Module #1 – Component #1

Elephant

PREFACE

Wildlife production is the optimum utilisation of renewable natural resources in harmony with the environment, with the intent to derive an income from it by sustainable consumptive and/or non-consumptive means. The commercial production of wildlife is not a recent phenomenon in South Africa.

Proposals for the domestication of indigenous wild animals were made as early as 1848 when it was suggested that both the buffalo Syncerus cafferand the eland *Taurotragus oryx* could be used for this purpose. Various products from ostriches Struthio camelus, but initially mainly the feathers, were produced commercially since the 1870s (Conroy, 1993). The ostrich industry has since waxed and waned several times, with ostrich leather and meat currently high in demand. The other highly intensive wildlife production system that has been practised for some time is the production of crocodiles *Crocodylus niloticus* for their leather, which is sought after in the fashion industry.

In southern Africa, commercial wildlife production has only developed in the past 50 years or so, mainly because of increasingly smaller farming units, often on agriculturally marginal land that had become economically unviable.

As recently as the late 1950s, land in the Eastern Cape was sold with the absence of wildlife being considered a major advantage (Flack, 2002). Initially, wildlife production was largely secondary to other animal production enterprises that involved domesticated livestock (Krug, 2001). This has all changed and extensive wildlife production currently is a multispecies, multifaceted, multimillion rand industry (Bothma, 2002a, 2003). Moreover, it is making a substantial contribution to the conservation of biodiversity (Krug, 2001; Bothma, 2002b).

Wildlife is one focus of the multimillion rand tourism industry in southern Africa, but there is also a considerable income from the consumptive use of indigenous wildlife (Krug, 2001; Bothma, 2002a, 2003). Moreover, wildlife has developed a considerable non-use value, with large amounts being paid by private individuals to conserve a particular biological resource such as a species or habitat, unrelated to any current or optional use such as recreation and tourism. This is known as an existence value. Another non-use value is the bequest value of wildlife, which concerns the passing on of assets by individuals to later generations or charities through bequests with the express purpose of furthering conservation (Krug, 2001).

The private sector in southern Africa has developed innovative mechanisms to promote both the non-consumptive and consumptive utilisation of wildlife resources (Krug, 2001). However, in the past the consumptive-use market has focused mainly on the extensive production of wildlife in what is referred to as wildlife ranching, with only ostrich and crocodile production being based on intensive methods through wildlife farming (Bothma, 2002b).

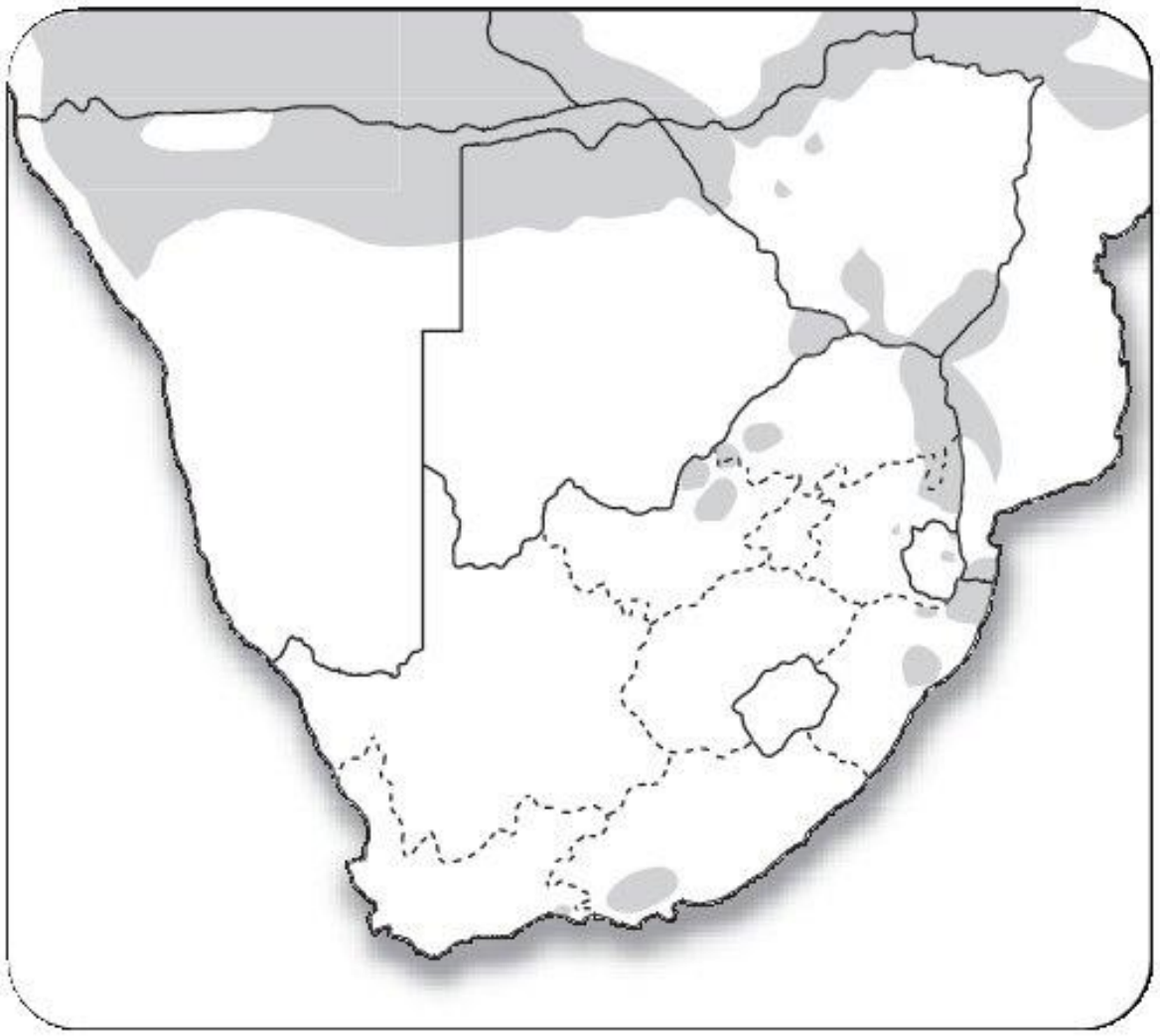
As wildlife production increases, more rare animals are entering the market, with major economic and conservation impact. However, in extensive production systems the growth rate of the populations of rarer wildlife is often retarded by deficiencies and mortalities of various kinds. When it was realised fairly recently that it was economically and practicably feasible to intensively produce some of these rarer types of wildlife, this provided a new stimulus and input into wildlife production in southern Africa. As more such enterprises developed, skills and knowledge were acquired that were not always readily accessible. The growing need for more detailed knowledge on the intensive production of wildlife, both on small and large land surface units, provided the stimulus for producing this Course.

Originally the proposed title for this Course was Wildlife farming in southern Africa to make it a readily recognisable companion to Game ranch management, which deals with the extensive production of wildlife on large areas of land (Bothma, 2002c). Wildlife farming by definition is the intensive production of wildlife on small units of land. However, because intensive wildlife production as described here can also be practised on large areas, it was decided to change the title to Intensive wildlife production in southern Africa.

The current volume is only a start. We hope to expand it in future editions as more types of wildlife are added to the intensive wildlife production enterprise, and as more experience and knowledge are acquired. Consequently we sincerely request continual inputs in terms of content and scope so as to produce a more comprehensive text in the future.

THE AFRICAN ELEPHANT

The African elephant *Loxodonta africana* is a sad remnant of the once huge order Proboscidea. These enormous mammals evolved about 60 million years ago. The original elephants of Africa belonged to the genus *Elephas* and not to *Loxodonta*, although both originated in Africa. The African elephant was originally regarded as a species of *Elephas* when Blumenbach first described it scientifically in 1797 as *Elephas africanus*, based on a specimen that was collected along the Orange River in South Africa.



Distribution in Southern Africa

The modern elephant family, the Elephantidae, originated during the Miocene and only two species or subspecies of the genera *Loxodonta* in Africa and *Elephas* in Asia are still living today. Their nearest relative is the mammoth *Mammuthus*, a genus which became extinct during the last Ice Age about 10 000 years ago. Based on cranial and dental evidence, it is believed today that *Mammuthus* and *Elephas* were more closely related than either is to *Loxodonta*. The generic name *Loxodonta* refers to the lozenge-shaped enamel plates of the molar teeth.

Two species and five subspecies of elephants have been recognised until recently. They are the savanna elephant *Loxodonta africana africana* and the forest elephant *Loxodonta africana cyclotis* in Africa, and the Indian elephant *Elephas maximus indicus*, the Sri Lankan elephant *Elephas maximus maximus* and the Sumatran elephant *Elephas maximus sumatranusi* n Asia. However, it has recently been suggested by DNA testing that the forest elephant of Africa may be a third distinct species, *Loxodonta cyclotis*. Morphologically the African and Asian elephants are distinctly different. Both species have gradually evolved to their present ecological roles and climatic conditions. The forest elephant of western and central Africa is smaller and has straighter and longer tusks than its savanna counterpart.

The Asian elephants have adapted to wetter climatic conditions and a lush vegetation by developing a smaller, more compact body, with smaller ears and a specialisation in their molar teeth. The rest of the discussion that follows will deal with the savanna elephant.

The total population of the African elephant has markedly dwindled in recent decades, especially in central and eastern Africa. This decline has occurred in the space of a human lifetime and was fuelled by the market for elephant ivory.

Elephants were first reported in South Africa by Vasco da Gama after seeing them at Mossel Bay in 1497. Today they are being reintroduced into large, privately owned wildlife areas. In South Africa there are no true forest elephants. Those that occur in the Knysna forests were pushed by human pressure into what is a marginal habitat for savanna elephants.

