

Whitebark and Limber Pine Restoration and Monitoring in Glacier National Park

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Abstract—Whitebark pine (*Pinus albicaulis*) and limber pine (*Pinus flexilis*) are keystone species important to watersheds, grizzly and black bears, squirrels, birds, and other wildlife. Both high elevation five-needled pines have dramatically declined in Glacier National Park primarily due to white pine blister rust (*Cronartium ribicola*) and fire exclusion, with mountain pine beetle (*Dendroctonus ponderosae*) as a potential threat. In 1997, we began collecting seed from trees that show phenotypic rust resistance in order to establish a restoration and monitoring program to maintain healthy whitebark and limber pine ecosystems in the park. Most of the seed has been propagated into seedlings through a cooperative agreement with the US Forest Service (FS) Coeur d'Alene Nursery. From 2000 to 2007, we planted nearly 6,400 whitebark and 4,700 limber pine seedlings. Following monitoring in 2010, 41 percent of all planted whitebark seedlings had survived, while only 6 percent of limber pine survived. In addition to restoration monitoring, we established blister rust monitoring plots as well as a program to monitor individual “plus” trees; trees that potentially have genetic resistance to blister rust. Currently, we are working with a FS regional geneticist to determine if our designated “plus” trees are actually producing blister-rust resistant seedlings.

Introduction

Whitebark pine and limber pine populations have declined dramatically in Glacier National Park, largely due to the introduction of the non-native fungus white pine blister rust. Severe climatic events, mistletoe infections, fire exclusion, and/or mountain pine beetles may have also contributed to the poor health of these trees. Whitebark pine mortality has been estimated at 44 percent within the park, with at least 78 percent of the remaining live trees infected (Kendall and Keane 2001). Kendall and Keane (2001) have also estimated limber pine mortality in Glacier National Park at 39 percent, with 78 percent of the remaining live trees infected. Extensive blister rust surveys on both five-needled pines were conducted in the mid 1990s, and many areas were re-surveyed between 2003 and 2009. The monitoring has shown a continual decline in the percentage of healthy whitebark and limber pine trees in the park (Asebrook and others in press). On the other hand, recent fires have burned into the habitat of both pine species, affording an opportunity to re-establish the pines in many areas.

In an effort to restore both species to Glacier National Park, restoration activities began in 1997 when seeds were collected from “plus” trees that showed potential for genetic

resistance. Park staff began to grow seedlings in 1998, followed by the first planting of whitebark pine in 2000, and the first planting of limber pine in 2002. Sites were selected based on accessibility for planting, appropriate habitat characteristics, and recent burn activity. Planting years were chosen based on the availability of seedlings. In addition, seeds from whitebark pine plus trees were directly planted at three sites in 2006 and 2007.

Overall, the whitebark and limber pine restoration program at Glacier National Park is complex, involving monitoring of “plus” trees, cone collection, production of seedlings, plantings, monitoring seedling survival, and ongoing research concerning the rust resistance of park trees and the use of ectomycorrhizae for increased survival and growth.

Monitoring Methods

The survival of planted whitebark and limber pine seedlings was monitored using circular plots installed at planting sites. The number of plots established at each site aimed to capture a minimum of 20 percent of the total planted seedlings. Circular plots ranged from a 5m to 20m radius, and were permanently marked with a nail in the center. Individual trees were located by measuring a distance and azimuth from this center nail. For each monitoring, height and width were measured for each tree and given a health rank from 1 to 5 (dead to healthy).

Overall, 56 plots were installed at four sites between 2000 and 2007 to monitor whitebark pine seedlings (table 1). A total of 1,577 whitebark pine seedlings are currently being monitored, capturing 21 percent of total planted seedlings. Forty-seven plots were installed at 13 sites between 2002 and 2006 to monitor limber pine seedlings (table 1). A total of 1,089 limber pine seedlings are currently being monitored, capturing 23 percent of total planted seedlings. All whitebark pine was planted in areas burned by wildfire while all limber pine was planted in non-burned areas, due to the fact that no limber pine habitat has burned by wild or prescribed fire in Glacier National Park.

