CHAPTER 12

Limber Pine Condition Along Montana's Rocky Mountain Front

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INTRODUCTION

White pine blister rust (WPBR) (*Cronartium ribicola*) has caused extensive crown dieback and mortality along Montana's Rocky Mountain Front since its introduction to limber pine (*Pinus flexilis*) east of the Continental Divide in the 1930s. The combined impacts of WPBR, mountain pine beetle (*Dendroctonus ponderosae*), and changing climate patterns are suspected to be contributing to mortality and the alteration of limber pine stands occupying the grassland-montane ecotone throughout this region. Few studies have monitored low-elevation limber pine in Montana (Jackson and others 2010). Information on stand conditions is needed to inform management and restoration efforts. The objectives of this study were to (1) assess site and stand characteristics that describe limber pine along Montana's Rocky Mountain Front, (2) determine the status and health of limber pine trees and regeneration, and (3) characterize the major damage agents on limber pine trees and regeneration and determine the occurrence, incidence, and severity of WPBR on limber pine.

METHODS

Limber pine-dominated stands, spanning multiple land ownerships along Montana's Rocky Mountain Front, were identified with aerial imagery supplied by The Nature Conservancy, and random plot locations were located using Region One Plot Locator (ROPL) software. To ensure an adequate sample of limber pine, plots included at least 30 limber pine stems ≤4.5 feet tall. Plot direction was determined using a random compass bearing that placed the plot within the limber pine stand. Plots were 200 x 50 feet and divided into three sections with three circular, fixed-area understory vegetation subplots (1/100 acre, 11.8-foot radius) at equal increments along the central transect. Survey methods were adapted from Burns and others (2011) and the Whitebark Pine Ecosystem Foundation's published methods (Tomback and others 2004).

Plot data collected included GPS coordinates, elevation, aspect, slope, slope position, stand structure, canopy cover using a line intercept method, and disturbance history. All trees ≥4.5 feet tall were permanently tagged; tree assessments included species, diameter at breast height (d.b.h.), height, status (healthy, up to 5-percent damage; declining, 6–50-percent damage; dying, >50 percent damage; recent dead [0–5 years], red needles and fine twigs present; old dead [>5 years], no needles or fine twigs present), crown class, crown ratio, canopy kill, height to green crown, ground cover at tree base, and damage agents with associated severities. Limber pines were additionally assessed for WPBR, including crown and stem impacts, number of cankers, and canker lengths. White pine blister rust severity was assessed by dividing both the crown and bole into thirds and counting individual branch and stem cankers within each third. Percentage of branches with WPBR cankers was estimated for each crown third. Stem canker severity was quantified by percentage of the stem circumference girdled. All regeneration <4.5 feet tall was assessed for species, height, and status, while limber pines were examined for WPBR within the entire plot. In each subplot, we recorded ground cover type (vegetation, wood, mineral soil, rock, litter), shrub species, and WPBR alternate host (*Ribes, Castilleja,* and *Pedicularis* spp.), and estimated associated percent covers of each.

RESULTS

In 2017 and 2018, a total of 74 long-term monitoring plots were established in limber pine-dominated stands along a 50-mile latitudinal gradient west of Choteau, MT (fig 12.1). Plots ranged in elevation from 4,499–6,185 feet and were located on a variety of aspects and slope positions. Mean slope was 15 percent and ranged from 0–40 percent.

We assessed 6,065 trees, of which 4,427 were limber pine. Limber pine was found in association with Douglas-fir (*Pseudotsuga menziesi*) on 82 percent of plots and subalpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta*) on <1 percent of plots. On 18 percent of plots, limber pine was the only tree species present. Plot density of live limber pine ranged from 35–475 trees per acre, and mean density was 150 trees per acre. Average d.b.h. of live limber pine was 4.3 inches (range = 0.1–33.3 inches), and average height was 10.4 feet (range = 4.5–42.6 feet). Thirty-seven percent of limber pines were classified as healthy, 21 percent were declining or dying, and 43 percent were dead (fig. 12.2). The most common damage agents affecting live limber pine were WPBR and twig beetles. Of the 2.7 percent of recent limber pine mortality, 40 percent was attributed to WPBR and <1 percent was attributed to bark beetles. Nearly 40 percent of limber pine were old dead, and cause of mortality was difficult to discern on most trees. Alternate hosts of WPBR were observed on 32 percent of plots with *Ribes* spp. on 22 plots, *Castilleja* spp. on 3 plots, and *Pedicularis* spp. on 2 plots.

White pine blister rust occurred in 100 percent of plots with a mean incidence of 36 percent (range = 4–90 percent). Incidence of WPBR was highest in the large (>8 inches) d.b.h. class at 48 percent (table 12.1). The mean number of branch and stem cankers per tree was 3.0 but was higher in the large d.b.h. class. Of all live infected trees, 88 percent had fewer than five branch cankers per tree. Most (55 percent) branch cankers were in the largest size category (>12 inches length) with only 15 percent of cankers in the smallest size category (1–3 inches length) (table 12.2). Half of all live infected trees had stem cankers. The incidence of stem cankers was highest in trees in the small (0–2 inches) d.b.h. class.

