

Phosphorus in Streambanks: A Net Source of Phosphorus to Streams

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**Biosystems
Agricultural &
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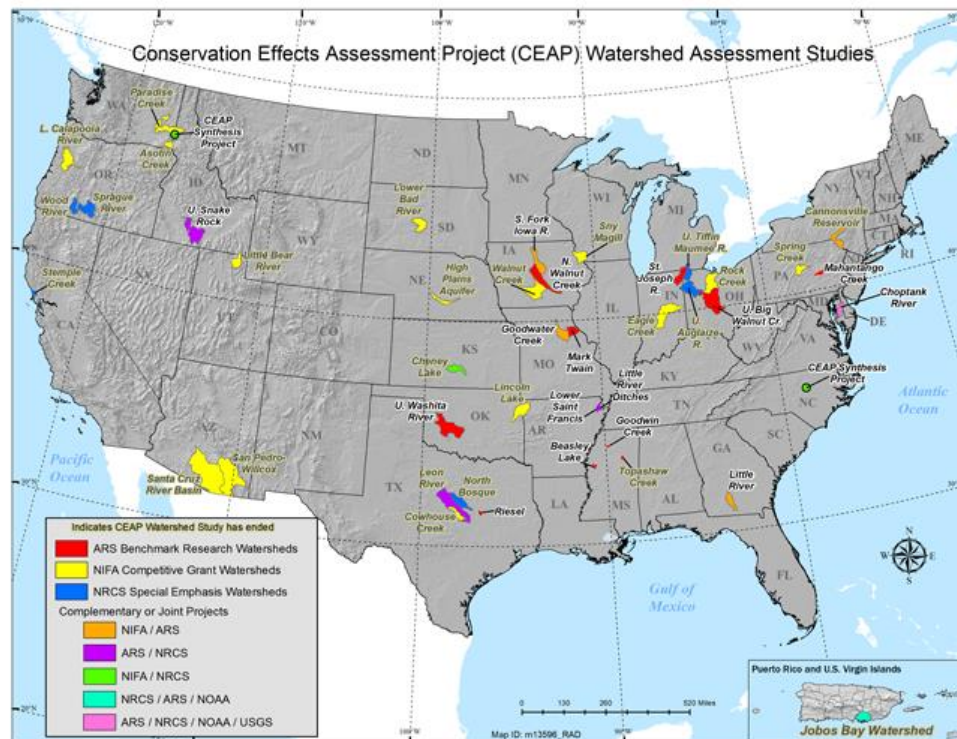
STREAMBANK EROSION

- Streambanks contribute to sediment loads:
 - Up to 92% of total sediment load in watersheds
- Sediment and P loading from streambanks unknown in many watersheds
- Growing body of literature on streambank P concentrations and loads



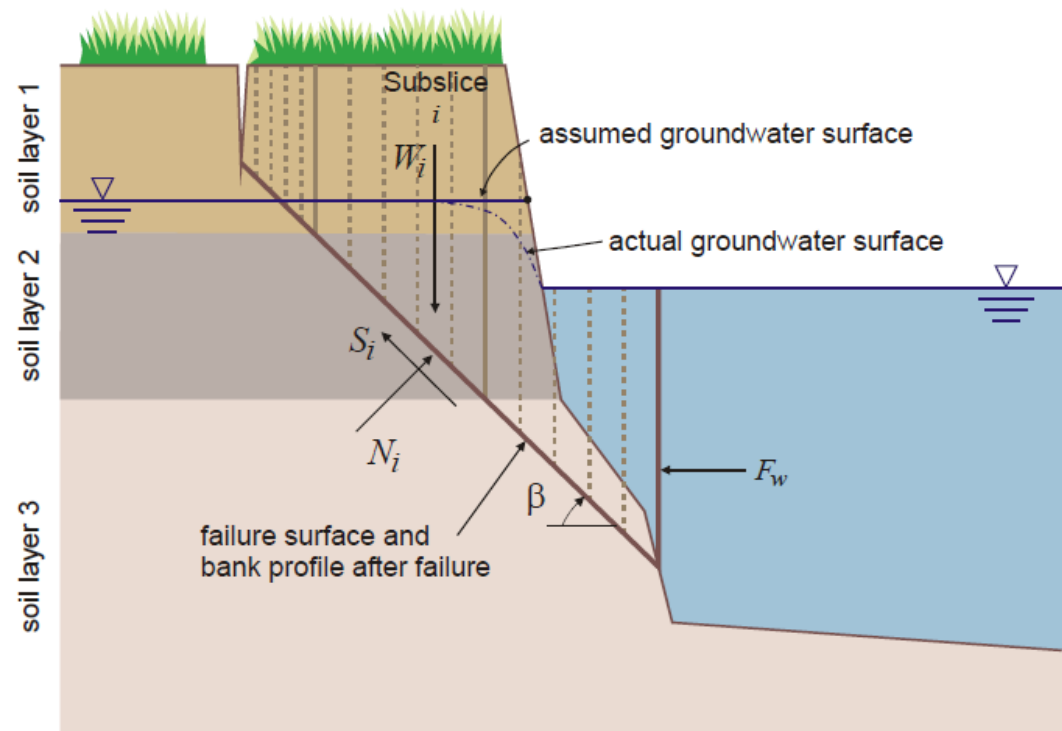
STREAMBANK SEDIMENT LOADS

- In many Conservation Effects Assessment Project (CEAP) watersheds, studies report that “...sediment in streams originated more from channel and bank erosion than from soil erosion” (Tomer and Locke, 2011).



