Electronic Supplementary Material

Both habitat change and local lek structure influence patterns of spatial loss and recovery in a black grouse population

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Appendix SI – Further information on candidate models to predict lek occupancy in black grouse based on habitat change and lek connectivity using generalised additive models

Full list of candidate models

Variables included in the models are: Initial ('Init'), change in the Open of the lek ('Open'), change in the Closed of the lek ('Closed'), change in the Moor of the lek ('Moor') and the number of lekking males within 15 km of the lek in the initial year ('Males').

Model variables	AIC	ΔAIC	Log-likelihood	Akaike weight
0.5 km Radius 1994 – 2000				
Init + Open	115.4	0.0	1.0	0.2
Init + Open + Moor	116.0	0.7	0.7	0.1
Init + Moor	116.2	0.8	0.7	0.1
Init + Open + Males	116.2	0.9	0.7	0.1
Init + Moor + Males	116.3	0.9	0.6	0.1

Init + Open + Moor + Males	116.6	1.2	0.6	0.1
Init	118.2	2.8	0.3	0.1
Init + Males	118.6	3.2	0.2	0.0
Open + Males	120.0	4.7	0.1	0.0
Open	121.4	6.0	0.1	0.0
Moor + Males	121.5	6.1	0.1	0.0
Open + Moor + Males	121.5	6.1	0.1	0.0
Males	121.8	6.4	0.0	0.0
Open + Moor	123.0	7.7	0.0	0.0
Moor	123.5	8.1	0.0	0.0

2000 – 2008

Init + Moor + Males	56.9	0.0	1.0	0.2
Moor + Males	57.5	0.7	0.7	0.2
Init + Open + Moor + Males	57.6	0.8	0.7	0.1
Open + Moor + Males	58.3	1.4	0.5	0.1
Closed + Moor + Males	58.5	1.6	0.4	0.1
Init + Closed + Moor + Males	58.6	1.7	0.4	0.1
Init + Open + Closed + Moor + Males	58.8	1.9	0.4	0.1
Open + Closed + Moor + Males	58.9	2.0	0.4	0.1
Init + Open + Closed + Males	62.0	5.1	0.1	0.0
Init + Open + Males	62.5	5.6	0.1	0.0
Open + Closed + Males	64.0	7.2	0.0	0.0
Open + Males	64.6	7.7	0.0	0.0
Init + Closed + Males	65.4	8.5	0.0	0.0
Closed + Males	65.9	9.0	0.0	0.0
Init + Males	67.3	10.4	0.0	0.0
Males	68.0	11.1	0.0	0.0
Init + Moor	69.5	12.6	0.0	0.0
Init + Closed + Moor	70.5	13.6	0.0	0.0
Init + Open + Closed + Moor	71.0	14.2	0.0	0.0
Init + Open + Closed	71.0	14.2	0.0	0.0
Init + Open + Moor	71.1	14.2	0.0	0.0

Init + Open	73.0	16.1	0.0	0.0
Init + Closed	73.0	16.1	0.0	0.0
Closed + Moor	74.0	17.2	0.0	0.0
Moor	74.9	18.0	0.0	0.0
Open + Closed + Moor	75.2	18.4	0.0	0.0
Init	75.6	18.7	0.0	0.0
Open + Moor	76.8	20.0	0.0	0.0
Open + Closed	77.3	20.4	0.0	0.0
Closed	77.4	20.5	0.0	0.0
Open	80.5	23.7	0.0	0.0

1994 – 2008

Init + Open + Closed	86.9	0.0	1.0	0.5
Init + Open + Closed + Males	87.0	0.1	0.9	0.4
Init + Open	91.2	4.3	0.1	0.1
Init + Open + Males	91.3	4.4	0.1	0.1
Init + Closed	94.6	7.7	0.0	0.0
Init + Closed + Males	95.0	8.2	0.0	0.0
Init + Males	97.4	10.5	0.0	0.0
Init	97.6	10.7	0.0	0.0
Open + Closed	99.6	12.8	0.0	0.0
Open + Closed + Males	100.3	13.4	0.0	0.0
Open + Males	102.4	15.6	0.0	0.0
Open	103.2	16.3	0.0	0.0
Closed	103.9	17.1	0.0	0.0
Closed + Males	104.2	17.3	0.0	0.0
Males	105.7	18.9	0.0	0.0

