

A Biogeographical Analysis of Distribution and Colonisation of Frost Hollows along a Latitudinal Gradient (Québec, Canada)

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écologie des perturbations



Centre
d'études
nordiques



CRSNG
NSERC

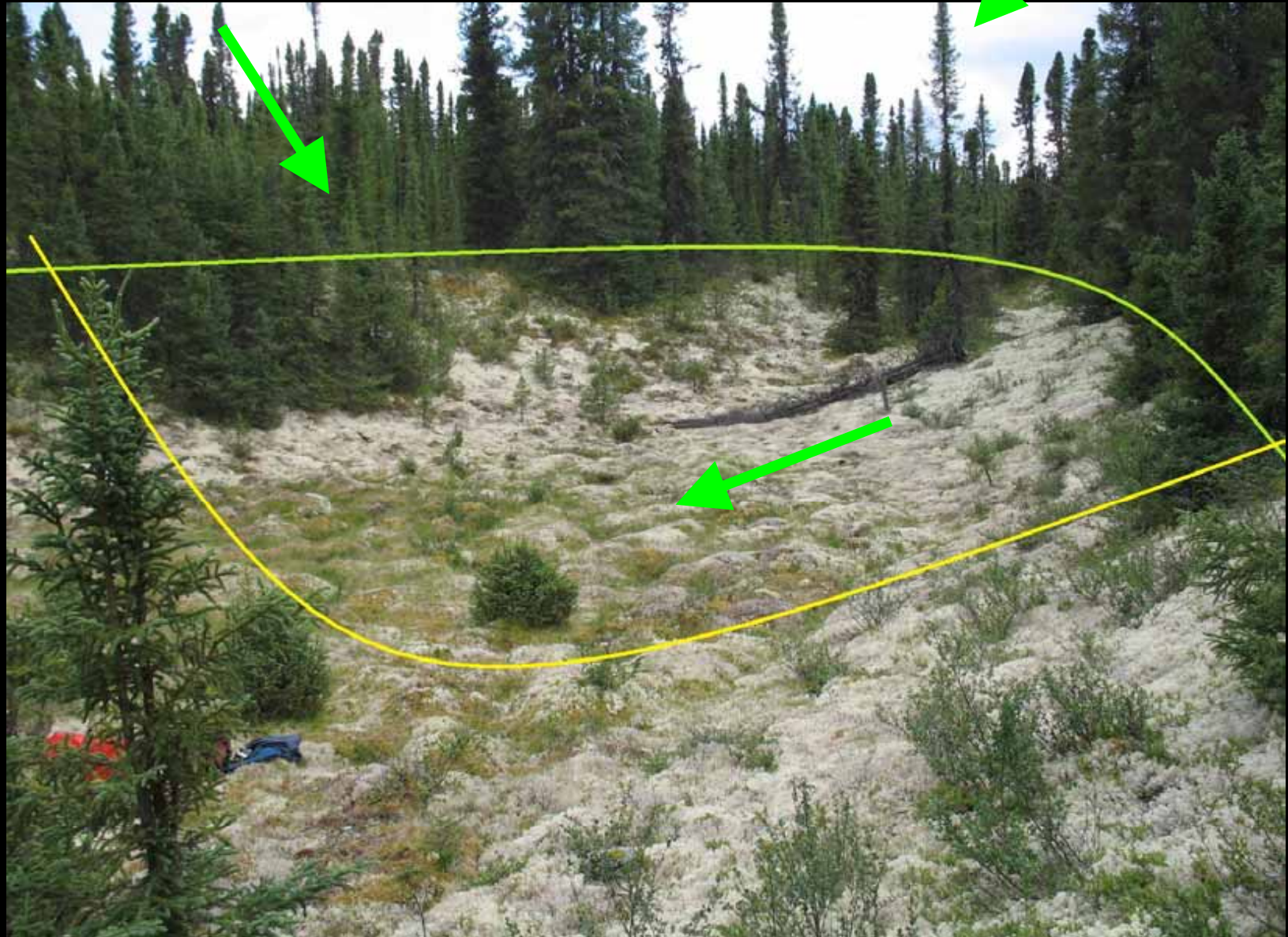








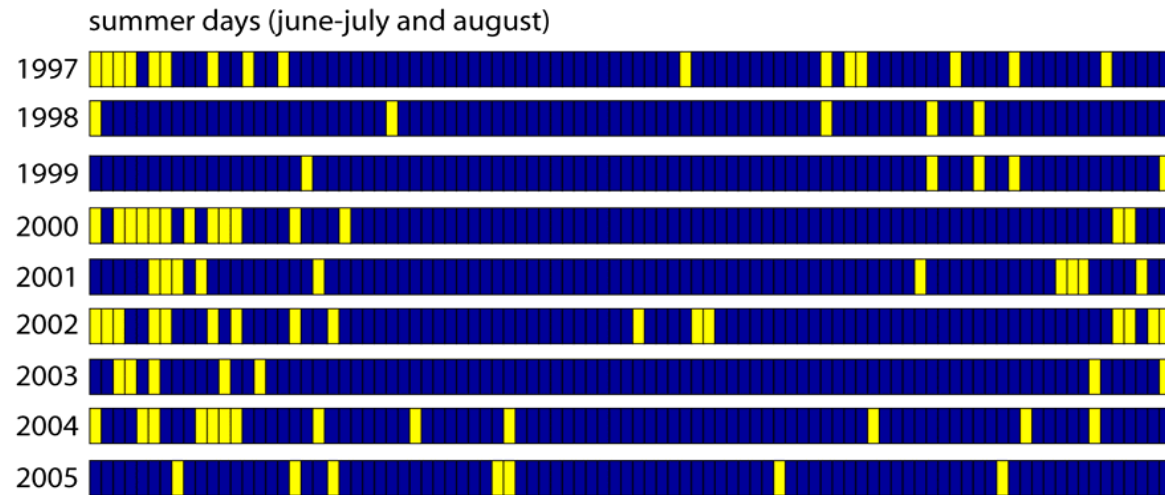
A frost hollow



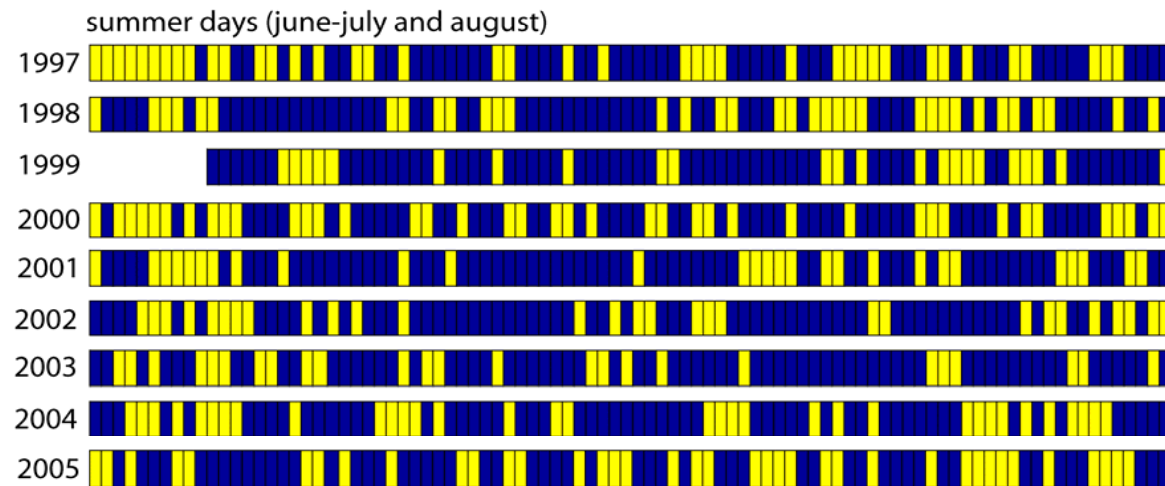
Presence-absence of summer daily frost during the 1997-2005 period

Parc des Grands-Jardins

Lichen-spruce woodland



Frost hollow



Optimum conditions for radiative frost

- Well-drained soil (fluvioglacial deposits)
- Open forest structure (lichen woodlands)
- Calm and clear night (orographic influence)



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- Open forest structure (lichen woodlands)
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- Concave topography (kettles and eskers)



