CalCAST Updates

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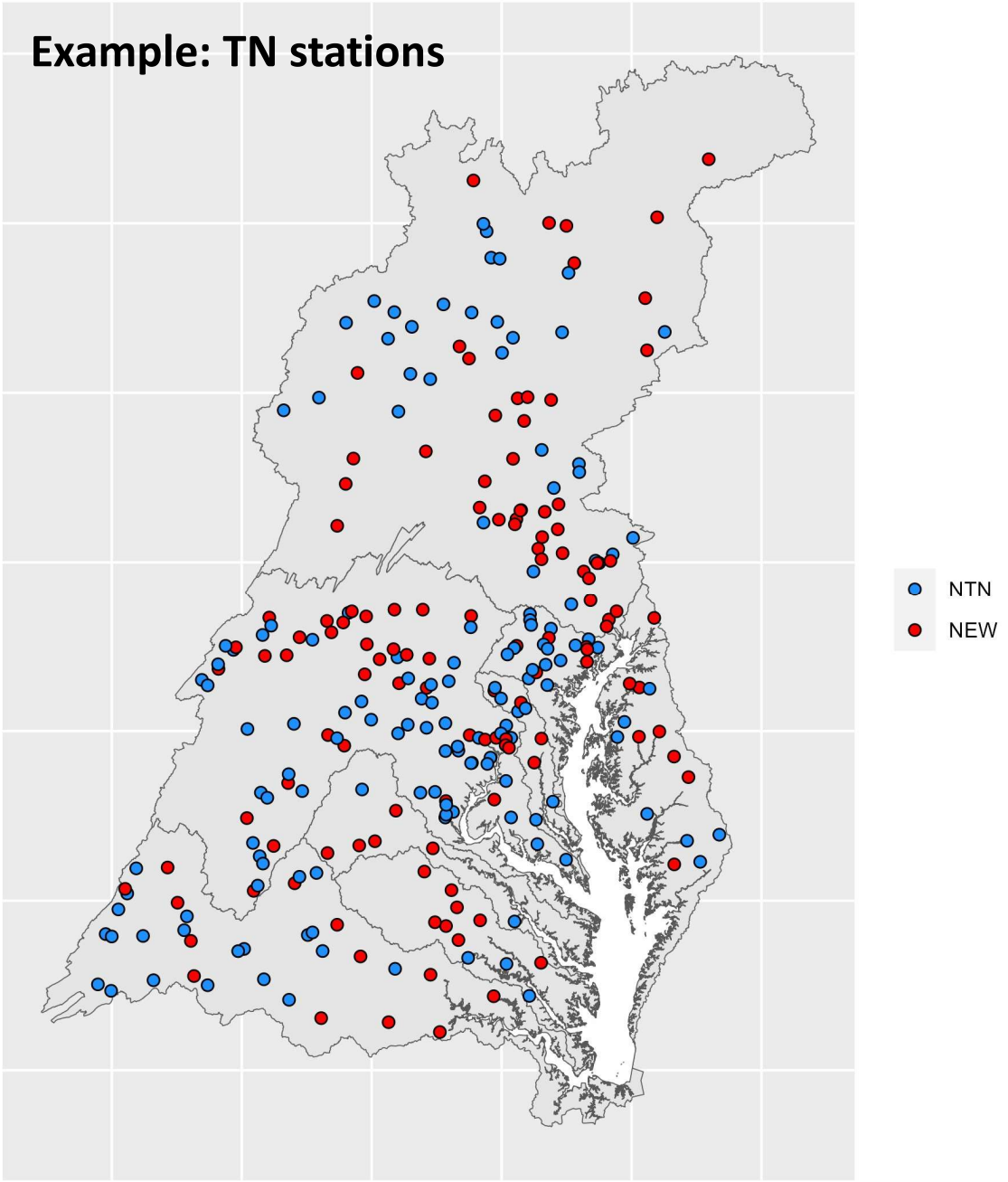
Modeling Workgroup Quarterly Review

04/02/2024

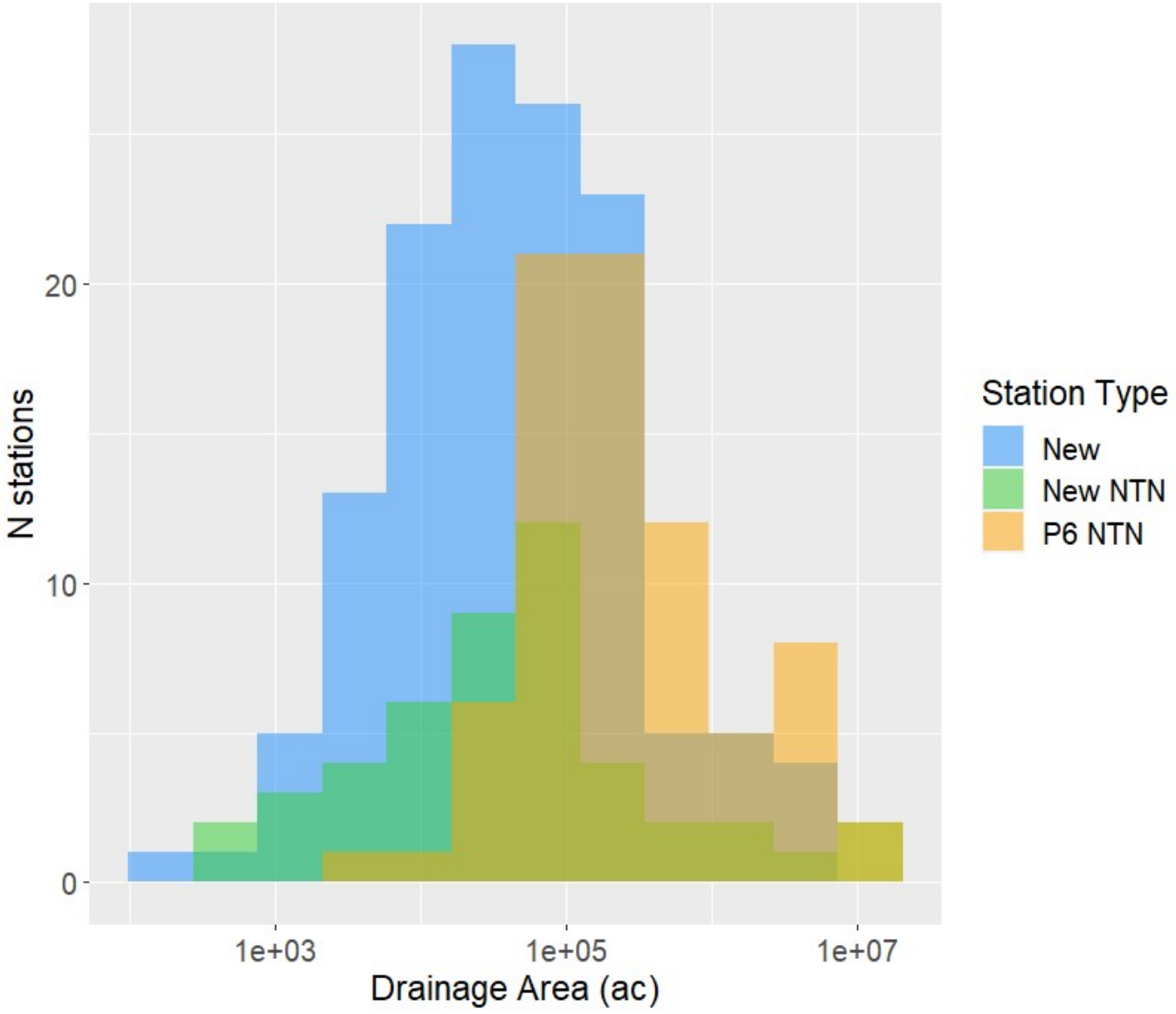
Current candidate set of CalCAST calibration stations

