



Research

## Forest owner representation of forest management and perception of resource efficiency: a structural equation modeling study

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**ABSTRACT.** Underuse of nonindustrial private forests in developed countries has been interpreted mostly as a consequence of the prevailing noncommodity objectives of their owners. Recent empirical studies have indicated a correlation between the harvesting behavior of forest owners and the specific conceptualization of appropriate forest management described as “nonintervention” or “hands-off” management. We aimed to fill the huge gap in knowledge of social representations of forest management in Europe and are the first to be so rigorous in eliciting forest owner representations in Europe. We conducted 3099 telephone interviews with randomly selected forest owners in Slovenia, asking them whether they thought they managed their forest efficiently, what the possible reasons for underuse were, and what they understood by forest management. Building on social representations theory and applying a series of structural equation models, we tested the existence of three latent constructs of forest management and estimated whether and how much these constructs correlated to the perception of resource efficiency. Forest owners conceptualized forest management as a mixture of maintenance and ecosystem-centered and economics-centered management. None of the representations had a strong association with the perception of resource efficiency, nor could it be considered a factor preventing forest owners from cutting more. The underuse of wood resources was mostly because of biophysical constraints in the environment and not a deep-seated philosophical objection to harvesting. The difference between our findings and other empirical studies is primarily explained by historical differences in forestland ownership in different parts of Europe and the United States, the rising number of nonresidential owners, alternative lifestyle, and environmental protectionism, but also as a consequence of our high methodological rigor in testing the relationships between the constructs. We suggest developing natural resource management concepts that emphasize forests not just as ecosystems, but as social-ecological systems.

**Key Words:** *attitudes; conceptualization; management concepts; natural resources; private forest owners; social representations theory; timber supply; values*

### INTRODUCTION

In contrast to the continual decline of forests globally (FAO 2010), European forests have been expanding since the middle of last century (Gold et al. 2006). Current resource conditions indicate their underuse in the past; the ratio of fellings to increment has declined from 90% in 1950 to 55% currently (Nabuurs et al. 2007). Future projections of the availability of timber from European forests show that if current management practices continue, timber supply may increase further for the next 50 years (Nabuurs et al. 2007). The timber supply potential and constraints in extraction have been acknowledged in several policy documents, e.g., the European Union (EU) Forest Action Plan (Commission of the European Communities 2006). The European Commission, while raising the target for renewable energy resources to 20% of overall energy consumption by 2020, underlined that the availability of woody biomass should be taken into account (European Parliament, Council of European Union 2009). Many estimations of the potential (e.g., Nabuurs et al. 2007) and realizable supply of woody biomass (Mantau et al. 2010, Verkerk et al. 2011) have emphasized the importance of social factors that may constrain timber supply. Given the fact that in the EU private forests prevail and that most of the individual- or family-owned forests in the EU are small scale (Schmithüsen and Hirsch 2010) and many private forest owners show strong nonmaterialistic attitudes toward their forests (e.g., Dhubháin et al. 2007), the willingness of private forest owners to provide timber is likely to be one of the key drivers in the mobilization of wood resources in the EU. Many studies on the

social availability of timber from the United States provide evidence on the significance of owner attitudes toward harvesting on timber availability (e.g., Butler et al. 2010, Markowski-Lindsay et al. 2012).

Whenever social factors have been considered in the projections of timber supply, they have been exclusively included as manifest variables, such as socio-demographic characteristics of forest owners or stated ownership objectives (e.g., Max and Lehman 1988, Verkerk et al. 2011). A significant body of private forest ownership literature on owner attitudes, beliefs, objectives, and motivations shows that a substantial share of private forest owners manage their properties for noncommodity objectives (Dhubháin et al. 2007), which do not always correlate with socio-demographic parameters (e.g., Ficko and Boncina 2013). Moreover, there is a lack of empirical studies on whether the harvesting behavior of private owners correlates to a specific representation of forest management that might differ from the scientific representation of forest management. Questions such as what forest owners understand by forest management and whether and how much their representation of forest management influences their perception of resource efficiency have never been studied in Europe on a national scale using social psychology theories and statistical methodologies that take a hypothesis-testing approach. Our research is the first of its kind in the relatively wide body of private forest ownership literature in Europe that studies the theoretical constructs of forest management and resource efficiency among private forest owners using a series of structural relation equations between the abstract

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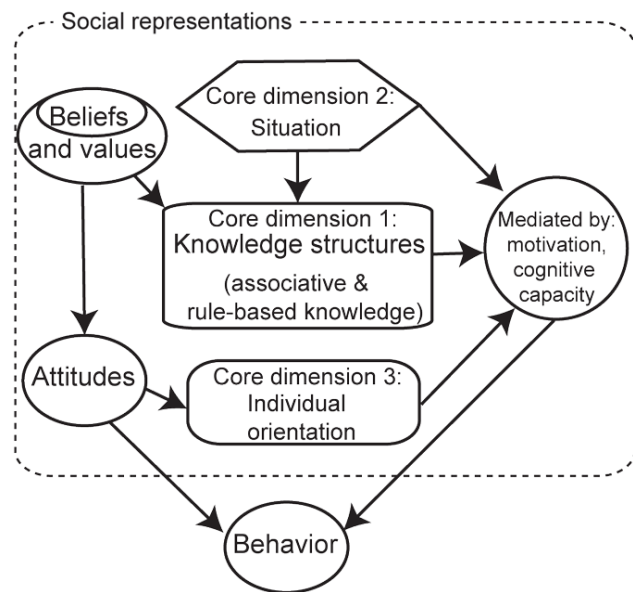
phenomena and their indicators. The differences in the conceptualization of forest management between private forest owners and natural resource professionals may become crucial for the implementation of sustainable forest management in the era of rapidly changing forest ownership from traditional types to new owner types (Hogl et al. 2005).

The rationale for looking beyond the level of private forest owner management objectives is provided within the social representations theory of Moscovici (2008). The theory claims that the beliefs, attitudes, or emotions of a social group constitute the social group-specific representation of reality. It implies that there is no objective world, but the perceived, framed into mental models that represent an internal representation of external reality (Jones et al. 2011). In the view of the social representations theory, any concept, e.g., forest management or efficiency, may be understood differently by different individuals and different social groups. The theory implies that the representations of social group members are similar and can be elicited by different techniques (Jones et al. 2011). Recently, Lynam et al. (2012) provided a synthesis of tools and processes needed to elicit and analyze mental models in human-environment relationships. They concluded that despite the high diversity of meanings associated with mental models, the core elements of social representations of a social group should be interpreted within the framework of existing knowledge structures and always take into consideration the context and the attributes of the individuals of the group (Lynam et al. 2012). Thus, forest owner behavior may be interpreted as the result of their representation of forest management, which consists of values, beliefs, and attitudes in a value-attitude-behavior hierarchy (Homer and Kahle 1988; left side of the Fig. 1) processed in a cognitive system referred to as mental model (Lynam et al. 2012; right side of the Fig. 1).

