Evaluating changes in water quality with respect to non-point sources and best management practices

poster presented at the 2014 American Geophysical Union Meeting
San Francisco, CA

March 23, 2015

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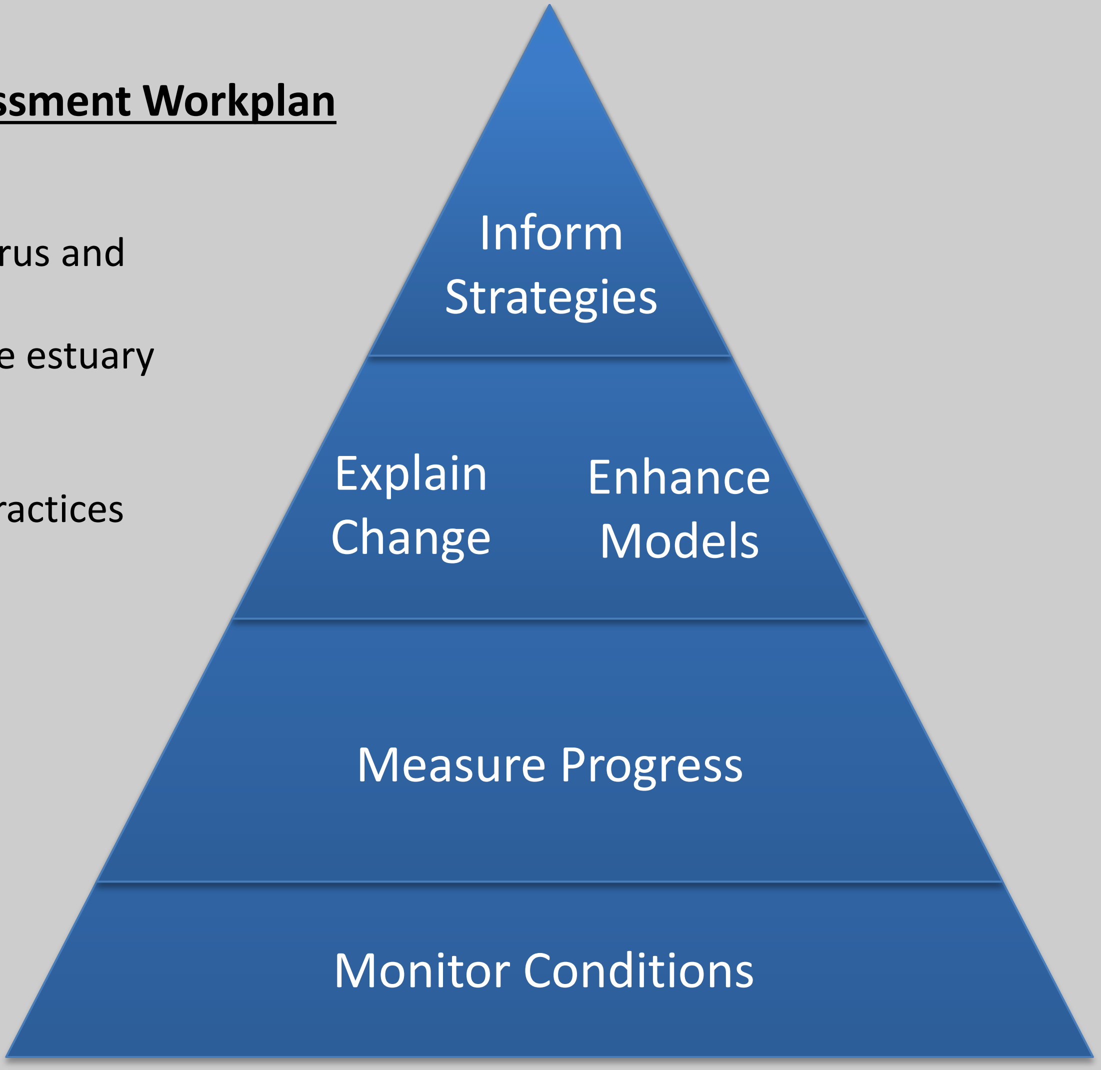
Using Monitoring Data To Measure Progress and Explain Change

STAR Workplan Elements

Elements of STAR Mid-Point Assessment Workplan

1. Measure progress
   - Trends of nitrogen, phosphorus and sediment in the watershed.
   - Trends of water quality in the estuary
2. Explain water-quality changes
   - Response to management practices
3. Enhance CBP models
4. Inform management strategies
   - WIPs
   - Water-quality benefits



comparative analysis generates hypotheses

Compare patterns in loads across watersheds

- What do similar watersheds have in common?
- Which one of these is not like the others?

Where we see interesting patterns:

- What can the models tell us about inputs and fluxes in these watersheds?
- What can data on nutrient sources and inputs tell us?
- How does this information compare with estimates of the effects of BMP implementation?

Integration of several complex datasets is required. Four components discussed here:

1. Environmental setting/watershed characteristics
2. Water quality monitoring (nutrient fluxes)
3. Models
4. Nutrient sources/inputs and BMP implementation

