# 13 · *African Buffalo Production Systems*

D. FURSTENBURG, E. GANDIWA,
Pa. OBEREM AND Pe. OBEREM

## Historical Perspective and Current Situation

Before the eighteenth century, the African buffalo *Syncerus caffer* was widespread and abundant in Africa (Furstenburg, 2015). Across the African continent, humans had used buffalo for millennia, well before domestic cattle were introduced, as a source of meat and co-products such as hides. The meat from buffalo and other game was the product of hunting, including trapping and even kleptoparasitism. Unfortunately, the use of buffalo has not always been sustainable, in particular since European explorers and settlers arrived with their guns (Chapter 12). In more modern times, human population growth, associated agricultural encroachment and modern weaponry has greatly impacted the conservation status of the African buffalo across its continental range, reducing its natural habitat and population size. In southern Africa especially, culling by white settlers from the 1650s to 1800s had a major impact. The great rinderpest epidemic of the 1890s spread south across the continent, further reducing the remaining buffalo population while also eradicating large numbers of other wildlife. This compounded the earlier impacts on the geographic distribution, population size, structure of herds, migration patterns, and hence production of buffalo.

Buffalo are asymptomatic carriers of SAT serotypes of foot-and-mouth disease (FMD), various species of *Theileria* causing East Coast fever, corridor disease and January disease, as well as tsetse-transmitted nagana (Chapter 9). To control and prevent the spread of these diseases to domestic stock, veterinary fences to control the movement of buffalo, other disease carriers and susceptible animals consequently have been used in southern Africa. This has had a further dramatic impact on the buffalo's range and numbers (Oberem and Oberem,

https://doi.org/10.1017/9781009006828.019 Published online by Cambridge University Press

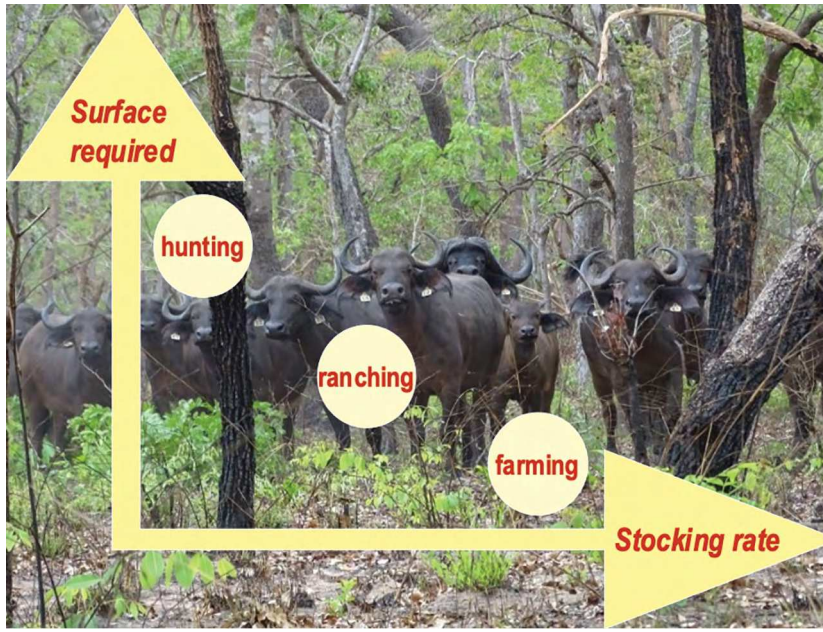


*Figure 13.1* Various categories of African buffalo production systems. Adapted from Chardonnet, 2011; background picture: © Christophe Morio.

2016). It is only recently, with the introduction of community-based natural resource management, private ownership and game ranching, that the concept of sustainable utilization has again, this time consciously, become widely practiced in southern Africa. Regional wildlife populations have grown in southern Africa with the increase of private ownership.

Globally, from the year 1900 to 2000, domestic animal numbers increased by a multiple of 4.5 while wildlife numbers were halved (Smil, 2011). Across African savanna areas, after evolving at varying times and speeds in different regions, the conservation status of habitat and species is today similar, with up to 80 per cent of wild animals lost and replaced in large areas by domestic stock, especially cattle. These developments across the continent have reached a point today where domestic livestock, although an exotic taxon, has virtually replaced buffalo, an indigenous taxon, and restricted the remaining buffalo populations to residual scattered wilderness.

Today, buffalo populations across Africa are broadly conserved in three major land-use systems, that is public protected areas owned by the State, communal land and private properties, the latter in only about

https://doi.org/10.1017/9781009006828.019 Published online by Cambridge University Press

five countries, all in southern Africa, out of the 37 African buffalo range countries. Variations in management objectives across these land-use regimes strongly influence the resultant production systems and the extent of the species' utilization by land managers. Consequently, buffalo production systems have evolved and diversified between extensive models with free-ranging buffalo at low densities on large land areas and, at the other extreme, intensive models with enclosed buffalo at high stocking rates on small, fenced properties (Figure 13.1). The various categories of buffalo production systems are not compartmented; there is a continuum between categories.

Buffalo farms are always fenced, most buffalo ranches are fenced, while most hunting areas with buffalo as a game animal are unfenced. In South Africa, however, all reserves, parks, ranches and farms where buffalo production occurs are enclosed by fences that restrict animal movement.

## Buffalo Production Systems

Wildlife production systems can be classified on a scale of intensity of management. Here they are structured into three categories of property size and management intensity: (1) extensive production systems, (2) semi-extensive systems (game ranches) and (3) intensive systems (game farms).

In Zambia, the 200 game ranches existing there in 2012 (with a growth rate of six (6 per cent) per year over the past 32 years) were classified in three similar categories: (i) large-size game ranches of over 500 ha (75 ranches, that is 38 per cent of the national total), (ii) intermediate-size game farms of between 50 and 499 ha (27 game farms, 13.5 per cent of the national total) and (iii) small-size ornamental properties of less than 50 ha (98 ornamental properties, 49 per cent of the national total) (Chomba et al., 2014).

This structure and these definitions are made in a quest to clarify and better understand the concepts. However, there are no strict limits between the three categories, it is rather a gradient of intensity.

### Extensive Production Systems

In extensive production systems, buffalo are free-ranging and occur at natural densities, with or without the ability to migrate between natural resources and without managerial or veterinary intervention, as seen through most of the range states in Africa. Wildlife in extensive production systems is managed to be utilized for ecotourism and/or regulated hunting (Bothma and Du Toit, 2016).

*Multispecies Bushmeat Hunting in Natural Ecosystems*

Africa's diverse ecosystems are endowed with wild large carnivores and herbivores that hold both ecological and socio-economic importance, and bushmeat hunting is probably as old as humans and still occurs today throughout Africa, both legally (hunting) and illegally (poaching).

In large areas, managers generally employ a more hands-off (extensive) management style utilizing multi-species in natural ecosystems. The smaller the area, the higher the likelihood that fewer species are more intensively managed.

The Cape buffalo *Syncerus caffer caffer* (hereafter, buffalo), given its large size and gregarious gathering in herds, was once one of the southern and eastern African mega-herbivores with the largest distribution (Hildebrandt, 2014). In Africa, humans have, with some exceptions, mostly been transformed from traditional hunter-gatherers into sedentary village hunters and farmers (Wilkie et al., 2016). Historically, subsistence hunting for consumption (bushmeat) in traditional systems was not considered to have a detrimental effect on wildlife populations, because hunting was regulated (Fa and Brown, 2009). Traditional hunting or human predation in multi-species natural wildlife production systems for animal protein (bushmeat) and other wild animal products characterize many tropical indigenous communities (Marks, 1977a; Manyanga and Pangeti, 2017). For example, the African buffalo is among the important target species for the Valley Bisa community in the Luangwa Valley, Zambia. Their hunting techniques and selection of prey is related to the ecology and behaviour of the prey and influence the hunting patterns and timing of hunts (Marks, 1977a, 1977b). This traditionally organized form of wild animal hunting has facilitated the persistence of wild animals due to its selectivity and associated cultural conservation practices (Marks, 1973). However, with the general decline in large wildlife populations (Craigie et al., 2010; Mabeta et al., 2018), species such as buffalo tend to be progressively substituted by medium to small-sized wild herbivores in response to the increasing demand of bushmeat consumption and trade in urban markets (Davies and Brown, 2007).

