Ecosystem Services 29 (2018) 128–136

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Not so biocentric – Environmental benefits and harm associated with the acceptance of forest management objectives by future environmental professionals

Brent D. Matthies [a,*], Annukka Vainio [b], Dalia D'Amato [c]

[a] Dasos Capital, Itämerentori 2, FI 00180 Helsinki, Finland
[b] Natural Resources Institute Finland (Luke), Bioeconomy and Environment, Latokartanonkaari 9, FI 00790 Helsinki, Finland
[c] Helsinki Institute of Sustainability Science, Faculty of Agriculture and Forestry (Dept. of Forest Sciences), University of Helsinki, Latokartanonkaari 7, P.O. Box 27, FI 00014 Helsinki, Finland

ARTICLE INFO

Article history:
Received 8 February 2017
Received in revised form 9 August 2017
Accepted 5 December 2017
Available online 20 December 2017

Keywords:
Environmental concern
Forest management
Bioenergy
Timber
Biocentric
Anthropocentric

ABSTRACT

It is not yet completely clear how individuals weigh positive and negative consequences of specific environmental actions to the self, others and nature, and how these evaluations are associated with the acceptance of such environmental actions. We explored how the acceptance of ecosystem service-related forest management objectives were associated with perceived positive and negative consequences, perceived knowledge of these objectives, and gender among future professionals in the bioeconomy context. We analysed a survey collected among Finnish university students majoring in agriculture and forestry, and biological and environmental sciences (N = 159). We found that environmental concerns followed a two-factor structure: concerns for humans and concerns for the environment. Perceived harm to nature and humans reduced the acceptance of timber and bioenergy objectives, but only the effect of perceived harm to humans remained when they were considered together with perceived benefits. Perceived knowledge of the objectives had little effect on acceptance of the objectives. Females endorsed the biodiversity and climate objectives more than males, whereas males endorsed timber objectives more than females. These results show that in the context of ecosystem service management, positive consequences are more important than negative when evaluating bioeconomy objectives, and that consequences to humans are more important than consequences to the environment.

1. Introduction

The bioeconomy is currently being promoted as an important sustainability avenue in the Nordic countries and globally (European Commission, 2012; USA, 2012; Hetemäki et al., 2017). The main idea is to replace non-renewable materials with bio-based solutions, including bio-fuels and bio-energy, bio-material and bio-chemicals (Hetemaki, 2014; Ollikainen, 2014; De Besi and McCormick, 2015). Forest ecosystems and the forest sector play a fundamental role in this context as an important provisioning source.

A renewal of forest management objectives under the Finnish Bioeconomy Strategy (Biotalous in Finnish) could affect the availability and trade-offs of ecosystem services to different societal actors. This discussion thus requires an assessment of the level at which sustainable bio-based value chains suit the motivations behind pro-environmental or 'green' value creation by value chain actors (e.g., Birch and Tyfield, 2013; Jing and Jiang, 2013). In the value-basis theory, attitudes can act to guide behaviour that is linked to the mitigation of negative environmental impacts (i.e., environmental externalities) based on the relative importance placed on that impact (Stern and Dietz, 1994). On that basis, actions by value chain actors to mitigate negative environmental impacts at different points in the value chain could be motivated by their concern for the potential impacts.

Value-basis theory can be considered a form of non-monetary approach to ecosystem services valuation to inform and enable sustainable ecosystem management. Despite the growing interest in non-monetary techniques in ecosystem service research, so far there have been very few direct applications of the approach to specific ecosystem service-oriented management objectives (for exceptions see e.g., Lamarque et al., 2011). Non-monetary valuation is important for addressing some of the limitations of

* Corresponding author.
E-mail addresses: brent.matthies@dasos.fi (B.D. Matthies), annukka.vainio@luke.fi (A. Vainio), dalia.damato@helsinki.fi (D. D'Amato).

https://doi.org/10.1016/j.ecoser.2017.12.003
2212-0416/

monetary valuation; especially of non-market valuation approaches (e.g., willingness-to-pay) that tend to not account for differences in value orientations between independent outcomes (i.e., two differing ecosystem service offerings – which are the basis of exchange whereby firms and individuals co-create value with natural ecosystems (Matthies et al., 2016a)), an outcome can lead to trade-offs or conflicts within the cognitive space.

In environmental psychology, pro-environmental behaviour has been defined as behaviour that aims at minimizing the negative impacts on the environment (Kollmuss and Agyeman, 2002). Since pro-environmental behaviour of individuals is driven by a complex set of underlying factors that are uniquely and phenomenologically determined, clarifying an entire set of factors behind pro-environmental behaviour by individual actors is challenging and potentially infeasible (Kollmuss and Agyeman, 2002). Still, the pro-environmental concerns of economic actors have previously been shown to be important predictors of pro-environmental behaviour (e.g., Schwartz, 1973; Schwartz and Howard, 1981; Stern et al., 1993, 1995; Schultz, 2001; Snelgar, 2006). Additionally, Fietkau and Kessel (1981) have demonstrated that knowledge and attitudes are also important for understanding pro-environmental behavior. To better understand the role of concerns in determining behavior, Schultz (2001) has presented a survey method for eliciting the attitudes of environmental concerns of individuals. He suggested that egoism (i.e., personal well-being), altruism (i.e., social well-being), and biospherism (i.e., environmental health) form a tripartite characterizing of the pro-environmental concerns of individuals following Stern et al. (1993). Other authors, such as Snelgar (2006), have demonstrated that this method is both robust and provides replicable results.

To better account for the trade-offs associated with the utilization of ecosystem service offerings by different value chain/network actors, we have proposed using the survey method that was developed by Shultz to elicit general environmental concerns related to self, other humans and nature, to elicit the pro-environmental concerns of actors for different forestry-related ecosystem service categories. The aim of this approach is to determine if there are differences in the environmental concerns among individuals towards different ecosystem service offerings in the context of the bioeconomy. This will be important, as previous research has indicated that there are important underlying factors related to concerns about bioenergy and timber production within the broader range of ecosystem services (e.g., in relation to the regulation of genetic diversity and climate change) (Karppinen, 1998; Halder et al., 2010, 2011).

