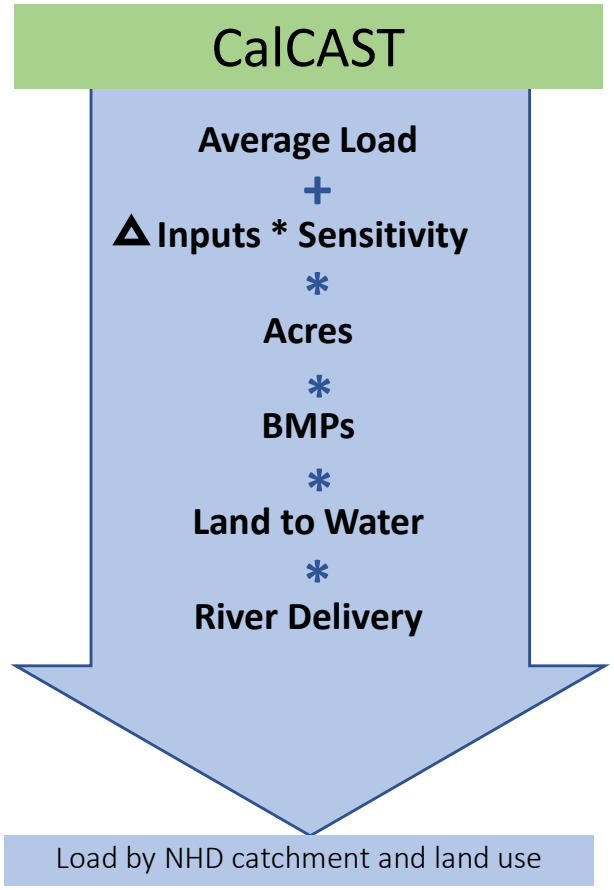
CalCAST Updates

Isabella Bertani, Gopal Bhatt, Joseph Delesantro, Lewis Linker, and the Modeling Team

Modeling Workgroup Quarterly Review

10/08/2024

Land classes represented in CalCAST until now



Land classes represented in CalCAST so far CBP (2013 1-meter Land Use Data classes)

Broad Class	Land Class
Cropland	Cropland
Cropland	Feeding space
Pasture	Pasture
Developed	Impervious non-roads
Developed	Impervious roads
Developed	Tree canopy over impervious
Developed	Tree canopy over turfgrass
Developed	Turfgrass
Natural	Forest
Natural	Water
Natural	Floodplain wetlands
Natural	Other wetlands
Natural	Mixed open

Expanded representation of same load sources as in CAST

Jess Rigelman performed crosswalk and downscaling of load source acres and inputs to NHDPlus scale for 1985-2023

Downscaling methods based on Devereux et al. 2022 https://www.sciencebase.gov/catalog/item/60be31b3d34e86b938910b2f

Broad Class	Land Class	Load Source
Cropland	Cropland	Double Cropped Land
Cropland	Cropland	Full Season Soybeans
Cropland	Cropland	Grain with Manure
Cropland	Cropland	Grain without Manure
Cropland	Cropland	Other Agronomic Crops
Cropland	Cropland	Silage with Manure
Cropland	Cropland	Silage without Manure
Cropland	Cropland	Small Grains and Grains
Cropland	Cropland	Specialty Crop High
Cropland	Cropland	Specialty Crop Low
Cropland	Feeding space	Non-Permitted Feeding Space
Cropland	Feeding space	Permitted Feeding Space
Pasture	Pasture	Ag Open Space
Pasture	Pasture	Leguminous Hay
Pasture	Pasture	Other Hay
Pasture	Pasture	Pasture
Developed	Impervious non-roads	CSS Construction
Developed	Impervious non-roads	Regulated Construction
Developed	Impervious non-roads	CSS Buildings and Other
Developed	Impervious non-roads	MS4 Buildings and Other
Developed	Impervious non-roads	Non-Regulated Buildings and Other
Developed	Impervious roads	CSS Roads
Developed	Impervious roads	MS4 Roads
Developed	Impervious roads	Non-Regulated Roads
Developed	Tree canopy over impervious	CSS Tree Canopy over Impervious
Developed	Tree canopy over impervious	MS4 Tree Canopy over Impervious
Developed	Tree canopy over impervious	Non-Regulated Tree Canopy over Impervious
Developed	Tree canopy over turfgrass	CSS Tree Canopy over Turf Grass
Developed	Tree canopy over turfgrass	MS4 Tree Canopy over Turf Grass
Developed	Tree canopy over turfgrass	Non-Regulated Tree Canopy over Turf Grass
Developed	Turfgrass	CSS Turf Grass
Developed	Turfgrass	MS4 Turf Grass
Developed	Turfgrass	Non-Regulated Turf Grass
Natural	Forest	CSS Forest
Natural	Forest	True Forest
Natural	Forest	Harvested Forest
Natural	Water	Water
Natural	Floodplain wetlands	Non-tidal Floodplain Wetland
Natural	Other wetlands	Headwater or Isolated Wetland
Natural	Mixed open	CSS Mixed Open
Natural	Mixed open	Mixed Open

Total Phosphorus Annual Flow-Normalized

Non-point source load generated by «Non-reg Tree Canopy Over Turfgrass (nch)» load source in catchment c and year t:

Watershed-wide average nch loading rate (lbs/ac)

Difference between local TP fertilizer input in catchment c and year t and watershed-wide long-term average TP fertilizer input (lbs/ac)

Change in fertilizer load exported from nch per change in unit of fertilizer input on nch

$$\boldsymbol{NPS_{nch,c,t}} = AVE_{nch} + \left(TP_{FERT,c,t} - \widehat{TP_{FERT}}\right) * SENS_{nch,FERT}$$

$$*$$

Acres of nch in catchment c and year t

$$ACRES_{nch,c,t}$$

$$*$$

BMP pass-through factor for nch in catchment c and year t

$$BMP_{nch,c,t}$$

$$*$$

Land-to-water delivery factor for catchment c

$$L2W_c$$

$$*$$

$$DEL_c$$

Stream delivery factor for catchment c

CalCAST

Average Load

+

Δ Inputs * Sensitivity

*****

Acres

*****

BMPs

*****

Land to Water

*****

River Delivery

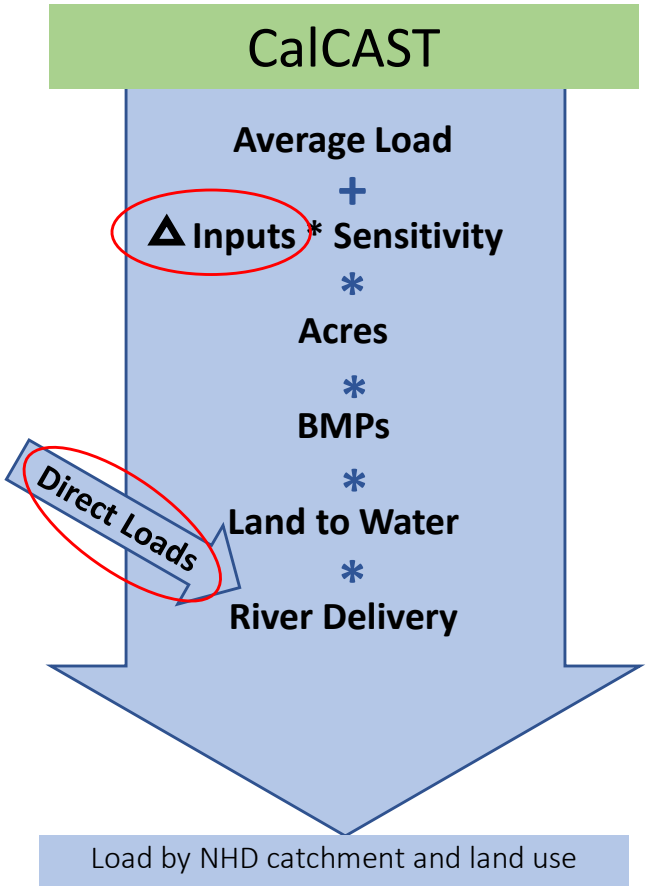
Load by NHD catchment and land use

Total Phosphorus - Inputs

The following P6 inputs were downscaled from CAST to NHDPlus catchment scale (thank you **Jess Rigelman** and **Olivia Devereux**!):

