Foothills Growth and Yield Association

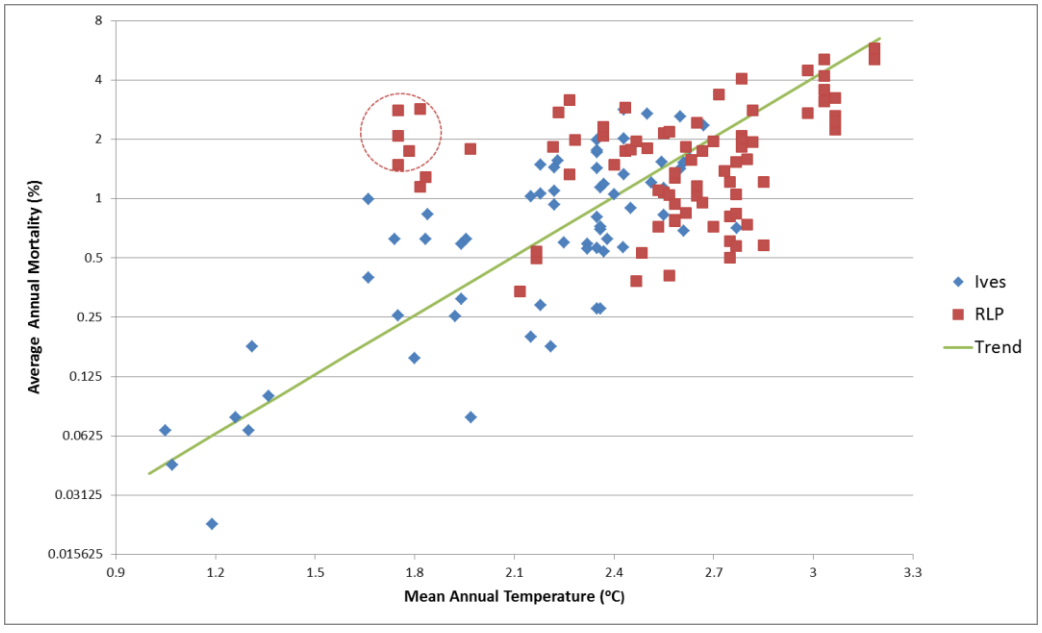
Technical Note 2011-1

Mapping the Risk of Climate-linked Mortality in Lodgepole Pine Regeneration

February 21, 2011

Dick Dempster[1] and Darren Wiens[2]

Annual mortality rates of young lodgepole pine show an exponential relationship with mean annual temperature. Mortality (note the logarithmic scale on the vertical axis of the graph shown below) doubles for every 0.3°C increase in temperature (shown on the horizontal axis). This general trend held true for data from two regional studies conducted over different time periods: one in planted lodgepole pine between 2001 and 2006[3], and another in naturally regenerating stands between 1981 and 1990[4]. The increase in mortality with temperature may be partly a direct result of climate injury, but climate-mediated pathogen effects are also strongly implicated. Deviations from the general trend appear to result from site or treatment factors. (For example, the 5 outlying samples circled at the top left of the scatter plot below are located on poorly drained acidic upland sites where survival of planted stock might actually benefit from warmer temperatures.) The general trend is of particular concern given observed and predicted levels of climate warming in the Foothills, and may warrant ameliorative or adaptive strategies.



Data from two independent studies showed a similar overall trend of mortality with mean annual temperature

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[3] Dempster, W.R. 2010. Regenerated lodgepole pine trial, 2009 crop performance report. *Foothills Growth and Yield Association Technical Report.*
[4] Ives, W.G.B. and C.L. Rentz. 1993. Factors affecting the survival of immature lodgepole pine in the foothills of west-central Alberta. *Forestry Canada Information Report NOR-X-330.*

We used the observed general trend between mortality and mean annual temperature, together with historic and projected spatial temperature data generated by ClimateAB[5], to map regeneration mortality risk throughout the forest management areas of FGYA members for two time periods.

- 1961 – 1990: based on historical climate "normal" data (see map on page 3);
- 2011 – 2020: based on projections by CGCM2[6] for the next decade (see map on page 4).

Three risk classes are recognized, based on the predicted level of mortality.

- Low: periodic average annual mortality less than 1%;
- Moderate: periodic average annual mortality 1 – 3 %;
- High: periodic average annual mortality greater than 3%.

The maps are preliminary, and further analysis and testing are required before their application to operational or policy decisions. Recently updated data are now available for both climate and mortality, and will be included in the expanded analyses. ClimateAB is currently being updated to include projections from the latest CGCM version.

