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Assessment of forest visitors' route preferences – Impact encounters across a range of forest environments

H. Skov-Petersen[a,*], F.S. Jensen[a], J.B. Jacobsen[b]

[a] University of Copenhagen, Department of Geoscience and Natural Rassource Management, Landskabe Architecture and Planlægning, Rolighedsvej 23, 1958, Frederiksberg, Denmark

[b] University of Copenhagen, Department of Food and Resource Economics, Centre for Macroecology, Evolution and Climate, University of Copenhagen, Rolighedsvej 23, 1958, Frederiksberg C, Denmark

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ABSTRACT

Studies of visitors' preferences for forest environments play a central role for the understanding of recreational behaviour. The encounter of other agents, such as wildlife or other visitors, has proven important for preferences, and this is something visitors may affect themselves. Thus, this study focusses on forest visitors' preferences for forest environments and potential encounters with other agents. 1089 respondents have been asked to consider a choice for change of direction at trail junctions, during a visit to the forest, by ranking five cards representing possible path segments. Each segment constituted a given forest environment (represented by text and a photo) and agent types and numbers (text and an icon), and the direction (text only) – relative to a preferred direction.

Results show that on average respondents will detour from their preferred direction, disregarding the forest environment, to experience wildlife. At the other end of the scale, larger groups of mountain bikers or runners can make respondents detour in all forest environments, except for the most preferred ones, to avoid an encounter. Based on a latent class analysis three classes are identified with distinct preferences. 20% of the respondents are unlikely to detour no matter the possible forest environment or agent types. 30% are not affected by encountering other agents, but are to a slight but significant extent affected by the forest environment. The majority, constituting 50% of the population, is strongly influenced by forest environments and even more by potential encounters with other agents. Results largely confirm earlier studies using an ordinal scale, but in addition, we estimate the mutual strength of the preferences and thereby allowing for better guidance of how to manage for forest recreation.

Management implications: In our study, a large group of people state that encountering other types of visitors or wild life matters a lot, and often overrules, the diverse utility of different forest environments. This highlights the necessity of focusing on the management trade-offs between nature conservation and recreational use.

1. Introduction

The need to assess the recreational values of nature and to understand people's preferences for forest environments has been emphasised for several decades and is increasing in importance as recreational services gain political importance (e.g. Mann et al., 2010; Sievänen et al., 2013; Forest Europe, 2015; Nordic Council, 2019). In addition, there is an increasing focus on how appreciation of recreational experiences is influenced by the encounter of other visitors (Manning et al., 1999). Encounters can be experienced as both attractions and repellents (Bakhtiari et al., 2014), depending on the type and the number of the wildlife and visitors[1] encountered (Jensen, 1999). Whereas, in the literature, most attention has been paid to negative effects on the recreational experience, especially when it leads to conflicts between visitor types (e.g. Absher and Lee, 1981; Hall and Cole, 2007; Jensen, 1999; Manning, 2011; Shelby et al., 1989) we also investigate how encounters can be positively perceived.

In this study, we assess the qualities visitors experience during a particular visit as a combination of environmental/scenic characteristics and the possibility of encountering other agents.

* Corresponding author.
E-mail addresses: hsp@ign.ku.dk, hsp@ign.ku.dk (H. Skov-Petersen), fsj@ign.ku.dk (F.S. Jensen), jbj@ifro.ku.dk (J.B. Jacobsen).

[1] Hereafter generally will be referred to as 'agents'. The term is the one used within the field of agent modelling and can constitute both human and non-humans. Other fields would more commonly use the word actors or if only people were involved simply recreationists or visitors.

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Some existing preference studies express forest characteristics or attitudes towards encountering other visitors by photographs (e.g. Gundersen and Frivold, 2008; Jensen and Koch, 2000; Ribe, 1989), by statements/items verbally expressed on cards (Jensen and Koch, 2000), or by use of expert evaluations (Edwards et al., 2012a, 2012b). Such approaches mainly address single aspects (typically forest types, particular locations, or encountering other visitors) and cannot comprehensively reveal knowledge about the combined preferences for scenic values and encounters.

Visitors' preference for combined scenarios have been studied by means of photos displaying combination of environments and various encounters. Typically, respondents are asked to rank photos to reveal an ordinal scale of preference. Koch and Jensen (1988) and later Jensen and Koch (1997) provided early examples where a stationary camera was used to capture images of an environment (for instance a forest road) with different objects installed (a family with a dog; a car, a roe deer; forest machinery etc.). Later, digital image processing enabled construction of combined images (Manning, 2013), resulting in several studies on that basis (e.g. Gibson et al., 2014; Gundersen and Frivold, 2011; Manning et al., 1996; Manning et al., 2002; Nielsen et al., 2018). In most cases, photos have been applied for a particular site (a parking lot, a viewpoint, a path, etc.) for assessment of the effects of different types and magnitudes of encounters. Such research designs will generally reveal visitors' preference with respect to that site only, affording less information about differences between environments and, in particular, the interactions between different encounters and different environments.

Using ordinal single-aspects ranking has some limitations: a) only the order, not the relative 'strength' of preferences of the involved combinations is expressed; b) visitors' behavioural reaction to changes is not expressed – only the ordinal preference (for instance below or above average rating (Manning, 2013)). In other words, assessment of the potential behavioural reaction to a scenario, for instance changing route or direction, cannot be made explicitly; and finally, c) the lack of comparison between environment types, beyond sceneries similar to the studied cases. Accordingly, generic applications of results can be problematic. The need for a combined approach is particularly apparent in near urban nature areas, in landscapes of high scenic or cultural quality, or areas that, for other reasons, have a high level of visits (Torbidoni et al., 2005; Manning, 2013).

The primary objective of our study is to investigate route preferences using a cardinal scale and thereby remedying these shortcomings. By combining forest environments and agents in various ways, it is possible to assess visitors' potential behavioural reactions to experiencing a variety of encounters, across a range of forest environments. By using photos that has also been used in earlier single-aspect studies in the 70s and the 90s (Jensen and Koch, 2000), we are able to isolate the effect of a combined evaluation and still enable justification of our results in the light of earlier findings.

In environmental economics, preferences are analysed by looking at the trade-offs people are willing to make. For instance, trade-offs include whether they are willing to travel longer to obtain certain environmental characteristics (a meta study of such findings are made by Zandersen and Tol (2009), and examples of newer studies are Elsassar et al., 2010, Dhakal et al., 2012, Abildtrup et al., 2013, Giergiczny et al., 2015; , Filyushkina et al., 2017; Agimass et al., 2018). As travel takes time and costs money, the extra distance travelled, or other measures of 'Willingness To Pay' (WTP) to obtain certain characteristics can be interpreted as an indirect price. This allows for a measure of recreational preferences on a cardinal scale whereby the relative preference 'strength' of the characteristics can be analysed. Thereby, it is possible to not only determine which characteristics are preferred, but also, to what degree positive characteristics may outweigh negative ones. In our study, we propose a new indicator of visitors' preferences as an alternative to transport distance or cost which better aligns with the type of decisions involved when making route choices during a visit.

Both destination choice and path selection, which are core characteristics of human movement (Golledge, 1999; Bierlaire and Robin, 2009), are influenced by environmental characteristics and encounters with other agents. We hypothesize that choosing a destination for recreational activities is rarely performed at random. It requires a priori, often static, knowledge about the options. Once in the destination area, the local path selection is to a higher extent influenced by dynamic, perceived information.

Compared to most other types of movement, including transport and commuting, recreational behaviour in nature is less destination-oriented.[2] Even though a destination is often known from the beginning of the trip, the utility of the visit is most frequently the routes per se rather than where they take the visitor. In particular, with respect to recreational walks, the characteristics of the environment traversed are considered just as important, sometimes even more, as the qualities of the intended destination. Examples of such consuming or 'undirected wayfinding' (Wiener et al., 2009) constitute lawn mowing, shoe shopping, pub crawling, and enjoying a stroll in the forest.

