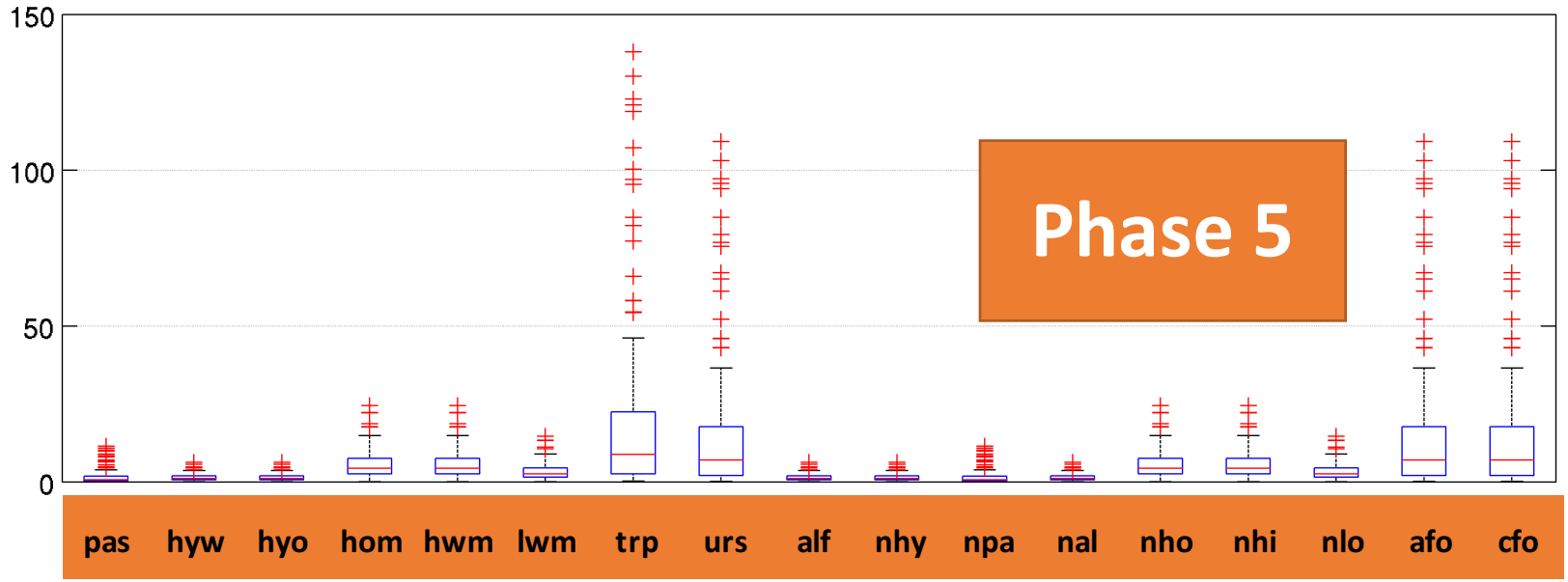
Phase 6 Watershed Model (*version beta-1 preview*)

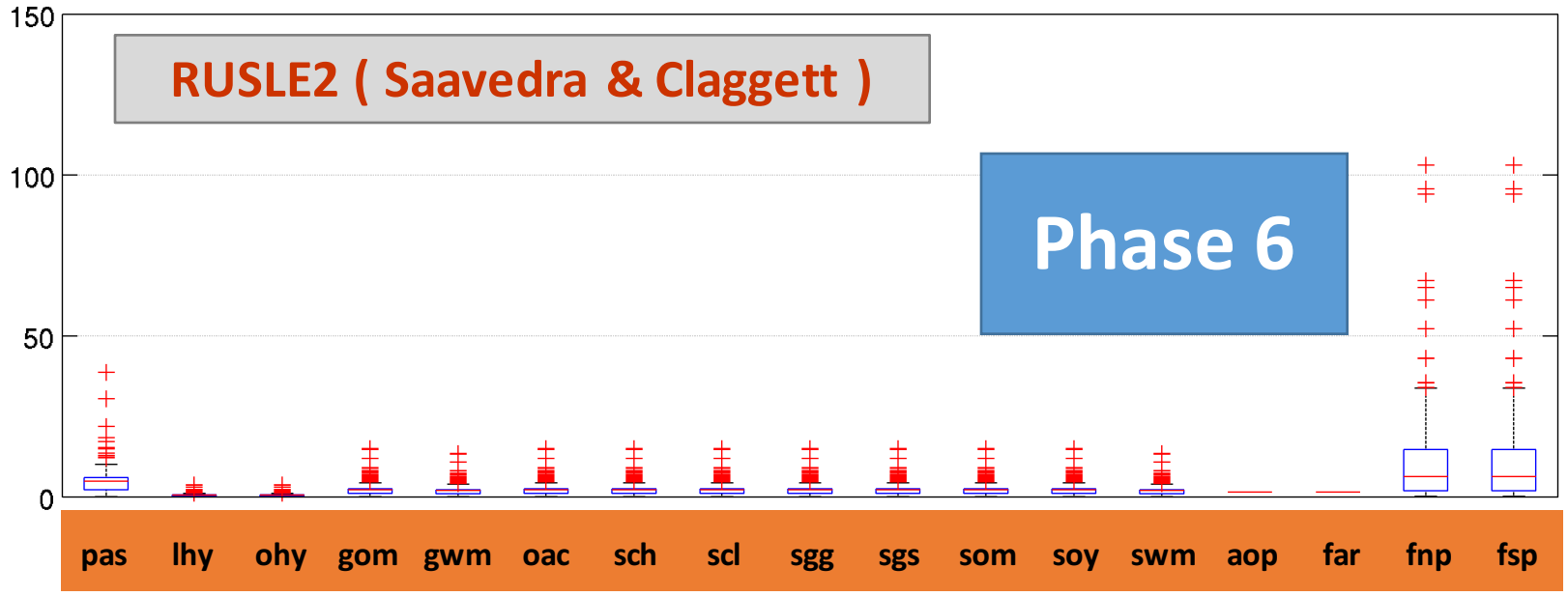
Gopal Bhatt (Penn State)

Presentation Outline

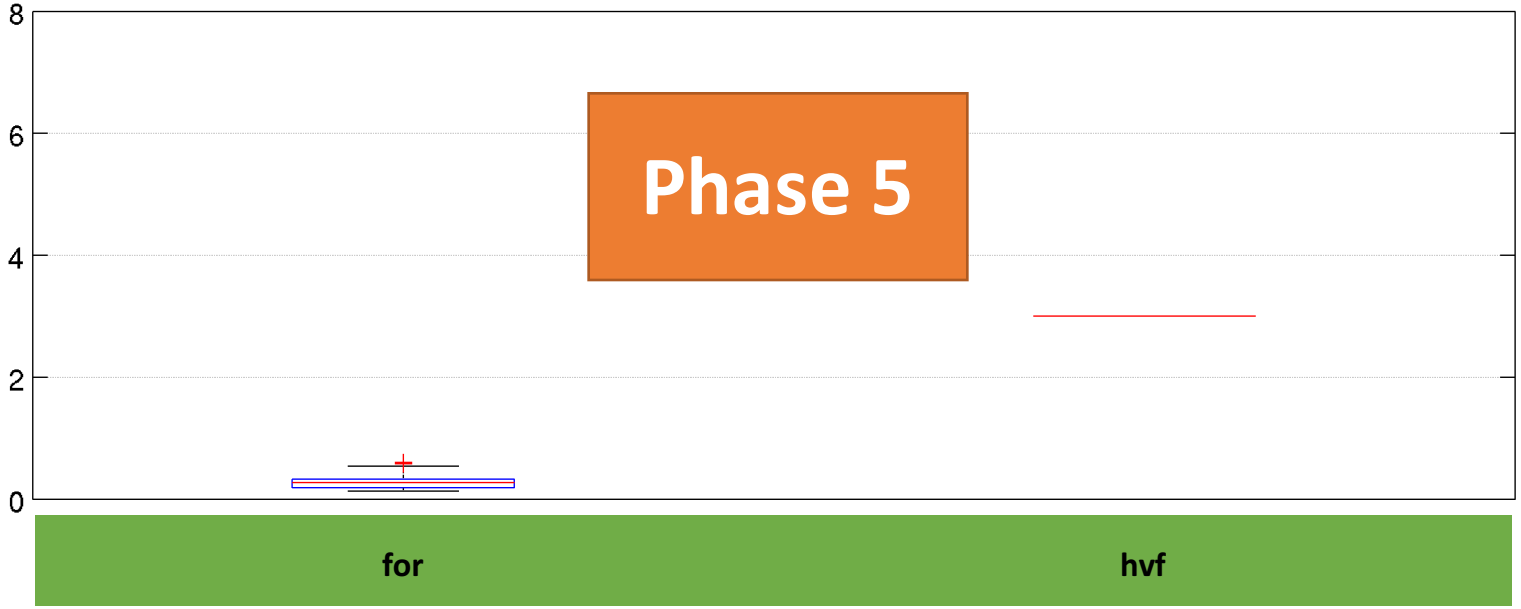
- Input Data Summary
  - Sediment export targets
  - Nutrient export targets
  - SPARROW land-to-water delivery variances
  - SPARROW stream-to-river delivery factors
- P6 model calibration
- P6 simulated loads vs. WRTDS
- An examination of nutrient budgets at RIM stations
- Options to address nutrient loading at RIM stations

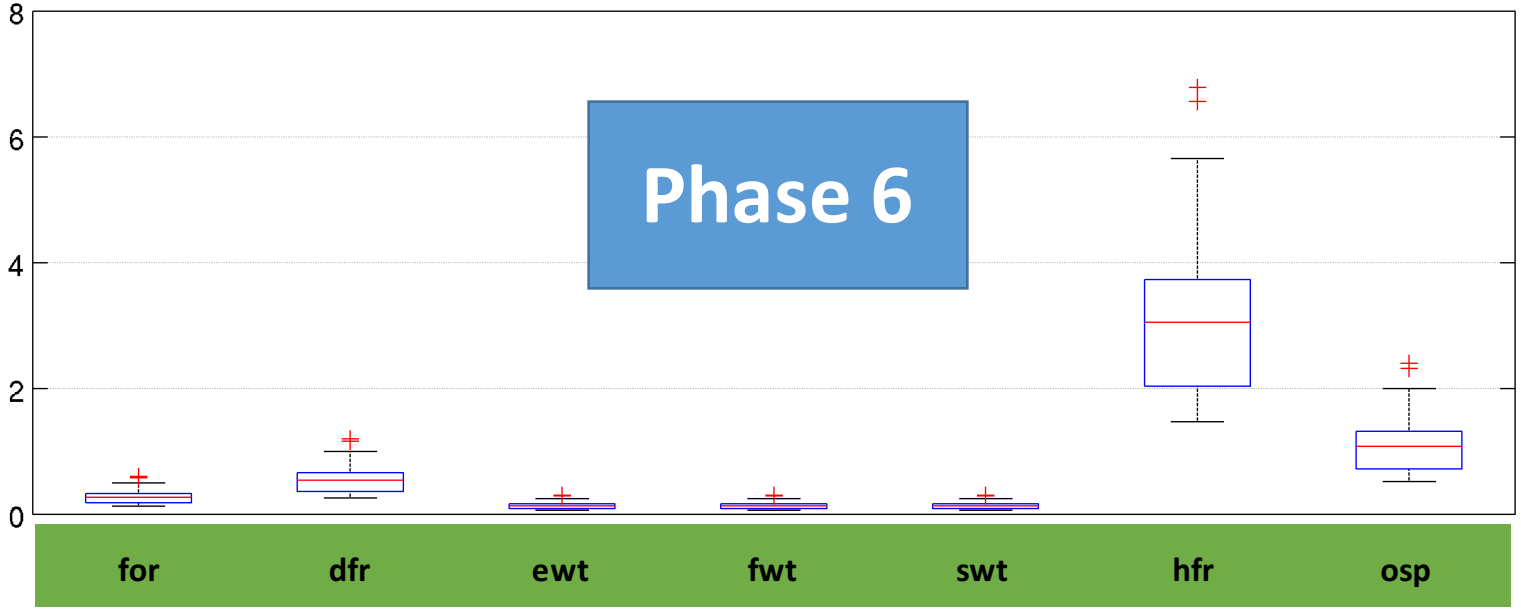
*Sediment Export Targets – **Agricultural** Land-uses*



