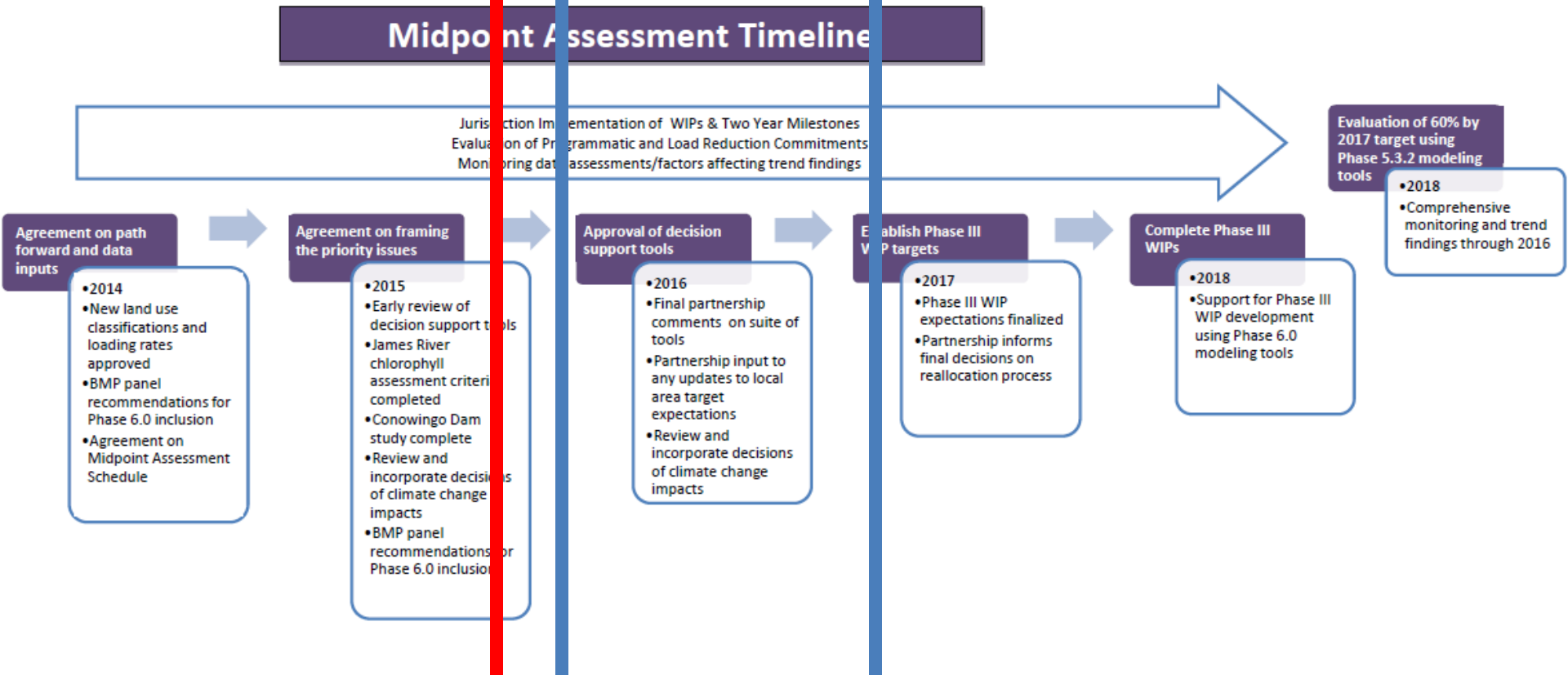
Scenario Builder and Watershed Model Progress toward the MPA

Gary Shenk Modeling Workgroup 9/3/2015



CREATE The Models

4 weeks of development to go

REVIEW The Models

Expect changes
Nothing guaranteed

USE The Models

Calibration Timeline

- **October 2014 –** Rough Draft of major changes to nutrient processing in Scenario Builder will need to be complete. Continued sensitivity refinement
- **February 2015 -** draft targets for draft land Uses
- **March 2015 –** All major partnership decisions are made on changes to scenario builder processing and data. Scenario builder final modifications begin.
- **April 2015 -** final targets approved by Modeling Workgroup for draft land uses
- **Early October 2015 – All inputs are final and delivered to the WSM by the scenario builder team for the final calibration run. Final targets are based on this information.**
- **December 2015 -** Phase 6 draft model is complete.
- **December 2015 – December 2016 -** Evaluation followed by fine tuning during the next year. Key scenarios available
- **September 2016 –** Final comments on the draft Phase 6 model
- **December 2016 -** All models are final. The partnership decision-making process begins to discuss how these new models will be used in the WIP3 process

Calibration Timeline

- **October 2014** – Ro… trier… will need to be comple… ent
- **February 2015** - dr…
- **March 2015** – All m… ade processing and dat… ions
- **April 2015** - final ta… kgro…
- **Early October 2015** – **All inputs are final and delivered to the WSM by the scenario builder team for the final calibration run. Final targets are base…**
- **December 2015** - Phase 6 draft model is complete.
- **December 2015 – December 2016** - Evaluation followed… t year. Key scenarios available
- **September 2016** – Final comments on the draft Phase 6…
- **December 2016** - All models are final. The partnership decision-making process begins to discuss how these new models will be used in the WIP3 process

Land use types:
Due 10/1/14
Finalized 8/28/15

Land use targets
Due 4/1/15
Finalized ?

Scenario Builder Structure
Due 3/1/15
Finalized 3/1/15

Scenario Builder inputs
Due 9/30/15
On Track

Model Structure
Due 3/1/15
Finalized 2014

Parameters
Due 9/30/15
On Track

Finished

Potentially Finished

Planned Update in 2016

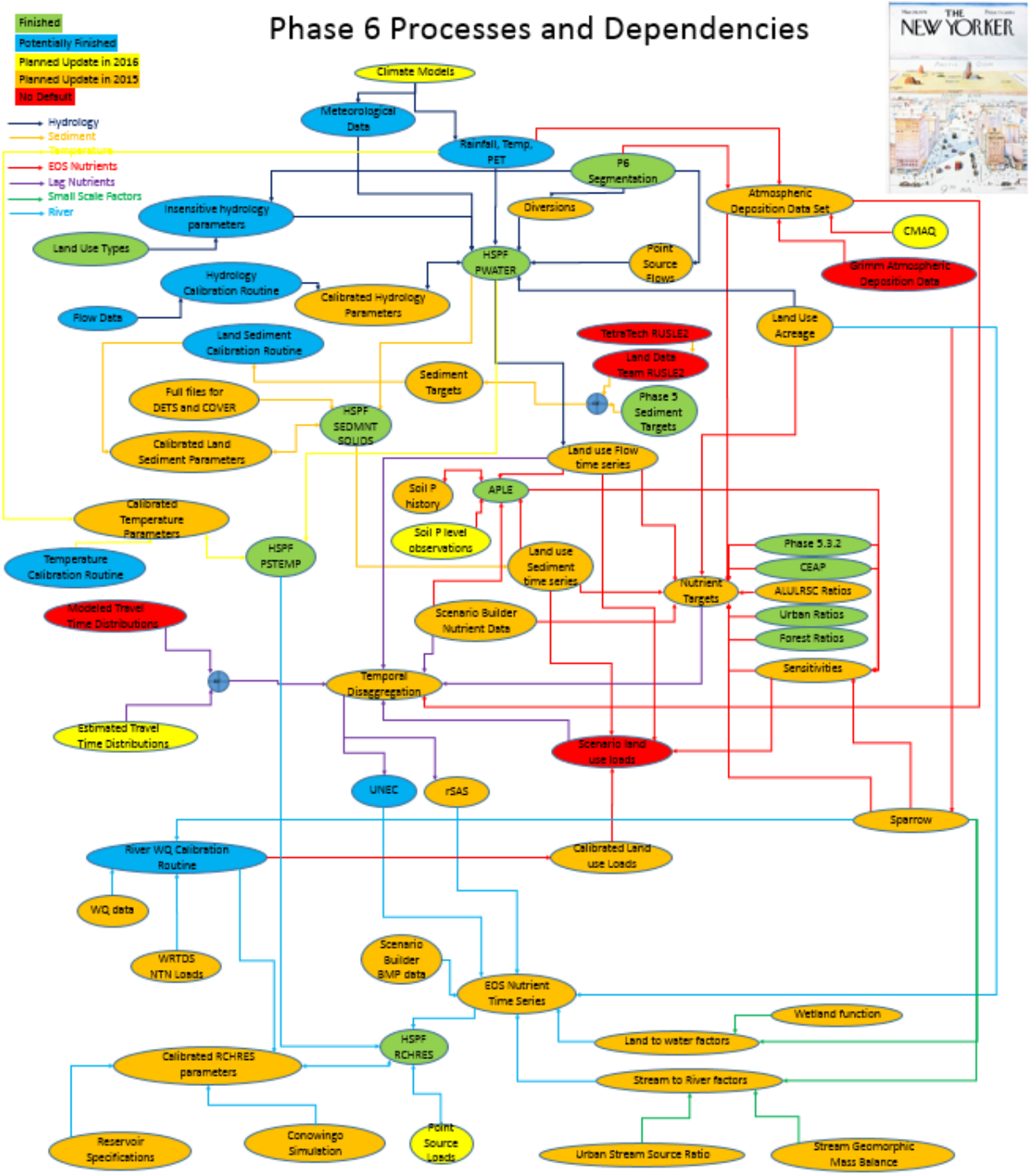
Planned Update in 2015

No Default

Each box represents a dataset, model, or process

Still a lot to get done, but all in the plan.

7/21/15



Finished

Potentially Finished

Planned Update in 2016

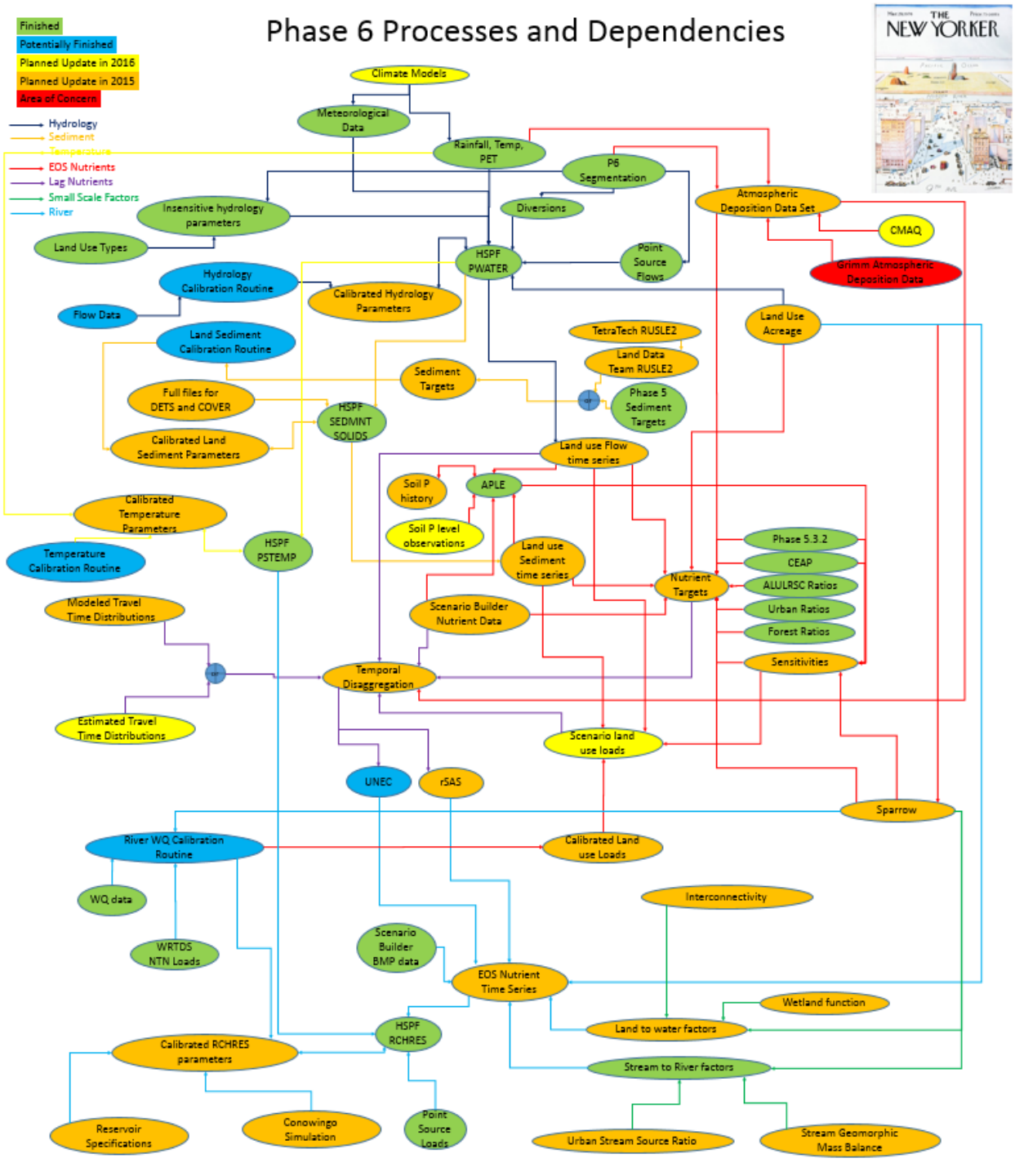
Planned Update in 2015

Area of Concern

Each box represents a dataset, model, or process

Still a lot to get done, but all in the plan.

Today



Finished

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Still a lot to get done, but all in the plan.

