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Range expansion of pied crows *Corvus albus* and consequences for biodiversity in Southwestern Africa

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Abstract

Pied crows *Corvus albus* are widespread in Africa south of the Sahara Desert. The species has undergone a range expansion and an increase in abundance into the shrubland, known as the Karoo, in the Northern Cape Province, South Africa. Most range expansions are caused by changes in food availability; this one has mostly been caused by the provision of nests sites: telephone poles and wind pumps. Therefore, these crows are an additional stress on an ecosystem working at carrying capacity. Culling is not recommended because there is a population of floaters that will occupy territories that become vacant. Fortunately, most of the poles and windpumps are no longer in use, having been replaced by cell phones and solar pumps, respectively. It is recommended that telephone poles be cut down and windpumps removed.

Keywords: *corvids, Karoo biome, range expansion, impact of predation, tortoises, artificial nest sites*

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1. Introduction

Observation of a pair of pied crows *Corvus albus* killing at least 465 angulate tortoises *Chersina angulata* while raising two broods of young [1] precipitated a great deal of heart-searching and deliberation in conservation circles in South Africa. The nub of the issue is finding a way ahead to deal with an indigenous species which acts like an invasive alien. The tortoise incident spawned a workshop on the impacts of pied crows on biodiversity [2] and field studies [3]. However, the agricultural community had started, six decades earlier, to raise concerns about the negative impacts of pied crows on their activities [4, 5]. The outcome of 60 years of deliberation is that the jury is still out on the question of whether pied crows have had a negative effect on either agriculture, biodiversity, or both. The main recommendation of the workshop held in 2020 was that more research is needed before any recommendations for action can be made [5].

The perspective presented here is that the logical evidence alone is overwhelming. In the areas where pied crows have expanded their range and their abundance, there is no need for further field research. The logical evidence is that the impacts of pied crows on biodiversity in these regions are entirely negative. The only discussion point is how to deal with the "pied crow problem".

This perspective thus focuses on two topics:

(1) Why is there no need for further field research?

(2) What actions can be undertaken to help deal with the issue?

The discussion of the first questions covers, in point form, a variety of relevant topics. It lays a foundation and builds the argument step by step. The second question is dealt with more succinctly.

This essay is written primarily with pied crows in the South African Karoo in mind but could be adapted to other species in other places.

2. Why is there no need for further field research?

2.1. Relevant pied crow biology and life history

Pied crows are the most common corvid in Africa, occurring in most areas except the tropical forests south of the Sahara Desert [5]. They are omnivores, eating both plants and animals; in terms of the latter, they can be described as generalist predators and as opportunistic scavengers [6]. However, as Jenkins & Underhill [5] pointed out, there is no substantive information relating to their survival rates, age at first breeding, clutch size, breeding productivity, or dispersal; understanding these parameters is crucial for developing population models for the species. The basics of the life history of pied crows represent a knowledge gap.

Prior to the extensive anthropogenic modifications of landscapes, taken here as starting in about the middle of the 20th century, nests of pied crows were "usually placed in a tree, but occasionally on the ledge of a krantz" [7–9]. This placed a limitation on their population sizes, especially in treeless biomes. This item of information is pivotal to the perspective presented here.

It is universally agreed that during the 20th century, the pied crow's distribution and abundance increased dramatically over the Karoo biome, mainly in the Northern Cape Province of South

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Africa [4, 5, 10–12]. The map in [2] showed that many grid cells in the Karoo biome experienced increases in reporting rates exceeding 50% between the First Southern African Bird Atlas Project (SABAP1) (1987–91) and the Second Southern African Bird Atlas Project (SABAP2) (2007–19, in their analysis) [5]. SABAP1 and SABAP2 have provided deep insights into bird distribution in southern Africa [13–16].

