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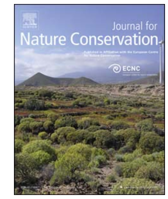

Assessing local acceptance of protected area management using public participation GIS (PPGIS)

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ABSTRACT

Protected area management can be highly contentious. Information about the acceptability of conservation actions can help environmental authorities design policies that are accepted locally, and identify potential areas of conflict between land users and conservation objectives. In this study, we implemented a spatially-explicit method for eliciting public preferences for land use and conservation policy (web-based public participation GIS; PPGIS). We invited randomly selected local residents in two mountainous regions in Norway to map their preferences for consumptive resource use, motorized use, land development and predator-control. We assessed whether local communities favored or opposed these human activities in nearby protected areas using mixed-effects logistic regression and controlling for landscape characteristics, accessibility and demographics. Local residents strongly favored consumptive resource use and predator control regardless of protected area status, and were more likely to oppose than favor land development inside protected areas. These preferences are largely consistent with the present protected area policy in Norway and Europe that promotes traditional consumptive use and the maintenance of cultural landscapes, but restricts land development. Our results suggest that use-based framing of conservation is more likely to resonate with these communities than narratives tied to the preservation of pristine nature and emerging conservation ideas of the rewilding of nature. Mapped community preferences can be a valuable tool for policy makers and stakeholders representing community interests in participatory processes, and for assessing the local acceptance of alternative management actions within protected areas.

1. Introduction

Many conservation actions involve tradeoffs between competing land uses and the protection of biodiversity. Decisions regarding which activities to allow and which to restrict, can involve a delicate balance between local preferences for land use with conservation objectives. Information about the local acceptance of such tradeoffs could allow decision makers to craft conservation policies that are more consistent with local preferences (Bennett & Dearden, 2014; Bennett, 2016; Heinen, 2010; Paloniemi et al., 2017). Social acceptability is important both for pragmatic (improve conservation outcomes; Andrade & Rhodes, 2012; Cetas & Yasué, 2017; Oldekop, Holmes, Harris, & Evans, 2015), and for moral and economic reasons (Brockington, 2004; Holmes, 2013), i.e., to avoid protectionist approaches with high social impacts (West, Igoe, & Brockington, 2006). Finding new ways to assess the consistency between local preferences and conservation could therefore help managers and decision makers develop initiatives that are more socially feasible and longer lived (Bennett et al., 2016, Raymond & Brown, 2011).

Social acceptability is a loosely applied concept in the social sciences that describes the extent to which a group of people prefer a given situation (Brunson, 1996). The social acceptability of conservation policies is often evaluated by using qualitative interviews or quantitative surveys (Bennett, 2016; Jones, Clark, Panteli, Proikaki, & Dimitrakopoulos, 2012; Steg, Dreijerink, & Abrahamse, 2005; Thomassin, White, Stead, & David, 2010). Participatory mapping, where participants map their land use or management preferences (Brown, 2013; Brown, Hausner, Grodzińska-Jurczak et al., 2015; Raymond & Brown, 2006), can also be used for this purpose. Web-based Public Participatory GIS (PPGIS) allows data to be collected over large areas by recruiting local residents through random household sampling. Previous studies have used web-based PPGIS to inform conservation

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planning (Karimi, Tulloch, Brown, & Hockings, 2017; Whitehead et al., 2014), to identify the potential for land use conflict (Brown, Kangas, Juutinen, & Tolvanen, 2017, Brown & Raymond, 2014; Karimi & Brown, 2017) and to map the relationships between governance (i.e., protection and property ownership), values and preferences (Hausner, Brown, & Lægreid, 2015). In this paper, we use web-based PPGIS to analyze the consistency between local people's preferences and Norwegian protected area management. We focus on four different categories of human activities: consumptive use, motorized use, land development, and predator control. We chose these categories because they cover issues of relevance to the general public and are central to issues concerning conservation.

Protected area management in Norway follows a sustainable use approach that can be traced back to millennia old traditions of subsistence use and the public right of access (Hammitt, Kaltenborn, Emmelin, & Teigland, 1992; Olsson, Austrheim, & Grenne, 2000). These traditions are also reflected in legislation as non-motorized, low-impact access, and small-scale consumptive uses such as hunting, fishing and grazing are allowed in most protected areas (Fauchald & Gulbrandsen, 2012; Hausner, Engen, Bludd, & Yoccoz, 2017 Lethal control of predators requires permits in some protected areas, but is allowed in most cases. Norway has zoning management to reduce human-wildlife conflicts, but these zones do not necessarily overlap with protected areas. Fishing, hunting and grazing are regulated through national, regional and local rules and regulations (i.e., licenses, restricted season, quotas, restrictions on gear etc.). Land development is generally not allowed inside protected areas and motorized vehicle use is usually restricted through permits and kept at a minimum. Both activities are more strictly regulated inside protected areas than outside, but the former more likely more so than the latter (Norwegian Environmental Agency, 2014; Norwegian Official Report, 2004).

Norwegian protected areas are enacted to fulfil multiple objectives: to maintain natural variation of habitat types, landscapes and biodiversity, as well as provide areas for small-scale outdoor recreation, and safeguard natural and cultural history (Nature Diversity Act § 33). Protected areas cover approximately 17.1% of mainland Norway. These areas are important for outdoor recreation such as hiking, camping, skiing, hunting and fishing. Like many countries, protected area restrictions in Norway attracts local conflict (Bay-Larsen, 2010; Daugstad, Svarstad, & Vistad, 2006; Ministry of Climate & Environment, 2015; Overvåg, Skjeggedal, & Sandström, 2016; Reitan, 2004). In an attempt to improve local acceptance and defuse conflict, decision-making power over protected areas was recently devolved to local boards who are both downwardly accountable to their constituency and upwardly accountable to the national environmental authorities (Hongslo, Hovik, Zachrisson, & Aasen Lundberg, 2015). Our study shows how web-based PPGIS could inform protected area management about activities that people favor and oppose, and whether they are likely to accept area use tradeoffs for the benefit of conservation.

The participants in this study were asked to place markers on a map indicating their preferred changes to current land management. For each of 13 different types of activities, they could identify a spatial preference to *accept/wish to increase* the activity, or a parallel spatial preference to *don't accept/wish to* d*ecrease* the activity (see Table 1). For simplicity, these activity preferences are referred to as *favor* and *oppose.* Our analysis of the spatial preference data was designed to determine whether the collective preferences of local residents reflect the actual legal restrictions inside and outside protected areas in Norway.

If the preferences of local residents are consistent with protected area policy, we expect:

1 Greater opposition than acceptance towards land development and motorized vehicle use inside protected areas compared with outside (activities that are currently more strictly regulated inside protected areas).
2 No difference in preferences for consumptive use and predator control inside and outside protected areas (activities that are regulated in the same way inside and outside protected areas).

2. Methods

2.1. Study area and approach

The study included two separate study areas, one in the northern and one in the southern part of Norway (Fig. 1). We chose the study areas to provide contrasts between: a) northern and southern Norway, b) protected and unprotected land, c) public and private land, and d) urban and rural areas. To assess the alignment between community preferences and protected area policy, we had to cover broad scales and recruit a large enough population to achieve a representative sample. Both regions are situated in mountainous fjord landscapes with the southern region including more than 10 of the highest peaks in Norway. The southern study area covers the five municipalities Sogndal, Luster, Vågå, Skjåk and Aurland with a total population of 35,000. The region is 14,601 km^2 with 53 protected areas comprising 61% of the total area. The northern region includes the municipalities Bodø, Fauske, Saltdal, Beiarn, Gildeskål and Sørfold with a total population of 68,600. The region is 8390 km^2 with 48 protected areas comprising 68% of the total area.