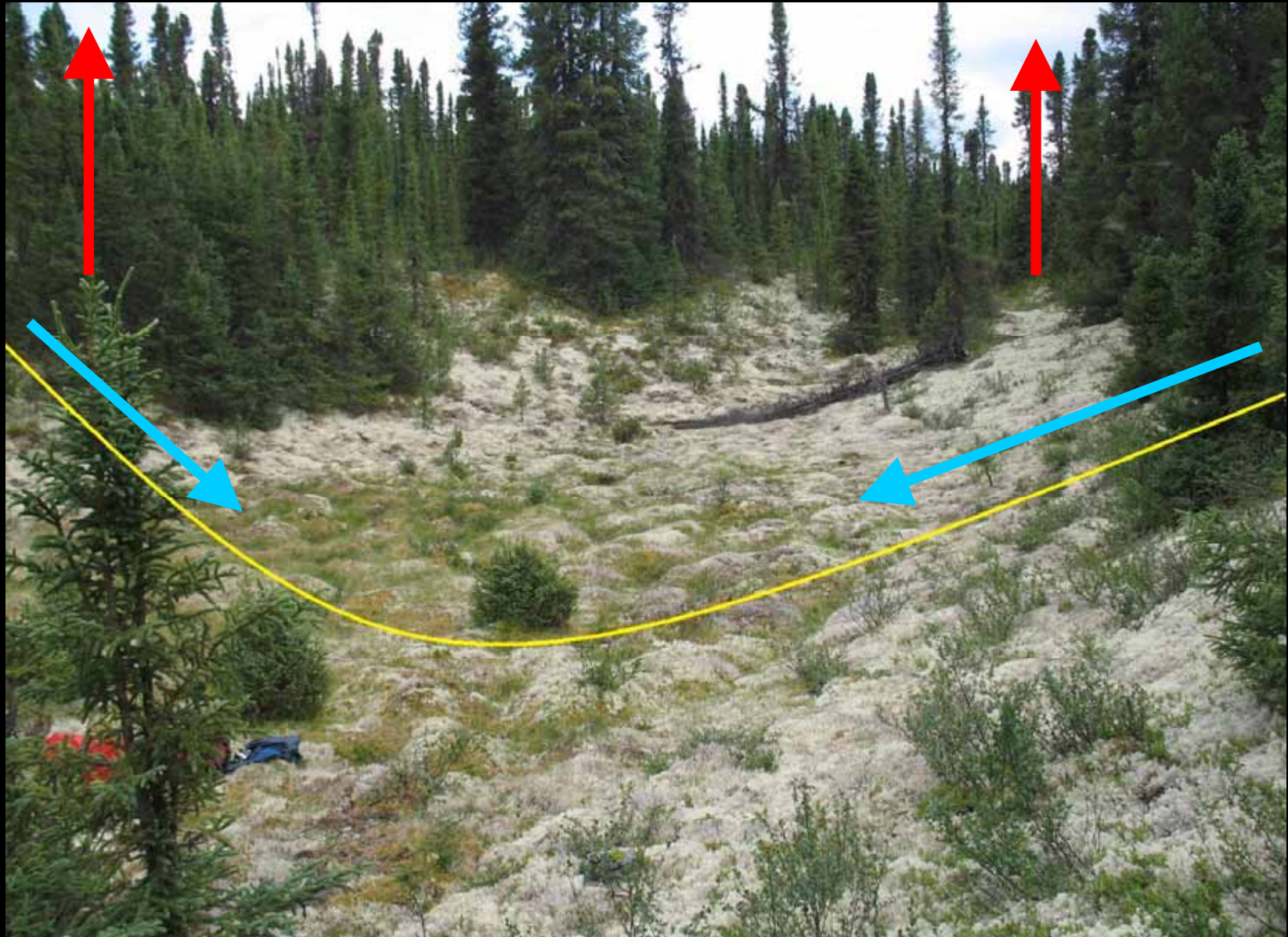
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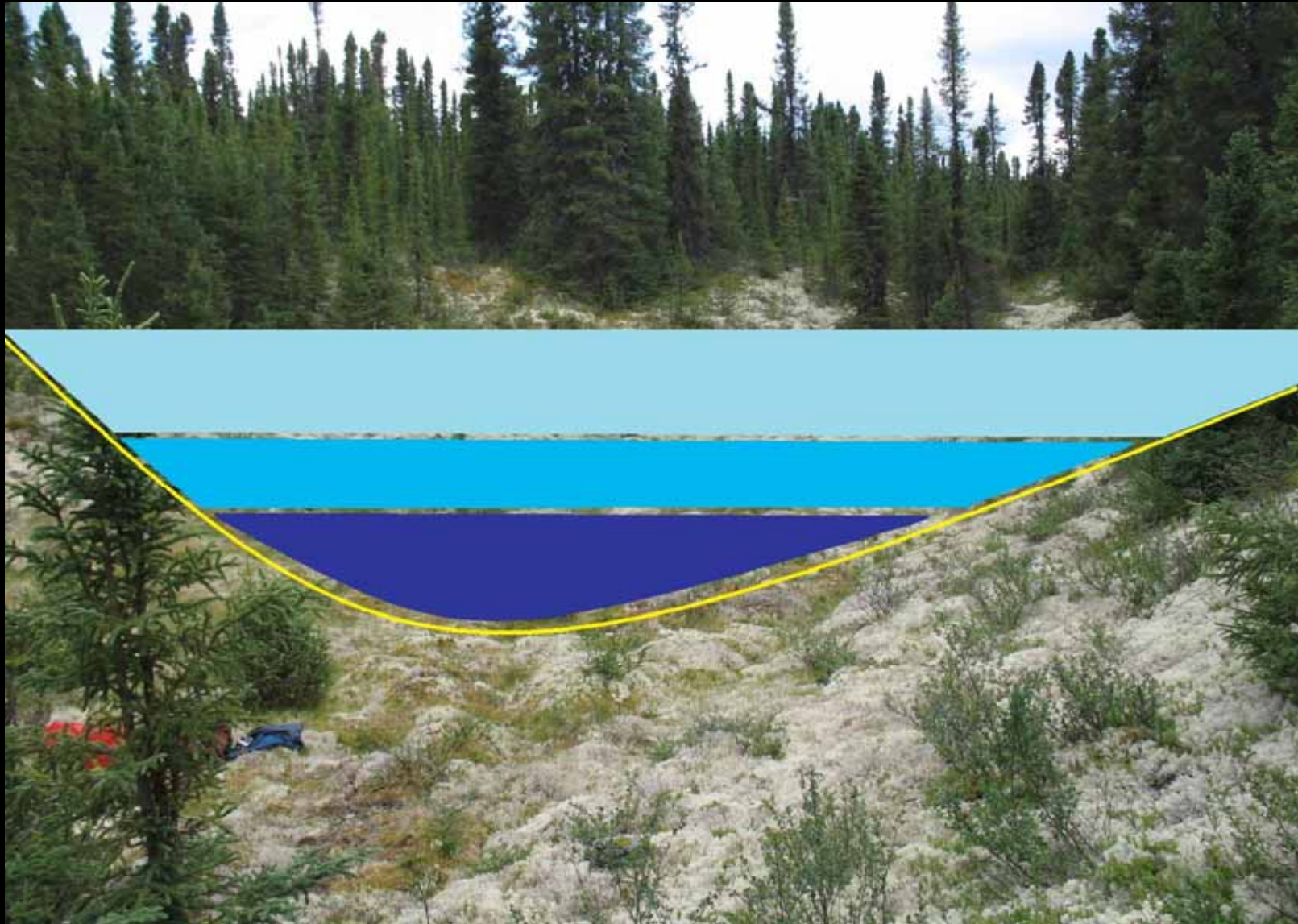


