Modelling the Influence of Climate on Black Grouse Population Dynamics in Lüneburger Heide (North Germany)

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CONTEXT

Using modelling as an exploratory method, previous works have shown the relevance of certain climatic variables to model the dynamics of Black grouse populations from various European nature reserves in Belgium, Germany, UK and the Netherlands. The concordant significant results have stressed the negative effect of mild and rainy winters and of rainy brooding and hatching periods, and the positive effect of a warm hatching period (Loneux 2001, 2003, 2004, Loneux & Lindsey 2004, Loneux et al. 2004).

Among the 6 populations tested (Fig. 1), Lüneburger Heide had the shorter continuous spring census period: 1980-1998. Moreover, the demographic data used were cock and hen numbers together, although cock numbers only were used for the other populations. This update analyses the relation over longer time and for spring cock number only, exploring the quality of the explanatory variables used in the modelling.

METHODS

We always use the amount of rainfall and the mean minimum temperature to model fluctuations in the yearly Black Grouse census, using Poisson multiple regression in the "R" software (a free S-Plus clone). The census is the spring number of Black cocks only, for the whole Black Grouse population of the Lüneburger Heide nature reserve (Fig 2). The tested variables are related to specific time periods in the life cycle of the Black Grouse. The explanatory variables are:
(1) cock numbers one and two years before (n1 & n2),
(2) mean minimal temperatures (T) during the winter (1st November to 31st March) and during three or four week periods while brooding and hatching the year before each census, and (3) the total rainfall (RR) during September and during three or four week periods while brooding and hatching the year before each census.

The rainfall data come from the station Wilsede (116m), situated in the nature reserve. This station has been closed from 1st July 2002, so the longest time series of continuous data could only be 1980-2002. Three sets of temperature data were tested, coming from three stations around the Lüneburger Heide nature reserve (location on fig 2): Hamburg-Fuhlsbüttel (airport, alt. 13m), Soltau (alt. 77m) and Buchholz (alt. 77m). All the meteorological data have been recorded and provided by the German weather office (*Deutsche Wetterdienst*, DWD).

Table I: short time scale 1980-1998, cocks and hens, best model (Loneux 2001, 2003, 2004)

Variables	Estimate	Std. Error	z value
(Intercept)	2,666	0,335	7,958
n1	0,042	0,008	5,133
n2	-0,010	0,010	-0,937
RR3w226	-0,005	0,002	-2,292
RR4w105	-0,006	0,003	-2,135
RR4w255	0,004	0,003	1,457
Twinter	-0,033	0,038	-0,861
Twinter1	-0,055	0,045	-1,218

Null deviance: 59.5504 on 16 degrees of freedom
Residual deviance: 2.5243 on 9 degrees of freedom
AIC: 106,95 (R^2: 95,76 %)

Table II: short time scale 1980-1998, cocks only, new best model

	Estimate	Std. Error	z value
(Intercept)	2.569	0.275	9.352
n1	0.078	0.015	5.281
n2	-0.030	0.015	-1.967
RR4w105	-0.012	0.004	-2.767
RR4w195	0.007	0.004	1.650
RR3w286	0.008	0.003	2.214

Null deviance: 48.6452 on 16 degrees of freedom
Residual deviance: 4.2479 on 11 degrees of freedom
AIC: 93.323 (R^2: 91.3 %)

Table III: Time scale 1980-2002, cocks only, new best model

	Estimate	Std. Error	z value
(Intercept)	2.713	0.250	10.840
no1	0.072	0.014	5.224
no2	-0.034	0.014	-2.456
RR4s105	-0.006	0.003	-2.575
RR3s286	-0.004	0.003	-1.499

Null deviance: 51.6507 on 20 degrees of freedom
Residual deviance: 8.4162 on 16 degrees of freedom
AIC: 113.75 (R^2: 83.7 %)

Fig. 3: Numbers observed and adjusted by modelling on two different time scales and with different demographic data : cocks and hens or cocks only.

