UNIVERSITY OF LJUBLJANA
BIOTECHNICAL FACULTY

Andrej FICKO

OPTIONS FOR CONSIDERING PRIVATE OWNER OBJECTIVES IN FOREST MANAGEMENT PLANNING - A CASE STUDY FOR SLOVENIA

Doctoral dissertation

Ljubljana, 2016

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MOŽNOSTI PRILAGAJANJA GOZDARSKEGA NAČRTOVANJA GOZDNIM POSESTNIKOM: VZORČNI PRIMER ZA SLOVENIJO

Doktorska disertacija

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The research was carried out at the University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources. Based on the Statute of the University of Ljubljana and the decision of the Senate of the Biotechnical Faculty from 19. 9. 2012, it was confirmed that the candidate fulfills the conditions for carrying out a PhD in the interdisciplinary doctoral study in Biosciences, Scientific Field Management of Forest Ecosystems. Prof Andrej Bončina was appointed as the supervisor and Prof Thomas Knoke as the co-advisor.

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The work is the result of my own research work. I declare that all scientific papers included in this thesis are identical to published versions. I agree with the publishing of the thesis in full text on the website of the Digital Library of the Biotechnical Faculty. I declare that the text in the electronic version is identical to the printed one.

Andrej Ficko

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We studied conceptual and financial options for implementing a forest property plan (FPP) into the forest planning system. By employing multiple quantitative surveys of Slovenian non-industrial private forest owners, we 1) examined how owners (n = 754) conceptualize forest management and resource-efficiency using structural equation modeling; 2) studied owners' (n = 374) decision-making styles using a probabilistic approach while controlling for model-reality consistency and acquiescence bias to account for uncertainties in owner classification; 3) explored owner' (n = 510) willingness-to-pay (WTP) for the FPP using the Heckit econometric model and estimated financial implications for publicly funded forest planning; and 4) analyzed satisfaction with the FPP using semi-structured interviews with the owners (n=11) for which the FPP prototypes have been prepared in the past two decades. We found that 1) owners underuse forest resources not because they object to harvesting, but mostly because of biophysical constraints in the environment; 2) multiobjective owners who consider mainly the extractive value of forests are prime candidates for the FPP; 3) owners are willing to pay for the FPP, and the cost-sharing could significantly reduce public budget expenditures for forest planning; and 4) owners were mostly unsatisfied with the FPP prototypes because of insufficient consideration of their demands. We conclude that owners support the FPP conceptually and financially. Further steps in the implementation of the FPP into practice should take into account the diversity of costumer segments and uncertainty associated with the survey-based research.

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Proučevali smo konceptualne in finančne možnosti za uvedbo načrta za zasebno gozdno posest (NGP) v zasnovo gozdarskega načrtovanja v Sloveniji. Na podlagi v letih 2009 – 2015 izvedenih osebno vodenih in telefonskih anketiranj lastnikov zasebnih gozdov smo 1) s pomočjo strukturnega modeliranja proučevali, kako lastniki (n = 754) razumejo gospodarjenje z gozdovi in gospodarnost; 2) proučevali načine njihovega odločanja (n = 374) pri upravljanju posesti uporabljajoč inovativen verjetnostni pristop ter dopolnjen postopek za zaznavo in odpravo sistematične napake v odgovorih zaradi odzivnih slogov anketirancev; 3) s pomočjo Heckmanovega ekonometričnega modela analizirali pripravljenost lastnikov (n = 510) za plačilo za NGP in vplivne dejavnike; 4) analizirali zadovoljstvo lastnikov (n = 11) s testnimi NGP. Ugotovili smo: 1) da lastniki ne nasprotujejo učinkovitejšemu gospodarjenju, saj med njihovim razumevanjem gospodarjenja in razlogi za negospodarjenje ni znatnih korelacij; 2) tisti z več cilji gospodarjenja, ki se odločajo predsem glede na uporabno vrednost gozda, so možni kandidati za NGP; 3) da so lastniki pripravljeni plačati za NGP, soudeležba pri plačilu lahko znatno zmanjša javne izdatke za gozdarsko načrtovanje; 4) da so bile slabosti testnih NGP prepodrobnost, neprilogodljivost in nezadostno upoštevanje ciljev lastnikov. Zaključujemo, da lastniki podpirajo NGP konceptualno in finančno. V priporočilih opozarjamo na raznolikost lastnikov in potrebo po sodobnih pristopih, ki upoštevajo negotovost pri proučevanju lastnikov in načrtovanju.

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I. Ficko, A., Boncina, A., 2015a. Forest owner representation of forest management and perception of resource efficiency: a structural equation modeling study. Ecology and Society, 20, 1: 36.

II. Ficko, A., Boncina, A., 2013. Probabilistic typology of management decision making in private forest properties. Forest Policy and Economics, 27: 34-43.

III. Ficko, A., Boncina, A., 2014. Ensuring the validity of private forest owner typologies by controlling for response style bias and the robustness of statistical methods. Scandinavian Journal of Forest Research, 29, Suppl.1: 210-223.

IV. Ficko, A., Boncina, A., 2015b. Forest owner willingness to pay for a forest property plan may reduce public expenditures for forest planning. European Journal of Forest Research, 134: 1043–1054.

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1 INTRODUCTION AND HYPOTHESES

Forests provide economic, social and environmental benefits to society. The sustainability of these benefits is indispensably related to forest management. Through the overexploatation of forest ecosystems, we have lost a great deal of the main global forest resources (Global forest…, 2010), and have been faced with the continuous loss of natural habitats (Kumar, 2010). On the other hand, managed properly, forests can provide us with essential products and services indefinitely (Young and Giese, 2003).

The appropriateness of management is highly dependent on subjective attitudes towards the forest. Foresters can and should use their expertise to suggest best management practices but the landowner, not the forester, determines management objectives (Guldin and Guldin, 2003). This principle and awareness that "the fate of much of the nation's forests lies in the hands of this diverse and dynamic group of people and organizations" (Butler, 2015) is fundamental for governing forests in countries with predominant private ownership. Due to the substantial presence of private forests in Europe and the U.S. (see Harrison et al., 2002 and Butler et al., 2014 for alternative definitions of non-industrial private forest (NIPF), individual- or family-owned small-scale forests), NIPF owners have been recognized as one of the key actors in sustainable forest management (Binkley, 1981; Bliss and Martin, 1989).

A number of private forest owner typologies have revealed the diversity of owner attitudes to forests and management objectives (see Dhubhain et al., 2007; Urquhart et al., 2012; Straka 2011 and Dayer et al., 2014 for a review). A common conclusion has been that forest owners do not manage their forests in line with management recommendations because of non-commodity objectives. However, the poor involvement of private forest owners in forest management has rarely been related to a lack of property-specific management support (but see Hujala, 2009). Moreover, the general feature that non-industrial private forest owners in the developed world own only a little and a few own a lot (Bliss and Martin, 2003) calls for a refocus of private forest owner research on owners controlling a larger proportion of forestland.

Forest management planning differs greatly between European countries (e.g. Bachmann, 2002; Toth et al., 2001; Montiel and Galiana, 2005; Eid, 2006; Serbruyns and Luyssaert, 2006; Wilmhelson, 2006; Cullotta and Maetzke, 2009; Tikkanen et al., 2010; Brukas and Sallnäs, 2012; Knoke et al., 2012). Differences partly originate from the historical development of the ownership structure (Schmithüsen and Hirsch, 2010) but are also the result of the responsiveness of forest policy to the emerging needs of society. With continuos societal changes new management objectives and bussines models may emerge (e.g. Ziegenspeck et al., 2004; Hogl et al., 2005). Any private forest planning, particularly in a country with predominantly privately-owned forests, needs to be adapted continuously with new planning instruments that can better meet private forest owner demands while fulfilling societal expectations regarding forests.

There are two approaches to the adaptation of forest planning; the expert top-down approach and the user-driven, bottom-up approach. The expert assesment on private forest planning has already been done for some countries (e.g. Bončina, 2003; Ficko et al. 2005; Ficko et al., 2010; Tikkanen et al., 2010; Hokajärvi et al., 2011; Straka, 2011). However, there is a lack of in-depth studies on the private forest owner attitudes to changes in forest planning. This thesis presents a generic framework for assessing the usability of a new forest-owner oriented forest planning instrument that considers the psychological, sociological and economic factors that facilitate its implementation (Fig. 1).

The framework consists of four steps: 1) exploring the conceptual attitude of forest owners towards forest management; 2) studying how decisions happen and what factors influence decision making; 3) estimating private forest owner willingness to pay for the new forest planning instrument; and 4) verifying customer satisfaction with the new planning instrument.

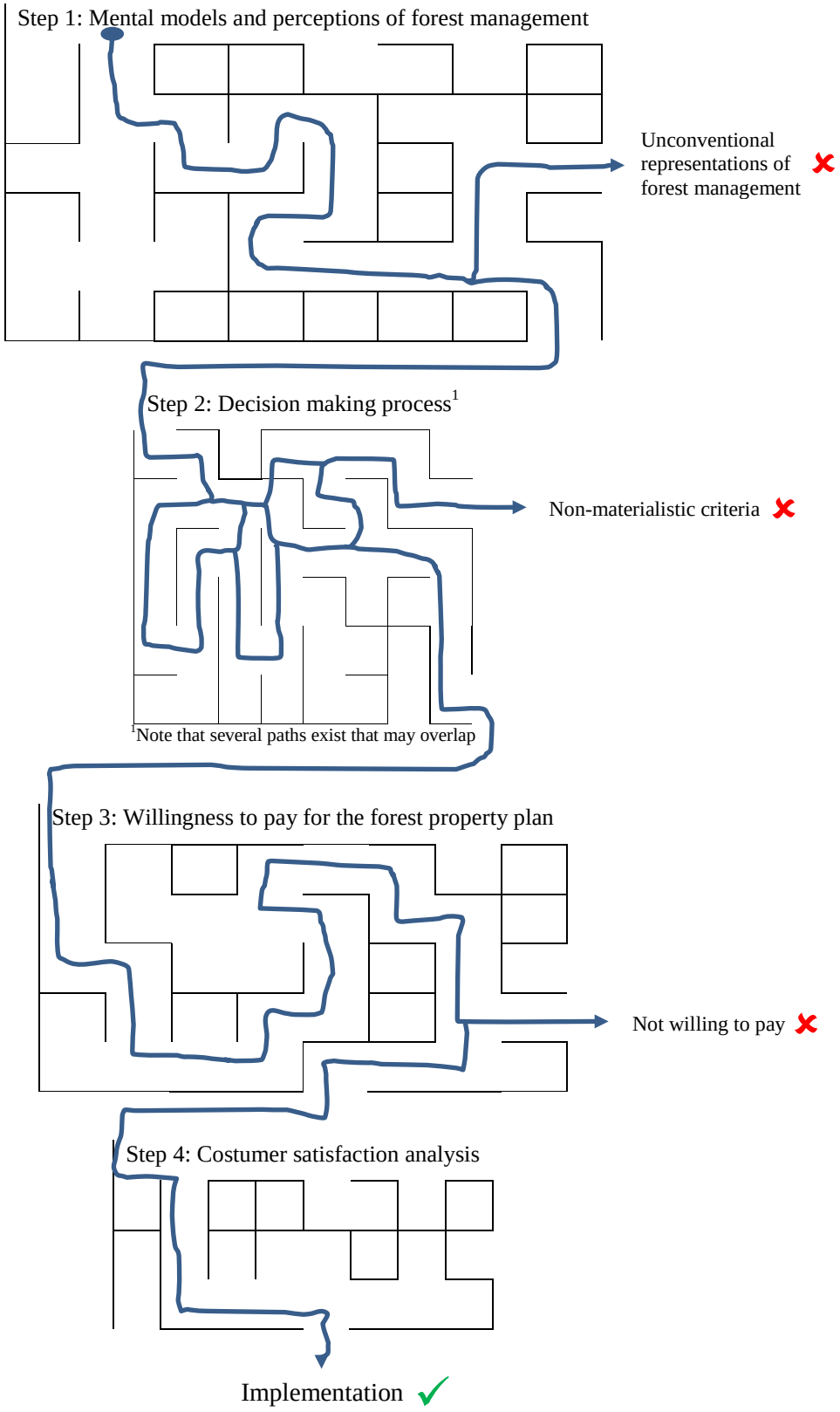

Fig. 1: Schematic workflow of tasks in implementing the forest property plan into practice

One of the planning instruments that could solve the long-standing problem of poor involvement of private forest owners in forest management is the private forest property plan (FPP). An FPP is a forest owner-oriented plan prepared for the level at which an owner makes decisions, e.g. individual private forest property, communal forest property, commons, joint ownership. It includes all information relevant for the owner such as stand inventory, allowable cut and an estimate of financial return (e.g. Bachmann, 2002; Tikkanen et al., 2010; Hokajärvi et al., 2011). Since it emphasizes private objectives and considers objectives from the superordinate management plans, the preparation of an FPP is usually co-financed by the owner of the property and subsidized by the state. As a cost-share instrument, the FPP has proved to be an effective policy tool for mobilizing forest owners in some countries with prevailing non-industrial private ownership such as Finland (e.g. Nuutinen, 2006; Tikkanen et al., 2010). It has often been upgraded to a computerized decision support system (e.g. Lexer et al., 2005; Pasanen et al., 2005; Pykäläinen et al., 2006; Härtl et al., 2013; Borges et al., 2014) that includes simulation and optimization tools at the stand and property level (e.g. Härtl et al., 2013; Rasinmäki and Rosset, 2015)

We will use Slovenia as a case study. In the current forest planning concept in Slovenia, management planning is limited to strategic and operational planning at the level of forest management regions and forest management units (Bončina, 2009). An individual forest owner is supported through advisory services but not through the private forest property plans. The fact that private owners with less than 1 ha of forests control merely 9% of the total private forest land implies that more research shuld be dedicated to the larger properties which cover 91% of private forest land (Medved et al., 2010).

In the next paragraphs we will further develop the studied topics, present the hypotheses and highlight their relevance in the context of studying options for considering private owner objectives in forest management planning.

1.1 THE ROLE OF MENTAL MODELS IN PRIVATE FOREST OWNER MANAGEMENT BEHAVIOR

In Slovenia and to no lesser extent elsewhere in Central Europe (e.g. Medved et al., 2010; Bouriaud and Schmithüsen, 2005), management intensity in private forests has been well below the desired level for the last decades. Many estimations of the realizable supply of woody biomass in Europe (Mantau et al., 2010; Verkerk et al. 2011) have emphasized the importance of various social factors that may constrain timber supply. One of them is the willingness of private forest owners to provide timber – probably one of the key factors in the mobilization of wood resources from private forests in the EU.

The literature provides a number of conceptual and practical reasons why private forest owners underuse their forests. The economic drivers of timber supply was one of the earliest topics in non-industrial private forest owner research (Max and Lehman, 1988; Hyberg and Holthausen, 1989; Majumdar et al., 2008; Joshi and Arano, 2009). However, much less attention has been given to the conceptual reasons for owner passiveness (e.g. Davis and Fly, 2010; Davis et al., 2015). Exploring the mental models that drive management behavior could bring new insights that corroborate or contrast the expertly-based conclusions (e.g. Van den Bergh, 2000; Jones et al., 2011; An, 2012; Lynam et al., 2012). The provision of timber and non-timber goods and services may be related to a specific representation of forest management that might differ from the scientific representation of forest management. In contrast to many studies from the US (Kearney and Bradley, 1998; Kearney et al., 1999; Rickenbach et al., 1998, Belin et al., 2005), questions such as what forest owners understand by forest management and resource-efficiency have almost been neglected in Europe on a national scale. Social psychology theories (e.g. the social representations theory of Moscovici, 2008) and statistical methodologies that take a hypothesis-testing approach (e.g. Homer and Kahle, 1988) offer great opportunities to go beyond the descriptive approach in studying factors influencing the provision of timber and non-timber goods. We analyzed the conceptualizations of forest management and resource-efficient management by private forest owners, compared their constructs with normative forest policy concepts as laid

down in EU and national forestry legislation, and examined the influences of mental models on the harvesting behavior of Slovenian private forest owners.

Hypothesis No. 1 was that forest owners conceptualize resource-efficient forest management differently than that set out in forest policy documents. The intent behind the hypothesis No. 1 is to verify whether forest owners conceptualize non-intervention as efficient forest management, and if so, whether their representation of forest management has an impact on management intensity.

1.2 PROBABILISTIC CLASSIFICATION OF FOREST OWNERS BY DECISION-MAKING STYLES

Knowing what private forest owners understand by efficient forest management and how their mental models influence on their willingness to provide wood was the first step towards better understanding forest owner involvement in forest management. In the next step we examined how forest owners make decisions. We hypothesized that there were specific decision making types of forest owners and that some types of forest owners were more likely candidates for a private forest property plan. A typology of private forest owner decision-making styles would enable a more targeted implementation of the FPP into the practice. By analyzing the predictors of decision making styles, we will attempt to determine which market drivers, policy variables, owner characteristics, and resource conditions influence the decision making style.

Moreover, understanding current management decision practices in private forests is also important also with regard to the neccessary adaptation of forest planning to changing business models and new technological options. In recent decades private forest ownership across Europe has undergone structural changes, for instance as a consequence of land restitution (Hogl et al., 2005; Järvinen et al., 2003; Bouriaud and Schmithüsen, 2005; Medved et al., 2010) or urbanization (Hogl et al., 2005). Technology, which private forest owners have heretofore not used extensively, offers

great opportunities for making decisions in an uncertain world easier (Haara et al., 2014).

NIPF owner decision-making styles are also interesting from a methodological point of view. In most of the studies on private forest owner management behavior forest management has been simplified to a pre-defined set of activities, and the underlying models of private forest owner behavior have usually been binary choice models (Beach et al., 2005). Under the influence of utility maximization theory the prevailing approach is that the forest owner maximizes his/her utility following the theory of rational choice (Harsanyi, 1976; March, 1994). However, in the real world this rather technical view on decision-making behavior is modified by several constraints, such as the limited number of alternatives to be considered, the decision maker's cognitive abilities and rationality and the social context of the decision-making process (Becker, 1962; March, 1994, van den Bergh et al., 2000; Ariely, 2009). It has also not been assumed that decision making is a cognitive process driven by the appropriate pieces of information. We wanted to determine, which social, ecological, and economic information private forest owners consider relevant for strategic and operational management of their forest properties rather than asking them directly which management activities they perform and classifying them according to stated activities.

Private forest owner classification is not novel. Numerous studies have attempted to classify private forest owners based on their objectives, the result being several forest owner typologies (e.g. Karppinen, 1998; Boon et al., 2004; Ingemarson et al., 2006). Most of the typologies were quantitative and were rather similar in their use of statistical methods. To identify customer segments, cluster analysis was employed (typically k-means clustering, but see Boon and Meilby (2007) who employed latent class analysis), whereby forest owners were clustered by their similarities in certain attributes into an interpretable number of types. However, in addition to the concerns mentioned above there is one regarding existing quantitative classification of private forest owners. Most private forest owner classification studies used the Frequentist approach instead of the Bayesian probabilistic approach (see Ghazoul and McAllister, 2003; Kangas and Kangas, 2004 for extensive description of both approaches). A

consequence of not using a probabilistic approach in classifying forest owners is that each private forest owner can only be assigned to one cluster. The use of mutually exclusive types to characterize the forest management behavior of forest owners may not provide an accurate representation of the decision-making process. A forest owner may have more than one significant management attitude or fall between different attitudes (Urquhart and Courtney, 2011). We suggest that the probabilities for distinct management behaviors should be calculated to better take into account the multi-objectiveness of private forest owners. Moreover, if the typology is to be applicable in practical forest policy it needs to be explained by variables that are directly observed in the field or readily accessible to typology users.

Hypothesis No. 2 stated that forest owners form a homogeneous group with the same attitude in decision making. With this hypothesis we set out to verify whether the decision-making of forest owners could be classified and what predictors could be used to describe private forest management behavior.

1.3 UNCERTAINTY IN THE CLASSIFICATION OF FOREST OWNERS

Most of the private forest owner research in forestry relies on surveys. When using surveys several issues should be considered to ensure the validity of the results. Surprisingly few survey-based studies in forestry have recognized the potential threats to the validity of conclusions due to bias in the survey data or insufficient methodological rigor during the analysis (e.g. Egan and Jones, 1993; 1995; Eyvidson et al., 2014). In quantitative segmentation, the analyst should account for uncertainty about whether responses reflect the real opinion of a respondent or are biased, and uncertainty about whether the classification of owners corresponds to reality, i.e. model-reality consistency (Bollen, 1989). Related issues include uncertainty about the number of customer segments and the fuzziness of membership. We will present how to account for these two uncertainties in order to develop a valid and robust private forest owner typology.

The first uncertainty, the uncertainty about the possible bias in the responses, may be linked to several external and internal stimuli for biased responding (e.g. Bachman and O'Malley, 1984; Baumgartner and Steenkamp, 2001; Van Vaerenbergh and Thomas, 2012). Inter alia, it may depend on an individual's attitude to risk (Hofstede, 2001); it may be influenced by social norms (e.g. the respondents may approve behavior that is socially desirable); or it may be related to the demographic variables and personality characteristics of the respondent. A lack of interest in the topic ("yeah answers") may also lead to bias. In any case, failing to control for response style may lead to invalid research conclusions.

In addition, the analyst should also account for a second source of uncertainty in the classification of forest owners: uncertainty about the model-reality consistency. In conventional approaches to forest owner classification (the Frequentist approach, Kangas and Kangas, 2004), the analyst reports uncertainty with probability statements to convey scientific uncertainty after statistical modeling (e.g. with p-values). In the alternative approach (the Bayesian approach), the analyst reports the certainty with "a number between 0 and 1 that conveys the strength of belief or weight of evidence for some particular conjecture or hypothesis" (Ghazoul and McAllister, 2003). The latter approach may have several advantages in customer segmentation (e.g. fewer segments, cluster membership is determined with probabilities, multi-objectiveness is inherent to members of all groups, Magidson and Vermund, 2002), but only if the model is robust enough. We developed a procedure for estimating the effect of response style bias in the event of response style contamination and explored the robustness of the probabilistic clustering algorithm to different requirements for the validity of private forest owner typology. Both steps can be considered as important intermediate steps in ensuring the validity of the survey-based investigations.

1.4 WILLINGNES TO PAY FOR A PRIVATE FOREST PROPERTY PLAN AND IMPLICATIONS FOR PUBLICLY FINANCED FOREST PLANNING

Unlike some countries with predominant private forest ownership (e.g. Finland, USA), which use a number of mechanisms to encourage private forest owners to develop

private property plans, no comparable nationwide program currently exists in Slovenia. In most of these programs, the preparation of the FPP is either cost-shared by the owners and/or subsidized by the state in different ways, e.g. cost sharing assistance, property tax reduction programs, special eligibility criteria for state subsidies etc. (Damery, 2006; Tikkanen et al., 2010; Butler et al., 2014; Metsään.fi, 2015).

Factors contributing to the success of cost-share funding mechanisms in forest management planning are diverse. Damery (2006) for instance, studied success factors observed in implementing the Forest Stewardship Program in eight states in the U.S. He found that the base level of funding, Stewardship Incentive Program cost-share monies, agricultural property tax rates, the number of forestry professionals and region were significant predictors of the Program's success. In a nationwide review of the success of Forest Stewardship Program in the U.S., Butler et al. (2014) investigated to what extent management plans, cost-sharing funding, technical assistance, and education influence the behavior of family forest owners. They found that available cost-share money had a positive influence on the participation in the Program. However, they found a number of other factors that contributed to higher demand for planning assistance such as age, education and income levels, parcel size, involvement in other programs and cooperation in certification schemes, timber harvesting ownership objectives etc. European experiences with cost-share mechanisms in forest planning show the importance of sufficient basic infrastructure for providing various services to forest owners and state funding in settting the scene. The Finnish Forest Centre for instance, which is a state-funded organization, developed Metsään.fi-eServices (Metsään.fi, 2015) which offers forest owners on a free-access basis the latest information about soil, the volume and growth of wood as well as forest management needs and felling possibilities on their properties. By providing these services for free, they are attempting to encourage individual owners to look for commercial providers of planning services. While the e-service allows forest owners to specify management or felling site and request the selected operators to communicate for the purposes of carrying out the work, a forest industry operator or a planning bureau may also take the initiative and approach the forest owner with an offer concerning a timber trade or management planning.

No matter how forest owners obtain support for management of their forests, the decision to ask for support ultimately depends on the price of the service. When the product is not yet on the market, its value can be estimated by contingent valuation techniques. In this section we upgraded the previous examination of forest owner management concepts and decision-making styles with a financial evaluation. We aimed to estimate the intention to pay for the FPP and the amount of voluntary committed cost sharing for the FPP. The estimation of the voluntary committed cost sharing required carefully planned research questions and the use of appropriate econometric methods to avoid bias (Greene, 1997; Sigelman and Zeng, 1999). Our primary research question was who is willing to pay for an FPP? Secondly, how much they are willing to pay for it? Moreover, since the study was meant as an exploratory research for the FPP as a product in the developmental stage, an open-ended offering format seemed appropriate. With such an approach, we did not constrain the respondents to think just about their willingness to have an FPP, but to think about the usefulness of a private forest management plan in general. By aggregating the proposed amounts to the national level using different aggregation approaches (e.g. Loomis, 1987; Harrison and Lesley, 1996), we estimated the possible financial effects of cost-share planning in private forests for the current planning system. In addition, we were interested in understanding what factors contribute to greater willingness to pay in order to identify the owners most interested in an FPP.

We hypothesized that if the forest management plan is owner-oriented and includes all information relevant for the owner, then the owner would be willing to pay for it. Accordingly, the hypothesis No. 3 was that the attitude of forest owners towards new forest property plans is positive. The utility of a forest property plan is a function of socio-economic, ecological and forest management factors.

1.5 FOREST OWNER EXPERIENCES WITH PRIVATE FOREST PROPERTY PLANS

The idea of a modern forest property plan (FPP) as an instrument for better management of private forests is relatively new in Slovenia (Bončina, 2003; Papler-Lampe et al.,

2004; Ficko et al., 2005). Some foresters of the Slovenia Forest Service voluntarily initiated the preparation of FPPs in the 1990s to motivate individual owners towards management (e.g. Papler–Lampe, 1994; Jerovšek, 2004; Čadež, 2004). These plans varied greatly in content and form and can only be considered FPP prototypes. However, the experiences of forest owners with these plans can be used to improve the concept of private forest property planning and provide better service in the future. Another source of customer satisfaction information are forest owners for whom forest management plans have been prepared in a form of a graduation theses at the Department of Forestry and Renewable Forest Resources of Biotechnical Faculty in Ljubljana. After more than two decades of FPP preparation, we set out to determine how satisfied forest owners were with these plans.

The analysis of forest owner experiences with the private forest property plans represents the last step in studying the options to consider private forest owner objectives in forest planning. Through evaluating the satisfaction of private forest owners with the FPP, we tested hypothesis No. 4 stating that the experiences of forest owners who have already used a property plan are positive.

2 SCIENTIFIC PAPERS

2.1 PUBLISHED PAPERS

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

Ficko A., Boncina A. 2015a. Forest owner representation of forest management and perception of resource efficiency: a structural equation modeling study (Predstave lastnikov zasebnih gozdov o gospodarjenju z gozdom in učinkoviti rabi virov: študija strukturnega modeliranja). Ecology and Society, 20, 1: 36.
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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 socialecological systems.

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Research

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

Andrej Ficko[1] *and Andrej Boncina*[1]

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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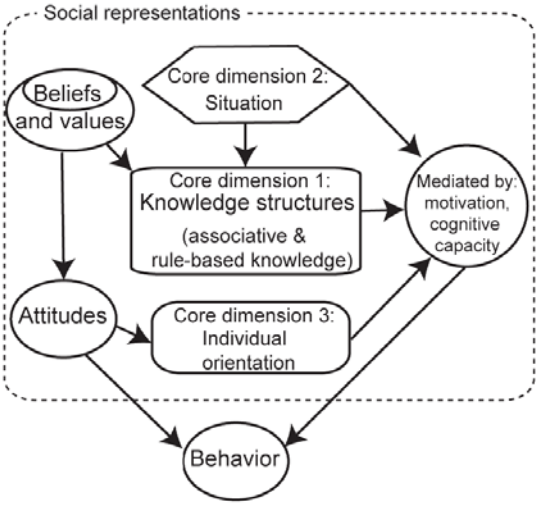
phenomena and their indicators. The differences in the conceptualization of forest management between private forest owners and natural resource professionals may become crucial for the implementation of sustainable forest management in the era of rapidly changing forest ownership from traditional types 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 are consensual and relatively stable. 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.

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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 ±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 (±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

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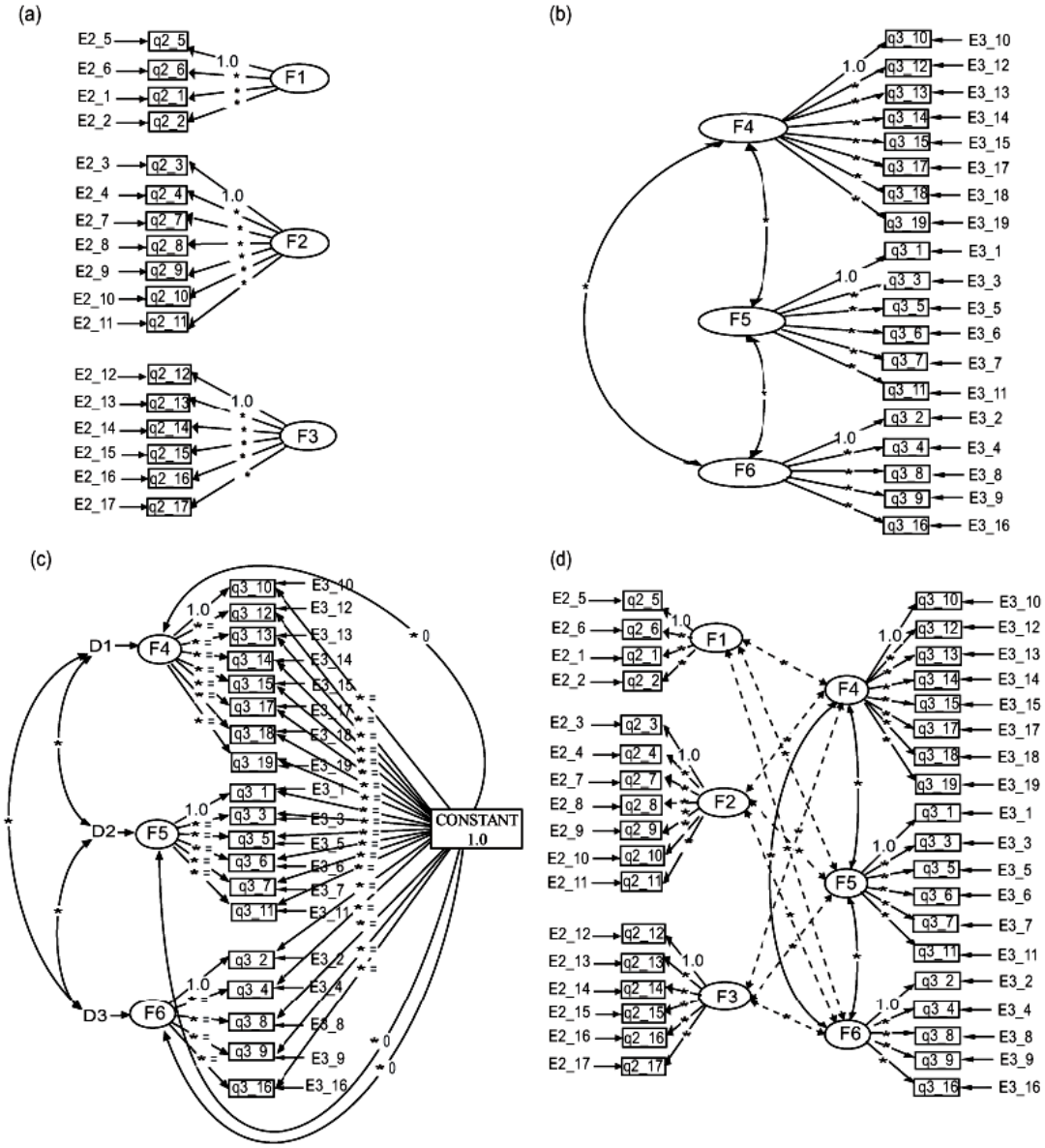
Fig. 2. Path diagrams for the hypothesized structural equation models for the estimation of (a) factors preventing forest owners from cutting more, i.e., cutting constraints F1, F2, and F3; (b) forest owner representations of forest management, i.e., F4, F5, and F6; (c) differences in factor means between 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 χ^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 χ^2 (ΔS-B χ^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 (ΔCFI) 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

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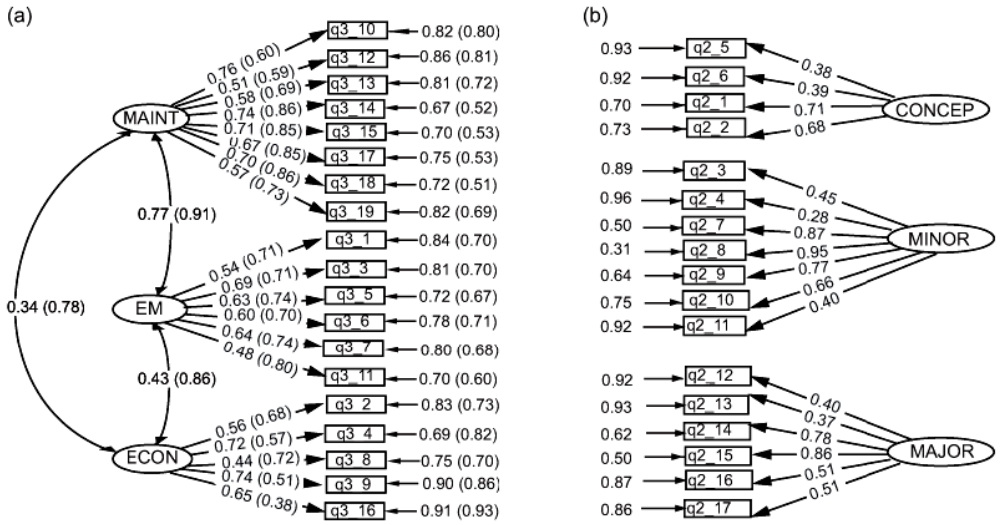
Fig. 3. (a) Forest owner representations of forest management: maintenance forest management (MAINT), ecosystem-centered management (EM), and economics-centered management (ECON). Standardized parameters reported for efficient owners, in parentheses for inefficient owners. (b) Factors preventing forest 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 ≥ 0.90 (Hu and Bentler 1999) and RMSEA ≤ 0.08 (McDonald and Ho 2002); the cutoff values for good fit are CFI ≥ 0.95 and RMSEA ≤ 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 ($\Delta S\text{-}B\ \chi^2 = 120$ 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 (ΔCFI = 0.01, Table 2).

