Eur J Forest Res (2015) 134:1027–1041
DOI 10.1007/s10342-015-0907-x

ORIGINAL PAPER

Characterising forest owners through their objectives, attributes and management strategies

Victor Blanco[1] · **Calum Brown**[1] · **Mark Rounsevell**[1]

Received: 31 March 2015 / Revised: 23 June 2015 / Accepted: 22 August 2015 / Published online: 4 September 2015

Abstract Changes in forest land use and management arise from the decisions of individual forest owners. To gain a better understanding of forest owner decision-making and its implications for forest land-use change, we develop a forest owner functional typology based on a meta-analysis of quantitative and qualitative information about forest owners and their decision-making strategies across the developed world. From this typology, we develop an index of forest owner sustainability. We find nine broad forest owner functional types: industrial productionist, non-industrial productionist, for-profit recreationist, for-profit multi-objective, non-profit multi-objective, recreationalist, species conservationist, ecosystem conservationist and passive owner. These owner types align along three gradients representing (1) their economic focus, (2) the intensity of their management practices and (3) the type of goods and services they provide (private vs. public). We also find that multi-objective and conservationist owners generally practise the most sustainable forms of forest management and industrial productionists the least sustainable in terms of triple bottom line sustainability. Supracontinental land owner typologies of this kind can be useful in assisting international policy making and in developing resource management programmes. We suggest that future studies should investigate forest owner typologies in the developing world, forest owner information-sharing networks, and the ways in which forest owners learn and adapt to environmental change.

Keywords Functional types · Land use · Sustainability · Typology

Communicated by Martin Moog.

Electronic supplementary material The online version of this article (doi:10.1007/s10342-015-0907-x) contains supplementary material, which is available to authorized users.

✉ Victor Blanco
v.blanco@ed.ac.uk

[1] Institute of Geography and the Lived Environment, School of Geosciences, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, UK

Introduction

Forest land use and management has changed considerably in recent decades (Rudel et al. 2005; Siry et al. 2005; Meyfroidt et al. 2010) with globalisation being identified as one of the main drivers of forest land use change (Seppälä 2008; Meyfroidt et al. 2010). A shift in the industrial production of timber away from boreal and temperate forests to fast-growing tropical and subtropical forests has taken place since the 1980s, as trade between these areas increases (Seppälä 2008), and as demand for timber products grows in many developing and newly industrialised countries, especially in the Asia–Pacific region (FAO 2012). This trend coupled with the increasing adoption of sustainable forest management and forest certification schemes, especially in developed countries (Siry et al. 2005; Seppälä 2008), has supported the provision of non-timber goods and services such as recreation or biodiversity conservation (Seppälä 2006). At the same time, the use of plantations to meet global demands for wood and fibre for industrial use has increased since the 1960s (Sohngen et al. 1999; FAO 2000, 2005).

Furthermore, social and economic change in developed countries has led to the environmental, biological and recreational benefits of forestry becoming better recognised and valued (Janse and Ottitsch 2005), leading to increased

demand for non-timber forest services. In particular, forest multi-functionality, understood as the capacity of a forest to provide multiple market and non-market ecosystem services (Millennium Ecosystem Assessment 2005; Ninan and Inoue 2013; Richnau et al. 2013), is encouraged increasingly by national and international policies (Otte et al. 2007), and its widespread adoption is a crucial land-use issue.

In the midst of these global and macroeconomic drivers of forest land-use change, forest owners make decisions about the management of their forests, and the subsequent provision of ecosystem services generated from forest land. Forest owners' attitudes towards forests and forestry, and the objectives for their forests, are perhaps the most important elements affecting management decisions (Ní Dhubháin et al. 2007; Nordlund and Westin 2011) and are likely to have substantial impacts on the range of goods and services provided (Arano and Munn 2006; Urquhart and Courtney 2011; Sorice et al. 2014). Hence, there is a need to investigate forest owner decision-making and its consequences for forest socio-ecological systems in order to inform land-use and forestry policy (Beach et al. 2005; Ingemarson et al. 2006; Urquhart and Courtney 2011) and sustainable forest management plans (Wiersum et al. 2005; Emtage et al. 2007). Additionally, such information can inform the development of simulation models as a means of representing interactions and feedbacks between "agents" (i.e. entities with autonomous behaviour depicting real-world actors) and their environment, a priority for the provision of improved insight and understanding of socio-ecological systems (Ferber 1999; Rounsevell et al. 2012).

Despite the key role of forest owners in determining the supply of forest ecosystem services at the epicentre of global forest land-use change, no attempt has been made so far to characterise forest owners at global[1] scales. Such large-scale studies need to recognise that each forest owner has their own unique characteristics and circumstances, rendering attempts to fully account for individual behaviour infeasible (Emtage et al. 2007). To deal with this heterogeneity within forest owner communities, a common approach is to group together similar "types" of land owners and then to detail the profiles of these groups. This leads to a land owner typology, which, while not describing individuals, depicts archetypal patterns that tend to repeat themselves within the community (Emtage et al. 2007). Hence, heterogeneity is reduced by creating clusters of land owner types, within which owners are expected to display somewhat similar behaviour and decision-making compared to individuals in other groups.

[1] Global refers here not to worldwide, but to international or supra-continental.

The creation of typologies is common in analyses of the agriculture sector (e.g. Guillem et al. 2012; Karali et al. 2013), but less so for forestry, where typologies have almost exclusively targeted specific local or national-scale cases. Such approaches have not been applied across scales where they could improve understanding of the management of forest systems internationally and the resulting provision of ecosystem goods and services, especially under global trade and environmental change.

Nevertheless, previous typological studies and reviews have suggested that a small number of broad classes may be sufficient to describe forest owners across large geographical scales (e.g. Beach et al. 2005; Wiersum et al. 2005; Ní Dhubháin et al. 2007).

Wiersum et al. (2005) observed that the management characteristics of forest owners were statistically more commonly associated with countries than with types of rural area (these differing in socio-economic and land-use characteristics). This suggests that at very large geographical scales, large-scale characteristics (e.g. national policies, culture) might better explain the forms of forest management practised than specific small-scale characteristics. Hence, we postulate that despite geographical heterogeneity, it should be possible to create forest owner typologies at large scales (i.e. supranational). These typologies may or may not replicate the same patterns found at lower scales (e.g. local, landscape), yet they can in principle depict the different types of owners according to the relative similarities and dissimilarities existing at the large scale.

This idea is supported by the agent functional type approach to the development of agent typologies in the context of large-scale socio-ecological systems (Rounsevell et al. 2012; Arneth et al. 2014), which suggests that three dimensions be used in the definition of agent typologies: functional roles, agent desires or goals and behavioural mechanisms, with the second and third dimensions nested within the first. An agent type's overall "function" in a socio-ecological system can therefore be denoted by functional roles such as *environmentalist* or *multifunctional* (as in the study of Wiersum et al. 2005). If a number of individuals within a forest owner community have similar attributes across the three dimensions, they can be represented by a single forest owner type. Similarities in attributes may increase or decrease across spatial scales.

