Is climate change influencing the decline of Cape Vultures and Bearded Vultures in southern Africa

Robert Simmons
University of Cape Town

COMMENTARY

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Robert E. Simmons & Andrew R. Jenkins

Summary

Traditionally, the decline of vulture populations in southern Africa has been explained by decreased access to food, various sources of unnatural mortality (in particular, poisonings, electrocutions and collisions) or habitat loss that occurs commonly across the subcontinent. Despite the establishment of numerous vulture restaurants, and years of campaigning to reduce the use of poisons and vulture-unfriendly utility structures in an effort to minimize some of these harmful anthropogenic effects, we note that populations of most vultures continue to decrease. Here we propose that global warming factors are consistent with many trends that we see in the demise of two of the larger, montane vulture species present in the region: the two northern-most colonies of Cape Vultures have gone extinct; a southern colony is the only one showing expansion; the lowland breeding sites of the Cape and Bearded Vulture have disappeared first around Lesotho causing both species' range to retract into the highlands of Lesotho; and equatorial populations of Bearded Vultures in Kenya have gone extinct. Each of these has occurred in the period (1950s to present) when the earth's temperature has been rapidly climbing to records levels. Each can plausibly be explained therefore by climatic warming over the vultures' range. Climate change may work in concert with these other factors to change habitats and ultimately reduce prey populations. We suggest tests involving north-facing colonies that can further tease apart the direct negative influences of climate change over poisons, food reduction and habitat loss. The close focus on immediate proximate factors may have clouded our perception of over-arching mortality factors, and as the cloud clears we may become aware of the "elephant in the room" that may be the real culprit in the demise of our charismatic vultures.

Introduction

Climate change is known to be rapidly changing the earth into a warmer and more storm-prone planet (Emanuel 2005). In many northern hemisphere regions this results in greater rainfall and flooding while in the southern hemisphere climate change mainly results in lower rainfall and lower soil moisture, altering plant growth and distribution (IPCC 2001, Midgley ***et al.*** 2001) and changing sea surface conditions (Timmerman ***et al.*** 1999). The present 1 in a 100-year drought in Australia and the record number of hurricanes impacting the United States are manifestations of these global changes. Biological impacts from these climatic changes are global and sometimes severe. The meta-analyses of Root ***et al.*** (2003) and Parmesan & Yohe (2003) indicate that over 400 species of plants and animals have shifted their distributions or changed their flowering or breeding phenology, and in several cases disappeared (Parmesan 2006). For example, the Golden Toad ***Bufo periglenes***, found in the cloud forests of Costa Rica, is now extinct, apparently as a result of fungus infections proliferating in a warmer environment (Pounds ***et al.*** 1999). It is a truism that mountain-top species are at high risk because of the lack of escape options open to them (Thomas ***et al.*** 2004). So what of mountain-dwelling bird species?

The endemic Cape Vulture ***Gyps coprotheres*** is a globally "Vulnerable" species found only around cliffs in southern Africa (Mundy ***et al.*** 1992, BirdLife International 2004), while the Bearded Vulture Gypaetus barbatus, classed as "Endangered" in South Africa (Anderson 2000a), is restricted to alpine habitats across Asia and sporadically across Africa. Both species are decreasing in most regions in Africa (Boshoff ***et al.*** 1998, Anderson ***et al.*** 2004, Boshoff & Anderson 2006, CBSG 2006,). This is typically and commonly attributed to the effects of poisons, mainly because of the large number of vultures that are known to have died in poisoning incidents (Brown 1991b, Simmons 1995, Anderson 2000b). Given that the largest Cape Vulture colonies, and the highest numbers and densities of extant Bearded Vulture nest sites, remain in areas relatively free of poisons but adjacent to either communal grazing, or natural food sources in protected areas, a lack of adequate food supply is also seen as a critical factor in the demise of both these species (Vernon 1988, Benson ***et al.*** 1990, Boshoff & Anderson 2006, CBSG 2006). Other sources of mortality which have been implicated on many occasions for vulture deaths are drownings (Anderson ***et al.*** 1999), electrocutions, collisions and harvesting for traditional medicines (Mundy ***et al.*** 1992, Anderson ***et al.*** 2004).

