A journal of the Society for Conservation Biology

LETTER

Integrating Social and Ecological Knowledge for Targeting Voluntary Biodiversity Conservation

Riikka Paloniemi[1], Teppo Hujala[2,3], Salla Rantala[1], Annika Harlio[4], Anna Salomaa[5], Eeva Primmer[1], Sari Pynnönen[6], & Anni Arponen[4]

[1] Environmental Policy Centre, Finnish Environment Institute (SYKE), Helsinki, Finland
[2] Natural Resources Institute Finland (Luke), Bio-based Business and Industry, Helsinki, Finland
[3] University of Eastern Finland (UEF), School of Forest Sciences, Joensuu, Finland
[4] Metapopulation Research Centre, Department of Biosciences, University of Helsinki, Helsinki, Finland
[5] Department of Environmental Sciences, University of Helsinki, Helsinki, Finland
[6] Central Union of Agricultural Producers and Forest Owners (MTK), Helsinki, Finland

Keywords
Conservation targeting; dialogue; landowner; prioritization; survey; voluntary conservation; Zonation software .

Correspondence
Riikka Paloniemi, Environmental Policy Centre, Finnish Environment Institute (SYKE), P.O. Box 140, Helsinki FIN-00251, Finland. Tel: +358 40 7017 250; fax: +358 9 5490 2190.
E-mail: riikka.paloniemi@ymparisto.fi

Received
15 August 2016
Accepted
23 December 2016

doi: 10.1111/conl.12340

Abstract

Improving the effectiveness of voluntary biodiversity policies requires developing trans-disciplinary conservation plans that consider social constraints to achieving ecological objectives. We integrated data on landowners' willingness to participate in voluntary conservation efforts with ecological data on conservation values in a spatial prioritization, and found that doing so considerably reduced the loss in conservation value caused by landowners' reluctance to participate. We learned that conducting prioritization with stakeholder input gained through dialogue during field visits could be beneficial for increasing the legitimacy of conservation plans with stakeholders. Thus, in addition to developing a methodology for using data on stakeholder perceptions of conservation in spatial prioritization, our study suggests that engaging landowners and other stakeholders in the conservation prioritization process will improve the success of conservation plans.

Introduction

International conservation efforts have so far failed to stop the loss of biodiversity (Tittensor et al. 2014). Efforts to expand and consolidate state-managed protected area networks (Jenkins & Joppa 2009) and improve the management of existing protected areas (Le Saout et al. 2013) are not sufficient to protect biodiversity. Engagement of practitioners and landowners is also necessary (Tallis & Lubchenco 2014). Voluntary conservation approaches involving private landowners and communities with a stake in biodiversity conservation are important for broadening conservation practices (Mayer & Tikka 2006; Selinske et al. 2015). A prevalent challenge for voluntary approaches is implementing conservation actions in places that achieve ecological objectives, while accounting for landowners' propensity to participate in voluntary conservation activities (Mönkkönen et al. 2009).

The field of spatial conservation prioritization supports conservation planning that improves the cost-efficiency and connectivity of conservation areas. Spatial conservation prioritization is primarily founded on biological knowledge and often does not consider sociopolitical constraints on conservation actions (Knight et al. 2011; Whitehead et al. 2014). The techniques used for spatial prioritization can account for biological, economic, and social constraints and produce alternative cost-efficient solutions (Moilanen et al. 2009; Klein et al. 2013). However, the practical application of information on social constraints to conservation actions, such as landowners' reluctance to get involved in conservation, remains a challenge.

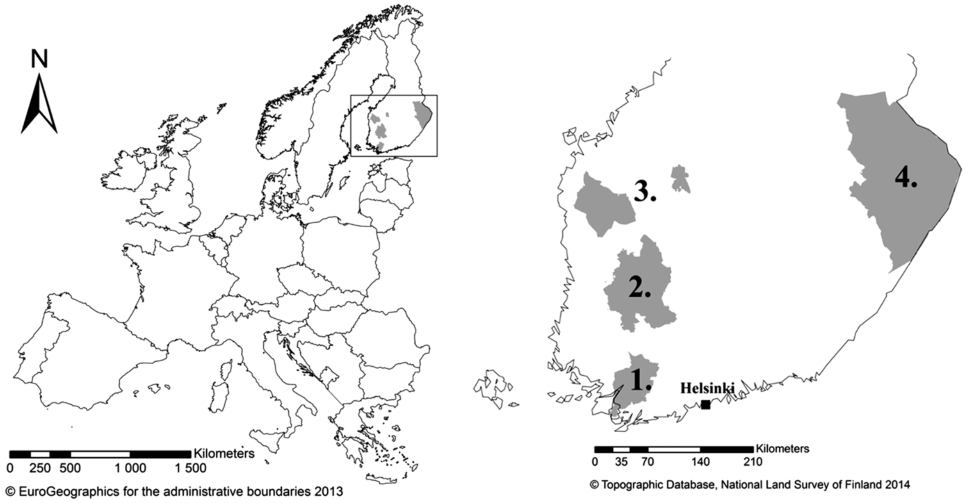

Figure 1 Study areas. The study areas are presented in the map in gray. 1 = Rekijokilaakso-Hyyppärä region; 2 = Pirkanmaa region; 3 = Southern Ostrobothnia; 4 = Northern Karelia. The landowner survey and the dialogue workshops were carried out in all areas (including a joint workshop in areas 2 and 3), and the spatial conservation prioritization analysis was conducted in the Rekijokilaakso-Hyyppärä region.

