Recommendations for PQUAL Sensitivity

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Objectives

- Build and present arguments as to the appropriate PQUAL sensitivity to inputs.

Phase 5.3.2 Sensitivity

- The HSPF uses the Agricultural Chemical Model (AGCHEM) and the Pervious Quality Model (PQUAL) modules for the simulation of nutrient.
- AGCHEM simulates biological and chemical processes and PQUAL simulates nutrient fluxes using a simplified first-order approximation.
- Although AGCHEM is a robust module from academic and scientific standpoints, its high level of complexity represents a obstacle for comprehension management communities. The PQUAL module would be more straightforward for comprehension and decision implementation.
- The Modeling Team has conducted a sensitivity analysis of the AGCEHM simulation between all nutrient inputs and outputs.
- **The coefficients resulted from the p532 and other existing models sensitivity analyses will be used to specify functional links between nutrient inputs and outputs in the PQUAL version of the Watershed Model.**

Comparison between P532 and existing watershed models

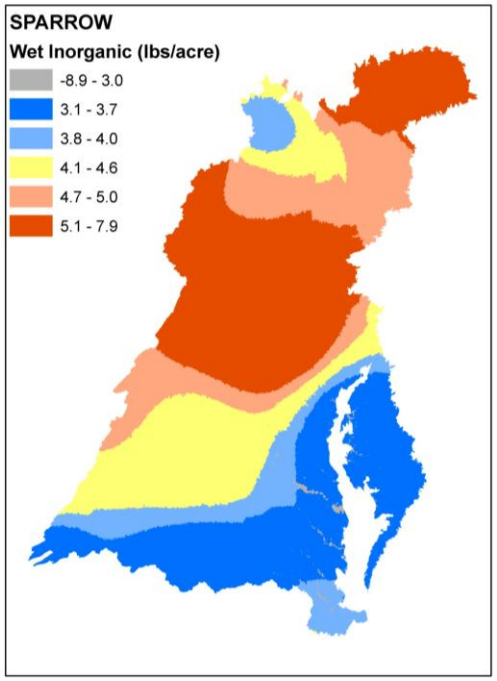
SPARROW model

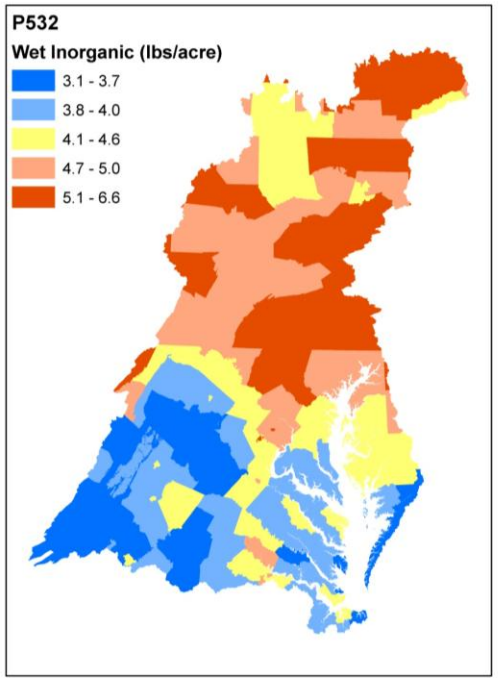
SPARROW is a spatially explicit, mass-balance watershed model that uses nonlinear regressions to quantify the relationship between observed nutrient fluxes in nontidal streams and inputs and factors that affect their overland and in-stream fate and transport.

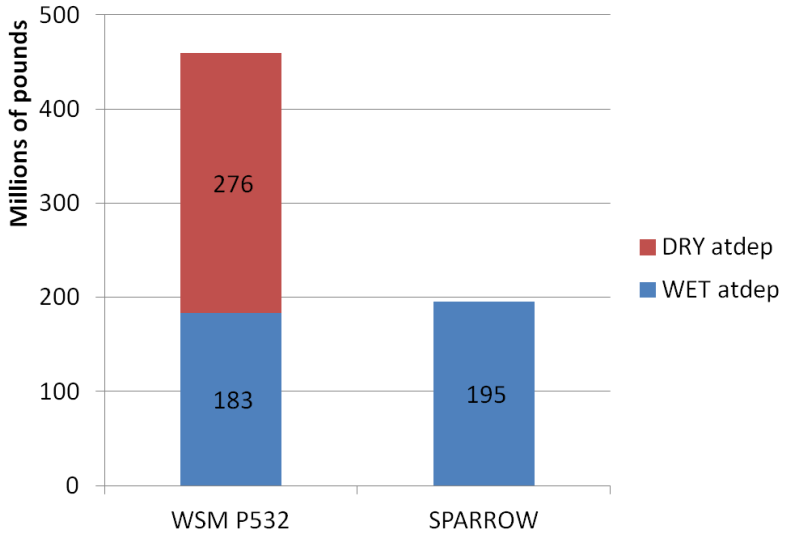
Spatially Referenced Regression on Watershed Attributes (SPARROW) Model has been used to provide empirical estimates of the source, fate, and transport of nutrients across the United States including the Chesapeake Bay Watershed.