2.2. PPGIS survey

We implemented a random household PPGIS survey in the two study regions in the winter of 2014. From the tax register, we drew a random sample of 10% of the adult population (> 18 years) in each of the two study areas, which included 3104 participants in southern Norway and 3054 in northern Norway. The invitation letter contained an access code and instructions on how to complete the survey. Two weeks later, we sent a reminder letter to non-respondents. Further, we recruited participants through emails to local organizations and advertisements in local- and social media. In total, we contacted 263 organizations in the south and 216 in the north for participation in the study, representing a diversity of interest groups relating to conservation or environmental management (e.g., clubs for snowmobile use, horseback riding, shooting, hunting, fishing, farming, hiking, kiting, industry, environmental NGOs).

Following consultations and advice from protected area managers, we used two types of markers for participant mapping: ecosystem values and land use/activity preferences. In this study, we focused on the preference markers. Following informed consent, participants were taken to a Google Maps interface where they were instructed to drag and drop the preference markers, namely whether they *favor* or *oppose* 13 different types of activities (Table 1) onto the study region map. The maps also showed the location of protected areas. We let participants place as many (or as few) markers as they deemed appropriate to reflect their knowledge and experience. Given this open-ended mapping request, we encouraged participants to place at least 20 markers as a heuristic guide for their response effort. The web-based PPGIS surveys can be accessed using the following links: Northern region: http://www.landscapemap2.org/norwaynorth, Southern region: http://www.landscapemap2.org/norwaysouth.

2.3. Study participants

Most study participants were recruited through random household sampling (90%). In total, 440 people in the south and 486 in the north participated in the survey. Our estimated response rates after accounting for non-deliverable letters were 14% and 16.3% respectively, which is comparable to other PPGIS studies (Brown & Kyttä, 2014). We excluded markers by participants that did not complete demographic questions, resulting in 3324 preference markers mapped by 197 people in the north and 189 people in the south. The number of preference

Table 1
Preferences mapped in the Public Participatory GIS survey.

Category	Human activity	Preference
Consumptive use	Grazing	Accept/increase or do not accept/decrease grazing in this area (e.g., sheep, reindeer, cows)
	Fishing	Accept/increase or do not accept/decrease access to fishing in this area
	Hunting	Accept/increase or do not accept/decrease hunting in this area
Motor use	Helicopter transport	Accept/increase or do not accept/decrease access to helicopter transportation of tourists in this area
	Roads/all-terrain vehicles	Accept/increase or do not accept/decrease access to the area by roads or all-terrain vehicles
	Snowmobiles	Accept/increase or do not accept/decrease the use of snowmobiles in this area (including snowmobile trails and/or extended seasons)
	Boating	Accept/increase or do not accept/decrease access for use of boats in this area
Development	Houses/holiday homes	Accept/increase or do not accept/decrease the construction of homes or holiday homes in this area
	Tourist facilities	Accept/increase or do not accept/decrease tourist facilities and accommodation in this area
	Industry/energy	Accept/increase or do not accept/decrease mining (e.g., minerals, stone, sand, gravel, etc.) or energy development (e.g., windmills, power plants, dams, power lines, etc.) in this area
Predator control	Culling of predators	Accept/increase or do not accept/decrease predator control in this area
	[a]Logging	Accept/increase or do not accept/decrease logging in this area
	[a]Other changes	Describe other changes in use or activities should increase or decrease

[a] Not analyzed in this study.

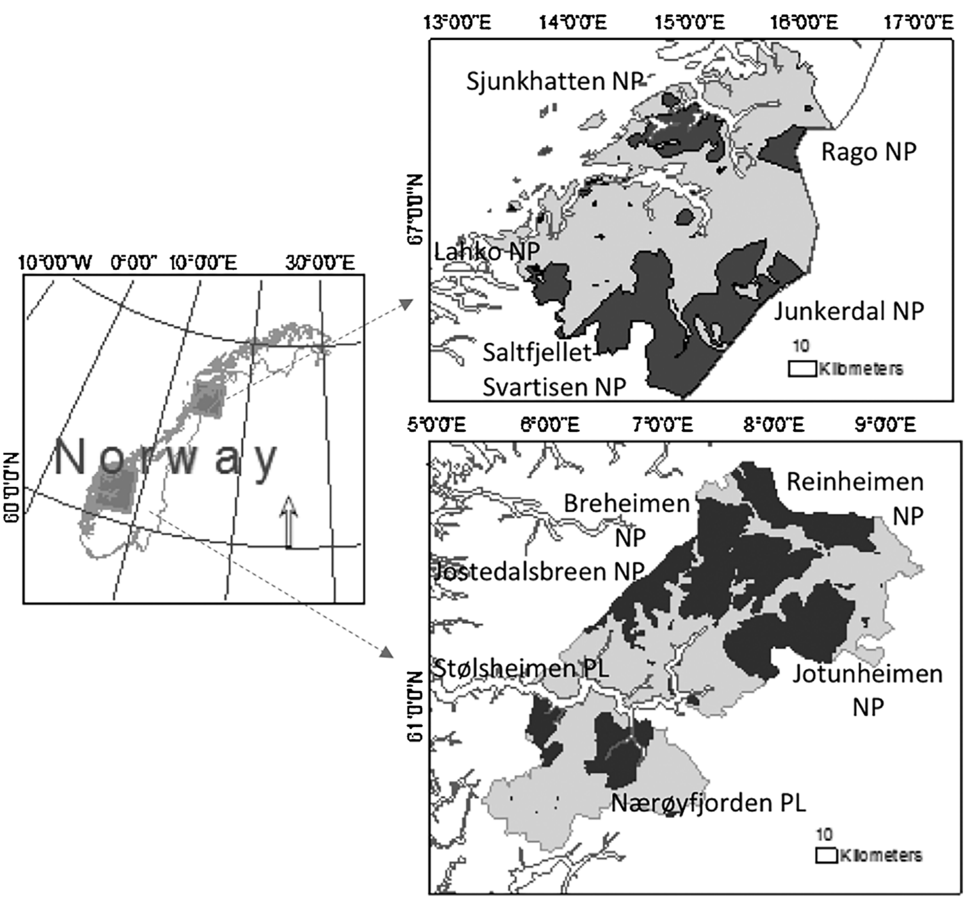

Fig. 1. Map over the study areas. Dark grey polygons show protected areas (NP = National Park - IUCN II, PL = Protected Landscape - IUCN V).

markers per person ranged from 1 to 138 (mean = 8.6). When compared with census data from the two regions, the sample was slightly biased towards males, people with higher levels of formal education, and with a higher income level (Table A3). The sampling method (voluntary vs. random household) did not have an effect on the data collected in this study (Brown, Hausner, Grodzińska-Jurczak et al., 2015).

2.4. Model of activity preferences

We used mixed effects logistic regression to analyze preferences for human activities (consumptive uses, motorized use, land development, and predator control) in protected and non-protected areas. Protected areas are not randomly located in the landscape, but are often found in more remote locations (Joppa & Pfaff, 2009). We therefore included landscape characteristics and accessibility covariates since we want to know if there is an additional effect of protection, i.e., whether people's preferences are influenced by the protection independent of its placement. Public land has been associated with more intangible values, similar to protected areas, whereas private land has been more associated with use values (Brown, Weber, & De Bie, 2014, Hausner et al., 2015; Jarvis, Breen, Krägeloh, & Billington, 2016; Raymond & Brown, 2006) so we also included land ownership as a covariate.

Preferences were coded as a binomial response variable, defined as

Table 2
Overview over covariates.

