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Rewilding cultural landscape potentially puts both avian diversity and endemism at risk: A Tibetan Plateau case study

Li Li[a,*], Dieter Thomas Tietze[b], Andreas Fritz[c], Zhi Lü[d], Matthias Bürgi[e], Ilse Storch[a]

[a] Wildlife Ecology and Management, University of Freiburg, 79106 Freiburg, Germany
[b] Natural History Museum Basel, Augustinergasse 2, 4001 Basel, Switzerland
[c] Remote Sensing and Land Information Systems, University of Freiburg, 79106 Freiburg, Germany
[d] School of Life Sciences, Peking University, Beijing 100871, China
[e] Research Unit Landscape Dynamics, Swiss Federal Research Institute WSL, 8903 Birmensdorf, Switzerland

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ABSTRACT

Ecological restoration is becoming a primary strategy to increase provisions of ecosystem services and reverse biodiversity losses. In cultural landscapes undergoing land use extensification, rewilding has been proposed as a viable approach to reverse biodiversity loss through reducing human impacts. The world's largest ecological restoration campaign is taking place on the eastern Qinghai-Tibetan Plateau (QTP) to combat grassland degradation and enhance the upper stream region's water retention capacity. However, little is known about whether the large-scale rewilding also benefits the unique bird assemblage of the eastern QTP. Our study aims to make science-based conservation recommendations for the Tibetan avifauna by detecting their diversity and endemism distribution patterns at the local scale. In the breeding seasons of 2014 and 2015, we carried out bird surveys and conducted a habitat mapping using three Unmanned Aerial Vehicles (UAVs). We developed a comprehensive set of 2D and 3D habitat feature parameters from the high-resolution (10 cm level) UAV-derived images. Meanwhile, we employed the participatory GIS approach to acquire farm-scale human land-use data. Our results indicate that the distributions of avian diversity, endemism and abundance are not congruent across the eastern QTP, which calls for the conservation of different habitat types. Vertical and horizontal habitat heterogeneity maintain the local bird diversity with anthropogenic elements significantly enriching the overall bird abundance. Degraded pastures provided key habitats for two highly abundant endemic passerines—the White-rumped Snowfinch *Onychostruthus taczanowskii* and the Ground Tit *Pseudopodoces humilis*. At the landscape scale, historical human-nature interactions between Tibetan nomads and the alpine environment formed the landscape's patchy vegetation structure. Our results reveal that the Tibetan cultural landscape maintains the structural heterogeneity needed to achieve multiple bird conservation objectives on the eastern QTP. Restoring the cultural landscape to a 'natural' tall-grass or dense-shrubland state of high water-retention capacity may result in the loss of both high-abundance avian communities and endemic species diversity. Our empirical study also indicated that rewilding abandoned agricultural landscape will not necessarily lead to a desired conservation outcome, especially when the requirements of habitat specialists and endemics are not taken into account. Moreover, ecological restoration projects should evaluate the divergences between their ecosystem service and biodiversity objectives.

1. Introduction

Worldwide, ecological restoration is becoming a key approach to reverse human-caused environmental degradation (Suding, 2011; Wortley et al., 2013). Conserving biodiversity and increasing provisions of ecosystem services are the two common aims of ecological restoration projects (Benayas et al., 2009). Human interventions in ecological restorations can be both passive and active (Holl and Aide, 2011). With regards to abandoned farmland in particular, it has been increasingly suggested that reducing human control of landscapes can facilitate ecological recovery towards a low-human-impact 'natural' state, thereby creating the possibility to increase biodiversity (Navarro and Pereira, 2015). This passive rewilding approach has a European focus (Jørgensen, 2015) and is considered applicable to regenerate a self-maintaining ecosystem in agricultural landscapes undergoing depopulation (Pereira and Navarro, 2015). However, the biodiversity impact of

* Corresponding author.
E-mail address: li.li@wildlife.uni-freiburg.de (L. Li).

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passive rewilding remains controversial (Corlett, 2016). The disappearing of native species resulting from the loss of their anthropogenic habitats (Normile, 2016) has recently been reported during the course of rewilding in the Japanese *satoyama* landscapes. A global review of 276 studies demonstrated that the biodiversity responses to agricultural land-use extensification differ among regions and taxa. Over 60% of negative responses were reported from European and Asian studies on avifauna and these also had the lowest proportion of positive impacts. Conversely, the most positive responses were reported from studies on arthropods from Central and South America and these had the highest proportion of positive impacts (Queiroz et al., 2014). In grassland landscapes in particular, traditional land use creates a spatial disturbance gradient which sustains structural heterogeneity and enables species coexistence (Diacon-Bolli et al., 2012; Maurer et al., 2006). Studies have shown that pasture abandonment is detrimental to grassland birds around the globe (Chamberlain et al., 2013; Laiolo et al., 2004; Regos et al., 2016; Sirami et al., 2008) in terms of reducing the overall avian richness in the pastoral system (Dyulgerova et al., 2015) or threatening endemic avian species due to the loss of grazing-created habitat (García et al., 2008).

