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The relationship between people's activities and values with the protection level and biodiversity

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ABSTRACT

We investigated how people's recreational activities, values, and land use preferences are related to the protection level, biodiversity and cultural heritage values of nature-based tourism areas in northern Finland. We assessed peoples' opinions using a public participation geographic information system (PPGIS) and analyzed the data together with spatial biodiversity and cultural heritage data from the same area. Associations between the PPGIS place markings with the protection level and biodiversity values were quite low, and for the cultural heritage sites they were altogether missing. Negative preferences were often marked in areas with high numbers of sites rated as pleasant and they overlapped with each other, indicating conflicting preferences. Since most activities are not noticeably related to the protection level or biodiversity values of a site they can be planned so as to protect the biodiversity of the area.

1. Introduction

Nature-based tourism and outdoor recreation are increasing activities in rural environments, where their social and economic importance may exceed that of other livelihoods (Butler, 2014). In regions with public access to land, such as northern Fennoscandia, recreation is permitted widely in protected areas and commercial forests irrespective of their protection or ownership status (Juutinen, Kosenius, Ovaskainen, Tolvanen, & Tyrväinen, 2017; Stokke & Haukeland, 2017, Eggers, Lindhagen, Lind, Lämås, & Öhman, 2018). These environments provide a wide range of activities such as nature observation, physical exercise, foraging for berries and mushrooms, fishing and hunting, and in many areas, also the use of motorized vehicles. Since nature-based tourism resorts are often located in the vicinity of protected areas (Wall Reinius & Fredman, 2007; Huhta & Sulkava, 2014; Tolvanen & Kangas, 2016), there is a need for multiple use planning, on one hand to fulfill recreational needs, and on other hand, to maintain the biodiversity values of the protected areas.

Environments are not equally suitable for different types of recreational activities. For example, nature observation is related to environments that are perceived as natural habitats (Pietilä & Kangas, 2015), whereas picking of berries is better in managed forests where the availability of natural products is higher (Lindhagen & Hörnsten, 2000). Differences between socioeconomic groups have been commonly found in terms of how people use and value their environment (Gundersen & Frivold, 2008; Munoz, Hausner, Brown, Runge, & Fauchald, 2019). For example forest cuttings may raise negative opinions in nature-based tourism areas due to the perceived harm to the landscape (Tyrväinen, Silvennoinen, & Hallikainen, 2017). However, these opinions may differ for example between women and men, local people and visitors, and also depending on the forest ownership (Silvennoinen, Pukkala, & Tahvanainen, 2002). Knowledge about these differences in opinions can be used to manage nature-based tourism resorts and their nearby protected areas in a way that fulfils the needs of the users.

Protected areas differ in terms of their protection level and the facilities concerning their use, which influence how they can be used for recreational purposes. The classification scheme by the International Union for Conservation of Nature (IUCN) implies that some areas should prioritize biodiversity protection while others should also include recreation and the cultural and historical elements in the landscape

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(Dudley, 2008). Biodiversity has been linked to recreational use especially in protected areas (Siikamäki, Kangas, Paasivaara, & Schroderus, 2015), but people perceive biodiversity in various ways. Some studies indicate no relationship between the measured species richness and the psychological well-being (Dallimer et al., 2012), while other studies have shown a positive relationship (Lindeman-Matthies, Junge, & Matthies, 2010), and a trade-off between biodiversity and peoples' values (Tyrväinen, Silvennoinen, & Kolehmainen, 2003). What is more consistent is the positive relationship between the perceived naturalness and wellbeing (Dallimer et al., 2012; Boll, von Haaren, & von Ruschkowski, 2014; Hoyle, Hitchmough, & Jorgensen, 2017). The discrepancy or lacking relationship between people's values and the assessed biodiversity values may lead to conflicts in conservation priorities, but on the other hand, it can be helpful to understand this aspect in order to better manage sensitive areas of high biodiversity that should be protected from excess recreational use.

A number of spatial models have been applied to raise awareness of the fragility of popular mountain ecosystems and their sensitivity to tourism development and recreational use (Uusitalo & Sarala, 2015). Such models have also been used to develop sensitivity criteria for landscapes based on changes in their visual quality after management (Store, Karjalainen, Haara, Leskinen, & Nivala, 2015). Biodiversity values, which are often based on the spatial data on valuable habitats and species (e.g. Moilanen et al., 2005; Willis et al., 2012), have also been assessed to locate the most sensitive areas for nature-based tourism and recreational infrastructure in terms of biodiversity protection (Kangas et al., 2016). A common problem in assessing biodiversity is that high-quality habitat and species level data is not generally available, and this is among the major factors still constraining the use of biodiversity data in land use planning.

A public participation geographic information system (PPGIS) provides a tool that can be used to assess socio-cultural values and ecosystem services in a landscape (Brown & Kyttä, 2014, Brown & Fagerholm, 2015) and the spatial value distribution of different user groups (Brown & Reed, 2009; Kahila-Tani, 2016, p. 223). The method usually involves web-based surveys, so that the spatial data can be collected from large numbers of diverse people. By linking PPGIS data with biophysical characteristics the relationship between place-based values and the environment can be explored (Munoz et al., 2019). Example applications include forest planning (Brown & Reed, 2009), national park planning to map visitor experiences and environmental impacts (Brown & Weber, 2011), assessments of the socio-ecological values concerning public land (Brown, Weber, & de Bie, 2014), and regional conservation planning (Karimi & Brown, 2017). This socio-ecological approach helps to identify specific hotspot areas that promote both human needs and nature values (Alessa, Kliskey, & Brown, 2008), or areas where human needs and nature values are in conflict.

In this paper we present a study in which high-quality spatial biodiversity and cultural heritage datasets were analyzed together with PPGIS survey data to investigate how people's recreational activities, values and preferences are related to the protection level, biodiversity value and cultural heritage sites of a nature-based tourism area. To our knowledge this is the first study where these human and biophysical characteristics have been assessed together to find ways to fulfil various needs related to the use of nature-based tourism areas. Our aims were to assess 1) whether people's activities, values and preferences are linked to the protection level, biodiversity values and cultural heritage sites, and 2) whether there are differences between the opinions of the respondents that reflect potential conflicts or provide knowledge that could be used to manage the area in a way that fulfils the needs of the concerned user groups. The study was carried out in a nature tourism area in north-eastern Finland, where multiple interests and needs such as tourism development, nature protection, and forestry concern the same forest areas, and conflicts have arisen (WWF Finland, 2017). We assessed the results using spatial analyses and multicriteria methods.

2. Material and methods

2.1. Research area

The research area of 1411.5 km^2 is located in the municipalities of Puolanka and Hyrysalmi in the sparsely populated region of Kainuu, in the north east of Finland (Fig. 1). The total population is approximately 5000 and average population density is 1.2 inhabitants per square kilometer in the two municipalities (Statistics Finland, 2015). The area is intended to be developed as nature-based tourism area in the regional development plan, highlighting the importance of nature, silence, cultural history, and opportunities to see wild animals (Kainuun maakunta–kuntayhtymä, 2007). Two nature-based tourism resorts (Ukkohalla and Paljakka, hereafter referred to as tourism resorts) are located in the area. During the time of the research in 2012 and 2013, the annual number of overnight stays in these resorts was approximately 80,000, of which over 90% were domestic visitors (Statistics Finland, 2015).