2.0 km Radius

1994 – 2000

Init	120.2	0.0	1.0	0.1

Open	126.9	6.7	0.0	0.0
Closed	125.1	5.0	0.1	0.0
Moorland	126.7	6.5	0.0	0.0
Males	123.8	3.6	0.2	0.0
Init + Open	121.6	1.4	0.5	0.1
Init + Closed	121.0	0.8	0.7	0.1
Init + Moorland	121.9	1.7	0.4	0.1
Init + Males	120.6	0.4	0.8	0.1
Open + Closed	127.1	6.9	0.0	0.0
Open + Moorland	126.7	6.5	0.0	0.0
Open + Males	125.5	5.3	0.1	0.0
Moorland + Males	124.6	4.5	0.1	0.0
Init + Open + Closed	122.9	2.7	0.3	0.0
Init + Open + Moorland	121.9	1.7	0.4	0.1
Init + Open + Males	122.3	2.1	0.4	0.0
Init + Closed + Moorland	122.0	1.9	0.4	0.1
Init + Closed + Males	120.8	0.7	0.7	0.1
Init + Moorland + Males	121.9	1.8	0.4	0.0
Open + Closed + Moorland	129.0	8.9	0.0	0.0
Open + Closed + Males	125.6	5.5	0.1	0.0
Open + Moorland + Males	125.2	5.1	0.1	0.0
Closed + Moorland + Males	125.3	5.1	0.1	0.0
Init + Open + Closed + Moorland	123.9	3.7	0.2	0.0
Init + Open + Closed + Males	122.7	2.5	0.3	0.0
Init + Open + Moorland + Males	122.1	1.9	0.4	0.0
Init + Closed + Moorland + Males	121.9	1.7	0.4	0.0
Open + Closed + Moorland + Males	127.1	7.0	0.0	0.0
Init + Open + Closed + Moorland + Males	123.9	3.7	0.2	0.0

2000 – 2008

Init	77.6	18.0	0.0	0.0
Open	81.7	22.1	0.0	0.0
Closed	76.4	16.9	0.0	0.0

Moorland	79.8	20.3	0.0	0.0
Males	70.0	10.4	0.0	0.0
Init + Open	77.8	18.2	0.0	0.0
Init + Closed	71.5	11.9	0.0	0.0
Init + Moorland	71.7	12.2	0.0	0.0
Init + Males	69.3	9.8	0.0	0.0
Open + Closed	74.0	14.5	0.0	0.0
Open + Moorland	81.3	21.8	0.0	0.0
Open + Males	71.7	12.2	0.0	0.0
Closed + Moorland	75.0	15.5	0.0	0.0
Closed + Males	68.5	8.95	0.0	0.0
Moorland + Males	65.3	5.79	0.1	0.0
Init + Open + Closed	69.5	10.0	0.0	0.0
Init + Open + Moorland	73.4	13.8	0.0	0.0
Init + Open + Males	71.8	12.2	0.0	0.0
Init + Closed + Moorland	68.5	8.9	0.0	0.0
Init + Closed + Males	67.0	7.5	0.0	0.0
Init + Moorland + Males	62.7	3.1	0.2	0.1
Open + Closed + Moorland	75.1	15.5	0.0	0.0
Open + Closed + Males	70.3	10.8	0.0	0.0
Open + Moorland + Males	65.8	6.2	0.0	0.0
Closed + Moorland + Males	63.5	3.9	0.1	0.1
Init + Open + Closed + Moorland	71.0	11.5	0.0	0.0
Init + Open + Closed + Males	67.9	8.4	0.0	0.0
Init + Open + Moorland + Males	61.5	2.0	0.4	0.2
Init + Closed + Moorland + Males	61.4	1.8	0.4	0.2
Open + Closed + Moorland + Males	64.3	4.8	0.1	0.0
Init + Open + Closed + Moorland + Males	59.6	0.0	1.0	0.4

1994 – 2008

Init	99.6	9.0	0.0	0.0
Open	108.0	17.4	0.0	0.0
Closed	100.2	9.6	0.0	0.0
Males	107.7	17.1	0.0	0.0
Init + Open	99.7	9.0	0.0	0.0
Init + Closed	91.8	1.2	0.6	0.2
Init + Males	99.4	8.8	0.0	0.0
Open + Closed	97.8	7.2	0.0	0.0
Open + Males	107.1	16.5	0.0	0.0
Closed + Males	101.4	10.8	0.0	0.0
Init + Open + Closed	90.7	0.1	0.9	0.3
Init + Open + Males	99.9	9.3	0.0	0.0
Init + Closed + Males	93.2	2.7	0.3	0.1
Open + Closed + Males	97.9	7.3	0.0	0.0
Init + Open + Closed + Males	90.6	0.0	1.0	0.4

‘Best’ models of lek occupancy at a 0.5 km radius

Generalised additive models with ΔAIC < 7 for each time period (1994–2000, 1994–2008 & 2000–2008) to predict lek occupancy in black grouse (based on habitat at a radius of 0.5 km) and demographic changes. The variables are referred to in the table as follows:

starting lek size as 'S', change in the proportion of open canopy forestry within 0.5 km as 'O', change in the proportion of moorland within 0.5 km as 'M', change in the proportion of closed canopy forestry within 0.5 km as 'C' and the density of displaying males within 15 km scaled for population size in each year as ‘L’. The evidence column indicates the evidence ratio (weight of ‘best’ model divided by weight of alternative model) indicating the support for the ‘best’ model over the alternative model in each row.

