Contemporary mature forest cover does not explain the persistence of Capercaillie (Tetrao urogallus) lekking areas in Finland

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Capercaillie (Tetrao urogallus) has traditionally been considered an old forest-dependent species. The lekking sites especially, were thought to be located in older forests. We studied the persistence of Capercaillie lekking areas in relation to mature forest cover at three study areas in Finland (southwestern, SW; central, CE; and northern, NO). A total of 381 leks were inspected twice at intervals of 10–30 years and were classified as either persisting or vacated. We defined mature forest as forest with > 152 m$^3$ha$^{-1}$ of timber (SW and CE Finland) or > 68 m$^3$ha$^{-1}$ of timber (NO Finland). We measured mature-forest cover within two radii around the leks (1,000 and 3,000 m) using satellite image-based forest inventories, and performed logistic regression analyses on these data. We did not find significant trends between mature-forest cover and lekking-area persistence in any of the study areas. However, the proportion of mature forests may have already been too low to detect the significance of this factor. The only significant factor affecting the lekking-site persistence was time lag between surveys. The positive relationship between the time lag and lekking-site persistence in CE and NO Finland may be due to the partial recovery of the landscapes in terms of forest regrowth, from extensive clear-cut harvesting in the 1950s and 1960s. In SW Finland, the relationship was negative, possibly indicating more permanent changes in the landscape that is currently characterized by human settlements and agricultural areas. We conclude that in present-day Finland, the area covered by mature forest is most likely too scarce to explain the lekking-area persistence of Capercaillie. An alternative explanation is that some important structural characteristics are missing from the current mature forests.
1. Introduction

Large-scale loss and fragmentation of old-growth forests have been generally acknowledged as driving forces behind the declines of many boreal-forest bird species (e.g., Virkkala 1990, Hansson 1992, Schmiegelow et al. 1997). Also, for Capercaillie (Tetrao urogallus), changes in forested habitats have been among the most important causes of its population decline in Finland and elsewhere (e.g., Lindén & Rajala 1981, Lakka & Kouki 2009, Storch 2000; but see Sirkiä et al. 2010a).

Capercaillie has long been considered a species associated with old forests (e.g., Valkeajärvi & Ijäs 1986, Storch 1993, Swenson & Angelstam 1993; but see Seiskari 1962). Males especially have been reported to prefer large forested areas with average tree age older than 60–70 years for their traditional lekking sites (Rolstad & Wegge 1987a, 1989a). In 1985 in Northern Finland, nearly 70 Capercaillie lekking sites were inventoried, and these leks were located in forests on average older than 120 years (Helle et al. 1989). However, since then, new lekking sites have been found in relatively young forests (Miettinen et al. 2005, Rolstad et al. 2007, Valkeajärvi et al. 2007), suggesting that fairly young forest stands (age at least 30–40 years) can be suitable habitat for Capercaillie and its lekking sites in managed boreal forests (see also Miettinen et al. 2008, 2010).

Capercaillie lekking areas consist of a lekking site and the surrounding daytime home ranges (daily territories) of males (Wegge & Larsen 1987). The minimum size for a lekking area, including the daily territory, is 300 hectares (Wegge & Larsen 1987). Landscape-level investigation is required to study phenomena affecting lekking areas because larger-scale landscape structure affects Capercaillie leks (e.g., Lindén & Pasanen 1987, Helle et al. 1994, Miettinen et al. 2005).

In addition to forest cover, grain size of the landscape mosaic is one of the major determinants of the viability of Capercaillie lekking population (Rolstad & Wegge 1987b, Rolstad & Wegge 1989a). Grain size is defined here as the average size of mosaic patches relative to home ranges or movement patterns of organisms (Rolstad & Wegge 1989b and references therein). In the present study, we aimed to discover the effects of mature forest cover and fragmentation on the persistence of Capercaillie lekking areas (for a definition, see above). We assumed mosaic-like, positive effects of fragmentation, mainly because a landscape that consists of many small patches can satisfy the year-round habitat requirements of a species more readily than a more homogeneous landscape (e.g., Helle et al. 1994). Management-wise, it is important to know exactly which forest-age or development classes are the most important for the lekking areas of Capercaillie, and whether the configuration of the focal habitat, in addition to the amount, should also be considered. As species responses to landscape-level phenomena depend on the spatial scale (e.g., Fuhlendorf et al. 2002), we studied the relationship between lekking-area persistence and mature forests at two spatial scales: 1,000 and 3,000 m radii.