2.2. Preconditions for range expansion

This is a model of population dynamics, simplified to its basics. A population consists of breeding adults, most easily visualized as territory-holders. They have an annual breeding event that produces juveniles. At some stage, these juveniles become sexually mature but do not yet breed and move between multiple territories. These birds are widely described as "floaters" [17]. In an ideal situation, the number of individuals per year which mature to become floaters should balance the annual mortality rate of the breeding adults. As adults die, there is a floater to take its place. If the number of floaters generated per year exceeds the mortality rate, there is opportunity for range expansion.

Two main conditions need to be met to enable range expansion: the availability of places to breed—for birds, this means nest sites—and the availability of food. Other preconditions include tolerable numbers of predators and roost sites outside the breeding season. Floaters, which tend to be mobile, are likely to continuously explore the edges of ranges for potential opportunities and learn how to exploit them. Opportunities for range expansion are often not exploited immediately but frequently occur with a delay, measured in decades [18]. For example, there may be challenges to adapting to new foods, to finding a different category of nest site, to competition for resources, and to adjusting to a new biogeographical zone.

2.3. What drives range expansions?

In general terms, range expansions and population increases for birds are usually based on additional food resources and occasionally on the removal of predators. Additional food, and new types of food, becomes available as a result of both environmental change and of anthropogenic impacts. Environmental changes linked to climate change have been described as the likely factors leading to northward range expansions of many species in Europe [19] and Asia [20] and to southward expansions in Australia [21]. Anthropogenic impacts which lead to increases in food availability include agriculture, artificial wetlands, and urbanization, with its by-products of rubbish dumps, parks, and suburban gardens Hockey et al. [22] made a list of 85 bird species which they considered to have increased in range and abundance in a large part of the Western Cape, South Africa, during the 20th century; for 84 of these species, the driving cause was listed as an increase and/or change in food availability.

In this list, the exception was the acacia pied barbet *Tricholaema leucomelas*. For this species, its range expansion is primarily attributed to the provision of nesting opportunities in alien *Acacia* thickets [23]. Other examples of range expansions in southern Africa attributable to the provision of nest sites are the martial eagle *Polemaetus bellicosus* [24] and Verreaux's eagle *Aquila verreauxii* [25, 26]; for these raptors, nest sites (and perches from which to hunt) have been provided by the construction of electricity transmission lines. This is described as a "positive ecological factor" by Brown & Lawson [27], but they do not explain why they categorized this as "positive". They possibly considered this "positive" because they are raptorphiles.

2.4. What were the drivers of the range expansion of the pied crow across the treeless Karoo?

The overwhelming majority of the Karoo retains the foundation of its natural shrubland vegetation. A tiny percentage of the vegetation has been cleared for towns, villages, roads, farmhouses, and other infrastructure. Although the natural vegetation is retained, it has been degraded by overgrazing, mainly by sheep farming. For more than a century, the organic material of the Karoo has been exported at a greater rate than it has been generated, through the export of wool and mutton. The Karoo, as a whole, is less productive than it was a century ago. Certainly, over the shrubland vegetation, no additional food resources have been available to sustain a range expansion or population increase for any species. So, the explanation for the range expansion and increase in abundance of the pied crow across the Karoo cannot be attributed to food. The most likely alternatives to food are the provision of nests sites or climate change.

Climate change can be eliminated as an explanation. Cunningham et al. [11] found an "exceptionally close correlation" between changes in reporting rate between SABAP1 and SABAP2 and changes in temperature over the 23-year period between the midpoints of the two atlas projects. However, these changes in temperature were in the order of 0.03 °C. In addition, they then proceeded to make the error of confusing correlation with causation. They provide no explanation of the mechanism whereby a change in temperature of less than 0.03 °C over a period of 23 years can make such a large change to the distribution of pied crows, in a region in which the daily fluctuations in temperature are, on average, 20 °C in both summer and winter, and the mean winter temperature is 20 °C less than the mean summer temperature [28]. Given the context, and without a plausible mechanism, the most parsimonious explanation of the correlation which Cunningham et al. [11] detected is that it is likely to be spurious.

