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ORIGINAL PAPER

Coppice reintroduction in the Czech Republic: extent, motivation and obstacles

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Abstract

Coppicing is a form of forest management in European broadleaved forests. While it is still practised in south-eastern Europe, in central and western Europe it was almost completely replaced by high forest management. Currently, there are increasing efforts to reintroduce coppice management into former coppice woods. However, little comprehensive knowledge is available about the extent and management of coppice reintroduction and the processes governing it. In this paper, we present an overview of localities in the Czech Republic where coppice reintroduction was taking place in 2020. We identified 8 localities and conducted 10 semi-structured interviews with experts involved in their management in order to understand what motivated them to restart coppicing and what obstacles they have had to face. The main motivation of site managers is nature conservation, while the most important obstacles are operational issues, such as bureaucracy, complicated land ownership and legal responsibilities or lack of workforce. Other motivating factors identified in other European countries (production of a renewable energy source and potential for rural employment) have so far played a minor role in the Czech Republic. We conclude that a major challenge for future forest policies will be to utilise the economic experiences of regions with active coppicing to foster the spread of coppice woods in order to combine renewable energy production with biodiversity conservation.

Keywords Traditional forest management · Central Europe · Nature conservation · Management policy · Economic potential · Semi-structured interviews

Introduction

Coppicing is a traditional forest management form, which used to be widespread in pre-industrial Europe, especially in the lowlands (Rackham 2003; McGrath et al. 2015; Szabó et al. 2015). It uses the ability of broadleaved trees to resprout after cutting from the stump or the root system. The coppice stool (the stump on which young shoots grow) becomes permanent and can be cut many times, although some species lose some of their resprouting ability if uncut for longer periods (Matula et al. 2012). The origins of coppicing probably go back to prehistory, although direct evidence for this is rather difficult to produce (Waller et al. 2012; Out 2013). Coppicing was explicitly mentioned for the first time by classical Roman authors. Tree ring evidence suggests that it was common in the first millennium AD (Muigg et al. 2020). From the thirteenth century onwards, there is copious written evidence from many European countries about the technical details and the extent of coppicing. The coppice cycle in the Middle Ages was short (ca. 7 years) and was prolonged to ca. 30 years in the Early Modern Period (Szabó 2022).

Coppicing was gradually abandoned in western and central Europe from the second half of the nineteenth century onwards (Müllerová et al. 2014; Buckley 2020; Kamp 2022). The main reason behind coppice abandonment was the replacement of the main coppice product—fuelwood—by

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cheap and widely available other sources of energy, mainly coal (Sieferle 2001). Many coppices were turned into high forest plantations. Others were 'singled-out', i.e. only the strongest shoot was left to grow on each coppice stool to produce a pseudo-high forest. Still others were abandoned and left with no management either by default or as part of non-intervention nature conservation. It is estimated that some 10–14% of European forests are managed as coppices today with the main strongholds for example in Turkey, Bosnia-Herzegovina, Serbia, Italy or Greece (Unrau et al. 2018; Buckley 2020). It needs to be noted, however, that many existing European coppice woods are not survivors of traditional management but plantations of fast-growing non-native tree species, for example of black locust (*Robinia pseudoacacia*, native in North America) in Hungary (Vítková et al. 2017).

In countries where traditional coppicing has become very rare, there have been attempts at its reintroduction since the second half of the twentieth century. Among the first known cases was the gradual recutting of Hayley Wood in England, which started in 1964 (Rackham 1975). Other examples are the area in the Salzgitter Höhenzug mountains in Germany, re-coppiced since 1986 (Strubelt et al. 2019), or a failed attempt after 1999 in Krumlov Wood, the first case of (experimental) coppicing reintroduction in the Czech Republic (Utinek 2004; Vild et al. 2013). Currently, coppicing is being restored at many locations in Europe, for example, in Belgium (Vandekerkhove et al. 2016), the Czech Republic (Štochlová and Hédl 2018), Germany (Ewald et al. 2018), Italy (Coppini and Hermanin 2007) or the Netherlands (Jansen and Kuiper 2004). Remarkably, similar processes of abandonment and revival of coppicing have been observed in Japan (Kuroda et al. 2012).

According to the majority of studies, coppice restoration has beneficial effects for many taxonomic groups constituting forest biodiversity, including ground herbs, butterflies, spiders and birds (Buckley and Mills 2015, Hédl et al. 2017, Fartmann et al. 2013, Fuller 1992, Hamřík et al. 2023; but see also Hambler and Speight 1995). The general idea behind conservation-based coppice restoration is that these forests have been influenced by humans for so long that their ecosystems have become dependent on coppicing. After coppicing had been abandoned, ecological succession resulted in darker, biotically homogenised forests (Van Calster et al. 2007; Hédl et al. 2010; Kopecký et al. 2013). Coupled especially with atmospheric nitrogen deposition (e.g. Dirnböck et al. 2014), this led to considerable biodiversity decline (Kirby et al. 2017), and consequently the future significance of coppice reintroduction for biodiversity maintenance is in little doubt. However, despite considerable efforts to map the current extent and state of European coppice woods (Unrau et al. 2018), detailed and comprehensive information on coppice reintroduction sites, key actors and processual patterns is not available in any European country except for a low-resolution map for Germany by Kamp (2022). As a result, little is known about the motivation of those who initiate and manage the renewal of this traditional forest management form and about the challenges they face. Lack of information makes it difficult to develop effective policies to foster coppice reintroduction on local, regional, national and continental levels in Europe.