Given the global and interconnected nature of drivers of forest land-use change, there is a clear need for forest owner typologies to be developed at supranational scales that can aid the understanding of forest owner choices and their implications at an international level. An international forest owner typology may be further used to create communities of agents that can populate agent-based models

Table 1 Number of publications cited per country and geographical scale at which the survey was conducted

	Geographic scale				
	Subnational	National/State(s) (US)	Supranational	Others	Total
Country/country cluster					
Sweden	2	5			7
Denmark		1			1
Finland	1				1
United Kingdom	1				1
Austria	1	1			2
Portugal		1			1
United States (1–5 states)	2	8			10
European Union (8 countries)			1		1
Others				7	7
Total	7	16	1	7	**31**

Review papers and papers not relating to a particular geographical location were included under the category "Others"

operating at continental to global scales. These models could provide unprecedented understanding of land-use processes and socio-environmental interactions, as no agent-based models have yet been created at such scales (Arneth et al. 2014). Moreover, an international typology in conjunction with smaller-scale nested typologies (e.g. national, local) may contribute a robust basis on which to construct forest policy and sustainable management plans (Emtage et al. 2007; Rounsevell et al. 2012).

To improve understanding and modelling of forest owners at international scales, we develop a qualitative forest owner typology based on a meta-analysis of quantitative and qualitative information about forest owner types and their decision-making strategies. We assess (1) whether groups of forest owners share characteristics across different locations and scales; and if so, (2) what these characteristics are and how they vary between groups; and (3) what forest owner functional types exist at the broad scale. Using this information, we discuss a forest owner typology across gradients of environmental, social and economic benefits provided by forests, and within a sustainability framework. We further discuss the typology's implications for forest multi-functionality and for future research on land-use decision-making and natural resource management.

Methodology

We conducted a meta-analysis of the existing literature on forest owner and forest manager typologies and decision-making mechanisms. Using the search database "Web of Science", we searched, under the categories "Topic" and "Title", for the term combinations: *forest owner typolog**, *forest manager typolog**, *forest owner typ**, *forest manager typ**, *forest owner profile*, *forest manager profile*, *forest owner objective**, *forest manager objective**, *forest owner decision*, *forest manager decision*. For all publications in the search output lists, we screened the title and abstract first, and, if there was a direct relationship to the topic of the study, we subsequently analysed the full paper. If these papers mentioned other, pertinent papers that were not identified during the initial search, these were included in the analysis. We restricted the analysis to papers published after 1990 to ensure that the information was up to date, while still covering a long period of time (24 years).

We selected 31 publications containing information directly relevant to the generation of a generic forest owner typology (Online Resource 1). Such information referred to forest owners (principally private forest owners) values, attitudes, beliefs, objectives, decision-making mechanisms, socio-demographic and economic attributes, and management strategies. These studies covered different geographical scales and locations within Europe and the USA (Table 1). No information was found for macro-regions other than these.

We used the agent functional type conceptualisation to establish the structure of the agent types (Rounsevell et al. 2012; Arneth et al. 2014). This hierarchical structure incorporates the overarching management roles at the highest level, with subdivisions of these leading to owner functional types at the lowest level. Overarching management roles were selected from among recurrent forest owner types found in the literature (i.e. emerging in at least five papers) that relate to their management strategies and objectives. On occasion, different studies applied different names to types with very similar underlying characteristics and overall motivations (e.g. productionist, economist, and

investor) according to the descriptions of types and the quantitative/qualitative information behind them. In such cases, these types were included under one overarching management role with shared characteristics. Where the internal variability of group characteristics was large, some overarching management roles were then subdivided into types. These types were defined according to subgroups found in the literature, which could be delimited within an overarching role because of their distinctive objectives and/or socio-demographic or economic attributes. The typology included those objectives and attributes that were either referred to as (at least) *somewhat/moderately important* in defining a forest owner type in at least three papers or as *very important* at national/state scale or larger in at least one paper.

Based on the comprehensive classification of forest management approaches developed by Duncker et al. (2012), we linked forest owner types with their management preferences (i.e. approaches). The choice of a particular management approach is based on decisions about the type of operation to implement during the development of a forest or stand (Duncker et al. 2012). These decisions were defined through the following variables: naturalness of tree species composition, tree improvement, type of regeneration, successional elements, machine operation, soil cultivation, fertilisation or liming, application of chemical agents, integration of nature protection, tree removals, final harvest system and maturity. We linked agent functional types with corresponding management approaches by considering the similarity in the content and coherence between functional types and possible management categories, and descriptions of management practices in the papers. We do not go into the details of particular operational decisions associated with each approach; for this information the reader is referred to Duncker et al. (2012).

Each forest owner type was defined according to primary and potential secondary management/ownership objectives, ranges of owner socio-demographic and economic attributes, and preferred forest management practices. Resulting groups of this subdivision of the forest owner population were "forest owner functional types".

We then characterised the different forest owner functional types within the triple bottom line sustainability framework (Elkington 1994) by quantifying the environmental, social and economic impacts of each type and its associated management practices. An overall sustainability index was then determined by calculating the average value of the quantified impacts. To quantify the environmental impact, we scored the five possible levels of management intensity and three possible levels corresponding to the importance of nature conservation and environmental quality objectives for the owner type. The social impact was quantified by scoring the importance given to objectives that could provide public services, namely public recreation, aesthetics, nature conservation, environmental quality and hunting. The economic impact was quantified according to the three levels of focus on profit-making objectives.

Score values for management intensity levels ranged from 0 to 0.4 and values for the importance of objectives ranged from 0 to 0.2, as shown in Table 2. These (arbitrary, but consistent) values were assigned following a semi-quantification of the objectives, attributes and management preferences of each owner functional type. The index generated for each impact was then the sum of the attributed values of the different characteristics corresponding to each owner type, divided by the sum of the maximum possible values of those characteristics. In this way, levels of management intensity and the importance of objectives, measured at different scales, were normalised (i.e. calculated on a common scale). Finally, the overall sustainability index, calculated by averaging the three impact index scores, took values between 0 (low sustainability) and 1 (high sustainability). While these indices could be calculated differently and are not intended to reflect meaningful absolute value (in particular, the functional relationships between owner type characteristics and their degree of sustainability may not be linear), they allow relative ranking of owner types through a clear numeric summary of qualitative information.

We considered this to be the best method with imperfect and semi-quantified information, and therefore, even though the overall index provides continuous numerical values, it is only meant to be a broad guide to sustainability.

The sustainability of each functional type was located within a three-circle Venn diagram, commonly used to

Table 2 Score values assigned to the different levels of management intensity and to the importance of objectives used to generate the forest owner functional type sustainability index

Score values	0	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4
Management intensity	Intensive	Intensive–high	High	High–medium	Medium	Medium–low	Low	Low–passive	Passive
Objectives	Not important		Secondary		Primary				

depict the triple bottom line framework, using values of the environmental, social and economic indices for each type on the corresponding axes. An equilateral triangle with corners at the furthest point of each circle from the centre of the diagram defined these axes, which spanned values 0–1. The point representing the sustainability of each functional type within the diagram was the centroid of a triangle with corners on the positions of the three corresponding index values.

Results

We found that management types and practices aligned along gradients of the provision of private versus public goods and services, generation of profit versus non-profit goods and services, and management intensity (Fig. 1). We define public goods and services as those ecosystem services provided by private or public land from which the general public may benefit, whether they are delivered on-site (e.g. recreation, aesthetic pleasure) or off-site (e.g. water purification, carbon sequestration). The profit versus non-profit gradient follows a general trend in the economic focus of forest owner types from those whose only objective is to maximise economic profit from forest activities, to those who have little or no interest in profit-making. Both the private/public goods and services and the intensity gradients follow a similar trend in terms of the positions of types along them. These gradients reflect management approaches selected by forest owners according to their objectives (Duncker et al. 2012) and socio-economic attributes. Generally, more profit-oriented owners are found to be willing to manage their forests more intensely and so occur at one extreme of each gradient.