There is an increasing amount of empirical evidence on different representations of environmental issues by different social groups in Europe, the key groups being scientific communities, e.g., natural resource professionals; policy makers, e.g., governments; and stakeholders, e.g., citizens; see, for example, Hovardas and Stamou (2006), Fischer et al. (2011), Buijs et al. (2012), and Buijs and Elands (2013). However, there is a huge gap in our knowledge of social representations of forest management, particularly with respect to private forest owner representation. This seems to be less the case for the United States. Kearney and Bradley (1998) and Kearney et al. (1999) investigated how U.S. Forest Service employees, timber company employees, and environmentalists, but not forest owners, conceptualize human dimensions of forest management and its content. Rickenbach et al. (1998) examined the adoption of an ecosystem-based forest management concept among private forest owners in Massachusetts and found a positive attitude toward it. Belin et al. (2005) conducted a similar study on the receptivity of private forest owners to an ecosystem-based approach to management in the northern United States using the same measurement instrument as Rickenbach et al. (1998). Although both studies investigated the adoption of a single management concept defined in advance and thus cannot be treated as social representations studies, they provide important insights on the attitudes of forest owners toward one forest management paradigm. Erickson et al. (2002) explored forest owner approaches to forest management in the midwestern

United States by asking them to indicate how well each of the several proposed activities describe the management on their properties. Steiner Davis and Fly (2010) conducted another quantitative empirical study on forest owner conceptualization of forest management. However, like the study of Erickson et al. (2002), this study also referred to the United States, which might make it difficult to use these as benchmark studies for research in other cultural contexts. Moreover, Steiner Davis and Fly (2010) did not quantify the magnitude of the relation between nonuse value-related representations of forest management and harvesting behavior.

**Fig. 1.** Simplified conceptual model of forest owner representation of forest management influencing harvesting behavior; mental model adapted from Lynam et al. (2012), complemented with the value-attitude-behavior hierarchy.



Recently, Lawrence and Dandy (2014) reviewed predominantly “grey literature” in the United Kingdom in the field of values, beliefs, and attitudes of private forest owners. They concluded that there is variability in the representation of management among forest owners and contrast between the official perception of undermanaged forests and owner beliefs that appropriate forest management was being undertaken. However, Lawrence and Dandy (2014) did not provide empirical evidence on forest owner representation of forest management.

Bearing in mind the lack of quantitative research on social representations of forest management in Europe, our aims were (1) to provide empirical evidence on forest owner representation of forest management using social representations theory and a confirmatory approach to the analysis of the forest management construct; (2) to identify the biophysical and conceptual constraints in timber supply perceived by private forest owners; and (3) to verify and quantify the association between forest owner representation of forest management and their perception of resource efficiency and the perceived cutting constraints.

## METHODS

### Study area

We interviewed Slovenian forest owners as an example of small-scale nonindustrial private forest owners. In Slovenia, 77% of forests are privately owned (Medved et al. 2010). Most private forests have been in the possession of natural persons for generations, typically farmers and their family members, and are <3 ha on average. The proportion of family farms has decreased from 64% in the 1950s to 30% currently (Medved et al. 2010). Owners with <1 ha represent 67.5% of owners but control merely 9% of private forests. The forest property size structure >1 ha is 71.9%, 21.9%, 4.7%, and 1.6% of forest owners in size classes 1-4.9 ha, 5-14.9 ha, 15-30 ha, and >30 ha of forestland, respectively. For most farmers and nonfarmers, the forest is not their main source of income. The realized supply of wood from private forests has declined to on average 65% of the allowable cut. Roundwood production from family farms has gradually decreased in the last 10 years, whereas fuelwood production has increased. Forest owners do the work mostly by themselves. Business models such as long-term property lease, harvesting leasing, cooperatives, or contracting are still scarce. "Close-to-nature" forestry has been the traditional approach to forest management in Slovenia for more than a century. It focuses primarily on the ecological dimension of sustainability. The clear-cutting of forests is prohibited. Property rights are limited by public interest and by the obligation to take into account multiple functions of the forests.

### Sampling design

We set a target number of 1000 responses to achieve an acceptable margin of sampling error of  $\pm 3.0\%$  (Krejcie and Morgan 1970), to fit our budget constraints, and to get a sample of sufficient size for statistical analyses with large sample techniques. To approach the required sample size, we conducted 3099 telephone interviews with randomly selected private forest owners owning at least 1 ha of forestland. The selection of the candidates was stratified by property size to match the forest property size structure >1 ha at the national level (Medved et al. 2010).

Forest owners were surveyed from September 23 to 27, 2013, after 4 PM, using computer-aided telephone interviewing. An average interview lasted 6.25 min ( $\pm 2.37$  min). Of the 3099 interviewees, 969 claimed to be nonowners (31.3%); 1074 (34.7%) were unreachable at the time of the call, i.e., each owner was called 6 times before being considered nonrespondent; and 2 were unaware of owning a forest, which resulted in a realized sample of 1054 forest owners. Without data imputation, the number of 1054 interviews would have eventually decreased to 701 because of item nonresponse to 2 major questions (Q2 and Q3, Appendix 1). Therefore, for all cases in which one of the items of Q2 and Q3 was missing, we used a multiple imputation technique after we checked graphically that the missing values exhibited a random pattern. Altogether, we imputed 0.19% of all responses. Given the negligible percentage of imputed values, we did not perform a sensitivity analysis. Eventually, the number of observations with imputation reached 754. Before all further analyses, we used case weights to fine-tune the sample to the population because of the slight overrepresentation of owners with smaller properties.

Representativeness of the sample was checked by inspecting the spatial distribution of respondents and nonrespondents and by

comparing their socio-demographic variables. We found that both respondents and nonrespondents were randomly distributed across the country and that they mostly came from the same places (Cramer's V for the association between the places of residence of respondents and nonrespondents = 0.798,  $P < 0.01$ ). Respondents did not differ significantly from nonrespondents in their age (61.1 vs. 61.4 years) and number of parcels per forest property (13.6 vs. 12.4; an independent samples t test,  $P > 0.05$  level), and male/female ratio was 1:2 in both groups (a 2-proportion z test, nonsignificant).

