Factors influencing nutrient and sediment retention by riverine wetlands in the Chesapeake watershed

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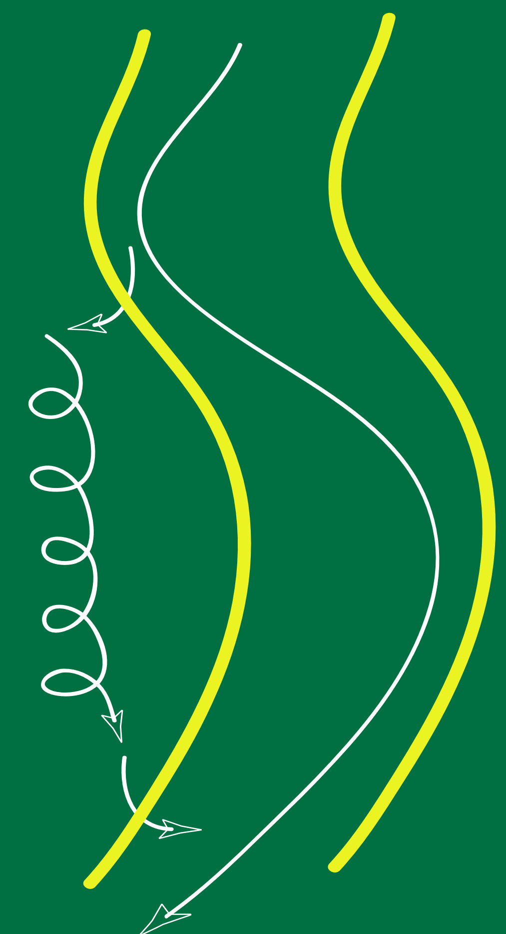
Floodplain nutrient and sediment retention

Floodplains are last location in watersheds for significant material retention before river loading into coastal waters

What are nutrient cycling and sediment deposition rates?

What are the controls?

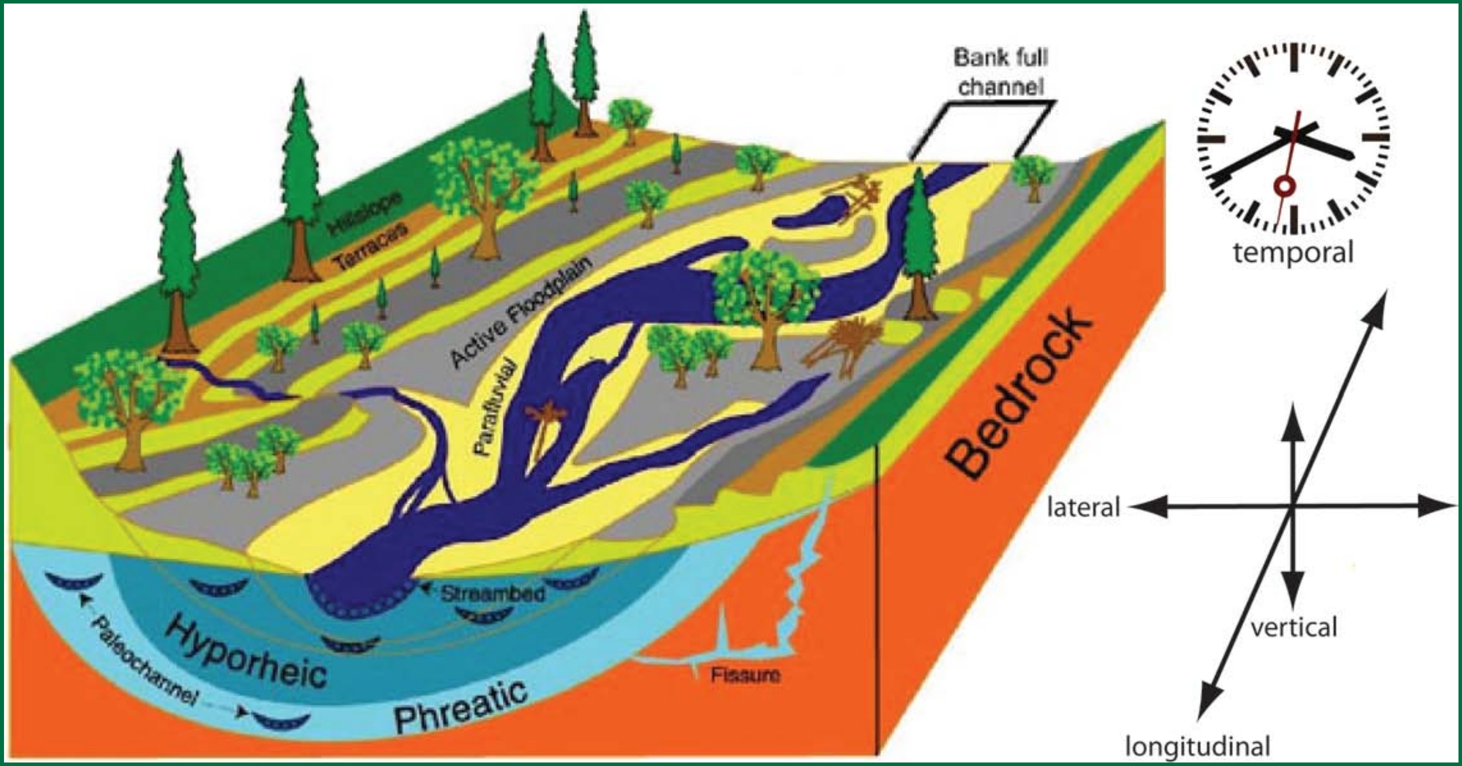
What is the percent retention of river loads by floodplains?



Hydrogeomorphic controls in floodplain ecosystems

Four dimensions of river corridors influence floodplain ecosystem processes through river-floodplain ***hydrologic connectivity***

This heterogeneity is critical to the prediction and scaling of floodplain effects on water quality



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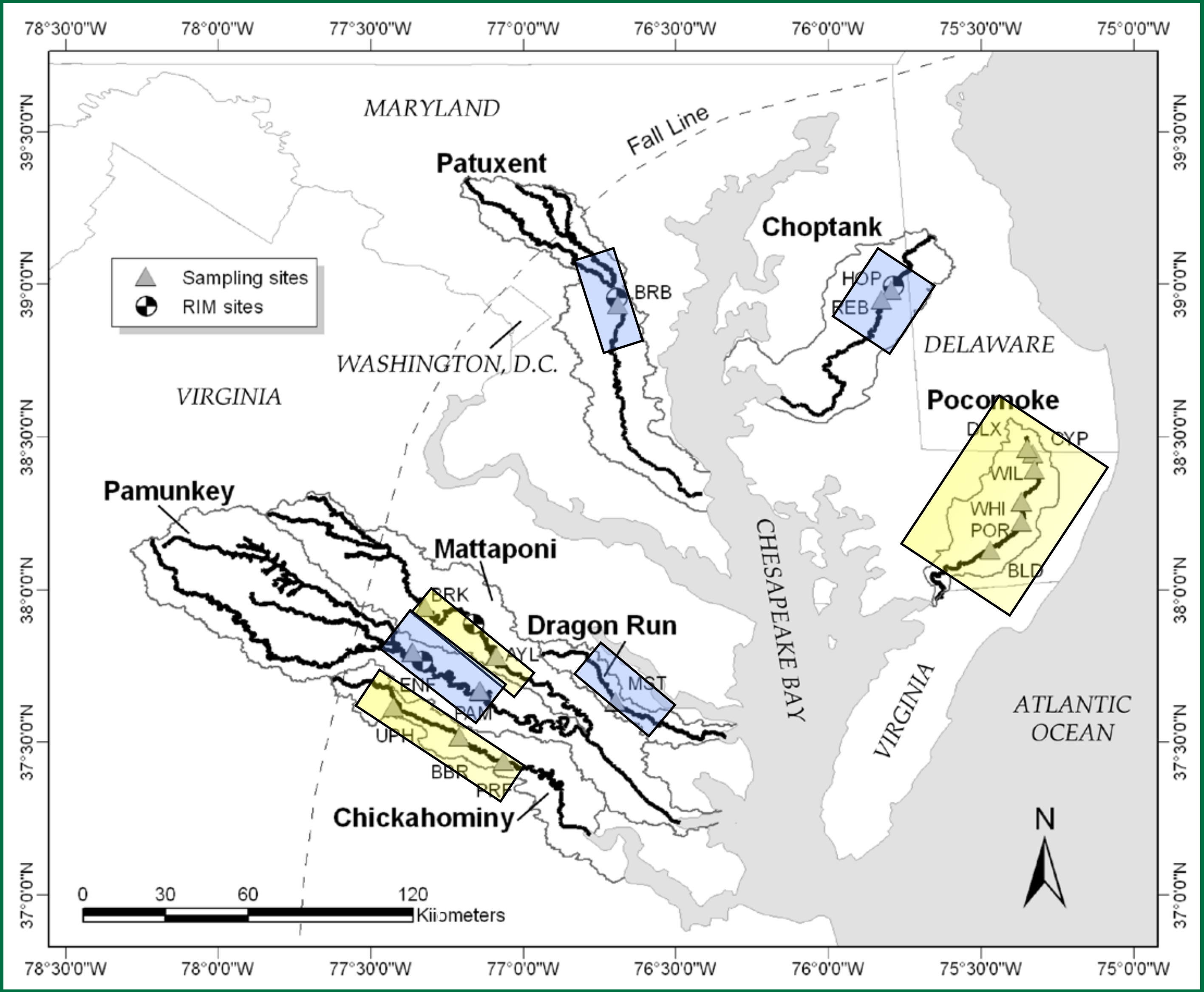
Noe. 2012. *Treatise of Geomorphology.* Modified from NRC 2002.

