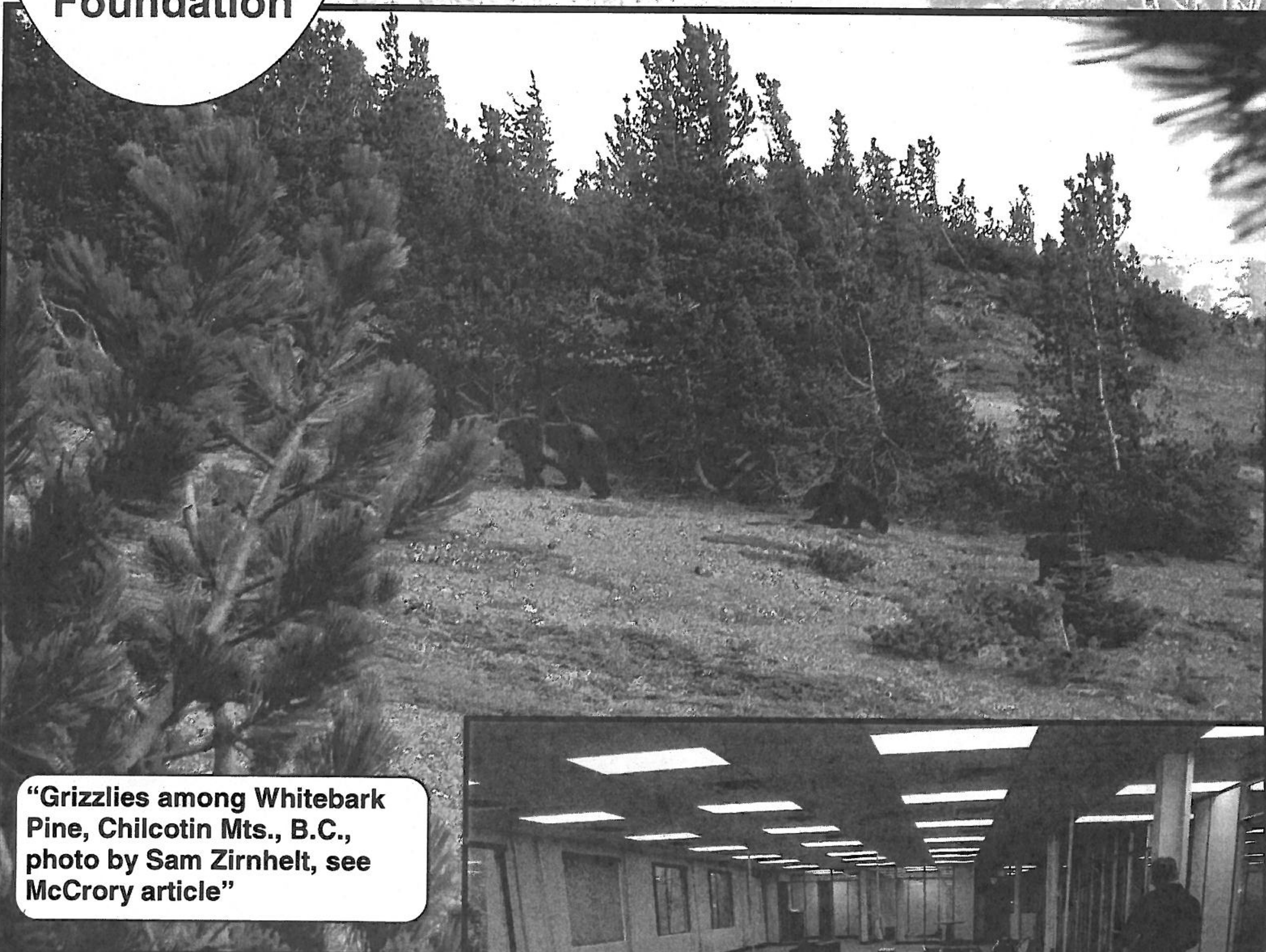
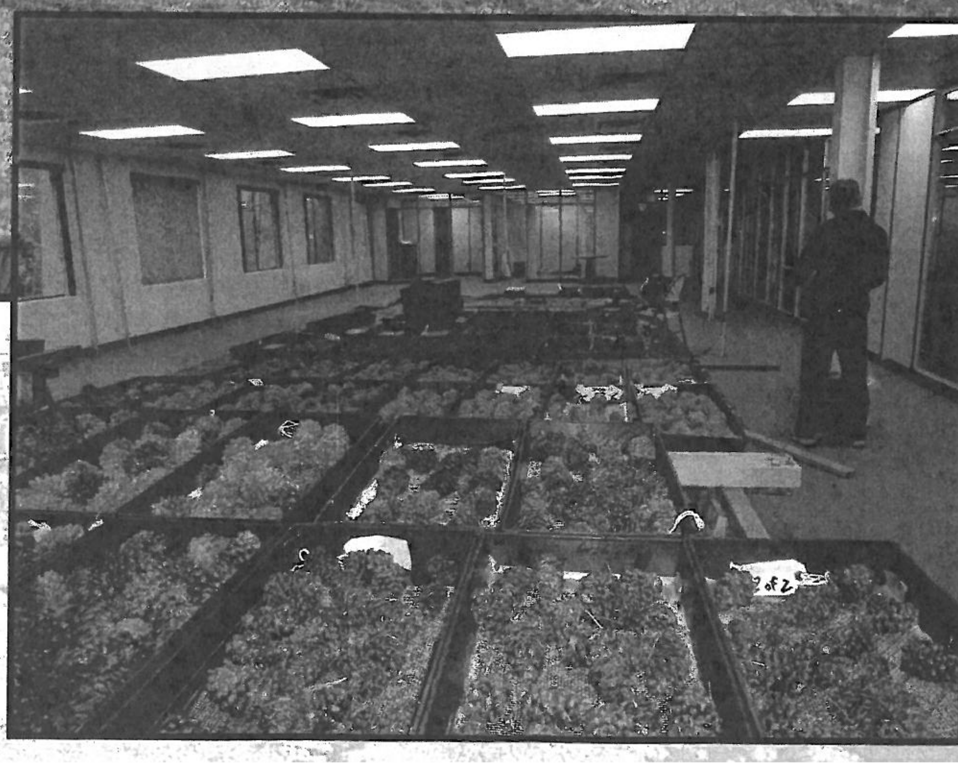
Issue No. 26: Spring/Summer 2014

