#### Predicting Phosphorus from Forested Areas in the Tahoe Basin

Bill Elliot & David Hall (RMRS) Erin Brooks (U of ID) Drea Traeumer (Em Hydro) Emily Bruner (WSU)





#### Outline

A bit of background
Phosphorus pathways
WEPP Hydrologic Framework
Modeling Phosphorus delivery with WEPP

Why worry about Phosphorus Prediction?

- Lake Tahoe clarity is important to many
- An increase in phosphorus leads to an increase in algal growth

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An increase in algal growth leads to a decrease in lake clarity

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- Generally, P delivery is associated with human activity
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#### Why worry about forests?

- Generally, P delivery is associated with human activity
- Forest covers > 80% of basin
- With the increased need to reduce fire risk in basin, fuel management activities are increasing
- What are the effects of different forest management practices on P delivery?





# How Does P get from forestland to the water?

• Surface Runoff

#### - Generally from roads or after wildfire







## How Does P get from the land to the water?

- Surface Runoff
- Eroded sediments









#### How Does P get from the land to the water?

- Surface Runoff
- Eroded sediments
- Subsurface Lateral Flow
- Groundwater



## Some Typical P Concentrations: Surface Processes: Sediment

Source	P Concentration Observed	Rainfall Simulation			
Sediment Granitic Volcanic Alluvial Suspended sediment	4 – 22 mg/kg 9 – 13 mg/kg 1500 – 4500 mg/kg	475 mg/kg 159 mg/kg 333 mg/kg			

Note that for suspended sediment, the "fines," carry the P







## Some Typical P Concentrations: Surface Processes: Runoff

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Sediment Granitic Volcanic Alluvial Suspended sediment	4 – 22 mg/kg 9 – 13 mg/kg 1500 – 4500 mg/kg	475 mg/kg 159 mg/kg 333 mg/kg					
Snow melt Simulation Study Volcanic Granitic	0.05 – 0.3 mg/l, typically 0.09	1.28 mg/l 0.89 mg/l					
Note that snowmelt con	centrations lower tha	n simulation					
INGTON STATE I INIVERSITY ROCKY Mountain Research Station							



#### Some Typical P Concentrations: Subsurface Processes

	Source	P Concentration					
	Soil Water @ depth 0 - 5 cm 5 - 20 20 - 50 > 50 Nr Moscow ~130 cm	4 - 10 mg/l 7.8 mg/l 0.02 – 5.6 mg/l 3.6 mg/l 0.4 – 1.4 mg/l					
	Interflow	0.002 – 11.1 (Median 4.3) mg/l					
	Base Flow	0.008 – 0.125 mg/l					
Co	omments: High variability Wally said this would be inte	eresting 2,600 - 2,600 - 2,200 - 1,11	, a , a , a , a , a , a , a , a , a , a				
VIV	ERSITY Rocky	y Mountain					

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## Some Typical P Concentrations: Runoff & Management

Source	P Concentration mg/1000 cm <sup>2</sup>	
Surface/Interflow runoff		
Undisturbed	0.02	
Harvested	0.01	
Burned, no harvest	0.01	
Harvest and burn	0.01	00
	X	1 A RAD

Question: Is there a nutrient buildup in fire-suppressed forests? \*\*\*\* What about those concentration units?





#### Some Typical P Concentrations: Runoff & Management

Source	P Concentration			
Surface/Interflow runoff Undisturbed Harvested Burned, no harvest Harvest and burn	0.02 mg/l 0.01 0.01 0.01			
Jackpot burn simulator runoff Forest Unmopped pile Mopped pile	0.37 mg/l 2.15 mg/l 0.36 mg/l			

Comment: "Mopping" a burn pile may be a good idea...



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#### WEPP Hydrologic Framework

- WEPP does a daily water balance
  - Precipitation, snow melt, infiltration and runoff
  - Evapotranspiration
  - Soil water content
  - Lateral flow
  - Deep seepage





#### WEPP Hydrologic Framework

- WEPP does a daily water balance
  - Precipitation, snow melt, infiltration and runoff
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  - Lateral flow
  - Deep seepage
- For runoff events
  - Rill and interrill erosion
  - Sediment delivery with surface area enrichment





To predict P Delivery, we have tapped into specific WEPP outputs

- WEPP does a daily water balance
  - Runoff
  - Lateral flow
  - Deep seepage for linear flow model
- For runoff events
  - Sediment delivery
  - Surface area enrichment