Soil P
Water Extractable P
Fertilizer
Sediment loss (EOF from Sediment-CalCAST)
Stormflow (from Stormflow-CalCAST)

Riparian Pasture Deposition
Rapid Infiltration Basins
Feeding Space
Wastewater
CSOs
Atmospheric Deposition (on water bodies)

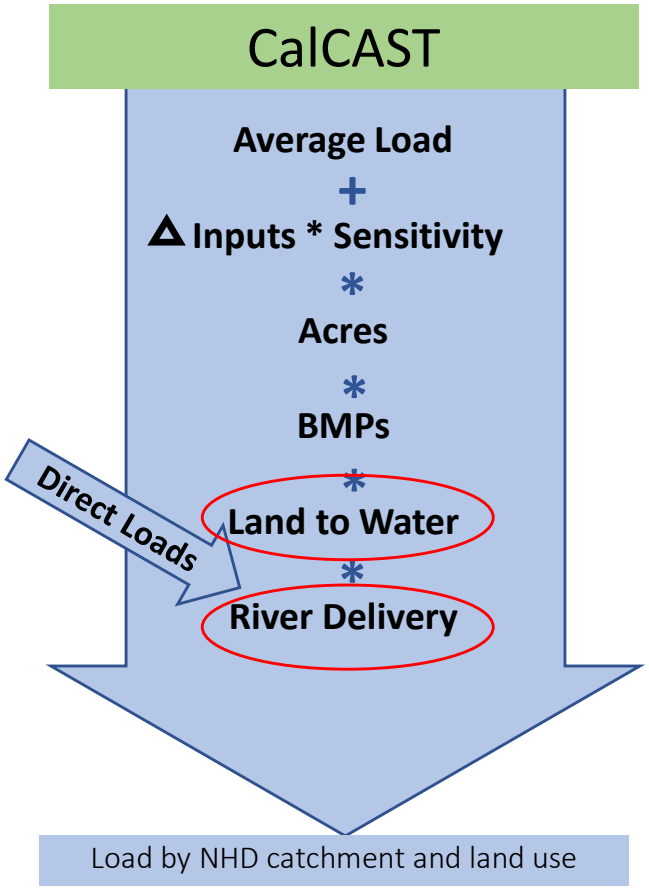


Downscaling methods based on Devereux et al. 2022
https://www.sciencebase.gov/catalog/item/60be31b3d34e86b938910b2f

Total Phosphorus – L2W and River Delivery

Best L2W factors so far

Variable	Coef sign
Hydrogeomorphic unit: Piedm. Carbonate (%)	+
Baseflow index (%)	-
Catchment elevation (m)	-



River Delivery

Reservoirs: $$Del_c = \frac{1}{1+bres*IHL_c}$$

Del_c = Reservoir delivery factor for catchment c
IHL_c = Inverse Areal Hydraulic Load for reservoir in catchment c
bres= estimated through CalCAST

Sediment Annual Flow-Normalized

Non-point source load generated by «Grain With Manure (gwm)» load source in catchment c and year t:

Watershed-wide average gwm loading rate (lbs/ac)

RUSLE edge-of-field load for crp in catchment c (lbs/ac)

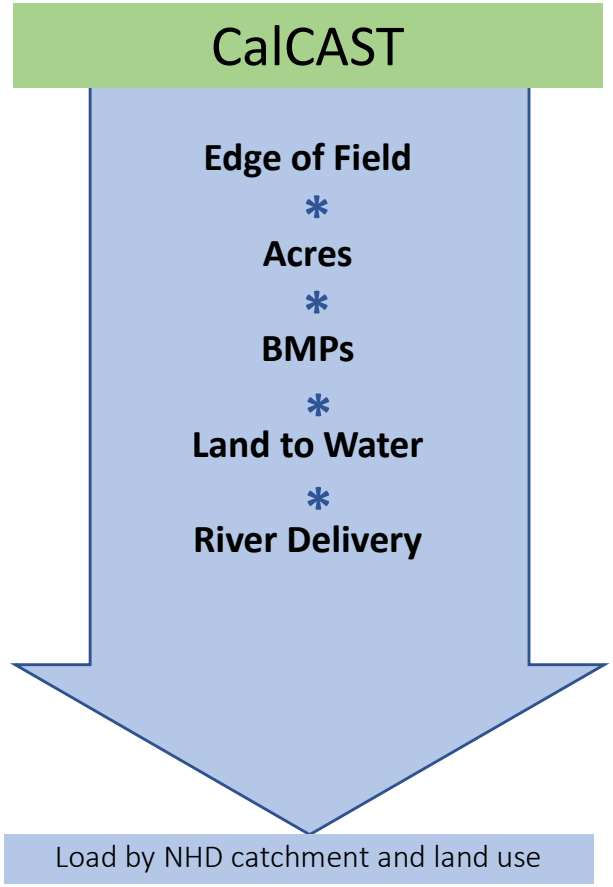
$$NPS_{gwm,c,t} = RUSLE\_EOF_{crp,c} * ACRES_{gwm,c,t} * BMP_{gwm,c,t} * (\alpha * IC_{crp,c} + \gamma) * DEL_c$$

Acres of gwm in catchment c and year t

BMP pass-through factor for gwm in catchment c and year t

Sediment delivery ratio for crp in catchment c (IC = Index of Connectivity)

