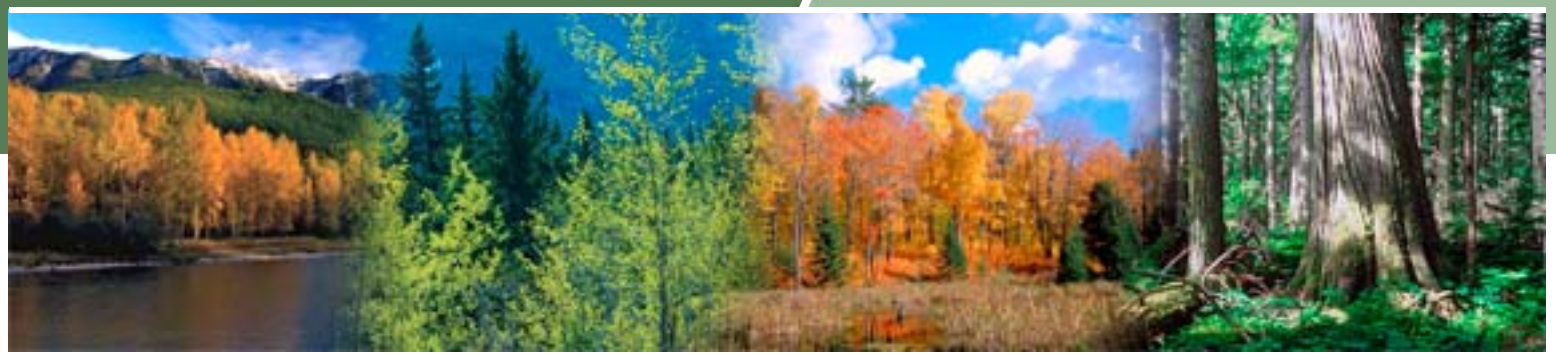

# Learning lessons from the mountain pine beetle outbreak in Canada

Dr Catherine Ste-Marie

Canadian Forest Service, Natural Resources Canada

ICF National Conference, Cardiff April 2015

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# The Canadian Forestry Context

Canada has

**348** million hectares of forest

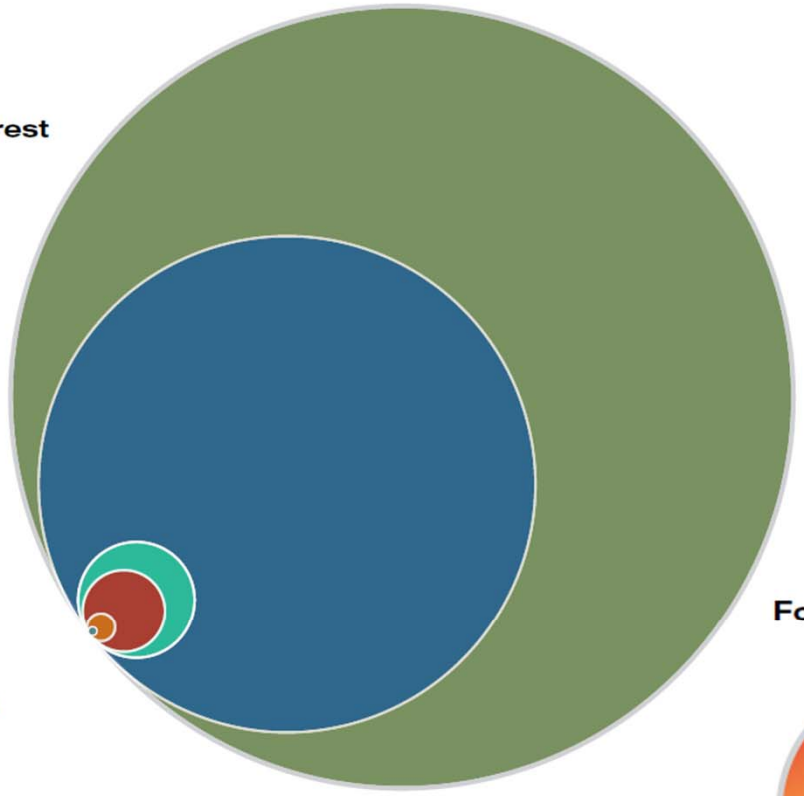
**153** million hectares of forest **independently-certified as sustainably managed**

**8.6** million hectares of forest **damaged by insects in 2012**

**4.2** million hectares of forest **burned in forest fires in 2013**

**0.6** million hectares of forest **harvested in 2012**

**0.05** million hectares of forest **deforested in 2012**



**Forest ownership**

**94%** are on public lands

**90%** provinces and territories
**2%** Aboriginal peoples
**2%** federal government

**6%** are on private lands

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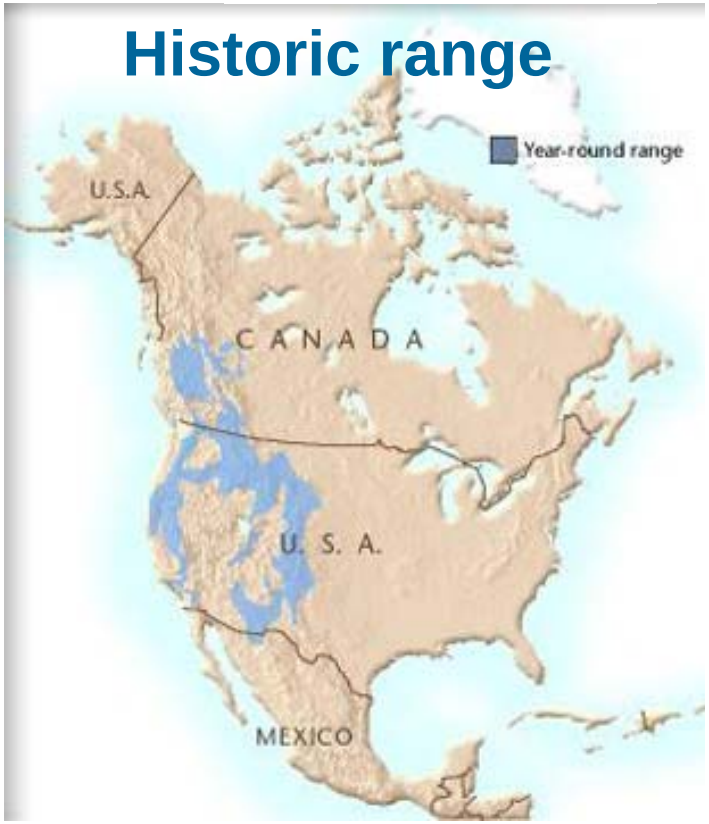
# The Mountain Pine Beetle (MPB)