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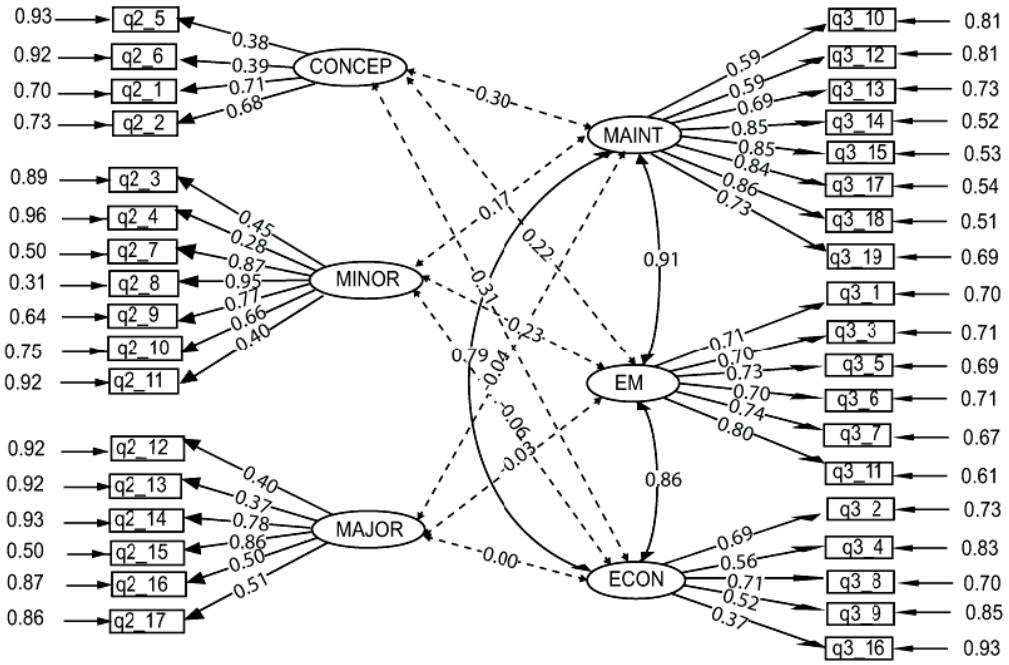
Fig. 4. Correlations between forest owner representations of forest management (MAINT, EM, and ECON) and perceived cutting constraints (CONCEP, MINOR, and MAJOR) shown as two-headed dashed arrows. All parameters significant at $P < 0.05$. MAINT = maintenance forest management; EM = ecosystem-centered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

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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.

	Model 2				Model 21				Model 2 vs. Model 21	
Group	CFI	χ^2 (df)	RMSEA	SRMR	CFI	χ^2 (df)	RMSEA	SRMR	ΔCFI	$\Delta\chi^{2\ddagger}$ (Δdf)
"Efficient" owners	0.923	8393 (149)	0.085	0.069	N/A†	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)*

† N/A not applicable to "efficient" owners.
‡ The Satorra-Bentler scaled χ^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	χ^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"	ΔCFI	$\Delta\chi^2$ (Δdf)		
	0.01	120 (19)*		

* 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*	
Construct equation	EM = -0.169 * V999 + 1.000 * D2	EM = 1.000 * D1
Standard error	0.047	
Robust test statistics	-3.573*	
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

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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 $\Delta S\text{-}B\ \chi^2 = 7636$ 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

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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 2012*b*:11) and "allows field foresters, forest owners and interested individuals to collaborate and exchange their experience" (Pro Silva Europe 2012*a*: 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[†]. 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[‡].		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...[§]		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)

[†]The measurement instrument may need to be adapted before used in other countries.

[‡]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.

[§]Internal consistency of the 19-item scale estimated with Cronbach's (1951) alpha was good (0.885).

2.1.2 Probabilistic typology of management decision making in private forest properties

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We conducted a quantitative study of private forest owner management behavior based on face-to-face interviews with 380 randomly selected private forest owners in Slovenia. Forest owners were asked to rate the relevance of nineteen factors representing information related to the social, ecological, and economic aspects of decision making based on a five-point Likert scale. This information was consolidated into major categories with Principal Component Analysis. Expectation maximization (EM) clustering was used to build a probabilistic private forest owner decision making typology. Six major categories of information determined 64% of the variability in decision making: non-wood goods and services, forest economics, property administration, optimization of wood production, forest protection, and minimum cutting restrictions. EM clustering revealed two decision making types differing in their attitude towards the total economic value of forests: Materialists, whose decisions are mainly related to the extractive value of forests and Non-materialists, who manage for non-extractive value. Full-time farmers, owners living within 2 km of their holdings, and owners who permanently cooperated with the public forest service were much more likely to be Materialists. The uncertainty in private forest owner typology building and the applicability of probabilistic models of private forest owners to end-users is discussed.

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Probabilistic typology of management decision making in private forest properties

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ABSTRACT

We conducted a quantitative study of private forest owner management behavior based on face-to-face interviews with 380 randomly selected private forest owners in Slovenia. Forest owners were asked to rate the relevance of nineteen factors representing information related to the social, ecological, and economic aspects of decision making based on a five-point Likert scale. This information was consolidated into major categories with Principal Component Analysis. Expectation maximization (EM) clustering was used to build a probabilistic private forest owner decision making typology. Six major categories of information determined 64% of the variability in decision making: non-wood goods and services, forest economics, property administration, optimization of wood production, forest protection, and minimum cutting restrictions. EM clustering revealed two decision making types differing in their attitude towards the total economic value of forests: *Materialists*, whose decisions are mainly related to the extractive value of forests and *Non-materialists*, who manage for non-extractive value. Full-time farmers, owners living within 2 km of their holdings, and owners who permanently cooperated with the public forest service were much more likely to be *Materialists*. The uncertainty in private forest owner typology building and the applicability of probabilistic models of private forest owners to end-users is discussed.

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1. Introduction

Numerous studies have attempted to explain the objectives of private forest owners and the determinants of their management behavior, the result being several forest owner typologies (e.g. Karppinen, 1998; Boon et al., 2004; Ingemarson et al., 2006; for a review see Dhubhain et al., 2007 and Emtage et al., 2007). Much of the early research on private forest management behavior concentrated on timber harvesting (Hyberg and Holthausen, 1989; Cleaves and Bennett, 1994). Later, a range of forest management activities, such as silviculture and harvesting (Karppinen, 1998) as well as non-timber activities, were included in management behavior. Joshi and Arano (2009) proposed four forest management activities: timber harvesting, silvicultural activities, property management activities, and recreation activities. Conway et al. (2003) modeled management behavior based on the maintenance of property for successors, the improvement of non-timber values of forest land, and the attitude of owners towards debt burdens. Novais and Canadas (2010) expanded management by including work organization and presented working models of private forest owner management practices.

There are two broad categories of behavioral models: normative models and descriptive models. In the field of management behavior of private forest owners, normative models have mostly been used. They are based on a neoclassical economic model of rational behavior that "rational" decision makers are expected to follow. They were primarily based on utility maximization theory (for a review see Beach et al., 2005). Descriptive models, on the other hand, originate from behavioral science and incorporate cognitive and other constraints, which could modulate the theoretical framework of the utility maximization theory. They are based on empirical evidence on human behavior in real-life decision making situations (for a review of alternative models of individual behavior see for example Van den Bergh et al., 2000). However, utility maximization theory-based studies have a strong methodological advantage over alternative theory-based studies by typifying landowners quantitatively, but thus fail to explore other possible decision making rationales of forest owners besides the hypothesized utility maximization.

Few studies of private forest owner behavior have addressed the cognitive aspects of forest management behavior, such as the information needs of a forest owner in decision making or his/her desire to learn (Järvinen et al., 2003; Toivonen et al., 2005). To our knowledge, Hujala et al. (2007) is the only study that presented private forest owner decision making types which did not hypothesize private forest owners as utility maximizers and further related decision making types to ownership objectives (Hujala et al., 2012).

The theories underlying the studies also partly dictated data acquisition and processing. Studies of private forest owner behavior adopted either qualitative methods of data collection and analysis (e.g. Hujala et al., 2007) or quantitative methods (e.g. Majumdar et al., 2008). Some, however, combined both (e.g. van Herzele and van Gossum, 2008). Many quantitative typologies of forest owners were rather similar in their use of statistical methods. Typically, as a first step, Principal Component Analysis (hereinafter PCA) was used to identify the principal components (hereinafter PC) influencing forest owner behavior from a set

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of objectives, attitudes, motivations, information sources, etc., depending on the aim of the typology building. In the next step, cluster analysis (usually *k*-means clustering) was employed, whereby forest owners were clustered by the PCs into an interpretable number of types. However, Boon and Meilby (2007) employed latent class analysis as an alternative approach to building a private forest owner typology. One of the major shortcomings of *k*-means clustering is that the number of clusters (*k*) needs to be specified before starting the cluster analysis (Witten and Frank, 2000). Typically, *k* was assessed by making a subjective determination of the degree to which clusters could be meaningfully characterized (e.g. Favada et al., 2009) or by a hierarchical cluster analysis performed prior to *k*-means clustering (e.g. Wiersum et al., 2005). An additional criticism of *k*-means is that it is a 'hard' rather than a 'soft' algorithm; forest owners were assigned to exactly one cluster and within that cluster, all forest owners were equal (MacKay, 2003). The assignment criterion in *k*-means clustering implicitly assumes that all clusters are represented by identical Gaussian distributions located at different means. In addition, since the *k*-means algorithm uses Euclidean distances, it cannot deal with the problem of clustering discrete or categorical data (Hill and Lewicki, 2007).

There are two main concerns regarding existing quantitative classification of private forest owners. First, under the influence of utility maximization theory, forest management was simplified to a finite set of activities, and the underlying models of private forest owner behavior were usually binary choice models, such as harvesting/no harvesting, willing/unwilling to cooperate (Beach et al., 2005). This approach to forest management assumed that the forest owner maximizes his/her utility following the theory of rational choice (Harsanyi, 1976; March, 1994). However, in the real world this rather theoretical behavior is modified by several constraints, such as the limited number of alternatives to be considered, the decision maker's cognitive abilities, and the social context of decision making (Becker, 1962; March, 1994; van den Bergh et al., 2000). Moreover, due to inconsistency in an individual's rationality over time (Thaler and Sunstein, 2008; Ariely, 2009) and the persistent uncertainty on whether a landowner maximizes or satisfices (March, 1994), there is a need for behavioral models that do not see forest owner decision making as a purely technical issue of maximization (Hujala et al., 2007; Butler, 2011). In addition, even though evidence on discrepancies between private forest owner conceptualization of forest management and scientific concepts is still scarce (e.g. Steiner Davis and Fly, 2010), more effort is needed to develop behavioral models that consider an owner's conceptualization of forest management. Comparison between closed-ended and open-ended questions in a survey showed that the fixed responses failed to capture many dimensions of forest owner behavior that emerged from the analysis of the responses to open-ended questions (Bengston et al., 2011). However, to our knowledge, none of the existing typologies of management behavior have been directly based on the owners' rating of the management information value in a real decision making environment (hereinafter DME) (Hujala et al., 2007). Any decision a forest owner makes (e.g. the decision to cut, to look for a professional advice, or to sell the wood) represents a course of action taken in a certain situation. The final decision results from the consideration of all relevant information in the DME. Thus, each management decision can be described as the result of the owner's cognitive process based on all information in the DME. In this study, we simplified the value of information (hereinafter VOI) to the relevance of information, since relevance is one of the principal indicators of the quality of information (Kangas, 2010). In addition, taking other criteria into consideration for determining VOI (e.g. the degree of detail of the information) or examining issues affecting the VOI (e.g. marginal uses of information) would be beyond the scope of this study. The relevance of information measures the ability that the information has to decrease the uncertainty in some specific decisions (Schamber et al., 1990). Kangas (2010) emphasized that the relevance of the information needed in decision-making has never been radically questioned. Management behavior is thus better understood by asking owners to identify the information they consider relevant in decision making than by directly asking them about their forest management activities.

The second concern regarding the classification of forest owners is the use of the Frequentist approach instead of the Bayesian probabilistic approach (see Ghazoul and McAllister, 2003; Kangas and Kangas, 2004). Karppinen (1998) determined the probability of assignment to forest owner groups based on landowner objectives and property characteristics but did not use probability as a measure of belief as in the Bayesian inference. Some methodologically similar typologies, in the sense that they communicated uncertainty, were developed in studies of multi-objectiveness in farm owners in France (Landais, 1998) but were notably different from forest typology building approaches in that they included expert knowledge in building the typology. A consequence of not using a probabilistic approach in classifying forest owners is that each private forest owner could only be assigned to one cluster. We believe that the use of mutually exclusive types to characterize the forest management behavior of forest owners may not provide an accurate representation of the decision making process. A forest owner may have more than one significant management attitude or fall in between different attitudes (Urquhart and Courtney, 2011). We suggest that the probabilities for distinct management behaviors should be calculated to better take into account the multi-objectiveness of private forest owners.

The goals of this study were (1) to identify the information that private forest owners consider relevant in daily management decision making; (2) to determine whether the management decision behavior of private forest owners can be typified, and if so, to determine the probability that a forest owner belongs to a particular decision making type; and (3) to identify the predictors of private forest management decision behavior.

2. Methods

This quantitative study of the forest management behavior of private forest owners was based on an interview in which owners were asked to identify the information they utilize in management and to assess the relevance of this information to their management decisions. We then identified the major categories of information used in decision making and the most probable decision making types. Finally, we identified the predictors of management decision behavior (see Fig. 1).

2.1. Survey of forest owners

We analyzed the answers from face-to-face interviews with 380 forest owners in northern Slovenia representing approximately 0.12% of the total number of private forest owners in Slovenia (Medved et al., 2010). The survey population consisted of individual private forest owners owning over 1.0 ha of forest land. The threshold of 1.0 ha was set to exclude forest owners with less than 1.0 ha who control only 9% of the private forest land in Slovenia and are substantially more disengaged in property management than owners of larger properties (Medved et al., 2010). Co-owners and commons were excluded from the research. Encrypted relational databases from the Landowner register from the Surveying and Mapping Authority of the Republic of Slovenia (SMARS, 2007) were used for the preparation of the list of private forest owners, and candidates were randomly selected for the interview. The random selection was separated into four groups based on forest property size (1.0–4.9 ha, 5.0–14.9 ha, 15.0–30.0 ha, and >30.0 ha) following national small-scale forest survey methodology (Medved, 2000) to ensure that all size classes were represented by a roughly equivalent number of 100 interviewees. The survey had a margin of sampling error of plus or minus 1.6 percentage points. A standard deviation in the population for the items in the survey of 0.83 was estimated using Cochran's (1977) sample size formula. The targeted number of 400, which we considered to be manageable, and which fit our budgetary constraints, was eventually reduced by 20 due to missing values. Face-to-face interviews were done in 2009 and 2010. If a forest owner

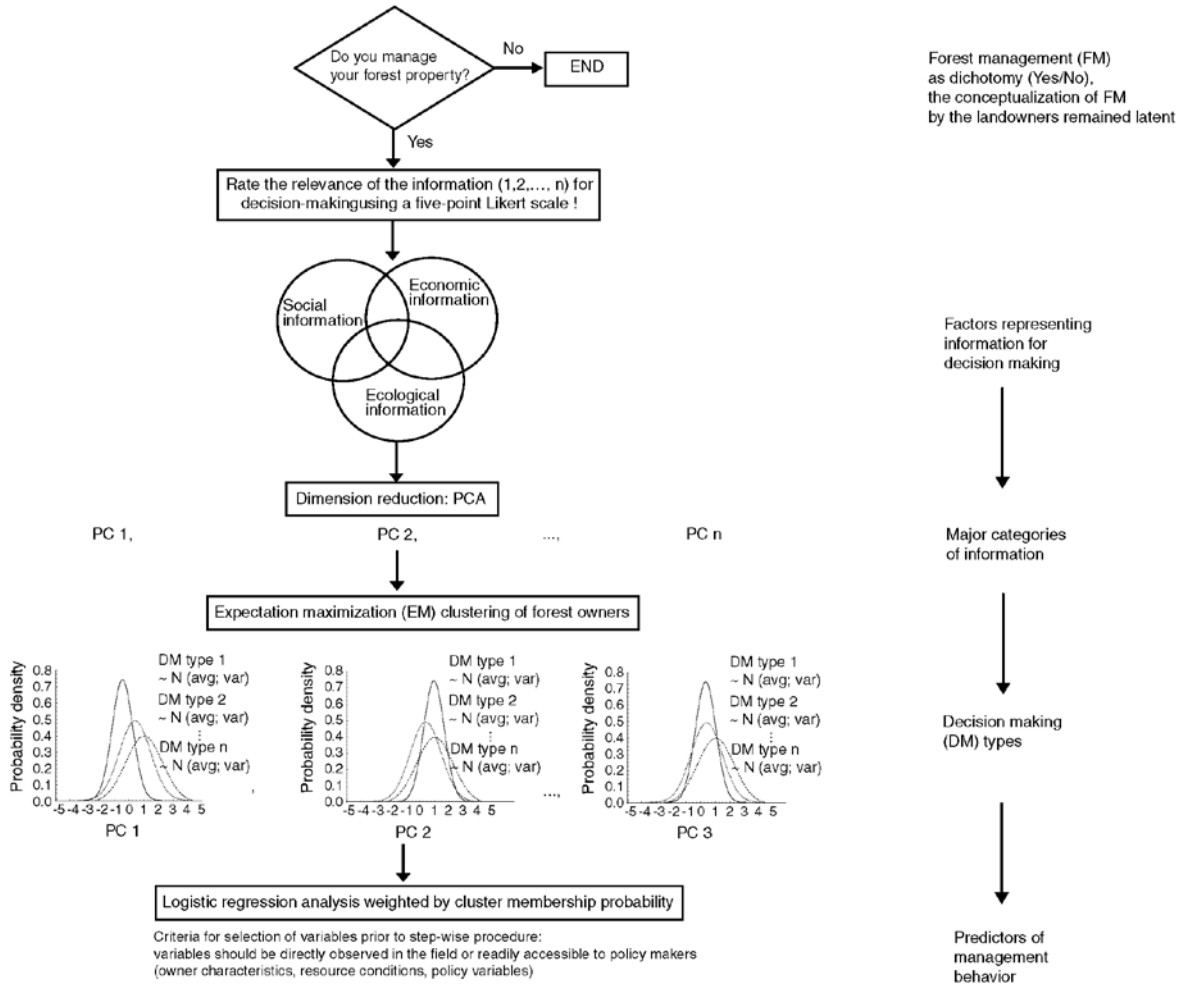

Fig. 1. Methodological model of the study.

was not available when the interviewer visited, the owner was contacted a second time by telephone to arrange a second meeting. The response rate was eventually 100%. Since the interviewees were randomly selected and the response rate was 100%, a survey or response bias assessment was not needed.

We left the meaning of the term "forest management" to remain latent, as conceptualized by forest owners and started the interview with the non-connotative question of whether they manage their forest property or not. Out of the 380 interviewees, 95.8% explicitly stated that they managed their forest properties and that they were fully able to assess whether or not they had the information they needed for property management. Thus, 364 forest owners were included in our analysis.

Before the interviews we prepared a list of nineteen factors representing information that we hypothesized forest owners might consider relevant in forest management decisions. The information was associated with the social, ecological, and economic aspects of forest management such as wood production, other ecosystem goods and services, profitability issues, property administration, and legal considerations. In the interviews forest owners were asked to rate the relevance of the information using a five-point Likert scale: (1) not at all important; (2) rather unimportant (3) not important and not unimportant (4) rather important; (5) very important. At the end of the interviews, the respondents were asked to suggest any other important information not on the list, but none was mentioned.

2.2. Study area

Our study included 8879 ha of managed private forests in two forest management regions (the Slovenj Gradec FMR and the Kranj FMR) in the northern part of Slovenia, where forest cover is slightly above the average for Slovenia (66%). Private forests account for 79% of the total forest area. The study area is characterized by above average private forest property size and small number of tracts per owner (Table 1), particularly in the Slovenj Gradec FMR where forest properties often consist of only one large tract, a result of the traditional self-sufficiency of farms making a living from wood production. A typical interviewee was a male who had finished vocational school and lived as a full- or part-time farmer on a farm where forests represent 37.5% of the total holding area on average. However, a substantial number of forest owners lived less than 10 km from their forest properties (37.4%) or were absentee owners (9.6%). Each forest owner cut nearly 4 m^3 ha^{-1} yr^1 on average in the last decade and more than half cooperated with the Slovenia Forest Service (hereinafter SFS) (Table 1).

Table 1
Characteristics of the private forest owners surveyed (N = 364).

Variable		Variable explanation	Mean values (lower and upper quartile in brackets) or proportions	Candidates for logistic regression
Male/female ratio		Gender	4.5:1	Yes
Age		Age (years)	56 (46; 66)	Yes
Socio-economic type	Full-time farmers	None of the active household members (age 15 to 65) employed outside family farm	40.4%	Yes
	Part-time farmers	Combinations of employments	55.2%	
	Non-farmers	All household members employed outside family farm	4.4%	
Formal education level		Average calculated from the following 7 levels: 1 <8 years, 2 primary school (8 years), 3 high school undergraduate, 4 vocational school, 5 high school graduate, 6 higher professional studies, and 7 college	3.7 (2; 5)	
Total forest area of the owner's holding		Total area of forest land in a holding (ha)	24.4 (7.0; 30.0)	Yes
Percentage of forest land in total holding		Quotient between the total area of forest land and total holding size	37.5%	Yes
Average number of tracts		Average number of forest parcels according to cadastre	7 (3; 9)	
Mean size of forest tracts		Quotient between total area of forest land and number of forest tracts (ha)	4.5 (1.5; 5.1)	Yes
Mean annual cut in the last decade		Cubic meters (m^3 ha^{-1}) harvested according to owner's statement	3.9 (0.7; 4.1)	Yes
Maximum distance between the owner's residence and his tracts	<2 km	Road distance between the farthest parcel and owner's residence (km)	49.7%	Yes
	2–10 km		37.4%	
	11–20 km		11.3%	
	>20 km		1.6%	
Cooperation with the SFS		Not familiar with the SFS	0.5%	Yes
		Familiar, but no cooperation	5.5%	
		Occasional	42.9%	
		Regular and active	51.1%	
Proportion of absentee owners		Absentee owners defined as the owners who do not personally manage their property	9.6%	

2.3. Statistical data analysis

2.3.1. PCA analysis

We used PCA (Hill and Lewicki, 2007) to identify the major categories of information involved in decision making from the list of 19 factors. We chose this approach because the correlation analysis found the degree of interdependence of the information, estimated by Pearson's R, at 0.05 and 0.01 significance levels. Deriving several PCs from many correlated factors enabled us to identify the major categories of information in decision making and facilitated the interpretation of the information. The reliability of the PCA was evaluated using Carmines' theta $\theta = (N/(N-1)) * (1 - 1/\lambda_1)$, where N is the number of factors from the list and λ_1 is the first eigenvalue (Carmines and Zeller, 1979). A Carmines' theta greater than 0.70 was considered an acceptable reliability coefficient. Based on the Kaiser criterion (1960), only components with an eigenvalue greater than one were considered. Thus, the first six PCs were extracted (controlling for 64.1% of the variance) and subsequently rotated with varimax rotation to increase their interpretability.

2.3.2. Expectation maximization (EM) cluster analysis

Forest owners were clustered into forest management decision types using PCs. Two separate cluster analyses were done: hierarchical cluster analysis and expectation maximization (EM) cluster analysis (Dempster et al., 1977; Hill and Lewicki, 2007). First, the six PCs were used as cluster variables in an unsupervised (hierarchical) cluster analysis to recognize the general pattern of information use in decision making. We used Ward's minimum variance method and the squared Euclidian distance as a similarity distance measure.

In the next step, we used EM cluster analysis (Hill and Lewicki, 2007). The EM clustering algorithm (Dempster et al., 1977; Witten and Frank, 2000) computes probabilities of cluster memberships based on Bayesian probability distributions rather than assigning owners to a pre-defined number of clusters. The goal of the EM clustering algorithm is to maximize the overall probability of the data based on the (final) clusters. With the help of a tree diagram of the hierarchical cluster analysis from the first step, the minimum number of clusters to begin the search for the best cluster solution was set at 2 and the maximum number of clusters was subjectively set at 5. Thus, for each PC several probability distributions with different means and standard deviations were calculated to maximize the likelihood of the observed data. In other words, the EM algorithm attempted to approximate the observed distributions of values based on mixtures of different distributions in different clusters.

EM cluster analysis enabled the use of a modified v-fold cross-validation scheme without the need for a pre-defined number of clusters or an a priori specification of the training sample to obtain the prior probability distributions. Since we did not have any prior probability distribution for cluster membership that would have enabled us to express our uncertainty about forest management decision types, we used v-fold cross-validation starting with a pseudo-random distribution of initial clusters. The random seed initialized the pseudo-random number generator, which was used to generate the initial clusters. To find the right number of clusters the v-fold cross-validation algorithm divided the overall sample into a number of v-folds (randomly drawn, disjoint sub-samples). EM cluster analysis was then successively applied to the observations belonging to the $v-1$ folds (training sample), and the results were applied to the testing sample to compute the index of predictive validity. The results for the v replications were averaged to yield a single measure of the stability of the respective model, which is average negative (log-) likelihood, computed for the observations in the testing samples. We used 10-fold cross-validation. When the log-likelihood from one iteration to the next varied by less than 0.001, the iterative clustering algorithm terminated. Before starting the EM cluster analysis, the distribution of all six factors was tested for normality; normal distribution was consequently set for each of them. The smallest percentage decrease in average log-likelihood of cases for the next cluster solution evaluation was set to 1%, assuring that the results with $k+1$ clusters were not at least 1% better than the solution with k clusters, which is presented in the results.

For each owner, the EM clustering algorithm computed the probabilities of belonging to each cluster. The differences in the distribution of the classification probabilities across management decision types were tested with the Kolmogorov–Smirnov test. To foster the interpretation of clusters and to enable later identification of the predictors of cluster

membership, the final 'hard' assignment of each owner to one of the clusters was done based on the highest classification probability.

2.3.3. Binary logistic regression

Logistic regression was used to identify the most important predictors of management behavior (Hosmer and Lemeshow, 2000). The dependent variable was dichotomous, i.e. membership to the specific decision making type versus the other type. To incorporate the inequality of the forest owners within the type into the regression model, the dependent variable was weighted by the respective probability for belonging to this type. In this way, forest owners having higher probability of belonging to this type had proportionally more weight in predicting the cluster membership. In contrast, owners whose classification to the forest management decision type was rather unreliable had proportionally less weight in predicting the forest management decision type. By using weights, we ensured that the explanatory logistic regression model of forest management decision types was better fitted to the real decision making types and thus more warranted.

The traditional approach to statistical model building involves searching for the most parsimonious model that still explains the data (Hosmer and Lemeshow, 2000, p. 92). However, private owner behavioral models included different factors depending on the aim of the study and the underlying conceptual model employed. Most commonly, studies tested the influence of the underlying theory supporting variables, such as econometric studies seeing forest owners as profit- or utility-maximizers (Beach et al., 2005) and included market drivers, policy variables, owner characteristics, and resource conditions. Some authors strove for applicable models and refrained from using all categories of groups of factors. Instead, they arbitrarily selected candidate variables that could be directly observed (e.g. "structural attributes" of private owners in Hogl et al., 2005 or "owner and holding characteristics" in Karppinen, 1998). The dilemma between arbitrary selection of candidate variables and solely statistically-driven methods of variable selection is common to logistic regression model building (Hosmer and Lemeshow, 2000). Our selection of independent variables in the logistic regression was based on two criteria: applicability and re-use of the model. First, in order to provide a typology which is applicable in practical forest policy, variables should be directly observed in the field or readily accessible to typology users, i.e. forest policy makers through the information systems of public services. Second, variables should enable easy re-identification of the owner types in recurring surveys. Consequently, nine variables were selected as candidates for the logistic regression: gender, age, socio-economic type (owner characteristics), total forest area of the owner's holding, percentage of forest land in the total holding, mean annual cut in the last decade, mean size of forest tracts, maximum distance between the owner's residence and his tracts (resource conditions), and cooperation with the SFS (policy variable) (Table 1).

First, collinearity was verified with Pearson correlation coefficients; if the Pearson correlation coefficient between two independent variables exceeded 0.45 (Mayer et al., 2005), one of the variables in the pair was excluded. Contingency tables and a χ^2-test for category variables and a two-sided *t*-test for continuous variables were used to check their univariate influence on the dependent variable. Any variable having a univariate test p-value < 0.25 was accepted as a candidate for the logistic model, while all other variables were excluded from the procedure. All continuous independent variables passed the test for linear correlation with the logarithm of the odds and were allowed to be included in the procedure as continuous variables. We used a forward stepwise algorithm, which was based on the maximum likelihood criterion with the limitation of the number of possible iterations set to 30. We calculated the variance inflation factors (VIF) for independent variables to check for possible multicollinearity left in the model. VIF ranged from 1.006 to 1.064 indicating the absence of multicollinearity. The goodness-of-fit was tested with the Hosmer–Lemeshow goodness-of-fit test (Hosmer and Lemeshow, 2000) and with an estimated D^2 (Guisan and Zimmermann, 2000). All statistical analyses were carried out using Statistica 8 software (StatSoft Inc., 2009).

3. Results

3.1. Major categories of information used in decision making

The most relevant information was knowing who to contact at the SFS when the owner wanted to harvest. Harvesting decisions, however, were not influenced by the ability to use mechanized harvesting contractors and their services; owners assigned the lowest relevance to the information regarding the possibilities for mechanized harvesting. Forest owners also did not consider information about other contractors offering forest operation services or the current forest land market situation as relevant (Fig. 2). The correlations between the information private forest owners use in decision making were moderate (the highest Pearson's R = 0.79) and positive for most pairs.

PCA analysis revealed six major categories of information among the nineteen factors representing the social, ecological, and economic aspects of forest management, which explained 64% of the variability in decision making (Table 2).

The most important category (PC 1) considered in management decision making in private forests, accounting for 23.6% of the total variability, was information regarding *non-wood goods and services*. PC 1 had the highest number of factors with factor loadings higher than 0.50, i.e. four, while the second PC had three factors. The third, fourth, fifth, and sixth PCs had three or fewer factors with factor loadings higher than 0.50. The information that distinguished decision making the most was the information regarding wildlife, the rights and duties of forest property possession, management restrictions due to nature protection, public goods and services in forests, and sylvicultural measures.

