CBP Modeling Quarterly Review Meeting

July 22, 2014

STAC Review of CBP Watershed Model Phosphorus processes

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College of Agriculture and Natural Resources
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Scientific and Technical Advisory Committee

June 17, 2014

Final report of the STAC ad hoc workgroup on how P transport from cropland is simulated in the Bay watershed model

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Discussions Regarding How P Reductions from Agriculture on the Eastern Shore of Maryland were Projected in the CBP Watershed Model for 1985-2000

MD DNR
February 16, 2011

Follow-up June 2011

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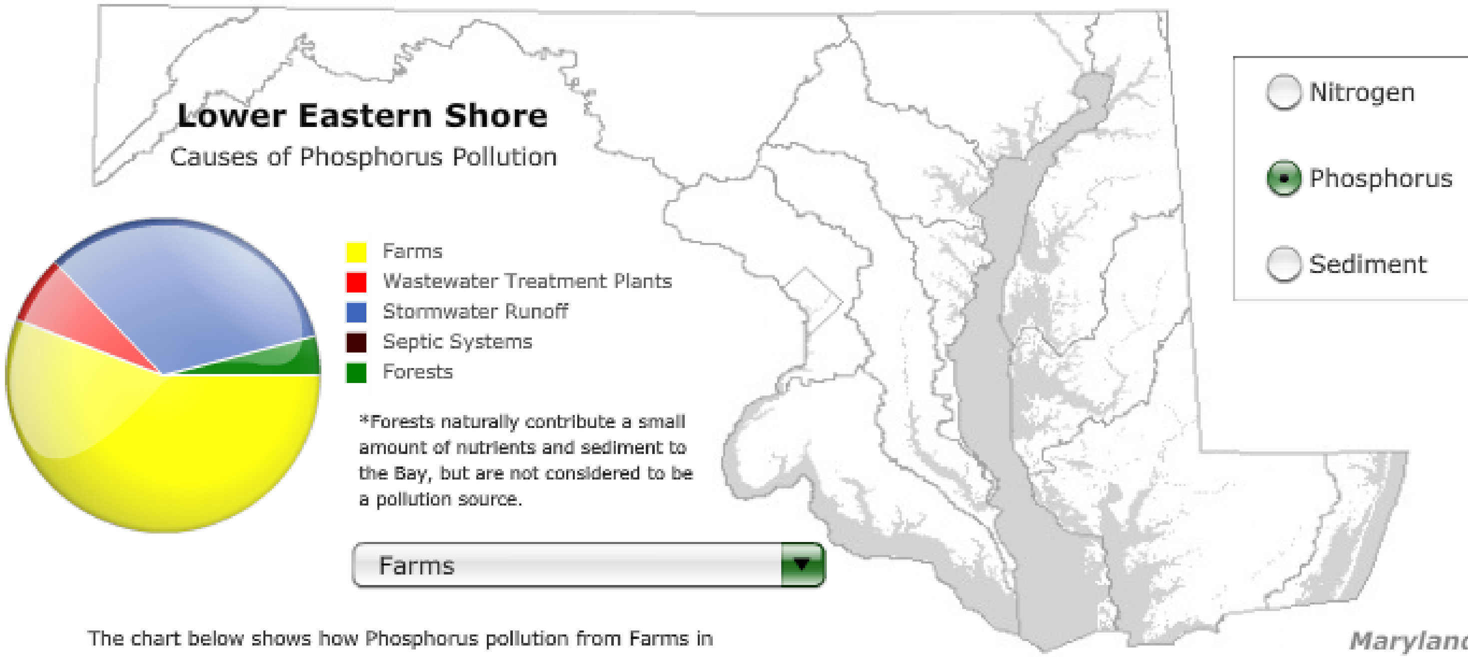
Causes of the Problems

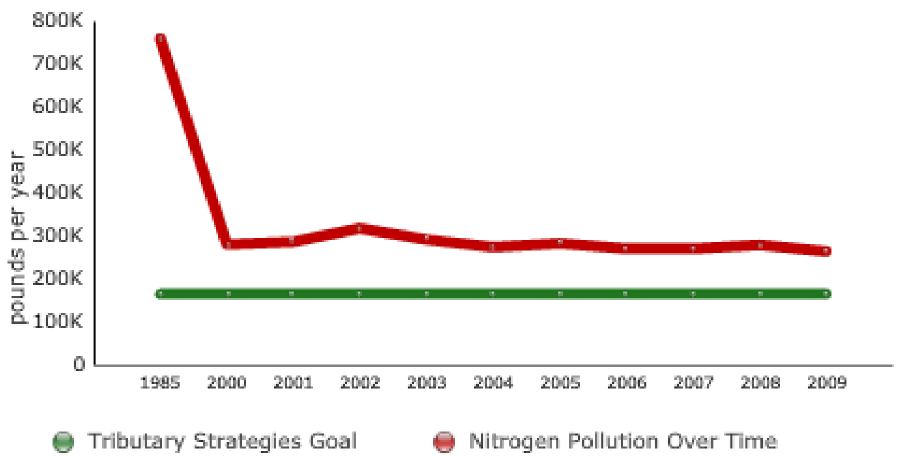


Nitrogen

Phosphorus

Sediment

The chart below shows how Phosphorus pollution from Farms in Lower Eastern Shore has changed over time.

