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Exposing ecological and economic costs of the research-implementation gap and compromises in decision making

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Article Impact Statement: Gaps between applied science and its implementation can be quantified and minimized.

Abstract: The frequently discussed gap between conservation science and practice is manifest in the gap between spatial conservation prioritization plans and their

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implementation. We analyzed the research-implementation gap of 1 zoning case by comparing results of a spatial prioritization analysis aimed at avoiding ecological impact of peat mining in a regional zoning process with the final zoning plan. We examined the relatively complex planning process to determine the gaps among research, zoning, and decision making. We quantified the ecological costs of the differing trade-offs between ecological and socioeconomic factors included in the different zoning suggestions by comparing the landscape-level loss of ecological features (species occurrences, habitat area, etc.) between the different solutions for spatial allocation of peat mining. We also discussed with the scientists and planners the reasons for differing zoning suggestions. The implemented plan differed from the scientists suggestion in that its focus was individual ecological features rather than all the ecological features for which there were data; planners and decision makers considered effects of peat mining on areas not included in the prioritization analysis; zoning was not truly seen as a resource-allocation process and emphasized in general minimizing ecological losses while satisfying economic needs (peat-mining potential); and decision makers based their prioritization of sites on site-level information showing high ecological value and on single legislative factors instead of finding a cost-effective landscape-level solution. We believe that if the zoning and decision-making processes are very complex, then the usefulness of science-based prioritization tools is likely to be reduced. Nevertheless, we found that high-end tools were useful in clearly exposing trade-offs between conservation and resource utilization.

Introduction

Game et al. (2013) summarized reasons why scientific conservation priority-setting exercises frequently fail to be implemented. This research-implementation gap is a serious problem in

individual cases and a challenge to applied scientific effort in general (Ehrenfeld 2000; Cabin 2007; Hulme 2014). It has been identified and discussed in the literature of conservation science (e.g., Ehrenfeld 2000; Knight et al. 2008) and restoration ecology (e.g., Cabin 2007; Giardina et al. 2007).

Progress toward better alignment between conservation scientists, planners, and decision makers has been frustratingly slow. However, scientists have suggested several approaches and methods to improve the usefulness of conservation prioritization results. It is intuitively important to report failures in implementation for the lessons' sake (Redford & Tabert 2000; Knight 2006). Applying research in decision making may also be beneficial if methods can be simplified and common sense is used to avoid oversophisticated analyses and experiments (Cabin 2007). Knight and Cowling (2007) call for conservation planning to support the use of arising opportunities (e.g., willingness of landowners to protect their land), whereas Pressey and Bottrill (2008) clarify the difference between systematic conservation planning in distancing decision making and harmful opportunism. Furthermore, better psychological understanding of human decision making could help close the gap between research and its implementation (Gilbert 2011). Conservation decision making is fundamentally a matter of resource allocation, and recognition of this could help identify better trade-offs between ecological and socioeconomic factors (Game et al. 2013). Credibility, legitimacy, and relevance of scientific solutions are increased and society's demands better defined when science-policy interfaces are constructed more openly (Your et al. 2014), and scientists should see the implementation interface as a multidimensional space rather than as a series of gaps and broaden their perspective on decision-making processes, socially, psychologically, and through problem-solving skills (Toomey et al. 2016). Finally, several implementation approaches expressly address bridging the gap between conservation planning analyses and

decision making by offering operational models for more effective implementation (e.g., Margules & Pressey 2000; Knight et al. 2006 2011).

Inspired by these discussions, we examined the case of a spatial prioritization exercise conducted to avoid ecological impacts of peat mining in a regional zoning process (Kareksela et al. 2013). We investigated the differences between a scientifically based prioritization outcome, prioritizations suggested by planners, the published zoning plan negotiated between stakeholders, and the final plan that incorporated the changes requested by decision makers of the highest authority. We then further analyze the consequent ecological and economic costs of the gap between research, planning and implementation, and illustrate how quantitative and qualitative tradeoffs in resource allocation projects can be exposed through replacement cost analysis (Cabeza & Moilanen 2006).