The second most important category (PC 2) represented information regarding *forest economics* and explained 9.7% of the variance in decision making. Three factors with particularly high factor loadings (above 0.70) indicated that information related to economic aspects was the

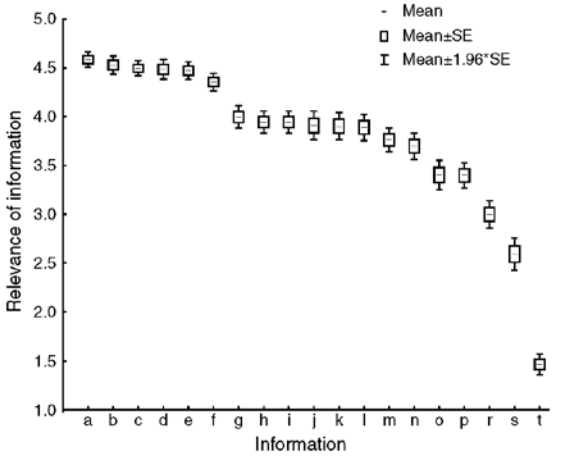

Fig. 2. Forest landowner assessment (N = 364) of the relevance of information in management decision making in private forest properties (*a* contact with a person in charge of cutting approval, *b* property boundaries, *c* forest protection and bark beetle prevention, *d* locations of all parcels, *e* allowable cut, *f* silvicultural measures, *g* costs of forest operations, *h* rights and duties of forest possession, *i* profitability of forest management, *j* wood prices and wood markets, *k* bucking techniques, *l* possible cut for each individual parcel, *m* management restrictions due to nature protection, *n* possibilities and costs of forest road building, *o* possibilities for hiring wood harvesting companies and the cost, *p* game species and population densities, *r* public rights on owner's holding, *s* current market prices of forest land, and *t* possibilities for mechanized harvesting).

Table 2
Factor loadings in the PCA analysis of the information used in management decision making in private forest properties (N = 364, Carmines' theta = 0.82). [a].

Information	Major categories of information[b]					
	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6
Costs of forest operations		**0.81**				
Profitability of forest management		**0.72**				0.29
Possibilities for hiring wood harvesting companies and the cost		**0.72**				
Possibilities for mechanized harvesting		0.48				
Bucking techniques				**0.71**		
Wood prices and wood markets				**0.85**		
Possible cut for each individual parcel				**0.58**		0.43
Silvicultural measures						**0.78**
Forest protection and bark beetle prevention						**0.77**
Current market price of forest land	0.31			0.41		
Property boundaries			**0.90**			
Locations of all parcels			**0.90**			
Possibilities and costs of forest road building	0.35	0.29				0.45
Rights and duties of forest possession	**0.72**					0.28
Public rights on owner's holding	**0.80**					
Game species and population densities	**0.82**					
Management restrictions due to nature protection	**0.62**					0.26
Allowable cut					**0.84**	
Contact with a person in charge of cutting approval					**0.81**	
Eigenvalue	4.49	1.84	1.64	1.56	1.38	1.27
Cumulative variance explained (%)	24	33	42	50	57	64

[a] Bolded loading indicates a value greater than 0.50, loadings below 0.25 are not shown.
[b] PC 1, non-wood goods and services; PC 2, forest economics; PC 3, property administration; PC 4, optimization of wood production; PC 5, minimum cutting restrictions; PC 6, forest protection.

second most important consideration in decision making, i.e. information regarding the costs of forest operations, the profitability of forest management, and possibilities for hiring wood harvesting companies and the cost of such services.

We identified a third PC as information related to *property administration*. It additionally explained 8.6% of the variability in decision making. Two indicators pointed to *property administration* as the third most important aspect of decision making, i.e. information regarding property boundaries and the locations of all parcels of forest land, both of which had factor loadings of 0.90.

The fourth (PC 4), fifth (PC 5), and sixth categories (PC 6) additionally explained 22.2% of the variability in decision making. They represented information regarding the *optimization of wood production* (8% of the variability), *minimum cutting restrictions imposed by the authorities* (7%), and *forest protection* (7%), respectively.

3.2. Private forest management decision types

Hierarchical clustering of forest owners into forest management decision types indicated that 2 to 5 clusters could be distinguished (Fig. 3). However, EM cluster analysis consolidated forest owners into only two forest management decision types, represented by an almost equal number of forest owners (Table 3). Decision making differed between cluster 1 and cluster 2, as evidenced by the significantly different relevance of all groups of information ($p = 0.000$), with the exception of minimum cutting restrictions imposed by the authorities ($p = 0.360$) (Fig. 4). Cluster 1 was particularly different from cluster 2 with regard to owner attitudes towards non-wood goods and services (PC 1) and in owner attitudes towards the economic aspects of forest management (PC 2).

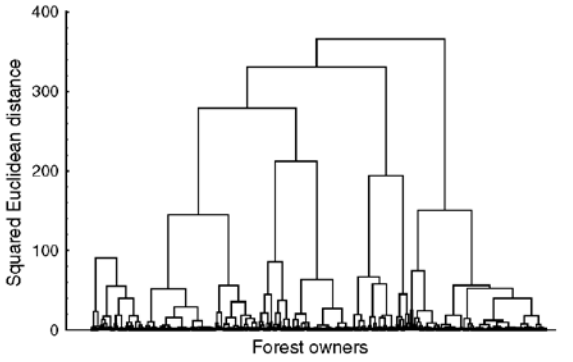

Fig. 3. Hierarchical clustering of forest owners (N = 364) into forest management decision types according to the major categories of information used in decision making.

Cluster 1 had positive mean values for all PCs, with the exception of PC 1. In contrast, in cluster 2, the PC 1 mean value was the only positive value and was the highest among all PCs, meaning that information regarding non-wood goods and services was the most relevant in the decision making of forest owners belonging to cluster 2. In addition, in cluster 2, the mean value of economic information (PC 2) was the lowest, indicating that forest management decisions of owners in cluster 2 were almost exclusively based on non-timber aspects. Forest owners differed regarding their attitude towards forest goods and services that can be consumed directly, i.e. attitude to use value of forests. The decision making of cluster 1 members was driven by materialistic objectives; they seek information related to the consumable, extractive goods and services. Cluster 2 members tend to manage for non materialized benefits from forests. Therefore, we may label cluster 1 as *Materialists* and cluster 2 as *Non-materialists*.

Probability distributions of values for the major categories of information used in decision making showed higher standard deviations for *Non-materialists* than for *Materialists* (Fig. 4), which suggested that the use of management information among *Non-materialists* was more heterogeneous. In contrast, the decision making behavior of *Materialists* was more homogeneous; about 95% of the values (within two standard deviations) for all major categories of information for *Materialists* lie within the interval mean ± 1.6, and for the *Non-materialists*, only 79.3% of values lie within the same interval.

The distribution of classification probabilities for both forest management decision types showed a high overall accuracy of final classification (Table 3); however, the management decision behavior of *Non-materialists* was assessed with significantly higher probability than that of *Materialists* (mean classification probability = 0.93 and 0.88, respectively, Kolmogorov–Smirnov test statistic = 5.02, $p < 0.001$).

Table 3
Normalized mean values of the major categories of information used in decision making by *Materialists* and *Non-materialists*.

		Cluster 1: *Materialists*	Cluster 2: *Non-materialists*
Major categories of information:			
Non-wood goods and services		−0.44	0.41
Forest economics		0.28	−0.28
Property administration		0.23	−0.22
Optimization of wood production		0.21	−0.20
Minimum cutting restrictions		0.05	−0.05
Forest protection		0.12	−0.14
Count		184	180
Mean classification probability		0.88	0.93
95% CI for mean classification probability	Lower bound	0.86	0.91
	Upper bound	0.90	0.95

Index of predictive validity: average negative log-likelihood = −8.103533.

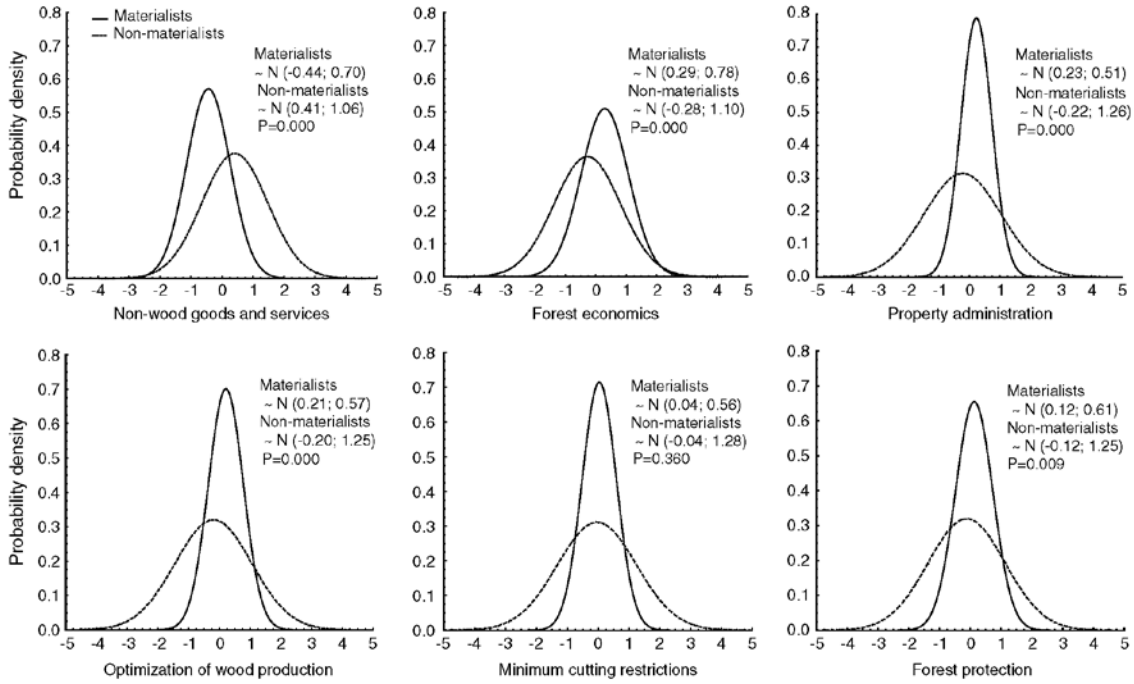

Fig. 4. Probability distributions for the six major categories of information used in decision making by *Materialists* and *Non-materialists* and significant differences between them.

3.3. Predictors of forest management decision behavior

Using a logistic regression model (Table 4), we found that the probability of falling into the *Materialist* decision making type was mostly dependent on the social characteristics of forest owners, i.e. their level and frequency of cooperation with the SFS ($p=0.000$), their socio-economic type ($p=0.021$), and the maximum distance of their residence from their tracts ($p=0.001$). Gender also appeared to be an important predictor of the decision making type; the odds of a women being an *Materialist* were 2.37 times greater than the odds of a man being one. Age turned out to be irrelevant in management behavior ($p=0.112$), controlling for other predictors in the model.

Table 4
Predictors and odds of forest owners belonging to *Materialists* vs. *Non-materialists*.

Predictor variables[a]	β	p	Exp(β)	95% CI for EXP(β)	
				Lower	Upper
Constant	−1.77	0.000	0.17		
Gender: women = 1	0.86	0.011	2.37	1.22	4.60
Maximum distance from the owner's residence to one of his tracts: <2 km	0.87	0.001	2.38	1.44	3.92
Cooperation with the SFS: Permanent and active = 1	1.78	0.000	5.96	3.56	9.95
Socio-economic status: active full time farmer = 1	0.60	0.021	1.82	1.09	3.04
Hosmer–Lemeshow test	p = 0.820				
D^2	0.062				
Total percentage of correctly predicted forest management decision type	Materialists	74.0%			
	Non-materialists	66.5%			

[a] Final model presented in the table contains only statistically significant variables, variables excluded in the stepwise procedure are: age ($p=0.112$), the total forest area of an owner's holding ($p=0.866$), mean annual cut ($p=0.870$), the percentage of forest land in the total holding ($p=0.929$), and the mean size of forest tracts ($p=0.583$).

The total forest area of an owner's holding ($p=0.866$) or mean annual cut ($p=0.870$) did not explain the distinction between *Materialists* and *Non-materialists*. Moreover, the percentage of forest land in the total size of the holding ($p=0.929$) and the mean size of forest tracts ($p=0.583$) did not have a statistically significant influence on the type of management behavior.

Forest owners who had permanently and actively cooperated with the SFS were 3.6 times more likely to make decisions as a *Materialist* than owners who had occasional contact with SFS or no contact at all. *Materialists* were 1.8 times more likely to be found among full-time farmers than in any other socio-economic type. *Materialists* were 2.4 times more likely than *Non-materialists* to live less than 2 km from their forests.

4. Discussion

4.1. Decision making types

We ascertained that decision making is influenced by six major categories of information. It is distinguished by forest owner attitudes to the total economic value of forests (Pearce and Moran, 1994). Forest owners differed primarily in their attitudes towards the economic extractive values vs. non-extractive values of forests. Half of the owners based their decisions mostly on the economic and administrative aspects of forest management and were classified as *Materialists*. They considered information regarding the profitability of management, expected costs of cut and forwarding, the possibilities of outsourcing, and the locations and boundary lines of parcels as indispensable for decision making. The other half of owners, who we described as *Non-materialists*, seemed to manage their properties for non-extractive or non-use values of forests. They considered information regarding wild game, management restrictions imposed due to nature protection, rights and duties of forest possession, and public rights on their properties (free access, non-commercial non-wood goods) most relevant for forest management. Hogl et al. (2005) and Weiss et al. (2007) similarly classified forest owners in Austria into two types based on their attitude

towards management information: the *traditional forest owners* and the *transitional types* match well with our *Materialists* regarding their use of information and level of cooperation with and trust in forestry institutions. *Economically-oriented forest owners* in Germany (Mutz, 2007) put high value on the maintenance of their holdings and on income, or consider their property as reserves, which is similar to economic extractive values of *Materialists*. Our *Materialists* also correspond well with the *economically interested forest owners* described in Bieling (2004). In a review of landholder profiling, Emtage et al. (2007) concluded, similar to Schaffner (2001), that three fundamental elements, i.e. economic, personal (or lifestyle), and conservation values for landholding, depict landowner management behavior. The economic values of landowners in Emtage et al. (2007) could be understood as the economic extractive values of our *Materialists*. We showed that *Non-materialists* are guided by criteria that are opposite to those used by *Materialists* and that they are comparable with the two other groups proposed by Emtage et al. (2007). However, based on a review of the forest owner typology literature, Dhubhain et al. (2007) interpreted only two common patterns of private forest owner management behavior: that which is concerned with the production of wood and non-wood goods and services to generate economic activity and that which is concerned with the consumption of wood and non-wood goods and services.

4.2. Uncertainty in the classification of private forest owners

By developing a probabilistic private forest owner decision making typology we have introduced a novel approach to the classification of forest owners. This approach offers two major improvements and may therefore benefit the end-users of the typology. First, in the probabilistic approach, only forest owner types with the highest likelihood emerge from the diversified population. In most typologies, which use discrete classification into disjoint owner types, re-identifying owners is difficult in practice because the characteristics that define types of forest owners are often overly specific. Such classification models might fit statistically well to the survey population they were developed for, but cannot be easily simplified without compromising the exclusiveness of the types (e.g. Brown and Reed, 2000) and are thus less useful for policy makers. Even in recurring and comprehensive national surveys (e.g. National Woodland Owner Survey, USA), forest owner types from subsequent surveys are harder to generalize due to changed sampling methodology and survey-specific questions (Bengston et al., 2011). In addition, even if the reliability of clustering was indicated or a validation test of the results was performed, non-probabilistic typologies can only be loosely compared, which has been partly recognized by Hogl et al. (2005), Boon and Meilby (2007), and Emtage et al. (2007). Latent class analysis proved to be an alternative probabilistic approach in the classification of land owners for it yields comparable or slightly better results than non-probabilistic classification, but only when adding covariates to the model, such as associations between the factors (Meilby and Boon, 2004) or individual characteristics of land owners (Pouta et al., 2011). A more extensive implementation of the Bayesian approach in studying private forest owner behavior could also facilitate meta analyses of typologies and cross-national evaluation studies.

The second advantage of our approach is that the probabilities of cluster memberships were calculated for each forest owner. This means that the end-user of the typology is not forced to simplify individual forest owner behavior into just one most typical mode, e.g. a typical timber manager or a pure nature conservationist. In existing typologies, this shortcoming has been partially avoided by the classification of forest owners into a multifunctional or multi-objective owner type. This owner type likely encompasses several forest owner goals, but the degree to which a forest owner incorporates multiple objectives in his management strategy has remained unclear (Urquhart and Courtney, 2011). By using the EM algorithm, the multi-objectiveness is not methodologically distorted; a forest owner could be production-oriented, protection-oriented, or multi-objective at the same time; multi-objective owners do not necessarily cluster into a separate group but could be members of any other group. This is particularly beneficial in a time of dynamic changes in the private ownership sector (Kvarda, 2004; Wiersum et al., 2005) when management objectives and motives should be constantly monitored. Such an approach is also advised in private forest research that is based on non-repetitive surveys, case studies, or samples where the validation of the typology is problematic. Moreover, in traditional typologies, it could be that some of the forest owners whose behavior was not clear-cut and could not be assigned to any other cluster were classified as uninterested (e.g. Bieling, 2004), indifferent (e.g. Wiersum et al., 2005; Boon et al., 2004), or passive/resigning (e.g. Ingemarson et al., 2006).

However, the EM algorithm for clustering has a number of limitations and shortcomings. The most documented shortcoming is its possible poor rate of convergence, but this does not appear to be a problem in practice for well-separated mixtures when starting the algorithm with reasonable starting values (Fraley and Raftery, 1998). The second shortcoming is that the number of assessed probabilities for each observation is equal to the number of components in the mixture, so that the EM algorithm for clustering may not be practical when very large numbers of clusters are expected in the survey population. One should also be aware that employing the EM algorithm for a model having a certain number of components when there are actually fewer groups may lead to the failure of the procedure due to ill-conditioning (Fraley and Raftery, 1998).

It is debatable whether the distinction between the management decision type and owner type is necessary. Here, the time aspect of the typology can be crucial, for it depends on how static one considers the typologies. We have argued (see Introduction) that decision making takes place in the DME. Hence, any change in the DME impacts decision making and could consequently change the decision making type. Similarly, forest owner types could also be considered as a representative generalization of private ownership for a limited period, i.e. until intervening events produce changes in an owner's intentions, management goals, or perceived behavioral control (Ajzen, 1991). In the theory of planned behavior (Ajzen, 1991), respecting the condition that intentions and perceived behavioral control must remain stable in the interval between their assessment and the observation of the behavior is indispensable for accurate behavioral prediction. This leads us to the conclusion that managing forest property for economic objectives (e.g. *economically interested forest owners*, Bieling, 2004) could correspond well to economically rational decision making for the period in which the owners are surveyed, but does not necessarily imply that the decision making type and forest owner type are coherent throughout the whole period of ownership. For instance, Ingemarson et al. (2006) found that roughly 30% of owners believed they would change their objectives in the next five years. However, we share the opinion of Hujala et al. (2007) that the verification and refinement of the relationship between the decision making type and the forest owner type require further research and more in-depth comparative analyses.

4.3. Implications for practice and conclusions

Typologies do not have explanatory power by themselves. We established two prerequisites in the preparation of the explanatory model of forest owner decision making. First, variables in the model were required to be rather basic and readily accessible to policy makers through the information systems of public services. Alternatively, they could be acquired via a cost-effective survey. Second, variables should in practice enable the easy re-identification of owners. This was done to enhance the instant applicability of the model and to reduce the possible erroneous interpretation of the model by forest policy makers which could result from different interpretations of the complex and sophisticated socioeconomic variables. We discovered that the social characteristics of forest owners influenced their economically-oriented behavior, not the more common attributes of production-oriented

forestry, such as the size of forest area (Cleaves and Bennett, 1994). Boon and Meilby (2007) similarly found that *Production-oriented owners* had comparatively smaller average forest area than *Environmental/ Recreational owners*. *Materialists* generally lived no more than 2 km from their forest land, actively cooperated with the SFS, and were most often full-time farmers. This indicates that the economically rational behavior of *Materialists* is not purely based on utility maximization strategy, but also has a historical and social background. The traditional self-sufficiency of farms making a living from wood production, which is prevalent in the north-eastern part of the study area, could have contributed to the economically rational reasoning and the substantial trust in the forestry authorities among *Materialists*. Following the administrative provisions of forest management was the first step in maintaining the sustainability of their forest properties. In order to maintain permanent incomes from their forests, owners were forced to behave in an economically rational way.

Like Lidestav (1998), Lidestav and Ekström (2000) and Nordlund and Westin (2011), we found differences between the attitudes of male and female owners to forest management. However, our findings were the opposite; women were more likely to behave as *Materialists* than as *Non-materialists*. This could be partly explained by the cultural and social contexts of gender in private forest ownership. Lidestav and Ekström (2000) attributed gender differences in forest management behavior to differences in value orientations resulting in different rationales; women may have greater responsibility as a result of their social role in society. Taking this into account, it seems reasonable that female forest owners would be more likely than men to be more deeply involved in the sustainable management of the property or in maintaining the property for the heirs and that they would be more likely to behave as *Materialists*.

The dichotomy in private forest owner management behavior should be clearly reflected in forest policy instruments that target *Materialists* and *Non-materialists*. Numerous authors have discussed forest policy instruments aimed at directing private forest management (e.g. Serbruyns and Luyssaert, 2006; Cubbage et al., 2007) and specified them according to groups of private forest owners. Cubbage et al. (2007) state that the selection of forest policy instruments is affected by forest resource characteristics, the social values of forests, and the ability to estimate economic values. *Materialists* did not differ from *Non-materialists* in forest resource characteristics. We found that private forest owners were distinguished by their attitude towards non-wood goods and services more than any other factor. This implies that on the one hand there is a group of owners whose decisions are driven by a strong motivation for direct benefits from forests, and on the other hand, there are owners whose benefits from forests are non-extractive. In the first group, there is a need for instruments that encourage the sustainable development of business activities on their forest properties. For instance, one of the instruments that supports forest owner decisions, and that has already been accepted among private forest owners in Slovenia (Ficko et al., 2010), is a forest property plan.

It is unclear whether *Non-materialists* can be identified as easily as *Materialists* in practice and therefore addressed using specific forest policy tools. So far, existing typologies have not provided a clear direction for forest policy makers working with private forest owners motivated by non-economic considerations. This is not only due to the huge variety of management motivations, values, and objectives among private forest owners, but rather to the lack of research on the contextual aspect of reasoning in their decision making. Our study sees *Non-materialists* as a likely changing superset of different forest owners who should be investigated repeatedly with probabilistic methods to avoid a static view of their behavior and to assure the highest level of certainty in their segmentation. In addition, explicitly incorporating the cognitive aspect of decision making into private forest owner research would provide deeper insight into the management practices of owners not driven by the consideration of extractive value of forests. Alternative theories of human behavior (An, 2012), which have largely remained untested in a forest owner's decision-making context, may provide new frameworks for understanding private forest owner behavior. Moreover, advanced methods for developing probabilistic forest owner typologies, such as fuzzy clustering (Döring et al., 2006), still wait to be pioneered in forest owner segmentation research. Surprisingly, besides latent cluster analysis in Meilby and Boon (2004) and the methods applied in this study, no other methods for estimating the analyst uncertainty of forest owner clustering have been used so far. In addition, the application of mixed methods (quantitative and qualitative methods) in forest owner segmentation should be encouraged. The resulting typologies would hopefully benefit the creation of forest policy instruments that are innovative and diversified enough to also govern *Non-materialists*' forests.

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2.1.3 Ensuring the validity of private forest owner typologies by controlling for response style bias and the robustness of statistical methods

Ficko A., Boncina A. 2014. Ensuring the validity of private forest owner typologies by controlling for response style bias and the robustness of statistical methods [= Zagotavljanje veljavnosti tipologij lastnikov zasebnih gozdov z zaznavanjem sistematične popačenosti odgovorov zaradi odzivnih slogov in uporabo robustnih statističnih metod]. Scandinavian Journal of Forest Research, 29, Suppl. 1: 210-223. DOI:10.1080/02827581.2013.837194

In survey-based segmentation of forest owners, two threats to the validity of results have largely been ignored: 1) response style bias, and 2) the robustness of the statistical methods. This study demonstrates response style bias detection, presents an approach for correcting for acquiescence – the systematic tendency to agree with survey items, and explores the sensitivity of a probabilistic clustering algorithm to requirements for the validity of the typology. Structural equation modeling and Monte Carlo data generation techniques were employed to detect acquiescence and estimate its effect on construct validity. A survey of the relevance of management information for private forest owners (N=364) was used as an example. Although acquiescence was confirmed, it had minor effect on the results and no effect on the substantive construct. Uncertainty about the number of forest owner types and membership can be reduced by using probabilistic clustering and observing the number of clusters while changing the requirements for the validity of clusters. The expectation maximization algorithm proved to be robust even to stringent requirements for the validity of clusters. By controlling for response style and the robustness of statistical methods, the validity of private forest owner typologies can be better ensured.

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RESEARCH ARTICLE

Ensuring the validity of private forest owner typologies by controlling for response style bias and the robustness of statistical methods

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In survey-based segmentation of forest owners, two threats to the validity of results have largely been ignored: (1) response style bias and (2) the robustness of the statistical methods. This study demonstrates response style bias detection, presents an approach for correcting for acquiescence – the systematic tendency to agree with survey items, and explores the sensitivity of a probabilistic clustering algorithm to requirements for the validity of the typology. Structural equation modeling and Monte Carlo data generation techniques were employed to detect acquiescence and estimate its effect on construct validity. A survey of the relevance of management information for private forest owners ($N = 364$) was used as an example. Although acquiescence was confirmed, it had minor effect on the results and no effect on the substantive construct. Uncertainty about the number of forest owner types and membership can be reduced by using probabilistic clustering and observing the number of clusters while changing the requirements for the validity of clusters. The expectation maximization algorithm proved to be robust even to stringent requirements for the validity of clusters. By controlling for response style and the robustness of statistical methods, the validity of private forest owner typologies can be better ensured.

Keywords: acquiescence; Monte Carlo simulation; non-industrial private forest owners; response style bias; structural equation modeling; survey

1. Introduction

Surveys are one of the most frequently used instruments of measurement in social research in forestry. A researcher should consider several issues to ensure the validity of the results, for example, selection of the type of survey best suited to the problem domain and target population and design of the questionnaire to avoid biases in advance. Social scientists have raised some important concerns regarding possible biases in responses and their influences on construct validity, but these have been largely ignored by their counterparts in forestry despite the fact that both parties investigate a comparable population and use similar research design and data processing. To our knowledge, there are only a few studies on the social aspects of forestry that have recognized the potential threats to the validity of results due to bias in the input data or insufficient methodological rigor during the analysis (e.g. Egan & Jones 1993, 1995).

In social studies in forestry, private forest owner segmentation has long been popular for describing the diversity of private ownership. The number of published forest owner typologies increased after Kuuluvainen et al. (1996) pioneered quantitative methods of market segmentation in forestry. In quantitative segmentation, the analyst should account for two main uncertainties (Creswell 2003): (1) uncertainty about whether responses reflect the real opinion of a respondent or are biased (respondent uncertainty) and (2) uncertainty about whether the final segmentation of owners into the number of (usually disjoint) sets corresponds to reality, that is, model-reality consistency (Bollen 1989). Related issues include uncertainty about the number of customer segments, their meaning, and the fuzziness of membership (analyst uncertainty).

Private forest owner typologists have typically made the assumption that respondents know the answers to the questions and that their responses are an accurate reflection of their opinions. However, several behavioral, marketing, and sociological studies (cf. Weijters 2006; Van Vaerenberg & Thomas 2012) have found evidence of systematic response bias. Such consistent responding to items on the basis other than that the items were designed for has been referred to as response style (Paulhus 1991). Three common response styles have been identified (Paulhus 1991): the acquiescence response style (ARS), or the tendency to agree with the item irrespective of the content of that item; the disacquiescence response style (DARS), or consistent disagreement with the items irrespective of their content; and extreme

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responding (ERS), which manifests as a preference for extreme response categories. Other common response styles include mid-point responding (MRS), or the tendency to use the middle response category and noncontingent responding (NCR), or responding that is careless, random, or non-purposeful (Van Vaerenberg & Thomas 2012).

Biased responding may be linked to several external and internal stimuli (e.g. Baumgartner & Steenkamp 2001; Van Vaerenbergh & Thomas 2012). Inter alia, it may depend on an individual's risk attitudes (Hofstede 2001); it may be influenced by social norms (e.g. the respondents may approve behavior that is socially desirable); or it may be related to the demographic variables and personality characteristics of a respondent. A lack of interest in the topic ("yeah answers") may also lead to bias. In any case, failing to control for response style may lead to invalid research conclusions.

When a respondent recognizes his/her uncertainty, it can be quantified directly with a follow-up rating question on certainty immediately after the valuation question. Several approaches have been developed to account for self-reported uncertainty in contingent valuation (see e.g. Shaikh et al. 2007). Alternatively, Hujala et al. (2009) added the "I don't know" category to the original Likert scale to control for respondent uncertainty and later eliminated these responses to account for self-reported uncertainty. However, such approaches still rely on a respondent's self-reports and cannot diagnose the latent bias of a respondent.

To diagnose latent response style behavior, several techniques have been developed in behavioral, social, and marketing research (Van Vaerenbergh & Thomas 2012). For instance, methods based on response style indices (e.g. Bachman & O'Malley 1984; Reynolds & Smith 2010) are able to detect multiple types of response style and eliminate bias on an individual level, but fail to distinguish clearly between the response style and the content (Baumgartner & Steenkamp 2001; De Beuckelaer et al. 2010). In addition, the convergent validity of methods based on indices and more advanced methods for response style detection are not always secured (De Beuckelaer et al. 2010). Most response style diagnostics, however, are based on the assumption that if biased behavior exists, it can be identified as a common response style factor that equally loads on all items independent of their content (Billiet & McClendon 2000; Welkenhuysen-Gybels et al. 2003). This is the rationale used in our study and further described in the methods section.

Billiet and McClendon (2000) developed a procedure for the detection of and correction for acquiescence when modeling a construct. However, they did not present how to eliminate acquiescence from the raw data if any analysis other than construct modeling is required. Since our aim was to examine the response style effect on the identification of private forest owner segments, we further developed Billiet and McClendon's procedure to eliminate ARS bias from the raw data.

The second source of uncertainty in the segmentation of forest owners is the analyst's uncertainty about the model-reality consistency. In conventional approaches to forest owner segmentation (the Frequentist approach; Kangas & Kangas 2004), the analyst reports uncertainty with probability statements to convey scientific uncertainty after statistical modeling (e.g. with *p*-values). In the alternative approach (the Bayesian approach), the analyst reports the certainty with "a number between 0 and 1 that conveys the strength of belief or weight of evidence for some particular conjecture or hypothesis" (Ghazoul & McAllister 2003). The latter approach has several advantages in customer segmentation (e.g. fewer segments, cluster membership is determined with probabilities, multi-objectiveness is inherent to members of all groups; Magidson & Vermund 2002; Ficko & Boncina 2013b).

The aims of this research are: (1) to demonstrate Billiet and McClendon's approach for the detection of response style bias in the field of forestry, (2) to develop a procedure for estimating the effect of response style bias in the event of response style contamination, (3) to explore the robustness of the probabilistic clustering algorithm to different requirements for the validity of private forest owner typology, and (4) to discuss the benefits of accounting for respondent and analyst uncertainty in private forest owner segmentation.

2. Methods

2.1. Sample survey design and preliminary analysis

We used responses from face-to-face interviews with 364 Slovenian private forest owners in the northern part of Slovenia (see Ficko & Boncina 2013b). Respondents were asked to rate the relevance of 19 items associated with management information for decision-making (Table 1, v_1 to v_{19}) using an equidistant five-point Likert scale (1 being not at all important, 5 being very important).

Like a marketer who uses the economic theory of market segmentation to maximize profit from selling a homogenous product to a market with heterogeneous demands (Wedel & Kamakura 1999), we attempted to identify major categories of information from the 19 items to structure the forest owners according to their information needs. Prior to this, we screened the distribution of response categories for each respondent and calculated various response style indices

(Table 1, v_{ARS_index}, v_{DARS_index}, and v_{ERS_index}), bearing in mind that the validity of research conclusions could be threatened if the responses were contaminated by the response style. The v_{ARS_index}, v_{DARS_index}, and v_{ERS_index} were 0.47, −0.47, and 0.57, respectively. The v_{ARS_index} and v_{ERS_index} correlated positively (Pearson $r = 0.23$, $p < 0.000$). We therefore assumed that the responses might be contaminated by ARS.

