Forest Ecology and Management 335 (2015) 216–224

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

The implications of stand composition, age and spatial patterns of forest regions with different ownership type for management optimisation in northern Latvia

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ARTICLE INFO

Article history:
Received 7 May 2014
Received in revised form 26 September 2014
Accepted 2 October 2014

Keywords:
Forest history
Forest management
Land ownership
Stand structure

ABSTRACT

Forests with different ownership type often form complex mosaics of stands, thus adding new challenges to the spatial planning of sustainable management in forested landscapes. This study attempted to analyse the spatial patterns and age structures of forest regions with different ownership type and to formulate suggestions for the optimisation of tactical planning of forest management planning by addressing ecological functionality at the landscape level. We hypothesised that structure of forests of various ownership groups differs significantly. National forest inventory data from 2011 was used in this study to compare spatial patterns of forest stands and clearcuts, as well as forest age structures. In total three areas with forest matrix in northern Latvia were selected for this study – owned by state, municipality and multiple private owners. Stand structure and current management regimen were characterised through the analysis of thematic landscape pattern maps and age structures of the canopy layer. Results showed significant differences between state and private patch configuration metrics. State forest stands were dominated by three tree species and a stable harvesting level. Municipal forest had largest stand patch size and the most even size of age classes in age structures. Lower road density, more complex canopy vertical structure and higher tree species richness characterised the private forest tract. We see landscape ecological planning of functionality as a way to optimise existing forest patterns. The incorporation of the modelling of future patterns under different management regimen in state, municipal and private forests could give valuable insights for more sustainable forest management.

1. Introduction

Forest ownership is regarded as the major factor influencing forest management practices, along with local site conditions, natural disturbances and land-use history (Crow et al., 1999; Bergès et al., 2013; Schaich and Plieninger, 2013). Ownership has been shown to be positively correlated with landscape structure (Stanfield et al., 2002). Different forest owners can have different goals for management of their forest holdings, which raises a need to explore how they influence stand patterns and age structures. Ownership patterns have been investigated at a European level (Pulla et al., 2013) and many studies have investigated the relation of forest ownership to landscape structure (Maltamo et al., 1997; Uuttera et al., 1998; Stanfield et al., 2002), rare species richness (Lovett-Doust et al., 2003), timber harvesting (Kittredge et al., 2003) and old forest fragmentation (Kurttila et al., 2002).

Nearly half of Europe's forests (excluding Russian Federation) are privately owned (Forest Europe and UNECE FAO, 2011; Pulla et al., 2013) and this ownership type deserves special attention. Small size of private forest holdings and ownership fragmentation has been explicitly recognised as a major problem for cost-effective management (Schmithüsen and Hirsch, 2010). Spatially complex ownership patterns, including private, can constrain management practices, for example restoration (Shinneman et al., 2010 and references therein). Among the private forest owners the proportion of enterprises is recently increasing compared to individuals (Schmithüsen and Hirsch, 2010), which indicates consolidation of properties and decrease of the number of private owners.

As all ownership types exist in Latvia, this region can be used to study how management style can influence landscapes of different ownership types within a common legal framework. Latvia represents a particularly interesting case due to the dynamic nature of

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http://dx.doi.org/10.1016/j.foreco.2014.10.001
0378-1127/

the landscape, as the forest area increased from 27% in 1935 to 52% in 2010 (Ruskule, 2013), largely due afforestation on marginal agricultural lands during the Soviet period (Tērauds, 2011; Vanwambeke et al., 2012). These dynamic and complex mosaics of state and non-state ownership types, both industrial and non-industrial, create problems in resource management planning and nature protection (Stanfield et al., 2002).

The understanding of landscape history is mandatory in studies of forest structure and spatial patterns. Forest ownership structure in Latvia changed significantly during the 20th century. During Soviet rule (1944–1991) all forests were owned and managed either by the state or collective farms – *kolkhozs* and *sovkhozs* (Ziegler, 1990). State forests were managed in a uniform manner, but management and timber harvesting in farm forests depended on local needs. After the restoration of independence the restitution and privatisation of forest properties were carried out in the mid-1990ies (the Land reform), creating approximately 150 000 private forest owners with average size of forest holdings of 8 ha (Meža nozare Latvijā, 2012). The Riga municipality also regained its ownership rights through the Land reform. In 2012, 47% of Latvia's forests were owned by the state, 50% by private owners, 2% by municipalities and the rest by other owners (Meža nozare Latvijā, 2012). Similar ownership patterns occur in Estonia (Kallas, 2002) and Lithuania (Lazdinis et al., 2009) due to the same political and economic shifts. A contrasting picture is in Poland where the majority of forest resources (approximately 85%) are still owned by the state (Brukas and Weber, 2009) and the role of private forestry is relatively insignificant. In recent years private industrial forestry companies and the Joint Stock Company *Latvian State Forests* (LVM) have been active in the purchase of individual properties (Meža nozare Latvijā, 2012).

