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Altitudinal shifts of Alpine grouse in the Veglia–Devero Natural Park, western Italian Alps

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Abstract

Alpine grouse are particularly vulnerable to climate and land-use changes. Average elevation of rock ptarmigan, dwelling the open areas above the treeline in the Alpe Devero, increased by 7.8 m/yr from 1996 to 2015, while the population decreased by 50%. In the same period, the forest dwelling black grouse population in Veglia-Devero did not show such a marked decrease, and the observed variations in the Veglia district (increase in average elevation, contraction of altitudinal range) can be explained in terms of change in population density. Spatial patterns of studied populations are discussed in relation to climate and treeline upward shift.

Keywords

Black grouse, rock ptarmigan, population trends, altitudinal shift.

Introduction

Alpine grouse represent isolated glacial relict populations of arctic species in the Alps, with specific adaptations to the mountain environment, and are therefore particularly vulnerable to climate and land-use changes (STORCH 2007). Both direct (excessive warming, shorter persistence of snow) and indirect (upward shift of plant species) effects of climate change can affect habitat suitability for these species. Similarly, the abandonment of traditional human activities led to an upward shift of the treeline, possibly affecting all animal populations living just below or above this limit. Both these factors can operate differently all over the Alps (PERNOLLET et al. 2015). An assessment of the elevational shift of these populations in different areas of their range is therefore needed, in order to disentangle the possible causes and to plan effective management actions. To this end, we monitored the populations of black grouse (*Lyrurus tetrix*) and rock ptarmigan (*Lagopus muta helvetica*) in a protected area in the western Italian Alps over two decades, and assessed the trend in density and elevation.

Methods

The study was carried out in the Alpe Veglia – Devero Natural Park and the Contiguous Area of Alpe Devero (Ossola Valley, north Piedmont, 46°19'N, 8°14'E). The protected area belongs to the Natura 2000 network (SCI and SPA IT1140016 Alpi Veglia e Devero – Monte Giove) and it is represented by large mountain basins of glacial origins and surrounded by the summits of the western Lepontine Alps (1600-3553 m asl). The lower part of the area is covered by meadows, pastures and larch *Larix decidua* woodlands with the understory dominated by rhododendron *Rhododendron ferrugineum* and bilberry *Vaccinium myrtillus*. Above the treeline the area is dominated by meadows (Poaceae and Cyperaceae), heaths with *V. uliginosum* and Alpine azalea *Loiseleuria procumbens,* rocks and screes with sparse vegetation.

Every year (1996-2015) a team of trained observers carried out separate counts for the two species, following the methodology described by CHAMBERLAIN et al. 2012 and BOSSERT 1997. For black grouse, the site was monitored at dawn from 24 fixed observation points, covered in 2 mornings (one for Alpe Veglia and one for Alpe Devero) during the second half of May. Observations of more than one male displaying within a maximum distance of 100 m from each other, and showing some kind of interaction, were considered as a lek (CHAMBERLAIN et al. 2012) and mapped as one observation.

The rock ptarmigan monitoring was carried out on a sample area of 2.7 km² located in Alpe Devero. It was selected taking into account the suitability for the species and the representativeness of the altitudinal range occupied by the species in spring. The site was monitored from 25 May to 15 June from 7 vantage points that allowed a comprehensive (visual and acoustic) cover of the area.

The location of each male/male group was then geo-referenced on QGIS (QGIS DEVELOPMENT TEAM, 2017) and elevation was assigned by mean of a D.T.M model. We calculated the average, minimum, maximum and range of elevation of the contacted males for each year. To account for non-independence of observations of males belonging to the same black grouse lek, we considered male group as the statistical unit. Then, we assessed the possible elevational shift of the populations over the study period by fitting a set of linear regressions with

average, minimum, maximum elevation and range as dependent variable and year (or year + density) as explanatory variable. In the same way we assessed the temporal trend of each population by fitting a model with density as dependent variable.