Ator, S., J. Brakebill, and J. Blomquist. 2011. Sources, Fate, and Transport of Nitrogen and Phosphorus in the Chesapeake Bay Watershed: An Empirical Model. *USGS.* Available online at http://pubs.usgs.gov/sir/2011/5167/

Estimates of Atmospheric Deposition inputs for the year 2002

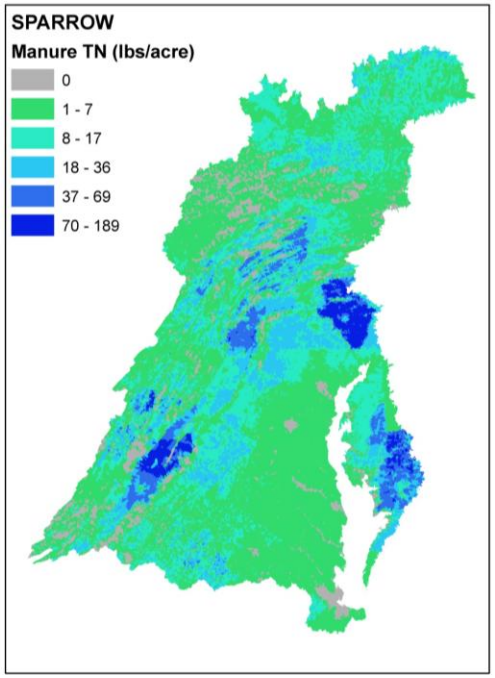


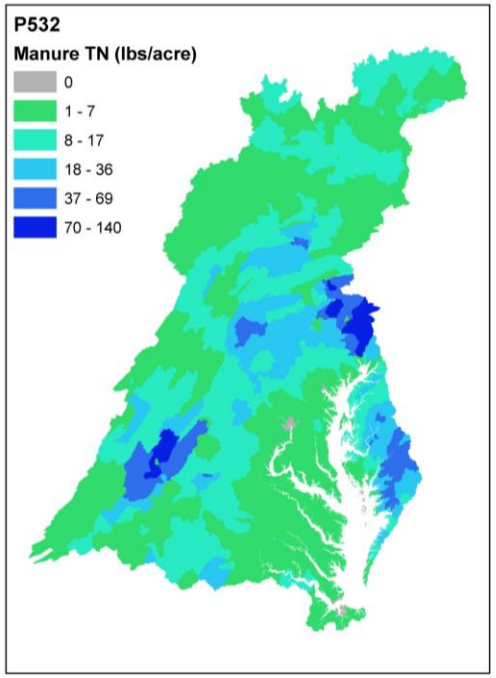


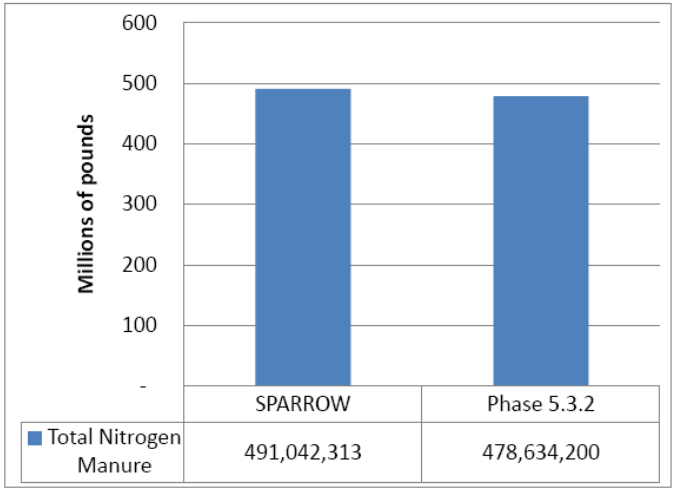


SPARROW input data set represents the average ***atmospheric (wet) deposition*** of inorganic nitrogen for the year 2002 compiled for every catchment of NHDPlus. Available online at http://water.usgs.gov/GIS/metadata/usgswrd/XML/nhd_atdep.xml

Estimates of Nitrogen input from Manure for the year 2002





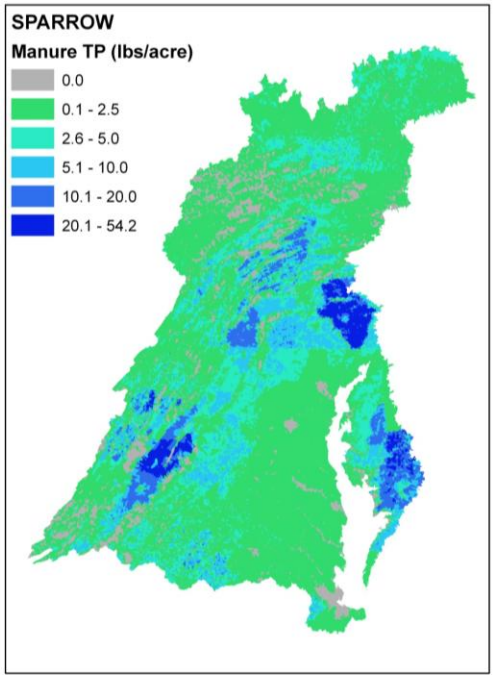


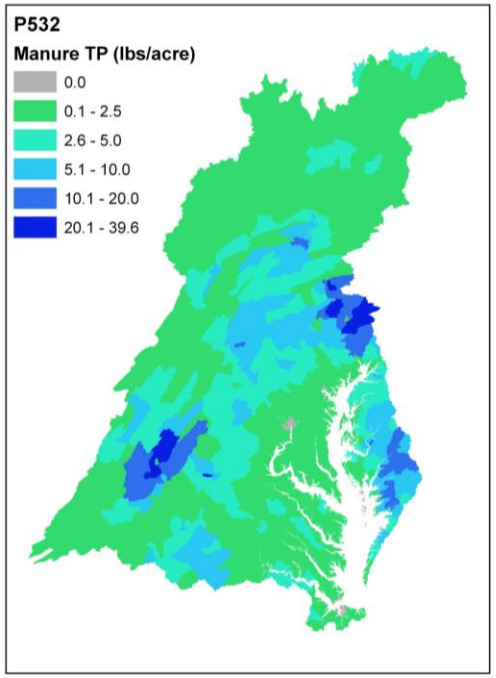
The nitrogen and phosphorus content of livestock wastes was estimated using Census of Agriculture.