*Dendroctonus ponderosae*

- Endemic to Western North America
- Reproduces in most pine spp.
- Usual / favorite hosts:
  - Lodgepole, Ponderosa and Whitebark pines
- Other suitable hosts:
  - Jack pine and Engelman spruce
- Has historically contributed to forest renewal by attacking older unhealthy trees



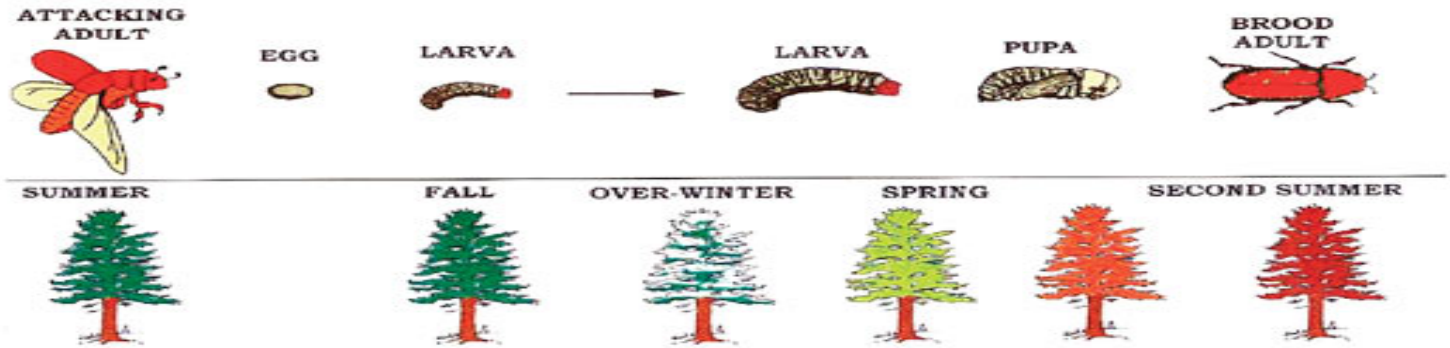
# MPB Life Cycle & Outbreak Stages

Infestation and introduction of blue stain fungus in sapwood

**Green Attack (months)**
Green dead trees with boring dust and resin pitch tubes on bark. Undetectable by areal survey

**Red Attack** (2-4y)
Dead trees with red needles

**Grey Attack**
Dead trees without needles are susceptible to burning and falling




MOUNTAIN PINE BEETLE LIFE CYCLE

# Forest and Forestry in BRITISH COLUMBIA

BC has 52M ha of certified managed forest

- 200k ha harvested yearly
- 1/5 job
- World largest exporter of softwood lumber
- 4-7% of BC GDP

Provides carbon sequestration, water regulation, natural habitat, tourism…

And is home to communities and aboriginal peoples

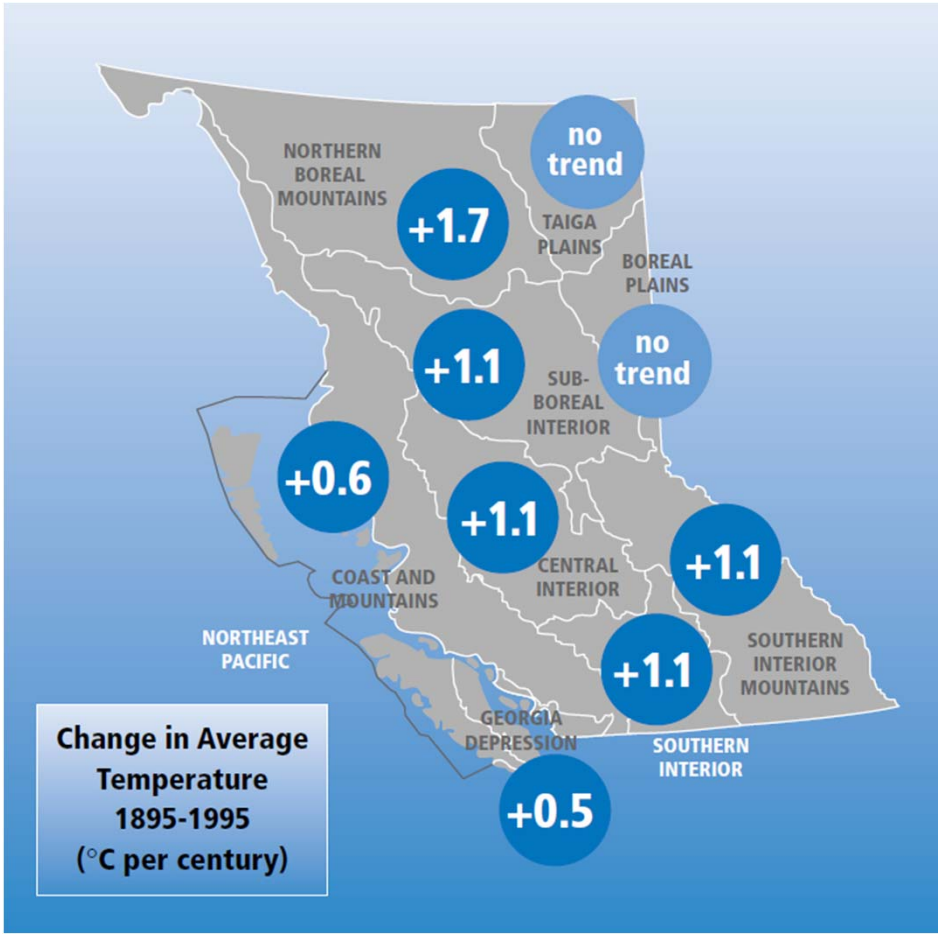
# A Century of Forest Fire Management

- Uneven-aged stands historically maintained by frequent surface fires
- Almost a century of effective wildfire management to protect forest resource and communities
- Increase in mature pine volume from 400M $m^3$ to 1,34B $m^3$ in early 90's
- A novel homogeneous landscape of mature pines ideal for the forest industry… and for the MPB!

