Poultry in the Chesapeake Bay Program's Phase 6 Watershed Model

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CBPO Non-Point Source Data Analyst

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USGS – CBPO

Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

How much? Applied where?

How is P runoff calculated?

*

Land Use Acres

*

BMPs

*

Land to Water

Direct Loads

*

Stream Delivery

*

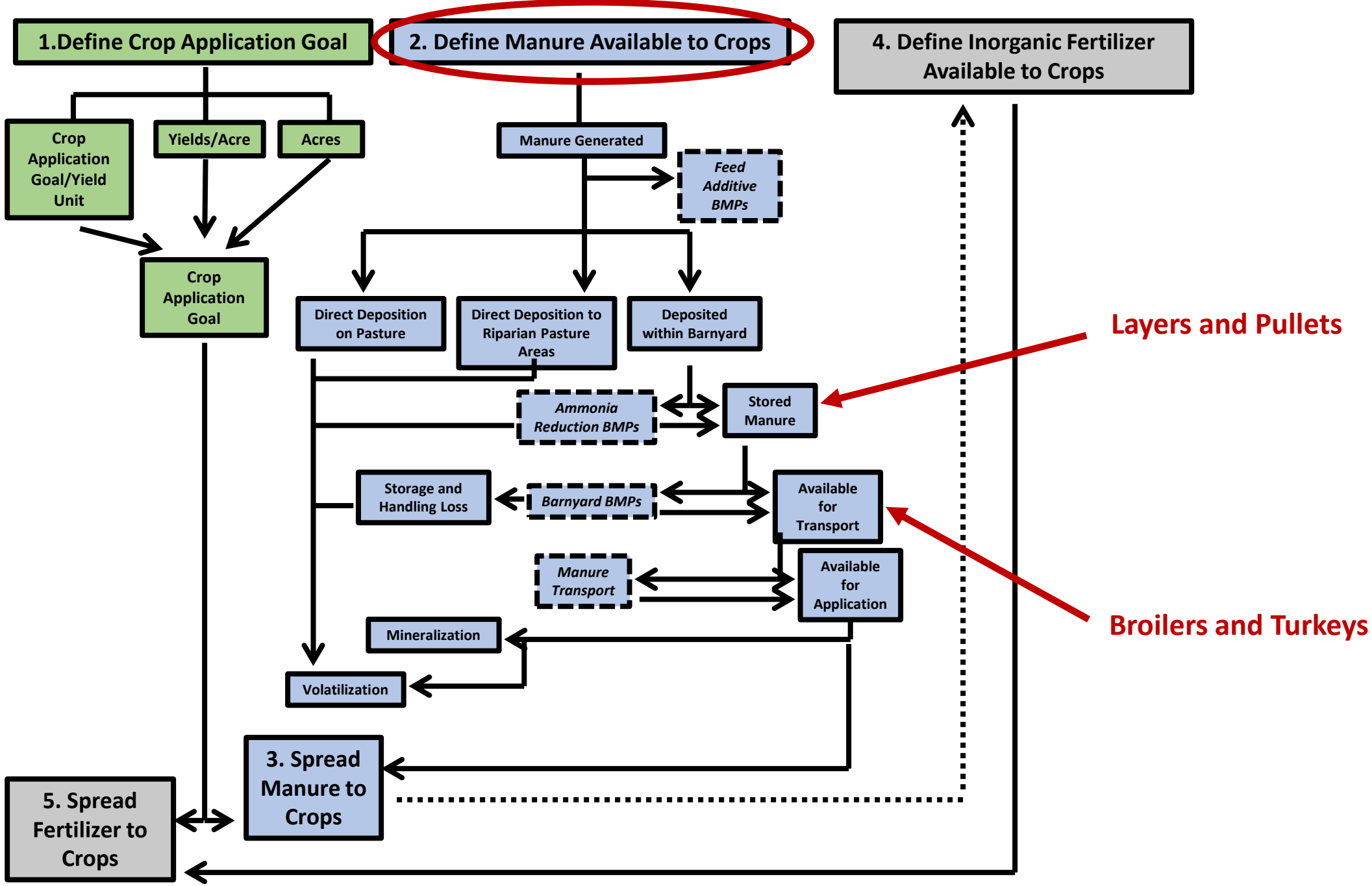
River Delivery

How does estimated delivery compare to monitored data?

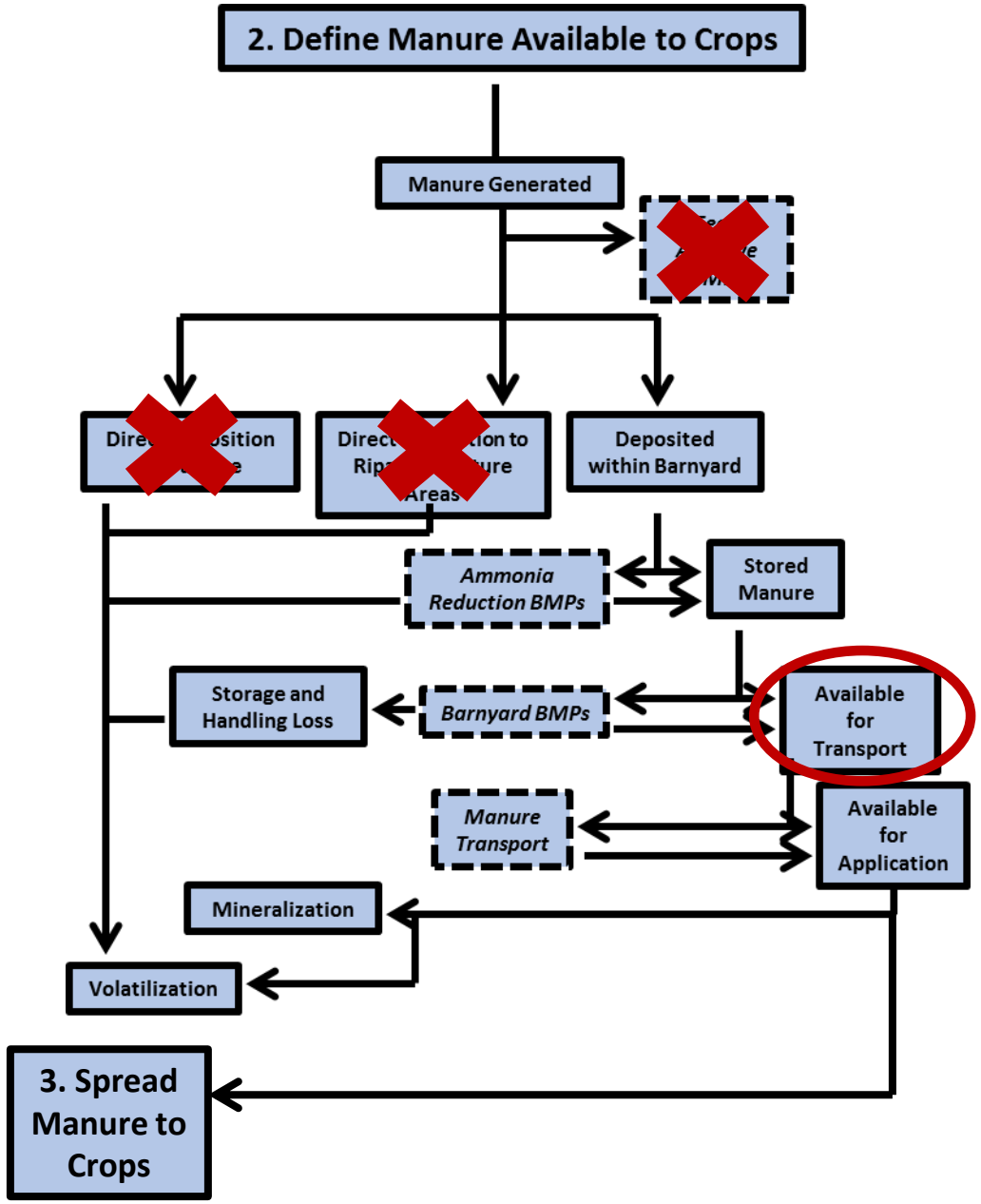
Phase 6

How far have we come?

- 2013 –
  - Building a Better Bay Model – Agricultural producers and industry representatives stressed the need for better poultry data to inform modeling tools.
- 2013-2015 –
  - Over 10,000 nutrient concentration samples collected and analyzed by partners across the watershed to better characterize poultry.
  - Developed new approach to estimating populations for turkeys and broilers.
- 2016-2017 –
  - Tested and refined poultry information in the model.
- Today –
  - Describe how it all works.
- Tomorrow-July 31 -
  - Provide feedback to Matt Johnston at mjohnston@chesapeakebay.net and Gary Shenk at gshenk@chesapeakebay.net.


1.Define Crop Application Goal
2. Define Manure Available to Crops
4. Define Inorganic Fertilizer Available to Crops
Crop Application Goal/Yield Unit
Yields/Acre
Acres
Manure Generated
Feed Additive BMPs
Crop Application Goal
Direct Deposition on Pasture
Direct Deposition to Riparian Pasture Areas
Deposited within Barnyard
Layers and Pullets
Ammonia Reduction BMPs
Stored Manure
Storage and Handling Loss
Barnyard BMPs
Available for Transport
Manure Transport
Available for Application
Broilers and Turkeys
Mineralization
Volatilization
3. Spread Manure to Crops
5. Spread Fertilizer to Crops

Manure Generation for Broilers - Equation

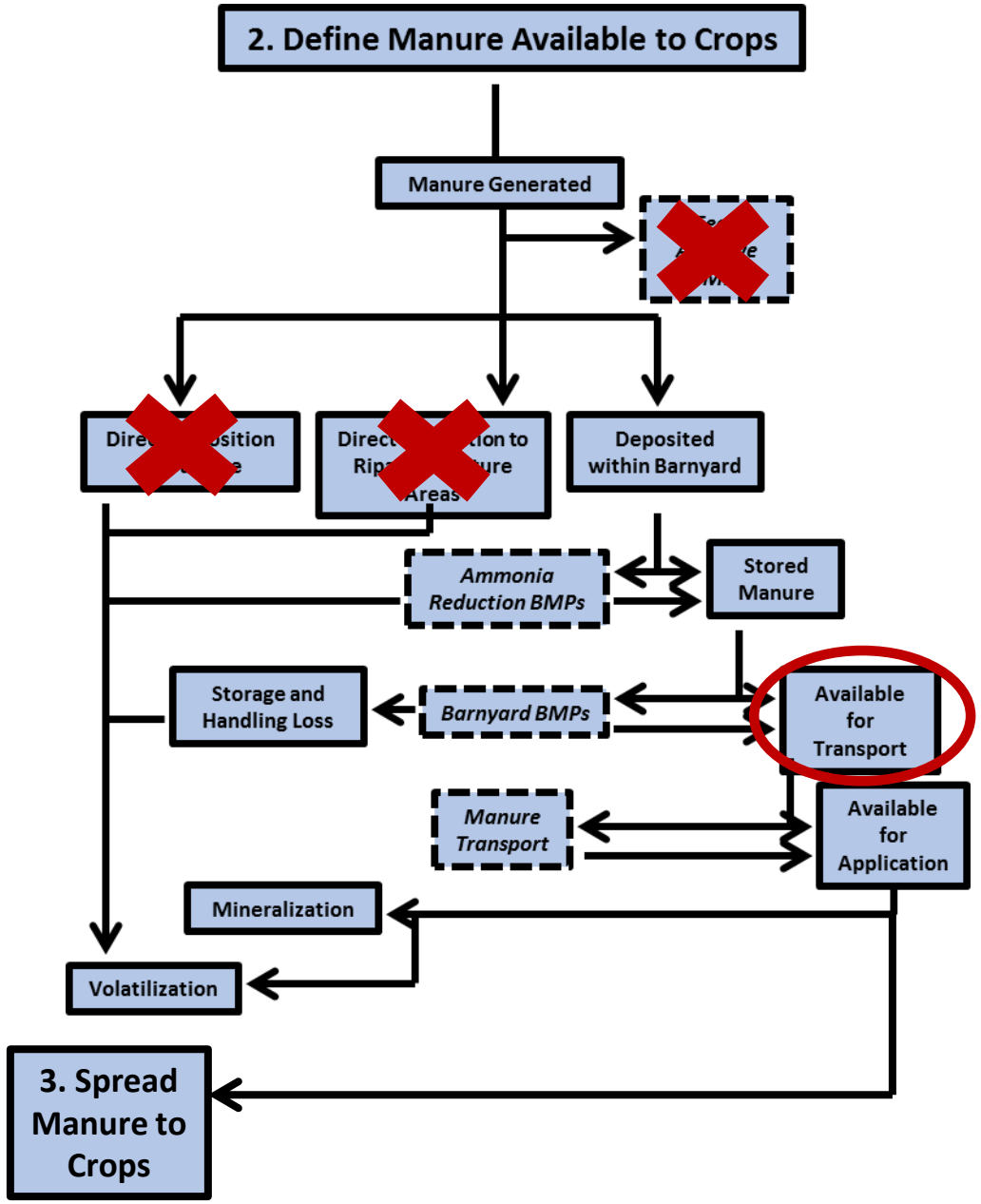


Lbs of P/Year =
(Lbs of Litter/Bird Produced)
X
(Lbs of Dry Matter/Lb of Litter)
X
(Lbs of P/Lb of Dry Matter)
X
(Birds Produced/Year)

Multiply:

- Litter Production – Based upon PLS report; tied to average market weight
- Dry Matter Fraction - Based upon PLS report
- Litter Nutrient Concentration - Based upon PLS report
- Birds Produced – NASS annual production data

Manure Generation for Broilers - Population



Broiler Production and Value – States, United States, and 19 State Total: 2013

[Annual estimates cover the period December 1 previous year through November 30. Broiler production including other domestic meat-type strains. Excludes States producing less than 500,000 broilers]

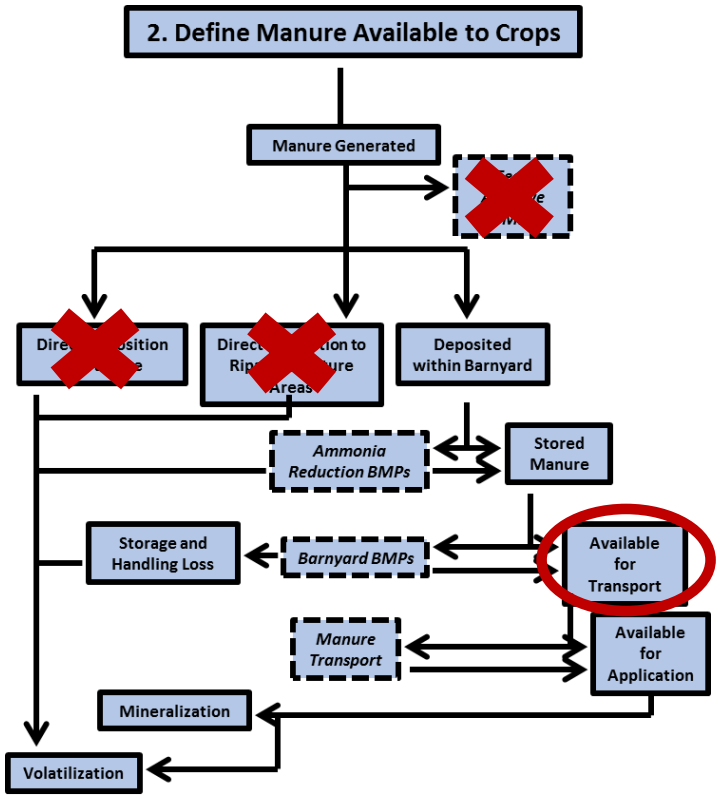
State	Number produced	Pounds produced	Value of production
	(1,000 head)	(1,000 pounds)	(1,000 dollars)
Alabama	1,048,600	5,872,200	3,558,553
Arkansas	996,400	5,978,400	3,622,910
Delaware	215,600	1,530,800	927,665
Florida	64,400	392,800	238,037
Georgia	1,334,600	7,607,200	4,609,963
Kentucky	309,000	1,668,600	1,011,172
Maryland	305,200	1,617,600	980,266
Minnesota	48,100	283,800	171,983
Mississippi	734,000	4,477,400	2,713,304
Missouri	277,400	1,331,500	806,889
North Carolina	785,500	5,891,300	3,570,128
Ohio	70,100	406,600	246,400
Oklahoma	206,200	1,360,900	824,705
Pennsylvania	168,800	945,300	572,852
South Carolina	226,500	1,585,500	960,813
Tennessee	172,800	898,600	544,552
Texas	610,100	3,599,600	2,181,358
Virginia	249,600	1,347,800	816,767
West Virginia	96,800	387,200	234,643
Wisconsin	53,100	223,000	135,138
Other States [1]	552,000	3,220,600	1,951,683
United States	8,524,800	50,626,700	30,679,781
19 State Total [2]	8,222,700	49,008,600	29,699,212

[1] California, Illinois, Indiana, Iowa, Louisiana, Michigan, Nebraska, New York, Oregon, and Washington combined to avoid disclosing individual operations.

