TRANSLOCATING BLACK RHINO
CURRENT TECHNIQUES FOR CAPTURE, TRANSPORT, BOMA CARE, RELEASE AND POST-RELEASE MONITORING

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This book is dedicated to Blythe Loutit, whose courage and tenacity ensured the survival of Namibia’s desert black rhino.

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INTRODUCTION AND GENERAL INFORMATION

This document gives recommendations on the practical aspects of translocating black rhino. Before this stage is reached, some broader issues must be considered. We strongly recommend that the *IUCN Guidelines for Re-introduction* and *IUCN Guidelines for the* in situ *Translocation of the African Elephant for Conservation Purposes* are consulted in the planning stage.

Black rhino, *Diceros bicornis*, belong to the Rhinocerotidae, one of the three surviving families of the order Perissodactyla (odd-toed ungulates). The other two surviving families are the Equidae (horses, zebras and asses) and the Tapiridae (tapirs). The relationship between rhino and horses is worth remembering as they have many similarities, especially in anatomy, physiology, parasites, disease, nutrition and response to drugs. Although veterinary knowledge of rhino is very limited, there is a huge amount of veterinary information on horses, which is useful to consult when working with rhino.

Black rhino were once common throughout much of sub-Saharan Africa (excluding the equatorial forest), but illegal hunting has decimated the species and less than 3500 remain. Currently, there are four sub-species of black rhino (*Diceros bicornis minor* – south-central, *D. b. bicornis* – south-western, *D. b. michaeli* - eastern, and *D. b. longipes* - western) in sub-Saharan Africa. Although the differences between sub-species are not large, they are worth keeping in mind.

Black rhino are browsers with a preference for hard, thorny species like acacias, leguminous forbs and Euphorbiaceae. They usually occur singly, in cow/calf combinations, male/female pairs, or two sub-adults together. Adult black rhino weigh up to 1 600 kg, stand 1.6 m at the shoulder and have a thick skin (up to 20 mm). Like the equids, fermentation takes place in the caecum and colon and they sweat after heavy exertion. The rhino gut is less efficient than that of ruminants, and can not utilise the protein formed by the bacteria, protozoa, and yeasts in the hindgut. As a result they have to eat more, have a relatively fast passage of gut contents, and have limited time to re-absorb water from the faeces. This makes them water dependent, and they are rarely found more than 15 km from a water source. They normally drink every day or every second day.

A black rhino in the wild lives for about 40 years. Males reach maturity at about eight and females at six years of age. They breed throughout the year. The gestation period is 15 months and the inter-calving is usually 2 ½ to 3 years. Calves will suckle until they are about 19 months old.

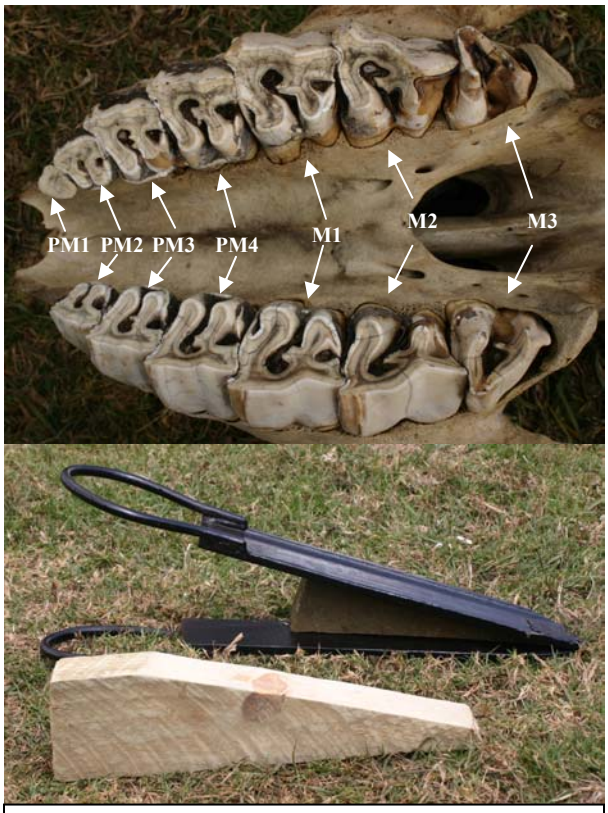
Senses

Black rhino are not almost blind as is often stated. They pick up movement at a long distance but can't recognise the object until it is much closer. This is because of the lateral position of their eyes on their massive heads, which prohibits binocular vision. As expected in an animal that mostly moves at night, they have good nocturnal vision. Rhino have a well-developed sense of smell and respond immediately to foreign scents, even when apparently sleeping. Wind direction, however, limits the value of a rhino's sense of smell. Rhino also have a remarkable sense of hearing. Not only can they pick up sounds from a long distance but because of their large, widely spaced, mobile ears, they also are very aware of the distance and direction of a sound. This makes it difficult to approach even a sleeping rhino. For an animal with such sensitive ears, transport in a rattling metal crate must be highly stressful until they get used to it.

Character

Black rhino have a reputation for being extremely aggressive, which is not totally fair. Living a solitary life in a bush environment where a threat is usually encountered at short distance, they struggle to recognise what the threat is because of their limited vision. Their initial response is to investigate the threat and approach the disturbance cautiously with head up, ears pricked, and scenting the air. Once they know what it is, especially if human, their natural inclination is to turn and run away, often with an accompanying

"huff and puff." A charge is the exception rather than the rule, and is normally only seen if you are very close, with injured animals, or when approaching certain aggressive individuals. If a black rhino has adequate warning of what is coming its way, especially if it can see you, it is much more relaxed.



(top) Maxillary teeth in adult female skull. (bottom) Gag and block of wood used to open rhino's mouth.

Black rhino are more intelligent than most people give them credit for, and they can be curious and can even be quite playful. For animals that are naturally shy and gravitate away from people, it is remarkable how they thrive on human company once they have settled in a boma. They also have good memories and a good sense of location, and a rhino which has been through a boma once, even years before, will settle down a lot faster the second time around. Black rhino have large individual variations in character, temperament and habits, and when keeping black rhino in captivity it is essential to recognize this and to respond accordingly.

Black rhino are naturally nervous and excitable; therefore if an animal is reported to be "tame," lethargic or unresponsive, it is probably sick and should be seen to immediately.

Ageing rhino

Accurate ageing of black rhino at capture is essential to make the right management decision. Ageing is done on body size, horn development, and tooth wear. There are good publications on ageing techniques, and with practice on skulls of various ages, it can be done accurately. It may be helpful to have the publication by Hitchins (See Appendix A) on hand when aging rhino in the field. The first step is to look at the rhino and decide if it is a young animal or not. Body size, horn development, and scarring give a rough answer. Then, using a gag and a piece of wood (see photo), open the mouth and see if the animal has deciduous or permanent teeth. As black rhino only have premolars and molars, you have to look back into the mouth to see what is going on. Deciduous teeth are much smaller and fewer than permanent teeth. Next, gauge the degree of wear by looking at the height of the teeth – this will give a good idea of approximate age. Then look at the grinding surface, especially of the maxillary teeth, which will give the most accurate indication of age. A good look/feel in the mouth should be enough to make a reasonably accurate assessment. A small torch can be useful here. Feel the back of the tooth row to see if M3 has erupted and what the degree of wear is. Tooth impressions are easily made using dental alginate and plaster of Paris and are good to visualise tooth wear and keep as a record (Wucher, 1994). Note that PM1 may disappear in adult skulls.

Evaluating condition

Judging the condition of a rhino is essential for making the right decision at capture as well as evaluating the performance of rhino in bomas and after release. This is not easily done and practice is essential to become competent. A useful condition scoring guide has been drawn up by Reuter et al. (See Appendix B) Keep in mind the differences in body form between the sexes and ages when evaluating condition. Try to see the rhino from various angles. Shadow, lighting, and wet or dry skin also affect evaluation. Various areas should be looked at including the gluteal muscle mass of the hindquarters, the shoulders, the neck and

most importantly the muscle mass adjacent to the spine, especially in the middle of the back. The ribs and the belly are not good indicators of condition. Serial photographs are useful to compare and to decide if condition is improving or declining. Remember that black rhino can appear to be in fair condition and yet still die from an acute energy crisis resulting from a high level of stress and poor nutrition (often exacerbated by cold weather).

A. CAPTURE

Until the early 1960's black rhino were still caught with ropes from a chase vehicle. Although dangerous to the operator and stressful to the animal, some operators in East Africa became remarkably proficient at this form of capture. Chemical capture was first attempted with the dissociative anaesthetic, phencyclidine and the curariform muscle relaxant, gallamine triethiodide. In 1960, during Operation Noah, many black rhino were saved from the rising waters of the newly built Lake Kariba, between Zambia and Zimbabwe, with these new techniques. Phencyclidine and gallamine were succeeded by opioids which were considerably safer and more easily reversed. Diethylthiambutene and morphine were used initially but were soon replaced by much more powerful opioids. For the last 40 years, etorphine has been the standard. Fentanyl and carfentanil have also been used with success, as has the recently introduced thiofentanil oxalate (A3080).

Before translocating black rhino, it is essential to gain practical experience on operations with knowledgeable people. A clear picture in your mind of what could happen is invaluable when deciding the best course of action. Opinions differ on how to translocate black rhino and consultation with numerous experienced people is essential. You must also be prepared to improvise. A single person with experience must be in charge of the capture operations and needs to have the authority to control the operation and to know when to call a halt to the capture or when to release an animal. The fewer spectators on a capture, the better. Sometimes a capture goes wrong – e.g. the rhino runs too far, overheats, doesn't stand well in the crate. In these situations it is often best to release the animal rather than risking further complications or even death. Even with limited funds and sub-optimal equipment, good translocation is still possible and much can be achieved with very little. Most of the problems seen in translocating black rhino are from a lack of effort rather than a shortage of equipment or finances.

A.1 Planning a translocation exercise

Good planning is essential and the following factors must be kept in mind.

A.1.1 Recipient area

The recipient area must have enough good black rhino habitat to sustain the envisaged population, taking into consideration that other browsers will be competing for the same resources. Water must be available year-round and it must be well distributed. If the area is fenced, fencing should be adequate and personnel should be trained to maintain it. The monitoring teams must have the vehicles, equipment and communication system necessary for monitoring the rhino and for dealing with possible emergencies. They should be well trained in rhino monitoring and antipoaching techniques. Appropriate measures should be taken when introducing rhino to an area where there are diseases present that they have never been exposed to (e.g. anthrax, trypanosomiasis – see E.1.9 Veterinary Problems).

Great care must be taken when introducing black rhino into an area where there is already an established black rhino population. Established bulls will usually fight with introduced rhino, especially bulls and sub-adults. If new rhino are being introduced into an existing population it is a good option, especially in smaller areas, to catch the dominant bull and keep him in a boma until the new animals have been released and have settled. Adult females have the best chance of being successfully introduced into an existing population.

A.1.2 Donor population

Young healthy animals with a good breeding life ahead of them are the best animals to move. Ideally the animals should be between about four and fifteen years old. Calves and young sub-adults lack confidence and physical strength and are easily pushed around and even killed by older animals. Old rhino generally don't settle as well in a boma or after release, and only have a limited breeding life ahead of them.

It is important to choose appropriate females. Young females between four and six years old, before they have bred or when in early pregnancy, are ideal to move but there are few of these available in a population and one is therefore often forced to move older breeding females. This is problematic. After a rhino cow starts breeding, she is usually pregnant and/or has a calf at foot. Moving cows with very young calves (under 9 months old) is extremely risky and almost always results in the death of the calf. Moving cows with calves under 18 months old is also traumatic and is best avoided. It can be difficult to re-unite the cow and calf and even if successfully done, the capture and boma stress can result in the cow drying up or even attacking the calf. If a black rhino cow calves in a boma she rarely manages to raise the calf. In the wild, a black rhino cow retreats to a quiet spot to calve and will stay there for the first month or two afterwards. In a boma she is too exposed and stressed from the presence of people and other rhino.

One should avoid moving heavily pregnant cows due to the risks involved.

Cows close to calving should also not be moved because of the anaesthetic risk and because of the chance of the cow aborting or giving birth in the boma. Without ultrasound equipment it is difficult to accurately gauge the stage of pregnancy – there is only the appearance of the cow's belly, udder, and vulva to go on. The size of the previous calf can also help give an indication of stage of pregnancy. The best option is a cow in early or mid-pregnancy with a calf of 18 months or older. However, there are not many of these combinations.

Older, more experienced bulls, not younger than 10 years old, should be used when starting a population with females old enough to breed. Younger "back up" bulls should also be included. A breeding bull must be a robust specimen. It is worth checking his penis, sheath and testicles at capture especially as this part of the body is often injured when fighting. (**Note**: The bull's testicles are very close to the body in the inguinal area and are not easily seen.)

A.1.3 Time of the year to translocate

Rhino are usually translocated in the dry/winter season because of:

- Dry field conditions – better for the movement of vehicles and the recovery of rhino (less problems of getting stuck in mud, crossing rivers etc). The working conditions for the capture personnel are also better.
- Cooler ambient temperatures - capture process is safer as there is less chance of hyperthermia and its associated problems.

However, there are disadvantages of moving rhino in the dry/winter season, especially late in the season:

- Body condition of rhino is often less than optimal
- Field conditions are often poor and declining and this can be critical for an animal released into a new area where it has to settle down, find the boundaries, water sources and best feeding areas, adapt to unknown plant species and fit in socially with established rhino.
- Rhino are very sensitive to cold, especially if their body condition is down.
- Lack of surface water can result in animals having to walk far to find water and they may suffer dehydration or even totally fail to find the water and die of thirst.
- A shortage of good browse makes it difficult to feed rhino in bomas adequately and as a result rhino are often released into the field in poor condition. There is also greater social competition between rhino in the field at this time of the year because of the limited food resources.

Because of the above problems rhino should be moved as soon as the rains have stopped and field conditions are good enough for the capture team to operate. In drier areas, it is even possible to translocate black rhino in the wet season.

Many of the problems of working in the wet season can be overcome with good planning and good equipment. The capture operation must be started early in the morning before ambient temperatures get too high. An upper "cut off" temperature should be decided upon. It may be possible to catch in the late afternoon and sometimes, if there is cloud cover, it is possible to catch all day. Quick induction and attention to cooling the rhino is important. Care must also be taken to prevent animals falling into water during induction. If things go wrong and an animal is excessively stressed, hyperthermic, or is impossible to recover or transport, you must be prepared to release it. If bomas are used in the wet season, they must have a good roof and good drainage to keep the rain out and prevent the bomas becoming a muddy mess. Fly control will be necessary. Releasing rhino in the wet season is no guarantee that they will find water to drink. Great care must still be taken to ensure that they have found water and good post release monitoring is essential. It may even be necessary to put out additional water, especially on fence lines. In the hot season animals have a greater need for water and a critical situation can develop rapidly.

A.1.4 Translocation through bomas

Most black rhino are translocated through bomas and this is generally the best way. There are three options of moving rhino through bomas.

A.1.4.1 Boma to boma

After capture, the animals are put into bomas at the capture site where they are should be held for a minimum of one month before they are transported to bomas at the release site. They are held in the release site boma for at least two weeks before release into the field. This is the best option, as the rhino knows the browse and conditions in the capture area and if there are any problems initially, it can be released back into an environment that it knows. Additionally, transport to the release site is less stressful and release in the new area is a more relaxed affair.

A.1.4.2 Field to boma

After capture the rhino are transported immediately to bomas at the release site where they are held for at least a month before release into the field. The disadvantages of this are that:

- during the initial period in confinement, they will be in a more foreign environment
- possibly eating unfamiliar browse
- the transport will probably be more stressful
- if there are problems and the animal has to be released, it will be in a totally foreign environment

The advantage is that if all goes well, the release should still be a relaxed affair and there will be a good chance of the rhino settling well.

A.1.4.3 Boma to field

The rhino is put into bomas in the capture area. The animal is held for about a month before being transported to the release site and released into the field immediately. This is the worst of the three boma options because although there are the same initial advantages as the boma to boma option, free-release into a new area is probably not going to be very relaxed and the rhino may be somewhat stressed and dehydrated after the transport. There is a greater chance of the animal not doing well after release.

A.1.4.4 Field to field

Sometimes it is a good option to move black rhino directly from the field to the field.

- When field conditions at the release site are excellent - in summer (or shortly thereafter) and there is an abundance of surface water
- Where the habitat at capture and release sites are similar
- If you have the services of an **excellent capture unit that can catch, transport, and release the rhino with very little stress and excitement**
- Where capture and release sites are not more than a few hundred kilometers apart (or about 12 hours travel) and the rhino will not be exhausted and dehydrated on arrival
- The recipient area does not have an established rhino population.
- If the available bomas and boma care are poor, it is better to take the risks of moving rhino directly from the field to the field rather than having them go through a bad boma situation where they will be stressed, lose condition, and be released into the field in a sub-optimal state

It is essential that the release should be quiet and stress-free and the rhino must be tranquillised with short- and long-acting tranquillisers (diazepam and/or azaperone plus acuphase) to keep it calm for the first few days (See F.3.2.2).

It is best if cows and calves are not moved from the field to the field. It can be done but it is trickier and there is a chance that they will split up after release. If it is done it is important that the calf is quite big so that, should they split, the calf has a fair chance of surviving by itself (or until it can be re-caught). The difficult part is to bring the pair together on release. This can be done by bringing them together in a boma or by immobilising them again at the release site and waking them up simultaneously next to each other.

Rhino released after a field to field translocation don't move much more than those released from a boma provided it is done properly and the field conditions are excellent. A disadvantage of field to field translocation is that, should a rhino have to be re-caught and put in the boma, it will not be used to the boma situation and will take time to settle down, which can be critical for rhino in poor condition. Also, a rhino that has learnt to take lucerne or other supplementary feed in the boma can often be fed supplementary feed in the field if necessary but this very rarely works with an animal that has not been through a boma.

A.2 Chemical immobilisation

(all drug doses given are for an adult black rhino in good condition unless otherwise specified)

Black rhino are generally good candidates for chemical immobilisation. If darted well with the right drugs at the right dose, induction is quick and predictable, there is no excessive excitement and vital functions are well maintained. Nevertheless, for a number of reasons, including their large size, aggressive nature, tendency to frequent thick bush in often rough terrain, thick skin and inclination to run into obstacles while semi-narcoticised, immobilising black rhino is not without problems and it should only be done by people with adequate experience.

Plastic Daninject dart with 60mm smooth needle for boma work (top) and Cap-Chur dart with 50 mm barbed needle for field work (bottom).

A.2.1 Equipment – darts and projectors

For capture in the field, both on the ground and from a helicopter, a robust and reliable system like Cap-Chur is preferable.

Assortment of dart needles for rhino work

Aluminium darts are the most reliable, especially as power settings and impact energy are high, where wind and or down-drafts from the helicopter can be a problem, and where one is sometimes forced to shoot through vegetation. Whatever system is used, the equipment must be thoroughly checked and the operator totally proficient in its use. A few practice shots are valuable to check out the gun and to ensure the correct power setting. Obviously the practice dart must be similar in all respects to that which will be used in the field. Conveyor belting or an old tire make a good target. A flat trajectory without excessive impact is required. Practice shots should be taken from the distances you expect to shoot from and it is important to be proficient at judging distances if darting on foot. Always have a push rod with you (to remove a dart from the barrel) and, if possible, have a spare gun as well.

The dart needle should be 5 to 6 cm long for adult rhino. Rhino skin can plug the lumen of a dart needle so to prevent this, use a needle that has a relatively thick wall and narrow lumen (as with the Cap-Chur NCL needles) or with the tip bent over (Fauncap darts) or where the point is sealed and side ports provided (D). A particularly good quality rhino needle with the Cap-Chur thread is made by Deon Joubert (see Appendix J for contact details). The needle must have a bead (A), low barb (C) or small collar about 25 mm from the base to hold the dart in the thick skin. Another type of needle with a deep thread cut (made by Deon Joubert) also works well in rhino (B).

In bomas all darting systems can be used, but the Telinject or Daninject plastic darts (with 60 mm x 2 mm smooth needles) are best, as they are quiet and atraumatic.

Other equipment required:

- Trucks, crates and sledges (see B. Transport)
- Sling
- Crow bar
- Pliers
- Wire
- Two 15 m x 2.5 cm soft braided nylon ropes
- Generator or power source if necessary
- Spades and picks
- Chain saws/pangas/axes to clear obstructing vegetation
- 40 or more litres of water (20 litre plastic containers or knapsack spray)
- At least 6 people to move/roll the immobillised rhino if necessary
- Blindfold or towel to cover rhino's eyes
- Saw, hoof clippers, and rasp
- Cotton wool or similar to block the ears
- Oxygen – with regulator and administration tube
- Pulse oximeter
- Pole syringe

Some of the equipment needed for rhino capture

- Electric prodder with extra batteries

Female (left) and male (right) black rhino.

A.2.2 Darting on foot

Darting free ranging black rhino on foot is a slow process and poses greater risks to the rhino and darter. The first opportunity to dart the animal is inevitably the best, for once a black rhino is frightened by an unsuccessful attempt, it is alert and difficult to approach. As a rhino's senses of smell and hearing are acute, great consideration must be given to wind direction and noise when stalking them. Oxpeckers are often associated with rhino and are quick to alert the animal to human presence. The noise of a spotter plane circling overhead can help cover the noise of the stalk. If there is no plane it works well to stalk the last 50 or 100 meters barefoot to minimise noise. When darting on foot, the shoulder is usually the best target. The hindquarters are also good but you have to take care not to dart too high as the angle of the rump often deflects darts. The dart should be placed squarely for deep intramuscular injection (the thick skin of a rhino often makes an angled shot ineffective). Black rhino usually run off after being hit by the dart, but sometimes they charge. In this case try to keep a tree, a bush or rock handy to dash behind.