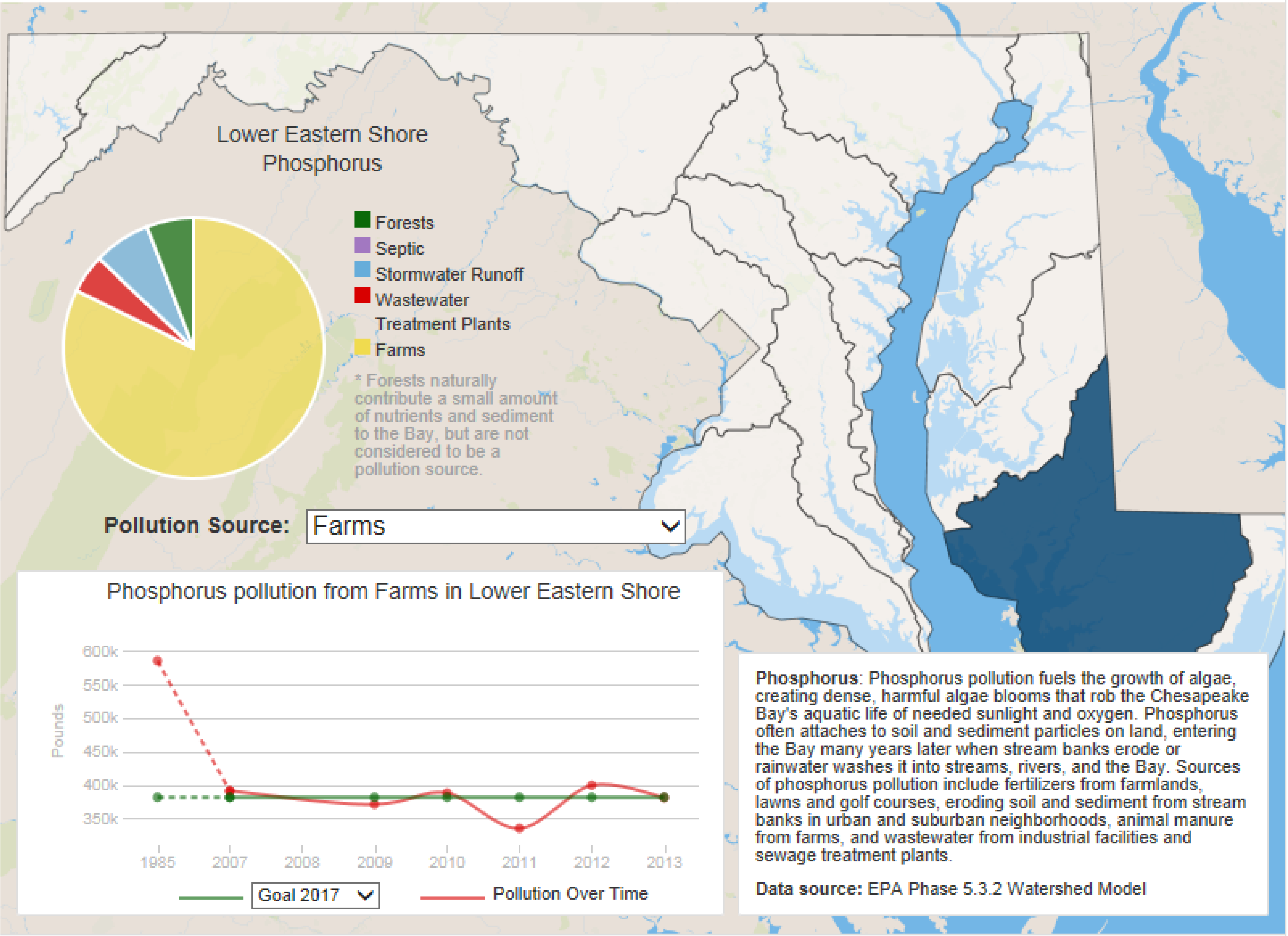


Phosphorus pollution fuels the growth of algae, creating dense, harmful algae blooms that rob the Chesapeake Bay's aquatic life of needed sunlight and oxygen. Phosphorus often attaches to soil and sediment particles on land, entering the Bay many years later when stream banks erode or rainwater washes it into streams, rivers and the Bay. Sources of phosphorus pollution include fertilizers from farmlands, lawns and golf courses; eroding soil & sediment from stream banks in urban and suburban neighborhoods; animal manure from farms; and wastewater from industrial facilities and sewage treatment plants.

Causes of Chesapeake Bay Pollution

Click map to select a basin.
Click here for statewide data.