2.2. Theoretical framework for acquiescence response style detection

Billiet and McClendon (2000) developed the theoretical framework for detection of acquiescence in survey research based on the approaches of Mirowsky and Ross (1991) and Watson (1992). We followed their basic ideas, which can be summarized in four steps:

- If a substantial number of respondents systematically favors positive response categories irrespective of the content of the item, such behavior can be identified as a latent common factor referred to as the acquiescence response style (ARS) factor.
- When the set of items is semantically balanced (i.e. half of the items are positively worded, half of the items are negatively worded with respect to the construct being measured), the ARS factor can be identified directly as a factor that loads on all items with equal weight. When the set of items is not semantically balanced, but only maximally heterogeneous in content, the equivalence of such a factor to acquiescence can only be assumed. The heterogeneity of items is high if the average inter-item correlation is low. Baumgartner and Steenkamp (2001) reported an average inter-item correlation of 0.12, Johnson et al. (2005) reported 0.20, cit. in De Beuckelaer et al. (2010, p. 766). The average inter-item correlation in our data-set was 0.19.
- The identity of the ARS factor can be validated (in the case of a semantically balanced set of items) or confirmed (in the case of a maximally heterogeneous set of items) if it is found in two or more balanced sets of items measuring independent constructs, and the correlation between the ARS factor and the ARS indicator is high. The ARS indicator is the variable measuring the frequency of the very important and rather important response category selection.
- If ARS contaminates the responses, the model in which the ARS factor is incorporated should outperform the model consisting of content factors only in replicating the correlation matrix of the data, evidenced by better model fit.

2.3. Modeling acquiescence with structural equation modeling (SEM)

The existence of the ARS factor was tested with confirmatory factor analysis (CFA), which is a special type of structural equation modeling (SEM). Within the CFA we tested the hypothesis that the observed correlation matrix is equal to the correlation matrix implied by the hypothesized models (Models A and B, respectively, Figure 1). The measurement models consisted of a set of matrix equations (Bollen 1989, p. 17) representing relations between manifest (v_i) and latent variables (η_i and δ_i), with $\lambda_{v,\eta}$ representing the loading of manifest variable v_i to factor η_i (Table 1):

$$v_i = \lambda_{v,\eta}\eta_i + \delta_i \quad (1)$$

The models are presented modularly with path diagrams (Figure 1).

The content factors, their number, and hypothesized loadings of items on the factors were specified by the preliminary exploratory factor analysis since we had no theory to guide us in building the model. We specified six content factors and related them to those items that the exploratory factor analysis indicated and we thought the factors might load on (Model A, Figure 1; solid arrows only). The content factors were not allowed to correlate for theoretical reasons; they are intended to represent major, uncorrelated categories of information used in decision-making of different customer segments. Similarly, there was no theoretical reason to allow the correlation of residuals. In order to operate with a standardized scale, we set the scale of the factors using a constrained Fisher Scoring algorithm to produce a standardized solution. This algorithm standardized the variances of the factors (Hill & Lewicki 2007) and thus replaced the common practice of manual fixing of one path per factor to 1. Moreover, we analyzed correlations instead of covariances, resulting in a completely standardized path model and correctly calculated standard errors. All models were built and analyses conducted in the SEPATH module of STATISTICA 7.0 (Hill & Lewicki 2007).

To specify the model with the content factors and the ARS factor (Model B, Figure 1; solid and dotted arrows), we added a new factor, ARS, to model A and fixed all loadings of the items on this factor with the same value. By fixing the loadings of the items on ARS, we specified that all items are expected to be equally affected by the response style. The correlations between the six content factors and the ARS

Table 1. Variables used in the detection of and correction for response style bias.

Variable name	Variable content
Manifest variables (v_i), measured with Likert scale (1 not at all important, 5 very important):	
v_1	Costs of forest operations
v_2	Profitability of forest management
v_3	Possibilities for hiring wood harvesting companies and the cost
v_4	Possibilities for mechanized harvesting
v_5	Bucking techniques
v_6	Wood prices and wood markets
v_7	Possible cut for each individual parcel
v_8	Silvicultural measures
v_9	Forest protection and bark beetle prevention
v_{10}	Current market price of forest land
v_{11}	Property boundaries
v_{12}	Locations of all parcels
v_{13}	Possibilities and costs of forest road building
v_{14}	Rights and duties of forest possession
v_{15}	Public rights on owner's holding
v_{16}	Game species and population densities
v_{17}	Management restrictions due to nature protection
v_{18}	Allowable cut
v_{19}	Contact with a person in charge of cutting approval
v_{ARS_index}	The difference between the number of positive score selection ("rather important" and "very important" category) and the number of negative score selection ("not at all important" and "rather unimportant" category), divided by the total number of items (van Herk et al. 2004). Range $[-1.0, +1.0]$, positive values indicating acquiescence
v_{DARS_index}	Opposite of v_{ARS_index}
v_{ERS_index}	The proportion of "not at all important" and "very important" response category (Bachman & O'Malley 1984). Range [0.0, 1.0], positive values indicating extreme response style
Factors (η_i):	
η_1	Non-wood goods and services
η_2	Forest economics
η_3	Property administration
η_4	Optimization of wood production
η_5	Minimum cutting restrictions
η_6	Forest protection
ARS (η_7)	Acquiescence response style
N_agree1 (η_8)	Scoring for agreement in set No. 1 (a set of 19 items used for customer segmentation)
N_agree2	Scoring for agreement in set No. 2 (a set of 5 items, measuring the expectation on the extension services from the public forest service)
N_disagree1	Scoring for disagreement in set No. 1
N_disagree2	Scoring for disagreement in set No. 2
N_extreme1	Scoring for extreme response in set No. 1
N_extreme2	Scoring for extreme response in set No. 2
Latent variables beside factors (δ_i):	
δ_1 to δ_{19}	Measurement error factors (residuals)
Parameters:	
$\lambda_{v,\eta}$	Loading of manifest variable v_i to factor η_i
$\psi_{\eta i,\eta j}$	Correlation between the factors η_i and η_j

factor were set to zero because there was no theoretical reason for correlation between the content and the style (e.g. Paulhus 1991).

To verify whether the ARS factor in Model B was indeed the ARS factor rather than an additional content factor, we added a new factor, "scoring for agreement" (N_agree1), to model B. We fixed the loading of the indicator variable measuring the frequency of the very important and rather important response category (v_{ARS_index}) on the factor N_agree1 to 1 and let N_agree1 correlate with the ARS factor and content factors. A negligible or insignificant correlation between N_agree1 and the content factors, but a strong correlation between N_agree1 and the

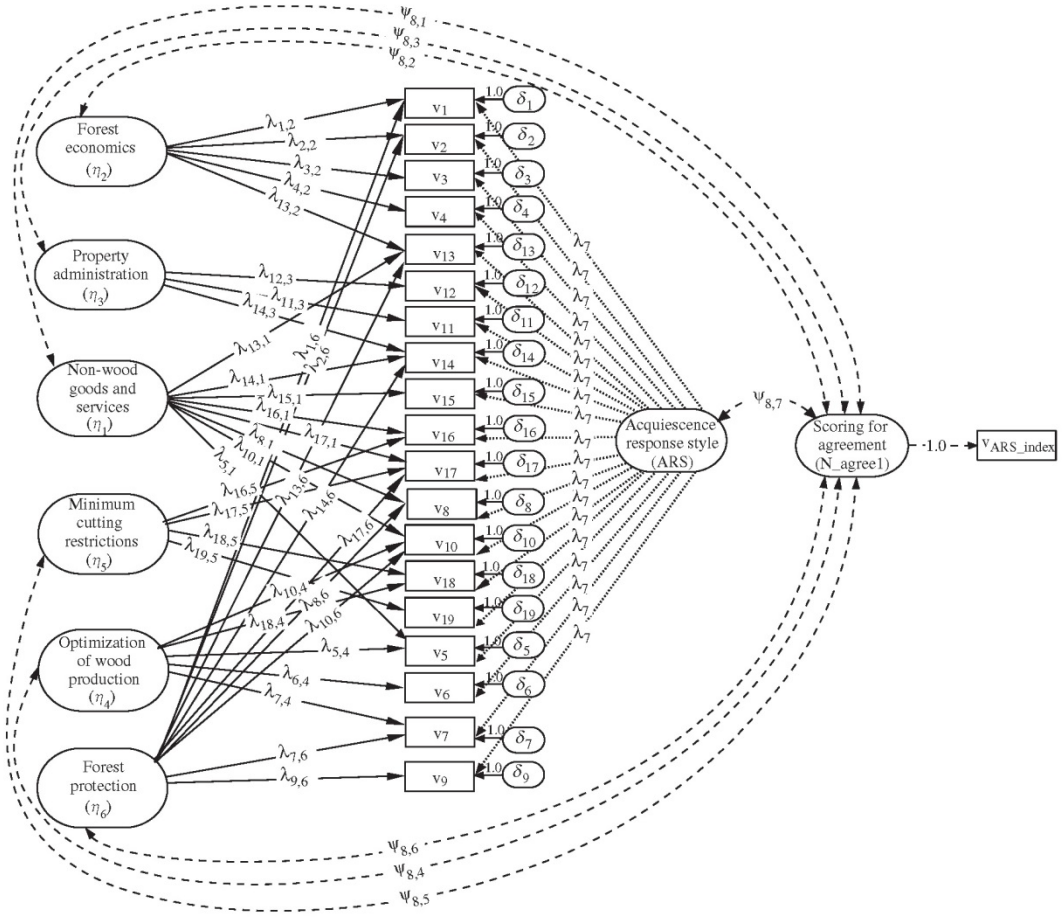

Figure 1. Path diagram of confirmatory factor analysis for the existence of acquiescence response style. A model with content factors only (η_1 to η_6) is represented with solid arrows only (Model A). A model with content factors and the acquiescence response style (ARS) factor is represented with solid and dotted arrows (Model B). The structural equation model for confirming the equivalence of the ARS factor to acquiescence (Model C) is represented by solid, dotted, and dashed arrows. Measured variables (manifest variables) are represented by squares; latent variables (factors, error terms) are represented by ellipses. Straight arrows indicate the hypothesized direct relationship between two variables. Curved two-headed arrows indicate correlation.

ARS factor would indicate that the ARS factor indeed measured acquiescence. We labeled the new model as model C (Figure 1; solid, dotted, and dashed arrows).

The v_{ARS_index} was constructed on two separate sets of items: the 19 items used for customer segmentation (set No. 1) and five items measuring the expectations of the extension services from the public forest service (set No. 2). If the ARS factor corresponds to the definition of stylistic responding, the correlation between the ARS factor and the two v_{ARS_index} constructed on two separate sets of items should be significant and stronger than the correlations between the ARS factor and the content factors. To additionally verify the identity of the ARS factor, the v_{ARS_index} in model C was replaced with the disaquiescence response style index (v_{DARS_index}) and extreme response style index (v_{ERS_index}), and the correlations between the ARS and scoring for disagreement factor and ARS and scoring for extreme response factor were estimated again.

2.4. Estimation procedure

Free parameters ($\lambda_{v,\eta}$, $\psi_{\eta i,\eta j}$, and δ_i) were estimated with a discrepancy function, which is a summary measure of the size of the residuals in the model. When choosing the discrepancy function, we noted that the standard errors for parameter estimates as

well as the chi-square might be incorrect when using maximum likelihood estimation with non-normally distributed multivariate data (Savalei & Bentler 2006). In addition, we were also aware of the sensitivity of the chi-square statistic to sample size (e.g. Ullman 2006).

As an alternative to the robust parameter estimation procedures implemented in some of the structural equation modeling software packages (e.g. EQS, Bentler 2005), bootstrapping is an effective way for correcting the standard errors in SEM analysis (Bollen 1989; Newit & Hancock 2001). Due to the indication of multivariate kurtosis in our data (normalized Mardia's (1970) coefficient > 3.00), we employed Monte Carlo bootstrapping to estimate the sampling distribution of model parameters and its standard errors as well as the distribution of the chi-square value. We used generalized least square estimation in the first five iterations, followed by maximum likelihood estimation until convergence (GLS-ML). We randomly drew a sample of size 364, 1000 times, with replacement, and each time fit the current model to the bootstrapped subsample.

Before deciding which discrepancy function to use, we compared the GLS-ML bootstrapping estimation with the asymptotic distribution-free estimation bootstrapping procedure (ADF), which is an alternative option in cases of multivariate non-normality (Savalei & Bentler 2006). The GLS-ML bootstrapping estimation resulted in a lower chi-square value than the ADF, which means that it was somewhat less restrictive to type 1 error, though the GLS-ML bootstrapped chi-square value was still higher than the critical value, where the hypothesis of perfect model fit would be accepted. More importantly, the GLS-ML bootstrapping estimation resulted in lower standard errors and smaller normalized residuals (max. ± 3), making it a favorable estimation method for all our models. This empirical evidence supports the simulation studies that report better performance of ADF in large samples (> 2500) or in rather simple models (e.g. Savalei & Bentler 2006; Ullman 2006). Neither of these two conditions was met in our case. Hence, all reported parameters in the models (Figures 2 and 3, and Table 2) are mean values obtained after GLS-ML bootstrapping 1000 times.

A theoretical perfect fit of the model to the data would result in a small chi-square value with a p-value of 1. The hypothesis of perfect fit was tested by comparing the GLS-ML bootstrapped chi-square at the corresponding df and p-value with the critical value at the corresponding df and p-value. In the goodness-of-fit quantification, we also considered model fit indices, which quantify how the pattern of correlations in the data is consistent with the specified model. Following the recommendations of Hu and Bentler (1999), we considered the Steiger-Lind Root Mean Squared Error of Approximation (RMSEA, Steiger 1990), the Goodness-of-Fit-Index (GFI) and Adjusted GFI (AGFI, Jöreskög & Sörbom 1993), the Comparative Fit Index (CFI, Bentler 1990), the Tucker and Lewis (1973) or Non-normed Fit Index (TLI), and the chi-square over the degrees of freedom ratio (χ^2/df) (Bollen 1989). If the model fits perfectly,

Table 2. Correlations ($\psi_{\eta i,\eta j}$) between the acquiescence response style factor (ARS), the content factors (η_1 to η_6), and the following factors: scoring for agreement (N_agree), scoring for disagreement (N_disagree), and scoring for extreme response (N_extreme), in two sets of items (No. 1 and No. 2). Correlations each time estimated with model C, other parameters of model C not shown.

	Set. No. 1			Set. No. 2		
	N_agree1	N_disagree1	N_extreme1	N_agree2	N_disagree2	N_extreme2
ARS	0.893*	−0.893*	0.377*	0.305*	−0.305*	0.130
η_1	0.386*	−0.386*	0.093	0.057	−0.057	0.022
η_2	0.181*	−0.181*	0.280*	−0.005	0.005	0.132
η_3	0.106*	−0.106*	0.055	−0.146*	0.146*	−0.159*
η_4	0.303*	−0.303*	−0.188*	0.260*	−0.260*	−0.229*
η_5	0.058*	−0.058*	0.119*	0.004	−0.004	−0.025
η_6	0.086*	−0.086*	0.480*	0.113	−0.113	0.222*
	Fit indices[a] for complete model C ($N = 364$)					
RMSEA	0.05	0.05	0.05	0.05	0.05	0.05
GFI	0.93	0.93	0.93	0.93	0.93	0.93
AGFI	0.90	0.90	0.90	0.91	0.91	0.90
TLI	0.94	0.94	0.89	0.93	0.93	0.92
CFI	0.95	0.95	0.93	0.94	0.94	0.94

[a]RMSEA (Steiger-Lind Root Mean Squared Error of Approximation, Steiger 1990); GFI, (Goodness-of-Fit-Index), AGFI (Adjusted Goodness-of-Fit-Index, both Jöreskög & Sörbom 1993); TLI (Tucker & Lewis 1973 or Non-normed Fit Index); CFI (Comparative Fit Index, Bentler 1990).
*Correlation significant at 0.05 level.

the indices should have a value of 1. Adequate model fit was evidenced by the indices having value of at least 0.90 (Hu & Bentler, 1999), except for the RMSEA, where a value of less than 0.06 (Hu & Bentler 1999), or 0.08 (McDonald & Ho 2002) is required. Statistically better model fit was determined by significant reductions in chi-square because model A and B are subsets of each other. Better model fit is also evidenced by higher values of fit indices and lower RMSEAs (Hu & Bentler 1999). All reported fit indices for models are mean values obtained after bootstrapping 1000 times.

2.5. Correcting for acquiescence

Once the ARS was detected, we proceeded with the following experiment to eliminate it from the raw data:

- Bearing in mind that the ARS inflates positive correlations and deflates negative ones between the items (Baumgartner & Steenkamp 2001; Van Vaerenbergh & Thomas 2012), we assumed that the observed positive correlations were more positive than they should be and the observed negative correlations were less negative or even positive.
- In confirmatory factor analysis, the model implied covariance matrix can be decomposed into matrices of factor loadings, factor covariances, and error covariances (Bollen 1989, p. 35, 236). In the standardized model with no correlations between the factors, the influence of factors on the correlation between two manifest variables reduces to the additive function of products of their loadings on those variables (Bollen 1989, see p. 192 for an illustration). This decomposition rule is fundamental for the next steps.
- If we managed to find a data-set whose correlation matrix perfectly fit the model A implied correlation matrix, then this data-set could be perfectly represented with exactly six content factors. Similarly, if we found a data-set whose correlation matrix perfectly replicated the model B implied correlation matrix, this data-set could be perfectly represented by six content factors and the ARS factor.
- To experimentally estimate the expected value of the ARS effect, we employed the Monte Carlo data generation technique. We simulated 1000 datasets from model A and 1000 datasets from model B, after A and B had been parameterized with the mean values obtained by the bootstrapping estimation procedure described in the section 2.4. From the 1000 datasets generated from the parameterized model A, we selected the one whose correlation matrix fit perfectly ($p > 0.99$) to the model (Table 3, the correlation matrix is shown as the lower triangular matrix). The same procedure was repeated for model B; the correlation matrix reproduced from the parameterized model B is shown in Table 3, upper triangular matrix.
- Since model A is nested within model B, that is, model A can be obtained by constraining ARS factor loadings in model B to zero for an increase of one degree of freedom, the ARS factor is uncorrelated to the content factors, and factor variances are fixed, the contribution of ARS to the correlation was estimated by comparing the correlation matrices implied by models A and B.
- Subtracting the lower triangular matrix from Table 3 from the upper triangular matrix from the same table provided an estimation of the effect of ARS on correlations (Net ARS).
- The Net ARS matrix was then subtracted from the correlation matrix of raw data to get a correlation matrix corrected for acquiescence.
- The raw and the corrected correlation matrices were analyzed by exploratory factor analysis and the results were compared. Each time we extracted the first six PCs with an eigenvalue greater than one and subsequently rotated them with varimax raw rotation to increase their interpretability.

Additional attempts were made with the Monte Carlo data generation procedure to simulate the population with corrected correlations among the items and desired distribution. We used Choleski factorization on the correlation matrix to convert independent normal random numbers to multivariate normal numbers with a desired correlation structure, and Vale and Maurelli's (1983) technique to transform multivariate normal numbers into variates with desired non-normal distribution. The pseudocode for the described procedures is available online in the supplemental data.

2.6. Analyst uncertainty – the probabilistic approach

We explored the robustness of the expectation maximization (EM) clustering algorithm (Dempster et al. 1977) to decision-maker requirements for the validity of the model. In addition to the desired minimum and maximum number of clusters, an analyst can also specify the desired validity of the clustering solution. This can be done by specifying the allowable smallest percentage decrease in the evaluation function in cross-validating the solution, and by setting the precision of the minimum increase of the evaluation function. While the latter is of less practical interest

Table 3. Above diagonal; correlation matrix of the items (v_1 to v_{19}) perfectly fitting ($p > 0.99$) to Model B, selected from 1000 Monte Carlo replications. Below diagonal; correlation matrix of the items (v_1 to v_{19}) perfectly fitting ($p > 0.99$) to Model A, selected from 1000 Monte Carlo replications ($N = 364$).

	v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9	v_{10}	v_{11}	v_{12}	v_{13}	v_{14}	v_{15}	v_{16}	v_{17}	v_{18}	v_{19}
v_1	1	0.55	0.41	0.20	0.09	0.12	0.14	0.29	0.27	0.15	0.15	0.13	0.33	0.14	0.04	0.11	0.17	0.12	0.09
v_2	0.53	1	0.33	0.20	0.07	0.08	0.16	0.27	0.24	0.11	0.15	0.13	0.28	0.07	0.07	0.08	0.10	0.07	0.04
v_3	0.38	0.31	1	0.20	0.10	0.11	0.10	0.11	0.14	0.11	0.16	0.14	0.22	0.06	0.01	0.10	0.13	0.12	0.08
v_4	0.18	0.17	0.16	1	0.10	0.06	0.10	0.14	0.10	0.06	0.07	0.07	0.16	0.07	0.17	0.04	0.10	0.08	0.13
v_5	−0.02	−0.04	0.00	0.00	1	0.53	0.31	0.11	0.10	0.20	0.12	0.11	0.12	0.20	0.18	0.19	0.17	0.23	0.14
v_6	0.03	−0.02	0.01	−0.04	0.51	1	0.51	0.12	0.08	0.27	0.16	0.12	0.11	0.12	0.09	0.10	0.13	0.31	0.12
v_7	0.07	0.10	0.00	−0.01	0.26	0.49	1	0.28	0.22	0.16	0.18	0.18	0.23	0.17	0.08	0.14	0.20	0.24	0.12
v_8	0.25	0.23	−0.01	0.03	0.01	0.01	0.22	1	0.58	0.21	0.18	0.17	0.41	0.32	0.17	0.22	0.28	0.11	0.08
v_9	0.23	0.21	0.03	−0.01	−0.01	−0.02	0.18	0.55	1	0.24	0.15	0.15	0.31	0.24	0.11	0.19	0.22	0.09	0.12
v_{10}	0.06	0.04	0.00	−0.05	0.16	0.23	0.13	0.17	0.19	1	0.03	0.03	0.28	0.23	0.27	0.32	0.19	0.19	0.14
v_{11}	0.04	0.05	0.05	−0.04	0.01	0.06	0.07	0.07	0.03	−0.08	1	0.81	0.21	0.30	0.11	0.15	0.13	0.06	0.03
v_{12}	0.02	0.03	0.03	−0.04	0.00	0.01	0.08	0.06	0.04	−0.08	0.81	1	0.18	0.28	0.11	0.15	0.11	0.05	0.06
v_{13}	0.29	0.25	0.14	0.08	0.03	0.00	0.15	0.38	0.27	0.23	0.09	0.06	1	0.33	0.23	0.31	0.24	0.13	0.10
v_{14}	0.05	−0.01	−0.06	−0.04	0.15	0.03	0.08	0.28	0.18	0.20	0.22	0.20	0.29	1	0.45	0.50	0.37	0.10	0.07
v_{15}	−0.07	−0.04	−0.10	0.07	0.13	−0.01	−0.04	0.10	0.00	0.24	0.00	0.00	0.17	0.43	1	0.56	0.33	0.11	0.10
v_{16}	−0.01	−0.04	−0.02	−0.06	0.14	−0.01	0.03	0.15	0.08	0.29	0.03	0.03	0.24	0.48	0.56	1	0.39	0.26	0.14
v_{17}	0.08	0.02	0.01	−0.01	0.10	0.03	0.12	0.22	0.15	0.15	0.01	0.00	0.18	0.33	0.29	0.36	1	0.32	0.20
v_{18}	0.02	−0.03	0.02	−0.02	0.16	0.26	0.16	−0.01	−0.03	0.11	−0.07	−0.08	0.01	−0.01	0.01	0.18	0.25	1	0.56
v_{19}	−0.02	−0.06	−0.02	0.03	0.04	0.02	0.01	−0.04	0.01	0.04	−0.09	−0.07	−0.02	−0.04	0.01	0.07	0.13	0.55	1

for policy-makers, the desired validity of the clustering solution is useful for typolgy users.

We simulated decision-maker requirements on the validity of the probabilistic model by decreasing the smallest percentage decrease in the average log likelihood of cases for the next cluster solution in steps of 0.5% points, examining whether the more stringent validity requirements would result in more clusters. The simulation of less stringent requirements was meaningless because the minimum number of clusters (i.e. 2) had already been reached at the initially specified value of 1% decrease of log-likelihood (Ficko & Boncina 2013b).

3. Results

3.1. Acquiescence response style (ARS) detection

The confirmatory factor analysis (CFA) of information forest owners use in management decision-making confirmed that different types of information can be reduced into six major categories of information (Figure 2). However, the hypothesis of perfect fit had to be rejected ($\chi^2 = 490.00$, the number of degrees of freedom (df) = 137, $p < 0.05$); model A fit the data only marginally well (RMSEA = 0.08, GFI = 0.91, AGFI = 0.87, CFI = 0.90, TLI = 0.87, χ^2/df = 3.6). The normalized residuals were in the approximate interval [−1, 4].

After adding the ARS factor to model A, loadings of the content factors dropped, but remained of the same sign; the ARS factor loaded on the items with 0.330 (Figure 3) and the model fit improved ($\chi^2 = 404.45$, df = 136) but remained imperfect ($p < 0.05$). The difference in the χ^2 statistics between model A and B amounted to 85.55 for 1 df, which is highly signficant, $p < 0.001$. The better fit of Model B compared to Model A was also indicated when comparing the fit indices (RMSEA = 0.07, GFI = 0.93, AGFI = 0.90, CFI = 0.94, TLI = 0.93, χ^2/df = 3.0). The normalized residuals were in the desireable interval [−3, 3]. We may conclude that the model with the ARS factor explains the data significantly better than the model with content factors only. The results thus demonstrated that respondents showed a tendency to agree with the survey items irrespective of their contents.

The parameters in Model C confirmed that the ARS factor indeed measured acquiescent responding and rejected speculation that the ARS factor is just an additional content dimension. The identity of the ARS factor was confirmed by the significant and strong correlation between the ARS factor

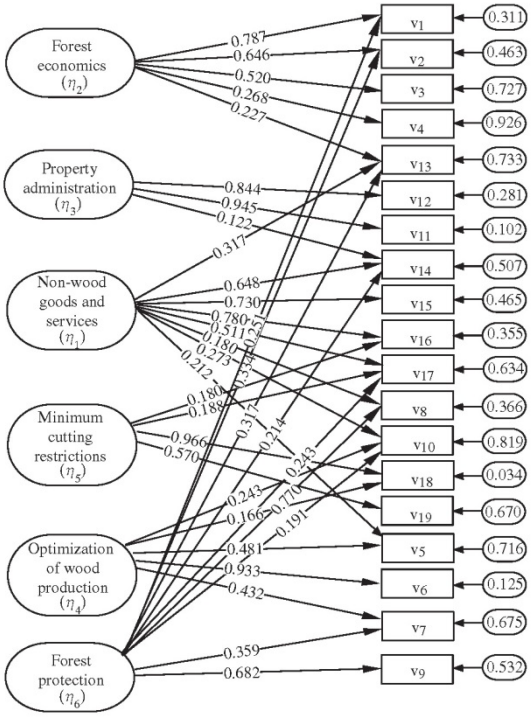

Figure 2. The standardized solution of model A: content factor loadings and residuals, all significant at $p < 0.05$ (Fit indices: RMSEA = 0.08, GFI = 0.91, AGFI = 0.87, CFI = 0.90, TLI = 0.87, χ^2/df = 3.6).

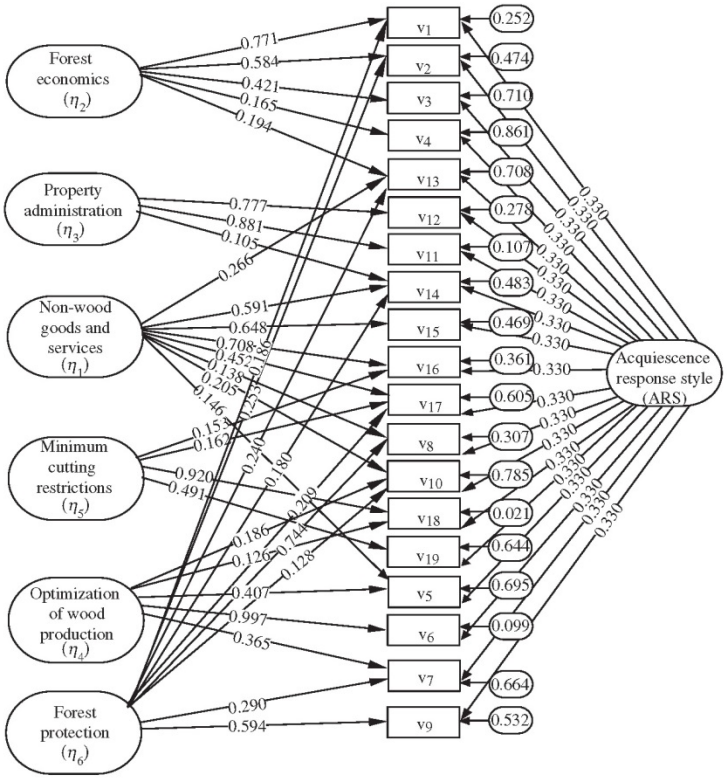

Figure 3. The standardized solution of model B: content factor loadings, the ARS factor loading and residuals, all significant at $p < 0.05$ (Fit indices: RMSEA = 0.07, GFI = 0.93, AGFI = 0.90, CFI = 0.94, TLI = 0.93, χ^2/df = 3.0).

and the scoring for agreement factor ($\psi = 0.893$, $p < 0.05$ for set No. 1, $\psi = 0.305$, $p < 0.05$ for set No. 2, Table 2). The correlations between each scoring for agreement factor and the ARS factor were higher than the correlations between each scoring for agreement factor and the content factors (Table 2).

When the scoring for agreement factor in model C was replaced with the scoring for disagreement factor (N_disagree1 or N_disagree2), which loaded on the disaquiescence response style index (v_{DARS_index}) with 1, the correlation between the N_disagree1 or N_disagree2 and the ARS was negative. Further indication of the identity of the ARS factor is given by the low correlation between ARS and N_extreme1 ($\psi = 0.377$, $p < 0.05$) and low and insignificant correlation between ARS and N_extreme2 ($\psi = 0.130$, $p = 0.243$). Moderate and significant correlations between N_extreme1 and content factors 6 and 2 ($\psi = 0.480$ for 6, and $\psi = 0.280$ for 2, $p < 0.05$) could be explained by the fact that the category "very important" was included in the calculation of both indices, v_{ERS_index} and v_{ARS_index}.

3.2. Correcting for acquiescence

In the Monte Carlo experiment, we perfectly simulated the responses with the amount of ARS contamination as model B specified ($\chi^2 = 85.41$, df = 136, $p > 0.99$). The generated responses with no ARS contamination also perfectly fit the model ($\chi^2 = 82.79$, df = 137, $p > 0.99$). The calculations of correlations in Table 3 were exact to six decimal places, but only 2 are shown).

The average inflation of the correlations due to ARS was low (mean = 0.09, standard deviation = 0.03). We may conclude that if we observed the correlations between two arbitrary items at the level of approximately 0.09, there would actually be no correlation between these two items. Analogously, if we concluded that there was no correlation between two items, these two items would actually be weakly negatively correlated.

Acquiescence had no effect on substantive construct (Table 4). Correction for acquiescence resulted in a more clear identification of the major categories of information forest owners use in management decision-making. The loadings of content factors on

Table 4. Factor loadings[a] obtained by the Principal Component Analysis of information (v_i) used in management decision making in private forest properties with raw data (a) and with data corrected for acquiescence (b) ($N = 364$).