[2] States in the 19 State Total include Alabama, Arkansas, California, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Missouri, Mississippi, North Carolina, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

NASS, 2014. Poultry Production and Value. United States Department of Agriculture's National Agricultural Statistics Service. Updated, April, 2014. http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1130

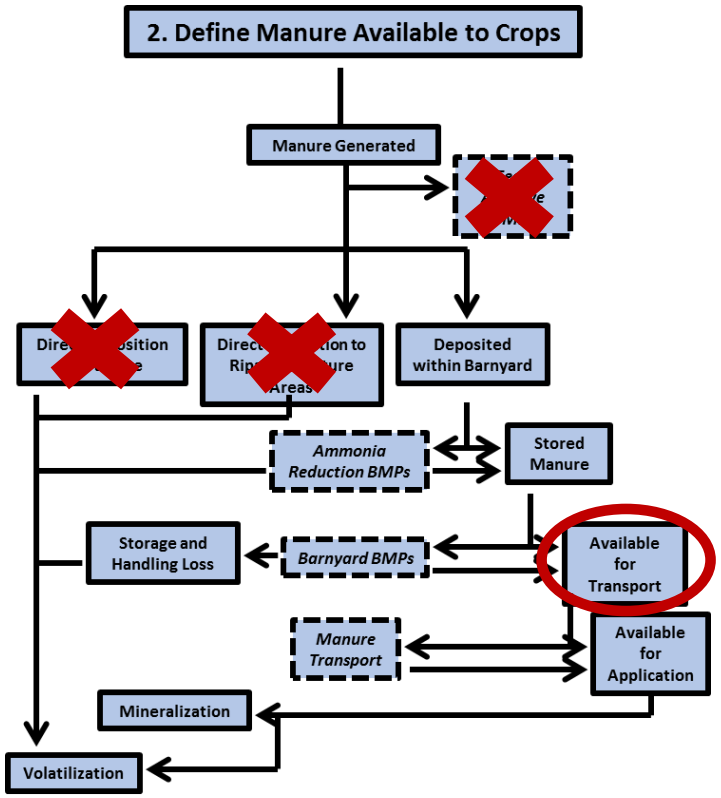
Manure Generation for Broilers - Population



County	2012 Ag Census Inventory	2012 Ag Census Fraction	2013 NASS Production	Final 2013 Production Estimate
Kent	7,708,825	0.178418	-	37,824,641
New Castle	-	-	-	-
Sussex	35,497,689	0.821582	-	174,175,359
Statewide	43,206,514	-	212,000,000.00	212,000,000

- NASS statewide data broken down to county based upon the fraction of Ag Census inventory data for broilers in that county.
- States have option of providing data to replace fractions.

Manure Generation for Broilers - Population



Look What the Chicken Industry Is Doing for Delmarva

2012 Facts about Delmarva's Meat Chicken Industry

Annual broiler/roaster/Cornish production	558,146,613
Total pounds produced	3,611,418,401
Number of broiler/roaster/Cornish houses	4,604
Broiler/roaster/Cornish house capacity	118,098,161
Broiler/roaster/Cornish, and breeder growers	1,632
Poultry company employees	13,300
Value of chicks started	$164,088,599
Annual feed bill	$1,232,577,588
Bushels of corn used for feed	78,986,205
Bushels of soybeans used for feed	24,793,709
Bushels of wheat used for feed	370,402
Packaging and other processing supplies	$174,682,277
Poultry company capital improvements	$71,987,475
Grower contract payments	$190,064,635
Poultry companies payroll, excluding benefits	$443,058,177
Wholesale value of broilers/roasters/Cornish	$2,675,660,872

Each job in the poultry processing industry creates 7.2 jobs elsewhere.

A University of Maryland study concluded that jobs directly and indirectly dependent upon the broiler chicken industry represent over one out of every twelve jobs in the region.

Prepared by:
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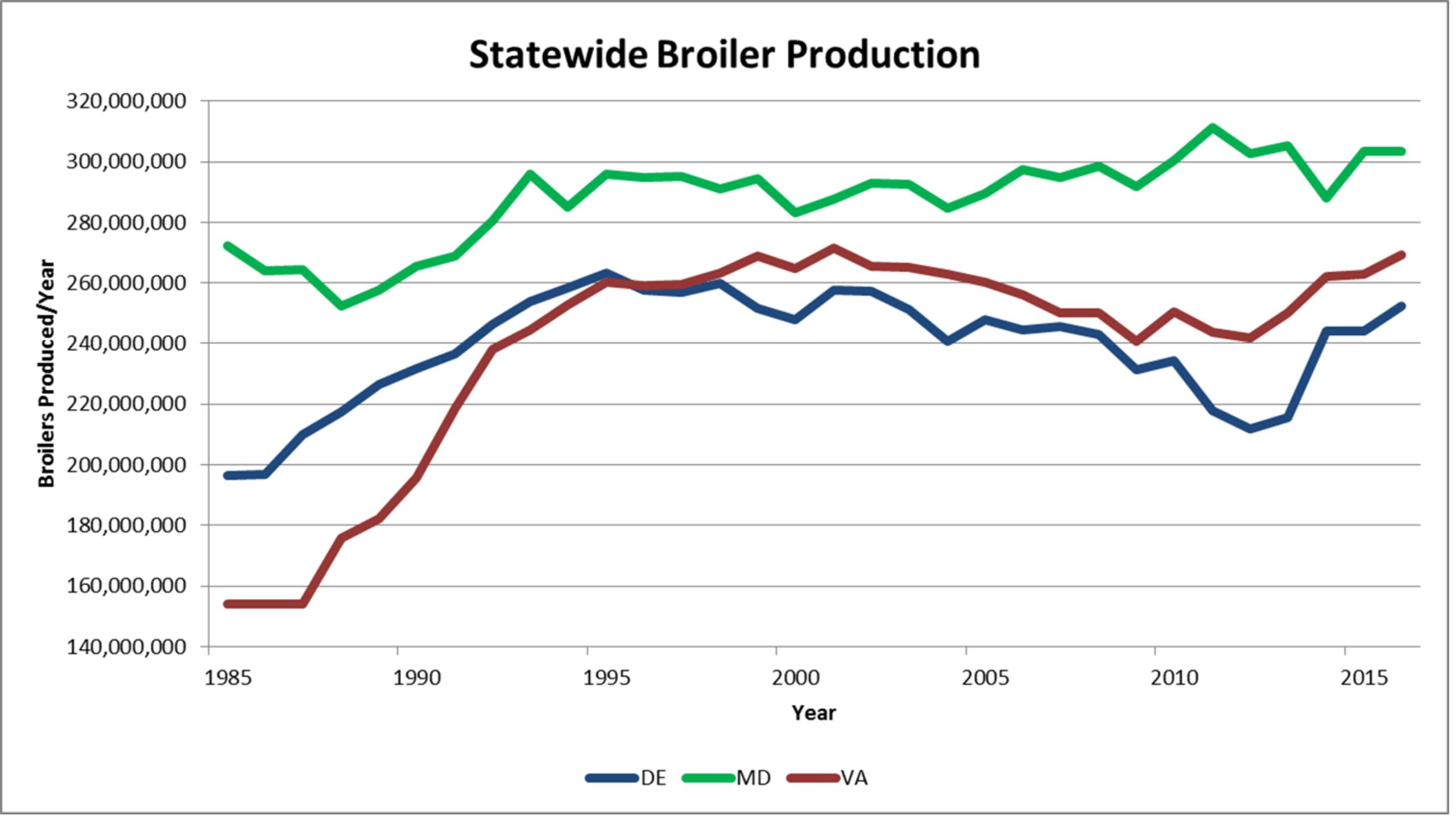
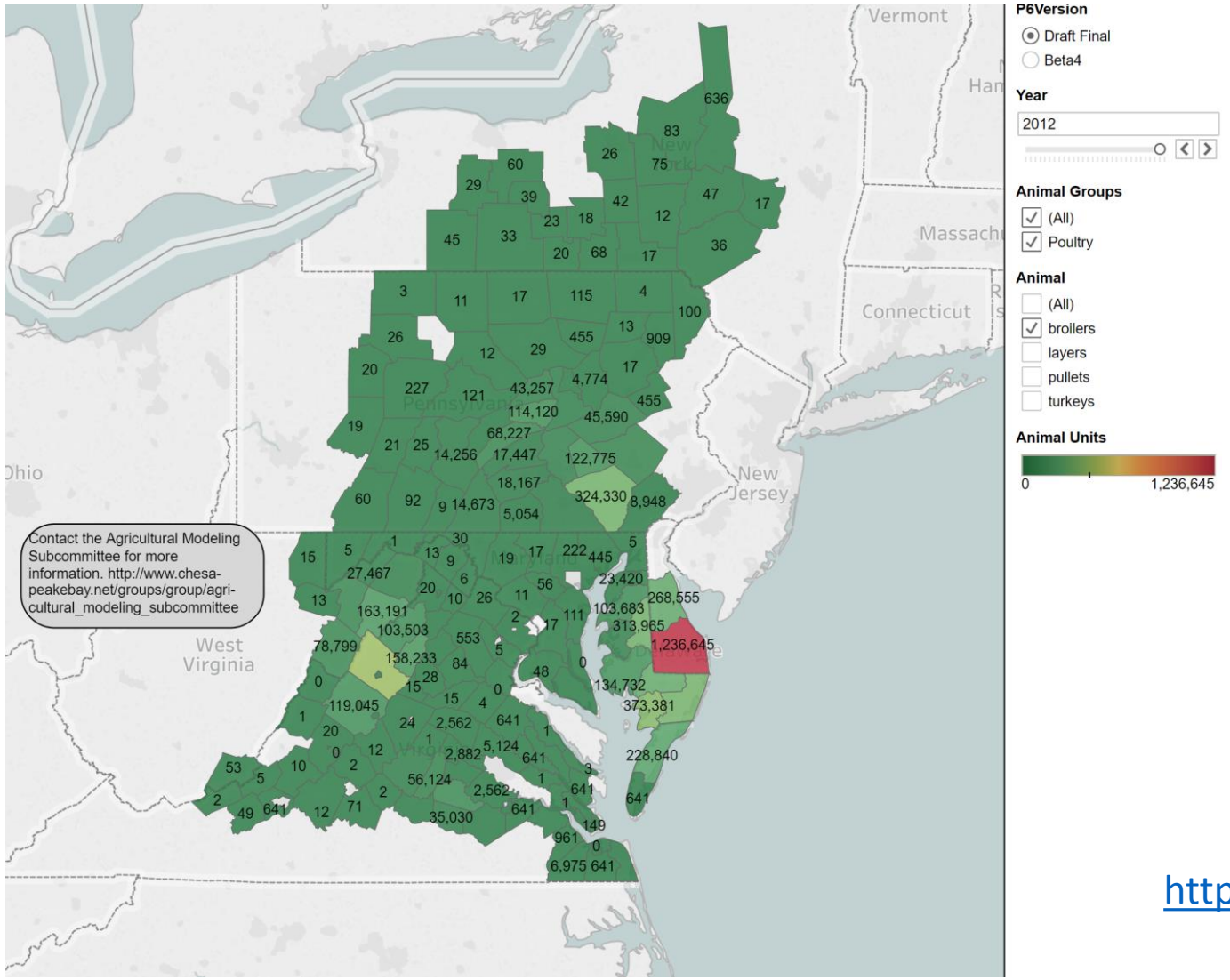
March 2013
f\facts12

- DPI estimated broiler population in Delmarva counties at 558 million in 2012.
- Phase 6 estimated 557 million in 2012.
- Total difference of 0.25%!


Statewide Broiler Production
320,000,000
300,000,000
280,000,000
260,000,000
240,000,000
220,000,000
200,000,000
180,000,000
160,000,000
140,000,000
Broilers Produced/Year
1985
1990
1995
2000
2005
2010
2015
Year
DE
MD
VA

