The effect of human-modified landscape structure on forest grouse broods in two landscape types

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The population sizes and the breeding success of Finnish tetraonids have been decreasing for decades. In this study, the presence of a grouse hen with a brood in a landscape was used to indicate habitat-related breeding success. We combined the locations of 938 black grouse (*Tetrao tetrix*), 388 capercaillie (*T. urogallus*), and 917 hazel grouse (*Tetrastes bonasia*) broods after the breeding season in mid-August with landscape data by employing Geographic Information Systems (GIS) and grouse data derived from the Finnish wildlife triangle censuses conducted during 1997–2004. Two large study areas with different landscape structures; northern forest-mire area and southern cultivated area, were selected for the investigation. The presence of grouse broods was strongly related to the amount of old coniferous mixed forest. Grouse broods may prefer this forest habitat because of a rich bilberry field layer offering a diversity of insects as food.

There was no general response to forest fragmentation. The effect of forest fragmentation on the broods' distribution did not increase even with decreasing forest cover. We suggest that there are several ecological causes for the observed spatial correlations. Predation on nests and broods by generalist predators is presumably high in human modified open and semi-open landscapes. Against our expectations, the effect of landscape composition on grouse broods was more marked in the northern than in the southern study area, most likely because predator populations are more food-regulated in the north. This finding supports the alternative-prey hypothesis. Further, large drained and reforested peatland mire areas had a negative impact on grouse broods in the north (analysed separately). In the drainage areas, decreased availability of insect food, increased predation risk, and drowning of chicks in ditches may increase brood mortality.

Table 1. Stepwise multiple logistic regression-based likelihoods for grouse hens with broods in relation to forest habitat variables measured at a radius of 500 m spatial scale.

1. Capercaillie

Independent variables	Coefficient	Std. Error	Wald	df	P
Intercept	-32.772	50.603	.419	1	.517
Year	.014	.025	.327	1	.567
Study area	.088	.211	.175	1	.676
Mixed forest (%)	2.164	.610	12.583	1	.000
Old forest (%)	1.312	.420	9.740	1	.002
Pine forest	1.285	.517	6.184	1	.013
Pine mire (%)	.932	.403	5.334	1	.021
Spruce forest (%)	-6.338	1.744	13.207	1	.000

2. Black grouse

Independent variables	Coefficient	Std. Error	Wald	df	P
Intercept	-19.155	36.073	.282	1	.595
Year	.009	.018	.238	1	.626
Study area	.578	.140	17.138	1	.000
Mixed forest (%)	1.638	.397	17.024	1	.000
Field (%)	-.999	.275	13.156	1	.000
Spruce forest (%)	-4.310	1.098	15.414	1	.000

3. Hazel grouse

Independent variables	Coefficient	Std. Error	Wald	df	P
Intercept	24.670	35.986	.470	1	.493
Year	-.013	.018	.561	1	.454
Study area	.238	.089	7.112	1	.008
Mixed forest (%)	1.249	.424	8.653	1	.003
Old forest (%)	1.373	.263	27.237	1	.000
Open mire (%)	-1.263	.455	7.721	1	.005

Table 2. Coefficients for open habitat (LOSS), forest fragmentation (FRAG), and their interaction in each multiple logistic regression on forest grouse hens with broods.

Species	LOSS	FRAG	Interaction
Capercaillie	-0.024**	-0.206	0.005
Black grouse	-0.021***	-0.097	-0.004
Hazel grouse	-0.016***	0.027	0.011
Grouse total	-0.017***	-0.077	0.006