Table 1.1 The basic characteristics of the elephant

Mean mass at maturity	Bull: 5000 kg Cow: 3000 kg
Shoulder height at maturity	Bull: 3.20–3.60 m Cow: 2.50–2.80 m
Feeding spectrum	Grass and forbs: 28%* Browse and fruit: 72%*
Water dependent	Yes
Water requirements in litres per day	130–300 (200)
Preferential feeding time	Day/night
Food consumption of adult elephant per day	150 kg
Number of mammae	2
Peak mating season	November to April
Gestation period	630–660 days
Peak birth season	January to March
Weaning age	2 years
Age when sexually mature	Bull: 12–15 years Cow: 9–14 years
Age at first mating	Bull: 12–30 years Cow: 9–22 years
Age of cow at birth of first calf	12–15 years
Mass of calf at birth	110–140 kg
Time between successive progeny	4–7 years
Life expectancy	55 years
Females per male at adulthood in nature	1
Females per male recommended for a wildlife ranch	6
Mean breeding herd size	15
Bachelor herd	Yes
Mean annual population growth	7%
Rowland Ward: minimum trophy size	36.5 kg (80 lbs)
Rowland Ward: record trophy size	108 kg (226 lbs)
Grazer Units (GU) per animal	9.80
Grazing animals per Grazer Unit	0.10
Browser Units (BU) per animal	11.77
Browsing animals per Browser Unit	0.08
Calf concealment	No
Nursery herds	No
Territoriality	Bull: No Cow: No

* *Note:* Percentages depend on habitat

DESCRIPTION

The characteristics of the African elephant appear in Table 1.1.

An adult cow stands about 2.5 to 2.8 m high at the shoulder (Table 1.2 and Figure 1.2). Bulls can reach a shoulder height of up to 3.6 m, depending on their habitat. There is considerable variation in shoulder height throughout the African continent, both between regions and among individuals in the same population.

Figure 1.1 Elephants in the Kruger National Park

Photo: C. Scott

For a field estimate, a male of 18 to 20 years old is about the size of an adult elephant cow. A rough approximation of the shoulder height is that it is twice the circumference of the forefoot. Therefore footprints can be used to estimate the size of a given individual. Sexual dimorphism is not only expressed in size and mass, with adult cows weighing up to 3 tonnes and bulls up to 6.5 tonnes, but also through the shape of the head and face. When viewed in profile, bulls have a rounded forehead, while cows have a distinctly angular one. The tusks are elongated upper incisor teeth. They are at their thickest near the lip, giving the face of an older male a characteristic hour-glass shape.

This shape starts in their mid-twenties, and becomes more prominent with age. Elephants can live up to the age of about 55 to 60 years. Although some cows have been known to give birth after the age of 50 years, this is generally the age of reproductive senescence.

Table 1.2 Criteria for the estimation of the age and mass of an African elephant

Age (years)	Height (m)	Mass (kg)
< 1	0.85	120
1	1.15	300
3	1.30	400
6	1.50	600
10	1.90	1200
15	2.20	1600
40	2.60	2400

Source: Du Toit (2001)

Because the elephant is the largest land mammal, with the mass of an adult bull varying from 4 to 6.5 tonnes, several anatomical characteristics have evolved to adapt to this mass. As a result of pneumatisation, during which air cells develop within fine bone compartments, the cranium is large. Pneumatisation makes the skull lighter, while still providing the necessary strength and attachment surface to accommodate the muscles. Unlike most other mammals, the legs of an elephant are almost vertical under the body. These pillar-like structures have limited flexibility at the joints and are therefore suited to supporting the large mass.

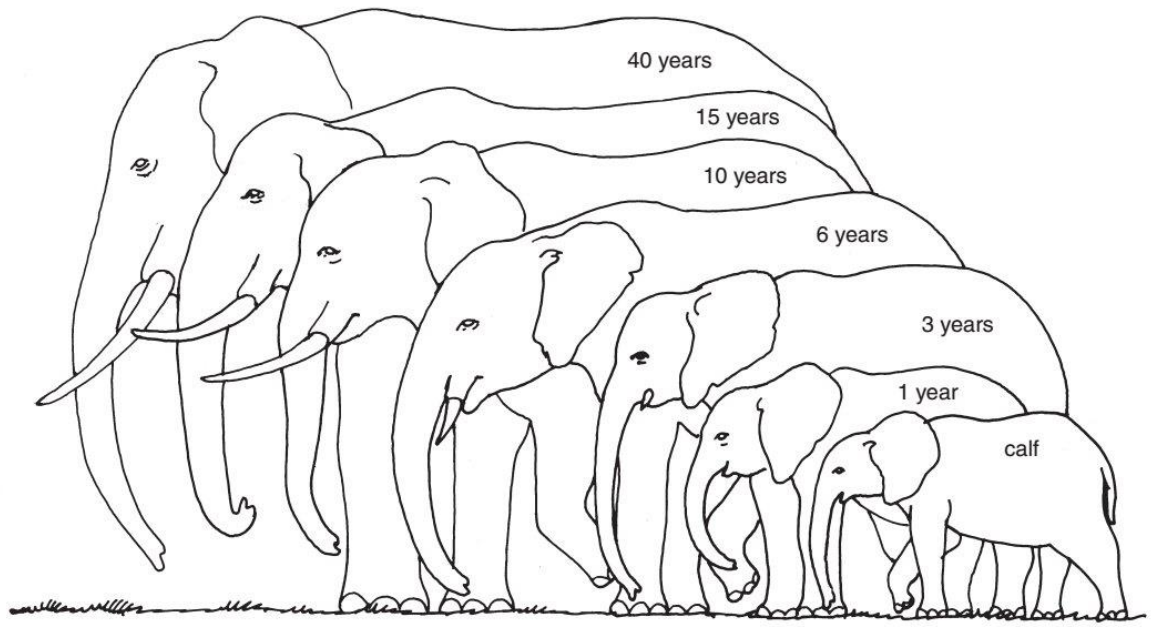


Figure 1.2 Age criteria for African elephants

Source: Du Toit (2001), based on Laws (1966)

However, this build restricts elephants in their movements. Although they are remarkably agile, elephants are not capable of jumping or trotting, but they can move quite fast when necessary. An elephant walks partly on its toes, with the bones supported by a large elastic and fleshy cushion that consists of a fat and fibrous matrix. This allows this huge animal to move around remarkably silently.

The lungs and respiration

Elephants do not possess a pleural cavity because the lungs adhere firmly to the thoracic cavity and to the diaphragm. Breathing is therefore the result of an active process of muscle movement and not by creating a negative pressure, or vacuum, within the chest, as in most other mammals. This is an ancient characteristic that greatly restricts breathing when the elephant is in a recumbent position, especially when it lies on its sternum (chest). An elephant that has been darted must therefore be pushed over onto its side immediately when it goes down into a sternal position, as usually happens. As a result of this anatomical feature an elephant will soon suffocate if the lungs have been pierced by objects such as bullets and arrows or during fighting.

Another consequence of the lungs being directly attached to the chest wall is that the heart rate of a recumbent elephant is higher than when it is standing.

This factor has to be considered when darting an elephant with an opiate drug, such as etorphine-hydrochloride (M-99), because the drug causes an increase in blood pressure. The immobilised elephant can die of so-called pink foam syndrome. It is therefore necessary to use the drug azaperone (Stressnil, Janssen) to lower the blood pressure

Reproductive organs

Unlike most other mammals the testes of the bull elephant are situated inside the body near the kidneys. Animals with this morphology are collectively known as the Testiconda. This makes sterilisation of males difficult, and it is not an option for population control. The females have two mammary glands that are situated between the front legs, similar to primates. The urogenital canal is up to 900 mm long, necessitating the bull to have a long, S-shaped penis. The unusual position of the female genital opening between the hind legs and the presence of a well-developed clitoris have confused many people as to the gender of an elephant.

The gender of an immobilised elephant can be determined by measuring the distance between its navel and genital opening. This distance is quite short in males but it is long in females.

Thermoregulation

The ratio of volume to external surface area is 3:2. Therefore an elephant has a relatively small surface area in relation to its bulk when compared with a small

mammal. This has some thermoregulatory consequences because the body temperature will not increase rapidly.

However, once warm, the body temperature does not decrease rapidly, therefore an elephant should never be allowed to become hyperthermic. One way in which the elephant deals with this problem is to dissipate heat through its large ears and wrinkled skin. Elephants have few sudoriferous or sweat glands, but they can lose some water through their skin. The horny outer layer of the skin has to be kept moist and supple by water diffusion from within the body. Despite the partially thick skin, diffusion is not a problem as long as the skin remains moist. The more wrinkled the skin, the larger the surface area that is available for evaporation. It has been calculated that a young elephant weighing 1.2 tonnes loses about 2.5L of water every hour at ambient temperatures. Therefore an adult elephant will probably lose twice as much water and must drink at least 120L of water per day to compensate for evaporation alone.

The ears have a relatively thin skin and the extensive vascular network is clearly visible on the inside of the ear. Heat loss as a cooling mechanism is greatly increased by ear movement which helps to cool the blood in the veins. This is why elephants regularly flap their ears in hot weather. The highest heat loss occurs along the outer edge of the ears. The combined surface area of both sides of both ears accounts for about 20% of the total skin surface area of an elephant.

Much of the heat loss requirements can be met through evaporation, but the greatest (80%) heat loss occurs through heat radiation. Therefore it is essential that elephants stay in the shade in hot weather.

Dentition

Like many other mammals, elephants have six molar teeth. They have no canines or premolars, and the tusks are modified second upper incisors. Unlike in most other mammals, the molars are replaced horizontally one at a time.

Each progressive molar tooth is larger than its predecessors, and as the jaw grows larger, the number of lozenge-shaped ridges on the tooth increases. Each current tooth is pushed forward and gets smaller and smaller as the surface is worn through abrasion by hard food.

Specific bone-destroying cells, called osteoclasts, decimate the tooth from the root side. At the same time, the next tooth starts to appear in the back part of the jaw. Therefore at any given time, there are one to two molars in each quadrant.