A.2.3 Darting from a helicopter

Most black rhino are darted from a helicopter. The advantages are:

- They are easily located.
- They can be driven to better terrain before darting.
- Water, dongas and other hazards can easily be seen.
- Darting is quick and easy (and if additional darts are necessary, they are easily given).
- There is some control over the rhino during induction.
- It is easy to get to an immobilised rhino quickly.
- The ground/recovery crew can be directed to the recumbent rhino from the helicopter.

Back off a good distance if you are not ready to dart and then come in quickly **and dart at the first opportunity to avoid too much chasing before and after darting**. Also keep this in mind when guiding a rhino to better terrain prior to darting.

The helicopter should be started up before the rhino is given the antidote. There have been a number of incidents where rhino have destroyed helicopters because they were woken up before the helicopter could get off the ground.

A.2.4 Darting from a vehicle

Vehicles are occasionally still used to dart black rhino from, either when they are standing or in the chase. Choose your driver carefully and fully brief him on what you want. In a chase, the rhino will inevitably try to turn and hit the vehicle and you must be ready for this. In open country, vehicles can be useful to slowly drive a rhino to a better area prior to darting. Sometimes it is an option to have the darter take cover behind something like a tree or rock and have a vehicle drive the rhino slowly past until it can be darted.

A.2.5 Dart placement

Good dart placement is essential. When darting from the helicopter, the muscles of the rump or the upper part of the hind leg offer the best target. In the boma, any large muscle mass can be used for dart placement although the neck is preferable. When darting rhino in the bush on foot, any good muscle mass can be used, but the shoulder is the best. Ensure that the shot is perpendicular to the skin for good drug

deposition – a second person can be useful to distract and turn the rhino slightly so that the darter can get a better shot at the shoulder. When black rhino are darted from a chase vehicle, the upper part of the hind leg, rump and shoulder are good sites.

A.2.6 Ambient temperatures

Rhino capture should be done when temperatures are lower than 25°C, usually in the early morning or late afternoon. Darting free ranging rhino when ambient temperatures are high increases the risk of elevated body temperatures and associated physiological stress. Experienced operators often do this and get away with it, but remember that the safety margin is much reduced. If working in the late afternoon, don't dart a rhino unless there is enough daylight left (leave an hour or more to process the animal and deal with potential problems). If a rhino has run hard it will be dark with sweat and its temperature will be above 40°C. Such an animal should not be darted or if it has already been darted, it must be doused with water and processed quickly. **If its temperature is above 41°C, give the antidote and release the rhino immediately.**

A.2.7 Cow and calf

When darting a cow with a calf from the helicopter, it is best to have a fixed-wing aircraft circling slowly above to assist with spotting. Dart the cow first and about a minute later dart the calf. If the timing and darting are good, the pair will often go down together. Should the pair split up, the fixed-wing can stay with one animal. In open country, when darting from a helicopter without the assistance of a fixed-wing, and where visibility is good, you can take a chance and dart the calf before the cow shows any drug effects. In more thickly vegetated country where it is difficult to observe two rhino if they are not running together, it is better to wait until the cow shows good effects or is even down before darting the calf. If the calf splits from its mother, the position of the immobilised mother can be taken by GPS or marked with a smoke grenade or toilet paper and the calf followed. Losing sight of a darted rhino is not a good situation and it is important to always have experienced trackers available.

When darting a pair on foot, the calf will usually stay close to its immobilised mother. If approached carefully, the calf can be darted and will usually go down close to its mother (black rhino calves are skittish and run off more easily than white rhino calves). Again, a fixed-wing aircraft circling above can be of much help in this situation.

A.2.8 Choice and dose of immobilising drugs

- It is best to have the dart greased up and ready, and to add the drug once you have seen the rhino - tailor the dose for size, age and condition of that animal. The rhino should not be chased while the dart is being made up.
- Four milligrams of etorphine (M99) is a good standard dose for an adult black rhino bull or cow in good condition.
- Young animals must be given a scaled-down dose. For example, a half-size calf about 2.5 years old can be given 2 mg etorphine and very young calves (2-3 months) can be immobilised with as little as 0.2 mg etorphine.

Drugs used in immobilising and transporting rhino.

- Azaperone is usually the tranquilliser of choice and is given at 60-250 mg/adult (the higher dose for rhino which are transported after being woken up with diprenorphine and the lower dose for rhino being transported after being woken up with nalorphine or the diazepam/nalorphine combination). Check azaperone carefully before use as it often crystallizes.
- Sometimes xylazine alone (about 100 mg/adult) or in combination with azaperone is used.

- Detomidine at 10 mg/adult has also been used.
- The tranquilizers do not shorten the induction time, but they do improve muscle relaxation once the animal is down, and they keep the rhino calm during transport.
- The addition of the spreading agent hyaluronidase greatly improves drug absorption and can markedly shorten the induction time.
- Xylazine in mixture results in a slightly quicker induction and more salivation (not a problem) than azaperone.
- Azaperone should be used in preference to xylazine when immobilising black rhino in bomas. The dose given above will result in quick induction and is useful when working in rugged terrain or in hot conditions. A lower dose must be used for rhino which are in bomas, debilitated, old or in situations where you can not get to the immobilised animal quickly (e.g. when darting on foot).

Immobilised rhino – note lateral recumbancy, cotton wool in ears, blindfold, oxygen and site of horn transmitter implant.

Be very careful with animals in poor condition.

There appears to be a slight difference in the dose needed for the various sub-species. *Diceros bicornis bicornis* needs a slightly higher dose than the other sub-species. While 5 or even 6 mg etorphine may be necessary for an adult *D. b. bicornis* bull in good condition, 4 mg is usually more than adequate for a similar response in a comparable animal of the *D. b. minor* or *D. b. michaeli* sub-species. Not only is there variation between sub-species but there also appears to be some variation between individuals. You must be aware of this and be ready to respond if an animal reacts unfavourably.

A quick induction shortens the period the rhino is moving in a semi-narcoticised state and thereby lessens the chance that the rhino will injure itself by running into a hazard. This is especially useful when immobilising black rhino in rough terrain. A quick induction also limits the exertion and the physiological stress associated with increased body temperature, heart rate, oxygen consumption, etc. The negative side is that respiratory depression increases with the dose of opioid used. However, at the doses of etorphine recommended, respiratory depression is usually not excessive and blood oxygenation remains good in healthy animals.

A.2.9 Induction time and effects of immobilizing drugs

With the above dose and with good dart placement, induction should be between 2.5 and 6 minutes. Induction is usually quicker in young rhino and longer in large bulls and heavily pregnant cows. If there are no signs at about seven minutes, the rhino should be darted again. Induction times of less than 3 minutes may indicate an overdose and it is important to get to such an animal quickly so that the respiration and other vital functions can be monitored (and nalorphine and doxapram given, if necessary).

As a rhino becomes affected by etorphine, its pace shortens, the feet are lifted higher ("Hackney gait"), and the head is elevated. The rhino then starts to blunder through bushes and slows down (it may circle) before going down into lateral or sternal recumbency. They are often stopped by an obstacle, e.g. bush or a fork of a tree, etc. In rough terrain rhino have a tendency to run downhill once they are heavily affected and

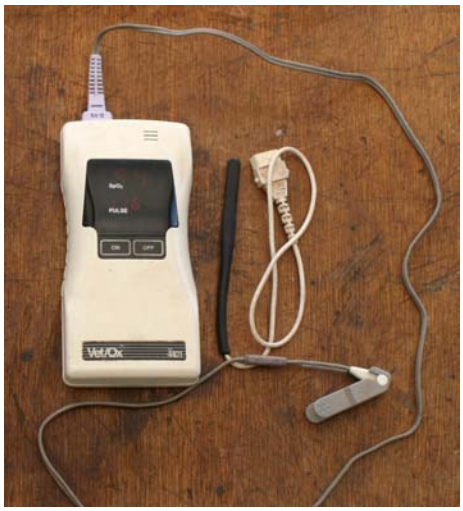
easily injure themselves by running into a gully or river. With a quick induction rhino tend to go down in sternal recumbency. Occasionally the forelegs collapse first and the hindquarters remain elevated. In this situation the full weight of the abdominal organs press on the diaphragm and respiration can be seriously compromised, especially in heavily pregnant females who have the weight of the foetus adding more pressure. The rhino must immediately be pushed onto its side. Usually a black rhino will be down when you get to it, but if it is still on its feet, the brake rope can be put on one of its back legs, the blindfold put over its eyes and cotton wool put in its ears.

A.2.10 Recumbent position

Traditionally, immobilised rhino are kept in sternal recumbency, however over the years, there have been a number of cases where both black and white rhino have developed irreversible damage to the muscles of their legs in this position (especially if the rhino goes down on a slope facing upwards with the full weight on its hind legs). It is caused by occlusion of the blood supply to the legs, usually the back legs, and it sometimes occurs even with careful "positioning" of the legs in an apparently natural position. It does not happen often but it happens frequently enough that it is probably best that all rhino that have undergone any degree of exertion should be placed in lateral recumbency for at least a few minutes. Thereafter they can be returned to sternal recumbency or left as they are. With the rhino on its side, the blood flow to the legs is improved and the muscles have a chance to get oxygen and get rid of the carbon dioxide and heat generated while running. While the animal is in lateral recumbancy, the legs should be physically "pumped" up and down by hand every 20 minutes to aid the circulation (especially the legs on the ground).

Although the gaseous exchange in the lungs may be slightly better in rhino in the sternal rather than lateral position, this small disadvantage is more than out-weighed by the advantage of improved circulation to the legs. As rhino are hind gut fermenters and not ruminants, there is little chance of regurgitation and inhalation pneumonia but the nostrils should still be positioned lower than the neck so that any saliva or leakage from the stomach can flow out.

Beware when changing the position of the anaesthetised rhino between sternal and lateral recumbancy or from one side to another, as the breathing pattern will change and you may get a period where the rhino does not breathe. Wait about 15 seconds and if there is no breath, kick the chest wall. If there is still no response, consider giving nalorphine/doxapram or the full antidote.
Special care must be taken when turning a rhino from left lateral recumbancy to right lateral recumbancy or visa versa. When doing this, put the animal sternal first and wait for the breathing to settle before pushing it over onto the other side.



Pulse oximeter with clip sensor and rectal probe.

A.3 Monitoring

Quickly get a rough idea of the rhino's age when you get to it. Older rhino need special care.

Be sure that nothing that can affect respiration is pushing against the rhino's belly or chest. Also be sure the rhino is not facing downhill with pressure against the diaphragm.

It is essential to work quickly while the rhino is recumbent and it helps to have a prioritised checklist (see Appendix D). A thorough clinical examination must be done as soon as you get to the rhino and the vital functions (respiration, temperature, heart rate, capillary refill) evaluated and re-evaluated for as long as the rhino is recumbent. The first 10 minutes of recumbency, until the rhino has stabilised, are the most critical. Concentrate on respiration, temperature and heart rate - in that order. These functions are very much dependant on the degree of exertion and excitement before and during induction and this must be kept in mind during your evaluation. Careful monitoring is especially important in old, debilitated, very young, and heavily pregnant

animals. Additional people can be used to help with monitoring – especially respiration. If it was necessary to use more than one dart, check if all the dart contents were injected. This is important for monitoring the animal and for deciding on how much antidote to give. Pulse oximetry is valuable to help monitor blood oxygenation and pulse in a recumbent rhino. The sensor clip can be attached to the rhino's ear. The ear must be scraped on both sides with a scalpel blade, almost until it bleeds, and the sensor clipped to this point. The sensor should be kept out of sunlight. Put a cloth or cap over it. A rectal probe against the nasal mucosae also works well. The rectal probe can also be used with varying success on the inside of the lips, against the gums, in the rectum or in the vagina.

A.3.1 Eyes and ears

Cover the eyes of the recumbent rhino with a large towel or proper rhino blindfold to prevent damage to the retina from direct sunlight and to keep dirt out of its eyes. Saline can be used to wash any dirt out of the eyes. The ears should be blocked with cotton wool or a cloth while the rhino is anaesthetised. If the rhino is being transported, its ears should remain blocked for the entire trip. The blindfold and cotton wool must be removed before the antidote is administered.

A.3.2 Respiration/oxygen

Respiration rate is the first and most important function to be monitored. Be sure there is a free flow of air in and out of the nostrils and that the blindfold does not restrict it. Concentrate on rate and depth of respiration and monitor by watching the chest movement or, in the case of an immobilised rhino being transported on a sledge where it is difficult to watch chest movement, use your hand held close to the nostrils to feel the warm exhaled air. Breathing must be deep and regular. Monitor respiration for at least 30 seconds to get an accurate picture, as an immobilised rhino often gives two or three quick breaths and then holds its breath for a short time. Respiratory rate is about 10-15 breaths/minute on induction, going down to 4-8 breaths/minute about 10 minutes post induction (may increase again slightly).

- Nalorphine given intravenously at 5-10 mg results in a marked and sustained improvement in the quality of respiration.
- 5-10 ml intravenous doxapram will also give an improvement in respiratory rate and depth but it only lasts for 10-15 minutes and may result in some muscle tremor.
- Nalorphine and doxapram can be combined.

The colour of the venous blood drawn is an excellent indicator of blood oxygenation. Dark red, almost black blood indicates poor oxygenation and lighter red indicates good oxygenation. Healthy pink mucus membranes also indicate good blood oxygenation.

Oxygen given intranasally can result in a rapid and significant increase in blood oxygen saturation in immobilised rhino. It is cheap and easily available and a bottle of oxygen goes far if used judiciously on animals that really need it. It is most valuable in the first ten minutes after induction and especially in animals that have undergone significant exertion and are hyperthermic. A control valve and flow meter must be attached to the bottle and the oxygen is given via a flexible plastic or rubber pipe, which is 2 m long and 10 mm in diameter. The end of the pipe should be rounded off to prevent trauma to the nasal mucosa. The pipe is lubricated with KY Jelly or saliva and inserted through a

Immobilized rhino – note lateral recumbancy, rhino doused with water to cool it down, photos taken for records, cloth over pulse oximeter sensor clip, blindfold, oxygen.

nostril almost to the level of the larynx. The best is to measure the pipe against the rhino's head before inserting it. Give the maximum flow rate (approx 15 l/minute) initially. Concurrent monitoring of the respiratory rate and depth, and blood oxygenation remains essential. A low dose of nalorphine will increase the rate and depth of respiration and markedly improve the efficacy of the oxygen supplementation. Nowadays there are aluminium oxygen bottles available which are small and light, and convenient to take in a helicopter.

If a rhino stops breathing, give 10 mg nalorphine or 10 ml doxapram, or consider total reversal with diprenorphine or naltrexone. To give artificial respiration to a rhino that has stopped breathing, put the rhino on its side and using your knee, push hard against the gut, diagonally forward towards the diaphragm. Keep on doing this every two seconds until you get a response. A second person may have to take over. A painful stimulus, such as a kick against its chest wall or a bite on the tail often gets the rhino to take a breath.

A.3.3 Body temperature

Body temperature is an important parameter and is the best indicator of the degree of exertion before induction. Keep in mind that for every one-degree increase in body temperature above the normal, there is a marked increase in oxygen consumption. A rhino's body temperature varies slightly during the day as the ambient temperature changes. Black rhino immobilised without excessive exertion have a rectal temperature of between 36° and 39°C. On a cold winter morning in a boma, the temperature may be as low as 35.5-36°C, while a rhino immobilised with moderate exertion on a hot afternoon can have a temperature of 39.5°C. Young rhino tend to have a higher body temperature than adult rhino after running a comparable distance. There is usually a slight increase (0.3-0.5°C) in rectal temperature a few minutes after induction as the heat moves from muscles to the general circulation. An animal with a body temperature of greater than 38.5°C must be doused with water to cool it down. Although dousing with water is important, it will not have a dramatic effect in lowering the body temperature, as there is considerable thermal inertia in such a big animal. It helps to fan the rhino with branches or cloths after it has been doused with water. The dousing or spraying should be continued regularly for as long as the rhino is down. Holding branches over the rhino to make shade can help lower the temperature, but it is important that people don't crowd around an immobilised rhino and prevent good air movement. A rhino with a temperature of over 39.5°C must be processed as quickly as possible (consider only doing the high priority tasks). With a body temperature of greater than 41°C consider giving the antidote immediatly.

A.3.4 Heart rate

Heart rate is best obtained using a stethoscope, by feeling the artery under the base of the tail (caudal artery) or on the inside of the ear (medical auricular artery), or by putting a flat hand on the chest over the heart. The heart rate can often be seen by looking at the chest wall over the heart. The heart rate is usually 55-80 beats/minute although it will be higher in rhino that have undergone marked exertion, especially in young animals (as much as 140/minute). The capillary refill time (CRT) should not be more than two seconds. The CRT, which indicates peripheral perfusion, is obtained by pushing hard with a finger on the rhino's gum for about two seconds and then releasing.

A.3.5 Dart wound

Darts are best removed by twisting in one direction and pulling at the same time. The dart wound must be treated with a broad-spectrum antibiotic – some mastitis ointment or 5 ml of a 100 mg/ml oxytetracycline solution.

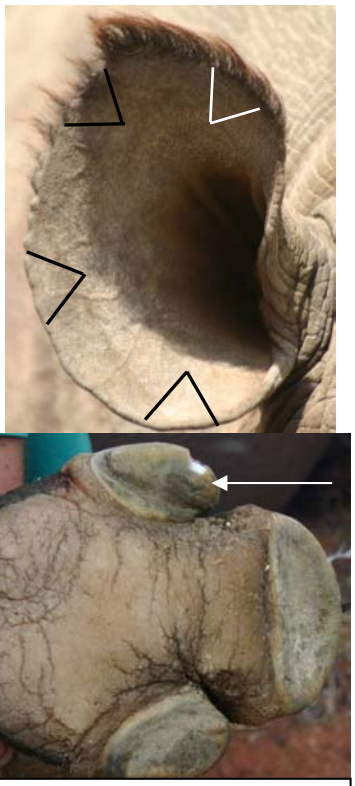
A.3.6 Drawing blood

The medial carpal vein on the inside of the foreleg is the best place to draw blood. This vein is easily accessible in rhino in lateral recumbency, especially if a tourniquet is used. If that vein is not accessible, one of the ear veins can be used.

A.3.7 Additional tasks

While the rhino is recumbent, numerous other tasks should be done or considered:

- Examine rhino thoroughly for wounds – treat superficial wounds with an antibiotic, fly-repellent wound spray. If a needle has broken off, try to find and recover it. If it can't be found, put a good dose of long-acting antibiotics in the needle wound (10 ml of 100 mg/ml Oxytet). The wound should be monitored and the new owner informed.
- Give azaperone or diazepam for tranquillisation during transport (best to give at least 10 minutes before waking up)
- Notch ears – a common method for identifying rhino. Usually a notch has a specific number value assigned to it. Discuss the choice of notches before the time and take care that there are no other animals with similar notches. The notches must be big enough and properly positioned (see photo). A notch on the inside of the ear (white in photo) is not recommended, as it is difficult to see from afar and affects the cartilage, often causing the ear to fold. It is best to first mark the notches with a felt tip pen and cut them only when happy with size and position. There is less bleeding if they are cut with scissors and artery forceps applied until the bleeding has stopped. Ferrous sulfate or "Superglue" applied to the cut surface can help stop bleeding. The cut surfaces should be treated with an antibiotic spray. The notches can be kept for genetic work.
- Notch nails – a notch made in a nail with a round file to aid post-release identification.
- Implant transponders – these microchips are implanted under the skin and in the horn to aid in identification. The chip can only be read from a very short distance, so they are used mainly to identify carcasses, horns, or an immobilised rhino. They are normally implanted under the skin behind the ear, in the neck, or in the rump. It is best to put a little oxytetracycline in with the transponder to prevent abscess formation.
- Implant radio transmitter in the horn – (see F. 5. Telemetry)
- Apply an acaricide for external parasites – It is best to use a pyrethroid spray like flumethrin (Bayticol). Stay away from organophosphates. Pour-on Drastic Deadline can be used but the standard concentration is too strong and burns the skin – get a weaker concentration made up.
- Inject long-acting tranquillisers and mineral and vitamin preparations
- Tip horn – cutting off the tip of the horn is useful when implanting a radio transmitter, as the hole for the antenna is drilled from the top of the horn. A shorter horn also reduces the leverage on the base of the horn and there is less chance of the rhino knocking it off during transport or in the boma.
- Collect parasites
- Collect faecal samples
- Take body measurements
- Dehorn (if necessary) – with a felt tip pen, mark the front horn 7 cm from the base, and 5 cm from the base for the back horn. Using a chainsaw or cross-cut wood saw, cut the horn off horizontally. The chainsaw or hoof clippers can be used to trim off the extra horn and round off the stump. Smooth the stump with a coarse rasp and apply Stockholm tar. Don't cut the horn too low. Make sure the rhino's eyes are well-covered to prevent damage by the chainsaw's exhaust and block its ears well to prevent stimulation from the noise of the saw. Careful consideration must be given to the pros and cons before dehorning.
- Insert a 20G Jelco cannula in the ear vein to aid in the administration of drugs.



Ear and nail notching are useful for identification and post-release monitoring.

- Administer 60 – 100 ml of long-acting penicillin (e.g. Peni LA) intramuscularly.

It is important to prioritise these tasks and to delegate where possible. All necessary data must be collected and detailed records of every immobilisation must be kept to evaluate and improve techniques.

A.4 Antidote

If black rhino are woken up in the field or in a boma, they are usually given diprenorphine at 2-2.5 times the etorphine dose or naltrexone at 50 mg/mg etorphine. Naltrexone is a pure antagonist and the rhino will be very lively after receiving it.

Nalorphine is very useful in black rhino

- to improve respiration, give 5-10 mg – can be repeated depending on response
- to "walk" a rhino, give 15-20 mg – more might be necessary, depending on response
- for transport, wake the rhino up into the crate with 40 mg nalorphine per 1 mg etorphine used

When waking a rhino into a crate, even better results are achieved by giving 10-15 mg diazepam intravenously and then waking the rhino up with nalorphine at 20 mg/1 mg etorphine plus 0.6 – 1.2 mg diprenorphine. This results in a rhino which is well tranquillised for about eight hours but which does not push or traumatise itself in the crate. In our experience, animals off-loaded into a boma were calm for up to 18 hours.

