REPORT

Reviving wood-pastures for biodiversity and people: A case study from western Estonia

Marlene Roellig, Laura M. E. Sutcliffe, Marek Sammul, Henrik von Wehrden, Jens Newig, Joern Fischer

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Abstract Wood-pastures are associated with high cultural and biodiversity values in Europe. However, due to their relatively low productivity, large areas of wood-pastures have been lost over the last century. In some areas, incentive schemes have been developed to revive wood-pastures. We investigated the effects of one such scheme in western Estonia. We compared the structure of grazed wood-pastures (old and restored) to those of abandoned wood-pastures and ungrazed forest stands to explore the effects of management, and conducted interviews with 24 farmers to investigate their motivations to carry out the management. We found a positive influence of active management on the semi-open structure of wood-pastures. Financial support was vital for management, but personal values related to tradition also played an important role. The interviewees differed widely in their range of motivations, suggesting that other strategies in addition to financial incentives would further improve the management of wood-pastures in the region.

Keywords Social–ecological systems · Agri-environment schemes · Silvopastoral systems · Semi-natural habitats · Farmer motivations · Agroforestry · Restoration

INTRODUCTION

Wood-pastures are complex social–ecological systems (Huber et al. 2013; Hartel and Plieninger 2014). Since their origin in Europe in the Holocene (Bergmeier et al. 2010), they have developed as multifunctional resources, shaped

by the local needs of humans, local social and environmental factors, grazing intensity, and type of livestock (Chételat et al. 2013; Hartel and Plieninger 2014). The resulting mosaic of grassland with shrubs and trees of different ages as well as variable light and shade conditions provides important semi-open and semi-natural habitats for a wide range of species (Bergmeier and Garbarino 2014; Falk 2014; Hartel et al. 2014).

As social–ecological systems, wood-pastures depend on management to maintain their characteristic structure. The loss of this management due to the changing social and economic context of farming and forestry has led to their decline throughout Europe over the last century (Bergmeier and Roellig 2014). In the European Union (EU), one major recent driver of changes in European wood-pasture management has been the availability of agricultural support payments under the EU common agricultural policy (CAP) (Hartel et al. 2013; Beaufoy 2014). Most wood-pastures are ineligible for single area support payments (SAP) from the first pillar of the CAP because they are too dense (Beaufoy et al. 2011). Nevertheless, some are eligible for payments through agri-environmental schemes (AES) under the second pillar of the CAP, or through national support schemes (Beaufoy 2014). AES and associated financial incentives have often been hailed as potential solutions to stop the decline of semi-natural habitats (Ahnström et al. 2008; de Snoo et al. 2013). Although financial aspects are important (e.g., Siebert et al. 2006; Burton and Schwarz 2013), they are not the only factors motivating land managers, and personal norms and values have also been found to play a role (Burton 2004; Siebert et al. 2006; Ahnström et al. 2009). It is therefore important to understand the interplay of different motivations of land managers to design effective conservation incentives (de Snoo et al. 2013; Birge and Herzon 2014).

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Like many other countries in Europe, Estonia has a long tradition of wood-pasture management (Talvi and Talvi 2012). In Estonia, grazing in forests was historically widespread (Troska 2004), and although this practice was stopped in eastern Estonia in the late 18th century, it continued in the west until the early twentieth century (Meikar 2002a, b). In western Estonia, wood-pastures were mostly used as common land until independence in 1918 (Troska 2004). After this, pastures in Estonia were rapidly divided up among farmers and fenced, leading to an abrupt reduction in forest grazing (Lotman and Lotman 2011). Much land fell out of use during the communist era due to rural depopulation, enforced collectivization, and later due to the industrialization of agriculture. By the 1970s, a large proportion of natural grassland had been plowed and fertilized, and most of the wood-pastures were abandoned or only grazed very lightly. This situation did not change after the end of the Soviet period in 1990, and by 1999 grazing in wood-pastures had almost completely ceased (Kukk and Sammuli 2006). In 1996, the first trials of grazing subsidies for managing and restoring semi-natural grasslands started in Matsalu National Park, which were later expanded to the whole country (Lotman 2004). Currently, Estonia is one of the only countries in the EU providing financial support to maintain intact wood-pastures and restore abandoned ones (Sammuli et al. 2008).