We assessed 5,899 seedlings (trees <4.5 feet tall), of which 65 percent were limber pine and 34 percent were Douglas-fir. Live limber pine seedlings occurred on 93 percent of plots, and density averaged 170 stems per acre (range = 0–985 trees per acre). Only one plot had no seedlings of any species. Of all limber pine seedlings, 69 percent were alive, 31 percent were dead, and WPBR occurred on 5 percent of live seedlings.

DISCUSSION AND CONCLUSIONS

White pine blister rust, the primary damage agent, has been established in the study area for >80 years. It is widespread, occurring on all plots in the study area. While incidence of WPBR on

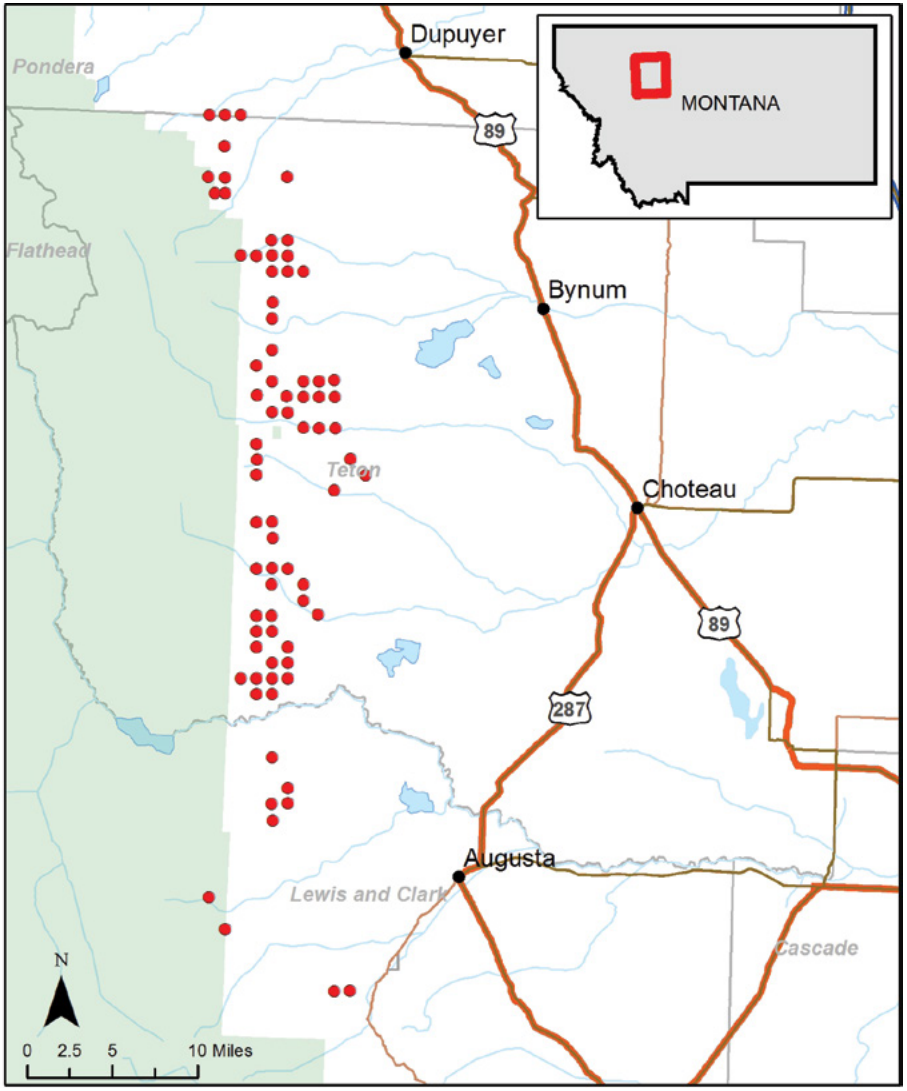

Figure 12.1—Location of limber pine monitoring plots along the Rocky Mountain Front in Montana, installed in 2017 and 2018.

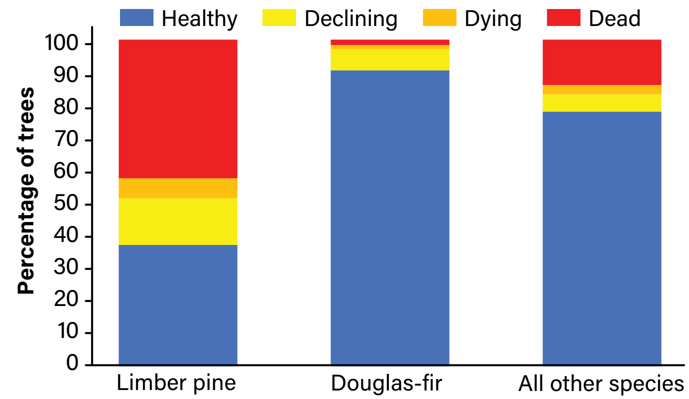

Figure 12.2—Health status of limber pine in comparison with Douglas-fir and all other tree species (all trees ≥4.5 feet tall) in 74 plots installed along the Rocky Mountain Front in Montana in 2017 and 2018. Healthy trees are those with up to 5-percent visual damage to crown or stem. Declining trees are those with 6–50-percent damage to the crown or stem. Dying trees are those with >50-percent damage to the crown or stem. Dead trees include both recent and older mortality.