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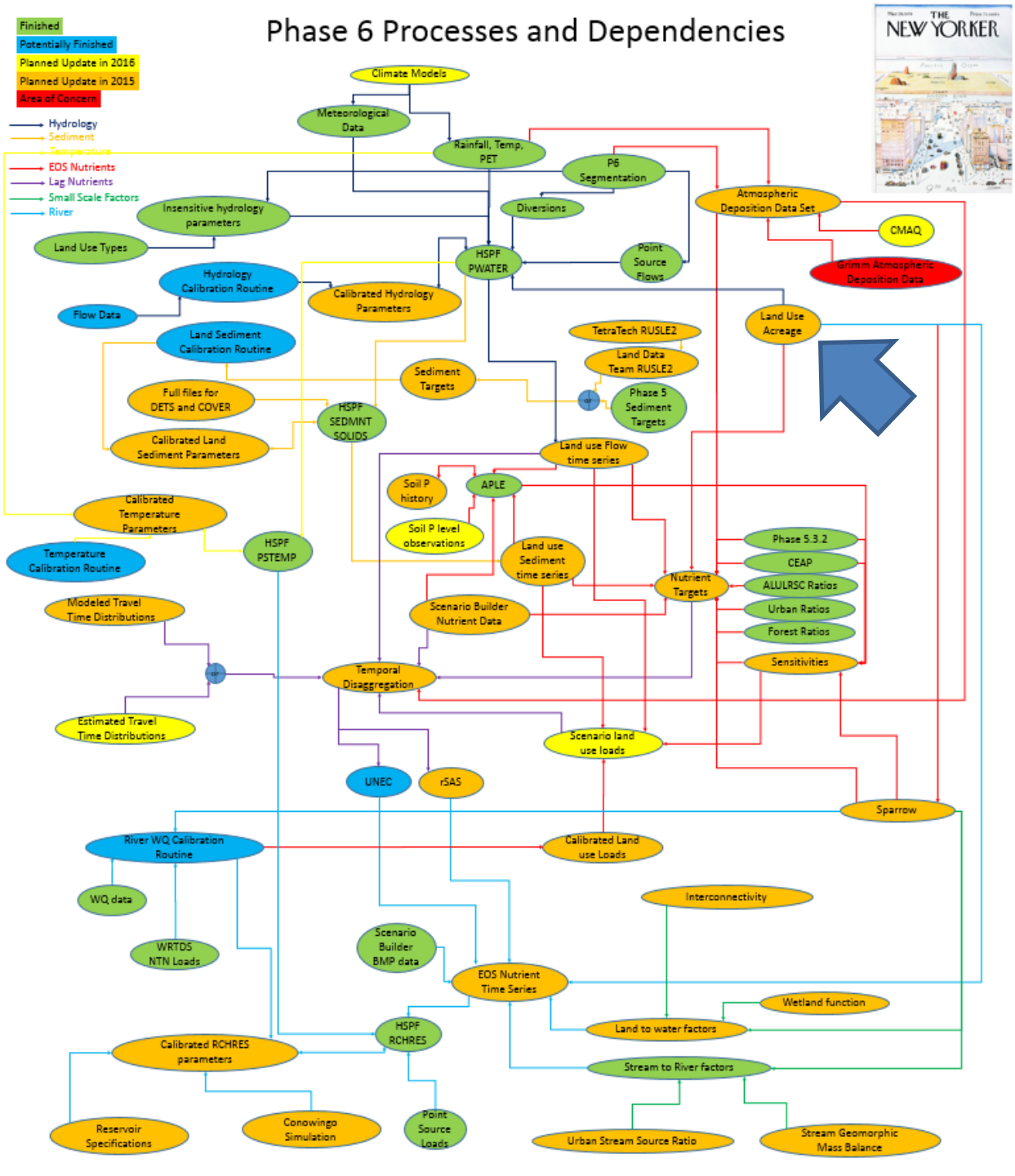
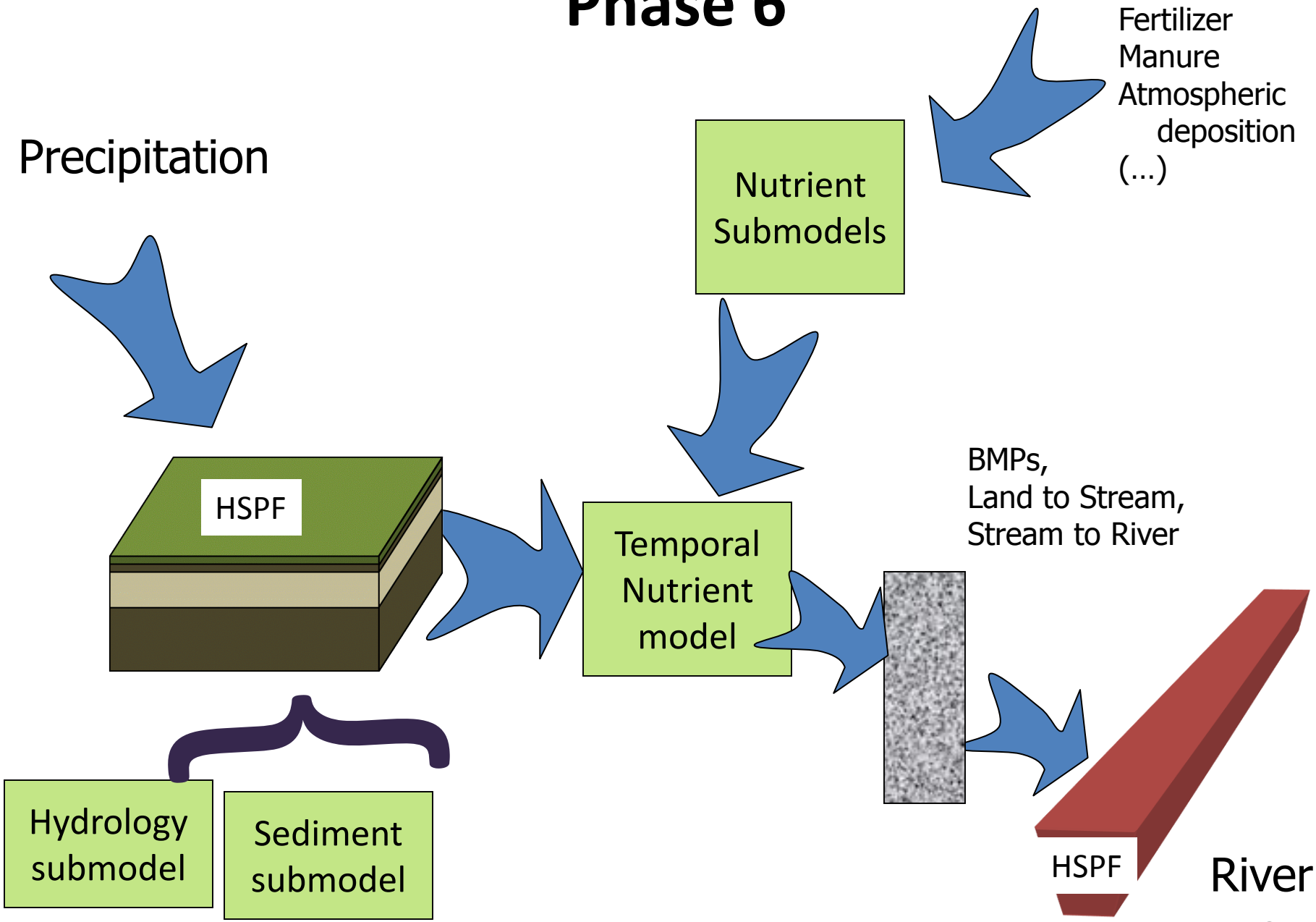


Phase 6


Fertilizer
Manure
Atmospheric deposition
(…)
Precipitation
Nutrient Submodels
HSPF
Temporal Nutrient model
BMPs,
Land to Stream,
Stream to River
Hydrology submodel
Sediment submodel
HSPF
River





Load for a land use in a segment =

Estimated Average Load + Sensitivity * Δ Inputs

*

BMPs

*

Watershed Delivery Variance

*

Stream Delivery

*

River Delivery

Phase 6

Yactayo
1:20 pm

Estimated Average Load + Sensitivity * Δ Inputs

*

BMPs

*

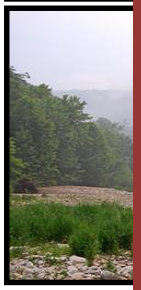
Watershed Delivery Variance

*

Stream Delivery

*

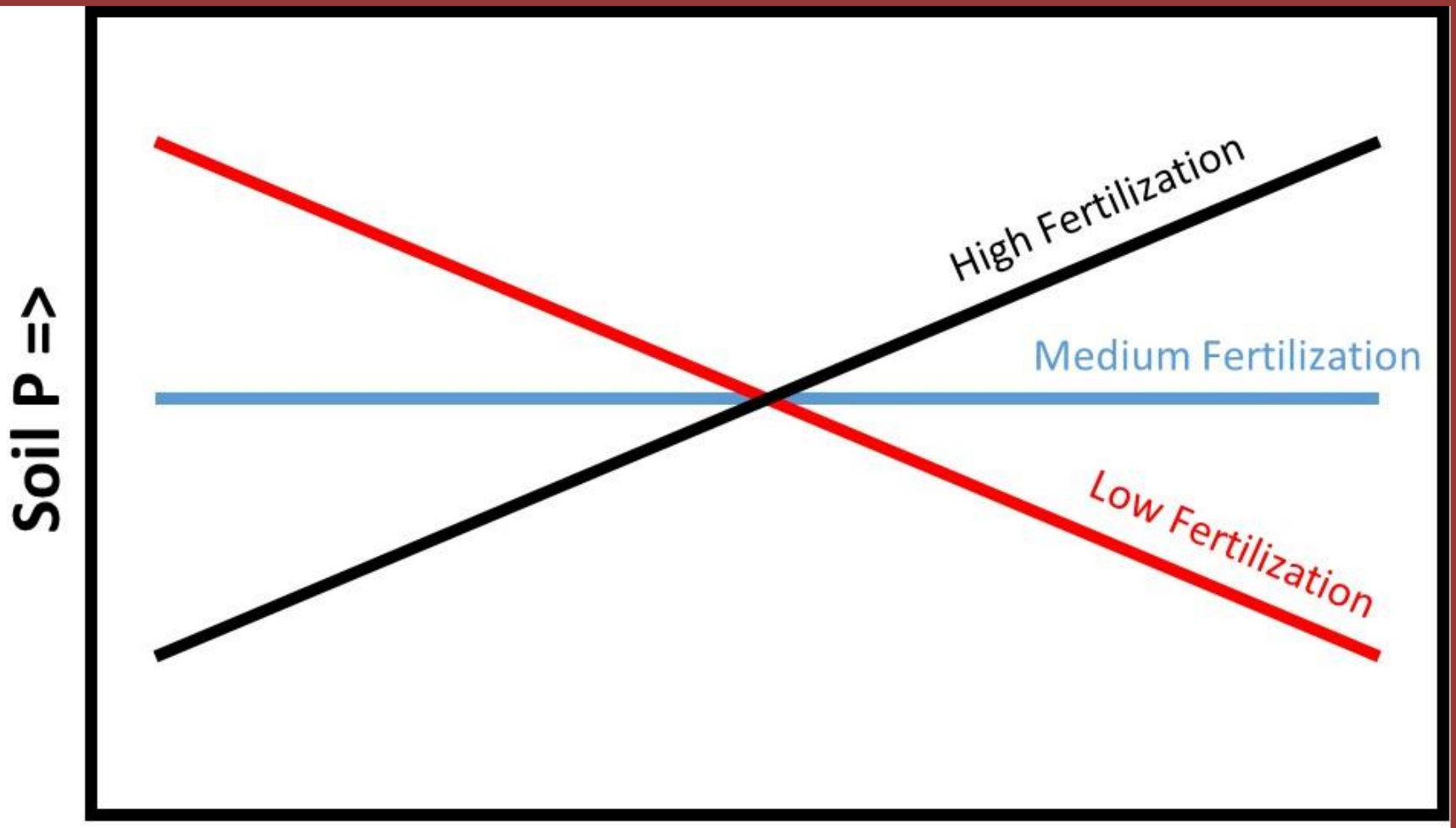
River Delivery



Yactayo

Estimated

Average + Sensitivity * Δ Inputs



Bhatt
12:40 am

Estimated Average Load + **Sensitivity** * **Δ Inputs**

*

BMPs

*

Watershed Delivery Variance

*

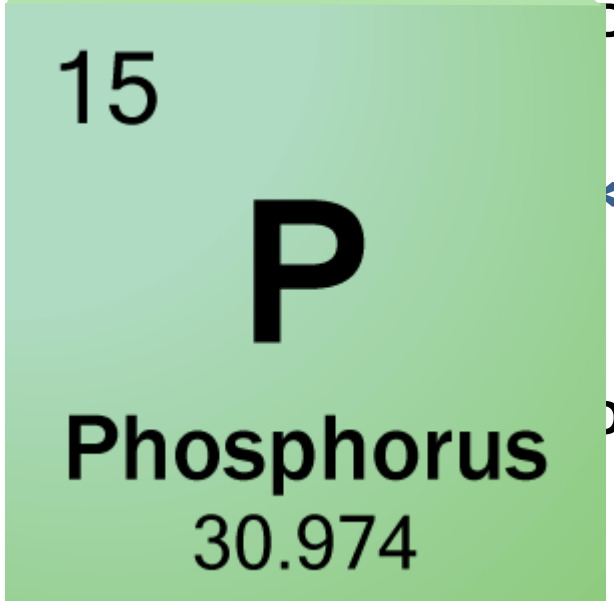
Stream Delivery

*

River Delivery

Estimated Average Load + **Sensitivity** * **Δ Inputs** * **BMPs** * **Watershed Delivery Variance** * **Delivery** * **Delivery**

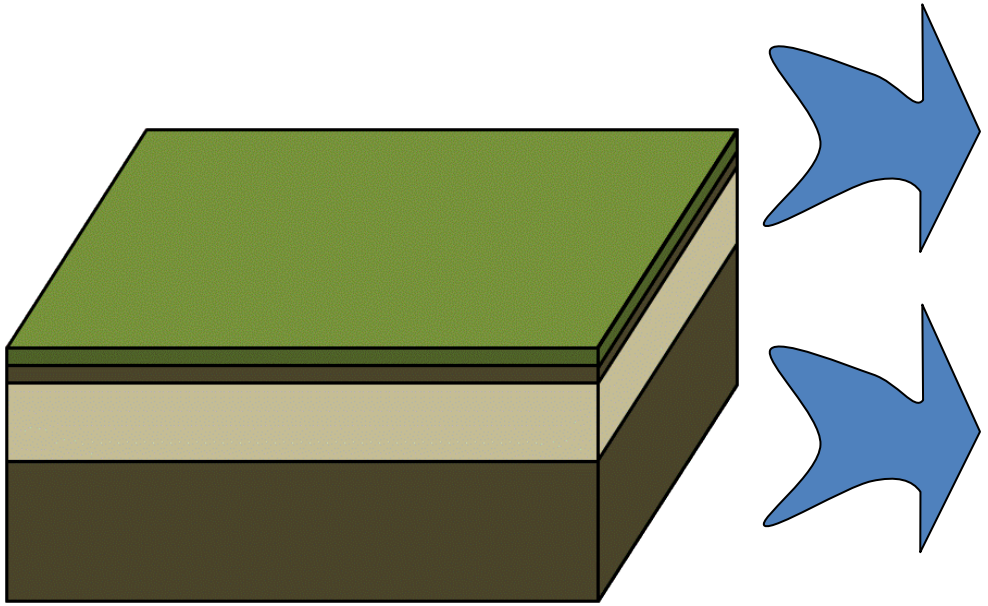
Bhatt
12:40 am



What did we know about Coastal Plain Phosphorus in Phase 5?

- Little information
- The available information pointed to the coastal plain being relatively retentive for P.