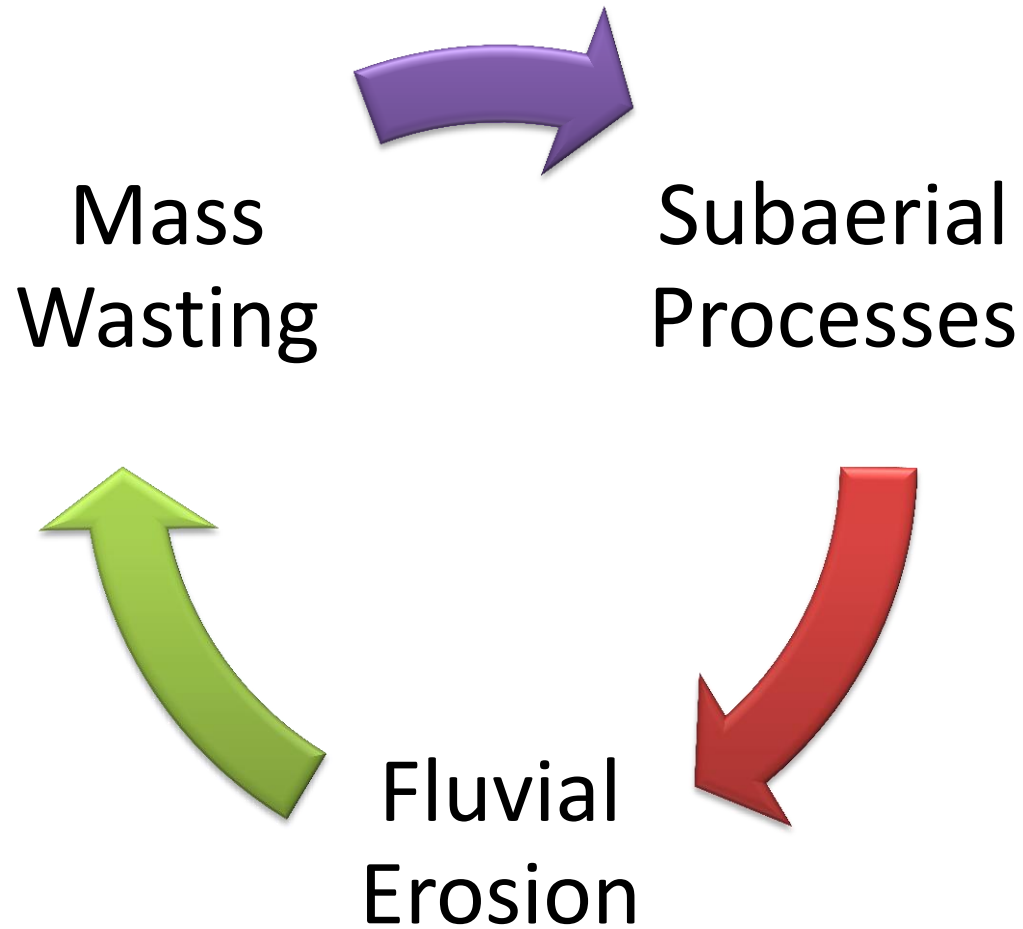
STREAMBANK EROSION

- Three primary mechanisms:
 1. Subaerial Erosion
 2. Fluvial Erosion
 3. Mass Wasting