Results

From 1996 to 2015 black grouse average density was 5.2 ± 1.59 males/km² in Alpe Veglia and 3.6 ± 1.01 males/km² in Alpe Devero, whereas rock ptarmigan population density was 4.8 ± 1.39 males/km². Population trend was positive only for black grouse in Alpe Devero ($\beta = 0.10 \pm 0.03$, $t = 3.15$, $p < 0.006$), whereas was negative in Alpe Veglia ($\beta = -0.14 \pm 0.06$, $t = -2.41$, $p = 0.028$) and for rock ptarmigan ($\beta = -0.19 \pm 0.03$, $t = -5.78$, $p < 0.0001$) (Fig. 1).

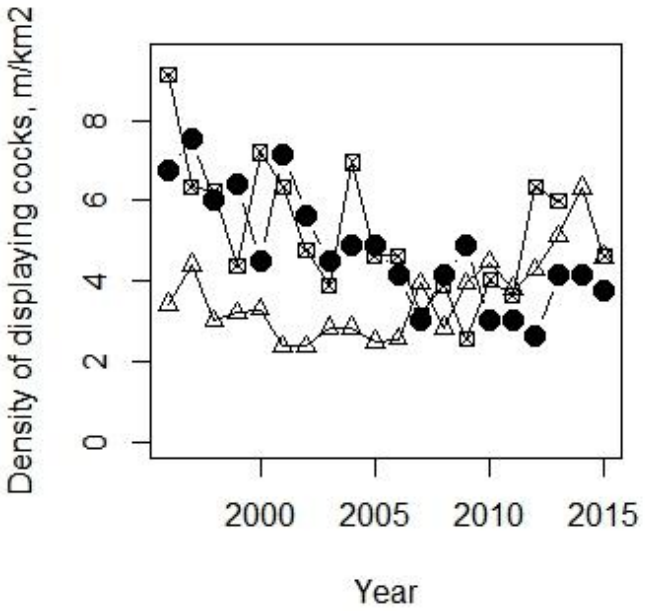

Figure 1:. Population trends of rock ptarmigan (black dots) and black grouse in Alpe Devero (triangles) and Alpe Veglia (squares).

Black grouse showed a significant positive trend in the average elevation of displaying cocks and a negative trend in maximum elevation and elevation range only in Veglia (Tab. 1., Fig. 2.), however all these trends disappeared when accounting also for population density, with maximum elevation and range significantly related with density. Average elevation of displaying rock ptarmigans showed a significant increase over the time (Tab. 1., Fig. 2.). This trend was significant even when we accounted for the change in population density, indicating that it was only partially affected by the observed population decrease in density (Tab. 2).

Black grouse, Alpe Devero			
	β ± S.E	t value	p value
Ave. elevation:	0.88 ± 0.54	1.632	0,119
Min. elevation:	2.30 ± 1.95	1.183	0,251
Max. elevation:	1.88 ± 1.06	1.779	0,091
Range:	-0.42 ± 1.87	-0,224	0,825

Black grouse, Alpe Veglia			
Ave. elevation:	1.06 ± 0.46	2.332	0,032
Min. elevation:	2.33 ± 1.40	1.665	0,114
Max. elevation:	-2.35 ± 1.10	-2.188	0,043
Range:	-4.68 ± 1.94	-2.408	0,028

Rock ptarmigan			
Ave. elevation:	7.79 ± 1.19	6.522	<0.0001
Min. elevation:	9.76 ± 2.85	3.426	0,003
Max. elevation:	3.50 ± 2.35	1.485	0,156
Range:	-6.26 ± 4.26	-1.471	0,16

Table 1: Regression coefficients ± standard errors, t and p value for linear regressions testing the trend in average, minimum, maximum and range in elevation.