This paper aims to provide an overview of the current state of coppice reintroduction efforts in the Czech Republic. Our goals are (i) to create an overview of coppice reintroduction localities in the country, and (ii) with the help of qualitative data analysis, to understand what motivated site managers to start with coppicing and what obstacles they have had to face so far. Interpreting the results in a European context aims to foster future comparative research efforts, potentially leading to better-informed policies for coppice reintroduction within and outside the Czech Republic.

Materials and methods

Study region

The Czech Republic covers 78,870 km^2 with 10.9 million inhabitants in central Europe. The western part of the country (Bohemia) is surrounded by low mountains (highest peak at 1603 m a.s.l.), while the eastern part (Moravia and Czech Silesia) is more open to the north-east and south. Climate is temperate transitional between oceanic and continental (mostly Dfb according to the Köppen classification). Mean annual temperature varies from 5 to 10 °C, and mean annual precipitation from 500 to 700 mm, except in extremes. The main tree species on an altitudinal gradient from the lowlands to the mountains are oak (*Quercus* spp.), hornbeam (*Carpinus betulus*), beech (*Fagus sylvatica*), silver fir (*Abies alba*) and spruce (*Picea abies*). At present, forest cover is 34.1% (Chytrý 2017).

Approximately half of the forests are owned and managed by the state. The Czech forest law distinguishes three categories of forests: commercial forests (which aim at timber production), forests for special purposes (where for example nature protection, water protection or recreation takes precedence over timber production), and protective forests (whose aim is to protect the soil and where harvests are minimal). The history of coppicing in the Czech Republic goes back at least to the fourteenth century and coppice woods were probably omnipresent in the lowlands in the Late Middle Ages (Szabó 2010; Szabó et al. 2015). By the end of the eighteenth century, practically all non-mixed broadleaved forests in the lowlands were coppiced. Coppice abandonment started in the late nineteenth century and became near complete after World War II (Maděra et al. 2017).

Identification of coppice reintroduction localities

We used our long-term experience to identify localities of coppice reintroduction in the Czech Republic. This was based on personal knowledge of the localities and their managers, as we have carried out systematic ecological and historical research at most of the localities for more than a decade (e.g. Szabó 2010; Kopecký et al. 2013; Hédl et al. 2017; Hamřík et al. 2023). A preliminary overview of coppicing reintroduction localities was published in Štochlová & Hédl (2018). For the present paper, we have identified one additional locality (Křivoklátsko PLA[1]). Since we conducted the research presented here (interviews in 2020), the situation has somewhat advanced. Even though, as far as we know, no new localities were added, existing ones have developed further.[2]

It should be noted that locality as a designation for the research unit in our study has a rather broad meaning in terms of physical and organisational form. In some cases, there are as many as five sub-sites spread over tens of km^2 and comprising multiple forest stands; in other cases, the whole locality is a single stand. The structure of coppicing reintroduction in the Czech Republic is complex and contains more than one hierarchical level. In order to maintain the consistency of the main message, we decided to follow the structure of sociological interviews when defining the localities as listed in this study.

Research sample and analysis

Qualitative designs in forestry management research are rare, yet useful for understanding socially and culturally conditioned aspects of coppice reintroduction phenomena (see e.g. Górriz-Mifsud et al. 2015, Hoogstra-Klein and Burger 2013, Jay and Schraml 2013). In our exploratory study, we opted for a qualitative research strategy based partially on principles of grounded theory constructivist approach (Charmaz 2006). This approach enables an empirically grounded understanding of expert experiences, meanings and concepts, but also to grasp the processes behind the production of existing situations (Flick 2018). Qualitative inquiry typically uses relatively small research samples, and its strength lies in an in-depth and contextualized view of a complex study problem. To gain detailed knowledge about the coppice localities and to understand the problems and obstacles of their management from the perspective of the local experts, we conducted ten semi-structured interviews with ten site managers in 2020. In sampling for the representatives of the coppice localities, purposive sampling was applied "looking for the core cases with the experience, knowledge, practice" (Flick 2018: 52). We aimed to find site managers who had the expertise and direct and recent experience with coppice management—either those responsible for proposing coppice reintroduction projects or those who worked as project leaders directly involved in coppice maintenance (Table 1). Semi-structured interviews are typically used to cover previously known key themes, however, the questions asked are open-ended, and the inquiry is dynamic as the order of the questions within the interview is not fixed. To obtain significant information, researchers also ask ad hoc questions that cover themes emerging from the particular interview, ask for further details, specifications or even use silence in order to enable the participant to reflect deeper on the theme (Brinkmann and Kvale 2015: 133). The interview guide for the semi-structured expert interviews (cf. Bryman 2008) contained themes such as historical and current site management practices, their extent or financing, motivations of site managers, perceived obstacles and problems of coppice reintroduction (for details, see Supplementary Material 1). These themes determined the main direction of the interviews and ensured that all aspects of coppice reintroduction were covered. However, each interview was unique and provided enough space for participants to formulate their perspectives and share their specific experiences (Charmaz 2006). The interviews took approximately one hour and were recorded and transcribed verbatim. The supplementary questionnaire focusing on the descriptive characteristics of the localities (size, information about the locality's history or its current ownership and management, etc.) was completed by each research participant after the interview. Missing data were filled in later via short follow-up phone calls with the participants. Each participant signed an informed consent form. Participants were informed in advance that the complete anonymisation of the data would not be possible due to the uniqueness of the research localities, and all participants agreed to the overt use of the interview data before the interviews were conducted. The participants authorised the current text—they expressed their agreement with the interpretation of the data, and we incorporated their minor corrections into the manuscript. This collaborative verification in the final phase helped increase the validity of the descriptive data and the trustworthiness of the interpretations in the qualitative part of the research.

