Tree mortality patterns in *Picea mariana* forests during transition stages in two regions of boreal Quebec

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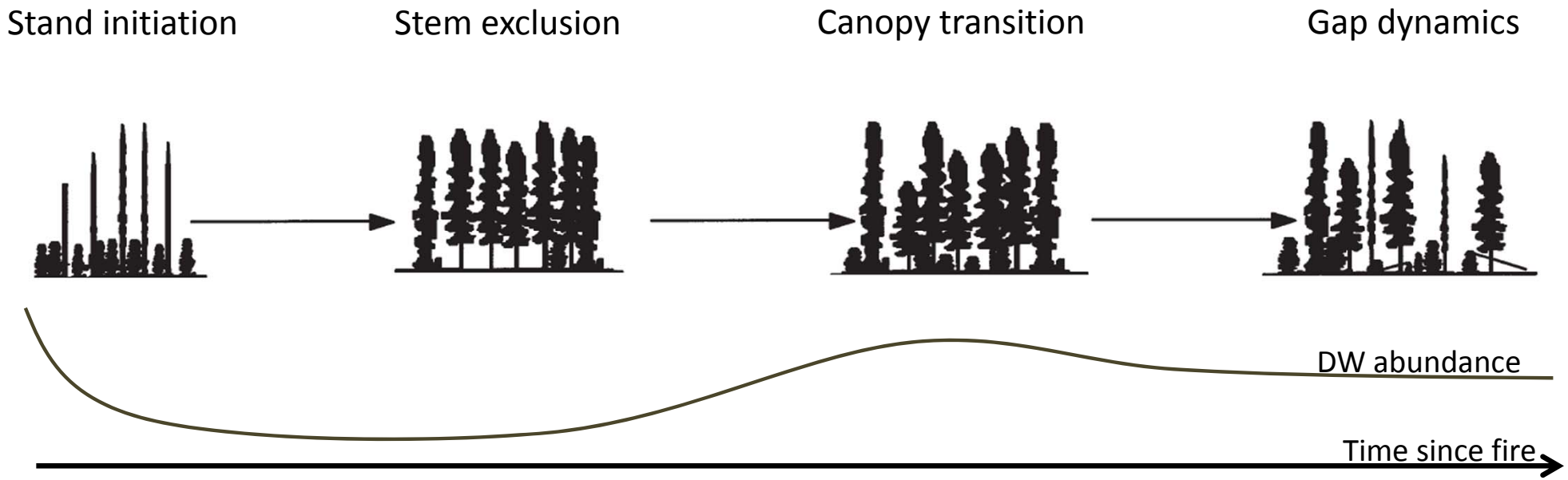
Black spruce forest dynamics



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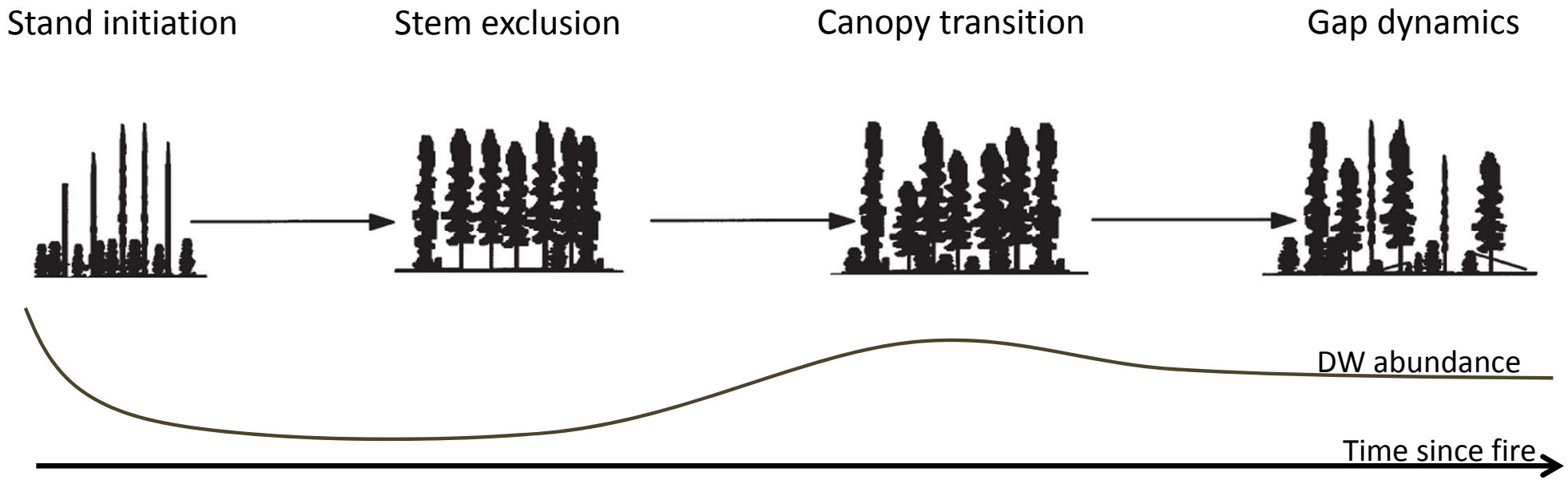

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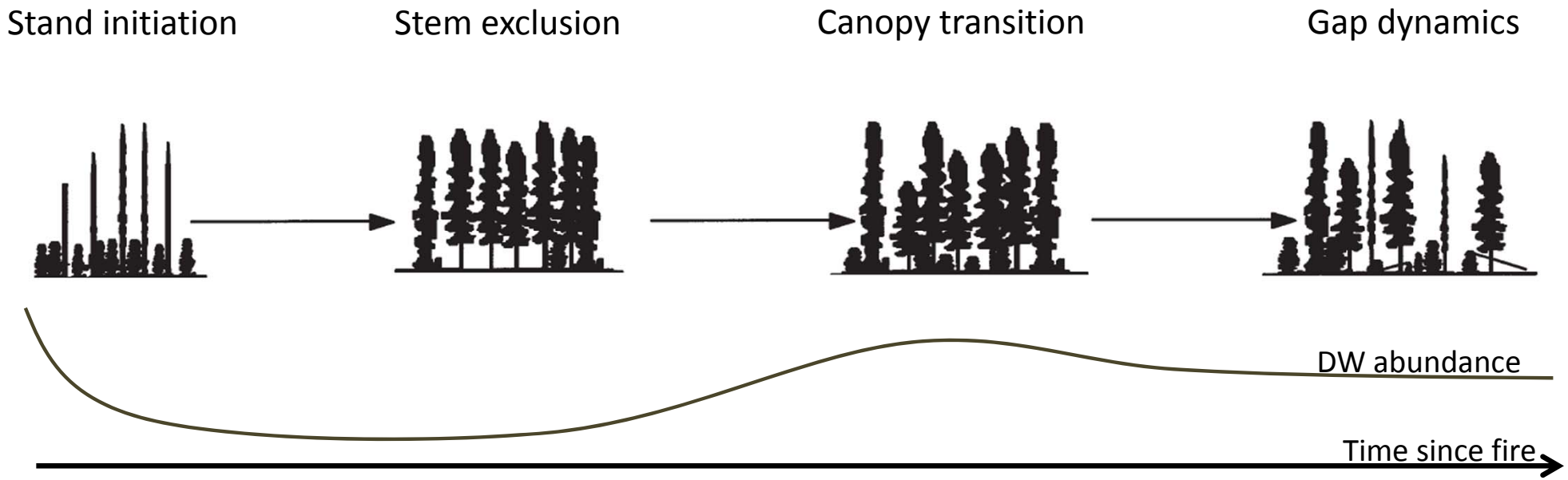

