Winter scavenging rates under power lines in the Karoo, South Africa

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Bird mortality from collisions with power lines, wind turbines and other infrastructure is a global conservation problem (Drewitt & Langston, 2008; Jenkins, Smallie & Diamond, 2010). Millions of birds are thought to die annually this way, but calculating accurate fatality figures is extremely difficult (Drewitt & Langston, 2008). Fatality rates are normally estimated from periodic carcass searches, e.g. under representative sections of power line, but alone these can give misleading underestimate of true rates (Smallwood, 2007; Ponce, Alonso, Argandoña, Fernández & Carrassco, 2010). Several bias factors should be taken into account to allow for carcasses missed through removal by scavengers or decomposition (scavenger bias), varying levels of observer efficiency/different habitat types (search bias) and injured birds that die away from the search area (crippling bias; Bevanger, 1999).

In South Africa, the power grid is extensive and expanding (www.eskom.co.za), and there is expected to be a proliferation of wind turbines in coming years (Jenkins, 2010). Power lines already pose a threat to several threatened bird species e.g. Blue Cranes, Anthropoides paradiseus (Shaw, Jenkins, Smallie & Ryan, 2010), Ludwig’s Bustards, Neotis ludwigii (Jenkins et al., 2011) and Cape Vultures, Gyps coprotheres (Boshoff, Minnie, Tambling & Michael, 2011). However, to really understand the impacts of such mortality, survey biases for large birds in the South African environment need to be assessed. In preliminary search and scavenger bias experiments conducted in the Hantam Karoo in summer 2011 (Schutgens, Shaw & Ryan, 2014), only 16% of experimental carcasses were removed (although most were scavenged in situ). However, scavenger bias may vary seasonally (Prosser, Nattrass & Prosser, 2008; Flint, Lance, Sowl & Donnelly, 2010). In this study, we repeat the experiment at the same locality in winter. We use camera traps to identify the scavenger guild, as they have been successfully used to monitor carcass removal elsewhere (e.g. Bumann & Stauffer, 2002; Smallwood, Bell, Snyder & Didonato, 2010).

METHODS

We conducted scavenger removal trials on the sheep (Ovis aries) farm Tierhoek (31°28’S, 19°40’E), approximately 10 km west of Calvinia. The arid landscape is characterized by dwarf shrub vegetation, with the main land use extensive livestock farming (Mucina & Rutherford, 2006). While predator control is minimal on Tierhoek, it is widely practiced in the region (Schutgens et al., 2014).

Wild Egyptian Geese (Alopochen aegyptiaca) were used for these trials as their size (1.8–2.4 kg; Hockey, Dean & Ryan, 2005) makes them good surrogates for a variety of bustard, goose and gamebird species, and they were free from odours associated with farmed birds (Smallwood, 2007; Prosser et al., 2008). The geese, which had been shot as agricultural pests, were frozen shortly after culling and defrosted 24 hours before deployment under the 66 kV power line also used by Schutgens et al. (2014). Five geese were deployed at a time, with each monitored by a motion-activated camera trap (Bushnell Trophy Cameras, model 119436). The cameras were attached approximately 0.4 m off the ground to pylons or nearby fence posts, and operated both day and night. When triggered, the cameras were set to take two photos every 10 seconds on a medium sensitivity setting.

The geese were deployed regularly spaced over approximately 8 km of power line, with three trials run consecutively from 3–7 July, 8–12 July and 12–14 July 2012. Different pylons were used in each trial, and the densities of geese were 1.20, 1.44 and 0.68 per km in the three trials. Scavenger swamping can occur when the number of carcasses exceeds the capacity of scavengers to process them (Smallwood, 2007), but we did not consider these densities to be excessive, being in the range of observed Karoo collision rates (Jenkins et al., 2011). Trials were started in the afternoon, with camera batteries and memory cards changed daily for 3–5 days. These regular visits were not

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thought to influence scavenger behaviour, as the local scavengers are familiar with human activity in this region. The quality of data obtained varied among cameras (some fogged up in wet weather and memory cards occasionally filled up when triggered by moving vegetation), so we only obtained about 75% coverage and thus could not compare the number of visits to different carcasses.

A final check on the presence and condition of each carcass was made on 19 July, 7–16 days after deployment. If present at this check, scavenging intensity was scored following Schutgens et al. (2014) as none (no change in appearance), light (several feathers removed, carcass relatively intact), moderate (< half of the carcass consumed), heavy (carcass dismembered or > half of the carcass consumed), or removed if there were <5 feathers and the carcass, if it remained, was >20 m from the power line (on standard surveys the area searched is 15 m wide; no bustards have been found beyond this without additional feather evidence under the line (J. Shaw, unpubl. data 2013)).

The Hantam Karoo normally experiences peak rainfall and a high incidence of frost during winter (Mucina & Rutherford, 2006). The conditions during the experiments were cold (temperature ranged between −2.9 and 19.8°C, −2.1 and 19.1°C and −4.4 and 10.1°C during the three trials, respectively) with some rain overnight on 8 and 9 July (South African Weather Services, unpubl. data 2012).