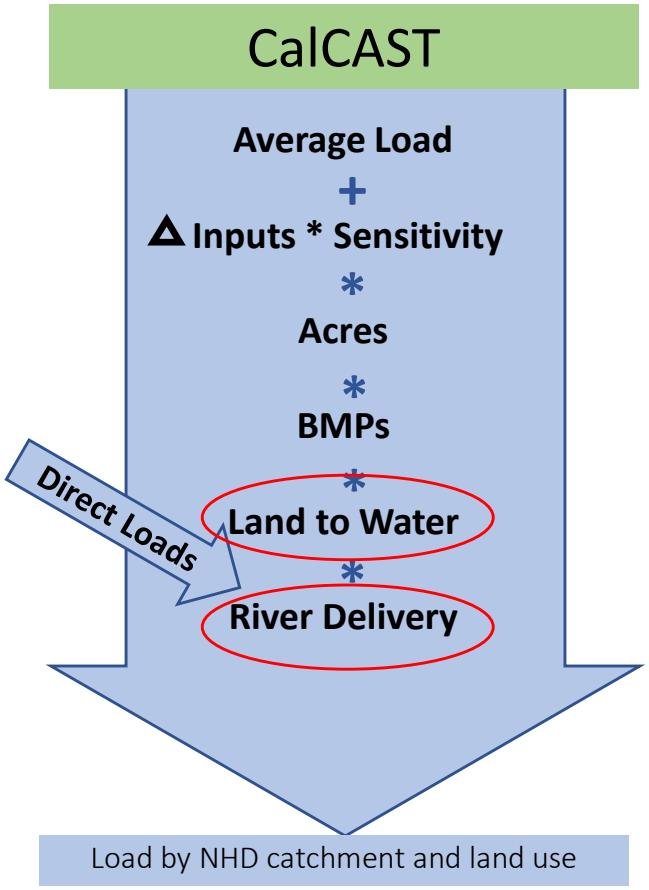
Stream delivery factor for catchment c



Sediment – L2W and River Delivery

Best L2W factors so far

Variable	Coef sign
Baseflow index (%)	-
Forest (%)	+
Impervious non-roads (%)	-



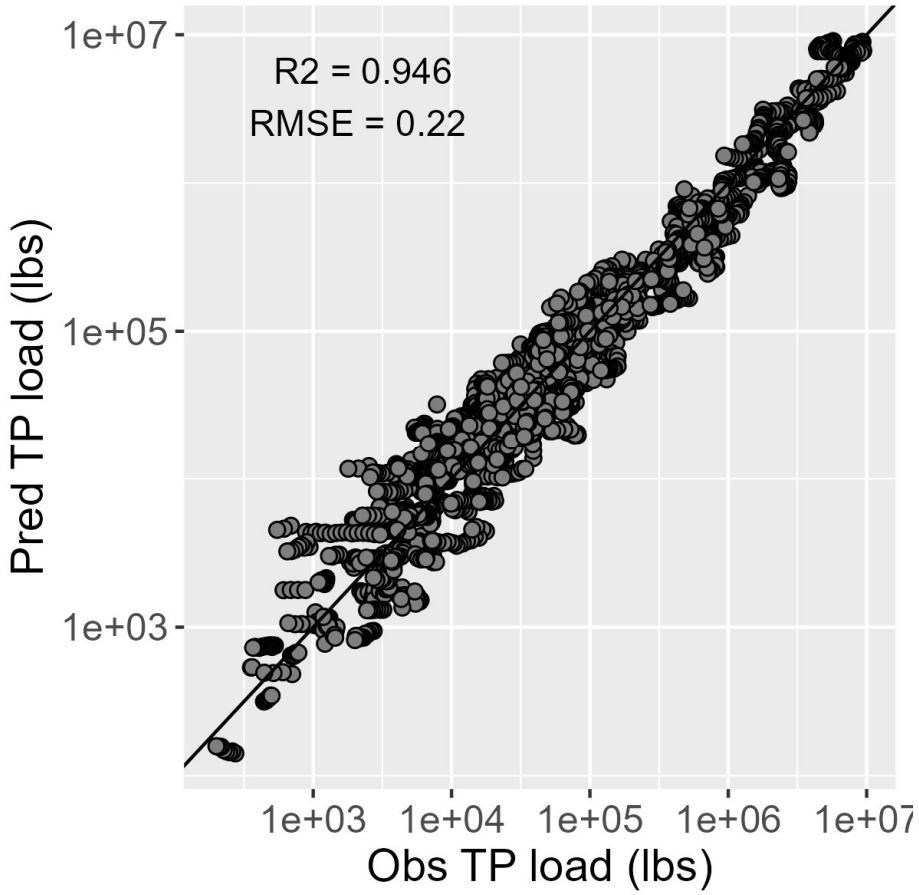
River Delivery

Reservoirs: $$Del_c = \frac{1}{1+bre \ *IHL_c}$$

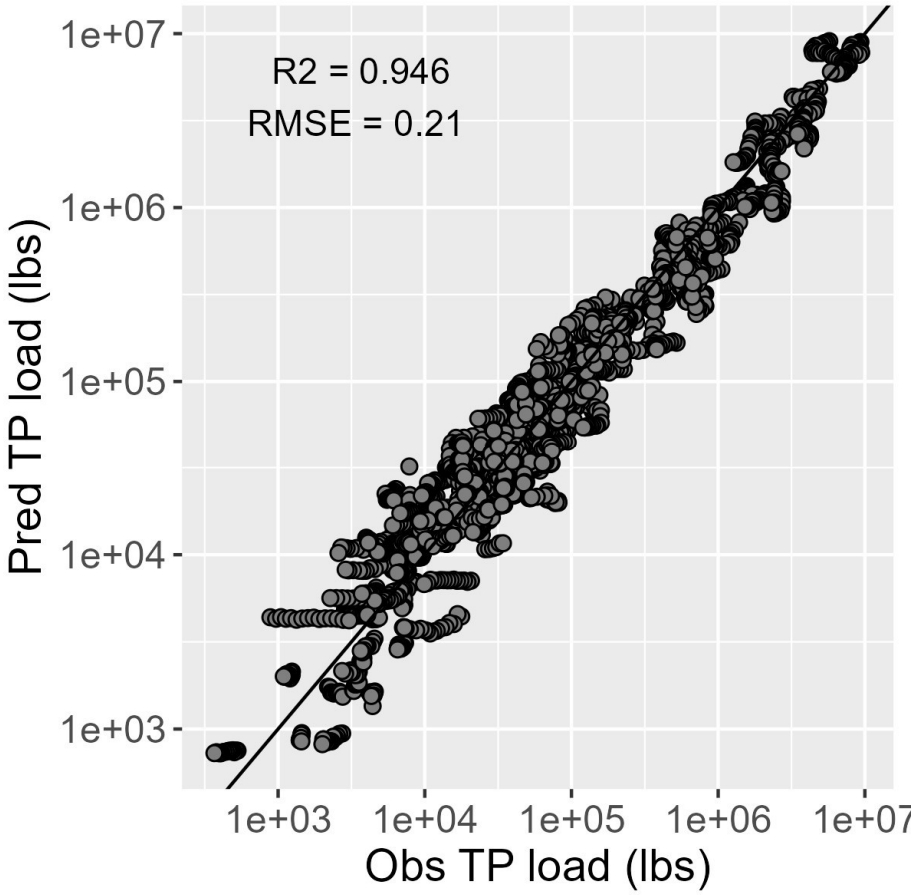
Del_c = Reservoir delivery factor for catchment c
IHL_c = Inverse Areal Hydraulic Load for reservoir in catchment c
bres= estimated through CalCAST

