



Quantifying the scale and socioeconomic drivers of bird hunting in Central African forest communities

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ABSTRACT

Global biodiversity is threatened by unsustainable exploitation for subsistence and commerce, and tropical forests are facing a hunting crisis. In Central African forests, hunting pressure has been quantified by monitoring changes in the abundance of affected species and by studying wild meat consumption, trade and hunter behaviour. However, a proportion of offtake is also discarded as bycatch or consumed by hunters when working, which can be overlooked by these methods. For example, remains of hornbills and raptors are found regularly in hunting camps but relatively few birds are consumed in households or traded in markets. Hornbill and raptor populations are sensitive to small increases in mortality because of their low intrinsic population growth rates, however, the scale and socioeconomic drivers of the cryptic hunting pressure affecting these species have not been quantified. We used direct and indirect questioning and mixed-effects models to quantify the socioeconomic predictors, scale and seasonality of illegal bird hunting and consumption in Littoral Region, Cameroon. We predicted that younger, unemployed men with low educational attainment (i.e. hunters) would consume birds more often than other demographics, and that relative offtake would be higher than expected based on results from village and market-based studies. We found that birds were primarily hunted and consumed by unemployed men during the dry season but, in contrast to expectations, we found that hunting prevalence increased with educational attainment. Within unemployed men educated to primary level (240 of 675 respondents in 19 villages), we estimated an average of 29 hornbills and eight raptors (compared with 19 pangolins) were consumed per month during the study period (Feb–Jun 2015) in a catchment of c.1135 km². We conclude that large forest birds face greater hunting pressure than previously recognised, and birds are a regular source of protein for men during unemployment. Offtake levels may be unsustainable for some raptors and hornbills based on life history traits but in the absence of sufficient baseline ecological and population data we recommend that a social-ecological modeling approach is used in future to quantify hunting sustainability.

1. Introduction

Overexploitation is the greatest immediate threat to global biodiversity (Maxwell et al., 2016; Benítez-López et al., 2017) and a growing hunting crisis threatens forest species, ecosystems and food security in

Asia, Africa and South America (Milner-Gulland and Bennett, 2003; Abernethy et al., 2013; Ripple et al., 2016; Benítez-López et al., 2017). For affected taxa, the direct consequences of excessive hunting are population declines and, in some cases, extirpation (Maisels et al., 2001). The indirect consequences are manifold and include the

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disruption of trophic cascades, reduced ecosystem functioning and changes in forest structure (Abernethy et al., 2013). For example, hunting of frugivorous birds and monkeys in Brazil's Atlantic rainforest reduced carbon storage capacity through the disruption of seed dispersal processes (Culot et al., 2017). Unsustainable hunting can therefore have wide reaching consequences for ecosystems and people who rely on forest resources for subsistence and commerce.

In Central and West Africa, where bushmeat (hereafter 'wild meat'; Milner-Gulland and Bennett, 2003) hunting is ubiquitous, there has been a focus on quantifying offtake of commercially valuable taxa, with an emphasis on the trade and consumption of large-bodied mammals (Fa et al., 2000; Brashares et al., 2004; Cowlishaw et al., 2005; Fa et al., 2006; Supplementary material in Benítez-López et al., 2017). However, the focus on commercial markets may have underestimated the diversity and abundance of hunted species because bycatch and local consumption (e.g. in villages or by hunters) is overlooked. Consequently, offtake of other less valuable taxa may have been underestimated (Trail, 2007; Fa et al., 2006). Extensive surveys of wild meat markets in Ghana failed to detect large-scale hunting of fruit bats (Kamins et al., 2011) and in Cameroon relatively few birds are sold in markets (Fa et al., 2006) but birds are killed regularly by hunters (Whytock et al., 2016). In West Africa, raptors are sold as 'fetish' for use in traditional medicine, witchcraft and as wild meat (Buij et al., 2016), but total numbers are low relative to mammals (e.g. in Nigeria: Fa et al., 2006), and this may have led to complacency over the threat that hunting poses to birds in the region.

It is widely acknowledged that hunting threatens game birds, hornbills and raptors in Asian and South American tropical forests (e.g. Thiollay, 2005; Dasgupta and Hilaluddin, 2012; Beastall et al., 2016), but evidence from Central and West Africa is equivocal. In the Republic of Congo and Gabon, hunting had a minimal effect on hornbills relative to mammals, and hunting appeared to indirectly 'benefit' some frugivorous hornbills due to competitive release (Poulsen et al., 2011; Koerner et al., 2017). In contrast, White-breasted Guineafowl abundance was lower in hunted forests in the Ivory Coast (Waltert et al., 2010). Improved access to firearms in recent years may have made birds and arboreal mammals more accessible to hunters in Central Africa, and demand for smaller taxa such as rodents and birds is expected to increase when populations of large-bodied mammals decline (Fa et al., 2000; Cowlishaw et al., 2005). Thus, even if birds have not historically been threatened by hunting pressure, hunting regime shifts could now pose a threat, particularly in heavily hunted areas (Benítez-López et al., 2017).

