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Identifying spatial overlap in the values of locals, domestic- and international tourists to protected areas

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ABSTRACT

Nature-based tourism is increasingly encouraged to support local socioeconomic development in and around protected areas, but managing protected areas for tourism could challenge existing park uses associated with self-organized outdoor recreation and local resource use. We used a web-based Public Participatory Geographic Information System (PPGIS) to identify the most important places and values of local, domestic, and international visitors to Jotunheimen National Park and Utladalen Protected Landscape in Norway. Scenic and recreation values were prioritized by all groups, but local users mapped more values relating to hunting, fishing, gathering and cultural identity. While the three user groups overlapped in some places, we found that they self-segregated to some extent. Our study affirms the importance of spatially explicit analyses to support protected area management. Understanding the spatial distribution of values held by different user groups can aid in designing tourism management strategies that minimize intergroup conflict.

1. Introduction

Though early protected areas largely ignored or excluded local residents in pursuit of protecting wilderness, iconic landscapes, and wildlife for public enjoyment, protected area management has over time become more inclusive of traditional uses and local cultures (Dudley & Stolton, 2010; Linnell, Kaczensky, Wotschikowsky, Lescureux, & Boitani, 2015; Nepal, 2002). Modern protected areas are expected to fulfil multiple and sometimes conflicting objectives (Dudley & Stolton, 2010; IUCN, 2017; Manning, Anderson, & Pettengill, 2017). Many protected areas share dual mandates of providing access to recreational areas for the public and of protecting biological diversity and resources for future generations. Protected areas are also increasingly expected to provide community benefits primarily through attracting more tourists to generate new jobs and stimulate local development (Murphy, 1988; Simpson, 2008; Weaver & Lawton, 2017). This brings with it new and complex challenges for management, such as offering high quality experiences to a broader range of visitors and generate income and livelihood benefits to communities, whilst minimizing adverse impacts on the environment and on the traditional users of protected land (Bushell & Eagles, 2006).

The rapid increase of nature-based tourism during the last decades (Balmford et al., 2009) coupled with the diversification of protected area objectives (Stolton & Dudley, 2010), implies that a broader range of values need to be handled and weighted by protected area managers (Chape, Spalding, & Jenkins, 2008). Conservation conflicts are often more about values, perceptions and attitudes than about facts (Dickman, 2010). Assessing users' values and priorities in protected areas is crucial for avoiding antagonism between user groups. Protected area management is also inherently spatial. Mapping users' values and experiences to specific places provides managers with information about the destinations that are preferred by tourists as well as their potential overlap with areas valued by local communities. Spatially mapped values can also be combined with biophysical data to identify potential threats to biodiversity conservation priorities (Gosal, Newton, & Gillingham, 2018; Whitehead et al., 2014).

Web-based Public Participatory Geographic Information System (PPGIS) is one of the tools that has been used to identify protected area values (G. Brown & Weber, 2011; van Riper, Kyle, Sutton, Barnes, & Sherrouse, 2012). PPGIS allows the general public and stakeholders to identify and map their place-based values and preferences using an online platform, thereby gathering spatially explicit information about

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the places valued by different individuals and groups. PPGIS has been used in a wide range of applications for protected areas G. Brown and Fagerholm (2015) and G. Brown, Montag, and Lyon (2012), including to identify park qualities from a visitors perspective including online mapping of visitor experience and satisfaction (Pietila & Fagerholm, 2016), identify value hotspots within park boundaries (Van Riper & Kyle, 2014a), and map of tourism preferences regarding development in or near park boundaries (G. Brown & Raymond, 2006; G. Brown & Weber, 2013). Few PPGIS studies have examined the spatial value distribution of both visitors and locals with the aim of identifying spatial overlap between user groups in highly valued areas, though such information is crucial to managing conflict between user groups.

The purpose of this study was to identify areas highly valued (i.e., value hotspots) by locals, domestic, and international visitors to assess the potential management challenges of attracting more tourists to Jotunheimen National Park and Utladalen Protected Landscape protected areas. These areas were recently included in a pilot study to improve visitor management and increase the value of park-related tourism (Norwegian Environment Agency, 2014). Customary rights to grazing, fishing, hunting, and gathering deriving from the pre-medieval ages persist in this region, and recreational consumptive uses are popular (Hausner, Brown, & Lægreid, 2015). Norway has a long history of self-organized outdoor recreation (Friluftsliv) often coupled to hunting, fishing, and berry picking. These activities have been supported by the Right of Public Access allowing free access to both public- and private land, including small-scale harvest as long as causing no harm to people, fauna, flora or economically valuable resources (Kaltenborn, Haaland, & Sandell, 2001; Sandell & Fredman, 2010; Tolvanen, Forbes, Wall, & Norokorpi, 2005). Given that the surrounding local communities have a strong cultural attachment to the uplands, we hypothesized that residents and visitors to the protected areas would differ in the areas that they value highly. Jotunheimen has an iconic status among domestic visitors as a popular outdoor recreation destination going back to the early 19th Century (Snøtun, 2011). Previous surveys conducted in the study area have indicated that Norwegian domestic visitors differ from international visitors in travel pattern, accommodation and recreational activities (Vorkinn, 2011). We therefore also expect domestic- and international visitors to value places differently, and assign different values to places.

We first defined and reviewed the concept of place-based values and how spatial mapping of values could be used to inform management of protected areas. Then, we examined differences in spatial priorities among visitors and local communities to identify potential management strategies for each group in the two protected areas. We used a two-step approach where we first identified the most valued hotspots, and secondly, analyzed the values identified by the different groups within and between the hotspots.

Our research was guided by the following research questions:

1. What types of place-based values are most important to the three groups of users: locals, domestic- and international visitors?
2. How are place-based values spatially distributed among the three user groups within the protected areas (i.e., dispersed vs. clustered)?
3. Are there spatial valuation zones associated with user groups that indicate incompatibility in the use of the park?
4. Given the results, what are the implications for protected area management that seeks to integrate local values with increasing tourism demand?

2. Place-based values and protected area management

Values are defined and interpreted differently depending on academic disciplines. In psychological and sociological literature, values are typically conceptualized as fundamental ideas and enduring principles that inform peoples' judgements and guide park users' choices and actions. (T. C. Brown, 1984; Rokeach, 1973; Schwartz, 1994). Such held values (also referred to as the *underlying values* (Ives & Kendal, 2014)), affect how users perceive the places they are visiting and the activities deemed appropriate in those areas (Rossi, Byrne, Pickering, & Reser, 2015; Zeppel, 2010). For example, Rossi et al. (2015) found deeply held environmental values to underlie park users' perceptions of other visitors and their recreational activities. In that study, park users with ecocentric value orientations (i.e., valuing nature for its own sake) were more negative to motorized activities than people valuing nature because of the material or physical benefits it can provide for humans (i.e., anthropocentric value orientation). Held values underpin whether people oppose or favor activities or management actions in protected areas, but has also been used to explain visitors motivation to undertake pro-environmental behaviors. For example, Curtis, Ham, and Weiler (2010) found using the theory of planned behavior that eliciting park users' beliefs is a requisite to understand their behavior and to manage for impact reduction through persuasive communication targeting beliefs instead of imposing management actions. Similarly, van Riper and Kyle (2014b) used value-belief-norm theory to understand how protected area users' value-orientation together with personal norms and beliefs influence their engagement in pro-environmental behavior.