In addition to the descriptive mapping of the coppice reintroduction localities, the interview data were analysed inductively. Interview transcripts were firstly coded in open, line-by-line coding. To answer the research questions, the

[1] PLA = Protected Landscape Area (in Czech, Chráněná krajinná oblast) is a legal term in Czech nature protection that denotes a different overall focus than that in national parks, which are designed towards a non-intervention management regime. Otherwise, the two categories are basically the same in their physical, natural and historical conditions.

[2] Including for example a LIFE project with two experimental sites in Český kras PLA and one site in southern Moravia.

Table 1 List of localities with coppice reintroduction in the Czech Republic and information on research participants

Locality	Research participant number	Position/profession	Education
Pálava PLA	RP1	Pálava PLA—forestry expert	Forest engineering (Mendel University)
Utinkův háj	RP2	Professional forest manager, forestry and environmental consultant	Forest engineering and forest cultivation (Mendel University)
Český kras PLA	RP3	Český kras PLA—forestry expert, memorable trees, greenery outside the forest	Forestry secondary school Písek
Školní lesní podnik Masarykův les Křtiny (ŠLP)	RP4	Školní lesní podnik Masarykův les Křtiny—director	Forest engineering (Mendel University)
	RP5	Školní lesní podnik Masarykův les Křtiny—Head of Development and Pedagogy Department	Faculty of Forestry and Wood Technology (Mendel University)
Bílé Karpaty PLA I	RP6	Bílé Karpaty PLA—forestry expert	Faculty of Forestry and Wood Technology (Mendel University)
Bílé Karpaty PLA II	RP7	Bílé Karpaty PLA—agriculture, Project LIFE	Biology–Geology and Environmental Protection (Palacký University)
	RP8	Bílé Karpaty PLA—zoologist, Project LIFE	Systematic biology and ecology (University of Ostrava); PhD in zoology (University of South Bohemia)
Křivoklátsko PLA	RP9	Department of Forest Management and Applied Geoinformatics, Mendel University—docent	Forest engineering (Mendel University); PhD at Faculty of Forestry and Wood Technology (Mendel University)
Podyjí National Park	RP10	National Park Podyjí—officer for natural management of forest and non-forest ecosystems, entomologist	Forest engineering (Mendel University); PhD in Landscape management (Mendel University)

second step in coding focused specifically on motivation structures and on identifying obstacles and barriers from the perspective of local managers. We are aware that grounded theory approaches, including the constructionist one, primarily aim at theory building. However, for our exploratory study, we used the tools of grounded theory to identify patterns in the data and to formulate the main categories, which are further explored below.

Results

Overview of coppice reintroduction localities with basic characteristics

We identified eight localities in the Czech Republic where coppicing is currently being reintroduced (Fig. 1, Table 1). Information on research participants is included in Table 1. For detailed descriptions of each locality, see Supplementary Material 2.

When considering the past three decades of coppicing reintroduction in the Czech Republic, four localities appear to be the most developed (Table 1). In three (Pálava PLA, Český kras PLA and Podyjí National Park), the coppices form part of nature reserves of the highest level of protection. The fourth locality, Školní lesní podnik Masarykův les Křtiny, is under the special regime of a university forest enterprise. In these localities, the reintroduction of coppice management has been actively promoted for at least ten years, and the total area of restored stands (implemented or planned) at each locality is in the order of tens of hectares. Furthermore, the site managers have a rather clear vision, which they are able to communicate and discuss. This promises a longer-term perspective and further expansion.

Motivations

This chapter outlines the most important motivations identified in the managers' narratives about their experiences with the coppice reintroduction process: conserving biological and landscape diversity, raising awareness, climate change mitigation and economic benefits.

Conserving biological and landscape diversity

Because coppice reintroduction typically happens in protected areas and the respondents were usually employed by nature conservation organisations, it is not surprising that coppice restoration in the Czech Republic is most often motivated by nature conservation purposes. This includes the protection of species or communities dependent on coppicing as well as the protection, restoration or fostering of two interrelated types of diversity: the biodiversity typical for open forests, and also more general landscape diversity.