= Frost hollow

A frost hollow



A frost hollow



Effects of frost on black spruces

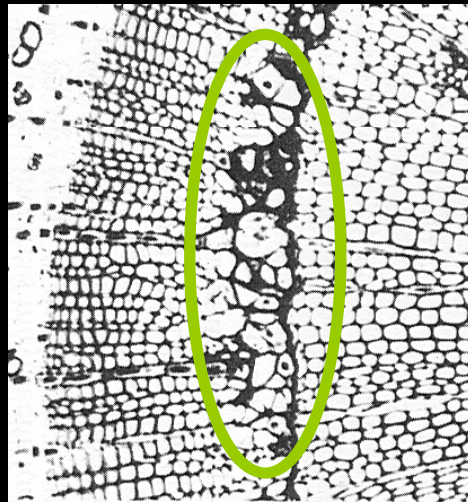
↓ Germination

↓ Growth



Loss in foliage

Frost rings



Reiteration

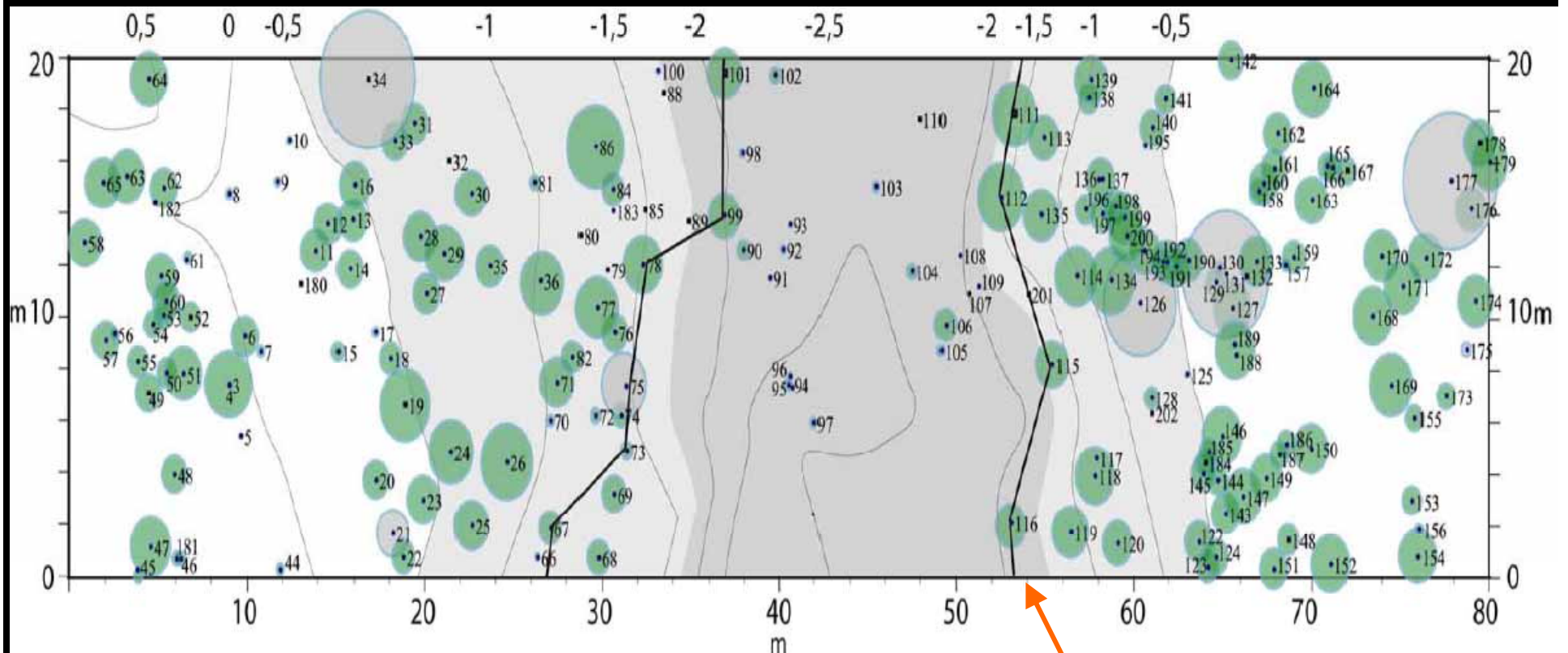
Reduction of radial and vertical growth

↓ Survival

= **Differential regeneration** inside *versus* outside the hollow

Quadrat's map of a frost hollow in Parc des Grands-Jardins

Contour lines (0,5 m)



□ Lichen woodland

■ Slope

■ Frost hollow

○ Crown projection on the ground

● Black spruce (*Picea mariana*)

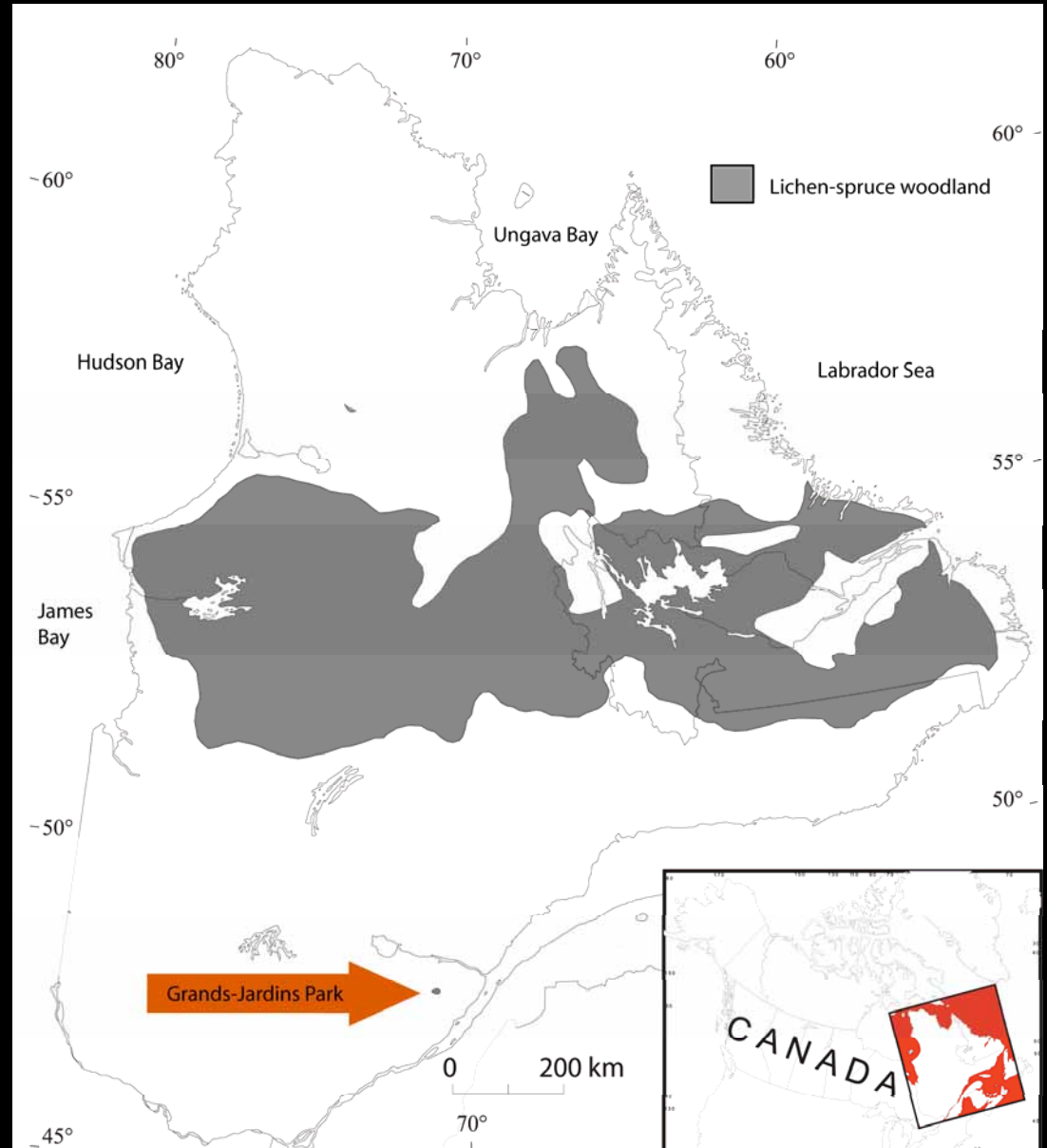
● Jack Pine (*Pinus banksiana*)

— Inverse treeline

First study about frost hollows

by Goulwen Dy and
Serge Payette
Parc des Grands - Jardins
2005

southernmost lichen-spruce
woodland



Objectives

1- Evaluation of distribution and abundance of frost hollows along a latitudinal gradient in central Québec.

2- Study of a possible colonisation pattern variability according to latitude.



Method

1- Evaluation of distribution and abundance of frost hollows along a latitudinal gradient in central Québec.

