

Reforestation Management in a Changing Environment

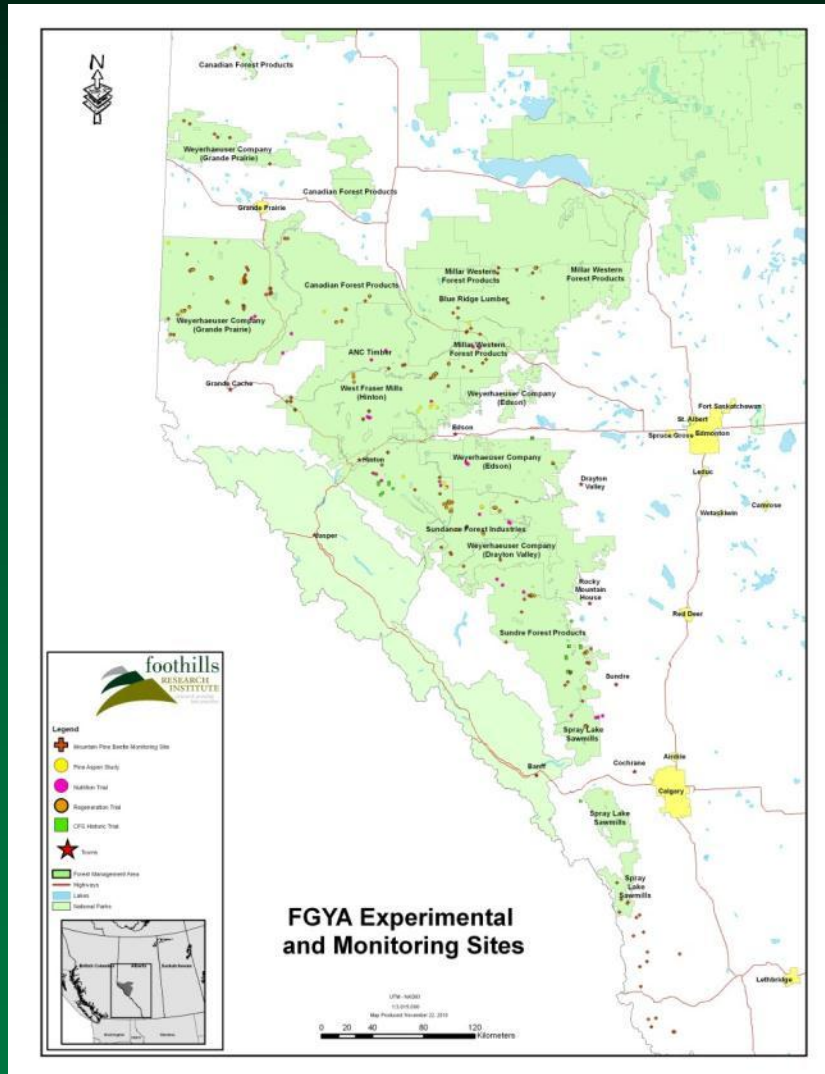
MEETING THE CHALLENGE

Foothills Research Institute Annual General Meeting

Edmonton, Alberta

October 4, 2011

Introduction and Presentation Outline



Outline

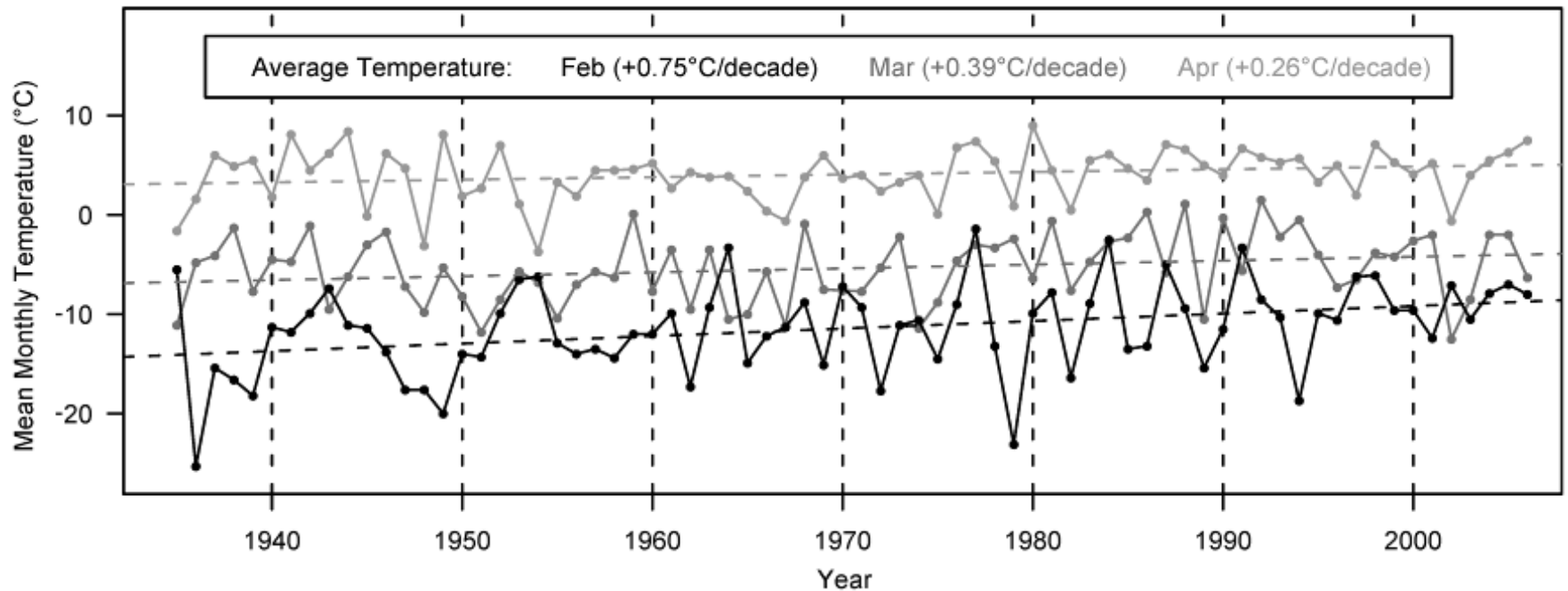
- What's changing in the Foothills forest environment?
- Meeting the challenge:
 - What have we done so far?
 - What are we going to do now?