Where landowners oppose centrally designed conservation plans, voluntary contracting can increase acceptance of conservation plans, because it respects landowner autonomy over land use decisions (Paloniemi & Tikka 2008; Paloniemi & Vainio 2011). Thus, the prioritization of voluntary conservation actions should consider the willingness of landowners to participate in voluntary contracts. However, a voluntary approach may not allocate conservation resources efficiently (Doremus 2003), particularly on a landscape scale. Consequently, voluntary conservation reliant on landowners' perspectives should be integrated into systematic conservation planning made at landscape scale (Grantham et al. 2010; Knight et al. 2011).

Voluntary contracts for conservation actions are exemplified in Finland. In Finland, private landowners' voluntary contracts for state-subsidized conservation are a central instrument under the ongoing Forest Biodiversity Program (Government of Finland 2014). However, the approach faces challenges for conservation effectiveness, because family forest estates are relatively small (30 hectares on average; Peltola 2014) and landowners' perceptions, motivations, and previous experiences of conservation as well as willingness to engage in conservation vary across the landscape (Primmer et al. 2014). Thus, voluntary conservation actions by individual landowners do not necessarily result in an ecologically optimal conservation network at landscape scale. In this article, we investigate how landowners' (un)willingness to participate in conservation actions that cross the boundaries of individual forest estates affects conservation outcomes.

We develop an approach that combines information on landowners' willingness to participate in voluntary initiatives with an optimization of conservation actions that targets ecological goals set at landscape level. To analyze how voluntary biodiversity conservation can be used to target conservation actions, we sought to answer the following questions:

(i) How do landowners perceive landscape-level biodiversity conservation across property boundaries?
(ii) What are the opportunities and limitations for integrating landowner perceptions with biological datasets in prioritization analyses that aim to achieve landscape-level ecological objectives?
(iii) What are the possibilities of multistakeholder collaboration to support the application of integrated prioritization and voluntary, landscape-level conservation in practice?

Methods

We combined data from a landowner survey, spatial conservation prioritization, and multistakeholder dialogue workshops. The study focused on southern Finland (Figure 1). The study areas were selected to cover a comprehensive spectrum of social and environmental contexts. They contain southwestern, western, central and eastern regions; forestry-dominated, agriculture-dominated and mixed landscapes; and varied in the extent of voluntary conservation efforts.

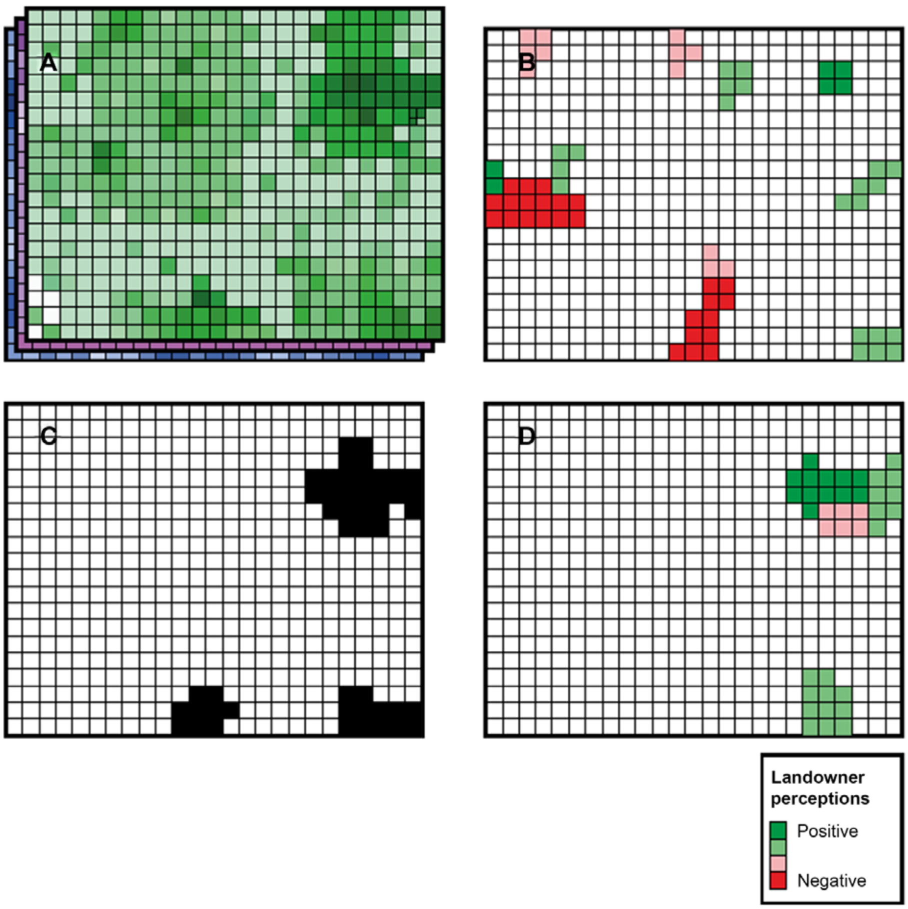

Figure 2 Schematic illustrating the spatial datasets for the Rekijoki-Hyyppärä region. We had multiple layers of spatial ecological data for use in Zonation (A). To obtain data on landowner perceptions, a questionnaire was sent to all private forest owners in the region, but responses were not received from all landowners (B). Zonation prioritization indicated where the highest priorities for ecological values were (C) and we complemented our questionnaire data by focusing on owners of forests that overlapped or were close to the high priority Zonation sites and around landowners with positive perceptions (D). The forest owners in the complementary sample were asked to respond only to the questions to be used in the spatial analysis.