Total Phosphorus Annual Flow-Normalized Load

All stations

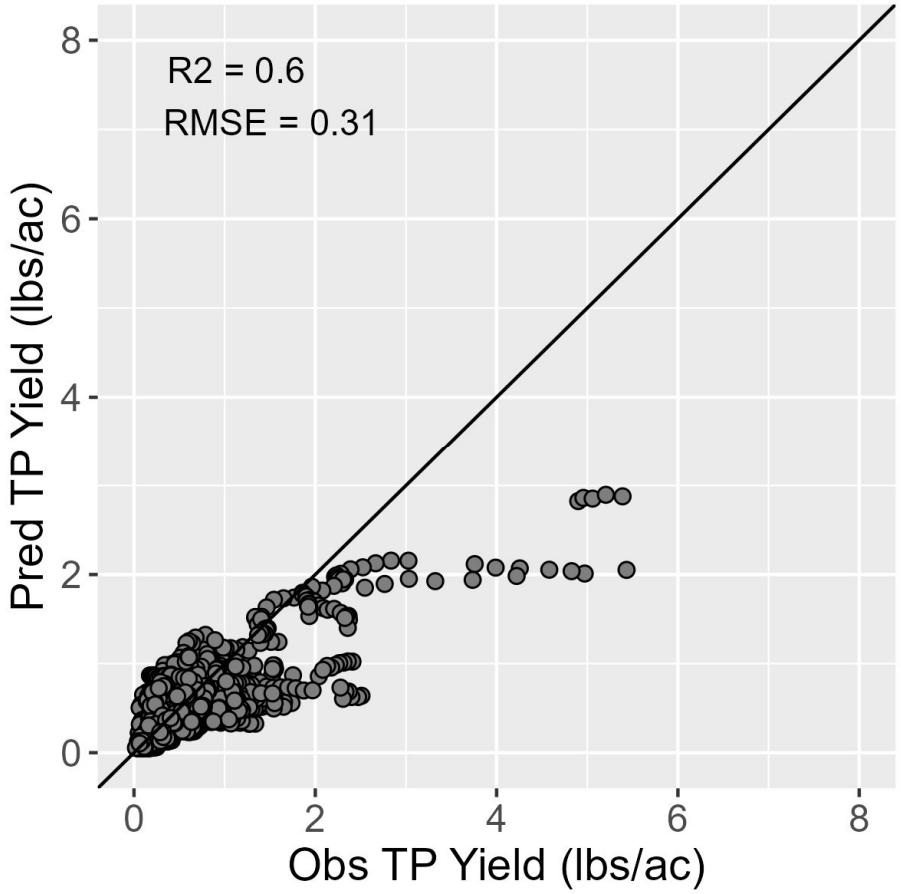


135 stations with >= 10 years of data

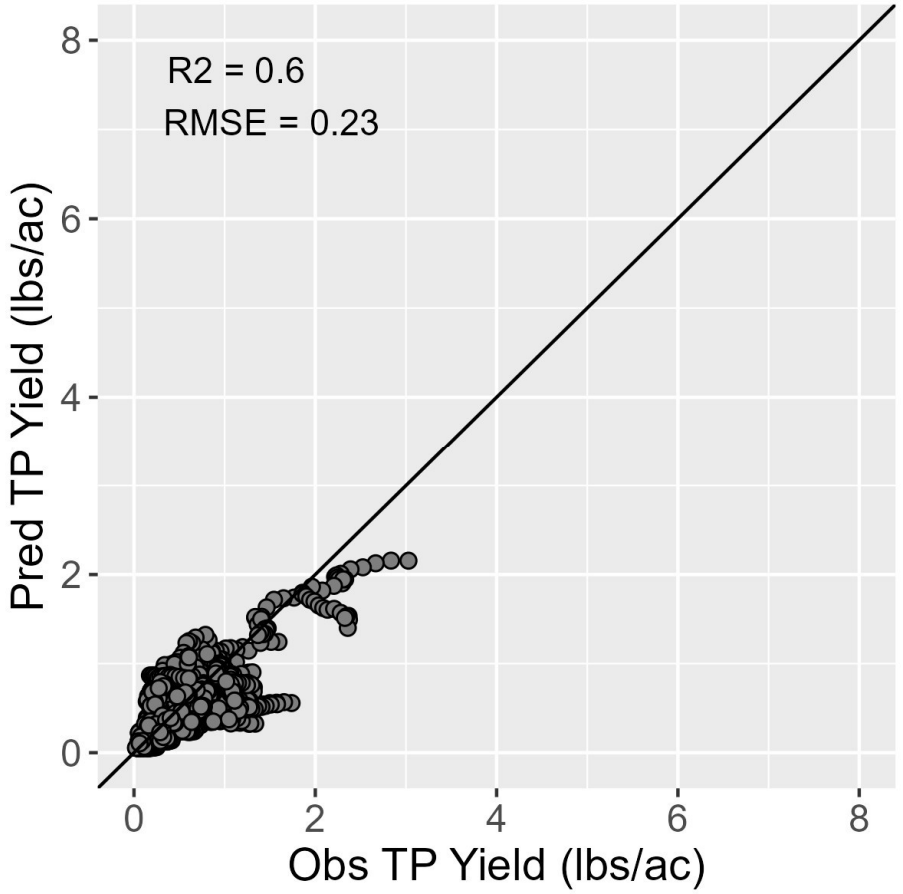


Total Phosphorus Annual Flow-Normalized Yield

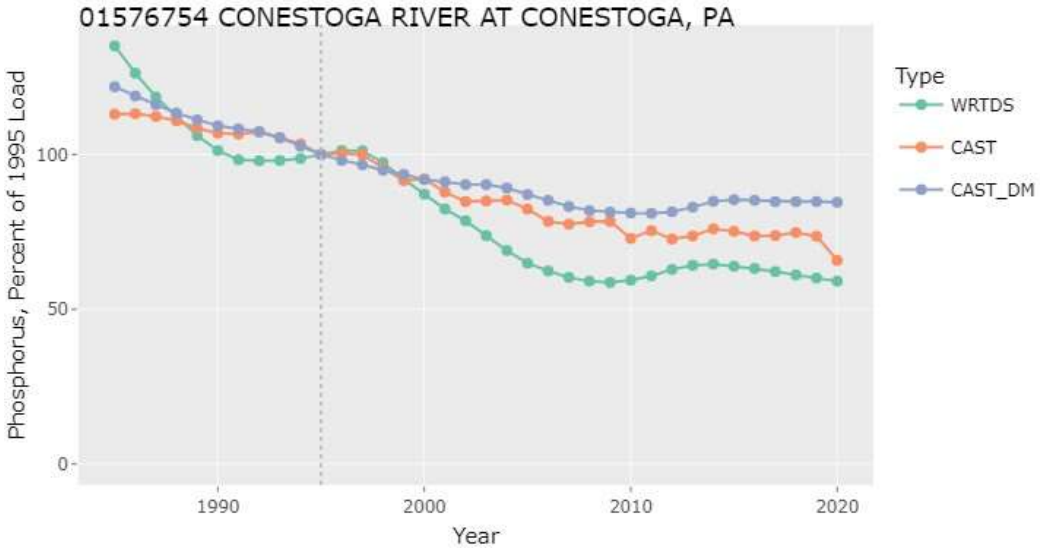
All stations

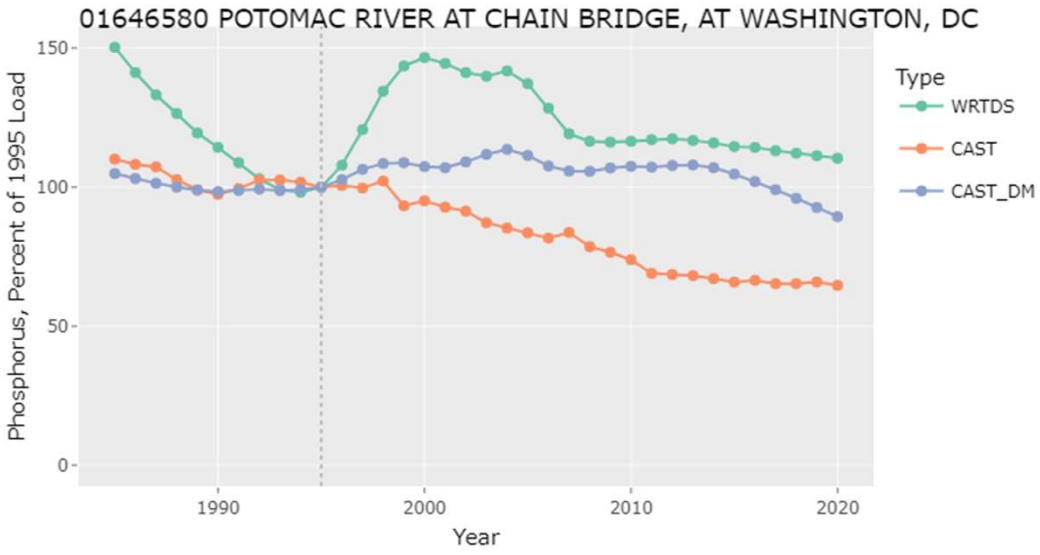


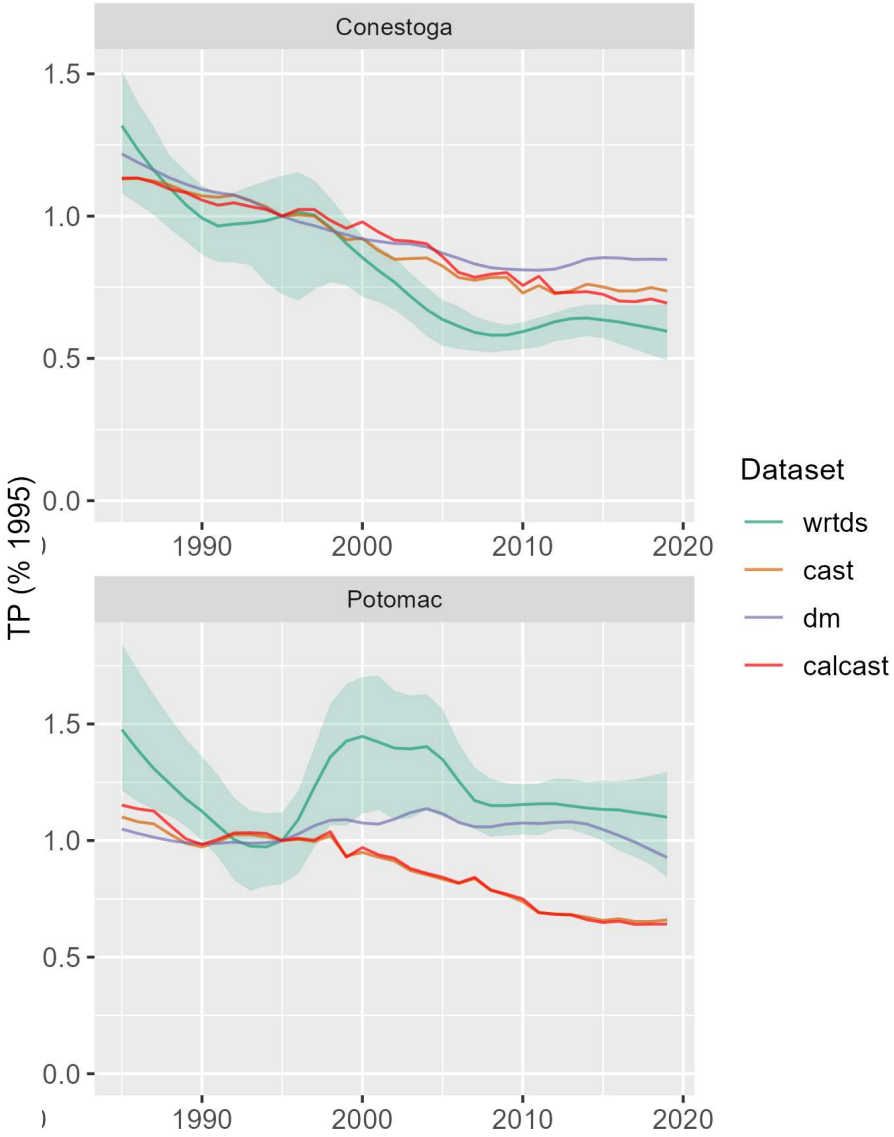
135 stations with >= 10 years of data



Monitored and Expected Total Reduction Indicator for the Chesapeake (METRIC)