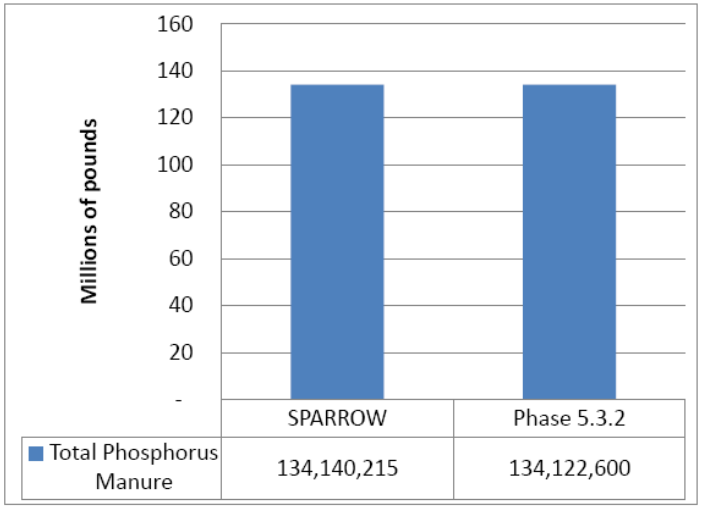
The procedures include: (1) estimating animal populations, (2) calculating nitrogen and phosphorus content of the animal manure, and (3) estimating the component of nitrogen and phosphorus from ***confined and unconfined livestock***.

SPARROW estimates of nitrogen input from manure ***do not account for loss through volatilization***. Thus, these estimates represent the total nitrogen content in manure as excreted by each livestock group. Available online at http://water.usgs.gov/GIS/metadata/usgswrd/XML/nhd_nutrients.xml

Estimates of Phosphorus input from Manure for the year 2002







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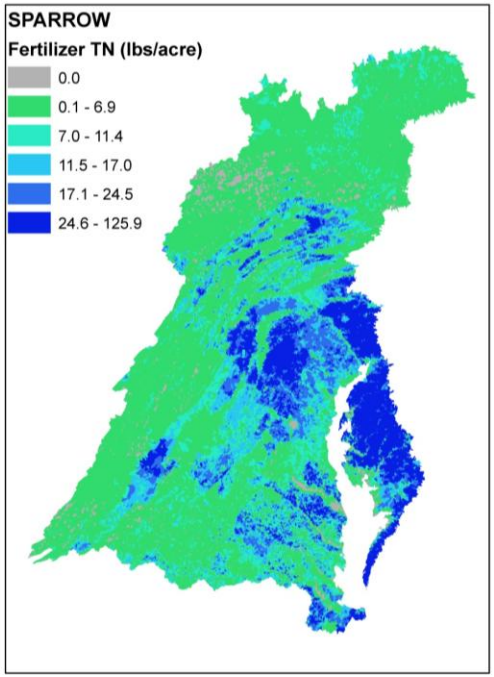
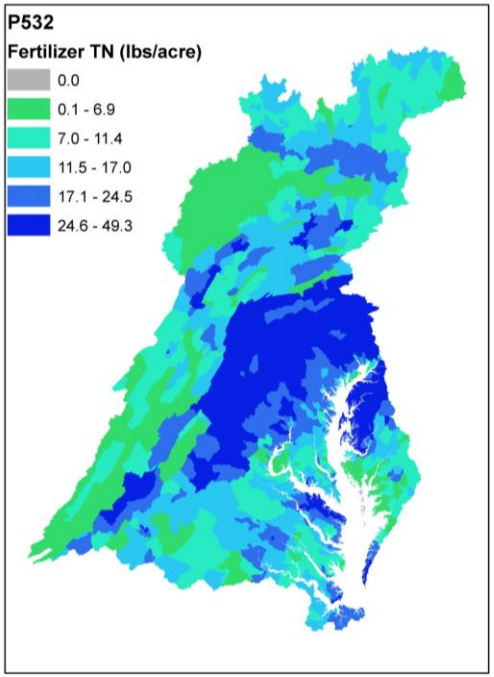
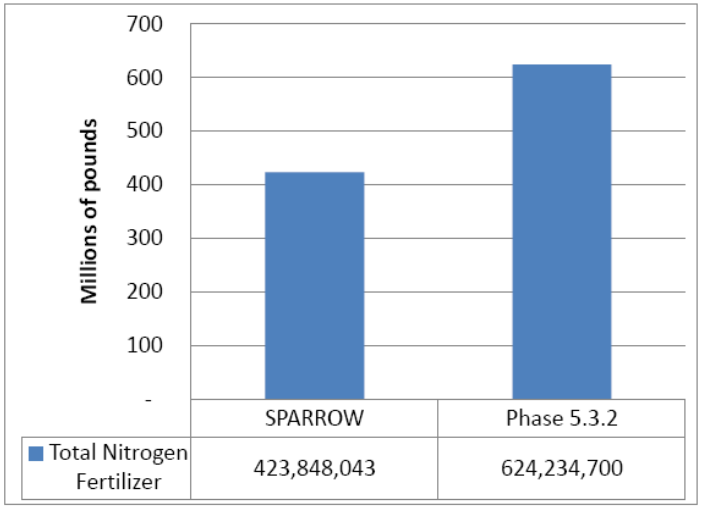
Estimates of Nitrogen input from Fertilizer for the year 2002







Estimates were calculated from the Association of American Plant Food Control Officials fertilizer sales data, Census of Agriculture fertilizer expenditures, and U.S. Census Bureau county population.

