Land Use Policy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Land Use Policy

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

Forestland connectivity in Romania—Implications for policy and management

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ARTICLE INFO

Keywords:
Forest connectivity
Romania
Landscape
Forest policy
Forest management
Growing space

ABSTRACT

Forest policies and management rules imposed on forests in Romania provide favourable habitat conditions for many species across forest landscapes. This is empirically proven by the high biodiversity of the Carpathians and their surroundings. However, they do not explicitly address the spatial arrangement of forest patches across landscapes. Therefore, assessment of the connectivity (inside tracts of continuous forest – i.e. intrapatch connectivity – and also among spatially separate patches – i.e. interpatch connectivity) is important. To analyze this, the CORINE Land Cover data set (2012) available for Romania was used. Forest patches were classified into three size categories considered to ensure survival of tree populations on short term, medium and long term: Interconnectivity Nodes (IN: 1,5 to 14,9 ha, minimum 30 m width), Habitat Islands (HI: 15,0 ha and 499,0 ha, minimum 100 m width) and Habitat Continuum (HC: over 500 ha with a minimum 200 m width) respectively. The connectivity of each patch to others around it was assessed for a maximum threshold distance of 1 km. Further connectivity was classified in terms of its strength (depending on the size category to which a patch is connected) and quality (size and structure of a resulting connected cluster). Next, the distributions of the main forest tree species on the various sizes, connectivity strength and quality patches of forest vegetation were assessed. The results showed good connectivity between forest patches, both in terms of intrapatch connectivity (85% of the area was included in the HC class) and interpatch connectivity (92,4% are included in 12 clusters over 10.000 ha; among these the one around Carpathians comprised 86,7% of the total forest area). The main tree species showed good connectivity in general, higher in mountainous areas than at lower elevations (area in Habitat Continuum patches: 97,5% for Norway spruce vs. 63,3% for pedunculate oak; strong connection – 97,8% for Norway spruce vs. 67,2% for pedunculate oak; high quality connectivity – 98,2% for Norway spruce vs. 68,6% for pedunculate oak). These results confirm that management policies and guidelines inherited from the past provide good conditions for connectivity of the main forest tree species and for forests in general. Further enforcement of these practices in the future should ensure the conservation of species across the forested landscapes at national scale and also provide routes for species migration in the context of climate change. However, as a large proportion of forestland is today not state-owned, financial incentives for private owners are a key condition for further acceptance of these policies and ensure these major goals are met.

1. Introduction

Growth and perpetuation of any living organism depends on the habitat conditions available at a certain moment in time. Habitat refers to the range of environments suitable for a particular species (Fischer and Lindenmayer, 2007), a concept similar to the growing space defined for trees by O'Hara as "all resources needed by a tree to exist on a given site" (O'Hara, 1988). Therefore, habitat degradation or loss is linked to species extinction, being recognised as the dominant threat for species on Earth (Sala et al., 2000). However, the same place cannot offer habitat to all living species as some species are able to use growing space in forms or concentrations that are unsuitable for others (Oliver and Larson, 1996). Therefore, certain vegetation structures and site conditions will favour some species and impede the development of others. To ensure the presence of most of the suitable species (a high level of biodiversity), the area must offer a large array of different conditions. Such diverse conditions cannot be met on small areas and therefore, biodiversity maintenance and enhancement should be sought over large tracts of land, or landscapes (large areas ranging from c. 3 km^2–c. 300 km^2 – (Fischer and Lindenmayer, 2007)) which contain a

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https://doi.org/10.1016/j.landusepol.2018.02.028
Received 5 October 2017; Received in revised form 14 February 2018; Accepted 14 February 2018

mosaic of various ecosystem types and development stages fulfilling the needs of most of the species and thus providing a high biodiversity (Lindenmayer and Franklin, 2002; Tscharntke et al., 2005). As a result, efforts for the conservation of biological diversity have embraced a landscape approach. However, natural landscapes have been shaped by human influences for centuries in most parts of the world (Lienert, 2004), including Romania. The evolution of human society has determined various ways and intensities of natural resources exploitation, some ecosystems being affected than others (e.g. almost half of the temperate broadleaf forests were converted to human dominated uses worldwide (Ehrlich and Pringle, 2008)). Areas suitable for human settlements and agriculture have been overexploited or converted to other uses, while those less suitable for exploitation, like the Carpathian forested landscapes of Europe, were less intensively altered by human activities(Biris and Veen, 2005). As a result, at present, human impacts on structure of the natural landscapes has become a key factor in the analysis and decision making for a sustainable management of natural resources.

However, the presence and mainly the perpetuation of a certain species depend not only on the simple presence of habitat conditions within the landscape. The quantity and quality of the habitat conditions together with their spatial arrangement (the connectivity of habitat patches) in the landscape are determinant factors affecting the fate of that species (Heinrichs et al., 2016). Low quantity of good habitat conditions provides resources for existence of small populations. A similar effect is expected in cases of low quality or degraded habitat (even if on larger areas) in the landscape. Combined with limited connectivity among the habitat islands (fragmentation), the chances for extinction increase substantially (Heinrichs et al., 2016). Therefore, the main anthropogenic threats to the global biodiversity are the degradation, destruction and fragmentation of habitats (Ehrlich and Pringle, 2008; Knorn et al., 2013).