Landowner survey

We quantitatively measured landowner perceptions on landscape-level conservation by mailing a questionnaire to randomly sampled and systematically selected owners of forests within the study areas (Figure 1, Annex A). After a reminder, 509 completed questionnaires were returned (response rate 23%) in April to May 2014. To cover more landowners in the *Rekijokilaakso-Hyyppärä* region where the spatial prioritization analysis was performed, we conducted follow-up interviews by phone in that region (Figure 2, Annex A). This complementary survey for the *Rekijokilaakso-Hyyppärä* region resulted in 32 new responses, producing a data set consisting of a total of 541 responses, of which 144 were from *Rekijokilaakso-Hyyppärä*. Profiles of the respondents and nonrespondents are provided in Annex B.

Perceptions about conservation were assessed by asking the respondents to rate a number of statements related to the principles and means of safeguarding biodiversity (Table 1). The statements were formulated to assess views on conservation values and attitudes, perceptions of fairness, and rationales for compensation. Statements were constructed on the basis of earlier research on forest conservation instruments (Parkhurst et al. 2002; Mayer & Tikka 2006; Paloniemi & Tikka 2008; Paloniemi & Vainio 2011; Primmer et al. 2014). The statement set was tested with landowner representatives and pilot participants before the questionnaire was sent to landowners. Respondents were also asked whether they had previously made various conservation decisions: temporary or permanent conservation contracts with nature conservation authorities or forestry authorities;

Table 1 Biodiversity conservation perceptions of landowners in southern Finland, identified through Exploratory Factor Analysis. Values indicate loadings from the factor analysis. Loadings with absolute value greater than 0.400 are in bold font to indicate which statements are interpreted to relate to each factor. The analysis is based on the responses to the survey questions (i) "*How important are the following aspects in safeguarding biodiversity in your opinion*" (the respondents were asked to first give a value of "5" to the 1–3 aspects perceived to be the most important, then give a value of "1" to 1–3 aspects that were perceived to be the least important, and, finally, to give values of "2"–"4") to the remaining aspects and (ii) "*The following statements describe the implementation of the Forest Biodiversity Program. Do you agree with the statements?*" (evaluated on a scale from 1 [totally disagree] to 5 [totally agree])

	Factor					
	1 Cross-boundary conservation efforts	2 Safeguarding biodiversity	3 Agglomeration bonus	4 Social norm	5 Economic benefit	6 Just a contract
Conservation efforts that cross the boundaries of forest sites and estates should be promoted more	**0.856**	0.190	0.013	0.071	–0.074	0.050
Neighboring forest owners should cooperate more to conserve biodiversity	**0.783**	0.158	0.119	0.074	–0.075	0.111
Personally, I would be ready to cooperate with my neighbors to establish a larger protected area network	**0.687**	0.127	–0.019	0.147	–0.006	0.380
Currently, biodiversity conservation is too often implemented by focusing on individual forest sites only	**0.665**	0.201	0.196	0.094	0.107	–0.215
It is important that a conservation area network constitutes an ecologically functional network	**0.556**	0.377	0.113	–0.001	–0.081	0.147
I ensure that a site important for me personally is protected	0.167	**0.762**	–0.018	0.107	0.023	0.108
I aim to preserve the (protected) site in its natural state	0.195	**0.683**	0.063	0.034	0.053	0.253
All species are needed in biodiversity-rich nature	0.129	0.380	0.074	0.145	–0.124	–0.113
It is the responsibility of human beings to conserve nature	0.235	0.379	0.010	0.031	–0.196	–0.085
Compensation for voluntary conservation should be weighted depending on the significance of the site for a conservation area network	0.114	0.092	**0.792**	0.059	0.019	0.022
Higher compensation should be paid for a site located next to a protected area compared to a site located far from other protected areas	0.063	0.031	**0.707**	0.021	0.131	–0.071
I can improve recreational opportunities for the general public	0.059	0.081	0.036	**0.725**	0.173	–0.008
I respond to the expectations of other people	0.116	0.126	0.068	**0.648**	–0.065	0.050
I get financial benefits from conservation	–0.005	–0.047	0.099	–0.008	**0.614**	0.173
A temporary conservation contract does not bind future forest owners	–0.063	–0.060	0.065	0.068	**0.486**	–0.177
I am willing to make a conservation contract only if I am fully compensated for the value of timber	0.062	–0.030	0.358	0.090	0.321	0.205
I am willing to make new conservation contracts [to be included in the Forest Biodiversity Programme] if suitable sites exist on my land	**0.486**	0.211	0.012	0.057	0.068	**0.574**

land sale or exchange with nature conservation authorities; or informal efforts.