Whitebark Pine Ecosystem Foundation

Nutcracker Notes



"Grizzlies among Whitebark Pine, Chilcotin Mts., B.C., photo by Sam Zirnhelt, see McCrory article"



Whitebark Pine cones from 2013 crop, see Haeussler & Clason article

[online]. Available from www.srd.alberta.ca/BioDiversityStewardship/SpeciesAtRisk/SpeciesSummaries/ [Accessed 30 July 2010].

Government of Canada. 2012. Order amending Schedule 1 to the *Species at Risk Act*. Canada Gazette Part II, Vol 146, No. 14, SOR/2012-113, June 20, 2012 [online]. Available from http://www.sararegistry.gc.ca/virtual_sara/files/orders/g2-14614i_e.pdf [accessed 16 September 2012].

Little, E.L., Jr. 1971. Conifers and important hardwoods. Volume 1 of Atlas of United States trees. Miscellaneous Publication 1146. US Dept. of Agriculture Forest Service, Washington, D.C.

Ogilvie, R.T. 1989. Distribution and ecology of whitebark pine in western Canada. Pp 54-60 *in* Proceedings – Symposium on whitebark pine ecosystems; 1989 March 29-31, Bozeman, MT. Compiled by W.C. Schmidt, K. J. McDonald. General Technical Report INT-270.

U.S. Geological Survey. 2013. Digital representations of tree species range maps from "Atlas of United States trees" by Elbert L. Little, Jr. (and other publications). http://esp.cr.usgs.gov/data/little/. [Accessed April 2014]. ■

Figure 2. New range map of limber pine in North America superimposed on the old range map by E. L. Little, Jr. (U.S. Geological Survey 2013).

Survival of Whitebark Seedlings Inoculated With Ectomycorrhiza

Cathy L. Cripps and Erin R. Lonergan,
Montana State University, Bozeman, and
Cyndi Smith (Scientist Emeritus) Parks Canada,
Waterton Lakes National Park, Alberta

Introduction and Methods

It has become widely accepted that restoration of whitebark pine (WBP) in areas that have been heavily impacted by white pine blister rust (WPBR) will require the planting of nursery-grown potentially rust-resistant seedlings (e.g., Keane et al. 2012). One of these areas is Waterton Lakes National Park (WLNP) in southwestern Alberta, where WPBR infection and mortality (from all causes) on eight plots averaged 78% and 65%, respectively, in 2009 (Smith et al. 2013). In 2010, we initiated a study into the effects of planting in small prescribed burns, in dense understory, in microsites, and with inoculation with native ectomycorrhizal (ECM) fungi (Lonergan et al. 2014). Here we briefly describe our methods (full details can be found in Lonergan et al. 2014) and the results of three years of monitoring these seedlings.