A national approach was used to estimate ***farm and nonfarm fertilizer*** inputs. Available online at http://water.usgs.gov/GIS/metadata/usgswrd/XML/nhd_nutrients.xml

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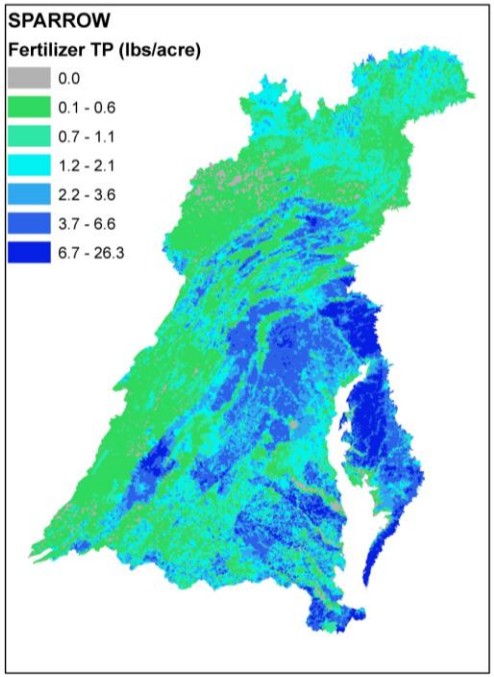