Moreover, much of the pro-environmental concern literature only considers environmental impacts at the general level focusing on negative impacts. Nevertheless, risk perception literature suggests that people evaluate both negative and positive consequences, which both influence the acceptance of a risk and that positive consequences can be even more important than negative ones (Siegrist, 1999, 2000; Siegrist et al., 2007; Visschers et al., 2011). Impacts act to constrain ecosystem service provisioning to the economy and society, and are phenomenologically determined by individuals along the value chain or in the network of chains. This includes both positive and negative environmental impacts, which influence the total potential value available along a value chain or throughout a network of chains (Jing and Jiang, 2013; Matthies et al., 2016a).

The aim of this study is thus to apply value-basis theory methods to elicit pro-environmental concern and acceptance of specific management objectives under a bioeconomy in Finnish forests. The four selected forest management objectives include: biomass for bioenergy production, timber for long-term storage of carbon, genetic and structural diversity to support ecosystem diversity, and conservation of forest to support carbon sequestration and storage. Forest management objectives were used in the survey, as these are terms that all students surveyed are familiar with whereas the concept of ecosystem services was considered unfamiliar to a minority of students. We have adapted the Schultz (2001) method to evaluate the pro-environmental concern and applied it separately to each of these four ecosystem service-related categories in the context of boreal forest management objectives in Finland. These four categories coincide with the categorizing according to the CICES (2013) classification framework. A survey was developed for eliciting how individuals' concern for each ecosystem service objective, including both positive and negative concerns, is structured (See Supplementary Materials). The survey was administered to students of natural resource management at the University of Helsinki in Helsinki, Finland between January and May 2016. The surveyed students represented future professionals who will make decisions about forest ecosystem services as part of their career work in the future, and therefore it was considered important to understand better how they perceive environmental concerns associated with forest management issues.

2. Pro-environmental concerns for ecosystem services in the bioeconomy

The ecosystem service concept emphasizes the benefits derived from natural and semi-natural ecosystems. It is an anthropocentric approach for determining the service value flows (i.e., quantity/quality over time) from ecological processes for the benefit of human beings (de Groot et al., 2002; MEA, 2005; Turner and Daily, 2008; Fisher et al., 2009; Matthies, 2016).

Lusch and Vargo (2014), Matthies et al. (2016a) and Vargo and Lusch (2016) all have proposed that the ecosystem service approach is actually a part of the service-dominant logic of value co-creation. Based on that logic, the interaction (e.g., management) with natural ecosystems by human actors results in decisions that impact ecosystem service provisioning over the entire chain or network of actors and value interactions. Actions that increase or decrease ecosystem service provisioning have co-current impacts on or trade-offs with the provisioning of other ecosystem service offerings. These impacts, which Matthies et al. (2016a) have termed *value-in-impact*, are part of the total potential value available to subsequent actors or beneficiaries in the chain or network. According to the same theory, an individual's environmental concerns can have an important role in determining the value creation opportunities that result from utilizing a given set of ecosystem service offerings relative to alternative sets of offerings.

In the context of environmental psychology, Schwartz's (1973, 1977) norm-activation theory states that pro-environmental behaviour is carried out in response to the personal moral norms related to those actions when the individual believes that certain actions lead to negative impacts on the environment, and thus on individuals or society. It follows that the individual also believes that their actions will help to avert the negative impacts on the environment. Following the norm-activation theory, the value-belief-norm (VBN) theory was further refined by Stern et al. (1999), also drawing from the New Ecological Paradigm (Dunlap and Van Liere, 1978, 1984). According to the VBN theory, held values shape individuals' worldviews and beliefs about environmental problems. When the individual believes that adverse consequences are threatening the valued object(s), personal norms take place in triggering response behaviours. The VBN theory suggests that there are three types of environmental concerns: egoism, social-altruism, and biospherism (Stern et al., 1995; Rhead et al., 2015). This three-factor model was postulated to be sufficient to fully capture individuals' concerns related to environmental issues,

based on both theoretical and empirical research (Stern et al., 1993; Schultz, 2001; Snelgar, 2006). Environmental concerns are thus shown to be based on values (e.g., Stern and Dietz, 1994). It is important to note that, in this study, we apply the concept of environmental concern as it was defined and operationalized by Schultz (2001) and we do not explore the association between values and environmental concerns.

Much of the pro-environmental concern literature only considers environmental impacts at the general level with a focus on negative impacts. Risk perception literature, instead, suggests that people evaluate both negative and positive consequences, which both influence the acceptance of risks associated with environmental actions; positive consequences can be even more important than negative ones (Siegrist, 1999; 2000; Siegrist et al. 2007; Visschers et al., 2011).

Furthermore, the acceptance of different environmental actions is also associated with individuals' knowledge of these in a complex way. For example in forest sciences literature, Halder et al. (2011) found that most knowledgeable students in bioenergy were also the most critical in their attitudes towards the use of forest-based bioenergy. Uliczka et al. (2004) found that private forest owners who perceived themselves as being knowledgeable about nature conservation also had most positive attitudes toward conservation. There has also been growing evidence that gender can also be an important determinant of acceptance of bioenergy management: females have been shown to have more negative attitude towards bioenergy production than males (Halder et al., 2011). Moreover, females are likely to express more biocentric value orientations toward nature than men (Fortmann and Kusel, 1990).

Based on the above-mentioned literature, we tested five hypotheses in conducting the survey in this study. We expected to find that environmental concerns, as defined by Schultz (2001), exhibited a three-factor structure, including biospheric, altruistic and egoistic concerns (e.g., Stern et al., 1999) (H1). Moreover, we expected to find female participants to express more negative attitude towards bioenergy production than males (Halder et al., 2011) (H2). We also expected to find that both positive and negative consequences are important in evaluating the acceptance of forest management objectives (H3) and that the positive consequences are more important than negative consequences (Siegrist, 1999; 2000; Siegrist et al., 2007; Visschers et al., 2011) (H4). Finally, we expected that perceived knowledge would affect acceptance of forest management objectives (Halder et al., 2011) (H5). In testing these hypotheses, we also considered forest ownership and age as demographic variables.