Almost half (48%) of the research area is state-owned. Nature protection, which does not allow forestry operations, is principally on state-owned land. Several protected areas and one strict nature reserve are located in the research area. Most protected areas in the research area are under 20 km^2, and areas outside the protected areas are principally managed commercial forests. Intensive forest cuttings have escalated a number of conflicts in the research area, since cuttings are considered a risk both to the biodiversity in the valuable areas outside the protected areas and to nature-based tourism (WWF Finland, 2017). Some of the planned cuttings have also been prohibited by the regional environmental authority (Kainuu ELY Centre, 2016).

2.2. Collecting data on people's activities and perceptions through PPGIS

We generated an Internet-based survey using the PPGIS tool developed at Aalto University (Kyttä & Kahila, 2011). The user interface included conventional survey questions and mapping pages. A paper format of the questionnaire was also available, where the respondents could mark the sites on a paper map. This was done to increase the response rate, which may sometimes be a challenge in PPGIS surveys (Brown & Kyttä, 2014).

The survey included four themes, whereby the first theme mapped the respondents' socioeconomic backgrounds in terms of their relationship to the research area (whether they were local people or visitors), gender, age, education level, employment status, and whether they were forest owners.

For the second theme the respondents could mark their activities on a map by using a polygon or a point. Each respondent could mark as many polygons and points as they wanted. After each marking a pop-up window appeared asking about specific activities performed at that site. Eight activities could be marked, and the respondents could mark one or several activities (Table 1). Another pop-up window asked about perceived land use threats, such as tourism, nature protection and forestry. These markings were pooled with the preference markings that will be described later.

For the third theme the respondents could mark sites regarded as pleasant or unpleasant. These were marked as points on the map. After marking the site, a pop-up window opened which asked for specific values for the site being pleasant or unpleasant. Ten values were used for pleasant sites (Table 2) and nine for unpleasant sites.

The fourth theme of the questionnaire asked the respondents about their land use preferences. The respondents were asked to mark sites which they thought should not be used for tourism, nature protection or forestry, for example. The markings could be made as polygons and as points. Since this question was quite similar to the pop-up question related to perceived land use threats under the first theme, the answers were pooled later and described as negative preferences towards tourism, nature protection and forestry. Pooling was done to increase

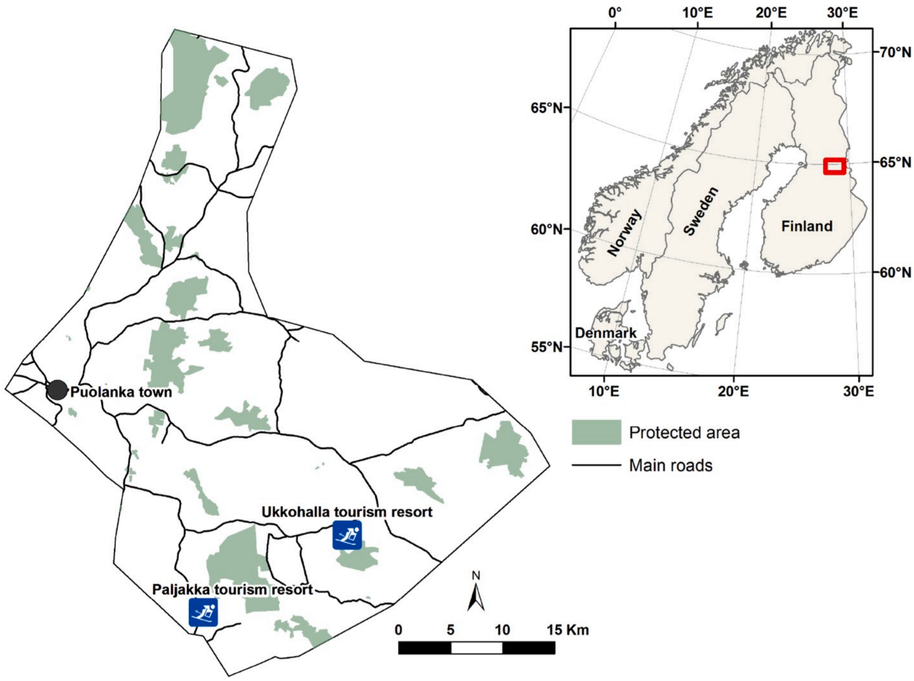

Fig. 1. Map of the research area.

Table 1
Gender, age, education level and employment status of the average population in the two municipalities and among the respondents. Population data from Statistics Finland (2015).

	Average population in the two municipalities	Local (88)	Visitor (168)
Female	NA	36 (41%)	74 (44%)
Male	NA	52 (59%)	91 (54%)
People 15–64 years	57.4%	74 (84%)	161 (96%)
People over 64 years	31.7%	13 (15%)	6 (4%)
Elementary school	NA	32 (36%)	9 (5%)
Secondary school	58.6%	32 (36%)	46 (27%)
College or University	14.6%	23 (26%)	111 (66%)
Work or entrepreneur	32.8%	34 (39%)	125 (74%)
Unemployed	10.8%	10 (11%)	4 (2%)
Retired	42.1%	23 (26%)	17 (10%)
Other (e.g. home parent)	NA	21 (24%)	20 (12%)
Forest owners	NA	45 (51%)	62 (37%)

the response rate to this topic.

In the mapping tasks we used topographic maps produced by National Land Survey Finland. In the Internet-based survey the mapping accuracy was improved by allowing mappings only if the participant had zoomed-in to a predetermined zoom level. The survey was piloted in a workshop with local stakeholders in February 2012. We made modifications to the survey based on the feedback, and the web-based survey was thereafter open to the public from July 2012 until March 2013. The questionnaire was advertised in local newspapers, on project webpages, social media, through local project partners, in village meetings and at specific events. One or two people were available in most of the events to help the respondents and to provide hardcopy versions. The questionnaire was also permanently available in the computer of the hotel lobby of one of the tourism resorts.

Table 2
The number of activities in 254 activity markings and their coverage in the research area. Several activities could be marked by the respondents; hence the sum of the markings cannot be calculated directly from the table.

Activity	Abbreviation	Markings (% of all 254 markings)		Number of grid cells (% of all grid cells) covered by the activity	
Hiking and sports	HikeSport	147	(57.9%)	70370	(48.4%)
Nature observation	NatObserv	123	(48.4%)	82604	(56.8%)
Hunting and fishing	HuntFish	73	(28.7%)	82108	(56.5%)
Natural products	NatProduct	72	(28.3%)	76518	(52.6%)
Other	Other	32	(12.6%)	17383	(12.0%)
Work	Work	26	(10.2%)	39694	(27.3%)
Forestry work	Forestry	23	(9.1%)	30359	(20.9%)
Motorsports	Motorsport	17	(6.7%)	24815	(17.1%)

2.3. Treatment of spatial PPGIS data

We divided the research area into 145,364 1 ha (100 m*100 m) grid cells and assigned the data from the PPGIS survey to these grid cells. We calculated scores for each activity both from the marked polygons and points. Each grid cell that was completely or partially located within a marked activity polygon or within a 100 m radius of a marked activity point was given one score. The 100 m radius from the marked points was used to reduce the effect of mapping inaccuracy (e.g. Brown & Fagerholm, 2015). In the case when a respondent had marked several activities for one marking, one score was given for each activity. Consequently in each grid cell, the final score per activity was the sum of the scores given by all respondents for that activity.

