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Biodiversity and bird surveys in Finnish environmental impact assessments and follow-up monitoring

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A B S T R A C T

Environmental Impact Assessments (EIAs) that are applied in the planning phases of large land-use and construction projects are aimed at aiding decision-making and mitigating significant environmental impacts. In light of the global biodiversity crisis, conducting high-quality biodiversity impact assessments is important, as biodiversity information, among other factors, has the potential to influence how projects will be implemented in the end. We investigated the biodiversity and bird surveys conducted and the number of bird species of conservation concern in peat extraction and wind farm projects to which an EIA was applied to in 1995–2016 in Finland and compared whether these factors differed between the project types and between implemented and unimplemented projects. We also studied the availability of follow-up monitoring data of biodiversity impacts within the two project types. The number of nationally threatened breeding birds was significantly lower in implemented than in unimplemented peat extraction projects. The overall probability of being implemented was significantly negatively associated with the year the EIA began for both project types. All permitted peat extraction projects and 22% of wind farm projects conducted post-construction biodiversity monitoring; however, only some projects enabled before-after comparisons. Our results are in line with earlier findings that demonstrate the difficulty of showing the direct impacts of biodiversity information on EIA decision-making and to what extent it is related to project approval or rejection. The role of follow-up monitoring in the EIA and project development could also be strengthened.

1. Introduction

Habitat changes caused by land use are globally threatening biodiversity (Foley et al. 2005), whereas land-use decision-making affecting the abundance and distribution of species is often conducted at very local scales (Theobald et al., 2000). In light of the global biodiversity crisis, conducting high-quality assessments of the biodiversity impacts of land-use projects is crucial. Environmental policy has globally adopted the process of Environmental Impact Assessment (EIA) as a mandatory part of the development of large land-use and construction projects (Morgan 2012). Above all, the EIA aims to provide decision-makers with essential information concerning the environmental consequences of a plan, project, or program before it is implemented and to mitigate or prevent significant impacts of projects on the environment.

Biodiversity is considered in several phases of the EIA process. An Environmental Impact Assessment statement (hereafter EIS), i.e. a report of the environmental impacts of a project, is one of the main documents of an EIA. It typically includes a section that considers the natural environment, where also the biodiversity in the area (e.g. threatened, protected, or valuable species and habitats) is presented. Whether the biodiversity section in the EIS follows established guidelines and regulations (procedural effectiveness) has been studied in the checklist reviews of the EIS, and its ecological part, and ecological biodiversity indices and interviews of EIA practitioners have been used to assess the quality of biodiversity surveys and impact assessments (Atkinson et al. 2000; Söderman 2005). These studies have shown that biodiversity surveys tend to focus on particular taxa (Atkinson et al. 2000; Knegtering et al. 2005) and that new baseline surveys are scarce (Chang et al. 2013), but also that the quality of ecological surveys has partly improved over time (Barker and Wood 1999; Drayson et al. 2017; but see Aniwofose et al. 2016). National variation occurs in how EIS quality is controlled, also including its biodiversity section (Günther et al., 2017). For example, the EIA liaison authorities in Finland may request for the complementation of an EIS. However, no studies have looked at how commonly such complementing is required.

Biodiversity surveying and recognized biodiversity values during an

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EIA may have the potential to associate with how, or sometimes even whether, the project is being implemented (substantive effectiveness), but most of the research shows that the final implementation of a project depends on multiple issues (Cashmore et al. 2004) and the direct link of biodiversity to consent decisions is difficult to show (Jay et al. 2007). Although information presented by an EIS may be essential for decision-makers (Glasson et al. 1997), better information does not necessarily lead to more rational decisions (Cashmore et al. 2004), an issue that is problematic from the perspective of conserving natural values. After decisions have been made, biodiversity impact monitoring should be implemented to investigate the real impacts of projects and the need for possible additional mitigation measures (Arts et al. 2001). The contents and quality of biodiversity monitoring have rarely been studied (but see Dias et al. 2019), even though the importance and lack of structured follow-up monitoring are widely acknowledged (Arts et al. 2001; Marshall et al. 2005). The aim of this article is to fill these gaps in knowledge, especially concerning the role of biodiversity surveying in EISs and post-EIA using Finnish EIA projects as a case study.

The Finnish EIA Act was launched in 1994 (Act on Environmental Impact Assessment Procedure 468/1994), and the latest reform was implemented in 2017 (Act on Environmental Impact Assessment Procedure 252/2017). Overall, the Finnish EIA Act is controlled by the European Union (EU) Directive (2014/52/EU). In the Finnish EIA process, a regional Centre for Economic Development, Transport, and the Environment (hereafter ELY Centre) is the liaison authority that controls and assesses the quality of the assessment documents; a procedure differs from certain European countries (Pölönen 2006). The biodiversity affected by a planned project is often surveyed by an environmental consultancy from the private sector, which in most cases also prepares the EIA scoping document and the EIS. EIA practitioners have evaluated the Finnish EIA system as functional (Pölönen et al. 2011). At the end of the EIA, the liaison authority gives a review of the EIS and its adequacy (Tallskog and Turtiainen 2004). Without an EIS review, it is generally impossible to continue to the decision-making or land-use planning phases. Post-construction monitoring of particular impacts (usage, emissions, water systems, and fisheries) is statutory for any project types that require environmental permission (for example, peat extraction areas and waste management plants). Contrastingly, the need for environmental permission procedures is considered case by case for other projects, and follow-up monitoring is also voluntary. The EIA Decree only requires having a proposal for the follow-up activities in the EIS.