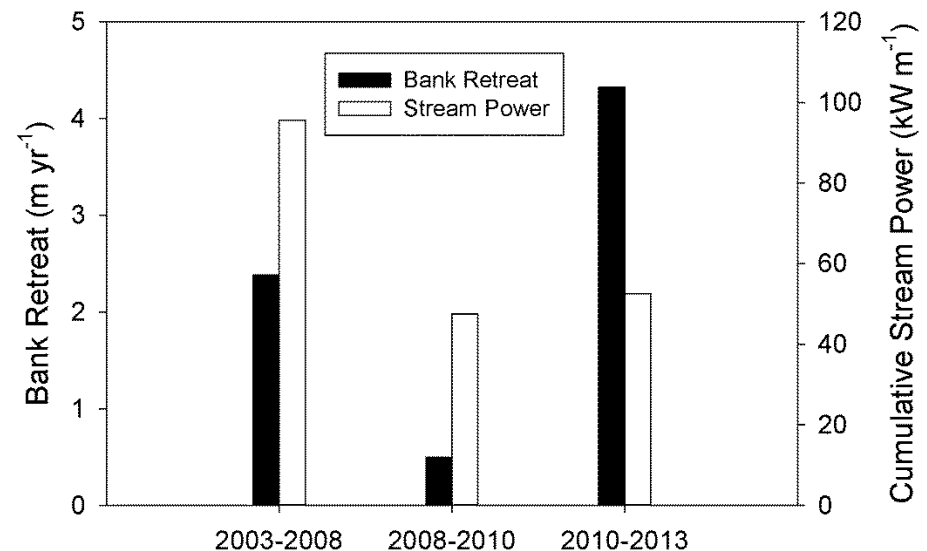
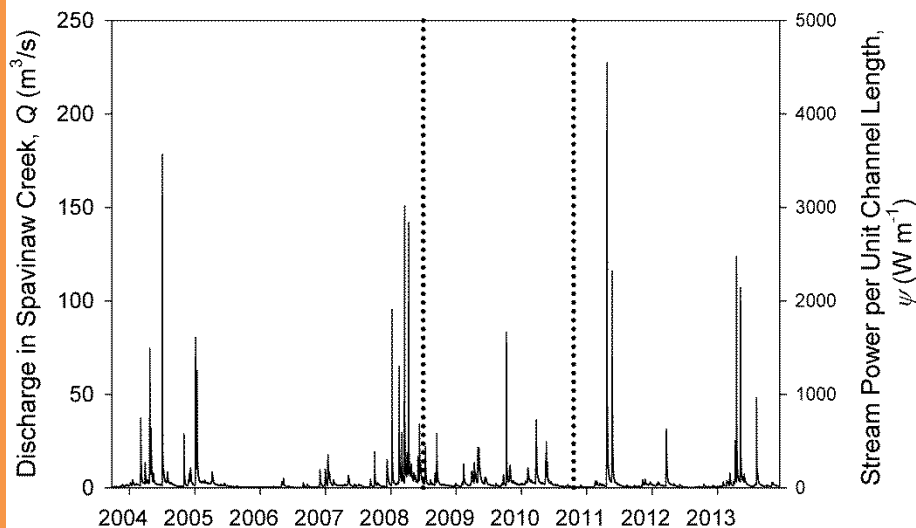
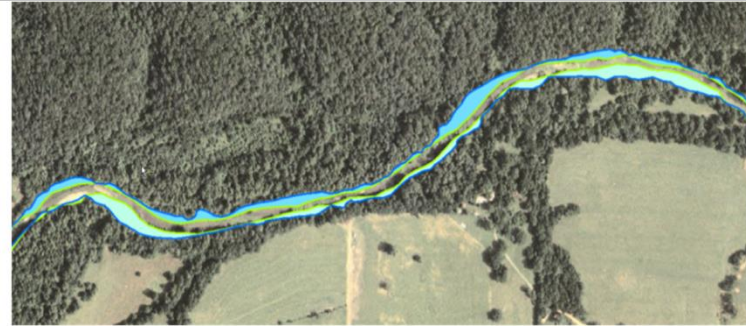
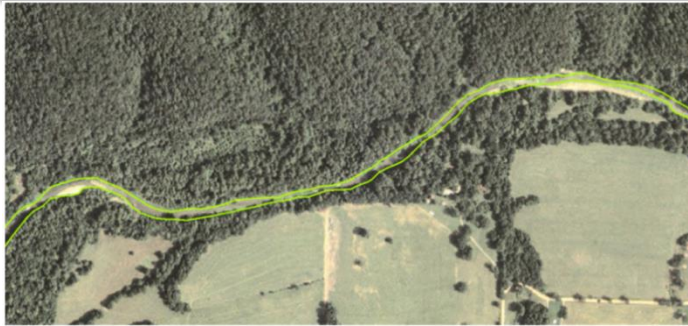


(Langendoen, 2000)

