

Regional coherence in solute interactions during stormflow in a statewide aquatic sensor network

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SusTainability
Consortium





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Flows can vary on the order of minutes to days

Weekly grab samples may miss the biogeochemical response

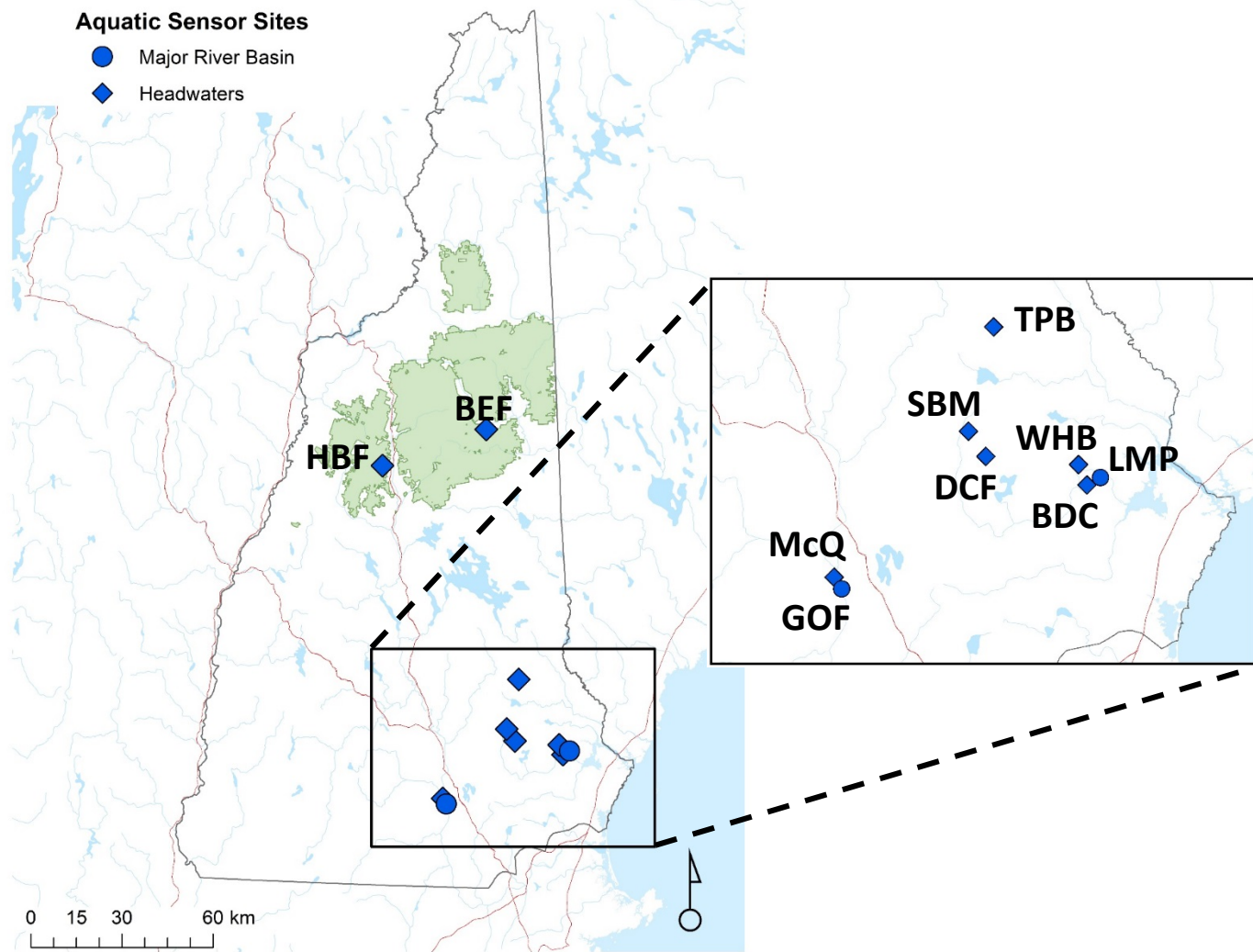




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EPSCoR Aquatic Sensor Network



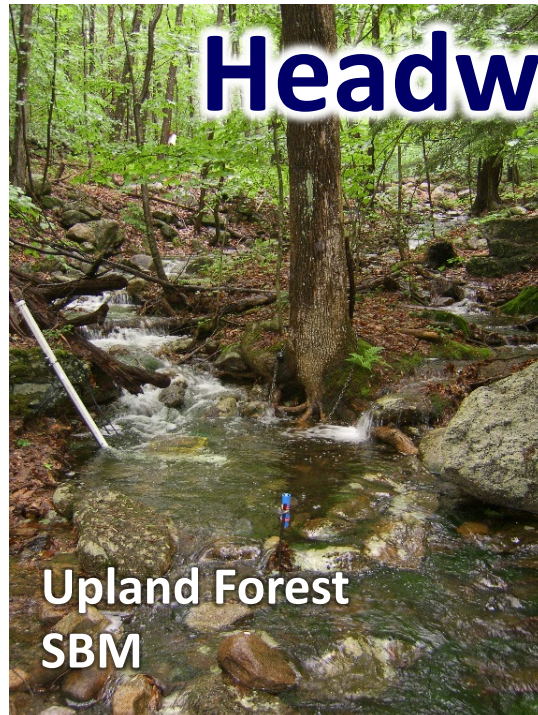
YSI EXO2 - FDOM,
turbidity, pH, DO,
conductance, temp



