Mountain pine beetle range expansion:

The potential threat to Canada's forest

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[2] BC Ministry of Forests, Lands and Natural Resource Operations

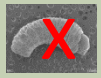
“Typical” One-Year Life Cycle – *temperature-driven*

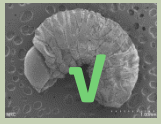
First summer (July, August)

Adults disperse, attack new trees, lay eggs, larvae grow

Overwinter

(big larvae = best survival)





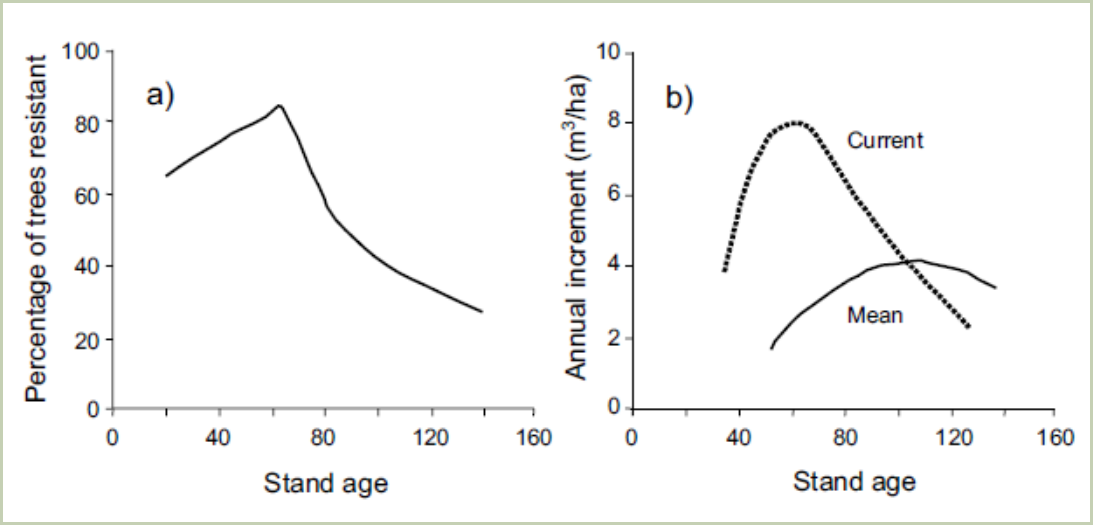
Second summer

Finish development, emerge and disperse

Pine Tree Defences

Preformed (constitutive) defence

Induced defence



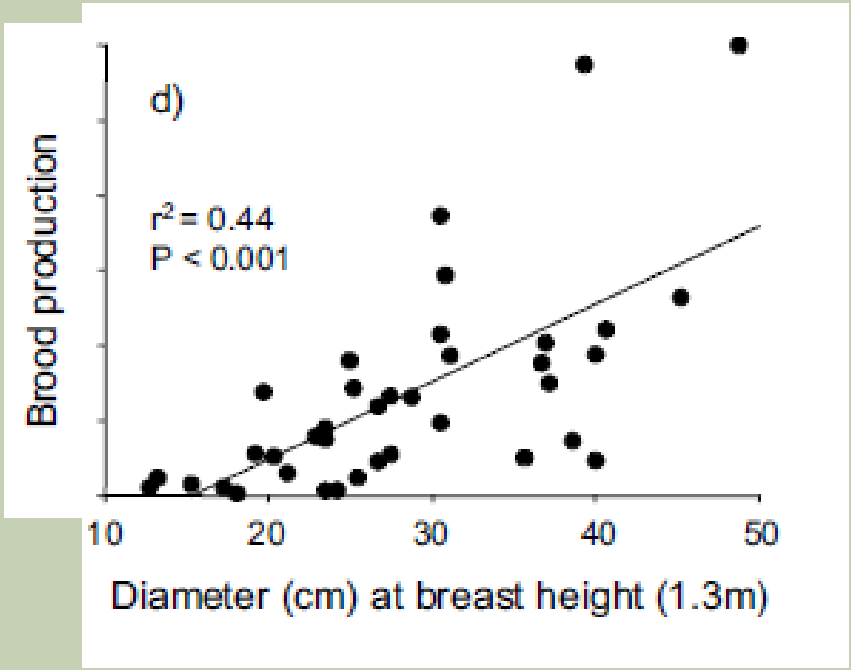
Safranyik 1974; Safranyik and Carroll 2006

Beetle-Tree Interactions

High population levels (*epidemic phase*)

- Overwhelm defences of large, healthy trees by attacking *en masse*
- Reproduction higher in larger, more vigorous trees (thicker phloem)

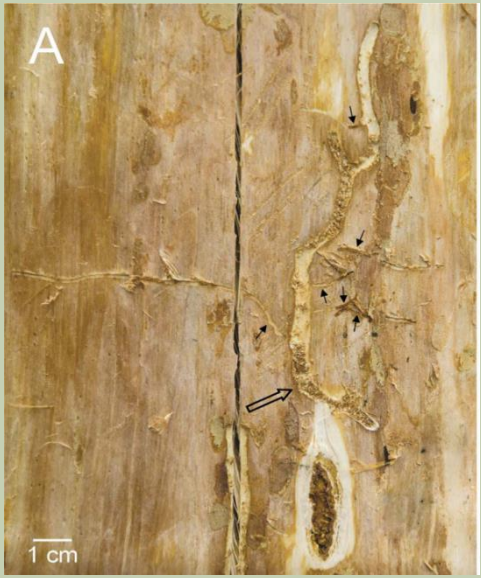
→ ***Positive Feedback*** **= rapid population growth**



Safranyik 1974; Safranyik and Carroll 2006

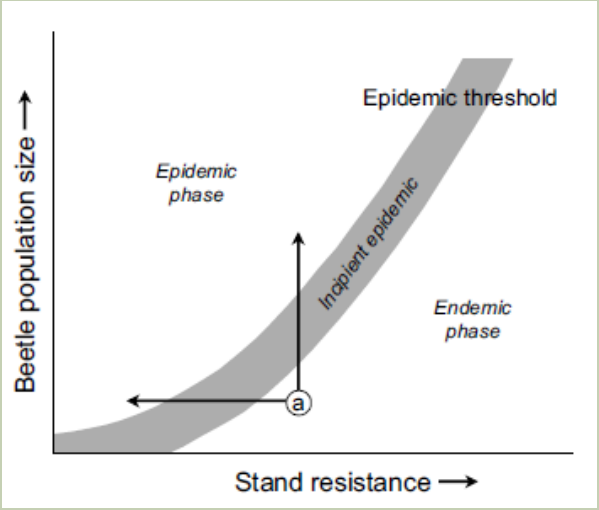
Low population levels (*endemic phase*)

- Attacks stressed host trees with weakened defences
- Poor quality hosts, reproduction is low