Category	Variable	Levels	Description
Landscape	LAND 1 LAND 2	Continuous	First and second component of the PCA analyses run on the variables: percent broad-leaved forest, -conifer forest, -cropland, -sparsely vegetated areas, -heath & shrub land and -wetland from the CORINE land cover dataset published in 2012 (Brown et al., 2016; Heggem & Strand, 2015), along with elevation. See Table A2 for factor loadings.
	WATER	Categorical (Yes, No)	Presence of major lakes (> 2 ha) and rivers within 500m calculated from data available at the Norwegian Water Resources and Energy Directorate.
Governance	PROTECT	Categorical (Yes, No)	Protected or not protected. The study areas include protected areas of IUCN categories I-V (source: Norwegian Environmental Agency 2016).
	PROPERTY	Categorical (Public, Not Public)	Public land owned by the Norwegian state-owned forest company, Statskog SF. Statskog SF is the largest land-owner in Norway and is caretaker of one fifth of mainland Norway (source: Statskog, 2015).
Accessibility	ROAD	Continuous	Euclidian distance to the nearest public and private roads, tractor roads, ATV tracks and paths (meters; source: The Norwegian Mapping Authority 2015).
	TOWN	Continuous	Euclidian distance to the nearest town (meters), where towns are defined as clusters of houses with at least 200 residents and where the distance between houses does not exceed 50 m (source: Statistics Norway, 2015).
Demographics	GENDER	Categorical (Female, Male)	Participant's gender.
	AGE	Continuous	Age of participant (years)
	EDUCATION	Categorical (Primary, Higher)	Participant's self-reported education. Primary education includes the steps from elementary to high school. Higher education means university or university college.
	INCOME	Categorical (300less, 300_500, 500_more)	Participant's self-reported income in Norwegian Kroner (NOK), ranging from 300,000 or less, between 300,000 and 500,000 or from 500,000 and more.
Human activity	ACTIVITY	Categorical (Hunting, Fishing, Grazing, Boat, Snow, Heli, ATV, House, Industry, Tourist facilities, Predator control)	Variable identifying the different types of preferences (see Table 1 for more details).

Table 3
Average covariate values for the whole study area (both northern and southern regions), the protected and the unprotected part.

Category	Variable	Whole study area	Protected area	Unprotected area
Landscape	Broad-leaved forest (%)	18.2	7.1	24.6
	Conifer forest (%)	4.5	0.7	6.7
	Cropland (%)	2.4	0.1	3.7
	Heath & shrub (%)	14.3	11.4	16.0
	Sparsely vegetated (%)	57.6	80.2	16.0
	Wetland (%)	1.1	0.6	1.5
	Water present 500m (%)	0.31	0.28	0.33
	Elevation (meters)	902.15	1163.05	750.73
Accessibility	Distance to coast (km)	22.14	29.05	18.16
	Distance to town (km)	25.56	31.33	22.21
	Distance to road (meters)	1399.67	1935.68	1087.78

1 for *favor* and 0 for *oppose*. We included covariates describing land cover, elevation, and the presence of waterbodies. The land cover variables were adapted from the CORINE land cover dataset (Heggem & Strand, 2015). A previous study successfully used the CORINE dataset to predict ecosystem values, suggesting a good correspondence between spatial markers and this land cover (Brown, Pullar, & Hausner, 2016). In this study, we reduced complexity in the CORINE dataset to lower the number of variables (see details further down). The land cover in the two study areas is relatively similar and dominated by mixed forests, sparse vegetation, and bare areas with relatively little land in agriculture, grassland, or developed areas (Brown et al., 2016). The accessibility covariates were the Euclidean distance to the nearest road and town. We extracted the covariate values for each mapped point using the coordinates of that point. To control for participants' socio-demographic characteristics, we included the covariates gender, age, income, and educational level. The variables are described in Table 2. Table 3 shows the average values of the land cover and accessibility variables in protected and unprotected areas in the study region. The table shows the location bias of protected areas, namely that protected areas are dominated by sparse vegetation, are found at higher elevation, and are less accessible than unprotected areas. To account for variability in mapping behavior (e.g., some people placed many markers while others placed few) and region (north and south), we used the participant's unique access code (LOGIN_ID) nested within REGION as a random factor in the analyses.

The continuous variables were standardized (z-scored) by subtracting by the mean and dividing by the standard deviation. The land cover classes were merged into six broader classes (Table A1) and the percentage of the area occupied by each class was calculated under a circular moving window with 1km diameter. To reduce the number of variables (and thus the risk of overfitting), we combined the land cover and elevation variables into two covariates using principal component analysis (PCA), which explained 50% of the variance. Decreasing values of the first principal component reflected sparsely vegetated areas at higher elevation while higher values indicated broad-leaved forest at lower elevation. Increasing values of the second principle component reflected conifer forest or cropland while lower values reflected wetland (see Table A2 for factor loadings). We also fitted models with all the land cover variables, including elevation and this did not change the overall results, so we selected the model with the PCA variables for parsimony. The correlations among the continuous variables were less than $+/-0.45$ (Spearman rank).

2.5. Model selection and statistical analysis

We limited the number of interaction terms by only including the effect most relevant to our main hypothesis, the interaction between protection and human activity. We performed model selection using single-term deletion minimizing the AIC starting with the full model:

$$\ln\left(\frac{P(\text{favor})}{1-P(\text{favor})}\right) = \text{ACTIVITY} + \text{LAND1} + \text{LAND2} + \text{WATER} + \text{ROAD} + \text{TOWN} + \text{GENDER} + \text{EDUCATION} + \text{INCOME} + \text{AGE} + \text{PROPERTY} + \text{PROTECT} + \text{PROTECT:ACTIVITY} + \text{REGION} \mid \text{LOGIN\_ID (random)}.$$

For the analyses we used R software and ArcGIS (ESRI version 10, 2010; R Development Core Team 2016). We assessed model adequacy from scaled residuals plots with values simulated both at the population level (i.e., without the random effect) and also taking into account the random effect using the *DHARMa* library (Hartig, 2016). We tested for overdispersion using the function *dispersion_glmer* from library *blmeco* (Korner-Nievergelt et al., 2015). We assessed the presence of spatial autocorrelation in the model residuals (Klain & Chan, 2012) from spline correlograms available from library *ncf* (Bjornstad, 2016). For the PCA we used the function *princom,* which is part of the base package of R. We used the libraries *lme4* (Bates, Mächler, Bolker, & Walker, 2015), *AICcmodavg* (Mazerolle, 2016) and *piecewiseSEM* (Lefcheck, 2016) for the mixed models and model predictions.

3. Results

3.1. Modelling results

The final model selected was ACTIVITY + LAND1 + LAND2 + WATER + GENDER + EDUCATION + AGE + PROTECT + PROTECT: ACTIVITY + REGION | LOGIN_ID (random). There was no overdispersion (dispersion_glmer = 0.768). We removed four variables from the model. These included the accessibility covariates ROAD and TOWN, in addition to participant INCOME and PROPERTY.

Industrial and property development were the only activities generally opposed inside protected areas. The odds that participants *favored* houses/holiday homes and industry/energy were lower inside protected areas than outside (houses: not protected = 0.78, 95% CI = 0.40–1.53, houses: protected = 0.09, 95% CI = 0.03–0.24; industry: not protected = 0.36, 95% CI = 0.17–0.76, and industry: protected = 0.04, 95% CI = 0.01–0.12). The differences between protected and unprotected areas were marginally significant (Table A5). Out of the three categories of land development, the odds that participants mapped *favor* was highest for tourism facilities (tourist: not protected = 2.67, 95% CI = 1.28–5.60, tourism: protected = 1.02, 95% CI = 0.38–2.75) and the difference between protected and unprotected areas was not statistically significant (Table A5).

Preferences for consumptive use, motorized use, and predator control were unrelated to protection, with the exception of fishing where the odds of favor was marginally significantly higher inside protected areas (Table A5). The odds that participants mapped *favor* rather than *oppose* consumptive uses and predator control were generally high (hunting: not protected = 11.25, 95% CI = 4.49–28.22, hunting: protected = 19.82, 95% CI = 5.60–70.18; fishing: not protected = 14.90, 95% CI = 6.33–35.11, fishing: protected = 70.49, 95% CI = 19.13–259.75; grazing: not protected = 11.30, 95% CI = 4.76–26.80, grazing: protected = 16.67, 95% CI = 5.40–51.52; predator: not protected = 7.72, 95% CI = 3.02–19.76, predator: protected = 3.72, 95% CI = 1.57–8.81).