3. Data and methods

3.1. The sample

Respondents were Bachelors and Masters level students from various major subject areas in the Faculties of Agriculture and Forestry, and Biological and Environmental Sciences at the University of Helsinki in Finland. A total of 165 questionnaires were collected between January and April 2016 during classroom hours. All the courses that were running in that period were invited to participate and all students who we present during the classroom hours were invited to participate. The questionnaire was administered in Finnish. The questionnaire took between 10 and 15 min for respondents to fill out. Six questionnaires were removed from the sample because two or more sections were unfilled.

The mean age was 25 years (SD = 5.63) and 40 percent of the participants were female, and 56 percent were forest owners; this is expected in Finland where there are high levels of private forest ownership; about 12 per cent of Finns own forests; Leppänen and Sevola, 2013). In Finland, it is common for families to own about 30 ha of forest and for owners to carry out the management of that forest (Natural Resources Institute Finland, 2013).

3.2. Survey design and analysis

The survey was designed to assess perceived consequences of pursuing four different forest management objectives, as well as participants' perceived knowledge, and acceptance of these objectives. These objectives were:

- Biomass for bioenergy production,
- Timber for long-term storage of carbon,
- Genetic and structural diversity to support ecosystem diversity, and
- Conservation of forest to support carbon sequestration and storage.

This article focuses on analysing the association between perceived positive and negative consequences and acceptance of the first two objectives. The trade-offs between four different objectives were also examined including perceived knowledge and acceptance of all four objectives in the analysis.

3.2.1. Perceived benefits and harm

We wanted to explore individuals' environmental concerns in the specific contexts of forest management practices. Therefore, we used Schultz (2001)'s survey format to measure environmental concern where respondents were asked to rank the 12 objects organized around self, other people and biosphere using a 7-point scale (see Supplementary Materials). However, we made two key modifications to the scale. First, the original method only evaluated participants' concerns of environmental problems at a general level. This lack of specificity is in contrast with the wide variation in environmental problems and their varied effects on people and the biosphere. Research applying Ajzen's theory of planned behaviour (TPB) (Ajzen, 1991) shows that psychological constructs that are specific to the same context as the outcome variable are stronger predictors of behavioural intentions than general constructs (Bamberg, 2003). Thus, we modified the method to account for these effects. We measured environmental concerns in the specific contexts of four different forest management objectives emphasizing the provisioning of the following ecosystem service categories: climate mitigation through the storage of carbon in long-live wood products, provisioning of energy through woody biomass, regulation of the climate and conservation of genetic diversity. For the sake of this analysis, only the results of the first two are reported in this study.

Second, since the original method only measures negative consequences for valued objects, we modified the survey to assess measured both perceived benefit and harm, in alignment with risk perception literature (Siegrist, 2000; Visschers et al., 2011) as well as previous research providing a reinterpretation of the findings about environmental consequences (Ryan and Spash, 2012), which both indicate that individuals make a distinction between positive and negative consequences. Concern about the positive and negative impacts (i.e. benefits and harm) were elicited separately for each of the forest management objectives. In this way, it was possible to evaluate the environmental concerns (i.e. biocentrism, altruism, egoism) towards management objective (i.e. bioenergy provisioning) in terms of both positive and negative impacts. These distinctions were made to determine if there were differences between the perceived positive and negative impacts of managing for different objectives, and if each of the ecosystem service-related categories followed a three-factor model when they were separated into individual concern categories.

In practice, the participants were requested to evaluate the importance of consequences of each forest management objective for the following 12 items: plants, birds, animals and climate (representing biocentric concerns); to oneself, own lifestyle, own health and own future (representing egoistic concerns); and to people living in Finland; all people; children; and future generations (representing altruistic concerns).

3.2.2. Perceived knowledge and acceptance of forest management objectives

The respondents were also asked to indicate their perceived knowledge about the four forest management objectives of from 1 (no knowledge) to 5 (a very high level of knowledge) and to do the same for their level of acceptance for pursuing these management objectives in Finnish forestry, on a scale ranging from 1 (does not accept at all) to 5 (fully accept).

Demographic data were collected about respondents' age, gender, major university subject, and whether their family owned forest land.

3.3. Statistical analysis

Three statistical methods were used to analyze the data. First, a principal component analysis (PCA) was carried out to determine if the data fit better with a two or three factor model (H1). Thompson (2004) provides a detailed explanation of the method and its use in similar research. We do not describe it in greater detail here, as the method is well-established in scientific research.

Second, an evaluation of the differences in acceptance between genders was carried out using a Mann–Whitney U test for not normally distributed samples. The Independent Samples Mann–Whitney U Test is a rank-based non-parametric test to determine differences between groups on a continuous or ordinal dependent variable. This method was used given that the data for acceptance of the four different management objectives was not normally distributed.

Third, to test whether the effect of perceived benefits may override perceived harm (H3 and 4) and whether perceived knowledge of objectives influenced acceptance (H5) we used hierarchical linear regression analysis where variables are gradually included in the model. Hierarchical linear regression is often used for testing the effects of certain predictors independently of the influence of others. In practice, this method enables the researcher to analyse changes in the effects of predictor variables on dependent variables when new variables are added to the model. Tabachnick and Fidell (2012) provide a detailed description of this method and its applications to different research contexts.

4. Results

4.1. Descriptive statistics and a two-factor model

Table 1 shows that egoistic benefits were evaluated as most relevant, followed by altruistic and biocentric benefits. This indicates that the benefits to nature are perceived to be less relevant than those for one's self and society. This trend was inversed when the harm from carrying out those management objectives was considered. The standard deviations followed a similar trend, with higher deviation for biocentric orientation under benefits and lower under harm. The inverse was observed for egoistic and altruistic orientations. Both acceptance of and knowledge about biodiversity conservation and climate change mitigation objectives were higher than for timber and bioenergy.

