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

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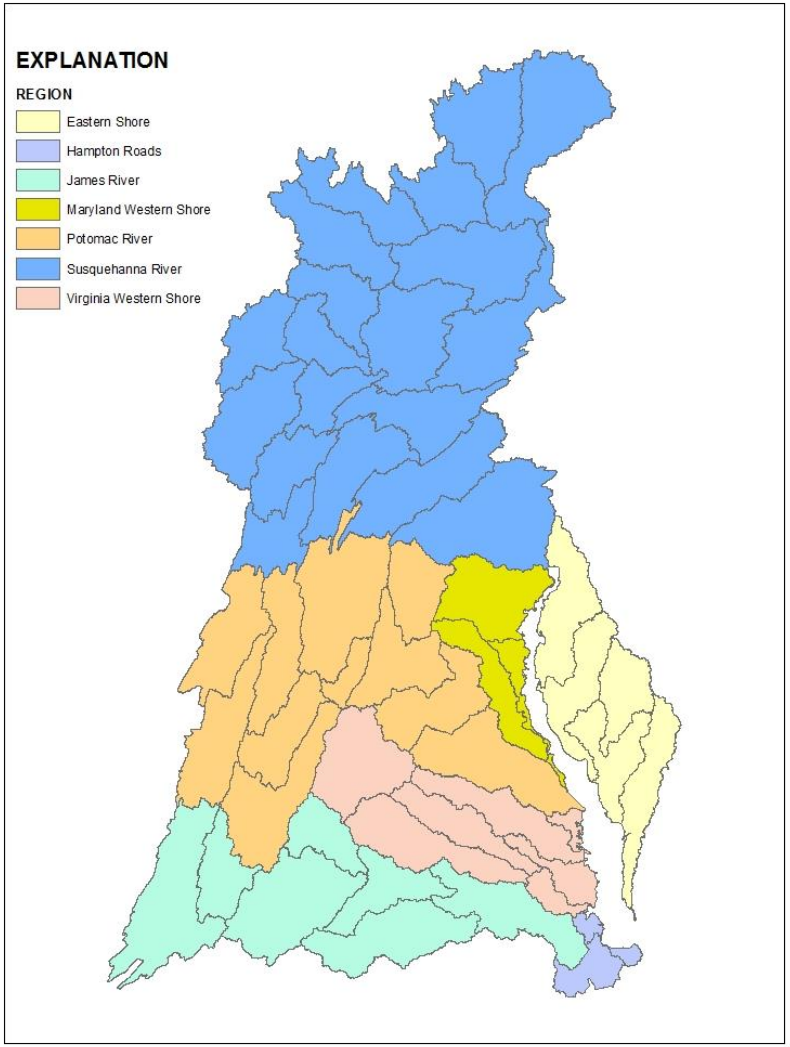
Questions

- 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?