Methods

Spatial prioritization analysis

In our original spatial prioritization analysis of 306 peatland areas in Central Finland (Kareksela et al. 2013), we prioritized areas to provide an economically viable set of peat mining areas that would least reduce landscape-level ecological values. Thus, we combined environmental-impact avoidance via spatial prioritization and conflict resolution between biodiversity conservation and resource extraction. In the analysis, we considered spatial data on multiple peatland-ecosystem types, their condition, threatened species, and bird territories. We built the model to emphasize complementarity, irreplaceability, connectedness, and ecological and economic cost-effectiveness based on economic value of the prioritized peatland areas (Supporting Information). After in-depth discussions with the authorities responsible for the zoning plan, we concentrated the analysis on avoiding harmful effects of

peat mining on biodiversity at landscape level and did not consider ecosystem services, except for the ecosystem service of the peat mining, the value of which was considered a trade-off between remaining biodiversity value and economic gains.

Our method allowed prioritization over the entire landscape, provided a ranking for each peatland area, and revealed the trade-off between ecological and economic values by iteratively removing areas from the landscape (to peat-mining use) and heuristically minimizing ecological losses and maximizing peat-mining profits (Kareksela et al. 2013). Site-specific economic value of peat mining was represented as proportion of each peatland area or peat pool suitable for peat mining, which is a common way to measure peat-mining potential in Finland. Although only a proportion of a peatland pool's area (peat depth >1.5 m) is considered profitable for mining, the entire area usually loses its ecological peatland characteristics because its hydrology is strongly affected by ditching methods used in harvesting. The proportion of the peatland sites' area suitable for mining can be used to estimate site-specific peat-mining potential. To minimize the ecological losses while satisfying economic targets, one must consider the site-specific mismatch between the 2 factors (Kareksela et al. 2013).

Zoning process and the use of information

Our (S.K., A.M., and J.S.K.) original spatial prioritization analysis (Kareksela et al. 2013) was commissioned by the Regional Council of Central Finland (O.R. and R.V.), who provided us with substantial economic and biodiversity data on the region. This spatial data and the prioritization results formed a major input into the planning process, during which the preliminary plan was modified according to comments by different stakeholders. Major parties in the zoning planning process were the Regional Council of Central Finland, which is responsible for zoning plans in the area, and a stakeholder group assembled to comment

and make decisions on different elements related to the zoning plan. Although the prioritization analysis was described to the stakeholder group, it was mainly used by the regional-council planning authorities who commissioned the analysis to support their planning work. The stakeholder group originally declined to consider the results of the prioritization analysis as a tool for their work. A multiobjective analysis of site-specific hydrological effects of potential peat mining was also conducted, but its results were not available when the ecological spatial prioritization analysis was being conducted. The final land-use zoning plan was agreed on and made public by the regional council in 2013. With moderate changes, it was approved by the Ministry of Environment in 2014. The plan was challenged in Supreme Administrative Court, but complaints were finally rejected and the plan became legally binding in 2016 (Fig. 1).

Investigation of the alternative solutions

Here, we analyzed the difference between 7 zoning plans: four versions of a spatial prioritization analysis; a suggestion developed by the planning authorities (mainly O.R. and R.V.); the final plan, which was negotiated as a compromise between expert opinion and local stakeholder desires; and the final plan changed according to demands of the Ministry of the Environment. We compared these plans in 3 respects: the number of sites for which the prioritization-analysis-based suggestion for land use (hereafter scientists' suggestion) differed from the suggestion of the planning authorities (hereafter planners' suggestion) and the final zoning plan; how well different zoning plans performed in terms of ecological and economic value; and the causes behind the differences among alternative plans. For ecological and economic values, we compared the marginal ecological losses and economic gain among solutions; that is, we determined to what extent the key peatland biodiversity elements were maintained in the landscape if sites identified for mining were drained and mined and key

biodiversity elements were lost from these sites. We calculated the proportion of these elements (e.g., proportion of the total area of an ecosystem type in the analysis or proportion of species occurrences or bird territories) (Table 1) remaining after the exclusion of the proportion that existed on areas allocated to peat mining in the focal scenario.

More specifically, the 7 scenarios compared were scientists' suggestion based on the original inverse-prioritization analysis and avoidance of ecological impacts (Kareksela et al. 2013); scientists' inverse prioritization suggestion with more peat extraction (stakeholder mandated); scientists' suggestion excluding certain sites from peat mining because of high expected damage to surface waters and recreational value; planners' suggestion; final land-use zoning; final land-use zoning changed according to the Finnish Ministry of the Environment; and scientists' suggestion modified to follow the demands of the Finnish Ministry of the Environment.