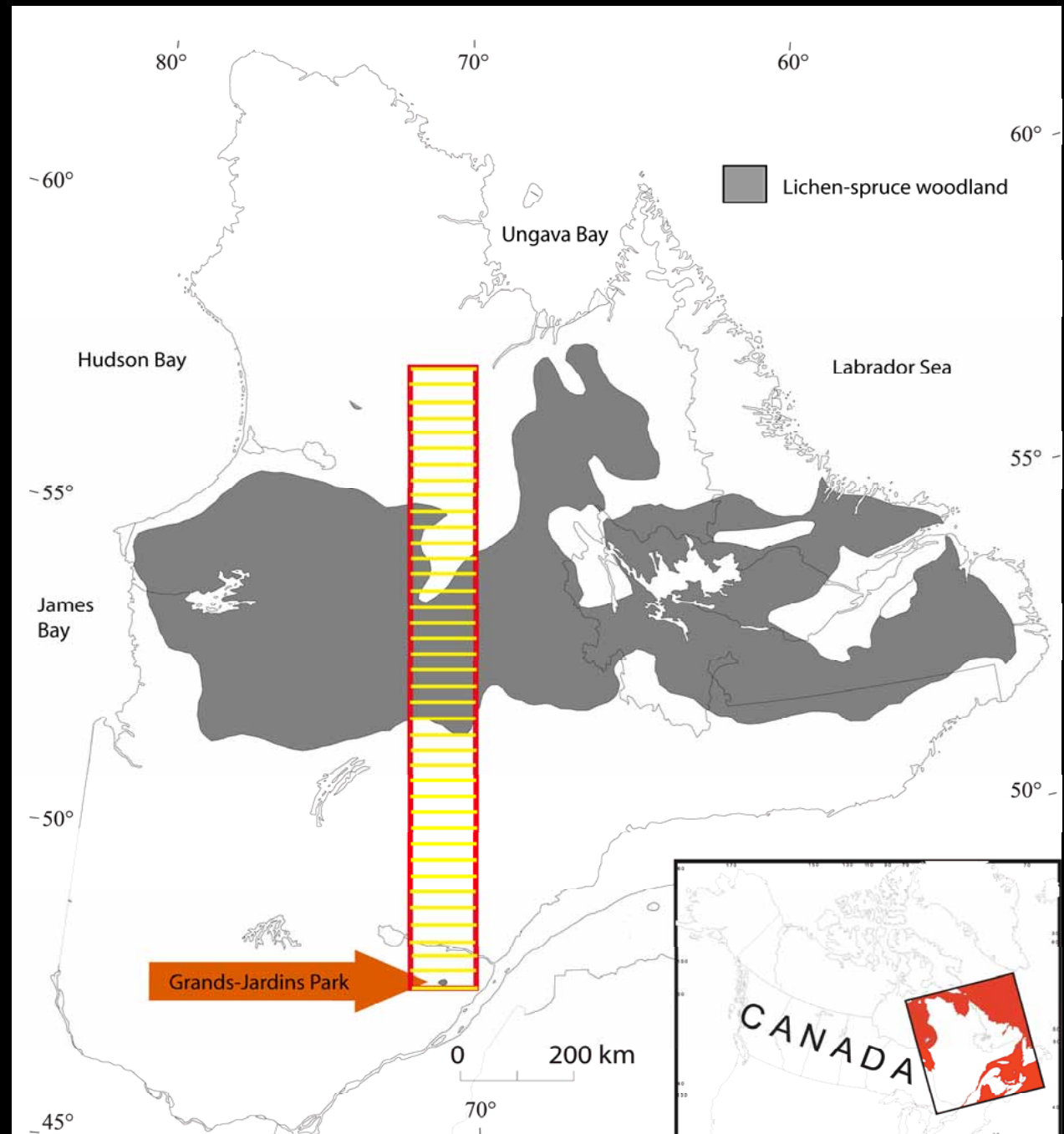


Québec, Canada

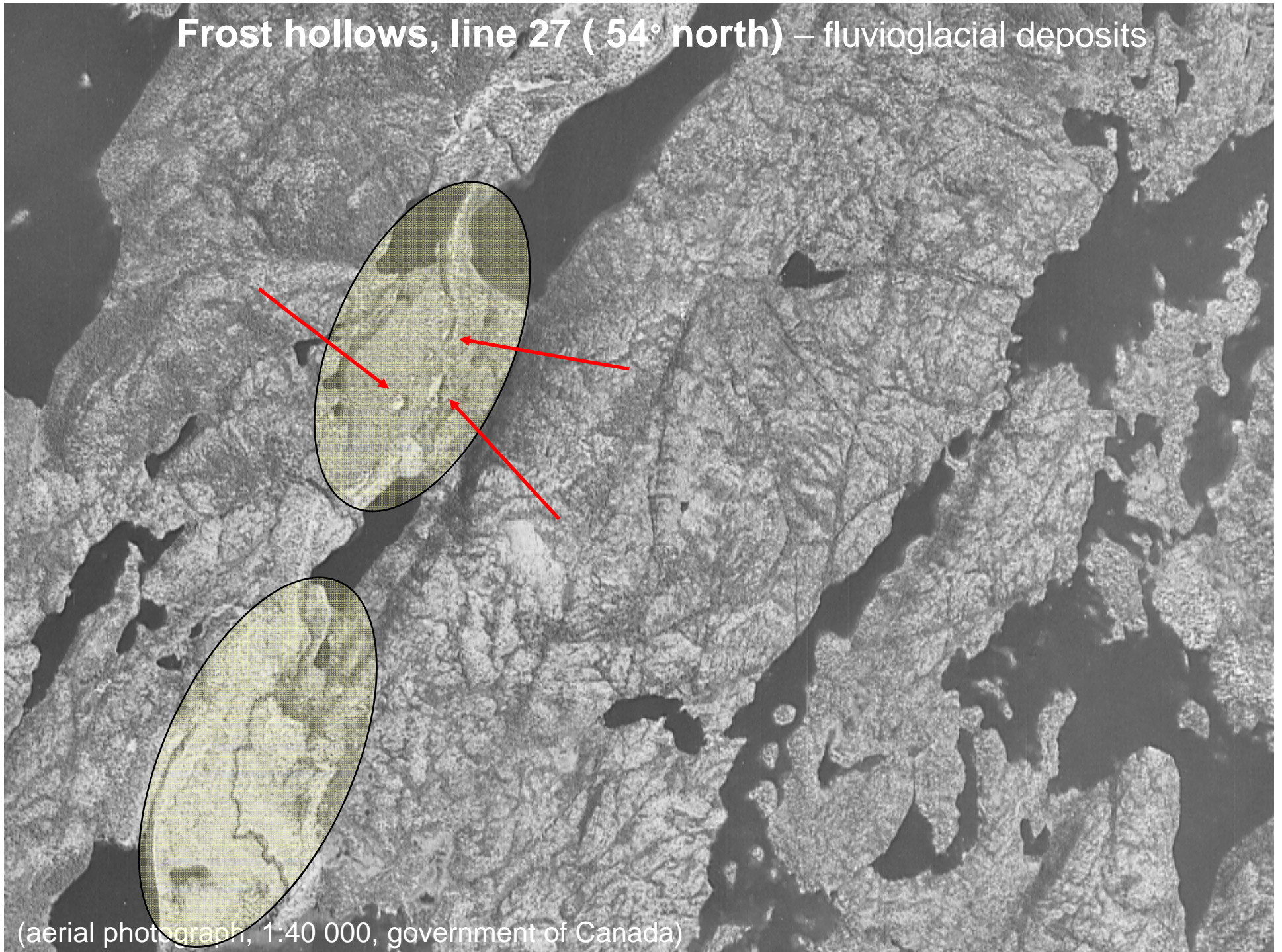
Between 70-72° west
and 48-58° north

Aerial photographs

40 lines
(each 15'; 4 lines/degree)



Frost hollows, line 27 (54° north) – fluvioglacial deposits



(aerial photograph, 1:40 000, government of Canada)

Method



2- Study of a possible colonisation pattern variability depending to latitude.