Relating Nutrient Inputs, Sources, and BMPs



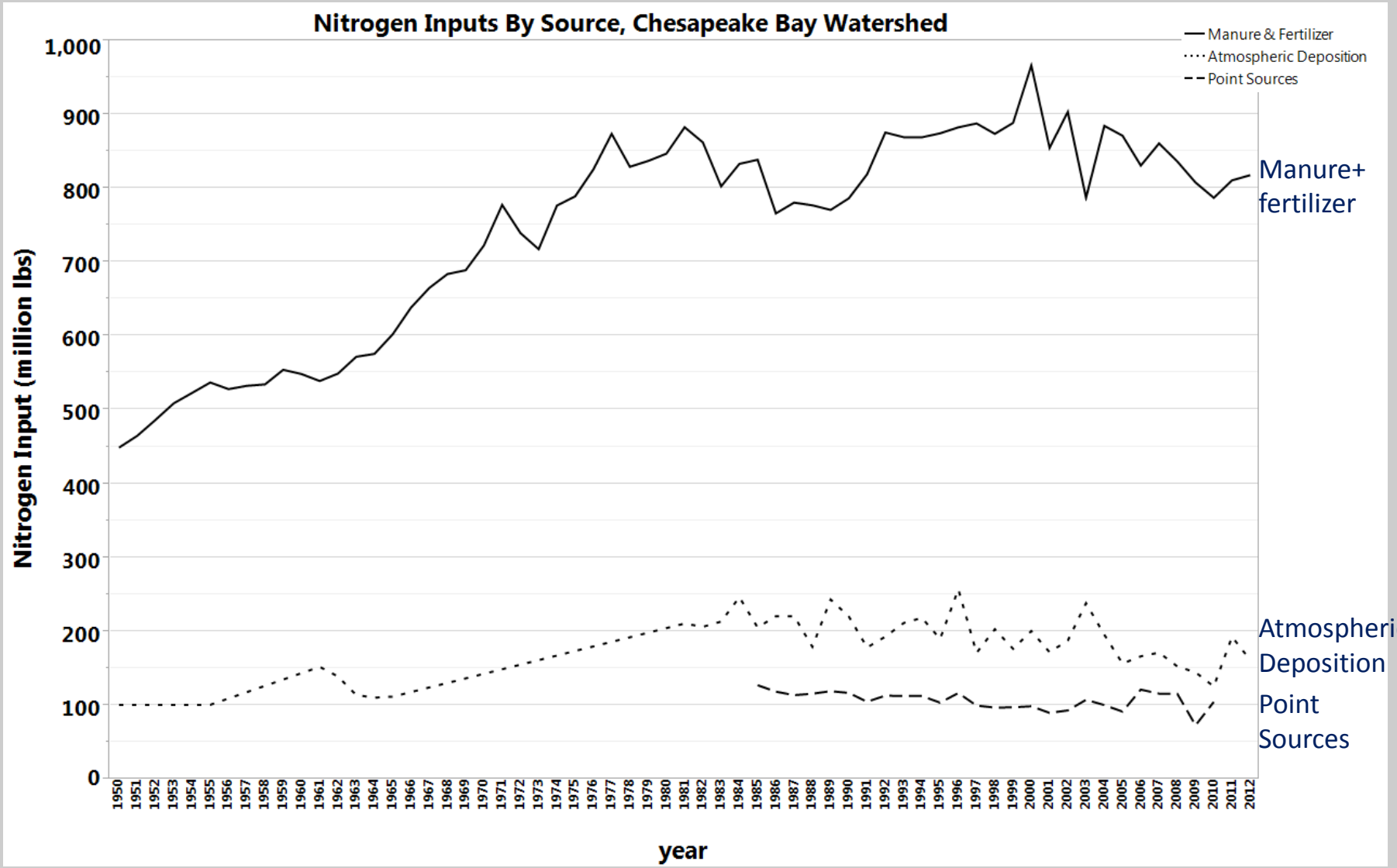
Study Units:

- **53 8-Digit HUCs**
- **7 regions**

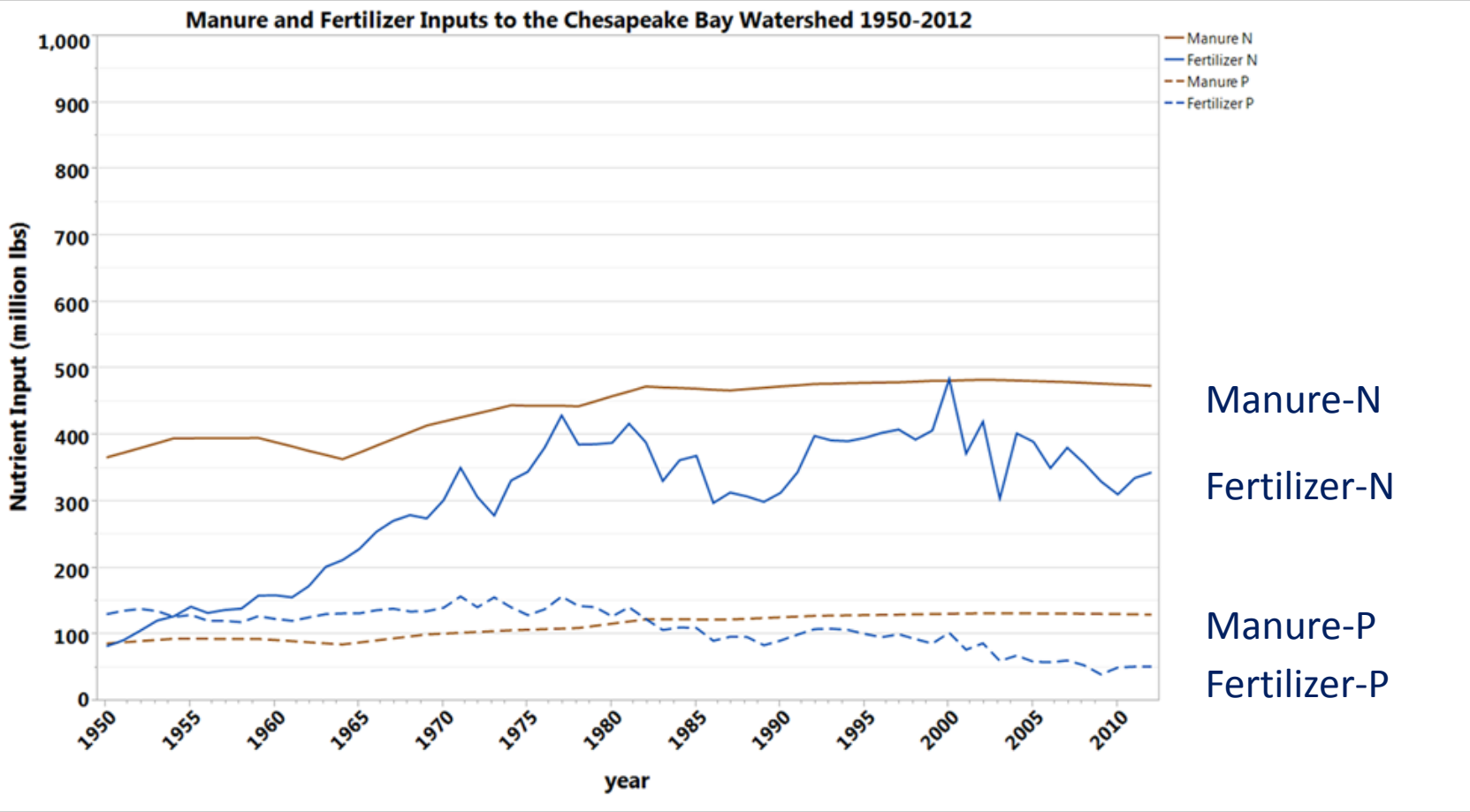
Region	Nr of HUCs	acres	square miles	Percent of Total
Susquehanna	19	17,591,020	27,486	43%
E. Shore	5	2,667,233	4,168	6%
MD W. Shore	3	1,585,094	2,477	4%
Potomac	11	9,070,399	14,173	22%
VA W. Shore	6	3,621,594	5,659	9%
James	7	6,169,892	9,640	15%
Hampton Roads	2	369,345	577	1%
Total	**53**	**41,074,577**	**64,180**	**100%**