Another way of understanding values, and one that has become particularly popular in resource economics and in non-market valuations of ecosystem services (i.e., the benefits that people derive from nature (Díaz et al., 2015)), is what T. C. Brown (1984) referred to as assigned values, that is, "expressing the importance or worth of the object relative to one or more other objects". While held values could be understood as the *values of people,* assigned values is how places, species and/or ecosystems are *valued by people* (Ives & Kendal, 2014). Assigned values may be related to the underlying environmental concerns and worldviews that people hold (Rossi et al., 2015; Van Riper & Kyle, 2014a), but in contrast to held values, individuals express qualities of the protected areas through their preferences for specific physical places, goods and services relative to others (Reser & Bentrupperbäumer, 2005; Seymour, Curtis, Pannell, Allan, & Roberts, 2010). The value attached to features and places in protected areas depends on context and is therefore less persistent than held environmental values, but useful for identifying places in protected areas highly prioritized by different user groups. Seymour et al. (2010) proposed that assigned values could be a better predictor of spatial behavior than held values, as held values, together with beliefs and norms, influence assigned values, and therefore are only indirectly linked to environmental behavior. The spatial behavior of visitors to protected areas refers to the use of the landscape they make, such as following designated trails, camping at designated campsites and respecting the minimum distance to wildlife. Several studies have used GPS tracking of visitors to uncover visitor distribution and behavior (Beeco, Hallo, & Brownlee, 2014; D'Antonio & Monz, 2016; Orellana, Bregt, Ligtenberg, & Wachowicz, 2012). However, coupling visitors' spatial behavior to values is still limited.

The values that park users attach to places also depend on symbolic meanings of places and an individuals' life experiences. These shape how and whether people think about a place as important (Cerveny, Biedenweg, & McLain, 2017; Van Riper & Kyle, 2014a). Thus, *place-based* values integrate *assigned* values with *held* values toward nature. Place-based values could be considered as *relational* values because values are shaped in interaction with the physical landscape (G. Brown & Weber, 2012; McIntyre, Moore, & Yuan, 2008). Relational values reflect that people could have strong bonds to places, species or ecosystems that influence their preferences for uses in a location as well as their attitudes towards management actions (Chan et al., 2016). For example, Klain, Olmsted, Chan, and Satterfield (2017) propose that relational values can better inform policy making than other approaches and alleviate the tensions introduced by intrinsic-instrumental value driven policy making, which tend to focus more on tangible values. Relational values acknowledge that use of protected areas cannot necessarily be separated from its cultural meaning. For example, for

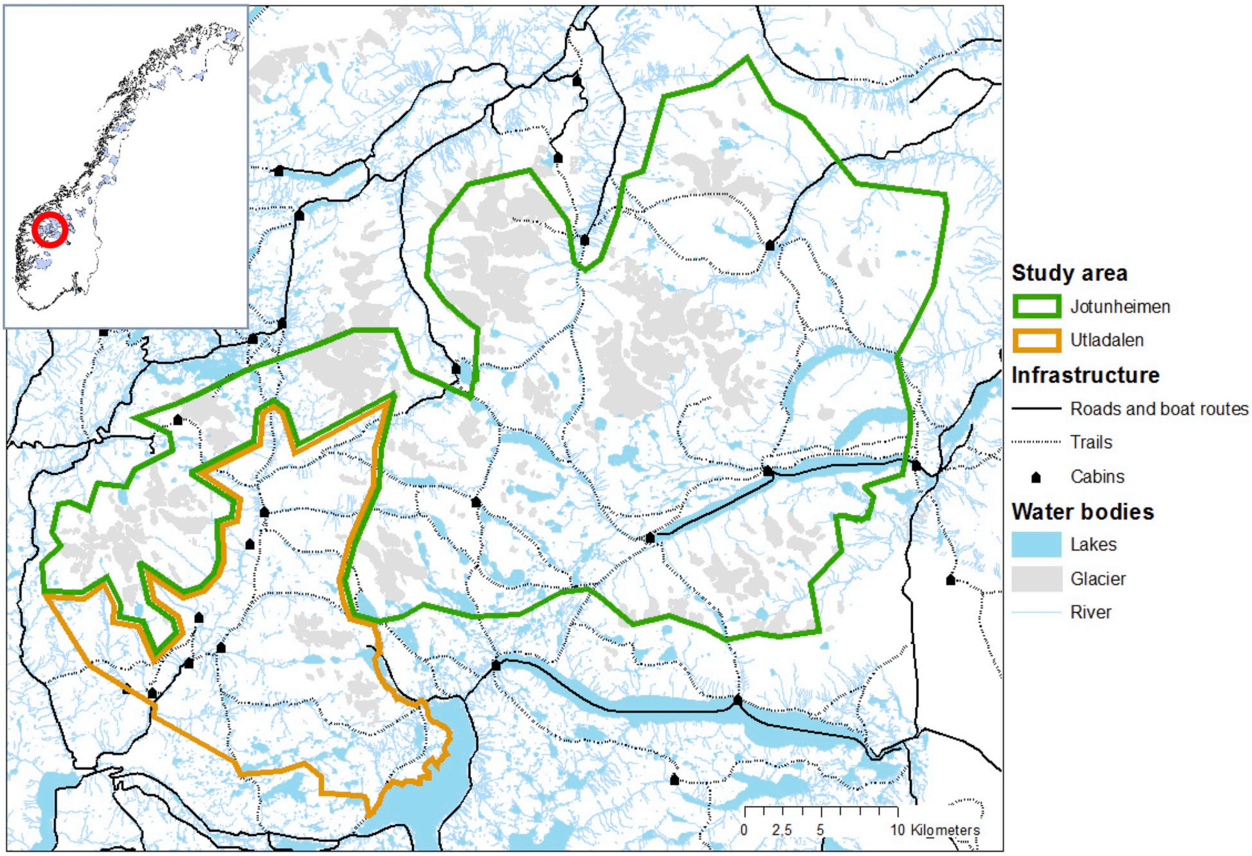

Fig. 1. The study area is located in southern Norway (map on the top left corner). Map over the study area including Jotunheimen NP and Utladalen PL.

many local communities, harvesting is not purely about provisioning of food, it is also deeply embedded in their culture. As noted by Ingold (2000, p. 192): "*a place owes its character to the experiences it affords to those who spend time there—to the sights, sounds and indeed smells that constitute its specific ambience. And these, in turn, depend on the kinds of activities in which its inhabitants engage. It is from this relational context of people's engagement with the world, in the business of dwelling, that each place draws its unique significance.*".