Nutrient trapping in the Coastal Plain

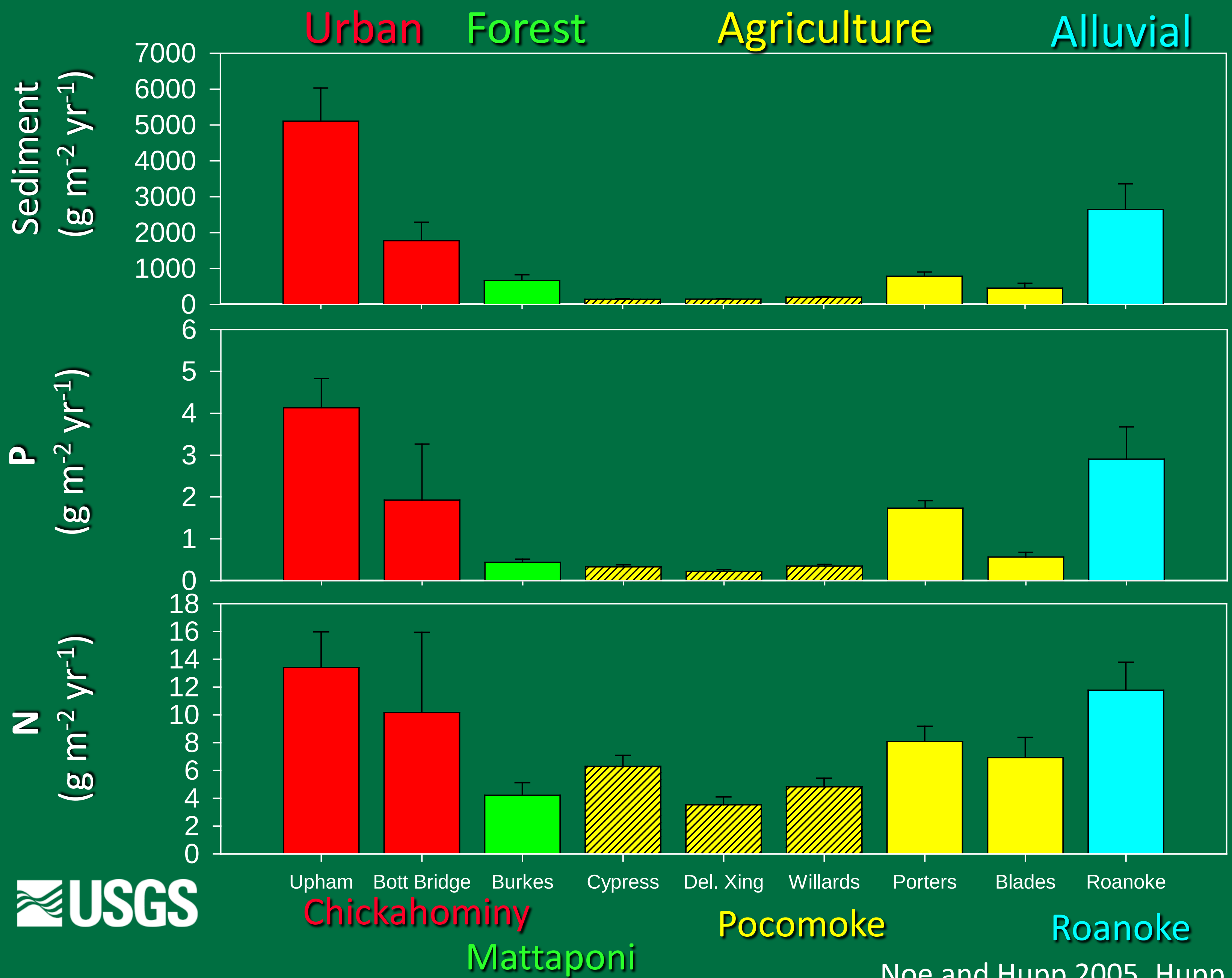
nutrients
n = 71

sediment
n = 114

n = 185



Net sedimentation rates



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Noe and Hupp 2005, Hupp et al. 2009

Mean annual % retention of river load

[(floodplain load trapping / river load)*100%]

	N			P			Sediment		
	Mean	-90%	+90%	Mean	-90%	+90%	Mean	-90 %	+90%
Chickahominy	104	49	305	245	121	840			
Choptank	5	3	7	14	9	22	85	56	130
Dragon Run	150	85	265	587	333	1035			
Mattaponi	56	43	75	66	51	87	476	360	632
Pamunkey	12	8	17	22	15	32	53	35	82
Patuxent	17	14	21	59	47	74	119	94	149
Pocomoke	22	17	30	21	16	27	690	529	911

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Noe and Hupp 2009

Does role of floodplains change upstream?

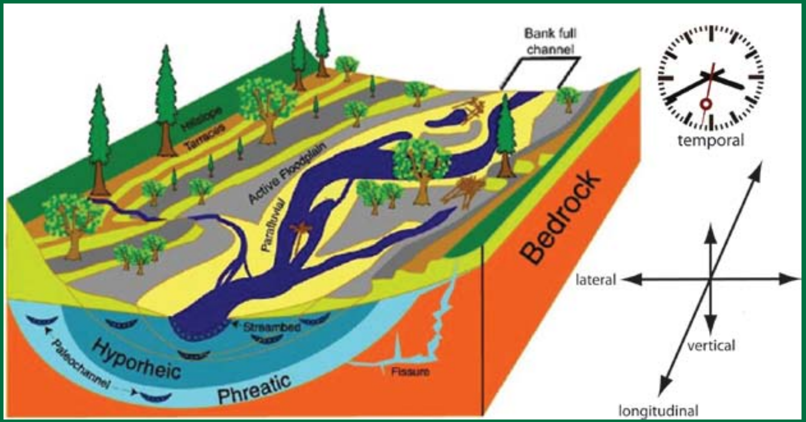

Table 1. Average annual sediment yields by physiographic province for 65 stations draining the Chesapeake Bay Watershed, 1952–2001.

[Mg/km²/yr, megagram per square kilometer per year]

Physiographic province	Sediment yield (Mg/km²/yr)	Number of stations used in the analysis
Appalachian Plateau	58.8	19
Blue Ridge	56.8	2
Valley and Ridge	66.3	19
Piedmont	103.7	21
Coastal Plain	11.9	4

Gellis. 2008. USGS SIR 2008-5186.

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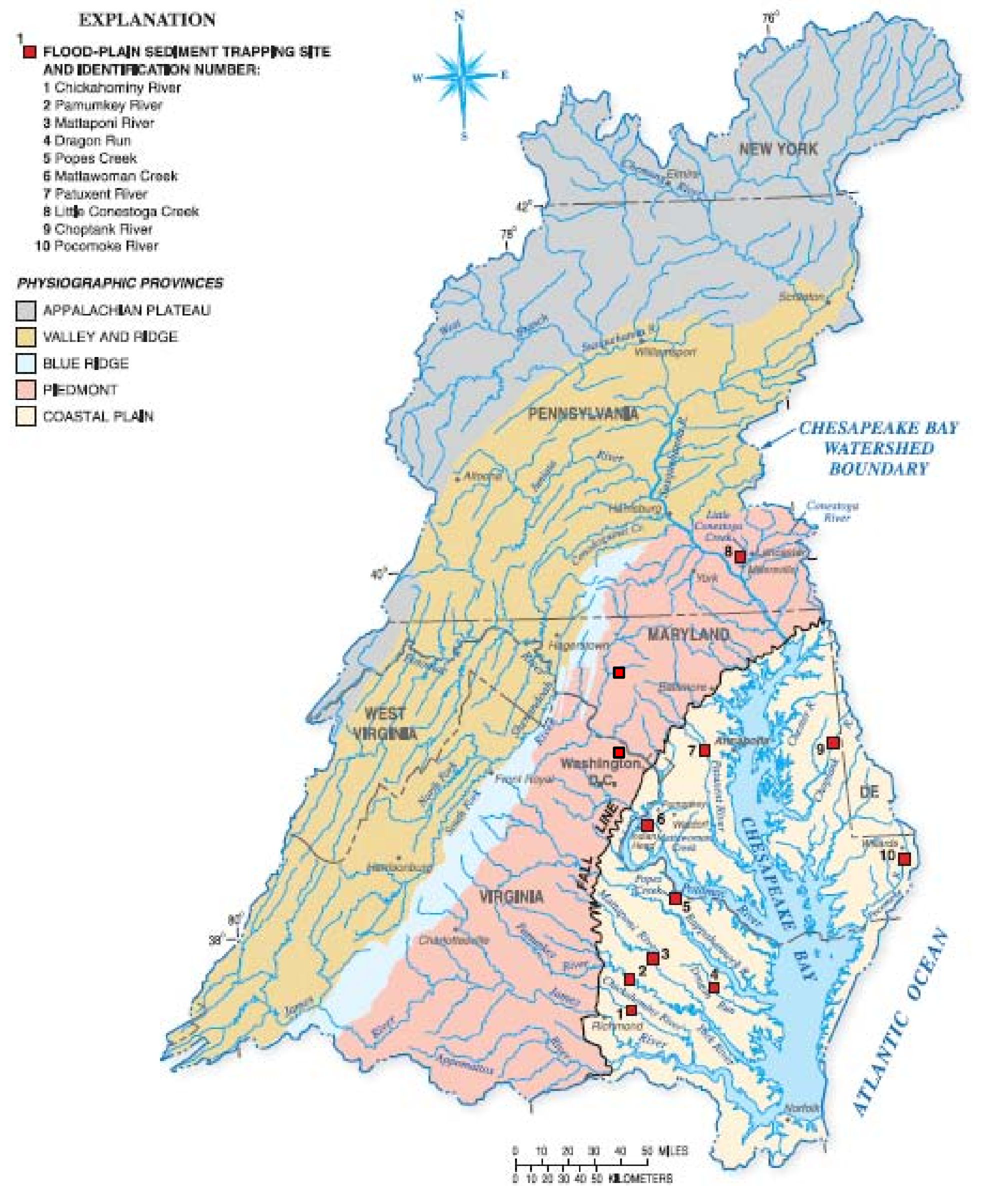
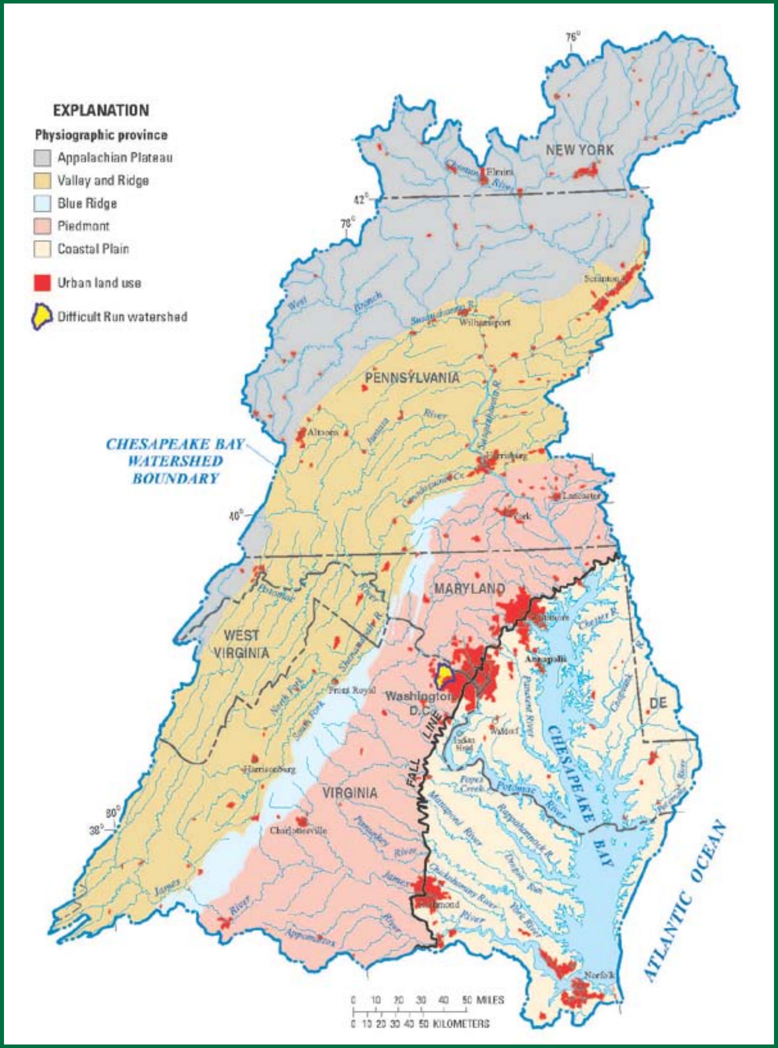