What's Changing in the Foothills Forest Environment?

Alberta's Historical Temperature Trends

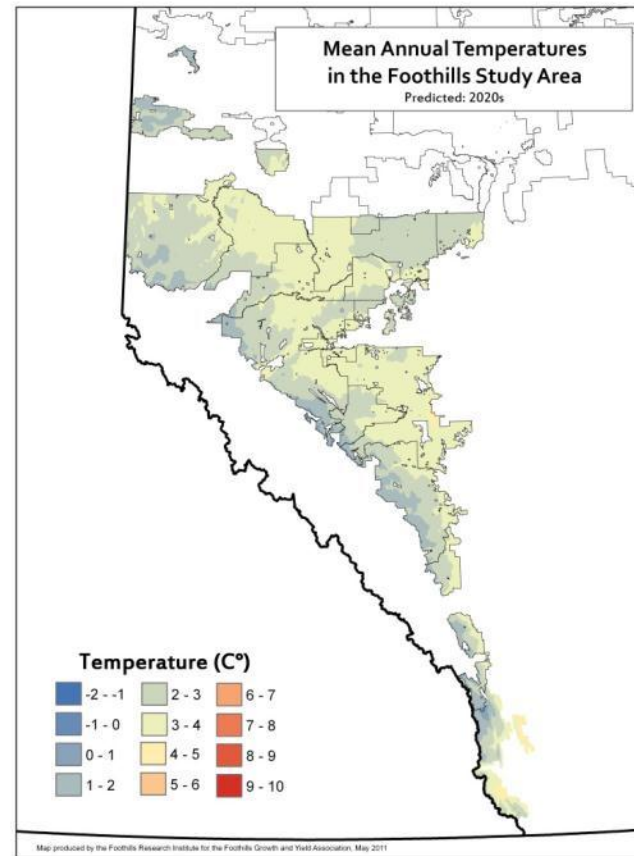
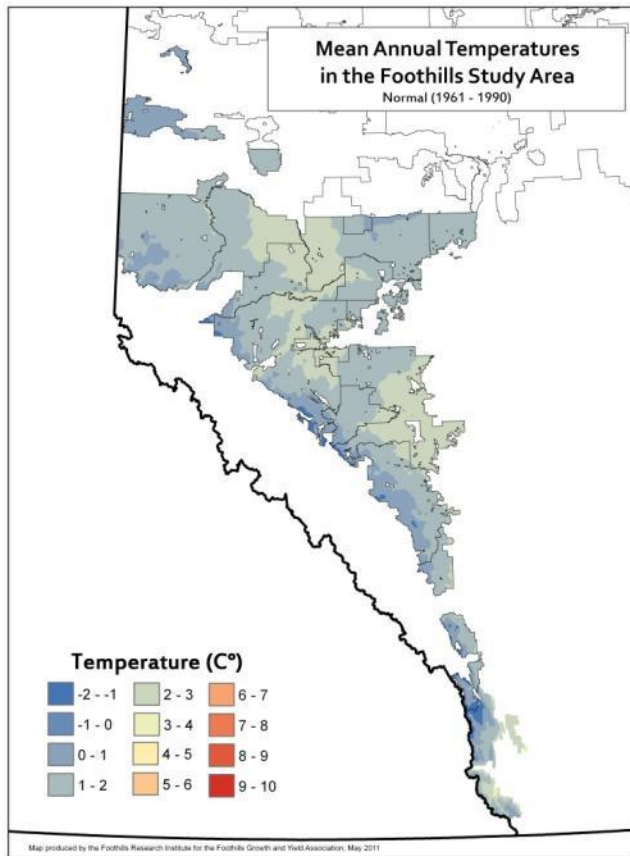
Monthly Temperature Trends (1935–2006)