People were more negative to motorized use (boat: not protected = 2.87, 95% CI = 1.04–7.95, boat: protected = 2.10, 95% CI = 0.41–10.92; helicopter: not protected = 0.52, 95% CI = 0.20–1.34, helicopter: protected = 0.23, 95% CI = 0.08–0.68; ATV/road: not protected = 0.44, 95% CI = 0.20–0.94, ATV/road: protected = 0.19, 95% CI = 0.07–0.52; snowmobile: not protected = 0.59, 95% CI = 0.30–1.16, snowmobile: protected = 0.99, 95% CI = 0.45–2.18). The odds that people *favored* snowmobile use was higher inside protected areas than outside, but the difference was not statistically significant (Table A5).

The odds that men were in *favor* of activity was significantly higher than for women (gender: male = 10.31, 95% CI = 3.82–27.85, gender: female = 2.87, 95% CI = 1.04–7.95). The effects of education and age were marginally significant. Respondents with primary education had higher odds of mapping *favor* than those with higher education (education: primary = 5.37, 95% CI = 1.79–16.17, education: higher = 2.87, 95% CI = 1.04–7.95) and the odds of *favor* decreased 28% with a unit increase in age (odds ratio: 0.72, 95% CI = 0.50–1.04).

The odds of *favor* increased 14% for a unit increase in LAND1 i.e., from sparse vegetation at higher altitude towards more broadleaved forest at lower altitude (LAND1 (odds ratio); 1.14, 95% CI = 1.01–1.28), and 13% for a unit increase in cropland/conifer forest (LAND2 (odds ratio); 1.13, 95% CI = 1.00–1.27) and was lower when water was present within 500m than when it was not (water500: not present = 2.87, 95% CI = 1.04–7.95, water500: present = 2.05, 95% CI = 0.75–5.55). LAND1 and water500 were statistically significant whereas LAND2 was marginally significant. See Fig. 2 and Table A5 for model output. Model estimates in Fig. 2 and in the text were predicted using the variable levels GENDER (female), ACTIVITY (boat), WATER500 (not present), EDUCATION (higher) and PROTECT (not protected) as a point of departure.

4. Discussion

Protected areas can benefit local users by providing opportunities for traditional land uses that are consistent with conservation objectives. Allowing small-scale consumptive uses, which is common throughout Europe (Linnell, Kaczensky, Wotschikowsky, Lescureux, & Boitani, 2015; Tsiafouli et al., 2013), can mobilize local conservation support against development (Brooks, Waylen, & Mulder, 2013; Nolte, Agrawal, Silvius, & Soares-Filho, 2013). We found that local people had a relatively low acceptance (i.e., low probability of favor relative to oppose) of activities considered detrimental to conservation such as industrial and energy development and houses/holiday homes *inside* protected areas (the differences between unprotected sites were marginally significant). This despite the potential for these development activities to be highly profitable (Heiberg, Haaland, Christensen, & Aas, 2006) and important for the local economy (Skjeggedal, Overvåg, & Riseth, 2016). The high acceptability of consumptive resource uses and predator control (i.e., high probability of a favor preference relative to oppose) likely has cultural origins tied to historical land use that emphasizes cultural landscapes and wildlife harvest (Gangaas, Kaltenborn, & Andreassen, 2015).

The alignment between local preferences and current conservation policy is perhaps not surprising given that Norwegians have a high degree of trust in public institutions, especially law enforcement (Kleven, 2016). Norway recently devolved protected area governance to local boards and the public can participate in the establishment of protected areas and in the daily park management through advisory councils. These arenas allow for collaboration between protected area authorities and local residents and can add to the explanation of the overall consistency between conservation policy and local preferences found in this study, and the overall satisfaction of residents with the management of these protected areas (results published in: Brown, Hausner, Grodzińska-Jurczak et al. (2015). That trust and participation is important for acceptance of protected area restrictions has been reported elsewhere (Andrade & Rhodes, 2012; Oldekop et al., 2015; Stern, 2008).

Other PPGIS studies have assessed the distribution of mapped values and preferences with implications for conservation policies. For example, a similar spatial survey to the one used in this study was

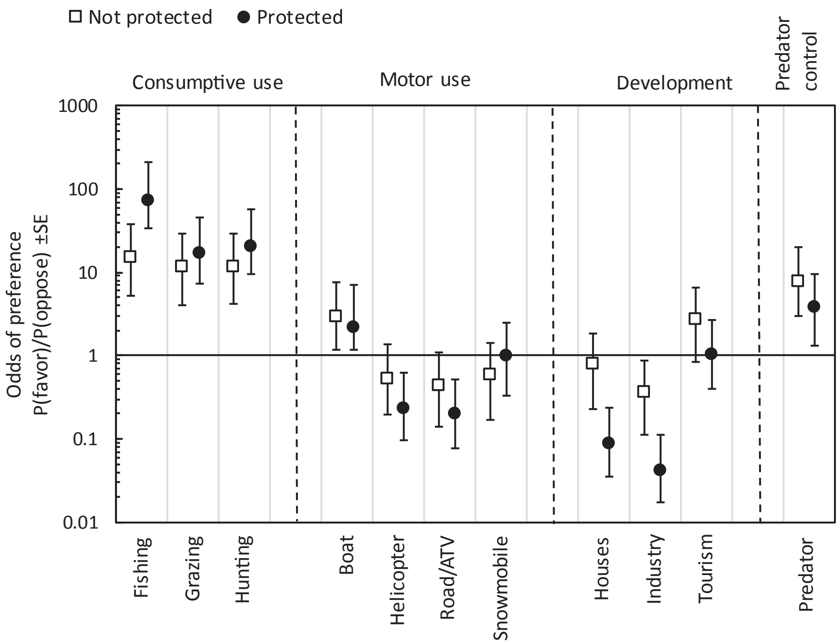

Fig. 2. Local preferences for small-scale consumptive use, motor use, land development and predator control in protected (filled circles) and non-protected (hollow rectangles) areas. The figure shows the odds (SE) that participants' mapped favor relative to oppose for the activity on the x-axis. Odds lower than 1 reflect that the local residents mapped more oppose relative to favor and odds larger than 1 reflect that they mapped more favor relative to oppose. Predictions are made for females, aged 45 years, with higher education, when there is no water present within 500m and LAND1 and LAND2 equals zero.

implemented in Poland and found that Polish residents mapped more environmental and conservation-oriented values and preferences compared to Norwegian residents who placed more emphasis on resource utilization (Brown, Hausner, Grodzińska-Jurczak et al., 2015). When study participants in both countries were asked about the most important reasons for visiting protected areas, respondents in both countries emphasized enjoying nature, tranquility, traditional recreation and social relations. However, harvesting resources was more important in Norway than Poland, indicating that conservation policies for protected areas need to account for cultural context.

Balancing the conservation objectives of protected areas with local preferences can be complex, particularly where local preferences appear to conflict with general assumptions about conservation needs. The higher acceptance of building tourist facilities inside protected areas may appear inconsistent with conservation objectives, but this finding is in line with a recent policy and general trends that seek to promote the development of nature-based tourism in protected areas (Fedreheim, 2013). Local preferences for snowmobile use may also appear inconsistent with conservation objectives since snowmobile use was more acceptable inside than outside protected areas (although the effect was not statistically significant). However, snowmobiles and other forms of motorized use were highly contested (i.e., the odds of preferences in *favor* relative to *oppose* were relatively close to one) in all areas, protected or not. Further, the degree to which protected areas actually limit motorized vehicle use in Norway is questionable because most permit-applications are granted, both in protected and unprotected areas (Engen & Hausner, 2017; Kleven et al., 2006; Multiconsult, 2014).