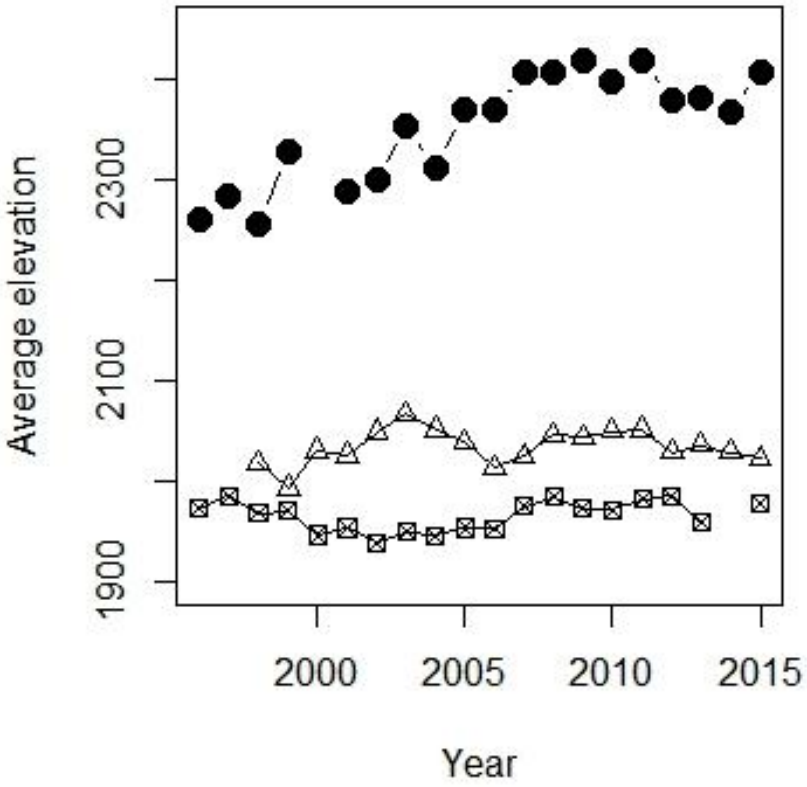

Figure 2: Trends of average elevation of displaying rock ptarmigan (black dots) and black grouse in Alpe Devero (triangles) and Alpe Veglia (squares).

	β ± S.E	t value	p value
(Intercept)	-6516.62 ± 4065.80	-1.603	0,128
year	4.46 ± 2.01	2.218	0,041
density	-16.12 ± 8.13	-1.083	0,065

Table 2: Parameters of the model testing the effect of density on trend in average elevation of rock ptarmigan (R^2=0.77).

Discussion

In our study area the population of rock ptarmigan showed a significant negative trend with population decreasing by 50% over the study period, in line with the trends shown by most of the monitored Swiss populations (FURRER et al. 2016). At the same time, the average elevation of displaying cocks showed a 7.8 m/yr increase, once again in line with the trend shown by population of southern Switzerland (PERNOLLET at al. 2015). In a previous study we showed how the dynamics of our population was mainly driven by climatic factors (IMPERIO et al. 2013). This could suggest that the observed shift in the average elevation could be at least partially caused by the reduction in population density. However, we now show that the observed trend in the population density only partially account for the observed altitudinal shift, indicating that some external factor is affecting the suitable area for this population.

Average winter snow depth cannot explain this shift, since there was no significant trend in this variable during the study period (β = 2.68 ± 1.86, t = 1.44, p = 0.17). Examining the aerial photos available online (http://www.pcn.minambiente.it/viewer/) for the study area it is possible to identify an upward expansion of larch saplings, starting from the end of the '90s, a pattern that could likely lead to the lost of suitable breeding habitat for rock ptarmigan, as observed in the Aletsch region by MARTI et al. 2016.

Contrary to rock ptarmigan, the two black grouse sub-populations monitored in our study did not show a significant trend in elevation of displaying cocks when accounting for population density, indicating that the ongoing environmental changes did not substantially reduce or expand the suitable habitat for this species in the study area.

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