There is a rich literature on how pro-environmental behavior is linked to different conceptualizations of value (e.g. Seymour et al. (2010); Van Riper and Kyle (2014a, 2014b)). Visitor use patterns are not, however, purely determined by values (Gosal et al., 2018), but also depend on accessibility, infrastructure and knowledge about an area (Kulczyk, Woźniak, & Derek, 2018; McIntyre et al., 2008; Seymour et al., 2010). Understanding how individuals are attracted to and use space and time e.g., through the location visited, travel routes and time spent in an area (e.g. Ellegård and Svedin (2012); Hagerstrand (1966); Manning (1979)) is equally important for visitor management as understanding how places are valued. In this line, Beeco and Brown (2013) advocate for the use of spatial indicators that allow integrating social, ecological, infrastructural and economic factors in order to benefit protected area management. For example, Chardonnel and Knaap (2002) explore the spatial and temporal use of trails in protected areas and stress the need to create spatial tools that map tourists' recreational behavior in space and time. Such analyses provide information about where people are or have been, but not necessarily which area they appreciate the most. Planning for increased tourism in protected areas would benefit from both identifying spatial valuation zones for both local users and visitors to separate, limit, disperse or channelize tourism into desired locations (Leung & Marion, 1999). Spatial value mapping, as those performed by web-based PPGIS, provides insights into how different user groups value different places in the protected area, which is most likely related to their actual use of the locations. However, it is also possible that people value an area without physically interacting with the place, for example by appreciating the existence of iconic peaks in a park without actually visiting the place.

Protected area planning and management can benefit from mapping spatially explicit place-based values by elucidating most valued areas, potential local conflicts and impacts, and actual use of protected areas. Identifying areas representing place-based values of different user groups is important for establishing visitor strategies that have the least impact on other users and that benefit multiple user groups in protected areas (McIntyre et al., 2008). Furthermore, the spatial location of values held by protected area users can help identify landscape features that are important for users (G. Brown & Raymond, 2014). Also, mapping preferences for land use (e.g. development) in protected areas along with spatial values can identify where conflict might arise around rules governing land use (Brown & Raymond, 2014).

The potential for conflict among user groups not only depends on place-based values, but also on whether the places valued by the different groups overlap spatially. Increased international tourism in places that are culturally important for local residents or destinations that are perceived as iconic by domestic visitors can result in loss of value for local and domestic park users (Wray, Espiner, & Perkins, 2010). Conflicts may also arise from increasing tourism in areas where local users prioritize other activities such as farming and forestry (Bragagnolo, Pereira, Ng, & Calado, 2016). However, if tourists are attracted to places which are less highly valued by local park users, then tourism development is less likely to have a negative impact on local park use.

3. Methods

We collected data from survey questions and mapping through PPGIS. We examined whether the three user groups (locals, domestic, international) shared similar place-based values (non-spatial analysis) using data collected through the mapping without considering the spatial location. To investigate the spatial overlap in place-based valuation (spatial analysis), we used data collected by explicit mapping through PPGIS which included coordinates. In the non-spatial analysis we used Chi-square statistics and Spearman rank correlation to determine whether there were significant differences in the frequency of different place-based values assigned by the three user groups, regardless of where those place-based values were mapped in the landscape. In the spatial analyses, we assessed whether the user groups mapped their place-based values in different locations using nearest neighbor statistics. To identify and map clusters of valuation we implemented the algorithm Density-Based Spatial Clustering of Applications with Noise (DBSCAN).

3.1. Study area

Our study was conducted in Jotunheimen National Park (hereafter Jotunheimen NP) and the adjacent Utladalen Protected Landscape (hereafter Utladalen PL) (Fig. 1). Jotunheimen NP was established for its "wilderness and untouched nature" and covers 1151 km^2 of mountainous and alpine vegetation, including several glaciers and lakes. Utladalen Protected Landscape was designated to protect scenic cultural landscapes (Klima-og miljødepartementet, 2014). In Jotunheimen NP, traditional outdoor recreation has been pursued by domestic visitors since the mid-19th century, and today it is particularly valued for the climbing areas and for cabin-to-cabin hikes provided by the Norwegian Trekking Association (Directorate for Nature Management, 2007). The NP is located on state commons where people have enjoyed subsistence rights to livestock grazing, hunting, fishing, and firewood since pre-mediaeval times (Hausner et al., 2015). It is a national symbol as it holds the highest peaks in Norway, and together with Utladalen PL, contains approximately 300 km of trails which connect several mountain lodges managed by the Norwegian Trekking Association. One of the most visited parts of Jotunheimen NP is the Besseggen ridge with over 30,000 visitors per year (Besseggen Tourism, 2014), located on the eastern side of the park.

3.2. Data collection

We recruited study participants by three methods: i) a household survey, ii) volunteers recruited through social media and traditional advertising, and iii) in-person recruitment at park entrances. *In-situ* and household surveys were combined in order to balance the representativeness of the three user groups studied. Data was collected during October–December 2014 and July–September 2015. A local household survey (available at http://www.landscapemap2.org/norwaysouth/) was performed in 2014 by sending invitation letters to Norwegian residents living in municipalities surrounding Jotunheimen NP and Utladalen PL (Voss, Sogndal, Luster, Skjåk, Vågå and Aurdal). Letters were sent to a random sample of 10% of the adult population (3104 households over 18 years of age). The survey also included volunteer recruitment by inviting local organizations on email, newspaper, and social media. A reminder was sent by post two weeks after the first contact.

During July–September 2015, the peak of the tourism season, visitors to Jotunheimen NP and Utladalen PL were recruited at the major entrances Those interested in participating were subsequently sent an email containing the link to the online visitor survey (available at http://www.landscapemap2.org/southnp/). Two reminders were sent to visitors. Feedback from respondents was used to develop an instructional video and "Frequently Asked Questions (FAQ)" answering the most common problems encountered by respondents which were attached on the second reminder.

Both surveys were conducted using web-based PPGIS method that collects the georeferenced locations of a set of markers representing different place-based values. We used a list of 12 place-based values that could be dragged and dropped by respondents onto a Google base map. Both PPGIS surveys were piloted on park managers and their feedback was used to improve the design and functionality of the PPGIS interface. The survey was granted ethics approval by the Norwegian Centre for Research Data under the Personal Data Act 2000. The opening screen provided for entry of a unique identifier provided to household survey recipients that was used to track responses. In the case of non-household surveys, a unique, dynamic access code was allocated through a "request" access button. These access controls allowed the tracking of people recruited by the random household surveys, through social media and invitation to organizations, and by on-site recruitment in the parks. The second screen included an informed consent for participation. The following screen contained instructions for the mapping activity which allowed participants to drag and drop place-based value markers on a Google® map interface. Respondents were informed that participants usually map 20 markers, but the number of markers was not constrained. A list of 12 place-based values were developed based on a value typology adapted from G. Brown and Reed (2000) using feedback from park managers (Table 1). The description of each value was available within the survey as a pop-up text box. In the last screen, a short questionnaire asked participants for socio-demographic information, their familiarity with the study area and the number of visits to the study area.