National guidelines for studying biodiversity in various land-use projects were published in 2003 in Finland (Söderman 2003). Currently, there is an ongoing process of developing new guidelines for biodiversity surveys. The recent development of wind energy has shown uncertainty in the impacts of wind farms on wildlife, particularly on birds (Stewart et al. 2007). Also, Finland has a wealth of EIA projects related to wind energy since 2001 (Finnish wind power association 2019). On the other hand, Finland has a long history of peatland use, whereas its impacts on birds have rarely been studied. Still, the populations of peatland birds in Northern Europe have decreased (Tiainen et al., 2016). Species in the EU Birds Directive Annex I (hereafter Annex I bird species) are considered particularly threatened, and along with nationally threatened birds should be considered in land-use planning. We use birds as a model group to assess whether the diversity of conservation concern species has been associated with overall project implementation. We focus particularly on wind farm and peat extraction projects undergoing EIAs until either project abandonment or implementation and a possible follow-up phase, and answer the following questions: 1) how were biodiversity, and more specifically birds, surveyed within projects; 2) did projects have to complement EIS because of the inadequacy of biodiversity surveys, 3) did the numbers of bird species of conservation concern differ between unfinished and implemented projects and did biodiversity surveys and the number of bird species of conservation concern relate with the current phase of the project. The final implementation of the project depends on many issues and in practice is more complex than the binary result of implemented versus non-implemented. For example, intensively studied biodiversity may result from assessed important biodiversity impacts that could lead to a reduced probability of a project being permitted. Finally, we explored what follow-up monitoring data are currently available and asked 4) whether the conducted follow-up monitoring differed between project types. Follow-up monitoring is a tool to understanding how realized actions influenced biodiversity, which is crucial for learning how negative impacts could be mitigated.

2. Materials and methods

We used data of two types of land-use projects in Finland, to which the EIA process has been applied to in 1995–2016. Data on EISs were collected from the website of Finland's environmental administration (Environmental Administration, 2019), whereas statements of older projects were requested from the archives of regional ELY Centres. The current phase of each project (in June 2019) was defined either from information gathered from project developers, by the environmental licenses for peat extraction projects, or from a database managed by the Finnish wind power association for wind farm projects (Finnish wind power association 2019).

In Finland, EIA is applied to all peat extraction projects with surface areas over 150 ha (Act on Environmental Impact Assessment procedure 126/2019). We had altogether 60 such projects in 1995–2015 (Appendix 1). One state-owned company accounted for most of the projects (88%). The EIAs of one-third of the projects were finished by 2019. A total of five projects had been interrupted by project developers, and the EIAs of eight projects were in progress. Permission for peatland extraction is gained through an environmental permit from Regional State Administrative Agencies. The environmental permit is separate from the EIA process, but an EIS review is required when applying for the permission. Altogether 29 projects went through the environmental permission process, 35% of which were either permitted in or in extraction by 2019.

An EIA is applied to all wind farms that have over ten turbines or a production capacity of over 45 MW, the earlier capacity threshold for the EIA projects being 32 MW (Act on Environmental Impact Assessment procedure 252/2017). A total of 124 projects were in operation during 2001–2016 (Appendix 2). Of all these projects, 33% had gained permission (as building permits) or were under construction or in operation by June 2019. The EIA was in progress and had to be complemented for 10% of the projects and 15% were in the land-use planning phase. Approximately 15% of the projects were interrupted by the developer.

2.1. Recorded variables and analysis

2.1.1. Taxonomy data

For each project, we defined particular species or taxonomic groups that were field-surveyed during the EIS phase, both following the guidance material by Söderman (2003), which was targeted at conducting biodiversity surveys in the EIA and zoning projects, and based on frequent appearance of the species/group among the EISs. We defined the following separate groups or particular species in the EU Habitats Directive Annex IV (92/43/ETY): vegetation, polypores, bottom feeders, beetles and gastropods, butterflies and bees, fishes, the moor frog (*Rana arvalis*), birds, bats, the Siberian flying squirrel (*Pteromys volans*, hereafter flying squirrel), and game mammals.

2.1.2. Bird data

More frequent bird surveying during the breeding season should produce more accurate numerical estimates of breeding pairs (e.g. a single-visit line transect covers 60% of the breeding birds in an area, whereas territory mapping on three separate visits results in a 90% accurate estimate of breeding pairs) (Järvinen and Väisänen 1975) and improves the possibility of detecting uncommon species that are often of conservation concern. All this should increase the reliability of assessing the avian impacts of a project. We classified the frequency of breeding bird surveys irrespective of the utilized method as follows: 1) once, 2) twice, or 3) on at least three occasions during one breeding season. In addition, we defined the used survey methods for breeding birds, such as territory mapping where the project area is surveyed by walking a route that covers the entire area, line transects where all birds are counted in belts around the surveyor, which are used for large survey areas, point counts made at exact locations where all birds are counted for five minutes, and applied methods that included surveys of particular habitats or species (Koskimies and Väisänen 1988; Söderman 2003). We focused on breeding birds and did not consider bird data during the migration season in our analyses. We also defined the number of Annex I bird species (Directive 2009/147/EC) and the number of Finnish threatened (red-listed as either critically endangered, endangered, or vulnerable) bird species (Rassi et al. 2001; Mikkola-Roos et al. 2010; Tiainen et al., 2016) for all projects.