Transport Theory



P mostly sediment-associated – lower loads in the coastal plain

Very Low dissolved P in groundwater

Previous Sparrow Parameters

Chesapeake Bay SPARROW

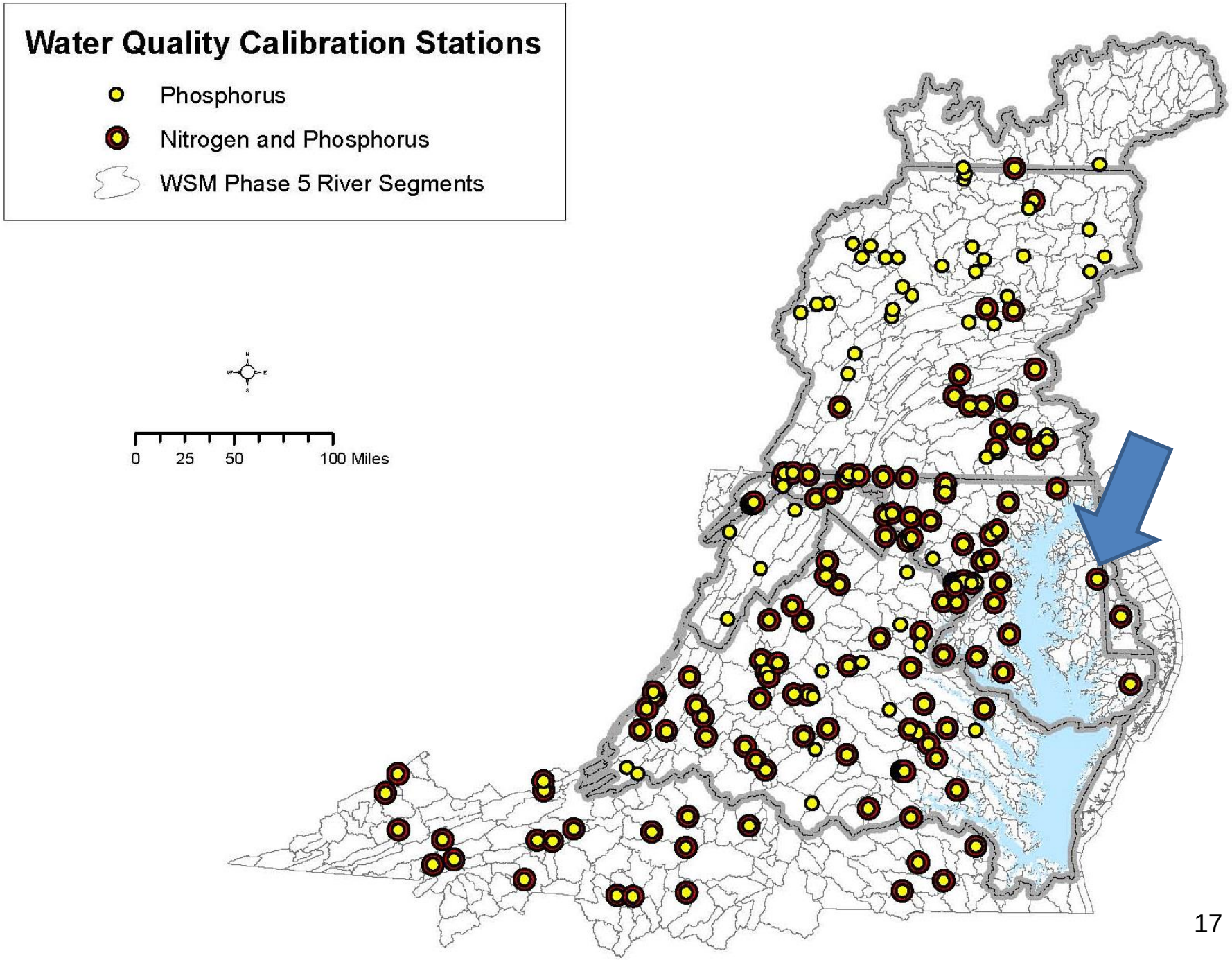
Comparison of Version II / Version III Parameter Estimates

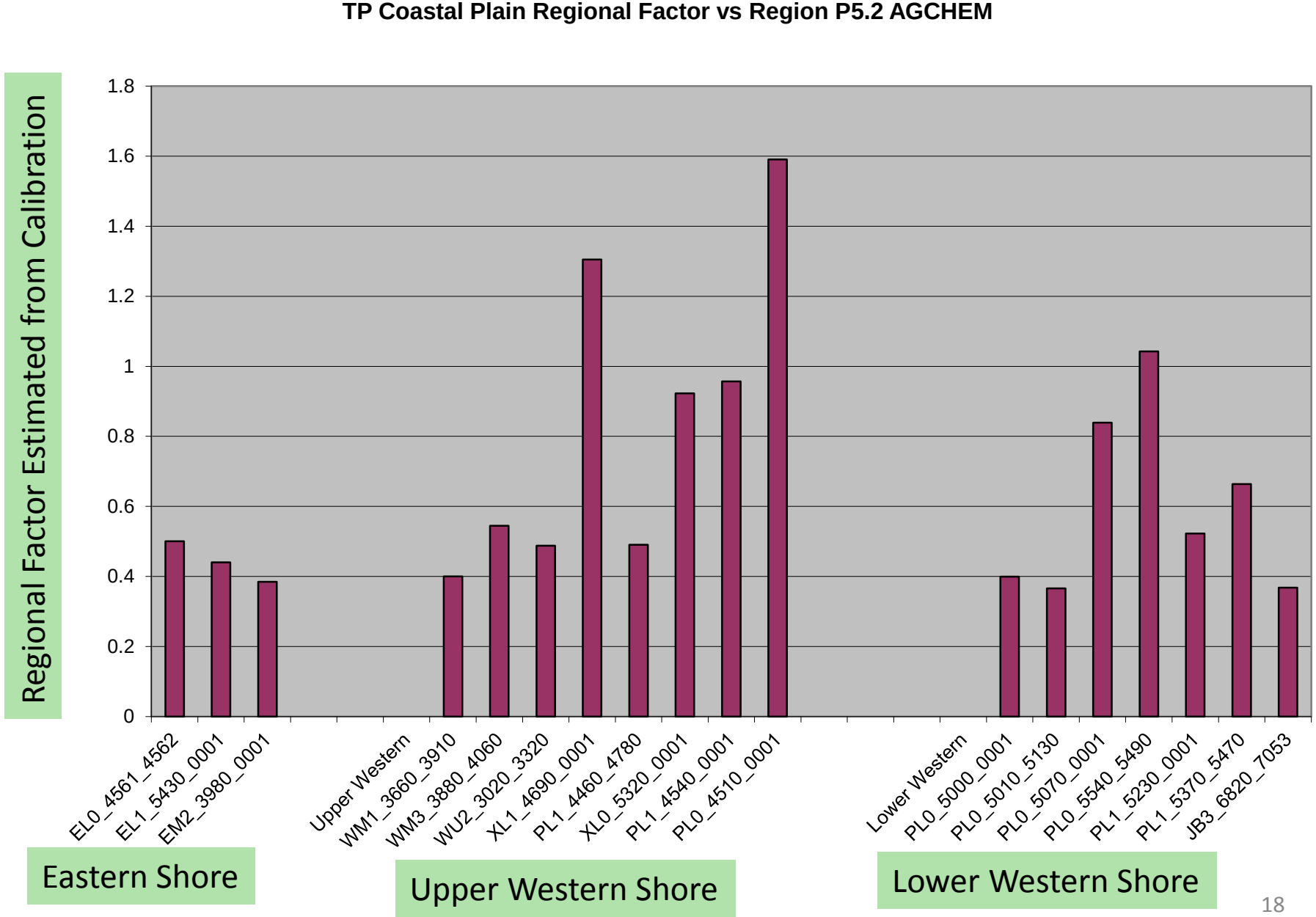
Total Phosphorus

Version II: n = 109 MSE = 0.112 R^2 = 0.970 Flow Classes: 1) 0 - 100 ft^3/s; 2) 100 – 500 ft^3/s; 3) >500 ft^3/s

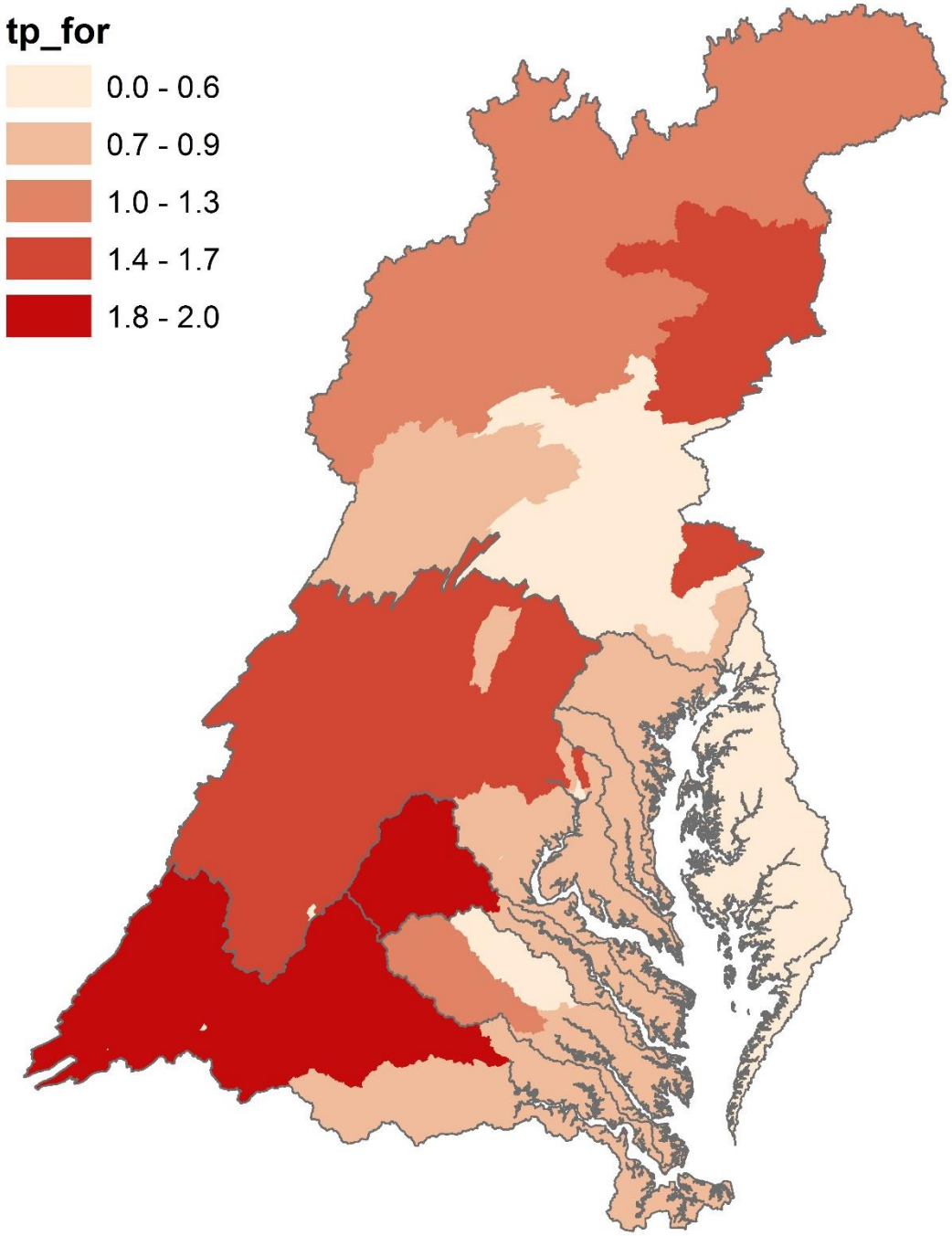
Version III: n = 104 MSE = 0.108 R^2 = 0.972 Flow Classes: 1) 0 - 100 ft^3/s; 2) 100 – 500 ft^3/s; 3) >500 ft^3/s

Parameter Name	Version II Exploratory Parameter Estimate	Version II Exploratory Significance Level	Version II Constrained Bootstrap Estimate	Version III Exploratory Exploratory Estimate	Version III Exploratory Significance Level	Version III Constrained Bootstrap Estimate
Instream Loss Rates						
Stream Loss Rate 1	0.128	0.400	0.143	-0.270	0.045	0.002
Stream Loss Rate 2	0.008	0.936	0.041	0.026	0.817	0.104
Stream Loss Rate 3	-0.011	0.834	0.021	0.028	0.601	0.047
Reservoir Loss	0.721	0.002	0.687	8.10	0.042	8.18
Land to Water Delivery Factors						
Sources						
Point Sources	0.582	<0.001	0.618	0.650	<0.001	0.684
Urban Area	0.996	<0.001	1.21	0.476	<0.001	0.617
Fertilizer	0.018	0.005	0.018	0.021	<0.001	0.021
Manure	0.013	0.049	0.015	0.008	0.028	0.012
Non-Agricultural Land	0.190	<0.001	0.218	0.093	<0.001	0.101


Water Quality Calibration Stations
Phosphorus
Nitrogen and Phosphorus
WSM Phase 5 River Segments
0
25
50
100 Miles


TP Coastal Plain Regional Factor vs Region P5.2 AGCHEM
Regional Factor Estimated from Calibration
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
EL0_4561_4562
EL1_5430_0001
EM2_3980_0001
Upper Western
WM1_3660_3910
WM3_3880_4060
WU2_3020_3320
XL1_4690_0001
PL1_4460_4780
XL0_5320_0001
PL1_4540_0001
PL0_4510_0001
Lower Western
PL0_5000_0001
PL0_5010_5130
PL0_5070_0001
PL0_5540_5490
PL1_5230_0001
PL1_5370_5470
JB3_6820_7053
Eastern Shore
Upper Western Shore
Lower Western Shore

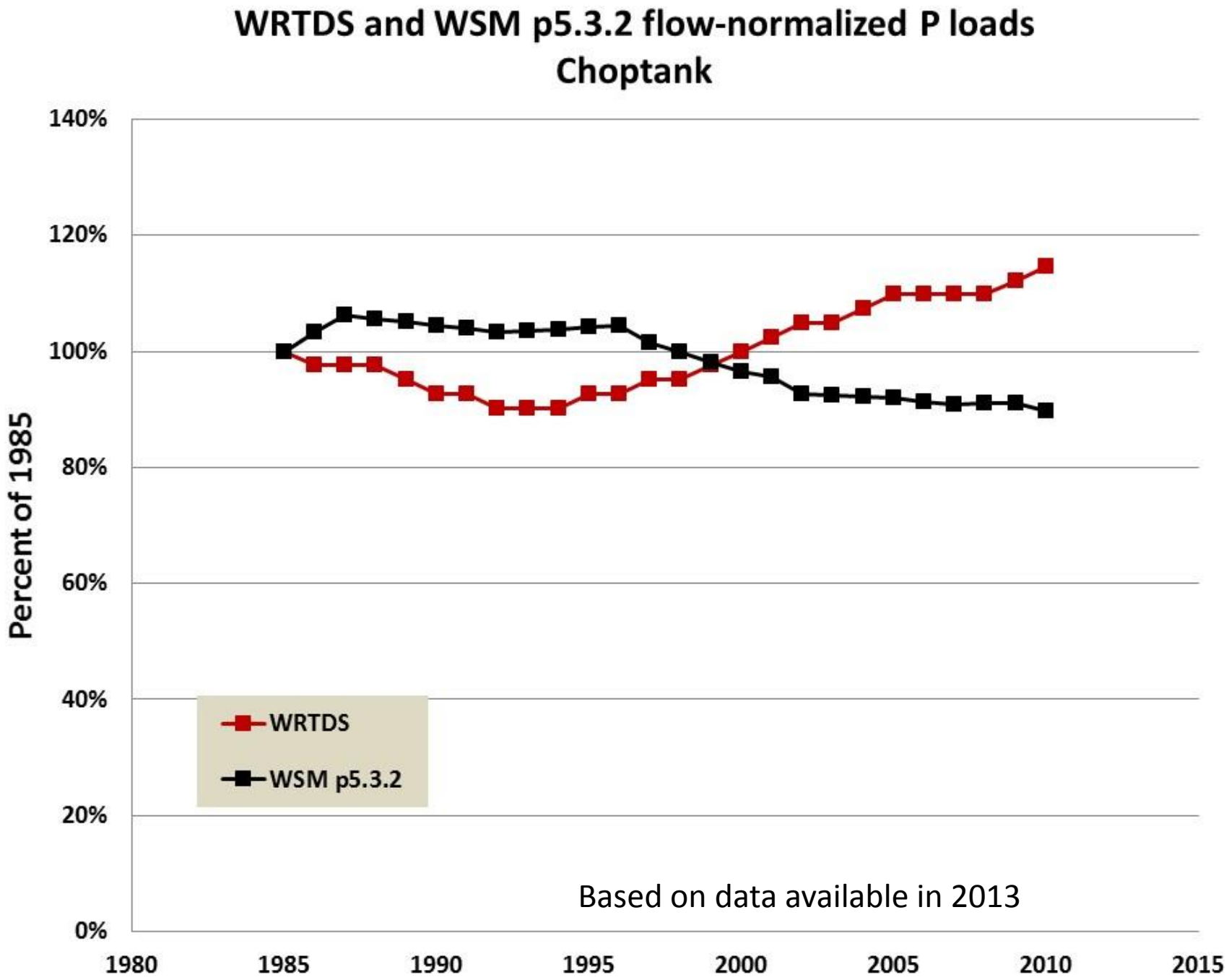
Phase 5.3.2 TP Calibrated Regional Factors



STAC Guidance

A Review of Agricultural P-dynamics in the Chesapeake Bay Watershed Model

"…output from CBWM [indicated] major reductions in P losses from cropland on the Maryland Eastern Shore that seemed to be inconsistent with research findings and monitoring data in the region."