This leaves nest site provision as the likely driver of the bulk of the range expansion and abundance increase for the pied crow. This is a plausible explanation. At various points during the 20th century, multiple anthropogenic activities provided additional nest site options; key examples are the construction of windpumps, the planting of trees in towns, at farmhouses, and as windbreaks, and the erection of poles and pylons for telephone communication and electricity transmission [5].

A proportion of the pied crows in the Karoo occurs in towns and villages, and these birds do experience the benefits of increased food supply, particularly if rubbish dumps are poorly maintained. Similarly, a proportion lives along tarred roads; these are the crows which are most frequently encountered by humans and are frequently observed to scavenge dead animals which have been killed by traffic. These crows thus also experience increased food supply. However, traffic on gravel roads generally moves more slowly than on tarred roads, and there is less food to scavenge (pers. obs). However, it is frequent that the most minor of gravel roads, and especially farm roads that lead to a farmhouse, are lined

with telephone poles. On the basis of area, it is likely that the bulk of the pied crow population in the Karoo does not live in areas where they benefit from anthropogenic food supplies, either at rubbish dumps or from animals killed on roads by vehicles.

2.5. The timing of the provision of nest sites

As early as 1962, in three administrative divisions of the former Cape Province, Beaufort West, Victoria West, and Loxton, Siegfried [4] estimated that the split between pied crow nesting sites on sheep farms was 39% on windpump platforms, 22% on telephone poles, 22% on trees and bushes, and 16% on cliffs and ledges (n = 215); more than half these nests were on windpump platforms and telephone poles. This suggests that an investigation into the timing of arrival of these anthropogenic structures would be useful. Government publications were searched for information on the development of telephone lines to farms and on the construction of windpumps.

On 21 April 1924, the South African Department of Posts and Telegraphs launched a promotion to develop telephonic services to the farming community [29]. This was hugely successful (**Figure 1**). On 1924 Mar 31, there was 4520 miles (7274 km) of farm lines in South Africa serving 2221 farms, and four years later, on 1928 Mar 31, this had increased about five-fold to 21,871 miles (35,198 km) serving 10,856 farms. This information provides a date for the commencement of the widespread availability of potential nest sites for crows in the form of wooden poles, each with a cross bar for the attachment of the copper telephone wire.

2. **Farm Telephone Lines.**—The Department of Posts and Telegraphs, recognizing the desirability in the interests of agricultural development of the greatest possible expansion of the farm telephone system, prepared revised conditions and reduced rates for this class of service and, assisted by a special financial appropriation of £300,000 (to be spread over two years), launched an intensive campaign of farm line development on the 21st April, 1924. A year later the experience gained permitted of a further revision of the conditions, on a basis even more favourable to the farming community. The response by the farmers to the Department's canvass was instant and wide-spread and, whereas at the 31st March, 1924, there were 4,520 miles of farm lines in the Union serving 2,221 farmers, by the 31st March, 1928, the mileage of farm lines had increased to 21,871, and the number of farmers connected to 10,856.

Figure 1 • An extract from the annual report for 1928 of the South African Department of Posts and Telegraphs [29].

The installation of windpumps was more gradual [30] (**Figure 2**). It was fastest in the middle of the 20th century, reaching a peak in 1960 and remaining roughly constant thereafter.

Telephone poles and windpumps might have been in place for decades before pied crows mastered the art of building nests on them. There are many examples of habitats becoming suitable for colonization by a bird species multiple decades before the species arrived. For example, large-scale agricultural transformation had occurred in the Overberg wheatfields east of Cape Town by 1950, but it was not until the 1970s and 1980s that this region was "discovered" and expanded into by white storks *Ciconia ciconia* [31] and blue cranes *Grus paradiseus* [32]. Similarly, the Greater Cape Town region had been suitable for the hadada ibis *Brachystigia hagadash* for a century or more before it arrived [22]. Also, the northern section of the Olifants River valley was transformed into irrigated farmland producing crops such as grapes and vegetables from the mid-1920s when the Bulshoek Dam was constructed, but the African red-eyed bulbul *Pycnonotis nigricans* did not colonize it until a century later [18]. It is more likely that the range expansion of pied crows between SABAP1 and SABAP2 was mainly facilitated by the wide-scale adoption of telephone poles and windpumps as nest sites. The important aspect of the argument here is that they were already in place when the main range expansion occurred.

