

# Whitebark Pine Ecosystem Restoration in Western Montana

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## Background

Whitebark pine (*Pinus albicaulis*) is a major tree species of upper subalpine forests of the northern Rocky Mountains (Schmidt and McDonald 1990). It is an important nutritional and structural component of wildlife habitat (Arno and Hoff 1990; Schmidt and McDonald 1990). Its large, nutlike seeds are a major food source for many birds and mammals (about 105 species) including squirrels, black and grizzly bears, and Clark's nutcrackers (Hutchins and Laner 1982). The species protects watersheds by stabilizing soil and rock on the harshest sites and by catching and securing snowpack. Historically, whitebark pine was a major species on 10 to 15 percent of the forest landscape in western Montana and central Idaho (Arno 1986); thus, its perpetuation is of concern for maintaining natural biodiversity and landscape structure.

A rapid decline in whitebark pine has occurred during the last 60 years as a result of three interrelated factors: epidemics of mountain pine beetle (*Dendroctonus ponderosae*); the introduced disease white pine blister rust (*Cronartium ribicola*); and successional replacement by shade-tolerant conifers, specifically subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). The effects of these factors have been exacerbated by fire exclusion policies of the last 60 to 80 years (Kendall and Arno 1990; Keane and Arno 1993).

Whitebark pine benefits from wildland fire because it is more capable of surviving and regenerating after fire than its associated shade-tolerant trees (Arno and Hoff 1990). Whitebark pine is able to survive low-severity fires better than its competitors because it has thicker bark and deeper roots. It readily recolonizes large, stand-replacement burns because its seeds are transported from distant stands by Clark's nutcrackers. The nutcrackers can disperse whitebark pine seeds up to 100 times further than wind can disperse seeds of subalpine fir and spruce (Tomback and others 1990). Most whitebark pine regeneration is from unexcavated seeds that germinate and grow (Keane and others 1990). The nutcracker prefers open sites with many visual cues for seed caching, much like the conditions after stand-replacement fires.

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## Restoration Treatments

Suggestions for restoring damaged whitebark pine communities include cutting trees that compete with whitebark pine, prescribed burning, and planting of rust-resistant seedlings. However, these practices have not been demonstrated or tested in research studies (McCaughey 1990). Three study areas in western Montana have been selected to investigate the effect of silvicultural and burning treatments on whitebark pine growth response and regeneration: Coyote Meadows, Smith Creek, and Snow Bowl (fig. 1). These areas were historically dominated by whitebark pine, but the species is currently experiencing an increase in blister rust infection and mortality, as well as a corresponding accelerated successional replacement by subalpine fir.

Since each study area is different in terms of tree composition, structure, and site conditions, we developed different sets of treatments for each study area. Fundamentally, all treatments involve the use of tree cutting and prescribed fire to accomplish study objectives. However, implementation differs by sample area and treatment site. Silvicultural treatments being tested include release cuttings, fuel enhancement, thinning, and tree understory removal. Differences in burning include no burn treatments, burns in natural fuels, burns in natural plus augmented (for example, slash) fuels, and burns in young and old stands.

Each treatment was designed to be implemented by Forest Service Ranger District personnel in an operationally feasible manner. No special cutting or burning methods unknown to District personnel are proposed. If feasible, merchantable material cut on the study area that is not needed for fuel enhancement can be harvested using low-impact techniques.

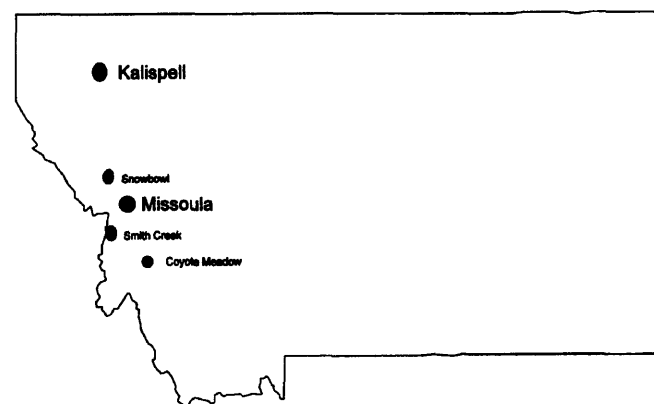


Figure 1—Map of Montana, U.S.A., showing locations of three whitebark pine study sites.

