Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences
Department of Ecology

Landscapes of recreation – Where, and what are they?

Carl Lehto

Introductory Research Essay
Department of Ecology
SLU

Uppsala 2020

Contents

Introduction

As the 1800s dawned an increasing number of people found themselves having more time for leisure activities. Technological advances and societal change had lessened the pressure of day-to-day survival; at the same time increasing urbanisation drastically changed many peoples relationship with the natural landscape. Concurrently romanticism was peaking, a movement which emphasised and glorified nature and the past, with for example the Norwegian poet and playwright Henrik Ibsen writing about the spiritual and physical benefits of outdoor life.[1] These are some of the factors that led to outdoor life purely for the sake of recreation becoming a folk movement in the 1900s in many countries. An example is Sweden, where at this time organisations such as *Friluftsfrämjandet* and the Swedish Tourist Association were created and started to flourish. Activities that used to be performed in order to survive, such as fishing or picking berries were now performed in a recreational fashion for the sake of enjoyment and relaxation.

Today opportunities for outdoor recreation is classified as a cultural Ecosystem Service (ES) that the natural environment provides. ESs have been the focus of increased attention in recent years, as the conflicts between provisioning ESs (e.g. production of food or timber) and other ES has become apparent; examples include usage of pesticides on arable land reducing populations of wild pollinators or conversion of marshlands reducing the capacity of the landscape to purify water. The issue of how to manage landscapes for multi-use, i.e. to promote different ES at the same time, has been discussed and is now included in strategic target goals under the Convention on Biological Diversity (the "Aichi targets" for 2020). Focus has mainly been on losses of ecosystem services that directly affect human well-being, such as purification of water or loss of pollinators negatively affecting food supply. However, emergent studies on the many psychological and health benefits of access to natural or semi-natural areas for recreation has increased attention for this ES. Attention has especially been paid to the management of peri-urban forests, which can serve as recreational hotspots for a large number of urban citizens. However, the question on how to manage landscapes to increase the potential for recreation is not a simple one. Scientific studies on what characterises a suitable landscape for recreation have been carried out since at least the 1960s, but the research field still has avenues that are unexplored, possibly due to its interdisciplinary nature existing in the space between sociology, psychology, landscape architecture, and biology. Another factor is the inherent complexity of studying human behaviour.

In this essay I will review the current state of knowledge regarding what kinds of landscapes humans prefer to recreate in, and the different ways the topic has been studied. This essay does not attempt to be an exhaustive review of the topic. It will mainly focus on studies on natural and production landscapes (e.g. managed forests) and not on recreation in artificial areas (e.g. city parks). There are different definitions of recreation, and I will be employing the definition by the Swedish

Environmental Protection Agency which reads as follows: “Activities performed outside in the natural or cultural landscape to achieve well-being or to experience nature without need for competition” (my translation).

The main questions to be answered by the essay are

- Where and in what ways have the topic been studied? Which research methods have been used, and what are the advantages and disadvantages of the different methods?
- What are the characteristics of the “Landscapes of recreation”, i.e. what kind of nature is preferred for recreation?

The essay will be structured as follows: first I will introduce a number of different methods that have been used to study recreation, after which I will broadly summarize conclusions regarding how different characteristics of landscapes affect their recreational value. Finally I will discuss advantages and disadvantages of different methods.

On the nature of preference and the preference of nature

Researchers have used many different methods in the study of outdoor recreation. I have divided the methods into three major groups: “Stated preference”, where data has been collected by asking recreationists about their recreational habits or preferences; “Revealed preference” where data has been collected on actual recreational behaviour; and finally “Combination studies, review studies and other” for studies that do not fit either of the other categories.

Stated preference

Early research of the topic of recreation was spurred on in the U.S. by the passing of the Multiple-Use Sustained Yield Act in 1960, which required that management of national forests include management for the purpose of outdoor recreation. At this time studies mainly focused on aesthetics and the beauty of forest stands using the framework of Psychophysics: a discipline of philosophy pioneered by Gustav Theodor Fechner in 1860 which aimed to explain the relation between physical stimuli and the sensations experienced by a subject. The most common method was showing photographs of (mainly near-view) forest landscapes to interview subjects and asking them to rate the scenic beauty on a scale, and then relating these scores to physical attributes of the forest landscapes using statistical regression models.