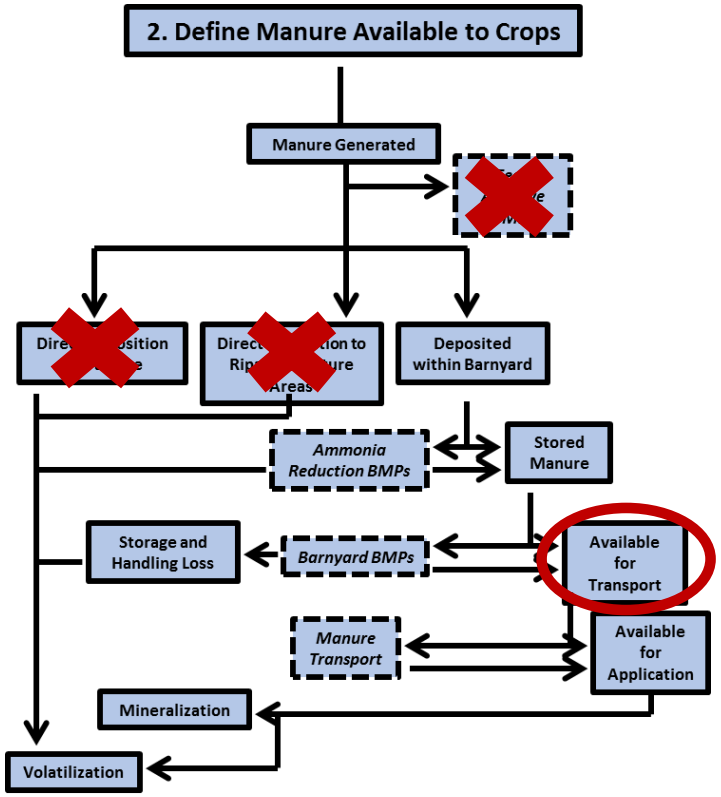
Broiler Populations - Tableau

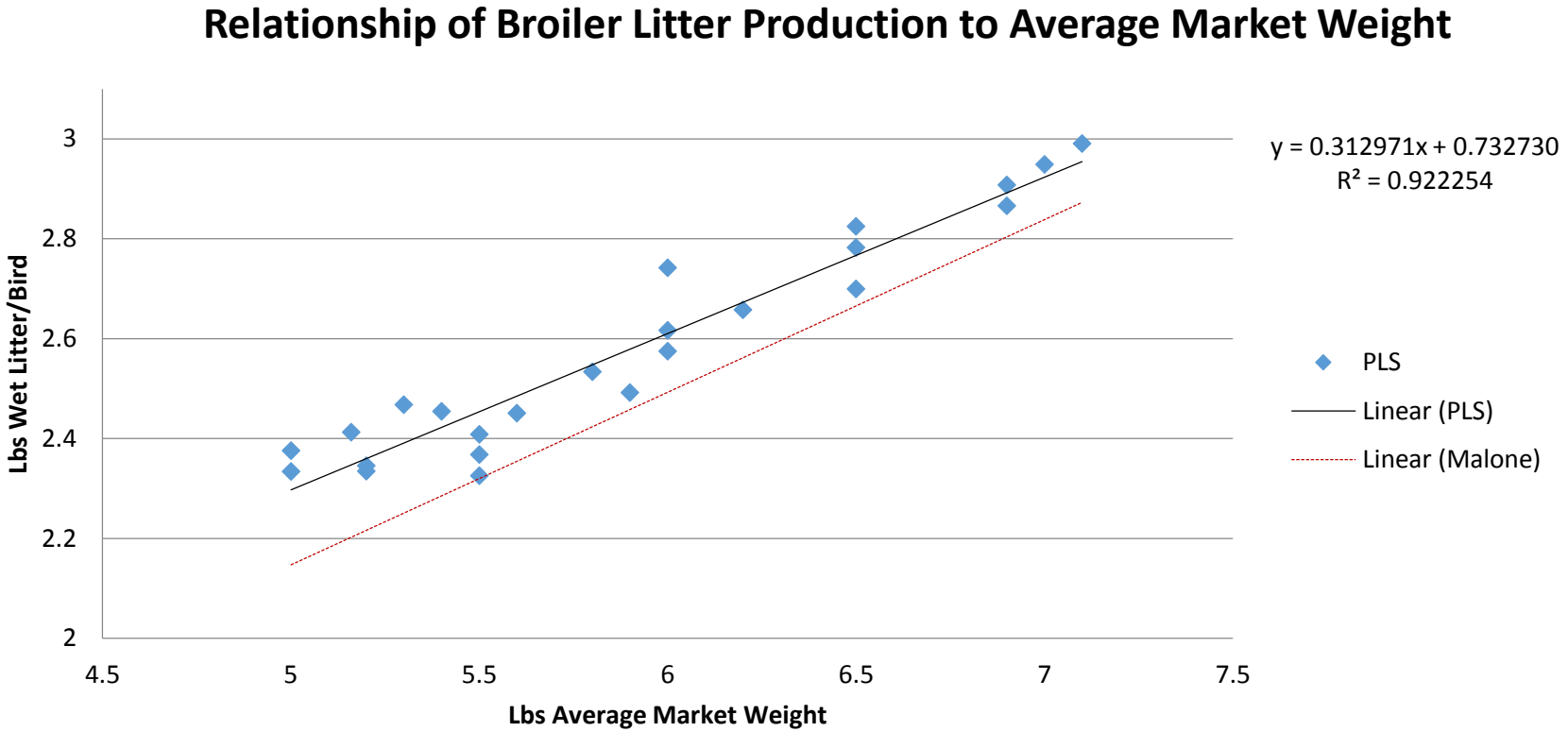


- Choose your year
- Choose your animal type
- Zoom in
- Analyze
- Ask questions

https://mpa.chesapeakebay.net/AnimalData.html

Manure Generation for Broilers - Litter

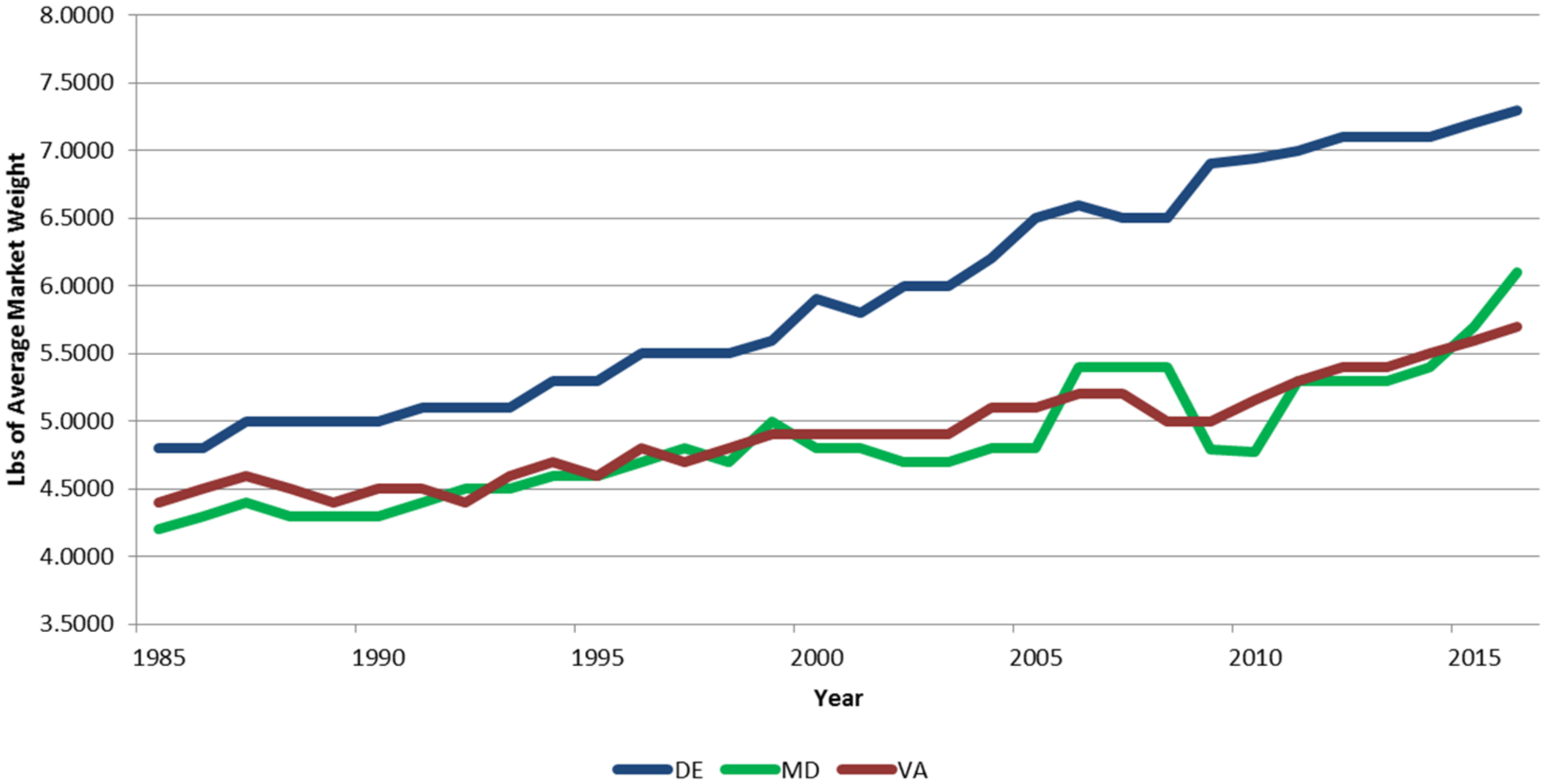




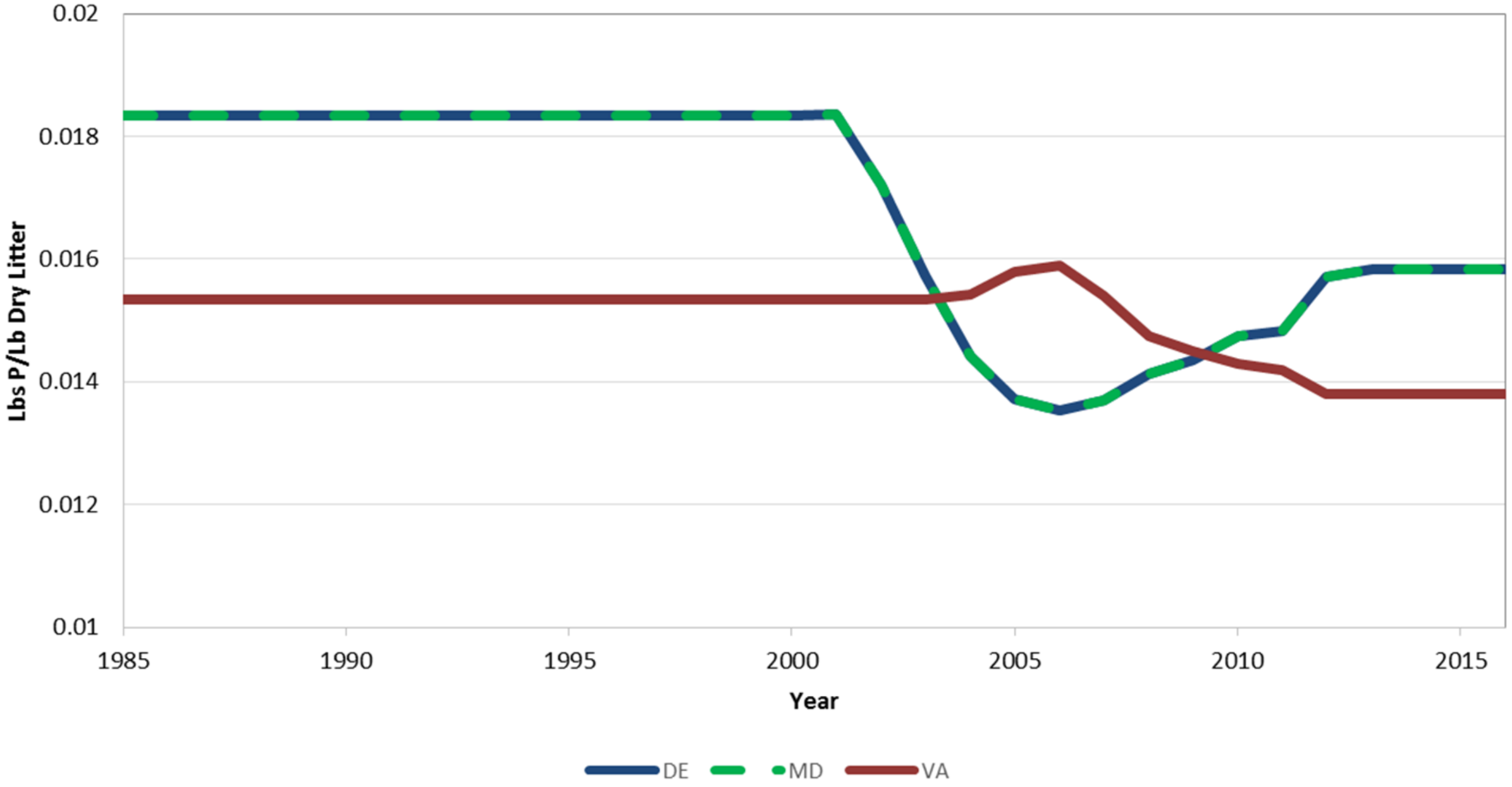
- PLS found that broiler litter production can be estimated based upon average market weight.

PLS report: http://www.chesapeakebay.net/documents/recommendations_to_estimate_poultry_nutrients_for_phase_6_model_03062015.pdf

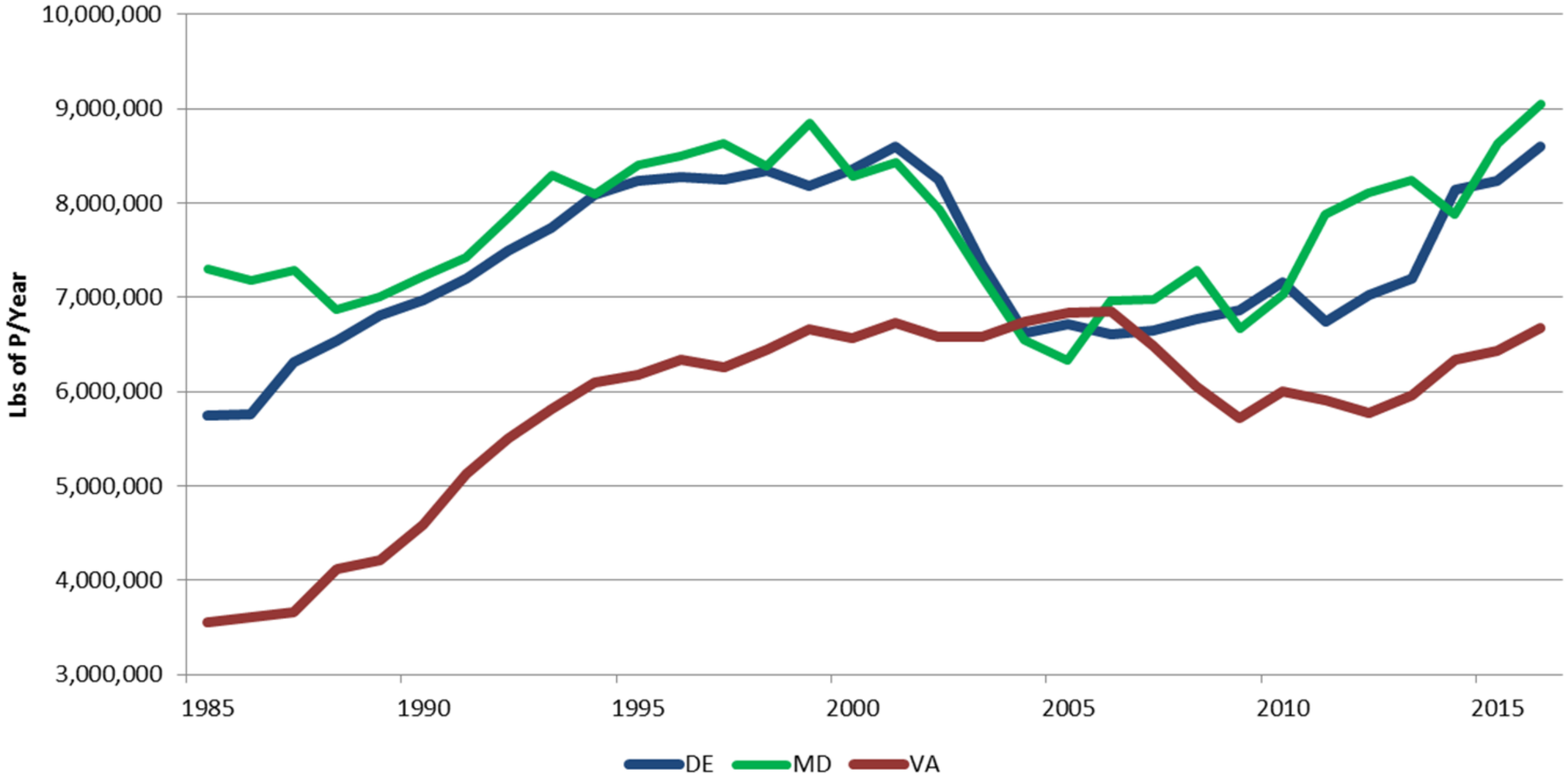
Statewide Average Broiler Market Weight



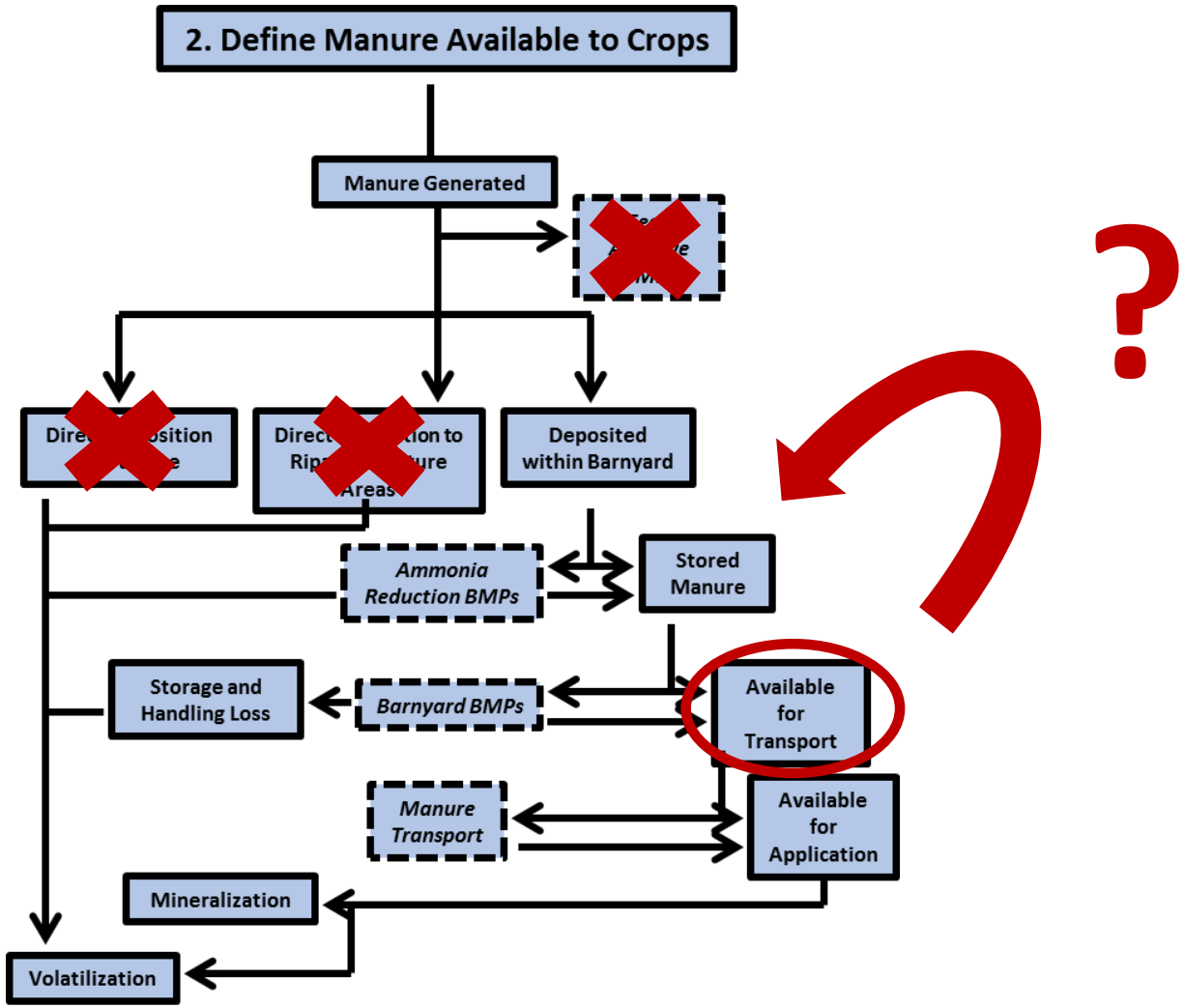
Average Phosphorus Concentration in Broiler Litter



Statewide Lbs of Phosphorus Available from Broilers



Animal Waste Management Systems

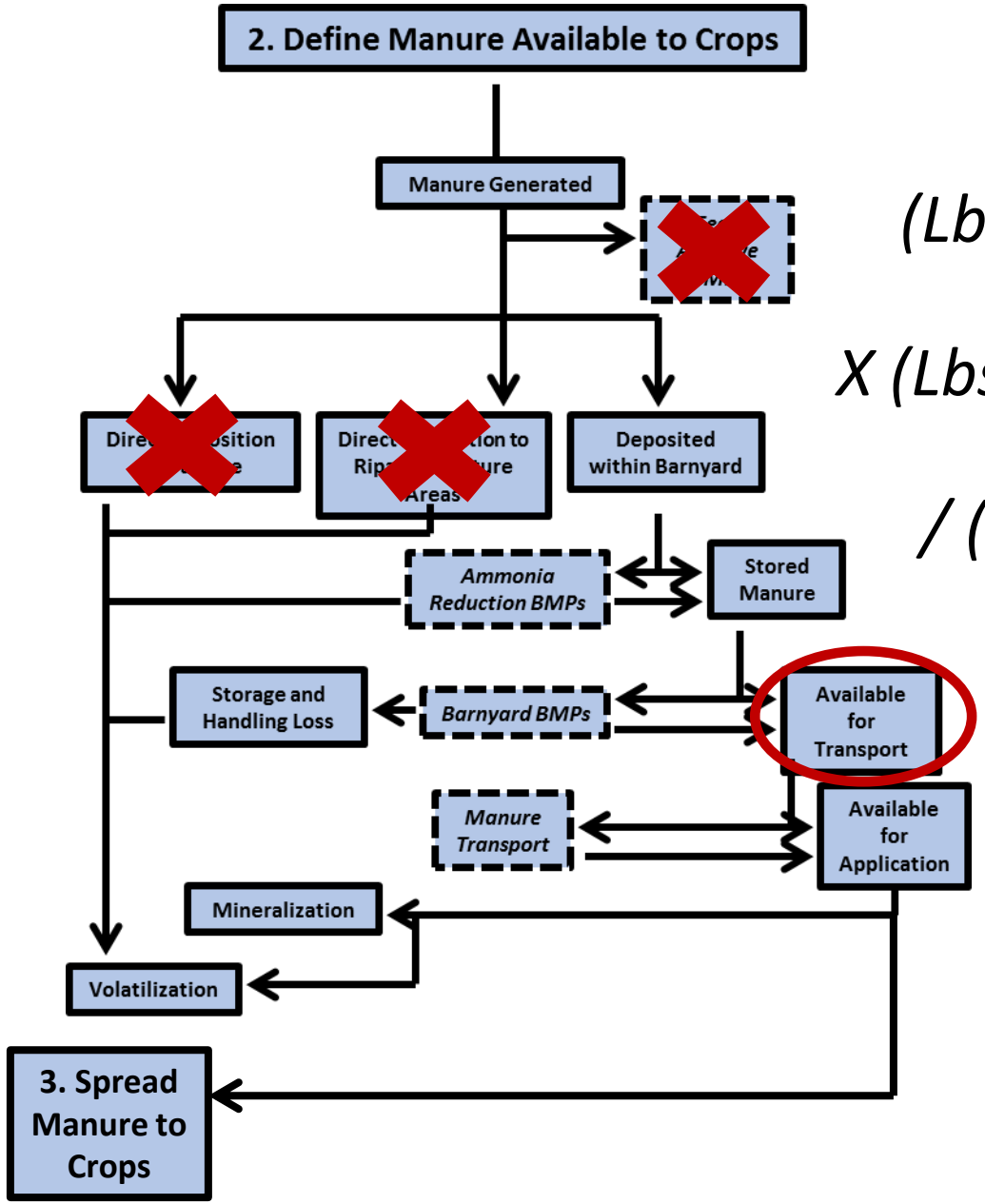


Animal	% Recoverable Without AWMS	% Recoverable with AWMS
Beef	60	99
Dairy	75	95
Other Cattle	60	99
Hogs for Slaughter	90	99
Hogs for Breeding	90	99
Broilers	90	99
Layers	90	99
Turkeys	90	99
Pullets	90	99
Sheep	95	98
Horses	95	98
Goats	95	98

- PLS provided as-applied litter amounts.
- As-excreted litter amounts are calculated by dividing the as-applied by % recoverable with AWMS.
- % Not recoverable becomes a load for the animal feeding space. (10% without proper storage, 1% with proper storage).
- http://www.chesapeakebay.net/channel_files/24554/awms_ep_report_for_cbp_review_05dec2016.pdf.