Figure 2. Location of flood-plain sediment trapping sites in the Chesapeake Bay Watershed. [Dates of measurements range from 1996 through 2006 (modified from Bachman and others, 1998).]

Difficult Run Floodplain Study

measuring sediment and nutrient retention along lateral and longitudinal floodplain gradients in an urban, Piedmont watershed



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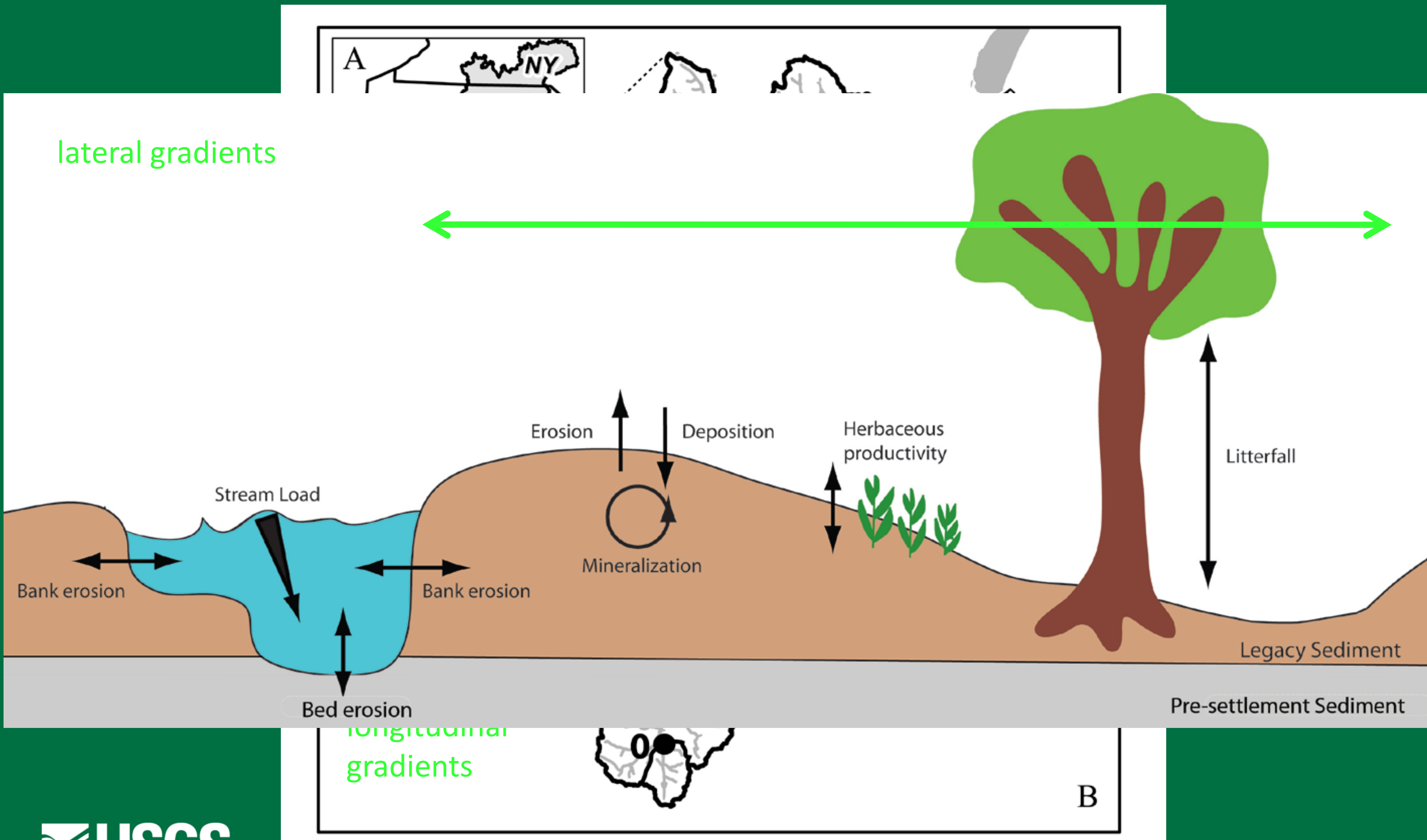
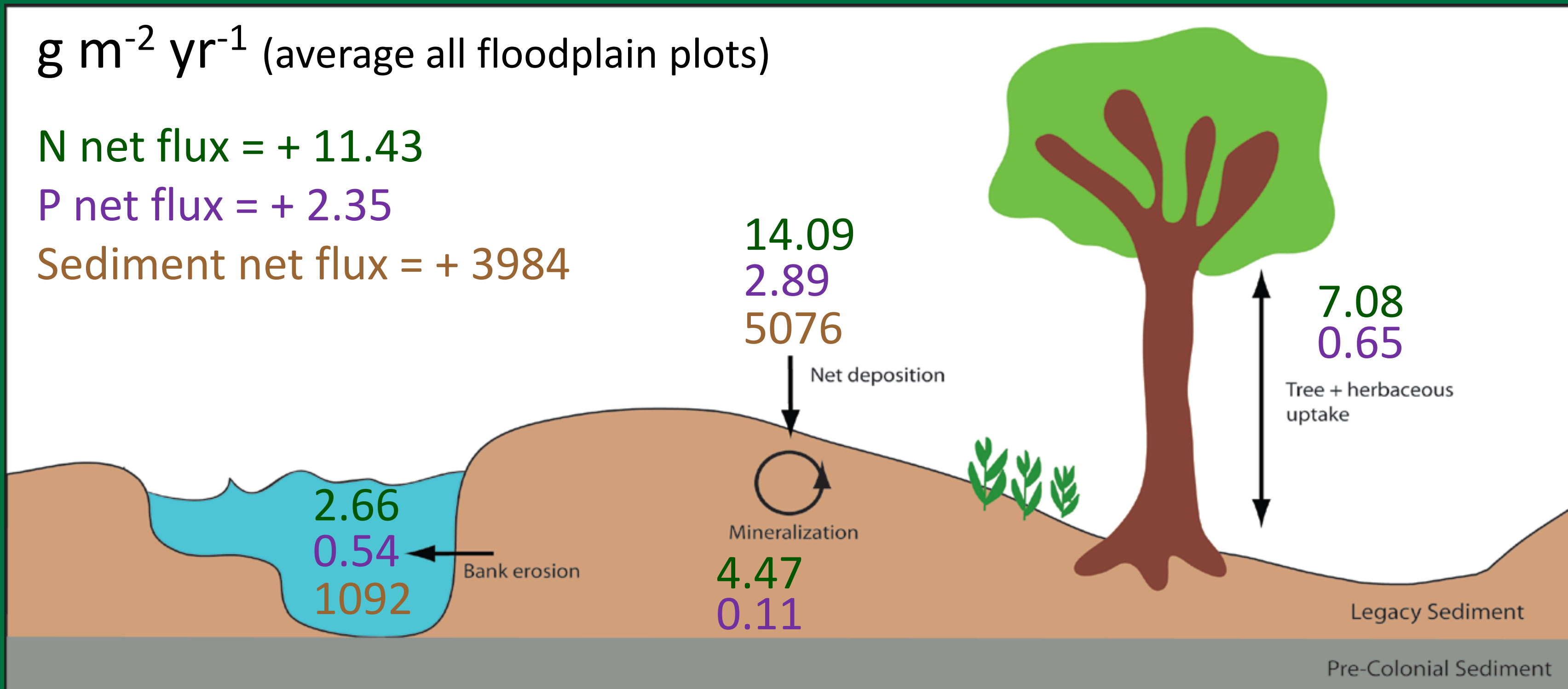
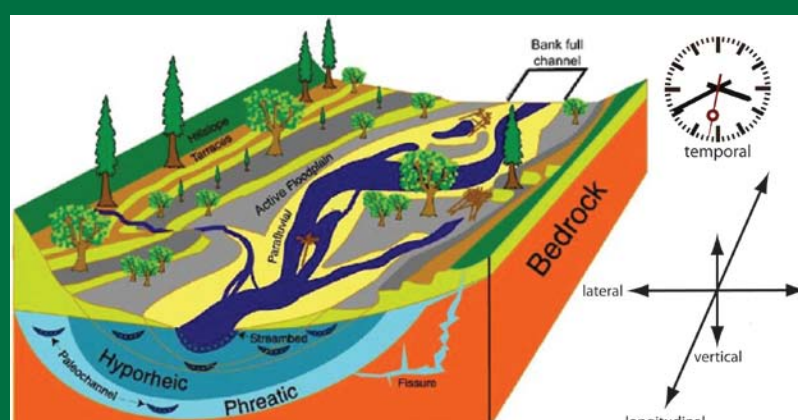


