

Limber Pine Health in the Canadian Rockies

Cyndi M. Smith, Parks Canada, Waterton Lakes National Park, Waterton Park, AB; **David Langor**, Natural Resources Canada, Canadian Forest Service, Edmonton, AB; **Colin Myrholm**, Resources Canada, Canadian Forest Service, Edmonton, AB; **Jim Weber**, Resources Canada, Canadian Forest Service, Edmonton, AB; **Cameron Gillies**, Tierra Environmental Consulting, Windermere, BC; **Jon Stuart-Smith**, Parks Canada, Waterton Lakes National Park, Waterton Park, AB

Limber pine (*Pinus flexilis*) reaches the northern limit of its range at about 52 degrees latitude in Alberta (AB) and 51 degrees latitude in British Columbia (BC). Most populations are found on the eastern slopes of the Rocky Mountains, with a few disjunct populations west of the Continental Divide in southeastern BC. Limber pine commonly grows in montane and lower subalpine regions on xeric to sub-xeric, exposed and wind-swept sites (ASRD & ACA 2007).

Limber pine plays an important role in the harsh environments in which it lives, providing ecological services including retention and slow release of moisture, shade for other species (Baumeister and Callaway 2006), and large seeds that serve as a high energy food source for many animals, such as Clark's nutcracker (*Nucifraga columbiana*) (Benkman and others 1984) and black bear (*Ursus americana*) (McCutchen 1996). Limber pine populations in Canada are threatened by a combination of white pine blister rust (WPBR; *Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*), drought and fire suppression (Achuff 1997, Kendall and others 1996, ASRD & ACA 2007). As a consequence, limber pine was listed as Endangered under *The Wildlife Act* in Alberta in 2008 (Government of Alberta 2010).

WPBR was first identified on limber pine in Canada in 1952 in southwestern Alberta, and within a decade had caused heavy infection (average 79-100 percent) and mortality (29-83 percent) in an unspecified number of sample plots

in three general areas (Gautreau 1963). In 1996, Kendall and others (1996) reported average infection levels of 84 percent and 52 percent, and average mortality from all causes of 40 percent and 15 percent, in Waterton Lakes National Park (WLNP) and Whaleback, respectively (Table 1).

In this study, our objective was to quantify the incidence of WPBR and mortality of limber pine in the Canadian Rockies, and compare these to previous studies.

In 2003 and 2004, we re-established 12 plots that Kendall had measured in 1996, and established 73 new plots; 83 of these plots are in AB and two are in BC (Figure 1). In 2009, we re-measured all 85 plots. Methods for establishing plots and assessing health were adapted from those recommended by Tomback and others (2005) for whitebark pine. All trees on public land plots were marked with numbered aluminum tags, while most on private land were not. Although Kendall's original plots were not permanently marked nor were the trees tagged, we were able to resample within the original stands by using geographical coordinates, plot photographs and azimuths (Kendall 2003). Plot size averaged 683 m² (range 125-3000 m²). Tomback and others (2005) recommend a fixed transect length of 50 m, but these surveys were started in 2003, using a draft of the methodology which recommended a minimum number of live and dead trees rather than a fixed length, which resulted in large plot sizes where mortality was very high.

Table 1. Incidence of white pine blister rust and limber pine mortality in the Canadian Rockies.

Zone and location	Year	No. of plots	Mean mortality % (range) ^a	Mean infection % (range)
Northern				
Bow Valley to Kootenay Plains	2003-04	28	12 (0-67)	2 (0-27)
Bow Valley to Kootenay Plains	2009	28	13 (0-62)	11 (0-85)
Central				
Hwy 3 to Bow Valley	2003-04	34	32 (0-60)	54 (0-96)
Hwy 3 to Bow Valley	2009	34	37 (0-80)	59 (2-97)
Whaleback	1996 ^b	4	15 (5-24)	52 (43-60)
Whaleback	2003-04	4	43 (37-50)	40 (18-69)
Whaleback	2009	4	32 (28-38)	64 (43-79)
Southern				
Hwy 3 to WLNP	2003-04	23	45 (24-87)	55 (20-79)
Hwy 3 to WLNP	2009	23	52 (24-69)	77 (26-100)
WLNP	1996 ^b	8	40 (22-57)	84 (65-96)
WLNP	2003-04	8	56 (39-87)	61 (44-79)
WLNP	2009	8	52 (24-66)	67 (26-93)

^a Includes mortality from all causes.

^b Kendall et al. 1996 and Kendall, unpublished data.