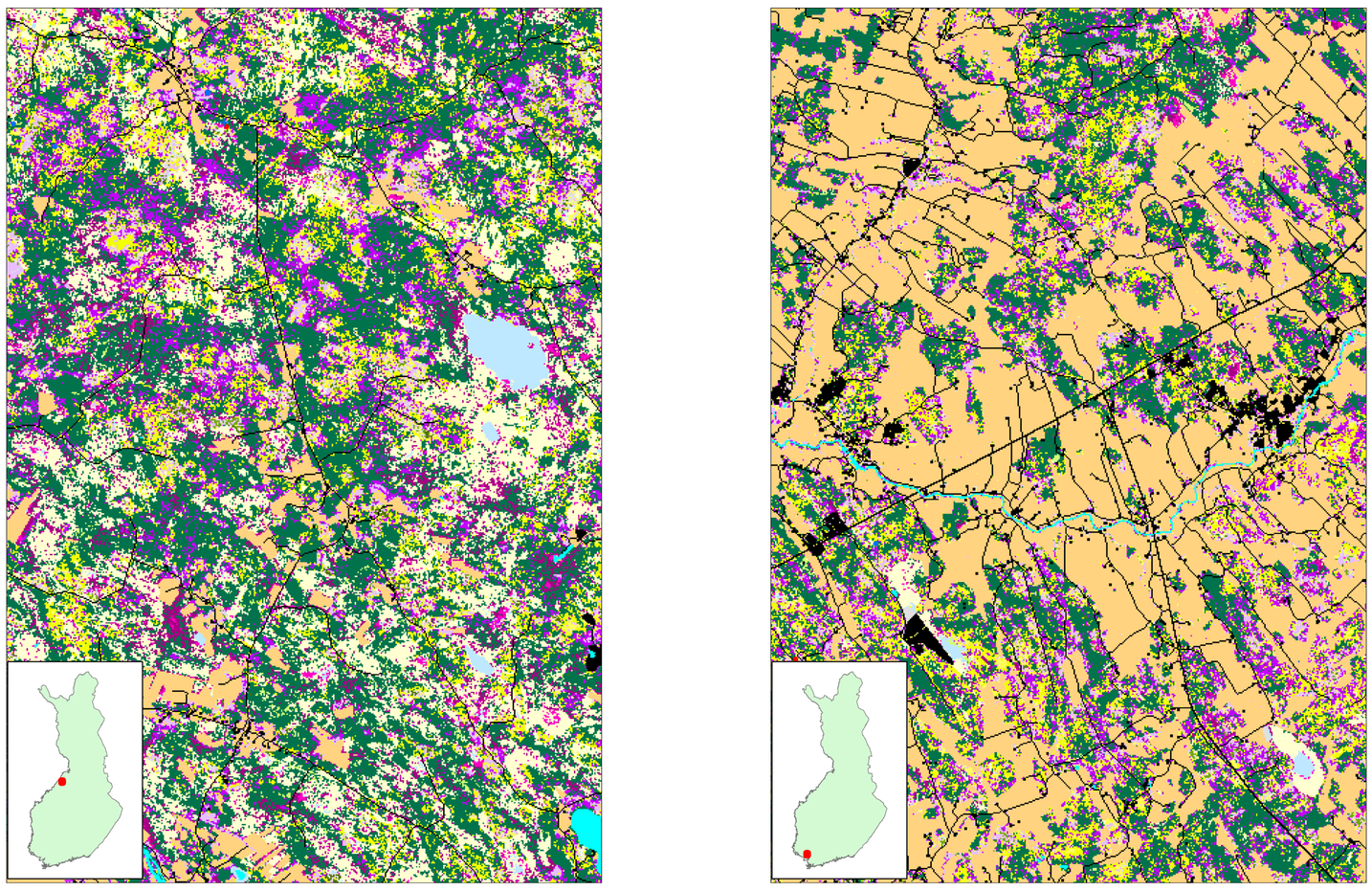

Figure 1. The illustration of landscape structure in the northern study area (left) and in the southern study area (right). Lakes and rivers described by blue, agricultural area by yellow, pine mire by white, and build-up area by black color. Other colors describe forests of different types.

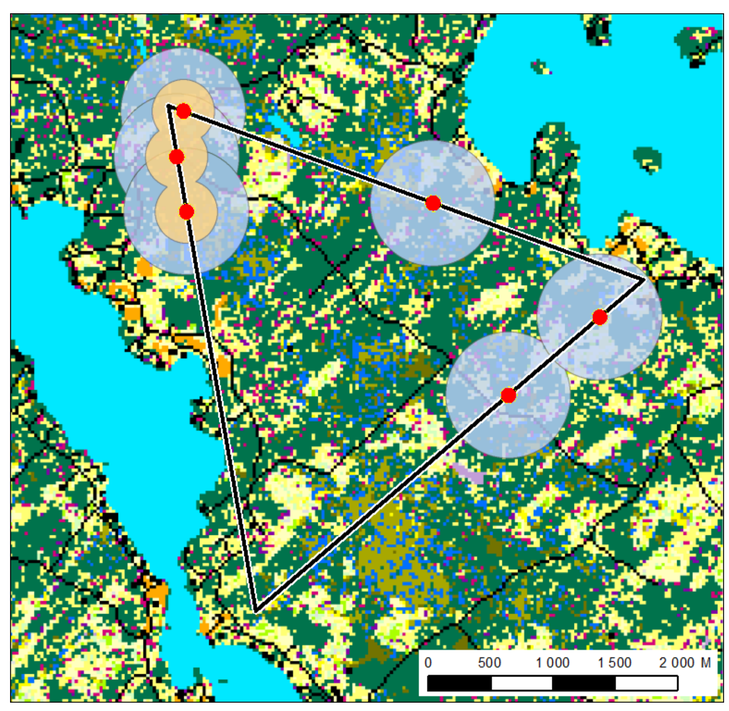

Figure 2. An example of the wildlife triangle in the landscape with grouse broods observations (red dots).

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