RESULTS AND DISCUSSION

The cameras recorded a variety of visitors to the geese (Fig. 1), with scavenging observed by Cape fox (Vulpes chama) on five of the carcasses, Cape Crow (Corvus capensis) on four, Pied Crow (Corvus albus) on three, yellow mongoose (Cynictis penicillata) on three, Southern Pale Chanting Goshawk (Melierax canorus) on two and domestic cat (Felis catus), Verreaux’s Eagle (Aquila verreauxii), small grey mongoose (Galerella pulverulenta) and striped polecat (Ictonyx striatus)

Fig. 1. Camera trap images of typical scavengers feeding on goose carcasses during a winter scavenger experiment in the Karoo (clockwise from top left: yellow mongoose, striped polecat, Cape Crows and Cape fox). Nocturnal images taken with infrared flash.
on one. Other species showed interest in the carcasses but did not scavenge, including bat-eared fox (*Otocyon megalotis*), porcupine (*Hystrix africaeaustralis*), sheep and (a likely feral) dog (*Canis familiaris*). The cat and Cape foxes removed carcasses from the vicinity of the camera immediately, whereas all other scavengers consumed geese *in situ* (Table 1). The goshawks, yellow and small grey mongooses, and Pied Crows were observed scavenging for the longest periods of time, spending approximately 7, 5, 9 and 4 hours respectively at specific carcasses, sometimes over several days.

All carcasses had been scavenged to some extent within a week of placement. Most activity occurred during the first few days, although not all scavengers started to eat the geese on first discovery. The time to first scavenging event increased over the three trials, from an average time of 9.5 hours in the first trial to 39 hours in the second and over 2 days in the third (Table 1).

Following normal power line searching methodology, we would have located eight of the 15 carcasses at the final check and considered the others removed (Table 1). However, feather remains disperse quickly and are unlikely to persist over a normal 3-month search interval (Stevens, Reese & Connelly, 2011). Most scavenging is likely to occur in the first few days (Smallwood, 2007), so if we assume non-feather remains are not further dispersed there would likely be just six of the 15 carcasses left for searchers to locate in a 15 m search corridor (one, one, and four across the three trials). This gives a minimum winter scavenging bias (Bevanger, 1999) of 60% (S.D. ± 35%).

### Table 1. Fate of 15 geese carcasses in three removal trials with time to first detection by a scavenger, time to first scavenging event, main scavengers recorded on camera or suspected of scavenging (indicated by '?'), as well as carcass condition at the final check with presence of feather evidence at the original site, state and position of carcass relative to pylon.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Time to first detection</th>
<th>Time to first scavenging event</th>
<th>Main scavengers</th>
<th>Final state of carcass</th>
<th>Feathers at original site</th>
<th>Final displacement of carcass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>46 mins</td>
<td>46 mins</td>
<td>Domestic cat</td>
<td>Gone</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>18 hrs</td>
<td>18 hrs</td>
<td>Verreaux’s Eagle, Southern Pale Chanting Goshawk</td>
<td>Heavy</td>
<td>X</td>
<td>8 m</td>
</tr>
<tr>
<td></td>
<td>14 mins</td>
<td>14 mins</td>
<td>Cape Crow, Southern Pale Chanting Goshawk, Cape fox</td>
<td>Only feathers</td>
<td>X</td>
<td>50 m</td>
</tr>
<tr>
<td></td>
<td>12.5 hrs</td>
<td>12.5 hrs</td>
<td>Cape fox</td>
<td>Gone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16 hrs</td>
<td>16 hrs</td>
<td>Pied Crow, yellow mongoose, ?Cape fox</td>
<td>Heavy</td>
<td></td>
<td>50 m</td>
</tr>
<tr>
<td>2</td>
<td>24 hrs</td>
<td>24 hrs</td>
<td>Pied Crow, Cape fox, striped polecat</td>
<td>Only feathers</td>
<td>X</td>
<td>20 m</td>
</tr>
<tr>
<td></td>
<td>46 hrs</td>
<td>4 days</td>
<td>?Avian</td>
<td>Light</td>
<td></td>
<td>2 m</td>
</tr>
<tr>
<td></td>
<td>2 hrs</td>
<td>23 hrs</td>
<td>Yellow mongoose, Cape fox</td>
<td>Heavy</td>
<td></td>
<td>40 m</td>
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<tr>
<td></td>
<td>6 hrs</td>
<td>6 hrs</td>
<td>Cape fox</td>
<td>Heavy</td>
<td></td>
<td>50 m</td>
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<tr>
<td></td>
<td>2 days</td>
<td>2 days</td>
<td>Cape grey mongoose</td>
<td>Gone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>&gt;2 days</td>
<td>&gt;2 days</td>
<td>?Avian</td>
<td>Moderate</td>
<td></td>
<td>0 m</td>
</tr>
<tr>
<td></td>
<td>&gt;5 days</td>
<td>&gt;5 days</td>
<td>?Cat</td>
<td>Heavy</td>
<td>X</td>
<td>10 m</td>
</tr>
<tr>
<td></td>
<td>31 hrs</td>
<td>&gt;2 days</td>
<td>?Mongoose</td>
<td>Moderate</td>
<td>X</td>
<td>10 m</td>
</tr>
<tr>
<td></td>
<td>30 hrs</td>
<td>&gt;2 days</td>
<td>?Fox</td>
<td>Heavy</td>
<td>X</td>
<td>20 m</td>
</tr>
<tr>
<td></td>
<td>&gt;2 days</td>
<td>&gt;2 days</td>
<td>?Mongoose</td>
<td>Moderate</td>
<td>X</td>
<td>6 m</td>
</tr>
</tbody>
</table>