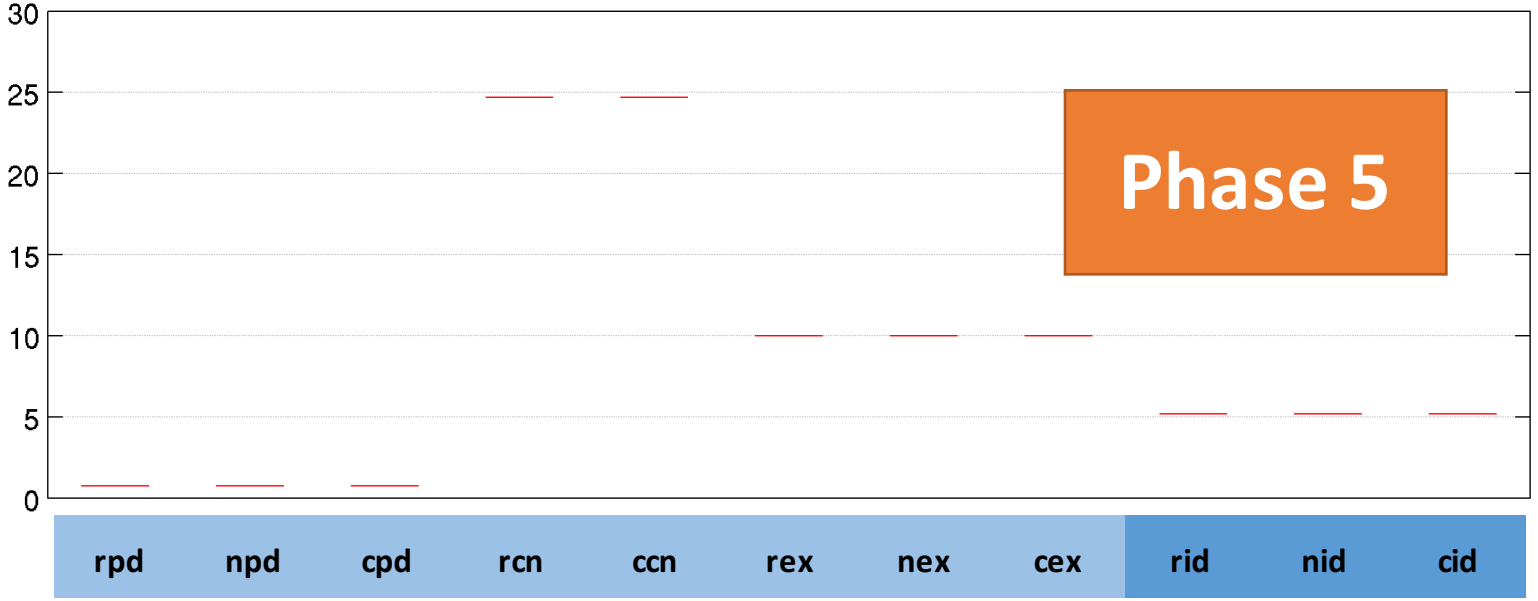


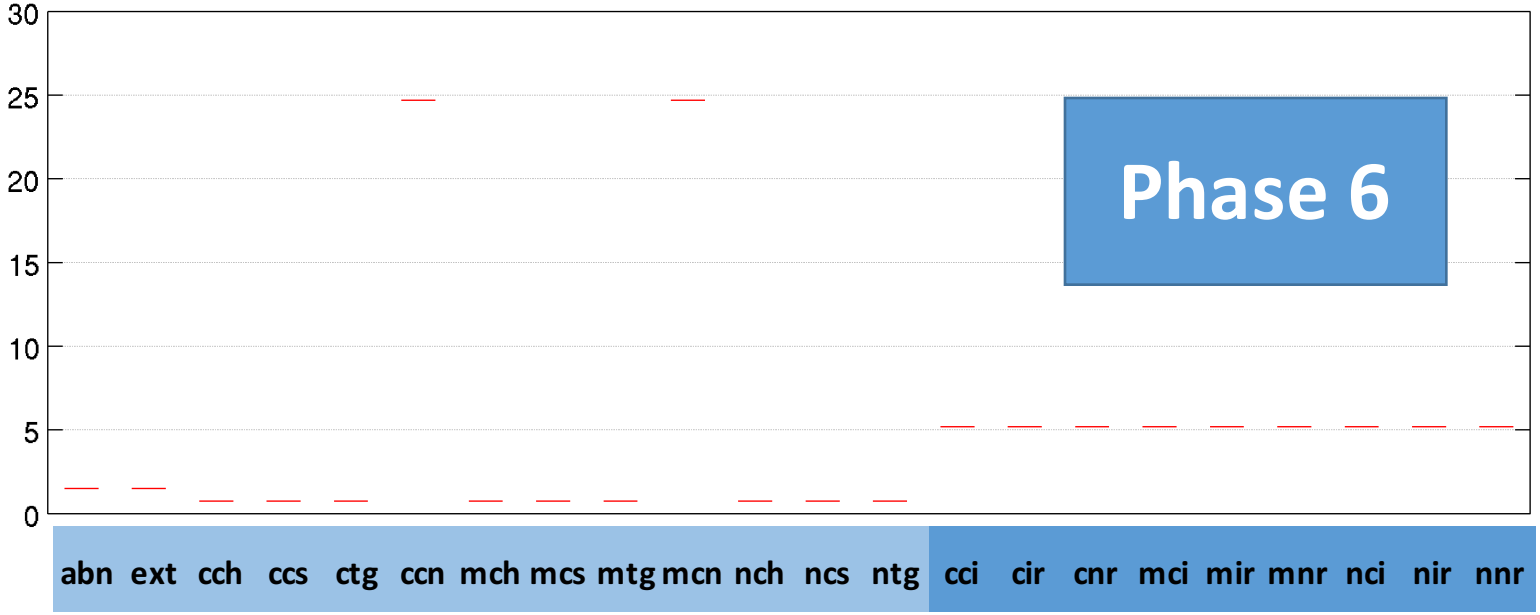
*Sediment Export Targets – **Natural** Land-uses*





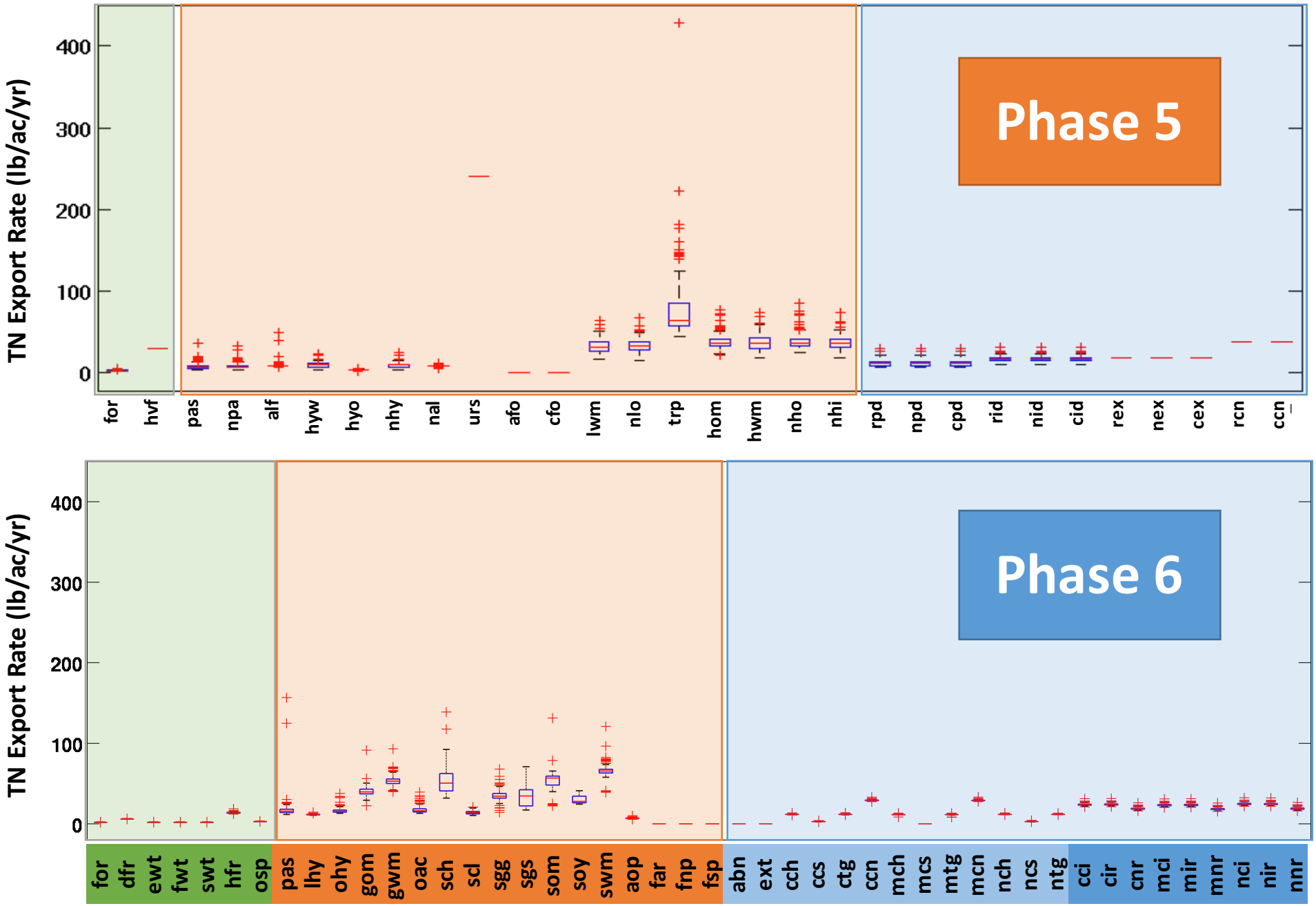
*Sediment Export Targets – **Developed** Land-uses*





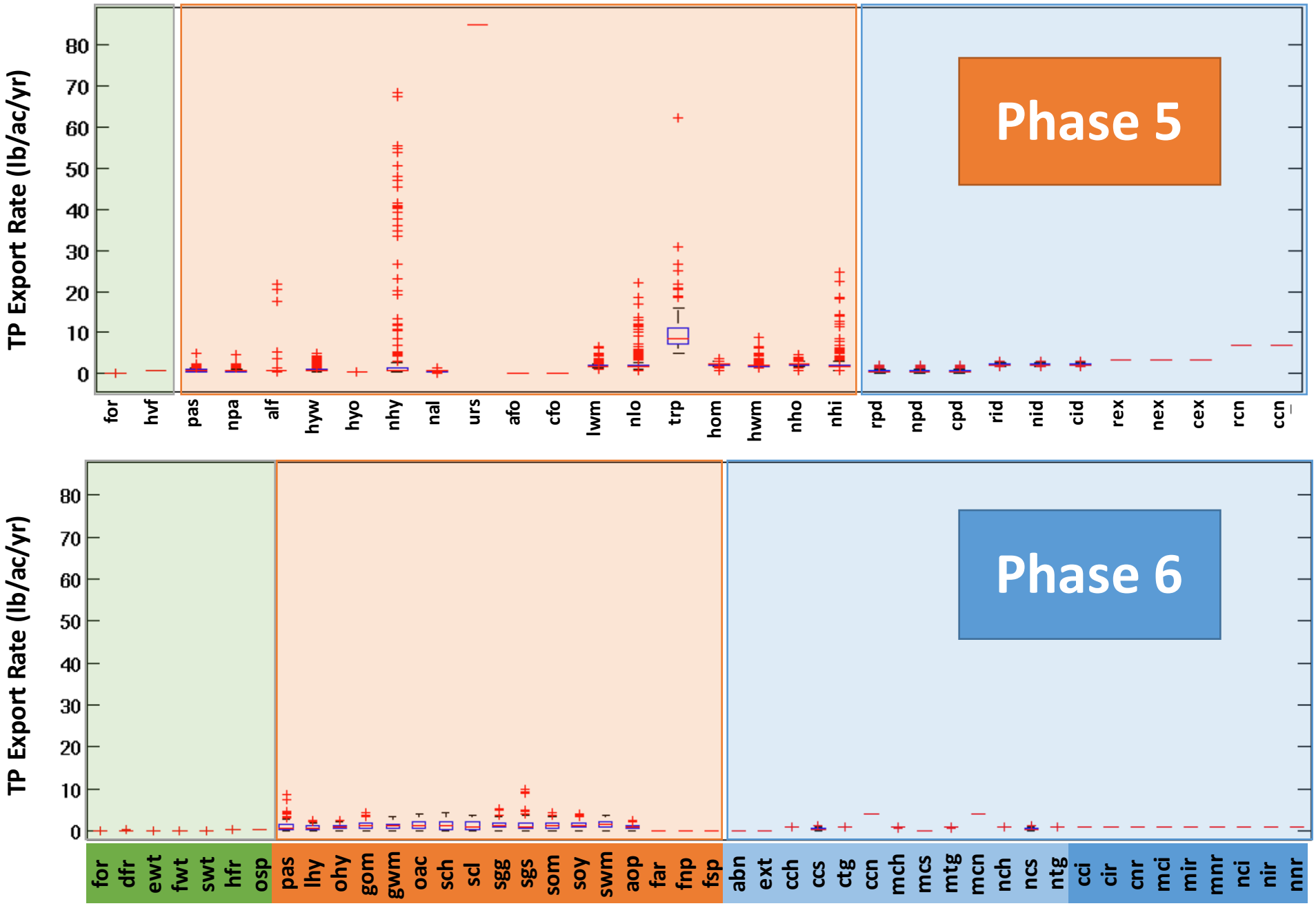
*Total **Nitrogen** Land-use Export Targets*

Olivia Devereux



*Total **Phosphorus** Land-use Export Targets*

Olivia Devereux

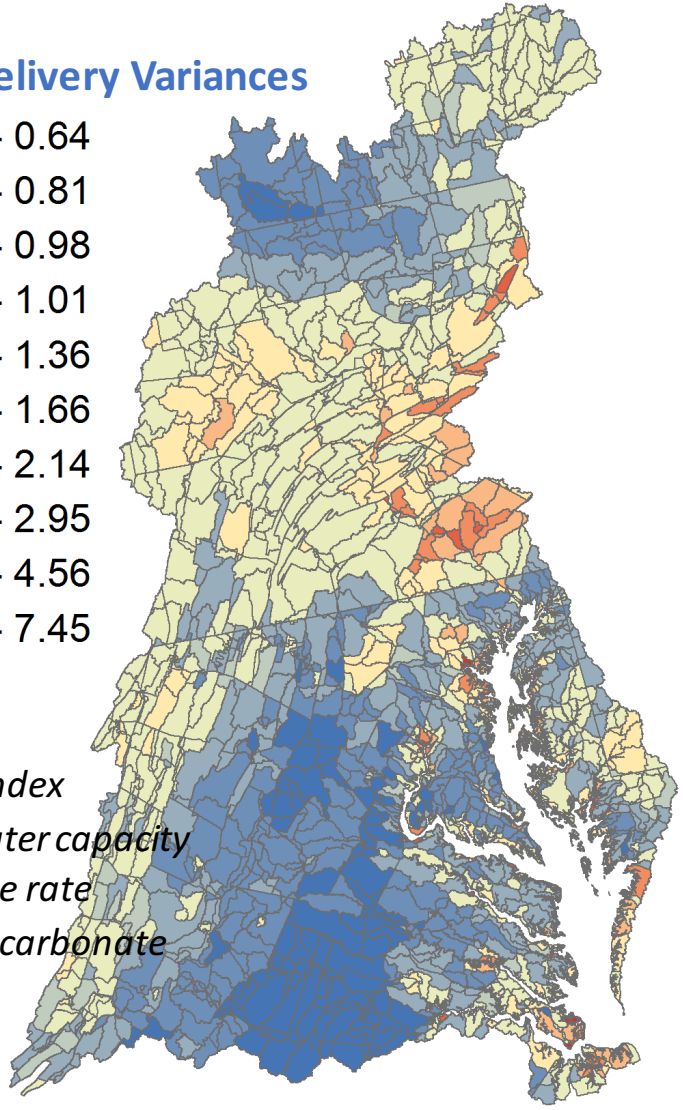


Based on APLE sensitivities for precipitation, sediment washoff, Mehlich, ~~uptake, & application rates.~~

Revised SPARROW *Land to Water* Delivery Variances

Nitrogen Delivery Variances

- 0.41 - 0.64
- 0.65 - 0.81
- 0.82 - 0.98
- 0.99 - 1.01
- 1.02 - 1.36
- 1.37 - 1.66
- 1.67 - 2.14
- 2.15 - 2.95
- 2.96 - 4.56
- 4.57 - 7.45

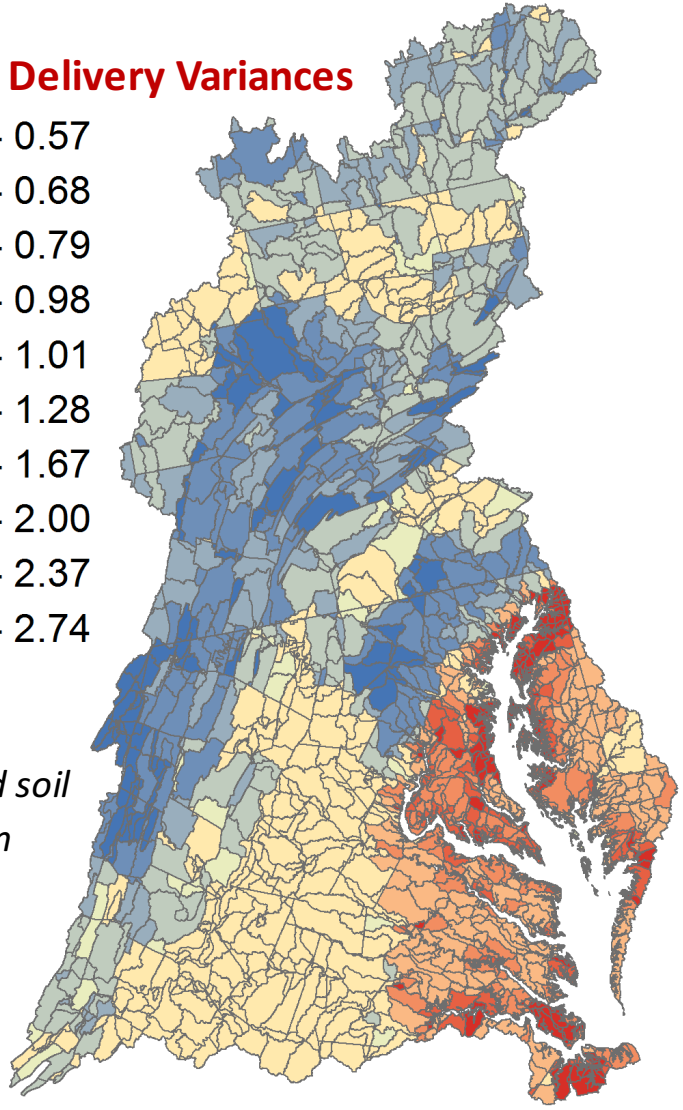


vegetation index
available water capacity
GW Recharge rate
% piedmont carbonate

1.076

Phosphorus Delivery Variances

- 0.44 - 0.57
- 0.58 - 0.68
- 0.69 - 0.79
- 0.80 - 0.98
- 0.99 - 1.01
- 1.02 - 1.28
- 1.29 - 1.67
- 1.68 - 2.00
- 2.01 - 2.37
- 2.38 - 2.74