Average budget of floodplains





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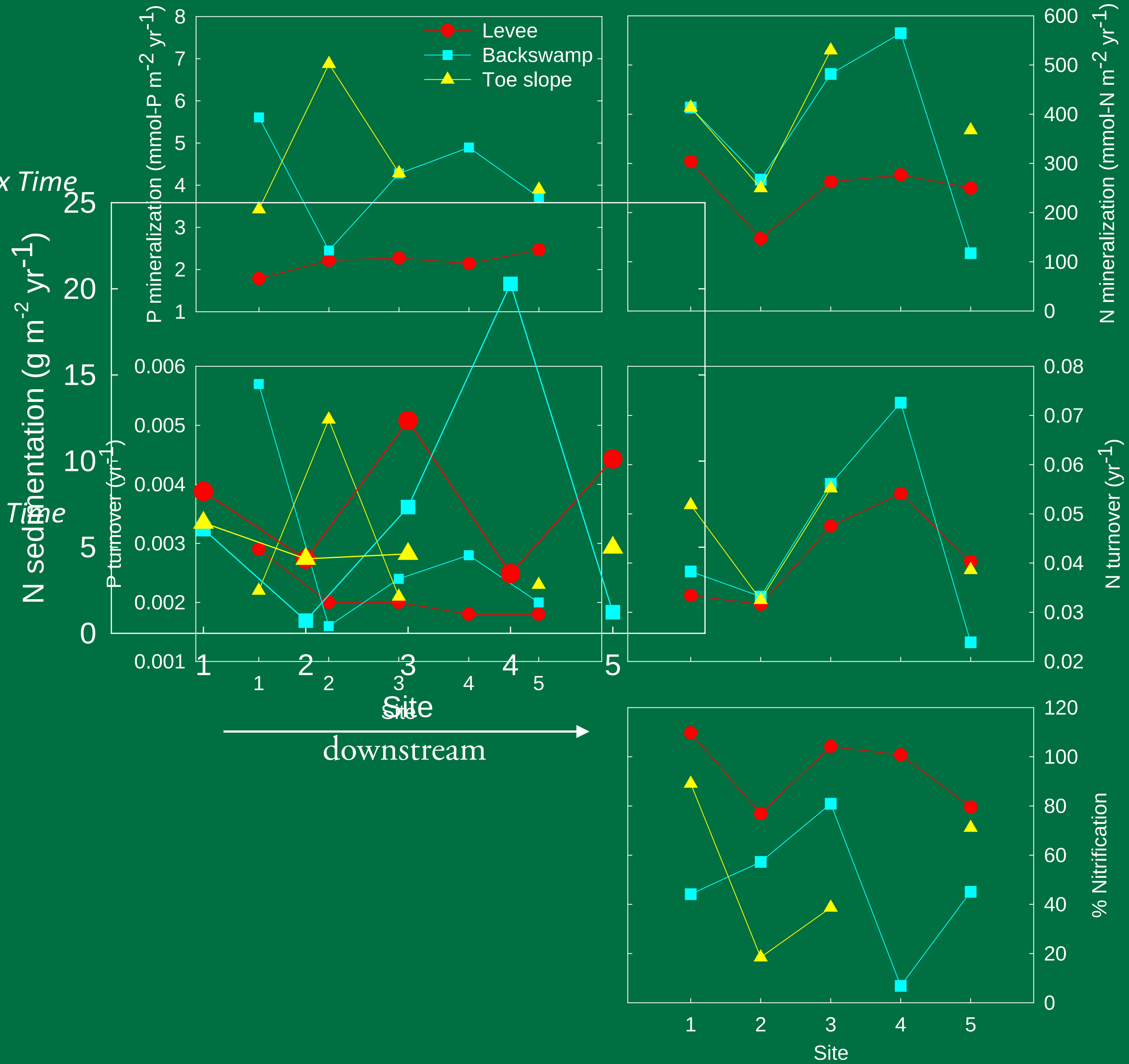
Annual net mineralization rates

