



# Small-scale private forest owners and the European Natura 2000 conservation network: perceived ecosystem services, management practices, and nature conservation attitudes

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## Abstract

The systematic designation of protected areas is a key strategy in modern biodiversity conservation. As for now, the Natura 2000 system of the European Union (EU) is the largest coordinated network of conservation areas worldwide. Since this scheme has a focus on forests, its effectiveness substantially depends on small-scale private forest owners who represent the largest forest ownership group in Europe. We conducted a quantitative survey ( $n = 1671$ ) in Northwest Germany focusing on the perceived importance of ecosystem services, the performance of management practices, nature conservation attitudes, as well as stand characteristics of small-scale private forest owners with and without Natura 2000 sites. Forest owners perceived regulating and cultural services as more important than provisioning ecosystem services while having a multifunctional perspective on their forest. Owners with Natura 2000 sites had a stronger focus on resource use and, with the exception of habitat-tree protection, did not perform conservation measures more frequently than those without. Moreover, we found more negative nature conservation attitudes among this ownership group. In conclusion, the Natura 2000 scheme needs to be more strongly adapted to the demands of small-scale private forest owners, for example by increasing profound participation and establishing a results-based incentive scheme for conservation measures. The perspectives of small-scale private forest owners have to be considered comprehensively to ensure the effective and sustainable implementation of the Natura 2000 conservation network.

**Keywords** Forest ownership · Nature conservation · Small-scale forestry · Quantitative survey · Sustainable forest management · Stakeholder participation

## Introduction

The systematic establishment of protected areas is a key strategy not only to conserve biodiversity (Branquart et al. 2008; Adams et al. 2018), but also to benefit human

well-being (Bonet-García et al. 2015), strengthen local economies, and adapt to or mitigate climate change (Watson et al. 2014). Currently, 14.9% of the earth's terrestrial area is protected by different kinds of conservation areas (UNEP-WCMC et al. 2018). The zero draft of the Convention on Biological Diversity demands a coverage of 30% of the planet by 2030 (CBD Secretariat 2020), while the Half-Earth approach even advocates for a share of up to 50% (Dinerstein et al. 2017). At present, the Natura 2000 system of the European Union (EU) is the largest coordinated network of conservation areas worldwide, covering 18% of EU countries' land surface (European Union 2020). With the establishment of the Natura 2000 network since 1992, the EU aims to conserve the natural habitats of Europe's unique flora and fauna. At the same time, it strives to consider the economic, social, and cultural conditions, as well as the local contexts in the framework of sustainable development (European Commission 1992). With its focus on multiple

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objectives, many insights and practical knowledge gained from this conservation scheme can probably be transferred to the future development of a global protected area network (Campagnaro et al. 2019).

Forests cover 40% of the EU's land area and contribute considerably to both biodiversity conservation and human well-being (European Commission 2013). In the EU in general (European Commission 2015) as well as in Germany (Beinlich and Hill 2010), half of the area protected within the Natura 2000 system is woodlands. While Natura 2000 has a spatial focus on forest ecosystems, the network has not always effectively contributed to forest biodiversity conservation. For instance, a comparison of actively managed sites inside and outside of Natura 2000 areas revealed no difference regarding the occurrence of forest-dwelling bats and their habitat conditions (Zehetmair et al. 2015). Similarly, wooded Natura 2000 sites did not show a higher diversity of microhabitats, increased deadwood volumes, or distinct differences in tree morphology than unprotected forests (Zharov 2015). This has been attributed to the relatively short span of several years since the local implementation of Natura 2000, as most ecological parameters will improve only over long time spans (Zehetmair et al. 2015; Zharov 2015). However, political, administrative, and practical implementation problems, as well as local conflicts may also contribute to this pattern. Conflicts can arise when forest owners perceive Natura 2000 as an imposed policy that contradicts their personal focus on sustainable management practices and forest health (Ferranti et al. 2017). Further, forest owners feel that the restrictions and income losses they have to bear are not considered enough (Meyer 2013). As a consequence, many forest owners perceive the acceptability and legitimacy of Natura 2000 as low, especially in regions where the scheme was implemented top-down (Weiss et al. 2017), without the involvement of local stakeholders (Engelen et al. 2008). In an extreme case, local opposition to the implementation of Natura 2000 resulted in a hunger strike of forest owners in Finland. Cases of cutting timber resources before a site was declared as protected have even been reported (Hiedanpää 2002). Furthermore, an analysis of the effects of Natura 2000 forest management plans in Germany indicates that they hardly influence forest management practices, as they are unknown or considered unimportant by local forest managers (Winter et al. 2014). Deepened knowledge about the spatial, socio-economic, and ecological dimensions is crucially important to anticipate, monitor, and resolve conflicts around Natura 2000 (Iojă et al. 2016).

Against the combined background of the implementation challenges of Natura 2000, the long-term development timeframe of forest ecosystems (Flensted et al. 2016; Janssen et al. 2017), and the requirement of some habitats for active conservation measures (Dolek et al. 2018; Mölder et al. 2019; Buckley 2020), there is a great need to examine the

objectives, management activities, and perceptions of forest owners. Private forest owners are particularly important in this context, and among them, the owners of small-scale private forests are very widespread. A comparison among the member states of the United Nations Economic Commission for Europe (UNECE) revealed that 56% of the forest area is privately owned (excluding North America and Russia) with 88% of private forest parcels being smaller than ten hectare (UNECE and FAO 2020). In Germany for example, private forest owners represent the largest ownership group (BMEL 2015), but their forest properties are quite small with an average size of 12 ha (Feil et al. 2018). Thereby, private forest owners form a heterogeneous group (Richnau et al. 2013; Tiebel et al. 2021) across Europe (Feliciano et al. 2017; Weiss et al. 2019). The number of private forest owners is increasing across Europe (Schmithüsen and Hirsch 2010), the USA (Zhang et al. 2008), within the UNECE-region (UNECE and FAO 2020), and even globally (Whiteman et al. 2015). Thus, private forest owners are important stakeholders to consider when designing conservation schemes such as the Natura 2000 network.

The effectiveness of Natura 2000 implementation within forests has been rarely investigated thus far (Rosenkranz et al. 2014; Weiss et al. 2017). While some economic consequences have been examined (Wippel et al. 2013), social sciences studies are largely missing (Blicharska et al. 2016). Only a small number of studies focused on the local management of Natura 2000 sites (Winter et al. 2014; Weiss et al. 2017), even though place-specific analysis and a consideration of local perceptions is considered important in landscape management (Fagerholm et al. 2020). Thus, research on small-scale private forest owners and the consequences and effectiveness of Natura 2000 implementation has been scant. However, research in this realm is important as social factors (Mascia et al. 2003), forest owners' perceptions (Joa and Schraml 2020), and the consideration of multiple knowledge types (Paloniemi et al. 2018) are strongly linked with the success of nature conservation schemes.