Nalbuphine (Nubain) has shown that it, too, may be used in a similar role as nalorphine for improving respiration (at about 20 mg intravenously).

Antidotes are best given intravenously in rhino, as response after intramuscular injection is often slow and incomplete. After receiving the antidote intravenously, the rhino will stand up after 60-80 seconds. Response to the antidote is first seen as an increase in the depth and rate of respiration and movement of the ears and eyes. Black rhino get to their feet fast and are immediately strong and aggressive. A rhino should be placed in sternal recumbency before giving the antidote or it will bash its head on the ground as it attempts to get up. Re-narcoticisation is rarely a problem in black rhino.

Occasionally, in a crisis situation (e.g. rhino darted and running towards a major hazard), it may be necessary to dart a rhino with antidote. The dart may fall out on its own later, but if not, the rhino will have to be re-caught a day or two later and the dart removed.

When boma-trained rhino are immobilised (e.g. to implant horn transmitter, etc.), they are often sedated for a long period after waking up. This is usually not the effect of the tranquilliser, but the agonist effects of the diprenorphine. One may consider giving some intramuscular naltrexone with a pole syringe to antagonise these effects.

A.5 Other drugs and doses for immobilisation

Black rhino can also be immobilised with the other opioids carfentanil, fentanyl and A3080. The following are doses of these drugs for adult free-ranging black rhino in good condition:

- 2.5-3 mg carfentanil
  Carfentanil gives a quick induction and it is not necessary to add azaperone or xylazine. Carfentanil must be reversed with naltrexone at 100 mg/1 mg carfentanil.
- 1.8 mg etorphine + 30 mg fentanyl
- 60 mg fentanyl

- Thiofentanil oxalate (A3080) is used mixed equally with etorphine. The adult rhino dose is 2 – 2.5 mg thiofentanil oxalate + 2 -2.5 mg etorphine. This mixture gives a faster induction time. The various antidotes for etorphine work well.

B. TRANSPORT

B.1 Problems associated with transport

Rhino with swollen face after traumatizing itself in the transport crate

Transporting black rhino is problematic because of their strength and their inclination to traumatize themselves in a crate. The stress and trauma they experience during transport can negatively affect the performance of the rhino in the boma or after release. Some of the possible risks and problems associated with transport include:

- Fracture of the nasal bones, especially a problem with cows and sub-adults
- Knocking horns off, again especially a problem with cows and sub-adults
- Muscle damage from pushing and straining, especially the hind legs
- Bruising and swelling of the lips – can be massive and often associated with loss of skin, but rarely a long term problem
- Heat stress, especially if a vehicle breaks down
- Vehicle accidents

Horn separation due to knocking crate in transport

B.2 Preparation

Planning, preparation of equipment and backup is essential. Not only must the vehicle and crates be in top shape but good back up and communication is essential and a high level of responsibility is necessary from all involved – from vet to driver.

- Trucks
    - Serviced and in top condition
    - Spare tires, wheel spanner, jack, toolbox, hacksaw, bolt cutter
    - Crane/winch – serviced and tested
    - Water, fuel, oil, brake fluid, hydraulic fluid
- Driver and spare driver/assistant
    - Trained how to drive with a rhino, check the rhino and respond to problems, etc.
        - Driver should know not to accelerate, brake, or turn too hard. The truck should not stop at noisy places, and the driver should be sensitive to what the rhino is doing.
    - Money
    - Food
    - Map
    - Contact telephone numbers
- Back-up vehicle
- Torch
- Radio/mobile phone
- Extra straps and ropes
- Veterinarian, equipment and drugs, especially prodder and pole syringe, should be on the truck
- Route worked out, avoiding low power lines and/or overpasses if necessary
- Contact with people receiving the rhino

B.3 Techniques

B.3.1 Anaesthetised transport

Transporting a rhino anaesthetised is a relatively stress free way of moving a rhino a short distance. The sleeping rhino does not strain or traumatise itself as can happen in a crate. It is a quieter way of introducing a rhino into a boma. Ideally the anaesthetised rhino is off-loaded, the vehicles and other equipment removed, and the animal quietly woken up. If done well there is little excitement or trauma from hitting the walls and doors.

This is a useful technique to transport a cow and calf. If woken up together in the boma with little disturbance, they inevitably bond again with minimal problems (compared to a cow and calf transported in crates, who can be difficult and traumatic to get together again).

In rough terrain/thick bush it is a good technique to recover a rhino that has been anaesthetized. In thick bush it can be difficult for a truck with a crate on the back to get through. Also, in this situation, a rhino in a crate is thrown around a great deal and is inclined to push and strain and traumatise itself.

The technique has its disadvantages. Skill is needed to monitor the immobilised rhino and ensure that anaesthesia is neither too shallow nor too deep. Either situation must be attended to quickly. If it is too shallow the rhino might thrash around or even stand up. If too deep, there is a possibility of an anaesthetic death.

The three options for transporting an anaesthetized rhino are:

- Sledge:
  - The rhino is immobilised, the sledge (1.7 m x 2.6 m) is put down next to it and the animal is rolled or slid onto the sledge and then tied securely with ropes. The sledge with the rhino is then pulled by hand, lifted using a crane, or winched onto the truck. The rhino is transported like this to the boma where it is off-loaded and then woken up. It is important that the rhino is well tied down and supported on the sledge, otherwise the rolling action can cause chafing wounds. A small tire or sack of grass should be placed under the rhino's head to keep it from bumping on the sledge and to position it with the ear up and the nose down.
  - Sometimes a rhino is put on a sledge and flown out by helicopter. This is a very useful technique in thick bush or rough terrain.
- Lifted onto the back of a truck by its feet:
  - Using straps (best to use 3 m, 3 ton, hi-lift slings) around the rhino's feet, a crane slowly lifts the rhino upside-down onto the back of a truck. Care must be taken lifting it up and putting it onto the back of the truck. An old mattress is useful to lower the rhino onto.
- Lifted up in a net:
  - A heavy net is put under the rhino and it is lifted up on its side. This technique has been used to get rhino out of difficult terrain by helicopter.

Anaesthetized rhino being lifted on a sledge by crane (top), by its feet onto a truck (middle) and in a net by helicopter (bottom).

Top photo: B. Beauchamp

Bottom photo: D. Cooper

B.3.1.1 Drugs/Maintenance of anaesthesia

Use low doses of etorphine alone or with azaperone to maintain anaesthesia. Try to give the drugs before the animal is too awake. Ear and leg movements are usually the first signs that the anaesthesia is becoming light.

- Give about 0.3 - 0.5 mg etorphine alone or with about 40 mg azaperone intramuscularly. Observe the respiration carefully for the next ten minutes. Try not to get into a situation where you have to give etorphine intravenously. This greatly increases the chance that the rhino will stop breathing.
- If intravenous etorphine is necessary, limit the dose to about 0.2 – 0.3 mg and watch the breathing carefully.
- Another good option is to give 5-10 mg midazolam slowly intravenously. This will keep the rhino down for a short time and make it calm on waking up.

B.3.2 Field recovery crate (for Export crate, see G.2 Export crate)

Black rhino are usually transported in crates. It is important that the rhino can stand up and lie down comfortably. The crate can have extra width and height, but there should be little extra length. If the crate is too long, the rhino tend to rush forward and traumatise their lips and knock off their horns. Sometimes horizontal poles are used at the back of the crate to aid in closing the doors. The disadvantage of having these poles is that the rhino may slide back and get its hind end stuck under the poles and be unable to stand. If this happens, the rhino may continue trying to stand, straining and pushing the poles until is suffers serious muscle damage. It is best if these poles are removed after loading.

Steel "fish plate" (top) and woven rubber matting (bottom) give good footing in a transport crate.

Crates big enough for an adult white rhino are too big for transporting a black rhino. A good size for a black rhino crate (internal dimensions) is 3 m long, 1.28 m wide and 2.0 m high. There should be a 50 mm hole in the front door 1.4 m from the ground to pull the rope through on loading. The flap, which drops down in front of the crate to help with loading, is 0.6 m long x 1.28 m wide.

It is also very important that the crate has good footing. A heavy-duty woven rubber mat, which is well bolted down with flat bar every 35 cm, is ideal. Steel "fish plate" also gives good footing. Smooth wood or steel can result in the rhino slipping and straining (especially if wet) with potentially lethal consequences. There should be drainage at the back of the crate for urine. The crate should be as quiet as possible and everything that rattles should be removed or properly secured.

The front and back thirds of the crate roof are open to allow adequate ventilation.

A field recovery crate is either an all-steel construction or made from steel and wood. If wood is used, it should be a good quality hardwood like Saligna or Pod Mahogany. The wood should be treated and regularly checked that it is not rotten (especially the floor). A steel and wood crate tends to be quieter and less cold/hot than an all steel crate. The frame is usually 75 mm channel with 1.5 mm plate or 30 mm hardwood planks attached to it. As the front door takes most of the bashing by the rhino, it is best if it is steel, or braced hardwood planks lined with steel plate. Sometimes a crate has to be dragged or pushed a short distance and it helps if there are skids (100 mm channel) beneath the crate to facilitate this.

With a steel crate, it is better if the inside is rubberised with conveyor belting. The rubber, like wood, absorbs much of the sound and prevents the crate from being too hot or too cold. The doors must be made of steel and lined on the inside with conveyor belting. Good ventilation is essential, as rhino moving a lot or pushing in a crate can generate a huge amount of heat. Usually the front third and the back third on the top of the crate are open. This allows good movement of air and access to the rhino for injection, spraying, prodding, etc. It is good if the forward opening has a flap of conveyor belt that can be fastened down over the opening to keep an animal quiet or warm if conditions are cold. The advantage of conveyor belting is that the rhino can not knock its horn off or injure itself by hitting it. An additional flap of conveyor belting can be used to cover the back third for travelling in very cold conditions. Great care must be taken to ensure there are no sharp corners or other objects a rhino can injure itself on, especially on the front and top of the crate.

It is often necessary to inject, prod, or spray a rhino in transit and the crate should be designed so that this is easily done. There must be footholds on the side and doors of the crate so that you can easily work with the rhino. It is also convenient to work from the roof of the crate and so it, also, must have good footing.

The crate doors should be designed so that it is easy to load the rhino – two doors which open up and funnel the rhino in and a flap which folds down and prevents the rhino from hooking its horn under the crate as it is woken up into the crate. The front door can swing, slide to the side or slide to the top.
Sliding to the side is excellent and swinging is also good. If off-loading into a boma or across into a mass crate, it is very important to consider how the door is going to be opened. Sometimes you are left with a gap. In other situations the boma door could prevent the crate door from opening. There must be places where chains, straps, and/or slings can be attached to lift, pull or tie down the crate.

The Multilift system in Namibia (top) and the KWS "Hannibal" system in Kenya (bottom) are used to load/unload crates.

B.3.2.1 Crate loading systems

There are several different loading systems for crates including:

- **Crane** – This system is the best system as, not only can it pick up a crate, a sledge, a rhino by its feet, or other equipment, but it can also be used to manoeuvre whatever it is lifting to a specific position (over boma walls, etc.). The crane usually lifts from the side, so it is important that the truck is properly braced with hydraulic legs to handle this.
- **Mulitlift** – A hydraulic arm hooks onto the front or back of the crate and pulls it up and onto the back of the truck from behind. This system is very strong but has limited flexibility, and for approximately ten seconds the rhino is standing at about 45° in the crate.
- **KWS "Hannibal" system** – This is a very strong system but has limited flexibility. The crate is kept horizontal while loading and unloading.
- **Winch** – It is also possible to winch the crate up runners onto the back of the truck. Great care must be taken to prevent the crate from falling off the runners while loading, especially if the rhino is moving in the crate. The rhino will be angled in the crate for a time while loading.

B.3.2.2 Mass crate

A mass crate is a single steel crate with six compartments, each holding one rhino, mounted on a flatbed trailer. The dimensions vary slightly with different mass crates, but they are approximately 3.2 m long, 1.1 – 1.3 m wide and 2 m high. Each compartment has a hatch on top for ventilation. The mass crate is useful for moving a large number of rhino over longer distances. Careful thought must be given to the loading and unloading of the mass crate.

B.3.3 Waking a black rhino into a crate

- Position the rhino in sternal recumbency with its head already partially in the crate. You may have to pull the rhino forward with ropes to get it into this position. It helps if the crate has a flap that opens to the bottom on which the rhino can rest its head. Put the crate as close as possible, as the rhino tends to drop its head as it stands up and can easily hook its horn under the crate.
- Check the blindfold, make sure the ears are blocked, put a brake rope on one of the hind legs (8 m rope just above foot) and attach the head rope. Special care must be taken with the head rope. It must be put behind the rear horn, with the lower part of the noose behind the angle of the jaw. The noose must be positioned such that it tightens easily as the rope is pulled. Take the end of the head rope through the hole in the front door and all it to extend for another 15 m.
- The crate doors must be locked in the open position to funnel the rhino into the crate.
- Put about eight people on the head rope (good to attach the end to the bull bar of a vehicle to pull as well – this is also insurance if something goes wrong), three people on the brake rope, and two or three people on each side to support the rhino. One person should be on the top or side of the crate to control the team and someone behind the rhino to apply the prodder.
- When everyone is in position, check the head rope again. Give the antidote. Wait about 50 seconds.
- Give the rhino a kick, prod it lightly, or bite its tail. If you are unable to stimulate the rhino to stand or walk, pouring water into its ear can be very effective.
- Pull. Try not to let the rhino hit the other side of the crate too hard or it will traumatise itself. If a vehicle is used, pull carefully.
- Hold the rhino at the front of the crate with the rope until you can slip horizontal poles in behind it and close the doors. Remove the brake rope.
- Remove the head rope and blindfold from the top of the crate. The safest way is to use a stick with a hook on the end. Be very careful as the rhino may throw its head up and hit you in the face with its horn.
- Let the animal settle. A kick or prod close to the ears may be necessary to get the rhino to back away from the front of the crate.

B.3.3.1 Problems

- The rhino gets its horn caught under the crate or misses the crate to the side. Give some slack on the head rope and pull on the brake rope. Extra people may be needed to help pull the leg rope. Once the horn is free, pull the rhino into the crate.
- The head rope slips off the head. The rhino may continue into the crate anyway. If not, try to get the rope on the head again and pull it into the crate.
- The rhino's hind legs collapse due to either the blood supply to the legs being cut off or incomplete antagonism of the etorphine. Put a sling under the rhino's stomach, and lift it slightly with a crane and give more antidote.
- If the rhino pushes in the crate, give it time to settle. Prod or kick it around the ears to get it to back off, as it may push its nose into the corner and block its nostrils. Give additional antidote. **Be careful, as it is easy to go from too much sedation to too little sedation.**

B.3.4 Walking a rhino

If the crate can not be placed directly in front of the rhino, it can be "walked" a distance and guided into the crate. When the rhino goes down, the blindfold, cotton wool, head rope and brake rope are applied as

above. Four to six people should be on each rope, two people on each shoulder, one person to the side controlling the team and two people walking in front of the rhino, clearing obstacles in its path. The rhino is given small incremental doses of nalorphine (10 – 20 mg at a time intravenously). Doses vary, but as little as 20 – 25 mg may be needed in total. After each dose, wait a few minutes and check the rhino's response to a prod or water in the ear. If there is no response, give another dose of nalorphine. Once the rhino stands, it should begin to stagger forward and it can be guided with the head rope and by the people on the sides. If it goes too fast, the brake rope can be pulled to slow it down. Slow the rhino when it gets close to the crate so it does not traumatise itself.

B.3.5 Tranquillisation during transport

All black rhino need tranquillisation during transport (with the exception of especially well-habitualised animals), otherwise they injure themselves. The veterinarian must always travel with the rhino and be prepared to give additional tranquilliser. It is important that the vet anticipates the animal's tranquillisation needs. You don't want to wait until the rhino is totally alert and bouncing around, traumatising itself in the crate. Keep in mind that a cool rhino is generally much more relaxed than a hot one.

Rhino settle into the rhythm of transport after a few hours. There can be no problems for several hours, but as most of the short-acting tranquillisers wear off, if the animal gets a fright (from stopping, off-loading, etc.) it can become very excited. It helps to inject the rhino while the vehicle is moving or alternatively, stop, inject and start moving again immediately. Hand-injecting the rhino is the best way to give additional tranquilliser. Jab a 20G (or thicker), 1.5-inch needle into the side of the neck or rump. When the rhino has settled, attach the syringe and inject. A pole syringe with a 17G, 1 inch needle can also be used, but beware of coring, as the rhino's skin may block the needle. It is a good idea to clean the injection sites before loading the rhino and spray them with an antibiotic spray. This will help prevent the formation of abscesses. Keep in mind that an intramuscular injection takes five to ten minutes to work. For a faster response, an intravenous injection into the ear veins is sometimes possible. **Don't** fall into the crate when injecting the rhino. If necessary, get someone to support you by holding on to your shirt, pants, etc.

It is good if the rhino lies down during transport, but it must be in a natural position. If the rhino lies down while the vehicle is moving, the rocking and bouncing action helps blood get to the leg muscles. Beware if it lies down for a long time (>30 min) in a stationary vehicle unless you are very comfortable with its position. Black rhino heavily sedated with opioids (unless actually anaesthetised) struggle to work out how to lie down; however if they manage to do it once, they will lie down more easily thereafter.

Long-acting tranquillisers help to calm an animal, but by themselves they are inadequate to calm an excited animal during transport. Acuphase (200 mg – 400 mg/adult rhino) takes about an hour to start working after administration, while perphenazine enanthate (Trilafon 200 mg – 400 mg/adult) takes about 12 hours to have an effect.

Short-acting tranquillisers like azaperone, xylazine and detomidine also help during transport, but again, on their own, they are inadequate to calm an excited animal. Azaperone is the tranquilliser of choice at 100 mg – 250 mg/adult and can be repeated every six hours if necessary. Forty mg/ml azaperone (Stressnil) is a convenient preparation and mixes well with etorphine if it has to be given simultaneously. Be careful not to give too much azaperone if you are also going to sedate with opioids, as the rhino may end up being too heavily sedated and collapse.

The administration of opioids, either alone or with intravenous diazepam is the only way to stop an excited black rhino from traumatising itself in the crate. With opioids, one is trying to achieve a heavy standing sedation through a number of options:

- Partially antagonising the etorphine used for immobilising the rhino with nalorphine at 40 mg/1 mg etorphine given intravenously. The nalorphine has fairly strong agonist effects and after the rhino has been woken up into the crate, it will remain heavily sedated for about eight hours. Sometimes, especially with adult rhino, there will be a fair amount of pushing in the crate after waking up with nalorphine. Give the rhino a few minutes to stabilise. You may have to prod it at the base of the ears to get it to back up in the crate. If the pushing persists and is serious, give a

low dose of naloxone (1 – 2 mg) or diprenorphine (0.6 – 1.2 mg) intravenously. Be careful not to give too much, or the rhino will be wide awake and bashing around in the crate.

- A variation on the previous option is to give 10 – 14 mg diazepam intravenously about ten minutes before waking the rhino into the crate. The rhino is woken up with nalorphine at 20 mg/1 mg etorphine plus 0.6 – 1.2 mg diprenorphine. The rhino wakes up better with this combination and there is very little pushing in the crate. Good sedation is achieved for about eight hours or more.
- A low dose of etorphine (0.1 mg + 100 – 200 mg azaperone) gives good sedation for about two hours. It can only be given a few hours after the rhino has been woken up in the crate, when most of the antidote is out of the system. It can be repeated a number of times until the rhino reaches its destination. Remember to limit the azaperone given to about 200 mg/6 hours.
- Butorphanol has been used in zoo situations for standing sedation in black rhino and it could probably prove useful for transporting as well.

C. HOLDING FACILITIES

C.1 Site selection

Careful selection of the boma site is necessary. For bomas from which rhino are going to be released directly into the field and which will only be used once or a few times at the most, bomas should be sited:

- Centrally in the new area
- Away from fences
- Close to a water source (beware of flooding rivers)
- Away from hazards like cliffs, etc.
- Area of good habitat
- Away from human disturbance.

Note slope of land and high, slanted zinc roof for good shade, protection and ventilation.

For bomas that are going to be used frequently over many years, mostly for removing rhino from an area, other factors are more important:

- Easy access by supervisory staff and labour
- Close to roads
- Good supply of water and proximity to electricity can also be an advantage
- Good supply of browse close by for feeding.

Some factors are common to all bomas:

- Good drainage
- Substrate in the bomas is not too dusty nor too slippery if it gets wet (might have to truck in sand or gravel)
- Attention to prevailing wind – upwind from close human habitation and downwind from water for release
- Cold – cold is much more lethal than heat. Don't put the bomas in very low-lying areas and position the bomas to keep out cold winds.
- Heat – position the bomas where there is some air movement and, if possible, where trees can provide shade.
- Sun – angle of the sun can be an important consideration in winter, especially farther away from the equator.
- Firebreak – there should be a firebreak around the boma area. If possible, fire-fighting equipment should be situated close to the bomas.

C.2 Boma design and construction – see Appendix E

Before constructing bomas, a number of things should be considered:

- Are the bomas to receive rhino straight from the field or have the rhino been boma trained? Boma-trained rhino are a lot easier to manage and can be accommodated in bomas that are less robust and less carefully designed.
- Are the bomas going to be used often over many years or is this a "one off" occasion?
- Would mobile bomas be an option?

C.2.1 Size

A black rhino boma should be 100 m^2. Black rhino don't settle well in bomas that are very small.