WRTDS and WSM p5.3.2 flow-normalized P loads
Choptank
140%
120%
100%
80%
60%
40%
20%
0%
Percent of 1985
1980
1985
1990
1995
2000
2005
2010
2015
WRTDS
WSM p5.3.2
Based on data available in 2013

What do we know about Coastal Plain Phosphorus in Phase 6?

- ~~Little~~ Lots of information
- The available information points to the coastal plain being relatively ~~retentive~~ leaky for P.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Phosphorus Symposium
chesapeake sparrow brake...
phosphorussymposium.com
phosphours symposium
The State of the Science of Phosphorus
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January 30, 2015
Chesapeake College
MARYLAND GRAIN PRODUCERS UTILIZATION BOARD
CHESAPEAKE BAY FOUNDATION
SAVE THE BAY
UNIVERSITY OF MARYLAND EXTENSION
Solutions in your community
Agenda
Presenters
Location
Hosts
The State of the Science of Phosphorus
This symposium drew 350 attendees seeking to better understand the current state of science surrounding phosphorus transport, soil dynamics, legacies, modeling, and its impact on water quality. Experts on the science of phosphorus from across the country were featured on the program.
Visit the Phosphorus Symposium playlist to watch presentations by selecting individual sessions or play all for continuous play of the program. Proceedings are also available in PDF format to download.
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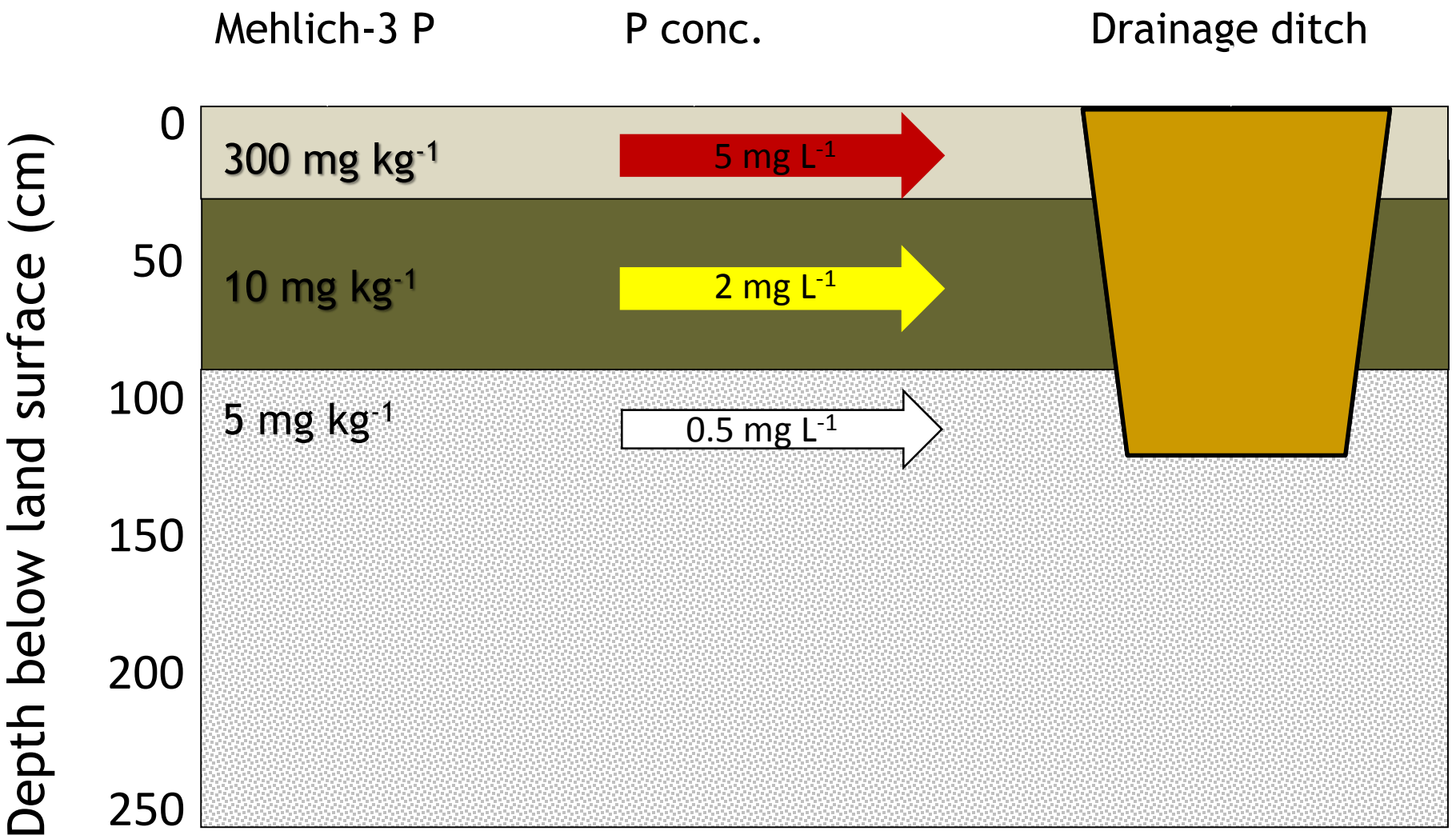
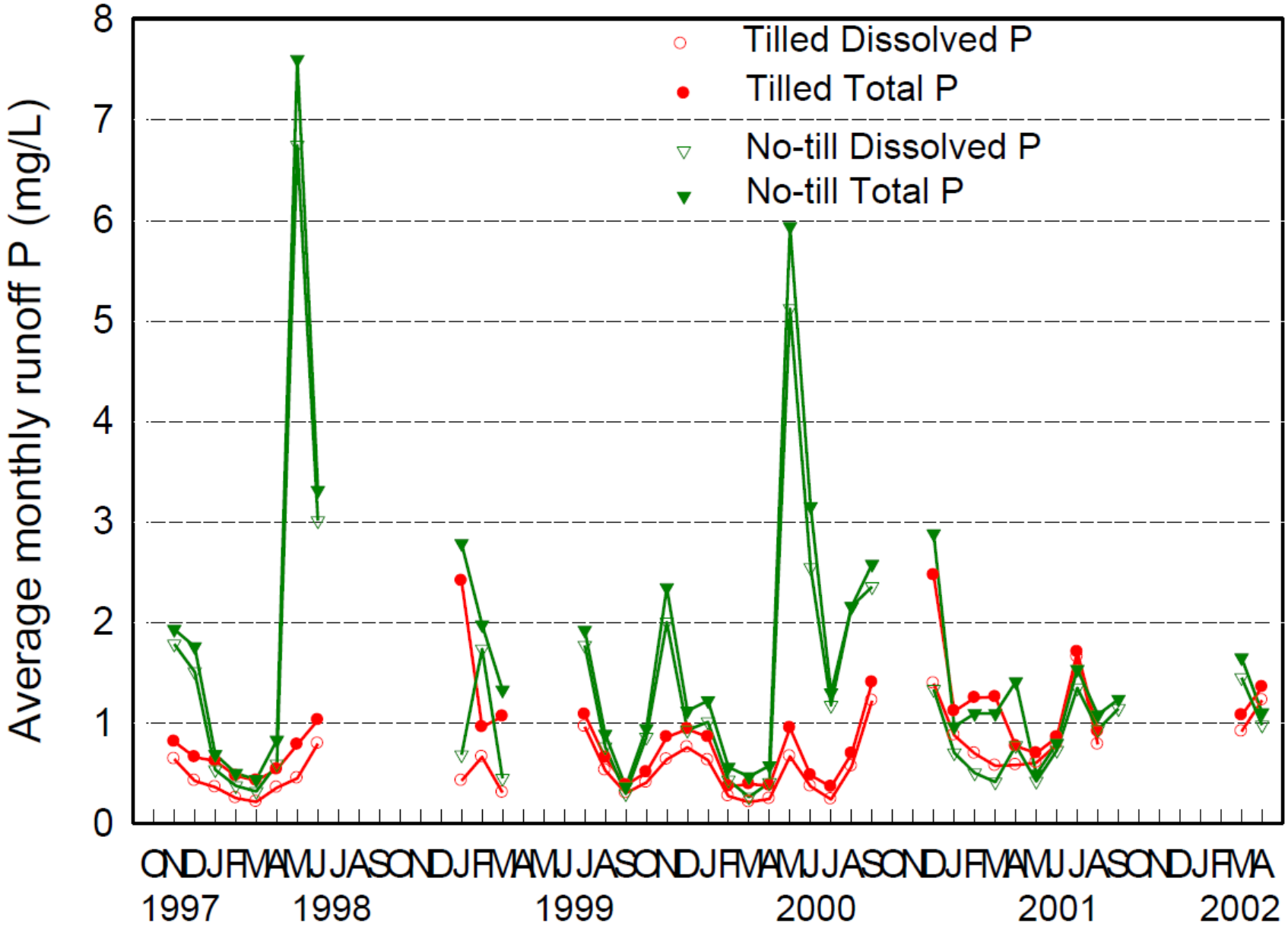
Transport Theory

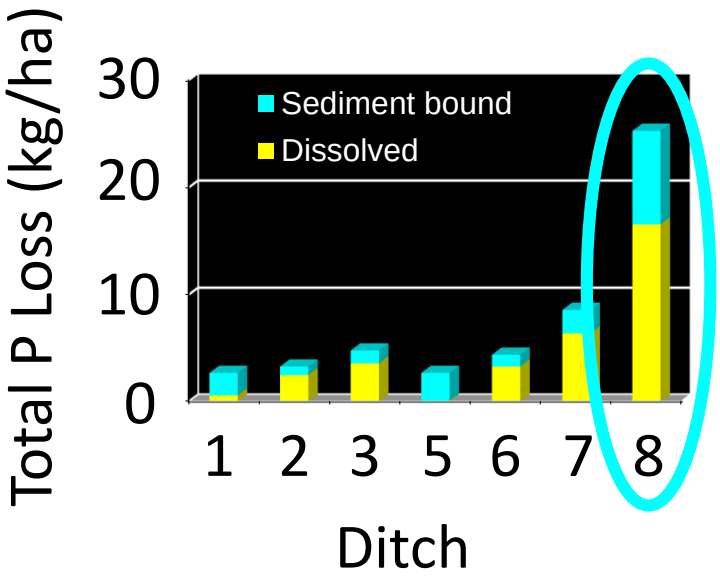


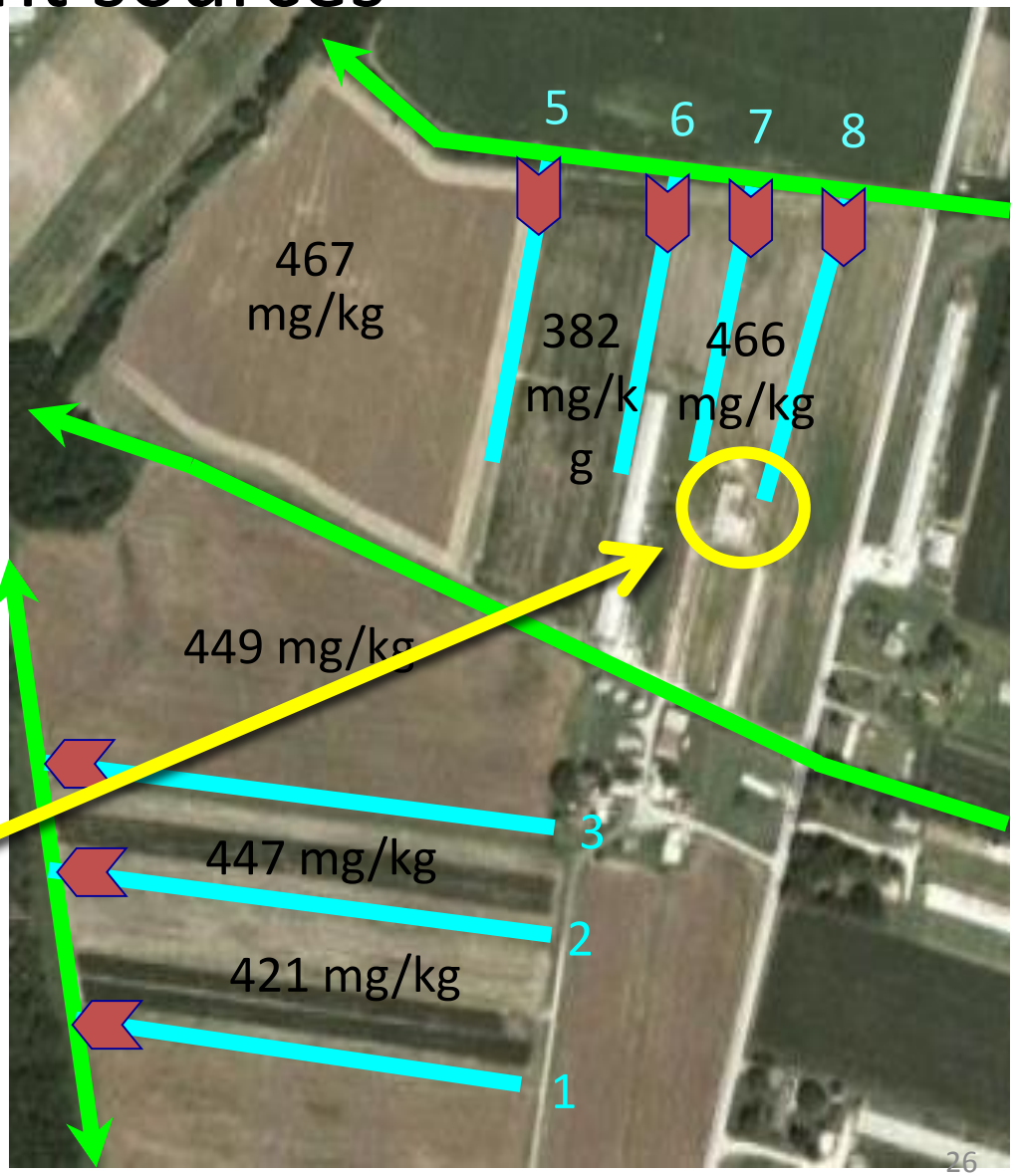


Ken Staver – Presentation to MWG 10/9/14 (and many times previously)