The process of tooth wear and tooth replacement is a good means of determining the age of an elephant. The loss of molar 1 (M1) occurs between the ages of one and two years, that of M2 between the ages of three and four years, that of M3 between the ages of 13 and 15 years, that of M4 between the ages of 26 and 28 years, that of M5 at about 47 years of age, and that of M6 at 60-plus years of age.

The tusks grow continually at a rate of about 150 to 170 mm per year. However, elephants utilise their tusks to varying degrees, often causing them to wear or break off. The length of the tusks cannot be used as an age-determining criterion because there is great genetic variation, with some elephants having only one tusk, while others have none. The latter state is probably caused by a shift in genetic composition through the effects of selective hunting. In general, bulls have thicker and longer tusks than cows. The tusks of a bull not only increase in length with age, but also increase in diameter near the lip. In imperial measurements, the mass of the tusk in a live elephant can be calculated as follows: mass (pounds) = length (feet) × circumference (inches).

DYNAMICS

Females reach sexual maturity at about 12 to 14 years of age. The female will typically give birth for the first time at the age of about 15 years. However, in translocated small populations, females can give birth as early as 10 to 11 years of age. Males are sexually mature from an age of 12 to 15 years, but because of social restraints are seldom allowed to reproduce before the age of about 30 to 35 years, except in translocated smaller populations, where the males are known to have reproduced at an age of 10 to 11 years. Oestrus lasts for up to six days. The males in musth guard the receptive females. Musth occurs at social maturity and is characterised by a copious discharge from the temporal glands. Only bulls in good physical condition come into musth.

The gestation period is about 22 months, varying from 630 to 660 days. Newborn calves weigh from 110 to 140 kg at birth. A single calf is usually born, but twins do occur. The calves are allowed to suckle until the birth of the next calf. Under normal conditions the calf will be about four years old when this happens. The intercalving period varies regionally and is known to have been as long as nine years under extreme drought conditions. Calves that lose their mothers when they are under the age of two years are not likely to survive.

Physical growth is rapid in young calves, but the males grow more rapidly than the females. This difference continues throughout life, showing a distinct sexual dimorphism. Although both sexes continue to grow throughout their lives, the growth rate of a cow levels off at at about 25 years of age, whereas that of a bull continues steadily. Because of tooth wear, elephants have a life expectancy of about 55 to 60 years, depending in part upon the abrasive nature of their food.

HABITAT AND ACTIVITY

The savanna elephants of eastern and southern Africa are highly adaptable and can be found in a variety of habitat types, but they seldom occur in forests. However, they do occur in deserts like the Namib Desert in areas where there is sufficient water and food, usually in the dry river courses that cross these arid regions. Some shade is also required. The mobility of elephants allows them to inhabit such areas with a limited supply of food and water. Elephants will walk vast distances in search of food and water. The range size of an elephant herd in dry regions of East Africa can exceed 3000 km^2.

A study done in the Timbavati and Klaserie Private Game Reserves of South Africa has shown that the range size of elephants decreases during the dry season. This is probably linked to the availability of water and food. The range size of a bull depends on its breeding status, and it is considerably larger for a breeding than a non-breeding bull. However, there are individual variations.
The destruction or overutilisation of the habitat by elephants is a controversial topic. Elephants have the habit of ring-barking or debarking trees, which leads to the death of the tree in the majority of cases. Bark provides elephants with nutrients such as minerals and fatty acids. Some trees are also pushed over so as to get to the nutritious upper leaves and roots. The positive effect of this feeding behaviour is that the foliage of tall trees is then brought within the reach of many of the smaller browsers, provided the tree is not totally uprooted. Inevitably, elephants that are restricted in their movements by fences and are allowed to multiply unchecked will eventually deplete their own food resources.

An adult elephant can produce 100 kg of dung per day, and dung beetles are quick to utilise the dung in certain areas. This is an important means of recycling nutrients and dispersing seeds. In mineral-poor areas, minerals are often supplemented by elephants through eating mineral-rich soil and utilising natural salt licks.

Elephants regularly require water and frequently wallow in mud to keep their skins supple, cool and free from parasites, and to prevent sunburn. Experiments have shown that, after being plastered with mud, the body of an elephant stays cool eight times longer than when it is sprayed with water only. Mud prevents direct sunlight from coming into contact with the skin and reduces water loss through evaporation. Therefore elephants utilise water in various ways daily and can only go without it in extreme circumstances. Normally an adult elephant will drink about 200L of water per day, but they also use a substantial amount to bathe in. If available, they will always choose fresh, clear water for drinking and will dig for water in dry river beds.
Elephants are gregarious animals that are active by day and night, the latter particularly in hot environments. Elephants will cross rivers as wide and deep as the Zambezi by swimming or walking on the bottom while holding their trunks above the water.

BEHAVIOUR

Elephants are interesting animals with a wide array of behavioural mechanisms. They are gregarious and several family herds may coalesce temporarily to form large herds. The following are some aspects of their natural behaviour:

Social behaviour

Elephants live within a complex network of social relationships and have a large repertoire of behavioural communication mechanisms. A typical family unit consists of an older matriarch, her older offspring and those of her daughters to form a herd of about 8 to 15 individuals. However, this varies greatly regionally. The matriarch is the pivot around which everything revolves. She keeps the family together, makes the major decisions as to movements, and defends her family. Sudden loss of the matriarch often leads to disruption of the family unit, unless the oldest daughter or a sister of the matriarch takes over her position immediately. Each individual has a specific role, with the older females helping the matriarch to defend and protect the family. The younger females help to look after the calves and are known as allomothers. The survival chances of the calves are greatly enhanced with an increasing number of allomothers. Calves with no allomothers are twice as likely to die as those with two or more allomothers. The females form strong bonds with each other. Only in times of stress do larger families split up into smaller units, but they reunite as soon as the conditions are favourable again. Within a population there are strong bonds between some family herds, and these bond groups are probably related to each other. The bonds between such families are reinforced by elaborate greeting ceremonies and frequent association.

Communication occurs through touch, smell and vocalisation. Elephants have a variety of vocalisations and they communicate over long distances by low-frequency calls or rumbles, which include an infrasonic component as low as 14 Hz. The lowest frequency that is detectable to the human ear is about 30 Hz. These calls are heard by elephants over a distance of up to 5 km or even more.

Research indicates that elephants can also pick up seismic waves that are caused by stomping elephants, such as those made during a mock charge. These waves travel through the ground and are probably picked up through the feet when made as far as 32 km away. The young bulls grow up in a female-dominated society until reaching puberty at 12 to 15 years of age, by which time they are at the social and spatial periphery of the unit and associate increasingly more frequently with other bulls. The old bulls become more solitary with time, but they will still associate with other bulls. There is a strict dominance hierarchy among the bulls in a given area, which is acquired and maintained by virtue of age, strength and the occurrence of musth.

Sexual behaviour

The word musth is derived from Hindi and means "to be intoxicated". It denotes a period of physiological and behavioural change in the life of an adult elephant bull. The first onset of musth normally occurs when a bull is well into his twenties. From then on it recurs once a year. A period of musth can last from a few days to a few months. During musth a bull has a testosterone blood level that is 50 times higher than that of bulls that are not in musth. Bulls in musth become aggressive and are dangerous. During this time the bull actively seeks out any receptive females to mate with. However, bulls not in musth are also capable of mating. Musth helps the male to secure a more dominant position within the dominance hierarchy of bulls, and consequently gives him the better mating opportunities because an experienced cow will give preference to a bull in musth over any other bull.

Bulls in musth are always dominant over those that are not in musth. A bull in musth will typically stay near a female during her oestrous period that lasts from two to six days. He will mate with her several times during this period. He will also guard her against the attentions of other bulls. The state of musth is advertised by a copious, visible secretion from the temporal glands that are situated between the eyes and the ears. These glands become swollen to the size of an orange. Bulls at the height of musth also display a constant dribbling of urine. Both the glandular secretion and the urine have a distinct smell. In addition, the bulls in musth advertise their state with a distinct head-swaying gait, with the head held high, and by typical musth rumbles. This warns the other bulls to stay away and to avoid confrontation. At the same time it informs any interested females in oestrus of his state of reproductive readiness.

Females in oestrus also make a specific rumble that announces their state of reproductive receptiveness. The onset, duration and termination of musth are governed by a variety of factors, including hormone levels; the presence of oestrous females; the presence, rank and musth state of other males; environmental factors; and the physical condition of the bull. However, generally the older the bull the longer will be the musth period. These factors were important considerations when adult bulls were reintroduced into the Pilanesberg National Park and Hluhluwe-Umfolozi Park. In both these parks some younger bulls had killed a number of rhinoceroses. In the absence of older bulls, the young elephant bulls came into musth at a much earlier age, and this unnatural condition probably led to these rhinoceros killings. When older bulls were introduced into the herds, the onset of musth in these younger bulls was suppressed.

Feeding behaviour

An African elephant digests about 44% of what it eats and fermentation occurs in the hind gut. This is a less efficient system than rumination. The digestive efficiency of crude protein can be as low as 22% in an elephant. Therefore an elephant cannot do well on limited quantities of high-fibre food, because it must pass the largest possible volume of food through the digestive system. An adult bull will consume 300 to 400 kg of fresh plant material per day, and a cow about 250 kg. The nutritional value of browse and grass depends on a specific site and season and the percentage contribution of the woody and grass components in the diet. Within the woody component it furthermore depends on the deciduous or evergreen nature of the leaves. However, elephants are more likely to feed on browse during the hot, dry season and on grass during the hot, wet season, depending on availability. Certain plant species are more palatable to elephants than others, and this can become a problem on smaller nature reserves, where rare plant species also occur.

Feeding wild elephants with oranges or sugar cane in the wild must be avoided at all costs, because this will make them lose their natural fear of humans, and could cause severe behavioural problems. Several cases are known where elephants have repeatedly broken into lodges, vehicles or other human constructions in search of such delicacies.