A PCA was run to determine if the data fit better with a two- or three-factor model. Schultz (2001) and Snelgar (2006) suggested that a three-factor model was better than a two-factor model for explaining the perceived awareness of consequences of behaviors. The correlation matrix was inspected to determine if there was an appropriate level of correlation. All variables had correlations for all questions greater than 0.5. For Timber-Benefit (1), Timber-Harm (2), Bioenergy-Benefit (3) and Bioenergy-Harm (4) questions, the Kaiser–Meyer-Olkin (KMO) measure was determined to be (1) 0.689, (2) 0.715, (3) 0.702 and (4) 0.727. Bartlett's test of sphericity was statistically significant ($p < 0.0005$) for all the outcomes noted in Table 1, which indicates that it was possible to carry out a PCA.

The PCA revealed that only one component had an eigenvalue greater than one. However, a visual inspection of the scree plots indicated that two components were appropriate to be retained for all questions. Given that both the Kaiser criterion (i.e., retain factors greater than one) and scree method have been shown to be conflicting, retaining too many or too few factors, we have proceeded with retaining two factors. This corresponded to eigenvalues greater than 0.5 in all cases. Furthermore, two-component solutions met the interpretability criterion. Varimax orthogonal rotations were used to aid interpretability of the solutions. Therefore, H1 (i.e., three-factor model) was not confirmed.

Factor loadings, explained variance of the factors and the communalities of the rotated solution are all presented in Table 2. In all cases, the aggregated altruistic and egoistic objects loaded on the first factor (later we refer to this factor as the anthropocentric factor), and the aggregated biocentric objects loaded on the second factor. Loadings below 0.5 were suppressed, although most suppressed loadings were below 0.3. The two factors explained a high level of variance for all the questions. The factors were then converted to logarithmic scale to be used in the subsequent regression analysis.

4.2. Gender and acceptance of environmental impacts

The Independent Samples Mann–Whitney U test (Table 3) revealed the distribution of acceptance towards different management objectives among male and female students. The median acceptance scores for timber, biodiversity, and climate mitigation were found to be different between males and females. In the case of timber males found the objective to be significantly more acceptable than females did, but females found management for biodiversity and climate mitigation to be more acceptable. For bioenergy, there was no gender difference. H2 was thus only partly accepted.

4.3. Regression models for forest management objectives

4.3.1. Timber

In the first step of the hierarchical regression analysis, perceived relevance of both types of harm – biocentric and anthropocentric (i.e., altruistic and egoistic combined) objects – were associated with reduced acceptance of forest management practices aimed at pursuing timber production objectives (Table 4). However, when perceived benefits were included in the model, only perceived harm to biosphere remained significant suggesting that perceived benefits were more important than perceived harm in explaining acceptance. Both types of benefit were associated with increased acceptance of timber production objectives.

The perceived knowledge of timber production and climate change mitigation objectives were associated with increased acceptance of timber production objectives. Conversely, perceived knowledge of bioenergy objectives was associated with reduced acceptance of forest management for meeting timber objectives. Of the three background variables included in the model, only gender was associated with the acceptance of timber objectives. Males had a higher level of acceptance of timber production objectives

Table 1
Descriptive statistics for all four ecosystem service-related management objectives: associated benefits and harm from undertaking them, perceived knowledge, and acceptance.

			Mean	Standard Deviation
Perceived relevance of consequences[a]				
Timber	Benefits	Biocentric	16.10	7.02
		Altruistic	19.22	5.66
		Egoistic	21.61	5.17
	Harm	Biocentric	18.77	6.51
		Altruistic	13.96	6.77
		Egoistic	15.87	7.13
Bioenergy	Benefits	Biocentric	15.48	7.10
		Altruistic	18.01	6.19
		Egoistic	20.11	6.04
	Harm	Biocentric	17.90	6.94
		Altruistic	13.80	6.76
		Egoistic	15.58	7.20
Biodiversity	Benefits	Biocentric	24.97	3.80
		Altruistic	21.95	5.23
		Egoistic	20.61	5.69
	Harm	Biocentric	11.17	8.56
		Altruistic	11.86	6.94
		Egoistic	10.05	6.59
Climate	Benefits	Biocentric	21.48	5.77
		Altruistic	22.80	5.09
		Egoistic	20.99	6.41
	Harm	Biocentric	12.01	7.82
		Altruistic	12.61	7.23
		Egoistic	10.97	6.81
Perceived knowledge of forest management objectives[b]				
timber			2.78	1.01
bioenergy			2.78	0.99
biodiversity			3.35	1.00
climate			3.02	0.99
Acceptance of forest management objectives[b]				
timber			3.69	1.04
bioenergy			3.29	1.08
biodiversity			4.37	0.97
climate			4.20	1.03

[a] Range of the scale: 4–28 (totally insignificant – extremely important).
[b] Range of the scale: 1–5.

Table 2
Factor loadings based on the two-factor model for perceived harm and benefits from pursuing timber and bioenergy management objectives.

Variable			Loading on Factor 1	Loading on Factor 2	Variance Explained	Commonalities
Timber	Benefits	Biocentric		0.952	36%	1.000
		Altruistic	0.877		55%	0.853
		Egoistic	0.884			0.858
	Total Variance Explained				91%	
	Harm	Biocentric		0.925	12%	0.997
		Altruistic	0.909		82%	0.928
		Egoistic	0.844			0.901
	Total Variance Explained				94%	
Bioenergy	Benefits	Biocentric		0.939	15%	0.997
		Altruistic	0.854		78%	0.877
		Egoistic	0.908			0.903
	Total Variance Explained				93%	
	Harm	Biocentric		0.913	10%	1.000
		Altruistic	0.871		84%	0.927
		Egoistic	0.889			0.933
	Total Variance Explained				94%	

than females. This also corresponds to the results noted in Section 4.2 (Table 3).