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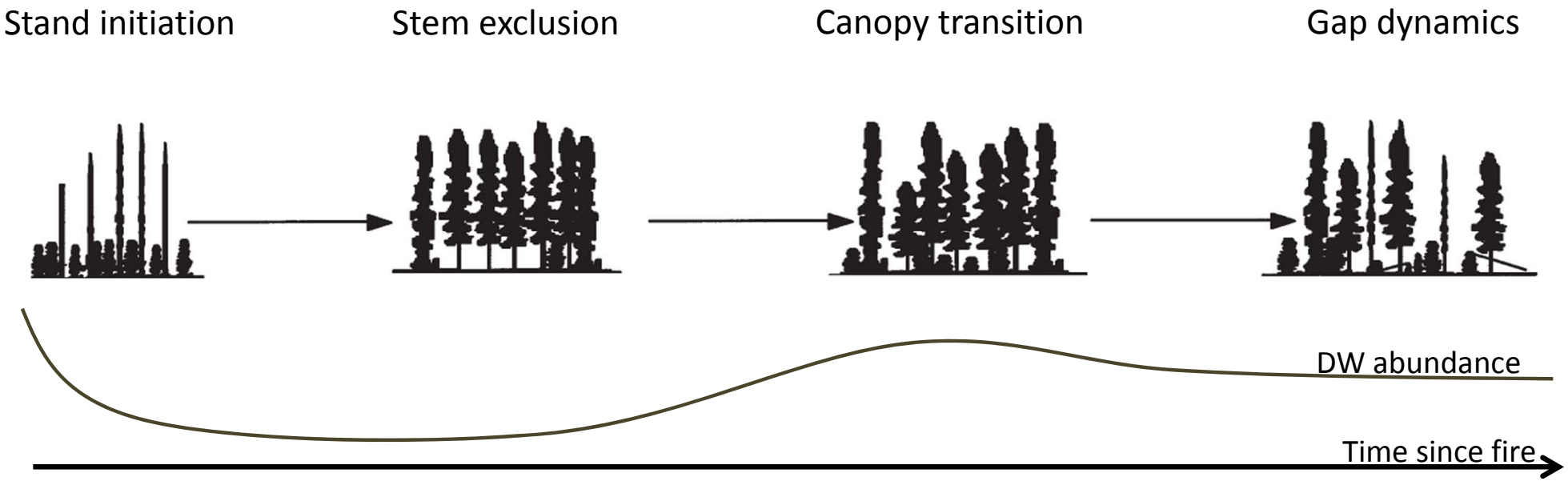

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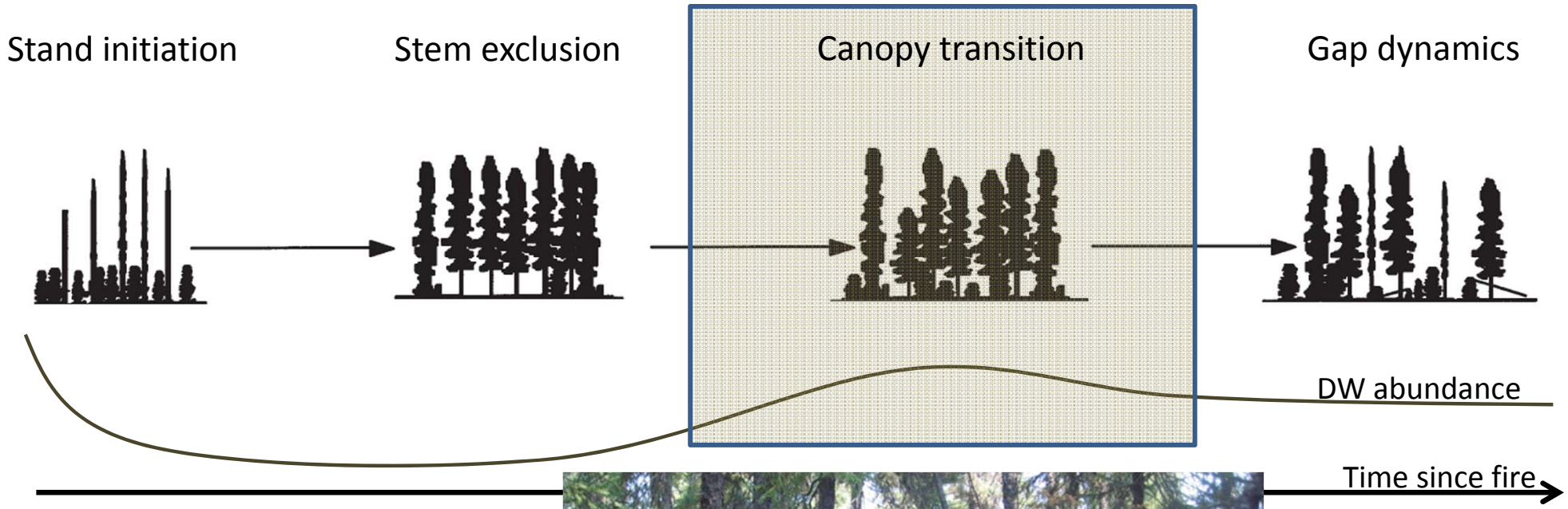
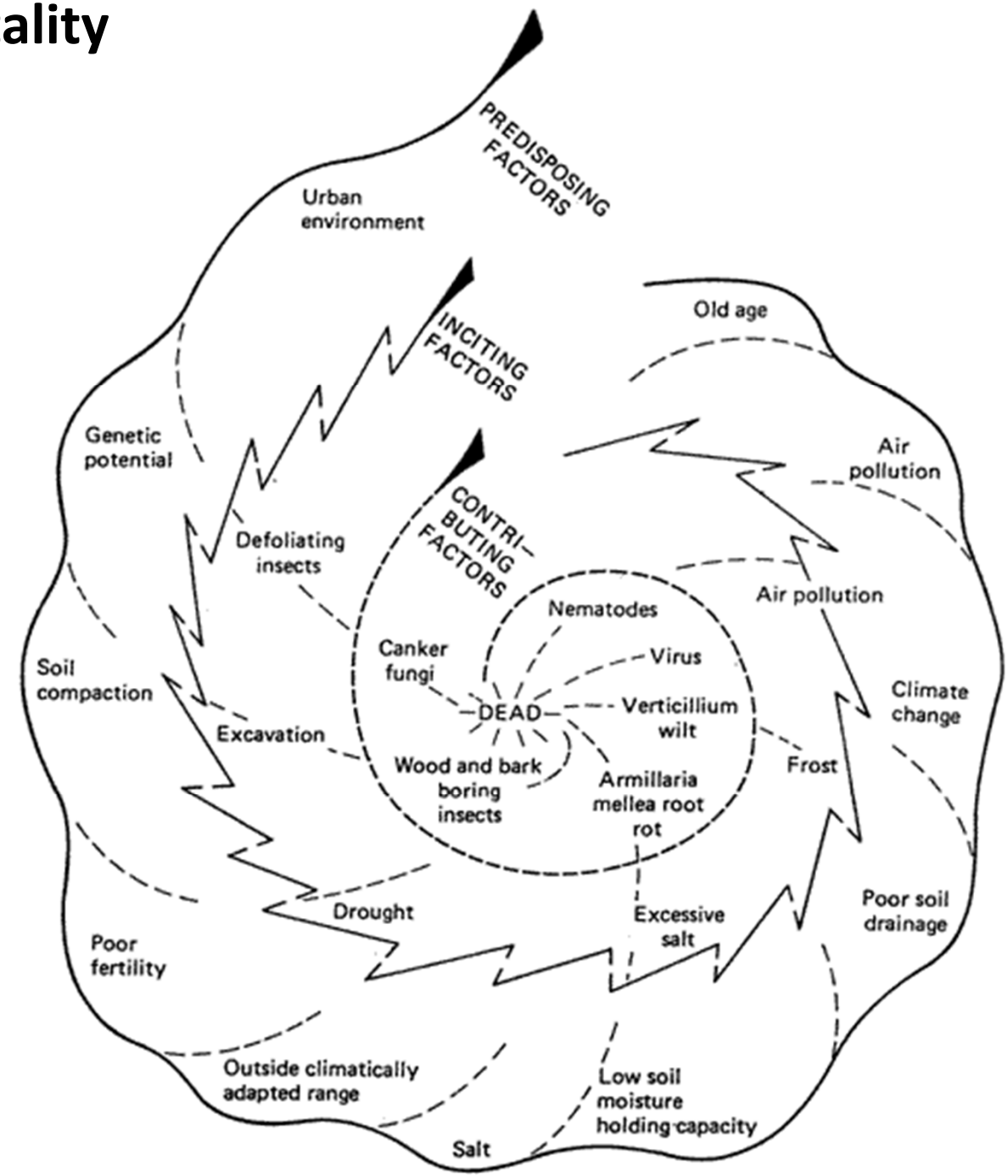