% well drained soil
% coastal plain
~~*soil erodibility*~~
~~*precipitation*~~

1.036

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Revised SPARROW *Stream to River* Factors

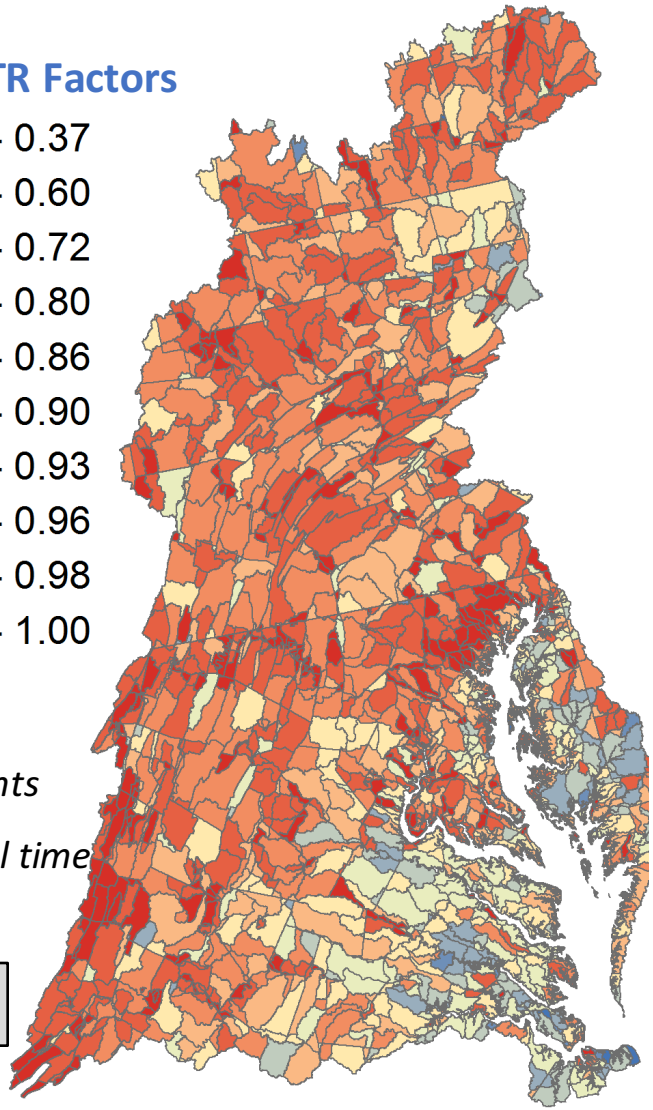
Nitrogen STR Factors

- 0.16 - 0.37
- 0.38 - 0.60
- 0.61 - 0.72
- 0.73 - 0.80
- 0.81 - 0.86
- 0.87 - 0.90
- 0.91 - 0.93
- 0.94 - 0.96
- 0.97 - 0.98
- 0.99 - 1.00

Impoundments

Stream travel time

0.919

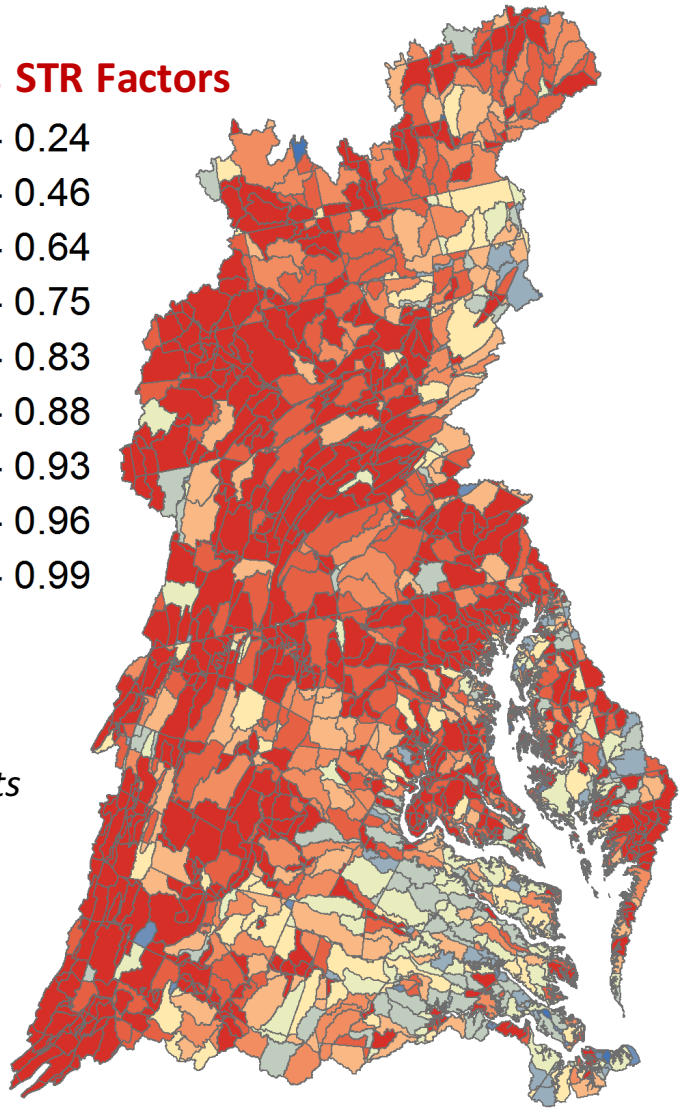


Phosphorus STR Factors

- 0.03 - 0.24
- 0.25 - 0.46
- 0.47 - 0.64
- 0.65 - 0.75
- 0.76 - 0.83
- 0.84 - 0.88
- 0.89 - 0.93
- 0.94 - 0.96
- 0.97 - 0.99
- 1.00

Impoundments

0.923



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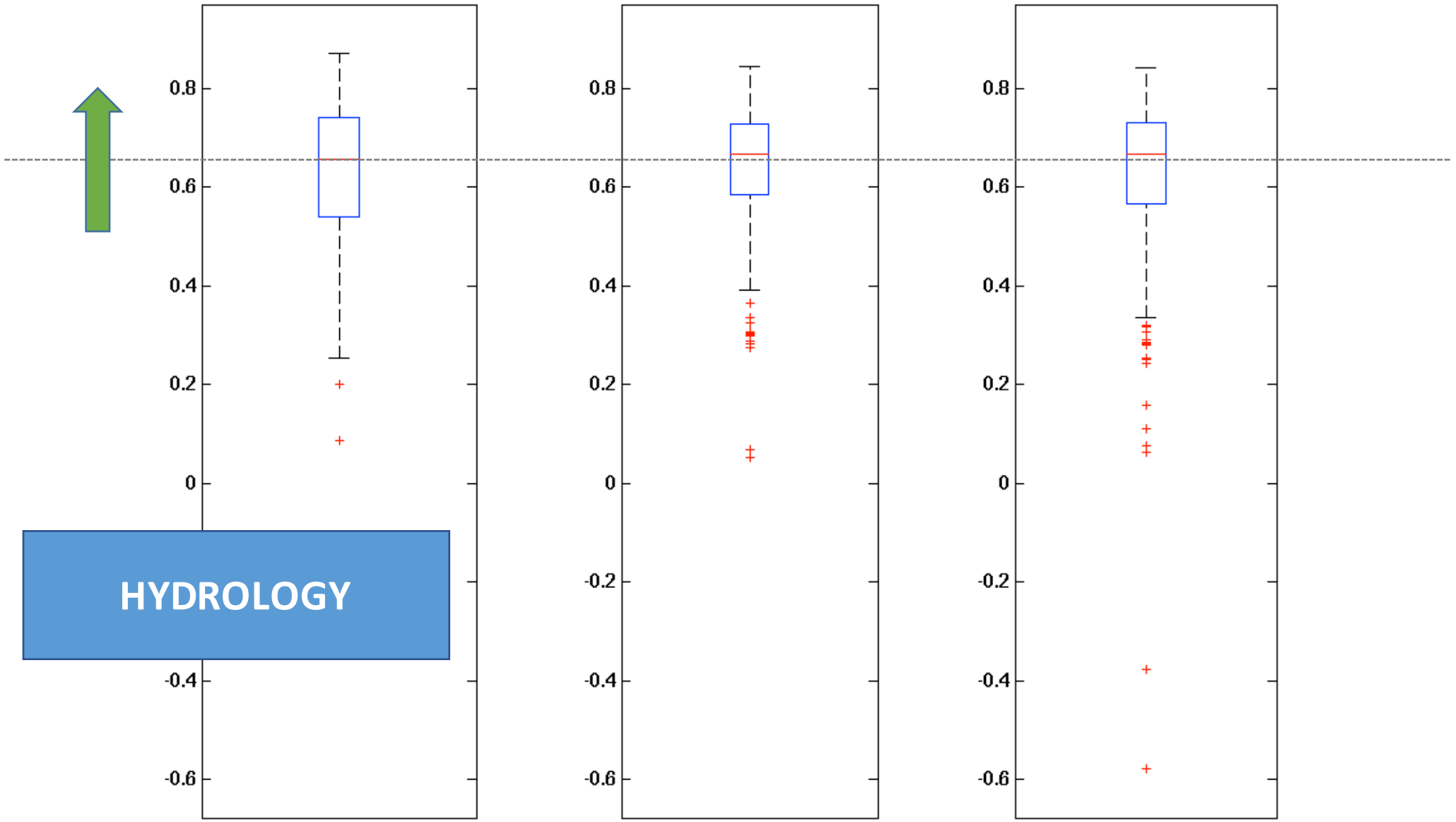
Other Datasets

- New Phase-6 land-use dataset – *Peter Claggett and SB team*
- All new Phase-6 input dataset including riparian pasture deposition – *Jessica Rigleman and SB team*
- Preliminary atmospheric deposition data based on NLDAS-2 precipitation – *Jeff Grimm*
- 26 additional flow stations – *Guido Yactayo and Kyle Hinson*
- Revised water quality observations – *Michael Langland and Guido Yactayo*
- Revised WRTDS data – *Jeffery Chanat and Guido Yactayo*

