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Bird conservation values of off-reserve forests in lowland Nepal

Bhagawan R. Dahal *, Clive A. McAlpine, Martine Maron

The University of Queensland, Landscape Ecology and Conservation Group, School of Geography, Planning and Environmental Management, Brisbane 4067, Australia

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ABSTRACT

Although protected areas are central to global biodiversity conservation, off-reserve forests are increasingly recognized as potentially important for the long term conservation of biota, particularly in less-developed countries where communities rely directly on resources from natural areas. We assessed the conservation value of differently managed forests for birds in lowland tropical forests of Nepal. In particular, we explored whether their conservation value was additional or complementary to those of formal protected areas. Using data collected from 112 sites in protected areas ($n = 31$), state managed forests ($n = 37$) and community managed forests ($n = 44$), we assessed how bird species richness, abundance, diversity and community composition varied among tenures. Although sites in protected areas had the greatest species diversity, community managed forests supported a complementary assemblage. Of 124 species recorded, only 45% were common to all management tenures. Overall, the distinctiveness and richness of species in sites in forests outside of protected areas contributed substantially to regional avifaunal diversity. These results highlight the potentially critical role of appropriately managed community forests. The maintenance of diverse bird assemblages in forest regions depends on complementary management of forests both outside and inside the established protected areas.

1. Introduction

In the face of growing pressure on global biological diversity, the protected area network is increasingly important for biodiversity conservation worldwide (Joppa et al., 2008; Jenkins and Joppa, 2009). However, there are concerns regarding the adequacy of protected areas in terms of representation of species and their habitats (Rodrigues et al., 2004). Recent work has highlighted limitations of protected areas in maintaining key biodiversity features in landscapes (Laurance et al., 2012; Clark et al., 2013). With the conservation focus primarily on particular areas, biodiversity conservation in surrounding landscapes can be neglected (Bhagwat et al., 2005; Hansen and DeFries, 2007).

There has been increasing interest in the importance of forests outside the protected areas for biodiversity conservation (Bhagwat et al., 2005; Persha et al., 2010). Off-reserve forests can be important reservoirs of biodiversity that are complementary to the existing protected area network in several ways. For example, off-reserve forests are often in different vegetation types to those within protected areas, providing habitat resources that are poorly represented within protected areas (Cox and Underwood, 2011). For instance, tropical moist deciduous and semi-evergreen forest in south Asia (Persha et al., 2010), evergreen mixed deciduous forests in Thailand (Tantipisanuh and Gale, 2013), and natural sacred forests in India (Bhagwat and Rutte, 2006) are predominantly represented outside of reserves, where community management initiatives appear important for biodiversity conservation. Such forests can also have greater habitat heterogeneity due to different disturbance regimes, therefore supporting species that use various successional stages of habitat (Brawn et al., 2001; Chandler et al., 2012). As no single habitat necessarily provides all the required resources for a given species' persistence (Saunders et al., 1991), conservation management of off-reserve forests can be essential for the persistence of many species (Sodhi and Ehrlich, 2010). Thus, effective off-reserve conservation policies help ensure a diversity of habitat resources across the landscapes in which protected areas are embedded.

In developing countries, about 22% of the total forest area is either community-managed or owned, compared with only three percent in developed countries (White and Martin, 2002). Community forest initiatives have been increasingly successful in preventing deforestation and restoration of forest condition in the landscapes (Klooster and Masera, 2000; Nagendra and Gokhale, 2008; Porter-Bolland et al., 2012). Nepal offers some of the best examples of community-based forest management in the world

* Corresponding author. Current address: The University of Queensland, Landscape Ecology and Conservation Group, School of Geography, Planning and Environmental Management, Brisbane 4067, Australia. Tel.: +61 0468321556.
E-mail address: b.dahal@uq.edu.au (B.R. Dahal).

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(Pokharel et al., 2007; Nagendra and Gokhale, 2008). About one-fourth of forests in Nepal are currently managed by community forest user groups (Kanel and Dahal, 2008; Ojha et al., 2009). Rates of habitat loss and degradation are reduced in community managed areas compared with state managed forests (Nagendra, 2007; Kanel and Dahal, 2008). There is a need to quantify the contribution of these areas to biodiversity conservation, and in particular, the extent to which the biota they support is complementary to that within formal protected areas.

In this study, we examine the contribution of differently-managed forests to the conservation of forest bird communities in lowland Nepal. The role of alternative forest management tenures in biodiversity conservation is often neglected. In particular, while state-centric forest management approaches tend to have spatially uniform management approaches, community management approaches can be diverse, while also securing the right to resources and embracing a participatory approach to the management of forest resources. We hypothesized that community managed forests in particular can play an important conservation role for forest bird communities, complementing that of protected areas. We specifically aimed to: (1) determine whether species richness, abundance and diversity of forest bird assemblages varied among sites in community forests, state forests and protected areas, and (2) compare the composition of forest bird assemblages among different management regimes to assess conservation values of variously managed off-reserve forests for avian biodiversity in Nepal's lowland landscapes.