2.1.3. Data from the EIA process and follow-up phase

We additionally specified the year the EIA began (i.e. the EIA scoping report was published), the year the EIS review was compiled by the liaison authority, and whether the EIS was determined to be sufficient or substantially insufficient. In cases where the EIS was considered insufficient, we studied whether the decision mentioned a lack of biodiversity surveys. Secondly, projects whose EIS or review was in progress or whose EIA had begun after 2016 were excluded from the following analyses. The remaining projects were classified into two categories according to the project phase: 0 for projects interrupted by the project developer, rejected during the permission procedure, or pending after the EIA or the land-use planning stage was finished, and 1 for projects in action, under construction, or permitted by building or environmental permits. For completed projects, we also gathered data concerning follow-up monitoring programs of the projects from project developers and environmental permits.

2.1.4. Analyses

To test whether the numbers of conservation concern bird species were significantly different between projects in the two distinct phases, we used general linear models with Poisson error distribution. We compared several elements separately within the project types: the number of Annex I species and the number of threatened species using the project phase (0 or 1) as an explanatory categorical variable. In case of overdispersion (the ratio between residual deviance and degrees of freedom was more than 1), standard errors were corrected by multiplying them by the square root of the dispersion parameter.

To find out whether the current phase of the project was related to the project type and its biodiversity information, we used generalized linear modeling with a binomial distribution and an information-theoretic approach (Burnham and Anderson 2002). The response variable was given 0 for pending, interrupted, and rejected EIA projects, and 1 for projects permitted, under construction, or in progress. This ranking was related to numeric variables concerning the number of surveyed taxa, bird survey frequency, number of Annex I species, and the year that the EIA began, and to categorical variables related to project type and the location of the regional ELY Centre in either northern or southern Finland. In addition to the abovementioned variables, the global model included how 1) the year that the EIA began interacted with the project type, the number of surveyed taxa, and the ELY Centre in question and 2) how the number of Annex I species interacted with the ELY Centre to account for potential spatial and temporal trends, resulting in a total of 13 explanatory variables. The numeric variables were standardized (mean of 0, standard deviation of 0.5) and the categorical variables were centered before model selection. We considered all possible combinations of explanatory variables for the global model, including a model with intercept only, and compared models by their Akaike Information Criterion values corrected for small sample size (AICc, Burnham and Anderson 2002). AICc is calculated using the number of fitted parameters in model and its maximum likelihood, and the function penalizes an increasing number of estimate parameters, thus favoring simplicity.

We defined a set of best-approximated models being within a 2-unit difference of the model with the lowest AIC_c. Because several models were included in the best-approximated model set, our model selection contained uncertainty, and we aimed to use the model for prediction, we computed model-averaged parameter estimates by substituting zero into those models that had no parameter (Grueber et al. 2011). This method is recommended when aiming to define which variables are most strongly associated with the response variable (Nakagawa and Freckleton 2011).

Finally, as permit procedures for peat extraction and wind farm projects differ, we analyzed separately within the project types whether follow-up monitoring was different for the four monitored groups, i.e. vegetation, biological water monitoring, fishes, and birds. Here we used an χ^2 test to compare observed and expected counts in different categories (Agresti 2007). We conducted all analyses with R software for statistical computing (R Core Team, 2020).

3. Results

3.1. Biodiversity surveys in the EIS phase

Biodiversity survey data were available for 45 peat extraction projects (in 1998–2015) and 101 wind farm projects (in 2007–2016). The number of organismal groups surveyed varied from two to six and averaged slightly less in the peat extraction projects (2.8 $\pm$ 1.0 SD) than in the wind farm projects (3.8 $\pm$ 1.0 SD). Peat extraction projects usually surveyed two or three groups, and four to six separate groups were surveyed in 18% of projects. Surveys were conducted for four groups in 40% of the wind farm projects, and five or six groups were surveyed in 22% of the projects.

Vegetation and birds were surveyed in all except one EIA project in our data (Fig. 1A). Of the EU Habitats Directive Annex IV species, bats and the flying squirrel were surveyed in most wind farm projects, whereas the flying squirrel was the least studied taxon in peat extraction projects. The moor frog was surveyed equally commonly in both project types. Butterflies and fishes were surveyed more often in peat extraction than wind farm projects. Bottom feeders and beetles, game mammals, and polypores were less-represented groups that were only surveyed in wind farm projects.

Bird survey data were available for 43 peat extraction and 101 wind farm projects. Bird surveys had a mean frequency of 1.8 ($\pm$ 0.6 SD) for peat extraction and 2.0 ($\pm$ 0.5 SD) for wind farm projects. Bird surveys were repeated twice per breeding season in 59% and 75% of peat extraction and wind farm projects, respectively. A third of the peat extraction projects relied on a single survey during the EIA, whereas 15% of wind farm projects did the same. The surveys were rarely repeated three or more times during one breeding season (8% and 9% of peat extraction and wind farm projects, respectively).