We also performed 3 replacement-cost analyses (Cabeza & Moilanen 2006) to quantify ecological and economic trade-offs among alternative plans (Kareksela et al. 2013). We estimated, for example, how one's ability to avoid losses on most threatened peatland ecosystem types would be reduced if some sites were excluded from the set of areas suggested for peat mining but the peat-mining target remained the same. In this case, sites that could not be mined were replaced with sites originally suggested to be saved from mining but which in the analysis had the lowest value out of the sites to be saved (i.e., the prioritization analysis provided continuous ranking over the landscape, which made it possible to replace sites with the next best options). The effect of forcing a suboptimal solution (relative to results of the original prioritization) then would either decrease the ecological value of the solution (if peat-mining sites were replaced with sites of slightly higher ecological value) or the economic value (if not replaced). One replacement-cost

analysis was for forcibly increased allocation of area suitable for peat mining (as mandated by stakeholders), and the other 2 were for forced retention of sites with potential surface-water effects, following the planners' suggestion and demands by the Ministry of the Environment.

Numeric comparison of the performances of different suggestions may be biased because the final plan may have been influenced by considerations (e.g. local politics and legislative issues) that were not represented by spatial data. Therefore, the planning process was evaluated together with the scientists and the authorities who commissioned the prioritization analysis (O.R. and R.V.) and were responsible for the zoning. We examined the process and the reasons behind differences between the scientifically based prioritization and the actual zoning plan. The leading planning authorities were the zoning project leader, an expert on peat mining (O.R.), and leader of the ecological evaluation, an expert on peatland biology (R.V.). The differences behind the two-way information gap were defined through discussions among the authors due to the low number of people involved (the authors).

Results

The actual zoning process was complex (Fig. 1), and the zoning plan evolved through five stages at different administrative institutions. It was commented on twice by the stakeholder group and four times by landowners and others affected by the zoning. The most time-consuming phase was circulation of the plan among planners, stakeholders, midlevel decision makers (Managing Board), and landowners and other interested citizens. Most of the area-specific zoning suggestions were agreed upon among parties in this phase. The Finnish Ministry of Environment required the modification that 40 sites, originally planned for peat mining, be zoned unsuitable for peat mining (mainly due to possible harmful effects to nearby water systems based on a separate hydrology analysis) in the fourth planning stage,

and then stakeholders were allowed to comment on the plan. All legal challenges were rejected, and the plan was approved by the Supreme Administrative Court.

Scientist and planner suggestions differed for 102 out of 301 peat-land areas. In the prioritization analysis (Kareksela et al. 2013), 35 of these areas were designated for peat mining and 67 were designated as not for peat mining. Similarly, the scientists' suggestion differed from the final zoning for 107 areas (50 areas for peat mining and 57 not for peat-mining). Planners' suggestion and the final zoning plan differed for 71 sites (41 sites suggested for peat mining by planners were not in the final plan). For 30 sites the situation was the reverse. Although differences were mostly for sites that had intermediate ranking according to the prioritization analysis, there were also notable differences for sites that had very high or low priority rank in the prioritization analysis. We explored the zoning report to investigate the arguments for the zoning decisions for individual peatland sites when the final zoning and the scientists' suggestions differed. Expected negative effects of peat mining to local surface-water systems and possible risks (negative effects) of peat mining to nearby NATURA 2000 network areas were the most common arguments for zoning sites not for peat mining in the cases where the sites were allocated for peat mining use in the scientists' prioritization (Table 2).

The greatest differences in the conserved proportions of ecological features were between the scientists' suggestion and the final land-use plan (Table 1). The prioritization-analysis-based plan delivered on average 12 percentage points more representation (i.e., arithmetic difference in the remaining proportions of ecological features between solutions) across all biodiversity features in areas designated as not for peat mining (Table 1). The scientists' suggestion would have achieved 40% less loss (proportional difference in the fractions of ecosystems and species occurrences remaining in different solutions) of peatland ecosystems

and species. Scientists' suggestions provided 6% (3 percentage points) less area suitable for peat mining and 13% (6 percentage points) less combined total peatland area allocated to peat mining, an outcome that resulted from the scientists' suggestion to allocate fewer but resource-richer areas for mining.

The use of one of the key elements of the prioritization analysis, ecological cost-effectiveness, was not properly transferred from the scientists to the planners or to the final zoning plan. On average 42% of a peatland's area (out of 306 prioritized peatland areas) contained peat that was profitably minable (i.e., >1.5 m deep). In comparison, areas that planning authorities suggested for mining that were not suggested for mining by scientists had an average peat-mining potential of 33%. In contrast, areas suggested for peat mining by scientists but not by planners had an average peat-mining potential of 48%. Higher peat-mining potential means that the same amount of actual peat-mining area can be achieved through smaller total area of peatlands drained (see Methods).