4.3.2. Bioenergy

Perceived biocentric and anthropocentric harm were associated with reduced acceptance of forest management with bioenergy objectives (Table 5). However, when perceived benefits were included in the model, only perceived harm to biosphere remained significant. This trend is the same as in the timber model. Both biocentric and anthropocentric benefits were associated with increased acceptance of bioenergy objectives.

Of the four forest management objectives, only knowledge of biodiversity conservation objectives were significant: it was associated with reduced acceptance of bioenergy objectives. These findings suggest that both perceived harm and benefits were important in evaluations of forest management objectives. Moreover, they suggest that some types of perceived benefits are more important than some types of perceived harm. For anthropocentric

Table 3
Differences between males and females in the acceptance of four different management objectives. The Independent Samples Mann-Whitney U Test results.

Management objective	Median values		Mann-Whitney U	Z-score	Significance*
	Male	Female			
Timber	4.0	3.5	3523.5	2.782	0.005
Bioenergy	3.0	3.0	2888.0	0.319	0.750
Biodiversity	4.0	5.0	2014.0	−3.439	0.001
Climate	4.0	5.0	2061.0	−3.040	0.002

* significance level is 0.05.

Table 4
Hierarchical linear regression predicting acceptance of forest management that focuses on maximizing timber objectives.

		Step 1			Step 2			Step 3			Step 4		
		B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Harm:	Anthropocentric	−0.20	0.07	−0.22**	−0.16	0.06	−0.18*	−0.15	0.06	−0.16*	−0.16	0.06	−0.17**
	Biocentric	−0.21	0.08	−0.21**	−0.11	0.07	−0.11	−0.08	0.07	−0.08	−0.05	0.07	−0.05
Benefit:	Anthropocentric				0.42	0.07	0.43***	0.38	0.07	0.38***	0.40	0.07	0.38***
	Biocentric				0.16	0.06	0.19**	0.16	0.06	0.19**	0.17	0.06	0.20**
Knowledge:	Timber							0.28	0.08	0.37***	0.25	0.08	0.33**
	Bioenergy							−0.14	0.08	−0.17	−0.14	0.08	−0.18
	Biodiversity							−0.31	0.08	−0.35***	−0.30	0.08	−0.34***
	Climate							0.20	0.08	0.23*	0.19	0.08	0.22*
Age											−0.11	0.11	−0.07
Gender (0 = female, 1 = male)											0.10	0.05	0.16*
Forest ownership (0 = no, 1 = yes)											0.00	0.04	0.01
Adjusted R^2		0.08**			0.27***			0.38***			0.39***		

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 5
Hierarchical linear regression predicting acceptance of forest management that focuses on maximizing bioenergy objectives.

		Step 1			Step 2			Step 3			Step 4		
		B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Harm	Anthropocentric	−0.20	0.08	−0.19*	−0.23	0.07	−0.22**	−0.21	0.07	−0.20**	−0.22	0.07	−0.21**
	Biocentric	−0.36	0.11	−0.25**	−0.12	0.10	−0.08	−0.10	0.10	−0.07	−0.11	0.10	−0.08
Benefit	Anthropocentric				0.48	0.08	0.42***	0.49	0.08	0.43***	0.50	0.08	0.44***
	Biocentric				0.44	0.08	0.37***	0.41	0.08	0.34***	0.41	0.08	0.34***
Knowledge	Timber							0.02	0.09	0.03	0.01	0.10	0.01
	Bioenergy							−0.04	0.10	−0.04	−0.03	0.10	−0.04
	Biodiversity							−0.22	0.10	−0.21*	−0.20	0.10	−0.19*
	Climate							0.17	0.09	0.17	0.17	0.10	0.17
Age											0.08	0.13	0.04
Gender (0 = female, 1 = male)											0.01	0.05	0.01
Forest ownership (0 = no, 1 = yes)											−0.03	0.05	−0.04
Adjusted R^2		0.09***			0.35***			0.36***			0.36***		

* $p < 0.05$.
** $p < 0.01$.
*** $p < .001$.

harm and benefits, they are equally important. In the context of biocentric benefits, they supersede the effect of perceived harm.

Of our hypotheses tested considering the hierarchical linear regressions, the hypothesis three (H3), testing the assumption that both positive and negative effects are important in evaluating the acceptance of forest management objectives, was fully confirmed. The hypothesis testing the assumption that the positive consequences are more important than negative consequences was partially confirmed (H4). The hypothesis testing the assumption that knowledge of forest management objectives is associated with acceptance of these objectives was fully confirmed (H5).

5. Discussion

In this study, we explored how environmental concerns, separated as perceived risks and perceived benefits, were associated with the acceptance of forest management objectives, and ultimately the levels of ecosystem service provisioning, in Finnish forests. The sampling utilized university students, who represent future environmental and forestry professionals.

We found that environmental concerns followed a two-factor structure: anthropocentric concerns (i.e. concerns for humans) and biospheric concerns (i.e., concerns for the environment). Most

studies applying the method by Schultz (2001) to general environmental concerns have confirmed a three-factor structure. However, the close association between altruistic and egoistic concerns have also been reported previously. For example, using a sample of university students in UK, Snelgar (2006) found that anthropocentric concerns (i.e., altruistic and egoistic) were more closely associated with each other than they were to biospheric concerns. Moreover, Rhead et al. (2015) used a different set of survey questions on a nationally representative UK sample, and found a three-factor structure including ecocentric and anthropocentric factors, and a "denial" factor representing scepticism. The studies applying other theoretical frameworks suggest that environmental concerns may likely follow a two-factor structure, as our study suggests: biocentric (i.e., nature valued for its own sake) and anthropocentric (i.e., nature valued for its contribution to humanity) (Steel et al., 1994; Thompson and Barton, 1994; Vaske and Donnelly, 1999). The adapted method in our study, looking at specific environmental problems/management objectives and the associated specific environmental concerns for a set of ecosystem services, suggests that comparison of results between studies looking at general perceptions and those looking at specific perceptions of environmental problems will require more testing and analysis.