Origin of mortality



Decline disease spiral from Manion (1991)

Origin of mortality

ENDOGENOUS

- **Senescence**
- **Resource access** (competition, fertility)

+

EXOGENOUS

- **Biotic**

  Spruce budworm outbreaks

  Decay

- **Abiotic**

  Climate (wind, drought, frost)

=

DEATH

Objectives

- Characterize and compare the temporal patterns of mortality between 2 regions.
- Determine the factors influencing the patterns observed.

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Hypotheses

Synchronous and discontinuous mortality

↑

Exogenous factors

Asynchronous and continuous mortality

↑

Endogenous factor

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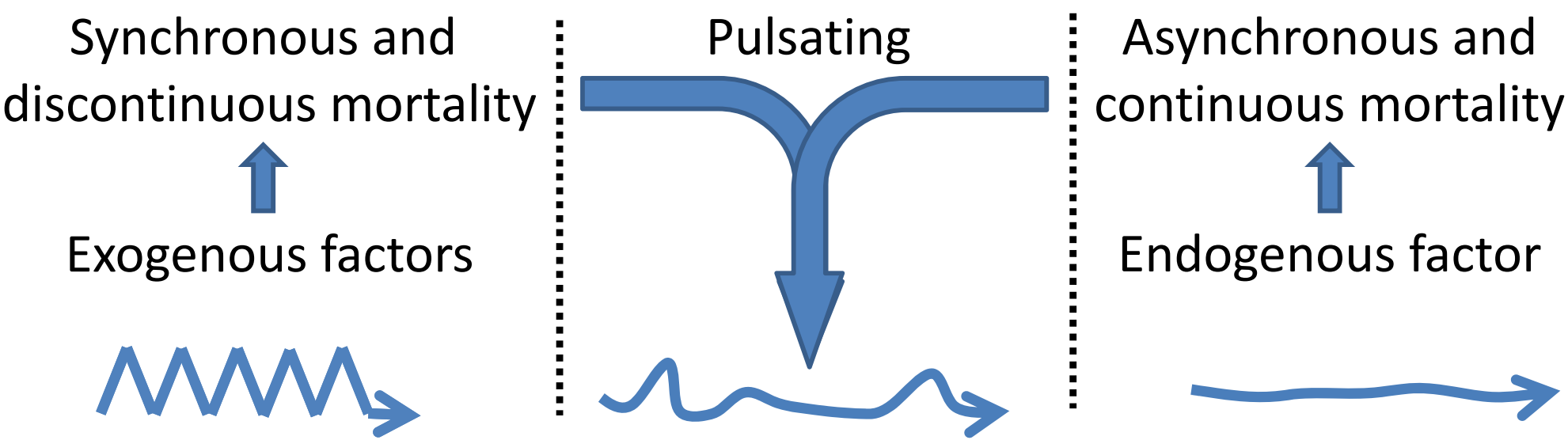
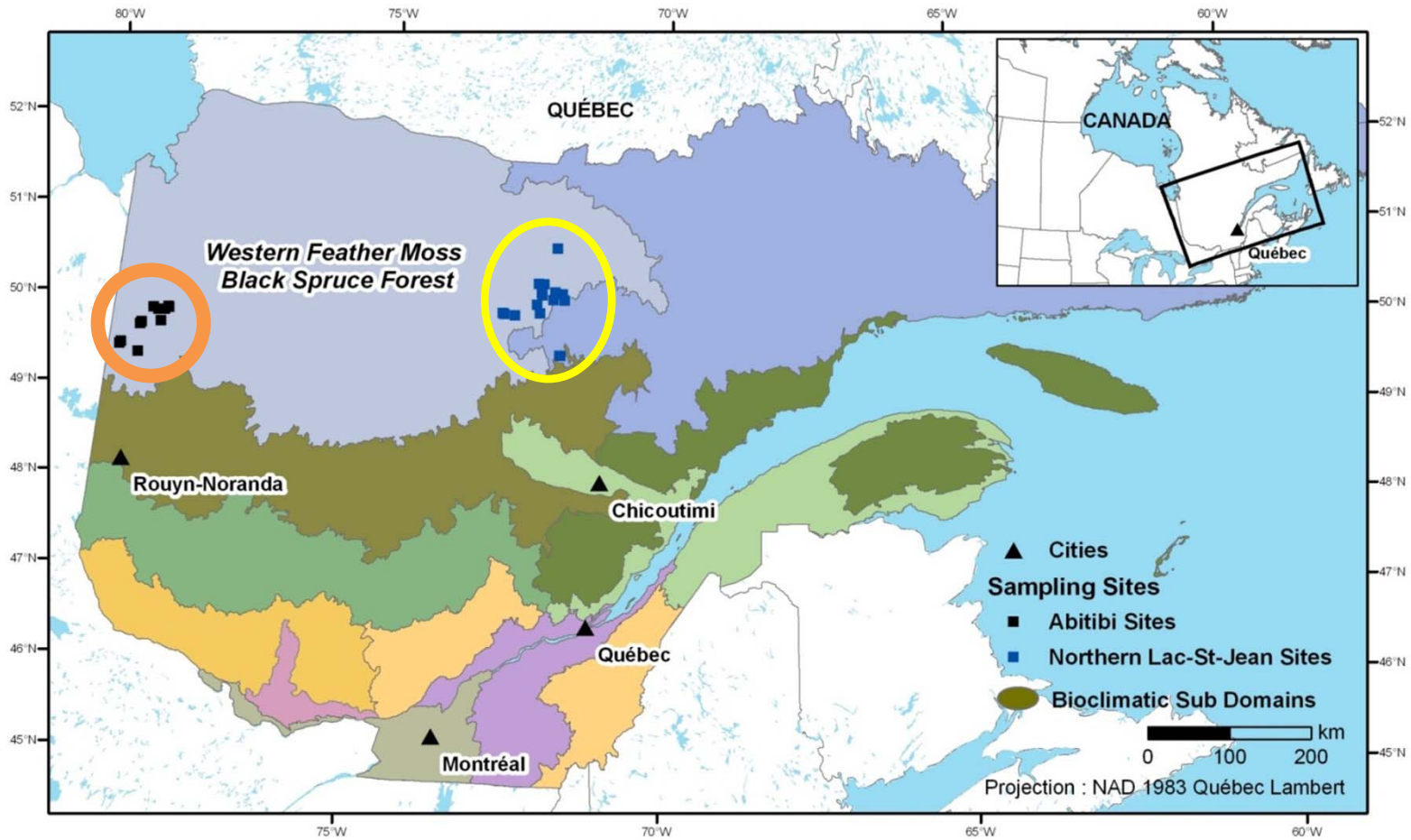
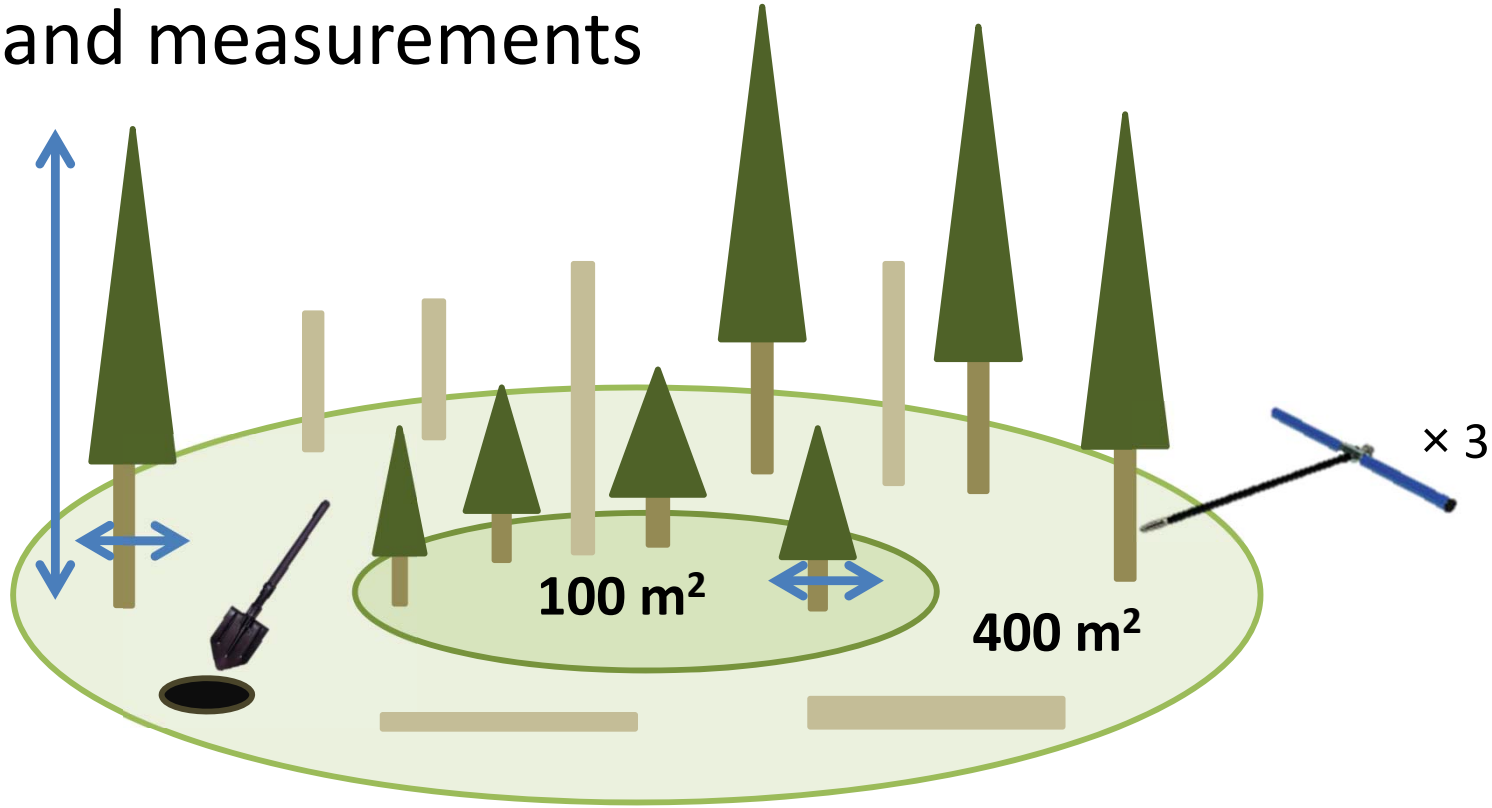
Hypotheses





Abitibi		Northern Lac St-Jean
11	**n. of sites**	16
132 to 234 years	**Age (time since fire)**	120 to 288 years
imperfect	**Drainage**	moderate
fine	**Soil texture**	coarse
< 40 cm	**Thickness of organic matter**	< 40 cm

Sampling and measurements



- **Deadwood**
  - ✓ All deadwood potentially datable, 2 disks/tree (base & top), DBH, height, decomposition classes, description (snag, log, uprooted…)
  - ✓ Disks were dried and sanded
  - ✓ Year-of-death was cross-dated and verified statistically