Predator control was widely preferred (the participants mapped 50 oppose markers and 279 favor markers) regardless of protected area status. While traditional consumptive uses (e.g., hunting and fishing) appear to support restricting development inside protected areas, these preferences seem to represent a trade-off with large predator conservation. Studies have shown that large predator conflicts are social conflicts that center around threats to traditional land use practices and a rural culture, more than material losses (Skogen, 2015). For instance, acceptance of poaching large predators has been attributed to the prevalence of big game hunting and sheep farming and unrelated to the presence of carnivores, the presence of priority zone for wolves or loss of sheep to predation (Gangaas et al., 2015). Norwegians also have less favorable attitudes towards large predators than Swedes, despite having lower densities of predators (Gangaas et al., 2015; Krange, Sandström, Tangeland, & Ericsson, 2017). Large predator species are all red listed in Norway (Henriksen & Hilmo, 2015) and their lethal removal is controversial (Linnell, Trouwborst, & Fleurke, 2017). Eight regional predator committees, consisting of regional politicians are responsible for managing brown bears, lynx, wolf and wolverines within a national framework with fixed population goals (Regulation on the management of predators, 2005; Skogen, 2015) and a national monitoring program for predators is in place to assess their population status.

Women and men use nature differently in Norway, and our study suggests they have different preferences for land management. Both genders are equally engaged in hiking, outdoor swimming and cycling, however men are much more involved in hunting, fishing, off-road cycling and snowmobiling, whereas women spend more time berry and mushroom picking (Vaage, 2015). These differences were evident in our data. For example, the average number of markers in favor of hunting, predator control and snowmobiles were much higher for men than women (Fig. A2). Some studies have reported that men are less likely to support conservation than women (Lute & Attari, 2016; Raymond & Brown, 2011), although the effect of gender on environmental behavior is ambiguous (Gifford & Sussman, 2012). Our study suggests that decisions on land management are likely to be biased by the current underrepresentation of women in decision-making processes concerning conservation and rural affairs (Aasen-Lundberg, 2017; Svarstad, Daugstad, Vistad, & Guldvik, 2006).

Our results demonstrate that web-based PPGIS can be a useful and cost-effective method for assessing acceptable conservation policies across a relatively large and representative cross-section of communities. Mapped community preferences can for example aid policy makers during stages of policy design or once conservation initiatives are in effect. Depending on the situation and timing of events, community mapping can assist stakeholders representing community interests in participatory processes and be valuable for assessing how the preferences of stakeholder groups align with the general population (Kaltenborn, Thomassen, & Linnell, 2012). Stakeholder input could also add to the understanding of community maps.

The strength of using spatially-explicit methods is that people can communicate their preferences for future development that are activity and place-specific. Such data provides the opportunity to analyze preferences at multiple spatial scales in the context of environmental characteristics, accessibility, and governance. In this study, we analyzed preferences at a regional scale, but the spatial information generated by PPGIS can be used to identify more specific areas of potential land use conflict as described by Brown and Raymond (2014), areas where participants collectively favor and oppose the same activity in the same geographic location (Fig. A1). PPGIS can also identify broader areas of potential conservation conflict, e.g., preferences in favor of development inside protected areas. With respect to areas where participants did not map preferences, this could imply satisfaction with the status quo. It could also imply that people are unfamiliar with those areas as studies have shown that mapping effort is related to participant's knowledge and familiarity with the study area (Brown & Reed, 2009; Zolkafli, Brown, & Liu, 2017). Our activity categories are broad and more targeted studies of acceptance of individual activities could be necessary depending on the situation.

5. Conclusion

In this study, we demonstrated how web-based PPGIS could be used to assess consistency between local preferences and conservation policy. We found local preferences to align with current conservation policy in Norway, which restricts land development while allowing small-scale consumptive uses in protected areas. Information on the preferences of local people for different land uses and management actions can be valuable both in the design phase of conservation initiatives and for assessing the social acceptability of conservation initiatives once they are in effect (Bennett, 2016). Our results suggests that a use-based framing of conservation is more likely to resonate with these communities than narratives tied to the preservation of pristine nature and emerging conservation ideas of the rewilding of nature (Chapron et al., 2014; Lorimer et al., 2015).

Conflict of interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: https://doi.org/10.1016/j.jnc.2017.12.002

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Table A1. Reclassification of the CORINE 2012 land cover layer.

CLC_CODE	**Reclassification, this study**	**CORINE classification**
211	Cropland	Non-irrigated arable land
212	Cropland	Permanently irrigated land
213	Cropland	Rice fields
221	Cropland	Vineyards
222	Cropland	Fruit trees and berry plantations
223	Cropland	Olive groves
231	Cropland	Pastures
241	Cropland	Annual crops associated with permanent crops
242	Cropland	Complex cultivation patterns
243	Cropland	Land principally occupied by agriculture, with significant areas of natural vegetation
244	Cropland	Agro-forestry areas
311	Broad-leaved forest	Broad-leaved forest
313	Broad-leaved forest	Mixed forest
312	Coniferous forest	Coniferous forest
321	Heath & shrub	Natural grasslands
322	Heath & shrub	Moors and heathland

323	Heath & shrub	Sclerophyllous vegetation
324	Heath & shrub	Transitional woodland-shrub
331	Sparsely vegetated areas	Beaches, dunes, sands
332	Sparsely vegetated areas	Bare rocks
333	Sparsely vegetated areas	Sparsely vegetated areas
334	Sparsely vegetated areas	Burnt areas
335	Sparsely vegetated areas	Glaciers and perpetual snow
411	Wetland	Inland marshes
412	Wetland	Peat bogs
422	Wetland	Salines
423	Wetland	Intertidal flats

Table A2. Factor loadings for the PCA analysis. The two first components were used as covariates in the analysis.

Variable	PCA1	PCA2	PCA3	PCA4
Broad-leaved forest	0.412	-0.43	-0.369	
Conifer forest	0.187	0.47		-0.79
Cropland	0.307	0.468	0.261	0.56
Heath & shrub	-0.167	-0.368	0.819	-0.151
Sparsely vegetated	-0.575	0.149	-0.305	0.165
Wetland	0.133	-0.463	-0.147	
Elevation	-0.57			
Proportion of variation explained	32.6%	17.6%	15.3%	13.9%

Table A3. Respondent demographics along with regional census data.

	South		North	
	Study participants	Census data*	Study participants	Census data*
Age (mean no. of years)	43.93	50.5	45.58	48.2
Gender:				
Male	59 %	50 %	55 %	52 %
Female	41 %	50 %	45 %	48 %
Education (highest level completed):				
Primary (Elementary to high school)	35 %	76 %	37 %	76 %
Higher (university or university college)	65 %	24 %	64 %	24 %
Household income:				
300 000 or less	12 %	18 %	9 %	19 %
300 000 - 500 000	32 %	22 %	27 %	22 %
500 000 or more	56 %	62 %	63 %	59 %

*Census data taken from (Brown, Hausner, Grodzińska-Jurczak, et al., 2015). Some categories do not sum to exactly 100% due to rounding.

Table A4. Model selection by AIC.

Model	**AIC**	**Removed variable**
ACTIVITY + LAND1 + LAND2 + WATER + ROAD + TOWN + GENDER + EDUCATION + INCOME + AGE + PROPERTY + PROTECT + PROTECT:ACTIVITY + REGION | LOGIN_ID (random)	2631.2	Full model
ACTIVITY + LAND1 + LAND2 + WATER + ROAD + TOWN + GENDER + EDUCATION + AGE + PROPERTY + PROTECT + PROTECT:ACTIVITY + REGION | LOGIN_ID (random)	2627.3	INCOME
ACTIVITY + LAND1 + LAND2 + WATER + ROAD + GENDER + EDUCATION + AGE + PROPERTY + PROTECT + PROTECT:ACTIVITY + REGION | LOGIN_ID (random)	2625.4	TOWN
ACTIVITY + LAND1 + LAND2 + WATER + GENDER + EDUCATION + AGE + PROPERTY + PROTECT + PROTECT:ACTIVITY + REGION | LOGIN_ID (random)	2623.8	ROAD
ACTIVITY + LAND1 + LAND2 + WATER + GENDER + EDUCATION + AGE + PROTECT + PROTECT:ACTIVITY + REGION | LOGIN_ID (random)	2623.6	PROPERTY

Table A5. Output from the best mixed effects logistic regression models following a backwards elimination procedure minimizing AIC criterion.