Both perceived benefits and harm were important determinants of the acceptance of timber and bioenergy objectives, and only the effect of perceived harm to humans remained when perceived benefits to humans and biosphere were considered. These findings are aligned with existing risk management literature (Siegrist, 1999, 2000; Siegrist et al., 2007; Visschers et al., 2011) suggesting that perceived benefits are more important determinants of acceptance than perceived harm, and that the perceived consequences to humans (i.e., anthropocentric concerns) are considered as more important than the perceived consequences to nature (i.e., biocentric concerns) in the context of forest management objectives. These findings suggest that there is a need to reformulate the concept of pro-environmental behaviour from being defined in terms of minimizing the negative impacts on the environment (Kollmuss and Agyeman, 2002) to also including considerations for the positive impacts. Methods that measure both the perceived negative and positive impacts are important for guiding decision-making around ecosystem service provisioning. In the mitigation hierarchy for classifying environmental impacts, the difference between the mitigation of negative impacts (i.e. avoiding, minimising and offsetting of residuals) and the provision of positive additionality is foundational (McKenney and Kiesecker, 2010). The identification and classification of negative and positive impacts guides decision-making around numerous policy tools, including offsetting/compensating, making perception of such impacts crucial to policy acceptance. Our method of analysing perceived benefits and harm to humans and nature appears to be useful for researchers and policy-makers to better understand individuals' acceptance of different objectives. However, further research is needed to understand different stakeholders' perceptions and clarify how these perceptions are linked to value orientations.

Perceived knowledge had little effect on acceptance of the bioenergy objective, but perceived knowledge of timber increased the acceptance of the timber objective. The perceived knowledge of the climate objective reduced the acceptance of the timber and bioenergy objectives. Risk management literature suggests that the effect of knowledge on the acceptance of risks might be indirect through perceived benefits and harm (see e.g., Martin et al., 2009), and in a similar way, pro-environmental behaviour literature suggests that environmental knowledge is not directly associated with pro-environmental behaviour (Kollmuss and Agyeman, 2002).

Knowledge and acceptance of different management objectives were both positively or negatively associated, which suggests that perceived knowledge of different types of forest management objectives may be aligned with respondents' environmental values. In Finland, there is an inherent trade-off between these two objectives (i.e. for bioenergy and timber) regarding the length of the forest rotation required under economically-derived decision-making, where the economically optimal forest rotation is approximately 70 years. This has resulted in an ongoing debate, in Finnish research and media, around the perceived benefits of bioenergy and timber as 'climate-friendly' forest management objectives due to the shorter rotations needed to grow forest biomass for energy (see e.g. Soimakallio et al., 2016). The result also indicates that knowledge is important for acceptance, and may indicate that there are confirmation biases in terms of the knowledge about these issues among the respondents. Many of the students were from the Faculty of Forestry and Agriculture at the University of Helsinki, which could indicate they are knowledgeable about these management trade-offs. The close links to production forestry and the growing bioenergy industry and bioeconomy strategy may also have had an impact on the outcomes of the survey, which is one of the reasons we chose to focus on these two management objectives.

Gender was associated with the acceptance of different management objectives: females endorsed the biodiversity and climate objectives more than males, whereas males endorsed timber objectives more than females. This finding is in line with previous research suggesting that females are more biodiversity and conservation oriented than males, whereas males are more timber and bioenergy oriented than females (Fortmann and Kusel, 1990; Halder et al., 2011). Forest management decision-making should therefore take careful consideration of the impacts of the demographics of forest owners, who are the managers of the ecosystem at the primary level but have an impact over the entire value chain through their decisions, having on the availability of ecosystem service value potential over the entire chain or network. Alignment of the concerns of different actors throughout that chain may be challenging, but it is important to consider these impacts and how they constrain value creation for other beneficiaries. If there are majority male forest managers and majority female beneficiaries, then the misalignment may create challenges and, potentially, conflict between different groups of stakeholders in the policy making around how to manage ecosystem service provisioning.

Our results also, more generally, provide important considerations for private sector actors who are aiming to co-create value with their suppliers and beneficiaries around pro-environmental behaviour in their value chain or network. This might require an approach that develops differing messages to ensure that their environmental concerns are addressed through framing of the challenge differently for each group (Matthies et al., 2016b).

In the results, being a forest owner was not associated with the endorsement of forest management objectives. This is in line with previous research indicating that in Finland, forest owners' values and management preferences are heterogeneous and similar to those of non-forest owners (Kangas and Niemeläinen, 1996; Karppinen and Korhonen, 2013).

The limitations of the study were related to the analysis of cross-sectional data, and for this reason the causal relationships between gender, perceived knowledge, environmental concerns, and acceptance of forest management objectives remain mainly hypothetical. Moreover, the results may have been influenced by some social desirability bias, which is a tendency to present oneself according to socially accepted standards (Chung and Monroe, 2003). The respondents may have presented themselves as more knowledgeable of forest management practices than they were. Our sample included university students in agricultural and environmental sciences and a half of them were forest owners, even if they are not representative of Finnish forest owners as a whole.

Moreover, the factor structure may be dependent on the type of scale that is used, and perhaps some other features of the sample that need to be identified in future research. We modified the scale by Schultz (2001) and measured benefits and harms separately, and the participants were requested to evaluate consequences of specific forest management objectives. It is possible that in the context of forest management, altruistic and egoistic concerns may not be as clearly separated as in some other environmental contexts. The result may also be dependent on the sample: the participants of this study were students of forestry, agriculture and environment, to whom environmental issues were personally relevant. The three-factor structure has been verified in nationally representative populations that also include individuals to whom environmental issues are not personally relevant, but not in the context of specific environmental challenges (e.g. biodiversity loss or climate change) nor under consideration for specific environmental management objectives. The lack of specificity in the earlier models may also have contributed towards the differing three-factor model results. In that case, the two-factor model may be more accurate in evaluating specific environmental problem contexts and trade-offs. Given the differing results from using the model in a more focused context, we encourage further research to explore the robustness of two and three-factor models under these varying applications.

