remainder of this presentation focuses on manure and inorganic fertilizer inputs from agriculture**

Watershed-Wide Manure and Inorganic Fertilizer Inputs

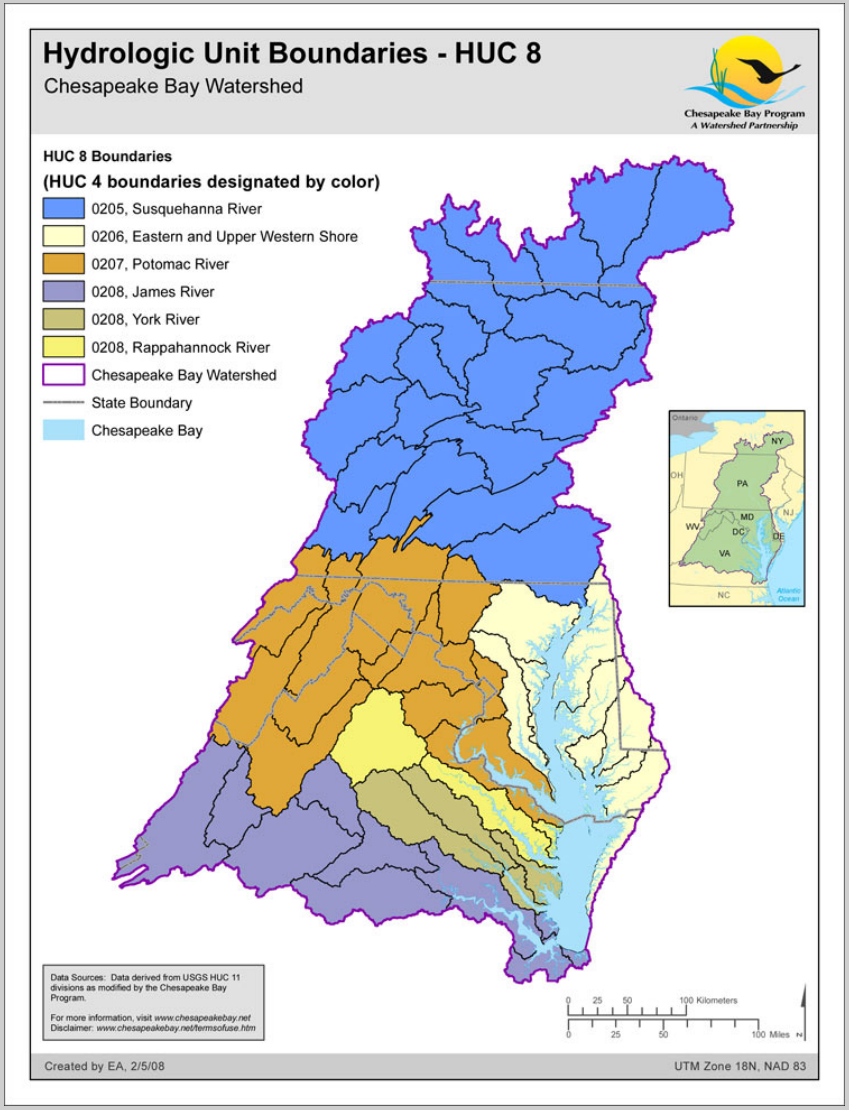
Patterns in N inputs and P inputs diverged over time

- Inputs from manure increased steadily over time
- Inputs from inorganic fertilizer increased sharply from 1950 to 1978 and fluctuated substantially thereafter



- Manure is driven directly by animal populations
- Fertilizer drivers are more complex and include crop type, crop acres, fertilizer costs, and manure availability