Point sources as a major concern

Point sources

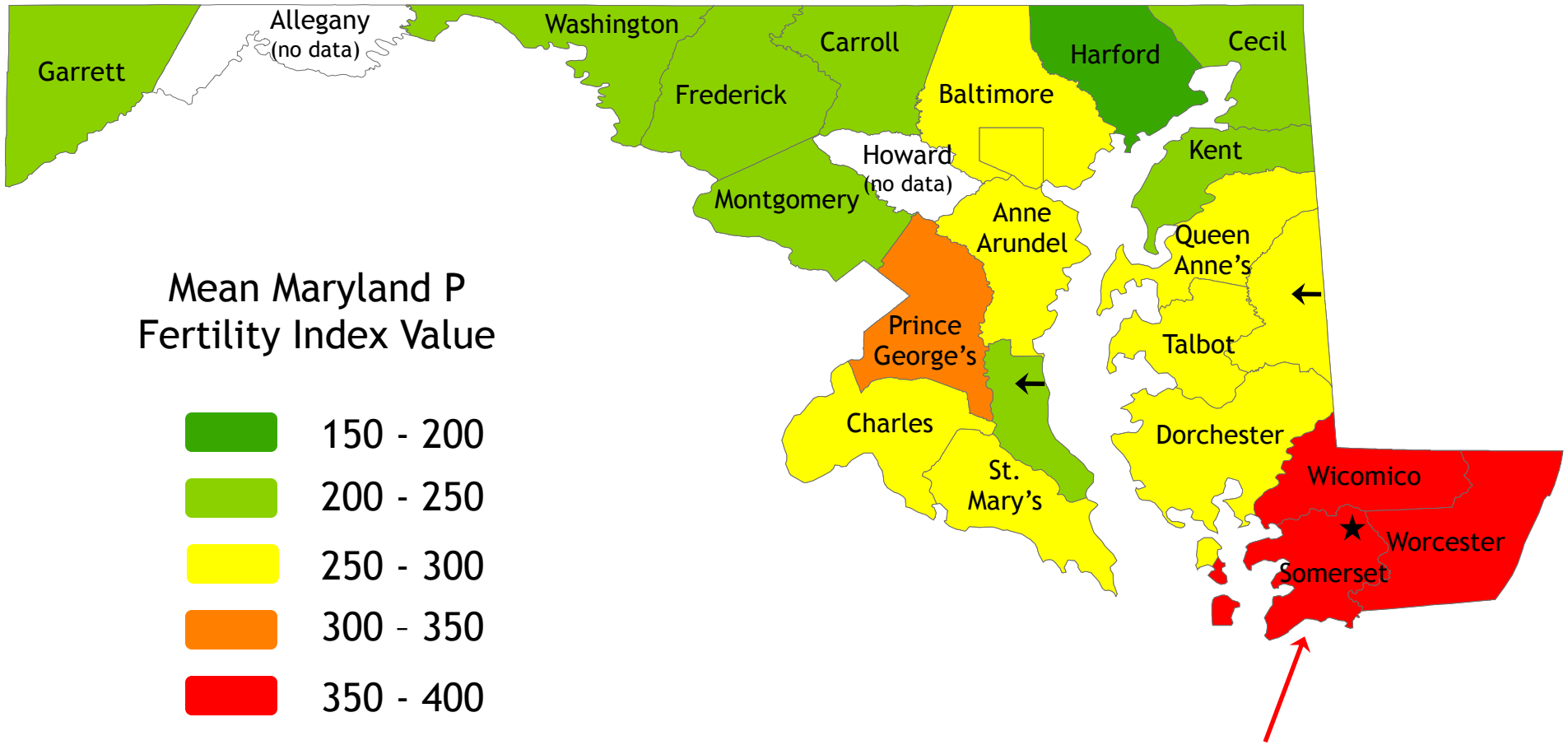




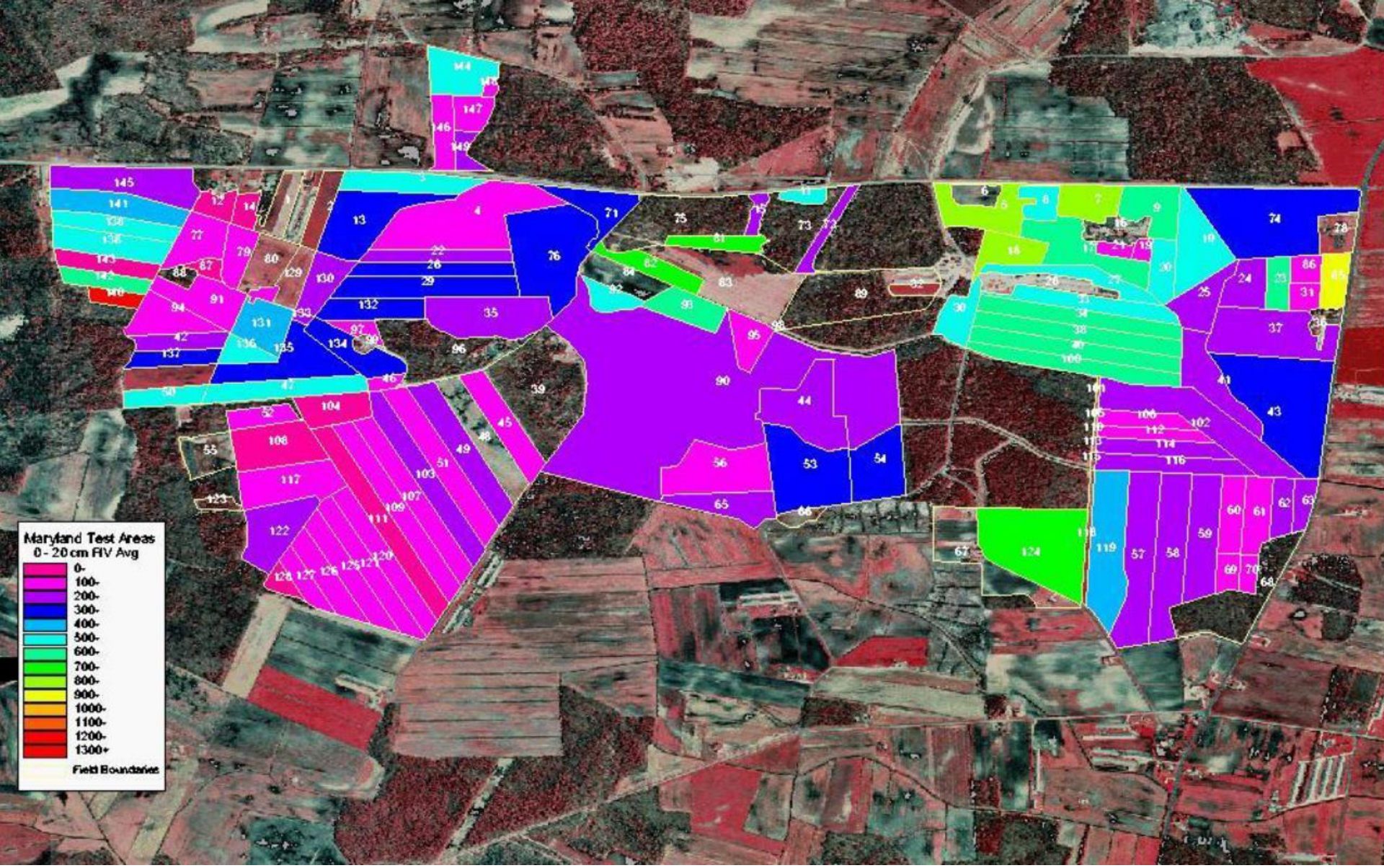
Kleinman et al., 2007 (J. Soil Water Conserv.)

Soil test P summary

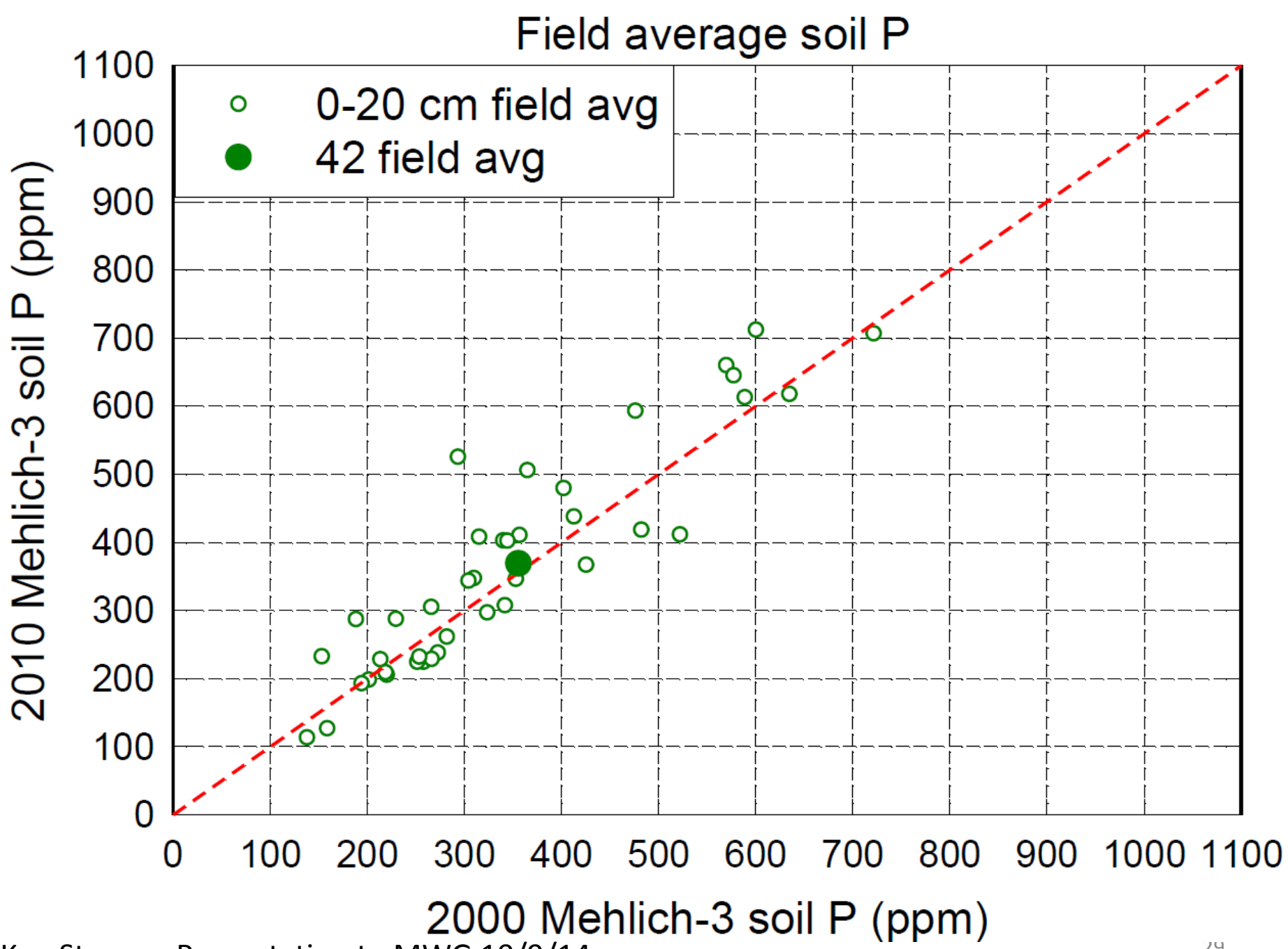
Restricted to fields where the Maryland P Index was run (FIV > 150 only)



Courtesy J. McGrath, Univ. Maryland

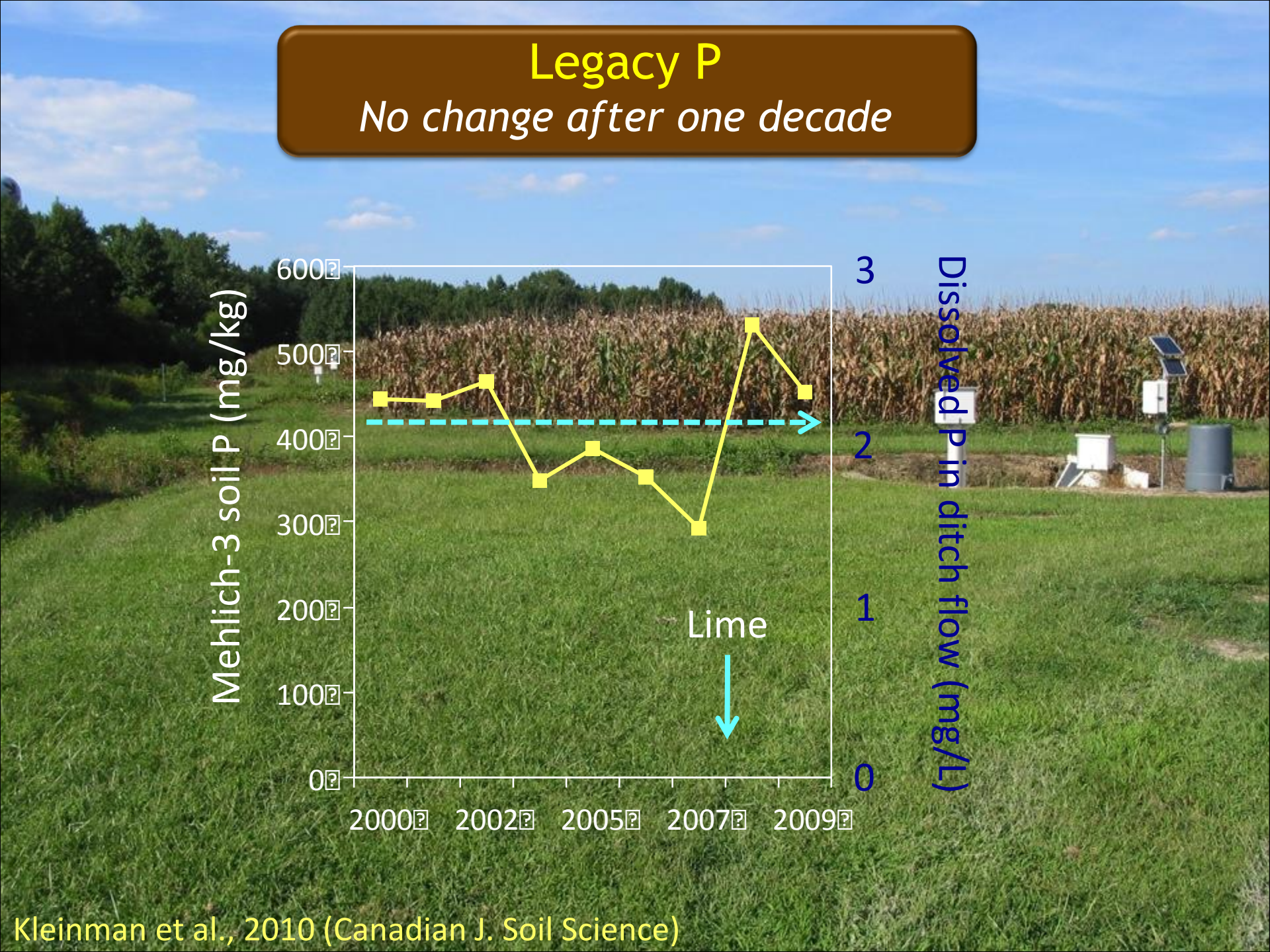


Ken Staver – Presentation to MWG 10/9/14


Field average soil P
0-20 cm field avg
42 field avg
2010 Mehlich-3 soil P (ppm)
2000 Mehlich-3 soil P (ppm)
0
100
200
300
400
500
600
700
800
900
1000
1100