	P6 NTN	New NTN	NEW
TN	77	47	133
TP	77	33	119
SS	77	34	109



NTN: Non-tidal Network - https://www.usgs.gov/tools/geonarrative-nontidal-network-mapper

Variability in TN station drainage area



Streamflow – Average Annual

Model formulation

$$\sum_t Q_{g,t} = \sum_t \sum_c \left(\left(P_{c,t} - \sum_l PET_{l,c,t} \times LUP_l \right) \times \left(\prod_f (a_f \times V_{c,f}) \right) - W_{c,t} + I_{c,t} \right)$$

Flow at gauge g in year t

Precipitation in catchment c in year t

PET for land cover l in catchment c in year t

Land cover-specific PET parameter

Coefficient for factor f

Value of factor f in catchment c

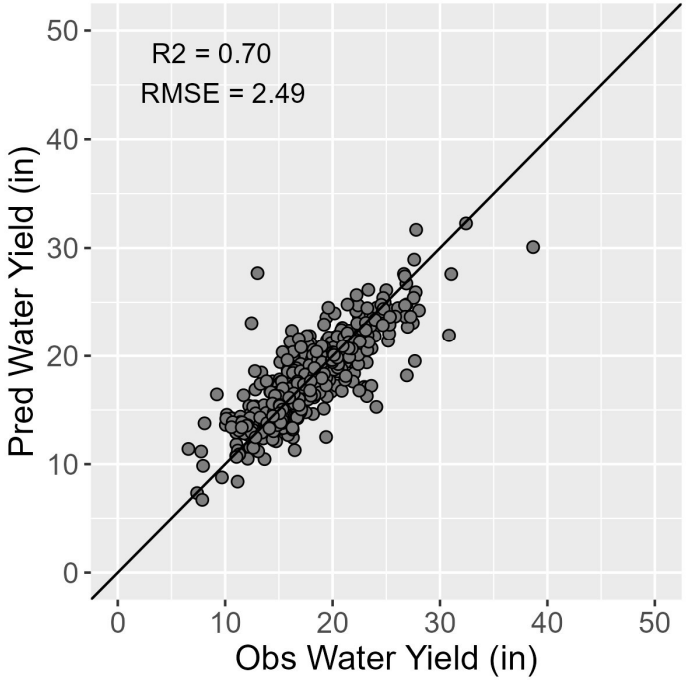
Withdrawals in catchment c in year t

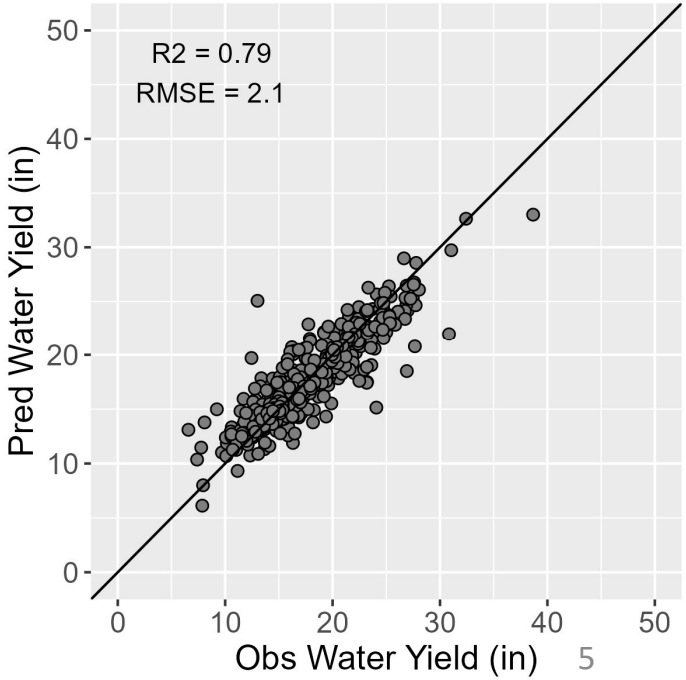
Direct loads in catchment c in year t

Streamflow – Average Annual

Best catchment predictors so far

Variable	Coef sign
Average Annual Temperature (degC)	-
Catchment elevation (m)	+
Hunt geology: Sandy and stony colluvium (%)	+
Anthracite Mine Land (%)	-
Hydrogeomorphic unit: Mesozoic Lowland (%)	+
Soller geology: sandy glacial till sediments (%)	+





% Stormflow – Average Annual

Stormflow/Total Flow:

$$SG_g = \frac{1}{A_g^a} \times \frac{\sum_l \sum_c \sum_t \left(SL_{l,c,t} \times R_{l,c,t} \right)}{\sum_l \sum_c \sum_t R_{l,c,t}}$$

- Fraction of stormflow at gauge g
- Drainage area of gauge g
- Drainage area coefficient
- Stormflow fraction for land use l, catchment c, year t
- Runoff for land use l, catchment c, year t

$$R_{l,c,t} = \sum_t \sum_c \left(P_{c,t} - \sum_l \left(PET_{l,c,t} \times LUP_l \times \prod_f \left(a_f \times V_{c,f} \right) \right) \right)$$

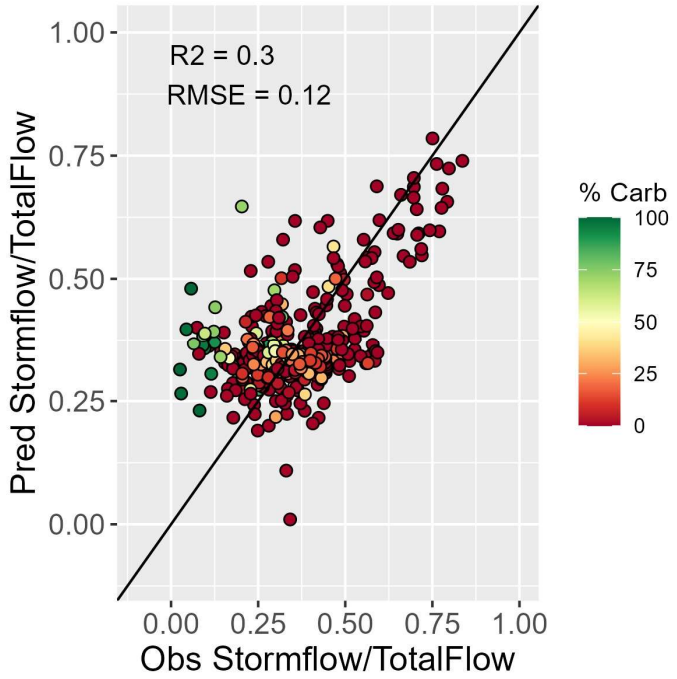
$$SL_{l,c,t} = SLG_l \times \prod_f \left(b_f \times VS_{c,f} \right)$$

