Seeing the Forest for the Streams: Headwater Watersheds and the Aquatic Interface

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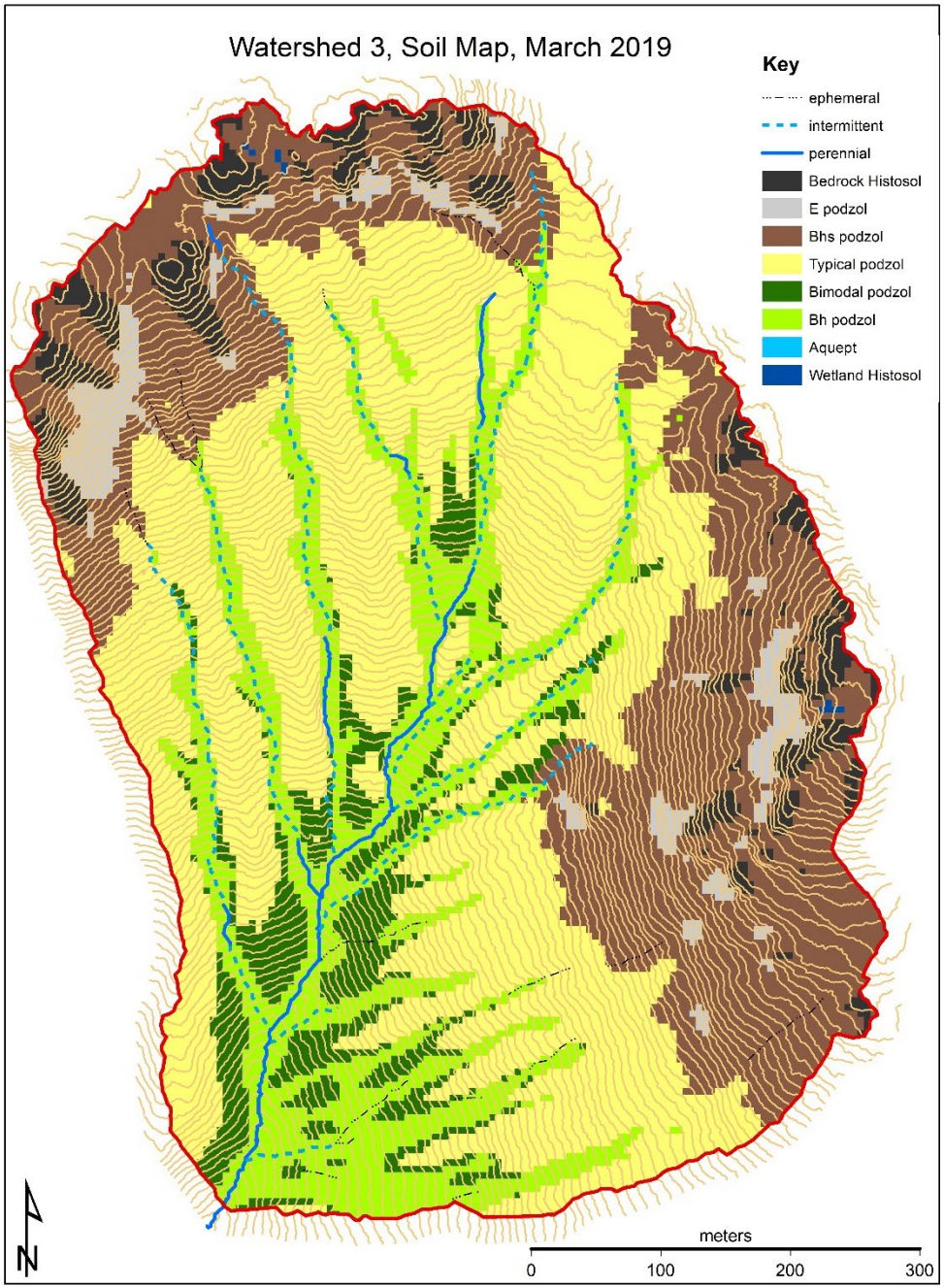

Acknowledgements

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INVITED COMMENTARY

HP TODAY

HYDROLOGICAL PROCESSES
Hydrol. Process. **22,** 1239–1242 (2008)
Published online 11 March 2008 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/hyp.7049

Aqua Incognita: the unknown headwaters

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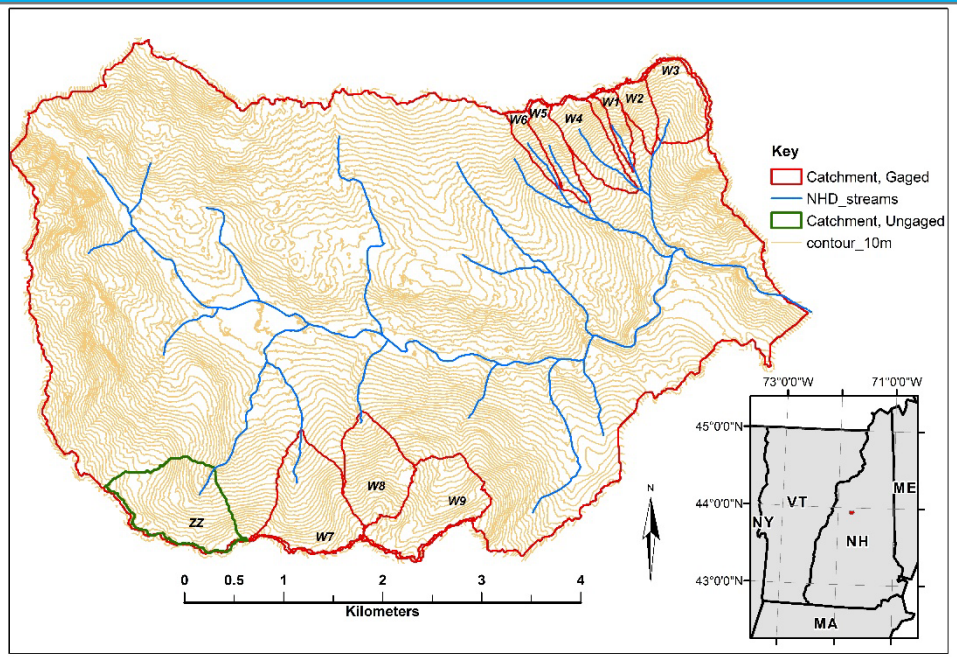
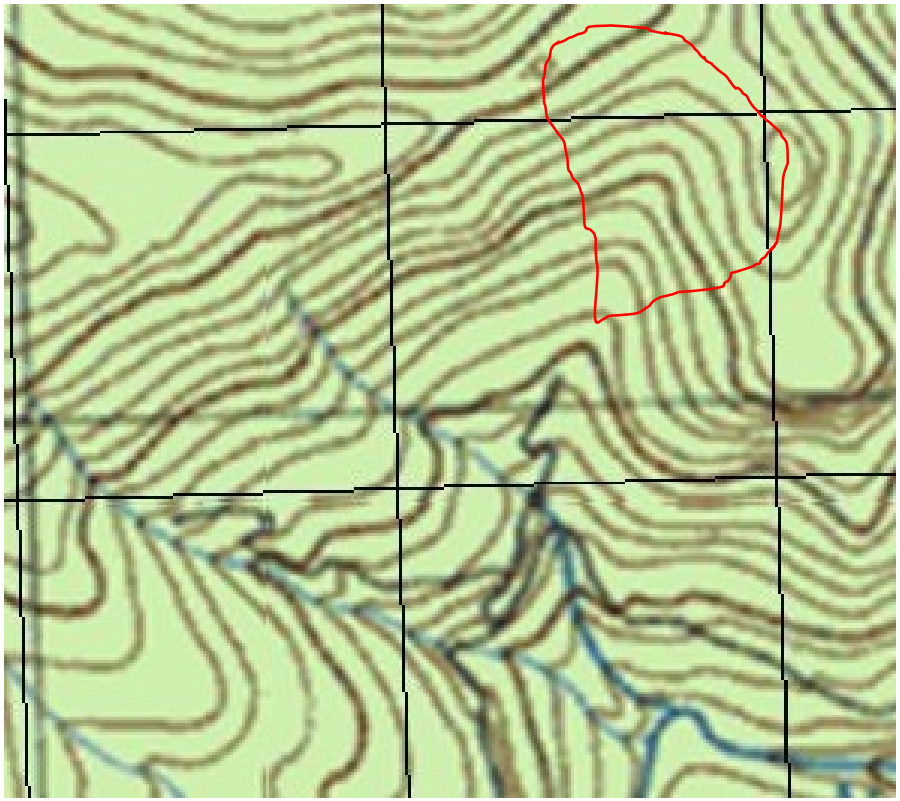
Running water comprises just over one millionth of the world's water. The importance of those streams and rivers as a resource for human welfare and biodiversity, however, is far out of proportion to that minuscule fraction. This explains why protecting running waters (the flow regimes, water quality and biota) is such a vital concern for society. Yet for all the focus and concern, how much do we actually know about these running waters, and the lotic habitat they comprise?

Consider what would happen if one asked any national environmental authority to assess the basic chemical and ecological status of running waters. At the river mouths, there would be enough information to

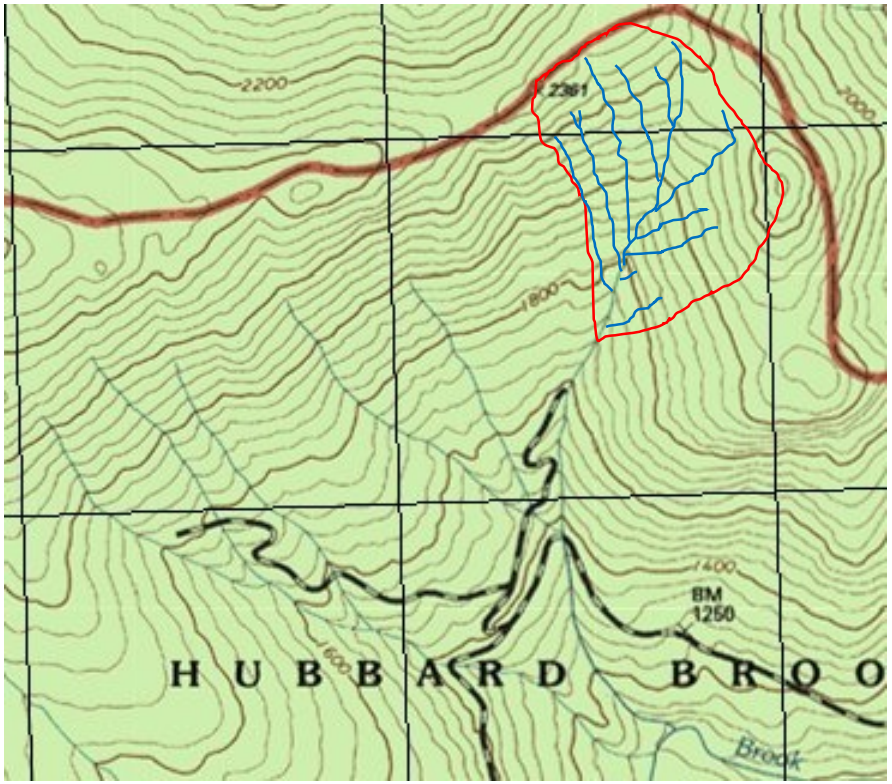
Hubbard Brook Experimental Forest: 7808 acres, 750 - 3310 ft. elev.