# MPB and Climate

- Canada's cold climate has historically limited the duration and damage of periodic outbreaks
- MPB is sensitive to severe temperature changes. More than 50% of the populations are generally killed by:
  - Mild winter: several straight days of -35$^{o}$C
  - Early fall and late spring: -25$^{o}$C, especially cold snap in the fall before MPB builds up its glycerol level
- These cold events were frequent in Canada

# MPB and Climate Change




BC government

* No trends indicate insufficient data

- But the climate changed: no cold snaps or widespread cold events since 1995-96 in BC
- Large populations of MPB can overcome the defence of large healthy pines, and there were a lot of them in BC in the 1990's
- Large trees provide the best habitat for the beetle

# History of MPB Outbreak

Provincial-Level Projection of the Current Mountain Pine Beetle Infestation

Cumulative percentage of pine killed:

observed 1999 to 2013

projected 2014 to 2020

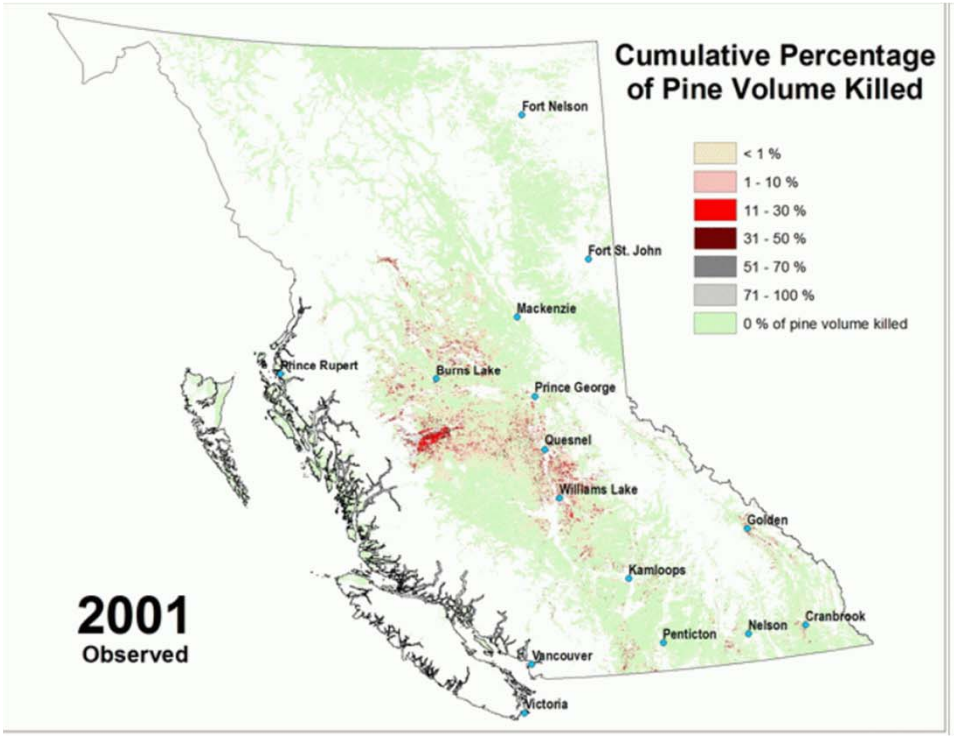
Canada BRITISH COLUMBIA

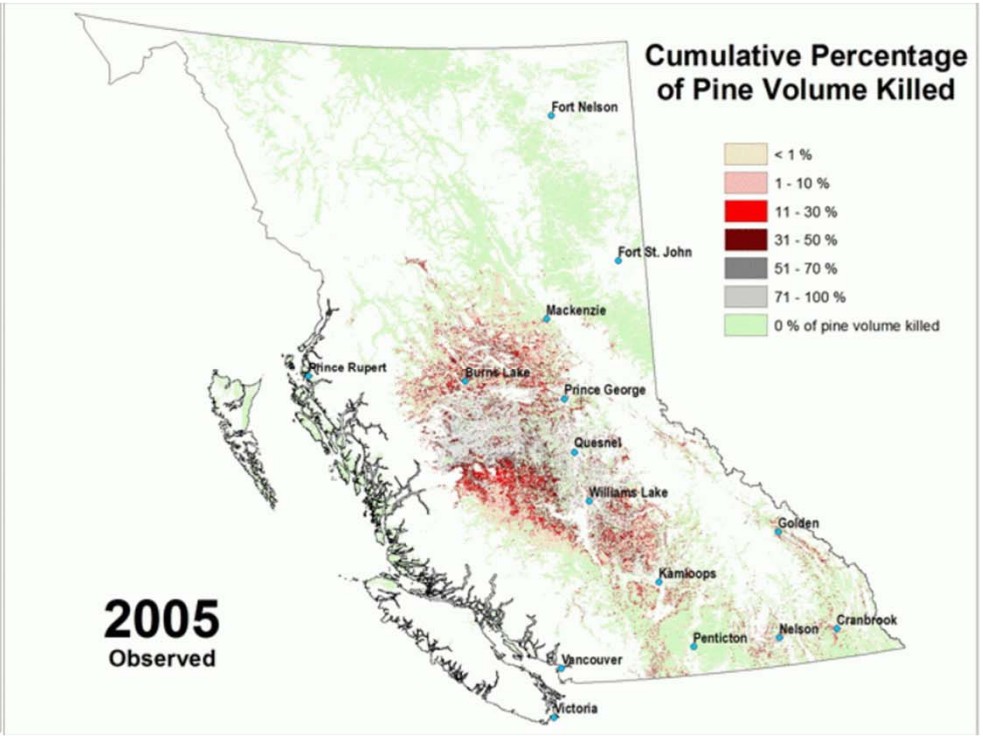
# History of MPB Outbreak

- In the early 2000's: 800K ha of forest killed
- BC stops waiting for cold weather and releases MPB Action Plan 2001's to fight the epidemic:
  - Destruction of infested trees on the leading edges
  - Increased harvest of infected and susceptible trees
    - Raise in annual allowable cuts in affected areas, new harvesting tenures to aboriginal peoples, permission to haul to other mills when local capacity is exceeded
- MPB Action Plan 2004 broadened to help the forest sector adapt to the crisis (Economic diversification, new forest-based enterprises, recovery of salvage wood)

# History of MPB Outbreak

In 2004, the infestation culminates with 140M $m^3$ of pine killed in BC.



