Acta Oecologica 92 (2018) 26–34

Contents lists available at ScienceDirect

Acta Oecologica

journal homepage: www.elsevier.com/locate/actoec

Can the effect of species ecological traits on birds' altitudinal changes differ between geographic areas?

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ARTICLE INFO

Keywords:
Altitudinal distribution
Mountain birds
Alps
Land abandonment
Forest regrowth
Response curve

ABSTRACT

The altitudinal distribution of mountain birds has recently changed following different patterns in space and time, probably due to the variability of the ongoing environmental processes. Although several studies have highlighted the effect of climate warming in affecting birds altitudinal responses, in the Alps, land abandonment and the consequential forest regrowth may have played a fundamental role.

We applied the response curve shape method to investigate changes in the altitudinal distribution of breeding birds over a ten-year period in two different alpine areas (Central and Western Italian Alps) and we performed a log-linear analysis to depict the differential responses of species grouped according to their breeding habitat preferences.

The patterns of change remarkably differed according to species ecological traits and between mountain areas. We did not highlight clear altitudinal changes in the Central Alps for any ecological groups, while in the Western Alps, woodland birds showed an expansion pattern and grassland birds suffered a retraction pattern. Since the two alpine areas did not suffer a significant temperature increase, but experienced different woodland cover dynamics, we believe that forest regrowth played a key role in shaping the different bird altitudinal responses between the two sites.

Our findings illustrate the effect of ecological traits in shaping altitudinal changes and the role of local environmental factors in affecting spatial variation. Particularly, we strongly suggest considering woodland cover expansion as a key driver of bird altitudinal changes in alpine areas.

1. Introduction

Several studies have demonstrated that species ranges have shifted upwards or polewards in recent decades (Parmesan et al. 1999; Hickling et al. 2006; Zuckerberg et al. 2009; Gillings et al. 2015). Although the recent rise of temperatures is considered the main driver of the observed shift dynamics (Parmesan and Yohe, 2003; Ambrosini et al. 2011a; Chen et al. 2011; Scridel et al. 2018), species inhabiting medium-latitude mountains have been shown to suffer the effect not only of global warming, but also of changes in agro-forestry and pastoral practices (Laiolo et al. 2004; Maurer et al. 2006; Braunisch et al. 2016). There is a growing evidence that the abandonment of traditional livestock farming and agricultural practices has changed across Europe (Ambrosini et al. 2011b; Hatna and Bakker, 2011; Lasanta et al. 2017). In particular, these changes has favoured forest regrowth, thus reducing the availability of open areas in European mountains (Beguería, 2006; Gehrig-Fasel et al. 2007; Gellrich et al. 2007; Pellissier et al. 2013), and mostly in the Alpine regions (Hunziker, 1995; Tasser et al. 2007). At the same time, it is acknowledged that the Alps suffered a temperature increase in the last century (Beniston, 2003, 2006; Brunetti et al. 2009; Acquaotta et al. 2014). The combined (Mantyka-pringle et al. 2012; Oliver and Morecroft, 2014) or independent (Zakkak et al. 2014; Flousek et al. 2015) action of these two factors has certainly played an important role in shaping the distribution of mountain species. Among these, birds are a conspicuous group particularly sensitive to climate and land-use changes (Laiolo et al. 2004; Lemoine et al. 2007; Lehikoinen et al. 2014), often used as an indicator of the responses of animal communities to these factors. However, not all bird species respond in the same way to different environmental changes, whose effects can be confounded by several factors (see for example Ewers and Didham, 2006). Among these, species-specific ecological traits and the degree of habitat specialization are known to affect species responses to

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https://doi.org/10.1016/j.actao.2018.08.001
Received 13 March 2018; Received in revised form 21 July 2018; Accepted 1 August 2018

environmental changes occurring both along disturbance (Williams et al. 2010; Dondina et al. 2015, 2017; Pacifici et al. 2017; Luppi et al. 2018) and altitudinal gradients (Reif and Flousek, 2012; Tingley et al. 2012; Auer and King. 2014). Since forests have recolonized both low and high altitude open habitats, thus changing the altitudinal distribution and the consequent structural and functional availability of the three main mountain habitats, i.e. woodlands, edges and grasslands (Maurer et al. 2006; Gehrig-Fasel et al. 2007; Tasser et al. 2007), we considered breeding habitat preference as an ecological trait potentially influencing the altitudinal responses of birds.

Moreover, birds responses may differ across geographic contexts, due to local specificity and variability of climatic and land-cover dynamics (Archaux, 2004; Popy et al. 2010; Chamberlain et al. 2013; Flousek et al. 2015). Indeed, even though the whole Alpine chain has undergone a well-documented and widespread land abandonment (Tasser et al. 2007; Pellissier et al. 2013), this process occurred, and still occurs today, with different temporal and spatial dynamics, depending on the socio-geographic context (Hinojosa et al. 2016). Finally, due to elevation and rough topography, mountains are usually characterized by a mosaic of local climates (La Sorte et al. 2014; Körner et al. 2017) which can result in different temperature trends between areas. To obtain a more comprehensive snapshot of the heterogeneity of bird altitudinal changes, it is thus fundamental to compare the responses of ecological groups from different geographic areas.

In this study, we explored the changes of the altitudinal ranges of breeding birds occurred over 10 years in two geographic areas, located in the Central and Western Italian Alps respectively, to investigate if patterns of change were consistent within ecological group and if these associations differed between the two areas.