The Elusive Headwaters



Paradise Brook on 1:100,000 map (enlarged)



Paradise Brook in Reality

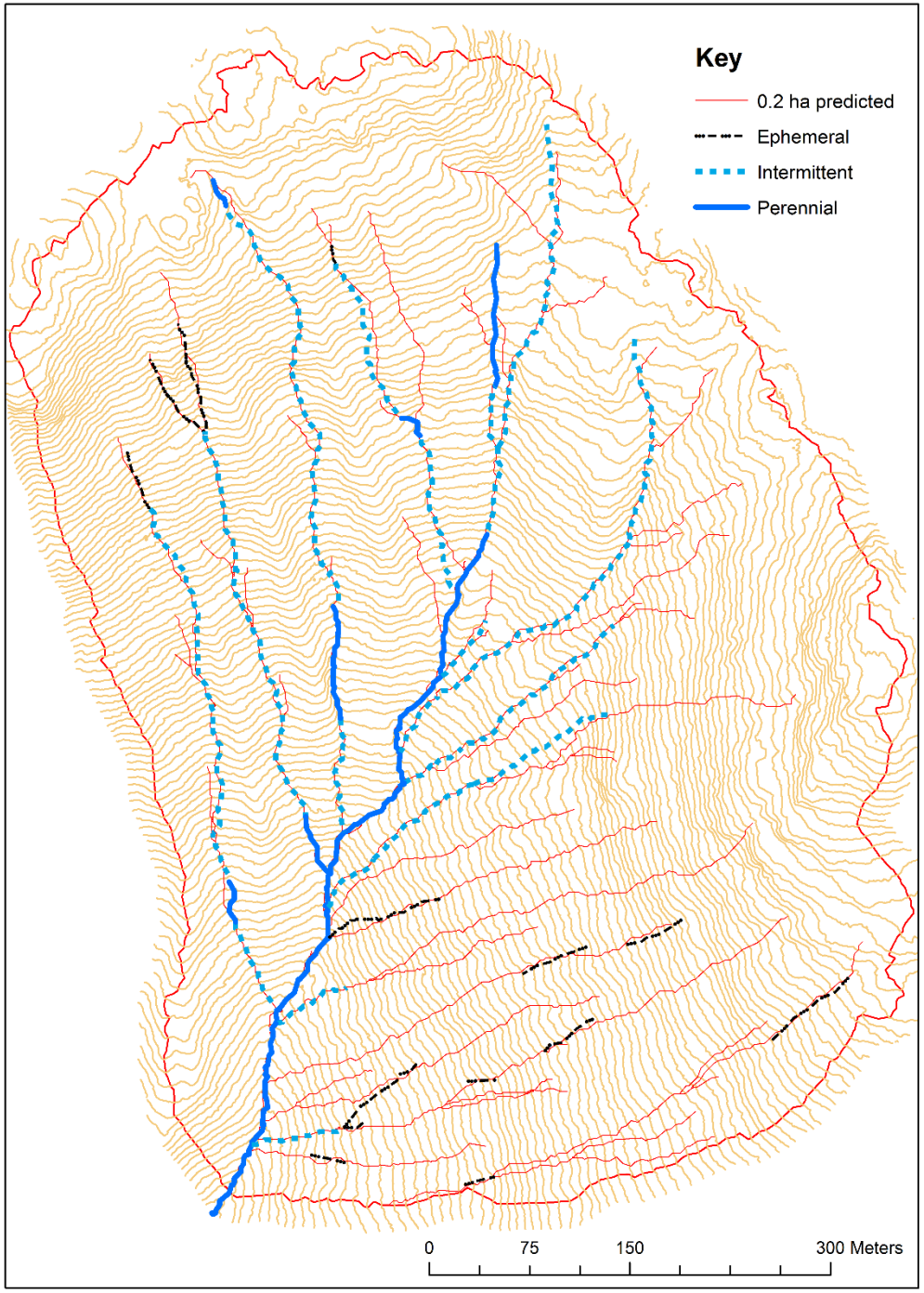
"Like the alveoli (the fine branches of the respiratory tree that serve as the primary gas exchange units of the lungs), headwater streams are characterized by the strong and vital interactions with the systems that surround them." – **Lowe and Likens 2005 *Bioscience***

Perennial: 800 m (21%)
cobbles and boulders; >1 m width

Intermittent: 2550 m (67%)
eroded into B horizon, cobbles/fine earth

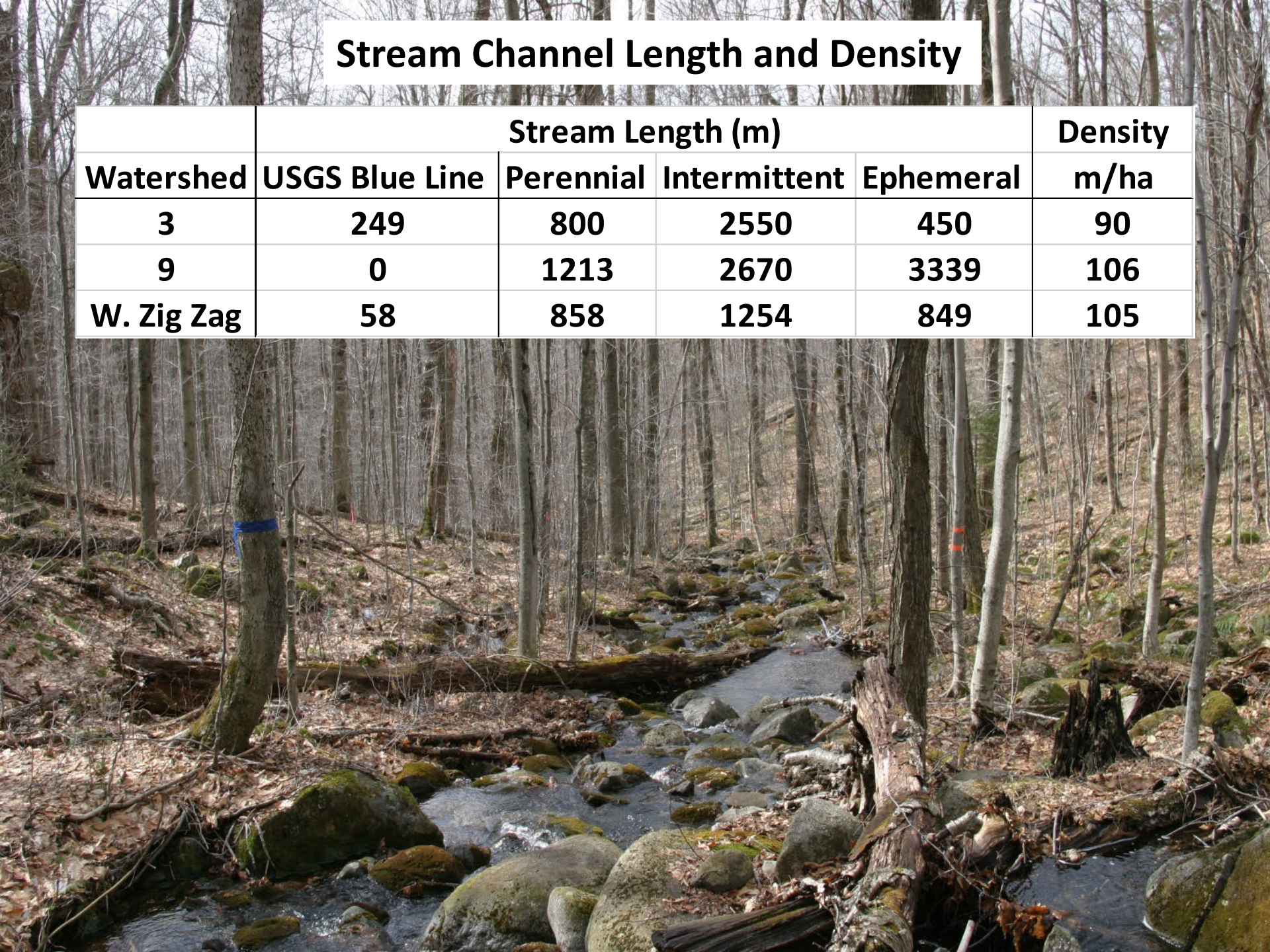
Ephemeral: 450 m (12%)
barely eroded into mineral soil. <0.5 m width

