Management Guide to Ecosystem Restoration Treatments:

Whitebark Pine Forests of the Northern Rocky Mountains, U.S.A.

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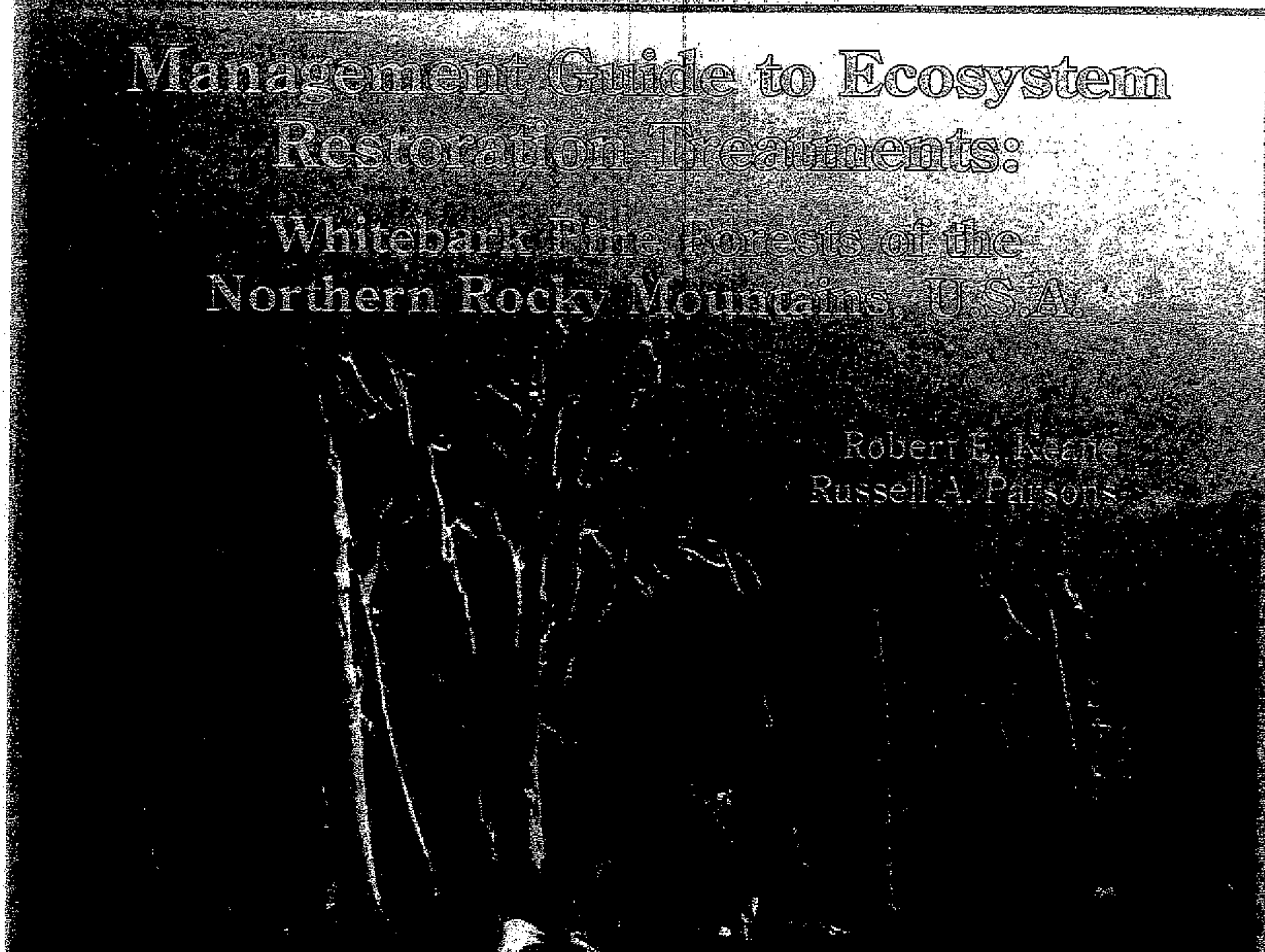

USDA
United States Department of Agriculture
Forest Service
Rocky Mountain Research Station
General Technical Report RMRS-GTR-232
January 2010

ECOSYSTEM TREATMENTS

Keane, Robert E.; Parsons, Russell A. 2010. **Management guide to ecosystem restoration treatments: Whitebark pine forests of the northern Rocky Mountains, U.S.A.** Gen. Tech. Rep. RMRS-GTR-232. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 133 p.