Our study aims to fill some of these knowledge gaps by comparing perceptions of ecosystem services, management practices, nature conservation attitudes, as well as forest stand characteristics of small-scale forest owners in North-west Germany with and without forests that are included in the Natura 2000 network. Given this background, we address three main research questions:

- How do small-scale private forest owners perceive the importance of ecosystem services and what are the characteristics of their forest management practices?
- How do the perceptions of ecosystem services, stand characteristics, management practices, as well as nature conservation attitudes differ between small-scale private forest owners with and without Natura 2000 sites?

- How can the ongoing implementation of nature conservation practices, and thus the effectiveness of the Natura 2000 scheme, be improved?

## Methods

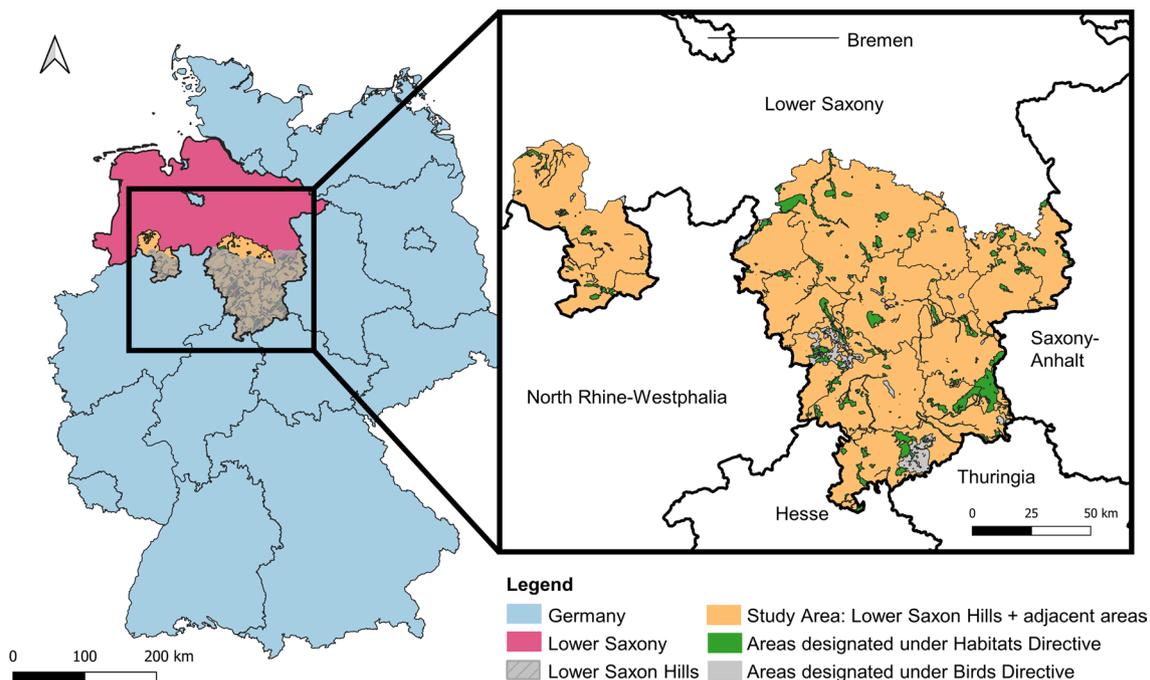
We conducted a quantitative survey among small-scale private forest owners in Northwest Germany. Focusing on a local to regional scale is a common approach within the field of forest owner research (Hiedanpää 2002; Bieling 2004; Joa and Schraml 2020; Tiebel et al. 2021) as it enables to gain in-depth insights while paying attention to the regional context. Even though such a focus may limit generalizations, detailed information about the studies' context (Polit and Beck 2010), and discussing insights of relatable studies (Lund 2014) allow readers to assess the case-to-case transferability of the findings (Maxwell and Chmiel 2014).

## Study area

We conducted a quantitative survey in the German federal state Lower Saxony (Fig. 1), more specifically in the Lower Saxon Hills (11,725 km<sup>2</sup>) and adjacent areas (2503 km<sup>2</sup>). While the Lower Saxon Hills is a forest landscape unit, adjacent areas were included since they complete the counties

where the forest holdings of our recipients are located. The study area was chosen given that it encompasses a relatively large area with a uniform legal situation which is especially important in the context of Natura 2000 as this scheme is implemented by each individual German federal state. Furthermore, the consistent governmental forest administration within this area prevents regional differences in the support, consultation, and treatment of small-scale private forest owners. While paying attention to the local context, the forest ownership mosaic as well as the small-scale structural diversity of our study area is comparable to many European countries (Schmithüsen and Hirsch 2010; Mölder et al. 2021) and enables a transferability of the findings.

The numbers presented in the following refer to the Lower Saxon Hills, as no specific data are available for the adjacent areas. The woodland coverage of the Lower Saxon Hills amounts to 33%. The dominant tree species are European Beech (*Fagus sylvatica*; 35%), Norway spruce (*Picea abies*; 29%), and oaks (*Quercus sp.*; 11%). Forty-three percent of the forests in the Lower Saxon Hills are privately owned. As in the whole of Lower Saxony, 45% of the private forest owners possess small-scale forest holdings with a size of less than 20 ha, and among these, 23% are smaller than 5 ha (ML Niedersachsen 2014). This fragmented forest structure can be traced back to the eighteenth and nineteenth centuries when common woodlands were partitioned and privatized



**Fig. 1** Left: the study area in the context of Germany and Lower Saxony. Right: Natura 2000 sites in the study area, separated into sites designated under the Birds and the Habitats Directive. Geodata: Germany and federal states: GeoBasis-DE and BKG (2021); administra-

tive borders of the study area: LGLN (2021); Natura 2000: NLWKN (2021); Lower Saxon Hills: Gauer (2005), slightly modified according to ML Niedersachsen (2014)

(Brakensiek 1994; Mölder 2016). Hence, ancient woodland sites with long ecological continuity are widespread in the private forests of the Lower Saxon Hills (Glaser and Hauke 2004). Mainly due to the low economic importance of small private forest parcels, as well as the individualism of the forest owners, structural relicts of historical forest management techniques such as coppicing have persisted until today and provide valuable wildlife habitats (Mölder 2016). In addition to their ecological value, the forests in the study area are generally important for wood production. In Lower Saxony, relatively large wood volumes are harvested in the private forests of the Lower Saxon Hills [7.5 m<sup>3</sup> of harvested wood volume per year and ha on average, as compared to 5.6 m<sup>3</sup> across all ownership classes in Lower Saxony]. Small-scale private forests, however, contribute only little to these utilization rates, with a harvested wood volume of 3.4 m<sup>3</sup> per year and ha (ML Niedersachsen 2014). Our study area was affected by severe storms in 2018 (Rohde et al. 2019) as well as by drought and a large-scale bark beetle infestation in conifer forests between 2018 and 2020 (Rohde et al. 2020a, b).

