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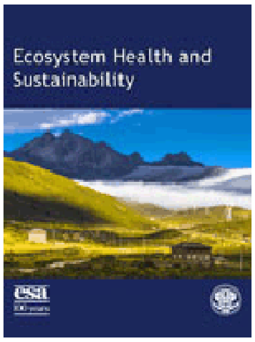

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Socioecological drivers facilitating biodiversity conservation in traditional farming landscapes

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Abstract. Traditional farming landscapes have evolved as tightly coupled socioecological systems that support high biodiversity. However, land-use change severely threatens the high biodiversity of these landscapes. Navigating nature conservation in such landscapes requires a thorough understanding of the key drivers underpinning biodiversity. Through empirical research on mammals, birds, butterflies, and plants in a traditional cultural landscape in Romania, we revealed seven hypothesized drivers facilitating biodiversity conservation. Similar proportions of three main land-use types support the landscape species pool, most likely through habitat connectivity and frequent spillover between land-use types. Landscape complementation and supplementation provide additional habitat for species outside their core habitats. Gradients of woody vegetation cover and gradients in land-cover heterogeneity provide mosaic landscapes with wide ranges of resources. Traditional land-use practices underpin landscape heterogeneity, traditional land-use elements such as wood pastures, and human–carnivore coexistence. Top-down predator control may limit herbivore populations. Lastly, cultural ties between humans and nature have a central influence on people's values and sustainable use of natural resources. Conservation approaches should aim to maintain or restore these socioecological drivers by targeting the heterogeneous character of the forest–farmland mosaic at large scales through "broad and shallow" conservation measures. These large-scale measures should be complemented with "deep and narrow" conservation measures addressing specific land-use types, threats, or species. In both cases, conservation measures should integrate the entire socioecological system, by recognizing and strengthening important links between people and the environment.

Key words: *countryside biogeography; coupled human and natural systems; cultural landscapes; human–environment systems; landscape ecology; resilience; Romania; Special Feature: Ecosystem Management in Transition in Central and Eastern Europe; Transylvania.*

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Introduction

Traditional farming landscapes are increasingly valued for their natural heritage, and their importance for biodiversity has been noted worldwide (Palang et al. 2006, Ranganathan et al. 2008, Takeuchi 2010, Robson and Berkes 2011, Liu et al. 2013). Traditional farming landscapes are characterized by a long history of largely persistent farming practices. The high biodiversity of these landscapes has been proposed to be supported through low-intensity farming techniques with low levels of agro-chemical input and little mechanization, and high heterogeneity in land cover and structural elements, including abundant seminatural vegetation (Bignal and McCracken 2000, Plieninger et al. 2006). Beyond such biophysical properties, biodiversity in traditional farming landscapes is also supported through reciprocal socioecological relationships, in which rural communities influence ecosystems and vice versa (Folke 2006, Fischer et al. 2012). The long history of socioecological interactions in traditional farming landscapes has created the opportunity for people's practices to have coevolved with the natural environment, thereby creating a landscape of high natural and cultural value (Bignal and McCracken 2000, Liu et al. 2007). Historically, people shaped the ecosystem through their activities, while the ecosystem provided them with important ecosystem services (i.e., the