Legacy P

No change after one decade



Kleinman et al., 2010 (Canadian J. Soil Science)

Phosphorus Conceptual Model

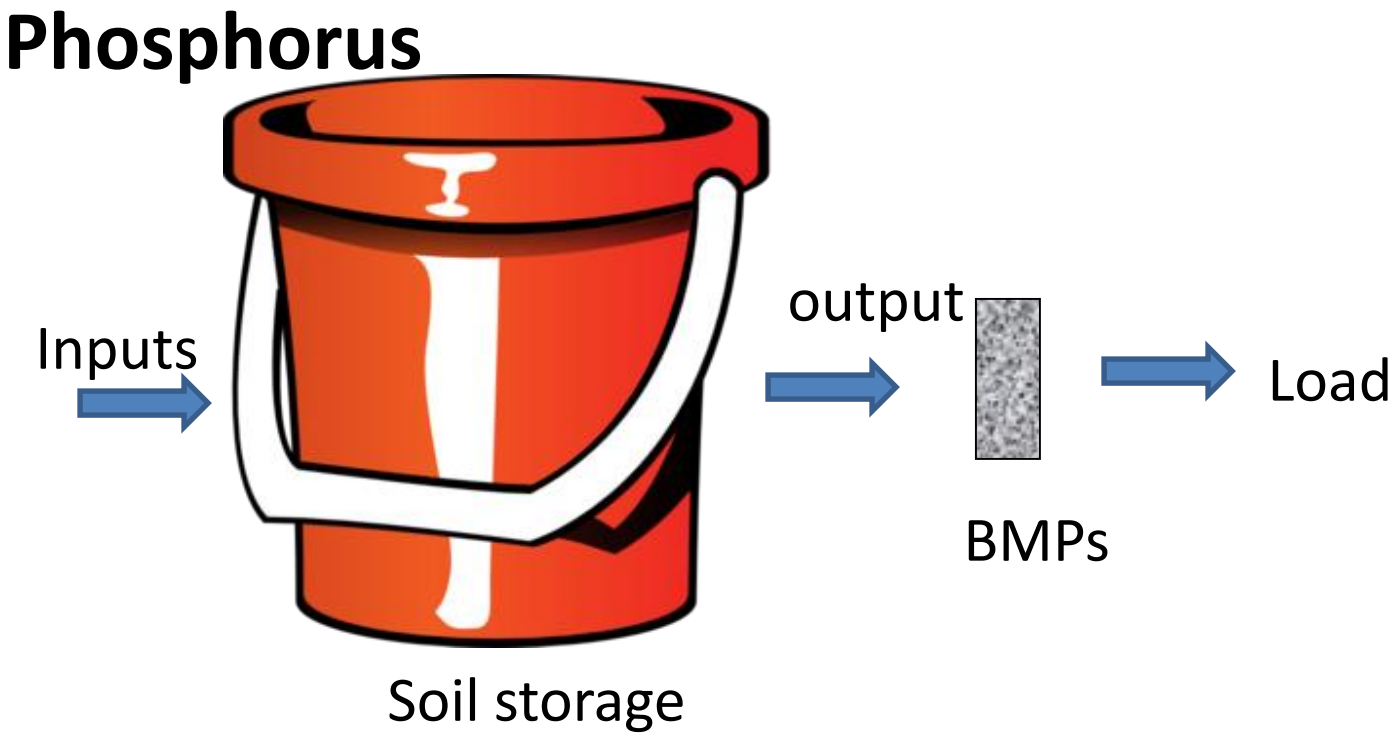
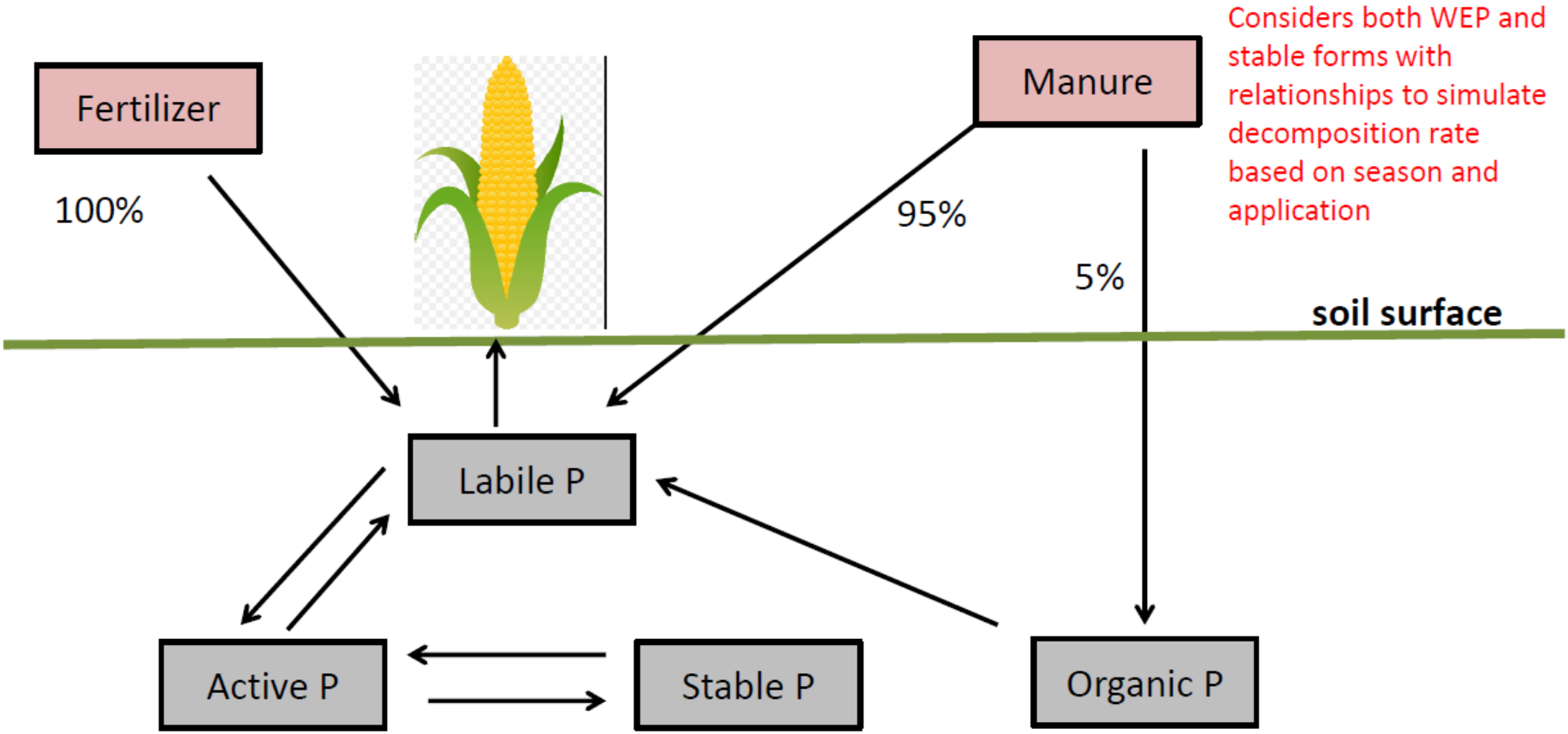


Diagram of APLE Nutrient Sources and Soil Pools



Equations to estimate Manure runoff P, Fertilizer runoff P, Sediment P loss, and Dissolved Soil P runoff

(Adapted from Vadas, et al. 2007)

Background – SPARROW Coefficients

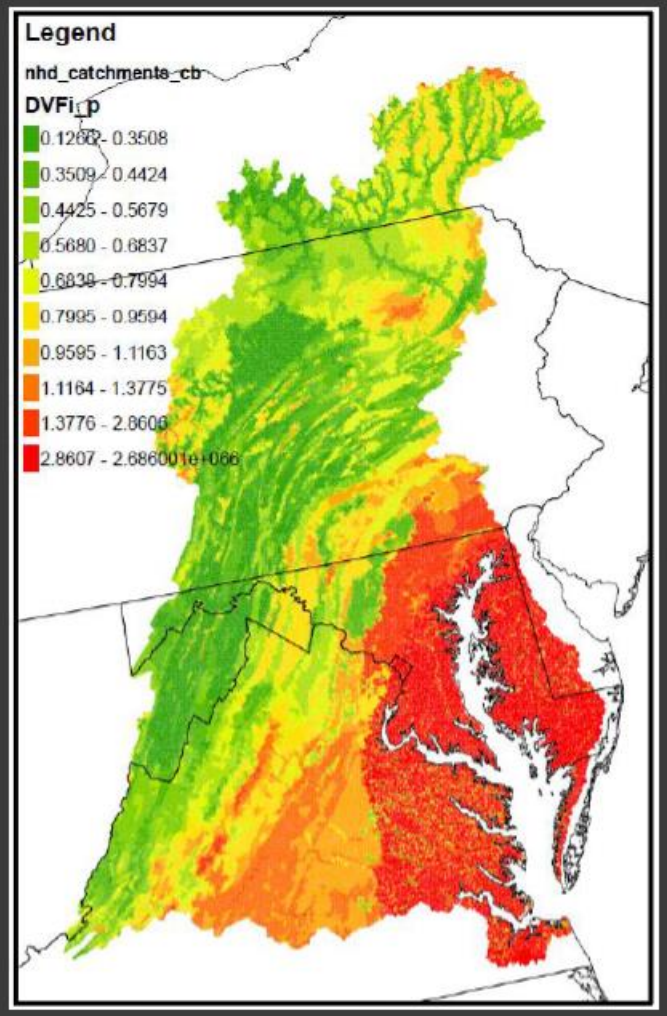
- Source coefficients
  - Intensive or extensive
  - Estimate mean proportion or yield delivered to streams
- Land-to-water coefficients
  - Allow for spatial variability in delivery to streams
  - Positive or negative
- Stream decay coefficients

RMSE=0.4741, R^2=0.9510, yieldR^2=0.7300

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 (area)	1.02	<0.0001
Aquatic Decay		
Impoundments	54.3	0.0174

Ator et al., 2011

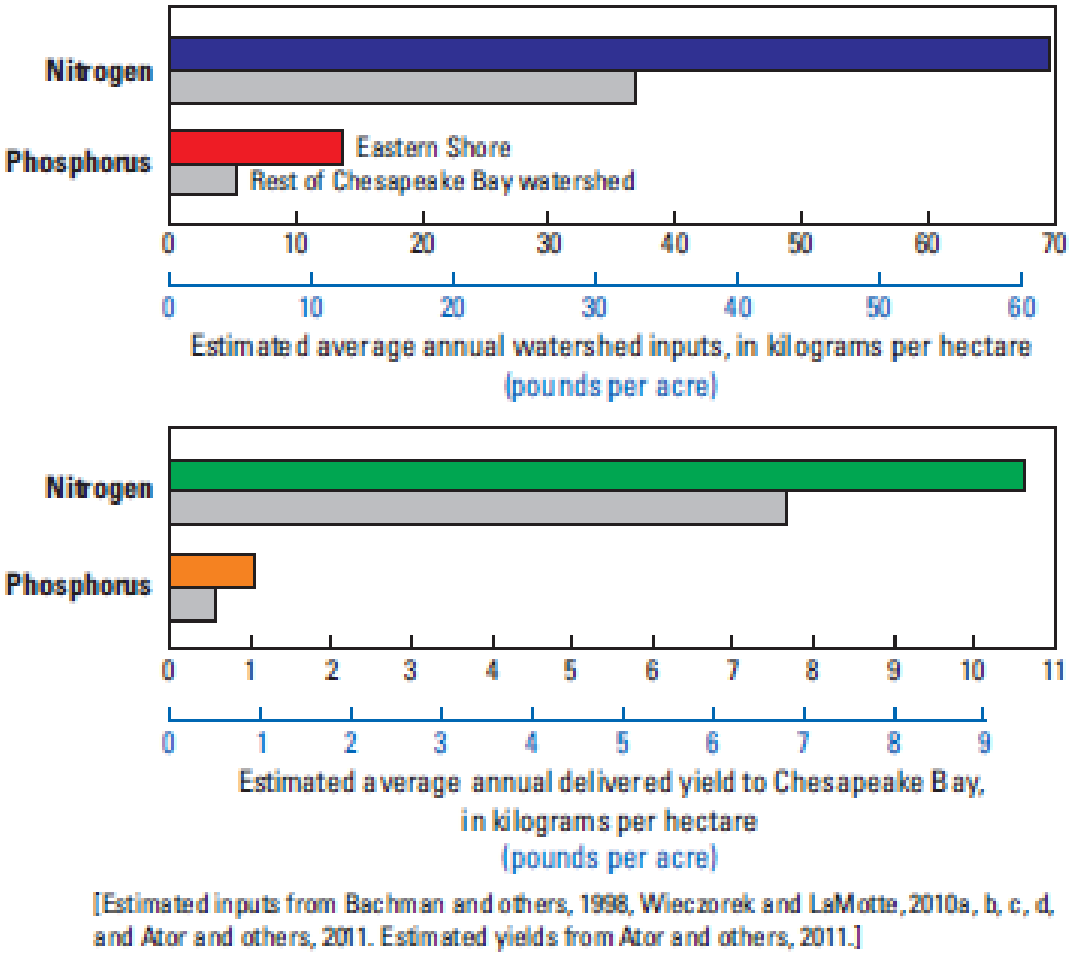
Delivery Variation Factor (DVF_i)



