A Decade of Watershed Responses to Mountain Pine Beetle in Colorado Subalpine Pine Forests

Chuck Rhoades, Rob Hubbard, Kelly Elder, Derek Pierson; USFS Rocky Mtn Research Station

Forested watersheds of western North America are experiencing rapid and extensive canopy mortality caused by a variety of insect species. The mountain pine bark beetle (*Dendroctonus ponderosae*) began to attack lodgepole pine (*Pinus contorta*) at the USFS Fraser Experimental Forest (FEF) in 2002. By 2007, bark beetles had killed 50 to 80% of the overstory pine in Fraser’s research watersheds.

**Soil Nitrogen:** Lower water and nutrient uptake by dying trees is expected to increase soil N after bark beetle attack. This was documented under Colorado lodgepole pine (Clow et al. 2011; above) and in every study where it has been examined (Rhoades in prep.). The increase in soil N occurs prior to significant needle drop (red needle phase) or other forest structure or microclimatic change.

**Streamwater Nitrate:** At Fraser, stream nitrate concentrations were statistically higher in the East St Louis Ck basin the decade after bark beetles killed 75% of lodgepole pine basal area compared to the pre-outbreak period. Nitrate increased in another unmanaged basin (Lexen), but not 2 managed basins (Fool, Deadhorse).

**Compensatory Responses**

A number of studies in Colorado found that stream nitrate responses to bark beetles were minor compared to harvesting and other disturbances (Rhoades et al. 2013).

At FEF there is widespread evidence of stimulated post-outbreak plant growth and nutrient demand. For example, we have found:

- Abundant new seedlings under dead pine.
- Understory tree growth 2X faster annually.
- Radial growth higher for 30% of trees.
- Foliar N increased following attack.

**Related Citations:**

Nitrogen dynamics in conifer forests affected by bark beetles. (in prep). Rhoades 2013


Changes in transpiration and foliage growth in lodgepole pine trees following mountain pine beetle attack and mechanical girdling. For Ecol Mgmt. Hubbard et al. 2013

Responses of soil and water chemistry to mountain pine beetle induced tree mortality in Grand County, Colorado, USA. Agol Geochem. Clow et al. 2011

Tree regeneration and future stand development after bark beetle infestation and harvesting in Colorado lodgepole pine stands. For Ecol Mgmt. Collins et al. 2011

---

**Unmanaged vs Managed**

Mountain pine beetles prefer larger diameter lodgepole pine, so areas populated by smaller diameter trees are more resistant to attack at the onset of an outbreak. Fraser basins that were treated in the 1950’s & 1970’s have less pine basal area and have lost < ¼ of their total basal area to beetles.

**Fool Creek:** Half the forested area was cut in the mid 1950s to quantify changes in snowpack and water yield.