### Natura 2000 in Lower Saxony

The Natura 2000 conservation scheme of the European Union (EU) consists of the Birds Directive, formulated in 1979, and the Habitats Directive that was enacted in 1992. EU member states were asked to list suitable areas according to pre-defined guidelines which, afterwards, were to be legally secured (Evans 2012). This process was supposed to be completed in 2004 at the latest (European Commission 1992). Within Germany, 97% of the areas designated under the Habitats Directive have been legally secured (BfN 2019a), whereas the process of legally securing the areas designated under the Birds Directive is reported to be continued without stating a current number (status for both: end of 2018) (BfN 2019b).

Already in 2004, the European Union criticized the German federal state Lower Saxony for the low number of listed Natura 2000 areas (Saerbeck 2006). Currently, 91% of the areas designated under the Habitats Directive (status: 16 February 2021; MU Niedersachsen 2021) and 34% of the Birds Directive sites (status: 30 April 2019; MU Niedersachsen 2020) have been fully secured in line with EU regulations in Lower Saxony. In February 2021, the European Commission announced that it would file a lawsuit at the European Court of Justice due to Germany's poor implementation of the Habitats Directive (European Commission 2021). Two days earlier, the Lower Saxony Ministry of the Environment stated that it would legally secure all areas designated under the Habitats Directive until July 2021 (MU Niedersachsen 2021).

The Lower Saxon Hills have a Natura 2000 share of 9.9% [compared to the German average of 9.3% of the terrestrial areas (BfN 2019c)]. A relevant share of Natura 2000 sites is situated in small-scale private forests, as 21% of the forest owners in our survey reported having designated forest areas. With more than a fifth of our respondents holding Natura 2000 sites ( $n = 287$ ), we argue that we have a sufficient number to compare owners with and without Natura 2000 sites.

### Data collection

We conducted a mail survey among 4204 small-scale private forest owners organized in local forest owner associations. We use the term “small-scale” because respondents of our survey owned an average of 11.2 ha of woodland (median: 2.8 ha), divided into an average of 3.3 forest parcels per respondent (median: 2.0).

In the design and method of distributing our survey, we followed in large parts Dillman's Total Design Method (Dillman 1991). Our mail campaign included an illustrated cover, the survey in a booklet format, and a self-addressed, postage-paid envelope. The cover letter explained key information of informed consent such as the purpose and scope of the study, the voluntary participation, and the anonymity of responses as well as the possibility to answer online. The survey consisted of 26 questions organized in three subsections. The first section focused on the relation of the forest owners to their forest and included, for instance, the perceived importance of ecosystem services, the performance of forest management practices, and attitudes towards nature conservation. While the second part focused on framework conditions such as funding possibilities, individual challenges, and influencing factors, the third section included sociodemographic and forest stand-related questions. Additionally, information on data security was provided. A translated version of the survey can be found in the Online Resource 1. Prior to the distribution of the survey, the need for approval by an ethics committee was evaluated by answering a questionnaire via the University of Kassel. No appraisal was required.

In a pre-test, we sent the survey to 12 private forest owners, researchers, and forest officials and asked them for feedback. After implementing their suggestions, we sent the survey to all 4204 forest owners organized in three local forest owner associations between June and August 2020. To comply with the EU General Data Protection Regulation and to maximize data security, the addresses were provided as stickers by the three local forest owner associations, pasted on prepared envelopes in their offices, and left in their care until dispatch. After two weeks, we sent out a reminder/thank-you postcard to all owners. Prior and during the distribution of our survey, intensive public relations

work was carried out by sending press releases to regional newspapers in the study area. This resulted in eight published newspaper articles (print and online publication). In total, 1798 (42.8%) private forest owners returned the survey. Sixty-one (1.5%) envelopes were returned unanswered as the addresses were not correct, the person had died, had sold their forest, or did not feel able to answer, for example, due to high age or recent forest damages. Thirty-eight (0.9%) online responses were not included since none or only one set of questions was answered. Furthermore, institutional forest owners such as churches were excluded (0.7%). Thus, 1671 (39.8%) responses were usable for the analysis. The sample size differed for individual questions as not every forest owner answered every question.

## Data analysis

We performed data analysis in R (R Core Team 2020). Thereby, we utilized the packages *lsr* (Navarro 2015), *DescTools* (Signorell et al. 2020), *psych* (Revelle 2020), and *summarytools* (Comtois 2020) for data processing and analyses. R Markdown (RStudio Team 2020), QGIS (QGIS Development Team 2020), Microsoft Excel (Microsoft Corporation 2019a), and Microsoft PowerPoint (Microsoft Corporation 2019b) were used for visualizations.

Our data were not normally distributed or of homogeneous variance. Thus, nonparametric tests were used to assess the differences between ownership groups. The Mann–Whitney U test was used to assess the difference of means between independent nominal and dependent ordinal variables. This test can be applied when data are not normally distributed and originate from two independent samples. A p-value less or equal to 0.05 was considered statistically significant. Further, the effect size *r* was determined for all significant results. The Chi-square ( $\chi^2$ ) test according to Pearson was used to assess the relation between dichotomous nominally scaled variables by testing their statistical independence. For significant results, the effect size was calculated using the phi-coefficient and interpreted according to Cohen (1988).

## Results

### Perceived importance of ecosystem services and forest management practices applied

When being asked to rate the importance of ecosystem services as objectives of their forest management, the small-scale private forest owners considered the four regulating ecosystem services as most important. Long-term preservation of a stable forest stand was shared as an important aim by virtually all respondents (97%, Fig. 2), followed by the