Lateral
Time
Longitudinal x Time



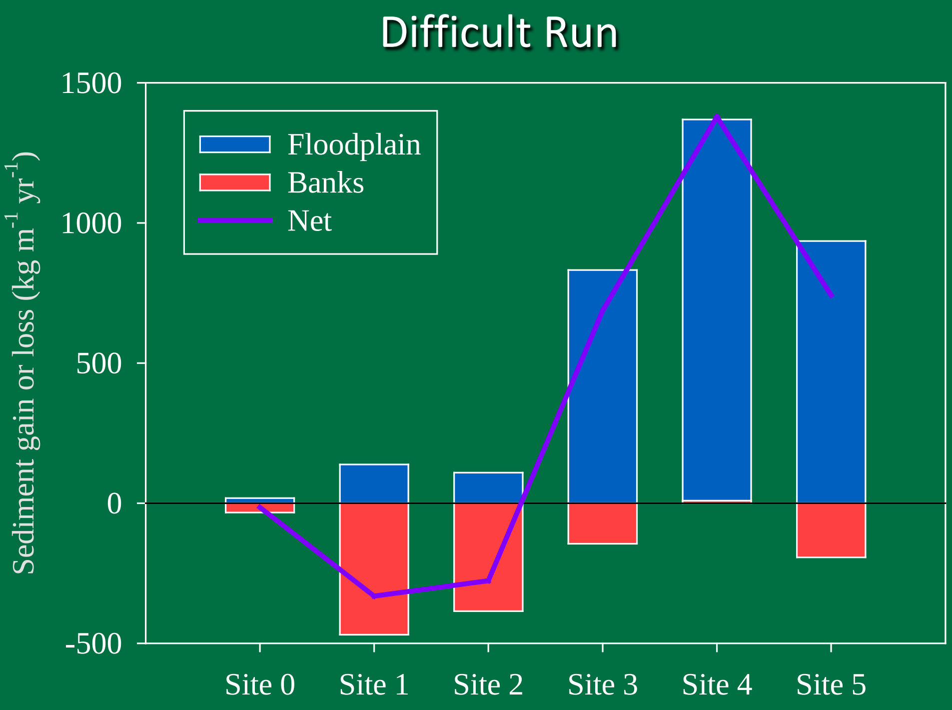
Lateral
Time

Time

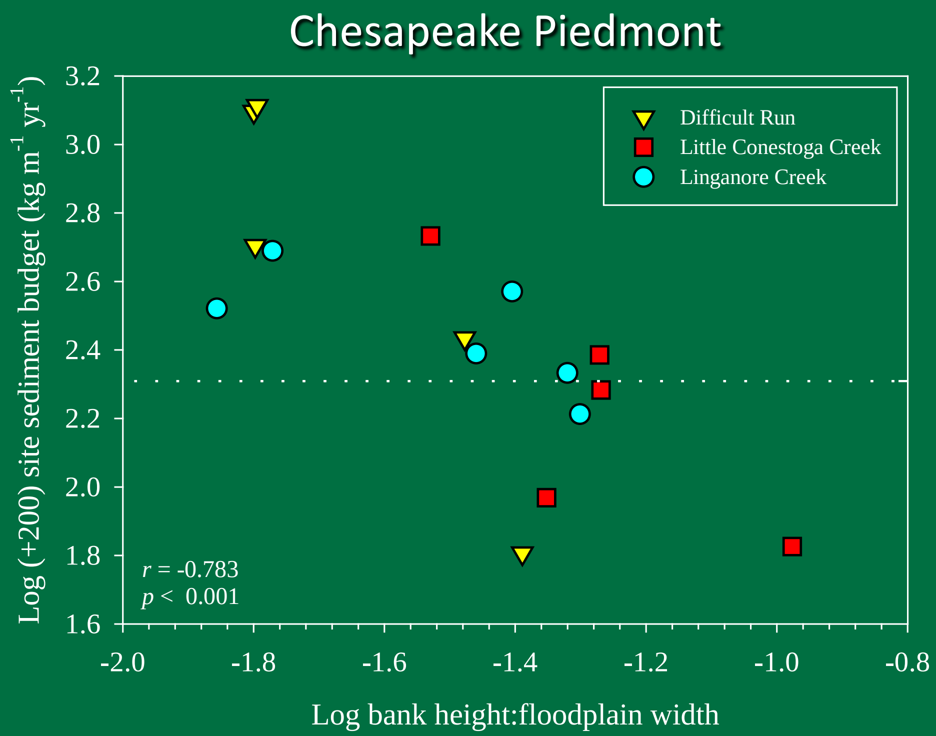
Time

Lateral

Geomorphic controls on sediment retention and loss

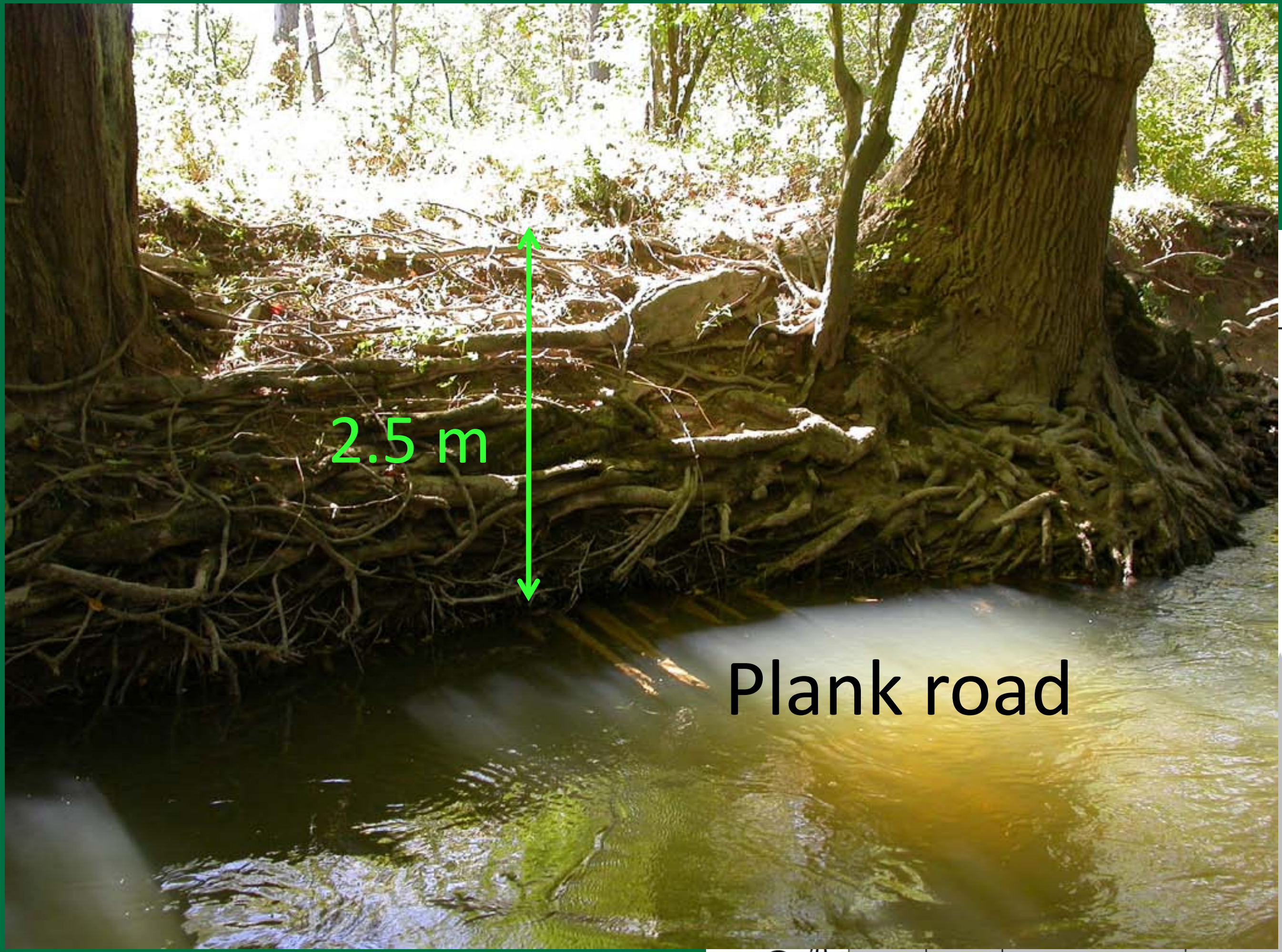


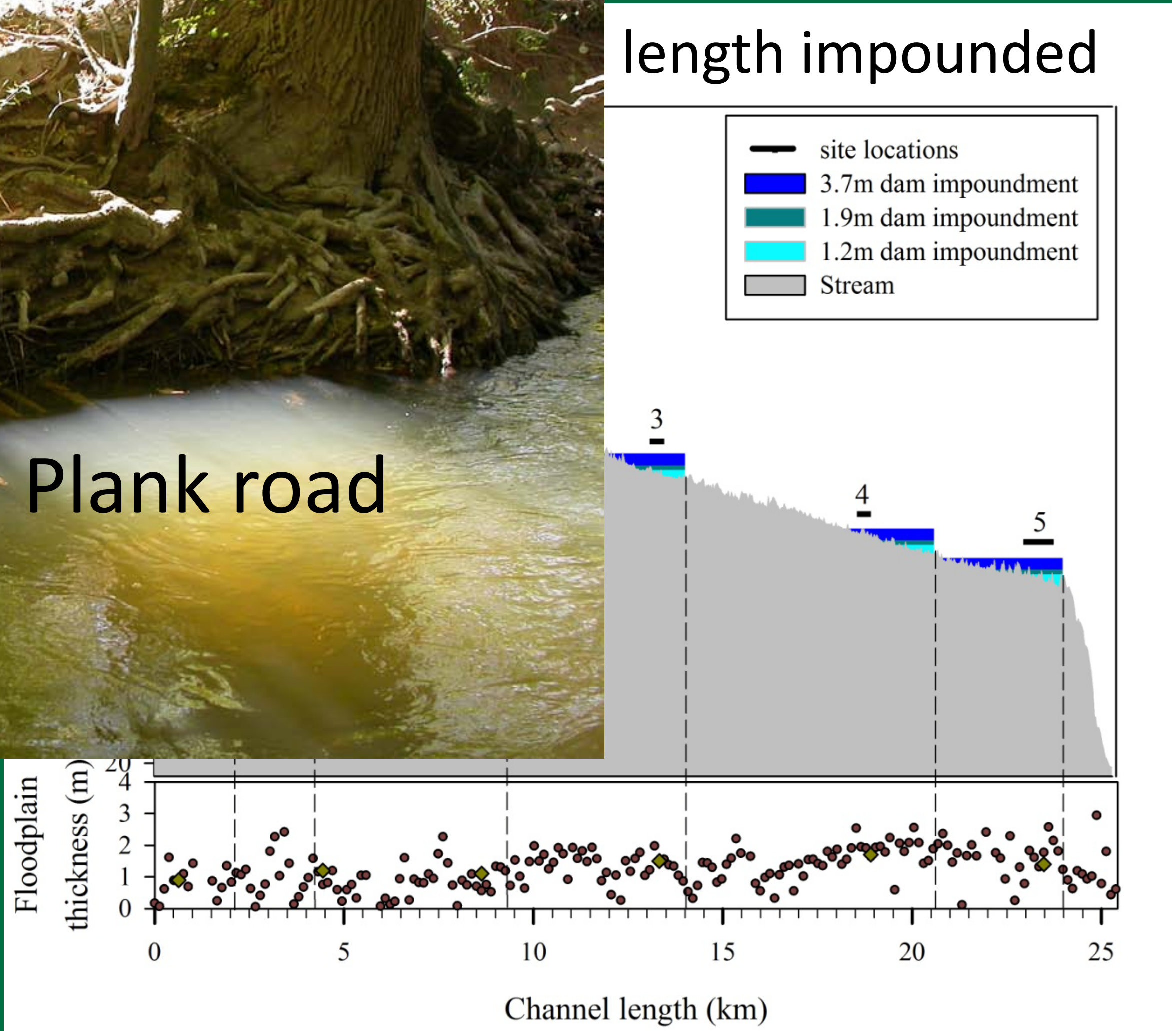
Hupp et al. *in review*



Schenk et al. *in review*

Historic mill dams and legacy sediment





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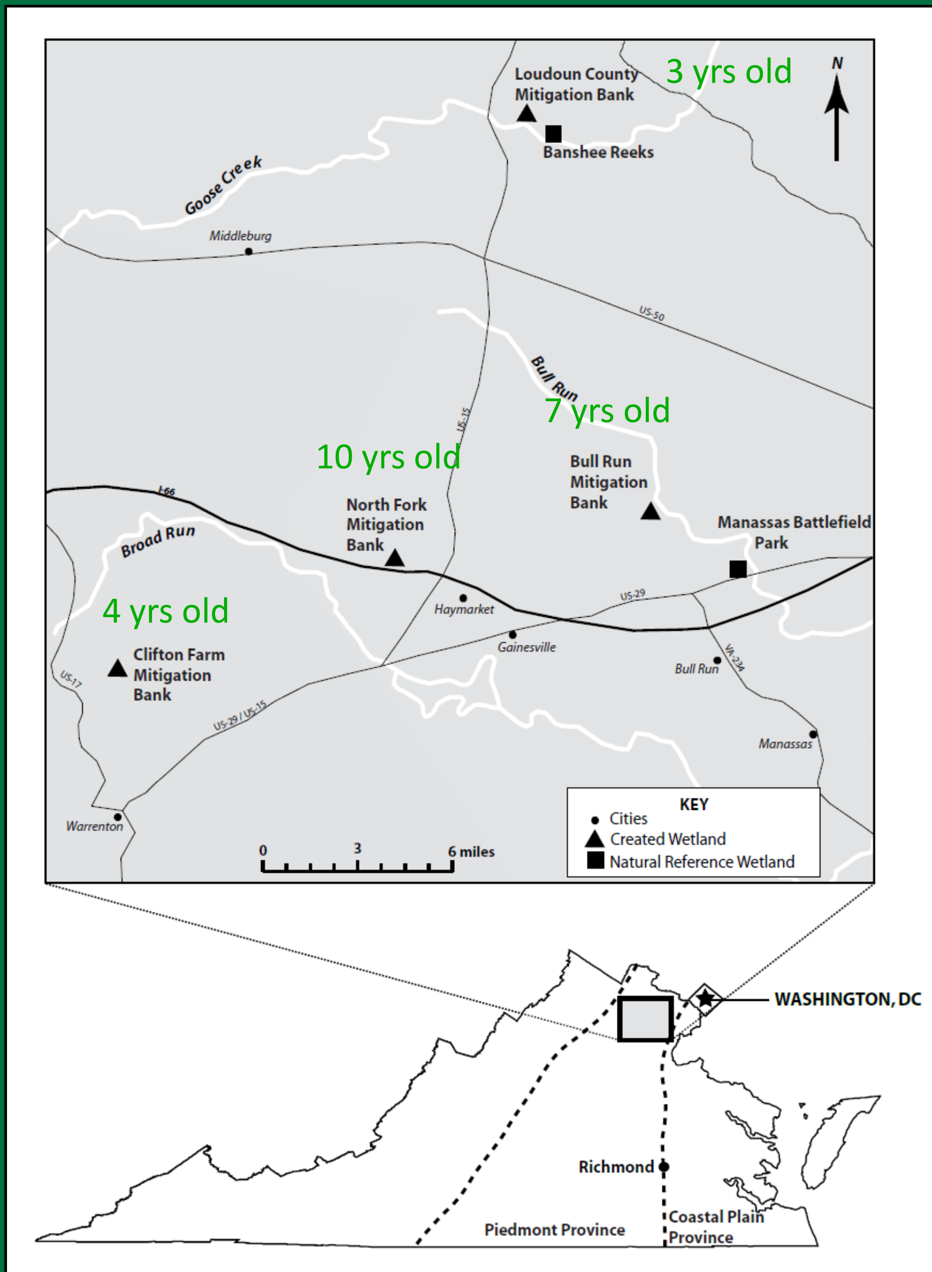