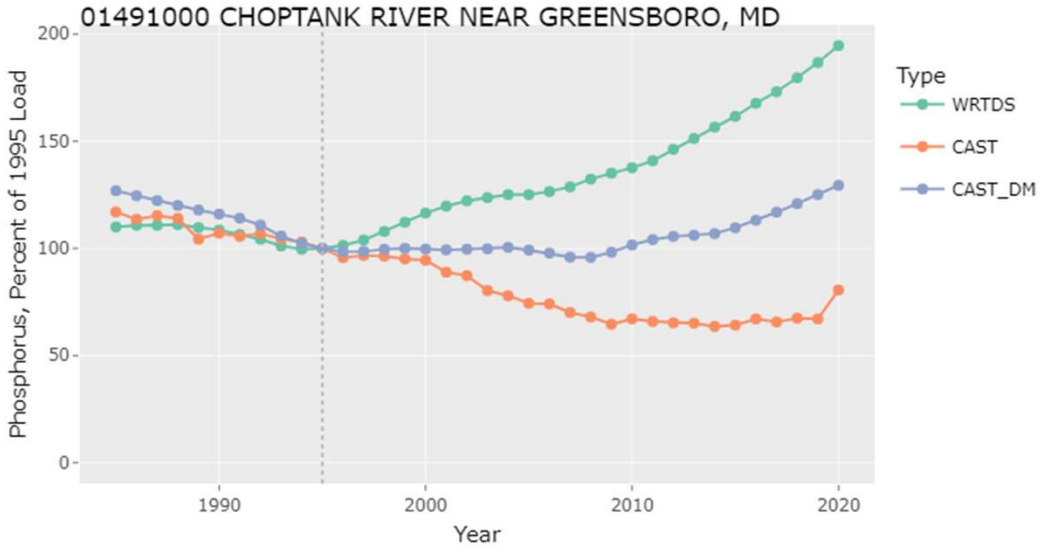


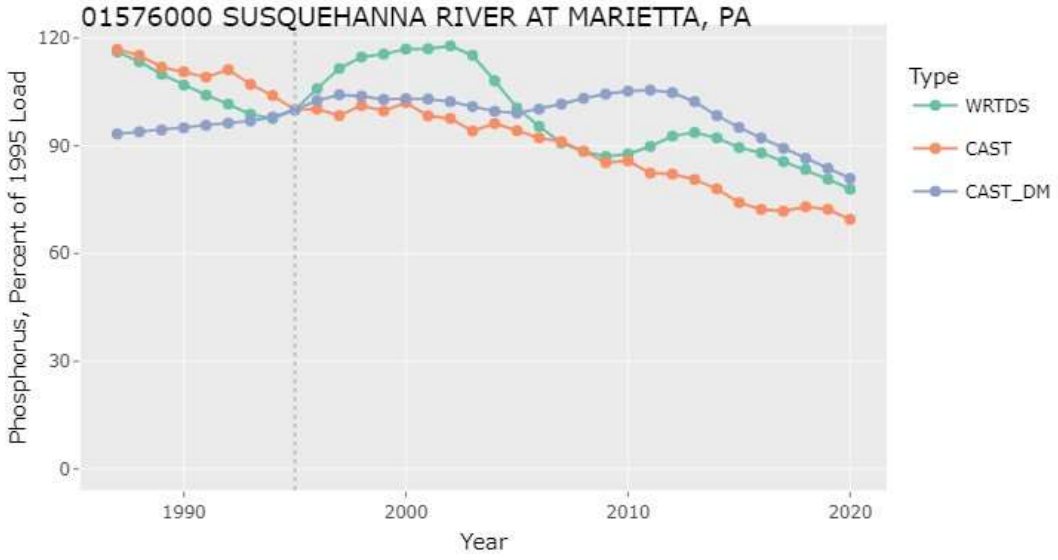


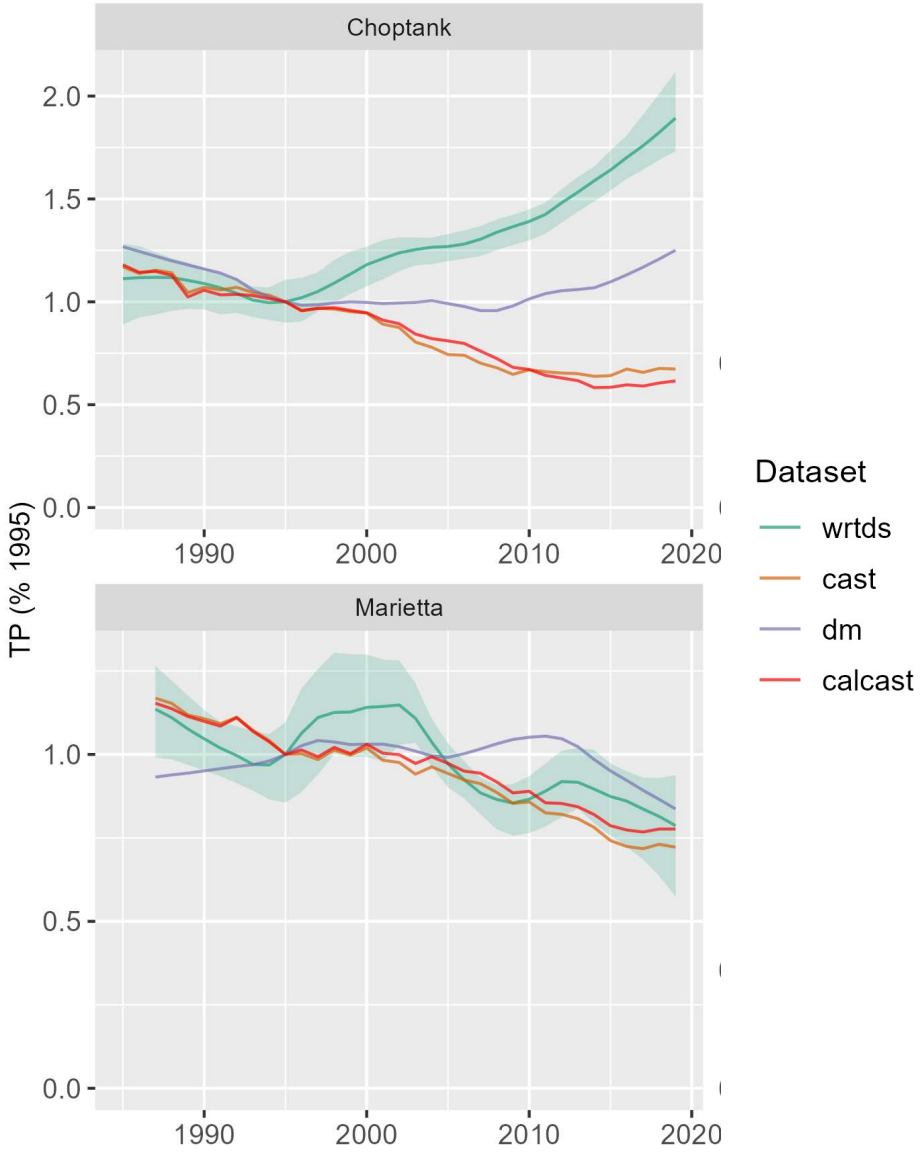


https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

Monitored and Expected Total Reduction Indicator for the Chesapeake (METRIC)



