# Using SPARROW to Represent Land-to-Water and Stream-to-River Processes

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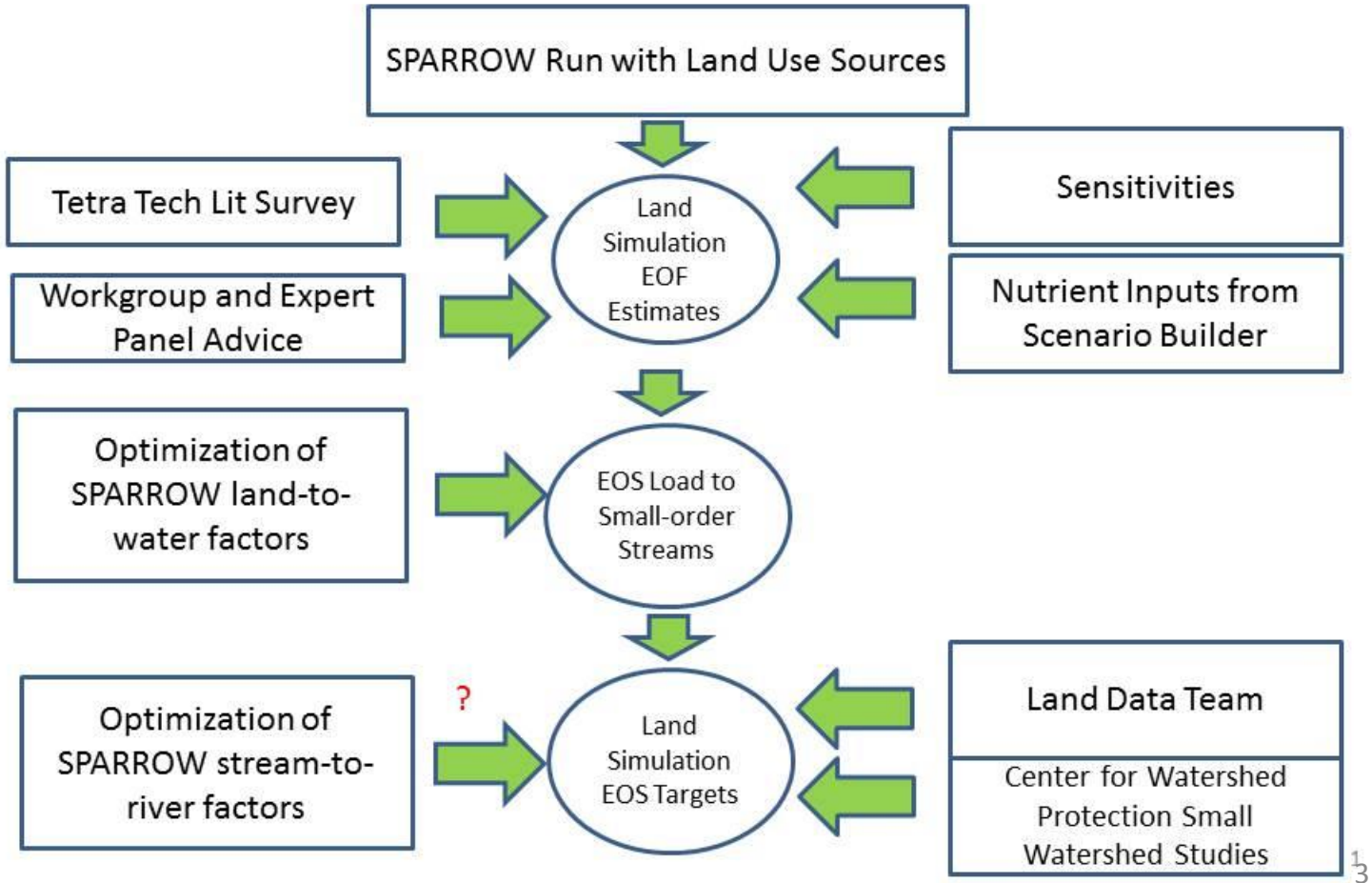
This work is supported by MDE who do not necessarily endorse its content

# Topics

- Planned SPARROW runs to calculate land-to-water (LTW) delivery factors and (maybe) stream-to-river (STR) delivery factors
- Test implementation of SPARROW LTW and STR delivery factors in p6*

# Land Simulation Development

| Scale |
| --- |
| Field |
| Hillslope Watershed |
| Small-order streams |



# Goal and Strategy

- Goal: Replace p5 Regional Factors with Land-to-Water (LTW) and Stream-to-River (STR) Delivery Factors
- Strategy: USGS will perform SPARROW simulations which
  - Replace current sources (manure, fertilizer, atmospheric deposition) with p6 EOF targets at NHD+ catchment scale
  - Fix source coefficients = 1 so SPARROW EOF load is same as p6 EOF load
  - Aggregate SPARROW results to land-river segment (LRS) scale

# SPARROW
# Estimated Equation

$$\text{Load}_i = \left\{ \sum_{j \in J(i)} \left[ \sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \exp(-\delta' T_{i,j}) \right\} \exp(\epsilon_i)$$

**Stream Load**

**Sources**

**Land-to-water transport**

**Aquatic transport**

**Error**

**Nutrient Models**
Fertilizer
Animal Wastes
Atmosphere (TN)
Industrial & Municipal Wastes
Nonagricultural Diffuse Sources
Land Use

Soil Permeability
Slope
Stream Density
Temperature (TN)