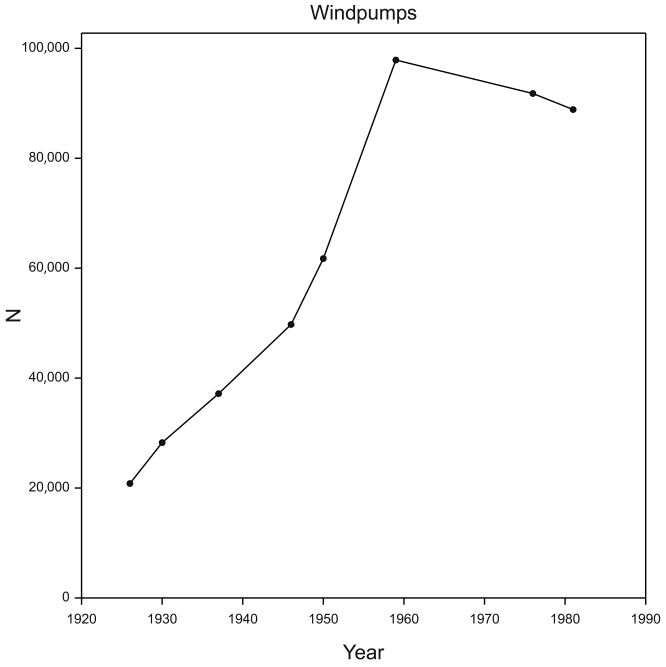


Figure 2 • The estimated number of windpumps in the Cape Province during the 20th century. These values are from agricultural censuses.

2.6. Potential positive roles of pied crows

Siegfred [4] speculated whether crows might play a positive role in the sheep-farming districts of the Karoo. He noted that crows consume caterpillars of the Karoo moth *Loxesege frustalis*; this caterpillar assumes pest status by defoliating one of the primary Karoo fodder plants for sheep, *Pentzia incana* [33]. However, it is likely that this deprives other species from utilizing this food resource.

Siegfried [4] also suggested that crows had moved into a niche which had arisen as a result of the elimination of vultures. The niche he suggested was the role of scavenger, keeping farms free of carrion, which is a potential breeding substrate for the sheep blowfly *Lucilia cuprina* [34]. Blowflies are also responsible for the spread of anthrax between animals [35] and gastroenteritis in humans. However, there are many insects which feed on carcasses in the Karoo and which remove carrion rapidly and efficiently: the hide beetle *Dermestes maculatus*, carcass beetles (Trogidae), carrion beetles (Silphidae), and also species of carrion-feeding dung beetle (Scarabaeoidea), such as *Scarabaeolus flavicornis*, *Scarabaeolus inquisitus*, and *Scarabaeolus kochi*.

Siegfried's [4] conclusion that there is a positive role for crows as scavengers therefore needs reconsideration. This is particularly relevant in light of the "early-rising crow hypothesis" [36], which noted that crows outcompete original avian scavengers, mainly vultures, for carrion because they start their daily searches at or before dawn, whereas vultures wait several hours until thermals commence before they take flight and start searching. In other words, the impact of pied crows as scavengers is negative because they pre-empt original avian scavengers on a daily basis [36].

