

The extent and impacts of ungulate translocations: South Africa in a global context

Dian SPEAR and Steven L. CHOWN

SUPPLEMENTARY METHODS

Impacts of non-indigenous ungulates globally

The last 20 years of literature, demonstrating the impacts of non-indigenous ungulates on biodiversity, was searched using ISI Web of Science (1988-2007). As ISI Web of Science limits the number of search terms used to 50, small sets of genera and vernacular names were used for searching together with the rest of the search terms. All searches made are represented by the following Boolean string:

(Addax or Aepyceros or Alcelaphus or Alces or Ammodorcas or Ammotragus or Antidorcas or Antilocapra or Antilope or Babyrousa or Bison or Beatragus or Blastocerus or Boselaphus or Bubalus or Budorcas or Camelus or Capreolus or Capricornis or Catagonus or Cephalophus or Ceratotherium or Cervus or Connochaetes or Dama or Damaliscus or Dicerorhinus or Diceros or Dorcatragus or Elaphodus or Elaphurus or Equus or Eudorcas or Eudorcus or Gazella or Giraffa or Hemitragus or Hexaprotodon or Hippocamelus or Hippopotamus or Hippotragus or Hydropotes or Hyemoschus or Hylochoerus or Kobus or Lama or Litocranius or Madoqua or Mazama or Moschiola or Moschus or Muntiacus or Naemorhedus or Nanger or Neotragus or Okapia or Odocoileus or Oreamnos or Oreotragus or Oryx or Ourebia or Ovibos or Ovis or Ozotoceros or Pantholops or Pecari or Pelea or Phacochoerus or Philantomba or Potamochoerus or Procapra or Przewalskium or Pseudois or Pseudoryx or Pudu or Rangifer or Raphicerus or Redunca or Rhinoceros or Rucervus or Rupicapra or Rusa or Saiga or Sus or Sylvicapra or Syncerus or Tapirus or Taurotragus or Tayassu or Tetracerus or Tragelaphus or Tragulus or Vicugna or ungulate or impala or hartebeest or elk or moose or dibatag or “Barbary sheep” or aoudad or springbok or pronghorn or blackbuck or deer or

babirusa or bison or gaur or yak or banteng or kouprey or aurochs or nilgai or buffalo or anoa or tamarau or takin or camel or tur or markhor or roe or serow or peccary or duiker or rhino or wildebeest or topi or tsessebe or bontebok or blesbok or beira or ass or zebra or onager or kiang or gazelle or giraffe or tahr or hippo or Taruca or guemal or “roan antelope” or “sable antelope” or chevrotain or hog or waterbuck or kob or lechwe or puku or guanaco or gerenuk or dikdik or brocket or bororo or antelope or suni or “mountain goat” or klipspringer beisa or gemsbok or oribi or muskox or argali or mouflon or “Bighorn sheep” or “Dall's sheep” or “snow sheep” or chiru or rhebok or warthog or bushpig or bharal or siola or pudu or reindeer or steenbok or grysbok or reedbuck or Barasingha or chamois or saiga or “Palawan pig” or “bearded pig” or “Heude's pig” or “warty pig” or “wild boar” or tapir or eland or nyala or bongo or kudu or bushbuck or sitatunga or mouse-deer)

AND (introduced or introduce or alien or extralimital or exotic or invasive)

AND (impact or effect or damage or competition or compete or hybrid or vegetation or disease or pathogen or parasite)

NOT (livestock or domestic or “invasive plant” or “alien plant” or “exotic plant”)

Impacts of ungulate introductions in South Africa

First, the ISI Web of Science (1900 - 2007), Zoological Record (1864 – 2007), and Africa-Wide NiPAD (1900 - 2007) were searched using ungulate species names and “South Africa” as search terms, specifically searching for published work on competition, hybridisation, vegetation degradation, the introduction of new parasites and pathogens and any other impacts of ungulates introduced to South Africa. Second, the contents pages of the following South African publications (and their precursors) were browsed: African Zoology (1965 - 2007), Annals of the Cape Provincial Museums (1961 - 1997), Annals of the South African Museums (1898 - 2004), Annals of the Eastern Cape Museums (2000 - 2007), Bontebok (1981 - 1994), Koedoe (1958 - 2006), Onderstepoort Journal of Veterinary Research (1933 -