Landscape metrics have been widely used to quantify forest patterns (e.g., Tinker et al., 1998; Stanfield et al., 2002) and several studies show that it is possible to characterise patterns with few relevant metrics (Lausch and Herzog, 2002; Leitão and Ahern, 2002). Spatial configuration of habitats influences species occurrence and behaviour in landscapes (McIntyre and Wiens, 2000). Shape of habitat patches can be an important factor in various ecological processes (Forman, 1995). Proximity index has been used to evaluate habitat patch isolation or clustering (Gustafson et al., 1994) and Euclidean nearest neighbour distance is often used to assess isolation of fragmented populations (Leitão et al., 2006).

Previous studies of forest structure and ecology in northern Latvia were focused on state forests (Tērauds et al., 2011; Madžule et al., 2012a) leaving out private forests. In a study by Rendenieks and Nikodemus (2012) spatial patterns of mature and old stands were compared between state and non-state forests in northern Latvia. The aim of this study was to analyse the spatial patterns and age structures of forest regions (spatial aggregations of forest compartments) with different ownership types and to formulate suggestions for the optimisation of forest management planning at the landscape level. We hypothesised that structure of forests of various ownership groups differ significantly. Ownership type of forest needs to be considered in tactical planning of sustainable forest management that addresses ecological functionality. This is especially topical in Post-soviet states, which are in search for more sustainable and ecologically sound forest management models (Lazdinis et al., 2007).

2. Materials and methods

2.1. Studied forest regions

In this study we defined three forest regions as spatial aggregations of forest compartments with uniform ownership types: state, municipal or private. The studied regions were located in northern Latvia (Fig. 1). Roughly similar size (1781–2063 ha) and abiotic conditions (regarding soil fertility class and moisture) enabled the comparison of these regions; however, their spatial configuration differed due to landscape history. Thus, the chosen regions match the size of an average management planning unit (2000–3000 ha) by LVM, thus making the scale of this study more relevant to forest management planning.

The selected regions were located in moraine plain with generally flat terrain, crossed by several river valleys; the altitude varied from 33 to 60 m a.s.l. The areas were located in the hemiboreal region with mostly mixed forests. Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), birches (*Betula pendula* and *Betula pubescens*), and black alder (*Alnus glutinosa*) are the most common species. Grey alder (*Alnus incana*) and European aspen (*Populus tremula*) covered smaller areas. Some species (*Tilia cordata*, *Quercus robur*, *Salix spp.* and *Ulmus glabra*) occupied very small areas and thus were not separately analysed. The majority of analysed stands were on fertile, wet soils (*Oxalidosa*, *Hycomiosa* and *Myrtillosa mel.* forest types); 33.3% of total stand area was artificially drained, reaching 67.1% in state forest region. These forest regions serve as production forests with only small areas excluded from forestry operations – 3.1% of state forest region had status of woodland key

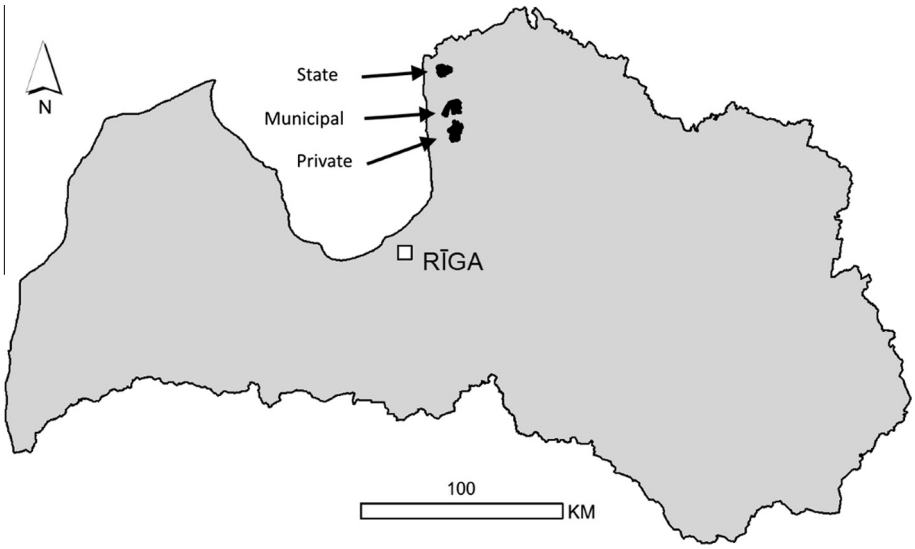

Fig. 1. The location of studied forest regions in Latvia.