Pleasant and unpleasant sites and their values could only be marked as points. Each grid cell that was completely or partially located within a 100 m radius of a marked point was given one score. In the case when a respondent had given several different values for pleasant/unpleasant sites per one marking, one score was given for each value. In each grid cell, the final score per pleasant/unpleasant site value was the sum of the scores given by all respondents for that value.

Scores concerning the negative preferences towards tourism, nature protection and forestry were calculated from marked polygons and points. Each grid cell that was completely or partially marked was given one score for the respective preference. In each grid cell, the final score per negative preference was the sum of all scores given by all the respondents for that preference.

2.4. Assigning protection level and biodiversity values from existing datasets

Protection level and biodiversity values were calculated for each 1 ha grid cell of the research area. The data was obtained from another study in which the assessment of ecological values had been conducted for the same research area (Kangas et al., 2016). The assessment was based on extensive spatial data from long-term field measurements and remote sensing. The information included data on the location of different types of protected areas, endangered and rare habitats and species, and forest stand characteristics. The data was used to assess the suitability of the habitats for 18 key species typical to old-growth forests, and to create a

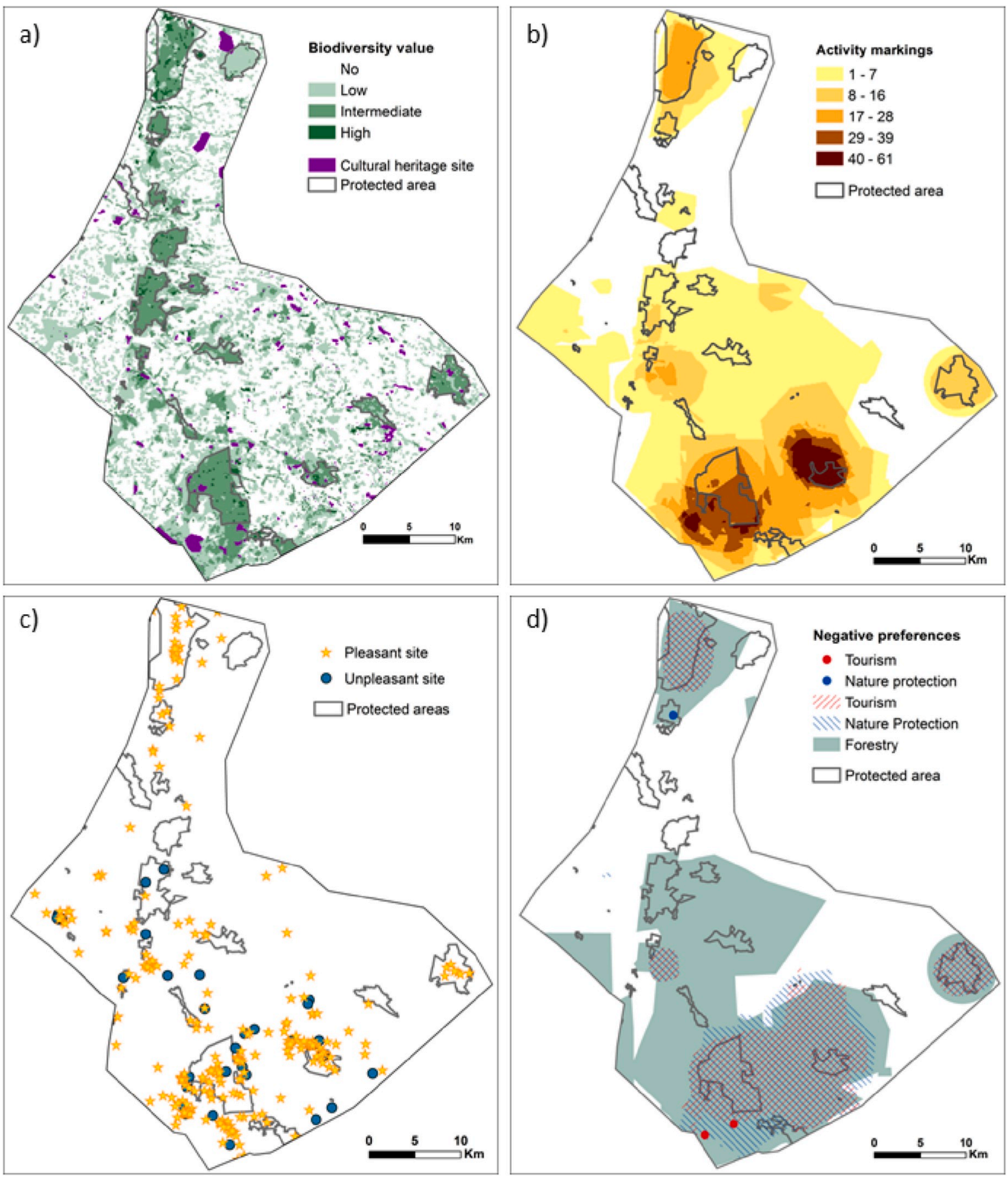

Fig. 2. A) Protected areas, biodiversity values (aggregated from three separate layers) and cultural heritage sites in the study area, B) the number of activity markings, C) the location of pleasant and unpleasant sites, and D) negative preferences (as points or polygons) towards tourism, nature protection and forestry based on PPGIS markings. For labeling and scoring of the protected areas and biodiversity values, see *DATA in Brief* and Kangas et al., 2016, respectively.

habitat suitability model (Kangas et al., 2016). The systematically inventoried data covered 78% of the project area, whereas the less systematic data on the occurrence of threatened species and forest resources covered the whole project area.

The scoring of the protection level and biodiversity values had been carried out in the workshops by experienced biodiversity specialists, researchers, conservation biologists and practitioners (Kangas et al., 2016) and the system was utilized also in this study. The protection levels were classified into four categories, with no, low, intermediate and high protection levels based on the IUCN classification and the size of the area (*DATA in Brief*). For the biodiversity value the scoring was done for three separate data layers; 1) the habitat: endangered and rare habitats, for which the IUCN classification scheme was used to form the scoring criteria, 2) species: endangered and rare species, for which the IUCN classification scheme was used to form the scoring criteria, and 3) modelling: habitats suitable for 18 valuable old-growth species based on the habitat suitability modelling (*DATA in Brief*). For the map in Fig. 2a the three biodiversity layers were aggregated for simplicity, whereas the layers were treated individually in the statistical tests. Altogether 71, 741 (49.4%) grid cells had a biodiversity value of >0.

2.5. Assigning cultural heritage sites from existing datasets

Data on the location of cultural heritage sites such as relics, ancient hunting sites, tar pits, and ruins was obtained from several sources. Information on regionally valuable culture history sites was provided by the Kainuu cultural environment program, on traditional cultural landscapes from the MARU landscape project (Lipponen, Jussila, & Peurasaari, 2014), and on nationally remarkable relics the data was obtained from the National Board of Antiquities. Data on notable historical cultural sites on state-owned land were obtained from Metsähallitus Parks and Wildlife, and data on similar sites on private land was acquired from the Finnish Forestry Centre. Each cultural heritage site type was assigned one score, and the total score was calculated by summing up all the cultural heritage site types located in that grid cell. There were altogether 221 cultural heritage sites that covered only a small area, including 3192 (2.2%) of all the grid cells in the research area (Fig. 2a).

