REGIONAL PATTERNS AND DRIVERS OF NITROGEN TRENDS IN A HUMAN-IMPACTED WATERSHED AND MANAGEMENT IMPLICATIONS

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AGU FALL MEETING

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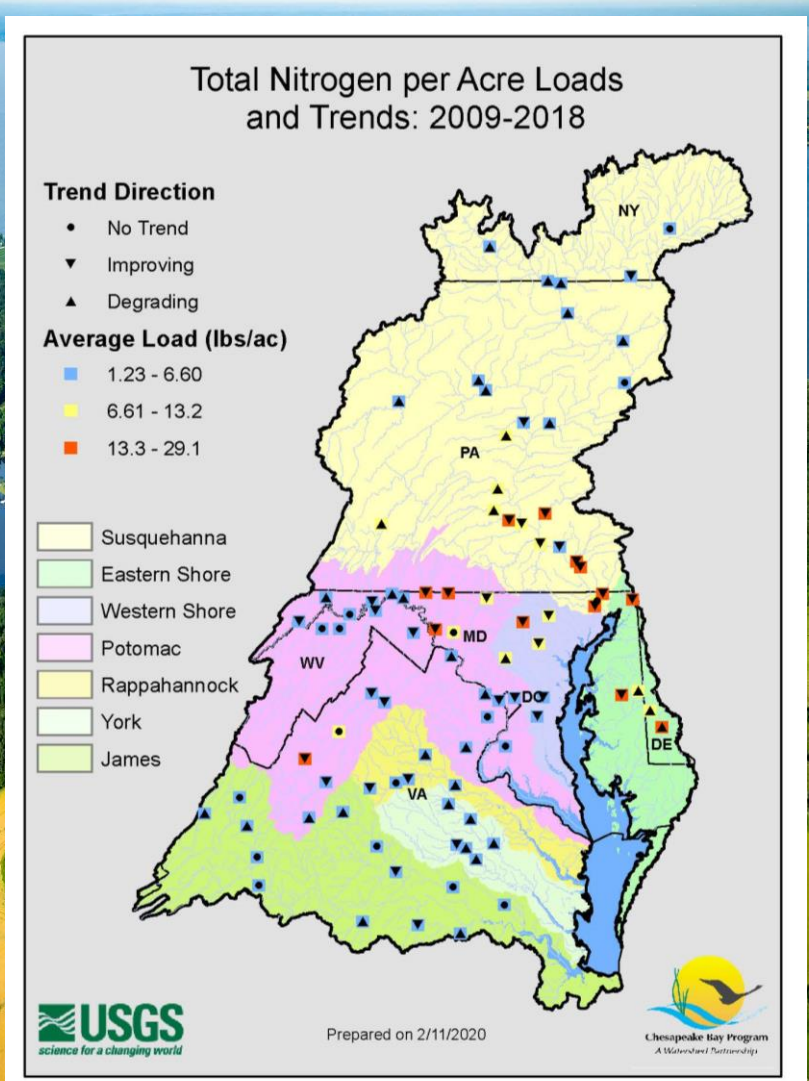
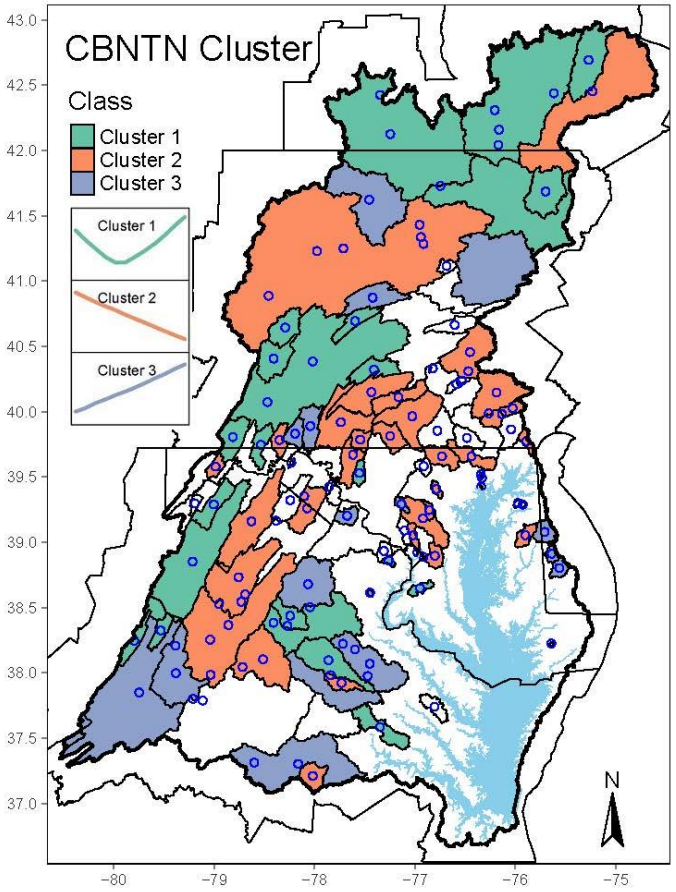
OBJECTIVE AND MOTIVATIONS