2. Material and methods

All material and methods are described in detail in Sirkiä et al. (2011).

2.1. Lekking-area occupancy data

Altogether 381 lekking sites were surveyed in three study areas situated in (1) South-western (SW, N = 55), (2) Central (CE, N = 238) and (3) Northern Finland (NO, N = 88; see Sirkiä et al. 2011 for a map). Leks were inspected twice, first during 1970–1992, and again during 2000–2005 (Sirkiä et al. 2011). The minimum time lag between the surveys varied from 10 to 32 years (Table 1). In both surveys, the sites were visited during the lekking season in March–May, and seen/heard Capercaillie individuals, snow tracks or fresh excrements were all interpreted as an occupied lekking area. We classified the occupancy data according to the distance between the leks of the old and new survey. We classified the old and new leks that were > 1,000 m apart as persisting leks (see Rolstad & Wegge 1989a), whereas sites with old leks > 1000 m apart from new leks were considered vacated. The remaining group of leks (new leks > 1,000 m away from the old ones) could contain leks that were already in use in 1970–1992 but were missed by the surveyors. Thus, we omitted this category of leks from statistical analyses. The proportion of vacated leks was 29, 84 and...
22% in SW, CE and NO Finland, respectively, in total being 62% (236 out of 381 leks).

2.2. Landscape data

The landscape data were derived from multi-source national forest inventories (MS–NFI, Tomppo et al. 2008). MS–NFI exploits Landsat TM 5 satellite images and ground reference plots to yield geographically explicit information of forest resources. The satellite images from SW, CE and NO Finland originate from 1998, 1996 and 2002–2003, respectively. Following the procedure described in Sirkiä et al. (2011), we classified the landscape data simply as “habitat” and “matrix”, so that the former included all the forest pixels (size of 25 m × 25 m) having volume of timber above a specific threshold (see next paragraph), and the latter included all the other areas, such as roads, inhabited areas, fields, and water, as well as forests with timber volume below the threshold.

In SW and CE Finland, forested areas with timber volume > 152 m$^3$ha$^{-1}$ were classified as habitat, whereas forested areas with timber volume ≤ 152 m$^3$ha$^{-1}$ were classified, along with non-forested areas, as matrix habitat. In NO Finland, however, the timber-volume threshold was 68 m$^3$ha$^{-1}$, reflecting the lower soil productivity in NO Finland and the consequent slower yearly increment in timber volume. These criteria fall in the middle of the average timber volumes of young and advanced thinning forests, defining the threshold towards older forest stands (Tomppo et al. 1998). “Habitat” thus always included advanced thinning stands and older, i.e., forests older than 51–70 years (hereafter referred to as “mature forest”, i.e., closed-canopy forests with some timber-sized trees; diameter at 1.3 m height > 17 cm; Peltola 2003).

We calculated landscape predictors around Capercaillie leks separately for two spatial scales with FRAGSTATS (McGarical & Marks 1995). The first spatial scale, a circle with a radius of 1,000 m from the central point of a lek, covered the whole lekking area (314 ha; e.g., Wegge & Larsen 1987). The second spatial scale, a circle with a radius of 3,000 m, represented the landscape context in which the lekking areas were embedded (covering 2,827 ha). Using large spatial scales (hundreds of hectares) decreases the standard error of the selected timber-volume estimates to approx. 10–20% (Tokola & Heikkilä 1997). We calculated the following indices: mature-forest cover (% of forest > 152 m$^3$ha$^{-1}$ for SW and CE Finland, > 68 m$^3$ha$^{-1}$ for NO Finland), PD = patch density (# per 100 ha), MPS = mean patch size (ha), TE = total edge (km), TIME = the minimum estimated time interval between the two lekking site surveys (years).