Estonian wood-pastures are listed in Annex I of the EU Habitats Directive (type 9070 Fennoscandian wood-pastures¹) and many are protected within Natura 2000 sites. Most Estonian wood-pastures do not receive SAP (Beaufoy et al. 2011), but are eligible for AES. After a 3-year pilot project, a national subsidy scheme was introduced in 2001 to support the management of semi-natural habitats, including wood-pastures. This included payments to maintain their semi-open structure (e.g., grazing and tree thinning), as well as to restore abandoned wood-pastures (e.g., tree removal and fencing) (Talvi 2010). Since 2007, the payments for wood-pasture maintenance are part of the national AES, while restoration is paid solely by the Estonian government. In the context of the widespread decline of wood-pastures throughout Europe, lessons learnt from Estonia could provide valuable insights for their conservation in other countries.

To date, there is little published information about the management and structure of wood-pastures in Estonia. Wood-pasture maintenance and restoration activities have not been investigated, either in terms of their effects on habitat structure, or concerning the motivations of farmers to carry out these activities. Focusing on western Estonia, we therefore investigated (i) the effects of restoration activities on the structure of wood-pastures and (ii) the motivations of farmers to carry out these activities. We also

provide general information about the structure of wood-pastures and their current management in western Estonia. To achieve these aims, we combined ecological surveys of 30 wood-pastures (abandoned, restored, and old), as well as of 10 ungrazed forest sites as reference points, with semi-structured interviews with farmers.

MATERIALS AND METHODS

Study area

The study was conducted in the counties Saaremaa and Läänemaa in western Estonia in summer 2013. Läänemaa is located on the west coast of mainland Estonia, while Saaremaa consists of the islands Saare and Muhu (as well as many other small islands) in the Baltic Sea (Fig. 1). The proportions of land-use types are similar in both counties, namely (average for both counties) 49 % forest (20 % broad-leaved forest, 17 % coniferous forest, 12 % mixed forest) and 28 % agricultural area (11 % arable land, 11 % heterogeneous agricultural land areas, 6 % open pastures) (CORINE land-cover; European Environmental Agency [EEA] 2006). The counties were chosen because of their relatively high abundance of wood-pastures (Lotman and Lotman 2011).

Ecological data

We selected 30 wood-pasture sites based on a map of the habitat type 9070 (Fennoscandian wood-pastures), information about grazing activities from the Estonian Environmental Board, and additional information about the history and the management of the sites from interviews with farmers (see below). We also selected 10 ungrazed forest sites for comparison, which were chosen randomly via ArcGIS based on CORINE land-use cover of deciduous forest and mixed forest (avoiding pine plantations). Active wood-pastures were categorized as *old* (actively used for >10 years with maintenance but no major restoration) or *restored* (used for <12 years with major restoration activity during this period). *Abandoned* wood-pastures had been unused for at least 5 years. Ten sites were surveyed for each of these four categories, seven of which were on Saaremaa and three on Läänemaa (due to the higher frequency of wood-pastures on Saaremaa) (Fig. 1).

To characterize the stands, we surveyed one 25 m × 25 m plot (0.0625 ha) in each site. The plots were placed subjectively in a representative area near the center. We measured the diameter at breast height (DBH) for all living and dead trees within this plot, estimated their height, and identified species. In plots with unusually low tree densities, we also measured trees in the immediate vicinity of the plot perimeter until a minimum of 50 trees

¹ <http://ec.europa.eu/environment/nature/natura2000>.