The method of showing people photographs of natural landscapes has continued to be a common approach, although the frameworks and research questions have broadened in scope. Some studies have focused more on the psychology of preference, e.g. as in a study by Eriksson & Nordlund where

people were showed pictures of forest landscapes and asked to rate the images on four criteria: if the image elicited a positive or a negative emotion (valence), if the image made them feel calm or energetic (activation), whether it was perceived to be easy to find ones way in the image (legibility) and how the participant perceived whether there were more to see in the forest if he or she had the chance to explore it further (mystery).[2] Others have e.g. examined how preference is affected by providing contextual information together with the picture;[3] the effect of socio-demographic factors and held attitudes;[4,5] the effect of familiarity with landscapes;[6] or combined the method with electroencephalography.[7]

An alternative approach was carried out by Edwards *et al.* where they asked experts in forestry preference research across four different regions of Europe (Great Britain, Nordic, Iberia and Central Europe) to participate in a Delphi survey. The survey was divided into two parts: the first part tasked the experts with defining the relationship between a specific characteristic of a forest and the forests recreational value for an "average visitor".[8] The second part instead asked the participants to rate the recreational value of different forest stand types that varied regarding forest management alternative, phase of development and tree species, again for an "average visitor".[9] Some of these predictions were later tested in a study by Giergiczny *et al.*[10]

Questionnaires have also been used to reveal habits of recreationists, such as which types of outdoor recreation is most common[11] or the preferred distance to their nearest forest.[12] In a study by Mattila *et al.*, municipalities in Finland were surveyed regarding how their forests were managed in regards to multifunctionality and recreation.[13]

Some studies have been performed in-situ, with researchers surveying visitors of the area under study. For example, two studies in Sheffield (UK) interviewed visitors to urban and peri-urban greenspace about their experience and their perception of biodiversity;[14,15] while in a Finnish study visitors to recreational sites were asked about their preferences for how the site were managed in a multifunctional perspective.[16]

Choice experiments

Discrete Choice Experiments (DCEs) is another method that has been used to investigate recreational preference. In these studies participants are asked to choose between two or more sites with different characteristics. The sites are usually hypothetical, each created as a specific combination of levels of the different characteristics. As an example, a study performed by De Valck *et al.* in Belgium presented respondents with the question of which of two hypothetical areas they would choose for their five next recreational visits.[17] The areas differed in travel distance from home, presence and quality of recreational facilities, noise level, presence of lakes or rivers, landscape openness, landscape naturalness and landscape diversity. The respondents were also asked what kind of

recreational activity they most often perform. The dataset was then analysed by mixed logit modelling to create regression models that could estimate preferences of real landscapes. Several regression models were created: one for the full dataset and four only using subsets corresponding to the four most commonly reported recreational activites (cycling, hiking, dog-walking, and jogging).

DCEs have been utilized to study e.g. how perceived recreational value is affected by forest stand diversity;[18] the presence of recreational facilities;[19] or different forest management scenarios.[20]

Visitor-employed photography

Another approach that has been used to study outdoor recreation is visitor-employed photography (VEP). In these studies participants are given a camera and asked to take pictures as a tool to elucidate their preferences or how they perceive the environment. This technique was for example used by Heyman in a study of an urban forest in Gothenburg (Sweden); study participants were asked to photograph areas of low or high preference along a trail.[21] A similar study by Qiu *et al.* used the same methodology but also asked the participants to photograph what they perceived to represent low and high biodiversity in the study area.[22] Using a psychological framework, Nielsen *et al.* utilized the method to compare the relative importance of "spatial configuration" (i.e. forest characteristics such as tree age, density, species composition) with "content-based attributes" (i.e. an object, such as a single veteran tree or a piece of recreational infrastructure) of the landscape on preference.[23]

