Exploring the linkage between fine sediment, phosphorus and stream ecology in wildfire impacted watersheds

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Introduction: In forested watersheds, large scale landscape disturbance by wildfire alter physical and biogeochemical processes that influence water quality and quantity in streams [1]. Such changes can strongly influence the ecology of downstream reaches [2]. Here we report long term changes in sediment and phosphorus (P) production and their impact on algae in streams studied for 10 years after severe wildfire in the Rocky Mountains (Alberta, Canada).

Methods: In 2003, the Lost Creek fire burned 21,000 ha of forests in the headwaters of the Oldman River Basin, Alberta. Seven watersheds with varying levels of disturbance (burned, post-fire salvage logged, unburned) were instrumented and monitored for 10 years [2]. Stream discharge was measured and changes in both the concentrations and yields of sediment and phosphorus (TP, SRP) reported [2]. Periphyton samples were collected on replicate unglazed porcelain tiles (155 cm^2) in midstream riffles. Chlorophyll *a* [4] and ash-free dry mass (AFDM) [5] were measured. Samples of suspended solids were collected using a network of in situ time-integrating samplers. The grain size distribution [3] and particulate P forms (NAIP, AP, OP) were determined [6]. The equilibrium phosphorus concentration (EPC_0) was determined using a series of batch tests to evaluate the aqueous P exchange potential of fine sediment [7].

Results and Discussion

Sediment Production: Sediment production was strongly influenced by land disturbance (wildfire and post-fire salvage logging) as well as topographic and hydro-climatic controls. Mean annual TSS concentrations and yields were significantly higher in burned and post-fire salvage logged watersheds than in reference (unburned) watersheds. No post-fire recovery in sediment production was observed in wildfire and post-fire salvage logged watersheds. Suspended solids were predominantly fine-grained and settling velocities were lower in burned and post-fire salvage logged streams than in reference (unburned) streams [8].

P speciation and sorption behavior: Mean total P concentrations and yields were significantly higher in burned and post-fire salvage-logged streams than in unburned streams. The sediment-associated P data indicate there has been little recovery of P to pre-fire conditions Levels of the most bioavailable particulate P form (NAIP) were significantly higher in burned and post-fire salvage logged streams compared to reference streams. The measured EPC_0 associated with sediments collected from burned and post-fire salvage logged tributaries were significantly higher than solids from reference streams. Coupled P and sediment interactions lead to slow recovery of P regimes in fire-disturbed watersheds.

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Stream Algal Response: Based on Chlorophyll *a* and AFDM data collected from porcelain tiles, annual algal productivity was significantly greater in streams within burned watersheds than in reference watersheds. Land disturbance by wildfire on the eastern slopes of the Rocky Mountains increased the production of fine sediment in wildfire and post-fire salvage logged tributaries. Fine sediment was characterized by having elevated levels of bioavailable P (NAIP) and higher aqueous P exchange potential (EPC_0). We hypothesize that increases in primary productivity of algal communities, in burned and post-fire salvage logged tributaries is related to P release from fine sediment in coarse gravel stream beds.

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