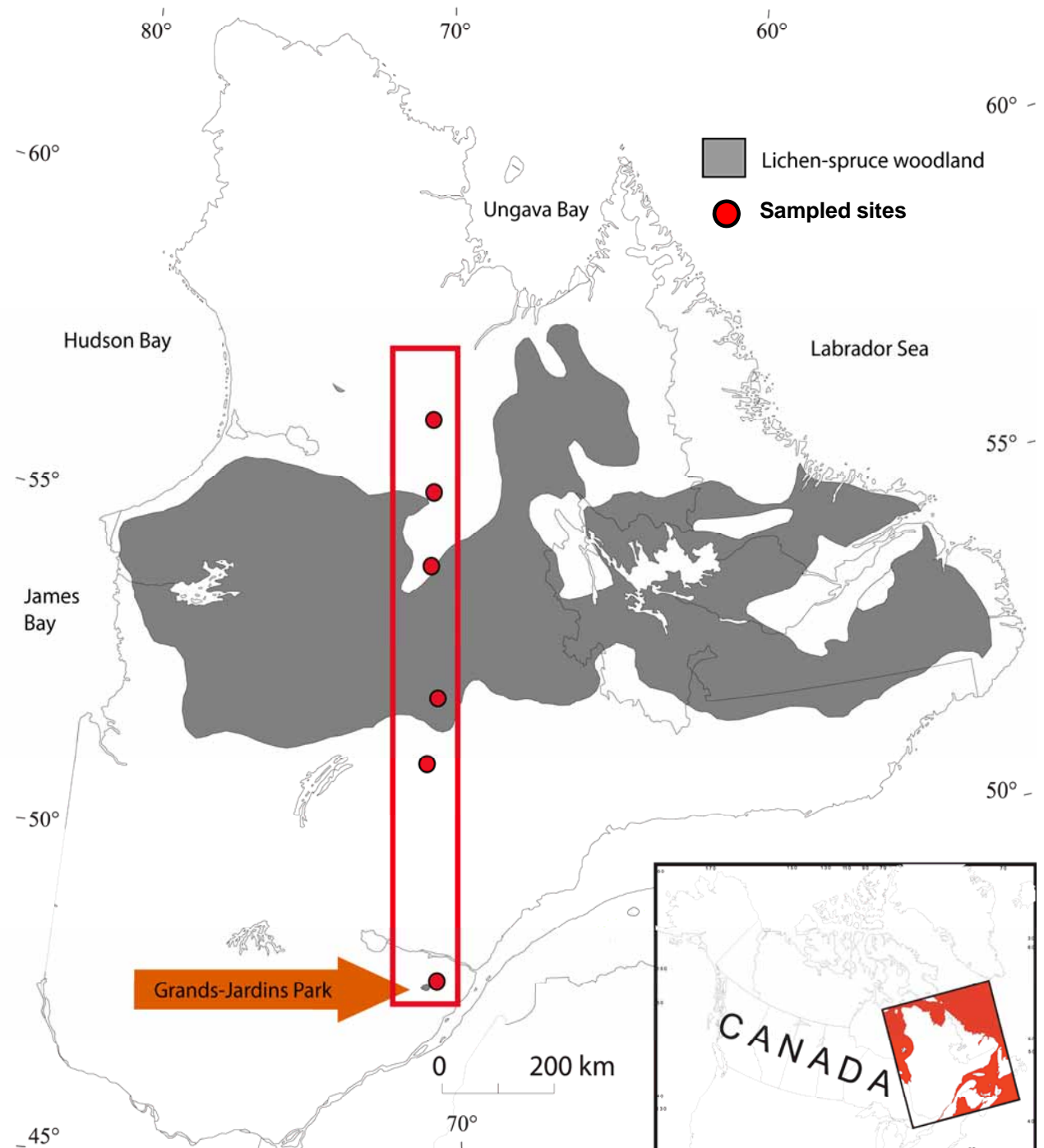
Québec, Canada

15 sites
5 latitudes

well-drained deposits
mature lichen-spruce
woodland

1-General characterization
(topography, treeline, vegetation)

2-Trees sampled inside and
outside the hollow
(situated, characterized,
partitioned)



Analysis

- colonisation chronology
- growth conditions during colonisation
- control site

Dendrochronological analysis

- tree establishment
- stem growth
- radial growth
- frost rings



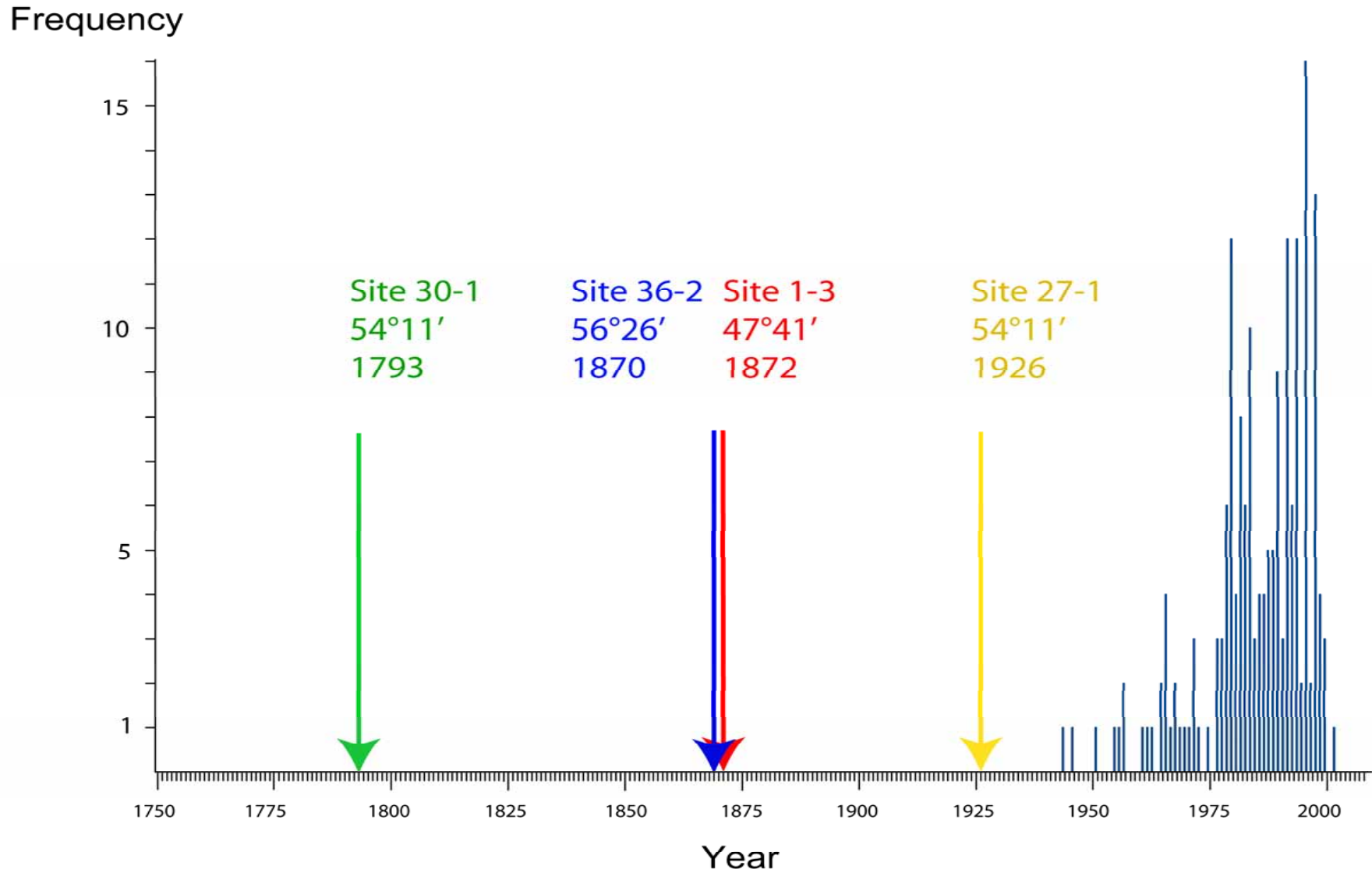
Outside






Inside

Establishment

Black spruce establishment in frost hollows along a latitudinal gradient and post-fire establishment

