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Landownership is an unexplored determinant of forest understory plant composition in Northern France

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ABSTRACT

Few studies have investigated the influence of landownership on biodiversity. Therefore we analysed how the presence of forest understory plant species varied according to landownership in a broad geographical context and assessed which plant traits discriminated between species associated with state, other public or private forests. We also quantified the degree to which differences in soil type, forest management and landscape structure among ownership categories could explain the differences in species composition. Landownership, climate, soil, forest stand and landscape variables were collected on 38,751 plots located in temperate forests (5.1 Mha) in northern half of France using the French National Forest Inventory and GIS analyses. First, logistic regressions were used to determine species response to landownership after controlling for month of the plant survey and spatial autocorrelation. Relationships between plant traits and species association with landownership were then tested. Second, climate, soil, forest stand and landscape differences among ownerships were investigated. Third, species and trait responses to landownership were re-examined after controlling for month of the plant survey, spatial autocorrelation and climate, soil, forest stand and landscape variations.

Of the 276 species, 69 were associated with state forests, 38 with other public forests and 85 with private forests. Species associated with state and other public forests were more often urbanophobic, ancient-forest species, barochores and myrmecochores whereas private forest species were more often nutrient-, light-demanding, urbanophilic and endozoochorous species. Differences among landownerships were detected for all the soil, climate, forest management and landscape variables investigated. However, the ownership effect remained or became significant for 131 plants after controlling for environmental variability.

Landownership is not simply an administrative classification of land without ecological signification but was evidenced as a driver shaping understory plant community composition and plant traits in Northern France. These differences were partly explained by soil, management, edge and patch size effects, but land use history may help to explain the residual landownership effect. Our results have major implications on biodiversity monitoring and large-scaled conservation strategies. There is a need for deeper investigation into the impacts of land policy on biodiversity.

1. Introduction

Land-use change and ecosystem exploitation are considered the primary drivers of biodiversity loss (Foley et al., 2005). Reports suggest an influence of forest landownership on forest management practices, landscape heterogeneity and land-use change over time (Crow et al., 1999; Stanfield et al., 2002; Wimberly and Ohmann, 2004; Ohmann et al., 2007; Ko and He, 2011). However, few studies have considered the extent to which type of landownership is associated with differences in biodiversity (Lovett-Doust and Kuntz, 2001; Lovett-Doust et al., 2003; Ohmann et al., 2007). Two studies in Ontario reported differences among private, public and mixed-ownership sites in the number of vegetation community types, rare vascular plants, butterflies, mammals, and regionally- and locally-rare breeding birds, with higher numbers at public and mixed-ownership sites compared to privately-owned sites (Lovett-Doust and Kuntz, 2001; Lovett-Doust et al., 2003).

However, many environmental and disturbance factors such as soil, climate, land use history, present and past management practices and landscape characteristics can also vary strongly among landownerships and could thus explain the differences in

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biodiversity at first sight attributed to landownership (Maltamo et al., 1997; Lovett-Doust et al., 2003; Zmihorski et al., 2010; Riitters et al., 2012).

Publicly-owned land has been found to occur more often at higher elevation and on soils less suitable for agricultural production, having been spurned by private ownership due to its lower value for agriculture and forestry and difficulties with access (Wright et al., 2001). The same trend may have occurred in France, but the one study to address the issue only compared the distribution of soil types and soil chemical properties between forest and agricultural land; the authors found that cambisols, stagnic, gleyic luvisols, gleysols and podzols were more frequent in forested areas (Badeau et al., 1999). Focusing on forest management and disturbance regime, it has been established that forest ownership is a relevant factor for variations in forest vegetation (Ohmann et al., 2007) and forest structure (Maltamo et al., 1997; Wimberly and Ohmann, 2004). A recent study in central Poland (Zmihorski et al., 2010) showed that (i) private forests showed lower DBH and basal area than state forests, but (ii) state forests displayed higher proportions of non-native tree species (*Robinia pseudoaccacia*, *Acer negundo*, *Prunus serotina* and *Platanus* sp.). The differences in DBH and basal area could be partly explained by origin and age differences between state and private forests. First, a substantial proportion of the private forests could have originated from secondary succession and second, large connected patches were more often state-owned whereas small isolated patches were more often private (Zmihorski et al., 2010). This suggests that past land use and landscape fragmentation could also be involved in the observed differences between public and private lands. However, the higher proportion of non-native tree species would tend to suggest different and maybe more intense management practices and timber harvesting in state-owned forests.