Satlantic
SUNA -
NO₃



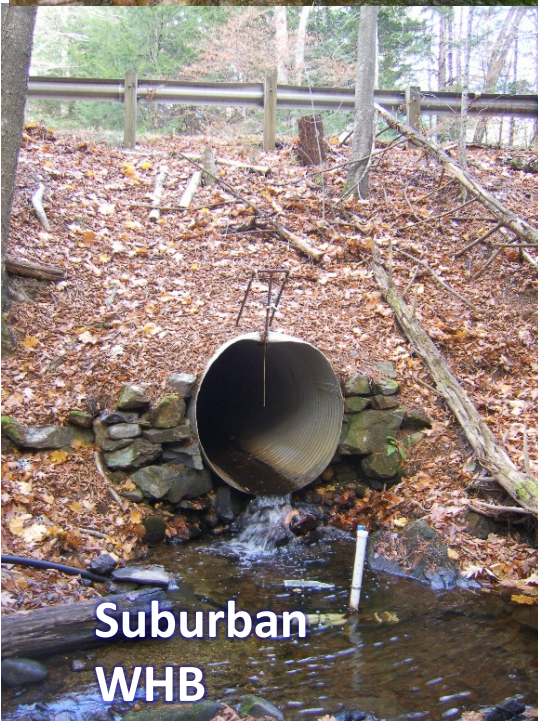
Headwaters



Upland Forest
SBM



Wetland
DCF



Suburban
WHB



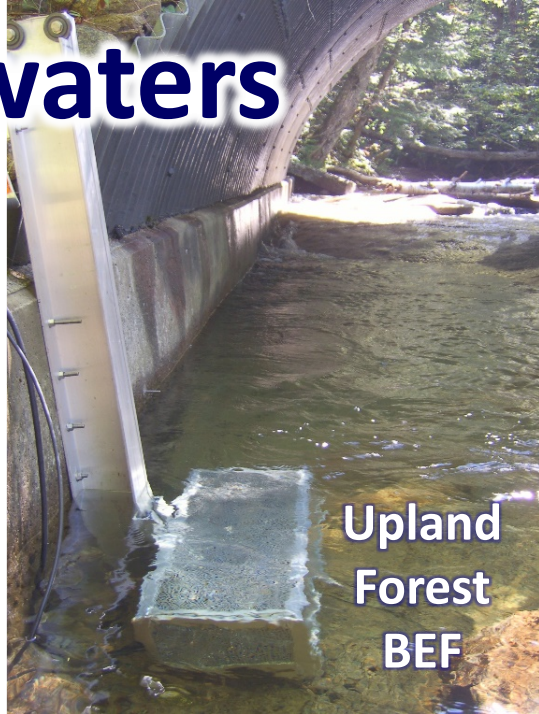
Agricultural
BDC

Lamprey River - LMP



Headwaters

Upland
Forest
HBF



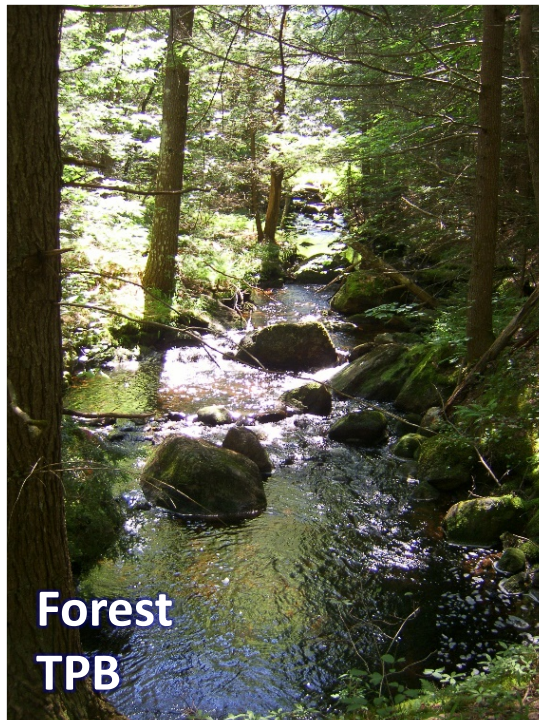
Upland
Forest
BEF



Merrimack River - GOF



Urban
McQ



Forest
TPB



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Fundamental questions sensor network can help address:

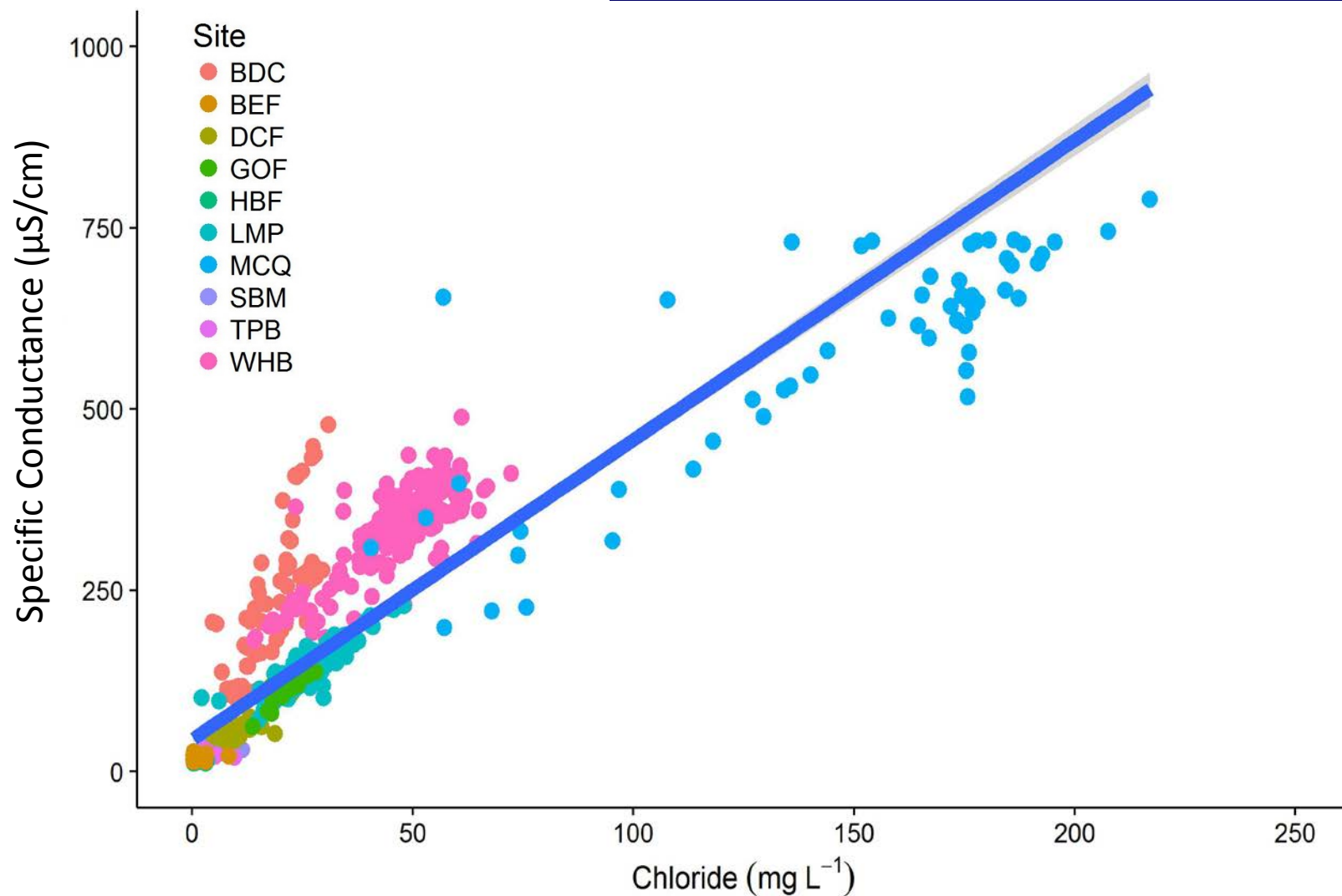
- How does flow affect stream water nitrate concentration, specific conductance and fluorescent dissolved organic matter (FDOM)?
- Are these solutes coupled in their response to flow?
- What do these patterns tell us about watershed sources?



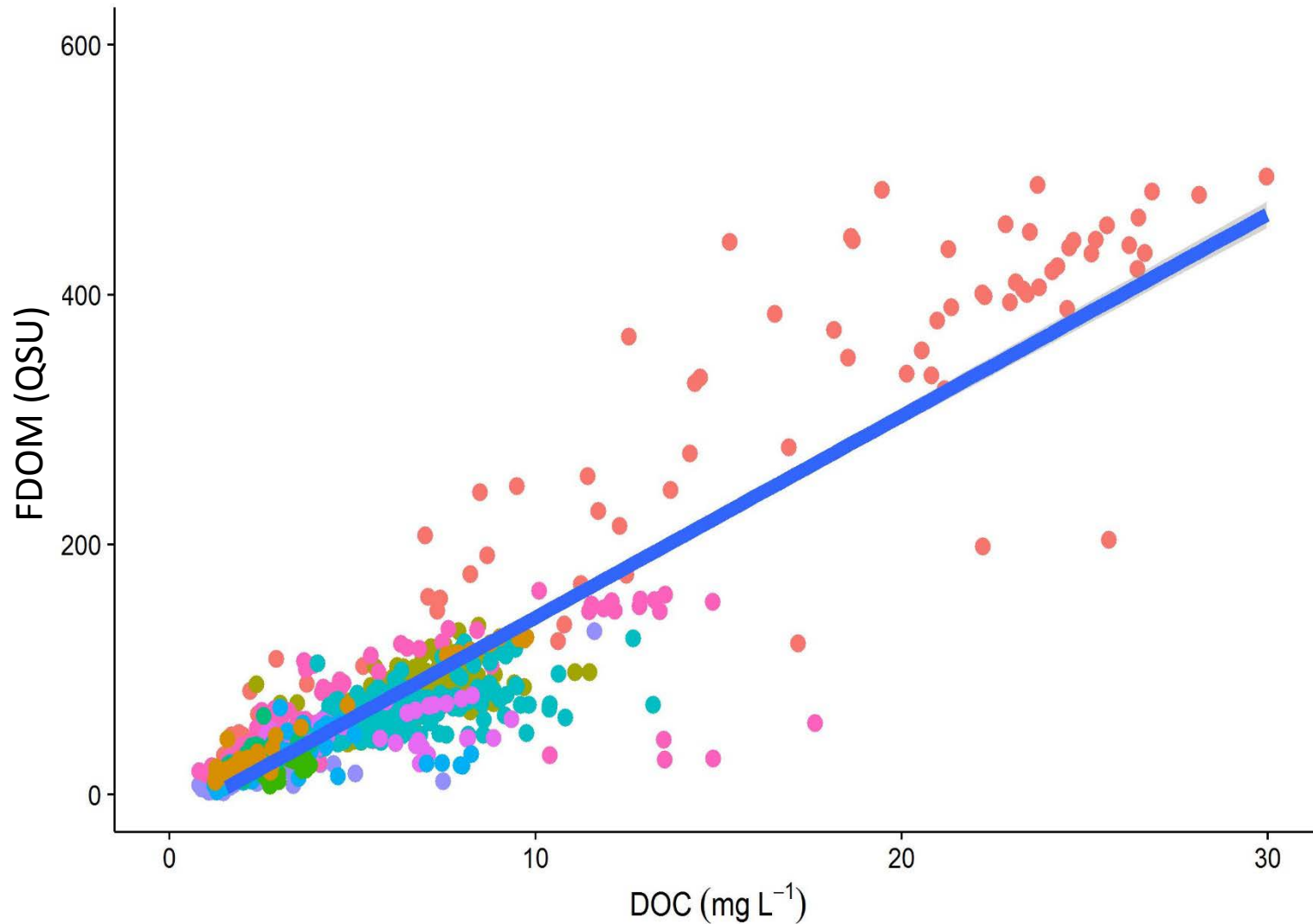
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Specific conductance is a proxy for chloride

