Phase 6 Watershed Model – Beta 4

Modeling Workgroup Quarterly Meeting – Dec 2016

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Presentation Outline

- A brief summary of input data / model updates
- Beta 4 land-use export rates (targets)
- Review of Beta 4 calibrations
- Next steps

Brief summary of input data / model updates

- Revised beta 4 model inputs.
- Updated atmospheric deposition data.
- Average loading rate (targets) were revised accordingly.
- Water quality calibration data for sediment were updated as well as additional data for the Conowingo from USGS-MDL were added.
- Land to water, Stream to river, and Reservoir efficiencies were updated.
- Rapid infiltration basins as a new input source was added.
- Small stream effects were included for direct loads – e.g., septic, riparian pasture, rapid infiltration basins.
- Seasonal parameters for UNEC lag-time were updated using an analysis of WRTDS data.
- Some of the issues in the Beta 3 calibration were addressed that were identified during the WQM calibration.

Beta 4 Edge of Small Stream Load (for the RIMshed)

	Total Nitrogen			Total Phosphorus		
	Beta 2	Beta 3	Beta 4	Beta 2	Beta 3	Beta 4
RIM Loads	213 Mlb	213 Mlb	213 Mlb	14.5 Mlb	14.5 Mlb	14.1 Mlb
BMP efficiency	5.79%	5.79%	5.63%	7.60%	7.60%	7.79%
Large river losses	53.30%	21.90%	**16.50%**	54.30%	16.90%	**9.40%**
Direct Loads	44.98 Mlb	53.13 Mlb	55.83 Mlb	5.41 Mlb	5.91 Mlb	7.31 Mlb
AFO/CFO loads	22.92 Mlb	58.75 Mlb	18.74 Mlb	3.72 Mlb	1.99 Mlb	0.78 Mlb
Small stream losses	6.20%	6.30%	**10.70%**	6.70%	4.30%	**11.80%**
EOSS LOAD	**444 Mlb**	**189 Mlb**	**219 Mlb**	**27.2 Mlb**	**11.5 Mlb**	**9.94 Mlb**

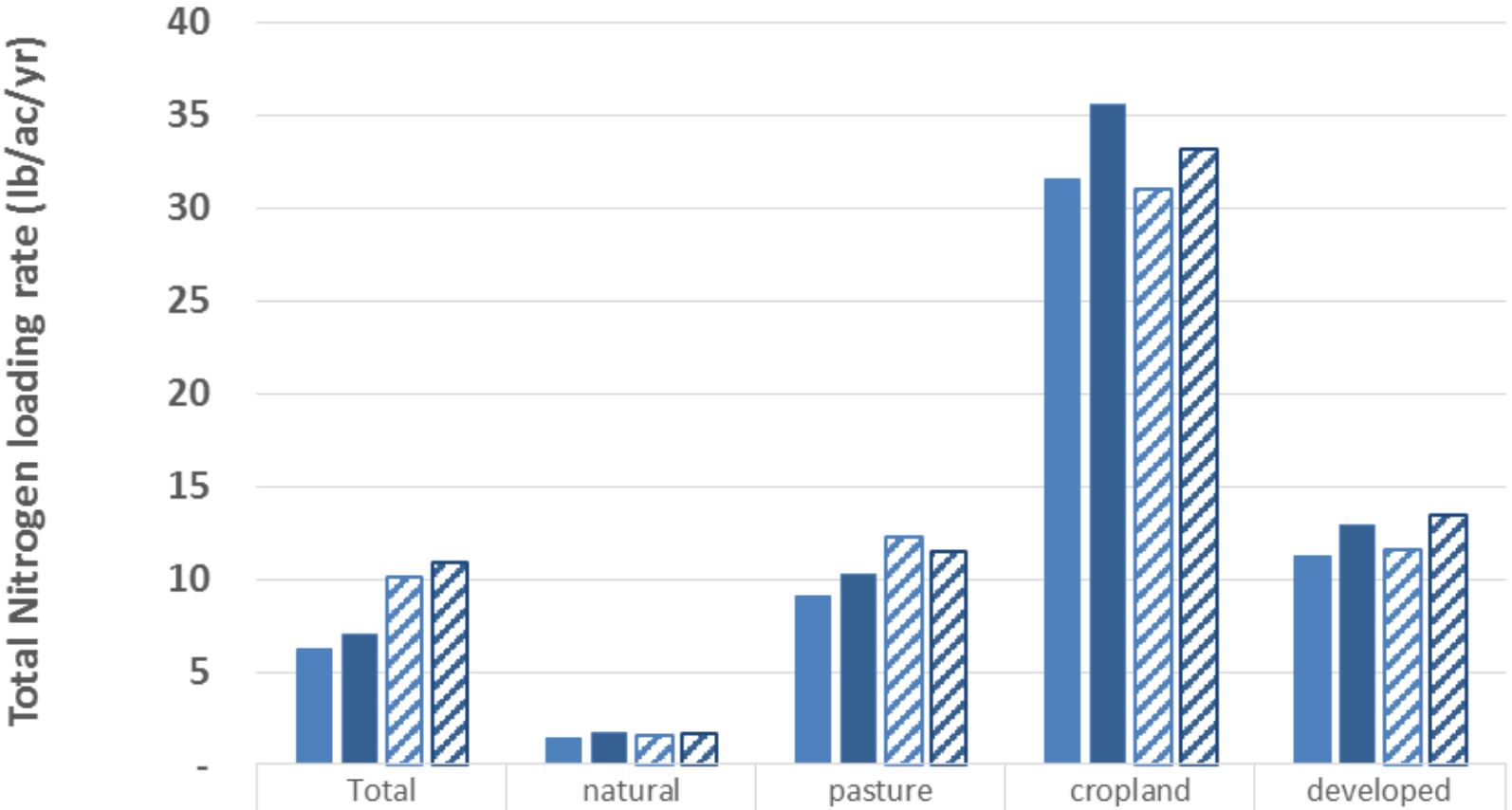
- Some of the issues that were identified in Beta 3 model were fixed. E.g., AFO/CFO loads
- Large and small-stream losses were estimated from SPARROW – Ross Mandel

Beta 4 Edge of Small Stream Load (for *non-RIMshed*)

	Total Nitrogen			Total Phosphorus		
	Beta 2	Beta 3	Beta 4	Beta 2	Beta 3	Beta 4
EOSS LOAD *	**185 Mlb**	**85.7 Mlb**	**92.4 Mlb**	**10.4 Mlb**	**4.73 Mlb**	**3.92 Mlb**
Direct Loads	56.5 Mlb	58.4 Mlb	56.7 Mlb	2.90 Mlb	3.32 Mlb	3.10 Mlb
AFO/CFO loads	2.33 Mlb	6.08 Mlb	0.65 Mlb	0.06 Mlb	0.93 Mlb	0.07 Mlb
BMP efficiency	6.17%	4.69%	6.06%	8.20%	5.49%	4.24%
Small stream losses						
Large river losses	12.08%	8.27%	7.88%	12.32%	7.49%	7.34%
Non-RIM Loads	201 Mlb	128 Mlb	124 Mlb	10.1 Mlb	8.4 Mlb	5.6 Mlb

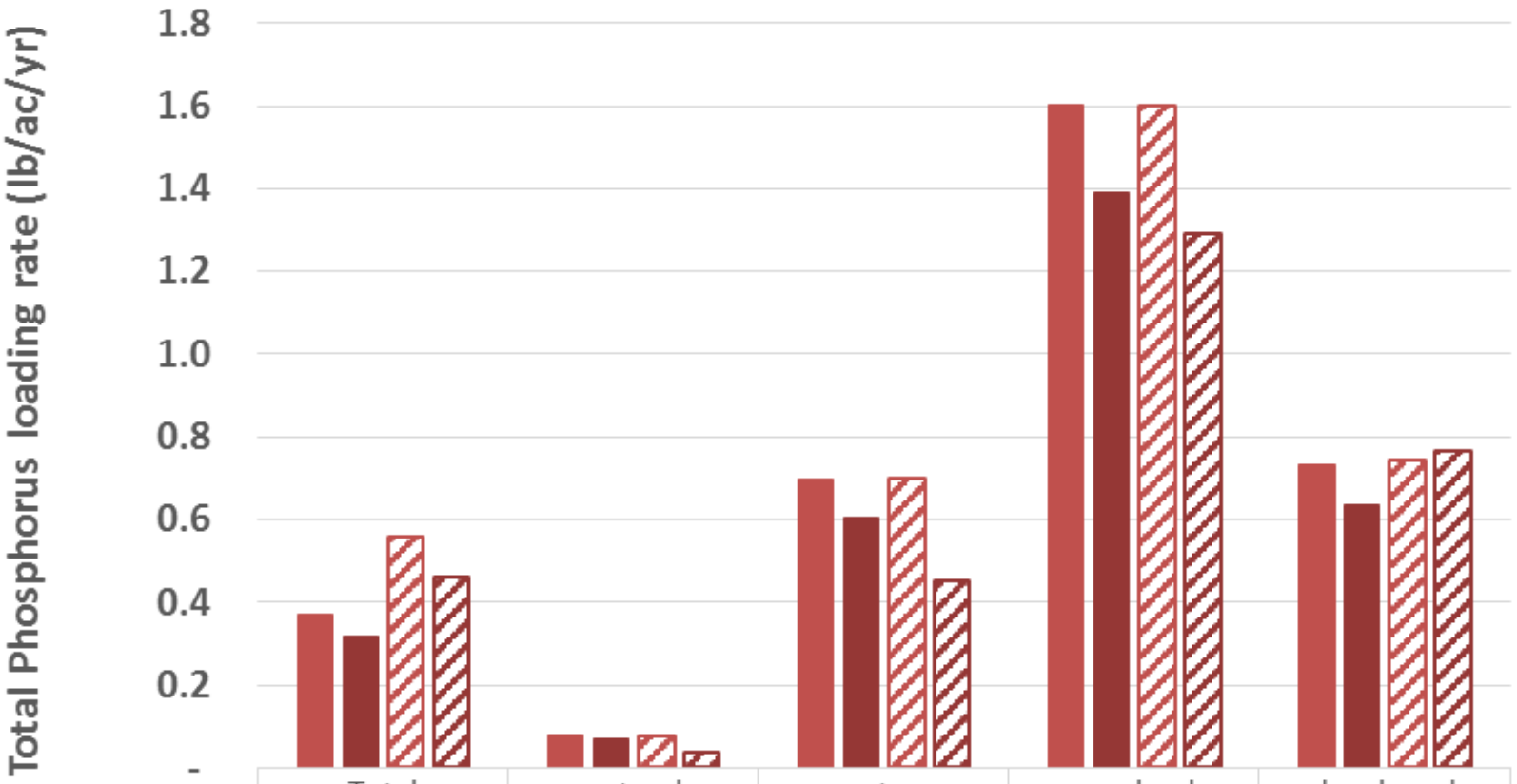
**** EOSS load for non-RIMshed is computed based on mass-balance of RIMshed.***

Nitrogen export rates to small streams (targets)



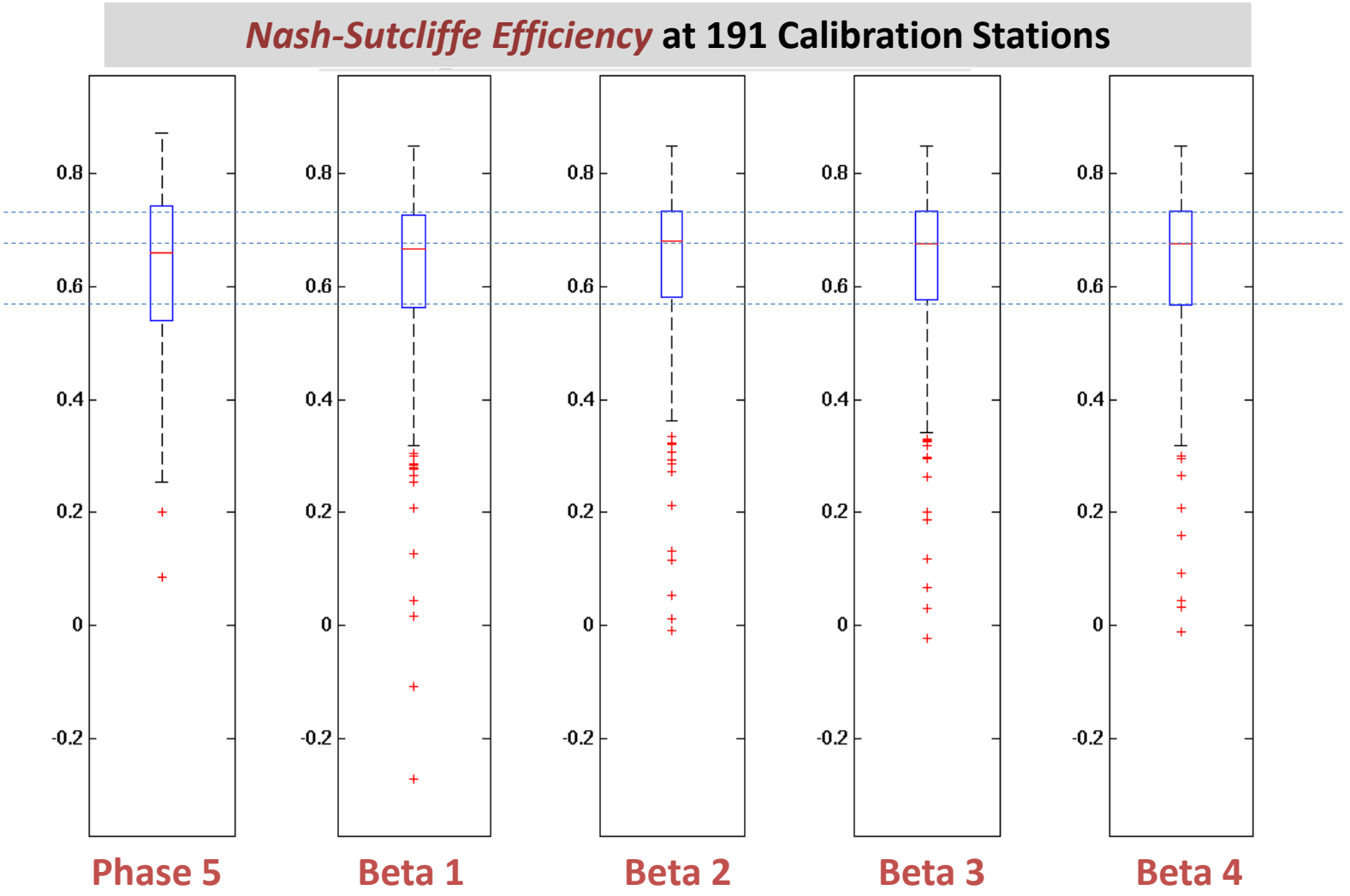
	Total	natural	pasture	cropland	developed
RIMshed (Beta 3)	6.20	1.47	9.04	31.51	11.28
RIMshed (Beta 4)	7.02	1.71	10.26	35.54	12.93
below-RIM (Beta 3)	10.12	1.53	12.26	31.01	11.56
below-RIM (Beta 4)	10.90	1.71	11.48	33.15	13.41