2.6. Statistical analyses

General analyses of the PPGIS survey data and all the statistical analyses were performed using R 3.3.2 (R Core Team, 2016). All spatial analyses and the visualization of the results on the map were carried out using ESRI ArcGIS for Desktop software version 10.3.1.

A factor analysis of mixed data (FAMD) was used to visualize the association of activities, the values expressed concerning pleasant sites, negative preferences and biodiversity values (concerning habitat, species, and modeling) with the protection level of the area (4 categories). FAMD analyses were performed separately for activities, values and preferences, whereas biodiversity values and protection level was included in all analyses. The last variable (the protection level) was a categorical factor. FAMD is a principal component method dedicated to exploring data with both continuous and categorical variables (*FactoMineR*-package; Lê, Josse, & Husson, 2008). The method provides specific graphs to visualize the associations between both types of variables. Continuous variables, for example the biodiversity values in each grid cell, are scaled to a unit variance, and the categorical variables such as the protection level are transformed into a disjunctive data table and then scaled in order to balance the influence of both continuous and categorical variables in the analysis. The percentage of variance explained by the dimensions of FAMD, and the correlation of individual continuous variables with the dimensions were calculated. For the categorical variables, the relationships between the two dimensions are specified as r^2. The relationship of each category of the variable is expressed as a contribution to the dimension (Contribution), distance of the projection from the dimension (Quality), direction along the dimension (V-test) and difference between the category average and the general variable average (Estimate). Cultural heritage sites were omitted from the FAMD ordination figures due to the missing association with any of the dimensions.

Adequacy of the PPGIS sampling was analyzed using KMO function (psych package, Revelle, 2016). The function calculates the overall measure of sampling adequacy (MSA), as well as estimates for each variable. The measure is known as the Kaiser-Meyer-Olkin (KMO) index, varying between 0 and 1 (Cerny & Kaiser, 1977; Kaiser, 1974). KMO indices higher than 0.6 and 0.8 indicate satisfactory and good sampling, respectively. Concerning the whole dataset the KMO indices ranged between 0.75 and 0.94. The indices ranged between 0.78 and 0.89, 0.55–0.89, and 0.59–0.77 for FAMD analyses concerning activities, values and preferences, respectively.

The socioeconomic background of respondents was evaluated by classifying them into different age, education, employment status and forest ownership categories. The relative frequencies of the respondents in different categories was analyzed using Pearson's chi-squared test ($\chi 2$; *CrossTable*-function in 'gmodels' package; Warnes, Bolker, Lumley, & Johnson, 2018). Pearson's chi-squared test ($\chi 2$) is a statistical test applied to sets of categorical data to evaluate how likely it is that any observed difference between the sets arises by chance. Under the assumption of homogeneity, probabilities of $p < 0.05$ indicate significant difference between observed and expected values (Meyer, Zeileis, & Hornik, 2016, 2006; Warnes, Bolker, Lumley, & Johnson, 2015).

3. Results

3.1. Respondents to the PPGIS questionnaires

Altogether 270 people replied to the PPGIS questionnaire. Of these, the responses of 261 people were selected for further analyses. Eighty-eight respondents (34%) were local people from the two municipalities of the research area, 165 (63%) were domestic visitors, 3 (1%) were foreign visitors, and 5 (2%) did not reveal their home district. Of the respondents 145 (56%) were men and 112 (43%) women, and 4 (2%) did not reveal their gender. Slightly more than half of the respondents (141, 54%) made markings on the map. Sixty-three of them provided markings in the paper format that were subsequently digitized on the map.

Compared with the average population in the two municipalities (Statistics Finland 2015), the age class >64 years, retired people, and those with secondary level education were underrepresented among the local respondents, whereas highly educated people were slightly overrepresented. Also men were probably slightly overrepresented, although there is no data on the gender ratio in the area (Table 1).

Compared to the visitors, a greater proportion of local respondents were over 64 years old ($\chi^2 = 10.6$, $p = 0.001$; Appendix 1).The educational level was on average lower, and a greater proportion of local respondents were outside the work community, i.e., they were unemployed, students, or retired compared to the visitors ($\chi^2 = 53.8$ concerning education and $\chi^2 = 34.9$ concerning work, $p < 0.001$; Appendix 1). A greater proportion of local people were forest owners compared to the visitors ($\chi^2 = 5.37$, $p = 0.020$; Appendix 1).

3.2. Activities

There were 254 activity markings (140 polygons and 114 points) marked by 124 respondents. The activity markings covered altogether 65.2% (94,720 out of 145,364 grid cells) of the research area. The activities were concentrated clearly in the two tourism resorts and the neighboring protected areas (Fig. 2b). The most common activities were hiking and sports, and nature observation (Table 2), whereas motorsports and forestry work were the least common activities. 'Other' was usually marked together with other activities, especially nature observation, and it was explained by the respondents as summer housing, orienteering, downhill skiing and general recreation in the area. 'Work' was not explained any further by the respondents. It was also marked together with other activities, usually nature observation.

In the FAMD analysis, all activities except 'other' were significantly and positively associated with Dimension 1 (Fig. 3a, $r = 0.65–0.96$, Appendix 2), which could therefore be denoted as the activity dimension (Fig. 3a). Likewise, modelling and habitat correlated significantly with Dimension 2 ($r = 0.66$ and $r = 0.55$, respectively, $p < 0.001$) so that the dimension was denoted as the biodiversity dimension. The correlation between the activities and the biodiversity dimension was generally quite low. A notable characteristic however was that the work and other categories showed a slight positive correlation with the biodiversity dimension ($r = 0.19$, $p < 0.001$ for both), nature observation and hiking and sports showed no correlation, and natural products, hunting and fishing, motorsports and forestry showed a negative correlation ($r = -0.13 – r = -0.52$, $p < 0.001$). Forestry activity was most negatively correlated with the biodiversity dimension ($r = -0.52$, $p < 0.001$). None of the activities were significantly associated with the protection level, whereas the association between habitat and modelling increased with an increasing protection level (Fig. 3a and b, Appendix 2).

3.3. Values for pleasant and unpleasant sites

Altogether 239 pleasant sites were marked by 103 respondents (Fig. 2c, Table 3). The markings covered only 1522 (1.05%) of all the grid cells, since they had been given as points instead of polygons. The pleasant and unpleasant sites concentrated principally on the same areas as the activities (Fig. 2c). Beautiful scenery and peaceful and silent places were checked as values in over half of the pleasant site markings (Table 3). Culture and history, economic benefit and 'other' reasons (e.g., own home, own holiday resort, swimming place, skiing, art exhibitions) were the least mentioned values.

Only 40 unpleasant sites were marked (Fig. 2c), and they had highly varying values, and many were listed under the category 'other' in the questionnaire. The most common value, present in 23 markings, was the spoiled environment, usually due to forest cuttings, and the second value with 16 markings was due to unpleasant scenery. Due to the low number of markings and their highly varying values, unpleasant sites were not analyzed statistically.

