A 13 year case study of the impacts of the Fridely Fire across land ownerships and management responses in the Northern Rockies

By Dr. Peter Kolb, MSU Extension Forestry Specialist

The Fridely Fire southeast of Bozeman in 2001 started on private lands and then burned northward across 25,000 acres of Wilderness Study area and onto more private lands just south of Livingston. The majority of the burn was across lodgepole pine at mid to high elevation and Douglas-fir at the lower elevations.

September 2001 looking NW at the smoke plume from the Fridely fire as it burns across Forest Service and onto private ranch lands.

Flame front showing intensity of the Fridely fire as it burns through dense lodgepole pine

Ranch property on northern edge of fire several days after the fire essentially ran out of dense forest fuel conditions and died down allowing for suppression.   Red circle is the area of the picture below.

Surveying the damage with owners – massive fire whirl (or tornado) created by crownfire and topography uprooted and broke off trees on the right side ridge demonstrating the energy released by this fire.

Close up of fire whirl aftermath

Panning uphill from main fire whirl effect to show stand density that as it burned helped fuel the event.

Mature lodgepole pine forest that supported this fire. Note seed cones at tops of trees. Lodgepole pine is a stand replacing fire adapted species that can protect seeds with thick closed cones. Heat slowly opens the cones which can then release seeds. However, this only works with a fast moving high intensity wildfire that moves through the stand in 10-15 minutes on any individual site, burns off needles and kills trees and then moves into new fine crown fuels. Other than needles, dead twigs, and in cases pitchy bark, live trees woody tissue (branches and stems) do not burn and fuel the fire. A longer lasting intense wildfire that would result if heavy dead fuels (dead tree stems and branches) existed in the understory that burn for hours to days can kill cone protected seeds leaving a site without a viable seed source. This is one reason natural regeneration of lodgepole pine may be patchy on the landscape after a landscape fire event.

Deer tracks in ashes after fire fill with dropped lodgepole pine seeds as wind blows them over the ash surface. Any roughness in the otherwise smooth 1-2 inch ash layer will collect seeds. Smooth surfaces get scoured by wind, rain or snowmelt erosion and may not provide an adequate seedbed for surviving seeds.

Erosion and ash flow after a wildfire. Ashes absorb moisture and liquify during a heavy rain event. The underlying mineral soil stays cooler during a fire and may collect volatilized organic waxes that resists water penetration which creates a "hydrophobic" layer that can facilitate erosion of upper ashes and soils.

For comparison, an area in SE Montana ponderosa pine forest impacted by severe crownfire that had been thinned several years prior to fire which allowed understory vegetation to become dominant ground cover with roots in mineral soil. These conditions allow for root system survival and rapid spring recovery. Note thinning also prevented a crownfire from spreading though intense heat lethally scorched tree crowns.

Unthinned area upslope supported denser canopy and thus an active crownfire and poorer understory vegetation – which was predomianntly rooted in organic layers. These plants, already sparse because of competition from trees, did not have surviving root systems and thus there is no early spring recovery.

Without any barriers to stop liquifyed ash movement during rain events, severe erosion of ash, topsoil and surviving seeds can occur with snowmelt or rain after a wildfire.

Ash and topsoil deposit in homeowners backyard after a rainfall event the spring after this wildfire.


The larger and more severe a fire and the steeper the slope the greater the erosion and sediment deposit.

The problem is that not only is topsoil lost but all the nutrient rich ash and seeds that survived the fire and would help naturaly recolonize the site are washed down the slope and often deposited where they are not wanted.

Is harvesting fire killed timber immediately after a wildfire an option? What are the consequences?

Fire killed trees have useable wood as the wet living sapwood of a live tree does not burn and is a valuable timber resource for sawmills. For this ranch, almost 2000 acres of fire killed trees represents a subtancial investment, and potential future cost for this ranch if left to decay on the stem and fall over to obstruct cattle access and provide a future severe wildfire fuelbed.

13 years later on adjoining Forest Service lands the fire killed forest remains standing in a protected swale, and a new lodgepole pine forest emerges from seeds that survived the fire. Falling trees can make this a dangerous site to be hiking or recreating in should any wind start to occur.

Another part of the forest, fallen over trees show the eventual fate of all fire killed stands where blow-down can be stacked 4-6 feet high making movement through these areas difficult for humans and wildlife.

Downslope, trees remain standing in patches or have blown over by winds. On many steep slopes natural regeneration remains sparse, perhaps from post fire erosion of ash and seeds the following spring during snow melt. Historically fires have played a major role limiting the expansiveness of forests across landscapes.

A major difference observed across salvage logged sites versus untreated is that when salvage logging removes stems, stumps and root systems remain in the soil, adding to the organic matter pool and long term carbon sequestration. Unlogged lodgepole pine stems act as levers to the wind, pulling belowground root systems out of the soil as they fall. Logging may help add soil carbon by keeping root systems in the soil.