Around the start of the twentieth century, the declines in wildlife populations prompted many African countries, most then under colonial rule, to criminalize the traditional livelihood strategy of bushmeat hunting (Child et al., 2012). This led to negative relationships and conflict among local people, wildlife and the state as most local communities' access to bushmeat was controlled. Any local hunting of wildlife now is labelled as poaching, and wildlife are mostly confined to protected game

areas and national parks (Child et al., 2012; Hildebrandt, 2014; Mutanga et al., 2015).

Today, bushmeat hunting is generally non-selective and indiscriminate with regard to the animal's sex and age and, when it is commercial, to the number of individuals taken. As rural populations grew, hunting methodologies became more modern, effective and less selective (firearms as opposed to the more traditional methods). As the land available for wild animal populations became limited by the expansion of farming and agriculture, bushmeat hunting concentrated in the remaining natural habitats was reported to threaten wildlife populations (Child et al., 2012; Wilkie et al., 2016). Literature points to hunting by humans, since the advent of modern firearms, having led to the extinction of wildlife species inclusive of large carnivores and herbivores (Martin, 1966; Ripple et al., 2019). Today, wildlife provides many ecosystem services in the form of ecotourism, trophy hunting, meat, medicinal products, aesthetic enjoyment and inspiration (Tchakatumba et al., 2019).

### *Community-Based Natural Resources Management and Multi-Species Hunting*

The introduction of community-based natural resources management (CBNRM) in the early 1980s was perceived as a necessary intervention to benefit wildlife and communities (Child et al., 2012). Where CBNRM is implemented properly, wildlife can be used sustainably as an economic engine in communal lands while simultaneously encouraging conservation (Child et al., 2012). For example, the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) is an example of a CBNRM programme that was designed and implemented by the Government of Zimbabwe in 1989 to stimulate the long-term development, management and sustainable use of natural resources in the country's communal farming areas adjacent to state-protected areas. Thus, under CAMPFIRE, extensive natural wildlife areas were actively managed by local communities in order to reduce unsustainable exploitation of wildlife and human–wildlife conflicts, while also providing local communities with conservation benefits and incentives (Muboko and Murindagomo, 2014). A major shift in the business model was the sharing of benefits inclusive of bushmeat derived from organized trophy hunting of multiple species of wild animals based on a participatory and sustainable quota setting system.

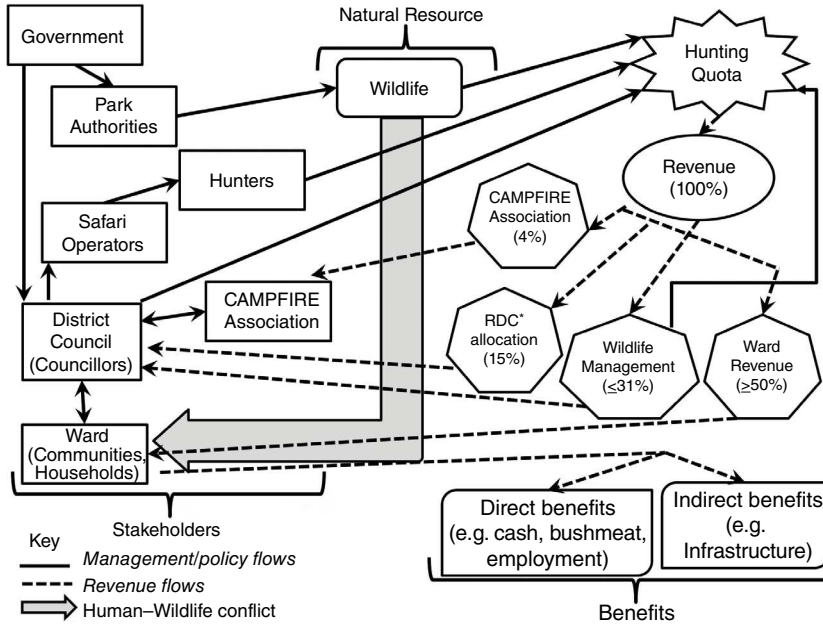


*Figure 13.2* Flow of direct and indirect benefits from CAMPFIRE programmes (Tchakatumba et al., 2019). *RDC refers to Rural District Council. Source: with permission of Taylor & Francis.

In 2022, a total of 58 of 60 districts in Zimbabwe were under CAMPFIRE programmes with a total area of 50,000 km$^2$ (12 per cent of Zimbabwe's surface area), which supports approximately 200,000 households (Machena et al., 2017; Campfire Association Zimbabwe, 2022). On average, CAMPFIRE generates about €1.85 million per year with trophy hunting, constituting the major source of revenue while other sources of revenue include ecotourism and lease fees (Machena et al., 2017). Thus, under CAMPFIRE, local communities realize both direct and indirect benefits from the sustainable management of local natural resources (Figure 13.2). The buffalo is identified as one of the 'Big Five' species, is valuable for both meat and trophy hunting and is a high-value species for photographic tourism. Local communities are tasked with conducting anti-poaching patrols and general resource monitoring in CAMPFIRE areas. Studies on CAMPFIRE show that wildlife habitats are being maintained well and have created conditions for increased wildlife populations outside protected areas (Gandiwa et al., 2013; Musiwa and Mhlanga, 2020). Nonetheless, there has been some criticism of the CAMPFIRE

https://doi.org/10.1017/9781009006828.019 Published online by Cambridge University Press

experience (e.g. Dzingirai, 2003). Elsewhere, similar CBNRM programmes (e.g. Botswana and Namibia) have led to enhanced conservation, benefits for local communities and recovery of wildlife populations (Mogomotsi et al., 2020; Stoldt et al., 2020).

### Semi-Extensive Production Systems: Game Ranches

A semi-extensive production system is a natural area that is large enough for self-sustaining wildlife populations to be managed, that is a game ranch or a national, provincial or private park or reserve (Cloete et al., 2015). It can be fenced or unfenced, but humans need to intervene to provide either water, supplementary and/or complementary feeding, control of parasites, control of predation or the provision of health care (Cloete et al., 2015). Camp sizes (subportion of a game ranch/reserve) vary from several hundred to several thousand hectares depending on the habitat, climate, environment, other herbivore species, topography of the land and the nature and scope of the business. Every production system is unique, with specific ecological and animal management parameters addressed scientifically and professionally by experts. Game ranches may be considered as an innovative, sustainable form of agriculture or animal husbandry where an important outcome is the rewilding of an area.

Buffalo ranching often occurs in semi-extensive multi-species production systems as one element of the herbivory with or without natural predation. Stocking rates may exceed the natural carrying capacity of the rangeland; hence, in such cases, the need to supply supplemental feed during the dry season. Without careful rangeland management, there is subsequently a risk of ecological deterioration of natural habitat conditions. Buffalo ranching is often practiced on marginal agricultural land that was formerly severely degraded due to monocropping or domestic stock farming, and there is a need over time for sophisticated habitat rehabilitation programmes to be implemented (Chapter 14).

Such systems also require the management of sex and age structure by (i) limiting the number of mature breeding bulls (selective per individual animal profiling), normally 1 bull per 20–40 mature cows; (ii) removing surplus young bulls, mostly allowing only one bachelor group of <10, or complete removal of all young bulls, to limit social confrontation and fighting with the usually very valuable breeding bull; and (iii) removing and/or replacing post-age and non-productive females from the population.