2007), South African Journal of Wildlife Research (1971 - 2007), The Lammergeyer (1971 - 2000), Transvaal Museum Annals (1962 - 1999), and a bibliography of the Natal Parks Board unpublished reports (1947-1998) (Sandwith, 2000). The reference lists of relevant papers were examined for additional literature that may have been overlooked during the first two searches.

Potential hybrid pairs

Seven species pairs were considered, three of which included one extraregional species: black wildebeest (*Connochaetes gnou*) and blue wildebeest (*Connochaetes taurinus*), red hartebeest (*Alcelaphus caama*), and Lichtenstein's hartebeest (*Alcelaphus lichtensteinii*), common tsessebe (*Damaliscus lunatus*), and bontebok (*Damaliscus pygargus*), Burchell's zebra (*Equus burchellii*) and mountain zebra (*Equus zebra*), roan antelope (*Hippotragus equinus*) and sable antelope (*Hippotragus niger*), waterbuck (*Kobus ellipsiprymnus*) and lechwe (*Kobus leche*), scimitar-horned oryx (*Oryx dammah*) and gemsbok (*Oryx gazella*) and three sub-species pairs were also considered: Cape mountain zebra (*Equus zebra zebra*) and Hartmann's mountain zebra (*Equus zebra hartmannae*), bontebok (*D. pygargus pygargus*), and blesbok (*D. pygargus phillipsi*) and Cape eland (*Taurotragus oryx oryx*) and Livingstone's eland (*T. oryx livingstonii*). The subspecies designations used were referred to with specific vernacular names in Landbou Weekblad (*Agriculture Weekly*).

SUPPLEMENTARY RESULTS

Impacts of non-indigenous ungulates globally

Table 1. The number of papers demonstrating the impacts of non-indigenous ungulates on biodiversity.

Demonstrated impacts of non-indigenous ungulates	Number of papers
Vegetation alteration by herbivory	31
Indirect effects e.g. competition, hyperpredation	7
Habitat alteration by rooting, soil erosion, soil composition etc	7
Hybridisation	2
Parasite transmission	2
Predation	1

Impacts of ungulate introductions in South Africa

The impacts of Himalayan tahr (*Hemitragus jemlahicus*), and wild boar (*Sus scrofa*) have been investigated in unpublished work from the Western Cape of South Africa. Unpublished studies documented vegetation damage and soil erosion by *H. jemlahicus* (P.H. Lloyd, 1975), the diet of *S. scrofa*, and damage to agricultural areas and relatively untransformed habitat by *S. scrofa* (J.H. Westdyk, 2000; D.L. Hignett, 2006). However, little seems known of the impacts of commonly advertised species such as fallow deer (*Dama dama*) and lechwe (*Kobus leche*). *D. dama* have reportedly spread into parts of South Africa, where they are continuously controlled through culling (Watson, 2006).

The most recent literature in South Africa largely concerns extralimital ungulates. Despite arguments that introduced ungulates may compete with their indigenous counterparts, only one study has attempted to demonstrate that this is the case. Coates and Downs (2005) reported anecdotal evidence of competition between bushbuck (*Tragelaphus scriptus*) and