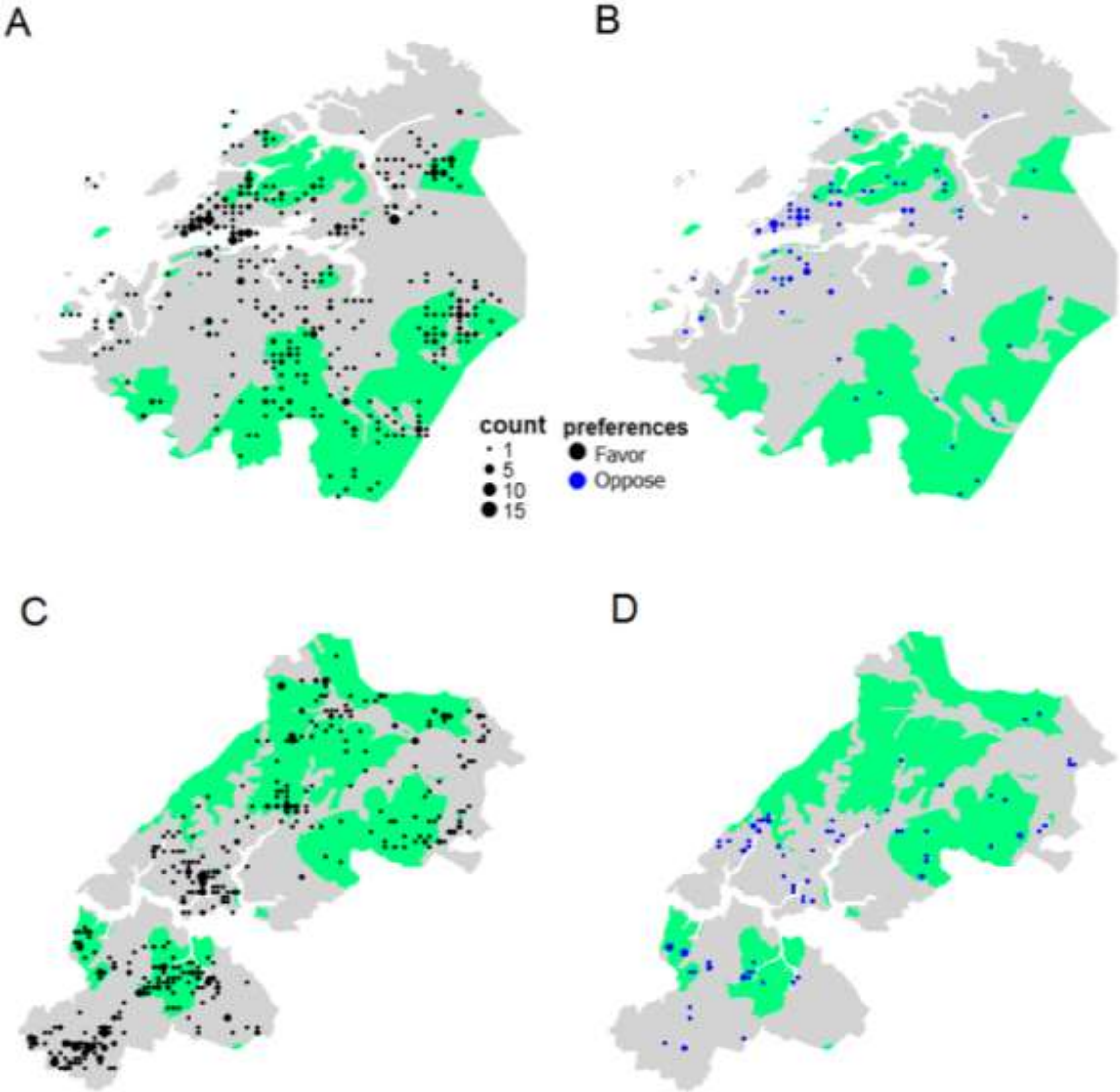
Model term	**Estimate**	**SE**	**z-value**	**Pr(>|z|)**	
Intercept (ACTIVITY (boat), WATER (not present), GENDER (female), EDUCATION (higher), PROTECT (not protected)	1.07	0.52	2.06	0.0391	*
ACTIVITY (fishing)	1.65	0.49	3.36	0.0008	***
ACTIVITY (grazing)	1.37	0.52	2.65	0.0081	**
ACTIVITY (heli)	-1.70	0.55	-3.09	0.0020	**
ACTIVITY (houses)	-1.31	0.44	-2.95	0.0032	**
ACTIVITY (hunting)	1.36	0.53	2.57	0.0101	*
ACTIVITY (indus)	-2.08	0.47	-4.43	0.0000	***
ACTIVITY (predator)	0.99	0.55	1.81	0.0709	.
ACTIVITY (road)	-1.89	0.48	-3.93	0.0001	***
ACTIVITY (snow)	-1.59	0.44	-3.58	0.0004	***
ACTIVITY (tourism)	-0.07	0.47	-0.15	0.8773	
LAND1	0.13	0.06	2.35	0.0187	*
LAND2	0.12	0.06	1.93	0.0536	.
WATER (present)	-0.34	0.14	-2.48	0.0130	*
GENDER (male)	1.28	0.37	3.50	0.0005	***
EDUCATION (primary)	0.63	0.38	1.65	0.0988	.
AGE	-0.33	0.19	-1.74	0.0828	.
PROTECT (protected)	-0.31	0.89	-0.35	0.7269	
ACTIVITY (fishing) : PROTECT (protected)	1.87	1.07	1.74	0.0823	.

ACTIVITY(grazing) : PROTECT (protected)	0.70	1.06	0.66	0.5072	
ACTIVITY(heli) : PROTECT (protected)	-0.51	1.05	-0.48	0.6293	
ACTIVITY(houses) : PROTECT (protected)	-1.89	0.99	-1.91	0.0567	.
ACTIVITY(hunting) : PROTECT (protected)	0.88	1.09	0.81	0.4187	
ACTIVITY(indus) : PROTECT (protected)	-1.85	1.00	-1.85	0.0641	.
ACTIVITY(predator) : PROTECT (protected	-0.42	0.99	-0.42	0.6719	
ACTIVITY(road) : PROTECT (protected)	-0.50	0.98	-0.51	0.6129	
ACTIVITY(snow) : PROTECT (protected)	0.84	0.93	0.90	0.3666	
ACTIVITY(tourism) : PROTECT (protected)	-0.65	1.00	-0.65	0.5129	