We analyzed landowner responses to the questionnaire using Exploratory Factor Analysis (e.g., Gorsuch 1988) (Table 1). Factor analysis is a multivariate method that enabled us to reduce the survey information from 17 statements into 6 unmeasured variables, termed factors. Analyses were performed using SPSS statistical software (version 23). We then used one factor that we interpreted to represent willingness to participate in conservation actions coordinated at landscape level in the spatial conservation prioritization.

Spatial conservation prioritization with Zonation

We carried out a conservation prioritization analysis for the *Rekijokilaakso-Hyyppärä* region (Figure 1), using the Zonation v4.0 software, a framework for spatial conservation prioritization (Moilanen et al. 2014). The Zonation algorithm is initialized with protection of the full landscape and then it iteratively removes the planning units contributing the least toward the objectives for protecting biodiversity. The results give the rank order in which planning units should be protected, which can be visualized as maps. Our objective was to cover the highest quality sites for the main forest types and wooded seminatural grasslands represented in our data.

Three different Zonation analyses were conducted: (1) prioritization based only on ecological data, representing a typical prioritization procedure conducted by conservation scientists or managers (*ecologically optimized*); (2) prioritization based on ecological data and landowner perceptions, representing how conservation can be optimized while considering an indicator of site availability (*integrated*); and (3) a post hoc analysis of the *ecologically optimized* prioritization with removal of sites where landowners had negative perceptions of conservation. Analysis (3) represented the outcome of an ecological prioritization where voluntary conservation contracts are not achieved in sites that were ranked high for their ecological value (*ecologically optimized excluding negative landowners*).

We produced gridded maps of habitat types using national forest inventory data from Finland (MS-NFI), and the Finnish national survey on the biotopes of wooded seminatural grasslands (Vainio et al. 2001; Tomppo 2006, Annex C). Each habitat type was given a weighting to reflect its conservation value relative to other habitat types. We accounted for connectivity between similar habitat types. Weights and connectivity parameters were based on Lehtomäki et al. (2009, Annex C).

For the *integrated* Zonation analysis (2), landowner perceptions were included as weightings on sites (Annex C). Weighting was proportional to the factor scores from the *cross-boundary conservation efforts* factor (median value for missing data, Annex C), which reflected willingness of a landowner to participate in conservation, and their willingness to coordinate conservation efforts with neighbors (i.e., Factor 1 in Table 1). A median value was used to the 79% of nonrespondent landowners in order to maintain connectivity in the landscape.

Dialogue workshops

To explore the stakeholders' perceptions on how the different information sources could support conservation that targets ecological goals set at landscape level in practice, we organized nine discussions in three workshops (in the Rekijokilaakso-Hyyppärä, Pirkanmaa, and Northern Karelia regions; Figure 1). Workshops involved 59 participants including local landowners (not overlapping with the survey respondents), forestry and conservation authorities, forestry professionals, researchers, and nature enthusiasts. Participant selection was based on nominations from regional experts and on snowball sampling (Salomaa et al. 2016). To elicit debate, the discussions were structured around statements concerning the implementation of environmental policies (Mickwitz 2003), including the Forest Biodiversity Program and the roles of different actors in landscape-level conservation (Annex D). The discussions were recorded and transcribed. The contents of the discussions were analyzed using NVivo software (Berg 2011; Bazeley & Jackson 2013), exploring how stakeholders discussed (i) possibilities to improve conservation outcomes through prioritization analyses and (ii) possibilities to integrate knowledge on social constraints into conservation planning in their practices.

Results

Landowners' conservation perceptions

The perceptions of those landowners who responded to the survey were analyzed and grouped into six factors (Table 1).

The *cross-boundary conservation efforts* factor captured the idea of promoting conservation across boundaries of individual forest estates. It encompassed the perceptions that conservation too often focused on a single forest site; there is a need to promote cross-boundary conservation efforts; neighboring landowners should cooperate more; and conservation areas should form an ecologically functional network. In addition, the factor included statements concerning personal willingness to conserve and cooperate with neighbors to create a larger conservation area. We used this factor in the *integrated* prioritization analysis because it represented in a single number the willingness of landowners to participate in landscape-level conservation planning.

The other factors were *safeguarding biodiversity*, which expressed personal commitment to conservation, *agglomeration bonus* that emphasized additional payments for conserving sites that complement the conservation network, *social norm* that focused on the sociocultural dimension of conservation, and *economic benefit* that underlined the economic benefits experienced by the landowner.

Forty-eight percent of the respondents reported that they had participated in at least one conservation oriented program. The most common formal conservation contracts were a temporary contract made with forestry authorities (21% of respondents) and a permanent private conservation area contracted with nature conservation authorities (2008 and after) (18%). Importantly, the *cross-boundary conservation efforts* factor correlated positively with contracts for permanent conservation areas (since 2008) (df = 316; $F = 9.567$; $P < 0.001$). In addition, 21% of respondents had privately set aside an area for conservation.