### Survey design

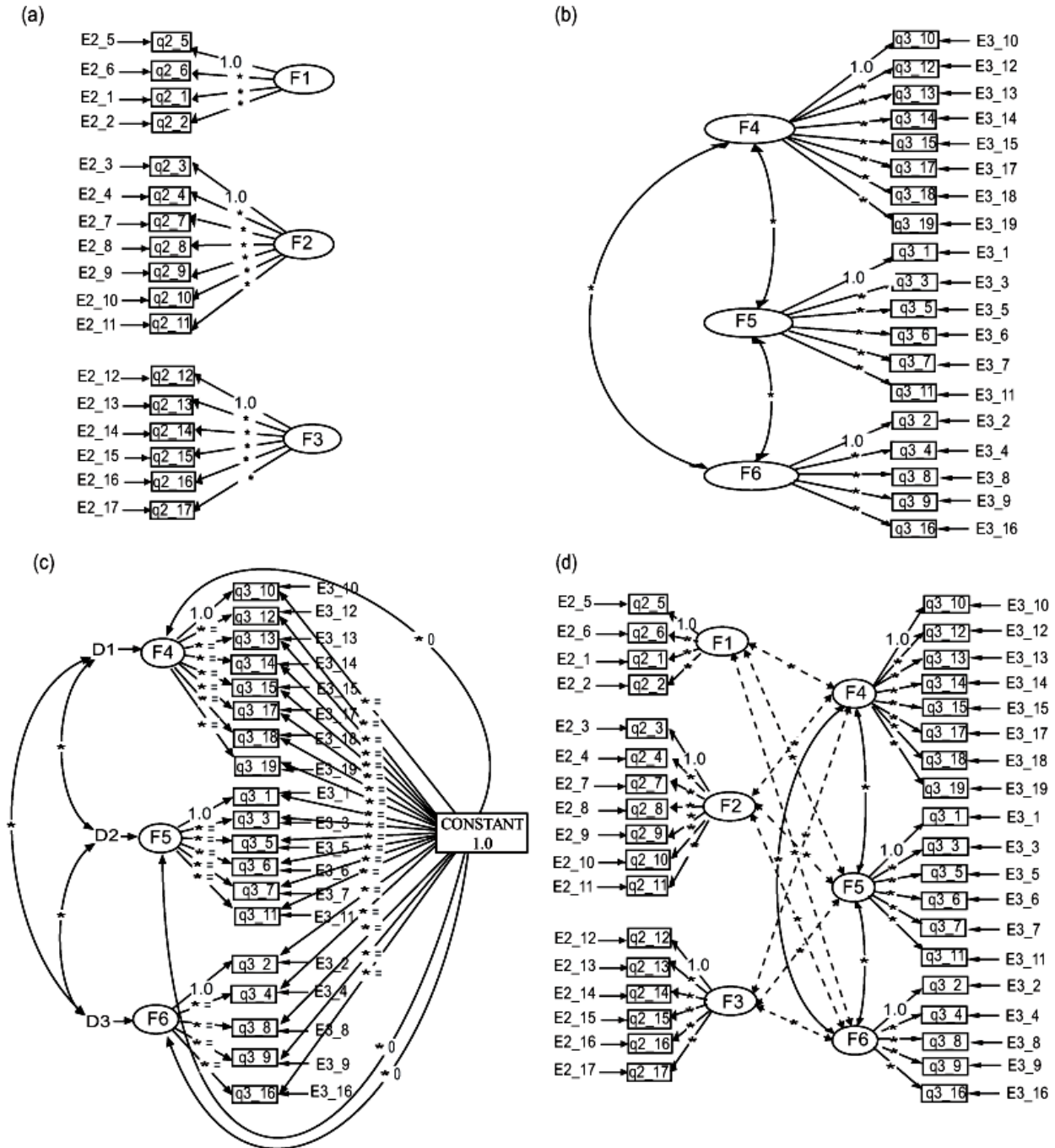
First, the interviewees were asked in the form of a closed-ended question whether they thought they managed their forest property efficiently (Q1). They were given a choice among five answers: (1) affirmative, reporting efficient management; (2) negative, reporting underuse of wood resources; (3) negative, reporting overuse of wood resources; (4) ambivalent, reporting indecision; and (5) no management, no cut. The respondents who reported efficient management (Q1 = 1) were labeled as the self-perceived efficient owners, hereinafter "efficient" owners. Those reporting underuse or no management (Q1 = 2 or 5), the self-perceived inefficient owners, hereinafter "inefficient" owners, were instructed to rate the importance of 17 items indicating possible reasons for underuse (Q2, q2\_1 to q2\_17, Appendix 1) using a five-point Likert scale, (1) being not at all important and (5) being very important.

The survey continued with the question of what they understood by forest management (Q3, Appendix 1). The respondents were provided with statements defining forest management (q3\_1 to q3\_19) and asked to indicate their level of agreement on a five-point Likert scale. When formulating the statements, we partly adopted the definitions provided in an empirical study of social construction of forest management in Tennessee, USA (Steiner Davis and Fly 2010), but edited and merged them to fit the national context and simplicity required for telephone interviews. For instance, we dropped the definition "using pesticides to keep insects from harming plants or trees" (Steiner Davis and Fly 2010:323) because the use of pesticides in forests is prohibited in Slovenia. We also included statements that resembled owner management objectives recognized in private forest owner typologies (Dhubháin et al. 2008, Urquhart et al. 2012), assuming substantial association between individual representation of forest management and his or her behavior.

### Constructing baseline models

The baseline model for the identification of cutting constraints (model 1, Fig. 2a) was a confirmatory factor analysis model. The number of cutting constraints and the hypothesized loadings of the items on them were based on past studies of management constraints in private forests in Slovenia (Tavcar and Winkler 2005, Veselic et al. 2010). Accordingly, we hypothesized the existence of three cutting constraints (F1, F2, and F3) and related them to the items that we considered their indicators (q2\_5 to q2\_17, Appendix 1). The cutting constraints were not allowed to correlate because they are intended to represent major, uncorrelated factors preventing forest owners from cutting more. We had no theoretical reasons for allowing the cross-loading of the items or the correlation of residuals (E2\_1 to E2\_17); items considered to measure only cutting constraints and none of the

**Fig. 2.** Path diagrams for the hypothesized structural equation models for the estimation of (a) factors preventing forest owners from cutting more, i.e., cutting constraints F1, F2, and F3; (b) forest owner representations of forest management, i.e., F4, F5, and F6; (c) differences in factor means between the efficient and inefficient owners, means and covariance structures model (MACS); (d) association between the cutting constraints and the representation of forest management (dotted two-headed arrows). The parameters to be estimated are denoted with an asterisk (\*). In each model, one path per factor was fixed to 1 for identification purposes. Measured variables and factors are represented by squares and ellipses, respectively. Regression-like error terms are represented with E. Disturbance terms for factors in MACS are represented with D. Single-headed arrows indicate the hypothesized causal relationship between two variables; two-headed arrows indicate correlation. The explanation of other symbols in MACS is provided in Methods.



combinations of the items were expected to measure constructs other than the one specified in the model. Review of the Lagrange multiplier statistics suggested adding several parameters to improve the model. However, the respecification yielded only trivial improvement of model fit, and there was no theoretical justification for post hoc modifications. Hence, we set the hypothesized model (Fig. 2a) as the baseline model for the identification of cutting constraints (cf. Savalei and Bentler 2006).