Watershed 3: Paradise Brook

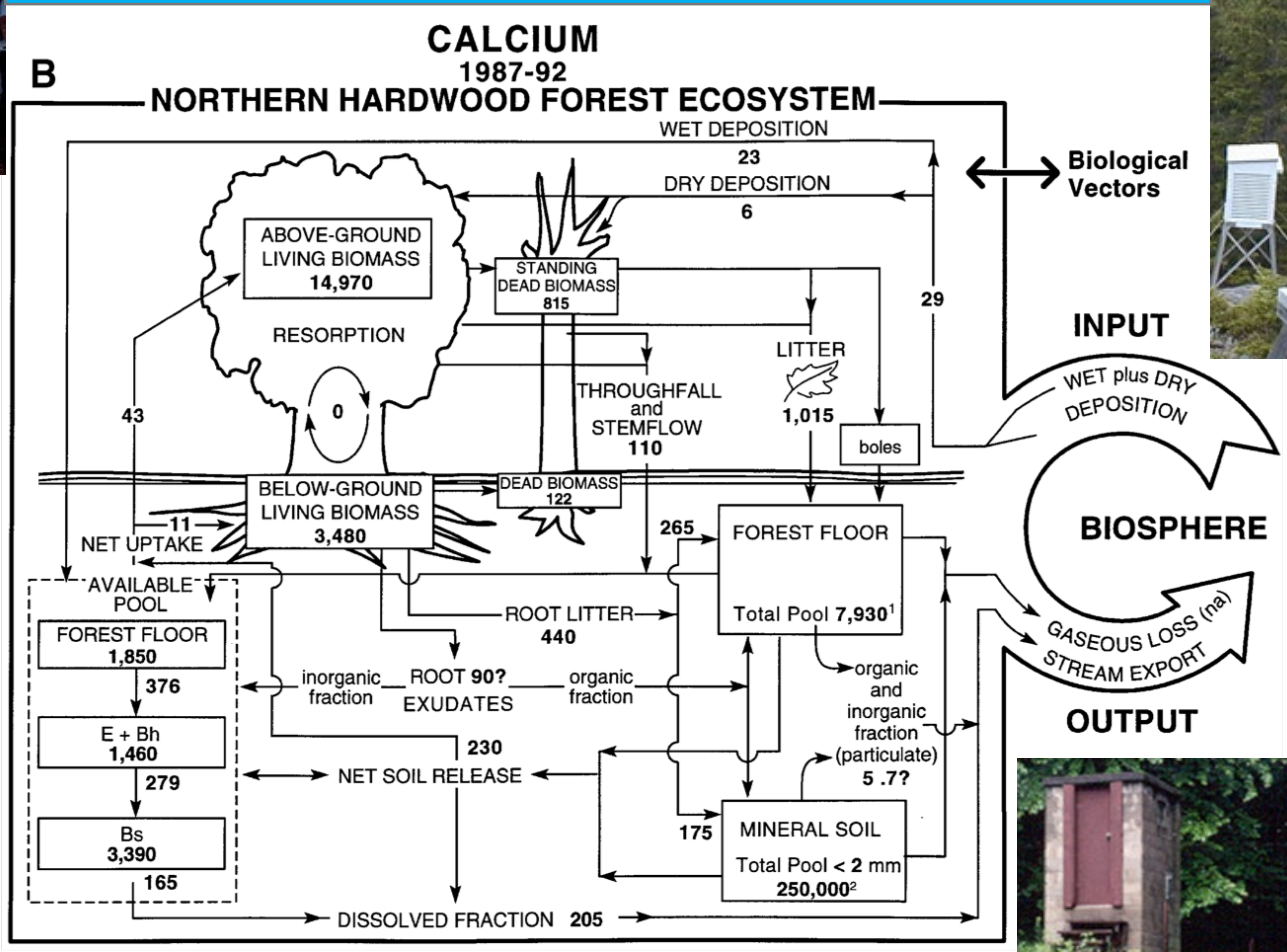


Stream Channel Length and Density

	Stream Length (m)				Density
Watershed	USGS Blue Line	Perennial	Intermittent	Ephemeral	m/ha
3	249	800	2550	450	90
9	0	1213	2670	3339	106
W. Zig Zag	58	858	1254	849	105



HBES Hallmark: Watershed-Scale Element Budgets



Likens et al. 1998

Units:
Stores: mol/ha
Fluxes: mol/ha-yr

HBEF: A typical upland soil landscape with Spodosols formed in coarse grained (sandy loam) glacial till

Exposed bedrock:
Rangeley mica schist

Lyman:
< 50 cm to bedrock
Excessively Drained

Tunbridge:
< 1m to bedrock
Well Drained

Peru/Marlow: > 1m to bedrock
Moderately-Well to Well Drained.
Firm Cd horizon (densipan)

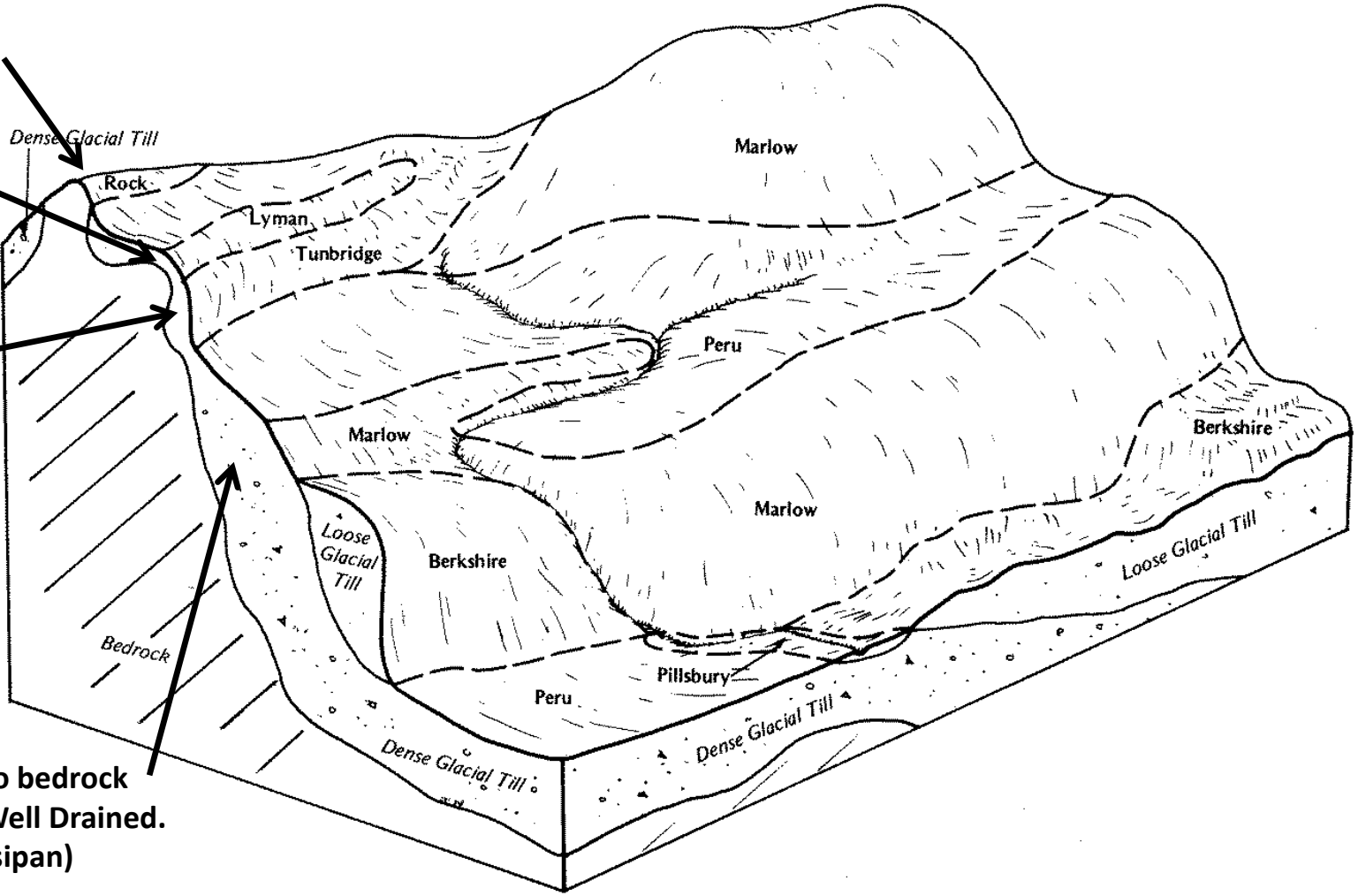
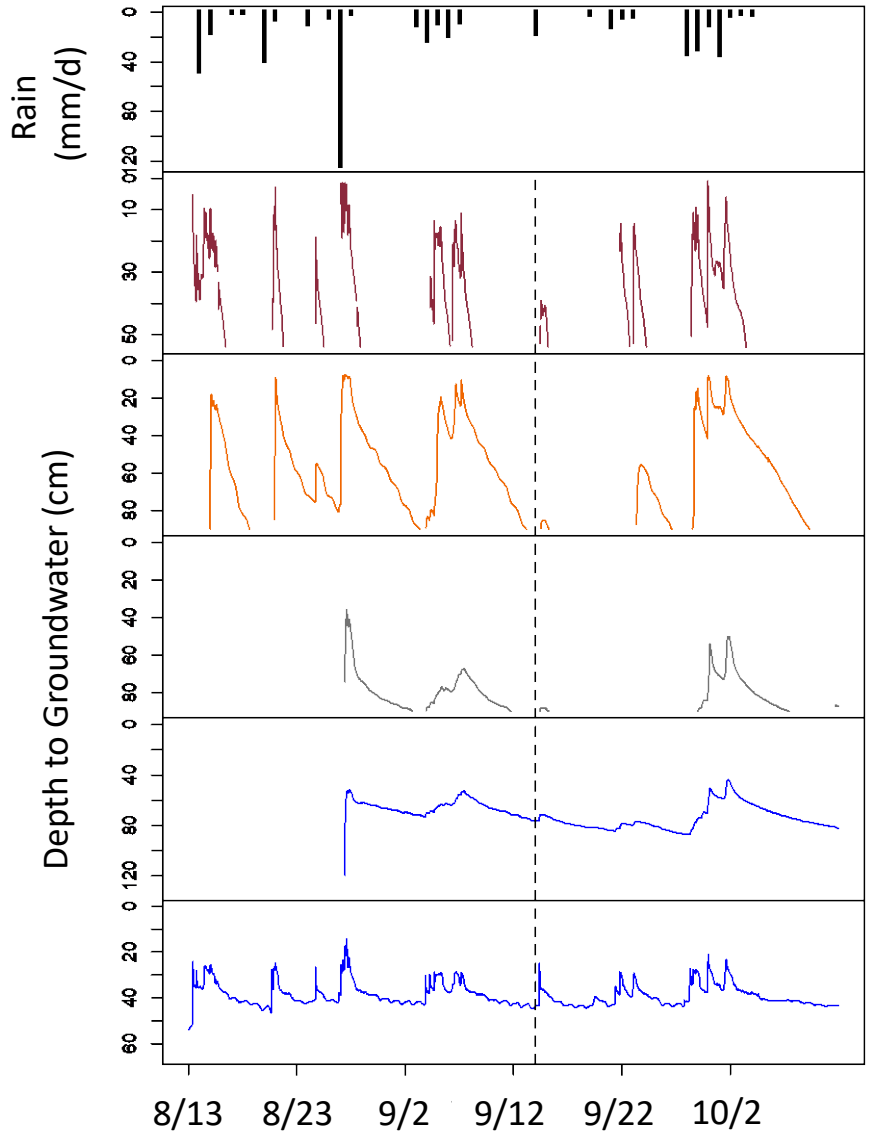