Tree mortality

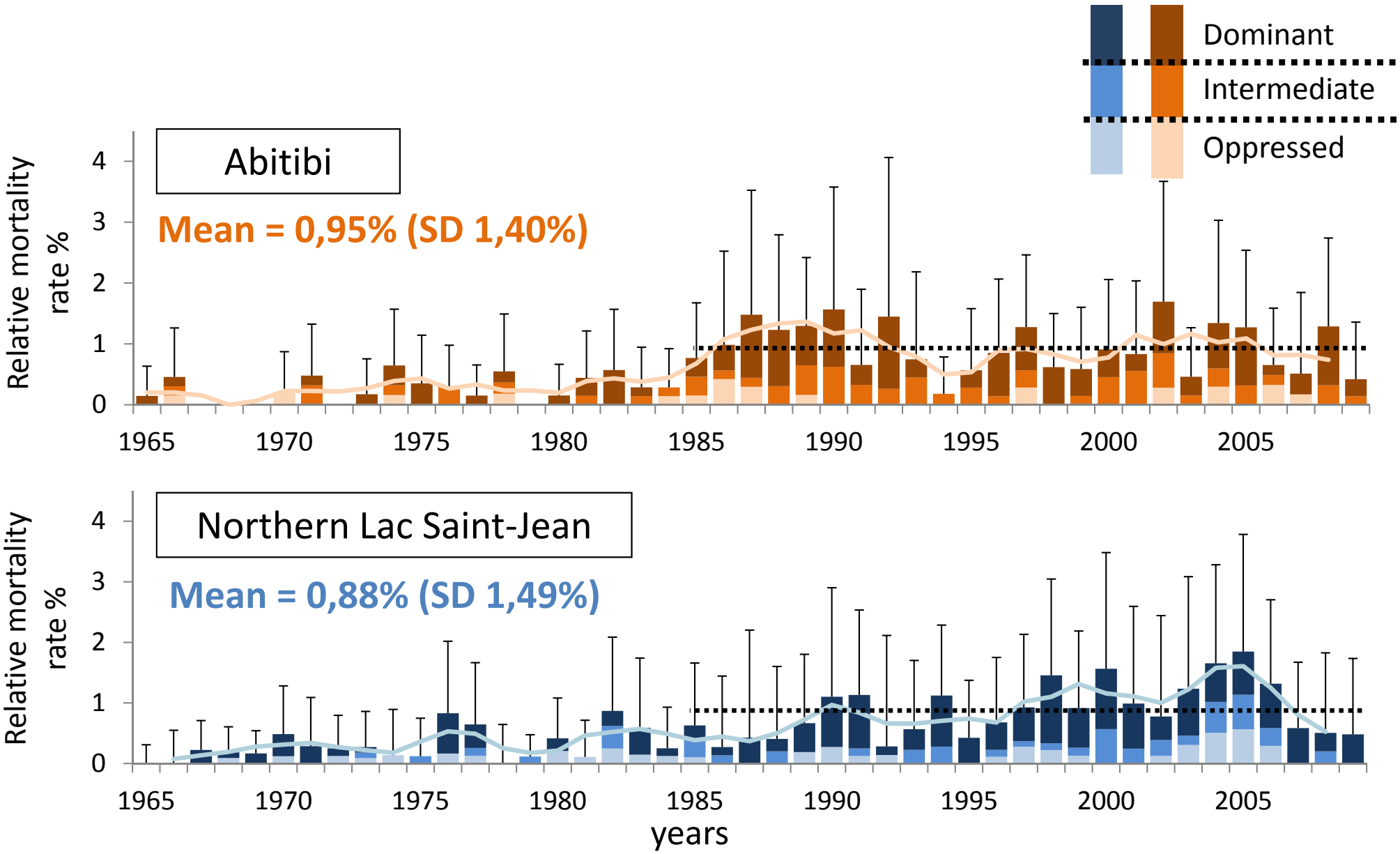
- **Dynamics of mortality**
  - ✓ Annual relative mortality rate
- **Causes**
  - ✓ Climate influences
    - Temperature
    - Precipitation
    - Wind
  - ✓ Spruce budworm outbreak influence

  } Compared with mortality dynamics
- **Intensity of mortality**

Sampling and measurements

	Abitibi	Northern Lac St-Jean	Total
Dead trees sampled & (disks)	215 (393)	280 (547)	495 (940)
Successfully cross-dated dead trees & (disks)	208 (373)	255 (498)	463 (832)
Dead trees with last ring present & (disks)	194 (324)	233 (463)	427 (787)
Percentage of trees with years of death	90 %	83 %	86 %