3.3. Statistical analysis

We classified respondents into three groups according to their residence: 1) locals, referring to inhabitants of the municipalities adjacent

Table 1
Definition of place-based values used in PPGIS mapping. Adapted from Brown and Reed (2000) to the Norwegian context.

Place-based values	Description
Biological diversity	Areas are important because they provide a variety of plants, wildlife and habitat
Clean water/air	Areas are important because they provide clean water/air
Cultural value (including cultural identity)	Areas are important because of their historical value, or for passing down the stories, myths, knowledge and traditions, and/or to increase understanding of the way of life of our ancestors
Gathering (mushroom and berry picking)	Areas are important for berries, mushroom or collecting herbs/plants
Hunting/fishing	Areas are important because of hunting and/or fishing
Scenic landscapes	Areas are important because they include beautiful nature and/or landscapes
Social value	Areas are important because they provide opportunities for social activities (e.g. associated with fireplaces, picnic tables, ski- or alpine arrangements, shelters, shared cabins, cabin complexes)
Spiritual value	Areas are important because they are valuable in their own right or have a deeper meaning; emotionally, spiritually, or religious
Therapeutic	Areas are valuable because they make me feel better, either because they provide opportunities for physically activities important for my health and/or they give me peace, harmony and therapy
Recreation	Areas are important for outdoor recreation activities (e.g. camping, walking, skiing, alpine snowmobiling, cycling, horse riding)
Wilderness and undisturbed nature	Areas are relatively untouched, providing for peace and quiet without too many disturbances
Special place	Please describe why these places are special to you

to the NP, 2) domestic visitors, which are Norwegian visitors from areas not in the municipalities surrounding the NP, and 3) international visitors, defined as visitors from a country other than Norway. For the purpose of this study, we selected respondents that mapped at least one value inside Jotunheimen NP or Utladalen PL. We assessed differences in mapped place-based values, particularly focusing on how local cultural values (local users) and traditional Norwegian outdoor recreational activities (domestic visitors) differ from the place-based values of international tourists.

To assess the non-spatial consistency in the frequency of place-based values mapped among user groups, we ranked the place-based values from 1 to 12 in descending order of frequency for each user group and calculated the Spearman rank correlation coefficients between pairs of user groups. In addition, we conducted a non-parametric Pearson's chi-square analysis using a contingency table for the user groups and place-based values (3 user groups x 12 place-based values). Pearson's chi-square tests on standardized residuals were used to identify statistically significant differences between observed and expected cell frequencies. Expected frequencies were calculated by multiplying the cell's row- and column-total counts and dividing the product by the total table counts. Standardized residuals were examined to assess statistically significant differences ($\pm$ 2.0) between observed and expected frequencies.

For spatial analyses, we calculated the median Euclidean distance between the geographic locations of place-based values to identify the degree of overlap between user groups. We first calculated the median distance between the nearest neighbor place-based values mapped by the users. Then we calculated the median distance between the nearest neighbor place-based values of two user groups at a time (i.e., local-domestic, local-international and domestic-international). The distance was calculated between pairs of points from different user groups. In addition to the measured median distance, we simulated a group-independent median distance to test whether differences in point distributions are based on user groups or belong to landscape features. For this, the user group label for each point was randomly replaced and the median distance between the nearest neighbor points was calculated. We report the 95% confidence interval for 9999 such simulations.

We implemented a Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm (Ester, Kriegel, Sander, & Xu, 1996) to find areas where people had mapped the highest density of place-based values (i.e., clusters), regardless of user group. The advantage of using DBSCAN is that one can identify clusters of irregular shapes that does not require the analyst to specify the number of clusters to be detected (Ester et al., 1996). In addition, it discards noise points, which are points that are sparse and relate to no cluster. It also reduces losing idiosyncratic data as in the case of methods that use clustering of cells based on density (McIntyre et al., 2008). We first generated a density plot of the distances between all mapped points (k-nearest neighbor distance), independent of user groups. Second, we chose a search radius distance for clusters by visually inspecting the threshold of the k-nearest neighbor distance plot. Third, we used the DBSCAN algorithm to identify clusters by searching for a minimum number of points located within the search radius of core points. A core point was defined as a point where a minimum of 10 points fell into the search radius; the minimum number of points was set to 10 in order to identify clusters with a diversity of place-based values between locals, domestic- and international visitors. Border points were defined as points that fell within the search radius of a core point but whose own search radius contained fewer than 10 points. Points classified as core and the corresponding border points formed clusters. Points not classified as core- or border points belong to no cluster and reflect dispersed points.

We then explored the differences in place-based values held by the different user groups within and outside clusters using a non-parametric Kruskal-Wallis test to avoid biases due to low cell values. We identified divergences from the expected frequencies of each value by calculating standardized residuals for each cluster that displayed significant variation in the distribution of place-based values between user groups. We also estimated the similarity in mapped place-based values between clusters using Spearman rank correlation for clusters that differed by place-based values mapped by user groups.

All analyses were conducted in R software (R Core Team, 2015), and the main libraries used were MASS (Venables & Ripley, 2002) for chi-square analyses, spatstat (Baddeley, Rubak, & Turner, 2015) for point pattern analyses and nearest neighbor distances, and dbscan (Hahsler, 2016) for cluster analysis. We enclosed the data and the R script in Appendix 5 and Appendix 6 respectively.

4. Results

4.1. Demographic variables and mapped value frequency

The household PPGIS survey was completed by 14% of the invited participants (440 responses) of which 117 participants mapped at least one value in the study area. A total of 1812 visitors to Jotunheimen NP and Utladalen PL were contacted at gateways during the visitor survey of which 14.7% completed the survey.

A total of 377 survey responses were included in our analyses (see Appendix 1) with a nearly even distribution of respondents from each visitor groups, i.e., locals, domestic- and international visitors. Among international visitors, Germans, Danish and Czechs comprised 41% of the respondents. The gender distribution of all respondents was 56.8% males and 43.2% females. The age of respondents varied from 18 to 78 years, with an average of 41 years. The majority of the respondents held a university degree or equivalent. Most of the respondents had visited the study area only once. The number of visitors with more than one visit was too low (13.5%) to allow separate analyses. Respondent knowledge about the area was mostly reported as average and low (see Appendix 1 for more details). A total of 2479 place-based values were mapped using PPGIS. The most frequently mapped place-based values were “Recreation” and “Scenic landscapes” (Table 2) in all three user groups, constituting 32.7% and 31% of the total mapped place-based values respectively.

4.2. Non-spatial analyses

There was strong consistency in the frequency of place-based values mapped by the different user groups (Table 2). The Spearman rank correlation coefficients between groups were accordingly relatively high, ranging between 0.61 (local vs. international visitors) and 0.94 (domestic vs. international visitors) (Table 3).