2.3. Fragmentation index and statistical models

We used a correlation-based Principal Component Analysis (Proc PRINCOMP, SAS 9.2) for both
spatial scales separately to obtain a fragmentation index from MPS, PD and TE (Trzcinski et al. 1999, Sirkiä et al. 2011). All correlations between MPS, PD and TE were significant at \( P < 0.0001 \), except for the correlation between PD and TE, which was non-significant (\( P > 0.05 \)) at both spatial scales. The first two components explained over 90% of variation at both spatial scales. However, PC 1 reflected mostly MPS, accompanied with increasing TE and decreasing PD (Table 2). In contrast, as PC 2 increased, PD and TE increased whereas MPS remained near zero, being slightly negative at 1,000-m spatial scale and slightly positive at 3,000-m spatial scale (Table 2). Thus, neither PC 1 nor PC 2 ultimately embodied the simultaneous effects of fragmentation, i.e., decreasing MPS together with increasing PD and TE (Trzcinski et al. 1999, Sirkiä et al. 2011). Moreover, the relationship between PC 2 and mature-forest cover was significantly positive at both spatial scales (Fig. 1; compare to figure 2 in Sirkiä et al. 2011). We thus concluded that a reliable measure of fragmentation using MPS, PD and TE in the PC analysis could not be created with our data. Hence, these variables were not used in further modelling.

To analyze the relationship between mature-forest cover and lekking-area persistence, we used logistic regression models (Proc GENMOD, SAS 9.2) with the dependent variable, lek, modelled binomially as persisting or vacated using a logit link function and forest cover (COVER) and the estimated minimum time lag between the lekking-site surveys (TIME) treated as independent variables. The modelling was conducted for each study area (\( N = 55, 238 \) and 88 for SW, CE and NO Finland, respectively) and for both spatial scales (1,000 and 3,000 m) separately.

### 3. Results

We found no significant effects of mature (> 152 \( m^3 ha^{-1} \) of timber for SW and CE Finland, and > 68 \( m^3 ha^{-1} \) of timber for NO Finland) forest cover on the persistence of Capercaillie lekking areas in any of the study areas, regardless of spatial scale (Table 3). Only the variable TIME, i.e., the minimum time interval between the lekking-site surveys, was significantly related to the persistence of lekking

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**Table 2. Principal component loadings for the indices representing mature-forest fragmentation, at 1,000 and 3,000 m radius surrounding lekking sites of Capercaillie (\( N = 381 \)).**

<table>
<thead>
<tr>
<th>Radius (m)</th>
<th>Indices</th>
<th>PC1</th>
<th>PC2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>Mean patch size</td>
<td>0.71</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>Patch density</td>
<td>-0.63</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>Total edge</td>
<td>0.33</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>% of variation explained</td>
<td>61</td>
<td>33</td>
</tr>
<tr>
<td>3,000</td>
<td>Mean patch size</td>
<td>0.72</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>Patch density</td>
<td>-0.65</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>Total edge</td>
<td>0.25</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>% of variation explained</td>
<td>61</td>
<td>35</td>
</tr>
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</table>

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**Fig. 1.** The relationship between the second principal component (PC 2) and the percentage of mature forest cover (> 152 \( m^3 ha^{-1} \) of timber for SW and CE Finland, and > 68 \( m^3 ha^{-1} \) of timber for NO Finland) at 3,000 m spatial scale surrounding the lekking sites (\( N = 381, r = 0.55, P < 0.0001 \)).
areas, with a positive relationship in CE and NO Finland, and a negative one in SW Finland (Table 3). We evaluated the goodness-of-fit of the models first by examining at the mean deviance, i.e., the ratio of deviance to its degrees of freedom (approx. 1 in a satisfactory model; Collett 2003). We found that the goodness-of-fit peaked for the models of SW and NO Finland (Table 3). In the model for CE Finland there seemed to be underdispersion, probably at least partly caused by the large proportion of zeros in CE Finland data (82%). Secondly, we calculated the Hosmer-Lemeshow statistics for each model (a measure goodness-of-fit of a model for ungrouped binary data; Collett 2003, Agresti 2007) and found that according to these statistics all the fitted models were satisfactory. Finally, we also tested if modelling all the study areas together \((N = 381)\) with study area as a categorical variable would change the results, but did not detect significant effects of mature-forest cover (results not shown; see also Sirkiä et al. 2011). When examining descriptive statistics for the surroundings of lekking sites, we found that mature-forest cover was low in all study areas (median between 21–27%; Table 1) and also variation in mean patch size (MPS) was only some tens of pixels (one pixel = 25 m × 25 m, i.e., 0.0625 ha; Table 1). Thus, mature-forest areas tended to be small and scattered in the studied landscapes.