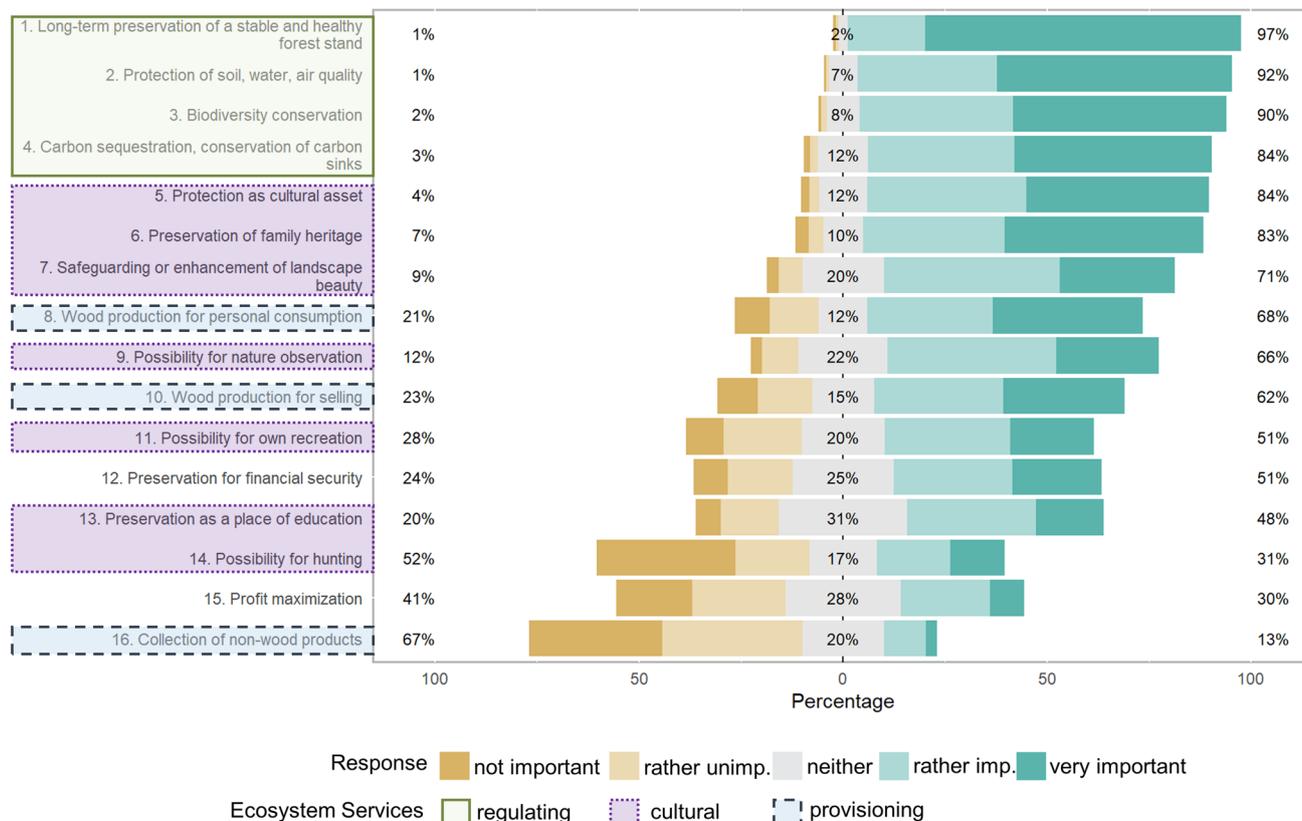
protection of soil, water, and air quality (92%). Biodiversity conservation was in third position, with 90% of the forest owners perceiving this service as important. The regulating services were followed by three cultural ecosystem services: forest protection as a cultural asset, preservation of family heritage, and safeguarding the landscape beauty. The most important provisioning ecosystem service, wood production for personal consumption, was found at eighth position with 68% of all small-scale private forest owners having perceived this as important. Wood production for selling was on tenth position with 62%. Two additional objectives, preservation for financial security and profit maximization, cannot be considered ecosystem services and are rated as important by 51% and 30% of the forest owners, respectively. The collection of non-wood products such as mushrooms, berries, and herbs was seen as least important.

Among the silvicultural practices applied, thinning was undertaken most commonly (86%). The usage of chemical pesticides (71%) and clear-cutting (65%) were predominantly avoided. Activities directly related to wood production were frequently carried out. Sixty-two percent of the owners stated that they sold wood and 48% harvested single mature trees. Conservation measures such as deadwood or habitat trees retention were slightly less central, with 45% of the owners performing these activities. While broad-leaved trees were promoted by 44% of owners, native tree species were more frequently planted or promoted (65%) than introduced species (33%) such as Douglas fir (*Pseudotsuga menziesii*) or northern red oak (*Quercus rubra*). Traditional forest management techniques, such as coppicing or coppicing with standards (12%), the use of logging horses (2%), and wood-pasture (1%), were only applied by a small minority of owners.

### Differences between small-scale forest owners with and without Natura 2000 sites

#### Perceived importance of ecosystem services

In general, the perceived importance of the different ecosystem services was not different between owners with and without Natura 2000 forest sites regarding most services (Fig. 3). However, private forest owners with Natura 2000 sites rated the provisioning ecosystem services wood production for personal consumption and for selling as more important than owners without Natura 2000 sites. Additionally, profit maximization, and the cultural services hunting, and preserving the forest for educational purposes were valued higher. Only wood production for personal consumption had an effect size of  $> 0.1$ , a low effect according to Cohen (1988).



**Fig. 2** Importance of ecosystem services among small-scale private forest owners. Percentages on the left: sum of response shares *not important* and *rather unimportant*; percentages on the right: sum of response shares *rather important* and *very important*

**Forest stand characteristics**

In general, forest owners with Natura 2000 sites possessed woodlands with a higher share of deciduous trees (Table 1). Forest parcels with an average deciduous tree share  $\leq 25\%$  were significantly less frequently owned by forest owners with Natura 2000 sites (effect size  $> 0.1$ ), while woodlands with a deciduous tree share of 51 to 75% were owned significantly more often by this ownership group (effect size: 0.08). As for the age structure, significantly fewer forest owners with Natura 2000 stands reported young average stand ages (effect size  $> 0.1$ ). In contrast, stands belonging to medium or mature age classes were more common within Natura 2000 sites.