Nutrient Sources and Inputs Watershed-Wide

Agricultural sources (i.e. manure and fertilizer) dominate nutrient inputs.



Agricultural Nutrient Sources and Inputs Watershed-Wide



- **Temporal changes driven largely by changing patterns in commercial fertilizer use: fluctuated annually by as much as 92 million lbs for N and 19 million lbs for P**

- **Fertilizer inputs more variable than manure: more complex matrix of drivers, including crop type and acreage, fertilizer prices, and manure availability**

Agricultural Nutrient Inputs By Region

Changes over time in manure and fertilizer inputs to 7 regions

Region	Nitrogen (mlbs)			N Input Change		Phosphorus (mlbs)			P Input Change	
	1950	1982	2012	1950-1982	1982-2012	1950	1982	2012	1950-1982	1982-2012
Susquehanna	201	350	321	74%	-8%	91	100	70	10%	-30%
E. Shore	34	135	144	296%	7%	24	38	31	60%	-19%
MD W. Shore	19	27	22	42%	-20%	8	7	6	-7%	-23%
Potomac	116	212	199	82%	-6%	54	60	48	12%	-20%
VA W. Shore	36	68	62	88%	-9%	21	20	11	-5%	-43%
James	41	66	63	61%	-4%	19	20	15	6%	-26%
Hampton Roads	2	4	7	113%	82%	1	1	1	-19%	-6%
Total	**449**	**863**	**818**	**92%**	**-5%**	**218**	**247**	**182**	**13%**	**-26%**

1950-1982:

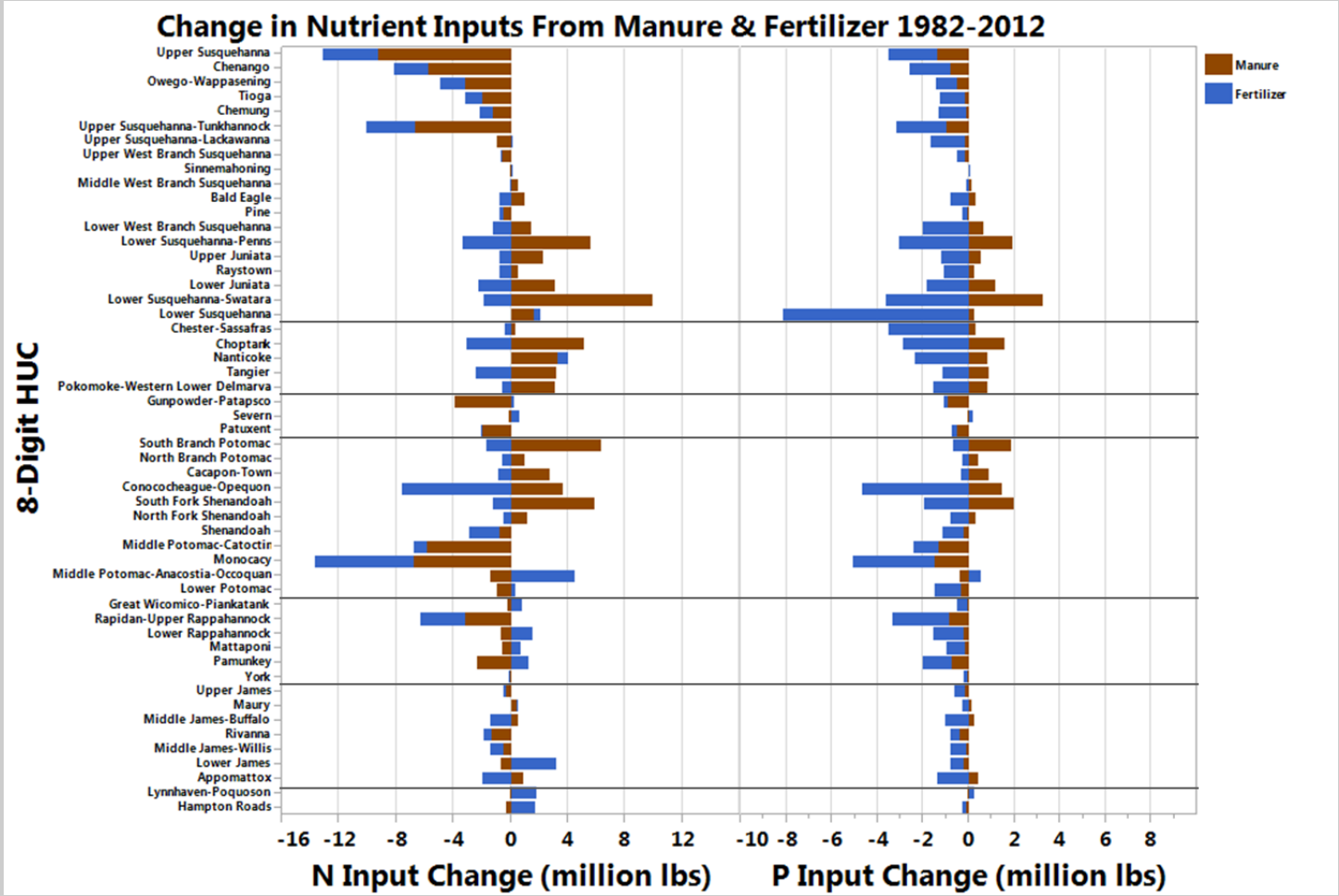
- **N inputs increased substantially everywhere**
  - ***Percent* increase most dramatic on Eastern Shore**
- **P inputs increased in 4 HUCs and decreased elsewhere**
  - **Eastern Shore again a stand-out**

1982-2012

- **P inputs decreased everywhere**
- **N inputs increased in Eastern Shore and Hampton Roads* regions; decreased elsewhere**

Change in Agricultural Nutrient Inputs By HUC

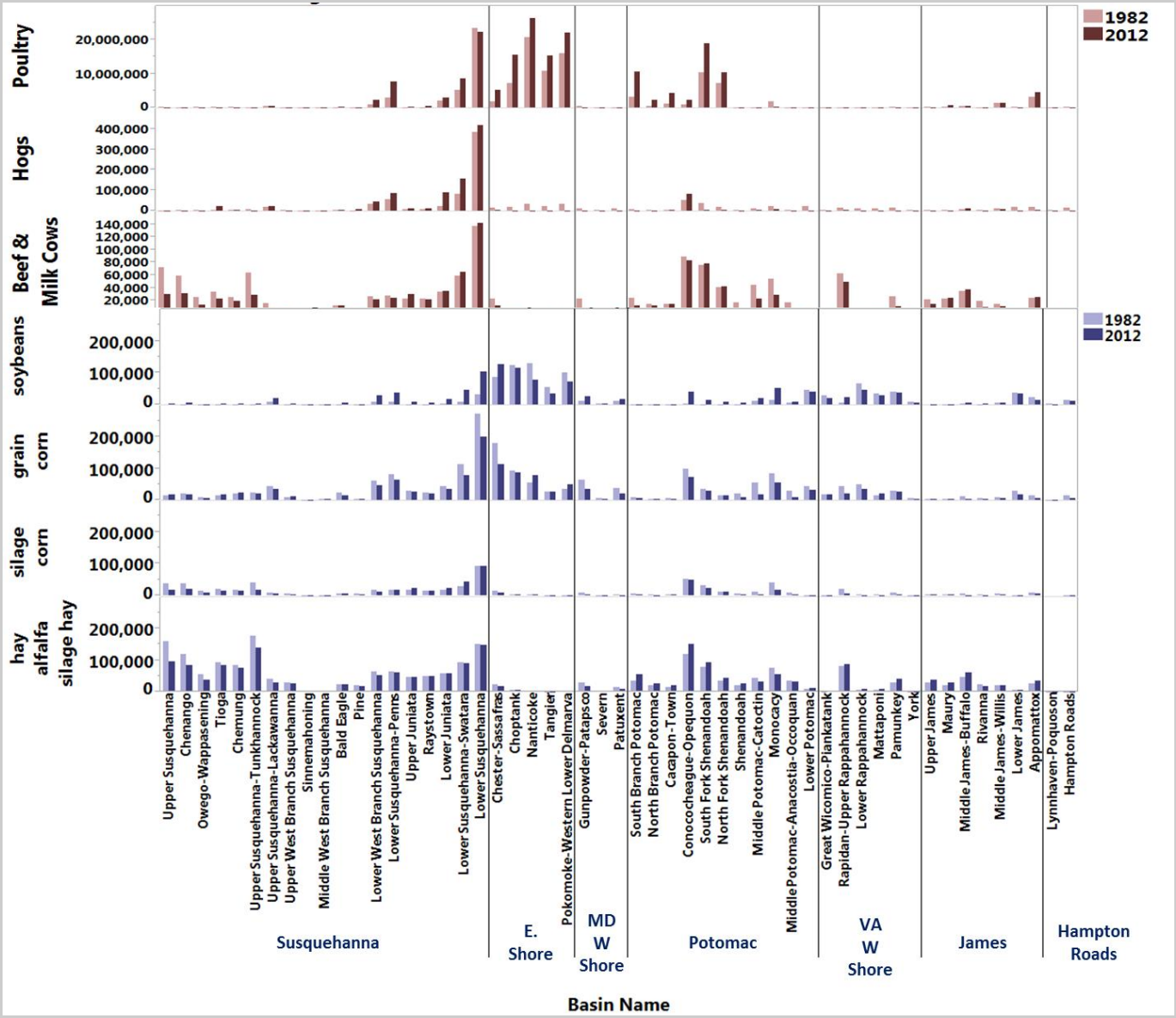
- Reductions mostly from fertilizer;
- Increases mostly manure
- Manure-N inputs increased in 23 HUCs
- Manure-P inputs increased in 24 HUCs