# 2005-06: The epidemic starts to slow down in BC

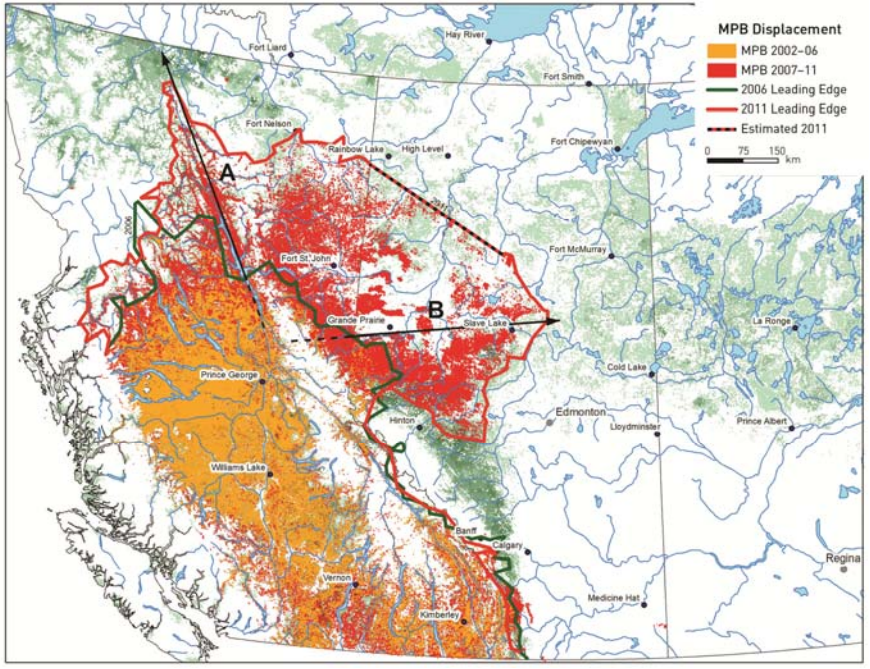
**Forest area containing mountain pine beetle-killed trees in Canada, 2003-2013**


The area disturbed by the mountain pine beetle is for British Columbia only.

**Source:** British Columbia Ministry of Forests, Lands and Natural Resource Operations. See *Sources and information* for more detail.

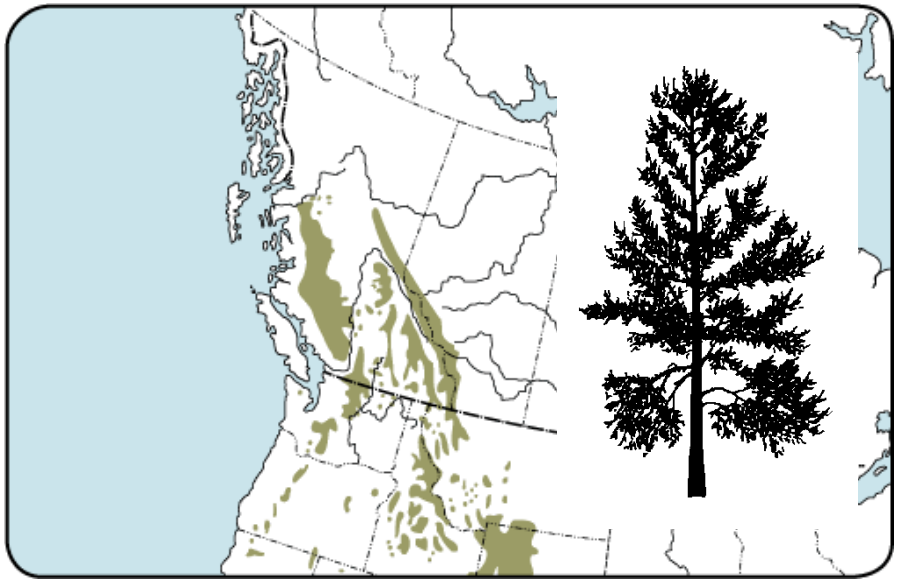
# 2005-06: MPB spreads East and North

- Significant MPB populations never established in Alberta
- In 2002, 2006 and 2009, MPB were carried on upper atmospheric wind, crossed the rocky mountain and were deposited in Northern BC and northwestern Alberta
- Inflight will continue until 80% of pines killed in BC