Nitrogen / **Phosphorus** / Sediment — Tributary Basins



Phosphorus: Phosphorus pollution fuels the growth of algae, creating dense, harmful algae blooms that rob the Chesapeake Bay's aquatic life of needed sunlight and oxygen. Phosphorus often attaches to soil and sediment particles on land, entering the Bay many years later when stream banks erode or rainwater washes it into streams, rivers, and the Bay. Sources of phosphorus pollution include fertilizers from farmlands, lawns and golf courses, eroding soil and sediment from stream banks in urban and suburban neighborhoods, animal manure from farms, and wastewater from industrial facilities and sewage treatment plants.

Data source: EPA Phase 5.3.2 Watershed Model

Powered by open data on https://data.maryland.gov/

The MD Baystat website shows large P reductions in all three Eastern Shore tribs for 1985-2000, especially the lower Eastern Shore. The narrative for what actions generated these reductions is largely absent.

The workgroup

- Scott Ator -- USGS
- Anthony Buda – USDA ARS (PA)
- Quirine Ketterings -- Cornell
- Peter Kleinman – USDA ARS (PA)
- Tom Sims – UD
- Gary Shenk – EPA
- Russ Brinsfield – STAC (UMD)
- Bob Hirsch – STAC (USGS)
- Jack Meisinger – STAC (USDA ARS)

Objective 1

To gain an in-depth understanding of how the CBP watershed model currently simulates phosphorus loads from cropland and whether the current simulation approach is consistent with the latest scientific consensus regarding phosphorus transport mechanisms.

Objective 2

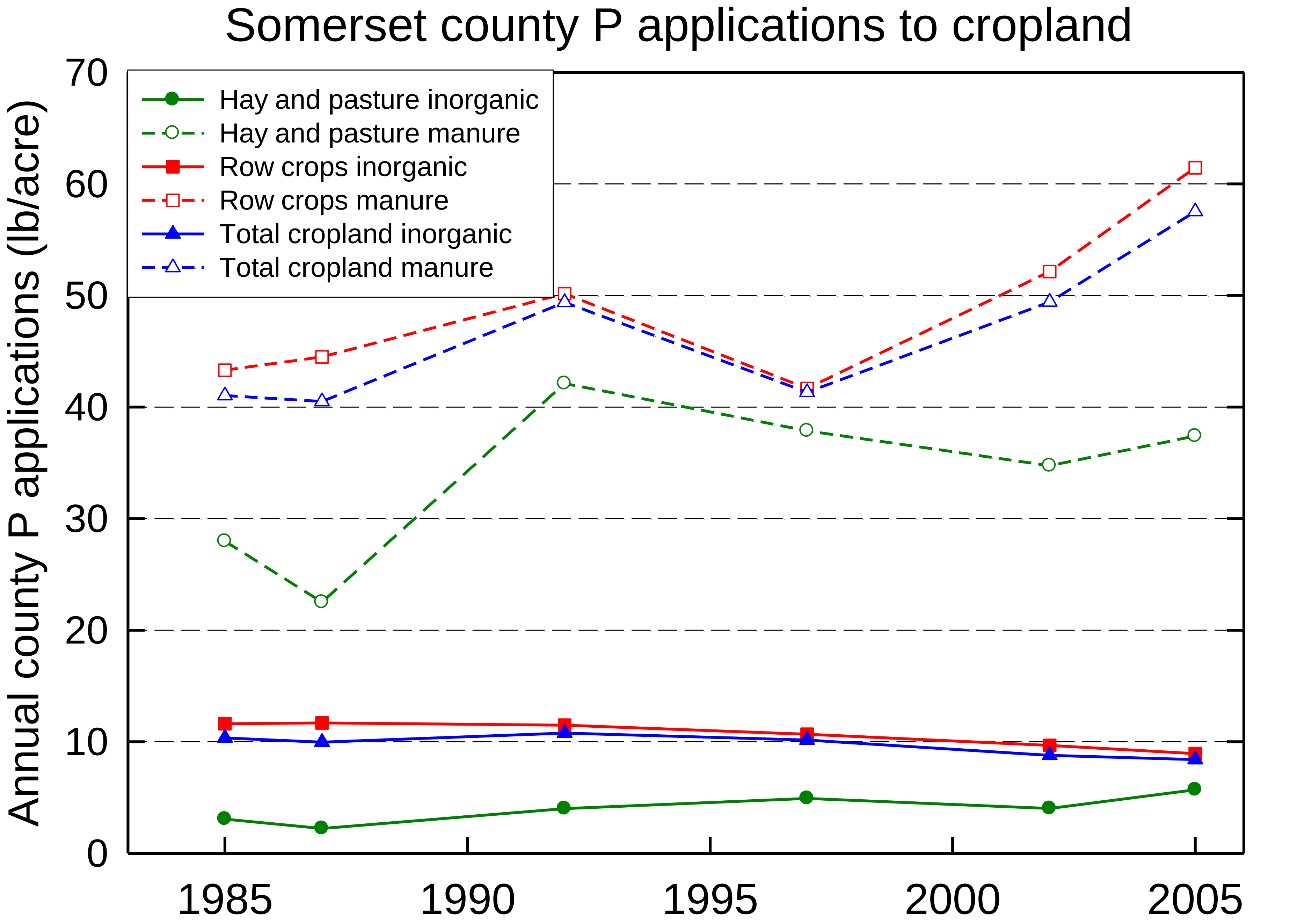
To make recommendations regarding how the CBP modeling approach should b restructured to more accurately reflect the latest research findings regarding phosphorus transport processes and what data inputs will be needed to support calibration and verification of a restructured modeling approach.

