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Factors Explaining the Willingness of Small-Scale Private Forest Owners to Engage in Forestry—A German Case Study

Johannes Stockmann ^{1,2,*} , Kristin Franz ¹, Björn Seintsch ¹ and Christoph Neitzel ³

¹ Thünen Institute of Forestry, Leuschnerstr. 91, 21031 Hamburg, Germany; kristin.franz@thuenen.de (K.F.); bjoern.seintsch@thuenen.de (B.S.)

² Graduate School Forest and Agricultural Sciences, Georg-August-University Göttingen, Büsingenweg 5, 37077 Göttingen, Germany

³ Federal Ministry of Food and Agriculture, Wilhelmstraße 54, 10117 Berlin, Germany

* Correspondence: johannes.stockmann@thuenen.de

Abstract: In Germany, 24% of the forest area is owned by small-scale private forest owners, whose property is affected by a societal demand for forest-related ecosystem services. In the inhomogeneous group of small-scale private forest owners, different living conditions and lifestyles exist, which are affecting the management of the forest ownership. To support the management activities of small-scale private forest owners, institutional instruments exist, but these are only used by a small proportion of forest owners. In order to gain insights into the accessibility and activation of small-scale private forest owners for management, and to draw conclusions for appropriate support instruments, a large number of studies have analyzed the factors influencing the management activities of forest owners. Some studies identify socio-demographic and socio-economic variables as important influencing factors, but do not take into account their complex interdependencies, which have developed as a result of the pluralization of lifestyles and individualization of forest owners. For this reason, in addition to the influencing factors identified in the literature as relevant for forest management activities of small-scale private forest owners, the lifestyle segmentation approach of Sinus milieus established in German market research was applied in this study. This approach allocates forest owners based on their complex lifestyles into ten different milieu groups. A logistic regression analysis was used to determine the parameters influencing the willingness to engage in eight different forest management activities. The results show that the willingness to engage in forest management activities in the future is higher compared to actions in the past. In addition to timber harvesting-related activities, the small-scale private forest owners show a high action potential for non-commodity-related activities. Non-commodity-related activities can primarily be explained by the Sinus milieu affiliation of the small-scale private forest owners. This result underlines the usefulness of a lifestyle segmentation approach such as the Sinus milieus to address small-scale private forest owners in a target group specific way in line with their willingness to engage in specific forest management activities. Institutional instruments such as the membership in a forest owners association or subsidies do not play a significant role for non-commodity-related activities and seem to be inappropriate for targeting small-scale private forest owners for these activities. Timber harvesting-related activities are primarily influenced by the presence of professional foresters, socio-demographic factors or institutional instruments. Based on these empirical findings, implications can be drawn for the target group-specific addressing of forest owners based on different management activities. In this way, forest owners can be motivated to engage in forest management and the provision of forest-related ecosystem services.

Keywords: non-industrial private forest owners; forest management activities; management behavior; behavioral intention; logistic regression analysis; lifestyle segmentation; Sinus milieus



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1. Introduction

In Germany, as in other European countries, society is making increasing demands on the provision of forest-related ecosystem services, leading to conflicts of interest among themselves and with forest owners [1–8]. The provision of ecosystem services depends on the decision of small-scale private forest owners to actively engage in forest management or to deliberately refrain from management activities. The implementation of these management activities is in the responsibility of the different forest owners. Across Europe, more than half of the forest area is privately owned [9,10]. In Germany, 48% of the forest area is owned by private forest owners. Similarly to other European countries, the share of small-scale private forest holdings, meaning properties smaller than 20 ha [11,12], is also considerable. Half of the German private forest area belongs to such small-scale forest owners (referred to as ‘small owners’ in this study). There are 1.74 million small owners in Germany alone. Their forest ownership is similar in average size and strong fragmentation to Eastern European countries such as Slovenia [13]. Due to the large proportion of forest area owned by small owners in Germany, their forest management activities are also of great importance for the provision of forest-related ecosystem services. As in other Western European countries, small owners in Germany have greater freedom to manage their forests due to fewer administrative regulations than in Eastern Europe [14] and differ from the more economically oriented management perspectives in Eastern Europe through more ecosystem-based management perspectives [15].

In order to encourage private forest owners in their forestry activities, financial subsidies from European or national funds are the most common instruments to support them [16]. In Germany, small owners are also supported through the promotion of forest owner associations and other forms of inter-company cooperation [17]. However, various national and European studies show that only a small proportion of these instruments meet the needs of small owners in particular [11,18–21]. For example, the use of public subsidies is perceived as too bureaucratic by small owners, or they do not see any additional benefit. A disproportionately low usage of public subsidies can also be observed in Austria, Finland and Slovenia [22].

To ensure targeted and effective support for small owners, essential information on small owners is needed to formulate comprehensive recommendations for private forest policy [23]. In general, it can be seen that the forest management objectives of European private forest owners have changed significantly over the last two decades, for example, due to the urbanization of lifestyles, withdrawal from agriculture, as well as economic restructuring [24]. These changes have led to a situation within the group of small owners, where they cannot be addressed as a homogeneous group by specific instruments [3,10,11,15,25,26]. Small owners actively manage or deliberately refrain from forest management. Forest management activities can include felling or maintaining forest roads, while the deliberate absence of management can be the refraining from logging or the leaving of deadwood. The activities in which they engage are influenced by a variety of factors such as education, gender, age, emotional attachment to the forest, forest income, place of residence, size of ownership, average skidding distance, and proportion of mature stands [27–31]. It can be seen that many studies primarily identify socio-demographic and socio-economic variables (e.g., age, gender, educational level, place of residence) as influencing factors for forest management activities [27–37]. Furthermore, characteristics of forest ownership (e.g., size of ownership, distance from home, income from forestry, membership in a forest owner association) have been found to influence forest management [27,29,33,34,38–40]. However, the factors so far identified as influencing the activities of forest owners are apparently only partially sufficient to develop appropriate instruments for small owners. Due to the pluralization and individualization of life situations and the complexity of social structures, these factors alone provide less and less information about subjective human decision-making and how to address small owners [41]. In order to enable the development of appropriate instruments and marketing strategies to address small forest owners, this study seeks to add to the scientific literature. In particular, it

emphasizes a comprehensive consideration of the complex interdependencies inherent in the social structures and associated lifestyles of these small-scale owners. For this purpose, we analyze the factors influencing the willingness of small forest owners to engage in eight different forest management activities under special consideration of their life situation. Therefore, in addition to the influencing factors already investigated in the literature, such as socio-demographics or forest structure, the affiliation of small forest owners to their respective group is considered in a lifestyle segmentation approach. By taking this segmentation approach into account, it is possible to recognize the complex life situations of small owners. Segmentation approaches are used to categorize individuals into groups of people who are similar on the basis of behavioral characteristics. This allows conclusions to be drawn for segment-specific marketing and communication programs to target groups of people [42,43]. The present study uses the Sinus [44] milieus for segmentation. This approach categorizes individuals into different lifestyle groups and is widely used and established in German market research. Based on the results, conclusions can be drawn about the circumstances under which small owners are willing to undertake a specific action in their forest.

Based on a representative German dataset [11] the study concentrates on the following research questions:

- Which variables influence the willingness of German small private forest owners to carry out different forest management activities?
- Does the lifestyle segmentation approach used (Sinus milieus) provide an explanatory contribution to the willingness to engage in forest management activities in small private forests?

In order to answer the research questions, the next section presents the conceptual framework of our analysis. This is followed by an explanation of the materials and methods used for the corresponding statistical analysis. Based on the previous sections we present our results, discuss them and draw some main conclusions for forest policies to target and motivate small owners to engage in forest management activities and thus support the demanded ecosystem services in small private forests.

2. Conceptual Framework

Decision-making is the process of choosing between at least two options, ideally culminating in the final selection of one option. This process is under the control of the decision-maker and is influenced by environmental factors [45]. The characteristics of the decision maker and the influencing environmental factors are complexly interrelated and can be represented by behavioral models, which provide a simplified representation of reality. In the present study, a dataset from the questionnaire study by Feil et al. [11] is used. This dataset was designed according to Pregernig's [46] Model for Explaining Human Decision-Making. Pregernig [46] states that human decision-making is the result of a multi-stage selection process (Figure 1).

The model is a further development of Langenheder [47], which has been successfully applied in agricultural sociological studies [48–50]. Pregernig [46] further developed Langenheder's [47] model and applied it in a forestry context, where it is used in studies such as Ruschko [51] and Hogl et al. [52].

It should be noted that the conceptual framework used here is not intended to provide a deterministic portrait of reality, but rather to heuristically structure an existing problem into broader categories and to find clues that allow us to better understand and explain human decision-making in a more general context [51]. The relationships represented in the framework are not intended to be empirically tested in a theorem-proving sense, so the structure of the conceptual framework differs from the structure of the statistical models described in Section 3.4.