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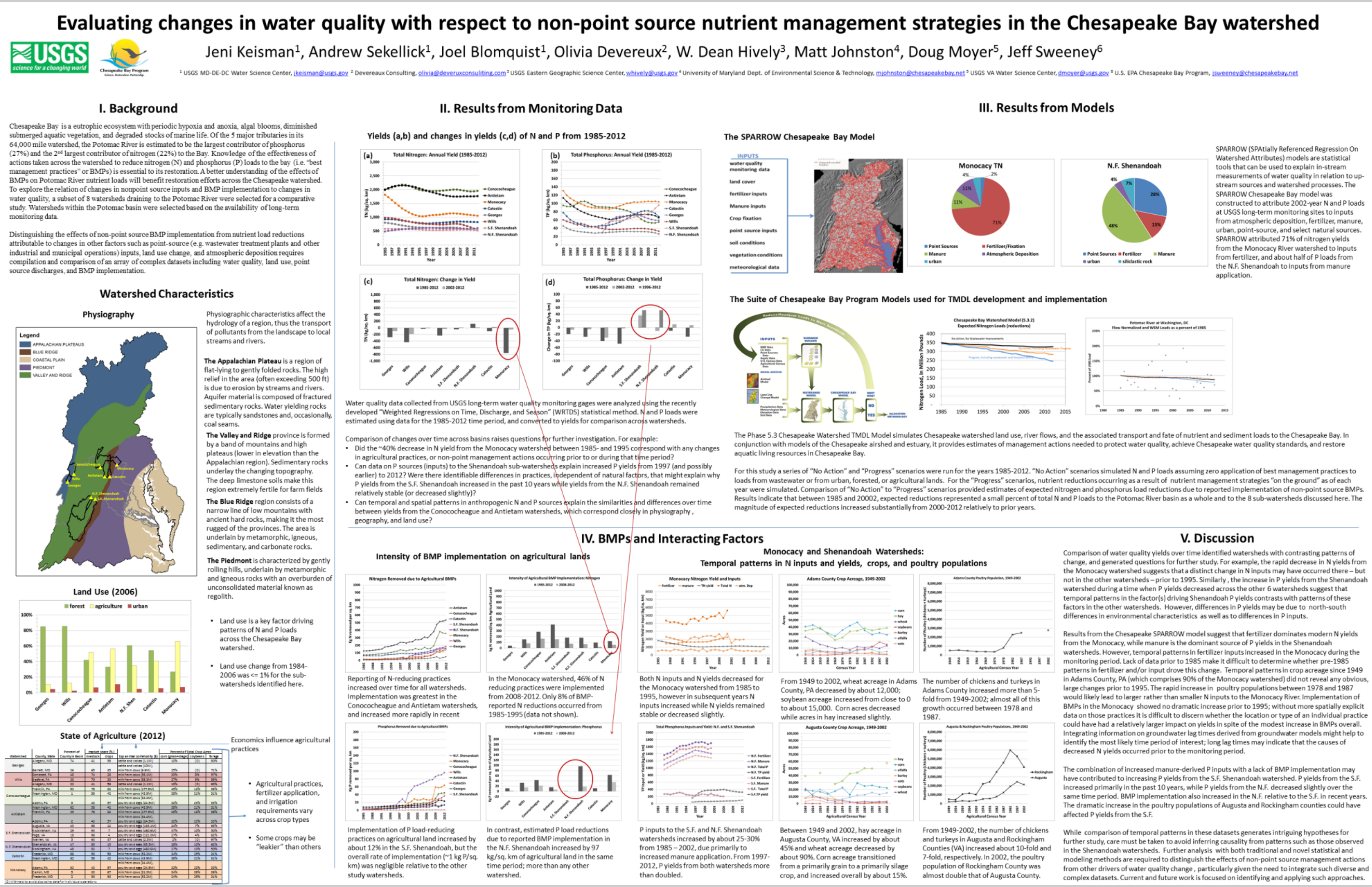
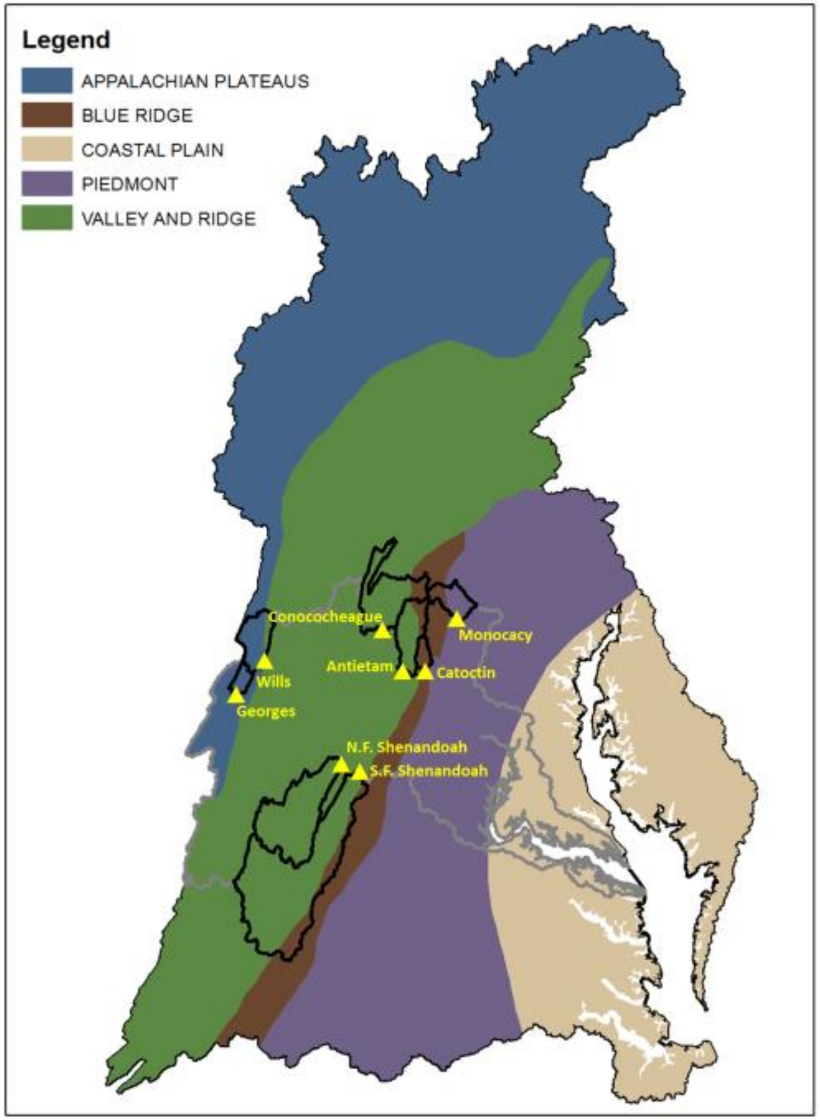
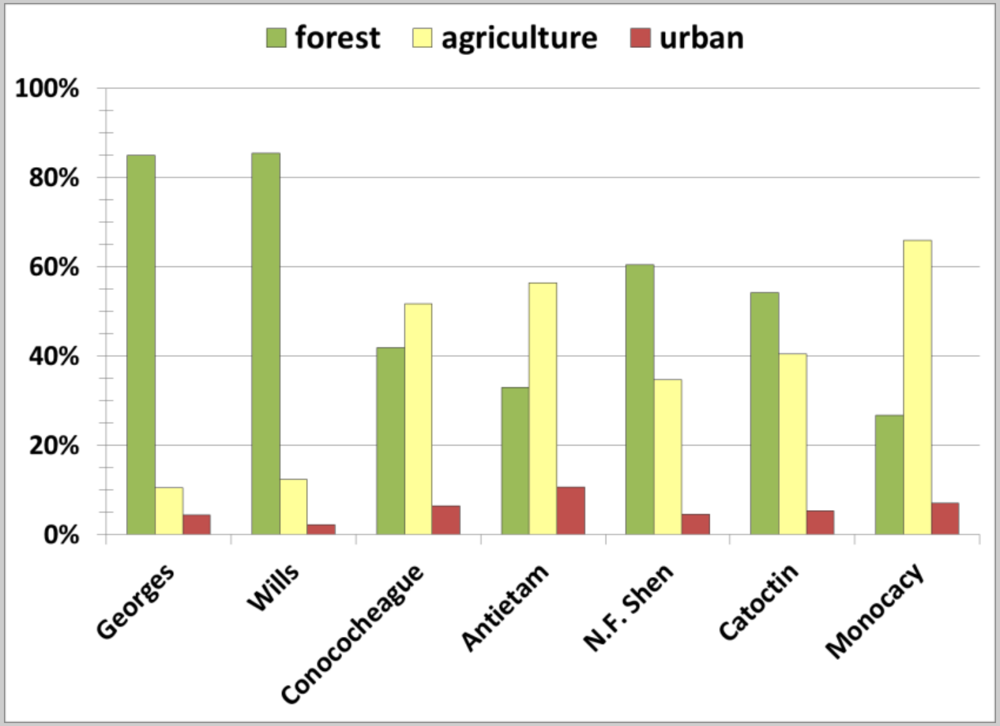