6. Conclusions

The results of this study confirm that the acceptance of different types of ecosystem management objectives by individuals is influenced by perceived harms and benefits, as well as perceived knowledge and gender. This study also contributes to the environmental concerns literature adding the dimension of positive consequences that were shown to be more important to respondents than negative consequences in explaining acceptance of management objectives. These findings are useful to guiding the ongoing discussion about how environmental concern influences each actor's behaviour in the value chain or value network, and the bioeconomy development. Human actions impact on the flow of value from the biosphere to the economy and society, having important implications for the efficiency and sustainability of natural capital use. Therefore, this study challenges earlier findings relating to the use of these methods concerning less specific environmental problem contexts. Environmental problems and decision-making to address them often involve many stakeholders and multiple trade-offs resulting in both potentially positive and negative impacts. This suggests that research on environmental concern should, at the very least, understand of the concerns for competing environmental management objectives by the professions charged with managing our societies' interactions with the environment. This article supports efforts in gaining a more robust understanding of that. These are critical questions to help guide policy and decision-making around stakeholders to address pressing global change challenges, such as climate change and biodiversity loss, in the context of the emerging bioeconomy paradigm.

Acknowledgements

Funding from the Academy of Finland (Grant reference no. 260595), EUMIXFOR Short Term Scientific Mission (FP1206) (Grant reference no. 170515-059236), Metsäteollisuustuotteiden Vientikaupan Edistämissäätiö, Jenny and Antti Wihurin rahasto, and the Kyösti Haataja Foundation (Grant reference no. 20170011) are gratefully acknowledged. We also acknowledge the helpful comments and feedback from Dr. Jaana E. Korhonen and Dr. Lauri Valsta of the University of Helsinki, and Dr. Marc Hanewinkel and Dr. Rasoul Yousefpour of the University of Freiburg.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ecoser.2017.12.003.

References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Dec. Processes 50, 179–211.
Bamberg, S., 2003. How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. J. Environ. Psychol. 23, 21–32.
Birch, K., Tyfield, D., 2013. Theorizing the bioeconomy: biovalue, biocapital, bioeconomics or... What? Sci. Technol. Human Values 38, 299–327.
Chung, J., Monroe, G.S., 2003. Exploring social desirability bias. J. Bus. Ethics 44, 291–302.
CICES: Common International Classification of Ecosystem Services (2013). CICES Version 4.3. http://cices.eu2015 (Accessed on: 02 March, 2016).
De Besi, M., McCormick, K., 2015. Towards a bioeconomy in Europe: national, regional and industrial strategies. Sustainability 7, 10461–10478.
De Groot, R.S., Wilson, M.A., Boumans, R.M., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ. 41, 393–408.
Dunlap, R.E., Van Liere, K.D., 1978. The "New Environmental Paradigm": a proposed measuring instrument and preliminary results. J. Environ. Educ. 9, 10–19.
Dunlap, R.E., Van Liere, K.D., 1984. Commitment to the dominant social paradigm and concern for environmental quality. Social Sci. Q. 65, 1013–1028.
European Commission, 2012. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Innovating for Sustainable Growth: A Bioeconomy for Europe, SWD (2012). 11 final. Brussels, 13.2.2012. COM(2012) 60 final.
Fietkau, H.-J., Kessel, H., 1981. Umweltlernen: Veraenderungsmoeglichkeite n des Umweltbewusstseins. Modell-Erfahrungen, Koenigstein, Hain.
Fisher, B., Turner, R.K., Morling, P., 2009. Defining and classifying ecosystem services for decision making. Ecol. Econ. 68, 643–653.
Fortmann, L., Kusel, J., 1990. New voices, old beliefs: forest environmentalism among new and long-standing residents. Rural Sociol. 55, 214–232.
Halder, P., Pietarinen, J., Havu-Nuutinen, S., Pelkonen, P., 2010. Young citizens' knowledge and perceptions of bioenergy and future policy implications. Energy Policy 38, 3058–3066.
Halder, P., Havu-Nuutinen, S., Pietarinen, J., Pelkonen, P., 2011. Bio-energy and youth: analyzing the role of school, home, and media from the future policy perspectives. Appl. Energy 88, 1233–1240.
Hetemäki, L. (2014). Future of the European Forest-Based Sector: Structural Changes Towards Bioeconomy. What Science Can Tell Us, No. 6., European Forest Institute. Available from: http://www.efi.int/portal/virtual_library/publications/what_science_can_tell_us/6/.
Hetemäki, L., Hanewinkel, M., Muys, B., Ollikainen, M., Palahí, M., Trasobares, A., Aho, E., Ruiz, C.N., Persson, G., Potoćnik, J., 2017. Leading the way to a European circular bioeconomy strategy. European Forest Institute: From Science to Policy 5.
Jing, H., Jiang, B.S., 2013. The framework of green business model for eco-innovation. J. Supply Chain Oper. Manage. 11, 33–46.
Kangas, J., Niemeläinen, P., 1996. Opinion of forest owners and the public on forests and their use in Finland. Scand. J. For. Res. 11, 269–280.
Karppinen, H., 1998. Values and objectives of non-industrial private forest owners in Finland. Silva Fennica 32, 43–59.
Karppinen, H., Korhonen, M., 2013. Do forest owners share the public's values? An application of Schwartz's value theory. Silva Fennica 47 (1). article id 894.
Kollmuss, A., Agyeman, J., 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environ. Educ. Res. 8, 239–260.
Lamarque, P., Tappeiner, U., Turner, C., Steinbacher, M., Bardgett, R.D., Szukics, U., Schermer, M., Lavorel, S., 2011. Stakeholder perceptions of grassland ecosystem services in relation to knowledge on soil fertility and biodiversity. Reg. Environ. Change 11, 791–804.
Leppänen, J., Sevola, Y., 2013. Metsämaan omistus. Metla, Metsätilastotiedote16/2013. http://www.metla.fi/metinfo/tilasto/julkaisut/mtt/2013/metsamaan_omistus2011.pdf (Accessed on: 02 March, 2016).
Lusch, R.F., Vargo, S.L., 2014. Service-Dominant Logic: Premises, Perspectives, Possibilities. Cambridge University Press, Cambridge, U.K..
Martin, W.E., Martin, I.M., Kent, B., 2009. The role of risk perceptions in the risk mitigation process: the case of wildfire in high risk communities. J. Environ. Manage. 91, 489–498.
Matthies, B.D., 2016. A service-dominant perspective on payments for ecosystem service offerings. Diss. For. 219.
Matthies, B.D., D'Amato, D., Berghäll, S., Ekholm, T., Hoen, H.F., Holopainen, J.M., Korhonen, J.E., et al., 2016a. An ecosystem service-dominant logic? Integrating the ecosystem service approach and the service-dominant logic. J. Cleaner Prod. 124, 51–64.