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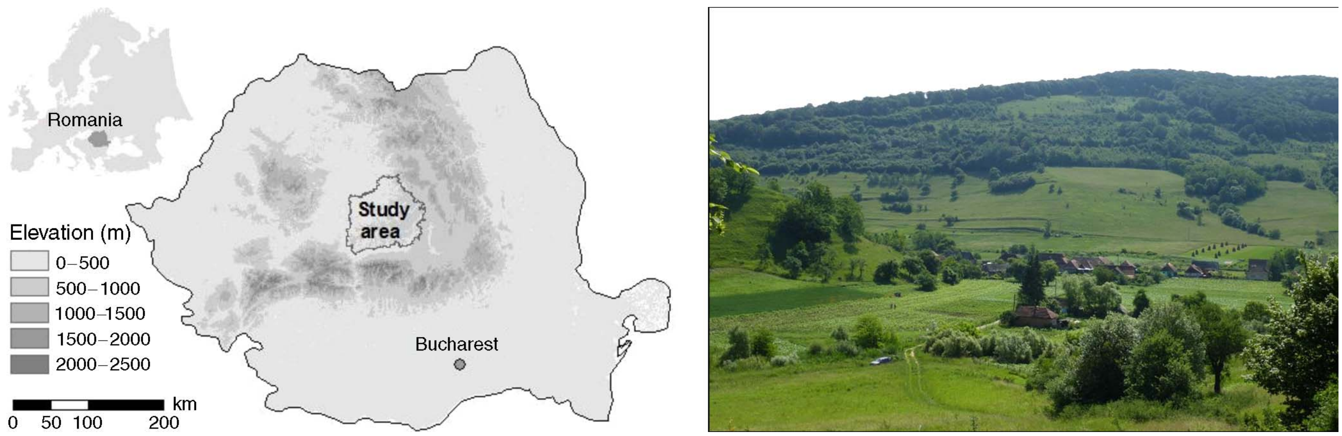

Fig. 1. The study area was located in the foothills (230–1100 m above sea level) of the Carpathian Mountains in southern Transylvania, Romania (right). The photo shows the main land-use types of the study area (left); forest, arable land, and grassland. Photo credit: I. Dorresteijn.

benefits people derive from nature; Millennium Ecosystem Assessment 2005), and this reciprocal relationship provided strong incentives for sustainable land use.

With the onset of globalization and modernization in the farming sector, however, traditional farming landscapes are increasingly influenced from the outside (e.g., via policies, market forces, and energy input). Rapid socioeconomic, political, and cultural changes have led to the cessation of traditional farming practices, either in favor of more intensive practices (Foley et al. 2005, Tscharntke et al. 2005), or causing the abandonment of farmland altogether (Plieninger et al. 2014, Queiroz et al. 2014). These changes in land use could potentially have a negative impact on the biodiversity of traditional farming landscapes (Plieninger et al. 2006, Kleijn et al. 2009, Queiroz et al. 2014). To successfully manage traditional farming landscapes in terms of biodiversity conservation, it is important to understand the key drivers that underpin their high biodiversity, which can then be used to inform conservation policy and management.

Here, we present our collective understanding of key socioecological drivers of biodiversity in one particular traditional farming system, namely southern Transylvania in Romania. Our understanding results from five years of research in this area that has integrated a wide range of ecological and social issues, including investigations of the distribution patterns of plants, butterflies, birds, and forest mammals, of people's perceptions on human–bear coexistence, of people's aspirations for future development, and of problems with the implementation of EU policy for biodiversity conservation (e.g., Dorresteijn et al. 2013, 2014, 2015*b*, Mikulcak et al. 2013, Hanspach et al. 2014, Loos et al. 2014*a*, 2015, Milcu et al. 2014). Our resulting expert knowledge of the study system thus has a firm basis in empirical work, but is inevitably also shaped by our combined experiential knowledge derived from a mixture of research, theoretical backgrounds as ecologists and social scientists, and personal experience in the study system (Fazey et al. 2005, 2006). Here, we present the drivers of biodiversity in southern Transylvania as a set of seven hypotheses. Thus, this study represents a synthesis of our accumulated multifaceted and in-depth understanding of one specific socioecological system. Our study should be considered a conceptual contribution rather than an empirical research study or traditional literature review. While our hypotheses are generated for one specific system (southern Transylvania), our results may also provide insights for scientists working in other traditional farming landscapes, especially in other parts of Eastern Europe.

Transylvania's Traditional Farming Landscape

Southern Transylvania in central Romania (Fig. 1) is one of Europe's last regions dominated by traditional, small-scale farming systems. The study region was shaped by the culture and land use of the Saxons, who settled in Transylvania in the 12th and 13th centuries. Despite several historical socioeconomic and political changes, the characteristics of southern Transylvania's farming landscapes have changed relatively little since preindustrial times. For example, during communism, agricultural land was collectivized under state ownership, but intensification was not severe enough to fundamentally change the biophysical composition of the landscape. The fall of communism in 1989 entailed a large exodus of Saxons from the region, leading to abandonment of part of the agricultural land, while restitution of small parcels of arable land to both remaining and new inhabitants prevented the intensification of agriculture and stimulated the ongoing practice of semi-subsistence farming.