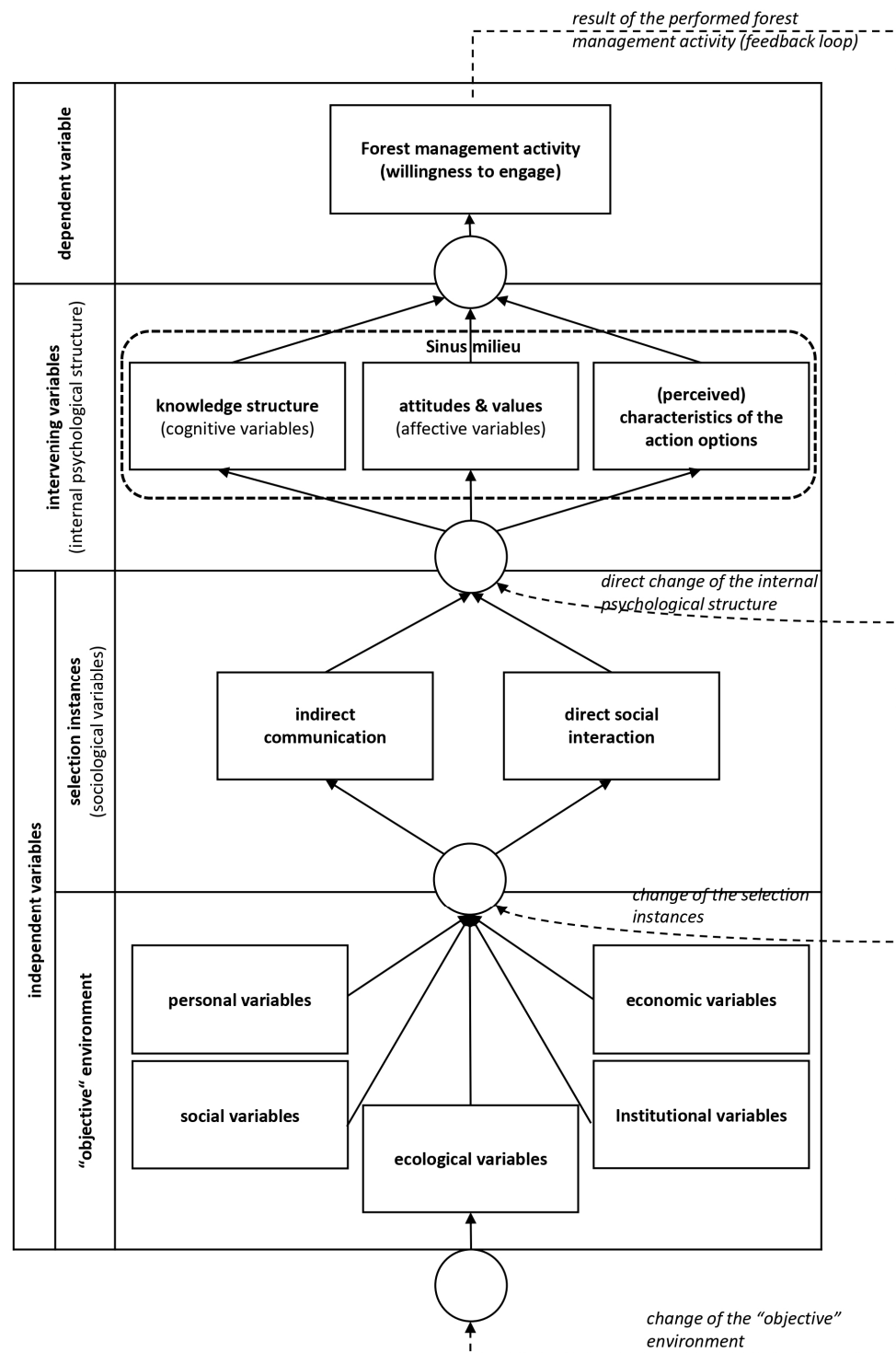


Figure 1. Adapted Model for Explaining Human Decision-Making (Pregernig [46]; acc. to Langenheder [47]).

The Model for Explaining Human Decision-Making focuses on a particular decision made by an individual that the model attempts to explain. This decision is defined as the dependent variable. Influencing factors are the objective environment and the selection instances, the latter acting as filters that allow only certain aspects of the objective environment to pass through [51]. Both factors are referred to in the model as independent variables. They influence the willingness to engage in a activity through the internal psychological structure that serves as a link between the independent variables and the

dependent variable [49]. For this reason, the model refers to the influencing factors of the internal psychological structure as intervening variables [46].

2.1. Objective Environment

The natural and social conditions of a person form the basis of his or her decision-making process and are characterized by five influencing factors [46]: socio-demographic (personal), socio-economic (economic), social, political-institutional (institutional) and ecological.

Personal factors refer to characteristics of the person under study, such as age or gender. According to Pregernig [46], the implementation of an action depends not only on the willingness, but also on the ability to carry it out. Economic factors limit a person's ability to act in an economic sense and are characterized, for example, by the size of a forest property or its financial resources. Social factors are co-determined by role expectations. If certain actions in the forest are associated with social acceptance, for example, through the approval of the spouse or other family members, this can increase the willingness to carry out an activity.

Institutional factors, unlike the other variables of the objective environment, are not individual-specific. Institutional variables can be broadly classified into regulatory instruments of command and control, (public) financial instruments of cash and non-cash benefit function, and information instruments based on education and advice.

Ecological factors reflect technical and environmental determinants and, in the context of forestry, mainly relate to climatic conditions, geology, hydrology, soil quality and forest structure (e.g., species composition, tree quality and age class distribution).

2.2. Selection Instances

A person's information and communication behavior determines which factors of the objective environment are perceived and in what way [51]. A distinction is made between indirect communication and direct social interaction.

Indirect communication usually refers to the media as a mechanism for the rapid distribution of information. Direct social interaction refers to face-to-face communication between at least two people, e.g., in contact with other forest owners, family or professional foresters [46].

2.3. Internal Psychological Structure

The Model for Explaining Human Decision-Making assumes that a person's plans are exclusively determined by the internal psychological structure [51]. This is characterized by the knowledge structure, attitudes and values, and the perceived characteristics of the action options of a person.

These perceived characteristics of the action options represent the importance that a person attaches to an object (here the perception of the forest by the small owner). This importance and evaluation results from social interaction with peers [51] and the person's own process of interpreting the object [46]. Knowledge in this context refers to the knowledge of how to evaluate options for action and how to apply them in practical situations. Attitudes describe the acceptance or rejection of a particular situation or object, whereas values tend to refer to a broader, overarching context.

In the present study, the knowledge structure, attitudes and values, and the perceived characteristics of the action options are represented by the lifestyle segmentation approach Sinus [44], which divides small owners into milieu groups based on their lifestyles. A "lifestyle" is sociologically defined as "the regularly recurring overall context of a person's behavior, interactions, opinions, knowledge and evaluative attitudes" [53]. According to this definition by Hradil [53], the elements of the internal psychological structure of small owners mentioned by Pregernig [46] can be covered by lifestyle segmentation approaches. These distinguish individuals on the basis of a specific lifestyle type, which is characterized by a broad spectrum of activities, interests and opinions [54]. The Sinus milieus used in this study are a scientifically based instrument with a wide range of potential applications

in the German-speaking region, with its approaches (“Meta Milieus”) used in 45 other countries [55,56]. Sinus assumes that the reconstruction of social reality cannot be directly measured objectively, but only by capturing people’s everyday consciousness [55]. This assumption is again consistent with the definition from Pregernig [46], who understands the internal psychological structure as unobservable circumstances that are effective within a person [51]. In contrast to a separate consideration of the components of the internal psychological structure (knowledge structure, attitudes and values, and the perceived characteristics of the action options), these components are represented as a milieu construct in the Sinus approach. Schahn [57,58] points out that knowledge, as a cognitive determinant of behavior, and attitudes and values, as affective components, influence environmental behavior (in this case, the willingness to engage in forest management activities) and are interrelated in a complex way. This further strengthens the rationale for the milieu construct at this point, rather than considering components separately.

2.4. Willingness to Engage and Feedback Loop

The dependent variable is a specific willingness to engage in an activity of an individual that the model seeks to explain. According to Pregernig [46], actions that have already been performed (feedback loop) cause a direct change in the internal psychological structure, the selection instances and the objective environment. In this way, a forest management activity in the past can determine the willingness to be active in the future.

3. Materials and Methods

3.1. Survey

To answer the research questions, individual explanatory variables were selected from the nationally representative dataset of German private forest owners by Feil et al. [11] on the basis of an extensive scoping review of the literature. This was limited to literature sources on European countries, as the differences in tenure, economic and social systems of small owners in developing and industrialized countries, for example, do not facilitate a straightforward basis for comparison [59]. Furthermore, only articles containing an empirical analysis of the factors influencing forest management activities were considered. The variables selected for data analysis are taken from a scientific survey by Feil et al. [11], which can be found in the Table S1. These variables had already been assigned by Feil et al. [11] to the variable groups of Pregernig’s [46] Model for Explaining Human Decision-Making. Additional independent variables not mentioned in the literature were assigned to the conceptual framework according to the expected causal relationship. This was particularly the case for the variables on the effect of past forest management activities in the feedback loop and on the Sinus milieus, which were to be tested for the first time in this study as an innovation in the context of the willingness of small owners to engage in forest management activities.

In the following sections, the variables listed in Table 1 are described in more detail. For the nominal variables, a reference category was chosen in each case, in relation to which the results of the variables are to be interpreted.

Table 1. Description of the variables in the dataset examined in the study. fbl = Feedback loop.

Variable	Variable Group (and subgroup) acc. to Pregernig [46]	Definition	Scale	Question Number in Feil et al. (2018) [11]	References
CONVERSION	Dependent variable (forest management activity)	Willingness to convert coniferous forest to deciduous forest in the next 10 years to make the forest more pristine	nominal	10.2_1	
ALIENPLANT	Dependent variable (forest management activity)	Willingness to plant alien tree species in the next 10 years to make the forest more diverse	nominal	10.2_2	

Table 1. Cont.