Bleiker et al. 2014

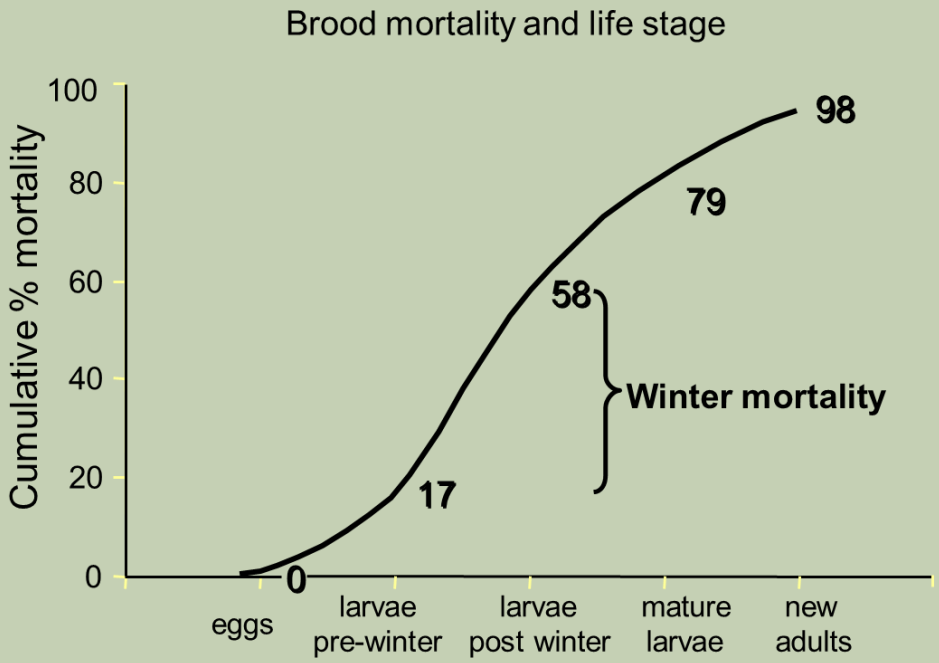
Endemic-epidemic threshold varies with beetle density and stand resistance



Safranyik and Carroll 2006

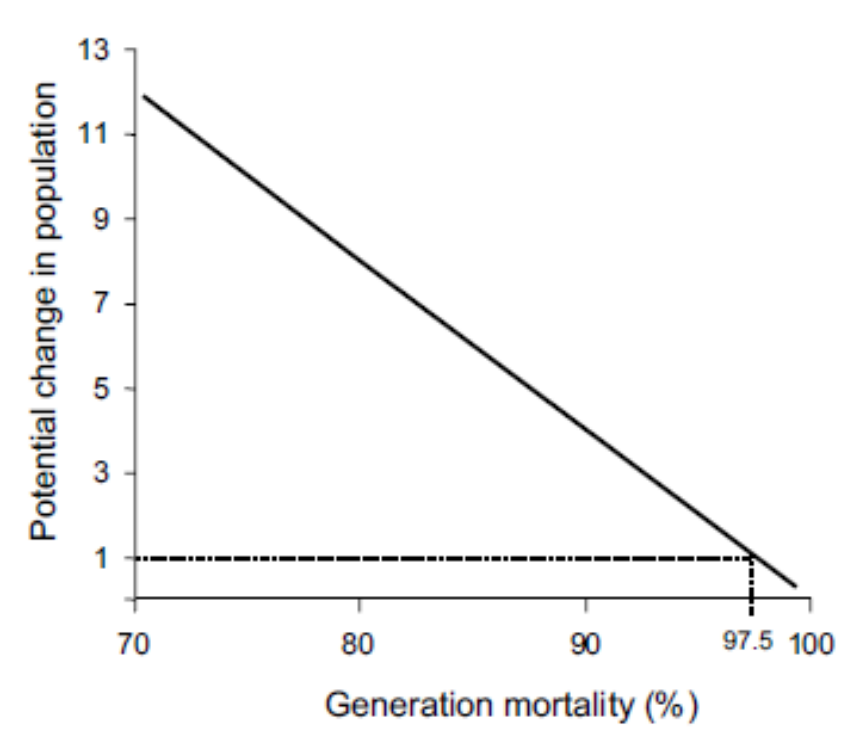
Mortality Factors

Tree defences
Natural enemies
Competition
Dispersal
Weather - **cold (e.g., 1984/5)



MPB's Reproductive Power

97.5% mortality = stable population



Safranyik and Carroll 2006

When conditions are good, one tree can easily produce enough beetles to kill 3-6 trees

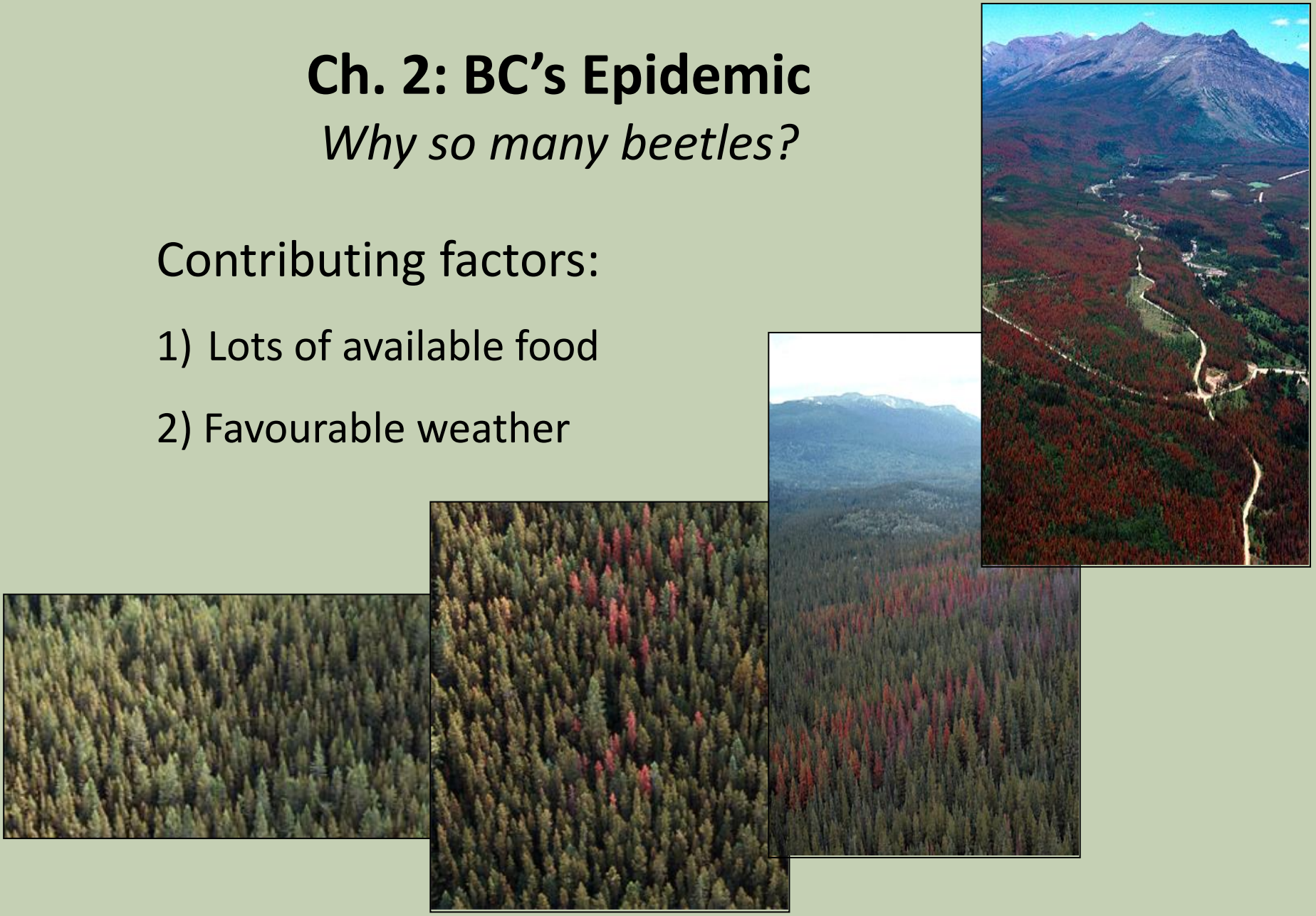
Ch. 2: BC's Epidemic

Why so many beetles?