SEMI-INTENSIVE PRODUCTION

Acquiring elephants vastly increases one's responsibilities, not only towards caring for the animals, but also towards other wildlife and the habitat. No matter how large the property is, when elephants are introduced a whole set of problems will eventually emerge that will have to be managed properly. It cannot be overemphasised that management objectives, including the decision to purchase elephants, must be clear at the outset. Nevertheless, an active adaptive management approach is recommended, because it allows the re-evaluation and, if necessary, adaptation of the management policy as the situation is monitored and unfolds. A management plan for elephants must include a strategy for monitoring vegetation over the long term to be able to evaluate the rate of habitat change. It is recommended that not more than 15% of the total wildlife biomass on small reserves be allocated to elephants.

Before releasing elephants on a property, a complete habitat assessment and natural resource inventory must be made. This must include details on the soil, topography, geology, climate and vegetation, and all the other wildlife present. Eventually, the ecological capacity of the property for elephants must be calculated. This will allow recommendations to be made regarding the number of elephants to be introduced; bearing in mind that initially only 50% of the actual ecological capacity should be introduced. An elephant population can double in size about every 15 years at an expected population growth rate of 6.7% per year.

The intensive production of elephants in the extreme sense of keeping a group in a small enclosure, boosting the reproduction rate and selling off the surplus animals is not possible. However, there are ways of benefiting from the semi-intensive production of elephants in a private wildlife area, with appropriate restrictions.

These restrictions are based on the social organisation and habitat requirements of elephants, their intelligence, their sensitivity and their biology.

The management of free-ranging elephants places a far greater responsibility on the owner than that of any other wildlife species on private land in southern Africa. Elephants are capable of changing their environment to the detriment of the area's biodiversity and may cause the loss of many biota, to the point where they will deplete their own source of food in a fenced-in area if they are not carefully managed. Sadly, however, proper ecological management objectives are often lacking at the time of the introduction of elephants. Generally, one objective is to have as many types of wildlife as possible on the property, whether for tourism or conservation of biodiversity. The elephants will therefore have to compete with other wildlife for space and the available food resources.

Ecological evaluation, management planning and monitoring

A management plan for elephants should consist of at least the following:

- A natural resource inventory: a thorough description of the physical and biological properties of the environment involved.
- Management proposals: guidelines on how to best manage the natural resources so as to ensure that the production of elephants is a sustainable enterprise.

Inventory of natural resources

When doing a natural resource inventory for an elephant management plan, at least the following should be included:

- The size and locality of the property
- The soil characteristics that are relevant to the specific area, including soil depth, soil texture (clay, silt and sand components), soil structure and degree of rockiness
- The topography in terms of landscape position, such as valleys, plateaux and slopes, and the altitude above sea level
- The geology which influences the physical and chemical components of the soil, its susceptibility to erosion, and the vegetation types
- The climate in terms of rainfall, temperature, evaporation rates and rainfall cycles (dry and wet years)
- The plant communities that will depend on the geology, soil and topography.

These aspects facilitate the identification of distinct and rare plant communities. The occurrence of sweet-, mixed- and sourveld can follow from this. The veld condition of each plant community must be determined and evaluated in terms of its economic and ecological capacity for grazing and browsing herbivores, but particularly for elephants. The sensitivity and susceptibility to erosion and bush encroachment of each plant community must be evaluated. If the protection or rehabilitation of a particular habitat is necessary, this should be identified at the outset and included in the overall management plan.

- Management aspects such as veld burning programmes, increasing levels of utilisation in specific areas, watering points and bush-clearing programmes can also affect the stocking rate.
- Allowing for other wildlife and their stocking densities will require a detailed inventory of the types of animal and their population sizes on the property.
- From the above, the ecological capacity for the number of elephants to be introduced can be calculated per unit of surface area.

Management planning

When developing a management plan for elephants in small enclosed areas, at least the following should be addressed:

- Management objectives:
  - to achieve and maintain an economic capacity within the ecological capacity of the area for elephants
  - to manage and control the elephant population
  - to rehabilitate degraded habitats and to prevent new damage
  - to incorporate elephant management into the overall wildlife management plan

- The exercise of population control programmes for the elephants and other wildlife through capture, sales, hunting, culling and contraception programmes
- The development and maintenance of a veld-burning programme
- The management of water resources
- Supplementary feeding
- Rehabilitation of certain areas
- The development and maintenance of monitoring programmes on key aspects of the elephant population and its habitat

Monitoring the impact of elephants

Once elephants are released on a property, it is crucial that the veld condition be monitored regularly to allow for rapid management intervention if necessary.

There are various ways of doing this.

Aerial photography

Aerial photography is an easy and effective way of evaluating the overall impact of elephants on the woody components of the habitat. The photographs must be taken from the same altitude, at the same time of year, under similar weather conditions and with the same type of lens and film. The photographs must be taken at a maximum of three-year intervals in midsummer and late winter.

Fixed-point photography

Specific sites on the property should be identified from which consecutive, slightly overlapping photographs are taken in a full 360°. The point from which these photographs are taken should be easily identifiable and permanently marked, for example with a Global Positioning System (GPS). The photographs must be taken at exactly the same angle every year. By comparing the photographs with those from previous years, a subjective evaluation of the woody plant component is possible, but especially of bush encroachment or the destruction of large trees.

Exclusion plots
Exclusion plots are areas of approximately 1 ha that are fenced off to prevent their utilisation by elephants. There should preferably be two such plots in each major habitat type, and in any ecologically sensitive area. One plot is submitted to the same burning programme as the rest of the reserve, the other is not. This will allow differentiation of any habitat changes that can be attributed to fire and those that can be attributed to elephants.

Permanent vegetation plots
Permanent vegetation plots are the most important monitoring tool for elephant management because they give the best-quality data on veld condition. However, they require strict commitment and regular monitoring. Permanent vegetation plots are transects of approximately 100 ×2m each that are unfenced and open to elephant utilisation. It is important to mark such a plot well, because the elephants often remove some types of marker, such as steel pegs. The height, canopy diameter and trunk thickness of trees must be measured or estimated where applicable. Similar data should be collected in the exclusion plots. Changes over time can then be quantified.

Population size
It is most important that the wildlife counts are precise (repeatable), irrespective of the fact that they may not be accurate (close to the actual population size). Precise counts will allow the manager to detect trends in the population size of the different types of wildlife and adapt the management programme accordingly.

All possible variables should be reduced to a minimum to ensure that the data obtained are comparable. There are many different methods of obtaining animal numbers, but aerial counts yield the most reliable results for wildlife when they are done at the same time every year, under similar weather conditions, with the same type of aircraft, flying at a specific and constant speed and height, and preferably with the same observers.

Elephant movements

It is important to monitor those areas that are preferred by the elephants and which they will 0utilise after their introduction. If there is only one herd, it may change its range use pattern over time. The areas that are used most often will be subjected to more use pressure and will require careful monitoring and management.

Particularly vulnerable habitats, such as riverine vegetation or rare plants, should be monitored intensively and might even have to be fenced off. Large rocks can be put around individual rare plants for protection against elephants. There are different ways to locate elephants on a property, and any one method or combination of methods can be used. The most practical, but expensive, method is to radio-collar the matriarch at capture and to radio-track her subsequently at regular intervals. Waterholes can also be monitored and gravel roads can be scanned every morning and the tracks of elephants followed. The mapping of tourist sightings can also be incorporated to assist with obtaining information on the movements of elephants.

Individual elephants can be recognised easily by prominent features such as holes or tears in the ears, and by the shape and size of the tusks.

FACILITIES

Considerable knowledge has been accumulated on elephant facilities and other management aspects over the past 20 or more years since the Kruger National Park started selling elephants to private landowners. To date, approximately 1800 elephants have been translocated from this park. The Elephant Management and Owners Association (EMOA) has been collecting and disseminating information on elephant management since 1992, and the following data are based on this acquired pool of knowledge.

Fencing

The fencing recommendations that follow here are minimum requirements, and although they have proved to be effective, there is no guarantee that elephants will not still break out of the property. Where large bulls are introduced onto a property, the fence should be strengthened to accommodate them. The fence should be 2.4 m high with a minimum of 20 wire strands. At least three electrified strands with a minimum diameter of 2.24 mm are necessary on the inside of the fence. The bottom strand is placed 0.6 m above ground level, with 225 mm double offset brackets. The second strand is placed 1.5 m high, with 225 mm or 450 mm double offset brackets. The top strand is placed along the top of the fence (here 2.4 m high), with 450 mm double offset brackets. An earthing strand on a double offset bracket is also placed 100 mm away from and on the inside of each live wire strand. A minimum electromotive force of 6000 V should be maintained on the whole peripheral electrified fence. The energisers must be powerful enough to maintain at least 6000 V, but preferably 9000 V, over a distance of 8 km.

Good earthing is vital, and to do so the following has proved successful, specifically when large bulls are to be kept confined. A minimum of four to six galvanised earthing pegs 2 m high with a diameter of 22 mm are knocked into the ground to a depth of 1.8 m. The pegs are spaced 3m apart and are connected with a single unbroken galvanised steel wire. A minimum of two earthing pegs are used every 500 m, and they are connected to the fence and the offset earthing strands with galvanised clamps. These earthing pegs should be placed in moist or conductive soil, such as a river crossing or wetland area along the fence. Secondary earthing pegs will help to protect the energisers from lightning damage. The most crucial factor is regular inspections and maintenance of the fence, because elephants will quickly notice a breakdown in the current, and may then break through the fence.

