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Raptor population trends in northern Botswana: A re-survey of road transects after 20 years

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ABSTRACT

Across Africa, many raptor species, especially vultures, are in steep decline. Botswana is regionally important for numerous raptor species including vultures, but recent population trends of raptors within this country are totally unknown. In 2015–2016 we repeated road transects for raptors across northern Botswana that were first conducted in 1991–1995. In total, we re-surveyed 20,712 km of transects. From these data we explored changes in abundance of 29 species. Fourteen species (48%) showed significant declines. Of these, 11 species declined by > 50% and three species declined by 37–50%. Non-significant declines of > 70% were shown for four species, of 30–65% for six species and of < 10% for a further two species. In contrast only three species, all large eagles – tawny eagle (*Aquila rapax*), brown snake eagle (*Circaetus cinereus*) and black-chested snake eagle (*Circaetus pectoralis*), showed significant but small increases of between 6 and 15%. For most species, population trends were similar both inside and outside of protected areas, with only two species showing significantly different trends. Declines of bateleur eagle (*Terathopius ecaudatus*) were lower inside protected areas. In contrast, brown snake eagles showed stable populations inside protected areas but large increases outside of protected areas. These re-surveys suggest extremely worrying trends for multiple raptor species in Botswana, and highlights the benefit of repeating historical surveys to understand population trends in countries that lack systematic monitoring of wildlife populations.

1. Introduction

Africa has some of the highest human population growth rates in the world (United Nations, 2015) resulting in unprecedented pressure on wildlife resources (Blom et al., 2004; Moinde-Fockler et al., 2006; Woodroffe and Ginsberg, 1999). Wildlife monitoring in Africa is less established than in more developed regions, however, wildlife trends appear to be following patterns of global declines (Blom et al., 2004; Caro and Scholte, 2007; Ogutu et al., 2011). Global wildlife population declines are principally driven by anthropogenic threats associated with increasing human populations and development (Balmford et al., 2001; Darkoh, 2003; McManus et al., 2015; Ogada, 2014; Remis, 2009; Thuiller et al., 2006).

Bird species across the world are declining (BirdLife International, 2013), with scavengers and carnivores showing some of the greatest declines (Buechley and Sekercioğlu, 2016; Ogada et al., 2012). Within Africa, these patterns have also been apparent, with large declines in many raptor species (Amar et al., 2015; Ogada et al., 2015; Virani et al., 2011). African vultures in particular appear to have suffered disproportionally large declines in recent decades, with many now describing the situation as an African vulture crisis (Krüger et al., 2014; Ogada et al., 2015) akin to that seen in Asia over the last 20 years (Green et al., 2004; Prakash et al., 2003). These declines have been reflected in the elevated threat status of many African vulture species by the International Union for the Conservation of Nature (IUCN) (IUCN, 2017; Ogada et al., 2015). However, our understanding of vultures' continental status suffers from knowledge gaps on population trends across many areas of the continent, including within many southern African countries outside of South Africa (Anderson, 2007; Monadjem et al., 2004).

Our current knowledge of raptor population trends in southern Africa comes from repeat atlas surveys (Amar et al., 2015; Hofmeyr et al., 2014) or repeat nesting surveys (Amar et al., 2015; Borello and Borello, 2002; Bridgeford and Bridgeford, 2003; Krüger et al., 2014). However, across Africa, road transects provide the main source of historical information for the greatest number of raptor species covering

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the largest areas (Ogada and Keesing, 2010; Thiollay, 2006a, 2007a; Virani et al., 2011). These types of surveys are particularly suitable for raptors, which often occur at low densities (Buij et al., 2013; Keys et al., 2012; Virani et al., 2011).

Within Africa, the protected area network is a primary strategy for species conservation (Burgess et al., 2007; Chape et al., 2005). Although not immune to threats (López-López et al., 2007; Pérez-García et al., 2011; Thiollay, 2006b), protected areas may buffer raptor populations from some of the key drivers of declines (Amar et al., 2015; Herremans and Herremans-Tonnoeyr, 2000; Thiollay, 2007a). Because of this, protected areas may be particularly important for raptors (Buij et al., 2013; Herremans, 1998; Ogada et al., 2015; Thiollay and Meyburg, 1988), especially as refuges for rare and threatened species (Sinclair et al., 2002; Turner et al., 2006). For example, the critically endangered white-headed vulture (*Trigonoceps occipitalis*) exists almost exclusively inside protected areas (Murn et al., 2016). For species like this, along with species that breed mostly within protected areas, protected areas are likely crucial for the species survival. However, they may have limited value for wide ranging species that spend much of their time outside of protected areas (Arroyo et al., 2002; Greyling, 2008; Lambertucci et al., 2014; Phipps et al., 2013; Van Eeden et al., 2017).