Streamflow
Water Velocity
Channel Length
Reservoir Hydraulics

USGS science for a changing world

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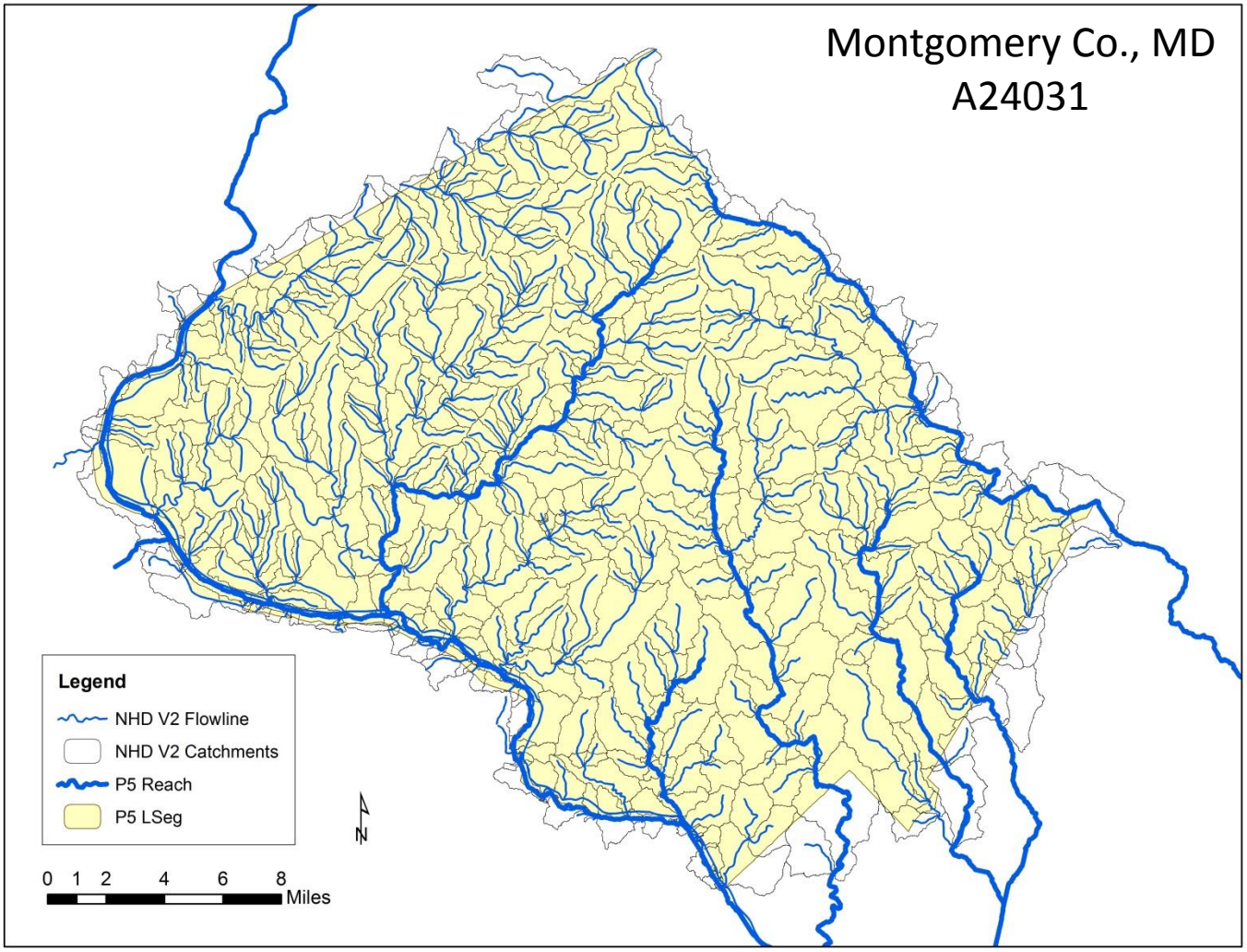
Smith et al., (2002) Overview of SPARROW Modeling
http://water.usgs.gov/orh/nrwww/National_sparrow_overview.pdf

# SPARROW Scale vs. P6 Scale



# Specification of SPARROW Run to Set Land-to-Water (and Stream-to-River) Delivery Factors

| Scale | SPARROW Input | SPARROW Output | P6 |
|---|---|---|---|
| Field | P6 EOF targets on land segment basis | Keep Fixed | EOF Loads |
| Hillslope Watershed | Land-to-Water Delivery Factors | Calibrate with SPARROW | Land-to-Water Delivery Factors |
| Small-order streams | NHD+ Streams | Calibrate with SPARROW or Fix with CWP/Land Data Team Information | Small-Stream Processes |
| Large-order Streams | NHD+ Rivers | | Reach Simulation |

# Test Implementation of LTW/STR Delivery Factors in P6*

- Test Implementation Features:
  - Use EOS loads from p6* (provisional operational version)
  - Calculate LTW and STR delivery factors from current (CB_v4) SPARROW models
  - Replace Regional Factors with LTW and STR delivery factors
- Goal: Test of machinery
  - Extract relevant info from SPARROW
  - Recalculate to land-river segment scale
  - Input into p6 modeling framework

