Veterinary Care of African Elephants

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Cover photograph by André van der Westhuizen
Pencil drawing of elephant by Alan Ainslie
Printed in the Republic of South Africa
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This book is dedicated to my brother Iaan
Foreword

The conservation of our natural heritage is a serious responsibility that we should all accept readily. Through concerted effort and by providing resources for conservation, we can ensure that future generations will be able to enjoy the splendour and wonders of the rich flora and fauna we are so blessed with in Southern Africa.

The task is large and the stakes are high. Fortunately over time, we have proven success through the efforts and determination of many individuals and groups. With their continued support, we will be able to ensure that our natural heritage remains an asset to be proud of.

Dr Kobus du Toit’s experience in wildlife is a fine example of how our skills in understanding the fauna of the country have developed. His book reflects this and passes onto others a wealth of information that becomes so important in successful conservation efforts of the modern age. Knowledge can lead to power when used in a selfish way. In direct contrast to this, Dr du Toit generously shares his expertise and knowledge of African elephants in a self-effacing way, ultimately leading to the benefit of these majestic giants.

The South African Veterinary Foundation’s foresight in supporting this publication represents the interests of so many of our Veterinarians whose chosen profession is the care for animals of all kinds. The recently established Novartis /SAVF Wildlife Research Fund enables funding for appropriate research to ensure that the conservation effort is supported with updated research findings.

Novartis is extremely proud to be able to substantiate our commitment to our current and future generations in supporting the conservation effort through the sponsorship of this publication. We wish all involved in conservation continued courage and enthusiasm in addressing the many challenges involved: we salute you!

Ian Piccione
General Manager
Novartis Animal Health
This manual is provided for information purposes in the interests of the conservation and management of elephants. It is a synopsis of important information relating to the capture and veterinary management of elephants. Any management operation involving elephants should only be conducted under the direct supervision of a qualified and suitably experienced veterinarian.

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Above: The loading of an immobilised elephant requires more inspiration than perspiration! Below: ‘Suckling calves’ are caught by hand after darting with a suitable sedative.
PRE-CAPTURE

1. PLANNING

1.1 PERMITS AND DOCUMENTATION

Within the borders of South Africa:

• Nature conservation export permit (origin) of Province
• Import permit (destination) of Province
• Veterinary permit of state veterinarian (origin)
• Ecological report of ranch by a qualified ecologist
• Inspection of the holding facility by a state veterinarian (quarantine purposes) and nature conservation official (training to respect an electric fence)…

Across international boundaries:

• Nature conservation export permit (origin) of Province
• Veterinary import permit
• Veterinary export permit (state that the import requirements of quarantine are in order)
• CITES Permit (import and export)
• Veterinary health certificate (nearest state veterinarian)
• Vehicle permits and insurance as required by the specific country
• Insurance of the animals
• Permission to take veterinary drugs into a foreign country
• Visas and work permits for labourers

1.2 EQUIPMENT

• Dart gun, darts and drug box

• Calculation of immobilizing and tranquilizing drugs required (use average animal’s shoulder height at 2,2m) - see checklist Appendix I.

• Water containers (20 litre) and rucksack sprayer for cooling animals

• Cotton ropes (30mm) to tie legs and pull animals over

• Converyer belt with chains and rollers for loading

• Shovels, axes, picks, tommy bar, bow saw

• Spare wheels, puncture repair equipment and pump

• Power generator (petrol), welder and tools

• Winch, hydraulic crane and cable

• Cattle prodder

• Two-way radios

• GPS (to identify capture sites)

• Microchips, reader and applicator

• White spray paint to mark individual animals
• Veld forms for data collection (Appendix 2)
• Measuring tape for height measurement
• Emergency medical drug box for staff
• Hose-pipe for watering animals

2. CAPTURE

2.1 GENERAL

The shoulder height can be used as an indication of the age of an elephant. Calves at birth have a shoulder height of 0,85m and will reach 1,10m at a year old. (As a general rule, the gestation period of mammals is equal to the suckling period). Calves will be milk-dependent up to the age of two years, but can suckle up to 3,5 years of age (intervalving period 3,5 - 4 years). Appendix 3 shows the age classes in relation to shoulder height.

Anatomical and physiological notes of importance during capture

• The body temperature varies from 36-37°C and a rectal temperature of 38°C can be a significant fever.

• Arteries pulsating behind the ear can be palpated to determine the heart rate (normal: 25-35 beats/minute). The difference in pressure in the vessels will indicate arteries and veins. Always use a vein to inject drugs and use the veins of the legs to inject tissue irritant drugs (e.g. glucose, phenylbutazone) to prevent the sloughing of tissues of the ear. Injections in the arteries of the ear can cause haematomas because of high blood pressure.

• The normal breathing rate is six times per minute, but this can increase to 15 in excited animals. Elephants cannot breathe through the mouth and will suffocate if there is a heavy weight or pressure on the trunk.

• If an elephant lies in sternal recumbency, the weight of the large
Above: A typical elephant holding-boma.
Below: Adult elephants in an electrified camp.
Above: The translocation of elephants is a capital-intensive operation. This includes the transfer of the elephants from the capture area to the main transport vehicles.

Below: Young elephants in ‘bomas’. Red clay soil is provided to supplement iron intake needs.
bowel against the diaphragm inhibits normal breathing and leads to asphyxiation.

- Sex can be determined by measuring the distance between the navel and genital opening. Short in males (opening facing antero-ventral) and longer in females (opening facing caudo-ventral).

2.2 FACTORS TO CONSIDER WHEN FAMILY GROUPS ARE INTRODUCED TO RANCHES

2.2.1 Social factors

The habitat should be suitable to maintain a minimum social group of 15 animals. The mean group size for elephant bulls in Tanzania is 3.08 and in Kenya 2.42 and the mean family group size is 11.6 animals. The ratio of bull herds to family herds is 1 : 5.7 (15% : 85%).

Young bulls join bachelor herds at about 16 years of age. Sex ratio of family units in the Kruger National Park between birth and 14 years of age is 1 male : 1.02 female.

The sex ratios of the adult and sub-adult animals from the Kruger National park are 1 male : 1.95 female. The average herd size is 8.2 animals. A practical problem is that a truck can hold 6-9 animals/load, depending on the size of the animals. The recommendation is that buyers must take animals in units of 7, therefore a minimum of two units to comply with the minimum social requirements.