Phosphorus export rates to small streams (targets)



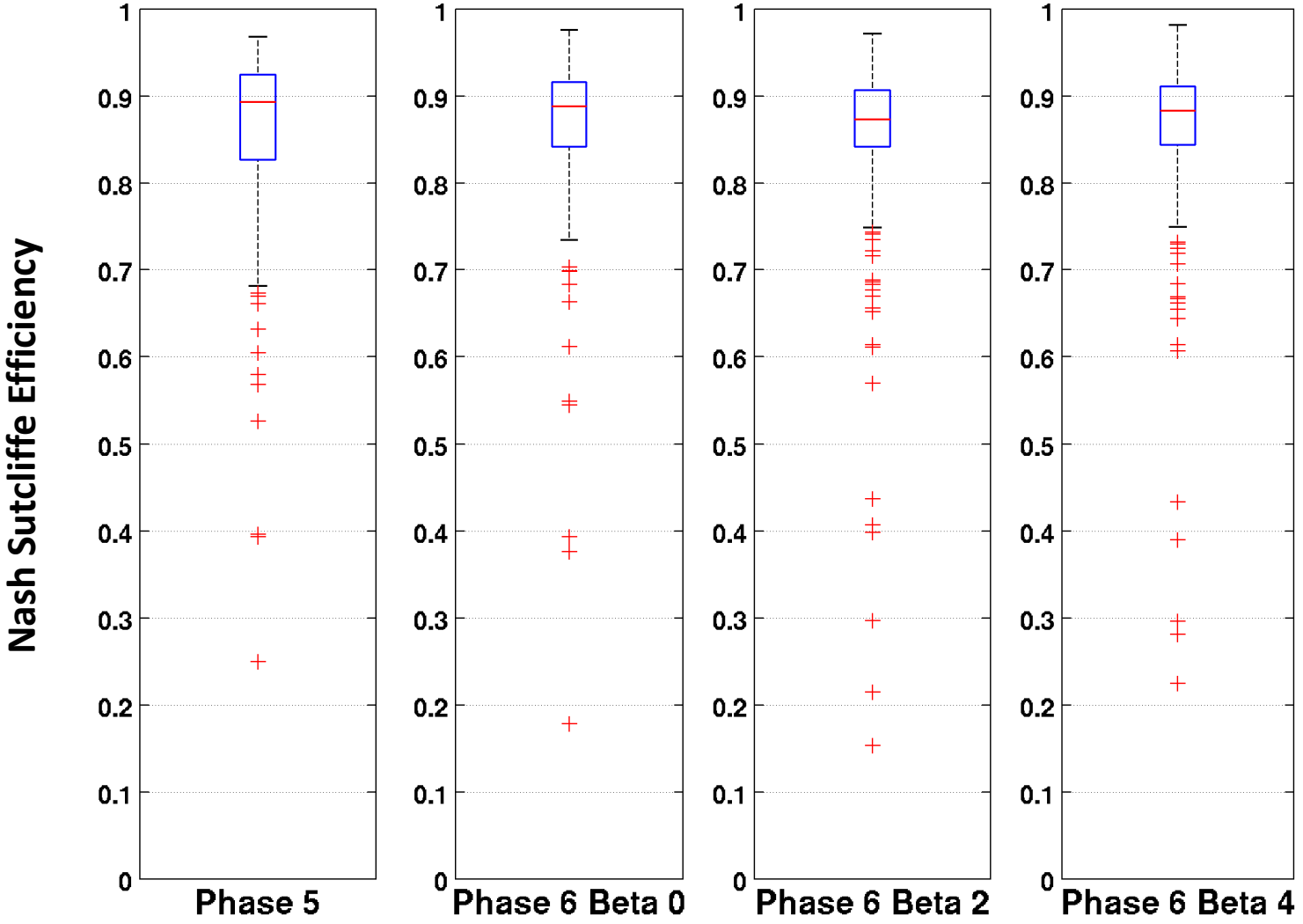
	Total	natural	pasture	cropland	developed
RIMshed (Beta 3)	0.37	0.08	0.70	1.60	0.73
RIMshed (Beta 4)	0.32	0.07	0.61	1.39	0.64
below-RIM (Beta 3)	0.56	0.08	0.70	1.60	0.74
below-RIM (Beta 4)	0.46	0.04	0.45	1.29	0.77

Hydrology calibration



Higher Nash Sutcliffe Efficiency (NSE) indicates better model performance.

Water temperature calibration

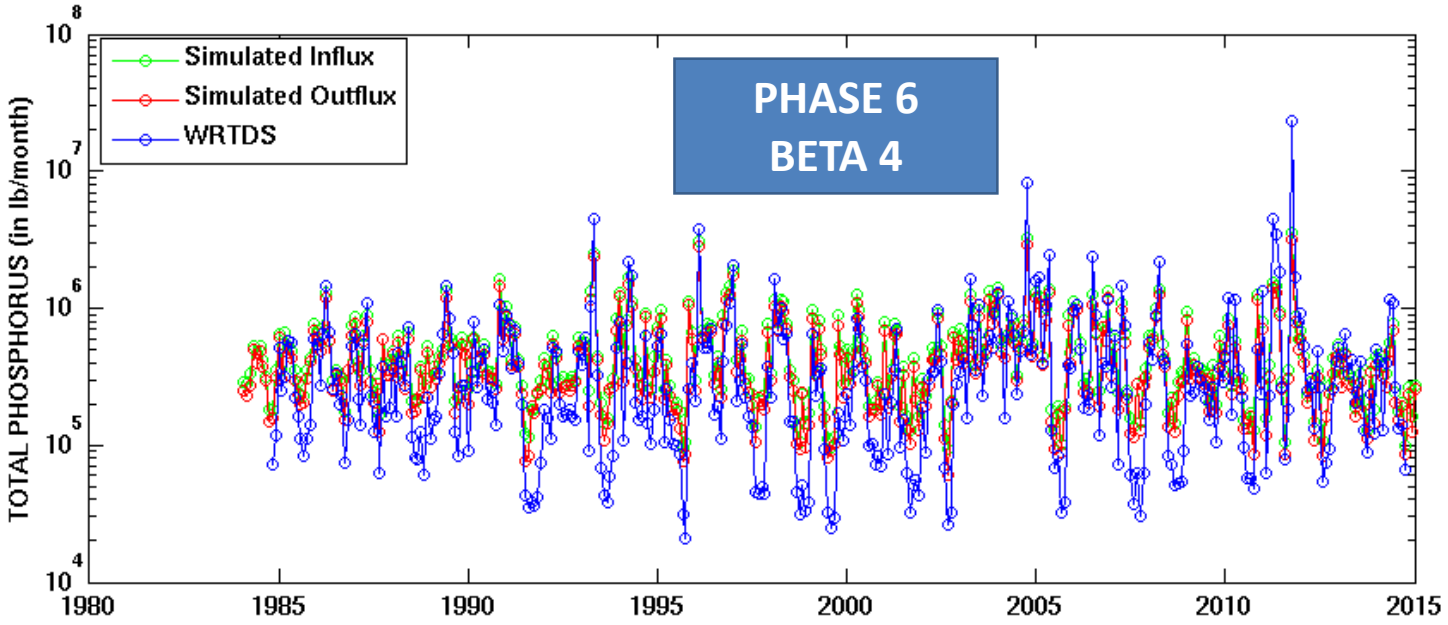


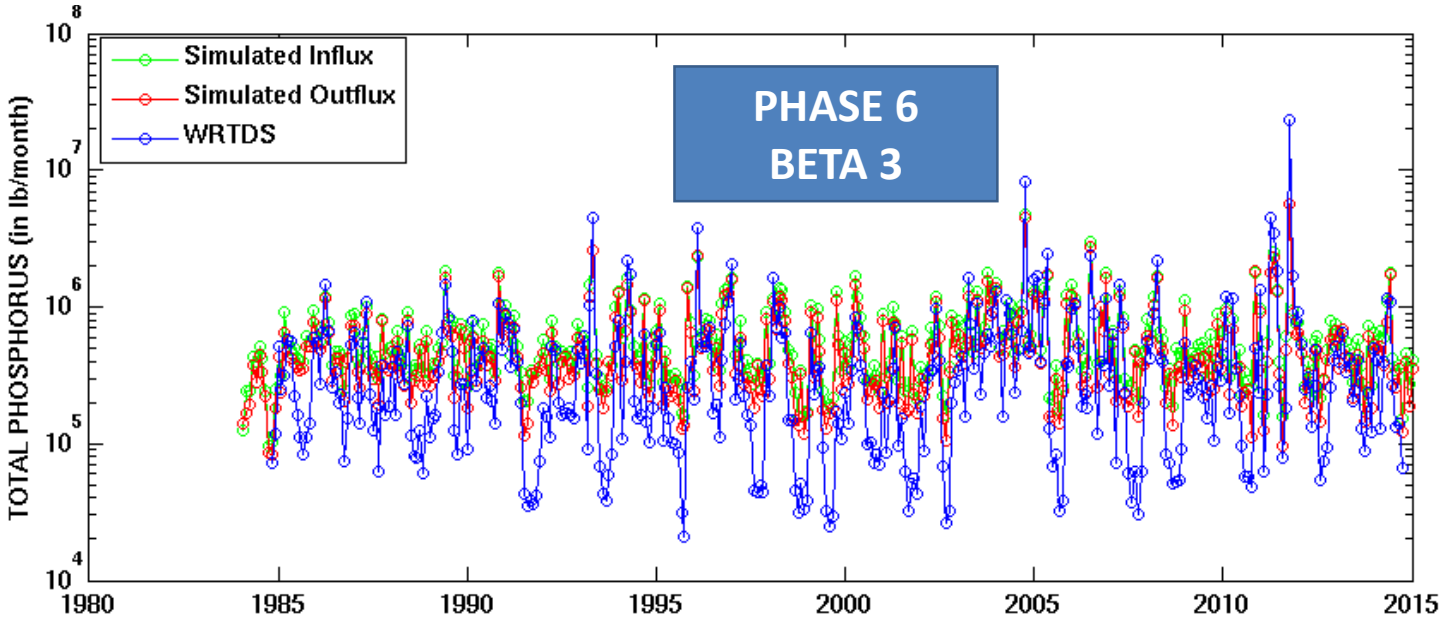
212 monitoring stations

Higher Nash Sutcliffe Efficiency (NSE) indicates better model performance.