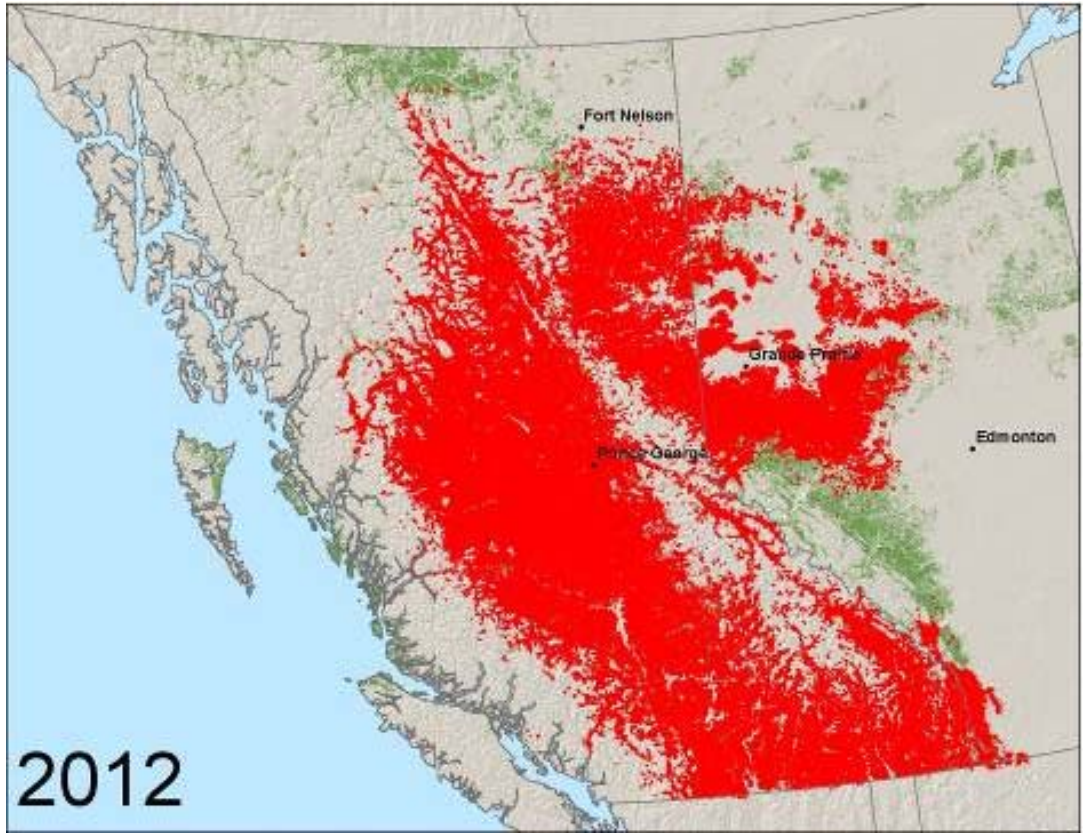
# More than a Forest Issue

- Cross-cutting impacts timber supply, communities & first nations, hydrology, natural habitats & biodiversity (Whitebark pine), tourism, roads, fire risks, carbon emissions…

# Current status

**Observed presence of mountain pine beetle from 1999 to 2012**



# Current status

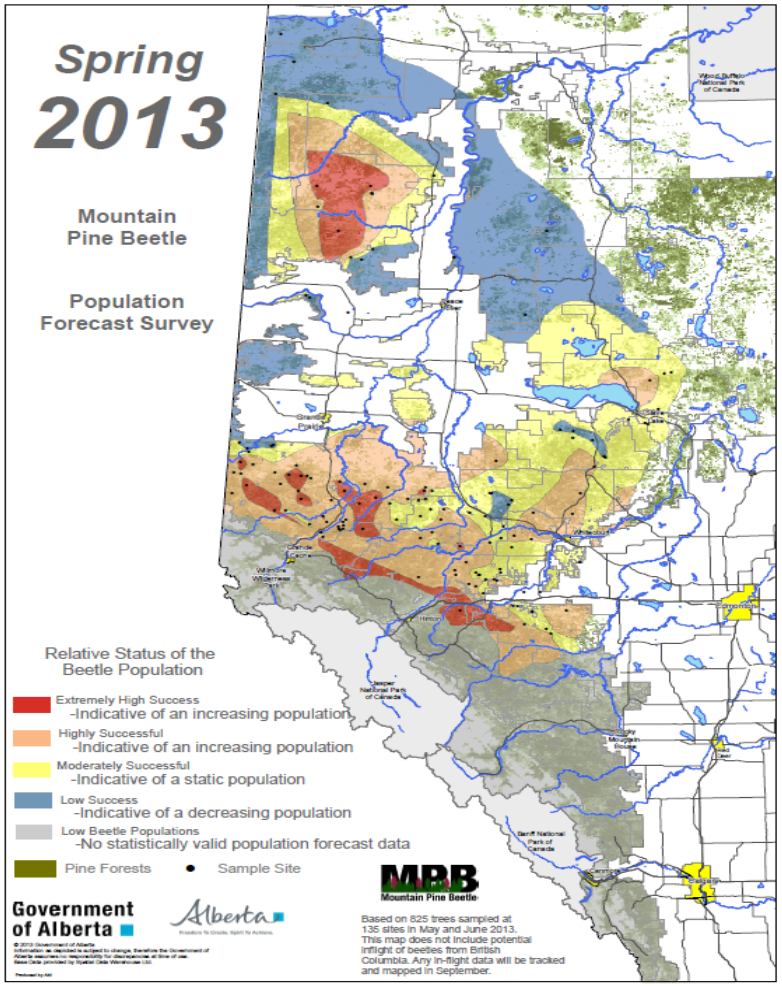
- So far, a cumulative volume of 54% or 728M $m^3$ of merchantable pine wood killed; 18,3M ha of BC's pine forest affected
- BC 2014: 5M $m^3$ of Red Attack: MPB running out of host
- MPB established in Northern BC and North central Alberta; reported North of the $60^o$ and in Saskatchewan
- MPB in establishing in boreal Jack pine forests

# Limiting the spread in Alberta - Prioritizing interventions

Extensive surveys to identify priority areas.

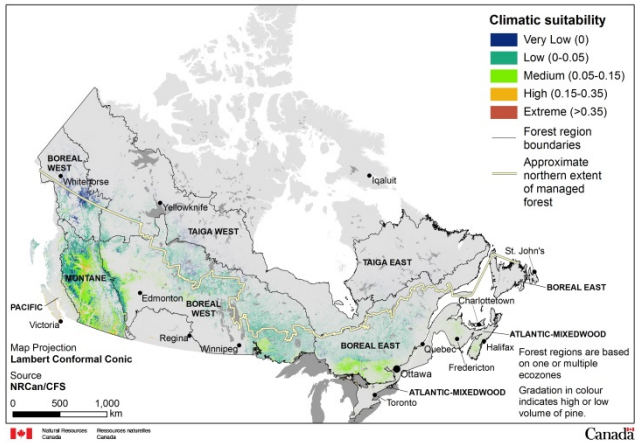
Selection of intervention based on:

- Stand susceptibility
- Connectivity with other pine stands
- Number of trees infested
- Location relative to potential spread east
- Inflight risks from other jurisdictions