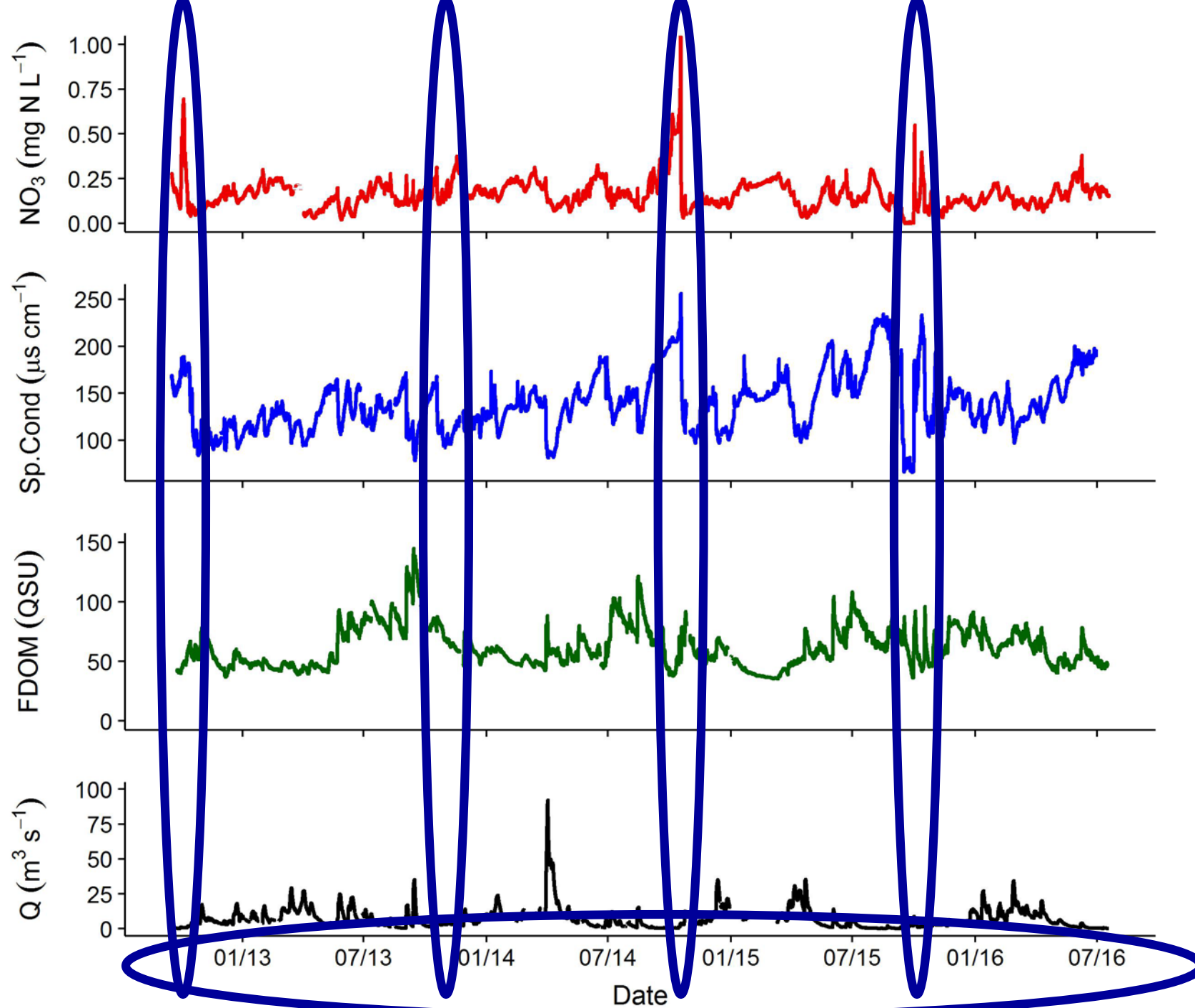


Florescent Dissolved Organic matter is a proxy for Dissolved Organic Carbon

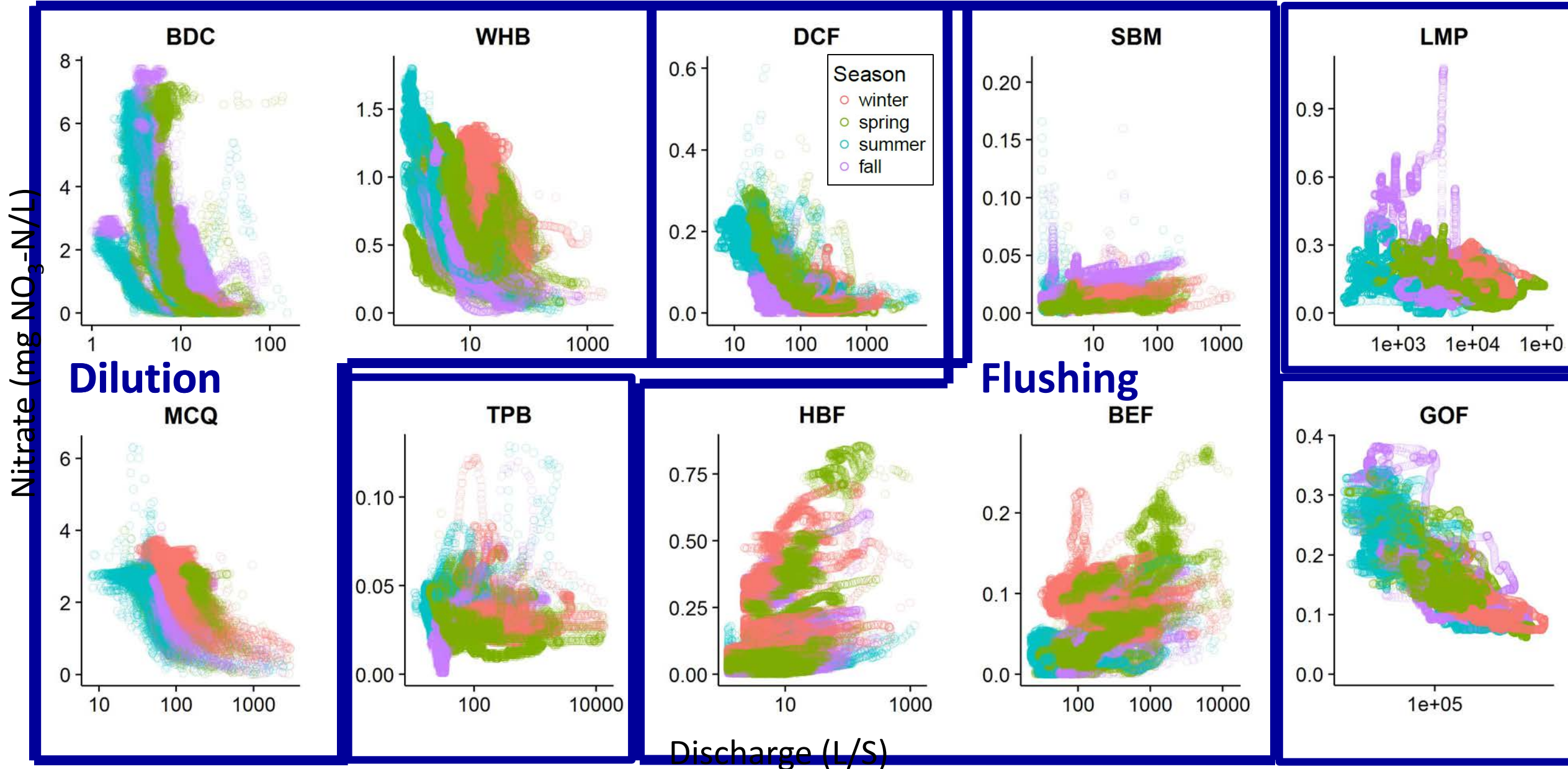


Lamprey River Time Series

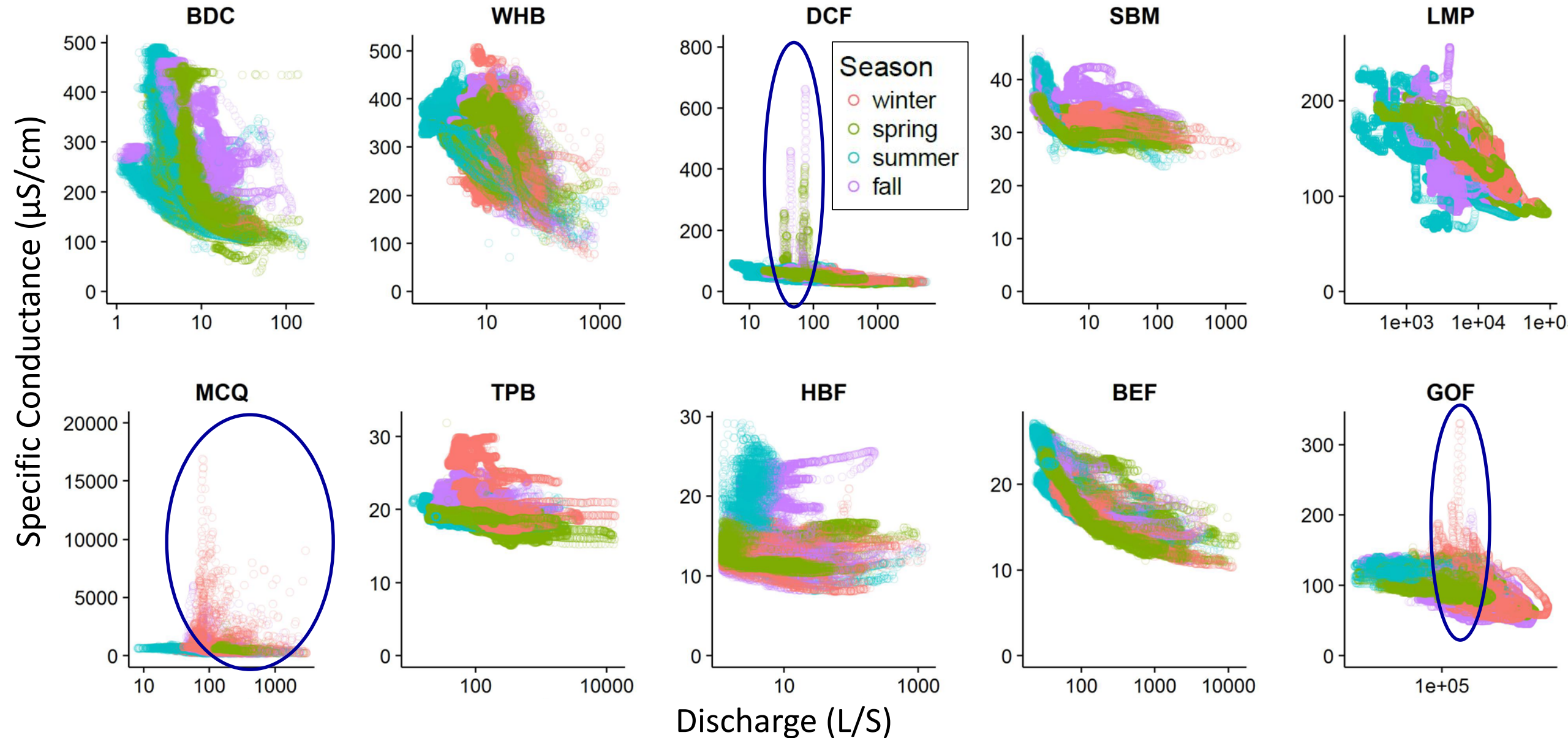
