

Re-measurement of Whitebark Pine Infection and Mortality in the Canadian Rockies

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Whitebark pine (*Pinus albicaulis*) populations are under threat across the species' range from white pine blister rust (*Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*), fire exclusion and climate change (Tomback and Achuff 2010). Loss of whitebark pine is predicted to have cascading effects on the following ecological services: provision of high-energy food for wildlife (Tomback and Kendall 2001), facilitation of succession (Callaway 1998) and retention of snowpack (Tomback and others 2001).

While numerous studies have reported on the incidence of white pine blister rust on whitebark pine and subsequent mortality (see Kendall and Keane 2001 and Smith and others (2008) for examples), only a few have reported on rates of change in these variables (Keane and Arno 1993, Smith and others (2008), GYWPMWG 2010). We report here on the change in blister rust incidence and mortality of whitebark pine, over two and three time periods, in the Canadian Rockies from Waterton Lakes National Park (WLNP) on the international boundary (49°N), north to McBride, British Columbia (53°N).

In 2003 and 2004, we re-established eight plots that Kendall and others (1996) had measured in 1996 in WLNP, and established 107 new plots; 71 of the total 115 plots are east of the Continental Divide in Alberta and 44 are west of the Divide in British Columbia (Figure 1). 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 from plot center along transect (Kendall 2003).

Methods for establishing plots (10 m x 5 m) and assessing health were those recommended by Tomback and others (2005). All trees (≥ 1.3 m) were marked with numbered aluminum tags. Both single seedlings and clumps of seedlings were counted as only one seedling site, and classified by two size classes (< 50 cm or ≥ 50 cm). Incidence of infection by blister rust was reported as proportion of live trees that were infected at the time of each survey. Mortality was from all causes and reported as proportion of dead trees at the time of each survey. Some dead trees may be decades old, while others were recently dead (still had red needles).

In 2009, we re-measured 114 plots, as we were unable to re-locate one. We assessed a total of 5,865 trees (≥ 1.3 m) and 2,874 seedling clumps (< 1.3 m) in 2003-04, and 5,896 trees and 3,645 seedling clumps in 2009. The increase in the

number of trees was because some seedlings grew above 1.3 m in height during the interval.

In all 114 plots, the rust infection increased from 42 percent in 2003-04 to 52 percent in 2009, while mortality increased from 18 percent to 28 percent (Figure 2), or about 2 percent yr^{-1} over the 6 to 7 year interval. Of the recently dead trees white pine blister rust was the dominant cause of death. Levels of infection continue to show a latitudinal gradient of highest infection in the southern zone of the study area, lowest in the central zone and rising again in the northern zone (Figure 2).

Infection level for seedlings was virtually unchanged, averaging 17 percent in 2003-04 and 15 percent in 2009, but again, levels were highest in the southern zone at 30 percent compared to 6 percent in the central zone and 2 percent in the northern zone. The mean density of the combined size classes was 0.04 seedling clumps per m^2 (± 0.06 seedling clumps per m^2 one standard deviation from the mean).

In the eight plots that have been measured three times, infection increased from 43 percent of live trees in 1996, to 70 percent in 2003 and 78 percent in 2009 (Figure 3). The highest increase in mortality occurred between 1996 to 2003-04, (from 26 percent to 61 percent) then rose slightly to 65 percent in 2009. Infection levels increased 4 percent yr^{-1} in the first seven years (Smith and others 2008), but only 1.3 percent yr^{-1} in the six years of the second remeasurement interval—the combined total was an increase of 3 percent yr^{-1} over the 13 years from 1996 to 2009. Mortality levels increased 5 percent yr^{-1} in the first seven years (Smith and others 2008), but less than 1 percent yr^{-1} during the second interval, for a combined increase of 3 percent yr^{-1} over 13 years.

While it appears that the rates of increase in infection and mortality have decreased in the last six years, rust is still killing many whitebark pine trees and this is cause for concern. Infection and mortality from white pine blister rust are present in all plots, but the highest levels were in southwestern Alberta and southeastern British Columbia. This area also had the highest levels of infection of seedlings, and canopy kill (Smith and others 2008).

The decline in whitebark pine populations has led to this species being listed as Endangered under *The Wildlife Act* in the Province of Alberta in 2008 (Government of Alberta 2010), and a recovery strategy is in preparation. Nationally, whitebark pine has been assessed as Endangered (COSEWIC 2010), public consultations have been completed, and legal