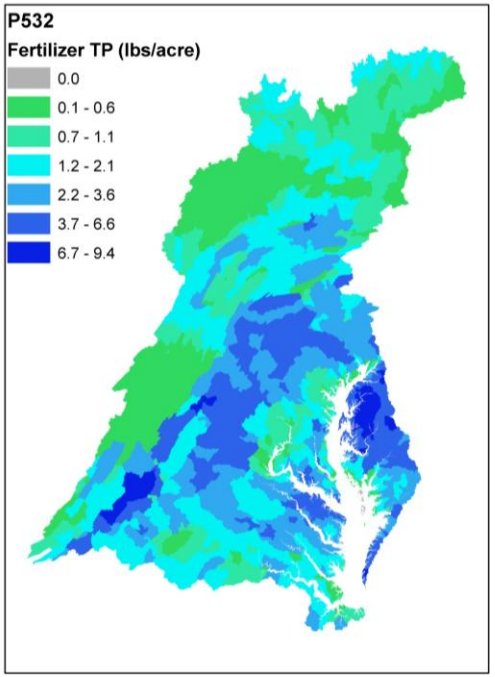

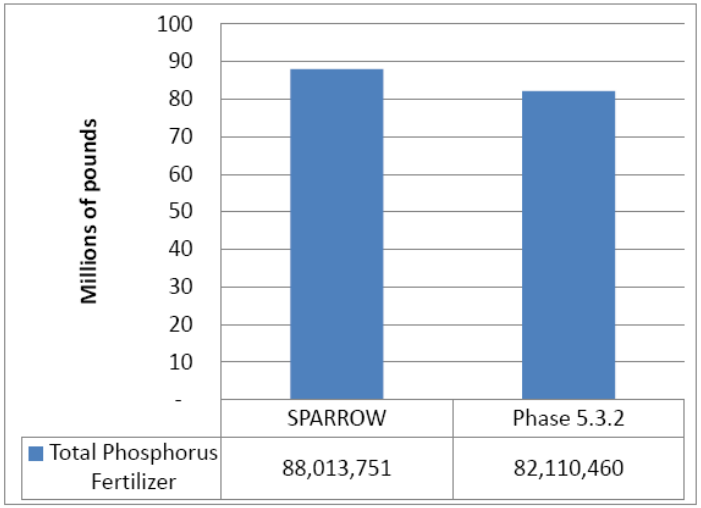

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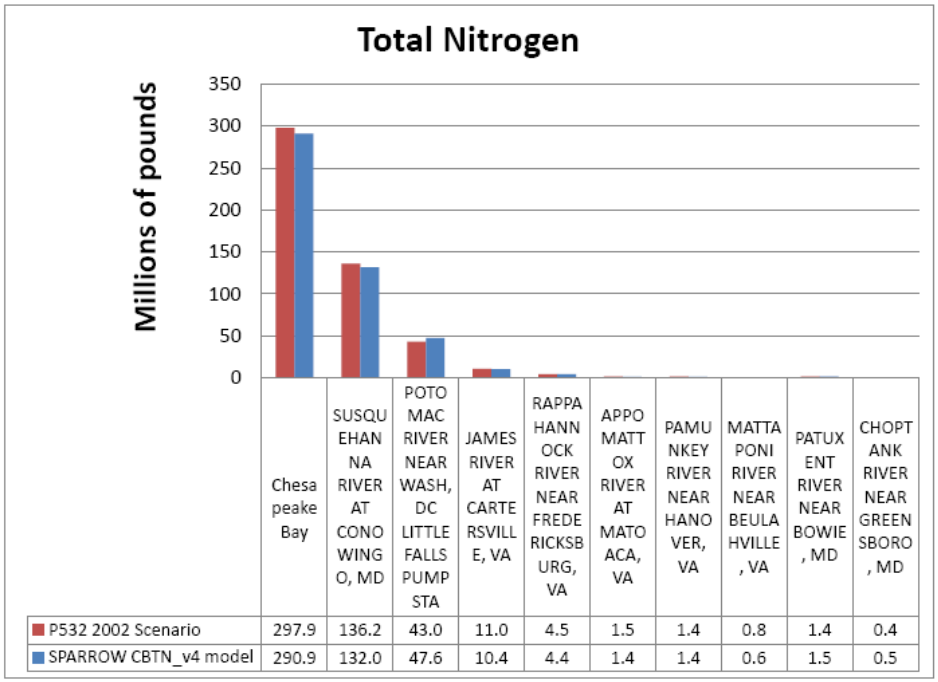
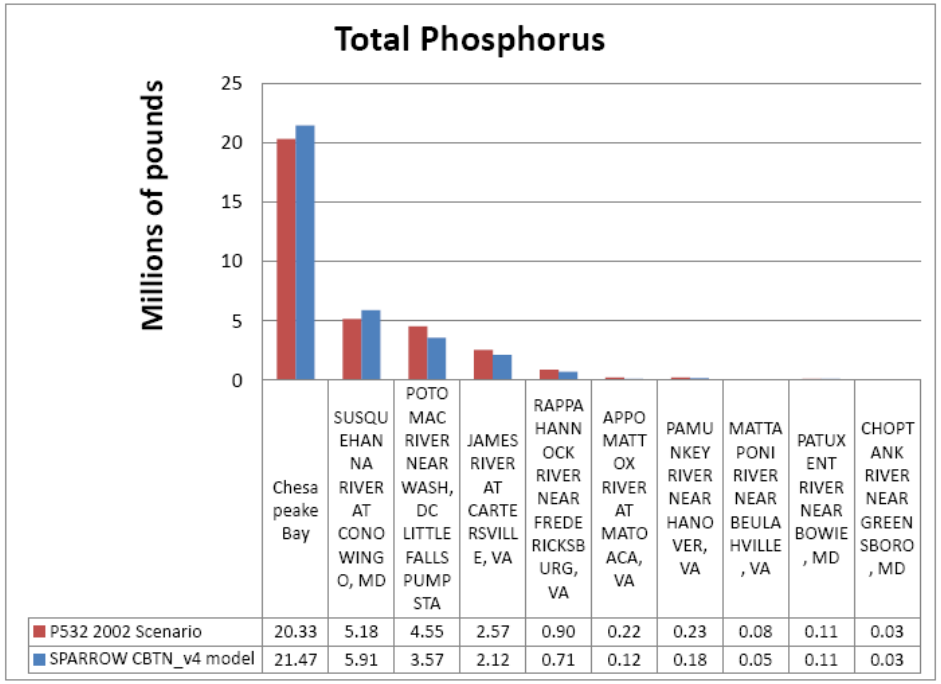
SPARROW Function

Sparrow estimated ***source-specific coefficients*** are interpreted as the proportion (fraction) of the applied or deposited nutrient mass transported to the tributaries.

- E.g. Ator et al. (2011) calculated a fertilizer source-specific coefficient of 0.24. in the same study it was estimated that 24% of TN from fertilizer was transported to the CBW tributaries in 2002. In other words, for every pound of TN from fertilizer 0.24 pounds was transported to the CBW tributaries in 2002.

Comparison between P532 and SPARROW outputs for 2002





In spite of SPARROW's unequal atmospheric and fertilizer input mass, spatial application rates distribution and approach to assess water quality , SPARROW showed almost the same output than P532 at 9 USGS stations.