1. Watershed characteristics





- Land use is a key factor driving patterns of N and P loads across the Chesapeake Bay watershed.
- Land use change from 1984-2006 was <= 1% for the sub-watersheds identified here.

1. Watershed characteristics

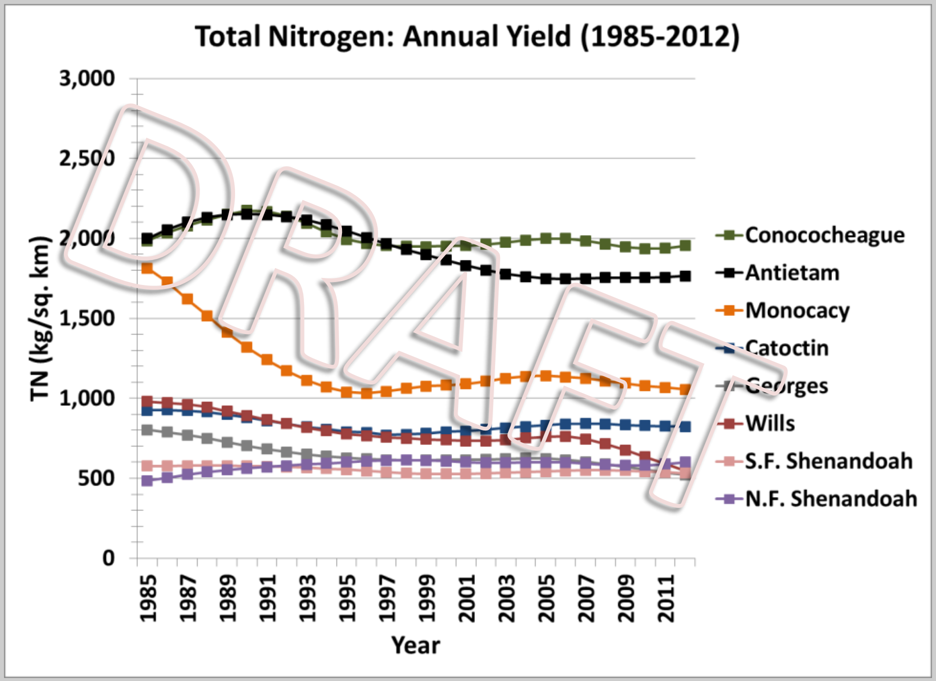
- Economics influence agricultural practices
- Agricultural practices, fertilizer application, and irrigation requirements vary across crop types

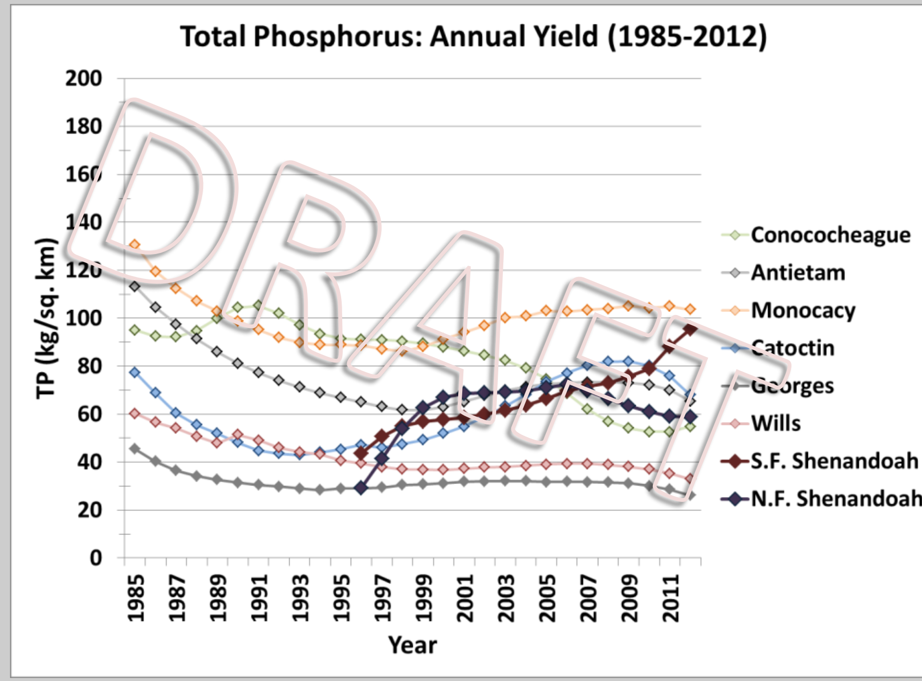
Watershed	County, State	Percent of County in Basin	market share (%)		top animal commodity ($)	Percent of Total Crop Acres		
			livestock	crops		corn (grain+silage)	soybeans	forage
Georges	Allegany, MD	74	41	59	cattle and calves (1.1M)	10%	(D)	90%
	Garrett, MD	26	65	35	cattle and calves (10M), milk from cows (9.9M)	25%	(D)	71%
Wills	Somerset, PA	48	74	26	milk from cows (58.1M)	30%	8%	57%
	Bedford, PA	30	70	30	milk from cows (55.3M)	37%	5%	55%
	Allegany, MD	22	41	59	cattle and calves (1.1M)	10%	(D)	90%
Conococheague	Franklin, PA	93	78	22	milk from cows (177.9M)	45%	12%	38%
	Washington, MD	1	58	42	milk from cows (43.9M)	38%	21%	31%
	Adams, PA	5	43	57	milk from cows (34.4M), poultry and eggs (24.5M)	32%	23%	33%
Antietam	Washington, MD	62	58	42	milk from cows (43.9M)	38%	21%	31%
	Franklin, PA	35	78	22	milk from cows (177.9M)	45%	12%	38%
	Adams, PA	2	43	57	milk from cows (34.4M), poultry and eggs (24.5M)	32%	23%	33%
S.F. Shenandoah	Augusta, VA	45	88	12	poultry and eggs (133.1M)	24%	7%	65%
	Rockingham, VA	29	93	7	poultry and eggs (460.6M)	37%	10%	50%
	Page, VA	18	96	4	poultry and eggs (121.0M)	27%	4%	62%
	Warren, VA	5	63	37	cattle and calves (2.5M)	2%	(D)	97%
N.F. Shenandoah	Shenandoah, VA	47	85	15	poultry and eggs (85.5M)	28%	10%	62%
	Rockingham, VA	49	93	7	poultry and eggs (460.6M)	37%	10%	50%
Catoctin	Frederick, MD	98	50	50	milk from cows (53.2M)	34%	25%	31%
	Washington, MD	62	58	42	milk from cows (43.9M)	38%	21%	31%
Monocacy	Adams, PA	93	43	57	milk from cows (34.4M), poultry and eggs (24.5M)	32%	23%	33%
	Carroll, MD	5	33	67	milk from cows (21.2M)	34%	29%	26%
	Frederick, MD	2	50	50	milk from cows (53.2M)	34%	25%	31%