Nash-Sutcliffe Efficiency at 191 Calibration Stations



Phase 5 [1985-2005] | **Phase 6 [1985-2014]** | **Phase 6 [1985-2014]**

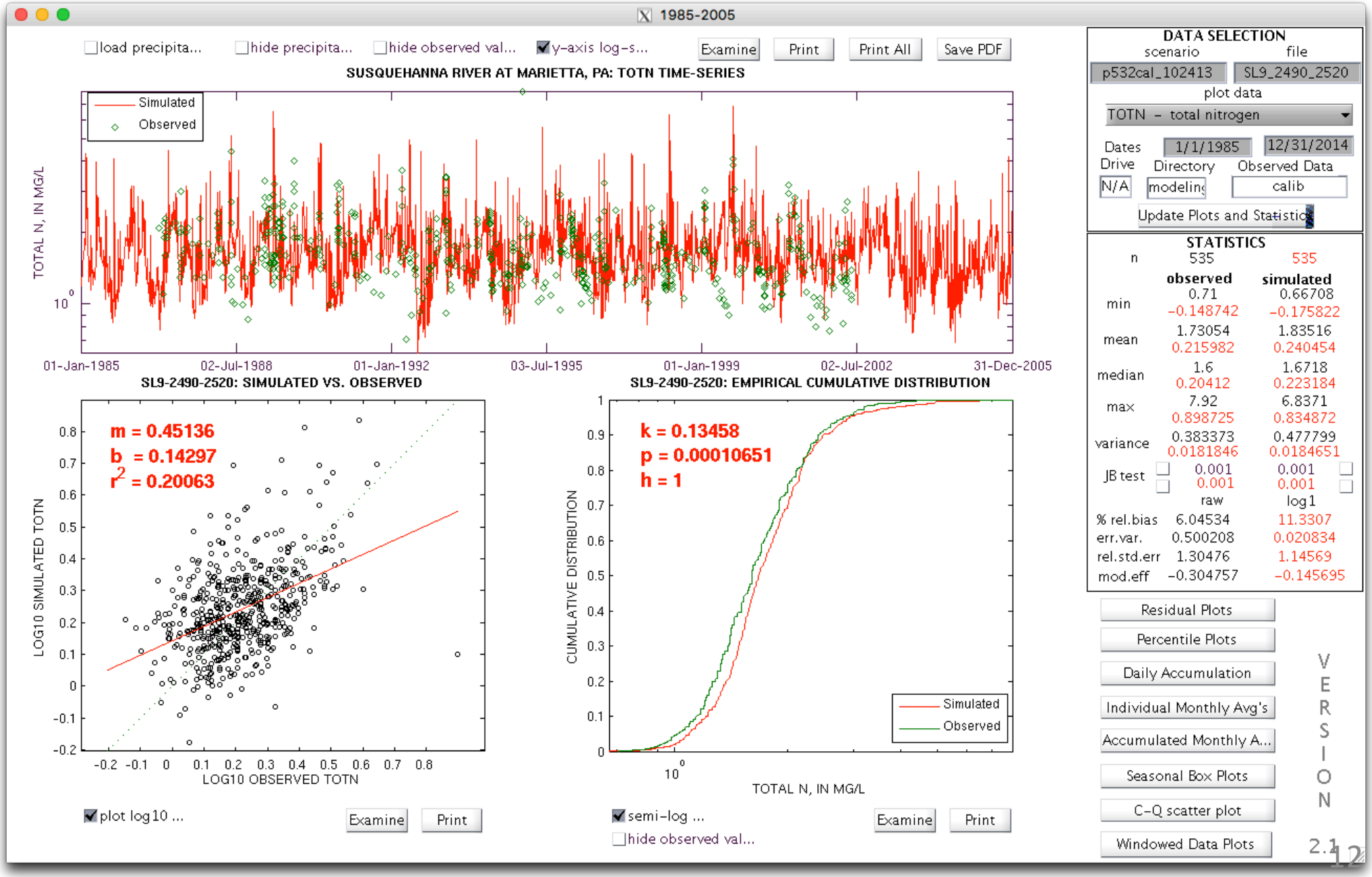
{P6 land segments and landuse*}

* August version with provisional datasets

SUSQUEHANNA AT MARIETTA

PHASE 5
1985 - 2005

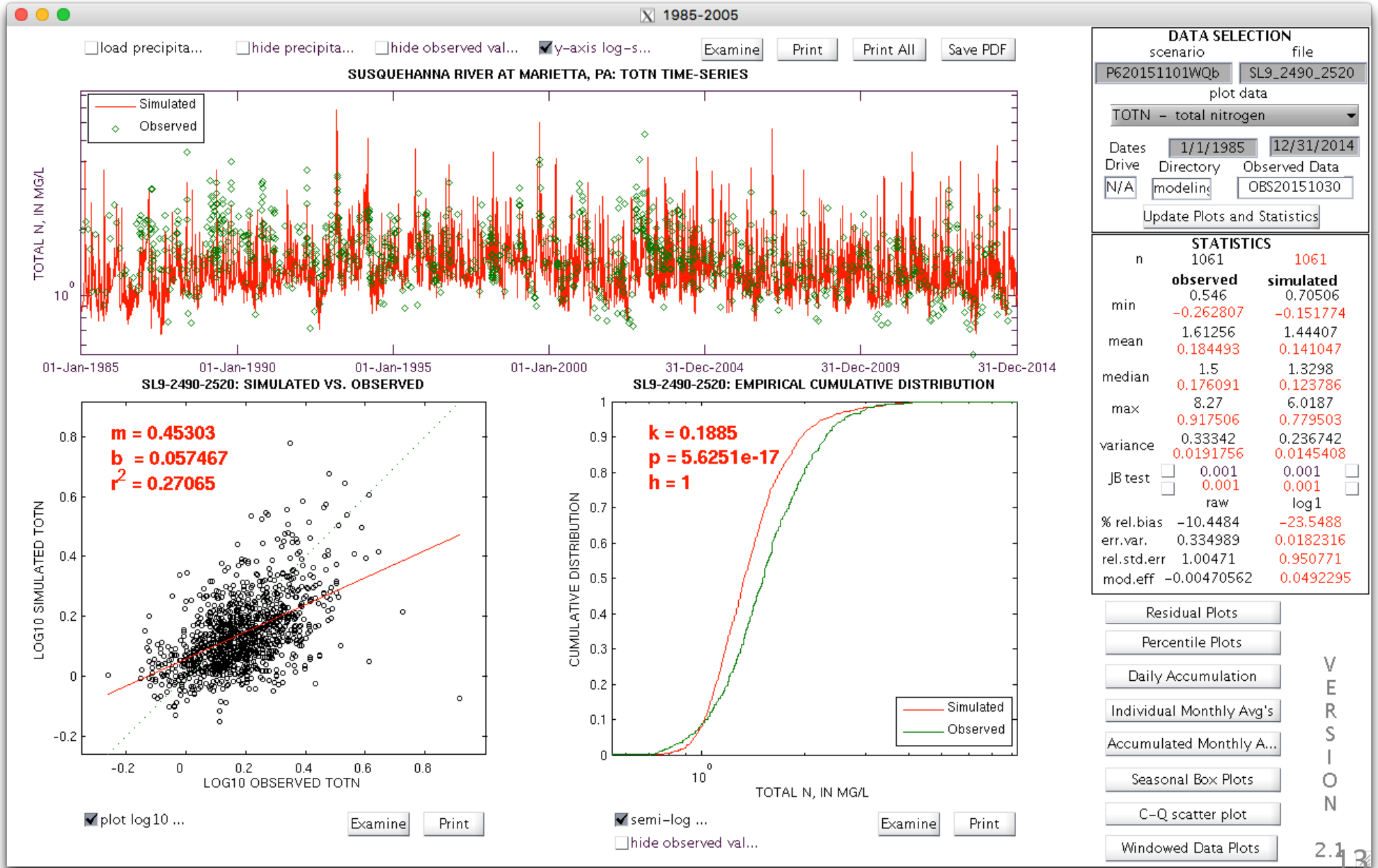
NITROGEN



SUSQUEHANNA AT MARIETTA

PHASE 6
1985 - 2014

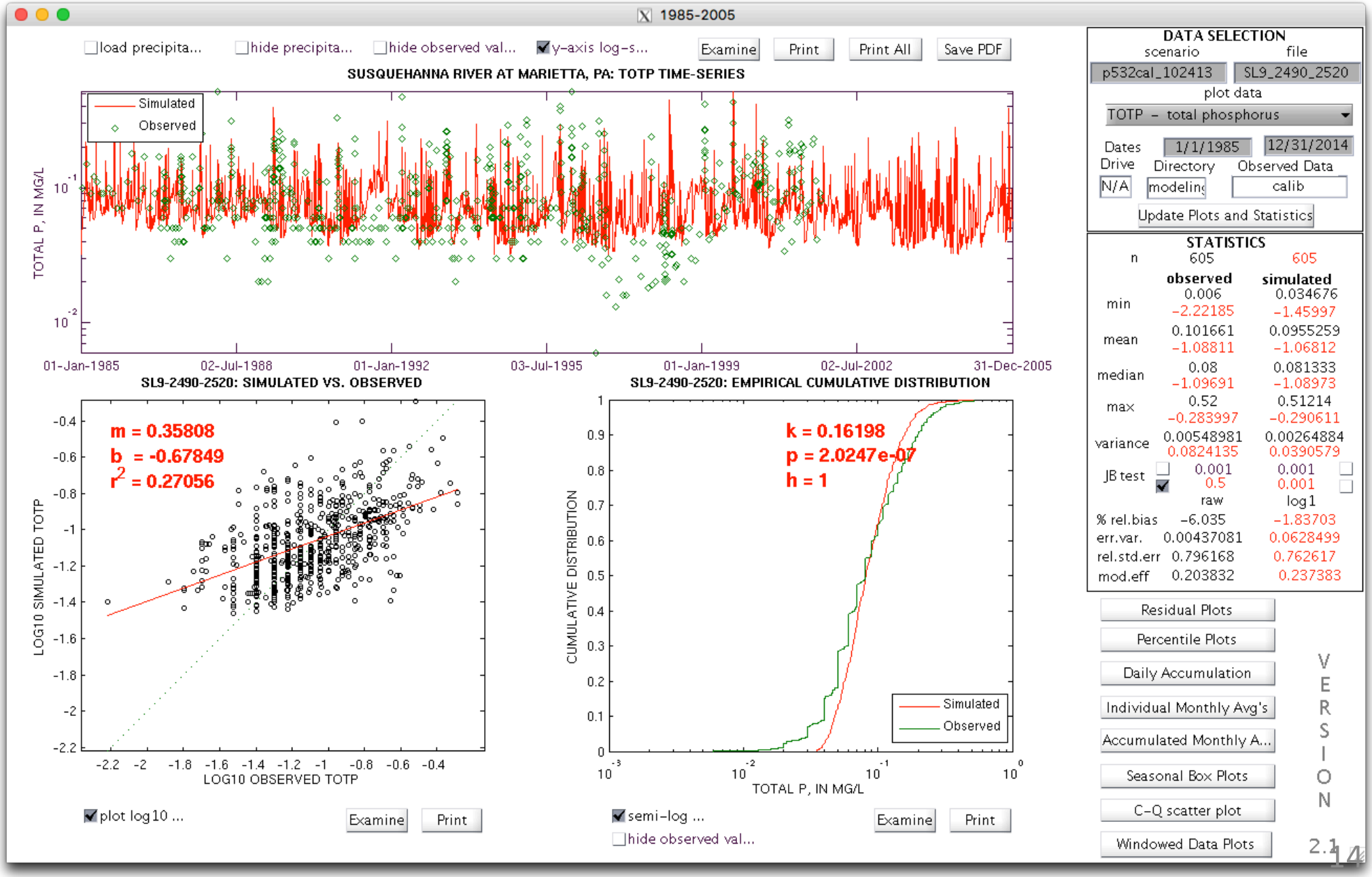
NITROGEN



SUSQUEHANNA AT MARIETTA

PHASE 5
1985 - 2005

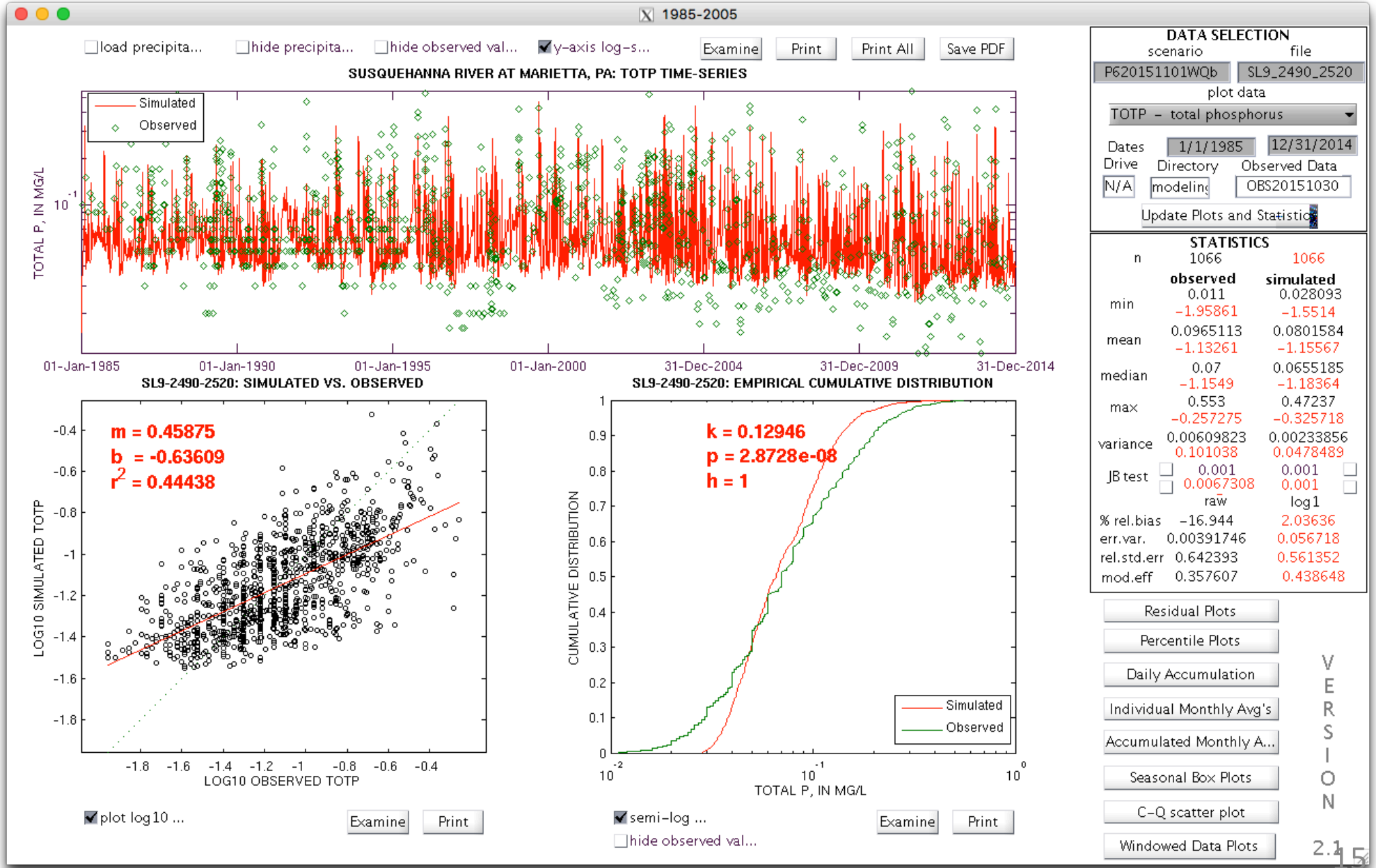