- SLG_l: Stormflow fraction coefficient for land use l
- b_f: Coefficient for factor f
- $VS_{c,f}$: Value of factor f in catchment c

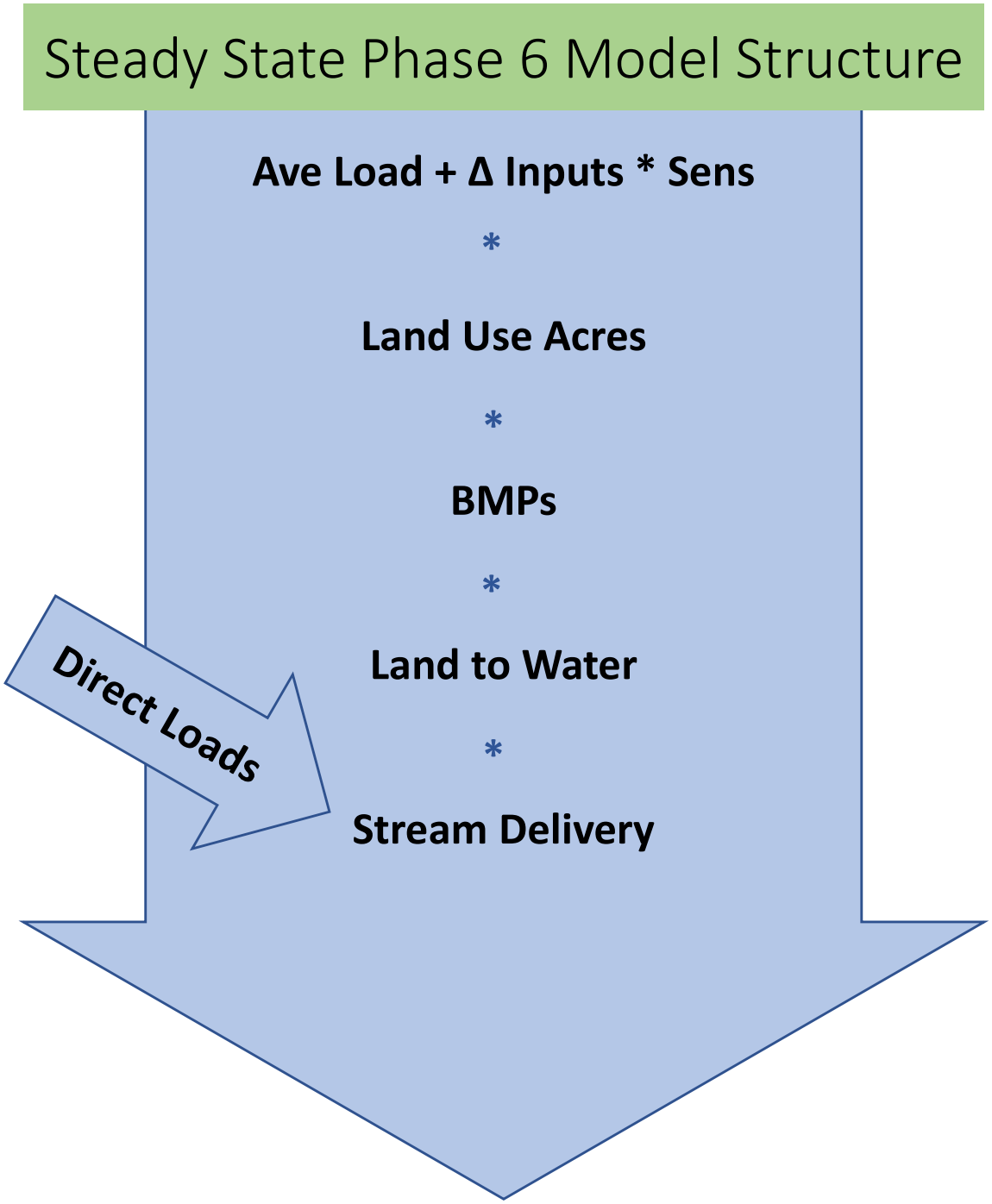
% Stormflow – Average Annual

Best catchment predictors so far

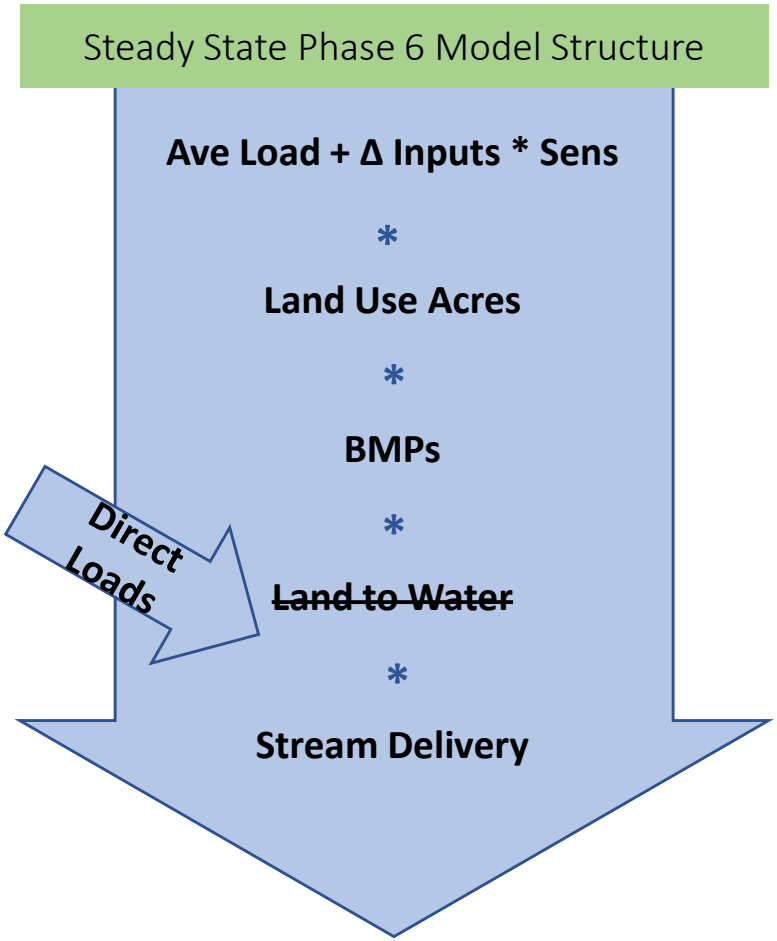
Variable	Coef sign
Olson Geology: Carbonate lithology (%)	-
Anthracite Mine Land (%)	-
Hydrogeomorphic unit: Blue Ridge (%)	-
Hydrogeomorphic unit: Mesozoic Lowland (%)	+
Well drained soil hydrologic group A (%)	-
Forest (%)	-
Groundwater age (years)	+

