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Valuation of non-market ecosystem services of forests: Preferences for Recreation, Effect of Childhood Experience, and the Role of Environmental Attitudes

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VALUATION OF NON-MARKET ECOSYSTEM SERVICES OF FORESTS:

Preferences for Recreation, Effect of Childhood Experience, and the Role of Environmental Attitudes

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The Lord God took the man and put him in the Garden of Eden to work it and keep it.

Genesis 2:15

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Valuation of Non-Market Ecosystem Services of Forests: Preferences for Recreation, Effect of Childhood Experience, and the Role of Environmental Attitudes

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Preface

My motivation to conduct environmental valuation studies stretches back to my MSc study at Addis Ababa University where I was aware of an environmental problem related to the fishery resource of Lake Tana, the biggest lake in Ethiopia. One of its unique fish species was listed being endangered to extinction due to unregulated fishing practices. In my MSc thesis, I (together with my supervisor) conducted a choice experiment study to evaluate the WTP of low-income fishermen for the fishery and watershed management initiatives, from which a paper is published in ecological economics. Soon after, I was able to do my second MSc study at the Wageningen University and Research Centre which further motivated me to pursue my PhD. So, my commitment in searching of fellowships realized with the Erasmus Munds Joint Doctorate program, a very competitive fellowship funded by the European Commission. I applied for one of the announced topics for the PhD application period 2014-2017 i.e. “Modelling forest recreation – does choice set composition matter?” and my application was successful. This PhD topic was, however, too specific for a PhD dissertation. I spent several months to find out alternative topics to be covered and to outline complete overview of the ‘what to do?’ in my PhD project. The valuation of the non-market ecosystem services of forests and specifically of recreational services was then chosen as a broader topic, with many research gaps in existing literature.

By this, I want to acknowledge the funding from the European Commission under Erasmus Mundus Action 1 Doctoral Fellowship in “Forest and Nature for Society” (FONASO) programme. It would not be possible for me to pursue my PhD at the world-class academic institutions without such funding facilities. I am grateful being part of the FONASO fellowship program. My appreciation goes to Professor Carsten Smith-Hall for establishing this program and creating this opportunity for many young researchers.

The help of my supervisor, Professor Jette Bredahl Jacobsen, came at the initial stage of the PhD fellowship application process. Her encouragement with critical comments since then has enabled me to accomplish my dream. Since the start of my PhD, she motivated me how to progress on each single paper with her devotion to support me when I got frustrated (and sometimes demotivated). She encouraged me to tackle challenges and tried her best pushing me to go independently. Her support was even extended to helping me settle down with my family life here in Copenhagen and ensuring the work-life balance. Her influence will remain in my future academic and research career.

The support of my co-supervisors, Dr. James Gibbons and Thomas Lundhede, was also enormous. Both of them were kind and helpful to me. They were available to give me critical comments and suggestions in any of my studies I requested for help.

The contribution of my friends should not be left unmentioned, as they helped me to get there in my PhD and socialize in our little community here in the University and outside. I couldn’t pass without mentioning the help of Habtamu Tilahun Kassahun and Solomon Zena Walelign who showed me the path pursuing a PhD in the FONASO programme. I also want to thank all fellows at the Department of Food and Resource Economics (IFRO). Specifically, the help of my colleagues at the Natural Resources and Environmental Economics section was a lot – for the fact that some technical understating is only possible through easily approachable personnel. My gratitude and appreciation shall go to those who helped me personally and to all my officemates. I also shall mention the good memories that I have from the stuff along the corridor: talking on relevant topics, our table-football games, and get-togethers.

Finally, my gratitude goes to my family: my wife Yetmwork Adamu, my daughter Feven Fitalew, and my son Eminet Fitalew to their affection and love living in my heart. You all are my source of inspiration and motivation to get into the right track in my education and life. I am also pleased to thank my brother Mezgebu Yitayal Mengistu for his encouragement and support throughout my education. The role of my mother, Debritu Belete Abate, cannot be described in few sentences here. Born from a rural peasant household, my destiny in education would be unthinkable without the strength and devotion of my mom. Mom hadn't got the chance to see the light of education herself yet knew its value and was determined to educate her only two sons with full heart and enthusiasm. So now, we both have achieved the highest level of education and her dream came true. We were unfortunate and heartbroken though, as we missed her just a year before I complete my undergraduate study. Mom! Your strength and devotion was my source of inspiration and will continue to work inside me. May God keep your soul in heaven!

Summary

Forests provide a multitude of ecosystem services to society. However, not all such services are being reflected in market prices and that leads to underestimation of their economic values, and suboptimal management schemes. Therefore, non-market valuation is required to provide complementary information for better forest management that underpin the concept of total economic values. In this PhD thesis, the non-market values of forests are evaluated with a focus to show the impact of forest management on ecosystem services. The thesis consists of four papers that address three main research questions: 1) Which forest structural characteristics and features affect recreational preferences? 2) Does childhood forest experience determine forest visiting habit in adulthood? And 3) How does environmental attitude influence individuals' willingness to pay for forest management initiatives designed to enhance ecosystem service provision?

In the first paper, we evaluate the effects of forest structural characteristics and diversity in forest stands on recreational preferences. The study is undertaken using choice experiment (CE) data about people's preferences for forest characteristics in their future recreational visits. In general, mixed tree species are found to be preferred to monocultures; and stands with varying height are preferred over stands consisting of same height trees. The variation between stands also increases the recreational value of forests; and in some instances, may outweigh the contribution of variation within a stand. In the second paper, we investigate the factors that influence the choice of forest site for recreation. The paper is conducted based on the survey data in which respondents were asked to indicate last visited forest sites using map tools. However, the number of alternative sites accessible to each respondent was too large to include all in the choice set, and hence, we use simple random sampling. Relevant attributes are identified by using spatial data analysis. The factors that significantly influence choice of forest site include: forest area, tree species composition, forest density, availability of historical sites, terrain difference, state ownership, and distance. In addition, we empirically show how large a number of alternatives are sufficient to provide consistent parameter estimates through the random selection.

The third paper investigates the impact of past experience, in this case childhood forest experience, on forest visit frequency in adulthood. The study is conducted based on data collected from nine European countries and hence examines cross-country variations in frequency of visit. Childhood experience is found to positively influence forest recreation practices. The frequency of visit is also significantly determined by current residential location and distance (to nearest forest).

In the fourth paper, we examine the role of environmental attitude on people's WTP for forest ecosystem services. We use the new environmental paradigm (NEP) scale to measure environmental attitude as a multidimensional concept. The variation in willingness to pay for ecosystem services is illustrated using different modelling approaches and people with an ecocentric attitude are found to have higher willingness to pay compared to those with anthropocentric attitude.

In general, the three main conclusions of the thesis are:

- The recreational importance of forests depends on the forest characteristics and other features which in one way or another are influenced by forest management principles. This provides evidence on the necessity to consider the non-market values in forest management so as to maximize social welfare.
- Forest recreational behaviour is found to be influenced by individuals' experiences during childhood, current residential location, and distance. This highlights the importance of improving accessibility of nature areas such as forests for more recreational participation of today's children – so that they could develop nature recreational habit and pro-environmental behaviour in adulthood.
- Individuals' environmental attitudes on the human-nature relationships influence their WTP for forest ecosystem services. This confirms the importance of understanding the heterogeneity among individuals, before practical policy options are taken from average WTP estimates.

Resumé (Danish summary)

Skove bidrager til en række økosystemtjenester for samfundet. En række af disse er ikke afspejlet i markedspriserne på skov, og derfor er deres værdi underestimeret, hvilket leder til suboptimal forvaltning set fra samfundets perspektiv. Derfor har man brug for værdisætning af ikke-markedsomsatte goder indenfor begrebet total økonomisk værdi – for at levere komplementær information til brug for skovforvaltning. I denne afhandling værdisættes ikke-markedsomsatte værdier fra skov ud fra et fokus på hvordan de påvirker skovforvaltningen. Afhandlingen består af fire artikler som adresserer tre hovedforskningsspørgsmål: 1) Hvilke strukturelle karakteristika og egenskaber ved skov påvirker befolkningens rekreative præferencer? 2) Påvirker oplevelser i barndommen med færdsel og brug af skoven hvordan man bruger den som voksen? Og 3) Hvordan påvirker natursyn individets betalingsvilje for ændringer i skovforvaltning der tilgodeser øget produktion af økosystemtjenester?

I den første artikel ser vi på effekten af strukturdiversitet og karakteristika af skove for rekreative præferencer. Studiet benytter data fra et valgeksperiment (CE) omkring folks præferencer for skovkarakteristika for deres fremtidige skovbesøg. Overordnet set viser resultaterne at blandede bevoksninger foretrækkes over monokulturer, og varieret højde foretrækkes fremfor bevoksninger med ens højde. Vi finder også at strukturvariationen mellem bevoksninger øger den rekreative værdi, og i nogle tilfælde kan det opveje variationen indenfor en bevoksning.

I den anden artikel ser vi på hvilke faktorer der er af betydning for hvilken skov man vælger at benytte til rekreation. Artiklen er baseret på spørgeskemadata hvor respondenterne er blevet bedt om at vise på et kort hvilken skov de sidst besøgte. Antallet af alternative steder de kunne være taget hen er enormt, og derfor brugte vi "simple random sampling" for at identificere alternativer. Relevante attributter er identificeret på baggrund af rumlig dataanalyse. De faktorer som påvirker valget af sted for skovbesøg er: skovens areal, træartssammensætning, tæthed, tilstedeværelsen af oldtidsminder, højdeforskelle, offentligt ejerskab og afstanden. Yderligere viser vi empirisk hvor stort et antal alternativer det er nødvendigt at trække for at få konsistente parametre.

Den tredje artikel undersøger betydningen af tidligere erfaringer, i dette tilfælde erfaringer fra barndommen, på skovbesøgsfrekvensen som voksen. Studiet er baseret på en dataindsamling fra 9 forskellige europæiske lande og undersøger derfor også forskelle på tværs af lande. Erfaringer fra barndommen påvirker positivt nutidig besøgsfrekvens. Andre faktorer som er bestemmende er hvor man bor, og afstanden til den nærmeste skov.

I den fjerde artikel undersøger vi betydningen af natursyn for folks betalingsvilje for skovøkosystemtjenester. Vi bruger "New Environmental Paradigm" (NEP)-skalaen til at måle natursyn som et multidimensionelt koncept. Forskellen i betalingsvilje er illustreret ved at benytte forskellige modelleringstilgange, og vi finder at folk med et økocentrisk natursyn har en højere betalingsvilje end de med et antroprocentrisk.

Overordnet set er der tre hovedkonklusioner af afhandlingen:

- Skoves rekreative betydning afhænger af skovkarakteristika og andre egenskaber som er påvirket af skovforvaltningen. Det betyder at det er nødvendigt at tage hensyn ikke-markedsomsatte værdier i skovforvaltningen for at maksimere samfundets velfærd.
- Rekreativ adfærd er påvirket af folks erfaringer fra barndommen, hvor de bor, og afstanden til den nærmeste skov. Det understreger betydningen af at forbedre adgang til naturarealer såsom skov for nutidens børn – så de kunne udvikle friluftslivsvaner og pro-miljø-adfærd som voksne.
- Individets natursyn vedr. forholdet mellem menneske og natur påvirker deres betalingsvilje for skovøkosystemtjenester. Dette understreger betydningen af at forstå forskelle mellem individer før politiske beslutninger tages på baggrund af gennemsnitlige betalingsviljer.

Contents

1. Introduction

Forest ecosystems provide a multitude of services to the society both at local and global scale. The most important products that come into people's first thought could be timber and other marketed products including pulp products, biofuels etc. However, the non-timber products and ecological functions are also valuable to the society. In general, it could be difficult to enumerate all specific benefits that forests could provide to human beings. One of the convenient ways of showing the multi-functionality of forest resources would be the classification based on the millennium ecosystem assessment report (MEA 2005). According to this classification, the main forest ecosystem services include: 1) provisioning services such as timber, food, medicine etc.; 2) regulating services like maintaining soil fertility, watershed protection, carbon sequestration, which are known to regulate ecosystem processes; 3) cultural services defined in terms of recreation, aesthetics, and amenities; and 4) supporting services which include the services necessary for primary productions, like photosynthesis and others. These services can also be classified into components of the total economic values namely, direct use values (timber, fuel wood, recreation, food); indirect use values (watershed protection, carbon sequestration, soil nutrient retention); and non-use values (option and existence values) (Pearce 2001, Nasi et al. 2002, Slee 2005, Ojea et al. 2012).

Society could gain more of the aforementioned services if forests are managed in an optimal way considering their total economic values. When forest products and services are not evaluated in an integrated assessment, decision makers entirely depend on the marketed products and use values, overlooking the value of other services. According to (Pearce 2001), one of the main reasons for the worldwide increased rate of deforestation and forest land conversion is associated with such underestimation of forest values. In other words, an optimal use of forest resources cannot be ensured unless the value of other ecosystem services is estimated in monetary units. As clearly explained by Slee (2005), valuation of non-market goods/services is essential not only to know the values of the resource per se but to halt the negative effects of policy outcomes that are guided by only the market goods. So far, a number of studies have been conducted elaborating the socio-economic values of multifunctional forests and emphasising the necessity of considering non-market values (see e.g. Slee 2005, Zandersen and Tol 2009, Bujosa and Riera 2010, Ninan and Inoue 2013, Häyhä et al. 2015, Miura et al. 2015). This thesis provides additional knowledge to the literature on the valuation of the non-market values of forests with particular emphasis on recreational services. It evaluates the importance of non-market forest ecosystem services and provides WTP estimates for different attributes.

1.1. Background and Motivation

Optimal forest management decisions can be realized by understanding the tradeoffs that exist between different products and services. This would be possible when an economic valuation of all forest products and services are expressed in terms of money as a common unitary measure, and through the assessment of use and non-use values. Many researchers have highlighted the importance of considering total economic values of a forest in management decisions (Douglass 1982, Ribe 1989, Pearce 2001, Rydberg and Falck 2001, Tahvanainen et al. 2001, Slee 2005, Arnberger 2006). Hence, non-market valuation approaches play a significant role to enhance informed management decisions. In general, the non-market forest ecosystem services could be evaluated by examining preferences and estimating WTP of the public. In the process, it becomes possible to show, e.g. WTP estimates, understand preferences and perceptions, evaluate consumer surplus and welfare changes, analyze variations, and outline the role of public participation, for different forest management initiatives.

As mentioned before, forest recreation is one of the direct use values of forests. In modern societies with more stressful life, forests are becoming important places for leisure activities. Some studies indicate how forests are being intensively used for recreational purposes in urban areas (see e.g. Brainard et al. 2001, Arnberger 2006). Moreover, many studies show the positive effects of outdoor recreation on health and psychological wellbeing (Rydberg and Falck 2001, Maller et al. 2006, Hartig et al. 2011, Heyman 2012). Health and psychological benefits are indicated in terms of more physical activities, stress and attention restoration, positive emotions etc. Furthermore, recreational participation in nature areas, such as forests, can influence individuals' environmental behaviours and concerns (Chawla 1998, Nord et al. 1998, Tarrant and Green 2009). However, the recreational services of forests are not often reflected in market prices and not considered in practical policy design and management decisions. Consequently, the economic value of forest recreation has to be estimated through application of non-market valuation techniques.

In this regard, analysis of preferences becomes imperative to identify better forest management schemes and enhance recreational facilities that can satisfy recreational desires of the public. In this thesis, we analysed people's preferences over forest characteristics using stated and revealed preference approaches. One of the main issues to be addressed in evaluating public preferences is to know which forest characteristics are relevant in affecting people's choices over forest sites for a visit. The literature shows the impacts of forest management on recreational values and indicates that maintaining diversity in forest characteristics within a stand of the forest being important (Willis et al. 2003, Nielsen et al. 2007, Gundersen and Frivold 2008, Dhakal et al. 2012). However, the empirical finding on the impact of having diversity between stands of a forest is limited. In line with such a motivation, in the first paper, we examine preferences over diversity in forest structures between and within stands of forests using choice experiment data. In the second paper, we evaluate the importance of different attributes of forest sites using detailed revealed data i.e. three reported visit experiences, which was lacking in previous revealed preference studies.

Moreover, this thesis includes a paper that examines significance of childhood forest experience affecting forest recreational behaviour at adulthood. Past experience is found to influence demand and preference in nature area recreation in general (see McFarlane et al. 1998, Bixler et al. 2002). Many studies also show the strong association between childhood outdoor participation and pro-environmental behaviour in adulthood (e.g. see Sebba 1991, Chawla 1999, Kals et al. 1999, Wells and Lekies 2006, Chawla 2009, 2015). However, the childhood-adulthood relationship in nature recreation, and specifically in forests, is not well documented. Here, in the third paper, we investigate how an individual's forest visit frequency is influenced by his/her childhood experience. We explicitly model annual frequency of forest visit at adulthood as a function of childhood experience and other covariates including residence area, distance to the nearest forest, and sociodemographic variables.

In addition to these, the thesis includes a study that elaborates on how to incorporate environmental attitudes into the valuation of forest ecosystem services to examine WTP variations. One of the important topics in preference studies is to handle preference heterogeneity among individuals. The problem can be addressed in different ways, one of which is through incorporating behavioural factors such as: attitudes and perceptions (Ben-Akiva et al. 1999a, Aldrich et al. 2006, Choi and Fielding 2013, Bartczak 2015). The motivation in this study is, therefore, to explain the unobserved heterogeneity by incorporating environmental attitudes measured through the NEP scale. Thus far, only some valuation studies take account of the role of environmental attitudes affecting WTP; yet, with limitations on the modelling procedures. In this study, we also illustrate how to deal with the latent variables in discrete choices with different modelling approaches.

1.2. Research Questions

The main issues addressed in the thesis include: preferences of people for forest characteristics and diversity (paper 1); factors affecting the choice of forest site for recreation (paper 2); effect of childhood experience on forest recreational behaviour in adulthood (paper 3); and effect of environmental attitude in the valuation of forest ecosystem services and related methodological issues (paper 4).

These papers address the main research question "What determines people's preferences for ecosystem service provision and in particular recreation – looked through forest structures (the physical aspect) and individuals' characteristics?" More specifically the thesis answers:

1) Which forest structural characteristics and features affect recreational preferences?
2) Does childhood forest experience determine forest visiting habit in adulthood?
3) How does environmental attitude influence individuals' willingness to pay for forest management initiatives designed to enhance ecosystem service provision?

2. The Importance of Forests in Outdoor Recreation

Various studies have shown the recreational importance of nature areas to modern societal life as early as in the 1960s (LaPage 1963, Douglass 1982). With changes in economic development and demography, the importance of forests for recreational use has increased over time (Smink 2011, Dhakal et al. 2012). According to Elands and Wiersum (2001), the ecological and amenity services of forests have started gaining more attention from decision makers while the primacy of production role started to decline. Forest recreation has been defined as any activity for mental refreshment or feeling of pleasure that includes physical exercise, relaxation, socialization, nature study, and aesthetic pleasure (Douglass 1982, Rydberg and Falck 2001). According to LaPage (1963), people having recreational activities in forests can gain many psychological benefits including: "feeling of solitude, sense of freedom, beauty, spirit of adventure, excitement, refreshment, spiritual awareness, serenity, and self-reliance". In general, forests are known to provide recreation services along with many health and psychological benefits (Rydberg and Falck 2001, Townsend 2006, Dhakal et al. 2012). However, the causal relationship between contact with nature and health benefits are still debatable (see Lachowycz and Jones 2013).

2.1. Impact of Forest Management on Recreational Services

Forest management schemes are important in influencing the recreational values of forests. Many studies show that silvicultural practices can impact the recreation values of forests by affecting forest structures (Ribe 1989, Mattsson and Li 1994, Tahvanainen et al. 2001). According to Mattsson and Li (1994), intensive forest management that targets only the production services, such as timber, reduces the recreational values. Quite many studies (e.g. Douglass 1982, Tahvanainen et al. 2001, Gundersen and Frivold 2008) discussed how clear cut silviculture can negatively impact recreation services. In general, any silvicultural practice affects forest characteristics i.e. tree species composition, age structure, understory cover, and other features. However, forest management can also have intended positive consequences on the recreational services (Dhakal et al. 2012, Edwards et al. 2012a).

A considerable body of literature (see e.g. Schroeder and Daniel 1981, Zube et al. 1982, Holgén et al. 2000, Heyman et al. 2011, Heyman 2012, Nielsen et al. 2012) show the impact of forest management on recreational values. Many studies (e.g. Axelsson-Lindgren and Sorte 1987, Ribe 1989, Lindhagen and Hörnsten 2000, Tahvanainen et al. 2001, Gundersen and Frivold 2008, Edwards et al. 2012a) show how forest management practices affect recreational benefits by changing the age structure and species composition. The literature supports the notion of maintaining diversity in species and age structures both for recreational purposes and biodiversity functions (Scarpa et al. 2000b, a, Horne et al. 2005, Nielsen et al. 2007, Gundersen and Frivold 2008, Dhakal et al. 2012, Giergiczny et al. 2015). The recreational value of forests also depends on the accessibility of the sites to residential locations and availability of recreational facilities. Appropriate facilities might be required to satisfy the demand of different user groups (Christie et al. 2007, Bujosa and Riera 2009, 2010, Giergiczny et al. 2015). According to Christie et al. (2007), identification of relevant recreational facilities and infrastructures is vital to meet the desires of different groups and to do cost-benefit analyses of necessary infrastructural improvements. The present studies provide empirical findings on the importance of forest structures for recreational uses and highlight the impact of forest management, and hence contribute filling literature gaps.

2.2. Forest Recreation in the Danish Context

The forest cover in Denmark is about 14% of the total area, relatively small compared to other Scandinavian or European countries, though it has been increasing starting from the 1990s after the introduction of an afforestation program (Madsen 2002). The afforestation program has been initiated to increase the forest cover to a 20-25% of the total area of the country in the next 80 years.

The recreational importance of forests in Denmark is well documented over the last four decades (see Skov-Petersen 2002, Hansen-møller and Oustrup 2004, Jensen and Koch 2004, Skov-Petersen and Jensen 2004, Termansen et al. 2004, Nielsen et al. 2007, Zandersen et al. 2007, Termansen et al. 2008, Jacobsen and Thorsen 2010, Campbell et al. 2013, Termansen et al. 2013, Bakhtiari et al. 2014). The Danes are known for making frequent visits to forests. It has been indicated that on average, an adult person visits forests about 11 times a year, and 90% of the population visit at least once a year (Jensen and Koch 2004, Smink 2011). The trend of making frequent forest recreational trips is indicated to remain stable (Jensen and Koch 2004). Moreover, Skov-Petersen and Jensen (2004) mentioned forest recreation as one of the main leisure activities (like cinemas, libraries, concert halls) for most adults. The main activities or purposes of forest visits among the Danes include walking (with or without dog), nature experience, the desire for peace and quietness, and family life (Jensen and Koch 2004, Smink 2011). The national surveys conducted by the Danish Forest and Landscape Institute in 1976/77 which are repeated in 1993/94 contributed much to an intensive research that evaluated the recreational use of forests (Jensen and Koch 2004, Skov-Petersen and Jensen 2004).

As outlined in many of the studies, distance is playing a crucial role in considering forest recreational trips. It has been reported that more than 75% of forests visitors make their trips within 10 km from their residence (Jensen and Koch 2004, Termansen et al. 2004, Smink 2011). This highlights the importance of distance in forest recreation.

Furthermore, previous studies also examine preferences of forest visitors for forest structural characteristics (see e.g. Jensen 1999b, Nielsen et al. 2007, Termansen et al. 2013). They indicate mixed and broadleaved species being preferred to coniferous types. In terms of age structure, forests with uneven age stands are found to be the most preferred.

The present research contributes to the existing literature of forest recreation in the Danish context by investigating preferences of forest visitors for different attributes of forests and outlining the role of forest management, e.g. the relevance of maintaining forest diversity between stands which was not studied before. In addition, the research findings could help to validate and support previous findings through evaluation of preferences using reported forest visit data.

3. The Non-Market Valuation Approaches

3.1. The Concept of Total Economic Value

Forests and their ecosystem services are environmental assets that are often undervalued due to market failure (Adger et al. 1995, Elands and Wiersum 2001, Pearce 2001, Slee 2005). Their management requires consideration of use and non-use values. Use values are the tangible values where people can derive utility through direct or indirect consumption of the good/service while the non-use values are intangible values from which individuals derive utility, without direct or indirect consumption. Many researchers indicate the relevance of considering total economic values of forests for better management (see Adger et al. 1995, Noble and Dirzo 1997, Pearce 2001, Zandersen and Tol 2009, Ojea et al. 2012, Ninan and Inoue 2013, Häyhä et al. 2015). As mentioned earlier, market prices do not reflect the full values, and relying only on marketable values of forests leads to underestimations (Adger et al. 1995, Pearce 2001, Häyhä et al. 2015). For instance, according to Häyhä et al. (2015), 60% of the economic value of the Italian Alpine forests would be invisible if the value is inferred from traditional market transactions alone (Häyhä et al. 2015). Therefore, non-market valuation approaches become essential to provide necessary information to decision makers and enable them follow optimal management options (Scarpa et al. 2000a, Pearce 2001, Ninan and Inoue 2013).

3.2. Stated Vs Revealed Preference Methods

In general, valuation of environmental goods/services can be performed using either stated or revealed preference methods (Adamowicz et al. 1994, Hanley and Barbier 2009). Revealed data describe the actual behaviour of individuals while stated data are based on the behavioural intentions and responses of individuals to hypothetical questions (Ben-Akiva et al. 1994). The stated preference (SP) approaches are applied to evaluate non-market goods/services from individuals' stated behaviours in a hypothetical market setting (Alpizar et al. 2001, Hanley et al. 2001). They are useful specifically in the estimation of non-use values which cannot be estimated by other means (Carson 2012). The SP methods enable us to elicit willingness to pay (or accept) for proposed changes. In the revealed preference (RP) approach, the value of environmental goods/services can be estimated through inspecting the actual behaviours of individuals in the market. In other words, the RP approaches are applicable only for market goods/services and hence could not be used to estimate non-use values that do not have market.

The most common SP methods include the contingent valuation method (CVM) and the choice experiments (CE) (Hanley et al. 1998, Carson 2000, Alpizar et al. 2001, Carson et al. 2001, Boyle 2003, Birol et al. 2006, Carson 2012). The CVM can be conducted to elicit values by directly asking individuals – 'how much they are willing to pay (or accept)' for proposed quality changes. On the other hand, CE is mainly conducted by asking people – 'to choose' among set of alternatives provided in consecutive choice sets. The CE method enables measuring the trade-offs between characteristics (attributes) of a multi-attribute environmental good/service. The two most widely used techniques within the RP approach are travel cost method and hedonic pricing (Hanley and Barbier 2009). Usually, the travel cost method is used to estimate recreational values by collecting data on individuals' travel expenses when visiting the recreational sites. On the other hand, the hedonic pricing method enables evaluating the values of nature from the price of an associated marketed good e.g. housing.

When critically evaluated, both SP and RP valuation approaches have many drawbacks. The SP methods are criticized for dependence on hypothetical scenarios in which individuals may not reflect their actual behaviour (Adamowicz et al. 1994, Swait et al. 1994, Hanley et al. 2002, Azevedo et al. 2003). As a consequence, the estimation results from SP methods often lack the validity and reliability in practical policy making. According to Ben-Akiva et al. (1994), discrete choice models estimated exclusively from SP data may not be able to accurately predict actual market behaviours. In general, hypothetical biasedness, uncertainty in proposed changes, protest responses, and choice task complexity (specifically in CE) can be mentioned as major pitfalls in the application of SP techniques (Hanley et al. 1998, 2001, Swait and Adamowicz 2001, DeShazo and Fermo 2002). On the other hand, the RP approaches are questionable on the ground that we could not look into the outcomes of different policy options. In addition, it will not be possible to explain preferences for distinct attributes of the good/service and make inference about welfare changes from proposed quality changes if data on these are not available (Adamowicz et al. 1994, Swait et al. 1994, Hanley et al. 2002). According to Ben-Akiva et al. (1994), the revealed data would have caveats in terms of limited coverage of attributes and levels, high correlation between attributes, and poor quality background information. In general, many scholars recognized the pitfalls and strengths of both approaches and hence justified for joint estimation whenever data is available (see Hensher and Bradley 1993, Adamowicz et al. 1994, Azevedo et al. 2003, Eom and Larson 2006).

The papers in this thesis are conducted using data organized from both approaches to address different research questions. The SP approaches are employed to evaluate preferences with detailed forest structures which are usually difficult to obtain from RP data. On the other hand, the RP studies are conducted to analyse choices in forest recreation where different attribute levels are obtained in rough measures. The SP data are obtained from choice experiment surveys developed to evaluate choices for proposed improvements in the management of forests for recreational uses (paper 1) and ecosystem services (paper 4). The other two papers are conducted using revealed data i.e. based on reported forest visit experiences.

3.3. Application of Choice Experiment

Choice experiment is one of the non-market valuation techniques, applied for the first time by Adamowicz et al. (1994) in environmental management problems (Hanley et al. 1998, Alpizar et al. 2001, Hoyos 2010). It is developed based on the Lancaster's characteristic theory of value (Lancaster 1966) and random utility framework (McFadden 1974, Manski 1977). This technique is applied based on the notion that individuals consider the value of characteristics (attributes) rather than the good/service per se (Lancaster 1966) and hence could provide detail information to evaluate individuals' preferences for separated attributes (Alpizar et al. 2001). The CE surveys are developed and implemented after several iterative steps: identification of attributes, designing the optimal combination of attribute levels, as well as preparation of scenario descriptions and choice sets (see Hanley et al. 2001). Attributes can be identified from literature reviews, discussion with experts, from focus group discussion, or pilot studies. The CE method is known to provide several advantages compared to other techniques e.g. CVM, despite its own drawbacks (Hanley et al. 1998, Alpizar et al. 2001, Hanley et al. 2001).

CE is employed to quite many issues in the management of environment problems, such as; economic value of recreational sites, nature conservation, land use planning, payments for biodiversity and ecosystem services, and landscape management. It is one of the most widely used methods to evaluate the recreational services of nature areas, such as forests (see for e.g. Train 1998, Scarpa et al. 2000b, Hanley et al. 2002, Birol et al. 2006, Christie et al. 2007, Nielsen et al. 2007). In most of the papers here, we mainly used data collected from CE surveys, which was found convenient to elaborate on the trade-offs of site specific characteristics.

4. Research Methodology and Data

The non-market valuation studies are commonly conducted using data that has to be collected from surveys. Questionnaire development is one of the key steps in stated preference studies which requires careful preparation and pre-tests before undertaking the main survey. It is also necessary to identify policy relevant variables. The studies in this thesis are conducted using survey data and following different modelling approaches within the context of discrete choice analysis.

4.1. Data and Sampling

In this thesis, data are obtained from three surveys where I have been part in data collection of two of these. In one of them I, together with a fellow PhD student, led the collection and in another I collaborated with other researchers in different European counties. I have been actively involved in the development of the questionnaire, especially on the design of the choice sets for two of the data sets. The choice set designs are performed using the 'Ngene' software (ChoiceMetrics 2014) applying the D-efficiency criterion. In both surveys, the optimal combination of attribute levels were tested through simulations and pilot surveys with some relevant adjustments made before undertaking the final surveys. The adjustments include modification and addition of question, avoiding dominant alternatives, and presentation of choice cards. All the surveys were administered using the web interface by surveying companies.

The first survey (used in paper 1 and 2) was a choice experiment survey where Danish forest visors were asked about their preferences for forest structural characteristics. It mainly focused on maintaining forest structural diversity for recreational purposes. The respondents were also asked about their recreation experiences and socioeconomic and demographic variables. In addition to the choice experiment, respondents were required to construct their own hypothetical forest in a similar way as provided in the choice sets so as to examine internal consistency of choice making. The other relevant part of this survey was questions regarding last visited forest sites. The respondents were asked to locate three most visited forest sites by pinpointing on both visited forest sites and departure locations using interactive google maps. That gives the spatial coordinates of the places as the basis to organize data on forest attributes and calculation of distance. A total of 1226 individuals have fully completed the questionnaire with a response rate of about 53%. However, the number of respondents correctly pinpointing on the visited forest locations (paper 2) becomes 481 (see table 1).

The second survey (used in paper 3) was conducted to study preferences for forest characteristics and recreational facilities using choice experiments across European countries consisting of: Austria, Belarus, Switzerland, Czech Republic, Germany, Denmark, France, Poland, Slovakia, and United Kingdom. In addition to the choice experiment task, respondents were asked about their forest recreational experience during the last year (before conducting the survey) and about their (remembered) forest recreational experiences in childhood. This survey was also conducted using a web interface in all countries (except Belarus), after the questionnaires are translated to respective national languages. The number of successful responses is about 1000 on average, predefined to be on quota basis, and representativeness being maintained by survey companies in each country.

In the fourth paper, we used another survey data previously collected by other researchers (see Campbell et al. 2013). The survey was conducted to evaluate the WTP of people for forest management initiatives proposed to protect forest ecosystem services using choice experiment. In addition, respondents were asked to report on their environmental attitudes measured through the new environmental paradigm (NEP) scale. It is such information that we used to do our study of how environmental attitude can explain difference in WTP. The analysis is made based on 722 fully completed responses to the NEP questions.

Table 1

Description of the surveys used in the thesis

Survey	Main sections of the questionnaire	Papers	Valid Responses
1) Forest recreation and preferences in Denmark	○ Demography ○ Forest recreation experience and locations of visited forests ○ Choice experiment and follow-ups ○ Making of ideal forest from a catalogue	Paper 1 Paper 2	1226 481
2) Forest recreation and preference across European countries	○ Demography ○ Forest recreation experience and locations of visited forests ○ Choice experiment and follow-ups ○ Extraction of non-timber products (berries and mushrooms) ○ Childhood experience in forest recreation	Paper 3	8793
3) Valuation of forest ecosystem services	○ Demography ○ Observation and perception on forest ecosystem services ○ Choice experiment on forest management to improve ecosystem service provision ○ Environmental attitudes to be indicated on the NEP scale (with nine items)	Paper 4	722

4.2. Theoretical Modelling Framework

The basic theoretical framework used in discrete choice analysis is random utility maximization RUM. In this framework, individuals are assumed to maximize utility from the chosen alternative comprising a bundle of characteristics. Often, discrete choice modelling is established to analyse choice making in two or more alternatives and preferences are evaluated based on the trade-offs observed from the individuals' choices of alternatives. However, the analysist could not observe the utility to be derived from the good/service. As a result, this unobserved utility function is defined by deterministic and random components. The deterministic part is a function of different characteristics of the good/service and individuals' socioeconomic status. The (unknown) random part is assumed to follow a certain distribution. In such a way, the utility function of an individual n from a given alternative *i* can be written as:

$$\mathrm{U_{in}} = \mathrm{V}(\mathrm{X_{in}}, \mathrm{S_n}) + \varepsilon_{\mathrm{in}} \qquad \text{eq. 1}$$

$\mathrm{V_{in}}$ is the deterministic utility and ε_{in} is the random component. The deterministic part is a function of $\mathrm{X_{in}}$, the characteristics of the good/service; and $S_{n,}$ characteristics of the individual (socioeconomic factors). By assuming linearity, the deterministic part can be rewritten as:

$$\mathrm{V_{in}} = \beta' X_{\mathrm{in}} \qquad \text{eq. 2}$$

with β representing a vector of parameters. Note that S is not alternative specific and hence can be included through interactions.