Replacement-cost analyses showed the trade-offs related to a forced solution (Table 1). For example, forced larger peat mining gains resulted in a moderate 3 percentage points decrease in mean ecological value, but the representation of vulnerable, near threatened, and rare species declined 9 percentage points between the original scientists' suggestion and scientists' suggestion with forced exclusion of areas to meet higher peat-mining demands.

According to the planning authorities (O.R. and R.V.), these potentially significant trade-offs revealed by the replacement-cost analysis were not quantitatively investigated in the decision-making process.

Discussion

The ability of prioritization-analysis experts to identify the most cost-effective spatial resource allocation clearly exceeds the ability to act on this knowledge (Knight et al. 2006).

Lack of optimal information exchange among researchers, planners, and decision makers was evident in our case study. Perhaps the clearest indication of the gap between research and implementation was the difference between the scientists' suggestion and the preliminary zoning plan, given that the results of the prioritization analysis and the scientists' recommendations were delivered directly to the planners (O.R. and R.V.).

During discussions of the differences between the zoning scenarios, we identified four main reasons why zoning plans differed substantially (Table 1). First, threatened species have higher legitimating power than other biodiversity features, which explains why they had relatively high occurrence levels both in the planners' zoning suggestions and in the final zoning plan (Table 1). Although it is valid to pay attention to threatened species in decision making, their occurrence data may be biased and preserving endangered species may not protect overall biodiversity and ecosystem functioning. Furthermore, the data on known threatened species occurrences used in all the plans (by scientists and planners) were for vulnerable, near threatened, and regionally threatened or rare species, whereas the ecosystem types ranged from near threatened to critically endangered, and the ecosystems in the comparison in Table 1 included critically endangered and endangered ecosystems in pristine or near pristine condition. Based on the trade-offs in the zoning scenarios and the reasons for these trade-offs (Table 1), it was evident in the planners' suggestions and the final zoning plan that the presence of a vulnerable species on a site outweighed the landscape-wide representation of pristine and near pristine critically endangered and endangered peatland ecosystems.

Second, plans changed in the process as additional environmental data were considered (hydrological analysis on the effects of peat mining and strict considerations of the proximity of Natura 2000 areas [Table 2]), which created further trade-offs and ultimately lead to decreased retention of the focal ecological features (Table 1, Supporting Information) in the final zoning plan. The sites had been preselected to be candidates for peat mining (e.g., protected areas and other large and ecologically valuable and intact areas were excluded) so that no clear categorical reasons (such as the proximity of Natura 2000 areas) should have existed for forcing peat-mining zoning without ecological-economic evaluation of trade-offs and replacement-cost analyses.

Third, we found empirical support to points made by Game et al. (2013). Cost-effectiveness resulting from the use of data on peat-mining potential (i.e., site-specific economic value) was significantly outweighed by site-level ecological-environmental factors (i.e., habitat and species occurrences at site level) in the planners' suggestion and the final plan. Considering economic returns, as in the prioritization analysis, would have made it possible to meet peat-mining goals while minimizing total mined area and thereby led to an overall higher retention of ecological and environmental values (Table 1) (e.g., Margules & Pressey 2000; Naidoo et al. 2006; Kareksela et al. 2013). This together with the fact that some relevant political and environmental factors (Table 2) were introduced only after the systematic prioritization analysis had been completed demonstrates a shortcoming of seeing these factors as part of the same resource-allocation process (Game et al. 2013). This failure is attributed to both the scientists and the planners; we failed to properly identify a priori all relevant decision criteria based on data available for the prioritization analysis.

Fourth, it became apparent during the planning process (Fig. 1) that the expert opinion of the planning authorities (e.g. authors O.R. and R.V.) tended to emphasize the importance of