Studies on revealed behaviour

Although the majority of research on the topic of preference are surveys of stated preferences, there are also studies looking at actual behaviour, i.e. how landscapes are actually used for recreation. For example, in a survey of people in the province of Antwerp (Belgium) performed by De Valck *et al.* participants were asked to identify up to three recreational areas they visited in the last year on a map, as well as state what kind of recreation they usually do.[24] Using these locations together with the distance the participant traveled to get there a measure of "substitutability" for the recreational area was computed, the reasoning being that an area that many people visit and are willing to travel a long distance to get to probably has unique properties compared to an area where most visitors only travelled short distances to visit. The result was a hot spot mapping of recreation divided into the four most common groups of recreationists (hikers, cyclists, dog-walkers, and joggers). A similar study was carried out in Denmark by Agimass *et al.*, which focused on understanding which forest characteristics lead to higher willingness to travel longer distances among recreationists.[25]

A novel technique that has become possible in recent years is using geotagged pictures uploaded to social media to study recreational use of landscapes. Some studies only used the locations of the photographs to map where and when recreationists use landscapes, such as a study by Sonter *et al.* that looked at how visitors moved in conserved lands in Vermont (US).[26] Other studies also include

analysis of the content of the photographs, such as a study by Tieskens *et al.* that looked at pictures taken in a peri-urban area on the outskirts of Utrecht (Netherlands).[27] In the study, a general linear model was fitted to predict densities of photograph locations using landscape characteristics, and then for locations with high positive or negative residuals (places where the model either underestimated or overestimated the amount of photographs) content analysis of photographs was performed to investigate why the model was not fitting. In a study by Oteros-Rozas *et al.* photographs across five sites in Europe were compared to see what landscape characteristics were positively associated to provision of different cultural ecosystem services.[28]

Yoshimura & Hiura instead utilised images downloaded from social media to map recreational usage on the island of Hokkaido (Japan).[29] Here, a sophisticated method to model in which directions photographs were most likely taken was developed. A machine learning model was then trained on the dataset along with environmental data to predict which areas potentially had high recreational preference potential but was not currently being used.

A method with some similiarities to thos above is to equip visitors with GPS trackers. That has mainly been used to map the usage of recreational areas such as national parks or nature reserves.[30]

Combination studies, reviews and other

Some studies have combined stated and revealed preference; for example in a study on how recreationists utilised a recreational area outside Oslo (Norway) a questionnaire was distributed in-situ and used together with automatic visitor counters.[31]

Computer calculation has also been used, for example in two studies on forest management: Eggers *et al.* used the Heureka modelling system to estimate the recreational value of forest stands under different management strategies,[32] while Pang *et al.* used the Landscape simulation and Ecological Assessment tool to see how different ecosystem services (recreation being one of them) were affected by different management strategies.[33]

Utilising a large dataset of photographs of landscapes in the UK that were rated for "scenicness" and also described with words, Chesnokova *et al*. used machine learning algorithms to perform language analysis of the descriptions and relate this to the scenicness score.[34]

Two reviews of what forest characteristics affect preference has been carried out; the first focusing on studies in North America[35] and the second focusing mainly on Fennoscandian studies.[36] Both of these mainly included studies of stated preferences. Creating a geospatial model from review of literature, Paracchini *et al.* developed a spatial model of recreation potential across the European Union.[37] Komossoa *et al.* expanded on this framework by performing a similar analysis but creating different models for five 'archetypes' of recreationist.[38]

Results

In this section I will broadly summarize the results of the research presented in the previous section.

Forest characteristics

The result of the Delphi survey of experts on the relationship between forest attributes of a forest stand and its recreational value can be seen in the table below (adapted from Edwards *et al.)*[8]

Attribute	Relationship to recreational value[a]				
	Great Britain (n=10)	Nordic region (n=12)	Central Europe (n=14)	Iberia (n=10[b])	All regions (%[c])
1. Size of trees	P	P	P	P	P (91)
2. Variation in tree size	P	B	P	P	P (63)
3. Variation in tree spacing	P	P	P	B	P (59)
4. Extent of tree cover	B	P/B	B	B	B (74)
5. Visual penetration	B	B	B	P	B (54)
6. Density of ground vegetation	B	B	B	N	B (59)
7. Number of tree species	P	P	B	P	P (52)
8. Size of clear-cuts	N	N	N	N	N (93)
9. Residue	N	N	N	N	N (69)
10. Amount of natural deadwood	B	N	B	B	B (59)
11. Variation between stands	P	B	P	P	P (59)
12. 'Naturalness' of forest edges	P	P	P	P	P (93)

a) P = Linear positive relationship on recreational value as attribute increases
N = Linear negative relationship on recreational value as attribute increases
B = Bell-shaped relationship on recreational value; as attribute increases recreational value increases until an optimum is reached, after which it decreases
b) n = 9 for attribute 12
c) Percentage of respondents that chose the most common relationship in parentheses