Five weeks before planting two-year-old seedlings grown from seeds of potentially rust resistant trees, 478 of them were randomly selected in the nursery and inoculated with a spore slurry made from sporocarps of the ECM fungus *Suillus sibiricus*. On Sept. 28, 2010, 983 WBP seedlings were planted within 21 plots near Summit Lake (elevation 1950 m). Approximately half of each 50-m diameter plot was burned in 2009 or 2010 using a terrestrial torch to reduce competing Engelmann spruce, subalpine fir and understory vegetation (Schwanke and Smith 2010), in particular beargrass. Seedlings were planted in clusters of three, with none, one, two or three inoculated seedlings in each cluster. Un-inoculated seedlings that were planted with inoculated seedlings were considered "exposed." The final experimental design consisted of nine treatments: burned/unburned, beargrass/no beargrass, microsite (yes/no), and the three inoculation treatments. All of the seedlings were monitored for survival in August 2011, 2012 and 2013. A seedling was considered "dead" if all needles were brown or gone or "alive" if some portion of the needles were green.

Results and Discussion

Overall seedling survival was 95% one year after planting and this dropped to 69% in year two. These high survival rates are likely due to particular treatment combinations possibly helped by favorable spring moisture conditions (Lonergan et al. 2014). In year three, overall seedling survival dropped to 47%.

One year after planting, seedling survival was high across all site conditions ranging from 88-98% (Fig. 1). Two years after planting, the highest seedling survival was on burned areas without beargrass (82%). Three years after planting, survival was highest on burned areas whether beargrass was present (50%) or not (57%). In the two-year assessment, survival was also high in un-burned areas with beargrass, especially when seedlings were inoculated with ECM fungi and planted near shelter objects (Lonergan et al. 2014). By year three, the overall survival on un-burned sites with beargrass dropped to 33%, which suggests that competition from beargrass may now be a factor. Seedlings planted in un-burned areas devoid of beargrass had the lowest survival rate (18%) after three years. This likely reflects poor site conditions; here the soil was often hard, rocky and exposed, and there may have been mechanical difficulties with planting. Results suggest the importance of site preparation/selection prior to planting whitebark pine seedlings.

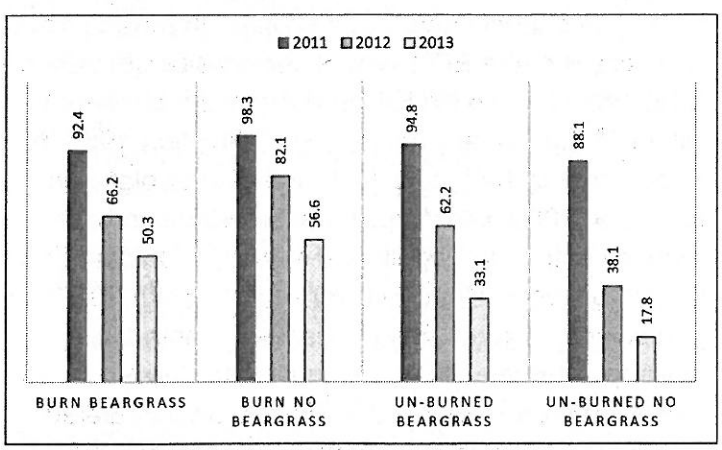


Figure 1. Seedling survival by site conditions over three years.

Planting within a microsite increased seedling survival by 11% overall across all sites after one year, and this increased to a 21% advantage in year two and 18% in year three, highlighting the value of planting seedlings with shelter objects (Fig. 2). After three years, planting in microsites was most valuable in the burned areas; here survival was increased 23% when beargrass was absent and 11% when it was present (Fig. 3). It should be kept in mind that on burned sites, the "presence of beargrass" refers only to the roots since the top vegetation layer was torched. It was also interesting that data taken in year two showed that planting in microsites improved survival 31% on the poorest planting sites (un-burned ground without beargrass), but by year three this initial boost from microsite was negated.