Fig. 1 Study area in western Estonia, with the counties Saaremaa and Läänemaa, showing broadleaf and mixed forest in the study area and all 40 survey sites

per plot was reached, so that the sample sizes for species composition and DBH distribution were statistically robust. The density of each plot was based on the number of trees within the 25 m × 25 m plot. Within each plot, we also recorded shrub cover including tree saplings (visual estimation) and took five pictures with a fish-eye lens to determine canopy openness. The latter were analyzed using the software Gap Light Analyzer 2.0 (Frazer et al. 1999). We analyzed seven variables (following McElhinny et al. 2005) to describe stand structure: (1) tree density per ha, (2) standard deviation of DBH, (3) standard deviation of height, (4) % shrub cover, (5) % of canopy openness, (6) basal area of dead wood, and (7) species richness within the plot or within the minimum of 50 trees. The variables density, shrub cover, and dead wood were skewed, so we log-transformed them for analysis. No strong correlations (Spearman's rank correlation coefficient <0.6) were found between the habitat variables.

To explore relationships between habitat variables and land-use categories, we performed a principal component analysis (PCA) with the set of habitat variables described above. To test for significant differences between the land-use categories, we used a MANOVA with default Pillai statistic. Afterwards, we performed individual ANOVAs with Bonferroni corrections for each single variable. For significant variables, a post hoc test (Tukey HSD, using the R package multcomp; Hothorn et al. 2008) was performed to determine differences between categories. All analyses

were performed using the “stats” package in the software R (version 3.0.2) (R Core Team 2013).

Interview data

To address the motivations of farmers for managing wood-pastures, we conducted 24 semi-structured interviews with farmers (both commercial and hobby farmers, hereafter referred to collectively as farmers). Of these, 17 were conducted on Saaremaa and 7 in Läänemaa. All interview partners actively managed wood-pastures, except one who owned but did not manage a wood-pasture. Because no owners of abandoned wood-pastures could be located, we did not include these in our interview sample. Interviews lasted on average for 30 min (min. 10 min, max. 1 h) and were conducted either in Estonian with the help of a translator ($n = 21$), or in English or German by the interviewer ($n = 3$). All interviews were recorded, sometimes only partly ($n = 4$), and supported by notes.

Our questions covered two themes: (i) details on wood-pasture management to provide background information about the system and for further analysis of the interviews, and (ii) motivations for managing wood-pastures and benefits of wood-pastures in general, but also benefits for the farm and livestock in question, as well as participation in and importance of AES and restoration schemes.

All interviews were transcribed and translated, and interview notes were added to the transcripts. We used

Fig. 2 Examples of sites from different management categories: **a** ▶ old wood-pasture dominated by hazel, ash, and birch; **b** restored wood-pasture with birch, hazel, and ash; **c** abandoned wood-pasture with hazel and lime; and **d** ungrazed forest dominated by hazel and pine

content analysis to identify motivations for farmers to manage wood-pastures, coding the interviews thematically using the software MaxQDA 11 (MAXQDA 2014). We then identified different types of farmers based on the different combinations of motivations.

RESULTS

Ecological data

In total, we measured 4808 trees in 30 wood-pastures and 10 forest sites. The density of wood-pastures ranged from 368 trees per ha (category old) to 6704 trees per ha (abandoned). The standard deviation of diameter per site ranged from 3.27 (old) to 15.51 cm (old), while that of height ranged from 3 m (abandoned) to 20 m (abandoned). Shrub cover ranged from 1 % (old and restored) to 50 % (forest). We found 3–14 tree species per plot, with maximum and minimum occurring in old sites. Canopy openness ranged between 8 % (forest) and 68 % (restored), and dead wood ranged from 0 cm² (old) to 19 718 cm² (old) (Fig. 2).

