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Compromising South Africa's natural biodiversity — inappropriate herbivore introductions

J.G. Castley^{a*}, A.F. Boshoff^b and G.I.H. Kerley^b

THE INTRODUCTION OF NON-NATIVE species can affect natural habitats in ways that are often difficult to quantify but that, despite their potential benefits, pose an increasing global threat to biodiversity. As a signatory to the Convention on Biological Diversity, South Africa is committed to preserving the natural biota. An analysis of a number of private wildlife operations in the arid/semi-arid regions of South Africa has

revealed an alarming degree of undesirable large mammal introductions. The extent of non-native species in private wildlife operations ranged between 10 and 57%, with two-thirds of all operations surveyed having 25% or more non-native species present. Such introductions intended to enhance local diversity so as to improve the economic viability of these operations, but, at present, the ecological as well as economic costs appear to outweigh the benefits. Private wildlife operations have the potential, however, to contribute significantly to the conservation of South Africa's biodiversity if appropriate precautionary measures are

adopted when introducing non-native species.

Local biodiversity may be increased through the introduction of non-indigenous species,¹⁻³ but, it has been argued, the loss of sensitive species (that is, those confined to certain microhabitats, endemics, etc.) as a result of competitive exclusion and associated effects ultimately diminishes regional landscape diversity as well as global diversity and ecosystem functioning.^{4,5}

As a signatory to the Convention on Biological Diversity, South Africa is obliged to control the introduction of non-native species either through eradication or by preventing the further introduction of such species. The government has drafted a policy on the threat of such non-native species to the country's biodiversity,⁶ to increase understanding of the problems associated with such introductions, and to promote the sustainable use of South Africa's indigenous resources. Critical to the success of such a policy is its acceptance and effective implementation by both state organizations and private individuals.

The recent resurgence of interest in game farming/ranching in southern Africa has been revealed as a sustainable alternative to livestock farming,⁷⁻¹⁰ especially in semi-arid areas where low rainfall precludes cropping and livestock production is marginal. Owing to the extirpation of a majority of native species through hunting and habitat transformation, many wildlife operations rely for their economic viability on the re-introduction of large herbivores as well as the introduction of species that do not occur naturally, but at unrecognized cost to ecological integrity and long-term sustainability.

The translocation of wildlife species as an important conservation management tool¹⁴⁻¹⁶ or as a means of generating economic activity (tourism, hunting) is a worldwide phenomenon, but those involving exotic species generally result in serious problems for conservation and management¹⁷⁻¹⁹ and species are often introduced into areas beyond their natural range.¹¹⁻¹³

Many non-native large mammal species, particularly ungulates, occur on private farms and reserves in southern Africa.^{8,20-22} Despite the recognized problems incurred by the spread of terrestrial and aquatic alien plants and invasion by smaller mammals (mice, rats)^{24,25}, it has been suggested that alien mammals are seldom invasive in South Africa²³ even though the translocation of these species beyond their historical range is commonplace.²² Little attention has been paid

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to the ecological and economic costs, however, of intentional introductions of terrestrial fauna in South Africa.

This article assesses the incidence of introduced large mammal species (predominantly ungulates and megaherbivores) on some of the larger wildlife operations in the semi-arid areas of South Africa, and illustrates the tendency to introduce non-native species. The aim is not to provide a comprehensive account of the status of such species on game areas throughout South Africa (although such information is badly needed), but to generate debate about the validity of such introductions, the reasoning behind many of them, and some potential costs and benefits. The study also tested the hypothesis that such introductions are more prevalent in more mesic areas, because of the opportunities they offer to maintain a wider spectrum of species.

Methods

Information about the large mammal species occurring in the semi-arid regions of South Africa was solicited from wildlife operations there, selected as being representative of relatively large commercial tourism or game ranching operations that focus on generating income from wildlife. A survey was conducted of 30 wildlife operations: 18 in the Northern Cape Province, eight in the Eastern Cape Province and four in North West Prov-

ince. The areas ranged in size from less than 1000 ha to more than 100 000 ha. Telephonic interviews were conducted with the managers/owners of each operation. To provide an indication of the range of species being stocked, complete species lists were requested of the ungulate and megaherbivore fauna, as these are generally the focal species in safari/wildlife ventures,⁹ as well as information about the presence of artificially maintained genetic variants on the properties and the motivation behind the re-introduction of certain species. The species lists were classified according to whether the species were native to the area, or introduced. Native species were identified as those which currently occur, or previously occurred, in the area, based on historical records for the southern African terrestrial fauna.²⁶⁻²⁹ Introduced species include all those native species translocated to regions beyond their natural historical range (extralimital), as well as all exotic species [defined here as those not recorded from the southern African subregion³⁰ and including naturalized species, for example, fallow deer (*Cervus dama*) and feral pig (*Sus scrofa*)]. The hypothesis of increased introductions into more mesic areas was tested using an ANOVA comparison of the incidence of introduced species in the Northern Cape and North West provinces versus the Eastern Cape Province.