- 4 years continuous data
- Peak nitrate in fall (except 2013), coupled with Sp Cond, not FDOM



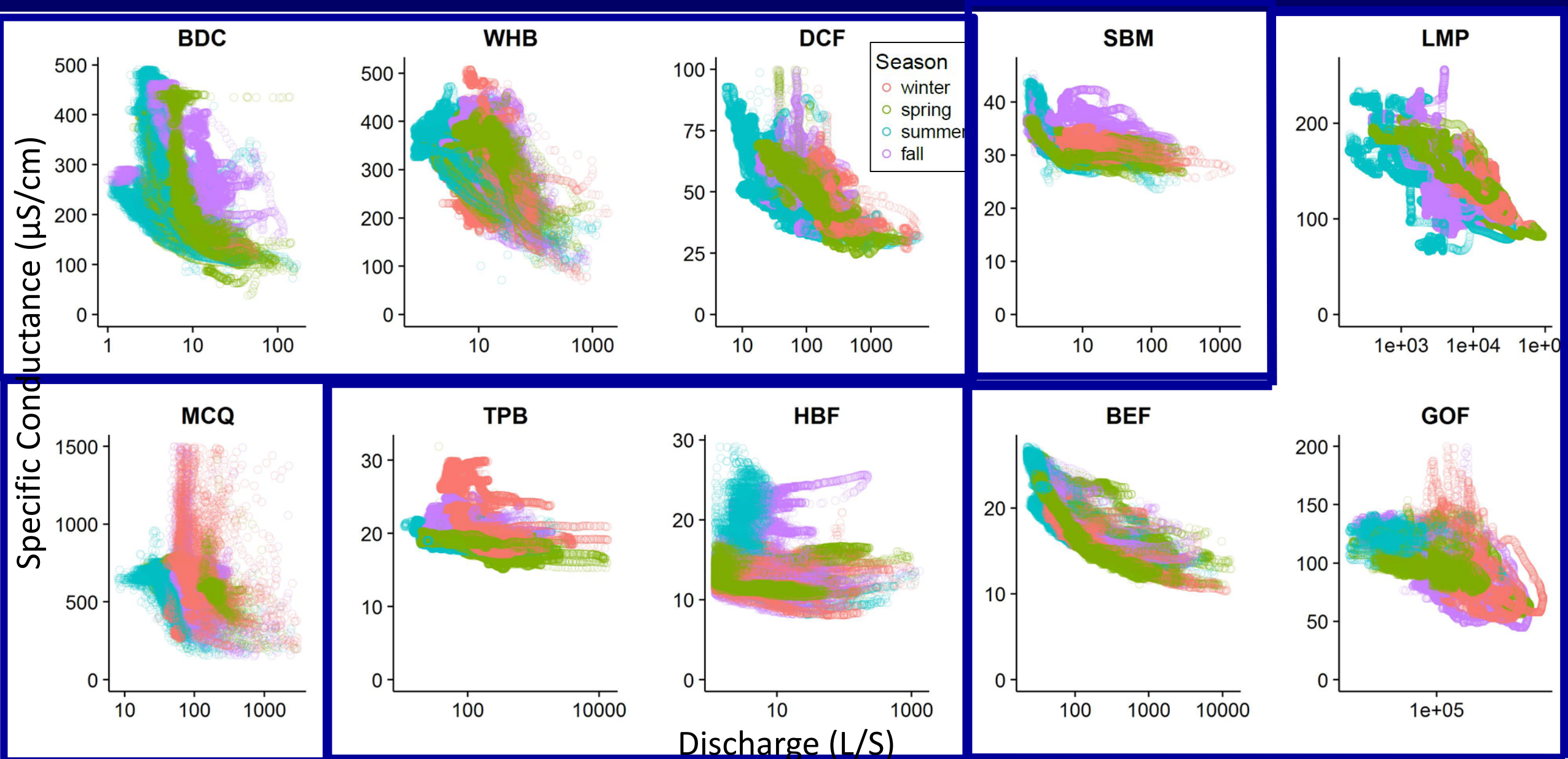
Nitrate response to flow varies within a site and among sites