Contributing factors:

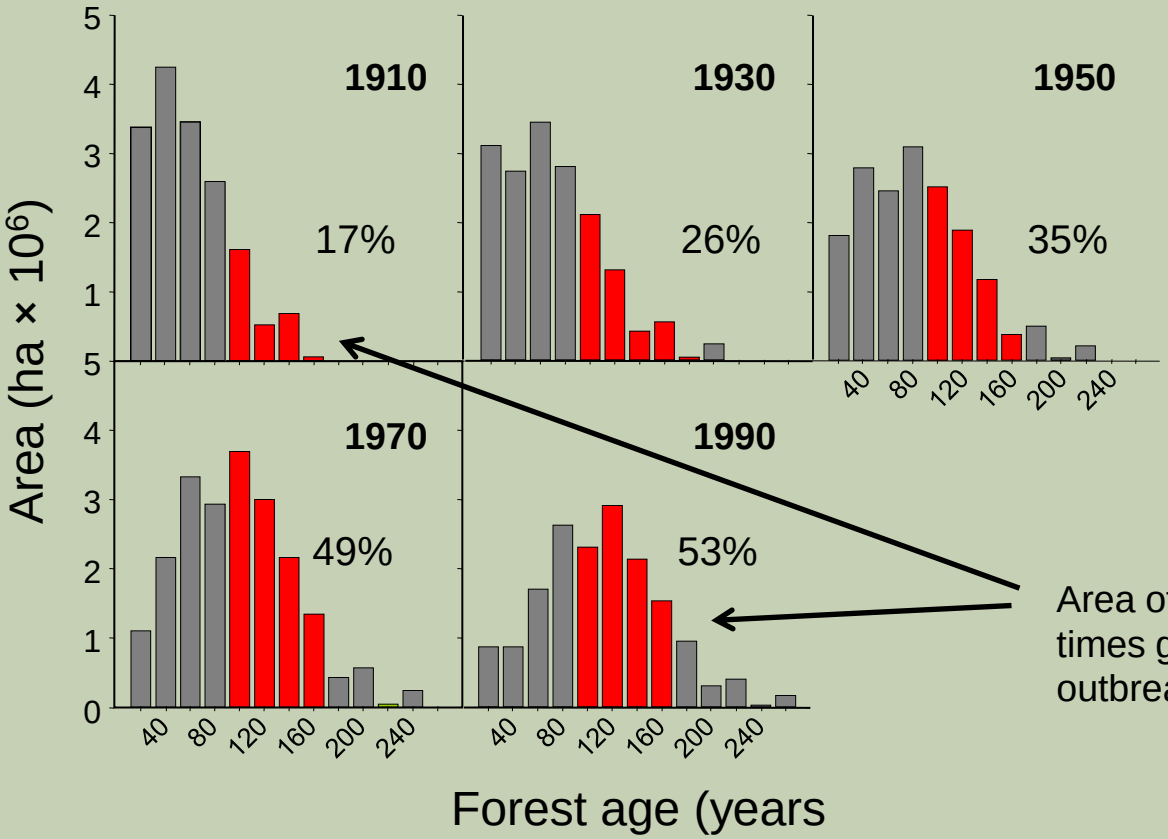
1) Lots of available food

2) Favourable weather



Distribution and abundance of susceptible hosts

Contiguous stands of big, old lodgepole pine trees



- Reconstructed pine forests based on past disturbances
- Trees most susceptible to MPB between 80 and 160 years old

Area of susceptible trees 3 times greater at start of outbreak than in 1910

Fires 1880s – regen
Fire suppression?
MPB doing job of fire?

Adapted from Taylor and Carroll 2004

Climate/Weather

Climate (long-term) – Determines potential distribution

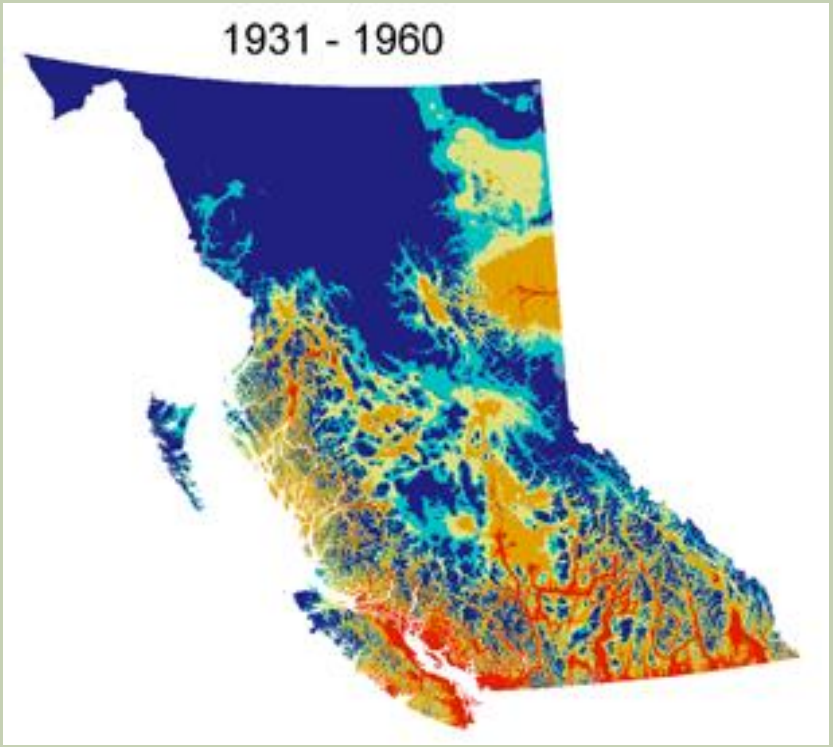
- Range of MPB is not limited by range of host tree

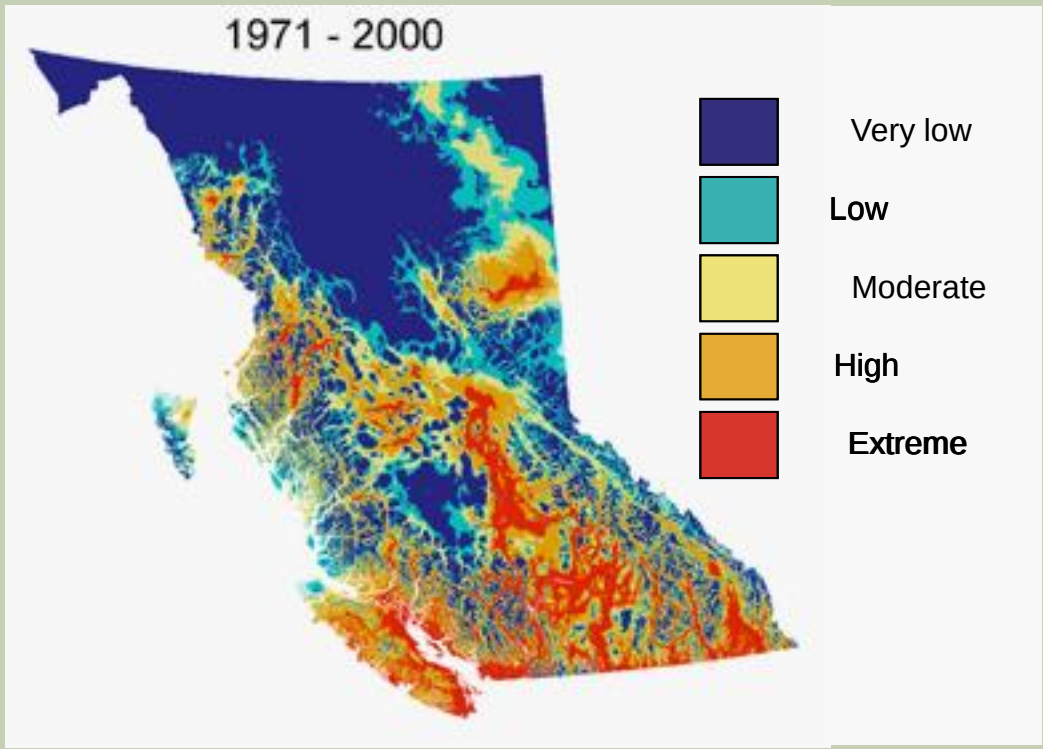
Weather (short-term) – Impacts annual abundance

