



Systematic targeting of management actions as a tool to enhance conservation of traditional rural biotopes



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ABSTRACT

Traditional rural biotopes (TRBs), which are biologically and culturally valuable habitats maintained by low-intensity grazing and mowing, are a core element of biodiversity in Europe. During the last decades, TRBs have faced severe habitat loss and fragmentation due to agricultural modernization. Despite their well-known critical state, their conservation remains inadequate, thus raising a need to advance TRB conservation via spatial land-use planning. In this study we analyze a national GIS database on TRBs in order to examine how the current TRB network can be complemented in terms of conservation value based on known ecological characteristics. Given different target scenarios for the amount of managed TRBs, we demonstrate where management should be directed to both on protected and unprotected areas. We conclude that in current state, biodiversity depending on TRB management is not efficiently sustained in Finland. Substantial amount of TRB habitats and populations of threatened TRB species are left unmanaged. Based on our results, we suggest that to advance TRB conservation in Finland, the cover of managed TRBs should be rapidly extended to form ecologically functional networks. The expansion would prioritize additional management to the Baltic Sea coast and smaller clusters within inland Finland, double the cover of managed TRBs, and direct management subsidies in a more cost-effective way.

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1. Introduction

Although protection of biodiversity has been a fundamental tenet of conservation biology since its early beginning (Soulé, 1985), tight coupling of social and natural systems escaped conservation scientists' attention for a long time in many regions (Kareiva and Marvier, 2012). Recently, temporal changes in how conservation is perceived have raised global attention to a social-ecological approach in conservation (Corlett, 2014; Mace, 2014). In Europe, a significant proportion of biodiversity is situated in landscapes formed through a sequential overlay of traditional rural land-use systems (Plieninger et al., 2006). This process has continued for thousands of years, resulting in a rich diversity of cultural landscapes and associated species which are sustained by human land use (Batáry et al., 2015; Plieninger et al., 2006; Pullin et al., 2009).

Since low-intensity land use is important for existence of a lot of European biodiversity (Halada et al., 2011; Pullin et al., 2009), much of nature conservation aims to halt the loss of farmland biodiversity, and

many protected areas are managed in ways that reflect traditional agricultural practices (Batáry et al., 2015; Linnell et al., 2015). Challenges, however, are substantial. Agricultural industrialization has caused a widespread decline in farmland heterogeneity and biodiversity (Benton et al., 2003; Strijker, 2005). Modern socioeconomy drives rural landscapes towards land abandonment and agricultural land-use intensification, centralization, and specialization (Beilin et al., 2014; Fjellstad and Dramstad, 1999; Knickel, 1990; Lambin et al., 2001). Therefore some of the most critical conservation issues today relate to the abandonment of traditional farming practices and the disappearance of biodiverse habitats dependent on them (Halada et al., 2011; Henle et al., 2008).

Traditional rural biotopes (TRBs) are heterogeneous disturbance-dependent grasslands and wood-pastures maintained through long-term grazing and mowing. The term "traditional rural biotope" refers to culturally influenced natural habitat complexes that are part of a traditional landscape formed through archaic rural livelihoods (Ministry of the Environment, 1992), and although its usage is specific to Finland, similar habitats are found throughout Europe (e.g. Bergmeier et al., 2010). Typical TRB habitats in Finland are grazed woodlands, sparsely wooded pastures, and mesic to moist meadows (Raunio et al., 2008). Management of TRBs is based on low-intensity raising of livestock on unfertilized vegetation growing on non-tilled soils, a practice that is especially valuable

Abbreviations: AES, agri-environment scheme; TRB, traditional rural biotope.

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for biodiversity conservation across Europe (Beaufoy and Cooper, 2013). TRBs are among the most diverse and species-rich habitats of rural landscapes (Cousins and Eriksson, 2002; Fjellstad and Dramstad, 1999; Luoto et al., 2003), and they are mentioned as central elements of high-nature-value farmland (Heliölä et al., 2009; Plieninger et al., 2015). As ecosystems, TRBs are highly variable and dynamic. Their species assemblages depend on the interplay between active management, vegetation succession, and metapopulation dynamics (Allan et al., 2014; Halada et al., 2011; Hanski, 2011).

Ongoing TRB loss and fragmentation has serious ecological effects. TRB species' metapopulations lose their viability, because unoccupied habitat patches are not colonized at the same rate as extant populations disappear, i.e. they reach their extinction threshold (Hanski, 2011). Yet, some species – especially vascular plants – react slowly to land-use changes and persist on abandoned TRBs for long time periods (Cousins, 2009; Eriksson et al., 2002; Lindborg and Eriksson, 2004). Unless targeted habitat restoration and proper management actions are secured, species specialized in TRBs continue to decline and their populations face inevitable local extinctions (Cousins, 2009; Krauss et al., 2010; Kuussaari et al., 2009).

Loss of farmland biodiversity has created a need for agri-environment measures, which are incentives designed to encourage farmers to protect and enhance the environment on their farmland (Anonymous, 2005). Countries within European Union are increasingly funding habitat management and restoration actions through voluntary, contract-based subsidies within national agri-environment schemes (AESs) (Batáry et al., 2015; Kleijn and Sutherland, 2003). The AES contracts are the main tool for encouraging management of TRBs. However, the effectiveness of AESs has been questioned in TRB management and biodiversity conservation in general (Arponen et al., 2013; Batáry et al., 2015; Kleijn and Sutherland, 2003). In Finland, during the 20th century, over 99% of TRB cover disappeared as a consequence of agricultural modernization (Raunio et al., 2008; Salminen and Kekäläinen, 2000). Currently, TRBs are the most threatened of all Finnish habitat types (Raunio et al., 2008) and provide habitat for a total of 1807 red-listed species (Rassi et al., 2010). Despite this, current conservation measures have been insufficient to tackle the situation.

