Geographic Isolation Runs

Gary Shenk and Richard Tian
CBPO
Modeling Workgroup
11/28/17

Geographic Isolation Runs

- Sets exchange ratios
  - States can choose to reduce more N and less P or vice versa in their WIPs
- Part of relative effectiveness
  - Geo Iso runs are (DO improvement) / (lb delivered)
  - Multiplied by (lb delivered) / (lb produced

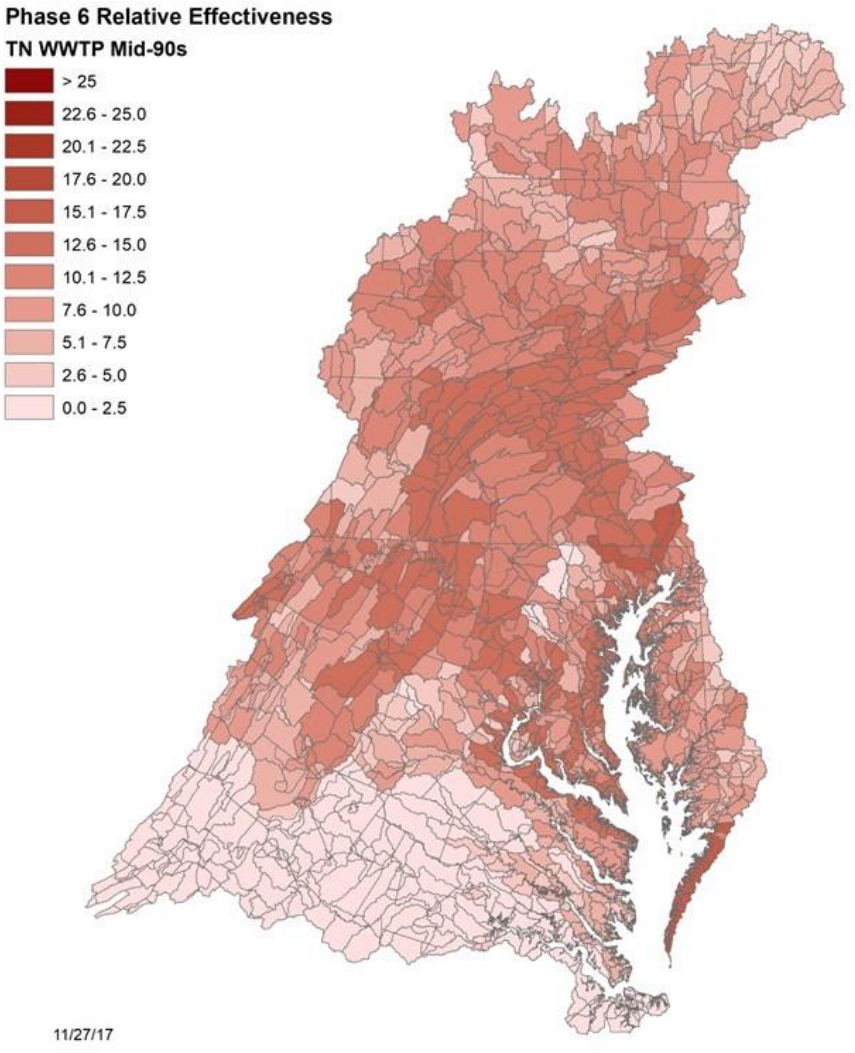
Relative Effectiveness

Key factors:

Watershed Transport
- Watershed Characteristics
- Travel time
- Existence of impoundments

Position along mainstem bay
- Estuarine circulation

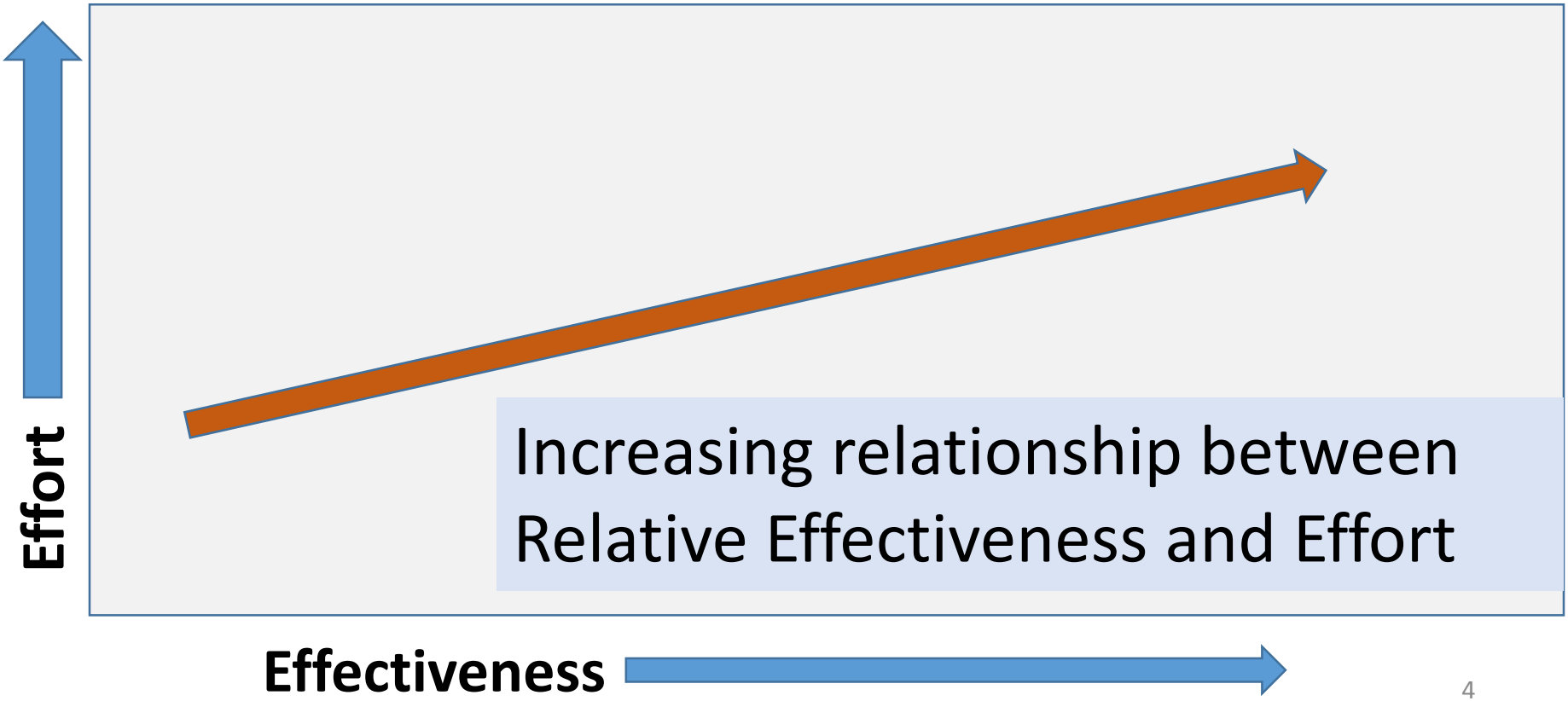
Existence of riverine estuary

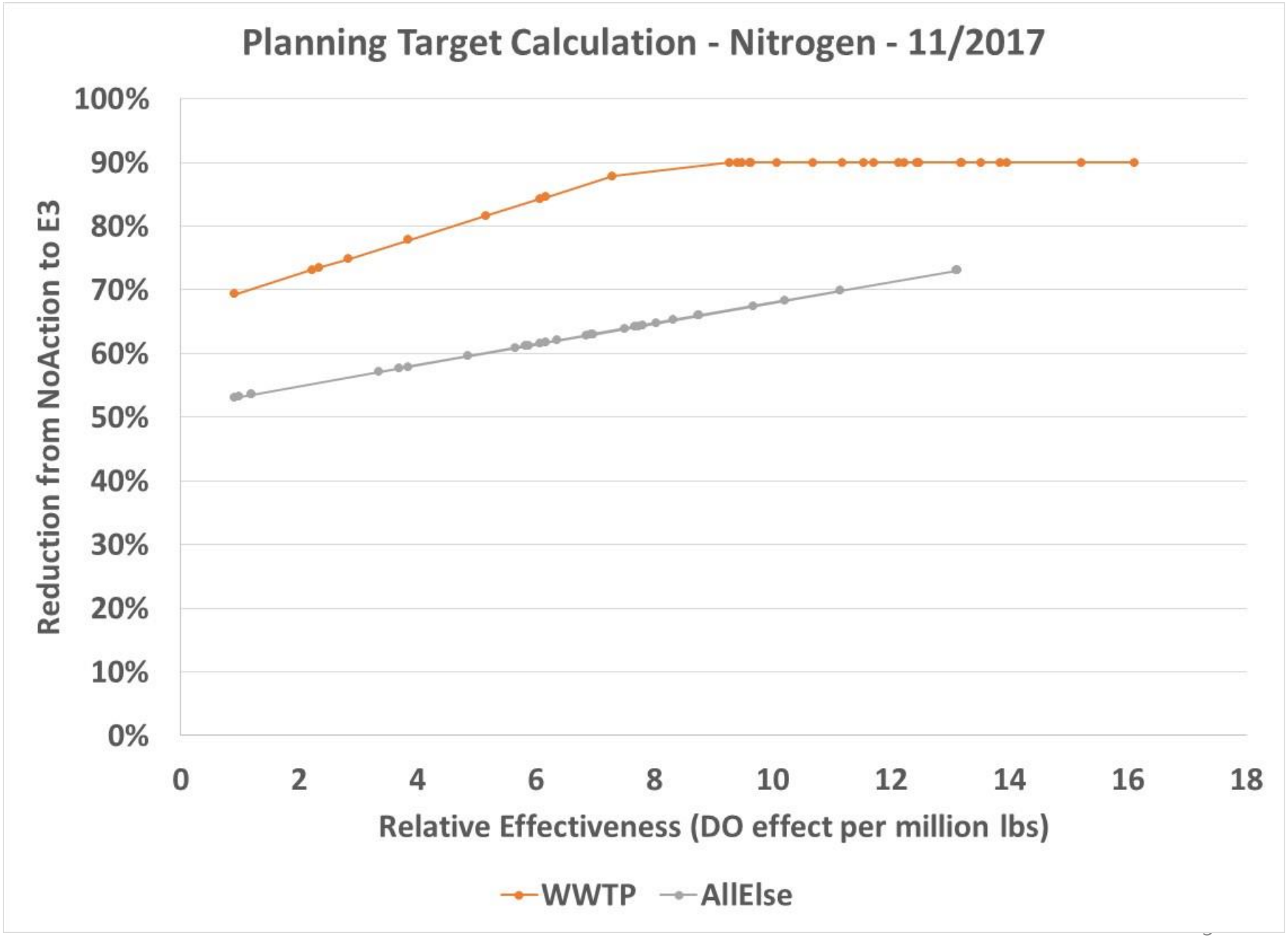


Watershed delivery:
Pound delivered per pound produced
Estuarine delivery
Oxygen reduced per pound delivered
Overall Effectiveness
Oxygen reduced per pound produced

Guidelines for Planning Targets

- Areas that contribute the most to the problem must do the most to resolve the problem.




Planning Target Calculation - Nitrogen - 11/2017
Reduction from NoAction to E3
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2
4
6
8
10
12
14
16
18
Relative Effectiveness (DO effect per million lbs)
WWTP
AllElse

Method

- Increase nitrogen by 1,000,000 lbs for a single basin
- Increase is implemented by multiplying each cell and day by the same factor
- Record the change in the 25th percentile of DO for each designated use
- Express result in terms of ug/l increase per million lbs TN
- Repeat for all basins
- Repeat using 100,000 lbs phosphorus

Nitrogen geo runs for Deep Water

Numbers are the 25th percentile of DO in mg/l for deep water in the model

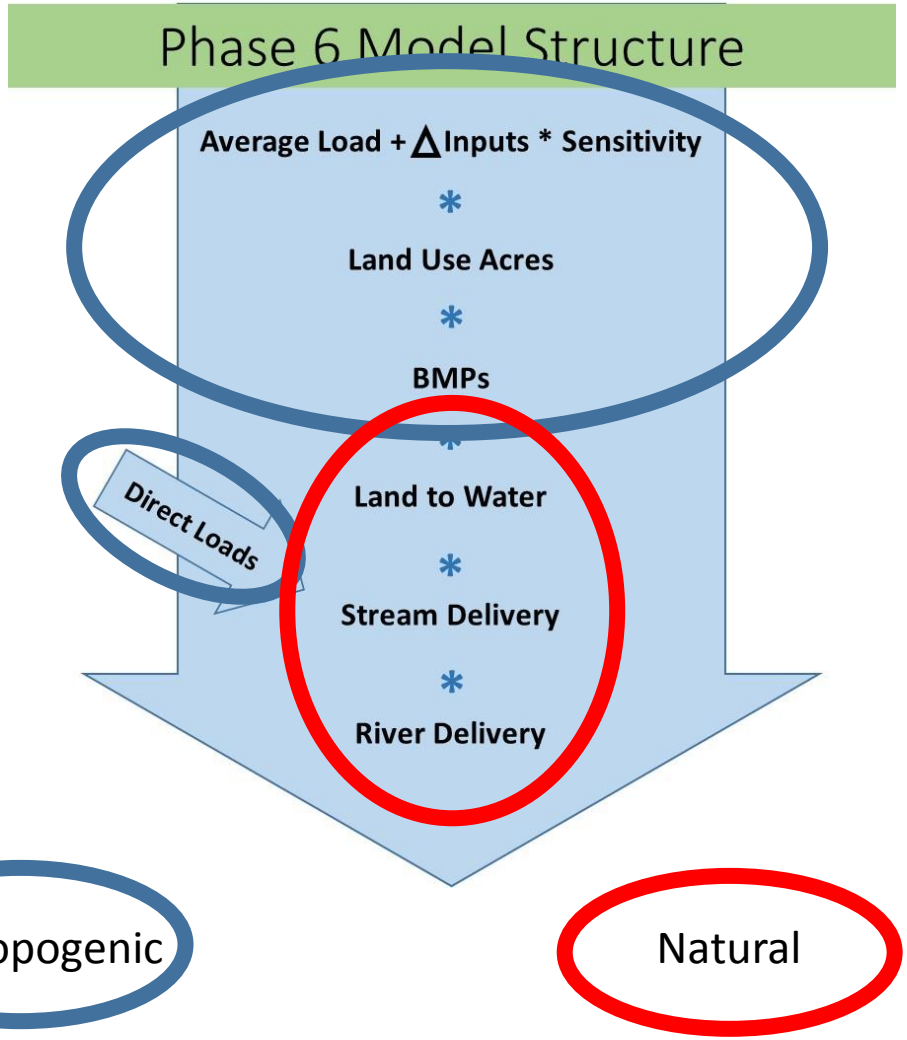
cbseg	2010WIP2_	Susq_N_n	JmsA_N_r	PotA_N_n	PxtA_N_n
CB3MH	3.39408	3.37855	3.39342	3.38322	3.38508
CB4MH	3.68027	3.66234	3.67711	3.66643	3.66859
CB6PH	5.39535	5.38879	5.39405	5.38922	5.39093
CB7PH	5.58111	5.57642	5.58007	5.57685	5.57789
CHSMH	3.16472	3.14495	3.16025	3.15244	3.15367
EASMH	1.74646	1.72349	1.74153	1.73284	1.73393
MA1MH	7.09061	7.08972	7.09053	7.09002	7.09005
MAGMH	7.01157	7.01941	7.01781	7.0171	7.01704
MD5MH	4.33992	4.32366	4.33667	4.32565	4.32847
MOBPH	6.72154	6.72086	6.7213	6.72083	6.72108
PA1MH	6.31824	6.31213	6.31749	6.31497	6.30117
PA2MH	3.9999	3.98098	4.00004	3.99298	3.88382
PATMH	3.41126	3.40115	3.41344	3.40829	3.40887
POMMH	5.99382	5.98733	5.99412	5.98682	5.98954
POVMH	6.72134	6.72397	6.72837	6.73199	6.72604
RPPMH	5.89315	5.88445	5.89209	5.88429	5.88716
SBEMH	4.9063	4.90157	4.85567	4.90149	4.90303
SEVMH	7.08791	7.09118	7.09013	7.09017	7.09014
SOUMH	7.53718	7.54641	7.53965	7.54127	7.54108
VA5MH	5.33635	5.3258	5.33445	5.32619	5.32918
YRKPH	5.21596	5.20959	5.21415	5.20941	5.21148