Botswana's low human population (2.3 million) and large proportion of protected areas (20%) and Wildlife Management Areas (WMAs) (20%) (Central Statistics Office, 2002; Kootsositse et al., 2009) make it an important country for African raptor populations (Herremans and Herremans-Tonnoeyr, 2000). Botswana supports a number of raptor species listed by the IUCN as threatened; including the Vulnerable martial eagle (*Polemaetus bellicosus*) and secretarybird (*Sagittarius serpentarius*), as well as migrant species such as the steppe eagle (*Aquila nipalensis*) (Endangered) and five species of vulture, all of which are either endangered or critically endangered (IUCN, 2017).

No systematic monitoring of raptors occurs in Botswana, but historical raptor road transects carried out in 1991–1995 by Herremans and Herremans-Tonnoeyr (2000) provide a unique baseline survey to explore changes in the abundance of raptors in this region over the last 20 years. In this study we repeat a proportion of Herremans' (2000) transects in northern Botswana during 2015–2016. We also explore whether changes in abundance differ inside or outside of protected areas, as has been found elsewhere (Thiollay, 2007b).

2. Materials and methods

2.1. Study area

Botswana covers an area of c. 580,000 km^2 (FAO, 2017) (Fig. 1). The country has amongst the lowest densities of people globally at around 2.3 million (World Population Review, 2017). Forty percent of the country is designated for the conservation of wildlife through protected areas (20%) and Wildlife Management Areas (WMAs) (20%) (Mbaiwa, 2005). Around half of the country is communal land, with agriculture (mostly free ranging livestock rearing) being the most predominant land use outside of protected areas (Central Statistics Office, 2013). Rainfall occurs in the Austral summer between November and April (the wet season) and ranges from an average of 250 mm in the south-west to 650 mm in the north and north-east (Barnes, 2001). During the wet season temperatures are high (18–45 °C). Rain ceases between May and October (the dry season) and temperatures are much lower between May and August (−5–25 °C). Our repeat surveys were conducted in the north of Botswana (north of latitude −22°) which is an area of around 240,000 km^2 (Fig. 1). It encompasses the majority of land mass designated as protected areas and six of the twelve nationally designated Important Bird Areas (Kootsositse et al., 2009). Around 25% of the total population lives in northern Botswana (Statistics Botswana, 2011). It holds approximately 30% of the country's traditionally farmed livestock populations and has far more abundant wildlife populations than the south of the country (Statistics Botswana, 2015a, 2015b).

2.2. Road transects

We repeated Herremans and Herremans-Tonnoeyr (2000) raptor road transects (hereafter Herremans' survey) in northern Botswana (Fig. 1) in 2015–2016 (Table 1). We aimed to repeat these surveys using the same approach as the original surveys in all respects. We used the original data to help facilitate repetition of the surveys to match them as closely as possible both in time and in space. Herremans' original surveys covered the whole of Botswana and comprised a total of 55,577 km of transects. However, due to logistical and time constraints, we resurveyed only those transects in the north of the country. The northern transect included the degree grid-squares (DGSs) north of latitude −22°; with the exception of 4 DGSs (latitude of −23°) that were included in the study because some of the main transects briefly passed through them. Herremans' original survey in northern Botswana covered 28,864 km of transects. It encompassed both the wet (16 October–15 April) and dry (16 April–15 October) seasons, and we attempted to match the re-surveys of specific transects with the months when the original transects were completed. To repeat the transects we followed Herremans' route descriptions and the DGSs associated with them.

A driver and additional observer (in the passenger seat) drove the transects and recorded all diurnal raptors sighted, including perched or flying birds. We used the same vehicle (Toyota Hilux 4 × 4 double cab) throughout the study, which was very similar to that used in the early surveys (Nissan One-tonner). We recorded the GPS location and species observed for each sighting. We conducted transects during daylight hours between 0630 and 1830 following Herremans' study, and in keeping with their surveys we began transects later in the winter to allow for thermaling and therefore improved visibility of larger raptors when using thermals rather than when perched. All GPS tracks were saved to ensure future repeatability. The principle driver/observer remained the same for all transects, but seven secondary observers were used. As with Herremans' study we recorded all raptors seen with the naked eye, only stopping and using binoculars (8 × 42) and a digital camera with a 500 mm optical zoom to help with species identification.

Individual transect routes varied from 65 km to 585 km (Table 1). Each transect route followed that of the original study; however, distances varied slightly due to changes in road networks over time and due to interpretation of original transect route descriptions (no GPS coordinates were available 20 years ago during the original surveys). We did not repeat a transect route during the same day, but several routes were repeated on different days as in the original surveys. Average speed driven was 42 km/h but differed depending on terrain, we followed the speeds used during the original Herremans' surveys of 20 km/h for sand/gravel roads and 59 km/h for paved roads (Table 1).

Raptors counted along transects were sub-divided by the DGS (c. 100 km × 100 km) through which they passed (Fig. 1), as did the Herremans' surveys. We recorded data from transects conducted on different dates in the same DGSs separately. To differentiate between transects inside and outside of protected areas (PAs), individual sub-transects (because some full transects passed through protected and non-protected areas) were allocated protected or non-protected status (Table 1). Classification of PA and Non-PA transects for both the original and current surveys were based upon the current distribution of official government protected areas only. Protected area (national parks) boundaries have remained the same since the original study.