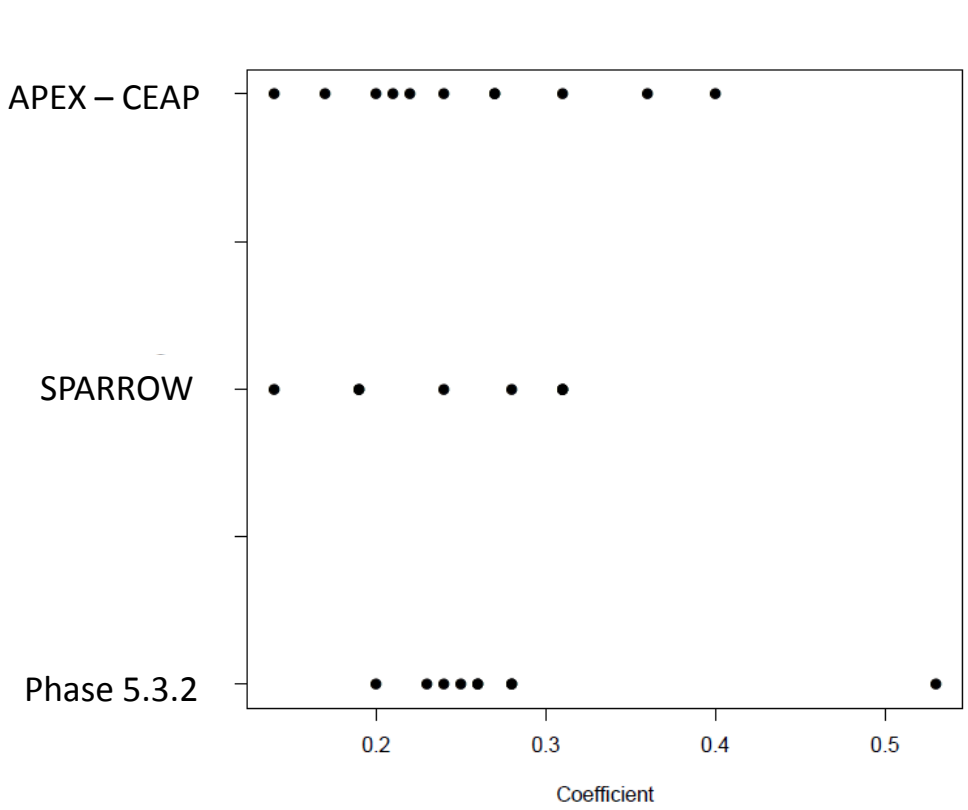
APEX - CEAP MODEL

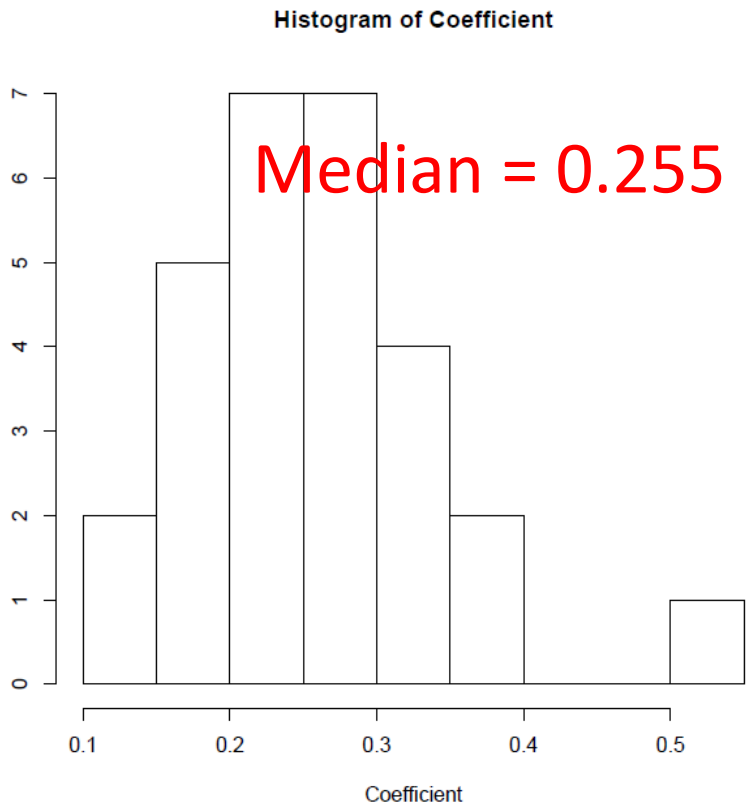
- ***Impacts of Conservation Adoption on Cultivated Acres of Cropland in the Chesapeake Bay Region, 2003-06 to 2011*** is the first revisit of the assessment by the USDA NRCS through the Conservation Effects Assessment Project (CEAP) (USDA NRCS 2011) http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1240074

- Output-input ratios were calculated dividing surface runoff and subsurface nutrient loss by the nutrient from all sources.