# Current (CB_v4) SPARROW Factors

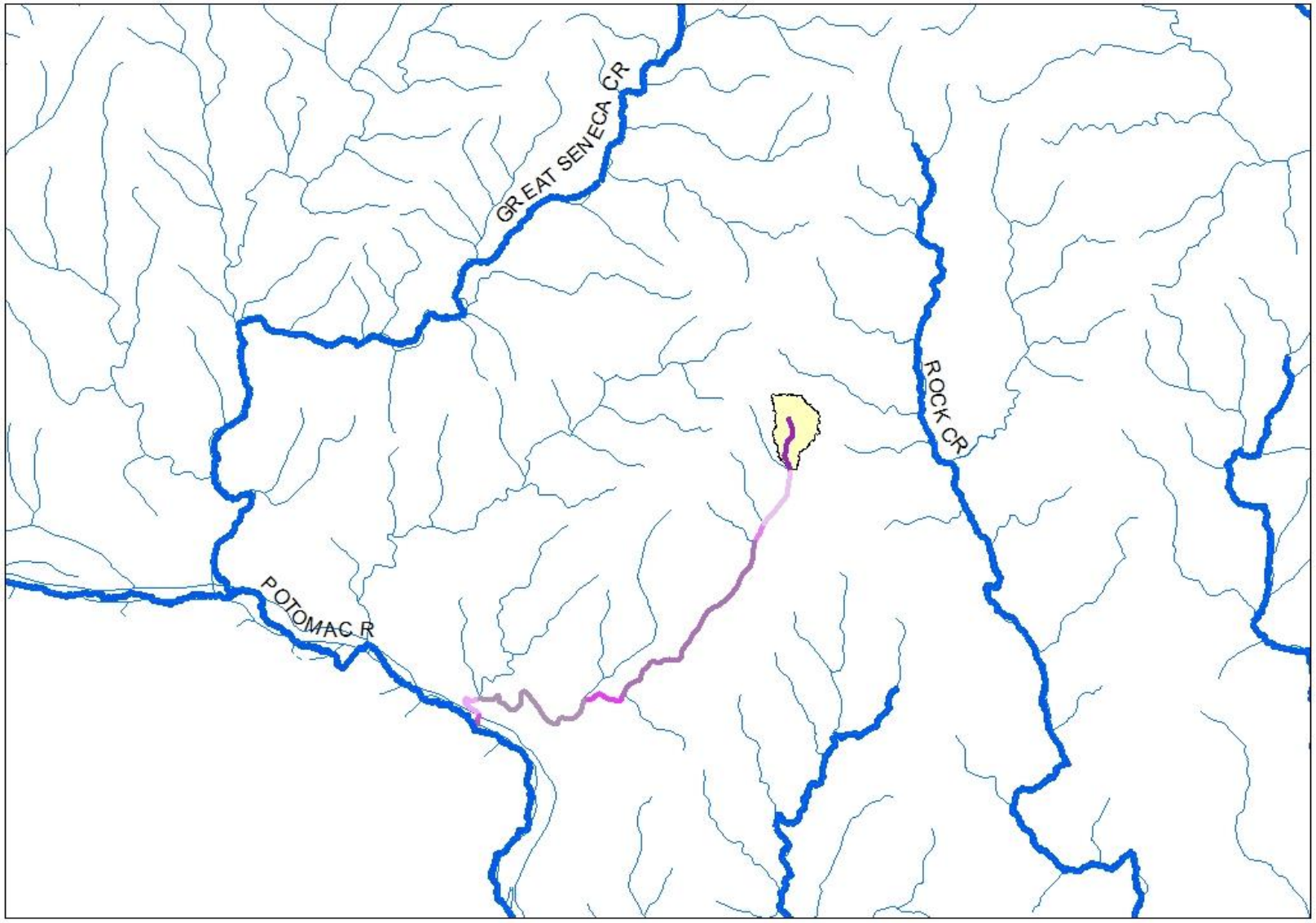
| Nitrogen | | Phosphorus | |
|---|---|---|---|
| **Factor** | **Coefficient** | **Factor** | **Coefficient** |
| **Land-to-Water** | | | |
| Ln[Enhanced Vegetative Index] | -1.70 | Soil erodibility | 6.25 |
| Ln[Soil Available Water Capacity] | -0.829 | Ln[percent well-drained soils] | -0.100 |
| Ln[Groundwater Recharge] | 0.707 | Fraction Area in Coastal Plain | 1.02 |
| Ln[Percent Piedmont Carbondate] | 0.158 | Ln[precipitation] | 2.06 |
| **Stream-to-River (Aquatic Decay)** | | | |
| Impoundments<br>(Inverse hydraulic load yr/m) | 5.93 | Impoundments<br>(Inverse hydraulic load yr/m) | 54.3 |
| Streams, travel time (d)<br>Small<br>(mean average flow <3.45 cms)<br>Large T30 >18.5 °C<br>Large T30 < 15 °C | <br><br>0.339<br>0.153<br>0.0131 | Streams | none |

# Land-to-Water Delivery Factor Calculation Steps

- Calculate LTW Delivery Factor based on component factors and SPARROW coefficients at NHD+ catchment scale.
- Calculate LTW Delivery Factor at Land-River segment scale as weighted-average (by area) of catchments in land-river segment