Despite the consistency among user groups in how they ranked values, there were significant differences in the number of place-based values mapped by the three groups (Table 2; Pearson's chi-squared test: Chi-squared = 174.16, degrees of freedom = 22, p value < .05, 0% cells with expected counts < 5). Local users mapped cultural values, undisturbed nature and consumptive values (gathering, fishing and hunting) more than expected, while they mapped biological diversity and clean water to a lesser extent (Table 2). Domestic visitors mapped biological diversity and scenery more often than expected, but mapped consumptive, spiritual and wilderness values less than expected. International tourists mapped clean water, spiritual values and wilderness values more than expected, while the frequency of mapped cultural values, hunting and fishing, scenery and therapeutic values were lower than expected.

4.3. Spatially explicit analyses

The median distances between nearest value markers mapped by each user group showed that domestic- and international visitors had higher clustering (i.e., shorter median nearest neighbor distance within the user groups; 159 and 141 m) than local visitors (273 m) (Table 3). Domestic- and international users were significantly more separated from locals (i.e., longer median nearest neighbor distances) than expected from the Monte Carlo simulations (Table 3). This suggested that

Table 2
Summary of the place-based values mapped by locals, and domestic- and international visitors. Perc. is the percentage of times a value was mapped. Rank is the ranking of place-based values in descending order of frequency. Residual is the standardized residual from the Chi-square analysis where color indicates if the frequency was significantly larger (blue italics) or smaller (red italics) than expected. The table is sorted by the sums of ranks with the most frequently mapped place-based values on the top.

	Local			*Domestic*			*International*		
	Perc.	Rank	Residual	Perc.	Rank	Residual	Perc.	Rank	Residual
Scenic	30.45 %	1	-0.35	33.98 %	1	*2.40*	28.51 %	2	*-2.05*
Recreation	29.55 %	2	-1.86	32.84 %	2	0.32	34.13 %	1	1.39
Clean water	6.12 %	5	*-3.58*	9.51 %	3	-0.11	12.20 %	3	*3.40*
Wilderness	9.10 %	3	*2.37*	3.85 %	5	*-4.69*	8.75 %	4	*2.47*
Biological	3.43 %	7	*-2.37*	6.68 %	4	*2.54*	4.97 %	5	-0.34
Special place	3.28 %	8	0.38	3.06 %	6	-0.02	2.92 %	6	-0.33
Cultural	4.18 %	6	*2.85*	2.94 %	7	0.65	1.30 %	10	*-3.26*
Social	2.69 %	9	-0.18	2.94 %	7	0.36	2.70 %	7	-0.20
Therapeutic	2.54 %	10	0.57	2.94 %	7	1.71	1.40 %	9	*-2.21*
Hunt/fish	6.27 %	4	*9.53*	0.34 %	11	*-4.29*	0.32 %	12	*-4.50*
Spiritual	1.19 %	11	-0.75	0.79 %	10	*-2.14*	2.38 %	8	*2.80*
Gathering	1.19 %	11	*2.81*	0.11 %	12	*-2.11*	0.43 %	11	-0.49

Table 3
Summary of the Spearman rank correlation and nearest neighbor distances (in meters). Spearman rank correlation coefficient was calculated based on value frequencies for user group pairs. The median distance between nearest neighbor place-based values was calculated for each user group and for pairs of user groups. The measured median distance was calculated by computing the distance between the nearest neighbor points. The Monte Carlo simulated median distances were calculated by computing the distances between nearest neighbor points on samples with randomly shuffled user group labels. Median and 95% confidence intervals were calculated from 9999 randomly shuffled samples.

	Spearman rank correlation rho	*p-value*	*Measured median distance (m)*	Monte Carlo simulated median distance (m) (95% CI)	
Local			272.7		
Domestic			158.9		
International			140.6		
Local-Domestic	0.71	< 0.05	351.3	193.8	(171.5; 218.1)
Local-International	0.61	< 0.05	463.1	188.9	(167.6; 213.6)
Domestic-International	0.94	< 0.05	205.6	188.7	(169.8; 208.9)

the spatial distribution of the place-based values of locals differed from the values of domestic and international users. The median distance between domestic and international users was however much shorter (206 m versus 351 m and 463 m), and fell within the Monte Carlo simulated confidence interval (Table 3), suggesting that the place-based value markers from these two user groups were not significantly separated. In short, locals mapped place-based values in locations that differed significantly from domestic- and international visitors.

The DBSCAN algorithm identified 13 clusters (Fig. 2) with a minimum number of search-radius-points set to 10 and the search distance set to 1100 m. We selected 1100 m as the search radius by visually inspecting the density plot of the k-nearest neighbor distances (see Appendix 2). An additional cluster 14 was dismissed as the border points of this cluster were shared and grouped with cluster 9, and therefore it contained only 3 points.

Most of the mapped points were located around popular trails, cabins and mountain peaks (see caption in Fig. 2). Locals mapped more place-based values in the westernmost part of our study area (clusters 1, 2 and 3) and in the Memurubreen glacier area (cluster 4). Domestic- and international tourists placed the majority of the points in the Besseggen trail and on the iconic peaks and glaciers in the north, including the highest peak in Norway, Galdhøpiggen (clusters 6 and 8) (Fig. 2, right).

We found significant differences in mapped place-based values by user groups in the two most visited locations, cluster 1 (Utladalen Valley, Kruskal-Wallis test: Chi-squared = 20.05, degrees of freedom = 11, p value < .05, 52.8% cells with expected counts < 5) (Appendix 4) and cluster 6 (the Besseggen trail, Kruskal-Wallis test: Chi-squared = 60.71, degrees of freedom = 11, p value < .05, 22.2% cells with expected counts < 5) (Table 4). However, the Spearman rank correlation indicated that ranking of place-based values in clusters 1 and 6 were significantly correlated (rho = 0.82, p value < .05). There were some differences, for example, where international visitors mapped more typical park recreation values than both domestic and local users (see Appendix 4 for more details).

Differences among user groups were most evident at Cluster 6 (Besseggen). Local users mapped more cultural and hunting and fishing values than expected. Domestic visitors mapped scenery and therapeutic values to a larger extent, while hunting and fishing were less mapped than expected. International tourists mapped more points representing spirituality and wilderness values than expected, while cultural values, and hunting and fishing were less frequent. We found no significant difference in mapping for the three groups when mapping biological, clean water, gathering, recreation, social values or special places (Table 4).

Of all points mapped, 17.1% did not fall within any clusters (i.e., noise) in the analysis. An analysis of these points (results in Table 5) revealed significant differences in mapped place-based values by user groups (Kruskal-Wallis test: Chi-squared = 47.16, degrees of freedom = 11, p value < .05, 52.8% cells with expected counts < 5). Again, local users mapped more fishing and hunting than the other groups, while domestic visitors mapped more biological diversity values. International visitors mapped significantly more clean water and wilderness values than the other user groups.