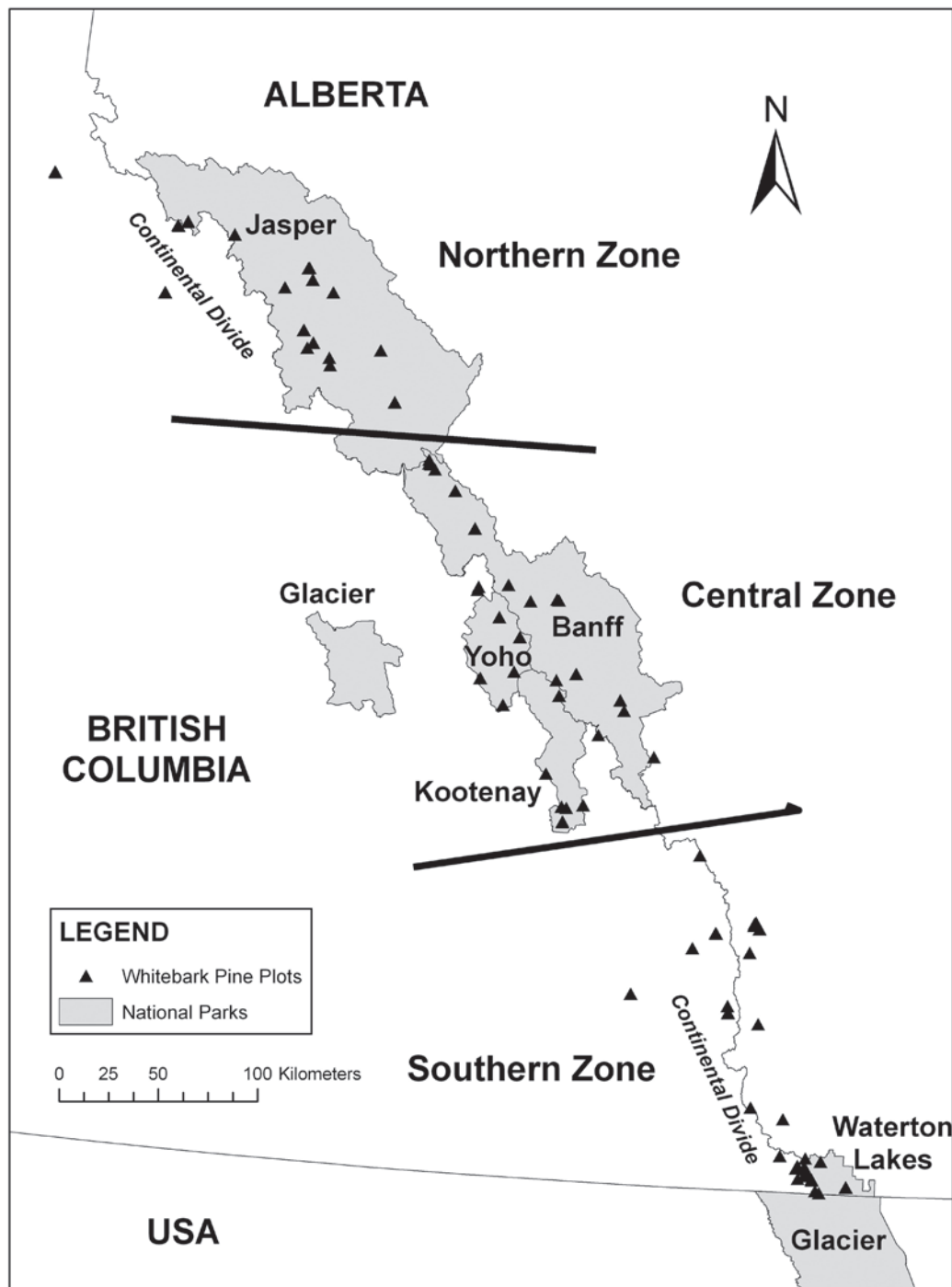


Figure 1. Study area showing three zones in the Canadian Rockies range of whitebark pine.

listing is pending. In WLNP, restoration activities underway include caging and collecting cones from putatively resistant whitebark pine trees and planting seedlings.

Acknowledgements

We thank Peter Achuff, Heather Anderson, Diane Casimir, Myles Carter, Tim Chevrier, Heidi Fingler, Doug

McNearney, Nicholas Niddrie, Jane Park, Ian Pengelly, and Geoff Skinner for their enthusiastic field work. Special thanks to Katherine Kendall for sharing her plot data from 1996. We thank Peter Achuff, Cathie Jean and Michael Murray for their helpful comments on previous drafts of this manuscript. Financial support was provided by Parks Canada Ecological Integrity Monitoring Programs in Banff, Jasper, Kootenay, Yoho and Waterton Lakes national parks.