# Stream-to-River Delivery Factor Calculation Steps

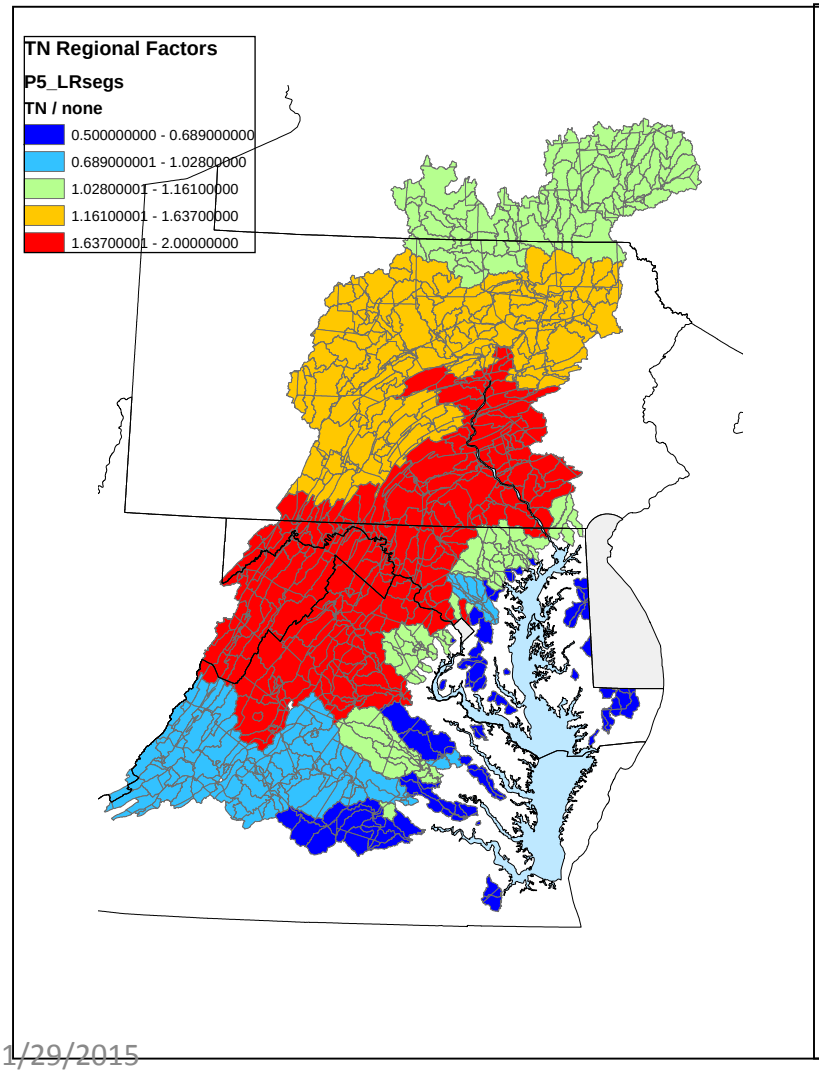
- Compute delivery (1- loss rate) for each NHD+ reach from SPARROW load output
- Create table with all pairs of NHD+ reaches with upstream-downstream relation restricted to:
  - Reaches smaller than represented in p6
  - Non-tidal (no 0000) only
- For each catchment, calculate downstream delivery to p6 reach (by aggregating log of delivery in downstream direction)
- Assume homogeneous loading rate for all catchments in river reach (not true)