Pause for questions…

Manure Generation for Turkeys - Equation



Lbs of N/Year =

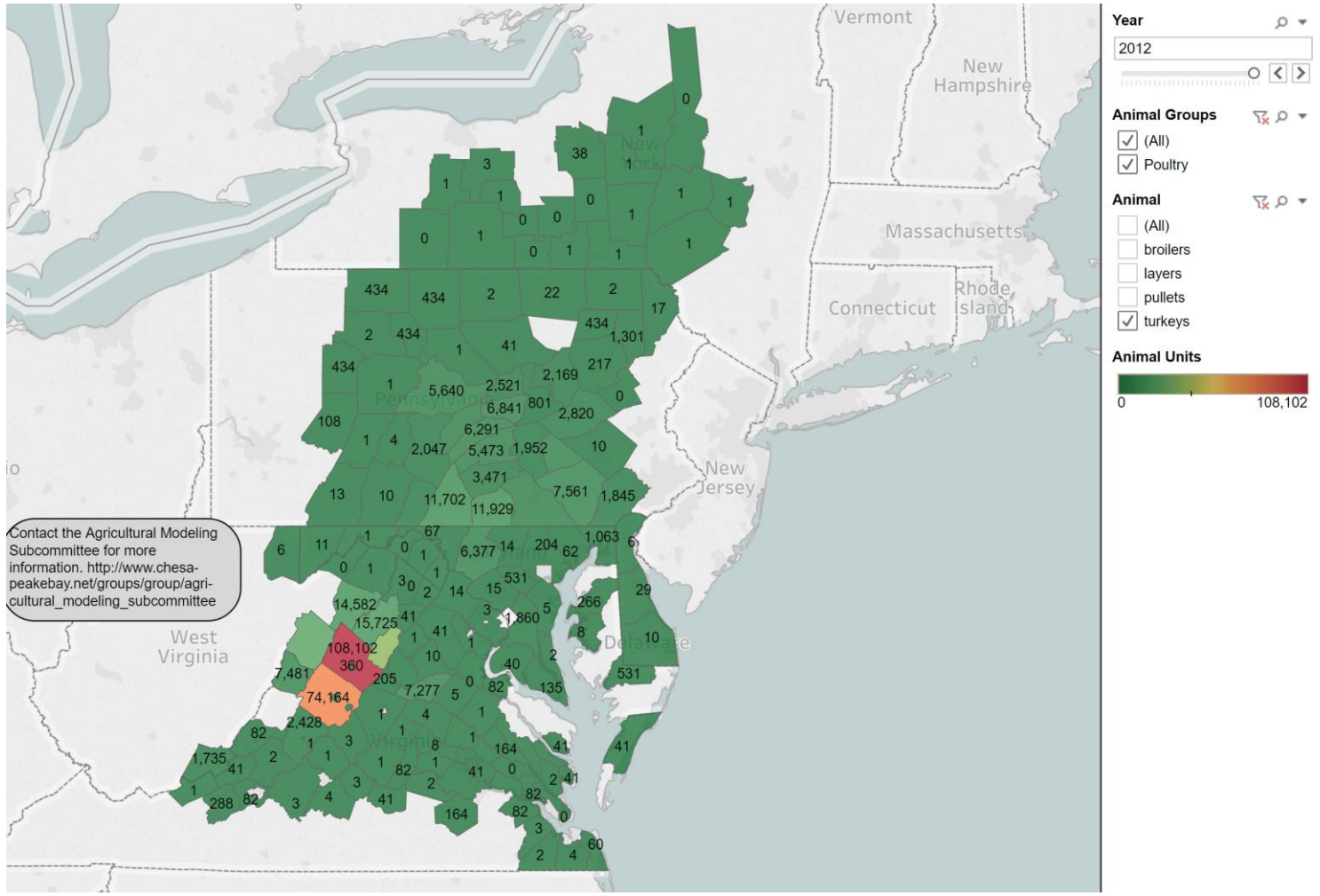
(Lbs of Applied Litter/Bird Produced) ← 10.62
/ (1-Barnyard Loss Factor) ← 0.99
X (Lbs of Dry Matter/Lb of Applied Litter) ← 0.7353
*X (Lbs of N/Lb of Dry Matter)**
/ (1-Barnyard Volatilization Factor) ← 0.6
*X (Birds Produced/Year)**

** Varies by Year*

Multiply:

Litter Production – Based upon Turkey Characterization Study; not tied to weight of birds
Dry Matter Fraction - Based upon Turkey Study
Litter Nutrient Concentration - Based upon Turkey Study
Birds Produced – NASS annual production data

Turkey Populations - Tableau



- Choose your year
- Choose your animal type
- Zoom in
- Analyze
- Ask questions

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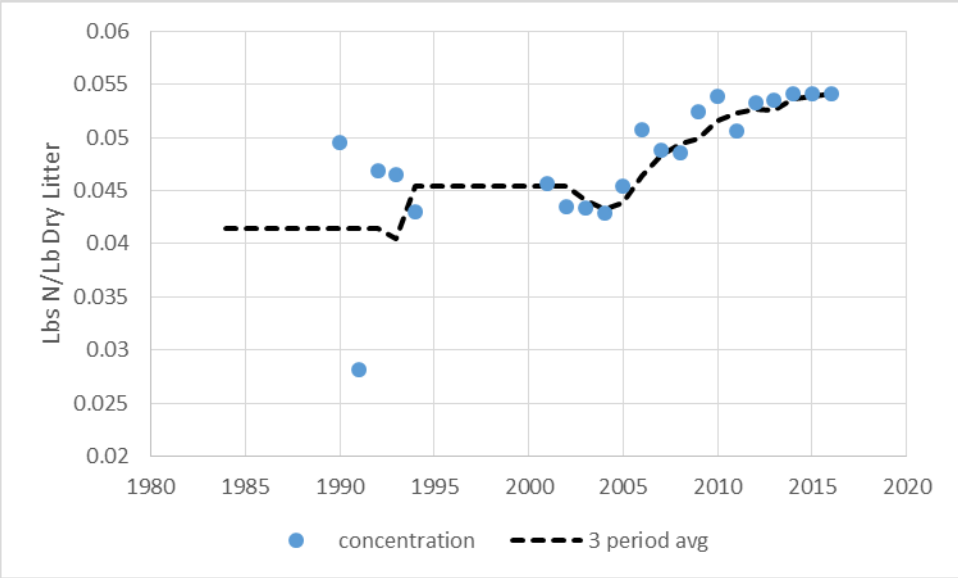
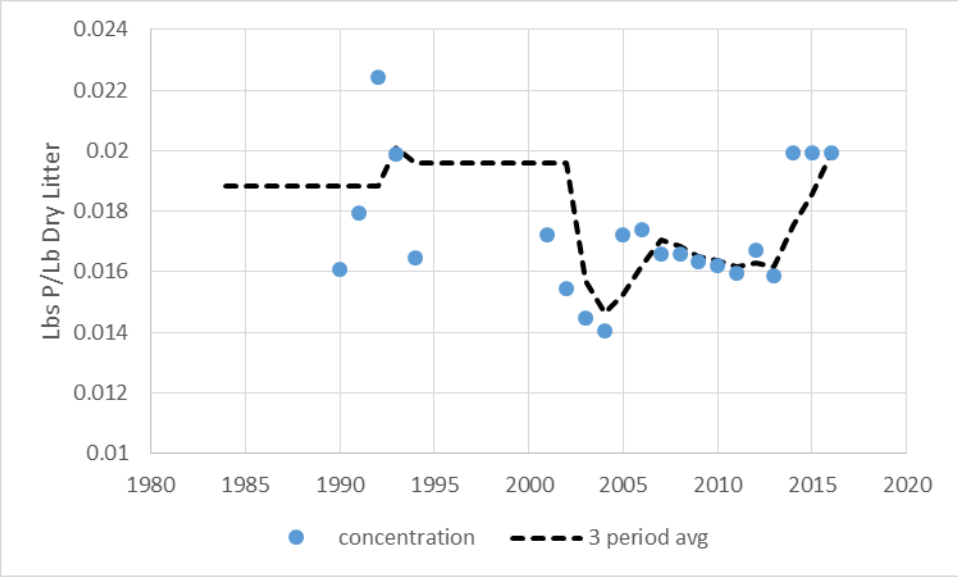
Turkey Nutrient Concentrations

Lbs N/Lb Dry Litter



Lbs P/Lb Dry Litter



- Sample years: Use 3-year moving average

- 1985 through first sample year: Use first moving average point

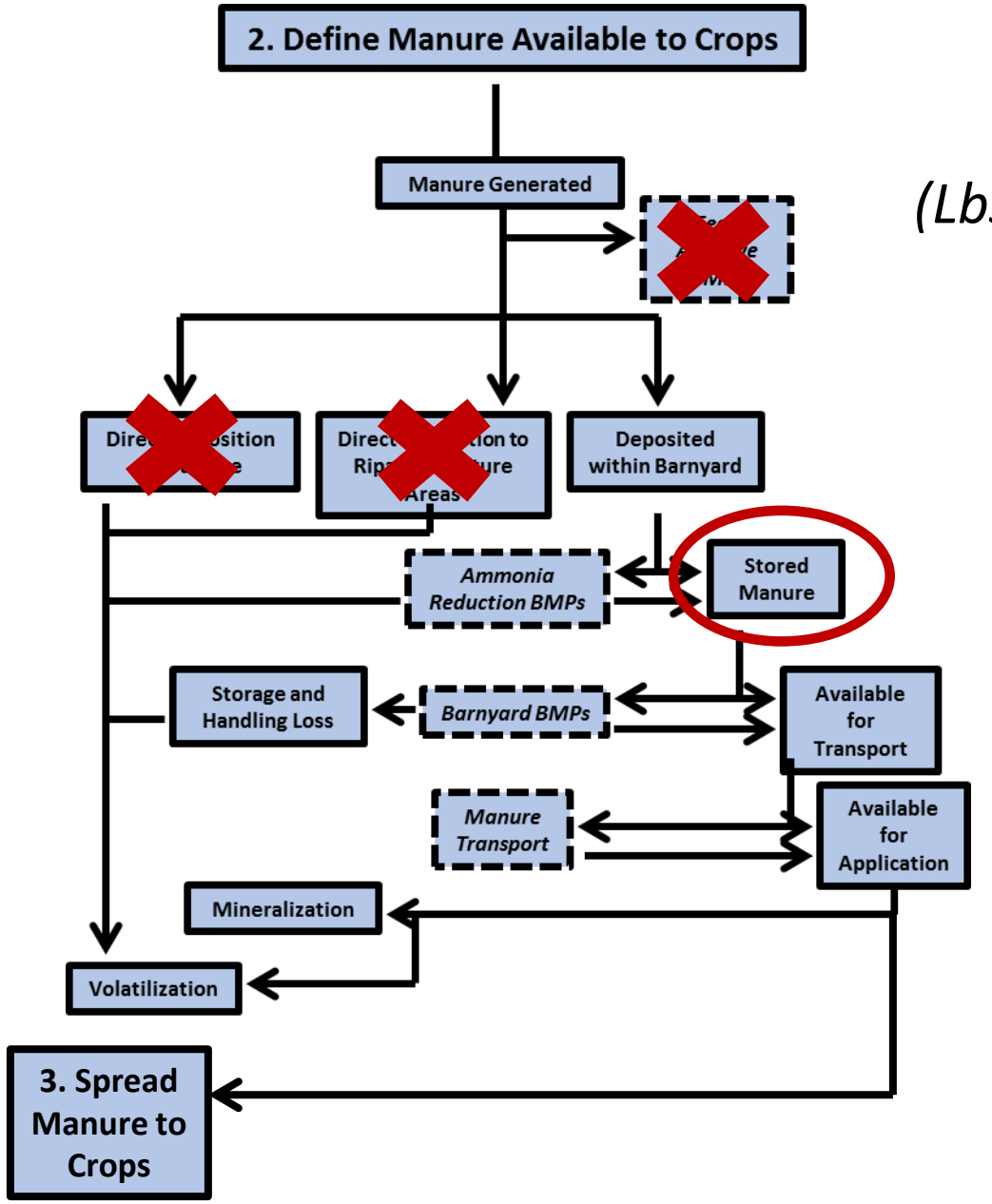
- Last sample year forward: Use last moving average point

- States should submit sample data each year

- If no sample data is collected, state receives Bay-wide average

http://www.chesapeakebay.net/channel_files/23305/draft_turkey_litter_nutrients_characterization_for_the_phase_6_watershed_model_111816.1.pdf

Manure Generation for Layers - Equation



Lbs of P/Year =

(Lbs of As-Excreted Manure/Bird Produced) ← 69.35

X

(Lbs of Dry Matter/Lb of Manure) ← 0.2579

X

(Lbs of P/Lb of Dry Matter) ← Varies

X

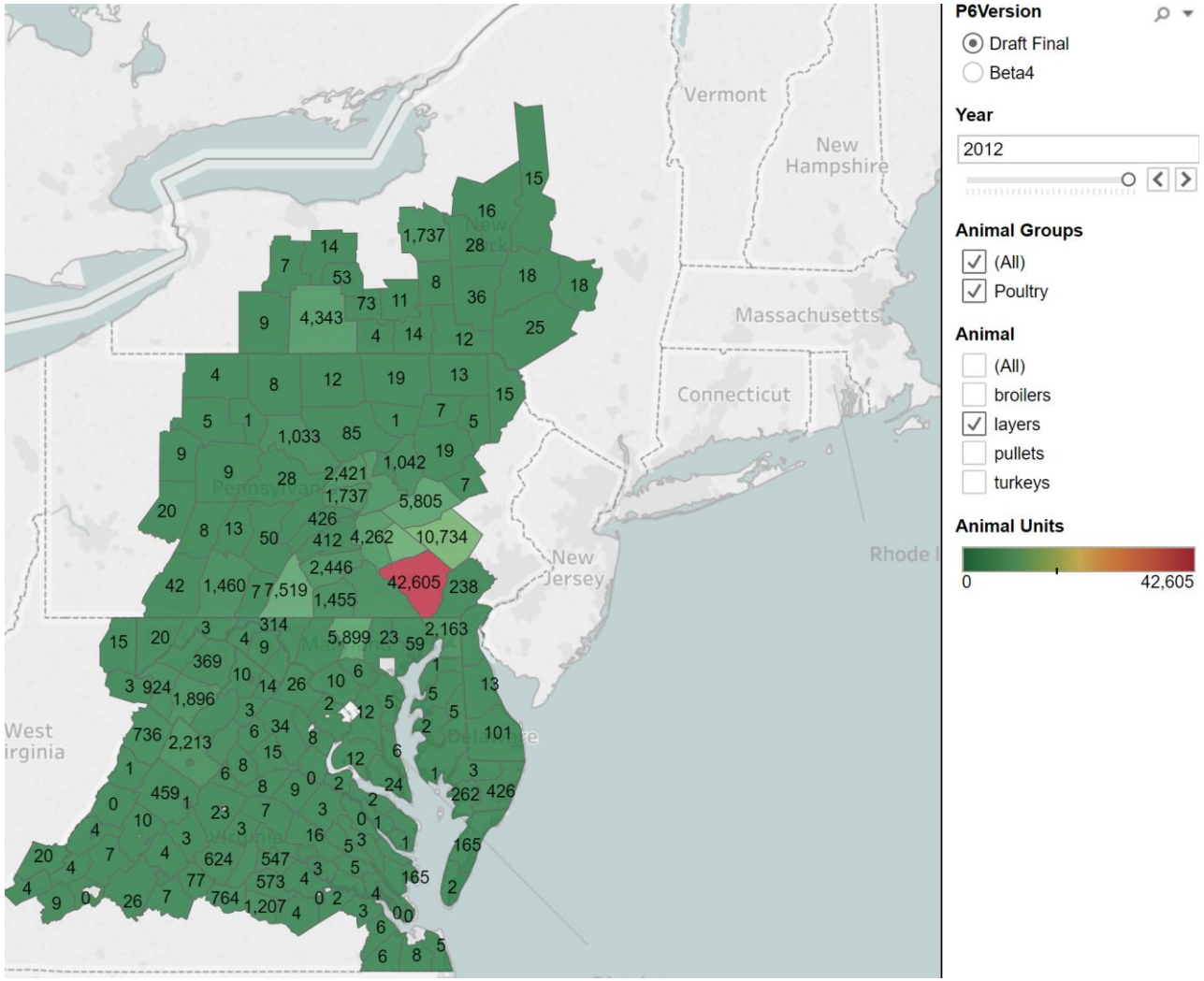
(Birds Produced/Year)