In addition, to assess the commercial extent of such activities, hunting operations listed in a South African hunting magazine, *Magnum*, were investigated through an analysis of advertisements placed for hunting opportunities including introduced species. Although this database is non-random in terms of wildlife-based ventures in South Africa, it does indicate the reliance of commercial hunting operations on introduced species.

Results

In total, 47 large herbivore species, of which 10 are exotic to the continent or sub-continent, were recorded from the 30 operations surveyed. All these operations supported populations of introduced herbivore species, with proportions ranging from 10 to 57% of the species on the property. Of the 30 operations, eight (27%) were characterized by a large number of introduced species (more than one third of the total number of species present), while 20 (66%) operations had 25% or more introduced species (Table 1). Fifteen introduced species native to southern Africa were also recorded in areas outside their natural historical distributions, so these records were regarded as extralimital. These extralimital distributions extended to the subspecies level where distinctive subspecies of roan antelope from West Africa (*Hippotragus equinus koba*) were recorded.

Table 1. The occurrence of introduced (extralimital and exotic) wildlife species reported from wildlife operations in each of three South African provinces.

Species	Scientific name	Frequency of occurrence		
		Northern Cape (n = 18)	Eastern Cape (n = 8)	North West Province (n = 4)
Black wildebeest	<i>Connochaetes gnou</i>	12	6	2
Blue wildebeest	<i>Connochaetes taurinus</i>	N/A	6	N/A
Bontebok	<i>Damaliscus dorcas phillipsi</i>	1	4	0
Blesbok	<i>Damaliscus dorcas dorcas</i>	4	1	0
Gemsbok	<i>Oryx gazella</i>	N/A	5	N/A
Giraffe	<i>Giraffa camelopardalis</i>	N/A	5	N/A
Hartmann's mountain zebra	<i>Equus zebra hartmannae</i>	7	1	0
Impala	<i>Aepyceros melampus</i>	14	8	2
Lechwe	<i>Kobus leche</i>	3	5	0
Mountain reedbuck	<i>Redunca fulvorufula</i>	4	N/A	2
Nyala	<i>Tragelaphus angasii</i>	4	4	3
Sable	<i>Hippotragus niger</i>	6	0	2
Springbok	<i>Antidorcas marsupialis</i>	N/A	2	N/A
Waterbuck	<i>Kobus ellipsiprymnus</i>	10	3	4
White rhino	<i>Ceratotherium simum</i>	N/A	5	N/A
Barbary sheep*	<i>Ammotragus lervia</i>	4	1	0
Blackbuck**	<i>Antilope cervicapra</i>	1	0	0
Camel**	<i>Camelus dromidarius</i>	2	0	0
Fallow deer**	<i>Cervus dama</i>	4	4	2
Himalayan thar**	<i>Hemitragus jemlahicus</i>	0	1	0
Hog deer**	<i>Axis porcinus</i>	0	1	1
Mouflon**	<i>Ovis musimon</i>	0	1	0
Sambar**	<i>Cervus unicolor</i>	0	0	1
Scimitar oryx*	<i>Oryx dammah</i>	0	1	1
Water buffalo**	<i>Bubalus amee</i>	0	0	2

**Denotes species that are exotic to the African continent and *those exotic to the subcontinent.⁵⁵

N/A indicates appropriate species for a particular province which are therefore not applicable in terms of the assessment of introduced species.

Table 2. Number of wildlife operations surveyed in three South African provinces, which support species with the potential to hybridize.

Species	Northern Cape (n = 18)	Eastern Cape (n = 8)	North West Province (n = 4)
Hartmann's mountain zebra/Cape mountain zebra or plains zebra	4	1	0
Black and blue wildebeest	12	4	2
Bontebok and Blesbok	1	4	0
Gemsbok and Scimitar oryx	1	0	1

The Eastern Cape had the highest proportion of introduced species (35%) with the Northern Cape (26%) and North West provinces (24%) supporting marginally lower proportions of introduced species. Eight operations (27%) maintained genetic variants of species, particularly white and black springbok (*Antidorcas marsupialis*), and white blesbok (*Damaliscus dorcas phillipsi*). In addition, 24 operations (80%) carried species which had the potential to hybridize (Table 2), although in a few cases these species were physically kept apart. The total number of species present on any particular operation ranged from 10 to 28 with a mean of 17.4 ± 0.90 (\pm s.e.). The mean number of native species from each operation was 12.3 ± 0.60 (range = 6–19) with no difference between the regions ($F = 2.15$, d.f. = 29, $P = 0.136$), while the mean number of introduced species was 5.1 ± 0.48 (range = 1–11), with the Eastern Cape having more introduced species than the Northern Cape and North West provinces ($F = 4.06$, d.f. = 29, $P < 0.05$).