List of basins (MWG 8/9/2017)

- Susquehanna
- Western Shore
- Patuxent AFL
- Patuxent BFL
- Potomac AFL
- Potomac BFL
- Rappahannock AFL
- Rappahannock BFL
- York AFL
- York BFL
- James AFL
- James BFL
- Upper Eastern Shore
- Middle Eastern Shore
- Lower Eastern Shore
- Eastern Shore Virginia

Watershed Delivery

- Pound delivered per pound produced
- Factor out anthropogenic effects and just include watershed delivery
- WWTP have higher delivery because they tend to be on large rivers in the lower sections of basins



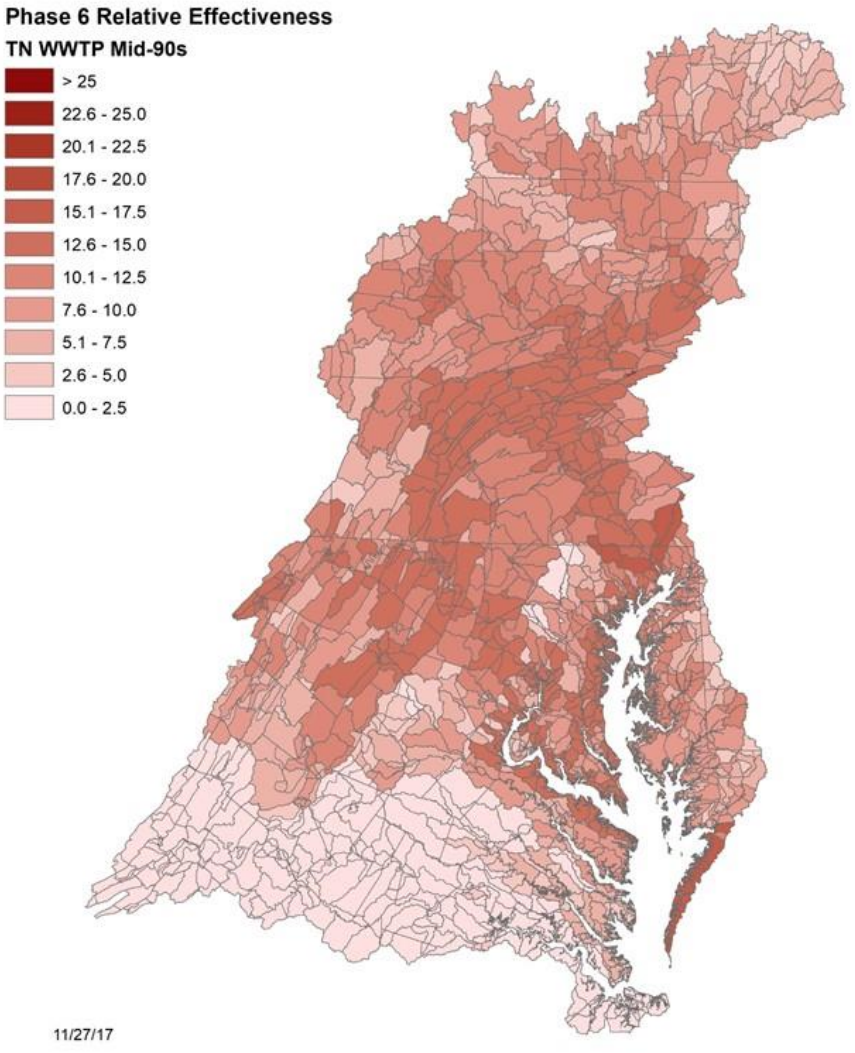
Relative Effectiveness

Key factors:

Watershed Transport
- Watershed Characteristics
- Travel time
- Existence of impoundments

