



## Charismatic species of the past: Biases in reporting of large mammals in historical written sources

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### ABSTRACT

Long-term biodiversity occurrence records are key to quantify long-term biodiversity patterns and trends and inform the conservation of threatened species, but they are strongly biased in terms of the species represented. This taxonomic bias, and its correlation to societal preferences, is well-identified in modern biodiversity datasets. However, it remains to be investigated, and its basis understood, in long-term occurrence datasets assembled from historical sources. Here we investigate taxonomic bias for 38 species of large terrestrial mammals using a dataset of 780 historical occurrence assembled from 16th to mid-19th century historical written sources in South Africa. We test if this bias is related to species' historical charisma, using a functional definition of non-human charisma, supported by anecdotes from the historical literature. We identify a strong taxonomic bias, with up to several order of magnitudes of difference in the likelihood of reporting between some species. Species' charisma alone explains 75% of the observed variance, the most charismatic species being largely over-reported. This is the first evidence of a positive relationship between taxonomic bias and charisma in a historical biodiversity dataset, within a homogeneous taxonomic group such as large terrestrial mammals. These results improve our understanding of the relationship between people and the large terrestrial fauna in historical times and suggest that species' charisma is a good predictor of taxonomic bias in long-term biodiversity datasets. This provides background for modern conservation by illustrating the durability of the charisma concept and of its relation with taxonomic bias, with implications for the representativeness of species in long-term conservation studies.

### 1. Introduction

Historical biodiversity datasets are key to detect and quantify long-term human impacts on biodiversity and inform the conservation of threatened species (Willis et al., 2007; Tingley and Beissinger, 2009; Turvey et al., 2015; Mihoub et al., 2017). Historical species lists, and particularly variations in the number of species counted at a site over time, may reflect biologically meaningful patterns of past communities of earlier ecosystems, which can be used to investigate species declines (Szabo et al., 2010). However, recorded differences in species richness may also reflect sampling biases that naturally arise from data collected opportunistically without modern sampling protocols. Of the four types of biases identified in long-term biodiversity datasets – geographical, environmental, temporal and taxonomic (Soberón et al., 2000; Newbold, 2010) – the latter has been the least investigated. However, taxonomic bias can lead to strong misconceptions of what communities and ecosystems used to look like, such gaps in knowledge affecting our understanding of biodiversity patterns and response to changes (McKinney, 1999; Feeley et al., 2017).

Taxonomic bias in conservation science has long been recognized (Clark and May, 2002) but the underlying processes that cause it are unclear. Previous studies that have investigated correlates of taxonomic bias in biodiversity datasets show a bias towards species that are more locally abundant (Royle and Nichols, 2003), or easily identified (Boakes et al., 2016). A recent study identified a strong correlation between societal preferences and taxonomic bias (Troudet et al., 2017), with the most popular species being also the species with the most records in biodiversity databases. These studies typically compared higher taxonomic groups (e.g. mammals, birds, reptiles, insects, plants, invertebrates) in modern datasets. The evolution of taxonomic bias over time has rarely been examined (Troudet et al., 2017) and, to our knowledge, no study has investigated if its relation to societal preferences is stable through time.

In southern Africa, historical accounts written by European settlers, missionaries, naturalists and explorers of the 16th to 20th century provide valuable information on the past composition of mammal fauna, but the taxonomic biases in these records remain to be investigated and understood. To report a species' presence in written

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accounts, an observer has to 1) detect the species, whether through direct sightings or indirect cues (e.g. footprints, scats, sound, presence of burrows), and 2) be willing to report it. The latter condition is probably driven by his or her own perception of the different species he or she encounters in the field. Similar to modern societal preferences (Troudet et al., 2017), species' charisma might be a key trait that contributes to taxonomic bias in historical reporting of biodiversity.

Wildlife charisma is a modern concept with strong implications for the use of species as flagships for conservation (Leader-Williams and Dublin, 2000), as attractions for tourism (Goodwin and Leader-Williams, 2000), and even as a marketing strategy (Feldhamer et al., 2002). The term *charismatic* was first coined for nonhuman use in the conservation literature in the 1980's (Myers, 1983; Western, 1987), and has since been used as one of the traits to identify flagship species in conservation (Heywood, 1995; but see Verissimo et al., 2011). While many recent articles use this expression, there is little consensus on a functional definition (Ducarme et al., 2013). In an attempt to map nonhuman charisma, Lorimer (2007) defined it as “the distinguishing properties of a nonhuman entity or process that determine its perception by humans and its subsequent evaluation”, insisting that the perception of charisma is subjective and dependent on the human population considered. Lorimer (2006, 2007) then provides a typology of the factors that define nonhuman charisma, describing it as an amalgam of “detectability and distinctiveness” (DETEC - how likely people are to see or hear a species and their ability to distinguish it from similar taxa), “socioeconomic biases” (ECON - the economic costs and benefits of species to different land users), “aesthetics” (AESTH - the distinguishing properties of an organism's behaviour and appearance that trigger particular emotions, both positive or negative, in those humans it encounters), and “intellectual satisfaction” (INTELL - the emotions experienced by humans in their practical interactions with an organism or group of organisms in the field). Understanding the persistence or durability of the *nonhuman charisma* notion can help us interpret the long-term relationships of humans with nature and how present conservation values came about. As Rangarajan puts it in a review of the conservation dilemmas in Africa, “by knowing better what choices were made in the past, when and why, the dilemmas of the present can be seen in a more holistic way” (Rangarajan, 2003:77).