C.2.2 Materials

Black rhino bomas are best made from wood. Wood is safer and more animal friendly. The disadvantage of wood is that it rots or is eaten by termites and it must therefore be treated. Tanalith is the treatment of choice. Creosote must not be used as it is toxic to black rhino. Because of the problems of rot, termites and lack of strength associated with wood, steel is sometimes used in bomas for corner poles, support poles, the door and its frame, and support of the vertical wooden poles. Steel must be used with caution. It has no "give," sharp edges can cut the rhino's skin, it is very noisy if hit by a rhino, and as it conducts heat easily, tends to be too hot or too cold. If a rhino charges into a steel pole it can easily fracture its nasal bones. This is a disaster; as such an animal may then develop a septicaemia and die. For this reason, steel in a boma should always be well covered with wood or rubber. Rubber (usually conveyor belting) must be very well attached; otherwise the rhino can easily pull it off.

Mobile bomas of steel or steel and conveyor belting are being used. Their advantage is that they can be erected and taken down relatively quickly. We recommend that their use be limited to the release of boma-trained rhino.

C.2.3 Roof

It is best to have a solid roof of corrugated iron or asbestos to keep rain out. In places that can get very cold, the solid roof also helps keep heat in. The roof should be about 280 cm or more from the ground. A roof that is too low inhibits ventilation and is easily broken by a rhino standing up on its hind legs against the wall. The roof should be angled so that rainwater flows away from the boma. If this can't be done then gutters should be used to take water away. There should be no single poles supporting the roof in the middle of the boma.

Trees are sometimes used for shade in a boma, but they don't keep rain out, they lose their leaves, often die after being damaged by rhino and if close to the boma wall, the rhino may get stuck between the tree and the wall, especially during immobilisation. Shade cloth and/or capture plastic are sometimes used, but they are not recommended. They don't keep rain out or heat in (in colder climates) and disturb the rhino if they come loose and flap in the wind.

C.2.4 Walls

Walls should be between 2.20 m and 2.40 m high. Take care to ensure that there are no places lower than this. An adult rhino can get its legs over a wall/door of approximately 190 cm.

A black rhino will initially test the limits of its enclosure by pushing and bashing the walls and doors. If it finds a weakness, it will focus its efforts on that particular spot. They are also adept climbers and, when first put into captivity, often climb against the walls of the boma.

Eucalyptus, pine, or indigenous (mopane, etc.) poles, 12-18 cm in diameter are best to use for boma walls. We recommend solid walls at the back of the boma and between the bomas, and solid or gap walls at the front. Solid walls are walls with the poles placed tightly next to each other, and gap walls having a space of 10-12 cm between poles. A good option is to have a gap wall at the front and to fasten poles to the gaps when the wild rhino is initially put in the boma. Once the rhino has settled, the wired poles can be removed. The vertical support poles and corner poles should be concreted 1 m into the ground.

The horizontal poles used to support the wall should be placed high and low (within about 30 cm from the top and bottom of the wall) to give maximum support and prevent the rhino from using them as footholds to stand against the wall. They should be long enough to go between the vertical support poles. If they are not long enough for this and two poles have to be used, the overlap between them should be at least one meter to prevent too much "play," which rhino will quickly discover.

The vertical wooden poles are either bolted, held by bent round bar or wired to the horizontal support poles. Bolted is the best, but great care must be taken to countersink the bolts/nuts.

The corners of the boma can be removed by using vertical poles with horizontal support poles. When rhino climb, they often climb in the corners and a less sharp corner makes climbing more difficult. Also, if the rhino has to be immobilised, it won't shove its head in the corner as is often the case.

(Top) Round bar bent to prevent rhino from injuring itself. (Bottom) Cable bomas are not recommended. The viewing platform is helpful to observe and feed the rhino.

In cable bomas, the vertical wooden poles are wired to horizontal cable stretched between the corner posts. This isn't recommended because the cable has a lot of "give" and if a rhino hits it or leans against it, even if it's pulled tight, the wall will move a great deal and anger the rhino in the adjacent boma. If a rhino stands against a cable wall, it will tend to swivel and lift at the bottom. Another problem is that the vertical wooden poles tend to slide along the cable and gaps open up through which the rhino can easily get its horn, and sometimes even its head.

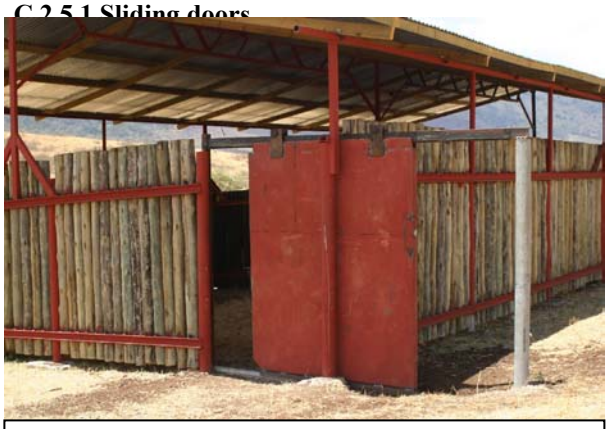
C.2.5 Doors

Doors are essential for boma management but great care must be taken with their design and use:

- Rhino easily injure themselves on doors and/or damage the door at the same time. When first in the boma, they tend to run through the doorway and often knock the door or the frame. Doors should be 1.5 m wide. Damage to the door most often occurs when the door is being opened or closed.
- When initially confined, the rhino test the walls and especially the doors, probably because they move, are noisy and are usually lower than the boma walls.
- There must not be a gap under the door, as the rhino can get its horn under it and lift the door off or break its horn off.
- Locking mechanisms must be reliable as rhino can force a door open and either escape or get into an adjacent pen.
- Rhino easily develop a "hang up" about going through a door because of associated noise, movement, human presence and/or because they have to go through a narrow space.

Strong locking mechanism on boma door

C.2.5.1 Sliding doors



Boma door with beam at top and bottom. Boma walls supported by vertical poles and horizontal channel.

Sliding doors are best used between pens. They are either all steel (plate on a pipe or square tube frame) or wooden with a steel frame. To prevent injury to the rhino and damage to the door, both wooden and steel doors should be covered with conveyor belting. Conveyor belting also makes the door quieter if it is hit or pushed. The sliding door moves on an overhead steel beam (best if it moves on bearings). The door is supported below by a beam or pipe and when closed should slot into a gap inside the boma. Sliding doors must always open to the outside of the boma. There should be little or no gap between the door and the supporting beam. Too much of a gap and the rhino will force its horn in there and either break off its horn or the door. It must also be impossible for the rhino to lift the door (put a spacer between the door and the supporting beam).

The height of the sliding door (or other boma door) must not be too dissimilar to the boma wall height or the rhino will try to climb over it. It is also important that it moves easily and there is minimal movement and noise if a rhino hits it from the side. Good handles should be welded to the doors on the outside. Handles and/or a door stop should be placed carefully to prevent the door operator's hand from being crushed should the rhino push the door while it is being opened.

There must be a very stout locking mechanism to keep the door closed and it is also good if there is a mechanism to hold it when opened.

C.2.5.2 Pole doors

Pole doors still have a place in rhino bomas. Pole doors are strong and easy to make but they are cumbersome and slow to use. They can be either horizontal or vertical. We prefer horizontal – a stack of poles between two vertical poles on either side of the door. Two vertical poles, one on either end, prevent the rhino from sliding the horizontal poles out. One of these is fixed and the other, the locking pole, is removable. It is also important that there are stoppers at the top of the pole door to prevent the rhino from lifting the poles out. Horizontal pole doors are a good option between the boma and the outside.

Vertical pole doors are not a bad option, but can be awkward to utilise. They can be more dangerous for the person opening the door, as one has to balance above the door and the rhino often tries to force its way through when the door is only half open.

2.5.3 Swing doors

Swing doors should only be used as doors that open to the outside (i.e. when no rhino is in that pen). They must never be used between pens.

2.6 Water trough - see Appendix F

The water trough should be 25-30 cm deep by 50 cm wide by 90 cm long (60 cm inside the boma, 30 cm outside) and hold 80 – 100 litres of water. If it is too small, the rhino lowers its head as the water level drops and it can potentially get its horn hooked under the side wall. Also, a small trough means that the water is refilled more often, increasing the disturbance to the rhino. If the water trough is too big, water is wasted and the rhino may attempt to bathe in it.

Water trough with concrete skirt, hosepipe to fill, emptied with a bucket (looking from outside in)

Photo: E. van der Westhuizen

Only 15 cm should be above ground and the sides should be sloped down to ground level so there are no sharp edges on which the rhino could injure itself. The trough should be placed approximately one meter from the outside door on the opposite side of the door from the feed area. If the trough is too close to the door to the adjoining pen, the rhino will kick dirt/sand in it every time it moves between pens.

There should be a good drainage system to get rid of stale water. A simple system with minimal pipes, etc. is usually best. All of the sand and plant material can easily block pipes. A French drain, a hole in the ground, or a channel are good for drainage whether the water is emptied through a pipe or just removed with a bucket.

Cement feed trough with concrete skirt (top). Feed tire should also have concrete skirt (bottom).

C.2.7 Feed area

Lucerne and cubes should not be fed on the ground, as the rhino will ingest dirt/sand which may cause colic. A car tire filled with concrete makes a good feed slab. There should be a shallow hollow in the middle and a concrete skirt around the tire so that the feed doesn't get pushed out immediately. The tire should be dug down so that only about 8 cm are above ground. Otherwise the rhino can easily get its horn under the tire and toss it around.

C.2.8 Off-loading ramp - see Appendix E

The off-loading ramp can be built-up or dug into the ground. A built-up off-loading ramp should extend 7 m from an end boma. Over the 5 m from the door, the ramp should gradually increase to a height of 1.6 m. The last 2 m should be flat. The walls of the off-loading ramp should be solid and the same height as the boma walls. The width should be 1.5 m, the same as the boma door.

C.2.9 Viewing platform

A small viewing platform outside each boma is useful to observe the rhino with minimal disturbance. Overhead walkways are not recommended, as the movement above their heads stresses them and makes it impossible to observe them quietly.

C.2.10 Other considerations

Some other things to keep in mind when building black rhino bomas:

- **Protection from the elements** – In colder climates, there should be an area of the boma that is completely sheltered (good roof, walls lined with conveyor belting) from wind and rain. An infrared light can be installed for extra heat, with special attention paid to keeping wiring protected and out of reach of the rhino.
- **Solid objects** – Things like tall concrete water troughs, solitary poles, etc. in the boma can often become something for the rhino to take its aggression out on, increasing the risk of injury, broken horns, or broken nasal bones.
- **Hideaway** - Black rhino, like many wild animals placed in captivity, prefer to have a "safe" area that they can retreat to. This area should be partially enclosed, dark and quiet. This is particularly important for recently caught animals. It provides an important psychological need initially and as the rhino becomes habituated to captive conditions, it can come out of this area into the more "exposed" part of the boma.
- **Interest** - Rhino appear bored in a boma that is just a square. A boma that is divided into two compartments or that has a pole wall towards the back keeps them happier and gives them options if they want to move.
- **Sounds, smells, sudden movements** – Loud, sudden sounds and human smells disturb newly caught rhino in particular. This is important to keep in mind when working in a boma situation and one should always make your presence known by talking and moving slowly. Even at a short distance and when a rhino knows you are there, if you make a sudden move, its response is to jab with its horn.
- **Individual variation** – Each rhino is unique in how it will respond to captivity. Some will settle very fast and within days will be eating well, unbothered by human activity, noise, etc. Others will take much longer to adapt. Certain individuals may never completely settle in a captive environment.
- **Ease of management** – It is important to find a balance between what is best for the rhino and making it easy and safe for the people to look after the rhino.
- **Other rhino** – Depending on circumstances, it may be possible to keep a rhino in a large, self-contained boma where shifting into bomas used by other rhino is not necessary when cleaning and feeding.

D. INTRODUCING RHINO INTO A BOMA

Introducing a rhino into a boma should be as stress-free and atraumatic as possible and enough thought should be given about which boma is the best for the rhino. The most valuable rhino should be put in the best boma. Cows with calves should be separate from the other rhino, or in the quietest part of the bomas.

D.1 Preparing a boma

- Check that there are no wire, nails, sharp pieces, etc. lying around.
- Make sure that the doors that should be closed are closed and locked and those that should be open are open and manned by someone responsible.
- The water trough should be empty initially, as the rhino may push its head into the water and possibly get its horn stuck under the fence. Wait a few hours after the rhino is off-loaded before filling the trough.
- Put a few branches of browse in to start with - preferably species without many thorns. Too many branches and the rhino will just push them around. More can be added later.
- No lucerne or cubes should be given initially.

D.2 Off-loading

D.2.1 Off-loading from a crate

For the offloading, the crate should be placed on the ground facing the door to the boma or lined up with the loading ramp on the back of the truck. Before opening the crate, check:

- No spectators, noise, unnecessary movement, lights/camera flashes
- Everyone in position to open doors, close doors, etc.
- The crate is chained to the boma (to prevent the rhino from turning around and pushing the crate out of the way)
- Additional tranquilliser (0.05 – 0.15 mg etorphine + 40 – 200 mg azaperone), given intramuscularly, will take a few minutes to take effect
- The cotton wool may be removed from the rhino's ears at this point, but you may prefer to leave it in and let it fall out later in the boma
- **One person must be in control**

Open the crate door. The animal may come out immediately, or it may not. Be patient and give the rhino a chance to work out what is going on. It will usually walk out by itself. If there is no response after a few minutes, you can scratch the rhino's hindquarters with a stick, tap it lightly close to the base of the tail with a stick, or use the prodder and jab it lightly at the base of the tail. Once the rhino is out, quietly close the door behind it.

If the crate is on the ground in front of the boma, it is best to let the rhino walk through to the adjacent boma, close the door behind it, and then close the crate and remove it. If you have to close the boma door with the rhino in the pen, do it quietly and carefully to prevent the rhino from fighting with the crate. If off-loading using a ramp, close the ramp/boma door immediately after the rhino enters the boma. You don't want the rhino to walk back up the ramp and into the crate. It's extremely difficult to get the rhino to back out of the crate and down the loading ramp. A dopey rhino should never be left in the boma or the field on its own. Someone should keep an eye on it until it is totally awake.

Off-loading at night is not a problem; it is actually much better as the rhino are more relaxed and move easily. Lights are not necessary (a rhino's night vision is excellent) and often just confuse the animal. Make sure torches are available when off-loading at night.

D.2.2 Off-loading from a sledge

When off-loading from a sledge, lift/pull the sledge plus the rhino into the boma. Slip/roll the rhino off the sledge. Be ready with the antidote. Remove the sledge, equipment and extra people. Put the rhino on its sternum. Give the antidote intravenously and wait 30 seconds. Remove the blindfold, the cotton wool from its ears and slip out of the boma. Sometimes a rhino that is only lightly anaesthetized will stand up as it is taken off the sledge or put into the sternal position. Push it back on its side or, if it is already on its feet, give the antidote, remove the blindfold and get out of the boma. Don't let the rhino strain against the wall in a half-anaesthetised state.

D.3 Cows and calves

It is difficult to reunite a cow and a calf in the boma. If transported in crates, it is best to put the cow and calf in adjacent bomas. Before off-loading, remove the cotton wool from the rhino's ears. It is good if there has been a fair amount of vocalisation for a few hours before trying to put them together. Also, they must not be too heavily tranquillised at this stage. Leave them overnight and quietly open the door between them as it is getting light. This is best done by one person. Back off totally and let them come together quietly. Human presence/movement causes excitement and greatly increases the chance of aggression between the cow and calf. Usually there will be a little huffing and puffing as they come together and then they accept each other and the calf follows the cow. Occasionally, especially if there is excitement involved, there will be a lot of vocalisation, fighting and associated aggression.

The calf tends to be the most nervous/aggressive in this situation. It is best to separate the rhino (often the calf will run into another pen and you can close the door). Once this has occurred, it is very difficult to get them together again. At this point, the options are:

- Try again after a few hours – this is rarely successful.
- Move to other pens in the boma complex and try again – the chances of this working aren't much better.
- Immobilise the cow and calf and wake them up in the boma with the calf behind the cow – there is a fair chance that this will work.
- Move them to a camp where there is more room – there is a good chance this will be successful.

Even if you are able to get the cow and calf together, there may be aggression between them later (see E. Captive Care - 1.6 Fighting).

If the cow and calf are brought into the boma immobilised, it is best to put them in the same pen with the calf about a meter behind the cow. Both animals are put in sternal position, the blindfolds removed and cotton wool taken out of their ears. The antidote is given intravenously to the cow first, and the calf about 30 seconds later. Get out of the boma and make sure there is no disturbance or human activity as the animals wake up. This method usually works quite well.

E. CAPTIVE CARE

Captive care is often neglected, because black rhino soon start eating and usually settle quickly in a boma after capture. This neglect results in animals in poor condition (often with medical problems). Such animals may do poorly after release. Specialist care by someone with experience is highly beneficial because:

- The nutrition of the rhino gets the attention it deserves and the rhino leave the boma in excellent condition.
- The idiosyncrasies, likes and dislikes of individual rhino are noted and their care is altered accordingly to achieve optimal management. This management of rhino as individuals is especially valuable when they are moved to different bomas in another area and this knowledge greatly facilitates the re-adaptation.
- Health problems are picked up at an early stage and managed accordingly. Because the rhino are less stressed and more approachable, treatment also tends to be easier and more successful.
- It is an excellent opportunity for the training of staff in the correct approach to the care of captive rhino.

Adaptation to a boma environment is a huge mental adjustment for a wild rhino. It is remarkable how they can adapt, but it does take time. One must be patient and accommodate the differences between individual rhino. Some people are better at this than others and those with a natural empathy for animals should be chosen to work with the rhino. Initially one wants to keep the rhino's environment as similar as possible to the environment it comes from, and slowly make changes as the rhino gets used to it. For example, the first few days should be quiet and the rhino should be given space. Rhino in the wild are mostly active at night and, because of the need to feed, water and clean the bomas during the day, they are forced to change their routine and be more active during the day and less so at night. As the rhino settles, it will get more accustomed to human noise and disturbance, and most rhino will begin to enjoy human attention. Rhino are very much creatures of habit. It is important that there is a daily program.

Besides its sudden confinement, the rhino has to adjust to the new smells, sounds and sights it is exposed to. This is extremely overwhelming, as most rhino would be unfamiliar with those characteristics of humans, vehicles, bomas and the equipment used around the bomas.

Calves that have been separated from their mothers are more sensitive to stress and disturbance and need special care and attention.

E.1 Boma management

There should be two experienced people at the boma 24 hours a day to handle any emergency. Someone responsible should sleep no more than 30 m from the bomas to hear if there are any problems during the night. The vet should sleep at the bomas for the first few days after capture. The people at the bomas must have the right equipment including a prodder, rifle, torch, radio or phone, some tools, etc. Often other rhino, elephant or lion come to the bomas. You must be able to manage the situation if a problem arises.

E.1.1 Routine

It is important to get the rhino into a routine of moving, cleaning, feeding, resting, etc. as soon as possible. They quickly settle into this system and once established, it must be closely followed. An example of a daily routine is:

- 07:00 Start cleaning bomas. While some people clean, others go to collect browse.
- By 10:00 All bomas are clean and have been packed with fresh browse.
- 12:00 Water troughs are filled with fresh water.
- 15:00 Workers go out to start collecting evening browse.
- 16:00 – 18:00 Remove browse from the morning and pack in the browse for the night's feed.

Note: Black rhino need time in the middle of the day when they can be left undisturbed to rest.

E.1.2 Cleaning

It is usually best to wait two or three days for the newly caught rhino to settle before starting to clean its boma. Before this, it can be too stressful to move the rhino or even to hook the branches out of the boma. To injure a rhino just to clean a boma is unnecessary.

Great care should be taken when moving a newly caught rhino from one pen to another. **It is totally unnecessary to get a rhino so worked up that it injures itself in the process.** If the rhino really does not want to move, just leave it. Hook some old branches out and put new ones in. Sometimes it is best to leave the door open between pens at night so that the rhino can explore the adjacent pens and won't be afraid to move. The rhino must learn to move through a door without much fuss from the beginning. It is easy to teach them, especially if some fresh branches or something good awaits them on the other side. Unfortunately some animals develop a phobia about going through doors, especially if there is a lot of shouting, waving of clothes, and charging through doors in the beginning.

Large amounts of good quality browse are necessary to keep black rhino in bomas.
Photo: E. van der Westhuizen

In addition to cleaning out the dung and old browse, you must make sure there are no thorns the rhino may step on (especially thorns from *Dichrostachys* and *Acacia karoo* or similar) or bits of rope that have been pulled in that might be ingested. The lucerne and cubes must be thoroughly cleaned out as well, or the rhino may try to pick up the small pieces from the ground and end up consuming sand/dirt.

E.1.3 Feeding

Black rhino are browsers. In the wild they eat approximately 30 – 35 kg of a wide selection of forbs, shrubs and bushes every day. In the boma it is essential to provide them with an adequate quantity and variety of browse. Although forbs are important, especially in the wet season, it is usually difficult to collect them on any scale for feeding in the boma and so you tend to collect palatable bushes. Generally hard thorny species like acacias are favoured, though preference varies with different areas (see Appendix G for list of favoured species).

Feeding a black rhino properly in the boma is a big job. It is almost impossible to maintain a rhino in good condition in the boma on browse alone, as it is extremely difficult to provide the quantity and variety that the rhino would get in the field. A black rhino only takes a few bites from every branch of browse presented and, therefore, large amounts of good quality browse must be given. Good supervision is necessary to ensure that an adequate quantity and variety is cut.

At least four or more species should be given at every feeding. The browse should be cut as soon as possible before feeding to limit wilting. If the browse is not fed immediately, it can be sprayed with water and put in the shade to help keep it fresh. The first few nights the rhino are in the boma, it is a good idea to keep some

A large variety of browse should be hung from the boma wall to keep the rhino from ingesting sand.

fresh browse to the side. If the rhino bashes around during the night, putting some fresh browse in the boma might help settle it. It is important when cleaning out branches from the previous feed, to note what the preferred species are and to concentrate on them although rhino tend to keep on changing their preferred species. Not only is it important to note what species are being eaten but also how much. This is particularly important in the early stages of captivity where intake may be very limited.

When selecting browse, it is important to cut branches that are higher up the tress. This is especially important with acacias. The lower branches tend to have more thorns and tannin levels than the higher ones.