Our aim here is to question whether these species are already suffering population decreases because of climate change. We do so by comparing various predictions based on climatic factors with known population trends. We also provide future research avenues that allow climate change questions to be investigated using the long-term data that already exist for these birds in order to differentiate between sources of mortality. We do not doubt that poisons have had a serious influence on some populations of scavengers, as shown for Namibian eagles (Brown 1991a) and the ***Gyps*** vultures in India and Pakistan (Oaks ***et al.*** 2004, Prakash ***et al.*** 2005). We do question, however, whether a bigger picture that includes climate change as an agent of population decrease is necessary to guide future appropriate conservation actions. We do so because if the cause of a decline is mis-identified, then any conservation response is likely to fail.

Predictions of climate change

To attribute population changes to global climate change one must first understand how other species are influenced. This is relatively easy, given that many species are already undergoing observed changes in distribution (e.g. Root ***et al.*** 2003). The classic "hockey-stick" graph of increasing temperatures over the last 1000 years (IPCC 2001) and revised by Moberg ***et al.*** (2005) indicates that unusual warming has occurred in the last three decades as CO_2 levels have continued to increase. So we expect to see changes within this timeframe (Root ***et al.*** 2003). First, species should be driven poleward. Second, mountain-slope or mountain-top species should be driven higher to avoid increasing temperatures in the lowlands (Root ***et al.*** 2003, Simmons ***et al.*** 2004). Third, species in the southern hemisphere at the northern limits of their distribution should be first affected. In vultures, we may expect impacts in terms of (1) frequency of breeding, (2) breeding success, (3) population size or (4) colony abandonment. Behavioural changes such as increased head-drooping may also be evident.

Given that Cape Vultures probably evolved in mountains, nest on cliff faces (and predominantly south-facing cliffs), and have a high wing-loading (42% greater than the African White-backed Vulture ***Gyps africanus***: Mendelsohn ***et al.*** 1989) to exploit strong orographic winds (Brown & Piper 1988), we would expect such birds to suffer from warming of its nesting environment, all else being stable. Their presence on low level coastal cliffs at places such Oribi, Mtamvuna, and Mtentu (S.E. Piper in litt.) is not unexpected since these places are oceanically cooled and enjoy sea breezes mimicking higher altitude regions. A similar well-known phenomenon is apparent with Afro-montane species that occur farther south in coastal forests in southern Africa (Hockey ***et al.*** 2005). Bearded Vultures are found most commonly in the Himalayas (del Hoyo ***et al.*** 1994) and in the alpine landscapes of Lesotho and the Ethiopian massif in Africa (Mundy ***et al.*** 1992), and they also are expected to show some effects of a warmer environment. The questions are: do such species follow patterns predicted by global climate change, and are they more threatened than other vultures less reliant on cool montane environments?

Trends and tests

<u>Cape Vultures</u>

For the Cape Vulture ***Gyps coprotheres***, with an estimated global population of 4000 pairs, the two northernmost colonies, Waterberg, Namibia (at latitude 20.5°S), and Wabai Hill, Zimbabwe (latitude 20°S) have gone extinct as breeding colonies within the last two decades while still retaining some non-breeding or hybridizing birds (Mundy ***et al.*** 1992, M. Diekmann pers. comm.). The Waterberg site is now extinct as a breeding colony despite a long-term feeding scheme designed to slow or prevent this demise (Jones & Brown 1985, Diekmann 2005, Simmons & Brown 2007). At the southern extreme of the range, in the temperate Western Cape, where both summer and winter temperatures are increasing (Midgley ***et al.*** 2005), the only known colony is increasing in size. The Potberg colony at latitude (34.5°S), has risen steadily from 79 individuals in 1996 (Anderson 2000b) to about 150 birds and about 40 breeding pairs in 2006 (K. Shaw, pers. comm.). One cannot necessarily attribute this increase solely to the provision of food at the nearby vulture restaurant given that similar restaurants – and poisoning – were prevalent at Namibia's Waterberg site which went extinct as a breeding colony in the 1990s. Hence vulture restaurants are not passports to success at colonies pressurized by other factors.