Release camp

Elephants are never released directly. A period of not more than two days of captivity in a small electrified release camp or boma is essential. The purpose of this is to train the elephants to respect electrified fences. If the perimeter fence of the area does not contain cables, one has to rely on the fear of the elephants for electricity to prevent them from breaking out. Such a release camp must be built according to the following specifications:

- The camp should be a minimum of 1 ha in size. This will accommodate a small family unit.
- The camp should be placed in a well-drained area at the centre of the release area, in a spot with dense vegetation for food and shelter and access to water.
- All large trees inside the Boma next to the fence must be removed, because elephants may push these trees onto the fence and damage or short-circuit the electrified section.
- The natural vegetation should be adequate to feed the elephants during their stay in this camp for two days at the most. Additional freshly cut branches can be provided before the elephants arrive. The elephants should not be disturbed while they are in the release camp.
- There must be adequate, clean drinking water and a mud bath. The latter can simply be an excavated hollow that is filled with water before the elephants arrive.
- The fence of the release camp must be at least 2.4 m high and 3 m for bulls.

Rail tracks or steel posts are concreted in holes of 1 m^3 spaced at 10 m intervals. A minimum of five steel cables, with one at ground level and the rest at 500 mm intervals, should be strung around the camp. The cable is strung on the inside of the posts except at the corners, where it goes around the outside of the corner post. This allows the strain of the cable to be directed at one point, while at the same time putting the straining force on the posts when an elephant pushes against the fence.

Veldspan or wire mesh fencing should also be erected from ground level to a minimum height of 2.4 to 3 m (bulls). Heavy steel droppers should be tied in at 1 m intervals.

- The fence must be electrified with five strands, with the offset brackets on the inside of the camp and an electromotive force of 6000 to 9000 V should be maintained. The bottom electrified strand must be 300 mm above ground level. The second electrified strand must be 1 m above ground level, and the rest are spaced approximately 500 mm apart, with the last strand on top of the fence with an additional earthing strand. Double offset brackets should be used for all the electrified strands, especially when adult bulls are introduced. The offset brackets must be 5 m apart to prevent the elephants from creating an electric short circuit when they push against the fence.

- Where adult bulls are introduced, the camp must be particularly well constructed and properly electrified. Additional earthing can be obtained by wetting an area of about 4 m wide along the inner side of the fence before the animals arrive. This will ensure that the earthing is optimal. A second and inner electrified fence, or electrified wire strands that are placed across the corners of the camp that will give the elephants a shock before they touch the outer fence has been suggested, but is still controversial. Installation of more than one energiser is recommended. It is advisable to construct a camp of at least 2 ha to ensure that the bulls do not run through the fence in a panic after their release. It will also ensure that the elephants have sufficient food during their short stay in the camp.

- The offloading ramp should be placed outside the fence. It is important that the gate that closes the ramp is also electrified when closed. This gate can be reinforced with thick, horizontal steel posts that are pushed through steel brackets after the elephants have been offloaded. Reinforcement of the gate is essential for elephant bulls. A sliding gate design is recommended. The offloading ramp should be about 2.4 m wide by 1 m high, and the ramp walls 3 m high. However, this will ultimately depend on the type of truck that is used and should be checked in advance. The sides of the offloading ramp that leads to the camp must be constructed of steel posts that are concreted securely into the ramp.

- There must be a separate gate 3 m wide to release the animals after their initial confinement. The release gate should preferably slide open so that it can be opened remotely with a cable or rope if necessary. This gate must also be electrified. The gate must be constructed of heavy steel because this is the most vulnerable part of the camp, especially when bulls are introduced. Additional reinforcement of the gate can be done by adding horizontal steel posts to it.

- The camp must be easily accessible for large, low-bed transport trucks, and good quality compacted and level roads must lead to the camp to prevent the trucks from getting stuck. Due consideration must be given to all bridges, culverts and overhead lines that may be in the way when positioning a truck for offloading. The trucks that are used to transport elephants are usually 20 m long and about 4.3 m high, and have a large turning circle. All telephone poles, branches and trees over the access road and the offloading area should be cleared in advance.

Most incidents where elephants break out of camps have to date occurred where the release camp was inadequate. Especially where adult bulls are introduced, the fence of this release camp must be exceptionally strong, and it must provide the animal with the strongest possible electric shock. This will ensure that once released onto the property, the bulls will avoid the electrified fences. One severe shock is usually sufficient to teach an elephant not to touch any electrified fence again.

Breeding stock

As more private landowners and small official nature reserves acquire elephants, these become part of a highly fragmented elephant population with no possibility for genetic exchange. Climatic, environmental and catastrophic events, and a narrow genetic base may increase the chances of these small populations dying out in future. Elephants should therefore rather be considered as being part of a meta-population of all the elephants that occur in a specific region, whether they are geographically isolated or not. However, as gene flow is necessary to qualify as a meta-population, the supplementation of genetic material through the exchange of bulls between isolated populations will be an ideal way of increasing their genetic viability. The Elephant Management and Owners Association has already collected information on wildlife areas that keep elephants and this is updated regularly. This database will help in providing information for the future exchange of bulls to ensure proper genetic management.

Introducing elephants into wildlife areas

The area of reintroduction should be at least 10 000 ha in size. The recommended minimum number of elephants to be introduced is a family group of 12 to 15 animals. The months of May and June are ideal for the capture of elephants. Animals from different family groups should not be mixed after capture and during transportation. Infrastructure such as water installations, rest camps and staff facilities should be fenced off with electrified fencing. Elephants should not be introduced into properties where crops or fruit are cultivated. Adult bulls should form approximately 15% of the total population.

Managing elephants after their release

Elephants are kept in the release camp for a maximum of two days to allow them to calm down and to get used to the electrified fence.

Long-acting tranquillisers may be used. The elephants must not be kept in the camp for longer than two days because they will soon get bored and the food will become depleted, and there is then a risk of their trying to break out. It is essential that they are observed from a distance but not disturbed. Once they have become habituated to the electrified fence, the release gate can be opened and the elephants left to leave the camp of their own volition.

Behaviour after release

Usually elephants will inspect the perimeter fence soon after their release, before they will eventually settle down in one area. They often first move in the direction of their original range. In time, they will start to utilise the entire available range, but their movements will be determined by the type of habitat, water, human activity and possibly other elephants. In some instances, aggressive behaviour by the matriarch towards vehicles can occur initially.

This depends on her character and experience. More than likely she will eventually calm down if left in peace. It is imperative to give elephants more than sufficient time and space to settle and calm down. Elephants should never be chased around or be exposed to the revving of vehicles. It is crucial that a calm, responsible and respectful attitude towards the animals be maintained at all times. Tourism vehicles should never get too close to elephants in an attempt to allow tourists to take better photographs. A safe, respectful distance must be kept. If there is hunting on the property, this should not be done in the area where the elephants are likely to be.

Behavioural problems of translocated elephants

In a number of nature reserves, displays of aggression by elephants towards vehicles and the killing of rhinoceroses and buffaloes by elephants has been recorded. In most of these cases young bulls apparently caused the problems.

This was observed when only juvenile animals were translocated, or when a family group with no adult bulls was introduced. Because the male social hierarchy is often lacking in small, translocated elephant groups, the young bulls come into musth at a much earlier age than would be normal in a large population containing adult bulls. Musth induces aggression and the young bulls cannot yet deal with it. Often they just seek sparring partners, a normal behaviour for young males who feel an urge to test their strength. The problem has been solved by adding adult bulls to these herds.

This causes musth to cease in the young bulls and they then become less aggressive. Additionally, the adult bulls appear to have a stabilising effect on the younger bulls. However, the introduction of adult bulls brings its own inherent problems. When adult bulls are introduced, it is advisable to introduce at least two bulls, because they will naturally seek the company of each other.

In some instances, elephant bulls have been known to break out of the perimeter fence of an enclosed area. There are a variety of reasons for this behaviour. Each elephant has its own character and individual behavioural pattern.

Older bulls, who have established their place in the dominance hierarchy of a population, regularly have access to a large number of females through entering into musth. When elephant bulls are translocated to a small wildlife area with possibly only one family unit, or at least a restricted number of females, they will wander around in search of females in oestrus. When the bulls come from a large natural area such as the Kruger National Park, they are used to moving about and utilising a large range, which is now restricted by fences. This requires adaptation and may create aggression and stress.

Other factors that may be responsible for breakouts include human disturbance, for instance through hunting, females that are in oestrus on a neighbouring property, or simply an urge to move around to find companions or to return to their former range. To date, the most frequent causes of breakouts have been inadequate fencing and boma facilities. There is no guarantee that an elephant bull will not attempt to break out of an enclosed area, but it is known that the younger the bulls, the less likely are the chances of their breaking out.

When translocating elephants to another wildlife area it must be considered that they can pick up signals from other elephants from a distance of at least 32 km, and that this could induce them to try to break out and move back to their original range.

Elephants in small wildlife areas are clearly not easy to manage. The intensive production of elephants, as is done with other herbivores, is impossible, but it can be done semi-intensively on large properties. This does not mean that private owners should not acquire elephants. It just means that the objectives and management options must be clear and the problems assessed, and there must be a willingness to adapt, tackle and solve any problems as they arise. Therefore it is strongly recommended that the feasibility of introducing elephants into a small area be seriously evaluated well in advance by doing a cost-benefit analysis and weighing up all the advantages and disadvantages. This includes budgeting for the entire pre-translocation period, the translocation itself, the post-release monitoring, and for any possible future management actions than can be anticipated.

Controlling population density

The objectives of the specific wildlife area will dictate how many elephants are to be introduced, and at what density the population should be maintained. Whatever the objectives, it is not advisable to stock the elephants at the ecological capacity of the habitat for elephants from the onset. Introduction of elephants at 50% of the ecological capacity will give the owner or manager time to assess the impact of the elephants on the vegetation, and to re-evaluate the objectives and goals if required. If the objective is to buy more time, one possibility is to introduce a family with no adult bulls. Bull elephants will become sexually mature at about 12 to 15 years of age, and adult cows will usually not accept a young bull for mating. However, the younger cows will do so. The major problem with this approach is that young elephant bulls on a property can become problem animals, as has been explained above.