Nylon parachute cord toggle used to hang browse from boma wall.

Presentation of the browse is important. The browse should be presented so that the bites are easily accessible. Sometimes it is better to hang the browse from the side of the boma (especially if the bomas are small or the ground muddy). If the bomas are small, a rhino will often walk through and churn it up and much good browse is wasted. Hang the browse from the side of the boma using natural hooks on the branches, bark rope, or nylon parachute cord in the form of a loop or toggle. Do not use wire as it may be pulled into the boma with the browse and consumed with fatal results.

Although browse must be presented as fresh as possible, there are some food items like the fruit of *Kigelia africana* (Sausage tree), Tsama melon and succulent euphorbia species that can be kept for a week or two without deteriorating. These items should be stored in the shade.

E.1.3.1 Supplementary feed

It is essential to get the rhino onto supplementary feed in the form of good quality lucerne and cubes as soon as possible. Lucerne should be leafy, of top quality and free of mould and dust. You must be very critical about quality and be prepared to pay extra for the best. In the beginning, take about an eighth of a bale, "loosen it up," and check the quality and that there is no wire or other foreign object buried inside. Make a heap on a feeding slab or in a feeding trough made from an old truck tire. For an adult rhino, increase the amount of lucerne slightly each day until it is taking a bale (15 – 20 kg) each day.

If a rhino doesn't want to take the lucerne right away, you can try to chop some of the favoured browse into small pieces and mix that in with the lucerne. Also, you can mix brown sugar and water until you get a syrup-like consistency. If you have a pressure sprayer, spray the browse as well as the lucerne. If you don't have a sprayer, make the mixture in a bucket and use a smaller container to splash it on the browse and lucerne. The browse and lucerne will have the same taste and they will take the lucerne easier. The syrup will also make the browse sticky and if the lucerne is sprinkled onto it, it will adhere it the browse.

Horse cubes or browse cubes are usually fed. Browse cubes are better than horse cubes. They are made from natural browse and are high in fibre and low in energy (see Appendix for supplier information). As much as 5 kg of browse cubes can be fed per adult per day. If horse cubes are being fed, increase the amount until the (adult) rhino is taking about 2.5 kg/day. Never feed horse cubes ad lib. The cubes are usually put on top of the lucerne or fed in a separate container. Don't feed cubes on the ground, especially if the ground is sandy. Sand will be ingested and result in a sand colic. This can also be a problem if the rhino is picking up berries from species like *Grewia* that have dropped to the ground.

Supplementary feed should be given until release to keep the rhino in the best condition possible.

E.1.4 Water

Black rhino need adequate fresh, untainted water in the boma. It is best if the water is replaced daily. After the trough is drained in the morning, it is good to scrub it out and then to leave it to dry for at least an hour or two to prevent algal growth. Check the water throughout the day and clean and refill it if the rhino has urinated or defecated in the trough. If the rhino is in the boma, it inevitably responds to the sound of flowing water and immediately walks over for a drink.

With freshly caught rhino, it is often best if the water trough is full during the day and drained an hour or two after it gets dark. If the water is not drained, the rhino tends to get in the habit of splashing the water out of the trough with its forelegs. Once the animal has settled, leave the water in during the night.

E.1.5 Wallow

Rhino enjoy a wallow but in the boma the wallow inevitably becomes contaminated with faeces and if the rhino drinks this water it will get enteritis. Therefore, a wallow in the boma is not recommended.

E.1.6 Fighting

Sometimes rhino in adjacent pens will try to fight with one another. Provided the pens are sturdy, and the gaps between the poles not too large, this is rarely a major problem. It seems to be worst in bomas where the poles are tied to cables. If the fighting is serious, spraying it with water or putting some fresh branches into the boma can distract the rhino. If possible, an empty boma should be left between two rhino that are fighting.

E.1.7 Keeping the rhino happy

After the rhino have settled, they often enjoy human attention and company. Hand feeding them some of their favourites, such as sausage fruit, euphorbia, sugar cane and Tsama melon will help them to relax and become used to people. Another way to help them settle is to play a radio near the bomas. This gets them used to having constant background noise. When everything is quiet, a sudden noise can be distressful. If there is constant radio noise, it's not such a worry. If no radio is available, someone sitting outside the boma talking or reading aloud can achieve a similar effect. The latter option is also good because the rhino is not only exposed to constant noise, but human smell and movement as well.

In hot weather rhino enjoy being sprayed with water although too much water makes the bomas slippery. When spraying a rhino, hold a finger over the end of the hose (a backpack sprayer also works well) until you get a mist or light flow and direct it upwards so the water falls on the rhino. Be careful to avoid directing the stream at the rhino's face and ears. Most rhinos won't really enjoy this until they are settled into the boma and more relaxed. Spraying is sometimes a good way to distract a rhino that is busy breaking down part of the boma or fighting through the wall with another rhino.

Abnormal bite (left) and normal bite (right)

E.1.8 Monitoring

It is essential to critically evaluate the health of each rhino every day. Note the rhino's condition. Critically evaluating a rhino's condition is not easy. It is even more difficult to decide if the rhino's condition is improving or deteriorating. The belly is not a good indicator of condition. A rhino in a boma, even a habituated rhino in excellent condition that is eating well has a much reduced gut volume. By periodically taking photos of the rhino from different angles, you can see the change in condition over time.

Go into the boma, especially in the morning when it is cleaned.

- Check the faeces for consistency, colour, smell, mucus, worms, etc. Keep in mind that the pieces of browse in an older rhino's dung tend to be long, stringy, and crushed rather than cleanly cut.
- Check the urine. Normal rhino urine can be clear or milky white. It is also normal for some browse species (e.g. *Acacia karroo*, *Dichrostachys cinerea*) to colour the urine to an orange/orange-red. If the urine is a darker, port wine colour with a lot of froth, that may indicate a haemolytic crisis (break down of the red blood cells) and the rhino must be attended to immediately. There are numerous potential causes, but the most likely with wild caught rhino is theileriosis. Sometimes the day after transport, there is a slight pinkish discolouration of the urine. This is myoglobin/haemoglobin from bruising and is generally not serious.
- Check to be sure there are no discharges – blood, pus, mucus, etc.

Skin abrasions on nose and lip due to self-inflicted trauma in crate and in boma.

- Check for teeth in the boma. Worn deciduous teeth might be found lying around. This is normal.
- Check to see which species and how much the rhino has eaten. Look to see if the bites from the branches are cleanly cut. An abnormal bite may indicate a problem with the teeth. Keep in mind that rhino will eat up to ⅔ of its total daily intake of browse during the night.

Stress bands on toenail

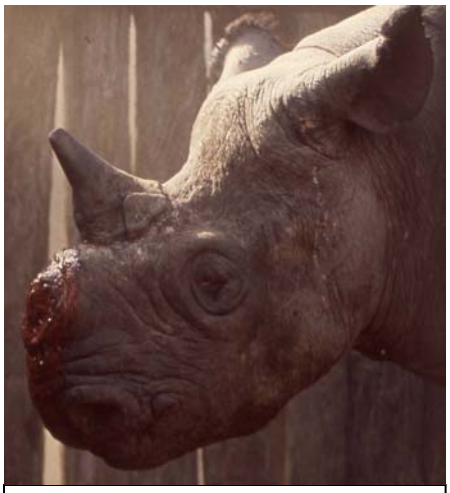
E.1.9 Veterinary Problems

- **Skin** – Cracks, cuts and abrasions often due to capture, transport or self-inflicted trauma in the boma. Skin on the lower legs often gets traumatised from walking through thorny browse in the boma, especially *Acacia mellifera*. Skin lesions usually heal easily. They can be treated with an antibiotic/fly-repellent spray or wound oil.
- **Nails** – Nails are sometimes damaged during capture or in the bomas. It is best to trim off the damaged part of the nail. We have seen rhino that have gone through a period of extreme stress lose toe nails on one or more feet.
- **Eyes** – There are fewer eye problems than one might expect. Often during capture, dust gets into the rhino's eye. This is best flushed out with saline or clean water. Oily eye ointments are not recommended, as they attract dirt. Often, corneal abrasions of the eye occur during capture. They are painful and the eye waters considerably. Antibiotic ointments or mastitis preparations can be used to treat them. Some animals will allow treatment through the poles of the boma. For more serious abrasions of the cornea, we have stitched the third eyelid over the eye for a few days. At capture, be sure that there are no thorns in the eye. This can easily happen if the rhino pushes its head into a thorn bush. It is not uncommon for rhino, especially bulls, to be blind in one eye from fighting and this should be picked up at capture. A blind animal may find it more difficult to adapt to captivity.

Purulent discharge from eye; note damage in front of eye due to hitting door post.

- **Abortion** – Occasionally pregnant females will abort in the boma. This is either from the stress of captivity or an infective

agent. Try to make sure that the placenta and membranes are out. It might be necessary to immobilise, flush out the uterus and insert antibiotic pessaries.



Horn loss in boma

Photo: M. Kock

- **Fractures** – Fractured nasal bones usually occur as a result of the rhino bashing into something solid like a steel pole, concrete water trough, etc. Typically you will see bleeding from both nostrils although it might not be a great deal of blood. Inevitably, if the rhino remains in the boma, continued trauma is going to result in a massive infection, septicaemia and death. It is best if the animal is immediately released back into the bush. If it has a fair-sized horn, it should be immobilised, the horn trimmed off, and given a good dose of broad-spectrum, long-acting antibiotic. We have seen a fractured jaw in a calf. The jaw was plated and the calf was fed powdered browse cubes until the jaw healed.
- **Diarrhoea** - This is very rarely a problem. Sometimes a stressed rhino will have a loose stomach for a day. An acute, fatal clostridial enteritis (*Clostridium perfringens* Type D) has been seen after a rhino was given ad lib high-quality lucerne soon after capture. This is why it is important to build up the amount of lucerne fed slowly over about 10 days.
- ***Salmonella* diarrhoea** - We have no experience with *Salmonella* infections in captive black rhino, but it is common in captive white rhino. The rhino are more susceptible to the infection during a period of stress. Symptoms include watery diarrhoea, possibly with blood, mucus and fibrin. It can be treated with oral antibiotics (furazolidone) and parential antibiotics (Potencil). Electrolytes, glucose, etc. should also be given. *Salmonella* is carried by rodents, so rodent control is essential, as is good overall hygiene.
- **Pneumonia** – This is potentially a problem, especially in cold and dusty conditions. Long-acting antibiotics given at capture help prevent pneumonia.
- **Babesia/Theileria** – It is possible that the stress of capture and captivity will precipitate clinical signs of babesiosis in animals in the boma. The rhino will be lethargic and have dark red frothy urine. The faeces will also tend to be yellow. The haematocrit (PCV) will be very low and the mucus membranes pale or yellow. A large number of piroplasms (small or large) will be found in the red blood cells. The rhino should be treated with diminazene (Berenil) or imidocarb (Forray 65) by pole syringe or dart and left in an environment that is as quiet and stress-free as possible. Immobilisation or exertion will almost certainly kill the rhino because of the lack of red blood cells and the inability to transport oxygen to the tissues.
- **Filarial wounds** – A filarial nematode, *Stephanofilaria dinniki* causes skin lesions under the neck and legs, and on the side of the chest behind the forelegs. The nematode is found in east Africa and the eastern part of southern Africa in more moist/humid environments. It is carried between rhino by a fly vector and probably does not occur in drier areas because of the absence of the vector. When moved from a filarial area, the wound can be treated with wound spray/oil and should heal. Dectomax or Ivermectin will kill the worm.

Filarial scar behind front legs

- **Colic** – The gut anatomy of a rhino is very similar to a horse and like a horse they can get colic. It is seen primarily in young rhino that are being bottle fed and older rhino where there is an obstruction or torsion of the gut. Great care must be taken to keep the rhino from eating from a sandy floor, as there is a good chance of a sand colic. In this case, an antispasmodic like Buscopan and a lubricant like liquid paraffin may help.

Snare wounds on front and back legs

Photo: C. Foggin

- **Snare wounds** – Often rhino with snare wounds are put into bomas, or rhino get snared after release. Typically the snare knot pulls to the back of the leg and sometimes the flesh has grown over the wire so that only a piece of wire is seen sticking out behind the wound. If the wire is deep in the flesh, it should be cut at the front of the leg with wire cutters and pulled out from behind. It might be necessary to work the wire loose. Once the wire is removed, the wound can be treated with agriflavine glycerine, antibiotic spray or wound powder. A fly repellent will probably also be necessary.
- **Joint swelling/pain** – In a small boma where rhino are turning a great deal, the turning action of the joints can result in inflammation, swelling and pain. The rhino may tend to lie down a great deal and be lame when it walks. Long-acting tranquillisers may help, but the rhino should be released or moved to a bigger boma.
- **Knocking off horn** – Horn loss is most commonly seen in sub-adults and cows and is often a result of bashing in the crate during transport. Animals with forward sloping horns are more likely to lose their horns. Sometimes the horn is knocked straight off, but usually it starts to lift from the base at the front and it may be a few days before it comes off. There will be some bleeding as it comes off, and the base can be treated with an antibiotic spray or wound oil. If the rhino settles quickly in the boma, the loss of the horn will not be a big problem. It is a problem in animals that continue to bash the boma with the stump and these animals should be released as soon as possible. Trimming the horn at capture, tranquillising well during transport and in the boma initially, and good crate and boma design can prevent horn loss.
- **Trypanosomosis** – Black rhino, which are carriers of *Trypanosoma* spp., can get the clinical disease after capture or naïve animals that are taken to an area where the parasite occurs can become sick after exposure. Death from trypanosomosis is rare and usually only occurs in very stressed or compromised black rhino. Stress appears to be important in precipitating the disease. Diminazine can be used for treatment and isometamidium can be used as a prophylactic. When introducing naïve black rhino into an area where the parasite occurs, care should be taken to limit exposure to tsetse fly initially, and increasing exposure allowed once the rhino are settled and in good condition. Tsetse targets and traps can be used to reduce and monitor exposure. Blood samples can also be taken to see if the animals are infected and what the parasitemia is.
- **Anthrax** – Vaccination against anthrax is possible, but it only lasts one year. The anthrax vaccine and antibiotics cannot be given simultaneously, and it is often better to cover the rhino with antibiotics.
- **Abscesses** – Rhino in boma may sometimes develop abscesses. This is usually a result of broken needles, untreated dart wounds, general debilitation, etc. Leave the abscess until it is ripe – increased in

Abscess formation on neck

size and localised. At a certain point over the abscess, the skin is thinner and tends to be shiny. Lance a cross into it with a scalpel blade over the lowest point. Squeeze all the pus out. Flush it with warm water and iodine. When it is "clean," flush it with a weak peroxide solution. Fill the abscess with an antibiotic like oxytetracycline or long-acting penicillin, or put in a pessary. Leave the cut open to allow it to drain. Inject the animal with long-acting antibiotics, even if they were given previously.

- **Deworming** – Black rhino naturally have high worm burdens, but they are not usually dewormed, though we have had to deworm rhino for export and sick rhino. Oral, injectable, and pour-on ivermectin (Ivomec) works well, as does injectable doramectin (Dectomax). No problems were encountered.

E.1.10 Pregnant females

Heavily pregnant females should not be caught, but if they are caught, they should be released into the bush as soon as possible to give her time to settle in the new area before calving. If she is put into a boma, a particularly close watch should be kept on her and release should be considered if she appears close to giving birth. Until then, she should be kept in a separate and/or quiet boma, especially if there is a boma with a camp attached to it, giving her room to move and a place to hide. If a cow gives birth in the boma, she usually either doesn't have milk and/or doesn't look after the calf properly. There is also a risk that in such a confined area, the cow may step on or crush the calf. If the cow does give birth in the boma and the calf needs to be hand-reared, see Appendix H.

E.1.11 Length of time in boma

It is difficult to specify hard and fast rules, as rhino and conditions vary.

For ordinary translocation from one conservation area to another, a minimum period of one month in bomas at the capture site is recommended. A longer boma period is better than a shorter one. Before the animal is moved, it must be

- used to being in the boma, relaxed, comfortable with the presence of people and used to the daily routine
- in good condition
- on supplementary feed – lucerne and cubes.

For export, the rhino should be in the boma at the capture site for at least two to three months. A much greater level of habituation is needed.

At the release site, the rhino should be held for 10 – 14 days. Before release, the rhino must be

- over the stress of transportation
- relaxed and in excellent condition
- used to the local browse and conditions.

E.2 Loading from the boma into a crate

E.2.1 Load with a very low dose of etorphine

A dose of 0.25 mg can be used to load an adult rhino into the crate. After darting/injecting, wait about 15 – 20 minutes until the rhino is affected. Its eyes will be glazed and/or partially closed, its head will be down, it will often salivate, and will walk with a stiff gait. Tie a sack or cloth to a stick and wave it back and forth in front of the rhino, close to the ground. The rhino will usually move towards the cloth. Keep doing this until the rhino is in the crate. This requires a lot of patience. It must be done quietly and carefully or the rhino may get a fright and back off. Sometimes the rhino will stop as it's going into the crate, but usually it will eventually go in. Once the rhino is in the crate, wait a little while until it has settled before putting the

pipes behind it and then close the door. With this dose, the rhino should stand well, but if it starts collapsing, give 20 mg nalorphine intravenously for an adult.

This technique works well, but takes a lot of time and patience and it is sometimes necessary to re-dart the rhino before you achieve the right level of sedation.

E.2.2 Load with a higher dose of etorphine

A faster method of loading is to use a dose of 1 mg etorphine + 50 mg azaperone. In this case, the rhino will walk into the crate a lot faster and more easily (usually after about 10 minutes). A cloth can be used (as above) to attract the rhino to the crate. Don't wait too long before trying to get the rhino into the crate or it might collapse in the boma. Once in the crate, close the door and give it 20 – 40 mg nalorphine intravenously. It is also an option to give 5 – 10 mg diazepam intravenously. If this is done, a low dose, about 0.6 mg, of diprenorphine will have to be given with the nalorphine. It will take a few minutes before the rhino stabilises on its feet. It may be necessary to prod the rhino around the ears to get it to stand up properly and then back off. (**Note**: With a black rhino pushing and collapsing in the front of the crate, never prod it at the base of the tail – this will just make it push more.)

This is a faster and easier way of loading a black rhino, but the rhino sometimes blunders around the boma for a while before it goes into the crate. It can be tricky to stabilise the rhino at the right level of sedation once it is in the crate so that it is not too lively, but is also not pushing or collapsing.

E.2.3 Immobilise the rhino in the boma and walk/pull it into the crate

Immobilise the rhino in the boma and walk it into the crate using a low dose of nalorphine, or pull it to the crate on its side and wake it up into the crate with nalorphine.

This is a quick way of loading a black rhino, but enough people and ropes are needed if you are going to walk or pull the animal. If the rhino is to be pulled, remove any rocks on the ground and put hay down to prevent abrasions. The ropes are attached to the feet, head and between the hind legs. This is a good technique if one has to do a big procedure (like implanting a horn transmitter) on loading.

* When loading animals for export, you can use one of the above techniques (probably the method described in E.2.1). What works well is to quietly inject the rhino intramuscularly while it is feeding in the crate and keep it feeding. It will slowly become affected and then, when ready, the door can be closed.

F. RELEASE AND POST-RELEASE MONITORING

A critical part of moving black rhino is the release process and the intensive monitoring of the rhino after release until the animal has settled in and is adapted to the area and conditions. This can take a few months or even a year or two.

F.1 Pre-release

Prior to release, the rhino's ears should be notched, photographs taken and characteristics noted. Spoor size should be measured in the boma and notches can be made in the hooves to differentiate tracks. All black rhino should have a radio transmitter implanted in the horn or, alternatively, a radio collar attached. The horn implant is the better option but a collar may be the only option for calves with very small horns or for rhino that have been dehorned. Before the rhino is released, the telemetry equipment should be checked to be sure the transmitters and receiver are working, you have the correct frequencies, and what the ranges of the transmitters are.

Before release the area should be checked for wire, snares, old wells, etc. Put additional water along the fence line, especially where there are corners. This water can be provided in half drums which are dug into the ground (be sure the drums are properly cleaned and there is no strange smell/taste to the water), water troughs which are low and accessible to the rhino and even shallow holes which are dug into the ground and lined with plastic. Put the water out before release. After release check to see if it is being used. Continue to refill until the rhino are properly settled.

We recommend that the dung of the rhino in the bomas be spread around the new area prior to release. The idea is that the rhino will be comforted finding their dung and that of the other rhino, in the new area and they will settle faster and want to stay in that area. It may or may not work, but it certainly does no harm.I

F.2 Training people to monitor rhino

It is essential that the people who are going to be monitoring the rhino are trained in monitoring and anti-poaching. They can be trained at another location, on site, or both. It is good to bring in experienced rhino monitors who can assist initially and help with training. The rhino monitors must be able to:

- Track a rhino and anticipate its reactions
- Record data, including track sizes and distinguishing features, horn shape and size, ear notches, other features
- Read a map and use a GPS
- Take photographs
- Write and take notes
- Use a telemetry receiver

F.3 Release

F.3.1 Release from a boma

Rhino should be released one at a time, with at least 24 hours between each. Young animals should be released first, followed by older females and, last of all, older males. This gives the young and the females time to settle before the big bulls move in to establish themselves.

It is best to release rhino in the early evening as it is getting dark. Being nocturnal, rhino see well at night and are more confident and more relaxed. Released in the early evening they have the whole first night to wander around and get used to the area before day comes. A good moon helps. They must go out well fed

and with a drink of water. Keep to the normal routine. In the afternoon before release, they must be watered and fed as usual. There should be no vehicles within a few hundred meters. No drums, ladders, wheel barrows or other equipment should be close to the boma (often the off-loading ramp is the best place to put loose equipment). There should also be a maximum of two people at the release.

Boma gate with browse laid out for rhino release.