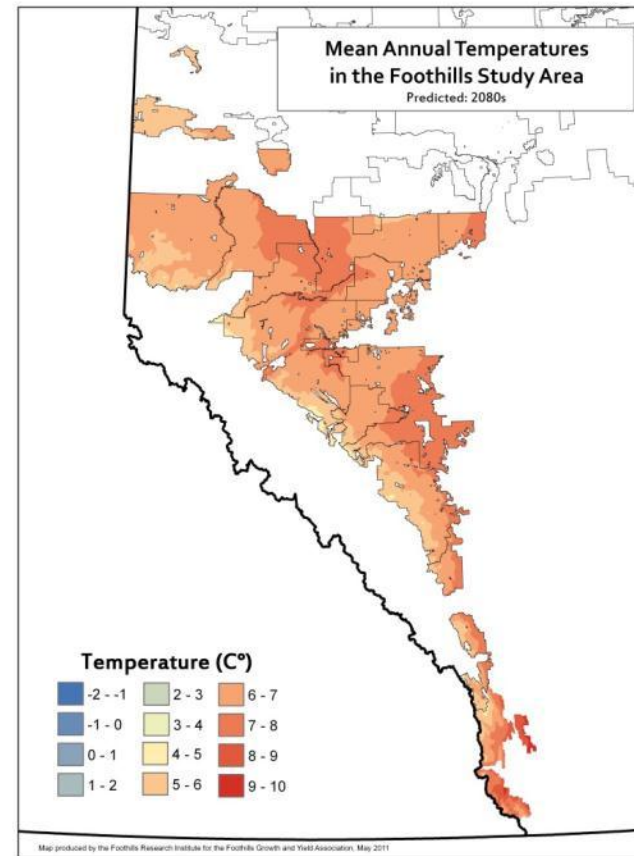
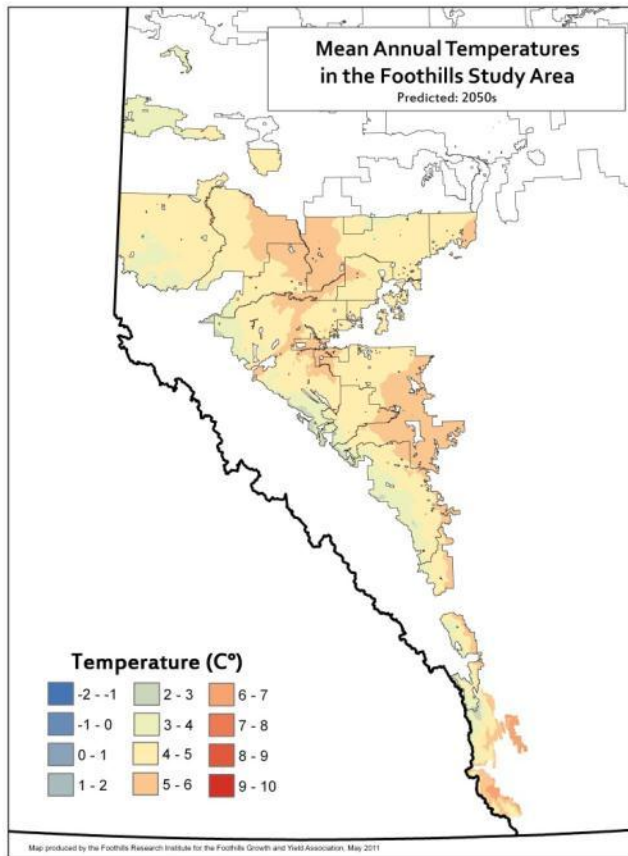
Climate Change in the FGYA Study Area

Climate Variable	Time Period		Change
	Climate Normal 1961-1990	Study Period 2001-2009	
Mean annual temperature (°C)	1.7	2.4	0.7
Mean warmest month temperature (°C)	13.9	15.0	1.0
Mean coldest month temperature (°C)	-11.7	-10.0	1.7
Mean annual precipitation (mm)	619	557	-62
Mean summer precipitation (mm)	415	364	-51
Precipitation as snow (mm)	165	151	-14
Annual heat moisture index (°C/m)	19	23	4
Summer heat moisture index (°C/m)	34	43	9
Chilling degree days (dd<0°C)	1345	1123	-223
Growing degree days (dd>5°C)	1036	1093	56