This prevailing semi-subsistence farming has maintained very high biodiversity (Cremene et al. 2005, Akeroyd and Page 2007), ranging from exceptional diversity of wildflowers in hay meadows (Wilson et al. 2012) to the presence of large carnivores in forests, such as the European brown bear (*Ursus arctos*). Furthermore, farming practices have maintained a land-cover mosaic with similar proportions of forests (28%), arable fields (37%), and grasslands (24%; Fig. 1; EEA 2006). Land-use is influenced by topography, with forests occupying the hilltops, arable fields located mainly in the valleys, and pastures occurring on the slopes. Forests are dominated by hornbeam (*Carpinus betulus*), oak (*Quercus* sp.), and beech (*Fagus sylvatica*). Arable lands are characterized by farming techniques that are small scale (most fields are smaller than two hectares) and typically of low intensity (most fields have low chemical input and are tilled by livestock). The seminatural pastures are grazed by sheep (dominant livestock), goats, and cattle. Hay meadows provide fodder for livestock and are often harvested by hand. The lack of large-scale mechanization has facilitated a high structural diversity, as evident, for example, in different sward heights in grassland during spring and summer, and abundant hedgerows, streamside vegetation, and scattered trees. Furthermore, the region is still rich in ancient wood pastures, which consist of open grasslands with scattered old trees, and are one the oldest European silvo-pastoral land-use types.

Although parts of southern Transylvania are protected, for example through Europe's largest lowland Natura 2000 area, profound ongoing societal and economic changes since Romania's inclusion in the EU in 2007 are leading to significant land-use changes (Mikulcak et al. 2013). Because traditional farming techniques have become economically unviable, local inhabitants increasingly either abandon their land or intensify land use. These changes, in turn, may significantly impact biodiversity in the future.

Hypothesized drivers of biodiversity in southern Transylvania

Similar proportions of three main land-use types support a rich regional species pool

At the regional scale, the similar proportions of the study area's three main land-use types (arable land, grassland, and forest) are likely to facilitate high biodiversity. Habitat loss and fragmentation are considered major drivers of species declines (Sala et al. 2000, Monastersky 2014) but typically become most pronounced below a threshold of 30% of available habitat (Andrén 1994, Hanski 2011). The approximately one-third forest cover within the study area seemed to provide sufficient habitat connectivity for the brown bear (Dorresteijn et al. 2014), probably facilitating species' movements and dispersal and thereby maintaining gene flow throughout the region (Kopatz et al. 2012). Within farmland, relatively large and similar proportional availability of grassland and arable land may maintain diverse bird and butterfly communities at the landscape scale that are not determined by land use per se (Loos et al. 2014*a*, Dorresteijn 2015), for example through facilitating frequent spillover between land uses (Tscharntke et al. 2012). Similarly, a substantial number of plant species were present in both grassland and arable land (Loos et al. 2015). Of the 556 plant species found in farmland, 242 occurred in both grassland and arable land, while 175 and 139 species were observed only in grassland or arable land, respectively. Nevertheless, plant species composition differed between grassland and arable land (Loos et al. 2015). In addition, a forest–farmland mosaic facilitates spillover effects from forests to farmland (Tscharntke et al. 2012), and we observed a considerable number of forest bird species also using farmland (Dorresteijn et al. 2013, 2015). It thus appears that the observed proportions of the three dominant land-use types in the study area are supportive of a rich diversity of species associated with farmland as well as with forests, with all three major land-use types contributing to high regional biodiversity.