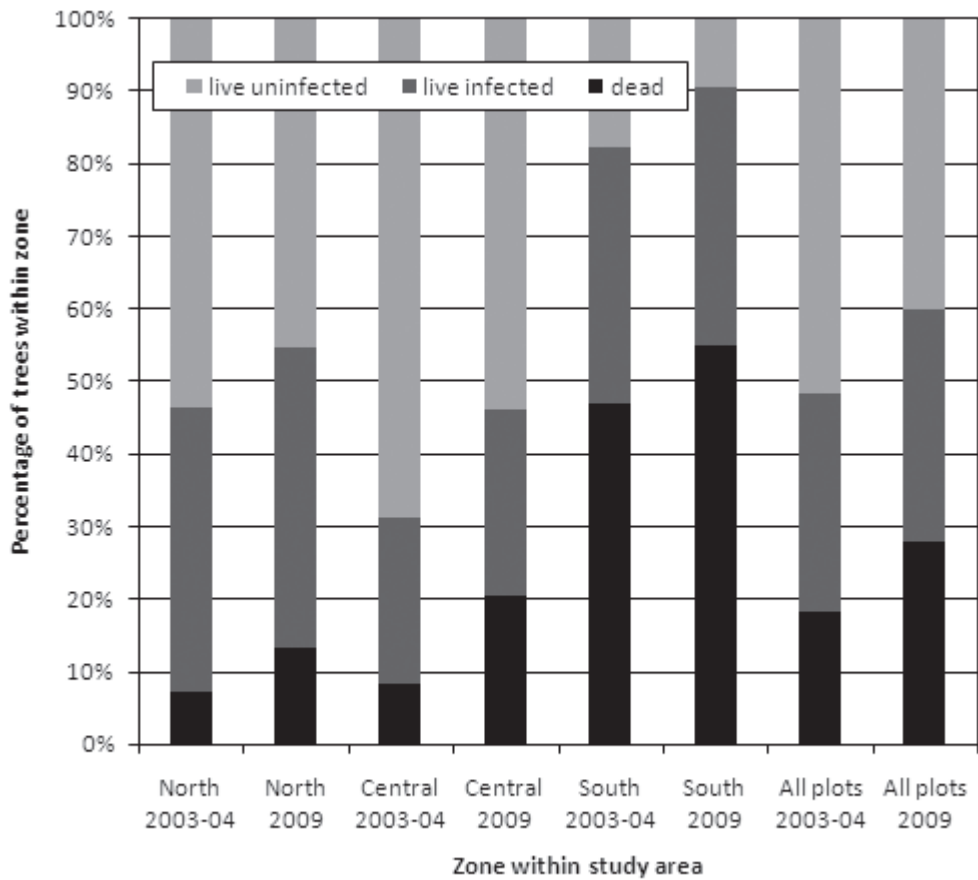


Figure 2. Incidence of white pine blister rust and whitebark pine mortality in the Canadian Rockies by latitude and study area.

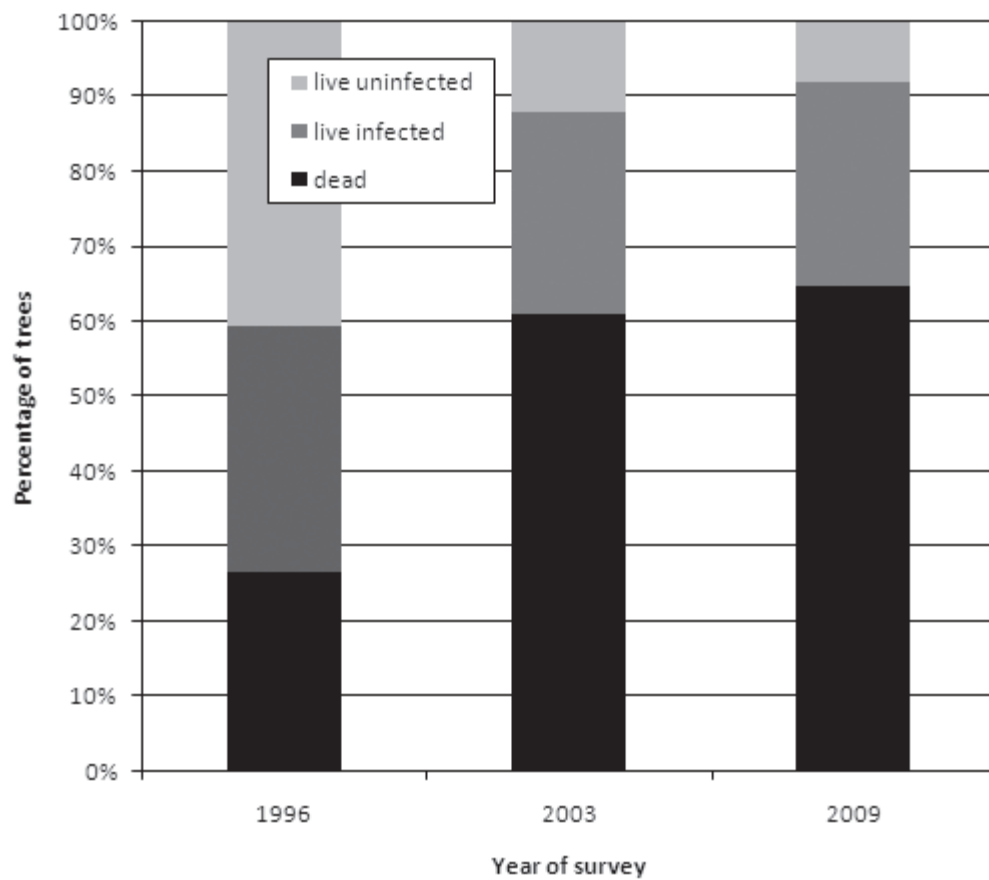


Figure 3. Incidence of white pine blister rust and whitebark pine mortality for eight plots over three time periods in Waterton Lakes National Park, Alberta.

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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.