When humans move, we navigate in two ways: either we depend on the a-priory knowledge (in terms of an internal, cognitive map), and plan our route by optimizing accordingly, or we 'muddle our way through' relying primarily on the information we perceive from our immediate surroundings. Thus, Golledge et al. (1995) distinguish navigation based on *survey-based knowledge* (i.e. a priori knowledge) and *route-based knowledge* (perceived knowledge). Montello (2005) refers to two similar terms, which he names wayfinding and locomotion. In the following, we will use the terminology of Golledge et al. (1995. When humans navigate, none of the two are applied in isolation. A mixture will often be applied. Which one dominates, will depend on a) prior knowledge about the area (e.g. whether you are a tourist or a commuter), and b) the information available (e.g. do you have a map or do you rely on your bearings). In addition, c) the influence of dynamic events on the way (e.g. congestion or encounters), and d) the purpose of the trip (e.g. going to work or enjoying the landscape) influences the navigational strategy (Golledge et al., 1995). During route-based navigation, some survey knowledge, for instance knowing the direction to the North or to the location of the destination can be applied. Finally, incorporation of dynamic events, like encountering other agents can influence route-based navigation. Assuming that a walk in the forest in the studied region is primarily a type of undirected navigation, the present study focuses on route-based navigation.

Skov-Petersen et al. (2018) demonstrated how both types of navigation could be applied concurrently to a revealed preference study, carried out by means of GPS tracking of commuting bicyclists' navigational preferences. Further, Findlay and Southwell (2004) analysed the effects of visitors' perception of signs, route-based navigation to and in forest areas. Their study reports that visitors 'follow their nose' or use 'instinct'. In our study, we suggest a similar approach to recreational navigation by applying deviation from a preferred or anticipated, 'follow-your-nose-direction' as a measure of WTP instead of the more common added distance or time.

Our *secondary objective* is to suggest and apply a new measure stick to be used on a cardinal preference scale and applicable to choices during a forest walk: visitor's willingness to change direction away from what would have been their primary choice of direction. We argue that such behaviour is largely based on route-based navigation, with a less significant element of survey-based navigation. A classic measure stick like distance would not be able to capture this as the destination is not clearly defined.

[2] According to a non-published presentation from the fifth international conference on Monitoring and Management of Visitor flows in recreational and protected areas, May 30–June 3, 2010, Wageningen, The Netherlands, only 23% of 682 respondents to a survey of visitor's navigation stated that they 'aim for a specific target location'. Skov-Petersen et al., 2010.

In our study we asked respondents to imagine that they were taking a walk in the forest and, standing at a crossroad, having to make a decision on which 'leg' of the path network to take next. Furthermore, they were are asked to rank five different alternatives that differed in terms of forest environment, the types and number of agents they could see, and whether the path was in the desired direction or deviating 90 or 180° from it – i.e. involving a detour (see Fig. 1). In so doing, we asked people to perform trade-offs between both agents, forest environments and detours, which allowed us to compare their relative importance directly. This is an extension of the current literature, which has mainly focused on the relative importance within each category. Since preferences for the attributes as well as the navigation type may differ between people, we model heterogeneity explicitly. This is important for recreational management because it is largely based on voluntary incentives rather than strict rules. Thus, understanding to what degree different groups of people react to certain changes is important.

In a policy perspective, our study contributes to the knowledge of how best to manage recreational facilities so the experience of visitors is not deteriorated by encounters by others. Compared to previous studies (Jensen and Koch, 2000; Manning, 2013; Manning et al., 1999), we enable assessments at a much more detailed level, including the combined effects of forest environment, and type and number of agents encountered.

2. Materials and method

2.1. Population, sampling technique and contact method

In Denmark, registration of births, marriages, deaths, changes of address, etc. take place almost immediately. This provides a unique and reliable sampling frame, which is updated daily by the Civil Registration System (the CPR) under the Ministry of Economics and the Interior. For the purpose of this study, a systematic gross random sample consisting of 2000 persons was drawn from the register in August 2007, representing the resident adult Danish population, aged between 16 and 78.

The data acquisition was carried out as a national survey based on postal questionnaires. In addition to the question examined in the present study, the questionnaire included a number of general questions regarding forest recreation, wildlife management, and sociodemographic characteristics of the respondents. The questionnaire was accompanied by a stamped and addressed reply-envelope, and a cover letter explaining the background of the survey and, if needed, followed by up to three reminders, mailed after two, three or five weeks, respectively.

The season is assumed a factor that influences forest preferences and use. There are two alternatives when either results are desired to cover the conditions of an entire year, i.e. to let the interviewee generalise for the period, or to ask at representatively distributed times. The former approach is assumed to diminish the results' external validity; therefore, the postal-questionnaires were sent out in 12 lots on a randomly sampled day in each month in the period from August 2007 to August 2008.

The resulting response-percentage was 65.6% ($n = 1258$), corrected for reduction during the one-year data collection period (death and change of address, $n = 81$). To determine whether or not non-response significantly changed the sample composition, the distribution of all respondents over age and gender ($p < .0001$) and geographical region ($p = .748$) was tested. The test revealed that the respondents geographically represent the resident population in Denmark (excluding Greenland and the Faroe Islands) aged 16–78, but with an overrepresentation of females (especially aged 50–69), and an underrepresentation of males (especially aged 16–39). Not all respondents completed all the questions used in the present analysis (ranking of 5 choice cards). Consequently, the analysed sample consists of 1089 respondents.

2.2. The questionnaire and choice set

After a number of questions regarding the respondent's last forest visit, each respondent was asked about their choices in a situation in which he or she was walking in the forest and had reached a path intersection. "Which way would you prefer?" is the essential question. Five paper cards were enclosed with the questionnaire, and respondents were asked to rank these by preference. Each card represented a situation with a type of agent (nine levels: 8 agent types, or no-one), a given forest environment (nine levels) and an annotation of whether the direction is the preferred, across the preferred (90°), or in opposite direction of the preferred (180°) (see example in Fig. 1).

The representations of the environmental and agent types were adapted from two previous rank ordering preference studies from 1977/78 and 1993/94 (Jensen 1999; Jensen and Koch, 1997; Koch and Jensen, 1988). One of the objectives of the present study was to re-assess the earlier findings by application of a conjoint method, and accordingly to evaluate the robustness of results. It has previously been concluded that visitor's preferences appeared to be stable between the studies in the 70th and the 90th (Jensen, 1999). It is expected that the results from the present study will be comparable to the earlier findings. Consequently, the selection of attributes, agent and environment types, was fixed to align with the original studies. These earlier studies showed that forest structure (species, age, openness) and types of agents encountered were particularly important. The nine levels for agents and environmental types were selected to represent the entire spectrum of the original studies which involved many more attribute levels. In the former studies, the forest environment were represented by b/w photos, which were reused unmodified in the present study. Originally, the agent types were represented as verbal statements printed on single cards. In the present study, the statements were reused and supplemented by icons. In few cases, the statements were adjusted. The direction was included (in

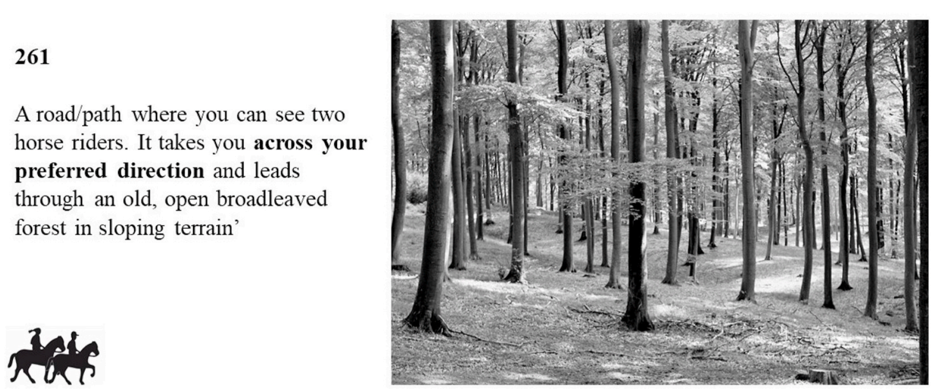

Fig. 1. Example of a choice card. Respondents were given one choice set out of 27 consisting of five cards. The present text is a translation of the original Danish text.

bold) only as a part of a text describing the entire option. The levels of the attributes can be seen in Table 1.