Relating Nutrient Inputs, Sources, and BMPs



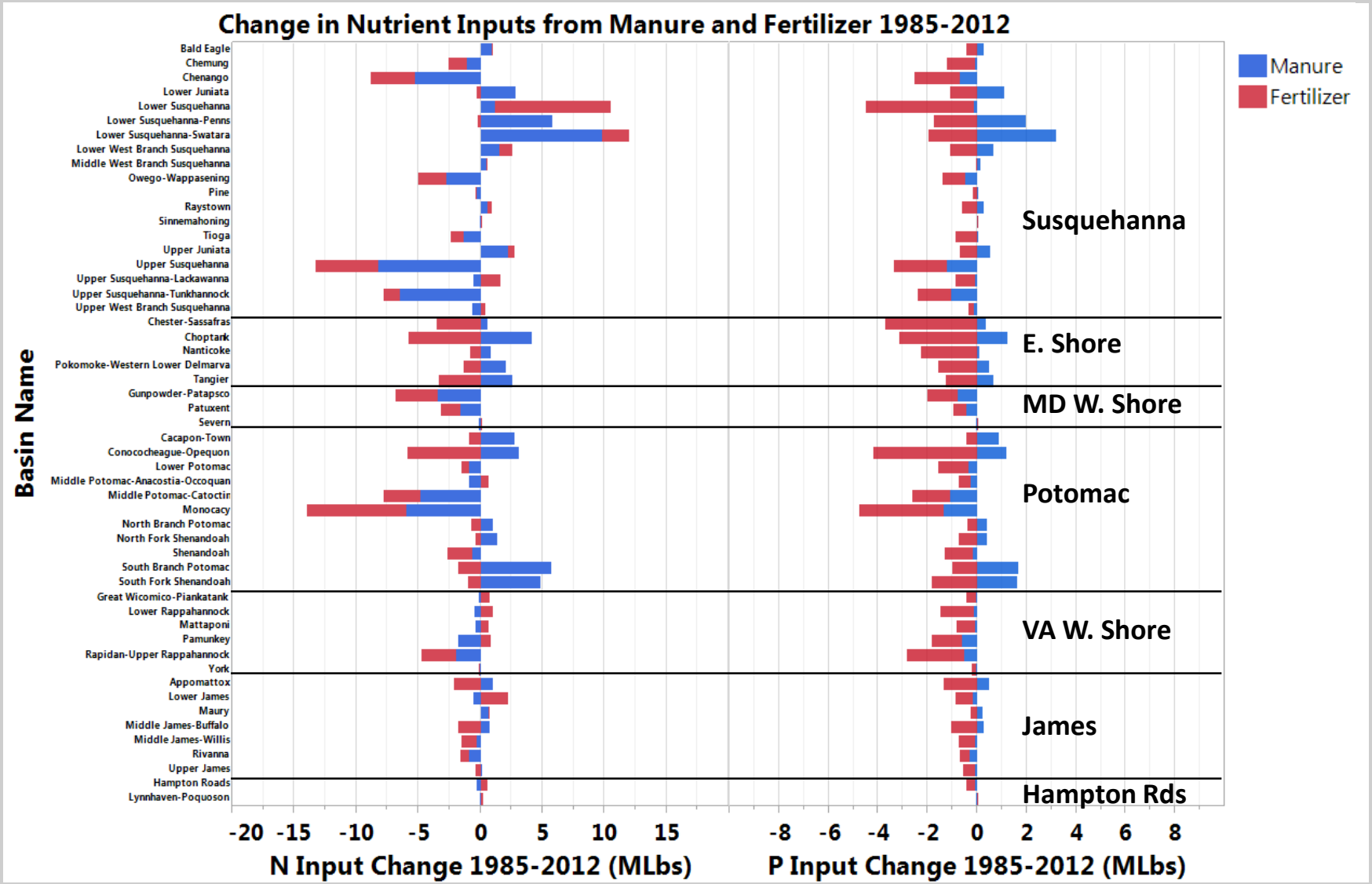
There are 53 8-digit HUC basins in the Chesapeake Bay Watershed

HUC 8 basins were grouped into 7 regions:

- Susquehanna
- Eastern Shore
- Maryland Western Shore
- Potomac
- Virginia Western Shore
- James
- Hampton Roads