In addition, a total of 723 whitebark pine seeds were planted in caches, shallow seed storage areas beneath the soil, along seven transects at three locations in the park in 2006 and 2007. Seeds were cached in groups, mimicking the natural planting schemes of Clark's nutcrackers (*Nucifraga columbiana*).

Table 1. Monitoring plot establishment for whitebark and limber pine seedlings.

Site	Year(s) Planted	# Plots Established	# Trees Planted	Mean # Trees Monitored	% Trees Monitored
Whitebark pine					
Flattop Mtn.	2001, 2002	38	5,160	921	18
Grinnell Point	2000	7	96	96	100
Caper Peak	2006	2	139	139	100
Red Eagle	2007	9	2,000	421	21
TOTAL		56	7,395	1,577	21
Limber pine					
Apikuni Flats	2002	2	160	25	16
Baring Creek	2004, 2006	8	700	162	23
Altyn Peak	2002, 2004	3	360	67	19
Dead Horse Pt.	2002, 2004, 2006	8	1,312	261	20
Firebrand Pass	2002	2	140	38	27
Poia Lake trailhead	2002	2	160	41	26
Rocky Point	2002	2	150	37	25
Scenic Point	2002, 2005	10	900	223	25
Sun Point	2002, 2004	4	470	107	23
Two Med CG	2002	2	160	35	22
Two Med store	2003	1	26	26	100
Two Med RS	2002	2	140	38	27
Wild Goose turnout	2002	1	100	29	29
TOTAL		47	4,778	1,089	23

Monitoring Results

Whitebark Pine

Except for one site, three- to eight-year whitebark pine seedling survival was between 31 percent and 54 percent (table 2). These results are in keeping with 11 other sites monitored in Montana, Idaho, and Wyoming where three- to eight-year survival rates typically ranged from 29 percent to 50 percent (Izlar 2007).

The relatively high survival rates for whitebark pine seedlings likely were due to the fact that all seedlings were planted in areas burned by wildfire that had deep, high-nutrient soil with excellent planting microsites. There also was no competing vegetation for the seedlings, and possibly the higher elevation whitebark sites did not experience higher air temperatures that can cause seedling desiccation. This was the case at the Red Eagle Campground site that was lower in elevation and had high sun exposure. All of the seedlings in that location were brittle by year two after planting.

Whitebark pine seed that was cached had less success. Only three out of 723 seeds germinated in year one with one seedling dying in that same season. By comparison, data from Waterton Lakes National Park documented that 144 out of 338 (43 percent) cached seeds germinated by year 2 (Smith and others 2007).

Limber Pine

Although limber pine seedling survival has been very low, survival rates have increased as planting projects have continued. At sites planted in 2002 and 2003, five- to seven-year survival ranged between 0.2 percent and 8 percent (table 3). At sites planted in 2004 and 2005, five year survival increased to 14 percent and 15 percent (table 3). Despite the positive trend, these survival rates were well below the 85 percent year one survival, 74 percent year two survival, and 69 percent year three survival at Waterton Lakes National Park (Smith and others 2007).

Poor survival for the earliest plantings was likely due to three factors. First, both plantings were followed by

Table 2. Whitebark pine seedling survival (percent).

Site	Year Planted	Survival						
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 7	Year 8
Grinnell Pt.	2000					41		
Flattop Mt.	2001	52			35	34		31
Flattop Mt.	2002			48	46		41	
Caper Peak	2006		46					
Red Egle Mt.	2007	75	55	54				
Red Egle CG	2007	91	0	0				

Table 3. Limber pine seedling survival (percent).