In the FAMD analysis, all values for pleasant sites, except culture and history, economic and other, correlated with Dimension 1 that was denoted as the value dimension (Fig. 4a $r = 0.61–0.87$, $p < 0.001$, Supplementary Material 4). The correlation of the values with the biodiversity dimension was low, although the versatile value showed a low positive correlation with the biodiversity dimension ($r = 0.12$, $p < 0.001$), and the safe, passable and training values had a low negative correlation with the biodiversity dimension ($r = -0.12$ - $r = -0.13$, respectively, $p < 0.001$). None of the values were significantly associated with the protection level (Fig. 4a and b).

Table 3
The number of values checked in 239 pleasant site markings and their coverage in the research area. Several values could be assigned for each marking, hence the sum of the markings cannot be calculated directly from the table.

Value for pleasant sites	Abbreviation	Markings (% of all 239 markings)		Number of grid cells (% of all grid cells) covered by the value	
Beautiful scenery	Beautiful	170	(71.1%)	1190	(0.82%)
Peaceful and silent place	Peaceful	123	(51.5%)	918	(0.63%)
Accessible terrain	EasyAccess	73	(30.5%)	514	(0.35%)
Versatile species assemblage	Versatile	65	(27.2%)	495	(0.34%)
Training opportunities	Training	65	(27.2%)	424	(0.29%)
Safety	Safe	52	(21.8%)	369	(0.25%)
Easily passable	Passable	52	(21.8%)	354	(0.24%)
Culture and history	Culture	41	(17.2%)	333	(0.22%)
Economic benefit	Economic	28	(11.7%)	224	(0.15%)
Other reason	Other	10	(4.2%)	77	(0.05%)

3.4. Negative preferences

Altogether 124 markings were made by 87 respondents concerning negative preferences. Negative markings concerning tourism, nature protection and forestry were typically overlapping especially in areas where the numbers of pleasant sites were also high (Fig. 2d). The overlap with the activities category was expected since the negative preferences were aggregated from two questions in the survey, and one was linked to the activities. Forestry was marked negatively most often, in 68 areas that covered 94,432 (65.0%) of all grid cells. Tourism was marked negatively in 29 areas covering 29,647 (20.4%) grid cells and protection

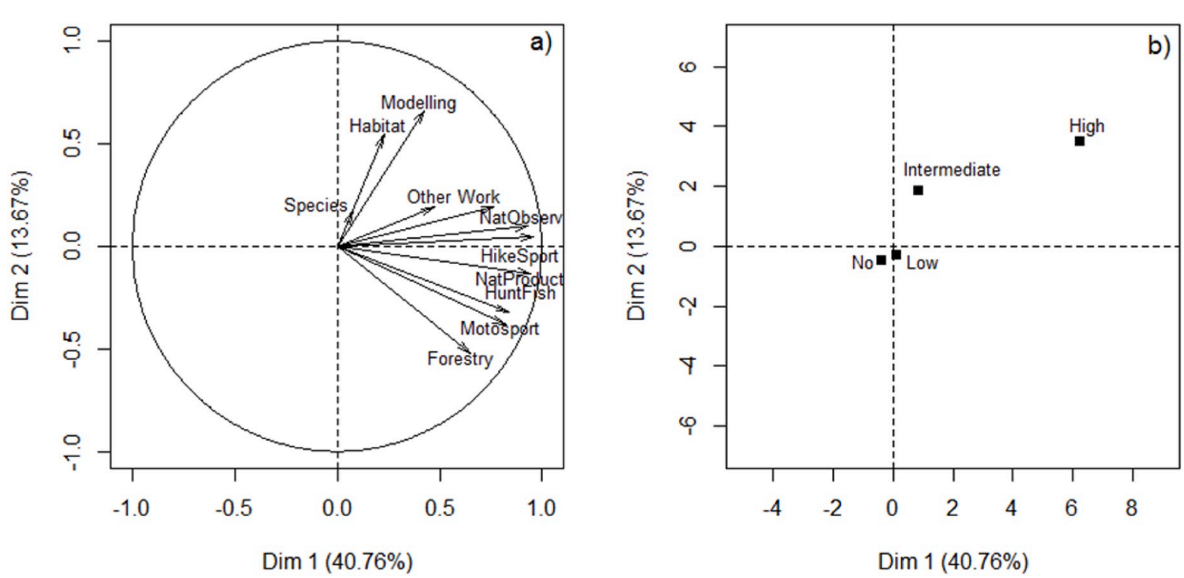

Fig. 3. Ordinations from the factor analyses of mixed data (FAMD; N = 145364 grid cells) showing the association of a) biodiversity values (Species, Habitat, Modelling) and eight activities with b) the Protection level. The contribution of the dimensions to the variation of the data is indicated in brackets. For the scoring of the protection level and biodiversity value, see *DATA in Brief* and Kangas et al., 2016. For the FAMD statistics, see Appendix 2.

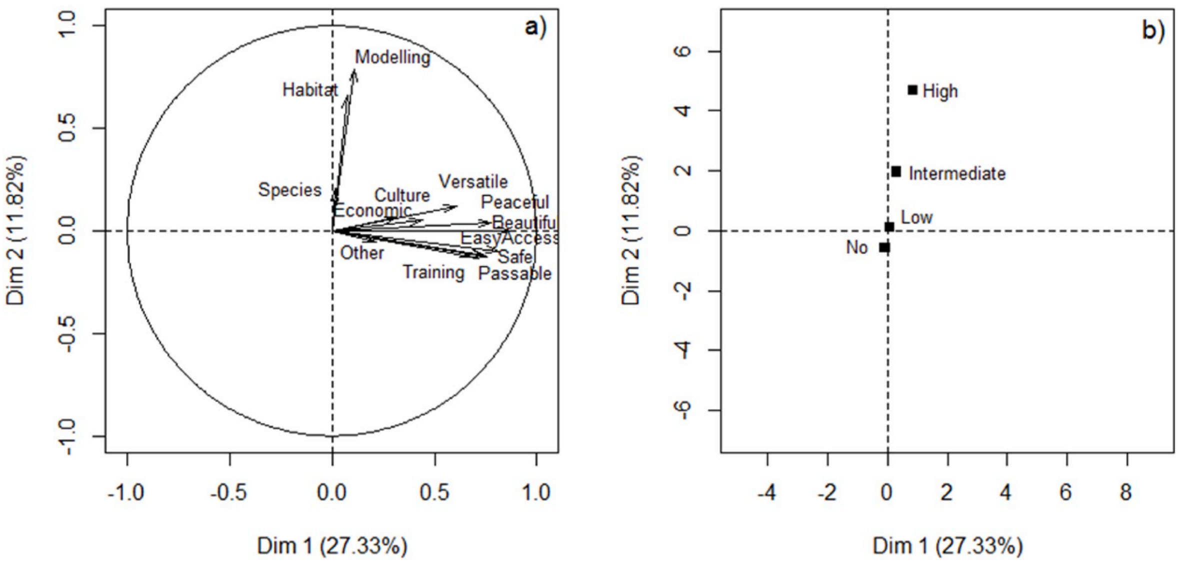

Fig. 4. Ordinations from factor analyses of mixed data (FAMD; N = 145364 grid cells) showing the association of a) three biodiversity variables and ten values with b) the protection level. The contribution of the dimensions to the variation of data is indicated in brackets. For the classification of the protection level and biodiversity value, see *DATA in Brief* and Kangas et al., 2016. For the FAMD statistics, see Appendix 3.

in 27 areas covering 36,108 (24.8%) of the grid cells.