Comparison between P532 and existing models coefficients

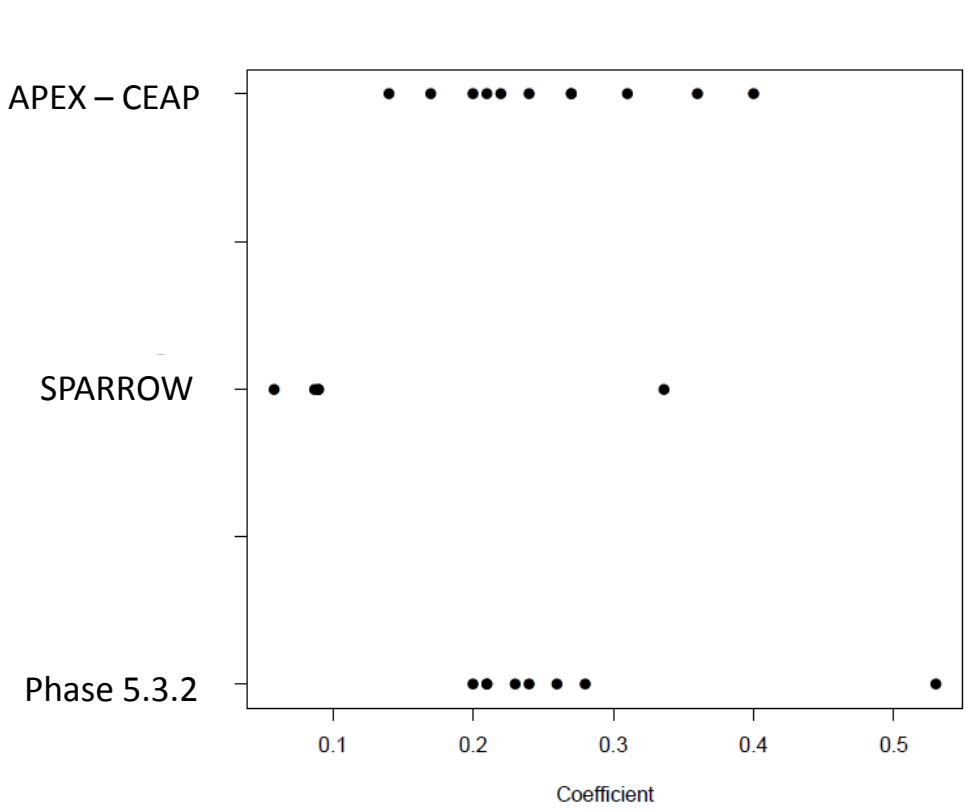
Fertilizer Nitrogen

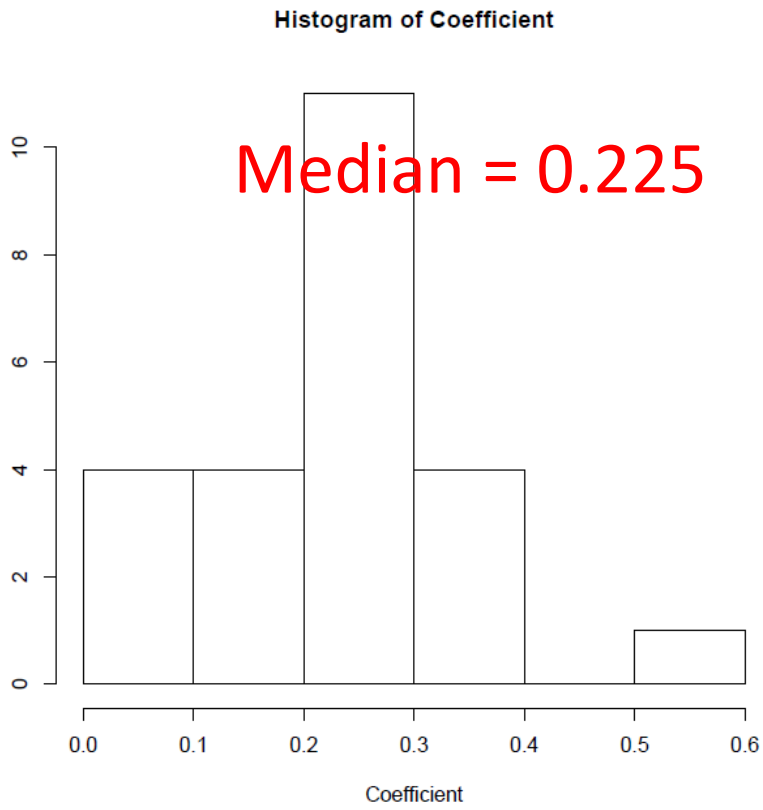




1. APEX – CEAP: Ratio between output and input (No-practice, 2006, and 2011 scenarios including all input sources in cropland areas)
2. SPARROW: source specific coefficient (Various studies in the Chesapeake bay and Northeastern and Mid-Atlantic regions)
3. Phase 5.3.2: Ratio between input and output, slope of multivariate regression, and slope between output and input (14 scenarios / hwm, hom, lwm, alf, and hyw landuses) https://archive.chesapeakebay.net/Modeling/phase5/Phase532/Sensitivity_coefficients_033114.xlsx

Manure Nitrogen





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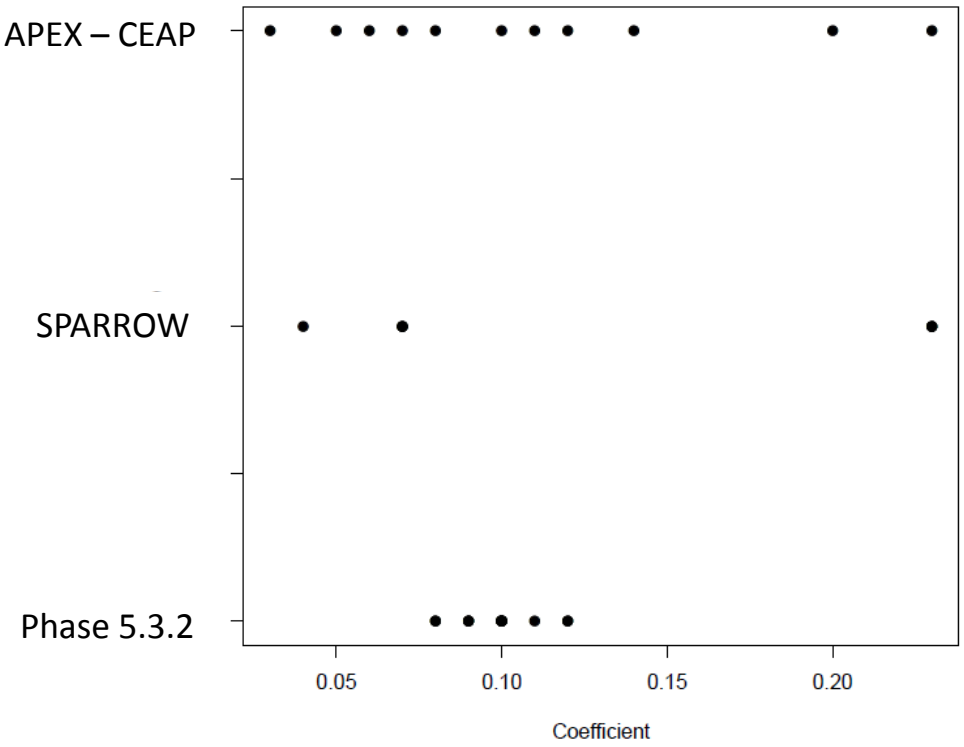

