Chapter 12: Reforestation of Areas Burned by Large Wildfires

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Introduction

California's forests with a Mediterranean climate have a long history of frequent fires (J. D. Miller & Safford, 2017), and the frequency and severity of fires across the West are increasing (Dennison, Brewer, Arnold, & Moritz, 2014; Stephens et al., 2018). The frequency of these fires have increased across all land ownerships, most dramatically on federal forest lands (Starrs, Butsic, Stephens, & Stewart, 2018). Fires that exceed 10,000 acres are becoming more common in the west and in particular in the forested portion of California (Stevens, Collins, Miller, North, & Stephens, 2017). Very poor natural regeneration after fires is common as a recent survey of fires on 10 National Forests in California found that 43% of all plots within fire perimeters had no conifer regeneration (Welch, Safford, & Young, 2016). These mega-fires are the result of more than a century of fire suppression, subsequent overstocked forests, drought, insect damage and a warming climate. Salvage logging after wildfire is a common practice on many managed forest areas and the effects are often closely related to site-specific characteristics (Leverkus et al., 2018; McIver & Starr, 2000). For forest land owners that precede with salvage logging to recoup value and initiate successful reforestation, there are significant challenges to ensure low post fire soil erosion, successful conifer reforestation, and the maintenance of other desired habitat and environmental outcomes. Fires of this magnitude pose unique challenges for those responsible for the subsequent timber salvage and reforestation operations. Those challenges include timely landscape level planning with complex decisions on logistics; and potentially limited labor resources and/or budget. This chapter will focus on the planning and practices that will help make these projects a success with a little less stress.

Planning

Planning the reforestation of a large wildfire requires a cooperative effort with those that are planning and executing the timber salvage operation as timing and location of reforestation activities are heavily dependent on salvage strategies. If the post-fire salvage requires multiple years or is more than several thousand acres, the reforestation effort will need to be broken up into multiple years. Using a fire that burned 12,000 acres in August of 2017 as an example, and on which salvage operations begin immediately, the beginning of the planting effort would likely be planned for fall of 2018 or spring of 2019. This would allow enough acreage to have salvaged completed and subsequent site preparation treatments in place. It is reasonable to split the effort into equal pieces, the size of which would reflect landowner objectives and capabilities. A common tactic for this is to split the burn area into three project areas of 4,000 acres each. This requires the planting of approximately one million trees per year and corresponding vegetation management treatment activities to ensure establishment of the seedlings. This seems to be a common threshold above which operational restrictions and logistics become increasingly more difficult.

The number of acres chosen as a yearly reforestation goal is up to the reforestation team and its capacity to carry out the necessary steps to properly establish the new forest. Some factors that limit the ability to successfully accomplish planting large acreages are lack of a suitable seed source, budget constraints and limited personnel. It is important to make reasonable goals based on the reforestation team's capacity and salvage schedule. Once a reforestation schedule is determined and seeds are sown in the nursery, the project planting area must be prepared the following spring. Vegetation management activities should be closely coordinated to ensure sites planned for planting are completed first. Planning the vegetation management activities should center around, but not be limited to, the area to be planted first.

Unitizing

Immediately after these large fires are controlled or even during suppression activities, foresters will begin making plans for the salvage of the damaged timber. Once the overall planning is completed regarding the integration of fire salvage and what can be a multi-year reforestation effort, the next step will be to break the wildfire area into logical harvest units and mapped... These operational salvage units will concentrate on the logging method most appropriate to the varying terrain and slopes present, as well as the available access. However, while the urgency of beginning the salvage of the fire damaged trees will drive early planning efforts, this is also the time for the reforestation team to become involved. Using the harvest units as a start, the entire fire area can be broken down into ultimate reforestation units as well. This complete unitization of the burn area will be critical to the systematic and orderly restoration effort of the complex project.

Multiple strategies can be utilized, but all depend on common principles. Units should be delineated into a size that is easily manageable, generally less than 100 acres, and that contain similar soils, slope, and timber type. Boundaries with features such as roads, streams or ridgelines can be used to define the unit. Timber salvage methods can further aid in determining unit boundaries as harvest methods should generally not be combined in a single reforestation unit, i.e. helicopter yarding and tractor yarding in one unit. A single logging method will result in common post-harvest conditions that will more easily yield common reforestation techniques.