nyala (*Tragelaphus angasii*) and the evidence was presented is in the form of responses to questionnaires sent to managers of game reserves and farms regarding the status (i.e. increasing or decreasing population numbers) of *T. Scriptus*, and *T. angasii*, on their properties. Two studies provided evidence of giraffe (*Giraffa camelopardalis*) impacts on vegetation in its extralimital range (Bond and Loffell, 2001, Parker and Bernard, 2005). Bond and Loffell (2001) provided comprehensive evidence that browsing by *G. camelopardalis*, occurring extralimitally alters tree species distribution and composition. No studies have convincingly demonstrated introgression among species and/or subspecies of indigenous ungulates. Grobler et al. (2005) investigated introgression between blue wildebeest (*Connochaetes taurinus*) and black wildebeest (*Connochaetes gnou*) but the outcome was not conclusive. Only Fabricius et al. (1988) have inferred fertile F1 offspring from hybridisation between *C. taurinus* and *C. gnou* based on circumstantial, observational evidence. Based on morphology, Fabricius et al. (1989) have also inferred hybridisation between subspecies, specifically between blesbok (*Damaliscus pygargus phillipsi*) and bontebok (*Damaliscus pygargus pygargus*). Only one instance of host-switching among parasites of ungulates in South Africa has been inferred (Meltzer, 1993). It was suggested that the translocation of springbok (*Antidorcas marsupialis*) extralimitally introduced a lungworm (*Bronchonema magna*), which then infested bontebok (*Damaliscus pygargus pygargus*) (Meltzer, 1993). Braack et al. (1995) showed that non-indigenous parasite species such as the tick *Rhipicephalus maculatus* were introduced to the Kruger National Park with the reintroduction of ungulates from elsewhere in South Africa. However, no studies have demonstrated the transfer of disease between introduced and indigenous ungulates in South Africa.

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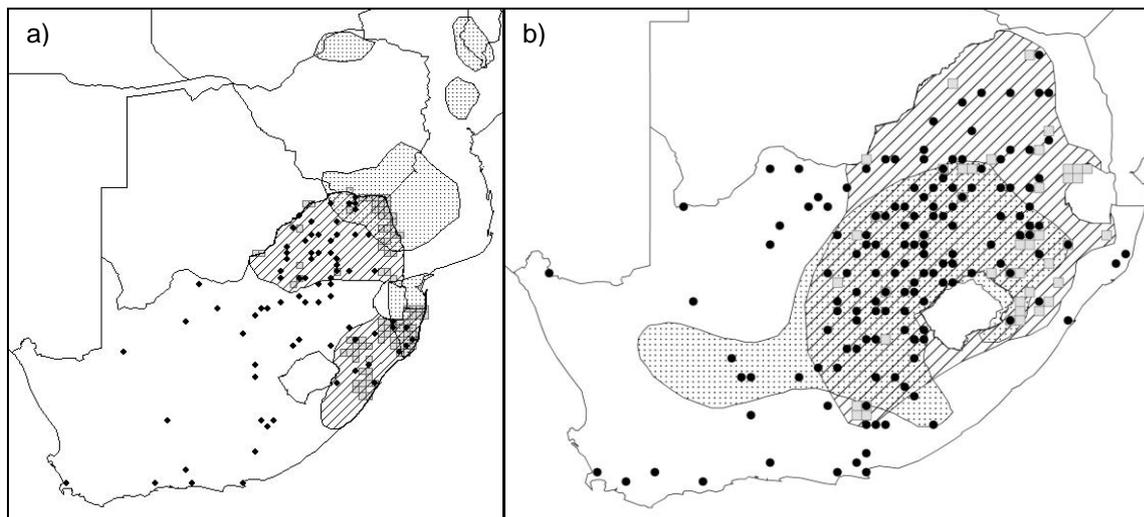


Figure 1. Data used for calculating the extent of range change for a) nyala (*Tragelaphus angasii*) and b) black wildebeest (*Connochaetes taurinus*). The extent-of-occurrence according to Keith (2004) is shown by the area with diagonal lines. The extent-of-occurrence according to Skinner and Chimimba (2005) is shown by the dotted area. Keith's (2004) area-of-occupancy data is represented by grey quarter-degree grid-cells and the black points represent locations where the species have been advertised for sale or for hunting in Landbou Weekblad.

References

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