Photo: E. van der Westhuizen

Open the door to the outside in an adjacent pen (make sure there is nothing blocking the exit). If the exit door is a swing or sliding door, make sure the door is fastened open. You can make a slight funnel using old branches to direct the rhino away from the boma. Place some preferred food like lucerne or euphorbia outside the boma to draw it out and away from the boma. (You want to draw the rhino away from the boma because if it comes back to the other pens from the outside, the other rhino in the boma will take umbrage at having a rhino approach them from an unknown side and get worked up, which may make the released rhino so excited that it charges off.) There should be absolutely no disturbance, lights, cameras etc. When everything is quiet, carefully open the door between the pens and quietly back off. After opening the door the person can quietly climb onto the catwalk behind the bomas or the off-loading ramp to observe the rhino leave the boma. Sometimes it is an hour or two before the rhino leaves the boma. Occasionally the rhino won't leave at all. Close the doors and try again the next evening. There is no need to chase the rhino, or get it excited in a rush to get it out of the boma. It must leave at its own time. Often a rhino will walk out of a boma and then return and possibly even do this a number of times, so water and food should be left until the following day. Once the rhino has left the boma, give it a while to wander off before moving. It might still be in the vicinity. Walk quietly away. If it is necessary to drive away from the boma, do so slowly and carefully. Once all the animals are released, the bomas can be left open with water until the rhino are settled. If there is an animal that is of particular concern, e.g. a sub-adult in poor condition, food can also be left in the boma until you are certain the rhino is relaxed and eating.

F.3.2 Release into the field

F.3.2.1 Immobilised

Take the animal to the release site (close to water, away from disturbances, etc.) in the field in a crate or anaesthetised on the back of a truck/trailer. If anaesthetised, put the animal on the ground, facing towards water and away from the people and vehicles. Move vehicles, equipment and surplus people at least 400 m away. Three or four people must stay. Put the rhino on its sternum, give the antidote, remove the cotton wool from the ears, remove the blindfold, and walk quietly away. Watch from about 60 m. Check that the rhino gets up well and then quietly move away.

F.3.2.2 Crate

Releasing black rhino directly from a crate into the field can be problematic. Inevitably they come out fast, turn around, hit the crate and charge off – not a good way to work with such a valuable animal! Various options have been explored over the last few years:

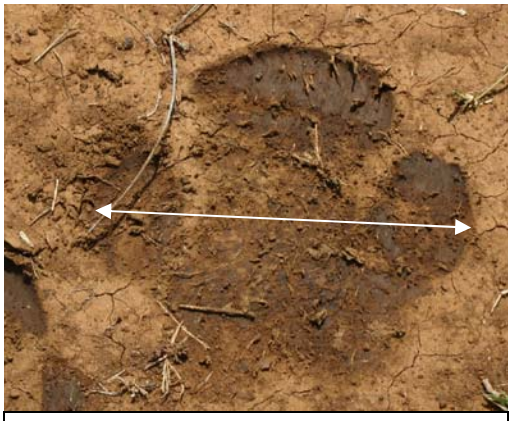
- Transporting the rhino anaesthetised until it is off-loaded – either on a sledge or on the back of a truck after picking it up by its feet. This works well if the distances are short. Good care of the anaesthetised animal during transport is necessary and "top-ups" may have to be given.

- Releasing rhino out of crate after giving a low dose of etorphine (0.05 to 0.15 mg) plus 80 – 200 mg azaperone. This can work well but the rhino may still get a fright. It is best to have someone watching the rhino from a distance until it perks up.
- Give the rhino an immobilising dose of etorphine (and, if necessary, azaperone) and either wait until it has gone down in the crate and pull it out, or, just before it goes down, let it walk out of the crate to lie down a short distance away (tie a rope to its hind leg to control it until it goes down). This is a good option, especially if you have to do any additional procedures (ear notching, photographs, etc).

Put the crate on the ground. It is best if the rhino is given another immobilising dose of etorphine and azaperone. Either have the rhino go down in the crate or open the door just before it goes down and let it walk out (with a rope attached to the hind leg). If it goes down in the crate, it is best to tip the crate and pull it out. The truck, crate and surplus people should be removed before the rhino is woken up.

F.4 Tracking

This is an essential skill for monitoring rhino. It is increasingly difficult to find good trackers and it is not a skill that is easily taught. Not only must a tracker be able to follow a rhino, he must also have the experience and confidence to get close to a rhino and to anticipate the rhino's movements. It is good if the trackers have a small tape measure to measure the track. The measurement is taken across the foot at the widest part – the two outer toes. Measure the same foot on the same side for each rhino's track. Records must be kept of the size and distinguishing features of a track. Making a distinctive notch in the nail of one of the toes at capture also helps to identify the track of a specific rhino for a few weeks after release.



Measuring black rhino track

F.5 Telemetry

All black rhino translocated into a new area should be fitted with radio telemetry. There are a number of manufacturers on the market, including Telonics, Sirtrac, and ATS. See Appendix for details.

Some of the equipment necessary to implant horn transmitter

F.5.1 Horn transmitter implants

Horn implants are generally the best option. A hole is drilled in the side of the horn (usually the front horn) which is slightly bigger than the transmitter. A Forstner drill bit is used for this. The horn is tipped and a second hole is drilled down the length of the horn from the flattened tip to the transmitter hole. This second hole is for the antenna. A 400 mm x 8 or 10 mm steel drill bit is used for this. The transmitter is implanted in the horn using dental acrylic. Depending on a number of factors including size of horn, position of transmitter and battery life, the horn transmitter will work for six months to two and a half years. A duty cycle (transmitter is only active during pre-set times) can be built into the transmitter to

increase the battery life. A mortality sensor is also useful. If the transmitter/animal hasn't moved for a certain number of hours, the transmitting signal changes frequency.

Radio collar on de-horned rhino

Photo: M. Kock

Transmitter implanted in horn – note position drawn out, hole from top for antenna, horn being drilled for transponder insert.

F.5.2 Radio collars

Radio collars don't work well in black rhino and are not recommended. They should only be considered when a horn implant is not an option. The only design worth considering is a canvas-type belting with an elastic insert at the top of the collar between the ears. Collars tend to come off easily, especially in the wet season when the rhino rub a lot after wallowing. Often the collars come half off, either over the ear or over the eye. There is also often chafing behind the ears and if the collar is put on too tight it can cut into the neck.

F.6 Post-release

For the first few days after release, the rhino should be given a chance to settle down with minimal disturbance. It is necessary to check fences to see that the rhino has not broken out, as newly released rhino often lie close to the fences. It is better to quietly walk around the fence line and observe from the outside. Checking the waters lets you see if it has been to drink, gives you an idea of where it is, and shows you whether or not it is moving from day to day. It is not necessary to actually see the animal for the first few days unless you suspect a problem. After about four days, it is a good idea to track the animal down to check on its condition and see that it is eating and appears alert. Thereafter, continue monitoring and try to see the rhino every few days.

F.6.1 Problems seen after release

- Rhino falling over cliffs, into dongas, getting stuck in rock dead ends, rivers and dams
- Rhino not finding water and breaking through the fence or dying of thirst
- Rhino being injured and/or killed in fights with other rhino, elephant, lion or hyena
- Rhino running out of energy. This happens when they move a lot and don't eat well. They use more energy than they can get from food and there is a breakdown of body reserves. This situation is more likely in cold winter conditions. These animals are often in fair condition, but lethargic and "tame" because of lack of energy. If this occurs, try to give supplementary food (lucerne and cubes) and water in the field. If necessary, the rhino can be caught and put in the bomas. Unfortunately,

Black rhino will often walk the fence line after release. Yellow flags have been tied to the fence to make it more visible.

rhino in this state often die.

- Rhino may hit a vehicle or be hit by a vehicle, as they often use roads to walk on and lie up close to the roads. If a vehicle drives by, the rhino may jump up and either hit or be hit by the vehicle.

G. EXPORT/IMPORT OF BLACK RHINO (most of this applies to transporting zoo rhino back for re-introduction)

The re-introduction of zoo-born rhino is not easy and must be well thought through.

G.1 Preparation

- The rhino selected should be a robust animal, less than ten years old.
- For wild rhino going to a zoo, selection must be made carefully. Some rhino have a personality that can cope with captivity and some haven't.
- The release site should be visited to check the bomas, transport and staff.
- Veterinary export and import permits and regulations need to be obtained.
- A good freight agent has to be found.
- Rhino should be screened for disease well in advance of transport.
- Wild rhino should be fed the diet they will receive in the zoo during the boma period (lucerne/alfalfa; browse/rhino/horse cubes; fruit – apples, oranges and bananas; vegetables – potatoes, carrots, sweet potatoes; grass hay)
- Rhino should be crate trained using a false crate.

G.2 Export crate

An export crate is not as robustly built as a field recovery crate. The frame is made of 75 mm channel iron and 40 mm pine planks. The internal dimensions of an export crate are 3 m long x 1.2 m wide x 1.8 m high. The external dimensions are very important for air transport and usually should not be more than 3.18 m long x 2.10 m high.

Export crates have simple swing doors made of wood and 50 mm angle iron. They are divided into a larger upper door and a smaller lower door. The front and back doors are similar except that the front door is lined with 1.5 mm steel plate. Doors of this design are necessary for feeding, cleaning and ventilation during transport.

There are four vertical 90 mm pipes at the front of the crate and three horizontal 60 mm pipes at the back of the crate at 0.6 m, 0.88 m, and 1.15 m from the floor. The two middle pipes at the front of the crate are bent outwards at the bottom so that a plastic baby bath can be slipped into the crate to provide water for the rhino in transit.

The front ⅔ of the crate roof is closed. A hatch that can be opened or closed can be made in the front third of the roof to aid in feeding or injecting the rhino, as it is not always possible to open the front door during transport.

The crate floor must be covered with a rubber mat that is well bolted down, as in the field recovery crate. The wooden floor should be well supported with channel iron across it every 48 cm.

G.3 Crate training

The best way to get a rhino used to being in a crate is to set up a false crate (see Appendix I) made up of poles with gaps between them. The false crate is less intimidating to the rhino and gives the handler greater access to the rhino. It also gets the rhino used to people working behind it. For a wild rhino, the false crate can be introduced a week or so after the rhino is put into the boma, giving it time to settle. The wild rhino's boma period should be about three months long. More time is required because a greater level

of habituation is necessary. For zoo rhino, crate training should begin a minimum of six weeks before export. When the rhino gets used to eating in the false crate, 2 m of poles are taken away and the export crate is placed in front. Ideally, the rhino should be comfortable being closed in the crate before export.

One way to work towards this is to get a strong wooden pole approximately 2 m long and about 15 cm thick. Attach strong ropes to both ends and tie the ropes to the horizontal support at the top of the vertical poles of the false crate. When lowered, this pole should be about 30 cm below the base of the rhino's tail. When the rhino is very comfortable with the false crate/crate, two people can stand on both sides of the horizontal pole and quietly lower it into position. If the rhino tries to back out, it will feel the pole. Within a few seconds it will probably begin to stress. You will see it in the rhino's eyes. Quietly lift the pole as the rhino moves forward. Repeat this and lengthen the period that the pole is in position until the rhino is happy being confined. Great care must be taken when doing this to prevent the rhino from getting a serious fright and refusing to go back into the crate/false crate. Ultimately you want a situation where the rhino is happy with someone climbing into the back of the crate (stand tightly in the corner) during transport to brush, clean or inject the rhino. While in the crate, the rhino must be comfortable with the noise of vehicles, aircraft, etc. It is helpful to play a tape recording of these sounds during the crate-training period.

Before export, the rhino should be totally habituated to eating and drinking (from a baby bath or a hosepipe) in the crate, and being comfortable with someone behind it while it's in the crate. This person should be able to talk, touch, brush the rhino, make sudden movements, etc. When transporting the rhino, tranquillisation may be necessary (see B.3.5. Tranquillisation during transport) but if the habituation is done well this should be minimal. It is also important to organise breaks during the trip during which the rhino can be fed, watered, cleaned and rested.

G.4 Flying with rhino

Discuss the flight with the pilot. Ask for a gradual ascent and descent and that he is careful about accelerating and braking. Also ask that the hold temperature is about 18°C (the rhino is calmer if it is cooler).

Face the rhino in the direction the plane is flying (as the back of the plane is lower than the front in flight). Try to get the pallet with the rhino positioned such that it does not have to be shifted around too much if cargo has to be loaded or off-loaded at stops on the journey. Try to position the pallet in such a way that it is possible to open the door in flight wide enough to give feed and possibly even water. It is also good if one can swing the lower door at the back of the crate during flight to remove faeces if necessary (not essential). Check that there is access from the top of the crate if you have to inject the rhino on the trip. Absorbent material must be put on the pallet under the crate to absorb any urine and plastic sheeting should be put under the crate and tacked to the sides to also prevent urine leakage in to the aircraft hold.

Make sure there is enough feed in the form of lucerne, fruit, vegetables, etc. for the trip. Put the lucerne bales in sacks. Keep the feed on the pallet next to the rhino. Also take at least 40 litres of water in 2 x 20 liter plastic containers on the pallet. Have about 3 baby baths or a hosepipe to give water (easily broken by the rhino). Make sure you have plastic refuse bags for faeces and old food, etc.

Besides veterinary equipment and drugs, you must have a pole syringe, torch (head-lamp best), prodder, bags for equipment, tools - including spanners to open and close the door bolts, a Leatherman, a small crowbar and some wire and thin rope. There is a great deal of noise and jerking the animal around with the loading and off-loading of the crate and transport to and from the cargo holding area - anticipate the needs of the animal regarding tranquillisation and give in good time so that the rhino does not stress during this period. One handler should always be with the rhino, especially with the loading, off-loading, and transport to and from the plane. Everyone will want to climb on the crate to see the rhino - keep them away. Make sure all the documentation is in order.

G.5 Moved to a new area

G.5.1 Zoo-born rhino to the wild

The rhino should be moved with a keeper and a vet that it knows. The keeper should stay in the new area with the rhino until it is settled. The wooden boma in the new area should have a few-hectare camp attached to it, surrounded by a fence that is easily seen. The rhino should always have access back into the boma from the camp and its normal routine should be followed until it has settled in the camp. After that, you can begin to decrease its contact with humans. Ultimately there should be only one person working with the rhino. When the rhino is ready, it can be moved into a 50-100 hectare camp and once it is settled, there should be almost no human contact. The rhino should stay in the large camp for six months to two years, when it can then be released into a wild/large area. It should receive supplementary feed in addition to browse until it is released. It is necessary to closely monitor the rhino after it is released.

G.5.1.1 Problems associated with zoo-born rhino re-introductions

- Zoo-born rhino have very limited exposure, and therefore different reactions to other things and situations, including other rhino.
- They aren't as physically robust as wild rhino.
- They are often very nervous.
- They haven't been exposed to parasites and disease agents.
- They don't know predators or other large herbivores.
- They have never had to find water.
- They haven't been exposed to natural browse, poisonous plants, etc.
- They can adapt, but it takes time (1-2 years).
- It is difficult but imperative to break the human link. They will naturally gravitate towards people.
- People must understand that a zoo-born rhino is very different from a wild rhino and needs special care and attention.

G.5.2 Wild rhino to a zoo

It is important to have the person who habituated the rhino travel with it to the zoo. It is also good to have one or more zookeepers spend some time with the animal before it is exported. Continuity is important and will help the rhino settle faster.

H. EUTHANASIA OF A RHINO

Sometimes it is necessary to euthanase a rhino. One gram of succinylcholine (Scoline) made up with water into a concentrated solution and injected intramuscularly will quickly kill the rhino and leave a non-toxic carcass. An overdose of etorphine (or other powerful opioid) or an overdose of pentobarbitone (barbituate anaesthetic) or a combination of both will also work and is more humane, but the carcass will be toxic. In some situations, a brain shot with a medium to heavy calibre rifle will also be an option.

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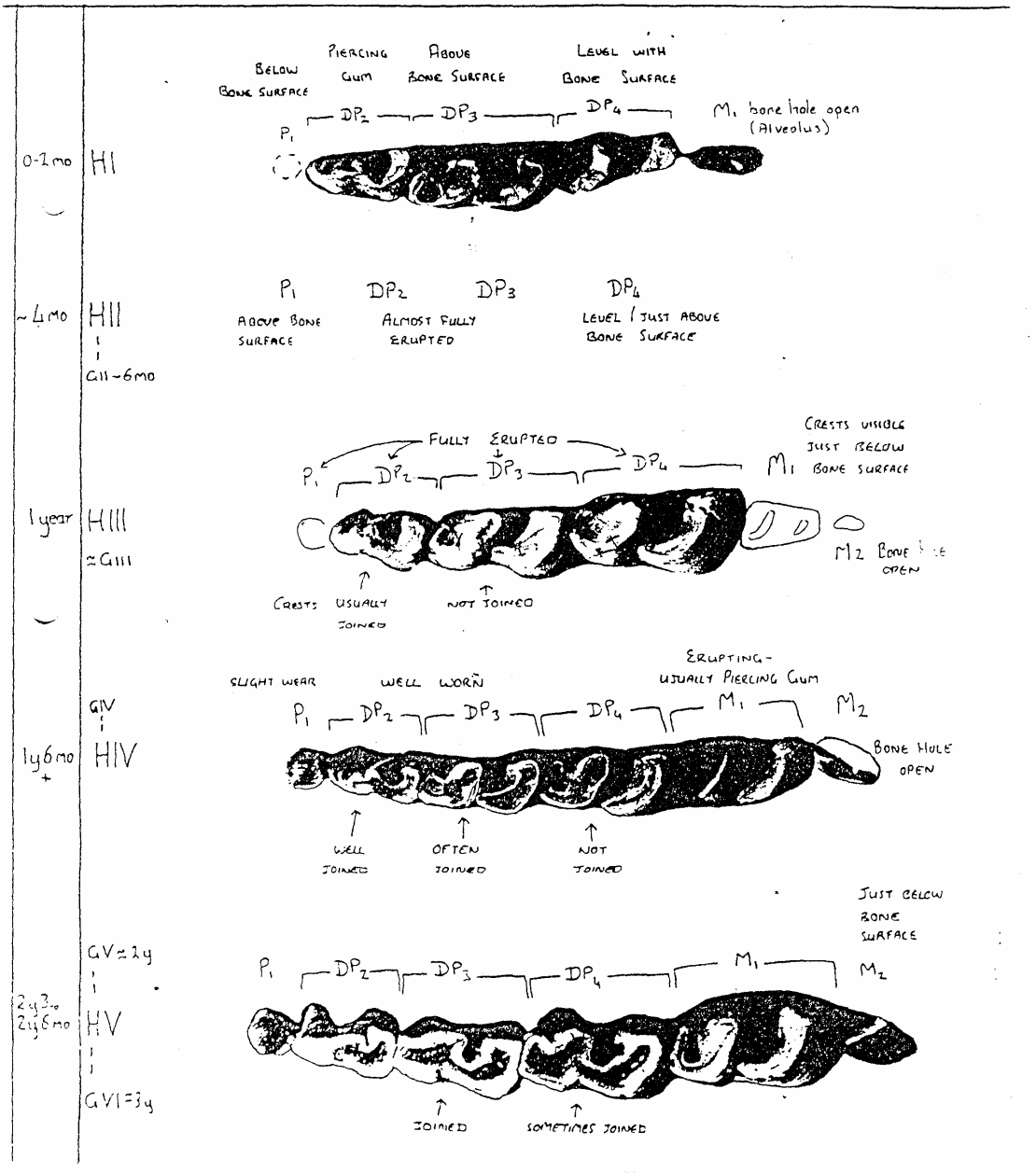
APPENDIX A

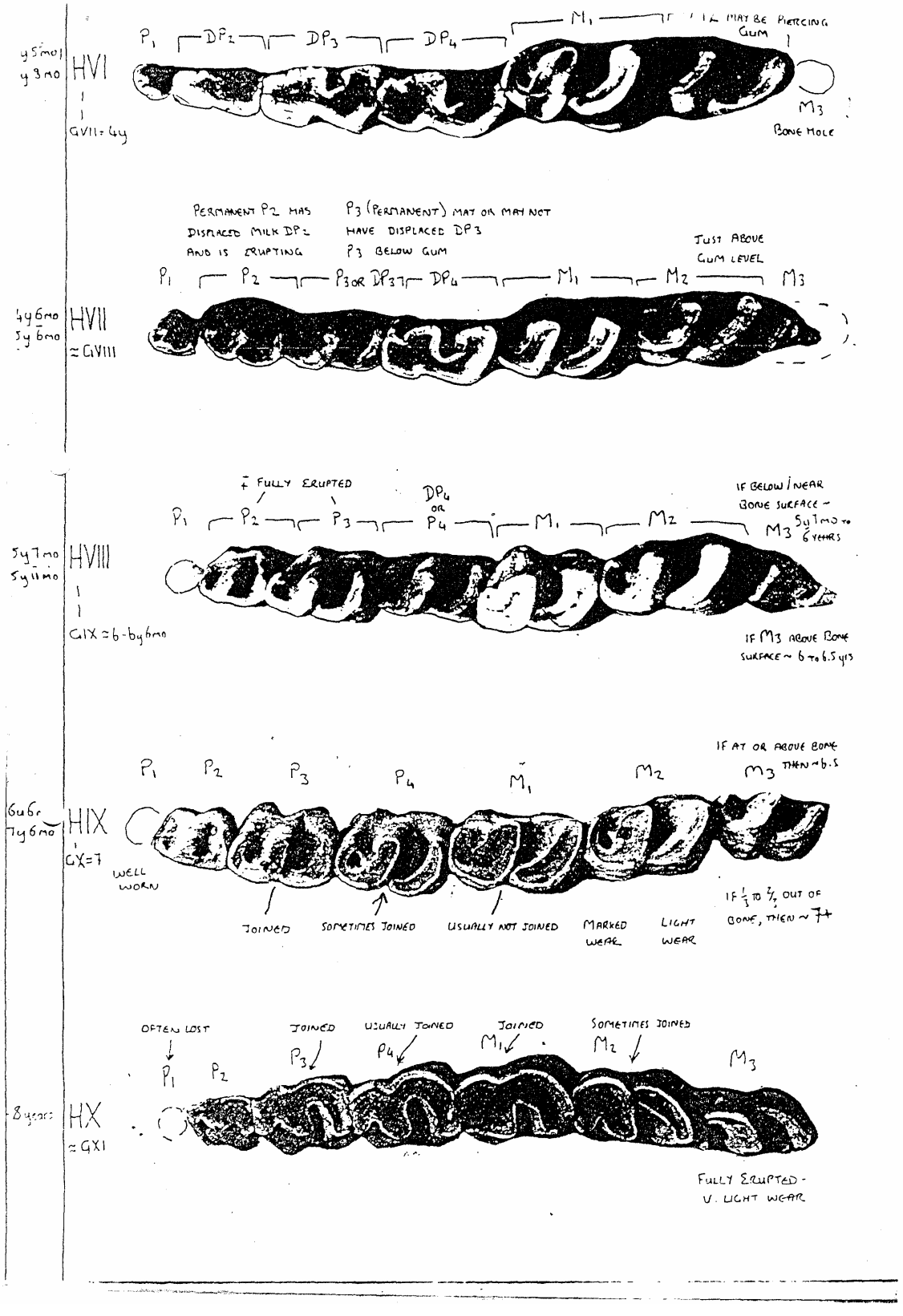
AGING BY TOOTH EMERGENCE AND WEAR
From Hitchins (1978) and Goddard (1970)

