



Original research article

Projected distribution shifts and protected area coverage of range-restricted Andean birds under climate change



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ABSTRACT

In this study we projected the effect of anthropogenic climate change in endemic and restricted-range Andean bird species that spread out from the center of Bolivia to south-eastern Peru. We also analyzed the representation of these species in protected areas. The ensemble forecasts from niche-based models indicated that 91–100% of species may reduce their range size under full and no dispersal scenarios, including five species that are currently threatened. The large range reduction (average 63%) suggests these mountain species may be threatened by climate change. The strong effects due to range species losses are predicted in the humid mountain forests of Bolivia. The representation of bird species also decreased in protected areas. Partial gap species (94–86%) are expected to increase over the present (62%). This suggests climate change and other non-climate stressors should be incorporated in conservations plans for the long-term persistence of these species. This study anticipates the magnitude of shifts in the distribution of endemic birds, and represents in the study area the first exploration of the representation of range-restricted Andean birds in protected areas under climate change.

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1. Introduction

Anthropogenic climate change is recognized as a serious threat to biodiversity (IPCC, 2007). Changes in the geographic distribution of species, decreases in species population sizes, changes in ecological interactions (Williams et al., 2007; Auer and Martin, 2013) and the extinction of various species are some of the predicted impacts of climate change (Thomas et al., 2004; Colwell et al., 2008). Modeling studies in particular of global studies predicted that climate change may be an important extinction driver in the tropics. In Latin America, the regions predicted to have the greatest changes in fauna include the tundra, Central America and the Andes (Lawler et al., 2009). In the Andes specifically a high extinction rates of plants is predicted (Malcolm et al., 2006) as well as a large number of vulnerable birds and amphibians (Foden et al., 2013). These assessments in most cases are attempts to lead management strategies that can help species survive in the future (Pacifiçi et al., 2015).

Tropical species and those that inhabit mountain regions are predicted to make altitudinal rather than latitudinal shifts (Colwell et al., 2008; La Sorte and Jetz, 2010; Buermann et al., 2011), which is consistent with recent evidence of species surveys (Peh, 2007; Feeley et al., 2011; Harris et al., 2012; Freeman and Class Freeman, 2014). Highland species may be very vulnerable to extinction induced by climate change (Şekercioğlu et al., 2008; Harris et al., 2014). The warming temperatures may force the mountain species to shift upslope, reducing their geographic ranges almost entirely, decreasing

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their population, and driving them to extinction (Shoo et al., 2005; Harris et al., 2014). Restricted-range and endemic species are also projected to be vulnerable to climate change (Malcolm et al., 2006; IPCC, 2007; Williams et al., 2007; Ohlemüller et al., 2008; Şekercioğlu et al., 2008; Harris et al., 2014). In the northern Andes, about 43% of bird species may reduce their geographic range and some species may become extinct due to climate change (Velásquez-Tibatá et al., 2012). In Costa Rica, the populations of nearly half of 77 forest bird species may decline, and seven of the eight species projected to become locally extinct are endemic to Costa Rica and Panamá (Gasner et al., 2010). The populations of endemic high-elevation birds in Indonesia are also projected to decline (Harris et al., 2014). Life history traits and dispersal ability among others factors could have a great influence determining current and future species ranges as well as their vulnerability to climate change (Bellard et al., 2012; Rehm, 2014; Pacifici et al., 2015). However, considering changes in land use are increasing in the tropics, the urban and crop areas and other management areas may negatively affect or restrict the range shifts (Jetz et al., 2007; Feeley and Silman, 2010; Şekercioğlu et al., 2012).