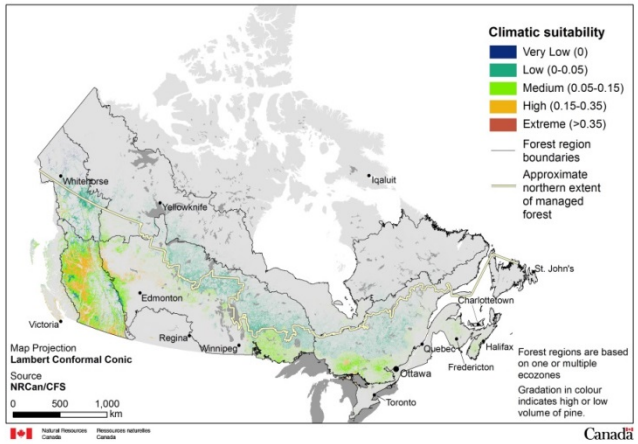


# Projection of potential future impacts based on current pine volume

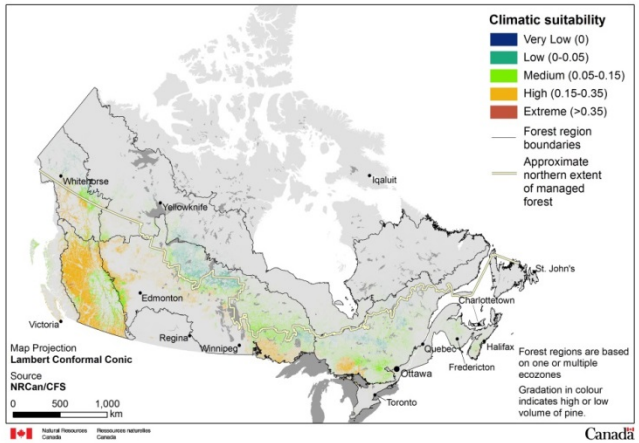
**1981-2010 | Baseline | Climate suitability for mountain pine beetle according to current pine volume**



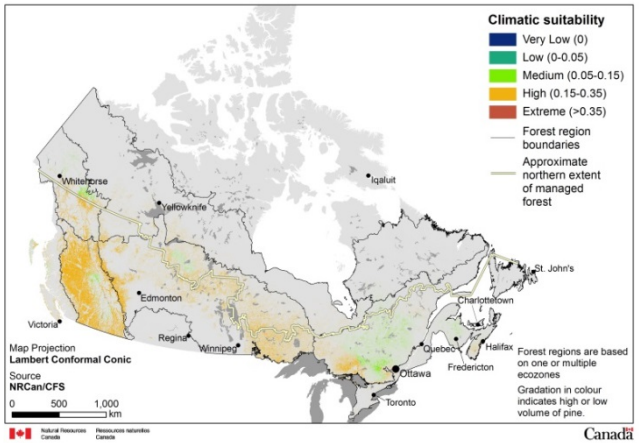

**2011-2040 | Short-term | RCP 8.5 | Climate suitability for mountain pine beetle according to current pine volume**




**2041-2070 | Medium-term | RCP 8.5 | Climate suitability for mountain pine beetle according to current pine volume**




**2071-2100 | Long-term | RCP 8.5 | Climate suitability for mountain pine beetle according to current pine volume**



# Projection of potential future impacts based on current pine volume

- In BC, 737M $m^3$ (55%) of merchantable pine projected to be killed by 2017, epidemic should be over by 2020.
- If climate conditions are favorable, the MPB could spread East, across Canada's boreal forest where Jack pine is the dominant pine species.
- Boreal Jack pine forests are not optimal for MPB given their low density and small trees.

# SOME LESSONS LEARNED

# 1. Partnership to address a cross cutting issue

From a local forest issue, the MPB grew into a national policy priority and was a catalyst for improved cooperation

- Coordinated actions across BC ministries
- BC-Alberta-Saskatchewan partnership for survey, research and intervention
- Funding and dedicated research from the federal government
- Consultation and collaboration with rural communities, natural resources industries, academia and government agencies

National Forest Pest Strategy established by the Canadian Council of Forest Ministers to improve coordination and integration in pest prevention and early detection.

# 2. A range of intervention to protect a diversity of values at risk

New ways of thinking about forest management in the context of climate change and social objectives

- Timely detection of Green Attack to inform intervention decision. On the ground survey of Canada's vast forests is challenging. Survey efforts are focused with:
  - Forecasts of population trends
  - Pheromone baits detect MPB in new areas
  - Comparison of green to red ratio across years to identify expanding populations

# 2. A range of intervention to protect a diversity of values at risk

- Prioritizing areas for intervention and selection of treatment:
  - Leading-edge zones - tree treatment (grinding, peeling and burning, insecticides, pheromone baiting). Block harvesting in some cases. Repellent pheromones to protect high value trees such as seed orchard trees
  - Holding zones - block harvesting, in some areas direct control is impossible
  - Salvage zone – harvest killed pines and optimize value
- Regeneration (200M/y seedlings planted in BC):
  - Forest for Tomorrow - guidance and support for planting, selection of spacing and species composition, silvicultural treatments including fertilization and site preparation
- .

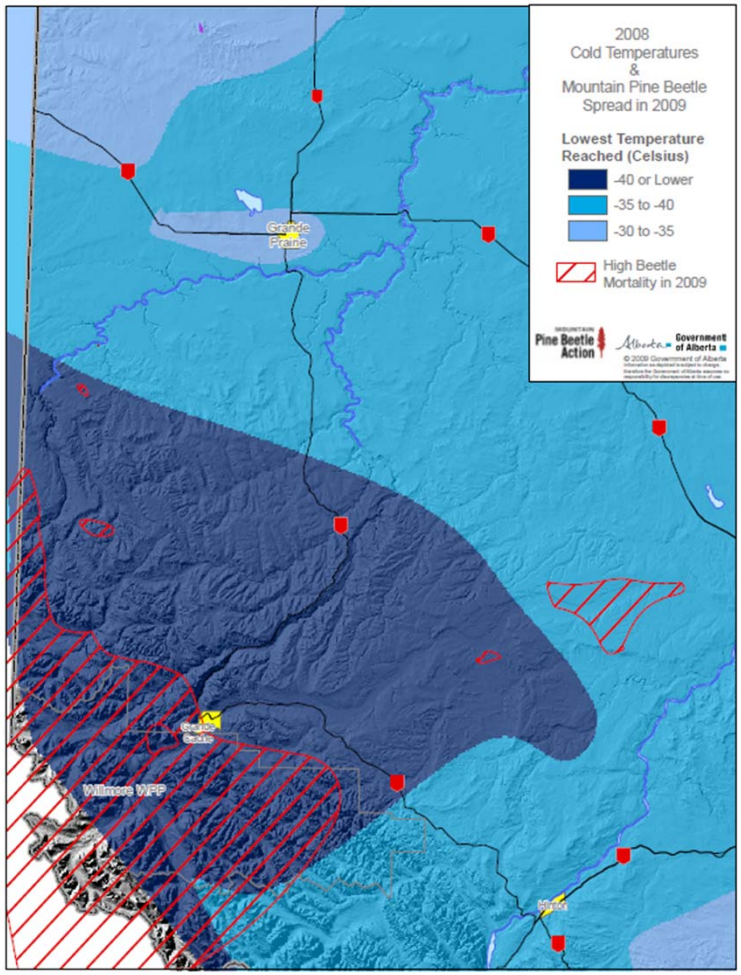
# 3. Improved understanding through science and monitoring