Variable	Variable Group (and subgroup) acc. to Pregernig [46]	Definition	Scale	Question Number in Feil et al. (2018) [11]	References
MAINTENANCE	Dependent variable (forest management activity)	Willingness to cut down single trees to maintain the forest in the next 10 years to allow other trees to grow	nominal	10.2_3	
TIMBERLOGGING	Dependent variable (forest management activity)	Willingness to log wood for firewood use or furniture production in the next 10 years	nominal	10.2_6	
TRACKCLEAR	Dependent variable (forest management activity)	Willingness to clear forest tracks in the next 10 years to make them specifically available to forest visitors	nominal	10.2_8	
HABITATTREENOTUSE	Dependent variable (forest management activity)	Willingness to not use habitat trees in the next 10 years to permanently preserve them for animals and plants	nominal	10.2_7	
ZEROLOGGING	Dependent variable (forest management activity)	Willingness to refrain from logging in the next 10 years to preserve the forest for plants and animals only	nominal	10.2_4	
KEEPOFF	Dependent variable (forest management activity)	Willingness to prohibit access to their forest in certain areas for the next 10 years in order to preserve the forest for plants and animals only	nominal	10.2_5	
CONVERSION _{fb1}	Feedback loop (forest management activity)	Converted coniferous forest to deciduous forest in the past 10 years to make the forest more pristine	nominal	10.1_1	
ALIENPLANT _{fb1}	Feedback loop (forest management activity)	Planted alien tree species in the past 10 years to make the forest more diverse	nominal	10.1_2	
MAINTENANCE _{fb1}	Feedback loop (forest management activity)	Cut down single trees (maintain felling) in the past 10 years to allow other trees to grow	nominal	10.1_3	[29]
TIMBERLOGGING _{fb1}	Feedback loop (forest management activity)	Logged wood for firewood use or furniture production in the past 10 years	nominal	10.1_6	[32]
TRACKCLEAR _{fb1}	Feedback loop (forest management activity)	Cleared forest tracks in the past 10 years to make them specifically available to forest visitors	nominal	10.1_8	
HABITATTREENOTUSE _{fb1}	Feedback loop (forest management activity)	Not used habitat trees in the past 10 years to permanently preserve them for animals and plants	nominal	10.1_7	[28]
ZEROLOGGING _{fb1}	Feedback loop (forest management activity)	Refrained from logging in the past 10 years to preserve the forest for plants and animals only	nominal	10.1_4	
KEEPOFF _{fb1}	Feedback loop (forest management activity)	Kept off the forest in certain areas in the past 10 years to preserve them for plants and animals only	nominal	10.1_5	
MILIEU	Intervening variables (knowledge structure, attitudes and values, (perceived) characteristics of the action options)	Classification of small owners to the Sinus milieus	nominal	15	

Table 1. Cont.

Variable	Variable Group (and subgroup) acc. to Pregernig [46]	Definition	Scale	Question Number in Feil et al. (2018) [11]	References
FORESTFUNCTION	Intervening variables (attitudes and values)	Attitude to the forest function of the forest ownership by the respondent (public vs. private) >0: private < public function <0: private > public function	Interval	11.2_1, 11.2_2, 11.2_3	[34]
CASHRELEVANCE	Intervening variables (attitudes and values)	Attitude to the economic relevance of forest ownership by the respondent (economic relevant vs. economic irrelevant) >0: high economic relevance <0: no economic relevance	Interval	13.10_1, 13.10_2, 13.10_4	[33,34,40]
OUTSOURCE	Intervening variables ((perceived) characteristics of the action options)	Willingness to outsource the forest responsibility in all aspects of forest management to professional foresters	nominal	12.6	[31]
MEDIA-QUAL	Selection instances (indirect communication)	Number of media channels consumed on the topic of forests in the past year	Ratio	9.2	
MEDIA-QUANT	Selection instances (indirect communication)	Frequency of retrieving information specifically on forest topics in the past year	Ratio	9.3	[60]
CONTACTPERSONS	Selection instances (direct communication)	Number of contact persons consulted for decision-making regarding the forest ownership	Ratio	9.5	[29,61]
OPERATOR	Selection instances (direct communication)	Main operator for the forest ownership	nominal	9.6	[28]
GENDER	Objective environment (personal variables)	Gender of small owners	nominal	16.1	[27,36]
AGE	Objective environment (personal variables)	Age of small owners	Ratio	16.2	[27,37]
OWNERS	Objective environment (social variables)	Number of members of the forest ownership community	Ratio	8.12	[30]
RESIDENCE	Objective environment (personal variables)	Residence of small owners	nominal	-	[27,36]
PRIMARYSECTOR	Objective environment (economic variables)	(Past) employment in the primary sector	nominal	16.6	[35]
SIZE	Objective environment (economic variables)	Size of forest ownership	Ratio	8.8	[15,27]
FRAGMENTATION	Objective environment (economic variables)	Number of forest fragments of forest ownership	Ratio	8.7	
DISTANCE	Objective environment (economic variables)	Distance between forest ownership and residence (in km)	Ratio	14.4	[27,39]
ROAD	Objective environment (economic variables)	Existence of a forestry infrastructure that allows timber harvesting	nominal	13.4	[30]
COMPOSITION	Objective environment (ecological variables)	Predominant forest type in forest ownership	nominal	13.1	[30,31]
MATURITY	Objective environment (ecological variables)	Age class distribution in forest ownership	nominal	13.2	[30,40]
FOA	Objective environment (institutional variables)	Membership in a forest owner association (FOA)	nominal	8.13	[29]
SUBSIDIES	Objective environment (institutional variables)	Use of public subsidization for activities in forest ownership in the last 10 years	nominal	13.8	[22]

3.1.1. Objective Environment

The five influencing factors of the objective environment, which form the basis of the decision-making process of small owners, are presented in this study as follows.

The personal influencing factors, as a limiting factor for the ability to act, are represented by the answers to the questions about the age (16.2), gender (16.1) and place of residence (note: the information on the place of residence of small owners is taken from the municipal code [62] to apply the degree of urbanization (accessed on 1 June 2022) [63], which was part of the raw data but not published in the Feil et al. [11] survey) of the small owner. The economic factors consider the infrastructural road network in the forests (13.4). Other economic constraints are the size of the forest property (8.8), the fragmentation of the forest (8.7) and the distance of the forest property from the place of residence (14.4). Current or former employment in the primary sector (16.6) is also considered as an influencing factor for forest owners' decisions. As social factors, the decisions of small owners may be influenced by the opinions of other co-owners, so their existence is considered. Institutional factors are divided in this study into the use of subsidies (13.8) as a financial instrument and membership in a forest owner association (8.13) as an information tool based on education and advice. Both serve to overcome structural disadvantages in the management of small owners and are therefore considered to be institutionally relevant. Ecological factors, as limits of site conditions and forest-specific influencing factors, are included in the analysis by the predominant stand type (13.1) and the age class distribution of the forests (13.2).

3.1.2. Selection Instances

The selection instances as representation of the communicative processes of small owners are covered on the one hand by the indirect communication structures. These include both the frequency of media consumption on forest issues (9.3) and the number of media channels used (9.2). On the other hand, direct social interaction/direct communication was operationalized by the number of contact persons consulted for decision-making regarding the forest (9.5) and the main person in charge of the forest (9.6).

3.1.3. Internal Psychological Structure

As described in Section 2.3, the operationalization of all components of the internal psychological structure (knowledge structure, attitudes and values, and the perceived characteristics of the action options) is represented by the lifestyles of small owners through the Sinus milieus (15). The Sinus milieus are supplemented by three further variables which reflect forest-related positions.

Sinus milieus are defined by *Sinus Markt- und Sozialforschung GmbH* (Heidelberg, Germany) by narrative interviews to make the areas of experience that are significant for the interviewees (work and associated income, family, leisure, etc.) and the lived everyday contexts, attitudes, values, wishes, fears and dreams transparent. Methodologically, the interviewees present the lifeworld areas relevant to them in their own language using non-directive lifeworld extrapolation, from which cross-case categories are derived. This results in hypothetical milieu models in which the interviewees are similar in terms of their values and basic life attitudes and lifestyles. These hypothetical models are then quantitatively tested and representatively generalized [55]. This distinguishes the creation of the Sinus milieus from inductive-empirical approaches that capture lifestyle types by means of statistical cluster or correspondence analyses (as practiced in many typization studies on small owners) and do not determine them a priori [64]. The generalized quantitative milieu models can then be re-modelled in any sample on the basis of requested "milieu indicators".

Based on the dimensions of social status, on the one hand, and the basic values based on historical epochs of dominant social guiding values and associated mentalities, on the other, ten different Sinus milieus are distinguished [44].

A visualization of the classification of the milieus based on the above-mentioned dimensions and the distribution of the shares of small owners to the ten milieu groups can be found in Appendix A (Figure A1). *Sinus Markt- und Sozialforschung GmbH* (Heidelberg, Germany) does not provide information on the exact accounting of considered information, weights and estimates used to classify individuals into the specific milieus. However, according to von Willert and Krott [65], the authors trust the Sinus milieus due to their

establishment in scientific studies of various disciplines [65–71] as well as their validity and representativeness, which is quantitatively tested each year by conducting approximately 80,000 interviews in several independent random samples [41]. In the survey of Feil et al. [11], the Sinus milieus were defined by *Sinus Markt- und Sozialforschung GmbH* as part of the small owner survey.

In addition to the Sinus milieus, statements of small owners on the assessment of the economic importance of their forest (13.10_1; 13_10.2; 13.10_4), as well as its function as a public or private good (11.2_1–11.2_3), and the willingness to hand over responsibility for forest management to professional foresters (12.6) were included as influencing factors in order to map the forest-related positions of small owners as part of their internal psychological structure.

3.1.4. Willingness to Engage and Feedback Loop

This research includes eight different questions about the willingness to engage in forest management activities of small owners in the next 10 years. The answers to these questions are in the focus of the statistical analysis which is described in more detail in chapter 3.4. The authors are aware that the willingness is a statement of intent and cannot be equated with observed behavior. The analyzed willingness to engage is based on the different forest management activities of Feil et al. [11], which were questioned as part of their survey and are listed in Table 1. The activities include the willingness to convert coniferous to deciduous forests (10.2_1), to plant alien tree species (10.2_2), to maintenance felling (10.2_3), to regular logging (10. 2_6), to clear forest tracks for recreational use (10.2_8), not to use habitat trees (10.2_7), to refrain from logging (10.2_4) and to keep off the forest in certain areas (10.2_5). These eight decisions for forest management activities cover the central aspects of forest shaping and development as well as the provision of forest ecosystem services in Germany. The level of implementation of these forest management activities in (small private) forests is also the subject of intense debate in the context of raw wood supply in a bioeconomy, biodiversity conservation, climate protection and adaptation or recreation. Some of these activities are also the subject of existing public subsidies in Germany.