Activities

- February 6, 2012 – full day meeting with Gary Shenk to understand the current modeling approach
- February 29, 2012 – follow-up questions submitted to the Bay Program watershed modeling group
- December 2, 2012 – Received first installment of answers
- February 5, 2013 – Received full set of answers

Asked for information for three Bay watershed areas

1. PA dairy –
   Bradford county
2. Lower Susquehanna mixed –
   Lancaster county
3. Delmarva poultry –
   Somerset county


Somerset county P applications to cropland
Annual county P applications (lb/acre)
0
10
20
30
40
50
60
70
1985
1990
1995
2000
2005
Hay and pasture inorganic
Hay and pasture manure
Row crops inorganic
Row crops manure
Total cropland inorganic
Total cropland manure

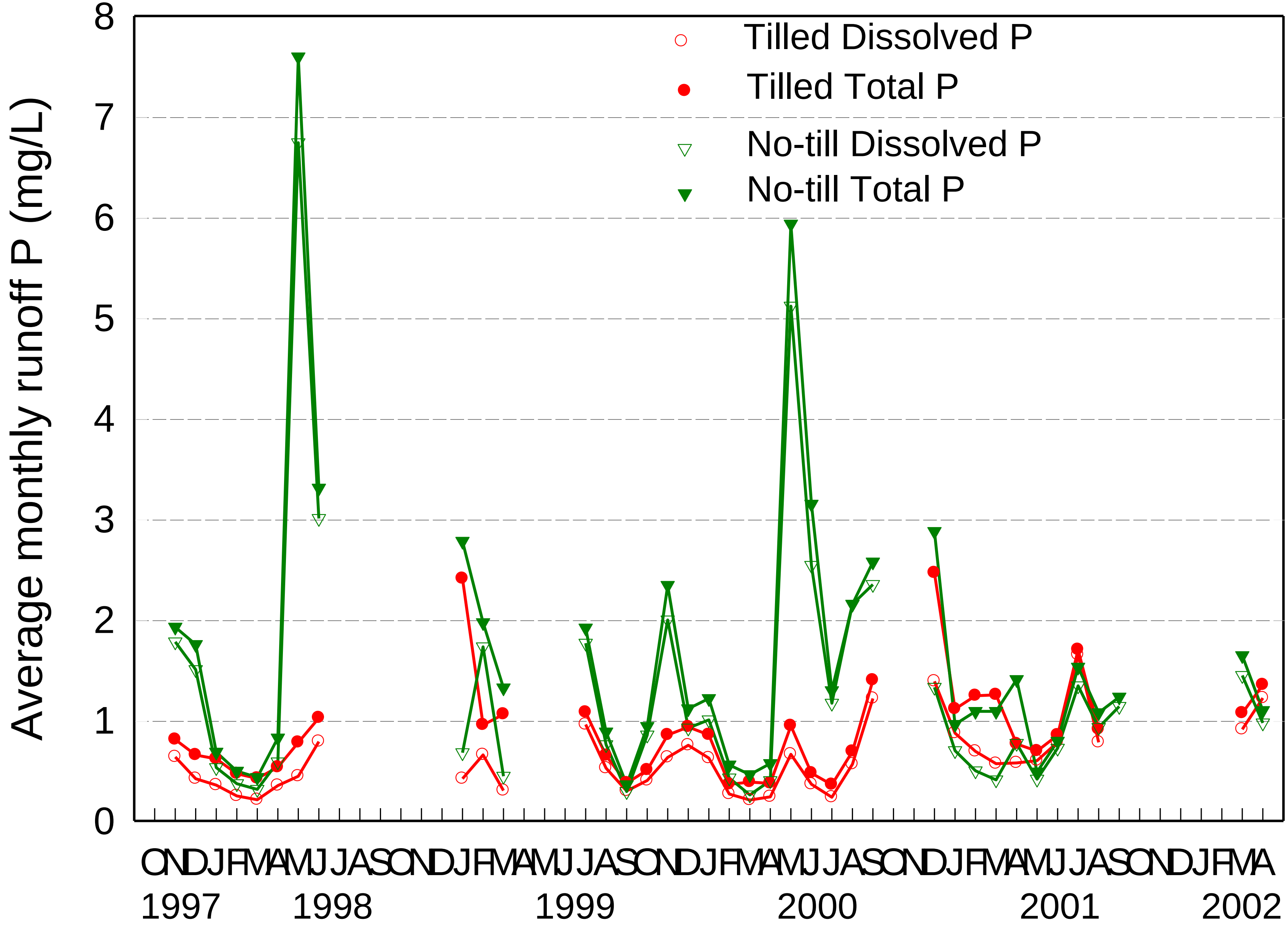
Agriculture and Phosphorus Management

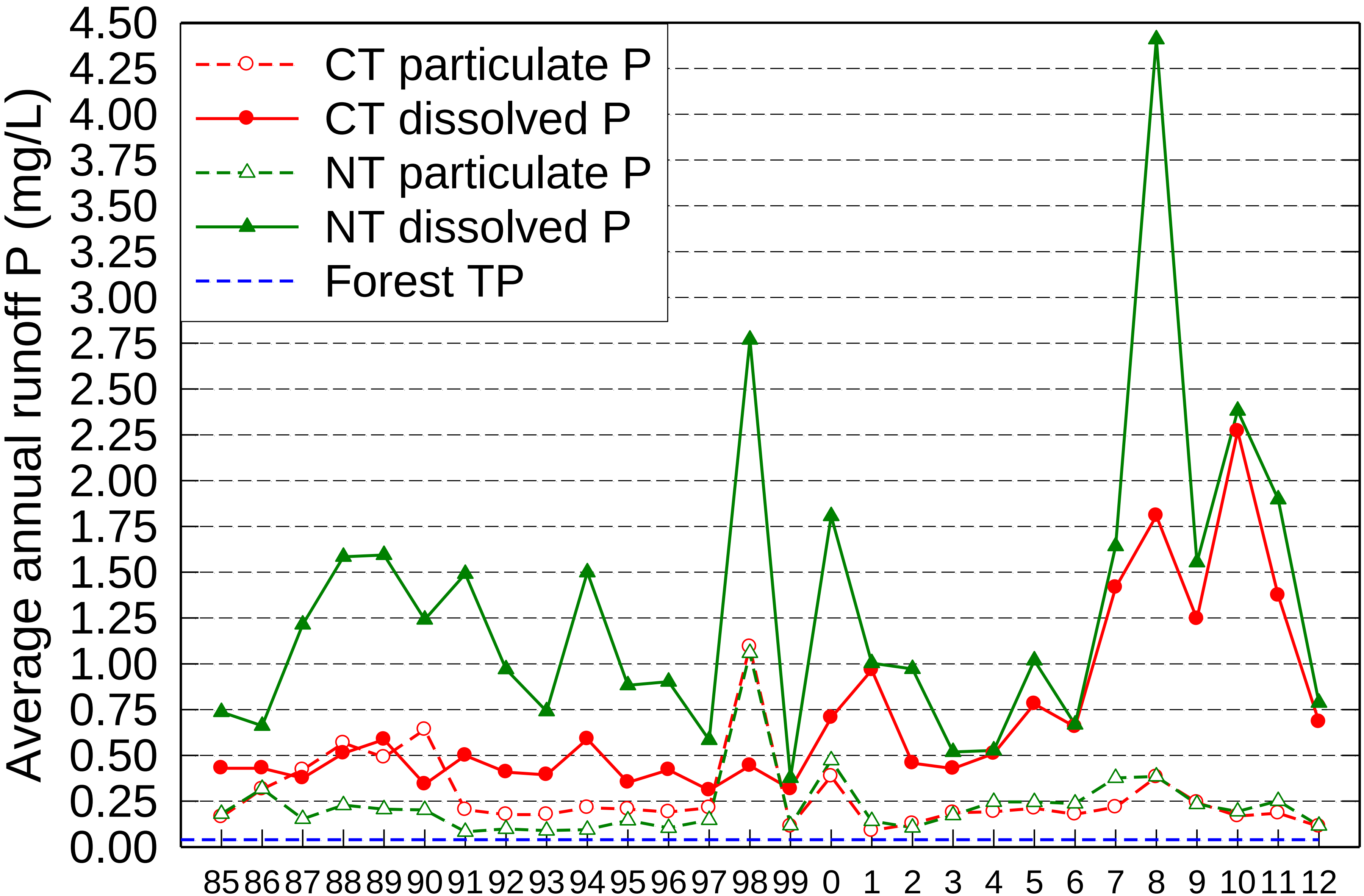
The Chesapeake Bay

Edited by Andrew N. Sharpley

Concluding Remarks

"The overall long-term goal of efforts to reduce P losses from agriculture to surface waters should aim to balance off-farm inputs of P in feed and fertilizer with P outputs as produce, along with managing soils in ways that retain nutrients and applied P resources."