Model	AIC	ΔAIC	Likelihood	Akaike weight	Evidence ratio
1994-2000					
S + O	115.4	0.0	1.0	0.2	1.0
S + O + M	116.0	0.7	0.7	0.1	1.4
S + M	116.2	0.8	0.7	0.1	1.5
S + O + L	116.2	0.9	0.7	0.1	1.5
S + M + L	116.3	0.9	0.6	0.1	1.6
S + O + M + L	116.5	1.1	0.6	0.1	1.8

S	118.2	2.8	0.2	0.1	4.1
S + L	118.6	3.2	0.2	0.0	5.0
O + L	120.0	4.7	0.1	0.0	10.3
O	121.4	6.0	0.1	0.0	20.0
M + L	121.4	6.1	0.1	0.0	20.8
O + M + L	121.5	6.1	0.1	0.0	21.5
L	121.8	6.4	0.0	0.0	24.7

2000–2008

S + M + L	56.9	0.0	1.0	0.2	1.0
M + L	57.5	0.6	0.7	0.2	1.4
S + O + M + L	57.6	0.8	0.7	0.1	1.5
O + M + L	58.3	1.4	0.5	0.1	2.0

C + M + L	58.4	1.6	0.4	0.1	2.3
S + C + M + L	58.5	1.7	0.0	0.1	2.3
S + O + C + M + L	58.8	1.9	0.4	0.1	2.6
O + C + M + L	58.9	2.0	0.4	0.1	2.7
S + O + C + L	62.1	5.1	0.1	0.0	13.1
S + O + L	62.5	5.6	0.1	0.0	16.5
1994–2008					
S + O + C	86.9	0.0	1.0	0.5	1.0
S + O + C + L	87.0	0.1	0.9	0.4	1.1
S + O	91.2	4.3	0.1	0.1	8.7
S + O + L	91.3	4.4	0.1	0.1	9.2

‘Best’ models of lek occupancy at a 2.0 km radius

Generalised additive models with ΔAIC < 7 for each time period (1994–2000, 1994–2008 & 2000–2008) to predict lek occupancy in black grouse (based on habitat at a radius of 2.0 km) and demographic changes. The variables are referred to in the table as follows:

starting lek size as 'S', change in the proportion of open canopy forestry within 0.5 km as 'O', change in the proportion of moorland within 0.5 km as 'M', change in the proportion of closed canopy forestry within 0.5 km as 'C' and the density of displaying males within 15 km scaled for population size in each year as ‘L’. The evidence column indicates the evidence ratio (weight of ‘best’ model divided by weight of alternative model) indicating the support for the ‘best’ model over the alternative model in each row.

Model	AIC	ΔAIC	Likelihood	Akaike weight	Evidence ratio
1994 – 2000					
S	120.2	0.0	1.0	0.1	1.0
O	126.9	6.7	0.0	0.0	28.9
C	125.1	5.0	0.1	0.0	11.9
M	126.7	6.5	0.0	0.0	25.4
L	123.8	3.6	0.2	0.0	6.1
S + O	121.6	1.4	0.5	0.1	2.1
S + C	121.0	0.8	0.7	0.1	1.5
S + M	121.9	1.7	0.4	0.1	2.4

S + L	120.6	0.4	0.8	0.1	1.2
O + C	127.1	6.9	0.0	0.0	32.1
O + M	126.7	6.5	0.0	0.0	26.0
O + L	125.5	5.3	0.1	0.0	14.4
M + L	124.6	4.5	0.1	0.0	9.3
S + O + C	122.9	2.7	0.3	0.0	3.9
S + O + M	121.9	1.7	0.4	0.1	2.4
S + O + L	122.3	2.1	0.4	0.0	2.8
S + C + M	122.0	1.9	0.4	0.1	2.5
S + C + L	120.8	0.7	0.7	0.1	1.4
S + M + L	121.9	1.8	0.4	0.1	2.4
O + C + L	125.6	5.5	0.1	0.0	15.2
O + M + L	125.2	5.0	0.1	0.0	12.5
C + M + L	125.3	5.1	0.1	0.0	12.9
S + O + C + M	123.9	3.7	0.2	0.0	6.3
S + O + C + L	122.7	2.5	0.3	0.0	3.4
S + O + M + L	122.1	1.9	0.4	0.1	2.6
S + C + M + L	121.9	1.7	0.4	0.1	2.4
O + C + M + L	127.1	7.0	0.0	0.0	32.4

S + O + C + M + L	123.9	3.7	0.2	0.0	6.3
2000 – 2008					
M + L	65.3	5.8	0.1	0.0	18.1
S + M + L	62.7	3.1	0.2	0.1	4.7
O + M + L	65.8	6.2	0.0	0.0	22.4
C + M + L	63.5	3.9	0.1	0.1	7.1
S + O + M + L	61.5	2.0	0.4	0.2	2.7
S + C + M + L	61.4	1.8	0.4	0.2	2.5
O + C + M + L	64.3	4.8	0.1	0.0	10.8
S + O + C + M + L	59.6	0.0	1.0	0.4	1.0
1994 – 2008					
I + C	91.8	1.2	0.6	0.2	1.8
I + O + C	90.7	0.1	0.9	0.3	1.1
I + C + L	93.3	2.7	0.3	0.1	3.9
I + O + C + L	90.6	0.0	1.0	0.4	1.0