## Coyote Meadows Study Area

The Coyote Meadows Study Area is within and adjacent to a 1960's logging unit on the 8,000 foot ridge in the Bitterroot National Forest southeast of Hamilton, Montana. The site originally supported a forest of large, mature whitebark pine mixed with lodgepole pine (*Pinus contorta*), spruce, and subalpine fir. White pine blister rust infections are common in and around the study area, but have not yet caused extensive mortality. The cut-over area was logged in an overstory removal treatment with no subsequent site preparation or burning, and as a result, it is dominated by patches of small subalpine fir, many of which pre-date the logging.

The study areas have been divided into five treatment areas. Treatment area 1 is in a clearcut area with a low density of subalpine fir regeneration, and treatment area 2 has a high density of subalpine fir. Within this logging unit there is a 7 hectare stand of old, dying whitebark pine with an understory of subalpine fir (treatment area 3). Fire scars on the pines indicate this stand last underburned in about 1780. Presumably, coverage of competing subalpine fir would have been greatly reduced if fires had continued to occur at a rate of one per century. This unlogged stand also experienced heavy mountain pine beetle mortality starting about 1927. Adjacent to the logging unit are two other study stands. One is a 300+ year old whitebark pine stand in which most whitebark pine trees are dead or dying, allowing fir and spruce to dominate the understory and replace them in the overstory (treatment area 4). The other is a portion of this old stand that burned in a stand-replacing wildfire in 1919 (treatment area 5). The burn now supports a vigorous young stand of young whitebark pine, lodgepole pine, subalpine fir, and spruce.

Each treatment area has an untreated control unit and one or two silviculture and/or fire treatment units. Treatment area 1 (low-density fir site) will be broadcast burned with no fuel enhancement treatment. Treatment area 2 (high-density fir site) will be broadcast burned with and without silvicultural cuttings to enhance fuel loadings to improve fire spread (for example, fuel enhancement treatments). Subalpine fir and spruce will be cut and allowed to cure to affect a more continuous fuel bed. Treatment area 3 (mature whitebark pine stand) will be underburned with and without fuel enhancement cuttings. Treatment area 4 is another mature whitebark pine stand that will receive release silvicultural cuttings performed at two densities (high and low). Treatment area 5 (70 year old whitebark pine) will be treated with the same release cutting to high- and low-residual density (McCaughey 1990).

## Smith Creek Study Area

The Smith Creek study area occupies a subalpine site at 7,000 to 7500 feet elevation northwest of Hamilton on the Bitterroot National Forest. Whitebark pine was once a major seral component of this forest along with minor amounts of lodgepole pine, subalpine fir, and spruce. Whitebark pine saplings have become established in a 1968 clearcut adjacent to the study area; however, approximately

90 percent of the live, mature whitebark pine are infected with blister rust and 20-30 percent of the whitebark pine have died in recent years. Subalpine fir is rapidly replacing whitebark pine and lodgepole pine.

Three treatments and a control are implemented on a 9 hectare stand in this demonstration area. Treatment 1 is a prescribed underburn that will somewhat mimic a natural underburn in whitebark pine. Burning will be done in late summer or early fall. A small amount of felling of subalpine fir may be done prior to burning to provide some red slash to promote fire spread.

Treatment 2 is the creation of small openings. Circular openings in the forest canopy will be created (50 meter diameter, 0.2 hectare) by removing all trees to encourage whitebark seed caching by the Clark's nutcracker. Additionally, all subalpine fir, spruce, dying lodgepole pine, and dying whitebark pine trees will be removed from areas adjacent to the openings leaving an open stand of whitebark pine and lodgepole pine. Slash will be piled in the openings and burned. If feasible, the areas surrounding these openings will be underburned.

Treatment 3 is the creation of openings similar to treatment 2 but without the burning of slash.