Elsewhere, other Cape Vulture colonies are either stable or declining (Benson ***et al.*** 1990, review in Anderson 2000b). During or before the 1990s the Lesotho population was thought to have decreased and it was the lowland sites that were no longer used (Maphisa 1997). Recent surveys (Allan ***et al.*** 2006) indicate that there are still about 500 pairs in Lesotho, suggesting that the birds may not have declined but moved from the lowland sites to other sites.

Bearded Vultures

For Bearded Vultures ***Gypaetus barbatus*** that breed in the KwaZulu-Natal Drakensberg and the highlands of Lesotho, surveys in the early 1980s indicated that an estimated 204 pairs occurred throughout suitable habitat in South Africa and Lesotho (Brown 1991b). Present surveys from 2006 indicate an apparent decline in range of 38% (Kruger 2006), but there are no presently published figures on the population size (although see CBSG 2006). Reasons for the apparent decline in this population are debated and generally attributed to either (1) high mortality of juveniles and adults through poisoning (Brown 1991b) or (2) habitat loss and a possible reduction in food supply associated with land-use changes and animal husbandry (Anderson 2000a, CBSG 2006).

Many breeding sites used in the lower altitude regions of the Lesotho Highlands were vacant during helicopter surveys in 2006 (D. Allan & A. Jenkins unpubl data). However, other higher altitude sites such as the northwestern Lesotho highlands, continue to be used by breeding birds (Allan ***et al.*** 2006). This is consistent with predictions that climatic warming should influence the lower altitude nests first (Table 1). There are no published data specifically detailing the altitude or orientation of deserted sites, past or present, so we recommend future focus on this aspect.

Furthermore, Bearded Vultures were also found breeding over a wider area of South Africa before the 1980s (Boshoff ***et al.*** 1998, Anderson 2000a) including the Eastern Cape (33 pairs), QwaQwa (4 pairs), and the Free State (3 pairs). Of these, the lower altitude sites in the Free State are now extinct and the Eastern Cape population is greatly reduced (Anderson 2000a). Thus, historically and in recent times there has been a general retraction of the range into the higher altitude Lesotho plateau in the last 30 years. This is once again consistent with, but not necessarily a result of climate warming. Some other lower altitude nest sites abandoned since the late 1970s include Nthabamhlope in the Estcourt area, and the Golden Gate Highlands National Park. Traditional explanations of population declines invoke reduced habitat suitability leading to reduced food availability (eg Kruger 2006), and this may also influence lowland sites before it influences the higher sites, because of greater human pressure around them. It is critical to separate the influence of direct human pressure and climatic factors for such sites, and this can be achieved by looking for sites within protected areas that do not face human pressure or food reduction. Cliffs in the lowlands of KwaZulu-Natal and Lesotho are now surrounded by much larger, more widespread human populations than in the recent past, and this could indeed explain their demise. Yet other lowland sites such as those in the Golden Gate National Park are situated within protected areas, have no human pressure, and are therefore unaffected by disturbance or reduced food supply. Their demise is therefore hard to explain by direct effects of habitat change or loss. Poisons cannot be ruled out however.

In Kenya, Bearded Vultures that once bred at Hell's Gate in Kenya disappeared in the 1990s and efforts to re-introduce these birds to the area have proved unsuccessful (S. Thomsett, pers. comm.). While the local human inhabitants are generally hostile to these birds, and are known to have stoned re-introduced birds (S. Thomsett pers. comm.), the reason for the original demise of this population – the only Bearded Vulture population known to nest on the equator – is unknown. Under climate change scenarios it would be the first population expected to go extinct.