Integration of landowner perceptions with ecological data

The size and quality of a landowner's site and the surrounding landscape affected how strongly their perceptions influenced the prioritization results (Figures 3A–C). Where landowners with negative perceptions toward conservation were located next to landowners with positive perceptions toward conservation, the *integrated* analysis shifted the priority toward landowners with positive perceptions when compared with the *ecologically optimized* analysis (Figures 3A–C, area 1). Sites with moderately high conservation value also increased in importance if they aligned with positive perceptions (Figures 3A–C, area 2). No change in the ranking of an area was observed for areas with low ecological importance when comparing the *integrated* and *ecologically optimized* analyses (Figures 3A–C, areas 3 and 4). The perceptions of landowners with larger sites affected the prioritization results more than those of landowners with smaller sites, because Zonation associates large sites with increased conservation value due to higher connectivity.

The loss of conservation value due to predicted non-participation (negative perceptions) was 2.4% for the top 5% priority network (2.6% for top 10%), compared to the *ecologically optimized* analysis. When landowner perceptions were accounted for (*integrated*), the loss was only 1.1% (1% for the top 10%) (Figure 3D).

Spatial overlap among priority sites for the three solutions was lowest between the *integrated* and the *ecologically optimized* solutions (Figure 4). The *integrated* priorities were displaced from those of the *ecologically optimized* because some high-priority sites turned out to be unavailable due to negative landowner perceptions, which may cause Zonation to further shift priorities into places that provide better connectivity. Overlap between the *ecologically optimized* and the *ecologically optimized excluding negative landowners* solution was high because only a few critical sites were excluded (larger loss in Figure 3D than for the *integrated* solution).

Opportunities to improve targeted landscape-level conservation through collaboration

In the dialogue workshops, the participants discussed the pros and cons of prioritization analyses and whether conservation outcomes could be improved through enhanced interaction between different stakeholders. The participants viewed prioritization analyses as a future option rather than a current practice. Identified benefits of prioritization analyses included saving time and resources (in particular in contacting landowners), systematizing the identification of potential sites, the ability to consider larger landscapes and connectivity, and helping to find new sites for protecting threatened species.

Potential negative aspects of prioritization included the need for field visits to complement remote sensing-based analyses, the limited ability of the analysis to identify new areas of high ecological value in addition to those already known, the maintenance and updating of databases, and limited access to the information produced in the analyses by actors other than those conducting them. It was also questioned whether prioritization would help to conserve moving species or address trade-offs between different species and habitat types. In addition, lack of social data (i.e., information on landowners' willingness for conservation) was seen to restrict integrative analyses, the acquisition of which also required extra effort in this study.

It was pointed out that prioritization analyses, if conducted without involving local stakeholders, could be associated with past experiences of top-down, forced conservation and thus might work against the spirit of collaboration achieved through the Forest Biodiversity Program. The participants therefore recommended combining prioritization analyses with field visits in order to coproduce understanding of ecologically important areas and to allow face-to-face knowledge exchange and negotiation between landowners, officials, and other relevant