- Winter survival, development in summer, tree stress/defences

75% increase in area of extreme climatic suitability

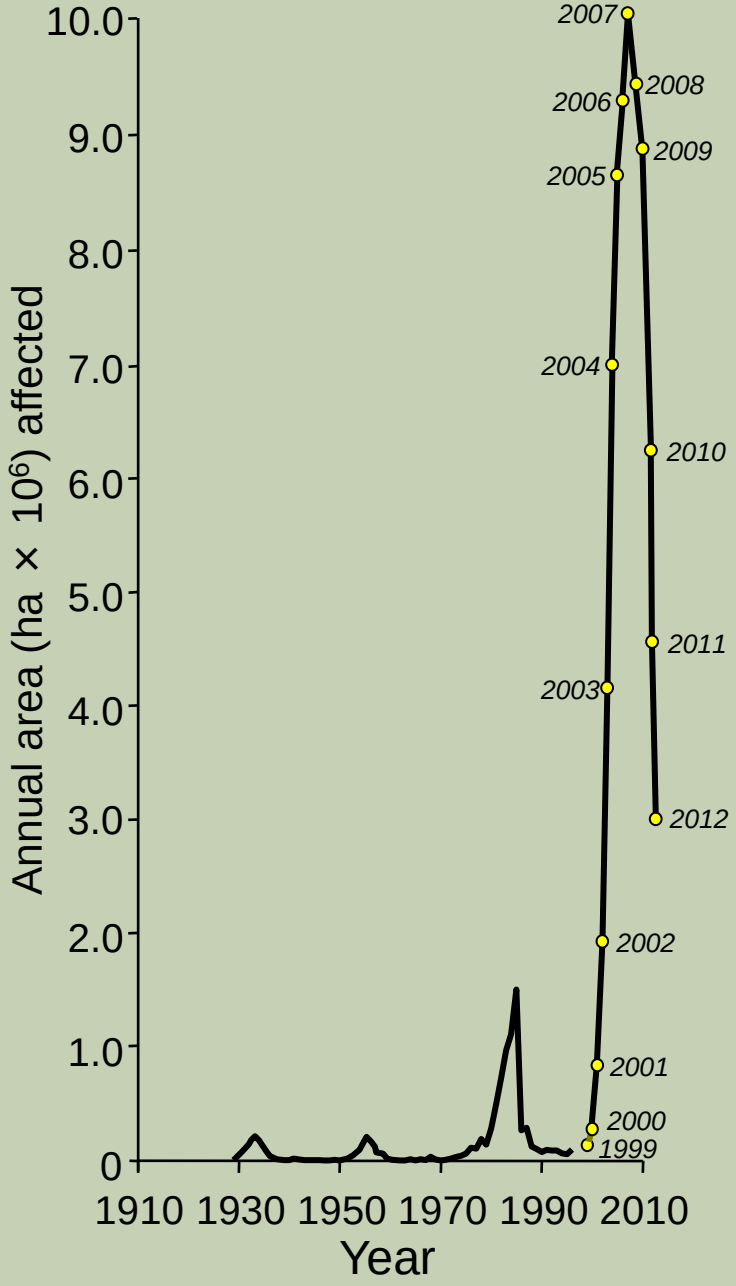
= Rapid range expansion into new habitats