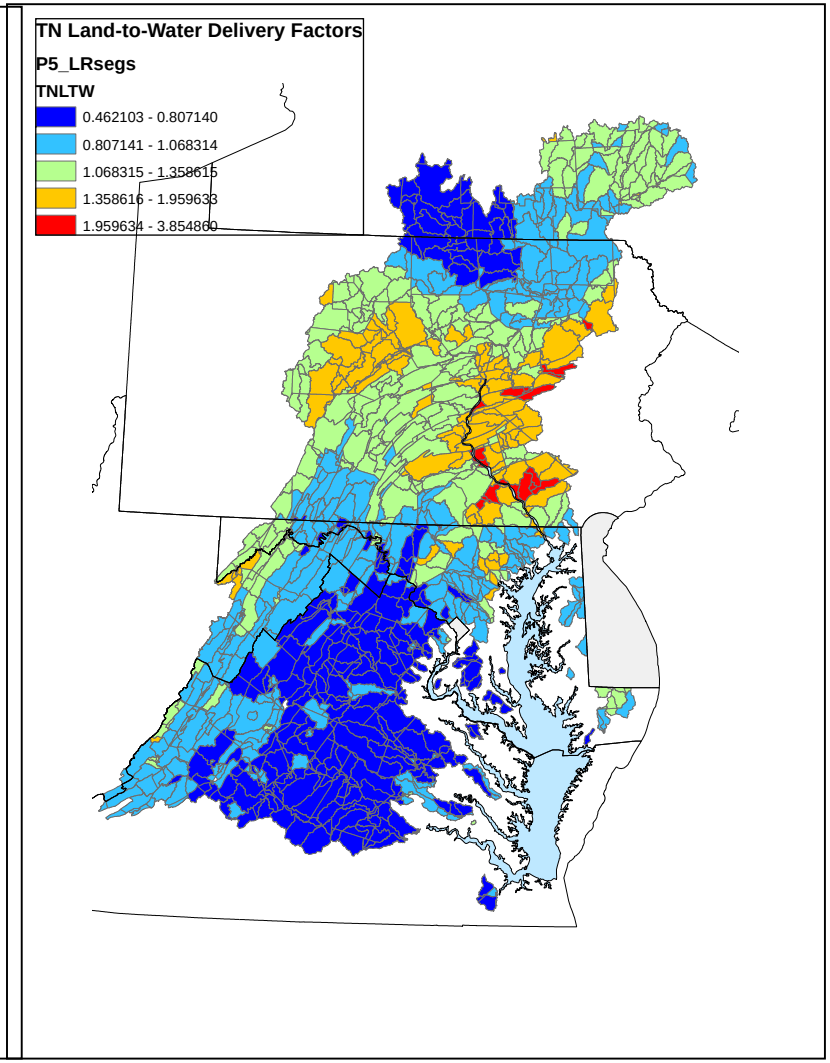

GREAT SENECA CR
ROCK CR
POTOMAC R

# Results

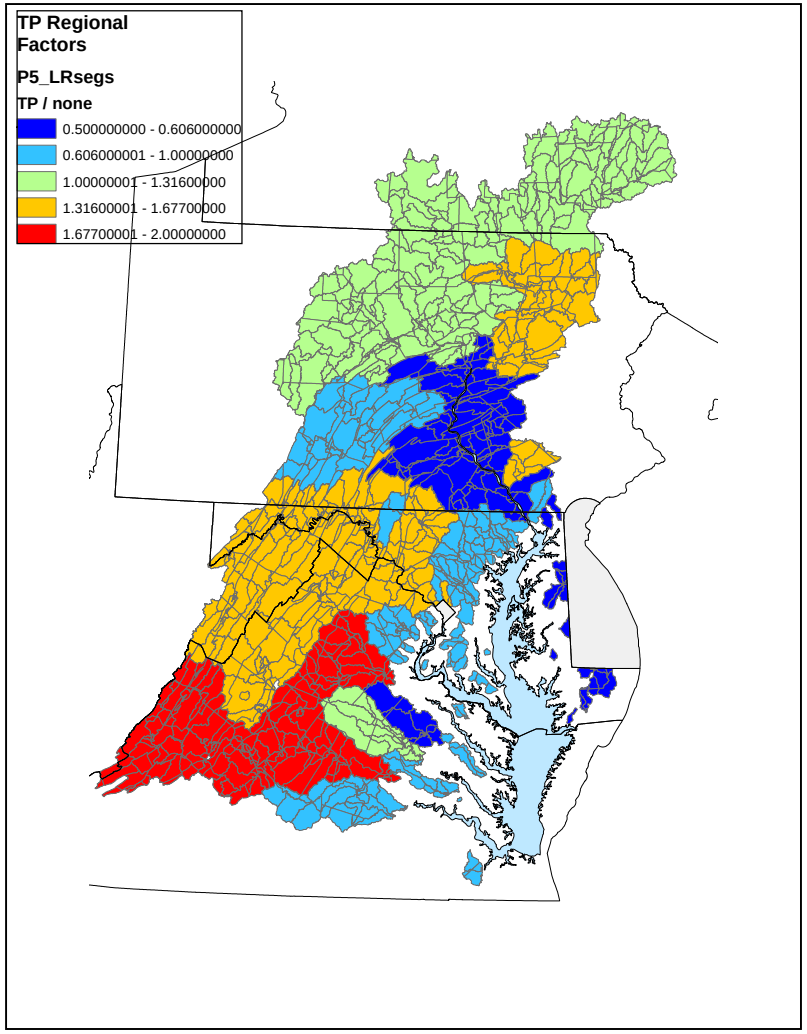
- Land-to-Water Delivery Factors
  - Do not show same geographic variability as Regional Factors
  - Some values > 2
- Stream-to-River Delivery Factors
  - Values close to 1
  - Do not show much geographic variability
  - Function of stream network density, river segment size

