Role of vegetation on fire behaviour in Fennoscandia forests during the Holocene

Chiara Molinari[1], Richard H.W. Bradshaw[2], Christopher Carcaillet[3,4], Gina Hannon[2], and Veiko Lehsten[1,5]

[1]Department of Physical Geography and Ecosystem Science, Lund University, Sweden; [2]School of Environmental Sciences, University of Liverpool, Liverpool, UK; [3]PSL Research University, EPHE, Paris, France; [4]Laboratoire d'Ecologie des Hydrosystèmes Naturels et Anthropisés, UMR 5023, Villeurbanne, France; [5]Department of Macroecology and Landscape Dynamics, WSL, Birmensdorf, Switzerland

The relationship between Holocene changes in Fennoscandia biomass burning (reconstructed by means of sedimentary charcoal records from lake and peat bogs, Figure 1) and main forest composition (based on pollen reconstructions from the same sites, Figure 1) divided into three different fire sensitivity classes (Table 1) is explored based on the hypothesis that fire-prone species are more abundant during periods characterized by higher fire disturbance, while fire-intolerant species dominate when biomass burning is low.

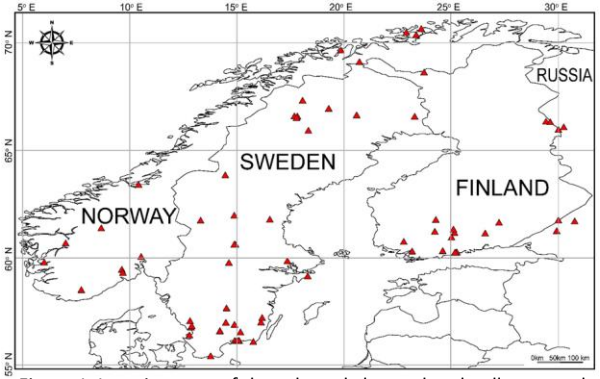

Figure 1. Location map of the selected charcoal and pollen records.

Fire-sensitivity class	Definition	Plant taxa/pollen types
Fire-intolerant trees/ shrubs (FI)	Taxa subjected to biomass decrease or local extinction after a fire	*Fraxinus*, *Picea*, *Tilia*, *Ulmus*
Fire-tolerant trees/shrubs (FT)	Taxa resistant to fire (moderate intensity)	*Alnus*, *Carpinus*, *Corylus*, *Fagus*, *Juniperus*, *Quercus*, *Salix*
Fire-prone trees/shrubs (FP)	Taxa normally favoured by fire	*Betula*, *Ericaceae*, *Pinus*, *Populus*

Table 1. Fire-sensitivity classes of dominant trees and shrubs, and the pollen taxa assigned to them.

As shown in figure 2, the overall patterns found across Fennoscandia suggest that fire-prone species are strongly positively correlated (significant statistical relationship) with multi-millennial variability of biomass burning. Positive but much weaker (and not always significant) relationships also exist between fire-tolerant species and long-term fire trends. A strong negative significant correlation is instead detected between biomass burning and fire-intolerant species.

This large-scale analysis supports our initial hypothesis that tree and shrub dominance was closely linked to biomass burning during the Holocene in the selected regions, although the relationship is less obvious during the last millennia probably due to human activities. Fire thus clearly appear as a chief functional driver dominant vegetation composition in Fennoscandia.

This palaeoenvironmental study presents useful information for improving the ability to manage ecosystems during current and future environmental changes. It has been demonstrated that vegetation can offset the effect of climate on fire regime. In a changing world, where higher fire activity constitutes an unknown factor in the global carbon cycle and a potential threat to ecosystem services, fire management based on interdisciplinary knowledge represents a challenge. We suggest that the promotion of broadleaf trees in mixed forests could decrease the intensity and rate of fire spread, improving suppression effectiveness and reducing wildfire impacts.