To allow estimation of the utility of the different attribute levels on the choice cards, a fractional factorial design of the 3*9*9 possible combinations was used. The attributes are combined using an efficient design with the %mktEX procedure in SAS (Kuhfeld, 2004), with 27 resulting combinations.

2.3. Econometric analysis

To analyse the data, a rank-ordered logit model was used (Beggs et al., 1981). It is essentially a conditional logit model in which it is assumed that the respondent first chooses the preferred option, then, from the remaining set, the preferred of these, and so on. Consequently, a conditional logit model of an exploded dataset (i.e. where the first choice for an individual is between the five alternative cards, the next is between the remaining four alternatives and so on) provides the same results. Data are analysed in the statistical software packages Stata 14 and Nlogit 5.

The underlying principle is the random utility theory where it is assumed that an individual derives utility from a good, in this connection a visit to a forest, and that he/she will choose the path so as to maximize the utility, U. If the quality of the good is described by attribute X (in our case the direction, which agents are seen and the forest environment), the utility of a given alternative j of agent n can be described as

$$U_{nj} = \sum \beta X + e_{nj} \tag{1}$$

where e_{nj} is an unobserved error term, being independently and identically distributed as type 1 extreme value. Using a logit formulation, the probability of choosing an alternative k over another alternative j can be estimated as

$$p(n,k) = \frac{\exp(\beta' x_{nk})}{\sum_j^J \exp(\beta' x_{nj})} \tag{2}$$

The obtained beta parameters express the preference for a certain attribute. However, they are subject to scale differences (suppressed in equation (2), cf. Train, 2003, p. 334), and can therefore not be compared between models. Therefore, the marginal rate of substitution (MRS) between two parameters is calculated with a given parameter as denominator. In environmental economics, a typical denominator is the price, whereby the marginal rate of substitution can be interpreted as a willingness to pay. In our case, there is no monetary attribute nor any obvious distance to use. Instead we ask respondents to make trade-offs with the forest environments, agents and directions they encounter on their way. Consequently, we use the deviation of 90° from the preferred direction as a denominator, which reflects the disutility experienced by deviation.

To analyse heterogeneity, we apply a latent class model of the exploded rank ordered dataset. In this model, the rank ordered logit model from above has been extended. Here a set of latent classes have been constructed, and the probability s of belonging to class m is modelled as:

$$s_m = \frac{\exp(\lambda_s Z_n)}{\sum_{s=1}^S \exp(\lambda_s Z_n)} \tag{3}$$

where Z is a set of characteristics of the individual: following the choice probability (eq. (2)) is adjusted to include this

$$pr(nk) = \sum_{m=1}^{M} s_m \left(\frac{\exp(b'_m x_{nk})}{\sum_j \exp(b'_m x_{nj})} \right) \tag{4}$$

where b'_m is a vector of class specific parameter values:

Selected sociodemographic and behavioural parameters are included as class membership variables Z. These include, income, gender, whether the respondent lives in densely populated regions, and the frequency of forest visits.

Table 1
The levels of the attributes. The baseline scenario is marked by '*'.

Directions (text)
Directly in the direction you wish*
Opposite the direction you wish
Across the direction you wish
Forest Environments (text and image)
Dense conifers*
Young conifers
Young broadleaved
Old, open conifers
Grassland view
Mixed broadleaved and conifers, uneven-aged
Forest lake
Old, open broadleaved forest in flat terrain
Old, open broadleaved forest in sloping terrain
Agents (text and icon)
No-one*
Two roe deer
Two joggers
A family of four
Two horseback riders
Two mountain bikers
A family of four and a loose dog
Ten joggers
Ten mountain bikers

3. Results

3.1. Main results

Table 2 shows the results from the random ordered logit model, where the reference level is a respondent moving in his or her preferred direction, where the forest environment is a dense conifer forest, and there are no other agents (wildlife or visitors) in sight. As seen, all the included parameters are significant and with the expected sign. A clear disutility of deviating from the direction of wish is found. Compared to the baseline scenario, seeing no one, the only agent type that can make visitors deviate from their intended direction, regardless the possible forest environment, is 'Two roe deer'. At the other end of the scale, 'Ten mountain bikers' will make visitors deviate the preferred route to avoid encountering. Compared to the baseline forest environment, a dense conifer forest, all alternative forest environments provide additional utility. The relative utility/disutility of encountering agent and forest environments can also be compared. To ease comparison, the marginal rate of substitution (MRS) is also shown in the table.

The MRS is seen as compared to the disutility an agent experience compared to the disutility of moving 90° from the preferred direction. Thus encountering a family of four with a loose dog provides a disutility almost twice as big as the disutility of turning 90° from the preferred direction (MRS = −1.78, cf Table 2). The standard error for the MRS's in the following tables are calculated based on the Delta method. To illustrate the MRS for various combinations of agents and forest environment, Table 3 shows the MRS for the various combinations. This is again seen as compared to a deviation of 90°. From this, it can be seen that highly preferred forest environments, including old, mixed or open types, a lake or open grasslands, will level out the disutility from encountering human agents. The agent type that provides the third and fourth highest disutility is 'a family with a loose dog', and, with an almost similar pattern, 'two mountain bikers', which will make visitors detour in young and dense conifer forests. Encountering two joggers, a family of four or two horseback riders are intermediate scenarios where only young and dense conifer forests have a marked disutility.

Table 2
Results from a random ordered logit model. Reference level: Moving in the preferred direction, in a forest environment consisting of a dense conifer forest stand, encountering no agents. The marginal rate of substitution (MRS) is seen as the disutility of deviating 90° from the preferred direction. All variables except for the deviation are dummy coded. *** indicates significance at the 1% level.

	Parameter value		std. Err	t-value	MRS		MRS std. Err	MRS 95% confidence interval		
Deviation from preferred direction	−0.426	***	0.024	−17.9						
A family of four and a loose dog	−0.758	***	0.079	−9.6	−1.78	***	0.21	−2.18	–	−1.37
A family of four	−0.235	***	0.077	−3.1	−0.55	***	0.18	−0.91	–	−0.20
Two joggers	−0.214	***	0.078	−2.7	−0.50	***	0.18	−0.87	–	−0.14
Two mountain bikers	−0.660	***	0.078	−8.4	−1.55	***	0.20	−1.94	–	−1.16
Two roe deer	0.648	***	0.079	8.2	1.52	***	0.20	1.13	–	1.91
Two horseback riders	−0.331	***	0.079	−4.2	−0.78	***	0.19	−1.15	–	−0.41
Ten joggers	−0.984	***	0.082	−12.0	−2.31	***	0.22	−2.75	–	−1.87
Ten mountain bikers	−1.513	***	0.086	−17.7	−3.55	***	0.27	−4.07	–	−3.03
Old, open broadleaved forest in sloping terrain	1.645	***	0.088	18.7	3.86	***	0.28	3.31	–	4.41
Old, open broadleaved forest in flat terrain	1.428	***	0.085	16.8	3.35	***	0.26	2.84	–	3.86
Mixed broadleaved and conifers, uneven-aged	1.118	***	0.083	13.4	2.62	***	0.23	2.17	–	3.08
Old, open conifers	0.940	***	0.082	11.5	2.21	***	0.22	1.78	–	2.63
Young conifers	0.245	***	0.082	3.0	0.58	***	0.19	0.19	–	0.96
Forest lake	1.334	***	0.085	15.7	3.13	***	0.25	2.64	–	3.62
Young broadleaved forest	0.812	***	0.084	9.7	1.91	***	0.21	1.49	–	2.33
Grassland view	1.084	***	0.084	13.0	2.54	***	0.23	2.09	–	3.00
LL-value	−4413.99									
N	1089									

Table 3
Marginal rates of substitution (MRS), compared to a deviation of 90° from the preferred direction. Sorted according to size.