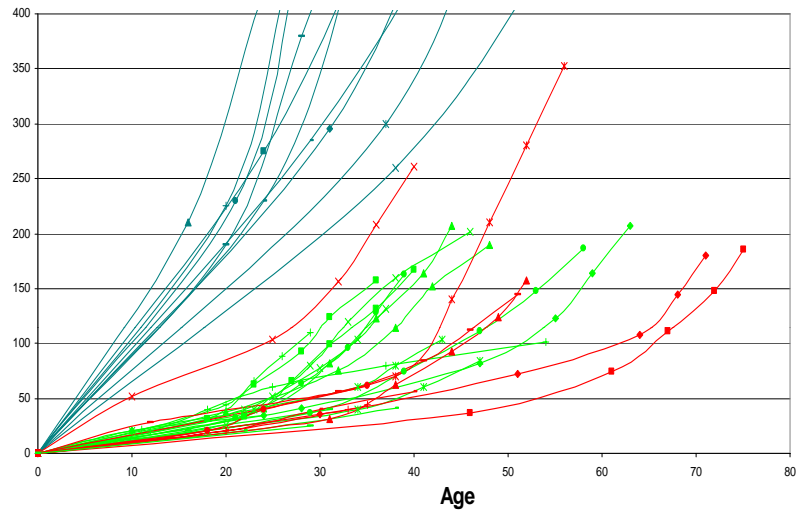


Frost impacts

-  Dominant trees outside hollows
-  Non-dominant trees outside hollows
-  Seedlings and saplings inside hollows

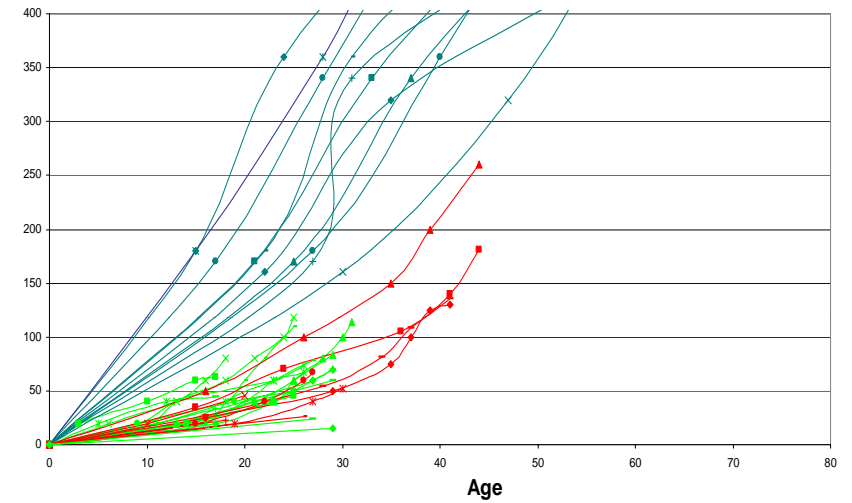
Site 1-3

Height



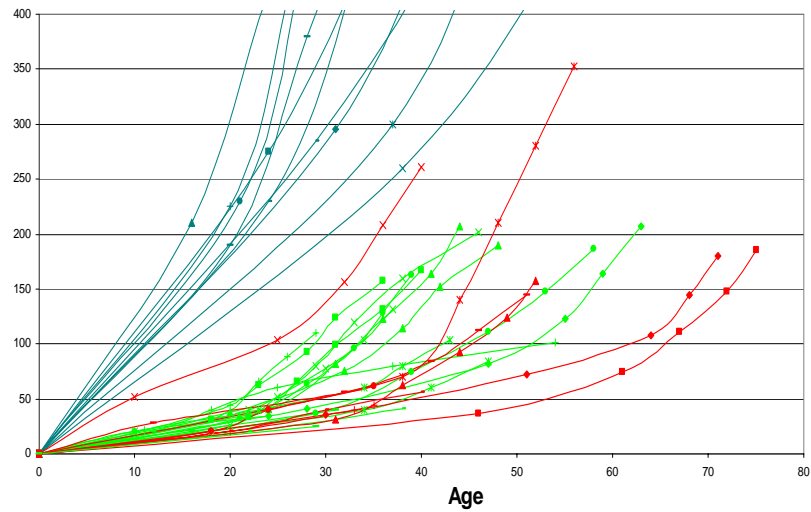
Site 27-1

Height



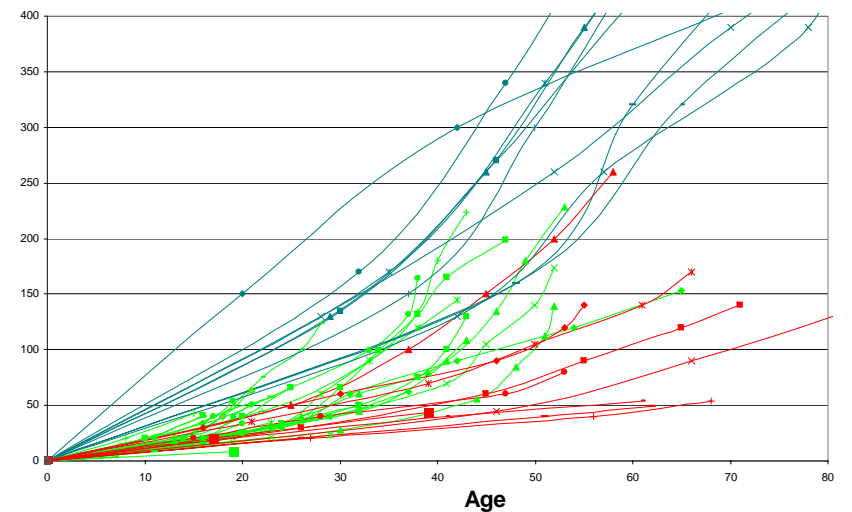
Site 30-1

Height



Site 36-2

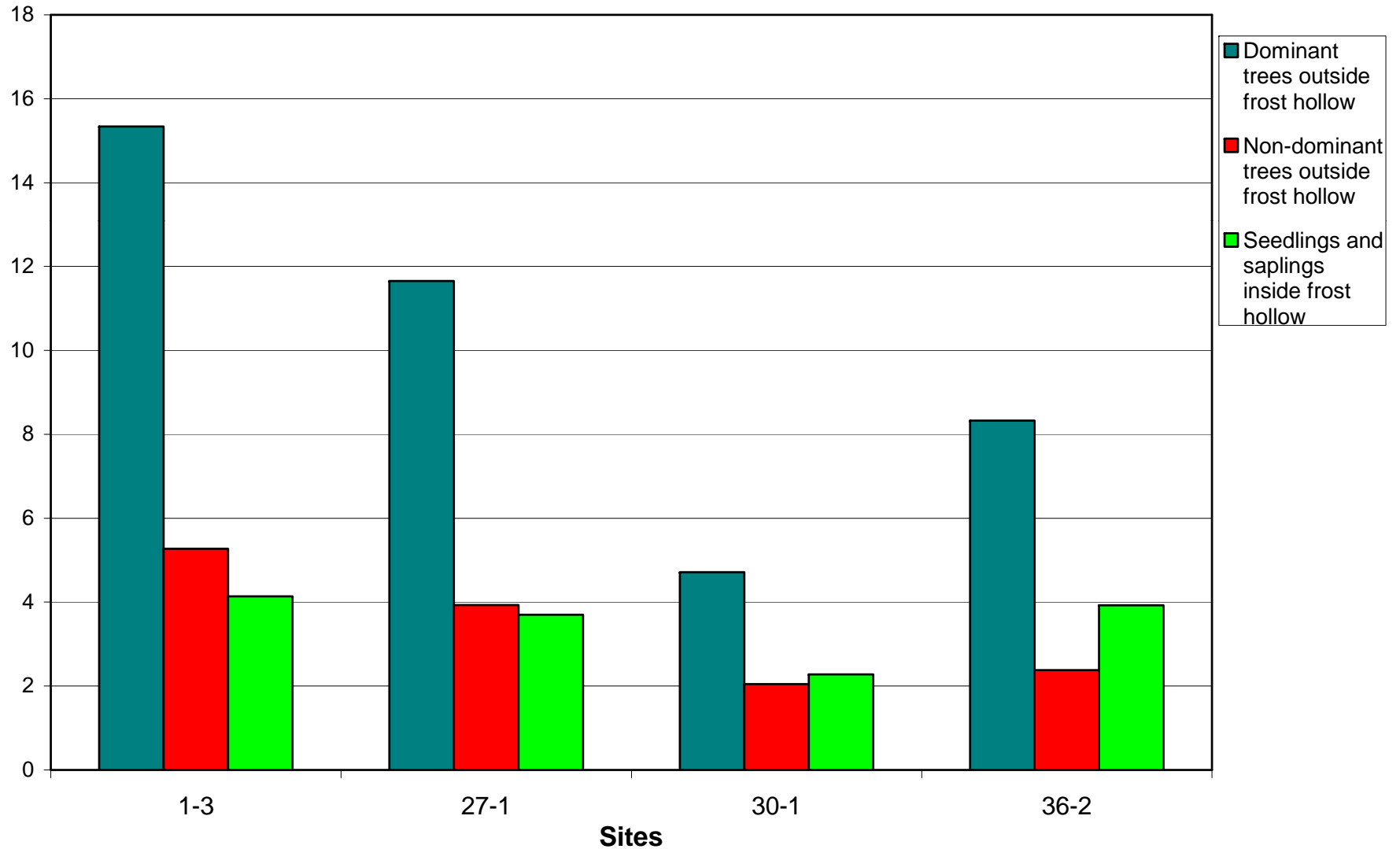
Height



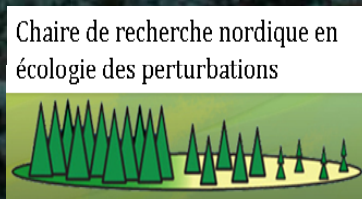
Frost impacts

Black spruce growth rate inside and outside frost hollows

Growth rate
(cm/year)