All the negative preferences and the modelling variable were positively correlated with Dimension 1, denoted as the negative preference dimension (Fig. 5a, $r = 0.60–0.88$, Supplementary Material 5). Tourism was negatively correlated with the biodiversity dimension ($r = -0.50$, $p < 0.001$). Forestry had the strongest contribution to the negative preference dimension and was associated especially with the high protection level (contribution = 27.07 and 9.91, respectively, Fig. 5 a, b).

3.5. Socioeconomic background

Residence and forest ownership were factors that most often had an effect on the activity markings (Fig. 6, Appendix 5). Hiking and sports were marked more often by visitors and respondents who do not own forest, whereas hunting and fishing, natural products and forestry work were marked more often by local people and/or forest owners. Women were more active in marking hiking and sports, whereas men more often marked hunting and fishing and motorsports. Respondents over 64 years marked hiking and sports and nature observation less compared to younger respondents.

The respondents' level of education most often had an impact on the marked values for pleasant sites (Fig. 6) Beautiful scenery, versatile species assemblages and culture and history were typically marked by respondents with a university background, while training opportunities and safety were marked by respondents with a high school and/or professional school background. Locals marked accessible terrain and economic benefits more often than the visitors did. Respondents who indicated their employment status as working typically marked beautiful scenery and versatile species assemblages, whereas retired respondents more often marked peaceful and silent place as their values.

Locals more often marked a protection risk compared to visitors (Fig. 6). Men made two-thirds of the forestry risk markings and most of

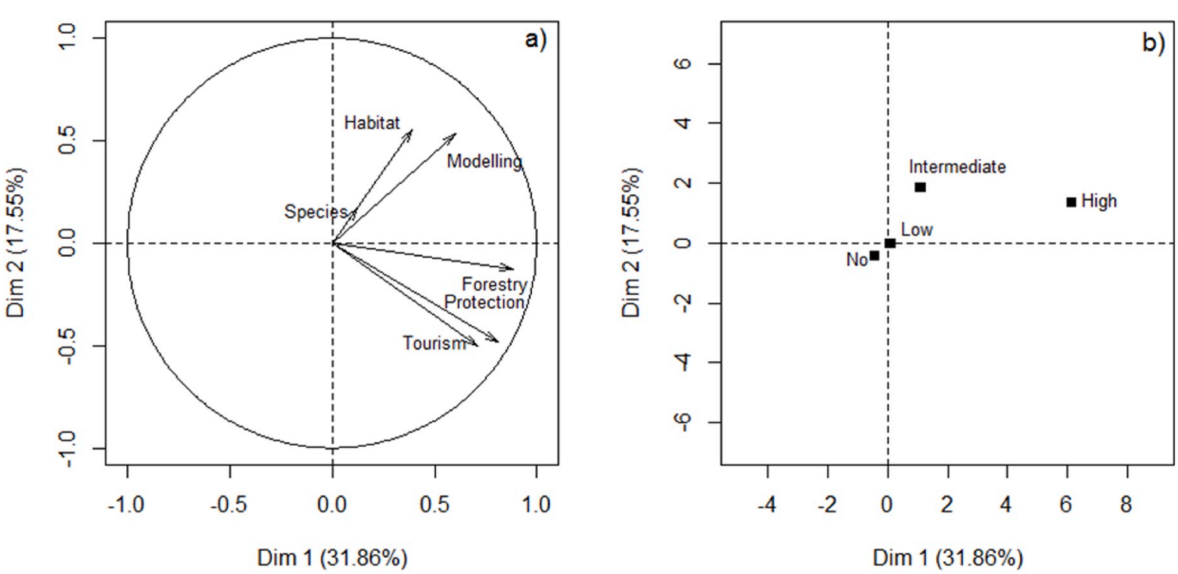

Fig. 5. Ordinations from the factor analyses of mixed data (FAMD; N = 145364 grid cells) showing the association of a) three biodiversity variables and three negative preferences with b) the protection level. The contribution of the dimensions to the variation of the data is indicated in brackets. For the classification of the protection level and biodiversity value, see *DATA in Brief* and Kangas et al., 2016. For the FAMD statistics, see Appendix 4.

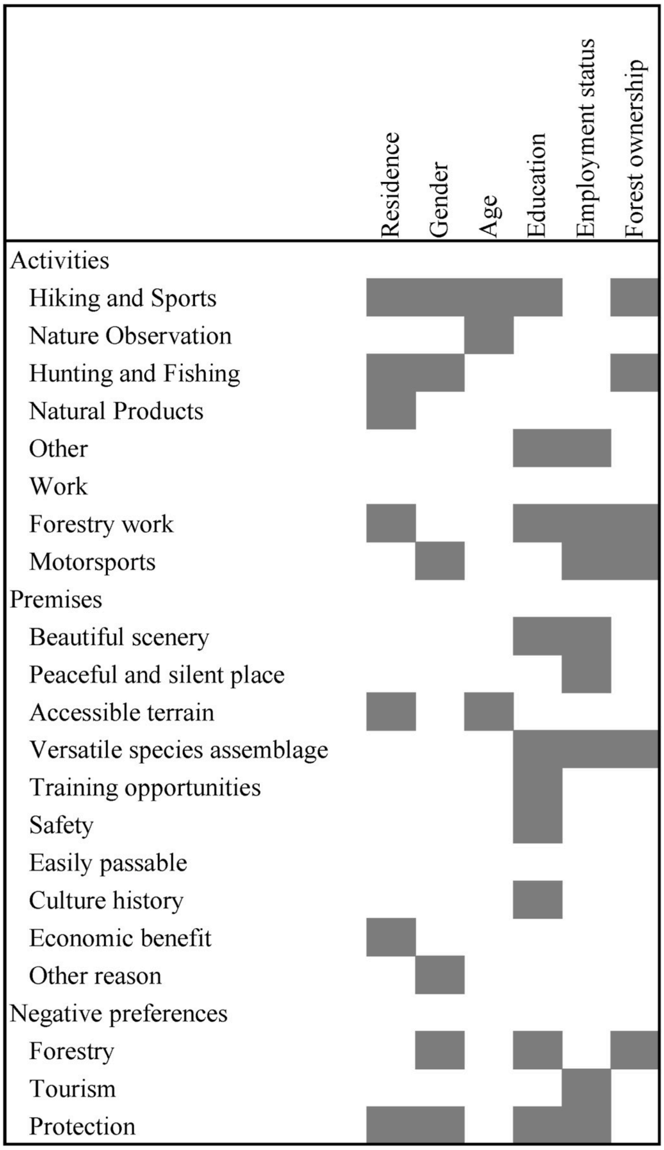

Fig. 6. The impact of the respondents' socioeconomic background on activities, values for pleasant sites and negative preferences. Statistical differences ($p < 0.05$) are marked in grey. For the details of the statistical tests, see Appendix 5.

the protection risk markings. Also two-thirds of the forestry risk markings were made by respondents with a university education, while protection risk markings with were made by respondents with a lower education. Unemployed respondents made more tourism and protection risk markings than statistically expected. Respondents who were not forest owners made most of the forestry risk markings.

4. Discussion

To our knowledge this is the first study that associates respondents' recreational activities, values and preferences with comprehensively assessed biodiversity and cultural heritage data in a nature-based tourism area. Logical associations were found between PPGIS markings and the biodiversity and cultural heritage values, which provide valuable new information for the planning and management of the area. We were also able to indicate conflicting interests towards tourism, nature protection and forestry, which helps to understand the needs of various user groups. The use of spatial analyses together with statistical multidimensional methods provided complementary information which together helped in finding associations between people and the environment.