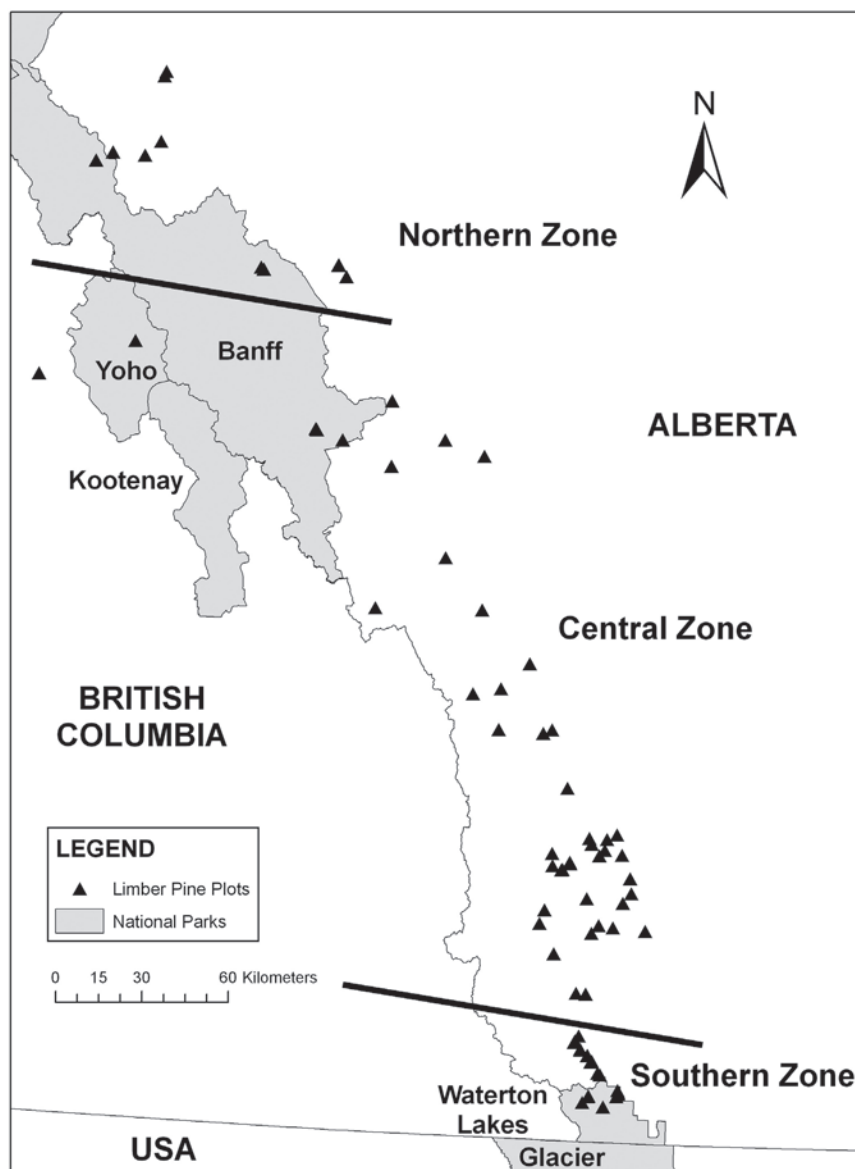


Figure 1. Study area showing three zones in the Canadian Rockies range of limber pine.

Incidence of infection by blister rust was reported as proportion of live trees (tree growth form > 1.3 m tall and krummholz growth form of reproductive age) that were infected at the time of each survey. Mortality was from all causes and reported as proportion of dead standing trees at the time of each survey. Some dead trees may be decades old, while others were recently dead (still had red needles).

We assessed 4,676 trees and 623 seedlings (< 1.3 m, separated from krummholz) in 2003-04 and 4,566 trees and 900 seedlings in 2009. The decrease in number of trees assessed is an artifact of standardising the size of many plots in 2009.

Over all 85 plots, WPBR infection increased from 33 percent in 2003-04 to 43 percent in 2009, while mortality increased from 32 percent to 35 percent. Infection and mortality is highest in southern Alberta and decreases near the northern limit of its range, but is present in all areas. Infection of seedlings (two size classes) was low, at 7 percent in 2003-04 and 4 percent in 2009, mostly in the 50-130 cm height class. This decrease in infection in seedlings may

account for the 30 percent increase in number of seedlings between the two time periods. Infected seedlings are known to have high mortality in other five-needled pines, such as whitebark pine (Hoff and Hagle 1990).