The baseline model for the identification of forest owner representation of forest management (model 2, Fig. 2b) was a structural equation model constructed for the group of efficient owners first. Based on the study of Steiner Davis and Fly (2010), which found three conceptualizations of forest management among private forest owners and related literature on private forest owner attitudes to forests (see *Introduction*), we tested the hypothesis that forest owners conceptualize forest management in three different ways (i.e., F4, F5, and F6) and that these concepts manifest through agreement with the statements from q3\_1 to q3\_19 (Appendix 1). We allowed F4, F5, and F6 to correlate because cognitive constructs are complex and are likely to overlap in their content (e.g., Vaske et al. 2001).

Upon evidence of adequate model 2 fit in the group of efficient owners, the construct validity was tested in the group of inefficient owners. Since model 2 fits adequately to both groups, we used it as a baseline model for the identification of forest owner representation of forest management and proceeded with the test of invariance of representations between efficient owners and inefficient owners.

#### **Testing the invariance in the representation of forest management**

Differences in the representation of forest management between the efficient and inefficient owners were tested in several steps (Bryne 2006). First, we established the configural model, which incorporated the single-group baseline models, i.e., model 2, into a multigroup model, yet without cross-group constraints on the equality of parameters. In the configural model, we allowed the parameters of the multigroup model to be estimated for both groups independently, but simultaneously, and estimated fit statistics for the multigroup model. The configural model served as a baseline model against which the subsequently specified, structural invariant model was compared. By setting equality constraints on factor loadings and factor correlations across groups, we tested whether model 2 is structurally invariant in both groups.

In testing the invariance of groups when using models that are subsets of each other (nested models), we followed both a traditional and a recent approach. In the traditional approach, two models are equivalent if the difference between the  $\chi^2$  values associated with the models (D test) is nonsignificant at the degrees of freedom calculated as the difference between the degrees of freedom associated with the models. Because of multivariate nonnormality of the data, the Satorra-Bentler scaled  $\chi^2$  ( $\Delta S-B \chi^2$ ) difference statistics (Satorra and Bentler 1988, 1994) were used instead of the D test. The recent approach is based on two criteria: the multigroup model still fits adequately, and the difference between the values of comparative fit index ( $\Delta CFI$ ) is  $\leq 0.01$  (Cheung and Rensvold 2002). Because results of invariance tests are frequently contradictory (see Bryne 2006:249), our evaluation

of the differences in the representation of forest management between efficient and inefficient forest owners is descriptive rather than statistically inferential.

#### **Testing the invariance of latent factor means**

Because concepts are unobservable, the conventional testing of significant differences in factor means between the groups is not possible. However, by applying the mean and covariance structures model (Sörbom 1974) in which the intercept variable is introduced and several intra- and cross-group constraints on factor loadings, loadings of the intercept variable on factors, and indicator variables are imposed (Fig. 2c), testing for factor mean differences is possible in a multigroup model. After the factor loadings were constrained to be equal across groups (marked with “\*=”), except for the loadings fixed to 1 for identification purposes), all intercepts for the indicator variables were constrained to be equal across groups (marked with “\*=”), and all factor intercepts were constrained to zero in the group of efficient owners, i.e., the reference group, but freely estimated in the other group (marked with “\*0”), differences in latent factor means between the groups were estimated in a relative sense. By comparing the parameters in the construct equations, we estimated how much the mean of factors F4, F5, and F6 from the group of inefficient owners differs from the mean of the same factors from the reference group, which always equals zero given the previously mentioned constraints. A full description of the procedure is provided in Bryne (2006:261-292), and a more detailed theoretical background can be found in Bentler (2006:203-222).

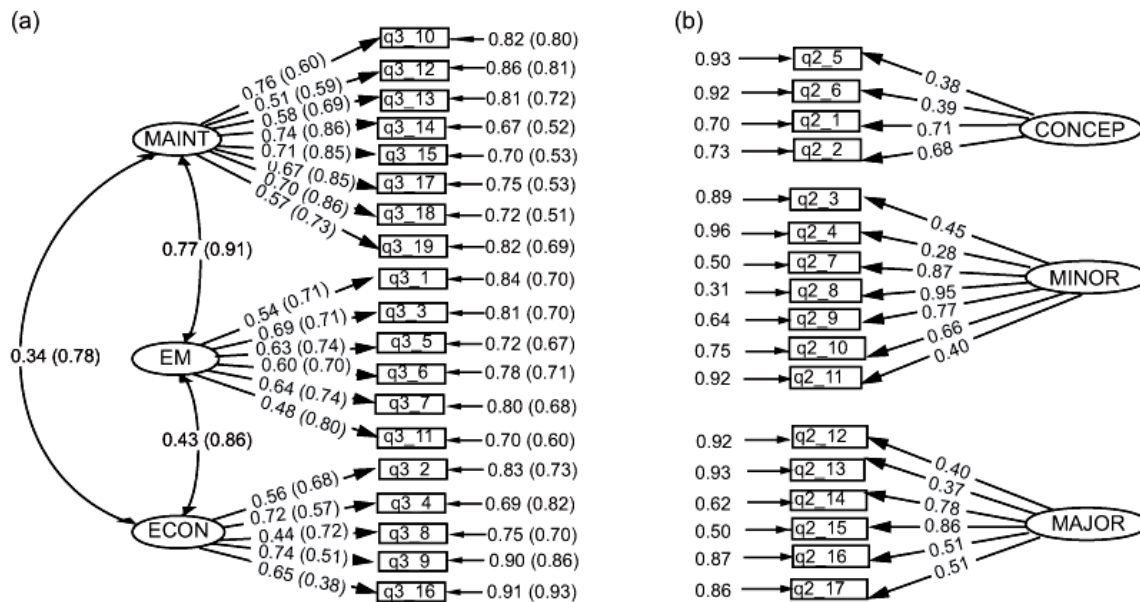
#### **Testing for association between representations of forest management and cutting constraints**

To test for the association between representations of forest management and perceptions of cutting constraints, we established model 21 (Fig. 2d) in which we combined model 2 and model 1 by adding the correlation paths between the factors from both models. If the representation of forest management has a significant impact on the perception of cutting constraints, then the correlation between owner representation of forest management and cutting constraints should be high and significant. For instance, if the nonintervention concept is responsible for the underuse of wood resources in private forests, then the correlation between the factor resembling this concept and the perceived cutting constraints from model 1 should be high and significant. In contrast, if the underuse of wood resources is mostly because of factors other than the conceptual, no correlations between owner perception of cutting constraints and their representation of forest management should occur.

#### **Estimation procedure**

We used the maximum-likelihood estimation method to test the validity of the described structural equation models. Given the evidence of multivariate kurtosis, i.e., Mardia's (1970) normalized estimates of 50.91 for efficient and 6.30 for inefficient owners, we based all tests on robust statistics (Satorra and Bentler 1988, 1994). In the goodness-of-fit estimation, we report the standardized root mean-square residual (SRMR) along with fit indices (Hu and Bentler 1995). A rule of thumb is that the SRMR should be  $< 0.05$  for a good fit (Hu and Bentler 1995), whereas values  $< 0.10$  may be interpreted as acceptable for social science studies (Hair et al. 1998). Among fit indices, we used the CFI

**Fig. 3.** (a) Forest owner representations of forest management: maintenance forest management (MAINT), ecosystem-centered management (EM), and economics-centered management (ECON). Standardized parameters reported for efficient owners, in parentheses for inefficient owners. (b) Factors preventing forest owners from cutting more: conceptual constraints (CONCEP), physical constraints (MINOR), and potentially removable constraints (MAJOR). All parameters significant at  $P < 0.05$ .