Mortality patterns from 1985 to 2009 in **Abitibi & Northern Lac Saint-Jean**



Mortality pattern from 1985 to 2009 in **Northern Lac Saint-Jean**

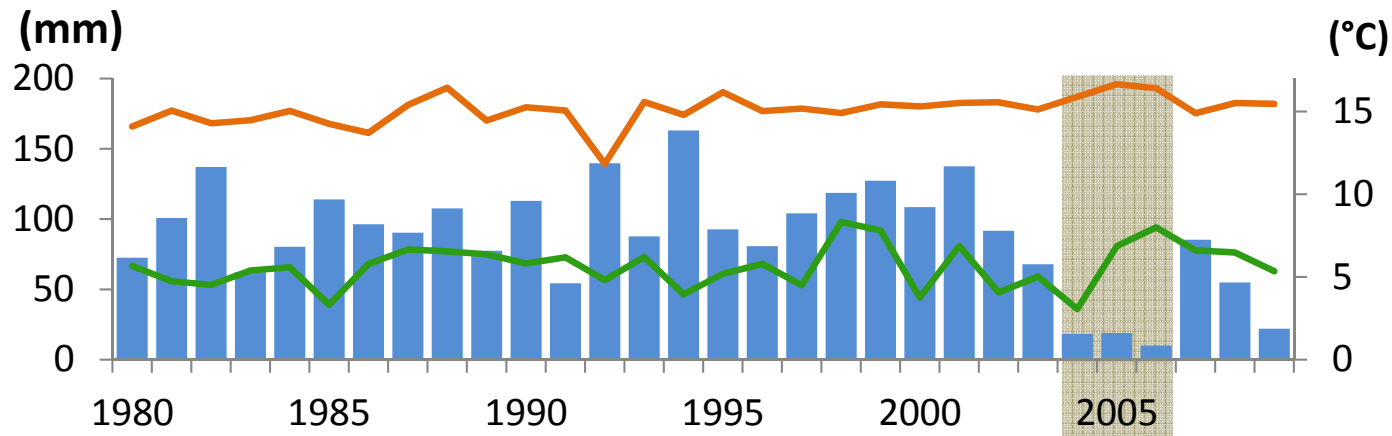
Climate influence

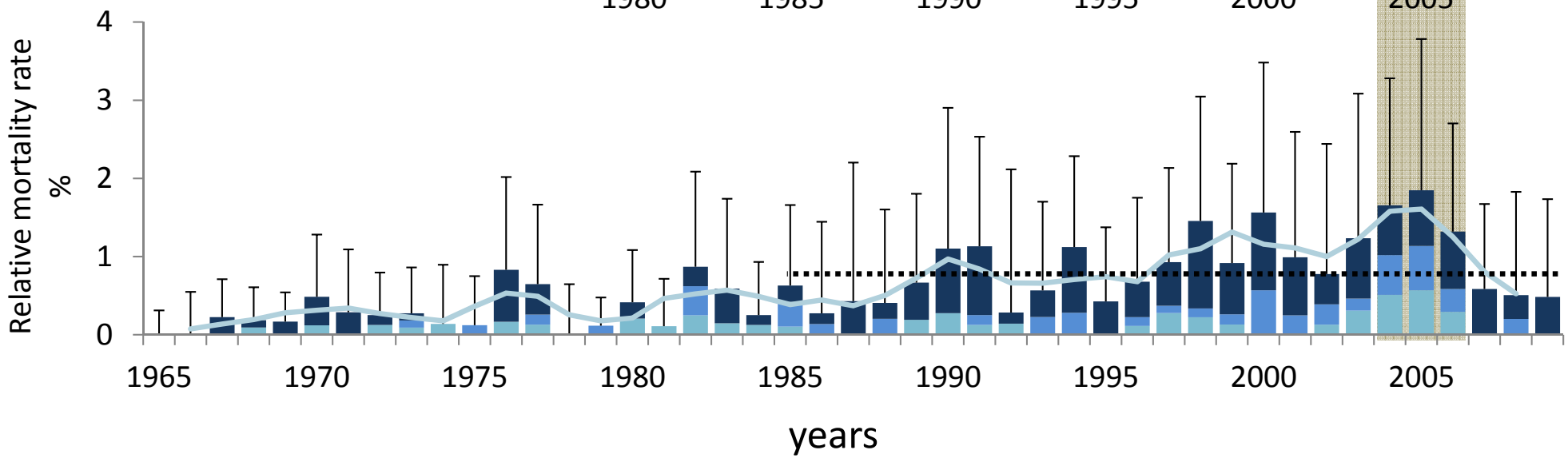
Influence of mean temperature