Beta 3 vs. Beta 4 *total phosphorus*

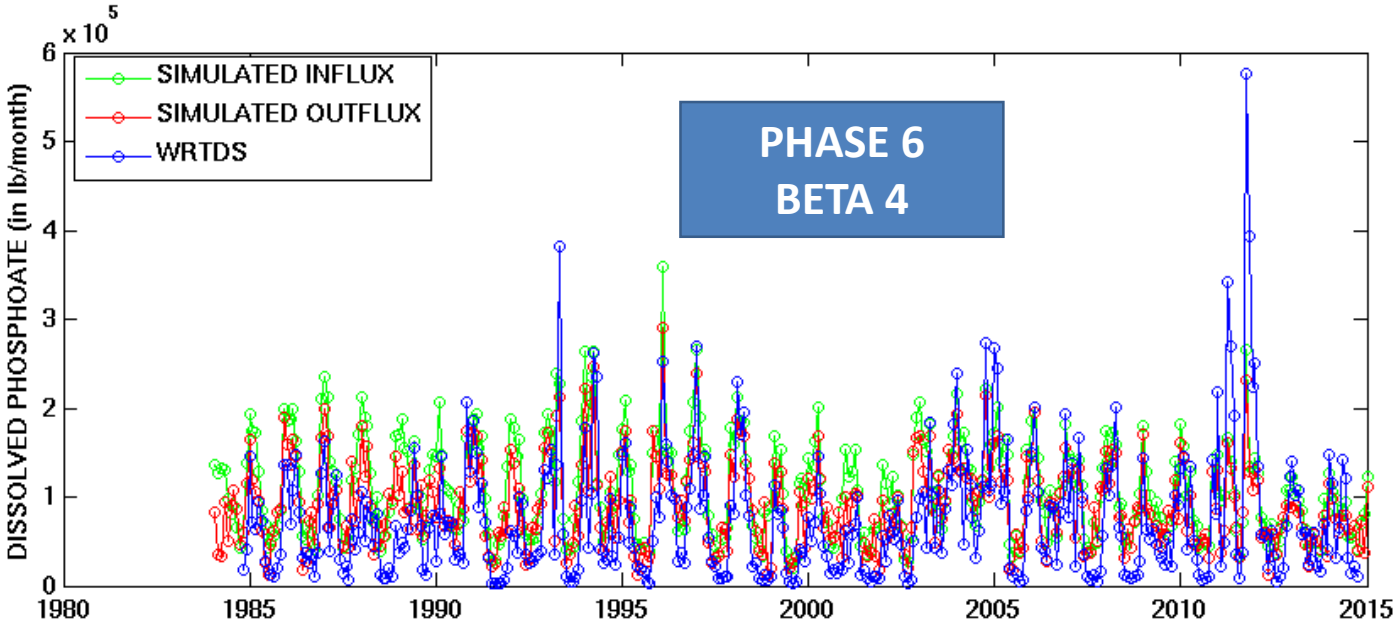
Susquehanna at Conowingo

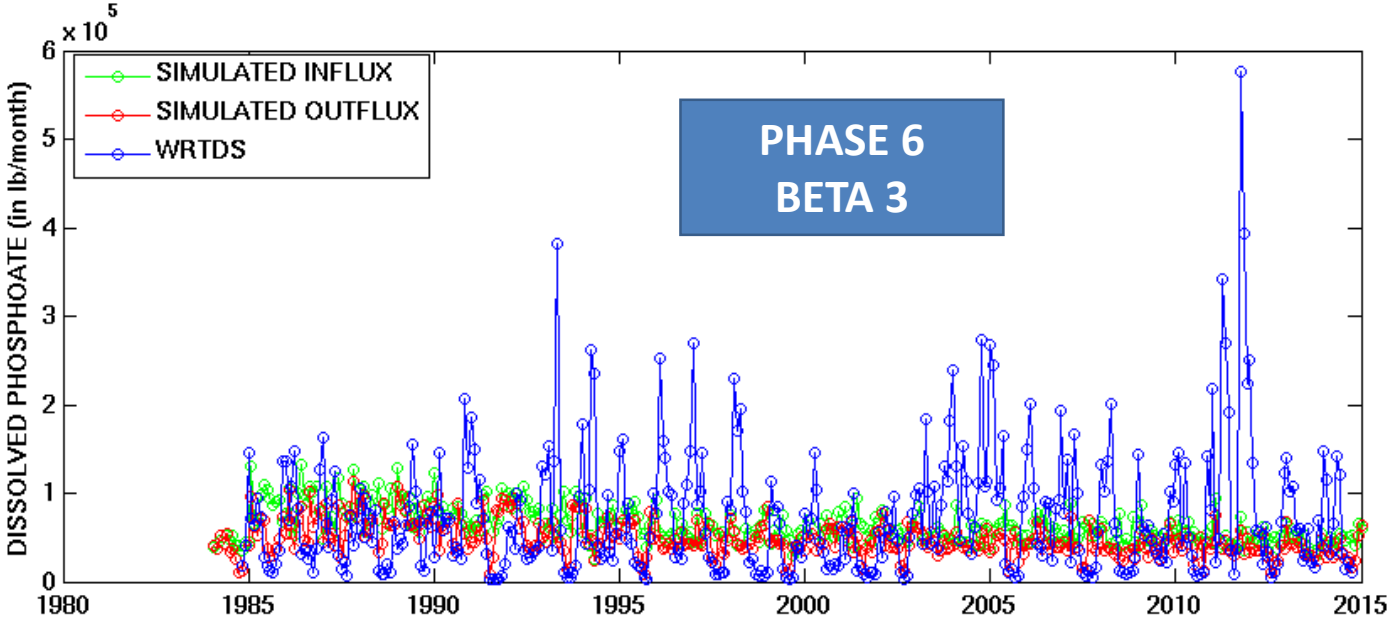




Beta 3 vs. Beta 4 *dissolved phosphate*

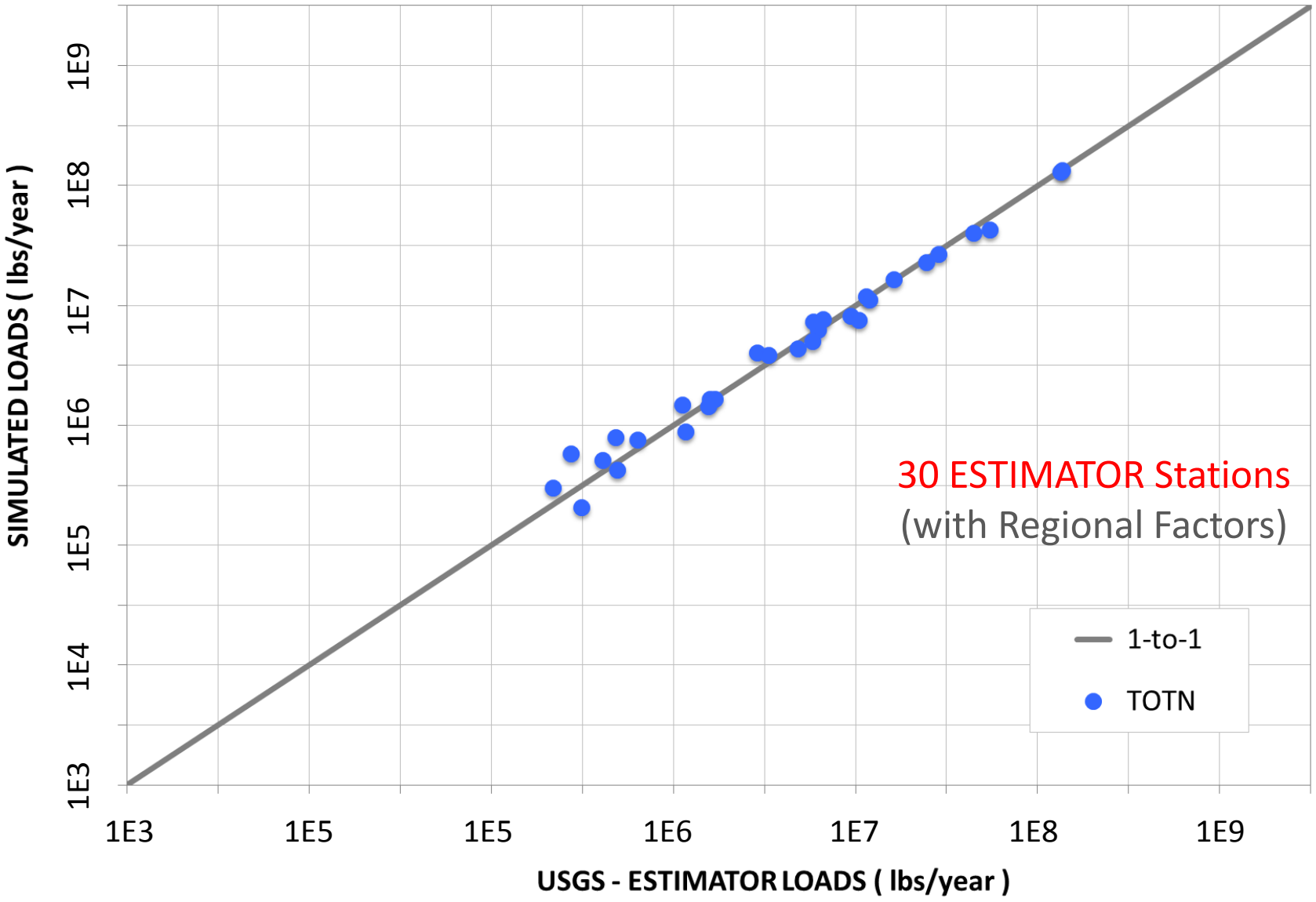
Susquehanna at Conowingo





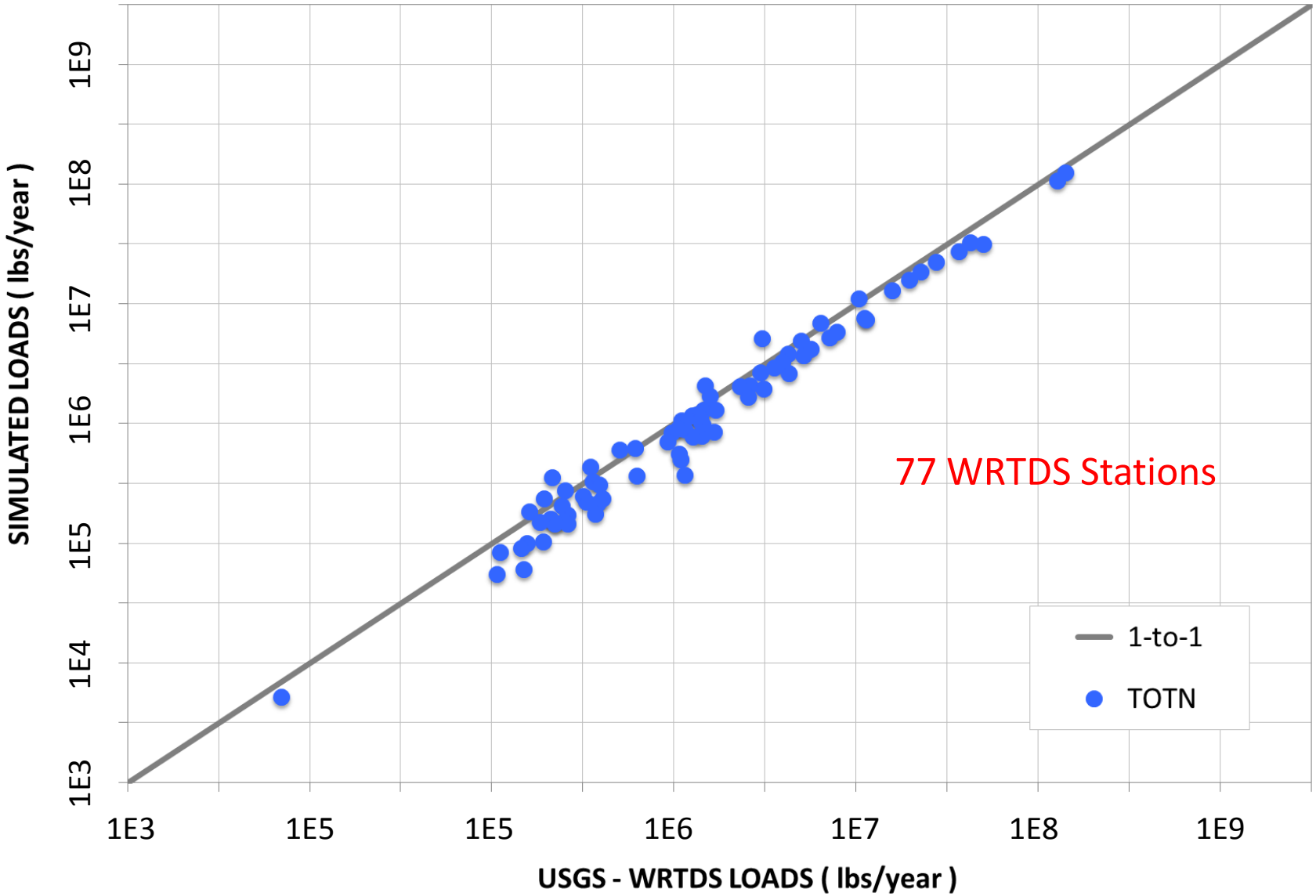
PHASE 5

NITROGEN



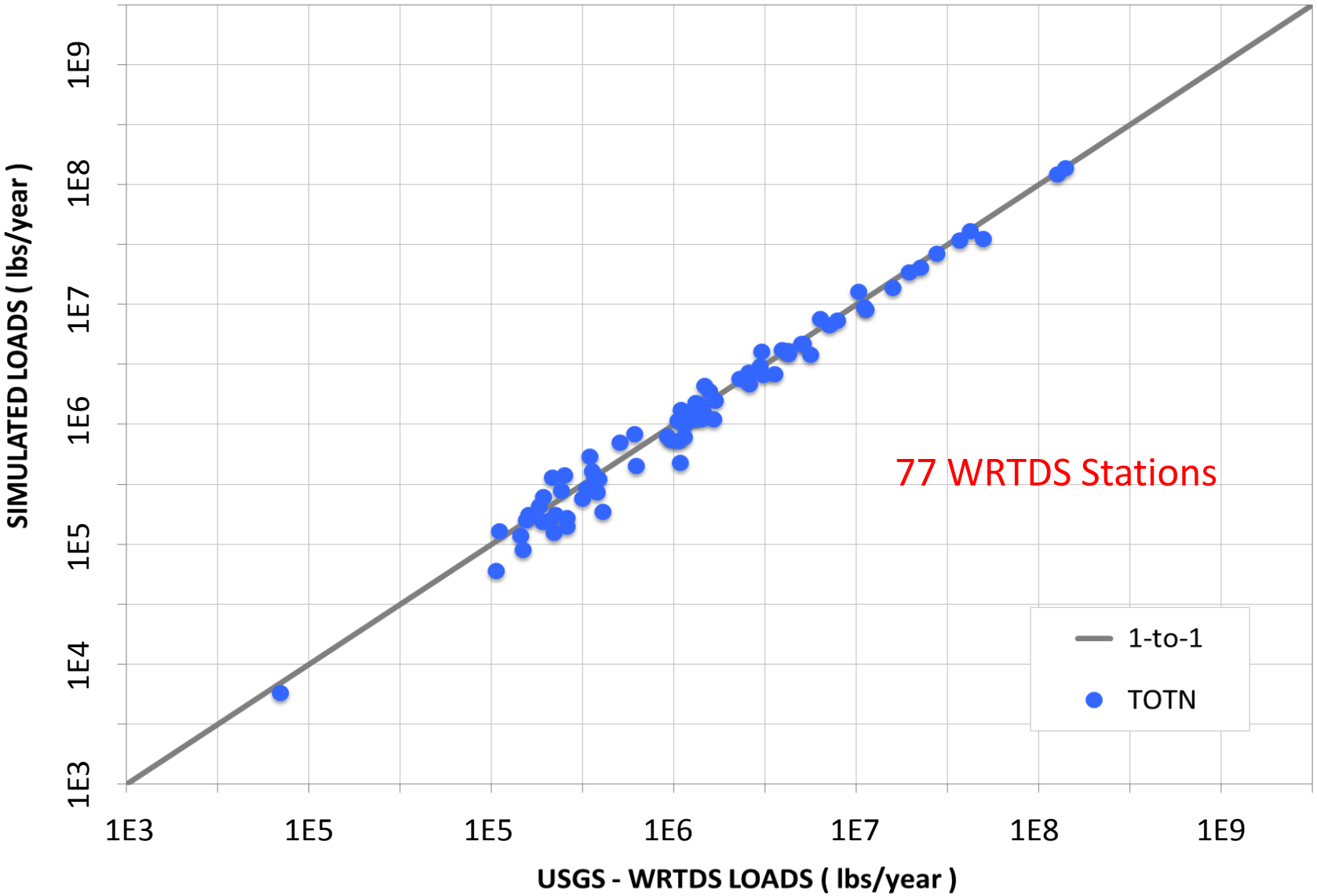
PHASE 6
BETA 3

NITROGEN