In the 12 plots that were established by Kendall and others (1996), WPBR infection varied from an average of 73 percent, 46 percent and 66 percent in 1996, 2003-04 and 2009, respectively, while mortality increased from 30 percent to 50 percent between 1996 and 2003-04, then dropped to 46 percent in 2009 (Table 1). Differences in infection levels between years might be due to 1) different trees being measured between the first two time periods, as Kendall's plots were not re-located exactly, but were within the same stand, 2) difficulty of field teams in identifying WPBR cankers due to limber pine's naturally rough bark, and the destruction of old cankers by wind, 3) incidence dropping after the most susceptible individuals die, and/or 4) a true change in infection levels. The apparent drop in mortality in 2009 is most likely a function of standardising plot sizes.

While WPBR infection levels may have stabilized during the last decade, the high levels in the very southwestern corner of Alberta will lead to additional mortality of limber pine. It is conceivable that there may be local extirpations of limber pine in the most heavily impacted areas, which could affect wildlife habitat, the distribution of forested land, the rate and possible fate of forest succession, and reforestation dynamics after fire (Schoettle 2004).

Acknowledgements

We thank Peter Achuff, Myles Carter, Tim Chevrier, Adrian Leslie, and Iain Smith for their enthusiastic field work. Special thanks to Katherine Kendall for sharing her plot data from 1996. We thank Peter Achuff, Marcus Jackson and Holly Kearns for their helpful comments on previous drafts of this manuscript. Financial support was provided by Parks Canada Species-at-Risk Inventory Fund and Western-Northern Canada Service Centre, and Ecological Integrity Monitoring Programs in Banff and Waterton Lakes National Park, the Canadian Forest Service and Alberta Conservation Association.

Literature Cited

- Achuff, Peter L. 1997. Special plant and landscape features of Waterton Lakes National Park, Alberta. Unpublished Technical Report. Waterton Park, AB: Parks Canada, Waterton Lakes National Park. 51 p.
- ASRD & ACA (Alberta Sustainable Resource Development and Alberta Conservation Association). 2007. Status of the limber pine (*Pinus flexilis*) in Alberta. Wildlife Status Report No. 62. Edmonton, AB: Alberta Sustainable Resource Development. 17 p.
- Baumeister, D.; Callaway, R.M. 2006. Facilitation by *Pinus flexilis* during succession: a hierarchy of mechanisms benefits other plant species. *Ecology*. 87: 1816-1830.
- Benkman, C.W.; Balda, R.P.; Smith, C.C. 1984. Adaptations for seed dispersal and the compromises due to seed predation in limber pine. *Ecology*. 65: 632-642.
- Gautreau, E. 1963. Effects of white pine blister rust in limber pine stands of Alberta. 1963. Canada Department of Forestry: Forest Entomology and Pathology Branch. Ottawa, ON. Bi-monthly Progress Report. 19(4): 3.
- Government of Alberta. 2010. Species assessed by Alberta's Endangered Species Conservation Committee: short list. [Online]. Available: <http://www.srd.alberta.ca/BioDiversityStewardship/SpeciesAtRisk/SpeciesSummaries/SpeciesAtRiskFactSheets.aspx> [July 30, 2010].
- Hoff, R.J.; Hagle, S. 1990. Diseases of whitebark pine with special emphasis on white pine blister rust. Pp 179-190 in *Proceedings of a symposium on whitebark pine ecosystems: ecology and management of a high-mountain resource*. INT-GTR-270. Fort Collins, CO; USDA Forest Service, Rocky Mountain Research Station.
- Kendall, Katherine C. 2003. Whitebark pine study master database. West Glacier, MT: U.S. Geological Survey, Northern Rocky Mountain Science Center.
- Kendall, Katherine C.; Ayers, Dayna; Schirokauer, David. 1996. Limber pine status from Alberta to Wyoming. *Nutcracker Notes*. 7:16-18.
- McCutchen, H.E. 1996. Limber pine and bears. *Great Basin Naturalist*. 56(1): 90-92.
- Schoettle, Anna W. 2004. Ecological roles of five-needle pines in Colorado: potential consequences of their loss. Pp 124-135 in *Breeding and genetic resources of five-needle pines: growth, adaptability, and pest resistance*. *Proceedings RMRS-P-32*. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.
- Tomback, Diana F.; Keane, Robert E.; McCaughey, Ward W.; Smith, Cyndi M. 2005. Methods for surveying and monitoring whitebark pine for blister rust infection and damage. Missoula, MT: Whitebark Pine Ecosystem Foundation.

The content of this paper reflects the views of the author(s), who are responsible for the facts and accuracy of the information presented herein.