2.2.2 Habitat

The production of vegetation depends on the rainfall. Appendix 4 indicates the carrying capacity for elephants on various game ranches where the animals form 15% of the total large herbivore biomass. The densities and veld types of the elephants on different ranches in the RSA can be seen in Appendix 5. The elephants prefer the riverine areas during the dry months.
2.2.3 Genetic

To keep the inbreeding coefficient below 1%, a minimum of 50 breeding animals is necessary. This will require a herd of about 150 animals, which is not in the framework of the average ranch size. To eliminate this problem, two adult bulls can be replaced every 10 years. This will prevent a bull mating with his daughters when they become sexually mature at 10 years of age.

2.2.4 Aggressive animals

Game ranches operating as safari lodges should be careful not to introduce aggressive females. The evaluation of aggressive animals during immobilisation is very difficult. The only criterion is to avoid big tuskless females or those with single tusks.

2.3 THE TEN RULES OF INTRODUCING ELEPHANT TO GAME RANCHES

2.3.1 The area must preferably be larger than 10 000ha.

2.3.2 The recommended minimum number for introduction is 15 animals.

2.3.3 Short-acting tranquillizers should be administered to elephants prior to their release.

2.3.4 The animals should be released into a one-hectare electrified camp and not be kept there longer than two days.

2.3.5 The ideal time of the year for capture is May or June, when enough browse is still available at the releasing point.

2.3.6 Family groups must not be mixed during the transport period. Vehicles with double containers can be used to transport 7-8 animals at a time.

2.3.7 Sex ratios are difficult to determine before capture and family groups will be moved as they are captured. It is therefore impor-
Above: Adult elephant cow in sternal recumbency being pushed into lateral recumbency to facilitate breathing.
Below: An immobilised elephant being transported from the capture area to the main transport vehicle.
Above: Elephant capture is an eventful operation!
Below: Spray paint can be used to mark elephants during capture operations. This is especially helpful when a large number of elephants are being captured.
tant not to mix family groups during transportation.

2.3.8 Fence off water installations, rest camps and workers’ quarters with an electrified fence.

2.3.9 Elephants should not be introduced onto properties where crops or fruit trees are cultivated.

2.3.10 Adult bulls taller than 2.2m shoulder height should make up 15% of the total population.

2.4 **FACTORS TO BE CONSIDERED TO PREVENT ANIMALS FROM BREAKING OUT OF RANCHES**

2.4.1 **Presence of other animals**

Elephants broke out at Phinda and Kwalata where other elephants were present during the introduction process. Elephants did not occur on Welgevonden and Atherstone during the introduction of family units. The presence of other elephants does not seem to play a role in preventing newly introduced ones from breaking out.

2.4.2 **Small calves**

The presence of nursing calves seems to curb the movement of herds. The introduction of females with small calves is strongly recommended on reserves smaller than 10 000ha.

2.4.3 **Time in exercise camp (100m x 100m)**

The aim is to introduce animals to an electric fence without the possibility of breaking out. It is therefore not necessary to keep them longer than two days in a camp of a minimum size of 1ha.

2.4.4 **Electrified boma (25m x 25m)**

The electrified boma is not recommended because the elephants get nervous in a confined area and this is an unnecessary financial
layout. The bomas at Venetia, Kwalata and Phinda were electrified. The boma at Venetia was too strong for elephants to break out. The presence of an electric fence caused animals to get excited after they were shocked; they bundled in a corner and forced the boma open.

2.4.5 Presence of a matriarch

The alpha females broke out of Kwalata and Phinda. With the introduction of adult elephants to Phinda in 1993, the dominant female was left behind in Ghona-re-Zhou. None of the elephants broke out of Phinda during the 1993 introduction. During 1994 the dominant female broke out 30 times at night, while the rest of the herd refused to follow her.

At Thornybush and Kapama, the dominant females were left behind in the Kruger National Park during the 1994 introduction. No animals broke out of these two reserves and both herds are very tame and often seen by tourists. The removal of the dominant female on reserves smaller than 10 000ha is strongly recommended.

2.4.6 Exercise camp

The elephants at Welgevonden and Makalali were introduced directly into an electrified exercise camp. A one-hectare exercise paddock is strongly recommended for reserves smaller than 10 000ha. The elephants at Thornybush were introduced into an 25ha electrified camp. The camp was opened after a day, but the elephants stayed inside for at least another 24 hours.

2.5 FACTORS TO BE CONSIDERED REGARDING THE SELECTIVE CAPTURE OF INDIVIDUALS FROM FAMILIES

The capture technique as described in 2.8 is important because it prevents juveniles from screaming in the vicinity of breeding herds. The calling attracts the attention of the matriarch, which can endanger the capture team on the ground. It is important that
Above: The leaking of an irritant injectable substance caused sloughing of the tissue of the arteries of the ear of this elephant.
Below: This ‘blind tusk’ is incised surgically to facilitate eruption.
Above: Oesophageal obstruction as result of an orange which was swallowed whole. The wound must be treated as an open wound to prevent stenosis of the oesophagus.

Below: Herpes viral lesions on the trunk of an elephant.
the breeding herd associates the capture operation with the helicopter and not with vehicles and people. A juvenile cannot be separated from the breeding herd while it is still milk-dependent and should thus not be captured. After capture, juvenile elephants must be habituated in a boma after capture for a period of at least 14 days before being put into a training facility. It is strongly advised that elephants of 1.8 - 2.2m shoulder height be tranquillized with long-acting tranquillizers. Animals larger than 2.2m shoulder height must preferably not be put in a training programme.

2.6 FACTORS TO BE CONSIDERED DURING THE CAPTURE OF ADULT BULLS

Bull groups form a looser association than breeding groups. When they are approached by the helicopter they will scatter, thus making it difficult to capture them. When the dominant bull is darted first, the askaris accompanying him may come back and threaten the capture team. When a group is to be caught and introduced to a new ranch or reserve, it is advisable to dart the leader and put a radio collar on the bull to save flying time. The bulls will regroup after a day, or the collared bull can be driven back to the group. Dart one animal at a time and start with the younger bulls. Bulls over 2.5m shoulder height must be transported on their own. Bulls over 3.5m shoulder height should not be moved over long distances because the total height of the transport vehicle may not exceed 4.2m (maximum for bridges over main roads). Bulls must be trained to respect electricity in an exercise paddock.