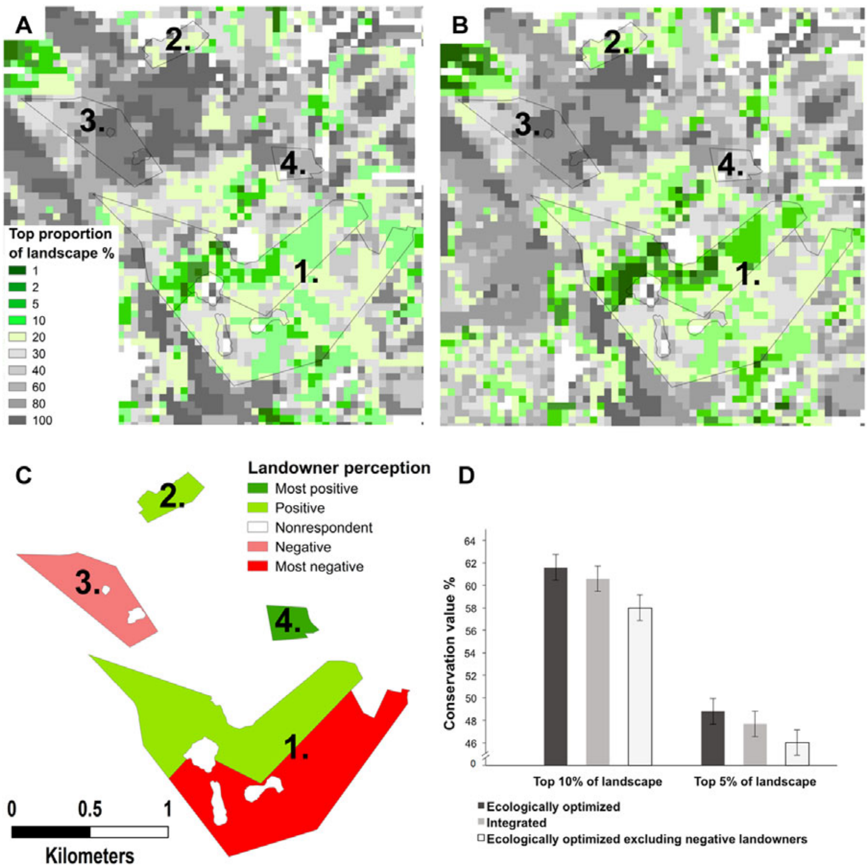

Figure 3 Zonation prioritization results for an example area from our study region. Zonation priorities are shown for the *ecologically optimized* (A) and *integrated* (B) analyses (the *ecologically optimized excluding negative landowners* priorities are not shown, see in Annex C). (C) The numbered polygons (1–4) indicate forest estates for which we had data on landowner perceptions. (D) The trade-offs in conservation value between the three analyses. Conservation value as viewed by Zonation is the mean of the quantity of unprotected habitat values for each habitat type, here a composite index of tree age and volume: $\sqrt{(age \times vol)}$ (Annex C). Note that the large proportion of high-quality forest retained in the priority site is due to high variation in forest quality across the region, from clear-cuts to old growth forests.

stakeholders, such as forest management associations and nature enthusiasts.

Discussion

A great societal opportunity related to implementing voluntary biodiversity conservation initiatives is integration of various types of knowledge (social, ecological, scientific, and local) in the conservation planning processes for greater legitimacy and effectiveness. We contribute to such practice-relevant research agenda by integrating landowner perceptions and landscape level conservation values into a spatial prioritization, and deliberating the potential of prioritization to achieve improved conservation outcomes in the dialogue workshops.

In our case, prioritization that integrated ecological and social information produced an outcome that considerably reduced the loss in conservation value caused by potential conservation tensions or conflicts. To a certain degree, the observed influence depends on the assumptions made in the analysis. For example, we used relatively coarse habitat classifications with a Zonation variant that enabled any valuable site to be fairly easily replaced by another. All prioritization results are context-specific, and depend on the socioecological and institutional circumstances of the study area and the ways in which they are operationalized in the analysis (Pressey et al. 2013). Thus, of particular relevance is the transferability of the prioritization by interpreting the assumptions and results in collaboration with relevant stakeholders with the aim of engaging them in practical conservation targeting.

We aimed to get all private landowners in the prioritization area to respond to the questionnaire, but found the strategy far too resource-intensive. However, in our

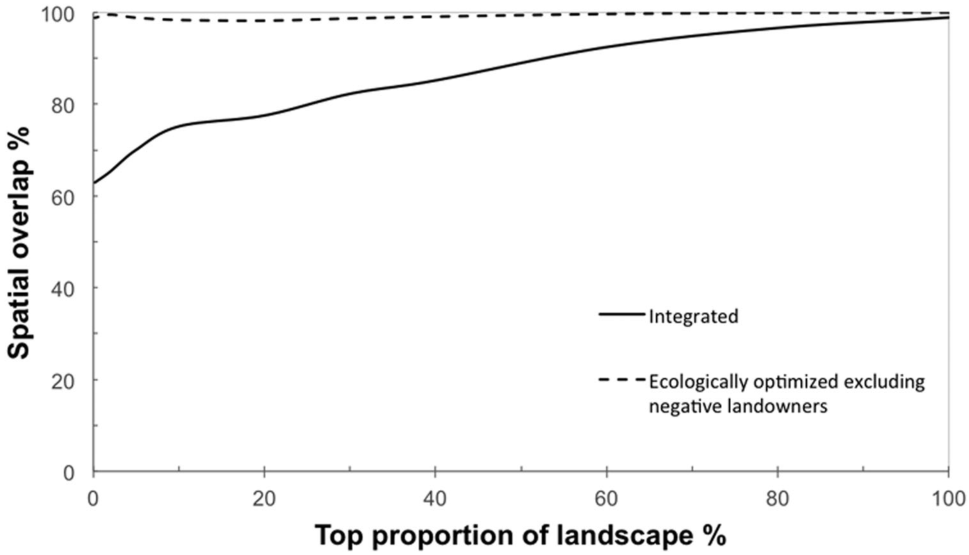

Figure 4 Spatial overlap (Jaccard's similarity index) of *integrated* and *ecologically optimized excluding negative landowners* solutions compared to *ecologically optimized* Zonation analysis. The solid line shows the overlap between the *ecologically optimized* and *integrated* solutions, and the dashed line shows the overlap between *ecologically optimized* and *ecologically optimized excluding negative landowners* solutions.

case the respondents did not differ significantly from the nonrespondents (Annex B), and thus the results should be regarded as illustrative, even though the magnitude of differences between different analyses may increase with more comprehensive data. We also complemented the dataset by focusing on sites with high conservation potential, where perceptions are most likely to have an impact on the prioritization outcomes. The strength of this spatially targeted dataset, even with its modest overall coverage, is the practical relevance of the prioritization outcomes: the research results are probably more relevant for conservation practice when selecting the most valuable sites for conservation than what could have been obtained with a similar sized random sample. Even quantitatively modest approaches might help progress the thinking and practice toward more socially minded prioritization.