STREAMBANK EROSION



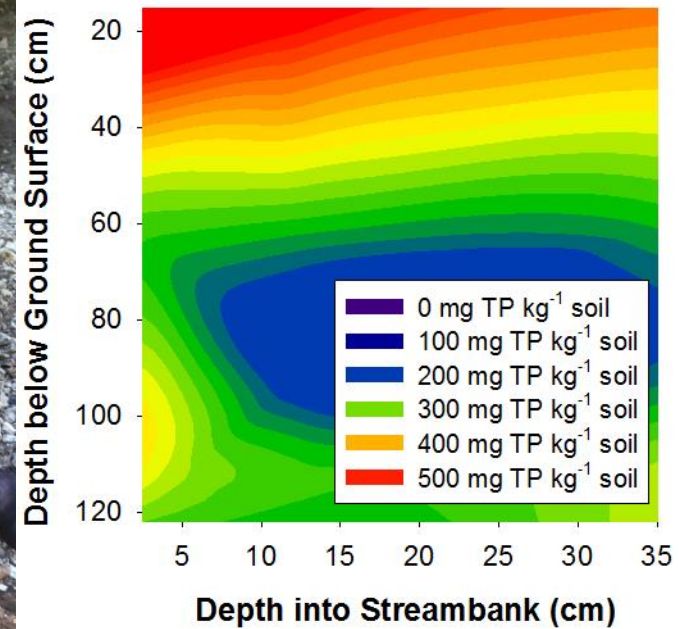
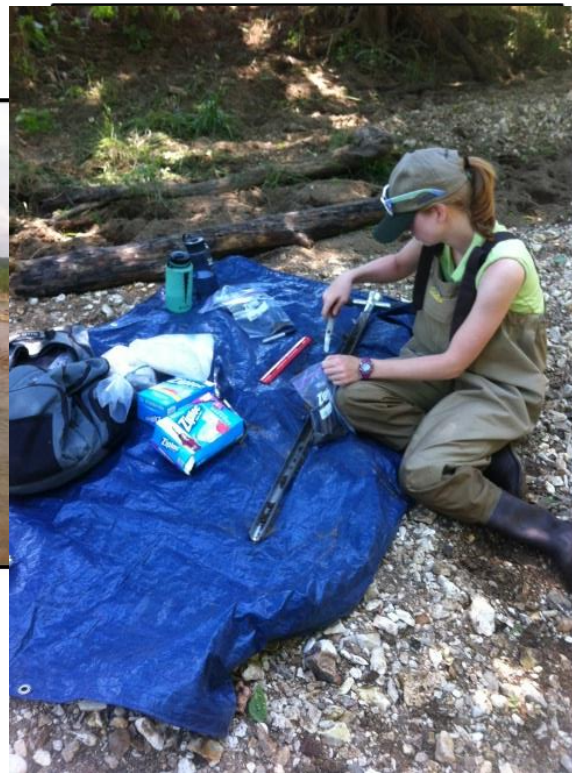
NOT JUST FLUVIAL EROSION



OVERALL OBJECTIVES

- Review current scientific literature on the following:
 - Streambanks as sediment sources
 - Streambank phosphorus concentrations
 - Streambank contributions to P loads
- Identify future research needs

TYPICAL METHODOLOGY



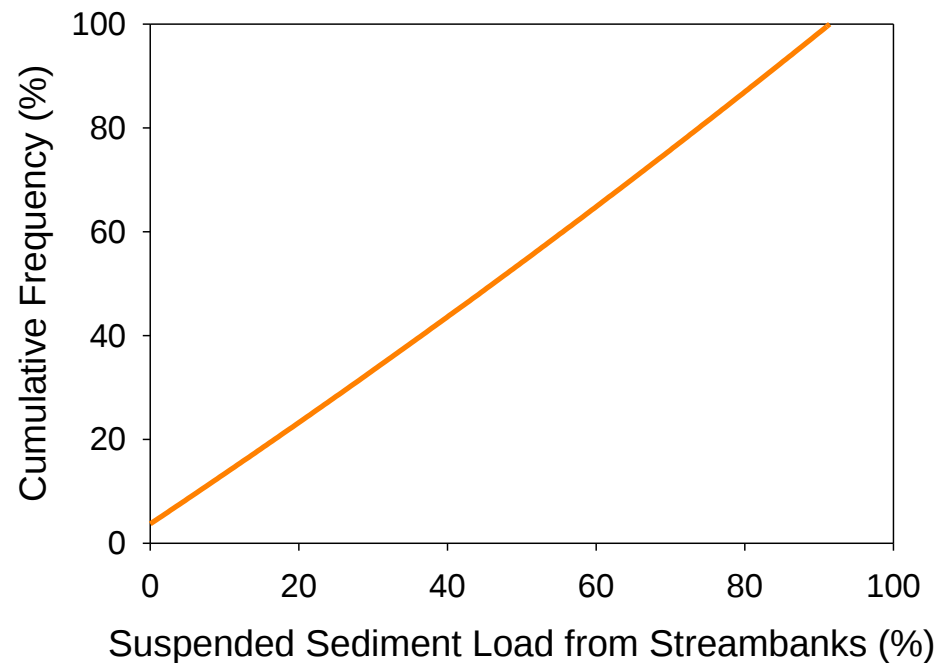
TYPICAL METHODOLOGY

- Sediment Load (SL):
 - $SL = EA \times D_{ts} \times \rho_b$
- P Load:
 - Streambank $WSP = WSP_{avg} \times SL$
and/or
 - Streambank $TP = TP_{avg} \times SL$