Post-fire satellite imagery products can help with the unitization process as fire intensity can be variable in all fires, but especially in large ones. Rapid Assessment of Vegetation Condition after wildfire (RAVG) products produced for fires that burn some federal land provide information that can assist post-fire vegetative management planning, and are generated by a change detection process using two satellite images captured before and after a wildfire (J. D. Miller, H. D. Safford, M. Crimmins, A. E. Thode, 2009; J. D. Miller & Quayle, 2015; J. D. Miller & Thode, 2007). The method is sensitive to vegetation mortality from the wildfire event and produces maps with estimates of basal area loss. In wildfires involving thousands of acres, aerial imagery is invaluable to identify unburned islands, non-timbered areas and other features not readily map-able using ground-based observation. Variability in fire severity that leads to different salvage intensity can be identified and delineated for follow-up reforestation as planning intensities may vary In addition, unstable areas or areas with high potential for erosion should be identified in this process because they may need different vegetation management strategies than more stable geological areas. A unique identifier should be assigned to the unit that can serve as a constant ID for the reforestation effort and beyond.   Once the unitization process is complete the planning phase of the operation can begin.

Planning the progression of the planting project depends on the progression of the timber salvage operations and subsequent site preparation activities. Units in which the timber salvage has been completed would be the best candidates in which to start the project because the ground disturbing harvest activities following salvage serve to scarify the soil, preparing the soil for planting and often increasing drainage potential. Slash left on the ground after harvesting such as limbs, tree tops and sub-merchantable trees will further serve to stabilize the soil. Where soils are hydrophobic and there is a high likelihood of erosion, areas that were predominantly brush, small trees or young plantations and that don't have merchantable timber should be delayed to allow some re-vegetation. These areas should also be considered for mechanical tilling or sub-soiling since there will be no harvest activities to help mitigate such hydrophobic (e.g. increased water repellency, decreased infiltration, and increased surface runoff) conditions. Prioritizing the planting progression also depends on the plan for mechanical site preparation activities within the burned area and the ability to apply pre-plant herbicides. If landing piles are to be disposed of by a chipping operation or by burning, it is important to have those activities completed prior to planting to avoid damage to the seedlings around the landings.

Large projects will require additional labor sources. It is a good idea to become familiar with the larger forest labor contractors that have the expertise and personnel to tackle the large numbers of trees to be planted and the potentially large acreages that will need to be hand sprayed. It is also important to include helicopter contractors in this phase of the reforestation effort so they can plan ahead for the additional work load.

Sourcing Seed

Seed sources could be limited for landowners faced with large reforestation projects. Outside of seed already owned and stored by the landowner, the best starting point for private landowners to find suitable seed is to consult the Cal Fire forester in the area nearest the burn. The L.A. Moran Reforestation Center in Davis, California maintains the State Seed bank that would be available to the public in time of need. The potential to get seed would be limited by the inventory of the seed in the bank that is appropriate to plant in the zone, elevation and species of the reforestation project. Another possibility for seed is to consult the larger landowners in the area of the burn. Most large timberland owners maintain seed banks to cover their reforestation needs following fire and they may have surplus quantities to sell. Private seed companies such as Silva Seed or Pacific Forest Seed may have a store of seed for sale and in some cases some may have seedlings grown for your area. Federal land managers maintain a seed bank in Placerville, California that may be available in times of need. The reforestation professional should resist the temptation to use readily available, but inappropriate seed and should adhere to existing standards of acceptable seed zone and elevation for the local burn area. If no seed appears to be immediately available, or to prepare for the future, trees within the burned area that are damaged, but survive the burn will frequently have a “stress crop” of cones that would yield seed for reforestation projects. In many cases the stress crops will not produce adequate quantities of viable seed for the total reforestation needs. It is therefore very important to verify that the developing cone crop contains enough viable seed of sufficient quality to make a collection worthwhile. Additionally, reconnaissance of unburned forest stands in the vicinity may yield seed collection opportunities. There are contractors available that specialize in the collection of conifer cones. Consult with the Area State Forester, Cooperative Extension Forester or a local Registered Professional Forester for information about climbing contractors for cone collection. Another consideration for alternate seed sources is to choose seed that is available from similar ecotypes from adjacent seed zone within breeding zones.