	(a) Raw data[b]						(b) Data corrected for acquiescence					
	Content factors						Content factors					
Manifest variable	1	2	3	4	5	6	1	2	3	4	5	6
v_1	−0.03	**0.81**	0.11	0.01	0.00	0.21	−0.07	**0.82**	0.03	−0.01	−0.02	0.16
v_2	0.07	**0.72**	0.14	0.10	−0.03	0.29	0.03	**0.77**	0.07	0.08	−0.03	0.25
v_3	0.12	**0.72**	0.05	0.00	0.12	−0.24	0.02	**0.69**	−0.02	−0.08	0.03	−0.34
v_4	0.24	0.48	−0.23	0.15	0.08	−0.10	0.13	0.42	−0.26	0.00	−0.07	−0.21
v_5	0.21	−0.03	0.05	**0.71**	0.12	0.04	0.20	−0.09	−0.01	**0.69**	0.06	−0.04
v_6	0.00	0.07	0.11	**0.85**	0.10	0.01	−0.05	0.02	0.04	**0.86**	0.08	−0.06
v_7	0.06	0.03	0.19	**0.58**	−0.02	0.43	−0.01	0.04	0.11	**0.63**	−0.01	0.41
v_8	0.21	0.05	0.00	0.14	0.12	**0.78**	0.19	0.06	−0.04	0.08	0.04	**0.78**
v_9	0.05	0.13	−0.07	0.04	0.14	**0.77**	−0.02	0.10	−0.11	−0.04	0.03	**0.78**
v_{10}	0.31	0.18	0.14	0.41	−0.22	0.20	0.32	0.11	0.04	0.42	−0.21	0.19
v_{11}	0.14	0.06	**0.90**	0.10	0.12	0.03	0.08	0.02	**0.93**	0.05	0.06	−0.01
v_{12}	0.09	0.08	**0.90**	0.09	0.09	−0.03	0.03	0.02	**0.93**	0.02	0.02	−0.06
v_{13}	0.35	0.29	0.22	−0.07	−0.06	0.45	0.34	0.32	0.11	−0.08	−0.09	0.43
v_{14}	**0.72**	0.08	0.22	0.04	−0.11	0.28	**0.73**	0.06	0.19	0.04	−0.14	0.25
v_{15}	**0.80**	0.03	0.08	0.08	0.12	−0.01	**0.81**	−0.03	0.03	0.03	0.05	−0.05
v_{16}	**0.82**	0.05	0.08	0.06	0.17	0.03	**0.84**	−0.02	0.02	0.02	0.13	−0.01
v_{17}	**0.62**	0.03	0.08	0.10	0.18	0.26	**0.62**	0.01	0.02	0.06	0.20	0.24
v_{18}	0.15	0.00	0.13	0.15	**0.84**	0.01	0.10	−0.03	0.04	0.14	**0.87**	−0.06
v_{19}	0.06	0.06	0.14	−0.01	**0.81**	0.19	0.02	0.01	0.05	−0.07	**0.85**	0.11
Eigenvalue	4.5	1.8	1.6	1.6	1.4	1.3	3.3	2.2	1.8	1.8	1.5	1.5
Cumulative variance explained (%)	23.6	33.3	41.9	50.1	57.4	64.1	17.3	28.8	38.3	47.6	55.7	63.3

[a]Bolded loading indicates a value greater than 0.50.
[b]PCA when acquiescence is left in the responses (Ficko & Boncina 2013b).

items characterizing them (i.e. items with loadings greater than 0.50, in bold text in Table 4) slightly increased, whereas the loadings that were negligible for the interpretation of the factors decreased or even changed sign. The cumulative variance in the decision-making of private forest owners decreased from 64.1 to 63.3% when the responses were corrected for the ARS.

Unfortunately, the Monte Carlo generation of the 364 responses with the desired corrected correlations between the 19 items was not accurate enough in 1000 attempts. Differences between the simulated data-implied correlation matrix and the corrected correlation matrix exceeded the average size of the ARS. Therefore, we stopped with the experiment in which clustering of generated cases was intended to resemble the clustering of forest owners.

3.3. Probabilistic clustering

EM clustering proved to be robust to the analyst's requirements for validity. The EM algorithm continued to consolidate forest owners into two types even if the decrease in average log-likelihood of cases was required to be relatively small (0.5% or more). When the alternative cluster solution was required to be better than the existing one by less than 0.5%, the number of clusters increased to four (Table 5).

4. Discussion and conclusions

4.1. Methodological issues

Even though we further developed Billiet and McClendon's procedure, the individual's ranking of importance of information irrespective of his/her tendency to agree remained unsolved. Our procedure only accounted for the aggregate level of response style bias by correcting the correlations among the items measuring the content factors. This may be a deficiency when the individual-level scores are of interest, for instance in psychological studies. However, in forest owner segmentation the aggregate-level scores are of primary interest; the analyst typically wants to know which groups of forest owners will emerge from the sample data and what their meaning is, not how an individual from the sample responded.

In addition to our procedure for correcting for acquiescence, one could also follow the rationale of a number of scholars in the field of marketing research (e.g. Greenleaf 1992; Baumgartner & Steenkamp

Table 5. The influence of desired validity of clusters on their number in expectation maximization clustering. The desired validity specified as the smallest percentage decrease in the evaluation function in cross-validating the solution.

Desired validity of clustering solution (smallest percentage decrease)	Index of predictive validity (training negative log-likelihood)	Number of clusters
1.00000	8.10357	2
0.51700	8.10357	2
0.51610	8.10315	2
0.51601	8.10315	2
0.51600	7.87817	4
0.50000	7.87817	4
10^{-8}	7.87817	4

2001; Reynolds & Smith 2010) and partial out the impact of ARS by regressing each item in the survey onto the acquiescence response style index. The residuals from the regression then replace the raw values since they represent each respondent's valuation of the items purified from the acquiescence response style. However, a necessary condition is that the v_{ARS_index} is constructed on a large set of items (preferably more than 100), not including the items used for the content analysis. This is important to avoid confounding between the content and the style (De Beuckelaer et al. 2010). If this condition is fulfilled, the regression procedure is also acceptable without prior identification of the ARS factor by structural equation modeling (Reynolds & Smith 2010). However, if there are few items in the survey (such as in our case), the regression procedure for correcting the individual's responses is valid only if there is equivalence between the ARS factor and the v_{ARS_index}. Since the correlation between the ARS factor and the v_{ARS_index} was 0.893 in our case and the inflation of the correlations due to ARS was relatively small (Table 3), we believe that the effect of acquiescence would not be accurately estimated due to the noise generated by the regression procedure for correcting the individual responses. In addition, comparison of the results of two exploratory factor analyses (Table 4) indicates that there was no effect of acquiescence on the number and identification of major categories of information. We may conclude that the major categories of information that forest owners use for decision-making are valid, and the number and the identity of forest owner types are not expected to change.

An additional methodological concern should be addressed. The restriction in Model B that the loadings of the ARS factor on the items should be equal is a rather strict representation of acquiescence. When setting the restrictions in a structural equation model, the Lagrange Multiplier (LM) statistics for each manifest variable should be zero if the equality constraints on the ARS factor impose no restrictions on the estimation of other parameters in the model (Savalei & Bentler 2006). Since the LM statistics were slightly above zero in our case, yet still did not exceed the standard error for 16 of the 19 items, we relaxed the equality constraints on the ARS factor loadings on these 16 items and repeated the estimation procedure. To retain the comparability of the procedures, we employed bootstrapping again. Even though relaxing the equality constraints did not make sense theoretically, and thus was against the vademecum for modifications of structural equation models (Savalei & Bentler 2006), the average loading of the ARS factor on the items remained of approximately the same size as the loadings calculated with equality constraints (0.306 vs. 0.330). This additionally bolsters our confidence about the minor effect of acquiescence.

We would also like to note that the Monte Carlo experiment for correcting the correlations is valid for descriptive purposes only. The main threat is that the sampling error of the correlation estimates remains unknown and thus the corrected correlations cannot be used for further statistical modeling. If modeling is to be continued, new confirmatory factor analysis should be employed with all variables included in the model simultaneously and corrected correlations should not be used as the input.

Nevertheless, when the response style behavior is left undiagnosed and uncorrected, the influence of biased responding to segmentation results can be simulated by skewing the distribution of the responses (for ARS and DARS) or by recoding the responses (for ERS) and continuing with the procedures using distorted data (Ficko & Boncina 2013a). Any type of severely biased responding would result in significantly different cluster membership assignment. This simulation study found that if strong response style bias in the data-set actually existed, biased response-based clustering would only reduce the uncertainty about the true clusters by 21.9% to 37.6%, depending on response style. We believe that the simulation of response style effects is strong enough to illustrate some pitfalls that might be encountered in private forest owner segmentation.

4.2. Significance for decision makers

The ARS should be of particular concern when it changes the sign of correlations between the items. Since numerous statistical techniques used in private forest owner segmentation (e.g. PCA, regression and cluster analysis) are influenced by the magnitude of correlations directly or indirectly, it is reasonable to pay more attention to methodological rigor, otherwise

conclusions directed toward policy-makers might be invalid. In our case, only loadings of content factors that were small changed sign from positive to negative or vice versa after the ARS was removed, having virtually no impact on the content of clustering variables.

In the justification of the possible reasons for acquiescence, we can only draw from this empirical study and general conclusions on respondent behavior from social and marketing studies. First, rating the relevance of information seems logical to generate an optimistic view of relevance by default; affirmative behavior may arise from the rationale that more information is beneficial when making decisions because information decreases uncertainty. Second, if the respondent is uncertain about how to respond, agreeing with an item may be less ambiguous than selecting a middle response category (Johnson et al. 2005; Smith 2004). Third, consistent agreement may also be a sign of politeness in face-to-face interviews or unwillingness to take on the cognitive load that the rating requires (Baumgartner & Steenkamp 2001). However, there is no agreement on the effect of these stimuli; ARS is reported to be less likely in face-to-face interviews than in other modes of data collection (Van Vaerenbergh & Thomas 2012).

Weijters (2006) investigated different sources of stylistic responding that range from survey instrument-based stimuli to personal characteristics. Unfortunately, none of these stimuli have been empirically proven to influence private forest owners. Despite this, some response styles besides ARS can be hypothesized to be more likely to occur among forest owners, for example socially desirable behavior (Steenkamp et al. 2010). When interviewed, forest owners could claim to be more multiobjective than they really are, trying to conform to the socially desirable concept of sustainable and multipurpose forest management. This could be the case for many typologies based on self-reported management objectives with a close-ended format. The authors of these typologies can verify their validity, test for the response styles, and make contributions to advanced social studies in forestry.

There is also space for analysts to improve typologies. In addition to the pros and cons of the probabilistic clustering of private forest owners that have already been discussed (Ficko & Boncina 2013b), we would like to point to the added value that the simulation of desired validity of clusters can create. The desired validity of clusters can be specified in advance by the user of the typology. For instance, policy-makers can specify that the risk of an inaccurate clustering solution should be less than 5%. Alternatively, the analyst can investigate the validity by himself, as we have done. Since the number of clusters at the initial level of validity was already at the minimum, we only simulated more stringent validity requirements. Probabilistic clustering remained stable even under rather unrealistic decision-maker requirements for the validity of clusters, indicating that materialists and non-materialists from Ficko and Boncina (2013b) are valid groups despite minor contamination by ARS.

Our study pioneers response style detection and correction in private forest owner segmentation. However, it is based on only one data-set and controls for the effect of only one type of response style. We have no strong evidence that private forest owners are likely to respond with acquiescence or with any other style in general.

We may conclude that in addition to respondent uncertainty, which can be directly measured via self-reported uncertainty scores, detected and corrected with the aid of structural equation modeling when latent, or assessed by simulation, the validity of survey results can also be improved by examining the sensitivity of statistical methods employed during the analyses. The message to decision makers would then be more valid, and the private forest owner typologies would better serve as decision support systems for policy-makers.

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Supplemental data

Supplemental data for this article can be accessed at http://dx.doi.org/10.1080/02827581.2013.837194.

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Supplemental file: Pseudocode for the detection of and correction for response style bias in a survey prior to customer segmentation procedure. Line numbers represent tasks performed sequentially after another. The syntaxes beginning and ending with the asterisk (*) are for explanatory purpose.

```
*Testing for heteroegenity of content*
1  COMPUTE correlations between the items;
2  SAVE TO FILE Raw_correlations.sav;
3  COMPUTE average inter-item correlation;
4  IF average inter-item correlation <0.20 THEN
        PRINT »Heterogenous content«
   ELSE
        PRINT »Non-heterogeneous content«
        END
   ENDIF;
*Specifying confirmatory factor analysis with content factors only (Model A)*
5  USE Raw_correlations.sav;
6  SET content factors;
7  SET error terms;
8  SET relations from factors to items;
9  STANDARDIZE variables;
10 RUN confirmatory factor analysis;
11 COMPUTE parameters by BOOTSTRAP = on and N replications =
   1000;
12 PRINT mean (parameters) INTO FILE: Model
   A_parameterized.cmd;
13 COMPUTE model fit;
14 PRINT as »Model A fit«;
15 IF model fit adequate THEN
        GOTO 16
   ELSE
        RETURN to 6
   ENDIF;
*Detection of response style (Model B)*
16 SET content factors;
17 SET error terms;
18 SET relations from factors to items;
19 SET response style factor;
20 SET relations from response style factor to all items;
21 SET loadings of response style factor on all items equal;
22 STANDARDIZE variables;
23 RUN confirmatory factor analysis;
24 COMPUTE parameters by BOOTSTRAP = on and N replications =
   1000;
25 PRINT mean (parameters) INTO FILE: Model
   B_parameterized.cmd;
26 COMPUTE model fit;
27 PRINT as »Model B fit«
28 IF Model B fit > Model A fit THEN
        PRINT »Response style detected«
```

```
  ELSE
       PRINT »Response style not detected«
       END
  ENDIF;
```

Confirming the equivalence of response style factor to acquiescence (Model C)

```
29 SET content factors;
30 SET error terms;
31 SET relations from factors to items;
32 SET response style factor;
33 SET relations from response style factor to all items;
34 SET loadings of response style factor on all items equal;
35 FOR each respondent COUNT number positive scores;
36 FOR each respondent COUNT number negative scores;
37 FOR each respondent COMPUTE (number positive scores -
   number negative scores)/ number items;
38 SAVE result as v_ARS_index;
39 SET scoring for agreement factor;
40 SET relation from scoring for agreement factor to v_ARS_index;
41 SET loading of scoring for agreement factor on v_ARS_index = 1;
42 SET correlations from scoring for agreement factor to
   response style factor and content factors;
43 STANDARDIZE variables;
44 RUN structural equation model;
45 COMPUTE parameters by BOOTSTRAP = on and N replications =
   1000;
46 COMPUTE model fit;
47 PRINT as »Model C fit«;
48 PRINT mean (correlations) between scoring for agreement
   factor, response style factor, and content factors;
49 IF mean (correlations) between scoring for agreement
   factor and response style factor high AND significant AND
   mean (correlations) between scoring for agreement factor
   and content factors low AND insignificant AND Model C fit
   adequate THEN
       PRINT »Acquiescence response style confirmed«
   ELSE
       PRINT »Acquiescence response style not confirmed«
       END
   ENDIF;
```

Correction for acquiescence (Monte Carlo methods)

```
50 USE Model A_parameterized.cmd;
51 REPEAT
       GENERATE dataset  with N lines = N respondents and N
     columns = N items with Monte Carlo
       COMPUTE model fit
   UNTIL N iterations = 1000;
52 USE generated dataset where model fit>0.99;
53 COMPUTE correlation matrix;
54 PRINT INTO FILE Lower_diagonal.sav;
55 USE Model B_parameterized.cmd;
56 REPEAT
```

```
      GENERATE dataset  with N lines = N respondents and N
    columns = N items with Monte Carlo
      COMPUTE model fit
  UNTIL N=1000;
57 USE generated dataset where model fit>0.99;
58 COMPUTE correlation matrix;
59 PRINT INTO FILE Upper_diagonal.sav
60 COMPUTE Upper_diagonal.sav - Lower_diagonal.sav;
61 PRINT  INTO FILE NetARS.sav;
62 COMPUTE Raw_correlations.sav - NetARS.sav;
63 SAVE TO FILE Corrected_correlations.sav;
```

The generation of a database (responses) with specified correlations

```
64 PRINT the Corrected_correlations.sav INTO FILE:
  Corrected_correlations.cmd;
65 USE Corrected_correlations.cmd;
66 SET kurtosis and skewness;
67 REPEAT
      GENERATE dataset  with N lines = N respondents and N
    columns = N items with Monte Carlo
      SAVE FILE to Generated_dataset.sav
      COMPUTE correlations
      PRINT correlations INTO FILE
    Correlations_from_generated_dataset.sav
  UNTIL N iterations = 1000;
68 IF mean (Correlations_from_generated_dataset.sav -
  Corrected_correlations.sav) << NetARS.sav THEN
      PRINT »Generation of a database with multivariate
      pseudorandom numbers with specified correlations
      successfull«
  ELSE
      PRINT »Generation of a database with multivariate
  pseudorandom numbers with specified correlations not
  successfull«
      END
  ENDIF;
```

Common procedures for costumer segmentation with expectation maximization algorithm, using the generated dataset with population parameters and multivariate relationships between the items equal to parameters and relationships in the dataset free of acquiescence

```
69 USE Generated_dataset.sav;
70 RUN exploratory factor analysis;
71 COMPUTE factor scores;
72 APPEND factor scores TO FILE;
73 SET factor scores as clustering variables;
74 SET minimum and maximum number of clusters;
75 SET prior probabilities;
76 SELECT expectation maximization algorithm;
77 CLUSTER lines;
78 END.
```

2.1.4 Forest owner willingness to pay for a forest property plan may reduce public expenditures for forest planning

Ficko A., Boncina A. 2015b. Forest owner willingness to pay for a forest property plan may reduce public expenditures for forest planning [= Pripravljenost lastnikov gozdov za plačilo načrta za zasebno gozdno posest lahko zmanjša javne izdatke za gozdarsko načrtovanje]. European Journal of Forest Research: 134: 1043–1054.

Fully publicly funded forest planning systems with no individual forest property planning are facing budget cuts and are of limited effectiveness in private forests. A cost-sharing planning instrument that might improve private forest management while providing public budget relief is the forest property plan (FPP). We explored the market for the FPP among private forest owners in Slovenia and estimated the financial implications of adapting the current planning system. We conducted 548 face-to-face interviews with randomly-selected private forest owners about their attitudes towards and their willingness to pay (WTP) for the FPP. Of the respondents, 55 % considered the FPP to be a usable instrument, and 34 % would pay for it. The suggested amounts per decade ranged from 5 € to 1500 € with a mean of 135.99 € or 28.31 €/ha. Heckit regression revealed that the primary supporters of the FPP are younger, better educated non-farmers with larger properties and good contacts with the district forester. Aggregating the stated WTP amount to forest owner population, we estimated that on average 17 % to 57 % of the current public budget expenditures for private forest planning-related tasks could be saved annually, depending on the tasks included and the aggregation approach.

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ORIGINAL PAPER

Forest owner willingness to pay for a forest property plan may reduce public expenditures for forest planning

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Abstract Fully publicly funded forest planning systems with no individual forest property planning are facing budget cuts and are of limited effectiveness in private forests. A cost-sharing planning instrument that might improve private forest management while providing public budget relief is the forest property plan (FPP). We explored the market for the FPP among private forest owners in Slovenia and estimated the financial implications of adapting the current planning system. We conducted 548 face-to-face interviews with randomly selected private forest owners about their attitudes toward and their willingness to pay (WTP) for the FPP. Of the respondents, 55 % considered the FPP to be a usable instrument, and 34 % would pay for it. The suggested amounts per decade ranged from 5 € to 1500 € with a mean of 135.99 € or 28.31 €/ha. Heckit regression revealed that the primary supporters of the FPP are younger, better educated non-farmers with larger properties and good contacts with the district forester. Aggregating the stated WTP amount to forest owner population, we estimated that on average 17–57 % of the current public budget expenditures for private forest planning-related tasks could be saved annually, depending on the tasks included and the aggregation approach.

Keywords Forest management planning · Cost-sharing · Willingness to pay · Forest owners · Heckman model · Public finance

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Introduction

In the top three most forested countries in Europe (Finland, Sweden, and Slovenia), private small-scale forestry is predominant (Schmithüsen and Hirsch 2010). Publicly funded forest management planning (hereinafter forest planning) in private forests should continuously reconcile manifold private forest owner objectives with public interests. Private forest owners are among the key end users of forest management plans; it is up to them whether, and to what extent, plans are finally implemented in practice. For several decades, forest owners have been the object of social research in forestry, which has focused mostly on their objectives and the determinants of management behavior (e.g., Urquhart et al. 2012). However, the significance of forest planning at the level of individual properties for private forest management has been addressed much less frequently (e.g., Hujala 2009; Tikkanen et al. 2010). Moreover, it has often been forgotten that the political focus should not be on the average small-scale private forest owner if the overall goal is improvement of private forest management. Most non-industrial private forests in Europe are controlled by individuals or families with properties larger than the average European small-scale private forest property (Schmithüsen and Hirsch 2010). If private forest management is to be improved, the policy should focus more on those forest owners who control the largest parts of privately owned forest area.

Although private forest owners in Europe show similarities in their attitudes to their forests and management objectives, private forest management planning differs greatly between countries (e.g., Bachmann 2002; Montiel and Galiana 2005; Knoke et al. 2012; Toth et al. 2001; Cullotta and Maetzke 2009). The differences are conceptual and related to the number of planning levels, the

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availability of the plans and responsibility for preparing them, the content of the plans, forest owner obligations, and state support and financing (see Brukas and Sallnäs 2012; Eid 2006; Tikkanen et al. 2010; Serbruyns and Luyssaert 2006; Wilmhelson 2006 for brief descriptions of forest planning in private forests in some European countries and Cullota et al. 2009 for a more general overview of planning).

Approaches for considering private forest owner objectives in forest planning in Europe can be simplified into two major concepts. The first concept is characterized by a hierarchical structure of forest planning that includes regional planning which considers mostly public interests, and planning at the level of individual properties. In some countries (e.g., Switzerland), forest planning in private forests is considered as subordinate to regional planning and is obligatory only for properties above a certain threshold (e.g., 50 or 200 ha), while most countries do not require small-scale forest owners to have a private forest property plan. Instead, some (e.g., Finland) invest a great deal into searching for improved and owner-specific forest planning and extension services for private forest owners (Hokajärvi et al. 2011; Nutinen 2006; Tikkanen et al. 2010; Metsään.fi 2015).

The second concept for considering private forest owner objectives in forest planning is characterized by a hierarchical structure of forest planning for all forest area where forest owners enter into planning at different levels and various ways. Planning is not primarily driven by segregation into public/private interests, but traditionally arranged spatially into a hierarchy, e.g., stands, compartments, forest management units (FMU), and forest management regions (FMR). As a result, forest management goals, allowable cut, priority areas for particular management objectives, silvicultural goals, and measures are defined for the whole forest area. In such planning concepts, private forest owners are stakeholders rather than shareholders (Wield 2006; Brukas et al. 2011; Cantiani 2012). They have the possibility to participate in planning by taking part in public disclosure of the plans, providing comments and suggestions to the plan drafts, and selecting trees to be cut together with the district forester. Although ownership is considered in plans in various ways (e.g., allowable cut may be specified by the ownership category, and silvicultural plans are co-produced with the owners), forest owners cannot recognize themselves in such plans unless their property size equals the size of the planning units and the property boundaries match the administrative boundaries. Such a concept advocates the ecological principles of forest management such as the cognitive approach to forest management and bottom-up and top-down planning at a broader and a detailed level, but falls short in considering the social and economic dimensions of forest resources (Kennedy and Koch 2004); each forest is owned by a distinctive forest owner having specific management objectives and making decisions at the level of his property.

Many small-scale private forest owners from either concept of private forest planning still lack a tool to support strategic and operational decisions at the property level, which decreases the possibilities for efficient achievement of national forest policy goals. The problem of no management in private forests may escalate with an increasing number of owners with less attachment to forests and traditional forestry knowledge and more non-amenity values (Ziegenspeck et al. 2004).

One of the policy instruments for considering private forest owner objectives in forest management planning is the private forest property plan (FPP). The FPP can be summarized as a forest-owner-oriented plan prepared for the level at which the owner's decisions are made and which includes all information relevant for the owner (e.g., Bachmann 2002; Hokajärvi et al. 2011; Tikkanen et al. 2010). It could be in printed form or a computerized decision support system (Borges et al. 2014; Härtl et al. 2013; Lexer et al. 2005; Pasanen et al. 2005; Pykäläinen et al. 2006). The FPP proved to be an effective policy tool in some countries with prevailing non-industrial private ownership such as Finland (e.g., Nuutinen 2006; Tikkanen et al. 2010). The FPP might also help to solve the long-standing problem of poor involvement of private forest owners in forest planning and management in countries in transition with no property-specific and cost-sharing planning instruments (FAO 1997).

We will use Slovenia as a case study to estimate the merits of adapting forest planning system with owner-oriented management plans and the financial consequences thereof. Forests cover 58.4 % of the land territory, and three quarters of forests are privately owned. Sixty-nine percent of forest owners have <1 ha of forestland, but their forests cover merely 9 % of private forests. Properties exceeding 1 ha represent 42 % of all private forest properties in Slovenia and 91 % of private forestland (Medved et al. 2010). The public forest service (the Slovenia Forest Service, SFS) inventories all forest area and prepares FMR plans, FMU plans, and silvicultural plans with no division between public and private ownership. SFS foresters had already voluntarily initiated the preparation of FPPs for different types of private forest owners two decades ago to enhance private forest management (see Ficko et al. 2010). However, the concept and the content of the FPP have been defined solely by experts (Boncina 2003; Boncina and Cavlovic 2009; Ficko et al. 2005; Papler-Lampe et al. 2004); forest owner interest in having such a plan has never been empirically measured.

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This study can primarily serve policy makers in countries with a high proportion of private forests but deficient planning in private forests when considering possible adaptation of the current planning system toward one that is more effective and owner-oriented. The aims of this study are to (1) estimate private forest owner attitudes toward FPPs; (2) examine private forest owner willingness to pay for the FPP; (3) estimate the price that interested owners are willing to pay for the plan; and (4) aggregate the WTP estimates at a national level and calculate the possible savings in state budget expenditures for private forest planning.

Methods

Sampling

We conducted two series of face-to-face interviews (in 2010 and 2013) with randomly selected private forest owners in Slovenia regarding their attitudes toward FPPs using mostly closed-ended questions. The survey population consisted of individual private forest owners with over 1.0 ha of forestland. Those with less than this amount were excluded for two reasons. First, the FPP is not an instrument for targeting forest owners with extremely small properties. For the same reason, co-owners and commons were excluded from the research. Second, owners with <1 ha control only 9 % of the private forestland in Slovenia and are substantially more disengaged in property management than owners of larger properties.

Candidates were randomly selected for the interview using the Landowner Register from the Surveying and Mapping Authority of the Republic of Slovenia (SMARS 2007). The random selection in each series was stratified by forest property size (1.0–4.9, 5.0–14.9, 15.0–30.0, and >30.0 ha), following the national small-scale forest survey methodology (Medved 2000) to ensure that all size classes were represented by a roughly equivalent number of 100 interviewees. To allow our sample to better reflect the population of private forest owners with more than 1 ha of forestland, we balanced the sample by weighting the responses with the ratio between the proportion of the property size group in the sample and in the proportion in the population (Loomis 1987; Harrison and Lesley 1996).

The targeted cumulative number of 400 interviews in a series had an acceptable 5 % margin of sampling error (Krejcie and Morgan 1970), was manageable, and fit our budget for the survey. In the first series, the number was reduced by 20 due to missing values. Of 380 interviewees, 364 explicitly stated that they managed their forest properties and that they were fully able to respond. We considered them as reliable respondents to willingness-to-pay (WTP) questions and included them in the WTP analysis. In the second series, the target number of 400 interviews was not reached due to fatigue and the early resignation of the interviewer, but we managed to continue the interviewing until a balanced sample with a proportional number of respondents in each forest property size category was reached. Using the same criteria as above, the number of responses in the second series was 190. Six respondents in the second series refused to answer to the WTP questions or expressed their WTP amount as a proportion of the total FPP cost and were excluded from the analysis. Thus, we have a total of 548 usable responses from both series with a margin of error of the pooled sample of 4.2 %.

If a forest owner was not available when the interviewer visited, the owner was contacted a second time by telephone to arrange a second meeting. The response rate was eventually 100 %. Since interviewees were randomly selected and the response rate was 100 %, a survey or response bias assessment was not needed.

Face-to-face interviews

Respondents were first asked the following closed-ended question on their attitude toward the FPP: "Do you think a plan that would analyze the state of your property, specify management goals, recommendations and measures and analyze the financial performance of forest management over a decade might be useful for you?" The respondents could answer with Yes, No, or I don't know.

The attitudinal question was followed by two major WTP questions: (1) "Would you be willing to share the costs of the management plan for your forest property?" If the answer was affirmative, we continued with the following question: (2) "How much would you be willing to pay for such a plan once a decade?" A clarification was added to the question that an offer does not oblige the respondent to make any payment.

The offering format was open-ended for two reasons. First, this study was meant as an exploratory research for the FPP as a product in the developmental stage. We examined a hypothetical payment for a hypothetical product. Second, although the subject of the offer was described sufficiently, the respondents were free to imagine its content and function. With such an approach, we did not constrain the respondents to think just about their willingness to have the FPP, but to think about the usefulness of a private forest management plan in general. Thus, the stated amount reflects the customer value of having such a plan.

The monetary values from both series of interviews were adjusted to the 2014 value using a 2 % interest rate as the average annual inflation rate.

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Econometric framework

The selection of the WTP estimation model was based on the nature of the decision problem and our research interests (Sigelman and Zeng 1999). We assumed that respondents first considered the decision whether to pay or not before how much to pay. In addition, we were interested in the questions of who is willing to pay and how much they are willing to pay, so the appropriate model for estimating the WTP is Heckman's (1979) two-stage sample selection model. Heckman's model (Heckit model) is a type of Tobit censored regression model by which Tobin (1958) described the relationship between a censored dependent variable and a vector of independent variables (Amemiya 1985). Censoring in Heckit occurs due to sample selection because the WTP amount is observed only when a "latent" selection variable is positive, i.e., only those who are willing to pay make bids. The Heckit WTP model consists of two equations: the "selection equation" (Eq. 1) and the "outcome equation" (Eq. 5). With the selection equation, the factors influencing the decision whether to pay or not are estimated. The outcome equation estimates the influence of factors on the stated payment amount.

Heckman's sample selection model

Consider z_i^* being a latent variable measuring the intention to pay for the FPP dependent on a vector of factors, w', with a vector of parameters, γ, and with a random disturbance, u_i (Eq. 1), where only the dichotomous variable z_i is observed (Eq. 2) (Greene 1997):

$$z_i^* = w_i'\gamma + u_i \tag{1}$$

$$z_i = \begin{cases} 1 & z_i^* > 0 \\ 0 \text{ otherwise} \end{cases} \tag{2}$$

Due to sample selection bias, the WTP model could be written as a linear model with X being a vector of explanatory variables and a random term e_i (Eq. 3) where u_i and e_i follow a bivariate normal distribution with means 0, variances as indicated, but having a correlation ρ (Eq. 4):

$$\mathrm{WTP}_i^* = X_i\beta + e_i \tag{3}$$

$$\begin{bmatrix} u_i \\ e_i \end{bmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \sigma_e\rho \\ \sigma_e\rho & \sigma_e^2 \end{pmatrix}\right] \tag{4}$$

Since only a subsample of respondents may participate in the WTP bidding and the bids can only be positive ($\rho \neq 0$ and $z_i = 1$, Eq. 5), the ordinary least-squares (OLS) estimation of the WTP yields biased estimates.

$$\mathrm{WTP}_i = \begin{cases} \mathrm{WTP}_i^* & \text{if } z_i = 1 \\ \text{missing} & \text{otherwise} \end{cases} \tag{5}$$

In such cases, one should use a conditional regression function (Eq. 6), Greene (1997):

$$\mathrm{WTP_i} = E\left[\mathrm{WTP}_i | z_i^* > 0\right] + v_i = X_i\beta + \left(\rho \cdot \sigma_\mathrm{e}\right)\mathrm{IMR}_i + v_i \tag{6}$$

where IMR is the inverse Mills ratio and v_i is the random disturbance term. The IMR is calculated as the ratio between the standard normal probability density function evaluated at the argument, $\varphi(\cdot)$, and the cumulative distribution function for a standard normal random variable evaluated at the argument, $\Phi(\cdot)$ (Eq. 7):

$$\mathrm{IMR_i} = \frac{\varphi(\mathrm{w_i'}\gamma)}{\phi(\mathrm{w_i'}\gamma)} \tag{7}$$

The random term v_i has conditional mean and variance (Eq. 8), Greene (1997):

$$E\left[v_i | z_i^* > 0\right] = 0, \mathrm{var}\left(v_i | z_i^* > 0\right) = \sigma_e^2(1 - \rho^2\delta_i) \quad \text{with } \delta_i = \mathrm{IMR}_i\left(\mathrm{IMR}_i + w_i'\gamma\right). \tag{8}$$

To estimate the probability of a respondent's willingness to pay for the FPP at the first stage, we ran a probit model with the binary dependent variable willingness to pay for the FPP using Eq. 3. For each observation of the full sample, we calculated the inverse Mills ratio and retained it as a variable for the outcome equation. In the second stage, we estimated WTP with OLS regression using Eq. 6 where IMR was used as one of the predictors. Since the estimated variance of the residuals from a regression was not constant but dependent on the values of the independent variables (indicated by the significance of the Breusch-Pagan LM Chi-square test), we used the White heteroskedastic model to estimate robust standard errors.