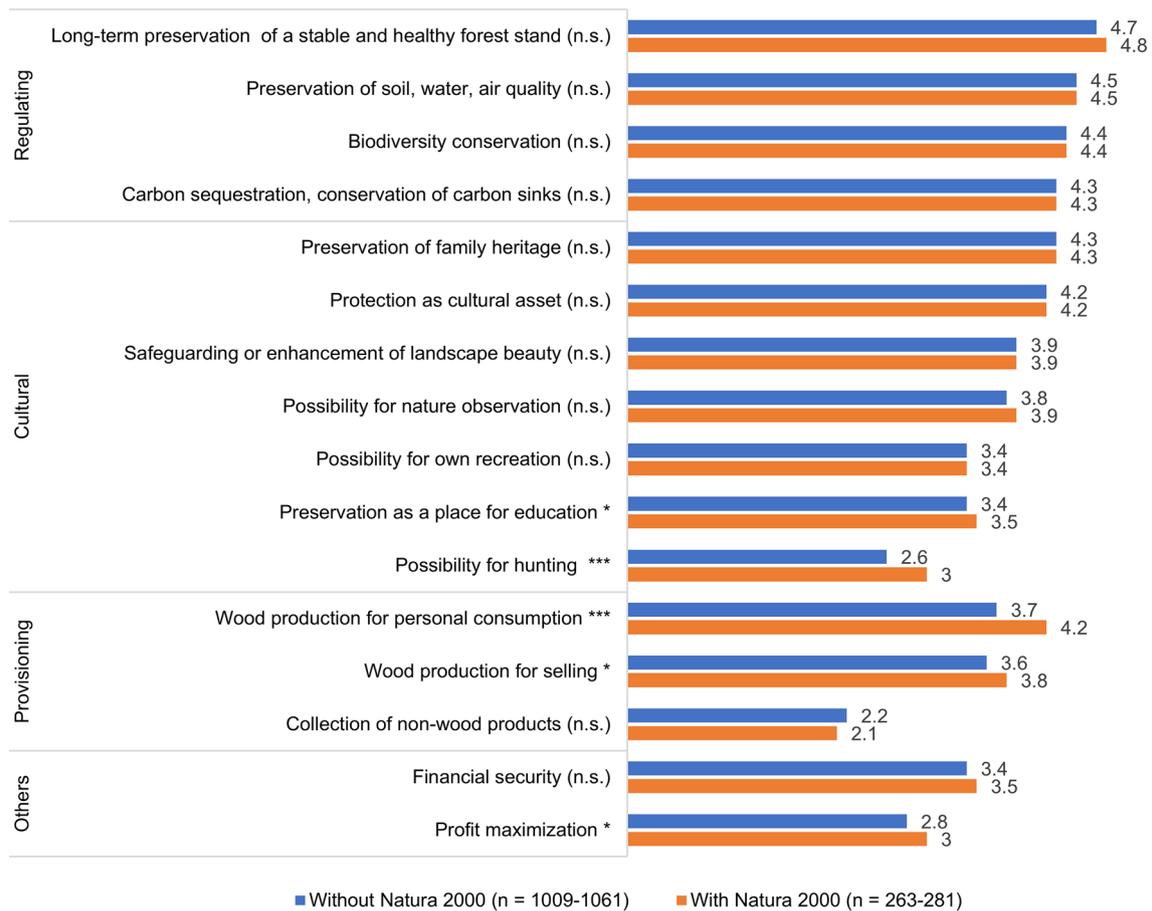
**Management practices applied**

We identified significant differences in forest management practices between small-scale private forest owners with and without Natura 2000 stands (Table 2). However, the implementation of conservation-specific activities did not differ much. In terms of silvicultural measures, a significantly higher number of small-scale private forest owners with

Natura 2000 stands performed thinning, protected young plants against browsing, promoted natural tree regeneration (effect size  $> 0.1$ ), and planted introduced tree species. The protection of habitat trees was the only conservation measure with a significantly higher frequency in this ownership group, but the effect size was below 0.1. As for wood production practices, harvesting single mature trees was significantly more common among forest owners with Natura 2000 sites (effect size  $> 0.1$ ).

**Attitudes towards nature conservation**

Attitudes towards nature conservation differed between small-scale private forest owners with and without Natura 2000 stands (Fig. 4). Owners with Natura 2000 sites showed a significantly higher agreement to statements that rated their management as well as their stand structures (effect size  $> 0.1$ ) as being close-to-nature. Out of all forest owners who possess woodlands designated as a protected area, forest owners with Natura 2000 sites perceived management restrictions as too strict more frequently than those without Natura 2000 stands (effect size  $> 0.3$ ). Regarding the implementation strategies of nature conservation in general, forest



**Fig. 3** Importance of ecosystem services among small-scale private forest owners with and without Natura 2000 sites (mean values of five-scale assessment: 1 (not important at all) to 5 (very important); \* ≤ 0.05, \*\* ≤ 0.01, \*\*\* ≤ 0.001, n.s. not significant)

**Table 1** Forest stand characteristics of parcels possessed by small-scale private forest owners with and without Natura 2000 sites (share of people marking a certain value)

Forest stand characteristics	Without Natura 2000 (n = 1029–1038)	With Natura 2000 (n = 278)	p (χ <sup>2</sup> )	Effect size (phi)
<b>Share of deciduous trees</b>				
≤ 25%	21.4	10.6	***	<b>0.12</b>
26–50%	17.3	18.8	n.s.	
51–75%	19.9	28.1	**	0.08
> 76%	42.0	42.9	n.s.	
<b>Age structure</b>				
< 40 y	26.2	13.5	***	<b>0.13</b>
40–100 y	66.9	78.4	***	<b>0.1</b>
> 100 y	8.7	8.9	n.s.	

\* ≤ 0.05; \*\* ≤ 0.01; \*\*\* ≤ 0.001, n.s. not significant

owners with Natura 2000 sites had a significantly stronger wish to be more involved. They also more frequently perceived personal freedom to be endangered and high costs as a consequence of nature conservation measures (all effect sizes > 0.1).

### Conservation policy instruments

The survey recipients were asked to rate the helpfulness of policy instruments in encouraging nature conservation practices. Only on-site consultation and financial incentives

**Table 2** Management practices by small-scale private forest owners with and without Natura 2000 sites (share [%] of people stating the performance of a certain measure)

Forestry measures performed	Without Natura 2000 ( <i>n</i> = 1084)	With Natura 2000 ( <i>n</i> = 286)	<i>p</i> ( $\chi^2$ )	Effect size ( $\phi$ )
<b>Silviculture</b>				
Thinning	87.5	92.3	*	0.06
Promotion of natural tree regeneration	57.6	73.4	***	<b>0.13</b>
Planting/promotion of native tree species	67.5	72.7	n.s.	
Avoidance of chemical pesticides	73.2	72.0	n.s.	
Avoiding clear-cuts	65.9	69.9	n.s.	
Protection of young plants against browsing	48.9	60.1	***	0.09
Reduction of damage due to logging	54.4	58.4	n.s.	
Promotion of broadleaf trees in coniferous forests	46.2	45.8	n.s.	
Planting/promotion of introduced tree species	33.9	43.7	**	0.08
<b>Forest conservation</b>				
Protection of habitat trees	46.7	54.9	*	0.07
Protection of dead wood	47.0	46.5	n.s.	
Protection/restoration of more open stand structures	23.7	27.3	n.s.	
Species protection measures	22.8	25.2	n.s.	
Removal of introduced species	22.5	24.1	n.s.	
Promotion of rare native tree and shrub species	18.0	19.9	n.s.	
Non-use of parts of the stand	16.3	19.2	n.s.	
Protection/maintenance of special structures (e.g. bizarre growth forms)	13.5	16.8	n.s.	
Coppicing/coppicing with standards	13.1	16.4	n.s.	
Promotion of a shrub layer	11.3	12.6	n.s.	
Renaturation of biotopes	5.5	6.6	n.s.	
Use of logging horses	1.8	3.5	n.s.	
Wood pasture	1.4	1.4	n.s.	
<b>Wood production</b>				
Timber sale	63.8	66.8	n.s.	
Harvest of single mature trees	49.4	65.7	***	<b>0.13</b>
Pruning	18.6	17.5	n.s.	
<b>No measures</b>				
None of the above	0.2	0.3	n.s.	