Its reputation has given the buffalo the status of being recognized worldwide as one of the 'Big Five'. The buffalo is the most dangerous of

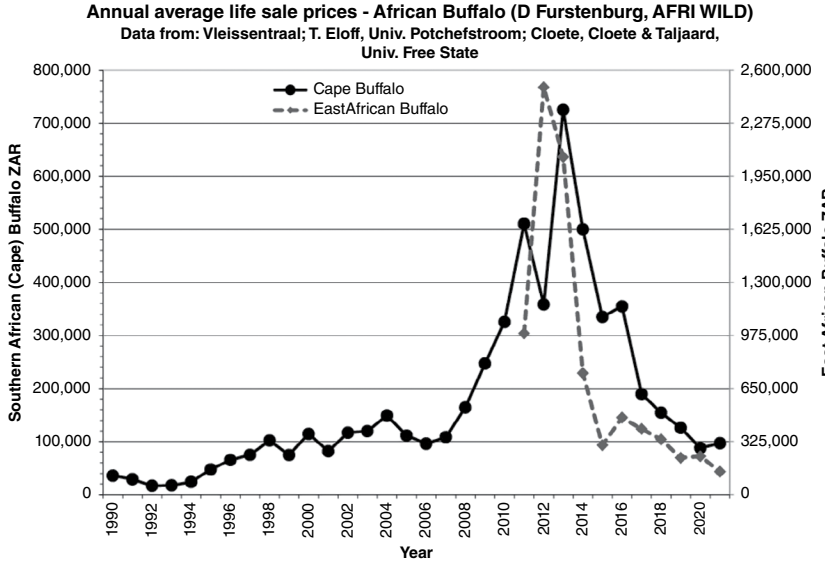


*Figure 13.3* Auction prices of live breeding buffalo bulls over time and illustrating the value initially placed by purchasers on buffalo of East African origin for reasons discussed in the section dealing with production of buffalo with large horn size, below. East African buffalo, formerly recognized as a subspecies, is phenotypically 12 per cent larger in body size, 10–20 cm higher shoulder height, with greater horn spread, lesser curve-drop and smaller bosses, than the southern African buffalo. East African buffalo was introduced into the South African production systems adding specific value market traits. © Deon Furstenburg.

all African game species, especially if wounded or solitary. Its economic value has been further enhanced (Figure 13.3) by veterinary restrictions that prevent its translocation due to the danger of spreading disease. Consequently, the captive breeding of disease-free buffalo in semi-extensive confinement has become a lucrative business, but one which must be approached properly to ensure success. There was a boom in prices after the worldwide economic crises of 2008, reaching a record high in 2017 (Figure 13.3), followed by a fall to more normal pricing trends during 2018–2019.

### Intensive Production Systems: Game Farms

Intensive wildlife production systems occur in small fenced areas where wild animals are intensively managed for the production of meat, hides

https://doi.org/10.1017/9781009006828.019 Published online by Cambridge University Press

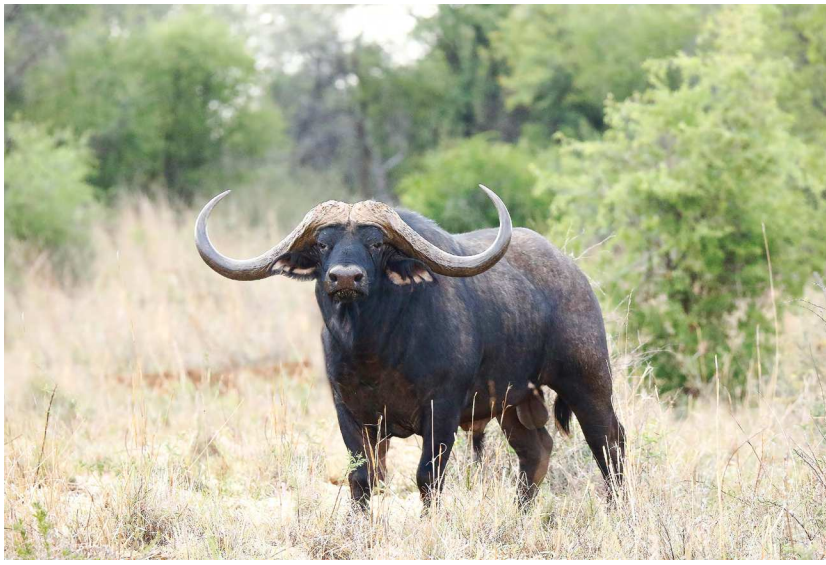

*Figure 13.4* Horizon, the most expensive African buffalo bull ever bred so far, was sold at an auction for €10.8 million. Horizon was bred by Jacques and Caroline Malan of Lumarie. According to the SCI method (following the external curve of the horns, in inches), he measures an impressive 55 6/8". © Nyumbu Game.

and live animals. Buffalo farming is also sometimes practiced intensively in small camps on game farms, mainly to produce highly priced animals for live sales, that is specific disease-free and specifically selected for phenotypes (e.g. body size, horn size and shape) of trophy buffalo (Figures 13.5 and 13.6; Bothma and Du Toit, 2016). A camp is fenced off to more closely manage rare and valuable animals that cannot move freely. These small camps vary in size from 5 ha pens to 80 ha camps. As a result of the small surface areas of the camps, daily supplement feeding, or even a complete feed, is provided all year round, the ratio depending on the camp size and quantity (biomass) and quality (nutritional contents) of the grass production. The animal load in the camps exceeds natural vegetative carrying capacity generally by two- to threefold or more. One mature bull (selected by its animal and genetic profile) and 10–40 mature cows depending on the specific situation are usually kept as a herd in a camp. As a result of socio-spatial restrictions, only one bull is kept and all male progeny are removed to a different camp before reaching sexual maturity and the risk of intersocial confrontation, that is fighting. However, because of the recent dramatic decline in prices attained for

*Figure 13.5* Aerial view of a 460-ha intensified multi-camp buffalo production system in savanna habitat with centred pens for handling, supplement feeding and rotation of stocking between camps. Optimal habitat management entitles (i) a 2-camp system per buffalo herd and rotated every 8 months, or (ii) a 3-camp system per herd and rotated every 4 months (Furstenburg, 2017a).

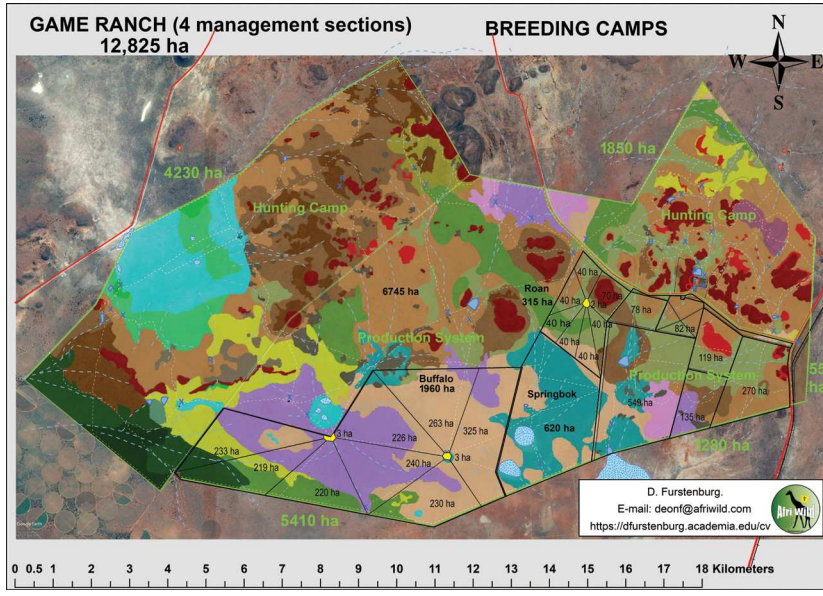


*Figure 13.6* Example outlay of a semi-extensive buffalo production camp system (2-camps, on average 230 ha each, per breeding herd, including two free-roaming areas >4,000 ha each for surplus animals) constructed per vegetation survey map in arid Kalahari savanna habitat (Furstenburg, 2017b).

https://doi.org/10.1017/9781009006828.019 Published online by Cambridge University Press

buffalo and due to the cost of management, feed, veterinary services and medication in these intensive systems, the truly intensive breeding facilities have begun to turn more to semi-intensive methods of ranching.