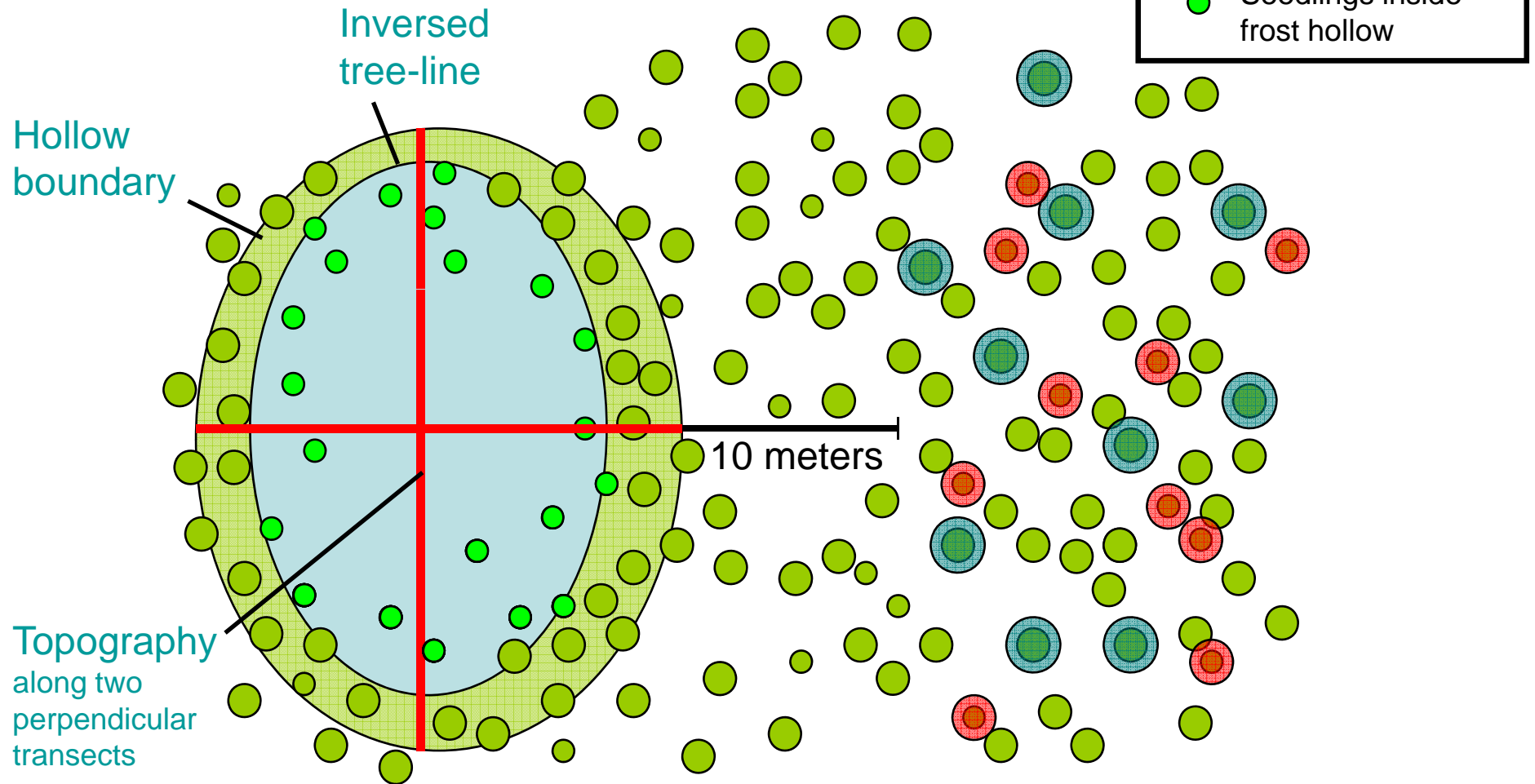


Thank you



Sampling

1. General characterization

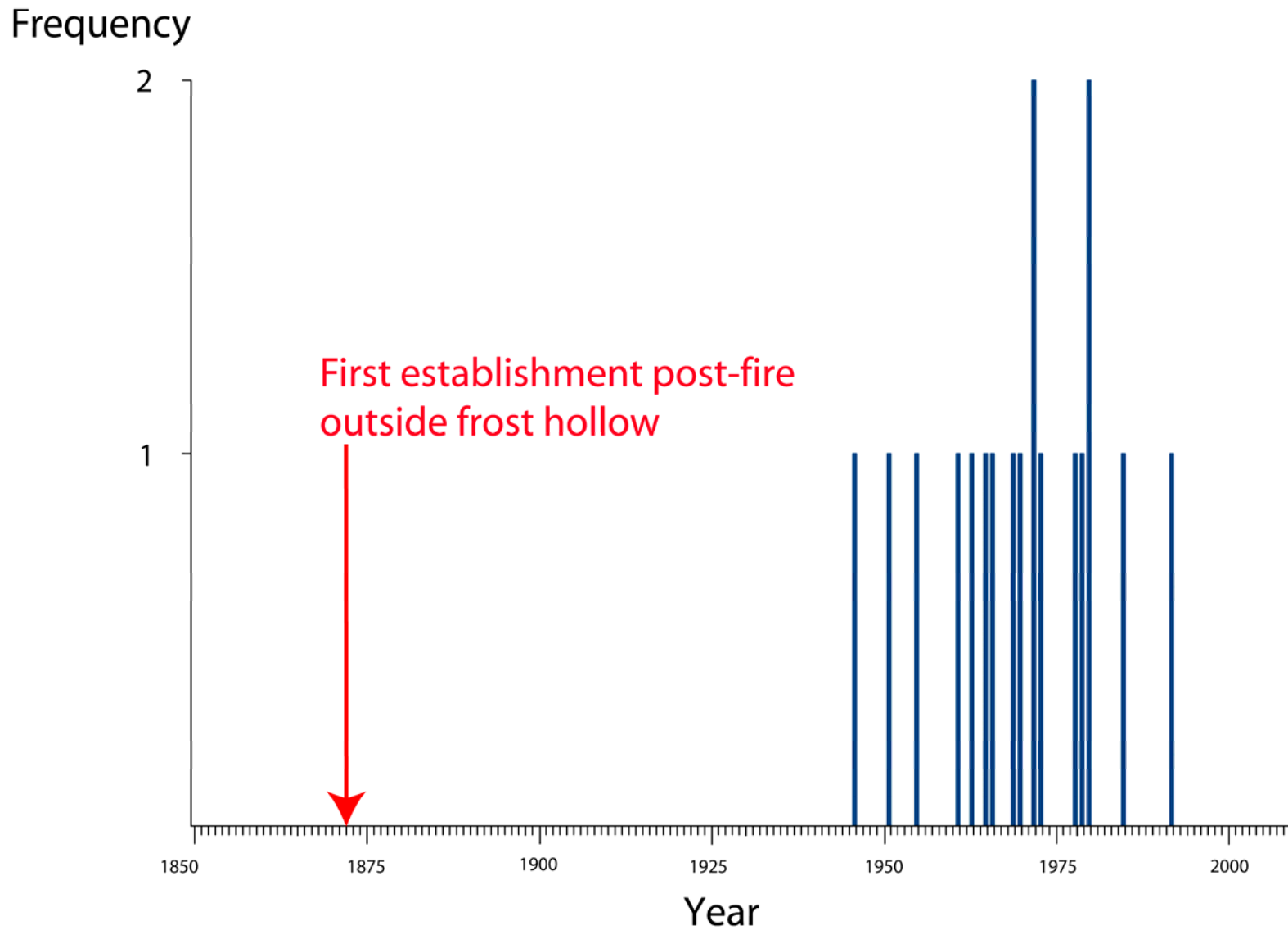


2. Colonisation pattern inside the hollow

3. Colonisation pattern outside the hollow

Site 1-3

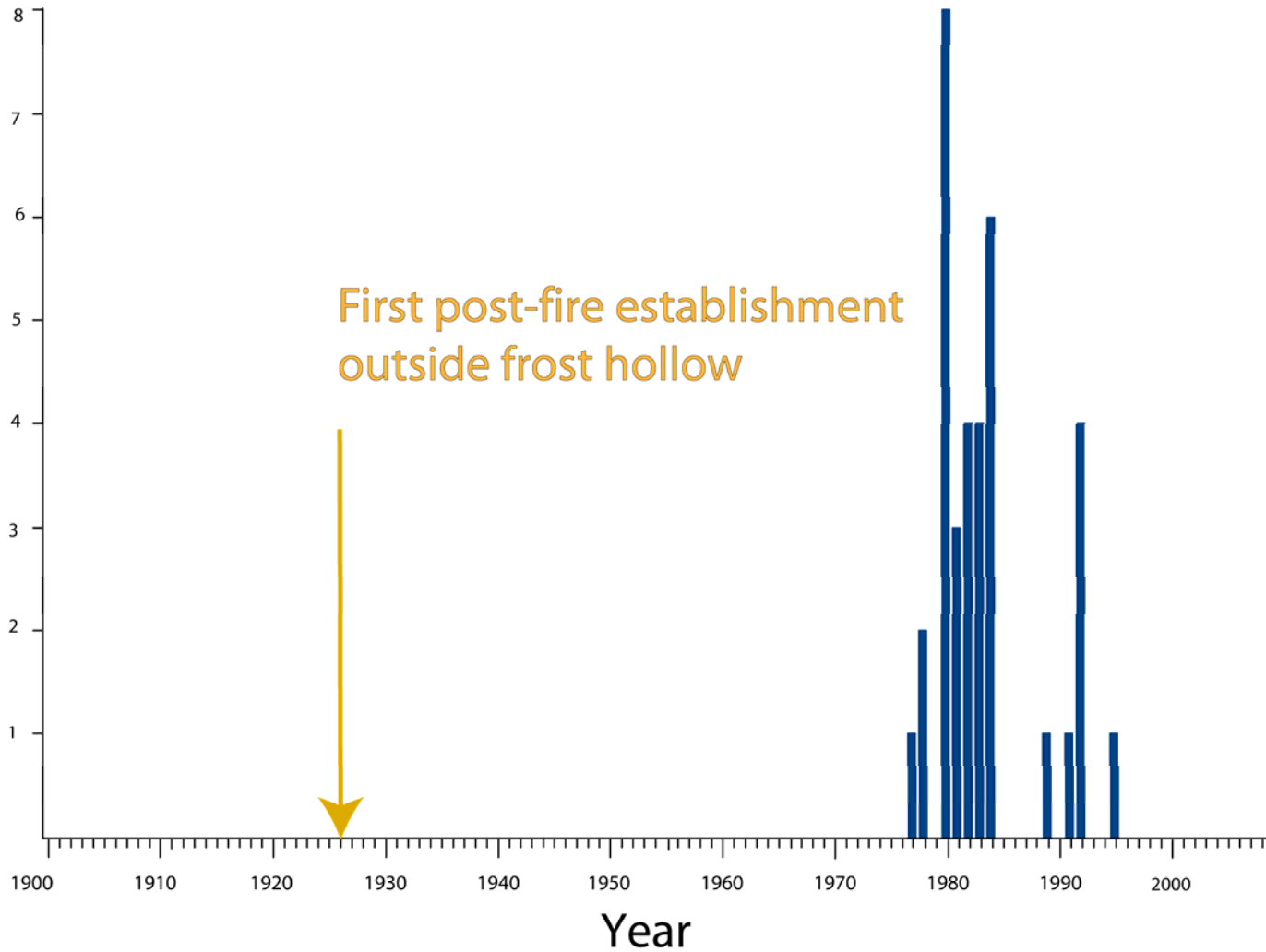
Black spruce establishment in frost hollow and post-fire establishment