Position along mainstem bay
- Estuarine circulation

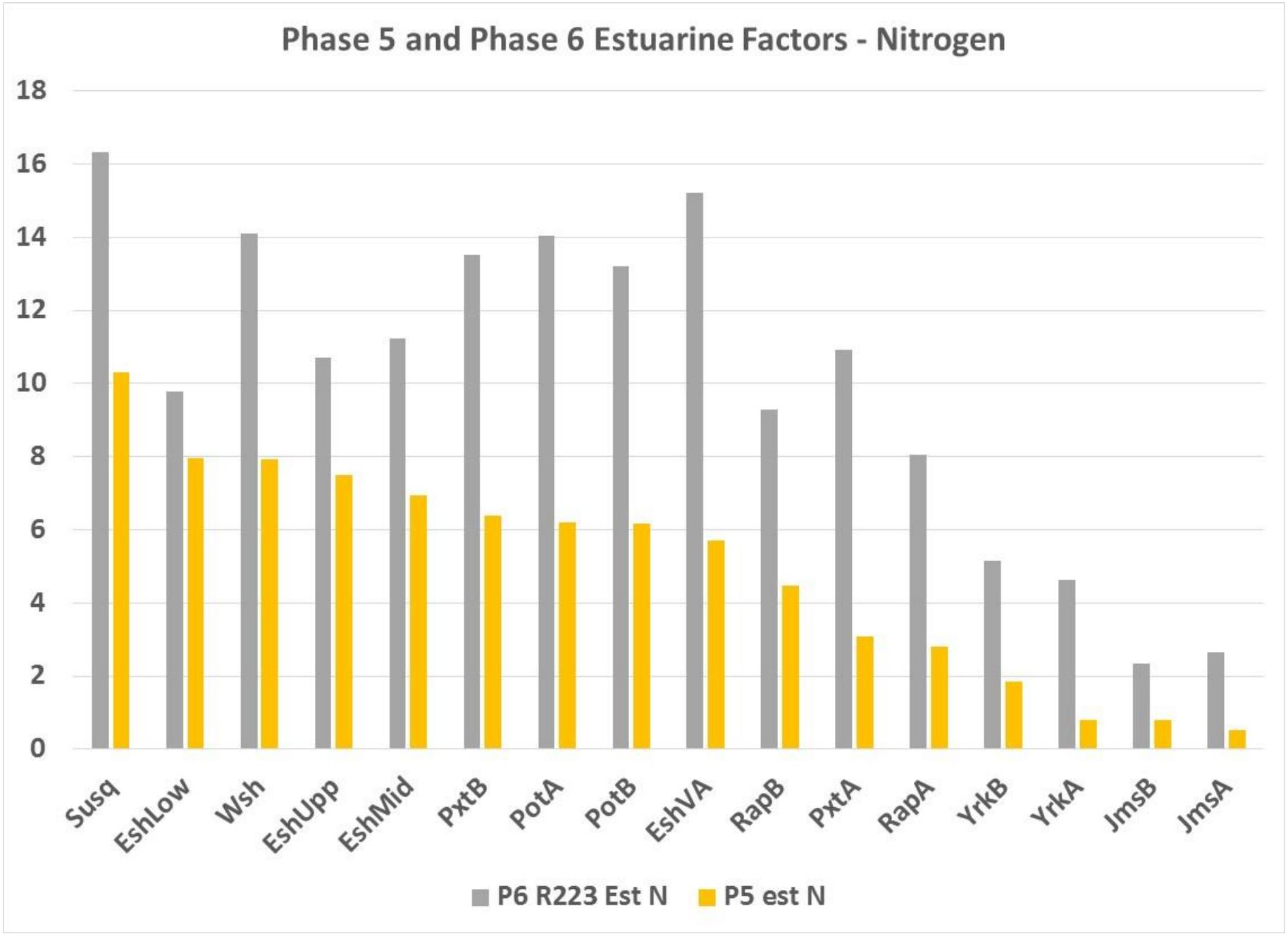
Existence of riverine estuary

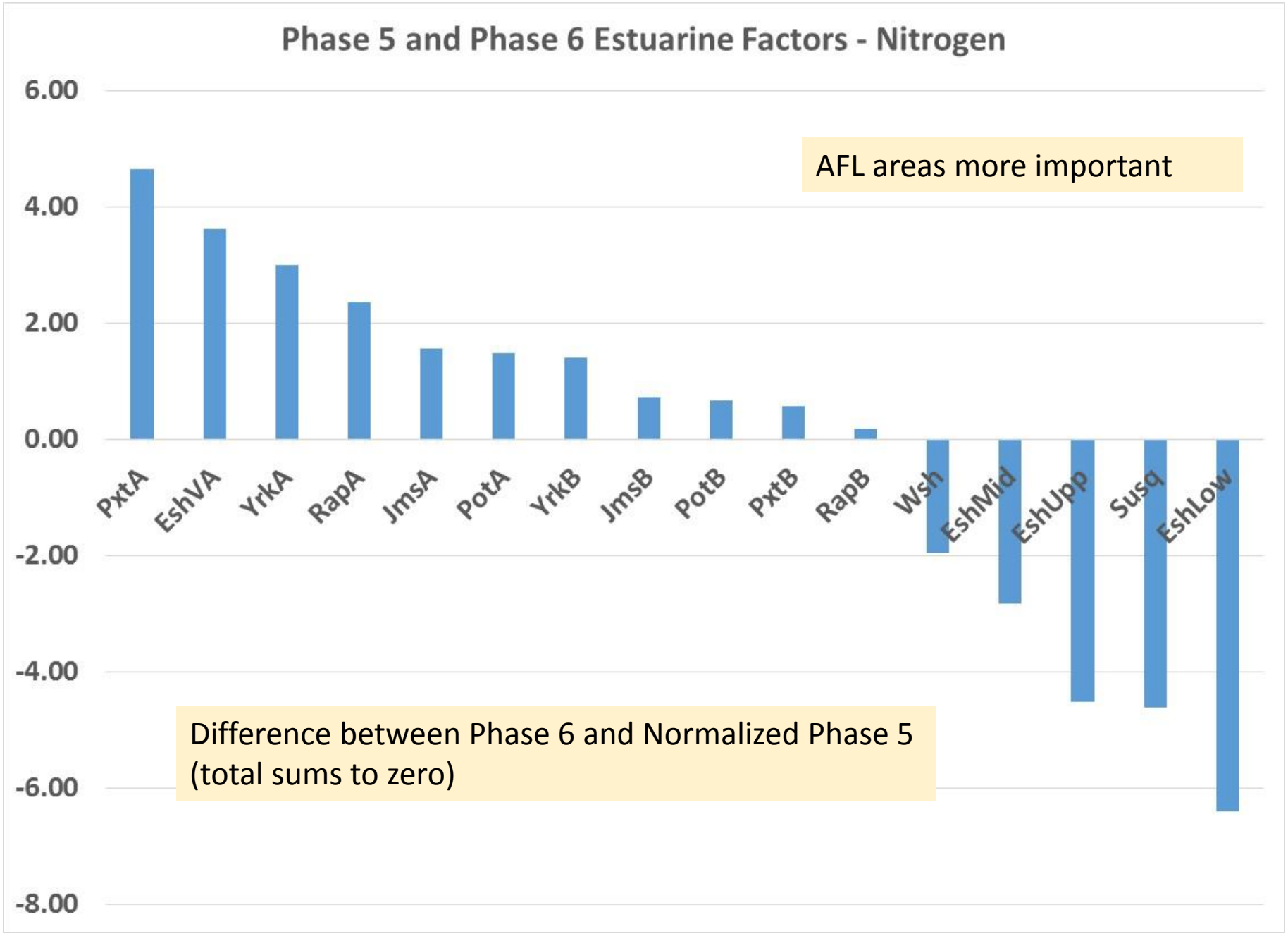


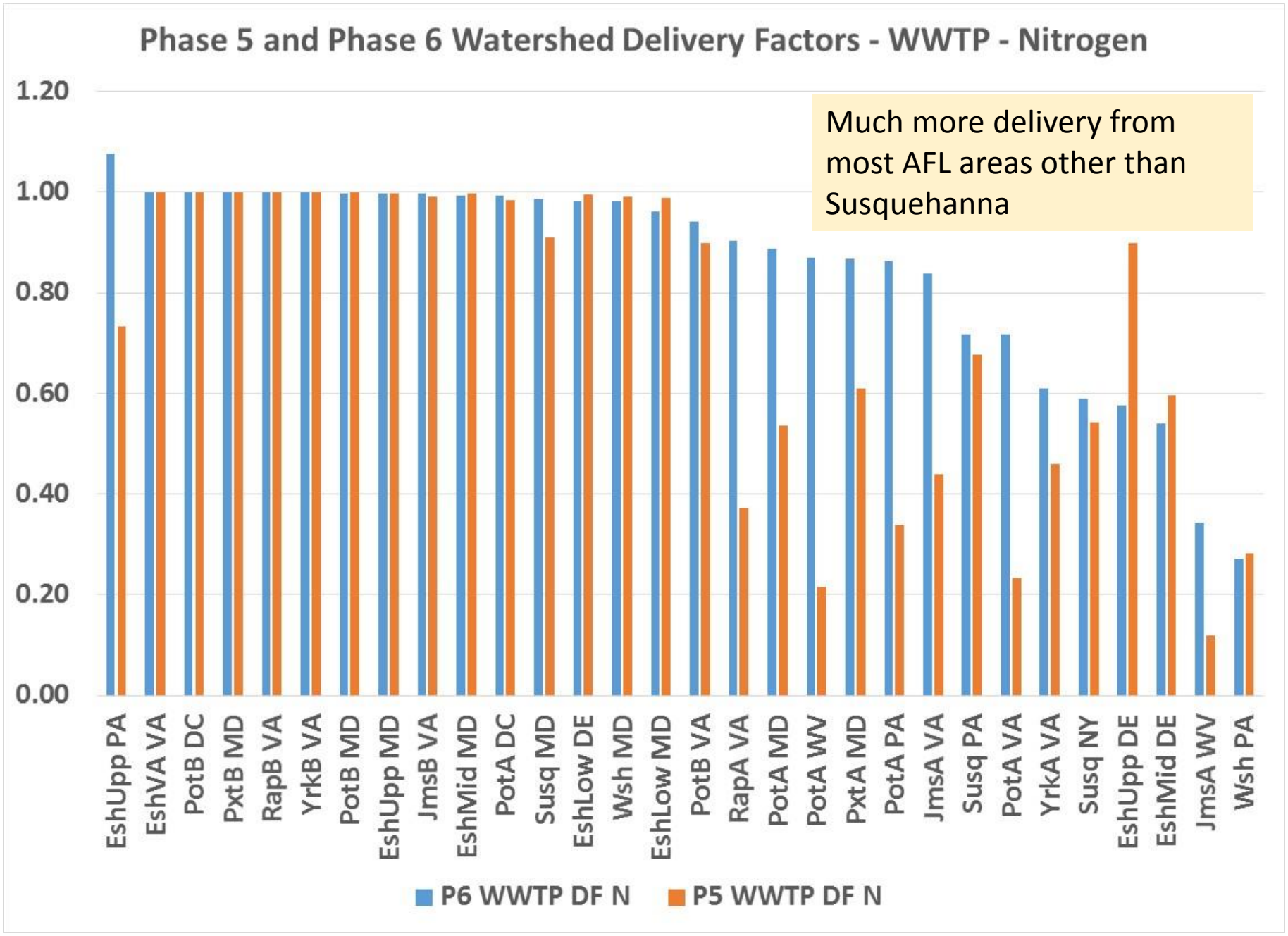
Watershed delivery:
Pound delivered per pound produced
Estuarine delivery
Oxygen reduced per pound delivered
Overall Effectiveness
Oxygen reduced per pound produced

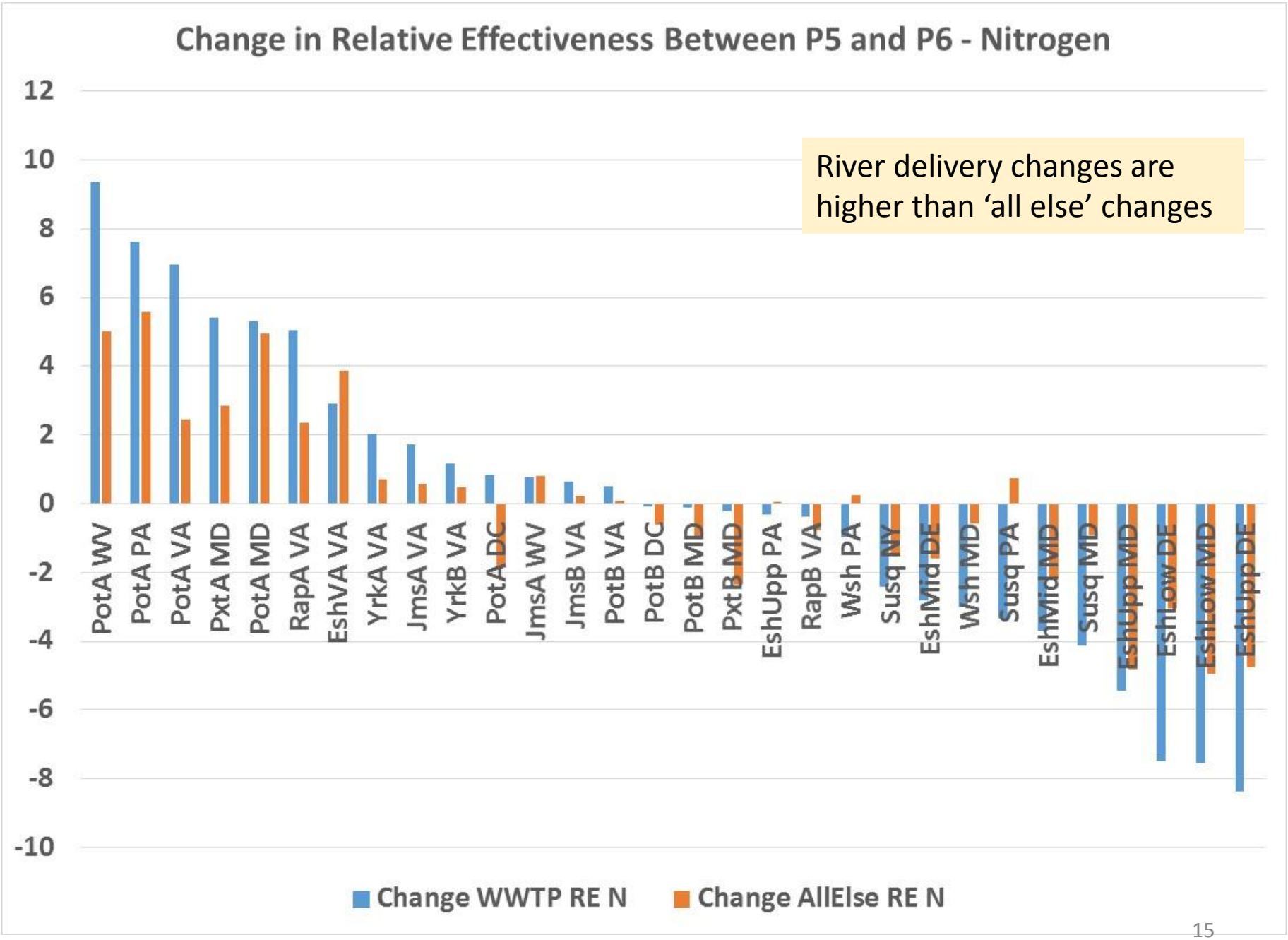
Schedule

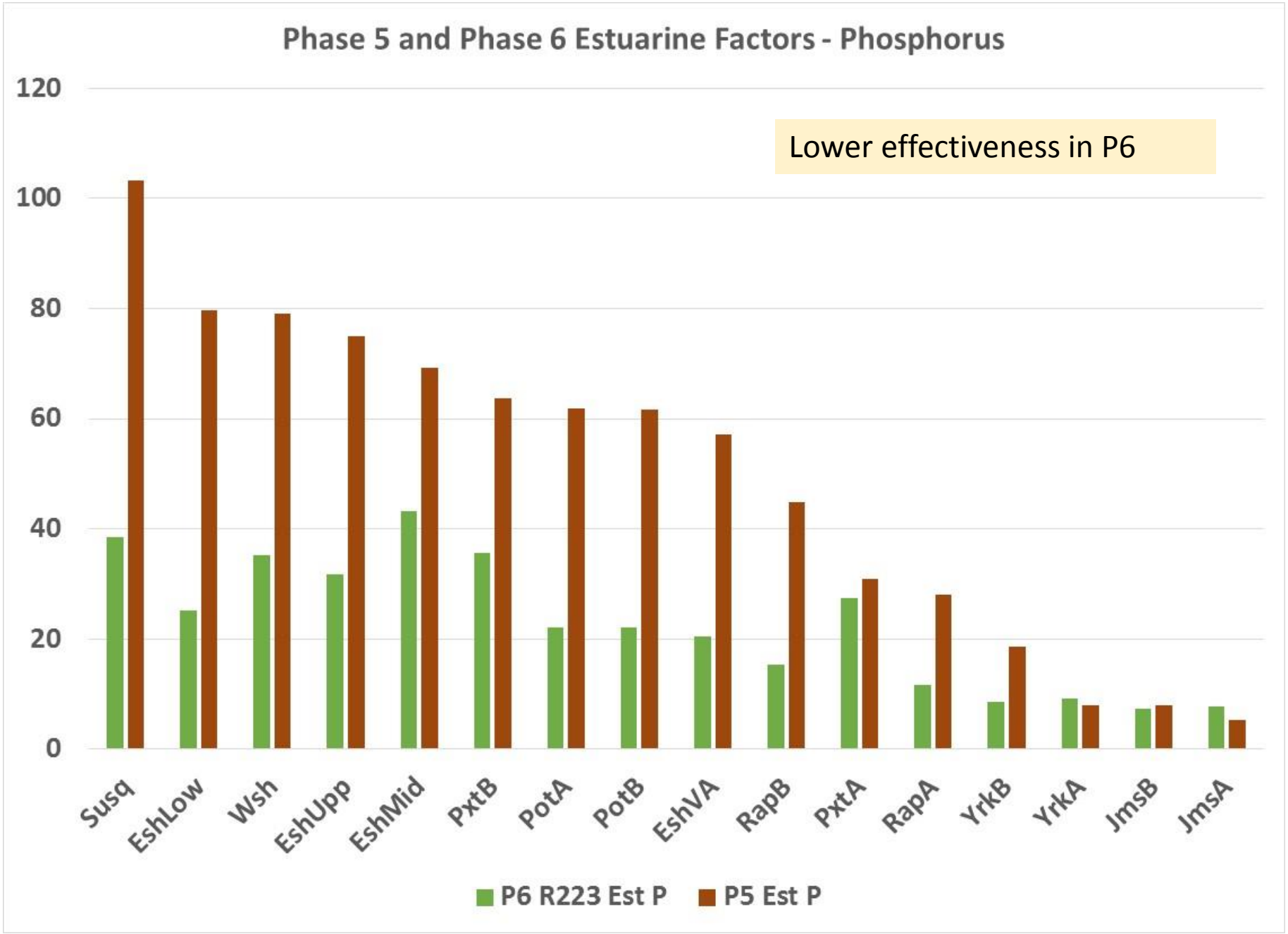
- First round of planning targets were based on
  - WQSTM run 199
  - September Draft P6
- Planning targets for 12/4 WQGIT and 12/19 PSC
  - WQSTM run 223
  - Final P6 for 2017 MPA

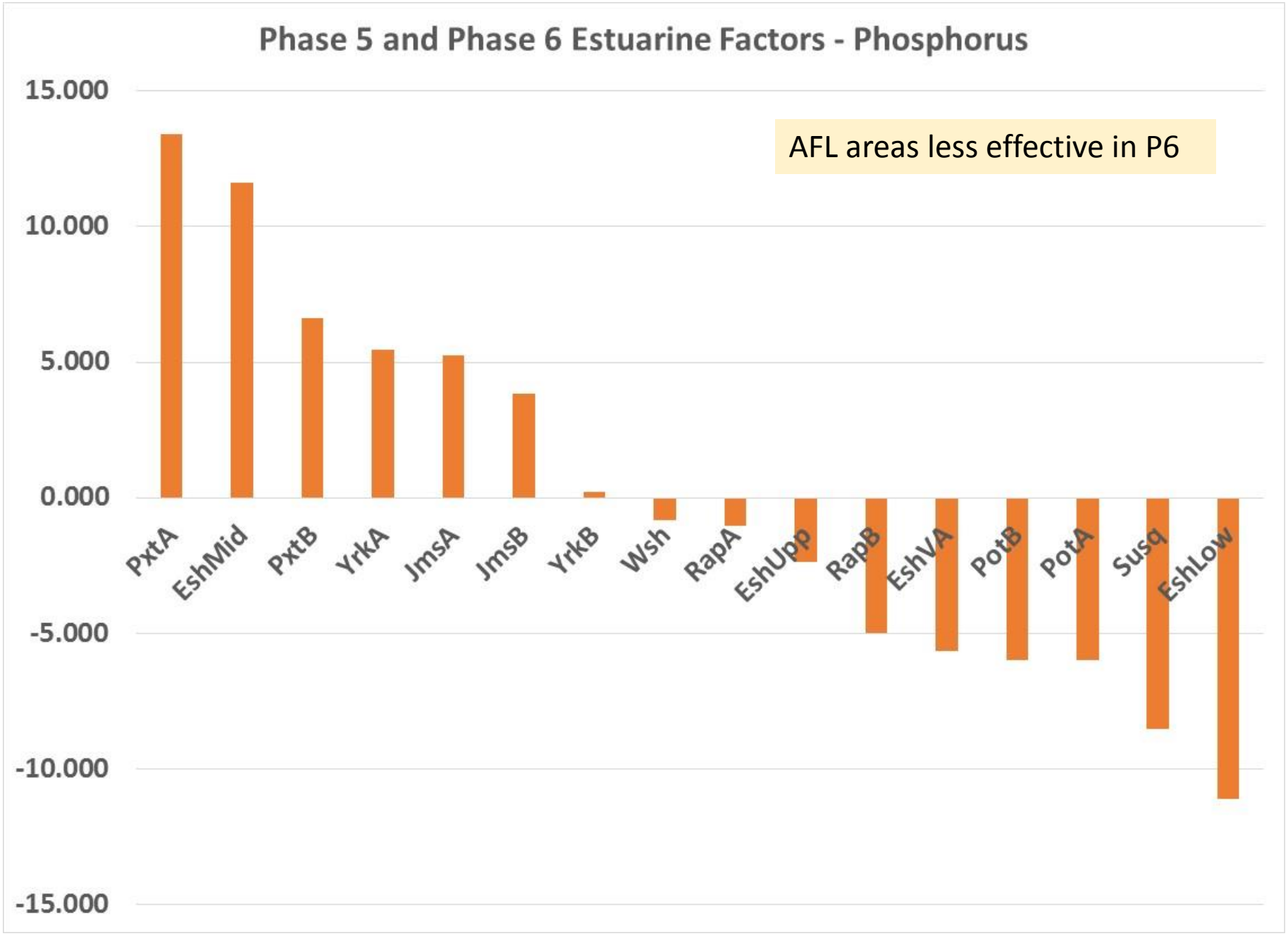

Phase 5 and Phase 6 Estuarine Factors - Nitrogen
18
16
14
12
10
8
6
4
2
0
Susq
EshLow
Wsh
EshUpp
EshMid
PxtB
PotA
PotB
EshVA
RapB
PxtA
RapA
YrkB
YrkA
JmsB
JmsA
P6 R223 Est N
P5 est N