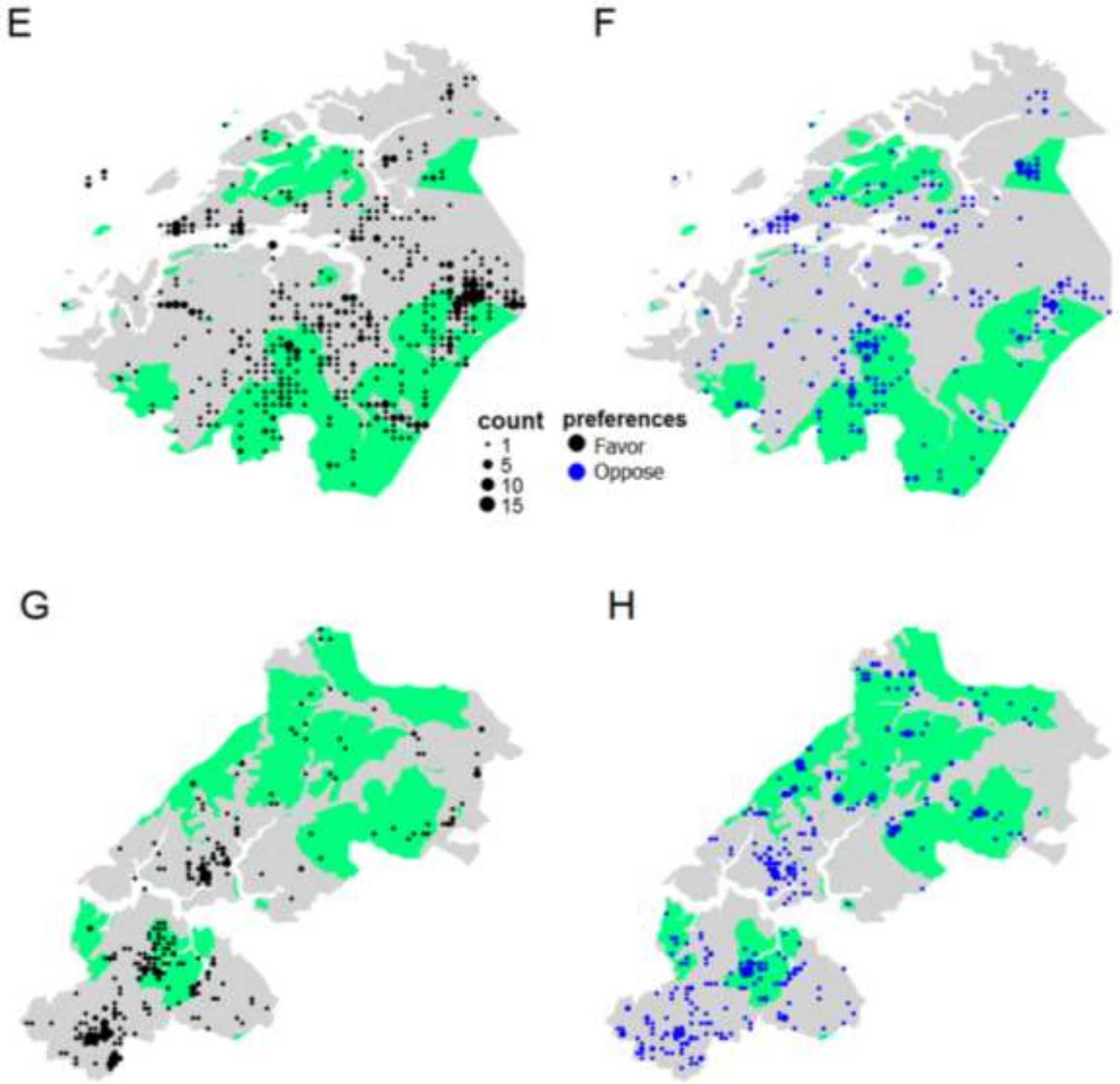
Spatial overlap of preferences

To visualize the spatial distribution of the preferences we divided the study area into 2x2 km grid cells, counted the number of markers in each cell belonging to the four overarching categories in Table 1 and made separate maps of *favor* and *oppose* preferences. As a trade-off between reducing the number of empty cells, but allowing a relatively high resolution at the same time, we chose the size of 2x2 km (Brown, Hausner, & Laegreid, 2015). The maps also include the preferences marked by participants that were removed for the modelling analysis due to incomplete demographical data.