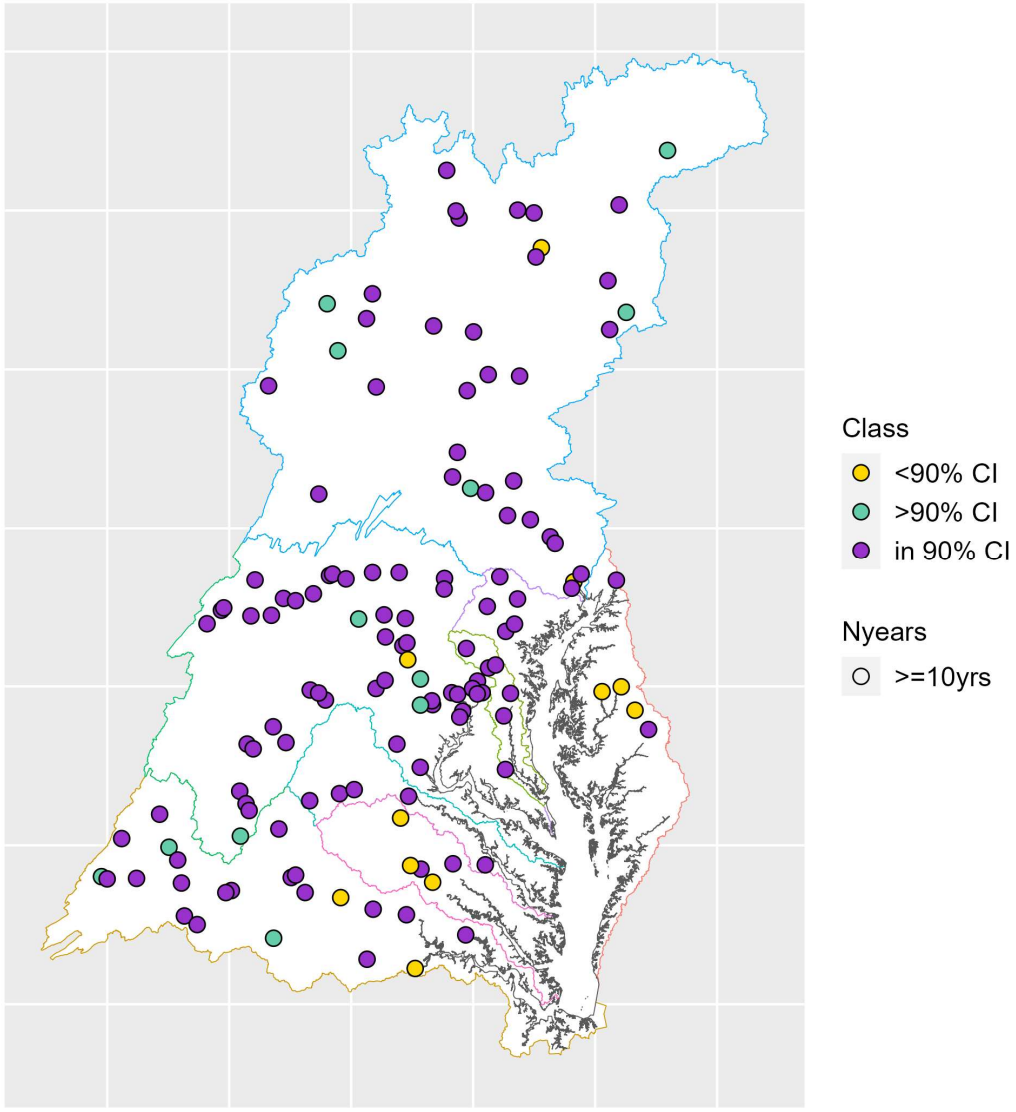




https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

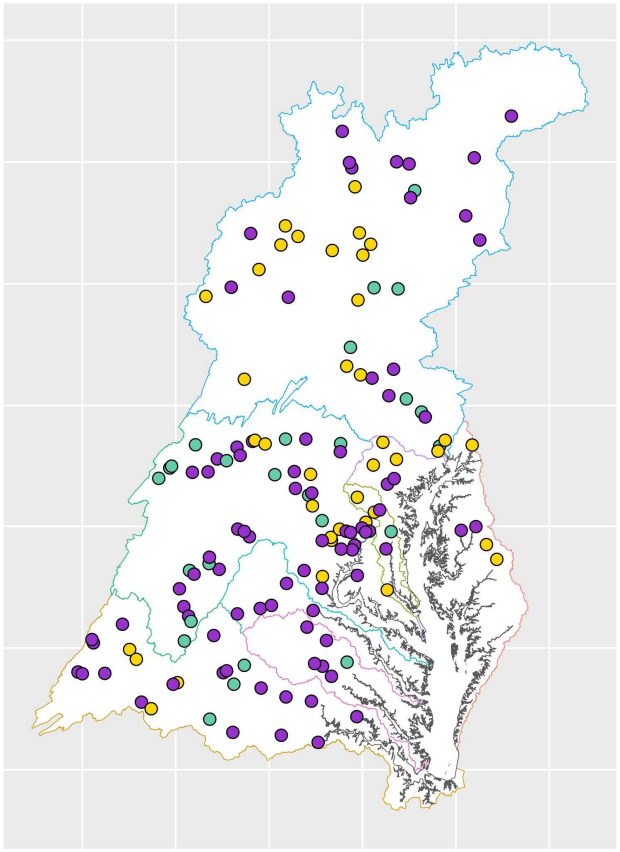
Total Phosphorus Annual Flow-Normalized

Trend agreement (stations >= 10 years)

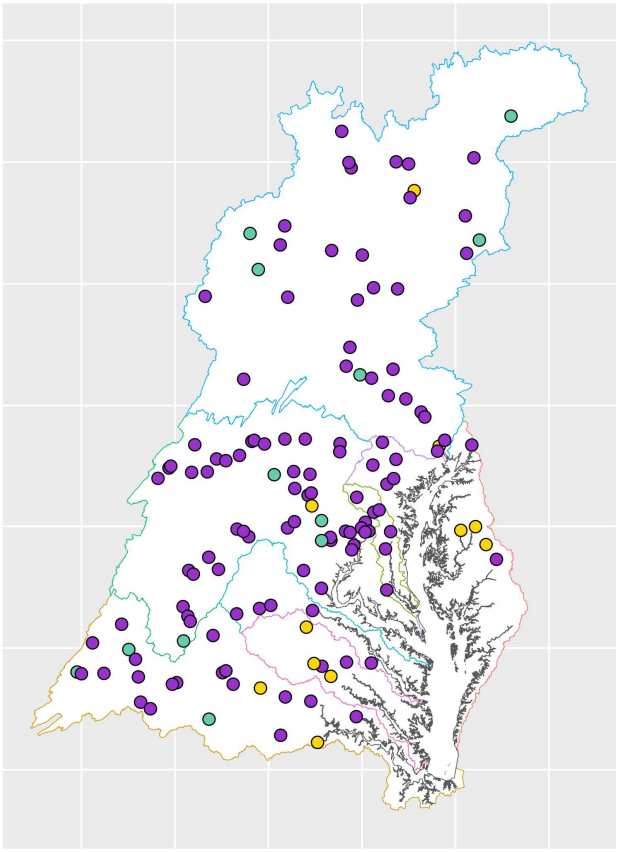


Trend agreement (stations >= 10 years)