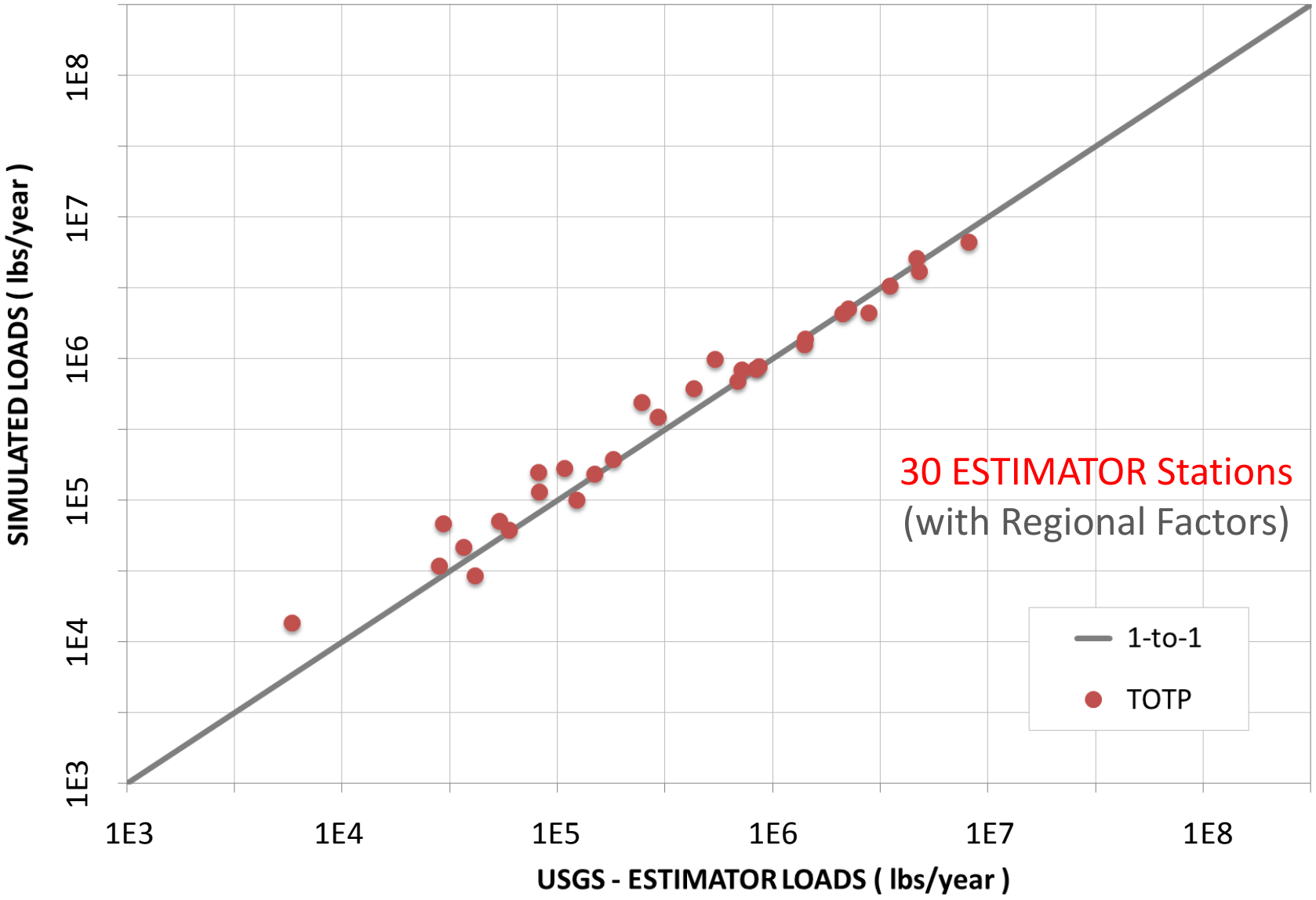
PHASE 6
BETA 4

NITROGEN



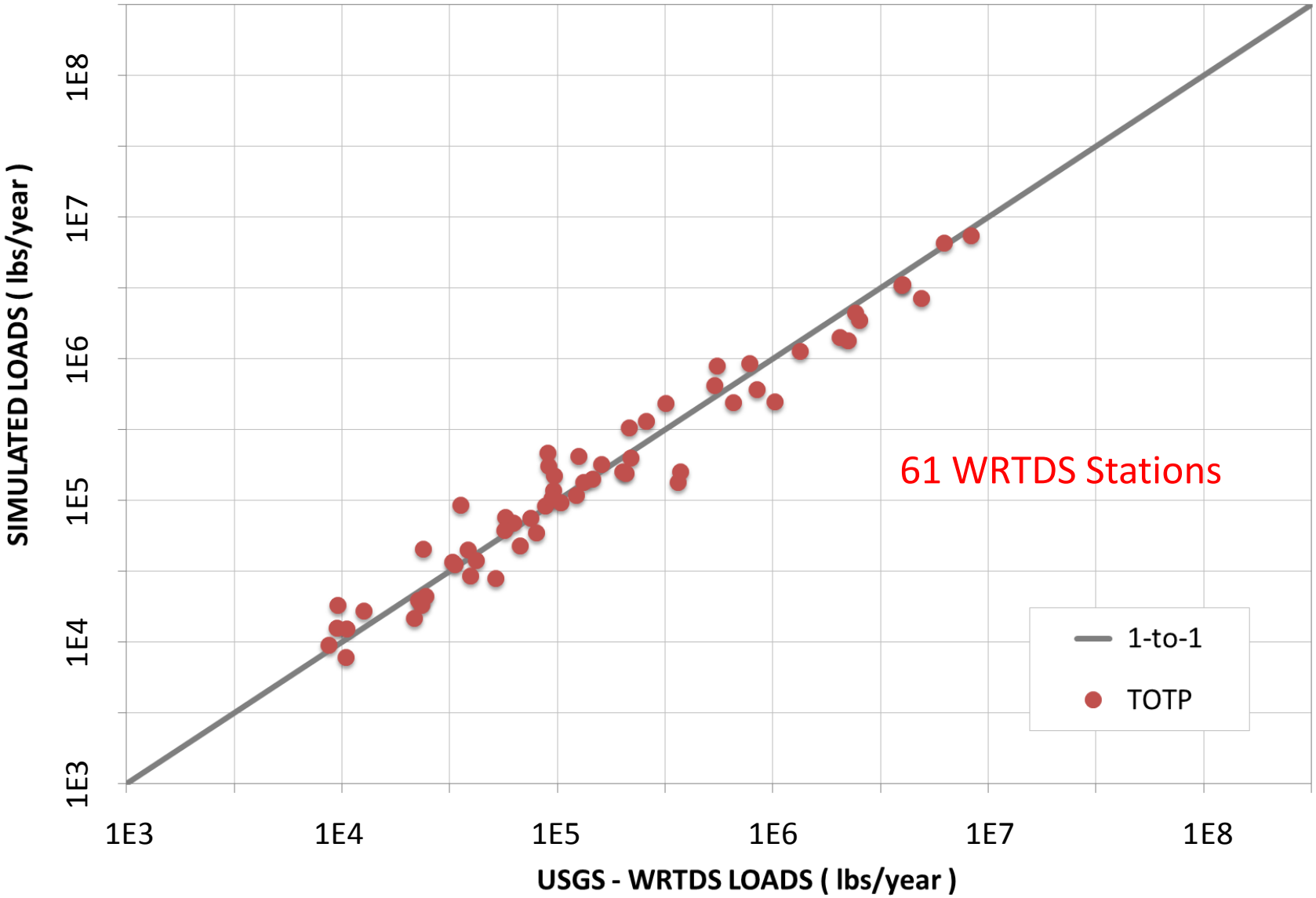
PHASE 5

PHOSPHORUS



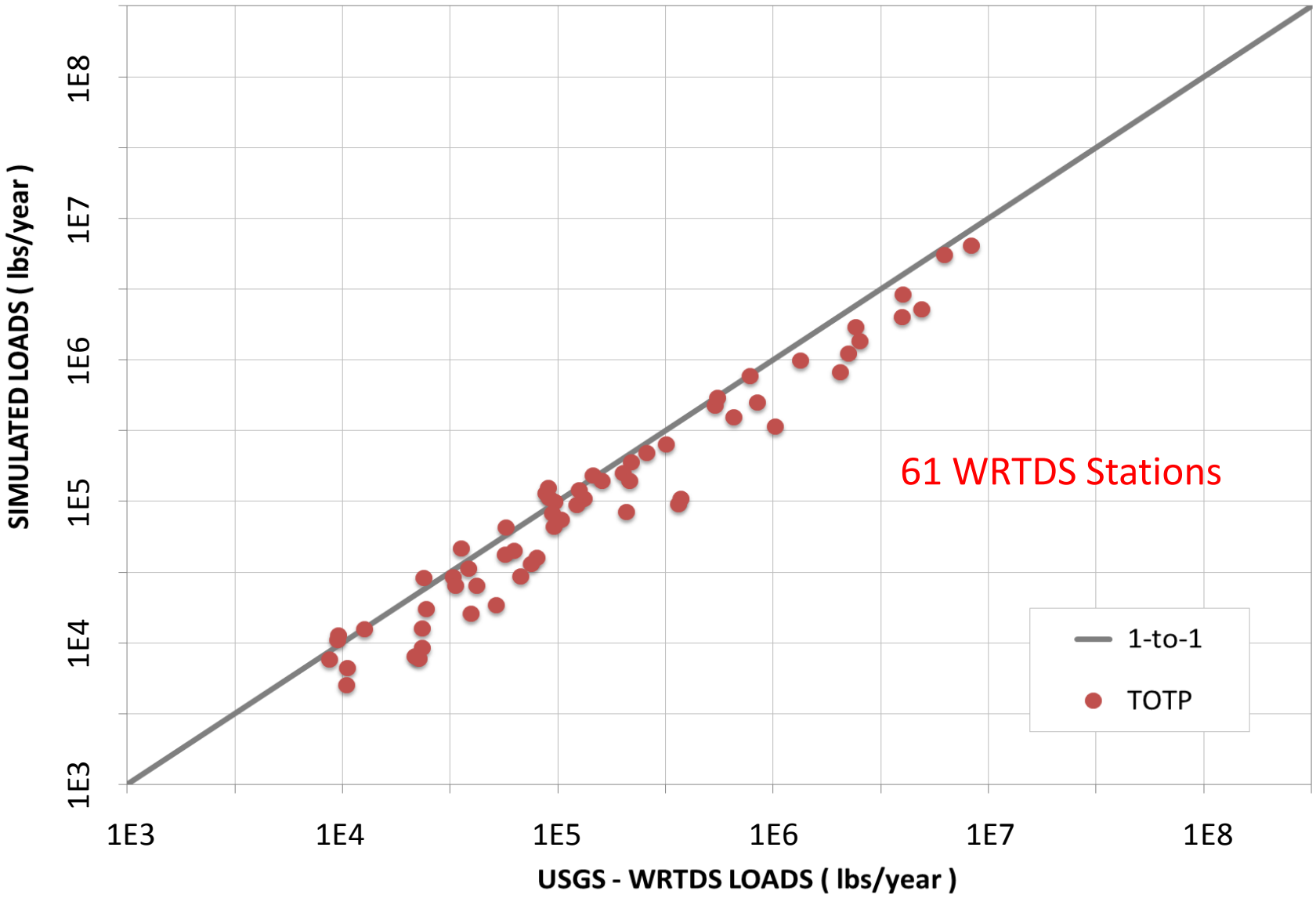
PHASE 6
BETA 3

PHOSPHORUS



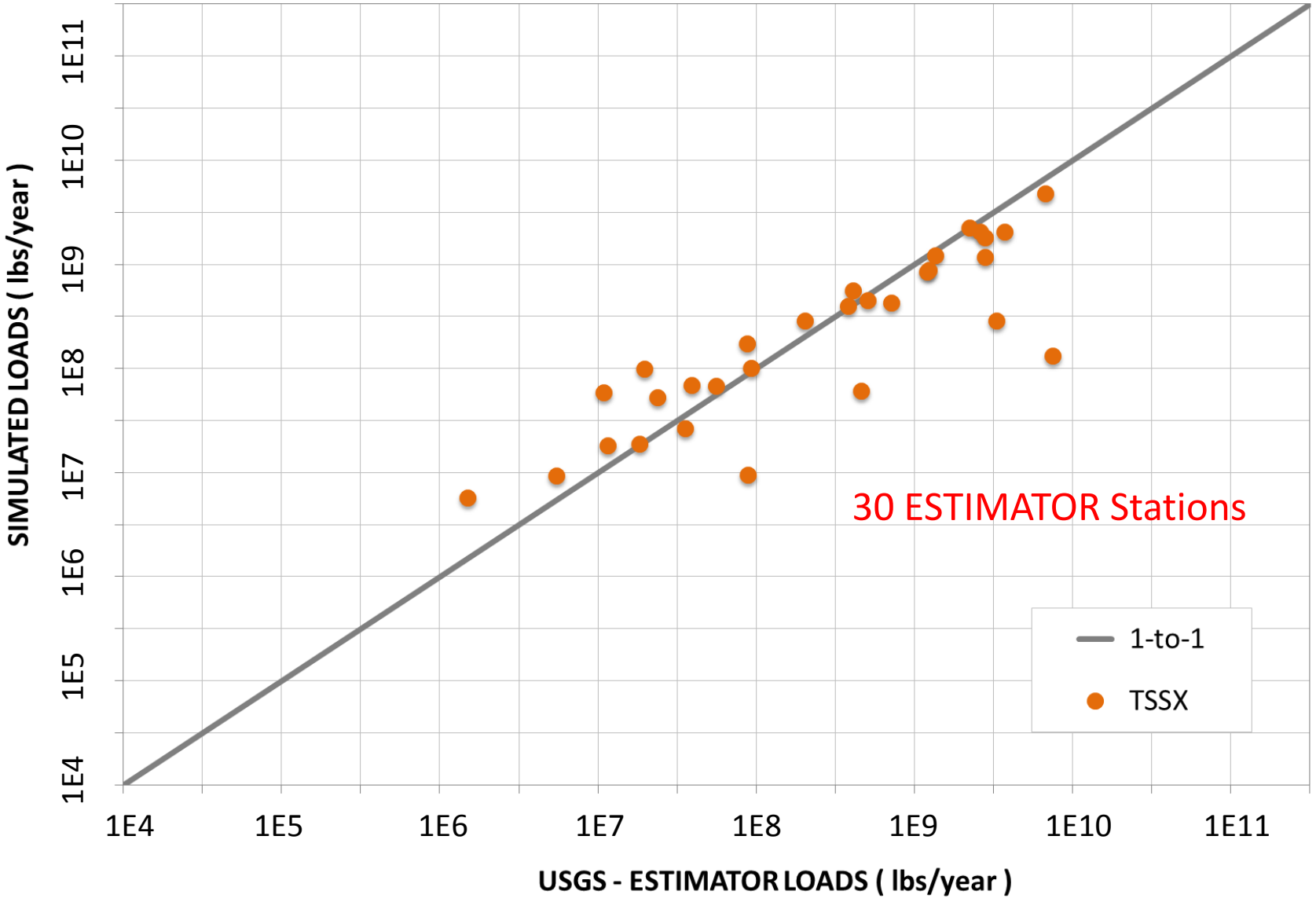
PHASE 6
BETA 4

PHOSPHORUS



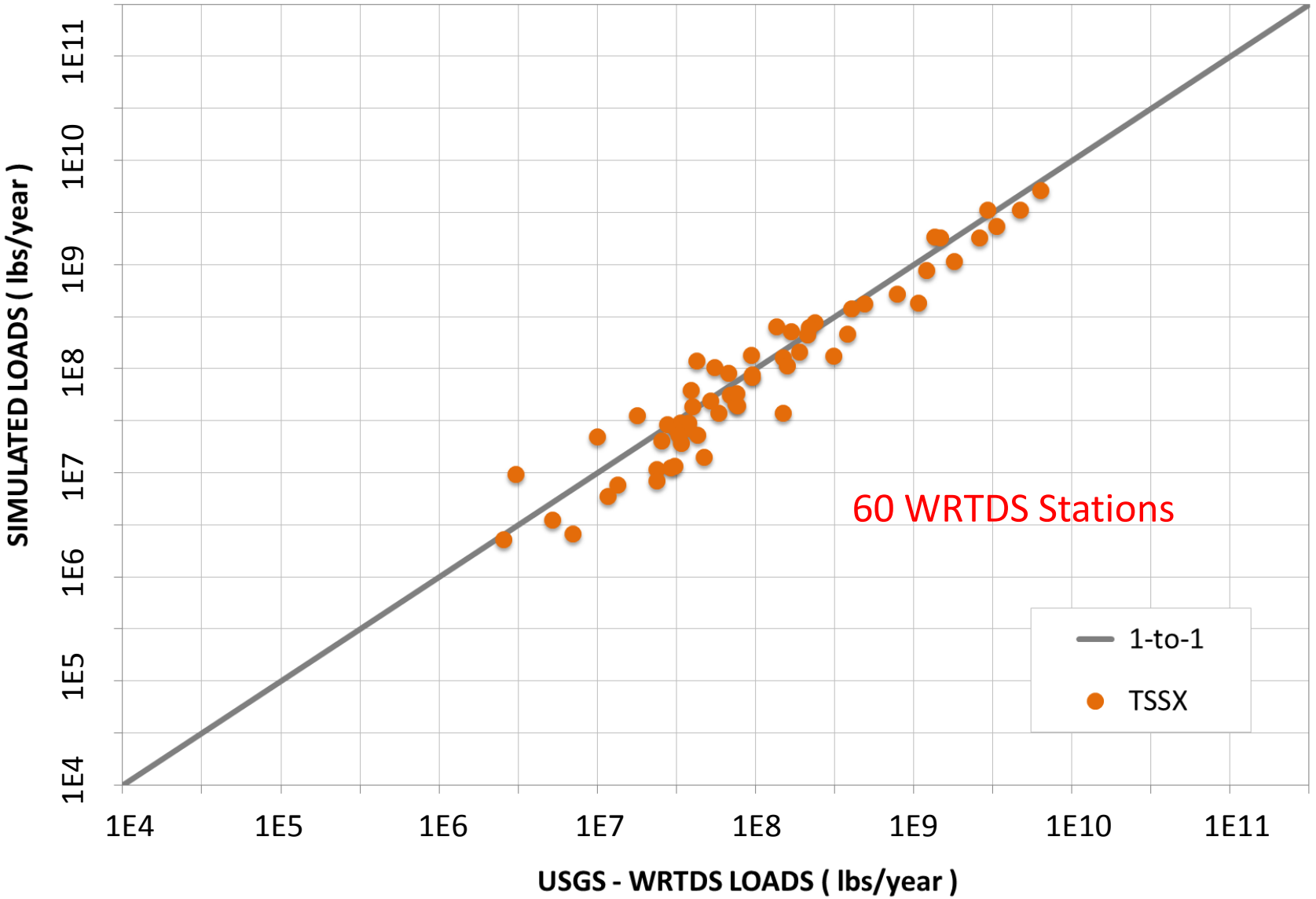
PHASE 5

SEDIMENT



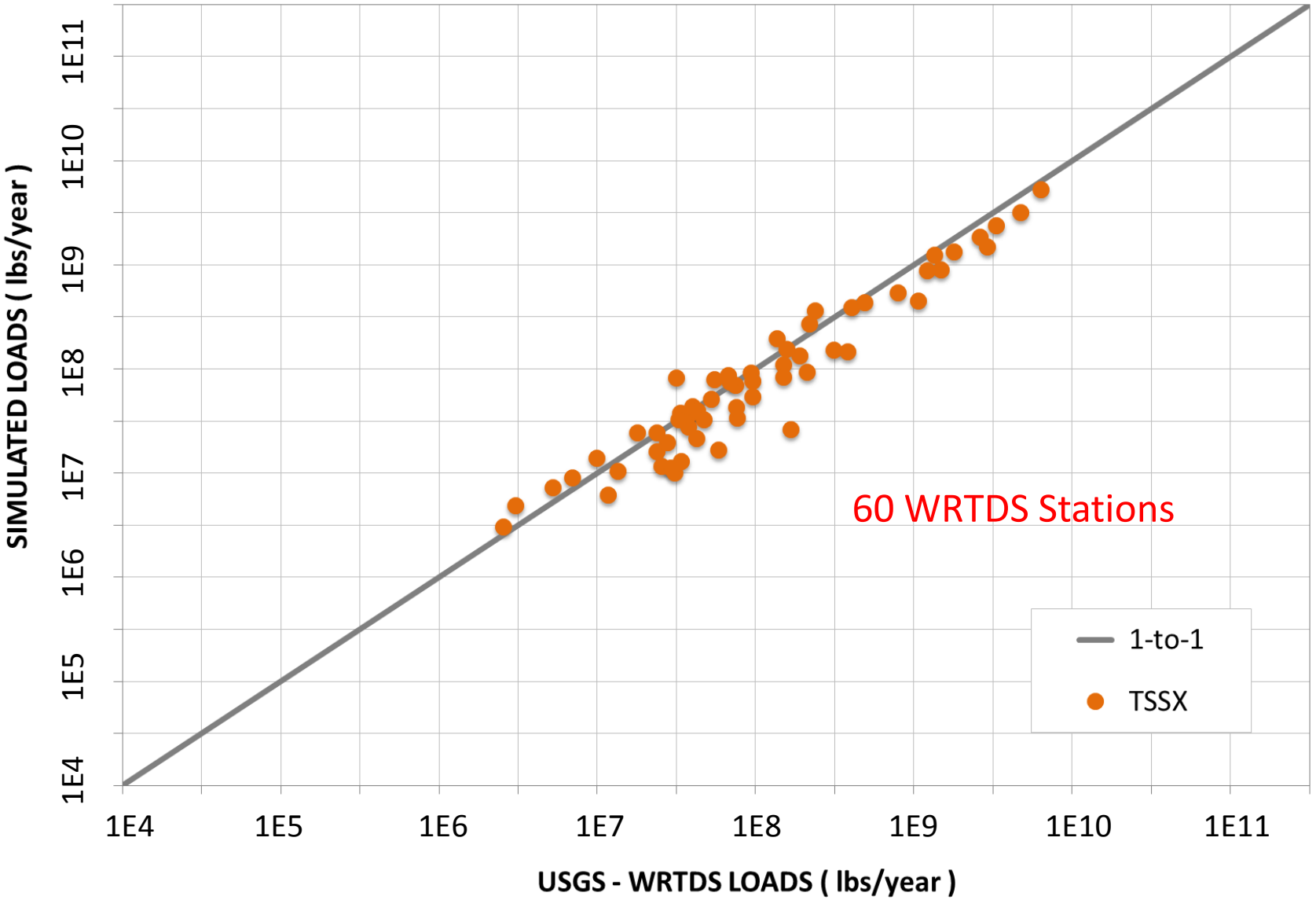
PHASE 6
BETA 3

SEDIMENT