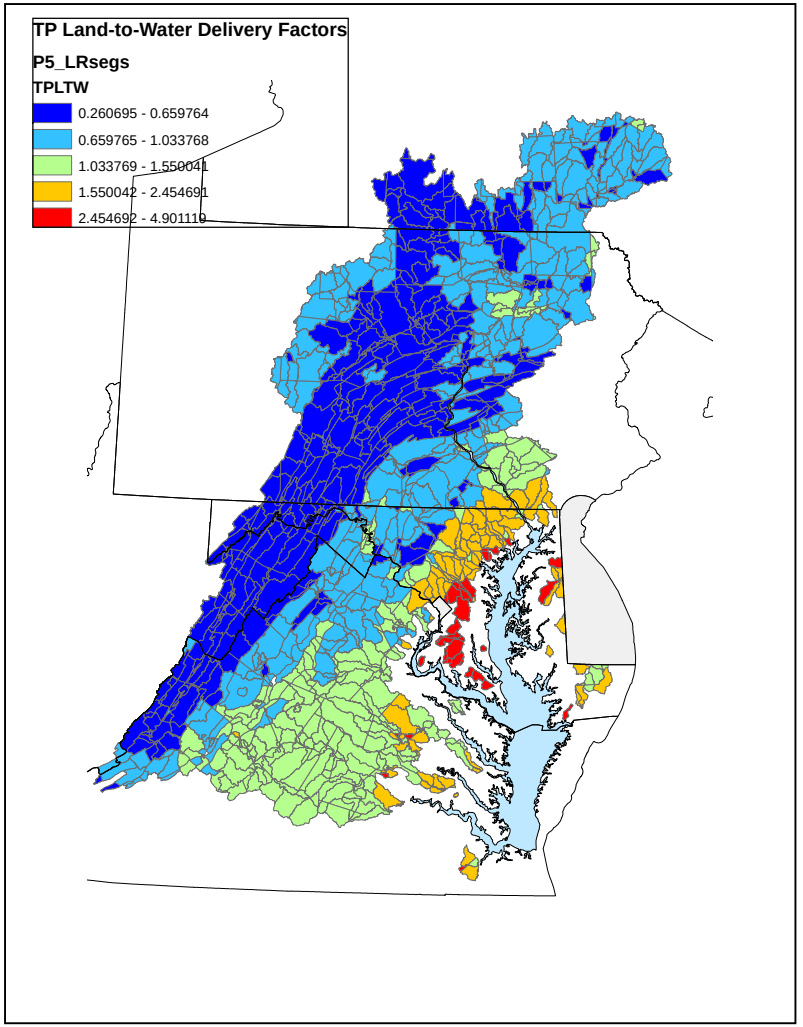
# TN Land-to-Water Delivery Factors



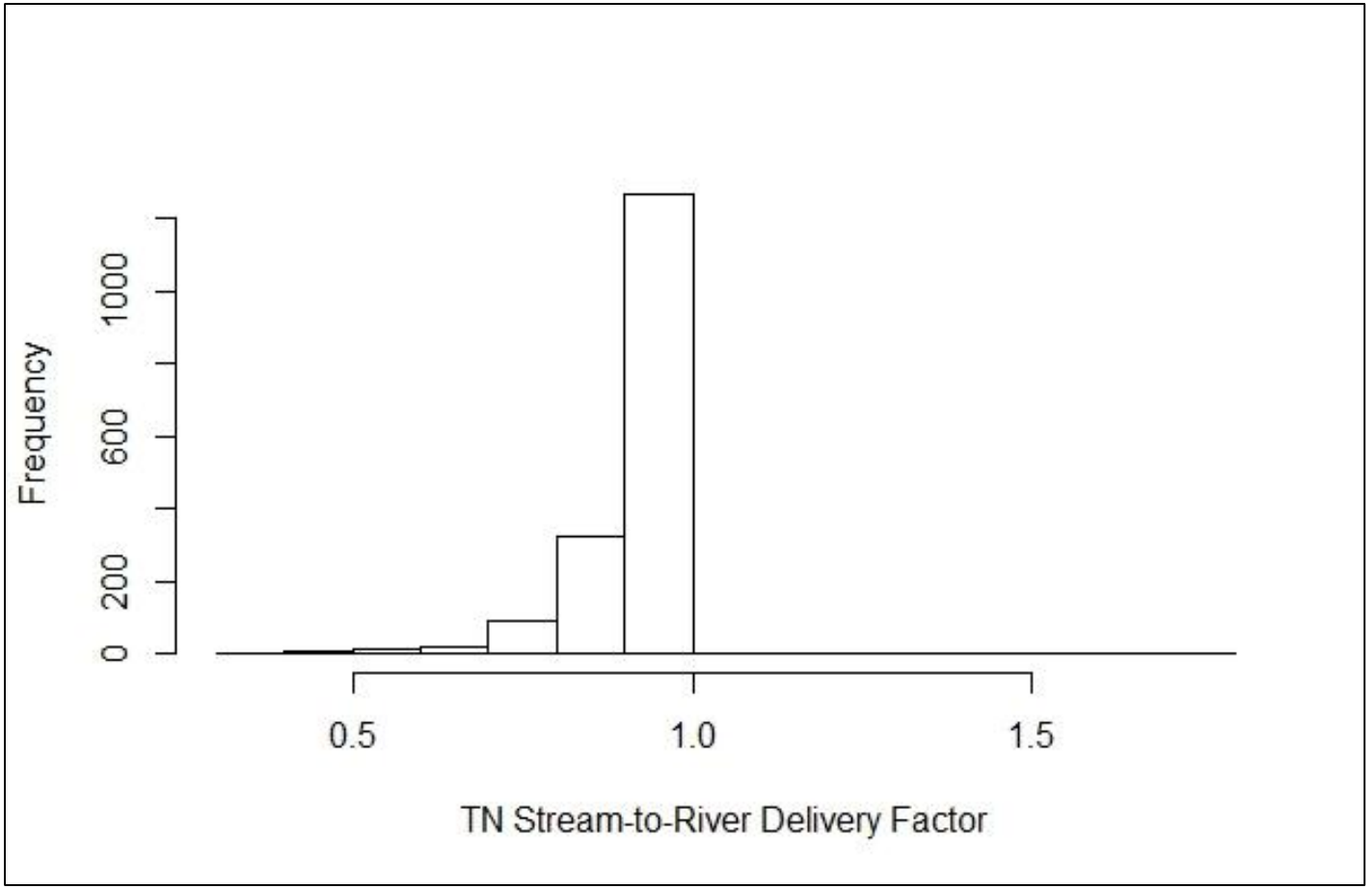



# TP Land-to-Water Delivery Factors

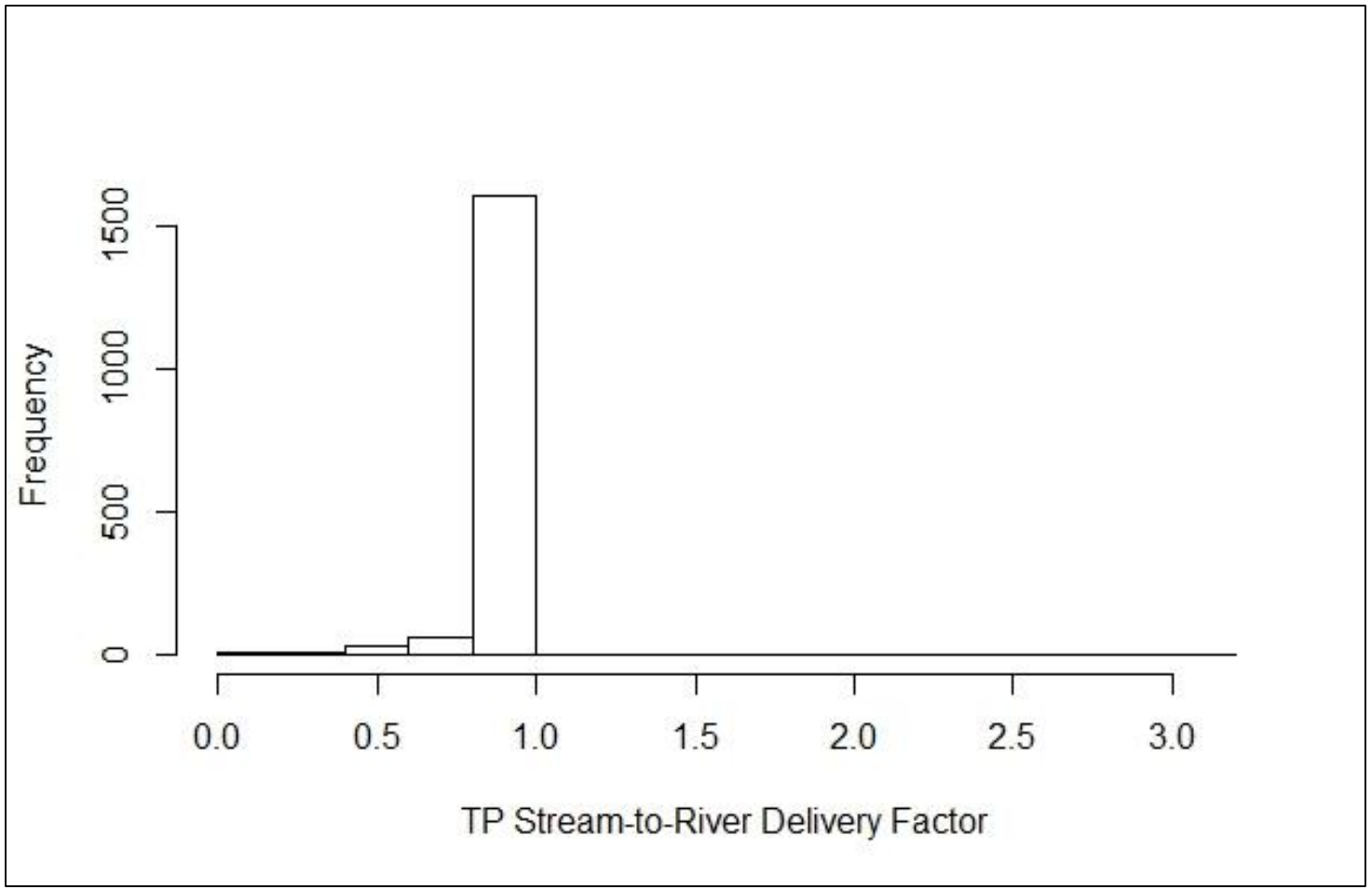