Table 1. Fate of 15 geese carcasses in three removal trials with time to first detection by a scavenger, time to first scavenging event, main scavengers recorded on camera or suspected of scavenging (indicated by '?'), as well as carcass condition at the final check with presence of feather evidence at the original site, state and position of carcass relative to pylon.
rates were high compared with those observed in summer (Schutgens et al., 2014). At the final winter check, on average only 7% (S.D. ± 12%) of goose carcasses were unscavenged/lightly scavenged, 20% (S.D. ± 35%) were moderately scavenged and 73% (S.D. ± 31%) heavily scavenged/removed (Table 1). Although scavenging levels were variable and decreased throughout our trials, they were higher throughout compared with those after 14 days in summer (32% unscavenged/light, 23% moderate and 45% heavily scavenged/removed, M. Schutgens, unpubl. data 2011). Therefore, scavengers made more extensive use of carcasses in winter. All recorded scavengers are resident in the region, so the increase in scavenging could be because other food sources are less abundant in winter, and cold conditions increase energetic requirements (Schmidt-Nielsen, 1990). At the time of this study, many avian scavengers had also started breeding (Hockey et al., 2005), potentially increasing their energetic demands.

At a finer scale though, it seemed that colder temperatures may have reduced scavenging activity within the three winter trials. Scavenging peaked during the first trial, which commenced on a warm day (maximum air temperature 19.3°C), and was least in the third trial, which started during a cold snap (maximum 5.2°C). Scavenging was intermediate in the second trial, which started in cool, wet weather. Air temperature has previously been reported to affect scavenging, with cold weather reducing scent dispersal and scavenger activity (Bumann & Stauffer, 2002). This declining interest among scavengers could also be evidence of scavenger swamping, but we suggest the temperature is more likely to have affected scavenging behaviour because all carcasses were eaten in the latter days of the later trials. This indicates that while scavenging activity overall is greater in winter, it might peak during warmer spells. However, a more extensive study would be required to reliably test this observation, and gauge the importance of temperature on scavenging activity in relation to other potential habitat, carcass, scavenger and weather factors.

The camera traps were extremely useful in identifying scavengers and documenting activity. While some foxes seemed to be aware of cameras triggering, there was just one abandoned scavenging attempt by a Cape fox (cf. Smallwood et al., 2010), and this goose was later removed by this species. A notable difference between the summer and winter trials was the impact of invertebrate decomposers, which compete with vertebrate scavengers for carrion (DeVault, Rhodes & Shivik, 2003). They were common in the summer trial, being present on 66% of carcasses after the first week (M. Schutgens, unpubl. data 2011), but were not observed in winter. Typically, the diurnal scavengers were too small to move carcasses far, and thus the time of carcass placement might affect persistence times if heavy daytime scavenging makes carcasses less attractive to larger, nocturnal scavengers. Most carcasses removed were carried off by Cape foxes, which probably took at least seven of 15 geese. Black-backed jackals (Canis mesomelas) are commonly reported as predators of livestock in the Karoo, and we were surprised not to photograph this species. However, they are subject to active control measures throughout the Hantam district, and the impact of Cape foxes could have been inflated as a result; fox numbers may increase where jackal numbers are low (Kamler, Stenkewitz, Klare, Jacobsen & Macdonald, 2012).

Scavenger and search bias are considered the most important biases in calculating accurate collision rates (Prosser et al., 2008; Ponce et al., 2010). The Karoo environment is generally open with low vegetation, so it is unlikely that search bias would change significantly throughout the year. As has been found in other areas though (e.g. Flint et al., 2010), scavenging rates in the Hantam Karoo varied seasonally, with scavengers quickly removing a large proportion of carcasses in winter. We have also observed this pattern on power line surveys, with much higher proportions of collision incidents represented by feather remains only in winter (J. Shaw, unpubl. data 2013). We therefore conclude that taking seasonal scavenger biases into account is important in calculating accurate Karoo fatality rates, and suggest that further studies test the generality of these scavenging rates across the region.

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REFERENCES


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