Site 27-1

Black spruce establishment in frost hollow and post-fire establishment

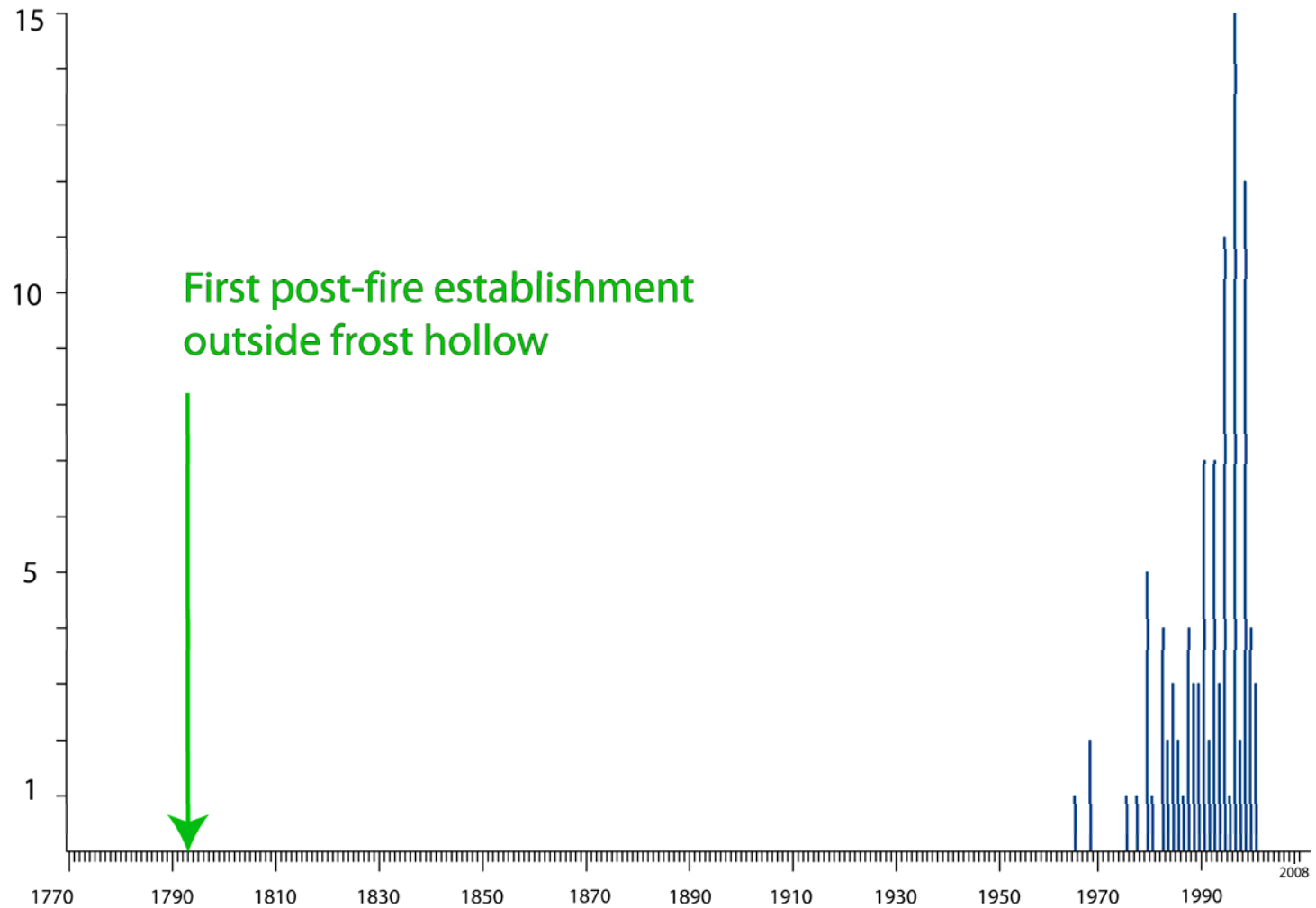
Frequency



Site 30-1

Black spruce establishment in frost hollow and post-fire establishment

Frequency



Year

Site 36-2
Black spruce establishment in frost hollow and
post-fire establishment