In order to take into account the influencing factors within the feedback loop, the actions taken over the past 10 years were included for each willingness to engage.

3.2. Data Selection

The data set examined was collected by *Forsa marplan Markt- und Mediaforschungsgesellschaft mbH* (Frankfurt am Main, Germany) in cooperation with *Sinus Markt- und Sozialforschung GmbH* in 2017 in a two-stage survey procedure using computer-assisted telephone interviews (CATI) by interviewing 1202 private forest owners. To obtain the survey data, the telephone master sample of the Working Group of German Market and Social Research Institutes was used, from which simple- or multi-stage samples were drawn. Private forest owners were defined here as owners or co-owners (e.g., community of heirs) of a forest area with a corresponding land register entry in Germany. Due to the relative rarity of the target group in the data set, it was additionally recruited via the population-representative multi-topic survey “*forsa.Omnitel*”. To compensate for possible biases in the sample, it was weighted by *Forsa* according to age, gender, region and education based on official data from the population estimation (key date: 31 December 2015) and the micro census (2015) [72].

As this study only focuses on forest owners with an ownership size < 20 ha, 1009 small owners were filtered from the dataset for further analysis. Additional information on the population, sampling procedure, selection plan and sampling can be found in Neitzel and Wachenfeld-Schell [72].

3.3. Data Transformation

The information selected from the survey using the conceptual framework presented in chapter 3.1 were further processed for statistical analysis and transformed into variables. While a large number of the parameters could be used in their raw form, some parameters were further transformed for the analysis. The processing of these parameters is explained in more detail in this chapter.

Two variables directly related to attitudes towards small owners' forest resource (FORESTFUNCTION and CASHRELEVANCE) were transformed from Likert-scale questions into dimensionless indices on a continuous scale using principal component analysis. This procedure serves two purposes: first, it reduces the number of dummy variables available, and second, it adds more variability to the dataset because the dimensionless index has a continuous scale.

FORESTFUNCTION refers to the difference in importance between the preferences of small forest owners for the usage (11.2_1), protection (11.2_2) and recreation (11.2_3) functions of the forest (according to Federal Forest Act §1) as the cornerstone of multifunctional forestry in Germany. While the use function provides the benefits of private goods, the recreation and protection functions provide more public goods. Small owners were asked whether they would like to be involved in increasing the provision of one function over the other in their forest ownership. This resulted in three comparisons: use versus recreation, use versus protection and recreation versus protection. Based on the preference statements, a matrix of ordinal scales was created. Using principal component analysis, these preference statements were transformed into a dimensionless index. Since the mean of a dimensionless index resulting from principal component analysis is zero, a positive value indicates a preference for increased provision of public goods over private goods, while negative values indicate the opposite. However, this does not provide any information on the quantification of potential changes in forest function or on the level of provision in the status quo.

In order to quantify the economic importance (CASHRELEVANCE) of the forest, small owners were asked about the economic relevance of their forest resources in terms of subsistence (13.10_2), income (13.10_1) and asset value (13.10_4). Answers were possible on a four-point Likert scale. Using principal component analysis, a dimensionless index was created, as already described for the example of the variable FORESTFUNCTION. Positive values indicate economic relevance and negative values indicate non-economic relevance.

The variable OPERATOR is used to indicate which person is mainly responsible for the management of the forest. Four groups are distinguished and associated persons are assigned to them: (a) internal: small owners or family; (b) external private: other forest owners, private foresters, associations or forest management communities; (c) external public: public foresters; (d) nobody: nobody.

Information on the residence of small owners (RESIDENCE) was taken into account using the municipal register [62] to apply the degree of urbanization [63] to distinguish an urban from a rural residence).

3.4. Statistical Analysis

To answer the research questions, this study uses nominal logistic regression to analyze the data set. This can be attributed to the dichotomous nature of the selected dependent variables, which are capable of assuming values of either 1 or 0. Logistic regression has already been applied in several empirical studies to investigate the factors influencing forest management activities [73–76] and offers the main advantage of avoiding confounding effects by analyzing the association of all variables simultaneously [77,78]. The analysis and modelling are performed in the RStudio environment, version 4.3.2 [79].

Logistic regression is based on a cumulative logistic probability function and estimates the probability of a given action given a set of variables [80]:

$$P_i = E(Y = 1|X_i) = \frac{1}{1 + e^{-(\alpha + \beta_i X_i)}}$$

where P_i is the probability that a small owner is willing to perform an activity in the next 10 years, β_i represents the model coefficients and X_i represents the influencing variables. Estimates of the model parameters are obtained using the maximum likelihood estimation.

The dependent variables described in Table 1 are the focus of the analysis. The variables of the objective environment, the selection instances and the internal psychological structure were imputed as influencing parameters in the regression models. Based on the full regression models with 22 influencing variables, backward variable selection was performed using the Akaike Information Criterion (AIC). In addition to the regression coefficients, the odd ratios (OR) were calculated, which provide an indication of the magnitude of the effect of each variable [81]. For negative odd ratios, the reciprocal value was calculated to ensure comparability of the effect sizes regardless of the direction of the effect. Following Chen et al. [81] and Ferguson [82], the effect size can be broadly categorized into a weak effect (OR > 1.5–2), a medium effect (OR > 3.0–3.5) and a strong effect (OR > 4.0–7.0).

For each independent variable in the respective model, the variance inflation factor (VIF) was calculated as a diagnostic statistic to check for possible multicollinearity [83].

Coefficients of determination according to Cox and Snell [84] and McFadden [85] were calculated for the regression models as a measure of goodness of fit. The Correct Classification Rate (CCR), which indicates the proportion of correct estimates in the model, was also calculated.

Based on the selected sample of 1009 small owners, the dataset for each model was reduced by incomplete data rows. To avoid potential bias from these reduced data sets, they were tested for significant differences with the complete data set using a Kolmogorov–Smirnov test. As no significant differences were found, it is assumed that there is no bias due to the reduced data sets (see [75]).

4. Results

The descriptive statistics of the dataset are summarized in Table 2. In general, it can be seen that about half of small owners are willing to engage in various activities. Only the willingness to plant alien tree species (ALIENPLANT) was confirmed by only 29.5% of the respondents. The highest willingness was measured for willingness to cut down single trees to maintain the forest (MAINTENANCE) with 88.7%. There is also a high willingness to harvest wood for timber usage with 75.4% (TIMBERLOGGING), to not use habitat trees with 77.3% (HABITATTREENOTUSE) and to convert coniferous forest to deciduous forest with 70.7% (CONVERSION).

Table 2. Summarized statistics on the variables of the dataset for small-scale private forest owners in Germany. Reference categories are underlined. fbl = Feedback loop.

Variable	N	Mean/Frequency in %	SD	Min/Max	Scale
CONVERSION	984	<u>no</u> : 29.3% yes: 70.7%			nominal
ALIENPLANT	980	<u>no</u> : 70.5% yes: 29.5%			nominal
MAINTENANCE	1000	<u>no</u> : 11.3% yes: 88.7%			nominal
TIMBERLOGGING	993	<u>no</u> : 24.6% yes: 75.4%			nominal
TRACKCLEAR	979	<u>no</u> : 51.9% yes: 48.1%			nominal
HABITATTREENOTNUSE	986	<u>no</u> : 22.7% yes: 77.3%			nominal
ZEROLOGGING	999	<u>no</u> : 43.1% yes: 56.9%			nominal
KEEPOFF	992	<u>no</u> : 55.9% yes: 44.1%			nominal

Table 2. Cont.

Variable	N	Mean/Frequency in %	SD	Min/Max	Scale
CONVERSION _{fb1}	1000	no: 56.9% yes: 43.1%			nominal
ALIENPLANT _{fb1}	1000	no: 86.6% yes: 13.4%			nominal
MAINTENANCE _{fb1}	1006	no: 25.7% yes: 74.3%			nominal
TIMBERLOGGING _{fb1}	1007	no: 31.2% yes: 68.8%			nominal
TRACKCLEAR _{fb1}	999	no: 58.2 yes: 41.8%			nominal
HABITATTREENOTNUSE _{fb1}	989	no: 55.8% yes: 44.2%			nominal
ZEROLOGGING _{fb1}	998	no: 58.4 yes: 41.6%			nominal
KEEPOFF _{fb1}	998	no: 83.5% yes: 16.5%			nominal
MILIEU	1009	Established: 25.0% Liberal-Intellectual: 10.0% Performers: 12.6% Expeditive: 5.0% Adaptive-Pragmatic: 1.7% Social-Ecological: 7.4% Modern Mainstream: 21.9% Traditional: 8.2% Precarious: 4.1% Hedonists: 4.0%			nominal
FORESTFUNCTION	974	−0.02	1.32	−1.96/1.69	interval
CASHRELEVANCE	991	−0.31	1.17	−1.57/3.82	interval
OUTSOURCE	999	no: 75.3% yes: 24.7%			nominal
MEDIA-QUAL	1004	1	1.17	0/5	ratio
MEDIA-QUANT	888	1.03	1.43	0/6	ratio
CONTACTPERSONS	991	1.14	0.55	0/5	ratio
OPERATOR	969	internal: 78.7% external private: 11.1% external public: 6.0% nobody: 4.2%			nominal
GENDER	1009	female: 36.6% male: 63.4%			nominal
AGE	994	52.49	14.97	19/87	ratio
OWNERS	996	2.77	9.41	1/200	ratio
RESIDENCE	1001	urban: 14.9% rural: 85.1%			nominal
PRIMARYSECTOR	986	no: 65% yes: 35%			nominal
SIZE	1009	3.47	4.52	<0.00/20	ratio
FRAGMENTATION	993	2.06	3.33	1/99	ratio
DISTANCE	984	46.02	129.78	<0.00/860	ratio
ROAD	1004	no: 33.1% yes: 66.9% mixed: 49.9%			nominal
COMPOSITION	1007	deciduous: 24.0% coniferous: 26.1% mixed: 13.3%			nominal
MATURITY	993	young: 56.8% middle: 9.5% old: 20.4%			nominal

Table 2. Cont.