In contrast, the ranch decided to act quickly, salvage logging immediately the fall after the fire to capture most of the value of fire killed trees. Not all trees were harvested, and in places patches of fire killed trees were left for wildlife habitat. The above picture is from the spring following the wildfire and salvage harvesting– note the stumps and dead woody debris left in or on the soil from harvesting.

The same scene from a slightly further distance 13 years later shows good tree and rangeland recovery. Weeds, in this case thistle, frequently treated by the landowner remain a problem across all burned areas.

As can be seen on picture 3, page 2, patches of younger trees on the landscape did not burn in the fire although the fire front surrounded them. One can speculate that this occurred for multiple reasons including: 1) a typical young-mature lodgepole pine forest does not support much understory vegetation or woody debris, thus only supports a weak surface fire, 2) heat from the flaming crowns rises due to convection and does not make direct contact with the lower level canopy, 3) younger trees do not use as much water and may be less drought stressed than the mature forest thus the hydrated needles are not as combustible as the drought stressed mature tree needles. It is common across wildfire affected mid to high elevation forests across the northern Rockies to find that wildfires do not burn through 30-year old or younger regenerated clearcuts – often referred to as the "clearcut effect". The exact mechanisms of this phenomenon are not yet clearly understood. Note the outside layer of younger trees was killed from the radiation heat of the surrounding crownfire but the needles did not catch fire.

The same view as above 13 years later. Note regenerating forest in harvested area and dead fallen over smaller trees that were killed through heat scorch in previous picture.

100yds up the slope from the previous pictures the fire effects surrounding the small clear cut can be clearly seen immediately after the fire.

13 years later the same approximate view. A patch of trees above the small clearcut was left untouched during salvage logging for wildlife and to minimize disturbance on the thin soils of the ridgetop. Note sparse tree regeneration in this area and blown down tree stems with root mass attached.

View from downslope of the previous pictures the summer 2002. Stumps and logging debris remain from salvage harvest the previous fall. Sparse grass and forb cover in dense previous forest results in sparse recovery. Not seen are the numerous tree seedlings germinating in the shade of the down woody debris.

The same site only looking downslope from within the non-harvest patch in 2014. Note the dense regeneration of tree seedlings in the salvage harvested area versus the non-harvested area in the forefront.

The same area upslope in 2002 of previous pictures showing thick layer of branch breakage and woody debris left from logging on the soil surface. This material can have a very beneficial effect in preventing erosion the spring following a wildfire, though too much can prevent seeds from reaching mineral soils.

The same site 13 years later. In areas where woody debris was too thick, no soil was lost but the debris itself prevented good seed germination. In addition, excessive woody debris can cause decay fungi to rob the soil of available nitrogen needed to digest dead wood that is mineral nutrient poor, note that lupines (blue flowers and that are nitrogen fixing forbs) dominate this site as they have a competitive advantage.

More commonly found logging debris from salvage logging on the soil surface. It appears the ideal is between 20-50% surface coverage of woody debris that has good soil stabilization impacts but leaves 80-50% bare mineral soil for seed germination. Note lodgepole pine seedling (red circles) germination is best in the shade of logging debris. Summer soil surface temperatures on bare soil/ash layer can exceed 170˚F which is well past the lethal high temperature for living tree seedlings.

Although blowdown from fire killed trees may eventually offer some soil protection, most whole stems are suspended off the soil and only have approximately 10% of their surface touching the soil offering poor erosion protection. Heavy accumulations of suspended logs dry out quickly and can fuel a severe surface fire.

The previously examined small clearcut that survived the fire from another view in the summer of 2002. Note the residual standing trees left for wildlife, or because they were too small to harvest for any market.

The same site in 2014. Previous pictures taken of soil surface effects were taken along the upper right side of the patch of green trees. Variability in cone production, severity of the fire effects even on protective cones, subsequent erosion of seeds and soil, seed predation by birds and rodents and other causes created a mosaic of tree seedling regeneration. Areas salvage logged in general had greater tree seedling recovery.

For comparison, a non-salvage logged site in 2002 – note good grass recovery in the meadow portions of the site and poorer recovery under denser clumps of trees where needle accumulations supported a hot smoldering surface fire and poorer initial under-story vegetation.

13 years later most of the smaller fire-killed trees have fallen over. An initial sparse forest overstory allows for faster recovery of surface vegetation as there was not enough surface woody debris in this open forest structure to allow for soil “baking” and destruction of surface vegetation root systems. An additional benefit of a “thinner” forest – either natural or managed is faster surface vegetation recovery.

Ranch landscape immediately after the fire in the fall of 2001. Half was harvested, half was not.