## Buffalo Products

All of the above production systems rely on one or more of the four sustainable use pillars of 'game ranching', namely (i) breeding for sale to new properties being converted to game ranches and rewilding; (ii) non-consumptive tourism, that is ecotourism; (iii) consumptive tourism, that is hunting; and (iv) production of meat and other animal products such as skins/leather, curios from horns, skins, hooves, bones, etc.

### Live Sales of Breeding Animals

Many game ranchers took the opportunity to breed game animals for live sales. Most of these specialized in specific so-called rare species, for example bontebok, black wildebeest, sable antelope, roan antelope. Others specialized in specific, sought-after characteristics such as buffalo and sable with trophy-quality horns and body conformation. Yet others focused on multiplying colour variants that occur naturally but rarely in nature, such as black impala, golden wildebeest, etc. The breeding, sale and translocation of these animals resulted in the rewilding of marginal conventional agricultural land that was converted into game ranches. Today, this market segment is less lucrative than at its summit in 2017 but is still thriving.

### Non-Consumptive 'Ecotourism'/Wildlife-Viewing Tourism

Non-consumptive tourism in the form of wildlife-viewing tourism can also be regarded as a production system where the product or service is a photographic, educational or recreational safari sold to clients who buy a period of time spent in nature to watch fauna and flora including buffalo. Buffalo, as one of the 'Big Five' and with a reputation of being dangerous, are highly prized by wildlife-viewing tourists. With appropriate management, both consumptive and non-consumptive tourism can be conducted in the same area to increase and diversify the value of the ecosystem service.

### Consumptive Tourism/Hunting Tourism = Sustainable Utilization

By definition, hunting tourism harvests a very low percentage of individuals within populations, old males or excess animals only, with the

ecological and economic objectives of (i) conserving a buffalo population and its habitats through sustainable hunting and (ii) sustaining the hunting enterprise as well as the ranch. The trophy-hunting model aims to produce large trophies, while the sport-hunting model aims to offer fair chase hunts to tourist hunters who are more interested in the quest than in the trophy.

These buffalo-hunting production systems operate over large to very large areas where the buffalo densities appear at their natural levels, which are low compared to intensive systems. In all of the countries where buffalo tourism hunting occurs, hunting areas are unfenced open range extending in size from between 50,000 and 300,000 ha. South Africa, where buffalo are hunted in fenced hunting areas of smaller but still physically substantial sizes such as a few thousand hectares, is an exception. Given the demand and value realized by these forms of buffalo hunting, hunting buffalo for meat in these semi-extensive systems is rare, in contrast with the hunting of more common, less expensive game species (Chapter 16).

### Animal Products

Game meat is considered a delicacy in many parts of the world where it is in demand for its rarity and its health benefits, such as high protein and low fat content. There are specialist harvesters who harvest excess animals for the purpose of supplying specialist game meat processors. The jurisprudence with respect to the South African Meat Safety Act 40, 2000 still needs (after >12 years of negotiations) to be amended to ensure that game meat can reach its true potential as a source of good, healthy, natural protein.

Many different curios are manufactured, formally and informally, from many parts of carcasses used for trophies and meat, including from skins (leather goods such as skin floor mats, shoes, handbags and belts, even furniture coverings), horns (door handles, lamps, wall decorations), bones (carved salt and pepper cellars, knife handles, lamp stands), etc.

## Case Study: The Wildlife Ranching Industry in South Africa

### The Buffalo in South Africa

In South Africa, the game ranching industry was born with the promulgation of the Stock Theft Act in South Africa in 1991, which confers

Table 13.1 *Percentage of various species, some endangered, on private land owned by private game ranches versus those on state reserves in South Africa (Nel, 2021; Furstenburg et al., 2022).*

| Species | % on private land | % on state land |
|---|---|---|
| Black wildebeest | 87 | 13 |
| Blesbok | 90 | 10 |
| Bontebok | 88 | 12 |
| Buffalo | 63 | 37 |
| Oribi | 97 | 3 |
| Roan antelope | 95 | 5 |
| Sable antelope | 97 | 3 |
| White rhinoceros | 65★ | 15★ |

★ Of the world population.

ownership of game to the owner of the land so long as the land is adequately fenced. It got a further growth boost in 1996 when the new South African Constitution was adopted; Section 24 of this constitution recognizes the principle of the sustainable use of natural resources in South Africa.

The 2008 economic crisis played a further role with investors seeking different ways to invest their money. At its summit in 2015/2017, 8,000–10,000 game ranches covered almost 20 million ha (i.e. 14 per cent of the national estate, an area 2.2 times larger than the formally protected areas of the country). Many game ranches were established on marginal land, that is farmland with low agricultural production potential. Others were established on degraded agricultural farmland that was previously occupied by monocultures of domestic stock and/or crops such as maize (Cloete et al., 2015), thus rewilding and converting former farms into wildlife-based enterprises.

Sustainable use as a form of conservation was at the beginnings of a massive private and privately funded 'rewilding' of the country. This brought about a major turnaround in the numbers of many endangered species, as well as in the 'ownership profile' of animals in the country. As can be seen from Table 13.1, the numbers of species, including endangered species, are much higher on privately owned game ranches compared to state land.

The same successful contribution has been made by private owners on private land to the survival of buffalo in South Africa. Table 13.2

Table 13.2 *Numbers and disease status of buffalo in South Africa; bTB = tuberculosis; CA = brucellosis; FMD = foot and mouth disease (personal research of P.T. Oberem).*

| Facility: State Protected Areas *versus* private ranches | Size (Ha) | Buffalo numbers | Sanitary status |
|---|---|---|---|
| Kruger NP | 2,000,000 | >35,000 | bTB, CA, FMD positive, theileriosis positive |
| Addo Elephant NP | 170,000 | 440 | bTB, CA, FMD, *Theileria* free |
| Mountain Zebra NP | 28,400 | 80 | bTB, CA, FMD, *Theileria* free |
| Hluhluwe–Imfolozi | 96,000 | >7000 | bTB, theileriosis positive CA free, FMD free? |
| Camdeboo | 19,400 | 75 | bTB, CA, FMD, *Theileria* free |
| Marakele | 61,000 | 20 plus | bTB positive?, CA, FMD, *Theileria* free |
| Mokala | 26,485 | 50 | bTB, CA, FMD, *Theileria* free |
| Madikwe | 72,000 | 800 | CA, *Theileria*, FMD free, bTb positive |
| **Total in State Protected Areas** | **2,401,285** | **>43,465** | **Only 645 disease-free** |
| **Total on private ranches** | **>7,000,000 (available)** | **>75,000** | **ALL DISEASE-FREE** bTB, CA, FMD, *Theileria* free |

indicates the number of buffalo in national and provincial parks versus game ranches as well as their disease status. There are only 645 disease-free buffalo in state parks compared with 75,000 disease-free buffalo on private ranches.

### Legal Status of Buffalo in South Africa

The South African Government Gazette No. 42464 dated 17 May 2019 amended table 7 of the Animal Improvement Act (Act no. 62 of 1998) and now lists 32 new wild animal species, including 24 indigenous mammals (e.g. the African buffalo), to provide for the breeding, identification and utilization of genetically superior animals to improve the production and performance of animals in the interest of the Republic. By declaring these wild animals as landrace breeds (in table 7 of the regulations), the Act typically provides for landrace breeds to be bred and 'genetically improved' to obtain superior domesticated animals with enhanced production and performance. Similarly, provision is made for

the Breeders Association to lay claim to the breed and to establish specific breed standards for animals to be included in stud books. Animals declared as landrace breeds can also be used for genetic manipulation, embryo harvesting, in-vitro fertilization and embryo transfers.