Extralimital or exotic species were introduced to enhance visitor experience by increasing the number of species to view in the majority of the eco-tourism operations, while at the same time providing a wide variety of species, which was important in hunting operations. Of 32 wildlife operations listed in a local hunting magazine offering hunting opportunities in the Eastern and Northern Cape provinces, 14 (44%) offer exotic or extralimital species. The most common species include fallow deer, blesbok, impala (*Aepyceros melampus*), Hartmann's mountain zebra (*Equus zebra hartmannae*) and red lechwe (*Kobus leche*). In two advertisements both black (*Connochaetes gnou*) and blue wildebeest (*Connochaetes taurinus*) are offered by the same operation, even though the potential exists for these two species to hybridize.

Discussion

Wildlife operations in the semi-arid areas of South Africa have a strong tendency to introduce both exotic and extralimital species on their properties, and this increases in more mesic habitats. These

efforts aim not only to boost the eco-tourism potential of the property but also to increase the number of huntable species, despite the fact that there is an abundance of native species^{26–28,30} to stock wildlife operations (more than 20 in most cases) in each of the three provinces covered in the study. This natural herbivore diversity, which is nearly twice that occurring on the entire North American continent,³¹ should preclude the need to introduce exotic or extralimital species.

Many of the operations appear directed by short-term commercial benefits rather than by long-term conservation philosophies and policies. The presence of introduced species as well as genetic variants (such as black or white springbok) result from a novelty factor, especially for game viewing and hunting. This was confirmed by respondents indicating that a number of species on their properties were introduced for the sole purpose of increasing the visibility and diversity of the game for tourism-based operations, whereas hunting outfits used introduced species as a drawcard for international markets.

The introduction of non-native species enhances wildlife uses through the artificial increase in diversity.⁸ It is predicted, however, that this artificial diversity, specifically in the context of eco-tourism, will seriously jeopardize the success of the industry as consumers become more environmentally aware. Anecdotal evidence suggests that tourists are becoming increasingly disillusioned with the presence of exotic and extralimital species on wildlife operations.

The introduction of species for reasons other than conservation has previously been reported for South Africa³² and is also widespread elsewhere.³³ Our analysis of wildlife operations in the semi-arid regions of South Africa makes it clear that a number of non-African species are stocked. The possible conservation threats posed by exotic species such as the scimitar horned oryx (*Oryx dammah*), barbary sheep (*Ammotragus lervia*) and mouflon (*Ovis musimon*), which were all recorded in the present analysis, have been highlighted previously,²² and it was

suggested that the latter two species in particular should not be permitted on private game farms at all, owing to their capacity to adapt to local conditions and their potential to become invasive. Introducing species that can hybridize with native species is also a concern, as they may affect the genetic integrity and long-term survival of the overall native population, and may also influence the commercial market value of these animals.

Not all introductions are of exotic species, and many operations include extralimital species native to southern Africa because the habitat is perceived to be suitable for the respective species, and in order to boost the eco-tourist potential of the property. Re-introducing species into areas within their historical range from which they have disappeared has become an important tool in wildlife management^{14,34–36} but it is imperative that the re-introduction of native species should always be conditional on the suitability and extent of the available habitat types and the presence of potential competitors. Habitat suitability appears to influence the success rate of introductions significantly, and even though potential release sites are within the historical range of particular species, these may no longer be suitable because of the transformed nature of the habitat.³⁶ Indiscriminate re-introductions of species without prior assessment of habitat suitability could therefore have severe ecological as well as economic repercussions.

Brooke *et al.*²² suggested that introducing alien species into natural areas was not itself significant in the conservation of natural ecosystems, but pointed out that the adverse effects were rather a function of the fecundity of these introduced populations and of the size of the founder population, which has a considerable influence on the survival of the introduced species. Non-breeding species can affect native populations subtly but substantially, however, by causing changes in the relative abundance of different species or guilds, modification of functional relationships,²³ resource competition, competitive exclusion and niche displacement,³⁷ genetic pollution (hybridization and loss of heterozygosity)^{13,38–40} and possible action as disease vectors.^{32,33,41,42} Decline of native species has also been shown in the face of competition with introduced species, particularly when resources are limited.⁴³ The potential to determine deleterious effects has been reduced, unfortunately, because the ecological interactions that an introduced species has on other species and on the

Table 3. Possible ecological and costs and benefits associated with the introduction of exotic and/or extralimital species by private wildlife operations.