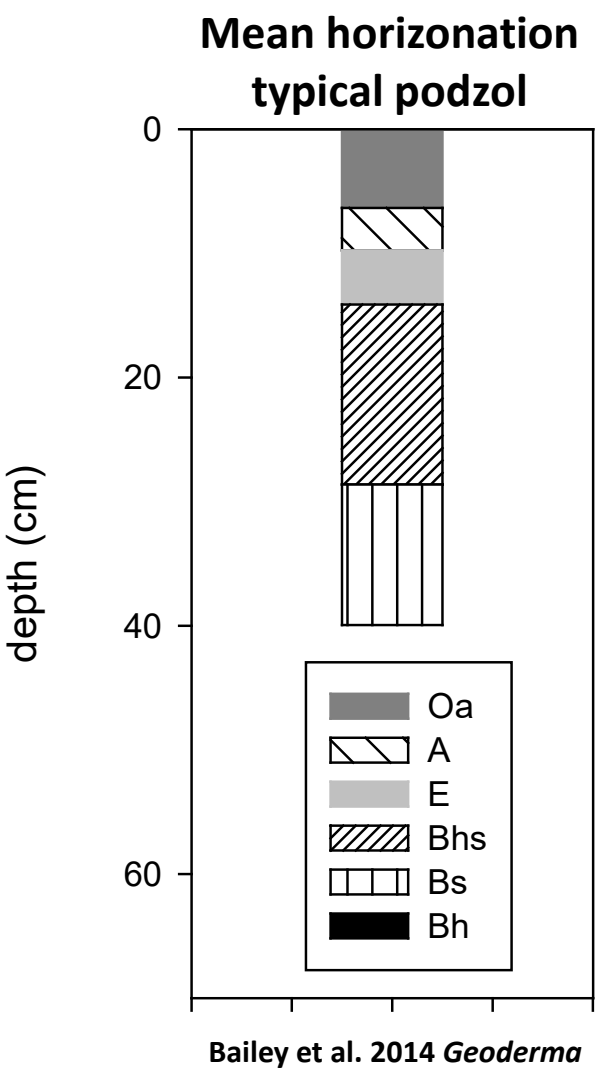
Figure 5.— Typical pattern of soils and underlying material in the Marlow-Peru unit.

NRCS 2001.
Grafton County Soil Survey

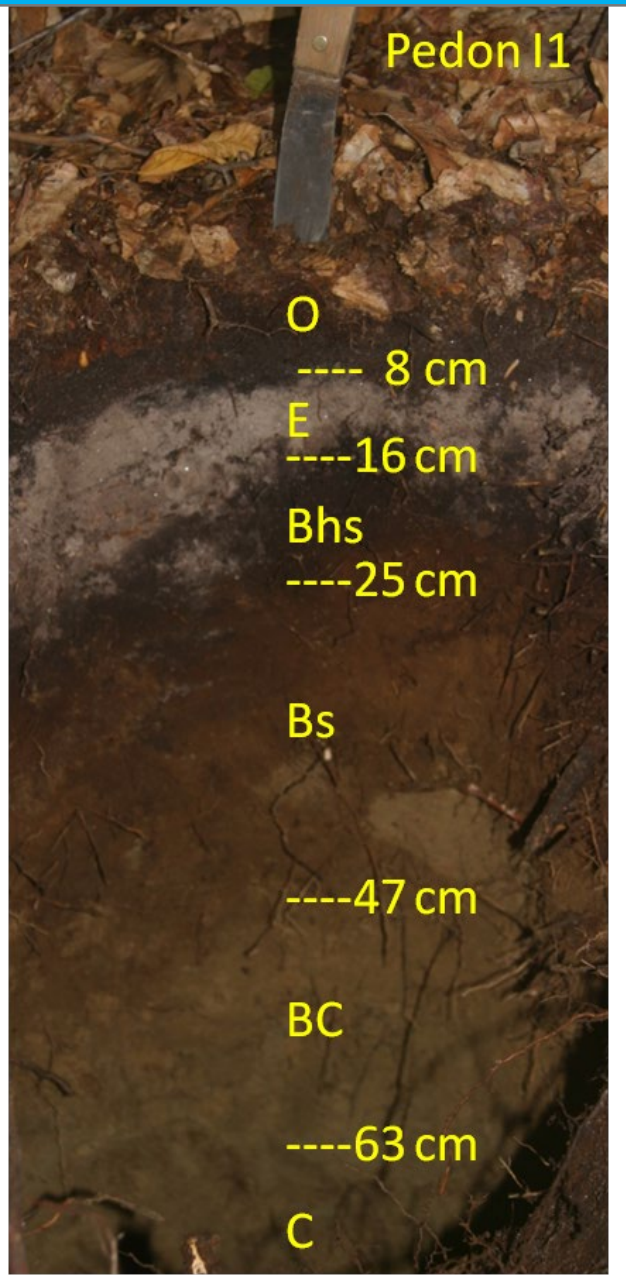
Groundwater in a steep headwater forest with coarse-grained soils?...!