Landscape complementation and supplementation facilitate the persistence of species outside their core habitat

In addition to the contribution to regional biodiversity made by each main land-cover type in its own right, heterogeneous landscapes can further support biodiversity through landscape complementation and supplementation (Dunning et al. 1992). Landscape complementation is provided in landscapes in which species encounter all required spatially separated habitats containing necessary resources, while landscape supplementation is provided in landscapes in which species encounter additional habitats that contain similar resources (Dunning et al. 1992). We observed several species in land-use types outside their core habitat. For example, wood pastures were extensively used by typical forest species, such as woodpeckers and brown bear (Dorresteijn et al. 2013, Roellig et al. 2014). The retention of forest elements across the landscape in traditional farming landscapes thus provides supplementary habitat for forest species (see also Mikusinski and Angelstam 1998). In farmland, the Corncrake (*Crex crex*) was present throughout the arable mosaic despite being considered a grassland bird species (Dorresteijn et al. 2015*b*), and similarly, several typical grassland butterfly species were also found in arable land (Loos et al. 2014*a*). Some species of butterflies were even observed to deposit their eggs in arable land, while grassland and uncultivated land were used for nectaring (J. Loos, *personal observation*). Thus, uncropped arable land, and arable land with low inputs of artificial fertilizers and pesticides, in combination with field margins or ditches, seemed to provide resources similar to grasslands (Corbett and Hudson 2010, Budka and Osiejuk 2013, Josefsson et al. 2013, Loos et al. 2014*b*). These examples illustrate that it is not only the main land-cover types by themselves that drive Transylvania's high biodiversity, but also their spatial juxtaposition.

Gradients of woody vegetation cover provide important structural diversity

At sub-regional to local scales, southern Transylvania's biodiversity was high because of the presence of gradients in woody vegetation cover. Bird, butterfly, and plant species richness responded positively to woody vegetation cover in farmland at small spatial scales (Loos et al. 2014*a*, 2015, Dorresteijn 2015), probably because woody vegetation cover contained important resources such as refuge areas, nesting, sheltering, and foraging sites (e.g., Dover et al. 1997, Benton et al. 2003, Ernoult and Alard 2011). However, responses by biodiversity to woody vegetation cover were not always positive or linear, and differed depending on spatial scale, land-use type, and species group under consideration. For example, richness of arable weeds decreased in arable land with increasing woody vegetation cover, and the richness of high nature value plants showed opposite responses to woody vegetation in arable land vs. grassland (Loos et al. 2015). Bird richness increased asymptotically with woody vegetation cover, with especially smaller and diminishing effects in grasslands (Dorresteijn 2015), which harbor a large number of open-country species that disappear beyond certain levels of woody vegetation cover (Sanderson et al. 2013). However, the richness of open-country farmland birds and butterflies decreased at a high cover of woody vegetation at large spatial scales, probably because it restricted the availability of open habitat, which some species depend on (Loos et al. 2014*a*, Dorresteijn 2015). Thus, biodiversity conservation in southern Transylvania relied both on the presence of open areas and on areas with woody vegetation at a range of different scales and densities.

Gradients in land-cover heterogeneity provide a diversity of niches

Gradients in land-cover heterogeneity, measured as the composition and configuration of different land covers, were also important in driving biodiversity patterns. These effects were particularly strong at relatively small scales for richness of butterflies and of high nature value grassland plants, but showed opposite effects between land-use types (Loos et al. 2014*a*, 2015). For both groups, the effects of heterogeneity were positive in arable land, but negative in grassland. The availability of different land-cover types in arable land provides a wide range of resources and facilitates the presence of species that require more than one land-use type (Dennis et al. 2003). In contrast, many grassland specialists require continuous, relatively homogenous habitat, and a high degree of heterogeneity may reflect a higher degree of fragmentation for these species in grassland (Batary et al. 2011*b*). We also found profound positive effects of land-cover diversity (compositional heterogeneity) on the distribution of a single bird species of conservation concern, namely the Corncrake (Dorresteijn et al. 2015*b*). The importance of maintaining land-cover heterogeneity was underlined by a simulation model, which showed a severe reduction of Corncrake habitat already occurred at modest levels of land-cover homogenization, indicating that biodiversity loss and loss of heterogeneity may not be linearly related (Dorresteijn et al. 2015*b*). Thus, for many species, the availability of a diversity of land-cover types is an important feature to ensure their survival; still, at the same time, some specialist species require large, relatively homogenous areas of a single type of land cover.