Sustainability index scores varied substantially between owner types, although none approached the most extreme values possible under the scoring method (Table 3). Figure 2 illustrates the relative positions of the functional types within the sustainability framework. We note that the different types span a larger range along the economic axis than they do along the environmental and social axes.

We find ten different objectives to be somewhat important in determining the forest management preferences of one or more forest owner functional types (Table 4). Additionally, eight socio-demographic or economic attributes are found to determine the definition of one or more forest owner functional types.

Our analysis resulted in five overarching forest management roles: profit-oriented, multi-objective, recreationalist, conservationist and passive owner (Fig. 1). Subdivisions of some of these roles produced nine forest owner functional types: industrial productionist, non-industrial productionist, for-profit recreationist, for-profit multi-objective, non-profit multi-objective, recreationalist, species conservationist, ecosystem conservationist and passive owner. We provide narrative descriptions here of all forest owner types that are included in the typology in terms of their main objectives, socio-demographic/economic attributes and forest management preferences. These narratives start with the overarching management role and follow the functional type hierarchy, where pertinent, down to individual forest owner functional types. Table 5 shows all characteristics defining each type, including those not described in the narratives.

Some trends are found to apply to all forest owners. Possibly due to bequest considerations, older owners are less likely to engage in harvesting or in wildlife and recreation improvement activities (Joshi and Arano 2009). Other general findings are that the types interested in ecosystem management tend to have higher education levels (Creighton et al. 2002) and that female owners tend to have more pro-environmental, recreational and human-centred values and attitudes (Stern et al. 1993; Nordlund and Westin 2011).

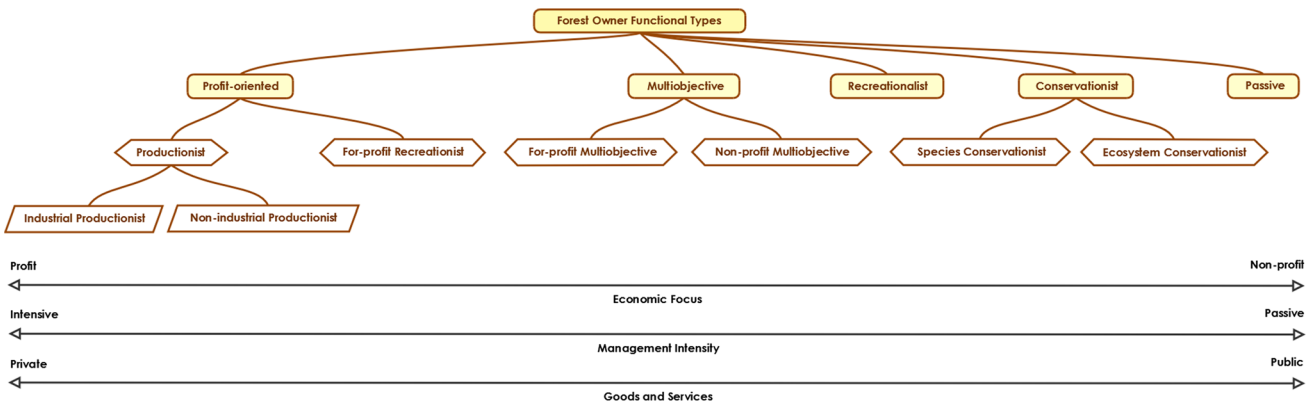

Fig. 1 Forest owner types separated into functional groups and their approximate relative positions on axes describing the economic focus and intensity of their management, and the nature of the goods and services they produce. Nine agent functional types were identified

Table 3 Index values (0–1) calculated for each forest owner functional type according to their capacity to fulfil the environmental, social and economic dimensions of sustainability, and the sustainability index resulting from the averaging of values for these dimensions for each type

	Environmental	Social	Economic	Sustainability
Industrial productionist	0.06	0.00	1.00	0.35
Non-industrial productionist	0.31	0.40	1.00	0.57
Profit-oriented recreationist	0.43	0.40	1.00	0.61
For-profit multi-objective	0.50	0.40	1.00	0.63
Non-profit multi-objective	0.87	0.80	0.50	0.72
Recreationalist	0.69	0.60	0.00	0.43
Conservationist	0.94	0.70	0.50	0.71
Passive	0.75	0.30	0.50	0.52

We assume equal importance for the three dimensions

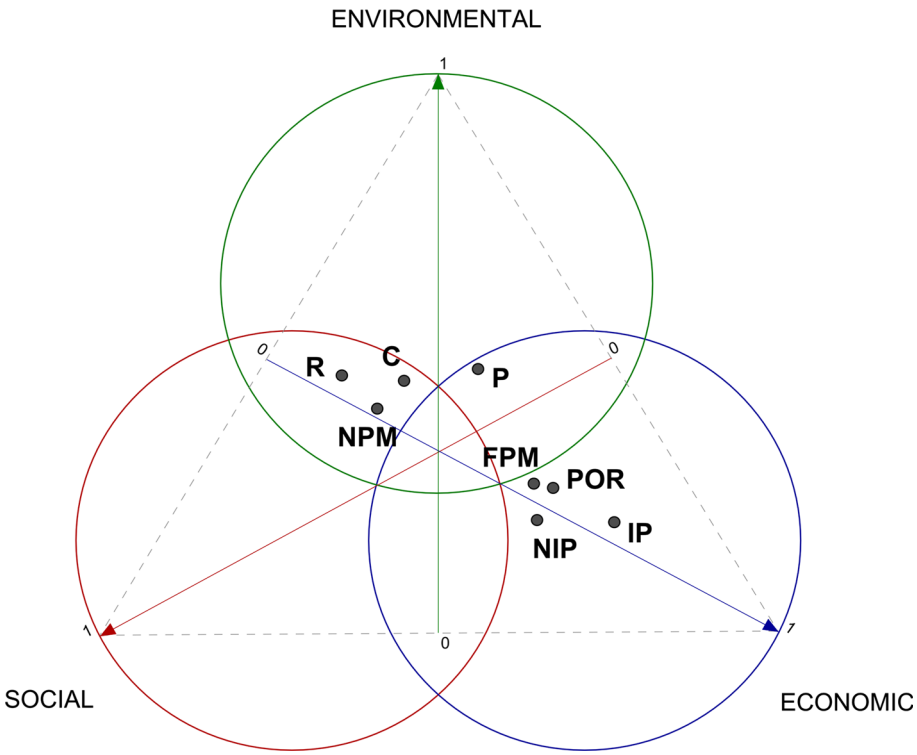

Fig. 2 Conceptualisation of forest owner functional types within the triple bottom line sustainability framework. The location of each type is a function of its position along the environmental, social and economic gradients determined by their corresponding index values (Table 3) for industrial productionist (IP), non-industrial productionist (NIP), profit-oriented recreationist (POR), for-profit multi-objective (FPM), non-profit multi-objective (NPM), recreationalist (R), conservationist (C) and passive (P)

Profit-oriented

Objectives

The main objective of profit-oriented owners is profit-making. Within this group, we can essentially distinguish three forest owner functional types, which we call "industrial productionists", "non-industrial productionists" and "for-profit recreationists", with the first two representing the majority of the profit-oriented group. There is a general consensus within the productionist group about the high importance of timber production and forest ownership as an investment (Kline et al. 2000; Boon et al. 2004; Ingemarson et al. 2006; Majumdar et al. 2008).