We found 25 tree species in total, 24 species in wood-pastures, and 23 species in forest sites. The most common species in wood-pastures was birch (*Betula* spp.), which occurred in 80 % of all wood-pastures and represented 10 % of all recorded individuals. Ash (*Fraxinus excelsior*) was found in 76 % of wood-pastures but represented only 8 % of all individuals. Hazel (*Corylus avellana*), on the other hand, was found in 71 % of wood-pastures and represented 22 % of all individuals in wood-pastures. Finally, oak (*Quercus robur*) occurred in 73 % of wood-pastures and represented 5 % of all individuals (Table S1).

The first PCA axis of habitat variables explained 37 % of the variance and represented a gradient from high canopy openness and low amounts of dead wood to low canopy openness and more dead wood (Fig. 3). The second axis (26 % of variance) represented the standard deviation of diameter and height. Of all variables, species richness had the lowest effect on the PCA. Old and restored wood-pastures were separated along the first axis from abandoned wood-pastures and forest sites.

The MANOVA also showed significant differences between the wood-pasture categories in terms of their structural characteristics ($d.f. = 21$, $F = 2.2$, $p < 0.01$). The

Fig. 3 Principal component analysis (PCA) of seven structural variables in old wood-pastures (squares), restored wood-pastures (triangles), abandoned wood-pastures (circles), and forest sites (crosses)

individual ANOVAs showed only density and canopy openness to be significantly different between categories (Table 1). The post hoc tests showed old and restored wood-pastures to be significantly less dense, with a significantly more open canopy than forest or abandoned wood-pastures (Fig. 4).

Interviews

History and management of wood-pastures

Around half of the interviewees took (back) possession of their current land in or after 1991 (the end of Soviet rule). Only a few of the interviewees had farmed independently before that time with a small amount of land, while the others established their farms more recently. Farming was the main source of income for the majority of the interviewees, but some kept animals as a hobby. Where farming was not the main business, it was often combined with tourism. Where farming was the main business, it mostly focused on livestock. Few farmers also grew crops commercially, while most made hay and grew crops for their own use.

The most common livestock in wood-pastures was cattle, mostly for beef. Dairy cattle had been declining in the last 10 years, because of the low price for the milk and/or the workload with the dairy cows. Besides professional farming, livestock also served to keep the land open. Sheep were more common 10 years ago, but for various reasons (e.g., lynx attacks on the mainland) many farmers changed

to cattle. Our sample included only one farm where horses and goats were kept in a wood-pasture. The number of animals per farm ranged from 5 to 300.

Over half of the farms practiced organic farming, but not all of them were certified. The main reason for not being certified was that farmers perceived the paperwork and monitoring as excessive: “*I was organic for 2 years in the beginning. I don’t use any fertilizers or chemicals, but the paperwork and requirements are just too much.*” (I3)

Of the wood-pastures we surveyed, the longest continuous use we could confirm (including use by previous owners) was 30 years, the shortest 6 years. Nevertheless, the history of wood-pastures was difficult to reconstruct due to changes in ownership and different land reforms, and previous land use sometimes even varied within a single pasture. Typically, wood-pastures were either grazed at low intensity, mown, or farmed more intensively as part of a collective farm. Many had been abandoned during the second half of the twentieth century. Only eight of the interviewees farmed only their own land. Typically, the majority, if not the whole area of a given wood-pasture, was rented from neighbors or the state. Often wood-pasture areas were adjacent to other semi-natural habitats such as alvars (natural calcareous grasslands) or coastal pastures.

Tree management was also diverse. Most farmers managed trees in some way, mainly to keep the pastures open rather than to produce wood. One farmer did not cut out trees, because his rented land had too many different owners and it was complicated for him to agree on a management regime with the other owners. Farmers often mentioned that it was difficult to manage the trees if the land belonged to the state. Tree management varied from cutting single trees with a chainsaw to removing groups of trees with light machinery (bought from the subsidies). All kinds of trees were cut, but in general farmers preferred to keep broadleaf trees or “*the good looking trees*” (I8). Oaks would always be kept and were considered typical wood-pasture trees. If there was a lot of wood left (e.g., after first restoration activities), it was typically used as firewood for personal use or sold for woodchips.