Predicted Warming in the Foothills



Predicted Warming in the Foothills



The Wake-up Call: Mountain Pine Beetle



Threats to Lodgepole Pine Are Not Confined to MPB



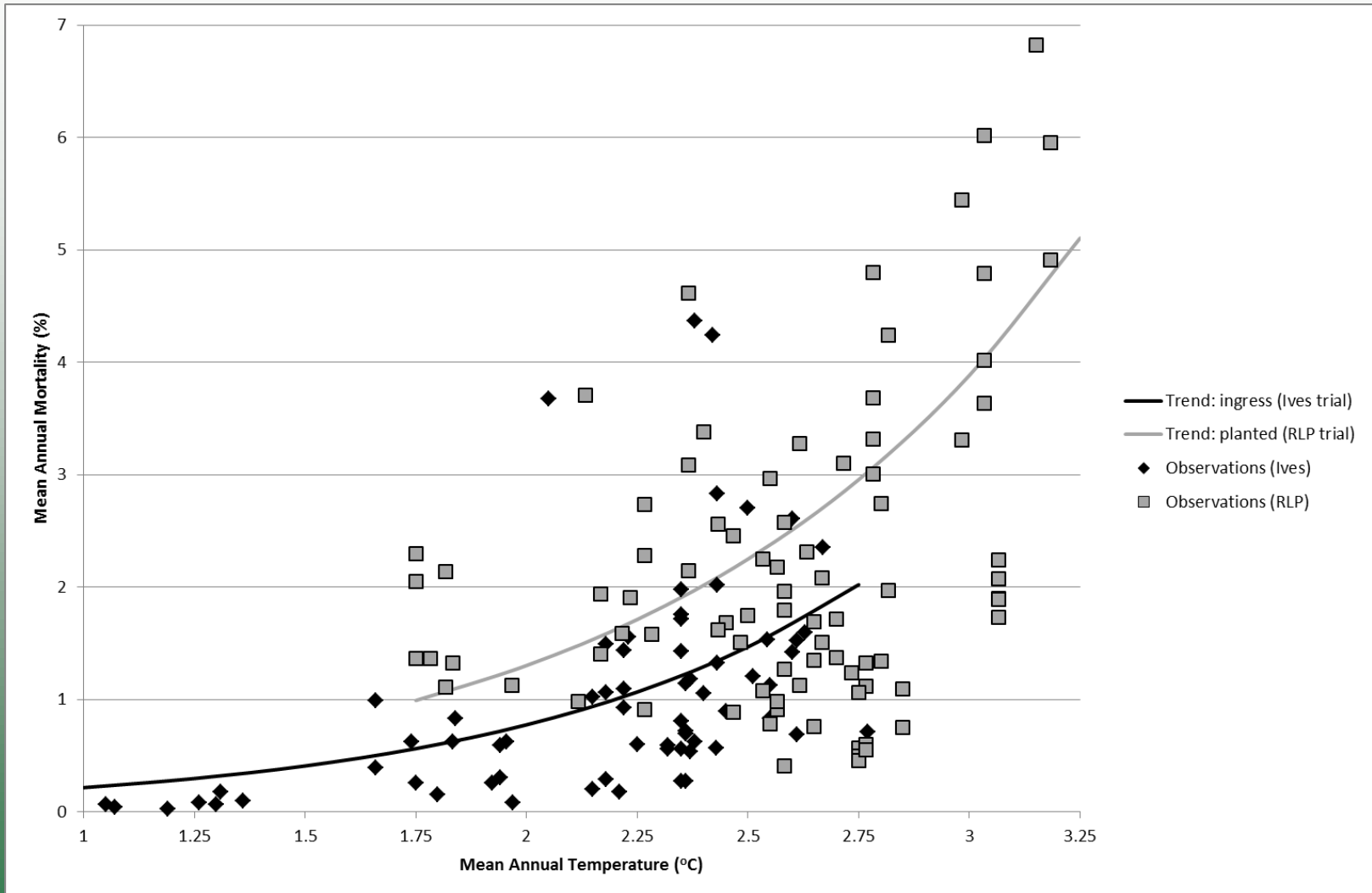
Hylobius Root Collar Weevil



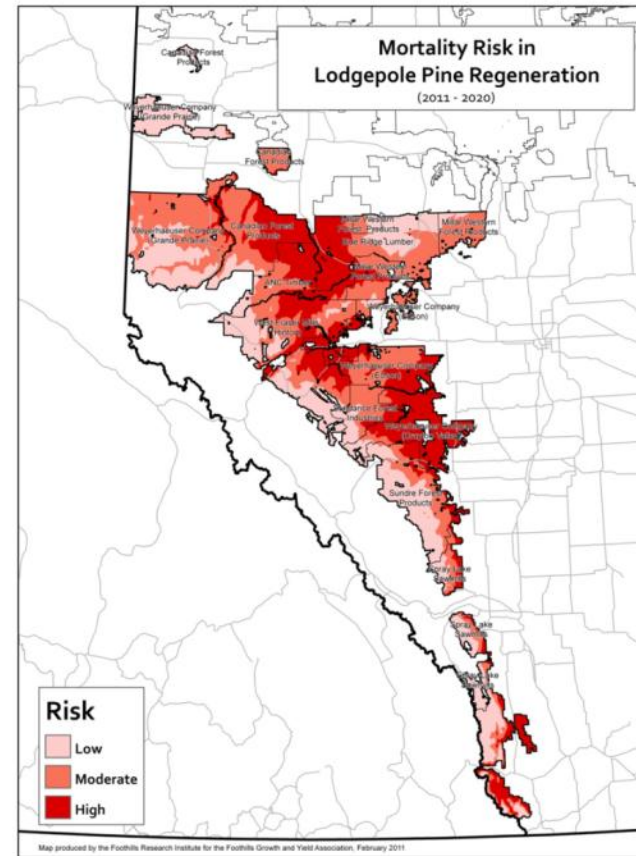
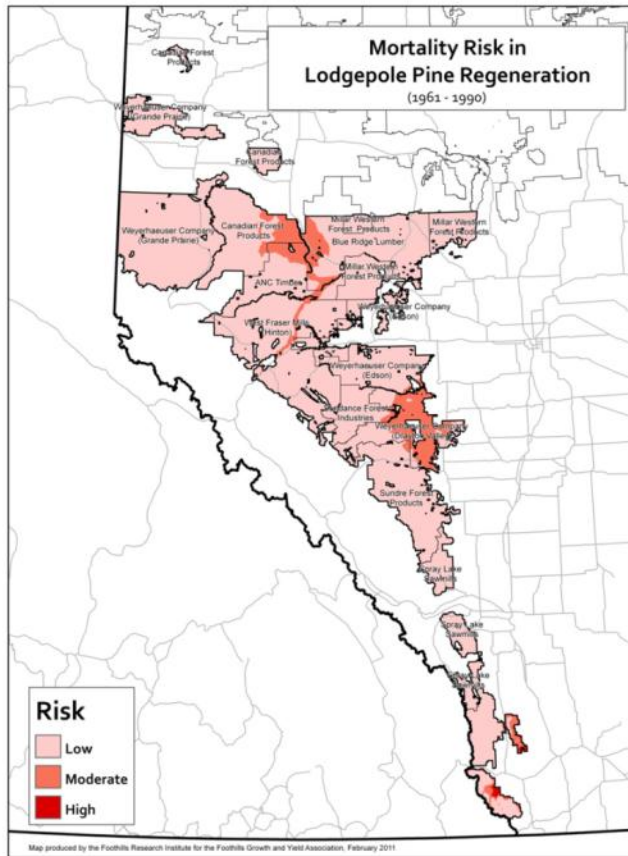
Armillaria Root Rot