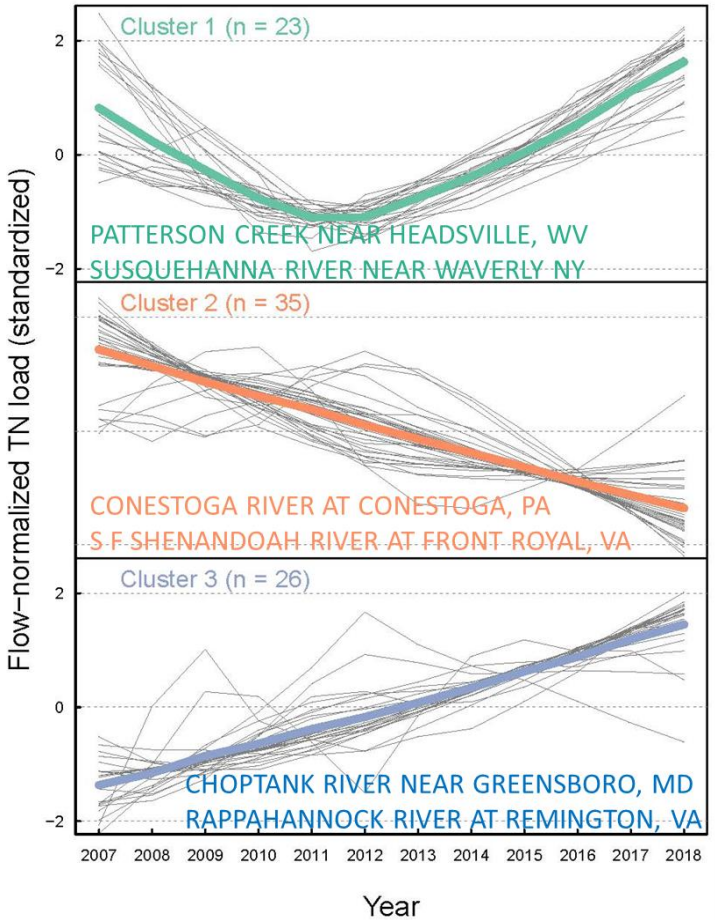
- To reveal regional patterns and drivers of total nitrogen (TN) trends using advanced machine learning approaches -- combined use of hierarchical clustering and random forest (RF).
  - ❑ Cover the Nontidal Monitoring Network (NTN).
  - ❑ Examine the similarity in TN trend signals and responses to natural and anthropogenic drivers.
  - ❑ Analyze short-term trends in order to incorporate newly established stations.
  - ❑ Incorporate important Agricultural variables.
  - ❑ Provide predictions for unmonitored areas.



1. REGIONAL PATTERNS OF TN LOAD TRAJECTORY (CLUSTERING)

- We used hierarchical cluster analysis to categorize the short-term (2007-2018) TN trends at the Chesapeake NTN stations (84) into three distinct clusters.
- Cluster 2 (n = 35) represents a trajectory of long-term decline in TN.





2. REGIONAL DRIVERS OF TN TREND CLUSTERS (RANDOM FOREST)

- We developed an exhaustive search algorithm to identify random forest (RF) models that can explain the TN cluster assignment.
- Three RF models selected by the search algorithm each settled on a specific set of features that are most useful to explain a specific cluster.

