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Holocene fire dynamics in Fennoscandia

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Prescribed burning is advocated in Fennoscandia to promote regeneration and to encourage biodiversity. This method of forest management is based on the perception that fire was much more frequent in the recent past and over a century of active fire suppression has created a boreal forest ecosystem almost free of natural fire. The absence of fire is thought to have contributed to the widespread dominance of Picea abies (Norway spruce) with the successive spruce dominated forest further reducing fire ignition potential. However, humans have altered the natural fire dynamics of Fennoscandia since the early- to mid-Holocene and disentangling the anthropogenic driven fire dynamics from the natural fire dynamics is challenging. Through palaeoecology and sedimentary charcoal deposits we are able to explore the Holocene spatial and temporal variability and changing drivers of fire and vegetation dynamics in Fennoscandia.

At the local-scale, two forest hollow environments (<20km apart) were analysed for high resolution macroscopic charcoal and pollen analysis and their fire and vegetation history are compared to identify unique and mutual changes in disturbance history. Pollen derived quantitative reconstruction of vegetation at both the local- and regional-scale identifies local-scale disturbance dynamics and large-scale ecosystem response. Spatio-temporal heterogeneity and variability in biomass burning is explored throughout Fennoscandia and Denmark to identify the changing drives of fire dynamics throughout the Holocene. Palaeo-vegetation 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.

Early-Holocene fire regimes in Fennoscandia are driven by natural climate variations and fuel availability. The establishment and spread of Norway spruce is driven by an increase in continentality of climate, but local natural and anthropogenic ecosystem disturbance may have aided this spread. The expansion of spruce led to a step-wise reduction in regional biomass burning and here we show the now widespread dominance of Picea is responsible for the low fire frequency observed throughout Fennoscandia. Mid-Holocene declines in the abundance of deciduous species and concomitant loss of floristic diversity were driven by an increased use of fire during localised anthropogenic disturbance recorded 1500 years apart at two local-scale sites (located <20km apart). The charcoal data presented show an underlying natural fire frequency of approximately 400 years in southern Finland that without intensive anthropogenic disturbance during the mid- to late-Holocene may have persisted to the present day. Modelled fire frequency appears to control vegetation dynamics with spruce dominance favoured by longer fire intervals and a projected 2˚C temperature rise would encourage an increase in deciduous species and floristic diversity, but only if the fire frequency remains low.