Traditional land-use practices underpin landscape heterogeneity, traditional landscape elements, and human–carnivore coexistence

While the biophysical character of the landscape is a key proximate predictor of biodiversity, this character is shaped by human land-use practices. Most obviously, the presence of variable woody vegetation cover and landscape heterogeneity directly stem from traditional, small-scale, semi-subsistence farming practices. Low-intensity farming, including a high degree of manual labor and low levels of agro-chemical inputs, is thus key to maintaining Transylvania's biodiversity. The manual cutting of hay in a mosaic pattern, for example, provides a variety of sward heights throughout the breeding season of the Corncrake, thereby facilitating its presence in agricultural land (Dorresteijn et al. 2015b). Manual cutting also facilitates the spread of seeds and supports high plant diversity in grasslands (Loos et al. 2015). High plant diversity, in turn, combined with the availability of nectaring plants throughout the season, is useful to maintaining butterfly diversity (Pywell et al. 2004). Similarly, wood pastures were created by traditional silvo-pastoral practices and support a high biodiversity, including ancient trees and numerous protected species (Dorresteijn et al. 2013, Hartel et al. 2013, 2014*b*, Roellig et al. 2014). As a last example, the use of traditional livestock husbandry techniques has been critical to facilitate the coexistence of humans and large carnivores (Dorresteijn et al. 2014, Dorresteijn 2015). The combination of shepherds, livestock guard dogs, and nightly confinement of livestock are successful in reducing livestock conflicts worldwide (Rigg 2001, Gehring et al. 2010). These various examples illustrate that the biophysical landscape patterns in Transylvania cannot be managed without understanding their roots in traditional land-use practices.

Top-down predator regulation may foster biodiversity in traditional farming landscapes in some instances

For systems with few humans, it is well known that large carnivores can benefit biodiversity through top-down control of mesopredators and herbivores (Estes et al. 2011, Ripple et al. 2014). Transylvania is an interesting landscape in that it has a long history of human land use, but still supports substantial carnivore populations, too. We found limited evidence for top-down control by the wolf (*Canis lupus*) and brown bear on the red fox (*Vulpes vulpes*), a key mesopredator in the region (Dorresteijn et al. 2015*a*). This could be explained by large differences in body size between the large carnivores and the red fox (Donadio and Buskirk 2006, Ritchie and Johnson 2009), or alternatively, by densities of wolves and bears being too low to effectively limit foxes. However, we found stronger top-down limitation by the wolf on the red deer (*Cervus elaphus*) and by the brown bear on the roe deer (*Capreolus capreolus*) (Dorresteijn et al. 2015*a*). The importance of trophic cascades for biodiversity has mainly been observed in wilderness areas (Ripple and Beschta 2012), whereas the role of large carnivores in structuring human-dominated ecosystems remains unclear (Sergio et al. 2014). Our findings suggest that the presence of large carnivores in human-dominated ecosystems could facilitate higher biodiversity, for example through limiting overgrazing and enhancing vegetation growth (Terborgh et al. 2001, Estes et al. 2011). To more fully understand the role of carnivores in traditional farming landscapes, including their effects on biodiversity, further research is needed on how humans mediate the potential top-down effects of large carnivores (Dorresteijn et al. 2015*a*).

Cultural ties between humans and nature support biodiversity conservation

In traditional farming landscapes, humans directly influence and are influenced by their environment. The resulting cultural ties to the environment can be important for biodiversity conservation (Pretty 2011). In southern Transylvania, this was most obvious through our work on carnivores. Large carnivore persistence not only depends on the biophysical environment, but also on the degree to which the rural population is willing to coexist with large carnivores (Treves and Karanth 2003). Unlike in many other landscapes, rural inhabitants in Transylvania generally had a positive perception of human–bear coexistence (Dorresteijn 2015). The ability of local people to tolerate carnivores appeared to partly stem from genuine links between humans and nature, with people valuing the natural heritage. Moreover, centuries of co-occurrence of humans and bears in southern Transylvania have probably shaped human culture to accept and adapt to living with carnivores (see also Glikman et al. 2012). Apart from carnivores, other examples also pointed toward close cultural ties with the landscape. For example, provisioning ecosystem services such as fresh water, healthy soils, firewood, and crops were especially and explicitly valued by rural inhabitants (Hartel et al. 2014*a*). The observed strong ties between people and the landscape thus may form the core of people's values and the basis for their sustainable use of natural resources. Human–environment ties have been shaped by a complex set of interacting drivers (Milcu et al. 2014), but are at risk of being interrupted in the future, through corruption, dissatisfaction with management authorities, agricultural mechanization, and rural emigration (Mikulcak et al. 2013, Edelman et al. 2014, Dorresteijn 2015).