The introduction of elephants in conjunction with an immuno-contraception programme is the best way to date to keep elephant population sizes in check. T

he Dan-inject darting system is usually used, and the females are vaccinated porcine zona pelucida to inhibit the sperm from penetrating the ova. The female has a normal reproductive cycle and is even served by the male, but conception does not occur. Two boosters are required two weeks apart, and subsequently once per year. A 3-in-1 dart is currently being developed to eliminate the necessity of follow-up boosters. The immuno-contraception programme was started in the Kruger National Park and has now been implemented in some private wildlife areas. To date, no behavioural changes have been noticed in the elephants that were vaccinated.

However, it is essential that the services of an experienced veterinarian be contracted for the programme.

It is strongly advised that this system of control should only be used for a limited number of years, allowing the cows to have some calves and to form a natural family unit. The contraception programme should therefore only be used to extend the inter-calving period, which normally is from 3.5 to 4 years. Such an extended inter-calving interval is quite natural because it also happens in the wild under stressful conditions such as drought. The castration of bulls is not feasible because their abdominal testes make it difficult, with a high risk of death during or as a result of the surgical procedure. However, research is currently being done on castration of bulls.

Once the ecological capacity of an area has been reached for elephants, excessive numbers can be removed by translocation, hunting or culling. The population density can also be decreased by enlarging the range available to the elephants. One alternative is to create large conservancies. This increases the size of the area and reduces the required level of management.

Negotiations to do so must be started long before the actual ecological capacity is reached, or even better, before introducing elephants at all, because creating a conservancy takes a long time. Habitat of suitable size for translocating elephants is becoming difficult to find in South Africa.

An attempt must be made to remove an entire family unit and the operation must be conducted by a professional team. Capture of an entire family unit is made difficult by the fact that elephants are gregarious and that a herd may split up occasionally. In small wildlife areas it is therefore imperative that pre-translocation monitoring of the donor herd takes place. The translocation process is stressful to the elephants and this stress will be more acutely experienced by cow-calf groups because of the tight bonding between family members. One must aim at minimising stress levels and therefore ensure that all related individuals are captured together. Pre-capture monitoring allows the identification and selection of those individuals or groups that spend most of their time together so that the translocation is conducted in as humanely a way as possible. This will help to ensure that family units are not broken up during translocation and will encourage group cohesion after release in the recipient area. If translocation aims at removing problem animals, it is also necessary to identify and monitor them. To avoid the stressful translocation process, a viable management plan must be in place in advance and the elephants must be prevented from reaching ecological capacity by timely implementation of alternatives, such as immuno-contraception and/or the enlargement of the property.

Trophy hunting is a profitable wildlife utilisation enterprise and the income derived from it can be reinvested. In South Africa a limited number of hunting permits are allocated each year to the provinces under the regulations of the Convention on the International Trade in Endangered Species (CITES). It must be remembered that the older the bull the bigger the tusks. The stronger, larger bulls will also be the carriers of the best genes, and they get the most mating opportunities. This implies that if these bulls are hunted too soon, there may be a loss of genetic material. In turn, this could have serious implications in a small population where the genetic variation is already reduced.

Large tuskers have almost disappeared all over the continent, except in the Kruger National Park, probably because of selective hunting. Bulls that are earmarked to be hunted must already have been separated from the family units and should not be near them or near any other male at the time of hunting to prevent the remaining elephants from becoming aggressive.

A hunting rifle, no smaller than 0.375 calibre and with a bullet mass of at least 300 grains must be used. Bullets should have a full metal jacket or monolithic construction. It is important to remember that all ivory collected must be registered immediately with the relevant provincial conservation authority.

The hunting of elephant cows is not acceptable. Taking out a female from a family unit will cause tremendous disruption, and the chances of her being either pregnant or lactating are great. The only exception would be a rogue female that has repeatedly caused severe damage or has become extremely aggressive. She may then be hunted, but only after all other options have failed. Moreover, in hunting her she should not be shot within sight of her family unit because this will cause extreme trauma and disruption in the group.

The Elephant Management and Owners Association does not sanction hunting of elephants with a bow and arrow because of the anatomy of an elephant. Because an elephant does not have a pleural cavity, the animal will die of suffocation through drowning in its own blood when the lungs are pierced by a bullet or arrow. This can be a long and traumatic process. The chances of an archer obtaining a heart shot are extremely remote because the heart is well protected by the large front legs. The risk of the animal being wounded is therefore simply too great.

There currently is a moratorium in South Africa on hunting elephants and rhinoceroses with a bow and arrow. As with translocation, culling must be done by an experienced team, and it must be ensured that an entire family unit is culled. Nevertheless, the culling option should only be considered when all others have failed.

HAND-REARING CALVES

Hand-rearing of elephant calves sounds like a cute proposition, but in reality it is extremely hard work because elephant calves are some of the most difficult animals to rear by hand. The calf is prone to all manner of illnesses, diet deficiencies and stress, and requires 24-hour supervision and constant social contact. Even in professional hands an elephant calf will not become safely tractable in less than a year.

Each elephant is also unique and the training method has to be adapted to the specific individual, its learning ability, its character and time requirements. Nevertheless, young elephants have a great capacity for learning. As highly social animals they will obviously require other elephants to socialise with.

Therefore the keeping of only one elephant in isolation has to be avoided at all times. The milk composition of an elephant is as follows, with the composition of cow's milk in brackets: total solids: 20.1 g (12.7 g); fat: 9.3% (3.7%); protein: 5.1% (3.8%); lactose: 3.7% (4.8%); ash: 0.73% (0.72%) and energy: 121 kcal (67 kcal).

FEEDING ELEPHANTS IN CAPTIVITY

There should generally be sufficient food in any wildlife area to make supplementary feeding of any type of animal unnecessary. This is one reason why the ecological capacity of elephants should not be approached. However, after severe fires or drought it might become necessary to supplement the food of elephants. A mixture of hay and lucerne is ideal to bridge the time until new green foliage is available again. Antelope pellets contain gossypol, which is known to be toxic to rhinoceroses and may be toxic to elephants too. Horse pellets have a higher protein content than antelope pellets, and are used for elephants instead. Nevertheless, horse pellets should only be used as a food supplement in extreme circumstances because these pellets will induce a change in the digestion process, requiring the elephants to adapt to it. Feeding elephants on horse pellets also makes them accustomed to the vehicles that bring the food. This can eventually become a great problem because the elephants might later chase or even damage any vehicle in an attempt to get food.

A combination of horse pellets, hay and lucerne is usually given to elephants in captivity. It is supplemented with as much natural browse as possible. The hay and lucerne mixture should be given at about 3 to 5 kg per 100 kg of body mass, but this can be less if horse pellets are also given. Ideally the elephants should be allowed to forage for themselves during the day. Otherwise, fresh branches must be supplied, but this is no easy task because it will require several truckloads of fresh browse daily. Branches are an important source of roughage, and also prevent the captive animal from becoming bored and developing abnormal behavioural patterns. Lucerne should always be mixed with hay because on its own it can cause colic and diarrhoea in elephants.

The horse pellets should not be given summarily, but if they are given they must contain vitamin C, else this vitamin must be provided in the form of fruit and vegetables. Cabbage must be avoided because it can cause bloating. Fruits are chopped to prevent the animal from swallowing them whole and choking. It is best to consult an experienced veterinarian for the diet of captive elephants. Young elephants especially must be fed with care because they need a balanced diet to avoid growth deficiencies. Calves must be hand-fed with a specialised milk formula, and expert advice must be sought on this topic.

DISEASES AND DISEASE CONDITIONS

Anthrax that is caused by *Bacillus anthracisis* endemic in the far north of the Kruger National Park, but it can occur in other regions of southern Africa too.

Elephants do not appear to be vulnerable to this disease, although elephant deaths from anthrax have been reported. An effective vaccine and one that is registered for cattle is available.

Encephalo-myocarditis has not been observed in captive elephants to date, but it does occur in bulls in the wild. Such an elephant eventually dies of acute heart failure. The symptoms are breathing discomfort, harsh breathing because of severe lung oedema, listlessness and death within 24 hours. A vaccine against encephalo-myocarditis is available. The disease is caused by the Picornavirus and is spread by rats and mice. Therefore, in captive elephants, hygiene and, where necessary, rodent control are of the utmost importance, especially where food is stored.

Floppy-trunk disease is known from Zimbabwe and the Kruger National Park. It appears to be a degenerative disease with no specific known cause, although many causes have been suggested. The disease is only seen in adult to old bulls where paralysis of the trunk slowly proceeds from the tip towards the head. Affected elephants usually die from severe emaciation because they are not able to feed.

Another disease is salmonellosis for which the clinical symptoms are profuse, watery diarrhoea that can contain blood and mucus, loss of appetite, weakness and fever. This is a life-threatening disease in captive elephants and its treatment must be vigorous. The disease does not generally occur in the wild because of an uncontaminated supply of natural food. It can be prevented in captivity through proper hygiene.

Captive elephants sometimes develop ulcers that are probably induced by stress. Colic may also occur. The symptoms of colic are restlessness, the animal gets up and lies down repeatedly, it adopts abnormal postures, groans, bites the tip of its trunk and has constipation. Colic can occur in cases where fresh lucerne is given without mixing it with hay. The lucerne causes intestinal spasms. A successful treatment consists of immobilisation, intravenous injection of spasmolytic drugs, and the administration of liquid paraffin through a stomach tube. In less severe cases the colic will clear up by itself after several hours.

Tooth abscesses have been found in wild elephants. Sometimes this causes the affected animal to become aggressive and dangerous, especially towards people. Immobilisation of the animal and treatment of the abscess can be effective.

The endotheliotropic herpes virus, which can be lethal in captive elephants, is usually carried asymptomatically by elephants. Many other infectious biological agents, such as foot-and mouth disease, are also of importance. However, little data exist on the epidemiology and pathogenicity of these and other infectious agents in free-living elephant populations, and most of the evidence of the various diseases has been obtained from captive animals.