MPB spread depends on:

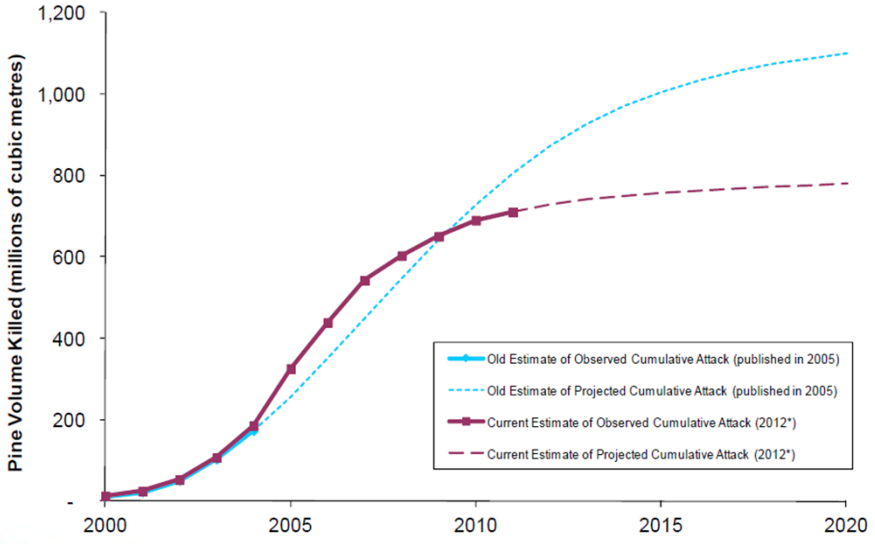
- MPB dispersal capacity
- Climatic suitability for infestation
- Susceptibility of boreal Jack pine stands
- Effectiveness of interventions

Monitoring and research help improve our understanding of the ecology and population dynamics of the MPB in its new and changing environment (in these 4 areas).

# 3. Improved understanding through science and monitoring




In 2009, extremely cold temperature occurred throughout the dark blue area in Alberta but significant MPB mortality was surveyed only in the area with red lines. The cold tolerance of the beetle is investigated.




Past models projected greater impacts and different spread patterns than those recorded in BC. Survey information contribute to validate and improve models for projections.

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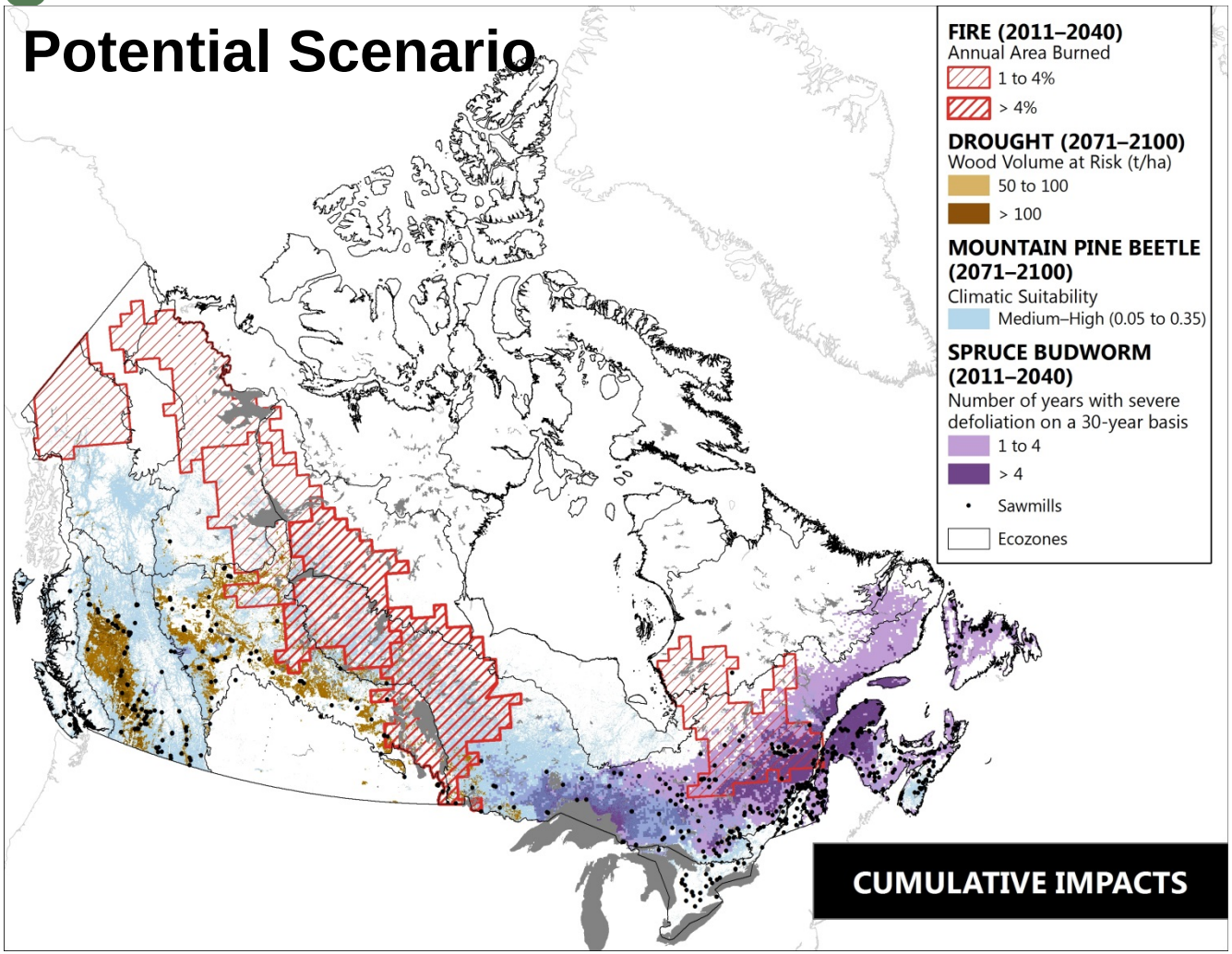
# 3. Improved understanding through science and monitoring