Territory mapping and line transects were the most commonly used methods for bird surveying in peat extraction projects (Fig. 1B). In a few cases, a part of the total project area was surveyed by territory mapping, and line transects were placed elsewhere within the area. Wind farm projects often combined different survey methods; applied territory mapping of breeding birds in part of the project area or territory mapping for only particular bird species were combined with line transects or point counts (Fig. 1B). Point counts and other surveys, such as separate surveys for special groups or nest or brood counts of waterbirds, were conducted in a minority of peat extraction projects but were more common in wind farm projects.

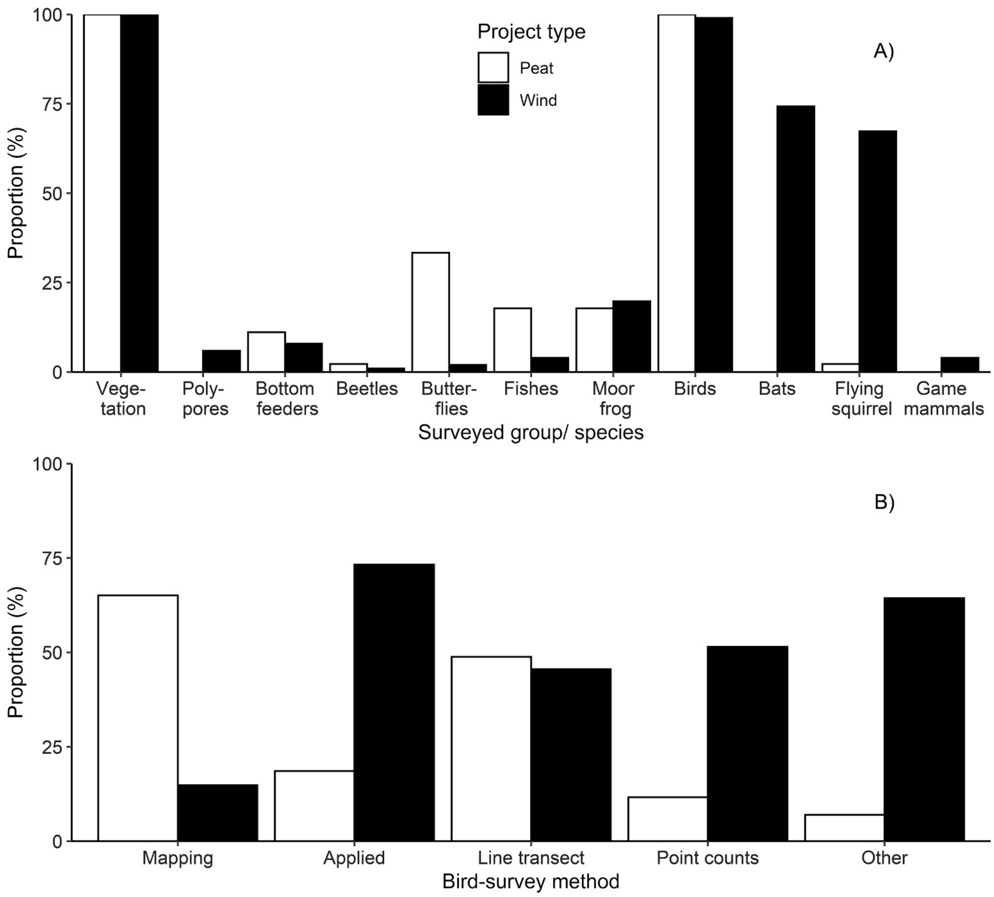

Fig. 1. Surveyed groups or particular species and breeding bird survey methods of a set of EIA projects in Finland in 1995–2016. A) Proportions of peat extraction ($n = 45$) and wind farm ($n = 101$) projects that conducted surveys for particular organismal groups or species of conservation concern based on the EIA statements. B) Proportions of bird survey methods used by the two project types (peat = 43, wind = 101) were as follows: mapping for territory mapping, applied for applied territory mapping where survey focused on part of the area or species or a combination of methods was used, line transect for line transect counting, point counts for point counts, and other for other survey methods or separate surveys for particular groups.

3.2. Adequacy of EIS in terms of biodiversity surveying

According to the 156 EIS reviews by the liaison authorities, most EIA projects sufficiently filled the EIA Decree requirements concerning surveyed biodiversity (see appendices 1 and 2 for peat extraction and wind farm projects, respectively). Despite being rated as sufficient, some supplementation was required at a later stage of project development, e.g. at the time of the environmental permission procedure. The EISs of three (6.3%) out of 48 reviewed peat extraction projects were evaluated as being substantially insufficient, and a complemented EIS was required to continue with project development. Each of these three projects also had shortcomings in other aspects than those related to the natural environment, and additionally their EISs had to be complemented by conducting new biodiversity field surveys of the project area that targeted fishes and crabs, EU directive species, and nationally threatened species. Of the 108 wind farm project EIS reviews, four (3.7% of all wind farms) were required to conduct complementation of the EIS for the natural environment. Three of these had to complement the avian impact assessment by clarifying impacts on bird populations and collision risks, by re-estimating impacts on migration, and by conducting complementing surveys in bird foraging areas and on the flights and movements of migrating birds. Other inadequacies were related to impacts on vegetation, other fauna apart for birds, biodiversity, estimated impacts on fishes, bottom dwellers, and sea mammals, and surveys conducted on endangered habitats and species in the EU Habitats Directive Annex IV. Additionally, some areas had not been covered at all by the nature surveys.