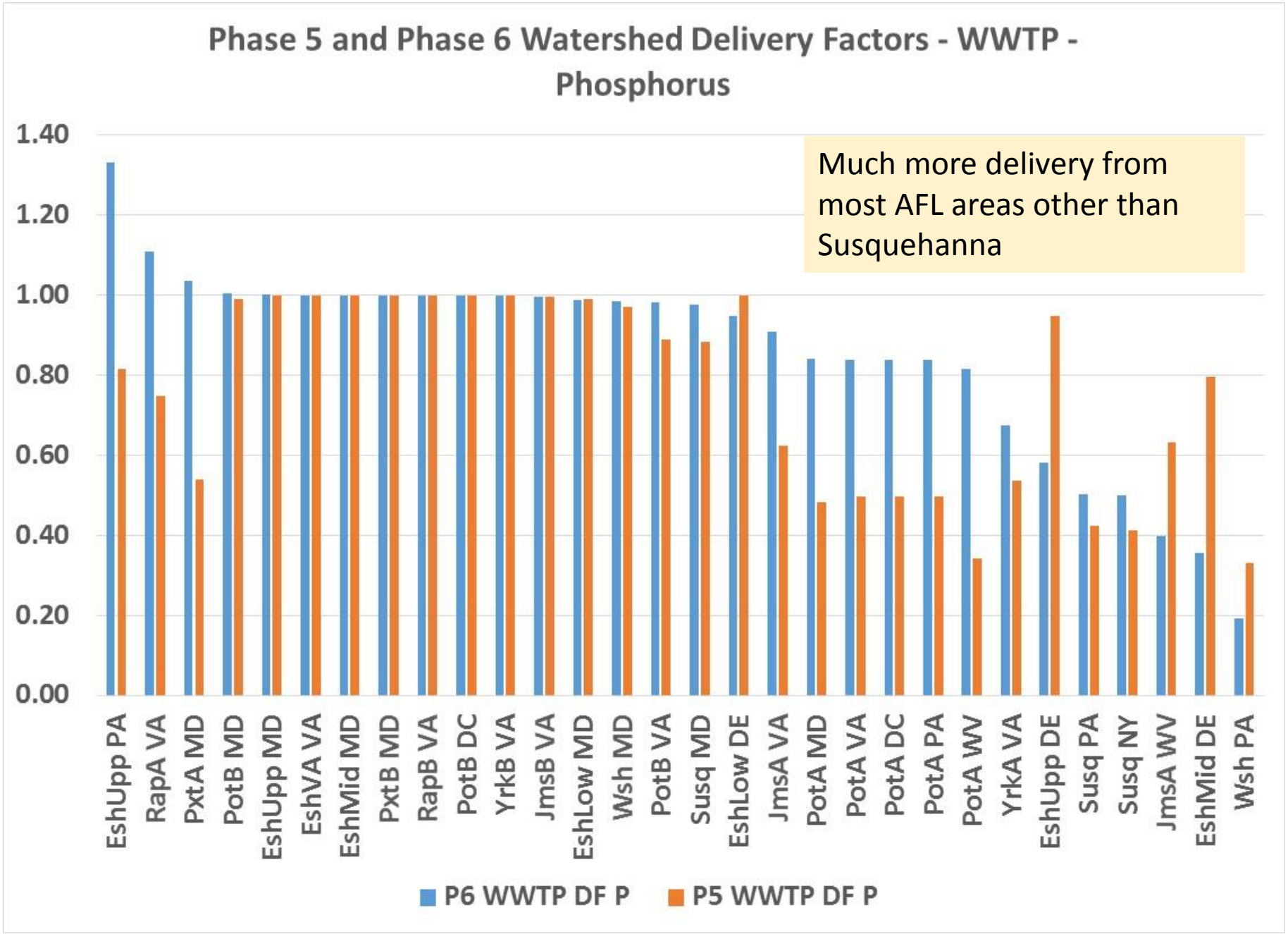

Phase 5 and Phase 6 Estuarine Factors - Nitrogen
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
PxtA
EshVA
YrkA
RapA
JmsA
PotA
YrkB
JmsB
PotB
PxtB
RapB
Wsh
EshMid
EshUpp
Susq
EshLow
AFL areas more important
Difference between Phase 6 and Normalized Phase 5
(total sums to zero)

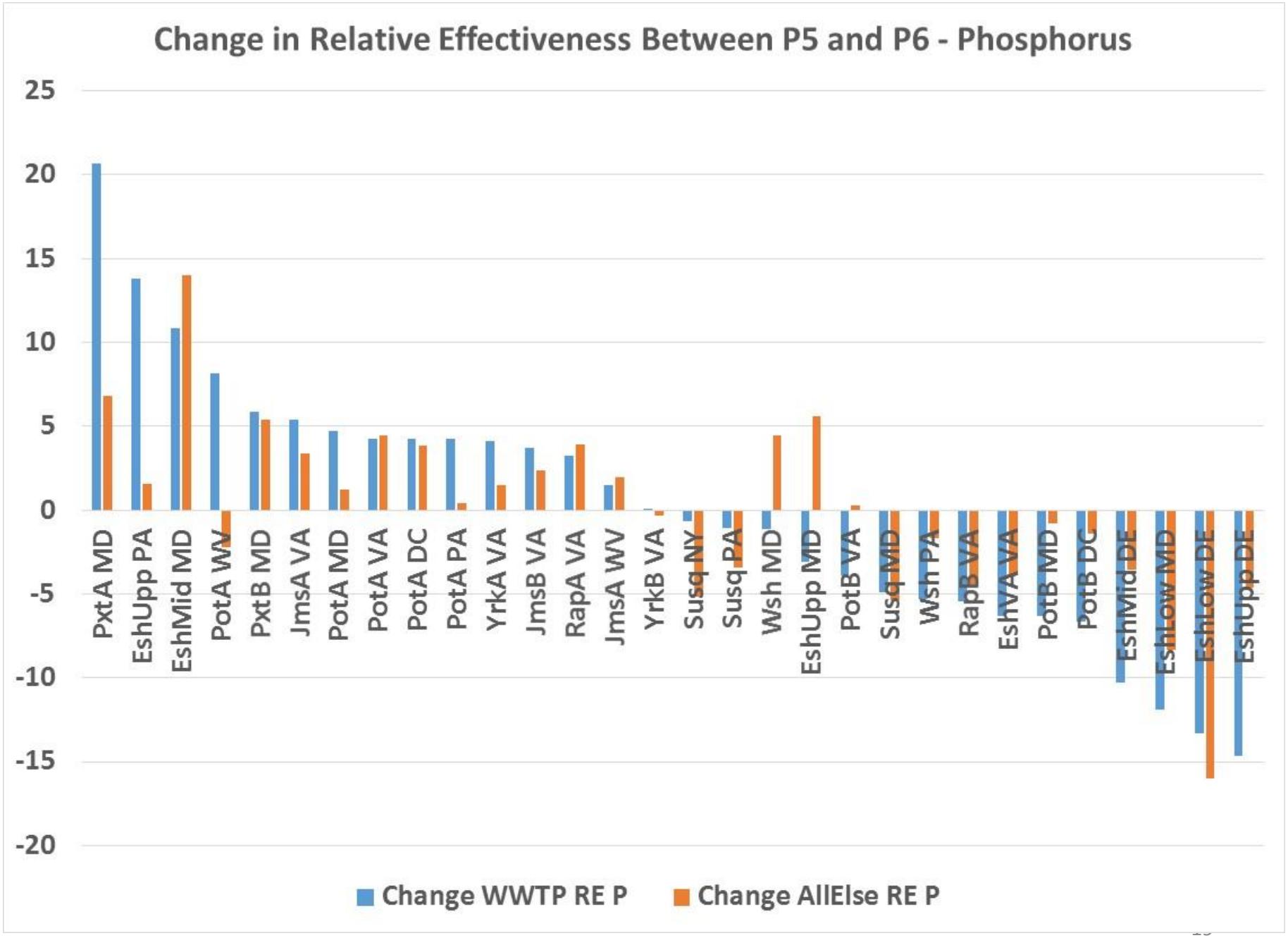

Phase 5 and Phase 6 Watershed Delivery Factors - WWTP - Nitrogen
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Much more delivery from most AFL areas other than Susquehanna
EshUpp PA
EshVA VA
PotB DC
PxtB MD
RapB VA
YrkB VA
PotB MD
EshUpp MD
JmsB VA
EshMid MD
PotA DC
Susq MD
EshLow DE
Wsh MD
EshLow MD
PotB VA
RapA VA
PotA MD
PotA WV
PxtA MD
PotA PA
JmsA VA
Susq PA
PotA VA
YrkA VA
Susq NY
EshUpp DE
EshMid DE
JmsA WV
Wsh PA
P6 WWTP DF N
P5 WWTP DF N

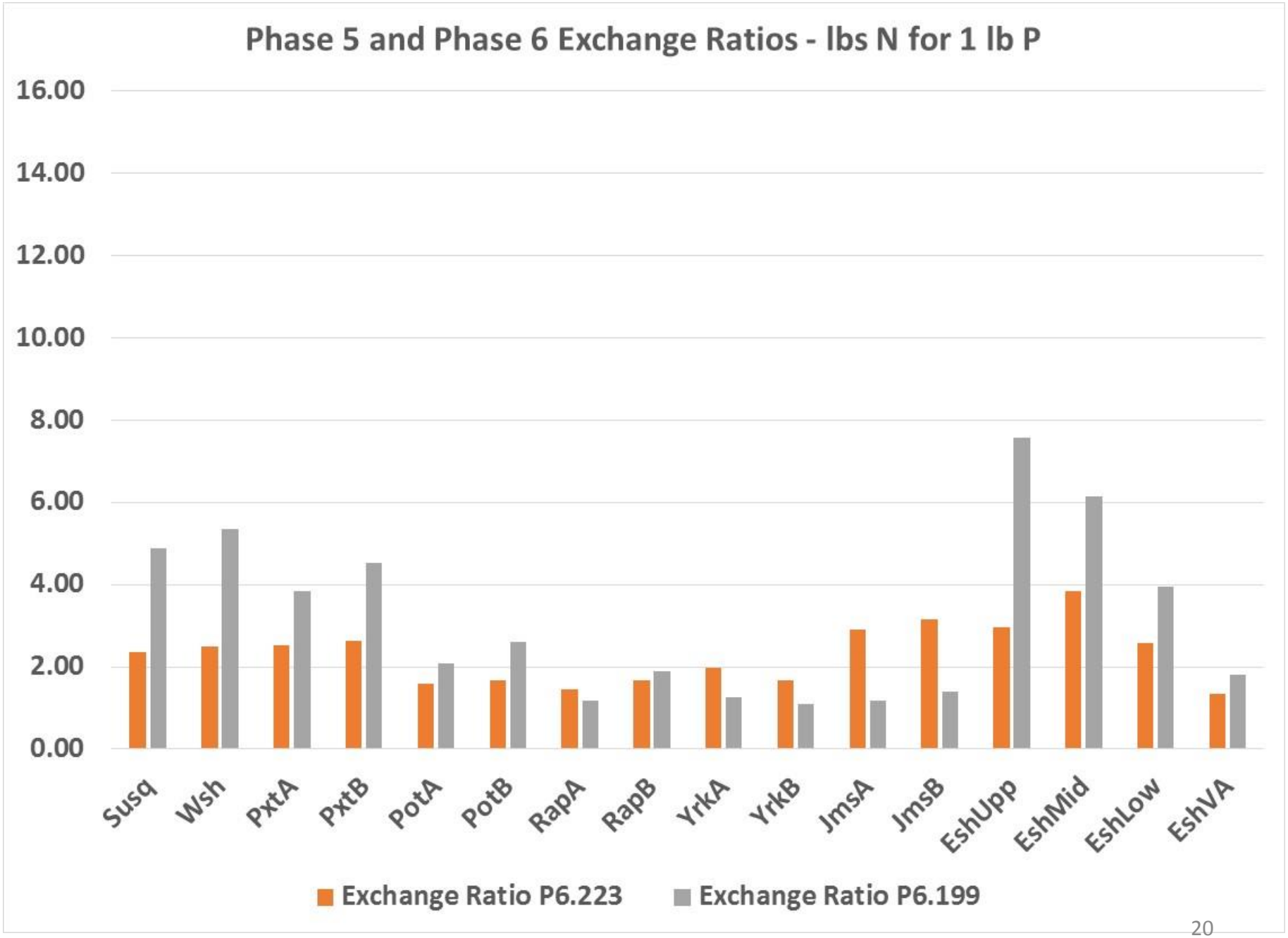

Change in Relative Effectiveness Between P5 and P6 - Nitrogen
River delivery changes are higher than 'all else' changes
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
PotA WV
PotA PA
PotA VA
PxtA MD
PotA MD
RapA VA
EshVA VA
YrkA VA
JmsA VA
YrkB VA
PotA DC
JmsA WV
JmsB VA
PotB VA
PotB DC
PotB MD
PxtB MD
EshUpp PA
RapB VA
Wsh PA
Susq NY
EshMid DE
Wsh MD
Susq PA
EshMid MD
Susq MD
EshUpp MD
EshLow DE
EshLow MD
EshUpp DE
Change WWTP RE N
Change AllElse RE N


Phase 5 and Phase 6 Estuarine Factors - Phosphorus
Lower effectiveness in P6
120
100
80
60
40
20
0
Susq
EshLow
Wsh
EshUpp
EshMid
PxtB
PotA
PotB
EshVA
RapB
PxtA
RapA
YrkB
YrkA
JmsB
JmsA
P6 R223 Est P
P5 Est P


Phase 5 and Phase 6 Estuarine Factors - Phosphorus
15.000
10.000
5.000
0.000
-5.000
-10.000
-15.000
AFL areas less effective in P6
PxtA
EshMid
PxtB
YrkA
JmsA
JmsB
YrkB
Wsh
RapA
EshUpp
RapB
EshVA
PotB
PotA
Susq
EshLow