Mechanical Site Preparation

If mechanical site prep is an option for the burned area, it is important to make those arrangements well in advance of the planned reforestation project. This is true, not only to ensure contractor availability, but also to take advantage of any opportunity to increase infiltration rates and disturb the potential post-fire hydrophobic soil conditions. This is considered especially important in the first year following the fire and prior to the first heavy rains. Hydrophobic soils are very common in burned areas and particularly where the fire intensity was extreme. Coarse textured soils are particularly prone to the development of a hydrophobic layer.

Piling or windrowing residual slash for subsequent burning has been used in the past to reduce fuel loading and to facilitate planting. The potential fire risk to the plantation from remaining fuels after the fire salvage needs to be carefully balanced with the benefit of having the slash on the ground to mitigate soil erosion. This is particularly true since recent experience has demonstrated that seedlings can be successfully planted through such slash loads without significant survival or growth issues. Other mechanical site preparation methods such as sub-soiling, ripping or tilling can have many beneficial effects in the establishment of new forests after fire. The use of sub-soiling was initially promoted as a mitigation measure for compacted soils in forest regeneration projects, but another positive effect is that it increases the area available for planting by exposing bare soil that may have been obscured by logging debris. It also serves to break down slash by crushing it and incorporating some of it into the soil. Slash that is in contact with the soil breaks down significantly more rapidly through microbial activity than debris that is not in contact with the soil. Starting the slash decomposition process is important not only to hasten the nutritional recycling process, but also because slash remains a source of increased fire hazard until it decomposes. Well planned and executed contour sub-soiling has been demonstrated to be an option in mitigating hydrophobic conditions on some sites in California by increasing the infiltration rate prior to the onset of winter rains and breaking up potential channels that could lead to excessive runoff caused erosion (James & Krumland, 2018). Sub-soiling can also improve the efficacy of soil active herbicides that require application to bare ground. For example, Hexazinone and Oxyflourfen are generally more effective when bare soil is exposed since they are susceptible to being tied up in organic material if high levels of slash obscure the soil layer and reduce the application effectiveness to the target soils.

Vegetation Management

Chapter 8 of this manual addresses the principles of vegetation management in detail. For this chapter we will discuss some of the unique challenges that are associated with vegetation management in the reforestation of areas that have burned.

The regeneration forester/Pest Control Advisor needs to anticipate the rapid vegetation succession that will occur. Burned areas can re-vegetate very rapidly as fire both scarifies serotinous weed species seeds and releases a flush of nitrogen that can be utilized by new plant growth. Taking advantage of a largely intact root system, some brush species and most hardwood tree species will re-sprout in the first year after the fire and grow rapidly. The following spring will see the initial flush of herbaceous weed species as well as the germination of brush seedlings. These two separate components of competing vegetation may have to be treated in different ways and at different times to be successful. The re-sprouting brush and hardwood plants may not have enough leaf area re-established for successful treatment with foliar active herbicides until after a full growing season has passed. Going back to the example of the 2017 August burn, the earliest the brush and hardwoods would be ready for a foliar treatment would be after the full growing season in 2018. In some instances and if using a helicopter application method, it may take even more time to allow the leaf area to grow to treatable levels with foliar active herbicides such as Imazapyr and Glyphosate. On the other hand, in the case of an early season fire the brush species and re-sprouting hardwoods may develop enough leaf area to successfully treat in the same season as the burn. In general, brush and hardwood species that are easily controlled with foliar applied herbicides should be treated as soon after the burn as possible as directed treatments on early stage small re-sprouts require less herbicide volume and are less expensive than treating larger sprouts. Hand-directed treatments may be preferable in this situation because helicopter applications may not provide adequate foliar coverage to control the small sprouts.

Brush and herbaceous competition can be treated in the first growing season after the burn with either soil active herbicides or with hand-directed spray applications. Some soil active herbicides such as hexazinone will control re-sprouting brush and hardwoods to some extent, but generally don't provide enough control to be a one-time treatment option, especially where there is a big component of hardwoods and re-sprouts. In most cases there will be the need for some conifer release spray applications by year 3 after planting. Effective control with the site prep sprays will help minimize the need for follow-up applications. In remote areas there may not be adequate road access to allow ground based herbicide applications. In these areas the only options are to aerially apply herbicides or to use manual weed control.