3.3. Biodiversity surveys, birds of conservation concern, and the phase of the EIA project

The number of Annex I bird species did not differ between unimplemented and implemented peat extraction projects. In contrast, the number of nationally threatened bird species was significantly lower in implemented peat extraction projects (Table 1). Wind farms in action, under construction, or with accepted planning permission averaged similar numbers of breeding Annex I bird species and nationally threatened species (Table 1).

A total of 10 models were included in the best-approximated set of models explaining the association of biodiversity information to the project phase project (Table 2). Model selection thus involved considerable uncertainty, and none of the models showed significant support in being the best model (Table 2). Out of the 13 original explanatory variables, six were included in the set of best models.

Among the variables included in the top model set, the year that EIA began and project type showed the highest probabilities of being included by the best models (Table 3). The probability of a project being in the implemented phase was negatively related with the year when EIA began for both project types (Fig. 2, Table 3).

3.4. Follow-up biodiversity monitoring

Each peat extraction project that went through an environmental permission procedure and received a positive decision (data on altogether 21 environmental permissions of permitted projects) had a statutory monitoring program controlled by the regional ELY Centre and was related to water usage and emissions to water. Fishes were monitored (according to permit regulations) in all projects. In contrast, biological water monitoring and vegetation monitoring were both required

Table 1
Differences in the numbers of European Union Birds Directive Annex I species (Annex I) and that of nationally threatened bird species (Threatened) in unimplemented (Project phase = 0) and implemented (Project phase = 1) peat extraction and wind farm environmental impact assessment projects in Finland in 1995–2016. Mean and standard deviation (SD), parameter estimate, standard error, *P*-value, and 95% confidence intervals are provided for both project types by the phase and the bird species group. The significance of differences was analyzed using general linear modeling with Poisson error distribution. *P*-value and confidence intervals that show a significant difference in the bird species group by the phase of a project are highlighted in bold.

Project type	Response variable	Project phase	Mean ± SD	Estimate*	Standard error	*P*-value	Confidence intervals
Peat	Annex I	0	4.8 ± 2.3	1.562	0.090	<0.001	1.381, 1.733
		1	5.3 ± 1.9	0.104	0.139	0.451	−0.169, 0.374
	Threatened	0	1.2 ± 1.5	0.208	0.218	0.347	−0.253, 0.607
		1	0.4 ± 0.6	−1.095	0.515	**0.040**	**−2.241, −0.172**
Wind	Annex I	0	9.7 ± 4.6	2.271	0.059	<0.001	2.152, 2.385
		1	10.2 ± 4.4	0.052	0.093	0.556	−0.132, 0.234
	Threatened	0	3.7 ± 2.8	1.212	0.103	<0.001	1.002, 1.408
		1	2.9 ± 2.4	−0.131	0.173	0.450	−0.475, 0.203

* The estimated value of the project in phase 0 (pending, interrupted, or rejected) is the model intercept.

Table 2
A total of ten best-approximated models (until $\Delta AIC_i = 2$) after model selection in explaining the probability of an environmental impact assessment (EIA) project being implemented in relation to the interactions and main effects of the following variables: project type (Type: peat extraction/wind farm), year that EIA began (Year), number of surveyed organismal groups or particular species in the field (Taxa), and the number of species in the European Union Birds Directive Annex I (Annex), and the model with intercept only. Models are ranked according to differences in AIC_c. Akaike weight (w_i) varies between 0 and 1 and describes the probability of a model being the best model (Burnham and Anderson 2002). R^2 is the r-squared adjusted for logistic regression and describes how much variation the model explains.

Model	Variables	ΔAIC_i	w_i	R^2
1	Type + Year x Taxa	0	0.16	0.13
2	Type + Year	0.06	0.16	0.09
3	Type x Year	0.39	0.13	0.11
4	Type + Year + Annex + Taxa x Year	1.12	0.09	0.14
5	Type + Year + Annex	1.26	0.09	0.1
6	Type x Year + Taxa	1.28	0.09	0.12
7	Type x Year + Taxa x Year	1.51	0.08	0.14
8	Type + Year + Taxa	1.54	0.08	0.1
9	Type x Year + Annex	1.75	0.07	0.11
10	Year + Annex	1.8	0.07	0.08
Null	Intercept	6	–	–

Table 3
Model-averaged results of the generalized liner models explaining the probability of peat extraction and wind farm environmental impact assessment (EIA) projects being implemented. Parameter estimates, unconditional standard errors (SE), 95% confidence intervals, and relative variable importance are provided for the standardized variables included in the best-approximated model set in Table 2 (Type = peat extraction/ wind farm project, Year = year that EIA began, Taxa = number of surveyed organismal groups or particular species in the field, Annex = number of species in the European Union Birds Directive Annex I). Relative importance is the sum of the Akaike weights over all models including each variable and represents the probability of a variable being a part of the best model. The effect of the peat extraction project is in the intercept.