Numerous concerns about the new legislation have been raised, including from scientists, over negative genetic consequences, ecological and economic risks, as well as direct conflict with other biodiversity laws in South Africa (e.g. IUCN SSC Antelope Specialist Group, 2015; IUCN, WCC 2016; Somers et al., 2020). However, many if not all of these concerns could be mitigated by the Code of Conduct of the game breeder association (Wildlife Ranching South Africa), which intends to become the administrative and implementing agent under this legislation.

### Macroeconomics

On the 20 million hectares occupied by game ranches, an income stream of €1.2 billion (ZAR 20 billion; €1 = ZAR 16.31) is generated annually, resulting in numerous decent jobs and outperforming the national economy (Oberem and Oberem, 2016).

Surveys of game ranch usage in South Africa (Taylor et al., 2020) revealed important facts about the benefits of private game ranching. Eighty per cent of private ranches utilized some form of consumptive sustainable use, with 5 per cent of the total land area covered by these private properties utilized for intensive breeding of rare species or colour variants. While profitability varied greatly between the properties, they produced an average return on investment (ROI) of 0.068 and employed more people at higher wages than equivalent domestic livestock operations. From the survey, it was concluded that the South African model could be a suitable option for other African countries seeking sustainable land-use alternatives.

A further survey (Taylor et al., 2021) assessed how the wildlife ranching sector (including intensive and semi-extensive) contributes to the conservation of herbivores. It concluded that individual ranches had a mean of 15.0 (±4.8) species, 1.9 (±1.5) threatened species and 3.6 (±3.1) extralimital species per property. In comparison to 54 state Protected Areas, wildlife ranches had significantly higher species richness, more threatened species but also more extralimital species, with total herbivore numbers estimated to be as many as 7.5 million. The report concluded that private game ranching in South Africa represents one of the few examples on earth where indigenous mammal populations are thriving and demonstrating how sustainable use can lead to rewilding.

Table 13.3 *Income from various economic activity pillars on game ranches in South Africa (Nel, 2021) (€1 = ZAR16.31).*

| Activity | Annual income (€1 = ZAR16.31) |
|---|---|
| Subsistence hunting (meat) | €735.9 million (ZAR 12 billion) |
| International hunting (sport/trophy) | €122.7 million (ZAR 2 billion) |
| Processed products (meat/leather/curios) | €306.6 million (ZAR 5 billion) |
| Live animal sales @ formal auctions | €61. million (ZAR 1 billion) |
| **Total** | **€1.2 billion (ZAR 20 billion)** |

Nel (2021) reported that 50 per cent of game ranches obtain an income from hunting, with hunting being the main income stream for 30 per cent of these ranches. Of these game ranches, 5 per cent conduct photographic tourism and 52 per cent are engaged in all four of the economic activity pillars. Table 13.3 indicates the income obtained from the economic activity pillars on game ranches.

In South Africa, buffalo was the number one income-generating species in 2016 (North-West University, 2017; Table 13.4), although it does not appear on the list of the top ten most hunted species. This is an outstanding demonstration of a high-value species that produces high income with a small number of harvested individuals.

## Basics of the Game Ranching Technology

In general, smaller properties require far more management inputs than larger ones where the size, diversity and lower density levels of animals allow for less close oversight and interventions.

### *Infrastructure*

Fences around game farms in South Africa are regulated by law. To own wild animals the property is required to have a Certificate of Adequate Enclosure (CoAE), which is issued by the Department of Environmental Affairs. The specifications (height, number of stands, etc.) are dictated by the law. In order to introduce and release African buffalo onto the property, a permit (WR number for the property) is required from Veterinary Services. Properties with buffalo also have specific minimum fencing requirements. Fences are not generally electrified, they are so usually only when very valuable animals are kept in small camps (<80 ha), and

Table 13.4 *Top 10 income generators (€1 = ZAR16.31) (North-West University, 2017).*

| Species | 2014 | 2015 | 2016 | % CHANGE |
|---|---|---|---|---|
| Buffalo | €7.8 million (ZAR127 million) | €8.9 million (ZAR145 million) | €13.5 million (ZAR220 million) | +73 |
| Sable | €3.5 million (ZAR57 million) | €4.5 million (ZAR73 million) | €7.2 million (ZAR117 million) | +106 |
| Lion | €12 million (ZAR195 million | €11.1 million (ZAR181 million) | €6.8 million (ZAR111 million) | –43 |
| Kudu | €4.8 million (ZAR78 million | €6.4 million (ZAR104 million) | €6.7 million (ZAR110 million) | +40 |
| White rhino | €4.4 million (ZAR72 million) | €4.7 million (ZAR76 million) | €5.1 million (ZAR83 million) | +14 |
| Nyala | €2.8 million (ZAR45 million) | €2.8 million (ZAR46 million) | €4.7 million (ZAR76 million) | +71 |
| Waterbuck | €2.2 million (ZAR36 million) | €2.5 million (ZAR40 million) | €3.1 million (ZAR51 million) | +39 |
| Blue wildebeest | €2.2 million (ZAR36 million) | €2.4 million (ZAR39 million) | €3.1 million (ZAR50 million) | +39 |
| Burchell's zebra | €2.4 million (ZAR39 million) | €2.8 million (ZAR45 million) | €3.1 million (ZAR51 million) | +29 |
| Oryx/gemsbuck | €2.4 million (ZAR39 million) | €3.1 million (ZAR51 million) | €3 million (ZAR49 million) | +27 |

this to keep aggressive bulls in adjacent camps from fighting and to prevent predation of the calves.

In order for any buffalo to be moved from one property to another, both properties need to be approved and registered (WR numbers) by Veterinary Services, the animals have to be tested for the four controlled diseases, namely FMD, corridor disease (i.e. theileriosis), bovine brucellosis/contagious abortion (CA) and bovine tuberculosis (bTB). Permits must then be issued by the Department of Environmental Affairs in the provinces involved (two if moving the animals from one province to the other).

Bomas, or small, sturdily built camps of 1 ha or less, are not often used. When they are, it is mainly only for temporary housing, for example when holding animals while waiting for disease test results and permits (no animals may be moved without permits, see above), while in quarantine and/or for adaptation purposes to new farms in new and different geographic areas (Figures 13.7 and 13.8).

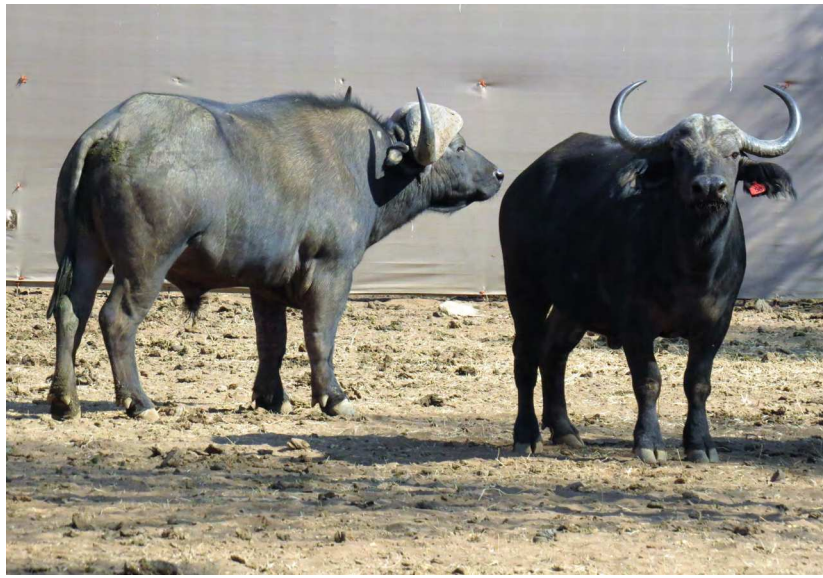

*Figure 13.7* Buffalo in boma. © Q. Strauss – MLP Media.