Socio-demographic and economic attributes

Productionists are found to have, in general, lower levels of education than conservationists or passive owners, but higher levels than multi-objective owners (Ingemarson et al. 2006). Nevertheless, productionists have less forestry knowledge (i.e. knowledge about forest management) than multi-objective owners. Generally, owners with a higher income are less likely to engage in harvesting (Joshi and Arano 2009), which we interpret as showing less dependency on income from forestry. Indeed, a large proportion of productionists have low-forest-income dependency, although a significant fraction of them have medium or high dependency (Ingemarson et al. 2006; Canadas and Novais 2014).

Table 4 Dimensions of the forest owner functional typology (in bold) and the different attributes within each dimension that a forest owner must or may have

Overarching management role	**Management objectives**	**Socio-demographic/economic attributes**	**Forest management preferences**
Profit-oriented	Profit-making	Age	Management intensity
Multi-objective	Private consumption	Educational level	
Recreationalist	Personal enjoyment	Forestry knowledge	
Conservationist	Public recreation	Gender	
Passive owner	Aesthetics	Income	
	Nature conservation	Property size	
	Environmental quality	Location of residence	
	Cultural conservation	Property acquisition	
	Hunting	Possession of forest management plan	
	Privacy		

Productionists tend to own much larger properties than recreationalists, passive or "non-timber" owners (Karppinen 1998; Kline et al. 2000; Boon et al. 2004; Majumdar et al. 2008; Canadas and Novais 2014; Eggers et al. 2014), probably because of their interest in maximising forest income (Arano and Munn 2006). Resident owners tend to have stronger productionist values and stronger economic management attitudes (Nordlund and Westin 2011), and Ingemarson et al. (2006) found a larger proportion of productionists living on or near their estate than conservationists or passive owners. Finally, productionists are more likely to have a forest management plan than any other owner type (Ingemarson et al. 2006; Majumdar et al. 2008; Eggers et al. 2014).

Management preferences

Productionists are more likely to carry out intensive forest management and to use single species plantations than any other type of owner (Fujimori 2001; Arano and Munn 2006; Duncker et al. 2012).

Profit-oriented forest owner functional types

Within the productionist group, two owner functional types can be distinguished: industrial and non-industrial productionists. Unlike non-industrial private forest owners, industrial forest owners generally own and operate a commercial wood processing plant and manage forests almost solely for timber and biomass production on the basis of profit maximisation (Newman and Wear 1993; Beach et al. 2005; Arano and Munn 2006; Liao and Zhang 2008). Industrial productionists also manage far larger properties than non-industrial productionists and generally manage them more intensely. They both fall within the "intensive" or "high" intensity classes of Duncker et al. (2012).

The for-profit recreationist type comprises owners who intend to make a business out of recreation associated with nature, adventure and outdoor sports activities, or hunting (Andersson 2006, personal communication; Matilainen and Lähdesmäki 2014) rather than timber. Their main objectives are likely to be profit-making and recreation, while they also give importance to aesthetics. Those making businesses out of hunting also attribute importance to game production. In Sweden, this functional type makes up a very small proportion of productionists. For-profit recreationists are expected to manage their forests in a non-intensive way, and differently depending on their recreational focus. They may fall within either the "passive" or "low"-intensity classes of Duncker et al. (2012).

Multi-objective

Objectives

Multi-objective owners are characterised by attributing high importance to several objectives. Like the productionists, they see forest ownership as an investment and concentrate on timber production (Ingemarson et al. 2006; Majumdar et al. 2008; Kline et al. 2000). In Sweden, annual income was also seen as important (Ingemarson et al. 2006). Personal enjoyment in the form of recreation, mushroom and berry picking or appreciation of green space is also regarded as an important objective by multi-objective owners. In the UK, they also valued public recreation (Urquhart and Courtney 2011). Other objectives prioritised by this class include aesthetics, game management and hunting, nature conservation and environmental quality (the latter including water and soil conservation, climate

Table 5 Semi-quantification of Forest Owner Functional Types (FMFT) according to their primary (✔✔) or secondary (✔) objectives and socio-demographic/economic attributes, and forest management preferences

	Profit-oriented	Productionist	Industrial productionist	Non-industrial productionist	For-profit recreationist	**Multi-objective**	For-profit multi-objective	Non-profit multi-objective	**Recreationalist**	**Conservationist**	Species conservationist	Ecosystem conservationist	**Passive**
Objectives													
Profit-making	✔✔	✔✔	✔✔	✔✔	✔✔	✔✔	✔✔	✔		✔	✔		✔
Private consumption						✔	✔	✔	✔	✔			
Personal enjoyment						✔	✔	✔	✔✔	✔			
Public recreation					✔✔				✔				
Aesthetics	✔	✔		✔	✔	✔✔	✔	✔✔	✔✔	✔✔			✔
Nature conservation	✔	✔		✔		✔✔	✔	✔✔	✔	✔✔			✔
Environmental quality	✔	✔		✔		✔✔	✔	✔✔	✔	✔✔			✔
Cultural conservation	✔	✔		✔		✔✔	✔	✔✔	✔	✔			
Hunting	✔	✔		✔	✔	✔✔	✔	✔✔	✔	✔			
Privacy						✔	✔	✔	✔	✔			
Attributes													
Age	✔					✔			✔	✔			
Educational level		Lower ✔				Lower ✔			Higher ✔	Higher ✔			
Forestry knowledge		Med. ✔				Higher ✔							Lower ✔
Gender	✔					✔			✔	✔			✔
Income dependency		L, M, H ✔✔				L, M, H ✔✔	L, M, H ✔✔	L, M ✔✔	L, M ✔✔	L ✔✔			L, M ✔✔
Property size			Greatly larger ✔✔	Larger ✔✔		Larger ✔✔	Larger ✔✔	Med. ✔✔	Smaller ✔✔	Smaller ✔✔			Smaller ✔✔
Location of residence		R:H A:L ✔✔				R:H A:L ✔✔			R:L A:H ✔✔	R:L A:H ✔✔			R:L A:H ✔
Property acquisition	✔					✔				✔			
Forest mgmt. plan		✔				✔				✔			✔
Mgmt. prefs.													
Management intensity			Intensive, high	Intensive, high	Low, passive		Medium	Low	Low, passive		Low, passive	Low, passive	Passive

Names of owner types in bold refer to overarching management roles, while names not in bold to the right of each overarching role are the FMFTs comprised within that role. An owner type may cover more than one forest income dependency category: Low (L), Medium (M), and High (H), and may be made by a high (H) or a low (L) proportion of residents (R) or absentees (A). Educational level, forestry knowledge and property size are categorised for each owner type in relative terms [Lower, Medium (Med.), Higher] with respect to the other types

change mitigation and pollution control) (Ingemarson et al. 2006; Majumdar et al. 2008; Urquhart and Courtney 2011). In Sweden, multi-objective owners also value cultural conservation very highly (Ingemarson et al. 2006).

Socio-demographic and economic attributes

Multi-objective owners generally have lower education levels than conservationists, productionists or passive owners, and yet they have higher average forestry knowledge than any of these groups (Ingemarson et al. 2006). Like productionists, multi-objective owners with greater experience in the forestry business seem to be prepared to take relatively large risks (Andersson 2012). In Sweden, the proportion of female owners was lower amongst multi-objectivists than amongst productionists, conservationists or passive owners. While a large proportion of multi-objective owners have low or medium dependency on their forest income, a significant minority displayed high dependency (Ingemarson et al. 2006). As with productionists, multi-objective owners with higher incomes are less likely to engage in harvesting (Joshi and Arano 2009). They generally have much larger properties than recreationalist, passive (Kline et al. 2000) and "non-timber" owners (Majumdar et al. 2008). A larger proportion of multi-objective owners than either conservationists or passive owners live on or near their estate (Ingemarson et al. 2006).