STREAMBANK SEDIMENT LOADS (SL)

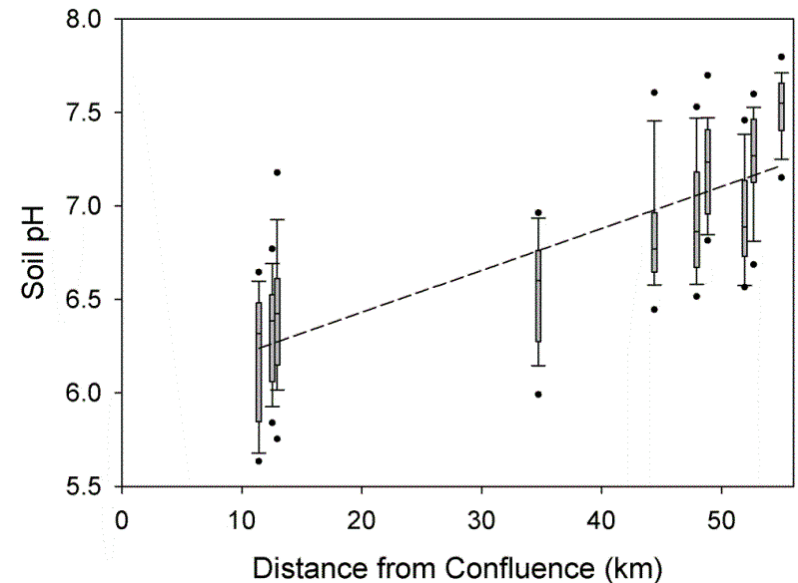
14 studies on streambank sediment loads (1983-2015):

- CA, TN, IA, MS, AL, MN, OK, England, Denmark, UK
- Various channel lengths: 1-100 km scale
- Drainage areas of 10 to 100,000 km²
- Suspended sediment load from streambanks = 7-92%



STREAMBANK P CONCENTRATIONS

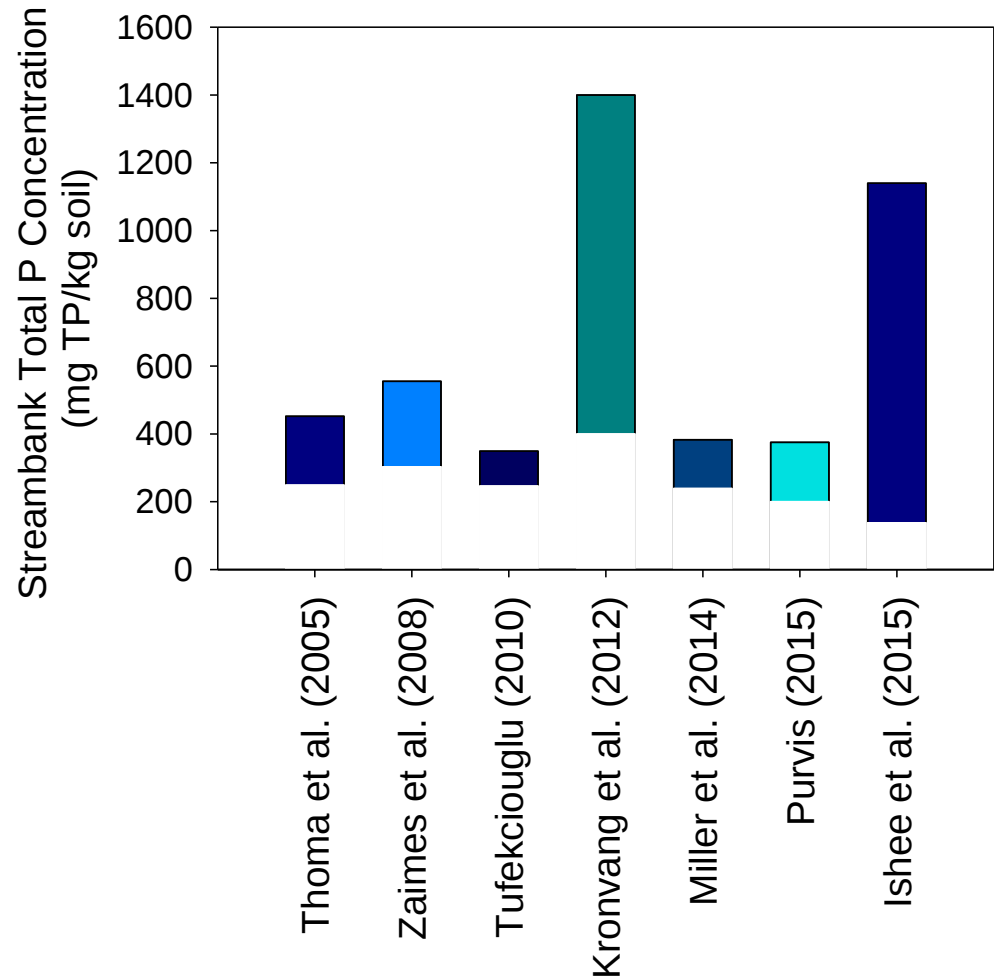
- Streambanks formed from eroded and deposited alluvial material
- Unique from upland soils:
 - Barren Fork Creek soil pH (Miller et al., 2014)
 - Riparian buffers lead to higher streambank P concentrations (Collins and Walling, 2007; Hoffman et al., 2009)