5. Discussion

Our study demonstrates that spatially explicit mapping of place-based values can identify distinct patterns in place-based values by user

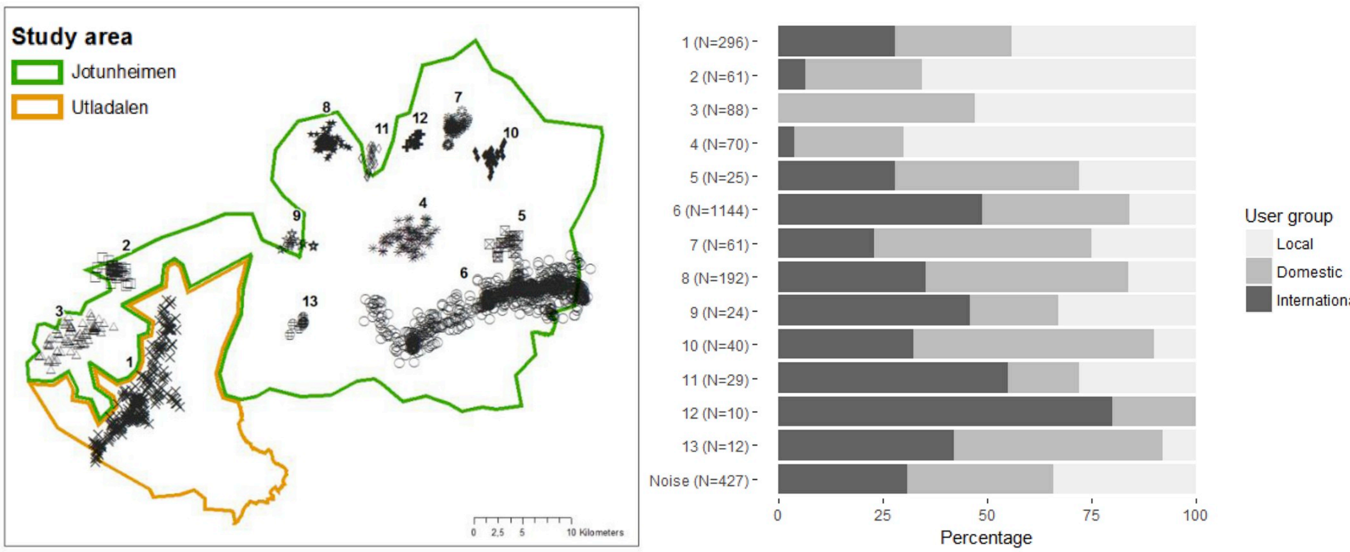

Fig. 2. Left: map of the clusters identified in the cluster analysis. Different clusters are represented by different shapes and numbers. A total of 13 clusters were identified. Right:Barplot showing the proportional contribution of each user group to each cluster. The numbers in parantheses correspond to the sum of all mapped place-based values in the cluster. Noise refers to the points that due to high dispersion, did not fall inside any cluster. A table with each ecosystem value per cluster can be found in Appendix 3. Cluster names: 1- Utladalen valley, 2- Helgedalen valley, 3- Hurrungane mountain range, 4- Memurububreen glacier, 5- Besshø mountain, 6- Bessegen trail, 7- Glittertind mountain, 8- Galdhøpiggen mountain, 9- Leivassbu cabin, 10- Glitterheim cabin, 11- Spiterstulen cabin, 12-Leitjønne lake, 13- Olavsbu cabin.

groups of protected areas. We found that locals and tourists valued some of the same places (Fig. 2), but held different values for those places (Table 4). The results were consistent with previous findings by Munro, Kobryn, Palmer, Bayley, and Moore (2017) where local residents mostly prioritized the same values as visitors, but differed somewhat with respect to the importance of consumptive uses and the locations mapped.

Non-spatial analyses showed that the three user groups ranked values similarly, and for most values, there were only minor differences among user groups. Locals differed from visitors by mapping more consumptive (i.e. gathering, fishing and hunting) and cultural values which could reflect a stronger identity associated with the state commons and subsistence-oriented recreation such as gathering, fishing and hunting (Hausner et al., 2015). Munro et al. (2017) also found that local residents mapped fishing values more frequently than non-residents in the Kimberley region in Australia. We found wilderness values to be held by locals and international visitors more than domestic visitors. This is consistent with previous studies from Norway which show that local recreational hunters and non-Scandinavian tourists share preferences for undisturbed nature, although each group value and perceive wilderness differently (Vistad & Vorkinn, 2012). Other studies have also found that domestic visitors value wilderness less than international visitors, which could be explained by the different expectations created by marketing strategies (Higham, Kearsley, & Kliskey, 2001).

Local residents mapped place-based values in significantly different locations than visitors. Furthermore, the place-based values of domestic- and international visitors were spatially closer to each other compared to locals, and the distance in locations mapped were largest between local and international visitors. Although value compatibility analysis conducted by Moore, Brown, Kobryn, and Strickland-Munro (2017) assumed conflicts between consumptive and non-consumptive

Table 4
For cluster number 6, summary of the different place-based values mapped by locals, domestic- and international visitors. Perc. is the percentage of times a value was mapped. Residual is the standardized residual from the Chi-square analysis where color indicates if the frequency was significantly larger (blue italics) or smaller (red italics) than expected.

	Local		*Domestic*		*International*	
	Perc.	Residual	Perc.	Residual	Perc.	Residual
Biological	2.21 %	-1.60	4.27 %	-0.22	5.31 %	1.38
Clean water	7.73 %	-1.28	9.80 %	-0.49	11.68 %	1.40
Cultural	4.97 %	*3.09*	2.01 %	0.00	1.06 %	*-2.26*
Gathering	0.00 %	-0.61	0.25 %	0.45	0.18%	0.02
Hunt/ fish	12.71 %	*9.99*	0.50 %	*-3.02*	0.35 %	*-4.42*
Recreation	30.94 %	-0.74	30.65 %	-1.39	35.93 %	1.86
Scenic	25.97 %	-1.76	37.19 %	*2.99*	29.38 %	-1.56
Social	4.42 %	1.25	3.52%	0.79	2.12 %	-1.67
Spiritual	0.00 %	-1.63	0.50 %	-1.62	2.12 %	*2.74*
Therapeutic	1.66 %	-0.61	3.77 %	*2.48*	1.42 %	-1.92
Wilderness	4.42 %	-0.75	4.02 %	-1.69	7.08 %	*2.16*
Special place	4.97 %	1.01	4.97 %	-0.20	3.36 %	-0.55

Table 5
For noise (dispersed points), summary of place-based values mapped by locals, domestic- and international visitors. Perc. is the percentage of times a value was mapped. Residual is the standardized residual from the Chi-square analysis where color indicates if the frequency was significantly larger (blue italics) or smaller (red italics) than expected.