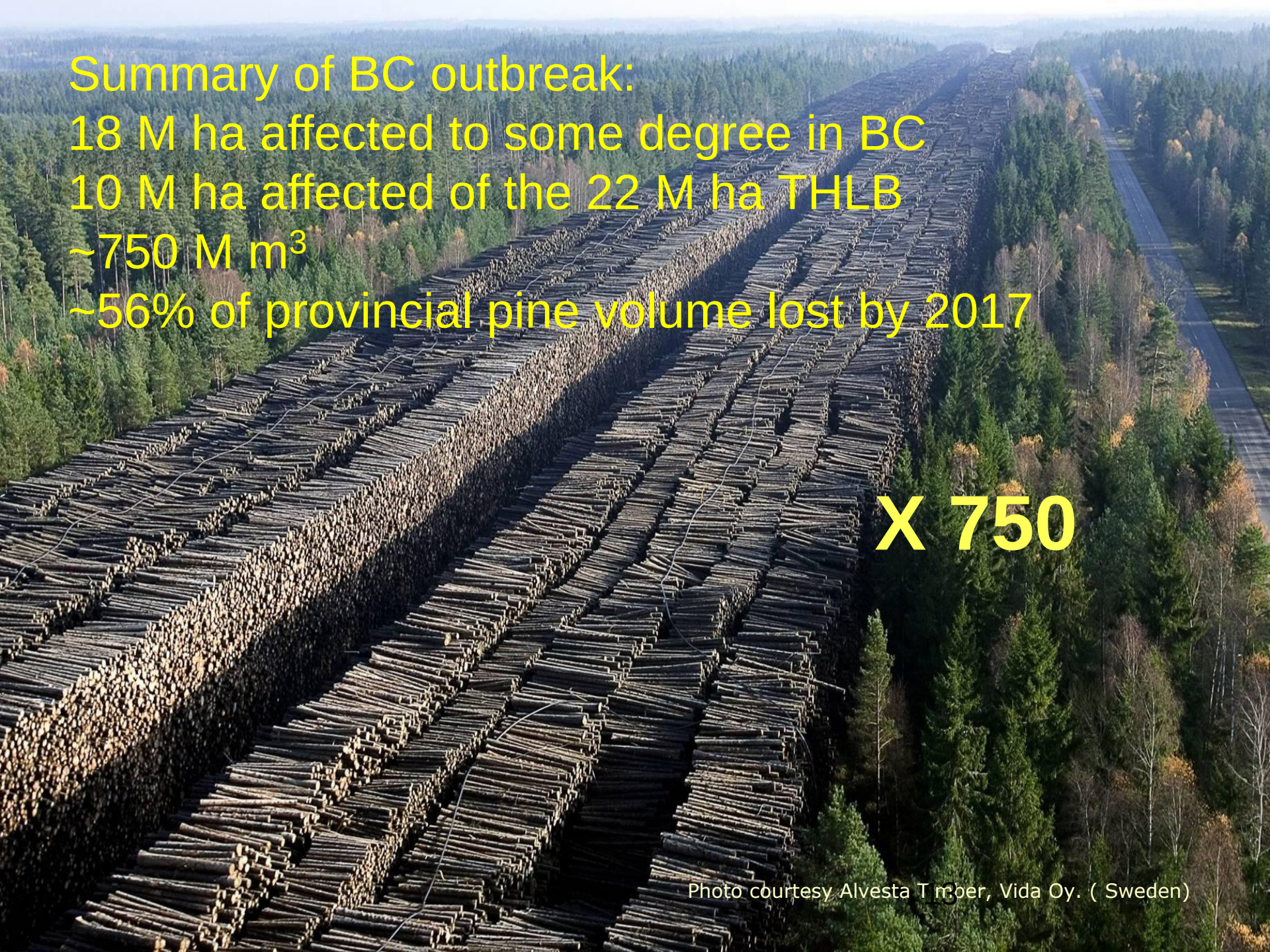


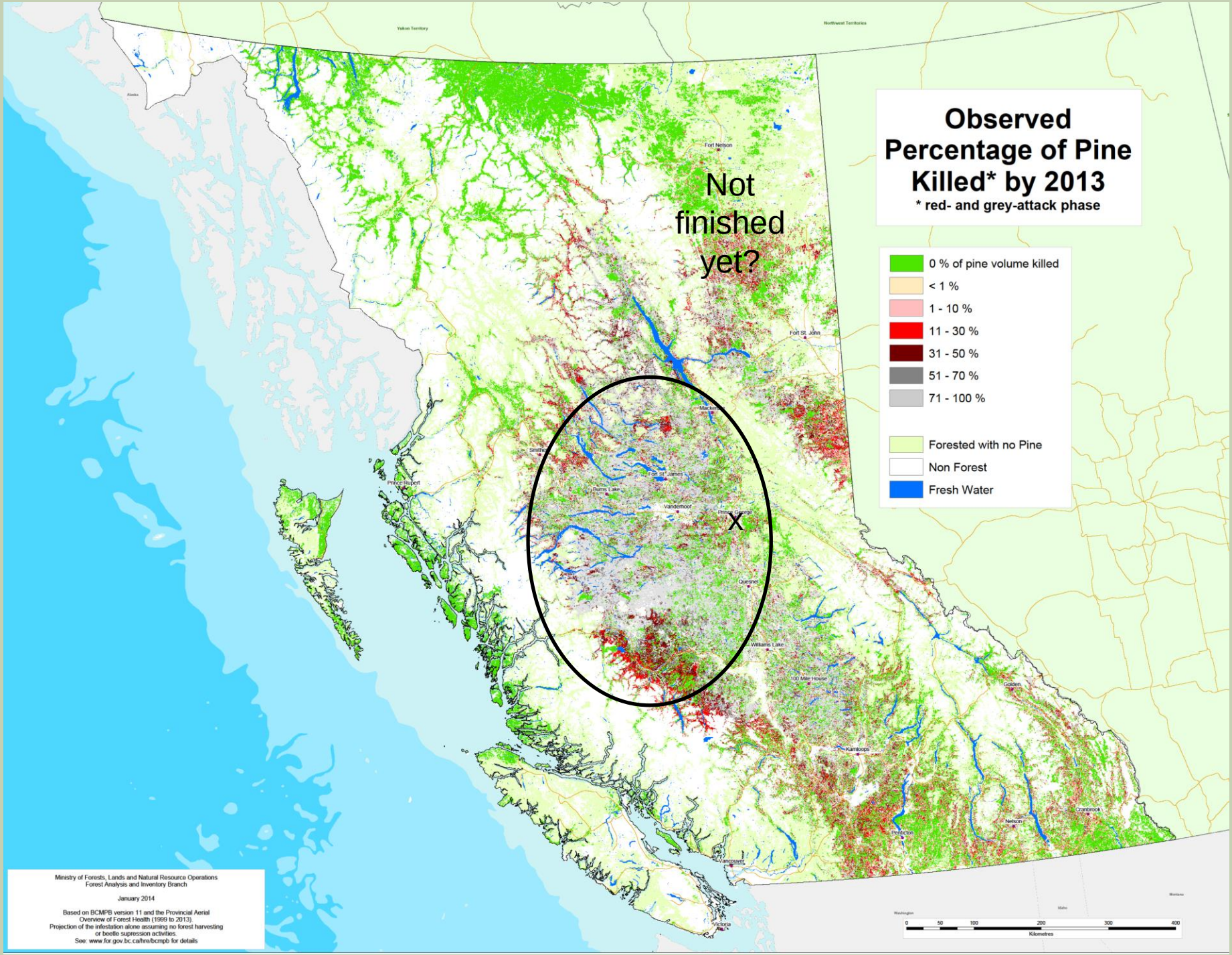


BC Outbreak

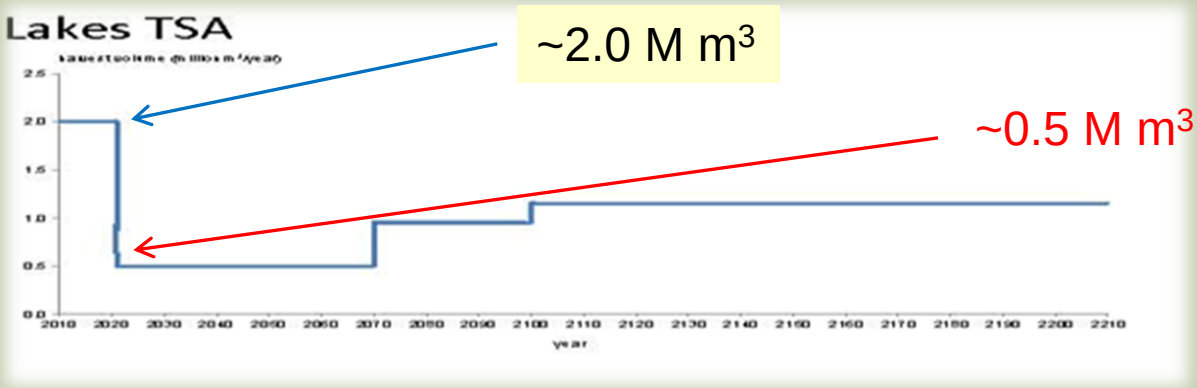
Order of magnitude larger than past outbreaks




Summary of BC outbreak:
18 M ha affected to some degree in BC
10 M ha affected of the 22 M ha THLB
~750 M m3
~56% of provincial pine volume lost by 2017
X 750
Photo courtesy Alvesta Timber, Vida Oy. (Sweden)

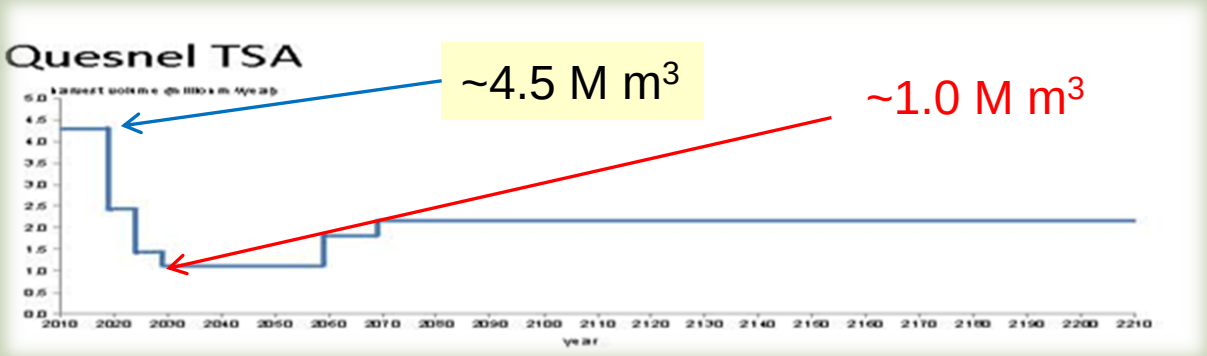

Observed Percentage of Pine Killed* by 2013
* red- and grey-attack phase
0 % of pine volume killed
< 1 %
1 - 10 %
11 - 30 %
31 - 50 %
51 - 70 %
71 - 100 %
Forested with no Pine
Non Forest
Fresh Water
Not finished yet?
X
Fort Nelson
Fort St. John
Prince Rupert
Burns Lake
Vanderhoof
Prince George
Quesnel
Williams Lake
100 Mile House
Kamloops
Golden
Cranbrook
Nelson
Penticton
Vancouver
Victoria
Ministry of Forests, Lands and Natural Resource Operations
Forest Analysis and Inventory Branch
January 2014
Based on BCMPB version 11 and the Provincial Aerial Overview of Forest Health (1999 to 2013).
Projection of the infestation alone assuming no forest harvesting or beetle supression activities.
See: www.for.gov.bc.ca/hre/bcmpb for details
0 50 100 200 300 400
Kilometres