PHOSPHORUS



SUSQUEHANNA AT MARIETTA

PHASE 6
1985 - 2014

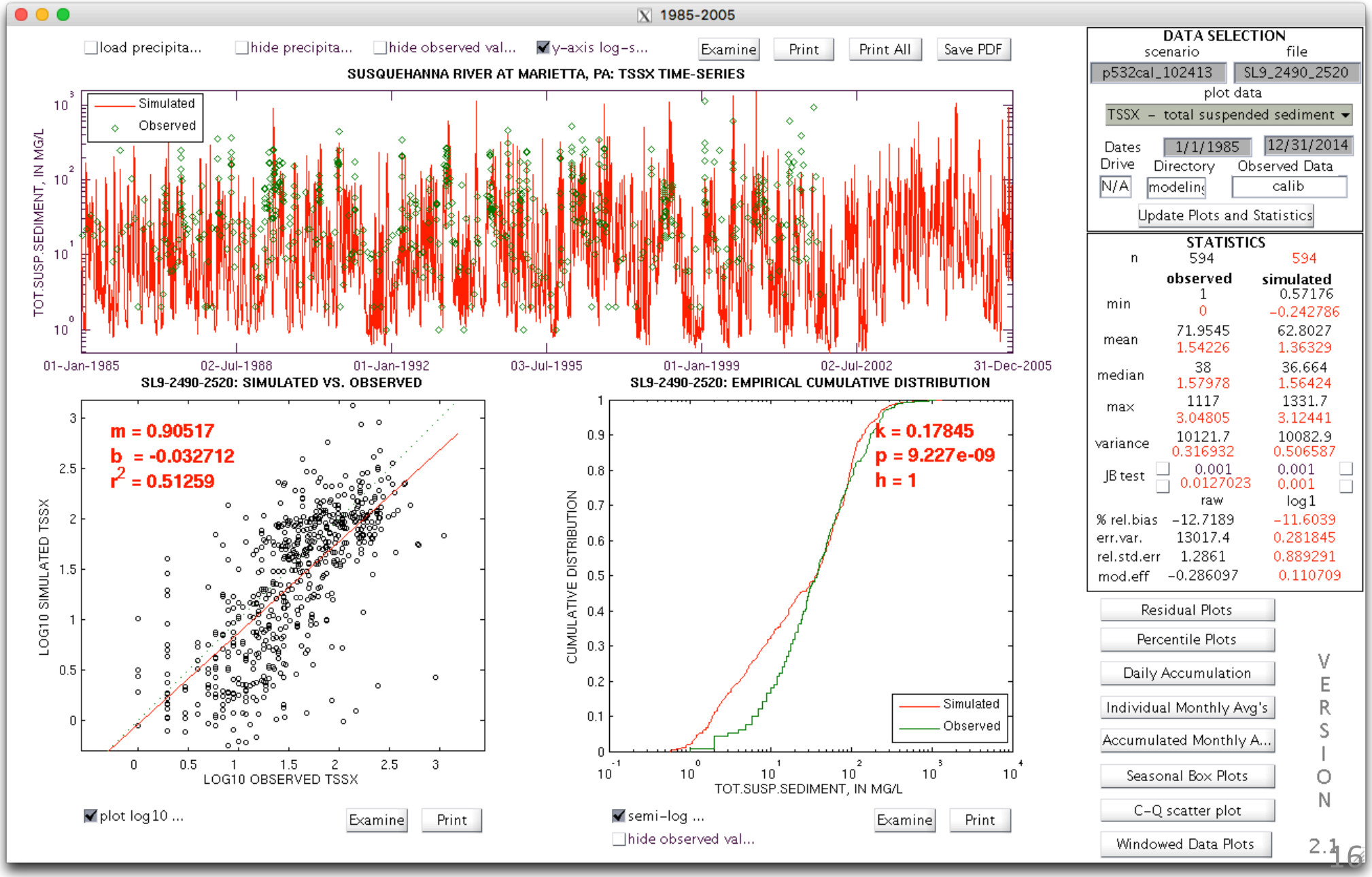
PHOSPHORUS



SUSQUEHANNA AT MARIETTA

PHASE 5
1985 - 2005

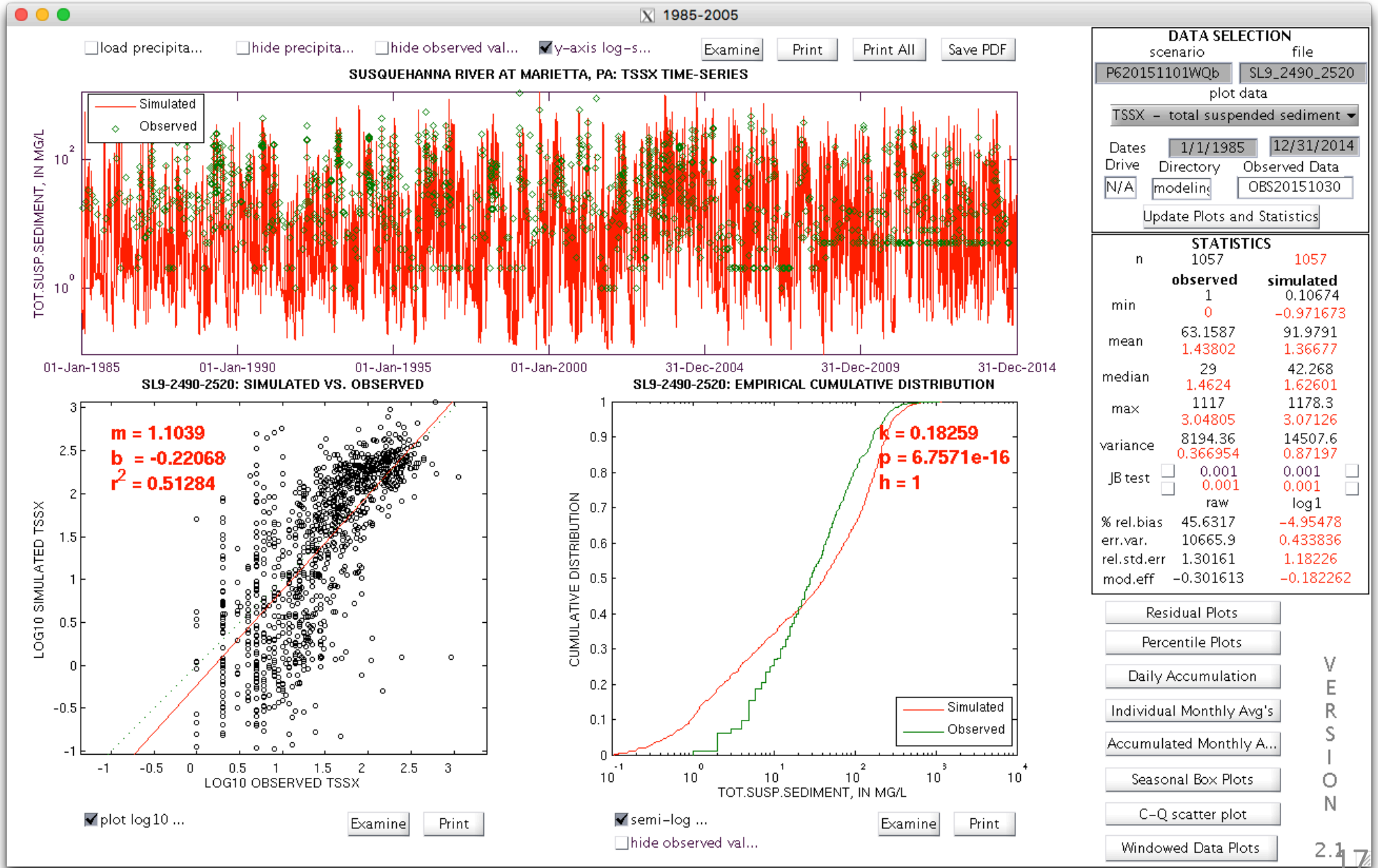
SEDIMENT



SUSQUEHANNA AT MARIETTA

PHASE 6
1985 - 2014

SEDIMENT



PHASE 5

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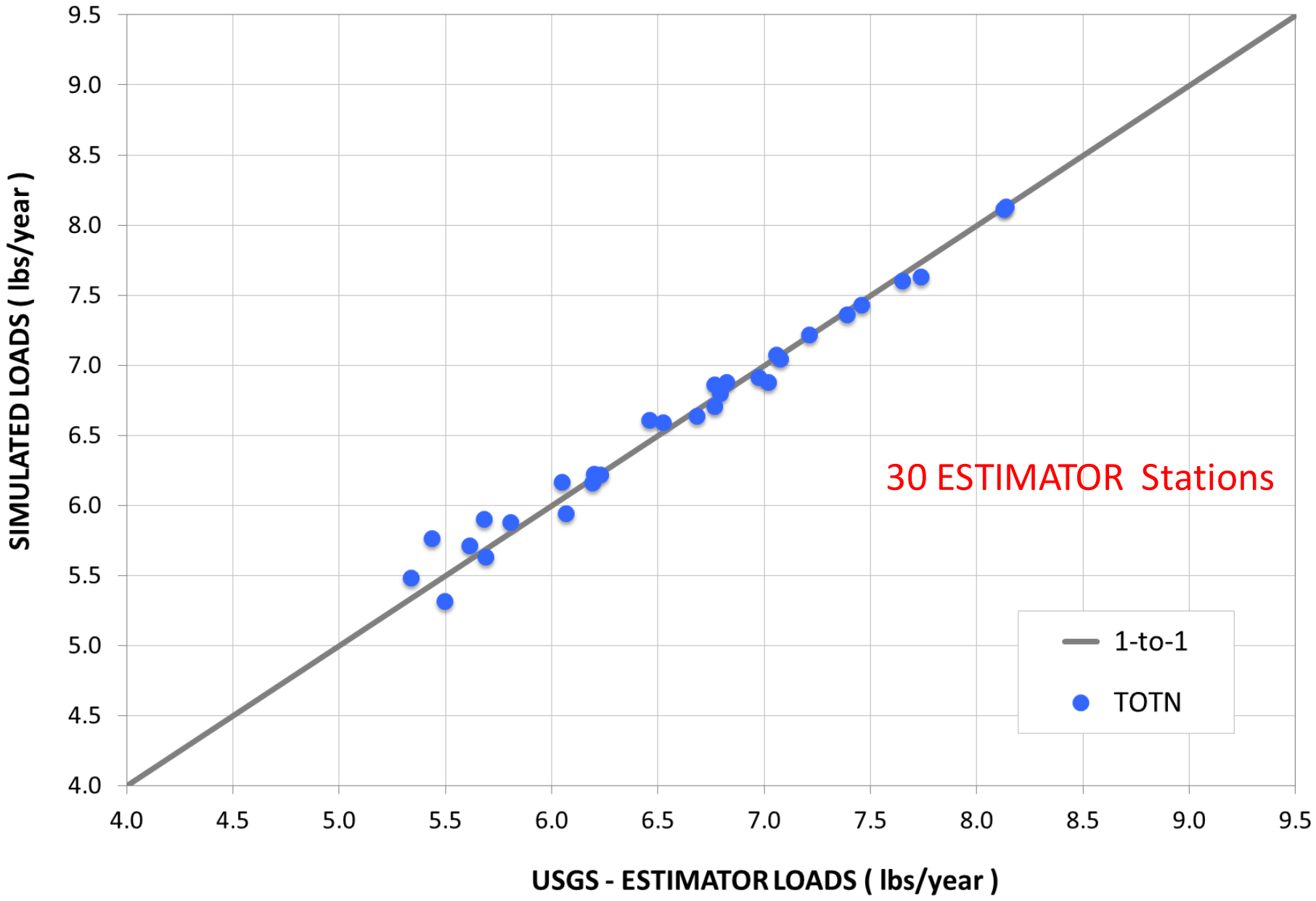

PHASE 6

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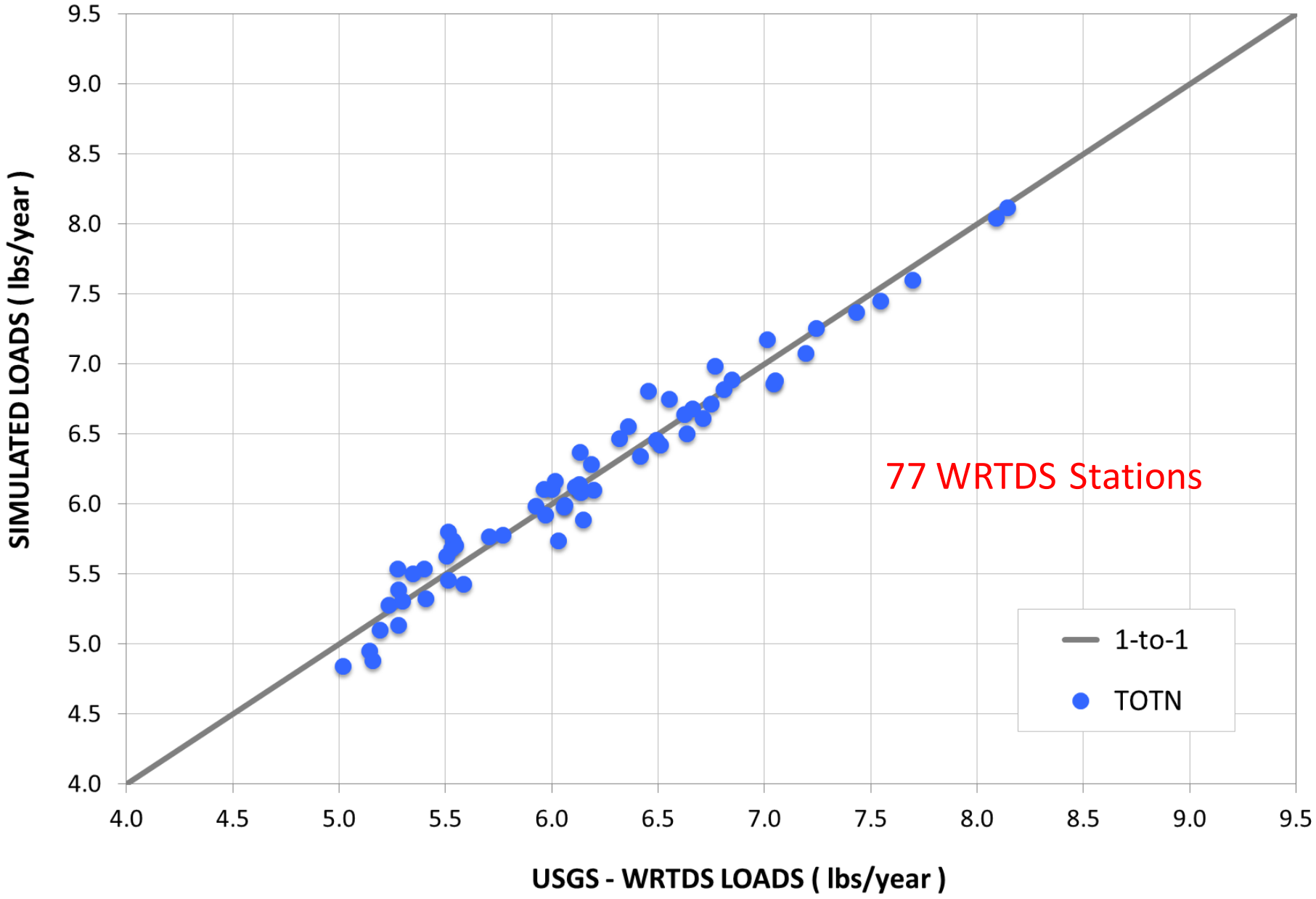
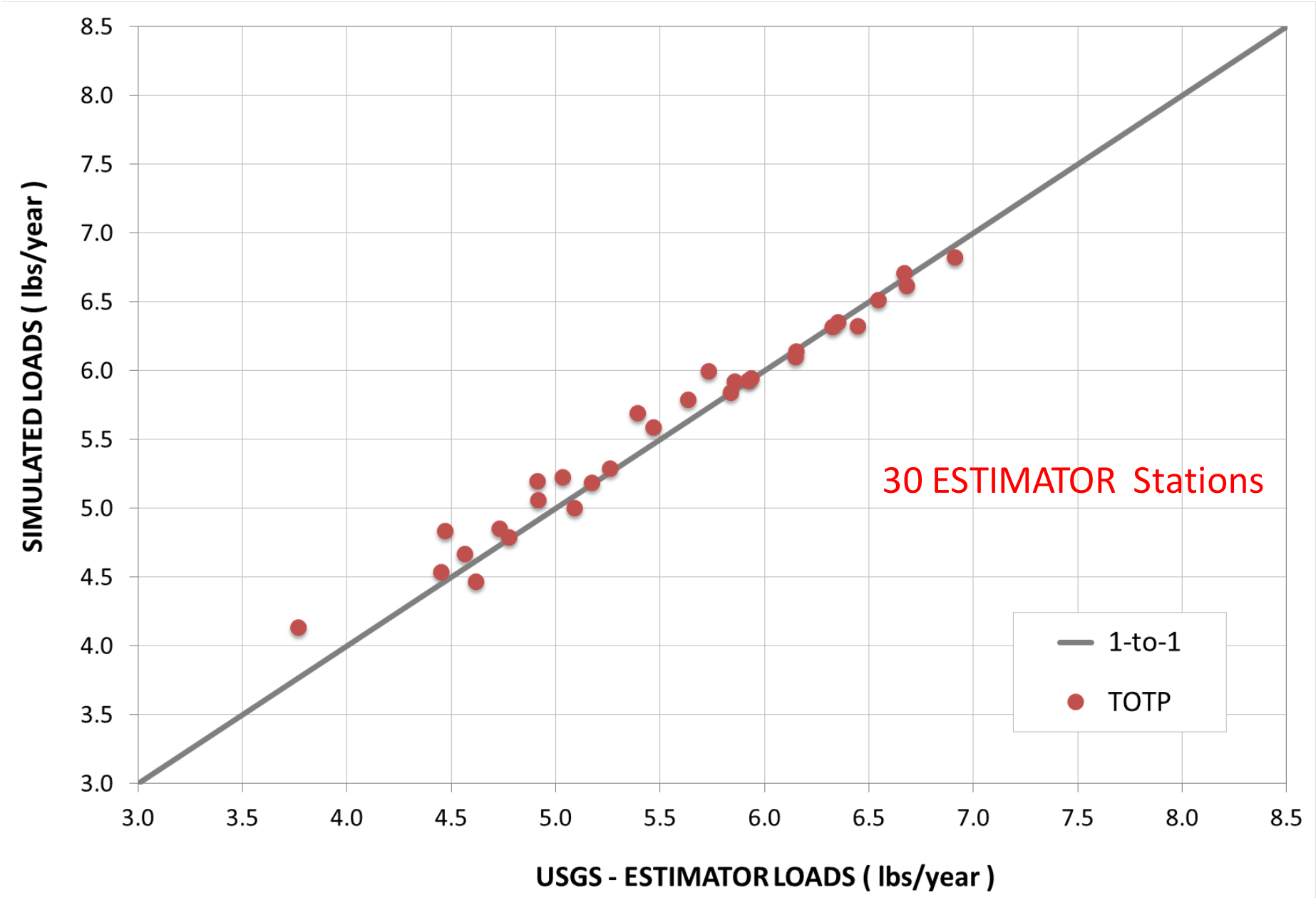