- Is independent of source*, a function only of land-to-water specification
- TP terms
  - Soil erodibility (+)
  - Soil drainage (-)
  - Coastal plain area (+)
  - Precipitation (+)

*DVFi = $\exp(\Sigma_m(\omega_{mn} Z_{mi} O_m))$, for sources interacting with same land-to-water terms

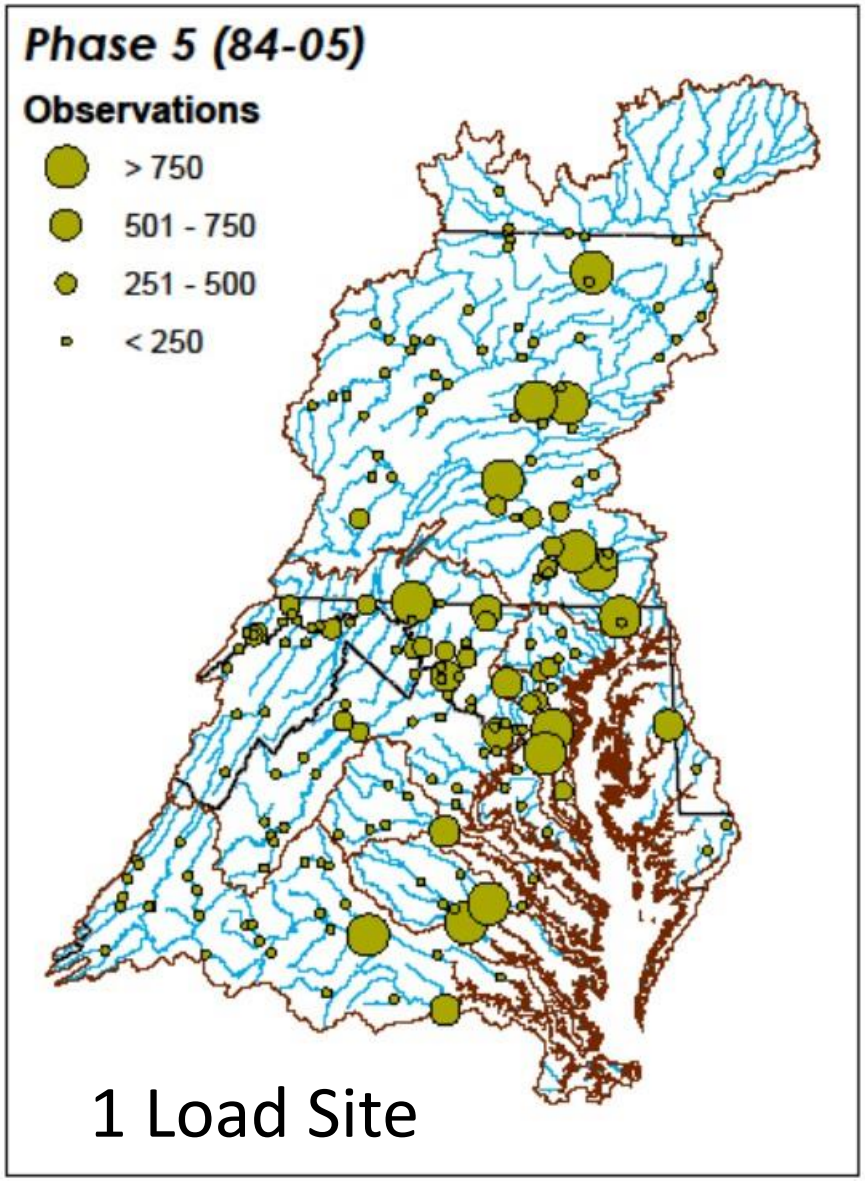
USGS eastern shore report

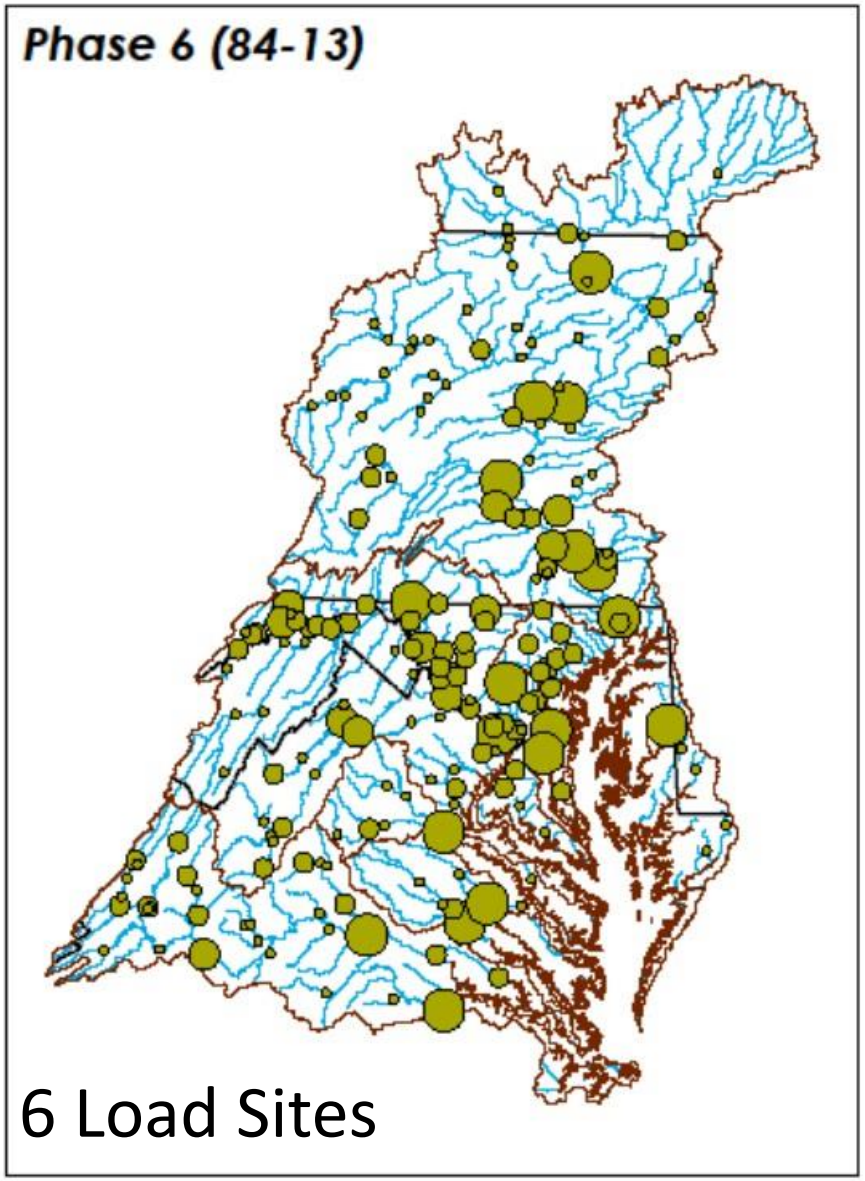


[Estimated inputs from Bachman and others, 1998, Wieczorek and LaMotte, 2010a, b, c, d, and Ator and others, 2011. Estimated yields from Ator and others, 2011.]

Figure 2. Nitrogen and phosphorus inputs to the Eastern Shore and yields from the Eastern Shore to Chesapeake Bay are substantially greater than in the remainder of the bay watershed.

Observed Total Phosphorus - Number of Observations

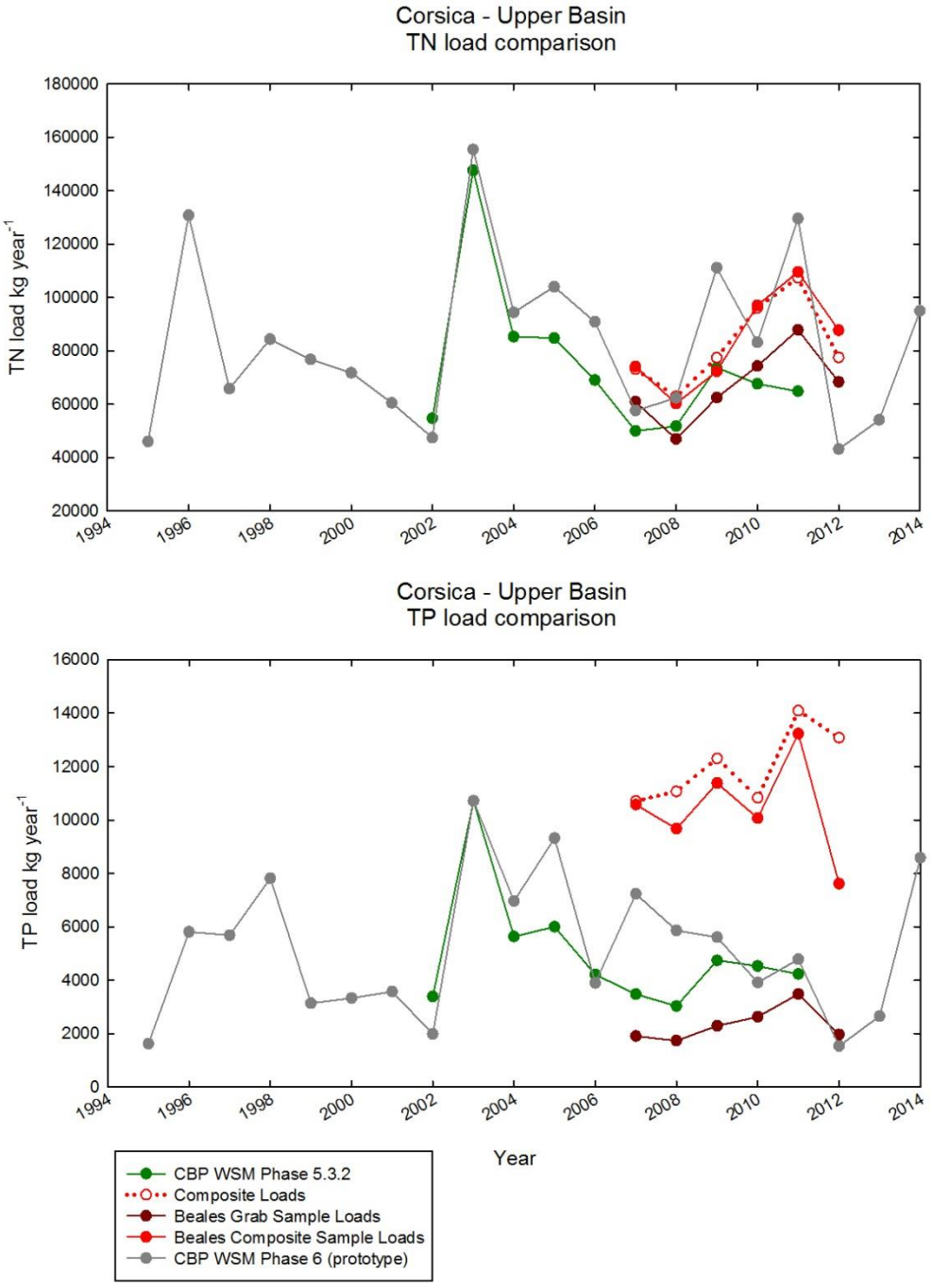




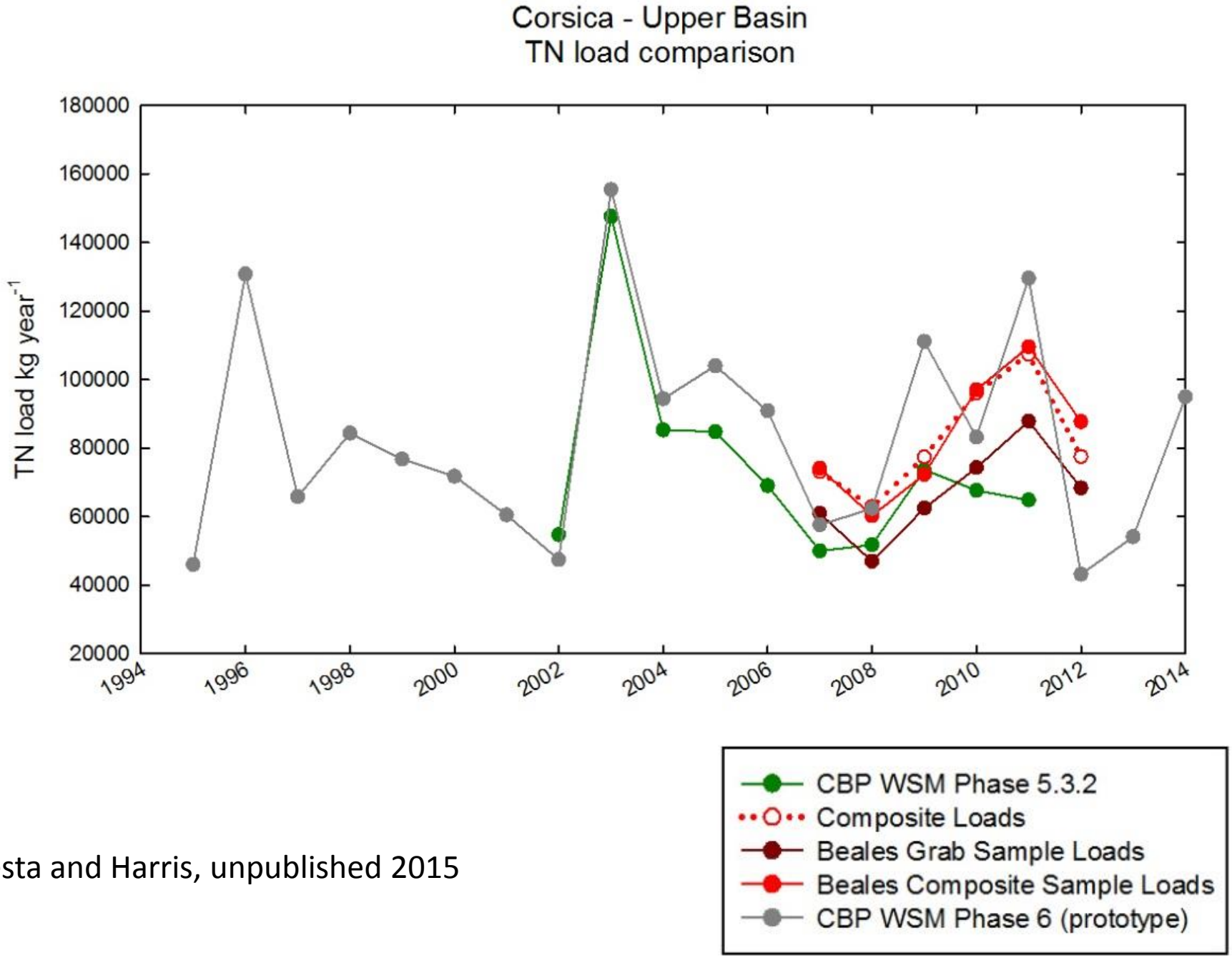
Comparing Different Load Estimates

1994-2014 (Model and Measured)