Matthies, B.D., Kalliokoski, T., Eyvindson, K., Honkela, N., Hukkinen, J.I., Kuusinen, N. J., Räisänen, P., Valsta, L.T., 2016b. Nudging service providers and assessing service trade-offs to reduce the social inefficiencies of payments for ecosystem services schemes. Environ. Sci. Policy 55, 228–237.
McKenney, B.A., Kiesecker, J.M., 2010. Policy development for biodiversity offsets: a review of offset frameworks. Environ. Manage. 45 (1), 165–176.
Ollikainen, M., 2014. Forestry in bioeconomy – smart green growth for the humankind. Scand. J. For. Res. 29, 360–1336.
Natural Resources Institute Finland, 2013. Forest statistics: structure and production. stat.luke.fi
MEA: Millennium Ecosystem Assessment, 2005. Millennium Ecosystem Assessment Synthesis Report. Island Press, Washington, D.C., USA.
Rhead, R., Elliot, M., Upham, P., 2015. Assessing the structure of UK environmental concern and its association with pro-environmental behavior. J. Environ. Psychol. 43, 175–183.
Ryan, A.M., Spash, C.L., 2012. The awareness of consequences scale: an exploration, empirical analysis, and reinterpretation. J. Appl. Soc. Psychol. 42, 2505–2540.
Schwartz, S.H., 1973. Normative explanations of helping behavior: a critique, proposal, and empirical test. J. Exp. Soc. Psychol. 9, 349–364.
Schwartz, S.H., 1977. Normative influences on altruism. Adv. Exp. Soc. Psychol. 10, 221–279.
Schwartz, S.H., Howard, J.A., 1981. A normative decision-making model of altruism. In: Rushton, J.P., Sorrentino, R.M. (Eds.), Altruism and Helping Behavior. Lawrence Erlbaum, Hillsdale, NJ, pp. 189–211.
Schultz, P.W., 2001. The structure of environmental concern: concern for self, other people, and the biosphere. J. Environ. Psychol. 21, 327–339.
Siegrist, M., 1999. A causal model explaining the perception and acceptance of gene technology. J. Appl. Soc. Psychol. 29, 2093–2106.
Siegrist, M., 2000. The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. Risk Anal. 20, 195–203.
Siegrist, M., Cousin, M.-E., Kastenholz, H., Wiek, A., 2007. Public acceptance of nanotechnology foods and food packaging: the influence of affect and trust. Appetite 49, 459–466.
Snelgar, R.S., 2006. Egoistic, altruistic, and biospheric environmental concerns: measurement and structure. J. Environ. Psychol. 26, 87–99.
Soimakallio, S., Saikku, L., Valsta, L., Pingoud, K., 2016. Climate change mitigation challenge for wood utilization: the case of Finland. Environ. Sci. Technol. 50, 5127–5134.
Steel, B.S., List, P., Shindler, B., 1994. Conflicting values about federal forests: a comparison of national and Oregon publics. Society Nat. Resour. 7, 137–153.
Stern, P.C., Dietz, T., Kalof, L., 1993. Value orientations, gender, and environmental concern. Environ. Behav. 25, 322–348.
Stern, P.C., Dietz, T., 1994. The value basis of environmental concern. J. Social Issues 50, 65–84.
Stern, P.C., Dietz, T., Guagnano, G.A., 1995. The new ecological paradigm in social-psychological context. Environ. Behav. 27, 723–743.
Stern, P.C., Dietz, T., Abel, T.D., Guagnano, G.A., Kalof, L., 1999. A value-belief-norm theory of support for social movements: The case of environmentalism. Human Ecol. Rev. 6, 81–97.
Tabachnick, B.G., Fidell, L.S., 2012. Using Multivariate Statistics. Pearson.
Thompson, B., 2004. Exploratory and Confirmatory Factor Analysis: Understanding Concepts and Applications. American Psychological Association.
Thompson, S.C.G., Barton, M.A., 1994. Ecocentric and anthropocentric attitudes towards the environment. J. Environ. Psychol. 14, 149–157.
Turner, R.K., Daily, G.C., 2008. The ecosystem services framework and natural capital conservation. Environ. Resour. Econ. 39, 25–35.
Uliczka, H., Angelstam, P., Jansson, G., Bro, A., 2004. Non-industrial private forest owners' knowledge of and attitudes towards nature conservation. Scand. J. For. Res. 19, 274–288.
USA, 2012. National bioeconomy blueprint. Ind. Biotechnol. 8, 97–102.
Vargo, S.L., Lusch, R.F., 2016. Service-dominant logic 2025. Int. J. Res. Market. https://doi.org/10.1016/j.ijresmar.2016.11.001.
Vaske, J.J., Donnelly, M.P., 1999. A value–attitude–behavior model predicting wildland preservation voting intentions. Society Nat. Resour. 12, 523–537.
Visschers, V.H.M., Keller, C., Siegrist, M., 2011. Climate change benefits and energy supply benefits as determinants of acceptance of nuclear power stations: investigating an explanatory model. Energy Policy 39, 3621–3629.