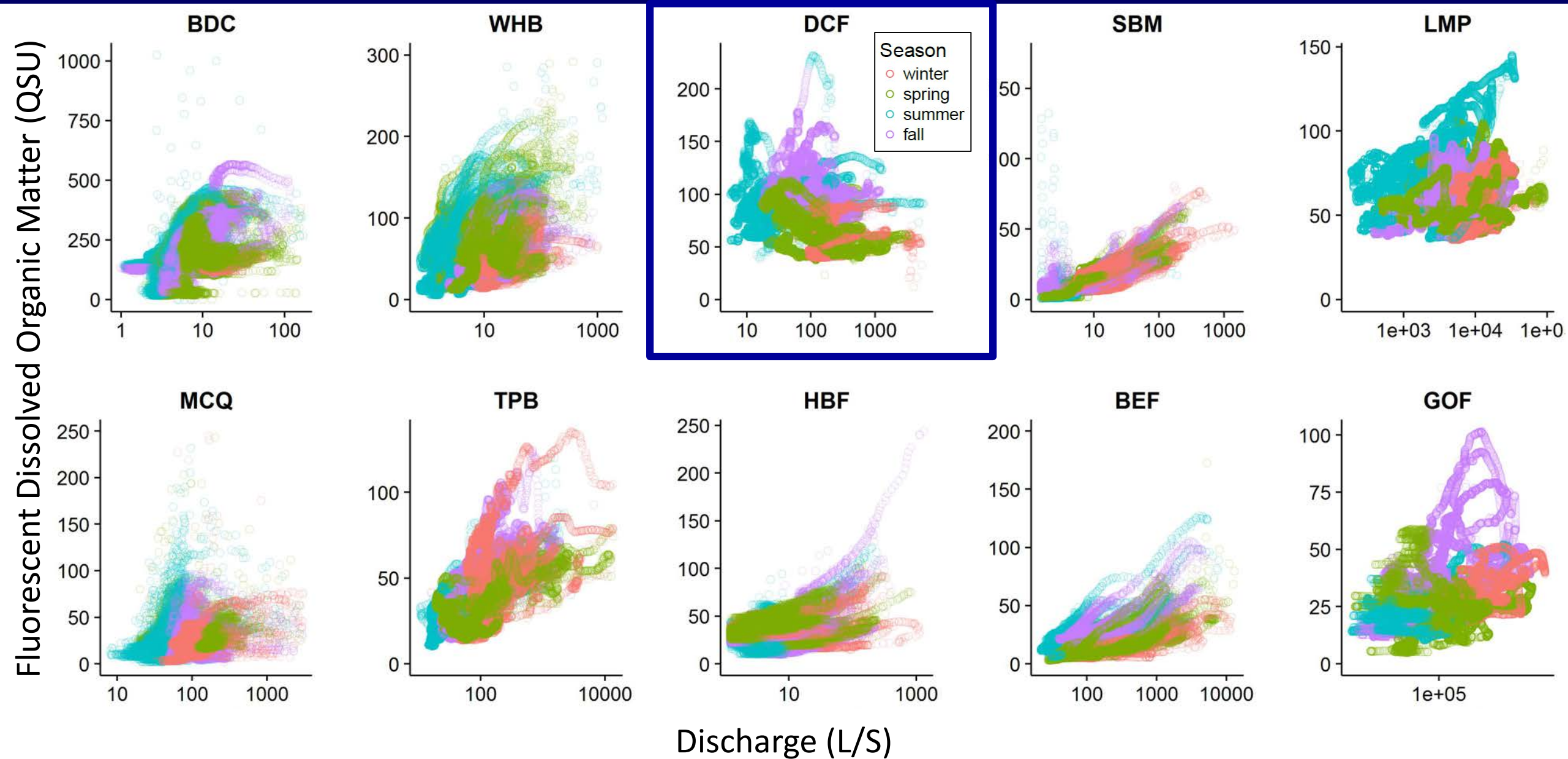
Sensors reveal excursions in specific conductance at some sites



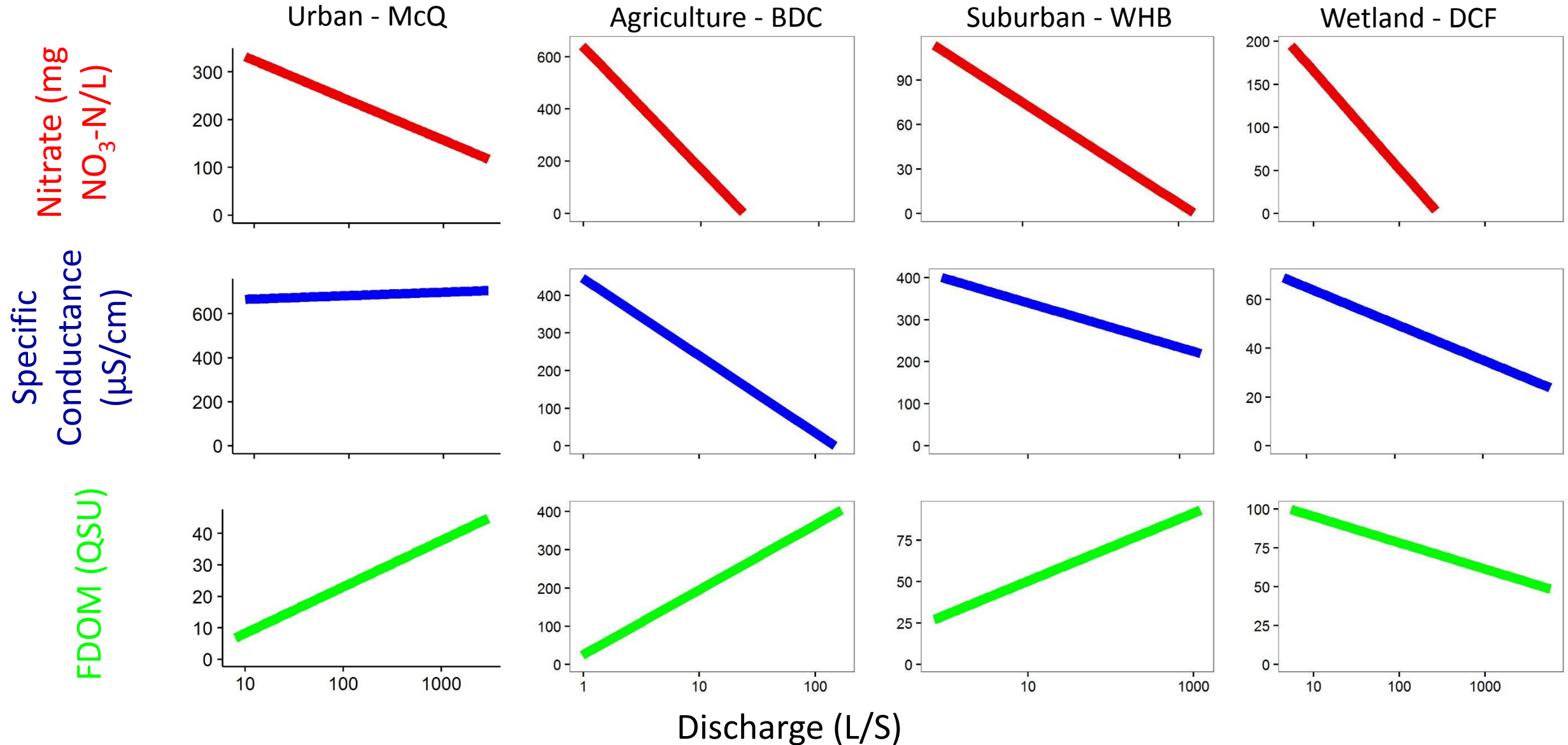
Specific conductance varies, but dilutes with flow at most sites