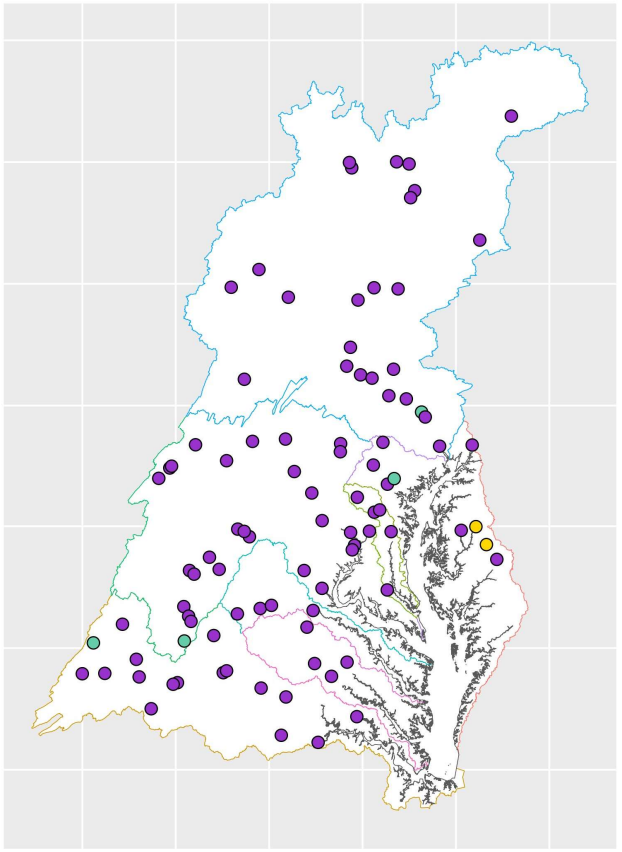
TN



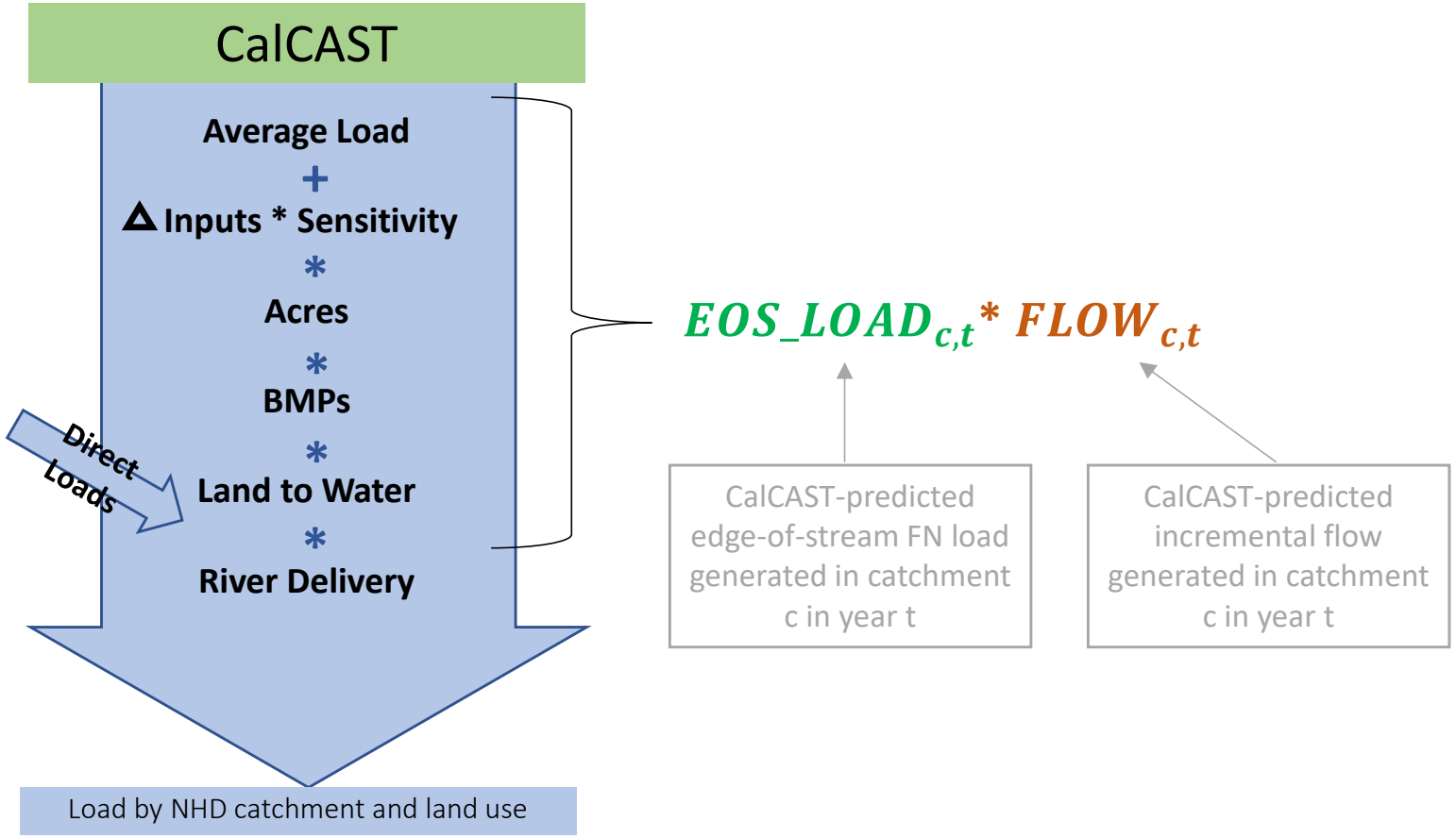
TP



SED

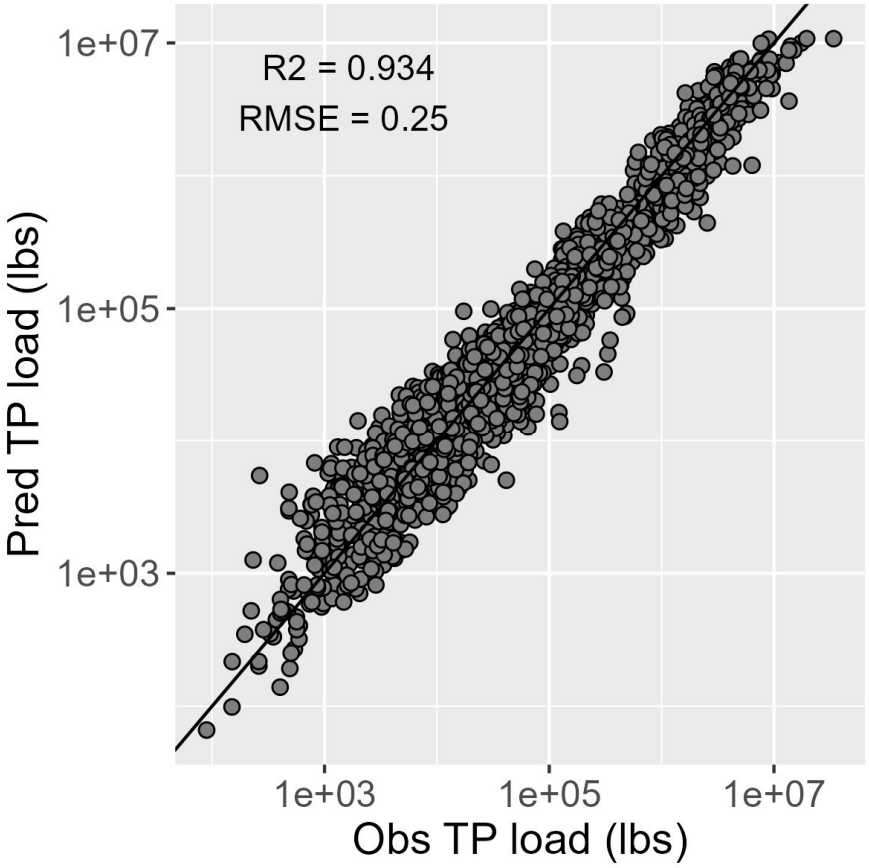


Total Phosphorus Annual True Conditions

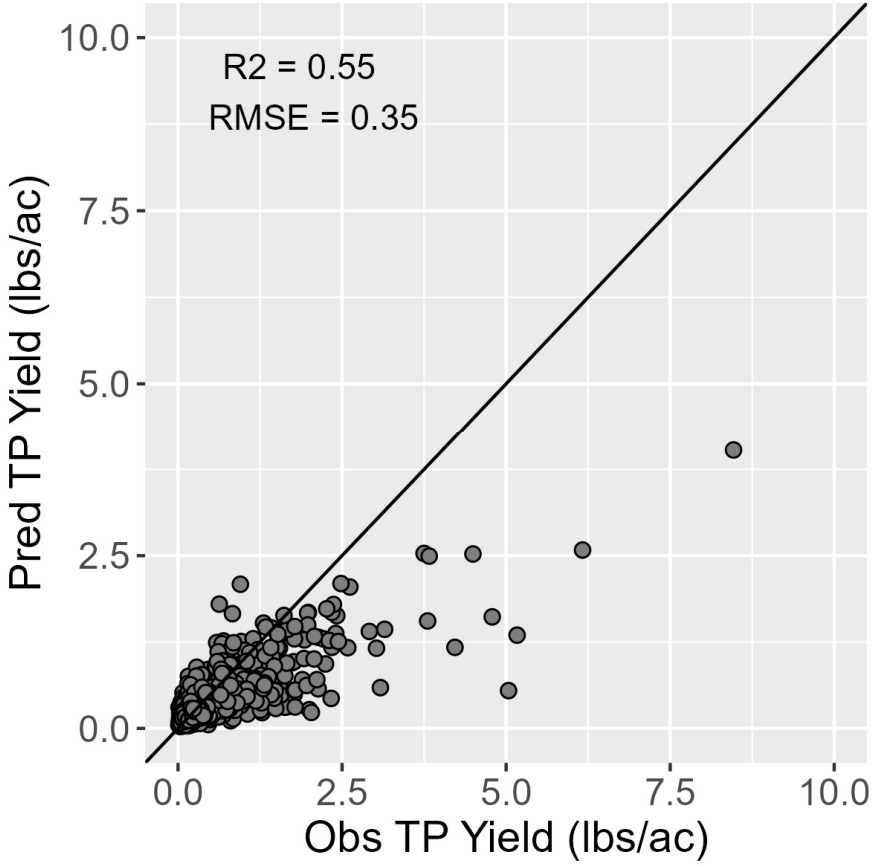


Total Phosphorus Annual True Conditions

TP load

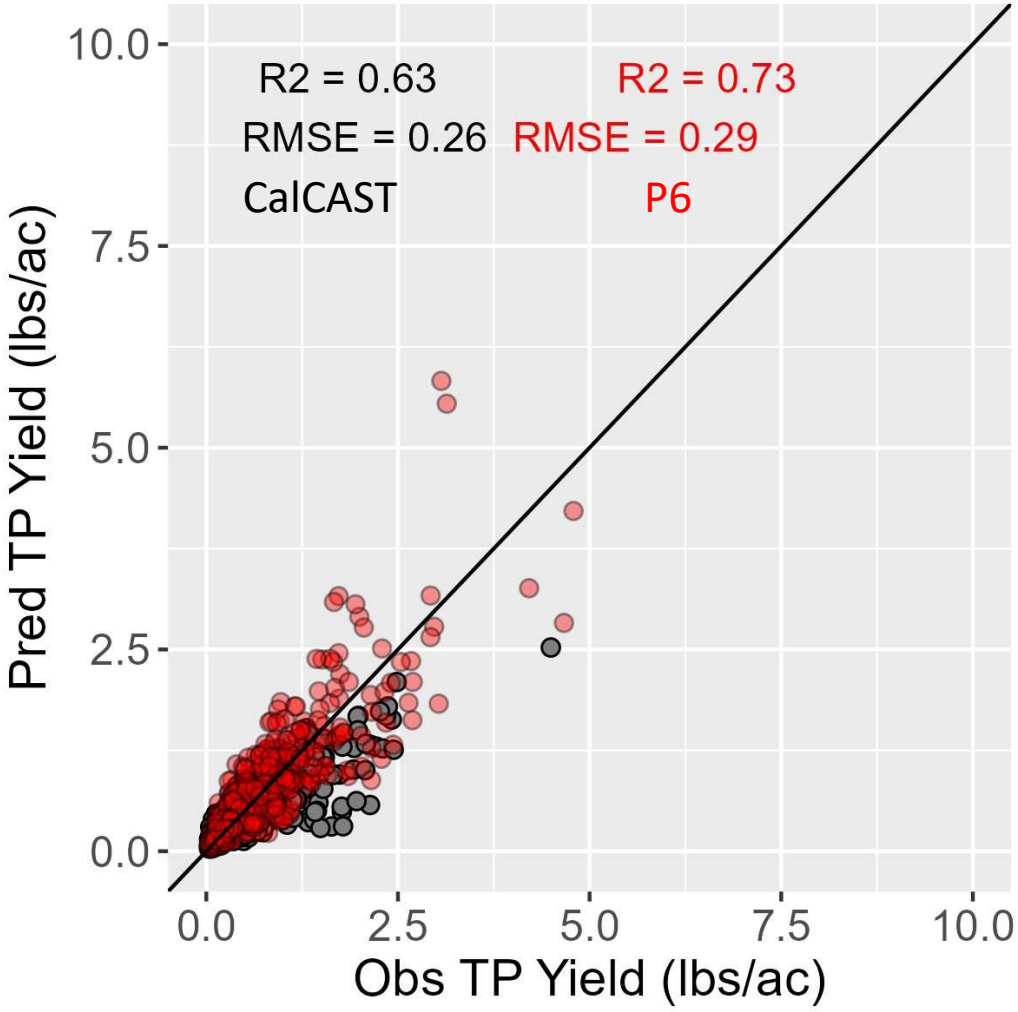


TP yield