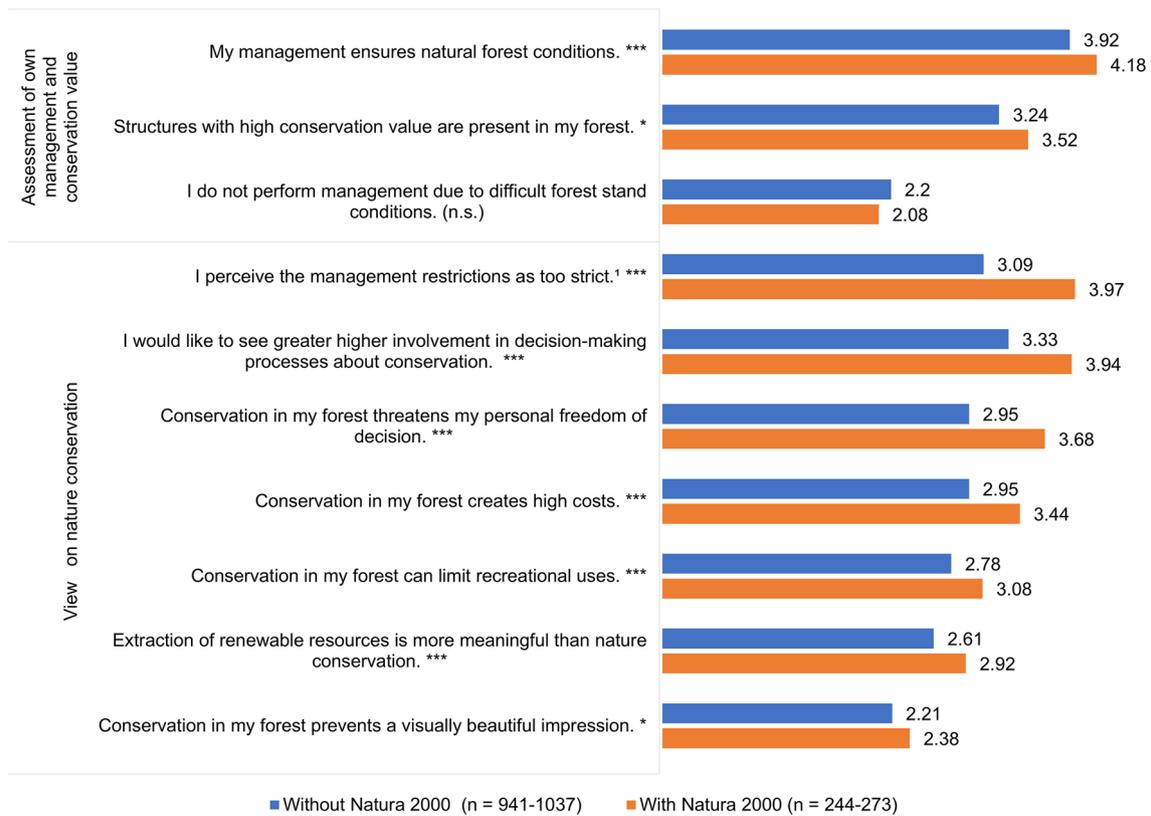
\*  $\leq 0.05$ ; \*\*  $\leq 0.01$ ; \*\*\*  $\leq 0.001$ ; n.s. not significant

were perceived as significantly more useful by private forest owners with Natura 2000 stands (Table 3, effect size 0.06, 0.1). Considering both ownership groups, these measures were rated the highest. Seventy percent of all small-scale private forest owners with Natura 2000 sites were unaware of the Lower Saxony compensation payment scheme, which is available under certain conditions for forest owners with Natura 2000 sites. Twenty-eight percent of Natura 2000 site owners knew of the support scheme but had not used it before; just 2% reported that they have used the financial support. Furthermore, all forest owners considered information about legal regulations, the possibility to exchange experiences, and visits to model forest stands with different management approaches to be useful. Written consultation and telephonic advice were rated the least helpful. Here,

the preferences did not differ based on ownership or non-ownership of Natura 2000 sites.

### Representativity of the survey sample

A comparison of our survey data with both a Germany-wide survey on private forest owners (Feil et al. 2018) and European data (Schmithüsen and Hirsch 2010) as well as a subsequent reasoning for the representativeness of our data can be found in the Online Resource 2. As a main result, it became obvious that rural-oriented, relatively old male respondents who own fragmented small-scale forest parcels prevail both among our respondents and across Europe. Therefore, we argue for a transferability of our results to regions with similar structures of private forest ownership.



**Fig. 4** Perceptions of nature conservation by small-scale private forest owners with and without Natura 2000 sites (mean values of five-scale assessment: 1 (completely disagree) to 5 (completely agree);

\* ≤ 0.05, \*\* ≤ 0.01, \*\*\* ≤ 0.001, *n.s.* not significant; <sup>1</sup>Only answers by people whose forest stands are located in a protected area with management restrictions (n = 312 + 261)

**Table 3** Helpfulness of policy instruments and knowledge/use of the Lower Saxony Natura 2000 compensation payment scheme among small-scale private forest owners with or without Natura 2000 sites (mean values of five-scale assessment: 1 (not helpful at all) to 5 (very helpful) and mean value [%] of people stating unknown, known, and used, *n.s.* not significant)

	Without Natura 2000 (n = 941–993)	With Natura 2000 (n = 247–270)	p (Mann–Whitney U)	Effect size (r)
<b>Helpfulness of policy instruments</b>				
On-site consultation	4.0	4.1	*	0.06
Financial incentives	3.9	4.1	***	<b>0.1</b>
Information about legal regulations	3.9	4.0	<i>n.s.</i>	
Possibility to exchange experiences	3.7	3.8	<i>n.s.</i>	
Visits to exemplary forest stands	3.7	3.7	<i>n.s.</i>	
Written consultation	3.1	3.0	<i>n.s.</i>	
Phone advice	2.8	3.0	<i>n.s.</i>	
	(n = 998–1089)	(n = 251–287)	(χ <sup>2</sup> )	(phi)
<b>Knowledge/use of Natura 2000 compensation payment</b>				
Unknown	79.3	70.1	**	0.09
Known but not used	19.5	27.9	**	0.08
Used	1.0	1.7	<i>n.s.</i>	

## Discussion

This study sets out to investigate the perceived importance of ecosystem services, management practices, and attitudes towards nature conservation among small-scale private forest owners in Northwest Germany. The surveyed small-scale private forest owners had a multifunctional perspective on their forest and considered both regulating and cultural ecosystem services to be particularly important. The most frequently applied forestry practices, however, were related to silvicultural or wood production activities. The comparison of owners with and without Natura 2000 stands revealed that wood production-related objectives and activities were more central to owners with Natura 2000 sites. Furthermore, they had a rather negative perspective on nature conservation. On-site consultation and financial incentives were rated as most useful by both ownership groups.

### Perceived importance of ecosystem services and forest management practices applied

Our results showed that small-scale private forest owners strongly considered a diverse range of ecosystem services as important. Thereby, all regulating and three cultural ecosystem services were assessed as more important than provisioning services. Similarly, in England (Urquhart and Courtney 2011), Denmark (Boon et al. 2004), and across Europe in general (Wiersum et al. 2005), private forest owners perceived biodiversity, landscape aesthetics, resource protection, and recreation as more important than resource use or financial aspects. Spatial differentiation demonstrated that small-scale forest owners from Western Europe were more ecosystem-oriented, while owners from Eastern Europe deemed economic aspects and forest maintenance more relevant (Feliciano et al. 2017). However, the general trend and change of objectives away from the traditional focus on resource use (Wiersum et al. 2005; Weiss et al. 2019) is attributed to ownership transfers (Ingemarson et al. 2006), fragmentation (Haynes 2002), a decreasing share of residential owners (Haugen et al. 2016; Oono et al. 2020), and an increasing interest in natural and cultural values (Hugosson and Ingemarson 2004). Despite this growing focus on regulating and cultural ecosystem services, the provisioning services are still perceived as important by many forest owners within our study area. Similarly, timber production is considered important among resident private forest owners in Sweden (Nordlund and Westin 2011) and private forest owners in Croatia (Curman et al. 2016), while a majority of private forest owners were willing to perform thinning for energy wood in Finland (Mynttinen et al. 2014).