- **Geographic re-distribution, especially in Susquehanna and Potomac regions**
  - Manure-N inputs to upper portion of Susquehanna region declined by about 30 mlbs
  - Manure-N inputs to lower portion of region increased by about 26 million lbs

Regional Distribution of Major Crops & Animals

- Poultry, soybeans, and grain corn concentrated on E. Shore
- Forage and silage crops co-located with cow populations
- Hogs concentrated in lower part of Susquehanna Region
- Lower Susquehanna HUC has everything



Change in Major Crop Proportions

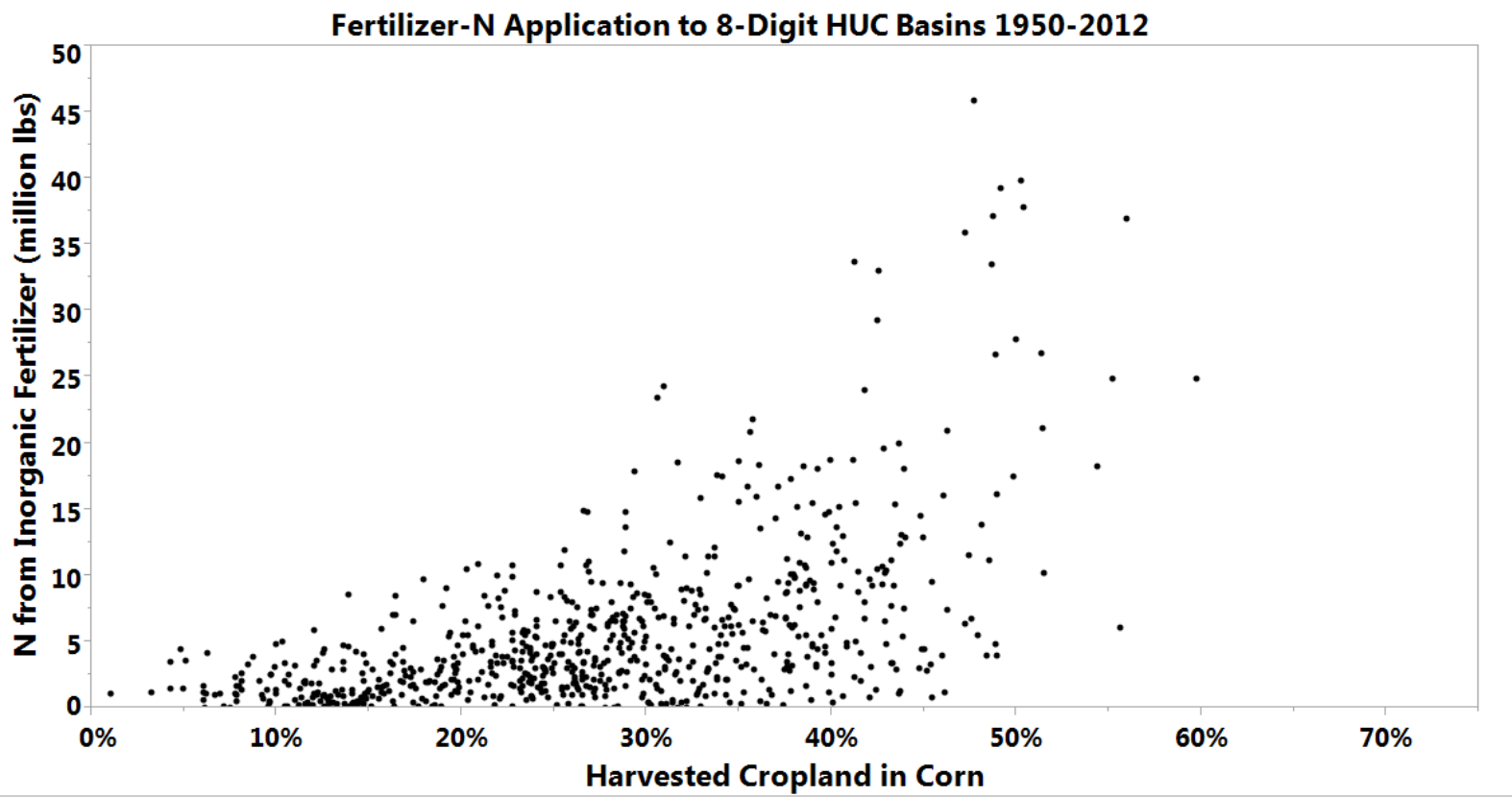
Annual percent of harvested cropland in most common cultivated crops of the Chesapeake Bay watershed, 1950-2012.