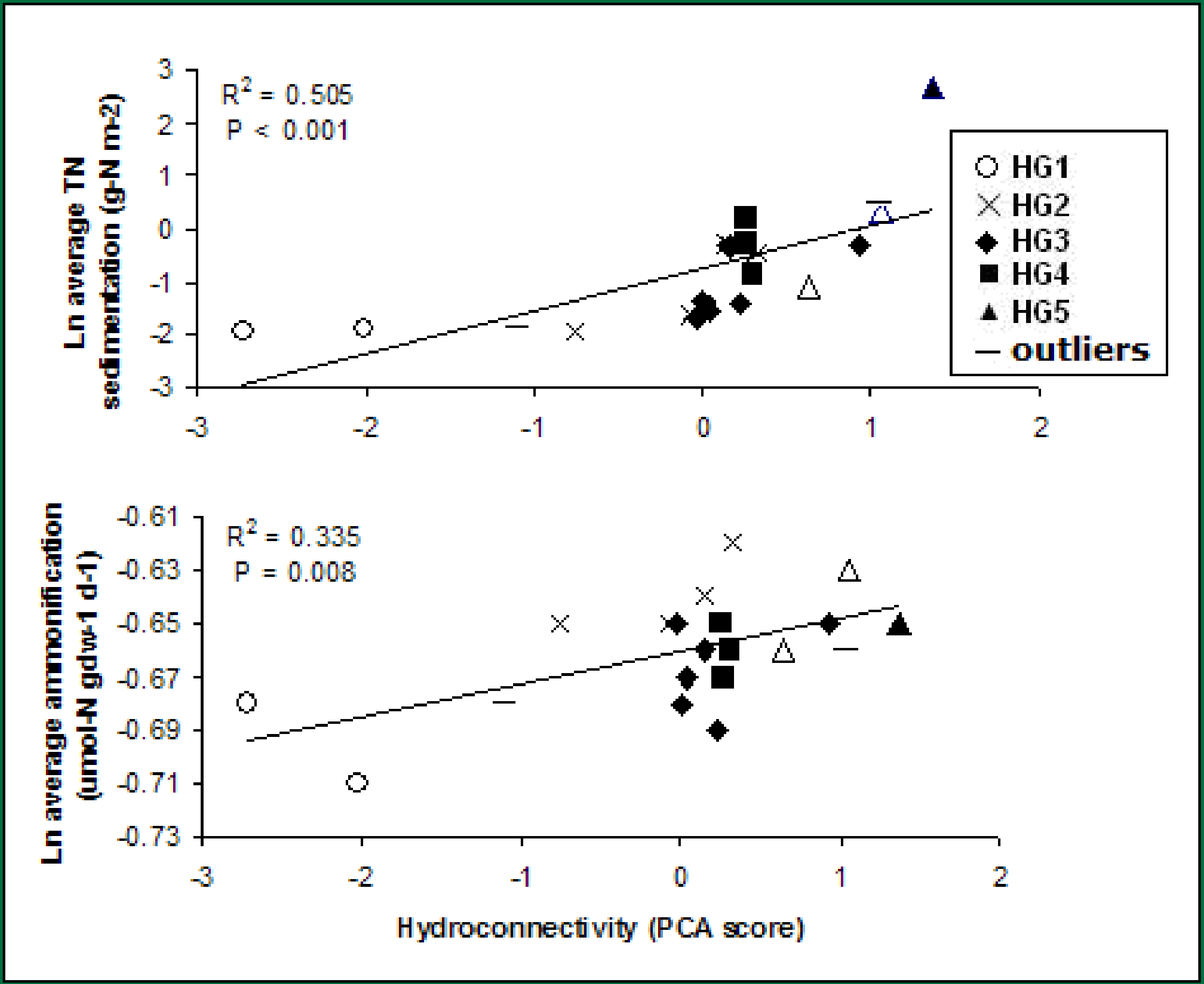
How to optimize N retention in created wetlands

Kristin Wolf, Ph.D., GMU



- 4 created wetlands
  - LC: disked vs. undisked
  - BR: overflow gradient
  - NF: main pod vs. vernal pool
- 2 natural reference wetlands
  - Open, herbaceous
  - Forested

Hydrologic connectivity among and within wetlands



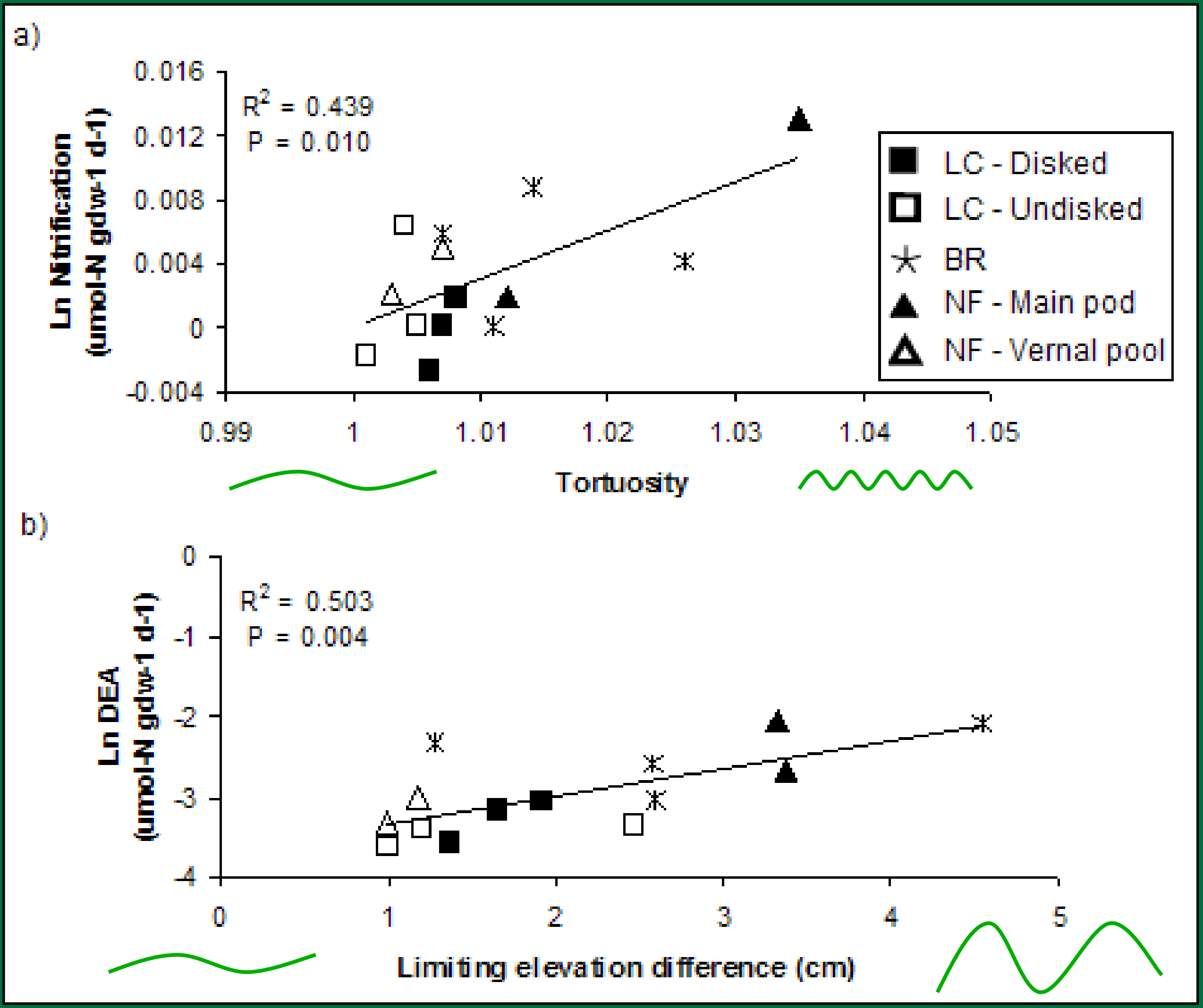
Total N sedimentation and ammonification increase with greater HC