The probability of choosing alternative *i* (that maximizes utility) over another alternative *j* within C_n choice sets can be written as (McFadden 1974):

$$\mathrm{P_{in}} = \mathrm{P}\big(\mathrm{U_{in}} \geq \mathrm{U_{jn}}\big); \mathrm{i} \neq \mathrm{j} \in \mathrm{C_n} \qquad \text{eq. 3}$$

The specific form of this function can be determined based on the assumption of the distribution of the random component. Usually, it is assumed to follow an extreme value (Gumbel) distribution i.e. a logistic functional form or a normal distribution which gives a probit form (Train 2003). Considering the multinomial (conditional) logistic form, the probability of alternative *i* being chosen is given by:

$$\mathrm{P_{in}} = \frac{\exp^{\beta' \mathrm{X_{in}}}}{\sum \exp^{\beta' \mathrm{X_{jn}}}} \qquad \text{eq. 4}$$

The multinomial (conditional) logit modelling is criticised mainly for the violation of the assumption of independence of irrelevant alternatives (IIA) which is related to the assumption of the error term being independently, identically distributed (IID) (Carson et al. 1994, Train 2003). Consequently, researchers suggest applying a random parametric logit (RPL), for its advantage in relaxing the IIA assumption and handling preference heterogeneity. That is practiced by assuming the parameter estimates to follow random distributions rather than being fixed (Train 2003). In this case, the probability function becomes:

$$P_{ni} = \int \frac{\exp^{\beta' X_{in}}}{\sum \exp^{\beta' X_{jn}}} f(\beta) d\beta \qquad \text{eq. 5}$$

where $f(\beta)$ denotes the density function of the parameters with a given distribution.

With regard to addressing heterogeneity, other advanced modelling approaches are being used with an extension to the random utility modelling procedure. One of these is the hybrid choice modelling approach (also called integrated choice and latent variables modelling) which relaxes the traditional choice modelling by incorporating latent variables (Ben-Akiva et al. 1999b). Latent variables are variables that are not known to the analyst but could be inferred from responses to several indicators. It has been pointed out that including such variables can explicitly address unobserved preference heterogeneities among individuals (see Aldrich et al. 2006, Choi and Fielding 2013). The hybrid choice model has three components: the utility function that includes the latent variables, structural function which defines the latent variable equations, and the indicator function where indicators are set to be explained by latent variables; all to be estimated simultaneously (for details see paper 4; and Ben-Akiva et al. 1999a, 1999b, 2002, Walker and Ben-Akiva 2002).

5. Research Contributions

This thesis mainly examines public preferences and WTP for forest ecosystem services. It also shows the effect of childhood experience in forest recreation. Moreover, the thesis highlights on the role of environmental attitude in the valuation of forest ecosystem service provision, and other methodological issues in discrete choice analysis. In the first two papers, we examine the preferences of forest visitors over their choices of forest sites using both the stated and revealed preference approaches. Therefore, the main contribution of these two papers is the analysis of preferences to evaluate which forest characteristics and features affect recreational services. In the second paper, we also considered more visited sites than just a single site to construct choice sets, hence allowing for better analysis of heterogeneity in RP setup. In paper 3, we show how forest recreational habit is strongly associated and determined by childhood experience. In paper 4, we analyse the variations in WTP for ecosystem services by including environmental attitudes into the choice modelling. Furthermore, the studies also contribute to other issues e.g. determining the appropriate number of alternatives to be taken through random sampling (paper 2), and to incorporate latent variables in different modelling approaches (paper 4).

5.1. Preferences for Variation in Forest Characteristics: Does Diversity Between Stands Matter? (Paper 1)

Anna Filyushkina, Fitalew Agimass, Thomas Lundhede, Niels Strange, Jette Bredahl Jacobsen
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In many ways, forest management principles that are implemented through silvicultural practices play an important role in affecting the recreational value of forests. Stated preference studies provide evidence that variation in structural characteristics is an important factor influencing the recreation value of a forest. However, many of them analyse variation from a single stand perspective or considering the whole forest having uniform features. Yet, forests may consist of different monoculture stands with various features between stands. This is especially true in production oriented private forests where several monoculture stands can be viewed diverse in structural features at the whole forest. Therefore, diversity both within and between stands of the forest could matter for recreational uses.

Many studies indicate how variation in forest characteristics may affect the recreational preferences (Kaplan & Kaplan 1989; Ribe 1989; Lee 2001; Bell et al. 2005; Ode & Miller 2011). More importantly, various studies have demonstrated that a forest stand comprising of mixed species or uneven age trees is preferred over monocultures (see e.g. Willis et al. 2003; Nielsen et al. 2007b; Gundersen & Frivold 2008; Dhakal et al. 2012). These findings cannot necessarily be extrapolated to a multi-stand forest. The aim of this study is to evaluate the effect of variation within a stand and between stands on recreational preferences for forests in Denmark. From including the diversity measures of variations in species and ages structures, we are able to show how important is diversity between stands relative to the diversity within a stand. Using a CE survey, respondents were asked to choose a forest site (for future recreational visit) from two hypothetical forest sites or 'no go' option – each consisting of three forest stands that are characterized by different tree species and heights. The choice sets include tree species composition (whether it is broadleaved, coniferous, or mixed), age structure (or height) (established, low, high, or uneven), diversity in species and age between stands, and distance in 8 levels (1, 3, 6, 10, 15, 21, 28, or 36 km). In the choice cards, coniferous types are represented by drawings of 'Norway spruce' trees while the broadleaves are represented by drawings of 'Beech' trees. In addition, respondents were asked to create their ideal forest for a visit by selecting drawings of three stands from a matrix of drawings. This is taken as an internal consistency test for the CE findings. Finally, we calculate aggregated willingness to travel (AWTT) for a number of forests (composed of three stands) using the mean WTT and the sum of 'levels' of attributes.

Main findings:

- All the included forest attributes significantly influence forest visitors' preferences
- Mixed or broadleaved tree species are preferred to coniferous types. Similarly, uneven age stands are preferred to even aged stands; and stands of higher trees are preferred to stands of lower height trees, in general.
- Maintaining diversity in species and age between stands of a forest increases the recreational value of the forest.
- More than 95% of the respondents make an ideal forest consisting of at least two different stands either in species or height, supporting the preferences of visitors for diversity between stands

That means forests with monoculture characteristics at single stand can be more preferable if the diversity between stands is maintained. On the other hand, close to nature forests with diversity in species and age structure, yet with similar visual characteristics, may even reduce the recreational desire of the society.

5.2. The Choice of Forest Site for Recreation: A Revealed Preference Analysis Using Spatial Data (Paper 2)

Fitalew Agimass, Thomas Lundhede, Toke Emil Panduro, Jette Bredahl Jacobsen
Under revision: *Ecosystem Services*

In this paper, we examine forest characteristics and other features important for recreational use of forests based on reported visited sites i.e. part of the survey where respondents indicated three most recently visited sites by pinpointing on a map tool. Because it is an RP study, the attributes are less detailed than in paper 1. The forest site attributes were identified from literature reviews and using spatial data sources such as GeoDanmark (DGA 2017) and CORINE land cover data (EEA 2014) applying different software packages in the R environment (R-Core-Team 2016). The attributes are forest area, ratio of forest area form, forest density, proportion of broadleaved species, presence of lakes and wetlands, terrain difference, presence of historical sites, state ownership, and distance.

In this case, all forest sites within 30 km from departure locations and only forests larger than 10 ha are considered as potential alternative sites that represent more realistic choice sets. With these restrictions, on average about 291 sites were counted as alternatives which may not be feasible for the choice modelling and analysis. Consequently, only small numbers of sites are taken using simple random sampling technique. We evaluate consistency of estimation results with different size of alternatives and show that taking as low as 50 alternatives could provide consistent parameter estimates. This is a fairly small sample size in contrast to the previous recommendations in transport studies (e.g. Nerella and Bhat 2004, Lemp and Kockelman 2012).

Main findings

- Big size forests and forests with higher proportion of broadleaved species are preferable for recreation while forest density has a negative impact.
- Forests which have a terrain difference of above 30 meter, which are in closer distance, with presence of historical sites, and which are owned by the state are preferred by visors for recreational uses.
- People who travelled on foot are more sensitive to distance than those who use other mode of transport in their forest trips
- Consistent parameter estimates can be obtained from simple random sampling technique in case of large number of alternatives available for a choice analysis.

These findings imply the recreational importance of different forest structural attributes to be considered in forest management and afforestation plans. For instance, decision makers need to be aware of the importance of accessibility of forests to residents in future afforestation plans. The findings also highlight the importance of other features from the perspective of recreational use of forests. For example, we found historical sites to increase the recreational values of forests. This suggests the need to preserve such heritage sites and to take precautionary measures in forest management decisions and silvicultural practices.

5.3. Forest Recreation in Adults and the Significance of Childhood Experience: Evidence from Nine European Countries (Paper 3)

Fitalew Agimass, Jens Abildtrup, Marius Mayer, Milan Ščasný, Niels Strange, Thomas Lundhede
To be submitted: *(Environment and Behaviour)*

In this paper, we examine the factors that affect individuals’ frequency of forest visit. Quite a great deal of literature shows how childhood experience in nature recreation can influence environmental behaviour and concern in adulthood (see e.g. Sebba 1991, Chawla 1998, 1999, Wells and Lekies 2006, Chawla 2007, 2009, Collado et al. 2013, 2015). However, its relationship with the recreational behaviour at adulthood is not well documented. The focus of this paper is to examine how individuals' forest recreational habit i.e. frequency of visit is influenced by their forest experience during childhood, in addition to other factors. Childhood forest experience is specifically represented by residency and frequency of forest visit during childhood. The study is conducted based on the data collection from nine European countries.

The dependent variable, frequency of forest visit, is measured on an interval scale where respondents were asked to report their frequency during a year (before the survey). Then, the indicated intervals are changed to three ordered categories of: 'more frequent', 'frequent', and 'less frequent' corresponding to visiting forests 'at least once a week', 'at least once a month', or 'at least once a year' respectively. The analysis is conducted using a generalized ordered logit model where frequency of forest visit is set to be a function of the variables including: frequency of forest visit during childhood, residency during childhood and now, distance to the nearest visited forests, and the sociodemographic factors (gender, age, education, income, and children under 18). The study indicates how childhood experience can play a significant role in affecting individuals' forest recreational behaviours.

Main findings

- People who have been visiting forests frequently in childhood are found to be more likely to be on a higher category of frequency of visit in adulthood
- Higher income groups and those who are living in rural areas now are more likely to be on a higher category of frequency.
- Based on the fixed effects estimation, we observe variations in 'level' of frequency of visit across the European countries.

These findings imply the requirement of accessibility of forest sites for current children so that they develop future recreation behaviour and also pro-environmental behaviour, as elaborated in other previous studies. On the other hand, assessing the frequency of visit can contribute for better management decisions; for instance, to enhance recreational facilities, decision makers may require knowing the amount of use (or level of frequency) of forest visitors.

5.4. Accounting for Environmental Attitudes to Explain Variations in Willingness to Pay for Forest Ecosystem Services Using the New Environmental Paradigm (Paper 4)

Fitalew Agimass, Suzanne Elizabeth Vedel, and Jette Bredahl Jacobsen

Under review: *Journal of Environmental Economics and Policy*

The study is conducted to evaluate the role of environmental attitude in explaining the variation in WTP for forest ecosystem services; specifically, the non-use value attributes. Four ecosystem services that are impacted by forest management schemes are identified and included in the choice sets. These are access to recreational sites, protection of endangered species, protection of natural process, and improving amount of groundwater. In addition to the choice experiments, respondents were asked to indicate their level of agreement or disagreement to items of questions from the NEP scale. Nine of the fifteen items of the NEP scale are presented in a Likert scale to measure environmental attitudes of respondents.

Previously, a number of studies show the role of environmental attitudes to explain variations in WTP for environmental goods/services. Some studies (see Aldrich et al. 2006, Choi and Fielding 2013, Bartczak 2015) considered the NEP scale as a unidimensional measure of environmental attitude. However, the NEP scale consists of items of questions that enable to indicate attitude in several dimensions. In this study, we illustrate the effect of NEP by taking account of such multidimensionality. The variation in WTP estimates are shown for two groups of individuals i.e. people with ecocentric or anthropocentric attitudes identified through factor analysis. Furthermore, in most of the studies, environmental attitude indicators such the NEP are directly incorporated into the modelling. However, attitude is a latent construct which makes it difficult to be directly incorporated into the choice model. Recently, many researchers justified the appropriateness of the hybrid choice model to handle latent variables (see e.g. Ben-Akiva et al. 1999a, 2002, Hess and Beharry-Borg 2011, Hoyos et al. 2015). So, the paper also presents variations in WTP estimates based on different modelling approaches that are commonly used in the literature.

Main findings

- Environmental attitudes influence WTP for ecosystem services. Most of the variables interacted with environmental attitudes i.e. anthropocentrism and ecocentrism are significant.
- The WTP of individuals with ecocentric attitude is higher than those with anthropocentric attitudes
- The hybrid choice model shows a relatively better model performance and is a preferred option to handle the latent variables
- The variations in WTP attributed to environmental attitudes is better explained by taking account of the multidimensionality of the NPE scale

It can be noticed that when the NEP scale is considered in its multidimensionality, we could illustrate the WTP estimates for the different groups of individuals. In this study, we found that people with ecocentric attitudes are willing to pay more for forest management plans for ecosystem services in contrast to those with anthropocentric attitudes. This implies the importance of considering differences in attitudes or motivations, and evaluating public support before implementing conservation measures based on average WTP estimates.

6. Conclusion and Further Study Remarks

Forests which are providing multiple ecosystem services to the society shall be managed in an optimal manner by considering the use and non-use values. The preference studies indicated what kinds of forest structural characteristics are better for recreational uses. In paper 1, we found diversity in tree species and age structure within and between stands of a forest being valuable for recreational purposes. In the second paper, area of the forest, availability of more broadleaves, and density of the forests were indicated to be important structural characteristics. In addition, presence of historical sites, higher terrain difference, being a state owned forest; all positively influence the choice of recreational sites. These are essentially useful insights on the choice of forest visitors that addressed the first research question. In the third paper, we found childhood experience being a significant factor that determines the recreational behavior during adulthood, which answered the second main research question. The last paper showed the differences in WTP estimates of two groups of individuals i.e. people with ecocentric and anthropocentric attitudes, and addressed the third main research question.

The studies also implied the importance of accessibility of forests to residential locations. Distance is the main factor affecting preferences and frequency of forest visit. Accessibility of forests to local residents is a valid concern in advanced countries where urban life has become more stressful. This can imply that in national afforestation programs which, in the Danish context, puts the recreational use of forests as one of the main objectives; attention should be given to the accessibility of forests to residents.

As clearly mentioned in Jensen and Koch (2004), research in forest recreation in the Danish context has influenced forest policy making. Therefore, we hope that these studies can contribute to the research regarding the non-market values of forests, specifically to the literature on preferences. The findings are consistent with previous studies adding relevant issues in forest management and planning. The studies showed the relevance of preserving diversity in forest structural characteristics, biodiversity functions, and conservation of historical sites so as to maximize socioeconomic benefits. According to Noble and Dirzo (1997) valuation of non-market forest ecosystem services will mean little unless they are accepted by the decision makers. Therefore understanding the forest features or attributes that affect the recreational importance of forests is an important step to guide the decision makers.

Finally, I shall mention some remarks for further research based on the insights from undertaking the thesis.

1) ***Combining SP and RP data in forest recreation:***

   In general, this thesis has been undertaken using stated and revealed preference data. As mentioned before, both of them have strengths and weakness. Many researchers suggested the use of combined data for joint estimation with more efficiency gains. Given the opportunity of both types of data from our first survey, we could undertake joint estimation based on the combined data sets. That is not included in the thesis for lack of time to organize the data sets, and therefore, can be commenced in the near future.

2) ***The effect of recreational activities and facilities on the choice of forest site:***

   It should be noticed that the preference studies in this thesis are conducted outlining the importance of different structural characteristics and features. Yet, other factors that can contribute for the recreational importance of forests could have been overlooked. For instance, some recreationists reported making trips to forests for watching birds and others for hunting wild animals. So, it would be quite relevant to include such attributes to understand preferences in a broader perspective. Furthermore, availability of recreational facilities could impact recreational values of forest sites and hence would be important to include them as additional attributes.

3) ***Analysis of presences using different payment vehicles:***

   In addition, the choice experiments are undertaken by taking distance reflecting the payment vehicle – which may be difficult to impute the exact cost in monetary units – as respondents may not 'mentally' compute all the travel costs. Therefore, choice experiments can be conducted with different payment vehicles rather than distance to analyze preferences, examine WTP difference, and make inferences on welfare changes.

4) ***Estimation of welfare changes, recreational demand, and cost-benefit analysis:***

   Furthermore, these studies didn't provide the analyses over recreational demand and further calculations (like welfare changes) relevant for cost-benefit analysis. Conducting such a study would provide solid foundation on the impact of different management and land use changes. With empirical evidence on such measures and knowing actual recreational uses of forests, decision makers could consider better management principles for optimal social welfare and sustainable uses.

Appendices

Appendix I (Paper 1)

Preferences for variation in forest characteristics: does diversity between stands matter?

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Abstract

The majority of existing studies of recreational preferences and forest characteristics focused on single stand attributes and demonstrated that people prefer stands with visual variation. However, it may be too simple since most people experience more than one stand when visiting a forest. This study aims at evaluating the effects of variation both within and between stands on recreational values. A choice experiment (CE) was applied to elicit people's preferences for forest types on their next recreational visit. Each alternative is presented with drawings of three forest stands which differ with respect to tree species, height (age) and distance to the site, the latter representing the cost factor – willingness-to-travel. Respondents also compose their ideal recreational forest by selecting three types of stands from the catalogue of drawings. We find that mixed tree species are preferred compared to monocultures. Stands with trees of varying height (uneven-aged stands) are preferred over stands consisting of trees of the same height (even-aged ones). Variation between stands is found to contribute positively to recreational value, and in some instances, this may outweigh contribution of variation within a stand. Comparing respondents' composition of their ideal forest with elicited preferences from the CE, confirm these findings.

Keywords

Outdoor recreation, choice experiment, variation, forest structure, forest management, visual diversity.

1. Introduction

Recreation is one of the most important services forests provide to society (Pearce 2001, Slee 2005, Daniel et al. 2012). Forest management plays an important role in designing forests and thus affects the potential recreational attraction of the site. Hence, understanding visitor preferences for different forest characteristics or attributes and their recreational values becomes imperative in order to integrate recreational interests in policy as well as in practical decision-making.

A considerable body of literature in the field of preference research has provided insight into impacts of forest management on recreational values of forests (e.g. Schroeder and Daniel 1981, Zube et al. 1982, Brown and Daniel 1986, Jensen 1999b, Bliss 2000, Holgén et al. 2000, Silvennoinen et al. 2001, Heyman et al. 2011, Nielsen et al. 2012). Variation in forest and/or landscape characteristics may affect the recreational experience and thus the recreational value (Kaplan and Kaplan 1989, Ribe 1989, Lee 2001, Bell et al. 2005, Ode and Miller 2011). A number of studies have demonstrated preferences for visual diversity at a single stand level e.g. that mixed stands in general are preferred over monocultures (see e.g. Willis et al. 2003, Nielsen et al. 2007, Gundersen and Frivold 2008, Dhakal et al. 2012). However, a recreational experience in a forest most often involves visits to several stands and so far, it remains unanswered whether these findings can be extrapolated to forest level i.e. how the recreational experience is affected by diversity between multiple stands. Is it merely a simple sum of the recreational experiences and values of individual stand values or a more complex judgement? The need to examine the effect of variation between stands has been expressed numerously (e.g. Ribe 1989, Mattsson and Li 1994, Nielsen et al. 2007, Gundersen and Frivold 2008). However, previous examples have mostly concentrated on preference comparisons without looking at the importance of this aspect relative to other preferences for structures (e.g. Axelsson-Lindgren and Sorte 1987, Price 2007, Edwards et al. 2012a).

The aim of this study is to evaluate the effect of variation within a stand and between stands on recreational preferences for forests in Denmark. Using a choice experiment (CE), respondents were asked to choose between sites for their next forest recreation visit from two alternatives – each made up by three drawings of forest stands that are characterized by tree species and height (as a function of age). Distance to the forest site was included as an attribute in order to estimate willingness to travel to the preferred forest. In addition, we asked respondents to create their ideal forest to visit by selecting drawings of three stands from a matrix of drawings, where each drawing could be chosen more than once. This was used as an internal consistency test for the CE findings. Finally, we calculated aggregated willingness to travel (AWTT) for a number of forests (composed of three stands) for a sample mean WTT and using individual posterior estimates.

The remainder of this paper is organized as follows. Section 2 summarizes relevant literature on forest recreation and provides hypotheses for this study. Section 3 outlines the CE setting and data collection. Section 4 presents main findings and section 5 provides a discussion of their implications for forest management.

2. Literature review and hypotheses

A number of studies show that visual diversity or variation within a stand of a forest is an important determinant of recreational value of forests (e.g. Ribe 1989, Lee 2001, Gustavsson et al. 2005, Nielsen et al. 2007, Dhakal et al. 2012). Variation has also been identified as a key cognitive factor that accounts for a considerable part of expressed preferences (Kaplan and Kaplan 1989, Nielsen and Jensen 2007, Bell 2009, Ode and Miller 2011). The present study defines forest and stand variation as presence of different levels of one or several forest characteristics (be it spatial, biological or structural) that results in a visually diverse recreational experience. In the landscape perception literature this is sometimes referred to as "complexity" (i.e. abundance of variety, where structure is not simple), "richness", "diversity", or "contrast" (e.g. Kaplan and Kaplan 1989, Ode and Fry 2002, Bell 2009). Hence, the visual variation depends on several features, among others tree species, tree size, stand density, presence or extent of understorey etc. This study focuses on two of them – tree species and tree height (age)[1]. The latter acting as a proxy for forest management system; i.e. stands consisting of trees of the same height (even-aged stands) often represent a clear-cut system, whereas stands comprised of trees of varying height (uneven-aged stands) indicate practice of single-tree selection systems. Variation may appear at different spatial scales; stand, forest, and landscape level. This study addresses it from both perspectives: within a stand and between stands.

2.1. Preferences and variation within a stand

Studies on recreational preferences show that the most important forest structure is related to tree age - older trees are preferred over younger ones (e.g. Ribe 1989, Lindhagen and Hörnsten 2000, Tahvanainen et al. 2001, Gundersen and Frivold 2008, Edwards et al. 2012b). According to the Danish study by Koch and Jensen (1988), this effect is more prominent in broadleaved than coniferous forests. A relatively low recreational value of young stands may partially be explained by a high density of trees inside the stand, which offers low possibility for visual and physical penetration of the stand. In contrast, semi-open forests provide a better view and sense of safety than dense forests (Kaplan and Kaplan 1989, Heyman 2012) and may also be seen as more penetrable, for e.g. mushroom picking (Varela et al. 2016). However, there seems to be a large degree of heterogeneity in preferences. For instance, children and young people often favour more dense alternatives, and higher environmental knowledge often correlates with preference for more natural-looking sites (Ribe 1989, Tyrväinen et al. 2003, Gundersen and Frivold 2008).

[1] This study is focusing on "tree height" as it is a direct visual component (as opposed to age). However, the literature mainly refers to "tree age". Thus, throughout this paper we use the terms height when referring to our study, but it may be interpreted as interchangeable with age.

Variation in tree size and tree spacing in the stand has been identified to have a positive relationship with recreational values across Europe (Willis et al. 2003, Edwards et al. 2012a). Trees of varying height are preferred over even-aged scenarios in Denmark (Nielsen et al. 2007) and a study performed in Germany demonstrated an even higher importance of structural variation under winter conditions (Elsasser et al. 2010).

Public preferences for tree species may partly be attributed to cultural and regional contextual issues. In the present paper, Denmark is used as a case where in general broadleaved and mixed forests are preferred to conifers (Jensen 1999b, Nielsen et al. 2007, Termansen et al. 2013). It has been shown that monocultures appear to be less preferred due their limited variation (Ribe 1989, Willis et al. 2003, Gundersen and Frivold 2008, Elsasser et al. 2010, Dhakal et al. 2012, Abildtrup et al. 2013). However, the highest preference have been found for monocultures when they are of old age (Jensen 1999a).

2.2. Preferences and variation between stands

In most cases, a recreational experience in a forest would imply that people are moving around in the forest and thus passing multiple stands. While uneven-aged mixed forest is found to provide the highest variation at a stand level, the visitor may perceive less variation if all stands in the forest are similar. This suggest forests comprised of uneven-aged mixed stands may have a lower recreational value, than forests with more inter-stand variation (Axelsson-Lindgren 1995). Findings of (Mattsson and Li 1994) suggest that variation between stands of different ages (though each of them individually more or less uniform) is consistent with a higher non-market value. Moreover, openings in the forest provide space and visual access to more distant areas (Kaplan and Kaplan 1989, Heyman 2012).

Existing studies focusing on the effect of variation between stands are limited and mostly confined to pairwise comparisons. Axelsson-Lindgren and Sorte (1987) compare in a Swedish study two trails with different extent of variation and conclude that the trail including many visually different stands had higher attractiveness among participants than the trail with lower visual diversity. Price (2007) found a similar result and stipulates that such results could be due to poor representation of visual progression through the forest. In the 1970s a sample of residents in the Oslo area reported that they preferred taking a walk in "a mixture of old and young forest" compared to taking a walk in "old forest" (Haakenstad (1972) cf Gundersen and Frivold (2008)). In a study by Koch and Jensen (1988) Danes showed preference for forest areas that contained both broadleaved and coniferous stands, especially if the majority of stands were broadleaved. Findings of a recent expert-elicitation study (Edwards et al. 2012a) on recreational values of forests demonstrate positive or a bell-shaped relationship between recreational value and "variation between stands along the path" (for Europe in general and Nordic countries respectively). Finally, results of a recent choice experiment study performed in Poland suggest that the average respondent prefers to visit forests that are comprised of stands that vary in tree species composition and age structures (Giergiczny et al. 2015). So while a few studies indicate importance of variation between stands, no studies have evaluated it relative to the variation within stands.

2.3. Hypotheses of this study

The main hypothesis of the present study is that variation matters. Not only variation within stands but also variation between stands affects the recreational value of a forest. Specifically: (1) Diversity in tree species composition across stands has a positive effect on recreational value; and (2) diversity in tree height across stands has a positive effect on recreational value. In addition, we expect preferences for tree species composition and height structures within the stand to follow same pattern, i.e. (3) mixed stands are preferred to coniferous and broadleaved stands and (4) stands with trees of varying height (uneven-aged stands) are preferred to stands with trees of same height (even-aged stands). The hypotheses are tested in two ways: by eliciting peoples' preference in a CE, and by asking respondents to create their ideal forest.

3. Method

Discrete choice modelling is one of the main techniques used to estimate non-market values of environmental (ecosystem) services, including recreation (e.g. Adamowicz et al. 1998, Hanley et al. 1998, Scarpa et al. 2000b, Hanley et al. 2002, Carlsson et al. 2003). The method was initially developed for market analysis (Louviere et al. 2000). Its formulation is based on Lancaster's demand theory (Lancaster 1966) and McFadden's Random Utility Maximization (RUM) framework (McFadden 1974). We use a standard random parameter logit model with panel specification, whereby we allow for preference heterogeneity, see e.g. Train (1998) for details. Thereby we are able to estimate a utility parameter, β, for each attribute entering the estimation.

The marginal rate of substitution between two attributes results in a marginal willingness to pay (WTP) when the denominator is a price. In this study, distance to be travelled is used instead of price and consequently willingness to travel (WTT) is being estimated using the following formula:

$$WTT = \frac{-\beta_{attribute}}{\beta_{distance}}$$

Note: it is possible to convert this to a WTP measure using a fixed cost per kilometer travelled (see e.g. Bakhtiari et al. 2014) for an example.

3.1. Design of the choice experiment

In choice experiment respondents were asked to choose between two forests for their next recreational visit (example of a choice card is presented in Figure 1). Each of the two alternatives were represented by drawings[2] of a forest, each forest comprising three stands and the distance that one would have to travel to reach the forest. Presence of more than one stand in each alternative and their horizontal alignment was an attempt to reflect the experience of a recreational visit to a forest (visiting several stands) and not just a single stand. The drawings included a red pictogram to the right of each stand representing an adult person visiting the forest, enabling respondents to make a judgement on the scale and height of trees. Furthermore, each stand had a label containing information on tree species and their height. All of this was explained to respondents in the text accompanying the drawings. Finally, each choice card contained a possibility of opting out by choosing the "I would not visit either of these forests" alternative.

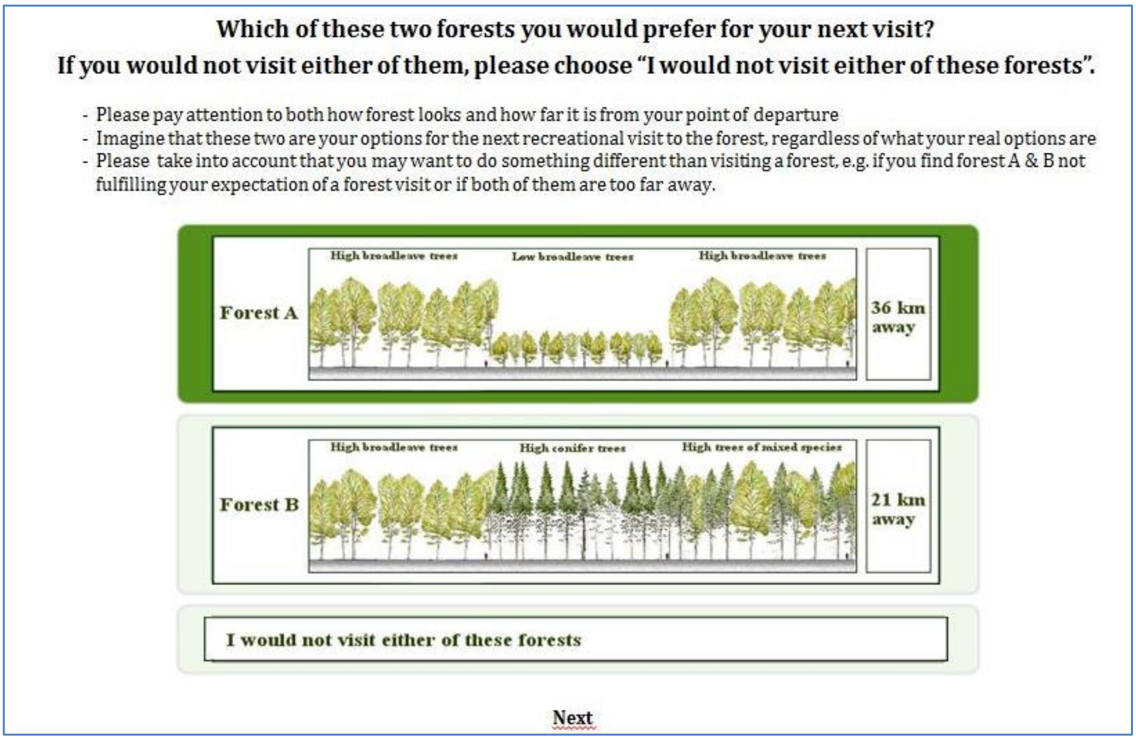

Figure 1: An example of a choice card. Text was in Danish, but here translated into English

A full list of the attributes and attribute levels is shown in Table 1. Tree species and height reflected the extent of variation within a stand; from coniferous or broadleaved monocultures to mixed stands and from trees of the same height within a stand (newly established, low, and high trees) to trees of varying height. Coniferous stands are represented by Norway spruce, which is the most common coniferous species in Denmark. Similarly broadleaved stands are represented by beech,

[2] The drawings of each tree are provided by Dr. Anders Busse Nielsen and are modified versions of those used in Nielsen et al. (2007b)

which is the most common broadleaved species. Mixed stands contain a mix of beech and Norway spruce in equal proportions. For each alternative two additional attributes were derived: tree species diversity and height diversity between stands. Distance to the forest site represents the cost factor, its levels were selected based on findings from other studies of stated travel distances (Jensen 2003, Bakhtiari et al. 2014).

Table 1

Attributes and levels with descriptions

Attributes	Levels	Description
Tree species		
Conifers[*]	Each can take	Number of stands of each type in the three
Broadleaves	0, 1, 2, 3	stands (forest).
Mixed		Sum of all tree species for the entire forest is 3
Stand height		
Newly established[*]	Each can take	Number of stands of each height structure in the
Low trees	0, 1, 2, 3	three stands (forest).
High trees		Sum of all height classes for entire forest is 3
Trees of varying height		
Tree species diversity across (between) stands	0, 1, 2	A derived attribute 0= if all three stands have the same tree species composition 1= if two out of three stands have the same tree species composition 2= if all three stands have different tree species composition
Tree height diversity across (between) stands	0, 1, 2	Derived attribute 0= if all three stands have the same height structure 1= if two out of three stands have the same height structure 2= if all three stands have different height structure
Distance to the forest	1, 3, 6, 10, 15, 21, 28, 36	Travel distance (km)

[*] Conifers & newly established stands are the reference levels.

The statistical design is based on three stands each of which could be one of three species, four height levels, and then eight travel distances. We used the software Ngene to create choice cards by optimizing D-efficiency for a multinomial model with main effects and priors estimated based on the pilot sample. The design consisted of 24 choice situations distributed with an ex-ante D-error of 0.188306. To test the specific effect of variation between stands, we constructed two derived attributes (tree species diversity and tree height diversity across stands) which were determined from the levels present in the three stands. As these are created by a combination of the others, they are in fact an aggregate of interactions and therefore not included in the D-efficient optimization in Ngene. To ensure balanced representation of levels of the two derived attributes, eight extra choice sets were constructed manually maintaining balance of other attributes' levels. Furthermore, attribute levels for 12 dominant alternatives were changed manually[3]. Based on the literature review presented above, a dominant alternative in this case is an alternative at short distance with preferred tree species types and height structures based on learnings form previous studies (e.g. forest stands consisting of mixed or broadleaved tree species and trees of high or varying height). The final design thus contained 32 choice cards distributed to four blocks, so that each respondent was presented with eight consecutive choice sets. Evaluation of the final design resulted in D-error of 0.151243. The order of the choice sets in each block was randomized between respondents.

As the design included the derived attributes, we wanted to test whether the design would bias results or not. To do so, we simulated 1000 answers to all choice sets based on a set of a priori set beta parameters. Following, we estimated a model based on these simulated answers. We were able to obtain parameters in the estimation for a variety of a priori set beta parameters and errors.

3.2. Data and sampling

The choice experimental data was collected in Denmark using a structured internet-based questionnaire. Two focus group interviews, individual interviews and an online pilot survey involving a total of 133 respondents were carried out in order to test the survey instrument, evaluate attribute levels and adjust both. The main survey was administered online from May 19th to June 8th 2015 and was managed by a survey company. The company invited members of their online panel to participate in the survey, ensuring representativeness of the sample. A total of 3,665 individuals accepted the invitation of which 1,339 respondents were screened out and excluded in the survey procedures to maintain representativeness in terms of gender, age, location and income of the respondent. From the remaining 2,326 respondents, a total of 1,226 respondents completed the questionnaire, which equals a response rate of 53%.