	Two roe deer	No-one	Two joggers	A family of 4	Two horseback riders	Two mountain bikers	A family of 4 and a loose dog	Ten joggers	Ten mountain bikers
Dense conifers	1.52	0.00	−0.50	−0.55	−0.78	−1.55	−1.78	−2.31	−3.55
Young conifers	2.10	0.58	0.07	0.02	−0.20	−0.97	−1.20	−1.73	−2.98
Young broadleaved forest	3.43	1.91	1.40	1.35	1.13	0.36	0.13	−0.40	−1.65
Old, open conifers	3.73	2.21	1.70	1.66	1.43	0.66	0.43	−0.10	−1.35
Grassland view	4.07	2.54	2.04	1.99	1.77	1.00	0.77	0.24	−1.01
Mixed broadleaved and conifers, uneven-aged	4.14	2.62	2.12	2.07	1.85	1.07	0.85	0.32	−0.93
Forest lake	4.65	3.13	2.63	2.58	2.36	1.58	1.35	0.82	−0.42
Old, open broadleaved forest in flat terrain	4.87	3.35	2.85	2.80	2.57	1.80	1.57	1.04	−0.20
Old, open broadleaved forest in sloping terrain	5.38	3.86	3.36	3.31	3.09	2.31	2.08	1.55	0.31

3.2. Latent class model

To analyse whether heterogeneity – i.e. different visitor types - can be observed in the preferences, we constructed a latent class model based on an exploded data set.

Table 4 shows the model results for a latent class model with 3 classes. Three classes provided better model fit than 2 according to BIC and AIC. Adding a fourth class had marginally better model statistics, but resulted in a very small group, which made it of little relevance for interpretation. Consequently, the 3-class model was used. Various variables used as class-membership probability variables were tested. The model presented in Table 4 is based on dummy (categorical) variables with low income indicating a household income less than DKK 600,000 (approximately 80,000 EURO), middle aged and old are dummies for age of 30–50 and above 50 years, as compared to younger than 30 years. 'Densely populated' is a dummy taking the value of 1 if the population density in the resident's postal code is higher than the national average (1448 persons/km^2), otherwise 0. Other population density variables (a continuous variable, a dummy for larger cities) were tested but did not reveal any other patterns and have therefore not been included.

The MRS of substitution are shown in Table 5. As is seen from Table 4, class 3 is the largest, consisting of almost half of the population. This class is willing to make detours from their preferred route – to reach a more attractive forest environment and to avoid encountering other human agents. Compared to this, class 2 is mainly concerned with the forest environment. They are less concerned with other people or animals. Only encountering a large group of mountain bikers can make them deviate. Compared to class 3, class 2 is more likely to include men, infrequent forest visitors, richer, and younger people.

Like class 2, class 1 is also mainly interested in the forest environment, although they are willing to deviate from the desired direction to see roe deer or to avoid a large group of mountain bikers. Other than that, they differ from class 2 in having a lower marginal rate of substitution, i.e. they are less willing to deviate from the planned route. Belonging to class 2 was more likely for higher income groups, than belonging to class 3, but no other class membership variables were significant.

3.3. Comparison with earlier studies using the same pictures and similar agents

Table 6 shows the implicit rank from Table 2 and compares it with the ranking from the earlier preference studies (Jensen and Koch, 1997; Koch and Jensen, 1988) using the same forest environments and (almost) same agents. As seen, the tendency is the same, though there are some differences, e.g. the forest lake that is ranked relatively lower in the current study, and the old, open broadleaved forest in flat terrain that is ranked relatively higher.

Experiencing wildlife ('two roe deer') and being on you own ('no-one', which is only included in the present study) are the most preferred (Table 7). Comparing the results with comparable earlier studies on encountering agents, the overall ranking largely remains the same.

Table 4
Parameter estimates for a latent class analysis of the choice sets. Deviation from the preferred direction is taking the value of 1 for 90° deviation and 2 for 180. All variables expected for the deviation are dummy coded. *** indicates significance at the 1% level, ** at the 5% level and * at the 10% level.

Attribute	Class 1				Class 2				Class 3			
	Parameter value		std. Err	t-value	Parameter value		std. Err	t-value	Parameter value		std. Err	t-value
Deviation from preferred direction	−2.171	***	0.259	−8.37	−0.209	***	0.066	−3.15	−0.309	***	0.057	−5.43
A family of four and a loose dog	−0.248		0.381	−0.65	−0.050		0.203	−0.25	−2.004	***	0.200	−10.04
A family of four	0.421		0.358	1.18	0.197		0.215	0.91	−1.076	***	0.182	−5.92
Two joggers	0.198		0.370	0.54	−0.120		0.193	−0.62	−0.807	***	0.178	−4.53
Two mountain bikers	−0.081		0.405	−0.20	−0.266		0.199	−1.33	−1.739	***	0.198	−8.80
Two roe deer	1.614	***	0.424	3.81	0.093		0.206	0.45	1.187	***	0.193	6.15
Two horseback riders	0.072		0.447	0.16	−0.289		0.195	−1.48	−0.997	***	0.186	−5.36
Ten joggers	−0.305		0.406	−0.75	−0.362	*	0.215	−1.68	−2.285	***	0.206	−11.10
Ten mountain bikers	−0.935	**	0.398	−2.35	−0.809	***	0.215	−3.76	−3.251	***	0.250	−13.00
Old, open broadleaved forest in sloping terrain	1.605	***	0.384	4.17	3.358	***	0.284	11.81	1.039	***	0.187	5.54
Old, open broadleaved forest in flat terrain	1.449	***	0.340	4.27	2.587	***	0.243	10.66	0.896	***	0.181	4.95
Mixed broadleaved and conifers, uneven-aged	0.870	**	0.354	2.46	2.182	***	0.231	9.45	0.705	***	0.178	3.97
Old, open conifers	0.942	***	0.358	2.63	1.617	***	0.208	7.79	0.619	***	0.166	3.74
Young conifers	0.490		0.361	1.36	0.340	*	0.190	1.79	0.097		0.167	0.58
Forest lake	1.984	***	0.418	4.74	2.159	***	0.254	8.49	0.936	***	0.190	4.92
Young broadleaved forest	1.546	***	0.348	4.44	1.102	***	0.222	4.97	0.583	***	0.173	3.36
Grassland view	1.500	***	0.377	3.98	2.029	***	0.236	8.61	0.620	***	0.164	3.79
Class probability membership variables												
Constant	−0.913	**	0.458	−1.99	0.144		0.364	0.39	–			
Male	0.347		0.246	1.41	0.363	*	0.218	1.67	–			
Less than 1 visit pr month	0.218		0.247	0.88	0.500	**	0.215	2.33	–			
Low income	−0.577	**	0.260	−2.22	−0.635	***	0.218	−2.91	–			
Middle aged	0.184		0.403	0.46	−0.775	**	0.329	−2.36	–			
Old	−0.187		0.417	−0.45	−0.572	*	0.305	−1.88	–			
Densely populated	−0.121		0.305	−0.40	−0.249		0.281	−0.89	–			
Class size (%)	18.6				34.3				47.1			
LL-value	−4230.08											
N	1089											

However, a difference, is ‘two joggers’ which are ranked lower in the study from the seventies (but not applied in the 90’s) than by the respondents in the present study. Another noteworthy observation is that in the present study, focus was on mountain bikers rather than cyclists, yet the ranking does not change.