Scaling up the prioritization to cover entire landscapes in multiple regions will require iteration and communication with planners, landowners and other relevant stakeholders. The dialogue workshops suggested that landowners and their advisers should be encouraged to collaborate more thoroughly in the prioritization process. For example, during field visits, the black box of prioritization could be opened by discussing the aim, analysis, and preliminary findings, thus involving landowners in iterating prioritization (Game et al. 2011) and developing ownership that supports future conservation collaboration. For practical implementation, we suggest that alternative prioritization analyses are produced and brought to regional stakeholder workshops, which would help determine the localities for targeted marketing of voluntary conservation by means of subsequent local meetings and personal communication. To be successful and cost-efficient, the phases should be conducted within existing policy processes and communicated transparently.

Our findings from the dialogue workshops support the idea that attitudes toward conservation evolve through social interaction (e.g., Bergseng & Vatn 2009), decreasing tensions attached to top-down, expert-driven conservation (Grantham et al. 2010; Winkel et al. 2015). Social learning through improved interaction could increase the acceptance of landscape-level conservation by two means: by changing individual attitudes and by changing shared perceptions of conservation within a social network (Cheng et al. 2011; Korhonen et al. 2013). Thus, in a specific area dialogue workshops might be a more accurate way to gather landowner perceptions than spending resources on numerous survey rounds or spatial nonresponse modeling. Even preliminary and incomplete prioritization analyses may be useful in such workshops.

Dialogue-based interpretation of prioritization can renew landscape-level targeting to a new level of integrative and inclusive conservation thinking (Tallis & Lubchenco 2014). However, certain institutional changes are required: the evolving technical tools and capacities go hand in hand with the opening and digitalization of data (Huijboom & Van den Broek 2011). In addition, landscape-level policy instruments that activate and provide financial incentives for cooperation between a number of landowners, such as agglomeration bonuses (Parkhurst et al. 2002) or multiscalar planning instruments (Kurttila & Pukkala 2003), are needed to support the change. Finally, education, leadership, and working resources are needed to support the change toward such adaptive management practices (Grantham et al. 2010).

Our results are applicable to many contexts where ecology-driven biodiversity conservation has faced resistance from stakeholders, or where the effectiveness of conservation has met challenges due to difficulties in designing and implementing high-quality conservation area networks, despite the general acceptance of conservation.

Acknowledgments

We would like to thank the Finnish Ministry of Agriculture and Forestry for funding the project and Iiro Ikonen, Maarit Jokinen, Sanna Kasurinen, Aija Kukkala, Mikko Kurttila, Leena Lehtomaa, Joona Lehtomäki, Marko Mäki-Hakola, Markus Nissinen, Outi Ratamäki, Sanna Tähtinen, and all the survey respondents and dialogue workshop participants for making the study possible in practice.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Annex A. Sampling of the survey and additional information about Factor Analysis in the Rekijokilaakso-Hyyppärä region.

Annex B. Differences between the respondents and nonrespondents of the survey.

Annex C. Material and methods used in Zonation prioritization analysis.

Annex D. Statements discussed in the dialogue workshops by the stakeholders.

References

Bazeley, P. & Jackson, K. (2013). *Qualitative data analysis with NVivo*, 2nd edn. SAGE Publications Ltd.

Berg, B.L. (2011). *Qualitative research methods for the social sciences*, 4th edn. Allyn and Bacon, Boston, MA.

Bergseng, E. & Vatn, A. (2009). Why protection of biodiversity creates conflict—some evidence from the Nordic countries. *J. For. Econ.*, **15**, 147-165.

Cheng, A.S., Danks, C. & Allred, S.R. (2011). The role of social and policy learning in changing forest governance: an examination of community-based forestry initiatives in the U.S. *For. Policy Econ.*, **13**, 89-96.

Doremus, H. (2003). A policy portfolio approach to biodiversity protection on private lands. *Environ. Sci. Policy*, **6**, 217-232.

Game, E.T., Lipsett-Moore, G., Hamilton, R., *et al.* (2011). Informed opportunism for conservation planning in the Solomon Islands. *Conserv. Lett.*, **4**, 38-46.

Gorsuch, R.L. (1988). Exploratory factor analysis. In J.R. Nesselroade, R.B. Cattell, editors. *Handbook of multivariate experimental psychology*, 2nd edn. Springer US, Boston, MA.

Government of Finland (2014). *Finnish Government Resolution on the continuation of Forest Biodiversity Programme for Southern Finland 2014–2025. [in Finnish]*. Finland.

Grantham, H.S., Bode, M., McDonald-Madden, E., Game, E.T., Knight, A.T. & Possingham, H.P. (2010). Effective conservation planning requires learning and adaptation. *Front. Ecol. Environ.*, **8**, 431-437.

Huijboom, N. & Van den Broek, T. (2011). Open data: an international comparison of strategies. *Eur. J. ePractice*, **12**, 4-16.

Jenkins, C.N. & Joppa, L. (2009). Expansion of the global terrestrial protected area system. *Biol. Conserv.*, **142**, 2166-2174.

Klein, C.J., Tulloch, V.J., Halpern, B.S., *et al.* (2013). Tradeoffs in marine reserve design: habitat condition, representation, and socioeconomic costs. *Conserv. Lett.*, **6**, 324-332.

Knight, A.T., Grantham, H.S., Smith, R.J., McGregor, G.K., Possingham, H.P. & Cowling, R.M. (2011). Land managers' willingness-to-sell defines conservation opportunity for protected area expansion. *Biol. Conserv.*, **144**, 2623-2630.

