Fire regimes and fire behavior in San Juan spruce-fir forests: Risks with and without beetle infestation

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Introduction

There are very few empirical studies on the impacts of large-scale spruce beetle epidemics and fire risk and hazard. Most of the studies in the last few years have focused on the mountain pine beetle epidemic in lodgepole pine forests. Existing bark beetle and fire studies tend to fall into two categories: (1) looking at past outbreaks and subsequent wildfire behavior and (2) using models to predict fire behavior and fuel conditions. Both of these have their shortcomings but fires in spruce-fir (SF) are rare and difficult to study. The following summary is based on my own observations as a fuels specialist, Silviculturist and based on my knowledge of fire behavior as a fire fighter and fire behavior modeler.

A. Historic Fire Regime (HFR) in the Spruce-fir forest - 2 basic types of fire (the primary disturbance agent in spruce-fir forests is spruce beetle)
    a. Primary HFR represented by 200-500 year fire return interval, stand replacement fires.
        i. Extremely dry conditions in late June to early July – before monsoon.
        ii. Different from HFR of lodgepole pine forests in the Northern Rockies which are 100-200 year return interval, stand replacement fire typically from July thru mid-September when live fuel moisture is at its lowest point.
    b. Minor component of spruce-fir HFR – more frequent fires that burn through larger fuels, underground roots ("skunk around") a few days up to 2 to 3 weeks, June thru October.
        i. These smaller fires create small scale heterogeneity, kill trees in small pockets and/or increase susceptibility to beetles and other pathogens.
        ii. Associated with stand replacement fires on less severe days when the fire isn't "ripping".
B. Changes to Fire Regime as a result of management and fire exclusion
    a. At the stand level, the FR has not been affected because no fire-return intervals have been missed.
    b. At the landscape level (Watershed and larger areas), a few medium size fires have been missed in last 100 years. Result is large contiguous areas (millions of acres) of mature and late successional stage SF forest = beetle heaven (per Wayne Sheppard).
    c. Most fires in SF start at lower elevations earlier in the season and when conditions are right, make a sustained run into the SF zone and may go to timberline. But, we have suppressed 99+% of fires in the lower elevations.
    d. We get lightning starts nearly every year in the SF zone, usually during monsoon season. They seldom get larger than 3 acres and don't last more than a few days. (Note this is where we may see a change as a result of BB).

C. Effects of beetle outbreaks on fire regime in SF forests (this includes spruce beetle, fir engraver and balsam borer, all of which have had huge impacts in the San Juan Mountains in the last 15 years)
    a. Three fire behavior factors are affected by beetle mortality (many things are affected but these 3 are the most important to fire fighters):
        i. Rate of Spread (ROS) – how fast the fire moves
        ii. Resistance to Control (how difficult it is to construct fire lines and effectiveness of aerial retardants.)
        iii. Fire fighter safety (entrapment and falling snags)
    b. I will classify effects based on three stages of beetle epidemics (research recognized 5 stages).
        i. Active stage (This is called "Red Stage" in LP forest but spruce trees turn yellow, not red) – beetles are active, generally mix of live and dead trees. Time period of 3 to 6 years following initiation of outbreak. Spruce beetle has a slower rate of compared to MPB. Most trees still standing. Immediate response of understory vegetation including grass, forbs, shrubs and aspen sprouts.
        ii. Post-epidemic (Researchers call this the "Grey Stage") 80 – 100% of trees over 5 inches DBH are dead. Some smaller snags beginning to fall. Time period of 6 to 10 years following initiation of outbreak. Response of understory vegetation has the greatest impact on fire risk and hazard.
        iii. Recovery – Young forest is established. Depending on elevation would be aspen, DF, ES or SAF. Some areas will be predominately shrubs. Timberline stands may remain in grass stage for many years. Most trees have fallen (15 to 50 years post epidemic) (Snag Fall stage)
    c. Effects on Fire risk and hazard by epidemic stage.
        i. Active Stage
            1. Increased risk of crown fire and higher ROS for 1- 2 years but needles fall from trees very quickly and short needles do not burn well on the ground. Ground fuels may dry out quicker because of reduced shading. Green needles of attacked trees have lower live fuel moisture than healthy trees.
            2. Resistance to Control is high because of higher ROS, crown fire risk and drier fuels. (Research doesn't support this. It is pure conjecture on my part.)
            3. Fire fighter safety – increased risk of entrapment. Moderate to high risk of falling snags (but there is always a high risk of falling trees in SF zone due to shallow roots and low resistance to fire)
        ii. Post-epidemic (Grey Stage) all needles and most small branches fallen from trees.
            1. Much decreased risk of crown fire and ROS. The primary carrier of the fire is understory vegetation (grass, small trees or shrubs) and strongly controlled by live fuel moisture and onset of monsoon.

2. Resistance to Control – low to moderate depending on live fuel moistures. Aerial retardant more affective. Indirect control more affective. Less spotting.
3. Fire fighter safety – moderate to high risk of falling snags on the fire line as they burn at the base. Indirect line may be much safer.

iii. Recovery (Snag Fall) stage – increase in heavy fuels (downfall), increase in small conifer trees, increase in aspen (at lower elevations).
1. ROS – very slow. Primary carrier of fire is heavy fuels (logs)
2. Resistance to Control – very high due to high fuel loads. Aerial retardant not affective. Lots of manual labor and chainsaw work. Indirect control is best option. (We are already seeing this type of fire behavior in lower elevations, mixed conifer stands and this has also been observed in areas originally burned in the Missionary Ridge Fire of 2002)
3. Fire Fighter Safety – high risk of falling snags both on the fire line and on indirect fire line.

D. Impacts to Water Quality (per Ivan Geroy and Kelly Palmer, Hydrologists, SJNF)
a. Fires in SF have greater potential for more severe impacts to watersheds
b. Impacts depend on fire severity and consumption of surface litter
c. Historic Fire Regime + steep slopes + highly erodible soil = higher risk of impacts to water quality.
d. Following the Missionary Ridge Fire (2002) there were large debris flows that affected runoff and water quality.

E. Summary
a. At the stand level, SF forests are within the HFR. At the landscape level there is slight departure.
b. There is still much we don't know about the impacts of the beetle outbreak but we expect to see more wildland fire in the SF zone post-epidemic (more fuel, more sun exposure, more wind exposure).
c. Climate change is the big wild card. We are already seeing the effects of shorter winters, earlier snow melt on spring and early summer fires at higher elevations. Monsoon season is a big unknown.
d. More fires will be managed with an indirect control strategy for fire fighter safety, resource benefit and cost effectiveness. Decisions will be made based on risk – fire fighter safety and cost versus values at risk.
e. Communities in Southwest Colorado are more likely to be impacted by smoke.