Table 12.1—Proportion of living limber pine trees with white pine blister rust (WPBR), mean number of WPBR cankers per live limber pine with WPBR, and proportion of live limber pine with WBPR stem cankers, each by diameter at breast height (d.b.h.) size class

d.b.h. class	Number of limber pines	Trees with WPBR		Mean cankers per tree (SD)	Trees with stem cankers
		number	*percent*		*percent*
Small (0–2 inches)	614	162	26	1.9 (1.6)	62
Medium (2.1–8 inches)	1,636	622	38	2.7 (3.3)	48
Large (>8 inches)	292	140	48	3.7 (5.0)	46

SD = standard deviation.

Table 12.2—Proportion of white pine blister rust cankers in canker length categories

Canker length category	Proportion of cankers
inches	*percent*
1–3	15
3–6	12
6–9	11
9–12	6
>12	55

live limber pine was comparable to incidence in other areas farther south in the Rocky Mountains (Burns and others 2011, Cleaver and others 2015), mortality in this study was higher, likely due to WPBR being established earlier in the northern Rocky Mountains. Recent mortality, however, was low, and bark beetles did not have a major impact on limber pine stands in this study area in recent years. About half of live limber pine with WPBR in each d.b.h. class had stem cankers. Fewer WPBR cankers in all the smaller size classes combined versus the largest size class suggest the possibility that there may have been a lack of recent wave years or that WPBR infections have plateaued beyond the wave of initial infections. Incidence of WPBR on seedlings was low and comparable with other studies in the Rocky Mountains (Burns and others 2011, Cleaver and others 2017, Smith and others 2013). The latitudinal gradient of the study area was relatively small, and there was no relationship between latitude and density of live limber pine or incidence of WPBR on live limber pine.

Density of live limber pine was consistent with limber pine stands farther south in the Rocky Mountains, but mean seedling density was three times higher in this study as compared to Cleaver and others (2017). While WPBR is well established in this study area and a high level of mortality has occurred, the lack of recent bark beetle mortality and impact from other stressors like dwarf mistletoe (*Arceuthobium americanum*) has allowed for relatively good regeneration.

This study established baseline conditions for low-elevation limber pine stands along Montana's Rocky Mountain Front. Continued monitoring will help to assess impacts of WPBR and bark beetles, monitor effects of future climate change, assist resource managers in forecasting WPBR impacts in areas more recently invaded by the disease, and inform future restoration activities for limber pine.

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LITERATURE CITED

Burns, K.S.; Blodgett, J.; Jackson, M. [and others]. 2011. Monitoring limber pine health in the Rocky Mountains and North Dakota. In: Keane, R.E.; Tomback, D.F.; Murray, M.P.; Smith, C.M., eds. The future of high-elevation, five-needle white pines in western North America: proceedings of the high five symposium, 28–30 June 2010; Missoula, MT. Proc. RMRS-63. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station. 376 p.

Cleaver, C.M.; Jacobi, W.R.; Burns, K.S.; Means, R.E. 2015. Limber pine in the central and southern Rocky Mountains: stand conditions and interactions with blister rust, mistletoe, and bark beetles. Forest Ecology and Management. 358: 139–153. https://doi.org/10.1016/j.foreco.2015.09.010.

Cleaver, C.M.; Jacobi, W.R.; Burns, K.S.; Means, R.E. 2017. Limber pine regeneration and white pine blister rust in the central and southern Rocky Mountains. Forest Science. 63(2): 151–164. https://doi.org/10.5849/forsci.16-052.

Jackson, M.; Gannon, A.: Kearns, H.: Kendall, K. 2010. Current status of limber pine in Montana. Report 10-06. [Place of publication unknown]: U.S. Department of Agriculture Forest Service, Forest Health Protection. 14 p.

Smith, C.M.; Langor, D.W.; Myrholm, C. [and others]. 2013. Changes in white pine blister rust infection and mortality in limber pine over time. Canadian Journal of Forest Research. 43(10): 919–928. https://doi.org/10.1139/cjfr-2013-0072.

Tomback, D.F.; Keane, R.E.; McCaughey, W.W.; Smith, C. 2004. Methods for surveying and monitoring whitebark pine for blister rust infection and damage. Missoula, MT: Whitebark Pine Ecosystem Foundation. 28 p.