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Uncovering the fruit bat bushmeat commodity chain and the true extent of fruit bat hunting in Ghana, West Africa

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ABSTRACT

Harvesting, consumption and trade of bushmeat are important causes of both biodiversity loss and potential zoonotic disease emergence. In order to identify possible ways to mitigate these threats, it is essential to improve our understanding of the mechanisms by which bushmeat gets from the site of capture to the consumer's table. In this paper we highlight the previously unrecognized scale of hunting of the African straw-colored fruit bat, *Eidolon helvum*, a species which is important in both ecological and public health contexts, and describe the commodity chain in southern Ghana for its trade. Based on interviews with 551 Ghanaians, including bat hunters, vendors and consumers, we estimate that a minimum of 128,000 *E. helvum* bats are sold each year through a commodity chain stretching up to 400 km and involving multiple vendors. Unlike the general bushmeat trade in Ghana, where animals are sold in both specialized bushmeat markets and in restaurants, *E. helvum* is sold primarily in marketplaces; many bats are also kept by hunters for personal consumption. The offtake estimated in this paper raises serious conservation concerns, while the commodity chain identified in this study may offer possible points for management intervention. The separation of the *E. helvum* commodity chain from that of other bushmeat highlights the need for species-specific research in this area, particularly for bats, whose status as bushmeat is largely unknown.

1. Introduction

The consumption of wild animals as meat, a product often called bushmeat, poses challenges for both wildlife conservation and human well-being. These challenges include depletion of threatened and endangered species (Milner-Gulland et al., 2003); the transmission of zoonotic diseases (Daszak et al., 2000; Wolfe et al., 2005); threats to the food and economic security of some of the poorest countries (Bennett et al., 2007); and the loss of vital ecosystem services, like pollination and reforestation, that are necessary for human wellbeing (Ehrlich and Wilson, 1991; McConkey and Drake, 2006).

As people frequently are dependent on bushmeat as a vital source of protein or income (Wilkie et al., 2011), it is necessary to assess the sustainability of bushmeat hunting before population crashes damage both human and ecosystem health. Using bushmeat marketplaces to monitor the status of hunted species (see Rowcliffe et al., 2003, Juste et al., 1995, Fa et al., 2003) circumvents many of the resource limitations of other, more direct techniques; however, it is also dependent on all species of concern making it to market. A growing body of research is beginning to answer questions of the species involved, extraction rates, impacts on biodiversity and socioeconomic aspects of the bushmeat trade (for example see Mbete et al., 2011; Wilcox and Nambu, 2007); but the structure of this trade is still poorly documented. Unraveling the commodity chain from capture to consumption for each species involved is vital to understanding how best to manage the trade, mitigate its potentially deleterious effects and powerfully utilize techniques like market surveys (Cowlishaw et al., 2005b).

Here we consider the bushmeat trade of the African straw-colored fruit bat, (*Eidolon helvum*) in Ghana. Little is known of the use of this species as bushmeat, and 31 supposedly comprehensive bushmeat survey papers failed to report anything on bats (Mickleburgh et al., 2009). A number of reports, however, mention the massive threat many species of fruit bats face as a result of severe

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overhunting (e.g. Struebig et al., 2007), and the IUCN Red List reports *E. helvum* as a near-threatened species due to overhunting (IUCN, 2010). The disparity between the lack of fruit bats being recorded in markets in Ghana where other types of bushmeat are found for sale (e.g. Cowlishaw et al., 2005b) and the reports of overhunting may indicate that bats do not follow a typical bushmeat commodity chain and standard bushmeat surveys may therefore be underestimating impacts. *E. helvum*, like many bat species, is especially vulnerable to hunting, due to a slow reproductive rate (Mutere, 1965). It is also an extremely widespread and highly mobile species (DeFrees and Wilson, 1988; Richter and Cumming, 2005) which could, in principle, help to reduce impacts if hunting is localized and limited. However, *E. helvum* congregates in large, predictable roosts (Happold and Happold, 1978), exposing a large proportion of the wider population to hunting, and likely resulting in widespread impacts across the range.

Furthermore, *E. helvum* plays an important role in seed dispersal and regeneration of valuable natural products (Taylor et al., 2000; Kankam and Oduro, 2009); overhunting of *E. helvum* could severely damage its ability to provide these vital ecosystem services. Another significant concern is that *E. helvum* may be host to several zoonotic or potentially-zoonotic infections of high public health importance, including henipaviruses (Hayman et al., 2008a), lyssaviruses (Kuzmin et al., 2008; Hayman et al., 2008b) and Ebola virus (Hayman et al., 2010). Unveiling the extent of the commodity chain would be the first step towards the identification of potential risk groups for zoonotic transmission.