2.7 CAPTURE TECHNIQUE FOR FAMILY GROUPS

An elephant family group of 6-10 animals is located by a Hughes-300 helicopter. As soon as the animals have been located, they are herded slowly to a large access road, towards the capture team. When the animals are a few hundred metres from the capture team, a radio message is sent from the helicopter, indicating that the animals are being darted. A number of M99 (Etorphine hydrochloride) darts are prepared prior to the operation: 3mg M99 (juveniles); 5mg M99 (sub-adult animals); and 8mg M99
The remainder of the dart is filled with azaperone, according to dosage in appendix 6 (Stresnil, Janssen). Using the helicopter, the darted animals are slowly herded towards the capture team. The first animal is usually affected within 10 minutes after darting; if this animal is the matriarch, the herd stays close to her.

When all the animals are lying down, the capture team moves in quickly to catch the small calves (under 1m shoulder height) by hand or dart with 1mg M99 and 10mg azaparone. The calves are injected with 5mg azaperone intramuscularly and loaded into a separate large container. The trunks are checked to ensure that the darted animals are breathing easily. Animals lying in a sternal position are rolled onto their sides. The ears are folded over the eyes and sprayed with water from a rucksack sprayer. Shrubs are removed to form an access road for the recovery vehicles which have to transport the elephants to the large container transport trucks.

Each elephant is numbered with white spray paint, its shoulder height measured, a micro-chip implanted at the base of the tail, the sexes and age groups determined, the dart wound treated with antibiotics and a long-acting tranquilliser (Trilafon, Sherag) and a short-acting tranquillizer (Haloperidol, Kyron Lab) are injected. The mouth cavity is checked for lesions of foot-and-mouth disease in endemic areas where the disease occurs.

The feet are tied together with rope and the animals are rolled manually onto a conveyor belt. The conveyor belt is connected to a cable, which in turn runs over a pulley fixed to the container. The animal is winched into the container. The antidote M5050 (Diprenorphine) is injected and the animal is driven by truck to the main road, where it is reloaded onto the transport trucks. The trucks can transport 6-8 elephants, depending on the size of the animals.

Old females (with prominent zygomatic arch) and lactating females must be revived first because they tend to recycle M99. When they lie down during transport they can die if the distance...
Above: Herpes viral lesions on the vulva of an elephant.
Below: This elephant calf was burnt extensively in a veld fire. In the absence of a matriarch, young animals can easily become panic-stricken in crisis situations.
Above: Small elephant calf with severe colic pain!
Below: This unfortunate calf lost its hind leg due to a snare.
exceeds 200km. Calves under 1.2m shoulder height should be put in a separate container and reunited with the rest of the family at the end of the loading procedure. Females may attack calves when put together as pairs. During capture, calves panic and may stick to a female for security. When immobilised, it is not necessarily the mother and calf lying next to each other.

2.8 CAPTURE TECHNIQUE FOR INDIVIDUALS IN FAMILIES

This technique can be applied in two ways. Firstly, the whole herd is darted and specific animals selected and loaded. The rest of the animals are revived with the antidote. Alternatively, the whole herd is culled and selected elephants darted (or immobilized). Secondly, the helicopter is used to separate the juveniles from the group. If the female does not allow separation, the juvenile must not be captured, as the bond is too strong and it may be the youngest calf. After being separated from the herd, the juvenile is darted with 4mg M99 and 60-80mg azaparone.

When the elephant has been immobilised for about 5 minutes, the capture team can move in. The elephant receives the same treatment as described in family groups: rolled onto a conveyor belt and loaded with a hydraulic crane onto a trailer. It is taken to a holding container and truck parked in a shady spot a few kilometres away. The elephant is then transferred into the recovery compartment and the antidote administered.

2.9 CAPTURE TECHNIQUE FOR ADULT BULLS

Adult bulls are difficult to handle when immobilised and should preferably be darted one at a time. Bulls will need 12mg M99 and 150mg azaparone for capture. Care must be taken not to give an overdose of tranquiliser because bulls do not get up easily in the recovery compartment. The loading is the same as for adult cows. Although it is not advisable, bulls can be kept immobilised for 6-8 hours provided they are rolled over every two hours.

Specialised reinforced containers are necessary to prevent bulls
from breaking out during transportation. It is important that this be done by experienced persons.

2.10 RECOMMENDED TRANQUILLIZERS FOR TRANSPORT

The tranquillizers used during transport are indicated in Appendix 6. Juvenile elephants with a shoulder height of under 1.6m must not be treated with haloperidol. Animals with a shoulder height of 1.8 - 2.1m are influenced quite markedly by the drug and are difficult to transfer onto the transport truck. It is better to administer the tranquillizers for transportation after the antidote has been given in the recovery compartment. Haloperidol works well for the first eight hours of the transportation. Sub-adult animals, which tend to fight, need supplementary tranquillizing with azaperone.

Trilafon (Sherag) is used to keep the animals calm in the exercise bomas and during release into the reserve. The combination of Haloperidol and Trilafon is recommended for larger animals. Azaperone is recommended just before the animals are released into the training boma.

2.11 FACTORS WHICH INFLUENCE THE FLYING TIME

2.11.1 Distance of the herd from main road

This factor varies according to the distribution of water and roads in the area. In Ghona-re-Zhou National Park for example, elephants drink at night and were found kilometres from the water during the next day.

2.11.2 ‘Bomb-shelling’or scattering of the herd after the start of the capture

This only applies to the situation where a large herd divides temporarily into smaller herds. A herd without a matriarch is extremely nervous and will start running if the helicopter comes too close.

2.11.3 Distance between base camp and the capture site
The legendary desert elephant of the Kaokoveld are known for their characteristic large feet. Part of natural adaption?
2.11.4 **Size of the herd**

It is more difficult to keep a large herd or family together; it takes longer to dart the animals and for the immobilisation to become effective.

2.11.5 **Disturbance of elephants by ground team**

When the elephants become aware of the ground team after they have been darted, they will usually run away and will have to be herded back to the road by helicopter. If the animal cannot be brought back to the road, the helicopter will have to assist the capture team into the area.

2.11.6 **Dart failure**

There is a detonator at the rear end of the Pneu-dart which discharges when the dart hits the elephant. When it is overcast, the mechanism sometimes fails to discharge, possibly due to the higher humidity. In such instances the elephant have to be darted again and this will lengthen the flying time.

2.11.7 **Concentration of elephant**

Elephants tend to move in smaller herds during the winter months. It seems as though the size of the herds is determined by the availability of forage close to water.