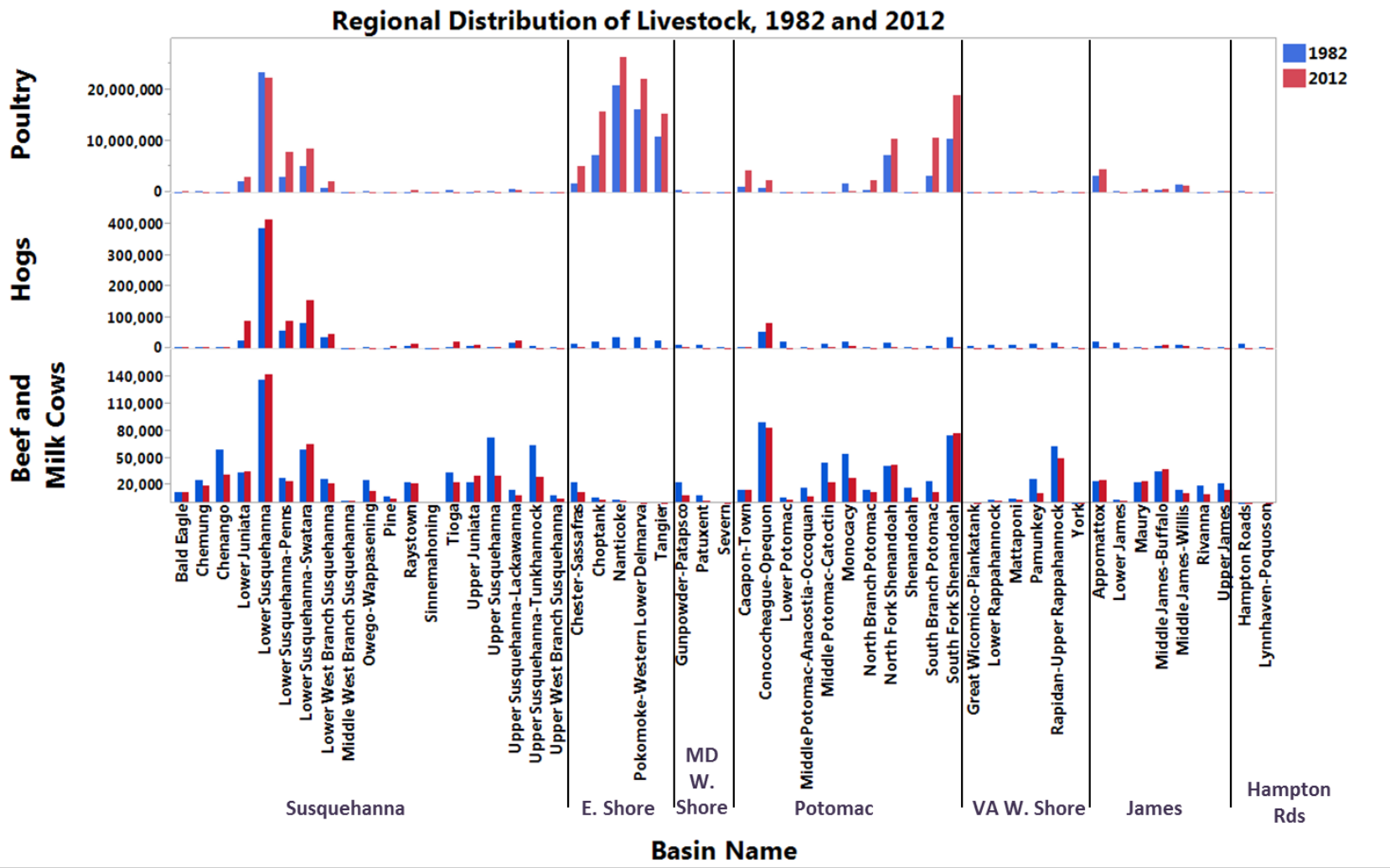
Nitrogen and phosphorus inputs varied within and across these regions