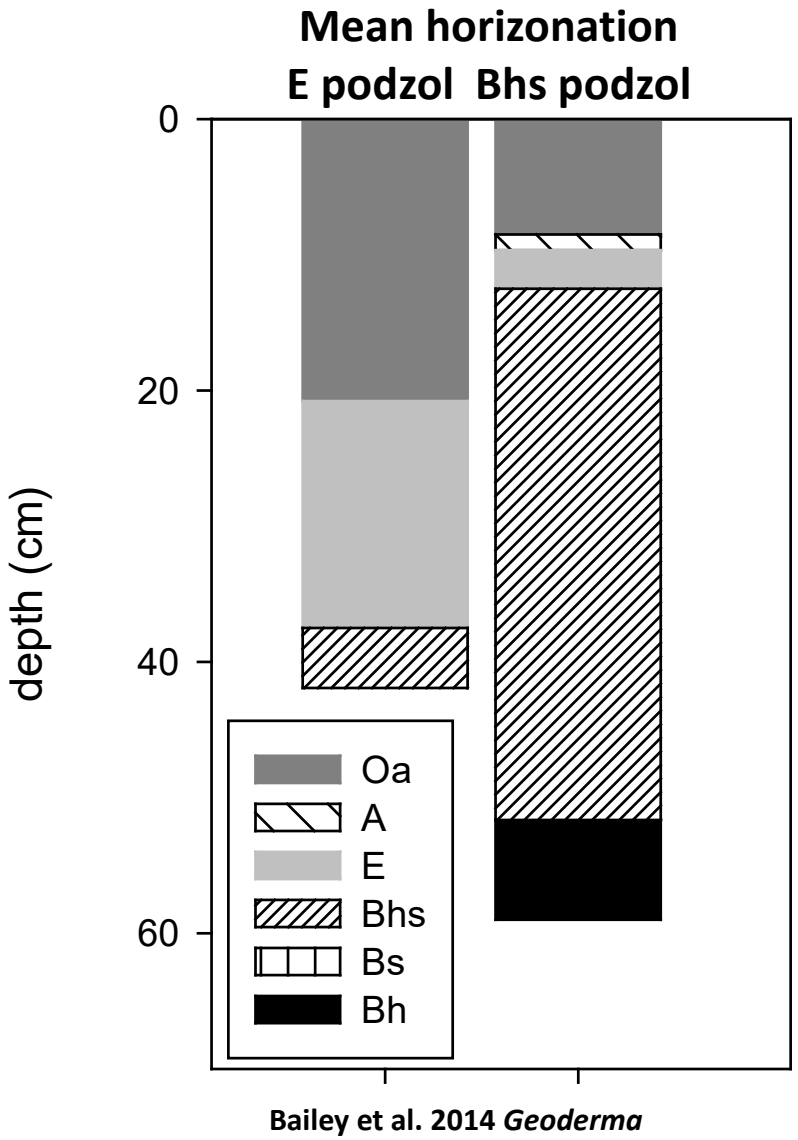
Typical Spodosols - Backslopes



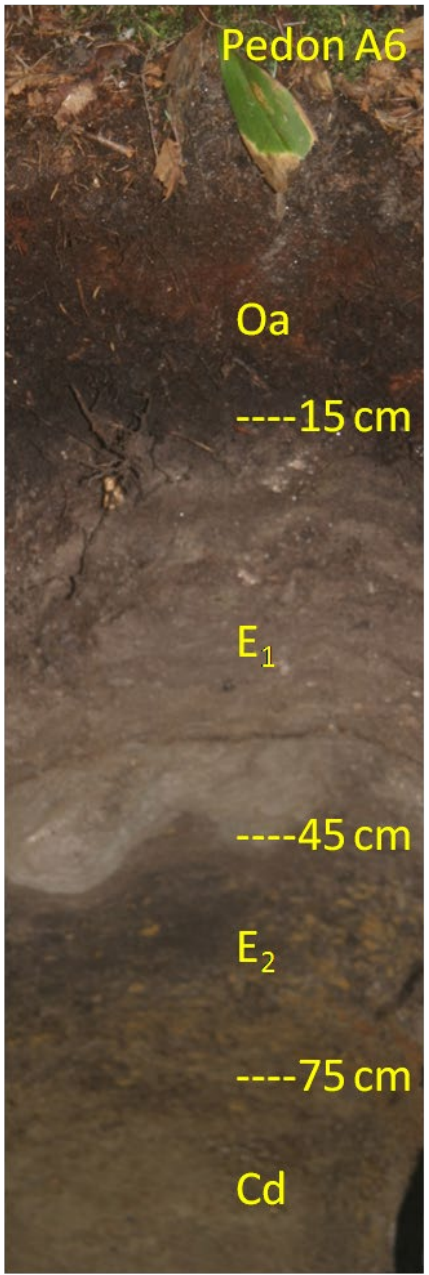
Bailey et al. 2014 *Geoderma*

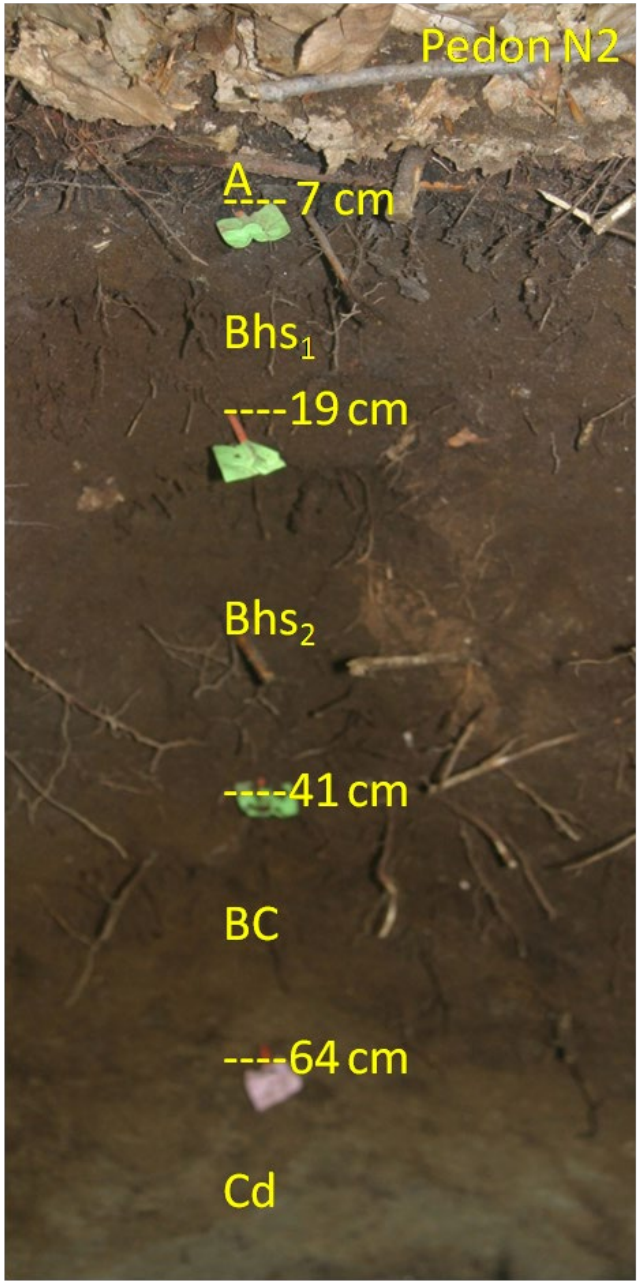


E and Bhs Podzols: Bedrock Controlled Landscapes

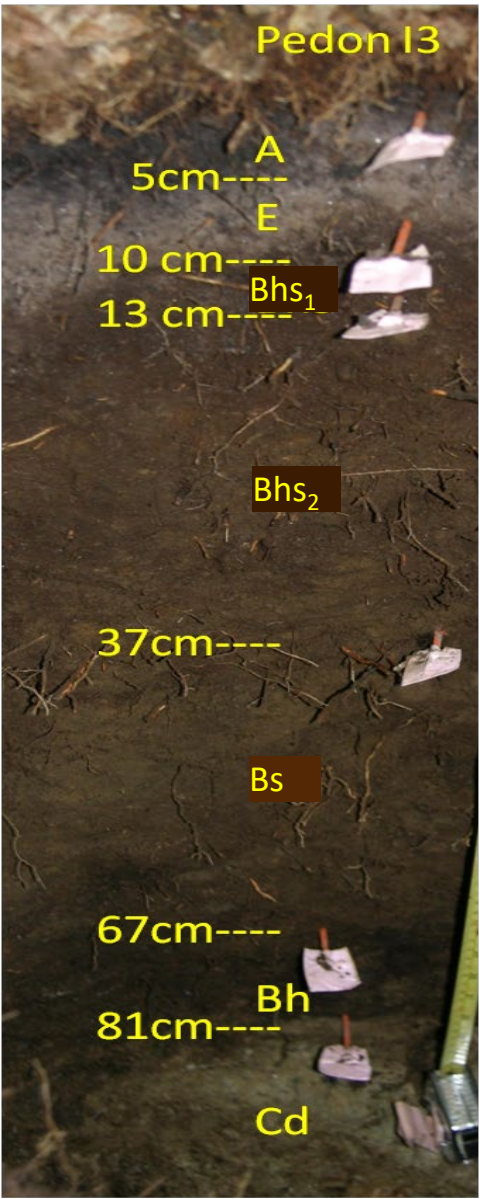


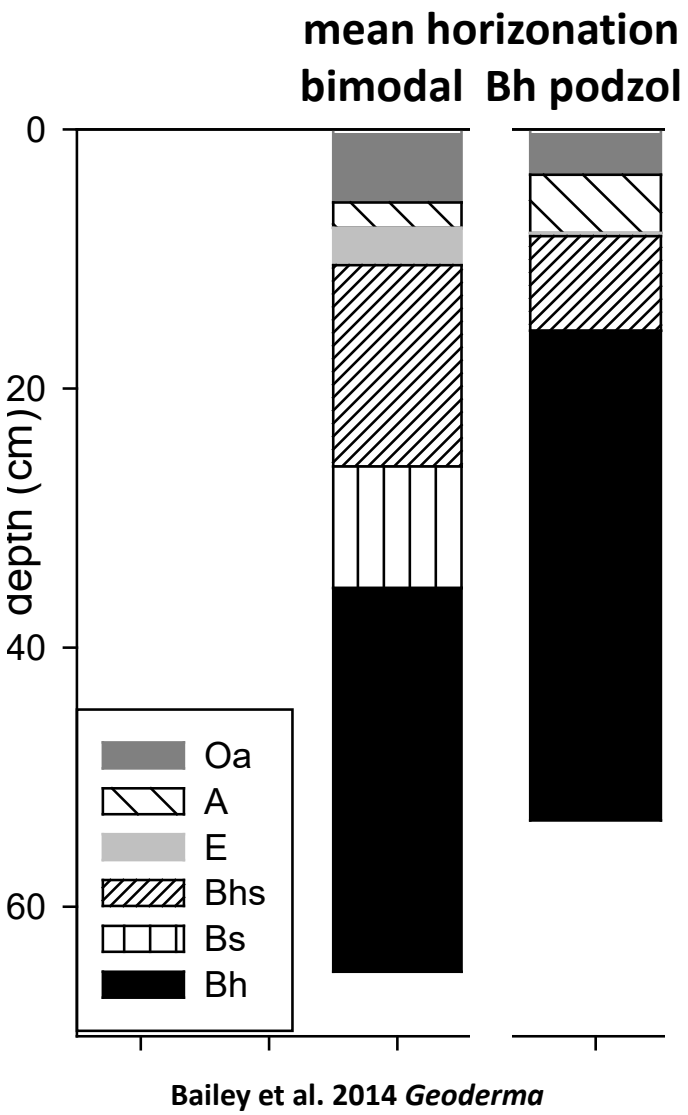
Bailey et al. 2014 *Geoderma*





Bimodal to Bh podzols: Benches, Toeslopes, Streamside