Abstract

Whitebark pine is declining across much of its range in North America because of the combined effects of mountain pine beetle epidemics, fire exclusion policies, and widespread exotic blister rust infections. This management guide summarizes the extensive data collected at whitebark pine treatment sites for three periods: (1) pre-treatment, (2) 1 year post-treatment, and (3) 5 years post-treatment (one site has a 10 year post-treatment measurement). Study results are organized here so that managers can identify possible effects of a treatment at their own site by matching it to the most similar treatment unit in this study, based on vegetation conditions, fire regime, and geographical area. This guide is based on the Restoring Whitebark Pine Ecosystems study, which was initiated in 1993 to investigate the effects of various restoration treatments on tree mortality, regeneration, and vascular plant response on five sites in the northern Rocky Mountains. The objective was to enhance whitebark pine regeneration and cone production using treatments that emulate the native fire regime. Since data summaries are for individual treatment units, there are no analyses of differences across treatment units or across sites.

Keywords: whitebark pine, ecosystem restoration, prescribed burning, fuel sampling, fire regime

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Discussion

Nearly all high and moderate intensity prescribed fire treatments combined with a cutting treatment effectively created desirable nutcracker caching habitat, as evidenced by the abundant nutcracker caching observed at nearly all sites. However, the whitebark pine regeneration that was expected to result from this caching has not yet materialized. Nearly all sites contain very few or no whitebark pine seedlings. This could be a result of many factors. First, we believe that many of the cached seeds have been reclaimed by the nutcrackers. We also feel that high rust mortality has reduced populations of cone-producing whitebark pine at or near our study areas so few seeds were actually available to be cached. At low levels of seed production, most seeds are consumed by the nutcrackers rather than forgotten and allowed to germinate. Next, severe site conditions could have killed many emerging seedlings. Our steep, high-mountain study sites experience deep snowpack, especially the Beaver Ridge site, which had more than 50 ft of snow in 1997. This heavy snowpack can "creep" down the slope and pull seedlings out of the ground. Moreover, most soils on our study site are highly erosive and spring snowmelts scoured the topsoil and washed away those seedlings rooted in it, especially in recently burned sites. Some researchers have identified a lag period of up to 40 years for the disturbed site to stabilize enough to allow whitebark pine to become established in upper subalpine zones (Agee and Smith 1984; Arno and Hoff 1990). Therefore, we believe that a 5-year evaluation period is too short to determine whitebark pine regeneration dynamics in these severe sites and a 10- or 20-year measurement might more accurately describe the success of our treatments. We recommend that sites where whitebark pine mortality is above 20 percent and rust infection is above 50 percent be planted with rust-resistant seedlings to shorten this long lag between disturbance and regeneration.

We lost many control plots on three study sites to wildfires. The fires that swept through the Bitterroot National Forest in 2000 burned the entire Coyote Meadows study site rendering all 30 control plots ineffective. The 2001 Dry Fork fire on the Salmon-Challis National Forest consumed 3 of 10 control plots on the Blackbird Mountain site. Embers from the prescribed burn at Blackbird Mountain started small fires in four of the control plots. The 2006 Gash Creek fire burned 5 of 10 control plots on the Smith Creek site and part of the Bear Overlook site (no control plots were burned). While a small wildfire at the Beaver Ridge site missed the control plots, it burned two cutting-only treatment units (3A and 2A; fig. 2e). The lack of sufficient control measurements makes it difficult to determine if changes measured on some of the treatment units were a result of the treatment and not of external factors such as climate. However, we found no significant difference in control plots for those sites that remained unburned (Keane and Parsons, in press).

Because of their lack of experience in burning high-elevation ecosystems, fire crews implemented prescribed burns under moister than desired conditions, thereby achieving less than desired fire intensity and severity. None of the fire crews had ever burned in the upper subalpine zone, so few wanted to risk burning in the desired dry conditions when the possibility of fire escape is high. In hindsight, as fire crews became familiar with burning in this high-elevation system, nearly all crews recognized that they could have easily achieved the higher severities. This may mean multiple treatments are needed to successfully realize burn plan objectives when experience is low or the consequences of escaped prescribed fires are severe.

Most treatments increased fuel loadings on most sites, especially the coarse woody debris (logs greater than 3 inches diameter). This was primarily because the prescribed fire burned through the bases of the abundant rust-killed whitebark pine snags within the treated stands. The newly fallen logs posed a low fuel hazard because they lacked fine fuels that contribute to increased fire spread. Their presence might actually improve the potential for whitebark pine regeneration by the restoration treatment could also be a fuel reduction treatment.