2.12 **FACTORS WHICH INFLUENCE THE CAPTURE TIME**

2.12.1 **Topography of the area**

Hilly areas with dense mopane veld (*Colophospermum mopane*) and Lebombo ironwood (*Androstachys johnsonii*) can delay access into the area. Sometimes a whole herd of elephant had to be revived and released, because they had moved into a dense
ironwood thicket and could not be loaded.

2.12.2 **Experience of the capture team**

The capture time is shortened drastically as the capture team becomes more experienced.

2.12.3 **Amount of capture equipment available**

The number of recovery trucks, conveyer belts and workers available to roll the elephant, are of cardinal importance.

2.12.4 **Effect of tranquillization**

Animals tranquillized with too much haloperidol or azaperone are moved with greater difficulty from the recovery vehicle to the transport truck.

2.12.5 **Dart failure and herd size**

Discussed previously.

3. **POST-CAPTURE**

3.1 **HANDLING THE IMMOBILISED ANIMAL**

The first step is to make sure that all the animals can breathe normally through their trunks. Sometimes they lie on each other’s trunks or the trunk can be pressed against a tree or object which prevents breathing. The second step is to pull over all animals that may be in sternal recumbency. The third step is to turn the ear to protect the eye against sunlight. At the same time water can be sprayed onto the ear, thus cooling the animal down. The fourth step is to identify the lactating as well as old females and process them to be loaded first. At the same time small calves can be caught by hand or darted on foot and loaded in a separate container.
Above: The habit of wild elephant of ringbarking baobab trees arises from their need for diet supplementation of long-chain fatty acids, which are an important component of elephant nutrition. Below: The daily provision of clean, fresh water is essential.

Photograph by A. du Toit
With the darting of a large group, a member of the capture team can sit on the head of the large adults to call if a top-up is necessary. Sub-adults can be topped up with 1mg M99 and 20mg azaparone. Adults can be topped up with double the dose. The tranquillizers for transport should be administered in the transport vehicle, just before the antidote (M5050) is given.

The time taken to catch and load family groups is ±25 minutes/elephant and the flying time approximately 10 minutes/elephant. The average herd size is 7.5 elephants/breeding herd. When selective capture is done, the flying time is approximately 60 minutes/elephant and the capture time approximately 15 minutes/elephant.

3.2 MONITORING THE IMMOBILISED ANIMAL

The most important factors monitored are:

- Respiration rate (approximately 6/min) - in large animals breathing is audible; for smaller animals a feather can be held at the tip of the trunk.

- Temperature (36-37°C) - cool animal down by spraying water; feel with hand to evaluate if it is necessary to spray more. Try to avoid catching elephants if the environmental temperature exceeds 20°C.

- Evaluate the mucous membranes (pink) of the oral cavity. Inspect for foot-and-mouth disease lesions if elephants are captured in an endemic area.

- Heart rate - the large arteries behind the ears can be used to monitor the heart rate of approximately 30 beats/minute.

3.3 RECOMMENDED SAFETY PRECAUTIONS FOR CAPTURE TEAM

3.3.1 After the animal is down, the helicopter can drop the person with the dart gun. The helicopter should drive other elephants to at least 2km away
from the capture site. In the event of individuals being caught, the helicopter must stay in the air until the capture team leaves the capture site.

3.3.2 Two riflemen with heavy calibre rifles and experience in the hunting of elephants must form part of the capture team. One must stay on the roof of the transport truck and the other must accompany the capture team to the loading site and back for safety.

4. TRANSPORT

Golden rules:

4.1 Never mix family groups.

4.2 Tranquillize animals before transport - be careful not to overdose (Appendix 6), because animals may lie down in sternal recumbency and die.

4.3 In the case of transport trips lasting longer than 12 hours, animals must be given drinking water with a hose-pipe from a tap.

4.4 Avoid transporting elephants during cold fronts (the Weather Bureau can be contacted at 012-309 3911).

4.5 Load females with calves together, but separately from sub-adults (1.5 - 2.1m shoulder height). Adult bulls should be transported on their own.

4.6 Enough bedding material (straw) to absorb urine must be provided.

4.7 Use experienced drivers and an additional vehicle to accompany the animals on a long route.

4.8 ACCOMPANYING EQUIPMENT

Dart gun and dart box, powerful torch, cattle prodder, heavy calibre rifle, hose-pipe and water containers.
APPENDIX 1

DRUG CHECKLIST

Etorphine hydrochloride (M99)

Diprenorphine (M5050)/Nalorphine/Naltrexone

Narcan

Long-acting penicillin

Intramammary antibiotics (dart wounds)

Ophthalmic ointment - ISSE (eye protection)

Tranquillizers:  
  Perphenazine (Trilafon)  
  Haloperidol (Serenace)  
  Azaparone (Stresnil)

Emergency:  
  Adrenaline  
  Doxapram (Dopram)  
  Finadyne

Wounds:  
  Spray/Ointment/Betadine

Acaricide:  
  Ivomec  
  Dectomax

Syringes/needles

Blood collection tubes
## APPENDIX 3
### DEFINITION OF AGE GROUPS

<table>
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<th>Adult male (AM)</th>
<th>Shoulder height</th>
<th>&gt;2.3m</th>
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<td>Suckling calves (SC)</td>
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APPENDIX 4

CARRYING CAPACITY FOR ELEPHANT ON GAME RANCHES AT 15% OF TOTAL BIOMASS ON A GAME

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<td>RANCH SIZE (ha)</td>
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<td>76</td>
<td>112</td>
<td>150</td>
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<td>250</td>
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APPENDIX 5

ELEPHANT DENSITIES AND VELD TYPES FOR DIFFERENT GAME RANCHES IN SOUTH AFRICA

<table>
<thead>
<tr>
<th>Name of Ranch</th>
<th>Density (ha/elephant)</th>
<th>Veld type</th>
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<tbody>
<tr>
<td>Kwalata</td>
<td>390</td>
<td>Sour-mixed Bushveld</td>
</tr>
<tr>
<td>Welgevonden</td>
<td>530</td>
<td>Sour-mixed Bushveld</td>
</tr>
<tr>
<td>Venetia Mine</td>
<td>710</td>
<td>Arid Mopane veld</td>
</tr>
<tr>
<td>Atherstone</td>
<td>1150</td>
<td>Sweet thornveld</td>
</tr>
<tr>
<td>Kapama</td>
<td>330</td>
<td>Knobthorn - Combretum</td>
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<tr>
<td>Thornybush</td>
<td>410</td>
<td>Knobthorn - Combretum</td>
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<tr>
<td>Makalali</td>
<td>580</td>
<td>Knobthorn - Combretum</td>
</tr>
<tr>
<td>Phinda</td>
<td>310</td>
<td>Mixed Bushveld</td>
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<tr>
<td>Kangwane</td>
<td>420</td>
<td>Mixed Bushveld</td>
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APPENDIX 6
TRANSPORT