Discussion

Around the world, socioeconomic changes are putting pressure on traditional farming landscapes and their associated biodiversity. Drawing on our in-depth case study in southern Transylvania, we proposed seven working hypotheses that can help to inform biodiversity conservation in this system. These hypotheses should not be seen as a blueprint for action, but rather as a basis for future research, to be adjusted and refined (or even refuted) as new insights emerge. A key premise of our hypotheses is that certain biophysical landscape features are critical proximate drivers of biodiversity. These biophysical features, however, arise from more ultimate drivers that are rooted in the sociocultural history of the region. These drivers include external social forces such as the influence of the communist regimes that severely transformed Eastern European countries; both the rise and fall of communism have triggered notable land-use changes in farming landscapes throughout Europe (Fraser and Stringer 2009, Sutcliffe et al. 2015) Besides the effects of external drivers, internal social variables such as the cultural ties to the land, informal institutions, or traditional knowledge significantly shape land management types and landscape structures (Barthel et al. 2013). Examples include traditional forms of transhumance in the Ukrainian Carpathians (Warchalska-Troll and Troll 2014), grassland management in the Maramures area (Romania; Wästfelt et al. 2012), and mixed farming in southern Hungary (Beaufoy et al. 1994). It follows that the successful management of biodiversity in Transylvania, and most likely in other traditional farming landscapes, will depend not only on managing biophysical features, but also on being cognizant of the sociocultural drivers underpinning these features. Current policies often fail to acknowledge critical links between the social and the ecological parts of the system, and often target either the social or the ecological part exclusively (Fischer et al. 2012). Such one-sided policies could inadvertently erode the established historical connections between people and the land that maintain the character of traditional landscapes, and hence the structures supporting high biodiversity.

Two key approaches to mitigate the loss of farmland biodiversity in Europe are agri-environment schemes (AES) under the Common Agricultural Policy, and the Natura 2000 network of protected areas. Agri-environment schemes provide financial support to farmers to improve environmental conditions (Skogstad and Verdun 2010). Despite their obvious appeal, the effectiveness of AES in maintaining biodiversity in traditional farmland has been questioned because many existing schemes have not been designed specifically for traditional farmland (Tryjanowski et al. 2011, Pe'er et al. 2014, Sutcliffe et al. 2015). For example, implementation of AES is often restricted to small scales (Whittingham 2007), which may render them less effective in highly heterogeneous landscapes whose ecological value arises from the landscape as a whole (Tscharntke et al. 2005, Concepción et al. 2008, Batary et al. 2011a). Natura 2000 areas are potentially more effective at covering larger spatial scales, and can have positive biodiversity impacts (Gruber et al. 2012, Brodier et al. 2013, Pellissier et al. 2013). However, their successful management also depends on a holistic, socioecological understanding of the selected sites (Popescu et al. 2014).

Building on the seven hypotheses raised previously, we propose a holistic combination of "broad and shallow" conservation strategies targeting the entire forest–farmland mosaic, with "deep and narrow" measures targeting specific species, land-use types, threats, or traditional practices (Koleček et al. 2014). Moreover, we argue that conservation strategies should integrate the entire socioecological system by recognizing important links between people and the environment.

In the case of traditional farming landscapes, large-scale conservation measurements could provide the more broad and shallow landscape perspective to maintain the heterogeneous landscape character at multiple spatial scales (Concepción et al. 2008). The recent scaling up of AES to the landscape scale has already proven beneficial for a range of species (Merckx et al. 2009, Dallimer et al. 2010). Appropriate measures could focus on maintaining certain proportions of land-use types, large-scale habitat connectivity, complementary and supplementary habitat of different species, and on maintaining gradients in land-cover heterogeneity and woody vegetation cover. Applying such a landscape perspective may, for example, prevent the undervaluation of certain habitats (e.g., wood pastures), and would actively encourage the consideration of supplementary habitat (e.g., arable land for the Corncrake and for butterflies).