STREAMBANK P CONCENTRATIONS - TP

Literature (7 studies):

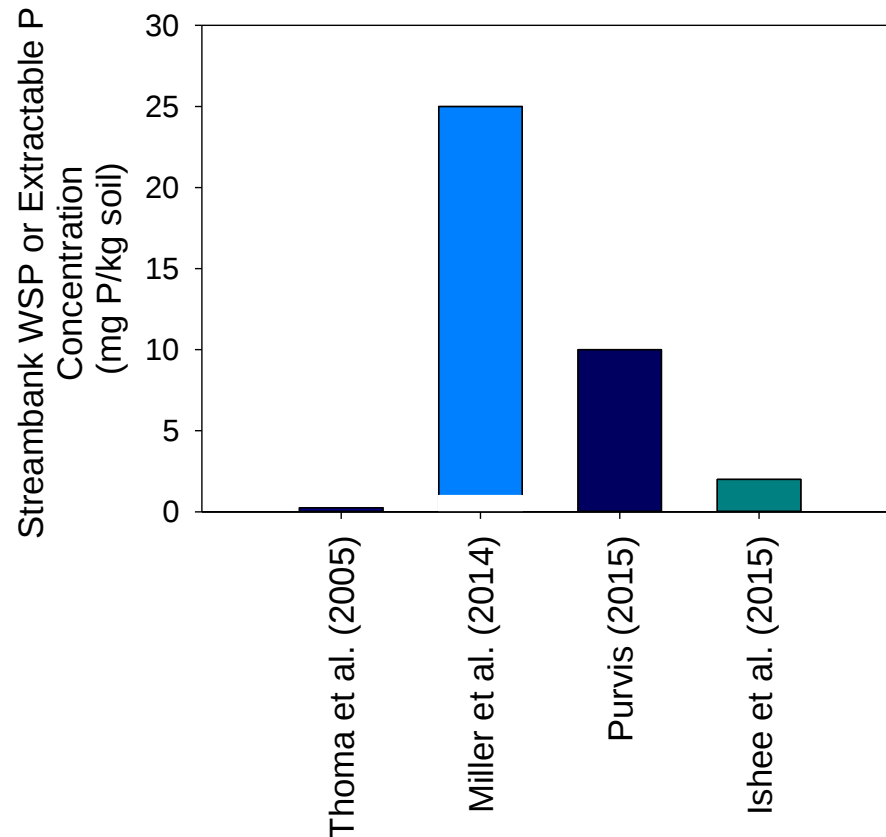
- MN, IA, OK, VT, Denmark
- TP consistently elevated above 250 mg P/kg soil
- Most studies report insignificant correlation to adjacent land use (Zaimes et al., 2008)



STREAMBANK P CONCENTRATIONS - WSP

Fewer studies report WSP or extractable P:

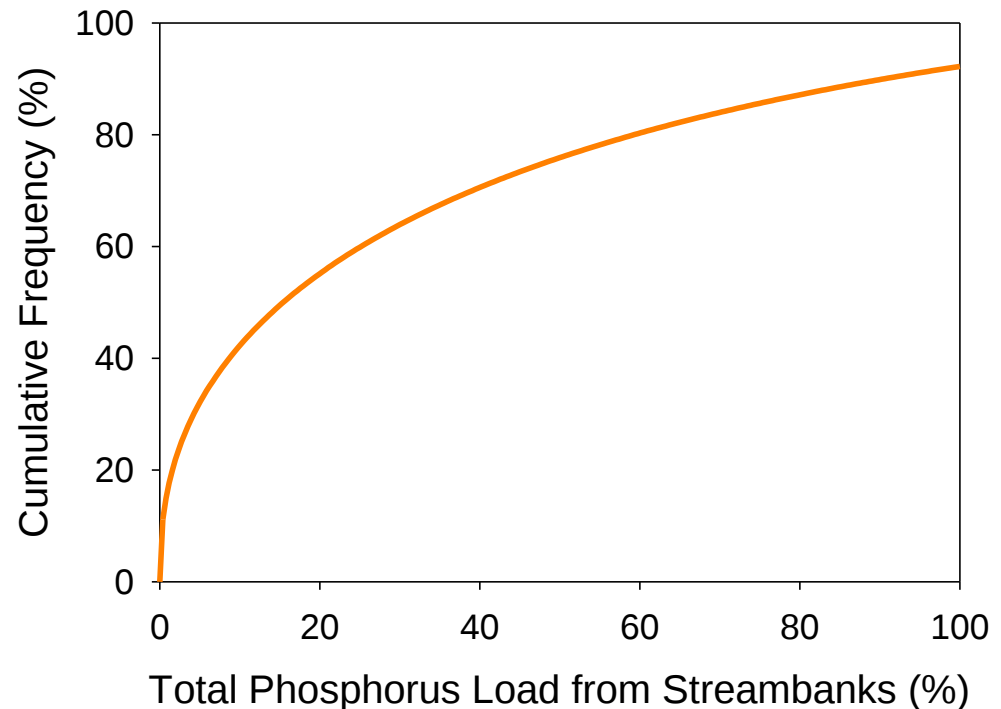
- WSP = soil P concentration readily available to the water phase (8.6 mg P/kg soil)