In Romania, the area occupied by forests has decreased from 80% of its territory in the Neolithic period to only 40% by the end of the nineteenth century and to 28% in 1940, a percentage which has remained relatively stable up to present (Veen et al., 2010). The present 6951 million ha of forest and other wooded land reported in 2015, represents 30,2% of the national territory, ranking the country in Europe on the 12th position (in terms of area) and on the 32nd position in terms of cover percentage (FAO and EFI, 2015) (Fig. 1).

The most affected areas by human activities in Romania were in the lowlands, where forested areas were converted to human settlements and agricultural lands (at present only 8% of the forestland is located in the plains, 27% in the hills and the remaining 65% is in the mountains – (Abrudan et al., 2009)). Therefore, forest ecosystems and their associated plants and animal species were historically more impacted at lower elevations than in the higher mountainous areas of the country. Moreover, recent changes in land ownership and the tendency for developing large infrastructure (highways, industrial and human settlements, touristic facilities) are increasing the probability for important changes in habitat conditions, including degradation, destruction and fragmentation. Restitution in the recent decades of a large proportion of forestland to former owners in the context of improper law enforcement capacity (Abrudan et al., 2009) has led to improper management especially on small ownerships. On such lands, inefficient state control and the lack of financial incentives for sustainable management combined with immediate economic benefits of small private owners (individuals) has led to the illegal logging of around 300.000 ha (The World Bank, 2000). Moreover, forest vegetation installed on agricultural lands was often cleared for the reclamation of mountainous pastures. Such changes have raised concerns about forest management sustainability at national level and has even misled some authors who claimed that forest management has shifted from extensive, selective logging to intensive clearcutting (Mikoláš et al., 2015). Moreover, recent studies on the connectivity inside the Natura 2000 network at European Union (EU) level (Estreguil et al., 2013) showed that despite of the large size of sites and total area included in Natura 2000 in Romania, (22,6% of the national territory), the network is not among the top connected networks at EU level.

Despite all these changes and the relatively low percentage of forest cover, Romania still harbours a very high species biodiversity compared to most of Western Europe. This diversity distributed across the entire country and not only in protected areas must be linked to the long-term land use policies and makes it worth of investigation. In terms of forest dwelling species, the legal context of forests and forestry, still tightly regulated by the state regardless of lands ownership (Stancioiu et al., 2010), produces diverse habitat conditions (fulfilling the growing space needs for diverse species) across forested landscapes due to the following provisions:

– through management, stand species composition must resemble the natural forest type (naturally occurring tree species must be

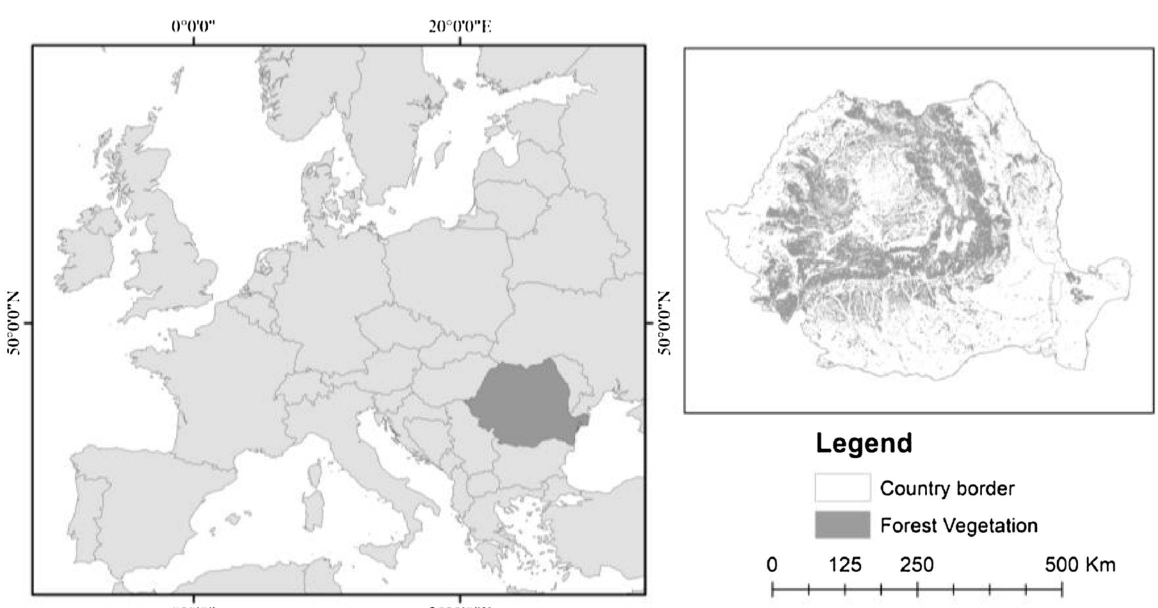

Fig. 1. Romania – geographical location and forest cover across the country.