Gwynns Falls: Data on hydrology, nutrient and sediment loads and concentrations

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4. Cary Institute of Ecosystem Studies

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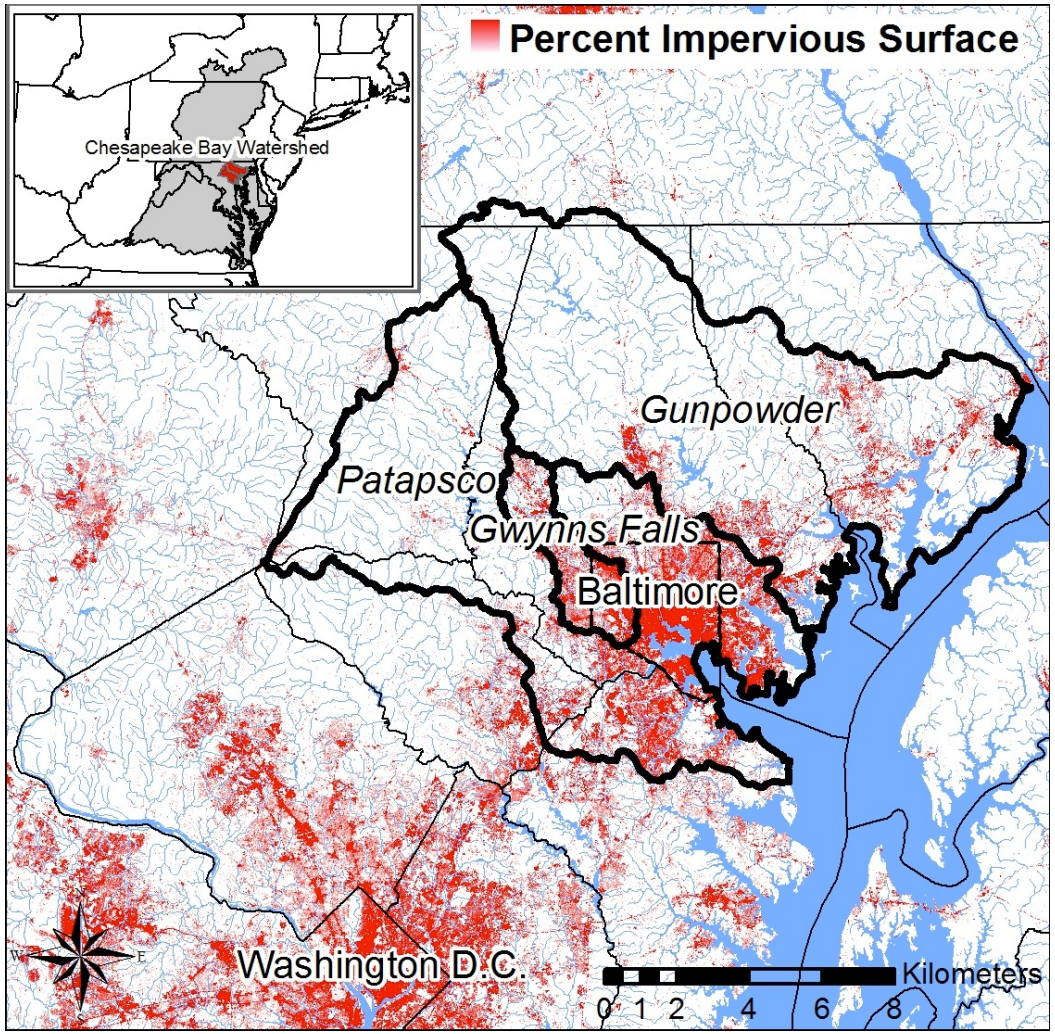
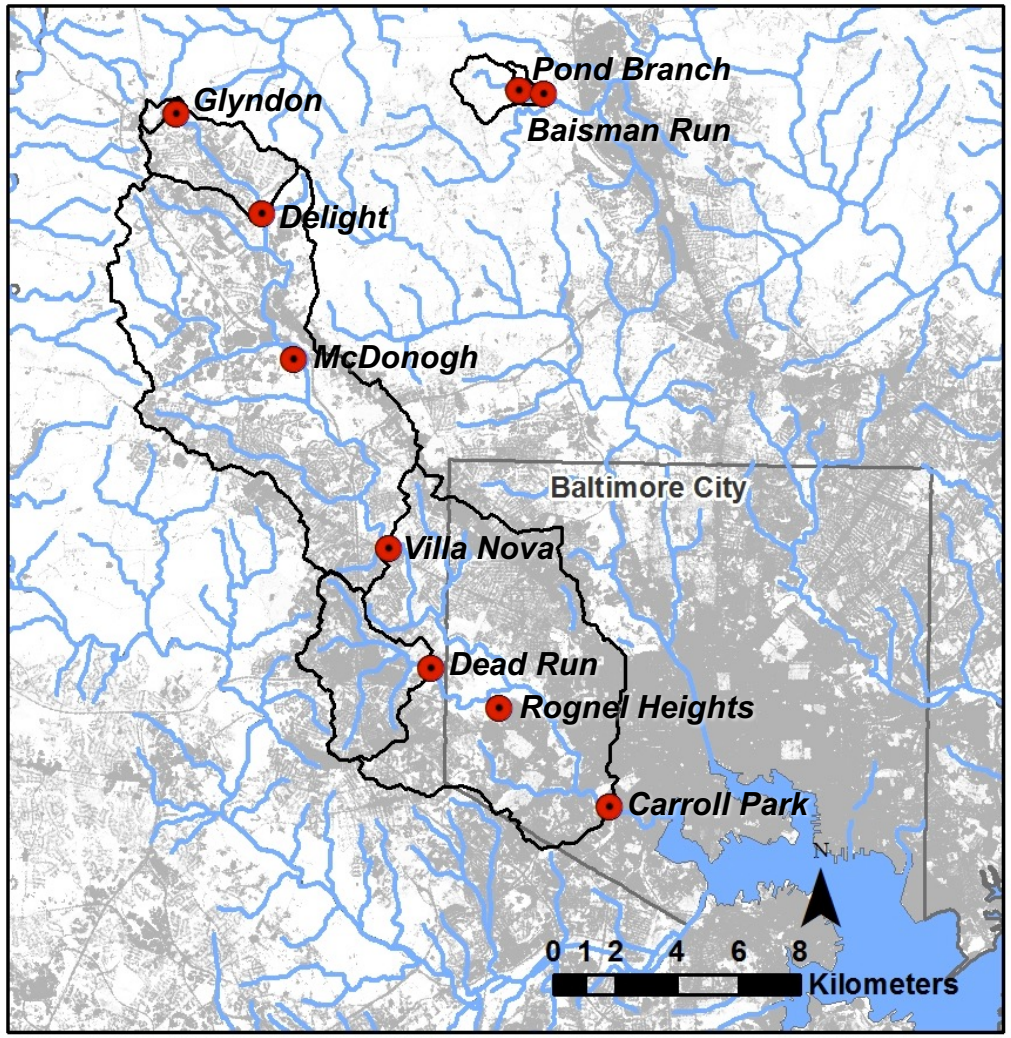
Baltimore Ecosystem Study
Long-Term Ecological Research Project

NSF: Hypothesis driven science



Gwynns Falls Watershed



171 km^2

Urban to rural gradient of land cover

Forested & agricultural reference sites

9 USGS stream gages

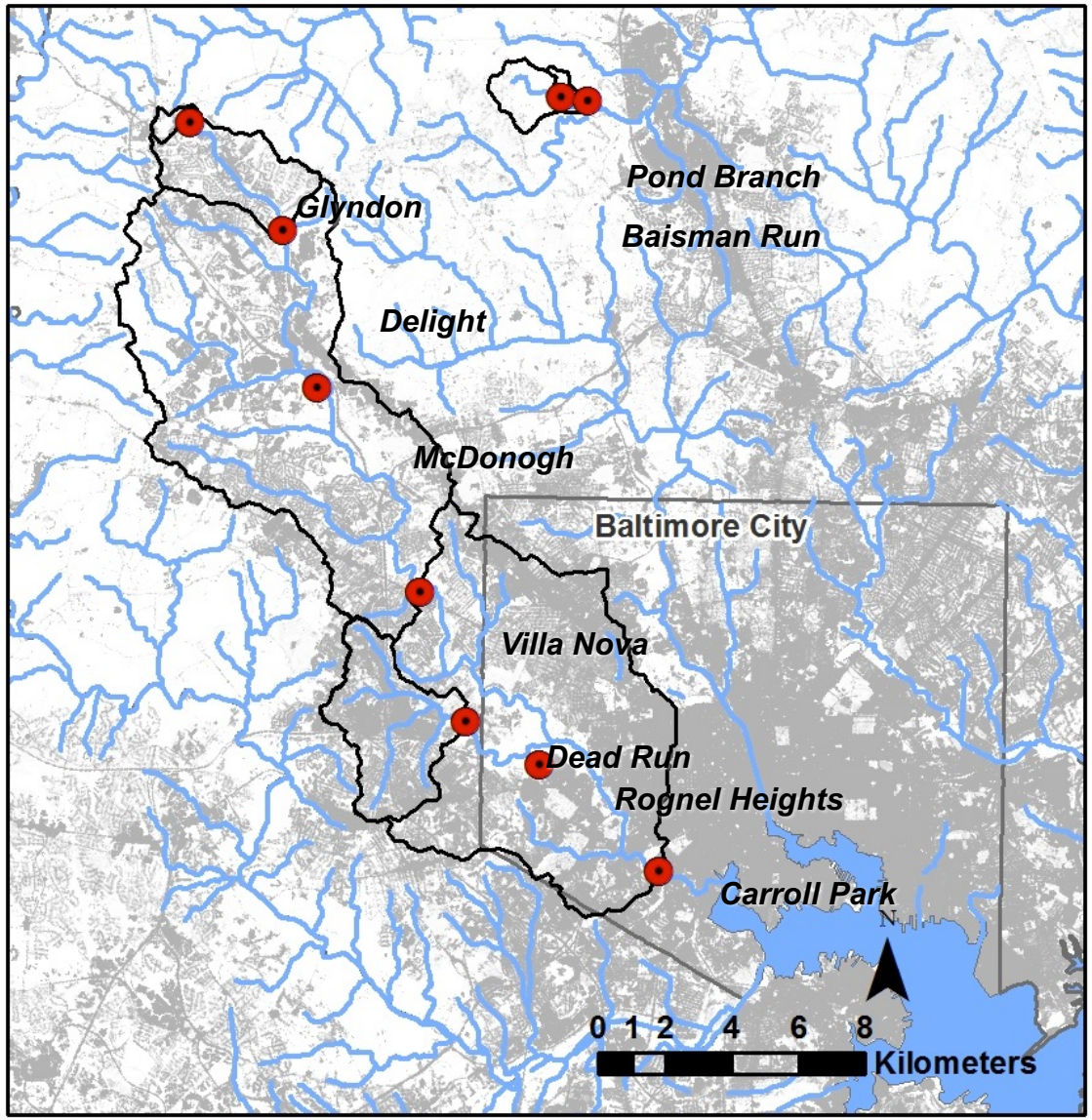
Nested watershed design

Weekly chemistry sampling since 1998

NO_3^-, PO_4^{3-}, SO_4^{2-}, Cl^-

Total N, Total P

Gwynns Falls Watershed



Watershed	Area (km^2)	Percent Imperv-ious
Pond Branch (forest)	0.4	0
Baisman Run (forest/exurban)	3.8	5
Glyndon	0.7	21.1
Delight	10.6	18.6
Villa Nova	84.5	21.1
Carroll Park	171	30.3
Dead Run (urban)	14.1	45
McDonogh (agriculture)	0.06	0

Data available for download from https://baltimoreecosystemstudy.org/

Baltimore urban watershed studies: BES lives?!