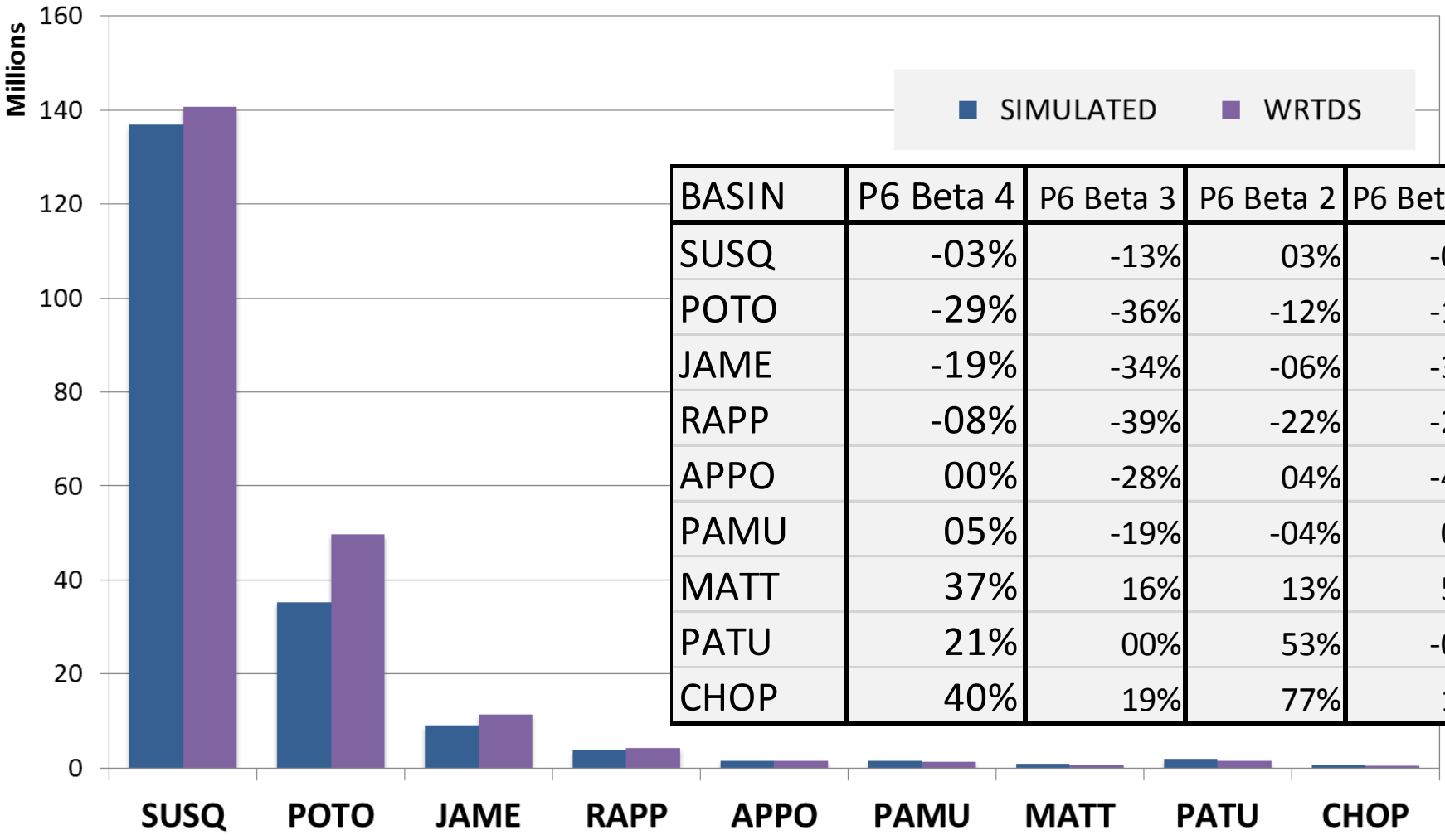


PHASE 6
BETA 4

SEDIMENT



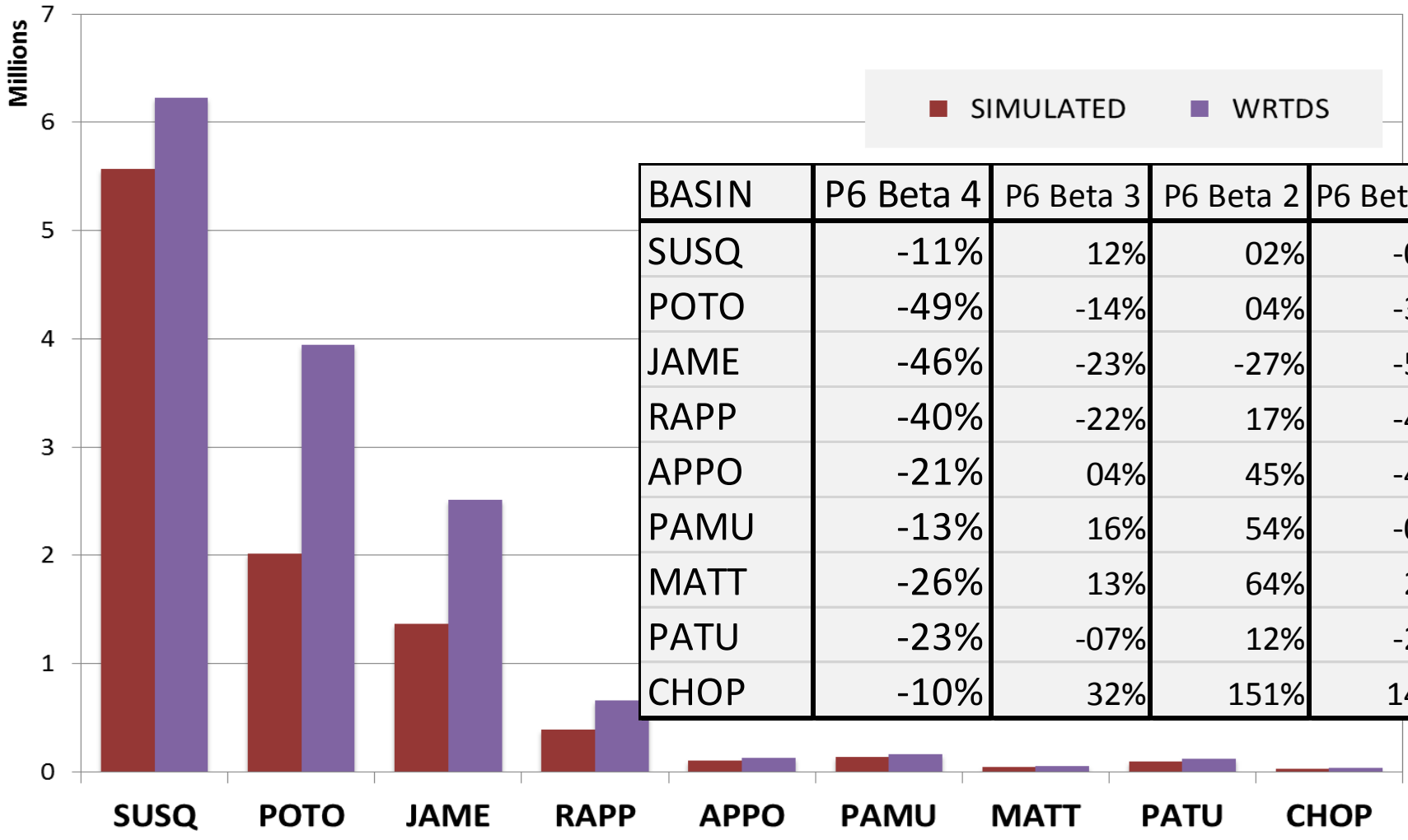
RIM loads: total nitrogen



BASIN	P6 Beta 4	P6 Beta 3	P6 Beta 2	P6 Beta 1
SUSQ	-03%	-13%	03%	-05%
POTO	-29%	-36%	-12%	-18%
JAME	-19%	-34%	-06%	-33%
RAPP	-08%	-39%	-22%	-25%
APPO	00%	-28%	04%	-44%
PAMU	05%	-19%	-04%	07%
MATT	37%	16%	13%	57%
PATU	21%	00%	53%	-03%
CHOP	40%	19%	77%	17%