All interviewees received agricultural subsidies from the state, but only one received SAP from the first pillar of the CAP. All other wood-pastures surveyed were not eligible for area support due to their high density of trees, but participated in the AES for grazing semi-natural habitats; ten of them also participated in the restoration scheme.

Farmers’ motivations to manage wood-pastures

Five categories of motivations emerged from the content analysis, which represent extrinsic motivations (two categories) and intrinsic motivations (three categories). Both extrinsic motivations were financially driven, but in

Table 1 Results of individual ANOVAs showing the significance of the differences between old, restored, and abandoned wood-pastures and forest categories. *P* values given with Bonferroni correction (** <0.01, *** <0.001). Differences between the site types are shown in Fig. 4

Variable	Degree of freedom	Sum of square	<i>F</i>	Corrected <i>p</i> value
Density (stems per ha)	3	9.568	9.023	0.001**
Standard deviation of DBH	3	7.490	0.226	1.000
Standard deviation of height	3	2.607	0.281	1.000
Shrub cover	3	10.282	3.895	0.116
Canopy openness (%)	3	3394.40	10.237	<0.001***
Dead wood	3	23.198	3.395	0.197
Species richness	3	30.600	1.671	1.000

Fig. 4 Variation in **a** tree density (shown on log scale) between old, restored, and abandoned wood-pastures and forest sites, and **b** canopy openness for the different categories. Significant differences ($p < 0.05$) according to the post hoc Tukey HSD are shown with different letters (see Table 1 for ANOVA scores)

different ways. Due to the rapid regrowth of trees and the similarly high labor costs of both management and restoration, the differences in motivation for management and restoration were often blurred. We therefore concentrated primarily on the motivation for management, but refer to the motivation for restoration in the description of different groups of farmers where appropriate (see below).

The most frequently mentioned motivation was **financial support**. Farmers could not afford to manage the wood-pastures without subsidies (either SAP or AES): “Without the subsidies it would be impossible to buy any kind of machinery. And since the cattle is on semi-natural habitat, their production isn’t as good as production-oriented cattle” (I8). Without the payments, most interviewees would give up the wood-pastures, keeping them only in some special cases, for example, in combination with other, more profitable land, or as a hobby. One farmer said that he would keep wood-pasture without the payments, if it were his own land.

The second extrinsic motivation was the **scarcity of land**. “There was no other land” (I24 and I13), especially because wood-pastures were historically common in western Estonia. During the Soviet era, farmers would use wood-pastures because this was the land left for private livestock after collectivization. Newly established or expanding farms recently looking for land only found semi-natural habitats (including wood-pastures) left for rent, which they were not allowed to clear as they were already included in a protected area.

The intrinsic motivations were more complex, but in our analysis, three main categories emerged. The most frequently mentioned kind of intrinsic motivation was **tradition**. This included traditional farming methods (“It has always been like this [with trees and grass]” (I17)) and the memory of the landscape (“When I was little, it was all clean and beautiful” (I20)). Keeping tradition alive seemed to be a strong motivation for land owners to maintain or

even restore wood-pastures. To keep the landscape open was part of this tradition, and land owners (especially hobby farmers) felt responsible for maintaining the landscapes.

The second intrinsic motivation was **animal welfare**, that is, providing “natural” conditions for the animals and healthy fodder in the wood-pastures (and in other semi-natural habitats). People believed that having animals in a wood-pasture was “*closer to nature*.” The animals could find shelter from rain, sun, wind, and snow. They were often out for the whole year and even gave birth in denser parts of the wood-pasture. The animals found more diverse fodder from ground and woody vegetation, with the result that some farmers did not have to medically treat their animals as much (e.g., for worms).

The third category, **biodiversity**, was less frequently mentioned. The farmers talked about the diversity of plants and also birds, sometimes even mammals. Some of the pastures were wooded meadows before, and as such had been the subject of scientific research—hence, some farmers were aware of rare species. Where farmers knew about rare species in their pasture, they expressed pride in hosting them.