Other examples of studies:

- Detailed mapping of the genome of the MPB, its fungal symbiont and of Lodgepole and Jack pine – it confirmed that Jack pine was a suitable host
- Investigation on MPB flight capacity (speed and distance)
- Development of pheromones baits to monitor MPB activity and to concentrate them on trees that are removed and destroyed

# 4. Proactive adaptation informed by Integrated Assessment



# 4. Proactive adaptation informed by Integrated Assessment

- A century of effective management for fire protection resulted in a landscape vulnerable to the MPB.
- Integrated projections of multiple impacts under different potential future scenarios inform planning and management decisions for resilient forests in a changing climate.
- However… We can plan for the known knowns. We can model, project and improve our understanding of the known unknowns. But there are also unknown unknowns. These things we don't know we don't know. And there are a lot of these with the changing climate…

# 5. A Nimble sector to take advantage of opportunities (reactive adaptation)

# 5. A Nimble sector to take advantage of opportunities (reactive adaptation)

BC supported the economic resilience of its forest sector:

- Incentives to increase harvest of salvage wood
- Development of new markets (e.g.China Wood Initiative to increase lumber exportation)
- Research to adapt harvesting and milling technologies to the changing resource
- Encourage use of wood for construction (e.g. Speed skating oval of the Vancouver Olympic games made from “pine beetle” wood)
- Support for bioenergy projects and increase in wood pellets production

These measures also help reduce GHG emissions from the decomposition and burning of dead trees.

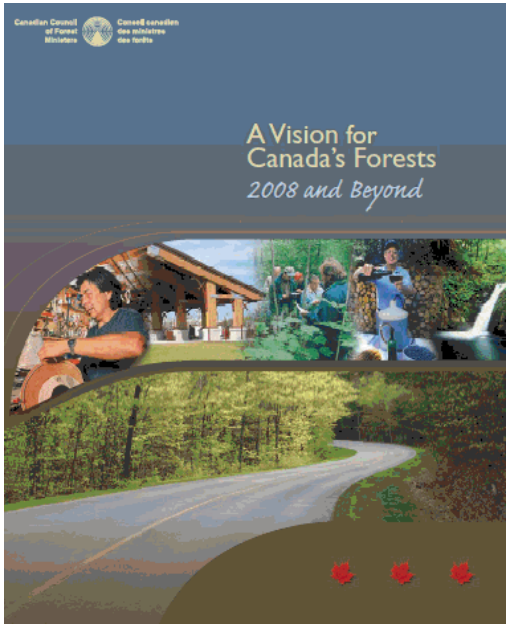
# 6. Catastrophic events can trigger action

Jan 2008 – Premiers (CoF) ask their forest ministers to collaborate with the federal government on adaptation.

**Canadian Council of Forest Ministers**

*A Vision for Canada's Forests: 2008 and Beyond*

*"Consideration of climate change and future climatic variability is needed in all aspects of sustainable forest management."*

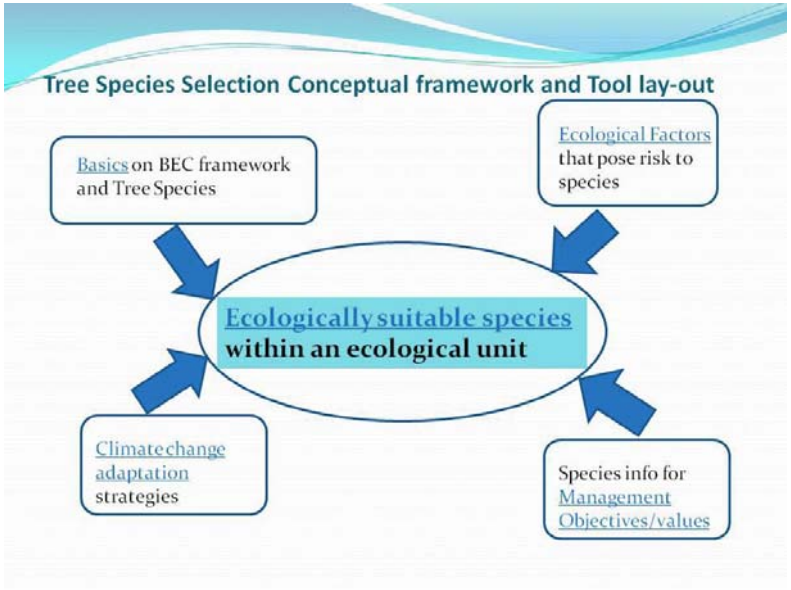


# 6. Catastrophic events can trigger action

Climate change became a key driver of BC's Forest Service Research Program.

The Future Forest Ecosystem Initiative created in 2006 aims at mainstreaming climate change into forest management policies and practices and increase the resilience of forest ecosystems:

- Development of scenarios of how climate change could affect forests
- Science to assist the migration of tree species and provenance into areas where the climate is projected to be suitable in the future
- Tree breeding to improve growth and resilience
- Assisted migration of 250,000 western larch seedlings up to 200 miles outside the species' native range



# Conclusion

More than $1.2B spent since 2001 to battle the MPB and mitigate future impacts.

Shows how changes in environmental conditions can have a domino effect on a whole suite of environmental, social, economic and policy conditions.

Highlight the unintended consequences of human intervention on natural ecosystems. The ease with which the epidemic spread through the homogeneous mature pine stands has shown the value of managing age-class distribution and increasing species diversity for increased resilience to fire, drought, insects attacks...