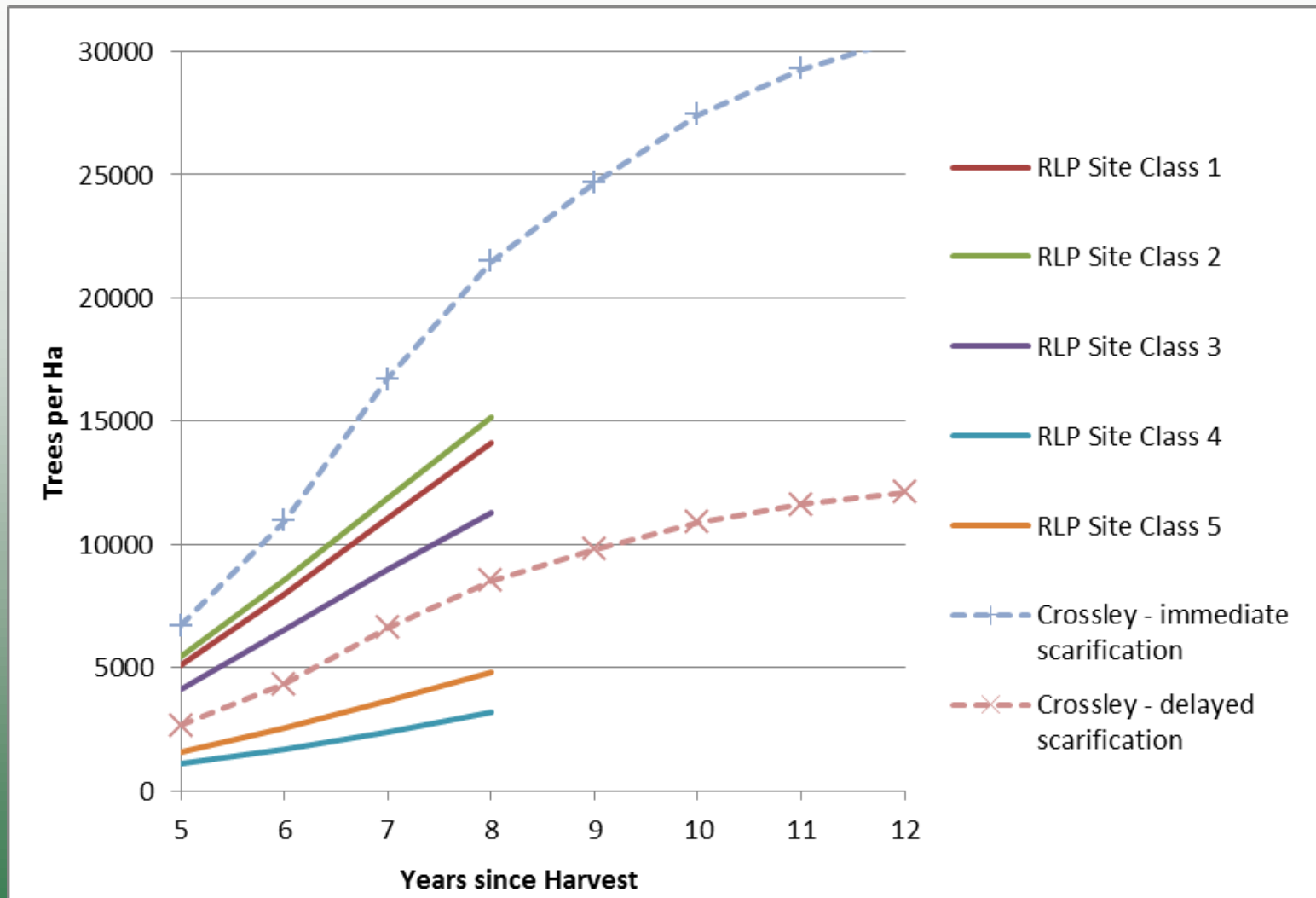
Juvenile Mortality Trends with Temperature



Increasing Juvenile Mortality Risk?



The Good News: Natural Regeneration



More Good News (or Wishful Thinking?)