Seedling Delivery from the Nursery to the Roadside

The sheer number of seedlings needed for the reforestation of a large wildfire presents many challenges for the reforestation team. One of the challenges is transportation of the large number of seedlings from the nurseries to local cold storage facilities and from the storage facility to the planting sites. Reducing the total number of seedling pallets that need to be transported and stored will improve efficiency This can be achieved by a) reducing the number of trees per acre (TPA) that are planted, or b)by using the smallest suitable seedling size, or c)by utilizing both strategies. Reducing the trees per acre will have a dramatic effect on the total number of trees planted. For example, a 3,000 acre burn planted at 12 feet x 12 feet spacing (302 trees per acre) will require 906,000 total trees. That same area planted at 18'x18' spacing (134 TPA) would only require 402,000 trees. In addition, to reducing the number of pallets that would need to be transported and stored, this strategy, where appropriate, would also significantly reduce many other complications and costs encountered in large acreage reforestation projects, including the amount of seed needed, nursery growing space, and the number of planting crews used during a short planting season window. Planting fewer trees per acre may also reduce the need for pre-commercial thinning in the following decade (7 to 10 years after planting) thereby moderating scope and cost of pre-commercial thinning and resulting slash loading across thousands of acres. However, it may not be advisable to plant on very wide spacing with more difficult to establish species or harsh sites as stocking levels will be quite low if there is much mortality.

Because reforestation with Ponderosa Pine (PP) and Jeffrey Pine (JP) typically results in very high survival rates when all of the proper reforestation steps are followed, a good option to consider is wider planting spacing of 134 TPA (18 feet by 18 feet spacing) if the ultimate desired forest spacing is near 100 TPA and the area is to be planted back to PP or JP. In areas where the dominant species is Douglas-fir and/or true fir, relatively higher planting densities are usually necessary to achieve the desired stocking densities for those species. Some recent efforts on USFS land where lower tree densities are desired (often based on land allocation) employ a "cluster" or diamond planting scheme on wide spacing in which multiple trees were planted at each planting site. For example, planting 3 seedlings close together in a group with 27 foot spacing between groups would require planting only about 180 trees per acre. If the goal is to have at least one tree remaining in each group, the stand will soon have spacing more similar to the historical spacing of a mature forest. This approach addresses the possibility of mortality at each planting site and allows multiple species to be planted at each site. It also could serve to reduce the cost of manual release in rehabilitating burned sites projects where herbicide use is restricted as the number of manual release circles per acre is reduced.

Using the smallest suitable size of seedlings can reduce the number of pallets needed for transport and storage. Small containerized seedlings or 1-0 bare root are packed at higher numbers per package and require less space in storage than similar numbers of larger seedlings. Cell sizes should be at least styro-4 for PP and JP, and no smaller than styro-6 for Douglas-fir, red fir (RF), white fir (WF), incense cedar (IC), and sugar pine (SP). The following table shows how many trees per load that a 53 foot refrigerated semi-trailer can haul and the influence of stock type on that number for a very commonly used nursery in California.

Table 12.1 Tree seedlings per transportation units (box, pallet, semitruck)

Cell Size	Trees/Box	Boxes/Pallet	Trees/Pallet	Pallets/Semi	Trees/Semi
St-4	400	18	7200	48	345,600
St-5	320	18	5760	48	276,400
St-6	270	18	4860	48	233,280
St-8	240	18	4320	48	207,360

Refrigerated Vans

If there is not room or facilities to store seedlings at the nursery for a project, refrigerated vans can be used to transport seedlings from the nursery to a commercial size cold storage facility designed and equipped to properly store seedlings and easily handle pallets of seedling boxes.

Refrigerated vans can also be used to store seedlings for short periods of time in order to supply the daily production needs of one or more planting crews because the nursery or other cold storage facility is not within a reasonable distance of the project area. Using the smallest stock type that is appropriate to plant might reduce the number of refrigerated vans that would need to be rented and maintained for the duration of the planting operations. Refrigerated vans used for cold storage must be monitored daily to make sure the refrigeration unit is operating properly and inspected to check van temperature, oil and fuel levels (if the refrigeration unit is fuel powered and not electricity), fan(s) and refrigerator coils, and other critical components. Also, it is prudent to line up and have on call a mechanic experienced with repairing these particular mobile refrigeration. Daily monitoring of the refrigerated vans and ready access to an experienced repair person is critical so that if (or more likely, when) a unit malfunctions it can be repaired within 24 hours. On large projects where refrigerated vans are used for temporary cold storage to supply daily planting needs, it is critical for the forester overseeing the project to plan and coordinate well with the nursery and monitor the production and progress of each planting crew supervisor on a daily basis. This is necessary so that each crew will have a ready supply of the specific seedling stock types, seed lots and species that will be planted each day.