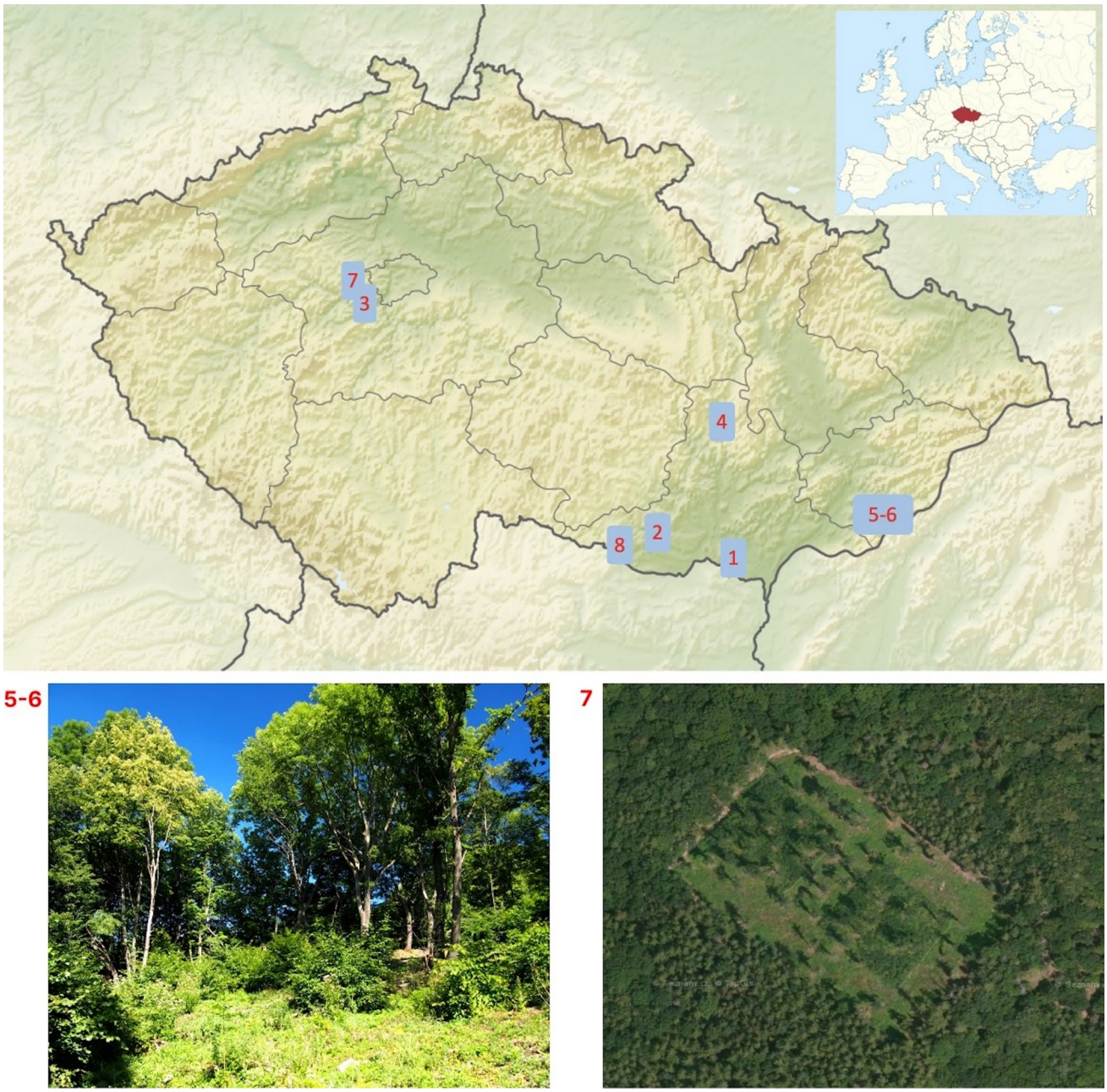

Fig. 1 The study region and the coppice reintroduction localities. 1: Pálava Protected Landscape Area (PLA). 2: Utinkův háj. 3: Český kras PLA. 4: Školní lesní podnik Masarykův les Křtiny. 5–6: Bílé Karpaty PLA I, II. 7: Křivoklátsko PLA. 8: Podyjí National Park. Photographs: Demonstration of coppice management in Bílé Karpaty, *source*: Authors'own archive (left). Aerial image of restored area in Křivoklátsko, *source:* Mapy.cz (right)

Biodiversity was mentioned by almost all participants and given unequivocal importance. According to research participants, coppices represent a stand-type that is missing from current Czech landscapes, as a result of which some species are disappearing, as illustrated by the case of the Pálava PLA: "*We knew that the species or the communities on Děvín were beginning to change. And for the worse, because some species were disappearing. So then we started to look at what our predecessors were doing so that so many species were preserved and why these were now disappearing … And it turns out that coppicing was abandoned sometime after the war and then nature conservation came in, and their first efforts were to leave everything to natural processes, to let it develop naturally. And from that time on the forests started to close in, they became thick and not hospitable for some of those species, and the*

forests themselves changed" (RP1). RP1 also pointed out the ambivalence described in the literature as the protectionist versus conservationist approach to nature. In the case of Pálava, the conservationist approach led to a decrease in biodiversity. Many species need open habitats, and non-intervention management is not suitable for them: "*Coppice forests or coppices-with-standards hold a certain type of biodiversity that is dependent on human activities, but such forests are gradually disappearing from the landscape. And it is necessary to somehow maintain or support this biodiversity*" (RP4). Biodiversity rather than the "natural" state of the habitat was formulated as the major goal of coppicing, as also in the case of the Podyjí National Park, where the site manager focused on environmental diversity: *"That was in fact one of the goals – to introduce a mosaic-like spatial structure into the forests so that they are not all even-aged forests with the same density, height and age"* (RP10).

'Mosaic' appeared to be a keyword illustrating the biodiversity goal in coppicing. Coppicing was seen as a complex management system with important temporal dimensions and a high level of uncertainty: *"You need to realise that coppicing is not simply regenerating trees through shoots. Coppicing is a management system. So if I cut a part somewhere, I need to count with the fact that I will some time afterwards cut the part next to this first part. Because … there is no certainty that high biodiversity is connected to freshly coppiced plots. But maybe biodiversity is dependent on stands with different conditions: fresh cuts, forests younger than ten years, closed forests with no light* etc. *So that all the organisms, which have various requirements, are able to find their own little corner, and when they stop feeling OK they move to the next spot"* (RP2). All managers seem to be aware of this prerequisite; therefore all those with sufficiently large areas plan to create a mosaic of various growth stages to support biodiversity via the environmental diversity of forest stands.