	Local		*Domestic*		*International*	
	Perc.	Residual	Perc.	Residual	Perc.	Residual
Biological	3.40 %	-2.83	16.78 %	4.36	5.38 %	-1.59
Clean water	7.48 %	-0.89	6.71 %	-1.27	13.85 %	2.24
Cultural	2.04 %	0.80	0.67 %	-0.94	1.54 %	0.15
Gathering	1.36 %	1.95	0.00 %	-1.04	0.00 %	-0.94
Hunt/ fish	9.52 %	4.86	0.67 %	-2.34	0.00 %	-2.61
Recreation	27.89 %	-1.85	38.26 %	1.53	34.62 %	0.33
Scenic	31.97 %	1.22	28.86 %	0.25	23.08 %	-1.53
Social	0.68 %	-0.41	2.01 %	1.69	0.00 %	-1.33
Spiritual	0.00 %	-1.46	0.67 %	-0.42	2.31 %	1.95
Therapeutic	1.36 %	0.25	1.34 %	0.24	0.77 %	-0.51
Wilderness	12.93%	1.08	3.36 %	-3.78	17.69 %	2.79
Special place	1.36 %	0.65	0.67 %	-0.42	0.77 %	-0.24

uses, in our case, the consumptive - and cultural values mapped by locals were significantly less abundant than other place-based values at this site. Also, the potential for user group conflict is strongly influenced by the intensity of use, not just the mere spatial overlap of potentially conflicting values (Wolf, Brown, & Wohlfart, 2017).

Whether or not the different place-based values (and associated uses) held by the different user groups at each place translates into conflict or diminished satisfaction is unclear. Further studies that spatially map people's preferences for different uses as described in G. Brown, Kangas, Juutinen, and Tolvanen (2017) are needed to clarify the potential for conflict. While the different user groups mostly shared the same values, differences in place-based values can be summarized as consumptive and cultural values (locals) versus conservation values (domestic and internationals). Hunting, fishing and gathering are generally accepted by locals in most protected areas in Norway (Hausner, Engen, Bludd, & Yoccoz, 2017), and domestic visitors might perceive these activities as acceptable even though they themselves do not prioritize these activities. We found that consumptive values are mainly present in cluster 6 (Fig. 2) and are otherwise dispersed throughout the protected areas. Over 17% of mapped place-based values were dispersed (i.e., not included in any cluster) reducing the value overlap between user groups, and potential conflicts. In a study on hunter typologies, Wam, Andersen, and Pedersen (2013) found that hunters differ in their tolerance to seeing other hunters, which may explain the mixed pattern of clustered and dispersed mapping of consumptive values. The different character (e.g., clustered vs dispersed) of different place-based values may require spatially distinctive management strategies, such as those defined by Leung and Marion (1999).

Study limitations and future research. Data on park visitor profiles and number of visitors per year is scarce, and we were unable to test the representativeness of visitors in our sample. However, the demographics of visitors in our sample were similar to previous studies. Vorkinn (2011) found that Jotunheimen NP and Utladalen are highly visited by international tourists, and 44% of their respondents were first time visitors. They also found that over three-quarters of the respondents had a university degree or professional education. Access to the internet and internet literacy may prevent certain users from responding the survey, or bias responses towards younger participants (Kaplowitz, Hadlock, & Levine, 2004). Our study reported a lower average number of mapped points (place-based values) per respondent than previous studies (G. Brown, 2017). One explanation may be that the majority of the respondents, especially the domestic and international visitors, are one-time visitors with less knowledge of the landscape. We increased the representativeness of local users by conducting a household survey in addition to *in-situ* recruitment of visitors. It may be possible to get an even more representative sample of park users by conducting both online PPGIS and *in-situ* mapping. A more intuitive web interface could also lower the potential for non-completion of the full online survey.

There were also inherent limitations in the spatial analyses performed. There are many different approaches and subjective parameter choices involved in value hotspot mapping (see Bagstad, Semmens, Ancona, and Sherrouse (2016); Beeco et al. (2014); Karimi and Brown (2017)). We used a combination of subjective hotspot parameter specification (i.e., minimum of 10 points in a cluster) and statistical methods (DBSCAN) to identify distinct clusters, but the choice of parameters and statistical methods can influence the results. Finally, our analysis focused on value hotspots, thus ignoring place-based values in remote and scattered locations which might be high-value areas important for conservation (Bagstad et al., 2016).

Further research could explore the associations between mapped place-based values and biophysical features in order to identify the places that are most valuable to park visitors and that have high ecological value, and thus contribute to policies that include ecosystem service valuation. For example, Alessa, Kliskey, and Brown (2008) used value mapping to identify socio-ecological hotspots, i.e., areas of high ecological importance and social value, showing the link between place-based values and ecosystem services. In addition, combining the mapping of place-based values with mapping of development preferences and visitors' experiences could increase our understanding of differences between user groups and inform management decisions in a wider context (e.g., G. Brown and Raymond (2006)). A next step that could more easily integrate place-based values of different users with the time-space movements and behavior of tourists in recreational areas (Chardonnel & Knaap, 2002) is mapping using smartphone-based technologies which could increase the accuracy of mapping while tracking the visitor use in the parks (Doherty, Lemieux, & Canally, 2014).

6. Recommendation for national park planning and management

The use of web-based PPGIS provided the opportunity to collect a large amount of data to identify areas that were most valued by locals, domestic- and international visitors. The methods we demonstrate here can inform strategies to avoid conflict or reduce overuse. For instance spatial zoning of national park users could be achieved via information and marketing, directing conflicting users to the areas we identify as less important for user groups with different values (Day, 2002; Tranel & Hall, 2003).

Our study could inform the new visitor strategy and paradigm for

Norwegian national parks where tourisms needs to increase in protected area to sustain the parks financially and/or support livelihood and development of local communities. Attracting more tourists to protected areas means satisfying a broader range of visitors without impacting conservation values or traditional users (Bushell & Eagles, 2006). Web-based PPGIS can identify park values on a sufficiently large scale to differentiate among user groups, both in terms of how they rank values and the specific places appreciated. Understanding value differences between locals and visitors is important for managing national parks (Gundersen, Mehmetoglu, Inge Vistad, & Andersen, 2015), particularly where an increased focus on economic revenue from park tourism could challenge the long-term local use of the area. Reassuringly, our spatial explicit analyses revealed that different user groups were self-segregating to some degree in the study area. As a result of this self-segregation, and with thoughtful management, it is possible that the continued push to increase rates of tourism in Norway's protected areas may be achieved without degrading the place-based values of local people.

Contribution

VH and GB initiated the study. LM conducted the fieldwork. LM and VH defined the hypothesis. LM conducted the main analyses. All authors discussed the results and contributed to the final manuscript.