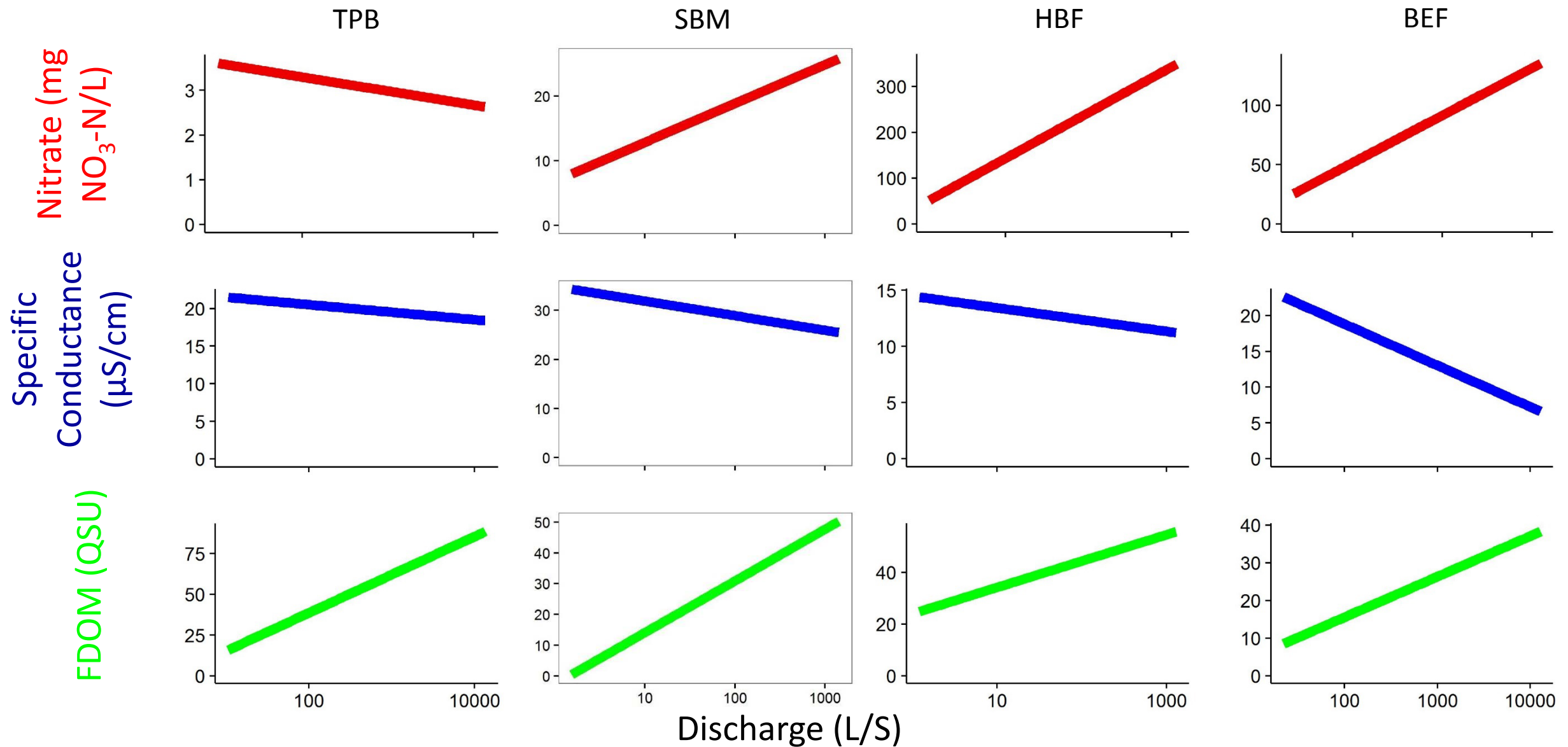
FDOM varies, but increases with flow at most sites



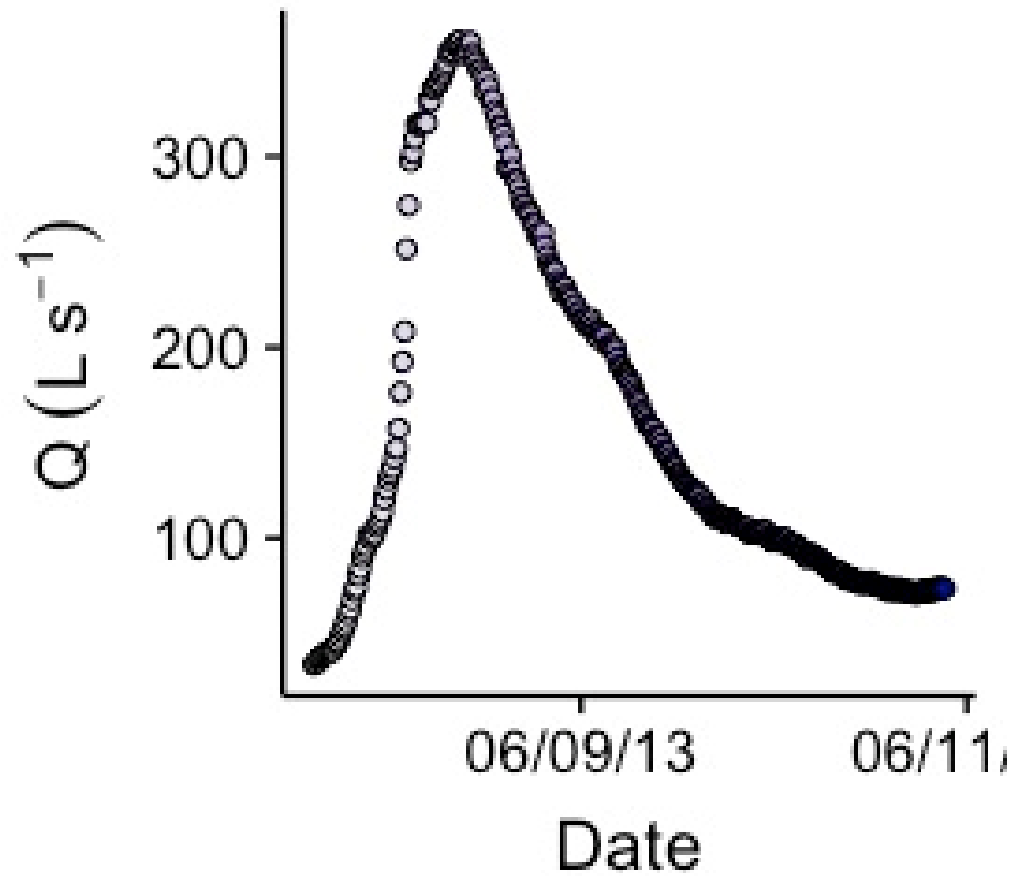
Coupling of NO_3 and Specific Conductance at most impacted sites