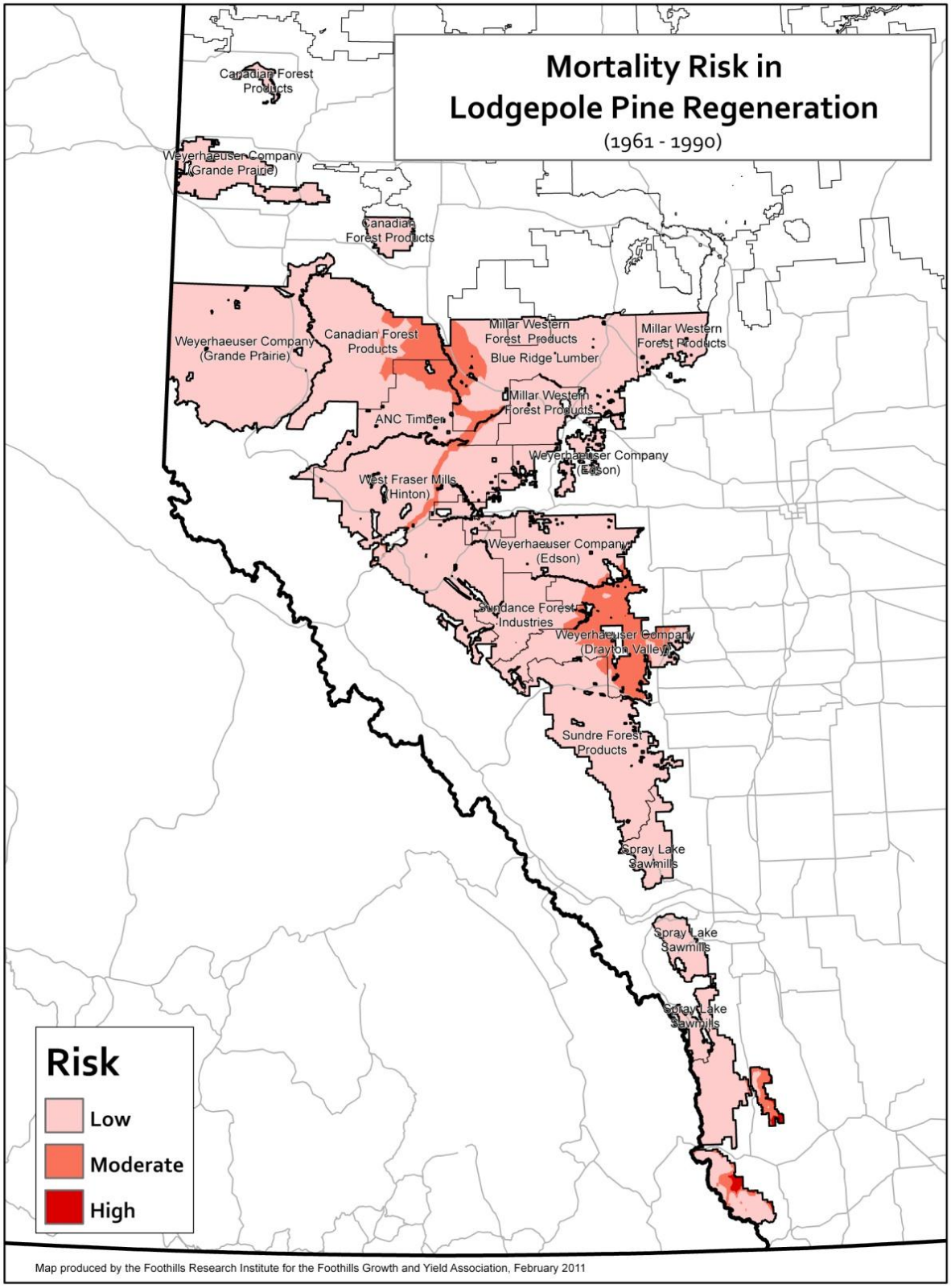
Subject to these validations, adaptive strategies may be warranted for areas indicated as having moderate or high mortality risks over the next 10 years. Possible examples of actions deserving consideration include:

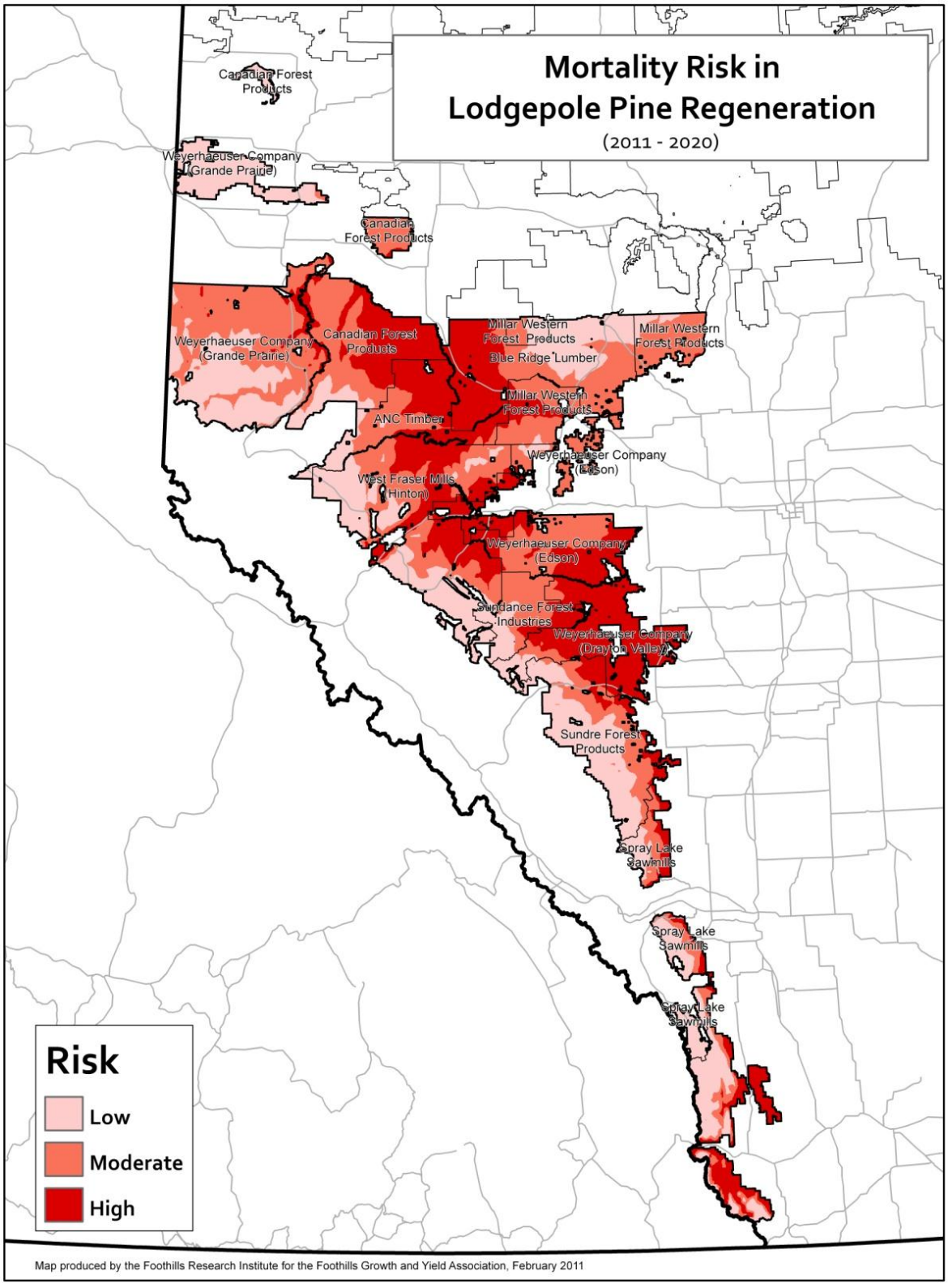
- Increase emphasis on risk assessment during regeneration planning and surveys;
- Develop and apply forest health decision aids for stand establishment and maintenance similar to those already being applied in other provinces and countries;
- Maintain or increase natural regeneration density targets;
- Minimize exposure of planted stock to conditions leading to high levels of physiological stress;
- Match seed sources to out-planting sites on the basis of present and future, rather than past, climate conditions.

In high risk areas, which historically appear to have approximated the lower end of lodgepole pine's elevation range, more innovative and aggressive strategies may be justified in addition to the above. These might include planting suitable alternative species where plentiful natural regeneration of pine is unachievable, and rigorous avoidance of planting pine or other susceptible species in locations where high levels of specific threats are identified.

Areas indicated as low risk are the least likely to experience mortality increase over the next decade as a result of climate change. Reforestation in these areas has sometimes been problematic, especially on sites having cold acidic soils with a thick insulating organic layer. Warming temperatures may be beneficial for establishing regeneration on such sites.

[5] Wang, T., Hamann, A., Spittlehouse, D., and Aitken, S. N. 2006. Development of scale-free climate data for western Canada for use in resource management. *International Journal of Climatology*, 26(3):383-397.
[6] Canada Centre for Climate Modelling and Analysis Coupled Global Climate Model, 2nd version.


Mortality Risk in
Lodgepole Pine Regeneration
(1961 - 1990)
Canadian Forest Products
Weyerhaeuser Company (Grande Prairie)
Canadian Forest Products
Weyerhaeuser Company (Grande Prairie)
Canadian Forest Products
Millar Western Forest Products
Blue Ridge Lumber
Millar Western Forest Products
Millar Western Forest Products
ANC Timber
Weyerhaeuser Company (Edson)
West Fraser Mills (Hinton)
Weyerhaeuser Company (Edson)
Sundance Forest Industries
Weyerhaeuser Company (Drayton Valley)
Sundre Forest Products
Spray Lake Sawmills
Spray Lake Sawmills
Spray Lake Sawmills
Risk
Low
Moderate
High
Map produced by the Foothills Research Institute for the Foothills Growth and Yield Association, February 2011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