*Figure 13.8* Buffalo in boma. © J. Malan.

https://doi.org/10.1017/9781009006828.019 Published online by Cambridge University Press

The sectoral focus that is the main economic driver and the size of the game ranch determine the need and type of water provision and/or water facilities provided. The biggest ranches would most likely rely mainly on natural water resources and sources such as rivers, dams and wetlands with perhaps (as is seen even in the 2 million ha Kruger National Park) some additional artificial drinking reservoirs and troughs to supplement the resource and ensure better utilization of the available habitat (pasture). At the other extreme, smaller farms and camps may rely entirely on such artificial sources.

*Habitat and Feeding Management*

Habitat management includes restoring the natural habitat and vegetation that generally has/had been damaged to varying degrees by earlier agricultural practices, including ploughing, overgrazing with a monoculture of species (e.g. cattle) and internal fencing/camping. It also includes providing artificial water sources, boreholes, reservoirs and dams to improve the utilization of the natural habitat across the property. Many of these former cattle farms also may be damaged as a result of bush encroachment (e.g. *Dicrostachys* sp., *Stoebe vulgaris*, various thorn trees of *Senegalia* and *Vachellia* sp.), which requires expensive interventions to restore the vegetative value and carrying capacity. It may also entail the removal of toxic invasive plants (often aliens) such as *Lantana camara* and *Asclepias* spp.

Especially on smaller properties, supplementary feeding needs to be practiced, in particular during the dry season (in South Africa this is mainly during the austral winter months) to ensure optimum health and reproductive rates. This would include vitamin and mineral supplements, protein supplements during the winter, and compounds to counteract the plant's own defences, for example inclusion of polyethylene glycol (PEG) and propylene glycol (PG) to bind terpines and tannins allowing better utilization of especially browse but also lignified sour grasses during the winter (van Hoven and Oberem, 2018).

*Breeding and Health Management*

The first most important breeding management interventions are reducing the number of male animals that are kept for breeding to allow a higher percentage of female animals, that is altering the sex ratio from 1:1 to 1 male for 25–40 females. Males that are not selected for breeding are used either for trophy/sport hunting or for harvesting game meat. The

second most important breeding management intervention is the selection of specific males for breeding to (i) maintain the natural characteristics of the species, (ii) improve adaptedness to that specific environment and (iii) improve general health by selecting against characteristics predisposing to parasites and diseases. For example, it is not recommended to breed with animals, in particular bulls, that habitually carry large numbers of ticks ('tick taxis'). In the case of buffalo, selection is often specifically to restore the 'lost' horn length and character, which was selected against by heavy trophy hunting over many decades. A further important reason for selecting specific males and keeping records thereof is to prevent inbreeding.

Reproductive performance can be greatly improved by supplementary feeding in particular, and by reducing the numbers of male animals – and hence competition. Production management reduces the average intercalving rate of cows from extensive areas (as seen in the larger protected areas) from 22 to 14.5 months. This increases the maximum number of progeny per lifespan (20 years, first mating at age 5) from a natural $n$ = 8 calves to $n$ = 12 per lifespan (i.e. a 50 per cent increase per breeding cow). The age at first calving can also be reduced through the provision of constant quality feeding.

Wild animals have various adaptations to reduce the impact of parasites such as ticks and helminths on them. In some cases, this consists of migrating away from heavily parasitized areas, which often is not possible on fenced properties. This requires management interventions to reduce parasite numbers. Various 'self-medication' forms of acaracide applications have been developed. However, they all have negative aspects (e.g. not being able to control which animals are treated, frequency of dose and/or rate/size dose are difficult to control). Recently, acaricidal balls have been developed, shot by paintball sporting guns, meaning that the correct pour-on acaricide dose can be applied to the correct animal at the required time. Helminth treatment is usually only necessary on small properties with a higher numbers of animals per hectare and is most commonly applied to the supplementary feed.

## Genetic Perspective of Buffalo Ranching

In South Africa, all buffalo are in fenced areas, either on private game ranches or National or Provincial Protected Areas. Similarly, veterinary fences and national boundaries in many cases prevent the migration and free movement of buffalo. This has created separate genetic pockets in

regions, countries, reserves and private ranches. Given the earlier genetic bottlenecks the African buffalo has suffered, namely the great rinderpest epidemic, and hunting and veterinary controls, this further genetic isolation is of great concern. Private game ranchers, however, have by the nature of their businesses traded and moved animals, in particular bulls, from farm to farm, a practice of metapopulation species management. The purpose was and is twofold, namely to (i) mitigate against inbreeding and loss of genetic diversity and (ii) enhance the quality of the animals on a property by being healthy specimens of the typical buffalo in line with the descriptions recorded by Skinner and Chimimba (2005).

A study of 4,000 buffalo from 26 private ranches (Greyling et al., 2013) revealed that 11 ranches had a genetic diversity 3 per cent lower, and nine ranches had a genetic diversity greater than that of Kruger National Park. The latter indicates the enhancement obtained from metapopulation outbreeding because of frequent trading between private populations. In comparison, relative heterozygosity of private production populations ranges from 1.05 to 0.7 (disease-free) compared to protected conservancy-based populations of (i) Kruger National Park = 1 (diseased, meaning with the four main diseases cited above, that is bTB, CA, FMD and theleiriosis), (ii) Hluhluwe–iMfolozi = 0.85 (diseased), (iii) Addo = 0.65 (disease-free) and St Lucia Estuary = 0.62 (diseased) (Greyling, 2017).

Metapopulation macro-genetic management by private production systems could not only enhance, but also restore historically depleted genetic diversity of game species, with a positive contribution to the survival of the species. The combination of climate change and human industrial development poses increased risk to species adaptation and survival (Furstenburg and Scholtz, 2009; Scholtz et al., 2010). Consequently, increased species and population heterozygosity (genetic integrity) has become directly essential for species survival, and sustained species marketing traits as incentive for production breeding being indirectly essential (Chapter 3).

### Production of Specific Disease-Free Buffalo

After detecting bTB in Kruger National Park in 1990, a project was developed to preserve the Kruger buffalo genotype. In 1998, 11 disease-free calves were successfully bred and moved to private land outside of Kruger National Park. As a result of the subsequent successful breeding of more than 27,000 privately owned disease-free buffalo in South Africa, the project was terminated in 2011 (Bengis et al., 2016).

In contrast to state and provincial parks, all buffalo in the private buffalo sector are thus currently disease-free (Table 13.2; Chapter 12).

## Production of Large Horn Size Buffalo

Early travellers' journal entries and many scientific studies indicate that buffalo, like many other species (e.g. sable, *Hippotragus niger*; greater kudu, *Tragelaphus strepsiceros*; eland, *Tragelaphus oryx*; elephant, *Loxodonta africanus*; and more), were exploited during the eighteenth and nineteenth centuries by continuous selective hunting. Trophy hunters in particular often first shot the largest individual in a herd, consequently possibly gradually depleting the natural genetic integrity and quality of the species. Studies of kudu populations by Furstenburg (2005) in both free-roaming conservancy production and semi-extensive production systems in the Eastern Cape and in Namibia revealed genetic quality depletion in under 20 years by continuous selective harvesting/hunting.

During the wildlife price boom of the 2010s, East African buffalo had greater trade value for having a 12 per cent larger body size and a greater horn spread than the Kruger and Addo phenotypes. Kruger buffalo are known for thick bosses and a deep drop at the side of the head before curving upwards, and Addo buffalo have smaller body sizes and smaller bosses. East African buffalo were introduced and bred with the Southern African private populations during the late 1990s. Gradually, trophy quality increased, and the first 50-inch trophy bull was auctioned in September 2013 for €1.6 million (ZAR 26 million), and re-auctioned in February 2016 at an all-time record for buffalo of €10.8 million (ZAR 176 million; the animal shown in Figure 13.4). Indications from auctions are that today there are more than 50 bulls with greater than 50-inch trophies among the breeding stock in private production systems in South Africa.