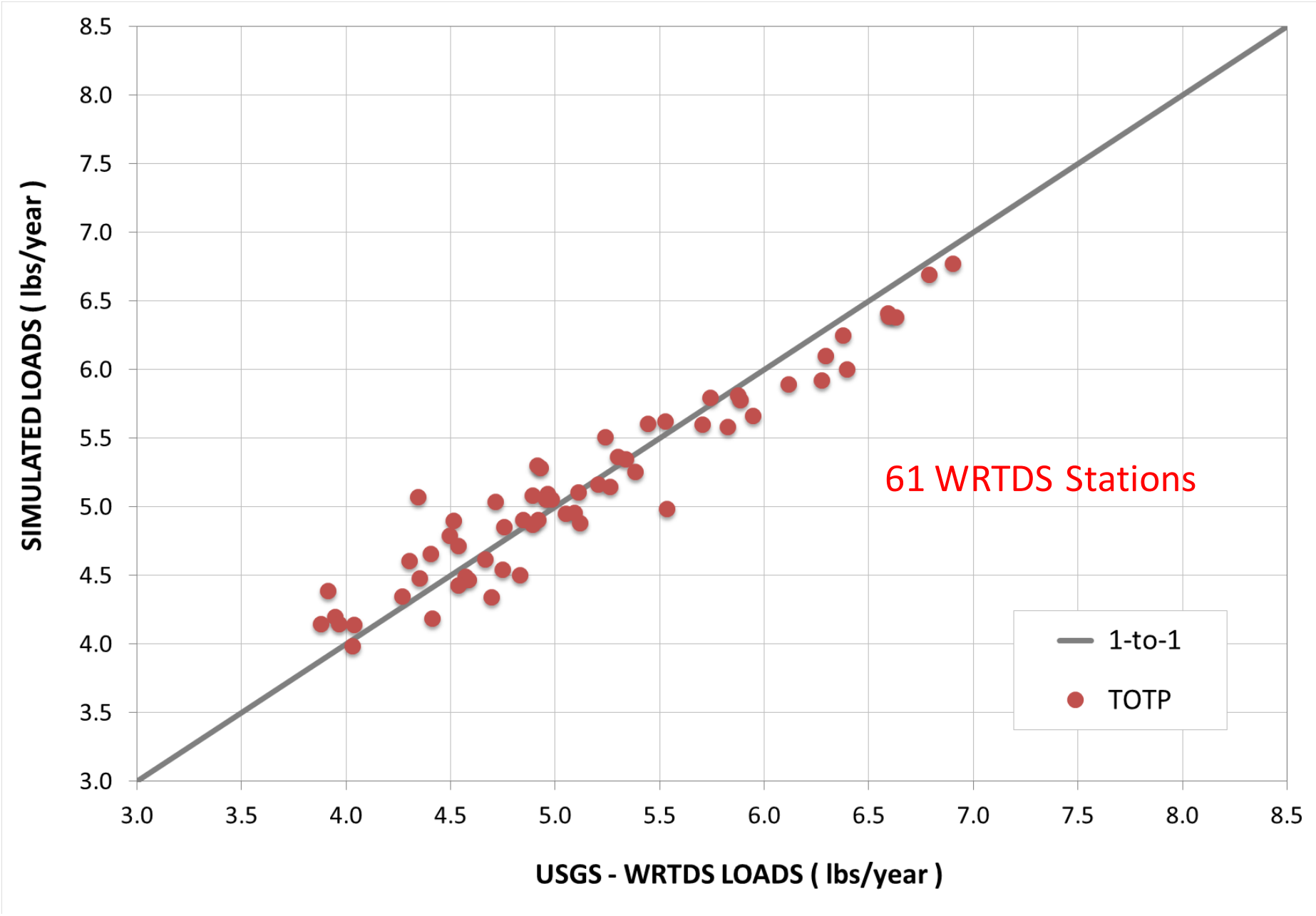
PHASE 5

PHOSPHORUS



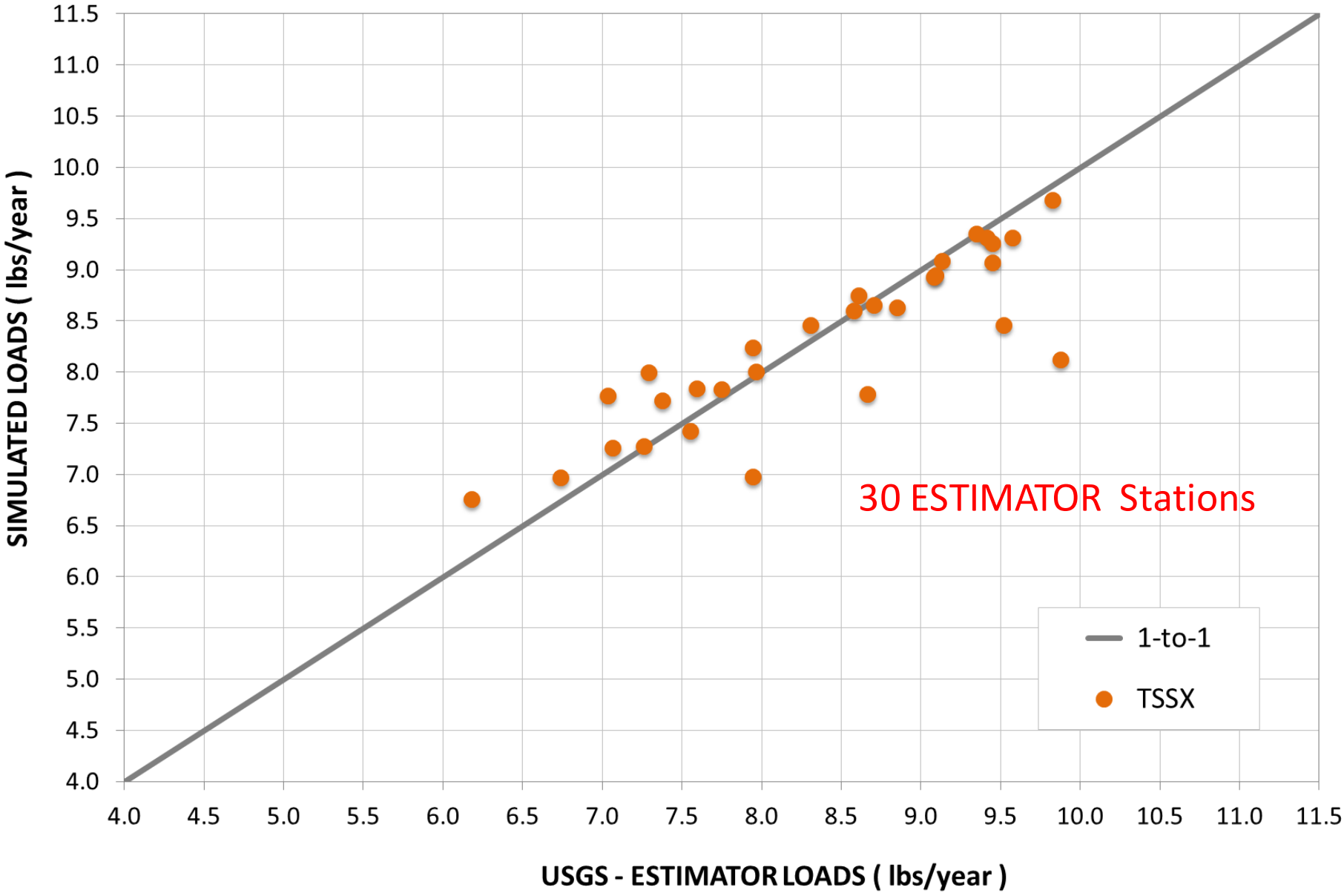
PHASE 6

PHOSPHORUS



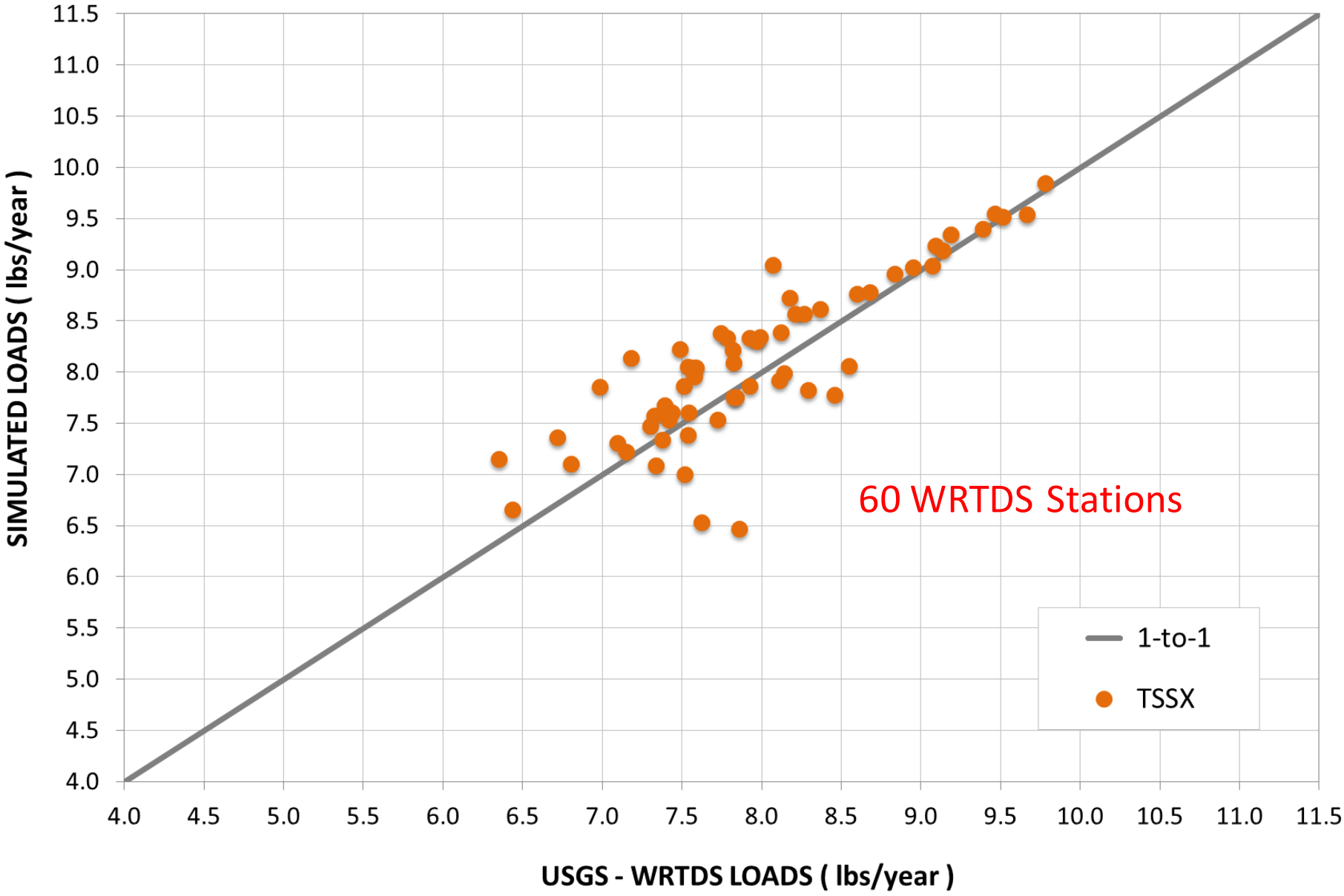
PHASE 5

SEDIMENT

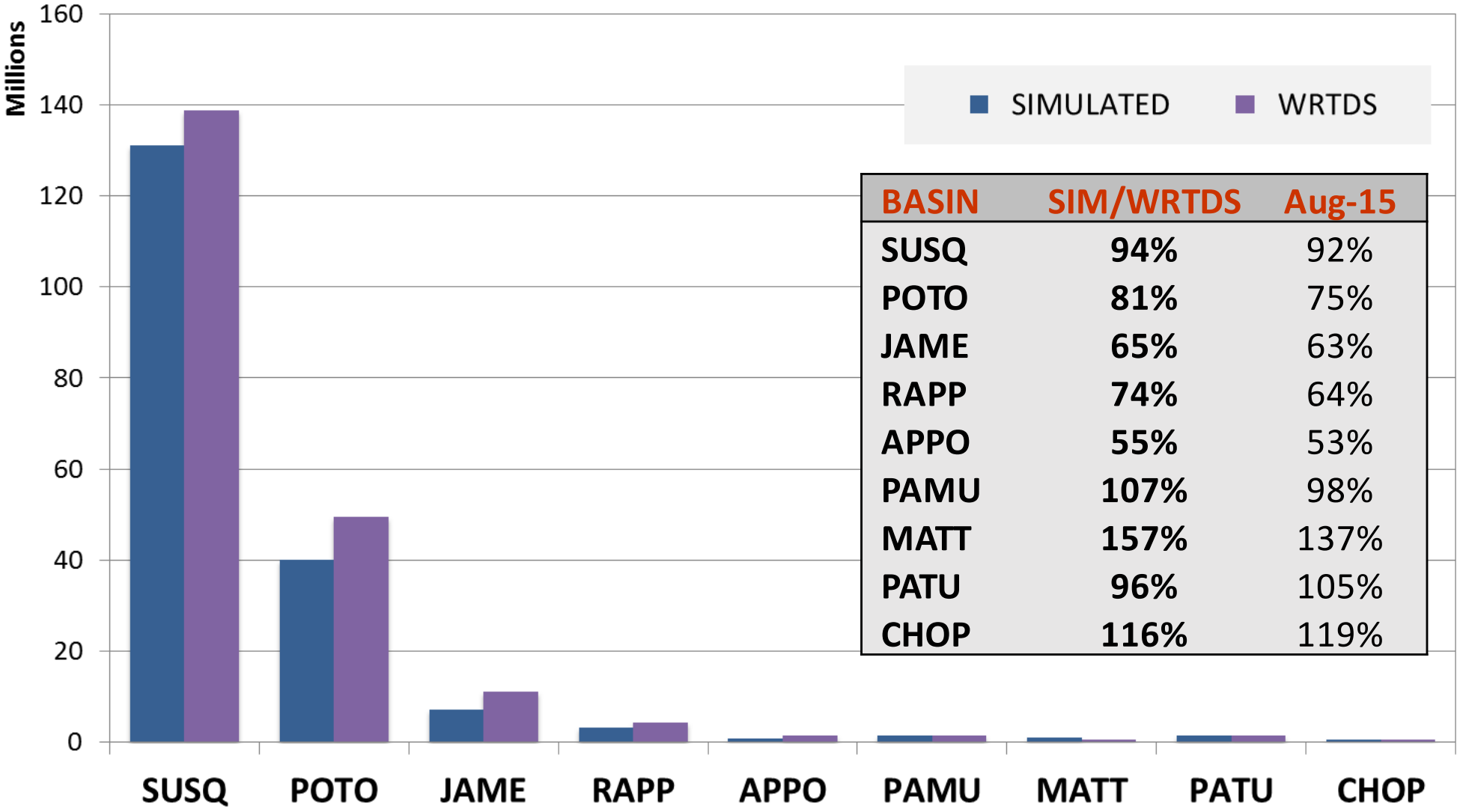


PHASE 6

SEDIMENT

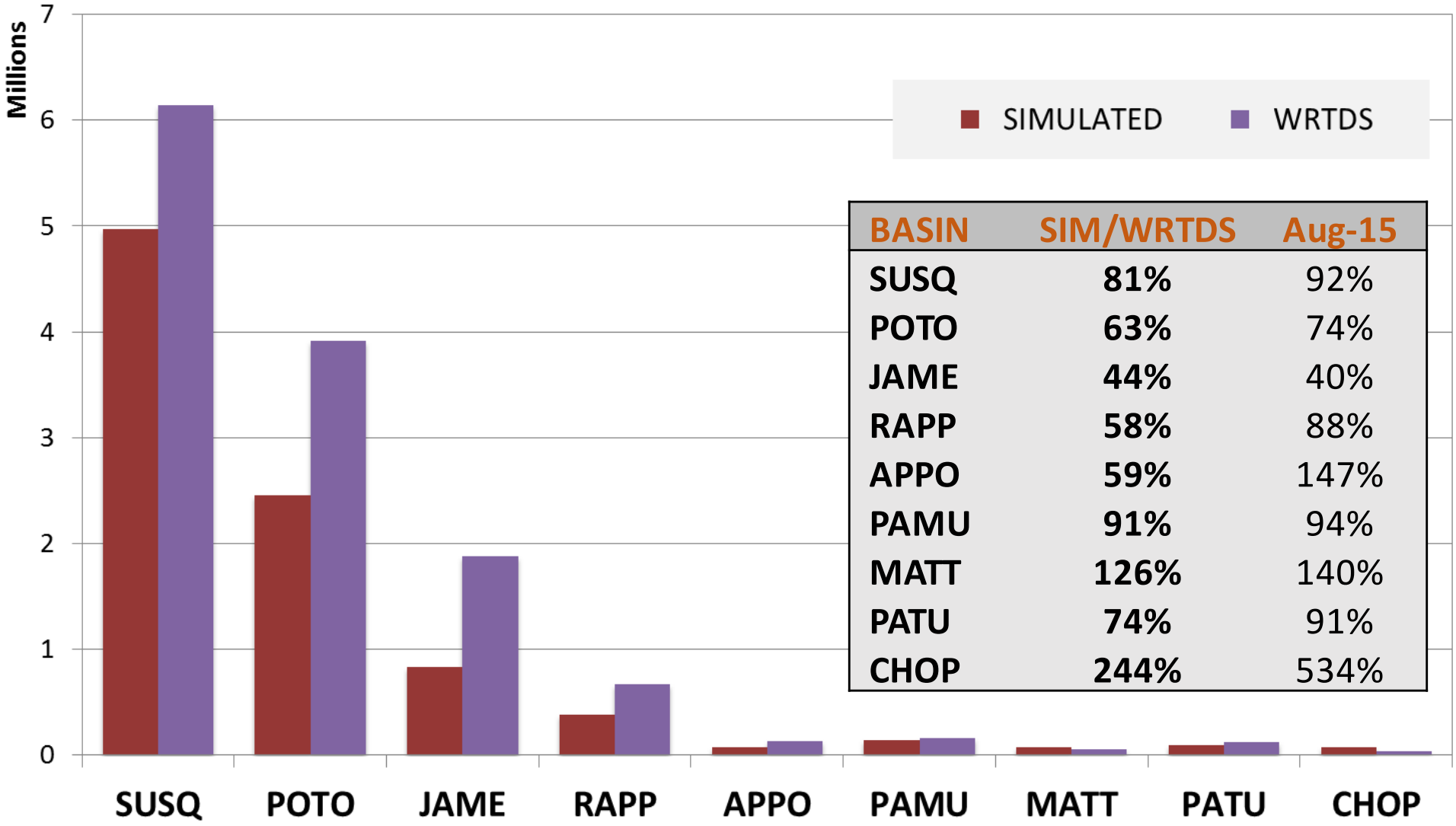


Total **Nitrogen** at RIM Stations



BASIN	SIM/WRTDS	Aug-15
SUSQ	94%	92%
POTO	81%	75%
JAME	65%	63%
RAPP	74%	64%
APPO	55%	53%
PAMU	107%	98%
MATT	157%	137%
PATU	96%	105%
CHOP	116%	119%