Management preferences

Multi-objective owners can be expected to manage forests with more than one tree species. Hence, they manage either a mixed forest or several fragments of different forest types. They also implement extended rotation periods (i.e. beyond the optimum economic harvest age) in order to allow for the biodiversity benefits created by older forests (Kline et al. 2000).

Multi-objective forest owner functional types

Multi-objective owners give relatively high importance to several different and potentially competing objectives, and there is often a large variability among the owners in this group in the relative importance they give to their objectives. Hence, they may be subdivided into smaller clusters depending on the relative emphasis they put on particular objectives. We draw the main subdivisions by looking at the two predominant groups of forest owners that Ní Dhubháin et al. (2007) observed. The primary objective of the first group was the production of wood and non-wood goods and services, usually for profit, while the second group's main objective was the consumption of such goods and services. We call these groups *for-profit multi-objective* owners and *non-profit multi-objective* owners, respectively, as the main difference between them lies in the importance they give to profit-making objectives. Hence, the for-profit multi-objective functional type places larger importance on profit-making objectives relative to the other main objectives of multi-objective owners. The non-profit multi-objective type, conversely, prioritises every other objective over the profit-making objective. These owners are comparable with Majumdar et al.'s (2008) "non-timber" owners and Ross-Davis and Broussard's (2007) "new forest owners".

For-profit multi-objective and non-profit multi-objective owners are expected to differ mainly in their forest income dependency and the size of their properties. Because non-profit multi-objective owners do not prioritise profit-making as highly as for-profit multi-objective, their forest income dependency is likely to be low or medium, while that of for-profit multi-objective owners is expected to span a wider range, including highly dependent multi-objective owners. At the same time, assuming that the profit-making objectives of for-profit multi-objective owners are similar to those of productionists, they are expected to own larger estates than non-profit owners. For-profit multi-objective owners generally fall within the "medium" intensity class of Duncker et al. (2012), while non-profit owners perform "low" intensity management.

Recreationalist

Objectives

Recreationalists' primary objectives are personal enjoyment and aesthetics (Kline et al. 2000; Boon et al. 2004; Majumdar et al. 2008), and often informal public recreation (e.g. walking, cycling, cross-country skiing, nature watching) (Urquhart and Courtney 2011). A substantial proportion of this group also judge nature conservation and environmental quality, hunting, private consumption of timber and fuel wood, cultural conservation and privacy to be important (Boon et al. 2004; Ingemarson et al. 2006; Majumdar et al. 2008; Urquhart and Courtney 2011; Andersson 2006, personal communication).

Socio-demographic and economic attributes

There is a tendency for recreationalists to have higher education levels than productionists, multi-objective or passive owners (Kline et al. 2000). This could be because recreationalists also tend to have higher non-forest incomes, as income can be partly explained by formal education level (Griliches and Mason 1972). Additionally, it is unlikely that recreationalists will have high-income

dependency on forests, given that they generally use their forests for their own enjoyment. Recreationalists very often own much smaller properties than productionists or multi-objective owners (Karppinen 1998; Kline et al. 2000; Boon et al. 2004; Majumdar et al. 2008; Joshi and Arano 2009) and are commonly absentee owners (Karppinen 1998).

Management preferences

Recreationalists are likely to own natural forests and forests largely comprising broadleaf deciduous trees, as these are generally perceived as more aesthetically pleasing than coniferous forests (Fujimori 2001). Forests with several successional stages (i.e. different stand development stages) also seem to contribute to this perception. Recreationalists fall within either the "passive" or "low" intensity classes of Duncker et al. (2012).

Conservationist

Objectives

Conservationists' primary objective is nature conservation, followed by aesthetics and environmental quality (Ingemarson et al. 2006; Majumdar et al. 2008; Urquhart and Courtney 2011). An appreciable number of owners in this group also value cultural conservation, timber production, private consumption, hunting, personal enjoyment and privacy (Ingemarson et al. 2006; Majumdar et al. 2008; Urquhart and Courtney 2011; Andersson 2006, personal communication).

Socio-demographic and economic attributes

There is a tendency for the conservationist owner group to include a larger proportion of females than the productionist or the multi-objective groups (Ingemarson et al. 2006). Also, conservationists often have higher education levels and lower-income dependencies than productionist, multi-objective or passive owners (Creighton et al. 2002; Ingemarson et al. 2006). In Sweden, the vast majority of conservationists had low-forest-income dependency, while only a very small proportion had medium dependency. Conservationists also tend to own much smaller properties than productionists or multi-objective owners (Majumdar et al. 2008; Eggers et al. 2014), and usually live further away from their forest than these and passive owners (Ingemarson et al. 2006; Nordlund and Westin 2011). In Sweden, while retaining the property within the family is considered a principal goal by most owners (Lidestav 2010; Lönnstedt 2012), conservationists had the highest proportion of owners who had bought, rather than inherited, property (Ingemarson et al. 2006).

Management preferences

Conservationists are likely to own mixed, natural or old growth forests with several successional stages and native species (Fujimori 2001). They commonly practice extensive—or no—management and allow natural growth. Those conservationists with an interest in timber production will practise extended rotation periods (Kline et al. 2000). Conservationists fall within either the "passive" or "low" intensity classes of Duncker et al. (2012).

Conservationist forest owner functional types

In terms of nature conservation goals, two main conservationist management strategies could be distinguished: species conservation and ecosystem conservation. Conservation of small or declining populations seeks to prevent particular species from becoming locally and/or globally extinct (Caughley 1994), while the ecosystem approach to conservation aims to preserve biodiversity and ecosystem functions rather than single species (Franklin 1993). Hence, forest management differs depending on the conservation goal. Population conservation is likely to entail more intensive management as the forest system may have to be moulded to cater to the needs of one or a few species (Baker et al. 2011), while ecosystem conservation will often imply lower management intensity.

Passive

Objectives

Passive owners typically do not give high importance to any particular objective and have low or no engagement in the management of their forests (Boon et al. 2004; Ingemarson et al. 2006). However, the fact that some Swedish passive owners had medium-forest-income dependency and that 33.5 % of them had a forest management plan no older than 10 years (Ingemarson et al. 2006) suggests that some do have profit-making objectives.

Socio-demographic and economic attributes

Passive owners have been recorded as having the lowest forestry knowledge of any owner group (Ingemarson et al. 2006). The majority of them have low-forest-income dependency, while a small proportion has medium dependency (Ingemarson et al. 2006; Eggers et al. 2014). They also tend to own much smaller properties and to live further away from these than productionists and multi-objective owners, yet closer than conservationists (Kline et al. 2000; Ingemarson et al. 2006; Eggers et al. 2014).

Management preferences

Passive owners generally do not manage their land. Those with profit-making objectives may undertake the minimal required management to make some profit from their forests. In general, passive owners fall within the "passive" management intensity class of Duncker et al. (2012).

Discussion and conclusions

We present a generic typology of forest owners that goes beyond the continental scale, including forest owner types found across a number of developed countries spanning Mediterranean, warm-temperate, nemoral, continental and boreal biomes. By analysing previously published qualitative and quantitative information about forest owners, we identified a small number of owner types for which there was consistent evidence across the developed world. We observed that similar types were found at the level of the overarching management role by studies performed at different locations and scales (e.g. Karppinen 1998; Boon et al. 2004; Majumdar et al. 2008; Urquhart and Courtney 2011).