We suggest, therefore, that patterns of disuse of colonies by Cape Vultures [(1) northern colonies going extinct, (2) southern-most colonies increasing] and for Bearded Vultures [(3) lower altitude sites unused and (4) a retraction of range into the high altitude Lesotho plateau] are consistent with, and predicted by, warmer climates over a broad front (Table 1). Both summer and winter temperatures in the Western Cape are known to be increasing (Midgley ***et al.*** 2005) and if the same is true of KwaZulu-Natal it may be the increasing winter temperatures that are detrimental to species such as Bearded Vultures. This species routinely begins breeding in the alpine winters of the high Drakensberg (Brown 1990).

Research priorities, predictions and further tests

Below (Table 1) we list research hypotheses designed to distinguish between climatic warming and other influences on Cape and Bearded Vulture populations, together with trends and whether they are consistent or not with climatic change.

<u>South versus north facing cliff sites:</u> vultures on north-facing cliffs should show reduction in numbers, lower breeding success and parents should spend more time shading nestlings than those on south-facing crags. The large, north-facing, Manutsa Cape Vulture colony is the ideal venue for such a study and this could be compared with the nearest south-facing colonies as a control. Recent data from here suggests that while both head-drooping and chick-shading behaviour is more common at Manutsa, there is no present reduction in numbers or success at this colony to suggest a current, negative effect of increasing ambient temperatures (P. Benson pers. comm.).

Table 1. Expected versus observed outcomes for colonies and nest sites if climate change is influencing Bearded and Cape Vulture populations.

	Expected	***Observed***	***Consistent/ inconsistent with climate change?***
Bearded Vulture			
Lowest altitude colonies	Lost first	Lost first in lowlands of SA	Consistent
Range retraction to higher altitudes	Retractions	Retractions into higher altitudes in Lesotho	Consistent
South African pothole or south-aspect nest ledges	Remain active longer than north-facing	No data	Test with current data
Ethiopian nests with south aspect	Abandoned first	No data	Test with current data
Cape Vulture			
Northern colonies	Extinction in last three decades	Extinction (2 colonies)	Consistent
Southern colonies	Expand	Expanding (1)	Consistent
North-facing versus south-facing nest sites	Nothern ledges abandoned first	No data	Test with current data
Warmer seasons influence breeding	Fewer pairs breed in warmer years	No data	Test with current data for both species

<u>Low altitude cliff sites versus higher altitude cliffs:</u> Low altitude sites should be abandoned first, or show lower frequency of use than high altitude ones. Given that anthropogenic pressures are possibly more common at lower altitudes, this test is best done inside protected areas or conservancies;

<u>Northern colonies versus southern colonies:</u> Cape Vulture colonies at the north or west of their distribution are expected to go extinct first, show gradual declines or reduced breeding success relative to colonies at the centre of the range. Colonies in southern temperate regions may show increased

use or success as conditions become more conducive to breeding;

Use of potholes versus ledges: Open ledge nest sites in unfavourable (north-facing or low altitude sites) should be abandoned first relative to pothole sites that may be retained for longer;

Temperature and breeding: In years with warmer winters fewer pairs of Bearded Vultures are expected to breed, and suffer higher nestling mortality if they do than in low temperature winters.

We believe Cape Vultures at the lower latitude, lower altitude colonies such as Manutsa, with north-facing nest sites, which have been monitored for more than 20 years (Benson ***et al.*** 1990, Benson 2004), may be ideal locations to test these ideas. The Bearded Vultures of the highlands of the Drakensberg and Maluti mountains, compared with those still present in the surrounding lowlands, will provide the best form of test for climatic effects. Sites in Ethiopia may provide a secondary testing ground of these predictions (Table 1).