HALOPERIDOL DOSAGE RATES (20mg/ml))

<table>
<thead>
<tr>
<th>Shoulder height (m)</th>
<th>Total (mg)</th>
<th>Total (ml)</th>
</tr>
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<tbody>
<tr>
<td>1,6 - 1,69</td>
<td>40</td>
<td>2,0</td>
</tr>
<tr>
<td>1,7 - 1,79</td>
<td>50</td>
<td>2,5</td>
</tr>
<tr>
<td>1,8 - 1,89</td>
<td>60</td>
<td>3,0</td>
</tr>
<tr>
<td>1,9 - 2,09</td>
<td>70</td>
<td>3,5</td>
</tr>
<tr>
<td>2,1 - 2,19</td>
<td>80</td>
<td>4,0</td>
</tr>
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<td>2,2 - 2,39</td>
<td>100</td>
<td>5,0</td>
</tr>
<tr>
<td>&gt;2,40</td>
<td>120</td>
<td>6,0</td>
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</table>

AZAPARONE DOSAGE RATES (mg)

<table>
<thead>
<tr>
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<th>Total (mg)</th>
</tr>
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<tbody>
<tr>
<td>&gt;2,4</td>
<td>200</td>
</tr>
<tr>
<td>2,0 - 2,4</td>
<td>150</td>
</tr>
<tr>
<td>All lactating females</td>
<td>150</td>
</tr>
<tr>
<td>1,5 - 2,0</td>
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<tr>
<td>1,2 - 1,5</td>
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<td>&lt;1,2</td>
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TRILAFON DOSAGE RATES (mg)

<table>
<thead>
<tr>
<th>Shoulder height (m)</th>
<th>Total (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,0 - 1,49</td>
<td>100 - 150</td>
</tr>
<tr>
<td>1,5 - 1,99</td>
<td>150 - 200</td>
</tr>
<tr>
<td>2,0 - 2,49</td>
<td>200 - 250</td>
</tr>
<tr>
<td>2,5 - 2,99</td>
<td>250 - 300</td>
</tr>
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1. GENERAL INFORMATION

Elephants can adapt to a wide spectrum of habitats - occurring from desert to forest - and can therefore be classified as mixed feeders in the wild.

The animals can change their diet according to seasons. During the dry season they will prefer browse and during the wet season grass.

Bark is necessary for essential fatty acids and minerals.

Red clay soil will provide salt (sodiumchloride).

Spend 12-18 hours per day feeding.

Their food intake is 1,2-1,5% of their body mass.

A gall bladder is absent in elephants - diet consists of low fat and high fibre.

2. METABOLIC REQUIREMENTS

The maintenance energy requirements of a wide range of animals vary in relation to $M^{0.75}$, where $M$ represents body mass. This means that the maintenance energy requirements of a 5000kg elephant should be 180 times that of a 5kg dik-dik, and not 1000 times, as expected. The energy requirements are measured in Joules.
3. **GUT ANATOMY**

The gut capacity increases in direct proportion to body size. $M^{1.03}$ is the best estimation as a power coefficient of variation between gut capacity and body mass.

4. **FOOD INTAKE AND DIGESTION**

Non-ruminants can tolerate a diet of higher fibre content and lower nutritional quality than a ruminant of equal body size. Non-ruminants like elephants have a lower digestive efficiency than ruminants and therefore a more rapid passage. The result is that an elephant will take in more food per time unit than a ruminant. Mean retention time in the elephant can be as low as 33 hours.

Large herbivores eat less food per day as a proportion of their body mass, than small herbivores. Small antelope take in 3,5-4% and medium-sized antelope take in 1,5-3,0% of their body mass. The mean dry matter food intake/day as a percentage of body weight is 1,0-1,2% for elephant males and non-lactating females and 1,2-1,5% for lactating females.

5. **FEEDING IN CAPTIVITY**

5.1 The following guidelines for elephant nutrition should be followed in balancing a diet:

- Metabolisable energy (ME) = 7-10% (max)
- Total crude protein (TCP) = 10MJ/kg
- Fibre = 36% (max)
- Fat = 3% (max)
- Calcium : phosphate ratio (Ca.) = 2:1

Adequate vitamins from fresh fruit and vegetables, and minerals from Boskos (WES - Thabazimbi). Rock salt ad lib.

5.2 **ANALYSIS OF FEED PRODUCTS**

*Lucerne*: 15% total crude protein (TCP); 7.5MJ/kg metabolis-
able energy (ME);  1,0% Calcium (Ca);  0,2% Phosphate (P)

Eragrostis: 8% TCP;  7,5MJ/kg ME;  0,33% Ca;  0,13% P

Veld grass: 4,0% TCP;  5,7MJ/kg ME;  0,25% Ca;  0,04% P

Blue buffalo grass: 6,5% TCP;  7,5MJ/kg ME;  0,32% Ca;  0,13% P

Maize hay: 10,0% TCP;  8,7MJ/kg ME;  0,25% Ca;  0,19% P

Oats hay: 3,0% TCP;  6,6MJ/kg ME;  1,3% Ca;  0,18% P

Oats: 9,5% TCP;  10,1MJ/kg ME;  0,15% Ca;  0,5% P

Bran: 14,0% TCP;  9,3MJ/kg ME;  0,13% Ca;  0,9% P

Maize: 8,5% TCP;  12,4MJ/kg ME;  0,02% Ca;  0,2% P

Analysis of Boskos (chopped trees in cube form): 10% TCP; 8,9MJ/kg ME;  35,6% fibre;  1,1% Ca;  0,25% P;  0,48% Na; 0,67% K;  0,32% Mg; Trace elements: Fe 776mg/kg; Cu 6,92mg/kg; Mn 30,7mg/kg; Se 2,53mg/kg; Zn 21,3mg/kg

5.3 RECOMMENDED FEEDING

Lucerne-tef mixture (50 : 50) ad lib.
Boskos (0,5-1,0% of body mass - max 10kg/day).
Rock Salt 150g/day/elephant.
Fruit/Vegetables 25-30kg/day/elephant.