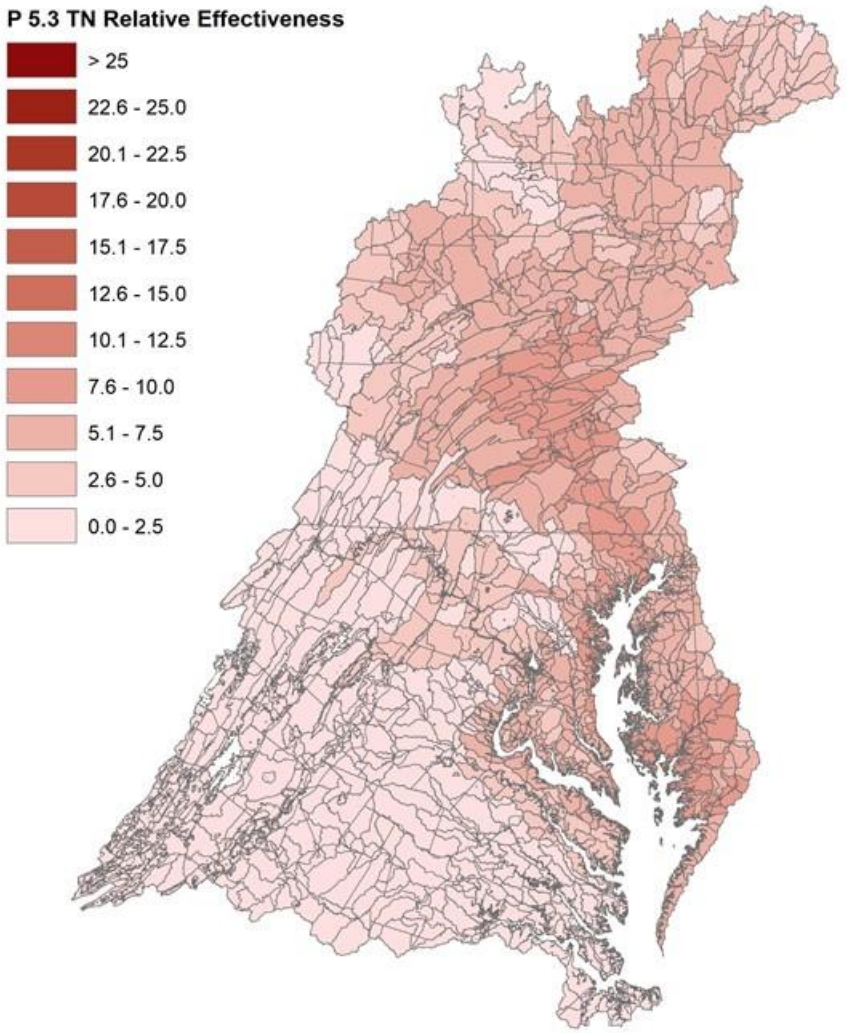

Phase 5 and Phase 6 Watershed Delivery Factors - WWTP - Phosphorus
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Much more delivery from most AFL areas other than Susquehanna
EshUpp PA
RapA VA
PxtA MD
PotB MD
EshUpp MD
EshVA VA
EshMid MD
PxtB MD
RapB VA
PotB DC
YrkB VA
JmsB VA
EshLow MD
Wsh MD
PotB VA
Susq MD
EshLow DE
JmsA VA
PotA MD
PotA VA
PotA DC
PotA PA
PotA WV
YrkA VA
EshUpp DE
Susq PA
Susq NY
JmsA WV
EshMid DE
Wsh PA
P6 WWTP DF P
P5 WWTP DF P


Change in Relative Effectiveness Between P5 and P6 - Phosphorus
25
20
15
10
5
0
-5
-10
-15
-20
PxtA MD
EshUpp PA
EshMid MD
PotA WV
PxtB MD
JmsA VA
PotA MD
PotA VA
PotA DC
PotA PA
YrkA VA
JmsB VA
RapA VA
JmsA WV
YrkB VA
Susq NY
Susq PA
Wsh MD
EshUpp MD
PotB VA
Susq MD
Wsh PA
RapB VA
EshVA VA
PotB MD
PotB DC
EshMid DE
EshLow MD
EshLow DE
EshUpp DE
Change WWTP RE P
Change AllElse RE P

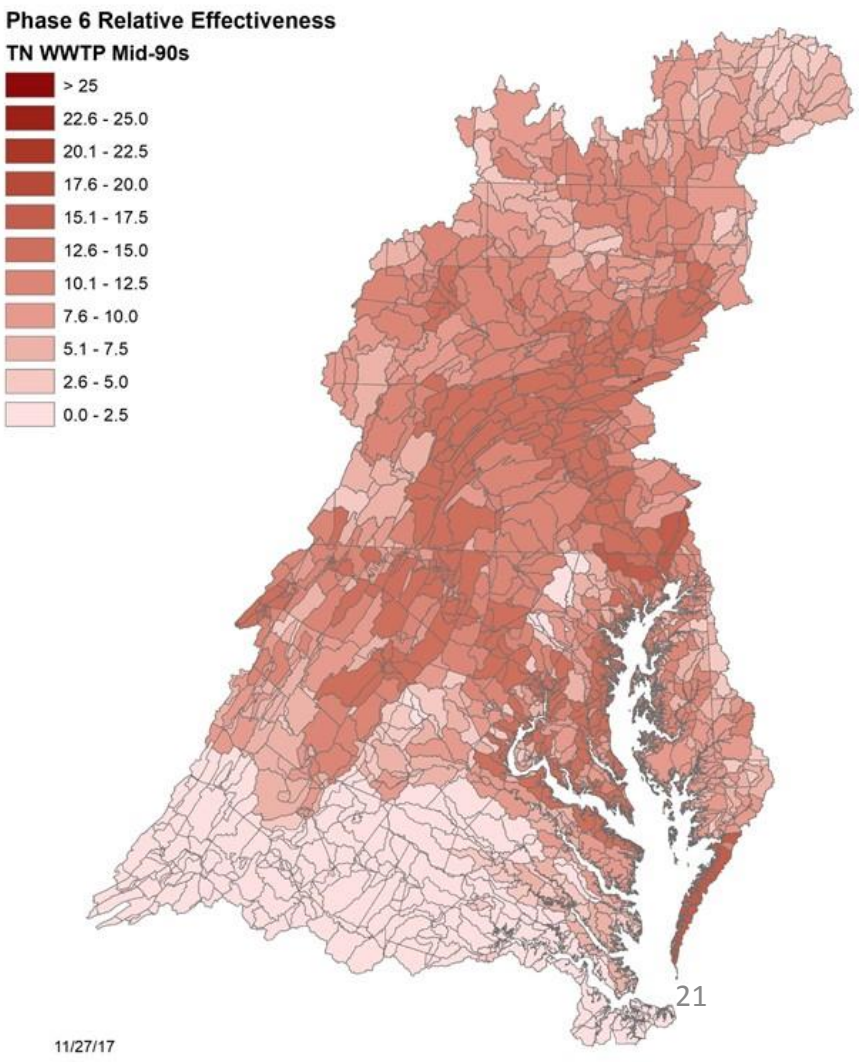

Phase 5 and Phase 6 Exchange Ratios - lbs N for 1 lb P
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Susq
Wsh
PxtA
PxtB
PotA
PotB
RapA
RapB
YrkA
YrkB
JmsA
JmsB
EshUpp
EshMid
EshLow
EshVA
Exchange Ratio P6.223
Exchange Ratio P6.199