Discussion

Our survey of geographical and altitudinal factors of Cape and Bearded Vultures colonies which have been abandoned show trends consistent with climate change expectations. We do not doubt that some of these trends can also be explained by multiple factors, particularly anthropogenic pressures or food reduction at some or many sites. However we have undertaken this survey to indicate that a much bigger presence (the elephant in the room) may be at play here, and that there are methods, detailed above, which allow researchers to distinguish between them. The focus on the immediate and tangible has probably clouded our perception and the elephant may loom large as we look outside our comfort zones.

It is often stated by biologist who have studied birds that they disbelieve that a few degrees difference in summer or winter temperature could make a difference to an individual's behaviour. A good way to convince the disbelievers is to observe ones study species on the hotter days of summer. Panting, or hiding for hours in the shade of bushes are (unpublished) behaviours that we have seen in our own study species (Black Harriers ***Circus maurus*** African Peregrine ***Falco peregrinus***) and many vulture biologists have reported head-drooping behaviour for Cape and African White-backed Vultures on hot days (M. Diekmann pers. comm., P. Benson pers. comm., M.D. Anderson pers. comm.). Changes in distribution, especially movements away from areas that have become hotter, are now well established in hundreds of studies globally (Parmesan 2006). For Bearded Vultures anecdotal evidence suggests that these birds prefer to stay out of direct sunlight as evidenced by an observation of three Bearded Vultures remaining in the shaded areas of cliffs around Sani Pass on a cold winter's day in Lesotho as the sun lit the remaining cliff (A. Jenkins pers. obs.). For Cape Vultures, adults shading nestlings with outstretched wings at the Manutsa colony at midday at their north-facing nests suggests sensitivity to high temperatures (A. Jenkins pers. obs., P. Benson pers. comm.). Such behavioural observations are important to document, and the long-term future success of the

Manutsa colony is a critical test for the climate scenario painted here. We have focused here on cliff sites because these are stationary, measurable units that both species of vulture are tied to. Effects of climate change on foraging areas, habitat and even carcass availability may be more open to behavioural adaptation and thus more likely to be solved by a vulture in the course of its daily routine. A montane-adapted vulture sweating it on a baking cliff face has few options other than to move to another location. Bush encroachment, however, is expected to increase with higher CO_2 levels and is thus a secondary consequence of climate change. This is a factor that may be forcing Namibia's Waterberg Cape Vultures to extinction (Schultz 2007).

Another school of thought insists that there is little conservation action that can be undertaken in the face of climatic change. We suggest that present measures such as supplementary feeding schemes and re-introductions could be focussed on sites where the least impact of climate change is expected – the core of the range or the highest altitude sites. All factors should be evaluated to turn around the slow decay of vulture populations in Africa.

There is an urgent need to enact long-term measures that will safe-guard these sensitive indicators of the environment. Such mitigation measures are already underway by the farming and forestry communities who have begun to plant in new areas or farm with different crops. These new strategies in response to future climate changes may well detrimentally alter the foraging landscape open to vultures in 50 years time. If vulturephiles remain focussed on present-day issues and ignore or deem unimportant the longer-term climatic changes that are probably already affecting vultures, then our grandchildren will only talk fondly of vultures their grandparents once studied when southern Africa was cool. The elephant is only likely to grow bigger!

Acknowledgements

Phoebe Barnard and Guy Midgley made numerous improvements to the original manuscript, and Steven Piper, Pat Benson and an anonymous reviewer made further suggestions for improvement.

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Key words: Climate change, population declines, poisons, montane vultures. Cape Vulture ***Gyps coprotheres***, Bearded Vulture ***Gypaetus barbatus***.

Authors address: Robert E. Simmons and Andrew R. Jenkins, Percy FitzPatrick Institute of African Ornithology, DST/NRF Centre of Excellence, University of Cape Town, Rondebosch 7701, South Africa; e-mail addresses: harrier@botzoo.uct.ac.za, ajenkins@botzoo.uct.ac.za