Lovett-Doust and Kuntz (2001) demonstrated that differences in biodiversity remained significant even after controlling for differences in landscape-level factors, which indicates a residual effect of landownership. This issue has yet to be explored in other geographical contexts and by controlling for a wider panel of environmental parameters (soil, climate and forest management). In this study, we focused on understory plants and basically assumed that plant species composition varied according to forest ownership (Fig. 1). However, we also hypothesised that the effect of forest ownership was actually attributable to a combination of environmental factors that differed among forest ownerships, i.e. abiotic conditions, forest management disturbances, landscape patterns and land-use history. Moreover, as species traits vary according to soil, climate, disturbance and landscape patterns, we assumed that plant traits also varied with forest ownership. We hypothesised that state forests were generally on less favourable site conditions than private lands, and thus would host species with lower nutrient requirements and indicator of wetter conditions. We also expected that private forest stands would be more intensively managed than public forests, and thus would be younger and have a lower stand basal area and volume and would host more disturbance-tolerant species, whereas public forests would host more disturbance-sensitive species. Finally, we expected a higher proportion of private forests to be recently afforested, smaller (Zmihorski et al., 2010) and often disconnected from ancient forests or preferentially located at their periphery (Bossuyt et al., 1999): thus, we hypothesised that fast-colonising species would be more frequent in private forests while species with lower dispersal ability would be more frequent in state forests. In addition to these assumptions, we assumed that environmental conditions and plant trait responses in "other public" forests (run by local public, departmental or regional authorities or by public institutions) would be intermediate between state and private forests.

The three research questions addressed in this study were:

(1) to analyse plant species responses to forest ownership on a broad geographical scale and determine what plant traits discriminated preference for forest ownership among habitat requirements, dispersal mode and life form;
(2) to analyse landownership differences in climate, soil, forest management and landscape patterns;
(3) to re-examine both individual species and plant trait responses to forest ownership after controlling for climate, soil, forest management and landscape variations in order to test whether a residual landownership effect remains and, if so, to propose an ecological interpretation.

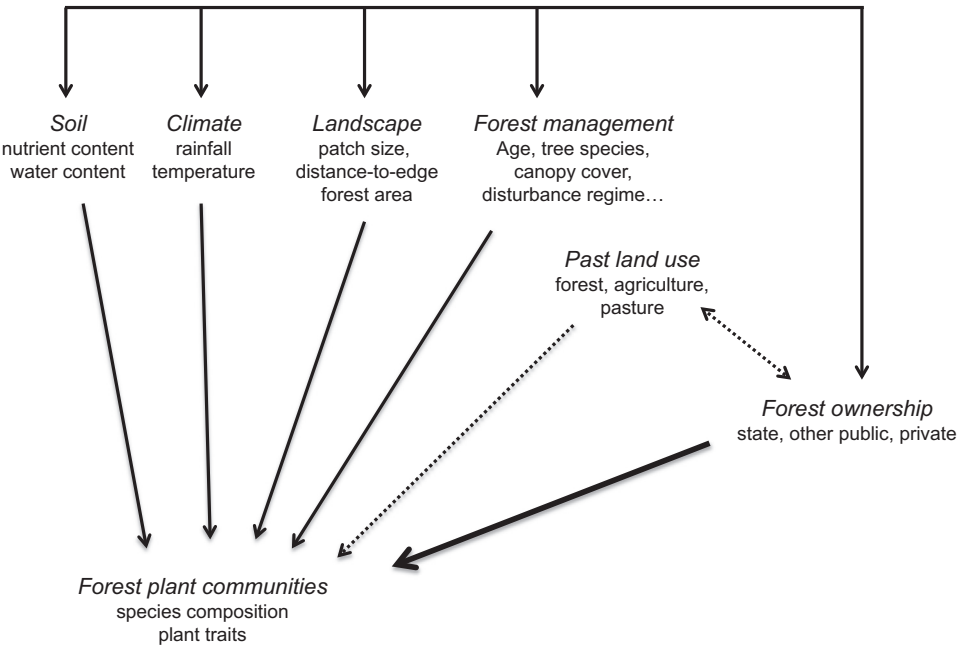

Fig. 1. Conceptual framework of the relationships among the environmental drivers and understory plant response.