- The Baltimore Ecosystem Study (BES) will continue as a research project/group/consortium, but without LTER funding.
- Long Term Research in Environmental Biology (LTREB) to P. Groffman et al. will continue long-term watershed, terrestrial plot, and social survey data streams.
- CZO Network Cluster: Urban Critical Zone processes along the Piedmont-Coastal Plain transition to C. Welty et al.
- USDA Forest Service Urban Field Station in Baltimore.
- Baltimore Social-Environmental Collaboratory (BSEC) DOE Urban Integrated Field Laboratory. Will provide stream chemistry and greenhouse gas emissions
- Chesapeake Bay Trust to C. Welty et al. densified sensors in Dead Run
- Other proposals to NSF DEB, NSF Macrosystems Biology, Foundations, etc.

What is included in the LTREB:

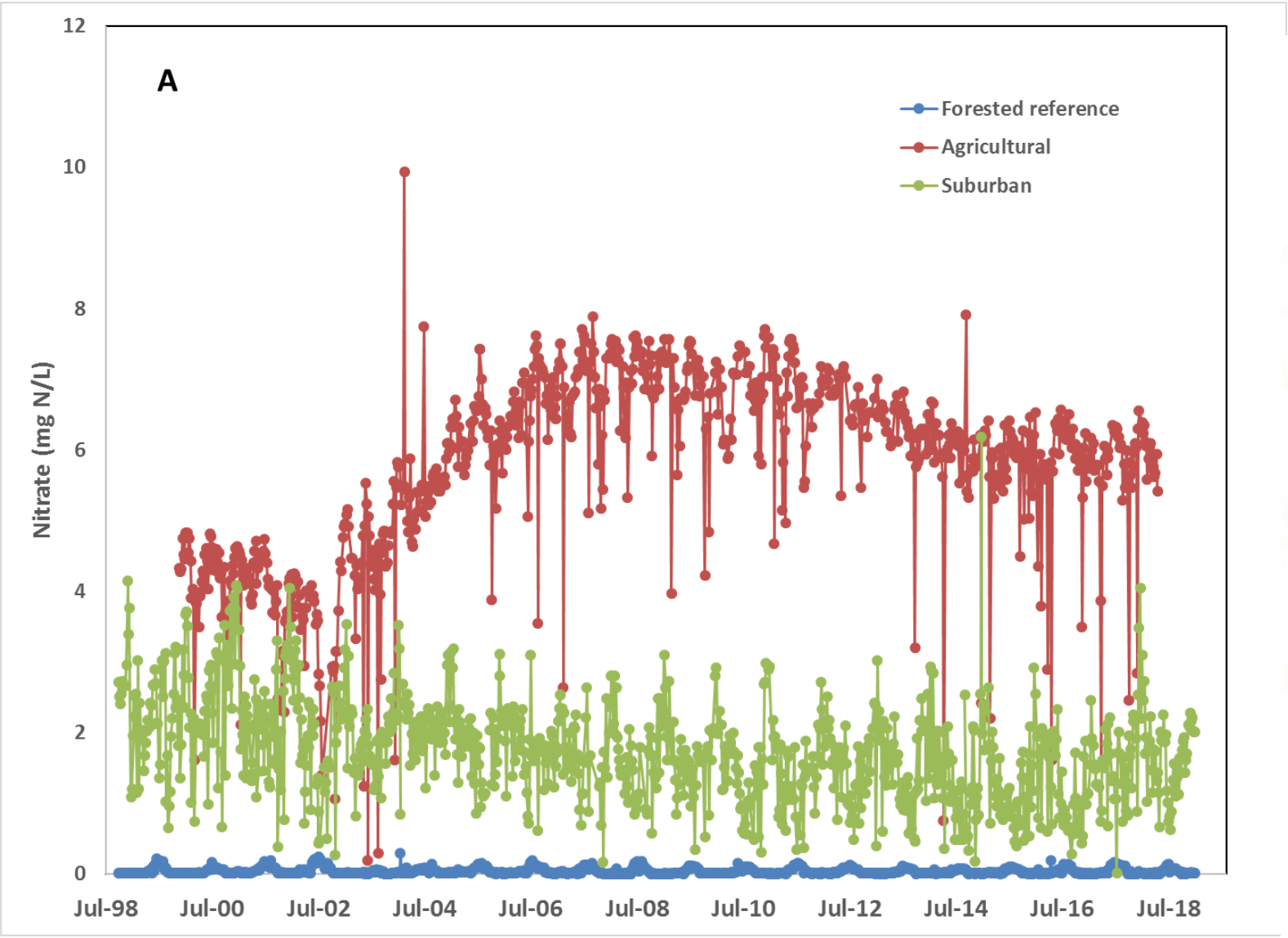
- Weekly sampling and analysis of Pond Branch (forested), Baisman Run (exurban), Gwynnbrook (suburban), Villa Nova (suburban), Dead Run (urban) and Carroll Park (urban) watershed sites.
- Monthly sampling of trace gas fluxes and soil solution chemistry at Oregon Ridge (forested, riparian) and UMBC (lawn) sites. Continuous monitoring of soil moisture and temperature.
- Riparian water tables at forested, suburban, urban sites.
- Five-year community survey of environmental knowledge, values and behaviors.

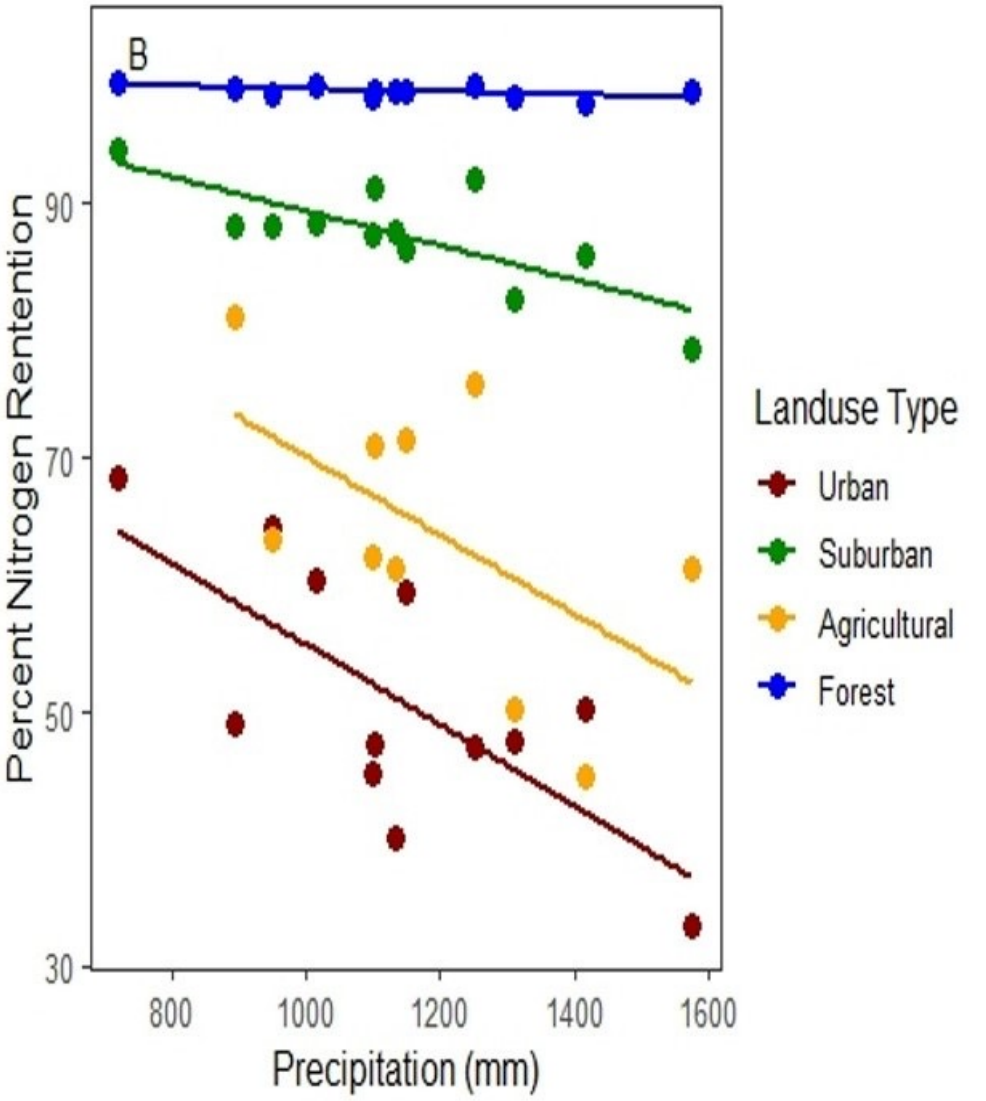
Science insights for CBP Modeling

1. Long-term + sensors yield important insights on trends vs. variability and extremes
2. Urban water infrastructure is important for water quality

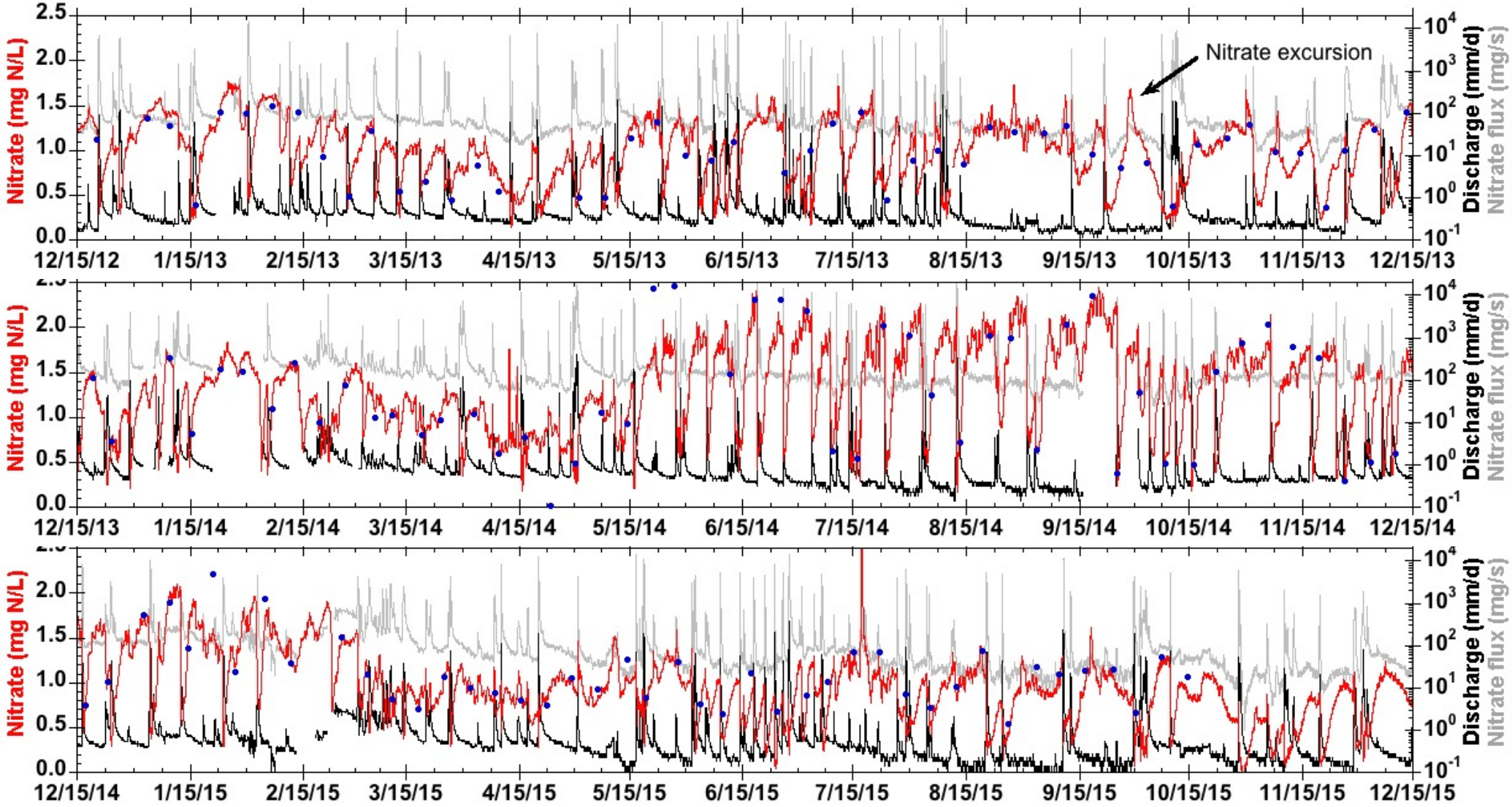
Weekly sampling since 1998 shows effects of land use on stream nitrate:

Environmental Data Initiative. https://doi.org/10.6073/pasta/45129da171f2a8ab5a96e9743d0d644b



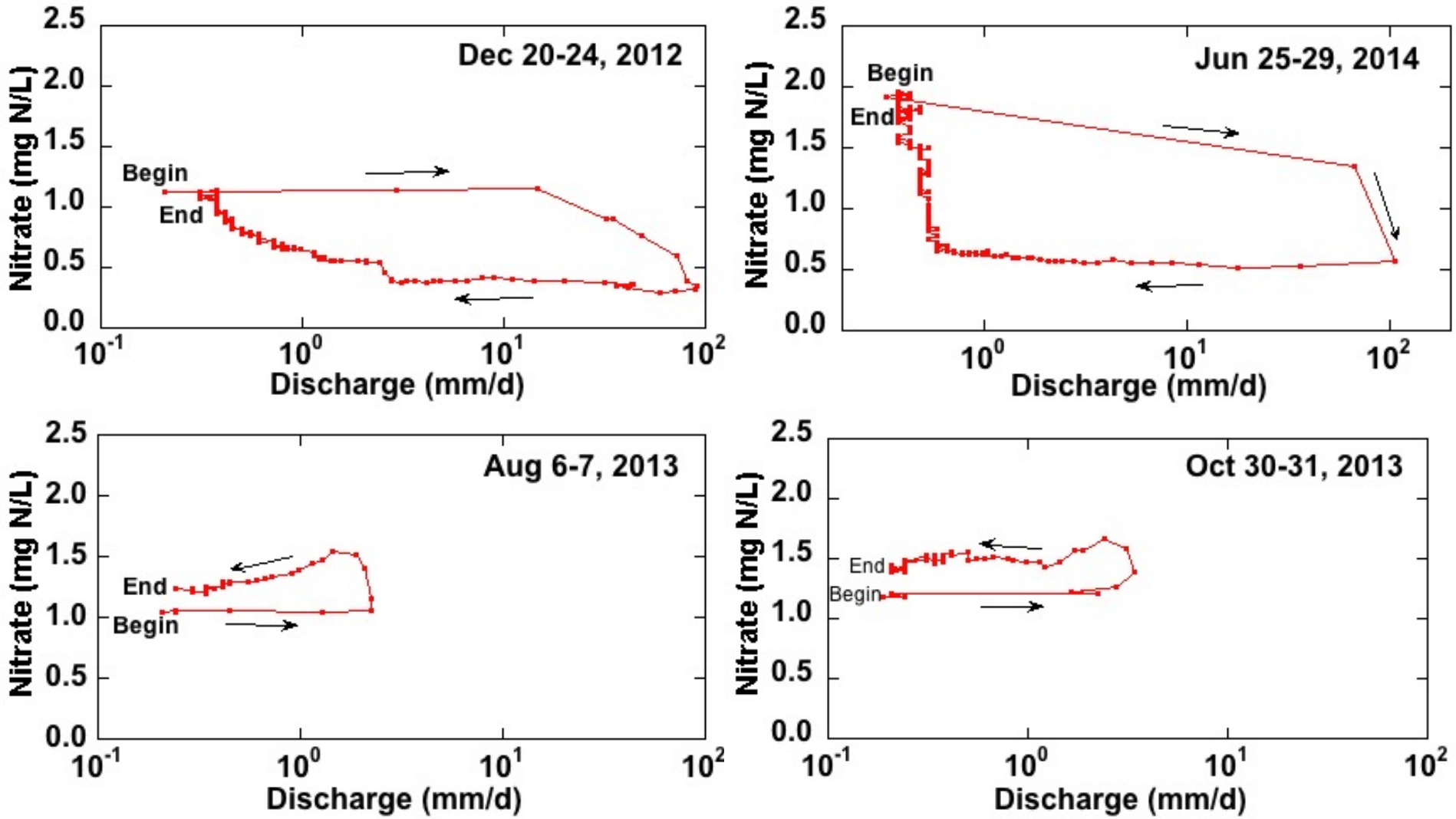


Concentrations higher at baseflow: groundwater important



Duncan, JM, Welty, C., Kemper, J, Band, LE, and Groffman, PM. (2017). Dynamics of Nitrate-Concentration Discharge Patterns in an Urban Watershed. Water Resources Research, doi: 10.1002/2017WR020500