- **Productivity increases in managed versus fire-origin lodgepole pine stands**
 - Udell and Dempster 1986
 - Huang, Monserud *et al* 2004
 - FGYA 2008
- **Productivity increases with climate warming**
 - Monserud and Huang 2002
 - Monserud, Yang *et al* 2008
 - Cortini, Comeau *et al* 2011
 - FGYA (unpublished)

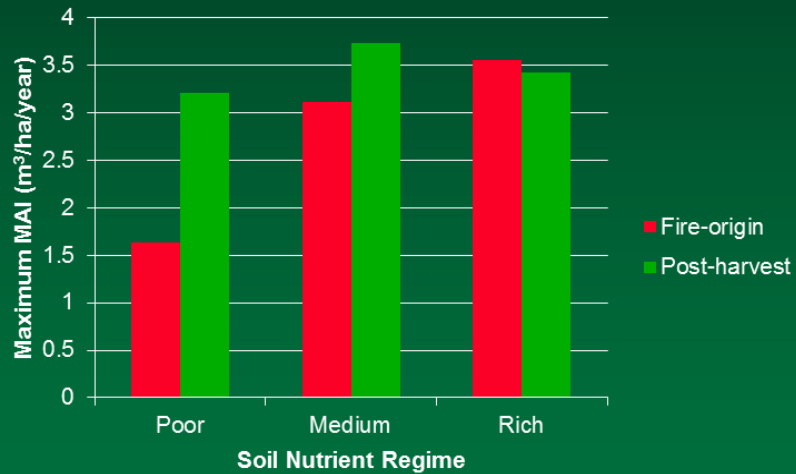
Operations: for Better or for Worse?



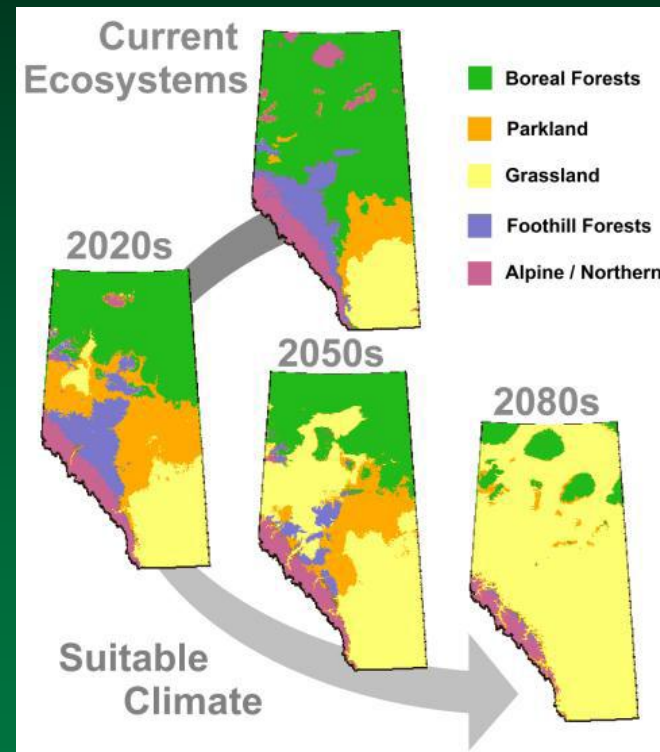
- Planting pine too soon after harvesting increases exposure to *Hylobius*
- Planting, brushing and thinning can aggravate susceptibility to *Armillaria*
- Reforestation to pure pine versus mixed-species may increase health risks
- Seed zone restrictions will result in stock being maladapted to future conditions

Conflicting Expectations?

Forest productivity is increasing



The end of the Foothills Forest is in sight



Change in a Nutshell

- **Climate warming has already occurred**
- **Impacts on pine not confined to mountain pine beetle**
- **Increased stand height growth and pathogen occurrence (both climate and management implicated)**
- **Increasing juvenile mortality likely, directly and indirectly linked to climate**
- **Yields forecast to increase, but**
- **.... most of Foothills forecast to become unsuitable for lodgepole pine within one rotation**
- **Major uncertainty and apparent inconsistencies in long-term predictions and interpretation of research results**
- **Some current reforestation practices may exacerbate risks**

Meeting The Challenge

- **Ignore risks and accept costs of non-adaptation?**
- **Adapt forest management practices to reduce risks, reduce costs and sustain healthy forests?**



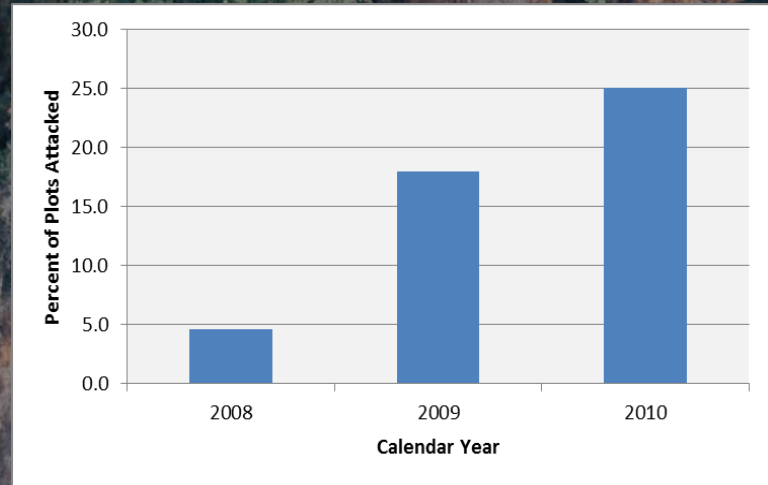


What Have We Done So Far?