Starvation during drought can render individuals susceptible to stress, or metabolic acidosis as a result of a recent change in diet from a flush of vegetation after rains. This will increase the risk of injury or death in the event of possible immobilisation, because of capture myopathy.

CAPTURE

The capture of elephants must only be done by an experienced capture team.

Capture and translocation should only be done during the winter months, and then at a cool time of the day, preferably when the ambient temperature is below 25 °C. The easiest way to locate a small family unit is by helicopter. It is advised not to select a large group for capture because it is difficult to keep the group together. It takes longer to dart more animals, which increases the risks involved. As soon as the elephants have been located, they are herded slowly towards a suitable road where the capture team is waiting. Because problems can be experienced during anaesthesia with chemical drugs, it is vital that a veterinarian be present during the entire capture operation.

Darts with a variety of dosages are prepared in advance, all containing a mixture of M-99 (etorphine-hydrochloride) and azaperone (Stressnil, Janssen-Cilag). Azaperone counteracts the increase in the mean arterial blood pressure that is induced by M-99 on its own, and which could cause massive lung oedema.

All the required emergency drugs such as an antidote, cardio-respiratory stimulants, corticosteroids, non-steroidal anti-inflammatory agents, diuretics and a complete kit for accidental human exposure to M-99 must be available, the latter made up and carried on the person firing the dart gun. M-99 is lethal to humans if an antidote is not administered immediately.

For elephants a dose of 1 mg M-99 per 600 kg of body mass is used. For the newer drug A3080, a dose range of 15 to 40 mg is used currently, but more field testing may refine the dosages.

It is best to dart the animals from a helicopter, and then gently herd them towards the ground team. The dart site should be a well-muscled part of the body, preferably the hindquarters. The matriarch should be darted first because the other elephants will then tend to stay near her. Inform the ground team by radio as soon as the elephants have been darted. After about ten minutes, the first elephant will go down. The helicopter pilot must try to keep the elephants together. Panic in the herd should be prevented because if the animals disperse, the risk of losing an elephant is considerably increased. Mothers and small calves must not be separated during herding, and must be captured and crated together. Members of cow/calf groups should all be darted together. Bulls must be darted separately and crated individually. Lameness or injury to the sensory organs such as the eye due to previous trauma or disease would make individuals less suitable for the rigours of translocation.

Time is crucial because a darted elephant must be prevented from falling onto its trunk or chest and suffocating. Suffocation can set in rapidly because of the lack of a pleural cavity. It has been the cause of most deaths among elephants during immobilisation. This again makes it advisable to dart only small family units at a time. An immobilised elephant must be pushed onto its side immediately. If the legs are spread out wide, the elephant can be pulled over with the help of a rope tied to the base of one of its tusks. The rope is pulled over the neck and then under the ear to the other side. All elephants on the ground must be attended to immediately.

The upper ear is folded over the eye. Since the pupils are constricted because of the drugs, an eye ointment is sometimes administered. The tip of the trunk must be free and kept open to allow natural breathing. The bottom ear should not be folded because this can damage it permanently. The breathing rate must be monitored. The normal breathing rate for an adult elephant is three to four breaths per minute, but in calves it varies from 16 breaths per minute in small calves to eight breaths per minute in older ones.

To control hyperthermia in an immobilised elephant, water must be poured over the ears, head, neck and shoulders. Hyperthermia is another common cause of death during capture. This is why elephant capture operations are usually done during the winter months, and in the early morning in the summer. Physical obstructions must be removed from the access route to allow the recovery vehicles or trailers to reach the capture site. Depending on the field situation and the types of vehicle that are available, the transport crate can either be brought up to the elephant, which is then loaded directly into the crate, or the elephant is first pulled onto a trailer and then taken to a road where the large trucks and crates are waiting. It is advisable to mark each elephant and to record its shoulder height, sex and an age estimate. A microchip can be injected into the base of the tail for future identification. The dart wound must be treated with antibiotics, and a tranquilliser such as haloperidol must be administered. The suggested doses for various tranquillisers as used for elephants in the Kruger National Park appear in Table 1.3.

To load an elephant onto a trailer or into a transport crate, the feet are usually tied together, and the animal is then rolled or pulled onto a piece of conveyor belt or large mat. This belt or mat is connected to a cable that runs over a pulley and is fixed to the trailer or crate. It is ultimately connected to a winch. Rollers are placed between the elephant and the trailer (or crate), and the elephant is pulled onto the trailer or into the crate with the help of the winch. The antidote for M-99 is M-5050 (diprenorphine) and this is now administered. As soon as the elephant is up and standing, the sliding doors leading to the truck are opened to allow the animal to walk straight into the crate. If the animal is already in a crate, the doors must be closed immediately, but the animal must be observed through a slit until it is certain that it has recovered fully.

Table 1.3 Doses of tranquillisers that are used for African elephants. This table has been revised but can be used as a guideline.

Shoulder height (m)	Mass (kg)	Haloperidol (mg)	Azaperone (mg)	Trilafon (mg)
All animals:				
< 1.2	< 355		10–20	
1.20–1.25	355	18.0	35.5	120
1.26–1.30	400	20.0	40.0	130
1.31–1.35	440	22.0	44.0	135
1.36–1.40	490	24.5	49.0	140
1.41–1.45	550	27.5	55.0	145
1.46–1.50	610	30.5	61.0	150
1.51–1.55	680	34.0	68.0	155
1.56–1.60	745	37.5	74.5	160
1.61–1.65	810	40.5	81.0	165
1.66–1.70	880	44.0	88.0	170
1.71–1.75	950	47.5	95.0	175
1.76–1.80	990	49.5	99.0	180
1.81–1.85	1050	52.5	105.0	185
1.86–1.90	1140	57.5	114.0	190
1.91–2.00	> 1200	60.0	120.0	200
2.01–2.19	> 1200	80.0	150.0	210
2.20–2.39	> 1200	100.0	150.0	215
2.40–2.49	> 1200	120.0	200.0	250
2.50–3.00	> 1200			250–300
Lactating females	> 1200		150.0	

Source: Raath (1999)

TRANSPORTATION

Depending on the size of the elephants involved, each truck can transport from six to eight animals. The crates are generally customised and reinforced shipping containers measuring 12 m long by 2.4 m wide and 2.7 m high. The crate is divided into two compartments with sliding doors. The sides of each compartment must have several ventilation grids 200 mm high and 400 mm long at floor level, and at least one 300 mm high and 2 m long at the top. Crates are also used for the individual transport of elephants. They are constructed of a metal frame lined with wood or metal plating and have doors that slide open vertically. The roof and floor should be slatted to allow water to be poured onto the elephants to cool them off, and urine and water to drain away. Crates to transport adult elephant bulls must have special reinforcements.

The animals must not be allowed to lie down during transport, and on long journeys the drainage passages should be opened at each stop if they have become clogged, preferably in a quiet area away from human noise and additional stress factors. The animals should be examined frequently during transport for any problems, and the impact of ventilation must be assessed by monitoring the temperature in the internal air space of each crate. If the temperature is increasing, ventilation should be increased and decreased if falling, or a source of heat must be provided. Water must be readily available and the animals must be watered during long journeys. The transportation time should not exceed 14 hours. The longer the animals are recumbent under anaesthesia, and the longer they are confined in crates, the greater will be the risk of mortalities. During transport, equipment and drugs for veterinary intervention and, if necessary, euthanasia should be carried with the convoy to cater for possible emergencies.

A rough indication of transport costs is R20 to R25 per km loaded from the Kruger National Park. Private capturers have their own price structure. The capture costs will depend on the number and size of the elephants, and the type and quantity of drugs used. About 30 minutes before the elephants are offloaded, the animals taller than 2 m at shoulder height should receive a supplementary dose of a short-acting tranquilliser, such as azaperone. It is a standard rule with elephants that the smaller the elephant the higher the dose in mg of tranquilliser per kg of body mass. Note that the height-to-mass ratio of elephants may differ from region to region.

DOMESTICATED ELEPHANTS

The taming and training of elephants are highly contentious issues in South Africa. In Asia, elephants have been domesticated for probably 4000 years and have been used in wars, for logging work and for religious ceremonies. In both Hinduism and Buddhism, the elephant is considered to be sacred. In more recent times, the tourism industry in Africa, including South Africa, has also been using elephants for elephant safaris in wilderness areas.

For some reason the African elephant was long thought to be untrainable and was only hunted. In 1879, King Leopold II of Belgium imported four Asian elephants and their mahouts into Africa. They were to be used to tame African elephants. However, all four of these elephants died, and only at the turn of the century was another attempt made to train African elephants in the then Belgian Congo, now the Democratic Republic of Congo. By 1951 there were more than 100 trained African elephants at the training station at Gangala-naBodia near the Garamba National Park in the Democratic Republic of Congo. They were used for agriculture and forestry work. However, the Asian training methods were too harsh for the sensitive African elephants. When the Congo gained independence in 1960 the interest in elephant training waned, and four years later there were only 15 elephants left at the training station.

In South Africa few people keep trained African elephants. In recent times there have been several successful enterprises offering elephant safaris in Botswana, Zimbabwe and South Africa, and this appears to be a viable undertaking. However, there are a number of problems. Training an elephant takes many years, and the elephants cannot be utilised for riding before they are well into their teens. Therefore, immediate financial gain is not possible. Moreover, feeding and housing domesticated elephants is expensive. In addition, professional handlers and trainers are virtually non-existent within South Africa.

There must be three handlers for every two trained elephants, which makes this a costly endeavour. Training an elephant is a highly specialised profession, and the risks to human life cannot be underestimated, especially in view of the sheer bulk and size of an elephant. It is generally accepted among elephant specialists that there are two possibilities for keeping elephants. They can either be completely wild or completely trained, but anything in between is dangerous. Of course, elephants can be habituated to human activity like any other animal, but this does not mean that they become tame.