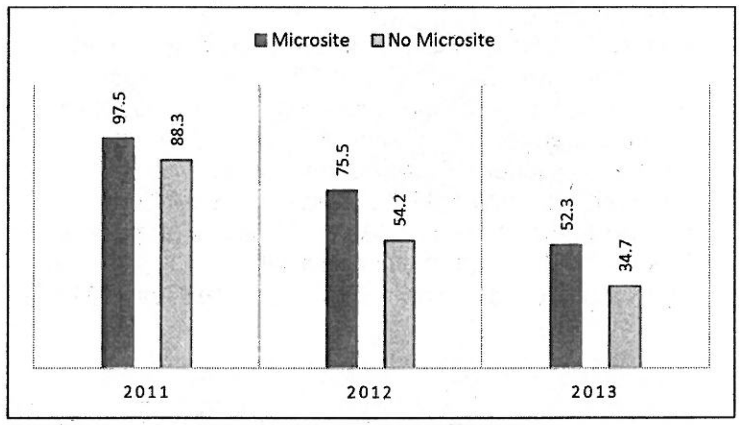


Figure 2. Three-year survival of seedlings planted in microsites.

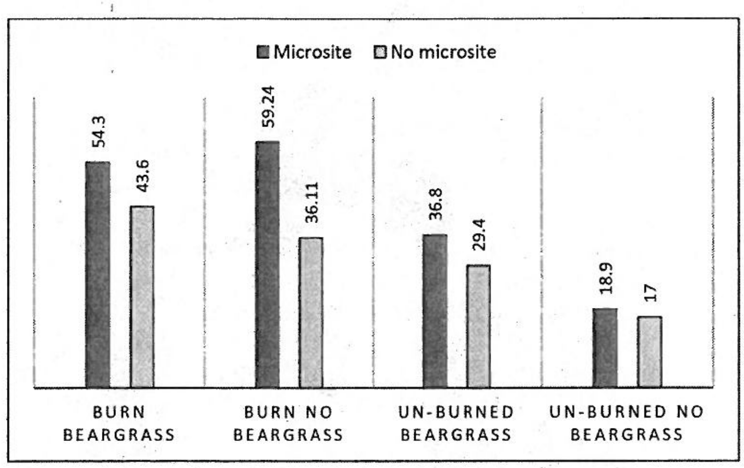


Figure 3. Three-year survival of seedlings by microsite and site conditions.

Inoculation with ECM fungi did not impact seedling survival overall in 2011, likely because survival rates were still high (92-95%) so treatment effects were masked (Fig. 4). After two years, mycorrhizal inoculation increased the overall seedling survival 6% and in year three it increased seedling survival 11% over un-inoculated controls. If this trend continues, then inoculation with native fungi is worth the investment. Results for the (exposed) seedlings planted adjacent to inoculated seedlings are less clear.

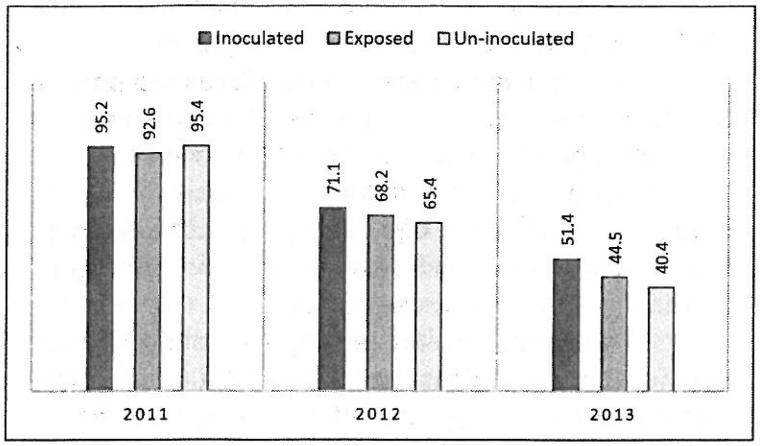


Figure 4. Three-year survival of seedlings that were 1) inoculated with native mycorrhizal fungi, 2) planted next to inoculated seedlings (exposed), or 3) not inoculated.

After three years, inoculation with ECM fungi increased seedling survival on the burned sites by 15% when beargrass was present and 6% when it was not (Fig. 5). Initially (after two years), mycorrhizal inoculation increased survival 17-24% on un-burned sites with beargrass (Lonergan et al. 2014), but this advantage dropped to 10% in year three. Results appear negative on the rocky un-burned sites without beargrass and are not explicable at this point; however, a bias may be the loss of whole clusters for mechanical reasons or the fungi may not have been able to survive the harsh conditions. Results are all for comparisons to un-inoculated seedlings, since results are less clear for exposed seedlings at this point.