Korhonen, K., Hujala, T. & Kurttila, M. (2013). Diffusion of voluntary protection among family forest owners: decision process and success factors. *For. Policy Econ.*, **26**, 82-90.

Kurttila, M. & Pukkala, T. (2003). Combining holding-level economic goals with spatial landscape-level goals in the planning of multiple ownership forestry. *Landsc. Ecol.*, **18**, 529-541.

Lehtomäki, J., Tomppo, E., Kuokkanen, P., Hanski, I. & Moilanen, A. (2009). Applying spatial conservation prioritization software and high-resolution GIS data to a national-scale study in forest conservation. *For. Ecol. Manage.*, **258**, 2439-2449.

Mayer, A.L. & Tikka, P.M. (2006). Biodiversity conservation incentive programs for privately owned forests. *Environ. Sci. Policy*, **9**, 614-625.

Mickwitz, P. (2003). A framework for evaluating environmental policy instruments: context and key concepts. *Evaluation*, **9**, 415–436.

Moilanen, A., Arponen, A., Stokland, J.N. & Cabeza, M. (2009). Assessing replacement cost of conservation areas: how does habitat loss influence priorities? *Biol. Conserv.*, **142**, 575-585.

Moilanen, A., Pouzols, F.M., Meller, L., Veach, V., Arponen, A., Leppänen, J. & Kujala, H. (2014). *Spatial conservation* *planning methods and sofware Zonation Version 4 User Manual*. C-BIG Conservation Biology Informatics Group, University of Helsinki, Finland. Helsinki. Available from http://cbig.it.helsinki.fi/files/zonation/zonation_manual_v4_0.pdf. Accessed 17 January 2017.

Mönkkönen, M., Ylisirniö, A.-L. & Hämäläinen, T. (2009). Ecological efficiency of voluntary conservation of boreal-forest biodiversity. *Conserv. Biol.*, **23**, 339-347.

Paloniemi, R. & Tikka, P.M. (2008). Ecological and social aspects of biodiversity conservation on private lands. *Environ. Sci. Policy*, **11**, 336-346.

Paloniemi, R. & Vainio, A. (2011). Legitimacy and empowerment: combining two conceptual approaches for explaining forest owners' willingness to cooperate in nature conservation. *J. Integr. Environ. Sci.*, **8**, 123-138.

Parkhurst, G.M., Shogren, J.F., Bastian, C., Kivi, P., Donner, J. & Smith, R.B.W. (2002). Agglomeration bonus: an incentive mechanism to reunite fragmented habitat for biodiversity conservation. *Ecol. Econ.*, **41**, 305-328.

Peltola, A. (2014). *Finnish statistic yearbook of forestry 2014*. Available at: www.metla.fi/julkaisut/metsatilastollinenvsk/. Tammerprint Oy, Tampere.

Pressey, R.L., Mills, M., Weeks, R. & Day, J.C. (2013). The plan of the day: managing the dynamic transition from regional conservation designs to local conservation actions. *Biol. Conserv.*, **166**, 155-169.

Primmer, E., Paloniemi, R., Similä, J. & Tainio, A. (2014). Forest owner perceptions of institutions and voluntary contracting for biodiversity conservation: not crowding out but staying out. *Ecol. Econ.*, **103**, 1-10.

Salomaa, A., Paloniemi, R., Hujala, T., Rantala, S., Arponen, A. & Niemelä, J. (2016). The use of knowledge in evidence-informed voluntary conservation of Finnish forests. *For. Policy Econ.*, **73**, 90-98.

Le Saout, S., Hoffmann, M., Shi, Y., *et al.* (2013). Conservation. Protected areas and effective biodiversity conservation. *Science*, **342**, 803-805.

Selinske, M.J., Coetzee, J., Purnell, K. & Knight, A.T. (2015). Understanding the motivations, satisfaction, and retention of landowners in private land conservation programs. *Conserv. Lett.*, **8**, 282-289.

Tallis, H. & Lubchenco, J. (2014). Working together: a call for inclusive conservation. *Nature*, **515**, 27–28.

Tittensor, D.P., Walpole, M., Hill, S.L.L., *et al.* (2014). A mid-term analysis of progress toward international biodiversity targets. *Science*, **346**, 241-244.

Tomppo, E. (2006). The Finnish multisource national forest inventory: small-area estimation and map production. In A. Kangas, M. Maltamo, editors. *Forest inventory methods and applications*. Springer, The Netherlands.

Vainio, M., Kekäläinen, H., Alanen, A. & Pykälä, J. (2001). *Traditional rural biotopes in Finland. Final report of the nationwide inventory*. Finnish Environment Institute. Series 527, Vammala.

Whitehead, A.L., Kujala, H., Ives, C.D., *et al.* (2014). Integrating biological and social values when prioritizing places for biodiversity conservation. *Conserv. Biol.*, **28**, 992-1003.

Winkel, G., Blondet, M., Borrass, L., *et al.* (2015). The implementation of Natura 2000 in forests: a trans- and interdisciplinary assessment of challenges and choices. *Environ. Sci. Policy*, **52**, 23-32.