Model	Model form	OOB accuracy, percent			
		Overall	*Cluster1*	*Cluster2*	*Cluster3*
A	Class ~ Natural_pct + Fertilizer_MK + ValleyRidge_pct + Deposition_MK + Carb_pct	70.5	66.7	68.8	**76.0**
B	Class ~ AgSurplus_MK + Fertilizer_MK + Deposition_MK + Natural_pct	70.5	66.7	**75.0**	68.0
C	Class ~ BlueRidge_pct + Deposition_MK + Coastal_pct + Crop_pct + Fertilizer_MK + Natural_pct	69.2	**81.0**	65.6	64.0

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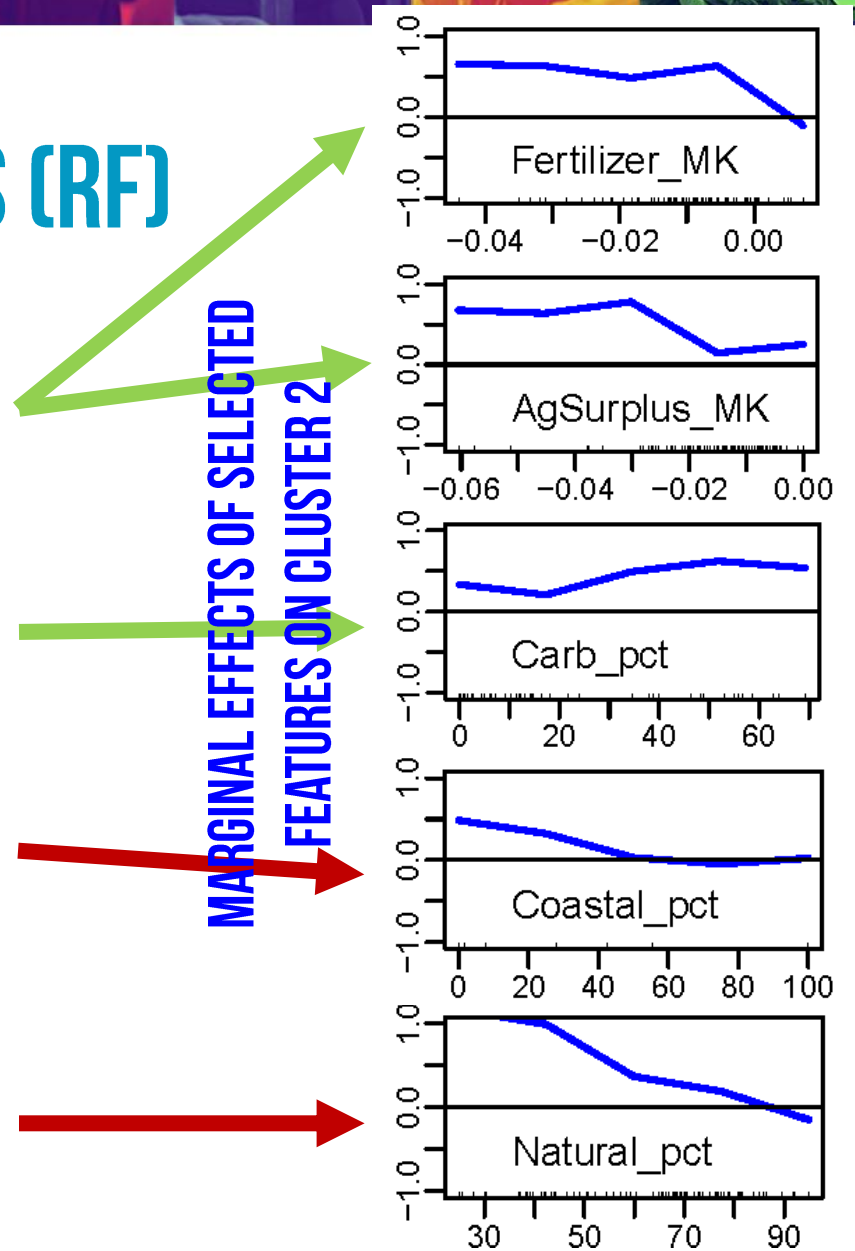
2. REGIONAL DRIVERS OF TN TREND CLUSTERS (RF)