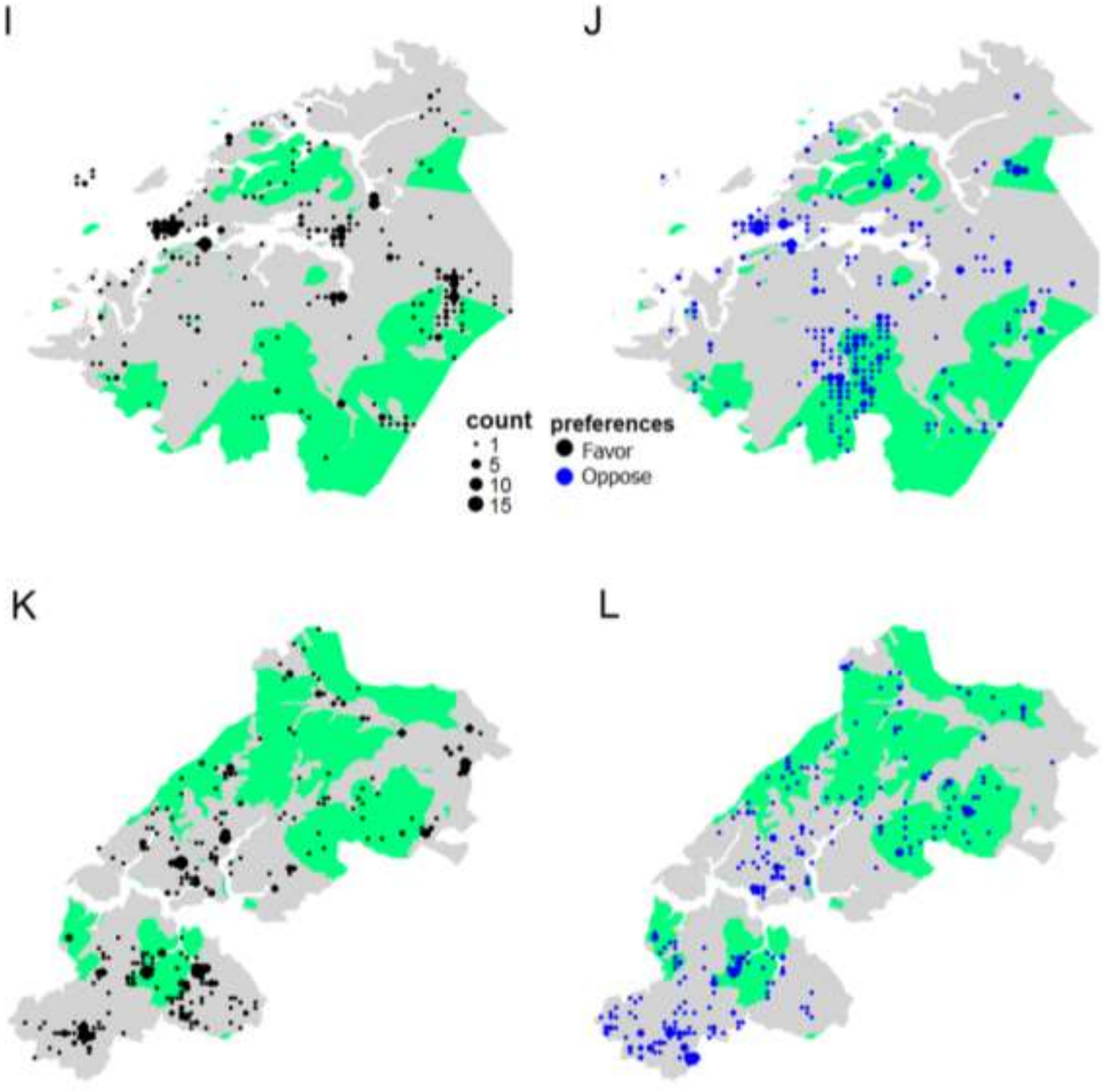
Consumptive use



Motor use



Development



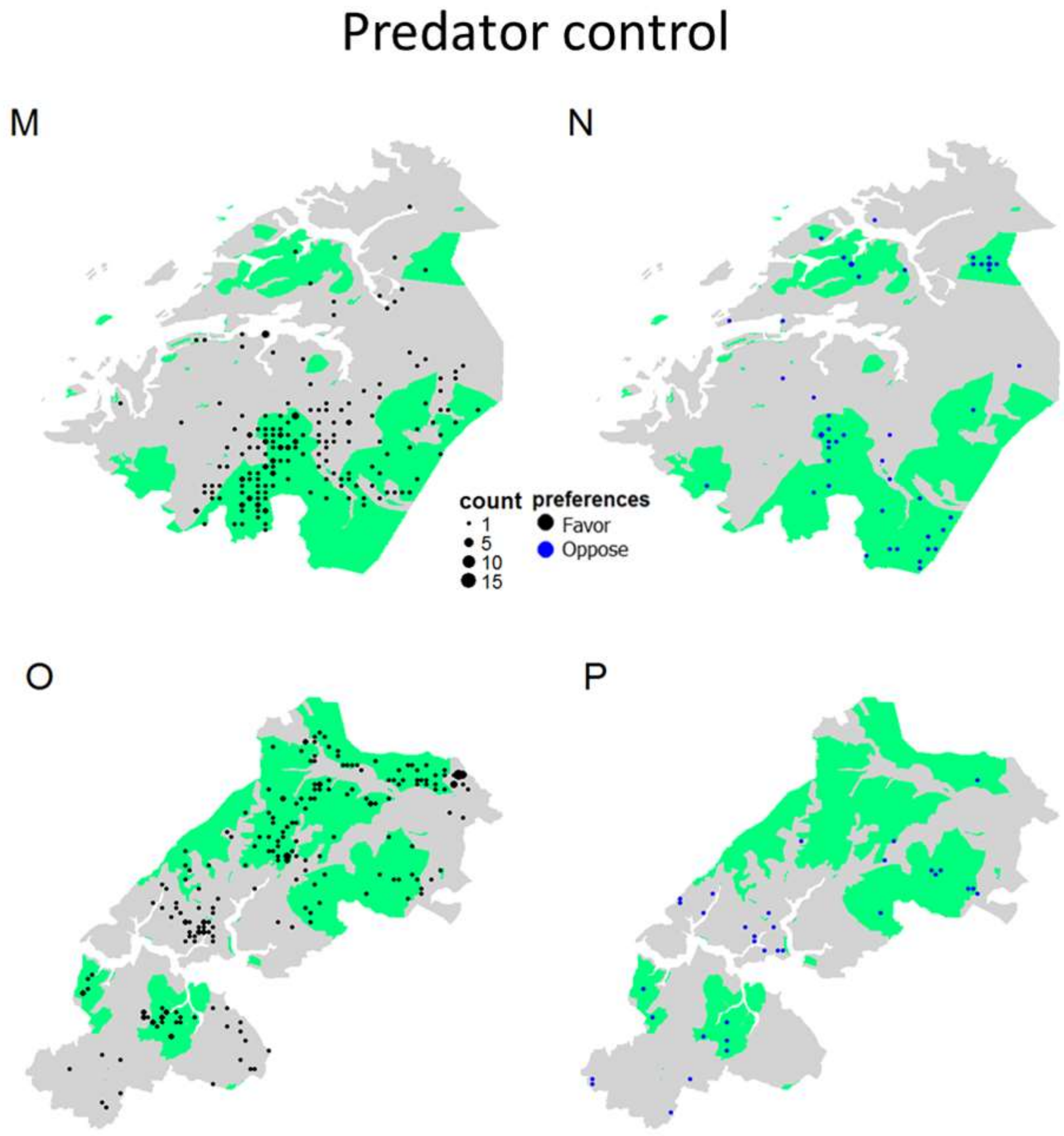


Figure A1. Site-specific preferences. Bubble plots showing the count of preferences that *favor* (**black**) and *oppose* (blue) consumptive use (grazing, hunting, fishing, **A-D**), motor use (snowmobiles, helicopters, boats and ATVs/ road access, **E-H**), development (industry/energy facilities, homes/holiday homes and tourist facilities, **I-L**) and predator control (**M-P**) per 2x2 km grid in the northern and southern study areas. Green polygons show the location of protected areas. The dot size shows the number of preferences.

Table A6. The number of preferences mapped and the number of unique mappers for the different preferences.

		Oppose		Favor	
	Activity	**Not Protected**	**Protected**	**Not Protected**	**Protected**
Number of points	Houses/holiday homes	159	72	212	19
	Tourist facilities	57	29	175	36
	Industry/energy	121	87	128	13
	Helicopter transport	38	38	47	21
	Roads/all-terrain vehicles	93	57	88	24
	Snowmobiles	188	71	258	114
	Boating	27	7	53	23
	Grazing	24	10	131	74
	Fishing	34	11	162	90
	Hunting	22	10	98	74
	Predator control	17	33	115	164
Number of unique mappers	Houses/holiday homes	82	49	106	16
	Tourist facilities	39	20	105	27
	Industry/energy	60	25	55	11
	Helicopter transport	30	22	28	12
	Roads/all-terrain vehicles	53	35	45	13
	Snowmobiles	76	39	82	30
	Boating	14	6	36	17
	Grazing	14	7	69	36
	Fishing	12	7	80	46
	Hunting	10	6	53	38
	Predator control	12	16	53	41

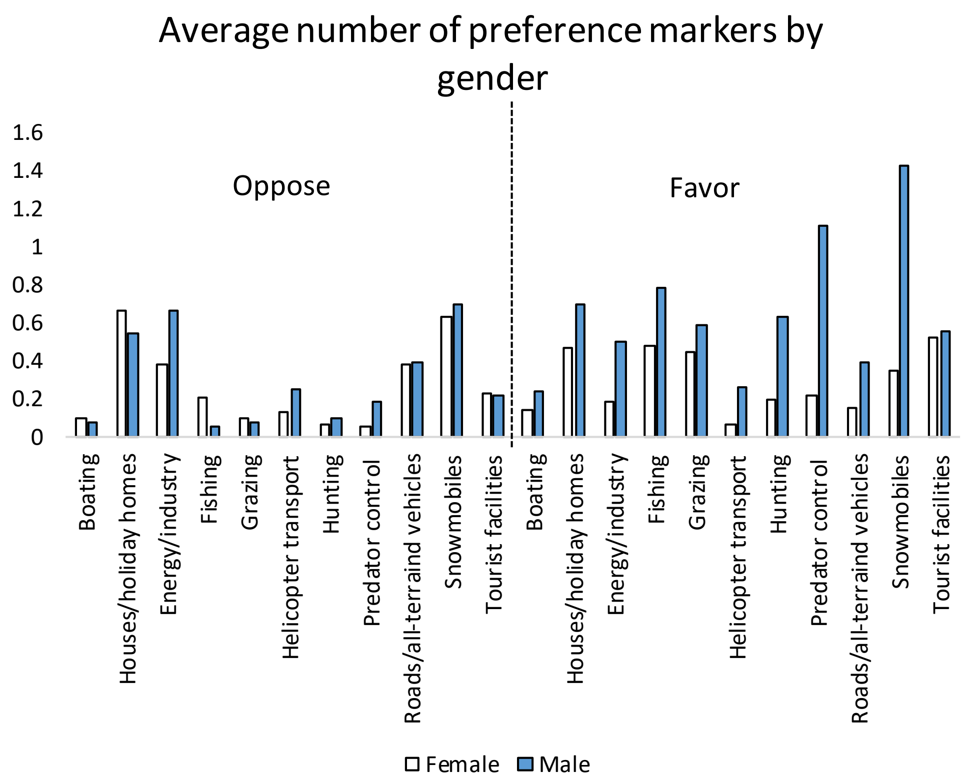


Figure A2. The average number of preferences by category and gender (males, n= 219 and females, n = 167).

References

Brown, G., Hausner, V., Grodzińska-Jurczak, M., Pietrzyk-Kaszyńska, A., Olszańska, A., Peek, B., … Lægreid, E. (2015). Cross-cultural values and management preferences in protected areas of Norway and Poland. *Journal for Nature Conservation*, *28*, 89–104. https://doi.org/10.1016/j.jnc.2015.09.006

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