Types of farmers

Based on the combinations of motivations stated by the interviewees, we identified three groups of farmers. Notably, some farmers did not fit into any of these groups, but rather showed a broad range of motivations.

The “**traditionalists**” had a high intrinsic motivation, valuing tradition above other factors. Their main concern was keeping the landscape open, because they “...*don’t want to live in the jungle*” (I3). They were not highly dependent on direct profits from the wood-pastures, because they often had only small pastures, sometimes in combination with larger areas elsewhere or non-farming income (e.g., tourism). Biodiversity and animal welfare were also important to this group, but were not the main motivation. Farmers in this group had little to no financial motivation, but still without the payments many would have been unable to manage the pastures. Some of the restored wood-pastures in this group were only reactivated because of tradition. Either “*it has always been like is*” (I17) or farmers wanted to maintain the landscape they remembered from their childhoods.

Second, “**profitable stewards**” had both extrinsic and intrinsic motivations. Farming was their main source of income, and often the wood-pastures were combined with other (large) semi-natural habitats such as coastal pastures. Profitable stewards wanted to make profit, but at the same time also had a high intrinsic motivation, mostly relating to animal welfare and biodiversity conservation. Old wood-pastures in this group often belonged to established organic

farms, including some of the first organic farms in the region: “*We have always been organic*” (I11 and I19). Farmers participating in the restoration scheme in this group were often looking especially for semi-natural habitat to rent and restore, because it was not only the most frequently available land, but also suitable for meeting organic farming guidelines and perceived as environmentally friendly.

Third, “**opportunists**” were mostly motivated by the extrinsic motivation of the scarcity of land, but also by financial aspects. Farmers in this category managed wood-pastures mainly because it was the only land they had. Since the wood-pastures were not eligible for the SAP, they joined the AES to get some additional money. If they took part in the restoration scheme, they often used the restoration subsidy to modify land they were already using so that it would become eligible for management subsidies.

DISCUSSION

Our results showed a positive effect of subsidies on the habitat value of wood-pastures, as restored sites were not significantly different from old wood-pastures in density and canopy openness, while abandonment rapidly led to a forest-like structure. The significant difference between old/restored and abandoned sites shows that wood-pastures in Estonia are dependent on active management. We identified a variety of motivations for farmers to carry out this management, both extrinsic (e.g., financial support) and intrinsic (e.g., tradition). The interviewed farmers differed considerably in their motivations. Nevertheless, almost all farmers confirmed that they would not manage the wood-pastures without the AES payments, making this a necessary (albeit not sufficient) condition for farmers to manage wood-pastures.

Wood-pasture structure

In general, Estonian wood-pastures appeared to be a lot denser than wood-pastures in other parts of Europe (min. 368 trees per ha). For example, an average of only eight trees per ha was recorded in Romanian wood-pastures (Hartel et al. 2013), while Spanish wood-pastures ranged from ~16 trees per ha in old stands and ~28 trees per ha in younger stands (Plieninger et al. 2003). Even in central Sweden (which has wood-pastures more similar to those in Estonia), a maximum of 200 trees per ha has been reported (Jakobsson and Lindborg 2014). This high density may have a historical explanation, as most wood-pastures in Estonia originate from grazed forests and have developed without strong conscious thinning efforts (Kukk and Kull 1997; Pärtel et al. 2005). In addition, there was a period of

abandonment (1980–2000) during which almost none of the wood-pastures were grazed in Estonia (Kukk and Sammuli 2006; Sammuli et al. 2008). Higher tree density also logically leads to a faster return to forest conditions, and thus an even greater threat of habitat loss through abandonment here than in other areas of Europe. During the interviews, farmers often mentioned the fast regrowth and the associated workload of cutting out trees in addition to grazing management. This suggests that although the restoration scheme has been successful in terms of its effect on the structure of wood-pastures, these effects may be rapidly reversed should management cease, for example, if subsidies were no longer available.