Variable	Estimate	SE	Confidence intervals	Relative importance
Intercept	−0.604	0.242	−1.08, −0.13	
Type	1.159	0.667	−0.16, 2.48	0.93
Year	−1.266	0.574	−2.40, −0.13	1.00
Taxa	−0.242	0.404	−1.04, 0.55	0.49
Year x Taxa	0.513	0.911	−1.28, 2.30	0.33
Type x Year	0.492	0.940	−1.36, 2.34	0.36
Annex	0.138	0.309	−0.47, 0.75	0.31

by 5% of projects (Fig. 3). Twenty-one percent of the 43 wind farms permitted, under construction, or in progress reported having conducted follow-up monitoring related to birds. In contrast, both biological water monitoring and fish monitoring were conducted in 2% of cases (Fig. 3). Follow-up monitoring varied for the monitored groups, and post-construction fish monitoring was conducted more often than vegetation, biological water, or bird monitoring. When examining project types separately, follow-up monitoring differed significantly by the monitored groups both within peat extraction ($\chi^2 = 74.4$, df = 3, $p < 0.001$) and wind farm projects ($\chi^2 = 20.5$, df = 3, $p < 0.001$).

Within the nine wind farm projects that monitored avian impacts, five projects (9% of all the permitted wind farms) had a follow-up program that monitored breeding birds (Appendix 3). Three of the projects monitoring breeding birds repeated the bird surveys partly using the same methods as the initial surveys, so that line transects were conducted in the same way as during the EIA phase. Results for these transects are comparable between the EIA phase and post-construction phase, while in two cases either the location of the line transects or the counting methods changed for the follow-up phase. Bird migration was followed throughout the monitoring programs in five wind farm projects (12% of all the permitted wind farms). The duration of the monitoring after the EIA phase varied from two to four years and was two years (in 73% of follow-up cases) in most cases. All avian impact monitoring programs have produced reports presenting their observations, mainly without robust statistical comparisons. The monitoring programs of six wind farms were jointly conducted by one consultancy.

4. Discussion

Our main findings are: i) birds and vegetation were the most field-surveyed groups in the peat extraction and wind farm project EIAs, ii) only a small number of EISs were determined by authorities to be substantially insufficient, iii) neither the number of bird species of international conservation concern nor the surveyed biodiversity associated with which peat extraction and wind farm projects were implemented, but implemented peat extraction sites had less nationally threatened species, and iv) other post-implementation follow-up monitoring except for fishes and fish stocks were uncommon on peat extraction sites.

4.1. Biodiversity surveys in EIS

The EIA projects and their areas evidently vary in general, and each project also considers different impacts on the environment to be significant. However, certain species groups, such as endangered butterflies and beetles, were less studied in the biodiversity surveys during the EIS phase than the more frequently surveyed groups. However, many species in these groups were classified as endangered according to national red-list assessments (Rassi et al. 2001, 2010). Birds and vegetation were the most often surveyed groups. This finding is in line with e.g. earlier observations in the USA and the Netherlands, where well-known and easily visible animals are surveyed more frequently (Atkinson et al. 2000; Knegtering et al. 2005) and in Finland, where the EIA projects in 1995–2001 did not carefully consider the selection of surveyed ecological groups (Söderman 2005). For example, in our case, bottom feeders

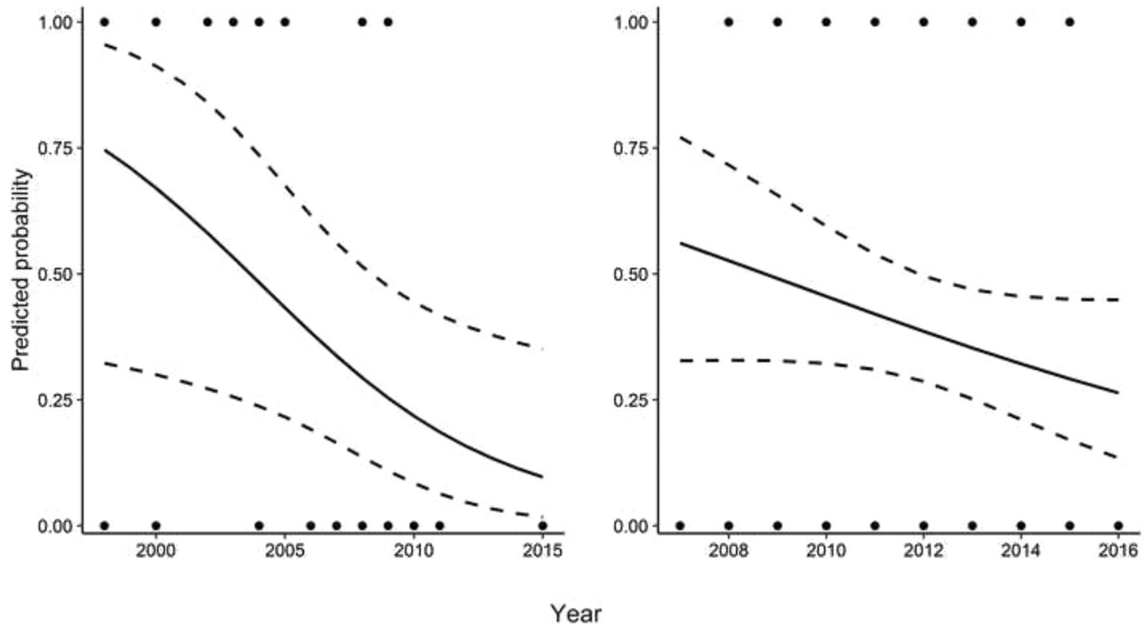

Fig. 2. Predicted probability of the EIA projects by type (peat extraction in the left panel or wind farm in the right panel) to be in the implemented phase in response to the year the EIA began (Year). Predictions are based on model-averaged parameter estimates in Table 3, and variables not seen in the figure are set to their mean values. Dashed lines represent lower and upper limits of 95% confidence intervals, and points show the raw data on implemented (1) and unimplemented (0) projects per each year.