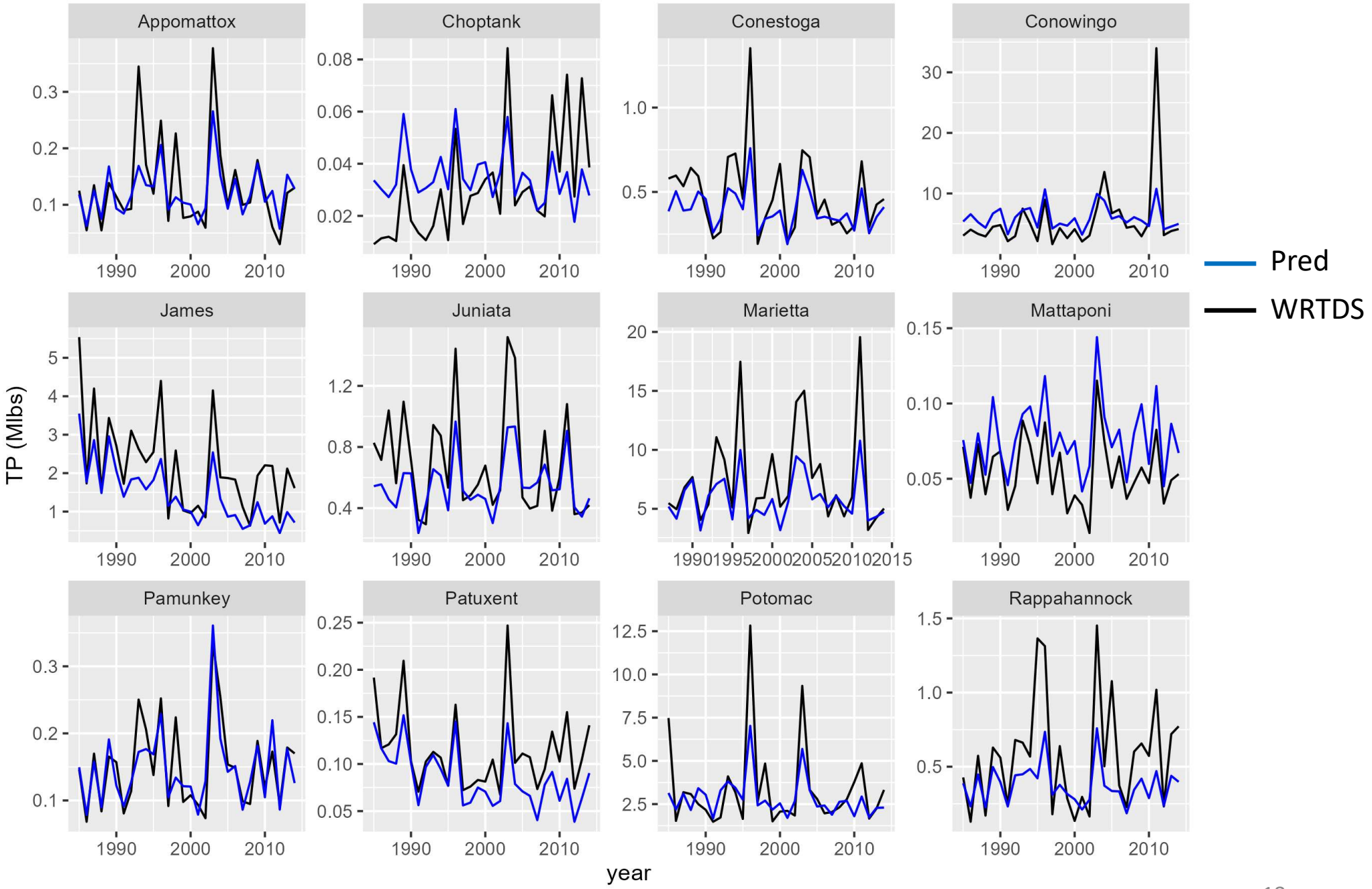


Total Phosphorus Annual True Conditions

Comparison with P6 at 61 NTN stations



Total Phosphorus Annual True Conditions



Next Steps

- Improve all annual models

- Examples of areas of potential improvement/refinement:
    - Sensitivities
    - Land to water / Stream delivery
    - Lag formulation