Tilled Dissolved P
Tilled Total P
No-till Dissolved P
No-till Total P
Average monthly runoff P (mg/L)
0
1
2
3
4
5
6
7
8
ONDJFMAMJJASONDJFMAMJJASONDJFMAMJJASONDJFMAMJJASONDJFMA
1997
1998
1999
2000
2001
2002



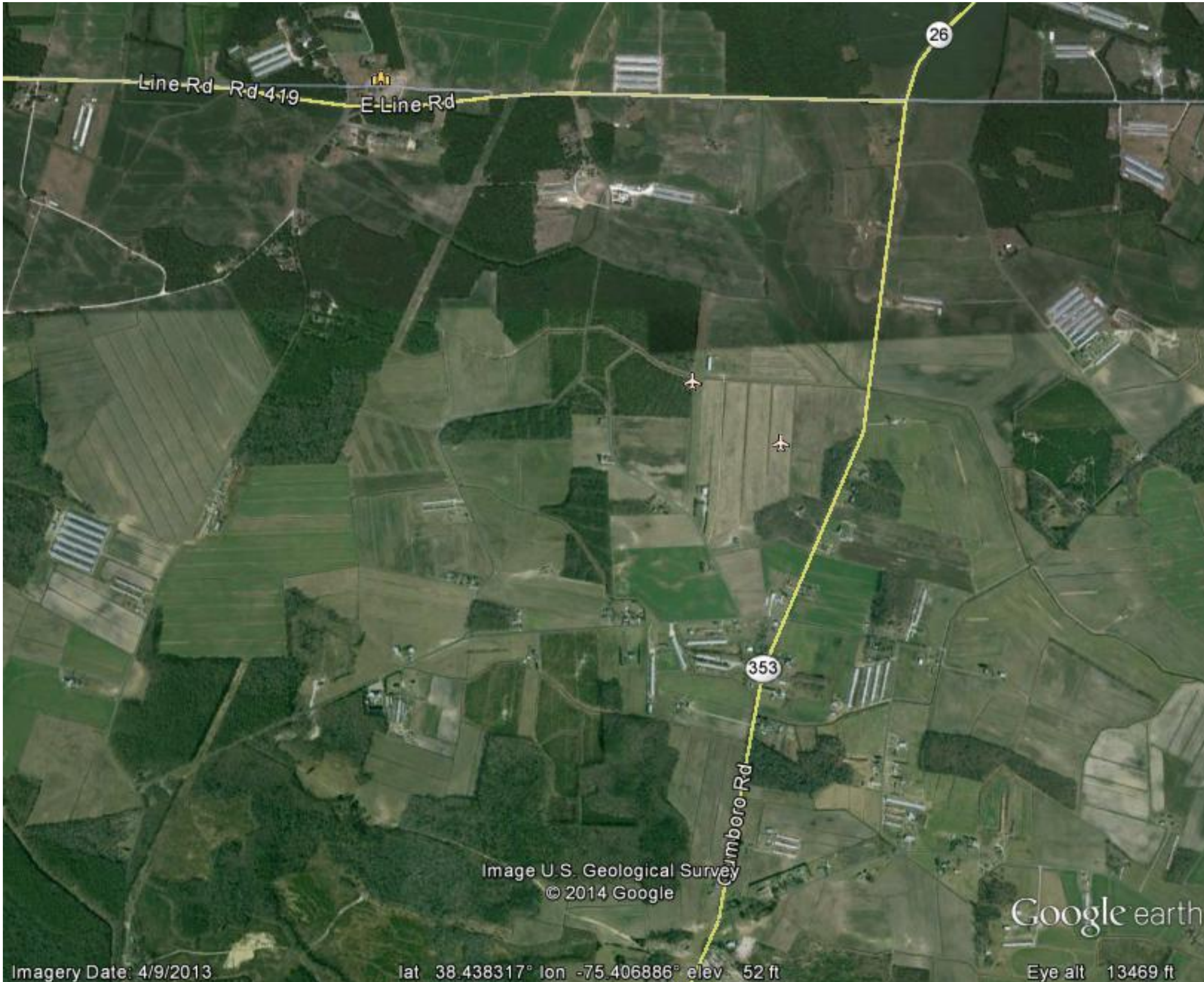
Average annual runoff P (mg/L)
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
CT particulate P
CT dissolved P
NT particulate P
NT dissolved P
Forest TP
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 0 1 2 3 4 5 6 7 8 9 10 11 12