Acknowledgements

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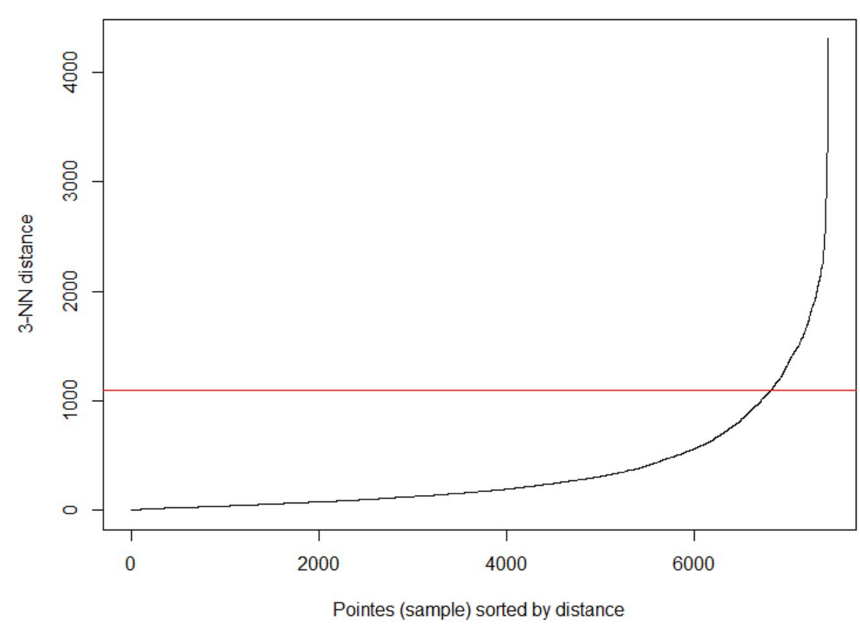
Appendix

Appendix 1

Summary of demographic variables of respondents by user group. Some questionnaires were incomplete, and therefore the sum of percentages might not be 100 in all cases below.

		Local	Domestic	International
Visitors	Total	117	127	133
Gender	Male	52.1%	57.5%	59.4%
	Female	47.0%	42.5%	39.9%
Age	Mean	46	42	36
Education	Secondary or lower	39.3%	14.1%	14.3%
	University degree or professional education	59.0%	85.0%	85.0%
Times visited	Median	1	1	1
	Mean	2.8	1	1
Knowledge	Good	19.66%	14.2%	26.3%
	Average	60.7%	43.3%	27.8%
	Low	19.66%	42.5%	43.6%
Mapped values	Total	670	883	926
	Average per person	6	7	7

Appendix 2



Plot of the k-nearest neighbor distances for all mapped values. k was defined as (2*dimension)-1.

Appendix 3

Amount of markers added by each user group in the clusters identified by the DBSCAN algorithm.

	Biolo-gical	Clean water	Cultural	Gathe-ring	Hunt/fish	Recrea-tion	Scenic	Social	Special place	Spiritual	Thera-peutic	Wilder-ness
Cluster 1: Utladalen												
Local	9	8	6	3	3	25	47	4	4	1	6	15
Domestic	7	12	11	0	0	17	27	2	1	0	1	5
International	3	10	1	2	0	26	27	5	0	2	0	6
Cluster 2: Helgedalen												
Local	1	1	1	0	0	14	15	0	3	1	2	2
Domestic	1	1	0	0	0	8	5	2	0	0	0	0
International	0	0	0	0	0	2	1	1	0	0	0	0
Cluster 3: Hurrungane												
Local	0	1	2	0	0	19	17	1	3	1	0	3
Domestic	1	4	0	0	0	19	12	0	3	1	0	1
Cluster 4: Memurububreen												
Local	2	3	3	2	0	10	12	1	0	2	4	10
Domestic	1	2	0	0	0	3	5	1	0	1	2	3
International	0	0	2	0	0	0	0	0	0	0	0	1
Cluster 5: Besshø												
Local	1	3	0	0	1	1	0	0	0	1	0	0
Domestic	1	3	1	0	0	2	4	0	0	0	0	0
International	0	1	0	0	0	2	2	0	0	0	0	2
Cluster 6: Bessegen												
Local	4	14	9	0	23	56	47	8	9	0	3	8
Domestic	17	39	8	1	2	122	148	14	14	2	15	16
International	30	66	6	1	2	203	166	12	19	12	8	40
Cluster 7: Glittertind												
Local	0	0	2	1	0	5	6	0	0	0	0	1
Domestic	0	1	0	0	0	13	16	1	0	0	0	1
International	0	1	0	1	1	2	7	0	0	0	1	1
Cluster 8: Galdhøpiggen												
Local	0	0	2	0	0	15	9	1	1	2	0	1
Domestic	4	5	3	0	0	31	31	1	8	2	6	2
International	2	8	1	0	0	20	19	1	6	4	2	5
Cluster 9: Leivassbu												
Local	0	0	0	0	0	5	3	0	0	0	0	0
Domestic	0	0	0	0	0	3	2	0	0	0	0	0
International	0	2	0	0	0	3	4	0	1	0	0	1
Cluster 10: Glitterheim												
Local	0	0	0	0	1	1	1	0	0	0	0	1
Domestic	1	5	2	0	0	9	4	1	0	0	0	1
International	1	2	0	0	0	5	1	3	0	0	0	1
Cluster 11: Spiterstulen												
Local	1	0	0	0	0	5	0	2	0	0	0	0
Domestic	0	1	0	0	0	2	2	0	0	0	0	0
International	1	3	0	0	0	8	2	1	0	0	0	1
Cluster 12: Leirtjønne												
Domestic	1	1	0	0	0	0	0	0	0	0	0	0
International	2	2	0	0	0	0	2	0	0	1	1	0
Cluster 13: Olavsbu												
Local	0	0	0	0	0	1	0	0	0	0	0	0
Domestic	0	0	0	0	0	4	1	1	0	0	0	0
International	0	0	0	0	0	0	3	2	0	0	0	0
Noise												
Local	5	11	3	2	14	41	47	1	2	0	2	20
Domestic	25	10	1	0	1	57	43	3	1	1	2	5
International	7	18	2	0	0	45	30	0	1	3	1	23

Appendix 4

For cluster number1, summary of the different place-based values mapped by locals, domestic- and international visitors. Perc. is the percentage of times a value was mapped. Residual is the standardized residual from the Chi-square analysis where color indicates if the frequency was significantly larger (blue italics) or smaller (red italics) than expected.

	Local		Domestic		International	
Biological	6.87 %	0.28	8.43 %	0.88	3.66 %	-1.20
Clean water	6.11 %	*-2.05*	14.46 %	1.54	12.20 %	0.73
Cultural	4.58 %	-0.96	13.25 %	*3.22*	1,22 %	*-2.17*
Gathering	2.29 %	0.71	0.00 %	-1.41	2,44 %	0.62
Hunt/ fish	2.29 %	1.95	0.00 %	-1.09	0,00 %	-1.08
Recreation	19.08 %	-1.42	20.48 %	-0.64	31,71 %	*2.21*
Scenic	35.88 %	0.57	32.53 %	-0.36	32,93 %	-0.27
Social	3.05 %	-0.54	2.41 %	-0.74	6,10 %	1.34
Spiritual	0.76 %	-0.38	0.00 %	-1.09	2,44 %	1.52
Therapeutic	4.58 %	*2.23*	1.20 %	-0.82	0,00 %	-1.66
Wilderness	11.45 %	1.44	6.02 %	-1.05	7,32 %	-0.55
Special place	3.05 %	1.62	1.20 %	-0.40	0,00 %	-1.40

Appendix 5

Data.

Appendix 6

Statistical analyses (script).

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