Total **Phosphorus** at RIM Stations

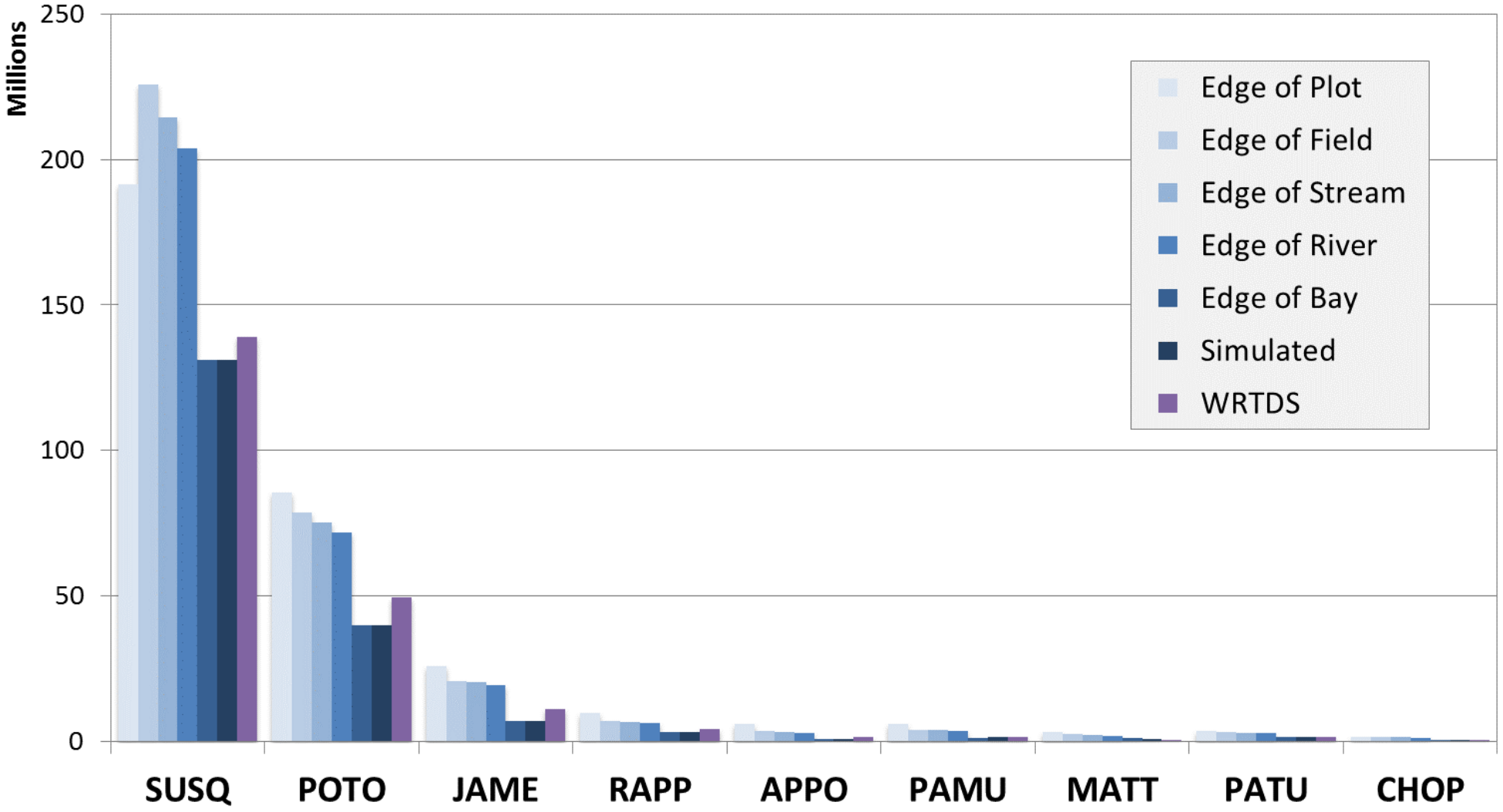


BASIN	SIM/WRTDS	Aug-15
SUSQ	81%	92%
POTO	63%	74%
JAME	44%	40%
RAPP	58%	88%
APPO	59%	147%
PAMU	91%	94%
MATT	126%	140%
PATU	74%	91%
CHOP	244%	534%

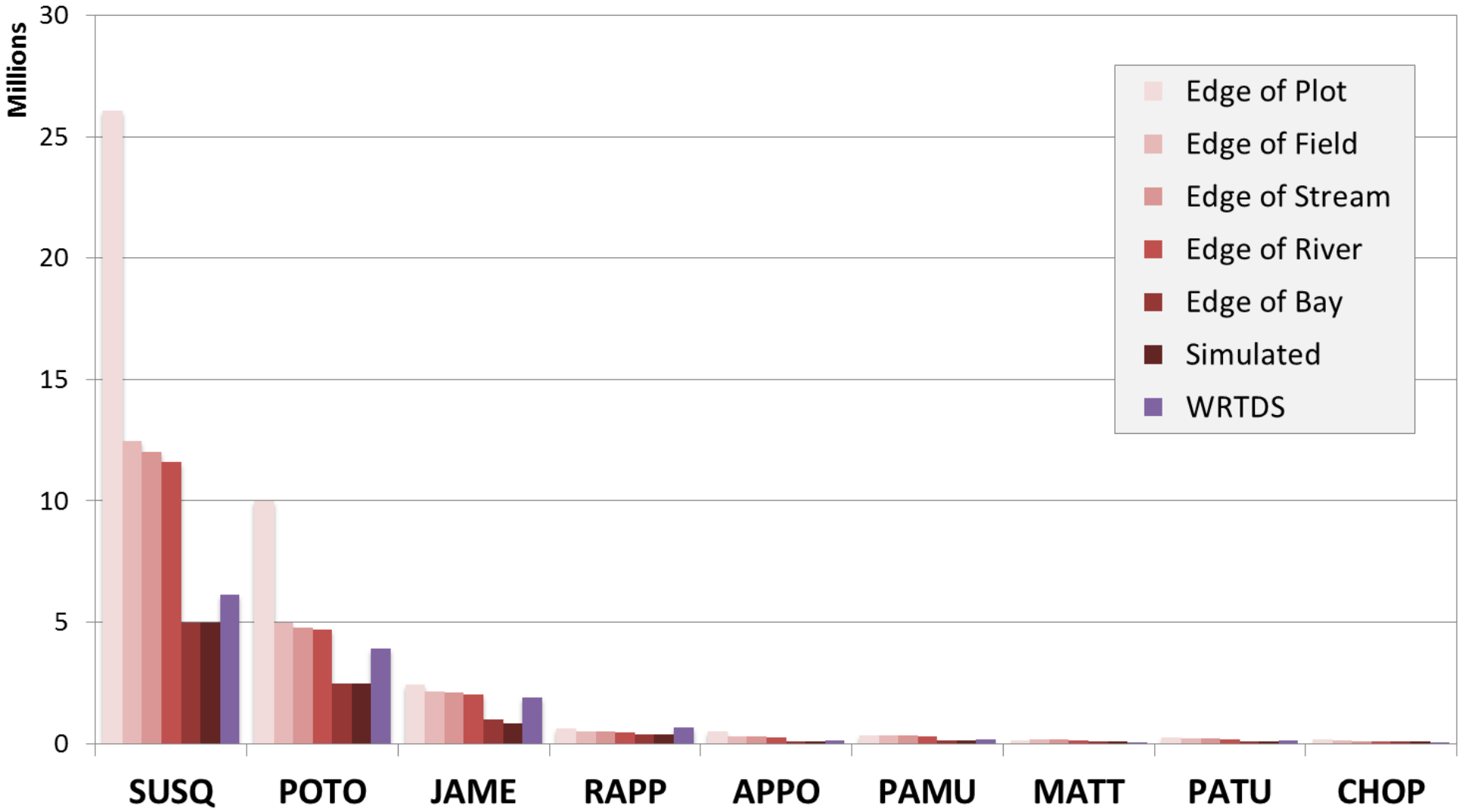
Phase-6 (process) simulation scales

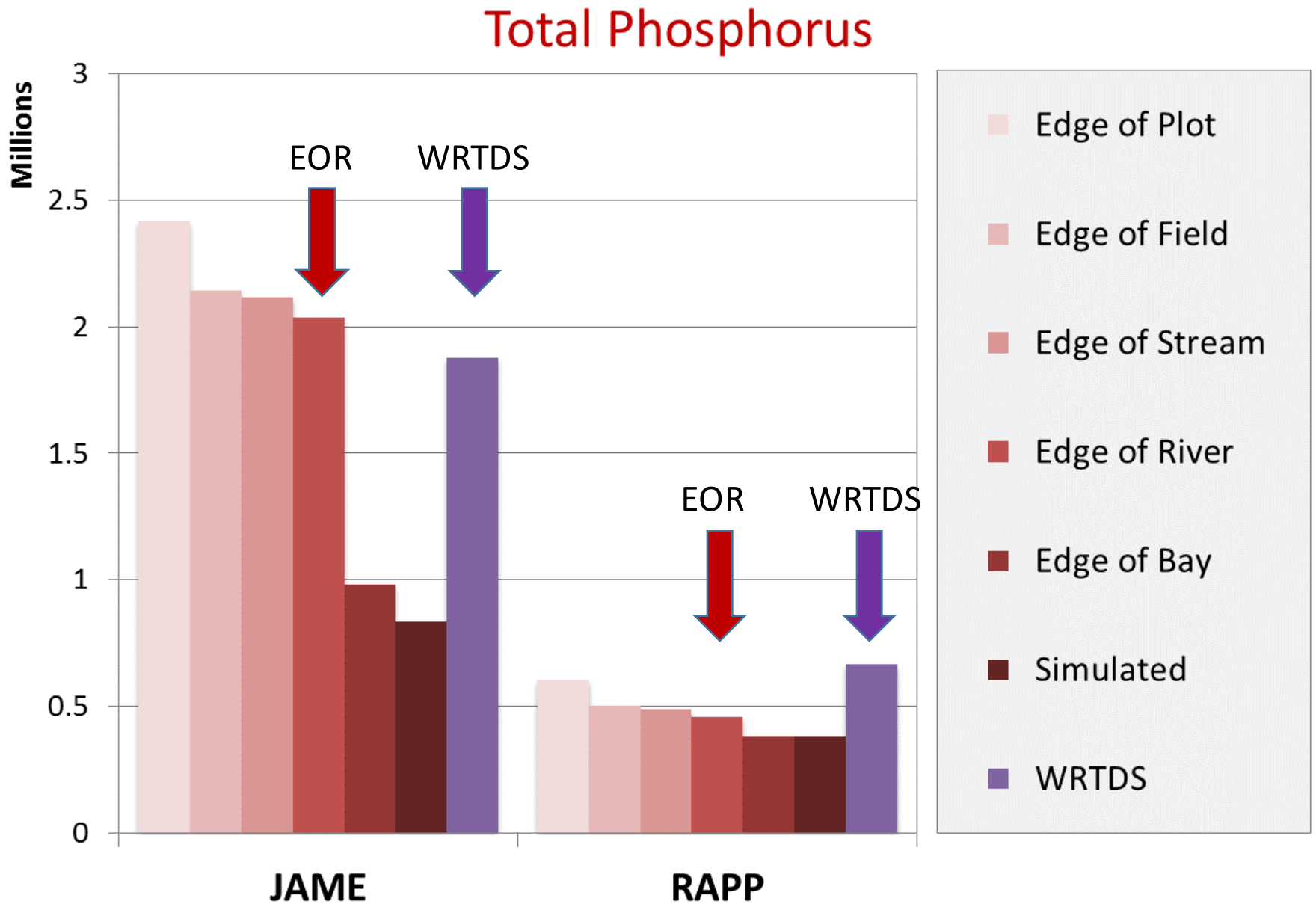
- **Edge of Plot** – loads from targets (*affect of source loads*)
- **Edge of Field** – loads after land-to-water variances
- **Edge of Stream** – loads after Septic, PS, & BMPs
- **Edge of River** – loads after stream-to-river factors
- **Delivered to Bay** – loads transported to the Bay

Nitrogen budgets at P6 simulation scales



Phosphorus budgets at P6 simulation scales




Total Phosphorus
Millions
3
2.5
2
1.5
1
0.5
0
EOR
WRTDS
EOR
WRTDS
JAME
RAPP
Edge of Plot
Edge of Field
Edge of Stream
Edge of River
Edge of Bay
Simulated
WRTDS