[3] Instead of doing this manually restrictions could have been included to the Ngene code. However, it is our experience that restrictions sometimes cause the optimization process in Ngene to be problematic, and testing the effect of the manual swopping in terms of balance and d-error provides a more efficient design

3.3. Content of the questionnaire

The questionnaire contained five sections. The first section assessed respondents' recreational behaviour including frequency of visits to the forests, type of activities, transportation mode and details of their last forest visit. This also served as a means to let them consider actively their behaviour before expressing their preferences. This was followed by a section assessing respondents' knowledge about common tree species. Half of the respondents received a small quiz asking them to identify and name common tree species from drawings and categorize them into native and non-native. The other half were simply given information about common tree species growing in Denmark. We found no significant difference between the two splits in respect to scale factor of evaluating levels of attributes, hence, we used a pooled sample for analysis. Sections three and four were aiming at capturing preferences for different forests using two methods: a choice experiment followed by a series of debriefing questions and an additional exercise where respondents composed their ideal forest for recreation respectively. In this additional exercise respondents were selecting three stands from a matrix of all drawings applied in the choice cards. The final forest could potentially consist of three similar stands, i.e. each stand could be chosen several times. The fifth section contained questions about their socio-demographic background.

4. Results

The socio-demographic characteristics of the samples were compared with the Danish population from Statistics Denmark[4]. We fail to reject the null hypothesis (at the 5% level) of equal samples for age and region, but not for gender, income, education and employment status (see Table A in Supplementary materials). The sample contains more women than in the national population, and more respondents in the lower income categories. Our sample has more respondents that have university degree but less in primary education; and more retired people but less that are in education.

Most of the respondents (83 %) stated that they had recreational forest visits within the last year. The average frequency of visits is 28 times a year with a median of four times a year[5]. More than 50% of the respondents indicated that they visited forests within the last two weeks (of filling out the questionnaire). Most respondents stay in the forest for 30-120 minutes. About 40 % of the respondents use their personal car to reach the forest while 13 % use bicycle and about 39 % travel on foot. As for the mode of transportation that respondents considered while making decisions in the choice experiment, a total of 61% indicated that they made choices assuming the same mode of transport as in their last forest visit. The share of respondents considering traveling by car remains almost the same (45 %). However, the share of respondents considering to walk to the forest is only 21 %, and those

[4] www.statistikbanken.dk

[5] The sample contains respondents who reported visiting a forest more than 1000 times a year – probably they live close to forest in which they can walk several times a day.

considering to bike is 21 %. This might be the result of longer distances presented in the choice cards. We calculated the actual travel distance in their most recent recreational visit to a forest[6]. The mean travel distance is 4.2 km for walkers, 6.8 km for cyclists, and 14.5 km or those who used a personal car. In the choice modelling, we assume that potential shift in transport mode does not change the functional form for the distance parameters.

The RPL specification used in this study assumes stable preferences for an individual across all choice cards (Train 2003). Estimation was performed with 1,000 Halton draws in NLOGIT 5.0 software (Greene 2012b). Between individuals, all the coefficients are assumed to be randomly and independently normally distributed except for the coefficient of distance, which is assumed to be fixed[7]. Tree species and height are dummy coded, whereas diversity indices and distance are coded linearly. A forest consisting of three coniferous stands is the reference for tree species, and thus variables ‘Broadleaves’ and ‘Mixed’ count the number of stands with broadleaves or mixed respectively instead (i.e. 0 to 3). For stand height, a forest consisting of 3 newly established stands is taken as the reference level, and the other variables like ‘Low trees’ are counting the number of stands in the forest from 0-3 with low trees. The constant of the regression, the ASC, is coded as dummy (= 1 for alternatives 1 and 2 and 0 for the “not visiting either of the presented forests” alternative).

Table 2 shows the parameter estimates and model performance characteristics. The adjusted McFadden’s R2 of the final estimation is 0.23, which is considered as a good fit (Louviere et al. 2000). All estimated parameters are significant, and with exception of distance have a positive effect on attractiveness of forest sites for recreation. As expected, the coefficient for distance to a forest is negative. ASC represents a negative utility of visiting a forest comprised entirely of newly established coniferous stands at a distance of zero (with tree species diversity and height diversity across stands being zero).

Table 2

Output from Random parametric logit estimation

Attributes	Coefficient	SE	Z	Prob |z|>Z*
Broadleaves[a]	0.37***	0.03	13.39	0.0000
Mixed[a]	0.51***	0.03	16.49	0.0000
Low trees[b]	1.07***	0.04	28.16	0.0000
High trees[b]	1.22***	0.04	28.89	0.0000
Trees of varying height[b]	1.48***	0.05	30.29	0.0000

[6] In the first section of the questionnaire we asked respondents to point to location of their last forest visit and place of departure on a google map provided in the online interface.

[7] A lognormal distribution of distance may be more appropriate, so we tested this and it did not cause any important change in the results. For ease of calculating WTT estimates, we therefore chose to keep it fixed.

Tree species diversity across stands	0.23***	0.03	7.51	0.0000
Tree height diversity across stands	0.24***	0.03	7.77	0.0000
Distance	-0.10***	0.00	-32.22	0.0000
ASC	-1.35***	0.14	-9.69	0.0000
Standard deviations				
Broadleaves	0.51***	0.03	15.40	0.0000
Mixed	0.29***	0.05	5.62	0.0000
Low trees	0.01	0.08	0.15	0.8817
High trees	0.56***	0.04	12.57	0.0000
Trees of varying height	0.31***	0.07	4.19	0.0004
Tree species diversity across stands	0.27***	0.08	3.50	0.0000
Tree height diversity across stands	0.40***	0.05	7.45	0.0000
ASC	2.52***	0.11	23.01	0.0000
Log likelihood function	-8320.02			
McFadden Pseudo R-squared	0.23			

*** indicates P<0.001

[a] Coefficients are for one of three stands being broadleaves or mixed instead of conifers

[b] Coefficients are for one of three stands being of low, high height or uneven-aged respectively instead of newly established

Table 3 presents the willingness-to-travel (WTT) estimates based on results from Table 3 with standard errors calculated using the Delta method (Greene 2012a). At stand level, we see that presence of broadleaved and mixed tree species as opposed to conifers would positively influence respondent's WTT to a forest for recreation. They are willing to travel additional 3.62 km for having one broadleaved stand out of three and 4.98 km for mixed stand (in both cases instead of a coniferous stand). Thus, we cannot reject the 3rd hypothesis that mixed stands are preferred over pure broadleaves or conifers. Among stands where trees are of the same height, stands with higher trees are preferred over those with lower trees. People are willing to travel additional 10.38 km and 11.85 km for seeing one stand out of three consisting of low or high trees respectively compared to newly established trees. Also, stands with trees of varying heights are favoured over stands with trees of same height, where people are willing to travel additional 14.35 km to experience one stand composed of trees of varying height compared to a newly established stand. Thus, we cannot reject the 4th hypothesis that stands with trees of varying height are preferred over those with trees of the same height. In conclusion, on a stand level respondents prefer more diverse stands both in terms of tree species composition and height structure.

Table 3

Estimated mean WTT and WTP across all respondents[a]

Attributes	WTT (Km)	SE	95% Confidence interval	WTP[b], (DKK)
Broadleaves	3.62***	0.27	3.10 - 4.15	14.48
Mixed	4.98***	0.30	4.39 – 5.57	19.92
Low trees	10.38***	0.34	9.72 – 11.05	41.52
High trees	11.85***	0.35	11.16 – 12.53	47.40
Trees of varying height	14.35***	0.41	13.55 – 15.16	57.40
Tree species diversity across stands	2.27***	0.30	1.68 – 2.85	9.08
Tree height diversity across stands	2.30***	0.32	1.67 – 2.94	9.20

Note:

[a] The WTT for ASC is -13.5 km. Analytically this equals visiting a newly established coniferous forest.

[b] WTP was calculated using a transport conversion factor where 1 km = 4 DKK (FDM 2009).

Variation in tree species and in height between stands positively affects the recreational attractiveness of the forest. People are willing to travel 2.27 km extra to reach a forest in which only two out of three stands are of the same tree species composition relative to of all of them being of the same species. Similarly, they are willing to travel 2.30 km extra to visit a forest in which two out of three stands have the same height instead of all of them having the same height. Thus, we cannot reject the first two hypotheses.

The next question is if diversity between stands can outweigh diversity within a stand. As it is evident from Table 3, this depends on the exact composition of the forest, which in this case is limited to tree species composition and height of each stand. With levels of these attributes established for this study (Table 1) and forest assumed to be comprised of three stands, there are 364 possible forest combinations (where the order of forest types does not matter). We calculate the aggregated willingness to travel (AWTT) for each of these possible forests using the following formula:

$$AWTT = ASC + \sum WTT_i * N_i$$

Where: i=attributes (WTT for each attribute), and N is the level of attribute (see Table 1 column 2).

First we calculate AWTT using sample mean WTT from Table 3. For example, applying the above equation to a forest consisting of two stands of mixed tree species of varying height and one high broadleaved stand (Figure 2b) results in following:

$$AWTT=ASC + 1*WTT_{broadleaves} + 2*WTT_{mixed} + 1*WTT_{high\_trees} + 2*WTT_{trees\_of\_varying\_height} + 1*WTT_{tree\_species\_diversity\_across\_stands} + 1*WTT_{tree\_height\_diversity\_across\_stands} = 45.2\ km.$$

Forest consisting of three stands with tree species of varying height (Figure 2a) has slightly lower AWTT (44.5 km), but the difference is not significant. A forest with maximum species diversity across stands but no height variation has a little lower AWTT of 35.2 km (Figure 2c), whereas a forest with maximum height diversity and no species diversity is a lot lower (24.2 km, Figure 2d). Figure A in the supplementary materials shows the distribution of AWTT for all 364 combinations for a sample mean WTT, and as is seen a number of them lie relatively close.

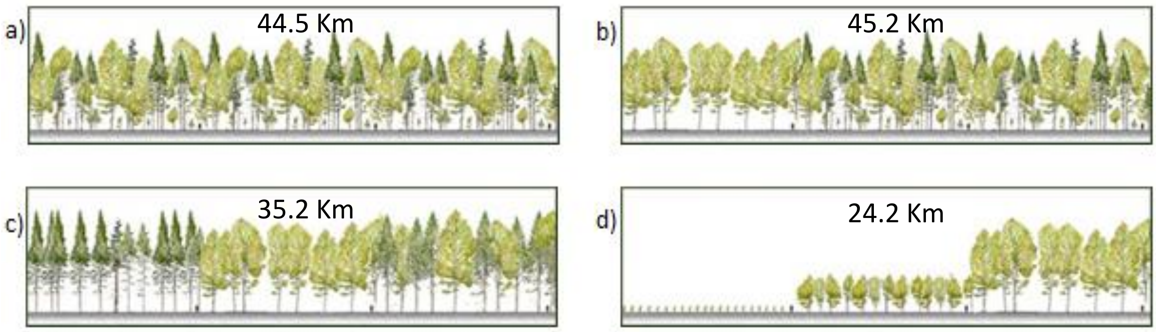

Figure 2: Examples of forests representing different combinations of tree species stand height, tree species diversity, and height diversity. Note that each forest is assumed to be comprised of three stands.

To analyse heterogeneity in this respect, we also calculate every respondent's AWTT for each of the 364 possible forests combinations of three drawings using the posterior individual coefficients from the RPL estimation and AWTT equation. Only 14 % of respondents chose a combination consisting entirely of stands of trees of mixed species and varying height (Fig. 2a). Thus, diversity across stands matter, and may outweigh diversity within a stand. In most cases however, presence of high trees or trees of varying height with species variation between *or* within stands results in an AWTT in the high end.

As a consistency check of findings from the choice experiment, we use the result of people's constructed ideal forest. As shown in Table 4 around 50 % of the respondents composed a forest, which consists of drawings that represent either two types of tree species or two types of height structures. 95 % of the respondents composed an ideal forest with an estimated AWTT, which lies within a 95 % confidence interval of the AWTT for the most preferred forest estimated based on the posterior beta parameters from the CE. Thus, the construction of ideal forest supports the findings of the choice experiment that variation between stands matter.

Table 4

Results from creating the ideal forest exercise: percentage of respondents considering levels of diversity in tree species composition and height in three stands they chose

Level of diversity across three stands	Attributes	
	Tree species composition (%)	Tree height (%)
"0" – All three stands share the same level of the attribute	19.5	33.3
"1" – 2 stands have different levels	48.1	51.9
"2" – All 3 stands have different levels	32.4	14.8

5. Discussion

This study aims at evaluating the effect of variation in two forest characteristics (tree species composition and tree height structure) both within a stand and between stands on recreational value of a forest. Different levels of these two forest characteristics define the management (silvicultural system) that is being applied. Thus, the main motivation is to contribute to the understanding of how forests can be managed in order to better accommodate societal recreational preferences. We found that, within a given stand, mixed tree species are preferred to broadleaved and broadleaved are preferred to coniferous. In general, stands comprised of higher trees are preferred to those consisting of lower ones and stands of trees of varying height are preferred to stands of tree with same height. This is consistent with findings of previous studies (e.g. Ribe 1989, Nielsen et al. 2007, Gundersen and Frivold 2008, Giergiczny et al. 2015).

If these findings were to be extrapolated from stand level to forest level without any additional considerations, the preferred forest would be comprised entirely of similar stands of uneven-aged mixed tree species. The question is whether a forest like this would have the highest recreational value? In order to analyse the effect of variation *between* stands on recreational value of a forest; our study's choice experiment specification also contained two diversity indices (tree species composition and height) that reflect variation between three stands. We find that both diversity in tree species and height structure between stands are positively contributing to individuals' choice of a forest to recreate in. The estimates for both diversity measures across stands are approximately of the same magnitude. For tree species composition, the magnitude of diversity between stands is compatible with the difference between two levels of variation within stand (broadleaved monocultures and mixed tree species) which indicates that in some instances monocultures could be preferred over mixed stands. We see that a forest comprised of three similar stands of mixed tree species gives a slightly lower

AWTT than one consisting of two stands of mixed tree species and one broadleaved monoculture stand. Regarding height (age), the diversity across stands is not enough to outweigh the difference in AWTT within a stand. However, considering the uncertainty in the estimates, the differences are not significant, leading us to conclude that variation between stands with regard to both height and species, can outweigh lack of variation within a stand and vice versa.

This study assumes that variation between stands contributes linearly to utility. However, Axelsson-Lindgren (1995), Ode and Miller (2011), and Edwards et al. (2012a) find that too much or too little diversity may have a negative effect on the recreational value of forests. To allow for a different functional form two additional models were estimated: a) with a log specification of the diversity indices which can reflect diminishing marginal utility and b) a specification with dummy coding of diversity. In doing so, only minor improvements have been reached in terms of the log-likelihood function (by four units in log specification and seven units in dummy specification) from the original linear specification; and it does not lead to different conclusions. Consequently, assuming linearity seems reasonable.

In this study we showed respondents three stands beside each other. It is possible that the absolute positioning (left, middle, right) as well as the relative one (what is next to a given stand) matters for the variation measures. While we find no significant difference between attributes allowing them to vary between absolute positioning, we do find that relative positioning may have an effect[8,9]. However, this was not included in the design of the survey, and as we are talking about third-order interactions, without explicit consideration in the design, results may be biased. To what degree respondents took specific positioning into account is unknown – we only know for certain that they were asked to consider each stand as a representation of proportion of a forest. In order to fully answer this issue, we would need other ways to present the forest structural data, e.g. based on video visualizations or actual habits.

Basing the study on drawings involves a level of abstraction, which is higher than if photos were used. However, it makes the illustrations less sensitive to light conditions and positioning of individual trees and easier to control different aspects of the content and thus was considered as more suitable for this study. Yet, other options exist, which may improve respondents' ability to better capture the reality. One such option is to invite respondents into an actual forest and let them chose their most preferred recreational paths. Also, findings could be checked by performing comparison with actual recreational habits of respondents. We leave such possible extensions to future research.

An obvious question is to what degree these findings can be transferred to other countries. Looking at the results from Edwards et al. (2012a) comparing preferences for forest structure for recreation by a Delphi study, tree size and species variation are some of the important attributes in

[8] We tested it by creating a dummy for whether the stand next to a given one was identical or not, and then interacting this with the diversity measures.

[9] These two extra models can be obtained from authors upon request.

most countries investigated. This speaks for results being transferable. The study is carried out in Denmark; a country where forestry has been dominated by even-aged monocultures. Consequently, it is likely that this anchoring would make the preference for variation between stands more pronounced. But to what degree remains an open question.

In this study we focused on recreational values of variation. However, people may have other values associated with variation in height or species – namely a non-use value in the form of e.g. naturalness (see e.g. Czajkowski et al. 2009, Campbell et al. 2013). It is unlikely that they are distinguishable from recreational values per se, but by focusing on transport distance as in this study we are likely to have higher emphasis on only the recreational values than in e.g. Nielsen et al. (2007) or the above mentioned studies using a monetary payment vehicle.

Findings of this study contribute to the on-going debate regarding the choice between even-aged or uneven-aged forest management and add to the question of striking a desired balance between public goods and production of timber. On one hand, stands of uneven-aged mixed tree species provides the highest variation *within* a stand and is on average the most preferred option at that level, supporting the argument for close-to-nature management or at least application of selection silvicultural systems. On the other hand, variation *between* stands also positively contributes to recreational value of forest. One could suppose that if close-to-nature forestry is implemented everywhere, it might reduce the variation on a forest level and result in loss of a portion of the recreational value. Even though results of the current study do not support a hypothesis that a mix of stands in different ages of clear-cut forestry is preferred on a between stands level, presence of least favoured stands is unavoidable and could be beneficial for recreation due to inter-stands variation. Also, trees in mature age in even-aged forest management are associated with relatively high recreational value. Thus, for management it suggested to promote both types of variation (within and between stands) through a variety of forest characteristics and management regimes. Finally, since variation is important for the recreational experience, the management should also allow the visitor to experience other types of variation, e.g. visual transparency allowing the visitor to observe geological and topographical variation.

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Appendix II (Paper 2)

The Choice of Forest Site for Recreation: A Revealed Preference Analysis Using Spatial Data

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Abstract

In this paper, we investigate the factors that can influence the site choice of recreation. Relevant attributes are identified by using spatial data analysis from a questionnaire asking people to indicate their most recent forest visits by pinpointing on a map. The main objectives of the study are 1) to examine the preferences of visitors for different forest attributes using data from actual visits and 2) to illustrate how many alternative sites needs to be considered for estimation in case of a large number of potential recreational sites. Estimation is performed using a conditional logit as well as a random parameter logit model. The variables that are found to affect the choice of forest location include: distance, forest area, tree species composition, forest density, availability of historical sites, terrain differences, and state ownership. Regarding the second research objective, we empirically show the possibility of getting consistent parameter estimates through random selection of alternatives. We find that increasing the number of alternatives increases consistency of parameter estimates.

Keywords

Discrete choices; forest recreation; revealed preference; spatial data; sampling of alternatives.

1. Introduction

Forests provide a multitude of ecosystem services to society, and recreation has become an important part of that, especially to modern urban lives (Douglass 1982). In Denmark, forest recreation is considered as one of the main leisure activities (Jensen and Koch 2004, Skov-Petersen and Jensen 2004). Therefore, it becomes apparent that the values of such services needed to be taken into account in forest management decisions so as to enhance social welfare. The non-market forest benefits can be estimated using either stated preference (SP) or revealed preference (RP) approaches. The SP approaches have become popular and widely used in the valuation of environmental goods. But, the requirement of a hypothetical market setting remains a major drawback (Hausman 2012) and the use of RP data may be considered as a better option. Estimations based on RP data can be used to validate findings from SP methods, for accurate prediction of choice behaviour with regard to changes in specific policy initiatives, and to support practical management decisions (Haener et al. 2001).

The application of RP methods for environmental valuation requires the use of spatial data to identify site specific characteristics. Moreover, spatial data is quite useful in evaluating preference heterogeneities due to the spatial allocation of environmental goods/services (Horne et al. 2005, Campbell et al. 2008, Hynes et al. 2008, Termansen et al. 2008). As a result, spatial data have received quite considerable attention in previous RP valuation studies, e.g. in forest recreation (see Termansen et al. 2004, 2008, Baerenklau et al. 2010, Abildtrup et al. 2013, Termansen et al. 2013, Abildtrup et al. 2014). Furthermore, understanding the spatial factors affecting non-market values can help providing essential information to decision makers (van der Horst 2006, Campbell et al. 2008).

The analysis of preferences and identification of the determinants of forest recreational sites may help to elaborate on what aspects should be considered in the management and planning decisions. In Denmark, the national forest program has set out a multitude of objectives, one of which is increasing recreational accessibility of forests to the public (DFNA 2002, Zandersen et al. 2007). It is clearly outlined that the aim is to promote forest management and afforestation plans that take account of recreation (DFNA 2002). The afforestation plan is also to expand the forest cover, from the current level of 14% to 20-25% in the next 80 to 90 years.

In the present paper, we examine preferences for the different attributes of forest recreational sites using spatial data corresponding to three last forest visits. The last visited forest sites are obtained from a web based survey where respondents were asked to pinpoint both their departure and destination sites[10] on an interactive google map. Then, forest sites along with different characteristics are identified using publicly available geographical information system (GIS) data, from various sources.

The study contributes to the existing literature in a number of ways. First, we identify relevant factors important for forest recreation. These include forest area, forest area form (shape), stand

[10] The survey also contained a stated preference part.

density, proportion of dominant species type, presence of nearby nature features (e.g. wetlands and lakes), terrain difference (slope of landscape), presence of historical sites, and a dummy for state ownership. Second, the study relies on higher resolution data than earlier studies and with a wider spatial coverage of survey data in Denmark, allowing for more detailed modelling and validation of earlier studies (Skov-Petersen 2002, Termansen et al. 2004, Termansen et al. 2008, Termansen et al. 2013). Such data, however, result in many forest site observations which require reducing strategies when analysing the choice of a given site. Therefore, the third contribution is to evaluate two modelling assumptions based on convergent validity; namely the validity of random sampling to reduce the number of alternative sites and an identification of the sufficient number of alternatives to include.

The remaining part of the paper is organized as follows. In the next section, we outline factors identified in the literature that influence preferences and the determinants of recreational value of a forest. In the third section, we examine previous research findings with respect to forest recreational practices in the Danish context. In the fourth section, we elaborate our data collection procedures, spatial data organization, and the methodological approach. The fifth section presents estimation results with interpretation of parameter estimates. Finally, we wind up with sections on discussion and conclusion of main findings.

2. Determinants of forest recreational values

The factors that affect the recreational value of forest sites are related to the characteristics of the sites i.e. forest attributes on the one hand, and to the visitors' characteristics on the other. First, the structural characteristics of the forest, nature area features, recreational facilities, and infrastructures are considered as the main factors influencing choice of forest site (see e.g. Christie et al. 2007, Termansen et al. 2013, Giergiczny et al. 2015). On the other side, the visitors' socioeconomic and demographic factors as well as recreational activities and purposes have been found to significantly affect both recreational demand and preferences (see Abildtrup et al. 2014, Giergiczny et al. 2015).

Many studies have shown the importance of forest structural characteristics affecting recreational preferences of individuals (see Boxall et al. 1996, Hörnsten and Fredman 2000, Scarpa et al. 2000b, a, Horne et al. 2005, Christie et al. 2007, Nielsen et al. 2007, Petucco et al. 2013, Filyushkina et al. 2017). Forest structural characteristics may consist of species composition, age structure, forest density, vegetation cover, its area, and so on. Edwards et al. (2012a) used a Delphi study to investigate the forest characteristics that affect recreational benefits and identified twelve characteristics being useful; of which the size of trees, size of clear-cuts, and presence of residues are the most important while the number of tree species is the least. Other studies (e.g. Nielsen et al. 2007, Abildtrup et al. 2013, Termansen et al. 2013, Filyushkina et al. 2017) considered 'species composition' as one of the main variables; and found mixed or broadleaved forests preferred to coniferous types. In addition, the number of tree species has been found to positively impact the recreational value of a forest (Giergiczny et al. 2015, Filyushkina et al. 2017). A number of studies have also shown the importance of age structure (see Ribe 1989, Lindhagen and Hörnsten 2000, Tahvanainen et al. 2001, Nielsen et al. 2007, Gundersen and Frivold 2008, Edwards et al. 2012b, Giergiczny et al. 2015, Filyushkina et al. 2017). Forests comprising of older trees are preferred over younger ones and the uneven aged stands are better than even-aged stands. In general, the common understanding is that diversity in species composition and age structure positively contributes to the recreational value of a forest (Axelsson-Lindgren and Sorte 1987, Bujosa and Riera 2009, Dhakal et al. 2012, Edwards et al. 2012b, Filyushkina et al. 2017).

Furthermore, many studies have indicated the positive impact of forest size and the landscape's scenic view i.e. from a topographic perspective (see Termansen et al. 2004, Bujosa and Riera 2009, 2010, Termansen et al. 2013). Similarly, openness for visual penetration (which is related to the density of stand trees), ground vegetation cover, and presence of dead woods have been found to impact the recreational value. In some studies (e.g. Kaplan and Kaplan 1989, Bjerke et al. 2006, Heyman et al. 2011), semi-open forests are considered to provide better view and sense of safety than dense forests. In contrast, ground vegetation cover and amount of residues negatively impact preferences (Edwards et al. 2012a, Giergiczny et al. 2015). On the other hand, Bjerke et al. (2006) showed a positive contribution of moderate vegetation cover on recreational preferences. Similarly, the presence of deadwoods which can be associated with biodiversity functions affects recreational value positively (Nielsen et al. 2007, Giergiczny et al. 2015). Forests which are managed to maintain natural processes and associated biodiversity functions are found to have better recreational values (Campbell et al. 2013, Bartczak 2015).

The recreational value of a forest can also be determined by the presence of (or closeness to) other nature area features – for complementary recreational activities. These can include presence of different landscapes (Bujosa and Riera 2009, Giergiczny et al. 2015), or closeness to water bodies and coastal lines (Boxall et al. 1996, Termansen et al. 2004, Abildtrup et al. 2013). In general, the availability of such features increases the recreational value of a forest.

Accessibility is another important factor that affects the recreational value of forests. Distance to the forest (usually from residential location) is the most important factor in the decision to take recreational trips (Hörnsten and Fredman 2000, Smink 2011). People with a shorter distance to forests will have the opportunity to make more recreational trips than those farther away. For instance, two thirds of forest recreational trips in Denmark are taken in areas close to residential neighbourhoods and about 75% of visitors travel only within a distance of 10 km, considering all transport modes (Jensen and Koch 2004, Termansen et al. 2004, Smink 2011). In Sweden where 60% of land area is covered with forests, the majority of the population indicate their desire to have short travel distance to forests i.e. to be within 1km from their residential location (Hörnsten and Fredman 2000). As a consequence, forests closer to urban areas are found to be intensively used for recreation (DFNA

2002, Arnberger 2006). On the other hand, some forest visitors may also be trading off distance and go farther to avoid congestion effects and user conflicts (Bakhtiari et al. 2014).

Availability of recreational facilities like picnic sites, educational paths, and parking lots can also impact the recreational benefits of forests. For instance, forests with hiking paths and picnic facilities have more recreational benefits than forests without such facilities (Christie et al. 2007, Abildtrup et al. 2013, Abildtrup et al. 2014, Giergiczny et al. 2015). Similarly, Termansen et al. (2004) found a positive effect of parking facilities in Danish forests. Availability of good infrastructures (e.g. access to main roads) are also important in contributing for the recreational use of forests (Bujosa and Riera 2009). According to Christie et al. (2007), identifying recreational facilities is essential to meet the requirements of different user groups and increase recreational value of a given site.

On the demand side, it is common to consider socioeconomic and demographic variables as main determinants of outdoor recreation. For instance, Bujosa and Riera (2010) examined variables such as income, number of children, education, and others to determine the demand for forest recreational trips. It is also common to incorporate such variables to account for preference heterogeneity between individuals (see Giergiczny et al. 2015). Another important factor which can affect the site choice is the mode of transport used in outdoor recreation (Termansen et al. 2013, Abildtrup et al. 2014). For instance, forest visitors who used personal cars can travel relatively farther away to visit high quality forests compared to visitors who travel on foot (Abildtrup et al. 2014).

While there are RP studies in between, most of the above literature treats preferences in a SP setting. This study adds to the literature by investigating if the same results can be found in a RP setting. Moreover, our use of high resolution spatial data helps to identify site specific forest attributes, hence avoiding potential biases by aggregation of data.

3. Forest recreation in Denmark

Forest cover in Denmark is relatively small compared to most European countries (Bell et al. 2007). It takes up about 14%[11] of the total land area of the country. For Danes, recreation in forests is an important aspect of their leisure activities. More than 90% of the population visit forests at least once a year, with a conservative estimate of 60 – 70 million annual visits (Jensen and Koch 2004). The majority of visitors spend one to two hours recreating in a forest per trip (Jensen and Koch 2004). Distance is found to play a substantial role in affecting the choice of forest site and also in determining the number of annual trips (Jensen and Koch 2004, Termansen et al. 2004, Smink 2011).

So far, many studies have been undertaken, in the Danish context, to assess the recreational value of forests. The national surveys on forest recreation conducted in 1976-1978 and repeated in 1993-1995 (see Jensen and Koch 2004) have contributed a lot. The surveys have been undertaken using questionnaires collected from onsite, car-borne recreation at selected recreational sites. These studies

[11] (http://eng.svana.dk/nature/forestry/ 2017)

mainly focused on assessing recreational value of forests with an emphasis on the role of forest management (Jensen and Koch 2004, Termansen et al. 2004, Zandersen et al. 2007, Termansen et al. 2008, 2013). The studies have also examined public preferences and recreation demand for specific sites (e.g. Termansen et al. 2004, 2013). Moreover, intensive investigations are undertaken on spatial substitution effects and visitors' preferences (Termansen et al. 2004, 2008, 2013). High resolution spatial data were collected to identify forest characteristics. They found that different forest characteristics – including forest area, fraction of broadleaved coverage, distance to coastal lines, and presence of nature (semi-nature) areas influencing recreational preferences. Other studies have been conducted to analyse preferences of forest visitors using survey data in SP techniques e.g. using choice experiments (see Nielsen et al. 2007, Jacobsen and Thorsen 2010, Bakhtiari et al. 2014, Filyushkina et al. 2017).

In the present study, we add to the case specific literature by using a much higher data resolution, allowing for a more detailed preference elicitation. We have also looked into preference heterogeneities by considering factors such as mode of transport and recreational activities or purposes.

4. Materials and Method

4.1. Sampling and data organization

In a web based survey, we asked respondents about their previous forest recreation experiences. In addition, they were asked to pinpoint their three most recent forest visits on the map, corresponding to their departure and destination sites. The survey was conducted online from May 19th to June 8th 2015 administered by a surveying company where members of a panel of respondents were invited. The participants were rewarded gifts for filling out the questionnaire.

A total of 3,665 individuals accepted the invitation to participate. However, 1339 respondents were pre-screened and excluded from the sample, before answering all parts of the questionnaire, to ensure representativeness of the sample in terms of socioeconomic and demographic variables. The sample was further reduced by 1217 respondents as they were not able to complete the questionnaire or fill out the questionnaire correctly. Therefore, a total of 1,109 respondents were able to correctly provide information about their most recently visited locations on the Google map. However, a lot of respondents did not correctly pinpoint on their departure and destination points. Instead of pointing on their actual departure location such as their home, place of work, or holyday home, more than half of the respondents pointed on the entrance to (or the edge of) the forest. In addition, about 100 respondents were removed as their destination or departure points were found outside of Denmark in nearby countries such as Sweden or Germany. Finally, 481 individuals were able to complete the questionnaire and correctly pinpoint on the required sites and become legible for our choice analysis.

In general, our sample can be considered representative in terms of gender and region (see table 1), slightly overrepresented by young people, people with tertiary education, and low income.

Table 1

Descriptive statistics of sociodemographic characteristics of respondents

Variable	Category	Expected[12]	Observed	P-value (chi)
Gender	Female	239	256	0.123
	Male	242	225	
Age	18 – 34	148	165	0.041
	35 – 49	145	155	
	50 – 70	188	161	
Education	Primary	99	37	0.000
	Secondary	46	68	
	Vocational	184	134	
	Tertiary[a]	152	242	
Gross annual income	Below 200 thousand DKK	96	151	0.000
	200 – 400 thousand DKK	172	211	
	400 – 600 thousand DKK	83	49	
	Above 600 thousand DKK	130	70	
Region	Hovedstaden	150	165	0.018
	Sjælland	70	49	
	Syddanmark	102	107	
	Midtjylland	109	122	
	Nordjylland	49	38	

[a] Tertiary education includes medium level 'further' education (like Bachelor, Nurse, or High school teacher) and higher education levels (like Master and PhDs).

The questionnaire also contained questions regarding recreational activities and purposes of visiting forests. As shown in figure 1, most of the respondents make forest trips for walking activities and nature experience. Quite a lot of them indicated visiting forests for socialization (getting together with family, friends, or other people) and to obtain peace and quietness. Very few use forests for running, biking, or playing with children. They also mentioned mushroom picking as one of their activities in their recreational visits. These are more or less similar to the results from previous studies (e.g. see Jensen and Koch 2004, Smink 2011).

[12] DANMARKS STATISTIK: http://www.statistikbanken.dk. The 'Expected' sample reflects what a representative sample (of 481 people) would look like based on official statistics

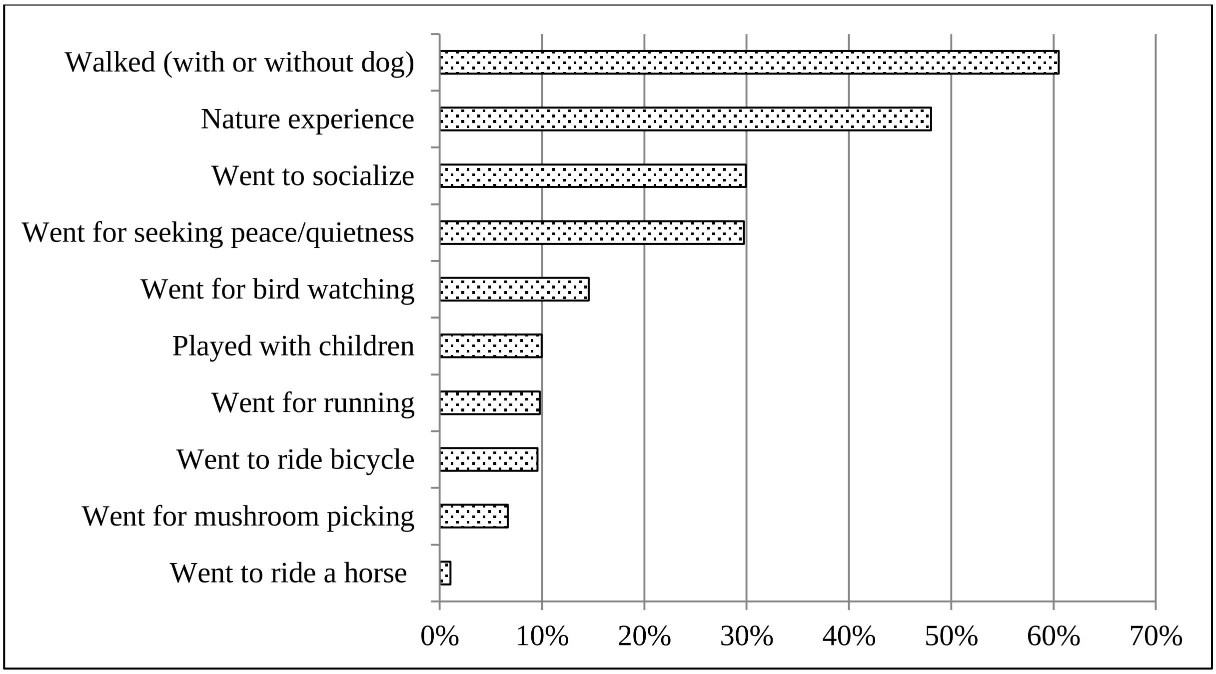

Figure 1: Recreational activities of forest visitors in their last visit

4.2. Forest attributes and spatial data computation

A spatial dataset that describe the characteristics of forests in Denmark is constructed based on the forest layer in the GeoDenmark geodatabase (DGA 2017). The Geodanmark database is managed by the Danish Geodata Agency and is part of a Danish effort to combine spatial data and make a common data infrastructure. The characteristics to enter the analysis are chosen on the basis of expectations from the literature as described in section 2 and 3.