Working from another perspective, Madden et al. [37] undertook a comprehensive review of crows' impacts on bird populations globally. Their main conclusion was that the impact of crows on bird populations was small. This review was "global" in the sense that it was comprehensive; however, 79% of the data used for the review came from a single country, the UK. From the perspective of this analysis of pied crows in the Karoo, the main flaw with Madden et al. [37] was that in virtually all of the studies examined, the increases in crow abundance were in places where crows occurred in substantial numbers anyway. Potential prey are therefore likely to be adapted to crows as predators, and Madden et al. [37] is therefore not relevant to a scenario where crows have expanded into ranges they have not previously occupied.

2.7. Magnitude of potential negative impact of pied crows

The equations presented by Nagy [38] provide estimates of the daily food requirements of pied crows. These equations required an estimate of the average mass of the crow, which was obtained from [39]. Using Nagy's [38] equation for the daily "fresh matter intake" (FMI) (g) for all birds (FMI = 2.065 $\text{mass}^{0.689}$) yields an estimate of 155 g per day for the pied crow.

In the case of the pied crow, the increase in range and abundance away from centers of human habitation can largely be attributed to the provision of nest sites, in such a way that the food requirements of the crows are an additional demand on existing resources which are already likely to be functioning in an ecosystem at carrying capacity.

In this context, it comes as no surprise that individual pairs of pied crows devise novel ways of meeting their energy needs and those of growing chicks. Fincham & Lambrechts [40] encountered a pair which had specialized in feeding on angulate tortoises. After having discovered this behavior in 2012, when 160 tortoise carapaces represented a partial count, they undertook a thorough investigation the following breeding season and found 315 tortoise carapaces at the nest of this pair of pied crows. They raised an alarm, pointing out that if this behavior was widespread, its impact on tortoise populations would be devastating. Fincham et al. [1] recommended that the overall impact of pied crows on the biodiversity of their territories needed to be investigated. Durá i Franch [3] made a start at this, examining the prey brought to the chicks at 125 nests. At 93 nests (74%), no tortoise predation was observed, 15 nests (16%) had less than one tortoise predation per week, and 5 nests (5%) had between one and two predations per week. Twelve pairs (13%) had more than two per week. A total of 268 tortoise predations were observed: 244 (91%) involved angulate tortoises, 23 (9%) involved tent tortoises *Psammobates tentorius*, and 1 (0.4%) was of a speckled padloper *Homopus signatus*.

Given that the mean carapace length of the angulate tortoise preyed on by pied crows is 67 mm, and from the figures and equations in Branch [41], the estimated total mass is c. 69.5 g. Iverson [42] estimated that the carapace and the skeleton of a terrestrial tortoise represent c. 28% of its body mass, so that its edible flesh is c. 50 g of wet mass. Thus, a pied crow with an exclusively tortoise diet would need to consume 3 daily, or 1095 per year. However, the focus on pied crows as tortoise predators is misplaced; this has occurred because tortoise shells are conspicuous and elicit an emotional response. Prey items such as lizard, snakes, and small mammals are consumed, and fragments of skeletons go unnoticed.

The summation of the discussion above suggests that pied crows in rural areas are having a devastatingly destructive impact on biodiversity in general [1]. They are generalist predators [6]. All the food that they consume is effectively stolen from all other components of biodiversity of the Karoo. They need to be viewed as an additional demand on an ecosystem at carrying capacity.

The impact of pied crows on the shrubby Karoo habitat which they have invaded can be compared with the introduction of alien fish into a river. The parallel is the introduction of a new species without the addition of food. The disruption caused by the colonization of a river by alien fish is likely to be similar in their ecosystem to the colonization of the Karoo by pied crows.

3. What actions should be taken?

3.1. Do not, except in special situations, cull

Culling pied crows is a pointless exercise because it is likely that there is a population of "floaters", nomadic pre-breeding adults which will quickly occupy nest sites in areas where culling takes place. A more appropriate description of a floater is the word "hooligan", introduced by Underhill [43].

3.2. Remove all redundant telephone poles and windpumps

The most appropriate approach to reducing pied crow abundance is reversing the process that enabled it to colonize and increase in the treeless shrubland of the Karoo. That involves removing nest sites.