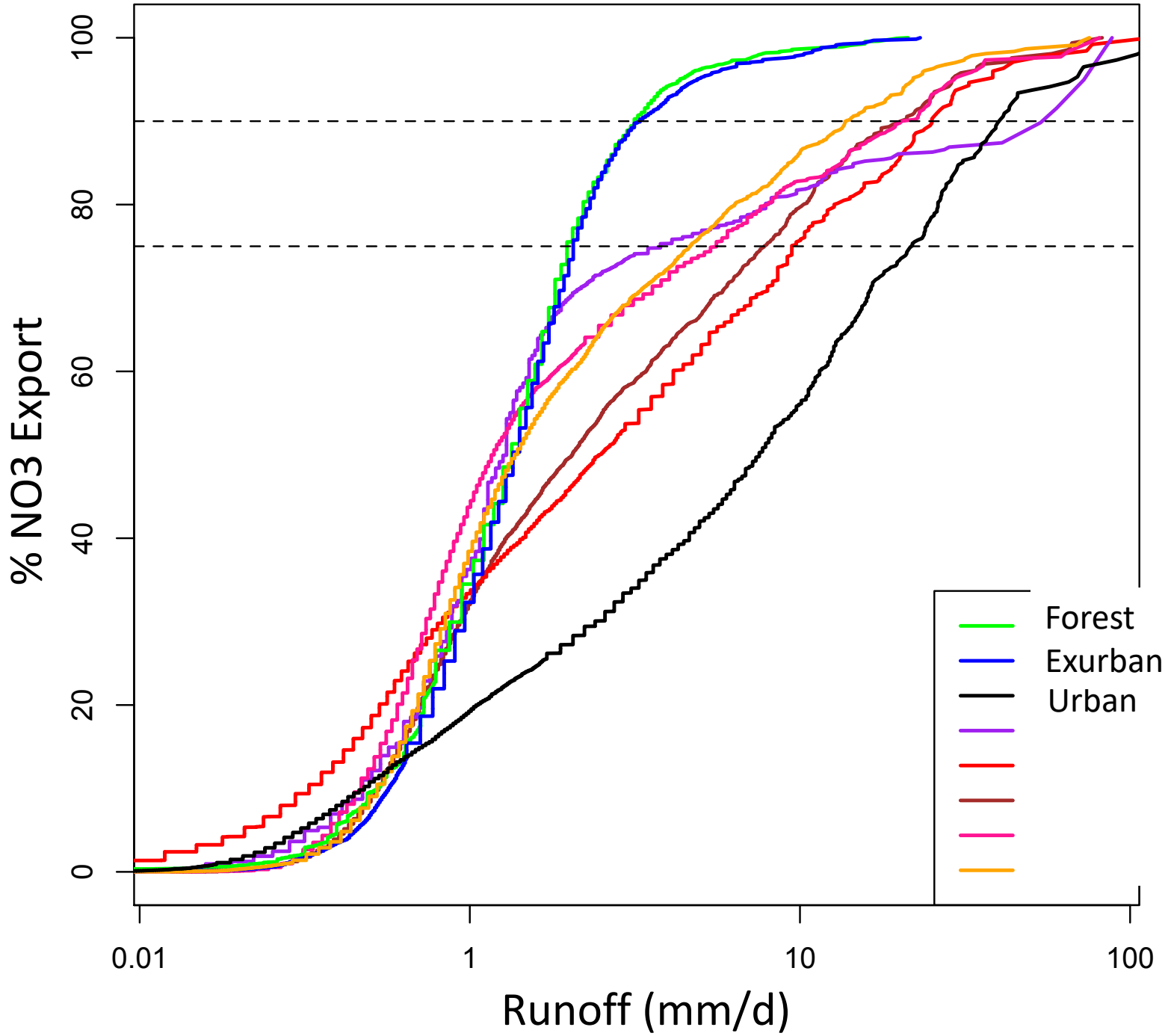
No evidence (yet) of first flush



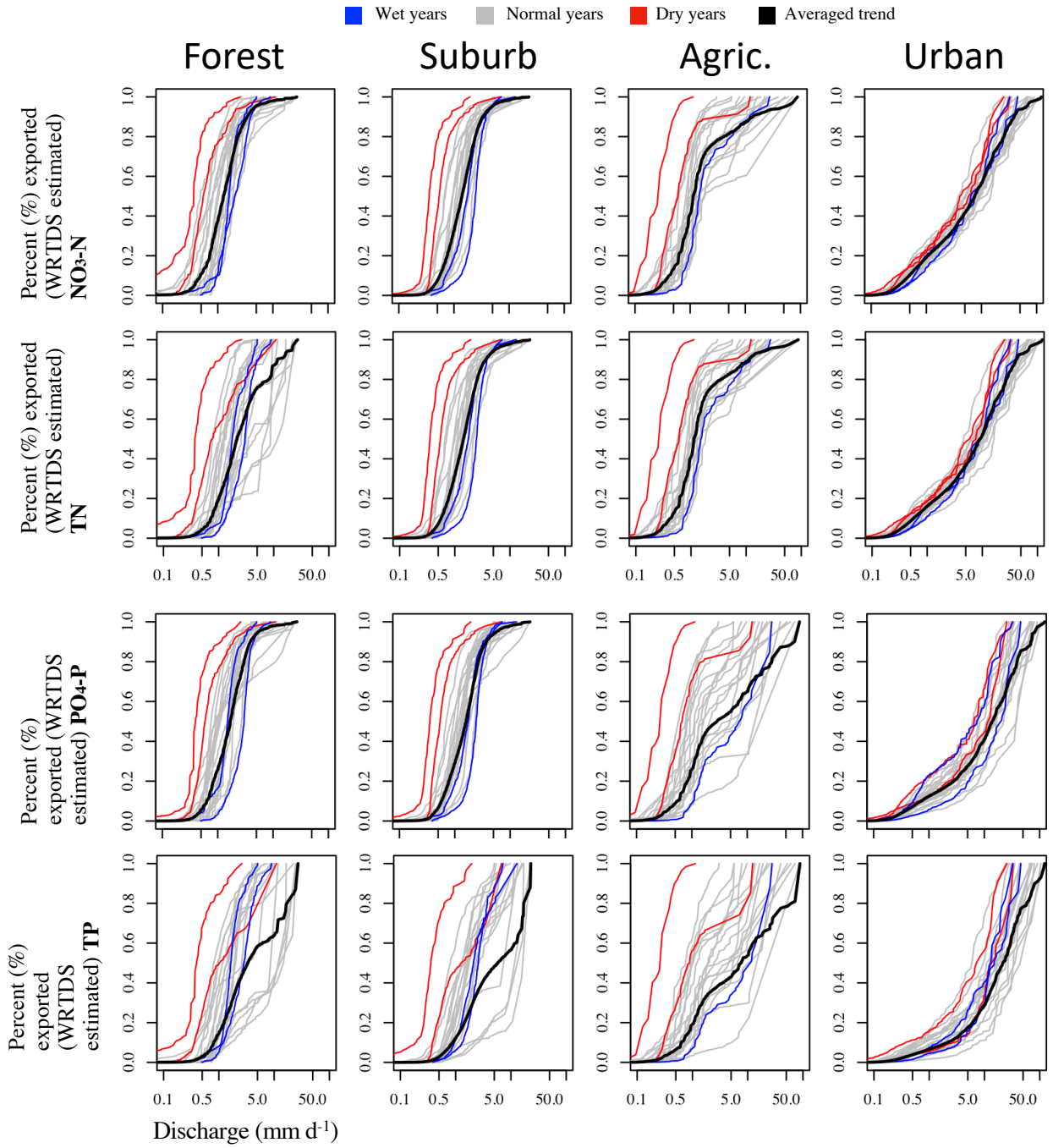
Cumulative Nitrate Duration Curves

Using WRTDS to estimate loads

Forest/exurban export much more nitrate at lower flows



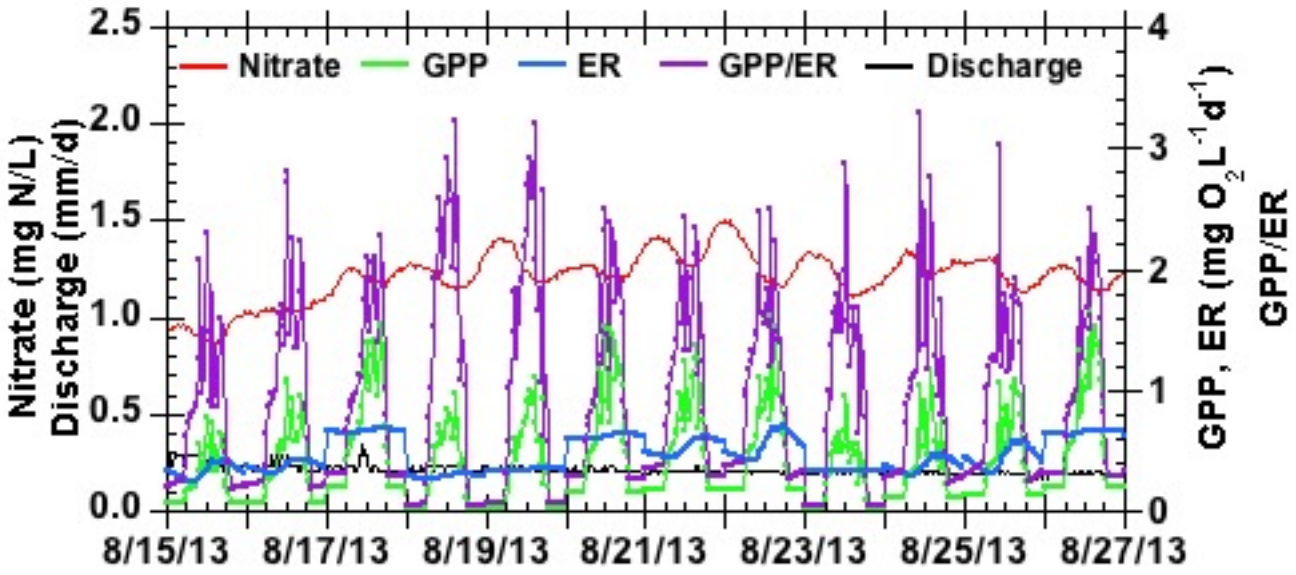
Duncan et al. in prep



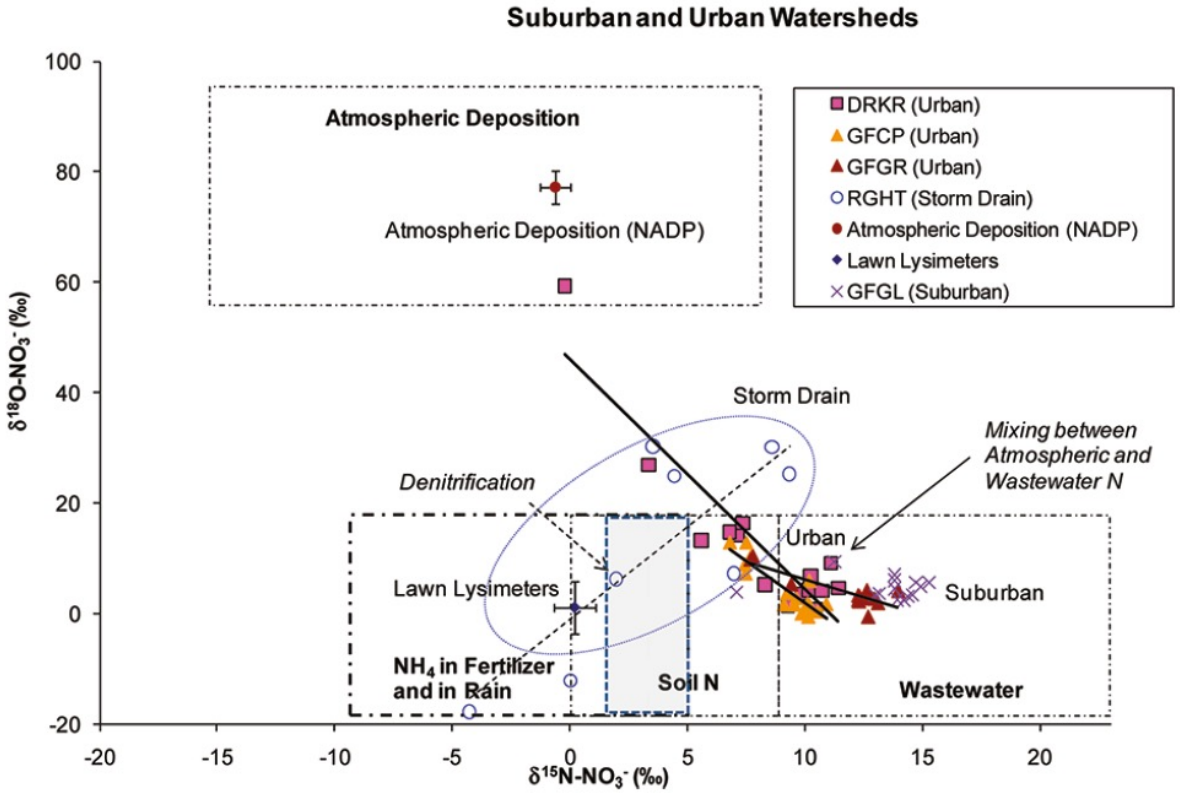
- Urban flux more dominated by Q
- P more variable than N
- TN and TP more variable than NO_3 and PO_4
- Large range of discharge with tremendous variabilit
- Sampling implications

Wastewater a likely source of stream nitrogen

Stream metabolism models

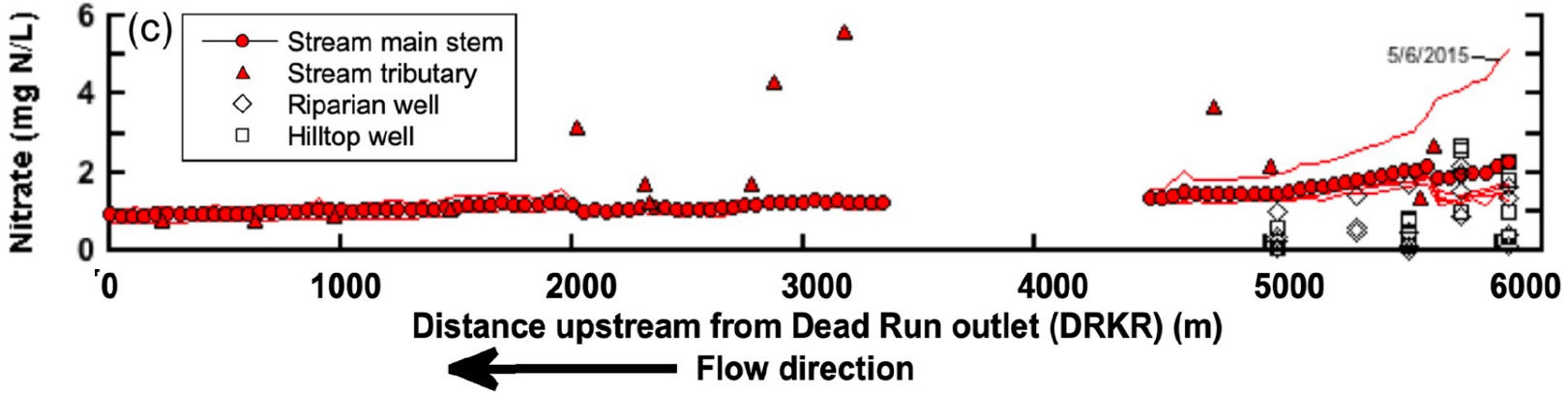


Dual isotopes of nitrate



Kaushal, S. S., Groffman, P. M., Band, L. E., Elliott, E. M., Shields, C. A., & Kendall, C. (2011). Tracking nonpoint source nitrogen pollution in human-impacted watersheds. Environmental science & technology, 45(19), 8225-8232.

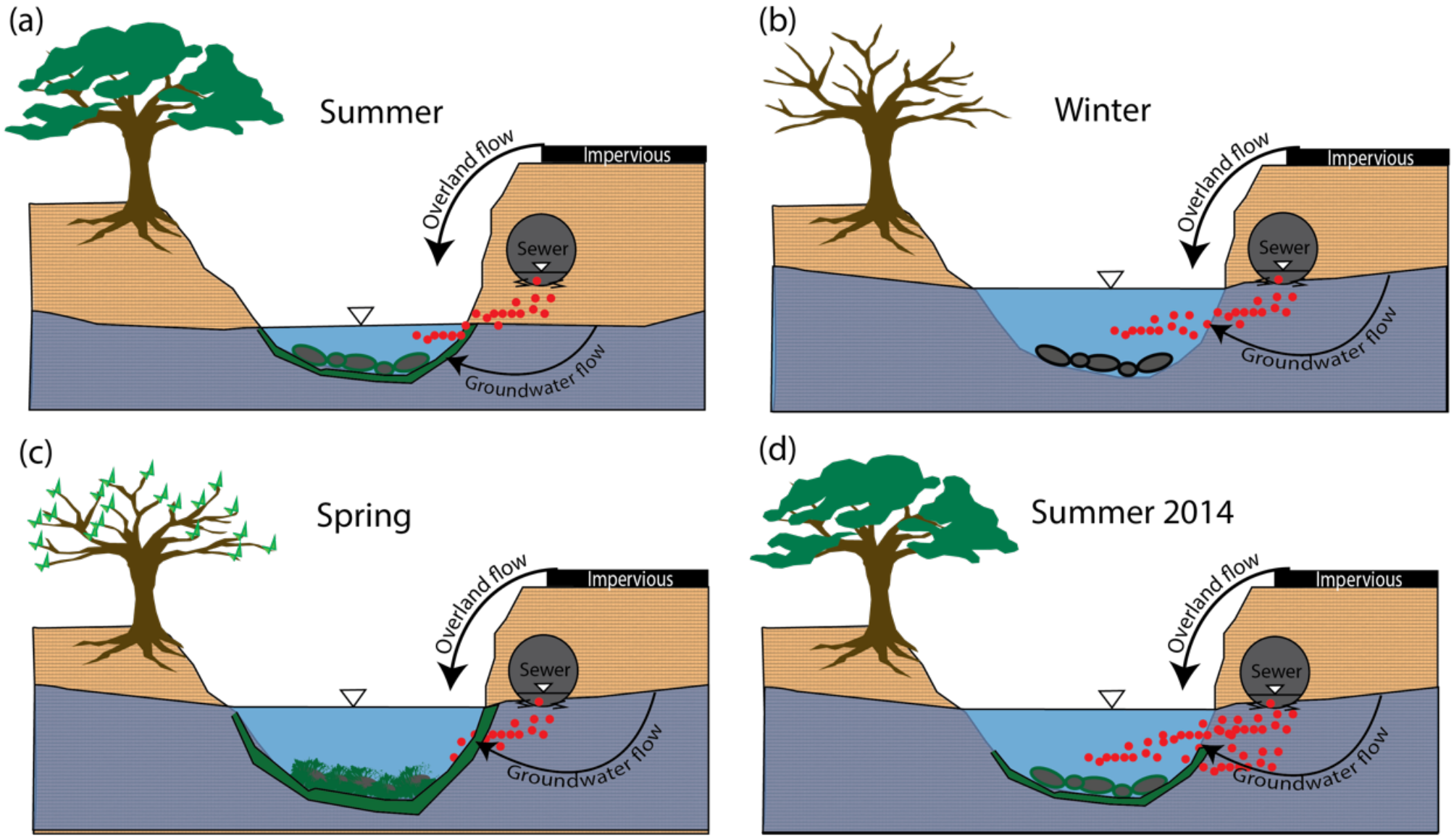
Spatial synoptics reveal importance of sanitary sewers



1. Nitrate higher in headwaters: sanitary sewers density highest
2. May 2015 outlier: sanitary sewer leak

Welty, C., Moore, J., Bain, D. J., Talebpour, M., Kemper, J. T., Groffman, P. M., & Duncan, J. M. (2023). Spatial Heterogeneity and Temporal Stability of Baseflow Stream Chemistry in an Urban Watershed. *Water Resources Research*, e2021WR031804.