Forests that are less than 20 meters apart are combined into a single forest, to consider them as relevant alternatives. Forests smaller than 0.5ha, are removed from the dataset as they are considered as groves rather than forests. The characteristics of each forest site are found by combining spatial data from different sources using the R environment and the R packages *rgdal* and *rgeos* (R Core R-Core-Team 2016, Bivand et al. 2016a, Bivand and Rundel 2016b). The data for each attribute are described as follows:

Forest area: The size of each forest area are calculated using the *gArea* function in *rgeos* (Bivand and Rundel 2016b). We expect the quality of forest recreational experience to be a function of size and that it will increase with the size of the forest, due to increased recreational trip options, a possibility of a more pronounced "sense of nature" and less potential congestion.

Forest area form (shape): The forest area form is calculated by comparing the total area of a forest to the minimum spatial square that the forest would fit in. A forest form value close to one would indicate a forest which is close to a square shape (and more coherent) while a forest form value close to zero indicates a scattered forest shape. In the econometric modelling it is treated as dummy (1 if the ratio is greater than 0.5 and 0 otherwise).

Forest density: The forest density measure is created by combining the GeoDenmark forest layer with the CORINE land cover data on tree cover density (EEA 2014). A high density value of the forest area would indicate a more dense forest with a high tree stand count.

Species composition: The dominant tree species are identified for each forest. The forest sites are merged with a grid point dataset with a resolution of 25*25 meters based on the tree type LIDAR satellite image from Schumacher (2014). The LIDAR satellite image differentiates between coniferous forests, broadleaved forests, and mixed forests. The distribution of grid-points falling inside each forest is created and the proportions of each type are calculated. The forest type calculated for each forest site is entered into the econometric model as a dummy variable (1 if the proportion is greater than half).

Other nature features: The forest dataset are merged with spatial data on lakes and wetland areas from the GeoDenmark geodatabase (DGA 2017). Lakes and wetlands within a distance of 20 meters of the forest are considered part of the forest. These are also treated as dummies in the modelling capturing effect of presence in the forest.

Historical sites: The number of historical sites within each forest is calculated based on data from the open spatial data source. The sites are limited to large constructions which a visitor would discover and recognize while visiting the forest. These historical sites mainly cover old hill tombs, old ramparts, castle and fortification ruins and various memorials of historical importance. This is also coded as dummy (1 if historical sites are present in the forest and 0 if not).

Terrain difference: The terrain of the forest is approximated by finding the difference between the lowest and the highest point of the forest. Data are based on a terrain line shapefile from the open GeoDanmark database. Note that Denmark is mostly flat compared to most regions around the world and that terrain difference is likely to be perceived as something that would add to the recreational experience, given the general undersupply of terrain difference throughout the country. This is also taken as dummy (1 if terrain difference is greater than 30 m, the mean value and 0 if lower).

State forest: The state owned forest data are merged with the forest layer from GeoDenmark (DGA 2017). In Denmark, private forests have restrictions on recreation access that are not practiced in state owned forests (see Campbell et al. 2013) which we believe could impact the recreational experience.

Distance: The Euclidian distance is calculated from all departure points to all forests within 30 km of radius. Distance to the last visited forest is calculated in a similarly way. Network distance calculations are not applied given the extensive number of distance calculations and the technical error it might introduce due to an incomplete data on road network at low level roads such as country lanes and gravel roads. Distance is a key variable in the analysis, which we expect will affect the recreational value negatively as it implies a cost.

The mean value of these attributes is reported in table 2 below. As shown in the table, most of the visitors made their trips to larger forests and forests dominated by broadleaved species. In addition, most visitors preferred recreating in forests which have wetlands or lakes, historical sites, have terrain difference (higher than 30 m), or are owned by the state.

Table 2

The mean value of attributes in overall forests and visited sites

Variable	Forest above 10 ha	Last visit	Second last visit	Third last visit
Area in ha	85	642	757	576
Area-form	0.21	0.18	0.15	0.15
Density	83	82	84	82
Pro. of broadleaved	0.52	0.70	0.68	0.69
Wetland	0.36	0.57	0.62	0.60
Lakes	0.33	0.71	0.72	0.71
State owned	0.13	0.46	0.52	0.49
Historical sites	0.37	0.72	0.75	0.72
Terrain difference	0.19	0.55	0.55	0.55
Distance	-	3.52	3.50	3.57

4.3. Selection of alternatives

In principle, any forest in Denmark could be considered as an option for a visit and thus part of the individual's recreational choice set. However, distance will in practice limit the possibility of making trips to all forests and hence consideration of the full choice set. In our sample, 97% of the trips were within 30 km; and DØRS (2014) reported the majority of forest trips being within a travel distance of below 50 km, and only 7% were above this. Consequently, we only considered alternative forest sites to be within 30 km from an individual's departure points. Within the 30 km radius, we identified an average number of 2,811 (minimum 530 and maximum 4,979) forest sites per respondent. It can be argued that a forest needs a minimum size to be relevant for recreation. Therefore, we tested a further reduction of the number of relevant forests by considering forests above 10ha. This reduced the number of alternatives to 291 on average (minimum 51 and maximum 668) per respondent. With large choice sets, analysis of choice making will become difficult both in terms of data arrangement and statistical computation.

Commonly, researchers follow two strategies of alternative reduction: site aggregation and random sampling (see Parsons and Kealy 1992, Parsons and Needelman 1992, Feather 1994, Termansen et al. 2004). Choice sets defined by aggregation are constructed through combining similar alternatives to be defined in some geographical boundary (like regions or counties) by taking an average value of the characteristics (Parsons and Kealy 1992, Feather 1994). Feather (1994) pointed out that such strategy would be preferable when data are only available at some aggregated level (e.g. regional data) or when there is little or no information available for some alternatives. The limitation of using aggregated choice sets is that it might lead to biased estimates due to the fact that an average value would not represent the actual attribute of a given site (Parsons and Kealy 1992, Parsons and Needelman 1992). In other words, spatial aggregation can obscure unique features of specific recreational sites (Horne et al. 2005). Consequently, it was not considered reasonable for this case, where the interest is in the details of the choice of the individual. The simple random sampling method is suggested to be used when data are available for each specific site and the full choice set is very large. This sampling method can also be used after choice sets are defined to be within certain spatial boundaries (Parsons and Hauber 1998).

Therefore, we apply the simple random sampling technique to select the alternative sites which together with the actual visited forests will form the choice sets. First, we examine the significance and consistency of parameter estimates with different number of alternatives by running conditional logit (CL) estimations using the most recently visited forest. The sampling and estimation procedure is sequentially repeated multiple times for a choice set with 5, 10, 50, and 100 alternatives. From this we conclude that models including 50 alternatives provide consistent estimates. Then, we estimate a random parameter logit (RPL) model by taking 50 alternatives for each of the visited forests utilizing the panel structure of the three reported visits.

4.4. Model specification

The recreational use of nature areas, such as forests can be evaluated by considering the travel cost of individuals. The travel cost models usually have two components: a site preference model and a count model which in combination can be used to analyse welfare changes associated with quality changes (Feather et al. 1995, Hausman et al. 1995, Herriges et al. 1999, Parsons et al. 1999, Bujosa and Riera 2010, Raguragavan et al. 2013). This approach is useful to estimate demand over a given period of time or a season (Feather et al. 1995, Bujosa and Riera 2010). Furthermore, preference studies have been conducted through combined use of revealed and SP data (Adamowicz et al. 1994, Azevedo et al. 2003, Eom and Larson 2006, Whitehead et al. 2008). The present study is conducted based on revealed data from reported visited sites, the characteristics of which are identified by using high resolution spatial data allowing us to obtain site specific characteristics. The focus is on estimating preferences and hence we do not carry out welfare estimates by relating it to count data modelling (see Hausman et al. 1995). The choice of recreational sites is modelled using the random utility maximization framework (McFadden 1974, 1978, Boxall et al. 1996, Train 1998). Hence, in our case, the choice analysis is undertaken based on the CL and RPL modelling, where the RPL is employed mainly to account for preference heterogeneity (Train 2003).

When alternatives are randomly sampled, the standard logistic formulation has to be modified by including an adjustment term which is the probability of generating the alternative, in order to yield consistent parameter estimates, provided some conditionality properties are being satisfied (McFadden 1978). Thus, the probability of alternative i to be chosen by individual n is given by:

$$P_{in} = \frac{e^{V_{in}+ln(\pi_n(D_n|i))}}{\sum_{j\in D} e^{V_{jn}+ln(\pi_n(D_n|j))}};$$

where V_{in} represents the deterministic component of utility, in our case, a function of forest characteristics and sociodemographic variables. The term $\pi_n(D_n|i)$ is the probability of generating an alternative set D_n given the actual choice i under the sampling scheme.

However, with simple random sampling where the probability of each non-chosen alternative is equal, no adjustment would be required (Lemp and Kockelman 2012). Estimation on the subsample alternatives can be done the same way as estimation of full size choice set (Frejinger et al. 2009, Lemp and Kockelman 2012). This is the case for the CL model. For an RPL model, approximate adjustments may be required. However, no single approximation seems to be superior. As our results from an RPL model and a CL turn out to be quite similar – except for the RPL model allowing for heterogeneity, it becomes a minor issue in our case; and consequently, we instead present both RPL and CL results.

5. Results

5.1. Importance of the number of randomly selected alternatives

Because we apply simple random sampling of alternatives, a relevant question is how many alternatives is enough to be considered in the choice modelling. To investigate this, we evaluate the sensitivity of estimates over an increasing number of sampled alternatives (5, 10, 50, and 100). Therefore, the CL model is used to perform this evaluation i.e. consistency of parameters over repeated sampling of different number of alternatives for which the RPL would not be feasible. The sampling and estimation process is sequentially repeated 100 times. Notice that we considered forests larger than 10 hectare[13]. The estimation results are illustrated with mean values corresponding to each sample size and distributions of the parameter estimates in kernel density graphs (see appendix A and C).

With regard to sampling of alternatives we observe two things. First, as the sample size of alternatives increases variables become significant; i.e. the explanatory power of the variables will improve as the number of non-chosen alternatives increases. For instance, the parameter for 'forest density' was estimated insignificant when we take 10 or less alternatives but becomes significant with 50 alternatives. Second, with large sample of alternatives, the variation in estimates from repeated sampling becomes smaller.

[13] A model with all forests (i.e. including smaller forests of 0.5ha threshold) was tested and provided similar results. However, for computational issues and because as Table 2 shows, the small forests are probably not realistic alternatives, we chose the limit of 10 ha.

5.2. Estimation based on random parameter logit model

To evaluate which forest characteristics people prefer, we estimated a RPL model in order to be able to model the potential heterogeneity of preferences in our data. Notice that all the parameters except distance are assumed to follow a normal distribution. As shown in table 3, most of the attributes are estimated significant with the expected signs. The random sampling of 50 alternatives and subsequent estimation of parameters is repeated 10 times and we only report the result with the highest 'maximum log likelihood' value. The parameter estimates over the 10 estimations are consistent in significance and sign; but differ somewhat in magnitude (see appendix B for the min. and max. estimates from the ten repeated estimations).

The size of a forest (area) contributes positively to the recreational value, as expected, with a decreasing marginal effect. This variable is considered in a log transformation rather than a linear measure, for better modelling performance and consistency with the assumption of decreasing marginal utility. The proportion of land area covered by dominantly broadleaved forest is also significant with a positive impact on the recreational value. In contrast, forest density reduces the recreational importance – i.e. visually dense forests are less likely chosen for recreational trips. The presence of historical sites increases the probability of a forest being visited. Similarly, forests with a terrain difference of greater than 30 m are more likely to be preferred for recreation. State owned forests are found to be preferred over privately owned forests. The negative sign of 'distance' implies that forests located farther away are less preferred as expected. In this modelling, the presence of other nature features, i.e. lakes and wetlands are not significant. Similarly, the variable 'area form' is not significant. This insignificance, at the mean value, could partly be attributed to the significant standard deviation i.e. heterogeneity in this variable. The standard deviations of the significant variables are also estimated significant implying preference heterogeneity among respondents.

In addition, we evaluate the interactions between distance and other variables such as age, mode of transport i.e. whether traveling on foot or car, and nature experience as a purpose of recreation. The interaction of distance with 'traveling on foot' is significant with its expected negative sign, while the interaction with 'traveling by car' is positive. The result shows that forests located at farther distance are less preferable by visitors traveling on foot, while visitors who used personal cars are less affected by distance. Forest visitors who had the purpose of nature experience are willing to travel longer compared to those traveling for other purposes.

Table 3

Estimation result based on the random parametric logit

Variable	Basic RPL			RPL with interaction		
	Est.	SE	P-value	Est.	SE	P-value
Ln area	1.21***	0.08	0.000	1.23***	0.09	0.000
Area-form	0.23	0.20	0.259	0.24	0.21	0.252
Density	-0.02*	0.01	0.073	-0.02**	0.01	0.036
Pro. of broadleaves	0.67***	0.18	0.000	0.63***	0.18	0.001
Availability of wetlands	-0.16	0.15	0.275	-0.10	0.16	0.535
Availability lakes	0.25	0.15	0.102	0.31**	0.16	0.050
State owned	0.82***	0.18	0.000	0.82***	0.19	0.000
Presence of historical sites	0.78***	0.18	0.000	0.76***	0.19	0.000
Terrain difference	0.71***	0.18	0.000	0.77***	0.20	0.000
Distance	-0.56***	0.02	0.000	-0.81***	0.07	0.000
Distance * age	-	-	-	0.002	0.001	0.139
Distance * foot	-	-	-	-0.24***	0.06	0.000
Distance * car	-	-	-	0.31***	0.05	0.000
Distance * nature viewing	-	-	-	0.10***	0.03	0.003
Standard deviations						
Ln area	0.56***	0.08	0.000	0.52***	0.09	0.000
Area-form	1.20***	0.33	0.000	1.12***	0.36	0.002
Density	0.02**	0.01	0.041	0.02**	0.01	0.015
Pro. of broadleaves	1.16***	0.33	0.000	-0.76*	0.45	0.093
Availability of wetlands	0.17	0.53	0.755	0.36	0.48	0.449
Availability lakes	0.07	0.51	0.888	0.08	0.50	0.871
State owned	0.90**	0.36	0.012	0.90**	0.41	0.026
Presence of historical sites	1.20***	0.33	0.000	1.07***	0.36	0.003
Terrain difference	1.57***	0.29	0.000	1.82***	0.30	0.000
Final LL	-1124.24			-1021.07		

***, **, * significance level at 1%, 5%, and 10% respectively

6. Discussion

Our motivation to undertake this study was to evaluate preferences of forest visitors in a revealed preference approach, using visited sites and to distinguish the main attributes that can affect the recreational use of forests. Hence, we investigated the effect of forest characteristics including: distance, forest area, area-form, forest density, tree species types, availability of other nature features (lakes and wetlands), terrain difference, presence of historical sites, and state ownership. These attributes were chosen based on literature reviews and availability of spatial data. The analysis was conducted using the standard random utility maximization framework (McFadden 1974) in which the utility was set as a function of the forest attributes. The choice sets of each respondent were defined to include all forest sites within a distance of 30 km from the respondent's departure location. To avoid overly large choice sets, we considered a reasonable number of alternatives using simple random sampling. As a result, the study also provides empirical evidence to the issue in determining number of alternatives required for consistent estimates.

As expected, distance is one of the main determinants that influence forest site choice. Its significant negative parameter estimate indicates how forests in short distance to residential areas are important for recreational trips. In addition, large size forests, forests with a greater proportion of broadleaved species and with lower stand density are more preferable for recreational visits. The estimate of area in its log transformation implies its positive impact with a diminishing marginal effect. Such an effect is also shown in previous similar studies (e.g. Scarpa et al. 2000b, Termansen et al. 2013). Forests with a greater proportion of broadleaved species are more preferred for recreational uses. Stand density is found to impact the likelihood of a forest being chosen negatively. It can be noticed that forest area, and stand density could reflect the wilderness of a forest and visibility. Yet, the recreational value of such wilderness forest will be reduced when the forest becomes too dense. Previously, some studies showed that forests with lower visual density could provide better scenic views and a sense of safety (Kaplan and Kaplan 1989, Heyman et al. 2011, Heyman 2012) or better access (Varela et al. 2016). The dummy variable indicating presence of 'historical sites' is also significant implying that 'historical sites' is an important factor when people chose forest sites for recreation purposes. Likewise, forests with higher terrain difference are preferred over those having lower terrain difference (i.e. relatively flat landscapes). Denmark is a relatively flat landscape country and terrain difference might add variation to the landscape and enhance opportunities for scenic views. Moreover, state owned forests are found to significantly contribute to the recreational importance of forests. This is most probably due to difference in recreational access rights, where these are generally much better in state owned forests. Another explanation could perhaps be that private forests tend to be more intensively managed for commercial purposes which may reduce recreational values.

In addition, the interaction effects highlight some important implications. For instance, we found visitors travelling by foot to be more sensitive to distance than visitors who use car as means of transport. In addition, the interaction between distance and purpose of visit (e.g. nature experience) is significant; individuals who visit forests for nature experience are not much affected by longer distance.

So far, various studies (e.g. Skov-Petersen and Jensen 2004, Termansen et al. 2004, Zandersen et al. 2007, Termansen et al. 2008, Termansen et al. 2013) have been conducted to evaluate preferences and demand for forest recreation using RP data in the Danish context. For instance, Termansen et al. (2004) evaluated preferences considering many attributes including travel distance, forest area, fraction of broadleaved area, distance to coast, slope, fraction of wet area edge, nature and semi-nature area, and some recreational facility indicators (parking and information on marked nature trail). The current study adds knowledge to the existing literature in the context of analysing recreational values of forests, especially using RP data with spatial data complements. We include forest attributes that are useful from the management perspective. In addition, understanding the interaction effects would help to justify the desired recreational facilities and imply management options (Arnberger 2006). Furthermore, we provide an empirical result showing how large randomly selected alternatives should be considered to get consistent estimates. Previously, Nerella and Bhat (2004) suggested a minimum sample on one-eighth of the full choice set with simple random sampling technique to generate consistent estimates. But, we thought our estimates are already consistent enough without such larger sample size. If considering their suggestion, we would expect only improvements in efficiency of the estimates.

To the end, it is worth to note a couple of limitations of the present paper. The first weakness is that we assume the most recently visited forest sites (i.e. 'chosen sites') to be representative of the respondent's 'stable' preferences. However, forest visitors can experience recreation in different locations for different purposes at different times. This becomes particularly important as data was collected in May 2015 thereby potentially incurring a spring seasonality bias (see Bartczak et al. 2011). The second issue is the exclusion of a sizable proportion of respondents. As mentioned earlier, our spatial data relies on respondent pinpointed locations of visited sites of which two-third of respondents fail to correctly indicate the 'destination' and 'departure' locations on the interactive map, probably due to misunderstanding of the instructions in the questionnaire. While this reduces the sample, we have no reason to believe it to be correlated with the last visits, and consequently we see no reason why this should bias the results.

7. Conclusion

Valuation of non-market environmental goods can be undertaken using both SP and RP approaches. But, due to limitations of the SP methods, related to the hypothetical nature; scholars recommend the use of RP when data are available (Adamowicz et al. 1994, Azevedo et al. 2003). Relying on such justification, the current study is conducted to analyse preferences for forest recreational sites using data from actual visits. Our analysis is performed by defining choice sets to included alternative forests within 30 km from departure locations. Such a definition is made to obtain more realistic choice sets and reliable estimates, as most forest trips are shorter than 30 km. We presume inclusion of all forest sites with consideration of spatial data to be a more robust approach in addressing variation. The RP approach which involves integration of spatial data may insure more realistic choice modelling of forest recreation than the SP approach. The study is able to validate the findings from previous SP studies in terms of relative size and significance of attributes (e.g. distance, species composition, area, and stand density). In addition, more variables are included than what would usually be the case in SP studies.

Most of the included forest attributes are significant and relevant to raise important policy issues. Distance is found to play a crucial role in affecting choice of recreational forest location; and that is inflicted by mode of transport used. The implication is that forests need to be accessible within residential locations of visitors for more frequent trips, and that shall be considered in future afforestation plans. The positive value of a higher proportion of broadleaves would imply a need to increase the amount of broadleaves in future forest management and afforestation plans. Moreover, we are able to indicate the relevance of other features. For instance, we showed that presence of historical sites increases the recreational value of forests. That could imply the necessity of precautionary forest management rules which should account for preserving such sites. The other important insight is about impact of state ownership. State owned forests are more preferable, probably, due to the unrestricted recreational access policies applied in state forests.

Forest recreation studies in Denmark have been undertaken for long and thought to brought about changes in forest policies over time (Jensen and Koch 2004). We believe that our study can contribute to the existing knowledge regarding the critical evaluation of recreational values of forests in the country. It enables to justify the importance of different forest attributes and the necessity of taking consideration of non-market services in forest management policies and afforestation plans. This becomes of particular importance for the trade-offs with other ecosystem services and where to provide which: recreational quality depends both highly on the characteristics of a forest and its relative distance to people.

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Appendix A

Consistency of parameters from different sample size of alternatives; based on CL estimation by taking alternatives only corresponding to the most recently visited forest. Mean value of the coefficients from repeated[14] sequential sampling and estimation.

Variable	5 alts	10 alts	50 alts	100 alts
Ln area	0.87	0.85	0.82	0.80
Area-form	0.44	0.38	0.41	0.42
Density	-0.01	-0.01	-0.01	-0.01
Pro. of broadleaves	0.50	0.52	0.57	0.60
Availability of wetlands	-0.07	-0.10	-0.16	-0.17
Availability lakes	0.32	0.35	0.42	0.42
State owned	0.60	0.53	0.36	0.28
Presence of historical sites	0.70	0.68	0.63	0.65
Terrain difference	0.60	0.60	0.66	0.69
Distance	-0.37	-0.39	-0.45	-0.47

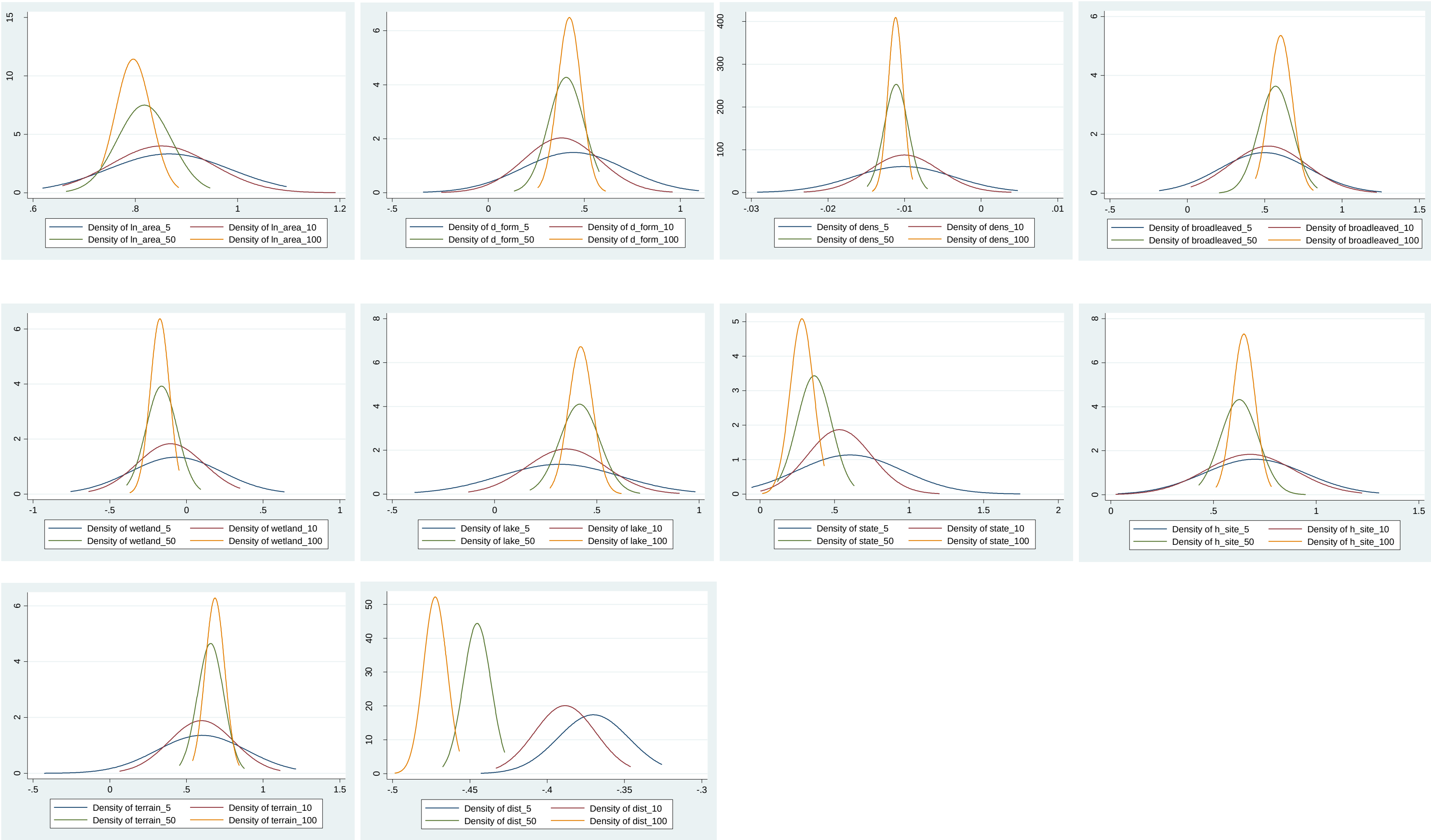
Appendix B

The variation in coefficients of significant variables from the sequentially repeated[15] sampling (50 alternatives) and estimation process based on the RPL model

Variable	Min.	Max.
Ln area	1.11	1.22
Density	-0.02	-0.01
Pro. of broadleaves	0.56	0.74
State owned	0.51	0.82
Presence of historical sites	0.78	1.07
Terrain difference	0.53	0.78
Distance	-0.56	-0.54

[14] These are the mean values from the estimation performed 100 times.
[15] Sequential sampling and estimation preformed 10 times

Appendix C



Distribution of coefficients from repeated estimation using the conditional logit model

Appendix III (Paper 3)

Forest Recreation in Adults and the Significance of Childhood Experience: Evidence from Nine European Countries

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Abstract

In leisure science literature, past experience is considered as one of the factors influencing individuals' recreational behaviour in nature areas. However, the impact of childhood experience in outdoors such as forests is not well documented. This study examines forest recreational practices at adulthood being impacted by the childhood experience along with other factors. The main focus is to examine frequency of forest visit in adults. It is conducted based on data collected from a joint online survey in nine European countries. Frequency of visit is measured in an ordinal scale leading us to employ the generalized ordered logit estimation. The same model is estimated controlling for cross country fixed effects. Childhood forest experience is significant in determining the level of frequency of visit now. Residential area, distance, and socioeconomic variables are additional factors that influence frequency of forest visit. The findings show the importance of forest accessibility to children for better recreational habits, and highlight the long run implications related to pro-environmental behaviour.

Keywords

Childhood, environmental behaviour, forest recreation, frequency of visit, generalized ordered logit.

1. Introduction

Nowadays, children are spending less time in nature areas (Valentine and McKendrick 1997, Kong 2000, Godbey 2009, Skår and Krogh 2009). Access to modern social media technology and playing equipment on the one hand and parental fear to allow for unsupervised playing opportunity on the other have reduced the time to be spent in nature areas (see Fjørtoft 2001, Godbey 2009, McCurdy et al. 2010). A number of studies (see e.g. Wilson 2003, Miller 2005, Fuller et al. 2007, Bjork et al. 2008, McCurdy et al. 2010) indicate the decrease in health and psychological wellbeing of children as a consequence of the disconnection with nature areas.

Many studies indicate how children's contact with nature, such as forests, could improve their psychological wellbeing and cognitive skills (see Bixler et al. 2002, Bell et al. 2003, Berman et al. 2008). According to Bixler et al. (2002) children playing in nature areas could develop better exploring skills and sense of autonomy. These experiences are long lasting and could enforce them to be strongly attached to nature areas in adulthood. According to Olds (1989), adults' recollections of healing places is rooted from the childhood outdoor experiences. Although the association between nature recreational experience and effects on health is indicated to be strong, the causality pathways are still debatable (see Lachowycz and Jones 2013).

Furthermore, participation in outdoor recreation has been found to significantly affect individuals' environmental behaviours and attitudes (e.g. Theodori et al. 1998, Teisl and O'Brien 2003, Berns and Simpson 2009, Tarrant and Green 2009). Several studies indicate the association between childhood outdoor experiences and pro-environmental behaviours in adulthood (see e.g. Sebba 1991, Chawla 1999, Kals et al. 1999, Wells and Lekies 2006, Chawla 2009, 2015). For instance, environmental sensitivity[16] and pro-environmental actions (related to energy consumption, recycling, environmental conservation etc.) are linked to childhood nature experiences (see Chawla and Hart 1995, Chawla 1998, Lohr and Pearson-Mims 2005). According to Chawla (2007), participation in outdoor activities during childhood leads to have more commitment to protect the environment. Strong connection with nature during childhood also fosters individuals' positive attitudes towards the intrinsic values of nature (Lohr et al. 2000, Bell et al. 2003, Lohr and Pearson-Mims 2005).

As mentioned above, many research findings support the association between childhood outdoor experience and environmental behaviour during adulthood. In contrast, empirical literature on the relationship between childhood outdoor experience and the recreational practices during adulthood is quite limited. Thus far, only few studies (see Thompson et al. 2008, Acharya et al. 2009, Asah et al. 2011) examine how childhood outdoor experience could influence the recreational behaviour at adulthood.

[16] "viewing of the environment from an empathetic perspective" Chawla (2009)

The present study contributes to these types of literature by analysing the childhood-adulthood relationship in forest recreational context. The main objective of the study is to elaborate the role of childhood experience (along with other covariates) determining frequency of forest visits, with data collection on frequency of visit during a year (before our survey) and remembered forest recreational experience during childhood. The study is conducted using a web-based survey data collected from nine European countries. We analyse how frequency of forest visit depends on the childhood experience, controlling for other variables including: current residential location, distance to the nearest forest, and sociodemographic variables (gender, age, education, income, and children under 18). In a similar study, Thompson et al. (2008) show the childhood factor being significant in determining adults' frequency of outdoor recreation to green areas. However, the study was based on a correlational analysis, and doesn't show further explanation on the extent of the relationship. In addition, the study shows the association of frequency of visit in adulthood and frequency of recreation during childhood without taking account of other predictors.

The main research questions that are addressed in this study include: 1) Does childhood forest experience (i.e. frequency of visit and/or type of residential settlement during childhood) influence the frequency of forest visit now (in adulthood)? 2) What other factors could significantly influence the frequency of forest visit? 3) Do the nine countries have significant variations in terms of the frequency of forest visitors? We hypothesize that childhood forest experience plays a significant role determining the level of frequency of forest visit now i.e. individuals who had more frequent visits in childhood are more likely to be on a higher level of frequency of visit now. Likewise, people who have grown up in rural areas tend to have higher frequency of visit. In addition, individuals currently living rural areas are more likely to be on a higher level of frequency of visit.

2. Childhood experience for adulthood recreational practices and environmental behaviour

Several studies indicate how recreational habit as well as environmental behaviour is strongly connected to outdoor experience during childhood. For instance, Bixler et al. (2002) show recreational activities and environmental preferences in adulthood being influenced by the person's outdoor experience during childhood. According to Asah et al. (2011), participation in nature-based recreation during childhood reinforces motivation and mitigates constraints of outdoor recreation in adulthood. Similarly, McFarlane et al. (1998) discovered that when children are more experienced to nature areas, they tend to appreciate more natural and less managed recreational sites at adulthood. In addition, experienced recreationists are found to prefer difficult and challenging routes. Wells and Lekies (2006) confirm similar recreational behaviour being observed in adolescents, i.e. those who had more opportunity playing in wilderness areas during childhood are more likely to prefer wildland walking paths and are more tolerant to the lack of modern recreational facilities.

Childhood outdoor experience is also a good predictor of frequency of forest recreational visits in adulthood, as shown in Thompson et al. (2008). In this study, more frequent forest visitors are found to be those who had been frequent visitors in their childhood. Less frequent visitors were those who had none or limited outdoor recreational experience during childhood. Similarly, Acharya et al. (2009) found the frequency of visit to a wilderness area in adulthood being determined by past wilderness experience and nostalgic feeling.

Furthermore, many studies explain the association between pro-environmental behaviour and outdoor recreational experience during childhood (e.g. see Lohr et al. 2000, Ewert et al. 2005, Hinds and Sparks 2008, Collado et al. 2013). Outdoor experience in early life is thought to have a significant role in creating positive attitudes towards natural environments (Bixler et al. 2002, Ewert et al. 2005, Thompson et al. 2008). For instance, individuals who have grown up in rural settlement and close to natural areas develop positive attitudes towards valuing trees (see Lohr and Pearson-Mims 2005). In a similar context, Bixler et al. (2002) argued that environmental activism in adults is linked to contact with nature during childhood. According to James et al. (2010), the pro-environmental behaviour influenced by childhood experience is a result of cumulative effects that involve transitions from early childhood to young adulthood. On the other hand, Chawla (1998) describe pro-environmental behaviour to be influenced by sympathetic and empathic feelings that are deeply rooted in childhood.

> *"This interpretation of an* ***empathetic perspective*** *toward the environment primarily applies to early childhood or implies that an animistic relationship with the world, first felt in early childhood, remains people's initial entry into the sequence of variables that eventually lead to responsible environmental citizenship." (Chawla 1998 pg. 18)*

In addition to that, the impact of childhood experience on recreational habits later in life can be described through nostalgic behaviour (see Nawas and Platt 1965, Acharya et al. 2009). Acharya et al. (2009) show nostalgia[17] being one of the main determinants of frequency of visit to wilderness areas.