Same ranch landscape in 2014, can you see the difference where salvage occurred versus where it did not? Note mass wasting of mountainside on upper left. Loss of forest cover allows for rapid snowmelt, super saturated soils and subsequent slope instability. Numerous areas in this area saw landslides and slumping of soils on steeper hillsides.

2014 ranch landscape. Rancher used funds from salvage harvest to pay for hay for last grazing ground the first year, grass seeding and weed control. Deferring grazing the first year after the fire allowed grasses to establish robust root systems and competitive cover against noxious weeds. Subsequent weed spraying has led to a fully recovered and productive ecosystem. Note left side of picture above trees the mass wasting that occurred after the fire because of water saturated soils. Rapid revegetation is essential to help stabilize soils and appeared to have been facilitated by harvesting immediately after the fire. Waiting one or two years to salvage would not have helped stabilize soils or recruit desired vegetation and would only have added another disturbance to an impacted recovering ecosystem.

The site of utter devastation for this ranch family was turned into a site of rapid recovery through income derived from hard work by the landowners, salvaging timber value, reinvestment into the property and rapid DNRC and NRCS postfire assistance. Active management has returned this land into viable grazing ground, a recovering forest and the return of wildlife including elk, wolves and grizzly bears. Ranchers are smiling because they had developed an informed action plan that may provide them with a future – they had actually considered selling the ranch immediately after the fire as they felt they had lost their livelihood.

The same site as the picture above 13 years later. Perhaps salvage logging was too successful as too much natural pine seedling recruitment is suppressing grasses and now would benefit from thinning.

Parting shots:

Shade is hard to find on a burned landscape for both recovering seedlings and wildlife. Excess logging debris piles benefit this mule deer much as shade from the right amount of down woody debris benefits recovering vegetation. Rodents and small carnivores also use such piles for shelter and denning.

Logging skid trails, where salvaged logs were hauled out by logging equipment pretty much killed tree seeds that had landed there. The long term impacts of skid trails may actually be beneficial as they now support diverse vegetation including nitrogen fixing lupines. Wildlife, cows and ranch managers use these trails to access the property for grazing and water access, weed control and future wildfire mitigation.

Lessons learned are that helping maintain a diverse landscape of forest structures and species helps create a more resilient landscape. Although initially very conservative about harvesting live trees, this ranch family wishes in retrospect they had harvested more across the landscape prior to the fire that would have left a greater diversity of tree age classes and species resulting in greater tree survival across the landcape.

The same view 13 years later. The only place any Douglas-fir and spruce trees survived was in the previously harvested patches where they now act as a genetic refuge and seed source. Only lodgepole pine is regenerating in the stand replacement burn areas which will result in a simplified landscape, less biodiversity and less resilience of this ecosystem to future impacts such as insect outbreaks, drought and another fire.

Salvage logging is not the “catch-all” solution for every site, but should be considered a viable alternative where the property owners values require the land to produce an income and raw materials for a progressive economy. If done correctly the ecological values at the very least will not be impacted and in many cases actually improved.

The blowdown of timber after a wildfire also provides a unique habitat for a variety of wildlife species, including den sites for Lynx. However, how much of this is needed and its distribution on a landscape that offers a benefit to wildlife versus a future fire hazard and travel barrier requires more study and thought.

The role of dead trees for wood peckers, cavity nesting birds, bark gleaners and a host of other species that utilize dead trees varies tremendously by species. In the case of this study, lodgepole pine provided very poor habitat for cavity nesters and wood peckers because it does not support many wood boring insects or woody decay fungi (right picture) as it has very thin sapwood that is the primary food source for most insects. Alternatively, Douglas-fir has bark and wood qualities that offer excellent habitat for wood boring insects and the birds that prey on them. In addition, the relatively thick carbohydrate rich sapwood also hosts many decay fungi that soften this layer making it possible for a host of animals to excavate hiding and nesting sites (left picture). Although extreme wildfire events can create a lot of dead trees, not all of them are utilized by wildlife, and can remove tree species with high value to wildlife such as Douglas-fir from landscapes. The only living or regenerating Douglas-fir found on this 2000+ acre portion of the Fridely fire were found in the harvesting units that through previous management had not offered a fuel condition that easily burned. This implies that in the next 100+ years, the tree species Douglas-fir and the values it brings to a forest has been removed from this landscape. Good evidence shows that we are in a warming trend across the northern Rockies that will support larger and more frequent extreme wildfire events. Well thought-out management actions can help moderate such events by helping maintain or create more diverse forest landscapes through "human assisted adaptation", which may become essential for maintaining these valuable forests in a rapidly changing and different future climate.

Peter Kolb (PhD)
MSU Extension Forestry Specialist
Associate Professor Ecology and Management
32 Campus Drive, Missoula, MT 59812
(406) 243-4705 peter.kolb@cfc.umt.edu