year	harvested cropland	alfalfa	grain corn	silage corn	silage hay	oats	soybeans	wheat	hay	other
1950	7,482,192	4%	20%	4%	1%	7%	2%	15%	32%	15%
1954	7,391,219	8%	20%	5%	2%	9%	4%	11%	28%	14%
1959	6,853,237	11%	20%	5%	2%	8%	6%	9%	27%	11%
1964	6,456,300	13%	18%	8%	2%	6%	7%	9%	26%	11%
1969	5,558,307	9%	22%	9%	2%	4%	8%	7%	20%	20%
1974	6,027,832	9%	25%	10%	4%	4%	11%	8%	17%	11%
1978	6,448,196	12%	28%	7%	5%	3%	12%	5%	18%	10%
1982	6,693,000	11%	29%	10%	5%	3%	14%	7%	17%	4%
1987	6,061,504	14%	24%	11%	6%	3%	14%	7%	18%	4%
1992	5,942,293	14%	24%	9%	5%	2%	18%	8%	17%	2%
1997	6,259,273	10%	22%	10%	6%	1%	19%	8%	22%	2%
2002	6,087,411	10%	20%	11%	8%	1%	18%	7%	23%	2%
2007	5,855,584	7%	25%	9%	8%	1%	17%	7%	22%	2%
2012	5,992,953	6%	24%	8%	8%	1%	20%	8%	21%	4%

- Proportion of harvested cropland in wheat, oats, and “other crops” declined
- Proportion in soybeans increased most dramatically (from 2% to 20%)
- Proportion in silage also increased (from 5% to 16%)

Relating Ag practices to fert and manure inputs

- 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



Reported BMP Implementation

"Land Use Change" BMPs reduce inputs through conversion from a high- to a low- or no-application use.

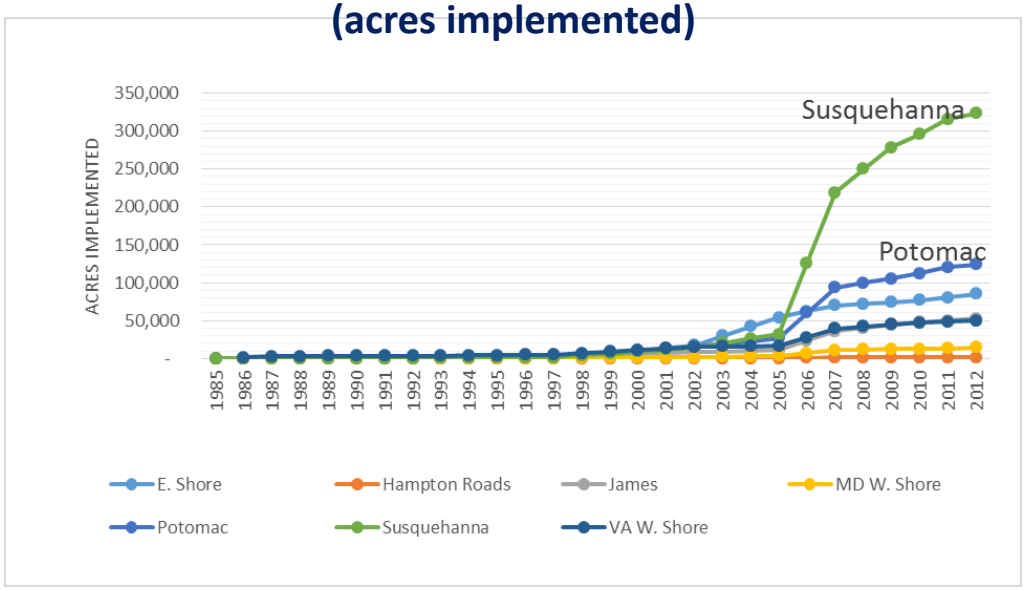
From Land Use	Land Use Change BMPs (Agriculture to Forest)	To Land Use
alfalfa	Forest Buffer, Tree Planting, Wetland Restoration	Forest
hightill without manure		
hightill with manure		
hay without nutrients		
hay with nutrients		
pasture		
degraded riparian pasture		