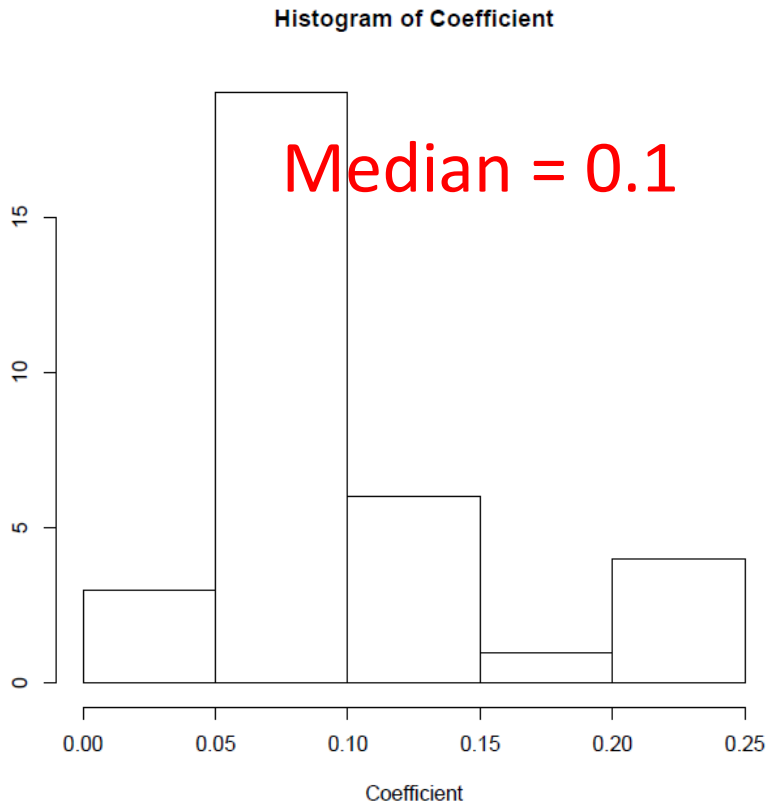

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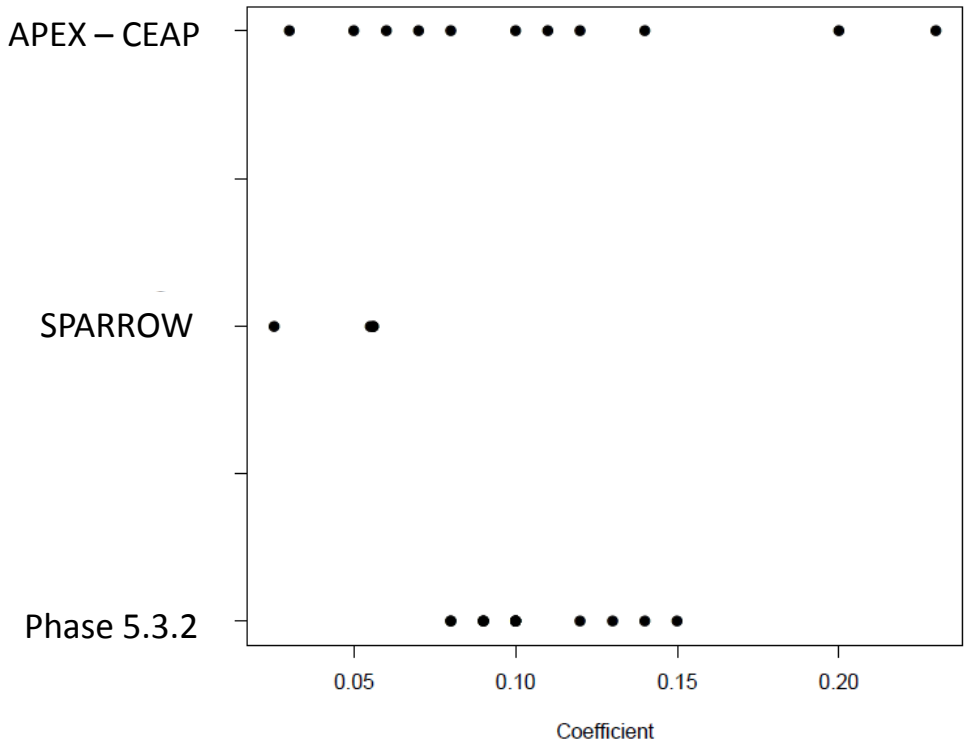

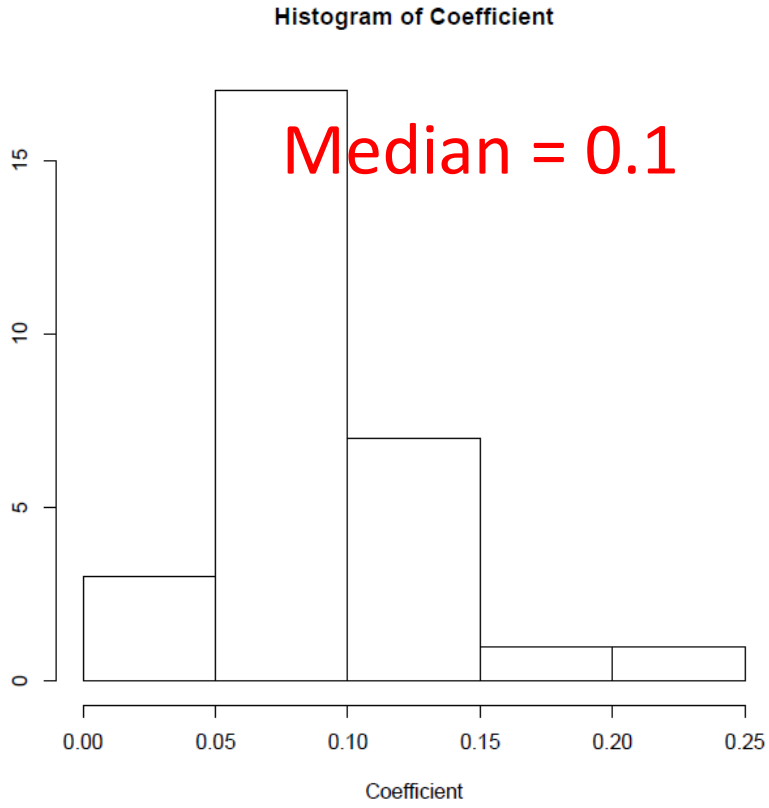

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Summary

- In spite of different inputs and approach to assess water quality, SPARROW showed almost the same output than P532 at 9 USGS stations in the year 2002.

- CEAP coefficients fall within the SPARROW and p532 coefficients range.

- We recommended to use a coefficient of 0.255 and 0.225 in PQUAL to calculate fertilizer and manure nitrogen losses, respectively.

- We recommended to use a coefficient of 0.1 in PQUAL to calculate both fertilizer and manure phosphorus losses.

What is next?

- APLE phosphorus model
- FLCM model (a MODIS approach to predicting stream water quality in forest)
- Phase 6 prototype including PQUAL sensitivity recommendations.