4.1. Protection level

Despite that protected areas are generally popular destinations for nature-based tourism and recreation (Balmford et al., 2015), the right of public access in Fennoscandia allows the use of public and private land for a wide spectrum of nature tourism and recreational activities irrespective of the nature protection status (Juutinen et al., 2017; Stokke & Haukeland, 2017). In our research area the recreational infrastructure is built through protected and unprotected areas, which may have been a reason for the lack of association between the activities which the respondents associated with the areas, the values they reported, and the protection level of the area. Activity markings extended to over half of the research area, although they concentrated in the two tourism resorts, where the tourism infrastructure is the most developed, and their nearby protected areas. A large strict nature reserve however is located next to one of the tourism resorts, at Paljakka. Strict nature reserves have limitations concerning their recreational use (Heinonen, 2007), which applies to the recreational use in this protected area.

Land tenure has been found to be a stronger predictor of the distribution of ecosystem values and land use preferences than a protected area status (Hausner, Brown, & Lægreid, 2015). For example land tenure influences the activities that can be carried out by forest owners and non-owners, and it also contributes to the differences in activities between locals and visitors. Hunting, fishing, and forestry work were more common activities for local people and forest owners than visitors. This was an expected result, since restrictions apply to hunting and fishing, and forestry work is restricted naturally to forest owners. It was apparent in the survey that small-scale forestry work, which is restricted to private commercial forests, was considered a recreational activity. The reason is that small scale household forestry is an important activity among private forest owners in Finland and can serve economic and recreational purposes for the owners (Kuuluvainen, Karppinen, & Ovaskainen, 1996). Forestry work also influences the opportunities for other people to carry out publicly allowed recreational activities through its impacts on the visual characteristics of the landscape (Store et al., 2015) and on berry harvests (Miina, Hotanen, & Salo, 2009).

4.2. Biodiversity values and cultural heritage sites

Biodiversity in terms of the number of valuable habitats and species has been observed to be an important characteristic in attracting tourists to national parks (Siikamäki et al., 2015). To emphasize the biodiversity, flagship species may be used to attract visitors and promote conservation (Walpole & Leader-Williams, 2002), and charismatic species have been observed to be the favorite groups in surveys and on social media (Hausmann et al., 2018). Nevertheless, since beautiful landscape and naturalness are regarded as important factors for pleasant tourism and recreational experiences (Edwards et al., 2012; Tveit, Ode, & Fry, 2006; Tyrväinen, Uusitalo, Silvennoinen, & Hasu, 2014, 2017; Uusitalo, 2017, p. 177), high biodiversity *per se* may not be the main motivation for selecting specific recreational sites. This may have been one reason why nature observation and hiking, which were the most common reported activities, showed no association with biodiversity in our study (see also Huhta & Sulkava, 2014). The attention and advertising of the research area focuses in general on the old-growth forest landscape that characterizes the area. Also, a great amount of hiking is concentrated in the vicinity of the two tourism resorts with low biodiversity values and their nearby protected areas where restrictions apply due to the strict nature reserve. Still, there was a positive correlation between biodiversity and the value the respondents assigned for versatile species assemblages. Although the correlation was low, it indicates that the respondents had assigned positive values to sites which represented higher biodiversity. We must note that we did not specifically ask people to mark high biodiversity sites on the map. Whether people can recognize the actual biodiversity or whether they just perceive a landscape to be of high biodiversity, is a controversial topic and varies between studies and environments (e.g., Lindeman-Matthies et al., 2010, Dallimer et al., 2012).

Activities concerning the consumption of natural resources, such as natural products, hunting, fishing, and forestry work, and those causing higher disturbance, such as the use of motorized vehicles, showed a negative association with the biodiversity values that the respondents reported. High biodiversity areas are not optimal, for example, for the growth of berries, which benefit from forest thinning (Miina et al., 2009). Additionally, the most biodiverse areas are usually protected, which poses restrictions on hunting, fishing, and forestry (Heinonen, 2007), as was already discussed. The use of motorized vehicles, requiring a landowner's permit, is often related to forestry work, or is concentrated on the public snowmobile route network (Metsähallitus, 2015).

There was a weak negative association between the biodiversity values that the respondents reported and training opportunities, apparently since sports activities usually require some infrastructure and are concentrated around tourism resorts. The negative association between biodiversity, safety and access apparently arises from characteristics related to high biodiversity and naturalness, such as a dense uneven canopy, decaying wood and dead trees, which can be viewed as a safety risk or otherwise unaesthetic and untidy (e.g. Gundersen & Frivold, 2011; Sheppard, Harshaw, & Mc Bride, 2001; Tyrväinen et al., 2003). In landscape preference studies, mature forests with good visibility and no signs of management are generally preferred (Silvennoinen et al., 2002). Good visibility nevertheless requires management in most forests.

Cultural and historical elements are important reminders of the heritage and are considered important for the visual quality of the landscape (Tveit et al., 2006). In our study many visitors indicated culture history as a value for pleasant sites, but we did not find any association between the cultural heritage sites and the respondents' activities or values. Although there are hundreds of cultural heritage sites in the research area, they are small sized and generally not marked in the landscape. A similar situation occurs with archaeological sites that are not always clearly visible (Antrop, 2005). Information on them may reside in scientific data that is not openly available to the public. In our study the cultural heritage sites may not be a specific target for visits, but they might become potential targets, if marked and maintained properly.

4.3. Socioeconomic background and potential conflicts

The way people use and value their environment is greatly influenced by their socioeconomic background. People living in urban environments with a higher education often place a higher value on immaterial benefits such as biodiversity and nature protection than people living in rural areas do who emphasize a more consumptive use of the natural resources (Hausner et al., 2015; Munoz et al., 2019; Tolvanen, Juutinen, & Svento, 2013). This study supports previous findings and shows that the level of education, employment, and place of residence were common explanators for the respondents' markings. There were also differences between women and men in their ways to use the environment which was similar to what has been observed earlier (Munoz et al., 2019).

Urbanized values may come into conflict with traditional ways of using the environment (Hausner et al., 2015). In our study local respondents commonly marked activities related to the consumption of natural resources, which, as we showed, were in negatively associated with the biodiversity. They also marked accessible terrain and economic benefits as good values more often than visitors did. These activities and values may have been behind the bias towards local residents in the protection risk markings. Men were overrepresented in negative preferences both towards forestry and protection. Men have been often observed to be less supportive of nature protection compared to women (Lute & Attari, 2017; Tolvanen et al., 2013), but this study indicates two groups of men with different educational backgrounds, who were generally more active in stating their land use preferences compared to women.

Besides different values between socioeconomic groups, natural resource management conflict may involve incompatible activities, or differences regarding the goals of the development of the target area (Brown, Kangas, Juutinen, & Tolvanen, 2017). Spatial mapping has been used to identify locations of sites of potential conflict in relation to different types of land uses (Brown et al., 2017), land ownership (Hausner et al., 2015) and the respondents' distance to the site (Pocewicz & Nielsen-Pincus, 2013). In our study, the negative preferences towards nature-based tourism, nature protection and forestry were usually marked in areas with high numbers of pleasant sites and they were usually overlapping with each other. The overlap indicates conflicting interests, whereby some of the markings could also be classified as protests. For example, negative preferences towards nature protection and forestry were sometimes placed inside protected areas, especially the strict nature reserve, for which there is no foreseen risk of cancelling the protection or allowing forestry operations.