5.4 WATER REQUIREMENTS

Adull elephants need 150-200 litres of fresh water per day. The water must preferably be available throughout the day. Clean water must be supplied in a cement trough, with the overflow in a mud pool to be used for wallowing.
5.5 **NUTRITIONAL DISEASES IN CAPTIVITY**

5.5.1 **Rickets**

Calcium and phosphorus are necessary for ossification of the skeleton. The ratio of the two minerals is very important for the normal function of the musculo-skeletal system. A ratio Ca : P of 2-1.5 : 1 is accepted as the norm. The clinical signs of a deficiency are lameness and swollen tibiotarsal joints of one or both rear legs.

The hindquarters support up to 60% of the body mass and inward buckling of the tibiotarsal joint will occur. Treatment in young animals is to correct the ration by lowering the total crude protein of the ration to approximately 9% and 1g Ca and 0.5g P per kg feed intake. Limit the movement of the animal and keep the animal on adequate bedding material. An orthopaedic brace can be used for support of an infected joint.

5.5.2 **Hypocalcaemic tetany**

Elephants that are kept indoors will develop a deficiency of Vitamin D, which is important for the uptake of calcium. A lack of calcium will cause tetany. The clinical signs are stiffness, nervous symptoms like eye twitching, unco-ordinated movement of the trunk and pharyngeal paralysis.

Treatment with calcium borogluconate (Rhone-Poulenc) can be done in ‘downer’ animals. The drip should be administered through a leg vein due to calcium being a tissue irritant substance that may lead to sloughing of the ear. ‘Downer’animals must be helped onto their feet as soon as possible. Wild elephants can suffer from a similar condition (shipping fever) and care must be taken as they are strong after the drip administration and will tend to attack people the moment they are helped onto their feet.

Elephants that are helped onto their feet can be treated with 10mg Diazepam (Valium, Roche) intravenously. This will stimulate the intake of water, to which electrolytes could be added.
5.5.3 **Anaemia**

Long-term chronic deficiency of iron can lead to anaemia. The clinical symptoms can be weakness and pale mucous membranes. The condition can be diagnosed by a haematologic profile (Ht <20). The treatment is ferrous sulphate in the diet or exposure to soil.

5.5.4 **Zinc (Zn)**

A deficiency of zinc in the diet is usually caused by too much calcium. This will lead to skin abnormalities. Treatment can be done with the correct diet and natural bark from browse or Boskos.

5.5.5 **Toxicities**

Avocados should not be fed to elephant, as they contain a cardiotoxin. Mouldy food should also not be fed to elephants. Fungi like *Diplodia* in maize and *Aspergillus* in groundnuts will result in nervous and liver problems respectively. The first signs may be colic in elephant.

6. **PRACTICAL FEEDING TIPS**

6.1 Feed the concentrates in 2-3 portions during the day to prevent acidosis.
6.2 Cut up fruit like oranges, because whole fruit may cause obstruction of the oesophagus.
6.3 Do not overfeed with lucerne, because it can have a laxative effect.
6.4 Animals in contact with soil should not have a shortage of rock salt. ‘Salt hunger’ will lead to excessive soil intake, causing obstruction colic.
6.5 During cold spells enough concentrates should be fed in the evening to prevent hypoglycaemia.
6.6 Deworming remedies (Ivomec) can be included in cubes.
6.7 Each elephant must be able to take concentrates from its own container.
6.8 One hay rack per three elephants to minimize competition and prevent waste of roughage.
6.9 Stick to a feeding routine.
3.1 VIRAL DISEASES

3.1.1 Herpes virus (Cutaneous papillomatosis)

The virus causes superficial skin lesions (1-3cm in diameter) with a pinkish colour. The lesions occur predominantly on the trunk, head and around the genital opening. The lesions are benign and disappear spontaneously. Secondary infection may occur in these lesions and can cause abscessation. There is no vaccine available.

3.1.2 Encephalo-myocarditis virus (EMC)

This is a viral disease that usually occurs in adult elephant bulls (more than 80% of cases reported). Animals die from cardiac failure. Virus isolation can be done from the heart muscle in fresh carcasses. There is evidence that rodents carry the virus and can urinate on food. Rodent control in the food storage facilities is therefore of the utmost importance for the prevention of an outbreak of the disease in elephants in captivity. An excellent vaccine can be manufactured on request by Onderstepoort Biological Products.

3.2 BACTERIAL DISEASES

3.2.1 Salmonellosis

Salmonella are small, non-sporeforming, gram-negative rods. The causative organism in elephants in captivity is described in the literature as Salmonella typhimurium. Three syndromes occur in animals: septicaemia, acute enteritis and chronic enteritis. The clinical symptoms are watery faeces, which can be contaminated with blood, mucus or fibrinous material. Animals show
signs of abdominal pain (hunched posture) and may eat soil. During the acute phase animals are anorexic.

The diagnosis can be made by culture of the organism from faecal material. Faecal samples must be taken for four successive days to ensure the diagnosis, because the organism can be excreted intermittently. Blood analyses will show neutropaenia and an elevated fibrinogen content.

Treatment can be started with ampicillin and an anti-inflammatory drug, e.g. Finadyne (Schering-Plough), until an anti-biogram has been done.

**Prevention**

- Stick to a routine to minimize stress in the animals.
- Rodent control - rats can carry the organism and contaminate the food.
- Deworm animals because internal parasites can cause an outbreak of the disease.
- Maintenance of a good level of hygiene - good quality drinking water.

### 3.2.2 Anthrax

The disease is caused by rod-shaped gram-positive bacteria *Bacillus anthracis*, surrounded by a well-developed capsule. The capsule is important for diagnosis of the organism in blood smears.

The disease can occur in captive and wild populations, the skin form being more common in India and the intestinal form in zoos and parks. The bacteria sporulate to form spores when they come in contact with the environment. Spores are very hardy and can survive for years in old bones and in the soil. Opening carcasses of animals dying from anthrax is therefore forbidden. Flies feed-
ing on anthrax carcasses will vomit spores onto vegetation.

Elephants can be infected by the intake of contaminated food or water sources. They can also spread the disease mechanically between water holes when taking a mud bath.

Clinical signs are sudden death (acute/peracute) or high fever, tremors, lethargy, colic, swellings, foam and blood from body openings.