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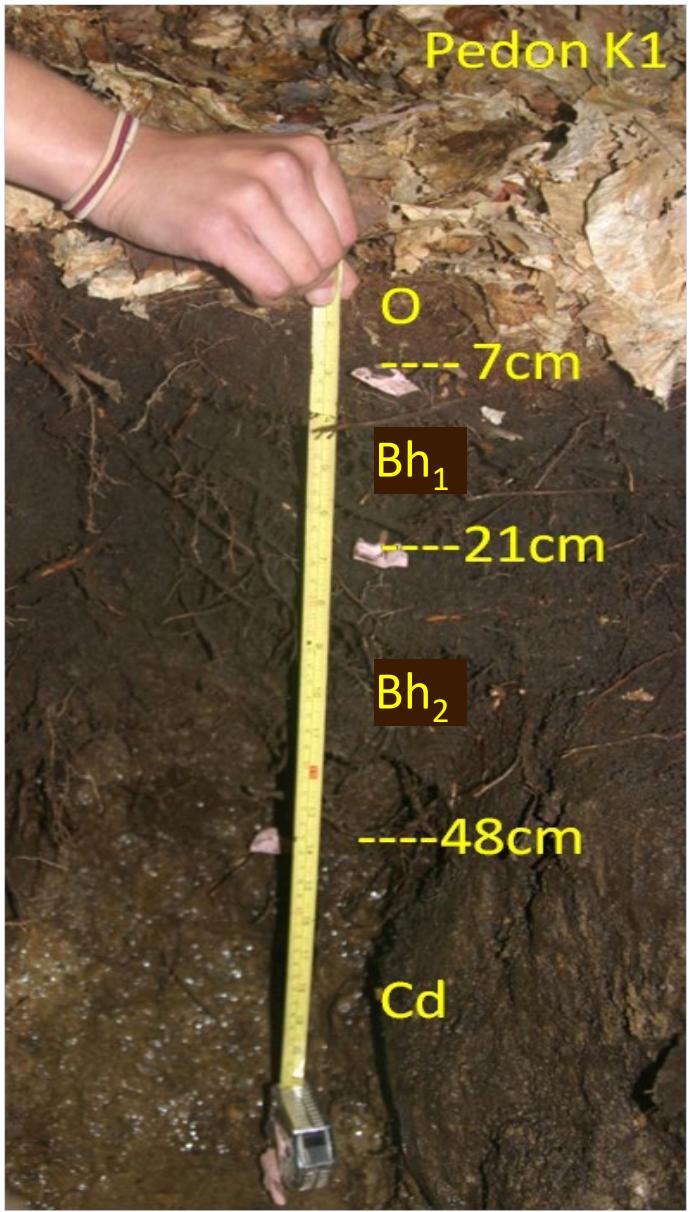
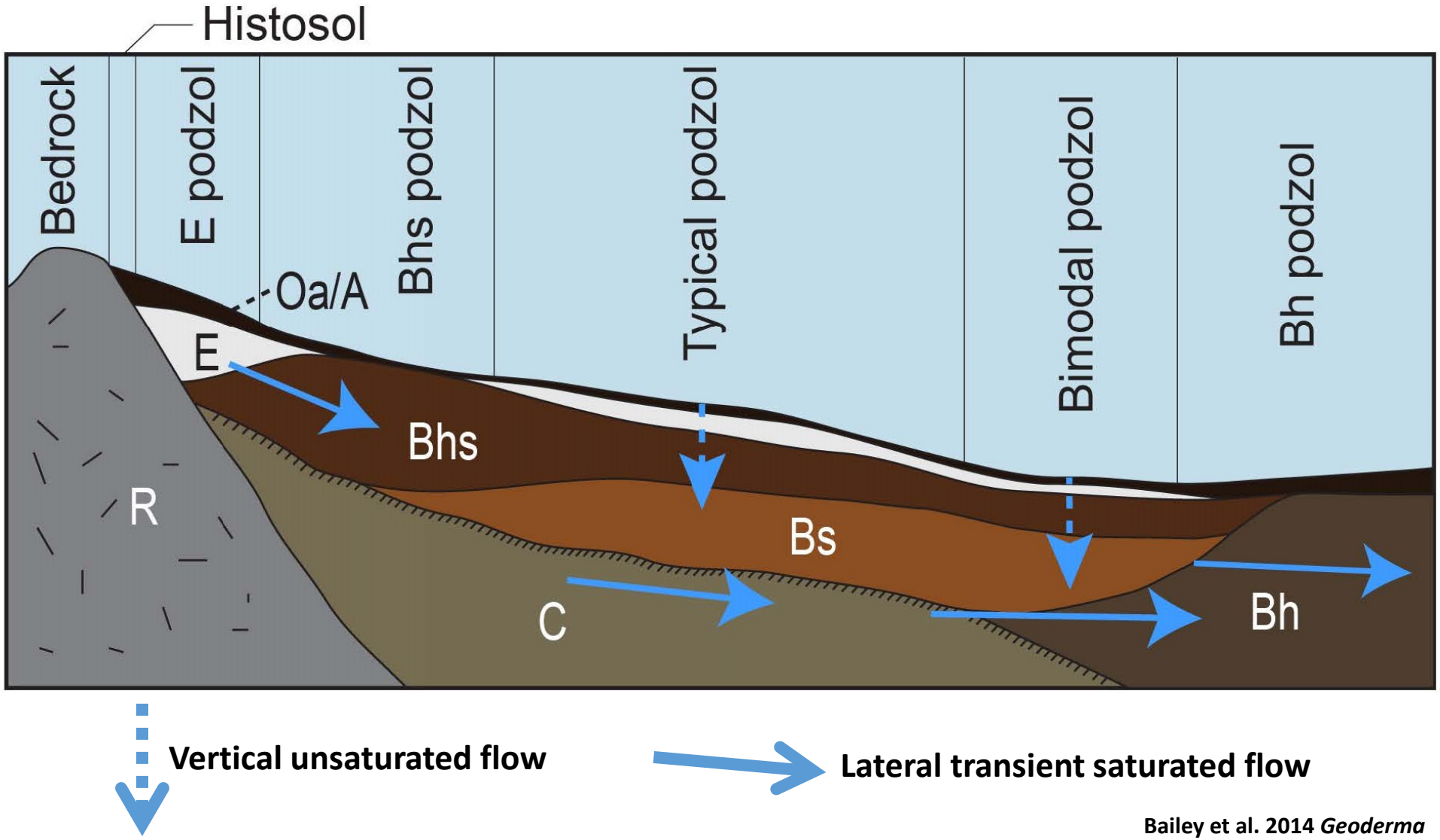
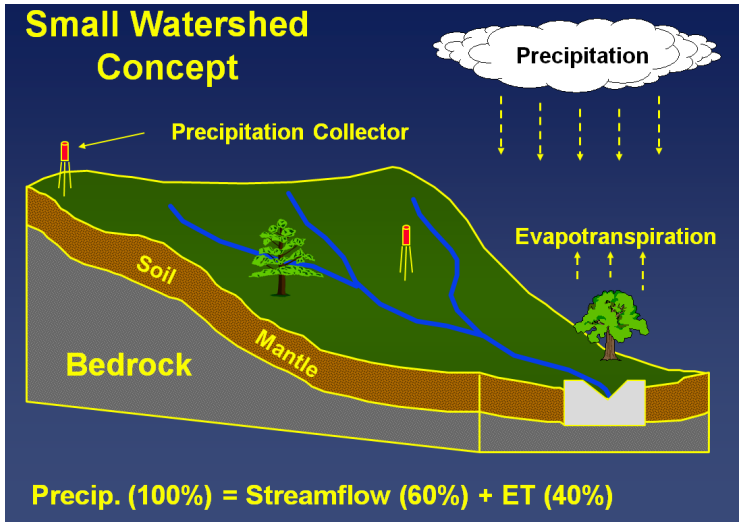


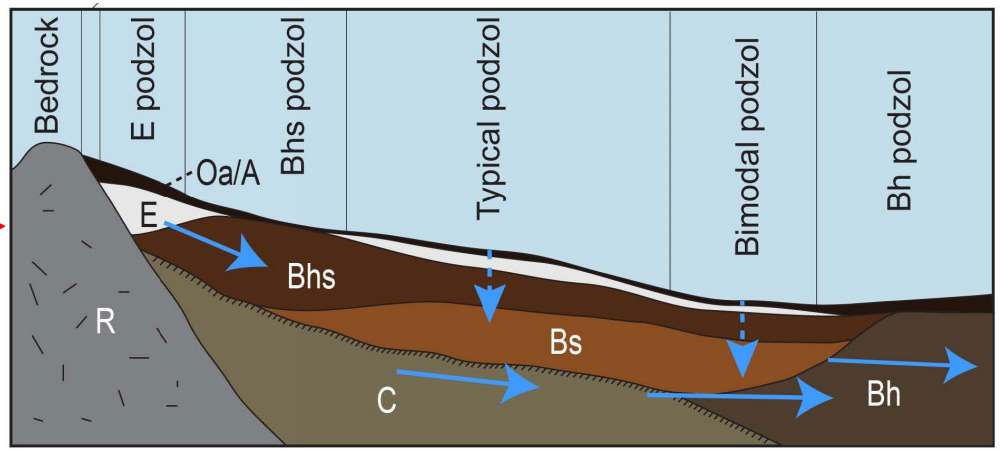
A Hydropedologic Catena:
Translocations and Hydrologic Connectivity



Bailey et al. 2014 *Geoderma*

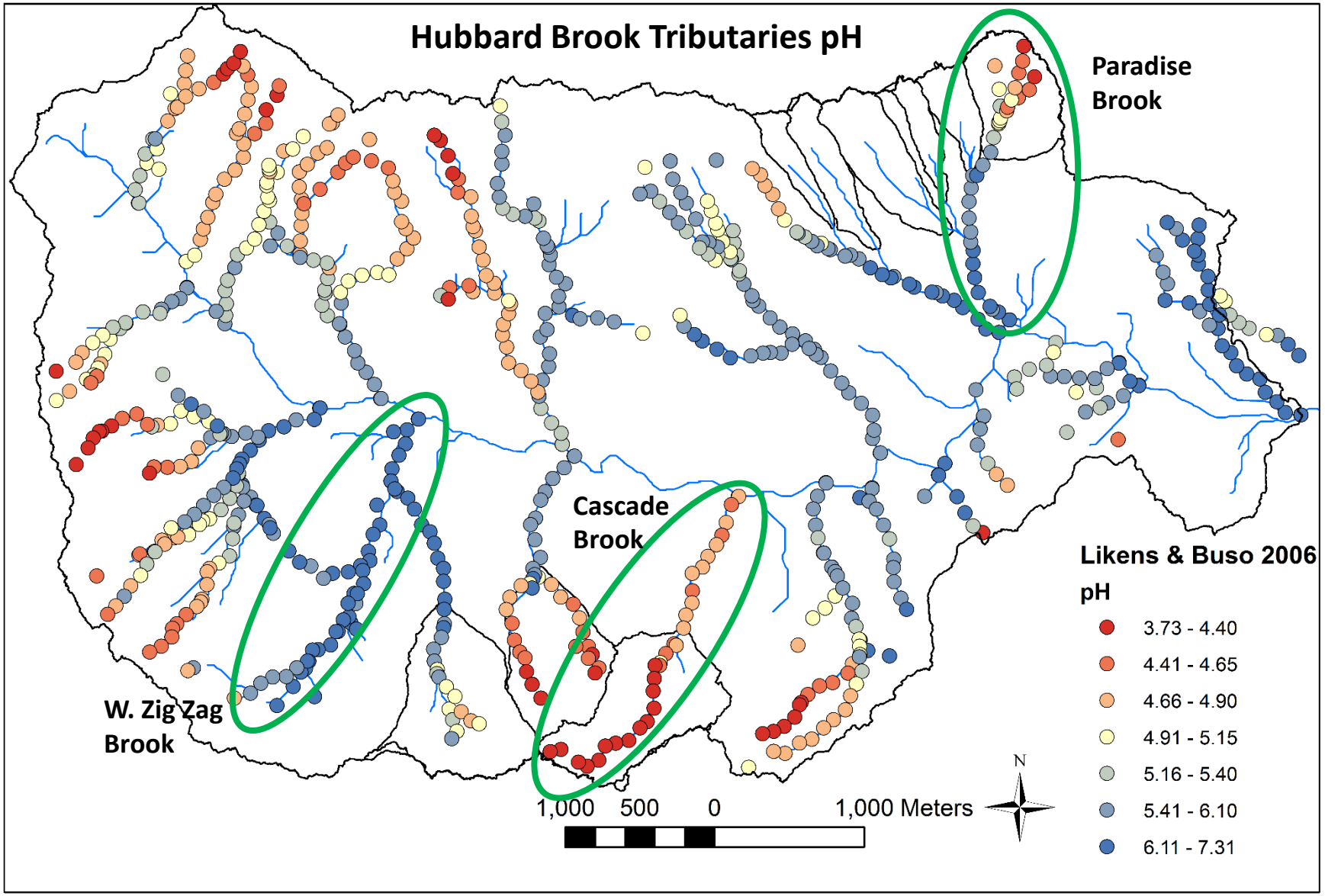
Hydropedology: A New Framework for Understanding Spatial Patterns in Forests