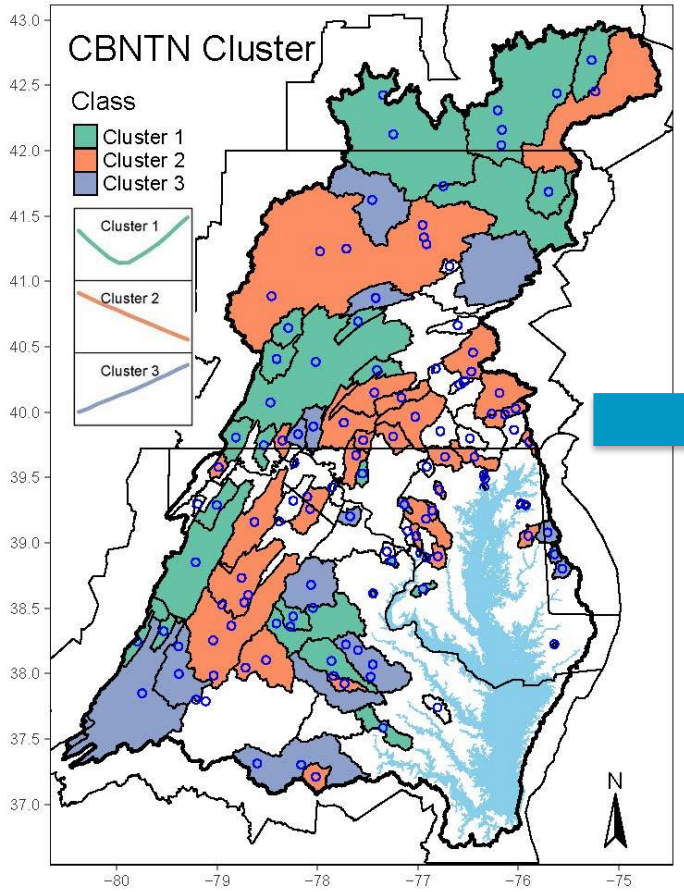
- Improved nutrient management has resulted in declines in agricultural nonpoint sources, which in turn contributed to water quality improvement.
- Water-quality improvements are more likely to occur in watersheds underlain by carbonate rocks, reflecting the relatively quick groundwater transport of this terrain.
- By contrast, water-quality improvements are less likely to occur in watersheds in the Coastal Plain, reflecting the effect of legacy N in groundwater.
- Results show degrading trends in forested watersheds, suggesting new and/or remobilized sources of N that may compromise downstream watershed restoration plans more focused on agricultural and urban areas.



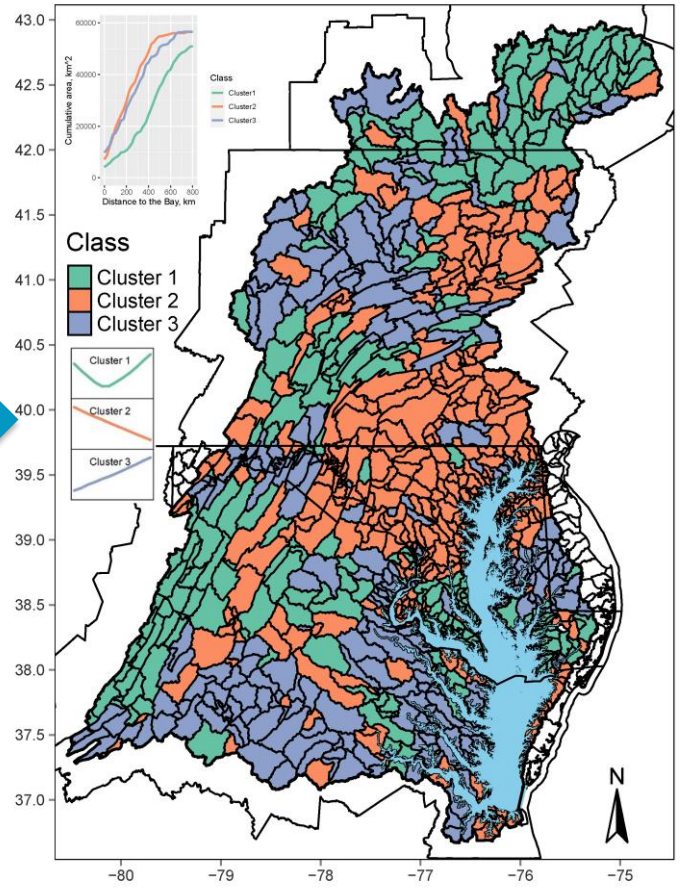
3. PREDICTIONS OF TN TREND CLUSTERS FOR THE ENTIRE WATERSHED

- We applied the RF models to predict short-term trend clusters for the entire Bay watershed at a fine spatial scale (i.e., river segments).
- These predictions are useful for managers to understand trends across the watershed, including unmonitored areas, and to choose priority watersheds toward water-quality improvement.

Observations



Predictions



THANK YOU

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