Multiply:

- Litter Production – ASABE, 2005; not tied to weight of birds
- Dry Matter Fraction – ASABE, 2005
- Litter Nutrient Concentration – Varies from PLS report
- Birds Produced – Census of Agriculture

ASABE, 2005: http://extension.psu.edu/animals/dairy/nutrient-management/certified-dairy/tools/manure-prod-char-d384-2.pdf

Layer Populations - Tableau



- Choose your year
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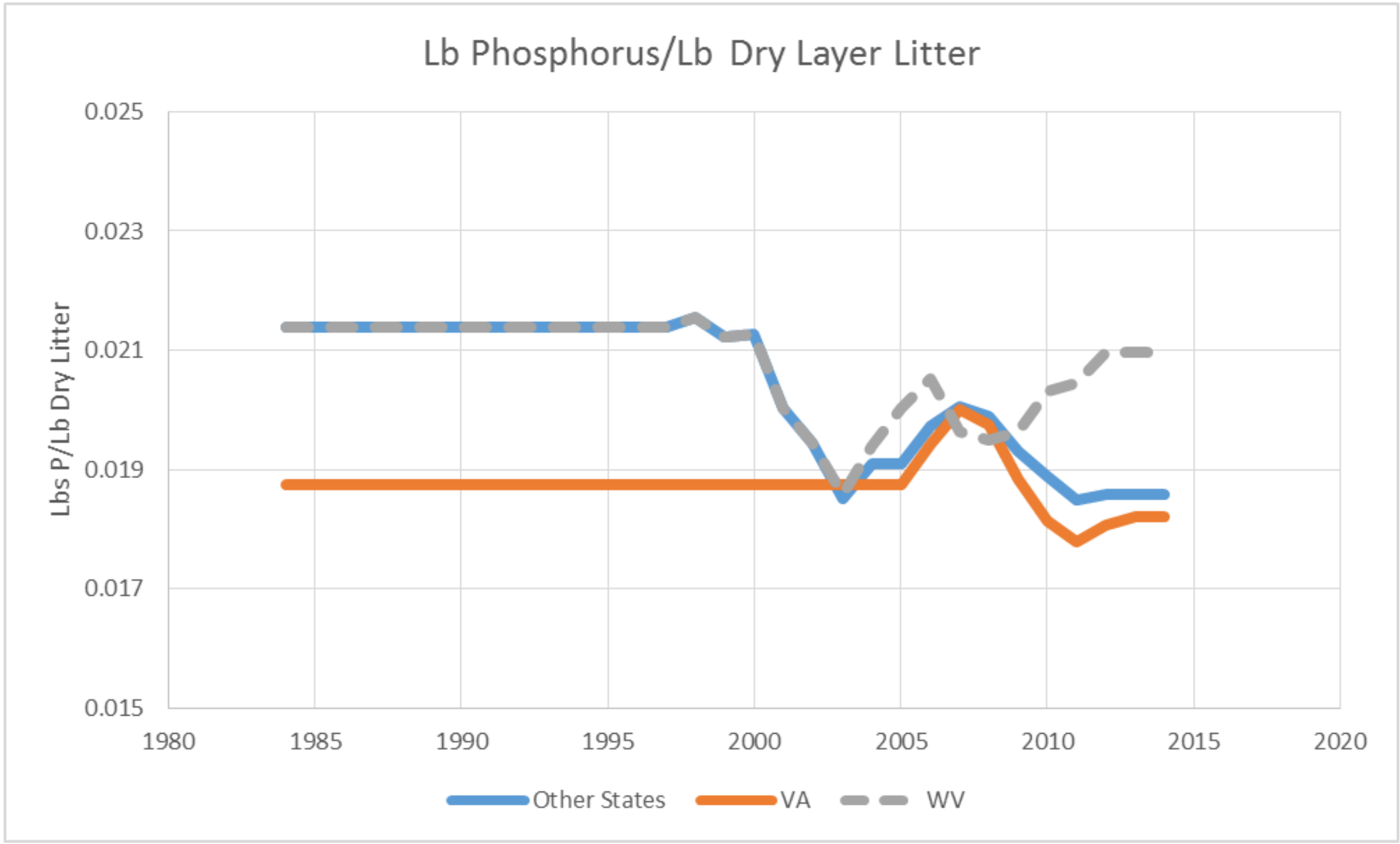
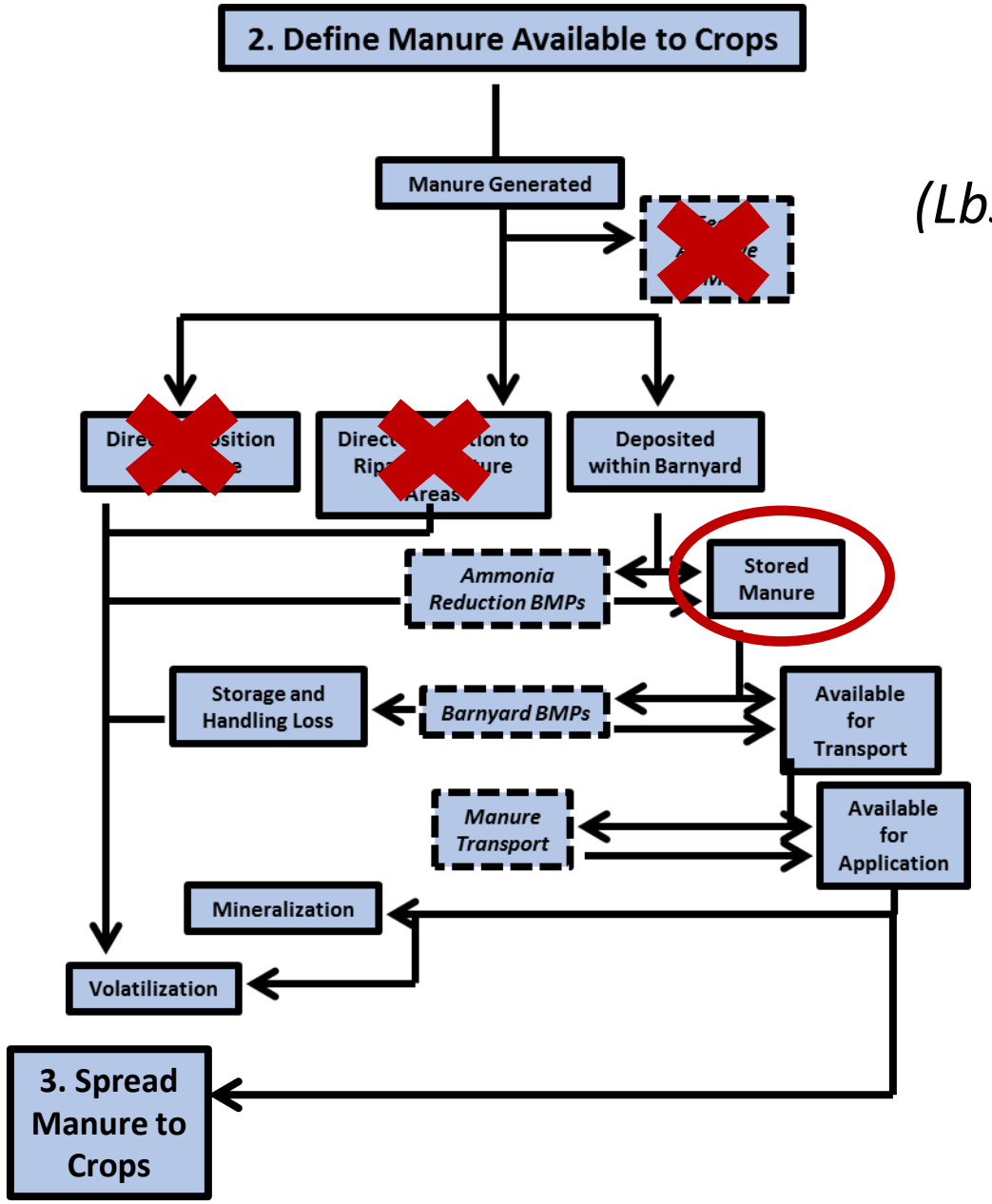

Lb Phosphorus/Lb Dry Layer Litter
Lbs P/Lb Dry Litter
0.025
0.023
0.021
0.019
0.017
0.015
1980
1985
1990
1995
2000
2005
2010
2015
2020
Other States
VA
WV

Manure Generation for Pullets - Equation



Lbs of P/Year =

(Lbs of As-Excreted Manure/Bird Produced) ← 49.91

X

(Lbs of Dry Matter/Lb of Manure) ← 0.2594

X

(Lbs of P/Lb of Dry Matter) ← Varies

X

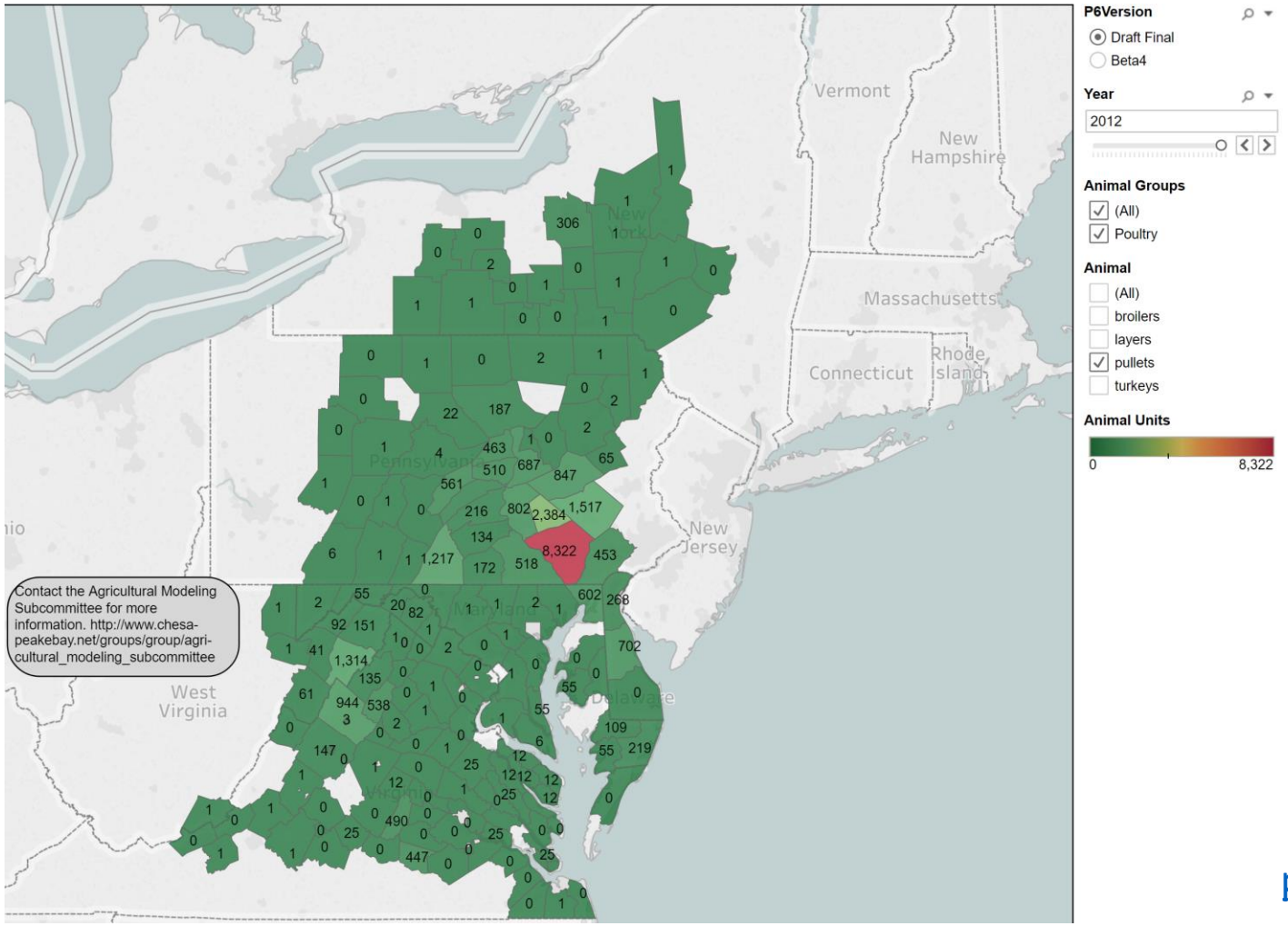
(Birds Produced/Year)

Multiply:

- Litter Production – ASABE, 2005; not tied to weight of birds
- Dry Matter Fraction – ASABE, 2005
- Litter Nutrient Concentration – Varies from PLS report
- Birds Produced – Census of Agriculture

ASABE, 2005: http://extension.psu.edu/animals/dairy/nutrient-management/certified-dairy/tools/manure-prod-char-d384-2.pdf

Pullet Populations - Tableau



- Choose your year
- Choose your animal type
- Zoom in
- Analyze
- Ask questions

ps://mpa.chesapeakebay.net/AnimalData.html

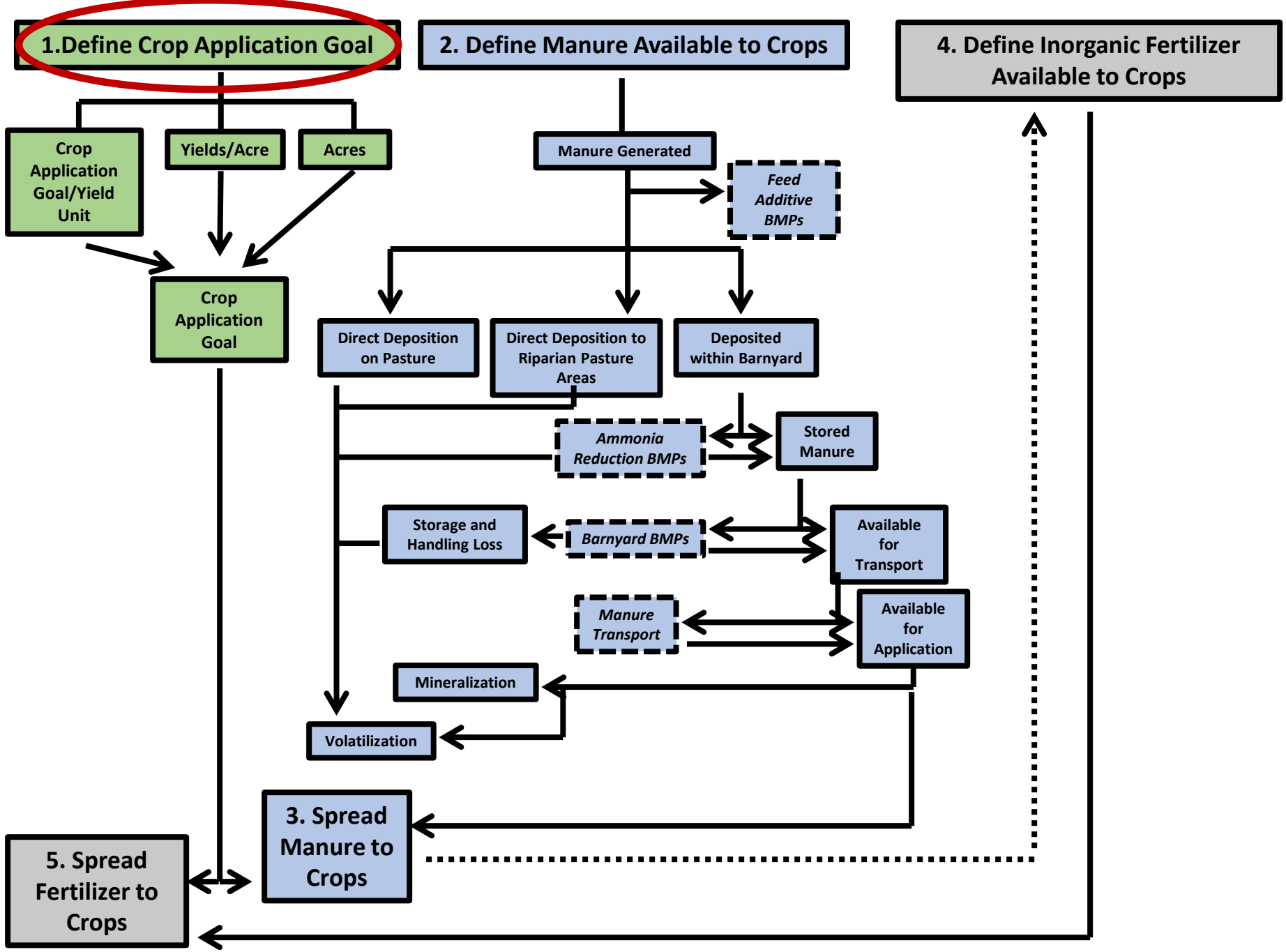
Manure Generation for Pullets - Concentration

Table 2. Pullet P Concentrations in Recoverable Manure

Year	Original Pullet P Concentration	Percent Change in Bay-wide Layer P	Final Pullet P Concentration
2002	0.019285	NA	0.019285
2003	0.019285	-4.76287%	0.018366
2004	0.019285	3.11706%	0.018939
2005	0.019285	-0.02386%	0.018934
2006	0.019285	3.31276%	0.019562
2007	0.019285	1.69592%	0.019893
2008	0.019285	-0.84711%	0.019725
2009	0.019285	-2.90331%	0.019152
2010	0.019285	-2.22071%	0.018727
2011	0.019285	-2.04213%	0.018345
2012	0.019285	0.41046%	0.018420
2013	0.019285	0.00124%	0.018420

- Original concentration from USDA
  - Gollehon, N., 2014. Personal Communications re: Unpublished. 2014 Update to: Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients (published December, 2000). USDA NRCS Economic Research Service. August, 2014.
- States provided evidence that pullet feed was similar to layer feed, so concentrations were adjusted to account for P changes seen in layer feed.