(Bentler 1990) and the Steiger-Lind root mean-squared error of approximation (RMSEA; Steiger 1990). An indication of adequate model-data fit is given when  $CFI \geq 0.90$  (Hu and Bentler 1999) and  $RMSEA \leq 0.08$  (McDonald and Ho 2002); the cutoff values for good fit are  $CFI \geq 0.95$  and  $RMSEA \leq 0.06$ .

Multiple imputation and scale reliability assessment were performed in SPSS 21 (StatSoft 2013); all structural equation modeling was performed in EQS 6.2 (Bentler 2006). We report standardized parameter estimates obtained after analyzing the correlation matrices.

## RESULTS

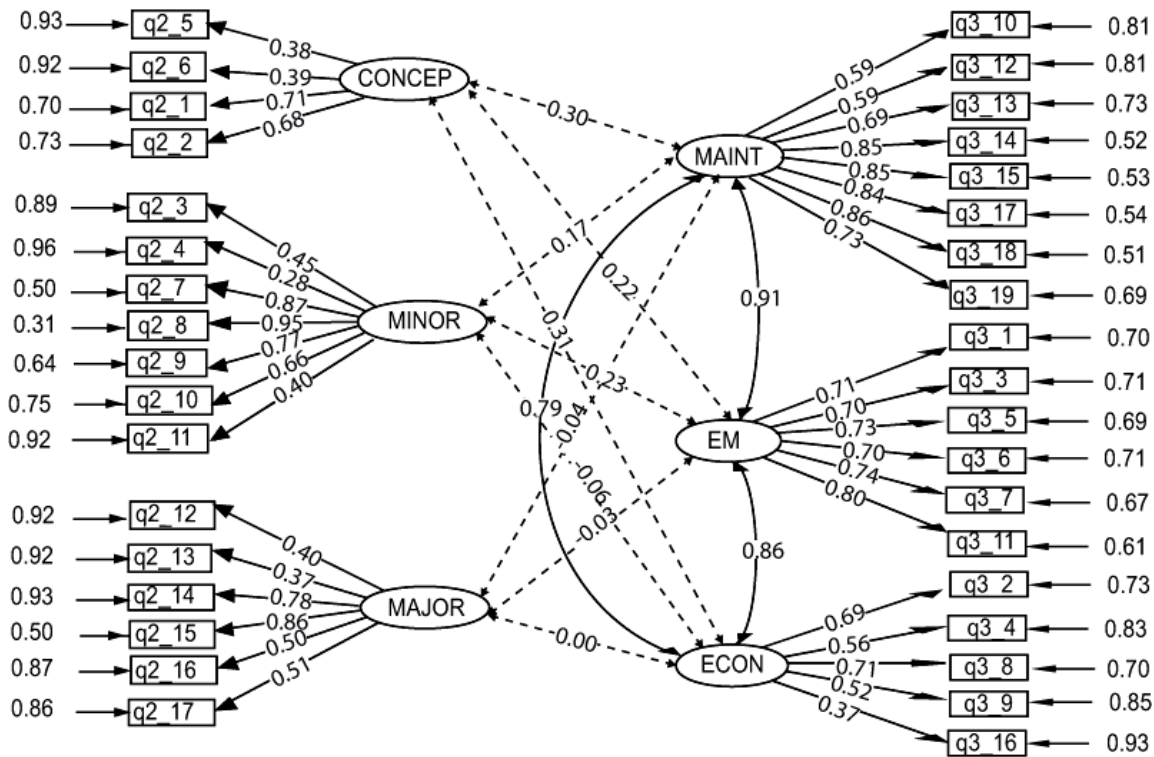
### Forest owner representation of forest management

We found that private forest owners conceptualize forest management in three different yet overlapping ways (Fig. 3a). The most adopted representation of forest management can be described as maintenance forest management (MAINT). Definitions with the highest loadings on this factor include the following: forest management emphasizes the continuation of work started by ancestors (q3\_10), ensuring a clean and natural environment in the neighborhoods (q3\_14), preserving large-diameter trees and removing low-quality trees (q3\_15), and taking care of the forest so it is not left in a state of neglect (q3\_18). The second representation can be referred to as ecosystem-centered management (EM). EM manifests as making decisions on what, when, and how a particular forest stand should be managed (q3\_3), preserving the forest for future generations (q3\_7), and caring for forest health and preventing diseases (q3\_5). The third representation is labeled economics-centered management

(ECON), indicated by five definitions emphasizing the economic aspects of forest management (q3\_2, q3\_4, q3\_8, q3\_9, and q3\_16). The overlap of forest management representations is substantial, particularly between MAINT and EM, which indicates that MAINT incorporates many aspects of EM. However, the concepts cannot be merged; a two-factor model with MAINT and EM merged and the ECON concept fit inadequately ( $CFI = 0.896$ ,  $RMSEA = 0.100$ ,  $SRMSR = 0.075$ ).

Efficient and inefficient forest owners conceptualize forest management in a similar way, yet the hypothesized structure of the forest management construct fits slightly better to inefficient (Table 1). The goodness of fit was also acceptable in multigroup testing; see goodness of fit of the configural model in Table 2. Thus, we confirmed that the number of representations of forest management and measurement variables used to identify them are equal in both groups. However, testing for the equality of factor loadings and factor correlations between efficient and inefficient owners, i.e., structural invariance, yielded slightly contradictory results, depending on the criteria used for the determination of invariance. If adhering to the traditional approach, we should conclude that factor loadings and factor correlations do not operate equally across both groups ( $\Delta S-B \chi^2 = 120$  at  $df = 19$ ,  $P < 0.05$ ). If adhering to the recent approach, we may conclude that efficient and inefficient owners conceptualize forest management with three structurally invariant concepts; the structural invariant model still fits adequately ( $CFI = 0.924$ ) to both groups, and the drop in model fit between the configural and structural invariant model is negligible ( $\Delta CFI = 0.01$ , Table 2).

**Fig. 4.** Correlations between forest owner representations of forest management (MAINT, EM, and ECON) and perceived cutting constraints (CONCEP, MINOR, and MAJOR) shown as two-headed dashed arrows. All parameters significant at  $P < 0.05$ . MAINT = maintenance forest management; EM = ecosystem-centered management; ECON = economics-centered management; CONCEP = conceptual constraints; MINOR = physical constraints; MAJOR = potentially removable constraints.