The world's largest grassland restoration project is taking place in the Sanjiangyuan region of the eastern Qinghai-Tibetan Plateau (QTP). The Sanjiangyuan National Nature Reserve covers an area of 152,300 km^2 (Shao et al., 2013) with over 250,000 residents (Xu et al., 2012) and an average stocking rate of 19,580,000 sheep units between 1988 and 2002 (Zhang et al., 2014). The current structure of the Sanjiangyuan grassland landscape is largely shaped by the coupling of the plateau environment and the nomads' pastoral tradition (Miehe and Miehe, 2007; Miehe et al., 2009). Diverse pasture land-use regimes form spatial land-use intensity gradients from plot to farm and landscape scales (Bürgi et al., 2015), which create a mosaic habitat structure composed of dwarf-shrub, tall-grass, short-grass and degradation patches. Geographically, Sanjiangyuan is of great ecological significance to the downstream regions. Three of Asia's major rivers – the Yellow, Yangtze and Mekong Rivers – originate from locations adjacent to this area. However, over 50% of the alpine grassland in Sanjiangyuan was reported to be moderately or severely degraded (Liu et al., 2008). Policy makers identified livestock overgrazing as the underlying cause of the degradation; therefore, the restoration goal was set to recover the landscape's 'natural state' by enhancing the water retention capacity and conserving biodiversity of the Sanjiangyuan region (National Development and Reform Commission, 2013). However, the definition of 'natural' in Sanjiangyuan is ambiguous. Fifty-four per cent of the Sanjiangyuan region is covered by alpine meadows dominated by *Kobresia* plants, which were created by a long history of pastoralism (Li et al., 2013; Miehe et al., 2008). In contrast, the alpine steppes, normally considered to be 'wilderness' given the presence of wild ungulates such as wild yak (*Bos mutus*), kiang (*Equus kiang*) and Tibetan antelope (*Pantholops hodgsonii*) (Schaller, 1998), only account for 14% of the Sanjiangyuan territory (Li and Li, 2002). Contrary to the rewilding of abandoned farmland in most developed countries, the rewilding of the Tibetan grassland is not, per se, 'passive'. The large-scale policy-driven ecological restoration campaign actively restricts human land use on the eastern QTP. From 2005 to 2012, the Chinese government invested a total of 7.5 billion CNY (ca. 1 billion USD) for the conservation project, including for the reversal of grassland degradation by 20% to 40% (Shao et al., 2016) through: the compensation of 100,000 nomads for moving out of the reserve (Wang et al., 2010); grass replantation; fencing for grazing prohibition; shrub protection; and rodent pest eradication (National Development and Reform Commission, 2013). By 2012, the stocking rate in the reserve had been successfully cut down by 20% (Zhang et al., 2014).

After a decade of implementation, positive effects have been observed in the biomass recovery of woody plants and grassland across 79% of the project area. Along with the habitat quality improvement, the population of charismatic mammals in Sanjiangyuan has also been expanding since 2002, e.g. an approximate increase of 10,000 kiang and 20,000 blue sheep was reported in a 2012 survey (Jiang et al., 2017). Yet, little is known about whether the same rewilding strategy has suited the conservation requirements of non-flagship organisms including members of the Tibetan avifauna. In 2014, the Sanjiangyuan ecological restoration received a 16 billion CNY (ca. 2.4 billion USD) replenishment till 2020 (Wu, 2014). However, similar to many ecological restorations (Benayas et al., 2009), it remains questionable whether the ecosystem service and biodiversity objectives can be congruently achieved in the second-phase project implementations.

Located in the transition zone between the Palearctic and the Oriental realms, the eastern QTP is the cradle for a high number of native flora and fauna and harbors an important center of endemic birds in Asia (Lei et al., 2007). Birds endemic to the QTP are characterized by unique phylogenetic histories, having diversified alongside the uplift of the young Plateau (Lei et al., 2014; Päckert et al., 2015). The QTP is the origin center of snowfinches, e.g. White-rumped Snowfinch (*Onychostruthus taczanowskii*) which was recognized as one of the oldest species from this clade (Gebauer et al., 2006). Besides the endemics, over 30 state protected species inhabit this region – e.g. Bearded Vulture (*Gypaetus barbatus*) and Black-necked Crane (*Grus nigricollis*) (Li and Li, 2002) – which reveals the intrinsic value of general conservation of diversity within the alpine avian community.

In this research, we aim to provide science-based answers to the following questions regarding the conservation of the Tibetan avifauna:

1. Which habitat features explain high avian species diversity and endemism?
2. How is the occurrence of these habitat features related to human land use? and
3. Will the ecological restoration campaigns, such as the one recently conducted on the eastern QTP region, benefit bird diversity and endemism?

Methodologically, we employed integrated bird survey, habitat mapping with small Unmanned Aerial Vehicles (UAVs) and participatory GIS to obtain a comprehensive dataset containing avian distribution, habitat feature and land-use data of matching scale.

2. Methods

2.1. Study area

The Nyanpo Yutse Mountain lies in the southeast of the Sanjiangyuan Nature Reserve (33°–34° N, 99°–102° E, Fig. 1), with altitudes ranging from 3600 to 5700 m a.s.l. and over 75% of the land used as seasonal pastures (Jiuzhi County Annals Editor's Group, 2005). During the past twenty years, there has been a 40% decline in livestock numbers compared to the historical peak in 1978 caused by political and socio-economic drivers. Li et al. (2017) found that the turning point towards grassland degradation in Nyanpo Yutse occurred in 2006. This was triggered by changes in nomads' land-use practices following past ownership reforms that started in 1984 and continued that have an effect over the following twenty years.

The Nyanpo Yutse region hosts a rich and representative Tibetan bird assemblage. The local avifauna include Przevalski's Finch (*Urocynchramus pylzowi*), the oldest endemic Tibetan passerine, which, after being controversially categorized between buntings and finches, was unexpectedly linked to the Ploceidae (weavers and widowbirds) (Päckert et al., 2016). The Tibetan Bunting (*Emberiza koslowi*) was considered a "first degree endemic" due to its extremely narrow-range distribution (Weigold, 2005). In 2005, the first community-conserved area for the *E. koslowi* was established in Nyanpo Yutse as a joint effort of Buddhist monks and local nomads (Ju and Golok, 2013).