Regional Changes in Manure and Fertilizer Inputs



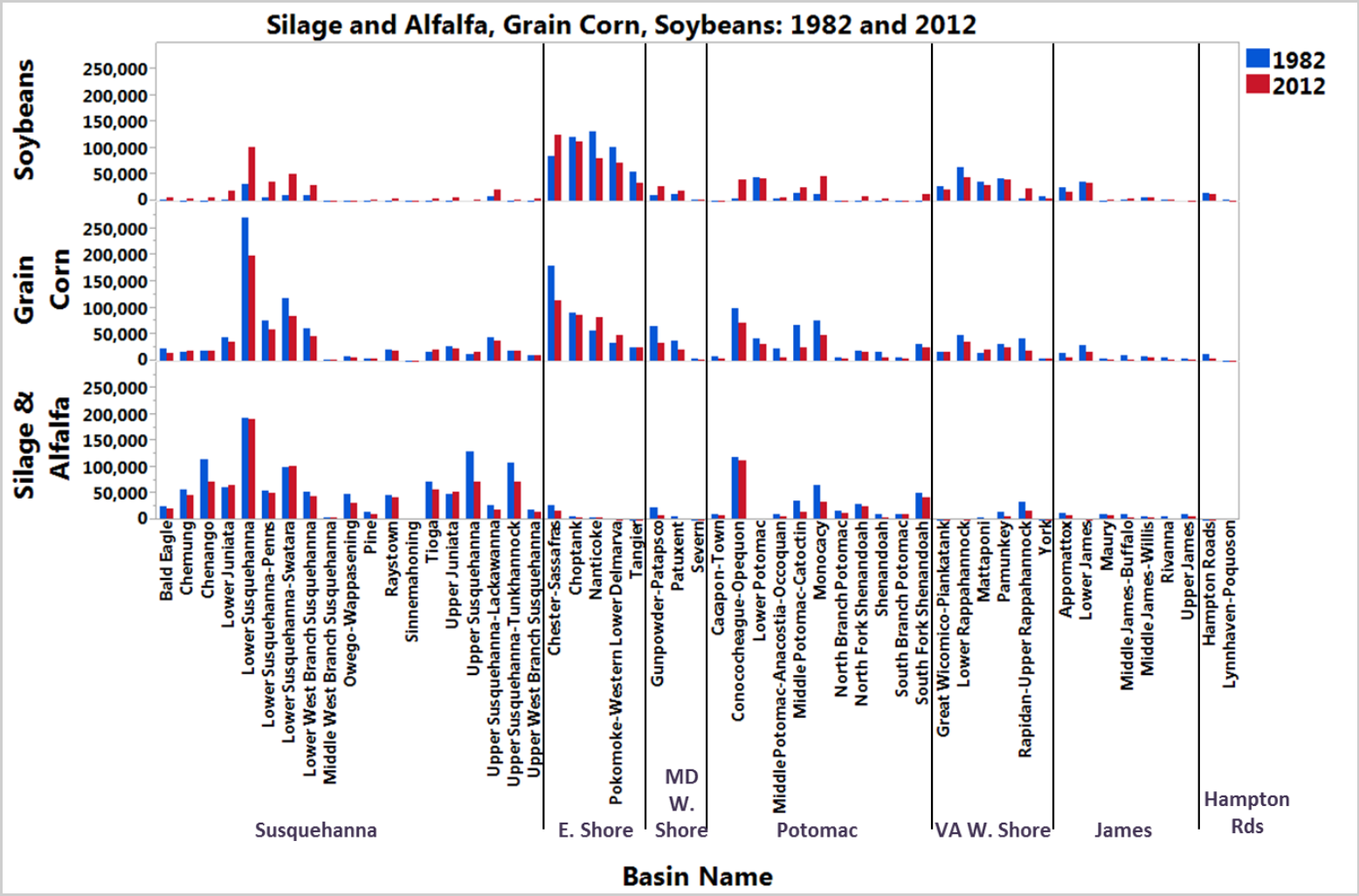
- **The majority of N increases were in manure, although fertilizer increased in some basins.**
- **Net change for P was generally negative; all P increases were in manure**