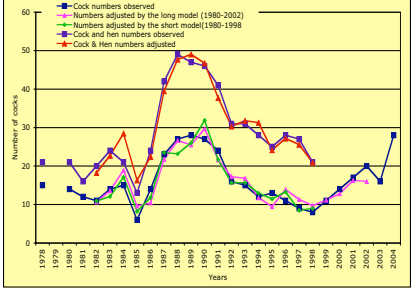
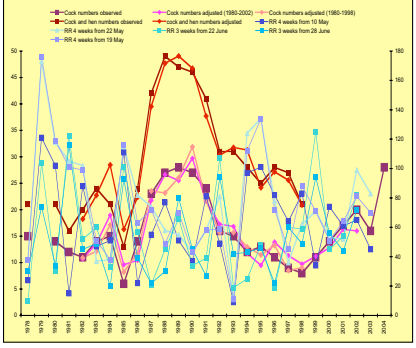


Fig. 4: Evolution of significant rainfall variables and numbers observed or adjusted. Years with few rainfall are those with higher Black grouse numbers.



RESULTS & DISCUSSION

1. For the previous short time series of data (1980-1998), the best model is not the same with cocks only rather than with cock and hen numbers (Tables I & II, Fig. 3). The best model with cocks includes only rainfall total variables during brooding and hatching time. The three or four week periods begin at different dates except the rainfall for 4 weeks from 10 May.
2. The best model for the longest set of available data (1980-2002) is not the same again (Table III). More simple, it includes only the the total rainfall during brooding and rearing time (negative effect). The relative impact of winter temperature (negative effect) and of T° from 16 June (positive effect for hatching time for very short time scale) are less important on long time scale in Lüneburger Heide.
3. The rainfall during the brooding time from 10 May is decisive, as this variable is in all the best models. The Black grouse does not like rain during the breeding time (fig. 4).
4. For the same model with temperature, the best AIC is given by data set from Hamburg, then Soltau, then Buchholz, although Hamburg is further away from the study area. But the differences are not large at all, meaning the climate over the whole area is not so different. But over the longest time scale of the study, the temperature is not involved at all any more. Only the rainfall is decisive for crucial periods of Black grouse breeding time, assumed to be during brooding (from 10 May) and rearing (June-July).

CONCLUSIONS from this improvement:

(1) Statistical analyses need trustworthy demographic data. The hen spring counts on the arenas do not represent the real hen population, because all the hens do not visit the arenas every day. Their influence in the statistical results cannot be explained with confidence. Only the spring census of black cocks are trustworthy, because of the territorial behaviour of the males, who come every morning on the lek.

(2) Statistical analyses need long time scale of data. The results change with the time scale of the study. The analyses performed in Hautes-Fagnes and Lange Rhön for 30 years and more give stable results (Loneux et al. 2004, Loneux et al. 2005). 15 and 20 years are too short. The minimum length could be between 25 and 30 years.

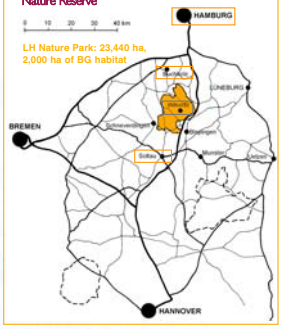
(3) The comparison of results among various populations must involve the same demographic data.

(4) From studying Black Grouse in North Germany, the results confirm that this species suffers from too much rainfall during the brooding month from 10 May, and during 3 weeks for rearing time from end of June (28/6).

(5) The dynamics of the Lüneburger Heide BG population is statistically explained by climate, but the climate does not explain all the fluctuations. Other factors than the climate play their role in that study area. A future development will study the use of one week time periods to define and compare the crucial moments for the brooding and rearing time periods, and will consider total rainfall also before 10 May.

Fig. 1: Location of the compared populations

Fig. 2: Location of the Lüneburger Heide Nature Reserve



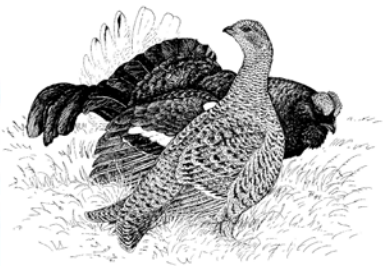


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Photo of the areat: Manfred Lütkepohl
Black Grouse drawing: Ernst Müller