(D) Withheld to avoid disclosing data for individual operations

2. Water quality monitoring

Comparison of changes over time across basins raises questions for further investigation.





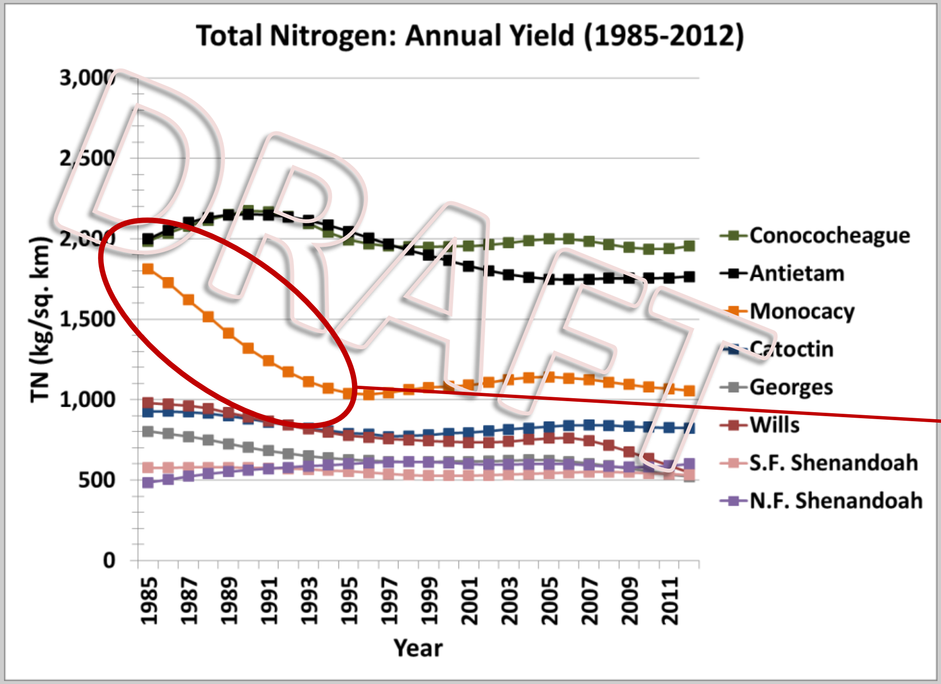
DRAFT

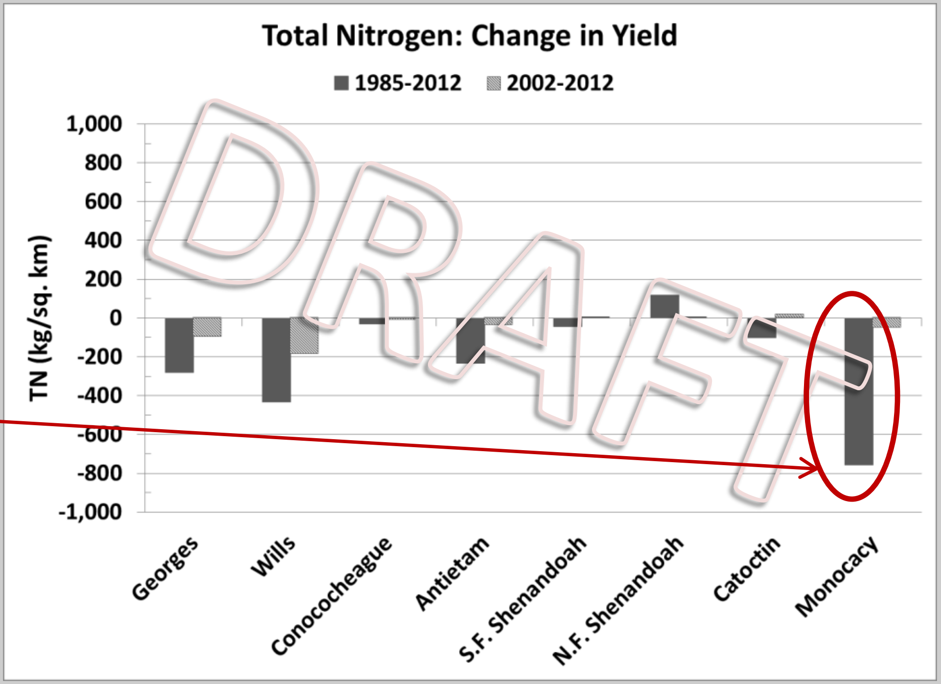
Can temporal and spatial patterns in anthropogenic N inputs explain the decrease in N yield from the Monocacy watershed from 1985-1995?

Can temporal and spatial patterns in anthropogenic N inputs explain the differences in P yields from the N.F. and S.F. Shenandoah watersheds from 1996 – 2012?

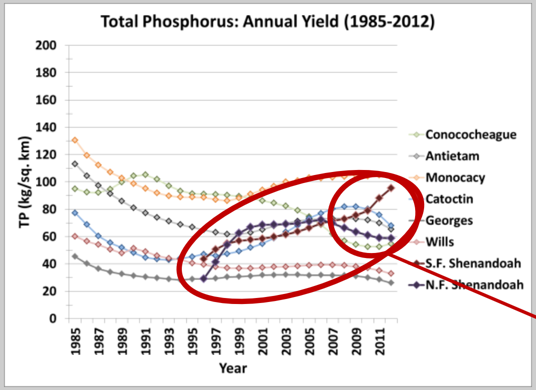
2. Water quality monitoring

Did the ~40% decrease in N yield from the Monocacy watershed between 1985- and 1995 correspond with any changes in agricultural practices or non-point management actions occurring prior to or during that time period?