Sick animals can be treated with penicillin.

3.2.3 **Abscessation**

The elephant has a thick skin and penetration wounds (thorns, darts, mahouts, etc.) can cause abscesses by bacteria, e.g. *Staphylococcus* and *Corynebacterium*. When an abscess cannot break through the skin, it will spread laterally and must be drained surgically. Culturing the organism and making an antibiogram are important for treating an abscess successfully. When an abscess is drained, the pus must be collected on cotton-wool and burnt to prevent the accumulation of bacteria in the facilities.

3.3 **VERMINOSIS**

Bile duct hookworm (*Grammocephalus calthratus*) occurred in newly captured elephants and caused mortality and morbidity. Injectable levamisole can be given routinely during capture to solve the problem.

Spirurid worms (*Parabronema rhodesiense*) cause damage to the mucosa of the stomach and with associated stress will cause ulcers. The parasite can be treated with antihelmintics of the Ivermectin group.

3.4 **COLIC**

Two types were described in elephants:
3.4.1 **Spasmodic colic**

The cause is mouldy lucerne; treat with Buscopan (Janssen).

3.4.2 **Obstruction colic**

The excessive intake of clay and high-fibre food will form hard faecal balls that pass with difficulty through the gastro-intestinal tract. Treat with muscle relaxant, Valium (Roche) and Finadyne (Schering-Plough).

**Symptoms of colic**

- Restlessness, rolling, stretching posture, bloating, lack of defecation, biting of trunk tip, tenesmus and groaning.

**Prevention**

- Feed good quality hay.
- Supplement minerals to prevent eating of soil.

4.5 **CHOKING**

Choking occurs when elephants compete for fruit or vegetables whole. Oranges can be too big to swallow and will cause obstruction of the oesophagus.

The symptoms are inability to drink water, resulting in dehydration. Muscle relaxants can be given as a conservative treatment, but usually the foreign body must be removed surgically. The wound must be treated as an open wound to prevent stricture of the oesophagus. Prevention of the problem is to cut up fruit and vegetables.

3.6 **TOXIC CAUSES**

3.6.1 **Floppy trunk**

Paralysis of the trunk was observed in elephants in the Satara area.
of the Kruger National Park and Fothergill Island in Lake Kariba. The primary lesions occur in the nervous system and the muscle atrophy appears to be secondary. Research is being done at the moment to see if plant toxins or heavy metals are causing the problem.

3.6.2 Poisoning

Elephants of the Hwange National Park in Zimbabwe died when they drank from dipping tanks containing organo-phosphates on cattle ranches. This can be a factor where cattle ranches are close to wildlife sanctuaries with bad water distribution.

3.7 TRAUMA

Small wounds of the trunk and legs are common, especially in young animals. Fighting and bullying will inflict wounds that can lead to abscessation. Infarction and sloughing of the ear occur when irritant drugs like Fenylbutazone (Phenix) are administered intravenously. Young elephants can panic easily and may run into veld fires in the absence of a matriarch. Severe burn wounds may be incurred under such conditions. Breaking of tusks occurs when newly-caught elephants charge people during the boma-training period.

3.8 TUSK CONDITIONS

3.8.1 Tusk sulcus infection

Traumatic impact of the tusks when elephants push against solid objects cause a purulent infection of the tusk sulcus. Healing usually takes place when the animals settle down in the bomas.

3.8.2 Blind tusks

Failure of the incisor to erupt through the skin may cause subcutaneous swelling. The elephant will push with its head against objects and will show signs of discomfort. A surgical incision can be made through the skin. Surgical gauze dipped in wound oint-
ment can be placed as a plug to prevent myiasis of the wound.

3.8.3 **Tusk pulpitis**

Fractured tusks with the exposure of the root canal to bacteria will lead to a fistulous tract with a purulent exudate. The fistula should be flushed twice daily with a 1 : 10 dilution of povidone-iodine. An antibiogram is important for the successful treatment of the wound. A ‘dental filling’ is important to keep the wound clean.

3.9 **HOOF PROBLEMS**

3.9.1 Inadequate management with poor hygiene causes a condition known as hoof canker. It is characterized by a purulent chronic infection of the skin area between the nail and toe. This condition can be treated surgically but it takes time for the tissue to heal properly.

The nails can overgrow in captive conditions and regular trimming of the nails and the area between the nails with a hoof knife is important. If neglected, cracking of the nail can cause lameness or infection.

Puncture wounds caused by sharp objects can lead to lameness and infection. Debriding and flushing of the wound with povidone-iodine is necessary with local and systemic antibiotic treatment. Vaccination against tetanus is recommended for elephants in captivity.

3.9.2 **Ulcerative pododermatitis**

Several cases of lameness in adult elephant bulls in mopane veld in the Kruger National Park were described recently. Large ulcers in at least one front foot occurred in these animals. Mopane stumps that penetrate the sole, caused secondary bacterial infection. Front legs usually support up to 60% of an animal’s weight.
3.10 **SUBCUTANEOUS DEPENDENT OEDEMA**

Oedema occurs with anaemia, liver fluke infection or conditions that lead to hypoproteinaemia. Specific ventral oedema usually manifests overnight. A theory that the cause is due to stress can, however, be questioned. A problem is that gravitation of the fluids to the umbilical area can lead to pressure necrosis and sloughing. Cases were treated successfully with hot and cold pressure bandages.

**APPENDIX 7**

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<thead>
<tr>
<th><strong>HAEMATOLOGY</strong></th>
<th><strong>RANGE</strong></th>
<th><strong>AVERAGE</strong></th>
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</thead>
<tbody>
<tr>
<td>Hb (g/l)</td>
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<td>118</td>
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<tr>
<td>RCC (x10¹²/l)</td>
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<td>MCV</td>
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<td>WCC</td>
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<tr>
<th><strong>PROTEIN</strong></th>
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<tr>
<td>TSP (g/l)</td>
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<td>Albumin (g/l)</td>
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<td>Globulin (g/l)</td>
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<td>A/G</td>
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<thead>
<tr>
<th><strong>ENZYMES &amp; MINERALS</strong></th>
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<tbody>
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<td>Serum osmolality (mOsm/l)</td>
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</tr>
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<td>ALT u/l</td>
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<tr>
<td>ALP u/l</td>
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</tr>
<tr>
<td>AST u/l</td>
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<tr>
<td>Na nmol/l</td>
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</tr>
<tr>
<td>K nmol/l</td>
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<td>5,3</td>
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<td>Tot Ca nmol/l</td>
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<tr>
<td>Urea nmol/l</td>
<td>1,7 - 4,4</td>
<td>–</td>
</tr>
<tr>
<td>Creatinine</td>
<td>53 - 133</td>
<td>–</td>
</tr>
</tbody>
</table>
## APPENDIX 8