The extent to which this is manipulated genetic engineering versus the restoration of historic natural genetic integrity continues to be debated at the national and international levels. At the national level, disagreements between various organizations are flaring, including between hunting organizations (Selier et al., 2018). Somers et al. (2020) point out numerous concerns in the new legislation, including the process of consultation, and argue that the law will not improve the genetics of the species mentioned but will have considerable negative genetic consequences and pose ecological and economic risks. At the international level, there is much concern about intentional genetic manipulations of wildlife, for

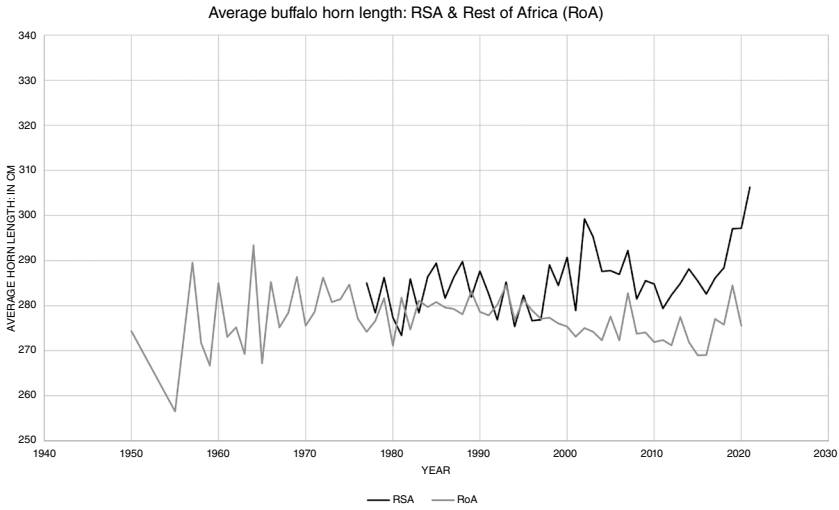


*Figure 13.9* Average horn length in Cape buffalo (*Syncerus caffer caffer*) in South Africa ($n$ = 777, 22 per cent) and in the 'Rest of Africa' (RoA), a variable composed of data from 11 countries from eastern and southern Africa: Angola, $n$ = 19; Botswana, $n$ = 35; Kenya, $n$ = 89; Mozambique, $n$ = 100; Namibia, $n$ = 16; Rwanda, $n$ = 3; Tanzania, $n$ = 857; Uganda, $n$ = 4; Zambia, $n$ = 482; Zimbabwe, $n$ = 811. All buffalo were hunted for trophy hunting in South Africa when buffalo in other countries may have been hunted for other reasons. Graph drawn from data published by Safari Club International (2022).

example (i) the World Conservation Congress at its session in Hawaii, United States of America, 1–10 September 2016, adopted the recommendation WCC-2016-Rec-100-EN on management and regulation of selective intensive breeding of large wild mammals for commercial purposes (IUCN WWC, 2016); and (ii) the Antelope Specialist Group of IUCN released in 2015 a position statement warning about intentional genetic manipulation of antelopes (IUCN SSC Antelope Specialist Group, 2015).

The twin impacts of indiscriminate hunting of the better trophy buffalo bulls in the rest of Africa and the managed breeding and sustainable use of these animals in South Africa are clearly visible in Figure 13.9 (Safari Club International, 2022). The growth of hunted buffalo's average horn length in South Africa can be seen in the graph of records from the 1990s. In comparison, the horn lengths of hunted buffalo from the rest of eastern and southern Africa have shown a steady decline, probably as a result of indiscriminate hunting of the better horned bulls.

https://doi.org/10.1017/9781009006828.019 Published online by Cambridge University Press

### Domestication

Domestication of a species is a process whereby, over time, and via genetic selection and modification of a species, it may be adapted for human association and use. Some species, through their genetic plasticity, are better suited for this process (e.g. the dog). It is important to distinguish domestication from 'taming' and 'habituation', both processes being short-term, individual- or small group-based and not involving genetic modification. Habituation can occur even in areas as large as Kruger National Park, where animals of all types become accustomed to and accepting of, for example, tourists in their vehicles on the roads and behave as if the latter were not there. Similarly, the concept of buffalo herding as practiced recently in Zimbabwe and historically in Mozambique is another example of habituation rather than domestication.

Domestication of the African/savanna buffalo, although unsuccessfully attempted on a few occasions, is not something to consider. First, the buffalo's aggressive temperament, massive size and huge horns renders this a risky exercise. Second, its value as a tourism (both consumptive and non-consumptive) icon would be eroded. As domestication would require genetic selection for docility and other 'agriculturally favourable' traits it might, if not very carefully managed, lead to a weakening of the desirable survival traits/genes of the species.

## Perspectives and Prospects

The hunger for land to feed the growing human population is rapidly driving the spread of agriculture into the remaining wilderness areas of Africa. With the disappearing wilderness and the loss of species, the need for formal conservation through the declaration of National Parks and the like increases. This in turn often leads to growing wildlife–human conflicts. Governments in many of the poorer developing countries just do not have the financial resources to fund, create and manage Protected Areas or compensate adequately those evicted from the declared areas, fuelling illegal bushmeat harvesting or, in other words, poaching.

Community-based resource management and private rewilding, funded through sustainable use, of the huge areas of marginal land already in use for other forms of agriculture should be considered to ensure the restoration and conservation of biodiversity, such as has been the case in South Africa. When the natural human inclination to want to determine one's own destiny on one's own piece of land is overcome through cooperation and the formation of a cooperative landscape on

much larger areas, then it becomes so much easier to sustainably create wealth and create decent jobs for communities previously excluded from tourism (consumptive and non-consumptive), meat harvesting and processing, and the production of many other products. This is a system somewhere in-between the CAMPFIRE programme and the smaller private game ranching as currently found in some southern African states, particularly South Africa. The benefits are habitat conservation, improved biodiversity, improved production, sustainable job creation, integrated community economic development and improved food security and welfare through sustainable use. The iconic buffalo, as one of the Big Five, and valuable as a hunting trophy, for photographic tourism and for meat production, plays a pivotal role in such developments.

## References


Bengis, R., D. Govender, E. Lane, et al. (2016). Eco-epidemiological and pathological features of wildlife mortality events related to cyanobacterial bio-intoxication in the Kruger National Park, South Africa. *Journal of the South African Veterinary Association* **87**(1): 1–9.

Bothma, J. du P. and J.G. Du Toit (2016). *Game Ranch Management*, 6th ed. Pretoria: Van Schaik Publishers.

Campfire Association Zimbabwe (2022). *Community Benefits Summary*. Campfire Association. www.campfirezimbabwe.org/article/community-benefits-summary.

Chardonnet, P. (2011). Wildlife ranching: ensuring present and future conservation benefits. 7th International Wildlife Ranching Symposium, 10–14 October 2011, Kimberley, South Africa.

Child, B.A., J. Musengezi, G.D. Parent and G.F. Child (2012). The economics and institutional economics of wildlife on private land in Africa. *Pastoralism* **2**(1): 1–32.

Chomba, C., C. Obias and V. Nyirenda (2014). Game ranching: a sustainable land use option and economic incentive for biodiversity conservation in Zambia. *Open Journal of Ecology* **4**: 571–581.

Cloete, F.C., P. van der Merwe and M. Saayman (2015). *Game Ranch Profitability in South Africa*. Cape Town: ABSA, pp. 1–192.

Craigie, I.D., J.E. Baillie, A. Balmford, et al. (2010). Large mammal population declines in Africa's protected areas. *Biological Conservation* **143**(9): 2221–2228.

Davies, G. and D. Brown (2007). *Bushmeat and Livelihoods: Wildlife Management and Poverty Reduction*. London: Blackwell Publishing.