The present study focuses on elaborating the effect of childhood in determining forest recreational behaviour of adults, where respondents were asked to indicate their current visit frequency and their forest experience during childhood. Therefore, it contributes to the literature outlining the role of childhood experience and other factors determining frequency of forest visit. It is not a study that explicitly shows the association between childhood experience and environmental behaviour.

[17] Nostalgia was defined as a dummy variable representing whether a person has grown up from a rural area (of less than 2500 people) and moved to a big city (of more than 100000 people).

3. Materials and Method

3.1. Survey and sampling strategy

The study is conducted based on a web-based survey undertaken in nine European countries: Austria (AT), Switzerland (CH), Czech Republic (CZ), Germany (DE), Denmark (DK), France (FR), Poland (PL), Slovakia (SK), and United Kingdom (UK). The survey is conducted from January to February 2017 by professional survey companies operating in respective countries, using web-based self-interviewing survey mode. The main purpose of the survey was to analyse preferences for different attributes of forest sites in these countries. A central part of this questionnaire is built around questions regarding current recreation practices and childhood experiences.

Respondents were selected from properly managed on-line panels. The survey companies make the 'quota based' sample selection ensuring representativeness in terms of gender, age, and education. The sample size containing 'all finished' interviews is about 1,000 respondents per country after screening out respondents who are defined as 'speeders' and who had not visited any forest during 12 months prior to the survey (*non-visitors*). The 'speeders' are those respondents who answered the questionnaire in less than 10 minutes. Considering the number of respondents who actually started viewing the questions i.e. clicking on the survey link, the valid response rates are above 40% in all countries except France, Slovakia, and UK. The percentage of non-visitors varied from 9% (Poland) to 24% (both in Germany and France) (see Table 1). The final cleaned sample consists of 8,793 valid observations.

Table 1

Number of respondents and response rate in each country

	Valid observations		Excluded	
	number	(%)	Non-visitors (%)	Speeders (%)
Austria	1,000	61	13	4
Switzerland	1,001	51	10	3
Czech Republic	883	43	12	5
Germany	1,003	45	24	6
Denmark	1,000	40	14	8
France	1,012	29	24	4
Poland	1,008	61	9	4
Slovakia	885	36	17	3
United Kingdom	1,001	12	22	26

3.2. Model specification

Adults’ frequency of forest visit during 12 months (before undertaking the survey) is indicated using interval sets of categories. The interval nature of ‘*frequency of visit’, i.e. the dependent variable,* could motivate either of an interval regression or ordinal data modelling approaches. As shown in table 2, the intervals are not evenly categorised and makes the interval data modelling less important. Therefore, we use the latter modelling approach after transforming the interval set of responses into ordered outcomes (see table 2). The ordered outcomes are labelled as *‘more frequent’*, *‘frequent’*, and *‘less frequent’* corresponding to the frequency of visit at least once a week, once a month, or once a year, respectively.

Table 2

Frequency of forest visit in childhood and now

Forest visit	Childhood (%)	Now (%)	‘Level’ of frequency
Almost every day	NA[18]	3	More frequent
3-4 times a week	19	5	
1-2 times a week	24	12	
2-3 times a month	19	32	Frequent
Once a month	12	8	
5-10 times a year	NA	18	Less frequent
2-4 times a year	23	18	
Once a year	NA	4	
Never visit	3	NA	

Then, we model how likely a forest visitor is to be on a higher category of frequency of visit (in terms of the ordered categories) being influenced by the explanatory variables. The frequency of visit is taken to be a function of the childhood experience and other explanatory variables including: current residence area, distance to the nearest forest (among the recently visited forests), and the sociodemographic variables; age, gender, education, income, and children under 18 (see the definition and coding of the variables in table 3). In this case, childhood forest experience is indicated by two variables: frequency of visit during childhood and residential area in childhood. Frequency of visit is coded as a categorical variable the same way as the dependent variable (see table 2). The residence area is coded as a dummy variable representing ‘rural or small town’ being a settlement of less than 3000 inhabitants. Notice that the childhood residency refers to the type of residential settlement until the age of 11, that the individual has been living for most of this time.

[18] (NA=not asked) i.e. the category was not included in the specific question

Table 3

Variable definition and coding

Variables	Categories	Code
Frequency of forest visit in childhood	Never visited	Reference
	Less frequent (1-4 times a year)	Dummy (1= less frequent, 0 otherwise)
	Frequent (1-3 times a month)	Dummy (1= frequent, 0 otherwise)
	More frequent (1-7 times a week)	Dummy (1= more frequent, 0 otherwise)
Residential area in childhood	Less than 3000 people	Dummy (1= rural/small town, 0= urban)
Residential area now	Less than 3000 people	Dummy (1= rural/small town, 0= urban)
Distance to the nearest visited forest	-	Dummy (1= if distance is above 5km[19], 0 otherwise)
Gender	-	Dummy (1= male, 0= female)
Age	Below 35 years	Reference
	Between 35 and 50 years	Dummy (1= 35-50, 0 otherwise)
	Above 50 years	Dummy (1= above 50, 0 otherwise)
Level of education	Primary or secondary school	Reference
	Vocational training	Dummy (1= vocation, 0 otherwise)
	Undergraduate studies or above	Dummy (1= undergraduate, 0 otherwise)
Monthly income after tax	Low income (<750€)	Reference
	Middle income (750 - 999€)	Dummy (1= middle, 0 otherwise)
	High income (>=1000€)	Dummy (1= high, 0 otherwise)
	Income refused	Dummy (1= refused, 0 otherwise)
Having children under 18	-	Dummy (1= yes, 0= no)

It should be noticed that the exact number of annual forest visits is not known to the analyst, and is considered as latent (unobserved). Therefore, the unobserved frequency of visit (y^*) of individual *n* can be formulated as:

$$y_n^* = X_n'\beta + \varepsilon_n \qquad \text{eq. 1}$$

[19] The median of the calculated Euclidian distance

X is a row vector of the explanatory variables and ε_n is an error term which could be assumed with logistic or normal distributions. The observed frequency of forest visit $(\mathrm{y_n})$ takes one of the three ordered values given by:

$$\mathrm{y_n} = \begin{cases} 1 = \text{less frequent } (1-10 \text{ times a year}) \text{ if } \mathrm{y_n^*} < \alpha_1 \\ 2 = \text{frequent } (1-4 \text{ times a month}) \text{ if } \alpha_1 < \mathrm{y_n^*} < \alpha_2 \\ 3 = \text{more frequent } (1-7 \text{ times a week}) \text{ if } \mathrm{y_n^*} > \alpha_2 \end{cases} \qquad \text{eq. 2}$$

where α_1 and α_2 are estimated cut off points. That means the possible outcomes are determined based on the likelihood of the latent variable being less than (or greater than) these cut off points. Assuming a logistic distribution of ε_n, we estimate a generalized ordered logit model (see Williams 2006) given by:

$$\mathrm{P}(\mathrm{y_n} > \mathrm{j}) = \frac{\exp^{(\alpha + \mathrm{X_n'}\beta_\mathrm{j})}}{1+\exp^{(\alpha + \mathrm{X_n'}\beta_\mathrm{j})}} \qquad \text{eq. 3}$$

The generalized ordered logit model is employed to account for different βs (slopes) of categories. This model is recommend when the parallel odds ratio assumption (where βs are taken to be the same in comparing each pair of categories) is violated in the simple ordered logit modelling (Williams 2006). Our test for the parallel odds ratio (Wolfe and Gould 1998, Long and Freese 2014) confirms the assumption being violated (see appendix B). As a result, we estimate a generalized ordered logit with partial proportional odds ratio i.e. by allowing the βs for the categories of variables (which do not violate the parallel odds ratio assumption) to be the same. Notice that the simple ordered logit model is a special case of the generalized model.

4. Results

4.1. Descriptive statistics

As presented in table 4, about 60% of the forest visitors made forest recreational trips at least once a month. We observe slight variation across the different countries. For instance, in France and UK, more than half of the forest visitors are categorised being *'less frequent'*.

About 74% of the respondents had the opportunity to visit forests at least once a month in childhood (see the responses in table 2). 61% of the respondents indicated being grown up in a rural or small town settlement. Each country sample is representative in terms of the quota variables; gender, age, and education. The sample includes 31% low income groups (i.e. reporting below 750€) and 17% who refused to report their income. For about 48% of the respondents, the calculated Euclidean distance to the nearest visited forest is found to be above 5km. About 30% of the respondents reported having children under the age of 18. The responses per each country cases are presented in appendix A.

Table 4

The responses per categorized frequency of forest visit in last 12 months (%)

Visit frequency	AT	CH	CZ	DE	DK	FR	PL	SK	UK	All
Less frequent	34	26	38	36	39	50	41	42	58	41
Frequent	44	45	40	44	39	35	42	41	32	40
More frequent	22	29	22	20	22	15	17	17	10	19

Figure 1 shows how the current levels of frequency of forest visit are associated with the levels frequency of visit in childhood. Considering all nine countries, 62% of the respondents who visited forests at least once a week are those who had visited forests at least once a week during their childhood. In addition, 48% of the respondents who indicated currently visiting forests at least once a month are those who had visited forests at least once a week during childhood. In general, respondents who are categorized as *more frequent* in childhood accounts for larger proportion of those categorized as *frequent* and *more frequent* visitors now. Notice also that about 72% of respondents who are categorized as *less frequent* visitors now are those who are categorized as *less frequent* or *frequent* visitors in childhood. Similar statistics are also observed for each country cases. In almost all the countries, more than 50% of those categorised as *more frequent* visitors are identified as *more frequent* visitors in childhood. In Austria, Switzerland, Czech Republic, and Slovakia this proportion becomes even more than 70%.

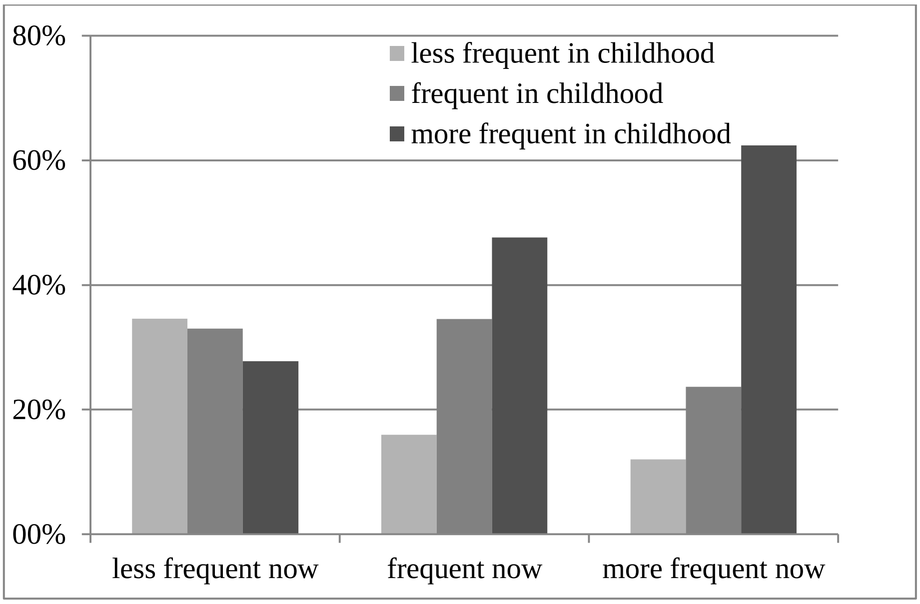

Figure 1: Frequency of visit as a child and as an adult (i.e. annual visits before the survey)

The association between the levels of frequencies during childhood and now is supported with the correlation statistics presented in table 5. The pairwise correlations between the different categories are significant with the signs of the correlation coefficient supporting our explanations. The magnitudes of the correlation coefficients are quite small since the variables are coded as dummies.

Table 5

Pairwise correlation of the categories of visit frequency in childhood and now

	Pairwise correlations		
	Less frequent now	Frequent now	More frequent now
Less frequent in childhood	**0.23*****	-0.13***	-0.13***
Frequent in childhood	0.02**	0.05***	-0.09***
More frequent in childhood	**-0.25*****	0.09***	**0.20*****

4.2. Estimation results

Below we present the estimation result of the generalized ordered logit model using the pooled data set. In general, frequency of visit in childhood, currently living in a rural or small town, and distance to the nearest forest significantly explained the likelihood of being on a higher category of frequency of visit now.

Table 6

Estimation results based on the generalized ordered logit model using pooled data from the nine countries

	More frequent or frequent compared to less frequent $P(freq\_now > 1)$			More frequent compared to frequent or less frequent $P(freq\_now > 2)$		
Variables	Coefficient	SE	p-value	Coefficient	SE	p-value
Visit frequency in childhood						
Less frequent	0.01	0.13	0.914	0.01	0.13	0.914
Frequent	**0.78*****	0.13	0.000	**0.37****	0.15	0.012
More frequent	**1.48*****	0.13	0.000	**1.25*****	0.14	0.000
Residential area						
Rural/small town in childhood	-0.06	0.05	0.221	**-0.26*****	0.06	0.000
Rural/small town now	**0.33*****	0.05	0.000	**0.54*****	0.06	0.000
Distance to the nearest forest	**-0.57*****	0.05	0.000	**-0.70*****	0.06	0.000
Male	**0.09****	0.05	0.044	-0.02	0.06	0.687

Age						
Between 35 and 50 years	0.01	0.05	0.875	0.01	0.05	0.875
Above 50 years	-0.07	0.06	0.200	**0.15****	0.06	0.018
Level of education						
Vocational training	**0.13****	0.06	0.022	-0.01	0.07	0.865
Undergraduate or postgraduate studies	**0.12****	0.06	0.049	-0.07	0.07	0.338
Net monthly income						
Middle income	**0.16****	0.06	0.011	0.004	0.07	0.955
High income	**0.16****	0.06	0.010	-0.002	0.07	0.983
Income refused	**0.19*****	0.07	0.006	-0.08	0.08	0.365
Having children under18	-0.11**	0.05	0.019	-0.11**	0.05	0.019
Constant	**-0.51*****	0.15	0.000	**-2.00*****	0.16	0.000
Final log likelihood	-8613.77					
Pseudo R^2	0.068					
Number of observations	8793					

***, **, * show the 1%, 5%, and 10% significance levels respectively

Notice that, as shown in table 6, almost all the parameter estimates are different in magnitude[20] for the two possible pairwise comparisons of categories.

Individuals' labelled as being frequent or more frequent visitors in childhood are more likely to be on a higher level of frequency of visit now - the effect being slightly reduced for the highest level. For instance, being a *more frequent* visitor than a *non-visitor* in childhood increases the probability of being a *more frequent* or *frequent* visitor now. This dummy variable has the same impact (with slightly lower magnitude[21]) for the highest category compared to the lower two categories. The effect of living in rural or small town settlement now can be explained in the same manner. In contrast, respondents who reported being grown up in rural or small town are less likely to be on the highest level of frequency of visit.

Similarly, the 'Euclidean' distance is negatively associated with the probability of being on a higher category i.e. distance to the nearest forest being above 5km decreases the likelihood of being on a higher level of frequency of visit. Notice that distance becomes more restrictive for the probability of being on the highest category. Furthermore, we observe that the probability of being on a higher category of frequency of visit increases with male respondents, individuals with higher levels of education, and those in middle or higher income groups. However, these socioeconomic variables are

[20] see the figures in bold letters to show such difference in magnitude as a result of using the generalized model estimation with partial proportional odds ratio

[21] Notice the difference between 1.48 and 1.25

not significant determining the likelihood of being on the highest category. Having children increases the probability of being on the current or lower level of frequency of visit.

Note that we also estimated the same model controlling for cross country fixed effects. Considering UK as a reference[22], all of the country dummies except for Slovakia are significant and positive (see estimation results reported in appendix C). That means people are more likely to be on a higher frequency of visit relative to the UK forest visitors.

Furthermore, we estimate the marginal effects of selected significant variables as reported in table 7. Higher levels of frequency of visit in childhood positively impact on the probability of a person being on a higher category of frequency of visit now. For instance, the probability of a person being on higher category than the less frequent category increases by 14% given the person was a more frequent visitor in childhood, the effect of other variables being constant at their mean values. This probability becomes 19% for the person to be on the highest level of frequency of visit now. The variables reflecting on the types of residential areas now and in childhood have significant marginal effects only for the highest frequency of visit. A person currently living in a rural or small town settlement is 8% more likely to be a *more frequent* visitor. In contrast a person who has grown up in such areas in childhood will be 4% less likely to be on the highest level of frequency of visit. Similarly, the probability of a person being on a higher category decreases when distance to the nearest forest is above 5km, e.g. the probability of being on the highest category reduces by 10%, other variables being fixed at the means.

Table 7

Marginal effects of selected explanatory variables

	More frequent or frequent compared to less frequent $P(freq\_now > 1)$			More frequent compared to frequent or less frequent $P(freq\_now > 2)$		
Variables	Coefficient	SE	p-value	Coefficient	SE	p-value
Visit frequency in childhood						
Frequent	0.12^{***}	0.02	0.000	0.06^{**}	0.02	0.016
More frequent	0.14^{***}	0.01	0.000	0.19^{***}	0.02	0.000
Rural residential area						
Rural/small town in childhood	0.02^{*}	0.01	0.074	-0.04^{***}	0.01	0.000
Rural/small town now	0.002	0.01	0.849	0.08^{***}	0.01	0.000
Distance to the nearest forest	-0.04^{***}	0.01	0.001	-0.10^{***}	0.01	0.000

[22] Notice that most of the UK visitors are categorized as 'less frequent' visitors

5. Discussion

The association between outdoor recreation experience in childhood and later in adulthood is not well documented in previous studies. In this study, we examined the role of childhood recreation experiences in forests along with other covariates determining frequency of visits now.

Our results showed frequency of forest visit being strongly associated with the childhood experiences. We found individuals who are classified as *more frequent* forest visitors in childhood being more likely to be on a higher level of frequency of visit now. Our main hypothesis that the frequencies of recreational visits now are positively influenced by visit frequencies experienced during childhood is confirmed. In this regard, our findings are consistent with the study by Thompson et al. (2008) who elaborated on the childhood factor as determinant of the frequency of greenspace recreation in adulthood. We also found a strong positive association between the current residential area and the level of frequency of forest visit now. People who are living in rural or small town settlements are more likely to be on a higher category of frequency of visit. In contrast, individuals who have been grown up in a rural or small town settlement are less likely to be on a higher frequency of visit. Previously, Acharya et al. (2009) indicated that individuals who have been grown up in rural area and moved to big cities being more frequent visitors of a wilderness area. The effect was justified by the nostalgic feeling. It is worth to mention that we were also estimating our model by recoding the variable in the same way as defined in their study, i.e. including a dummy[23] variable for people growing up in a rural area and currently living in a city. Our estimation in this way doesn't change the result. Therefore, in this context, our finding is not consistent with this previous study and our hypothesis doesn't hold.

The other significant factor determining frequency of visit is distance to the nearest forest. As shown in the result section, it is negatively associated with frequency of visit. Note that the variable was defined as dummy indicating the Euclidian distance between residential locations and the nearest visited forest being above 5km. Initially it was calculated from the coordinate points based on pinpointed locations on a map tool in the questionnaire. Therefore, this measurement may not show the exact travel distances. More importantly, the respondents may fail to pinpoint on proper locations as elaborated in many applications. Hence, we believe the dummy coding could avoid such limitations without obscuring the relationship.

The sociodemographic variables are found to significantly determine the level of frequency of forest visits. The dummies of gender, level of education, and income are significant only at the first category i.e. a higher level of frequency of visit - and not at the highest level. Among these, age being above 50 years is found to be significant only for the highest level of frequency of visit. According to Bell et al. (2007), life expectancy is increasing in the developed nations, with increasing proportion of

[23] The dummy takes 1 if a person has grown up in a settlement with less than 3000 inhabitants and currently living in a city with above 100000 people, and 0 otherwise.

old people who would have more leisure time to be spent outdoors. That means older people would become more frequent forest visitors having the time to do so.

The level of frequency of visit in most of the countries is more or less the same where about 60% visited forests at least once a month, except in France and United Kingdom. We also found cross country fixed effects being significant supporting the variation illustrated in the descriptive statistics. Notice that in the estimation with country fixed effects the UK was considered as a reference. A different result could be obtained by changing the reference country. The cross country variation could be attributable to different factors that we couldn't provide any further examination. Perhaps, it could be related to differences in forest cover of the country and accessibility, forest ownership, recreational access policies, availability of recreational facilities, and the like (see Bell et al. 2007, Edwards et al. 2012b).

In general, this study elaborates the role of childhood experience in recreation behaviour at adulthood, with an implication to future recreational behaviour of the current children. Quite a lot of studies have shown that children are being denied of the opportunities to play in nature areas in contrast to what the previous generations had (see Valentine 1996, Valentine and McKendrick 1997, Kong 2000, Bell et al. 2003). It is indicated that most childhood activities are becoming more confined to the playgrounds, backyards, playrooms, and bedrooms (e.g. Bell et al. 2003, Thompson et al. 2008). Moreover, most of children's time is being spent on watching TV or playing video games (Godbey 2009, Skår and Krogh 2009) which could be linked to health problems of children, such as obesity (see Bjork et al. 2008, McCurdy et al. 2010). Many studies (Valentine 1997, Valentine and McKendrick 1997, Matthews et al. 2000, Bell et al. 2003) mentioned parental anxiety as one of the main reasons for children's lack of access to nature areas. It is indicated that even the parents and grandparents, who had the opportunities for outdoor recreation during their own childhood, do not allow their children to do the same. A similar conclusion can be taken from our study where 79% of the respondents who have children indicated that they do not let their children recreate in forests unsupervised, and that having children is associated with a lower level of frequency of visit. As indicated in Jacobs et al. (2008), more frequent nature area visits at old ages could contribute to better health conditions.

Finally, we need to mention the main limitation of the study. As indicated before, our analysis of the long term impacts of childhood experience is based on remembered survey data on childhood forest recreational practices. Remembering childhood experience might be difficult for most people and perhaps could be one of the reasons for ignoring such a factor in many studies on outdoor recreation (Wells and Lekies 2006, Thompson et al. 2008, Asah et al. 2011). It might also be difficult for the respondents to clearly state their childhood experience in a concise way i.e. reporting frequency of visit from recreational experiences passed over a number of years. The preferred approach for more reliable analysis would be using longitudinal data on life path experiences (Asah et al. 2011). However, longitudinal data regarding respondents' outdoor experiences are hardly available. The retrospective approach becomes a feasible option to examine the childhood experiences affecting adulthood behaviours (see Kals et al. 1999, Chawla 2009).

In contrast to such a limitation, studies showed that outdoor experiences in childhood could be vividly remembered at adulthood (see Sebba 1991, Lohr et al. 2000, Bell et al. 2003, Asah et al. 2011). For instance, Sebba (1991) has indicated that natural features from outdoor experiences are the predominantly remembered significant places in one's life and explained how adults' memory could be maintained as a central childhood experience from a child's sensory perception.

> *"...one can conclude that the request to recall an environment significant in childhood seemed to be a request to pinpoint a place that stirred up their original recreation as children." (Sebba 1991 pg. 407)*

Therefore, we hope our estimations based on the self-reported remembered childhood experiences being fairly measured and the results not being biased to such a limitation.

6. Conclusion

The main objective of this study was to examine the impact of childhood forest experience on the recreational behaviour at adulthood. Our estimation results revealed the role of childhood experience in affecting an individual's frequency of forest visit. Respondents who reported more frequent forest visits in childhood tend to be on a higher level of frequency of visit now. Furthermore, the study showed the importance of accessibility of forests i.e. residential settlement and distance to the nearest forest playing a crucial role in determining frequency of visit.

In previous studies, it is indicated that having nearby access to nature areas being important for recreational activities, and perhaps, for better physical activities and health (see Olds 1989, Bjork et al. 2008). In addition, outdoor recreational experience has been found to play a significant role determining one's environmental behaviour (see Dunlap and Heffernan 1975, Teisl and O'Brien 2003). As Collado et al. (2013) indicated, contact with nature in children is essential for a sustainable future through pro-environmental actions. This study shows the relevance of being in close contact with forests during childhood – not only to develop strong forest recreational habit, but also for pro-environmental behaviours and concerns in adulthood. However, it should be noticed that such collusion could be made presuming the strong association between outdoor recreational experience and environmental behaviour, and that the connection is built from childhood. That means children need to have the access and opportunity to play in nature areas not only for their better health and psychological wellbeing but also to help them develop a sense of responsibility for future sustainable environments.

In this regard, it is noticeable to consider the problems of today's children who are lacking the unsupervised access to recreate and play in nature areas, such as forests due to various reasons. As clearly mentioned in Skår and Krogh (2009), different actors (government institutions, teachers, and parents) can play a crucial role in increasing children's opportunity to play outdoors. Therefore we believe the present study contributes to the understanding of the impact of childhood outdoor experience on recreational practices in adulthood, and hence could influence different actors support and design strategies for children's better access to forests.

Appendix A

Responses per category of the variables across courtiers shown in percent

Variables	AT	CH	CZ	DE	DK	FR	PL	SK	UK	All
Visit frequency in childhood										
Never visited a forest	1	1	2	2	4	4	4	1	7	3
At least once a year	14	10	14	18	31	33	33	16	35	23
At least once a month	31	32	33	32	34	35	30	32	29	32
At least once a week	54	57	51	49	32	27	34	52	29	42
Residential area										
Rural/small town in childhood	62	76	63	55	62	63	53	70	48	61
Rural/small town now	52	71	57	45	55	57	41	61	43	54
Distance above 5km	43	30	42	52	34	62	54	45	68	48
Female	50	50	51	49	50	50	51	51	49	50
Male	50	50	49	51	50	50	49	49	51	50
Age classes										
Below 35 years	31	32	29	26	23	25	36	31	18	28
Between 35 and 50 years	35	36	33	35	30	34	30	33	33	33
Above 50 years	34	32	38	39	47	40	34	37	49	39
Level of education										
Primary school	5	5	6	4	28	1	6	4	3	7
Secondary school	36	12	27	19	11	17	10	33	24	20
Vocational	30	53	42	48	27	28	65	43	17	39
Undergraduate	12	17	7	10	23	40	19	5	13	18
Postgraduate	17	13	18	19	10	14	0	15	43	17
Net monthly income										
Less than 500€	53	16	11	10	27	17	9	7	11	18
500 – 749€	17	21	14	12	8	17	9	14	10	13
750 – 899€	3	16	10	11	10	16	18	11	13	12
900 – 999€	1	10	12	16	11	21	19	10	16	13
1000 – 1199€	0	7	12	8	9	18	25	17	17	13
1200 – 1500€	0	3	15	14	5	6	3	15	12	8
More than 1500€	0	2	11	13	11	1	1	11	4	6
Don't know/refuse	25	26	15	16	19	4	16	14	16	17
Has children under 18										
No	72	74	65	73	77	62	64	59	73	69
Yes	28	26	35	27	23	38	36	41	27	31

Appendix B

Estimation results from an ordered logit model and test of the parallel (proportional) odds ratio assumption

Variables	Coefficient	SE	p-value
Visit frequency in childhood			
Less frequent	0.01	0.14	0.921
Frequent	0.71***	0.13	0.000
More frequent	1.45***	0.13	0.000
Residential area			
Rural/small town in childhood	-0.13***	0.05	0.006
Rural/small town now	0.40***	0.04	0.000
Distance to the nearest forest	-0.61***	0.04	0.000
Male	0.05	0.04	0.198
Age			
Between 35 and 50	0.01	0.05	0.879
Above 50	0.01	0.05	0.851
Level of education			
Vocational training	0.08	0.05	0.104
Undergraduate or postgraduate studies	0.05	0.05	0.309
Net monthly income			
Middle income	0.10*	0.06	0.073
High income	0.10*	0.06	0.070
Income refused	0.10	0.06	0.117
Having children under 18	-0.11**	0.05	0.020
Cut-off point1	0.37	0.14	
Cut-off point2	2.37	0.15	
Final log likelihood	-8658.34		
Pseudo R^2	0.063		

Brant Test of Parallel Regression Assumption

Variable	Chi-square	p-value
All variables	96.68 (df=15)	0.000
Less frequent	1.78	0.182
Frequent	12.75	0.000
More frequent	6.93	0.008

Rural/small town in childhood	10.65	0.001
Rural/small town now	13.02	0.000
Distance to the nearest forest	3.85	0.050
Male	4.15	0.042
Between 35 and 50	0.34	0.561
Above 50	6.40	0.011
Vocational training	4.67	0.031
Undergraduate or postgraduate studies	5.42	0.020
Middle income	4.47	0.035
High income	4.00	0.046
Income refused	9.61	0.002
Having children under 18	0.07	0.789

The approximate likelihood-ratio test of proportionality of odds across response categories has a chi-square value = 91.33 (with df =15).

Appendix C

Estimation results from the generalized ordered logit model with country fixed effects

	Less frequent compared to frequent and more frequent $P(freq\_ad > 1)$			Less frequent and frequent compared to more frequent $P(freq\_ad > 2)$		
Variables	Coefficient	SE	p-value	Coefficient	SE	P-value
Visit frequency in childhood						
Less frequent	-0.04	0.14	0.784	-0.04	0.14	0.784
Frequent	0.70^{***}	0.13	0.000	0.29^{*}	0.15	0.053
More frequent	1.38^{***}	0.14	0.000	1.15^{***}	0.15	0.000
Residential area						
Rural/small town in childhood	-0.06	0.05	0.240	-0.27^{***}	0.06	0.000
Rural/small town now	0.33^{***}	0.05	0.000	0.54^{***}	0.06	0.000
Distance to the nearest forest	-0.51^{***}	0.05	0.000	-0.64^{***}	0.06	0.000
Male	0.05	0.04	0.256	0.05	0.04	0.256
Age						
Between 35 and 50	0.02	0.05	0.668	0.02	0.05	0.668
Above 50	-0.01	0.06	0.863	0.19^{***}	0.06	0.004
Level of education						
Vocational training	0.07	0.06	0.221	-0.09	0.07	0.212

Undergraduate or postgraduate studies	0.15**	0.06	0.017	-0.07	0.08	0.321
Net monthly income						
Middle income	0.23***	0.06	0.000	0.02	0.08	0.799
High income	0.28***	0.07	0.000	0.06	0.08	0.461
Income refused	0.18**	0.07	0.012	-0.10	0.09	0.259
Having children under 18	-0.08	0.05	0.097	-0.08	0.05	0.097
Country fixed effects (reference=UK)						
Austria	0.71***	0.10	0.000	0.51***	0.11	0.000
Switzerland	0.78***	0.09	0.000	0.78***	0.09	0.000
Czech republic	0.40***	0.09	0.000	0.40***	0.09	0.000
Germany	0.54***	0.09	0.000	0.54***	0.09	0.000
Denmark	0.61***	0.09	0.000	0.61***	0.09	0.000
France	0.29***	0.09	0.001	0.29***	0.09	0.001
Poland	0.61***	0.09	0.000	0.61***	0.09	0.000
Slovakia	0.16*	0.09	0.084	0.16*	0.09	0.084
Constant	-0.97***	0.16	0.000	-2.44***	0.17	0.000
Final log likelihood	-8553.74					
Pseudo R^2	0.074					
Number of observations	8793					

Appendix IV (Paper 4)

Accounting for Environmental Attitude to Explain Variations in Willingness to Pay for Forest Ecosystem Services Using the New Environmental Paradigm

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Abstract

In the environmental psychology literature, the new environmental paradigm (NEP) scale has been used to measure environmental attitude as a multidimensional concept. This study is conducted based on this multidimensionality concept to analyse preferences for forest management targeting non-use value ecosystem services. In most previous studies, the NEP scale has been considered as a unidimensional measure and directly incorporated into the modelling. In our case, we consider three modelling approaches to illustrate the different ways of incorporating environmental attitude. The first and second models are random parametric logit models where NEP score is incorporated differently. The third model is a hybrid choice model. All the modelling approaches show that environmental attitude is a factor that can influence preferences and willingness to pay estimates, but the first one ignoring the multidimensionality may tend to exaggerate its impact. The hybrid choice model helps to take account of unobserved heterogeneity and has the advantage of showing the link between environmental attitude and sociodemographic variables. This model also shows slightly better statistical performance. The use of two latent variables enables us to elaborate willingness to pay variations and implications of imposing payments on people with different attitudes.

Key words

Anthropocentrism, ecocentrism, hybrid choice modelling, new environmental paradigm, non-use values, random parametric logit, willingness to pay.

1. Introduction

The NOAA panel (Arrow et al. 1993) has recommended consideration of environmental attitude in contingent valuation studies to interpret the responses, and this recommendation was recently supported by Johnston et al. (2017). Following this, some contingent valuation studies have shown the importance of introducing such a variable to WTP elicitations (e.g. Kotchen and Reiling 2000, Meyerhoff 2006). Valuation studies that applied discrete choice modelling have also included variables reflecting attitude to show the association with WTP estimates (Choi and Fielding 2013, Bartczak 2015). The other justification to incorporate environmental attitude is based on the proposition that WTP expresses behavioural intention (Heberlein and Bishop 1986, Barro et al. 1996, Choi and Fielding 2013). With the understanding of such a proposition; it seems obvious to explicitly incorporate environmental attitude in estimating WTP for quality improvements of environmental goods. In addition, it helps to explain unobserved heterogeneity in preferences (Aldrich et al. 2006).

Attitude can be defined as a person's evaluation of an entity in question (Ajzen and Fishbein 1977, Meyerhoff 2006); and specifically, environmental attitude as a psychological tendency to be expressed by evaluating the natural environment with some degree of favour or disfavour (Hawcroft and Milfont 2010, Bartczak 2015). According to Meyerhoff (2006), the concept of attitude can be defined in three ways: general environmental attitude, attitude towards a public good to be valued, and attitude towards the behaviour of paying money. In our case we refer to the general environmental attitude in which individuals express their worldviews on human-nature interactions; measured by the 'New Environmental Paradigm' (NEP) scale (Dunlap and Van Liere 1978, Dunlap et al. 2000, 2008).

The intention with the NEP scale is to measure environmental attitude along several dimensions, which are not necessarily reflected in simple sums or average scores of the scale. Yet, most studies analysing its relation with WTP elicitation use an average score of the NEP items. For instance, Bartczak (2015) considered the average score of 12 NEP items and indicated the impact on WTP estimates using interaction effects. Aldrich et al. (2006), Choi and Fielding (2013) have used total score of the NEP scale to examine WTP differences of individuals with different levels of environmental attitude; and Kotchen and Reiling (2000) as an explanatory variable to the bid function in a contingent valuation.

In our study, we want to compare this approach with different approaches considering explicitly the multidimensionality of the NEP scale. The basis for our more detailed approach is a principal component analysis (PCA). We employ PCA to identify groups of the NEP questions reflecting different dimensions. It turns out that two groups are separable – reflecting 'ecocentric' and 'anthropocentric' attitudes. Hence, we follow three modelling approaches. The first model is a model where the average NEP score is included directly, as commonly done in previous studies. In the second model, we use an average score of the NEP items (within each group identified by the PCA) to define 'levels' of the two components. In the third model, we use hybrid choice model (HCM) where the two components (latent variables) are determined using structural equations and their effect on choice and NEP responses estimated simultaneously. By this, we avoid the potential endogeneity problem, that could arise from including the indicators directly in to the choice modelling (Hess and Beharry-Borg 2011). It can also help to explain unobserved preference heterogeneity in WTP, which could not be explained by other means - like interacting with sociodemographic variables alone (see Aldrich et al. 2006, Choi and Fielding 2013). More importantly, incorporating latent variables in the HCM can provide a richer explanation of behaviour associated with sociodemographic variables (Walker and Ben-Akiva 2002).