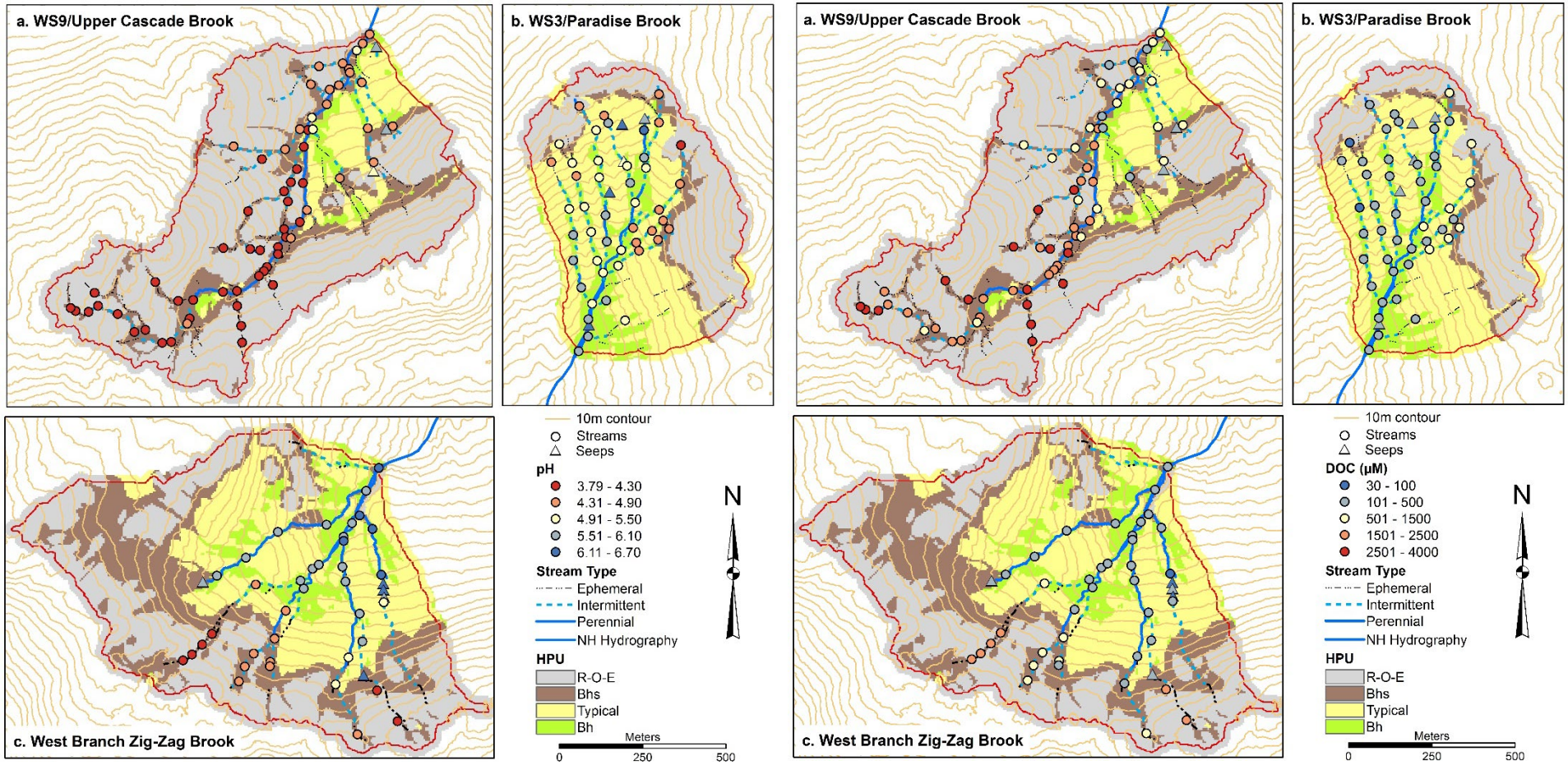
Bailey et al. 2014

How do Forests Regulate Water Quality?



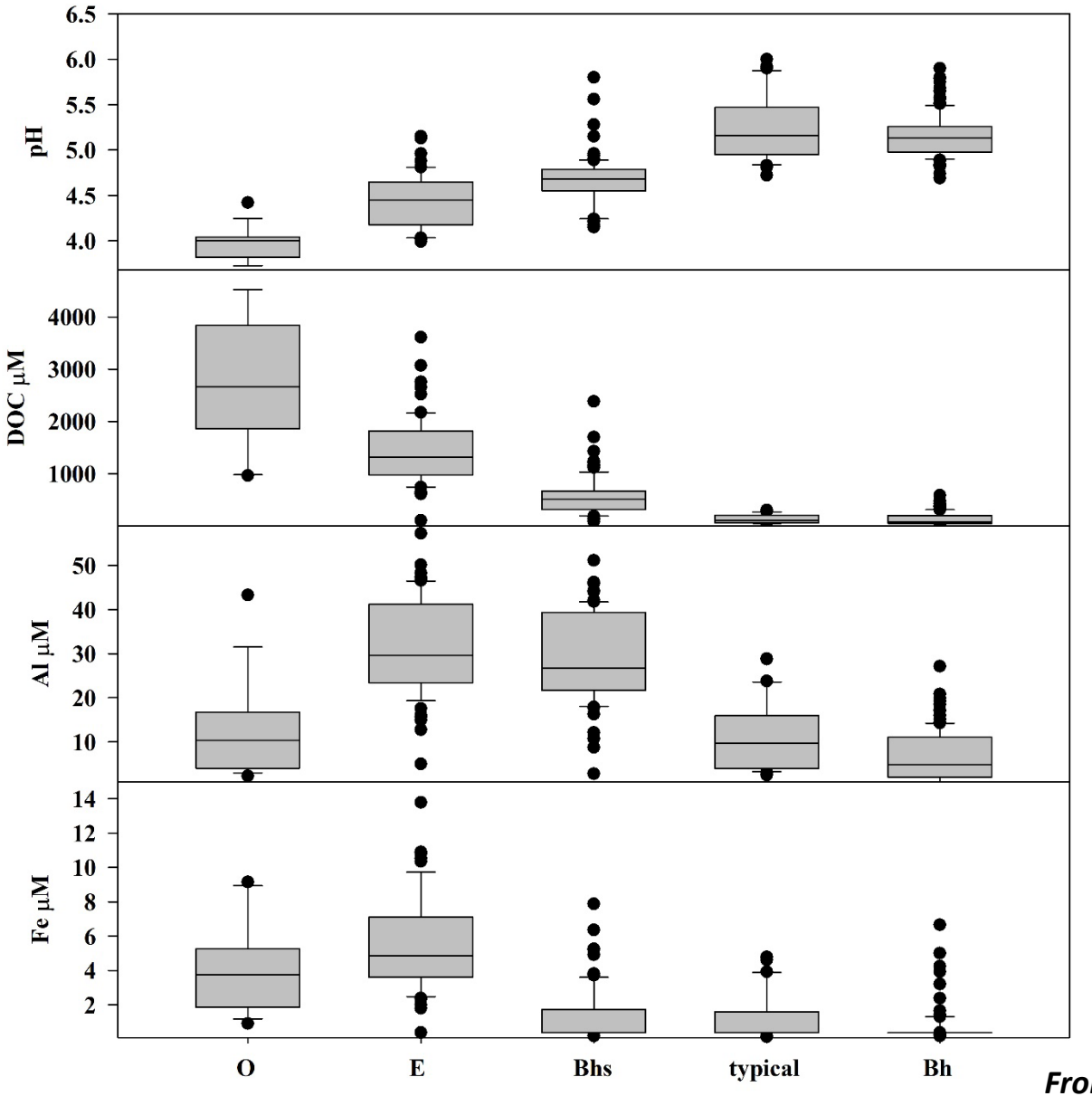
after Likens and Buso 2006

Soil Distribution vs. Stream Chemistry: pH and DOC



Bailey et al. 2019
Frontiers in Earth Science

Groundwater Chemistry by Soil Type



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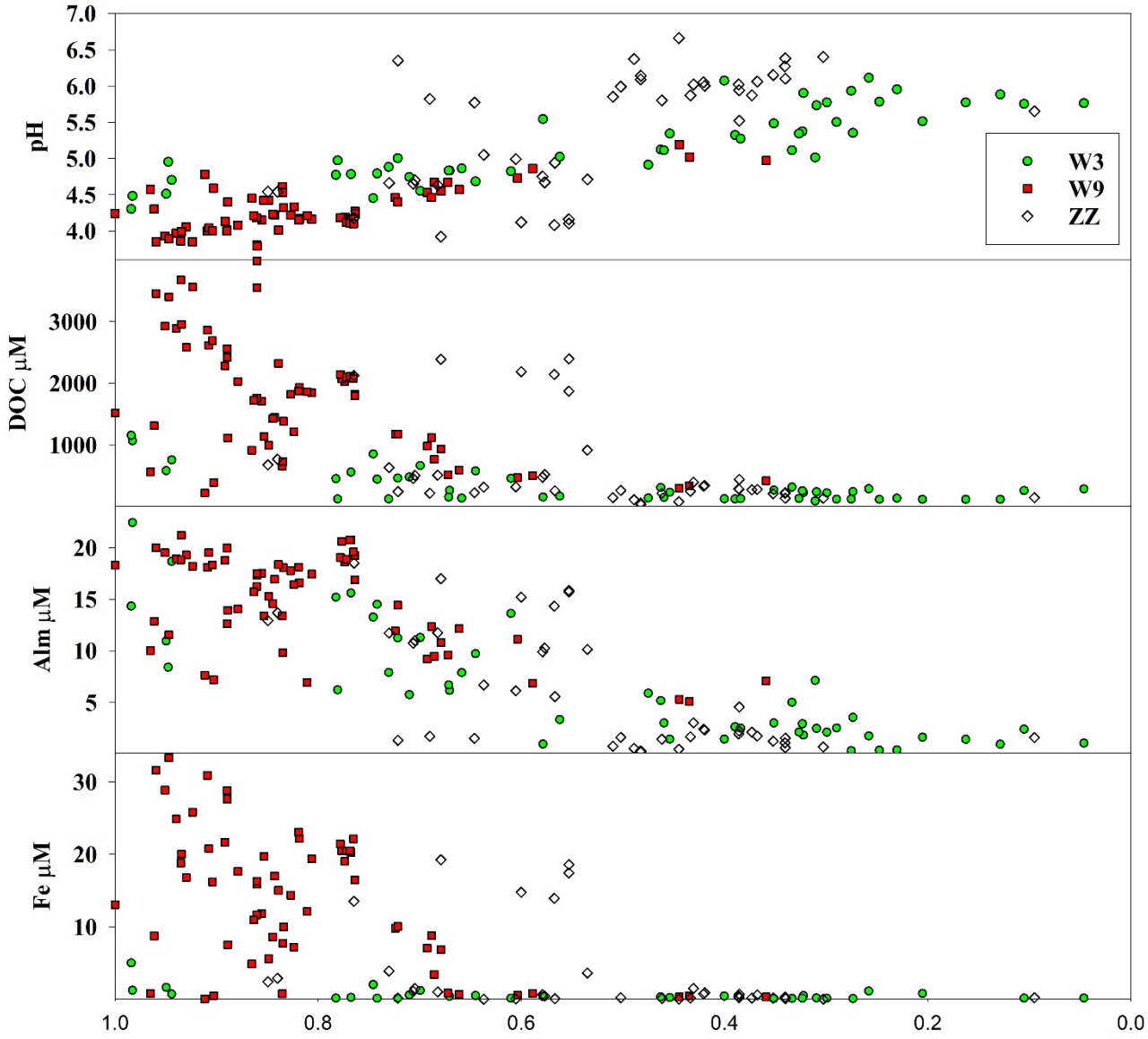
Subcatchment Soil Composition vs. Stream Chemistry