- **- july (t-1 & t)**
- **+ spring (t)**

Influence of total precipitation

- **+ June (t-1 & t)**





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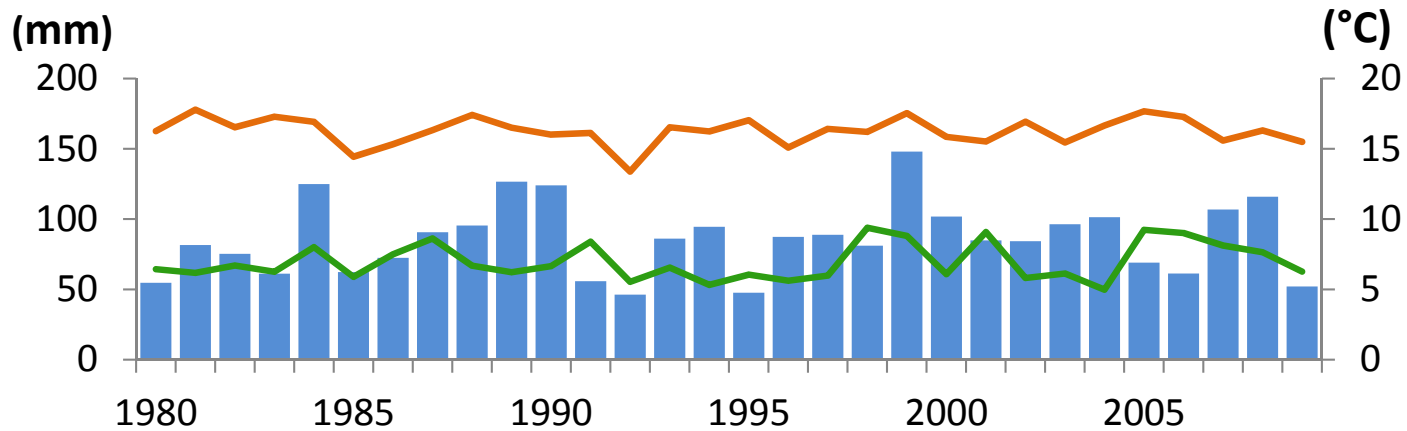
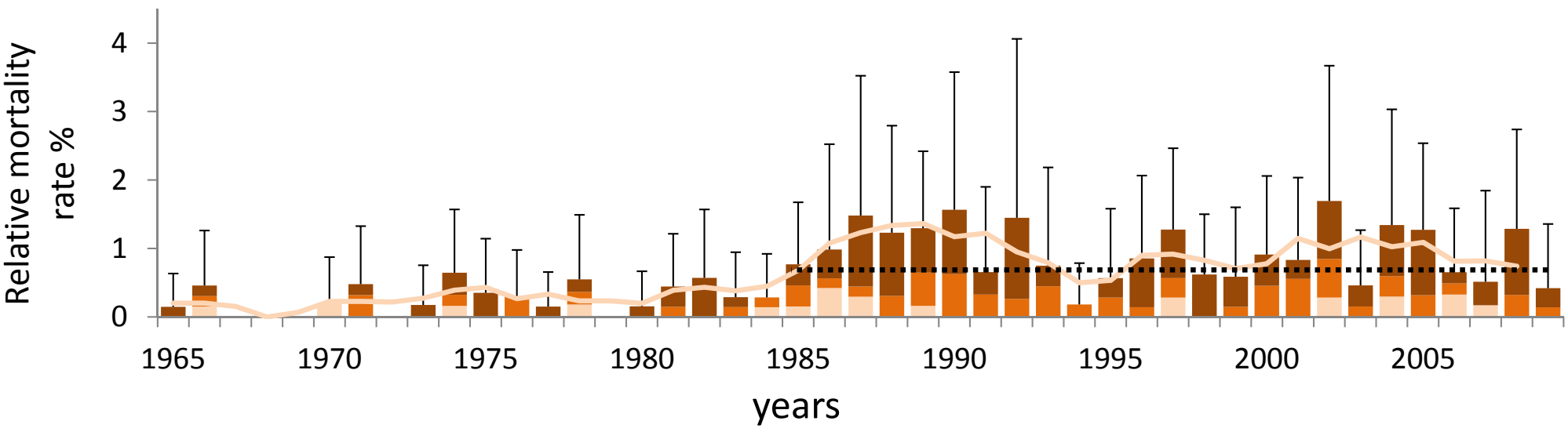
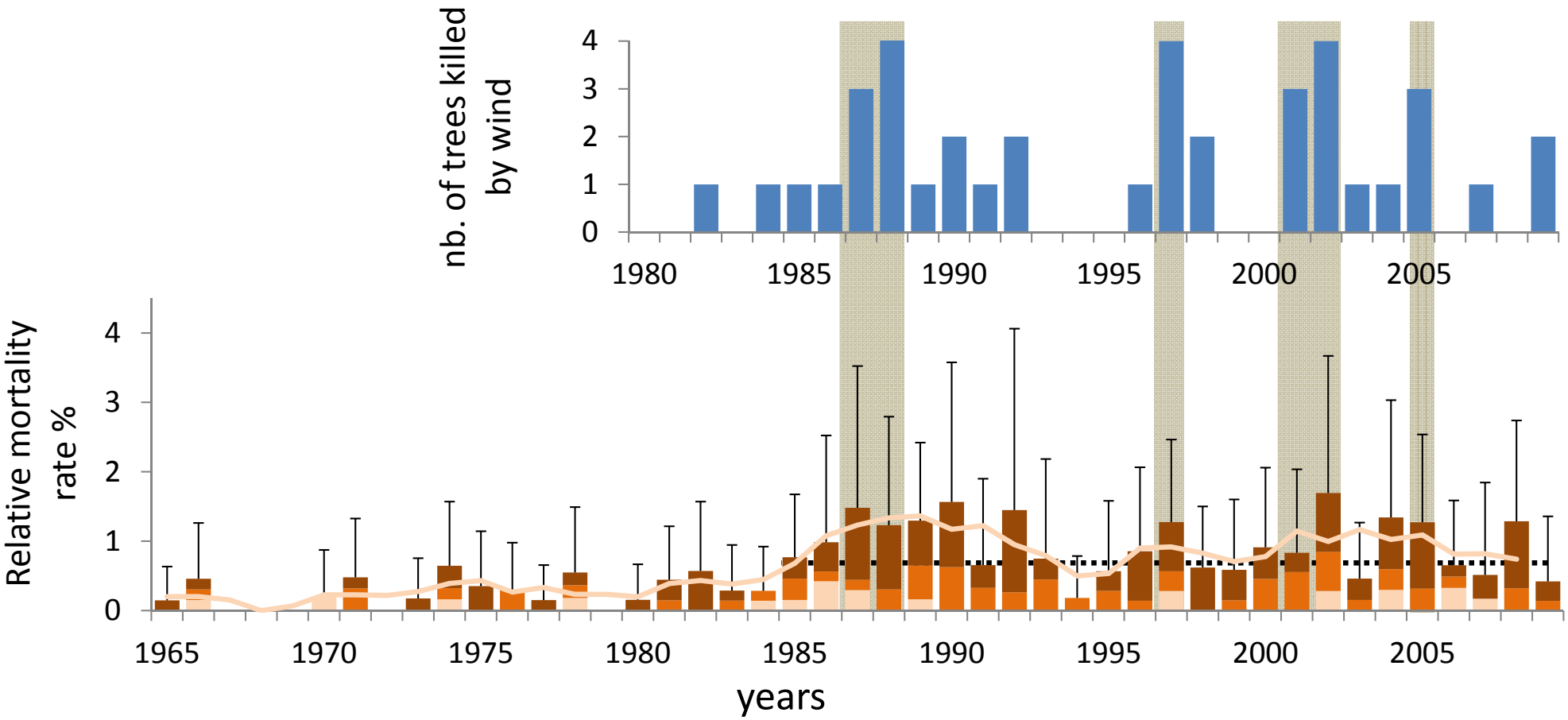