Mountain Pine Beetle (Cooperative Research with the MPB Ecology Program)

- **Monitoring**

- network of 240 permanent sample plots established to monitor impacts of beetle attack on stand development



- **Forecasting**

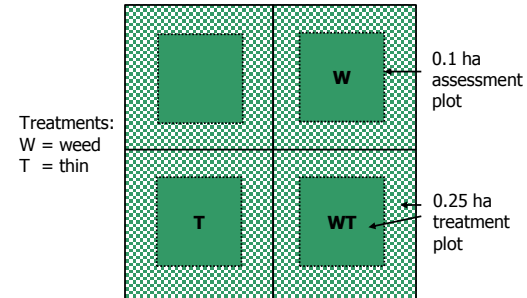
- decision-support tool forecasting stand development following beetle attack



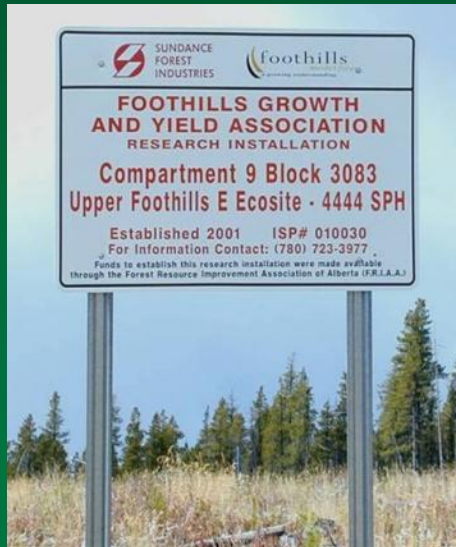
Regenerated Lodgepole Pine

- Monitoring stand development of harvest-origin lodgepole pine in relation to site, planting density, and vegetation management
- Split-plot design with replication
- 102 one-hectare plot clusters established throughout the Foothills, 2000 – 2002

Lodgepole Pine Regeneration Trial
Design of a Plot Cluster



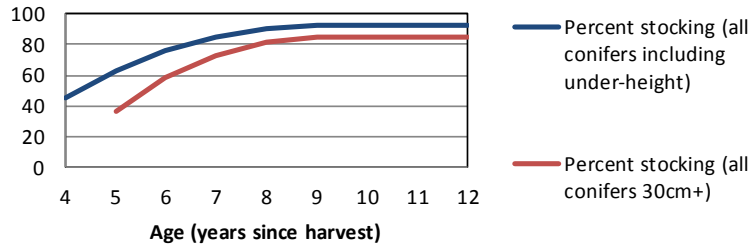
(102 clusters installed across 5 site types at 6 planting densities, with replication)



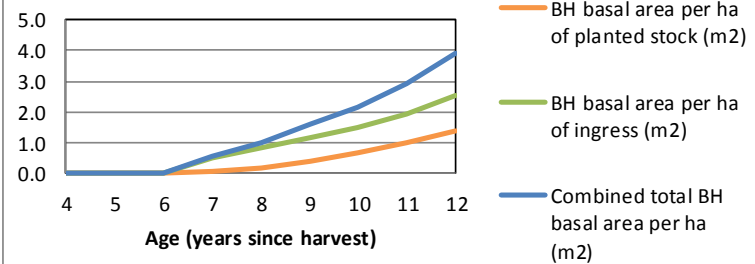
Forecasting Regeneration Performance

Graphs

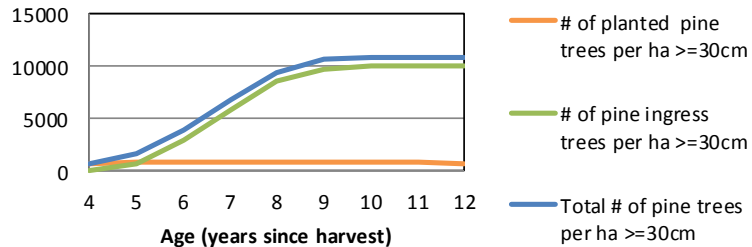
Coniferous % Stocking



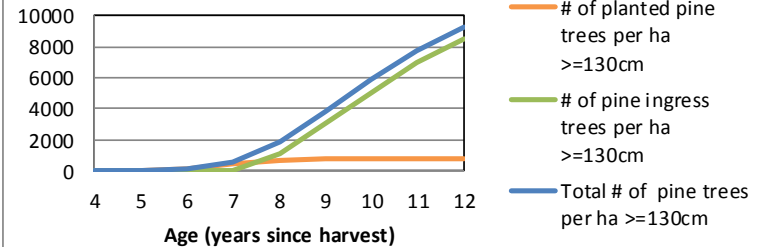
Pine Basal Area



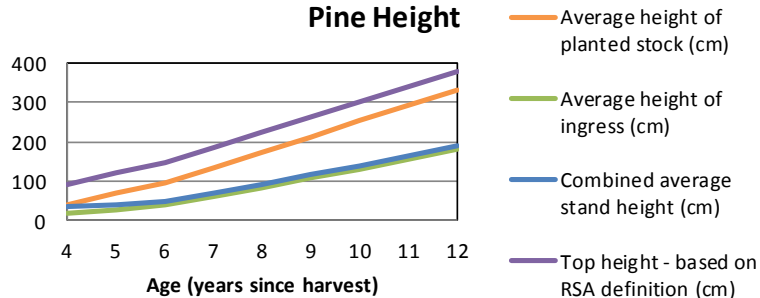
Pine Density (trees 30cm+)