Since the coefficients in the Heckit model should not be interpreted as the effect of predictors on the dependent variable as in the linear regression model, a simple scaling of the coefficients does not reveal the effects of the predictors. By analyzing the partial effects, we examined the effects of the predictors when the explanatory variables are kept at their means. The partial effect for dummy variable x was the change in probability due to the change in the value of the dummy variable from 0 to 1: $E[y|x, d = 1] - E[y|x, d = 0]$. For categorical variables with more than two possible values, the partial effect is the difference in the predicted probabilities for cases in one category relative to the reference category.

All analyses were done in NLogit 5.0 software (Econometric Software Inc. 2012).

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Variables

Due to the discrete nature of the respondent's first decision (i.e., to pay or not to pay for the FPP), we assigned a value of 1 to the WTP variable in the first stage if the respondent was willing to pay for the FPP and 0 otherwise. The dependent variable for the second stage was the stated payment amount in € once a decade.

When selecting the candidates for the predictors, we considered the general recommendations of the econometric literature (Beach et al. 2005). Hence, the desire to improve forest management was considered to be a consequence of landowner characteristics, plot/resource characteristics, and forest management characteristics. The description of the predictors and the expected effect of the predictors are presented in Table 1.

Aggregation to the country level and financial performance of alternative planning

To aggregate the WTP estimates to the national level, we used three approaches according to Loomis (1987) and Harrison and Lesley (1996): (1) The mean WTP value of the sample was considered as the mean WTP value of the population; (2) unwilling to pay responses were recoded to zero bids; and (3) variable sample means were adjusted through the estimated total marginal effect. The financial performance of the current planning system in private forests and cost-sharing planning was estimated by comparing the public forest service labor costs for private forest planning in 2012 (Annual report of the SFS 2013) and the estimated annual revenues from forest property planning. To financially evaluate the labor costs for private forest

Table 1 Variables used for the estimation of willingness to pay for a private forest property plan (FPP)

Variable	Variable type	Description and variable coding	Expected effect	Mean (SD)[a]	
				For WTP = 1	For WTP = 0
Gender (GENDER)	Dichotomous	Male = 1, female = 2	−	1.2 (0.4)	1.2 (0.4)
Age (AGE)	Continuous	Age of the respondent (years)	−	49.4 (13.5)	58.6 (14.1)
Socioeconomic type (TYPE)	Dichotomous	Full-time farmer = 1, otherwise = 0	−	0.1 (0.4)	0.2 (0.4)
Forest property size (AREA)	Continuous	Total forest area of the owner's holding (ha)	+	7.3 (15.6)	5.3 (6.8)
Education (EDU)	Categorical	The duration of formal education (<8 years = 1, 8 years primary school = 2, high school undergraduate = 3, vocational school = 4, high school graduate = 5, higher professional studies = 6, college = 7	+	4.3 (1.7)	3.4 (1.6)
Percentage of forests in the total property area (%_FORESTS)	Continuous	(0, 100] %	+	40.4 (17.8)	38.8 (16.1)
Average forest parcel size (PARCEL)	Continuous	Total forest area of the owner's holding divided by the number of all forest parcels	+	1.5 (2.2)	1.5 (1.8)
Contact with the district forester (CONT)	Dichotomous	Contacts about the silvicultural plan, subsidies, extension services = 1, otherwise = 0	+	0.3 (0.4)	0.2 (0.3)
Cooperation with the SFS (COOP)	Dichotomous	Active = 1, otherwise = 0	+	0.3 (0.4)	0.2 (0.4)
Forest tending (TENDING)	Dichotomous	Practicing = 1, otherwise = 0	+	1.0 (0.2)	0.9 (0.3)
Maximum distance from the owner's residence to one of his parcels (DIST)	Dichotomous	<2 km = 1; otherwise = 0	+	0.4 (0.5)	0.5 (0.5)
Cutting intensity (CUT)	Continuous	Mean annual cut in the last decade (m^3 ha^{-1})	+	3.3 (2.8)	3.3 (2.8)
Self-sufficiency in forest operations (SELF_SUFF)	Continuous	[0, 1]; all operations done by the owner = 1, all operations outsourced = 0	+	0.7 (0.4)	0.6 (0.4)
Willingness to expand the property (EXPAND)	Dichotomous	Would keep or expand the property = 1, would sell or outsource the management = 0	+	1.0 (0.1)	1.0 (0.1)
Reason for cutting (CUT_REASON)	Dichotomous	Salvage cut = 1, otherwise = 0	−	0.3 (0.5)	0.2 (0.4)

[a] Mean values for the subsamples of respondents who intended to pay for forest property plan (WTP = 1, $N = 203$) and did not intend to pay (WTP = 0, $N = 345$), weighted to correct for the overrepresentation of larger properties. Standard deviations in parenthesis

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planning, we used the gross salary of a junior forestry engineer in the public forest service. The calculations include only labor expenditures related to owner-oriented planning in private forests and do not include material costs and other planning-related tasks in private forests (e.g., wildlife management planning). Labor costs for planned and realized hours in private forests are not the incurred costs that the SFS had in 2012 but the reference costs of current private forest planning under the assumption that alternative forest planning (i.e., forest property planning) is done by the graduate forestry engineer.

Results

Of the total number of 548 respondents, 304 (55.5 %) considered the FPP as a usable instrument, 95 (17.3 %) had a negative opinion about it, and 149 (27.2 %) were undecided (Table 2). The overall percentage of owners willing to pay for the FPP was 37.0 % (203), from 30.8 % in 2010 WTP increased to 49.5 % in 2013. Most of the respondents willing to pay for the FPP had a positive general attitude toward it; however, respondents with a rather negative general opinion (6.3 % of those) and undecided respondents (14.1 % of those) were also willing to share the costs.

Willingness to pay can be explained with nine variables (66.2 % of correct predictions, Table 3). Younger (AGE) and better educated forest owners (EDU) with larger properties (AREA) and more forestland (%_FORESTS) not living as full-time farmers (TYPE) and having their forest more than 2 km away from their homes (DIST) were more willing to pay for the FPP. Owners who practiced forest tending (TENDING) and have regular contact with the district forester (CONT) were more likely to pay.

Table 2 General attitude of private forest owners toward a forest property plan and their willingness to pay for it

Attitude[a]	Intention to pay[b]	Frequency
Positive	No	128
	Yes	176
Negative	No	89
	Yes	6
Indifferent	No	128
	Yes	21
		548

[a] The exact wording was: "Do you think a plan which would analyze the state of your forest property, set management goals, recommendations and measures, and analyze the financial performance of forest management over a decade might be useful for you?" The respondents could choose "Yes," "No," or "I don't know"

[b] The exact wording was: "Would you be willing to share the costs of the forest management plan for your forest property?"

Contrary to our expectations, females (GENDER) and owners whose major reason for cutting was salvage cut (CUT_REAS) had higher probabilities for willingness to pay than owners who cut regularly. Surprisingly, willingness to pay was not significantly dependent on the current level of harvesting (e.g., the assumption the more they earn from the forest the more they can afford was incorrect), nor did it depend on self-sufficiency in forest operations or to forest owner plans to enlarge the property. Looking at the partial effects of the variables, we can identify the isolated effects of the variables on the WTP. For example, women were about 14 % more likely to pay than men, and willingness to pay decreases by 1 % per year of age, but increases if the forest owner has contacts with the district forester or does salvage cutting (for 36 and 19 %, respectively), keeping other variables in the model at their means. Measures of the goodness of fit indicate that the binomial probit model fits the data fairly well suggesting that there is a strong relationship between the intention of an individual to pay for the FPP and the explanatory variables.

Nominal amounts of suggested payments ranged from 5 € to 1530 €, which is 0.51–113.33 €/ha. Recalculated to 2014 and adjusted for sample representativeness, the mean WTP amount was 135.99 € or 28.31 €/ha. Mean present WTP values increased significantly (at $p < 0.05$) from 2010 to 2013 by 59.4 % (from 166.47 € to 265.36 €). Three factors positively influenced the proposed amount of money significantly (Table 5): forest property area, the cooperation with the SFS, and percentage of forests in the total property area. Each hectare of forest property area increased average WTP by 2.19 €, cooperation with the SFS increased the mean WTP amount by 76.38 €, and each percent of forests in the total property area increased average WTP amount by 1.91 €. Willingness to expand the property has a negative influence on the proposed amount of money; forest owners considering selling the forest or outsourcing the management would pay significantly more for the FPP than the owners who plan to keep or expand the property. There was a correlation ($\rho = -0.36$) between disturbances in the selection equation and outcome equation. The IMR variable was not significant, indicating that there would not be a sample selection bias if the IMR was omitted from Eq. 6. We found no significant mediating effects of any of variables on stated amounts through the intention to pay. Model fit was sufficient ($R^2 = 0.20$).

The countrywide WTP aggregation suggested a decadal turnover of approximately 3.5–4.6 million € for FPP preparation depending on the calculation approach (Table 6). The expected payments for FPPs would suffice for 42–57 % of current public budget expenditures for tasks related to private forest planning (without forest inventory and forest management planning at the FMU and FMR level) and for 17–23 % of all publicly financed

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Table 3 Probit regression of the intention to pay for the forest property plan (first stage of Heckit model), $N = 548$

Variables	Coefficient (S.E.)	Marginal effect (S.E.)
Constant	−0.701 (0.825)	
GENDER	0.382** (0.159)	0.139** (0.058)
AGE	−0.029*** (0.005)	−0.010***(0.002)
EDU	0.117*** (0.041)	0.042*** (0.015)
AREA	0.019* (0.011)	0.007 (0.004)
%_FORESTS	−0.001 (0.004)	−0.001 (0.002)
CUT	−0.013 (0.026)	−0.005 (0.009)
PARCEL	−0.082 (0.050)	−0.030 (0.018)
COOP	−0.234 (0.186)	−0.085 (0.068)
TYPE	−0.455** (0.192)	−0.165** (0.070)
TENDING	0.461* (0.273)	0.167* (0.099)
SELF_SUFF	0.158 (0.192)	0.057 (0.070)
EXPAND	0.375 (0.653)	0.136 (0.237)
DIST	−0.490*** (0.149)	−0.178*** (0.054)
CONT	1.005*** (0.246)	0.365*** (0.091)
CUT_REASON	0.532*** (0.150)	0.193*** (0.055)
McFadden Pseudo R^2	0.18	
Log likelihood	−271.5	
Rest. log likelihood	−332.4	
χ^2 (15 d.f.)	121.9***	
Percent correct predictions	66.2	

*; **; *** significance at 1, 5, and 10 % levels

Standard errors in parenthesis

planning tasks related to private forest management (Table 7).

Discussion

Our results show that the general attitude of forest owners toward cost-sharing in planning is positive. A high percentage of owners with a positive attitude and their willingness to pay for the FPP give confidence to forest policy reformers to continue with restructuring of publicly funded private forest planning. A fact encouraging FPP developers to increase promotion of FPPs is also that almost one-third of the respondents were still undecided about the plan's usefulness. However, high interest in the potential product could also be explained by the "promised" positive attributes of the FPP in the attitudinal question.

There are several viewpoints that should be addressed when assessing the financial implications of the FPP. First, the two-stage approach to WTP estimation and open-ended bidding format provide a rather conservative WTP estimate (Brown et al. 1996; Halvorsen and Soelensminde 1998). However, the approach was consistent with our primary question, i.e., how many private forest owners would consider FPP as a usable instrument. The WTP for the FPP was of secondary importance. The selection of the WTP estimation model corresponded to the nature of the decision problem and the character of the FPP as a non-obligatory planning instrument. The open-ended format was used to get the robust estimation of the FPP value. However, the estimated WTP may be still subject to uncertainty. List and Gallet (2001), for instance, estimated based on the meta-analysis of the laboratory WTP studies that respondents overstate their actual values on average three times when asked a hypothetical question. On the one hand, the number of owners with the intention to pay and the average proposed amount increased from 2010 to 2013, while on the other hand there was also an increase in the percentage of respondents with a positive attitude toward the FPP but zero bid, from 21 % in 2010 to 28 % in 2013, with 128 (23.4 %) such respondents in the pooled sample (Table 2). A portion of them could be interpreted as protest zero bidders. Unfortunately, it remained unclear whether they are protest zero bidders or just true zero bidders who cannot afford to pay because the questionnaire did not include the follow-up questions on the reasons for their unwillingness to pay. However, given the step-wise character of the WTP estimation, the latter uncertainty does not influence the estimation of the mean WTP amount as much as "hypothetical bias" arising from overstating actual, but it may be important for the governments in implementing the FPP into practice.

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Second, it is unclear how private forest owners interpreted the role of the FPP. If they interpreted it as an instrument that increases their benefits by itself, then the proposed amount is inflated due to the psychological effect that the FPP is beneficial by default. In contrast, if respondents participated in bidding with rather symbolic amounts to hide their income status, then the WTP amount is a rather conservative estimate of true willingness. The distribution of the proposed amounts shows that 25 % of respondents proposed a rather symbolic price for the plan (≤51 €/property/decade, Table 4), supposedly to prove their general support for the FPP. Also supporting such a conclusion is that 50 % of the households were willing to pay <9 €/ha once in a decade, or 108 €/property, which amounts to about 2–3 m^3 of fuel wood.

Third, although the explanatory power of the WTP regression is in the range typical for WTP studies using sociodemographic explanatory variables (e.g., Cho et al. 2005; Ovaskainen et al. 2006), we considered it low. The total marginal effect was significant only for the percentage of forests in the total property area (%_FORESTS), which is a rather non-informative variable. It means that the

Table 4 Descriptive statistics of the proposed amount that forest owners ($N = 203$) were willing to pay for a forest property plan in 2010 and 2013, recalculated to 2014 and adjusted for sample representativeness

	Proposed amount		Per hectare	
	Unweighted	Weighted[a]	Unweighted	Weighted[a]
Mean	210.80	135.99	16.84	28.31
Maximum	1530.00	1530.00	113.33	113.33
Median	108.24	102.00	9.02	25.50
Minimum	5.41	5.41	0.51	0.51
Fifth percentile	32.47	20.40	1.40	3.61
25th percentile	54.12	51.00	3.50	10.15
75th percentile	270.61	153.00	24.05	40.80
95th percentile	541.22	510.00	56.42	68.00
Standard deviation	229.70	166.30	20.06	22.06

[a] Responses weighted to correct for the overrepresentation of bigger properties to better reflect the population of private forest owners with 1 ha of forestland or more which was targeted in the survey

Table 5 Ordinary least-squares regression of the stated payment amount for the forest property plan (second stage of Heckit model), $N = 203$

Variables	Coefficient (S.E.)	Total effect for variables in both parts[a] (S.E.)
Constant	337.633 (263.466)	
GENDER	−14.913 (42.195)	−1.573 (52.615)
AGE	1.248 (2.502)	0.242 (3.424)
EDU	2.616 (12.350)	6.689 (15.617)
AREA	2.189* (1.155)	2.838 (1.900)
%_FORESTS	1.915*** (0.716)	1.861** (0.742)
CUT	1.716 (5.116)	1.273 (5.259)
PARCEL	0.846 (7.592)	−2.007 (10.081)
COOP	76.381** (38.319)	68.210 (43.105)
TYPE	11.931 (51.802)	−3.974 (63.800)
SELF_SUFF	−2.776 (37.564)	2.740 (39.682)
EXPAND	−283.594* (172.298)	−270.478 (174.961)
DIST	4.489 (50.716)	−12.656 (64.437)
CONT	−102.928 (99.138)	−67.794 (128.312)
CUT_REASON	−41.273 (46.867)	−22.650 (63.724)
IMR	−54.894 (127.273)	
R^2	0.20	
Adjusted R^2	0.13	
F test (15, 187)	3.10***	

*; **; *** significance at 1, 5, and 10 % levels

[a] Direct plus indirect effect

Standard errors in parenthesis

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Table 6 Country-wise aggregation of WTP for forest property plans under different aggregation approaches

Approach	Number of private forest properties ≥1 ha owned by individuals	WTP rate (%)	Mean WTP amount/property (€)	Aggregate WTP/decade (€)
Mean WTP value of a sample considered as a mean WTP value of a population	86,415	37	135.99[a]	4,348,083
Unwilling to pay responses recoded to zero bids[b]	86,415	100	40.12	3,466,970
Variable sample means adjusted through the estimated total marginal effect[c]	86,415	37	146.39	4,648,759

[a] If mean WTP is replaced with median (102.00 €), the aggregate WTP amounts to 3,261,302 €/decade

[b] Using OLS regression on a full sample of 548 respondents, responses with WTP = 0 recoded to WTP = 1 and WTP amount = 0 (see Loomis 1987)

[c] Sample means for variables GENDER, AGE, AREA, PARCEL adjusted to population means and mean WTP for the population adjusted through the total marginal effect of these variables in the second stage of Heckit regression (Harrison and Lesley 1996). We had no population information for the rest of the variables in the model and kept them at their sample means

landowners whose properties consist mainly of forests are more likely to pay for the plan and that they are willing to pay more than the landowners whose forests constitute just a minor part of the property. The effects of the variables directly observed in the field or readily accessible to FPP project managers through the information systems of public services (e.g., age, gender or property size) were insignificant, implying that candidates for the plan will not be easy to find. The significance of more subtle predictors indicates that the implementation of the FPP should not follow a campaign but a snowball technique, by which the owners–promoters of FPPs should be identified first and then the less interested owners could be mobilized by networking.

The aggregation of WTP on the national level and the comparison of the FPP costs with the current costs for private forest planning show encouraging results. The expected payments could cover 42–57 % of public budget expenditures for specific tasks related to private forest planning (without inventory and forest management planning at the current levels), and 17–23 % of all tasks related to private forest planning. These calculations are best possible estimates; the expected cost-sharing should be interpreted as the expected value under the law of large numbers. If for practical reasons a much more cautious WTP estimate is used, for instance, the lower quartile (i.e., 51 €), the expected payments would cover 9–22 % of the private forest planning-related labor costs of the SFS in 2012.

We should note that the aggregate estimate of the FPP value is accurate if all assumptions about the implementation hold (legal status of the plan, successful promotion, the response rate, etc.). In practice, the real engagement of private forest owners is likely to be lower at least at the beginning of the FPP implementation, when building the network of promoters should take priority over the number of mobilized owners. Barriers to successful implementation of FPP may also lie in the formalization of the FPP in the current forest management planning system and the regulation of FPP preparation. In Slovenia, forest management planning is currently the domain of the public forest service. However, the legislation does not prohibit opening the market for planning services such as non-obligatory forest management plans as long as they are consistent with the general principles of forest management and objectives set in higher-level plans and stand-wise management guidelines. A potential danger to successful implementation of the FPP is its formalization as a non-obligatory planning instrument substituting some planning services offered for free to increase the state budget revenues and to consolidate the public forest service financing. Public funds for the forestry sector are usually not earmarked nor are they stable (e.g., Held et al. 2013; Shigematsu and Sato 2013). The Slovenia Forest Service's budget has been cut for years as a part of the National Reform Program for the consolidation of public finances and is not expected to recover until fiscal stability is reached in 2017 (Stability Programme 2014). If some of the actors impose their interests, the process of FPP implementation may follow the double spiral of Amdam (2000), where the initial idea evolves in an outward spiral and then mutates in an inward spiral to a final solution that differs substantially from the one designed at the initial stage of the process (Kouplevatskaya-Buttoud 2009).

The unsolved questions in the implementation are the percentage of cost-sharing and the cost of the FPP. The WTP estimation only clarifies the owner contribution to FPP costs. If we compare the median of the suggested amount from our study (25.50 €/ha, Table 4) with the prices forest owners paid for private forest plans abroad in the same period (7–47 €/ha, Landesforsten Rheineland-Palatinate 2014; Nuutinen 2006; Smith 2006), we see that

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Table 7 The SFS budget for private forest planning in 2012 (adapted partly after the Annual Report of the SFS 2013) and possible cover of expenditures by the payments of private forest owners for forest property plans

Planning tasks	Planned hours in total	Realized hours in total	Planned hours in private forests[c]	Realized hours in private forests	Labor costs for planned hours in private forests[d]	Labor costs for realized hours in private forests
Silvicultural plans[a]	55,575	54,388	42,793	41,879	347,777 €	340,349 €
Total forest management planning[b]	188,260	156,942	144,960	120,845	1,178,093 €	982,111 €
Individual counseling (cut approval and tree selection)	42,000	41,787	32,340	32,176	262,828 €	261,495 €
Other counseling (silvicultural planning, extension, rural development program)	13,000	11,364	10,010	8750	81,351 €	71,114 €
Technological part of silvicultural plans	20,830	10,692	16,039	8233	130,350 €	66,908 €
Total tasks related to private forest planning	319,665	275,173	246,142	211,883		
Total tasks within public forest service	886,734	886,734			2,000,399 €	1,721,977 €
Expected annual income from the FPP production, lower/upper bound (Table 6)					346,697 €/464,876 €	346,697 €/464,876 €
Minimum/maximum cover of costs for tasks related to private forest planning					17 %/23 %	20 %/27 %
Minimum/maximum cover of costs for tasks related to private forest planning *excl*. forest management planning					42 %/57 %	47 %/63 %

[a] Due to budget reduction, the SFS produced 28 and 43 % fewer silvicultural plans in 2013 than in 2011 and 2010, respectively

[b] Incl. forest inventory, field stand descriptions, adaptation of forest management plans to conservation guidelines for NATURA 2000 areas, Kyoto measurements, approvals for clearances, and field maintenance of administrative borders of subcompartments and management units

[c] Breakdown of planned and realized hours into public and private forests is proportional to the area

[d] Labor costs of a forester with a university degree at the beginning of a career

it matches the owner's contribution to FPPs abroad. The typical contribution of forest owners for having such a plan abroad ranges vary greatly; it ranges from 25 to 75 % of the costs (Eid 2006; Landesforsten Rhineland-Palatinate 2014;Tikkanen et al. 2010), and the rest is covered by public authorities through subsidies or one-time plan preparation grants. Other mechanisms supporting forest-owner-oriented forest planning include financing stand inventories or tax reduction for forest owners with a plan (EFI 2004; Nuutinen 2006; Smith 2006; Wilhelmson 2006).

Conclusions

Implementation of cost-sharing planning instruments in private forests is a long-term process due to uncertainties about the content, standard format, responsibility for the preparation, and the legal status of the instruments. For countries with prevailing private forests, but low gross added value of forestry (e.g., GDP is <1 % in Slovenia, SURS 2014), fully publicly funded planning systems in private forests may no longer be economically sustainable. In addition, current planning does not always reach its goals at the operative level. We estimated that more than half of owners with forest property larger than 1 ha would consider FPP as a usable instrument and that approximately each third would be willing to pay for the plan, which could result in possible savings in public forest service budget expenditures for private forest planning of 17–57 %. The non-obligatory character of the FPP could have manifold impacts: an intensification of private forest management in a bottom-up manner, opening the market for extension services for private forest owners and new jobs for forestry engineers as forest planners, a revival of the roundwood market and its better organization and transparency as a consequence of increased wood mobilization, etc.

The findings of this study could be useful for forest planners, forest administration, and policy makers when considering adaptations in private forest planning and the financial consequences thereof. The final decision about the future of private forest planning is in the hands of policy makers.

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2.2 UNPUBLISHED PAPERS AND OTHER RESEARCH RESULTS

2.2.1 The experiences of forest owners with the private forest property plan

Ficko A., Boncina A. 2015c. Forest owners' experiences with the forest property plan [= Izkušnje lastnikov gozdov z načrti za zasebno gozdno posest]. An unpublished manuscript.

In the last 20 years several prototypes of forest property plans (FPP) have been prepared by the Slovenia Forest Service or as graduate theses. By employing semi-structured face-to-face or telephone interviews with a selected number of private forest owners (n = 11), we set out to determine 1) how satisfied forest owners were with the FPPs and 2) what improvements they recommend. We found that most of the FPP prototypes were prepared on the initiative of foresters who tried to motivate forest owners towards management, or by forestry students who thus practiced their engineering skills. The owners were rather skeptical about the usefulness of such a plan, stating that 1) the FPP was too detailed for their management decision practice which takes place mostly on a yearly basis; 2) the FPP was not adaptive to changes in the environment and wood market; and 3) wishes and objectives were not considered properly before the preparation of the plan, and there were no follow-up activities such as plan revision or customer satisfaction analysis. We conclude that the expert-driven implementation of the FPP was a major failure. Although the experiences we collected are not very helpful for designing a user-friendly forest owner-oriented plan, we suggest conducting a systematic costumer satisfaction analysis and targeted search for owners with an interest in the FPP in the future.

1. Introduction

In contrast to some European countries with a longer research history of small-scale private forest property planning (e.g. Tikkanen et al., 2010), there are only a few studies questioning the private forest planning concept in Slovenia (e.g. Bončina, 2003; Papler-Lampe et al., 2004; Ficko et al., 2005). Most of these studies call for the adaptation of the current planning concept towards one that is more owner-oriented and efficient – also through introducing novel planning instruments such as the forest property plan (FPP).

The FPP has been thought of as a non-obligatory planning instrument at the operative level of an individual forest owner, prepared on demand for the owner. However, since the FPP may consider also strategic issues that go beyond property management (e.g. investments, land use conversion, stand risk management) the significance of the FPP might be much broader.

Some foresters of the Slovenia Forest Service voluntarily initiated the preparation of FPPs in the 1990s in an attempt to motivate forest owners towards management. However, in most of the cases, the FPPs were prepared without any thought on the revision of the plan and the developers never analyzed satisfaction with the FPP. The ultimate goal of these – let us call them the prototypes of FPPs – was to increase the owner motivation towards regular management. It is not surprising that these prototypes were upgraded silvicultural plans with rather simple calculation of allowable cut for the next decade supplemented with the calculation of the net revenue.

The popularity of FPPs in the 1990s and particularly from 2000 onwards was manifested in the large number of graduation theses at the Department of Forestry and Renewable Forest Resources of the Biotechnical Faculty of the University of Ljubljana, in the form of management plans for private forest properties. User feedback collected during prototype testing is instrumental for the developer of a new planning instrument (e.g. Haara et al., 2014). Unfortunately, few of the theses reached the owners. After

more than two decades of use one should ask how satisfied customers were with these plans.

The usability of a product is a multi-faceted feature. It can be defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. To run a successful usability test, we need to identify the population of users first, select a representative sample from it, carefully design the questions to elicit unbiased information,and successfully complete the interviews. This is not easy when a limited number of prototypes have been tested and in most of the cases more than a decade has passed since the release of a prototype.

This study represents the last step in studying the options to consider private forest owner objectives in forest planning. By examining private forest owner experiences of private forest owners with the FPP we aimed to determine: 1) how satisfied forest owners were with the FPPs; and 2) what improvements they recommend.

2. Methods

We searched for printed versions of FPPs because, to our best knowledge, no digital FPP had been prepared. We started with a compilation of FPPs that we became acquainted with during years of research on private forest planning with the help of foresters from the Slovenia Forest Service (see also Papler-Lampe et al., 2004; Ficko et al., 2005). In addition to the plans prepared by the foresters, several FPPs were prepared as graduation theses at the Department of Forestry and Renewable Forest Resources of the Biotechnical Faculty in Ljubljana under the supervision of Prof Iztok Winkler or Prof Andrej Bončina. We searched in the database of (under)graduate and postgraduate theses covering the period 1954-2015 (Forestry Library, 2015) for theses containing any kind of management plan for private forest property. Altogether we found 22 graduation theses or FPPs ranging from 11 ha to more than 1000 ha. About half of the owners were part-time farmers, non-farmers or absentee owners with restituted forests. To search for publicly unavailable FPPs and to collect information about the current state of the

properties for which the FPPs were prepared more than a decade ago, we asked for the assistance of two district foresters who were most active in the preparation of the FPPs.

Table 1: The list of forest properties for which the forestry property plan (FPP) was prepared (incomplete data because some information was missing in the FPPs, the interviewees were unreachable or preferred not to reveal some information)

Forest property	Size (ha)	Year of FPP preparation	FPP prepared as a	Owner profile
Florin	190	1996	Graduation thesis	Part-time farmer
Strugar	N/A	1996	Graduation thesis	N/A
Bačovnik	N/A	1997	Graduation thesis	N/A
Rudež	1600	1999	Graduation thesis	Non-farmer, restituted forests
Jakše	N/A	1999	Graduation thesis	N/A
Lavrin	21	2000	Graduation thesis	Part-time farmer
Verderb	26	2001	Graduation thesis	Non-farmer, restituted forests
Cestnik	46	2001	Graduation thesis	Part-time farmer
Kasjak	105	2001	Graduation thesis	Active full-time farmer
Novak	86	2002	Graduation thesis	Part-time farmer
Plantarič	11	2003	Graduation thesis	Non-farmer
Kersnik	73	2003	Graduation thesis	Elderly retired owner
Gogala	12	2004	SFS service	Part-time farmer
Kavalar	24	2004	SFS service	Part-time farmer
Hlebanja	32	2004	SFS service	Active full-time farmer
Kral	N/A	2005	Graduation thesis	Part-time farmer
Košir	46	2006	SFS service	Active full-time farmer
Kolovec	60	2006	Graduation thesis	Retired absentee female, restituted forests
Kuštrin	36	2010	Graduation thesis	Active full-time farmer
Jemec	98	2010	Graduation thesis	Active full-time farmer
Medja	24	2015	Part of graduation thesis	Part-time farmer
Pandom	>50	<2015	SFS service	Non-farmer, company

After the list of FPPs was prepared (Table 1), we eliminated from further analysis the FPPs for which we could not find the address of the owner, the owner lived abroad or we considered it very likely that the owner was deceased due to his age at the time of the plan preparation. With all owners remaining on the list, we tried to arrange a personal visit by calling the owner first by telephone. Most of the owners preferred not to be visited personally stating that they did not have time or had no valuable information about the plan. To get the information about their satisfaction with the plan anyway, we briefly interviewed them over the telephone. Some were willing to talk intensively about forest management but we could not obtain information on how satisfied they were with the FPP in practice. For instance, we arranged a personal visit

of interviewee 10 several times, but he always cancelled the meeting due to unexpected obligations. In several cases we could not interview the person who was the owner at the time of the plan preparation, mostly because of his death or inheritance.

The interviews were open-ended. Open-ended questions can provide meaningful and interpretable data if their formulation is unambiguous and focused enough to suggest a clear direction in the content of the answers (Creswell, 2003). We started with a brief introduction of the topic and continued more or less directly with questions about their satisfaction with the forest property plan depending on the openness of the interviewee. Since the first interviewees rejected being voice-recorded and requesting permission for recording substantially diminished the positive rapport between the interviewer and the interviewee, we decided not to record the interviews but to transcribe them by memory and notes at home in the best possible manner.

Due to the limited number of completed interviews with relevant information and the shortness of the conversations, we applied simple content analysis in which we consolidated the items reported by the interviewees into main success/failure factors by semantic similarity. We preserved the original wording of the interviewees whenever possible.

3. Results and discussion

The FPPs varied greatly in their content, level of detail, computational approach and writing style. Since most of the plans were prepared on the initiative of foresters or forest students, they are frequently overburdened with technical descriptions of computational procedures and detailed site and stand descriptions which often refer to similar descriptions from forest management plans for forest management units. All plans also include an introductory presentation of the property and a description of the socio-demographic status of the owner, which indicates that the plans were not primarily designed for forest owners but served as a test for foresters in designing a forest owner-oriented management plan.

We recognized a positive general attitude to private forest planning from most of the interviews. However, the interviewees were only partially satisfied with the FPP prototypes. The most important reasons for their dissatisfaction can be summarized into three main groups:

1) The FPP was too detailed for typical forest management decision practices because forest owners make decisions mostly on a yearly basis.
2) The FPP was not adaptive to changes in the environment and wood market, which are very likely to happen in the plan's lifetime.
3) During plan preparation, owners' wishes and objectives were not considered properly and there were no follow-up activities such as a plan revision or customer satisfaction analysis after the plan preparation.