4. Discussion

In the current study we have constructed a cardinal preference-ranking of *both* agent types *and* forest environments which is based on choice modelling, and which thereby allows us to directly compare the two, and the trade-offs they are subjected to. This is an extension of the existing literature, in which ordinal scales are mainly used. As a measure stick, we used deviation from the desired direction. This seemed to work well – people were able to respond to it, and results were fairly in line with earlier findings from studies using the same test material for agent types and forest environments individually (Jensen 1999; Jensen and Koch, 1997; Koch and Jensen, 1988). We show that when people make route choices during a recreational trip in a forest, they make trade-offs between forest environments and which agent types they encounter.

4.1. Objectives of the study

The overall objective of our study is to investigate route preferences for visitors to the nature. Our primary objective is to suggest and apply a cardinal scale of utility to remedying the shortcomings of previous preference studies applying ordinal single-aspects ranking. Our secondary objective is to test visitor’s willingness to change direction away from their primary choice of direction as cardinal scale. We show that.

a) the relative strength of preferences can be estimated. For instance, we show that respondent’s utility of young broadleaved forest is three times as high as for young conifers, whereas old broadleaved forest provides almost twice the utility of young broadleaved forests. Similarly, we show that the disutility of encountering ten mountain bikers is twice as high as meeting a family with a loose dog. None of such relative terms could be revealed from previous, ranking-based studies (Jensen 1999; Jensen and Koch, 1997; Koch and Jensen, 1988; Manning, 2013). Further, our results enable interpretations expressing the trade-off between preferred forest environments and encountering less or more favoured visitor types. For instance, we show that even though meeting 10 mountainbikers is associated with a large negative utility; if it is combined with an old open broadleaved forest in a sloping terrain, then it is preferable to the base situation. In the other end, meeting two roe deer or no one, is such a large utility gain, that respondents are willing to choose the least preferable environment (the base scenario).
b) by means of our method, applying a cardinal preference scale to ranges of environmental and agent types, enables application of results to evaluation of generic situations beyond the exact locations and encounters represented in the survey material. Previous studies primarily addresses evaluation of concrete locations (e.g. an entry point to a given national park) and one type of encounters (e.g. an increasing number of visitors (Manning, 2013).
c) by applying the willingness to deviate from the preferred route as a measuring stick, we can assess the behavioural reaction to change as probabilities of choice. This is useful in an agent based model (ABM). The parameter estimates can be transformed into probabilities of choosing optional path segments, given their characteristics and possible encounters. By issuing the relative utilities of available options to a (weighted) random draw, results can directly be applied as spatial explicit choices made by virtual visitors under way in a recreational path network. In spite of the obvious potential in combining choice experiments and ABM’s (Skov-Petersen, 2005; Gimblett and Skov-Petersen, 2008; Hunt, 2008), the linkage has seldom been put in action in relation to studies of recreational behaviour (Hunt, 2008).

In comparison with earlier ranking studies using the same photos (Jensen 1999; Jensen and Koch, 1997; Koch and Jensen, 1988), our

Table 5
Marginal rates of substitution (MRS), for the latent class model shown in Table 4, with deviation as the denominator. *** indicates significance at the 1% level, ** at the 5% level and * at the 10% level.

Attribute	Class 1				Class 2				Class 3			
	MRS		std. Err	95% confidence interval	MRS		std. Err	95% confidence interval	MRS		std. Err	95% confidence interval
A family of four and a loose dog	−0.114		0.173	−0.454 – 0.225	−0.241		0.980	−2.162 – 1.681	−6.492	***	1.370	−9.176 – −3.807
A family of four	0.194		0.167	−0.135 – 0.523	0.940		1.050	−1.117 – 2.997	−3.485	***	0.894	−5.237 – −1.734
Two joggers	0.0914		0.173	−0.248 – 0.430	−0.574		0.924	−2.385 – 1.238	−2.614	***	0.763	−4.109 – −1.119
Two mountain bikers	−0.037		0.186	−0.402 – 0.327	−1.270		1.070	−3.368 – 0.828	−5.634	***	1.244	−8.072 – −3.195
Two roe deer	0.744	***	0.214	0.324 – 1.163	0.445		0.984	−1.484 – 2.374	3.846	***	0.869	2.142 – 5.549
Two horseback riders	0.033		0.207	−0.372 – 0.438	−1.381		1.057	−3.452 – 0.690	−3.230	***	0.883	−4.961 – −1.499
Ten joggers	−0.141		0.186	−0.505 – 0.224	−1.734		1.213	−4.111 – 0.643	−7.401	***	1.550	−10.438 – −4.364
Ten mountain bikers	−0.431	**	0.173	−0.770 – −0.092	−3.868	**	1.719	−7.237 – −0.498	−10.531	***	2.077	−14.601 – −6.461
Old, open broadleaved forest in sloping terrain	0.739	***	0.188	0.371 – 1.107	16.064	***	5.106	6.055 – 26.072	3.364	***	0.902	1.597 – 5.132
Old, open broadleaved forest in flat terrain	0.667	***	0.165	0.345 – 0.990	12.375	***	4.128	4.284 – 20.466	2.901	***	0.805	1.323 – 4.479
Mixed broadleaved and conifers, uneven-aged	0.401	**	0.170	0.068 – 0.734	10.438	***	3.362	3.849 – 17.028	2.284	***	0.729	0.856 – 3.713
Old, open conifers	0.434	***	0.159	0.123 – 0.745	7.737	***	2.609	2.624 – 12.849	2.005	***	0.661	0.709 – 3.301
Young conifers	0.226		0.166	−0.099 – 0.551	1.626	*	0.978	−0.290 – 3.543	0.316		0.547	−0.757 – 1.388
Forest lake	0.914	***	0.196	0.530 – 1.297	10.325	***	3.305	3.848 – 16.802	3.032	***	0.806	1.453 – 4.611
Young broadleaved forest	0.712	***	0.164	0.390 – 1.034	5.272	***	1.779	1.785 – 8.759	1.890	***	0.621	0.672 – 3.108
Grassland view	0.691	***	0.164	0.369 – 1.013	9.707	***	3.190	3.455 – 15.959	2.009	***	0.661	0.713 – 3.304

Table 6
Rank order of forest environments of the present study (2007/08) compared to the two previous national studies from 1977/78 and 1993/94 (Jensen 1999; Jensen and Koch, 1997; Koch and Jensen 1988). The ranking in the previous studies was based on a mean assessment of 52 b/w photographs by the general population. Here, this has been translated into a rank order from 1 (first choice, highest rank) to 9 (lowest rank) among the 9 forest environments evaluated here. The numbers from the present study show the implicit rank as derived from Table 2.

	1977/78	1993/94	2007/08 (Present study)
Old, open broadleaved forest in sloping terrain	2	1	1
Old, open broadleaved forest in flat terrain	5	4	2
Forest lake	1	2	3
Mixed broad-leaved and conifer forest, uneven-aged	3	3	4
Grassland view	4	5	5
Old, open conifers	8	7	6
Young broadleaved forest	6	6	7
Young conifer	7	8	8
Dense, conifers*	9	9	9

Table 7
Rank order of agent types of the present study (2007/08) compared to the two previous national studies from 1977/78 and 1993/94 (Jensen 1999; Jensen and Koch, 1997; Koch and Jensen, 1988). The ranking in the previous studies was based on a mean assessment of 100 verbal stimuli by the general population. This is here translated into a rank order from 1 (first choice, highest rank) to 9 (lowest rank) among the 9 agents evaluated here. As not all agent types were present in the previous studies, the lowest rank in the 1977/78 study was 8 and in 1993/94 it was 5. The numbers from the present study show the implicit rank as derived from Table 2. Texts translated from Danish.