There was a consensus regarding the effect of certain attributes for recreational value, e.g. size of trees, size of clear-cuts and 'naturalness' of forest edges, while others had some differences between regions such as amount of natural deadwood and density of ground vegetation. The second part of the survey, where the experts rated hypothetical forest stands with combinations of forest stand attributes, generally showed the same trend across the four regions. "Phase of development" was the most important factor explaining recreational value with older forests having a higher value, followed by "forest management alternative" where more intensive management received a lower value, and finally "tree specie"s where presence of deciduous trees gave a higher value. Trends for the three characteristics were consistent between regions, with the exception of Nordic researchers having a lower predicted recreational value for forest nature reserves and a higher predicted value for intensively managed forests compared to their colleagues from other regions.[9]

Some of the predictions of the two studies were tested in a DCE performed by Giergiczny *et al.*[10] The results were in agreement, with positive preferences for variation in tree spacing, number of tree species and variation between forest stands. There were negative correlations with increasing management intensity and residue from harvesting, while density of understory, 'naturalness' of the forest edge and volume of deadwood showed bell-shaped relationships.

The two large reviews on stated preference research were also largely in agreement with the predictions above.[35,36] In both reviews large trees, both in regards to diameter and height, were preferred. Young forests were in general not perceived as preferable, which might be confounded by the fact that they often are dense, which also was a characteristic that received low scores. Presence of deadwood was negatively correlated with preference, however natural downed wood was more preferable than residue from logging operations (slash). Other signs of forestry were also negatively correlated with scenic beauty, where scores decreased the more apparent the forestry operation. Dramatic changes such as after clear-cutting or fire were negative, while a varied tree species composition and a large amount of vegetative ground cover was positive. The reviews found few studies that looked at virgin or unmanaged forests, and the ones that did so reported low preferences for such forests.

Stoltz *et al.* analysed what characteristics lead to a high "restorativeness potential" of a forest stand andfound that the most important factors were tree age, tree height and tree sparsity; i.e. the most restorative forest was one with large trees that was not too dense, similar to the findings above on recreational value.[39]

Other landscape types

With a few exceptions, studies have looked at recreation in forests. A study by Oteros-Rozas *et al.* analysed photographs taken in five areas across Europe for presence of cultural ES and showed that wood pastures, water bodies and mountainous regions were overrepresented in these images compared to their land cover percentage.[28]

Biodiversity

The studies of whether people can perceive biodiversity and how it affects recreational preference does not paint a wholly coherent picture. In the VEP-study of an urban forest trail by Qiu *et al.,* study participants could correctly identify areas of low and high biodiversity, however the most preferred areas were the ornamental, park-like areas of the trail with low biodiversity. The authors however note that this negative correlation should not be generalised, as analysis of the comments that the study participants provided along with the photographs showed that preference was more influenced by specific features such as evidence of human intervention.[22] The results differed between he two studies from Sheffield, where visitors to urban greenspace were surveyed to estimate biodiversity

along with their well-beingstudies. In the first study, Fuller *et al.* showed that the study participants could correctly estimate plant diversity, and to a lesser extent diversity of birds but not that of butterflies, and also that psychological benefit was positively correlated with actual biodiversity of the greenspace.[15] In the second study by Dallimer *et al.*, study participants could not correctly estimate the actual biodiversity, but perceived biodiversity was highly correlated with well-being, showing that respondents enjoyed areas they believed to be more species-rich but were unable to correctly identify the actual biodiversity of plants, birds or butterflies.[14]

In a series of experiments and field studies, Lindemann-Matthies *et al.* showed that people found grasslands with diverse plant communities more aesthetically pleasing.[40] Similar to the Dallimer study appreciation had a positive correlation with perceived biodiversity, even when actual biodiversity did not increase. People in this study were able to correctly perceive species richness, but overestimated when actual species richness was low and underestimated when species richness was high.