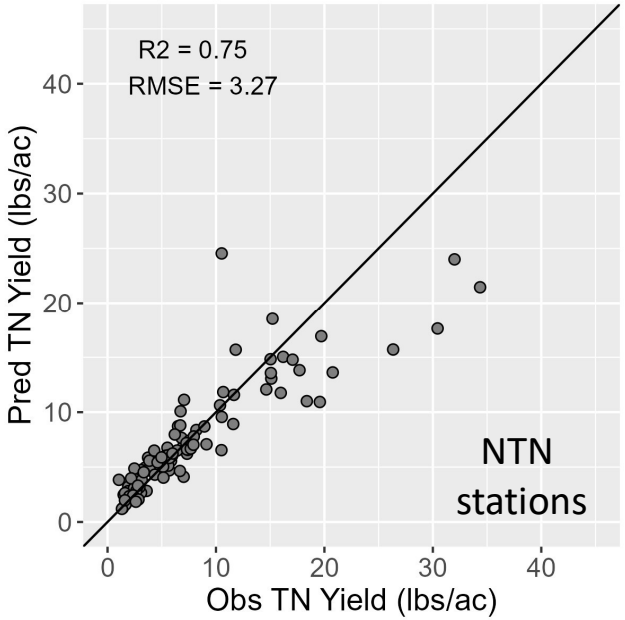


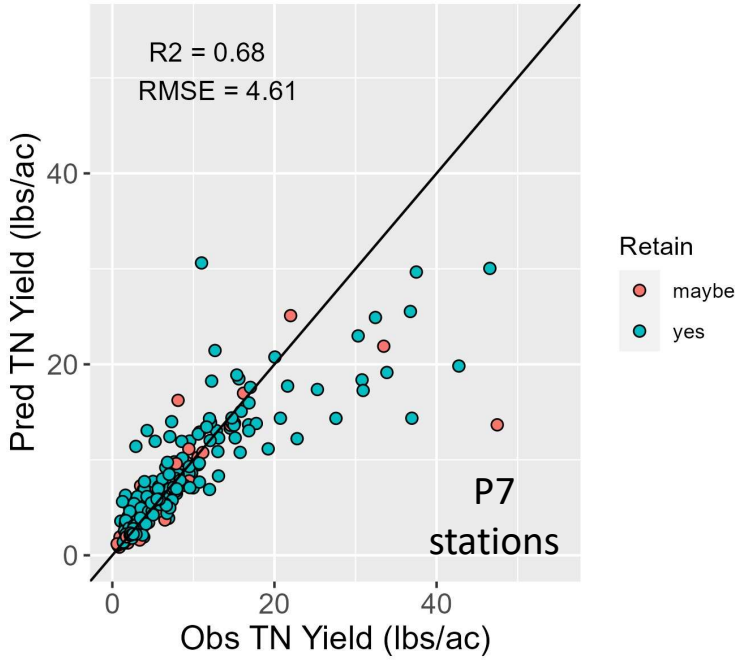
Nitrogen and Phosphorus – Average Annual



Total Nitrogen - Average Annual



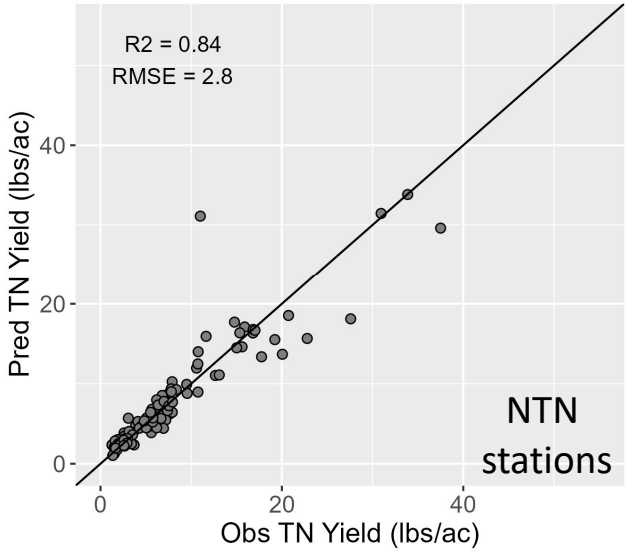


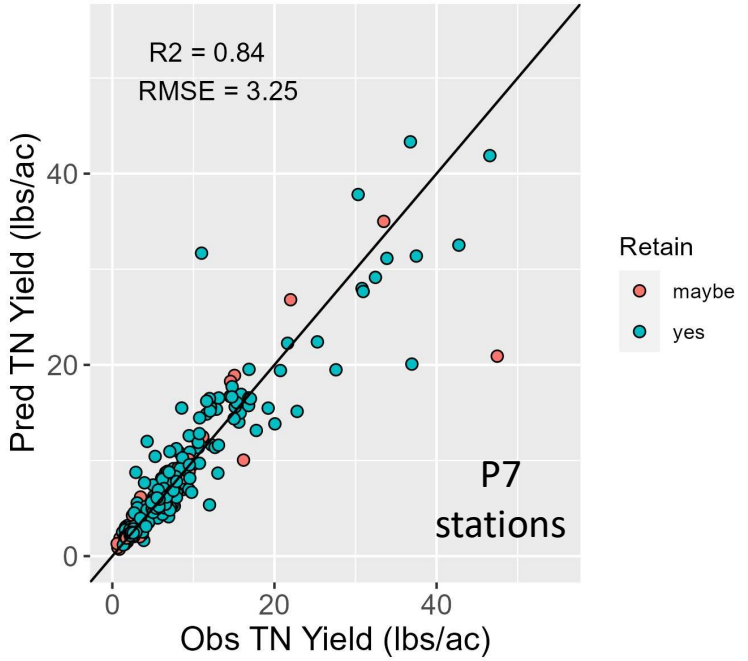


Total Nitrogen – Average Annual

Best catchment predictors so far

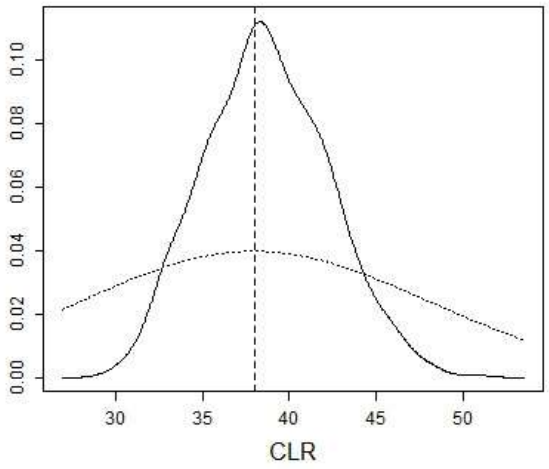
Variable	Coef sign
Hydrogeomorphic unit: Piedm. Carbonate (%)	+
Groundwater recharge (mm)	+
Hydrogeomorphic unit: Coastal Plain (%)	-
Anthracite Mine Land (%)	-