Regional Distribution of Livestock



- The Eastern Shore was dominated by poultry populations; additional hotspots in the Susquehanna and Potomac
- Hogs were concentrated in the Lower Susquehanna
- Cows were distributed across the watershed; there were local hotspots in the Lower Susquehanna and Potomac regions

Regional Distribution of Major Crops

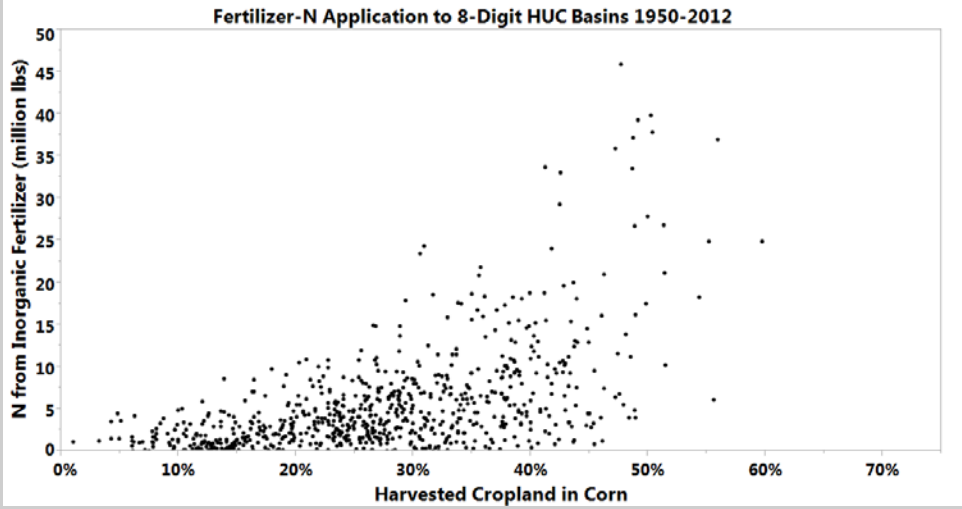


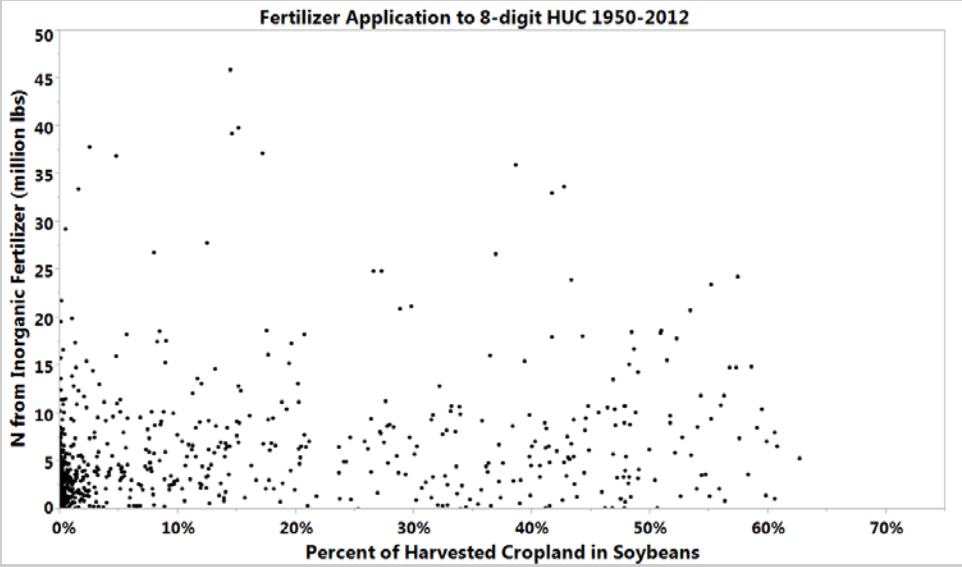
- Silage and alfalfa crops were concentrated in the Susquehanna region
- About 50% of soybean acres were concentrated on the Eastern Shore in 1982; Susquehanna and Potomac gained soybean acres in 2012
- The lower Susquehanna region and the Eastern Shore stand out for crops as well as for livestock