Nitrogen Relative Effectiveness

P5

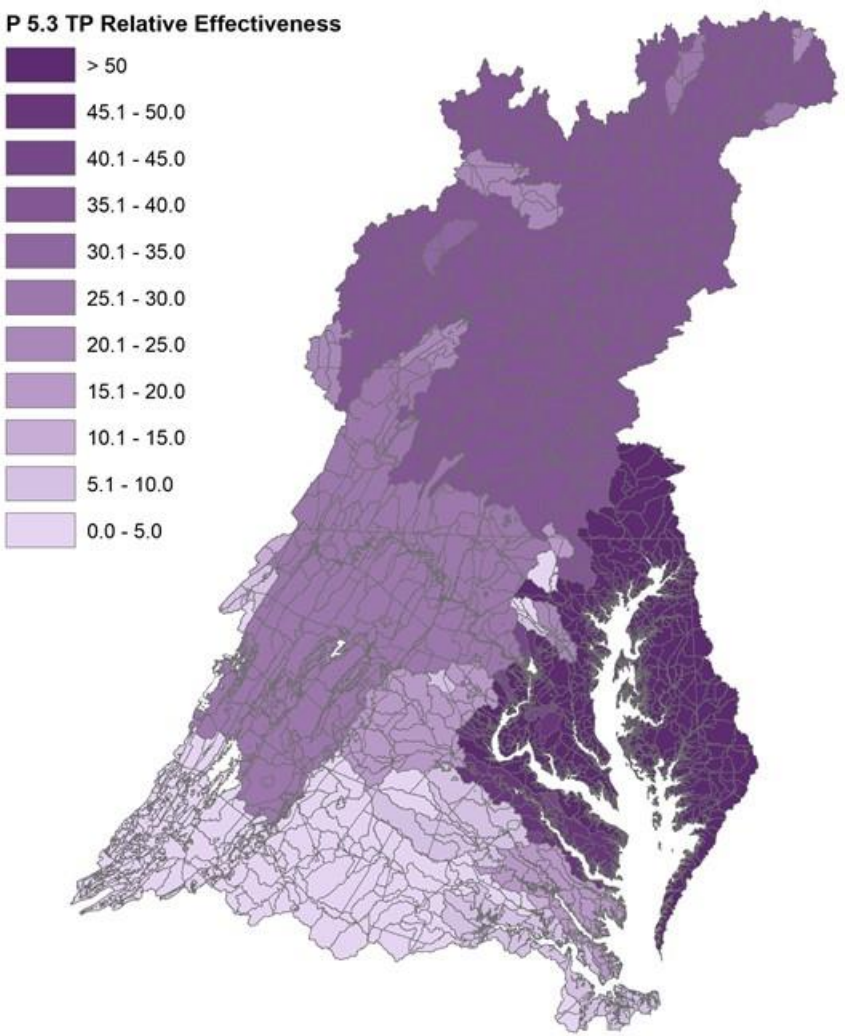


P6

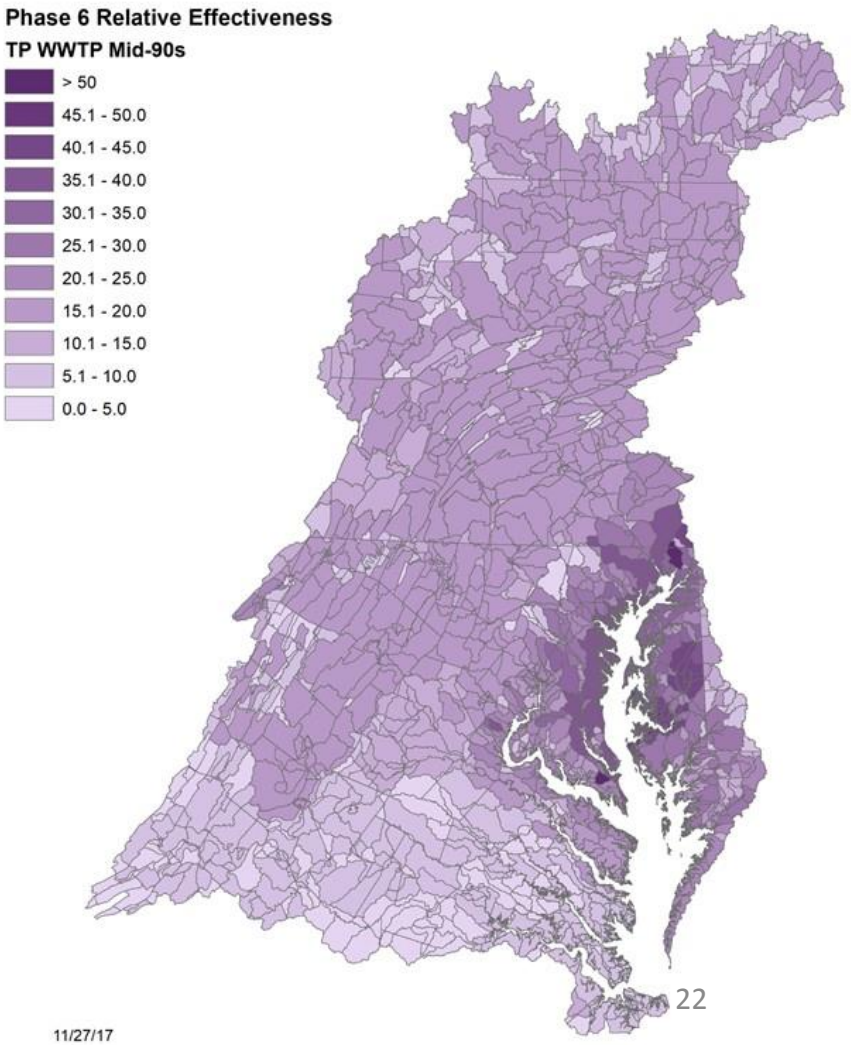


Phosphorus Relative Effectiveness

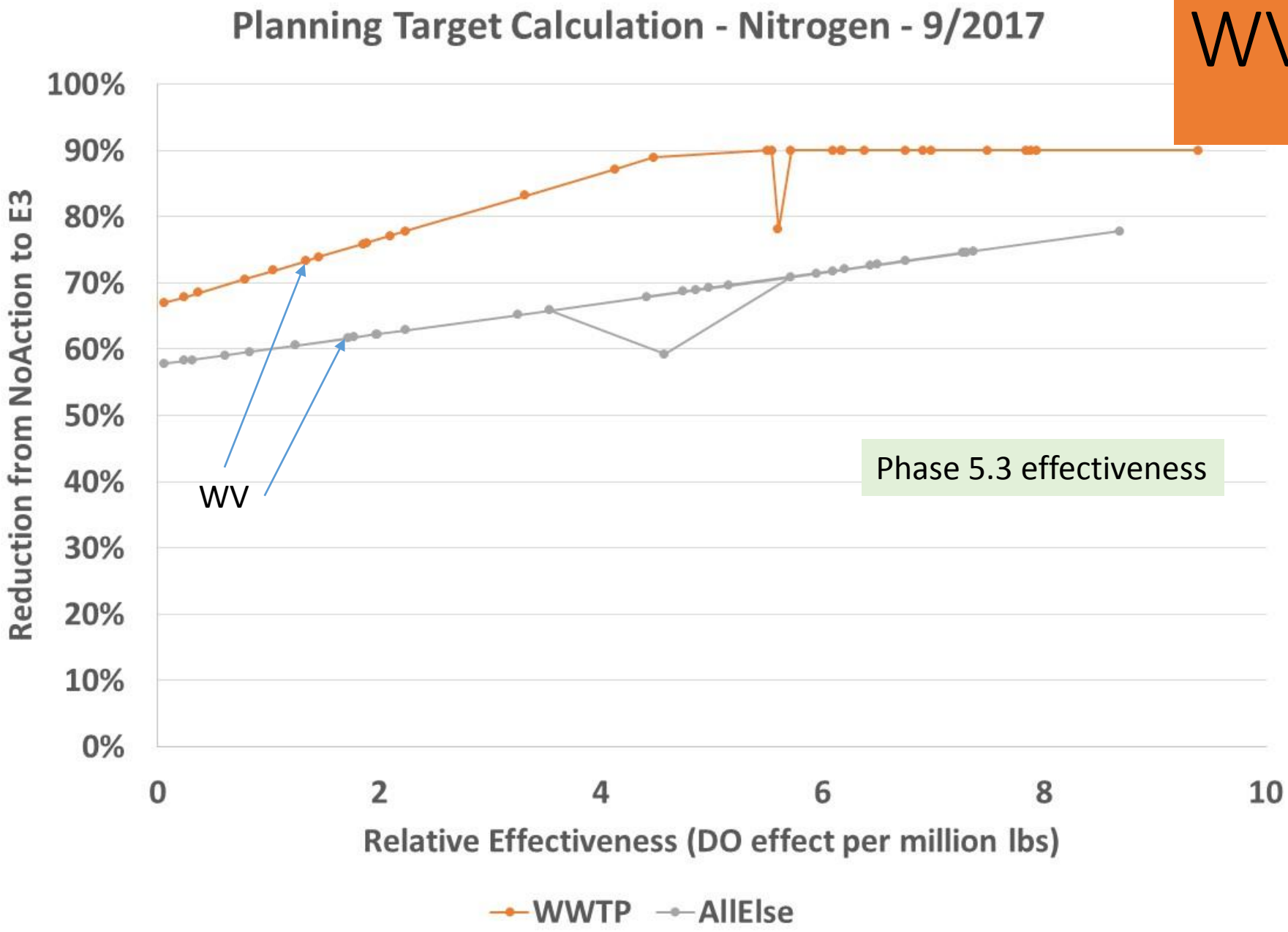
P5



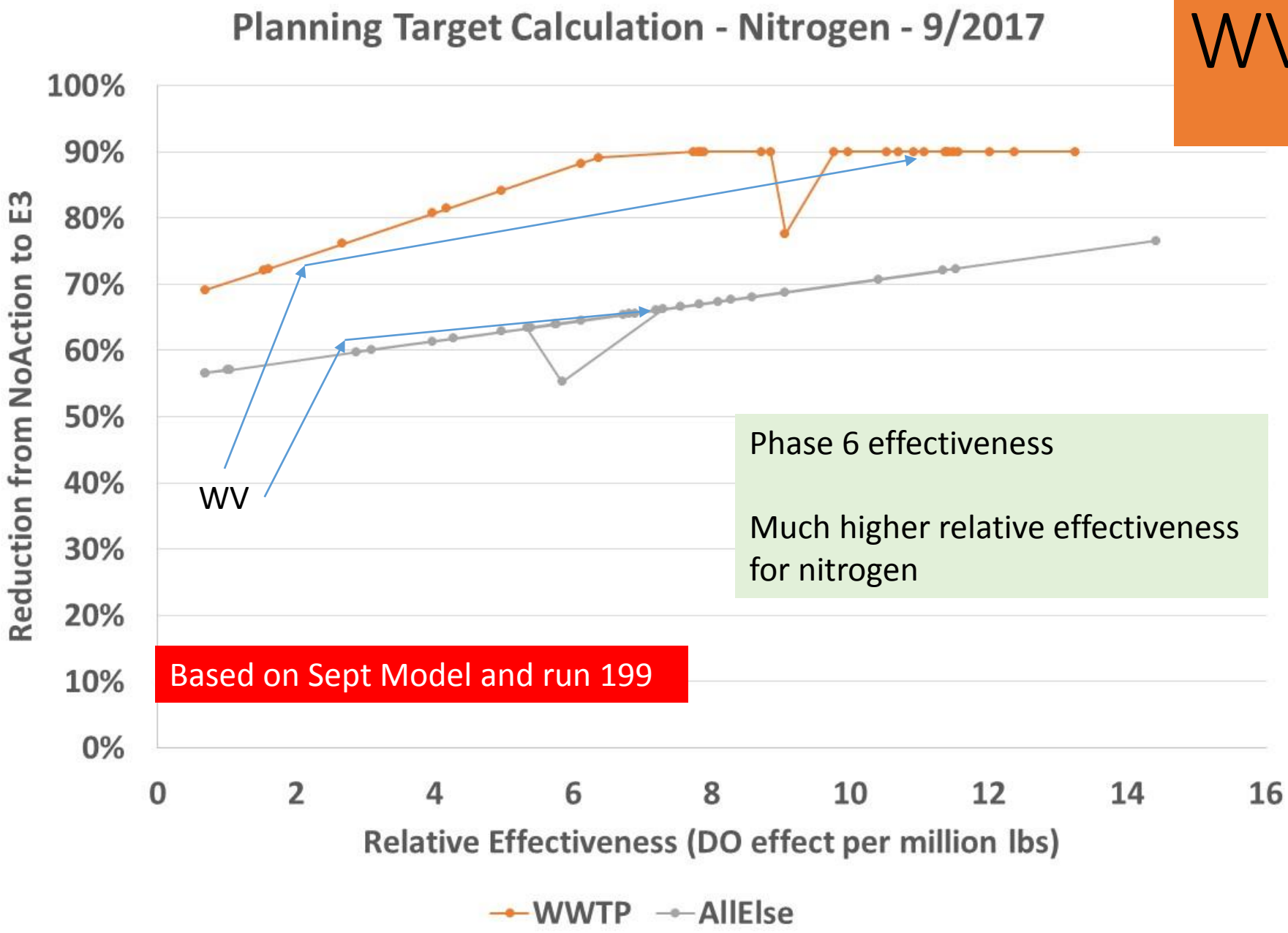
P6



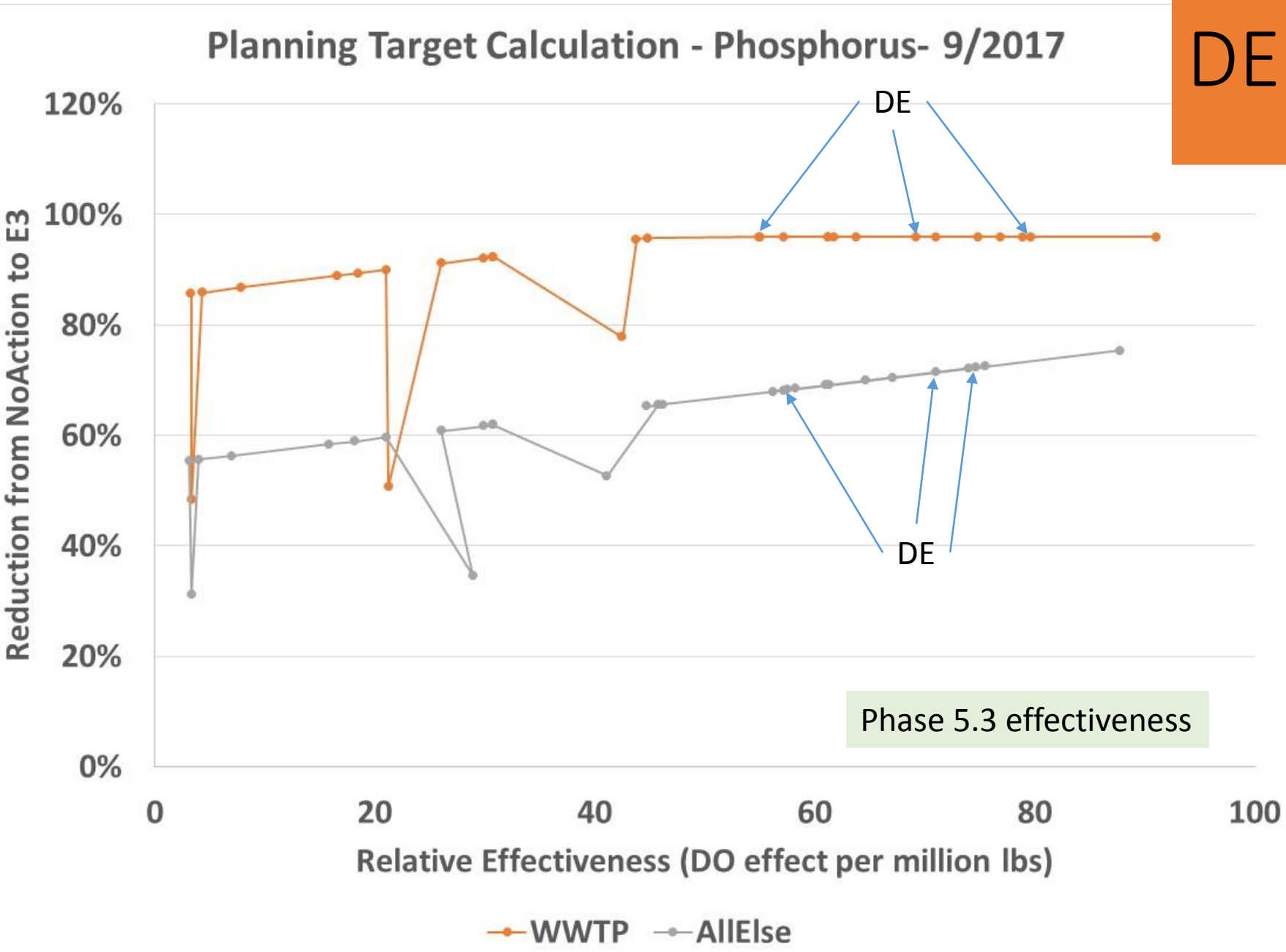
WV


Planning Target Calculation - Nitrogen - 9/2017
Reduction from NoAction to E3
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2
4
6
8
10
Relative Effectiveness (DO effect per million lbs)
WWTP
AllElse
WV
Phase 5.3 effectiveness

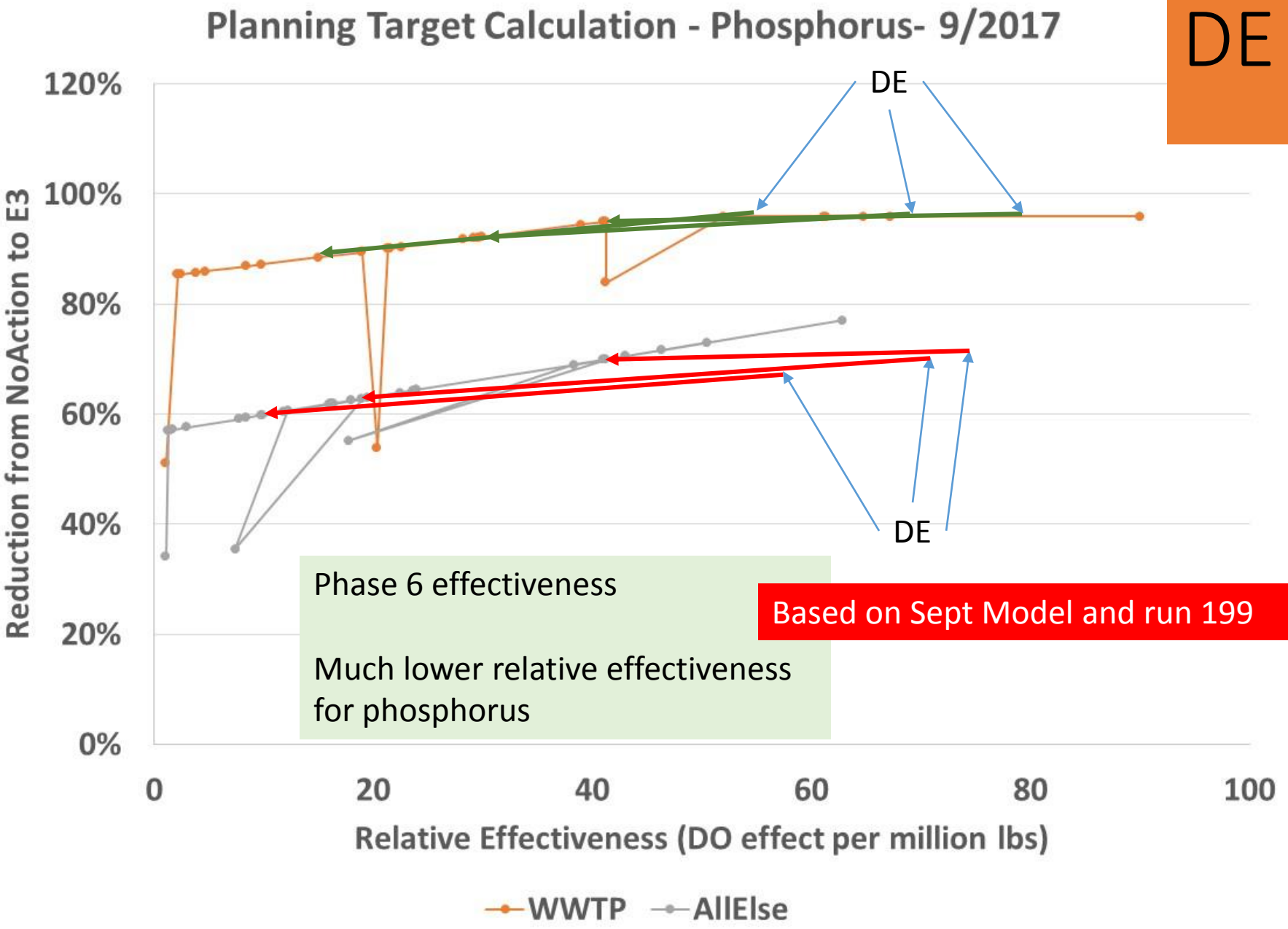
WV

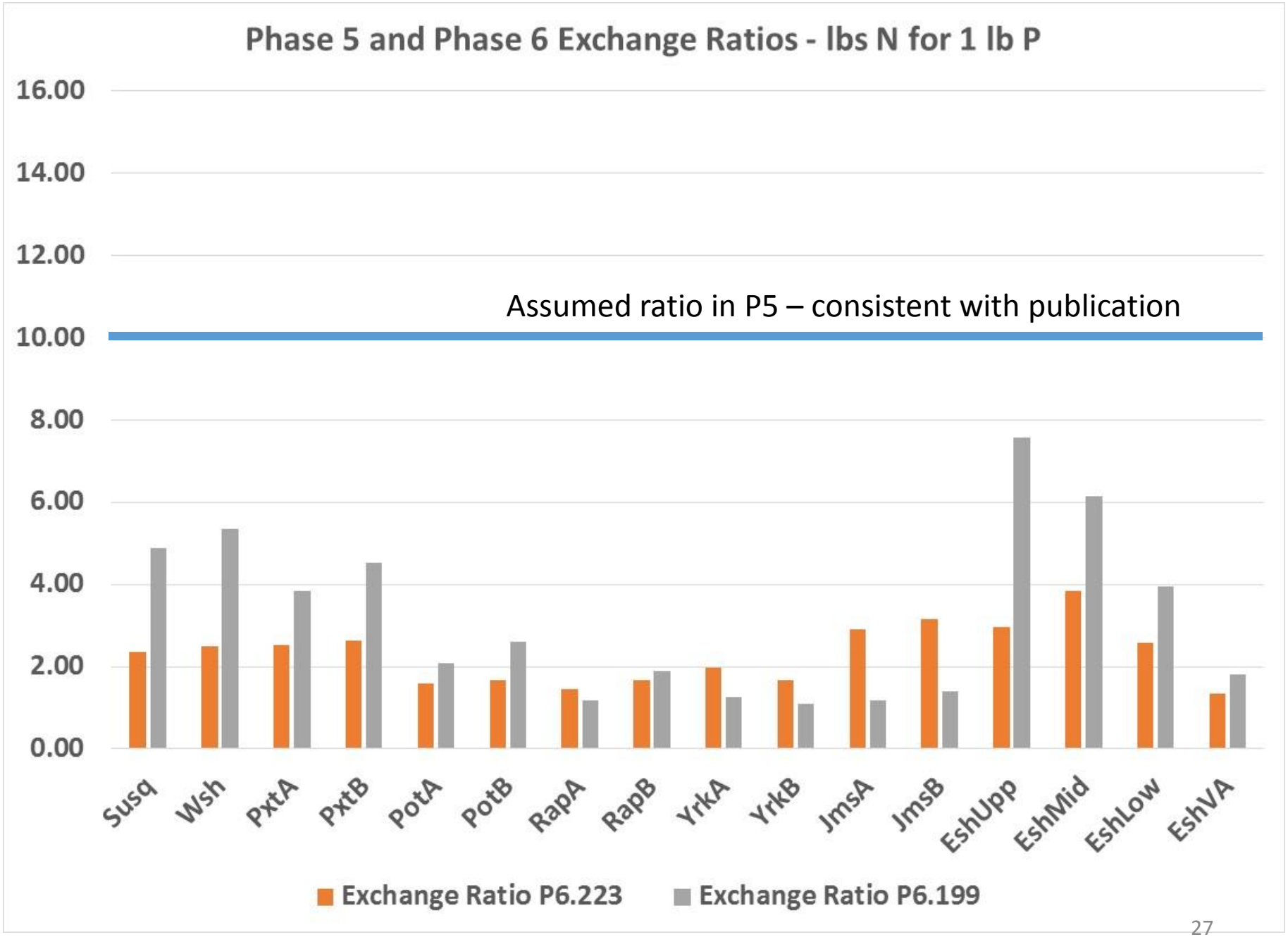

Planning Target Calculation - Nitrogen - 9/2017
Reduction from NoAction to E3
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2
4
6
8
10
12
14
16
Relative Effectiveness (DO effect per million lbs)
WWTP
AllElse
WV
Phase 6 effectiveness
Much higher relative effectiveness for nitrogen
Based on Sept Model and run 199