Within this context, we found a large concordance between the perceived importance of wood production for

both personal consumption and selling, and the reported management activity of selling wood. Notwithstanding the perceived high importance of regulating ecosystem services, management practices that actively contribute to the regulating ecosystem service of biodiversity conservation were less frequently applied. The tendency to perform standard forest management despite different objectives was also found in Finland, where private forest owners, differentiated by five diverging discourses, showed a great consistency to perform the widespread traditional approach to Finnish forest management, even-aged management with clear-cuts (Takala et al. 2019). However, in Southwest Germany, perceived positive conservation impacts increased the likelihood of conservation measures to be implemented by private forest owners (Joa and Schraml 2020).

The difference between the high valuation of biodiversity conservation and the smaller share of conducting such forestry practices among the small-scale private forest owners of our survey is attributable to different circumstances. Often, small-scale private forest owners perceive their forest management as being close to nature (Takala et al. 2019) and assess their influence on forest stand characteristics such as species composition as low (Bieling 2004). An influence of the former “wake theory” could be assumed. This approach suggested that forestry focusing on wood production fulfils all other ecosystem services automatically in the wake (Peters and Schraml 2015). Further, high personal costs are associated with a promotion of ecosystem services that are of common interest (Kline et al. 2000). Additionally, many private forest owners rely on or ask for recommendations of professionals such as the local forester (Hujala et al. 2007). The attitudes between private forest owners and forest officers may differ, however, as reported from Sweden, where the latter emphasized wood production more strongly (Kindstrand et al. 2008). In our study, potential sources of recommendations are forest owner associations that generally have a strong focus on wood resource use in Germany (Petkau 2007).

### Differences between small-scale forest owners with and without Natura 2000 sites

The general support of a range of ecosystem services by private forest owners, Natura 2000’s aim to consider economic, social, and cultural conditions (European Commission 1992), and the conservation potential associated with small-scale ownership structures (Schaich and Plieninger 2013; Mölder et al. 2021), are a promising foundation for an integrative protected area network. The implementation of Natura 2000, however, has been criticized due to the difficulty to combine conservation with wood production and other local demands (Rosenkranz et al. 2014), ineffective funding (Sarvasova et al. 2019), and resulting conflicts (Blondet et al.

2017). As the success of conservation depends on the awareness and decisions of affected private landowners (Kittredge et al. 2015), these problems might impact the effectiveness of the Natura 2000 network.

Our data revealed that private forest owners with Natura 2000 sites had a stronger focus on the use of wood resources. This was expressed through a higher assigned importance to provisioning ecosystem services and profit maximization as well as through a more frequent performance of a variety of silvicultural practices and the harvest of single mature trees. The central question of cause and effect between the designation of Natura 2000 sites and an emphasis on forest resource use cannot be answered unequivocally.

Active management and resource use could have led to high conservation values and subsequently to the designation of Natura 2000 sites. This perception was reflected in comments on the survey such as “We have allowed the beech trees to get thick and have been ‘punished’ for it.” or “[...] nevertheless, I have no understanding for the fact that the state simply decides from the national side on private forests [...]. Who, over generations, has shaped the forest the way it is today? In earlier thinning measures, care was always taken to leave some of the older trees in the stand, so that today we find over-200-year-old beeches, over-100-year-old spruces and oaks in our forests.” This relates to the term *biocultural diversity* which implies that cultural aspects such as traditional management techniques are linked to biological diversity (Bridgewater and Rotherham 2019). For example, traditional and local knowledge regarding forest management is considered important for biodiversity conservation in the USA (Charnley et al. 2007). Within our study area, traditional forest management techniques such as coppicing resulted in high conservation values of small-scale private forests (Mölder 2016). However, the general wood utilization rates are considerably lower in the small private forests of Lower Saxony in comparison with other ownership classes (ML Niedersachsen 2014), which may have sustained conservation values such as deadwood particularly in the broad-leaved forests assigned as Natura 2000 areas.

Alternatively, the designation of their forest as a protected area, and the impeding restrictions followed by legally securing the area, could have increased the forest owners’ interest in active management before their decisions might face limitations. Within the context of Natura 2000, the designation of habitat trees, protection of native tree species, and the demand for trees in a mature stage were perceived as the strongest restrictions of management plans (Rosenkranz et al. 2014). In our study area, the process of legally securing the sites is not fully completed and Natura 2000 management plans often do not exist yet. The significantly higher frequency of planting introduced species by private forest owners with Natura 2000 sites could thus be interpreted as an indicator that a change of the forest structure

is attempted before restrictions are in place. Similarly in Finland, the implementation of Natura 2000 with a focus on flying squirrels resulted in cases of harming this species as an attempt to keep decision freedom (Jokinen et al. 2018). Within the same country, felling was performed after a site was planned to be part of the Natura 2000 network (Hiedanpää 2002). This phenomenon has been frequently studied in the context of the US Endangered Species Act, the implementation of which led to cases of pre-emptive harvest decisions (Lueck and Michael 2003). Recipients of our survey indicated the possibility of similar behaviour: “If an FFH site [area designated under the Habitats Directive] will be designated, the stand will be cleared.” Another asserted, “Many forest owners are against the FFH site in our community. Therefore, some are considering to manage the forest more intensively in advance. This means that old trees worthy of protection will be cut down, or if the plots are quite small, they will be cleared. This would not happen if the forest could simply continue to be managed without restrictions.” In contrast, the protection of habitat trees was the only conservation measure that was performed significantly more often by private forest owners with Natura 2000 sites and contradicts this hypothesis. This may be an indication that the long-established habitat-tree protection idea (Mölder et al. 2020) is also recognized by the otherwise critical owners of Natura 2000 sites.

Our analysis of nature conservation attitudes of private forest owners with and without Natura 2000 sites reinforces the impression of a low acceptability of the Natura 2000 scheme. Regarding owners with Natura 2000 sites, we discovered higher dissatisfaction regarding the process of nature conservation, increased perceived loss of personal freedom (“expropriation”, “significant restrictions”), and a higher association of costs with nature conservation. Similarly, negative attitudes towards Natura 2000 can be seen among private forest owners in Finland (Hiedanpää 2002), forest owners and hunters in Spain (Ferranti et al. 2017), and private landowners in Estonia (Suškevičs and Külvik 2007). These findings contrast with research showing that conservation in general is often supported if it does not compromise personal goals (Young et al. 2005), even if it implies a reduction of timber usage (Feil et al. 2018). Thus, the described negative attitudes towards nature conservation within the Natura 2000 network seem to be closely related to the scheme itself. Grodzinska-Jurczak and Cent (2011) attributed a low acceptance of the Natura 2000 scheme to insufficient information, a lack of knowledge, and poor communication.