1977/78	1993/94	Formulation previously applied (1977/78 and 1993/94).	2007/08 (Present study)	Formulation (and icon) in present study (2007/08)
1	1	A roe deer	1	Two roe deer
	–		2	No-one
4	–	Two joggers	3	Two joggers
3	2	A family in the woods	4	A family of four
2	–	Two horseback riders	5	Two horseback riders
7	–	Two cyclists	6	Two mountain bikers
5	3	A family in the woods to exercise their dogs	7	A family of four and a loose dog
6	4	Ten joggers	8	Ten joggers
8	5	Ten cyclists	9	Ten mountain bikers

study largely confirms their findings. As can be seen, the forest lake is ranked relatively lower in the current study. However, if we look at the confidence intervals (Table 2) we see that old open broadleaved forest in sloping terrain is only slightly above the 95% confidence interval for forest lake and old open broadleaved forest in a flat terrain is within the confidence interval. Thus, by using a cardinal scale we were able to demonstrate that the differences between the rankings may not be that pronounced. With respect to the possibility of encountering other agents, we find, as with the former studies, that seeing roe deer is very attractive, and the larger groups of human agents, the larger is the disutility of encountering these. A possible interpretation of why joggers were ranked lower in the 70s than in the current study, could be that back then, encountering joggers in the nature was still a relatively unfamiliar event.

4.2. Heterogeneity and latent classes

Looking into the question of heterogeneity, we find that almost half of the sample (class 3) experiences a large disutility of encountering other (human) agents, and this will, for such 'silence-seekers' - outweigh the gain from going to a more attractive forest environment. Other studies find that experiencing silence is a main attraction for recreational forest visits (e.g. Jensen 1999). This may be what we also see here – that the forest environment is important, but not as important as not encountering other agents. Notice that most of these agents are generally not expected to be a source of conflicts – except larger groups of mountainbikers (e.g. Bakhtiari et al., 2016; Jensen, 2003, p. 335). This is important for policy, as it shows that even if there are no larger conflicts, the recreational attractiveness can be increased by segregating agents, for example by specialised path networks or prioritizing many but narrow paths over fewer, but broad ones.

Compared to the silence-seekers (class 3), about a third of the population (class 2) cares a lot about the forest environment, but much less about the agents they encounter. Apparently, 'nature-watchers' interest in or joy of nature is generally not distracted by most other visitors. Only a large group of mountain bikers can make them deviate from the preferred route, but for most other agent types, it is not enough to outweigh a poorer forest environment. Compared to the silence-seekers, this group more likely consists of men, above 30, with high income, and who visit the forest seldom.

The last group of people (class 1) resembles class 2 in that they do not experience large disutility of encountering other agents. However, as opposed to class 2, they are less concerned with the forest environment – the marginal rates of substitution (MRS) are much smaller for this class. They walk along planned routes where only small deviations are acceptable. They are more frequent visitors than class 2. An interpretation of this group is that they enjoy the forest per se, but they pay little attention to what and whom they see. Unfortunately, we do not have information of the different user types, but it can be hypothesized that this class of 'targeted visitors' constitutes people with a specific purpose – e.g. walking the dog or jogging – and who are well acquainted with the area they are in. An alternative hypothesis could be that members of this group have difficulties navigating in nature and therefore are not willing to deviate much from the planned route, e.g. by following a marked trail or trail on a map.

While there are clear differences between these three groups in how much they are willing to deviate from the preferred route to encounter the different forest environments and agents, they are quite similar in their rankings. This shows the importance of the approach used here, allowing for analysing the strength of the preferences for different groups, compared to earlier studies.

A range of other studies, involving clustering of visitors in relation to preferences, has been conducted (Collins and Hodge, 1984; Torbidoni et al., 2005; Benson et al., 2013). The motivation for clustering is often to cater for the heterogeneity of results, as it is in the present study. Direct comparison of the results and the identified visitor types is hard to make, since the targeted type of behaviour and the regional setting are very different. In the study by Benson et al. (2013) visitors are clustered according to visitors' willingness to travel versus the affordances of the destination. Such behaviour is, compared to the present study, at a much larger scale. It involves decisions you make while planning for and traveling to a destination, rather than what you do while you are actually at your destination. Accordingly none of the types identified in the study -Do It All Adventurists; Windshield Tourists; Value Picnickers; Creature Comfort Seekers; Backcountry Enthusiasts - are compatible with our findings. A similar study of WTP in terms of transport to the nature by Collins and Hodge (1984) identifies four visitor types: Families; Agile youth; Picnickers; By-passers. As in the previous case, none of them compares to ours. Like the two previous, the study by Torbidoni et al. (2005) also addresses selection of the destination rather than navigation inside the nature area. Again, the revealed visitor types - Conservationist Visitors, Casual Visitors, Contemplator Visitors, and Active-adventurous Visitors are not easily aligned with our findings. The environmental economic literature on recreation also looks at heterogeneity in recreational preferences (e.g. Doherty et al., 2013; Howley et al., 2012; Scarpa and Thiene, 2005). Campbell et al. (2014) find that preferences for increased access in forests is highly heterogeneous, and differences not easily explainable by sociodemographics. Agimass et al. (2018) look at preference heterogeneity for forest management based on categorization according to the New Environmental Paradigm (Dunlap and Van Liere 1978; Dunlap et al., 2000, 2008)) and find the same individuals to hold both ecocentric and anthropocentric attitudes and that the strength of both affects preferences. They do not have emphasis on recreation, but as recreation is by nature anthropocentric, the recreational preferences are also likely to be linked to a broader set of environmental preferences.

4.3. Limitations and methodological approach of the study

It is worth mentioning that the sample bias (overrepresentation of females – especially aged 50–69, and underrepresentation of males – especially aged 16–39) might have an impact on, for instance, the non-preference of mountain bikers. In the original preference study from the 70s, it was, for instance found that males rated encountering two cyclist higher than females did. Furthermore, people over 60 years had the lowest preference for meeting ten cyclist in the forest, in contrast to the youngest age group (aged 15–29) who had the highest preference for such an encounter (Koch and Jensen, 1988).

In the current study, we have focused entirely on the route-based navigation made during forest recreational trips, and focussed on what is visible from the path, i.e. route knowledge. Our study is less suited to evaluate preferences in relation to recreational navigation in situations where recreationists know an area very well and therefore are able to foresee, for instance, where along the route encounters are likely to happen. On the other hand, exactly in these settings it might be simple for them to deviate from the route as they can find alternatives easily (so the "cost" of choosing an alternative route is smaller). In reality, navigation will be based on a combination of both route and survey knowledge (Golledge et al. (1995); Skov-Petersen et al., 2018).

Our study represents a Stated Preference (SP) choice experiment – i. e. respondents are asked to state their preferences (e.g. by choosing between or ranking options). The classic alternative is studies based on Revealed Preference (RP), where respondents' actual behaviour is recorded and compared to potential/realistic alternatives (Wardman, 1988). One advantage of SP is that hypothetic situations can be tested, and comprehensive and balanced choice sets are easier to generate. Further, and of particular relevance here, is the fact that it would be rather difficult to study the encounter of other agents by RP – unless in a complete surveillance society. Furthermore, RP requires quite specific data on the forest environment – data that is often not available at a sufficiently fine grid. One disadvantage of SP, which must be considered, is that hypothetic bias (Deviation from real-World evidence (Hensher, 2010)) is often observed. For instance in a study of bicyclists' navigation, SP by a method similar to the present study (Vedel et al., 2017) and RP by means of GPS tracking (Skov-Petersen et al., 2018) was applied concurrently. It was found that cyclists state that they are willing to go additionally 40% longer to be on a bicycle track, whereas, when actual navigation was observed, the willingness appeared to be only 28%. Even though our results are in line with previous single-aspect studies in terms of ranking, it might be that the preferences estimated based on the responds' choices are exaggerated because of hypothetical bias. However, we have no reason to believe that it should be more pronounced for agents than for forest environments (or vice versa), and thus the values relative to each other, which is our focus, would not be affected.