Coupling of NO_3 and FDOM at most forested sites



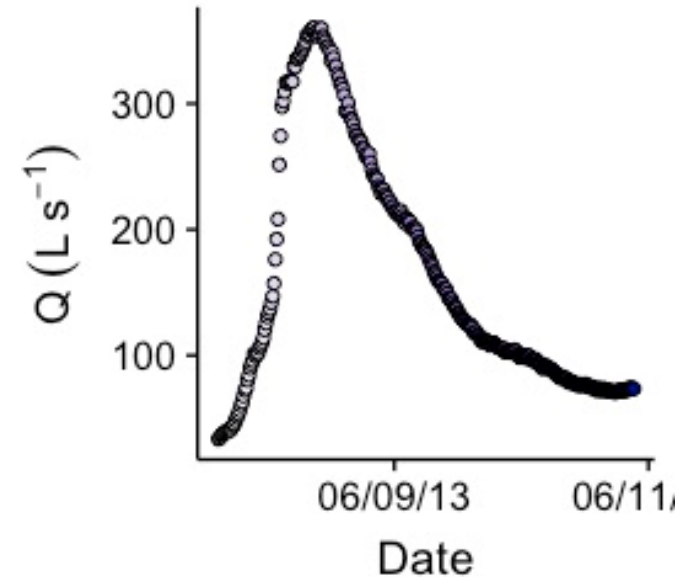
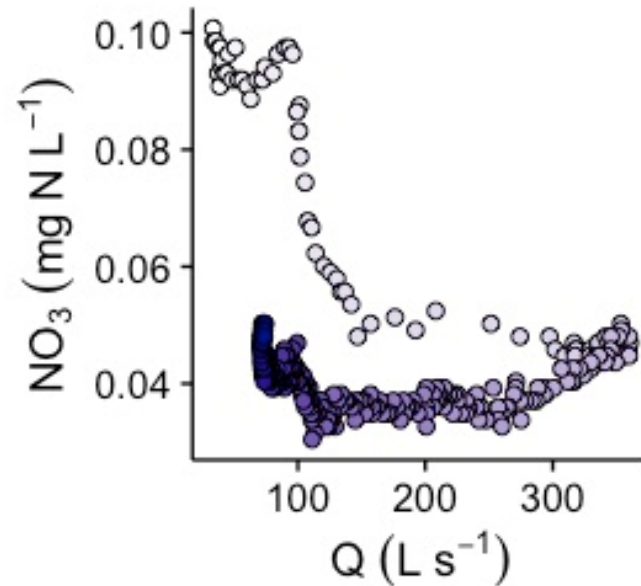
Analysis of storms at DCF –Wetland site – 106 total



Analysis of storms at DCF –Wetland site – 106 total

Nitrate

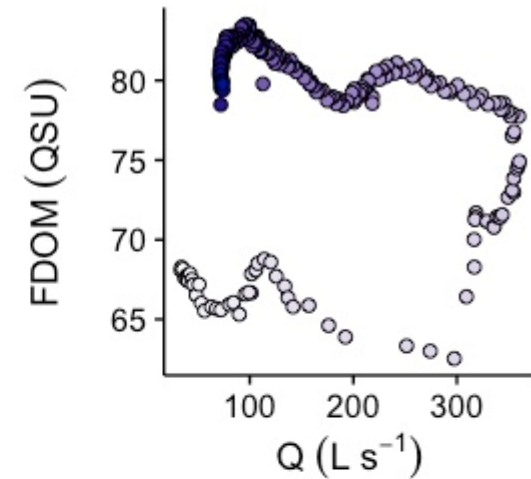
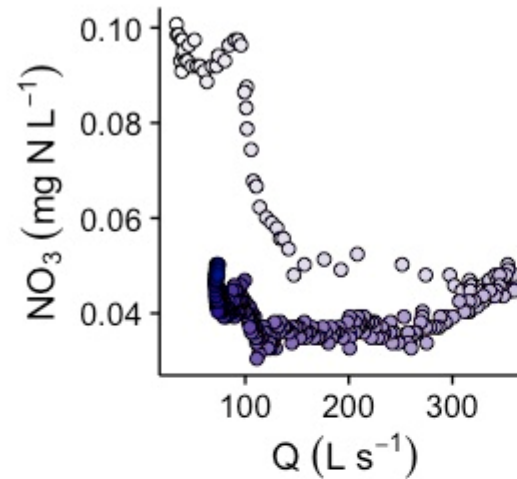
- Clockwise hysteresis
- Sources close to stream are diluted by storms (source-limited)



Analysis of storms at DCF –Wetland site – 106 total

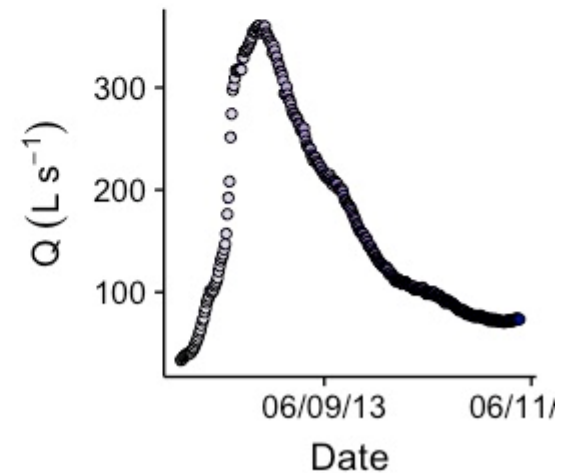
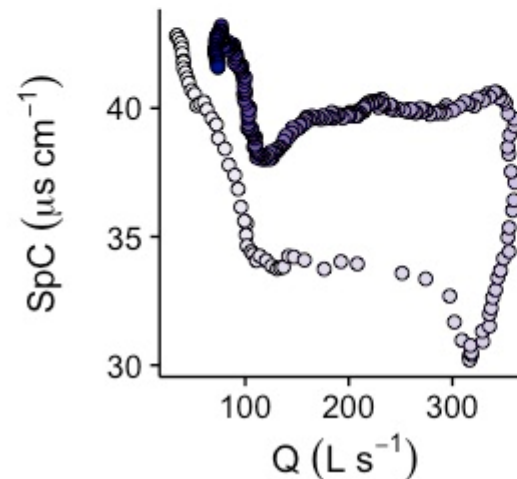
Nitrate

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Sp Cond and FDOM

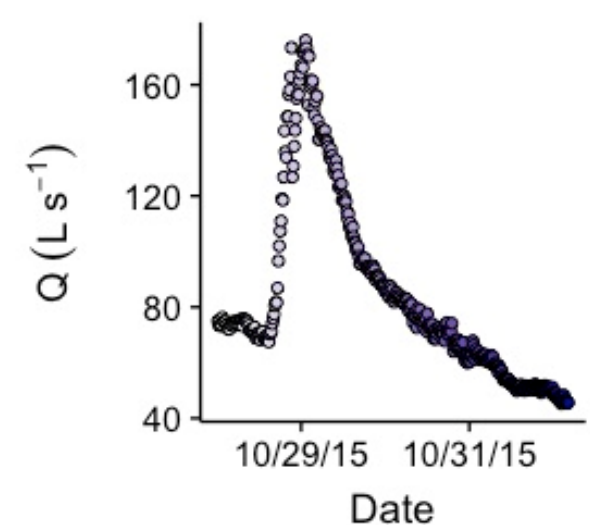
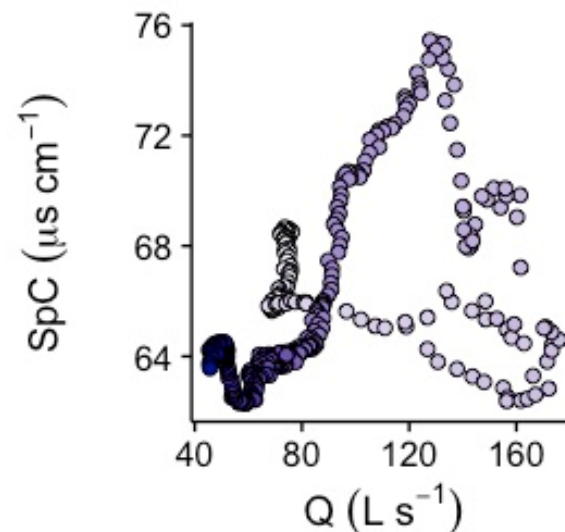
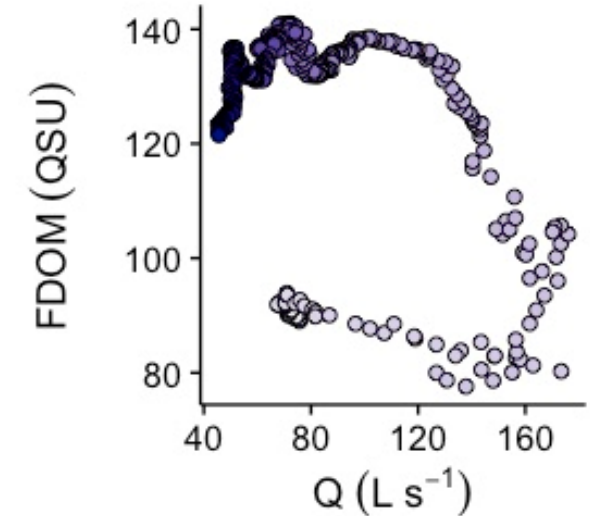
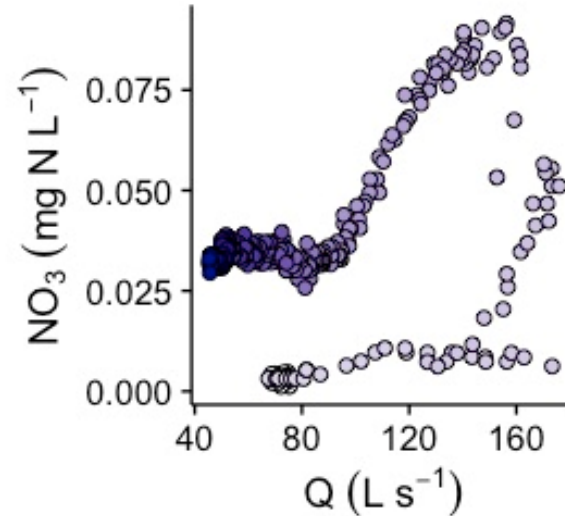
- Counterclockwise hysteresis
- Storms activate and flush distant sources (transport-limited)



