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Fire in Fennoscandia: A palaeo-perspective of spatial and temporal variability in fire frequency and vegetation dynamics

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Active fire suppression in Fennoscandia has created a boreal forest ecosystem that is almost free of fire. Absence of fire is thought to have contributed to the widespread dominance of Picea abies (Norway spruce), though the character and structure of spruce forests operates as a positive feedback retarding fire frequency. This lack of fire and dominance by Picea abies may have assisted declines in deciduous tree species, with a concomitant loss of floristic diversity. Forest fires are driven by a complex interplay between natural (climate, vegetation and topography) and anthropogenic disturbance and through palaeoecology we are able to explore spatio-temporal variability in the drivers of fire, changing fire dynamics and the subsequent consequences for forest succession, development and floristic diversity over long timescales. High resolution analysis of palaeoenvironmental proxies (pollen and macroscopic charcoal) allows Holocene vegetation and fire dynamics to be reconstructed at the local forest-stand scale. Comparisons of fire histories with pollen-derived quantitative reconstruction of vegetation at local- and regional-scales identify large-scale ecosystem responses and local-scale disturbance. Spatio-temporal heterogeneity and variability in biomass burning is explored to identify the drivers of fire and palaeovegetation reconstructions are compared to process-based, climate-driven dynamic vegetation model output to test the significance of fire frequency as a driver of vegetation composition and dynamics.

Fire was not always so infrequent in the northern European forest with early-Holocene fire regimes driven by natural climate variations and fuel availability. The establishment and spread of Picea abies was probably driven by an increase in continentality of climate, but local natural and anthropogenic ecosystem disturbance may have aided this spread. Picea expansion led to a step-wise reduction in regional biomass burning and here we show the now widespread dominance of Picea was responsible for the low fire frequency observed throughout Fennoscandia. Mid-Holocene declines in abundance of deciduous species were driven by increased use of fire during localised anthropogenic disturbances recorded 1600 years apart at two local-scale sites (located <18km apart) that also show reduced floristic diversity. These changes may have been assisted by coincident shifts to cooler, wetter climate conditions, but the strong association with biomass burning negates use of declines in deciduous species to infer past climate change. The charcoal data presented show an underlying natural fire frequency of approximately 400 years in southern Finland that without intensive anthropogenic disturbance may have persisted to the present day.