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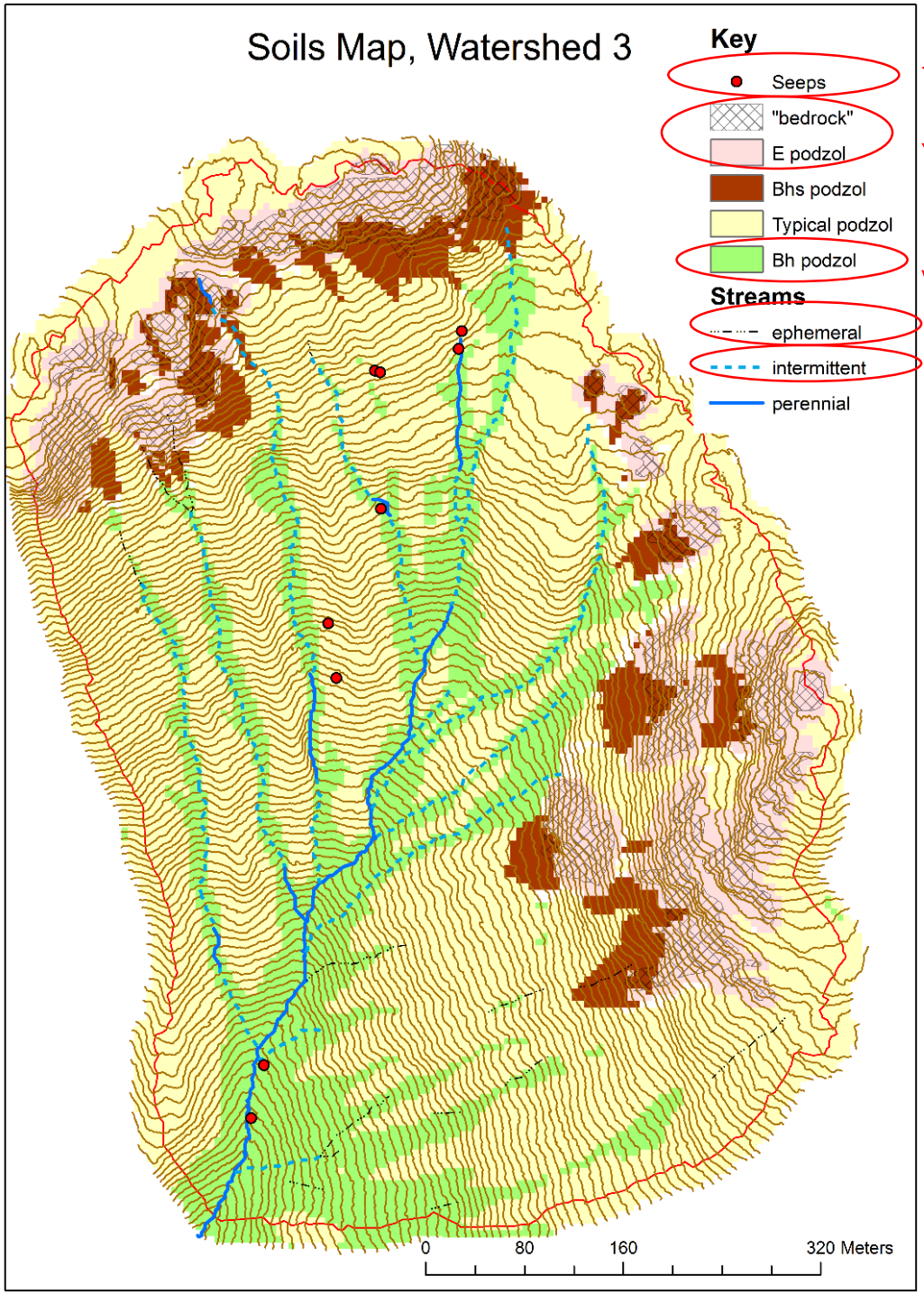


Buffer acidity; sources of Ca, Mg, Si
Zimmer et al. 2013 Hydrologic Processes

Sources of dissolved organic carbon
Gannon et al. 2014 Water Resources Res.

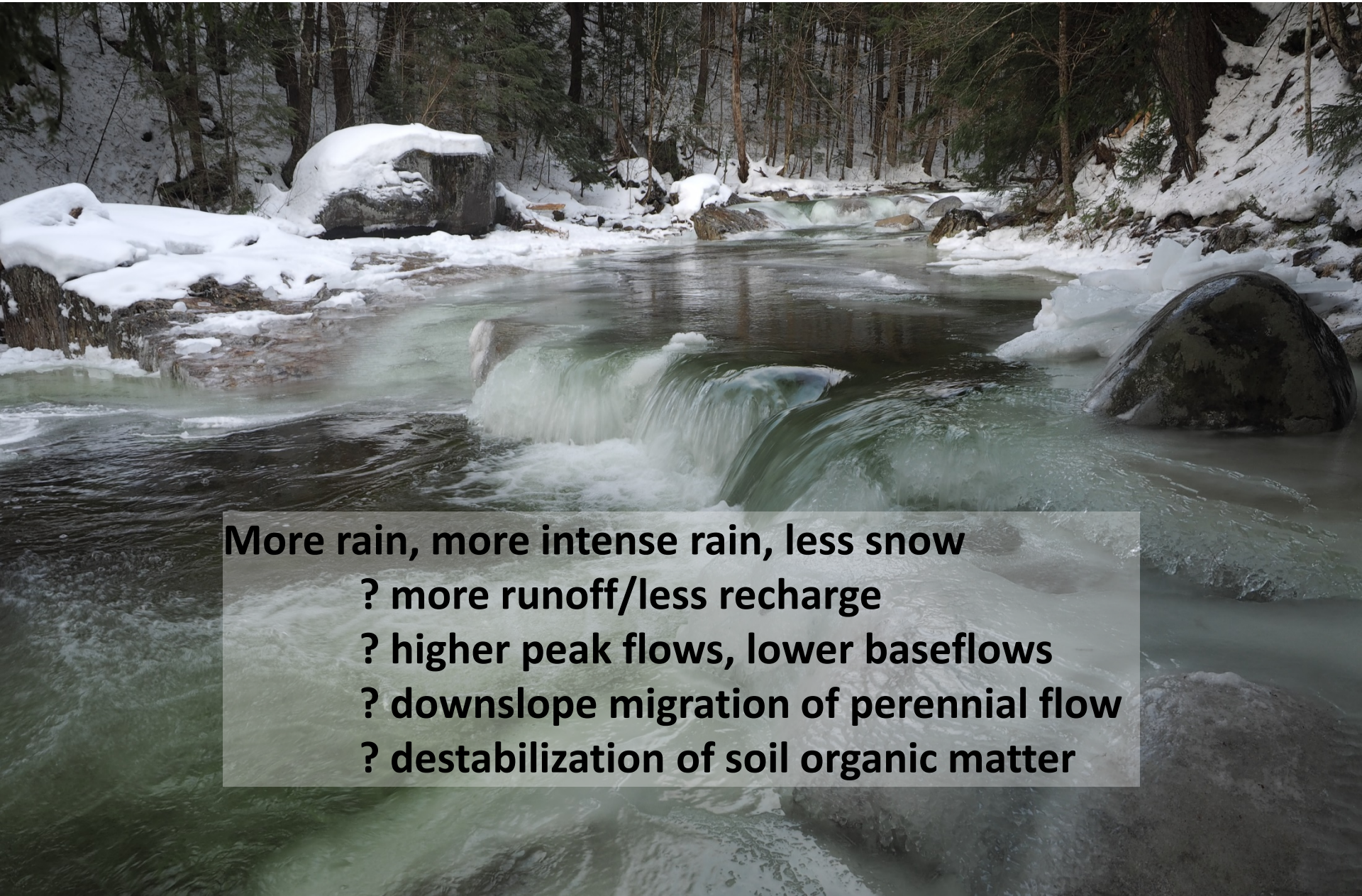
Denitrification
Wexler et al. 2014 Proc. Nat. Acad. Sci.

Can we recognize portions of the landscape vital for protecting watershed function

- **Treatment prescriptions**
- **Buffers**

Gillin et al. 2015
Soil Science Society of America Journal

What does Climate Change Mean for our Headwater Streams?



Take Away

Seeing the Forest for the Streams…

Headwater streams reflect and are an integral part of soil forming processes at the watershed scale.