Pause for questions…


1.Define Crop Application Goal
2. Define Manure Available to Crops
4. Define Inorganic Fertilizer Available to Crops
Crop Application Goal/Yield Unit
Yields/Acre
Acres
Crop Application Goal
Manure Generated
Feed Additive BMPs
Direct Deposition on Pasture
Direct Deposition to Riparian Pasture Areas
Deposited within Barnyard
Ammonia Reduction BMPs
Stored Manure
Storage and Handling Loss
Barnyard BMPs
Available for Transport
Manure Transport
Available for Application
Mineralization
Volatilization
3. Spread Manure to Crops
5. Spread Fertilizer to Crops

Crop Application Goal

- States provided the following for each crop:
  - Total N and P application goals per acre or yield unit
    - Example: 0.92 lb of N/bushel of corn for grain yield
  - Fraction of total application goal which should be met by applications in each month
    - Example: 0.4 of yearly total N on corn for grain should be applied in April
  - Indication of which applications are eligible to be met by only inorganic fertilizer, or by any kind of nutrient in each month
    - Example: April applications are eligible to be met by inorganic and organic fertilizer. June applications are eligible to be met by only inorganic fertilizer.

Crop Application Goal on Major Crops

Crop	DoubleCrop	Nutrient	Yield Unit	DE_1	MD_1	NY_1	PA_1	VA_1	WV_1
Alfalfa Hay Harvested Area	N	TN	dry tons	1	1	1	1	1	1
Alfalfa Hay Harvested Area	N	TP	dry tons	5	5	5	6	5	5
Corn for Grain Harvested Area	N	TN	bushels	0.92	0.92	0.92	0.92	0.92	0.92
Corn for Grain Harvested Area	N	TP	bushels	0.12	0.12	0.12	0.12	0.12	0.12
Corn for Grain Harvested Area	Y	TN	bushels	0.92	0.92	0.92	0.92	0.92	0.92
Corn for Grain Harvested Area	Y	TP	bushels	0.12	0.12	0.12	0.12	0.12	0.12
Wheat for Grain Harvested Area	N	TP	bushels	0.31	0.31	0.31	0.31	0.31	0.31
Wheat for Grain Harvested Area	N	TN	bushels	1.25	1.25	1	1	1.25	1.25
Wheat for Grain Harvested Area	Y	TP	bushels	0.465	0.465	0.465	0.465	0.465	0.465
Wheat for Grain Harvested Area	Y	TN	bushels	1.25	1.25	1	1	1.25	1.25
Pastureland and rangeland other than cropland and woodland pastured Area	N	TN	acres	15	15	15	15	15	15
Pastureland and rangeland other than cropland and woodland pastured Area	N	TP	acres	4	4	4	4	4	4
Soybeans for beans Harvested Area	N	TN	bushels	0.12	0.12	0.12	0.12	0.12	0.12
Soybeans for beans Harvested Area	N	TP	bushels	0.33	0.33	0.33	0.33	0.33	0.33
Soybeans for beans Harvested Area	Y	TN	bushels	0	0	0	0	0	0
Soybeans for beans Harvested Area	Y	TP	bushels	0	0	0	0	0	0

- Data provided by states after consultation with nutrient management program staff.

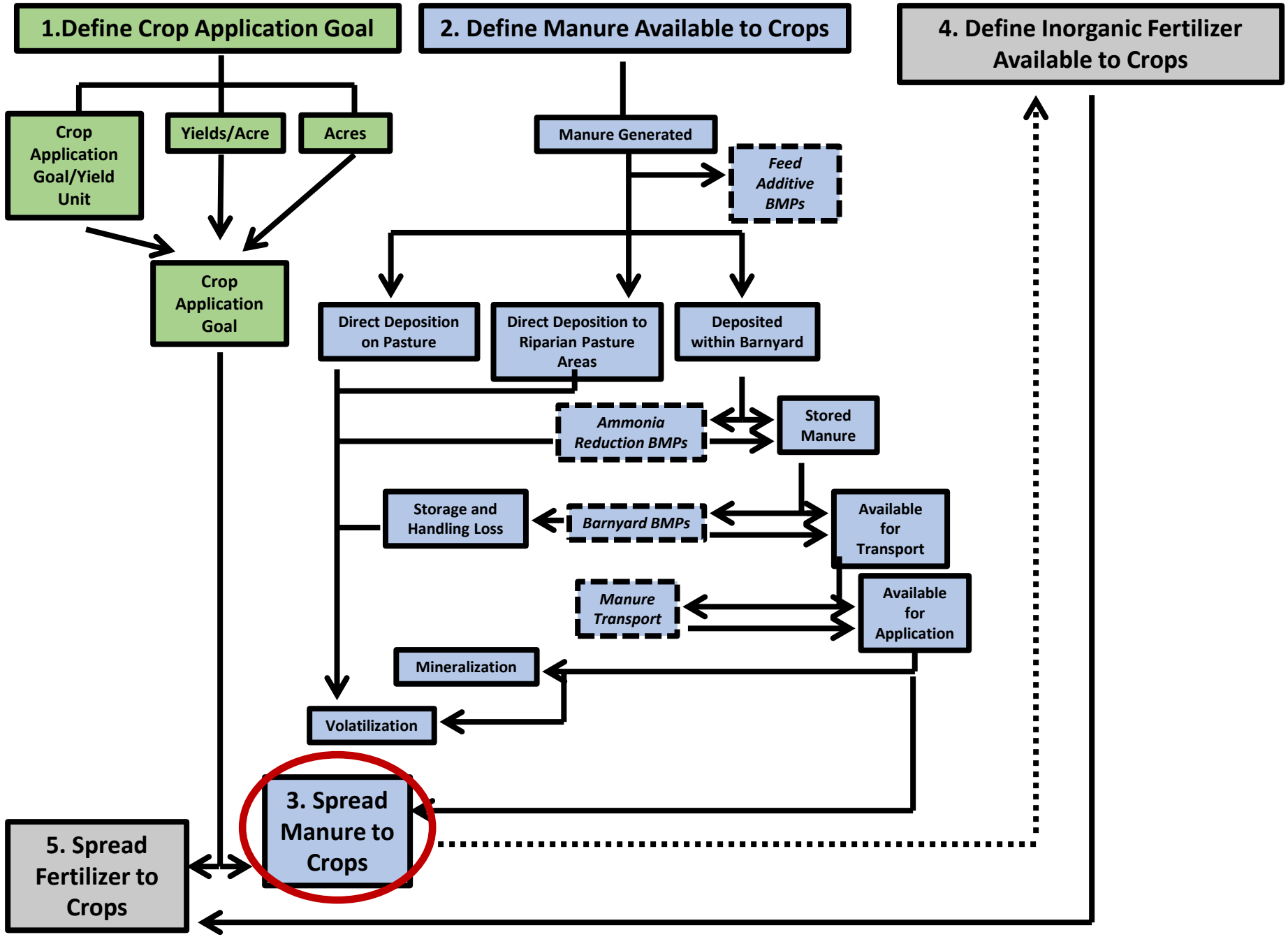
Non-Nutrient Management Application Goal Multipliers

Land Use	Non NM N Multiplier	Non NM P Multiplier
Full Season Soybeans	1.2	1.5
Grain with Manure	1.3	3
Grain without Manure	1.2	1.5
Legume Hay	1.2	1
Silage with Manure	1.4	3
Silage without Manure	1.2	1.5
Small Grains and Grains	1.2	1.5
Small Grains and Soybeans	1.2	1.5
Specialty Crop High	1.3	2
Specialty Crop Low	1.2	2
Other Agronomic Crops	1.1	1.5
Other Hay	1	1
Pasture	1	1

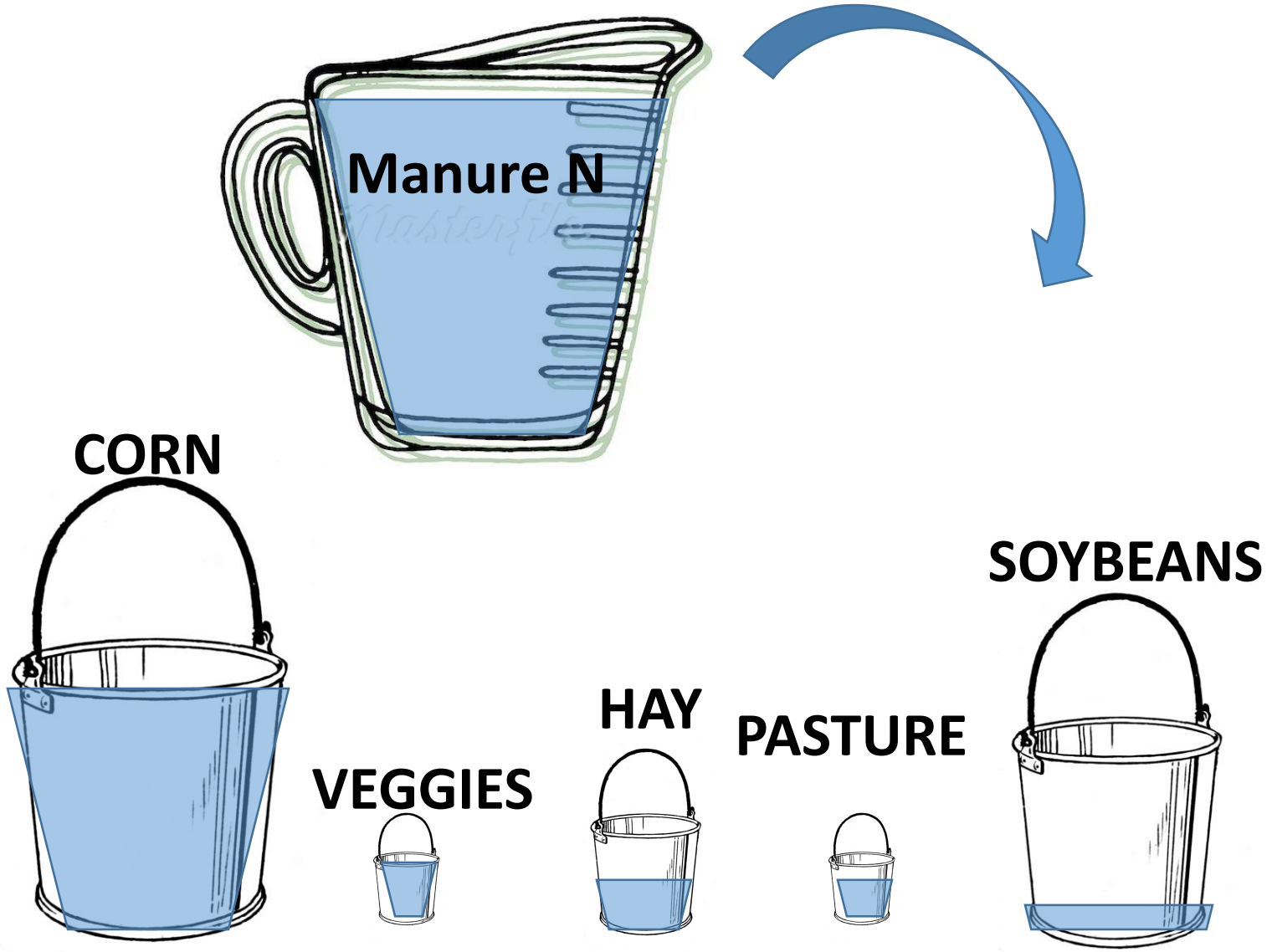
- Data provided by Nutrient Management Panel.
- Acres of core NM do NOT currently qualify for reduced P applications.

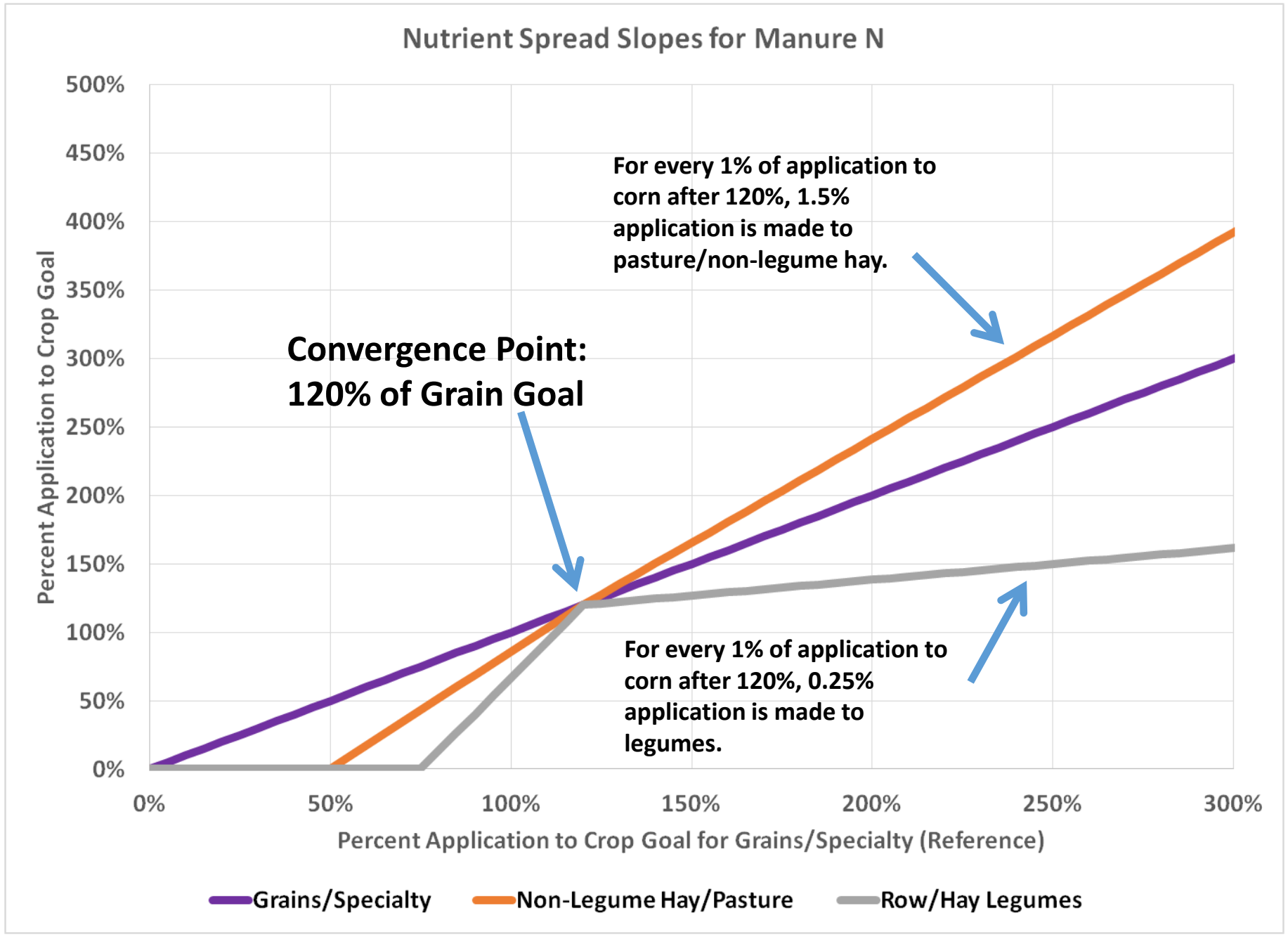
Incorporating Yields into Crop Application Goals

- Crop Application Goal Equation:
  - *Lbs of N/Year = State-Supplied Lbs of N/Application Goal Yield Unit/Year X Yield/Year*
- Application goals are yield-based for the following major crops:
  - Alfalfa Hay; Barley; Buckwheat; Corn for Grain; Corn for Silage; Oats for Grain; Rye for Grain; Sorghum for Grain; Sorghum for Silage; Soybeans for Beans; and Wheat for Grain
- Application goals are per acre for all other crops, and do not vary across the years.
- Yearly yields provided by NASS for major crops.