On a 14,000 acre burned area planting project a private forest manager planted 4,000 to 6,000 acres per year over a three year period, using an average of four 12 to 14 person planting crews and renting 3 refrigerated vans. One tractor/trailer driver was hired to rotate the vans loaded with seedlings from the nursery to a secure location within a relatively short distance of the project area. Two vans were loaded at the nursery with the specific seedling lots that would be needed for the first week of planting and transported to a central, temporary storage location prior to the start of the planting project. Every morning each of the four crews loaded the number and lots of seedlings from the van used for each day's planting. The reforestation project manager coordinated with the nursery manager, tractor/trailer driver and planting inspectors assigned to each crew so that the third van was scheduled for loading and delivery of seedlings from the nursery to the temporary storage location and an empty van could be picked up by the tractor driver. This coordination and scheduling was done to rotate vans such that each planting crew could readily load a sufficient number of seedlings each day for each species, seed lot and stock type that were scheduled for planting into each particular area. By daily communication with the planting inspector for each crew, the project manager could instruct the nursery to load the vans in a specific order with specific pallets of seedling lots at specific locations within the van. This allowed for seedling boxes to be unloaded just once on the morning of planting and not unloaded and reloaded with the crews having to rummage around in the vans looking for the specific seedling lots (species/stock type/elevation) scheduled for planting each day. When ordering, the project manager would instruct the nursery to load the seedlings that were to be planted last to be loaded first towards the front of the van so that seedlings scheduled to be planted first would be at the back of the van closer to the doors. It is advisable to map pallet locations by seed lot and species within the van when ordering and/or loading to facilitate and improve seedling handling efficiency.

Freezing Seedlings

Freezing conifer seedlings for long term storage is a good way to arrest mold development and is the preferred way to store seedlings longer than three months. When freezer storage is used, it is important to have an area to thaw the seedlings prior to the anticipated planting date. If the storage facility is located in an area where the ambient temperatures are very low, thawing may be impossible. In that case, it would be advisable to place the reefer van at a lower, warmer elevation to facilitate the thawing process. Thawing time can vary widely and is dependent on the packaging, stock type, moisture content of the containerized seedling, air flow around the containers and the ambient temperature. Opinions and experience vary about the best way to thaw seedlings for optimal survival. Several researchers report that while the stock is either being frozen or thawed the air temperature should not be more than 3.6 degrees above or below freezing. This would be considered a slow thaw and could take up to a month or longer for the seedlings to be ready for out plant. Many other practitioners report that a quick thaw at an ambient temperature of 50-65^{o} F degrees provides satisfactory results and is much more predictable with thaw duration lasting a week or less. Boxes on pallets should be separated slightly to allow air flow around individual boxes to help thaw the boxes more evenly. Spacers can be placed between the boxes in the nursery during packing if the plan is to freeze the seedlings at the time of packing. This also facilitates a more rapid freeze. Thawed trees should be planted as soon after thawing as possible.

Seedling Delivery from the Roadside to the Field and Planting

In burns that have limited access, the reforestation team may be faced with getting seedlings to planting crews far away from roads. Using wide spacing and small nursery stock will help, but delivery of the seedlings to the planting site may require extra effort. In very steep terrain using a tree yarder may facilitate seedling delivery. The tree yarders can deliver boxes of seedlings to sites as far away as 2,000 yards by suspending them from cables, provided there are not many obstacles such as standing timber or rock outcroppings that cause deflection problems. Planting crews can then either bag up along the tree yarder's corridors or crew members can be employed as packers to deliver to more remote portions of the unit that are inaccessible to the yarder. In this type of terrain the combination of yarding and packers can extend the plantable area significantly.

In areas that are less remote, using ATV/UTV's is a good way to get seedlings to the planting crews when the roads are not passable by pickup due to wet weather or snow (Figure 12.1). ATV's can also access areas that are not roaded using skid trails and open ridgelines. Equipment that is in the area doing salvage operations could be used to open trails or make trails on ridgelines for such planting access. Working closely with the foresters that are managing the salvage operations will ensure the best possible access for planting.

Figure 12.1 UTV delivering seedlings to planting crew via skid trail.