Predicted Impact of MPB on the AAC



THLB Volume: 64% pine
% Pine killed: 81%

1982 – 1.5 M m³
1996 – 1.5 M m³
2001 – 2.9 M m³
2004 – 3.1 M m³
2011 – 2.0 M m³
2030 – 0.5 M m³



THLB Volume: 67% pine
% Pine killed: 76%

1981 – 2.3 M m³
1996 – 2.3 M m³
2001 – 3.2 M m³
2004 – 5.2 M m³
2011 – 4.5 M m³
2030 – 1.0 M m³

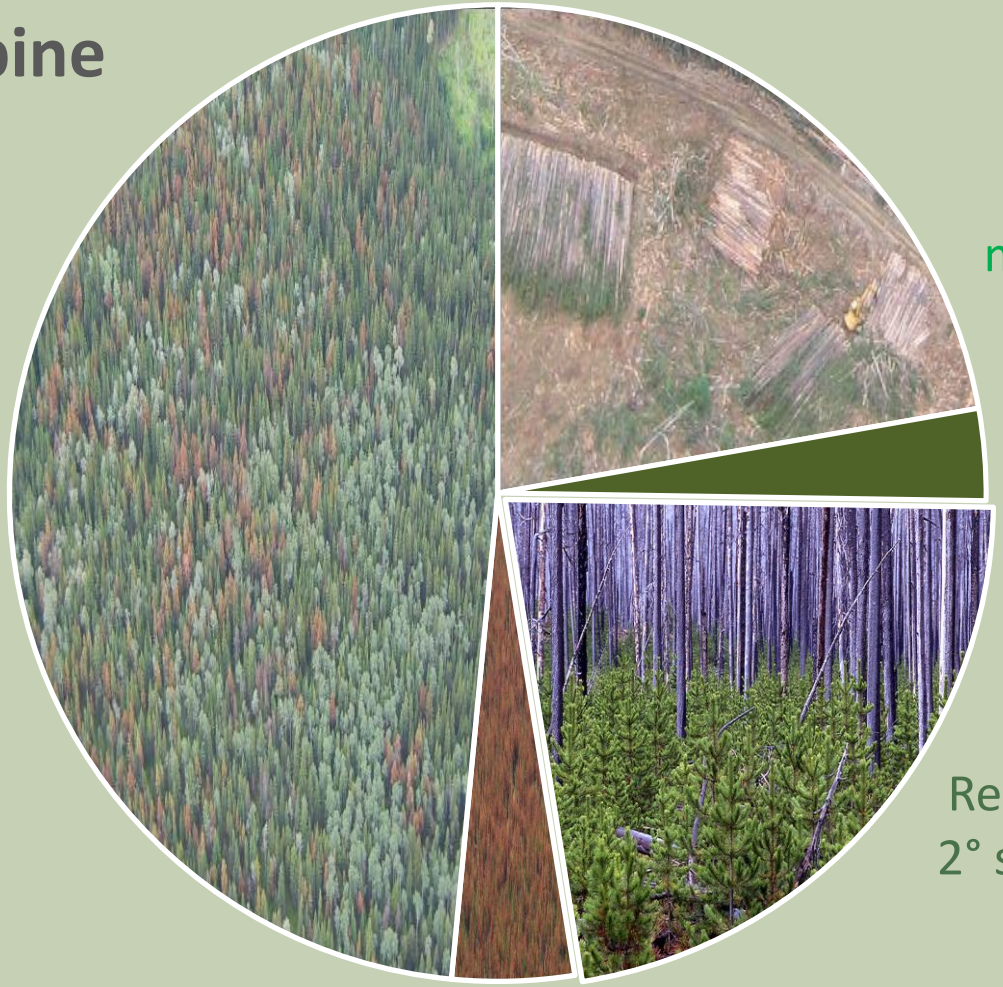
THLB impacted by MPB in BC:
10 M ha

4.8 M ha
<50% pine

5.2M ha
>50% pine

10 M ha of the THLB impacted by MPB

4.8 M ha
<50% pine