Our case relies on a study investigating the general public's preferences for forest ecosystem services in Denmark[24]. These services include both use and non-use value oriented attributes. We want to examine to what extent people's attitude affect preferences for different forest management initiatives. In particular, we expect the relation between non-use value attributes and environmental attitude to be more pronounced, as justified by Choi and Fielding (2013), and hence consider the interaction with those variables.

In summary, our aim is to address the following research questions: 1) does environmental attitude, measured through the NEP scale, influence WTP for forest management? 2) Being a measure of environmental attitude, how the NEP scale should be treated in the modelling? 3) Which modelling approaches can be employed to take account of the multidimensionality of the NEP scale and with better statistical performance?

2. Literature review

2.1 Environmental attitude in environmental valuation studies

Of the large number of studies conducted to value environmental goods and services, only a few have included environmental attitude - commonly measured through the NEP scale (e.g. Kotchen and Reiling 2000, Aldrich et al. 2006, Meyerhoff 2006, Milon and Scrogin 2006, Choi and Fielding 2013, Bartczak 2015) or the 'awareness of consequences' (AC) scale (see Spash 2006, Ojea and Loureiro 2007, Hoyos et al. 2012). In these studies, environmental attitude has been considered in the valuation various environmental goods and services; such as endangered species, protection of ecosystem services, land use changes, or alternative management initiatives.

The NEP scale, originally with 12 items of questions, was developed to assess an individual's endorsement of environmental attitude (Dunlap and Van Liere 1978, Dunlap et al. 2000). Later, it has gone through some revisions to update the wording of items and increase the number of underlined dimensions (conceptual components) (Grendstad 1999, Dunlap et al. 2000, Lalonde and Jackson 2002, Dunlap 2008, Amburgey and Thoman 2011). The revised NEP scale consists of 15 items of questions with five dimensions (see Dunlap et al. 2000, Dunlap 2008, Amburgey and Thoman 2011).

[24] This data has also been used in Campbell et al. (2013) to investigate heterogeneity in WTP for public recreational access

2.2 Empirical overview

Most of the studies have shown the positive impact of pro-environmental attitude on the value of environmental goods and services. For instance, using the NEP items in a contingent valuation of species recovery efforts, Aldrich et al. (2006) found that stronger pro-environmental attitude increases estimates of mean WTP for the species recovery efforts. The same conclusion has been drawn from a similar study conducted by Kotchen and Reiling (2000). In their study, individuals with strong pro-environmental attitude tend to be less likely to provide protest responses. In a case study about protection of endangered species, Choi and Fielding (2013) also showed WTP for endangered species being mainly influenced by an individual's environmental attitude.

Meyerhoff (2006) has shown the effect of environmental attitude on willingness to pay for management actions targeting protection of riparian ecosystems of a river in Germany. He argued that intentions to perform the behaviour are strong predictors of the stated preferences. Similarly, Milon and Scrogin (2006) incorporated the NEP items in a choice experiment application to evaluate wetland ecosystem restorations. They used a latent class modelling to examine preference heterogeneity and concluded that introducing attitudes can provide richer understanding of the source of heterogeneity.

In a choice experiment study, Bartczak (2015) has introduced 'environmental attitude' to examine WTP for management of the Białowieża Forest, Poland. The focus was to study preferences over management plans that could maintain naturalness of the forest. She has indicated the significant impact of environmental attitude in estimating WTP. She has found individuals with strong environmental attitude willing to pay higher for improvements in naturalness of the forest. Those individuals were also found less opposing to restriction on number of forest visitors; one of the measures proposed for better management.

Given that environmental attitude can play a role to determine WTP for improvements in environmental goods; the methodological approach to incorporate such a variable has to be clearly justified. Attitude is a cognitive construct which shall be treated as a latent variable (Ben-Akiva et al. 1999a, Ben-Akiva et al. 2002, Hess and Beharry-Borg 2011). In most of the previous studies, responses to the NEP items are directly incorporated as explanatory variables of WTP estimates. These variables are considered to explain bid function (in CVM) or latent classes identifiers to examine heterogeneities in discrete choice analysis (see Aldrich et al. 2006, Milon and Scrogin 2006). Since indicators are usually measured using Likert scale, measurement errors will lead to endogeneity problem (Louviere et al. 2005, Hess and Beharry-Borg 2011). In addition, the latent variables that are incorporated as determinants of WTP are presupposed to be influenced by sociodemographic variables (Ojea and Loureiro 2007). Therefore, the choice modelling procedure has to take account of these variables with a simultaneous equation set up. In this regard, we found the study by Hoyos et al. (2015) that looked into these issues applying a hybrid choice model.

The current study contributes to the literature in different ways. First, it adds to the empirical evidence on the effect of general environmental attitude in estimating WTP for ecosystem services. Second, it compares different modelling approaches to treat NEP scale. In addition, it can show the importance of considering multidimensionality of the NEP scale to illustrate variations in WTP.

3. Materials and method

3.1 Data collection

Data comes from a questionnaire designed to assess people's attitudes towards nature and value of environmental goods in Denmark (see Campbell et al. 2013 for detailed reports). The questionnaire had four main sections. The first part includes information and questions regarding the case study area, motivation and attitudes of individuals towards forest use and their environmental values. The second section presents the choice experiment with descriptions of attributes as well as follow-up questions. The third dealt with household consumption patterns and attitudes to environmental subsidy schemes[25] while the final section consisted of socioeconomic and demographic questions. The survey was administered online, from August to September 2011. Before the final survey, the questionnaire was tested in focus groups and pilot sample which led to a redesign of some attributes and questions.

3.2 Choice set design

The attributes in the CE were selected to be aligned with ongoing policy initiatives for implementation of NATURA2000 and also some certification schemes. The main attributes included in the CE are:

1) ***Recreational access*:** Danes have access to recreate in public forests day and night, also outside paths and roads. In private forests, they are restricted from recreating outside walking paths and during nights. Therefore, the proposed alternative scenarios show possibilities of increased recreational access in forests outside walking paths.
2) ***Protection of endangered specie*s:** Currently, 25% of animal and plant species in forests are endangered. It is, therefore, vital to manage forests and make targeted efforts to protect the species (e.g. by providing nesting boxes, fencing critical areas, devising mechanisms for dispersion of species, and so on). In this choice experiment, alternative scenarios were proposed to protect the endangered species – by securing survival of a fixed number of species.
3) ***Opportunity for natural processes:*** Animals and plants in the forests depend on presence of large, old and dead trees. That means forests have to be managed properly to maintain their biodiversity functions. The alternative scenarios were to either keep a few old trees

[25] This part is not of the relevance for this study

for natural decay, or to set aside part of the forest area as untouched forest reserve, or to do both of these.

4) ***Groundwater:*** Drinking water in Denmark comes from groundwater. For the last 20 years, many groundwater wells have become contaminated by chemicals, often from agricultural activities. Groundwater discharged under forests is clean, in general. The proposed improvement scenarios are to increase the amount of groundwater obtained from forests through changes in forest management practices (e.g. planting more broadleaved trees or letting forests regenerate naturally).

Table 1

Description of attribute levels

Attribute	Levels
1) Increase access outside of the paths and roads in the forest (**Access**)	○ On 25% of the area also outside road and path (status quo) ○ Allowed on 50% of the area ○ Allowed on 100% of the area
2) Protection of endangered species (**SP_50, SP_100**)	○ 660 endangered species (status quo) ○ 50 species can be secured survival through a special initiative ○ 100 species can be secured survival through a special initiative
3) Opportunity for natural processes in the forest (**NP1, NP2, NP3**)	○ Dead trees left only occasionally and 0.01% of forest area set aside as untouched forest reserves (status quo) ○ 5 trees per ha left to natural decay and 0.01% of forest area set aside as untouched forest reserves (medium level) ○ 7% of broadleaved forest area set aside as untouched forest reserves (high level) ○ 5 trees per ha left to natural decay and 7% of broadleaved forest area set aside as untouched forest reserves (very high level)
4) Increase recharge of groundwater (**Groundwater**)	○ Same as now (status quo) ○ Increase to 20 million m3 (corresponds to 10% households in case study area) ○ Increase to 40 million m3 (corresponds to 20% households in case study area)
5) Extra annual income tax per household (**Payment**)	○ 0 DKK (status quo) ○ 250 DKK, 500 DKK, 750 DKK, 1000 DKK, or 1250 DKK

In the choice experiment, each respondent was provided with six consecutive choice sets. Attribute levels and payment vehicle were described in detail, illustrated with diagrams (see Fig. 1). Respondents had to make their choices out of three provided alternatives i.e. labelled as ‘initiative one’ or ‘initiative two’ with forest management changes, or the status quo option stated as ‘existing forest management continues’. Along with each choice set, a web link was added to enable respondents to access a webpage repeating the attribute level description (see Campbell et al. 2013 for details on choice set design).

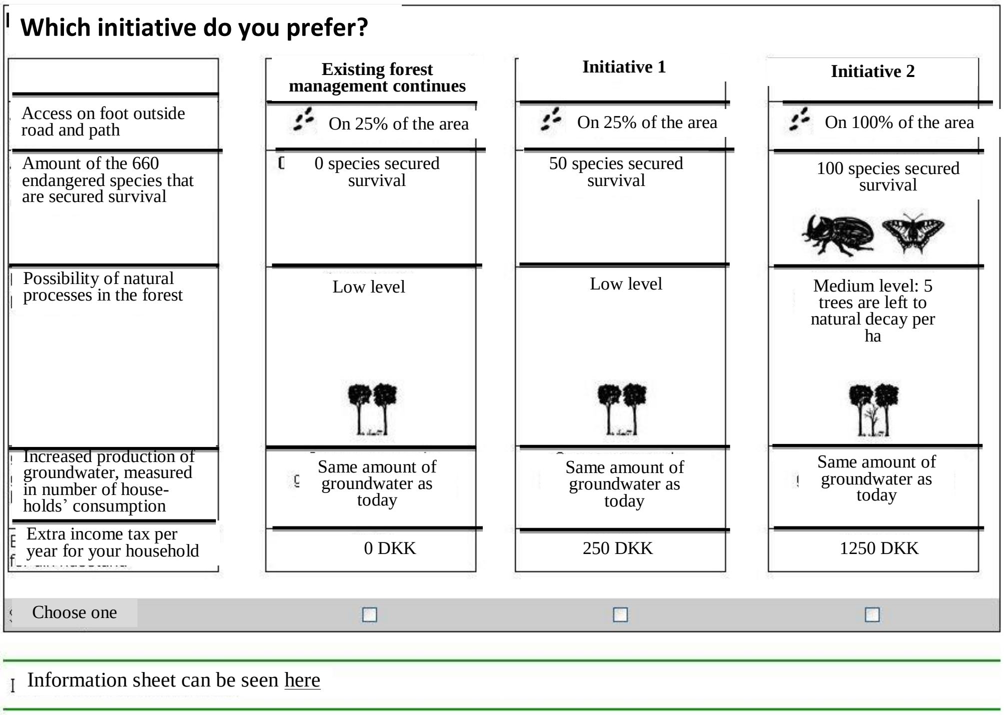


Figure 1: Sample choice set

3.3 The NEP scale

Items of the NEP scale are descriptions on worldviews towards human influence on natural environment. The respondents were asked to indicate their ‘level’ of agreement or disagreement to nine (of the fifteen) items. These items were meant to address three components of the NEP scale; i.e. ‘ecological crises’ (item 2, 5, and 8), ‘balance of nature’ (item 3, 6, and 9), and ‘anthropocentrism’ (item 1, 4, and 7) (see Amburgey and Thoman 2011). The remaining NEP items, related to ‘limits of growth’ and ‘exemptionalism’ dimensions were not considered of importance for the case.

Table 2

The NEP items used: Evaluated on a Likert scale from completely agree (1) to completely disagree (5).

	NEP statements
1	Humans have the right to modify the natural environment to suit their needs
2	When humans interfere with nature it often produces disastrous consequences
3	Mankind is severely abusing the environment
4	Plants and animals have as much right as humans to exist
5	The balance of nature is strong enough to cope with the impacts of modern industrial nations
6	The so-called ‘ecological crisis’ facing humankind has been greatly exaggerated
7	Humans were meant to rule over the rest of nature
8	The balance of nature is very delicate and easily upset
9	If things continue on their present course, we will soon experience a major ecological catastrophe

3.4 Econometric modelling

3.4.1 Choice modelling framework

The standard approach in discrete choice analysis is the random utility maximization (RUM) framework consisting of deterministic and random components (McFadden 1974). Estimation of the utility maximization is done through the deterministic component and with distributional assumptions of the random part. The deterministic utility is formulated to be explained by observable characteristics of the good/service.

One way of handling preference heterogeneity is to apply a random parametric logit (RPL) model, in which individual differences are allowed to vary with a given distribution of parameters. Another way involves use of sociodemographic variables as interaction terms to explain part of the observable heterogeneity. However, the unobserved taste variation among individuals would still prevail; and one of the options to address such heterogeneity is through incorporating latent variables (Aldrich et al. 2006, Hoyos 2010, Hoyos et al. 2012, Choi and Fielding 2013). These may include variables, such as attitudes and perceptions that can be incorporated into the modelling to explain the deterministic utility (Ben-Akiva et al. 1999b, Hoyos et al. 2012, Hoyos et al. 2015).

A more rigorous way of dealing with the issue of heterogeneity can be justified from the understanding of the choice making process. Choice making is performed after mental process influenced by interconnected psychological factors, like attitudes and perceptions (Ben-Akiva et al. 2002, Hoyos et al. 2012). An illustrative description of the choice making process is shown in the following diagram (Fig. 2).

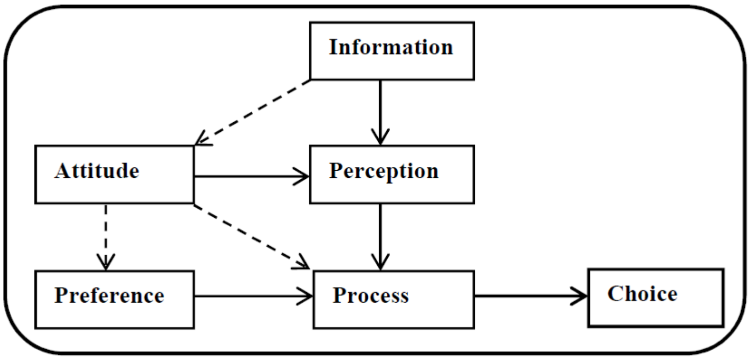


Figure 2: Choice making process (slightly modified) (McFadden 2001, Ben-Akiva et al. 2002)

Consequently, the choice modelling procedure requires expanding the RUM formulation through introducing a behavioural framework explicitly; using psychological factors identified from some indicators (Ben-Akiva et al. 1999b, Ben-Akiva et al. 2002). The approach is to construct latent variables based on the information obtained from indicators e.g. through items of questions included in a survey (Bahamonde-Birke et al. 2015). The association between the latent variables and indicators can be treated in a multiple indicator multi-cause (MIMC) modelling. In MIMC modelling, latent variables are set to explain a number of indicators and in turn be explained by individual's characteristics (Bahamonde-Birke and Ortúzar 2013, Bahamonde-Birke et al. 2015).

3.4.2 Model specification

We follow three modelling procedures. Model 1, which has been used in most previous studies, accounts the NEP score interacted with attributes and is considered as reference for comparison. In model 2 and 3, we consider NEP in its multidimensionality with different ways of treating the latent variables. The three modelling approaches are similar with regard to the specification of the utility function. Here, we present specification of model 3 (HCM) to show its additional components.

The HCM is structured in three sets of equations: a choice model, structural equations, and measurement equations. In our case, the latent variables are defined as 'LV-ecocentrism' and 'LV-anthropocentrism', and the indicators of the latent variables are items of the NEP scale. The explicit modelling specification can be written as follows: (details about the structure of HCM can be seen in Ben-Akiva et al. 1999a, 1999b, Ben-Akiva et al. 2002, Walker and Ben-Akiva 2002, Daly et al. 2011, Bahamonde-Birke and Ortúzar 2013, Hoyos et al. 2015).

1) The choice model:

The choice model is an extended version of RUM which includes latent variables in the deterministic part. Hence, the utility function can be written as:

$$\mathrm{U} = \mathrm{V}(\mathrm{X}, \mathrm{LV}; \beta) + \varepsilon \qquad \varepsilon \sim \mathrm{D}(0, \Sigma_\varepsilon) \qquad \text{eq. 1}$$

From the basic RUM formulation, the logit model with an IID assumption of the error term is

$$P(i|C) = \frac{\exp^{V_{in}}}{\sum \exp^{V_{jn}}}; i, j \in C \text{ and } i \neq j \qquad \text{eq. 2}$$

where U is a vector of utilities consisting of a deterministic component V and a random disturbance term ε. X is a vector of observed attributes of alternative i of individual n. LV is a vector of latent variables; β represents a vector of parameters to be estimated. Specific to our case, the deterministic utility becomes:

$$\begin{aligned}
V = V\ (&\text{payment},\\
&\text{recreational access},\\
&\text{protection of endangered species},\\
&\text{opportunity for natural processes},\\
&\text{provision of clean ground water, and}\\
&\text{latent variables}^{26})
\end{aligned}$$

$$\begin{aligned}
V_{in} = ASC + \beta_{payment} * Payment_{in} &+ \\
\beta_{access} * access_{in} &+ \\
\beta_{species50} * species50_{in} &+ \\
\beta_{species100} * species100_{in} &+ \\
\beta_{naturalprocess1} * naturalprocess1_{in} &+ \\
\beta_{naturalprocess2} * naturalprocess2_{in} &+ \\
\beta_{naturalprocess3} * naturalprocess3_{in} &+ \\
\beta_{groundwater} * groundwater_{in} &+ \\
\beta_{ecocntricinteraction} * ecocentricinteraction_{in} &+ \\
\beta_{anthropocentricinteraction} * anthropocentricinteraction_{in} & \qquad \text{eq. 3}
\end{aligned}$$

2) ***Structural equations:***

This is a representation of set of equations where the latent variables are considered as functions of sociodemographic variables. In our case, the two latent variables, which we name 'LV-ecocentrism' and 'LV-anthropocentrism', are set as functions gender, age, education, and being member of the Danish nature protection organization.

$$LV = h(X; \gamma) + \eta \qquad \text{eq. 4}$$

$$LV_{ln} = \gamma_{lr} * S_{rn} + \eta_{ln} \qquad \text{eq. 5}$$

$$LV_{ln} = h(\text{age, gender, education, org\_prot});\ l = \text{'ecocentrism' or 'anthropocentrism'}$$

$$LV_{ln} = \gamma_{age} * age_{ln} + \gamma_{female} * female_{ln} + \gamma_{educ} * educ_{ln} + \gamma_{org_{prot}} * org\_prot_{ln} \qquad \text{eq. 6}$$

[26] replaced by NEP score in model 1, but similar in model 2

S represents sociodemographic and other variables, γ the corresponding parameters to be estimated, and η error term of the latent variable (assumed to be normally distributed).

3) *Measurement equations:*

The measurement equation allows each of the NEP items to be explained by the latent variables. Based on the factor loadings (see section 4.1.2); items 2, 3, 8, and 9 are specified to be explained by 'LV-ecocentrism' and items 1 and 7 by 'LV-anthropocentrism'.

$$\mathrm{I} = \mathrm{g}(\mathrm{X}, \mathrm{LV}; \alpha) + \nu \qquad \text{eq. 7}$$

$$\mathrm{I}_{\mathrm{qn}} = \tau_{\mathrm{q}} + \alpha_{\mathrm{lq}} * \mathrm{LV}_{\mathrm{lqn}} + \nu_{\mathrm{qn}} \qquad \text{eq. 8}$$

$$\mathrm{Items}_{1-6} = \mathrm{g}('\mathrm{ecocentrism}', '\mathrm{anthropocentrism}')$$

Here I is a vector of indicators (the NEP items), α the associated parameters to be estimated, τ is a threshold levels of indicators (constant), and ν a random disturbance terms. $l, q, and\ r$ are indices linked to the latent variables, indicators, and sociodemographic variables respectively.

Since the NEP questions are presented in 'five level' Likert scale, it could have been modelled using ordered choice models consistently with how they are measured (Daly et al. 2011). However, in our case, a single latent variable was set to explain many indicators and treating all these indicators with ordered choice model resulted in non-convergent estimation which would have made it harder to satisfy a set of simultaneous equations. Hence, we do not employ this modelling, and instead recode the six items as dummy variables so that indicators are modelled in a binary logit function.

$$\mathrm{P}(\mathrm{I}_{\mathrm{qn}} = 1) = \frac{1}{1 + \exp^{\mathrm{LV}_{\mathrm{lqn}}}} \qquad \text{eq. 9}$$

Based on the above set of equations, the joint likelihood is estimated from the joint probability of observable variables y (observed choice) and I conditional on the exogenous variables, X:

$$\mathrm{LL}(\mathrm{y}, \mathrm{I}|\mathrm{X}; \alpha, \beta, \gamma) = \sum_{\mathrm{n}}^{\mathrm{N}} \int \mathrm{P}(\mathrm{y}|\mathrm{X}, \mathrm{LV}; \beta) \mathrm{f}_{\mathrm{I}}(\mathrm{I}|\mathrm{X}; \alpha) \mathrm{f}_{\mathrm{l}}(\mathrm{LV}|\mathrm{X}; \gamma)\, \mathrm{d}(\mathrm{LV}) \qquad \text{eq. 10}$$

Technically, estimation of the HCM can be done either sequentially or simultaneously with simulated maximum likelihood by taking random draws of the latent variables to depict their probability distribution (Ben-Akiva et al. 1999a, Ben-Akiva et al. 2002, Bahamonde-Birke et al. 2015). In our case, we carry out the estimation simultaneously using R-programming. Initially, we run HCM estimation with 500 Halton draws. At this stage, the priors in the choice model are taken from the basic RPL model estimated with only the attributes; priors in the structural model are taken from simple linear regression; and priors for the indicator and interaction terms of the latent variables are '0'. The final estimation is performed based on 1000 draws.

Notice that the latent variables are not alternative specific and hence, need to be considered through interaction effects. Therefore, we consider the interaction with an 'alternative specific constant' (ASC) and non-use value attribute levels; 'SP_50', 'SP_100', 'NP1', 'NP2', and 'NP3'. The interaction with the ASC can show effect of latent variables on WTP for changes in forest management altogether while the interaction with specific attribute levels can disclose preference heterogeneities in those attributes.

4. Results

The total number of individuals responding to the web-based survey is 811, with a response rate of 29%. Out of those who completed the questionnaire, 16 were identified as protesters for objections regarding payment vehicle or lack of trust in the scenarios (see Campbell et al. 2013). In addition, 73 individuals did not fully respond to the NEP questions, and are excluded. Therefore, a total of 722 individuals are found eligible to be included in this analysis.

4.1 Descriptive statistics

The respondents were aged between 18 and 70, with mean of 48. 47% were female. Most of the respondents have completed high school education. About 87% of them have personal income below the mid income category, and 65% reported their total monthly income to be between 8000 – 2500 DKK. Our sample is overrepresented by people older than 50 years and low income groups (see Appendix 1).

In addition, 84% participate in nature experiences (such as picnics); 18% participate in consumptive activities like hunting, collecting berries, or fishing in forests; and 22% of the respondents indicated that they are members of at least one nature protection organization.

Table 3

Descriptive statistics of attribute levels

Variable	Mean	Std. Dev.	Min	Max
Access	0.45	0.50	0	1
SP_50	0.22	0.41	0	1
SP_100	0.22	0.42	0	1
NP1	0.17	0.37	0	1
NP2	0.17	0.38	0	1
NP3	0.17	0.37	0	1
Groundwater	1.33	1.63	0	4
Payment	416.53	456.05	0	1250

As presented in the table, the main attributes except ‘payment’ and ‘groundwater’ are coded as dummy variables. Also notice that age of the respondent and education are considered as continues variables in the latent variable structural equations of the HCM. The rest of the variables used in the structural equation are also coded as dummies.

4.1.1 Answers to NEP questions

For the purpose of consistent description of a pro-environmental attitude and grouping; we reversed the scale of items 1, 5, 6, and 7 (1 to 5; 2 to 4) (see also Choi and Fielding 2013, Bartczak 2015); which were phrased in negative connotations to such an attitude. As shown in figure 3, the majority of respondents have agreed to the pro-environmental descriptions of the NEP.

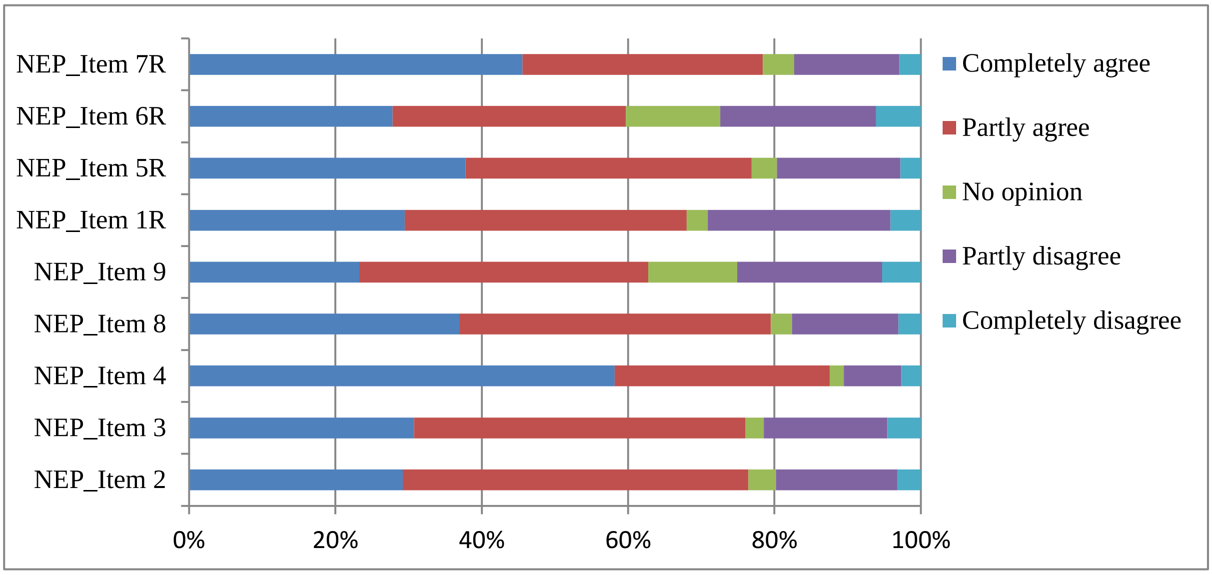


Figure 3: Responses to NEP items

4.1.2 Principal component analysis

Principal component analysis (PCA) is used as a factor reduction method to identify latent variables from the nine items. Doing PCA, we end up with two components, with the criteria of Eigen values greater than 1. The first component explains 29.2% of the total variation with an Eigen value of 2.6 and the second explains 21.6% of the total variation with an Eigen value of 1.9. The Cronbach’s alpha as test of internal consistency is 0.79 – which can be regarded as satisfactory (Gliem and Gliem 2003). The total mean score on the NEP scale is 19.38. Results of PCA can be seen in the appendix.

From the nine items included, six of them contribute to the factor loadings uniquely to one of the components. The other three items, which load more or less equally to both components, are not included in the choice model. The two latent variables are considered as representations of ‘ecocentric’ and ‘anthropocentric’ attitudes. The first component (‘ecocentrism’) has loadings from four items (2, 3, 8, and 9) and can thus be taken to represent ‘ecological crisis’ and ‘balance of nature’ dimensions, while the second component (anthropocentrism') has loadings from only two items (1 and 7) (see Amburgey and Thoman 2011).

Notice that PCA is used to identify components that are to be included in model 2 and 3. Hence, the responses to NEP questions are treated differently in the three modelling approaches. In model 1, the mean score calculated from responses to the six NEP items is used directly. In Model 2, the mean score is calculated separately for each group of items that loaded to the components in the PCA. The mean score[27] on items 2, 3, 8, and 9 were taken to determine 'level' of 'ecocentrism' while the mean score on items 1 and 7 determine the 'level' of 'anthropocentrism'. In Model 3, we estimate two latent variables which can affect the answers to the NEP questions. The same grouping as above is used, i.e. 'LV-ecocentrism' set to explain about item 2, 3, 8, and 9; and 'LV-anthropocentrism' is set to explain item 1 and 7.

If we look at the distribution of the anthropocentric and ecocentric individuals according to their answers to the NEP questions, we see (in table 4) that 5% could be regarded as both 'ecocentric' and 'anthropocentric' while 39% could be neither. Therefore, proper analysis of responses can be made by considering the NEP as multidimensional measure. Modelling with NEP scale as unidimensional measure will lead to force the 45% counted in one of the two dimensions.

Table 4

Individuals with ecocentric vs anthropocentric attitudes[28]

		Anthropocentric		
		0	1	Sum
Ecocentric	0	39%	7%	46%
	1	49%	5%	54%
	Sum	88%	12%	100%

4.2 Choice modelling results

The results reported in table 5 are based on the three modelling procedures. Results reported in model 1 are based on a RPL model where the average NEP score is directly interacted with the ASC and non-use value attributes. Model 2 shows the result of a RPL model in which the two latent variables identified from the PCA, i.e. 'ecocentrism' and 'anthropocentrism' are used as interaction terms with the same variables mentioned. Model 3 shows the estimation result based on the HCM where the two latent variables, 'LV-ecocentrism' and 'LV-anthropocentrism' are interacted with those variables in a similar way.

[27] Based on this mean score, a dummy variable was created taking the value 1, if the score was below 2; and 0 otherwise. Note that a level below 2 means 'higher' agreement to those items. This is to make it close to the labelling of items in indicator equations of model 3.
[28] This is based on definition of latent variables in model 2.

Table 5

Choice model estimation results for 3 different ways of treating answers from NEP question

Variable	Model 1: RPL (NEP)		Model 2: RPL (PCA)		Model 3: HCM	
	Est.	SE	Est.	SE	Est.	SE
ASC_alt1	-3.17***	0.63	-1.47***	0.32	-1.76***	0.50
Payment	-0.003***	0.0002	-0.003***	0.0002	-0.002***	0.0001
Access	-0.12	0.13	-0.16	0.13	0.06	0.08
SP_50	3.23***	0.39	1.73***	0.19	1.38***	0.20
SP_100	6.23***	0.57	2.49***	0.25	2.11***	0.56
NP1	1.66***	0.33	0.76***	0.16	0.73***	0.13
NP2	2.74***	0.41	1.04***	0.19	0.91***	0.24
NP3	1.31***	0.48	1.36***	0.24	0.72***	0.13
Groundwater	0.31***	0.04	0.30***	0.04	0.32***	0.03
NEP score_ASC_alt23	-0.56**	0.27				
Ecocentric_ASC_alt23			1.14***	0.40	0.73***	0.19
Anthropocentric_ASC_alt23			-0.44	0.64	-2.13***	0.21
NEP score_SP_50	-0.55***	0.16				
Ecocentric_SP_50			0.64***	0.24	0.46***	0.11
Anthropocentric_SP_50			-0.56	0.38	-0.71***	0.12
NEP score_SP_100	-1.40***	0.22				
Ecocentric_SP_100			1.58***	0.33	0.92***	0.18
Anthropocentric_SP_100			-1.45***	0.49	-2.43***	0.20
NEP score_NP1	-0.28*	0.15				
Ecocentric_NP1			0.48***	0.21	0.16	0.11
Anthropocentric_NP1			0.50	0.39	-0.33***	0.13
NEP score_NP2	-0.57***	0.18				
Ecocentric_NP2			0.84***	0.26	0.45***	0.13
Anthropocentric_NP2			0.16	0.49	-0.86***	0.14
NEP score_NP3	0.07	0.20				
Ecocentric_NP3			0.11	0.30	-0.03	0.13
Anthropocentric_NP3			0.54	0.50	0.12	0.14
Final Log Likelihood	**-3257.23**		**-3274.63**		-3312.20 **[-3269.12]**[29]	
AIC	**6572.46**		**6631.27**		11035.34 [**6592.24**]	
BIC	**6757.30**		**6892.59**		11296.67 [**6764.33**]	
No of parameters	**29**		**41**[30]		**41**	

[29] Values in closed brackets are from the reduced HCM

Table 6

Estimation results of the structural and indicator function from the HCM model

Variables in the structural equations	**Est.**	**SE**
Ecocentric Female	0.30***	0.10
Anthropocentric Female	0.13	0.09
Ecocentric Age	0.008**	0.004
Anthropocentric Age	0.002	0.003
Ecocentric Education	-0.02	0.025
Anthropocentric Education	-0.001	0.02
Ecocentric member of nature org.	0.58***	0.18
Anthropocentric member of nature org.	-0.52***	0.16
Variables in the indicator equations		
NEP item2 (α_2)	2.90***	0.49
NEP item3 (α_3)	1.75***	0.23
NEP item8 (α_8)	1.71***	0.22
NEP item9 (α_9)	1.80***	0.24
NEP item1 (α_1)	0.21**	0.10
NEP item7 (α_7)	0.13	0.12
NEP item2 (τ_2)	1.12	0.72
NEP item3 (τ_3)	0.93**	0.44
NEP item8 (τ_8)	1.22***	0.43
NEP item9 (τ_9)	-0.04	0.45
NEP item1 (τ_1)	-0.92***	0.10
NEP item7 (τ_7)	-1.58***	0.10

Note: ***, **, * is level of significance at 1%, 5%, 10%, respectively.

The main effect attributes except recreational access are significant with expected signs in all the three models. In the first model, all the interaction terms except with 'NP3' are significant with expected negative signs. Note that the NEP items are scaled from 'higher' to 'lower' level of agreement (lowest score indicates for 'completely agree' scale). The scales to items 1 and 7 are also reversed in order to make it consistent with the one dimension pro-environmental attitude. So, the negative coefficients of these interaction terms imply that people with less pro-environmental attitude tend to be less likely to pay for improvements in those variables.

[30] Including standard deviations of parameter estimates

In model 2, the interaction between ASC and 'ecocentrism' is positive – implying that respondents' likelihood of choosing a scenario over the status quo is higher for ecocentric people. It is also evident that the interaction between 'ecocentrism' and 'protection of endangered species' is significant and positive which implies that highly ecocentric individuals would like to choose scenarios with improvements in this variable. We can see that the higher the number of species protected, the higher would be the utility of 'ecocentric' individuals. The interaction between 'anthropocentrism' and 'SP_100' is negative indicating that highly anthropocentric people are less likely to choose forest management initiatives that may secure survival of 100 endangered species. In addition, 'ecocentrism' positively contributes to 'protection of natural processes' with its levels defined as 'NP1' and 'NP2'. But the interactions with 'highest level' of this attribute ('NP3') are not significant.

In model 3, the interaction effects between the levels of 'protection of endangered species' and 'LV-ecocentrism' are positive; while the interactions with 'LV-anthropocentrism' are negative. The interactions of the latent variables and 'opportunity of natural process' indices 'NP1'and 'NP2' are significant with the expected signs. But, in this case 'LV-ecocentrism' matters only for 'NP2' while 'LV-anthropocentrism' influences both 'NP1' and 'NP2'.