In addition to increasing the diversity of forest stands, respondents also mentioned their motivation to recreate the complex landscapes which used to be made up of a mosaic of various biotopes. Coppice forests were not only mosaics themselves but formed an important part of the more complex mosaic of the cultural landscape before the collectivisation of agriculture and the subsequent simplification of land use in rural areas during the communist era: "*At Zahrady pod Hájem there were coppices, that's how management worked. At the end of the village, there were gardens, small fields, meadows and a forest … So the villagers went to get apples, potatoes, hay and wood … All that was then abandoned because of collectivisation and the coppices became high forests. The point is to restore that landscape complexity, including the coppices*" (RP6). This historical image played an important part in the narrative of the motivation for the reintroduction of coppice management, which was seen as a desired part of the wider process of landscape recovery.

Raising public and professional awareness

The conservation motivation, built on the historical prevalence of coppicing in the Czech landscape, was also connected with the educational motivation. Because coppicing hardly exists in the Czech Republic nowadays, some managers see its reintroduction at their localities as a tool to inform and educate other foresters, students and the wider public. In some cases, this is based on their own research, such as in the privately owned forest Utinkův háj. According to its founder and proprietor, "*the original motivation [in Utinkův háj] has been research, because I wanted to somehow describe, publish and prove that [coppicing] is possible. … I did my PhD on the topic, I'm interested in this management type, and I still read about it. … I know that [in the Czech Republic] it's a marginal and suppressed topic also from the perspective of foresters, who, and I don't really know why, are convinced that coppicing is simply wrong. Even though it's not that wrong. I don't think it will redeem forestry as such, but in some stand types it's an option*" (RP2).

Managers of the Křivoklátsko forestry park, which is financed by the Forests of the Czech Republic (FCR),[3] expressed a similar motivation. In their case, the aim was not so much to convince than to demonstrate: "*The purpose of forestry parks is to show how classical forest management works. It's the opposite of national parks in some sense. Although forestry parks have no legal status, they are a sort of voluntary effort by foresters to demonstrate how they manage the forests*" (RP9). Because Křivoklátsko used to be a typical coppice area before the twentieth century, FCR chose to finance a project to reintroduce coppicing. Again, the historical legitimation served as the basis for the reintroduction of this geographically and symbolically marginalised type of forest management. The area now also serves as a place to demonstrate traditional coppicing to forestry students and other interested parties.

Preserving forest ecosystems in the context of climate change

For the past decade, there have been intense debates among scholars as well the lay public on the effects of global climate change on forests (Trumbore et al. 2015). Recent dry and hot periods appear to have influenced some of the coppice restoration sites discussed in this paper. While the

[3] Forests of the Czech Republic (in Czech, Lesy České republiky) is a state-owned company that manages 45.6% of the forests in the Czech Republic.

aforementioned inspiration by the mosaic of the pre-collectivisation landscape and educational purposes of coppicing reintroduction found their legitimisation in recovering the past, the climate change thread links coppicing management to the future: *"In those stands that are the most exposed to heat and drought … oaks of generative origin tend to dry out. In such stands, coppiced oaks survive better because … in coppice forests, for example, 40 individuals in the form of coppice stools share the water, but in high forests, you have, say, 150–160 mature individuals. And coppice stools are able to manage the water more effectively"* (RP4). According to RP4, the prevalence of coppices in the Mediterranean also attests to their resistance to heat and drought. This is why in ŠLP, restoring coppicing was thought to be the best solution to preserve forest ecosystems against the effects of climate change-related drought, especially in stands where natural generative growth does not occur and tree planting does not pay off.

In the hot and dry regions of southern Moravia and central Bohemia, climate change intensified droughts and aggravated already existing risks in even-aged forests. Coppicing is seen as a suitable management form outside extreme conditions as well: "*Oak tends not to regenerate after it falls down. So the stands break up and black locust appears. That was, in fact, one of the reasons why we started [coppice restoration]. Because we knew that if we don't start doing something now, stands will break up on a large scale and the biotope will decline*" (RP1).

Economic aspects

None of the coppice restoration sites discussed in the paper was established for direct financial benefits. When managers mentioned economic aspects at all, they considered them secondary. In some cases, their aim was to simply prove that coppicing can be economically viable, rather emphasising an educational motivation aiming to increase awareness among professionals.

One of the economic benefits of coppicing is the production of firewood, which, however, is seen as limited in the current circumstances: "*Nowadays, customers prefer quality firewood, which means firewood of a certain length and diameter that fits easily into fireplaces. Customers want such wood delivered straight home. That puts limits on production – we cannot expect the market to want so much wood as can be grown on thousands of hectares of coppices*" (RP4). However, according to others, the demand for firewood has been growing recently. Furthermore, coppice firewood represents a distinctive quality: "[it is] *an exclusive product even now when we have so much wood from salvage fellings that we don't even know what to do with. But spruce wood from salvage fellings is simply not as good for heating as oak or hornbeam firewood*" (RP9).

According to most managers, coppices could be economically viable above all for small woodland owners who own a few hectares of woodland, live in the countryside and could provide their own firewood through this traditional management option. RP2 is convinced such people should be the target group of restoration efforts in the future: "*Now it's mostly nature protection, but I think that [coppicing] should be promoted mainly for production. Because I can dramatically lower management costs, and I can also establish a sustainable system relatively easily. … From the perspective of forest management results, this should be more beneficial than high forests, which can generate enormous gains from small areas in certain periods and then nothing for decades*" (RP2). In contrast, in coppices, even small woodland owners can harvest a few acres every year and do not have to wait extended periods for economic profitability.