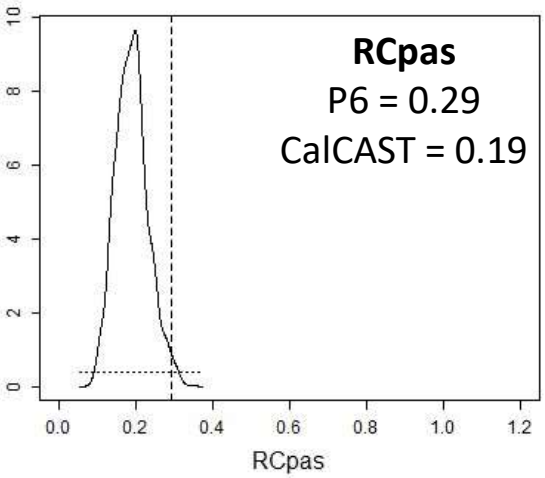


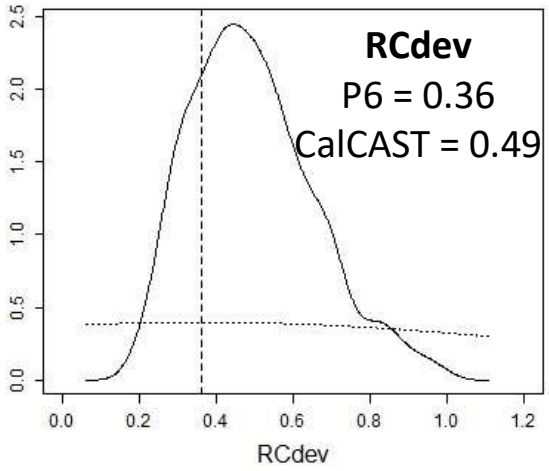


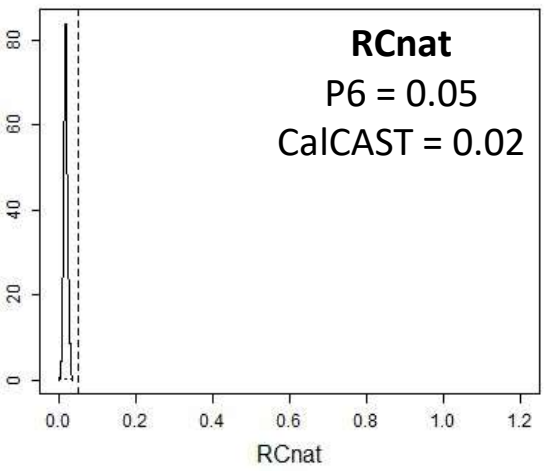
Total Nitrogen – Average Annual

CLR
P6 = 38 lbs/ac
CalCAST = 38.71 lbs/ac









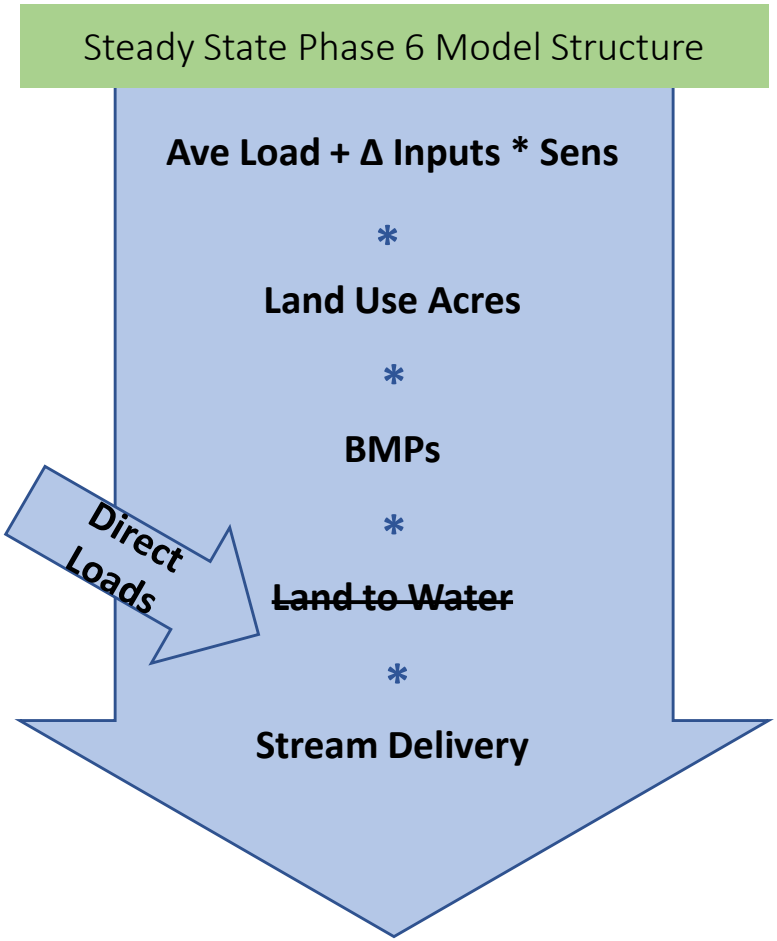
Steady State Phase 6 Model Structure

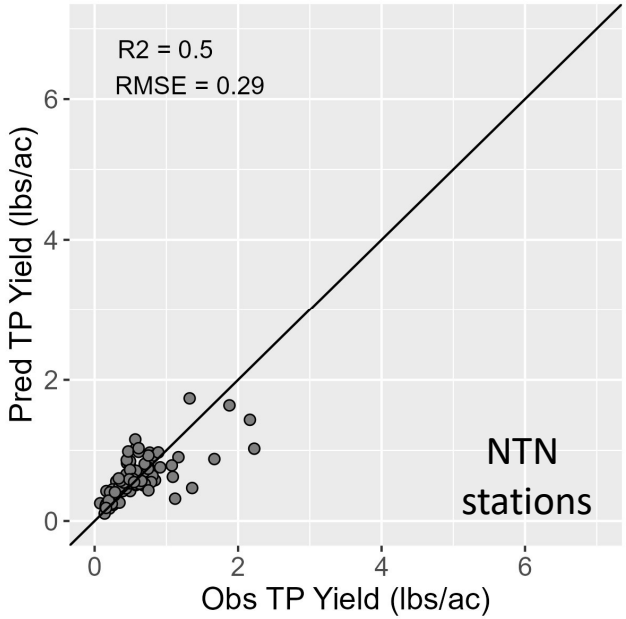
Ave Load + Δ Inputs * Sens

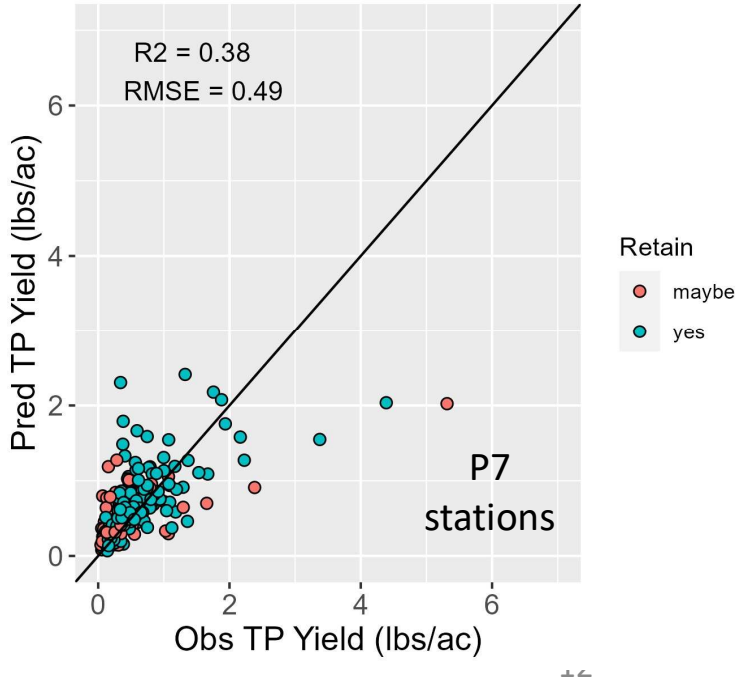
$$\mathbf{Ave}_{\boldsymbol{l}} = \mathbf{CLR} \times \mathbf{RC}_{\mathbf{cl_l}} \times \mathbf{RL_l}$$

l: land use
cl: broad land class (PAS, DEV, NAT, CRP)