4. Discussion

4.1. Effect of mature-forest area

The area of mature forests was not among the major determinants of Capercaillie lekking-site persistence in managed boreal forests in Finland, at least in the three studied landscapes (see also Sirkiä et al. 2010a). Our results match those of Miettinen et al. (2008), who found that the amount of mature forest was either not significantly associated with Capercaillie density, or the relationship was negative. However, their study was conducted in a grid of 50 km × 50 km, which probably affected variation in the amount of mature and other forest stands. Miettinen et al. (2005) concluded earlier that mature forests (> 100 m\(^3\) ha\(^{-1}\), age typically 30–90 years) were actually more abundant near lekking sites in eastern Finland, compared to “average” landscapes. Their main conclusion, however, was that lek size (number of males) was mostly affected by the area of thinning stands (36–100 m\(^3\) ha\(^{-1}\)).

In managed boreal forests of present-day Fin-

<table>
<thead>
<tr>
<th>Area</th>
<th>Radius (m)</th>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>(\chi^2)</th>
<th>(P)</th>
<th>Dev/DF</th>
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<td>2.225</td>
<td>6.66</td>
<td>0.010</td>
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<tr>
<td></td>
<td></td>
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<td>0.65</td>
<td>0.420</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td>0.107</td>
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<tr>
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<td>0.220</td>
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<td>0.060</td>
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<td></td>
</tr>
<tr>
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</tr>
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<td>0.18</td>
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<td>7.103</td>
<td>38.04</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td>0.002</td>
<td>0.030</td>
<td>0.00</td>
<td>0.954</td>
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</tr>
<tr>
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<td></td>
<td>TIME</td>
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<tr>
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<td></td>
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<td>0.00</td>
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<tr>
<td></td>
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<td>TIME</td>
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</table>
land, the overall forest cover seems to explain Capercaillie presence better than older forest classes (e.g., Miettinen et al. 2008, Sirkiä et al. 2011). By referring to “overall forest cover” we mean all timber-volume classes from young thinning forest upwards, that is, roughly > 60 m$^3$ha$^{-1}$ of timber in the southern half of Finland, and > 30 m$^3$ha$^{-1}$ of timber in the northern half of Finland (age approximately > 30–40 years). As suggested by Rolstad et al. (2007), leks observed in present mature forests might have been established decades ago when these stands were younger, but stands regenerated in the era of modern forestry (starting around 1940s) have until now been too young for Capercaillie. Comparison of the habitat use of Capercaillie in the 1980s and 1990s with that in the beginning of 2000s confirm this kind of change in Capercaillie habitat use during a relatively short period (Miettinen et al. 2009). Miettinen et al. (2009) concluded that Capercaillie habitats in northern Finland (at 800-m spatial scale) were still rich in mature forest (diameter at 1.3 m height 24–40 cm) in 1989–1992, but not in 2000–2003. Younger forests might not be optimal for Capercaillie, but rather the best available in the modern landscape, because older forest areas have become too small, especially for Capercaillie leks (Mykrä et al. 2000, Miettinen et al. 2005). For instance, Mykrä et al. (2000) concluded that in northeast Finland, only 8% of randomly-located 1,257-ha landscapes included enough mature (> 100 m$^3$ha$^{-1}$) forest for a viable Capercaillie lek (defined as an area of 300 ha). Thus, the overall size of a given forest area might be more important than forest age or tree-species composition, especially when considering the spatial requirements of the lekking sites (Lindén & Pasanen 1987, Helle et al. 1994, Sirkiä et al. 2011).