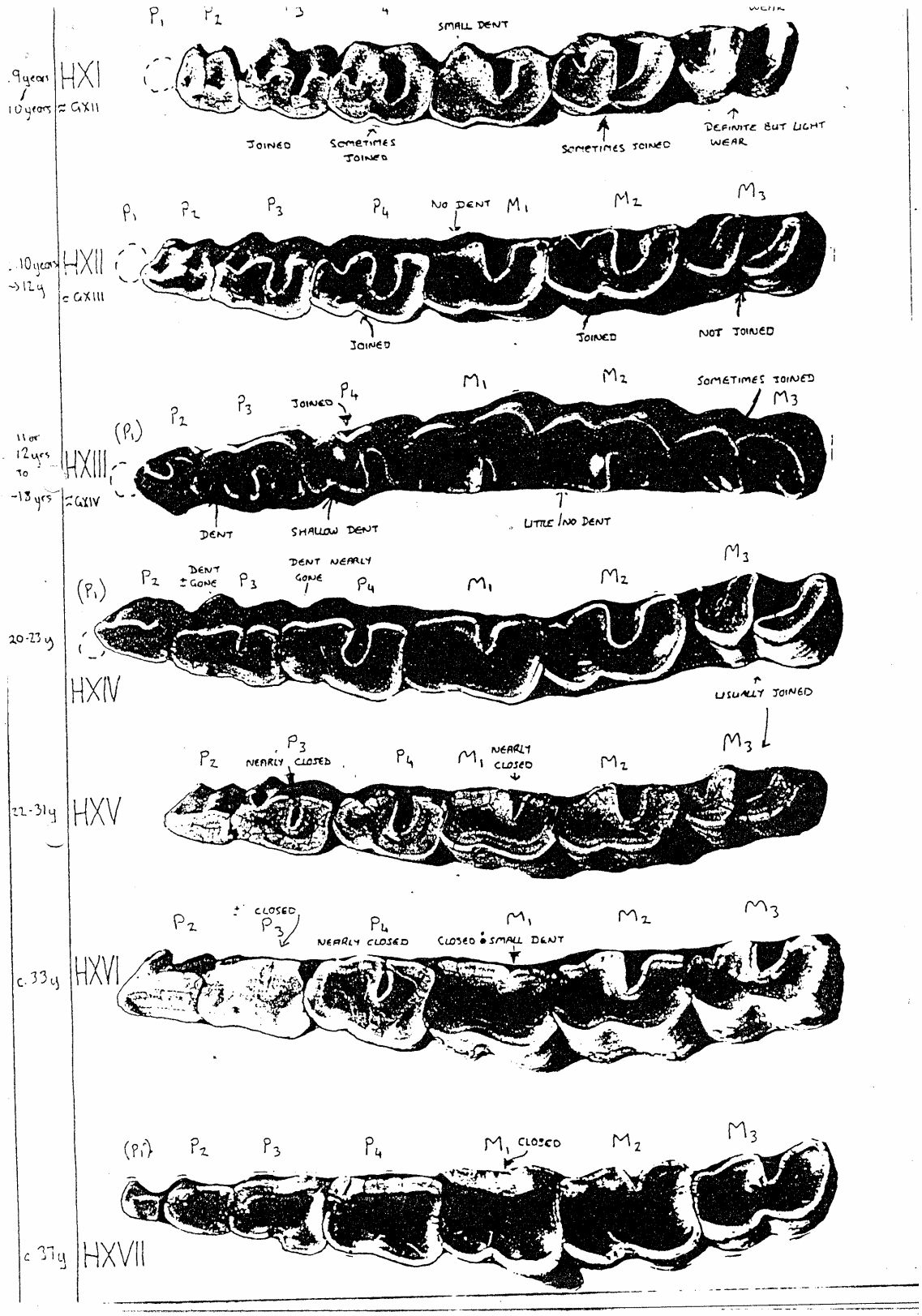
These descriptions are for teeth in the skull of dead rhino. The original gum line is where the tooth side curves back to the root, often shown approximately by a change in color of the tooth (top area above gum line is darker).

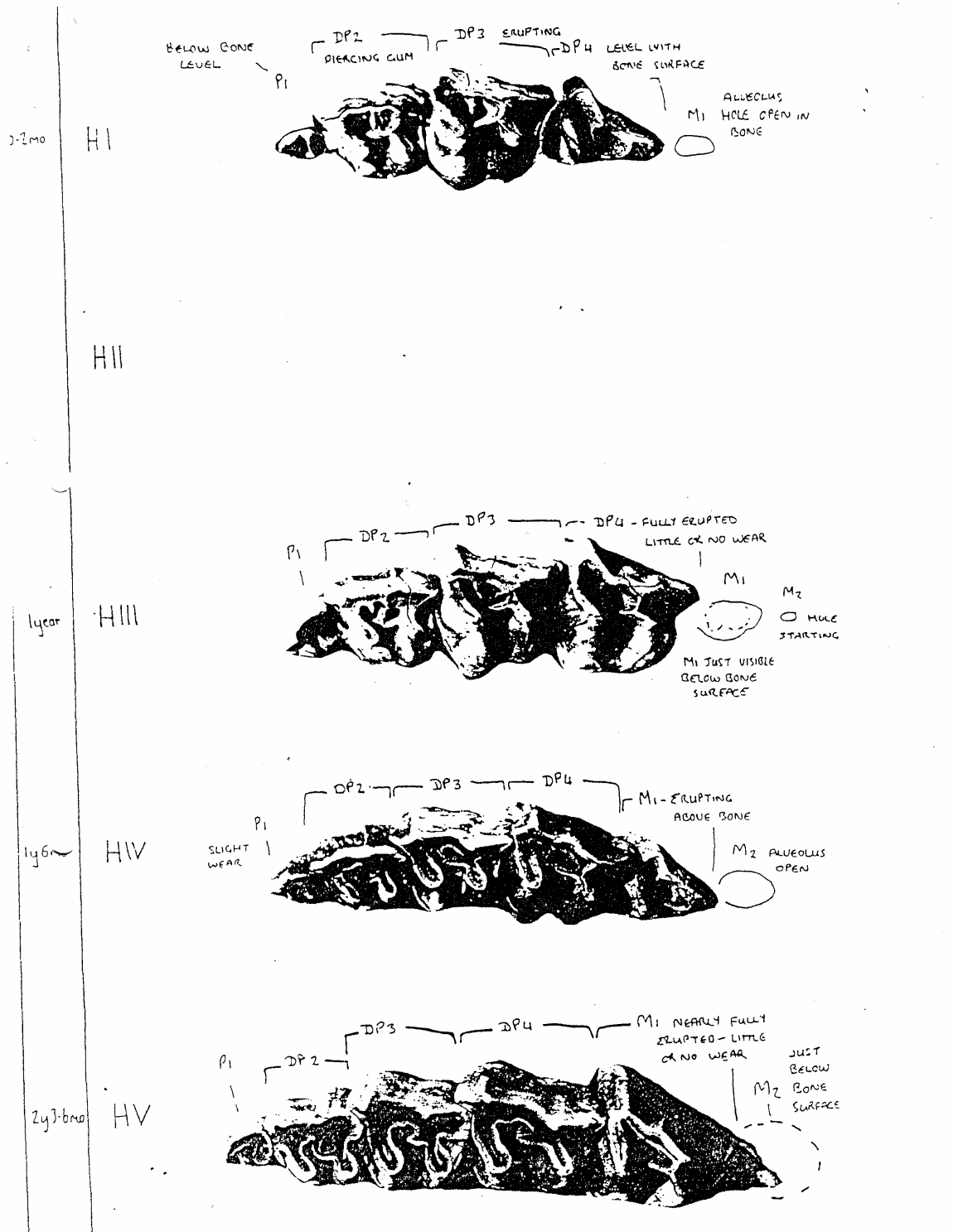
HI HIX etc = Hitchins' age class GI GIX etc = Goddard's age class

DP = Deciduous premolar - milk premolar P = Premolar (permanent) M = Molar




y5mo
y3mo
HVI
GVII=4y
P1 DP2 DP3 DP4 M1
MAY BE PIERCING GUM
M3
BONE MOLE
PERMANENT P2 HAS DISPLACED MILK DP2 AND IS ERUPTING
P3 (PERMANENT) MAY OR MAY NOT HAVE DISPLACED DP3
P3 BELOW GUM
JUST ABOVE GUM LEVEL
P1 P2 P3 OR DP3 DP4 M1 M2 M3
4y6mo
5y6mo
HVII
≃GVIII
∓ FULLY ERUPTED
DP4 OR P4
IF BELOW / NEAR BONE SURFACE ~ 5y7mo to 6 YEARS
P1 P2 P3 P4 M1 M2 M3
5y7mo
5y11mo
HVIII
GIX=6-6y6mo
IF M3 ABOVE BONE SURFACE ~ 6 to 6.5 yrs
IF AT OR ABOVE BONE THEN ~6.5
P1 P2 P3 P4 M1 M2 M3
6y6r
7y6mo
HIX
GX=7
WELL WORN
JOINED
SOMETIMES JOINED
USUALLY NOT JOINED
MARKED WEAR
LIGHT WEAR
IF 1/3 TO 1/2 OUT OF BONE, THEN ~7+
OFTEN LOST
JOINED
USUALLY JOINED
JOINED
SOMETIMES JOINED
P1 P2 P3 P4 M1 M2 M3
8 years
HX
≃GXI
FULLY ERUPTED - V. LIGHT WEAR


HXI
HXII
HXIII
HXIV
HXV
HXVI
HXVII
SMALL DENT
JOINED
SOMETIMES JOINED
DEFINITE BUT LIGHT WEAR
NO DENT
NOT JOINED
DENT
SHALLOW DENT
LITTLE / NO DENT
USUALLY JOINED
NEARLY CLOSED
CLOSED
SMALL DENT


BELOW BONE LEVEL
DP2
PIERCING GUM
DP3 ERUPTING
DP4 LEVEL WITH BONE SURFACE
P1
ALVEOLUS HOLE OPEN IN BONE
M1
0-2mo
HI
HII
DP2
DP3
DP4 - FULLY ERUPTED
LITTLE OR NO WEAR
P1
M1
M2
HOLE STARTING
M1 JUST VISIBLE BELOW BONE SURFACE
1year
HIII
DP2
DP3
DP4
M1 - ERUPTING ABOVE BONE
P1
SLIGHT WEAR
M2 ALVEOLUS OPEN
1y6m
HIV
DP3
DP4
M1 NEARLY FULLY ERUPTED - LITTLE OR NO WEAR
P1
DP2
JUST BELOW BONE SURFACE
M2
2y3-6mo
HV

APPENDIX B

Standardised Body Condition Scoring System for Black Rhinoceros (Diceros bicornis)

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Abstract

The body condition scoring system for black rhinoceros *(Diceros bicornis)*, which has been described by Reuter H.-O. and Horspool L.J.I. in 1996 has been modified. More detailed descriptions of seven body regions to be assessed and pictures which show the specific characteristics of each body condition score have been included in this simple descriptive 5-point scale for assessing black rhino condition. The aim is to minimise assessor bias and thus provide a standardised, reliable and repeatable body condition scoring system for black rhino.

Introduction

When an animal is loosing condition, the fat reserves are mobilised and then muscle wasting sets in to supply the required energy demand. Body condition scoring assesses the amount of subcutaneous fat and the degree of muscling. This will reflect changes in body weight and provide an estimate of nutritional status and fitness. The average condition among animals indicates the response of a population to prevailing environmental conditions. However, behaviour and sex-based differences between individuals also effect condition. For example, nutritional demands on females increase greatly during late pregnancy and lactation, and such females are often the first to loose condition when food limitations arise.

In animal management, many important decisions, *e.g.* the provision of supplementary feed, are based on the assessment of body condition. In game species, the assessment of body condition during boma confinement and in the initial post-release period provides an indication of the response of an animal to the translocation and its new environment. In black rhino, loss of body condition is often the only indication of chronic disease. Resistance to disease, drought and frost are also related to an animal's condition. Moreover, there is evidence that mammals may require a minimum level of body fat for adequate reproductive performance. The provision of a standardised, reliable body condition scoring system for black rhino will enable management to be optimised and increase the speed at which several problems can be detected.

During 1996 a study has been conducted in Namibia by H.-O. Reuter and L.J.I. Horspool, during which a simple descriptive 5-point scale for assessing condition on several body regions of black rhino has been statistically tested for the repeatability and agreement between observers. The results of this study have been published in a paper presented at the Joint 50th Anniversary Congress of the Namibian Veterinary Association and 2nd Africa Scientific Congress of the World Veterinary Association, 10-12th September 1997, Swakopmund, Namibia. (Assessing body condition using observable criteria in free-ranging black rhinoceros, *Diceros bicornis bicornis*. Reuter, H.-O. and Horspool, L.J.I.)

The most repeatable use of the scale was by calculation combined scores given to the various body regions by an observer. During the study it was apparent, that the subjectivity of a descriptive scale scoring system led to assessor bias, *i.e.* a tendency for some assessors to score consistently high or low.

More detailed description of the body regions to be assessed and better pictures to illustrate the specific characteristics of each body condition score will help to minimise such assessor bias, thus providing a standardised, reliable and repeatable body condition scoring system for black rhino.

Description of body regions to be observed when assessing body condition in black rhino

A) The neck

The rhino neck has a complex set of muscles between the back of the head to the rhino's whithers, shoulders and chest, allowing the wide range of movements necessary for moving the head during feeding, and lifting and balancing the forequarters while walking or running. The nuchal ligament runs along the top of the neck from head to whithers, above the neck vertebrae which are more deeply embedded in the neck. This muscle and ligament structure means the neck can change greatly in appearance, providing a useful measure of condition.

- When black rhino are in good body condition the neck region appears thick across the top, and is well muscled, with a smooth gradation between it and the shoulder blade. It must be noted that adult rhino bulls have a thicker (more muscled) neck then female rhino.
- As body condition deteriorates and muscle wasting sets in the neck region becomes narrower and flattened in appearance. The muscles hollow out in front of the shoulder blade, so that a prescapular groove develops.
- Eventually the nuchal ligament, back of the skull (occipital bone) and in very emaciated rhino the cervical (neck) vertebra become visible.

(Neck muscles include the cervical part of the trapezius, splenius, cervical serratus, rhomboideus , complexus and the bracheocephalic muscles.)

B) The shoulder (scapular) region

The scapular (shoulder-blade) with its spine is a prominent bony feature in the shoulder region.

- When a rhino is in good condition, this area is well covered by the infra- and supraspinatus, the deltoid and the trapezius muscles, and the subcutaneous fat layer under the thick skin.
- The rounded appearance of the shoulder changes by a flattening of the region, as body condition deteriorates.
- The spinous process of the scapula and eventually the leading (anterior) edge of the scapula become more sharply defined, and the muscled areas appear concave in front of and behind the scapular spine as body condition worsens.

C) The ribs (costal region)

- When rhino are in excellent condition the ribs are covered with thick skin folds, especially just behind the shoulder and elbow region.
- As the subcutaneous fat reduces in thickness, the ribs become visible and with further loss in condition increasingly more noticeable.

D) The spine (vertebral region)

The spinous processes of the vertebra are covered along the top (dorsally) by the supraspinal ligament and on either side by the longissimus dorsi muscles.

- The vertebral region appears rounded and the long back muscle and fat deposits fill the gap between the ribs and the spine, if black rhino are in excellent condition.
- As the subcutaneous fat layer is lost the supraspinal ligament, which covers the spinous processes become visible as a defined line.
- Due to wasting of the longissimus dorsi muscles, the back hollows out either side of the spine, which become progressively move obvious. Eventually the costal processes of the vertebrae become visible.

E) The rump (gluteal region)

The bony protuberances of the pelvis, namely the tuber coxae, the tuber sacrum and tuber ischiadicum, and the major trochanter of the femur along with the surrounding gluteal and biceps femoris muscles are good indicators of a rhino's condition.

- If a rhino is in excellent condition this region appears rounded and the bony points are covered.
- The rump starts to hollow out quite early on during loss of condition, and the bony points become visible as a rhino is losing condition.
- As condition worsens, the bony protuberances become increasingly prominent and the muscled region eventually appears markedly concave, with ropy ligaments and muscle strands showing under the skin.

F) The abdominal region

- The abdomen appears filled and taught when a rhino is in good condition.
- As a rhino is losing condition, the abdomen becomes tucked in and a skin fold in the flank becomes visible. During a period of anorexia this flank-fold also becomes prominent, even 'though the rhino has not otherwise lost condition noticeably. This suggests that the fullness of the intestinal tract and the state of hydration influence the prominence of the flank-fold.

G) The tail-base (caudal region)

The amount of subcutaneous fat around the tail-base can help to indicate how good a rhino's condition is. From forming a broad swelling up to the spine, this area narrows and appears more and more bony and raised above the rump, as condition deteriorates.

Table 1. Descriptions of the appearance of each of the assessment sites at different body conditions in black rhino

(Modified from Reuter and Horspool, 1996)

	CONDITION	Numerical scale	5	4	3	2	1
	Assessment site	**Descriptive scale**	**excellent (heavy)**	**good (ideal)**	**fair (average)**	**poor (thin)**	**very poor (emaciated)**
A	**Neck**	**General appearance**	thick, well muscled, rounded	well muscled, rounded	Rounded	flat, narrow neck; nuchal ligament visible	narrow, angular (bony) neck; nuchal ligament prominent
		Prescapular groove	-	-	slightly visible	obvious	deep groove very obvious
B	**Shoulder**	**General appearance**	well-muscled, rounded	rounded	Flat	flat, slightly angular (bony)	angular, bony
		Scapula	covered	covered	spine visible	obvious	very obvious
C	**Ribs**		well covered (skin folds)	covered (skin folds)	Visible	obvious	very obvious
D	**Spine**	**General appearance**	rounded	slightly angular	back groove visible	back groove obvious	deep back groove very obvious
		Spinous processes	covered	slightly visible	Visible	prominent	very prominent
E	**Rump**	**General appearance**	well rounded	flattened	slightly concave	concave	obvious depression
		Bony protuberances	covered	slightly visible	Visible	prominent	very prominent
F	**Abdomen**	**General appearance**	distended, taught	filled	slightly tucked in	tucked in	tucked in
		Flank-fold	none	sometimes slightly visible	slightly visible	visible	obvious
G	**Tail base**		rounded (bulging)	rounded	Narrow	slightly bony	very thin and bony

Figure 1 in the Appendix illustrates the body regions and specific anatomical features to be observed when assessing a rhino's condition.

Figures 2 in the appendix illustrate the appearance of black rhino for body condition scores 4, 3, 2, and 1 respectively.

Assessment procedure

Satisfactory condition scoring can only be achieved if an undisturbed rhino is viewed from it's side at close range (not more then 100 metres away) in the open using binoculars. The quality of light is important for reliable assessment and preferably the rhino must be viewed slightly back-lit (early morning or late afternoon), so that any bony prominence become noticeable through the contrast revealed by their shadows.

The most reliable and repeatable body condition scoring will be achieved by assessing all the regions separately, giving a score (1-5) using unit increments to each region and then combining these scores or calculating their average.

It may be useful to observe other body regions as well. For standardised, repeatable assessment, however, the side view of the above mentioned regions was found to be most reliable.

Frequently rhino may, however, present facing the observer or run away before assessment of all sites is completed. Sometimes not all assessment regions are visible, e.g. when rhino are found in thick bush. Also, rhino in a boma are frequently viewed from an elevated position and rhino seen from an aircraft are viewed at an angle from above. Even if only some of the above body regions and their characteristics can be assessed during a rhino observation, some indication of the rhino's body condition will be gained.

Observers trained to assess condition by applying the described method, will usually find it easier than untrained people to get some indication of a rhino's body condition, even if conditions for observation are not optimal. The reliability and repeatability of such observations can be assumed to be less consistent, however, than assessment of all the regions under optimal condition. Therefore, whenever possible efforts should be made to view rhino under optimal conditions when assessing their body condition.

Acknowledgements

The authors would like to thank R. Brett, R. du Toit , R. Emsley, B. Loutit and P. Morkel for their constructive input towards this paper and for sharing their valuable field experience in assessing condition of rhino with the authors. The original rhino picture adapted for this work is from Penny (1987) 6.