5.2M ha
>50% pine

1.7-2.6 M ha
merchantable stands

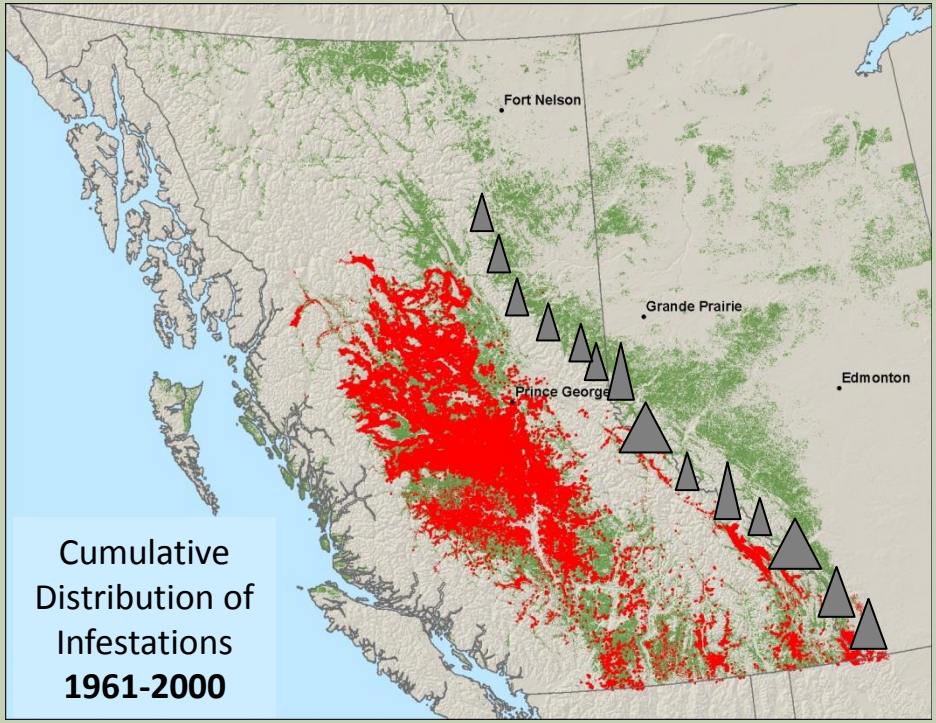
~0.3 M ha Unmerch.
Forests
for Tomorrow

Unmerchantable
Recovering 1.5-2.5 M ha
2° structure/well-stocked

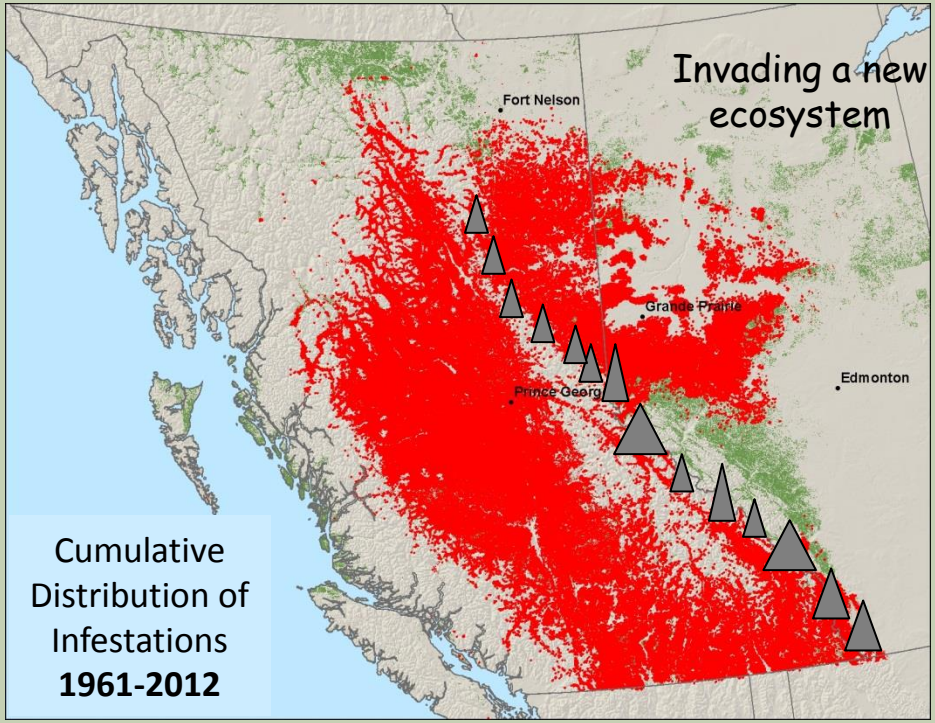
Other Impacted Areas
0.45-0.72 M ha

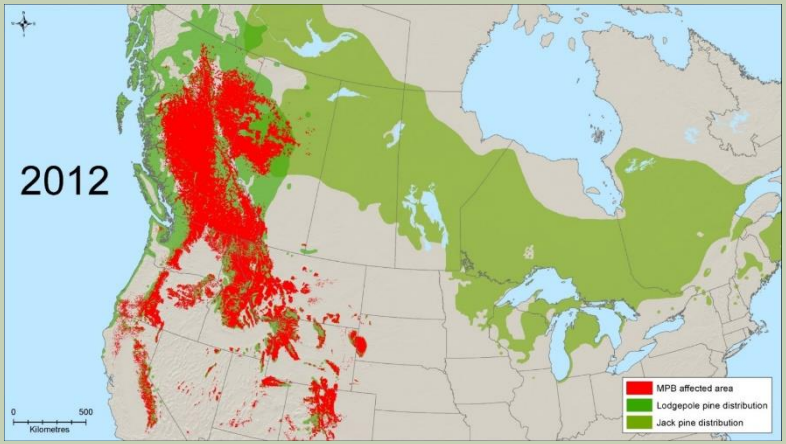
Ch. 3: MPB Range Expansion

"Historic" Range



"Recently-expanded" range

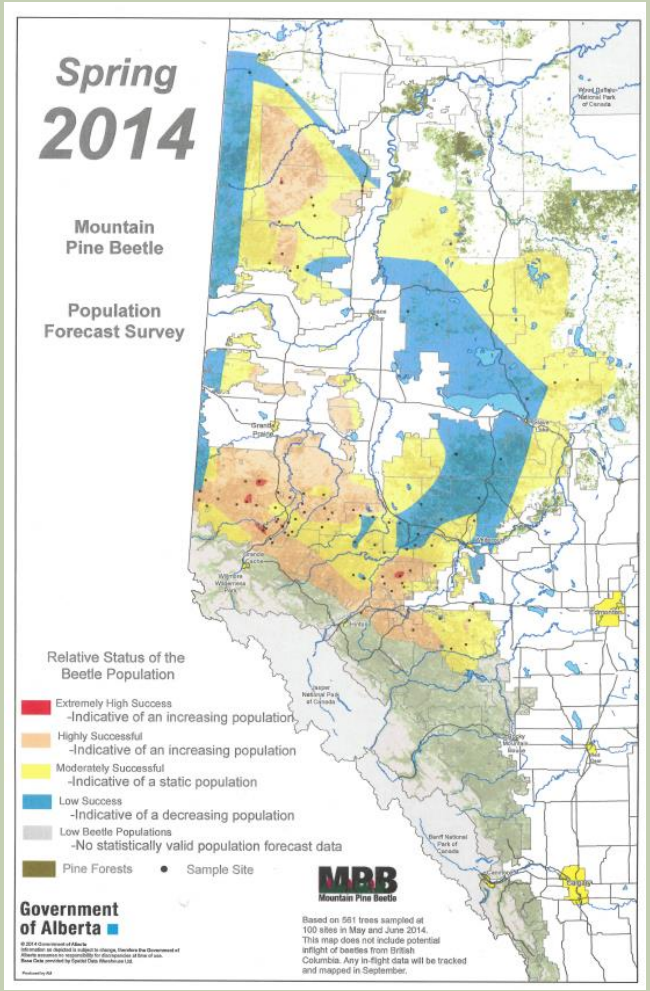




Will it continue to spread?
Many factors to consider.