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

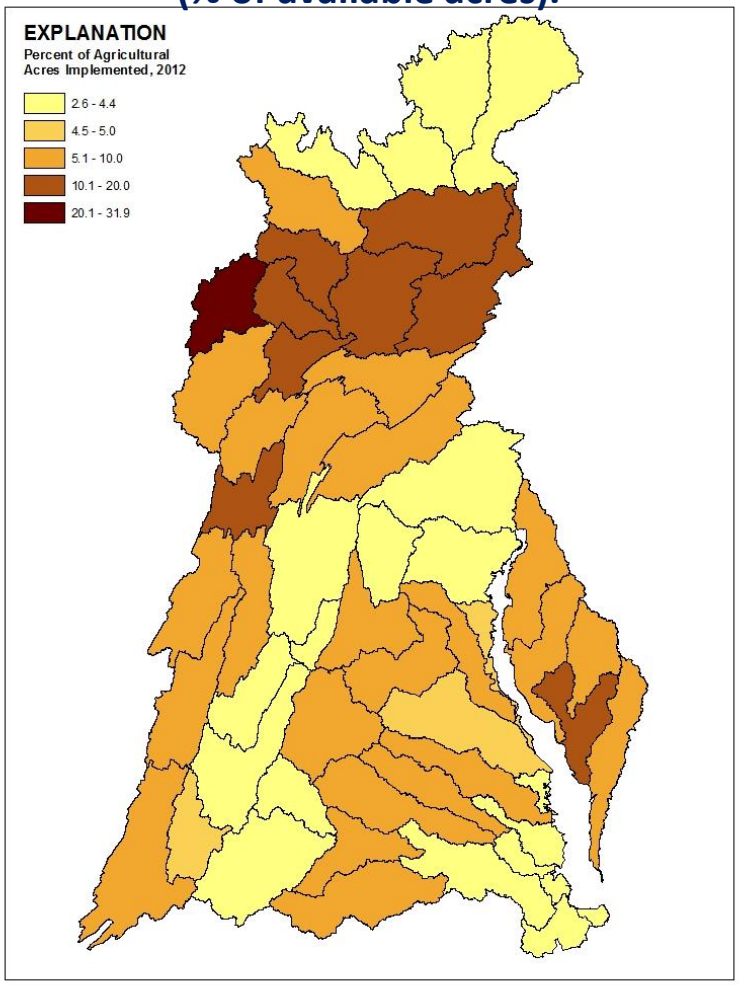
Animal BMPs	Nitrogen Reduction	Phosphorus Reduction	Applicable Animals
Dairy Precision Feeding/Forage Management	24%	25%	Dairy
Poultry Phytase	0%	Varies by jurisdiction and animal type	Poultry
Swine Phytase	0%	17%	Swine
Transport			All
Composters	100% of dead animals		All animal types

Reported BMP Implementation

LU Change BMP implementation 1985-2012 (acres implemented)



implementation of agricultural land use change BMPs as of 2012 (% of available acres).