Rodents and small mammals such as blue duiker *Philantomba monticola* can tolerate high levels of hunting pressure (Cowlishaw et al., 2005), but hornbills and other relatively large-bodied birds are vulnerable to over-exploitation due to their slow life histories (Owens and Bennett, 2000; Thiollay, 2005; Sreekar et al., 2015). Known hunted species in Central Africa such as black-casqued hornbill *Ceratogymna atrata* and palm-nut vulture *Gypohierax angolensis* have low fecundity, producing a maximum of one (rarely two) offspring per annum, and population densities are intrinsically low (Stauffer and Smith, 2004). Declines of other large-bodied birds with similar life-history traits also provide forewarning, and Africa's savannah vulture populations have undergone recent, continent-wide declines due to persecution and hunting for belief-based use and meat consumption (Ogada et al., 2015).

Contrary to SE Asia and S America, where commercial bird hunting is common (Thiollay, 1984; Thiollay, 2005; Beastall et al., 2016), in Africa the international and local trade of hornbill body parts is relatively small or almost non-existent, and hornbill skulls, feathers and other body parts are regularly discarded as wastage in forest hunting camps (e.g. in Cameroon). This suggests that, although hunting does occur, birds have relatively low commercial value (Whytock et al., 2016). Actually, hunters might consume birds instead of commercially valuable meat when working from forest camps, thus maximising

profits (Whytock et al., 2016). However, hunters are reluctant to discuss potentially illegal activities for fear of recrimination, and establishing the scale and drivers of this cryptic, non-commercial hunting pressure is therefore challenging.

Here, we combined direct and indirect questioning, which gives respondents anonymity and prevents self-incrimination (Unmatched Count Technique: Nuno et al., 2013; Nuno and St. John, 2015), to quantify the scale, seasonality and socioeconomic drivers of bird hunting and consumption in Littoral Region, Cameroon. For comparison, we also quantified consumption of small mammals to compare relative offtake levels. Based on previous work in our study area, which found a relatively high number of bird remains discarded in forest hunting camps (Whytock et al., 2016), we expected that (1) birds would be hunted and consumed by younger, unemployed males with low educational attainment (i.e. the assumed demographic of hunters in our study area), and (2) bird offtake would be higher than estimated by market and village-based studies, assuming that most birds are consumed in the forest by hunters rather than sold commercially or extracted to villages.

2. Methods

2.1. Study area

Nineteen villages were surveyed in the Nkam and Sanaga Maritime departments of Cameroon's Littoral Region. Villages bordering the proposed Ebo National Park that use the forest for hunting were selected for surveys (ENP; Fig. 1). The ENP (c.1135 km²) is characterised by lowland and sub-montane closed canopy forest, with subsistence farming and oil-palm plantations at its edge (Morgan, 2008).

The Ebo Forest Research Project was established in 2005 and conducts a permanent programme of conservation research and education in the ENP and its surroundings. Local communities are therefore familiar with basic wildlife law in Cameroon. There has also been a high-profile increase in wildlife law enforcement in Cameroon during the past decade (Last Great Ape Organization, 2014) and very few hunters are thought to have the legal permits required to hunt wildlife or own a firearm (quantitative data unavailable). Hunters are therefore reluctant to discuss their activities for fear of prosecution.

2.2. Bird hunting prevalence

To quantify bird hunting prevalence, we used the Unmatched Count Technique (UCT: Droitcour et al., 1991), which has been successfully used to quantify illegal hunting prevalence in East and Central African hunting communities (Nuno et al., 2013; Harrison et al., 2015; Nuno and St. John, 2015). We approached potential respondents ≥ 18 years old and asked if they would like to participate. A coin toss was used to randomly assign consenting respondents to a treatment or control group. We then used a scripted questionnaire (Supplementary material) to record demographic variables (gender, age, place of upbringing, educational attainment and employment status) before asking two UCT questions, which were (1) How many of these activities do you do in the dry season? and (2) How many of these activities do you do in the wet season? The control UCT list included four non-sensitive activities, which were 'transport commercial timber', 'buy from the market', 'farm work' and 'construction work' and the treatment UCT list included the additional sensitive activity 'hunt birds with a slingshot or gun'. Questionnaires, historic census data for the study area and additional information on the UCT method are given in Supplementary material.

The UCT is dependent on respondents' understanding and willingness to participate. We therefore asked respondents if the questionnaire was easy to understand, if they felt anonymous, and if they felt comfortable answering the questions. The interviewer also assessed how well respondents understood the interview, how willing they were to participate, and if they were perceived to be honest.

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