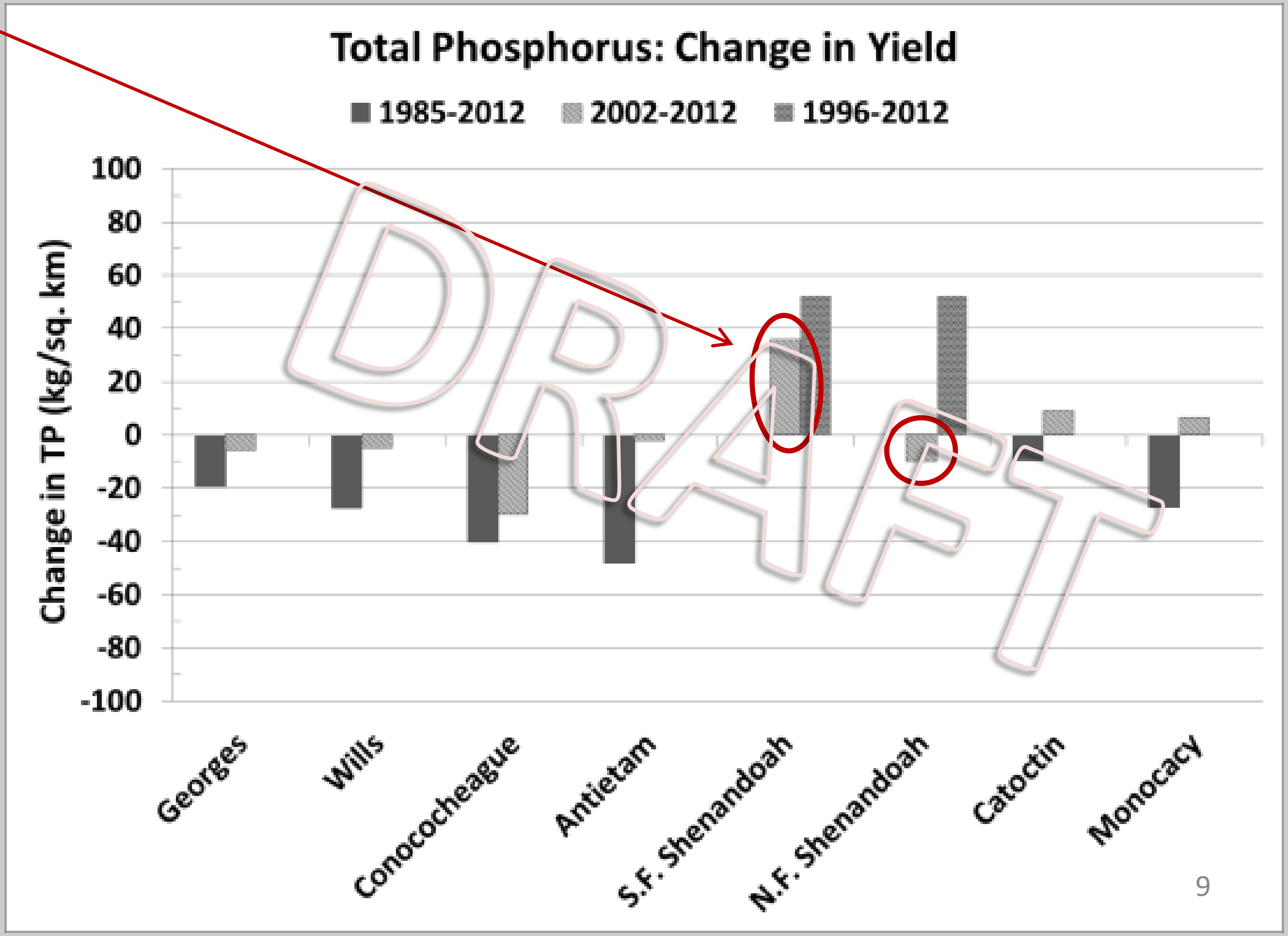




2. Water quality monitoring



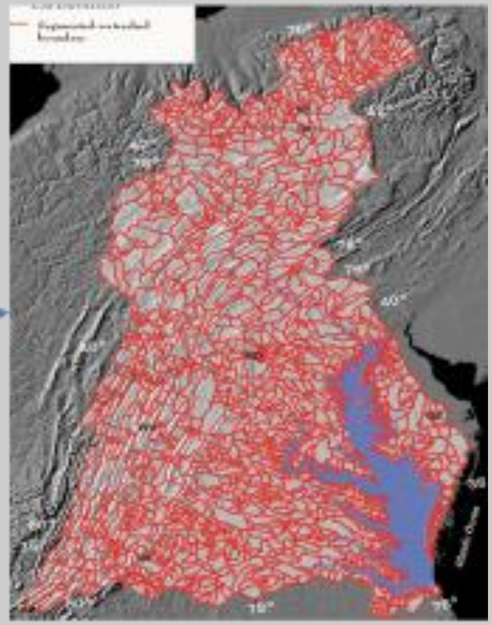
Were there identifiable differences in practices, independent of natural factors, that might explain why P yields from the S.F. Shenandoah increased in the past 10 years while yields from the N.F. Shenandoah remained relatively stable (or decreased slightly)?