Gundersen *et al*. showed that the preference for photographs of forest stands increased if deadwood was digitally removed from the picture; however when contextual information on the role of deadwood in relation to biodiversity was provided along with the photographs the negative effect decreased significantly.[3]

When comparing Finnish national parks, Siikamäki *et al.* showed that visitor numbers were correlated with high biotope diversity. The study also revealed that within the national parks visitor densities were higher in areas of high species diversity.[41]

Psychology and individual variation

Several studies suggest that psychological processes and individual variation can be predictors of preference. In Eriksson & Nordlund, study participants rated images of forest stands on the criteria of valence, activation, legibility and mystery, and the results showed that these cognitive and emotional variables were strong predictors of preference.[2] The results varied by recreational activity however, with for example legibility being important for intention to exercise and activation being important for studying plants or animals. Different recreational activities leading to different preferences was also shown by De Valck *et al.*, which contrasted the preferences of dog-walkers, joggers, cyclists, and hikers: e.g. showing that the distance they were willing to travel to perform the activity varied between groups.[17] Kearney & Bradley compared preference data of forest landscapes between four stakeholder groups: foresters, environmentalists, rural public and urban public.[4] They also analysed the effect of demographic factors and held attitudes on preference. Attitudes towards forest management was the single most important factor in affecting preference. Stakeholder group was not a significant predictor after taking into account the correlation between stakeholder groups and attitudes.

Svobodova *et al.* showed that study participants award higher preference scores to pictures of landscapes that resembled nature where they were from, compared to landscapes they were currently living in.[6]

Discussion

As shown above, outdoors recreation research is a diverse field, employing many different methods and frameworks to understand the various aspects of where, why and how humans choose to recreate in nature. Early research, dominated by stated preference studies using photographs or questionnaires, has flourished into a cornucopia of sophisticated approaches using modern tools such as GIS, machine-learning algorithms, and neural networks. The broadened scope of the topic together with varying methodology has sometimesmade comparisons of results and general conclusions harder to make, but has also led to new insights. These different methods have different strengths and weaknesses, and below I briefly contrast them to each other.

Showing photographs of landscapes to people and asking them to rate their aesthetic or recreational preference is a simple and direct method to estimate preference. Today, the usage of internet surveys has made it easier to achieve larger sample sizes for such studies (despite the common issue of low response rates). An important question arises regarding what conclusions can be drawn from these studies: do preference for images of a landscape translate to preference for the actual landscape itself? I was unable to find any studies where the same study participants ranked images of a landscape and subsequently were brought into the depicted landscape itself, as a way to validate the method. The distillation of a landscape into a photograph removes many factors that might affect recreational value, such as sounds or smells.

Turning the method on its head, visitor-employed photography studies instead tasks the study participant to directly show preference by taking the photographs themselves. This method is harder and possibly more subjective to analyse since the photographs need to be interpreted by the researchers. It is also a resource intensive method, making it hard to acquire large sample sizes or study large areas, but it might lead to insights which other methods miss. Heyman *et al.* however suggest that some caution should be taken when drawing conclusions: “Walking in the forest with a camera and a clearly defined task will most likely be different to other forest visits. Several participants stated that the photo process gave them a new perspective on their forest experience, and I believe that the high degree of involvement by the participants must be taken into account when VEP is compared to other preference studies.”.[21]

Utilising geotagged images downloaded from public sources is a useful method to easily acquire large amount of data on the actual use of landscapes, but has its own pitfalls. Demographic data of the users

that upload the images are seldom available, which means that it is hard to know if the sample is representative of the population in the area under study. It might not be fully representative of the types of recreation being performed either, e.g. one could imagine that a mountain biker might be less likely to take photographs during an outing than a dog-walker. The method is also reliant on there being a high enough density of users. Analysing the contents of the photographs themselves, such as performed by Oteros-Rozas *et al.,* is a powerful (but resource intensive) way to gather insight into behaviour of recreationists.[28]