Dzingirai, V. (2003). 'CAMPFIRE is not for Ndebele migrants': the impact of excluding outsiders from CAMPFIRE in the Zambezi Valley, Zimbabwe. *Journal of Southern African Studies* **29**(2): 445–459.

Fa, J.E. and D. Brown (2009). Impacts of hunting on mammals in African tropical moist forests: a review and synthesis. *Mammal Review* **39**(4): 231–264.

Furstenburg, D. (2005). The greater kudu. In J. du P. Bothma and N. van Rooyen (Eds.), *Intensive Wildlife Production in Southern Africa*. Pretoria: Van Schaik Publishers, pp. 14–168.

Furstenburg, D. (2015). *Game Species Window*. Amazon E-Books, pp. 832–1263.

Furstenburg, D. (2017a). Bestuur en Produksie, Basis van Wildplaasontwikkeling. *Wildlife Ranching* 2017(**4**): 66–73.

Furstenburg, D. (2017b). Wildlife Scoping Technical Report, 257 pp. Afri Wild Services (formerly Geo Wild Consult), South Africa (unpublished report).

Furstenburg, D., Otto, M., Van Niekerk, P., Lewitton, D. (2022). Contribution of private game ranching and captive bred operationjs in South Africa to White rhino Ceratotherium simum species survival conservation. J. Vet. Health Sci. 3(4):331-360. DOI: 10.33140/JVHS.03.04.05

Furstenburg, D. and M. Scholtz (2009). Global climate change and animal production in southern Africa: a short review. Paper submitted to the *Livestock Science* Supplement on the 10th World Congress on Animal Production.

Gandiwa, E., I.M. Heitkönig A.M. Lokhorst, et al. (2013). CAMPFIRE and human–wildlife conflicts in local communities bordering northern Gonarezhou National Park, Zimbabwe. *Ecology and Society* **18**(4): 7.

Greyling, B. (2017). Buffalo genetics, highlights from two decades of research. *The Buffalo Journal*, pp. 14–16.

Greyling, B., D. Furstenburg and P. van Hooft (2013). Ranched populations: the implications for conservation management of the African buffalo from a genetics point of view. National Parks Board Symposium, Skukuza.

Hildebrandt, W.R. (2014). *Management and reproduction of the African savanna buffalo Syncerus caffer caffer*. Doctoral dissertation, Stellenbosch University.

IUCN SSC Antelope Specialist Group (2015). IUCN SSC ASG Position Statement on the Intentional Genetic Manipulation of Antelopes Ver. 1.0 (30 April 2015).

IUCN WCC (2016). World Conservation Congress Recommendation WCC-2016-Rec-100-EN. WCC-2016-Rec-100-EN Management and regulation of selective intensive breeding of large wild mammals for commercial purposes.

Mabeta, J., B. Mweemba and J. Mwitwa (2018). *Key drivers of biodiversity loss in Zambia*. Policy Brief # 3. Zambia: Biodiversity Finance Initiative (BIOFIN).

Machena, C., E. Mwakiwa and E. Gandiwa (2017). *Review of the communal areas management programme for indigenous resources (CAMPFIRE) and community based natural resources management (CBNRM) models*. Harare: Government of Zimbabwe and European Union.

Manyanga, M. and G. Pangeti (2017). Pre-colonial hunting in Southern Africa: a changing paradigm. In M. Manyanga and S. Chirikure (Eds.), *Archives, Objects, Places and Landscapes: Multidisciplinary Approaches to Decolonised Zimbabwean Pasts*. Bamenda, Cameroon: Langaa RPCIG, pp. 277–294.

Marks, S.A. (1973). Prey selection and annual harvest of game in a rural Zambian community. *African Journal of Ecology* **11**(2): 113–128.

Marks, S.A. (1977a). Buffalo movements and accessibility to a community of hunters in Zambia. *African Journal of Ecology* **15**(4): 251–261.

Marks, S.A. (1977b). Hunting behavior and strategies of the Valley Bisa in Zambia. *Human Ecology* **5**(1): 1–36.

Martin, P.S. (1966). Africa and Pleistocene overkill. *Nature* **212**(5060): 339–342.

Mogomotsi, P.K., L.S. Stone, G.E.J. Mogomotsi and N. Dube (2020). Factors influencing community participation in wildlife conservation. *Human Dimensions of Wildlife* **25**(4): 372–386.

Muboko, N. and F. Murindagomo (2014). Wildlife control, access and utilisation: Lessons from legislation, policy evolution and implementation in Zimbabwe. *Journal for Nature Conservation* **22**(3): 206–211.

Musiwa, A.R. and W. Mhlanga (2020). Human–wildlife conflict in Mhokwe Ward, Mbire District, North-East Zimbabwe. *African Journal of Ecology* **58**(4): 786–795.

Mutanga, C.N., S. Vengesayi, N. Muboko and E. Gandiwa (2015). Towards harmonious conservation relationships: a framework for understanding protected area staff-local community relationships in developing countries. *Journal for Nature Conservation* **25**: 8–16.

Nel, L. (2021). Sustainability in wildlife-based enterprises. The conservation of biodiversity and landscapes: is sustainable use an option? WESSA Lowveld Conference, 4 September 2021.

North-West University (NWU) (2017). A marketing and spending analysis of trophy hunters, 2015/16 season. Tourism Research in Economic Environs and Society.

Oberem, P. and P.T. Oberem (2016). *The New Game Rancher*. Pretoria: Briza Publications.

Ripple, W.J., C. Wolf, T.M. Newsome, et al. (2019). Are eating the world's megafauna to extinction? *Conservation Letters* **12**(3): e12627.

Safari Club International (2022). Online Record Book: Species Detail – Cape or Southern Buffalo. www.scirecordbook.org/species, accessed 21 April 2022.

Scholtz, M., D. Furstenburg, N. Maiwashe, et al. (2010). Environmental–genotype responses in livestock to global warming: a Southern African perspective. *South African Journal of Animal Science* **40**: 408–413.

Selier J., L. Nel, I. Rushworth, et al. (2018). *An assessment of the potential risks of the practice of intensive and selective breeding of game to biodiversity and the biodiversity economy in South Africa*. Report: Xvi, 172 pp.

Skinner, J.D. and C.T. Chimimba (2005). *The Mammals of the South African Sub-Region*. Cambridge: Cambridge University Press.

Smil, V. (2011). Harvesting the biosphere: the human impact. *Population and development review* **37**(4): 613–636.

Somers M.J., M. Walters, J. Measey, et al. (2020). The implications of the reclassification of South African wildlife species as farm animals. *South African Journal of Science* 116(1/2): Art. #7724.

Stoldt, M., T. Göttert, C. Mann and U. Zeller (2020). Transfrontier conservation areas and human–wildlife conflict: the case of the Namibian component of the Kavango-Zambezi (KAZA) TFCA. *Scientific Reports* **10**(1): 1–16.

Taylor, W.A., M.F. Child, P.A. Lindsey, et al. (2021). South Africa's private wildlife ranches protect globally significant populations of wild ungulates. *Biodiversity and Conservation* **30**, 4111–4135.

Taylor, W.A., P.A. Lindsey, S.K. Nicholson, et al. (2020). Jobs, game meat and profits: the benefits of wildlife ranching on marginal lands in South Africa. *Biological Conservation* **245**: 108561.

Tchakatumba, P.K., E. Gandiwa, E. Mwakiwa, et al. (2019). Does the CAMPFIRE programme ensure economic benefits from wildlife to households in Zimbabwe? *Ecosystems and People* **15**(1): 119–135.

van Hoven, W. and P.T. Oberem (2018). Afrivet Business Management (Pty) Ltd. Video: https://youtube/xRCWnEflITg.

Wilkie, D.S., M. Wieland, H. Boulet, et al. (2016). Eating and conserving bushmeat in Africa. *African Journal of Ecology* **54**(4): 402–414.