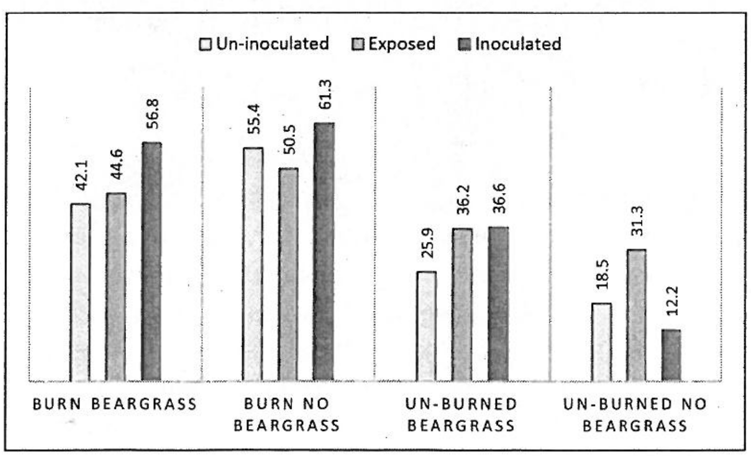


Figure 5. Three-year survival of seedlings inoculated with native mycorrhizal fungi, exposed or not inoculated, in different site conditions.

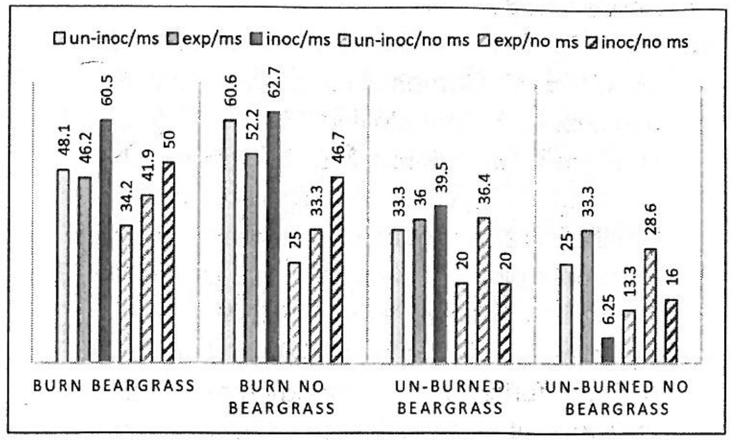


Figure 6. Seedling survival three years after planting for four site conditions, planted with/without microsite (ms), and with/without inoculation with native mycorrhizal fungi (or exposed to inoculated seedlings).

Conclusions and Recommendations

In the larger scheme of things, the highest survival rates for whitebark pine seedlings recorded after three years were on the burned sites (Fig. 6). Here, seedlings planted with shelter objects and inoculated with ECM fungi, whether with beargrass (60.5%) or without beargrass (63%) had the highest survival rates; those planted in microsites on burns devoid of beargrass, but without inoculation, also had a high (61%) survival rate. This research highlights the value of selecting appropriate sites for planting whitebark pine seedlings grown in containers. From our data we recommend planting in burns (or at least small torched areas), with shelter objects (microsite) and if trends hold, results show inoculation with ECM fungi can further benefit survival on some site conditions. Seedlings need to be inoculated in the greenhouse weeks or months prior to planting for this strategy to be effective (Lonergan et al. 2013). Continued monitoring will determine which factors will enhance the survival of whitebark pine in the long run.

Acknowledgements

We thank the Glacier Park Native Plant Nursery and revegetation crew, WLNP staff (especially Queenie Gray who monitored the seedlings in 2013), and volunteer planters, for their assistance. Funding was provided by Parks Canada's *Restoring Terrestrial Ecosystems Together* project.

Literature Cited

Keane, R. E., D. F. Tomback, C. A. Aubry, A. D. Bower, E. M. Campbell, C. L. Cripps, M. B. Jenkins, M. F. Mahalovich, M. Manning, S. T. McKinney, M. P. Murray, D. L. Perkins, D. P. Reinhart, C. Ryan, A. W. Schoettle, and C. M. Smith. 2012. A rangewide restoration strategy for whitebark pine (*Pinus albicaulis*). USDA For. Ser. Gen. Tech. Rep. RMRS-GTR-279.

Lonergan, E. and C. L. Cripps. 2013. Use of low nitrogen fertilizer as a strategy for maintaining mycorrhizal colonization on whitebark pine seedling inoculated with native fungi in the greenhouse. Native Plants 14:213-224.