Mortality pattern from 1985 to 2009 in **Abitibi**

Wind influence

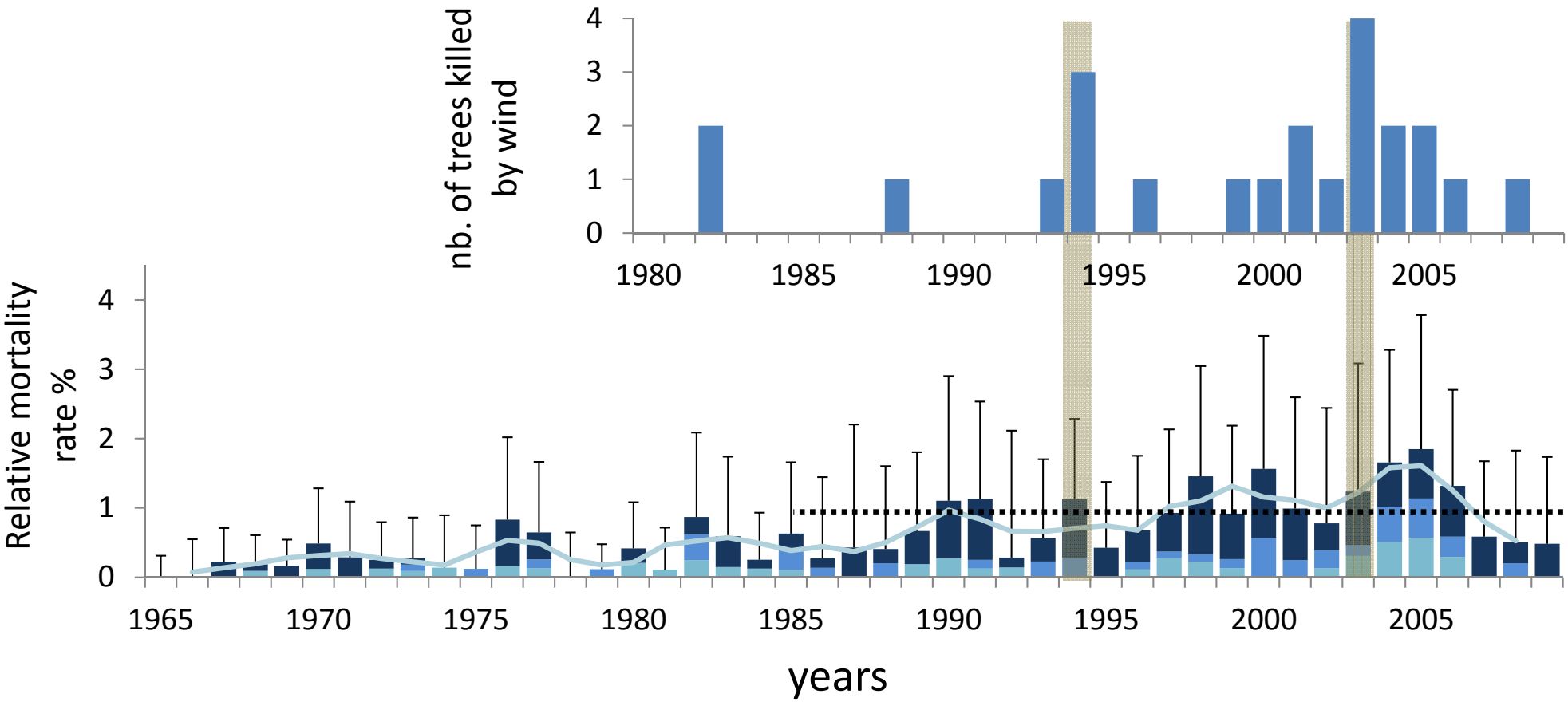
29% of dead trees were uprooted or broken by wind