Motivations of farmers

Understanding farmers' motivations to manage semi-natural habitats such as wood-pastures is an important step in tailoring future incentive schemes, so they have the best outcomes for biodiversity (de Snoo et al. 2013; Birge and Herzon 2014). This is not always straightforward, as farmers are typically quite heterogeneous in their motivations (Busck 2002). Such heterogeneity was also shown by the three main groups of farmers identified in our results, as well as by some farmers that did not fit into any of the groups.

The most common motivation, shared by almost all farmers, was the financial compensation for the management of wood-pastures. This shows that this financially oriented policy instrument plays a key role in the survival of wood-pasture habitats (see also e.g., Beaufoy 2014), which are rarely eligible for the single area payments from the first pillar of the CAP (Beaufoy et al. 2011). However, there is also a threat that farmers will become too dependent on subsidies and grazing will lose its economic value.

The second extrinsic motivation was the scarcity of grazing land. This is somewhat in contrast to trends in other parts of Europe, where farming is concentrated in the most productive areas and marginal habitats are abandoned. The use of wood-pastures as extra land brings indirect financial gains due to an increase in productive area and was especially important for the group of *opportunists*. While there is some debate about the importance of production (independently of profit) in farmer decision making today, it appears to remain at least one of the major factors for European farmers (Busck 2002; Burton and Wilson 2006). However, in addition to this productivist aspect, several farmers mentioned the symbolic importance of the ownership, rather than simply the use of land, suggesting that the need for land as a motivation may also have an intrinsic aspect.

Tradition, in terms of landscape esthetics and farming practices, was the most frequently mentioned intrinsic motivation and the main motivation of the *traditionalists*. It was so strong that it even extended to rented land. The importance of tradition was to some extent unexpected, because there is relatively little information on the effects of tradition on farmer decision making (although in a wider sense, the influence of norms and values has been widely studied, see e.g., Beedell and Rehman 1999, 2000; Burton 2004). The role of tradition may therefore be an aspect that could be capitalized on in other countries in order to promote the use of wood-pastures.

The second and third most frequently mentioned intrinsic motivations were animal welfare and biodiversity benefits of wood-pastures, respectively. Birge and Herzon (2014) also found animal welfare and nature conservation (similar to our category of biodiversity) among the motivations of Finnish farmers to manage semi-natural habitats. Herzon and Mikk (2007) also showed that Estonian farmers were willing to implement simple conservation measures in semi-natural habitats even without financial compensation. Hence, although this motivation was less important than the others, it does appear to play a role for many farmers. Thus, as other studies have shown (e.g., Siebert et al. 2006; Burton and Schwarz 2013), financial support is a necessary prerequisite, but is not the only (or even main) motivation for farmers to carry out biodiversity-friendly management such as wood-pasture maintenance and restoration.

Groups of farmers and targeting of incentives

Ideally, different groups of farmers should be addressed with different incentives within AES (Schmitzberger et al. 2005). In our study, three groups of farmers were identified—the *traditionalists*, *profitable stewards*, and *opportunists*—with different sets of motivations for managing wood-pastures. Of the farmers, the *opportunists* appeared to be most strongly motivated by (as opposed to facilitated by) the subsidies in their decision to manage wood-pastures. However, although financial incentives can maintain traditional farming practices in the short term, in the long term they can de-couple social systems from ecological benefits (Fischer et al. 2012). In Estonia, there was still evidence of a tight link between social systems and ecological benefits. The *traditionalists* and *profitable stewards* still had strong links to the past, but also actively sought to diversify their benefits from wood-pastures by adopting organic farming or farm tourism. Instead of, or in addition to, support payments, these farmers may be better supported in their choice to farm wood-pastures by what Fischer et al. (2012) described as a “transformation strategy”

for the sustainable development of traditional landscapes. Such a strategy entails the creation of new direct links between nature and social and economic well-being, which are then viable over the longer term and robust to changing conditions. This could happen in Estonia through support of organic farming and farm tourism as well as through developing and supporting local and regional initiatives that create value-added products from wood-pastures.