Many of the studies reviewed here focus on a small scale, looking at how the characteristics of a single forest stand or an area affects recreational preference. However, outdoor recreation (depending on activity) is generally performed on a larger scale, and various types of landscapes might be experienced at the same time. Although the use of geotagged images is an exciting avenue for large scale mapping of recreation it does not yield detailed information on how an individual moves through a landscape. Individual GPS tracking, for instance as performed by Beeco *et al.,* can be used for this purpose but is a resource intensive method.[30]

An obstacle for studies looking at recreation on a larger scale could be the possibility of spatial sorting. Abildtrup *et al.* showed that people are more inclined to live in areas with greater access to nature if recreation is more important to them.[42]

Another aspect that the research has shown is that preferences are heterogenous. They vary between individuals, and also between the mode of outdoor recreation considered: e.g. a typical cyclist does not have the same preferences as a typical hiker.[24] The importance of this heterogeneity of preference was shown by Silvennoinen *et al.* where their model of preference was highly accurate in estimating the average recreational value of a forest stand given by a group, but was unsuccessful in predicting the response of individuals.[43] Since outdoors recreation is an expression of human culture, variance between countries or regions is expected, a factor that could make comparisons between different studies harder. An example could be differences between countries with laws or traditions of "right-to-roam" (e.g. Fennoscandia) compared to countries with stricter laws regarding access to private land. There could also be shifts of preference over time.

Regarding the connection between biodiversity and recreation the picture is not entirely clear. Although there seems to be preference against some of the elements that correlate with high levels of biodiversity (such as large amounts of deadwood and dense, virgin forests),[3,36] there is also support for the idea that we enjoy and seek out areas of high biodiversity.[14,15,41] This could be an example of a preference that is changing over time, since the issue of biodiversity and the importance of structural elements of forests such as deadwood and virgin forests has received increased attention during the last few decades, and as Gundersen *et al.* showed, such knowledge can affect preference.[3] The potential relationship between recreation and biodiversity is important in the perspective of

multifunctional landscapes, where land is managed to benefit many ESs at the same time. Dronova *et al.* suggest that increased landscape hetereogeneity can increase both the aesthetic value of landscapes (which in turn benefits recreation) and biodiversity at the same time.[44]

Conclusions

Outdoor recreation is a complex phenomenon, necessitating the bridging of the natural sciences and the humanities in the pursuit of understanding. Knowledge on why, how and where humans recreate in the natural environment is important for a multitude of reasons. Studies showing the numerous health benefits of access to areas suitable for recreation, and that people are becoming increasingly "nature-illiterate", have spurred on the calls for increased attention to recreation in landscape planning.[45] Since outdoor recreation is such a broad topic, including many different activities with varying demands on the natural environment it is inherently a complicated issue and further research is needed. This essay might give the impression that the task at hand is a daunting one, and drawing general conclusions on what humans across the different cultural contexts want from the natural environment is difficult, but I would like to end by paraphrasing John F Kennedy: We choose to study recreation; and we choose to do it not because it is easy, but because it is hard.