Total Phosphorus - Average Annual



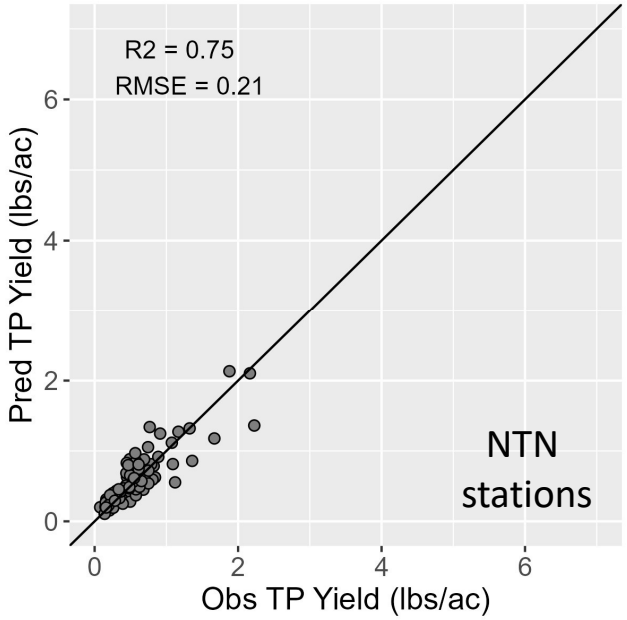


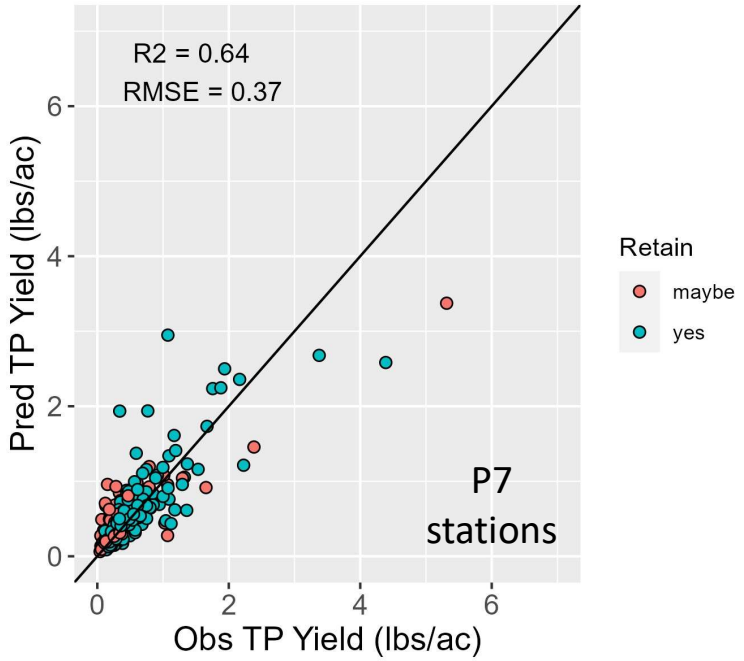


Total Phosphorus – Average Annual

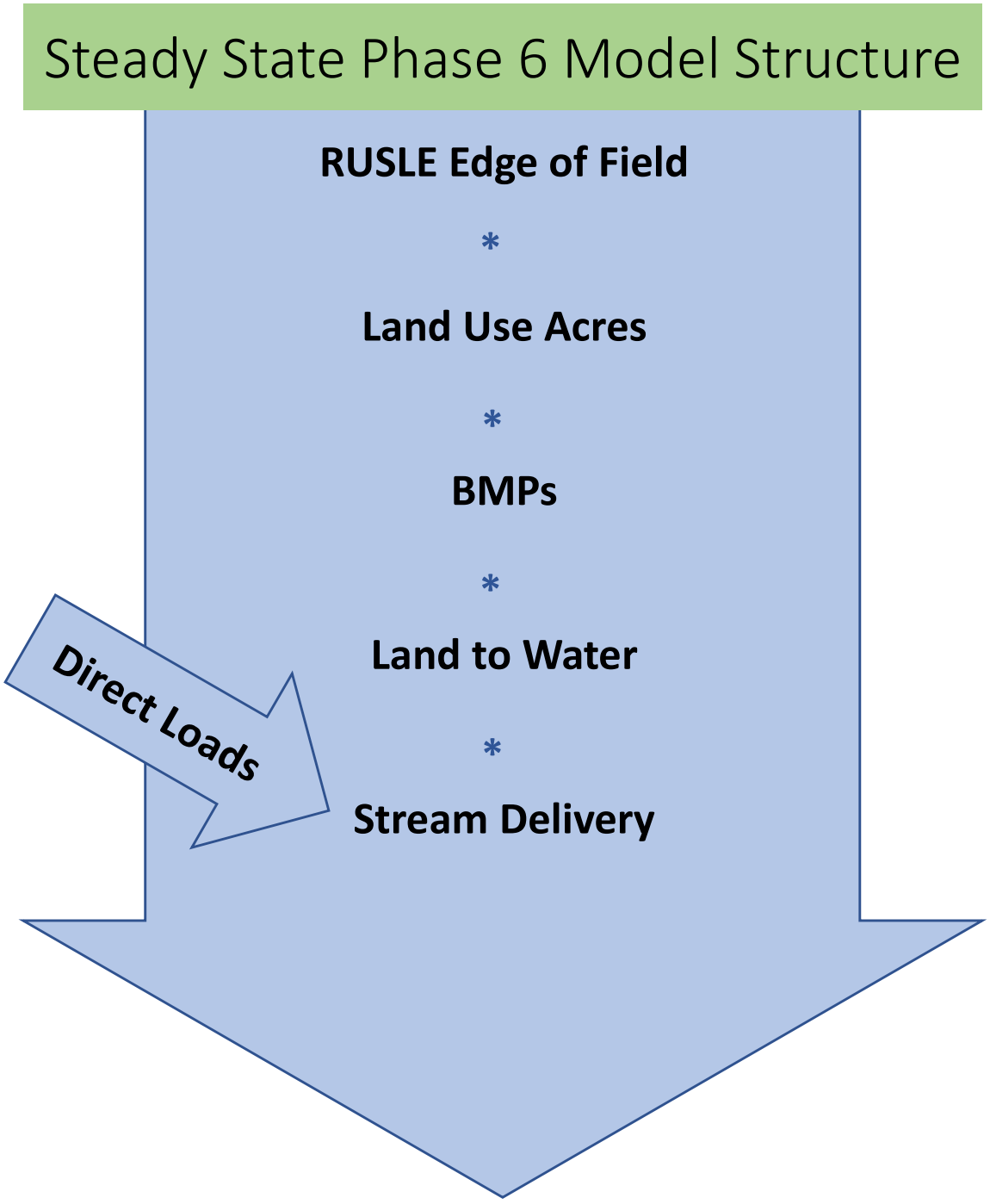
Best catchment predictors so far

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

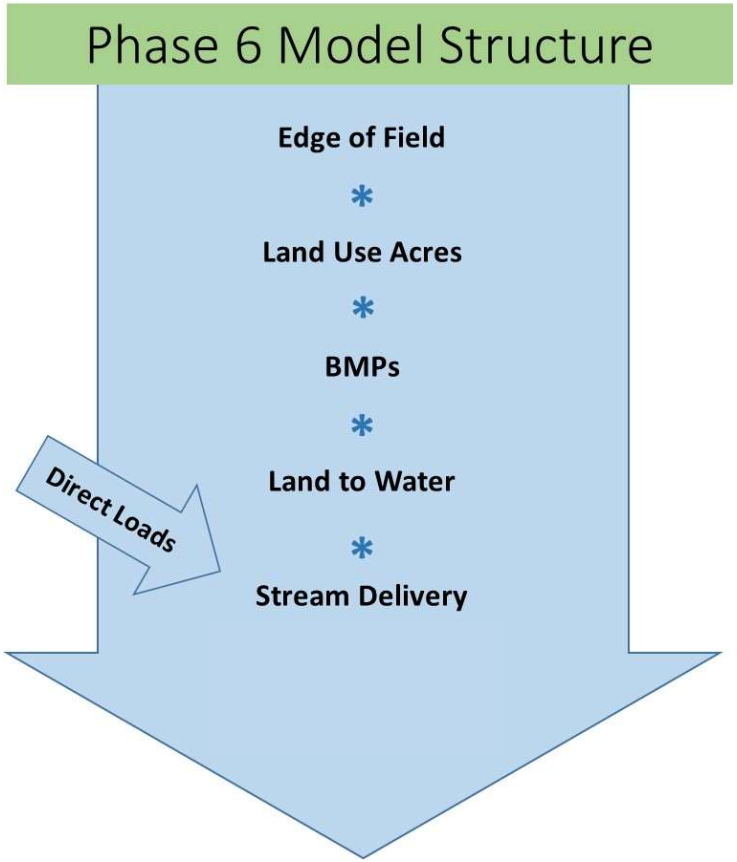


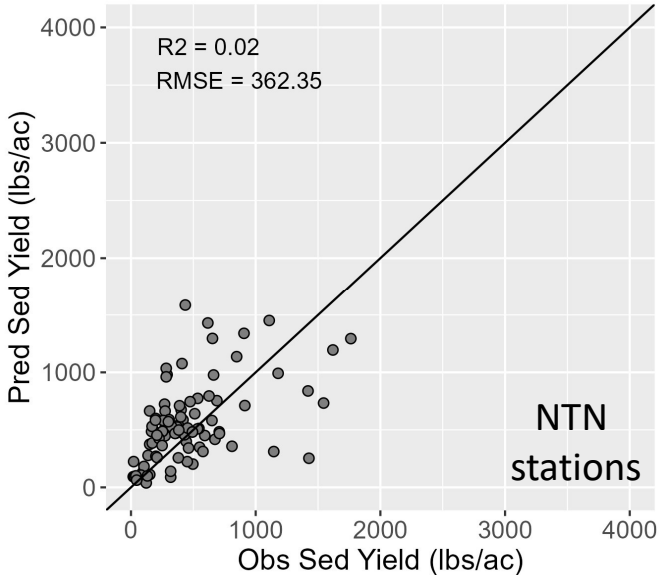


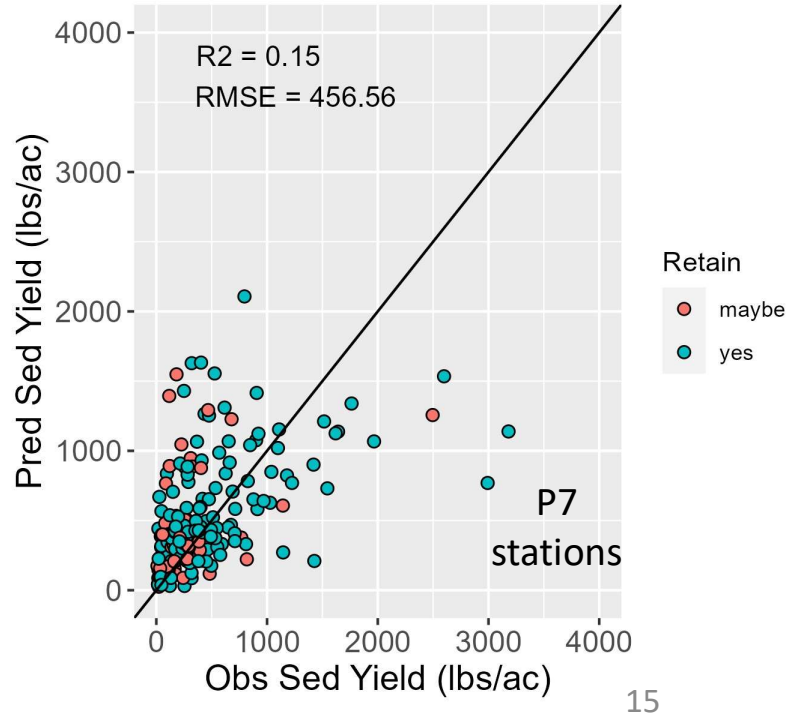
Sediment – Average Annual