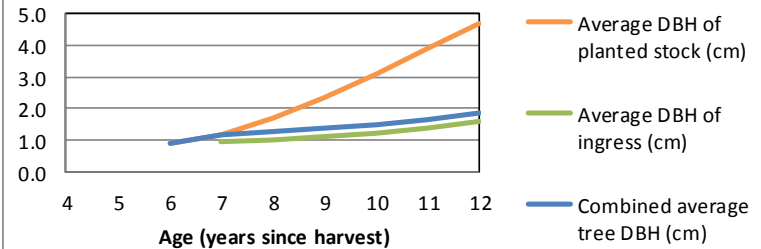
Pine Density (trees 130cm+)



Pine Height



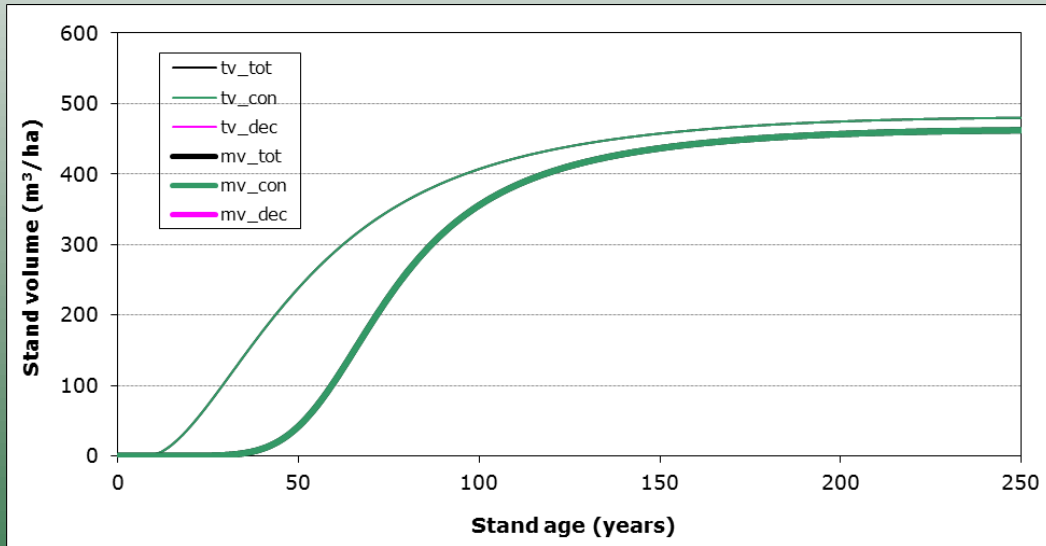
Pine Diameter Breast-height (DBH)



Linking Regeneration to Long-term Productivity

Forecast Summary

	4	5	6	7	8	9	10	11	12
Opening age (years since harvest)									
Total age (years since germination)	4	5	6	7	8	9	10	11	12
Top height - based on RSA definition (cm)	92.6	120.9	149.2	187.4	225.6	263.7	301.9	340.0	378.2
Total # of coniferous trees per ha	1,356	2,902	5,228	7,812	10,056	10,990	10,990	10,990	10,990
# of pine per ha >=30cm	770	1,602	3,838	6,755	9,397	10,606	10,773	10,839	10,857
Percent stocking (conifers 30cm+)		37.1	58.8	73.0	81.7	84.7	84.7	84.7	84.7
Pine BH basal area per ha (m2)	0.00	0.00	0.01	0.55	1.01	1.58	2.17	2.91	3.91



A photograph showing four people walking away from the camera on a dirt path through a forest. They are wearing safety gear, including orange hard hats and high-visibility vests. The path is flanked by tall evergreen trees, and the background shows a dense forest under a blue sky with scattered white clouds.

What Are We Going To Do Now?

Research and Decision Support

- **Research emphasis on forecasting regeneration health, performance and risks**
- **Decision support for establishing and restoring healthy stands, and associated opportunities for reduction of silvicultural risks and improvement of operational effectiveness:**
 - Continued monitoring, data collection and analysis
 - Inclusion of additional species to support species selection decisions
 - Interdisciplinary discussion and cooperation
 - Operational testing and validation

Opportunities Being Explored for Risk Reduction

- **Reduced reliance on early planting of lodgepole pine**
 - adjusted planting prescriptions based on improved forecasting of pathogen threats and natural regeneration
- **Improved assurance of natural regeneration**
 - slash re-distribution where necessary to achieve adequate cone densities
- **Reforestation of problem pine sites with alternative species or mixtures**
 - primarily white spruce, aspen
- **Maximization of AAC contribution of non-pine species**
 - improved identification and management of existing understories
- **Adjusted deployment of planted stock**
 - matching seed sources to out-planting sites on the basis of current and future (versus past) climate conditions

Acknowledgments