References

1. Ibsen, Henrik. *Paa Vidderne*. (1859).
2. Eriksson, L. & Nordlund, A. How is setting preference related to intention to engage in forest recreation activities? *Urban For. Urban Green.* **12**, 481–489 (2013).
3. Gundersen, V., Stange, E. E., Kaltenborn, B. P. & Vistad, O. I. Public visual preferences for dead wood in natural boreal forests: The effects of added information. *Landsc. Urban Plan.* **158**, 12–24 (2017).
4. Kearney, A. R. & Bradley, G. A. The Effects of Viewer Attributes on Preference for Forest Scenes: Contributions of Attitudes, Knowledge, Demographic Factors, and Stakeholder Group Membership. *Environ. Behav.* **43**, 147–181 (2011).
5. Gunnarsson, B., Knez, I., Hedblom, M. & Sang, Å. O. Effects of biodiversity and environment-related attitude on perception of urban green space. *Urban Ecosyst.* **20**, 37–49 (2017).
6. Svobodova, K., Vondrus, J., Filova, L. & Besta, M. The role of familiarity with the landscape in visual landscape preferences. 15 (2011).
7. Johansson, M., Gyllin, M., Witzell, J. & Küller, M. Does biological quality matter? Direct and reflected appraisal of biodiversity in temperate deciduous broad-leaf forest. *Urban For. Urban Green.* **13**, 28–37 (2014).
8. Edwards, D. *et al.* Public preferences for structural attributes of forests: Towards a pan-European perspective. *For. Policy Econ.* **19**, 12–19 (2012).
9. Edwards, D. M. *et al.* Public Preferences Across Europe for Different Forest Stand Types as Sites for Recreation. *Ecol. Soc.* **17**, art27 (2012).
10. Giergiczny, M., Czajkowski, M., Żylicz, T. & Angelstam, P. Choice experiment assessment of public preferences for forest structural attributes. *Ecol. Econ.* **119**, 8–23 (2015).
11. *Friluftsliv 2018: nationell undersökning av svenska folkets friluftslivsvanor*. (2019).
12. Hörnsten, L. & Fredman, P. On the distance to recreational forests in Sweden. *Landsc. Urban Plan.* **51**, 1–10 (2000).

13. Mattila, O., Häyrinen, L., Tervo, M., Toppinen, A. & Berghäll, S. Challenges of municipal greening and multifunctional forest management: The case of Finland. *Urban For. Urban Green.* **14**, 982–990 (2015).
14. Dallimer, M. *et al.* Biodiversity and the Feel-Good Factor: Understanding Associations between Self-Reported Human Well-being and Species Richness. *BioScience* **62**, 47–55 (2012).
15. Fuller, R. A., Irvine, K. N., Devine-Wright, P., Warren, P. H. & Gaston, K. J. Psychological benefits of greenspace increase with biodiversity. *Biol. Lett.* **3**, 390–394 (2007).
16. Horne, P., Boxall, P. C. & Adamowicz, W. L. Multiple-use management of forest recreation sites: a spatially explicit choice experiment. *For. Ecol. Manag.* **207**, 189–199 (2005).
17. De Valck, J. *et al.* Outdoor recreation in various landscapes: Which site characteristics really matter? *Land Use Policy* **65**, 186–197 (2017).
18. Filyushkina, A., Agimass, F., Lundhede, T., Strange, N. & Jacobsen, J. B. Preferences for variation in forest characteristics: Does diversity between stands matter? *Ecol. Econ.* **140**, 22–29 (2017).
19. Christie, M., Hanley, N. & Hynes, S. Valuing enhancements to forest recreation using choice experiment and contingent behaviour methods. *J. For. Econ.* **13**, 75–102 (2007).
20. Juutinen, A., Kosenius, A.-K., Ovaskainen, V., Tolvanen, A. & Tyrväinen, L. Heterogeneous preferences for recreation-oriented management in commercial forests: the role of citizens' socioeconomic characteristics and recreational profiles. *J. Environ. Plan. Manag.* **60**, 399–418 (2017).
21. Heyman, E. Analysing recreational values and management effects in an urban forest with the visitor-employed photography method. *Urban For. Urban Green.* **11**, 267–277 (2012).
22. Qiu, L., Lindberg, S. & Nielsen, A. B. Is biodiversity attractive?—On-site perception of recreational and biodiversity values in urban green space. *Landsc. Urban Plan.* **119**, 136–146 (2013).
23. Nielsen, A. B., Heyman, E. & Richnau, G. Liked, disliked and unseen forest attributes: Relation to modes of viewing and cognitive constructs. *J. Environ. Manage.* **113**, 456–466 (2012).