We undertook this study at a number of sites across southern Ghana. The initial focus for the study was the city of Accra, which holds a massive seasonal colony of 250,000–1 million *E. helvum* individuals (Hayman, 2008), and where we had observed local hunting and consumption of *E. helvum* prior to this study. Given the large numbers and dense, highly visible roosting of *E. helvum* in Accra in comparison to other bat species, we expected that it would be the predominant bat species used as bushmeat in the city. There is a notable scarcity of bats in published reports of the bushmeat trade in Ghana (e.g. Brashares et al., 2004; Cowlishaw et al., 2005b), which led us to hypothesize that the use of bats as bushmeat had been underestimated. The primary aim of our study, therefore, was to evaluate the numbers of fruit bats in general, and *E. helvum* in particular, that are hunted or sold in southern Ghana as bushmeat. If our hypothesis of a previous underestimation of the presence of fruit bats in the bushmeat trade was confirmed, we aimed to understand why this might have occurred. Finally, we sought to establish if hunted *E. helvum* passed through the same commodity chain as other Ghanaian bushmeat, and from where these bats were sourced.

2. Materials and methods

2.1. Study area

We examined two cities: Accra (5°33′N, 0°11′W) and Kumasi (6°41′N, 1°37′W); a town: Nkawkaw and surrounding villages (6°33′N, 0°46′W) and two broader localities in the Volta Region (7°12′N, 0°19′W), and the Afram Plains (7°2′N, 0°4′W), all located within southern Ghana. Accra is the capital of Ghana, with an urban population of 1.6 million in the 2000 census (Ghana Statistical Service, 2002). With 1.4 million inhabitants, Kumasi is the second largest city in Ghana, located to the northwest of Accra in the Ashanti region (Ghana Statistical Service, 2002). In Kumasi there is a large central market, where bushmeat is sold, as well as a bushmeat-specific market. Nkawkaw is a small, rural town in the hills of the Eastern Region, located along a major road that runs from Accra to Kumasi. Markets in this region are very small, usually supplying a single village. The Volta Region stretches along the eastern border of southern Ghana. Each town in the Volta Region has a central market that is active on a given market day each week. The Afram Plains lie in the easternmost part of the Eastern region, nestled into the western shores of Lake Volta. As in other parts of Africa (Milner-Gulland et al., 2003), farmers in the Volta Region and the Afram Plains often hunt bushmeat for food, for additional income and to protect their crops.

2.2. Questionnaires

In order to obtain information about the use of bats as bushmeat, we conducted face-to-face interviews using a standardized questionnaire. Since previous studies had not shown extensive bat hunting in Ghana, we initially directed interviews to hunters we witnessed shooting *E. helvum* and to vendors selling *E. helvum* in the markets. These interviewees provided details of other hunters and vendors, and thus we were able to penetrate the entire commodity chain through a cascade effect. In addition, we conducted convenience sampling in each of our sites by standing at the entrance to each main market place, or along the only main road of each small village, in our study sites and by choosing for interview the first person who walked by at exactly 5 min after we had completed our previous interview. All interviews were conducted in person first in English, with a local Ghanaian translator translating if the interviewee did not understand something. Fruit bats are legal to hunt, and there is no taboo or stigma associated with consuming bats across southern Ghana. All interviewees were relaxed and comfortable answering our questions.

Interviews were conducted in November 2009 and February 2010, and these enabled us to trace the bat bushmeat commodity chain in southern Ghana. From our interviews, we identified four actor types involved in the bat bushmeat trade: hunters, vendors, chopbar (local restaurant) owners and individual consumers. We further identified hunters as either (1) subsistence hunters, who hunted bats only for personal or family consumption, or (2) commercial hunters, who hunted bats to obtain an income. We defined vendors as individuals who retailed bats that someone else had captured. We classified primary vendors as those who bought bats from hunters, and secondary vendors as those who bought bats only from other vendors. Vendors were predominantly located in markets, although a few were "wandering vendors" in the street. We also distinguished between "active" and "inactive" hunters and vendors, using activity within the last 12 months as the cut-off between the two states.

Our questionnaire design was informed by a previous survey of bushmeat trade in southwestern Ghana (Cowlishaw et al., 2005b). We used a standard questionnaire, comprised of both multiple-choice and open-ended questions, for all respondents. This questionnaire enquired about demographic information of the respondent, interactions with bats (e.g. hunting or eating of bats), beliefs about bat bushmeat, perceptions of disease risks from bats, and general meat preferences. We asked any respondent that sold or hunted bats to complete additional questionnaires relating to these activities, which asked for details such as the frequency and locations of bat hunting or purchasing of bats. We interviewed a total of 551 people in southern Ghana (Table 1). We also visited a variety of market places in an attempt to assess the numbers and species of any bats being sold.

2.3. Analyses

The sporadic occurrence of fruit bats in bushmeat markets ultimately made direct market counts unfeasible as a means of estimating numbers of bats traded. We therefore used interview responses to estimate the numbers of bats hunted (N_H) and sold