Nitrogen Application Need for Major Harvested Crops

year	pasture	harvest cropland	grain corn	silage co	other silag	wheat	oats	alfalfa	soybeans	other
1950	7,074,371	7,481,295	20%	4%	1%	15%	7%	4%	2%	47%
2012	2,616,123	5,992,220	24%	8%	8%	8%	1%	6%	20%	24%
Change	-4,458,248	-1,489,075	5%	4%	8%	-7%	-6%	2%	18%	-23%
Nitrogen Crop Need (Lbs/Acre)			114	100	85	63	49	3	5	--

- Corn and silage crops require more nitrogen than some of the crops that they replaced
- As the intensity of corn cultivation increases, application of commercial nitrogen fertilizer increases
- As expected, we do not see this with soybeans





Nutrient-Input BMPs

"Land Use Change" BMPs reduce inputs through conversion from a high- to a low-application use.

Some animal BMPs reduce inputs by reducing feeding rates and/or nutrient content of manure

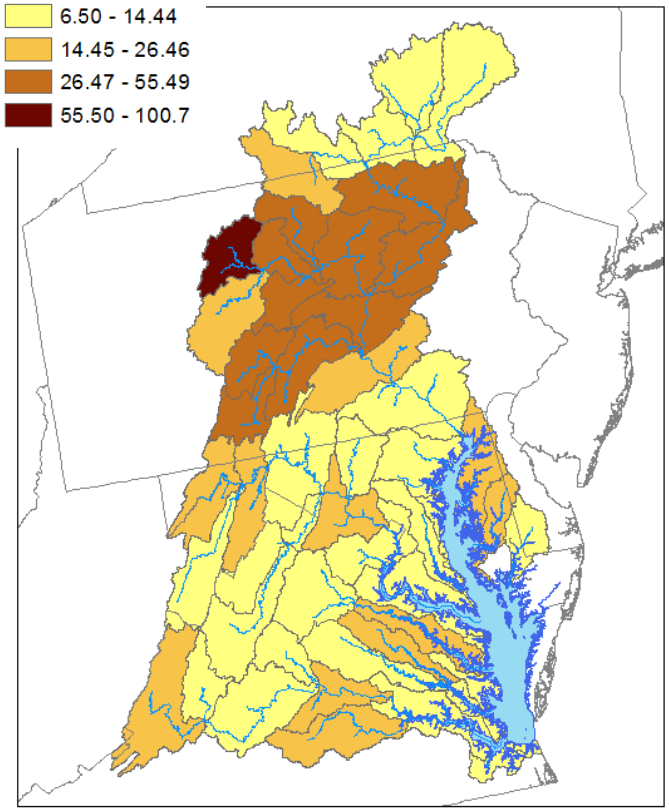
From Land Use	Land Use Change BMPs (Agriculture to Forest)	To Land Use
alfalfa	Forest Buffer, Tree Planting, Wetland Restoration	Forest
hightill without manure		
hightill with manure		
hay without nutrients		
hay with nutrients		
pasture		
degraded riparian pasture		

Animal BMPs	Nitrogen Reduction	Phosphorus Reduction	Applicable Animals
Dairy Precision Feeding/Forage Management	24%	25%	Dairy
Poultry Phytase	0%	Varies by jurisdiction and animal type	Poultry
Swine Phytase	0%	17%	Swine
Transport			All
Composters	100% of dead animals		All animal types