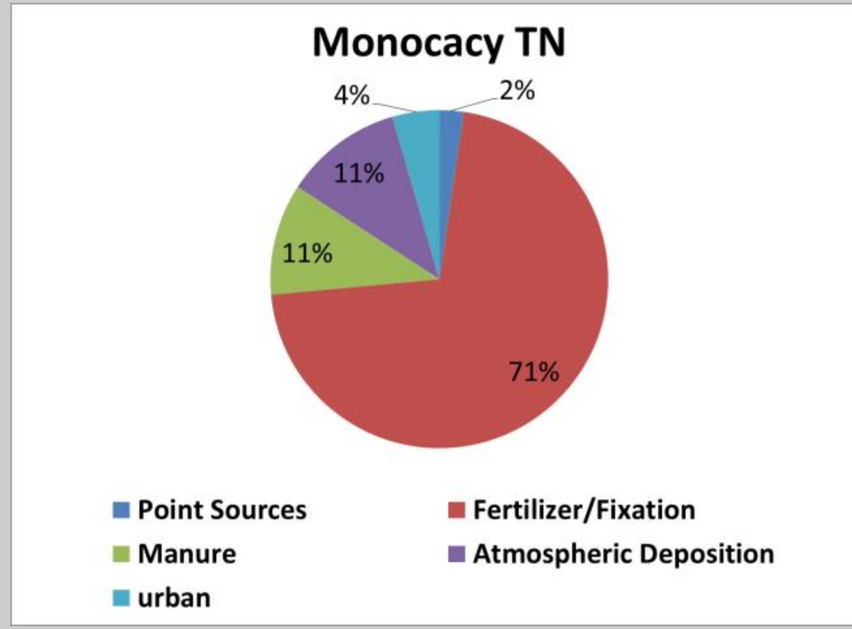


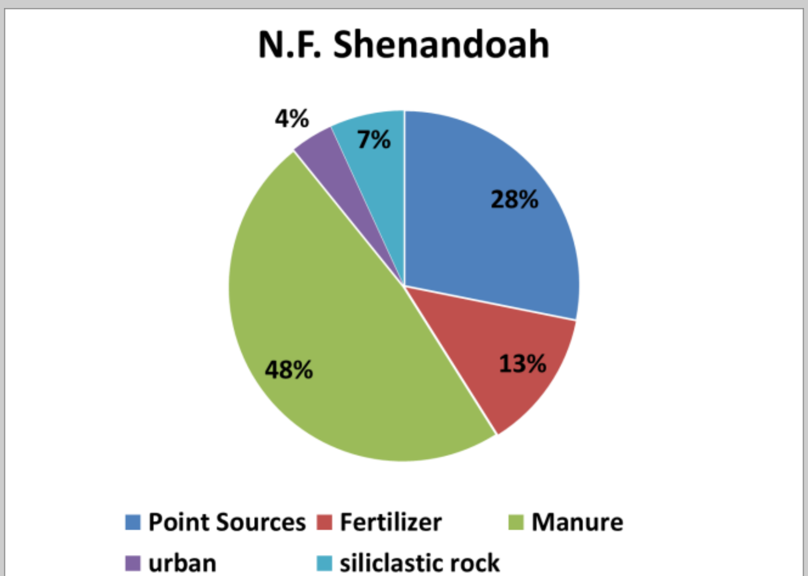
3. Models: 2002 SPARROW

INPUTS

- water quality monitoring data
- land cover
- fertilizer inputs
- Manure inputs
- Crop fixation
- point source inputs
- soil conditions
- vegetation conditions
- meteorological data



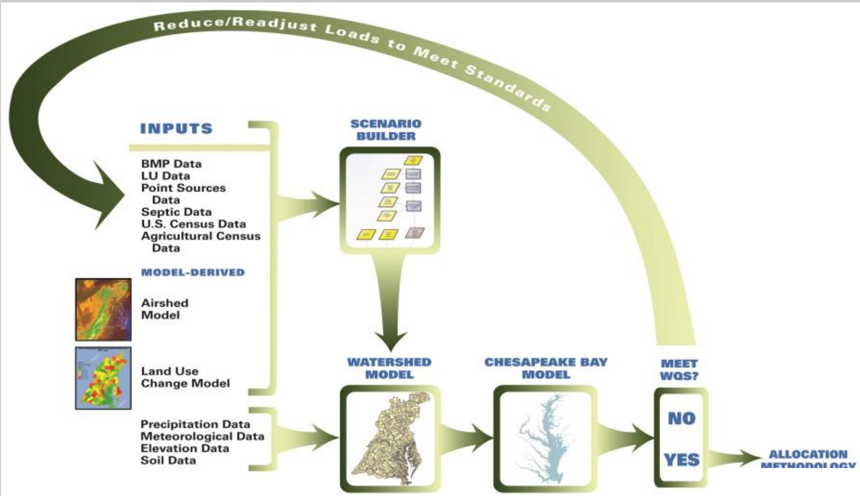




Fertilizer accounts for about 70% of nitrogen yields from the Monocacy watershed.

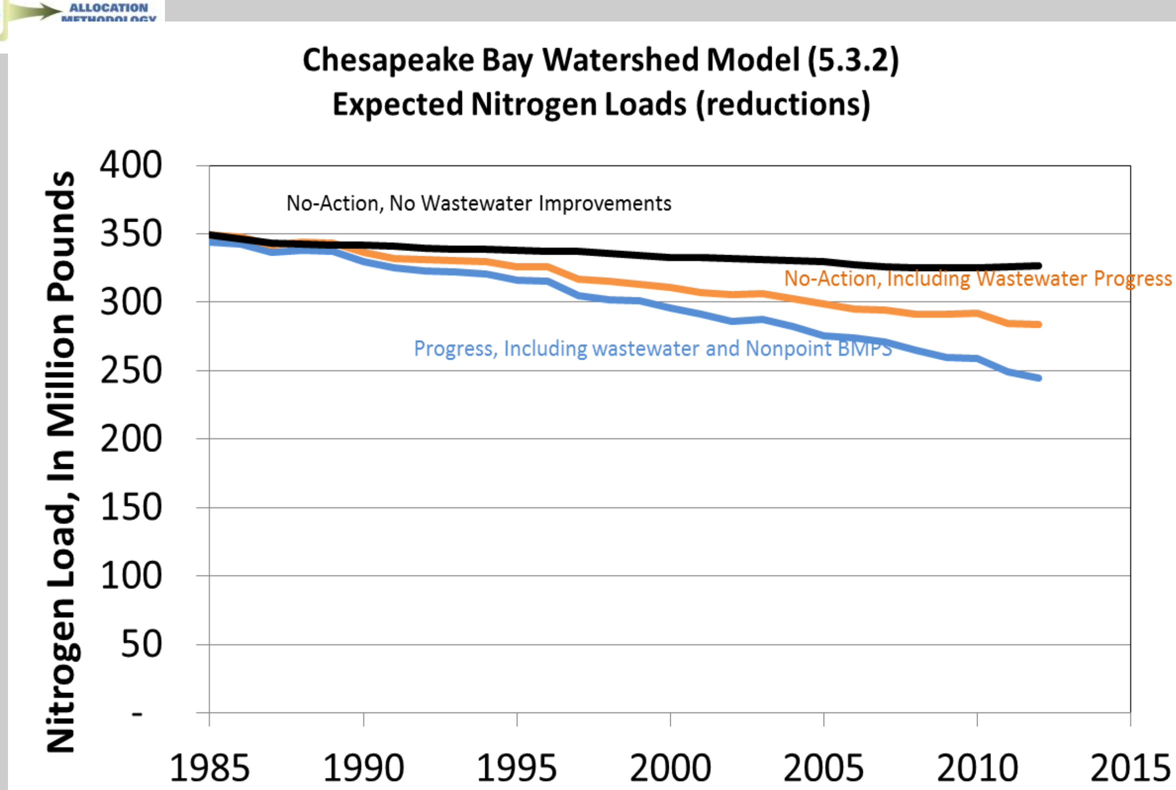
Manure is the dominant component of phosphorus loads from the N.F. Shenandoah