Here we aim to identify the taxonomic bias in a dataset of historical occurrence records of large terrestrial mammals collected from written sources of the 16th to mid-19th century in South Africa. We hypothesize that this taxonomic bias is related to the perception and attitude of people towards the large mammal fauna, approximated by species' charismatic value. We test whether this hypothesis is supported by a positive relationship between the reporting bias in the South African dataset and the perceived charisma of species.

## 2. Study area

We focused on the Cape Floristic Region planning domain in southwestern South Africa, an area for which we have data on the estimated historical relative abundance of each species in the dataset (Kerley et al., 2003b). It includes the Cape Floristic Region (CFR) and an extension of approximately 60 km beyond the boundaries of the CFR, for a total of 122,590 km<sup>2</sup>, as described in Kerley et al. (2003b). The CFR is a global priority for conservation action and is listed as a biodiversity hotspot of global significance (Myers et al., 2000), for its diversity of endemic flora and fauna.

## 3. Methods

### 3.1. Historical occurrence records

We used a dataset of 780 historical occurrence records of large terrestrial mammals (31 species in 10 families) within the CFR planning domain, this assembled from letters, journals, diaries or books written

by literate pioneers in southern Africa (Boshoff et al., 2016). This dataset comes from a compilation of written distribution records extracted from a range of key references (e.g. Skead, 1980, 2011; Rookmaaker, 1989, 2007) and complemented with additional occurrence records previously overlooked in literature sources (Boshoff et al., 2016). The first record dates back to 1497, when the Portuguese explorer Vasco de Gama reported the presence of elephants in Mossel Bay (in Colvin, 1912). We only considered records collected before 1850, after which the impact of European settlers on the large mammal fauna in the study area increased significantly, from direct hunting pressure, increased predator control (Skead, 2011:426), loss of habitat due to the growth of the stock industry (Skead, 2011:436) and the development of roads and railways (Van Sittert, 2005:277). The reliability of these records in terms of identification and locality is discussed in Boshoff and Kerley (2010).

### 3.2. Taxonomic bias

We quantified the taxonomic bias in the historical dataset as the ratio between the observed relative frequency of species in the historical dataset, and their expected relative frequency based on estimated historical relative abundances, obtained from an independent study (Kerley et al., 2003b).

#### 3.2.1. Observed relative frequency

Each occurrence in the dataset may correspond to one or more individuals observed, particularly for gregarious species. To calculate observed reported abundance, we multiplied the number of times each species appeared in the dataset by an estimate of the average group size for that species, as an estimate of the actual number of individuals seen by observers. Values of mean average group size for each species were extracted from the literature and are detailed in Appendix (Table A.1). We calculated species' observed relative frequency as the ratio between each species observed reported abundance and the sum of all species' reported abundances.

#### 3.2.2. Expected relative frequency

Kerley et al. (2003b) estimated the potential historical abundance of the large and medium-sized mammals in the Cape Floristic Region, calculated from estimates of historical distribution and the densities, social structure, territory sizes and home ranges for carnivore species, and forage availability estimates and metabolic requirements for herbivores. Their study includes 41 large and medium-sized mammal species (mass > 2 kg) indigenous to the CFR, but excluded the hippopotamus *Hippopotamus amphibius* and the African clawless otter *Aonyx capensis* (Kerley et al., 2003b). We did not include four species that have marginal habitat in the study area (cheetah *Acinonyx jubatus*, gemsbok *Oryx gazella*, oribi *Ourebia ourebi* and warthog *Phacochoerus aethiopicus*) and extracted potential historical abundance for the remaining 37 species. We calculated each species' historical expected relative frequency as the ratio between that species' historical abundance and the sum of all species' abundances.

#### 3.2.3. Reporting bias index

The reporting bias index ( $B_i$ ) for each species ( $i$ ) is the ratio between that species' observed relative frequency in the historical dataset and its expected historical relative frequency. A value of  $B_i > 1$  means that the species was over reported compared to what would be expected given its estimated historical abundance (and vice versa for  $B_i < 1$ ). Seven species were not recorded in the historical dataset despite being historically present in the study area (aardvark *Orycteropus afer*, aardwolf *Proteles cristata*, African wild cat *Felis silvestris lybica*, Cape fox *Vulpes chama*, honey badger *Mellivora capensis*, mountain reedbuck *Redunca fulvorufula* and small spotted cat *Felis nigripes*). We assigned a value of  $B_i = 0.01$  to these species, representing a very low (about 1/4 of the lowest value for reported species) but non-null reporting bias index,

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