2. Material and methods

2.1. Study area

The study was conducted in the eastern and central Terai of Nepal. Nepal has a total landmass of 147,181 km^2 divided among three main geographical regions: the Himalayan region, mid hill region and the Terai region. The lowland Terai encompasses most of the country's tropical moist forest from the Mechi River in the east to the Narayani River in the centre. The area is characterized by a tropical climate, with average precipitation of approximately 1800 mm (Springate-Baginski et al., 2003) and mean maximum temperatures of 15–40 °C (Sah et al., 2002). Before 1950, the region was an uninterrupted patch of dense tropical forest. With the eradication of malaria in the early 1950s, the highly productive lowland zone of the country was settled and subsequently agricultural expansion occurred (Hrabovszky and Miyan, 1987). Consequently, most of the forest was destroyed and remaining forest areas were subjected to intense human exploitation. Nearly half of the country's population lives in the 17% of the country that is lowland (Central Bureau of Statistics, 2011).

The government of Nepal introduced and implemented forest legislation in 1978 with the aim of diversifying the management tenures and reducing large-scale clearance of forest (Department of Forest, 2009). Thus, forests in Nepal are now managed under three major regimes: as state managed forests (forests managed by the central government), community managed forests (forests managed by local forest user groups), and protected forests (IUCN management categories I–IV). About 3.4 million hectares of the country's forests are currently protected areas (Department of Forest, 2009). Approximately 1.2 million hectares of forests are currently managed by the community forest user groups (>14,000 community forest user groups) (Kanel and Dahal, 2008; BCN and DNPWC, 2012) while ~1 million hectares of forests is directly managed by the central government (Shyamsundar and Ghate, 2011).

2.2. Study sites

A total of 112 sites were selected within lowland tropical forest within an elevational range of 90–300 m asl. These sites were allocated among three management tenures in approximate proportion to the available area within each. We randomly allocated survey sites within forests of each tenure type using digital vegetation mapping data. Initially, we chose 128 sites using a GIS, but based on accessibility, we ended up with 44 sites within community managed forests, 37 within the state managed forests and 31 within protected areas, including in Chitwan National Park and its buffer zone forest of Barandabhar corridor, Parsa Wildlife Reserve which have been managed for conservation for more than twenty-five years (Baral and Inskipp, 2005). The southern part of the Barandabhar core forest is managed by the park authority; its peripheral areas are community-managed forests. Geographically, 60 sites were located in the eastern landscapes (Eastern Terai forests) and 52 sites were located in the central lowland landscapes (Parsa and Chitwan forests). The vegetation of the lowland Terai is mainly consisted of *Shorea robusta* mixed forest. Therefore, all sites were located within the same vegetation type. All sites were located at least 500 m from roads to minimize any road induced variation on bird assemblages. The minimum distance between sites was at least 1000 m so as to reduce the chance of spatial dependence (see Fig. 1).

2.3. Bird surveys

Each study site comprised a belt transect measuring 200 m × 50 m. Study sites were demarcated by placing visible markers at each site and taking GPS coordinates. Each transect was surveyed on three occasions between November 2012 and May 2013. On each visit, the observer (BRD) recorded all birds seen or heard within 25 m of the centreline of the transect while walking along its length over a 10-min period.

Surveys were conducted only between 0600 and 1100 h in the morning and 1400 to 1745 in the afternoon. Although we did not test for effects of time of day on bird observation prior to actual field survey; several other studies reported that the detection rate of most bird species is greater in morning (Bried et al., 2011) with another peak in activity in the late afternoon, 2–3 h before sunset (Kessler and Milne, 1982). Generally birds tend to avoid the mid-day heat (Pizo et al., 1997), therefore we surveyed birds within 4 h after sunrise and within 3.45 h before sunset. To avoid possible bias, we standardized the survey protocol in such a way that although not all sites had afternoon surveys, this occurred equally among site categories, and so no bias was introduced due to this. All surveys were conducted by the same observer during fair weather at no heavy rain and wind.

2.4. Explanatory variables

Data on vegetation and habitat structure were collected at each bird survey transect. Using four randomly-located 20 m × 20 m quadrats, the percentage of tree canopy cover was estimated, the number of trees counted, and their diameters measured within the 20 m × 20 m quadrat. Tree cover was estimated visually (Pattison et al., 2011). We divided the quadrat into quarters, and assessment of tree canopy cover was determined by two observers for each quarter. The cover values for each quarter were then averaged and the four mean values for each quadrat averaged, before a grand mean was calculated for the site. Nested within each of the 20 m × 20 m tree quadrats was a 5 m × 5 m quadrat, used to collect understorey vegetation data. The shrub cover and number of individual shrubs were collected within each of these nested quadrat and the grand mean taken for each transect. We