3. Models: CBP Modeling Suite



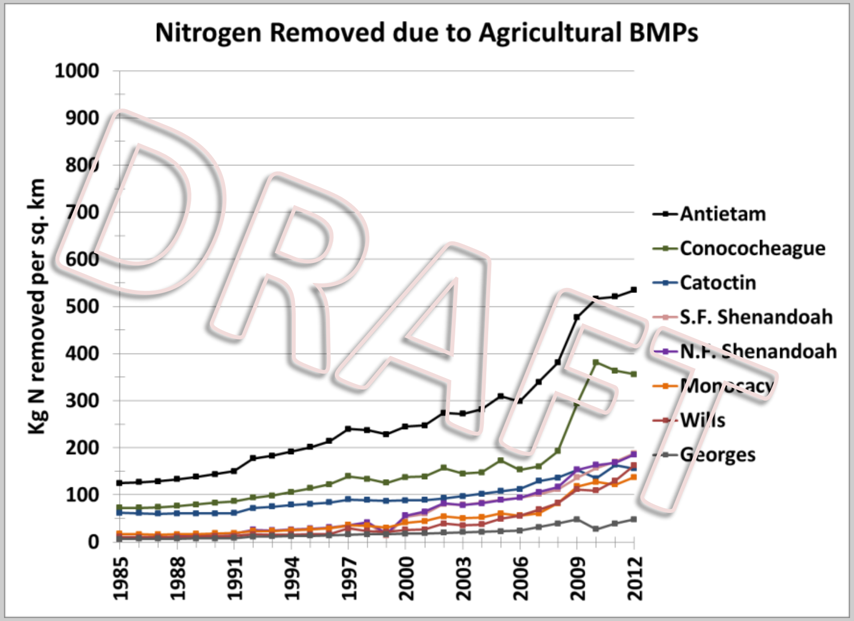
- "No Action" scenarios = No BMPs implemented
- "Progress" scenarios = BMPs "on the ground" as of each year were simulated.

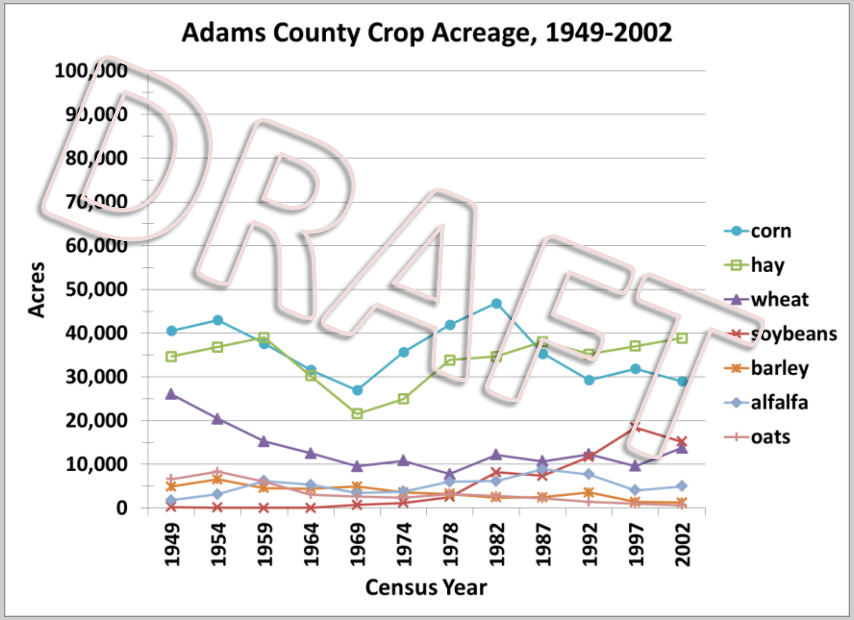
Estimates of expected nutrient load reductions due to reported implementation of non-point source BMPs.

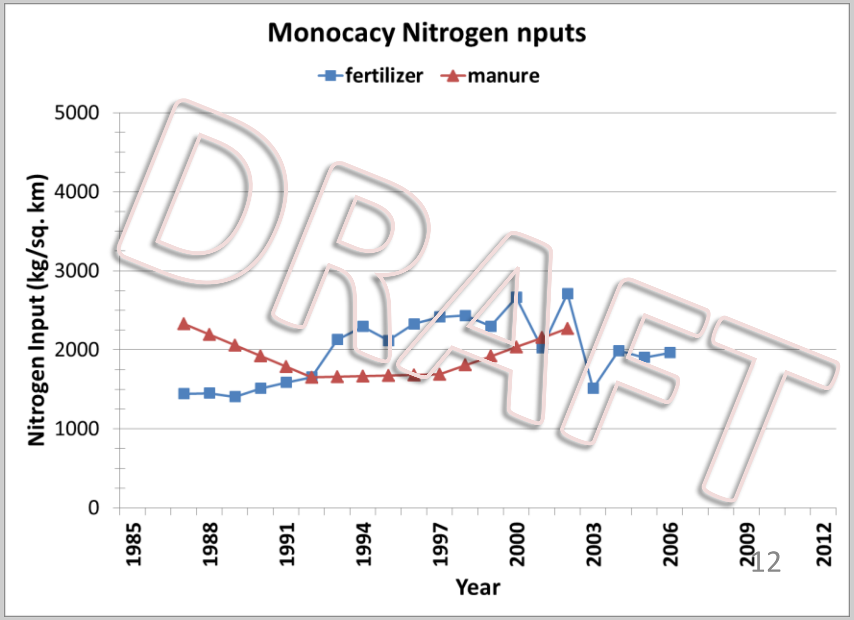


4. N inputs and interacting factors

- Manure inputs appeared to decrease between 1985 and 1993, while fertilizer inputs increased slightly.
- Corn acres decreased between 1982 and 2002
- BMP implementation inconclusive