Sediment - Average Annual



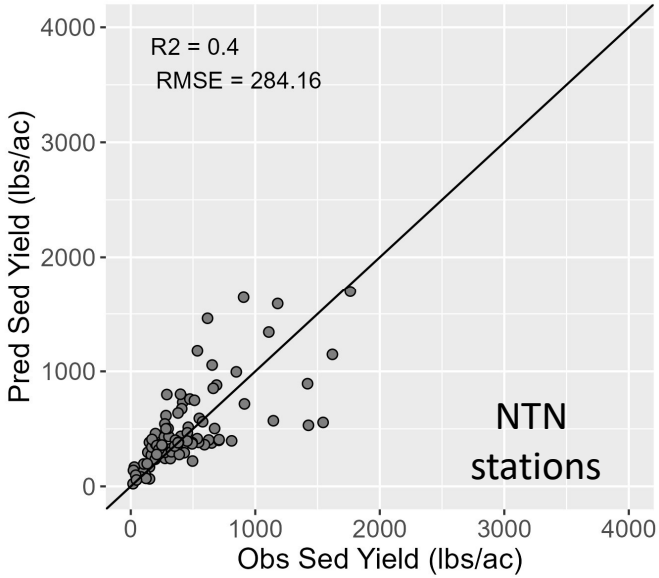


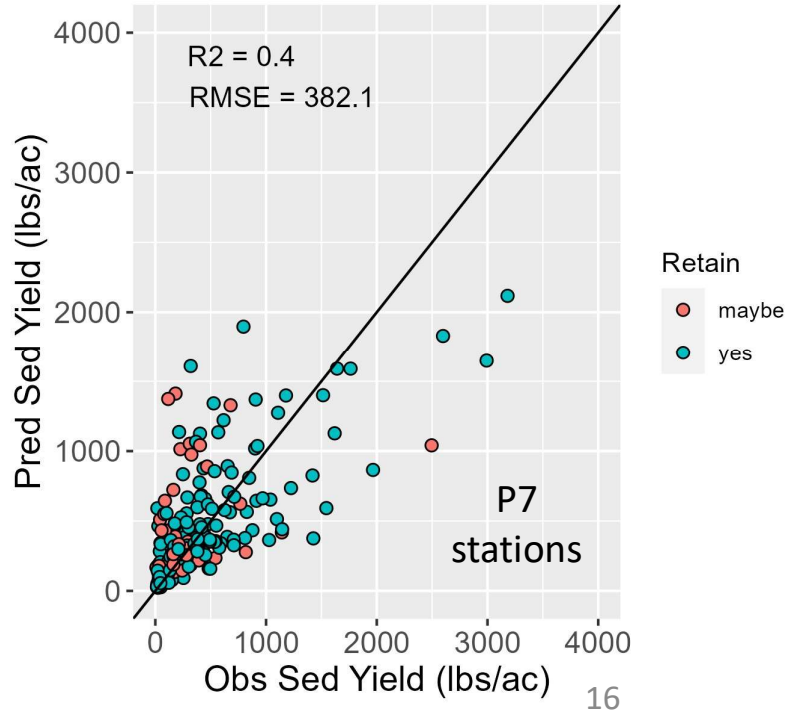


Sediment – Average Annual

Best catchment predictors so far

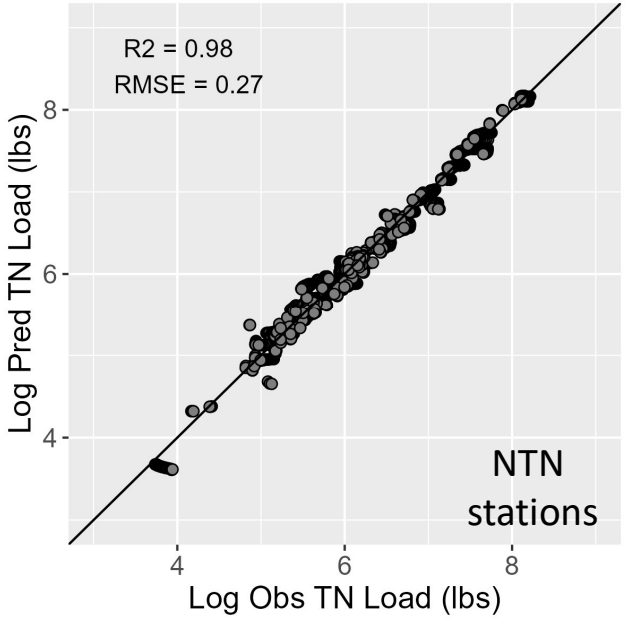
Variable	Coef sign
Baseflow index (%)	-
Forest (%)	+
Impervious non-roads (%)	-



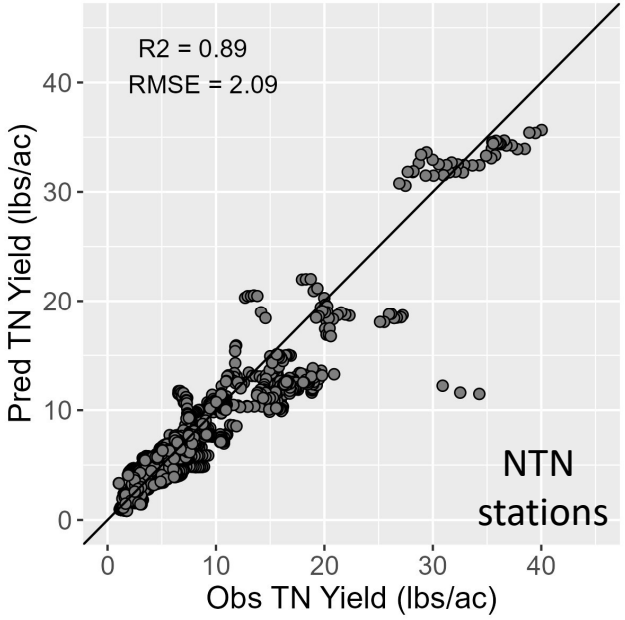


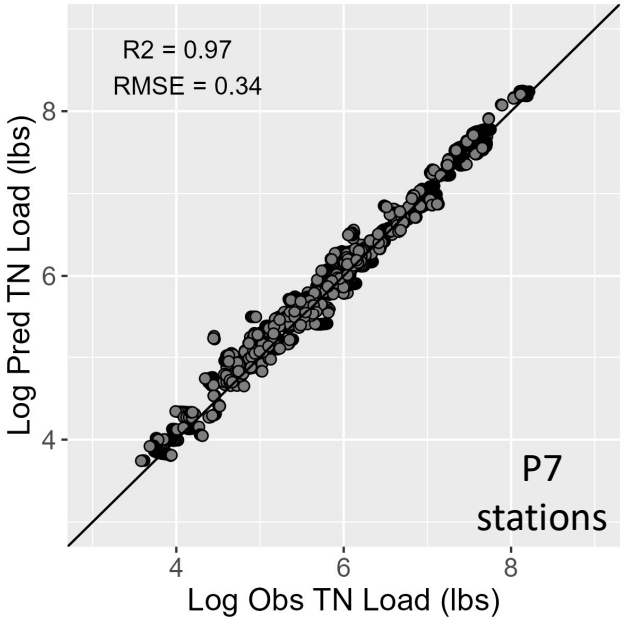
Total Nitrogen – Annual (Flow-Normalized)

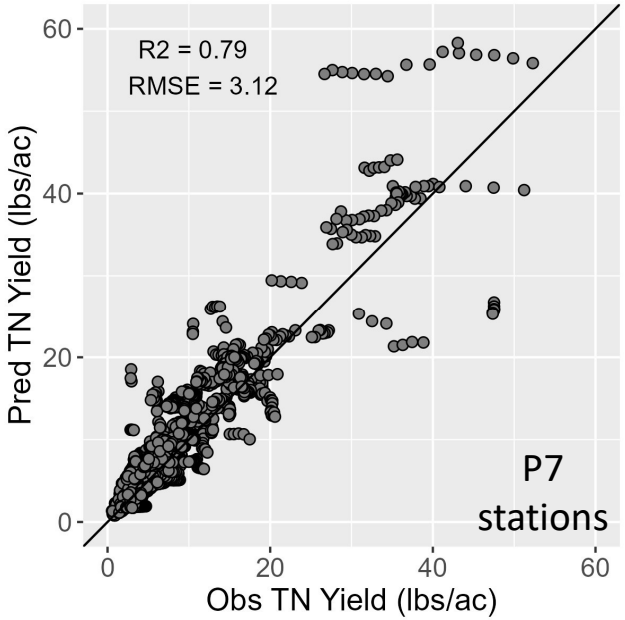
TN load



TN yield







Next Steps

- Improve all CalCAST models, with a focus on
    - TP model
    - SS model
    - Annual models

- Examples of areas of potential improvement/refinement:
    - Inputs
    - Sensitivities
    - Land to water / Stream delivery
    - Uncertainty in calibration loads
    - Lag formulation (annual models)

- *Continue refining calibration dataset (e.g., Hampton Roads stations, feedback from VADEQ)*