Deep and narrow conservation measures can then complement landscape-scale measures to target specific threats or species (Koleček et al. 2014). Here, it seems vital to advance our understanding of scale-dependent responses of different species to woody vegetation cover and land-cover heterogeneity (Koleček et al. 2014). Biodiversity responses in our study also differed between land-use types, indicating the need for distinct and more detailed strategies for grasslands and arable fields. Similarly, biodiversity may benefit most from policies targeted to mitigate either abandonment or intensification. For example, abandonment may be more prevalent in remote grasslands on steep slopes and could be mitigated by providing incentives to maintain rotational livestock grazing to remove shrubs. In contrast, intensification is more likely to occur in accessible arable land where the retention of woody vegetation cover should be prioritized. Deep and narrow conservation measures could also focus on preserving specific elements of traditional farming landscapes. For example, maintaining the small-scale heterogeneous character of the landscape is key to safeguard the observed high biodiversity. The small-scale structure of the landscape is tightly linked to traditional land use and practices, and deep and narrow conservation could emphasize the preservation of key elements of traditional land-use and practices (e.g., small-scale farming and livestock herding techniques), as well as on strategies for their future integration in new land-use systems (Plieninger et al. 2006).

These priorities provide tangible starting points for biodiversity conservation. However, ultimately, the persistence of biodiversity in traditional farming landscapes will depend on navigating socioecological change so that it does not only maintain biodiversity but also benefit local people. Traditional farming practices have become largely unviable. Conventional conservation policies have largely taken a preservation approach where financial incentives are provided for people to maintain traditional farming practices (Fischer et al. 2012, Plieninger and Bieling 2013). Such strategies, however, may fail in the long term, because they fail to account for sociocultural ties with the natural environment (Milcu et al. 2014). For example, people in Transylvania did not tolerate bears for their economic benefits, but because of non-use values ascribed to them (Dorresteijn 2015). Understanding and addressing such held values, and links between people and the environment, could reduce conflicts between rural populations and conservation initiatives (Ives and Kendal 2014). Moreover, the links between people, their activities, and the environment could form the base for a more integrated transformation approach to biodiversity conservation (Fischer et al. 2012). Such an approach would seek to foster new links between the social and the ecological parts of the system, aiming to support key biophysical properties of traditional farming landscapes while also fostering human well-being. To this end, options may include the development of agro-ecotourism or the wider uptake of agro-ecological and organic farming (Hole et al. 2005, Young et al. 2010). Importantly, landscape characteristics are often more important drivers of biodiversity than farm management, and thus the uptake of modern organic farming will only foster biodiversity if the small-scale heterogeneous character of the landscape is not compromised (Piha et al. 2007, Gabriel et al. 2010). Because people may have aspirations for the future different from those prioritized by conservation (Milcu et al. 2014), community participation and the support of bottom-up driven initiatives are essential for the development of holistic conservation strategies. Importantly, biodiversity conservation of traditional farming landscapes can only be facilitated if initiatives support not only natural capital, but also manage other capital stocks (e.g., social, human, financial, physical; Mikulcak et al. 2015). In the end, the future of traditional farming landscapes in a globalized world will depend on how well people can capitalize on the available opportunities (Hanspach et al. 2014), and thus successful biodiversity conservation will hinge on the integration of the entire socioecological system.

Outlook

The seven working hypothesis posed were developed on the basis of our understanding of southern Transylvania, but they are also likely to provide useful insights for other traditional farming landscapes. Most importantly, we believe there is a lot of value in seeking to combine understandings of ecological patterns and drivers of biodiversity with deeper, sociocultural drivers. Some of the lessons learned from Transylvania may directly translate to other systems, but other lessons may be very different in different settings. Further developing the hypotheses posed thus could provide new stimuli for socioecological research around the world, ultimately leading to well-grounded visions for how to manage traditional farming landscapes for both biodiversity and human well-being.

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