A few Oct/Nov storms at DCF behaved differently

Nitrate, Sp Cond and FDOM

- Counterclockwise hysteresis
- Sources near stream are depleted
- Storms activate new sources further from the stream (transport-limited)



General nitrate, FDOC and specific conductance response to flow during storms

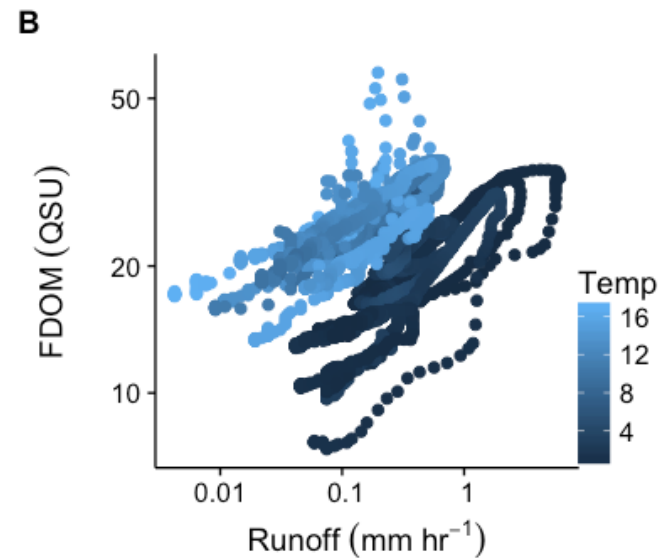
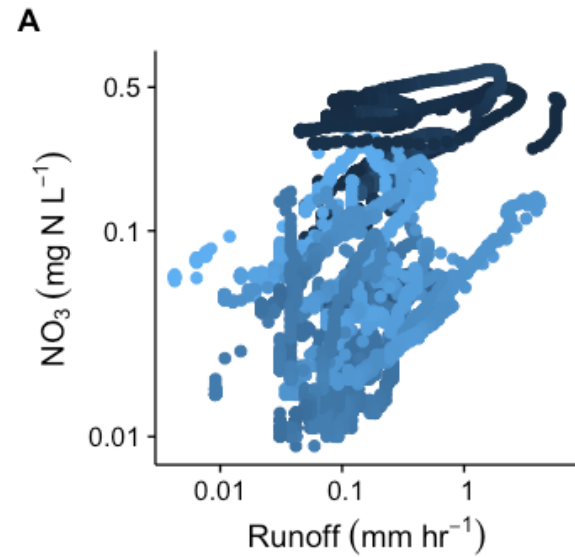
Stream Site	Landuse	Data record	# Storms	In situ Nitrate		In situ FDOM		In situ specific conductance	
				Flushing or Dilution	Dominant Hysteresis	Flushing or Dilution	Dominant Hysteresis	Flushing or Dilution	Dominant Hysteresis
SBM	Forested	5/2013 – 6/2016	39	Flushing	Clockwise	Flushing	Anti-Clockwise	Dilution	Anti-Clockwise
HBF	Forested	10/2012 – 7/2016	99	Flushing	Anti-Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise
TPB	Forested	10/2013 – 7/2016	72	Flushing	Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise
BEF	Forested	3/2014 – 7/2016	74	Flushing	Anti-Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise
DCF	Wetland	4/2013 – 6/2016	106	Dilution	Clockwise	Flushing	Anti-Clockwise	Dilution	Anti-Clockwise
BDC	Agriculture	3/2013 – 7/2016	56	Dilution	Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise
WHB	Suburban	12/2012 – 7/2016	46	Dilution	Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise
MCQ	Urban	11/2013 – 4/2016	80	Dilution	Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise
LMP*	Forested	9/2012 – 7/2016	75	Dilution	Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise
GOF*	Forested	9/2014 – 7/2016	37	Dilution	Clockwise	Flushing	Anti-Clockwise	Dilution	Clockwise

*Mainstem

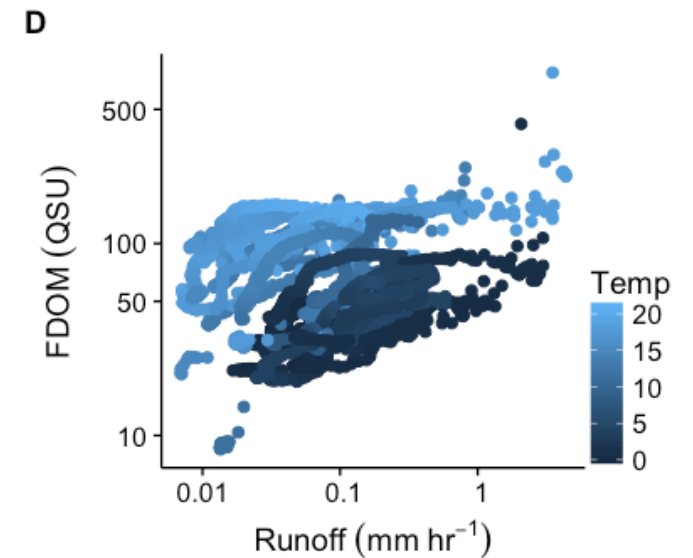
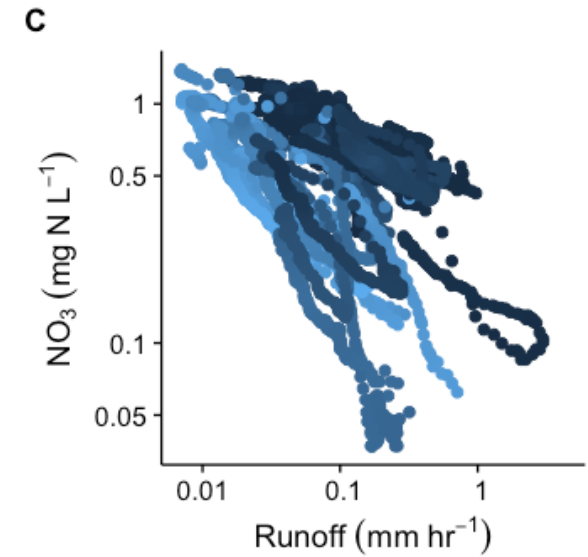
Total Storms: 684 Black text occurred 66-100% of the time, gray text occurred 50-65% of the time

General stormflow trends can be modified by season

Forested HBF 2013



Suburban WHB 2014





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Summary and Conclusions

- Sites impacted by urban, suburban and agricultural land use
 - Coupling of NO_3 and Sp Cond – dilution suggests groundwater source – human activity
 - FDOM decoupled - flushed to stream through surficial flow paths – forest soils
- Forested sites
 - NO_3 and FDOM are coupled - flushed to streams during storms
- Wetland site
 - Coupling of NO_3 , Sp Cond and FDOM - overall dilution but varies by storm
- Storm by storm analysis can reveal coupling/decoupling and provide insight to source proximity
- General stormflow trends can be modified by season



Questions?

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