5. Study approach

Our approach provides a new method to assess whether and how people's markings and the biophysical characteristics of the environment are interrelated. The approach helps to reconcile nature-based tourism and recreational activities with the protection of biodiversity, and it is applicable also to other land uses. We could overcome the data limitation in terms of the biodiversity and cultural heritage sites, which covered 78% and 100% of the research area, respectively.

There were limitations and biases in our study, however these were related largely to the low number of respondents. The used method was apparently new for most, if not all respondents. Challenges in the mapping may have reduced the response rates. Especially older people, who were underrepresented in our study, may find web-surveys complicated due to their cognitive limitations and the difficulty of mapping on the computer screen (Gottwald, Laatikainen, & Kyttä, 2016). To counteract this, personal advice and hardcopy maps were also provided, and they markedly increased the response rate. The effectiveness of PPGIS depends on high participation and response rates, and the common problem is bias toward formally educated male participants with higher incomes (Brown & Kyttä, 2014). Low response rates are also a common problem (Brown, 2017), and this is emphasized in sparsely populated rural areas, such as in our study. Our questionnaire was openly available and represented volunteer sampling, which typically activates people who are more interested in the topic of study (Brown & Kyttä, 2014). The low response rate also implies that despite that we found statistical differences between socioeconomic groups in terms of their markings, these differences could not be analyzed in terms of how they were located on the map.

The spatial scale was apparently one reason for the low correlations in our multidimensional models. The size of the research area was large in relation to the 1 ha grid cells. For this reason the number of grid cells without PPGIS markings, without protection, without biodiversity values, or without cultural heritage sites was quite high. These 'valueless' grid cells overruled other values in the statistical analyses. A larger grid size, e.g., 500 m^2, or a larger radius than 100 m around marked points might have suited our analyses, as it would reduce the effect of mapping inaccuracy (e.g. Alessa et al., 2008; Brown & Fagerholm, 2015, Karimi, Brown, & Hockings, 2015). The most common value that the respondents indicated for pleasant sites was beautiful scenery (71% of all values), which assumedly comprises a wider area than a 100 m radius from a marked point, especially since the study area is located in a range of hills. Nevertheless, we selected the 1 ha grid cell for our analyses since the locations of threatened species and cultural heritage sites are usually quite local, and we wanted to use a scale which tackles these characteristics as accurately as possible.

We tested statistical analyses in which the grid cells were classified as non-hotspot and hotspot areas and these were used as a categorical factor. The results were similar to the final analyses in that the association between the PPGIS markings, biodiversity values and cultural heritage sites were low. Another means of analysis would have been to test the relationship only for those cells that have scores >0 for at least one of the factors: PPGIS markings, biodiversity, protection status, or cultural heritage sites. Nevertheless, our aim was to assess the area as a whole, as it is seen as an important target for the tourism and recreation development (Kainuun maakunta–kuntayhtymä, 2007).

The used approach is not able to foresee the tourism impacts, if the number of users or their placement changes dramatically (Uusitalo & Sarala, 2015). A future way to use biodiversity data would be to predict tourism and recreational impacts, for example, in terms of the degradation and recovery rates under different recreational pressures. This needs long-term monitoring data which is even harder to obtain than spatial biodiversity data. There are a number of studies on the long-term impacts of tourism and recreational activities in Finland (e.g., Kangas, Tolvanen, Kälkäjä, & Siikamäki, 2009; Törn, Tolvanen, Norokorpi, Tervo, & Siikamäki, 2009, 2006), which may provide a means to predict tourism and recreational impacts in the future.

5.1. Implications of the results on the planning of nature-based tourism areas

The increase in tourist numbers in northern Fennoscandia outweighs those in other northern, boreal, Arctic regions and is related to the development of both tourism resorts and protected areas (Tolvanen & Kangas, 2016). A broad range of recreational activities and values of a variety of stakeholders have to be considered by the authorities. Although many stakeholders associated with protection, management and utilization of natural resources are involved (Engen et al., 2018; Fredman & Tyrväinen, 2010), the experiential information is usually poorly collected and used in the planning (Faehnle, Bäcklund, Tyrväinen, Niemelä, & Yli-Pelkonen, 2014). Since tourism and recreation are considered threats to wilderness ecosystems and threatened species (Ballantyne & Pickering, 2013; Cole & Landres, 1996; Rankin, Ballantyne, & Pickering, 2015; Tolvanen & Kangas, 2016), and since the magnitude of tourism impacts vary with the activity type (Buckley, 2004), it requires planning that promotes recreational activities and positive experiences simultaneously with the protection of the biodiversity. Social acceptability is important for managers and decision makers to develop socially feasible and longer-lived initiatives (Bennett, 2016).

Our study shows a weak negative or even missing relationship between peoples' activities and their expressed values with the protection levels and biodiversity values. This is useful information as it implies that most sites with high biodiversity may be set aside from recreational use without compromising recreational experiences. On the other hand, some of the cultural heritage sites could be used as visitor attractions if they are advertised to the public. Since strong links have been found between biodiversity and the historic value of landscapes (Fry, Tveit, Ode, & Velarde, 2009), care should be however taken to avoid damage to these historical sites due to excess use. The management decisions protecting biodiversity often serve in the protection of the historical sites however (Fry et al., 2009).

Our study also shows conflicting preferences between the respondents, which sees to arise from different place-based values and the overlap of places valued by the different opinion groups (Brown et al., 2017; Munoz et al., 2019). The cutting-initiated conflicts in the research area (WWF Finland, 2017) and elsewhere around tourism resorts in Finland call for new forest management methods which do not cause dramatic changes in the forest landscape. For example, adapted forest management regimes by avoiding intensive cuttings or through uneven age stand management has been proposed in areas used for nature-based tourism (Tyrväinen et al., 2017). Many old forest species might also benefit from the new management regime, which would reduce the conflicts between biodiversity protection and forestry.

Knowledge-informed planning recognizes the need to manage diverse forms of information and for that information to be processed so it can contribute to the decision-making (Kahila-Tani, 2016, p. 223). This, however, depends on the planning authorities as to whether and in which way the available information is used. Scientific information often requires complicated analyses and high-level expert evaluation, which may limit its use in practical planning. To have a real effect, scientific information should be inserted and, if needed, simplified to fit the decision-making criteria (Tolvanen & Aronson, 2016). In this way, the needs of different land uses can be assessed together and optimum activities can be targeted for the areas where they are best suited.

Author contribution

AT, OT and KK initiated the study. KK, MK, AT, ST, LT, and OT planned the PPGIS questionnaire. KK conducted the fieldwork to collect data. KK, AJ, EH, OT and AT were responsible for the scoring of biodiversity and protection level data. KK, AN, and VN conducted the GIS analyses and OT the statistical analyses. All authors contributed to the final manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tourman.2020.104141.

Data

Author names (anonymous at the reviewing phase). Data on the relationship between recreational activities, values and land use preferences and the protection level and biodiversity values in nature-based tourism areas in Finland. 2019.

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