A companion study will be conducted on this study site by University of Montana graduate student Janet Howard with Dr. Ragan Callaway. Seedlings from apparent rust-resistant and nonresistant phenotypes will be grown from seed obtained from Ray Hoff, Geneticist, Forest Sciences Laboratory, Moscow, Idaho. These seedlings will be grown in a nursery and planted after 2 years in the nutcracker openings in both burned and unburned treatments (treatment areas 2 and 3). Rust resistance, tree survival, and tree growth will be compared across these openings. Regeneration success and subsequent growth will be measured in relation to treatment microsites (different burn severities and unburned conditions). Density of natural regeneration will also be measured for several years.

## Snow Bowl Study Area

The Snow Bowl study area lies about 10 air miles northwest of Missoula, Montana in the Snow Bowl Ski Area on the Lolo National Forest. Elevation ranges from 7,200 to 7,900 feet and aspects are mostly southeast. Treatment blocks within the study area lie mostly between proposed ski runs in tracts of 2 to 3 hectares. This area is experiencing extensive tree mortality with approximately 60 to 80 percent of the overstory whitebark pine killed by blister rust (Keane and Arno 1993). Subalpine fir is increasing in the understory and overstory as a result of this mortality. However, there are large patches of whitebark pine regeneration (2 meters tall, 20+ years old) in the study area that have not yet been severely impacted by the blister rust.

Three treatments and a control are proposed between ski runs within the Snow Bowl site. Since this study is still in the planning stages, details of treatment location and implementation are currently lacking. The three proposed treatments are prescribed burn, thinning and prescribed fire to favor whitebark pine, and thinning without fire.

## Study Methods

In all three study areas, permanent sample plots will be located in each treatment area. These plots will be used as the basis for fuel, vegetation, and natural and artificial regeneration measurements (table 1).

Many attributes will be measured to study the treatment effects on whitebark pine growth and regeneration. Whitebark pine seedlings will be counted in microplots within treatment area macroplots for approximately 5 to 10 years. Vascular plant development and changes in ground cover will be measured using microplot techniques. Long-term fire effects on tree growth will be monitored from tree cores taken 5 and 10 years after the burn. Fuel consumption will be calculated by measuring fuel loads, duff depths, and litter depths before and after the burn (Brown 1970; Brown and others 1982). Selected macroplots will be photographed semiannually to illustrate vegetative development following treatment. Leaf area indices will be estimated using the LiCor LAI-2000.

## Stand Replacement Prescribed Fire

The low intensity treatments presented in this study attempt to reestablish whitebark pine at the stand level. These treatments are generally, but not specifically, designed to mimic low-severity underburns common in dry whitebark pine forests. However, there are many whitebark pine forests where fire burned entire landscapes in stand-replacement fires (Arno 1986, Keane and Arno 1993). Whitebark pine has a distinct advantage in colonizing these large burns because of the great seed dispersal distances provided by the Clark's Nutcracker. The nutcracker can disperse whitebark pine seed much further than wind can disperse subalpine fir seed (Schmidt and McDonald 1990).

Currently, most whitebark pine stands in the stand-replacement fire regime of the upper subalpine zone are rapidly becoming dominated by subalpine fir due to accelerated succession caused by the rust. These landscapes must have fire reintroduced at an unprecedented scale to mimic

the ecological processes that resulted in whitebark pine dominance prior to European settlement (Brown and others 1994). A viable restoration treatment is a prescribed stand-replacement fire that burns a large land area (>1,000 hectares).

The main objective of the prescribed stand-replacement fire is to create a burned area so large that wind-dispersed seeds only land on the perimeter of the burn. This intense fire can be small (300 to 1,000 hectares) if the fire burns from the bottom to the ridgetop on landscapes where wind will not disperse subalpine fir seed into the burn. An operational prescribed burn of 200 acres is planned for the summer of 1996 on the Bitterroot National Forest and a few such burns are planned for 1997 on the Kootenai National Forest.

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**Table 1**—Stand characteristics sampled on each plot pre- and post-treatment.

	Sampling schedule	
	Pre-treatment	Post-treatment
Canopy coverage vascular plants	X	X
Tree seedling size and density	X	X
Overstory tree characteristics	X	X
Down woody fuel loadings	X	X
Litter loadings	X	X
Duff depth	X	X
Ground coverage (duff/mineral soil)	X	X
Release cutting measurements		X
Regeneration measurements		X