The first group of reasons for dissatisfaction can be illustrated by the statement of interviewee No. 4: *"When the plan was prepared, the owner was my father. After I took over the property I looked over the plan once. I am not very familiar with it. (…). We plan management year by year, like cutting, tending, road construction…."* Interviewee No. 7 is of a similar opinion: *"I already know what's in there. I have the plan in my head. I cut every year what needs to be cut. Before I cut, I have a consultation with the district forester, and we always look for a compromise between his requirements and my wishes* (…). *I have no need to use the plan for my property. We regularly take care of all things with the district forester. It is simple; you count 85 € per cubic meter; the costs are 20 € and that's it. (…)"* Interviewee No. 11 is a diligent forest owner who takes care of the family farm very well and underuses his forests. He pointed out that anything could be written in the plan, particularly detailed site stratification and extensive silvicultural planning. But he considered such a plan as one primarily designed for foresters: *"The plan is nice and well-prepared. However, I always have to look for good prices of wood; they dictate where and how much I will cut."* Interviewee No. 5 considered that the plan needs revision after more than a decade and natural disturbances, but he did not do it because he said "*I have the plan in my head*." The opinion that the FPP was too academic and thus unable to fulfill the demands of the users is also indicated in the following statement of an elder owner (Interviewee No. 6):

"I don't know much about that plan. I am not interested in the plan. I have three sons who took over the management of the farm. My son could tell you more but he is very busy, he goes to work every day and he doesn't have any time."

Quite a few interviewees considered the fact that an FPP in paper form cannot adapt to changes in the environment and wood markets as a major disadvantage of the FPP, for example Interviewee No. 5 stated: "*I prepared this plan* (the plan was indeed prepared as a graduation thesis by the district forester, who is the current owner of the property). *The plan was useful, but it should be adapted now because unexpected natural disturbances happened in the past years. (…) I think that the plan is useful for young successors, who thus get familiar with their properties and the opportunities their forest offers. Later the plan has to be adapted.* (Forest) *management is directed by natural disasters, but most of all by wood prices."* Interviewee 9 also emphasized the unreliability of the planned work and saw the FPP more as an instrument for the forest property inventory*: "I used the plan to get familiar with the parcels. I don't use the plan. Management has to adapt to circumstances, mostly unexpected natural disasters. I know the situation in my forest considering growing stock and stands."*

Several interviewees commented on the inappropriate implementation process and suggested that the way forest owners were integrated into the process was a major impediment to its success. For example, Interviewee 1 said: "*When the plan was under preparation, the owner of the property was my grand father with the coownership of my father. I have never used the plan and I have never been familiar with it. I have no information except that I know that the plan was prepared as the result of a graduation thesis by C. Z. who is our district forester now. He still cares for all things on our property regarding forest management planning."* Interviewee 2, the mother of the successor of the property, was of a similar opinion: "*The plan you are asking about was prepared only to finish forestry studies and to prepare a graduation thesis. It was not the wish of the owner. The owner has never used the plan. But I think that it would be interesting to have such a plan."* Interviewee 3 was very disappointed with the FPP preparation: *"The plan was prepared as a thesis to finish forestry studies. I have never had the opportunity to see the plan. It was inaccessible to me, and I was very*

disappointed about that at that time. I am very keen on such plans, but they have to be available to the owners. The owner should also receive a shorter version, just to have it for management. I like forest management a lot and I have a good relationship with the Slovenia Forest Service." Interviewee 7 was even more disappointed about the preparation process considering that the FPP is more a decision support tool for foresters helping them to control larger areas of private forest land ownership: *"It was like the plan was prepared at the initiative of a district forester. I didn't cooperate in the preparation and I haven't seen the plan.* (…) *Before I cut I consult with the district forester, and we always look for a compromise between his requirements and my wishes. The forest property plan serves only as a technical basis for a district forester so that he is able to advise larger forest owners."* One absentee owner very clearly stated that he does not use the plan, but on the other hand he was convinced about the positive effects of private forest planning: *"I don't know anything about my forest property plan. But planning is very important and the Slovenia Forest Service is cooperating very well with us. Such cooperation is very important. In this way the management is proper and owner interests are considered. I know about the levels of forest planning in Slovenia, that we have regional forest management plans and plans for forest management units"* (then follows the off-topic discussion about planning in general which the interviewer could not redirect back to the main issue).

4. Conclusions

We conclude that the FPP prototypes were not primarily designed for forest owners. The experiences of forest owners with variable prototypes are mostly negative particularly due to 1) the lack of added-value of the plan in comparison to what private forest owners already know about their forests; 2) poor adaptibility of the plan in the case of unexpected changes in the environment; and 3) the preparation process was initiated by foresters and did not result from forest owner demand. The latter reason for the dissatisfaction indicates that the experiences we collected may not be very helpful in designing the forest owner-oriented plan because they represent the feedback of a population who should not be targeted primarily in costumer satisfaction analysis. In the

future we suggest more targeted search for interested owners and a systematic analysis of forest owner satisfaction with the FPP.

3 DISCUSSION AND CONCLUSION

3.1 DISCUSSION

3.1.1 Forest owner representation of forest management

In the first part of the dissertation we shed light on social representations of forest management. We hypothesized that specific representation of management may be crucial for understanding the involvement of private forest owners in forest management. Hypothesis No. 1 was that forest owners conceptualize resource-efficient forest management differently than that prescribed in forest policy documents. We confirmed the existence of three very much overlapping representations of forest management, of which the maintenance-centered concept is the most adopted concept by private forest owners (Ficko and Bončina, 2015a). This finding suggests that we cannot reject the hypothesis in the part that considers the conceptualization of forest management. However, our findings on the consequences of forest management representations for management behavior contrast those of other studies. Several studies and reviews from the US and UK (see Ficko and Bončina, 2015a) concluded that private forest owners prefer no active management and to let nature take its course as a consequence of a deep-seated philosophical objection to harvesting or as a consequence of the prevalent belief that "non-intervention" is the appropriate forest management. They showed that this perception is the reason for underuse of forest resources (e.g. Berlik et al., 2002; Erickson et al., 2002; Lawrence and Dandy, 2014). We showed that underuse of wood resources in Slovenia is mostly due to biophysical constraints, not to the general belief that logging is worse for the environment than non-management (Ficko and Bončina, 2015a). Thus, we must reject Hypothesis No. 1 and conclude that forest owners in Slovenia do not conceptualize resource-efficient forest management differently than that prescribed in forest policy documents and that the underuse of wood resources is not due to environmentalism.

The reason Slovenian private forest owners conceptualize efficiency of forest management similar to foresters may lie in the historical dimension of forestland ownership. Reference studies from the US and the UK noted a wide cultural gap between farming and forestry, which, however, is not the case in Slovenia, particularly

because of the slower urbanization of forest owners (Medved et al., 2010). Family farms were the dominant socio-economic category of private forest ownership in Slovenia until 2005, when the share of family farms equaled the share of other forms of private ownership. Currently 39% of private forest owners still run family farms (Medved et al., 2010), which are typically small in size and fragmented. Most of the owners in Slovenia still maintain a close relationship with their properties and follow traditional forest management. We assume that the continuum of knowledge transfer from current owners to successors 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 maintenance concept overlapped substantially with the ecosystem-centered and economics-centered concepts. Based on this, we can expect that the FPP might be an appropriate instrument for supporting private forest management.

However, generational knowledge transfer on traditional forest management may change in the future given the further increase of non-farm ownership types. Bearing in mind 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 U.S., where there are a growing number of non-residential owners who see the forest as part of an alternative lifestyle, and where environmental protectionism may be the principal constraint in the mobilization of wood resources from private forests.

The empirical evidence from Slovenia that the non-intervention forest management concept is not the reason for the undersupply of wood resources from private forests needs to be verified in other European countries. Although the non-industrial private forest owner literature is extant, none of the behavioral studies investigated the association between observed behavior and the fundamental understanding of concepts underlying forest management quantitatively. Structural equation models offer the opportunity to test even more complex hypotheses about the structure of mental models and influential factors without compromising the content of the constructs. For instance, with the Multiple Indicators Multiple Causes (MIMIC) model (Jöreskog and

Goldberger, 1975), we can explain what factors influence a mental construct and confirm the construct validity with multiple indicators.

A significant contribution of our study to contemporary research on the influence of mental models on forest owner behavior lies in its methodological power. 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 between the constructs and (3) measure latent concept means, which would otherwise be unmeasurable by conventional testing. In particular, the last two achievements ensure that the substance of mental constructs is no longer a matter of labeling but can also be quantified through correlations and latent concepts means. However, the presented approach also has its limitations. First, respondents could not present their perception of forest management with their own words or phrases. Second, structural equation modeling can elicit only the long-term and stable knowledge structures of a social group since it is a large sampling technique. Structural equation models cannot handle qualitative data which means that the quality of results depends on the communality level between the variables, the degree of non-normality of data, the estimation method, and particularly on 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 which may not always be feasible for simple hypotheses and a limited budget. Fortunately, parameter estimates (e.g. factor loadings and correlations) which convey the relations between the variables, settle at the smallest sample sizes (Bentler, 2006). This makes us confident that the content of forest management concepts elicited in our study and the relationship between them is valid.

One of the major challenges in analyzing human-environment behavior is the general discrepancy between what is found in a survey and the actual behavior in a given situation. We showed how to detect and correct for consistent responding to questionnaire items on a basis other than that the items were designed for (Ficko and Bončina, 2014). We improved the method for the detection of and correction for acquiescence by Billiet and McClendon (2000) and showed that our results are neither strongly biased nor invalid. No response style bias was found in the study on social

representations (Ficko and Bončina, 2015a) and the response style bias in the study of decision-making style was negligible (Ficko and Bončina, 2014).

3.1.2 Decision making types

In Hypothesis No. 2 we assumed that private forest owners are homogenous with regard to decision-making style. Based on the results from Ficko and Bončina (2013) we rejected the hypothesis. We (*ibid.*) determined that private forest owner decision making is distinguished by owner attitudes to the total economic value of forests (Pearce and Moran, 1994). Half of the owners based their decisions mostly on the economic and administrative aspects of forest management and were classified as Materialists. We see them as primary candidates for the FPP. They considered information regarding the profitability of management, expected costs of cutting and forwarding, the possibilities of outsourcing, and the locations and borderlines of parcels as indispensable for decision making. Materialistic decision making was the result of materialistic objectives; forest owners in the Materialists group were more interested in information related to consumable, extractive goods and services much more than their counterparts, who managed for the non-material benefits from forests. Although labels may introduce some connotations, they helped in describing a non-homogenous group with obvious decision-making segments. In our case Materialists and Non-Materialists represent two groups of forest owners with completely opposite attitudes to decision making; however, this does not imply that forest owners in general are either Materialists or Non-Materialists.

The other half of owners, who we described as Non-materialists, seemed to manage their properties for non-extractive or non-use values of forests. They considered information regarding wild game, management restrictions imposed due to nature protection, rights and duties of forest possession, and public rights on their properties (free access, non-commercial non-wood goods) as most relevant for forest management. Our findings fit well to the conclusions of Hogl et al. (2005) and Weiss et al. (2007) on traditional forest owners and the transitional types of forest owners in Austria. Both groups match well with our Materialists regarding their use of information and level of

cooperation with and trust in forestry institutions. Economically-oriented forest owners in Germany (Mutz, 2007) placed high value on the maintenance of their holdings and on income, or consider their property as reserves, which is similar to what our Materialists do. Our Materialists also correspond well with the economically interested forest owners described in Bieling (2004) and to landholder profiling by Emtage et al. (2007), who concluded, similar to Schaffner (2001), that three fundamental elements, i.e. economic, personal (or lifestyle), and conservation values for landholding, depict landowner management behavior. The economic values of landowners in Emtage et al. (2007) could be understood as the economic extractive values of our Materialists. We showed that Non-materialists are guided by criteria that are opposite to those used by Materialists and that they are comparable with the two other groups proposed by Emtage et al. (2007). Comparing our typology to a review of the forest owner typologies by Dhubhain et al. (2007) we may conclude that the production of wood and non-wood goods and services to generate economic activity (the first type of owners in Dhubhain et al., 2007) is preferred by Materialists, while Non-Materialists are characterized by the consumption of wood and non-wood goods and services (the second type).

3.1.3 Uncertainty in the classification of private forest owners

By developing a probabilistic private forest owner decision-making typology we have introduced a novel approach to the classification of forest owners. This approach offers two major improvements and may therefore benefit the end-users of the typology. First, in the probabilistic approach, only forest owner types with the highest likelihood emerge from the diversified population. In most typologies, which use discrete classification into disjoint owner types, re-identifying owners is difficult in practice because the characteristics that define the types of forest owners are often overly specific. Such classification models might fit statistically well to the survey population they were developed for, but cannot be easily simplified without compromising the exclusiveness of the types and are thus less useful for policy makers. Even in recurring and comprehensive national surveys (e.g. National Woodland Owner Survey, USA), forest owner types from subsequent surveys are harder to generalize due to changed

sampling methodology and survey-specific questions (Bengston et al., 2011). In addition, even if the reliability of clustering was indicated or a validation test of the results was performed, non-probabilistic typologies can only be loosely compared, which has been partly recognized by Hogl et al. (2005), Boon and Meilby (2007), and Emtage et al. (2007). Latent class analysis proved to be an alternative probabilistic approach in the classification of land owners since it yields comparable or slightly better results than non-probabilistic classification, but only when adding covariates to the model, such as associations between the factors (Meilby and Boon, 2004) or individual characteristics of land owners (Pouta et al., 2011). A more extensive implementation of the Bayesian approach in studying private forest owner behavior could also facilitate meta-analyses of typologies and cross-national evaluation studies.

The second advantage of our approach is that the probabilities of cluster memberships were calculated for each forest owner. This means that the end-user of the typology is not forced to simplify individual forest owner behavior into just one most typical mode, e.g. a typical timber manager or a pure nature conservationist. In existing typologies, this shortcoming has been partially avoided by the classification of forest owners into a multifunctional or multi-objective owner type. This owner type likely encompasses several forest owner goals, but the degree to which a forest owner incorporates multiple objectives in his management strategy has remained unclear (Urquhart and Courtney, 2011). By using the Expectation Maximization (EM) algorithm, the multi-objectiveness is not methodologically distorted; a forest owner could be production-oriented, protection-oriented or multi-objective at the same time; multi-objective owners do not necessarily cluster into a separate group but could be members of any other group. This is particularly beneficial in a time of dynamic changes in the private ownership sector (Kvarda, 2004; Wiersum et al., 2005), when management objectives and motives should be constantly monitored. Such an approach is also advised in private forest research that is based on non-repetitive surveys, case studies or samples where the validation of the typology is problematic. Moreover, in traditional typologies, it could be that some of the forest owners whose behavior was not clear-cut and could not be assigned to any other cluster were classified as uninterested (e.g. Bieling, 2004), indifferent (e.g. Boon et al., 2004; Wiersum et al., 2005) or passive/resigning (e.g. Ingemarson et al., 2006).

However, the EM algorithm for clustering has a number of limitations and shortcomings. The most documented shortcoming is its possible poor rate of convergence, but this does not appear to be a problem in practice for well-separated mixtures when starting the algorithm with reasonable starting values (Fraley and Raftery, 1998). The second shortcoming is that the number of assessed probabilities for each observation is equal to the number of components in the mixture, so that the EM algorithm for clustering may not be practical when very large numbers of clusters are expected in the survey population. One should also be aware that employing the EM algorithm for a model having a certain number of components when there are actually fewer groups may lead to the failure of the procedure due to ill conditioning (Fraley and Raftery, 1998).

It is debatable whether the distinction between the management decision type and owner type is necessary. Here, the time aspect of the typology can be crucial since it depends on how static one considers the typologies. We have argued (see Ficko and Bončina, 2013) that decision making takes place in the decision-making environment (DME). Hence, any change in the DME impacts decision making and could consequently change the decision making type (cf. Hujala et al., 2007; Kangas, 2010). Similarly, forest owner types could also be considered as a representative generalization of private ownership for a limited period, i.e. until intervening events produce changes in an owner's intentions, management goals or perceived behavioral control (Ajzen, 1991). In the theory of planned behavior (Ajzen 1991), respecting the condition that intentions and perceived behavioral control must remain stable in the interval between their assessment and the observation of the behavior is indispensable for accurate behavioral prediction. This leads us to the conclusion that managing forest property for economic objectives (e.g. economically interested forest owners, Bieling, 2004) could correspond well to economically rational decision making for the period in which the owners are surveyed, but does not necessarily imply that the decision making type and forest owner type are coherent throughout the whole period of ownership. For instance, Ingemarson et al. (2006) found that roughly 30 % of owners believed they would change their objectives in the next five years. However, we share the opinion of Hujala

et al. (2007) that the verification and refinement of the relationship between the decision making type and the forest owner type requires further research and more in-depth comparative analyses.

3.1.4 Implications of a probabilistic typology for policy

Typologies do not have explanatory power by themselves. We established two prerequisites in the preparation of the explanatory model of forest owner decision making. First, variables in the model were required to be rather basic and readily accessible to policy makers through the information systems of public services. Alternatively, they could be acquired by a cost-effective survey. Second, variables should enable easy practical re-identification of owners. This was done to enhance the instant applicability of the model and to reduce the possible erroneous interpretation of the model by forest policy makers which could result from different interpretations of the complex and sophisticated socioeconomic variables. We discovered that the social characteristics of forest owners influenced their economically-oriented behavior, not the more common attributes of production-oriented forestry, such as the size of forest area (Cleaves and Bennett, 1994). Boon and Meilby (2007) similarly found that production-oriented owners had comparatively smaller average forest area than environmental/recreational owners. The traditional self-sufficiency of farms making a living from wood production, which is prevalent in the northeastern part of the study area, could have contributed to the economically rational reasoning and the substantial trust in the forestry authorities among Materialists.

The dichotomy in private forest owner management behavior should be clearly reflected in forest policy instruments that target Materialists and Non-materialists. Materialists did not differ from Non-materialists in forest resource characteristics. We found that private forest owners were distinguished by their attitude towards non-wood goods and services more than any other factor. In the first group (i.e. Materialists), there is a need for instruments that encourage the sustainable development of business activities on their forest properties. For instance, one of the instruments that supports forest owner decisions is the FPP. It is unclear whether Non-materialists can be identified as easily as

Materialists in practice and therefore addressed using specific forest policy tools. So far, existing typologies have not provided a clear direction for forest policy makers working with private forest owners motivated by non-economic considerations. This is not only due to the huge variety of management motivations, values, and objectives among private forest owners, but also to the lack of research on the contextual aspect of reasoning in their decision making. Our study sees Non-materialists as a likely changing superset of different forest owners who should be investigated repeatedly with probabilistic methods to avoid a static view of their behavior and to assure the highest level of certainty in their classification. In addition, alternative theories of human behavior (An, 2012), which have largely remained untested in a forest owner decision-making context, and advanced methods for developing probabilistic forest owner typologies, such as fuzzy clustering (Döring et al., 2006), may provide new frameworks for understanding private forest owner behavior.

3.1.5 Willingness to pay for a private forest property plan

In the hypothesis No. 3 we assumed that the attitude of forest owners towards new forest property plans was positive and that the utility of an FPP is a function of socio-economic, ecological and forest management factors. In Ficko and Bončina (2015b) we showed that forest owners support cost-sharing of the FPP and that the value of an FPP is a function of socio-economic, ecological and forest management factors. A high percentage of owners with a positive attitude and willingness to pay for the FPP does not allow us to reject the hypothesis No. 3. A fact encouraging FPP developers to continue with FPP implementation is also that almost one third of the respondents were still undecided about the plan's usefulness. However, high interest in the potential product could also be explained by the "promised" positive attributes of the FPP in the attitudinal question (Ficko and Bončina, 2015b).

There are several viewpoints that should be addressed when assessing the financial implications of the FPP. First, the two-stage approach to WTP estimation and open-ended bidding format provide a rather conservative WTP estimate (Brown et al., 1996; Halvorsen and Soelensminde, 1998). However, the approach was consistent with our

primary question, i.e. how many private forest owners would consider FPP as a usable instrument. The WTP for the FPP was of secondary importance. The selection of the WTP estimation model corresponded to the nature of the decision problem and the character of the FPP as a non-obligatory planning instrument. The open-ended format was used to obtain a robust estimation of the FPP value. However, the estimated WTP may be still subject to uncertainty. List and Gallet (2001) for instance estimated based on the meta-analysis of the laboratory WTP studies that respondents overstate their actual values on average three times when asked a hypothetical question. On the one hand the number of owners with the intention to pay and the average proposed amount increased from 2010 to 2013, while on the other hand there was also an increase in the percentage of respondents with a positive attitude towards the FPP but zero bid, from 21 % in 2010 to 28 % in 2013, with 128 (23.4 %) such respondents in the pooled sample. A portion of them could be interpreted as protest zero bidders. Unfortunately, it remained unclear whether they are protest zero bidders or just true zero bidders who cannot afford to pay because the questionnaire did not include follow-up questions on the reasons for their unwillingness to pay. However, given the step-wise character of the WTP estimation, the latter uncertainty does not influence the estimation of the mean WTP amount as much as "hypothetical bias" arising from overstating actual, but it may be important for the governments in implementing the FPP into practice.

Second, it is unclear how private forest owners interpreted the role of the FPP. If they interpreted it as an instrument that increases their benefits by itself, then the proposed amount is inflated due to the psychological effect that the FPP is beneficial by default. In contrast, if respondents participated in bidding with rather symbolic amounts to hide their income status, then the WTP amount is a rather conservative estimate of true willingness. The distribution of the proposed amounts shows that 25 % of respondents proposed a rather symbolic price for the plan (≤ 51 €/property/decade, Ficko and Bončina, 2015b), supposedly to prove their general support for the FPP. Also supporting such a conclusion is that 50% of the households were willing to pay less than 9 €/ha once in a decade, or 108 €/property, which amounts to about 2–3 m^3 of fuel wood.

Third, although the explanatory power of the WTP regression is in the range typical for WTP studies using socio-demographic explanatory variables (e.g. Cho et al., 2005; Ovaskainen et al., 2006), we considered it low. The total marginal effect was significant only for the percentage of forests in the total property area, which is a rather non-informative variable. It means that the landowners whose properties consist mainly of forests are more likely to pay for the plan and that they are willing to pay more than the landowners whose forests constitute just a minor part of the property. The effects of the variables directly observed in the field or readily accessible to FPP project managers through the information systems of public services (e.g. age, gender or property size) were insignificant, implying that candidates for the plan will not be easy to find. The significance of more subtle predictors indicate that the implementation of the FPP should not follow a campaign but a snowball technique, by which the owners-promoters of FPPs should be identified first and then the less-interested owners could be mobilized by networking.

3.1.6 The implications of cost-sharing for publicly financed forest planning

The aggregation of WTP on the national level and the comparison of FPP costs with the current costs for private forest planning show encouraging results. These calculations are the best possible estimates; the expected cost-sharing should be interpreted as the expected value under the law of large numbers. We should also note that the aggregate estimate of FPP value is accurate if all assumptions about the implementation hold (legal status of the plan, successful promotion, the response rate etc.). In practice, the real engagement of private forest owners is likely to be lower at least at the beginning of FPP implementation, when building a network of promoters should take priority over the number of mobilized owners. Barriers to successful implementation of the FPP may also lie in the formalization of the FPP in the current forest management planning system and the regulation of FPP preparation. In Slovenia forest management planning is currently the domain of the public forest service. However, the legislation does not prohibit opening the market for planning services such as non-obligatory forest management plans as long as they are consistent with the general principles of forest management and objectives set in higher-level plans and stand-wise management

guidelines. A potential danger to the successful implementation of the FPP is its formalization as a non-obligatory planning instrument substituting some planning services offered for free to increase the state budget revenues and to consolidate the public forest service financing. Public funds for the forestry sector are usually not earmarked nor are they stable (e.g. Held et al., 2013; Shigematsu and Sato, 2013). The Slovenia Forest Service's budget has been cut for years as a part of the National Reform Program for the consolidation of public finances and is not expected to recover until fiscal stability is reached in 2017 (Stability Program, 2014). If some of the actors impose their interests, the process of FPP implementation may follow the double-spiral of Amdam (2000), where the initial idea evolves in an outward spiral and then mutates in an inward spiral to a final solution that differs substantially from the one designed at the initial stage of the process (Kouplevatskaya-Buttoud, 2009).

The unsolved questions in the implementation are the percentage of cost-sharing and the cost of the FPP. The WTP estimation only clarifies the owner contribution to FPP costs. If we compare the median of the suggested amount from our study (25.50 €/ha) with the prices forest owners paid for private forest plans abroad in the same period (7-47 €/ha, Smith, 2006; Nuutinen, 2006; Landesforsten Rhineland-Palatinate, 2014), we see that it matches owner contributions for FPPs abroad. The typical contribution of forest owners for having such a plan abroad ranges very greatly – from 25 % to75 % of the costs (Eid, 2006; Tikkanen et al., 2010; Landesforsten Rhineland-Palatinate, 2014), with the rest covered by public authorities through subsidies or one-time plan preparation grants. Other mechanisms supporting forest-owner oriented forest planning include financing stand inventories or tax reduction for forest owners with a plan (EFI, 2004; Nuutinen, 2006; Smith, 2006; Wilhelmson, 2006).

3.1.7 User experiences with the forest property plan

Hypothesis No. 4 was that the experiences of forest owners who already have used a property plan are positive. Based on several interviews with the forest owners, we must reject the hypothesis. To better understand owner dissatisfaction with the plans, we will

discuss the content of the plans, evaluate the preparation process and highlight the broader context of barriers to private forest management.

Based on the comparison of plans with respect to the content, the level of detail and structure, we consider these plans extremely diverse. They range from a hand-written simplified silvicultural plan with stumpage price-based estimation of net revenue to a detailed management plan with extensive stand inventory and work organization planning. Some owners might have interpreted oversimplified plans without added-value. On the other hand, the plan that was too detailed was also unpopular. Forest owners suspected that too many assumptions were made in the calculations, which means that such a plan is far from realistic.

We should emphasize that the preparation process did not follow the customer-oriented approach in which individual property strengths, weaknesses, opportunities and threats would be evaluated. Conversely, most of the FPPs were prepared on the initiative of a forester or were graduation theses where the owner demand for the plan was not the principal reason for the preparation of the plan. Thus, we consider these plans as either very silviculture-centered lacking decisions about alternative management strategies or too technical with too much computational detail. If the initiative came from the forest owner, we would expect fewer complaints about the preparation process. We should also note that the FPPs that were prepared as graduation theses were very likely less application-focused. Typically, the plan was not handed-over to the owner after graduation unless the graduate student was a family member of the owner or a forester studying part-time.

Not the least, dissatisfaction with the test versions of the FPP could be the consequence of unrealistic expectations on the part of owners that the FPP can solve all their problems and improve financial return per se. Our study on management concepts and constraints (Ficko and Bončina, 2015a) showed that the greatest factor preventing owners from cutting more are physical constraints in forest work, general dissatisfaction with the timber market and lack of skills. None of these constrains can be removed just by a forest-owner oriented planning.

Experiences from abroad (Metsään.fi, 2015) show how important good communication is between forest owners and service providers. A portal where forest owners can check which service providers are available in the area surrounding the forest property, and, if necessary, authorize chosen partners to view their data or transfer them to their own systems, is an example of a modern communication channel that might help forest owners more than just a written private forest property plan

3.1.8 Guidelines for forest-owner oriented forest planning

Based on the results and personal insights gathered during years of research on private forest owners we propose the following recommendations for adaptation of private forest planning in Slovenia:

1. When it comes to private forests, treat forest owners as shareholders not as stakeholders. This distinction will not deprivilege other stakeholders in private forests but will change the role of forest planning from regulation to service provision.
2. Think about who controls private forest land. Share research enthusiasm for extremely small, scattered properties and their owners with social scientists and focus more on the owners who control the majority of private forests.
3. Take the forest owner objectives as axiomatic. Rather than trying to make forest owners behave as they should, accept the full legitimacy of their management behavior.
4. Avoid using the top-down approach in the adaptation of private forest planning. Conversely, start with the examples of good practices and look for the quality of the plans instead of the area brought into planning.
5. Intensify interdisciplinary studies of private forest owners using solid models that account for all sources of uncertainty and include foresters, social scientists and economists to obtain most up-to-date and reliable information.
6. Design a national forest owner survey and use a standardized methodology (preferably of a probabilistic type), which would enable constant following of ownership structure and changing ownership objectives.

7. Think ahead and do not be constrained by the current technology or planning routine. A written FPP should be gradually replaced with easy-to-use modular planning software that can be upgraded with optimization and simulation tools to meet the diverse demands of today's users as well as those of tommorow.
8. Today's forest owner manages his property himself; the forest owners of tommorow might no longer do it that way. Stimulate the evolution of new business models and ownership types and be ready to advance your established forest planning services with complex counseling services that go beyond forestry.
9. Create a favorable environment for active cooperation between businesses, the public sector and academia. To increase the efficiency of private forest planning, forestry businesses, forest owners and timber buyers should interact with each other in a technologically advanced system (e-portal, mobile apps etc.).
10. Do not hope for success unless you have forest policy support and a strategic and operational agenda on how to do it step by step.

3.2 CONCLUSION

The dissertation suggests the best practice in evaluating conceptual and financial options for implementing a forest property plan (FPP) into the forest planning system. The proposed four steps (Fig. 1) represent scientific and professional achievements. The contribution of the dissertation to forest science is primarily reflected in the following scientific achievements: a pioneering study quantifying the role of social representations of forest management on harvesting behavior in Europe (Ficko and Boncina, 2015a); the first typology of Slovenian private forest owners (Ficko and Boncina, 2013); a novel probabilistic approach to private forest owner segmentation (Ficko and Boncina, 2013); an improved method for detection of and correction for the systematic tendency to agree with items in surveys (Ficko and Boncina, 2014). The major professional achievement of the dissertation is that best practice is illustrated for the case study of Slovenia, which has direct implications for private forest policy in this country.

The conclusions can be summarized into five points. First, the result that underuse of wood resources in private forests in Slovenia is not a consequence of the general belief

that logging is worse than non-management implies that forest owners are not conceptually against more intensive management. On the contrary, we showed that for the most part biophysical constraints prevent forest owners from cutting more. Second, through several face-to-face interviews, it became evident that forest owners lack information that could improve management efficiency. We expect that at least the type of forest owners who we classified as predominant Materialists will be interested in the FPP. Third, as private forest owner management objectives are becoming more and more diverse, we expect that management objectives and attitudes towards the forest may change in the future. We showed how probabilistic clustering could help researchers to cope with fuzzy and changing management objectives. NIPF research in quickly changing societies will also have to better account for uncertainty in owner classification to ensure the validity of messages to policy makers. Fourth, the fact that more than half of the owners surveyed consider the FPP as a usable instrument and that approximately each third would be willing to pay for the plan suggests that the implementation of the FPP is financially justified and beneficial for the public budget. Finally, a challenge for the policy makers will remain how to implement the FPP in the planning system. Implementation of cost-share planning opens questions about the standard content and format, responsibility for the preparation and the legal status of the instruments. The non-obligatory FPP could help to intensify private forest management in a bottom-up manner, open the market for extension services for private forest owners and create new jobs for forest planners, revive the round-wood market and contribute to its better organization and transparency as a consequence of increased wood mobilization. None of these questions have been answered nor have they been the focus of this thesis and therefore remain to be explored.

4 SUMMARY

4.1 SUMMARY

This dissertation explores the possibilities for the adaptation of private forest management planning towards one that is more owner-oriented. We hypothesized that the forest property plan (FPP) considers management objectives of non-industrial private forest (NIPF) owners properly and help them to manage their properties more efficiently. The research was based on the following starting points. First, we verified the conceptual conditions for the adaptation of forest planning. Several studies indicate correlation between harvesting behavior of NIPF owners and the specific conceptualization of appropriate forest management described as “non-intervention” or “hands-off” management. The correlation, however, has never been confirmed quantitatively thus it remains unclear if NIPF owners need a decision support tool for more efficient management. Second, forest owners have extremely diverse management objectives (Straka, 2011; Dayer et al., 2014) and they contrast in decision making styles (Hujala, 2009). By grouping them into decision making types, those more interested in the FPP could be extracted from the population and described by a set of variables, which would enable their easy reidentification in the future. Third, entirely dependent on surveys, we considered response style bias and the robustness of the statistical methods highly important for maintaining the integrity of the results. Fourth, if the FPP considers property owner objectives, we expect that an owner will be willing to share the costs for FPP preparation. We expect that cost-sharing in publicly funded forest planning systems might increase NIPF owner interest in forest management while providing public budget relief. Finally, we consider customer satisfaction analysis as an important step before giving the recommendations for more forest owner-oriented forest planning.

We have stated four hypotheses: 1) Forest owners conceptualize resource-efficient forest management different than that prescribed in forest policy documents; 2) Private forest owners form a homogeneous group with the same attitude in decision-making; 3) The attitude of forest owners towards new forest property plans is positive; 4) The experiences of forest owners who have already used a property plan are positive.

To test hypothesis No. 1 we conducted 3099 telephone interviews with randomly selected forest owners 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 upon a 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 correlate to the perception of resource-efficiency.