Groundwater and infrastructure are important



Science insights for CBP Modeling

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SPARROW Informed Monitoring

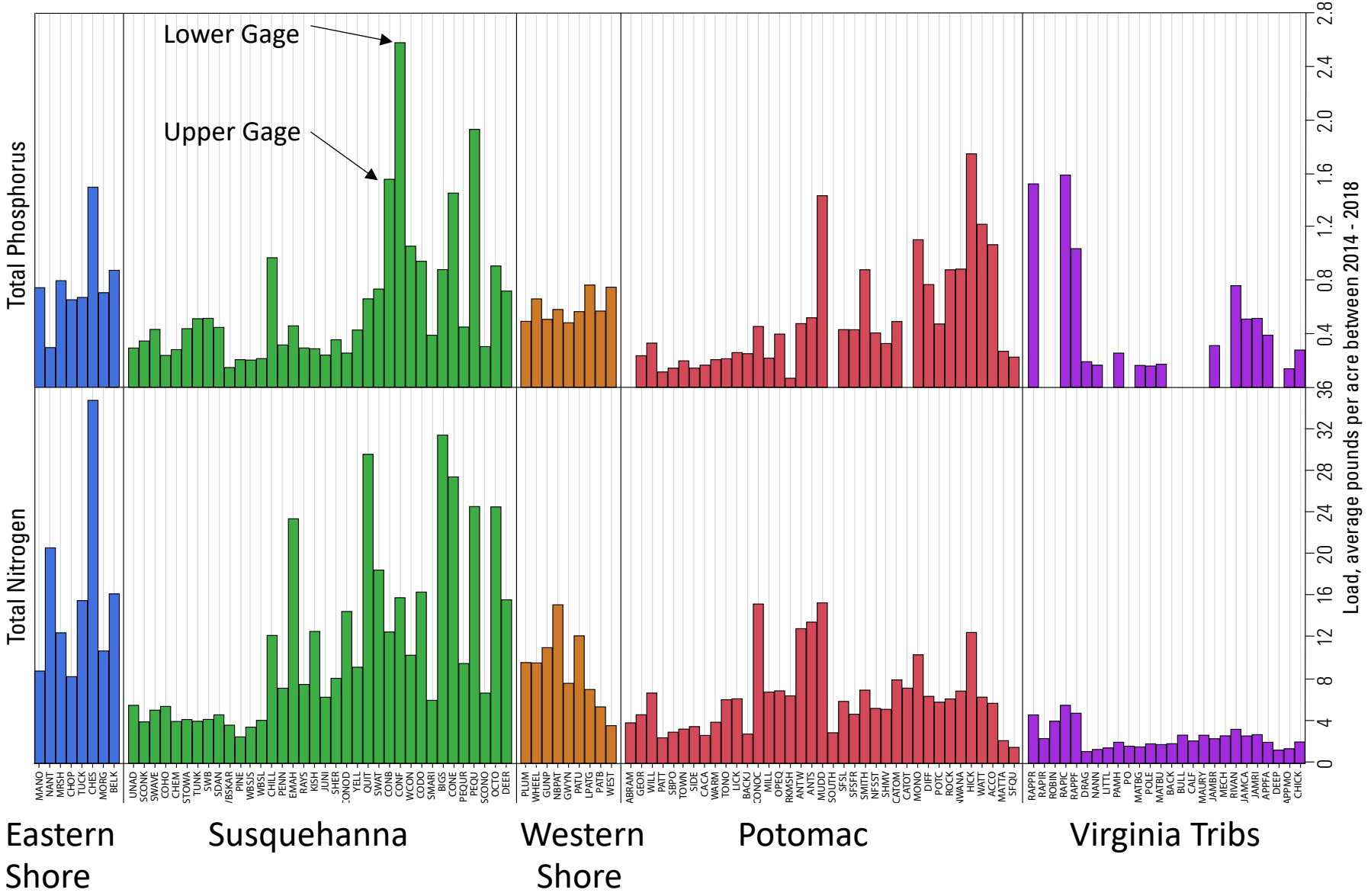
- Conewago Creek Watershed: centerpiece for Penn State Research and Outreach
- Part of the LTAR network