individual sites over the landscape-level solution, which differs substantially from the complementarity-based approach typically used in spatial conservation prioritization (e.g. Kareksela et al. 2013). This issue is closely related to the failure to see zoning as resource prioritization and cost-effective resource allocation (Game et al. 2013). The danger in focusing on individual sites is that interests of stakeholders and local considerations are overemphasized in the trade-off between individuals and the common good, and the balance of the solution as a whole is less than what it could be (Ahlroth & Kotiaho 2009). In other words, complementarity and cost-efficiency end up being deemphasized and the performance of the overall solution is lessened. In contrast, the planners, who in this case were also the midlevel authorities, most often needed to justify their suggestions at the level of individual sites. Although authorities at the highest level may see the overall results of the prioritization analysis as a valid argument for the individual sites, the same may not be the case for landowners or the law should landowners challenge the legitimacy of the decision on a specific site. In Finland this at least partially explains the increased weight given to legitimating ecological features (usually some specific species), which here manifested as elevated occurrence levels of endangered species in the final zoning suggestion. When there are many competing factors, it is not easy to claim the superiority of one solution over another. However, there are quantitative ways to evaluate trade-offs. For example, trade-offs between single sites and a landscape-level solution can be evaluated by replacement-cost analysis (Cabeza and Moilanen 2006; Kareksela et al. 2013) (Table 1), which makes explicit the losses and gains that follow from potentially suboptimal decisions.

Perhaps the most striking lesson from the scientists' perspective was the complexity of the decision-making process (Fig. 1). The fact that the planners' suggestion and the final zoning plan still differed in 71 sites out of 300 shows there are multiple gaps in the knowledge

transfer interactions of the process. As Fig. 1 further illustrates, the challenge for applied conservation science is to transmit the scientific information developed on multiple occasions to multiple institutions within a single zoning process. The operational models suggested for improvement of implementation also add complexity to situations that usually are already complex (Young et al. 2014). Following the suggestion of, for example, Knight et al. (2006, 2011) would have left us trying to tackle the complex decision-making process (Fig. 1) with something that the authors describe as an operational model of “complex, heuristic, web-like structure” with nearly twenty different steps. Implementing prioritization analysis becomes increasingly complex as the number of stakeholders involved increases because of the need to reconcile an increasing number of conflicting perspectives. In a step-wise process, as we had here, implementation of a scientifically based and cost-effective solution is no longer about a gap but about multiple gaps that may be difficult to perceive in advance, as shown by our results (Fig. 1). In addition to making the science-policy interface work better (Spierenburg 2012; Young et al. 2014), conservation scientists need to rethink whether it is complex operational models of implementation strategies or simplified, reduced prioritization analyses that best help bridge the gaps. As pointed out by the planners (O.R. and R.V.), the prioritization analysis would have benefitted from being implemented earlier in the process (i.e., the preparatory phase of the zoning project). Starting the implementation process early enough is of course emphasized in many operational models for prioritization (Margules & Pressey 2000; Knight et al. 2006, 2011). In the present case, S.K., A.M., and J.S.K. did not become engaged in the project until after it was already underway. This is unlikely a unique situation, and best implementation practices are still to be identified for the circumstances where the optimal implementation pathway is no longer available.

In an ideal world, increased communication through the planning process (e.g. Young et al. 2014) would have improved both the analysis and its uptake and reduced ecological impacts of peat mining. Such communication and proper identification of objectives is part of the standard process of systematic conservation planning (Margules & Pressey 2000; Pressey & Bottrill 2008). Spatial plans such as the one in Kareksela et al. (2013) have to be developed under potentially severe constraints on time, money, and work force. For this reason, good a priori availability of spatial biodiversity data is of primary importance for the timely delivery of high-quality policy-relevant spatial prioritizations. If data are available, it is possible to concentrate on developing the utility of the analysis itself. If data are not available, much time may be spent on data collection. Moreover, development of the analysis structure with stakeholders is hindered when there is uncertainty about availability of ecological information on the prioritized areas. Early availability of data facilitates easier communication throughout the process and allows multiple iterations of the analysis and customized comparisons that reveal the ecological and economic costs of compromises to stakeholders, which then facilitates improved relevance of the final outcome. In addition to time and money, education and capacity building are needed for administrative personnel and scientists (e.g. Toomey et al. 2016) because quantitative analyses are more likely to be ignored when administrators or stakeholders lack familiarity with spatial prioritization or systematic planning and when scientists lack social perspective in creating analysis models. We agree with Walsh et al. (2014) that this knowledge gap may lead to neglecting results that are not as self-evident as, for example, the number of threatened species per site. Now that methods exist for large-scale, high-resolution, multifeature spatial prioritization, long-term investment in the development and maintenance of data and proactive offering of information on different analysis possibilities (e.g. Dicks et al. 2014) becomes more relevant than ever.