The large number, and the geographical and scale diversity of the selected studies on forest owner and forest manager typologies and decision-making mechanisms provide a basis for differentiating forest owner types at a supra-continental level. Nevertheless, the scale diversity and the imbalance between the number of studies selected from different countries (e.g. seven from Sweden vs. one from the United Kingdom) make a comparison of results between countries difficult. This is, however, not important here, since a cross-country comparison was not the aim of this study.

Nevertheless, the fact that the results only refer to Europe and the USA limits their significance within the broader developed world. It is important to note as well the increasing abstraction of typologies at increasing scales, which could make the meaningfulness of such a classification at smaller scales less valid given the possibility of very different historical and legal frameworks. In this sense, a "developed world" typology has the advantage over a truly global typology of being more context-specific, and therefore less abstract. Notwithstanding this potential limitation, the typology does summarise the forest owner community in these areas at a "global" scale and can serve as a starting point in studies of these owners at particular locations. While we may expect most or all forest owner functional types to be present in developed countries and administrative regions with considerable forest cover, the proportion of owners falling within each of these functional types will vary from place to place. Furthermore, there will be within-functional-type variability in particular attributes between different owner communities. Our use of classes (e.g. low, medium, high) as opposed to continuous values to subdivide attributes reflects the uncertainty about these attributes.

It should be noted that the coverage of forest owners in this study is largely limited to private forest owners, while other types of owners such as local communities, indigenous people, NGOs or religious organisations (e.g. the church) were not included, even though some of these may own large areas of forest in some regions. These types of owners may differ from private forest owners in their objectives and attributes; research into these owners may require a different approach given the predominance of literature focused on private owners, and this would complement the findings presented here. Nevertheless, we believe that the overarching roles we identify are likely to hold for at least some of these other types.

The different forest owner functional types in the typology can be associated with three gradients according to (1) their economic focus, (2) the intensity of management associated with their objectives and (3) the type of goods and services they provide. The profit versus non-profit gradient concurs with the dichotomy highlighted by Beach et al. (2005), who distinguished profit maximisers from utility maximisers. Our typology further arranges owner functional types according to the degree of importance that they place on profit-making and non-pecuniary utility generation within their objectives. Awareness of the particular economic foci of, and the objectives pursued by, different owner types found at a location can help to determine the type of policy instruments to be put into effect. For instance, while profit-oriented owners tend to be motivated by financial instruments (i.e. economic incentives and disincentives), recreationalists or conservationists, having little interest and dependency on profit generation through their forests, are likely to be more influenced by information and advisory services that can instruct them on issues such as nature restoration or biodiversity conservation (Boon et al. 2004; Ingemarson et al. 2006).

The forest owner functional types can also be separated along an intensity gradient. Having coupled the functional types with the five forest management approaches proposed by Duncker et al. (2012), the typology of forest owners follows a similar trend in management intensity as in the classification of their forest management approaches. We interpret management intensity as the degree of manipulation of natural processes (Duncker et al. 2012), and this broad definition allows us to qualify the intensity of management not only for production purposes, but also for a number of other objectives (e.g. recreation, conservation), which may involve very different management practices and intensities.

Partly as a result of the approaches taken to their management, forests generate various ecosystem services. Public institutions are increasingly encouraging private forest owners to provide public-good benefits (Kline et al. 2000; Boon et al. 2004; Ingemarson et al. 2006; Urquhart and Courtney 2011). As we follow the gradient in goods and services provision from industrial productionists to passive owners, there is a general increase in the proportion of public goods provided and a decrease in private goods. Commensurate with this finding, previous studies have observed that ecological and societal goals are prioritised in unmanaged and "close to nature" forests (e.g. Duncker et al. 2012; Gamfeldt et al. 2013; Ninan and Inoue 2013). This tendency is especially strong in regions (such as Sweden or Slovenia) where private forests are open to the general public (Eriksson 2012; Ficko and Boncina 2013). Where forests are closed to the public, access to public goods and services such as recreation or aesthetics is clearly limited (Urquhart and Courtney 2011; Finley and Kittredge 2006). However, the fact that forests provide services such as water purification beyond their boundaries may render this gradient true even for private forests without public access. The relevance of this gradient depends therefore on the nature of the services provided by a particular forest and on where these services are delivered.

Sustainable forest management recognises the necessity of balancing the ecological, social and economic outputs from forests (MCPFE 2003). However, it can be difficult to ascertain what degree of sustainability can be expected in managed forests given the wide range of managerial objectives, forest types and management practices. We illustrate the relationship between the different owner functional types in terms of their sustainability by placing them within the triple bottom line framework. It is important to stress that this quantification is not intended to be absolute, but to summarise the qualitative information we identify in a transparent numerical fashion. In particular, the values attributed to each "level" within the social, environmental and economic axes could be varied, but the overall ranking would remain the same unless these variations were extreme. From this conceptualisation, it appears that multi-objective and conservationist owners are generally the most sustainable types, as might be expected given the large number of objectives they manage for. In contrast, industrial productionists emerge as the least sustainable owners given their almost exclusively economic focus, followed by recreationalists, penalised for attributing no importance to economic objectives. Even so, the fact that a generic functional type may hold some variability within its objectives, attributes or management strategies implies that the values taken by the index may consequently vary for each type within a certain spectrum. Therefore, sustainability index values generated here should be taken with caution and understood as approximate for the generic owner types. Furthermore, it is important to recognise that this index only evaluates the sustainability of forest owners from the supply side. When evaluating the sustainability of forest owner activities, the demand for services produced by the owner are also important. For instance, if a particular type of timber is oversupplied, its continued production by, for example, productionists is likely not to be economically sustainable, in spite of productionists scoring highly in the index for economic sustainability.

This conceptualisation links well with the concept of multi-functional land use, which attempts to maximise the diversity of goods and services that a land unit can provide. Multi-objective owners are an obvious example of land users aiming for multi-functionality, and this largely ensures that they achieve high sustainability scores compared to industrial productionists, for instance. However, multi-functionality can potentially be addressed at different scales, through multi-functional landscapes and even regions. It has been argued that at these scales, a range of specialised, often mono-functional, land uses within an area can provide a multiplicity of ecosystem services (Vereijken 2002; Wiggering et al. 2006). In such cases, more specialised owner types such as productionists or conservationists may have larger roles. It may be bold, however, to assume that, for the same land area, a combination of specialised land uses and a multi-functional land use will be able to supply the same amounts of the same ecosystem services and that these will be distributed spatially in a similar fashion (Le Dû-Blayo 2011). The approach used may in the end be determined by local and regional conditions (Cocklin et al. 2006). A sustainability index as presented here that scores owner functional types may not be sufficient to evaluate sustainability at the landscape or regional level, whereas an index that scores the sustainability of different combinations of functional types could be useful for this purpose.

Different socio-economic, ecological and cultural framing conditions can result in different forest owner actions, even when the owner attitudes and objectives are the same. For this reason, our findings on the sustainability index and the typology do not translate directly into actions. While such typologies have some use for large-scale policy development, the effects of policy instruments still depend on individual, socio-cultural and other behavioural factors that are not included in this analysis, along with other "framing conditions". Therefore, care needs to be taken in not interpreting a typology too simplistically.

The development of indices and categories such as those presented here is also valuable as a basis for the development of future surveys, aiming to analyse the attitudes,

objectives and management strategies of forest owners. For instance, standardised questionnaires could be generated from the indices and categories presented here to confirm the results and to seek more detailed information at particular locations. On this basis, it would be possible to further characterise forest owner's attitudes, objectives and management strategies in a comparable way across locations.