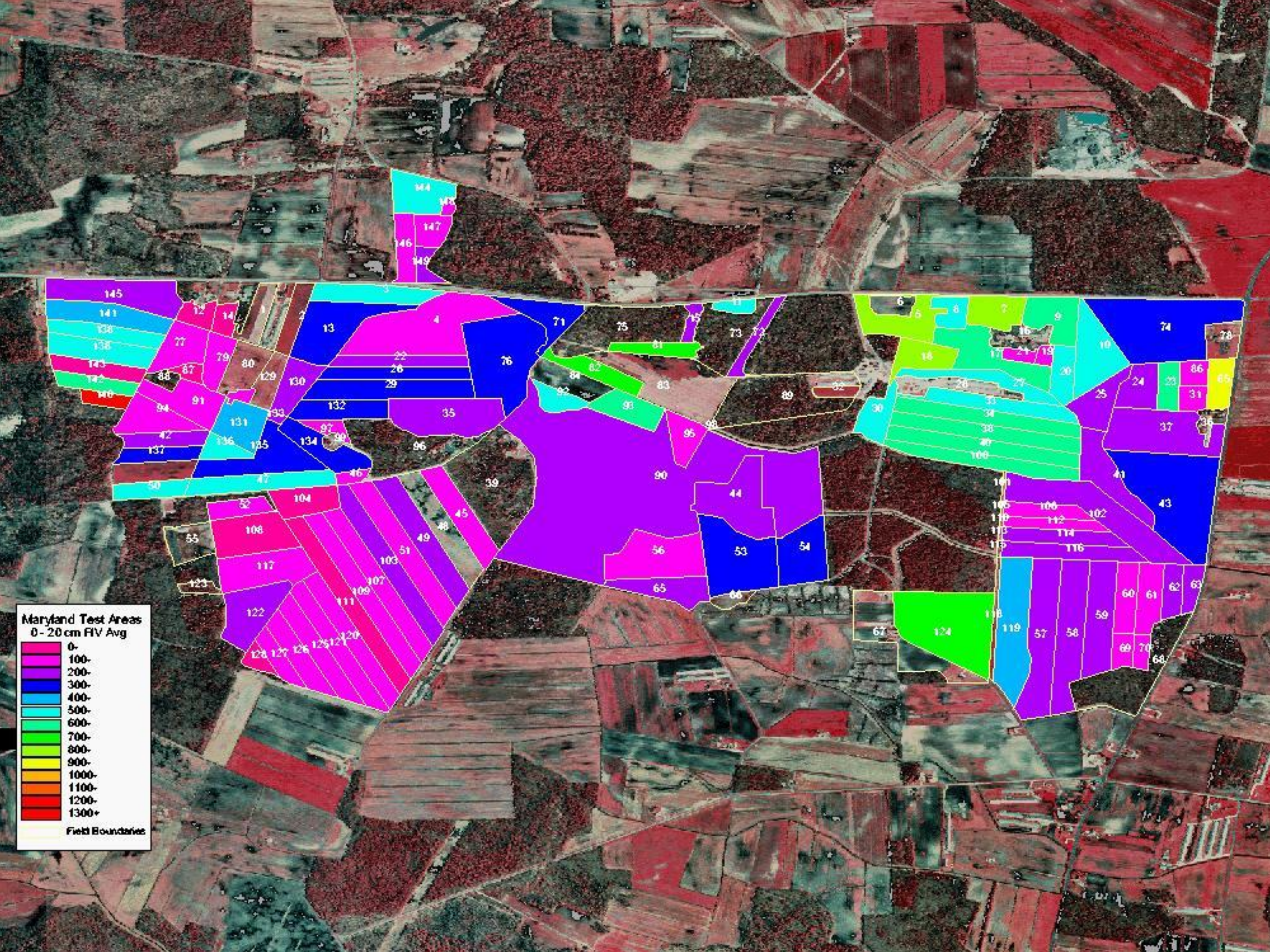
How P applications are managed is crucial to controlling P losses in surface runoff, independent of soil P levels.

Concluding Remarks

"The overall long-term goal of efforts to reduce P losses from agriculture to surface waters should aim to balance off-farm inputs of P in feed and fertilizer with P outputs as produce….",