24. De Valck, J. *et al.* Contrasting collective preferences for outdoor recreation and substitutability of nature areas using hot spot mapping. *Landsc. Urban Plan.* **151**, 64–78 (2016).
25. Agimass, F., Lundhede, T., Panduro, T. E. & Jacobsen, J. B. The choice of forest site for recreation: A revealed preference analysis using spatial data. *Ecosyst. Serv.* **31**, 445–454 (2018).
26. Sonter, L. J., Watson, K. B., Wood, S. A. & Ricketts, T. H. Spatial and Temporal Dynamics and Value of Nature-Based Recreation, Estimated via Social Media. *PLOS ONE* **11**, e0162372 (2016).
27. Tieskens, K. F., Van Zanten, B. T., Schulp, C. J. E. & Verburg, P. H. Aesthetic appreciation of the cultural landscape through social media: An analysis of revealed preference in the Dutch river landscape. *Landsc. Urban Plan.* **177**, 128–137 (2018).
28. Oteros-Rozas, E., Martín-López, B., Fagerholm, N., Bieling, C. & Plieninger, T. Using social media photos to explore the relation between cultural ecosystem services and landscape features across five European sites. *Ecol. Indic.* **94**, 74–86 (2018).
29. Yoshimura, N. & Hiura, T. Demand and supply of cultural ecosystem services: Use of geotagged photos to map the aesthetic value of landscapes in Hokkaido. *Ecosyst. Serv.* **24**, 68–78 (2017).
30. Beeco, J. A., Hallo, J. C. & Brownlee, M. T. J. GPS Visitor Tracking and Recreation Suitability Mapping: Tools for understanding and managing visitor use. *Landsc. Urban Plan.* **127**, 136–145 (2014).
31. Gundersen, V., Tangeland, T. & Kaltenborn, B. P. Planning for recreation along the opportunity spectrum: The case of Oslo, Norway. *Urban For. Urban Green.* **14**, 210–217 (2015).
32. Eggers, J., Lindhagen, A., Lind, T., Lämås, T. & Öhman, K. Balancing landscape-level forest management between recreation and wood production. *Urban For. Urban Green.* **33**, 1–11 (2018).
33. Pang, X., Nordström, E.-M., Böttcher, H., Trubins, R. & Mörtberg, U. Trade-offs and synergies among ecosystem services under different forest management scenarios – The LEcA tool. *Ecosyst. Serv.* **28**, 67–79 (2017).
34. Chesnokova, O., Nowak, M. & Purves, R. S. A Crowdsourced Model of Landscape Preference. 13 (2017).

35. Ribe, R. G. The aesthetics of forestry: What has empirical preference research taught us? *Environ. Manage.* **13**, 55–74 (1989).
36. Gundersen, V. S. & Frivold, L. H. Public preferences for forest structures: A review of quantitative surveys from Finland, Norway and Sweden. *Urban For. Urban Green.* **7**, 241–258 (2008).
37. Paracchini, M. L. *et al.* Mapping cultural ecosystem services: A framework to assess the potential for outdoor recreation across the EU. *Ecol. Indic.* **45**, 371–385 (2014).
38. Komossa, F., van der Zanden, E. H., Schulp, C. J. E. & Verburg, P. H. Mapping landscape potential for outdoor recreation using different archetypical recreation user groups in the European Union. *Ecol. Indic.* **85**, 105–116 (2018).
39. Stoltz, J. *et al.* Planning for restorative forests: describing stress-reducing qualities of forest stands using available forest stand data. *Eur. J. For. Res.* **135**, 803–813 (2016).
40. Lindemann-Matthies, P., Junge, X. & Matthies, D. The influence of plant diversity on people's perception and aesthetic appreciation of grassland vegetation. *Biol. Conserv.* **143**, 195–202 (2010).
41. Siikamäki, P., Kangas, K., Paasivaara, A. & Schroderus, S. Biodiversity attracts visitors to national parks. *Biodivers. Conserv.* **24**, 2521–2534 (2015).
42. Abildtrup, J., Garcia, S., Olsen, S. B. & Stenger, A. Spatial preference heterogeneity in forest recreation. *Ecol. Econ.* **92**, 67–77 (2013).
43. Silvennoinen, H., Alho, J., Kolehmainen, O. & Pukkala, T. Prediction models of landscape preferences at the forest stand level. *Landsc. Urban Plan.* **56**, 11–20 (2001).
44. Dronova, I. Environmental heterogeneity as a bridge between ecosystem service and visual quality objectives in management, planning and design. *Landsc. Urban Plan.* **163**, 90–106 (2017).
45. Soga, M. & Gaston, K. J. Extinction of experience: the loss of human-nature interactions. *Front. Ecol. Environ.* **14**, 94–101 (2016).