Variable	N	Mean/Frequency in %	SD	Min/Max	Scale
FOA	1007	no: 71% yes: 29%			nominal
SUBSIDIES	992	no: 87.2% yes: 12.8%			nominal

A comparison of the willingness to engage in specific activities with the feedback loop also shows that the willingness to engage for all activities is higher in the future. This higher frequency is particularly pronounced for HABITATTREENOTUSE (+33.1%p), CONVERSION (+27.6%p) and KEEPOFF (+27.6%p).

It can be seen that 25% of the small owners belong to the Established milieu (MILIEU) and almost 80% of the forests are managed by small owners or their families (OPERATOR). Small owners live mostly (85%) in more rural areas (RESIDENCE) with an average distance of 46 km (median: 2.5 km) to their forest property (DISTANCE) and share the forest with 1–2 co-owners of their ownership community (OWNERS). Remarkably, only 29% of small owners are members of a forest owner association (FOA) and only 12.8% have received public subsidies in the past (SUBSIDIES).

The results of the eight regression models reduced by backward selection procedure (Table 3) are presented and described below. Only significant factors relevant to the discussion of the results are mentioned in the text.

4.1. CONVERSION Model

The willingness to convert coniferous to deciduous stands (CONVERSION) is strongly determined by milieu affiliation (MILIEU). For example, small owners in the Adaptive-Pragmatic, Social-Ecological and Modern Mainstream milieus show a significantly lower willingness to convert coniferous forest to deciduous forest, while Expeditive small owners show a higher willingness. Small owners who are willing to convert coniferous forests into deciduous forests show an attitude towards the economic importance (CASHRELEVANCE) of their forest. Small owners with a homogeneous rather than heterogeneous age class distribution in their forest ownership (MATURITY) show a significantly lower willingness to convert their forests, which is reflected in all three regression coefficients (young, middle, old). The main operator for the forest ownership (OPERATOR) has a significant positive effect on the willingness to CONVERSION. Thus, small owners whose forest is managed by external public foresters show a higher willingness to convert their forest.

4.2. PLANTALIEN Model

The willingness to plant alien tree species (PLANTALIEN) is mainly determined by variables of the selection instances (OPERATOR and CONTACTPERSONS). For instance, small owners whose forest is managed by public foresters (OPERATOR) show a lower willingness to plant than self-managed small owners. The same applies to small owners whose forest management may be the responsibility of private foresters. On the other hand, CONTACTPERSON has a positive effect on the willingness to PLANTALIEN. Similarly, living in the countryside (RESIDENCE), being a member of a forest owner association (FOA) and having an old versus a mixed age distribution (MATURITY) in the forest ownership have a positive effect on the willingness to plant alien tree species.

Table 3. Estimates of the backward selected logistic regression models on the willingness of small-scale private forest owners in Germany to engage in forest management activities; OR = odd ratios; SE = standard error.

Variable	CONVERSION				PLANTALIEN				MAINTENANCE				TIMBERLOGGING			
	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>
Intercept	1.176	3.243	0.601	*	−2.665	14.368	0.748	***	5.653	285.036	1.220	***	−2.472	11.848	0.853	***
Forest management activity _{fb1} ¹	2.660	14.297	0.304	***	4.847	127.352	0.551	***	2.836	17.047	0.468	***	2.124	8.362	0.274	***
MILIEU	Established															
Liberal-Intellectual	−0.147	1.158	0.418						−1.358	3.890	0.696	*				
Performers	0.480	1.616	0.376						−1.501	4.486	0.611	**				
Expeditive	1.531	4.623	0.596	**					−2.744	15.551	0.782	***				
Adaptive-Pragmatic	−3.097	22.130	1.159	***					−5.237	188.139	1.149	***				
Social-Ecological	−0.755	2.128	0.431	*					−0.245	1.277	0.987					
Modern Mainstream	−0.892	2.441	0.286	***					−1.502	4.489	0.643	**				
Traditional	0.265	1.304	0.457						−1.021	2.777	0.834					
Precarious	0.118	1.126	0.635						−1.476	4.375	0.920					
Hedonists	0.661	1.936	0.569						−1.752	5.767	1.060	*				
FORESTFUNCTION	0.229	1.257	0.082	***	−0.128	1.137	0.085		0.129	1.138	0.146		−0.329	1.389	0.104	***
CASHRELEVANCE	0.191	1.211	0.105	*	−0.109	1.116	0.108		−0.282	1.326	0.204		0.504	1.655	0.143	***
OUTSOURCE	0.534	1.706	0.273	*	0.618	1.855	0.283	**								
CONTACTPERSONS	0.401	1.493	0.194	**	0.412	1.510	0.207	**					0.047	1.048	0.251	
OPERATOR	internal															
external private	−1.086	2.964	0.391		−0.739	2.094	0.444	*	−0.486	1.625	0.591		−0.702	2.018	0.445	
external public	0.671	1.957	0.494	***	−0.959	2.608	0.555	*	2.582	13.219	1.285	**	2.253	9.517	0.804	***
nobody	−0.157	1.171	0.492		−1.417	4.125	0.896		−1.157	3.180	0.579	**	−0.611	1.842	0.545	
MEDIA-QUAL					−0.206	1.229	0.148									
MEDIA-QUANT	0.117	1.124	0.072		0.129	1.138	0.106		0.255	1.291	0.140	*	0.063	1.066	0.087	
GENDER									−1.208	3.345	0.433	***	0.511	1.667	0.262	*
AGE					−0.014	1.014	0.008	*	−0.037	1.038	0.014	***	−0.008	1.008	0.009	
OWNERS					0.005	1.005	0.013									
RESIDENCE	0.188	1.207	0.332		0.885	2.424	0.466	*	−1.139	3.123	0.565	**	2.122	8.350	0.377	***
PRIMARYSECTOR	0.033	1.033	0.239										−0.634	1.884	0.309	**
SIZE	−0.074	1.076	0.030	**					0.100	1.105	0.069					
FRAGMENTATION	−0.072	1.074	0.049		−0.047	1.049	0.059						0.247	1.280	0.121	**
DISTANCE	0.000	1.000	0.001		0.000	1.000	0.001		−0.001	1.001	0.002		0.002	1.002	0.001	
ROAD	0.115	1.122	0.244		0.409	1.505	0.258		2.026	7.585	0.435	***	0.474	1.606	0.273	*
COMPOSITION	mix															
	deciduous															
	coniferous															
MATURITY	mix															
young	−1.711	5.536	0.458	***	0.242	1.274	0.415		−1.447	4.249	0.855	*	0.536	1.710	0.498	
middle	−1.249	3.487	0.419	***	0.135	1.145	0.372		−1.700	5.474	0.773	**	0.158	1.171	0.449	
old	−2.008	7.447	0.513	***	0.987	2.684	0.510	*	−1.613	5.019	0.889	*	0.398	1.489	0.583	

Table 3. Cont.

Variable	CONVERSION				PLANTALIEN				MAINTENANCE				TIMBERLOGGING			
	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>
FOA SUBSIDIES	−0.210	1.233	0.356		0.553 0.354	1.739 1.424	0.264 0.390	**	1.104	3.017	0.577	*	0.864 0.586	2.373 1.798	0.378 0.600	**
N	703				697				763				709			
CCR	0.73				0.79				0.91				0.86			
Cox and Snell R ²	0.30				0.33				0.26				0.32			
McFadden R ²	0.34				0.38				0.56				0.44			
Variable	TRACKCLEAR				HABITATREENOTUSE				ZEROLOGGING				KEEPOFF			
	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>
Intercept	−0.578	1.782	0.610		1.364	3.911	0.740	*	0.978	2.658	0.695		0.086	1.090	0.676	
Forest management activity _{fbi} ¹	2.946	19.025	0.210	***	2.266	9.644	0.310	***	1.693	5.435	0.236	***	2.660	14.297	0.322	***
MILIEU																
Established									−0.214	1.239	0.390		0.286	1.331	0.371	
Liberal-Intellectual									−0.285	1.330	0.348		0.375	1.454	0.330	
Performers									0.854	2.348	0.551		0.643	1.903	0.531	
Expeditive									5.261	192.696	2.186	**	−2.563	12.973	1.382	*
Adaptive-Pragmatic									−1.409	4.091	0.409	***	−0.388	1.474	0.392	
Social-Ecological									1.184	3.268	0.295	***	0.490	1.632	0.279	*
Modern Mainstream									0.495	1.640	0.405		0.841	2.319	0.372	**
Traditional									−0.086	1.090	0.658		0.768	2.157	0.583	
Precarious									0.897	2.451	0.560		−0.557	1.745	0.538	
Hedonists									0.393	1.482	0.085	***	0.188	1.207	0.079	**
FORESTFUNCTION	−0.030	1.031	0.076		0.563	1.756	0.094	***	0.393	1.482	0.085	***	0.188	1.207	0.079	**
CASHRELEVANCE	0.090	1.094	0.091		−0.111	1.118	0.104		−0.321	1.378	0.098	***	−0.214	1.239	0.097	**
OUTSOURCE													0.637	1.892	0.260	**
CONTACTPERSONS	−0.140	1.150	0.177		0.498	1.646	0.196	**	0.442	1.555	0.182	**	0.214	1.239	0.175	
OPERATOR																
internal																
external private	0.120	1.127	0.375		−1.537	4.649	0.388	***	−0.483	1.620	0.388		−1.485	4.417	0.441	***
external public	0.503	1.654	0.469		1.919	6.812	0.769	**	1.309	3.703	0.502	***	0.094	1.098	0.437	
nobody	0.374	1.454	0.496		−0.412	1.510	0.633		0.888	2.430	0.588		−0.222	1.248	0.527	
MEDIA-QUAL									−0.185	1.203	0.129		−0.252	1.287	0.128	**
MEDIA-QUANT					−0.007	1.007	0.079		0.101	1.106	0.098		0.303	1.353	0.096	***
GENDER	0.680	1.974	0.208	***	−0.379	1.460	0.258		−0.614	1.848	0.233	***	−0.583	1.792	0.217	***
AGE	−0.020	1.020	0.007	***	0.003	1.003	0.008		−0.011	1.011	0.008		−0.003	1.003	0.008	
OWNERS	0.005	1.005	0.019		0.005	1.005	0.015		−0.013	1.014	0.012		0.010	1.010	0.009	
RESIDENCE	−0.009	1.009	0.302		−0.715	2.044	0.469		−1.349	3.853	0.386	***	−0.506	1.659	0.301	*
PRIMARYSECTOR	−0.136	1.146	0.223						−0.543	1.722	0.224	**	0.131	1.139	0.218	
SIZE									0.076	1.079	0.028	***				
FRAGMENTATION	−0.011	1.011	0.050		−0.056	1.057	0.053		0.003	1.003	0.051		−0.013	1.014	0.051	
DISTANCE	0.002	1.002	0.001	*	0.005	1.005	0.003	**	0.000	1.000	0.001		0.000	1.000	0.001	
ROAD	0.740	2.096	0.223	***					−0.448	1.566	0.241	*	0.004	1.004	0.226	

Table 3. Cont.