Lonergan, E. R., C. L. Cripps, and C. M. Smith. 2014 (in press). Influence of site conditions, shelter objects, and ectomycorrhizal inoculation on the early survival of whitebark pine seedlings planted in Waterton Lakes National Park. Forest Science 60(2):000-000 doi.org/10.5849/forsci.13-511.

Schwanke, R. and C. M. Smith 2010. Imitating lightning strikes for whitebark pine restoration. *Nutcracker Notes* 19:12-13.

Smith, C. M., B. Shepherd, C. Gillies, and J. Stuart-Smith. 2013. Changes in blister rust infection and mortality in whitebark pine over time. *Canadian Journal of Forest Research* 43(1):90-96. ■

Whitebark Pine Seed Orchard on the Lewis and Clark National Forest Service

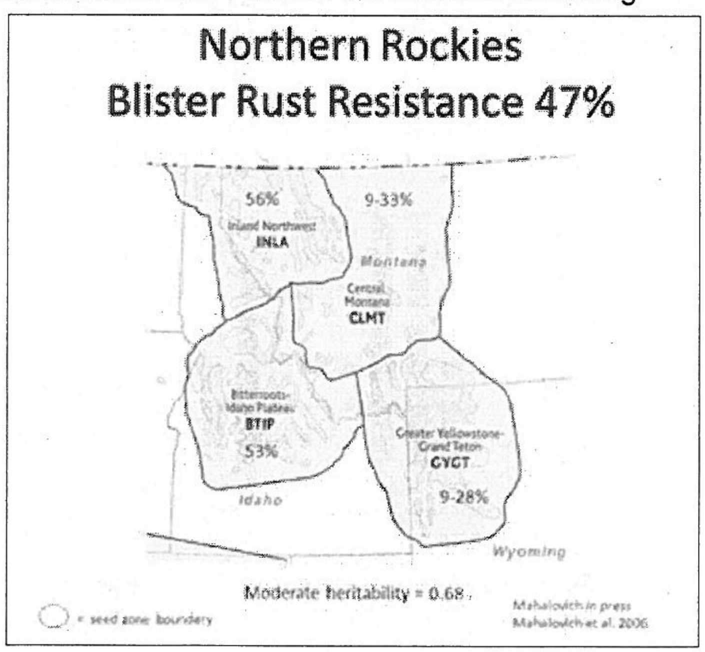
Tanya Murphy, Silviculturist
Lewis and Clark National Forest, Great Falls, MT

Since 2011, the Lewis and Clark National Forest has been proud to host the Central Montana seed zone's Adams Creek whitebark pine seed orchard. The orchard is part of the Northern Region's Genetic Resource Program and the Intermountain Whitebark Pine Restoration Program with the objective of producing whitebark pine seed with improved white pine blister rust resistance for planting within the seed zone. The Central Montana zone is composed of all or portions of the Beaverhead-Deerlodge, Bitterroot, Gallatin, Helena, Lewis and Clark, and Lolo National Forests. Partnerships with other agencies and organizations within the geographic area could expand the orchard's contribution to restoration.

As the orchard is cultured for early and abundant flowering, rather than chasing periodic cone crops across the landscape, Adams Creek will provide a reliable cone crop among partners for immediate restoration planting needs. Aggregating valuable whitebark genetic material in a central location enhances our ability to effectively protect the resource from wildland fire, insect, and disease loss compared to individual elite trees across the forest.

The orchard is situated approximately 53 miles southeast of Great Falls, Montana, at 7300 feet in the Adams Creek drainage of the Little Belt Mountains. The 1.5-acre orchard is designed for 33 genotypes replicated five times (165 whitebark pine) on a 20-foot by 20-foot grid. There is potential to expand the orchard to meet increasing restoration seed needs from partners. As of September 2013, Forest Service employees representing all disciplines have successfully fall planted 14 genotypes (39%). Annual planting will continue until the orchard planting design has been achieved. Although some grafts have died or shown stress, the planting design has 100 percent survival due to double-planting at each site.

For the past several decades, forests in the seed zone identified and collected seed from mature whitebark pine with phenotypic blister rust resistance, also known as plus trees. Their seedlings are grown at the Coeur d'Alene Nursery, artificially inoculated with blister rust, and then subjected to several rust screening assessments to determine their genetic rust resistance levels. Results from the rust screening



Whitebark pine seed zone map for the Northern Rockies indicating rust resistance levels among the four zones.