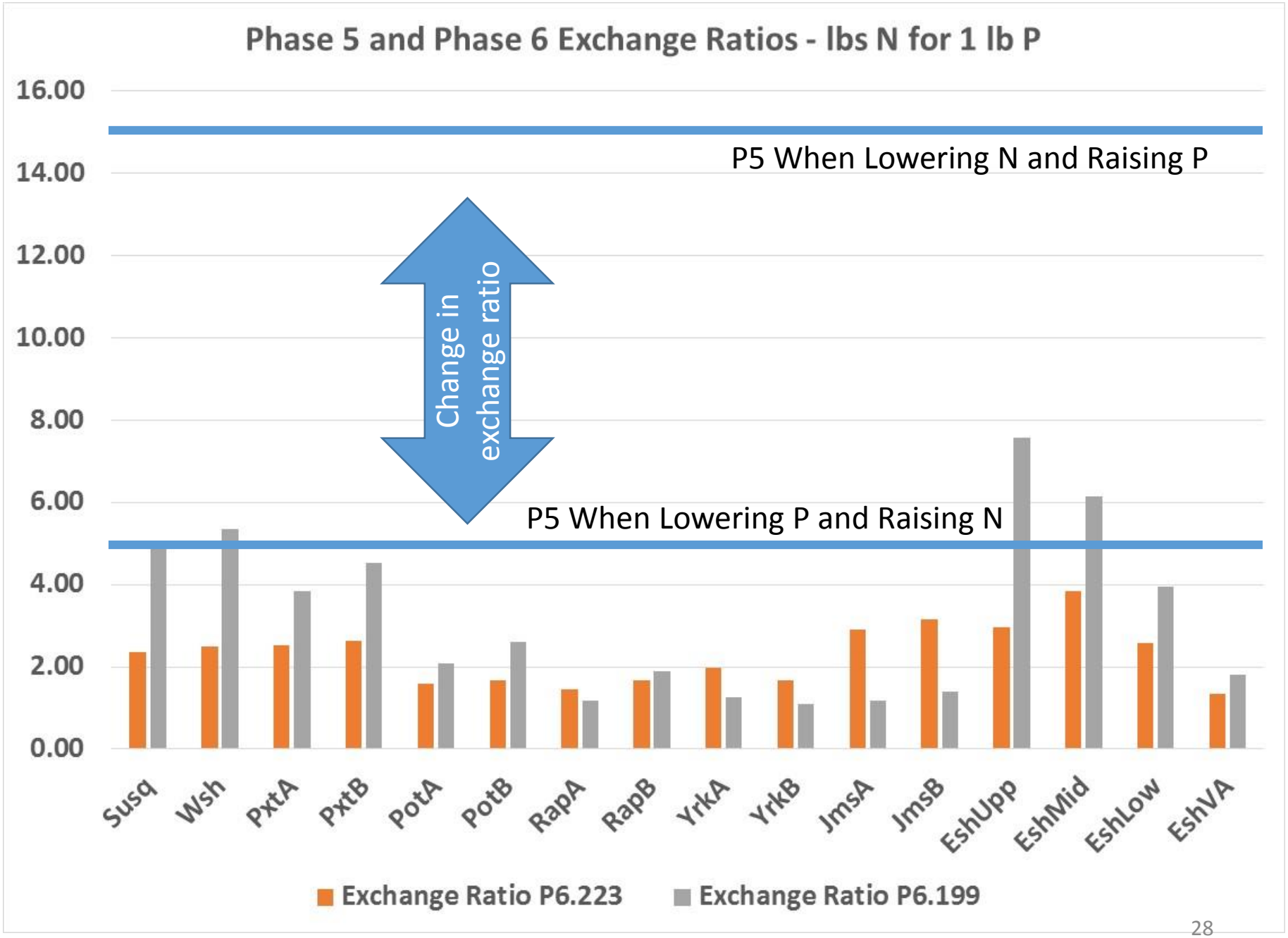
DE


Planning Target Calculation - Phosphorus- 9/2017
DE
DE
Phase 5.3 effectiveness
Reduction from NoAction to E3
120%
100%
80%
60%
40%
20%
0%
0
20
40
60
80
100
Relative Effectiveness (DO effect per million lbs)
WWTP
AllElse

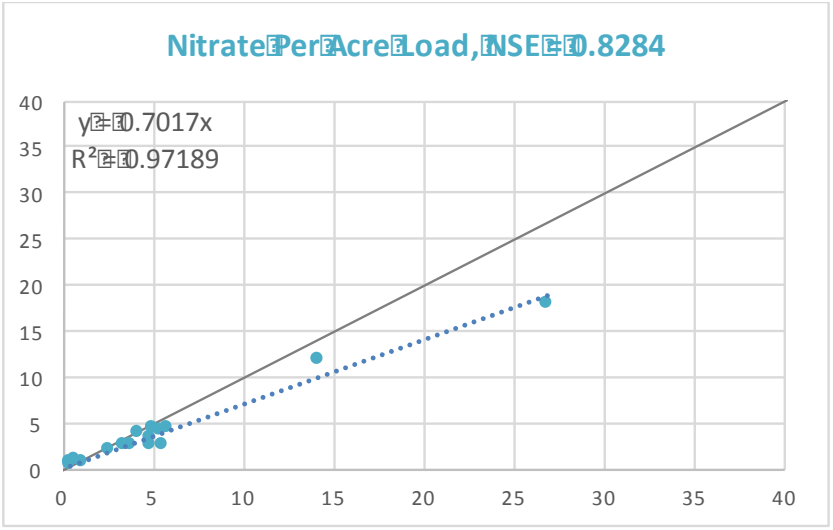
DE

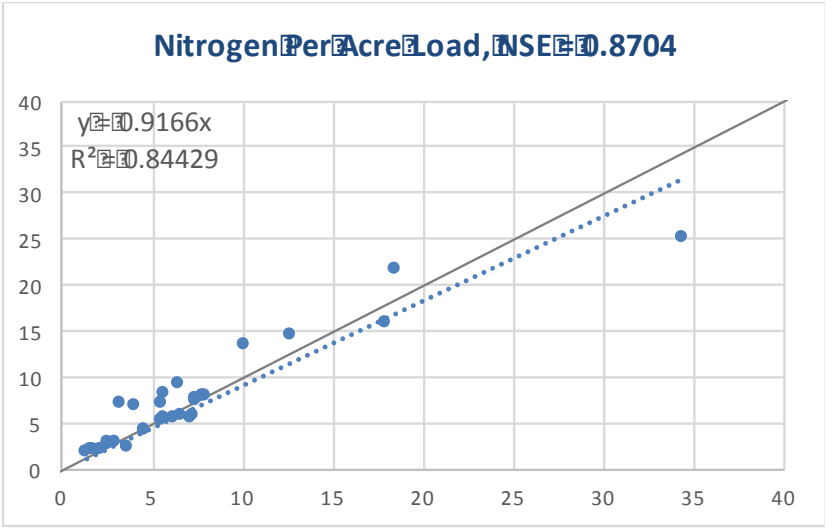

Planning Target Calculation - Phosphorus- 9/2017
DE
DE
Phase 6 effectiveness
Much lower relative effectiveness for phosphorus
Based on Sept Model and run 199
Reduction from NoAction to E3
120%
100%
80%
60%
40%
20%
0%
0
20
40
60
80
100
Relative Effectiveness (DO effect per million lbs)
WWTP
AllElse

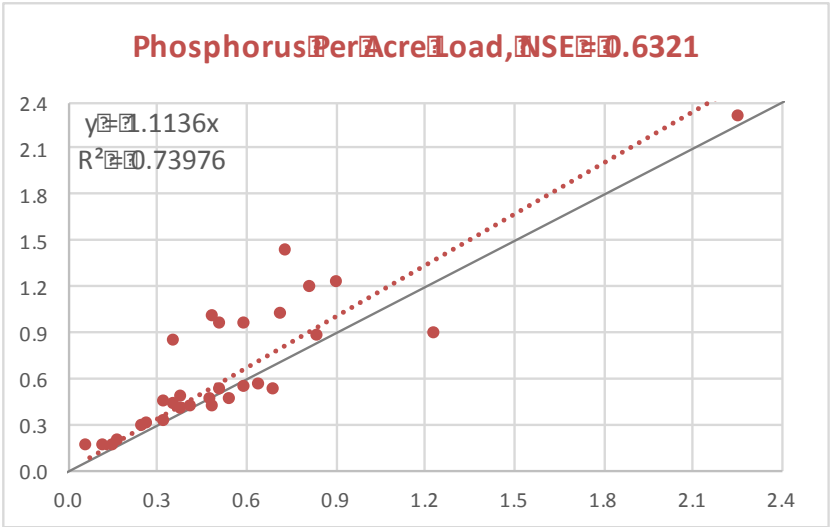

Phase 5 and Phase 6 Exchange Ratios - lbs N for 1 lb P
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Assumed ratio in P5 – consistent with publication
Susq
Wsh
PxtA
PxtB
PotA
PotB
RapA
RapB
YrkA
YrkB
JmsA
JmsB
EshUpp
EshMid
EshLow
EshVA
Exchange Ratio P6.223
Exchange Ratio P6.199

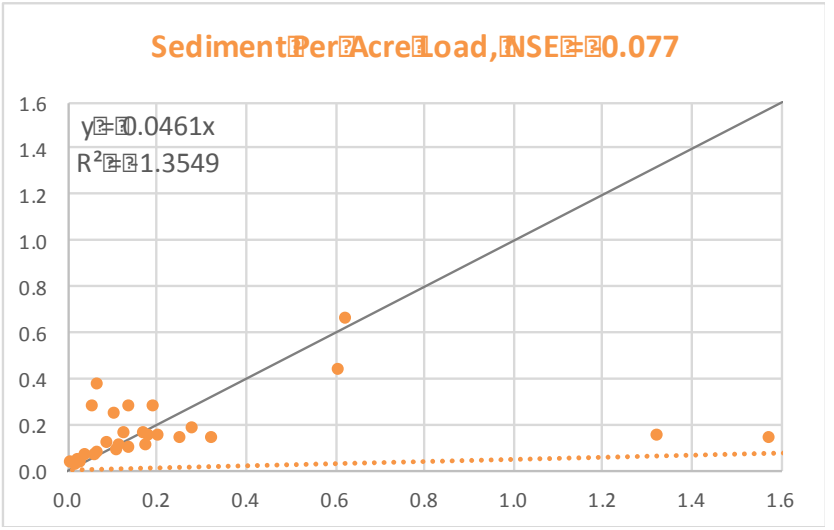

Phase 5 and Phase 6 Exchange Ratios - lbs N for 1 lb P
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
P5 When Lowering N and Raising P
Change in exchange ratio
P5 When Lowering P and Raising N
Susq
Wsh
PxtA
PxtB
PotA
PotB
RapA
RapB
YrkA
YrkB
JmsA
JmsB
EshUpp
EshMid
EshLow
EshVA
Exchange Ratio P6.223
Exchange Ratio P6.199

