A burning paradox: whitebark is easy to kill but also dependent on fire

Bob Keane, USFS Rocky Mountain Research Station, Missoula Fire Sciences Laboratory
Andrew Bower, USFS Olympic National Forest, Area Geneticist and PNW Region WBP Restoration Program Lead
Sharon Hood, USFS Rocky Mountain Research Station, Missoula Fire Sciences Laboratory

Many research studies and syntheses have suggested that prescribed fire (Rx fire) and wildland fire use fires (WFU) are perhaps the most effective tool for restoring whitebark pine ecosystems (Murray et al. 1995, Keane et al. 2012, Perkins 2015, Keane 2018). Rx and WFU fires can kill competing conifers; reduce surface and canopy fuels; and create attractive sites for nutcracker caching. They best mimic historical fire regimes, much better than mechanical thinnings and cuttings (Keane and Parsons 2010). However, the primary assumption of their application as a restoration tool is that the Rx and WFU fires are not so hot that they kill mature, cone-bearing whitebark pine. A little mortality is acceptable (>10%) due to the uncertainty with applying fire, especially in the understory where some whitebark pine saplings may be the same age as the overstory (Keane and Parsons 2010). But Rx and WFU fires that kill over 20-30% of healthy, mature whitebark pine in the overstory are undesirable or ineffective at successful restoration. This is especially true in areas with heavy blister rust mortality and there are limited seed sources for nutcracker dispersal.


Figure 1

Lately, there have been multiple reports of Rx fires killing healthy whitebark pine trees. A contingent of people from USFS R6 recently toured a stand of ~70 year old, pole-sized trees in southern Oregon that had been part of a burnout during management of a wildland fire that killed nearly all whitebark pine trees in the stand (Figure 1). Before the fire, the site had been mechanically thinned, leaving all whitebark pine and a few lodgepole pine individuals (Figure 2). Trees were pole-sized (6-12" DBH) and widely scattered on the site and it was assumed that they would withstand a low intensity backfire. The bark on most of the trees were relatively un-charred, yet all trees where fire burned completely around the tree were killed (Figure 3). The only trees that survived had some unburned grass and duff around the tree (Figure 4). It is unclear whether it was damage to the roots or to the cambium at the root collar that caused mortality, but it was very clear that


Figure 2

trees of this size and age class were unable to withstand even a low-intensity fire.

In fact, the Keane and Parsons (2010) restoration study found that there was well over 40% whitebark pine mortality on their Rx burns. This mortality was sometimes equal to the subalpine fir fire-caused mortality. One of their research sites burned in one of the Bitterroot fires of 2000 and fire-caused mortality in mature whitebark pine was over 80%. However, another sites burned in an Rx burn which caused less than 5% whitebark pine mortality.

Many silviculturalists and managers have also expressed other concerns about implementing Rx burns in areas that have been mechanically thinned or treated. Rightly, they ask the questions – why should I take the chance of losing valuable whitebark pine to Rx fire when these stands have just been treated, usually at great expense, specifically to prevent their loss? Won't Rx fire make them more susceptible to beetle and rust attack? Will the benefits outweigh the negatives for Rx fires?

What is going on? Obviously, fire scars on living whitebark pine trees attest to the species' ability to survive fires, but why are we seeing such high mortality in recent burns? Rx and WFU can still be important tools for whitebark restoration, but to be successful, we will have to put individual whitebark pine trees in the context of the forest environment. There are several things to consider with burning in whitebark pine forests. First and most important, the capacity of whitebark pine to survive a fire has been vastly overestimated. Hood et al. (2007) found that previous mortality equations for whitebark pine overestimated post-fire mortality, but these equations were limited because they only accounted for crown scorch. Hood and Lutes (2017) updated the mortality equations in the FOFEM model, and the new whitebark model showed outstanding accuracy in an updated evaluation (Cansler et al. In Review). Recently, Stevens et al. (2020) rated whitebark pine 27th of 29 western US species in fire resistance based on fire-adapted traits. While whitebark pine has a sparse crown and deep roots, it has thin bark making it especially susceptible to damage from even a low-intensity surface fire. Even with just light charring, there is a 60% percent chance that the cambium is dead, and the chance goes to almost 100% with moderate char (Hood et al. 2008).