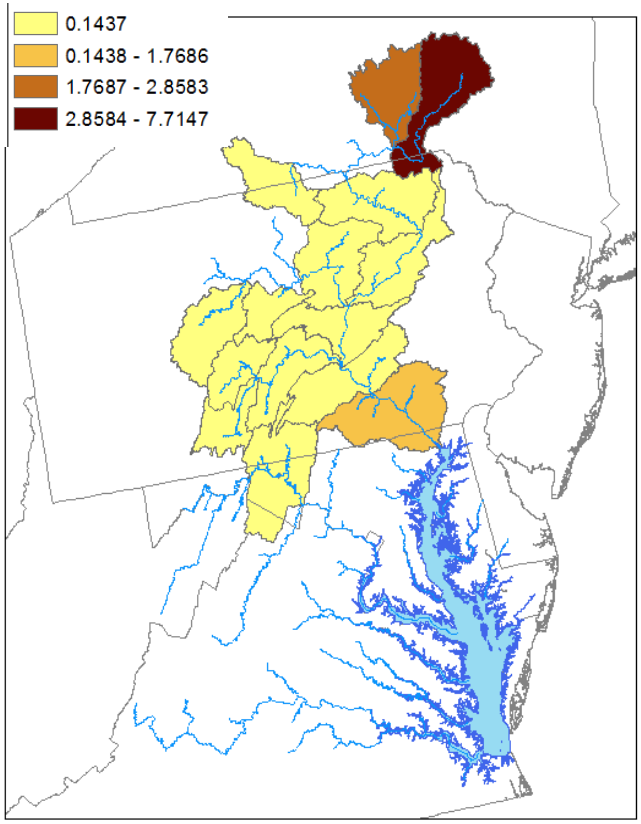
Regional Distribution of BMPs

BMP implementation on the ground as of 2012: percent of available acres

Land Use Change BMPs



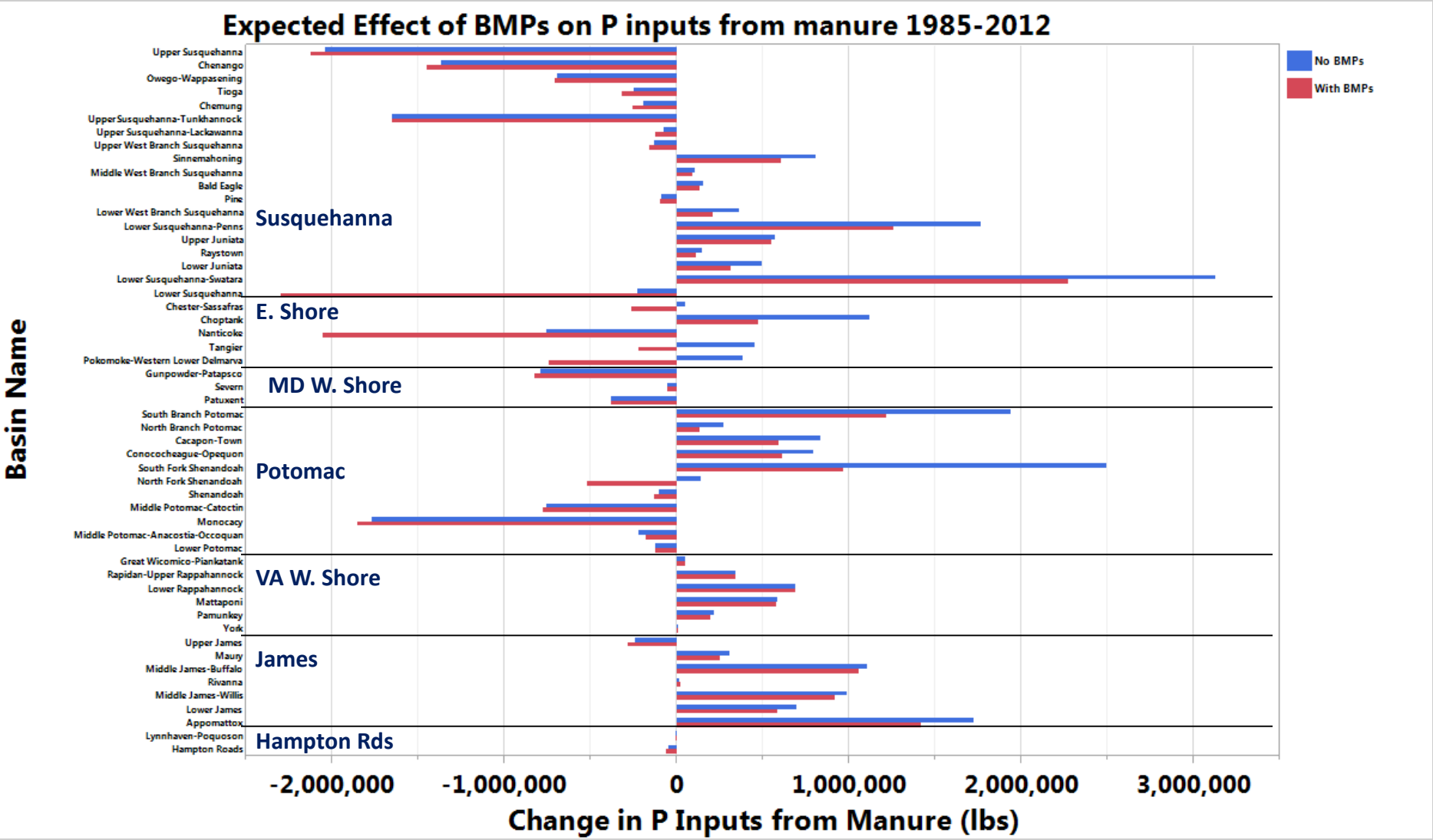
Dairy Precision Feeding



- Implementation of dairy precision feeding practices has been limited to the Conococheague basin (Potomac Region) and to basins in the Susquehanna region
- Implementation was limited to less than 2% in all but the 2 northern-most basins

- Implementation of Land Use Change BMPs has occurred across the watershed, but the highest rates are in the Susquehanna region

Expected Effect of BMPs on P Inputs from Manure



- **Much of this expected effect is due to poultry phytase implementation**
- **In some basins with heavy poultry production, phytase was expected to substantially reduce P inputs from manure**

Summary and Next Steps

- Nitrogen inputs have increased in 25 of the 53 HUC 8 basins since 1985. Increases were driven mostly by manure; the Lower Susquehanna saw large increases in fertilizer-N.

- Phosphorus inputs increased in 7 basins; all increases were driven by manure.

- Livestock populations were unevenly distributed. Poultry populations were concentrated on the Eastern Shore, in the lower Susquehanna, the North and South Fork Shenandoah basins, and the South Branch Potomac. Hog populations were almost exclusive to the lower Suquehanna basins.

- The distribution of major crops varied regionally. Most of the watershed's soybeans were grown on the Eastern Shore; most of its silage and alfalfa were grown in the Susquehanna.
- The type of crop grown influences fertilizer inputs; corn cultivation appears to correlate with nitrogen fertilizer application.

- Reported implementation of land use change BMPs is prevalent throughout the watershed. Dairy precision feeding is less popular and limited to the Susquehanna region.

- Modeling scenarios can be used to estimate the expected effect of these BMPs on nutrient inputs.

Next Steps:

- Can multivariate analyses quantify spatial relationships between livestock populations, crops grown, nutrient inputs, and BMP implementation?

- Are changes in nutrient inputs related to changes in fluxes from the watershed?

Thank you!

The rest of the USGS Explaining Trends Team: Joel Blomquist, Scott Ator, Doug Moyer, Ken Hyer, Jimmy Webber, Judy Denver, Brandon Fleming, John Brakebill, Scott Phillips

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