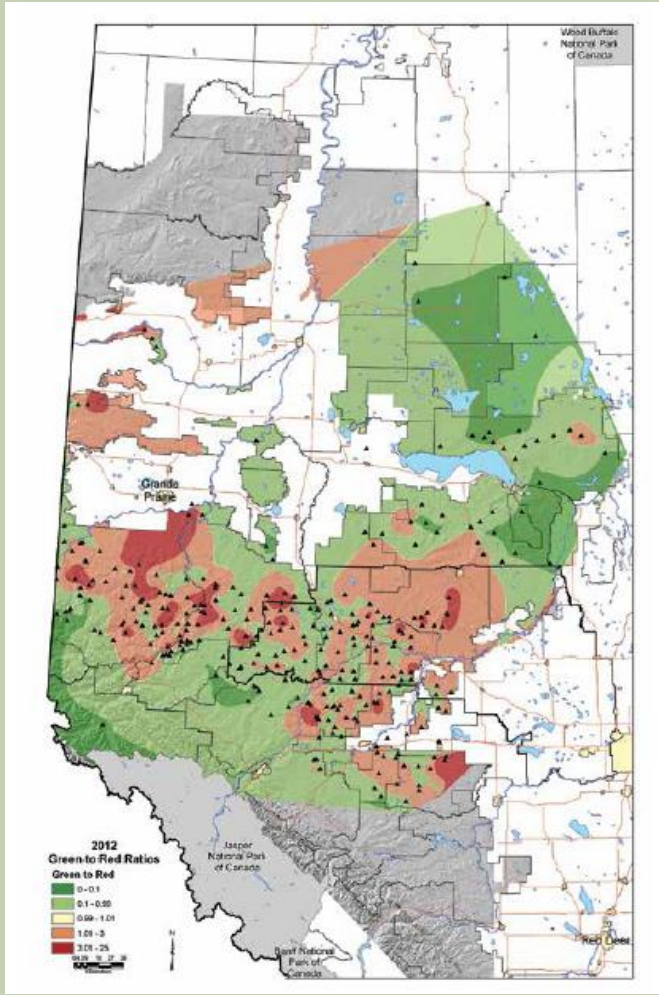
Baited trees

R Values
Insect survival

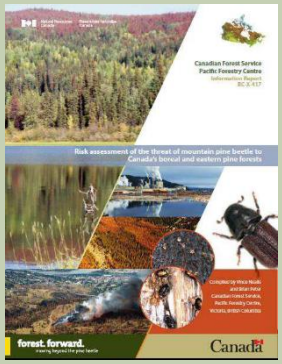


Green:Red Ratios

$$\frac{\text{\# trees attkd this year}}{\text{\# trees attkd last year}}$$



Addressing the Threat to Canada's Boreal Forest



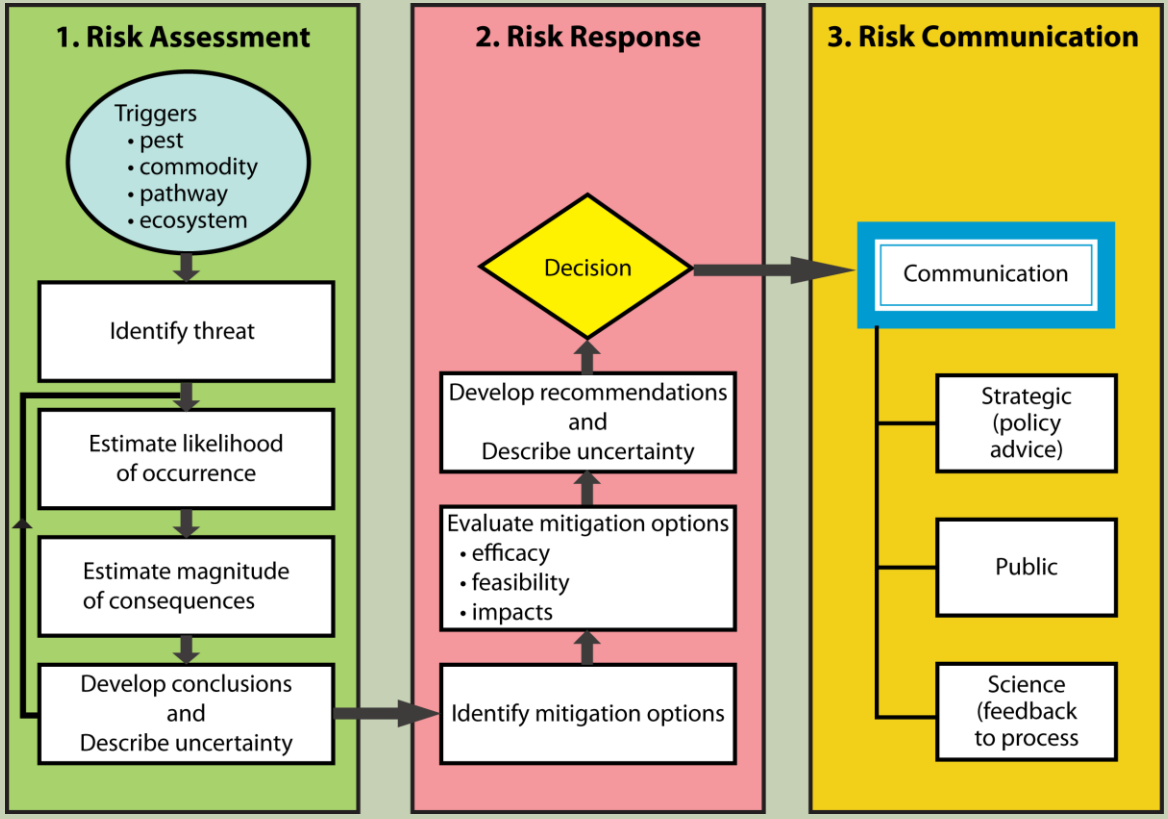
Provinces developing a coordinated response plan

Create specific **STATEMENT** relevant to question

Identify scientific **EVIDENCE** that supports statement

Identify sources and magnitude of **UNCERTAINTY** in evidence

Identify **INFORMATION NEEDS**

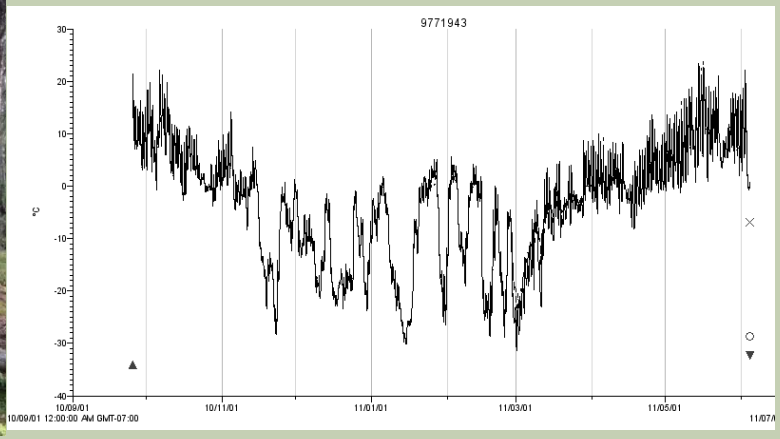


CFS
MPB Strategic Plan

Table Two: CFS Strategic MPB Research – Focusing on MPB future spread

Research/ Policy Theme	Research Areas	Description of Research Areas
A **Ecological**	**RA1** Novel Habitat Ecology	The persistence and success of the MPB in novel boreal habitats and pine species depends on how the species adapts to new host environments and novel ecological interactions (e.g., with fungi, natural enemies and competitors). CFS research will include work on understanding MPB population dynamics, persistence, climate, and other issues related to the ecology on invasive spread.
	RA2 Dispersal and spread	Understanding patterns and rate of MPB dispersal and spread in novel boreal forest landscapes is essential to develop sound management and optimize investment decisions for slowing spread through the boreal. CFS research will use modelling approaches to create decision support tools to predict boreal stand susceptibility to MPB and compare efficacy of different management options to slow spread.
	RA3 Ecological Impact	The potential ecological impacts of mountain pine beetle in boreal and eastern pine forests are yet largely unknown but expected to vary from stand to stand across landscapes, among host species and among ecological regions.
	RA4 Detection & Control	Management of MPB requires monitoring beetle spread and assessing effectiveness of intervention efforts to slow spread. CFS research will use field and lab research to develop new tools to detect MPB spread, assess MPB responses to management interventions, contribute to detection support systems, and test model predictions.
B **Economic & Social**	**RB1** Economic Impact	Estimation of the economic impact of MPB spread in the boreal is needed to: allow a comprehensive threat assessment; inform policy decisions with respect to control and post-MPB mitigation options; and provide input into research investment decisions. CFS research will assess current economic impacts on a broad range of forest values and will use modelling approaches to predict future impacts under various scenarios.
	RB2 Social Impact	The MPB is already affecting wood supply and other forest values in the boreal, and these ecosystems are changing in unprecedented ways that may have long-term consequences for social disruption and displacement. CFS research will measure social impacts and expectations that will: provide policy-makers with information necessary for a threat assessment; allow assessment of forest management response options to the pest outbreak; and assess post-MPB mitigation policy.
C **Integration & Implementation**	**RC1** Research integration, synthesis & collaboration	Accurate assessment of the full threat of MPB spread in the boreal, and Canada's response to this threat, necessitates an integrated approach that draws on all sources of pertinent knowledge. CFS research will utilize broad collaboration to develop comprehensive syntheses that integrate ecological, economic and social information from multiple disciplines and partners to influence science and policy development federally and in provinces and territories.

MPB Cold Tolerance and Development Research



Example questions addressed:

- What are the lethal lower cold tolerance thresholds for each life stage?
- How does survival vary with severity and duration of cold exposure?
- Is loss of cold tolerance reversible?
- How does MPB maintain its seasonality?

Example expected outcomes:

1) Improved predictions of annual population trends
2) Enhanced identification of areas at risk to MPB invasion through improved climatic suitability index

Thank-you for your attention