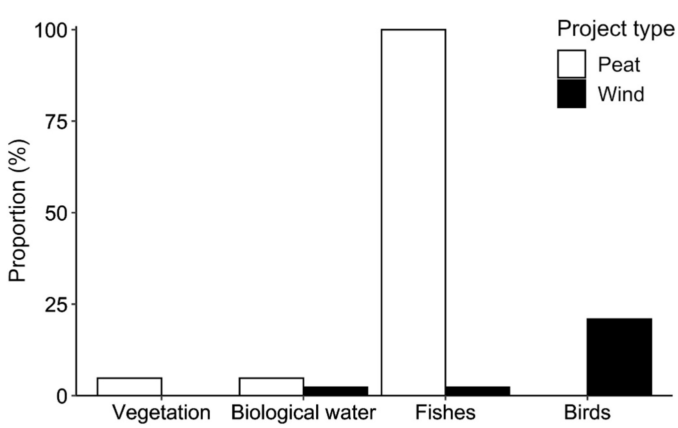

Fig. 3. Post-construction follow-up monitoring in permitted peat extraction ($n = 21$) and wind farm ($n = 43$) projects in Finland in 1998–2015. Bars represent the proportions of four monitored groups by the project type.

and fishes were surveyed in surprisingly few peat extraction projects when considering the negative impacts of peatland drainage on species dependent on moist and aquatic environments (Carroll et al. 2011). Peat extraction is globally relatively restricted, and Finland has been one of the largest peat energy producers in Europe (European Union 2019). International comparisons of EIA peat extraction projects are therefore scarce. On the other hand, wind farm EIAs are globally more common, and the quality of the information provided by the EISs have shown national variation, with the UK and Germany producing high-quality EIAs (Phylip-Jones and Fischer 2013), while improvements are needed in Spain (Salvador et al. 2018). Finnish standards appear relatively high, for example concerning the impacts of wind farms on bats, as 75% of the case studies conducted field surveys on bats compared with the sampled EIAs in the USA (46%) (Chang et al. 2013).

According to guidance materials for conducting biodiversity surveys in EIA and zoning projects in Finland (Söderman 2003), the numbers of territories for bird species breeding in an area should be prioritized when assessing avian impacts, using standardized methods developed for bird monitoring (Koskimies and Väisänen 1988). The projects in our data used several, mostly standardized methods for bird surveys. Our EIS data showed that when breeding birds were surveyed using territory mapping, the number of counting rounds was rarely high enough to produce reliable breeding pair number estimates (less than 10% of our cases filled the criteria in Söderman 2003, which recommends 3–5 mapping rounds). Despite this, Finnish EIA practitioners have generally considered field-survey data to be good in quality (Jalava et al. 2010). Whereas in the USA, pre-construction bird surveys were considered insufficient in altogether 60% of cases (Chang et al. 2013).

4.2. Adequacy of the biodiversity surveys reviewed by liaison authorities

Interviewed Finnish EIA authorities considered the EIS environmental descriptions to be of high quality (Jalava et al. 2010), which is in line with the observation that only a few EISs in our data were determined to be insufficient regarding their biodiversity surveys to the point where the EIS phase had to be complemented and reaccepted by the liaison authority before project development could continue or environmental permissions could be applied for. Nonetheless, surprisingly many requests were made for non-compulsory complementing biodiversity surveys. Finnish authorities meet and discuss with the EIA consultants and comment on the drafts of EIA documents throughout the procedure, so they have the possibility to affect the ecological survey design and its quality before the EIS phase. Also, comments from other stakeholders, such as the general public and municipalities, must be addressed in the EIA review. While liaison authorities may fail in assessing EIS legitimacy (Pölönen 2006), Finnish court rulings show that a high weight is given to the opinion of the liaison authority regarding EIS adequacy (Pölönen et al. 2011). Quality control procedures generally vary nationally (Lyhne et al., 2016; Günther et al., 2017), although EU countries follow Directive guidelines for reviewing. Provisions for quality control have been historically very strong for example in the Netherlands, where EISs are reviewed by a separate EIA Commission, but despite this leading to a more appropriate scope of EISs, the substantive outcomes do not necessarily increase (Lyhne et al., 2016). On the other hand, market-based mechanisms targeted at EIA professionals could provide additional quality control especially in mature EIA systems (Bond et al. 2017).