Variable	CONVERSION				PLANTALIEN				MAINTENANCE				TIMBERLOGGING				
	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	Coefficient	OR	SE	<i>p</i>	
COMPOSITION																	
	mix				0.324	1.382	0.321		0.500	1.648	0.259	*	0.500	1.648	0.246	**	
	deciduous				−0.465	1.592	0.250	*	−0.203	1.225	0.257		−0.180	1.197	0.248		
	coniferous																
MATURITY	mix																
	young	−0.968	2.634	0.348	***	−0.463	1.589	0.401		0.196	1.217	0.368		−0.078	1.081	0.349	
	middle	−0.404	1.498	0.297		−0.165	1.180	0.367		0.621	1.861	0.323	*	−0.944	2.570	0.313	***
	old	−1.398	4.046	0.431	***	0.392	1.479	0.569		−0.144	1.155	0.466		−1.182	3.260	0.450	***
FOA		0.603	1.827	0.247	**												
SUBSIDIES		−0.655	1.924	0.343	*	−0.089	1.093	0.335		−0.320	1.378	0.325		−0.562	1.755	0.345	
N		791				705				702				698			
CCR		0.78				0.78				0.71				0.69			
Cox and Snell R ²		0.35				0.26				0.34				0.26			
McFadden R ²		0.37				0.33				0.36				0.26			

¹ This variable represents the forest management activity in the past 10 years in correspondence to the dependent variable. For example, in the case of CONVERSION, it is CONVERSION_{fb1}. * Significant at $\alpha \leq 0.10$; ** significant at $\alpha \leq 0.05$; *** significant at $\alpha \leq 0.01$.

4.3. MAINTENANCE Model

Similarly to CONVERSION, the willingness to cut down single trees to maintain the forest (MAINTENANCE) is strongly dependent on the milieu affiliation (MILIEU). In this case, small owners of all significant milieus show a lower willingness compared to small owners of the Established milieu. The variable OPERATOR shows that, in contrast to private foresters, public foresters cause a higher willingness to MAINTENANCE. The variable ROADS has a positive effect on MAINTENANCE, so that MAINTENANCE increases with the existence of a forestry infrastructure. In contrast, the variable MATURITY has a strong negative influence on MAINTENANCE. Thus, small owners with a homogeneous distribution of age classes in their forest ownership show a significantly lower willingness to cut down single trees to maintain the forest than small owners with a heterogeneous distribution of age classes, which can be seen for young, middle and old stands. There is also a difference between deciduous and coniferous forests (COMPOSITION). Here, small owners with a deciduous forest type show a higher willingness to MAINTENANCE. The variables GENDER and RESIDENCE show a negative effect on MAINTENANCE, whereas FOA has a positive effect. This suggests that women and urban owners are more likely to cut down single trees to maintain the forest. On the other hand, membership of a forest owner association reduces this willingness to engage.

4.4. TIMBERLOGGING Model

The willingness to log wood for timber usage (TIMBERLOGGING) mainly shows a strong dependence on the variables OPERATOR and RESIDENCE. Public foresters positively determine the willingness to TIMBERLOGGING. A rural residence shows a beneficial effect on the willingness to log wood for timber usage. Small owners who show a willingness to log wood for timber usage assign an economic relevance (CASHRELEVANCE) to their forest. Compared to women, men (GENDER) show a higher willingness. Similarly to the willingness to cut down single trees to maintain the forest (MAINTENANCE), the existence of a forestry infrastructure (ROAD) and the membership in a forest owner association (FOA) have a positive effect on TIMBERLOGGING. Only (past) employment in the primary sector (PRIMARYSECTOR) negatively conditions TIMBERLOGGING.

4.5. TRACKCLEAR Model

The willingness to clear forest tracks for forest visitors (TRACKCLEAR) is determined by the age class distribution (MATURITY) of the forest ownership. Accordingly, small owners with an inhomogeneous age class distribution show a significantly higher willingness to TRACKCLEAR compared to a young or old age class distribution. Males (GENDER) show a higher willingness to clear forest tracks for forest visitors. Similarly, the existence of a forestry infrastructure (ROAD) and the membership in a forest owners association (FOA) positively determine the willingness to clear forest tracks as seen in the MAINTENANCE and TIMBERLOGGING model. It should be noted that a weak correlation ($\Phi = 0.22$) was found between the dependent variables of TRACKCLEAR and TIMBERLOGGING. This suggests that small owners are not only willing to clear their tracks specifically for forest visitors, but also to transport harvested wood. Finally, the use of public subsidies (SUBSIDIES) in the past shows a negative influence on the TRACKCLEAR model.

4.6. HABITATTREENOTUSE Model

The results for the HABITATTREENOTUSE model show that the non-usage of habitat trees depends primarily on the person who takes care of the forest (OPERATOR). As in the previous models, public foresters are shown to have a significant positive effect on the willingness of small owners, in contrast to private foresters. The number of contact persons (CONTACTPERSONS) also shows a positive influence on the willingness to not use habitat trees. Consistently with the influence of OPERATOR, this result shows that direct communication with contact persons has a positive influence on the willingness towards non-usage of habitat trees. Small owners who are willing to not use habitat trees

assign a more public forest function (FORESTFUNCTION) to their forest property. Small owners with a coniferous forest type compared to a mixed forest type (COMPOSITION) show a significantly lower willingness to not use habitat trees.

4.7. ZEROLOGGING Model

The results for ZEROLOGGING show that the willingness to not log wood depends strongly on the milieu affiliation (MILIEU). In particular, Adaptive-Pragmatic small owners as well as Modern Mainstreamers show a significantly higher willingness than small owners from the Established milieu. Small owners who are willing to not log wood show no attitude towards the economic importance (CASHRELEVANCE) of their forest. Compared to the coefficients in the TIMBERLOGGING model, the variables RESIDENCE and GENDER have an opposite effect on the willingness to not log wood. Thus, urban living and female small owners are more willing to not log wood than rural living or male small owners. In this model, the variable OPERATOR shows an effect similar to RESIDENCE: small owners whose forest is managed by public foresters show an increasing willingness to not log wood. As in the PLANTALIEN and HABITATREENOTUSE models, an increasing number of contact persons (CONTACTPERSONS) has a positive effect on the willingness to ZEROLOGGING. Small owners with a more deciduous-dominated forest ownership (COMPOSITION) show a higher willingness to not log wood, as well as do small owners with a more homogeneous age class distribution (MATURITY), which is significant for a middle aged forest-dominated age class distribution. The variable PRIMARYSECTOR has a weak negative influence on ZEROLOGGING, showing that small owners with a former or current employment in the primary sector are less willing to not log wood.

4.8. KEEPOFF Model

Once again, the variable MILIEU shows a strong influence on the willingness of small owners to prohibit access to the forest in certain areas (KEEPOFF). Members of the Adaptive-Pragmatic milieu show a significantly lower willingness to prohibit access compared to the Established small owners. In contrast, the milieus of the Modern Mainstream and Traditional milieu show a significantly higher willingness to prohibit access to the forest in certain areas. As in the ZEROLOGGING model, small owners do not show any attitude towards the economic importance (CASHRELEVANCE) of their forest if they are willing to prohibit access their forest. From the group of the internal psychological structure, the willingness to outsource the forest responsibility in all aspects of forest management to professional foresters (OUTSOURCE) also shows a positive influence on willingness to prohibit access to the forest. OPERATOR shows a strong influence on KEEPOFF. Accordingly, self-managed small owners are more willing to prohibit access to the forest than small owners whose forests are cared for by private foresters. The variable MATURITY shows a medium and weak effect on KEEPOFF. The willingness to prohibit access to the forest in certain areas decreases with an increasingly older age class distribution, as shown by the variable MATURITY. The results of the variables GENDER, RESIDENCE and COMPOSITION are similar to those in the ZEROLOGGING model. Thus, male as well as rural living small owners show a lower willingness to prohibit access to the forest in certain areas. Small owners with a rather dominant proportion of deciduous wood in their forest ownership also show a higher willingness to prohibit access to the forest than small owners with mixed forests.

5. Discussion

Small owners manage one quarter of the forest area in Germany, so that the forest management activities of this group of people are of central importance for the provision of forest services demanded by society. For this reason, this study analyzed the factors influencing the willingness of small owners to engage in eight different forest management activities. In order to draw implications for the development of a target-group-specific design of support instruments the first-time implementation of the lifestyle segmentation

approach according to Sinus [44] expanded the knowledge of potential explanatory factors in the analysis, in addition to the relevant influencing factors on forest management activities already identified in the past.