#### Adoption of a certain representation of forest management

The level of adoption of a certain concept differs between efficient and inefficient owners. As the factor intercepts in forest management representation equations show (Table 3), inefficient owners do not adopt on average the MAINT and EM concepts as much as efficient owners, whereas we found no significant difference between them in the adoption of the ECON concept. The mean values of the MAINT and EM concepts were lower by an average of 0.342 and 0.169, respectively (Table 3).

#### Perception of resource efficiency and cutting constraints

Almost 87% ( $n = 651$ ) of the surveyed forest owners perceived themselves as efficient and that they should not cut more. None of the respondents reported overuse of wood resources or was ambivalent. Factors preventing the inefficient owners ( $n = 103$ ) from cutting more can be adequately represented (CFI = 0.90, RMSEA = 0.09, SRMSR = 0.100) with three cutting constraints (Fig. 3b), presented in order of decreasing percentage of variance explained: (1) physical constraints in forest work, dissatisfaction with the timber market, and lack of skills (22.0% of variance), which can be overcome through education, better equipment, and higher market prices and are therefore labeled as MINOR; (2) potentially removable constraints, which are harder to overcome, e.g., unmarked boundary lines, ignorance of parcel locations, and lack of time to manage (16.5%), labeled as MAJOR; and (3) constraints of a conceptual nature, which are thus relatively

noncontrollable (12.5%), labeled as CONCEP. MINOR and MAJOR accounted for most of the explained variance, indicating that underuse of wood resources in private forests in Slovenia is mostly because of biophysical factors, either minor or major, rather than a consequence of no need for wood or income from the forest or other objective circumstances.

#### Representation of forest management and perceived cutting constraints

None of the correlations between forest management representations and cutting constraints were substantial ( $r \leq 0.31$ ,  $P < 0.05$ , Fig. 4), suggesting that forest management representations cannot be considered an important driver for underuse of wood resources. The specific hypothesis that the nonintervention forest management concept could explain low cutting intensities in private forests was not confirmed. Although the correlations between the conceptual constraints (CONCEP) and forest management representations were the highest among all correlations, the correlation between EM and CONCEP was no stronger than the correlations between CONCEP and other cutting constraints at the same probability level ( $r = 0.22$ ,  $r = 0.30$  for CONCEP-MAINT and CONCEP-ECON, respectively,  $P < 0.05$ ). We found no significant correlation between factor MAJOR and forest management representations ( $r = 0.00$ ,  $-0.03$ , and  $-0.04$ , for MAJOR-ECON, MAJOR-EM, and MAJOR-

**Table 1.** Goodnes-of-fit statistics of the model of forest owner representations of forest management (model 2) for efficient (n = 651) and inefficient (n = 103) owners, and the model of association between the representation of forest management and cutting constraints (model 21). CFI = comparative fit index; RMSEA = root mean-squared error of approximation; SRMR = standardized root mean-square residual.

Group	Model 2				Model 21				Model 2 vs. Model 21	
	CFI	$\chi^2$ (df)	RMSEA	SRMR	CFI	$\chi^2$ (df)	RMSEA	SRMR	$\Delta$ CFI	$\Delta\chi^2$ ( $\Delta$ df)
“Efficient” owners	0.923	8393 (149)	0.085	0.069	N/A <sup>†</sup>	N/A	N/A	N/A	N/A	N/A
“Inefficient” owners	0.948	3370 (149)	0.103	0.076	0.857	11064 (582)	0.079	0.123	0.127	7636 (433) <sup>*</sup>

<sup>†</sup> N/A not applicable to “efficient” owners.

<sup>\*</sup> The Satorra-Bentler scaled  $\chi^2$  difference (Satorra and Bentler 1988, 1994) is used due to multivariate non-normality.

\* Significant at P < 0.05

**Table 2.** Testing the invariance in the representation of forest management between efficient and inefficient forest owners. CFI = comparative fit index; RMSEA = root mean-squared error of approximation; SRMR = standardized root mean-square residual.

	Goodnes-of-fit statistics			
	CFI	$\chi^2$ (df)	RMSEA	SRMR
Configural model: no equality constraints	0.934	11977 (298)	0.088	0.073
Structural invariant model: factor loadings and correlations equal	0.924	13829 (317)	0.083	0.139
“Efficient” vs. “Inefficient”	$\Delta$ CFI	$\Delta\chi^2$ ( $\Delta$ df)		
	0.01	120 (19) <sup>*</sup>		

\* Significant at P < 0.05

**Table 3.** Testing for differences in the adoption of the MAINT, EM, and ECON concepts between inefficient and efficient owners (reference group) with mean and covariance structure analysis (MACS). Values besides the constant (V999) in the construct equations are factor intercepts and represent concept means. Concept means in reference group are always zero. MAINT = maintenance forest management; EM = ecosystem-centered management; ECON = economics-centered management.

	Test group: “Inefficient” owners	Reference group: “Efficient” owners
Construct equation	MAINT = -0.342 * V999 + 1.000 * D1	MAINT = 1.000 * D1
Standard error	0.059	
Robust test statistics	-5.766 <sup>*</sup>	
Construct equation	EM = -0.169 * V999 + 1.000 * D2	EM = 1.000 * D1
Standard error	0.047	
Robust test statistics	-3.573 <sup>*</sup>	
Construct equation	ECON = 0.080 * V999 + 1.000 * D3	ECON = 1.000 * D1
Standard error	0.052	
Robust test statistics	1.539	

\* Significant at P < 0.05



MAINT, respectively,  $P > 0.05$ ). This may have a simple explanation: poor openness of forests with forest roads (q2\_13), unclear boundary lines (q2\_14), or ignorance of parcel locations (q2\_15) have nothing to do with forest management concepts. Nevertheless, model 21 fit the data significantly worse than model 2 ( $\Delta CFI = 0.127$  and  $\Delta S-B \chi^2 = 7636$  at  $df = 433$ ,  $P < 0.01$ , Table 1), confirming that the correlations between the representations of forest management and cutting constraints do not improve the understanding of harvesting behavior of private forest owners.

## DISCUSSION

### Forest owner representation of forest management

We have shed light on social representations of forest management in the first-ever quantitative national study of forest management conceptualization among private forest owners in Europe. We confirmed the existence of three representations of forest management, greatly resembling the forest owner concepts elicited by Steiner Davis and Fly (2010) in Tennessee. The EM concept may be similar to Steiner Davis and Fly's (2010:325) concept of "creating and enhancing forest habitat," a comparison could be drawn between the ECON concept and "making money," and the MAINT concept appears to closely resemble the "property maintenance" concept. The maintenance-centered concept is the most adopted concept by private forest owners in both studies.

The result that the owners who believe they are inefficient do not consider the maintenance of their properties as important as those who believe they are efficient and that such owners do not have a strong ecosystem-centered perception of forest management indicates that the perception of being inefficient is more prevalent among owners who mostly favor timber amenities but who are frustrated by the inability to extract as much as they wish to. We may conclude that forest owner perception of resource efficiency is similar to the traditional notion of economic efficiency.