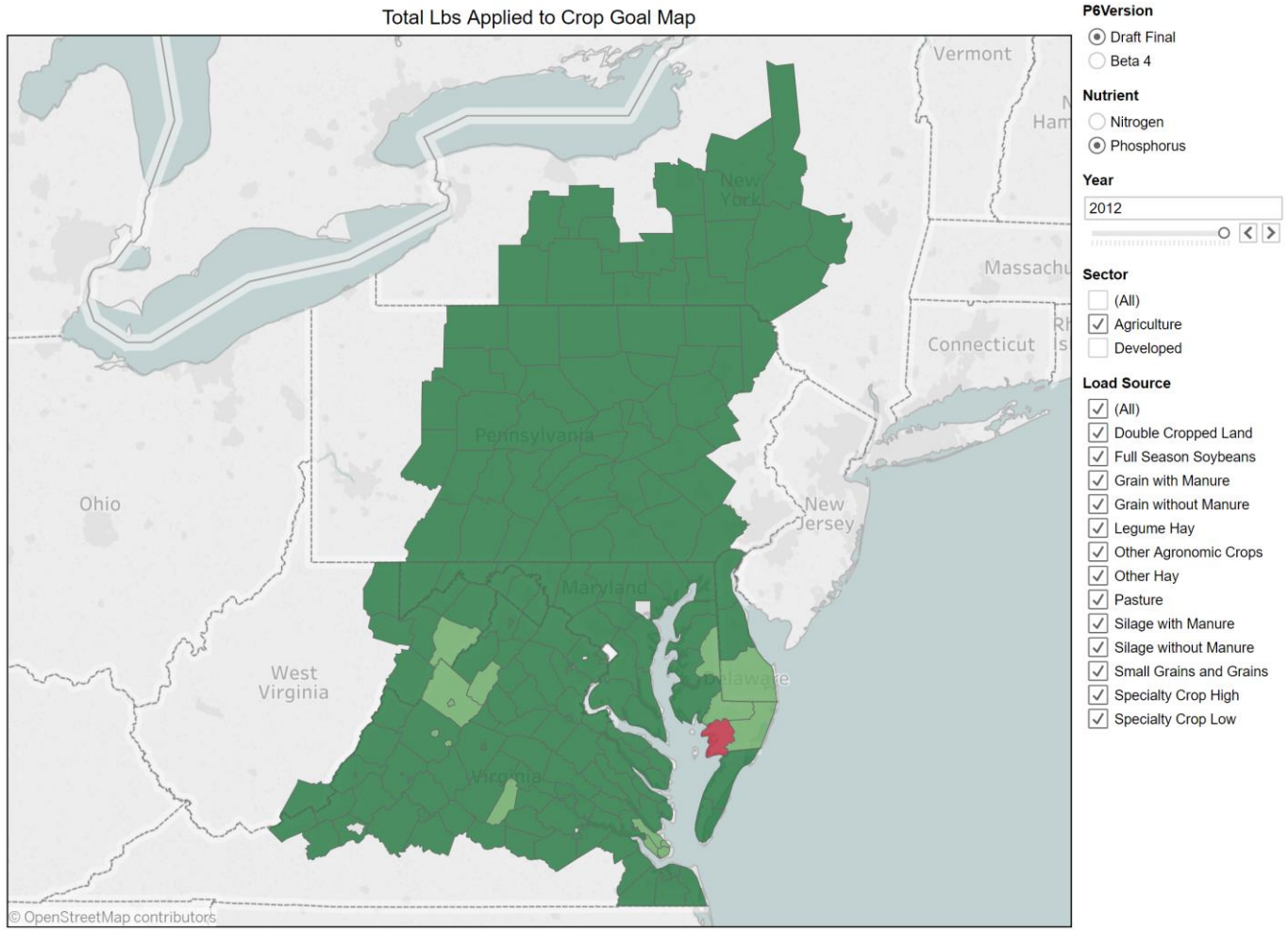

1.Define Crop Application Goal
2. Define Manure Available to Crops
4. Define Inorganic Fertilizer Available to Crops
Crop Application Goal/Yield Unit
Yields/Acre
Acres
Crop Application Goal
Manure Generated
Feed Additive BMPs
Direct Deposition on Pasture
Direct Deposition to Riparian Pasture Areas
Deposited within Barnyard
Ammonia Reduction BMPs
Stored Manure
Storage and Handling Loss
Barnyard BMPs
Available for Transport
Manure Transport
Available for Application
Mineralization
Volatilization
3. Spread Manure to Crops
5. Spread Fertilizer to Crops

Filling the Buckets of Organic Application Goal




Nutrient Spread Slopes for Manure N
500%
450%
400%
350%
300%
250%
200%
150%
100%
50%
0%
Percent Application to Crop Goal
For every 1% of application to corn after 120%, 1.5% application is made to pasture/non-legume hay.
Convergence Point: 120% of Grain Goal
For every 1% of application to corn after 120%, 0.25% application is made to legumes.
0%
50%
100%
150%
200%
250%
300%
Percent Application to Crop Goal for Grains/Specialty (Reference)
Grains/Specialty
Non-Legume Hay/Pasture
Row/Hay Legumes

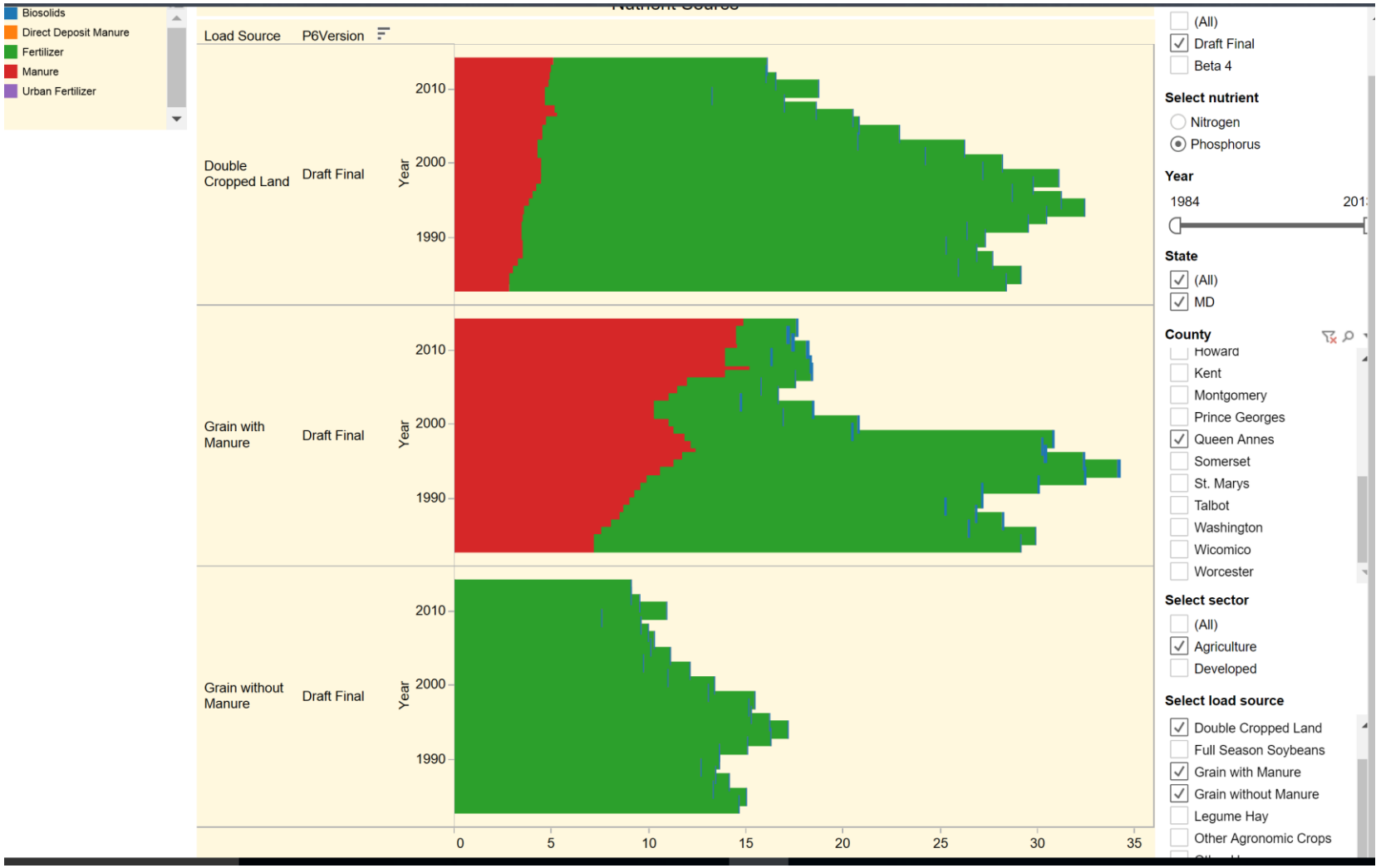
Total Phosphorus Applications- Tableau



- Choose your year
- Choose your nutrient
- Zoom in
- Analyze
- Ask questions

https://mpa.chesapeakebay.net/NutrientData.html

Phosphorus Applications by Source- Tableau



- Choose your county
- Choose your nutrient
- Choose your land use
- Analyze
- Ask questions

https://mpa.chesapeakebay.net/NutrientData.html

Pause for questions…

Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

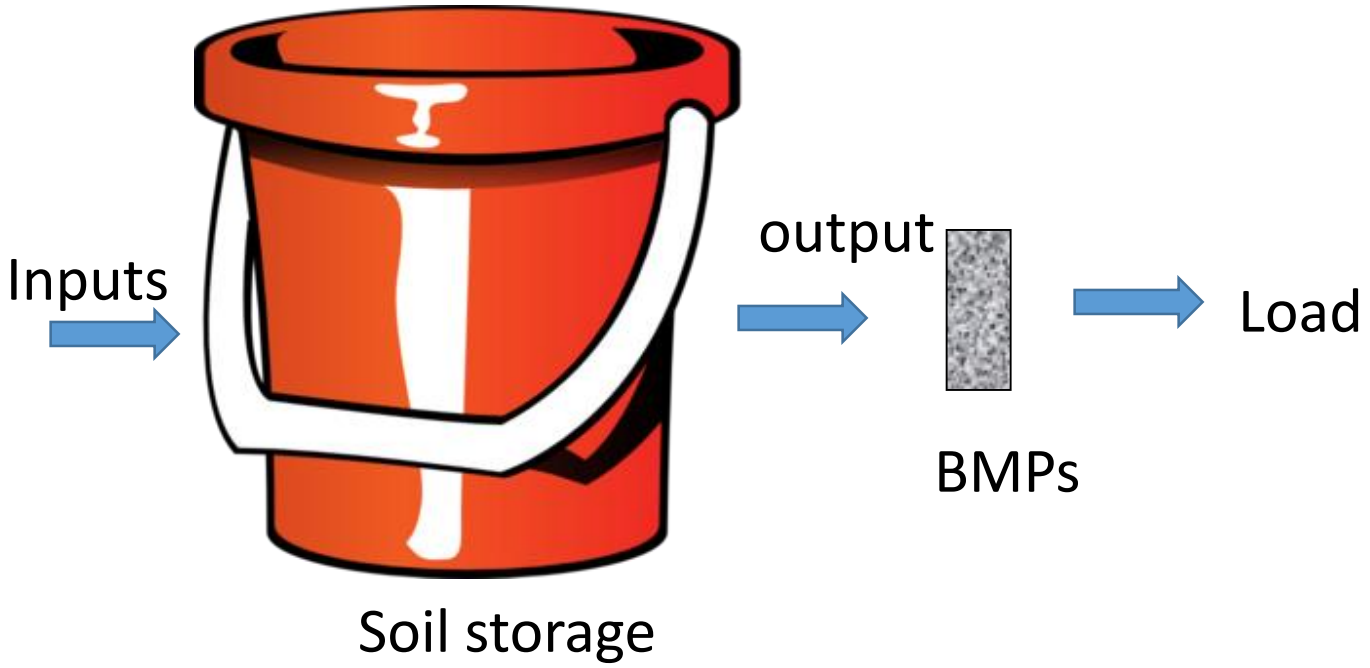
River Delivery

Direct Loads

How is P runoff calculated?

Phase 6

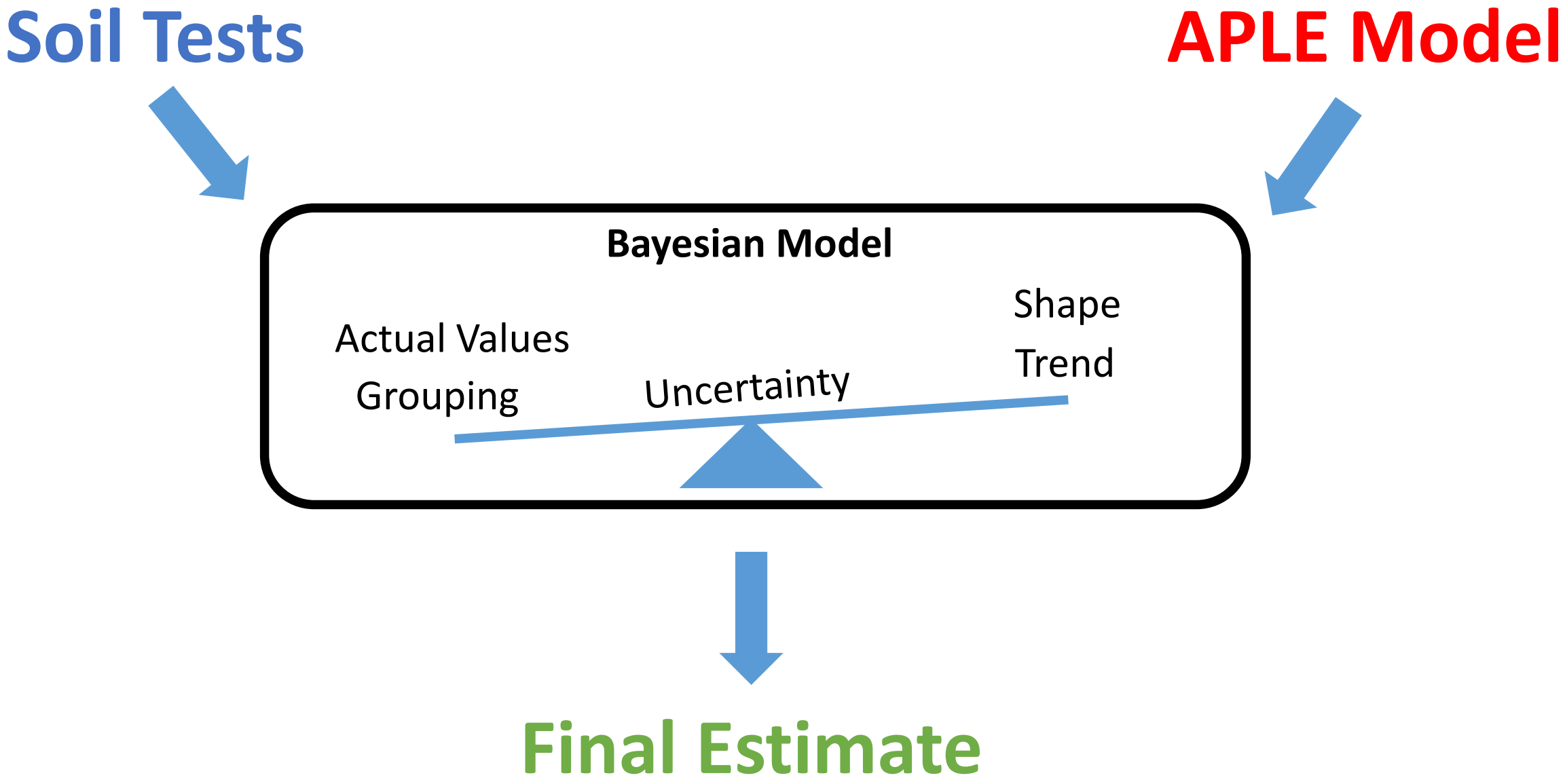
Phosphorus Conceptual Model

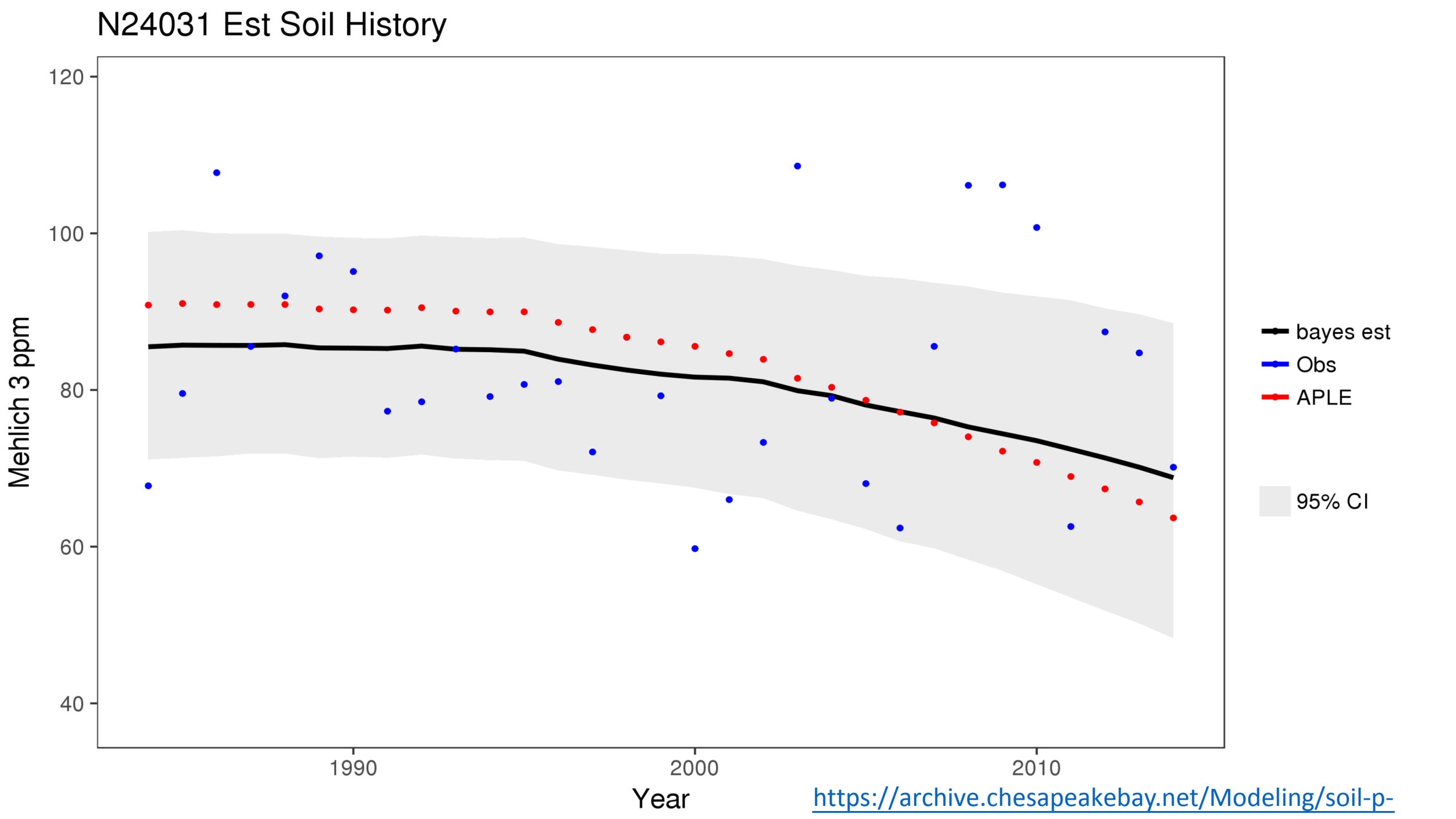


- In the model, the benefits depend on how long you have changed inputs
  - Benefits = (Change in Inputs) X (**X** Years)

- In the real world, a small portion of the benefit is received right away, the greater portion is lagged for many years.