4.3. Implementation of the EIA projects

We found weak support that the numbers of breeding bird species of conservation concern in the EU have a definite impact on the decision to implement peat extraction or wind farm projects. However, we also found that the number of nationally threatened bird species was lower in implemented peat extraction projects. Such a connection was not observed in the wind farm projects. This result indicates that national lists of conservation concerns may have more importance than international ones (Moilanen and Arponen 2011), at least in relatively small-scale EIA projects such as peat extraction projects. Peat extraction and wind farm projects may differ from each other because in addition to breeding birds, migratory birds are also often considered significant on wind farm sites (Hüppop et al. 2006; Santangeli et al. 2018, but see Pearce-Higgings et al., 2012), but they are not typically surveyed in peat extraction areas (personal observation based on EISs).

Our findings do not support either of our hypotheses that the number of surveyed taxa may influence project implementation. This finding could mean that each project area is a case study of its own, where the number of surveyed taxa needs to be decided based on the special features of the site. Therefore, more information of local conditions is required to evaluate this question more thoroughly. We also found that EIA projects that began earlier had a higher probability of being implemented, which may mean that application criteria have become stricter or that the implementation process of projects that began later is currently not ready. An overall decreasing trend in EIAs is visible in Finland since 2007, particularly for peat extraction areas (Statistics Finland 2012). According to the national climate and energy strategy of 2013, the use of peat for energy will decrease (Ministry of the Employment and the Economy 2013). This fact may also have decreased the number of permits granted to peat extraction projects. The visible trend in the development of wind farm projects may be related to political considerations but also to the relatively long land-use planning phase and possible appeals (an EIA together with the master plan runs from one to three years). Local residents' attitudes and the level of participatory planning may influence the decisions made by the planning authority and the success of the wind energy project (Loring 2007). Moreover, decision-making related to the EIA is complicated and not purely rational (Owens et al. 2004), and decisions relate not only to political considerations but also associate with the values and aims of decision-makers and their behavior in the EIA (Leknes 2001; Bond et al. 2016). Decision-making related to project EIAs is often made at local scales in relation to local land-use planning and is therefore relatively separate from the EIA process (e.g. in Finland see Pölönen et al. 2011). Measuring whether an EIA manages to reduce environmental impacts is nearly impossible due to its counter-factuality (Loomis and Dziedzic, 2018). Identifying the impacts of EIA projects and separating them from impacts caused by other factors is difficult (Pölönen et al. 2011). As many groups take part in the decision-making of EIA projects understanding what is actually causing the project to be approved or rejected is also challenging (Bond et al. 2016).

Our analysis of project implementation is limited because we conceptually simplified the association with decision-making to a binary outcome of implementation or not. We neither accounted for mitigation nor that projects could have been modified during the course of implementation (Barker and Wood 1999), and a more environmentally friendly alternative could have been chosen for further development and implementation. For example, even though environmental and biodiversity information have rarely been directly related to consent decisions, the EIA may have indirect outcomes (Jay et al. 2007). EISs have also been considered e.g. increasing the availability of information concerning the environmental consequences of a project (Blackmore et al. 1997; Wood and Jones 1997). It is also possible that impacts on bird species of conservation concern were not assessed as significant for projects in our data. Thus, they did not associate with overall project implementation.

4.4. Biodiversity information in the follow-up monitoring

From the conservation viewpoint, it is also important to know how implementation affects nature values. Question-driven biodiversity monitoring with scientific aims that exceeds over various project phases is crucial for understanding how development projects affect species (Marshall et al. 2005; Lindenmayer and Likens, 2010). Our findings suggest that follow-up monitoring is rare and not always comparable with earlier surveys. Approximately one-fifth of all completed projects have conducted follow-up bird monitoring. Mining projects in Brazil monitored birds with a similar frequency (Dias et al. 2019). As a comparison, the follow-up monitoring of fauna (including birds) was conducted in only 10% of cases when looking at 50 Finnish EIA road projects in 1994–2007 (Jalava et al. 2015), and this study showed that Finnish peat extraction projects generally do not monitor other fauna apart for mandatory groups. Thus, significant improvements in monitoring efforts are needed in these sectors.

The survey methods of avian impact monitoring on wind farms were not consistent in every project over the monitoring period. More careful planning and guidance, along with discussions between scientists and project management, are needed to build appropriate study questions and hypotheses, and to ensure that results are comparable between study periods and that analyzing the impacts of wind farms on birds is robust (Lindenmayer and Likens, 2010). Monitoring duration depends on the monitored group and question. In our cases, bird monitoring on wind farms varied from two to four years, which is a relatively short time for observing long-term changes in bird populations but should be long enough to reveal immediate short-term impacts.

5. Conclusions

Despite the general quality of biodiversity impact assessments increasing, our results indicate that room for improvement still remains. Based on our results, we conclude that (1) projects do not carefully follow survey recommendations and for example only repeat breeding bird surveys over one breeding season to gain the most reliable population estimates. (2) Although we found evidence that nationally threatened species may influence the decision to implement a project, the effect of biodiversity values continues to be difficult to address and show in the decision-making of EIA projects. We also call for further investigation of which factors actually cause a project to be approved or rejected. (3) More emphasis should be given to the design of biodiversity monitoring programs, including follow-ups together with scientists, project operators, and consultancies, which typically perform the monitoring. This would result in high-quality biodiversity monitoring and learning from the EIA. Evaluation of the impacts occurring would be important, not only for biodiversity conservation, but such measures will also be needed if biodiversity offsetting becomes a more common practice in land-use projects in the future (Moilanen and Kotiaho 2018).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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