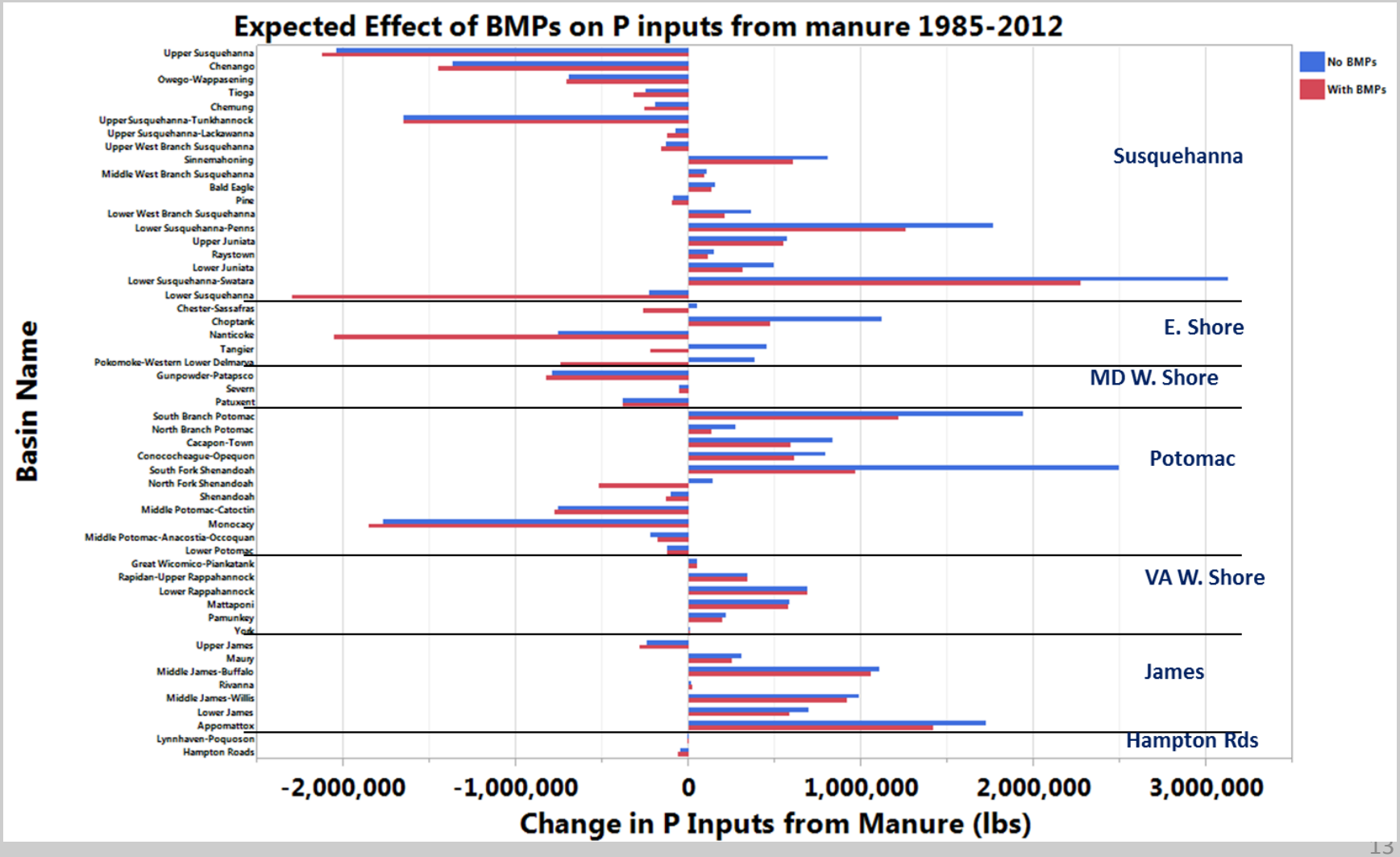


- **Large increase in reported implementation from early 2000s on**
- **In 2012, Agricultural LU Change BMPs on the ground ranged from about 2.6% to about 32% of available acres**

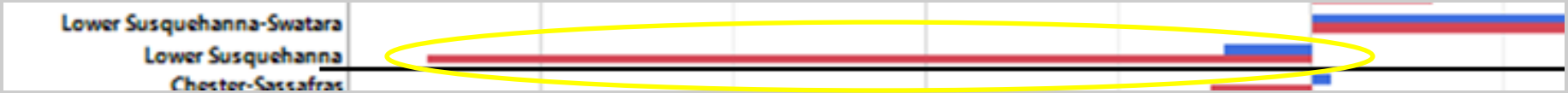
Expected Effect of BMPs on Nutrient Inputs

CBP ran 2 sets of scenarios with Phase 5.3.2 Watershed Model for each year 1985-2012

- "No Action" – assumed no BMPs on the ground in given year
- "Progress" – assumed all reported BMPs on ground in given year



Expected Effect of BMPs on P inputs from Manure



Lower Susquehanna:

- No BMPs scenario = decrease of about 300,000 lbs
- With BMPs scenario = decrease of about 2,500,000 lbs
- Expected effect of BMPs = additional decrease of about 2.2 milion lbs

North Fork Shenandoah

- No BMPs scenario = increased about 100,000 lbs
- With BMPs scenario = decreased about 500,000 lbs
- Expected effect of BMPs = decrease of about 600,000 lbs

Pokomoke-Lower Delmarva

- No BMPs scenario = increased about 400,000 lbs
- With BMPs scenario = decreased about 750,000 lbs
- Expected effect of BMPs = decrease of about 1.15 million lbs

Thank You

Questions/Feedback?