### SHOULDER HEIGHT VERSUS BODY MASS OF ELEPHANT CALVES

<table>
<thead>
<tr>
<th>SHOULDER HEIGHT (m)</th>
<th>BODY MASS (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.05-1.10</td>
<td>245</td>
</tr>
<tr>
<td>1.11-1.15</td>
<td>275</td>
</tr>
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<td>1.16-1.20</td>
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<tr>
<td>1.21-1.25</td>
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<tr>
<td>1.26-1.30</td>
<td>400</td>
</tr>
<tr>
<td>1.31-1.35</td>
<td>440</td>
</tr>
<tr>
<td>1.36-1.40</td>
<td>490</td>
</tr>
<tr>
<td>1.41-1.45</td>
<td>550</td>
</tr>
<tr>
<td>1.46-1.50</td>
<td>610</td>
</tr>
<tr>
<td>1.56-1.60</td>
<td>745</td>
</tr>
<tr>
<td>1.61-1.65</td>
<td>810</td>
</tr>
<tr>
<td>1.66-1.70</td>
<td>880</td>
</tr>
<tr>
<td>1.71-1.75</td>
<td>950</td>
</tr>
<tr>
<td>1.76-1.80</td>
<td>990</td>
</tr>
<tr>
<td>1.81-1.85</td>
<td>1050</td>
</tr>
<tr>
<td>1.86-1.90</td>
<td>1140</td>
</tr>
<tr>
<td>1.91-2.00</td>
<td>&gt;1200</td>
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</tbody>
</table>

*J. Raath: Unpublished data.*
### APPENDIX 10

**CRITERIA FOR ESTIMATING AGE AND MASS**

<table>
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<tr>
<th>AGE (y)</th>
<th>HEIGHT (m)</th>
<th>MASS (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.85</td>
<td>120</td>
</tr>
<tr>
<td>1</td>
<td>1.15</td>
<td>300</td>
</tr>
<tr>
<td>3</td>
<td>1.30</td>
<td>400</td>
</tr>
<tr>
<td>6</td>
<td>1.50</td>
<td>600</td>
</tr>
<tr>
<td>10</td>
<td>1.90</td>
<td>1200</td>
</tr>
<tr>
<td>15</td>
<td>2.20</td>
<td>1600</td>
</tr>
<tr>
<td>40</td>
<td>2.60</td>
<td>2400</td>
</tr>
</tbody>
</table>
Above: Due to the unusual composition of elephant milk, the hand rearing of calves is a difficult task and expert advice must be sought. Below: Trained elephants are the result of hand-reared calves.

Photograph by André van der Westhuizen
<table>
<thead>
<tr>
<th>SPECIES</th>
<th>TOTAL SOLIDS (g)</th>
<th>FAT (%)</th>
<th>PROTEIN (%)</th>
<th>LACTOSE (%)</th>
<th>AS H ENERGY (k cal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant</td>
<td>20.1</td>
<td>9.3</td>
<td>5.1</td>
<td>3.7</td>
<td>121</td>
</tr>
<tr>
<td>Human</td>
<td>12.4</td>
<td>3.8</td>
<td>1.2</td>
<td>7.0</td>
<td>68</td>
</tr>
<tr>
<td>Cattle</td>
<td>12.7</td>
<td>3.7</td>
<td>3.8</td>
<td>4.8</td>
<td>67</td>
</tr>
<tr>
<td>Horse</td>
<td>10.1</td>
<td>1.6</td>
<td>2.2</td>
<td>6.0</td>
<td>48</td>
</tr>
<tr>
<td>Pig</td>
<td>21.0</td>
<td>8.5</td>
<td>5.8</td>
<td>4.8</td>
<td>94</td>
</tr>
<tr>
<td>Rhino</td>
<td>8.8</td>
<td>0.5</td>
<td>1.5</td>
<td>6.1</td>
<td>35</td>
</tr>
<tr>
<td>Giraffe</td>
<td>23.8</td>
<td>12.5</td>
<td>5.8</td>
<td>3.4</td>
<td>154</td>
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<tr>
<td>Rabbit</td>
<td>31.1</td>
<td>16.7</td>
<td>10.4</td>
<td>2.0</td>
<td>206</td>
</tr>
</tbody>
</table>
DATA ON ADULT ELEPHANT BULLS

- Body mass (kg): 5000
- Shoulder height (m): 3.2
- Age at sexual maturity (yr): ± 10
- Longevity (yr): ± 50
- Food consumption per day (kg): 150
- Water consumption per day (l): 200
- Skin weight as percentage of body mass (%): 8
- Average group size of bull herds: 3
- Percentage of total elephant population (%): 15

Calculation of tusk weight (in live animal), in pounds.
= Tusk Length (feet) x Tusk Circumference (inches)
Above: Robust and expensive equipment is necessary to capture adult elephant bulls.
Below: Adult bulls in musth can cause serious injuries. This wound was caused by a tusk.
Above & below: Trees, such as these baobabs, can get to a thousand years of age. They are especially vulnerable to destruction by elephants. Thus, the management of elephant populations cannot be avoided.
Man-made structures can be protected from damage by placing sharp rocks around the base of objects, like this telephone pole in Etosha National Park.
Helicopters are used to dart elephants close to access roads.
The distance between the umbilical node (A) and the genital opening (B) is wider in cows than in bulls. Ref. cow (above) and bull (below).
Above: Darter area from rear (Gluteus muscle group).
Below: Darter area from side (Triceps muscles).
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REFERENCES

1. Allen, J L; Jacobson, E R; Harvey, J W & Boyce, W 1985
   Haematologic and serum chemical values for young African elephants
   (Loxodonta africana) with variations for sex and age. *Journal of Zoo
   Animal Medicine* 16: 98-101
   management*. Pretoria: J L van Schaik.
   care, accommodation and transportation of wild African animals*.
7. Van Heerden, J & Penzhorn, B L (eds) – 1991 – *Proceedings of a sym-
   posium on the African elephant as a game ranch animal*. Wildlife Group
   of the S A Veterinary Association, Onderstepoort.

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