#### The Prototype Interface

🖉 Tahoe Basin Sediment Model - W	Vindows Interne	et Explorer prov	vided by USDA Forest Serv	rice				_ 🗆 🔀				
COO V 🛃 http://forest.moscowfs	sl. <b>wsu.edu</b> /cgi-bin/f	swepp/tahoe/tahoe	pf.pl	<b>v</b> 🖻 🐓	🖌 🏹 Live Se	earch		<b>P</b> -	and the	1-20-00	in the	
File Edit View Favorites Tools	Help		0.10RS							_	<b></b>	
B V S WEPP Interfaces	Google Image	e Result for http	C Tahoe Basin Sediment Mo	×	• 🔊 - 🖃	🖶 🔹 <u>P</u> age 🗸	<u>S</u> afety <del>•</del> T <u>o</u> ols •	• 🕢 • »	• In	i but i	fields	are
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FSWEPP		-	Tahoe Basin Sedin	nent Model					b	eing	adde	d
								1	_	- Fine	sedin	nent
Climate *RUBICON #2 CA SNOTEL *HEAVENLY VALLEY CA	2	Element	Treatment / Vegetation	Gradient (%)	Horizontal Length (ft)	Cover (%)	Rock (%)		_	- <b>P</b> cor	ncontra	ations
*Almota Hill + *CedarThom, MT + *ECHO PEAK CA SNOTEL *TAHOE CITY CROSS CA S *Beirut Lebanon + *Goose Ck CO + *Rock Creek MT + DENVER WB AP CO MOUNT SHASTA CA SEELEY LAKE RS MT 22.5 SEXTON SUMMIT WB OR CHARLESTON KAN AP WW Horseshoe2 + CHIRICAHUA NAT MON AZ	SNOTEL 55 + V	Upper	Mature forest Thin or young forest Shrubs Good grass Poor grass Low severity fire High severity fire Bare Mulch only Mulch and till Low traffic road High traffic road Skid trail	0	50	100	20				ICEIIII	
BIRMINGHAM WB AP AL MOSCOW U OF I ID FLAGSTAFF WB AP AZ TROUT CREEK RS MT 38.8 Custom Climate Soil Texture ? Igranitic volcanic alluvial rock/pavement -> alluvi	33+ + closest	Lower	Mature forest Thin or young forest Shrubs Good grass Poor grass Low severity fire High severity fire Bare Mulch only Mulch and till Low traffic road High traffic road Skid trail	30	50	100	20					
Fines less than 10	microns	Phosphorus	surface 0.5 mg/l	lateral flow 4.3	mg/l	sediment 20	mg/l					
		Run description				Years to simulate:	50		search S	itation	University of Idaho	19
					😜 Interi	net	- 🖓 👻 🔍 10	JO% 🔹 🚽			available charge ascelence.	

#### The Output

#### Precipitation, runoff, erosion, phosphate for 50 years

Precipitation, runoff, erosion, phosphate, fines analyses										
	Total for	r Av	Average		Phosphate Analysis					
	50 years	a a	annual		Concentration		/ery			
Precipitation	4841 sto	orms 62.6	6 in.							
Runoff from rainfall	130 eve	ents 0.1	7 in.	0.5	ma/l	0.002	lb/ac			
Runoff from snowmelt or winter rainstorm	50 eve	ents 0.3	1 in.	0.5	шул	0.002	ib/ac			
Lateral flow	177.36 in.	0.5	9 in.	4	mg/l	0.021	lb/ac			
Upland erosion rate (0.052 kg m <sup>-2</sup> )		0.23	1 tac <sup>-1</sup>							
Sediment leaving profile (3.43 kg m <sup>-1</sup> width)		0.16	9 tac <sup>-1</sup>	20	mg/kg	<u>0.003</u>	lb/ac			
				То	otal	0.027	lb/ac			
	Fi	Ratio		Delivery						
		Clay				0.01	lb/ac			
			Silt	0.31		0.05	lb/ac			
		Silt < 1	0 microns	10.85		1.83	lb/ac			
		Total <	10 micron			0.05	lb/ac			
	SSA enrich	nment ratio lea	ving profile	1.10						
	SSA enrich	nment ratio lea	ving profile	1.10						

Lateral flow dominant pathway for **P** delivery (Observed 0.04 – 1 lb/a)





#### What about the Base Flow?

- Necessary for modeling watershed processes
- The Brooks Linear Flow Model:
  - Sponge and leaky tub, or

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Soil => temporary reservoir=> base flow and losses





#### What about the Base Flow?

- The Brooks Linear Flow Model:
  - Set up a dynamic groundwater reservoir
  - Recharge with deep seepage
  - Every day:

Base flow = K1 x depth in reservoir, and Groundwater losses = K2 x depth in reservoir







#### **Base Plus Surface and Lateral Flow**

• Adding it all up: runoff hydrograph



## Questions or Comments?