Several reasons contribute to inefficient conservation of TRBs in Finland. These include capacity, knowledge, institutional, and ideological obstacles (cf. Bennett et al., 2016). Firstly, besides the AES, other funding sources for TRB management are scarce (Ministry of Agriculture and Forestry, 2013). Secondly, management actions have not been efficiently directed to biologically valuable sites (Arponen et al., 2013; Kemppainen and Lehtomaa, 2009), and thirdly, the dynamic and management-dependent character of TRBs challenges Finnish environmental authorities, who have mostly relied on establishing permanent set-asides to conserve natural habitats, aiming to exclude most or all human influence from them (Vuorisalo and Laihonon, 2000). In this sense, Finnish nature conservation has not followed the European tradition where nature and culture are intertwined, but rather a wilderness-oriented approach that separates people from nature (Linnell et al., 2015). In this context, the biological value of TRBs is deemed “semi-natural”, and the motivation for conserving these “unnatural” habitats is undermined (Cronon, 1996; Mace, 2014).

As a result, TRBs are weakly represented in Finnish nature conservation policies. They have often been excluded from conservation networks such as Natura 2000 (Ministry of the Environment, 2015; Council of State, 1996; Vuorisalo and Laihonon, 2000). Although sole establishment of protected areas is insufficient for TRB conservation (Arponen et al., 2013; Bengtsson et al., 2003), there are valuable TRB sites on protected areas. However, the majority of them are unmanaged, and protection status is regularly based on conservation of other habitats (Pakkanen et al., 2015; Raatikainen and Raatikainen, 2015).

Several means to enhance the conservation of TRBs have been proposed. These include establishing complementary management funding sources (Keränen et al., 2012), increasing AES uptake (Grönroos et al.,

2007), and targeting funding to manage locations with high biodiversity (Arponen et al., 2013). Achieving a favorable TRB conservation status needs increasing their cover under protection, restoration, and active management alike. Because human influence essentially drives TRB ecology, TRB restoration requires reviving traditional social-ecological interactions. Therefore we refer to it as bio-cultural restoration (Egan et al., 2011).

In this paper we explore if and how conservation of TRBs could be improved by directing restoration and management actions spatially on a national scale. We began by evaluating the current management status of TRBs (Fig. 1). Then we explored how the current surveyed network of valuable TRBs can be complemented, assuming that the most important aim of network expansion is to secure the maintenance of threatened habitats and species dependent on TRB management. We answered the questions via a spatial prioritization analysis, where several layers of information contribute to the conservation value of a given habitat patch, and yield an optimized management network solution.

The purpose of the analysis was to inform management allocation on large scale instead of suggesting whether a specific site should be managed or not, and we did not aim to exclusively point out the most valuable individual TRB sites in whole Finland. Rather, we synthesized currently available spatial information. The quantified results provide a starting point for developing a national implementation strategy for further conservation action (Knight et al., 2006).

Given the national goal of securing management of all valuable surveyed TRBs and increasing the total cover of managed TRBs to 60,000 ha (Kemppainen and Lehtomaa, 2009; Kotiaho et al., 2015; Salminen and Kekäläinen, 2000), we formulated a spatial prioritization solution for four nested management scenarios (A: surveyed TRBs, B–D: surveyed TRBs with a progressive addition of managed area). In each consecutive scenario, ca. 4000 managed hectares were added, thus forming a realistic step-wise plan for expansion of the management network. The most extensive scenario (D) yielded a spatial allocation of nearly 45,000 ha of managed TRBs.

2. Materials and methods

2.1. Data sets

We used existing GIS data derived from five different sources: (1) a national network of surveyed TRBs, covering ca. 30,300 ha; (2) AES subsidy contracts on TRB management in year 2014, ca. 19,200 ha; (3) habitat type inventories on protected and state-owned areas, ca. 4,620,200 ha; (4) database on protected private and state-owned TRBs, ca. 32,200 ha; and (5) 16077 point occurrences of 133 TRB-specialized red-listed vascular plant species. The data sets are further described in Supplementary Appendix A. The Åland islands were excluded because of their self-governmental status. Without the Åland islands, the land area of Finland is 30,234,700 ha (National Land Survey of Finland, 2016).

We incorporated data on surveyed and protected TRBs in the analyses without modifications. AES contract sites outside surveyed TRBs or protected areas were omitted from spatial prioritization, as their biological value as TRBs has not been surveyed in the field, and according to our personal experience their quality varies from good to very poor. Habitat type inventory data is built on a nested structure, which was used to form GIS layers of different TRB habitats on two levels. Firstly, we derived an upper-level TRB habitat classification comparable to the assessed threatened habitat types (Raunio et al., 2008). Secondly, we categorized more strictly defined Natura 2000-habitats (listed in the Habitats Directive Annex I: Council of Europe, 1992) as separate layers (Table 1). This allowed us to give increased weight on sites having high conservation value at the European level. However, the inventory did not cover all TRB sites. For these sites, a layer of undefined TRB habitat was formed, as there were no data on specific habitat types available.

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