Phase 5 – geographic efficiencies





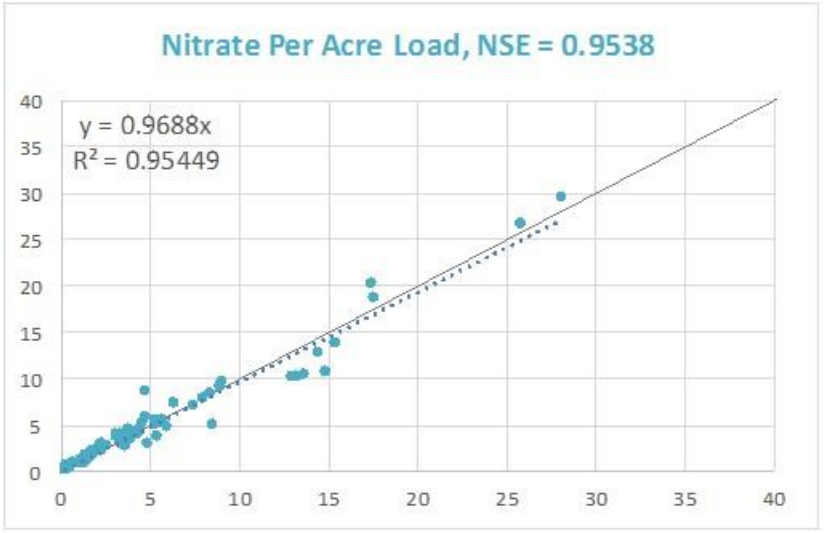


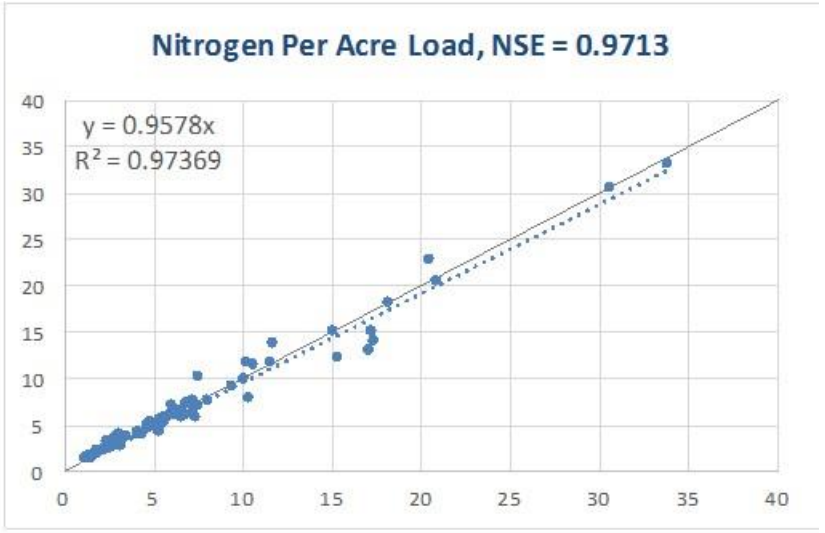


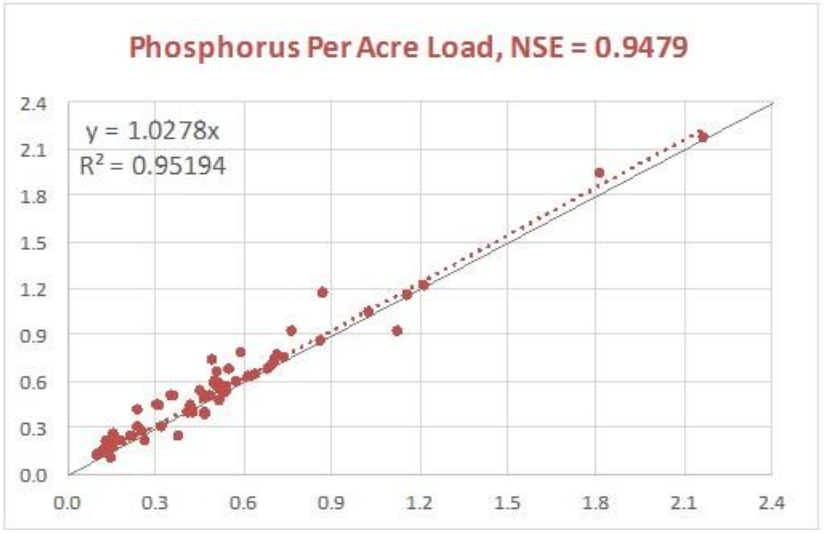
Simulated Per Acre Load

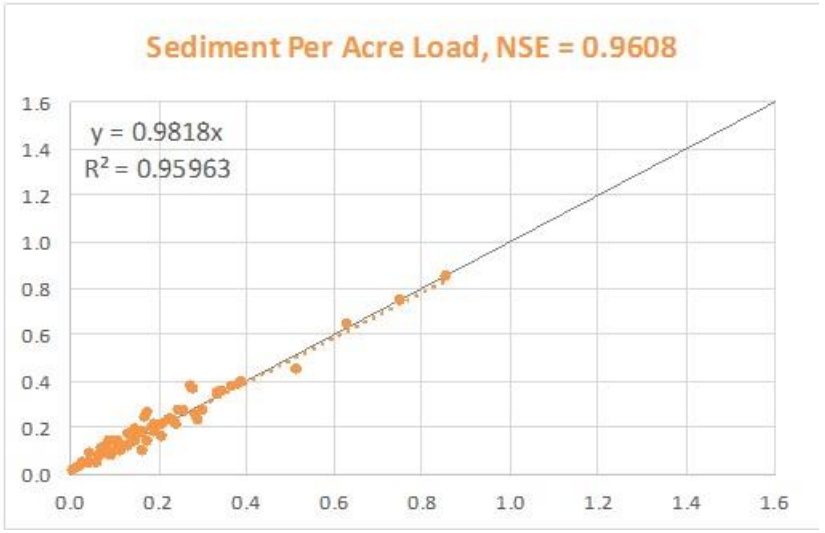
WRTDS Per Acre Load

DRAFT P6 – geographic efficiencies







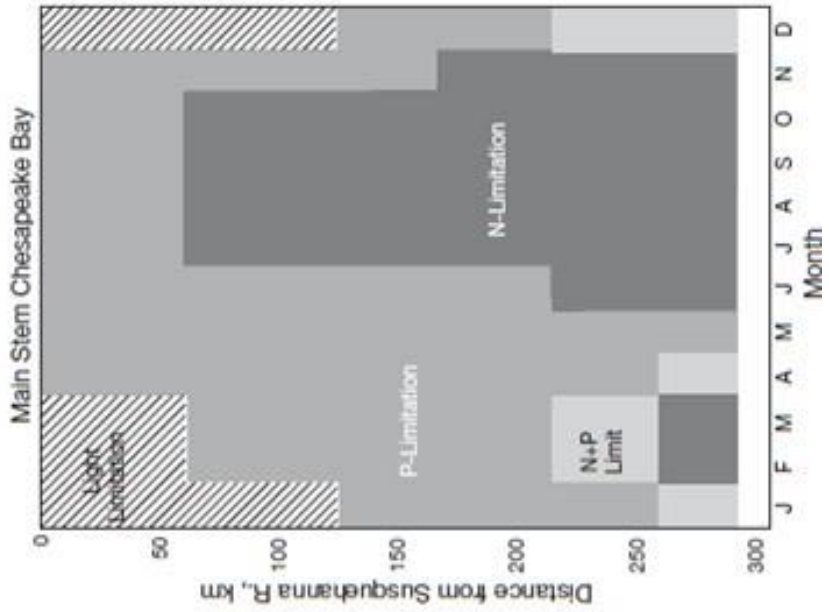


Simulated Per Acre Load

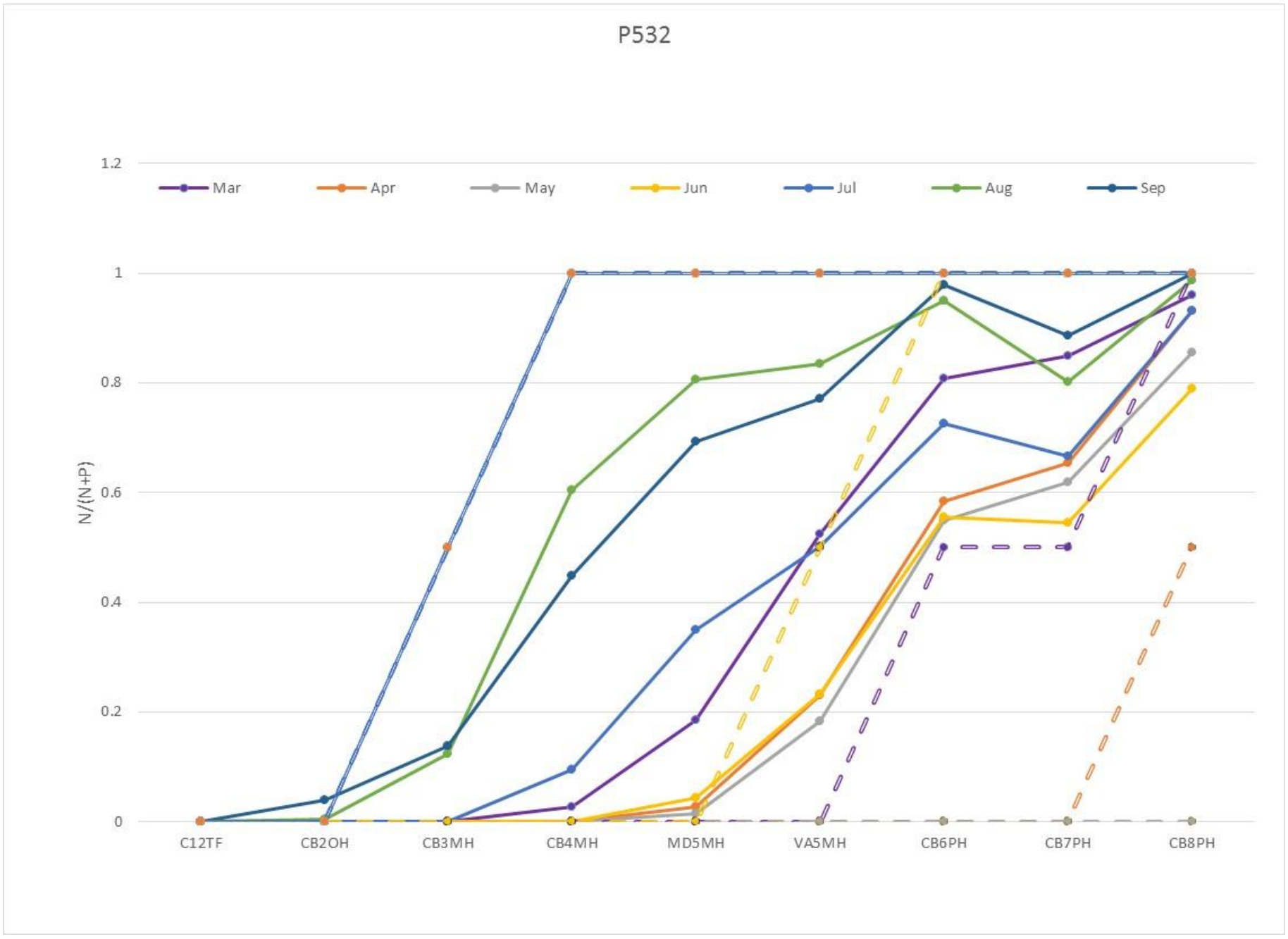
WRTDS Per Acre Load

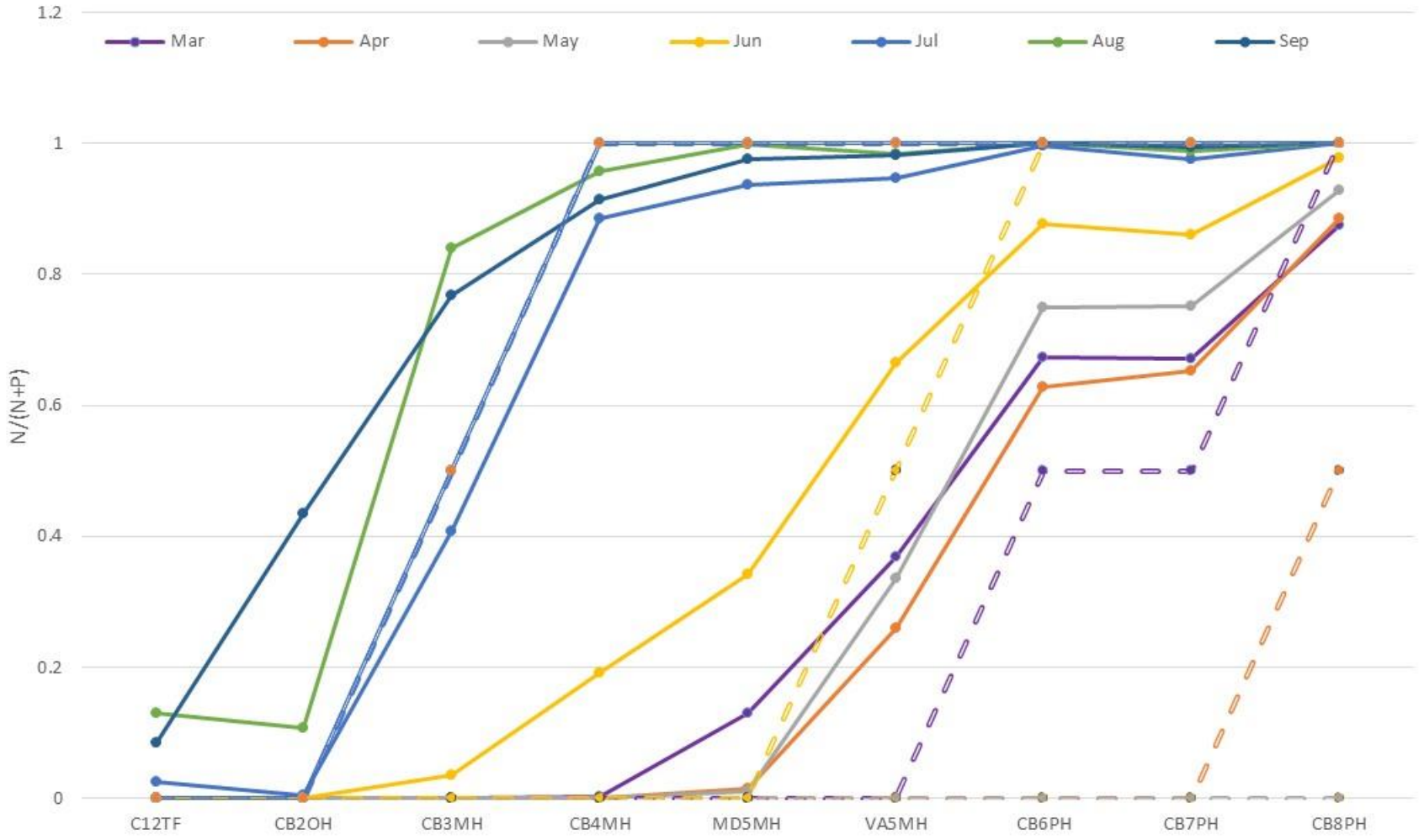
Fisher plot converted to table

	C12TF	CB2OH	CB3MH	CB4MH	MD5MH	VA5MH	CB6PH	CB7PH	CB8PH
F Mar				0	0	0	0.5	0.5	1
F Apr	0	0	0	0	0	0	0	0	0.5
F May	0	0	0	0	0	0	0	0	0
F Jun	0	0	0	0	0	0.5	1	1	1
F Jul	0	0	0.5	1	1	1	1	1	1
F Aug	0	0	0.5	1	1	1	1	1	1
F Sep	0	0	0.5	1	1	1	1	1	1




Fisher
F Mar
F Apr
F May
F Jun
F Jul
F Aug
F Sep
1.2
1
0.8
0.6
0.4
0.2
0
N/(N+P)
C12TF
CB2OH
CB3MH
CB4MH
MD5MH
VA5MH
CB6PH
CB7PH
CB8PH


P532
1.2
1
0.8
0.6
0.4
0.2
0
N/(N+P)
Mar
Apr
May
Jun
Jul
Aug
Sep
C12TF
CB2OH
CB3MH
CB4MH
MD5MH
VA5MH
CB6PH
CB7PH
CB8PH


1.2
1
0.8
0.6
0.4
0.2
0
N/(N+P)
Mar
Apr
May
Jun
Jul
Aug
Sep
C12TF
CB2OH
CB3MH
CB4MH
MD5MH
VA5MH
CB6PH
CB7PH
CB8PH

Summary

- Improved watershed and estuarine models give new insights into effective areas for reductions
- Nitrogen more important relative to phosphorus
- Upstream areas more important relative to the previous estimates