(Var. water depth, Var. redox, sedimentation)

USGS

Wolf et al. *in review*

Geomorphology within wetlands



Microtopography increases coupled nitrification and denitrification

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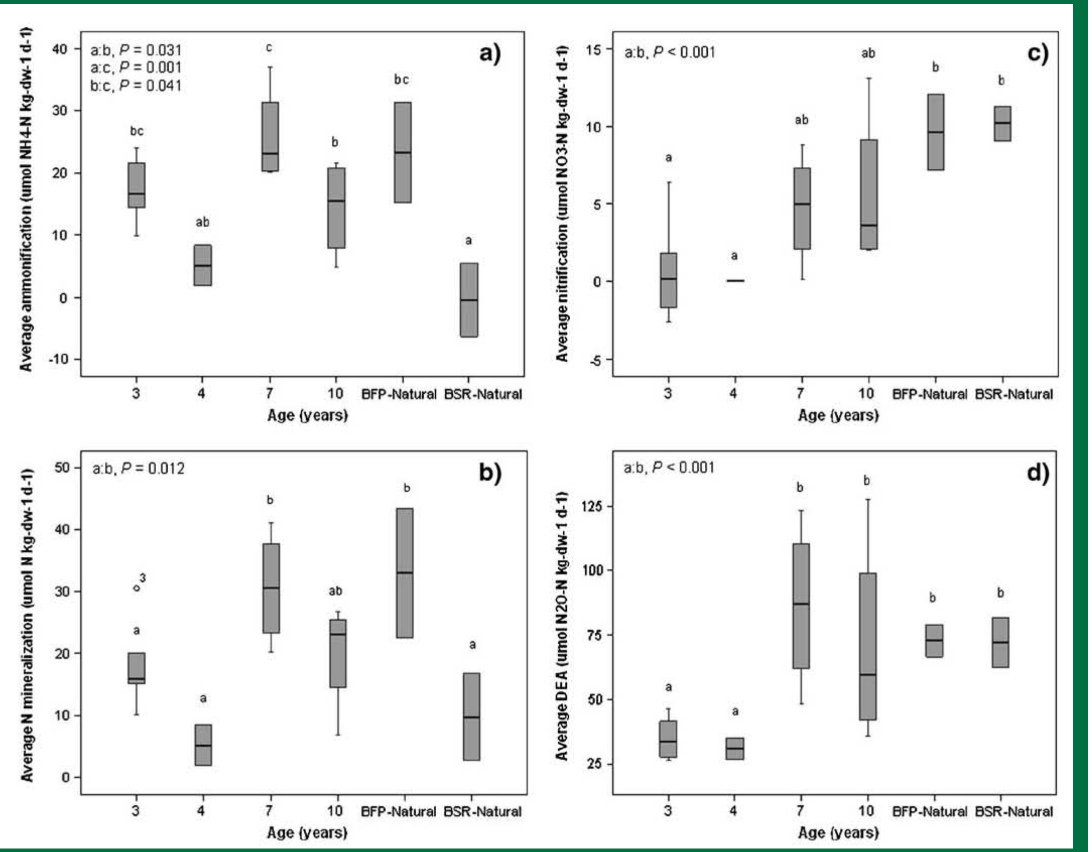
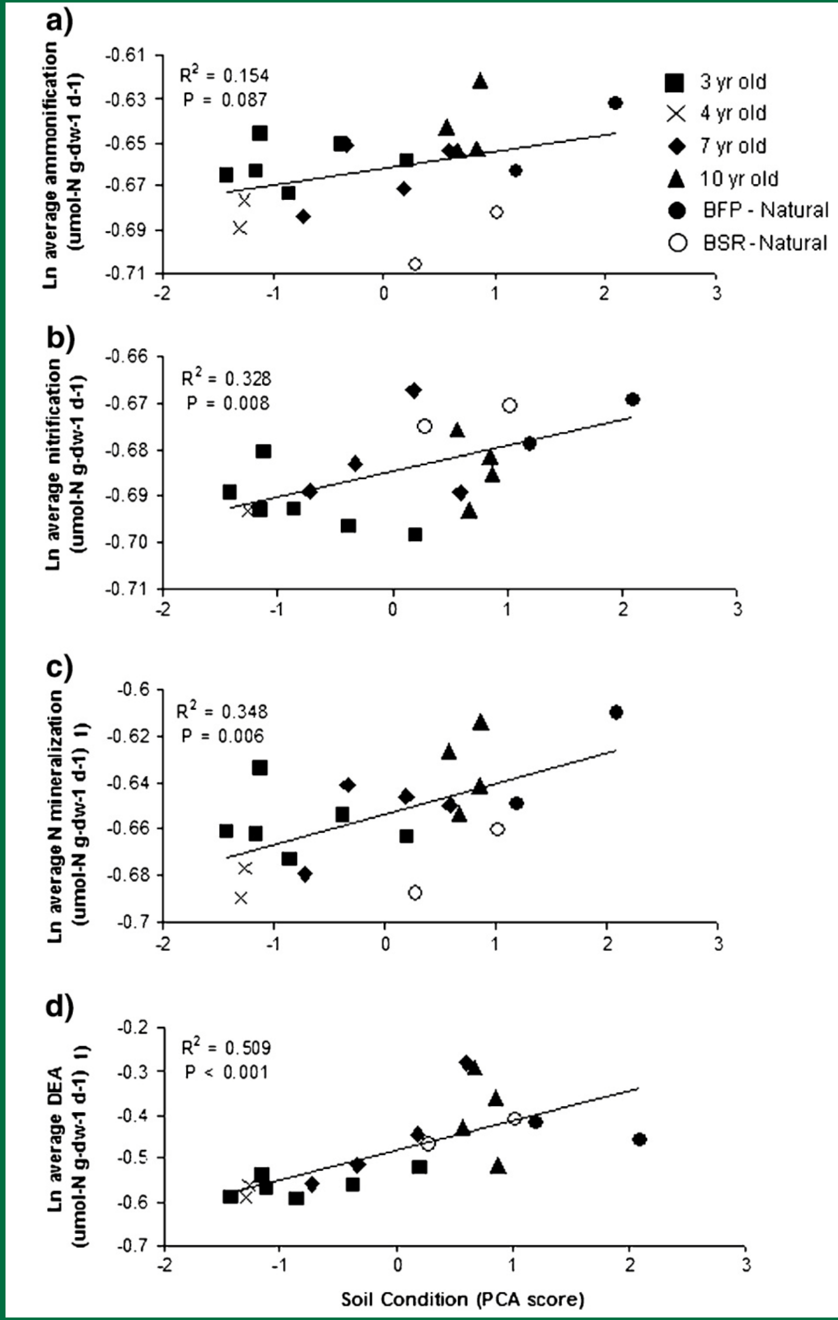
Wolf et al. 2011. *Ecol. Eng.*