Chesapeake Bay Nutrient Loads by Watershed

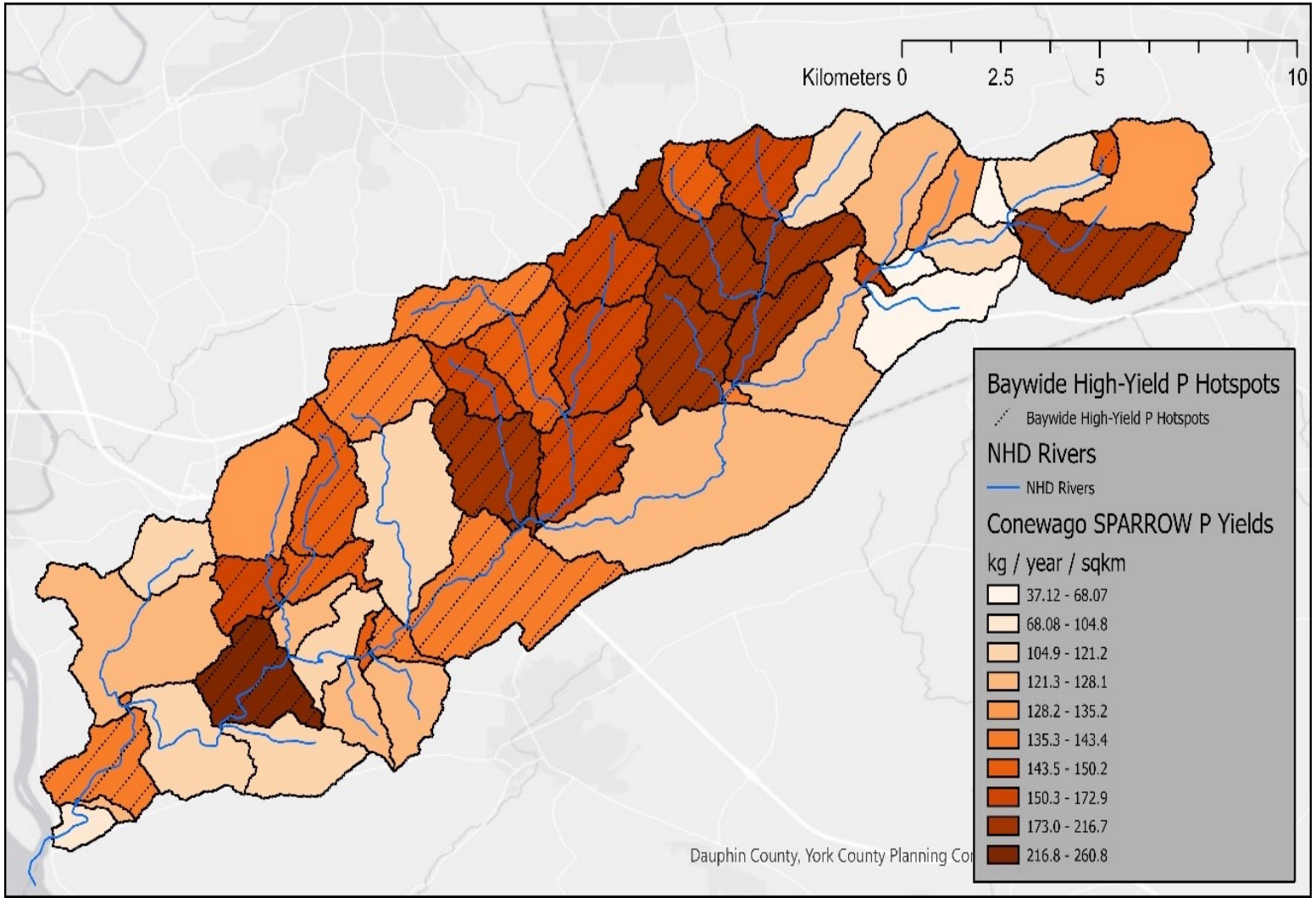
Conewago Creek

SPARROW P prediction:
0.39 lb/acre at Lower
0.42 lb/acre at Upper

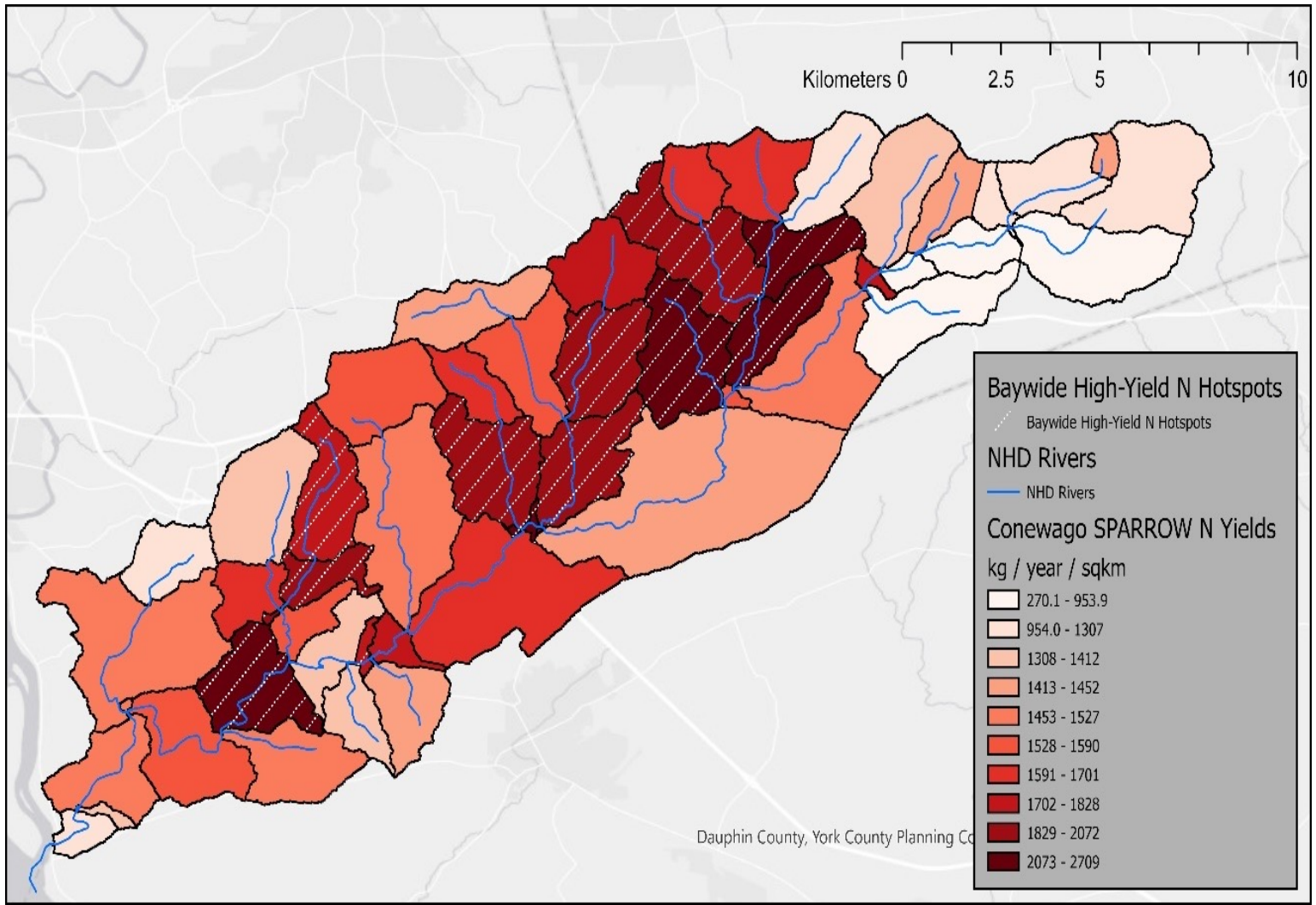
USGS Data & Figure



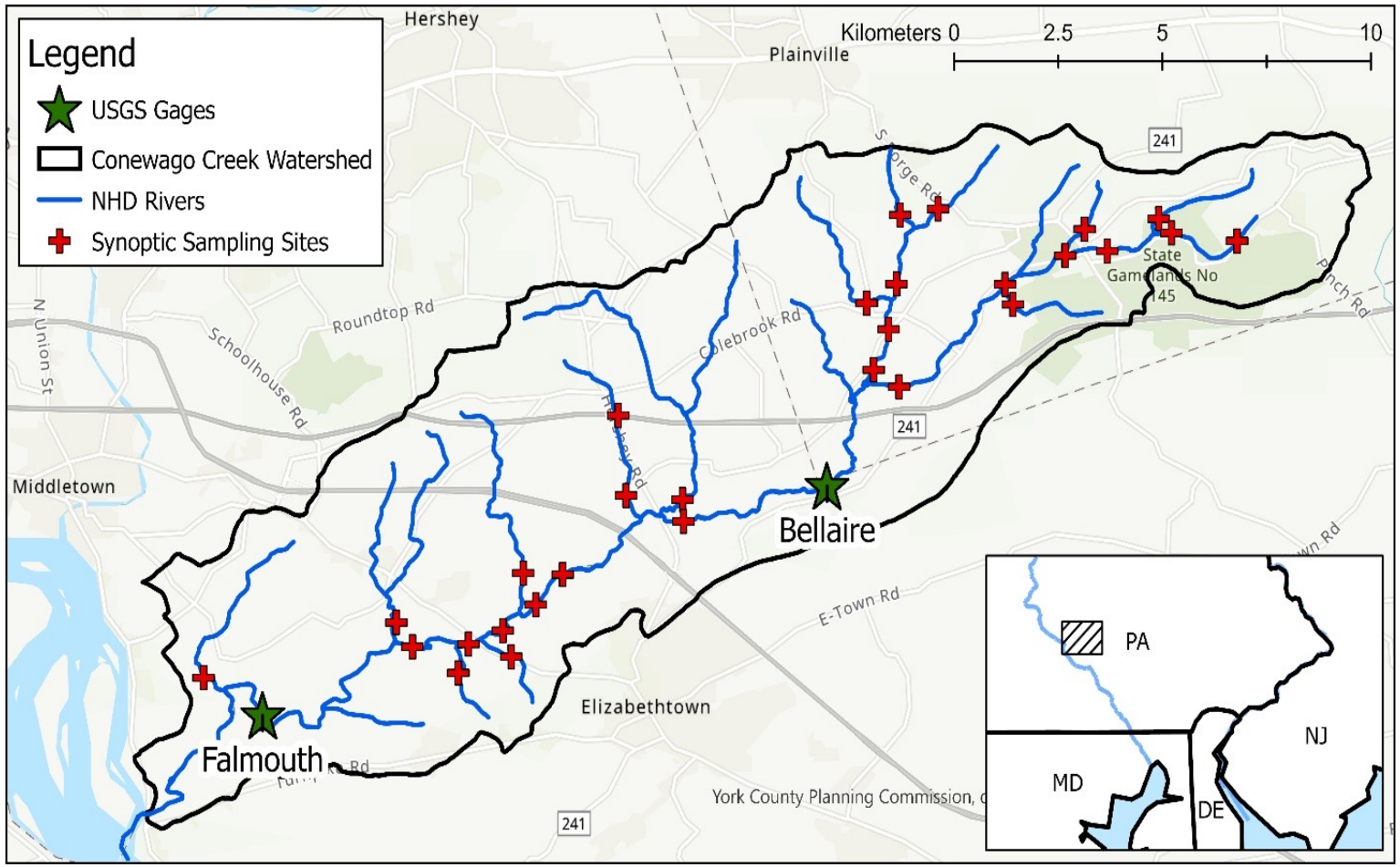
Conewago TP Yields from SPARROW



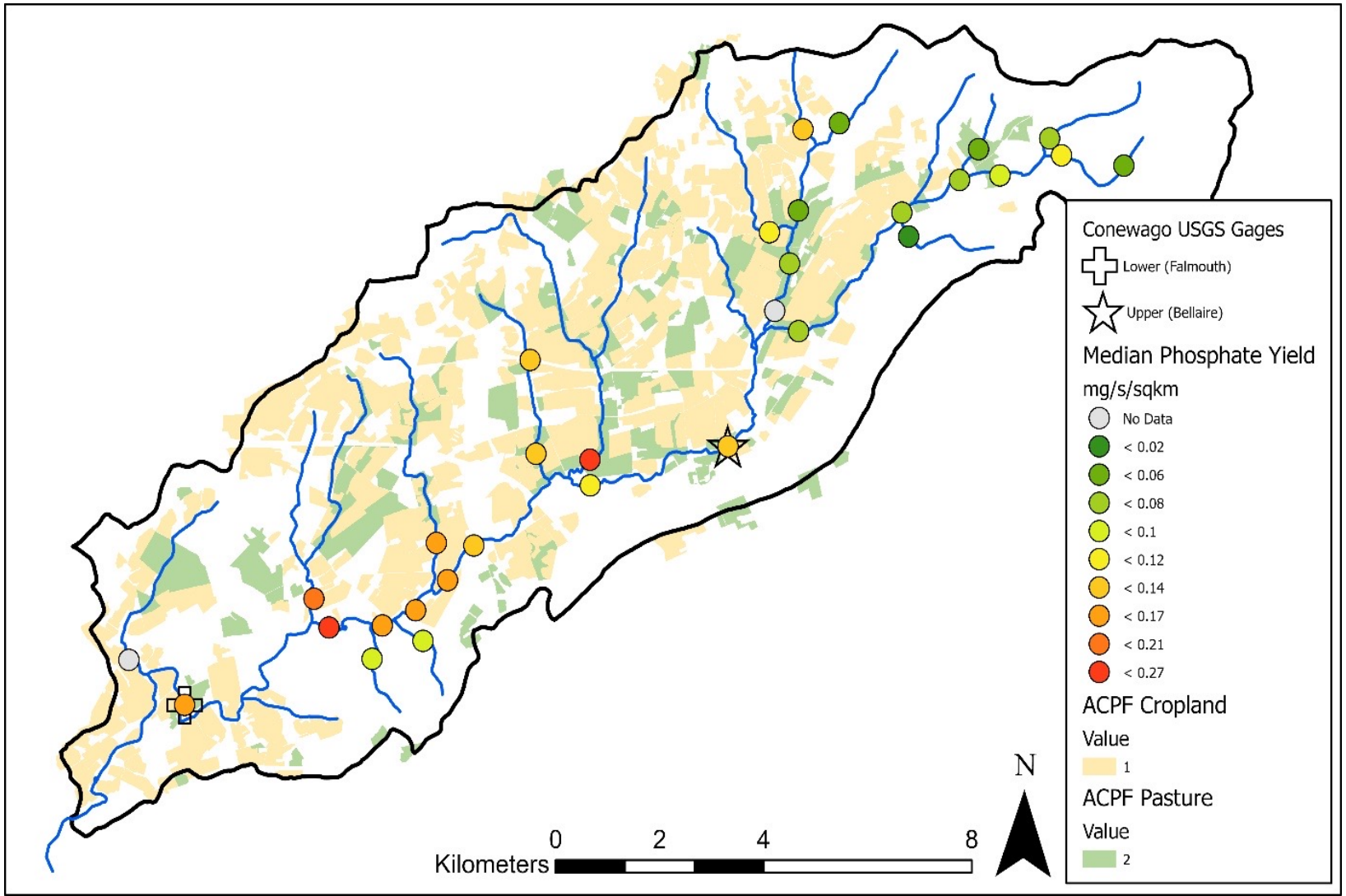
Conewago TN Yields from SPARROW



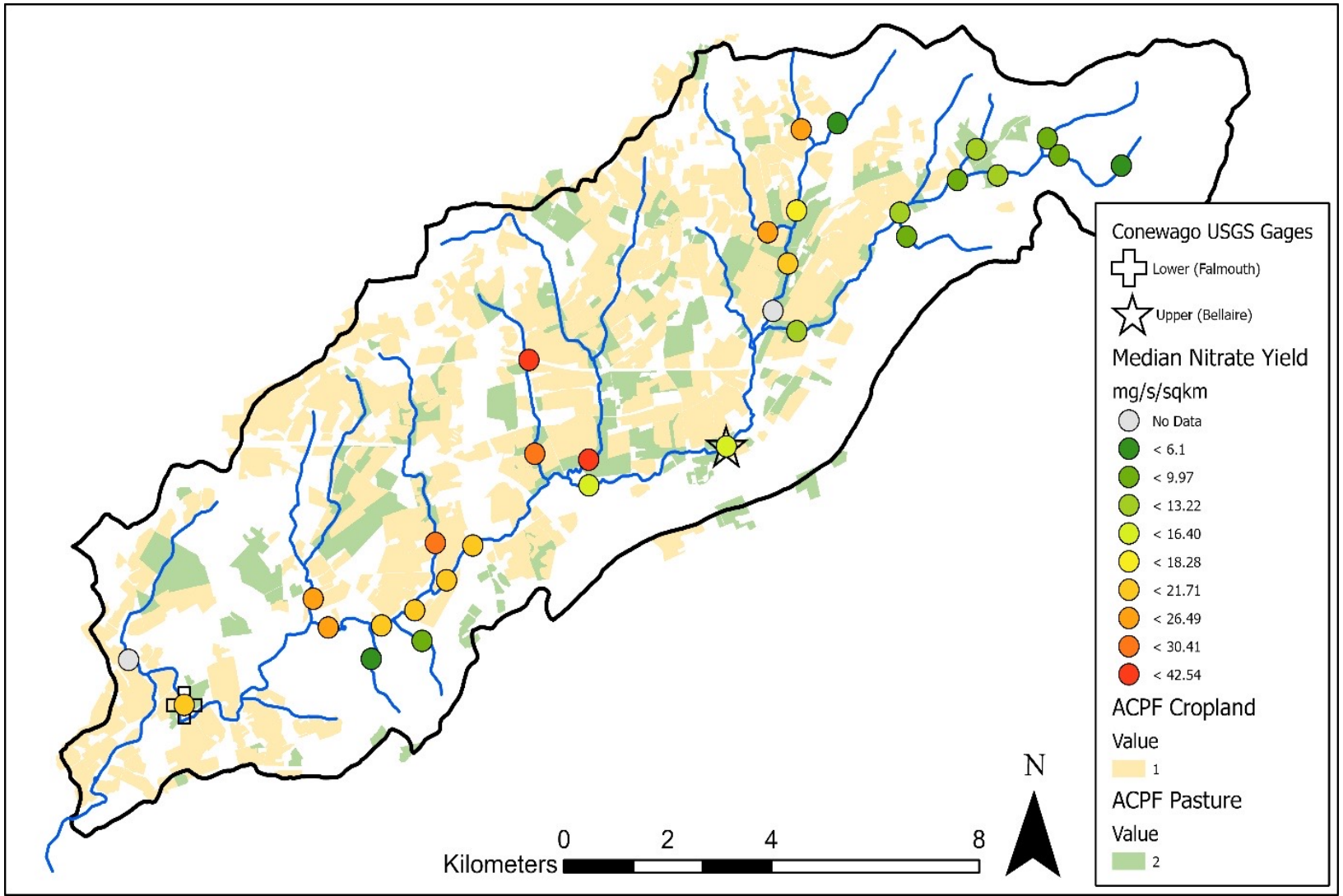
Synoptic Sampling Campaigns to Verify Patterns