### Conservation policy instruments

In a survey among European conservation scientists, the change of negative attitudes of local stakeholders into

positives ones by local and national political action was identified as the main challenge in the implementation of Natura 2000 (Kati et al. 2015). In concordance, many studies highlight the importance of stakeholder participation in the implementation of Natura 2000 (Grodzinska-Jurczak and Cent 2011; Winkel et al. 2015). Also, the small-scale forest owners with Natura 2000 sites in our study area strongly desired more involvement in decision-making processes. Such an approach implies that the relevant guidelines consider the perceptions of forest smallholders (Meyer 2013), their diverse traditional practices, and their underlying motivations (Sourdril et al. 2012). Thus, especially regarding both the Natura 2000 sites that are yet to be legally secured and the development of management plans, we recommend a strong engagement with local forest owners to develop trust between different actors, to consider local knowledge, and to increase the acceptability (cf. Mölder et al. 2021). However, while past participation efforts increased the acceptability of Natura 2000, no influence on forest management was found in case studies across Europe. A profound participation procedure that could lead to such changes needs to include mutual learning, establish trust, and include a broad spectrum of different stakeholders, which results in a long process (Blondet et al. 2017). However, given the imminent lawsuit of the European Commission, due to Germany's poor implementation of the Habitats Directive (European Commission 2021), and the related pressure, such an approach might not be feasible. A resulting lack of engagement, however, might further intensify the conflict as already this quote from our survey illustrates: "Feeling of paternalism; feeling that the designation was made only to meet the EU requirements." Notwithstanding that Natura 2000 sites have been already legally secured in other European countries, such a profound participation strategy could be beneficial for the further development of these conservation areas.

Aside from increased profound participation, a stronger adaptation of the Natura 2000 conservation scheme towards the needs, demands, and personal situations of small-scale forest owners is needed. Thus, conservation policy recommendations concerning private forest owners frequently include a targeting of instruments towards ownership groups (Ingemarson et al. 2006; Boon and Meilby 2007), and a stronger consideration of individual backgrounds (Bieling 2004; Joa and Schraml 2020) as forest owners differ, for example, regarding their economic focus, their management intensity, and the provision of goods and services (Blanco et al. 2015). Further, proposals focus on particular instruments ranging from certification (Bieling 2004) to compulsory regulations (Danley 2019), on improved communication (Eggers et al. 2014; Vainio et al. 2018), and an enhanced relationship between different stakeholders (Van Gossum et al. 2011; Salomaa et al. 2016; Tiebel et al. 2021). As for potential instruments, our data show that the majority

of Natura 2000 forest owners regarded financial incentives and on-site consultation as helpful for increasing their conservation practices. The high valuation of a financial tool is in contrast to other studies showing little additionality (Urquhart et al. 2012; Vedel et al. 2015) and low perceived importance (Feliciano et al. 2017) of compensation payments or subsidies. The current Natura 2000 compensation payment model in Lower Saxony failed to reach most private forest owners within our study area, which is in concordance with other research across Europe (Winkel et al. 2015; Sarvasova et al. 2019). At the time of our survey, only the owners of certain Natura 2000 sites were eligible for the compensation payment. They had to be legally secured as a nature protection area (Naturschutzgebiet), include a Natura 2000 habitat type or a breeding or resting place of certain species, the management had to be impacted, and the payment needed to exceed a certain monetary threshold (ML Niedersachsen and MU Niedersachsen 2019). This structure is of low suitability for small-scale private forest owners due to the imbalance between small holding sizes, the monetary threshold to be achieved, and the associated administrative efforts. Also in other European countries, the structures of approaches to funding Natura 2000 have been criticized as the budget is insufficient, the usage rate is low (Geitzenauer et al. 2017), and since potential income losses are not considered (Anthon et al. 2010; Hily et al. 2015). However, examples exist where financial support was targeted towards small-scale private forest owners within the scope of Natura 2000. In the German federal state Bavaria, a contract-based conservation program is used that was revised to the needs of small-scale forest owners. The newly created possibility to protect single habitat trees for a duration of twelve years led to an increased uptake of contracts (Hipler et al. 2017), and the funding sum in private forests almost doubled within five years (Bayerischer Landtag 2020). Most conservation payment schemes, however, focus on compensation and thus assume a conflict between forest ownership and conservation and do not acknowledge past nature conservation efforts by private forest owners or the societal demand to promote actions of public interest (Paschke 2018). Instead, a results-based reward for conservation practices shows a large potential by providing economic incentives for implementing conservation actions (Anthon et al. 2010; Paschke 2018; Demant et al. 2020). Such an instrument is also recommended within the context of Natura 2000 (Anthon et al. 2010) and could combine landowners' identity and efficient conservation practices by leaving the decision freedom to the individual owner, resulting in directly observable changes on their lands (Gooden 2019). Further, other measures that were evaluated as helpful in increasing conservation actions by the recipients of our survey could be promoted. These include legal information as well as an exchange of experiences and visits to exemplarily managed forest stands.

The insights gained by our analysis of small-scale private forest ownership and Natura 2000, especially the need to adapt this nature conservation scheme to small-scale forest owners, can be transferred to other conservation networks to ensure the integrative and sustainable implementation of biodiversity conservation measures by small-scale private landowners. Thereby, local peculiarities and past experiences have to be taken into account. In general, the ownership structure of our case study, which is comparable to other European regions, and our findings regarding the perceived importance of ecosystem services, the performance of management practices, and the generally negative attitudes towards the Natura 2000 scheme are in concordance with other studies across Europe.

## Conclusions

We found that small-scale private forest owners in North-west Germany had a multifunctional perspective on their forests while perceiving regulating and cultural services as most important. Though this is a good prerequisite for Natura 2000 as an integrative nature conservation scheme, our results indicate low effectiveness and conflicts regarding the implementation of this network of conservation areas. Habitat-tree protection as a long-established concept was the only conservation measure that had been more frequently implemented by small-scale private forest owners with Natura 2000 sites than by those without. Instead, Natura 2000 forest owners had a stronger focus on resource use and more negative nature conservation attitudes.

Natura 2000 needs to be adapted to the demands of small private forest owners. This includes an improved implementation strategy that is accepted by private forest owners, for example, by increased profound participation and an enhanced scheme of results-based economic incentives for conservation measures. As small-scale private forest owners represent the majority of forest owners in Europe, their perspectives have to be comprehensively considered to ensure the effective and sustainable implementation of the Natura 2000 conservation network.

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**Informed consent** We enabled the recipients to participate by informed consent in the following way: (i) In the introductory text, we described the objectives of the survey and clarified that the survey is part of a research project. (ii) Further, we pointed out that participation in the survey is voluntary and that the analysis will be conducted anonymously. (iii) We added contact information to address any arising questions or concerns of the participants. (iv) Additionally, we added an information sheet on Art. 13 of the EU General Data Protection Regulation and provided contact information on the data protection supervisory authority responsible for the University of Göttingen.

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