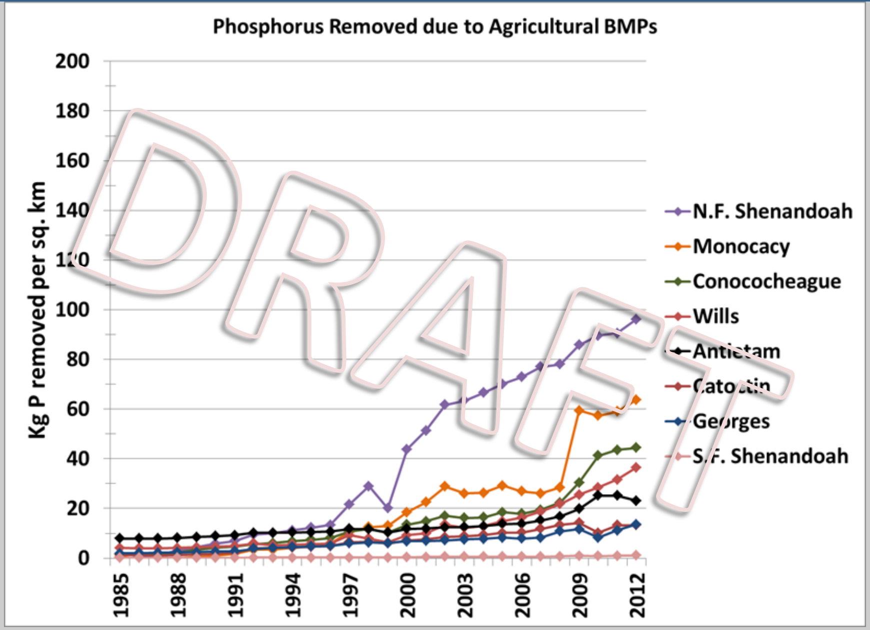


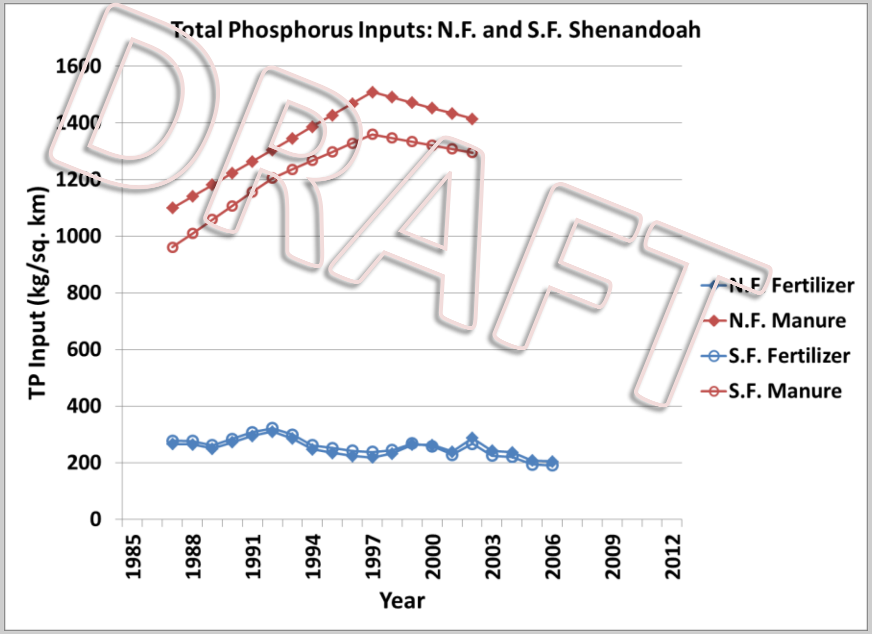


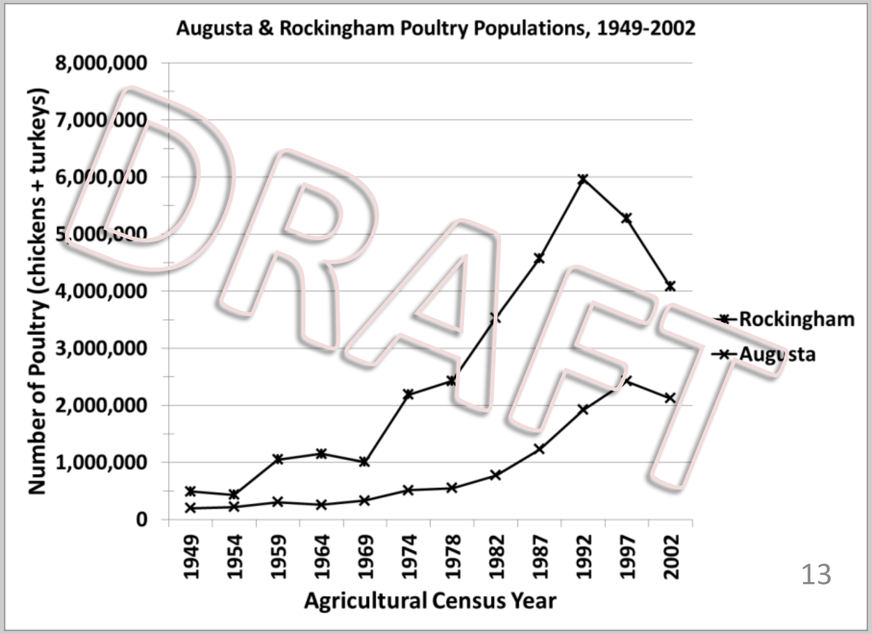


4. P inputs and interacting factors

- **Manure inputs increased substantially from 1987 – 1997, and decreased thereafter, while fertilizer inputs decreased steadily**
- **Poultry populations increased dramatically between 1970 and 1997**
- **Large increase in BMP implementation from 2000 – 2012 in the N.F. Shenandoah, but not in the S.F.**







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comparative analysis generates hypotheses

Compare patterns in nutrient yields across watersheds

- The Monocacy watershed displayed a large decrease in N yield not observed in other Potomac sub-basins
- The North Fork and South Fork Shenandoah showed increases in P yield between 1985 – 2012, while P yields from other basins decreased.
- P yields from the N.F. decreased in recent years while P yield from the S.F. increased

Where we see interesting patterns:

- SPARROW (2002) suggests that fertilizer inputs **MAY** be responsible for the majority of nitrogen fluxes from the Monocacy, while manure **MAY** be responsible for most of the phosphorus leaving the N.F. and S.F. Shenandoah watersheds.

- CBP models allow us to compare these patterns with estimates of the effects of BMP implementation

Integrating information across data and models:

- Identifies areas for further study
- Generates **HYPOTHESES**

Both traditional and novel statistical and modeling methods are required to distinguish the effects of non-point source management actions from other drivers of water quality change

Inform Management Strategies

Midpoint Assessment Timeline

Jurisdiction Implementation of WIPs & Two Year Milestones
Evaluation of Programmatic and Load Reduction Commitments
Monitoring data assessments/factors affecting trend findings

Evaluate 60% by 2017 target using Phase 5.3.2 modelilng tools

- **2018**
- Comprehensive monitoring and trend findings through 2016

Agreement on path forward and data inputs

2014

Agreement on framing the priority issues

2015

Approval of decision support tools

2016

Partnership input to any updates to local area target expectations

Establish Phase III WIP targets

2017

- Phase III WIP expectations finalized
- Partnership informs final decisions on reallocation process

Complete Phase III WIPs

2018

Support for Phase III WIP development using Phase 6.0 modeling tools