Costs and benefits
Ecological costs
Potential loss of animals due to stochastic events ^{46,49}
Potential competition with native species for limited resources ⁴³
Potential for social (interspecific and intraspecific) problems
Potential for habitat degradation ⁵⁰
Potential for hybridization with native species ^{22,38-40}
Potential for spread of disease and parasites ^{41,42}
Potential for inbreeding and increased juvenile mortality ^{51,52}
Ecological benefits
Potential to fulfil key ecological functions, e.g. bulk grazing
Potential maintenance of critical refugia for endangered species ^{53,54}
Economic costs
Extra costs associated with 'out of area' purchase and transport
Reduced potential for cooperation with neighbours in conservation/wildlife-based ventures
Possible negative eco-tourism marketing image, e.g. 'zoo in the wild'
Loss of investment capital due to mortality caused by environmental extremes and social conflicts
Loss of potential revenue (from game sales) as a result of hybridization
Economic benefits
Increased number of species to view, therefore an increased potential to attract (non-discerning) eco-tourists
Increased number of species to harvest for live game sales, trophy hunting, venison markets

environment are not fully understood.^{32,44}

The benefits of introductions, therefore, need to be weighed up against the unanticipated costs, particularly where exotic animals are introduced. Such cost/benefit analyses are complicated by the uneven distribution of effects across ecosystems, regions, society and time.¹² Hence, warnings have been issued against those introductions that take insufficient account of genetic, taxonomic and ecological considerations.³⁸ As an example, the Addo Elephant National Park in the Eastern Cape is bordered by private wildlife operations supporting extralimital species whose spread [including impala and crocodile (*Crocodylus niloticus*) to date] into the national park causes management problems for South African National Parks, who have to control the animals.

Although case studies show some of the benefits of introducing non-native organisms,⁴⁴ the costs appear to exceed them (Table 3) and the uncertainty of surrounding scientific predictions regarding the ecological and economic costs of these introductions is reflected in the lack of introduction policies.¹² More research on the costs and benefits is clearly needed.⁴⁴ Some of the ecological benefits (such as bulk grazing) can be more efficiently provided by the judicious use of domestic herbivores, which are easier to manage.

Whether species are imported as biological control agents⁴⁵ or as a means of artificially increasing local biodiversity, inappropriate introductions may have problematic consequences for native species.⁴⁶ Prospective game-based operators need to be aware of the dangers of undesirable species which, although

economically viable in the short term, may ultimately reduce local and regional biodiversity (and long-term economic viability). To compound the problem, many of these introductions are recent, so the assessment of the long-term persistence and impacts of these species is not yet possible.⁴⁷

Although the rising numbers of private game-based operations and their possible contribution to the survival of South Africa's biological diversity is encouraging, it must be viewed in terms of ecological sustainability. Callicott and Mumford⁴⁸ proposed that the underlying benefits of ecological sustainability must meet human needs without compromising the health of the ecosystem. The concepts of sustainable yield and sustainable development are directly linked to human use of natural resources, which makes them different from the concept of ecological sustainability. A paradox exists in that wildlife operations are potentially a more suitable, and more sustainable, form of land use than pastoralism,⁹ but the introduction of inappropriate species to these areas may compromise and negate the benefits. It has been argued that the severe impact of non-indigenous organisms on native species and ecosystems worldwide is a form of global change, with individual species being responsible for ecosystem level changes.¹² The precautionary principle is therefore advocated when future introductions are considered.

The IUCN's guidelines for re-introducing species to enhance regional conservation efforts¹⁶ stress the importance of re-introduction into their former distribution ranges only, and concentrate only on

those areas where attempts are being made to establish viable populations. In the South African situation, many wildlife operations are directed purely at the hunting fraternity, in which case the guidelines set out by the IUCN may not be applicable. Where the operations are directed towards game-viewing eco-tourism, however, it is imperative that the underlying principle of re-introducing species into their former range is adhered to.

This study shows that this principle is disregarded in a large percentage of South African wildlife ventures, and an urgent review of translocation policy in South Africa is required. The current permit application system is flawed as it ignores ecological considerations and is based purely on restricting introduced species to particular properties. The present financial and logistical constraints facing conservation in South Africa have severely reduced the country's capacity to enforce conservation policies and regulations, especially with regard to translocations. A more successful strategy may be to focus on the ecological and economic impacts of inappropriate introductions, and to educate managers as well as the eco-tourist public about the consequences.

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