CONCLUSION

We have shown that wood-pastures in western Estonia are social–ecological systems that depend strongly on active management to maintain their habitat value. This management, in turn, is dependent on various factors such as EU and national policies, but also on the extrinsic and intrinsic motivations of farmers. For example, (extrinsic) financial incentives play an important role in farmers' decision making, but we also found a strong (intrinsic) influence of tradition on our interviewees.

Although this was a regional case study, our results also provide insights that may be of use in other countries aiming to revive wood-pasture management. For example, we have shown that national subsidies may be an effective means of restoring and maintaining the habitat value of wood-pastures. If eligibility problems mean that EU funds through the CAP are not available, payments can alternatively be provided by national funds. In addition to financial incentives, land managers have a range of other motivations for the management of wood-pastures, which should be taken into account when designing incentive mechanisms for the management of such semi-natural habitats. Particularly, the role of tradition is rarely focussed on in the agricultural context, but could play an important role in maintaining wood-pastures.

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AUTHOR BIOGRAPHIES

Marlene Roellig (✉) is a doctoral candidate at Leuphana University Lueneburg. Her research focuses on the governance, ecology, and ecosystem services of agroforestry systems in Europe. Address: Faculty of Sustainability, Institute of Ecology, Leuphana University Lueneburg, Rotenbleicher Weg 67, RW017, 21335 Lueneburg, Germany. e-mail: roellig@leuphana.de; Marlene.roellig@leuphana.de

Laura M. E. Sutcliffe is a post-doc at the University of Göttingen in Germany. Her research focuses on the ecology and governance of agricultural ecosystems in Europe. Address: Plant Ecology and Ecosystem Research, Georg-August University Göttingen, Untere Karspüle 2, 37073 Göttingen, Germany. e-mail: sutcliffe.laura@gmail.com

Marek Sammul is a researcher at the University of Tartu. His research interests include restoration ecology and dynamics of ecosystems in general and more specifically the development of semi-natural communities. He has also studied clonal growth in plants and species interactions. Address: Chair of Natural Resources, Department of Zoology, Institute of Ecology and Earth Sciences, Tartu University, Vanemuise 46, 51014 Tartu, Estonia. e-mail: marek.sammul@ut.ee

Henrik von Wehrden is a professor in quantitative methods in natural sciences. His research focusses on creating a link between ecosystem function and ecosystem services, thereby having a strong emphasis on biodiversity and community ecology research as well. Furthermore, he has a strong standing in quantitative analyses and conservation biology. Address: Faculty of Sustainability, Institute of Ecology, Leuphana University Lueneburg, Rotenbleicher Weg 67, RW017, 21335 Lueneburg, Germany. Address: Center for Methods, Leuphana University Lueneburg, Scharnhorststr. 1, C04.003a, 21335 Lueneburg, Germany. Address: Research Institute of Wildlife Ecology, Savoyen Strasse 1, 1160 Vienna, Austria. e-mail: Henrik.von_Wehrden@leuphana.de

Jens Newig is a professor of governance and sustainability at Leuphana University Lüneburg. His research interests include environmental politics, policy, and governance for sustainable development. *Address:* Research Group Governance, Participation and Sustainability, Faculty of Sustainability, Leuphana University Lüneburg, Scharnhorststr. 1, C11.105, 21335 Lüneburg, Germany.
e-mail: jens.newig@leuphana.de

Joern Fischer is a professor of sustainable landscapes at Leuphana University Lüneburg. His research focuses on biodiversity conservation and food security in social–ecological systems. *Address:* Faculty of Sustainability, Institute of Ecology, Leuphana University Lüneburg, Rotenbleicher Weg 67, RW017, 21335 Lüneburg, Germany.
e-mail: Joern.fischer@leuphana.de