2. Material and methods

2.1. Study areas

2.1.1. Central Alps

The first study area is located in the Central Italian Alps (C-Alps) and encloses the whole mountain area of the Lombardy region (Northern Italy, 45°N, 9°E; Fig. 1). Lombardy mountains can be divided into two main sub-regions: the Prealps in the South, and the Alps in the North. The Prealps have a mean altitude of 840 m and cover 27% of Lombardy, while the Alps cover 17% of the regional surface and have a mean altitude of 1860 m. The two mountainous sub-regions show some differences in land-cover patterns (ERSAF, 2014). About one half (52%) of the prealpine area is covered by forests, mainly composed of deciduous species. Grasslands cover 15% of this sub-region, waterbodies 8%, and both rocks and shrubs 6%. By contrast, the alpine area is mostly occupied by rocks (35%) and forests (35%), with a large amount of coniferous species, while both grassland and shrub percentages are similar to those of the Prealps. The two sub-regions show a different degree of continentality, which leads to a variation in climate regimes. Indeed, climate conditions gradually change from the Prealps to the inner Alps, ranging from a suboceanic regime to a strictly continental one (Caccianiga et al. 2008).

2.1.2. Western Alps

The second study area, located in the Western Italian Alps (W-Alps), was split into three sampling sites situated in three different protected areas: the Gran Paradiso National Park (GPNP; 45°31′N - 7°19′E), the Orsiera Rocciavrè Natural Park (ORNP; 45°3′N - 7°19′E) and the Veglia-Devero Natural Park (VDNP; 46°12′ N - 8°14′ E; Fig. 1). The GPNP covers an area of 720 km^2 and has a mean altitude of 2400 m. The ORNP has a surface of 110 km^2 and is the site with the lowest mean altitude, equal to 1970 m, while the VDNP has an area of 86 km^2 and a mean altitude of 2230 m.

The GPNP is dominated by rocks and grasslands, which cover 31% and 27% of the protected area, respectively, while forests and shrubs cover 24% and 6%, respectively. The ORNP is mainly characterized by grasslands (39%) and forests (35%), and, secondly, by rocks (18%) and shrubs (7%). Grasslands and rocks are the predominant land cover classes in the VDNP, showing the same cover percentages as in the GPNP. Forests cover 22% of this study site, while shrubs occupy 6% of the area (Martinasso, 2011). All protected areas are characterized by a continental climate showing modest differences in terms of climatic regimes (highest monthly precipitation and lowest annual mean temperature in the VDNP). The overall environmental variability of the three parks can be considered a representative sub-sample of the whole Western Italian Alps (Viterbi et al. 2013).

2.2. Data collection

2.2.1. Central Alps bird data

Bird data for the C-Alps were obtained from the long-term series (1992–2015) of the monitoring program of breeding birds in Lombardy (Bani et al. 2009). The project started in 1992 with the aim of monitoring the population trends of breeding birds in the whole region. Data collection followed a stratified sampling design, according to both landscape and habitat variability in the study area (for details see Massimino et al. 2008, Bani et al. 2009). Bird data were collected using the unlimited distance point count technique, performed during the breeding season (10 May-20 June) from sunrise to 11.00 a.m., only in good weather conditions (sunny to cloudy, without rain or strong winds) (Blondel et al. 1981; Fornasari et al. 1998; Bibby, 2000; Massimino et al. 2008). From the regional database, we selected 1400 point counts performed from 1150 m to 2700 m, between 2006 and

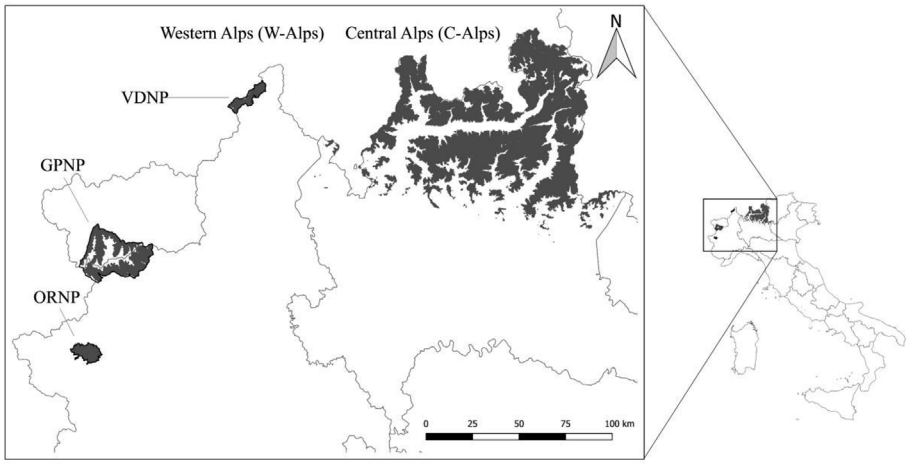

Fig. 1. Location of the study areas: Central Alps (C-Alps) and Western Alps (W-Alps) with the protected areas (Gran Paradiso National Park – GPNP; Orsiera Rocciavrè Natural Park – ORNP; Veglia-Devero Natural Park – VDNP): the zones between 1150 m and 2700 m (the altitudinal range selected for the research) are highlighted in dark grey.