Problems and obstacles

Besides their motivations for coppicing, managers also informed us about obstacles and problems they have encountered in the process of coppice reintroduction at the sites they manage in the Czech Republic. We identified five main types: legal framework, legitimacy of reintroduction, lack of workforce, biotic factors and abiotic factors.

Legal framework, administrative processes

Practically all localities (except for Křivoklátsko and Bílé Karpaty I) discussed in this study are categorised as "forests for special purposes", for which it was relatively easy to obtain an exception from the forest law, a necessary precondition to start coppicing. That is why none of the managers mentioned legislation as the main obstacle. In addition, the forest law has been recently amended to make coppicing easier, which was assessed positively by research participants: "*Now [the forest law] is prepared in a way that if the owner wants [coppicing], there aren't many legislative obstacles. It is more about negotiating with the state authorities, setting up some conditions and mutual respect. There is no ban. [Coppicing] is now very accessible, and it is up to the manager or the owner if they want it or not. If they think it makes sense or not*" (RP9). But this unproblematic view was not unequivocal, and according to others, it is still virtually impossible to start coppicing: "*Because it is a forest, you simply cannot start [coppicing]. There would really have to be a project for it, and the state authorities would need to authorise it. Which I think is very complicated*" (RP6). That is why in the Bílé Karpaty PLA, the managers chose to establish coppice forests in the area that is officially non-forest ground.

Related bureaucratic processes and often complicated structures of legal responsibilities at the localities were

among the problems most often mentioned by the research participants. In most of the problematic cases, the organisation responsible for coppice reintroduction either does not own the property or is not responsible for forest management, both of which lead to reduced capacities for action. This situation causes major problems, for example, in the Pálava PLA, where FCR is responsible for forest management. The complicated administrative framework is often linked to the conflicting agendas of various actors: "*We had to go through all the legal procedures. Nonetheless, the forest law says that the request for the exception [from the forest law] must be handed in by the manager of the forest appointed by the state, and that's again not us, or by the owner of the property*" (RP1). According to our research participant, forest workers employed by FCR often simply ignore instructions by the Pálava PLA. In some areas, the fear of complicated negotiations over ownership resulted in the substantial postponement of planned coppice reintroduction, such as in the Podyjí National Park. Managers at this locality decided to wait for more than a decade until the areas planned for re-coppicing were transferred from the city of Znojmo to state ownership. Ownership structures have complicated the reintroduction of coppicing also in the LIFE project in the Bílé Karpaty PLA, even though the managers tried to utilise privately owned land. Properties in the Bílé Karpaty PLA are typically small and discontiguous with many different owners, some of which are not easy to find. Even when available, small owners do not view coppicing as a preferable management type. In order to produce functioning coppices, the PLA wanted to find a larger contiguous area, which they have not managed so far, and coppicing is thus practised on small areas only.

Legitimacy of coppice reintroduction

While many participants expressed their concerns about the complicated ownership structures, reintroducing coppicing on state-owned land did not result in a non-problematic process, either. The differing legitimizations of protected areas and competing views on the role and purpose of such areas came to the fore, highlighting the importance of establishing professional relationships and effective communication on the level of local actors. One of our participants commented on the beginning of the reintroduction process as follows: "*As a start, we had to convince [FCR] to carry out such management at all, which for them probably seems pointless. … So we had to convince [FCR] to hand in the request. And because they don't really agree with the whole thing, it was quite demanding*" (RP1). The educational approach, mentioned above, accompanied by the long-term relationship with the major actors involved, also played an important role in the Český kras PLA. The PLA aimed at reintroducing coppices partly on state-owned land where FCR is responsible for forest management. The planning phase was long, and the original standpoint of FCR was rather conservative, claiming that nature protection in a national nature reserve should aim at non-intervention: "*We have enlightened state forest management here. We've been cooperating with them for a long time, and we even do forest grazing. … We couldn't do [coppicing] without them, and we're glad they were willing to go along*" (RP3). FCR appears to be the key actor: it is essential for the successful reintroduction of coppicing, but it also often represents a more conservative approach towards forest management.

In two cases, problems also emerged with the public viewing coppice cuts negatively. In Pálava, people from the general public often called the PLA, asking how it was possible that trees were harvested in a national nature reserve. At the ŠLP location in Lesná, mainly the inhabitants of Brno-Lesná were dissatisfied with the management, which contradicted the contemporary public image of a forest: "*Once the public is used to relatively uncluttered and pretty high forests, and we harvest those, and then it regenerates into a dark jungle, that makes a bad impression on the public*" (RP5). This conflict caused enormous problems for the entire institution as well as for Mendel University. The managers tried to explain their agenda on information plates, and there were even public presentations at ŠLP Křtiny about coppice management. Both conflicts settled down after a while when the public got somewhat used to coppice woods.

Lack of workforce

Lack of workforce to carry out coppicing was mentioned as a side issue. In the Podyjí National Park, this led to missing some of the deadlines for harvest, clearing out the wood or setting up the fences. "*The first year, it happened that we fenced off the fresh cuts awfully late, when the shoots were already growing, and they were very much eaten by the animals. In the end, things worked out, but it showed us that we need to organise all steps of the coppicing process systematically*" (RP10). In the Bílé Karpaty PLA, the general depopulation of the region causes problems for coppice management as well. In the past years, many contractors that normally work in the area have taken up more lucrative jobs in the Vysočina region, where large forest areas destroyed by a bark-beetle outbreak needed to be harvested on short notice. In general, according to our participants, there are simply too few people working in agriculture.