Various endemic and restricted-range bird species inhabit the Bolivian and Peruvian Andes (Stattersfield et al., 1998) and most are little known. For example, in the humid mountain forests known locally as “Yungas” are 35 endemic birds, six of which are globally threatened (Stattersfield et al., 1998). The highest percentage of endemic birds is found at the highest elevations (Ibisch and Mérida, 2003). This region was historically isolated from the lowlands by the uplift of the Andes, creating a complex structure of high mountains and inter-Andean valleys (Ibisch and Mérida, 2003). The species of the Andes may be relict populations that survived global change periods in places where the climate was moderate or stable (Fjeldså et al., 1999). Although these species are of interest for conservation, currently most are threatened by habitat loss, and the occurrences of most species in protected areas in Bolivia and Peru is limited (Hennessey et al., 2003). In fact, critical areas of bird endemism may be only partially covered in these protected areas (Young et al., 2009). These protected areas are also at risk, facing threats that include but are not limited to deforestation (Killeen et al., 2007), roads, mining activities, fires and hydrocarbon projects (Ibisch et al., 2007; SERNANP, 2007). Moreover, climate change adds an additional relevant threat in protected areas and their management. For example, some studies have reported species may move outside of the protected areas (Araújo et al., 2004; Hannah et al., 2005) so their effectiveness in securing species under rapid climate change is uncertain (Araújo et al., 2004). Conserving species in Bolivia and Peru is currently a challenging task, but under climate change may require new management plans and adaptive strategies that should be included in each country's plans. It is considered that more detailed studies of these species under climate change are needed for a better understanding of the status of the birds and their long-term conservation. In this study we projected the changes in geographic distribution in restricted-range birds of the Andes found in Bolivia and southeastern Peru by using two climate change scenarios and two dispersal scenarios for 2080. We also identified gap species in the current protected areas and propose recommendations for their conservation.

2. Methods

2.1. Study area

The study area is located on the eastern slope of the Andes; it extends from Cusco in Peru to the center of Bolivia (between 73° 5'W and 19° 7'S). The Yungas ecoregion is located in this sector of the Andes between 500 and 4000 m elevation (Olson et al., 2001; Josse et al., 2009). The most important vegetation types for bird species are: (1) the Yungas, humid cloud forests (1000–4200 m) with annual precipitation between 1500 and 6000 mm and temperature of 7–24 °C (Ibisch and Mérida, 2003); (2) the sub-Andean Amazonian forests (500–1000 m), a transition area between Andean and Amazonian species with annual precipitation between 1500–7000 mm and temperature of 24–26 °C (Ibisch and Mérida, 2003); and (3) the inter-Andean dry forests and transition Yungas to Puna (1700–4000 m), located on the east flanks of Yungas (Ibisch and Mérida, 2003; Hennessey et al., 2003). These areas in Bolivia are in La Paz, Cochabamba and part of the Departments of Santa Cruz and Beni. In Peru these areas are in Puno, Cusco and part of the Madre de Dios department.

2.2. Study species

We studied 21 species of endemic birds distributed from the center of Bolivia to southeastern Peru. These birds have geographic ranges of less than 50 000 km² (Stattersfield et al., 1998) and most have more than 80% of their range in Bolivia (see maps of Ridgely and Tudor, 2009 and Swenson et al., 2012). These species are also found in endemic bird areas (EBA) suggested for conservation (Stattersfield et al., 1998).

In the Yungas forests (Bolivian and Peruvian upper Yungas, EBA 055) are the high-elevation birds (range extent below 4000 m elevation, see Appendix A): Black-winged Parrot *Hapalopsittaca melanotis melanotis*, Hooded Mountain-Toucan *Andigena cucullata*, Light-crowned Spinetail *Cranioleuca albiceps*, Diademed Tapaculo *Scytalopus schulenbergi*, Orange-browed Hemispingus *Hemispingus calophrys*, Yungas Tody-Tyrant *Hemitriccus spodiops*, and Scimitar-winged Piha *Lipaugus uropygialis* (ranked as Vulnerable) (IUCN, 2014). The endemic birds of Bolivia include the Black-throated Thistletail *Asthenes harterti*, Black-hooded Sunbeam *Aglaeactis pamela*, Rufous-faced Antpitta *Grallaria erythrotis* and Bolivian Brushfinch *Atlapetes rufinucha*.

In the sub-Andean Amazonian forests (Bolivian and Peruvian lower Yungas, EBA 054) are the middle-elevation birds (referred to here as species whose range extent is below 2500 m elevation): Bolivian Recurvebill *Syndactyla striata*,

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