assuming +/- 10% uncertainty in WRTDS estimates

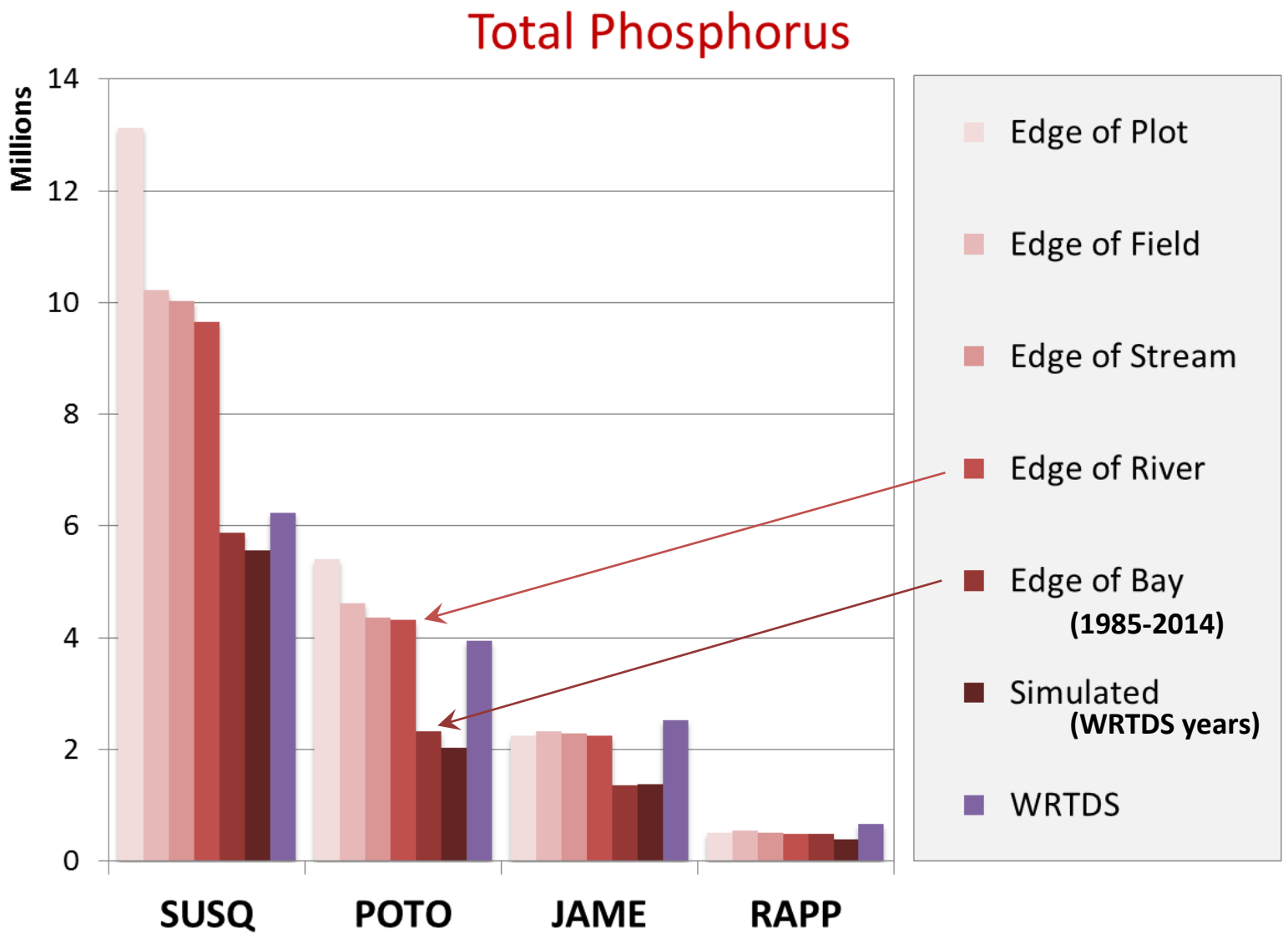
RIM loads: total phosphorus



BASIN	P6 Beta 4	P6 Beta 3	P6 Beta 2	P6 Beta 1
SUSQ	-11%	12%	02%	-08%
POTO	-49%	-14%	04%	-36%
JAME	-46%	-23%	-27%	-54%
RAPP	-40%	-22%	17%	-42%
APPO	-21%	04%	45%	-41%
PAMU	-13%	16%	54%	-08%
MATT	-26%	13%	64%	27%
PATU	-23%	-07%	12%	-25%
CHOP	-10%	32%	151%	147%

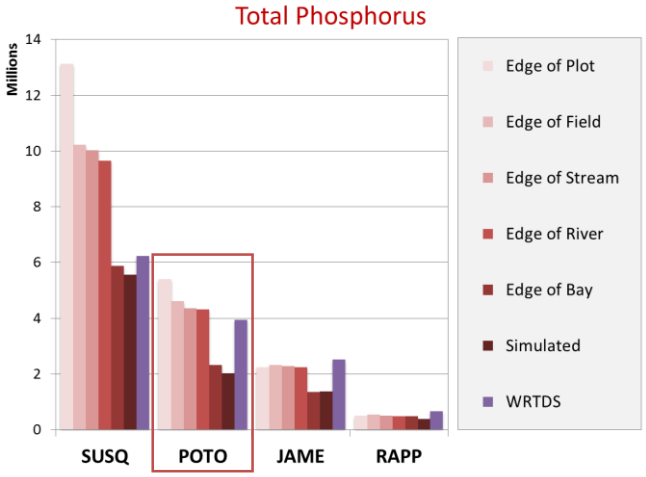
assuming +/- 15% uncertainty in WRTDS estimates

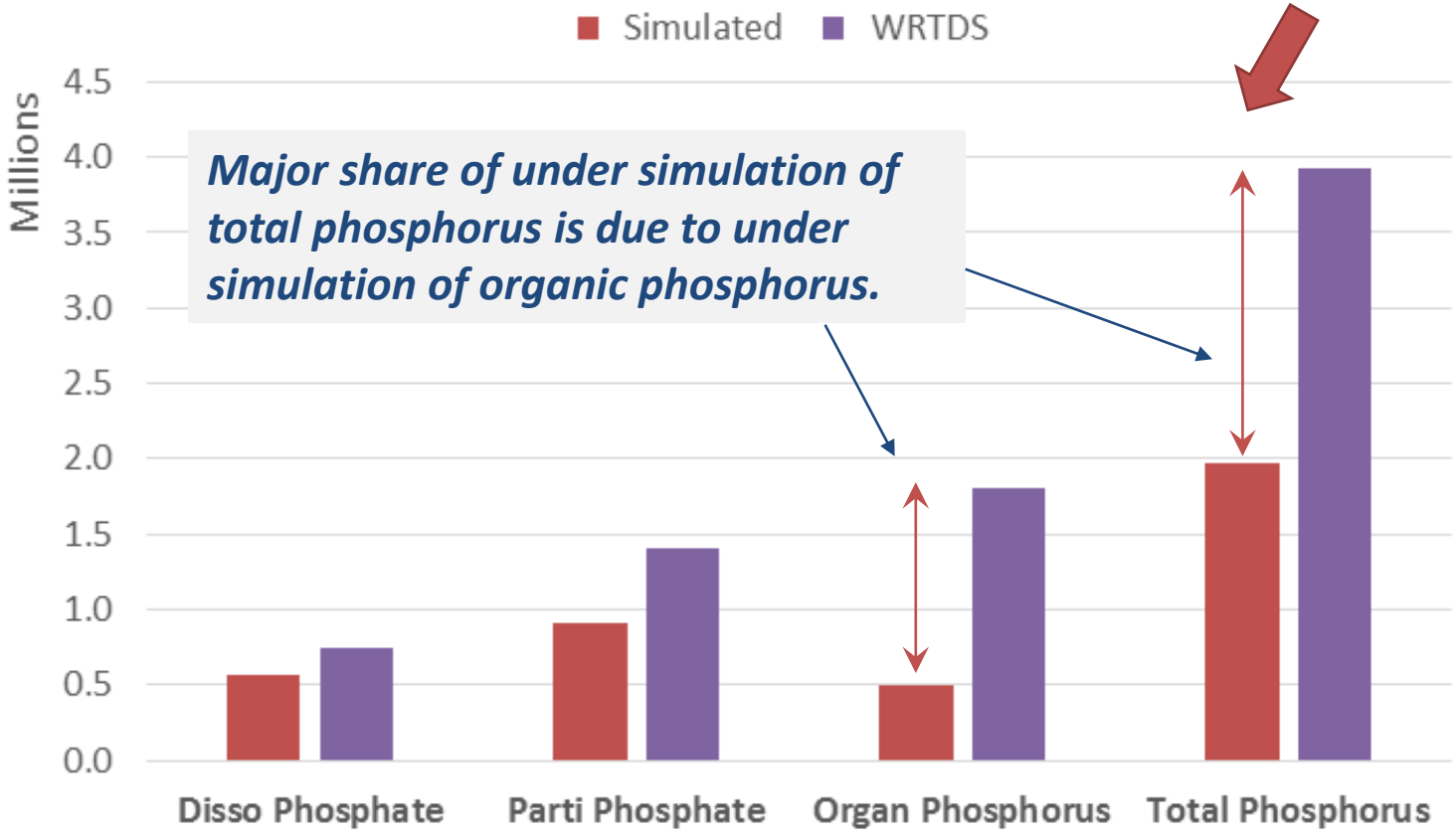
Phosphorus Simulation



Phosphorus Simulation

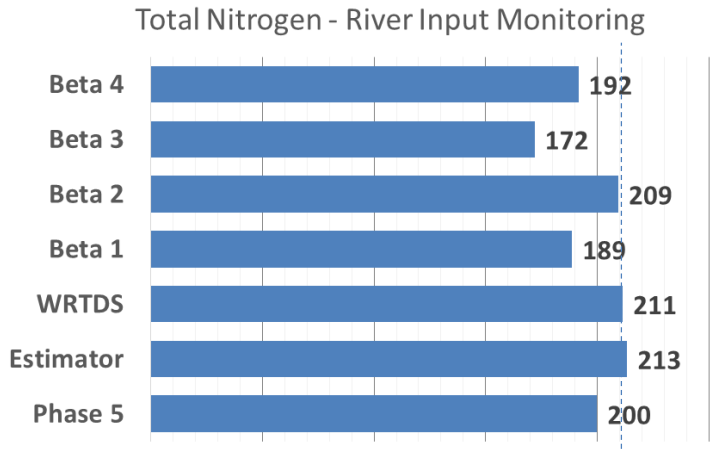
Potomac RIM

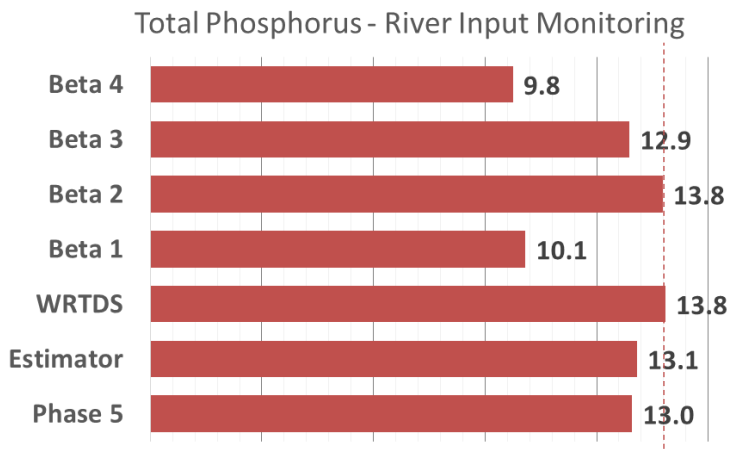


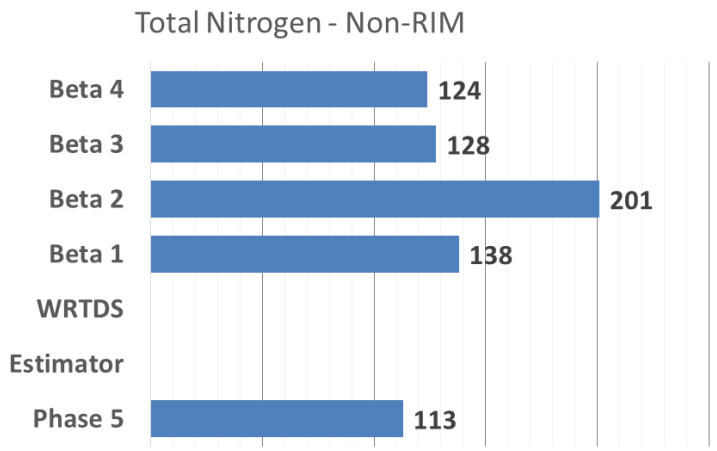


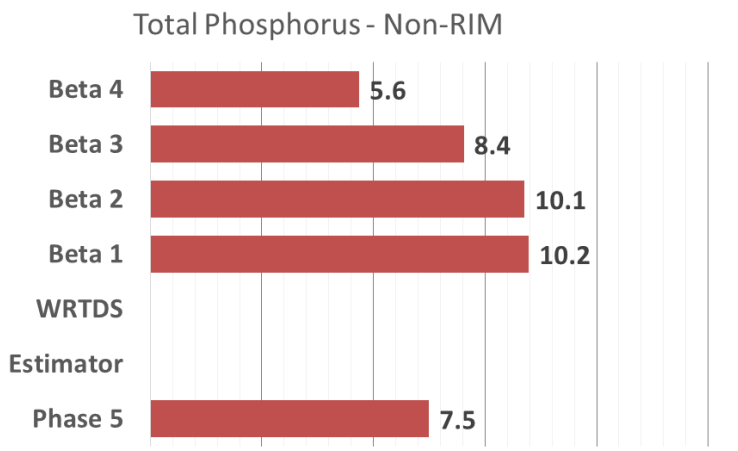
RIM and Non-RIM Loads

(in millions of pounds / year)