Planting whitebark pine seedlings on the Beaver Ridge site was marginally effective in this study (approximately 30 percent survival after 5 years) because nursery techniques and planting guidelines for whitebark pine at the time of planting were not as refined as they are today (McCaughey and others 2009). Our seedlings were small and they were planted in mid-summer, just after snowmelt, so they had to survive three hot, dry months of drought. There is now extensive reference material for growing whitebark pine in nurseries and recommendations for planting whitebark pine (Scott and McCaughey 2006; McCaughey and others 2009; Izlar 2007). Our success would have been improved using today's technology. Planting should be done in mid-autumn and seedlings should be planted near structures, such as stumps, logs, and rocks, that provide stability from snowpack damage. Recently, Perkins (2004) found that grouse whortleberry had a positive effect and elk sedge had a negative effect on the growth and survival of planted whitebark pine seedlings. But Izlar (2007) found safe sites are more important to survival than sufficient whortleberry cover.

We recommend a fuel enhancement cutting implemented at least 1 year prior to a prescribed burn to ensure that burn objectives are fully realized. Adding cured slash to discontinuous fuelbeds facilitates burn effectiveness by providing additional fine fuel to aid fire spread into all areas of the treated stand and augment quick-drying fine fuel levels so the burn can be implemented in moister conditions. Prescribed burns had greater coverages (50 percent increase in burn coverage) and severities in fuel-enhanced stands. Fuel enhancement is an easy, inexpensive, and relatively rapid treatment that can be implemented by timber crews, fire crews, or contractors. We found that shrub and herbaceous fuels were much drier after the first hard frost in late summer or early autumn. Frost kills the aboveground foliage that allows the plants to take water from the soil so the aboveground plant structure can dry sufficiently for burning.

Ignition methods were important in this study. Most prescribed fires were ignited using strip head fires whose width was increased if higher fire intensities were desired. However, some study sites were so moist at ignition that even wide strips couldn't generate our desired intensities. Using the terra-torch and heli-torch, we were able to burn large areas to achieve the high target intensities. However, because these techniques may not always be available, the drip-torch is the primary ignition technique. To be effective, these drip-torch ignitions should be done in dry conditions to generate sufficient intensities to kill undesirable tree species. If possible, multiple burns may also produce similar effects as one high intensity fire.

Summary and Conclusions

Whitebark pine will continue to decline across its range as extensive exotic blister rust infections, more frequent and severe mountain pine beetle epidemics, and fire exclusion-oriented management policies continue. An extensive and long-term, integrated research and management program is needed to maintain this valuable tree species on the high-mountain landscape in the western United States and Canada. Restoration of this precious ecosystem will depend on cost-effective, coordinated efforts to

- conduct fundamental ecological research in whitebark ecosystems,
- develop methods to harvest seed from rust-resistant trees,
- refine nursery techniques to produce high quality, inexpensive rust-resistant seedlings for planting,

- create effective guidelines for planting rust-resistant seedlings and seeds,
- develop methods to plan and prioritize those areas in greatest need of whitebark pine restoration, and
- develop innovative prescribed burning and silvicultural cutting methods for restoring the keystone whitebark pine ecosystem (Keane and others, in press).

This management guide is a first step to develop restorative burning and cutting methods. Details in this report can be used to prioritize, plan, and implement restoration treatments in declining whitebark pine stands by providing a reference for determining effects of various prescribed burning and cutting treatments. Though we have not yet observed significant whitebark pine regeneration in many of our treated areas, we feel these techniques can be combined with planting of rust-resistant seedlings to effectively return whitebark pine to the landscape.

We recognize it will be impossible to implement the treatments explored in this study on all whitebark pine lands during this period of rapid decline. But, there will be critical whitebark pine forests that will require immediate and extensive proactive restoration, and the findings of this study will provide critical information for the successful planning and implementation of restoration activities. Since most whitebark pine forests are in protected areas such as National Parks, Wilderness Areas, and proposed Wilderness Areas that prohibit many of the treatments detailed in this report (Keane 2000), we feel wildland fire use (in essence, letting lightning-ignited fires burn under allowable parameters) will be the primary vehicle for treating deteriorating whitebark pine stands. No matter the treatment type, it will be critical to extensively monitor the effects of all direct (used in this study) and indirect (wildland fire use) treatments so we can refine and modify treatment guidelines in the future to account for local conditions and changing environments (for example, climate change and rust epidemics). Though the outlook may seem bleak for whitebark pine, recent exciting advances in research and many management successes will hopefully help secure the conservation of this keystone species.

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