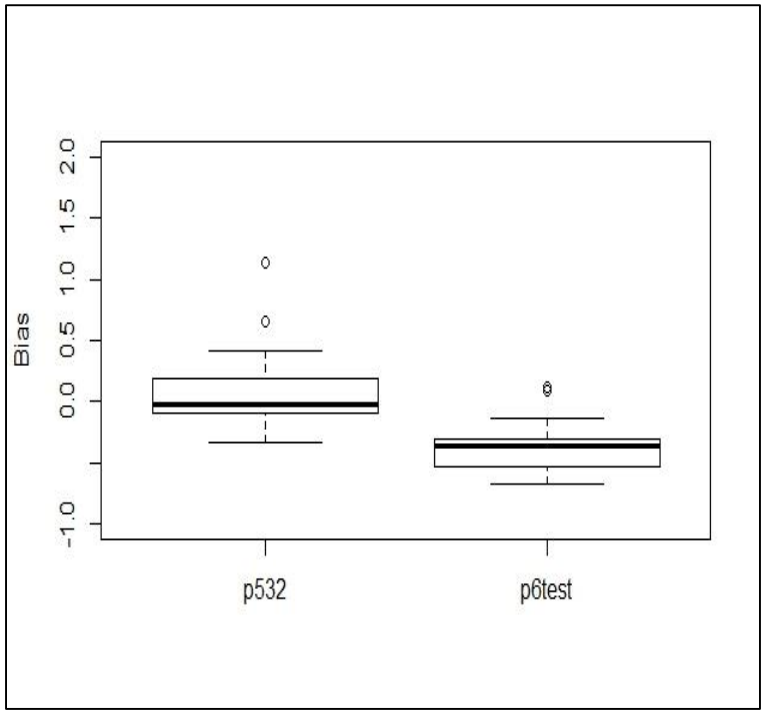
# TN Stream-to-River Delivery Factors

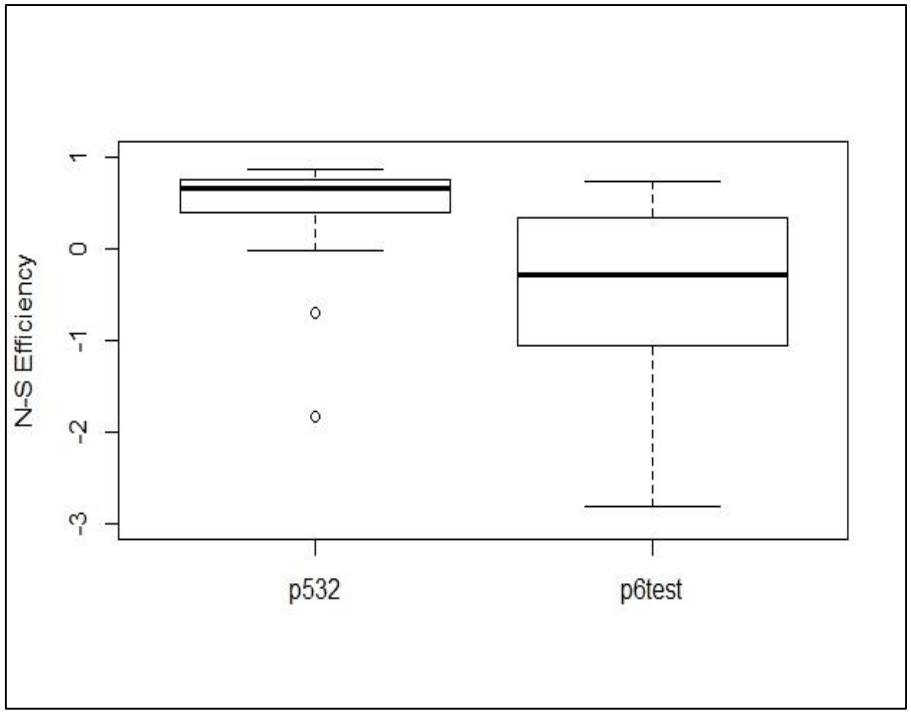


# TP Stream-to-River Delivery Factors

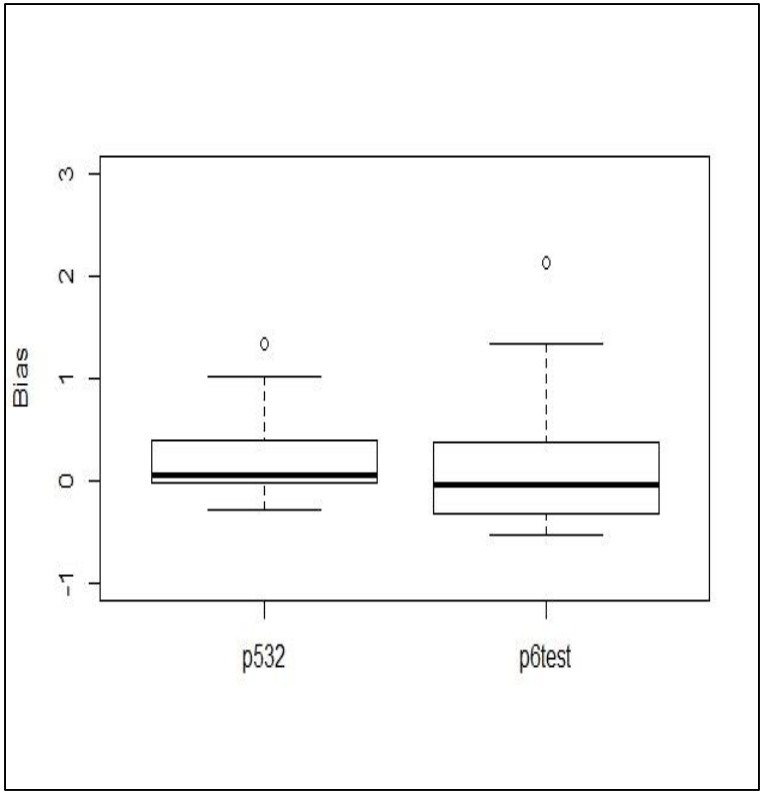