From the estimation of structural equations of latent variables, we can see that gender and age can explain an ecocentric attitude positively. Older people and female are more ecocentric than their counterparts. But anthropocentric attitude is not found to be explained by any of the included demographic variables. In addition, being member of nature protection organization can explain 'LV-ecocentrism' positively and 'LV-anthropocentrism' negatively.

In the indicator equations, we found all except item 7 being significantly positively explained by the identified latent variables. That means, on average, ecocentric individuals have 'agreed' to the descriptions of item 2, 3, 8, and 9; while anthropocentric individual 'agreed' only to item 1. This indicates that 'LV-ecocentrism' is a stronger predictor than 'LV-anthropocentrism'. Jointly, we can say that the attitude of ecocentrism is the one which loads the most into NEP questions and also the one that affects WTP the most.

In general, it seems that model 1 performs better based on the final log-likelihood values and information criteria. Yet, it cannot be compared directly with the other two models as attitude is measured differently. To compare the other two models, we can look into a reduced form HCM. The reduced form of HCM is a model without indicator equations. Even though the latent variables cannot be treated exactly as in the longer form, it enables us to compare the relative model performance with the same number of parameters as in the second model. In addition, estimates in the reduced model are different from that of the longer form, since the latent variables cannot be explicitly identified through NEP items. As can be seen in table 5, the log likelihood and the information criteria of the reduced from show that the HCM performs slightly better than model 2. It should also be noticed that in model

2, the measurement of the two latent variables is carefully taken to be consistent with the measurement of the NEP items considered in model 3.

4.3 Estimation of WTP

The average WTP of a person (with ‘mean value’ attitude) for non-use value attributes are calculated based on parameter estimates from the different models. To do that, we considered the mean of the ‘latent variables’. In model 1, we take the mean score of 2.2 on the six items of the NEP scale. In model 2, the mean values of 0.54 and 0.12 were calculated for ‘ecocentrism’ and ‘anthropocentrism’ respectively. These values become 0.47 and 0.10 respectively, in model 3; calculated by multiplying the coefficient and levels of explanatory variables in the structural equations.

As shown in figure 4, the average WTP based on estimates from the different models is not significantly different, nor are they different from the WTP calculated using a basic RPL model (one that does not account for NEP[31]). Model 3 shows slightly lower average WTP in all attributes. In general, it seems difficult to show the variation in WTP when the ‘mean value’ attitudinal measure is considered in all the models; for the fact that opposite effects of the latent variables are being concealed.

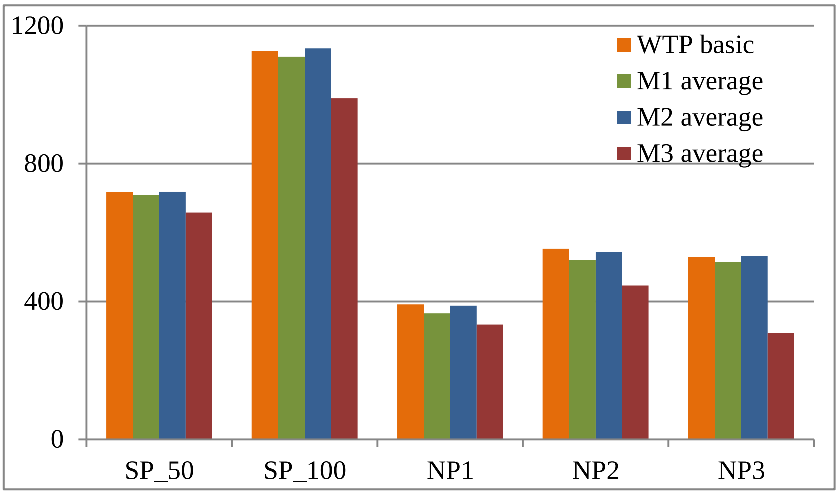


Figure 4: Average WTP (DKK/Person/year) based on estimates of a ‘mean’ value attitude person

To look into how the models estimate the most extreme responses, we calculate WTP of the two groups considering ‘highest value’ attitude measures. Figure 5 shows the WTP that each model could predict for an individual with ‘most ecocentric’ and ‘most anthropocentric’ attitudes respectively.

[31] This estimation is from RPL model using basic attributes alone (result reported in appendix 1).

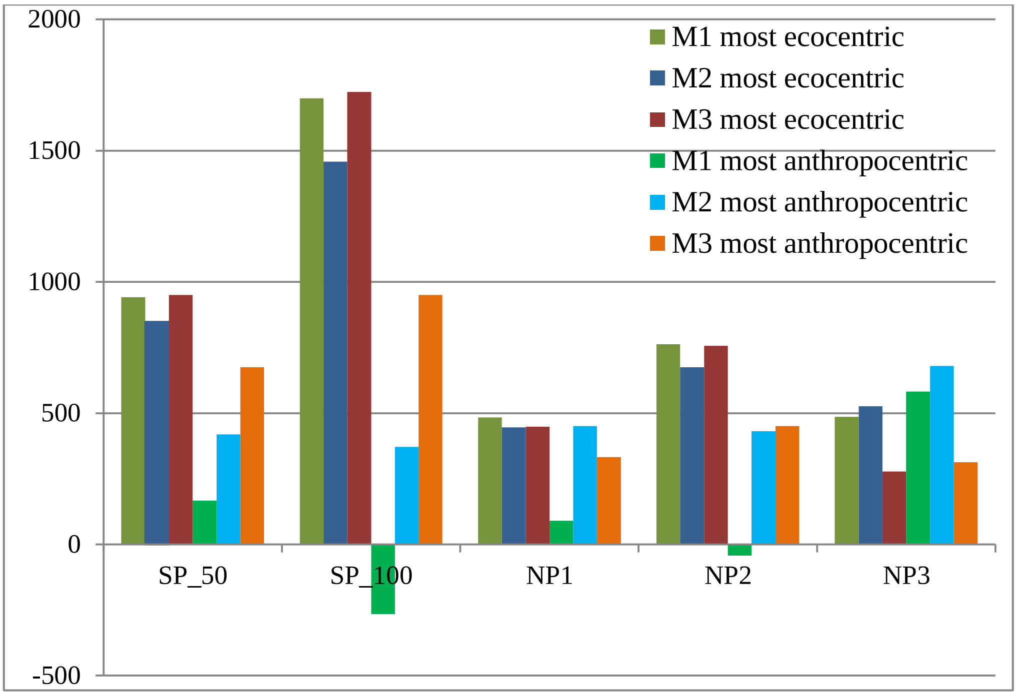


Figure 5: Average WTP (DKK/Person/year) based on estimates of 'most ecocentric' vs 'most anthropocentric' person

It is evident that WTP estimates computed for the 'most anthropocentric' persons are significantly lower than the WTP computed for the 'most ecocentric' persons in all models. The only exception is for the variable defined as 'NP3' in which interaction terms are insignificant. Model 1 shows the lowest WTP for the 'most anthropocentric' persons, which become even negative in two of the attribute levels. It can be argued that this model overestimates the impact of attitude as it measures the NEP on a linear scale, which our previous results have shown not to be consistent. In general, the first two models can show the variation in WTP explicitly by considering the multidimensionality of the NEP scale; and these two models provided almost similar estimates.

A final way to look at the differences in WTP is by splitting respondents into two groups depending on whether they are anthropocentric or ecocentric, according to table 4. Figure 6 shows this effect from a RPL model for 'ecocentric' and 'anthropocentric' individuals compared to the whole sample (estimation results reported in the appendix). The WTP of 'ecocentric' subsample is by far greater than 'anthropocentric' subsample.

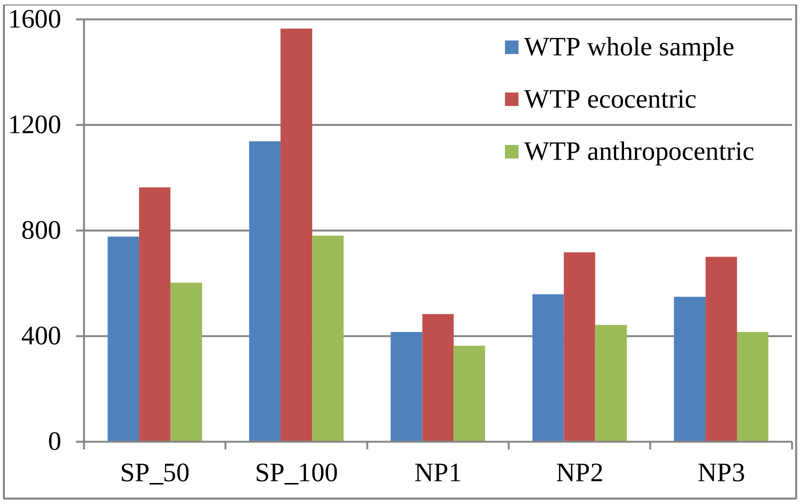


Figure 6: Average WTP (DKK/household/year) per groups in attitude

5. Discussion

There are several arguments for incorporating individual's environmental attitude in the valuation of environmental goods. Based on the attitude-behaviour relationship, environmental attitude is presumed to impact on behavioural intention of individuals and hence their WTP for environmental goods (Ajzen and Fishbein 1977, Meyerhoff 2006). Similarly, attitude is considered as one factor that can influence the choice making process (Ben-Akiva et al. 1999a, Ben-Akiva et al. 1999b, Ben-Akiva et al. 2002). In addition, it has been recommended to include such a variable to address unobserved preference heterogeneity (see Aldrich et al. 2006, Choi and Fielding 2013).

Our findings also support the proposition that environmental attitude should be considered to explain variations in WTP estimates. Our results from the three modelling approaches consistently show that 'ecocentric' individuals are likely to pay more to forest management initiatives with better ecosystems services, and specifically to non-use values. Therefore, the hypothesis that strong pro-environmental attitude can positively impact on WTP is found valid.

In the first model, we used the aggregated NEP score, not allowing for unequal weighting and scaling of anthropocentric and ecocentric attitudes. This leads to overestimate the impact. With better statistical performance, accounting the multidimensionality of the NEP scale, the HCM can be considered as a preferred modelling approach. However, it is informative that the second model can also play the same role, if the measurement of the latent variables is carefully considered.

Through the application of HCM, the link between sociodemographic variables and WTP can be well explained from explicit modelling of latent variables. For instance, we found women and the elders to be more ecocentric compared to their counter parts. That means female and older people are willing to pay more for forest management targeting ecosystem services. Such explicit explanation would not be evident from the other two modelling approaches. Furthermore, it is worth mentioning another advantage of using HCM, namely handling the endogeneity problem which could arise from incorporating environmental attitude into choice modelling. Endogeneity can arise from measurement of indicators with a Likert scale (Hess and Beharry-Borg 2011). It can also be linked to the causality of attitude – behaviour relationships. For instance, outdoor recreational participation is found to be a strong predictor of environmental attitude which is assumed to predispose environmental behaviour (see Levine and Langenau 1979, Tarrant and Green 2009).

Treating the NEP scale as unidimensional as in Model 1 is less preferable to represent attitude towards the environment. In a confirmatory factor analysis using all fifteen items, Amburgey and Thoman (2011) have shown that the NEP can be best described as a multidimensional scale. They indicated that the fifteen NEP items represent five interrelated components. That means, incorporating environmental attitude distinctly by 'ecocentrism' and 'anthropocentrism' dimensions would provide better assessment than with single average or aggregate score.

Previously, Bartczak (2015) has indicated that environmental attitudes can have an impact on the amount people are willing to pay for changes in forest management. People with strong pro-environmental attitude tend to choose a forest management which maintains the naturalness of the forest and restricts the number of forest recreationists. On the one hand, this explanation is in line with our finding that people with 'ecocentric' attitude are more committed to support policies with environmental conservation. On the other hand, her study could not explicitly show how individuals with an 'anthropocentric' attitude would react to such measures.

Beyond the dimensionality, we want to mention the limitation of the NEP scale in terms of the effectiveness of the items to reflect on attitude as determinant of WTP for forest ecosystem services. The NEP scale considered in this study is used to measure general environmental attitude. And therefore, on purpose, not modified in wording to be particularly linked with advantages of forest management for ecosystem services. It is possible that a scale linked more directly to the topic would provide different results (see Notaro et al. 2017). Moreover, the ordering of the NEP questions and choice experiment in the questionnaire might be of critical importance. Presenting the NEP scale questions before the choice experiment might potentially have created psychological awareness, which could have influenced responses in choice experiments.

The attitudes of people towards human-nature interaction have important implications on their willingness to pay for conservation measures. For instance, with an anthropocentric attitude, humans are viewed as being separated and insusceptible to nature; and nature as instrumental for the benefit of humans (Stokols 1990, Grendstad 1999). With such an attitude, it would become difficult to implement proposed conservation measures (Thompson and Barton 1994). Therefore, consideration of environmental attitudes in the valuation of environmental goods and services is relevant to make an informative outline of management decisions.

One of the challenges of valuation studies with hypothetical scenarios is their actual implementation when the policy options are placed into action. According to Fischer and Young (2007), understanding individuals' environmental attitude would be essential to ensure general public acceptance and support of conservation measures. Thompson and Barton (1994) have shown that ecocentric and anthropocentric individuals could have positive and strong commitments towards conservation; yet with different motivation and level of acceptance for policies to be realized. Anthropocentric individuals would not be willing to act on conserving environmental goods if such goods do not have direct human benefits. People with such attitude might understand the pre-existing human-nature interaction and may value nature from utilitarian perspective. The ecocentric individuals, on the other hand, are those committed to support management decisions and contribute for protection of environmental goods (even with non-use values as found in this study) because they understand the intrinsic values of nature. Those are people who could value environmental asset in its natural setting and opt for conservation measures at their individual expenses.

6. Conclusion

In this study, the impact of incorporating environmental attitude on WTP estimates of protection of endangered species and natural process in forests has been outlined. We have done so by the use of a NEP scale. The relation between answers to these questions and WTP have been estimated in three different models: 1) an aggregated score of the NEP questions interacted with non-use attributes using RPL modelling; 2) two groups of the NEP items identified from PCA and interacted with same attributes in RPL modelling; and 3) a HCM model, where answers to the NEP questions are assumed to be affected by two different latent variables. The last two approaches allow for a more nuanced view of the heterogeneity than the first. Part of the heterogeneity explained by the latent variables is indicated better in model 3 than the others. Model 1 may not show the effect of environmental attitude in the right way because the effect of attitude is overestimated due to the linearly measured NEP scale by ignoring its multidimensionality.

The main research questions raised in the study are addressed sufficiently. Our results explicitly show how environmental attitude can explain variations in WTP. As mentioned before, we are able to show that 'ecocentric' people are in favour of forest management initiatives for improvements in ecosystems services. In doing so, we illustrate the relevance of taking account of multidimensionality of the NEP scale in measuring environmental attitude. We also show performance of different modelling approaches, incorporating latent variables in discrete choice models.

Consideration of environmental attitude in distinct concepts of 'ecocentrism' and 'anthropocentrism' can help to understand the different motivations of payment for forest management initiatives. It can be argued that if the majority of people justify forest management initiatives from ecocentric attitudes as in our case; the implementation of proposed scenarios taking this into account will get better public acceptance.

Appendix 1

Sociodemographic variables

Variable	Percent
Gender	
Male	52.8
Female	47.2
Age category	
Below 35 years	17.6
Between 35 – 50 years	34.8
Above 50 years	47.5
Level of Education	
Secondary	25.6
Tertiary	46.3
Above tertiary	28.1
Personal monthly income before tax	
Below 25,000 DKK	71.8
25,000 – 50,000 DKK	16.3
Above 50, 000 DKK	11.8

Appendix 2

Estimation result from RPL model of attributes alone

Variables	RPL (sample)		RPL (ecocentric)		RPL (anthropocentric)	
	Est.	SE	Est.	SE	Est.	SE
ASC_alt1	-2.04***	0.26	-0.72***	0.18	-0.77***	0.18
Price	-0.003***	0.0002	-0.003***	0.0003	-0.004***	0.0003
Recreational access	-0.20	0.13	0.18	0.20	-0.36*	0.21
Species_50	1.94***	0.14	2.47***	0.24	2.19***	0.24
Species_100	3.05***	0.22	4.01***	0.37	2.84***	0.33
Old trees left (np1)	1.06***	0.11	1.24***	0.16	1.32***	0.20
Intact forest area (np2)	1.50***	0.14	1.84***	0.22	1.61***	0.25
Both np1 and np2 (np3)	1.43***	0.17	1.79***	0.25	1.51***	0.25
Groundwater	0.28***	0.04	0.33***	0.07	0.27***	0.07
Final log-likelihood	-3319.58		-1635.08		-1777.18	
No of respondents	722		358		364	

Appendix 3

Results of the PCA

Total Variance Explained (%)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Var.	Cum.	Total	Var.	Cum.	Total	Var.	Cum.
1	3.37	37.43	37.43	3.37	37.43	37.43	2.63	29.22	29.22
2	1.20	13.37	50.80	1.20	13.37	50.80	1.94	21.58	50.80
3	0.97	10.80	61.60						
4	0.73	8.09	69.68						
5	0.66	7.26	76.94						
6	0.56	6.39	83.33						
7	0.55	6.16	89.49						
8	0.51	5.71	95.20						
9	0.43	4.80	10.00						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component	
	1	2
NEP1r		0.79
NEP5r	0.48	0.51
NEP6r	0.39	0.39
NEP7r		0.81
NEP2	0.72	
NEP3	0.75	
NEP4	0.39	0.41
NEP8	0.67	
NEP9	0.74	

Rotation Method: Varimax with Kaiser Normalization[a]

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.79	0.79	9

Appendix V: Questionnaire I - A Choice Experiment Study of Forest Recreation in Denmark

Welcome to the survey!

How would you prefer the forest you visit to look like?

We would like to investigate Danish population's preferences on how forests for recreation should look like. This knowledge potentially can then be used for management of forests that would better meet demands of Danish population for outdoor recreation.

The survey is carried out by University of Copenhagen. It is an independent research, not requested by any organization or authorities. We are interested in your opinion and we kindly ask you to answer honestly. Answers will be treated anonymously.

It will take approximately 20 minutes to fill out the questionnaire.

Thank you for your cooperation!

===

[Part 1]

Some personal information

1. Your year of birth: 19____ **[two digit numerical value]**

2. Your gender:

1) Female
2) Male

3. In which region do you live?

1) Copenhagen area
2) Zealand
3) Southern Denmark
4) Central Jutland
5) Northern Jutland
6) Abroad
7) Don't know /refused

4. How much is your household income before tax per year? **[Only one answer]**

1) Under 100 000 DKK
2) 100 000 – 149 999 DKK
3) 150 000 – 199 999 DKK
4) 200 000 – 249 999 DKK
5) 250 000 – 299 999 DKK
6) 300 000 – 349 999 DKK
7) 350 000 – 399 999 DKK

8) 400 000 – 449 999 DKK
9) 450 000 – 499 999 DKK
10) 500 000 – 549 999 DKK
11) 550 000 – 599 999 DKK
12) 600 000 DKK or more

[Part 2]

General information about your visits to forests for recreation

We would like to ask you about your visits to forests for recreation. By visit to a forest we mean visit to forests that are outside cities (not parks).

5. How far away do you live from the nearest forest? **[Numerical space]**

_______ Km (if it is less than 1 Km, ___________ Meter)

6. How often have you visited any forest for recreation in the last 12 months? **[Only one answer]**

1) Once
2) 2-5 times
3) 6-10 times
4) More than 10 times
5) I have not visited forest for recreation in the last 12 months

On the next three pages we will ask you to indicate which forests have you visited during last three visits. For each visit we will also ask you to mark on the map, where was your point of departure (for example home, summerhouse etc).

- You can zoom in on the map and mark forests by clicking on the mouse.
- If you visited the same forest more times in the last three visits we are asking you to mark it on each map.
- If you can't remember your last visit to the forest, it is not necessary to indicate where it was.

7. Please mark the forest of **<u>your most recent visit</u>** for recreation and form where you departed. **[Interactive good map]**

- First click to indicate the area you visited
- Then click to indicate where you travelled from

8. Please mark the forest of **<u>your second most recent visi</u>**t for recreation and form where you departed. **[Interactive good map]**

- First click to indicate the area you visited
- Then click to indicate where you travelled from

9. Please mark the forest of **<u>your third most recent visit</u>** for recreation and form where you departed. **[Interactive good map]**

- First click to indicate the area you visited
- Then click to indicate where you travelled from

Now consider the last visit to a forest for recreation, the most recent of the three visits you mapped

10. How long time ago was this visit? **[Only one answer]**

1) A day
2) 1 to 6 days
3) 1 to 2 weeks ago
4) 2 to 4 weeks ago
5) 1 to 2 months ago
6) 3 to 4 months ago
7) 5 to 6 months ago
8) 7 to 8 months ago
9) 9 to 10 months ago
10) 11 to 12 months ago
11) Over a year ago
12) Don't remember

11. Which mode of transport did you use to reach the forest for this visit?

Pick one of the alternatives. Should you have used more than one, please indicate the one with the longest duration. **[Only one answer]**

1) By foot
2) Bicycle
3) Motorbike / scooter
4) Personal car
5) Bus / rutebil
6) Train / S-tog
7) Other (please specify ______________)

12. How long did you stay in the forest during your last recreational visit? **[Only one answer**

1) Less than 5 min
2) 5-30 min
3) 31-60 min
4) 1-2 hours
5) 3 to 4 hours
6) 5 to 8 hours
7) More than 8 hours
8) Don't remember

13. Which of the following recreational activities did you undertake during this visit to the forest? (tick all relevant) **[Multiple answers possible, randomize order, except the last]**

1) walking with a dog
2) walking (without a dog)

3) experiencing nature / place
4) studying nature / place
5) wildlife / bird watching
6) fishing
7) running
8) orienteering
9) horseback riding
10) cycling (not mountain biking)
11) mountain biking
12) gathering wild mushrooms, berries, plants etc
13) hunting
14) camping
15) playing with children
16) appreciating scenery from your car
17) other (please specify) ___________________

14. What were your most important motivations for you in this visit to the forest? (Tick all relevant) **[Multiple answers possible, randomize order, except the last]**

1) To experience nature
2) To meet other people
3) to exercise your dog
4) for health or exercise
5) to entertain children
6) to enjoy scenery
7) to enjoy / observe wildlife
8) for fresh air
9) to relax and enjoy peace and quiet
10) to spend time with friends
11) other (please specify) ____________________

15. Who did you go with to the forest during this last visit? **[Only one answer, randomize order, except the last]**

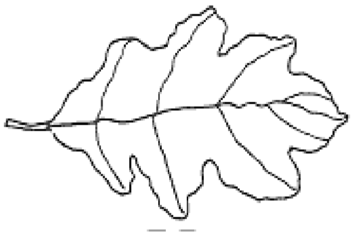
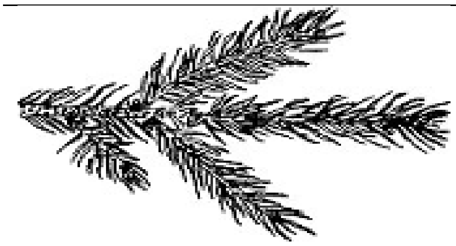
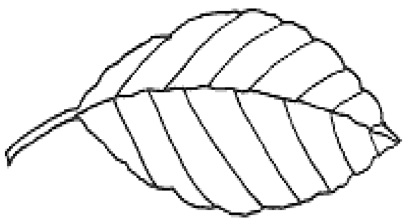
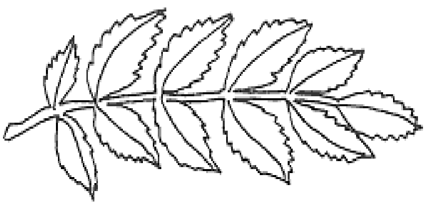
1) Alone
2) With my family
3) With my friends
4) Trips organized by associations or local entities
5) Other (please specify ______________________)

[Part 3]

[Split with a quiz, half of respondents in all three blocks, random allocation]

Forests in Denmark consist of different tree species. Not all species are equally easy to recognize, and some are rarer than others. Therefore, in the next questions we will ask you to answer “Do not know” if you do not know them.

16. Leaf of which tree species is shown on this picture?

	__ oak __ beech __ Scots Pine __ Norway Spruce __ I don’t know
	__ Scots pine __ Norway spruce __ birch __ Hazell __ I don’t know
	__ birch __ beech __ maple __ lime __ I don’t know
	__ rowan __ maple __ beech __ ash __ I don’t know

Not all trees that grow in Danish forests are native to Denmark, some of them are introduced by people.

17. Do you know that?

1) Yes
2) No

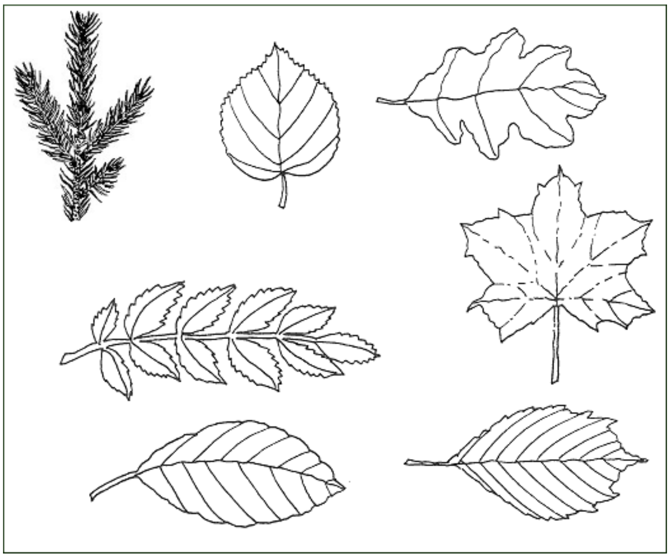
18. **[If yes]** which of these tree species do you think are native to Denmark? **[More than one answer is possible]**

(Tree species is native, if it has naturally migrated to Denmark, and not native if it has been brought by people)

Beech	Native	Not native	Don't know
Norway spruce			
Oak			
Birch			
Tilia			
Acer			
Scots pine			
Elm			

[Split without a quiz, other half of respondents]

Forests in Denmark consist of different tree species, for example beech, oak, elm, Norway spruce. Some of them are native to Denmark, while others have been introduced by people. Below you can see drawings of leaves of some of these trees.



19. When you are in the forest, do you notice that forests consist of different tree species?

1) Yes
2) No

[Part 4]

Preferences for forests

In the following questions we ask you to think about forests for recreation, and how you would like forests to look like when you visit them.

We will ask you eight questions, in which you can choose between different options for your next visit to forest for recreation. If you don't want to visit neither of the two forests, you can choose the third option "I would rather not visit either of these forests".

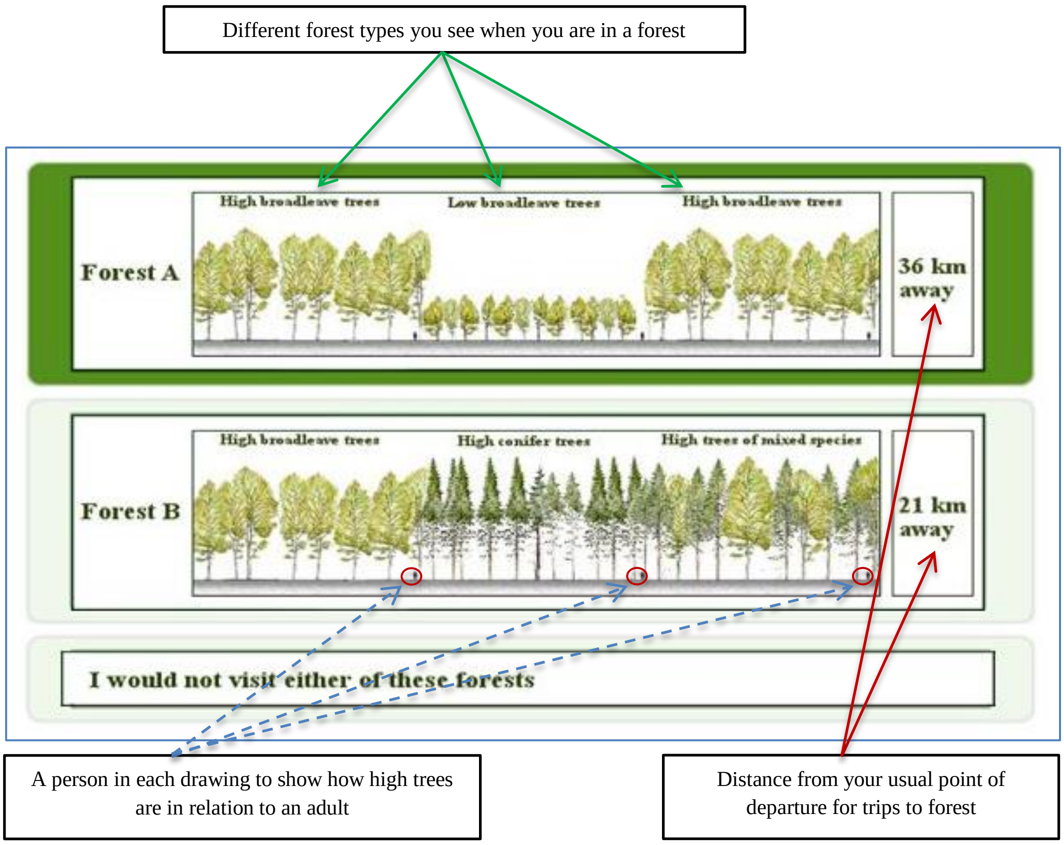
When you visit the forest, its appearance might change as you go through it. In the next page we will show you, how forests with different features can look. When you answer the questions you should imagine that you are seeing all three forest types on your visit to the forest. Imagine that the forest consists of shown features, but not necessarily in the same order.

For each forest you can visit, there is distance that you would have to travel to reach it (from the departure point you would normally use, e.g. your home, summerhouse etc.).

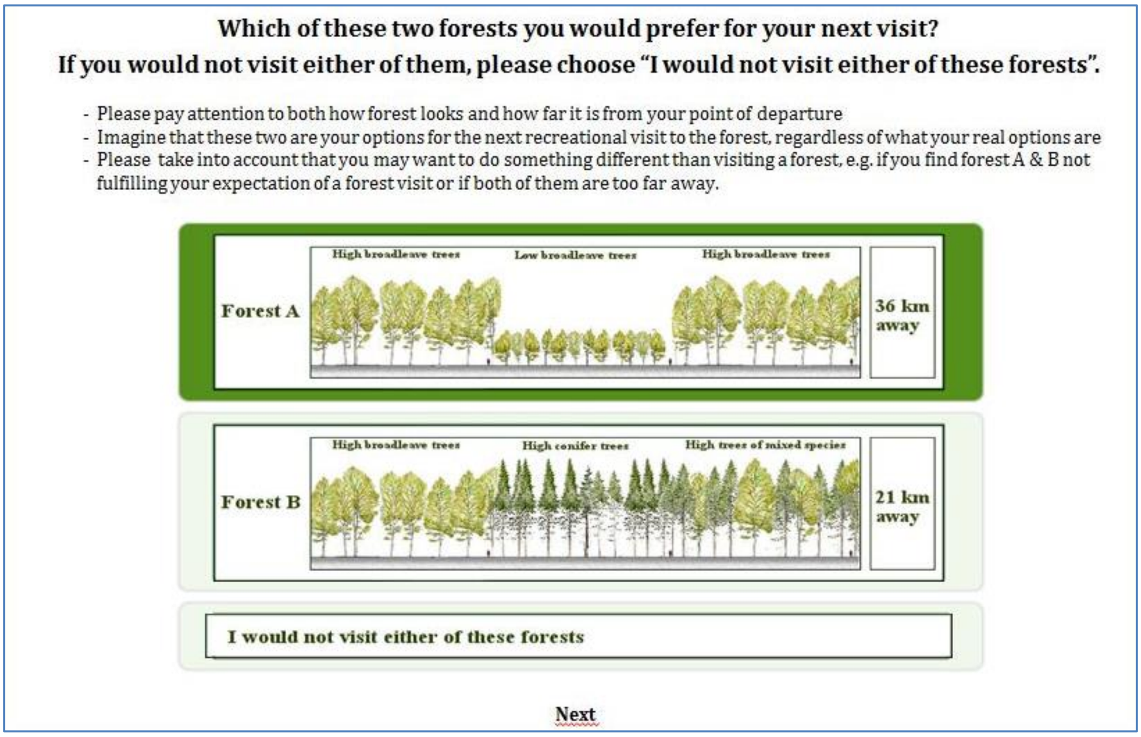
We ask you to imagine that two shown alternatives are your options for the next visit to a forest for recreation, regardless which alternatives you have in reality.

- Please take into consideration that normally you can use your time for something else than visiting a forest, for example, it could be that none of the forests meet your requirement or both of them are too far away.

Here you see an example of how the choices we ask you to make looks:



[8 choice questions as presented in the figure below]



[Follow-up if respondent in each choice set chose the 3rd option "I would NOT go to any of these the forests"]

20. You chose "I would not visit any of these forests" in all the above choices. What were the reasons for selecting this option? **[Multiple answers possible, randomize order, except the last]**

1) I don't like to recreate in the forest
2) The provided alternatives are too far away
3) I could not imagine, how shown forest would look in reality
4) Forest that are shown don't exist where I live
5) I live in the city and going to the forest is not an option for me
6) I don't think people should interfere in how forests look
7) Other (please specify)________________________________

[OR: If they choose at least one of the alternatives A and B in one out of the eight questions]

21. When making choices in previous eight questions what was the main recreational activity you had in mind?

1) walking with a dog
2) walking (without a dog)
3) experiencing nature / place

4) studying nature / place
5) wildlife / bird watching
6) fishing
7) running
8) orienteering
9) horseback riding
10) cycling (not mountain biking)
11) mountain biking
12) gathering wild mushrooms, berries, plants etc
13) hunting
14) camping
15) playing with children
16) appreciating scenery from your car
17) other (please specify) ___________________

22. When making choices in the previous questions what was the main mode of transportation you had in mind? **[Only one answer]**

1) By foot
2) Bicycle
3) Motorbike / scooter
4) Personal car
5) Bus / rutebil
6) Train / S-tog
7) Other (please specify _______)

23. The choices were shown with forest pictures in summer. Forest look different in winter, e.g., broadleaved trees do not have leaves. Would your choice have been different if it was a winter trip?

