Streamwater chemistry and sediment responses to wildfire in the Colorado Front Range

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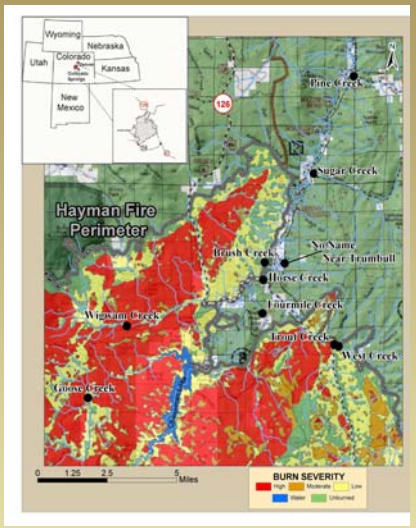
Introduction

The influence of forest fire on streamwater chemistry depends on the extent and conditions of the burn, the physical and biotic characteristics of the watershed and the flow regime. A monthly streamwater monitoring network initiated in 2001 on the Pike National Forest allows evaluation of fire effects in catchments burned by the 2002 Hayman fire and allows comparison of streams in burned and unburned drainages.



The Hayman Fire – Colorado's Largest Fire

- Started: June 8, 2002
- Contained: July 2 Controlled: July 18
- Area: 558 km^2 (137,760 acres)
- Cost: $39,100,000

Site Characteristics

- Colorado Front Range, S. Platte River Drainage
- Montane Forest Ecosystem
  - Ponderosa Pine (53%) / Douglas-fir (36%)
- Elevation: 1980 m to 2750 m (6500 to 9000 ft)

Background Information:

Graham R T 2003 Hayman Fire Case Study. RMRS-GTR-114, Rocky Mountain Research Station

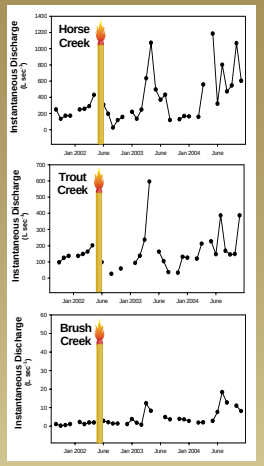
Study Watersheds, South Platte River Drainage, Colorado Front Range

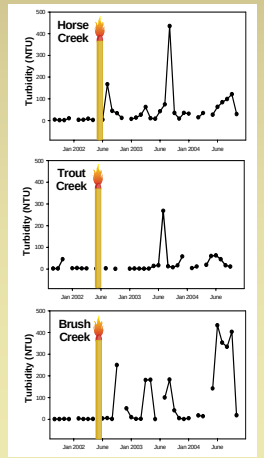
	Watershed Area	Burned Area		Burn Severity			Burn Severity		
	km^2	ha	%	Low	Mod	High	Low	Mod	High
				ha			%		
Burned Watersheds									
Brush*	6.1	5.3	87	1.8	0.2	3.4	28.9	3.0	55.6
Fourmile	21.4	15.1	71	2.5	2.2	10.5	11.5	10.1	48.9
Goose	49.6	25.7	52	8.9	2.1	14.7	18.0	4.2	29.7
Wigwam	57.5	27.4	48	8.6	1.2	17.6	15.0	2.1	30.5
West	178.9	84.8	47	39.4	26.6	18.8	22.0	14.9	10.5
Trout*	300.9	25.6	8	11.0	10.8	3.7	3.7	3.6	1.2
Horse*	486.7	116.9	24	51.8	38.5	26.6	10.7	7.9	5.5
Unburned Watersheds									
No Name*	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sugar*	31.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pine*	33.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* Pre and post-burn samples

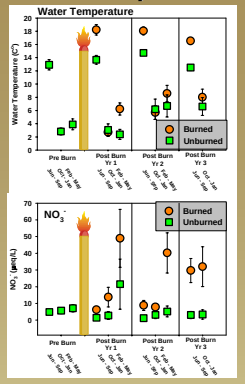
High Severity Stand-replacing	**Crown fire** Kills most of canopy, understory Kills all roots, rhizomes Consumes all surface organic matter Possible water repellency
Low Severity Non-lethal	**Surface fire** Kills few canopy trees Creates open forest structure Rapid vegetation recovery Consumes little surface organic matter Little water repellency
Moderate Severity	**Intense surface fire** Canopy is scorched in areas Stand-replacing in pockets (Romme et al. 2003)

Individual Streams Pre-fire / Post-fire

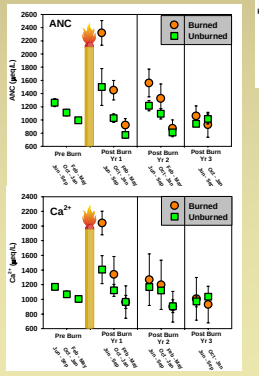




Burned / Unburned Mean Comparisons

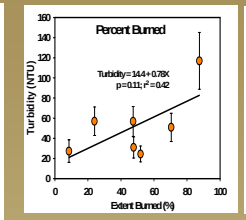


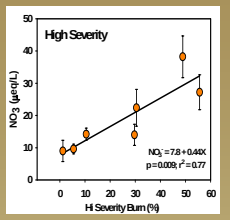
Temperature, NO_3^-
- 4 ºC summer increase
- 5X spring NO_3^- increase
- Sustained responses



ANC, Calcium
- Immediate 50% increase
- Recovery within 2 years
- Similar: Mg^{2+}, NH_4^+

Burn Extent & Severity

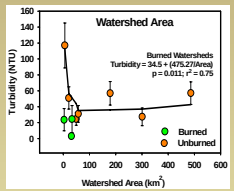


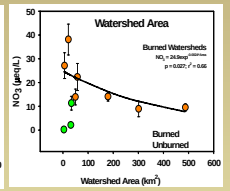


Percentage burned –
- Turbidity increases by 0.8X (r^2 = 0.42)
- Nitrate increases by 0.3X (r^2= 0.64)

High severity area –
- Nitrate increases by 0.4X (r^2 0.77)

Burn extent decreases with watershed area
- Decline by -0.1X (r^2 = 0.65)





Summary

Water quality response to wildfire depends on
- Relative extent and severity of burn
- Catchment area (small basins respond most)

Immediate, Temporary, Prolonged responses
- Cations, ANC increased then declined rapidly
- Sediment, nitrate, water temp remain elevated after 3 seasons