Created wetland age





Older wetlands develop soils conducive to coupled denitrification

Wolf et al. 2011. *Wetlands.*

USGS

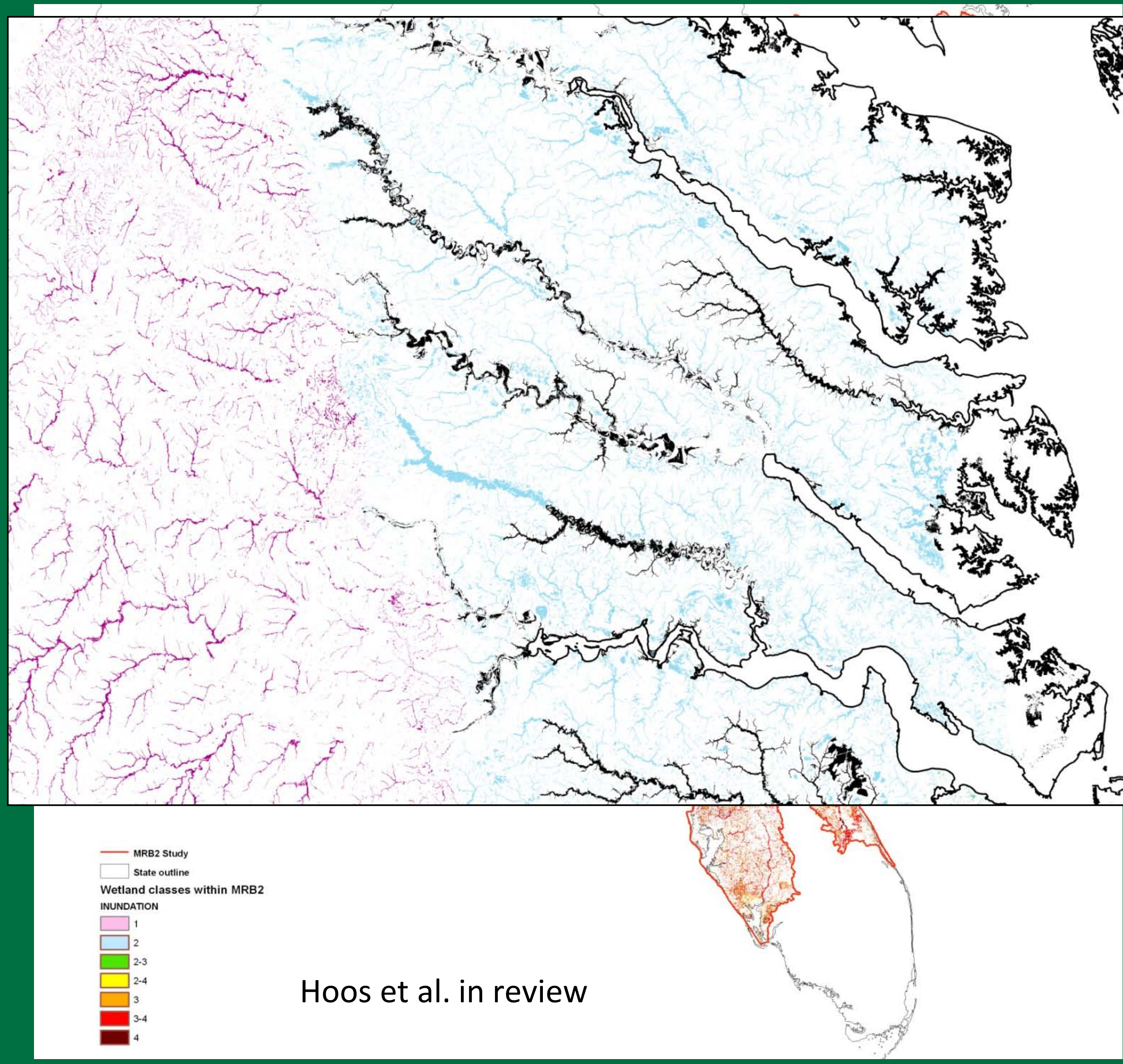
Regional evaluation of influence of wetland hydrotypes on N and P loads

1) NatureServe GAP/Landfire mapping of wetland types

2) Classification of riverine vs. isolated wetland

3) Classification of hydroperiod

4) Input into NHD+ SPARROW model



Hoos et al. in review

Wetland hydrotypes influence N and P river loads

Nitrogen	NE	SE
Land delivery to stream		↑ long hydroperiod non-riparian wetlands ↓ short hydroperiod non-riparian wetlands
In-stream loss	small streams: ↑ (k + width of riparian wetland) * TOT large streams: ↑ (width of riparian wetland) * TOT	

% of wetland area	SEGAP_CODE	SEGAP_NAME	Inundation regime	Inundation regime	Riverine?
2.97	CES203.304b	Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest - Taxodium/Nyssa Modifier	4	semi-permanent	0
4.54	CES203.384	Southern Coastal Plain Nonriverine Basin Swamp	4	semi-permanent	0
1.13	CES203.384a	Southern Coastal Plain Nonriverine Basin Swamp - Okefenokee Taxodium Modifier	4	semi-permanent	0
4.48	CES203.251	Southern Coastal Plain Nonriverine Cypress Dome	4	semi-permanent	0
11.34	CES203.493	Southern Coastal Plain Blackwater River Floodplain Forest	3-4	seasonal to semi-permanent	1
6.51	CES203.247a	Atlantic Coastal Plain Blackwater Stream Floodplain Forest - Forest Modifier	3-4	seasonal to semi-permanent	1
4.68	CES203.250	Atlantic Coastal Plain Small Brownwater River Floodplain Forest	3-4	seasonal to semi-permanent	1
8.26	CES203.249	Atlantic Coastal Plain Small Blackwater River Floodplain Forest	3-4	seasonal to semi-permanent	1
2.22	CES203.077	Floridian Highlands Freshwater Marsh	3-4	seasonal to semi-permanent	0
2.43	CES411.381	South Florida Pine Flatwoods	3	seasonal	0
1.72	CES203.304a	Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest - Oak Dominated Modifier	3	seasonal	0
5.70	CES203.267	Atlantic Coastal Plain Peatland Pocosin	3	seasonal	0
7.32	CES203.489a	East Gulf Coastal Plain Large River Floodplain Forest - Forest Modifier	2-4	occasional to semi-permanent	1
12.58	CES203.559	East Gulf Coastal Plain Small Stream and River Floodplain Forest	2-3	occasional to seasonal	1
1.68	CES202.706	South-Central Interior Small Stream and Riparian	2	occasional	1
3.72	CES202.323	Southern Piedmont Small Floodplain and Riparian Forest	2	occasional	1
5.51	CES203.501	Southern Coastal Plain Hydric Hammock	2	occasional	1
1.32	CES203.265	Atlantic Coastal Plain Northern Wet Longleaf Pine Savanna and Flatwoods	1	rarely	0
1.51	CES203.375c	East Gulf Coastal Plain Near-Coast Pine Flatwoods - Offsite Hardwood Modifier	1	rarely	0
4.63	CES203.375a	East Gulf Coastal Plain Near-Coast Pine Flatwoods - Open Understory Modifier	1	rarely	0

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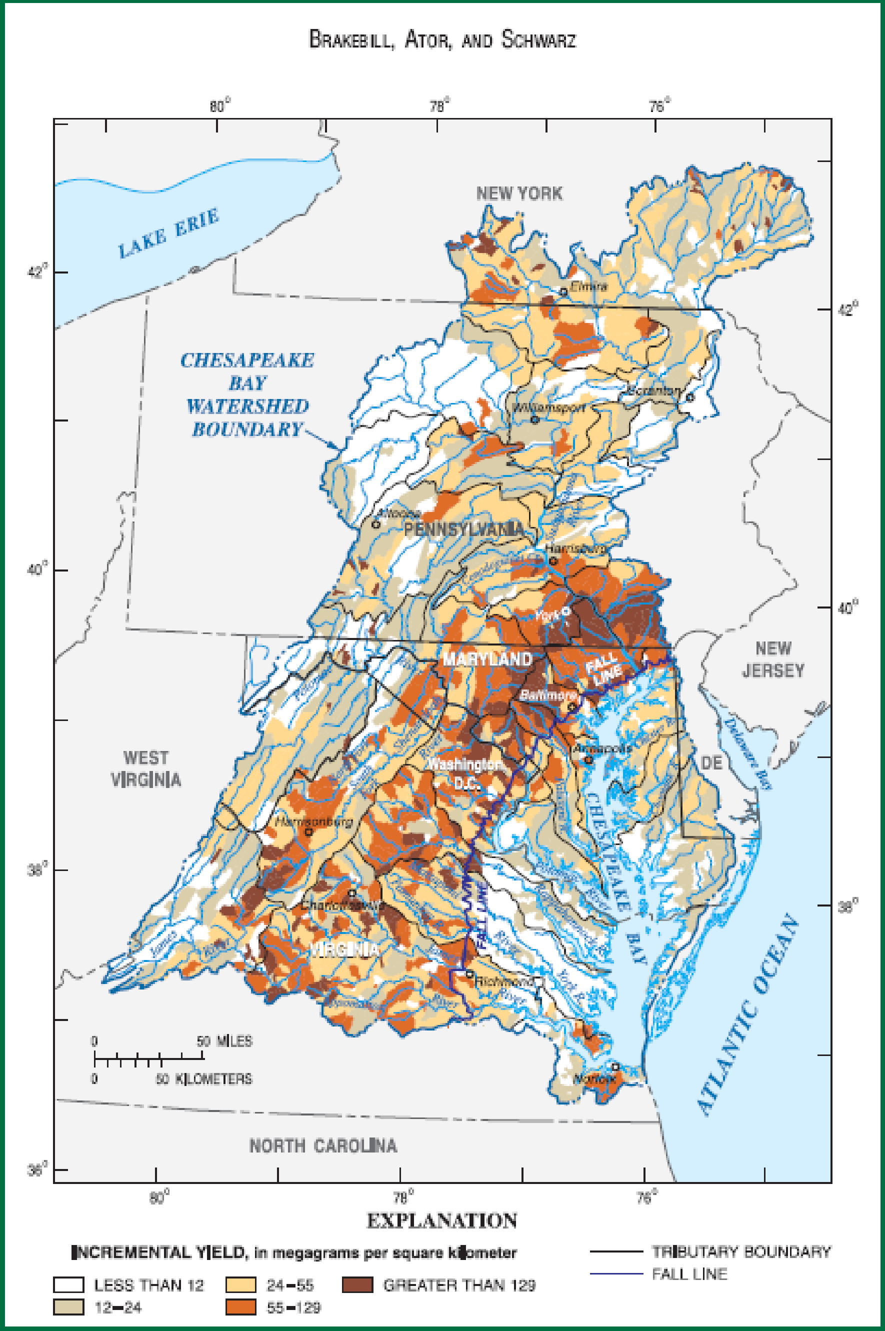
Hoos et al. in review

SPARROW sediment model (RF1)

Small streams out of Coastal Plain: <u>source</u>

Large streams in Coastal Plain: <u>sink</u>

USGS



Hydrogeomorphic controls on trapping by riverine wetlands

Connectivity, load, and geomorphology

- Physiographic province
- Land use
- Floodplain disconnection
- Stream-floodplain geomorphology
- Geomorphic complexity within floodplain
- Wetland hydrotypes