1) Yes
2) No
3) Don’t know

24. **[If yes]:** Please describe what would you have paid more attention to if you were to visit the forest in winter? ____

25. When you were deciding in eight choice questions, did you take into account the forest that you have visited last?

1) Yes
2) No

26. **[If yes]:** how did you take into account of your last visit in your choices

1) _____ I chose the forest, that most remind me about the forest I visited last
2) _____ I chose the forest that is different from my last forest visit

27. What was the most important for you when you made your decision in the eight choice questions?

1) How shown forests look – no matter how far away they are
2) How shown forests look and how far away they are
3) I chose the closest forest in all
4) I imagined how the forest I most often visit looks and chose the one that reminded me of it
5) I put emphasis on other things (please specify) _________________

28. Do you think that it is difficult to choose between different forest types?

1) Yes, very difficult
2) Yes, somehow difficult
3) Not difficult

29. **[If yes]:** What was the most difficult for you in choosing between forest types? **[More than one answer is possible]**

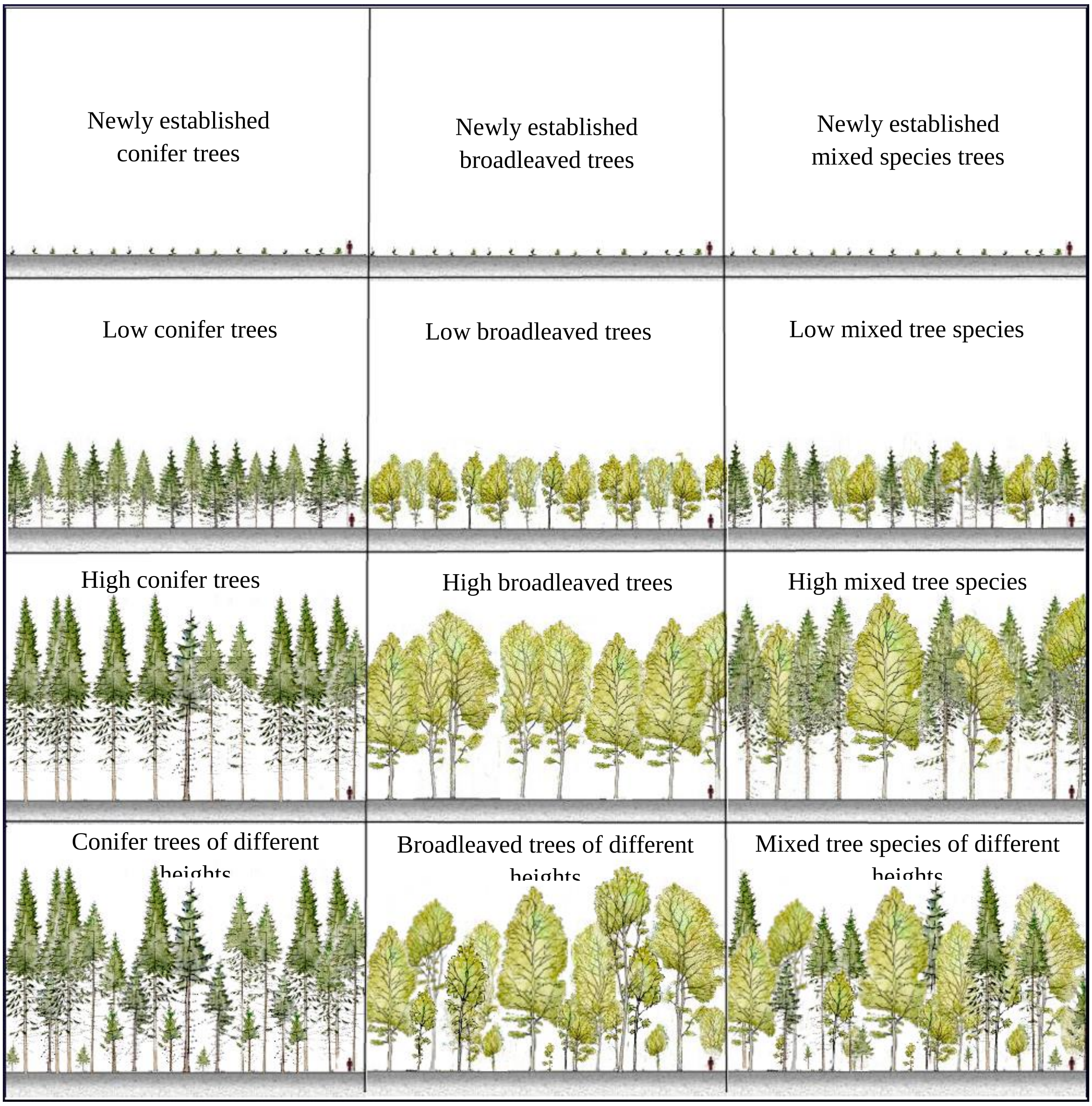
1) Many consecutive choice sets
2) Difficult to relate to many different forest types
3) Alternatives were not realistic
4) Difficult to relate to how far the forests are
5) Difficult to see differences on drawings
6) Difficult to imagine how forests look in reality
7) Difficult to imagine forest height
8) Difficult to relate to tree species
9) Other (please specify)___________________

[Part 5]

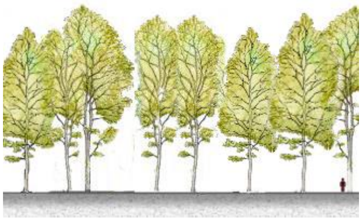
Designing your ideal forest

Imagine how a forest should look like for you to have the best recreational experience.
Below you see 12 drawings of different forest types. You have already seen most or all of them in the previous questions.
On next pages we will ask you to choose three drawings that show the ideal forest composition. As above, we ask you imagine that the forest may consist of different forest features. You can choose whether to have three same forest types or to have them differently.
Please pick the first forest type from the catalogue and put on the first box.

Your ideal forest:



Now you can see the first forest type you chose.

Please choose your second and third choice from the catalogue and place them on consecutive boxes to complete your ideal forest drawing.

Now you can see your ideal forest. Does it look the way you wanted? If you would like to make changes, you can click on "Back" and make adjustments.

30. When you made your choices above, did you only consider recreational aspects, or did you also take into account other functions of forests?

1) Yes
2) No

31. **[If yes]**: what function(s) did you consider?

1) Biodiversity
2) Timber production
3) Ground water
4) Wildlife habitat
5) Other (please specify _________________)

[Part 6]

About yourself

Last we will ask a few questions about you. Remember that all answers will be treated confidentially.

32. In which post code do you live? _______

33. What is your highest level of education?

1) Primary school
2) High school
3) Vocational education
4) Short, higher education
5) University degree, BSc
6) University degree, MSc or above

34. Do you have any education related to forestry or environment?

1) Yes
2) No

35. **[If yes]**: What kind of education related to forestry or environment do you have?

____

36. What is your present occupation?

1) Self-employed
2) House person
3) Employed full time (at least 32 hours per week)
4) Employed part-time (hourly)
5) Unemployed
6) On leave
7) Undergoing education
8) Førtidspentionist
9) Efterlønsmodtager
10) Folkepentionist
11) Other

37. How many people is your household comprised of? (Household consists of people who live in the same address and who are dependent on the same income, typically a family).

1) Number of adults: ______
2) Number of children (under 18 years old): _____
3) Number of adults contributing to the household income:______

38. Which of the following best describes the area you live in now and the area you lived in during your childhood (till 14 years old)?

I live/lived in:	Now	Childhood
Greater Copenhagen		
A big city (over 100, 000 inhabitants)		
A city (20, 000 to 100, 000 inhabitants)		
A town (500 to 20, 000 inhabitants)		
countryside (less than 500 inhabitants)		
Don’t know/refuse		

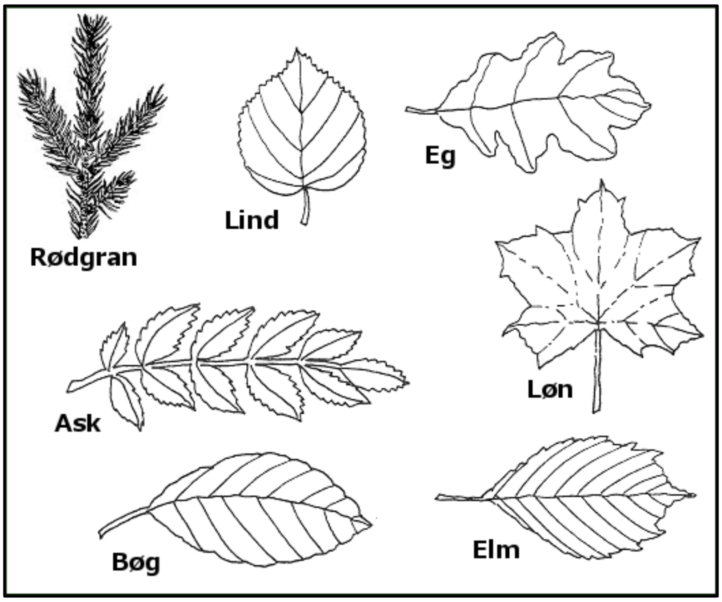
39. Are you a member of any of the following outdoor or environment associations? **[Multiple answers]**

1) Danish Nature Conservation
2) WWF
3) Birdlife Denmark
4) Hunter's association
5) Angler's association
6) Mountain bikers association
7) Association for the protection of animals
8) Other organization / association connected to nature or environment (please write the name) ___________________________
9) I am not a member of any organization/association

If you have comments / questions to this survey, please write them in the space below.

[Text box]

Thank you for your time!



Drawings of tree leaves are from Evan Wulf (www.skoven-i-skolen.dk).

Drawings of forest types were made by Anders Busse Nielsen.

Appendix VI (Questionnaire II) - Transnational Choice Experiment Study of Forest Recreation

FOREST RECREATION SURVEY

Welcome to this survey about your recreational visits to forests in Scotland. By forests we mean forested areas and woodlands outside of towns and cities.

We will ask you some questions regarding your visits to forests and woodlands and your preferences for how you think they should look and be managed. We are interested in your opinion, and thus there are no right or wrong answers.

The survey is part of European research collaboration on forest management. Consequently there may occasionally be activities mentioned which you find of little relevance but which are relevant in other countries. Please answer the questions anyway.

The answers will be treated anonymously and only be reported in summary form.

Please note that survey should not be completed via mobile devices.

If you have any questions regarding the survey, you are welcome to contact:

Dr. Klaus Glenk, Klaus.Glenk@sruc.ac.uk

==

[Part 1]

M1. What is your gender?

☐ Male ☐ Female

M2. Please specify the type of settlement you live in.

	Now	In your Childhood
Rural area or settlement with less than 500 inhabitants	☐	☐
A small town with 500 to 2 999 inhabitants	☐	☐
A town with 20-100 thousand inhabitants	☐	☐
A city with more than 100 thousand inhabitants	☐	☐

M3. Please, specify the year of your birth

[19____]

M4. What is your level of education? Please, choose from the following options

Primary school	☐
Secondary school	☐
Vocational training	☐
Undergraduate studies	☐
Postgraduate studies	☐

[Part 2]

N1. Have you visited a forest or woodland for recreation during the past 12 months? **[One forced answer]**

When answering please consider that <u>the main reason</u> for the visit was recreation. This may include walking, bird or wildlife watching, sports, mushroom or berry picking. This also includes visits **for recreation** to forests on trips taken for other purposes such as holidays or weekend trips, whether in your own country or in other European countries.

1. Yes
2. No [stop the survey]

We would like you to think about the forest you visited *last*

N2. Was your visit to this forest the only purpose of your trip or was your visit to this forest made as part of another activity (e.g. family visit, holidays, business trip etc.)?

After leaving my home **[One forced answer]**

1. … visiting this forest was the only purpose of my trip
2. … the visit to this forest was made on some other occasion (e.g. family visit, visit to secondary home, etc.)

[N3-N10 show if N2 =1]

N3. Where was this most recent forest visit located? Please find the forest on the map and point (approximately) at that part of the forest that you visited. Please zoom the map in so you are sure that you point at the forest □or part of it□ which you visited.

You need to zoom in pressing the + symbol <u>at least 4 times</u> before being able to mark the location of the forest you visited last. **[One forced answer]**

N4. What is the name of the village (or town or city) that the visited forest is closest to? **[Allow continuation if not answered]**

________________________________+ don't know.

N5. How much time did you approximately spend in this forest?

(We refer to your last visit to this forest) **_____________hours _____ minutes**

N6. What did you do in the forest? (We refer to your last visit to this forest)

Please select all answers that apply. **[Multiple answers possible]**

1. __ walking with a dog
2. __ walking without a dog
3. __ hiking
4. __ studying nature
5. __ wildlife / bird watching
6. __ fishing
7. __ running

8. __ horseback riding
9. __ cycling
10. __mountain biking
11. __ cross country skiing
12. __ gathering wild mushrooms, berries, plants etc
13. __ hunting
14. __ camping
15. __ playing with children
16. __ appreciating scenery
17. __ other (please specify) _______________

N7. How many times have you visited this forest in the past 12 months? (Including the last forest trip we are talking about here)|__||__|times _______________________+ don't know.

N8. Please point out the approximate location of your place of residence on the map.

You need to zoom in pressing the + symbol <u>at least 4 times</u> before being able to mark the location of the forest you visited last. **[One forced answer]**

N9. Please indicate the approximate distance □one way□ which you travelled to reach this forest from the departure point. **[One forced answer]**

1. Less than 1 mile
2. 1-4 miles
3. 5-9 miles
4. 10-19 miles
5. 20-39 miles
6. 40-69 miles
7. 70-99 miles
8. 100-150 miles
9. More than 150 miles

N10. What mode of transport did you use to visit this forest? (We refer to your last visit to this forest) **[One forced answer]**

1. On foot
2. Bike
3. Public transport (for example bus or train)
4. Car
5. Other or a mix of these, please specify which transport mode you used: ______________

[N11-N22 show if N2 =2]

N11. On what occasion have you made the visit to this forest?

1. Recreational trip □e.g. mountains, lakes, sea etc.□, where forests do not play the main role
2. Holidays

3. Weekend trip
4. Business trip
5. Family visit
6. I was at my secondary house (cottage)
7. Other, please specify ___________________________

N12. Taking into account all the purposes of your trip, how important on a scale of 1 to 10 was *this* forest visit as part of the whole trip for you?

Not important at all | The only purpose of my trip

1	2	3	4	5	6	7	8	9	**10**
□	□	□	□	□	□	□	□	□	□

N13. Where was this most recent forest visit located? Please find the forest on the map and point (approximately) at that part of the forest that you visited. Please use the zoom to find the (part of the) forest that you have visited.

You need to zoom in pressing the + symbol <u>at least 4 times</u> before being able to mark the location of the forest you visited last. **[One forced answer]**

N14. What is the name of the village (or town or city) that the visited forest is closest to? **[Allow continuation if not answered]** __________________________________+ don't know.

N15. How much time did you approximately spend visiting this forest? _____hours ______minutes

N16. What did you do in the forest?

Please select all answers that apply **[Multiple answers possible]**

1. __ walking with a dog
2. __ walking without a dog
3. __ hiking
4. __ studying nature
5. __ wildlife / bird watching
6. __ fishing
7. __ running
8. __ horseback riding
9. __ cycling
10. __mountain biking
11. __ cross country skiing
12. __ gathering wild mushrooms, berries, plants etc
13. __ hunting
14. __ camping

15. __ playing with children
16. __ appreciating scenery
17. __ other (please specify) ___________________________

N17. How many times have you visited this forest in the past 12 months?

|__||__|times _________________+don’t know.

N18. Please point out the departure point for this trip on the map. By *departure point* we mean the place you set out for this respective forest trip. It may have been your home or may have been the location of your cottage, friend's house, holiday accommodation, business trip destination etc.

You need to zoom in pressing the + symbol at least 4 times before being able to mark the departure point.

N19. What is the name of the village (or town or city) that this departure point is closest to?

[Allow continuation if not answered] _____________________________+ don’t know.

N20. Approximately how far is this departure point from your home (or other place where you live)?

_______km

N21. Please indicate the approximate distance one way which you travelled to reach this forest from this departure point. **[One forced answer]**

1. Less than 1 mile
2. 1-4 miles
3. 5-9 miles
4. 10-19 miles
5. 20-39 miles
6. 40-69 miles
7. 70-99 miles
8. 100-150 miles
9. More than 150 miles

N22. What mode of transport did you use to visit the forest from the departure point? **[One forced answer]**

1. On foot
2. Bike
3. Public transport (for example bus or train)
4. Car
5. Other or a mix of these, please specify which transport mode you used:______________

N23. Do you have a travel card?
[IF N10 or N22=3]

1. Yes
2. No

If not, what is the approximate price per person you paid for this trip? ________________

N24. How many other persons did you travel with in the car? **[One answer, IF N10 or N22=4]**

________________ person(s)_______________+ don't know

N25. Do you know the approximate fuel economy of your vehicle (how many km per gallon of fuel)? **[One answer, if N10 or N22=4]**

1. Yes, please specify __________miles / gallon
2. No

N26. Which type of car did you drive in? **[One answer, If N25=2]]**

1. Micro car (e.g. VW up, Toyota aygo)
2. Mini car (e.g. VW polo, Ford Fiesta)
3. Small family car (e.g. VW Golf, Honda Civic, Ford Focus)
4. Medium family car (e.g. VW Passat, Mazda 6, Ford Mondeo)
5. Large family car (e.g. Volvo V70, Audi A6)
6. Other, please specify:_________________________________

N27. Did you visit the forest on a week day (Mon-Fri), during the weekend / public holidays, or during a holiday? (We refer to your last visit to this forest)

1. Weekday
2. Weekend / public holidays
3. Holidays
4. Don't know

N28. Was your overall trip that included the forest visit longer or shorter than 1 day? **[One forced answer]**

1. Longer than one day
2. 1 day or shorter

N29. How many nights did you stay away from your home? ____________nights**?**

[One answer, IF N28=1]

N30. Where did you sleep during this trip?

[One answer, IF N28=1]

1. At my cottage/secondary house
2. Friend's/family house
3. Hotel
4. Rented apartment/room
5. Camp site
6. Other
7. don't know/ refused to answer

N31. How often do you visit the place where you stayed overnight?

[One answer, IF N28=1]

1. Every weekend or more often

2. About every second weekend
3. About once a month
4. Less than once a month
5. About once a year
6. This was my first visit
7. Don't know

N32. During this trip, on how many days did you visit forests? _____days

[One answer, IF N28=1]   + don't know

[Part 3]

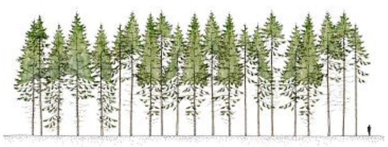
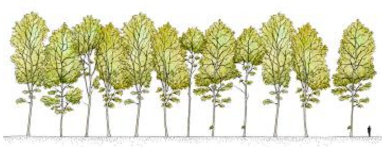
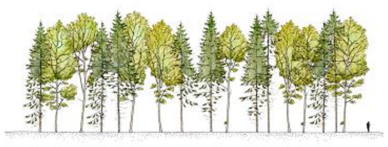
Preferences

We would like to learn more about your preferences for different forest characteristics.
Forests can differ in many ways. In the following we will show examples of how they can differ.
However, first we are interested in how the forest you visited looked like. On the following pages we will ask you some questions about the characteristics of the last visited forest.

Q26. Forest type

There are three basic types of forests: coniferous, broadleaved and mixed

Was the forest you visited last mostly conifer, broadleaved or mixed? Please click on the forest which most resembles the forest you visited last.

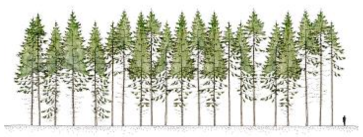
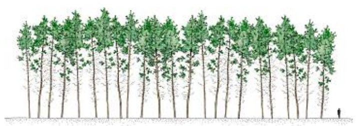
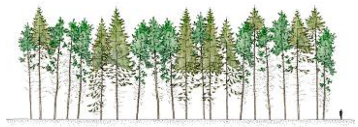
Coniferous composed mostly of coniferous tree e.g. Pine, Spruce, Fir	Broadleaved composed mostly of broadleaved tree e.g. Oak, Beech, Ash	Mix of both composed of coniferous and broadleaved tree species
		
O	O	O

Q26a

Coniferous forests can be composed of one tree species of any kind or can be a mixture of different coniferous tree species.

Which of the forests below most resembles the coniferous forest you visited last? Please choose the forest which you THINK looks the most like the one you visited.

[**Ask If Q26=1]**

Coniferous spruce or similar in appearance	Coniferous pine or similar in appearance	Mix of at least 2 coniferous tree species
		
O	O	O

1) Spruce
2) Pine
3) Pine-Spruce

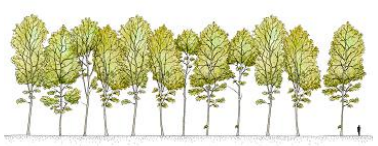
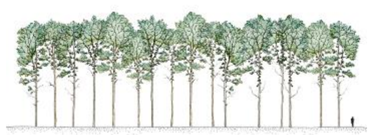
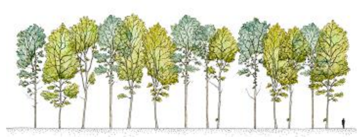
Q26b

[Ask If Q26=2]

Broadleaved forests can be composed of one tree species of any kind or can be a mixture of different broadleaved tree species.

Which of the forests below most resembles the broadleaved forest you visited last?

Please choose the forest which you THINK looks the most like the one you visited.

Broadleaved beech or similar in appearance	Broadleaved oak or similar in appearance	Mix of at least 2 Broadleaved tree species
		
O	O	O

1) Beech
2) Oak
3) Beech-Oak

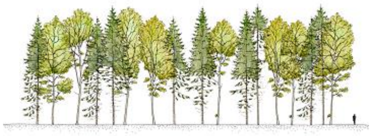
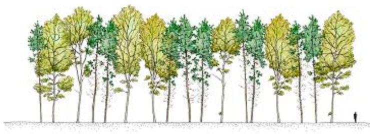
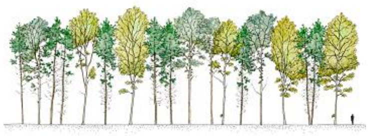
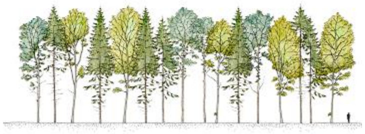
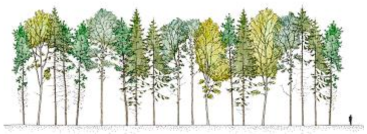
Q26c

[Ask IF Q26 =3]

Mixed forest can be a mixture of different broadleaved and coniferous tree species. It can be a mix of 2 or more than 2 different tree species.

Which of the forests below most resembles the forest you visited last?

Please choose the forest which you THINK looks the most like the one you visited.

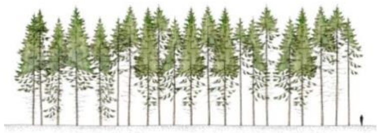
Mix composed of 2 tree species spruce and beech or similar in appearance	Mix composed of 2 tree species pine and beech or similar in appearance	Mix composed of 3 tree species pine, beech and oak or similar in appearance
		
O	O	O
Mixed composed of 3 tree species spruce, beech and oak or similar in appearance	Mix composed of tree species spruce, pine, beech and oak	
		
O	O	

1) Beech-Pine
2) Beech-Spruce
3) Beech-Oak-Pine
4) Beech-Oak-Spruce
5) All

Q28. Height of the tallest trees in the forest

In forests, trees can have different ages and thus heights. For illustrating the scale (tree sizes) an adult person is shown in the bottom right corner of each drawing.

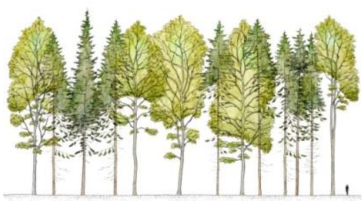
Which of the forests below resembles most the forest you visited last?

Recently planted Height around 8 meters	Growing Height around 18 meters	Mature Height around 24 meters or more
		
O	O	O

Q29. Forest age variation

[IF Q28=1 OR Q28=2]

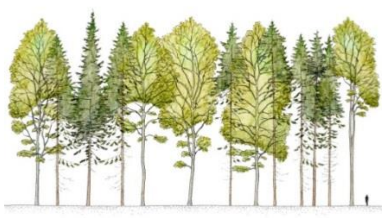
Forests can also differ with respect to the age of different trees in the same place. Which of the forests below most resembles the forest you visited last?

Single-aged composed of trees are of the same age and similar size	**Two-aged** composed of trees that are of two age and size classes	**Multi-aged** composed of trees of varying age and size classes
		
O	O	O

[IF Q28=3]:

Forests can also differ with respect to how different trees in the same place vary with respect to their age. The forests in our study can be: single-aged, two-aged, multi-aged.

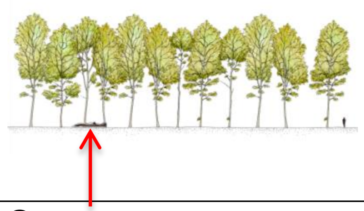
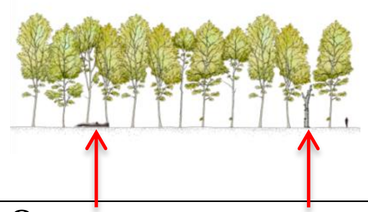
Which of the forests below resembles most the forest you visited last?
If you are not sure, please choose the one which you THINK looks the most like it

Single-aged composed of trees are of the same age and similar size	**Two-aged** composed of trees that are of two age and size classes	**Multi-aged** composed of trees of varying age and size classes
		
O	O	O

Q30. Trees left for natural decay

Dying or dead trees can be left in the forest for natural decay. They provide good living conditions for numerous rare species of animals, plants and fungi. Trees left for natural decay can be lying or standing. In the majority of forests in Europe, there are few trees that are dead or left for decay. Only near natural forests have a high volume of dead and dying trees.

Which of the forests below resembles most the forest you visited last?

None No trees left for natural decay	**Low** Few trees left for natural decay; on average wood left for decay can be found every 50 m	**Medium** Several trees left for natural decay; on average wood left for decay can be found every 25 m
		
O	**O**	**O**

Combining all the characteristics above, the last forest you visited looks like this:

[Show description – like in SQ]

[HERE Insert a picture consisting of the levels indicated as perceived status quo]

Q31. On a scale from 1 □very poorly□ to 10 □very well□, how well does this forest resemble the most frequent character of the forest you visited last?

Please note that other aspects which may be important such as the presence of water bodies, tree density, visitor facilities, parking facilities, roads and so on are not shown. This means that we here only consider a naïve representation that focuses on selected forest characteristics.

Please use the slider above the scale for your answer.

Very poorly Very well

1	2	3	4	5	6	7	8	9	**10**
□	□	□	□	□	□	□	□	□	□

If [Q31 below 5]

Could you tell in what aspects the presented forest poorly resembles the forest you visited?

[Open]

Q32. Were there any other characteristics of the forest you visited last that you find important? If so, please list them here: ____________________ + No

Q33. Visitor facilities

Forests can also vary with respect to whether there are picnic facilities (tables and benches), and/or marked hiking trails.

Please indicate if either facility or both facilities shown below were present at the forest you visited last.

Picnic facilities	**Marked trails**	**None**
		□

[Allow multiple clicks]

We would now like you to think about the most recent recreational trip to the forest - the one you just told us about. Imagine that there were two alternative forests (Forest A and Forest B) that you could visit for the same recreational activity.

We will soon show you 12 cards. Each card shows you a combination of the forest you visited last and two alternative forests A and B. Amongst these forests; we will ask you to choose the forest you prefer, taking all their characteristics into account. Then, we will ask you for your choice amongst the remaining two forests.

The two alternative forests A and B will differ with respect to the forest characteristics presented on previous pages. They also differ with respect to the distance you would have to travel to access them. While the forest you actually visited will be exactly as far away as it was, Forest “A” and “B” could be closer or further away, therefore requiring more or less travelling. **All distances are total distances from your point of departure to the forest.** Please take this into account **- that is, please bear in mind that travelling involves costs and time.**

Assume that all other characteristics (for example the presence of body waters, mountains, parking places, roads) remain the same as in the forest you actually visited. Please also assume that the context of your trip (holidays, weekend, family visit etc.) and the purpose of your visit (walking, sports, mushroom or berry picking, hunting etc.) remain unchanged.

Please make the choice in the same context as your last visit (e.g. jogging on a week day, family visit on a weekend, etc.)

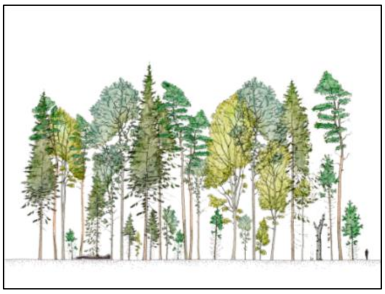
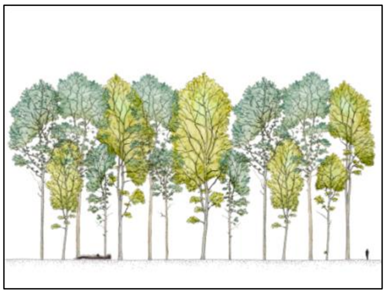
[Written above every single choice set]

CHOICE SETS

Which of these two forests would you visit?

Second step:

<u>If the one you have just chosen would not be available, which of the remaining two would you choose?</u>

Forest A	**Forest B**	**Last visited forest**
Mix of coniferous and broadleaved tree species, multi-aged, tallest trees 24 m, medium amount of trees left for natural decay	Mix of broadleaved tree species, two age classes, tallest trees 24 m, low amount of trees left for natural decay	[drawing and content corresponding to it based on part 1]
		
		
One way distance 30 km	**One way distance 6 km**	

[The chosen drawing should disappear, ranking]

[Part 4]

Additional to preferences

Now we have a few questions regarding the choices you just made:

Q34. In all choice situations you have chosen the 'last visited forests'. What was the main reason for this?

[One answer, [IF SQ in all choice sets]]

1. The other forests were too far away
2. I have a better option nearby where I would go to
3. I did not understand the questions
4. The forests differed in too many aspects and choosing the last visited forest was the easiest option
5. A forest is always diverse. I do not think it makes sense to pick just one picture to represent a forest trip
6. I prefer other activities to visiting forests
7. Other______________________

Q35. Were there any characteristics that you did not take into account when making your choices? Click'+icon'to expand. **[Multiple answers possible]**

1. **Yes, I did *not* consider [Multiple answers possible]**
    1. Forest type (Coniferous, Broadleaved, Mixed)
    2. Number of tree species (1, 2, 3 or 4 tree species)
    3. Tree height (8m, 18m, 24m and more)
    4. Age variation (Even-aged, Two-aged, Multi-aged)
    5. Presence of trees left for natural decay (None, Low, Medium)
    6. Visitor facilities (picnic sites and marked trails)
    7. Distance
2. **No, I considered all forest characteristics**

Q36. Why did you not consider it?

[One answer to each in 3ai.-3avii and please specify, If Yes to 2, Dynamic grid, ask for all mark answers in Q35, if Q35=2, don't show]

1. It is not important to me
2. I forgot
3. I did not notice it in the illustrations
4. Other – please specify

[Part 5]

Other locations

Q37. Regarding forest visits in general, how often have you visited a forest in the past 12 months?

1. Almost every day
2. 3-4 times a week
3. 1-2 times a week
4. 3-4 times a month
5. 1-2 times a month
6. Once a month
7. 5-10 times a year
8. 2-4 times a year
9. Once a year

Q38. Have you visited other forests apart from the one you visited last during the past year?

1. Yes
2. No

Q39. How many other forests have you visited apart from the one you already told us about**?**

[If Q38=1]

1. None
2. 1 forest
3. 2 forests
4. 3 forests
5. 4-5 forests
6. More than 5 forests

[IF Q39=2]

[IF Q39 = 4, 5 or 6 show:]
We will now ask you about the locations of **up to two** other forests you have visited, even if you may have visited more.

Q40. Where is this other forest that you have visited located? Please find it on the map.

Point (approximately) at that part of the forest that you have visited. Please zoom the map in so you are sure that you point at the forest (or part of it) which you visited.

You need to zoom in pressing the + symbol at least 4 times before being able to mark the location of the forest

IF Q39=2

Q41. Of these other forests that you have visited, which one did you visit most recently? Please find this forest on the map.

Point (approximately) at that part of the forest that you have visited. Please zoom the map in so you are sure that you point at the forest (or part of it) which you have visited.

You need to zoom in pressing the + symbol at least 4 times before being able to mark the location of the forest

Q42. How many times have you visited this forest in total during the past 12 months? ___________

Q43. Of these other forests that you have visited, which one did you visit second most recently?

Please locate it on the map.

Point (approximately) at that part of the forest that you have visited. Please zoom the map in so you are sure that you point at the forest (or part of it) which you have visited.

You need to zoom in pressing the + symbol at least 4 times before being able to mark the location of the forest

[Part 6]

Berries & Mushroom part

We now have a few questions regarding forest-related activities

Q45. Have you picked mushrooms in a forest in the past year?

1. Yes
2. No

Q46. Approximately how many kg of fresh mushrooms did you collect last year? _______kg

Q47. Have you picked berries in a forest in the past year?

1. Yes
2. No

Q48. Approximately how many liters of berries did you collect in the past year? _______liters

[Part 7]

Childhood

The next questions are about your visits to forests in your childhood (until the age of 11) and how you remember them. Of course that may not be easy to remember. But please give us your best recollection.

Q49. How far away was a forest from your childhood home? **[One answer]**

1. Next to my house
2. Within 1 mile
3. Within 3-5 miles
4. Further away than 5 miles

Q50. On the map, please point approximately at your place of residence during childhood.

You need to zoom in pressing the + symbol at least 4 times before being able to mark the location of the forest you visited last.

Q51. Do you remember having visited forest areas without adult supervision during your childhood? **[One answer]**

1. **Yes,** I remember having visited forests without adult supervision
2. **Yes,** I remember **not** having visited forests without adult supervision
3. **No,** I can't remember clearly

Q52. How often did you visit a nearby forest during your childhood? **[One answer]**

1. More than twice a week
2. Twice a week
3. Once a week
4. 2 – 3 times a month
5. Once a month
6. 2 – 4 times a year
7. Never **[go to Q55]**

Q53. Which types of tree species do you remember to be dominant in the forest you visited the most during your childhood? **[One answer]**

1. Conifers (e.g. Pine, Spruce, Fir)
2. Broadleaves (e.g. Oak, Beech, Ash)
3. Mix of conifers and broad-leaved trees
4. I don’t remember the type

Q54. Which of the following would best describe the forest that you have visited the most in your childhood? **[One answer]**

1. Trees standing in lines
2. Trees standing irregularly
3. I don’t remember

Q55. Have you visited forests at other locations in your childhood?

1. Yes
2. No

Q56. Have you, as an adult, re-visited a forest that you had visited in your childhood?

1. Yes
2. No

Q57. If you have children under the age of 11, do they visit and play in forests without the supervision of you or other adults, for example teachers?

1. Yes, why? ________________________
2. No, why? _________________________
3. I don't have children

[Part 8]

Demography

In the last part of the questionnaire we have a few more questions about yourself.

This survey is anonymous and the information gathered will only be presented in summary form.

M5. How many persons are currently living in your household including yourself? ____________.

Note: A 'household' includes adults and children who live in the same house/apartment and have a common family budget.

M6. How many of them contribute to your household's budget (including yourself)?

M7. How many children under 18, if any, live in your household?

M8. What is your zip-code? ________________ + don’t know / refuse to answer

M9. What is your household's net monthly income （net means after paying tax）?

[Change into deciles of net income in each country]

1. lower than 500 Euro
2. 500 – 749 Euro
3. 750 – 899 Euro
4. 900 – 999 Euro
5. 1000 – 1199 Euro
6. 1200 – 1500 Euro
7. higher than 1500 Euro
8. Don't know / Refuse to answer

This was our last question. Thank you for filling in the questionnaire and helping our study!

M11. This was our last question. Thank you for filling in the questionnaire and contributing to our study!

If you have any comments please use the space below:

____

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