While it would be desirable to develop a typology that covers the different types of forest owners found across the globe, the typology presented here does not account for the developing world due primarily to a lack of relevant literature. A forest owner typology for developing countries is in principle likely to differ substantially from the one presented here. While in the developed world the environmental and recreational elements of forestry have become more important in recent decades as a result of social and economic developments (Janse and Ottitsch 2005; Nordlund and Westin 2011), the focus in most developing nations remains on forest utilisation for income generation and subsistence (Seppälä 2008, Arnold and Perez 2001). Therefore, production-oriented management will likely dominate in these countries, while management for recreation and conservation is likely to be much less common. Furthermore, it may not be possible for profit-oriented owners in low-income economies to implement high-intensity management practices due to a lack of access to the necessary infrastructure and financial capital. Also, the use of forest products for personal consumption in subsistence communities may be considerable, while it is rare in the developed world (Urquhart and Courtney 2011).

Networks and knowledge transfer are an additional key element to consider when studying forest owner interactions and decision-making (Beratan 2007). The way owners interact, who they interact with and the degrees of trust with which they interact strongly affect how they deal with complexity and uncertainty in the land-use system. We have observed here for instance that a large proportion of forest owners are absentee owners and are therefore likely to seek information in different ways and places than owners residing on or near their property. While more traditional social networks among resident land owners may not apply to absentees, their interactions with forestry cooperatives, the forest administration and other forest advisors near a place of residence could be crucial. In the case of industrial productionists, information exchange may even occur at trans-regional or transnational scales, making accurate representation of networks very important within the context of a globalised forestry sector. Further studies are needed to explore how different types of forest owners interact and gather information relevant to their forests.

An additional important consideration is that typologies may evolve over time (Emtage et al. 2007). The typology presented here represents a snapshot of the forest owner community over a particular period of time. Despite the typology incorporating studies of forest owners across 24 years, it does not reflect the "evolutionary trajectory" (Landais 1998; Paquette and Domon 1999) of the different owner types across this period. To reduce the uncertainty associated with trying to understand future land use with "time-point" typologies, research on the ways in which owner types evolve, learn and adapt to environmental change is required.

Further in-depth studies are also needed to construct a qualitative global typology covering all existing forest owner types. As developing countries are absent from our typology and the forest owner typology literature in general, future research should aim to fill this knowledge gap. The main objective of this study was to identify commonalities in management approaches across very large geographical extents, and the significance of the findings lies in the nature of these commonalities and their broad applicability. Despite the above caveats, the fact that a typology of forest owners can be clearly distinguished from the literature and aligned along gradients of management focus, intensity, motivation and sustainability, suggests that it is both possible and useful to develop global typologies of forest owners and land owners in general. These could assist policy making by supporting policies that are orientated towards functional types and the development of resource management programmes and agent-based models of land-use processes at international scales. The incorporation of such a typology within an agent-based model that includes a way of representing land owner decision-making and behavioural processes could support studies of future land-use change at large scales. Insights from such studies can in turn be valuable for land-use policy planners to inform international policy (e.g. conventions, directives).

Acknowledgments We thank Dr. Mats Andersson for his valuable comments during the creation of the typology. The research of VB is currently being supported by the Mistra-SWECIA Programme and the University of Edinburgh. CB and MR would like to acknowledge the contributions of the European Commission Framework 7 VOLANTE project (http://www.volante-project.eu/). We also want to thank two anonymous reviewers for their constructive comments and assistance in improving this manuscript.

References

Andersson M (2012) Assessing non-industrial private forest owners' attitudes to risk: do owner and property characteristics matter? J For Econ 18:3–13. doi:10.1016/j.jfe.2011.05.001

Arano KG, Munn IA (2006) Evaluating forest management intensity: a comparison among major forest landowner types. Forest Policy Econ 9:237–248. doi:10.1016/j.forpol.2005.07.011

Arneth A, Brown C, Rounsevell MDA (2014) Global models of human decision-making for land-based mitigation and adaptation assessment. Nat Clim Chang 4:550–557. doi:10.1038/nclimate2250

Arnold JEM, Perez MR (2001) Can non-timber forest products match tropical forest conservation and development objectives? Ecol Econ 39:437–447. doi:10.1016/s0921-8009(01)00236-1

Baker AM, Lacy RC, Leus K, Traylor-Holzer K (2011) Intensive management of populations for conservation. WAZA Mag 12:40–43

Beach RH, Pattanayak SK, Yang JC, Murray BC, Abt RC (2005) Econometric studies of non-industrial private forest management a review and synthesis. Forest Policy Econ 7:261–281. doi:10.1016/s1389-9341(04)00065-0

Beratan KK (2007) A cognition-based view of decision processes in complex social-ecological systems. Ecol Soc 12:27

Boon TE, Meilby H, Thorsen BJ (2004) An empirically based typology of private forest owners in Denmark: improving communication between authorities and owners. Scand J For Res 19:45–55. doi:10.1080/14004080410034056

Canadas MJ, Novais A (2014) Bringing local socioeconomic context to the analysis of forest owners' management. Land Use Policy 41:397–407. doi:10.1016/j.landusepol.2014.06.017

Caughley G (1994) Directions in conservation biology. J Anim Ecol 63:215–244. doi:10.2307/5542

Cocklin C, Dibden J, Mautner N (2006) From market to multifunctionality? Land stewardship in Australia. Geogr J 172:197–205. doi:10.1111/j.1475-4959.2006.00206.x

Creighton J, Baumgartner D, Blatner K (2002) Ecosystem management and nonindustrial private forest landowners in Washington State, USA. Small Scale Econ Manag Policy 1:55–69. doi:10.1007/s11842-002-0005-z

Duncker PS, Barreiro SM, Hengeveld GM, Lind T, Mason WL, Ambrozy S, Spiecker H (2012) Classification of forest management approaches: a new conceptual framework and its applicability to European forestry. Ecol Soc 17:51. doi:10.5751/es-05262-170451

Eggers J, Lamas T, Lind T, Ohman K (2014) Factors influencing the choice of management strategy among small-scale private forest owners in Sweden. Forests 5:1695–1716. doi:10.3390/f5071695

Elkington J (1994) Towards the sustainable corporation—win-win-win business strategies for sustainable development. Calif Manag Rev 36:90–100

Emtage N, Herbohn J, Harrison S (2007) Landholder profiling and typologies for natural resource-management policy and program support: potential and constraints. Environ Manag 40:481–492. doi:10.1007/s00267-005-0359-z

Eriksson L (2012) Exploring underpinnings of forest conflicts: a study of forest values and beliefs in the general public and among private forest owners in Sweden. Soc Nat Resour 25:1102–1117. doi:10.1080/08941920.2012.657749

FAO (2000) The global outlook for future wood supply from forest plantations. FAO, Rome

FAO (2005) Trends in wood products 1961–2003. FAO, Rome

FAO (2012) Global forest products products facts and figures. http://www.fao.org/forestry/en/. Accessed 28 March 2014

Ferber J (1999) Multi-agent systems: an introduction to distributed artificial intelligence. Addison-Wesley Longman, Harlow

Ficko A, Boncina A (2013) Probabilistic typology of management decision making in private forest properties. Forest Policy Econ 27:34–43. doi:10.1016/j.forpol.2012.11.001

Finley AO, Kittredge DB (2006) Thoreau, Muir, and Jane Doe: different types of private forest owners need different kinds of forest management. North J Appl For 23:27–34