The farm telephone lines constructed in the 1920s provided a vital communication service for farmers until around 2000, when cell phone connectivity became the norm. Most houses and offices at farms were then connected to the internet by Wi-Fi devices via radio linkages. By 2024, a century after their promotion, farm lines had become redundant. Most of the copper wire had been removed, but the wooden poles and the cross bars, which provide nest sites for pied crows, remained standing.

I recommend that the disused telephone poles which remain standing be cut down to remove the cross bar used as platform for a nest. The poles can be cut at any level; if the poles stand out above the surrounding vegetation, they can be used by raptors. This will remove one source of nest site opportunities for pied crows. An alternative is to remove just the cross bar and the insulator at the top of the pole and to cut the pole diagonally to a point so that the crows cannot use them to anchor their nests.

By 2024, most windpumps were not in working order (pers. obs). Maintenance was expensive, and most had been replaced by solar-powered pumps. However, many windmill structures remained in place and hosted the nest of a crow. They can be removed.

It is fortunate that in this particular case, the fundamental cause of the problem consists of infrastructure that has mostly served its functions and can be removed. Generally, conservationists have to accept that infrastructure is permanent, and the best option is to mitigate; one example of this is in the Mojave Desert in California,

USA, where the best that can be done is to monitor the impacts of infrastructure on biodiversity [44, 45].

One likely objection to the removal of telephone poles and windpumps is that they are used as hunting perches by raptors. This argument is not valid for the same reason that the crows ought to be removed. They are subsidized predators. Raptors represent an unnatural additional pressure on the biodiversity of an ecosystem operating at carrying capacity.

3.3. The special case of Robben Island

Robben Island, Table Bay, South Africa, has been a World Heritage Site since 1999 and plays a key role in the biodiversity conservation framework of South Africa, especially for African penguins *Spheniscus demersus* and bank cormorants *Phalacrocorax neglectus*. Both species are Critically Endangered. The island lies 7 km from the nearest point on the mainland. The first comprehensive lists of the birds of Robben Island were compiled by Simmons [46], who described the pied crow as "rare", and by Crawford & Dyer [47], who described it as a visiting species. Even though it has increased in abundance to a 2025 population of 10–15 birds seen regularly (Chris Wilke pers. comm., pers. obs), it has retained that non-breeder status (Bruce M Dyer, Richard B Sherley pers. comm., pers. obs).

In this particular situation, it seems to be appropriate to apply the precautionary principle towards protection of the seabirds, especially penguins and cormorants. It is likely that these intelligent birds will learn how to rob the nests of seabirds of eggs and chicks.

Three actions seem appropriate in this special context:

(1) Make an exception from the general rule above and cull the pied crows on Robben Island.

(2) Examine the crop contents of all birds culled to determine what they are consuming.

(3) Set up a monitoring program to determine the frequency of colonization, and cull any crows that settle.

These three actions need to be reviewed at regular intervals, probably every two years. Ultimately, the motivation for culling rests on the reality that there is not a nearby population of floaters to take the place of the birds removed.

Given the distance of Robben Island from the mainland, it is possible that colonization events are rare and that therefore it will be a relatively easy task to keep Robben Island crow-free. These actions will also help inform crow removal programs elsewhere. For example, if there is an isolated population of pied crows at a farm or campsite, and no others within a range of, say, 10 km, then the Robben Island experience, properly documented, will aid in the decision on whether or not to remove crows in this context.

4. Conclusions

The bulk of the range expansion of the pied crow is attributed to the provision of nest sites, mainly telephone poles and wind pumps. By the third decade of the 21st century, these were largely redundant. They should be systematically removed.

Culling of pied crows is not recommended, except under special circumstances. "Floaters", pre-breeding crows which do not have territories, are continuously searching for breeding opportunities and are likely to rapidly occupy any gaps created by the removal of territorial crows. Culling can be justified in situations where there is an isolated population, as on Robben Island.

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