However, our empirical findings on the consequences of forest management representations contrast those of other studies, most of which are from the United States. Erickson et al. (2002:108) concluded that private forest owners prefer no active management and to "let nature take its course." Our results show that underuse of wood resources in Slovenia is mostly because of biophysical constraints, and not to the general belief that "logging is worse than nonmanagement for the environment," which is said to be a consequence of a "deep-seated philosophical objection to harvesting" (Berlik et al. 2002:1564). Lawrence and Dandy (2014) concluded that the prevalent belief of private forest owners regarding the appropriate forest management in the United Kingdom is "nonintervention" and that this concept is to be blamed for underuse of forest resources. However, because Lawrence and Dandy (2014) built their review mostly on "grey literature" and did not provide statistical evidence for such a conclusion themselves, we cannot judge whether the difference between our results and theirs is because of the different social context of the studies and thus substantive; is because of different research methodologies, i.e., rapid evidence assessment versus structural equation modeling; or should be interpreted in light of the general discrepancy between the elicited mental constructions and actual behavior of an interviewee in a given situation (e.g., Lynam et al. 2012).

Leaving nonsubstantive explanations aside, we first point to differences in the historical dimension of forestland ownership in different parts of Europe, and the United States as well, particularly to the changing pattern of ownership. Lawrence and Dandy (2014) noted a wide cultural gap between farming and forestry in the United Kingdom, which is clearly not the case in Slovenia (Medved et al. 2010). Family farms were the dominant socioeconomic category of private forest ownership in Slovenia until 2005, when the share of family farms equaled the share of other forms of private ownership. Nevertheless, most of the owners still maintain a close relationship with their properties in terms of traditional forest management. Currently, 39% of private forest owners still run family farms (Medved et al. 2010), which are typically small in size and fragmented. Forests are not being planted. So far, the continuum of knowledge transfer on forest management to successors has been secured, which could be the major reason that the interviewed owners emphasized the maintenance of forest properties as the principal approach to forest management and that the MAINT concept overlapped substantially with the EM and ECON concepts.

However, generational knowledge transfer on traditional forest management may change in the future given the further increase of nonfarm ownership types. The elasticity between the prices of fossil fuels and prices of fuelwood (Härtl and Knoke 2014) may also contribute to faster mobilization of wood resources. Given our results that underuse of wood resources from private forests mostly relates to physical constraints, we believe that the increase in timber supply from private forests in Slovenia might be faster and greater compared to some Western European countries or the United States, where the growing number of nonresidential owners seeing the forest as part of an alternative lifestyle and environmental protectionism may be the principal constraint in the mobilization of wood resources from private forests.

Our empirical evidence that the nonintervention forest management concept is not a driver of the undersupply of wood resources from private forests seems to be contradictory to the conclusions of contemporary private forest owner research in Europe. However, rather than being contradictory, it is supplementary. None of the behavioral studies investigated the association between observed behavior and the fundamental understanding of concepts underlying forest management quantitatively, though they often refer to the theory of planned behavior (Ajzen 1991), which assumes a causal relation between beliefs and behavior. Some behavioral studies found the temporal instability of management objectives. For instance, Ingemarson et al. (2006) found that roughly 30% of owners believed they would change their objectives in the next 5 years, which seems to be in line with the suggestion of our structural equation models that the behavior in practice has only weak association with the representation of forest management, and that forest owner behavior might be more likely to change than researchers expected.

### Benefits and limitations of structural equation models in social representations studies

A significant contribution of our study to contemporary research on forest owner conceptualization of forest management is in its methodological power. It is the first of its kind to be so rigorous in the relatively wide body of private forest ownership literature

in Europe. Structural equation models allowed us to (1) keep the representations of forest management latent, (2) quantify the overlap between the representations by setting the correlation paths, and (3) measure latent concept means, which would otherwise be unmeasurable by conventional testing. By setting the correlation paths between the concepts, the substance is no longer a matter of labeling sufficiently for analytical interpretability, but it is also indicated through the correlations. Labels that have been used for forest owner conceptualization of forest management, such as nonintervention management, custodianship, guardianship (Lawrence and Dandy 2014), or “hands-off” management (Erickson et al. 2002), largely lack the statistical evidence on how much they overlap with each other and what their relation is to scientific concepts of forest management.

However, the presented approach also has its limitations. First, responses were constrained by finite lists of questions or variables. Respondents could not present their perception of forest management with their own words or phrases. Second, although structural equation modeling is a powerful multivariate technique, it cannot elicit all elements of mental models. The statistical theory underlying structural equation modeling is asymptotic, which means that we can elicit only the long-term and stable knowledge structures of a social group (see Fig. 1) but not the dimensions of the mental model related to specific circumstances or individuals (cf. Lynam et al. 2012). Third, structural equation models cannot handle qualitative data, which means that the quality of the results depends on the communality level between the variables, the degree of nonnormality of data, the estimation method, and particularly the sample size and features of the model of interest (Bentler 2006). More complex models turned out to require larger samples for the same degree of fit. Getting an acceptable fit for complex models may be problematic, which researchers should account for in their desire for a model that resembles complex human reasoning as closely as possible. Fortunately, parameter estimates, e.g., factor loadings and correlations, settle at the smallest sample sizes, and maximum likelihood estimation seems to be good even under violation of normality (Bentler 2006). This makes us confident that the content of forest management concepts we elicited, and the relationship between them, is valid, despite a somewhat mediocre model fit.

One of the major challenges in analyzing human–environment behavior is also the general discrepancy between the elicited mental models and actual behavior in a given situation. Some elements of the mental model relate to the situation in which individuals find themselves. Considering this, social scientists have raised some important concerns regarding consistently responding to questionnaire items on a basis other than that for which the items were designed, referred to as response style (Paulhus 1991). Response style can lead to biased models of social representations when elicited by quantitative methods without the detection of, and correction for, response styles (Billiet and McClendon 2000, Ficko and Bončina 2014). We found no acquiescence bias in our study (results available upon request).

#### Challenges for natural resource policies

Two of the concepts adopted by the owners in our study, i.e., the ECON concept and the EM concept, are incorporated in several

natural resource management paradigms, which can be arranged along a commodity/noncommodity continuum (Brown and Harris 2000), by biocentric/anthropocentric value orientations (Vaske et al. 2001), or by a management intensity–silvicultural decisions matrix (Duncker et al. 2012).