Nevertheless, being habituated to human presence is often misinterpreted as being tame. Elephants in a wildlife area that approach vehicles or come for titbits remain wild elephants and are uncontrollable, except that they have lost their natural fear of humans. This is a potentially dangerous situation. There are various methods of training elephants. These include a variation from direct contact with the animal to no direct contact, where the trainer and the elephant are separated by a protective barrier.

The approach that is used depends on the objectives for training and the institution's policy. In Africa there are generally few young elephants available for possible training. The capture of young elephants in the wild is not acceptable because of the strong bonds that exist between a mother and her calf.

The only possibilities of obtaining young elephants are natural orphans, or elephants that were born in captivity. Elephants should be trained when they are young because the older elephants will have to be subjected to harsh treatments to train them. This is not acceptable in modern society. However, different trainers have different views on this.

ECONOMICS

Introducing elephants into a reserve is a costly endeavour. Not only must the elephants and their transport be paid for, but electrified fences and the holding camp are costly. A monitoring programme must also be budgeted for, and the security must be upgraded in the form of fence patrols, rangers and anti-poaching units. Other cost-related aspects include annual insurance cover in the case of breakouts, and even damage to property and injury to people.

Elephants are currently sold either by the Kruger National Park or by private owners whose population has reached its ecological capacity. The Kruger National Park sells entire family units on tender every year. They require the owner to have a proper release camp to accommodate the animals on arrival.

The camp is inspected by them before closing the sale. Because of the strict requirements that must be met before elephants can be purchased, they are generally not available at wildlife auctions. Elephants currently cost a minimum of R20 000 each when in a family unit, and from R150 000 or more for single adult bulls that are purchased from the Kruger National Park. Private owners have varying prices.

A major return on an investment in elephants is by way of tourism. This can be quite profitable and is the most suitable form of income for smaller wildlife areas. However, the impact of elephants on the habitat can be great if there is no strict population control. It is always best to have guided tourist drives. The guides must be specially trained to deal with difficult and potentially dangerous situations. They should have an intimate knowledge of elephant behaviour, show a healthy respect for and knowledge of elephants, and display a sensible and calm attitude at all times. Management policies should ensure that vehicles are never allowed to approach too close to the elephants, and that they never cut off part of a group or prevent the group from moving in a desired direction. The elephants must at all times be allowed to choose the distance that they wish to keep from the vehicles. These requirements must be especially strictly adhered to when there are bulls present that could be in musth. Where guests drive around on their own, it is highly recommended that they be briefed on how to behave near elephants when entering the area.

This can be done verbally or in a suitable pamphlet. People all too often venture too near an elephant or behave inappropriately to get a good photograph. The real danger is that they may have an experience that they would rather not have had. The ultimate result may even be death and endless sorrow.

Green hunting or darting safaris are a recent development. This involves shooting animals with paint balls or immobilisation darts. There is a strict code of ethics involved in this type of activity. Moreover, immobilisation drugs are controlled by legislation and only qualified persons are allowed to handle them.

Therefore any such operation would have to be supervised by a veterinarian who carries full responsibility for the animals and the drugs. Once the animal is down, photographs can be taken and the hunter can have the trophy measured and cast. When the paint ball method is used, the entire hunt can be captured on video. The paint is visible where the animal has been hit, but otherwise the animal is left untouched. However, little is known about the social impact of these types of hunting. They may also easily lend themselves to abuse and repeated darting of the same individual can pose a high risk to its health or life. Until more information is available and stricter legislation is in place, this method is not sanctioned by the Elephant Management and Owners Association. Nevertheless, there are some proponents of this type of non-consumptive utilisation.

LEGISLATION

Before any conservation authority will issue a permit to keep elephants, there are certain requirements that have to be met. Although these requirements may differ between provinces, an electrified fence is a standard one. A permit to transport elephants out of a given province and an import permit from the province of final destination will have to be acquired. Elephants that are being transported over an international border will also require a CITES permit. Most populations of the African elephant currently fall under Appendix I of CITES. However, some southern African populations fall under Appendix II, including the South African population, but there are specific restrictions.

An international trade ban was agreed to in 1989 after a massive illegal industry in ivory saw elephant populations plunge in the 1970s and 1980s. This placed all elephant populations in Appendix I. Recovering numbers, however, have prompted calls for some limited ivory exports in states where populations have been well managed.

At the CITES Conference of the Parties 2002, the annotations under which the South African elephant population was included in Appendix II were amended to allow trade in hunting trophies for non-commercial purposes, trade of live animals for *in situ* conservation, and trade in hides and leather goods for non-commercial purposes. However, live elephants in South Africa still fall under Appendix I of CITES and they require an import permit of the destination country before an export permit will be issued by the South African authorities.

The 13th Conference of the Parties in 2004 approved South Africa's proposal for trade in elephant hair and leather goods for commercial purposes. A monitoring system called MIKE – Monitoring of Illegal Killing of Elephants – has been implemented by CITES to evaluate the level of poaching of elephants. As the conditions may change from time to time, it is best to consult with the relevant authorities before planning on trading in elephants or their products.

Each year a specific number of CITES elephant permits are allocated to South Africa, and of these permits each province receives an annual hunting quota based on the number of elephants within that province. A hunting application must be lodged with the relevant conservation authority. A CITES export permit must be obtained if the ivory is to leave South Africa. Certain countries will also require an import permit. The ivory must be registered and marked by the local conservation authority.

ELEPHANT MANAGEMENT AND OWNERS ASSOCIATION

This is an active group of elephant owners that can provide guidelines to any elephant owner or prospective owner.

Information can be obtained through the Elephant Management and Owners Association (EMOA)
PO Box 98, Vaalwater 0530,
Tel/fax 014 755 4455.

BIBLIOGRAPHY

Bothma, J. du P. 2002a. Some economics of wildlife ranching. In: Penzhorn, B.L. (Ed.) Game ranch management and planning. Wildlife Group, SA Veterinary Association, Onderstepoort, 23–30.

Bothma, J. du P. 2002b. Semantics and selected principles of some wildlife production systems. In: Penzhorn, B.L. (Ed.) Game ranch management and planning. Wildlife Group, SA Veterinary Association, Onderstepoort, 5–12.

Bothma, J. du P. (Ed.) 2002c. Game ranch management. Fourth edition. Pretoria: Van Schaik.

Bothma, J. du P. 2003. Economics of wildlife ranching: 2003. Paper presented at the Boscia.

Conroy, A.M. 1993. An introduction to the South African game industry. In: Woodhouse, I. (Ed.) A salute to deer farming. Wellington: New Zealand Deer Farmers Association, 20–22.

De Klerk, G.J. 2000. Guidelines for the drafting of ecological plans for the management of game ranches and other wildlife areas with specific reference to the introduction of elephants. Vaalwater: Elephant Management and Owners Association.

Du Toit, J.G. 2001. Veterinary care of African elephants. Johannesburg: Novartis SA.

De Villiers, P.A. & Kok, O.B. 1997. Home range and related aspects of elephants in the eastern Transvaal Lowveld. African Journal of Ecology35: 224–236.

Eltringham, S.K. (Ed.) 1991.The illustrated encyclopaedia of elephants: from their origins and evolution to their ceremonial and working relationship with man. London: Salamander Books.

EMOA, Policy. 2005. The introduction and management of elephants in confined areas. Elephant Management and Owners Association.

Garaï, M.E. 1997. The development of social behaviour in translocated juvenile African elephants Loxodonta africana(Blumenbach).Ph.D. thesis. Pretoria: University of Pretoria.

Garaï, M.E. (Ed.) 1999. Managing African elephants: guidelines for the introduction and management of African elephants on game ranches. First edition. Vaalwater: Elephant Management and Owners Association.

Garaï, M.E. (Ed.) 2002. Managing African elephants: guidelines for the introduction and management of African elephants on game ranches. Second edition. Vaalwater: Elephant Management and Owners Association Forum Wildlife Workshop, George, 30–31 October.

Flack, P.H. 2002. The conservation revolution. Game & Hunt8(10): 29, 31, 33.
Krug, W. 2001. Private supply of protected land in southern Africa: a review of markets, approaches, barriers and issues. Workshop paper. World Bank/OECD International Workshop on Market Creation for Biodiversity Products and Services. Paris: 25–26 January.

Laws, R.M. 1966. Age criteria for the African elephant Loxodonta africana africana. East African Wildlife Journal4: 1–37.

Maglio, V.J. 1973. Evolution of the Elephantidae Transactions of the American Philosophical Society 63: 1–49.

Poole, J.H. 1987. Rutting behaviour in African elephants: the phenomenon of musth. Behaviour102: 283–316.

Poole, J.H. 1989. Announcing intent: the aggressive state of musth in African elephants. Animal Behaviour 37: 140–152.

Raath, C.P. 1999. Relocation of African elephants. pp. 525–533. In: Fowler, M.E. & Miller, R.E. (Eds) Zoo & wild animal medicine: current therapy. Volume 4. Philadelphia: WB Saunders.

Shoshani, J. (Ed.) 1992. Elephants: majestic creatures of the wild. Australia: Weldon Owen. Slotow, R., Reilly, B., Owen, P. & Kettles, R. 2004. A generic management plan for African elephants. Elephant Management and Owners Association.

Spinage, C. 1994. Elephants. London: Poyser Natural History.

Stockley, J. 1999. Training and elephant back safaris, pp. 35–42. In: Garaï, M.E. (Ed.) Proceedings of the EMOA Workshop, Berg-en-Dal: Kruger National Park.

Sykes, S.K. 1971. The natural history of the African elephant. London: Weidenfeld & Nicolson.

Wright, P.G. 1984. Why do elephants flap their ears? South African Journal of Zoology19: 266–269.

Wright, P.G. & Luck, C.P. 1984. Do elephants need to sweat? South African Journal of Zoology19: 270–274