The key to whitebark pine surviving fire is to not burn around the entire circumference of the bole. A blackened bole, even if it's just a thin sliver at the base, virtually guarantees the tree will die because the connections between the crown and roots are severed. Next, some sites may have too much fuel to support a successful Rx or WFU burn. Heavy loadings of litter, fine woody, and shrub fuels may foster fires that are too intense for mature whitebark pine to survive and even low-intensity fires may be too hot for younger whitebark pine to survive. Some sites may also have steep slopes and south aspects that often promote higher fire intensities. Whitebark can survive crown scorch levels less than 25% but again, only if the bole is not charred all around the circumference (Cansler et al. In Review). It also may be that the mature whitebark pine trees stressed by blister rust, competition, and climate change, have a lower capacity of surviving any fire. And last, perhaps there is a great genetic diversity in fire-adapted traits for the species across its range?

What's a practitioner to do? There is no doubt that Rx and WFU fires can be

Figure 3

Figure 4

beneficial under the right circumstances. These fires perform many desirable tasks that are impractical with mechanical treatments, such as killing the carpet of subalpine fir seedlings and other competing trees, consuming fuels to

PARADOX continued on page 34

PARADOX continued from page 8

reduce intensities of future wildfires, recycling nutrients and minerals, and creating good caching sites for whitebark regeneration. But, the huge questions on everyone's lips is, of course, when is Rx or WFU appropriate?

We'll take a stab at possible conditions under which to burn:

1. Reduce fuels. Treat canopy and surface fuels to reduce the amount and subsequent fire intensities.

2. Protect mature trees. Pay special attention to fuels around the bases of trees that must survive. Light raking to remove the litter and duff from around trees can protect tree boles from charring and widen the prescription window for burning.

3. Burn under higher moisture prescriptions. It may be that burning under higher wind and higher fuel moistures will ensure higher survival and encourage patchy burns.

4. Apply fire sparingly. Unburned patches are good! If the majority of the forest floor is black, you've probably burned too much of the unit.

5. Use thinner strips. When lighting under strip headfire ignition patterns, try to use smaller distances between each strip and don't light continuous strips. If using aerial ignition techniques, use a lower intensity than in other forest types to achieve a patchy burn, especially under hot, dry, windy conditions.

Clearly, more research is needed here, but also there needs to be more Rx burning experience in these high elevation environments to fine-tune our burn techniques to minimize mortality in the valuable whitebark pine. The take-home message is that fire is still an important tool in the toolbox to restore whitebark pine forests. BUT, it's essential to make sure fires are patchy and do not burn all the way around the bases of the most important whitebark pines to retain.

References

Cansler, C. A., S. Hood, P. J. Van Mantgem, and J. M. Varner III. In Review. A large database supports the use of simple models of post-fire tree mortality in the continental United States. Fire Ecology.

Hood, S., and D. Lutes. 2017. Predicting Post-Fire Tree Mortality for 12 Western US Conifers Using the First Order Fire Effects Model (FOFEM). Fire Ecology 13:66-84.

Hood, S. M., D. R. Cluck, S. L. Smith, and K. C. Ryan. 2008. Using bark char codes to predict post-fire cambium mortality. Fire Ecology 4:57-73.

Hood, S. M., C. W. McHugh, K. C. Ryan, E. Reinhardt, and S. L. Smith. 2007. Evaluation of a post-fire tree mortality model for western USA conifers. International Journal of Wildland Fire 16:679-689.

Keane, R. E. 2018. Managing Wildfire for Whitebark Pine Ecosystem Restoration in western North America. Forests 9:648.

Keane, R. E., and R. A. Parsons. 2010. A management guide to ecosystem restoration treatments: Whitebark pine forests of the Northern Rocky Mountains. General Technical Report RMRS-GTR-232, USDA Forest Service Rocky Mountain Research Station, Fort Collins, CO.

Keane, R. E., D. F. Tomback, C. A. Aubry, A. D. Bower, E. M. Campbell, C. L. Cripps, M. B. Jenkins, M. F. Mahalovich, M. Manning, S. T. McKinney, M. P. Murray, D. L. Perkins, D. P. Reinhart, C. Ryan, A. W. Schoettle, and C. M. Smith. 2012. A range-wide restoration strategy for whitebark pine forests. General Techical Report RMRS-GTR-279, USDA Forest Service Rocky Mountain Research Station, Fort Collins, Colorado.

Murray, M. P., S. C. Bunting, and P. Morgan. 1995. Subalpine ecosystems: The roles of whitebark pine and fire. Pages 295-299 in Fire Effects on Rare and Endangered Species and Habitats Conference, Coeur d'Alene, ID.

Perkins, J. L. 2015. Fire Enhances Whitebark Pine Seedling Establishment, Survival, and Growth. Fire Ecology 11:84-99.

Stevens, J. T., M. M. Kling, D. W. Schwilk, J. M. Varner, and J. M. Kane. 2020. Biogeography of fire regimes in western US conifer forests: A trait‐based approach. Global Ecology and Biogeography.