4.4. Further studies

In the current study respondents are asked to perform trade-offs by imagining that they are at a crossroad and then have to choose what to do. This can involve many different situations, and it is likely that their actual choice will depend on such other aspects – whether it is in the beginning or the end of the trip, whether a person goes alone or in a group, whether the kids are getting tired, etc. Likewise, we have asked for the situation where a person can see an agent from the junction in order to resemble route based navigation. It may be argued that if you have survey-based knowledge that on certain routes, it is more likely to encounter certain agents, it can be taken into account in a more probabilistic way. These aspects, we leave for future studies to investigate.

5. Lessons learned and management implications

We argue that explicitly looking at route-based navigation is important for the kind of management that relates to how to affect where people move in the forest. A large group of people state that the dynamic aspects of encountering other agents matters a lot. This is a challenge for management where there are trade-offs between nature conservation and recreation (disturbance). As many people want to avoid other people, it can become problematic to concentrate them in areas to allow more undisturbed parts for the forest environment. On the other hand, our result also shows that segregated networks in less attractive forest environments may be a means to cater for possible negative encounters – as the majority of people are willing to give up on the preferred forest environments to avoid other people.

Furthermore, our study may have implications for path network planning in areas with less preferred forest environments (e.g. present in recently afforestation areas), where path segregation may be more important than in the more preferred forest environments, where it can be difficult to get people to change to another route.

6. Conclusions

A choice experiment involving possible forest environments and potential encounters with other agents (visitors or wildlife) at junctions of the path network was conducted. As an alternative to willingness-to-pay, in terms of e.g. money or transport time, the deviation of 90° from the preferred direction was applied as a measure stick. Our study applied photos and statements that had been evaluated previously in single-attribute ranking experiments. Our results are for forest and agent types individually in line with earlier findings. However, because we evaluate them jointly, we can take a step further in understanding the trade-offs.

We conclude that given the present context respondents will deviate from their preferred route to encounter wildlife (represented as 'two roe deer'), whereas a detour will be preferred to avoid encountering a large group of mountain bikers or runners in far most forest environment.

Analysis of the heterogeneity reveals that half of the population is highly affected by both forest environments and presence of agent types. A smaller group, around 30%, is less sensitive to seeing other agents, whereas 20% only in very few situations are willing to detour at all.

CRediT authorship contribution statement

H. Skov-Petersen: Conceptualization, Methodology, Validation, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Supervision. **F.S. Jensen:** Conceptualization, Validation, Investigation, Resources, Data curation, Writing – review & editing, Supervision, Visualization, Project administration, Funding acquisition. **J.B. Jacobsen:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Funding acquisition.

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References

Abildtrup, J., Garcia, S., Olsen, S. B., & Stenger, A. (2013). Spatial preference heterogeneity in forest recreation. *Ecological Economy, 92*, 67–77. https://doi.org/10.1016/j.ecolecon.2013.01.001

Absher, J. D., & Lee, R. G. (1981). Density as an incomplete cause of crowding in backcountry settings. *Leisure Sciences, 4*(3), 231–247.

Agimass, F., Lundhede, T., Panduro, T., & Jacobsen, J. B. (2018). The choice of forest site for recreation: A revealed preference analysis using spatial data. *Ecosystem Services, 31*, 445–454. part C.

Bakhtiari, F., Jacobsen, J. B., & Jensen, F. S. (2014). Willingness to travel to avoid conflicts in Danish forests. *Urban Forestry and Urban Greening, 13*(4), 662–671.

Beggs, S., Cardell, S., & Hausman, J. A. (1981). Assessing the potential demand for electric cars. *Journal of Econometrics, 17*, 1–19.

Benson, C., Watson, P., Taylor, G., Cook, P., & Hollenhorst, S. (2013). Who visits a national park and what do they get out of it?: A joint visitor cluster analysis and travel cost model for yellowstone national park. *Environmental Management, 52*(4), 917–928.

Bierlaire, M., & Robin, T. (2009). Pedestrians choices. In H. Tiommerman (Ed.), *Pedestrian behavior: Models, data collection and applications (pp. 1-26)*. Emerald Group Publishing Limited. Pedestrian behaviour.

Campbell, D., Vedel, S. E., Thorsen, & Jacobsen, J. B. (2014). Heterogeneity in the WTP for recreational access – distributional aspects. *Journal of Environmental Planning and Management, 57*, 1200–1219. http://www.tandfonline.com/doi/full/10.1080/09640568.2013.793173.

Collins, R., & Hodge, I. (1984). Clustering visitors for recreation management. *Journal of Environmental Management, 19*(2), 147–159.

Dhakal, B., Yao, R. T., Turner, J.a., & Barnard, T. (2012). Recreational users' willingness to pay and preferences for changes in planted forest features. *Forest Policy and Economics, 17*, 34–44. https://doi.org/10.1016/j.forpol.2011.11.006

Doherty, E., Campbell, D., & Hynes, S. (2013). Models of site-choice for walks in rural Ireland: Exploring cost heterogeneity. *Journal of Agricultural Economics*. https://doi.org/10.1111/1477-9552.12002

Dunlap, R. E. (2008). The new environmental Paradigm scale: From marginality to worldwide use. *The Journal of Environmental Education, 40*(1), 3–18 [Taylor & Francis Online], [Web of Science ®], [Google Scholar].

Dunlap, R. E., & Van Liere, K. D. (1978). The new ecological Paradigm: A proposed measuring instrument and preliminary results. *The Journal of Environmental Education, 9*, 10–19 [Taylor & Francis Online], [Web of Science ®], [Google Scholar].

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the new ecological Paradigm: A revised NEP scale. *Journal of Social Issues, 56*, 425–442 [Crossref], [Web of Science ®], [Google Scholar].

Edwards, D., Jay, M., Jensen, F. S., Lucas, B., Marzano, M., Montagné, C., Peace, A., & Weiss, G. (2012a). Public preferences for structural attributes of forests: Towards a pan-European perspective. *For Policy Econ, 19*, 12–19.

Edwards, D., Jay, M., Jensen, F. S., Lucas, B., Marzano, M., Montagné, C., Peace, A., & Weiss, G. (2012b). Public preferences across Europe for different forest stand types as sites for recreation. *Ecology and Society, 17*(1), 27, 11pp.

Elsasser, P., Englert, H., & Hamilton, J. (2010). Landscape benefits of a forest conversion programme in North east Germany: Results of a choice experiment. *Annals of Forest Research, 53*, 37–50.

Europe, F. (2015). In *Work programme. Pan-European follow-up of the 7th FOREST EUROPE ministerial conference and the extraordinary ministerial conference*. Madrid, October 2015 https://foresteurope.org/wp-content/uploads/2016/08/FE-Work-Programme-2016-2020-1.pdf.

Filyushkina, A., Agimass, F., Lundhede, T., Strange, N., & Jacobsen, J. B. (2017). Preferences for variation in forest characteristics: Does diversity between stands matter? *Ecological Economics, 140*, 22–29. https://doi.org/10.1016/j.ecolecon.2017.04.010

Findlay, C., & Southwell, K. (2004). 'I just followed my nose': Understanding visitor wayfinding and information needs at forest recreation sites. *Managing Leisure, 9*(4), 227–240. https://doi.org/10.1080/1360671042000317261

Gibson, A. W., Newman, P., Lawson, S., Fristrup, K., Benfield, J. A., Bell, P. A., & Nurse, G. A. (2014). Photograph presentation order and range effects in visual-based outdoor recreation research. *Leisure Sciences, 36*(2), 183–205.

Giergiczny, M., Czajkowski, M., Żylicz, T., & Angelstam, P. (2015). Choice experiment assessment of public preferences for forest structural attributes. *Ecological Economy, 119*, 8–23.

Gimblett, H. R., & Skov-Peterseon, H. (Eds.). (2008). *Monitoring, simulation, and management of visitor landscapes*. University of Arizona Press.