Biotic factors

In addition to legal, administrative and symbolic obstacles to coppice reintroduction, invasive and expansive plants pose varying levels of threats at the localities. In the Pálava PLA, they are seen as a potential problem after stands are cut,

but at the Podyjí National Park and, to a lesser degree, in the Bílé Karpaty PLA, they are already a significant issue. At Zahrady pod Hájem, where there are fewer coppice stools, wood small-reed (*Calamagrostis epigejos*) and thistle (mostly *Carduus* spp., *Cirsium* spp.) invade from neighbouring forests. "*Those invasives are starting to suppress the herb layer, which came up amazingly strong in the first and second years … We're trying to eliminate them mainly by pulling them out, at least the thistles. For wood small-reed, we should use chemicals, which we don't want. But we're expecting the herb layer to evolve and eventually to suppress the small-reed*" (RP6).

At the Podyjí National Park, invasive trees cause major problems. "*Black locust and tree of heaven [Ailanthus altissima] appeared basically on all the plots where we had started to reintroduce coppicing. These invasive species thrive through the disturbances caused by harvests and the subsequent removal of wood. That's a risk of this management that you support not only the beneficial species but also the invasive ones, and you have to account for these in the management*" (RP10). Based on previous experiences, managers apply herbicides straight to the trunks of these trees in order to eliminate them. In addition to invasive trees, many species of ruderal herbs also appeared at the coppice sites. However, the hope is that these will disappear through natural succession.

A significant problem is also represented by game numbers, in particular the number of mouflons in the Český kras PLA and roe deer at the other localities. Young shoots are regularly eaten by these animals; therefore, the managers try to fence off newly cut areas. The situation is similar at Křivoklátsko. However, the problem with game is not specific to coppices. In fact, forests of generative origin are even more at risk: "*The advantage of coppice shoots is that there's a great many of them and they have the roots of the shoots, so they're very vital. When animals eat them, they grow back again, sometimes even stronger than seedlings*" (RP5). This, however, appears to work better for larger plots, whereas for smaller plots, fencing is necessary.

Abiotic factors

From among abiotic factors, drought has caused the most significant problems in coppice reintroduction. In Utinkův háj, the dry years of 2018 and 2019 eventually led to the abandonment of the original plan to create a coppice-with-standards, instead of which the locality will probably be managed as a simple coppice. The oaks chosen as standards were slowly drying out and therefore had to be cut down in order to preserve their ability to coppice. In contrast, in the Český kras PLA, there occurred problems with stools rather than standards. During the drought of 2015–2016, many coppice shoots dried out. However, the area affected was relatively small, and the managers believe this will not influence the overall results of coppice reintroduction at the locality.

Discussion

Coppice reintroduction in the Czech Republic is a bottom–up process, although often within an institutional framework. It is advanced by the efforts of dedicated forestry or biology experts, who often become site managers. Exploring the motivations and experiences of these managers and mapping the obstacles they have encountered is therefore a key research task, which can be best approached by the qualitative design we chose. However, we are aware that qualitative research design with purposive sampling and inductive data analysis have limitations. We presented only a part of the complex issue of coppice reintroduction and emphasize that other stakeholders, such as land owners, experts from state forest institutions, or other conservationists might have a different perception of the process. Our research focused on the perspective of those experts actively involved in coppicing reintroduction and must be read as such.

Pan-European research identified three main reasons behind the recent increased interest in coppice forests: (1) their role as a renewable energy source, (2) their usefulness in biodiversity protection and resilience to biotic and abiotic disturbance factors, and (3) their potential as a source of rural employment (Unrau et al. 2018, see also Wolfslehner et al. 2009).

Our results were similar to these as regards biodiversity. The reason behind this is probably the fact that most of our research participants were involved in nature protection. However, while there is a general consensus that coppicing is beneficial for biodiversity (Müllerová et al. 2015; Kirby et al. 2017; Buckley 2020; Kamp 2022), our research participants had differing opinions about the resilience of coppices to climate change. Some argued that coppice stools, with their well-developed root systems, can withstand higher temperatures and drought better than tall trees of generative origin in high forests (cf. Stojanović et al. 2017), others observed the drying out of standards or even coppice stools at their sites. This apparent contradiction probably stems from a combination of extreme site conditions (shallow, desiccation-prone soils), unexpected extreme climatic events (summer droughts) and management decisions (opening up the canopy and leaving standard trees unadapted to the conditions) at both Utinkův háj and Český kras. In other localities with deeper soils, such as Pálava or Bílé Karpaty, no major drought damage to trees is evident. Oak species, often used by foresters both as coppice resprouts and standards, are highly plastic in terms of water household and especially in relation to drought. It appears that regeneration

through coppicing may indeed be an appropriate strategy to counteract the increasingly drier conditions of the Czech Republic (Matoušková et al. 2022; Řehořková et al. 2022). However, the assumption that coppicing will compensate for the effects of climate change may eventually fail, as tree species face their physiological limits (e.g. Tognetti et al. 1998). Furthermore, vegetative regeneration does not allow for natural evolution towards more resilient tree genotypes, therefore genetic lineages adapted to milder climates may not be able to survive future climate extremes.