Franklin JF (1993) Preserving Biodiversity: species, Ecosystems, or Landscapes? Ecol Appl 3:202–205. doi:10.2307/1941820

Fujimori T (2001) Ecological and silvicultural strategies for sustainable forest management. Elsevier, Amsterdam

Gamfeldt L et al (2013) Higher levels of multiple ecosystem services are found in forests with more tree species. Nat Commun 4:1340. doi:10.1038/ncomms2328

Griliches Z, Mason WM (1972) Education, income, and ability. J Polit Econ 80:S74–S103. doi:10.2307/1831252

Guillem EE, Barnes AP, Rounsevell MDA, Renwick A (2012) Refining perception-based farmer typologies with the analysis of past census data. J Environ Manag 110:226–235. doi:10.1016/j.jenvman.2012.06.020

Ingemarson F, Lindhagen A, Eriksson L (2006) A typology of small-scale private forest owners in Sweden. Scand J For Res 21:249–259. doi:10.1080/02827580600662256

Janse G, Ottitsch A (2005) Factors influencing the role of non-wood forest products and services. Forest Policy Econ 7:309–319. doi:10.1016/s1389-9341(03)00068-6

Joshi S, Arano KG (2009) Determinants of private forest management decisions: a study on West Virginia NIPF landowners. Forest Policy Econ 11:118–125. doi:10.1016/j.forpol.2008.10.005

Karali E, Brunner B, Doherty R, Hersperger AM, Rounsevell MDA (2013) The effect of farmer attitudes and objectives on the heterogeneity of farm attributes and management in Switzerland. Hum Ecol 41:915–926. doi:10.1007/s10745-013-9612-x

Karppinen H (1998) Values and objectives of non-industrial private forest owners in Finland. Silva Fenn 32:43–59

Kline JD, Alig RJ, Johnson RL (2000) Fostering the production of nontimber services among forest owners with heterogeneous objectives. For Sci 46:302–311

Landais E (1998) Modelling farm diversity new approaches to typology building in France. Agric Syst 58:505–527. doi:10.1016/s0308-521x(98)00065-1

Le Du-Blayo L (2011) How do we accommodate new land uses in traditional landscapes? Remanence of landscapes, resilience of areas, resistance of people. Landsc Res 36:417–434. doi:10.1080/01426397.2011.583010

Liao XC, Zhang YQ (2008) An econometric analysis of softwood production in the US South: a comparison of industrial and nonindustrial forest ownerships. For Prod J 58:69–74

Lidestav G (2010) In competition with a brother: women's inheritance positions in contemporary Swedish family forestry. Scand J For Res 25:14–24. doi:10.1080/02827581.2010.506781

Lönnstedt L (2012) Small scale forest owners' responsibilities: results from a Swedish case study. Small Scale For 11:407–416. doi:10.1007/s11842-011-9187-6

Majumdar I, Teeter L, Butler B (2008) Characterizing family forest owners: a cluster analysis approach. For Sci 54:176–184

Matilainen A, Lahdesmaki M (2014) Nature-based tourism in private forests: stakeholder management balancing the interests of entrepreneurs and forest owners? J Rural Stud 35:70–79. doi:10.1016/j.jrurstud.2014.04.007

MCPFE (2003) Improved Pan-European Indicators for Sustainable Forest Management

Meyfroidt P, Rudel TK, Lambin EF (2010) Forest transitions, trade, and the global displacement of land use. Proc Natl Acad Sci USA 107:20917–20922. doi:10.1073/pnas.1014773107

Millennium Ecosystem Assessment (2005) Ecosystems and human well-being: Synthesis. Washington, DC

Newman DH, Wear DN (1993) Production economics of private forestry—a comparison of industrial and nonindustrial forest owners. Am J Agric Econ 75:674–684. doi:10.2307/1243574

Ní Dhubháin Á, Cobanova R, Karppinen H, Mizaraite D, Ritter E, Slee B, Wall S (2007) The values and objectives of private forest owners and their influence on forestry behaviour: the

implications for entrepreneurship. Small Scale For 6:347–357. doi:10.1007/s11842-007-9030-2
Ninan KN, Inoue M (2013) Valuing forest ecosystem services: case study of a forest reserve in Japan. Ecosyst Serv 5:78–87. doi:10.1016/j.ecoser.2013.02.006
Nordlund A, Westin K (2011) Forest values and forest management attitudes among private forest owners in Sweden. Forests 2:30–50. doi:10.3390/f2010030
Otte A, Simmering D, Wolters V (2007) Biodiversity at the landscape level: recent concepts and perspectives for multifunctional land use. Landsc Ecol 22:639–642. doi:10.1007/s10980-007-9094-6
Paquette S, Domon G (1999) Agricultural trajectories (1961–1991), resulting agricultural profiles and current sociodemographic profiles of rural communities in southern Quebec (Canada): a typological outline. J Rural Stud 15:279–295. doi:10.1016/s0743-0167(98)90063-8
Richnau G et al (2013) Multifaceted value profiles of forest owner categories in South Sweden: the River Helge å catchment as a case study. Ambio 42:188–200. doi:10.1007/s13280-012-0374-2
Ross-Davis A, Broussard S (2007) A typology of family forest owners in north central Indiana. North J Appl For 24:282–289
Rounsevell MDA, Robinson DT, Murray-Rust D (2012) From actors to agents in socio-ecological systems models. Philos Trans Roy Soc B 367:259–269. doi:10.1098/rstb.2011.0187
Rudel TK, Coomes OT, Moran E, Achard F, Angelsen A, Xu JC, Lambin E (2005) Forest transitions: towards a global understanding of land use change. Global Environ Chang 15:23–31. doi:10.1016/j.gloenvcha.2004.11.001
Seppälä R (2006) Global trends and issues in the forest sector and challenges to forest research. Allg Forst Und Jagdztg 177(8–9):138–141
Seppala R (2008) Global forest sector: trends, threats and opportunities. In: FreerSmith PH, Broadmeadow MSJ, Lynch JM (eds) Forestry and climate change. Cabi Publishing-C a B Int, Wallingford, pp 25–30
Siry JP, Cubbage FW, Ahmed MR (2005) Sustainable forest management: global trends and opportunities. Forest Policy Econ 7:551–561. doi:10.1016/j.forpol.2003.09.003
Sohngen B, Mendelsohn R, Sedjo R (1999) Forest management, conservation, and global timber markets. Am J Agric Econ 81:1–13. doi:10.2307/1244446
Sorice MG, Kreuter UP, Wilcox BP, Fox WE (2014) Changing landowners, changing ecosystem? Land-ownership motivations as drivers of land management practices. J Environ Manag 133:144–152. doi:10.1016/j.jenvman.2013.11.029
Stern PC, Dietz T, Kalof L (1993) Value orientations, gender and environmental concern. Environ Behav 25:322–348. doi:10.1177/0013916593255002
Urquhart J, Courtney P (2011) Seeing the owner behind the trees: a typology of small-scale private woodland owners in England. Forest Policy Econ 13:535–544. doi:10.1016/j.forpol.2011.05.010
Vereijken PH (2002) Transition to multifunctional land use and agriculture. Neth J Agric Sci 50:171–179
Wiersum KF, Elands BM, Hoogstra M (2005) Small-scale forest ownership across Europe: characteristics and future potential. Small-scale Econ Manag Policy 4:1–19. doi:10.1007/s11842-005-0001-1
Wiggering H et al (2006) Indicators for multifunctional land use—linking socio-economic requirements with landscape potentials. Ecol Indic 6:238–249. doi:10.1016/j.ecolind.2005.08.014