Site	Year Planted	Survival					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 7
various	2002	49	0.5		0.5	0.5	0.2
Two Med store	2003	96		35		8	
various	2004	46	34	25	23	15	
Scenic Pt.	2005	26	14	14		14	
Baring Ck.	2006	13	3	3			

hot, dry summers. Air temperatures were above average and precipitation was low in 2003 and 2004, resulting in heat stress to the seedlings. Second, our experience planting five-needled pines was limited. Seedlings were not always planted in favorable microsites, and overall site selection may have been poor, including rocky soil, areas of soil creep, areas not burned, and areas with high vegetative competition. As better sites were chosen in 2004 and 2005, seedlings were more consistently planted in microsites and survival increased. Temperature and precipitation levels were also average for those years.

Planting at Baring Creek in 2006 was the exception, with only 3 percent survival in year three. Although this site had relatively low vegetative competition, planting areas were highly exposed with few suitable microsites. In addition, experimental shade netting that was used on a majority of the seedlings did not hold up, negatively impacting the trees. Finally, 2007 temperatures were above average with low precipitation, resulting in heat stress to the seedlings.

Future Management

The future management of whitebark and limber pine at Glacier National Park will continue with active restoration of both five-needled pine species. At present, we have identified 62 whitebark and two limber pine trees as “plus” trees that appear to show genetic resistance to blister rust. We will continue to monitor these trees and search for new trees to add to the plus tree pool. Whitebark seed from Glacier’s plus trees is currently part of a USFS Coeur d’Alene Nursery project to assess the genetic resistance of plus trees to blister rust (Mahalovich and others 2006). We will continue to investigate the resistance of the park’s trees and continue collecting cones and growing seedlings from trees with phenotypic rust resistance. In addition, we are cooperating with Montana State University to investigate the potentially positive effects of inoculating whitebark and limber pine seedlings with certain *Suillus* mycorrhizae, an associated mushroom (Cripps and others 2008; Mohatt and others 2008).

Future management will also include finding additional planting sites for whitebark and limber pine, and incorporate appropriate planting techniques as they are identified (McCaughey and others 2009; Izlar 2007). These include the use of favorable microsites, growing vigorous trees, clumping trees when planting, and using burned areas whenever possible to plant in areas with reduced overstory and competition.

Literature Cited

- Asebrook, J.M.; Hintz, J.L. [In press]. Glacier National Park blister rust surveys: 2003–2009. Unpublished technical report. West Glacier, MT, National Park Service, Glacier National Park.
- Cripps, C.; Smith, C.; Carolin, T.; Lapp, J. 2008. Ectomycorrhizal fungi with whitebark pine. *Nutcracker Notes*. 14: 12–14.
- Izlar, D.K. 2007. Assessment for whitebark pine seedling survival for Rocky Mountain plantings. Missoula, MT, University of Montana. 84 p. Thesis.
- Kendall, K.C.; Keane, R.E. 2001. Whitebark pine decline: infection, mortality, and population trends. In Tomback, D.F.; Arno, S.F.; Keane, R.E. *Whitebark pine communities: Ecology and restoration*. Washington, DC, Island Press: pages 221–242.
- Mahalovich, M.F.; Burr, K.E.; Foushee, D.L. 2006. Whitebark pine germination, rust resistance and cold hardiness among seed sources in the Inland Northwest: planting strategies for restoration. In: *National Proceedings: Forest and Conservation Nursery Association*; 2005 July 18–20; Park City, UT. RMRS-P-43. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 91–101.
- McCaughey, Ward, Scott, Glenda L.; Izlar, Kay. 2009. Whitebark pine planting guidelines. *Western Journal of Applied Forestry*. 24(3): 163–166.
- Mohatt, K.R.; Cripps, C.L.; Lavin, M. 2008. Ectomycorrhizal fungi of whitebark pine (a tree in peril) revealed by sporocarps and molecular analysis of mycorrhizae from treeline forests in the Greater Yellowstone Ecosystem. *Botany*. 86: 14–25.
- Smith, C.M.; Poll, G.; Gilles, C.; Praymak, C.; Miranda, E.; Hill, J. 2007. Limber pine seedling and seed survival project, Waterton Lakes National Park, 2003–2006. Unpublished technical report. Waterton Park, AB: Parks Canada, Waterton Lakes National Park. 33 p.

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