Furthermore, this study allows, for the first time, statements to be made about small owners on a representative level for the whole of Germany. On the one hand, the results show that Germany has a growing ecosystem-based management perspective compared to other Western European countries, as already noted by Feliciano et al. [15]. On the other hand, the low usage of public subsidies and their limited influence on individual forest management activities is evident, which was also found by Haeler et al. [22] for Austria, Finland and Slovenia.

5.1. Factors Influencing the Willingness to Engage in Forest Management Activities

All variable groups of Pregernig's [46] framework used to conceptualize the study provide explanatory contributions for the analyzed willingness of small owners to engage in various activities in their forests. The relevant identified influencing variables on forest management activities can be characterized into feedback loop, Sinus milieus, communication structures, sociodemographic and socioeconomic factors and institutional support instruments. For half of the examined forest management activities, the classification to different Sinus milieus, i.e., the lifestyle type of small owners, provides a significant explanatory contribution. A discussion of Sinus milieus and the additional variables FORESTFUNCTION and CASHRELEVANCE will be addressed in a subsequent chapter. The remaining influencing factors will be covered in the following paragraphs.

The feedback loop has a strong influence on the willingness to all analyzed forest management activities. This underlines that small owners, presumably due to positive experiences with the activities undertaken, have lowered a "threshold" and thus intend to continue implementing the same activities in the future. This highlights the importance of the "initial activation" of small owners for forest management activities [32]. In the context of biodiversity conservation measures, Koskela and Karppinen [36] also conclude that previously implemented actions have a positive effect on future activities. Furthermore, the repetition of an activity leads to reduced transaction costs for small owners [86], who do not have to face high information costs for potential service providers or the sale of forest products on the timber market before implementing a forestry activity [87].

Another important influencing factor for all analyzed forest management activities, with the exception of TRACKCLEAR, is the communication structure of small owners. In this context, the presence of professional foresters (OPERATOR) and the total number of contact persons for forest management decisions (CONTACTPERSONS) play a decisive role. This result is in line with several studies. These conclude that the presence of an advisory forester has a positive influence, e.g., on the approval of conservation practices [29], stand improvement decisions [88] and measures to safeguard biodiversity [36], or generally playing an important role in motivating, organizing and extending forest owners [39]. The positive influence of public foresters (OPERATOR) is particularly evident in this study. Public foresters may be more effectively involved in decision-making processes than private foresters, forest service providers, other forest owners, associations, forest administrations or leaders of forest owner associations. In addition, as members of local institutions, public foresters may enjoy a higher level of trust among small owners. However, only 6% of small owners reported that public foresters take care of their forests as operators. When comparing small owners whose forests are managed by private foresters with those who manage their forests themselves, it can be interpreted that self-managed small owners may show a higher willingness because they are actively involved in the decision-making processes as part of self-management and thus have a higher potential for action. Only the willingness to engage in PLANTALIEN is negatively influenced by the presence of public foresters, which can be attributed to the forest management concepts of the public forest administrations when advising private forests.

The results on socio-demographic and socio-economic factors are largely in line with the literature: older small owners (AGE) are less likely to engage in forest management activities than younger ones [27,30,37]. Owners with a focus on timber harvesting (TIMBERLOGGING) tend to be male (GENDER) and also have a rural residence (RESIDENCE) [32,89–91]. Female small owners and those living in urban areas show a higher willingness to engage in more or less resource-related activities (MAINTENANCE, ZEROLOGGING, KEEPOFF) [92]. However, it is important to note that small owners often share forests with several owners, so the interpretation of gender-specific willingness may not be free of bias.

The negative effect of (past) employment in the primary sector (PRIMARYSECTOR) on TIMBERLOGGING can be explained by the fact that small owners working in the secondary and tertiary sectors may receive more advice and support from professional foresters due to their lower level of expertise. As a result, these small owners may be more willing to engage than small owners in the primary sector who manage their forests independently and without advice.

The size of forest ownership only contributes to the explanation of two activities: the willingness to convert coniferous to deciduous stands (CONVERSION) and to not log wood (ZEROLOGGING). This finding is in direct contrast to other studies which indicate a greater impact of this variable on forest management activities [15,27,30]. This effect can possibly be explained by the fact that the small owners surveyed in this study only own forest land <20 ha, while economic aspects may be more important for forest enterprises >20 ha.

The structural characteristics of the forests, with the predominant age class of the stands in the forest holding (MATURITY) on the one hand, and the predominant forest type (COMPOSITION) on the other hand, influence and are influenced by forest management activities [40,93]. Juutinen et al. [35] and Eggers et al. [38] point out that forest-related factors, such as age-class distribution, are important variables for analyzing the management decisions of small owners, and their omission may limit the results and the conclusions derived from these. For this reason, the structural characteristics of forestry holdings were taken into account in the analysis, but are not discussed in detail here. However, these fundamental characteristics of the forest must be taken into account when drawing conclusions from this study for the development of support instruments for small owners.

Public subsidies (SUPPORT) as an institutional support instrument play a relatively limited role for small owners. Public subsidies have generally had a minor impact on the willingness to engage in activities in the past, as confirmed by Mostegl et al. [18] and Church and Ravenscroft [94]. Small owners often do not take advantage of these subsidies because their forest areas are too small and they do not see any additional benefit in seeking such support [95]. Individual transaction costs for a one-off subsidy may be too high due to bureaucracy and administrative requirements [19].

In contrast, a membership in a forest owner's association (FOA) has a positive influence on timber use-related willingness and associated activities (ALIEN, MAINTENANCE, LOGGING, TRACKCLEAR) [74,96]. This result is in line with the objectives of forest owner associations according to §17 of the Federal Forest Act. Forest owner associations serve as a classical instrument to overcome the structural disadvantages of small owners, but they only reach slightly less than one third of the forest owners surveyed in this study (29%). In addition, the high willingness to cut down single trees to maintain the forest (MAINTENANCE) and to log wood for timber usage (TIMBERLOGGING), but low growth rates, suggest that the organization of small owners through FOAs is unlikely to be very popular in the future and that the additional potential for action with regard to these activities may already be exhausted. The positive effect of a FOA membership on willingness to clear forest tracks for forest visitors (TRACKCLEAR) can be explained by the correlation of TRACKCLEAR with TIMBERLOGGING, indicating that TRACKCLEAR can be interpreted as a measure in the process of timber provision and is not undertaken specifically for recreationists. It can therefore be assumed that, despite an increasing

demand for forests by visitors compared to the past [97], the free right to enter the forest for recreational purposes, as provided for in the Federal Forest Act [98], is only tolerated by many small owners and not actively supported.

5.2. Contribution of the Sinus milieus to Explain the Willingness to Engage

When examining the explanatory contributions of the Sinus milieus, it is first of all noticeable that they have a significant influence primarily on CONVERSION, MAINTENANCE, ZEROLOGGING and KEEPOFF. The milieu affiliation is the strongest significant influencing factor on the willingness to engage in forest management activities. This result emphasizes the potential of a lifestyle segmentation approach like Sinus [44] to address small owners in a target group-specific way based on their willingness to engage in forest management activities. In contrast, with the exception of MAINTENANCE, these forest management activities do not show any significant association with the classical institutional activation and support instruments for small owners (FOA and SUPPORT). It can therefore be assumed that these forest activities are more closely associated with owner perspectives that are not in line with the traditional objectives of a FOA. It also shows that the activities CONVERSION and KEEPOFF, which can be explained by the Sinus milieus, have an increased potential for action among small owners. This increased potential for action may be an indication of the growing popularity of these non-commodity-related activities, which has also been found in other studies [34]. Forests are thus seen not only as suppliers of wood products, but also as landscapes for the implementation of climate and nature conservation goals [99–101].

Within the group of small owners surveyed, the milieu-specific lifestyle types according to Sinus [44] are clearly identifiable. For example, the significantly lower willingness of small owners from the Performer milieu to engage in extensive maintenance activities can be explained by their stronger efficiency and performance-oriented attitude compared to small owners from the Established milieu [44,102]. Small owners from the Liberal-Intellectual milieu do not differ significantly from small owners from the Established milieu in terms of their willingness to engage in CONVERSION, ZEROLOGGING and KEEPOFF. Against this background, it can be assumed that the Liberal-Intellectual milieu and the Established milieu can be activated with similar objectives through policy mixes. This assumption can be supported by the findings of Schleer and Reusswig [103], who attribute a significantly higher level of environmental awareness to both milieus, suggesting a greater willingness to engage in related activities. It can be assumed that the financial situation of small owners in both the Modern-Mainstream and the Adaptive-Pragmatic milieus is a key determinant of their willingness to engage in specific management activities. Both milieus show a significantly lower willingness to invest in CONVERSION and MAINTENANCE, but a higher willingness for the cost-free activity of ZEROLOGGING. Investment activities in the forest are probably more feasible for small owners with a higher social status. This interpretation is supported by the significant effects of the variables FORESTFUNCTION and CASHRELEVANCE. The willingness of small owners to engage in CONVERSION, HABITATTREENOTUSE, ZEROLOGGING and KEEPOFF reflects a public forest function (FORESTFUNCTION) in their forests, but in the CONVERSION model, it also reflects an economic relevance (CASHRELEVANCE) of the forest ownership. However, in the KEEPOFF and ZEROLOGGING models, this economic effect is negative. From the perspective of small owners, these non-resource-related activities appear to serve a public or societal function. CONVERSION is more complex because it depends on the financial situation of the owners. In addition to the suggestion in the previous chapter that economic motives play a relatively minor role for small owners, it can also be assumed that although small owners may not have a direct income objective related to their forests, they consciously evaluate their investment decisions in their forests. The effect of higher education on a reduced willingness to engage in forest activities related to timber provision, as observed in Dennis [104] and Joshi and Mehmood [89], is not evident in the present study when assessed in the context of Sinus milieus. However, a greater willingness to engage in nature-

and climate-related activities due to higher education [28,29,105–108] can be assumed based on the results for the Established and Liberal-Intellectual milieus.