Our research participants were well-aware of the dangers posed by invasive plant species in recoppiced forests. This is a general problem at all of our research localities. In particular, black locust (*Robinia pseudoacacia*) has become invasive in Europe (Vítková et al. 2017), although evidence for it being promoted by coppicing is relatively scarce (e.g. Radtke et al. 2013). The spread of black locust and also of tree of heaven (*Ailanthus altissima*) is being actively prevented in the restored coppices in Podyjí National Park, and it may soon be necessary elsewhere, e.g. in Pálava PLA. On the other hand, the eradication of native weeds, for example mowing thistles (*Carduus*, *Cirsium* and other related taxa) by the managers in Bílé Karpaty, seems quite unnecessary and even harmful to biodiversity (e.g. Swanson et al. 2011). These plants form an early stage of succession in clearings before forest plant communities spontaneously recover. During the first two to three years after clearing, endangered annual species that have already lost their suitable habitats in the surrounding agricultural landscape also appear (Vild et al. 2013; Hédl et al. 2017).

As for the other two factors identified by Unrau et al. (2018), coppicing has so far not been considered as a source of rural employment in the Czech Republic. Quite the contrary, workforce (or, to be more precise, lack thereof) was mentioned as an obstacle for coppice reintroduction by our research participants. This may be connected to local population decline (as argued for Bílé Karpaty) or perhaps to a lack of interest among locals in manual forestry work. In the twentieth century, the diversification of rural regions in the process of rural transition (Pospěch 2014) manifested itself in varying degrees of depopulation impact, levels of industrialisation and job opportunities as well as diversified transportation and connectivity enabling people to commute for work. In general, after 1989 there was a tremendous outflow of workforce from agriculture and forestry and a rapid shrinkage of agricultural production. As the unemployment level in the country is low (between 2 and 3% in 2021 through 2023: Český statistický úřad 2021) and work in forestry is among those with the lowest wages, the field is currently not attractive for local workers. Depopulation is especially significant in peripheral regions (Vaishar et al. 2020), which, at the same time, often include protected areas with potential coppice reintroduction sites.

Coppicing as a source of renewable energy has so far played a minor role in the reintroduction of this management type in the Czech Republic. This is in stark contrast with international scientific literature, which devoted considerable attention to this topic. The circumstances in some of these studies clearly differed from ours in that they examined functioning coppice systems rather than reintroduction efforts (Spinelli et al. 2014, 2016; Schweier et al. 2015). However, other papers addressed the potential of coppice products (Suchomel et al. 2012; Jansen & Kuiper 2004) in situations not unlike that in the Czech Republic. A recently published paper by Mejstřík et al. (2022) investigated biomass production at one of our coppice reintroduction localities, pointing out that the yield from resprouts depends on the density of standards. The type of response differs among the tree species: oak and hornbeam respond negatively, while lime and field maple remain unaffected. Regarding the biomass from resprouts, the economic function of coppices probably cannot include anything else than fuelwood. If woody resprouts are left to grow for longer than 20–30 years, the resulting logs require significant labour to cut and split. Producing construction timber using conventional methods is more profitable. Nevertheless, economic issues may play a stronger role in coppice reintroduction in the future than they do at present.

Only a few studies addressed the opinions of those directly involved in coppicing (continuously active or reintroduced). Bartlett (2016) completed questionnaires with 204 coppice workers active in south-east England. In this region, coppicing remained alive all through the twentieth century, therefore the research participants were not reintroducing it but depended on it for their livelihoods. The SWOT analysis resulting from the questionnaires in Bartlett (2016) showed that the main threats to coppicing here were insurance and housing costs, personal health and injury, competition from other workers and imports, lack of workforce, and legislation and bureaucracy. Because these research participants were manual workers, their answers reflect particular concerns that only partly overlap with our results. Notably, workforce and legislation were deemed problematic in both samples. On the other hand, biodiversity, the leading motivation for our participants, apparently played no role for English managers, even though it was part of the governmental agenda to promote coppicing (Bartlett 2016). At the same time, English coppice workers mentioned educational goals even though more in the context of bringing awareness to local products than promoting cultural heritage as at our localities. On the level of individuals, those identified as the 'new tradition' (educated middle-class individuals taking up coppicing-related crafts) in Collins (2004) are closer to our participants. These workers entered coppicing from partly romantic reasons connected to living and working in the countryside.

In another paper, Bartlett et al. (2018) studied barriers to the development of small-scale coppice management in Europe. Their participants included academics as well as practitioners; the main obstacles observed tended to focus on economic issues. The related issue of energy wood production was investigated through surveys among 232 owners of small private forests (mainly coppices) in Croatia and Serbia. Participants showed a positive motivation vis-à-vis the creation of new jobs and commercial opportunities. Again, this is in contrast with our results, which showed that research participants did not consider economic issues as overly important.

Conclusions

Coppicing in the Czech Republic is being reintroduced at a handful of localities. The key role in the bottom-up process is played by local site managers that are mainly motivated by nature conservation. The perceived obstacles are of a practical nature (administrative barriers, complicated ownership and responsibility structures, lack of workforce). This signifies a situation in which coppicing may remain a small-scale activity in protected areas dependent on the initiative of site managers and irrespective of larger socioeconomic considerations. However, general European trends indicate that coppicing can gain more ground if it is accepted as a viable economic alternative to high forests, mainly for small woodland owners. Our research participants were also aware of this issue, but, with few exceptions, they did not consider it too relevant for themselves. In any case, economic motivation appears to be important in countries or regions where coppicing is still an active management form. In western and north-western Europe, in this sense including the Czech Republic, a major challenge for future policies will be to utilise the economic experiences of regions with active coppicing to foster the spread of coppice woods in order to combine renewable energy production with biodiversity conservation.

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Declarations

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