Habitat selection of a species is scale-dependent (e.g., Fuhlendorf et al. 2002). Therefore, we may not have been able to detect a significant connection between the mature-forest proportion and lekking-site persistence, because our analyses may have operated at spatial scales not relevant to Capercaillie leks. For instance, Virkkala and Rajasärkkä (2006) found that Capercaillie densities in northern Finland were nearly an order of magnitude higher in old-forest areas (size 40–120 km$^2$, forest age > 100 years, timber volume 150–195 m$^3$ha$^{-1}$) compared to the surrounding managed forest. Thus, by including an even larger radius than 3,000 m (covering 28 km$^2$) our results may have changed. Similarly, it is possible (albeit unlikely) that searching for a relationship between mature forests and lekking-site persistence at a forest-stand scale, a radius of a few hundred meters, would have yielded different results. However, several recent studies suggest a weak or non-existing relationship between mature forests and Capercaillie response (occurrence of a lekking site or density; e.g., Rolstad et al. 2007, Miettinen et al. 2008, 2010, Sirkiä et al. 2010a, 2010b, Wegge & Rolstad 2011). All these papers studied the phenomenon using different spatial (and temporal) scales, some covering areas up to several thousands of square kilometers (e.g., Sirkiä et al. 2010b).

There is seemingly something more general behind the weak relationship between mature or old forests and Capercaillie occurrence. Besides the overall size of the forest area, found to be important by Virkkala and Rajasärkkä (2006), one explanation could be connected to the structural variability inside mature-forest stands. Modern-day mature forests may not resemble natural-like old forests, because some important structural characteristics are missing (Miettinen et al. 2009, 2010). From the satellite-image-based data it is impossible to account for the amount of horizontal cover, the quality and quantity of food (see also Lakka & Kouki 2009) or other stand characteristics that may be important for the species. Thus, although the growing-stock volume of Finnish forests has continuously increased in Finland since the 1960s (e.g., Peltola 2003), we cannot be certain if the quality of the current mature forest stands corresponds to that needed for the long-term viability of Capercaillie and their lekking sites.

4.2. Effect of time lag between surveys

Capercaillie males spend a large proportion of their year near lekking sites (Wegge & Larsen 1987). The males are also faithful to the same lekking site year after year, and according to a forest-cutting experiment, lek populations are relatively tolerant to disturbances (Rolstad & Wegge 1989c). Moving the lekking centre from a forest patch to another may be regarded as an adaptation
to disturbances, natural or human-caused (Rolstad & Wegge 1989c, Rolstad et al. 2007, Valkeajärvi et al. 2007). These aspects make it probable that there is a time lag between the diminishing amount of mature forests (caused by logging) and lekking-site extinction (e.g., Wiens & Rotenberry 1985, Ewers & Didham 2006). Indeed, with separate models for the three study areas we found significant effects of the estimated minimum time period between the surveys, both negative (for SW Finland) and positive (for CE and NO Finland).

Although significant, the factor describing time lag contains many uncertainties and must therefore be interpreted with caution. To quantify the precise duration of lekking-site persistence it would have been necessary to survey the leks more frequently, i.e., each year. However, acknowledging constraints in the interpretation of our results, we can still hypothesize that there are major differences between the landscapes of southernmost Finland and those in central and northern Finland. The positive relationship between the time lag and lekking-site persistence in CE and NO Finland might be due to the partial recovery of the landscapes in terms of forest regrowth to the vast areas that had been clear-cut harvested in the 1950s and 1960s (Miettinen et al. 2008). In SW Finland, however, human land-use is dominated by settlements and agricultural areas, making these parts of the landscape more or less permanently unavailable for lekking Capercaillie (Lindén & Pasanen 1987, Helle et al. 1994, Lindén et al. 2000). Thus, the longer the time period between the surveys, the more likely it is to find a lekking site to have become vacated in SW Finland.

4.3. Effect of fragmentation?

Technical reasons for us not being able to establish a reliable measure of fragmentation might partially depend on the landscape data used. Firstly, forest estimates derived from satellite images are not accurate at the level of a single pixel (25 m × 25 m in our data; Tokola & Heikkilä 1997), which causes adjacent pixels to be erroneously classified as different habitat. Secondly, the division of pixels according to some threshold (e.g., > 152 m² ha⁻¹ and ≤ 152 m² ha⁻¹) yields a similar effect: gradients of forest age are artificially defined as separate habitat patches, despite not being perceived as such by Capercaillie (Miettinen et al. 2005, Sirkiä et al. 2011). Distortion caused by either one or both of these factors leads to an increasing amount of edge along with increasing mean patch size (as with the PC 1 in our analyses; Table 2). Hence, we could not obtain a fragmentation index independent of forest cover as described in Trzcinski et al. (1999). This problem suggests that the means whereby habitat quality is quantified should be considered carefully in future studies of habitat cover and fragmentation.