The declarative care for forest property as an integral part of forest management can be found among human dimensions of almost all contemporary management paradigms. For example, forest ecosystem management “... must include consideration of the physical, emotional, mental, spiritual, social, cultural, and economic well-being of people and communities” (USDA Forest Service 1994:4 as cited in Kearney and Bradley 1998). However, traditional knowledge and the role of local forest owners are not explicitly mentioned in the EM concept (cf. Grumbine 1994, Yaffee 1999). Close-to-nature forestry, i.e., nature-based forestry, which is an indigenous derivative of the sustainable forestry concept in Central Europe where we conducted research (Johann 2006), sets the emulation of natural processes as the guiding principle (Duncker et al. 2012). Normatively, it incorporates the “traditional emotional attachment of people to forests and nature” (Pro Silva Europe 2012b:11) and “allows field foresters, forest owners and interested individuals to collaborate and exchange their experience” (Pro Silva Europe 2012a: article 1). However, both concepts strongly emphasize forests as ecosystems, not as social-ecological systems. The MAINT concept is most directly incorporated into the paradigm of community-based forest management applied mostly in developing countries, where forest management draws on the ingenuity and knowledge of local people (Swanson and Chapin 2009), but it seems to be widely missing in the policy initiatives of the developed countries from the Northern Hemisphere.

One of the top priorities in natural resource agendas in developed countries is still resource efficiency, though it has been redefined in different initiatives such as the green economy (OECD 2011), biobased economy (<http://www.biobasedeconomy.eu>), resource-efficient management (EC 2012, EREP 2013), or regenerative circular economy (<http://www.ellenmacarthurfoundation.org>). A common rationale behind these initiatives is that efficiency has to be upgraded, e.g., by using innovative technologies, to match the needs of society and its values, e.g., stakeholders, forest owners being just a part of them, in a changing world. Given our results, the question is whether appropriate forest management should always be articulated in a top-down manner by an open discourse. Would it not be, at least at the local scale, equally socially and ecologically effective to support traditional small-scale forest management that accounts for the ecological, economic, and social aspects of forests? Some examples (e.g., Schaich and Plieninger 2013) show that small-scale private forests in Central Europe have higher diversity of stand structures, store more carbon, and provide more habitat structures and diversity relevant for the conservation of typical and rare forest species than other forms of public ownership. We provide social psychological evidence on the significance of private forest owners for securing the ecological integrity of forests while maintaining the supply of the wood from forests.

#### CONCLUSION

We aimed to fill the gap in the understanding of social representations of forest management in Europe by studying how

private forest owners conceptualize forest management and how they perceive resource efficiency. We have undertaken the first-ever quantitative national study of forest management conceptualization among private forest owners in Europe that uses the theory of social representations and a hypothesis-testing approach. Our findings on the number of management concepts among nonindustrial private forest owners and their content are similar to those from the United States. Private forest owners consider maintenance of forests the main principle in managing the forest. However, the result that underuse of wood resources in Slovenia is not a consequence of the general belief that logging is worse than nonmanagement contrasts with the conclusions from other, although still scarce, studies on private forest owner representations that the passiveness of private forest owners is to be attributed to their nature-centered worldview. It is thought that forest owner management objectives and attitudes toward the forest have not been changing rapidly, but the theory of social representations could change this commonly accepted view. As private forest owners are becoming more and more urbanized in countries in which traditional forest ownership has persisted until recently, it is likely that they will become more responsive to societal changes in the future. A challenge for both researchers and policy makers will remain how to track these changes and especially how to develop management concepts that will meet the demands of rapidly changing societies.

Responses to this article can be read online at:  
<http://www.ecologyandsociety.org/issues/responses.php/7189>

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**Appendix 1.** Reasons for underuse or no cut (q2\_1 to q2\_17) used for the identification of cutting constraints, and statements defining forest management (q3\_1 to q3\_19) used to elicit forest owner representations of forest management<sup>†</sup>. Mean scores and standard deviations are reported ( $n = 103$  for Q2,  $n = 754$  for Q3).

Q2: Please rate the relevance of each reason for underuse or no cut with a 5-point Likert scale <sup>‡</sup> .		Mean (S.D.)	Q3: Please indicate the level of agreement with the following statements defining forest management with a 5-point Likert scale. Forest management is... <sup>§</sup>		Mean (S.D.)
q2_1	I don't need wood	3.12 (1.54)	q3_1	The application of knowledge on how to manage the forest ecosystem	3.83 (1.14)
q2_2	I have my forest as a reserve	3.25 (1.54)	q3_2	Capital management	2.89 (1.27)
q2_3	Forest operations are too costly	3.41 (1.48)	q3_3	Making decisions on what, when and how a particular forest stand should be managed	3.34 (1.12)
q2_4	Timber prices are too low	3.17 (1.43)	q3_4	A good business opportunity	2.84 (1.28)
q2_5	No cut is necessary	2.70 (1.42)	q3_5	Taking care of the forest health and disease prevention	4.12 (1.09)
q2_6	I don't need money from wood	2.62 (1.63)	q3_6	Possessing the forest, taking care of the property and borders	3.86 (1.10)
q2_7	I am not qualified for forest work	3.59 (1.56)	q3_7	Preserving the forestland for future generations	4.07 (1.08)
q2_8	I am not properly equipped to work in the forest	3.52 (1.58)	q3_8	Good opportunity to earn additional money or to improve the family budget, as any other side-business opportunity	2.65 (1.20)
q2_9	The work in the forest is dangerous	3.82 (1.42)	q3_9	Leisure and free-time activity in the woods instead of recreation	3.01 (1.30)
q2_10	The work in the forest is physically demanding	3.90 (1.28)	q3_10	Systematic continuation of the work started by our ancestors	3.74 (1.18)
q2_11	My forest property is too small to be efficient	3.31 (1.50)	q3_11	Mimicking natural processes in the forest and securing natural regeneration	3.92 (1.09)
q2_12	I was not called to do the cut	2.82 (1.50)	q3_12	About work in the forest, e.g. using chainsaw, winch, doing forest operations	3.75 (1.22)
q2_13	The openness of forests with forest roads is poor	3.19 (1.46)	q3_13	Ensuring regular flow of goods from my forest which I need, such as fuel-wood	4.02 (1.18)
q2_14	The boundary lines are partly unclear	2.57 (1.50)	q3_14	Ensuring a clean and natural environment in the neighborhoods	4.27 (1.02)
q2_15	I don't know the exact locations of my parcels	2.53 (1.46)	q3_15	Preserving large-diameter trees and removing low-quality trees	4.20 (1.04)
q2_16	I don't have time to manage the forest	2.75 (1.46)	q3_16	A source of subsidies	2.44 (1.35)
q2_17	The allowable cut is below my desire	2.51 (1.25)	q3_17	Keeping the forest beautiful exactly the way I like it	4.09 (1.08)
			q3_18	Making sure the forest is not left neglected or messy	4.22 (1.00)
			q3_19	Cutting large-diameter trees when they are ready to be cut	4.08 (1.10)

<sup>†</sup>The measurement instrument may need to be adapted before used in other countries.

<sup>‡</sup>The average inter-item correlation between the seventeen items was 0.26, indicating sufficient heterogeneity of content. Internal consistency of the 17-item scale using Cronbach's (1951) alpha was 0.988, which is excellent.

<sup>§</sup>Internal consistency of the 19-item scale estimated with Cronbach's (1951) alpha was good (0.885).