Mortality pattern from 1985 to 2009 in **Northern Lac Saint-Jean**

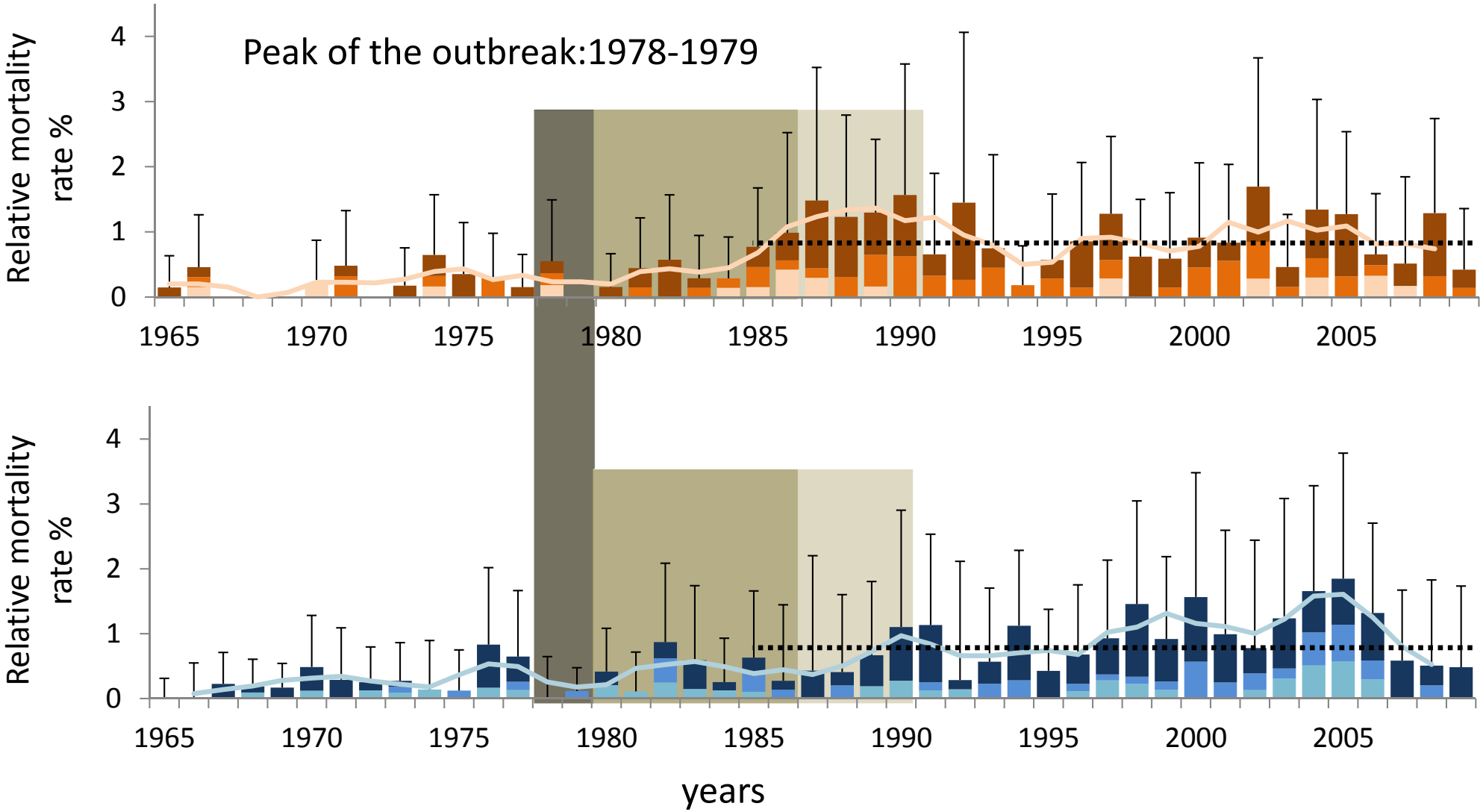
Wind influence

13% of dead trees were uprooted or broken by wind

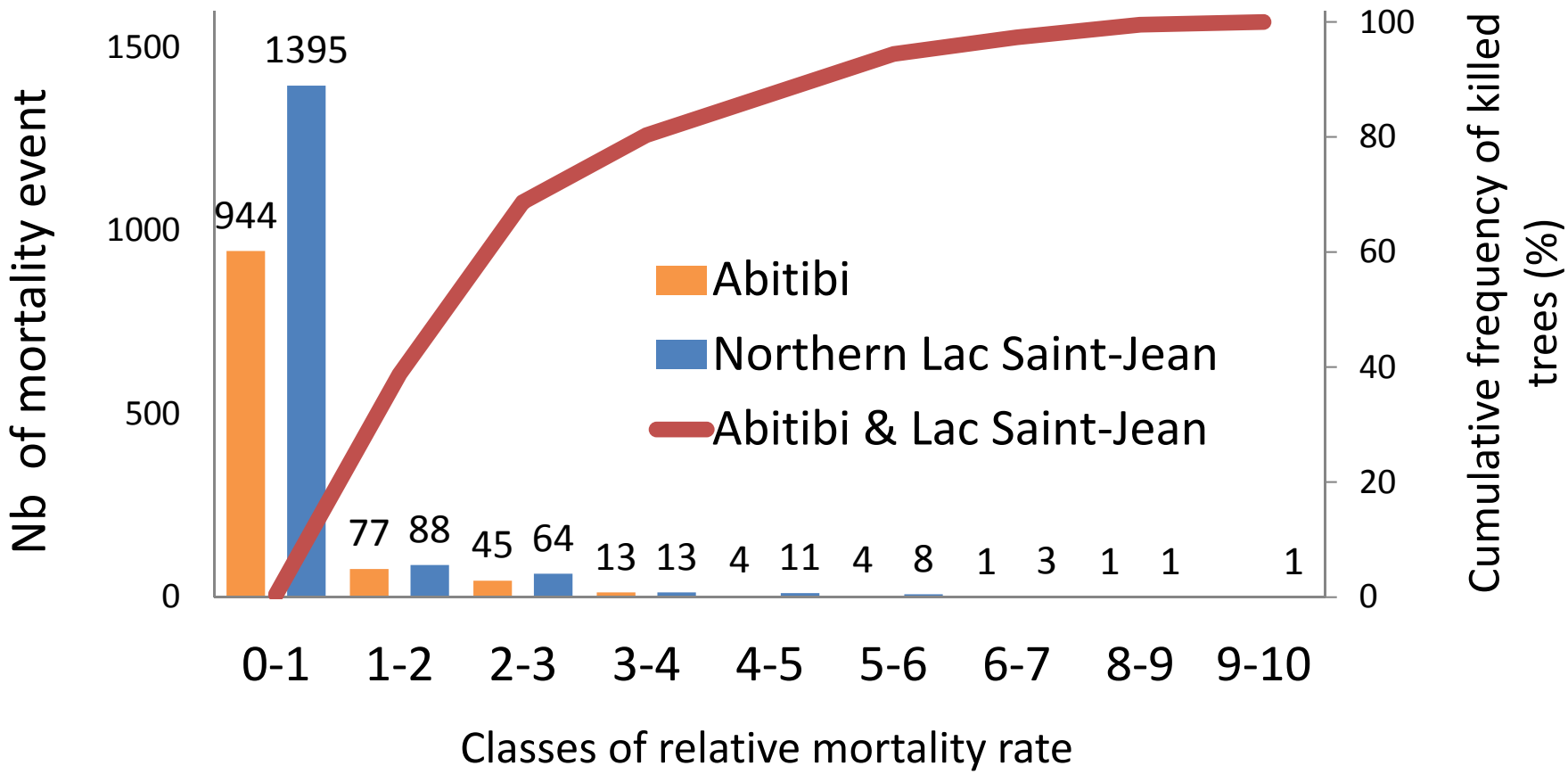


Mortality patterns from 1985 to 2009 in **Abitibi & Northern Lac Saint-Jean**

Spruce Budworm outbreak influence



Severity of single event of mortality



- 19 events with a rate > 5%
- 80 % of trees died in event of low severity (0-1 to 3-4%)

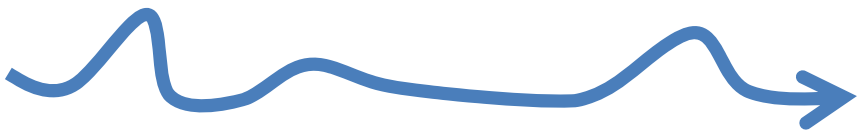
- The factors involved in mortality are numerous and difficult to identify

  - ✓ Stress caused by climate variability seems to play an important role in tree mortality
  - ✓ Wind plays an important role in tree mortality
  - ✓ Spruce budworm outbreaks. An absence of evidence is not an evidence of absence…

- Rates and variability of tree mortality are relatively stable
  - ✓ Years of low severity are dominant
  - ✓ Years of highest severity are rare but contribute to mortality

Continuous mortality constitute the background of mortality

Synchronous events of mortality are present but infrequent



Pulsating pattern

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