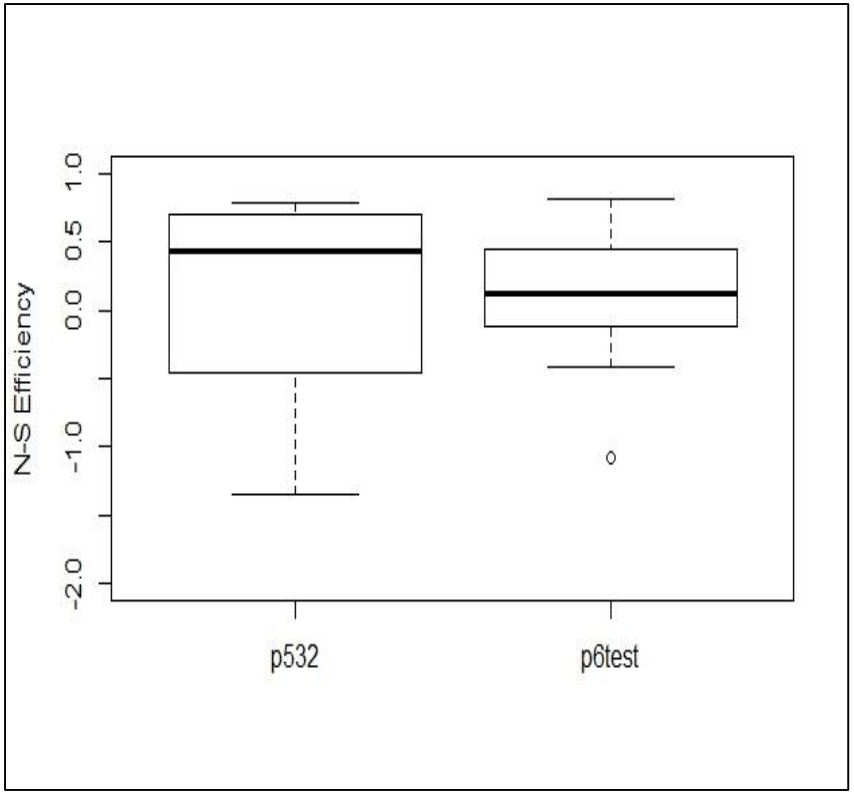
# Simulated Annual TN Loads vs. ESTIMATOR



# Simulated Annual TP Loads vs. ESTIMATOR



# Contact Information

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