Preliminary Instantaneous Phosphate Yield



Preliminary Instantaneous Nitrate Yield

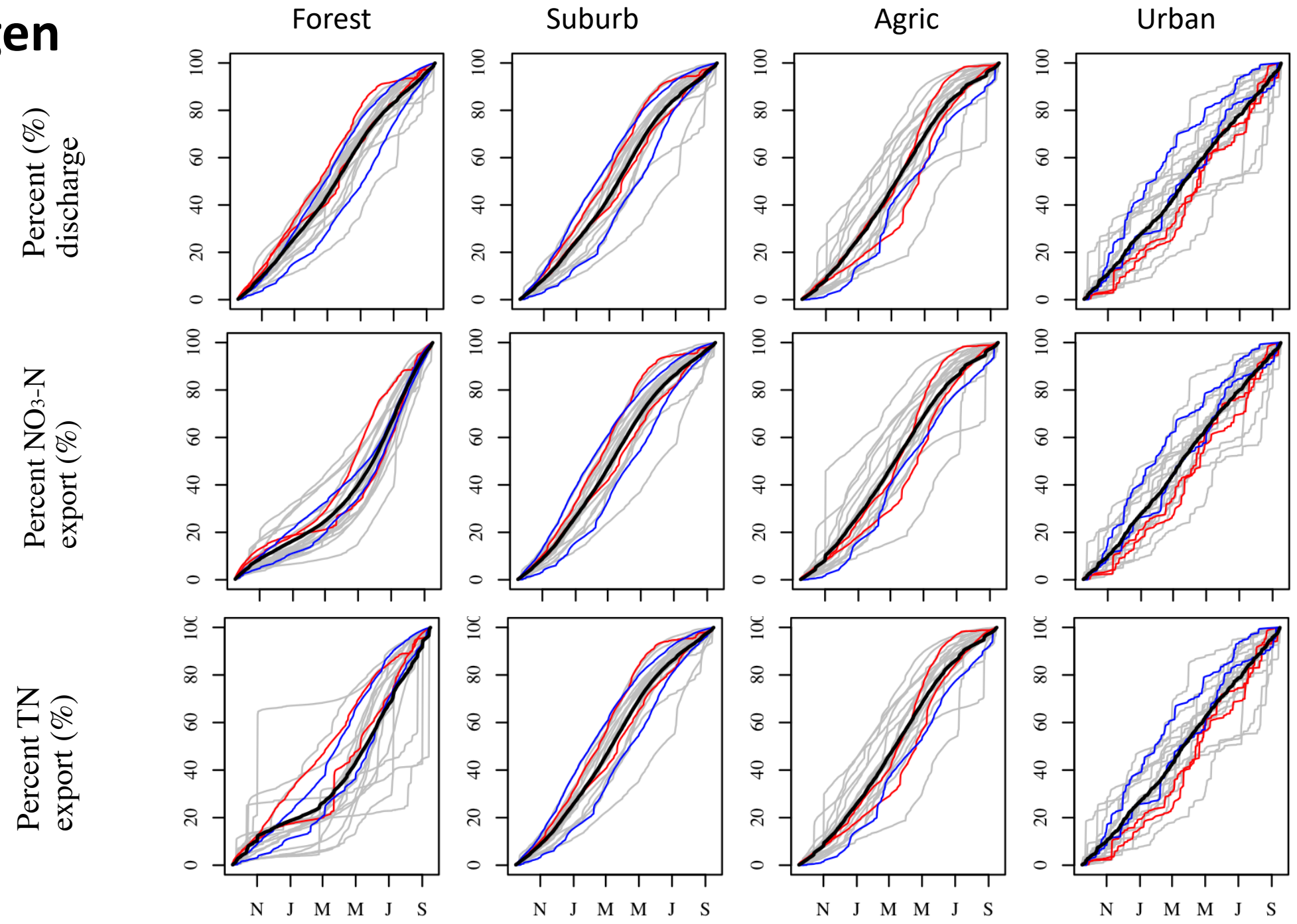


Acknowledgements

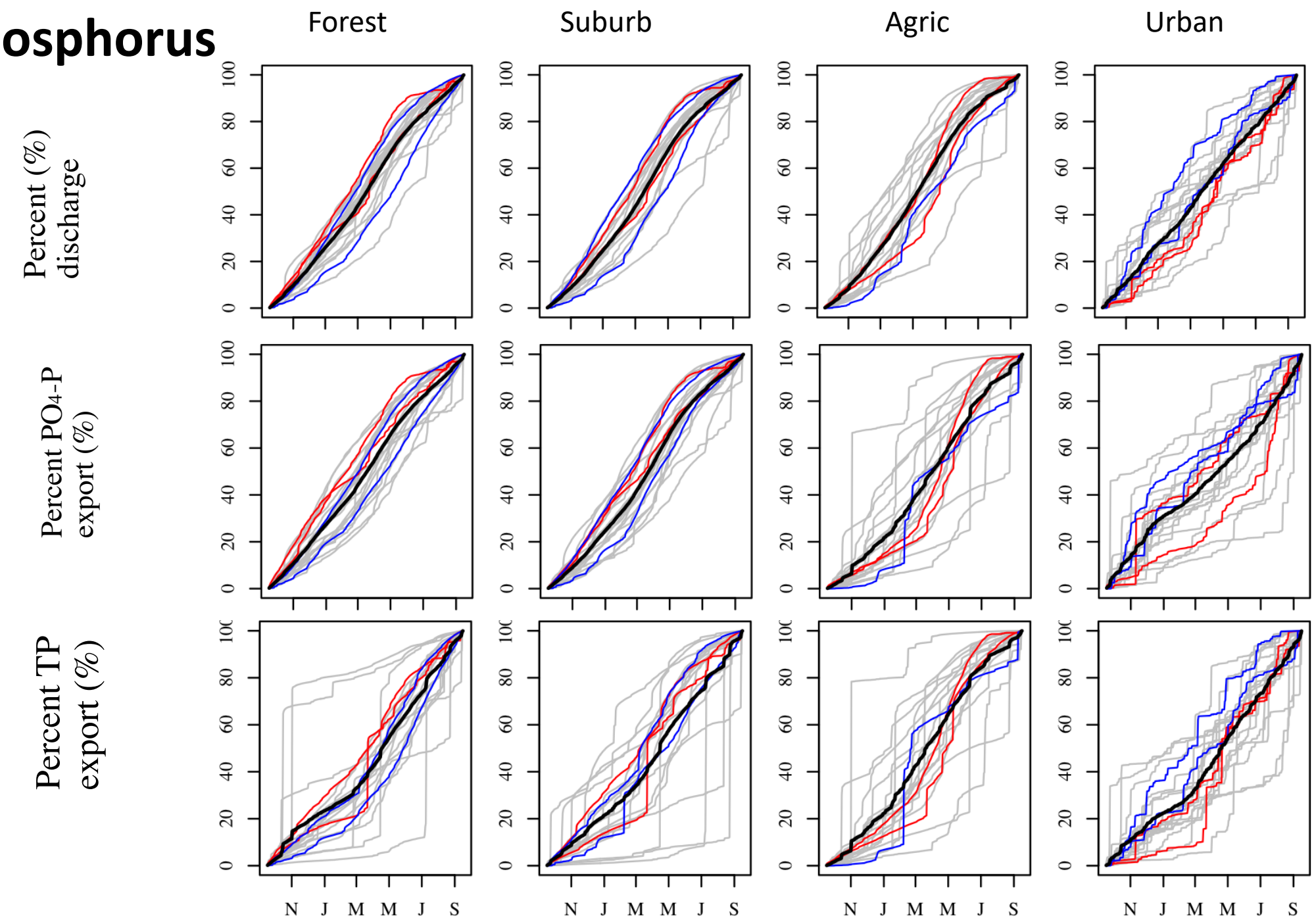
Current LTREB hypotheses:

- The flashiness of urban stream hydrology will decrease over the next 20 years.
- Concentrations and exports of nitrogen and metals will decline over the next 20 years.
- Watershed and ecosystem knowledge will increase and affect willingness to support watershed improvements.

Nitrogen


Forest
Suburb
Agric
Urban
Percent (%) discharge
Percent NO3-N export (%)
Percent TN export (%)
0
20
40
60
80
100
N
J
M
M
J
S