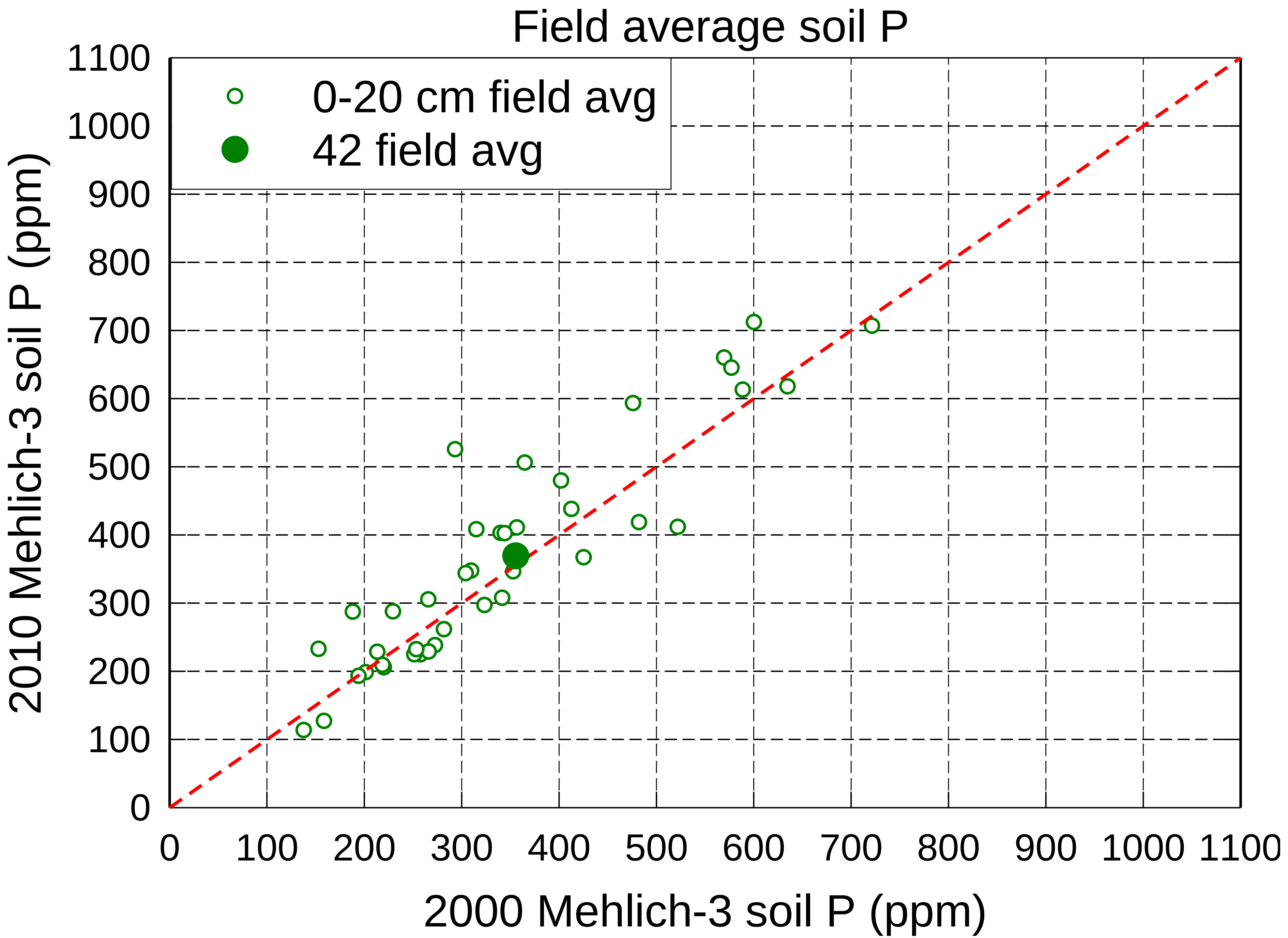
More simply: Manage soil P


26
Line Rd
Rd 419
E Line Rd
353
Cumboro Rd
Image U.S. Geological Survey
© 2014 Google
Google earth
Imagery Date: 4/9/2013
lat 38.438317° lon -75.406886° elev 52 ft
Eye alt 13469 ft


Maryland Test Areas
0 - 20 cm RV Avg
0-
100-
200-
300-
400-
500-
600-
700-
800-
900-
1000-
1100-
1200-
1300+
Field Boundaries

Pocomoke River Watershed

- 4 million lbs poultry litter P/year
- 100,000 acres cropland
- 40 lbs P/acre/year applied
- 20 lbs P/acre/year removed in harvested grain


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

After assumptions, the math is simple!

From 1960-2000 P was being added to cropland in Green Run watershed at a rate of ~ 40 kg/ha/yr, increasing M-3 P ~ 9 units/yr. 2000-2010 average crop harvests in Wicomico County removed ~ 20 kg P/ha, which will reduce M-3 P ~ 4-5 units/year.

What we know about managing cropland P losses

1. Soil P concentrations and how we manage the soil and P applications are the major drivers for P losses that we can control.

2. Most efforts to reduce cropland P losses address these drivers.

It follows that …

The simulation process should capture the effect of management efforts on the major drivers of cropland P losses which will require collection of needed information.

Recommendations – general

1. Identify the fraction of P losses associated with short- versus long-term management
2. Model function should be capable of scaling down to provide segment and field guidance on drivers of P loss
3. Shift away from using model logic and proxy data for key parameters

Recommendations – soil P

1. Account for existing soil P reservoirs on a segment by segment basis
2. Track segment P balances to determine whether soil P reservoirs are increasing or decreasing
3. Describe the temporal dynamics of the effects of drawdown/buildup of soil P reservoirs on P losses
4. Vary soil P isotherms based on soil type

Rec. – Management of P inputs

1. Account for variations in P application method and if manure is incorporated
2. Apply manure at rates and times based on watershed or regional information
3. Account for P stratification that develops in soils in continuous no-till
4. Account for interaction effect between tillage and manure application on potential for P losses

Future data needs

1. Segment baseline soil P levels
2. Information on P application methods
3. Spatial and temporal data on manure application
4. Inorganic P application rates
5. More systematic storm water sampling in predominantly agricultural watersheds for use in model calibration