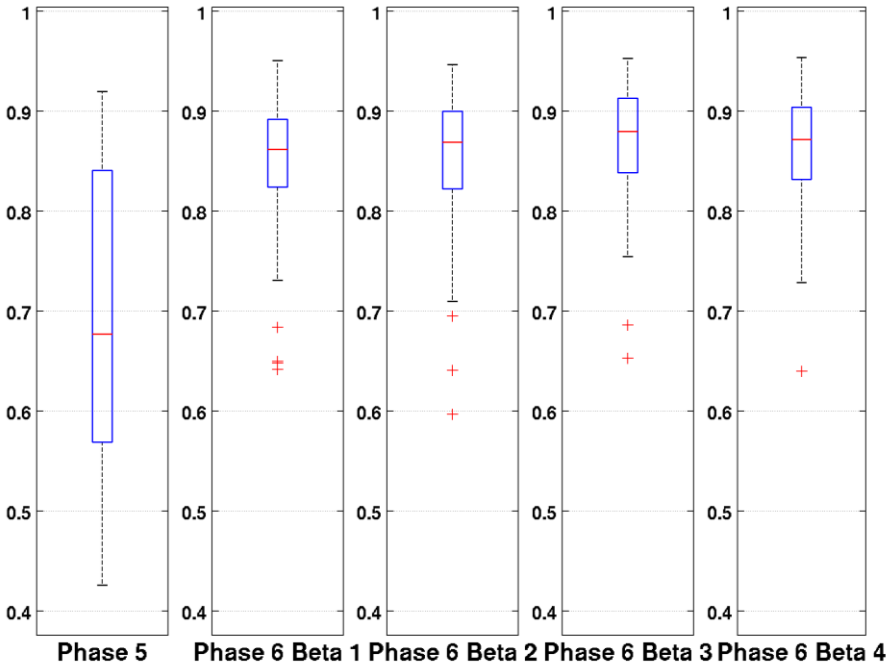




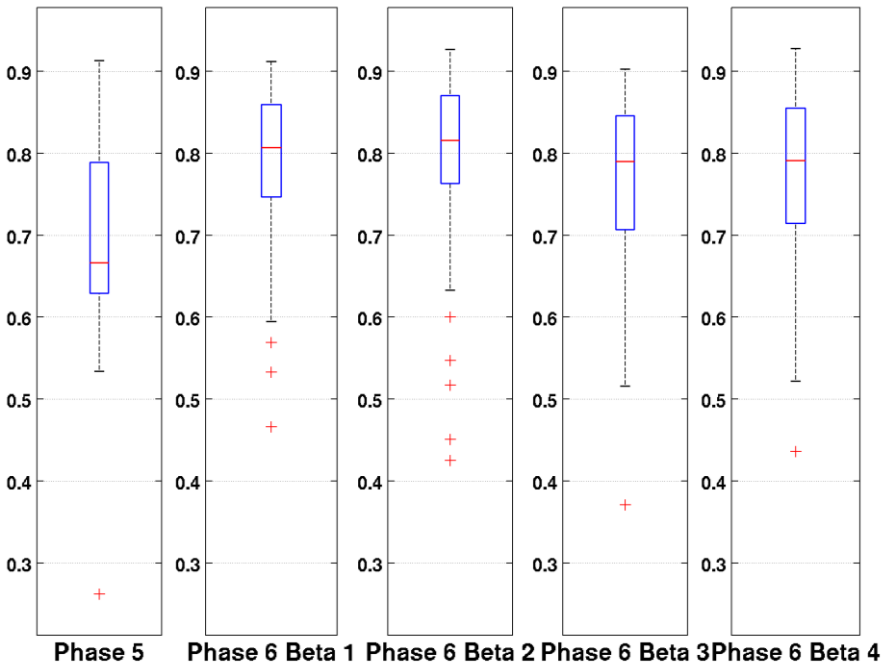


Seasonality of simulated monthly loads

Correlation of nitrogen loads



Correlation of phosphorus loads

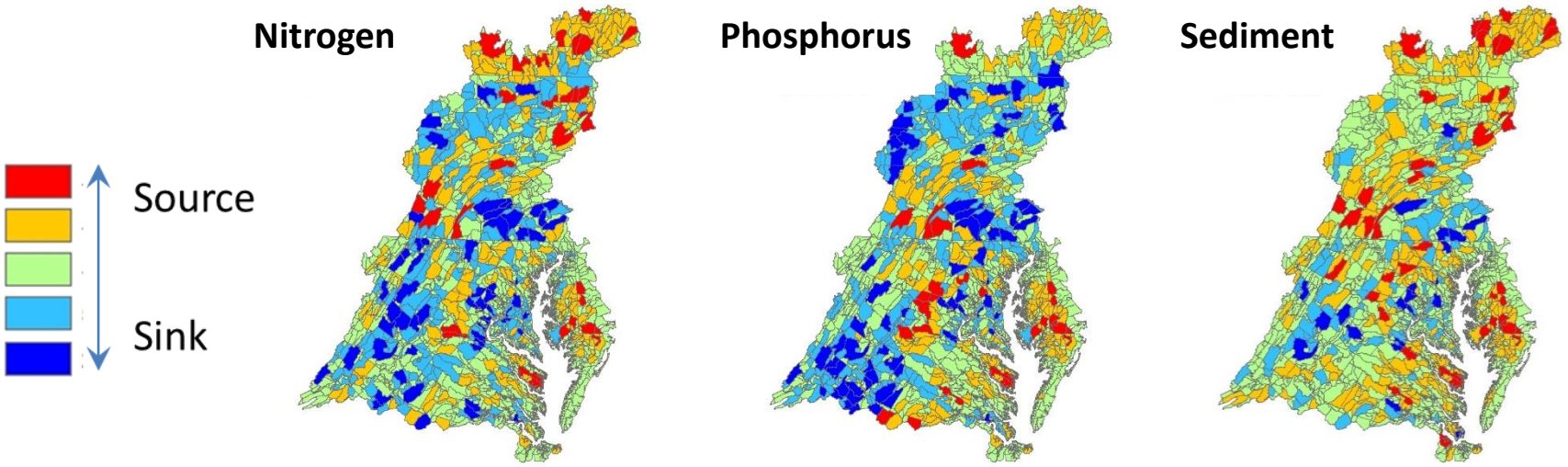


There is a good agreement in the seasonality of simulated loads with WRTDS, for both total nitrogen and total phosphorus.

Next steps

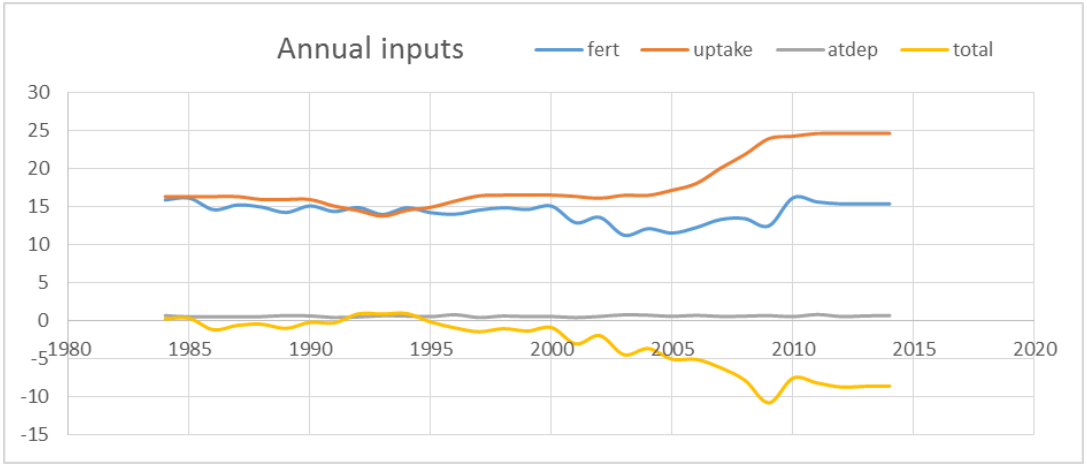
- Incorporation of stream bed/bank and floodplain loads (Noe/Claggett) in the watershed model
  - Data has been processed for Phase 6 segments – Ross Mandel
  - Model development and initial testing has been completed.

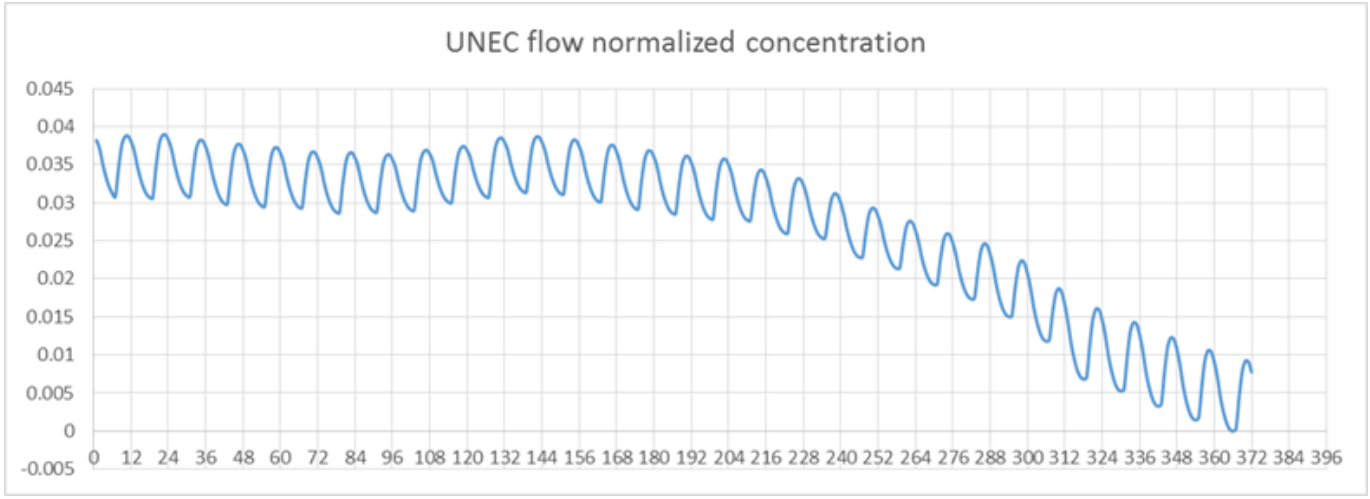
	Nitrogen	Phosphorus	Clay	Silt	Sediment
Bed and Bank (Mlb/yr)	18.6	4.7	5277	10945	16222
Floodplain (Mlb/yr)	-14.6	-4.9	-3049	-8284	-11333
Net Stream Load (Mlb/yr)	4.0	-0.2	2228	2662	4890
% of EOR Loads	**3.5%**	**-3.7%**			**39.6%**



Next steps

- Incorporation of relative sensitivity in lag time simulation can help address situations when uptake begins to dominate the response.



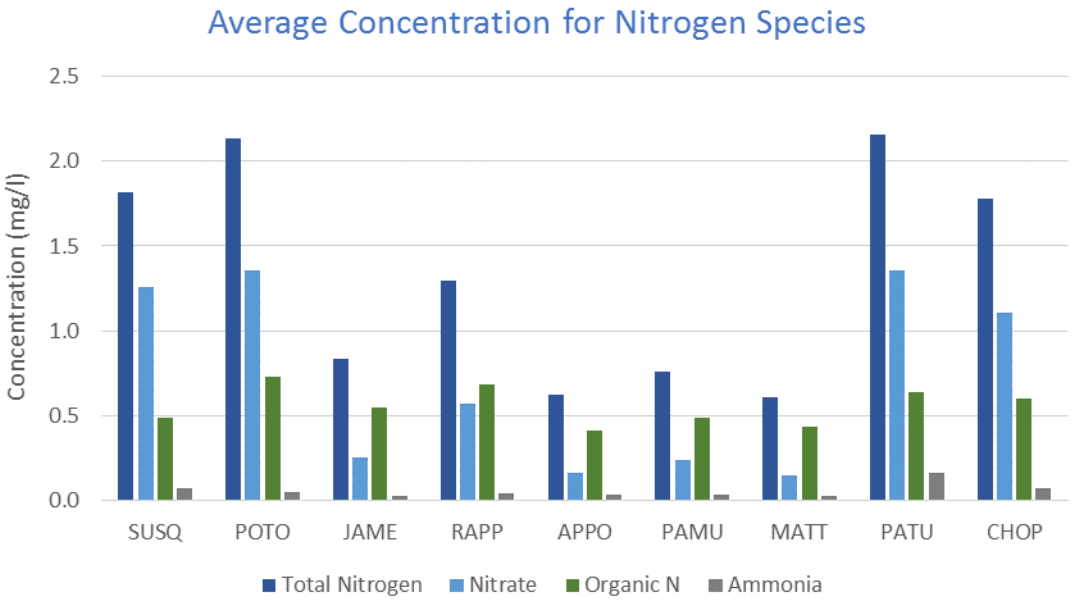


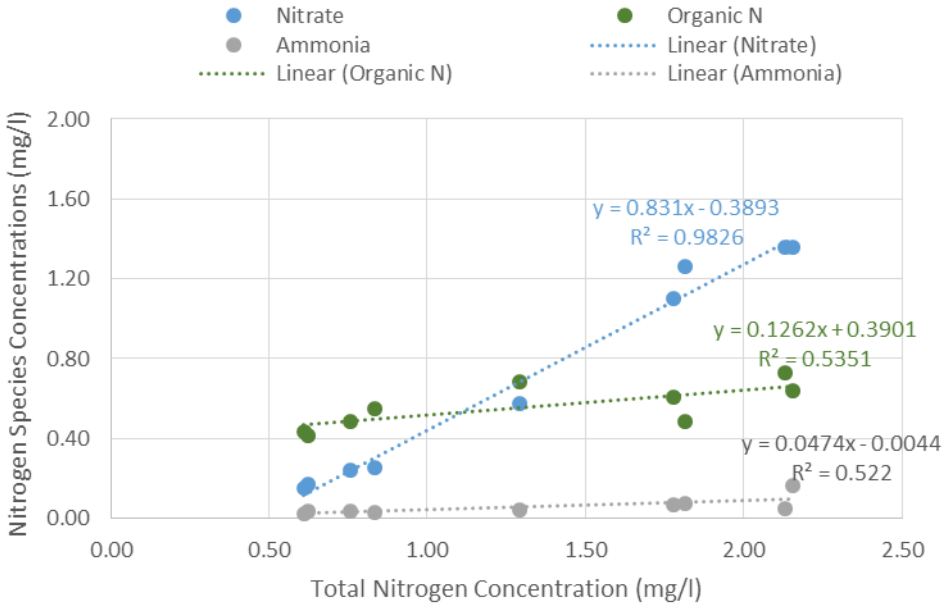
Next steps

- Investigate partitioning of nutrient species in target calculations.