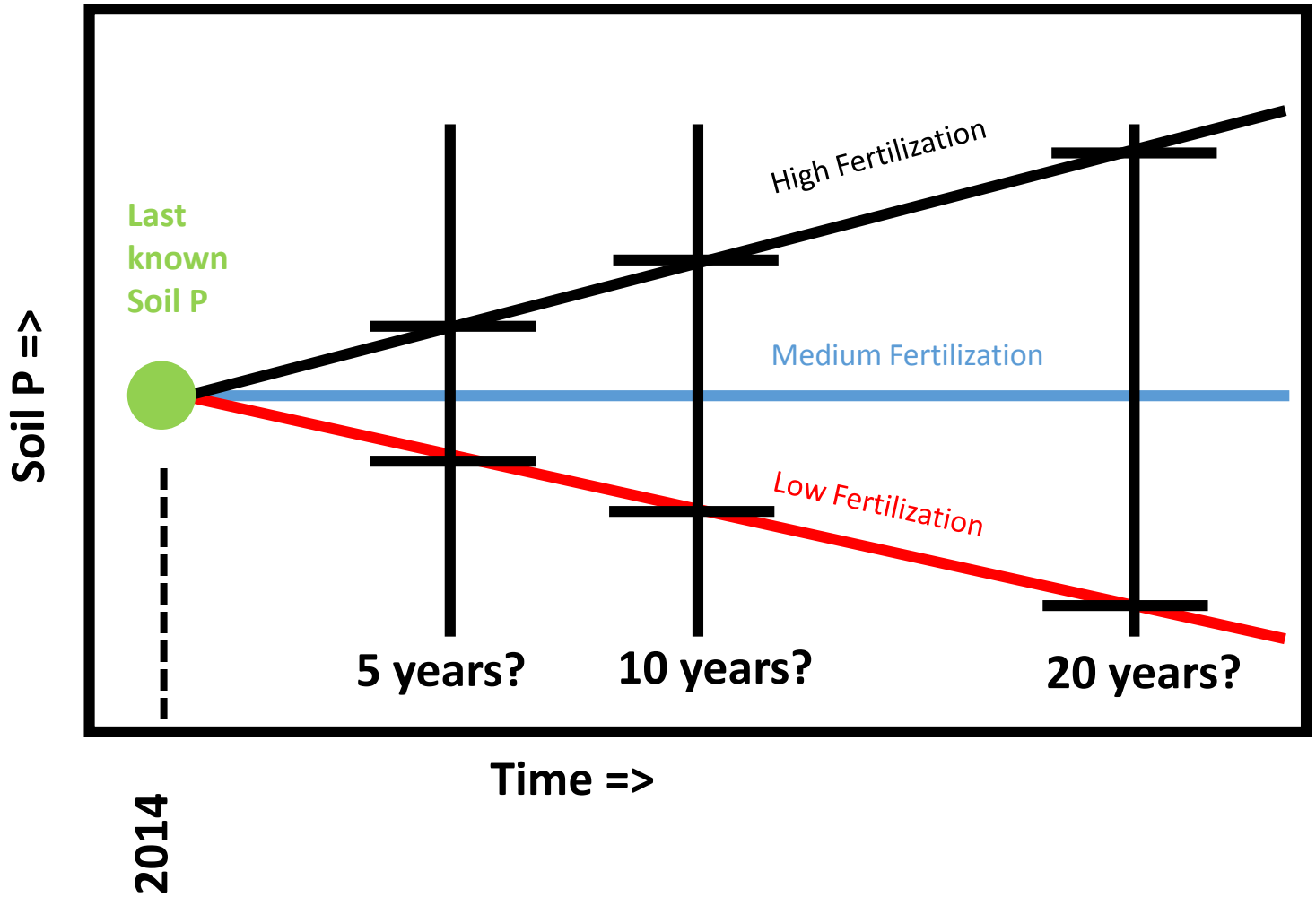
Balance of what the two data sets are telling us



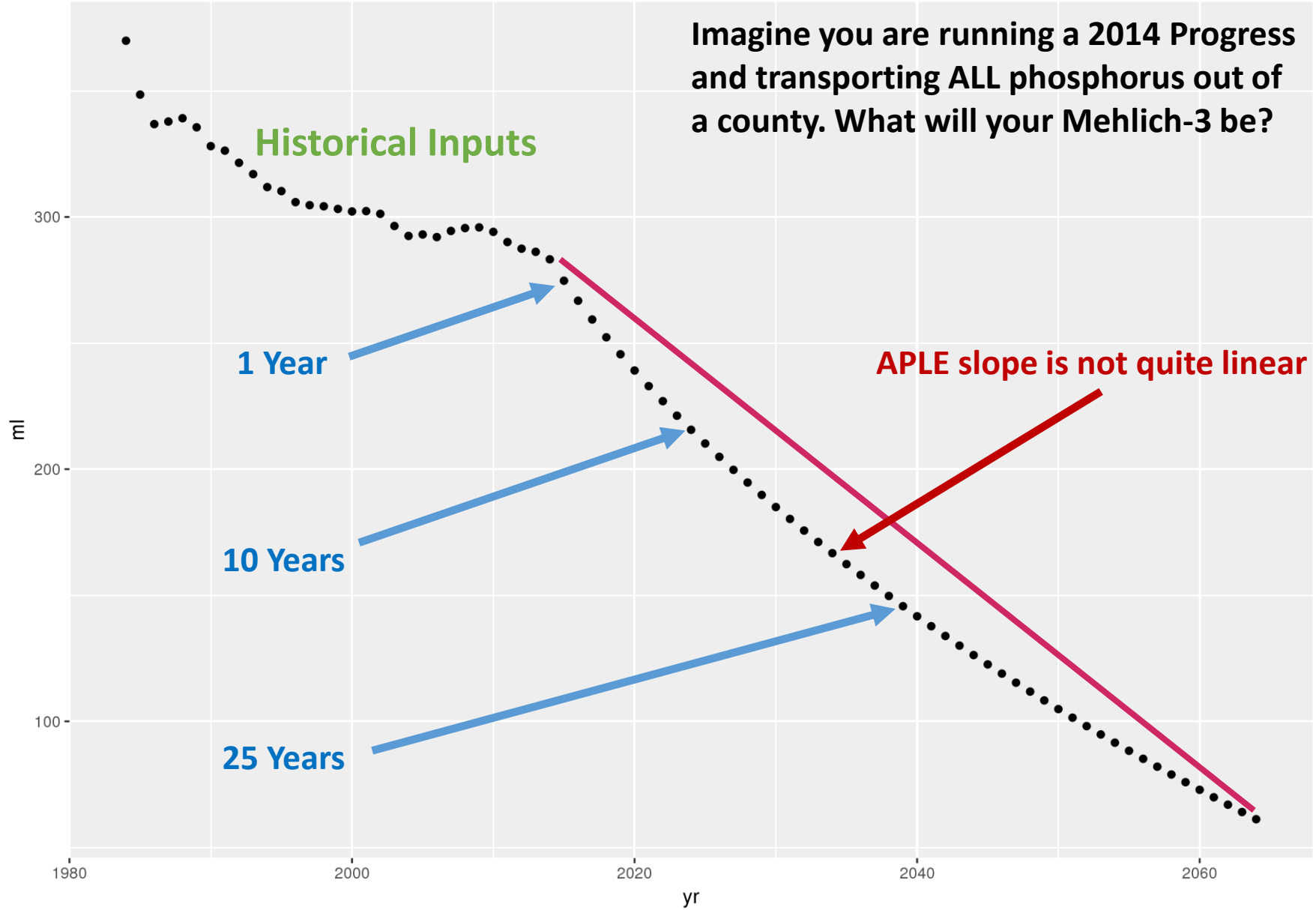


https://archive.chesapeakebay.net/Modeling/soil-p-

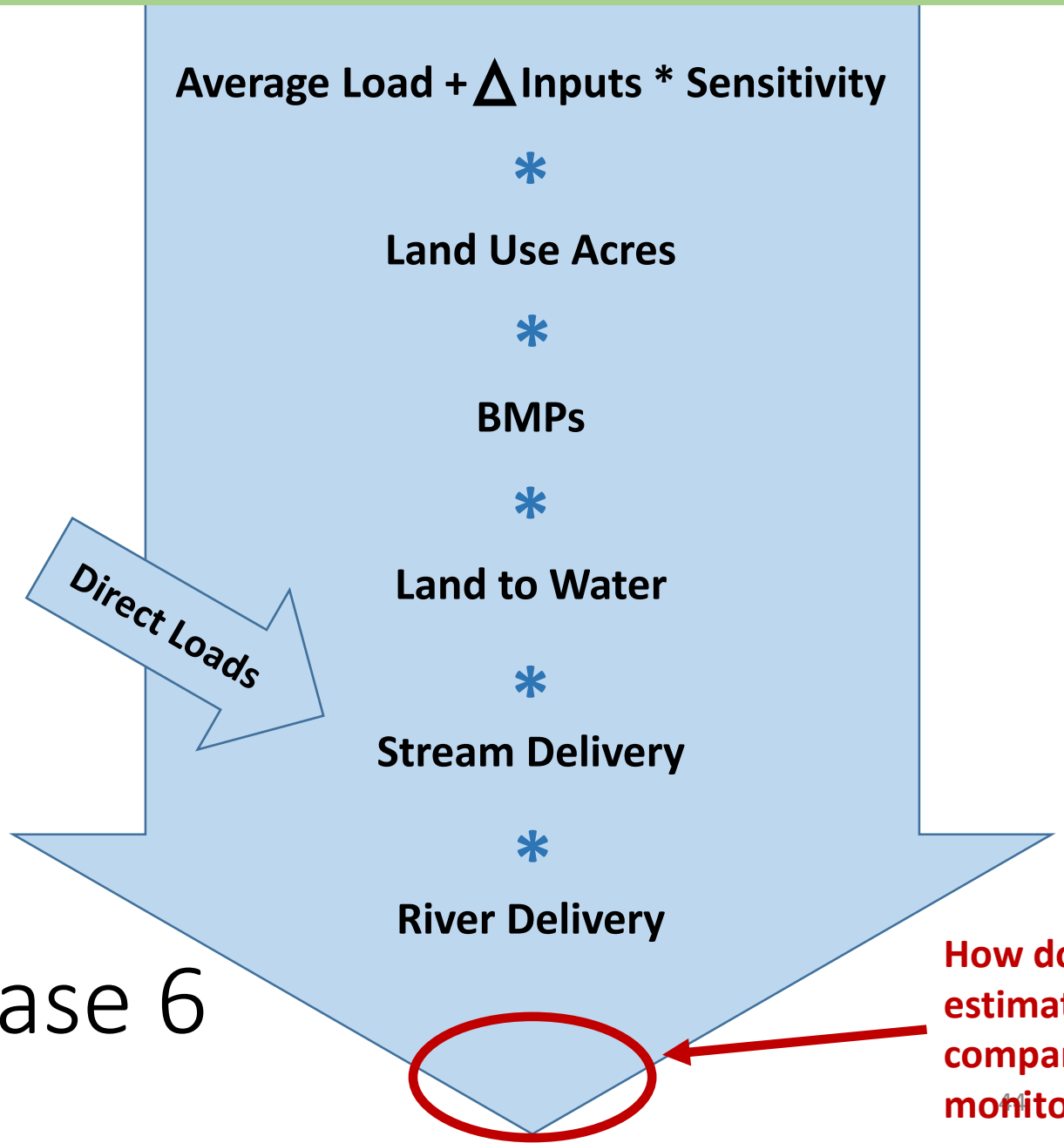
How APLE Responds Over Time to Changes in Inputs (Conceptual)



How APLE Responds Over Time to Changes in Inputs (Actual Run)



Phase 6 Model Structure



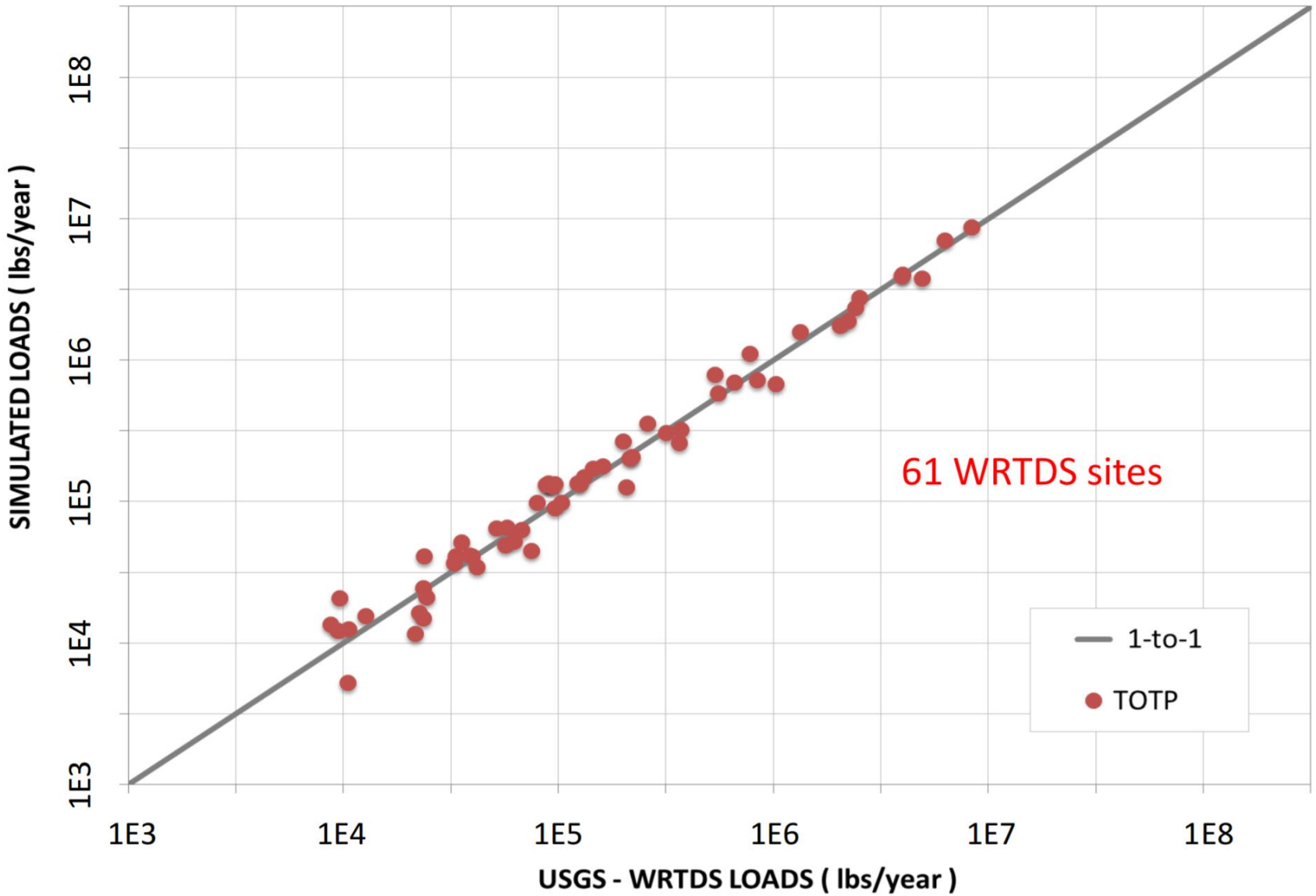
Phase 6

How does estimated delivery compare to monitored data?

DRAFT G

Revised inputs, model refinements, and calibration methods

PHOSPHORUS



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