Regional Factors – Four Options

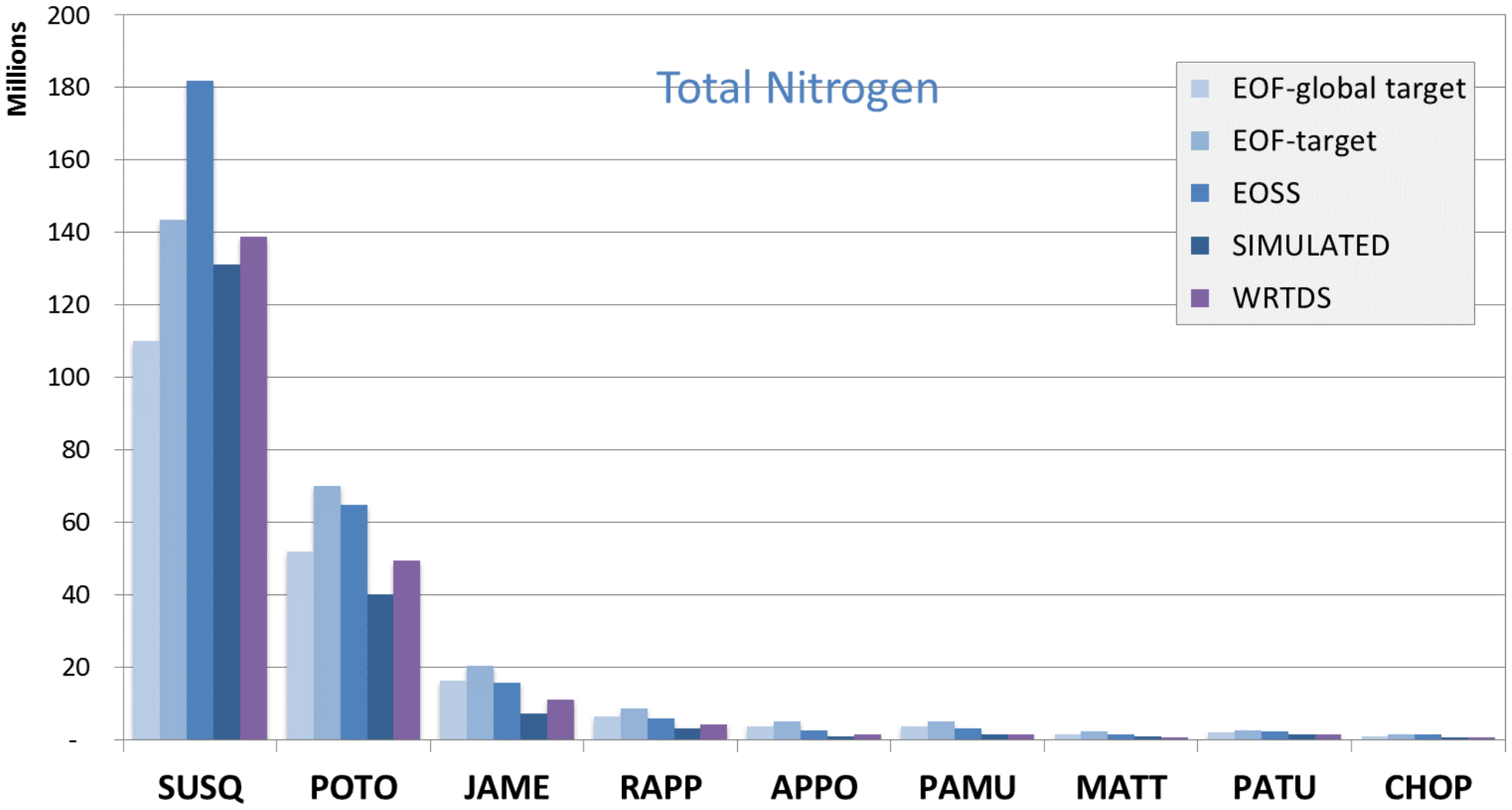
1. No regional factors
   - Load fully explained by data
   - Calibration may not be quite as good as P5
2. No RFs; load the WQSTM with WRTDS
   - WQSTM would have accurate loads
   - Would cause problems with climate and seasonal runs
3. Regional factors
   - Would provide a better calibration
   - Still some unexplained variability
4. Regional factors that apply to the calibration targets
   - Sensitivities to inputs would not be affected
   - Makes sense if we believe that the unexplained variability is due to errors in inputs

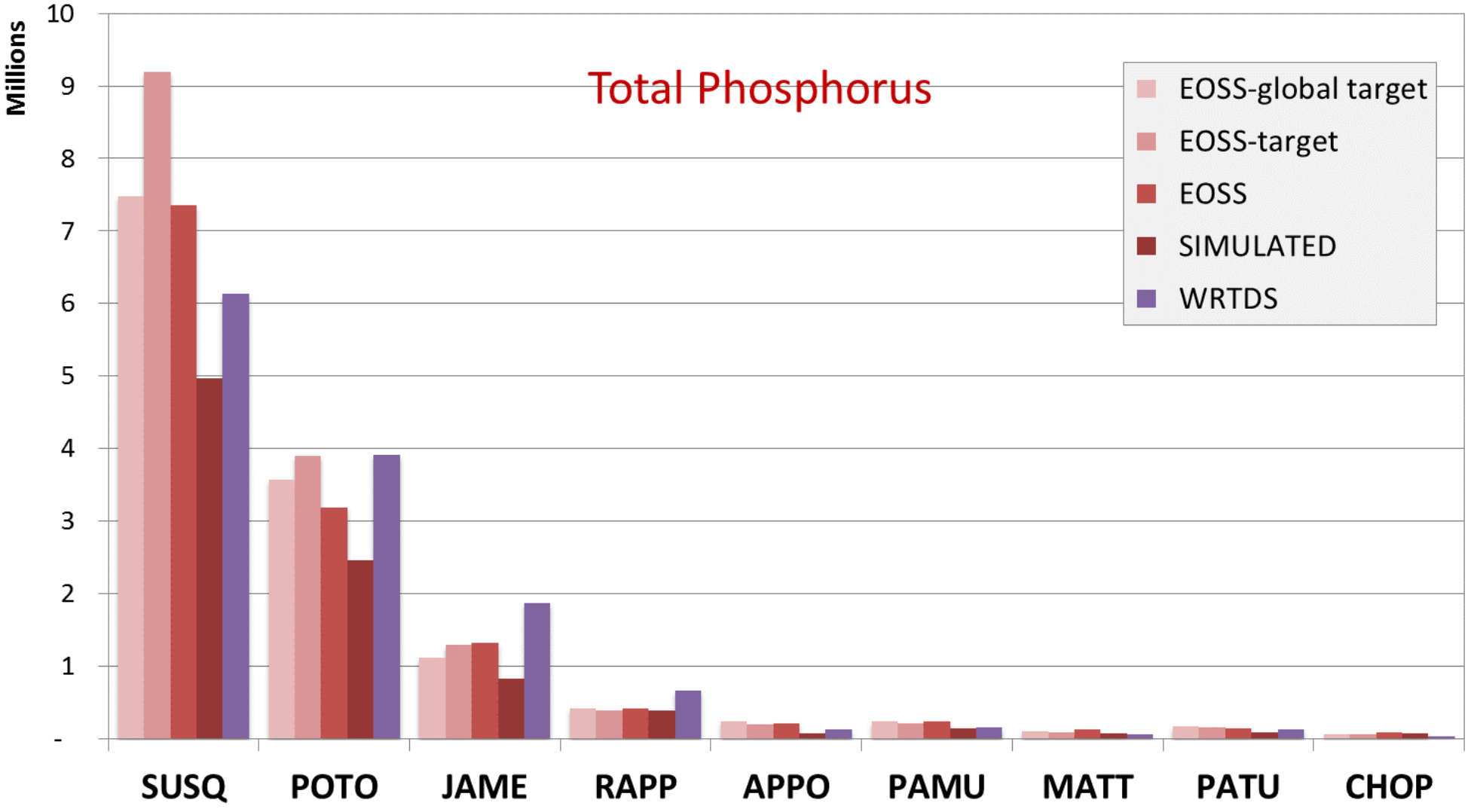
Land-use Key

fsp	Permitted Feeding Space
fnp	Non-Permitted Feeding Space
lhy	Legume Hay
ohy	Other Hay
aop	Ag Open Space
far	Farmstead
pas	Pasture
rpa	Riparian Pasture Deposition
soy	Full Season Soybeans
gwm	Grain with Manure
gom	Grain without Manure
swm	Silage with Manure
som	Silage without Manure
sgg	Small Grains and Grains
sgs	Small Grains and Soybeans
sch	Specialty Crop High
scl	Specialty Crop Low
oac	Other Agronomic Crops

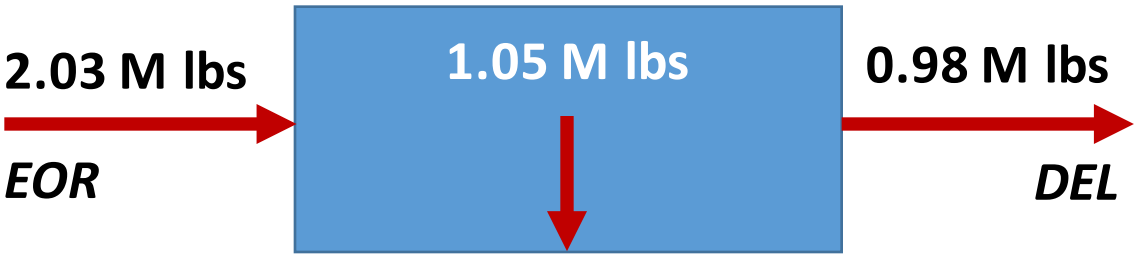
dfr	Disturbed Forest
hfr	Harvested Forest
for	Forest
fwt	Forested Wetland
swt	Scrub-Shrub Wetland
ewt	Emergent Wetland

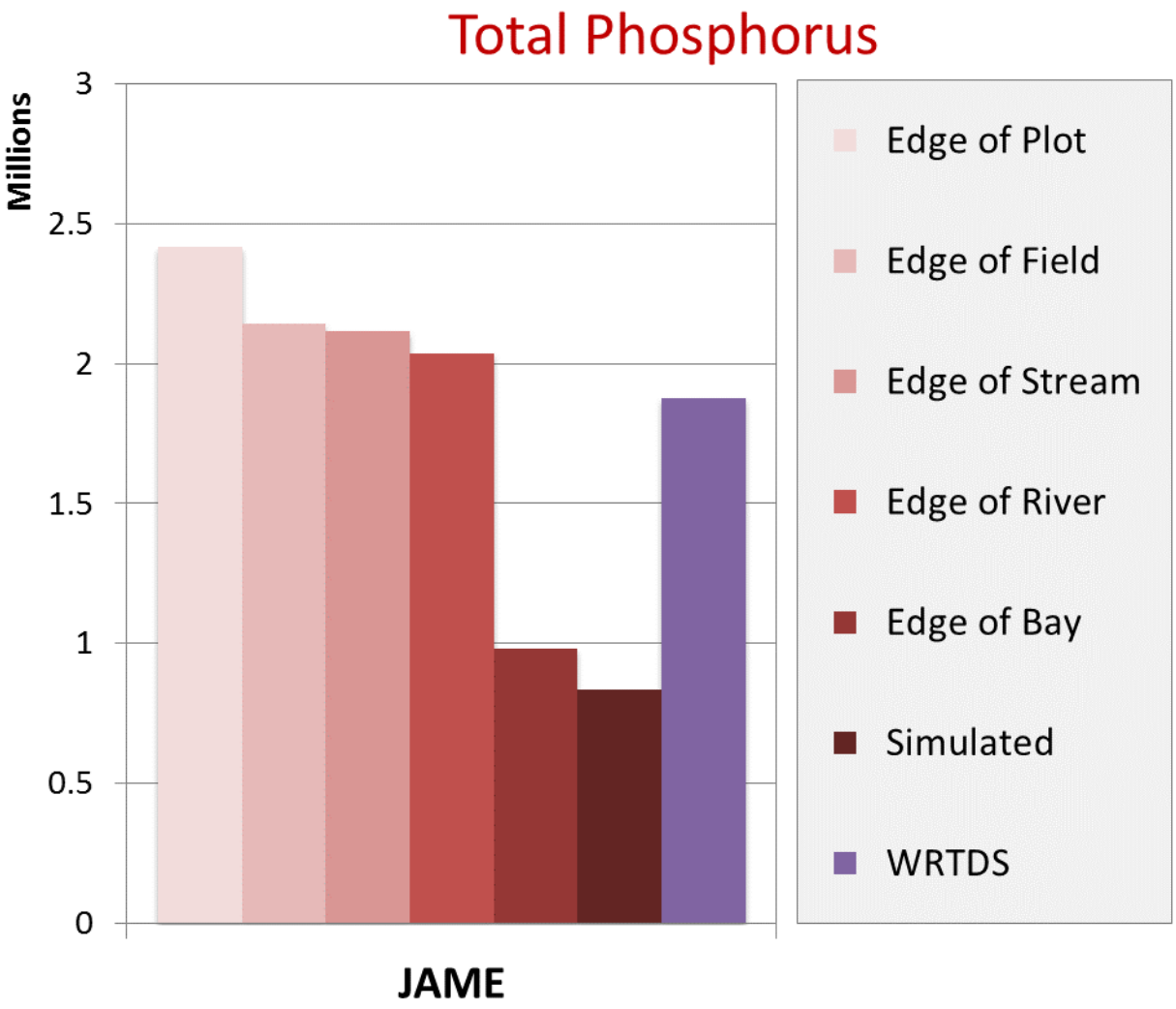
mcn	MS4 Construction
ccn	CSS Construction
abn	Abandoned Mines
ext	Active Mines
nnr	Non-Regulated Buildings and Other
nir	Non-Regulated Roads
nci	Non-Regulated Tree Canopy over impervious
mci	MS4 Tree Canopy over Impervious
mnr	MS4 Buildings and Other
mir	MS4 Roads
cir	CSS Roads
cci	CSS Tree Canopy over Impervious
cnr	CSS Buildings and Other
nch	Non-Regulated Tree Canopy over Herbaceous
ncs	Non-Regulated Tree Canopy over Scrub Shrub
ntg	Non-Regulated Turf Grass
mch	MS4 Tree Canopy over Herbaceous
mcs	MS4 Tree Canopy over Scrub Shrub
mtg	MS4 Turf Grass
cch	CSS Tree Canopy over Herbaceous
ccs	CSS Tree Canopy over Scrub Shrub
ctg	CSS Turf Grass

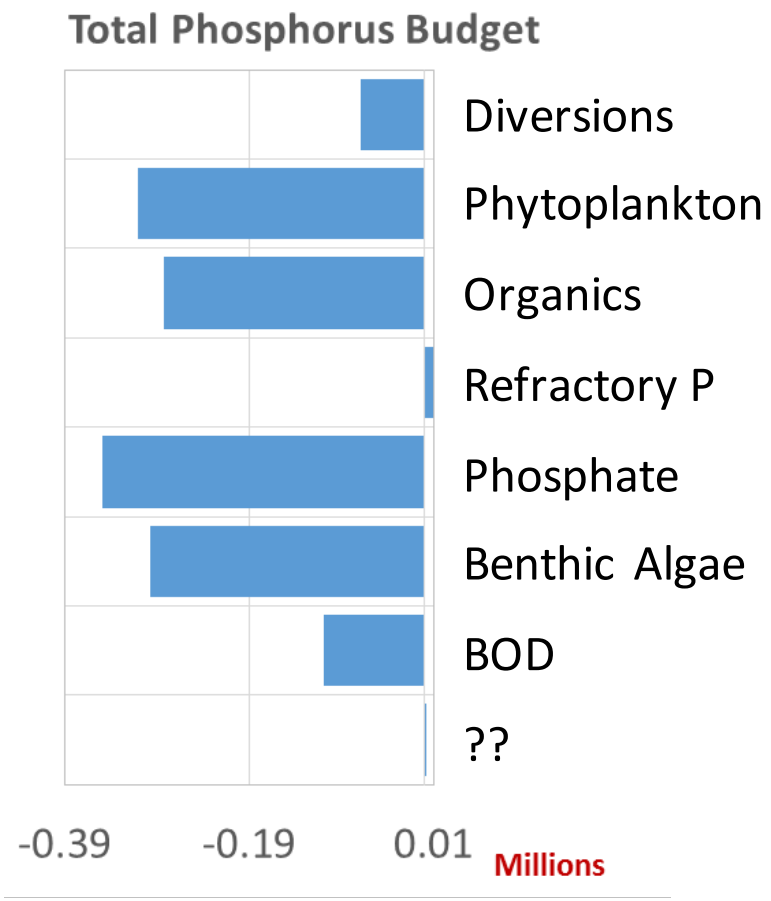

Total Nitrogen
Millions
200
180
160
140
120
100
80
60
40
20
-
EOF-global target
EOF-target
EOSS
SIMULATED
WRTDS
SUSQ
POTO
JAME
RAPP
APPO
PAMU
MATT
PATU
CHOP


Total Phosphorus
Millions
10
9
8
7
6
5
4
3
2
1
-
EOSS-global target
EOSS-target
EOSS
SIMULATED
WRTDS
SUSQ
POTO
JAME
RAPP
APPO
PAMU
MATT
PATU
CHOP

Phosphorus budget for James River System







Regional factors – four options

Gary Shenk

1. No regional factors – completely explained by inputs, but the match is not quite as good as P5 (probably)
2. No regional factors, but load the WQSTM with WRTDS – best argument for RFs is to get the estuarine model correct. This would take care of that.
3. Regional factors – better match than p5, but there is still some unexplained difference in loads
4. Regional factors that apply to the calibration targets – same reasons as #2, but the sensitivity to inputs won't be affected by these RFs