STREAMBANK P LOADS - TP

Literature (9 studies):

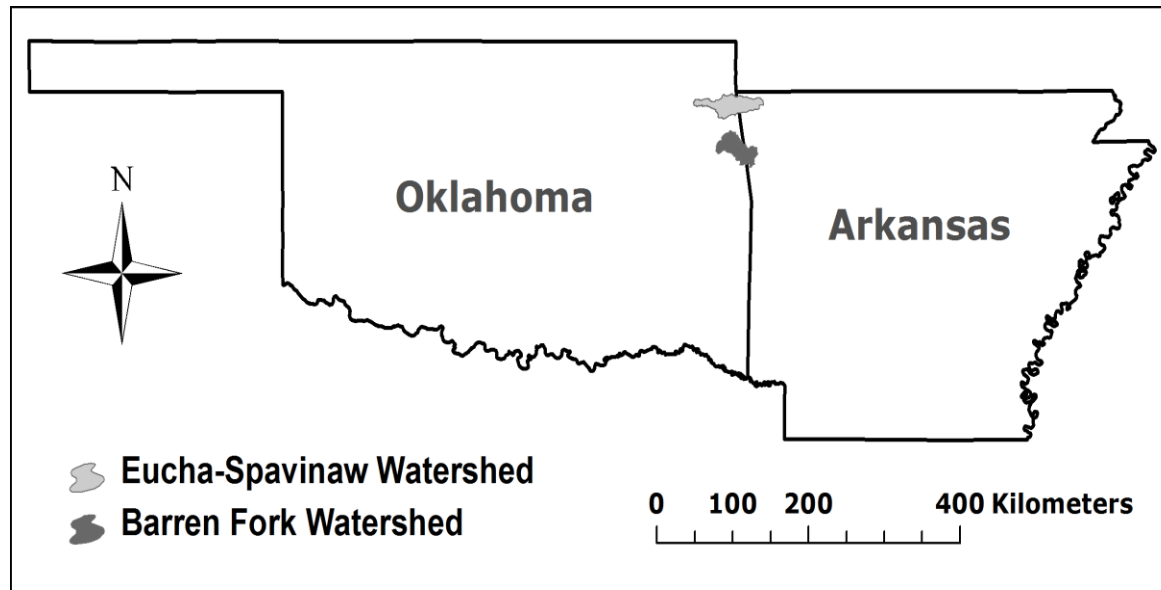
- MD, MN, IA, OK, VT, Denmark
- TP loading from ranged four orders of magnitude:
- 6 to 93% of TP



ARE LOADS COMPARABLE IN SIMILAR STREAMS?

Barren Fork versus Spavinaw Creek:

- Miller et al. (2014) in *Ag. Ecosystems & Environ.*
- Purvis et al. (2016) in *J. Hydrol. Engr.*



ARE LOADS COMPARABLE IN SIMILAR STREAMS?

Barren Fork versus Spavinaw Creek:

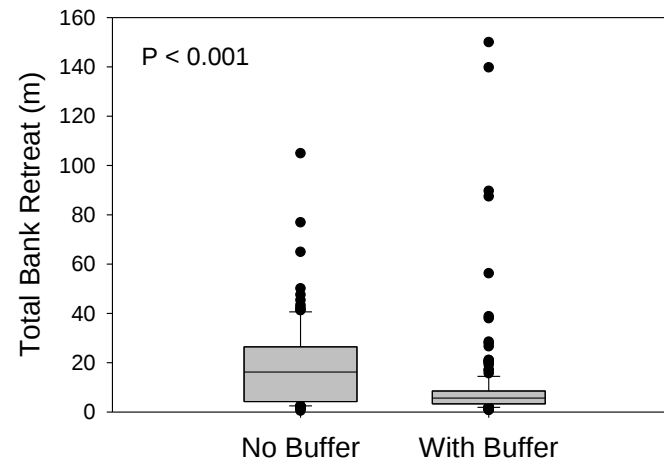
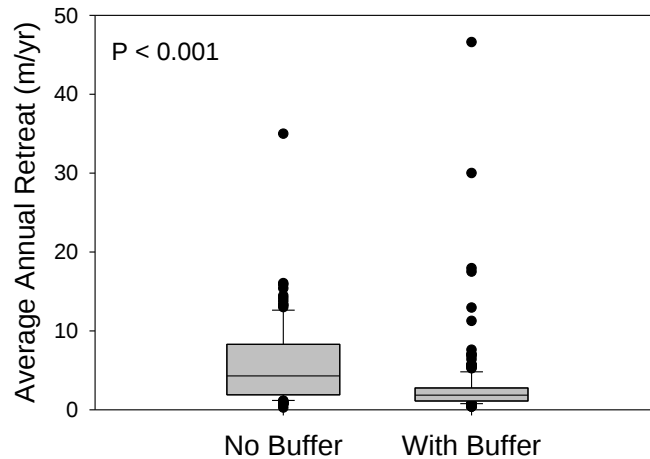
Location	Method	DP (kg yr ⁻¹ ha ⁻¹)	WSP (kg yr ⁻¹ ha ⁻¹)	Total P (kg yr ⁻¹ ha ⁻¹)
Spavinaw Creek	Streambanks	-	1.5 x 10 ⁻⁴ (1%)	1.3 x 10 ⁻¹ (Approx. 30%)
	Stream Gauges	1.5 x 10 ⁻²	-	4.1 x 10 ⁻¹
Barren Fork Creek	Streambanks	-	1.5 x 10 ⁻² (10%)	1.2 x 10 ⁰ (Approx. 100%)
	Stream Gauges	1.7 x 10 ⁻¹	-	5.7 x 10 ⁻¹

ROLE OF RIPARIAN PROTECTION?

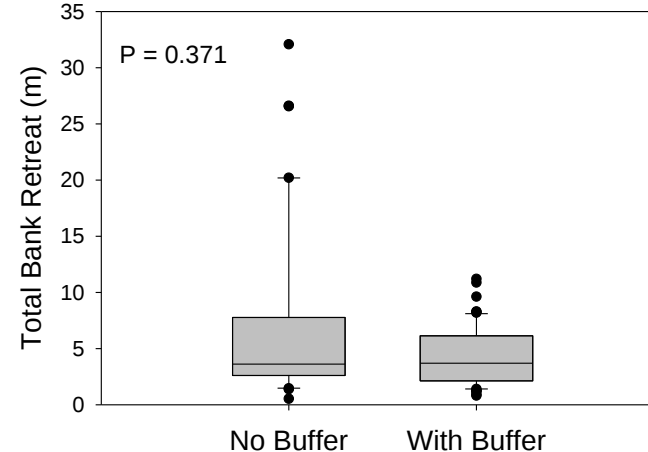
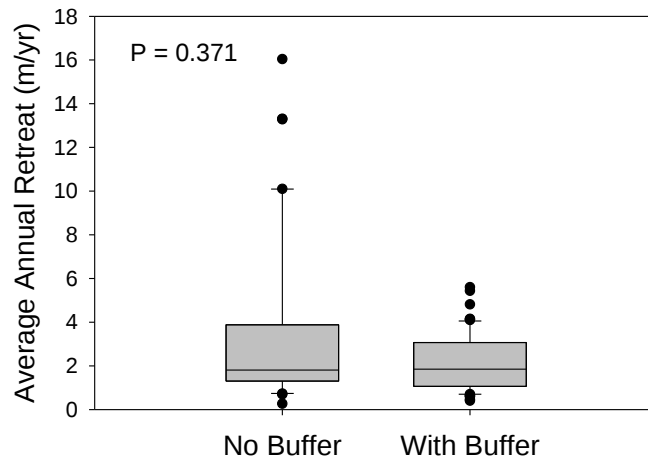
- Harmel et al. (1999) in Illinois River watershed:
 - Grassed banks four times more likely to experience notable erosion
- Barren Fork (Miller et al., 2014) versus Spavinaw Creek (Purvis and Fox, 2016):
 - Banks with established riparian buffers experienced three times less bank retreat (2003-2013)

ROLE OF RIPARIAN PROTECTION?

2003-2013



2008-2010



CONCLUSIONS

- Large number of variables that control streambank contributions to sediment and P
 - Streambank migration rates vary considerably even in same stream
 - Sampling typically conducted only at a few sites
 - Uncertainty analysis approach required
- Streambank TP concentrations – consistently elevated above 250 mg TP/kg soil
- Streambank retreat accounts for 7 to 92% of suspended sediment load and 6 to 93% of TP
- Additional research needed:
 - Dynamics and movement of P between sediment and water in streams
 - Techniques for stream stabilization in rapidly migrating systems

Questions?



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