Moreover, if it had been possible to include a whole range of landscapes, i.e., also those with more than 54% of mature (> 68 m³ ha⁻¹) forest cover into the analysis (see NO Finland in Table 1), a more reliable fragmentation index could probably have been calculated (e.g., Sirkiä et al. 2011). Cooper and Walters (2002) experienced similar problems in using PC analysis to create a fragmentation index, and concluded that the degree to which fragmentation could be separated from the effects of habitat cover depended on the amount of cover at a particular scale. But also the resolution of landscape data, in relation to grain size perceived by species, should be considered to avoid misinterpretations caused merely by technical or qualitative properties of the data. Thus, the extent of the focal habitat, the grain size of fragmentation in relation to spatial requirements of the focal species, and the resolution of the landscape data probably all influenced our results. It is important to note that we cannot exclude the possibility that the fragmentation of mature forests affects Capercaillie lekking-site persistence, and that there are several other options for measuring fragmentation that are not dealt with here.

4.4. Conclusions

Modern forestry has apparently caused major changes both in the small-scale structure of forests (e.g., cover and food provided by the multi-layered forest structure) and in the large-scale availability of forest habitats and their configuration (e.g., Hansson 1992, Mykrä et al. 2000, Miettinen et al. 2009). How well the Capercaillie really is adapted to younger forests is a question that in our opinion still needs to be resolved, both by taking
into consideration lekking-site viability and by examining life-history stages (see also Sirkiä et al. 2010a). In present-day Finland, however, the task is challenging, because the overall amount of mature forest (particularly natural-like mature forest) is so small. Management-wise, the overall forest cover (young thinning forest and older) should be maintained at high level especially within the larger landscape surrounding known lekking sites (e.g., Helle et al. 1994, Sirkiä et al. 2011). Another priority would be to enhance the structural variability of forest stands within large forested areas (Miettinen et al. 2010, Sirkiä et al. 2011).

Vanhan metsän määrä ei selitä metson soidinalueiden säilymistä nyky-Suomessa

Metso (Tetrao urogallus) on perinteisesti tunnettu vanhasta metsästä riippuvaisena lajina; lajin soidinpaitat sijaitsivat pääosin vanhoissa metsissä. Selvitimme, miten vanhan (kuutiotilavuus > 68 m$^3$ ha$^{-1}$ Pohjois-Suomessa ja > 152 m$^3$ ha$^{-1}$ Varsinais- ja Keski-Suomessa) metsän määrä on yhteydessä metson soidinalueiden säilymiseen Suomessa.

Yhteensä 381 soidinpäkkää tarkastettiin kahteen otteeseen 10–32 vuoden välein, ja luokiteltiin tarkastusten perusteella säilyneiksi tai hylätyiksi. Vanhan metsän osuus mitattiin satelliittihavaintoihin perustuvan metsien inventointiaineistoa käyttäen 1 000 ja 3 000 m säteellä soidinten ympärillä. Aineisto analysoitiin logistisella regressioanalyysillä. Vanhan metsän määrän ja soidinalueiden säilymisen väliltä ei löytynyt merkitsevää yhteyttä yhdelläkään kolmesta tutkimusalueesta. Vanhan metsän osuus maisemassa oli kuitenkin alhainen, mikä saattoi hankaloittaa yhteyden havaitsemista. Myös muut tekijät, joita ei mitattu (kuten metsän sisärajan), saattoivat vaikuttaa tuloksiin.

Ainoastaan soidintarkastusten aikavälillä oli merkitsevä yhteys soidinalueiden säilymiseen. Pohjois- ja Keski-Suomessa soidin säilyi sitä todennäköisemmin, mitä kauemminkin aikaa tarkastusten välillä oli kulunut. Varsinais-Suomessa puolestakin soidin oli sitä todennäköisemmin hylätty, mitä pidempi tarkastusten aikaväli oli. On mahdollista, että soidinmaisema on metsäisemmillä alueilla Pohjois- ja Keski-Suomessa ennättänyt palautua laajempien avohakkuiden ajoista, kun taas eteläisimmässä Suomessa maiseman muutokset ovat pysyväämpiä, mm. ihmisasutuksen ja peltoisuuden aiheuttamia.

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