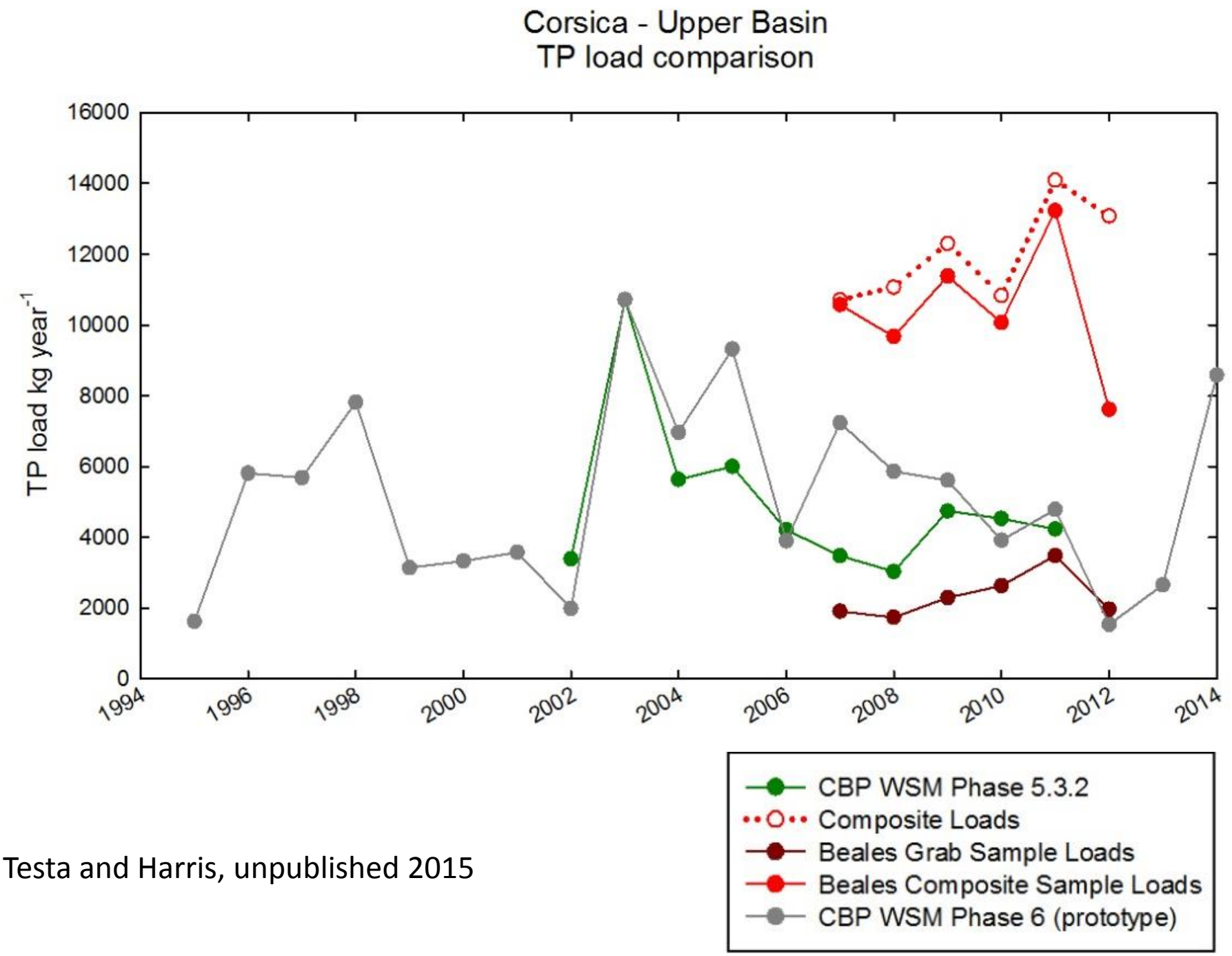
TN and TP



Testa and Harris, unpublished 2015

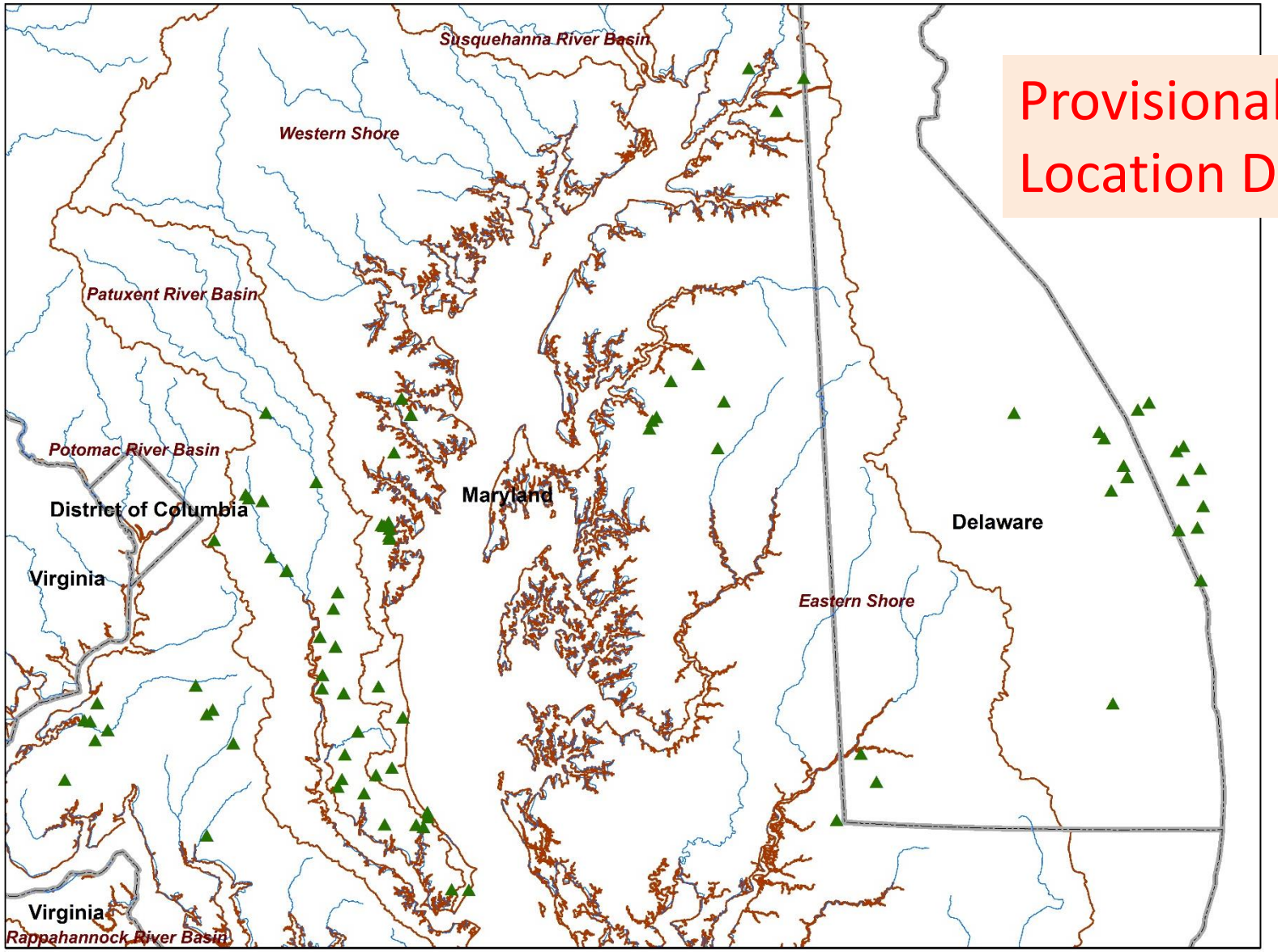


Testa and Harris, unpublished 2015

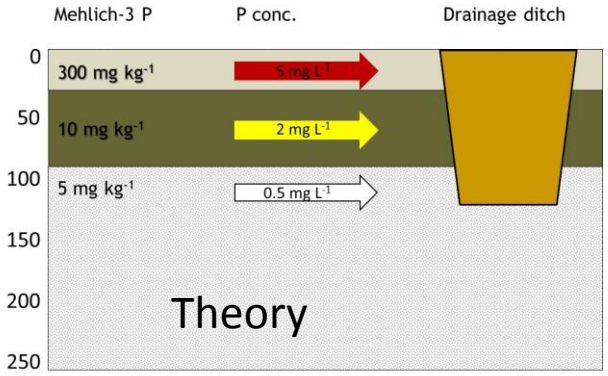


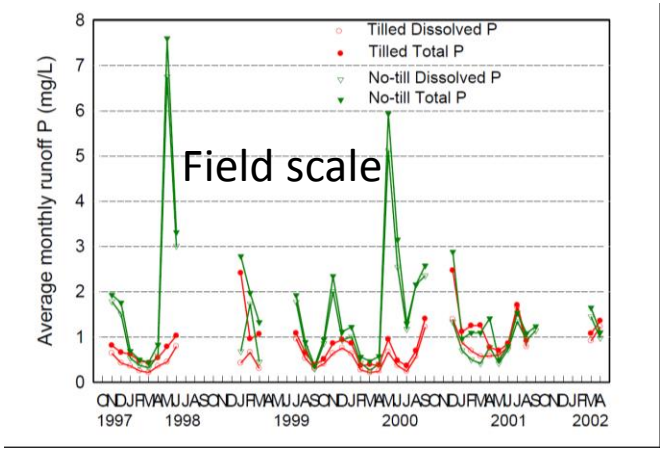
Testa and Harris, unpublished 2015

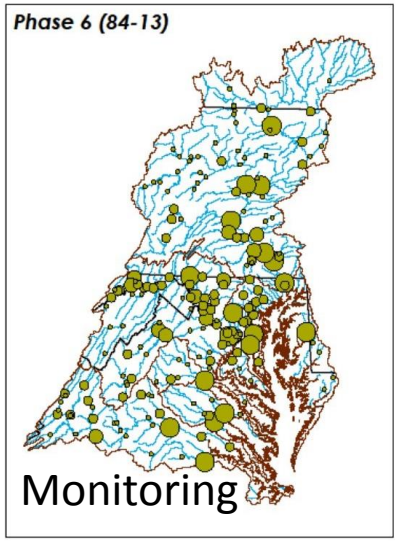
UMCES/SERC Load Data sites

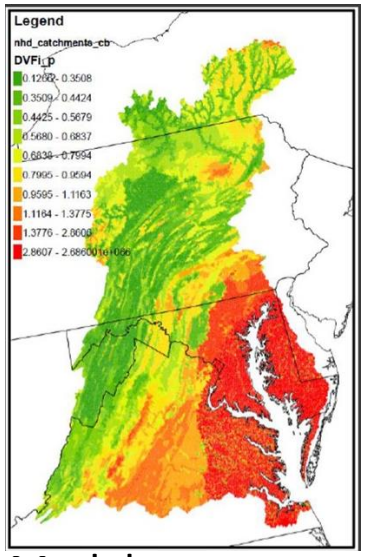


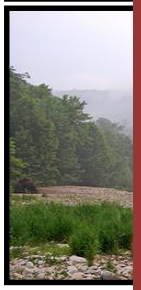
All Point in the same direction





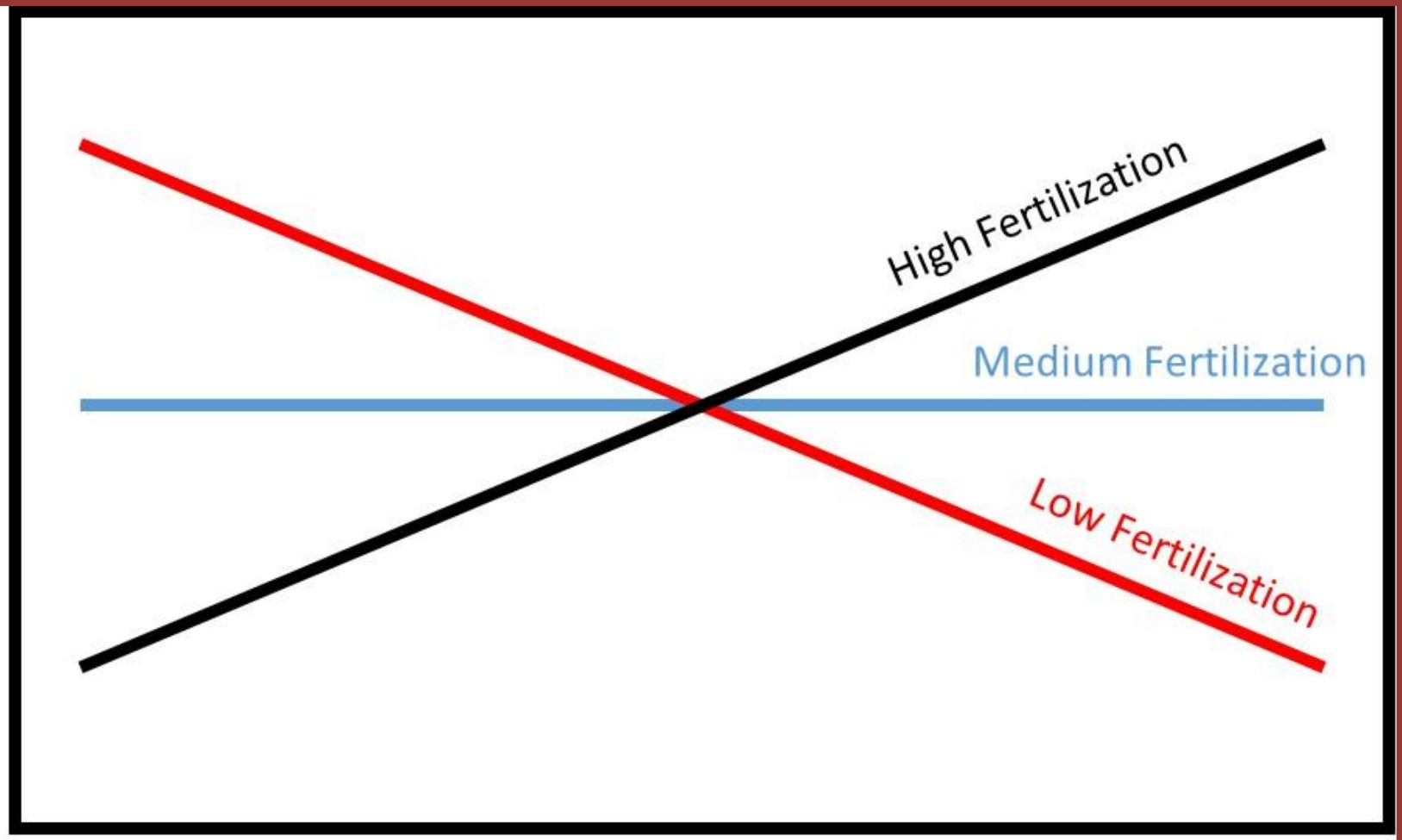






Yactayo

Estimated Average + Sensitivity * Δ Inputs



Estimated Average Load + **Sensitivity** * **Δ Inputs** * **BMPs** * **Watershed Delivery Variance** * **Delivery** * **Delivery**

Bhatt
12:40 am