To test hypothesis No. 2 we interviewed 380 randomly selected private forest owners face-to-face. Forest owners were asked to rate the relevance of nineteen factors representing information related to the social, ecological and economic aspects of decision making based on a five-point Likert scale. This information was consolidated into major categories with Principal Component Analysis. Expectation maximization (EM) clustering was used to build a probabilistic private forest owner decision-making typology. Logistic regression was used to identify the most important predictors of management behavior (Hosmer and Lemeshow, 2000). The inequality of the forest owners within the type was accounted for by weighting the dependent variable by the respective probability for belonging to this type. To detect acquiescence – the systematic tendency to agree with survey items (Paulhus, 1991) – and estimate its effect on construct validity, we used structural equation modeling and Monte Carlo data generation techniques (Bollen, 1989; Newit and Hancock, 2001).

To test hypothesis No. 3, we conducted 548 face-to-face interviews with randomly selected private forest owners about their attitudes towards the FPP and their willingness to pay (WTP) for it. We used Heckman's (1979) two-stage sample selection model with a set of variables describing landowner characteristics, plot/resource characteristics and forest management characteristics to estimate which factors influence the intention to pay and the stated payment amount.

To test hypothesis No. 4, we interviewed a sample of forest owners for which FPP prototypes had been prepared in the past (n = 11). We analyzed their satisfaction with

the plan and prepared a list of end-user recommendations for the improvement of the FPP.

We determined that forest owners conceptualize 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 as a factor preventing forest owners from cutting more. The underuse of wood resources was mostly due to biophysical constraints in the environment and not to a deep-seated philosophical objection to harvesting.

Most of the variability in decision making can be explained by six major categories of information: non-wood goods and services, forest economics, property administration, optimization of wood production, forest protection, and minimum cutting restrictions. Probabilistic clustering revealed two decision-making types among NIPF owners which differ in their attitude towards the total economic value of forests. *Materialists'* decisions are mainly related to the extractive value of forests while *Non-materialists* manage for non-extractive value. Full-time farmers, owners living within 2 km of their holdings and owners who permanently cooperated with the public forest service were much more likely to be *Materialists*.

Of the respondents, 55 % considered the FPP to be a usable instrument, and 34 % would pay for it. The suggested amounts per decade ranged from 5 € to 1500 € with a mean of 135.99 € or 28.31 €/ha. Heckit regression revealed that the primary supporters of the FPP are younger, better educated non-farmers with larger properties and good contacts with the district forester.

Forest owners considered the non-adaptability of the FPP prototypes elaborated in the past to the changes in the wood market and environment as two principal shortcomings.

We interpreted the difference between our findings on the influence of forest management representations on management activities and other empirical studies from abroad primarily as a consequence of historical differences in forestland ownership in

different parts of Europe and the US, the rising number of non-residential owners, alternative lifestyle and environmental protectionism – but also as a consequence of our high methodological rigor in testing the relationships between the constructs.

Although we confirmed acquiescence in the series of interviews about decision-making style, it had a minor effect on the results and no effect on the substantive construct. We discussed how uncertainty about the number of forest owner types and membership can be reduced by using probabilistic clustering and observing the number of clusters while changing the requirements for the validity of clusters. We showed that the expectation maximization algorithm is robust even to the stringent requirements for the validity of clusters.

We showed that cost sharing for the FPP is a win-win situation. Aggregating the stated WTP amount to the forest owner population using three different approaches (Loomis, 1987; Harrison and Lesley, 1996), we estimated that on average 17 % to 57 % of the current public budget expenditures for private forest planning-related tasks could be saved annually, depending on the tasks included and the aggregation approach.

We conclude that NIPF owners support the FPP conceptually and financially. Further steps in the implementation of the FPP into practice should take into account the diversity of the customer segments, the uncertainty associated with survey-based research and the importance of permanent assessment of customer satisfaction.

4.2 POVZETEK

Skromen obseg gospodarjenja v zasebnih gozdovih lahko označimo za enega izmed glavnih problemov slovenskega in evropskega gozdarstva v zadnjih desetletjih (Bončina, 2004; Winkler, 2005; Schmithüsen in Hirsch, 2010). Mnoge tuje študije možnosti povečanja poseka v zasebnih gozdovih in večje mobilizacije lesa iz zasebnih gozdov (npr. Mantau in sod., 2010; Verkerk in sod., 2011; Markowski-Lindsay et al., 2012) poudarjajo pomen različnih družbenih dejavnikov pri oskrbi trga z lesom in lesno biomaso. Eden izmed ključnih dejavnikov pri zagotavljanju lesa iz zasebnih gozdov v Evropi je prav gotovo načelna pripravljenost lastnikov gozdov za gospodarjenje.

Pod vplivom teorije maksimiziranja koristi in teorije racionalne izbire (Harsanyi, 1976; March, 1994) je bilo obnašanje lastnikov gozdov največkrat razumljeno kot pragmatično racionalno; lastnik naj bi v vsakokratnih gospodarskih in družbenih razmerah gospodaril s svojim gozdom tako, da si zagotovi največjo korist (Beach in sod., 2005; Majumdar in sod., 2008; Joshi in Arano, 2009). Ekonometrični modeli, s katerimi so poskušali pojasniti vedenje lastnikov gozdov ob gibanju tržnih cen lesa, cenah energentov, posegih politike in drugih makroekonomskih dogajanjih, so se v gozdarski literaturi začeli uporabljati že razmeroma zgodaj (Max in Lehman, 1988; Hyberg in Holthausen, 1989). Sočasno z ekonometričnim pristopom k razumevanju vedenja lastnikov gozdov so se začeli razvijati pristopi, ki so temeljili na alternativnih teorijah obnašanja človeka v odnosu do narave (za pregled nekaterih teorij glej Van den Bergh, 2000; Jones in sod., 2011; An, 2012; Lynam in sod., 2012). Mnoge raziskave obnašanja zasebnih lastikov gozdov so pokazale, da lahko med lastniki gozdov prepoznamo podobne vzorce vedenja, t. i. tipe lastnikov (odlične preglede nudijo Dhubhain in sod., 2007; Urquhart in sod., 2012; Straka 2011 in Dayer in sod., 2014). Vendar pa mnogi raziskovalci zaključujejo, da so lastniki zasebnih gozdov zelo heterogena lastniška kategorija in da mnogih dejavnikov vedenja preprosto še ne poznamo. Med tematike, ki so bile deležne zelo malo raziskovalne pozornosti, tako lahko štejemo raziskave, kako lastniki sploh razumejo gospodarjenje z gozdovi. Manjša aktivnost nekaterih lastnikov gozdov je lahko močno povezana z razumevanjem pojmov gospodarjenja in gospodarnosti. Mnoge teorije socialne psihologije (npr. teorija družbenih predstav Moscovicija (2008)) in posebne metode modeliranja, s katerimi lahko preverjamo vsebino in strukturo miselnih konstruktov ter mesebojne odvisnosti med prikritimi spremenljivkami, ponujajo priložnost, da pogosto zgolj deskriptivni pristop pri proučevanju vedenja lastnikov gozda nadgradimo v kompleksnejše modeliranje.

S proučevanjem, kako lastniki gozdov razumejo učinkovito upravljanje gozdov in kako njihovi miselni modeli vplivajo na pripravljenost za sečnjo, smo naredili prvi korak na poti k boljšemu razumevanju vključenosti lastnikov gozdov v gospodarjenje z gozdovi. Temu je sledilo ugotavljanje, na podlagi katerih informacij se lastniki gozdov odločajo pri gospodarjenju in kako sprejemajo odločitve. Predpostavljali smo, da bomo lahko

prepoznali posebne tipe odločanja, za katere lahko z večjo verjetnostjo domnevamo, da potrebujejo pomoč pri odločanju. S tipologijo odločanja smo želeli poiskati lastnike z večjim zanimanjem za upravljanje posesti ter tako prispevati k diferenciranemu uvajanju načrtov za zasebno gozdno posest v prakso. Pri proučevanju načinov odločanja smo izpostavili še dva vidika. Prvič, predlagali smo metodološko izboljšavo do sedaj prevladujočega načina razvrščanja lastnikov z izjemno pestrimi cilji gospodarjenja v izključujoče se tipe. Drugič, opozorili smo na slabšo uporabnost tipologij lastnikov gozdov, kjer je opis lastnikov pogosto mogoč le s težko izmerljivimi spremenljivkami. Tipologija lahko prispeva k diferenciranem uvajanju načrtov za zasebno gozdno posest le, če lahko razlike med tipi pojasnimo s spremenljivkami, ki so lahko izmerljive ali že dostopne v obstoječih podatkovnih bazah, s katerimi razpolaga država.

Večina segmentacijskih študij zasebnih lastnikov je namreč pri razvrščanju lastnikov uporabila frekvenčni pristop namesto verjetnostnega (glej Ghazoul in McAllister, 2003; Kangas in Kangas, 2004). Posledično je bil lahko vsak lastnik razvrščen samo v en tip, kar pa morda ne ustreza dejanski pestrosti lastnikov. Lastnik gozda se na primer o poseku ne odloča samo na podlagi tržnih informacij, saj ima lahko poleg močno izraženih ekonomskih ciljev tudi neekonomske, ali pa obratno. Takšnega lastnika bi težko uvrstili v samo en tip, razen če takšna razvrstitev predvideva zelo veliko tipov, s čimer pa se izgubita preglednost in sporočilnost tipologije (Urquhart in Courtney, 2011). Zato smo predlagali, da se namesto razvrščanja lastnikov v diskretne tipe, uporablja verjetnostno razvrščanje, kjer se lastnika v določen tip (odločanja) razvrsti z določeno verjetnostjo.

Poleg zgoraj dveh omenjenih vidikov pri razvrščanju lastnikov pa v disertaciji opozarjamo še na dve nevarnosti. Večina raziskovalcev zasebnih lastnikov gozdov pri pridobivanju podatkov uporablja različne vrste anketiranj. Presenetljivo malo raziskav izpostavlja slabosti takšnega pristopa, ki lahko celo ogrozi veljavnost rezultatov (npr. Egan in Jones, 1993; 1995; Eyvidson in sod., 2014). Pri kvantitativnem razvrščanju lastnikov v skupine moramo upoštevati predvsem dve negotovosti. Prvič, ali zbrani odgovori ustrezajo resničnemu mnenju proučevane populacije in ali niso morda sistematično popačeni zaradi odzivnih slogov anketirancev (Paulhus, 1991,

reprezentativnost vzorca tu že ni več vprašanje) in drugič, ali modeli, s katerimi proučujemo pojav, zadostno ponazarjajo njegovo strukturo in vsebino. Podrobnejša vprašanja, s katerimi bi se morali ukvarjati raziskovalci lastnikov gozdov, obravnavajo še število tipov lastnikov, disjunktnost tipov ter robustnost rezultatov. V disertacije smo pokazali, kako zmanjšati ti dve negotovosti z namenom pridobiti veljavno in robustno tipologijo lastnikov, ki bo hkrati tudi uporabna za gozdno politiko.

Vendar pa načelna pripravljenost lastnikov za gospodarjenje in odločanje, ki v večji meri sledi poslovnim ciljem, še nista dovolj za aktivnejše gospodarjenje v zasebnih gozdovih. Ob tem se zastavlja vprašanje, kako lahko z gozdnogospodarskim načrtovanjem vplivamo na boljše gospodarjenje z zasebnimi gozdovi. Temu vprašanju je bilo celo v tujini namenjeno relativno malo pozornosti z izjemo nekaterih skininavskih držav (npr. Hujala, 2009; Tikkanen in sod., 2010). V Sloveniji vprašanje učinkovitosti gozdarskega načrtovanja v zasebnih gozdovih prihaja v ospredje v zadnjih 10 letih (npr. Bončina, 2003; Papler-Lampe in sod., 2004; Ficko in sod., 2005; Ficko in sod., 2010), ko je postalo očitno, da je izvedljivost zastavljenih ciljev gospodarjenja, na primer iz Nacionalnega gozdnega programa (Resolucija ..., 2007), v zasebnih gozdovih v splošnem majhna. Res da morda zato, ker cilji v strateških dokumentih niso dovolj diferencirani in operativni, vendar pa tudi zato, ker ne najdemo vzvodov za njihovo uresničevanje. Nedoseganje ciljev lahko povzroči malodušje in spodbuja vprašanja o učinkovitosti gozdarske stroke in smiselnosti gozdnogospodarskih načrtov. Ob vsem tem ne moremo mimo dejstva, da se družba in okvirni pogoji za gospodarjenje z gozdovi spreminjajo hitreje kot gozd (Ziegenspeck in sod., 2004; Hogl in sod., 2005) in da se spremembam mora smiselno prilagajati tudi gozdarsko načrtovanje, če želi biti uporabno.

Gozdarsko načrtovanje v zasebnih gozdovih se je v evropskih državah razvijalo precej neenotno (Toth in sod., 2001; Bachmann, 2002; Montiel in Galiana, 2005; Eid, 2006; Serbruyns in Luyssaert, 2006; Wilmhelson, 2006; Cullotta in Maetzke, 2009; Tikkanen in sod., 2010; Brukas in Sallnäs, 2012; Knoke in sod., 2012; Metsään.fi, 2015), kar je deloma pogojeno z različno tradicijo načrtovanja in lastniško strukturo, deloma pa tudi z reformno naravnanostjo gozdne politike in njeno sposobnostjo prepoznati probleme v

zasebnem sektorju. Ko govorimo o načrtovanju v zasebnih gozdovih, zato mislimo na najbolj splošno definicijo male (*small-scale*) ali neindustrijske (*non-industrial*) gozdne posesti kot »posesti, ki je v zasebni lasti posameznikov ali gospodarskih družb razen lesne industrije in kjer gospodarjenje poleg lesnoproizvodnih ciljev temelji tudi na drugih ciljih« (Harrison in sod., 2002: 3).

Slovenijo smo uporabili kot študijo primera za možnosti prilagajanja gozdarskega načrtovanja gozdnim posestnikom predvsem v državah, ki v svoji zasnovi gozdarskega načrtovanja ne poznajo načrtovanja za posamezne gozdne posesti. V sedanjem konceptu načrtovanja gozdov v Sloveniji je načrtovanje omejena na strateško in operativno načrtovanje na ravni gozdnogospodarskih območij in gozdnogospodarskih enot, ne poznamo pa načrtovanja za gozdno posest (Bončina, 2009). Menimo, da v takšnem konceptu lastnik, ki je odgovoren za upravljanje svojega gozda, nima instrumenta, ki bi mu pomagal pri sprejemanju strateških in operativnih odločitev. Pri tem izhajamo tudi iz dejstva, da skupna površina gozdov v lasti zasebnih lastnikov gozdov, ki imajo manj kot 1 ha, predsatvlja le 9 % zasebnih gozdov. Kar 91 % zasebnih gozdov pa je v lasti lastnikov, ki imajo več kot 1 ha gozda (Medved in sod., 2010) kar zahteva več raziskovalne pozornosti nameniti posestim, ki so večje od 1 ha.

Načrt za gozdno posest kot načrtovalski instrument, ki izpostavlja zasebni interes, bi lahko prispeval k reševanju problemov majhne aktivnosti lastnikov gozdov in izboljšal neučinkovitost načrtovanja. Zasnova načrta za gozdno posest (NGP) v Sloveniji je bila delno že predstavljena (Bončina in sod., 2003; Papler-Lampe in sod, 2004; Ficko in sod., 2005) vendar pa še ne razpolagamo s celovito analizo zahtev lastnikov gozdov do gozdarskega načrtovanja in potreb po načrtu za gozdno posest. Temeljna značilnost NGP je, da je namenjen lastniku in izdelan za prostorski okvir, kjer prihaja do odločanja, na primer gozdna posest posameznika, posest v solastništvu več fizičnih oseb, občinska gozdna posest, posest agrarnih skupnosti ipd. Lastnik si z načrtom za svojo posest pomaga pri presoji ekonomičnosti dolgoročnega gospodarjenja, načrt mu omogoča lažje prilagajanje časa sečnje glede na nujnost, ponudbo na trgu, omogoča mu vodenje lastnih evidenc dela v gozdu in lastno načrtovanje potrebnih sredstev. Ena izmed glavnih značilnosti NGP je, da izhaja iz pregleda in problematike celotne gozdne

posesti in ne iz posameznega sestoja. Načrt vključuje vse vsebine, ki jih lastnik potrebuje za uspešno vodenje svoje posesti (Ficko in sod., 2005): sestojno inventuro, oceno možnega poseka, oceno donosov in tveganj (prim. Bachmann, 2002; Tikkanen in sod., 2010; Hokajärvi in sod., 2011). Ponekod so klasične pisane načrte nadgradili v sisteme z računalniško podporo odločanju (Lexer in sod., 2005; Pasanen in sod., 2005; Pykäläinen in sod., 2006; Härtl in sod., 2013; Borges in sod., 2014; Rasinmäki in Rosset, 2015).

Ker načrt postavlja v ospredje zasebne interese, izdelavo načrta praviloma sofinancira lastnik. V disertacije smo poleg načelnega zanimanja za načrt za gozdno posest ocenili tudi pripravljenost lastnikov gozdov za plačilo načrta ter ugotovili, kaj vpliva na višino ponujenega zneska. Obenem smo ocenili kakšne finančne posledice bi imela uvedba prostovoljne soudeležbe pri plačilu načrta za javnofinančne izdatke na področju gozdarskega načrtovanja. Pri oceni pripravljenosti za plačilo smo izhajali iz predpostavke, da je odločitev za soudeležbo najprej načelna, kjer lastnik izrazi pripravljenost podpreti izdelavo načrta finančno, zatem pa ponudi znesek, ki bi ga bil pripavljen plačati, da se zanj enkrat v desetletju izdela načrt za posest. Načrt za gozdno posest v finančnem smislu vidimo kot »win-win« rešitev, kjer bi soudeležba pomenila tudi finančno razbremenitev proračuna javne gozdarske službe.

Na koncu smo želeli nakazano podporo za uvedbo NGP podpreti še z empiričnimi izsledki uporabe načrtov v praksi. Po osamosvojitvi je bilo v Sloveniji izdelanih okrog 30 načrtov za zasebno gozdno posest, največ kot diplomske naloge (Digitalna knjižnica..., 2015), deloma pa kot rezultat dela javne gozdarske službe (npr. Čadež, 2004). V letu 2008 je bil izdelan računalniški program za izdelavo načrta za gozdno posest (FORPLAN, 2008), na osnovi katerega lahko lastnik gozda za desetletno obdobje izračuna ekonomsko upravičenost različnih ukrepov, vendar program ni v večji meri zaživel. Z analizo zadovoljstva lastnikov gozdov s načrti smo želeli izvedeti, kaj bi bilo potrebno izboljšati pri nadaljnjem sistematičnem uvajanju načrtov v sistem gozdarskega načrtovanja.

V disertacije smo preverili štiri hipoteze:

- Hipoteza št. 1: Lastniki gozdov razumejo gospodarjenje in gospodarno upravljanje z gozdom drugače kot ju opredeljuje gozdarska politika.
- Hipoteza št. 2: Lastniki gozdov so homogena skupina z nerazličnimi načini odločanja pri upravljanju gozdnih posesti.
- Hipoteza št. 3: Odnos do uvedbe načrta za zasebno gozdno posest je med lastniki gozdov pozitiven, njegovo vrednost lahko pojasnimo s socioekomskimi, okoljskimi in gozdnogospodarskimi dejavniki.
- Hipoteza št. 4: Med lastniki gozdov z že izdelanimi načrti za zasebno gozdno posest prevladujejo pozitivne izkušnje pri njihovi uporabi.

Hipotezo št. 1 smo preverili z analizo telefonsko izvedenih strukturiranih intervjujev v letu 2013 o razumevanju gospodarjenja in gospodarnosti med 3099 naključno izbranimi lastniki gozdov, kjer je bil v celoti realiziran 701 intervju. S pomočjo delnega pripisa manjkajočih vrednosti smo povečali vzorec na n = 754 uporabnih anket. S strukturnim modeliranjem (različne potrditvene faktorske analize (CFA) in Sörbomov (1974) strukturni model sredin in kovarianc (MACS), glej tudi Bollen, 1989 in Bryne, 2006) v programski opremi EQS 6.2 for Windows (Bentler, 2006) smo ugotavljali, kako lastniki razumejo gospodarjenje z gozdom, ter poiskali povezave med koncepti gospodarjenja in vzroki za negospodarno upravljanje, ki smo jih strnili v glavne vzroke s CFA analizo.

Hipotezo št. 2 smo preverili s kopičenjem osebno anketiranih lastnikov v letih 2009 in 2010 (n = 364) v tipične skupine glede na njihovo vrednotenje okoljskih, ekonomskih in socialnih informacij, ki jih uporabljajo pri upravljanju svojih posesti. Uporabili smo metodo glavnih komponent za prepoznavo glavnih informacij (PCA analiza), čemur je sledilo kopičenje lastnikov v verjetnostne skupine z optimizacijskim algoritmom (EM kopičenje, Dempster (1977)) v programski opremi Statistica 8. Verjetnost pripadnosti skupini smo v nadaljevanju uporabili kot utež pri pojasnjevanju dejavnikov, ki vplivajo na pripadnost skupini z logistično regresijo. Sistematično popačenost odgovorov zaradi odzivnih slogov anketirancev (Paulhus, 1991) in robustnost rezultatov smo preverjali z gradnjo različnih strukturnih modelov v SEPATH modulu (Hill in Lewicki, 2007) v

programski opremi Statistica 8 (Statistica., 2009) ter z Monte Carlo simulacijami (Bollen, 1989; Newit in Hancock, 2001).

Hipotezo št. 3 smo preverili s kontingenčno metodo hipotetične pripravljenosti za plačilo za izdelavo načrta za gozdno posest med lastniki gozdov, ki načrta za zasebno gozdno posest še nimajo (n = 548). Lastnike smo osebno intervjuvali v letih 2010 in 2013. V programski opremi NLOGIT 5 (Greene, 2012) smo uporabili Heckmannov dvostopenjski regresijski model (Greene, 1997), kjer smo načelno pripravljenost za plačilo v prvi fazi in ponujeni znesek v drugi fazi poskušali razložiti z naborom spremenljivk, ki opisujejo lastnikove značilnosti, značilnosti njegove posesti in gospodarjenja, ko to priporoča ekonometrična literatura s področja zasebnih lastnikov gozdov (Beach in sod., 2005).

Hipotezo št. 4 smo preverili s kvalitativno analizo osebno vodenih polstrukturiranih intervjujev (n = 11), ki smo jih izvedli leta 2015 z lastniki zasebnih gozdnih posesti, za katere je bil kakršenkoli načrt za gozdno posest izdelan v preteklosti. Zaradi slabega odziva, kratkih intervjujev in dolge časovne oddaljenosti od trenutka, ko so lastniki načrt prejeli do intervjuja, zbrani material ni omogočal kvalitativnih analiz s pomočjo tekstovnega rudarjenja niti ni bilo potrebno vsebinsko zgoščevanje s kodiranjem v posebni programski opremi, kot je bilo predvideno v zasnovi doktorske disertacije.

Ugotovili smo (Ficko in Bončina, 2015a), da lastniki razumejo gospodarjenje z gozdovi kot mešanico treh konceptov: 1) vzdrževalski koncept gospodarjenja (MAINT), kjer je gospodarjenje z gozdom razumljeno kot vzdrževanje in ohranjanje gozdne posesti, čistega okolja in nadaljevanju dela, kot so ga začeli predniki; 2) ekosistemski koncept (EM), ki poudarja pomen dela s sestoji za ohranjanje zdravja gozdnega ekosistema za naslednje generacije; in 3) ekonomski koncept (ECON), kjer je gospodarjenje z gozdom razumljeno predvsem kot dejavnost za ustvarjanje denarnih koristi. Koncepti med seboj močno korelirajo, posebej MAINT in EM, kar nakazuje, da lastniki razumejo gospodarjenje z gozdom kot izrazito večnamensko. Najbolj poudarjeni koncept je vzdrževalski koncept. Primerjava z normativnim razumevanjem gospodarjenja z gozdom je pokazala, da ga najdemo zgolj na normativni ravni nekaterih najpogostejših

paradigm gospodarjenja z gozdom. Zato sprejemamo hipotezo v delu, ki pravi, da lastniki razumejo gospodarjenje z gozdom drugače, kot ga opredeljuje gozdna politika. Med lastniki, ki se počutijo pri gospodarjenju neučinkoviti in tistimi, ki menijo, da so učinkoviti, nismo ugotovili statističnih razlik v temeljnem pogledu na pojem gospodarjenja z gozdom. Pač pa smo ugotovili, da lastniki, ki se počutijo neučinkoviti, v manjši meri podpirajo vzdrževalski in ekosistemski koncept gospodarjenja (glej MACS model v Ficko in Bončina, 2015a). To lahko razumemo tako, da želijo v večji meri izkoriščati svoj gozd, pri tem pa se morda počutijo omejene, ker zaradi različnih ovir tega ne morejo doseči. Vzroke za negospodarjenje smo strnili v tri glavne: fizične omejitve v okolju in trgih lesa ter pomanjkanje znanja (MINOR); neoznačenost meja in njihovo nepoznavanje ter pomanjkanje časa (MAJOR); ter konceptualni razlogi, kot sta nepotreba po lesu ter varčevanje za primere večjih potreb (CONCEP). Vendar pa smo dokazali, da med koncepti gospodarjenja in glavnimi razlogi za negospodarjenje ni znatnih korelacij ($r \leq 0{,}30$), kar pomeni, da izrazito ekosistemsko razumevanje gospodarjenja, ki bi nasprotovalo aktivnejšemu poseganju v sestoje, ni pomemben dejavnik za neizkoriščanje možnega poseka. Zato moramo hipotezo v delu, ki pravi, da lastniki razumejo učinkovito gospodarjenje drugače kot gozdna politika, zavrniti. Jasno se je namreč pokazalo, da glavni razlogi za negospodarjenje niso nepotreba po lesu (CONCEP), niti naravovarstveni pogledi na gospodarjenje. To spoznanje je v nasprotju z zaključki podobnih študij v tujini, predvsem v ZDA, ki navajajo, da je negospodarjenje v zasebnih gozdovih posledica nasprotovanje sečnji in prepričanja, da je neposeganje boljše za gozd. Pri vzporejanju naših na strukturnih modelih temelječih izsledkov z zaključki študij iz anglosaksonskega sveta opozarjamo na metodološke razlike v testiranju konstruktov, temeljitost pri dokazovanju strukture in vsebine konstruktov ter zaključujemo, da v Evropi še nimamo poglobljenih nacionalnih raziskav na to temo.

Pri preučevanju načinov odločanja lastnikov gozdov (Ficko in Bončina, 2013) smo ugotovili, da lahko lastnike razvrstimo v le dve podobno veliki skupini, kar je znatno manj kot v drugih klasičnih segmentacijskih študijah. Materialiste in Nematerialiste, kot smo imenovali v pogledu odločanja dve izrazito nasprotujoči si skupini, razlikuje odnos do uporabne vrednosti gozda. Materialisti pri odločanju uporabljajo predvsem

informacije povezane z ekonomiko gospodarjenja (npr. zanimajo jih stroški sečnje, donosnost, razpoložljivost izvajalcev), želijo imeti pregled na upravljanjem posesti (lokacije parcel in parcelne meje), zanima jih tehnologija sečnje in spravila (npr. načini krojenja sortimentov, odkupne cene lesa) in pazijo na gojitvena in varstvena dela. Nematerialisti tudi gospodarijo, vendar pa v mnogo večji meri uporabljajo informacije, ki niso povezane s pridobivanjem lesa, ampak nelesnih dobrin, zanima jih živalska komponenta in omejitve zaradi naravovarstva. Večji raztros vrednosti pomena informacij pri Nematerialistih kaže na večjo heterogenost načinov odločanja znotraj Nematerialistov v primerjavi z Materialisti. Pri pojasnjevanju dejavnikov, ki vplivajo na način odločanja, smo ugotovili, da velikost posesti ali količina poseka ne vplivata na to, da bi nekdo v večji meri bil Materialist. Pač pa način odločanja največ vpliva socioekonomski status, sodelovanje s strokovnimi službami in stik z gozdom. Tako smo ugotovili, do so obeti za upravljanje posesti kot Materialist večji v primeru aktivnih kmetov ter tistih, ki redno sodelujejo z gozdarsko službo in imajo svoje parcele v neposredni bližini doma. Izpostavili smo naslednje prednosti verjetnostnega razvrščanja lastnikov gozdov: 1) Prepoznani so samo najbolj verjetni tipi lastnikov, 2) Cilji lastnikov niso obravnavani kot izključujoči; 3) Lastnik ima vse cilje gospodarjenja opredeljene z verjetnostjo; 4) Večnamenskost gospodarjenja je možno kvantificirati; 5) Podana je zanesljivost razvrščanja, kar omogoča nadaljnjo segmentacijo; 6) Lažja primerljivost tipologij iz zaporednih proučevanj. S preverjanem robustnosti verjetnostnega kopičenja in testiranjem prisotnosti morebitnih odzivnih slogov pa smo potrdili, da so 7) zaključki nepristranski in da je uporabljena metoda robustna (Ficko in Bončina, 2014).

Med 548 anketiranci jih je 55 % menilo, da je načrt za posest koristen pripomoček, 34 % pa bi jih bilo pripravljenih plačati, da bi imeli načrt enkrat v desetih letih. Predlagani zneski so segali od 5 € do 1500 €, v povprečju 135.99 € oziroma 28.31 €/ha. Pojasnitev dejavnikov, ki vplivajo na odločitev za načrt in na višino plačila, je zelo težavna. Med 14 spremeljivkami smo odkrili, da jih na pripravljenost za plačilo značilno vpliva devet, na višino pa vplivajo samo štiri. Najbolj zainteresirani lastniki z največjimi ponudbami so mlajši, bolje izobraženi nekmetje z večjimi posestmi in dobrimi stiki z revirnimi gozdarji. Te vidimo kot najbolj verjetne stranke za načrt za gozdno posest, hkrati pa bi

lahko delovali tudi kot promotorji načrta med tistimi lastniki, ki so do načrta še nezaupljivi ali pa načrt zgolj načeloma podpirajo, zanj pa ne bi bili pripravljeni plačati ali zgolj simbolično. Z agregiranjem ponujenih zneskov po treh različnih metodah smo prišli do presenetljivo podobnih rezultatov, ki vsi kažejo, da lahko soudeležba lastnikov pri plačilu stroškov izdelave načrta za gozdno posest pomeni znantno razbremenitev državnega proračuna, letno bi ocenjen prihranek lahko bil kar v višini 17-57 % vseh z načrtovanjem v zasebnih gozdovih povezanih izdatkov.

V analizi preteklih izkušenj lastnikov gozdov z načrti za gozdno posest smo ugotovili, da načrt sicer podpirajo, da pa z načrtom niso bili povsem zadovoljni. Ker je večina v preteklih dveh desetletjih izdelanih načrtov zelo neenotnih glede vsebine in strukture in ker je bil dobršen del načrtov izdelan v okviru diplomskih nalog ali pa na pobudo revirnih gozdarjev in ne lastnikov, menimo, da zbrane izkušnje uporabnikov ne predstavljajo izkušenj ciljne populacije zainteresiranih lastnikov. Medtem ko so na pobudo revirnih gozdarjev izdelani načrti večinoma z ekonomskim ovrednotenjem nadgrajeni gojitveni načrti, so diplomske naloge za lastnika pogosto preobširne in osredotočene na postopke izračunov. Zato štejemo izkušnje lastnikov s temi načrti za splošna priporočila pri izdelavi načrtov za posest. Lastnike je motila prezapletena vsebina, nezmožnost prilagoditve načrta v primeru naravnih motenj ali večjih sprememb na trgu in sam postopek izdelave načrta.

Zaključujemo, da lastniki načelno in finančno podpirajo načrte za gozdno posest in navajamo deset priporočil za uvajanje načrtov v prakso. Dejavnike, ki so se pokazali kot najbolj omejevalni pri gospodarjenju, lahko omili načrt za gozdno posest. Mnoge informacije, za katere so lastniki izjavili, da jih potrebujejo pri vodenju svojih posesti, danes niso dostopne. Načrt za posest bi lahko predstavljal pomemben pripomoček za aktivnejše usmerjanje gospodarjenja z zasebnimi gozdovi, omogočil bi razvitje trga za svetovalske in načrtovalske storitve in s tem delo gozdarskih strokovnjakom, spodbudil bi trg z lesom in prispeval k večji transparentnosti kot posledici večje konkurence na trgu. Na koncu ostajajo odprta vprašanja, kako načrt za gozdno posest prenesti v prakso gozdarskega načrtovanja, kakšna naj bo zakonska ureditev ipd., a vse to so vprašanja, ki niso del disertacije in čakajo na nadaljnjo obravnavo.

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