5.3. Model Validation

Compared to the reliable studies by Cai et al. [73], Joshi and Arano [75] and Shin and Yeo-Chang [109], the eight regression models provide acceptable goodness of fit compared to the McFadden R^2 in those studies. The weakest model statistics in the comparison are shown for the HABITATTREENOTUSE and KEEPOFF models. These may be more difficult to explain because activities such as ZEROLOGGING and KEEPOFF are less actively pursued by small owners, but rather the result of their deliberate or possibly undeliberate inactivity in the forest.

The high explanatory contribution of the Sinus milieus in the models CONVERSION, MAINTENANCE, ZEROLOGGING and KEEPOFF underlines the need to take into account the complexity of social living conditions, compared to the isolated approach of these influencing factors in previous studies.

In this research, site conditions were considered by providing information on the dominant forest type (COMPOSITION) and the age class distribution in the forest stand (MATURITY).

In particular, MATURITY has a strong influence and a significant explanatory contribution in almost all models.

The analysis of the indirect communication variables shows only a small influence on the activities of small owners. Nevertheless, according to Lawrence et al. [14] and Virkkula [110], digital communication structures are considered important for the implementation of forestry extension in the future. Koller and Gaggermeier [111] highlight that forest owners are evolving from linear, one-way communication styles to digital and participatory two-way communication styles in their media usage. The low informative value of the variables describing media usage in this study can be attributed to an unfavorable operationalization of the variables in the models. The inadequate survey coverage of the relevance of information for forest owners with different media usage may also be a factor. In future studies, the media channels used by small owners should be considered separately as explanatory variables.

5.4. Limitations

Firstly, because of the statistical correlation between TRACKCLEAR and TIMBERLOGGING, the results do not allow clear conclusions to be drawn about the factors influencing the willingness to engage in actions to clear forest tracks specifically for recreationists. It should also be noted that small owners show a higher willingness to engage in some activities due to increased social attention and demand for, for example, non-commodity forest services, combined with an increased “social desirability” of these services. Accordingly, in some cases the fulfilment of this social desirability may have led respondents to provide answers without actually being willing to undertake the chosen forest management activity [103,112]. The low level of willingness to engage in PLANTALIEN can be explained by the skepticism of small owners towards non-native tree species [113]. However, it is also conceivable that during the survey, it was unclear to some small owners what was meant by “alien tree species” in general, which should be taken into account in a follow-up survey. Technical silvicultural terms should therefore be explained more clearly in a follow-up survey.

When interpreting the results, it should be noted that they are only representative at the federal level and that regionalized analyses are not possible due to an insufficient number of subsamples at the state level. However, several forest-related issues differ considerably between the federal states and, in some cases, between regions within a federal state [114–116]. For example, many forest policy competencies are transferred from the federal to the state level, leading to differences in institutional support by agencies between and within states [116], which plays a role in the FOA and SUBSIDIES variables, for example.

Moreover, the results are only valid under the forest management conditions at the time of data collection. For example, it is possible that the position of public foresters could be weakened in the future by the change from indirect to direct subsidization of forest owners by forest owner associations in some countries [117]. This could also change the influence of forest owner association membership on provisioning-based activities. The extreme weather events in parts of Germany in 2018 and the following years and the increasing awareness of climate change are not reflected in the dataset, so the results of a today's survey could be different [118].

6. Conclusions

The sustainable management of small private forests has become increasingly important due to a growing societal demand for forest ecosystem services, the adaptation of forests to climate change, diverse owner objectives and current forest policy challenges. Therefore, the aim of this study was to analyze the influencing factors on the willingness to forest management activities. The results allow a target group-specific approach of small owners, in order to motivate them to support demanded ecosystem services in small private forests.

The study found that, in addition to a high level of willingness to engage in non-commodity-related activities, wood provision is already largely undertaken by small owners, which is in line with the aim of the Charter for Wood [119]. Wood provision is most dependent on the influence of professional foresters, factors of the objective environment and membership in a forest owner association. In this respect, the role of local foresters and forest owner associations is crucial to ensure that the actions intended by small owners can be implemented. However, the low participation rates of small owners in these mobilization and activation instruments illustrate their limited reach and the need to expand support mechanisms. Traditional instruments in their current institutional form may not be sufficient to support a wide range of forest activities and associated forest ecosystem services.

The willingness to engage in non-commodity-related activities is generally high compared to previous actions, which can be explained either by a change in the prioritization of these activities by small owners or by a discrepancy between attitude and behavior [120], which could be influenced by social pressure, for example. Non-commodity-related activities are strongly influenced by the milieu affiliation. This underlines the importance and advantage of a lifestyle-based segmentation approach, as used in this study, in order to take into account the complex living conditions of small owners when analyzing their willingness to engage in forest management activities. On the other hand, conclusions can be drawn about which activities can reach and activate specific small owners through a target-oriented approach. For example, small owners from the Established and Liberal-Intellectual milieus make up just under a third of forest owners (35%) and show a high willingness to engage in activities like CONVERSION or ZEROLOGGING. Small owners from the Modern-Mainstream milieu (7.4%) show a similar willingness, but are more dependent on financial resources. Accordingly, this milieu should be particularly receptive to sector-specific financial support instruments in order to be able to undertake active forest management. These results demonstrate the importance of lifestyle segmentation approaches like the Sinus milieus for addressing small owners in a target-group-specific way. Due to the changing objectives in small private forests and the need for a change of perspective in advising forest owners, these findings should be further developed in future studies. On this basis, new direct and indirect information and communication concepts could be developed.

This study is the first to determine the 'status quo' of the willingness of small owners to engage in forest management activities at the federal level, which should be repeated on an ongoing basis in order to be able to better assess current developments. Similarly to the National Forest Inventory, Feil et al. [11] propose a 10-year telephone survey for

this purpose, as well as a weighted online panel survey in the intermediate years. The continuation of the survey was welcomed by most private forest owners.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/f15020319/s1>, Table S1: Questionnaire for the survey of private forest owners in Germany [11].; Table S2: Eigenvector matrices for FORESTFUNCTION and CASHRELEVANCE. PC = principal component.; Table S3: Variance inflation factor (VIF) values of the explanatory variables.

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Appendix A

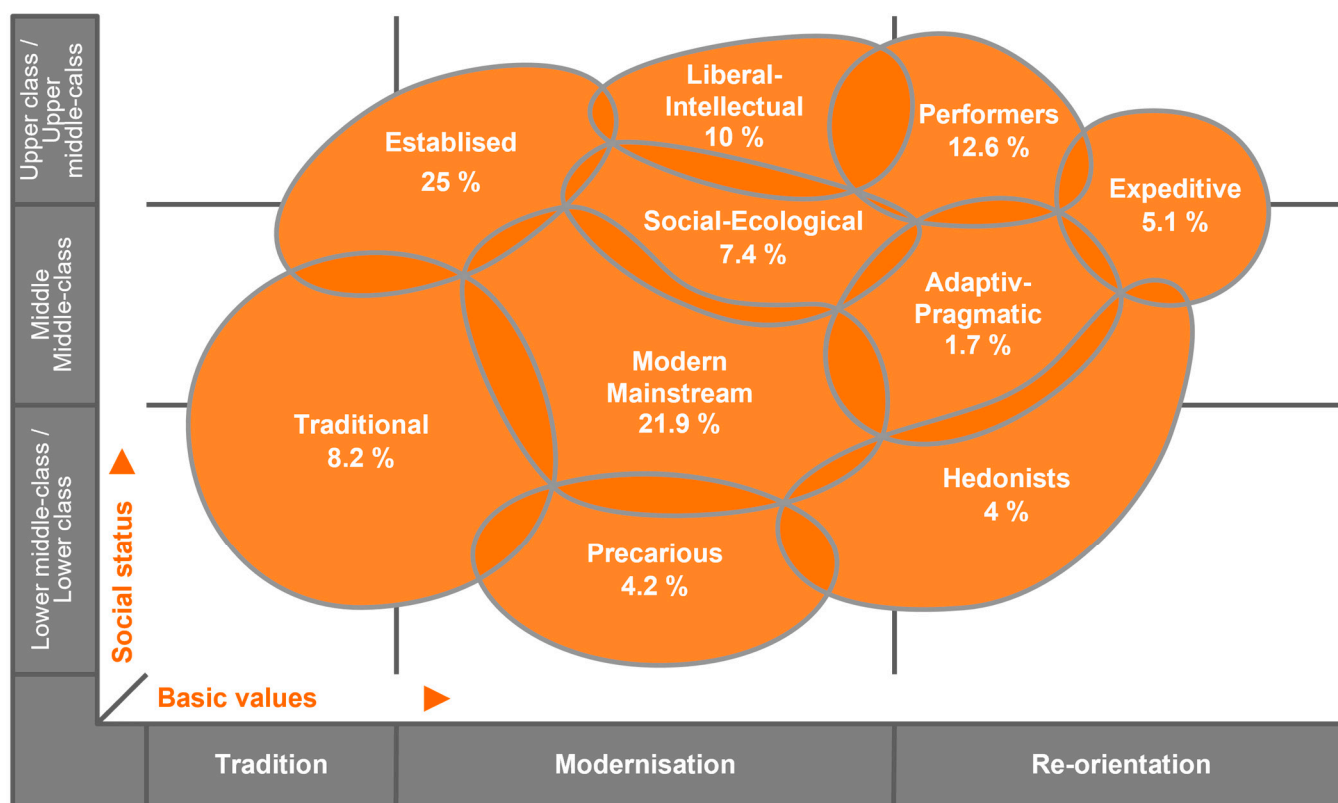


Figure A1. Distribution of German small-scale private forest owners in the Sinus milieus [44], reproduced with permission of Sinus Markt- und Sozialforschung GmbH, 2017.

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