Some extreme circumstances may be encountered where neither road access nor terrain allow any mechanical access. Delivery of the seedlings by helicopter can be evaluated, but it is a very expensive option. Another possibility is to arrange a big enough planting crew so that some personnel can be used to transport tree boxes long distances from the nearest road to the actual planting site (Figure 12.2). In the case where as many packers are needed as planters, it may double the cost of planting, but, given the absence of other options, is likely the best way to reforest this type of terrain. Utilizing some combination of these options can extend the plantable areas of a large wildfire significantly. In roadless areas that have burned making large planting efforts unfeasible, the USFS has started planting "founder stands" where a small portion of the high severity burn area will be planted as an island. The hope is to establish a seed source for future natural seeding where there is none.

Figure 12.2 Worker packing trees in the Moon Fire.

Managing Sediment Transport within Wildfire Units

Large wildfires often result in additional sediment discharge into waterways for a number of reasons. Stream flow should be expected to increase sharply after a high intensity fire as the vegetation that normally intercepts precipitation and protects the soil is gone resulting in more water flow into channels. Springs and wet areas may appear that were not evident pre-fire and generate sediment transport. Many, soils after a wildfire may exhibit hydrophobic characteristics that repel water and cause a higher level of surface water flow during the first heavy rains of the season after the burn. It is important to consider actions to reduce additional sediment transport associated with logging and reforestation activities.

Salvage logging operations can help break up the continuity of hydrophobic conditions through scarification hydrophobic conditions, similar to the effect mechanical site prep such as tilling. The increased infiltration rates associated with these activities can reduce the rate of sediment transport (James & Krumland, 2018). Logging will also commonly result in the deposition of a layer of slash that can help stabilize soil movement. Planning some of the land alterations along the contours can also prevent sediment delivery into streams. In regards to the application of herbicides, it is inadvisable to immediately broadcast herbicides to hydrophobic soils or soils that are undisturbed by salvage operations after a fire as offsite movement would be possible in the absence of effective infiltration. An alternative is to apply herbicides by hand at low rates per acre directly to the small, emerging foliage of re-sprouting brush species that are susceptible to the particular herbicide at that early stage of resprouting. Applying spray on a limited site specific basis will significantly reduce the chance of movement off-site.

Burns that have elevated erosion hazard areas should be evaluated for additional mitigation measures to address the possibility of erosion and sediment discharge. The Pest Control Advisor/Forester should evaluate the choice of herbicide to address the potential of creating bare ground in erodible soils. Use of foliar contact rather than soil active herbicides and species-specific, rather than broad spectrum herbicides will retain additional vegetative cover that can reduce potential sediment transfer. Another measure would be to allow the area to re-vegetate for a period of time to help stabilize the soil and minimize movement. It is critical that the dead vegetation resulting from this control method be left on site to effectively utilize this extra protection. Follow-up tilling may be beneficial, but subsequent mechanical equipment clearing to bare soil should be avoided. Leaving vegetated buffer strips along stream courses and areas that have slides or gullies is another method to help stabilize areas to prevent even greater erosion (Figure 12.3). It is important to recognize, that the presence of competing vegetation can impact tree seedling survival and future growth. Any intentional retention of competing vegetation or delay in treatment can significantly increase costs, threaten plantation success, and unintentionally result in an un-forested landscape unless the prescribed series of treatments have accounted for that action.

Figure 12.3 Unsprayed vegetative strip on edge of eroded feature.

If seedlings are growing in the nursery for other projects that can be delayed to another year but are suitable for the area burned in the fire, then another strategy is to utilize them immediately in areas planned as buffers to herbicide use. This allows for planting these newly designated stream buffer units in the fall or spring immediately after the fire when competing vegetation has not yet established roots, and it can facilitate first year conifer seedling survival. Treating the competing vegetation might then just require a directed foliar spray within four or five feet of widely spaced conifer seedlings with an herbicide that is not mobile in soil. If done properly this could provide sufficient vegetative cover for the buffer zone while providing for successful reestablishment of a conifer over story.

Conclusion

When carefully analyzed, planned, executed and funded, the reforestation of large burns can successfully regenerate the fire-damaged landscape. When conducted in a timely manner and with a well co-ordinated series of treatments, it can help alleviate the long-term wildfire effects on the affected watershed, restore the previous forest more quickly than if left alone, and minimize the total costs and amount of herbicides necessary for that success.

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