Golledge, R. G. (1999). Human wayfinding and cognitive maps. In *Wayfinding behavior: Cognitive mapping and other spatial processes* (pp. 5–45).

Golledge, R. G., Dougherty, V., & Bell, S. (1995). Acquiring spatial knowledge: Survey versus route-based knowledge in unfamiliar environments. *Annals of the Association of American Geographers, 85*(1), 134–158.

Gundersen, V. S., & Frivold, L. H. (2008). Public preferences for forest structures: A review of quantitative surveys from Finland, Norway and Sweden. *Urban Forestry and Urban Greening, 7*(4), 241–258. https://doi.org/10.1016/j.ufug.2008.05.001

Gundersen, V. S., & Frivold, L. H. (2011). Naturally dead and downed wood in Norwegian boreal forests: Public preferences and the effect of information. *Scandinavian Journal of Forest Research, 26*(2), 110–119.

Hall, T., & Cole, D. (2007). *Changes in the motivations, perception and behaviors of recreation users: Displacement and coping in wilderness. RMRS-RP-63*. Fort Collins, Colorado, USA: US Department of Agriculture,- Forest Service, Rocky Mountain Research Station.

Hensher, D. A. (2010). Hypothetical bias, choice experiments and willingness to pay. *Transportation Research Part B: Methodological, 44*(6), 735–752.

Howley, P., Doherty, E., Buckley, C., Hynes, S., van Rensburg, T., & Green, S. (2012). Exploring preferences towards the provision of farmland walking trails: A supply and demand perspective. *Land Use Policy, 29*, 111–118.

Hunt, L. M. (2008). Choice models: Estimation, evolution, limitations and potential application for simulation modeling. In R. H. Gimblett, & H. Skov-Petersenm (Eds.), *Monitoring, simulation, and management of visitor landscapes, 189*. Arizona University Press.

Jensen, F. S. (1999). *Forest recreation in Denmark from the 1970s to the 1990s. The research series, no. 26-1999*. Hørsholm, Denmark: Danish Forest and Landscape Research Institute.

Jensen, F. S. (2003). *Friluftsliv i 592 skove og andre naturområder. Skovbrugsserien nr. 32-2003* (p. 335). Hørsholm, Denmark: Skov & Landskab.

Jensen, F. S., & Koch, N. E. (1997). *Friluftsliv i skovene 1976/77 - 1993/94. The Research Series no. 20-1997*. Hørsholm, Denmark: Danish Forest and Landscape Research Institute.

Jensen, F. S., & Koch, N. E. (2000). Measuring forest preferences of the population - a Danish approach. *Schweizerische Zeitschrift für Forstwesen, 151*(1), 11–16. https://doi.org/10.3188/szf.2000.0011

Koch, N. E., & Jensen, F. S. (1988). Skovenes friluftsfunktion i Danmark. IV.del. Befolkningens ønsker til skovenes og det åbne lands udformning. (Forest Recreation in Denmark. Part IV: The Preferences of the Population.) Det Forstlige Forsøgsvæsen i Danmark. *København, 41*, 243–516, 1988.

Kuhfeld, W. F. (2004). In *Marketing research Methods in SAS. Experimental design, choice, conjoint, and graphical techniques. SAS 9.1* (p. 782). Cary, NC., USA: TS-694. SAS Institute Inc.

Manning, R. E. (2011). In *Studies in outdoor recreation: Search and research for satisfaction* (3rd ed.). Corvallis OR, USA: Oregon State University Press.

Manning, R. E. (2013). *Parks and carrying capacity: Commons without tragedy*. Island Press.

Manning, R. E., Freimund, W. A., Lime, D. W., & Pitt, D. G. (1996). Crowding norms at frontcountry sites: A visual approach to setting standards of quality. *Leisure Sciences, 18*(1), 39–59.

Manning, R., Valliere, W., & Wang, B. (1999). Crowding norms: Alternative measurement approaches. *Leisure Sciences, 21*(2), 97–115. https://doi.org/10.1080/014904099273174

Manning, R., Valliere, W., Wang, B., Lawson, S., & Newman, P. (2002). Estimating day use social carrying capacity in Yosemite national park. *Leisure/Loisir, 27*(1–2), 77–102. https://doi.org/10.1080/14927713.2002.9651296

Mann, C., Pouta, E., Gentin, S., & Jensen, F. S. (2010). Outdoor recreation in forest policy and legislation: A European comparison. *Urban Forestry and Urban Greening, 9*, 303–312. https://doi.org/10.1016/j.ufug.2010.06.004

Montello, D. R. (2005). Navigation. In P. Shah, & A. Miyake (Eds.), *The Cambridge handbook of visuospatial thinking* (pp. 257–294). N.Y. Cambridge University Press, 2005.

Nielsen, A. B., Gundersen, V. S., & Jensen, F. S. (2018). The impact of field layer characteristics on forest preference in Southern Scandinavia. *Landscape and Urban Planning, 170*, 221–230.

Nordic Council. (2019). Committee: Prioritise outdoor life. https://www.norden.org/en/news/committee-prioritise-outdoor-life.

Ribe, R. G. (1989). The aesthetics of forestry: What has empirical preference research taught us? *Environmental Management, 13*(1), 55–74. https://doi.org/10.1007/BF01867587

Scarpa, R., & Thiene, M. (2005). Destination choice models for rock climbing in the northeastern alps: A latent-class Approach based on intensity of a latent-class Approach preferences. *Land Economics, 81*, 426–444.

Shelby, B., Vaske, J. J., & Heberlein, T. A. (1989). Comparative analysis of crowding in multiple locations: Results from fifteen years of research. *Leisure Sciences, 11*, 269–291.

Sievänen, T., Edwards, D., Fredman, P., Jensen, F. S., & Vistad, O. I. (Eds.). (2013). *Social indicators in the forest sector of Northern Europe. A review focusing on nature-based recreation and tourism. TemaNord 2013:584*. Nordic Council of Ministers.

Skov-Petersen, H. (2005). Feeding the agents-collecting parameters for agent-based models. In *, 60. Batty, SE computers in urban planning and urban management*. UCL.

Skov-Petersen, H., Barkow, B., Lundhede, T., & Jacobsen, J. B. (2018). How do cyclists make their way? - a GPS-based revealed preference study in copenhagen. *International Journal of Geographical Information Science*. https://doi.org/10.1080/13658816.2018.1436713

Skov-Petersen, H., Jensen, F. S., & Jacobsen, J. B. (2010). Decisions made along the tracks in forests (unpublished slides). In *Presented at the fifth international conference on Monitoring and Management of Visitor flows in recreational and protected areas*. Wageningen: Holland. May 30–June 3, 2010.

Torbidoni, E. I. F., Grau, H. R., & Camps, A. (2005). Trail preferences and visitor characteristics in Aigüestortes i Estany de Sant Maurici National park, Spain. *Mountain Research and Development, 25*(1), 51–59.

Train, K. (2003). *Discrete choice methods with simulation* (p. 334). New York: Cambridge University Press.

Vedel, S. E., Jacobsen, J. B., & Skov-Petersen, H. (2017). Bicyclists' preferences for route characteristics and crowding in Copenhagen–A choice experiment study of commuters. *Transportation Research Part A: Policy and Practice, 100*, 53–64.

Wardman, M. (1988). A comparison of revealed preference and stated preference models of travel behaviour. *Journal of Transport Economics and Policy*, 71–91.

Wiener, J. M., Büchner, S. J., Wiener, J. M., Büchner, S. J., & Hölscher, C. (2009). Taxonomy of human wayfinding tasks: A knowledge-based approach. *Spatial Cognition and Computation, 9*(2), 152–165.

Zandersen, M., & Tol, R. S. J. (2009). A meta-analysis of forest recreation values in Europe. *Journal of Forest Economics, 15*, 109–130.