Phosphorus


Forest
Suburb
Agric
Urban
Percent (%) discharge
Percent PO4-P export (%)
Percent TP export (%)
0
20
40
60
80
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J
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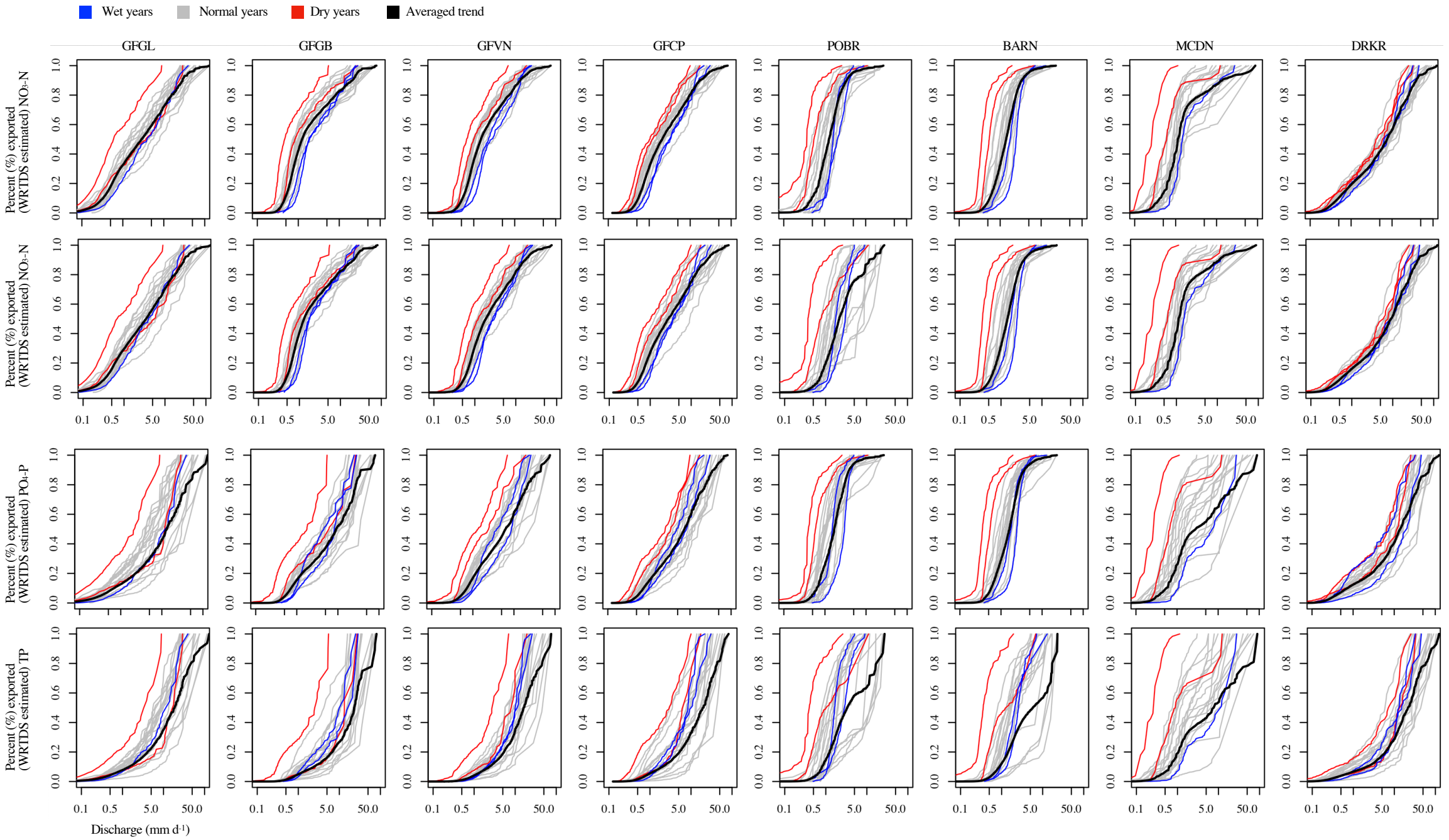
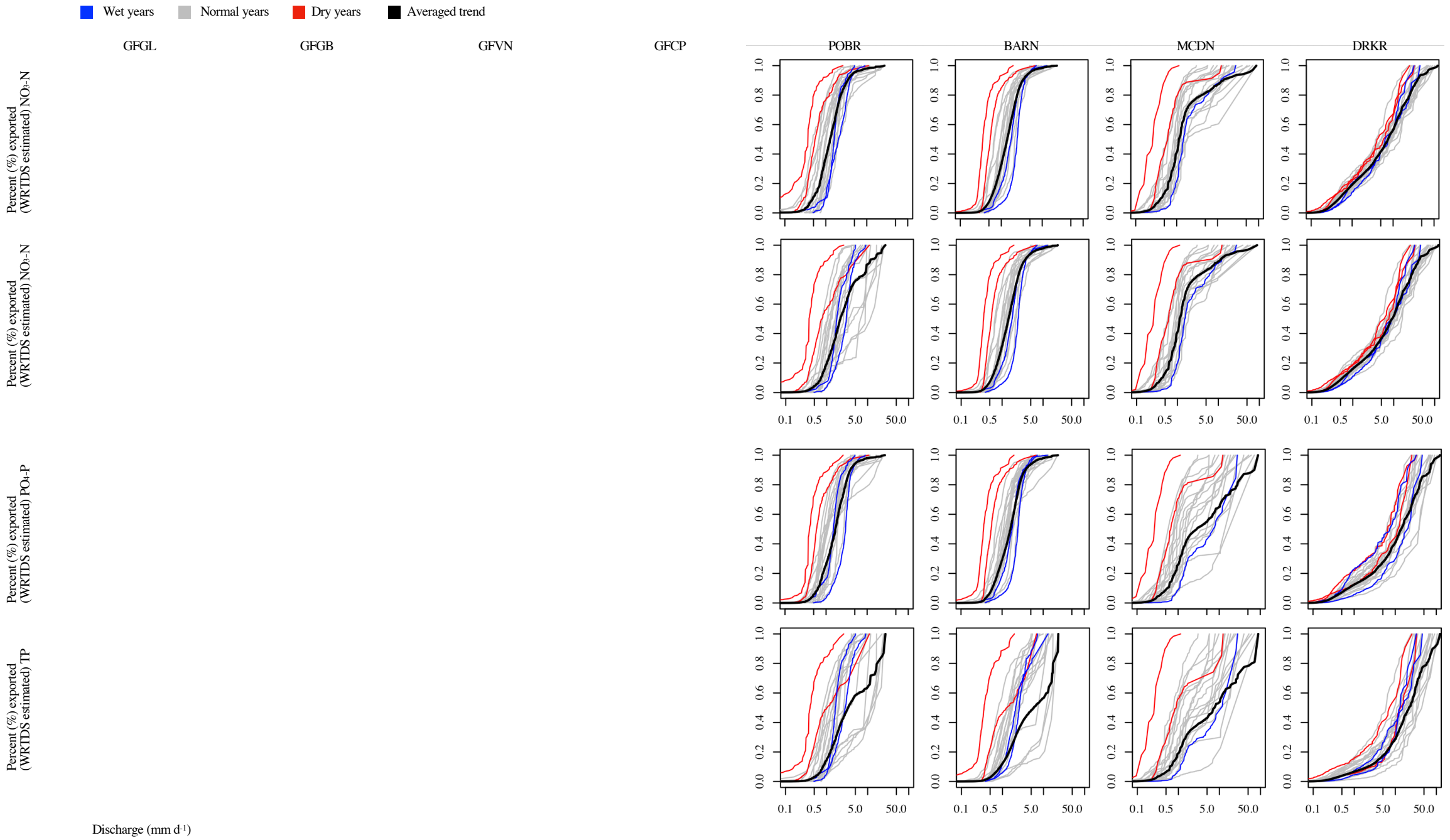

Wet years
Normal years
Dry years
Averaged trend
GFGL
GFGB
GFVN
GFCP
POBR
BARN
MCDN
DRKR
Percent (%) exported (WRTDS estimated) NO3-N
Percent (%) exported (WRTDS estimated) NO3-N
Percent (%) exported (WRTDS estimated) PO4-P
Percent (%) exported (WRTDS estimated) TP
0.0
0.2
0.4
0.6
0.8
1.0
0.1
0.5
5.0
50.0
Discharge (mm d-1)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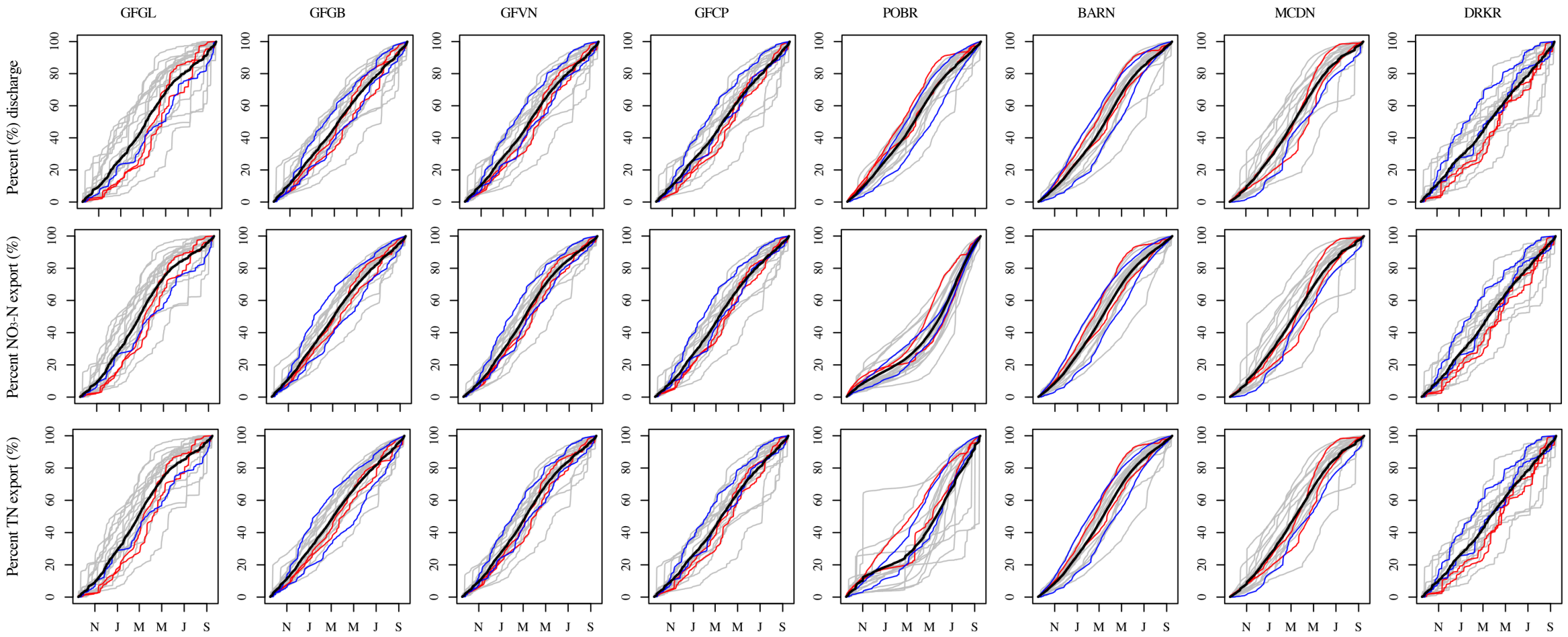
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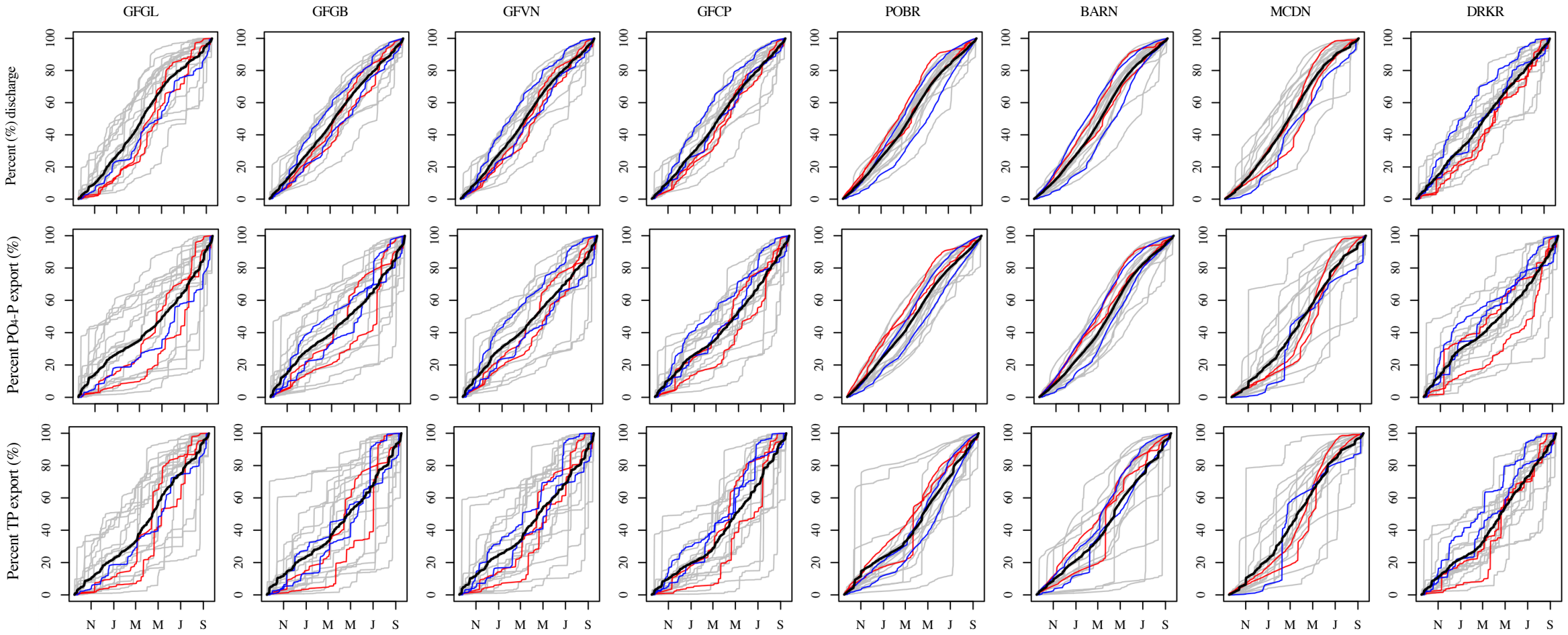
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