We emphasize, first, that to design a socially relevant and ecologically effective prioritization analysis it seems there cannot be too much interaction between all the different parties on the sides of the multiple gaps in the process. However, the problems to be solved are wicked by nature (Game et al. 2014) and the decision-making processes complex (Fig. 1), so perhaps more flexible and less hierarchical approaches are needed to implement the latest methods to solve these problems (e.g., Toomey et al. 2016). Second, the analytic evaluation of the trade-offs within and between different land-use decisions should be highly supported. Looking at the values in Table 1 and the reasons behind them shows there never is absolute solution; rather, there are different trade-offs, where the weighting of the different elements varies between the analysis solutions (Hirsch et al. 2011). However, differences should not be interpreted as meaning all solutions are equal or that no complex analyses or trade-off evaluations are needed. Only through proper evaluation can the most beneficial trade-offs and the potential pitfalls of some suggestions be identified. Biodiversity preservation oriented ecological decision analyses may well lag behind in social relevance, but they represent the ecological or conservation extreme and as such offer a baseline for the nature-conservation perspective in decision making.

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Table 1. Comparison of proportion of ecological values retained and proportion of area designated as suitable for peat mining (peat-mining potential) in different land-use plans.^a

Compared feature	Land-use plan						
	scientists' suggestion based on prioritization	scientists' suggestion with larger peat-mining goal ^b	scientists' suggestion with forced exclusion of areas ^c	planners' suggestion for land-use zoning plan	final land-use zoning plan	final land-use zoning plan changed according to demands ^d of Ministry	scientists' suggestion forced according to demands ^e of Ministry of

						of the Environme nt	the Environme nt
Proportion of planning area not mined	0.58	0.58	0.60	0.50	0.52	0.63	0.68
Pristine and near- pristine peatland area	0.80	0.78	0.77	0.77	0.68	0.80	0.81
Critically endanger ed and endanger ed ecosyste ms (pristine or near pristine)	0.86	0.84	0.87	0.75	0.69	0.77	0.91
Vulnerable,	0.78	0.68	0.69	0.83	0.83	0.84	0.71

near threatene d, and rare species (occurren ces)							
Birds, high priority (territories)	0.88	0.86	0.87	0.79	0.72	0.77	0.88
Birds, medium priority	0.77	0.73	0.73	0.58	0.59	0.65	0.77
Mean	0.82	0.78	0.79	0.75	0.70	0.77	0.81
ecosyste m and species distributi ons							
Achieved proportio n of the total peat-	0.45	0.48	0.45	0.48	0.48	0.35	0.35

mining

potential

^a See Supporting Information for details on biodiversity features.

^bThe threshold between peat mining and no peat mining is set so that area allocated to peat mining equals that in the final zoning plan (48 % of the area that is suitable for mining).

^cEighteen sites where peat mining is expected to have negative effects on surface-water systems are forcibly excluded from areas designated for peat mining, irrespective of ecological values or peat-mining potential in the sites.

^dForty sites where peat mining is expected to have negative effects on surface-water systems are excluded from mining.

^eTwenty-eight sites (in addition to the 18 in footnote *c*) where peat mining is expected to have negative effects on surface-water systems are excluded from mining.

Table 2. Arguments for zoning decision not to mine an area for peat and the number of areas for which the final zoning plan and the authorities' statement differed* from the scientists' suggested plan based on spatial prioritization (Kareksela et al. 2013).

Argument's origin and reason	Number of areas
Zoning report for final land-use plan	
expected negative effects of peat mining on local surface water systems	18
possible effects of peat mining on nearby NATURA 2000 network areas	18
unspecified ecological value of site	9
unspecified connectivity concern	1
Authorities' statement (specifications of Ministry of the Environment)	

* In all cases, sites are not suggested for peat mining in the planners' zoning plan or in the final plan approved by authorities. Source: Zoning Report available from <http://www.keskisuomi.fi/4.vmk> (in Finnish, accessed March 2014).

Figure 1. Land-use decision-making process for mining of peat in Central Finland (dashed arrows, flow of data and considerations; narrow arrows, circulation of a working version of the zoning plan; wide arrows, steps from a lower administrative level to a higher level).

Although the responsibility for producing the zoning plan was on the planning authorities of the Regional Council of Central Finland, the stakeholder group had a large advisory role from the beginning relative to, for example, the socioeconomic targets. The planning authorities (mainly O.R.) presented and guided the plan through the steps. There were 2 rounds among the planners, stakeholders, managing board, and the landowners and citizens before an official zoning plan was presented by planners to the managing board for approval and moved to the highest levels of national administration.