Based on the WRTDS data, some of the river basins (e.g. James) have high proportion of organic nitrogen

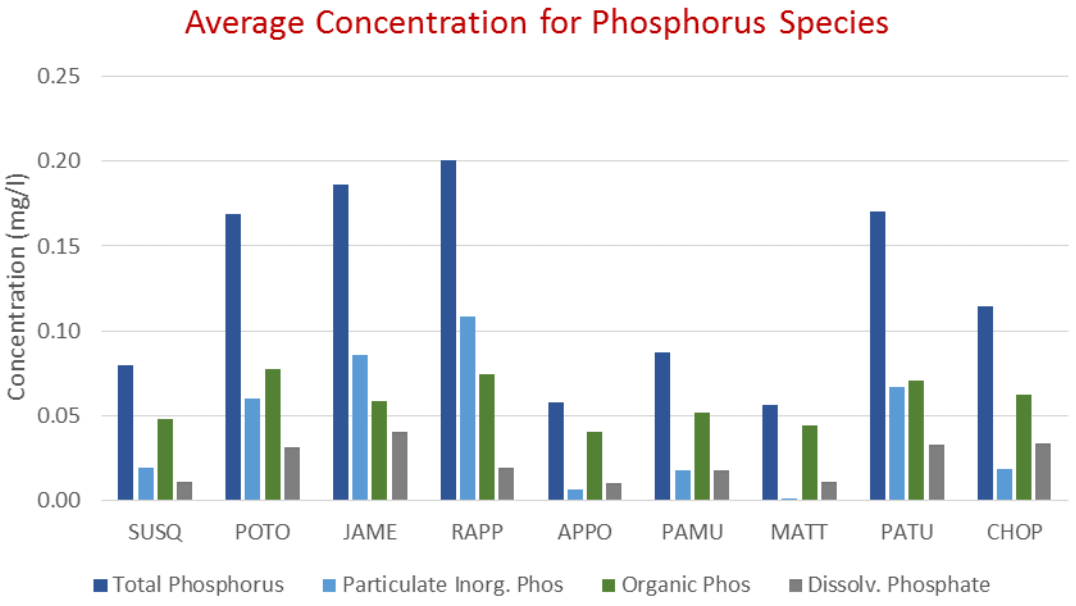
Basins with higher total nitrogen concentrations, have major differences in nitrate loads.



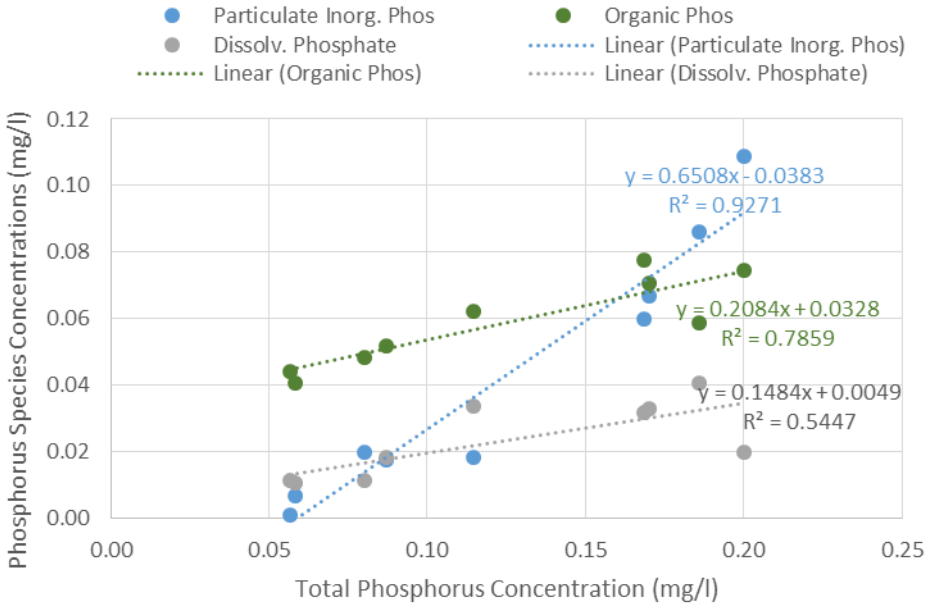


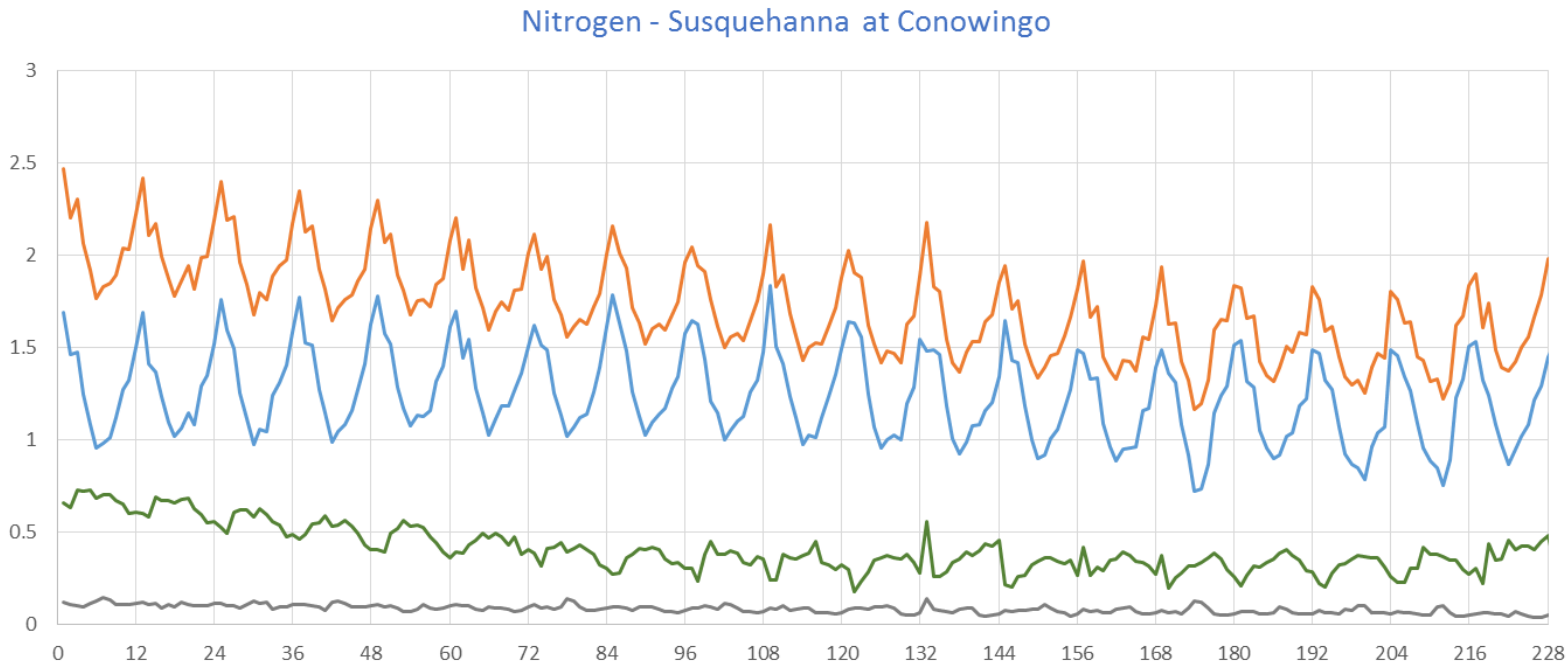
Next steps

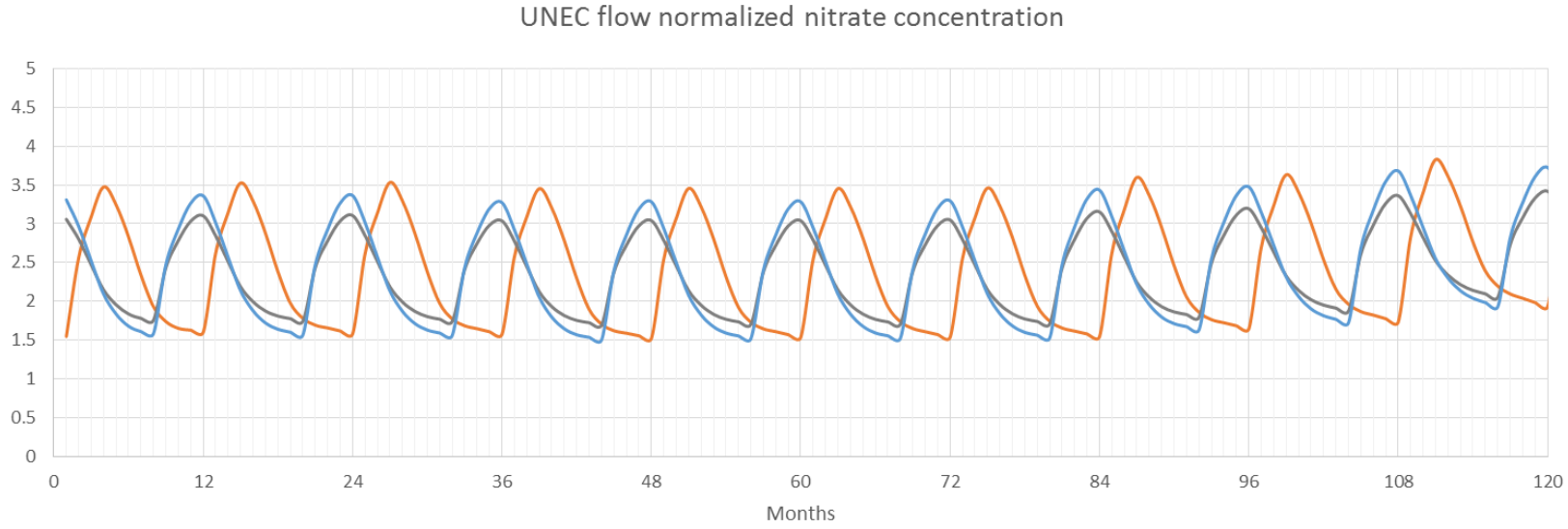
- Investigate partitioning of nutrient species in target calculations.



Rappahannock, James, Potomac and Patuxent have high average total phosphorus concentrations.

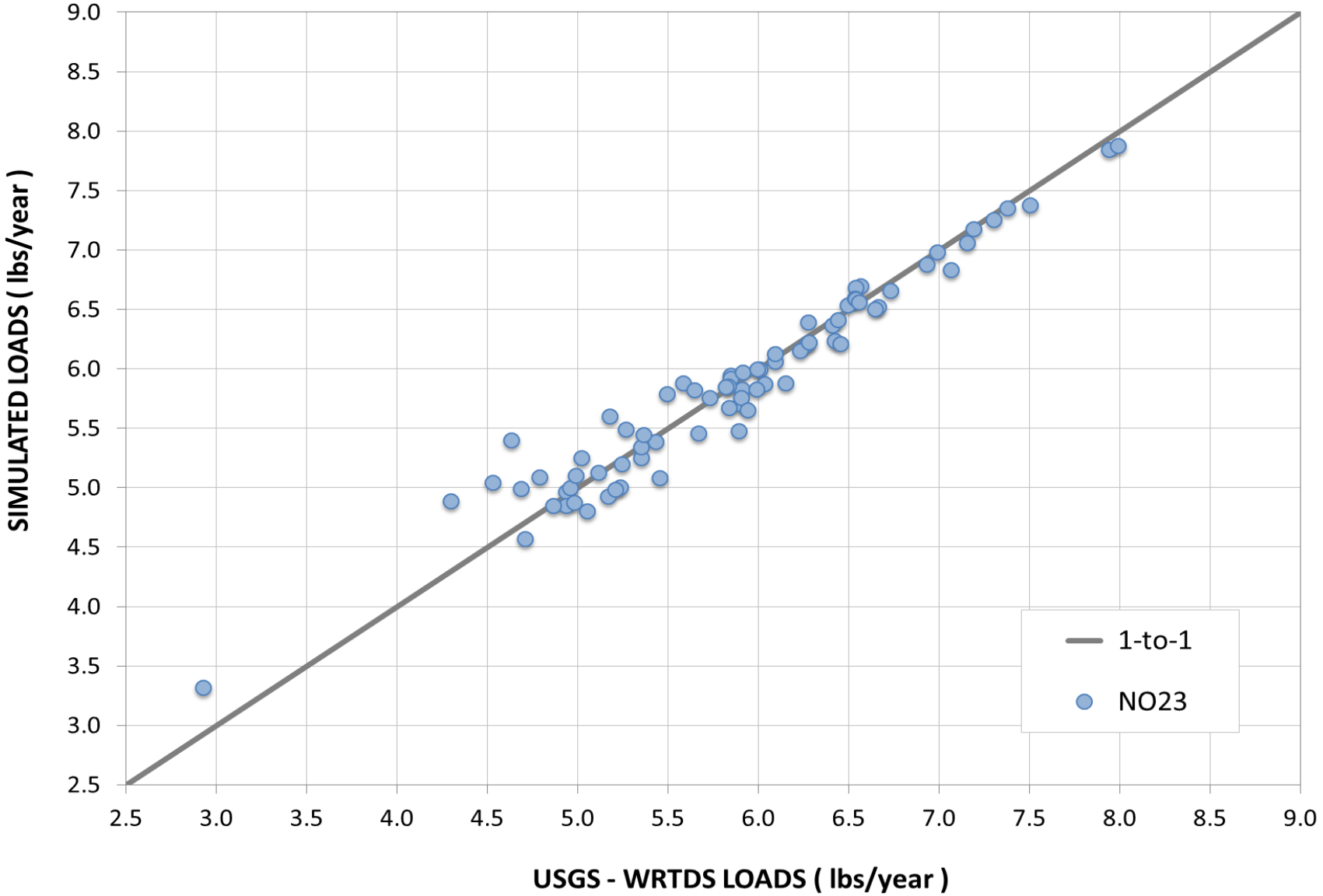



Nitrogen - Susquehanna at Conowingo
3
2.5
2
1.5
1
0.5
0
0
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
192
204
216
228


UNEC flow normalized nitrate concentration
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
12
24
36
48
60
72
84
96
108
120
Months

PHASE 6
BETA 4

NITRATE



PHASE 6
BETA 4

PHOSPHATE