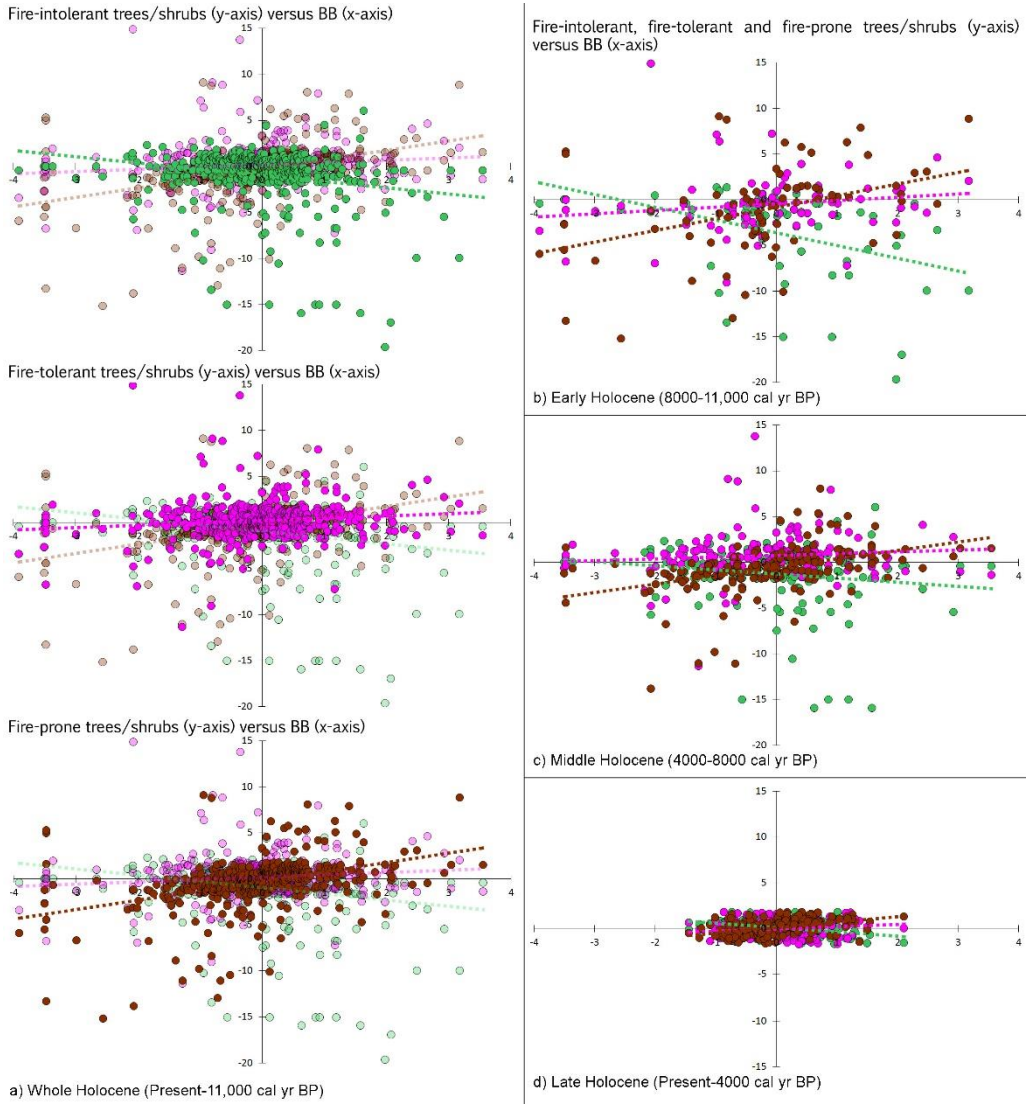

Figure 2. Correlation between biomass burning and the vegetation cover of different fire-sensitivity classes for (**a**) the whole Holocene, (**b**) the early Holocene, (**c**) the middle Holocene and (**d**) the late Holocene. Z-score and regression line of fire-intolerant trees/shrubs (FI ●), fire-tolerant trees/shrubs (FT ●), and fire-prone trees/shrubs (FP ●).