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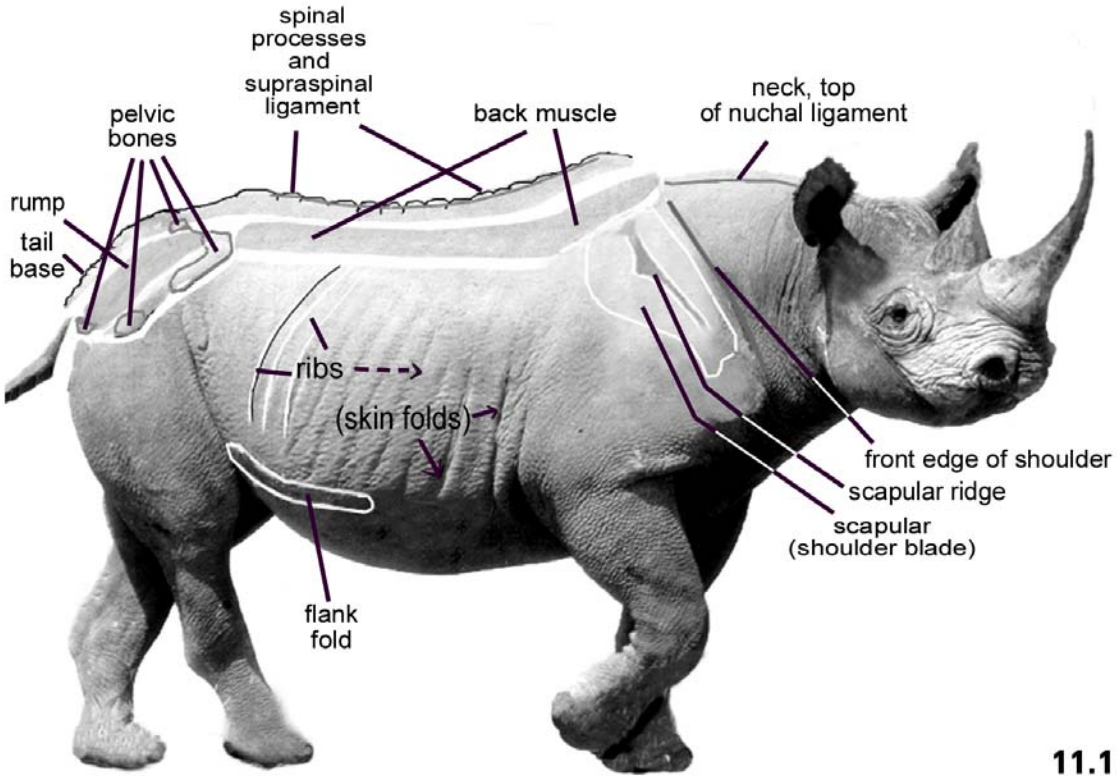


Appendix

Figure 1: Body regions to be observed when assessing condition in black rhino

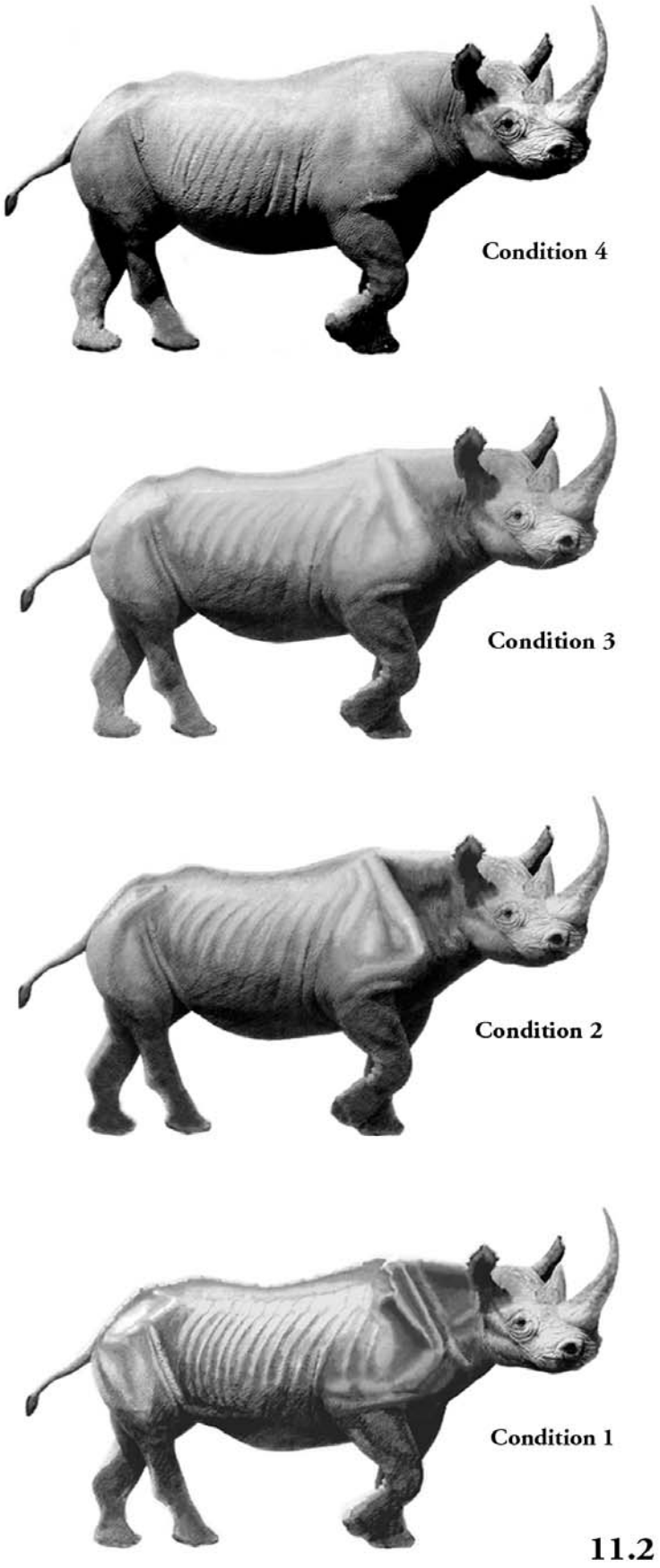


Figure 2: Black rhino: Condition 4, 3, 2 and 1

APPENDIX C

Generic Names and Trade Names of Drugs Mentioned in Text

Generic Name	Trade Name
Thiofentanil oxalate	A3080
Acuphase	Clopixol Acuphasae
Azaperone	Stresnil
Hyoscine-n-butylbromide	Buscopan
Carfentanil	Wildnil
Detomidine	Domosedan
Diminazine	Berenil
Diazepam	Valium
Diprenorphine	M5050
Doxapram	Dopram
Etorphine	M99
Fentanyl	Sublimase
Flunixin	Finadyne
Hyaluronidase	Hyalase
Imidocarb	Forray 65
Isometoamidium	Samorin
Midazolam	Dormicum
Nalbuphine	Nubain
Naltrexone	Naltrexone
Nalorphine	Lethidrone
Isometamidium	Samarin
Succinylcholine	Scoline
Xylazine	Rompun

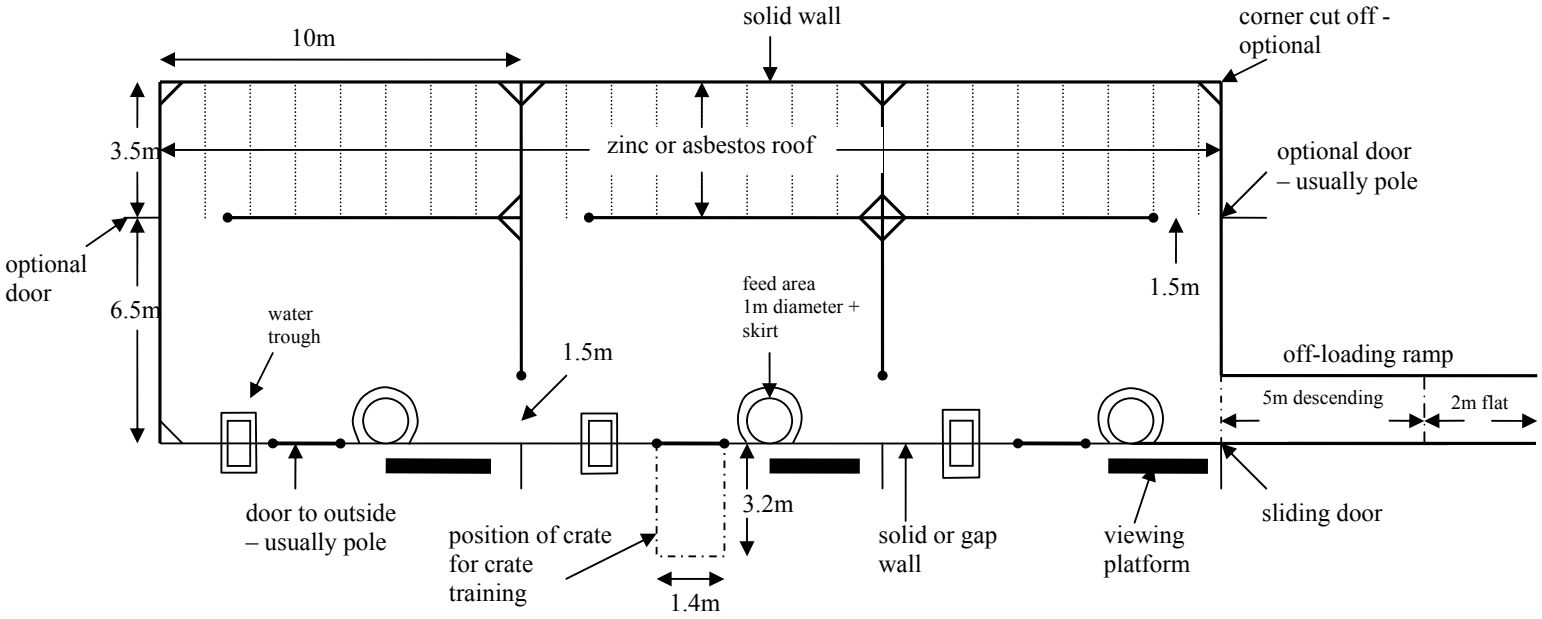
APPENDIX D

Example of Checklist for Black Rhino Immobilization

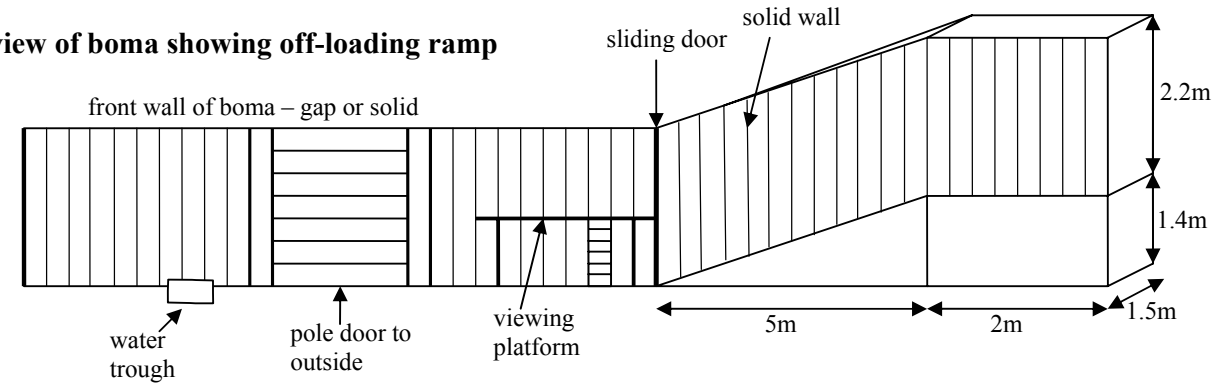
Cover eyes
Block ears
Put ropes on the head and hind leg
Push into lateral recumbancy
Check breathing and re-check every few minutes
    Respirations per minute
    Pulse oximetry
    Blood color
Give nalorphine if necessary
Take temperature and douse with water if necessary
Remove dart and treat wound
Examine thoroughly for wounds and treat with antibiotic/fly-repellent spray
Give long-acting tranquilizers
Give long-acting antibiotics
Draw blood
Notch ears
Notch feet
Tip horn
Implant horn transmitter
Implant transponders
Take body measurements
Apply acaricide
Collect parasites, faecal sample, etc.
Give intravenous Valium 10 minutes before waking into the crate
Check that everything is done and data recorded
Wake into crate with nalorphine and diprenorphine

APPENDIX E

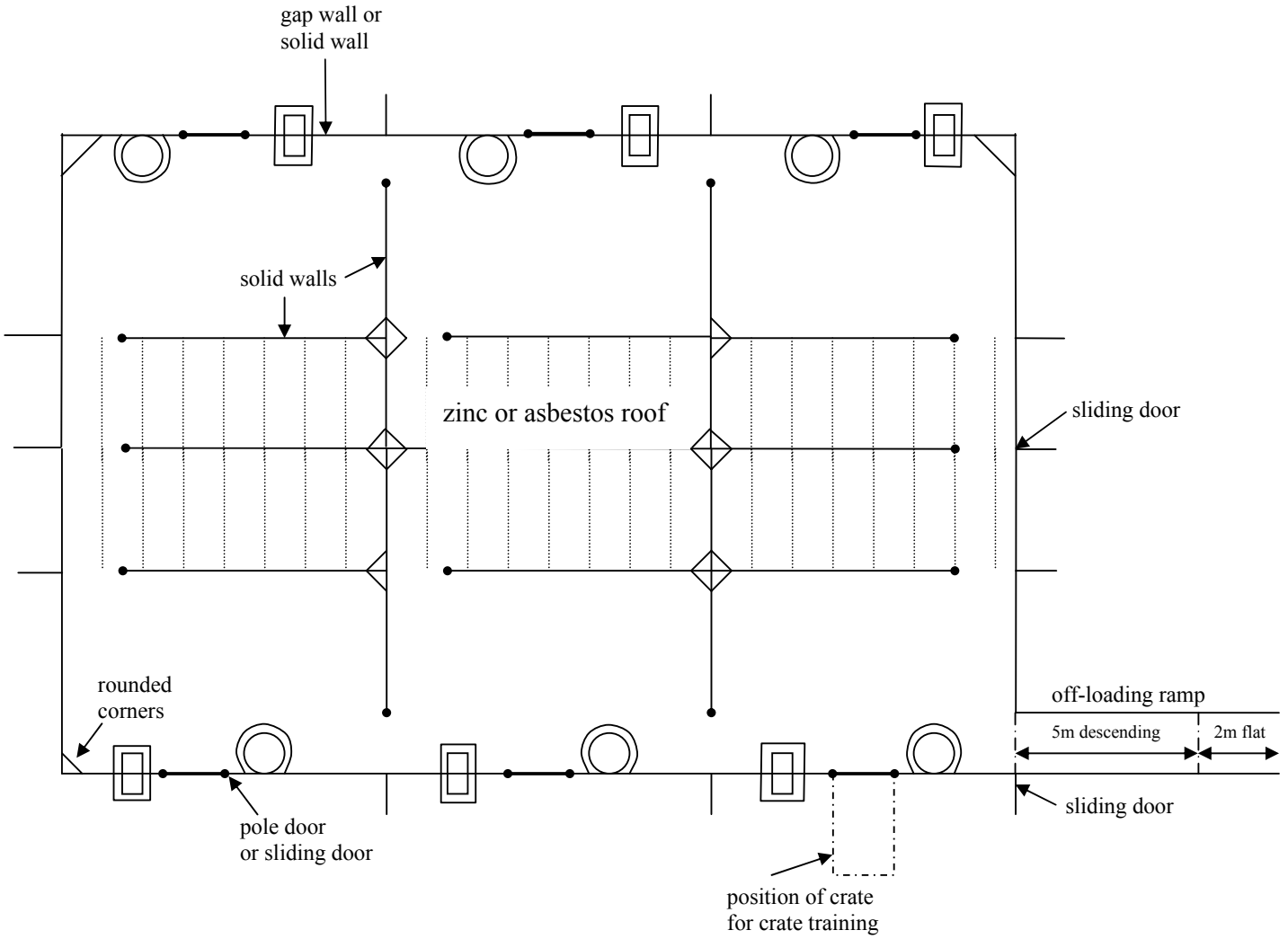
Black rhino bomas



Front view of boma showing off-loading ramp



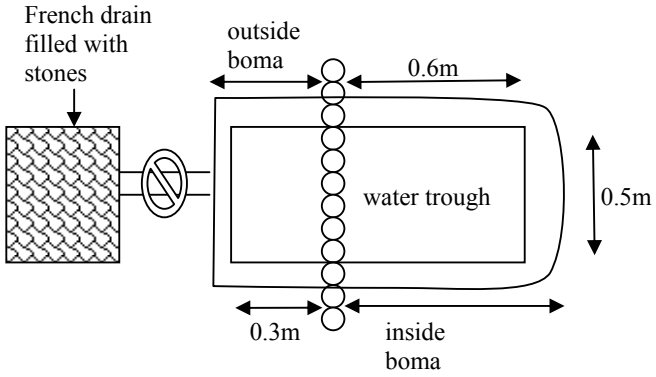
Set of six black rhino bomas



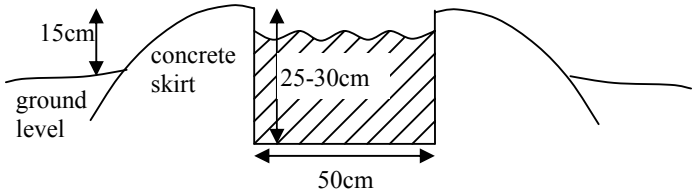
APPENDIX F

Water trough

View from above



Cut through



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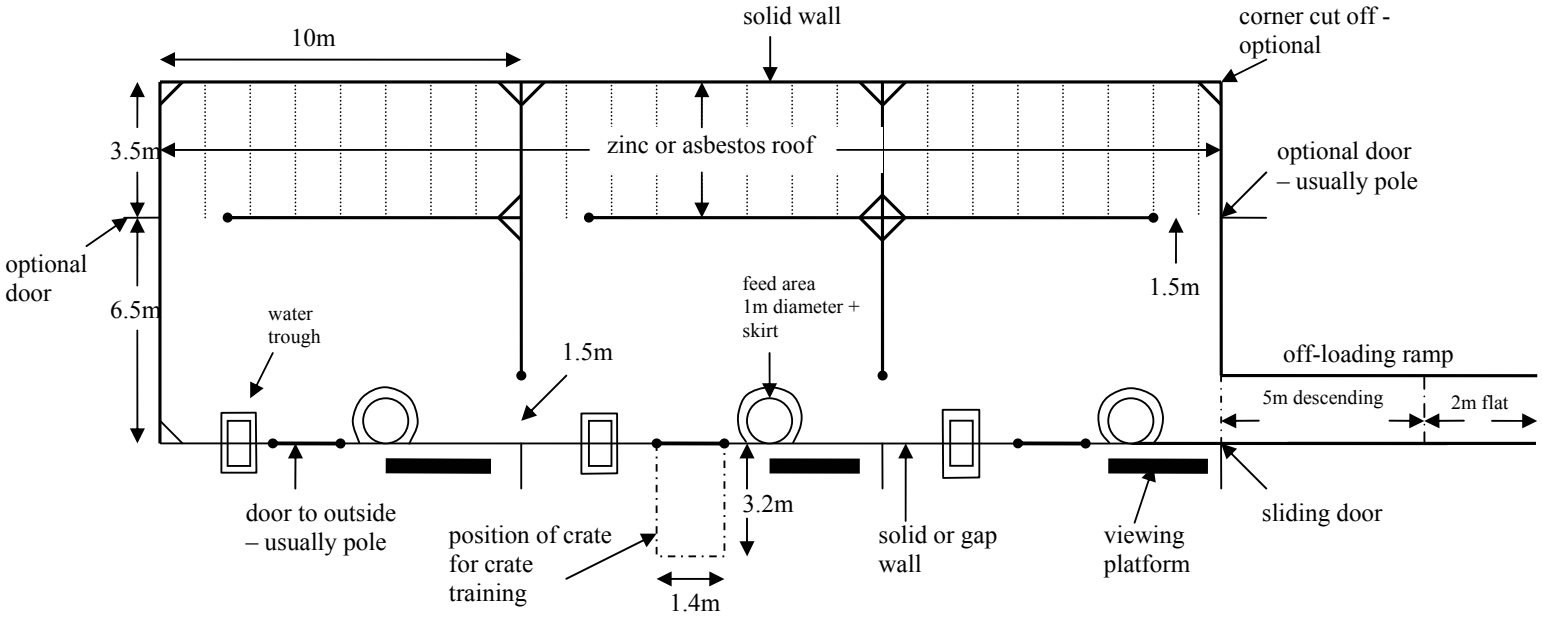
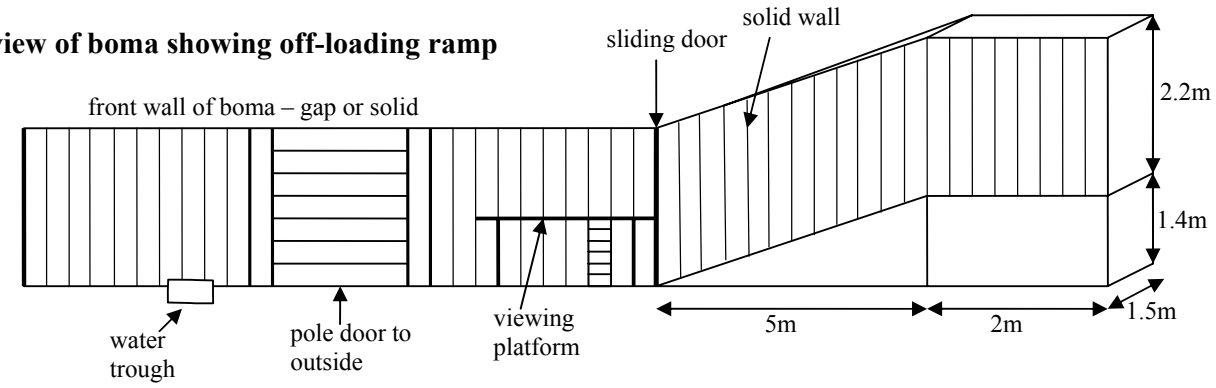
Black rhino bomas



Front view of boma showing off-loading ramp



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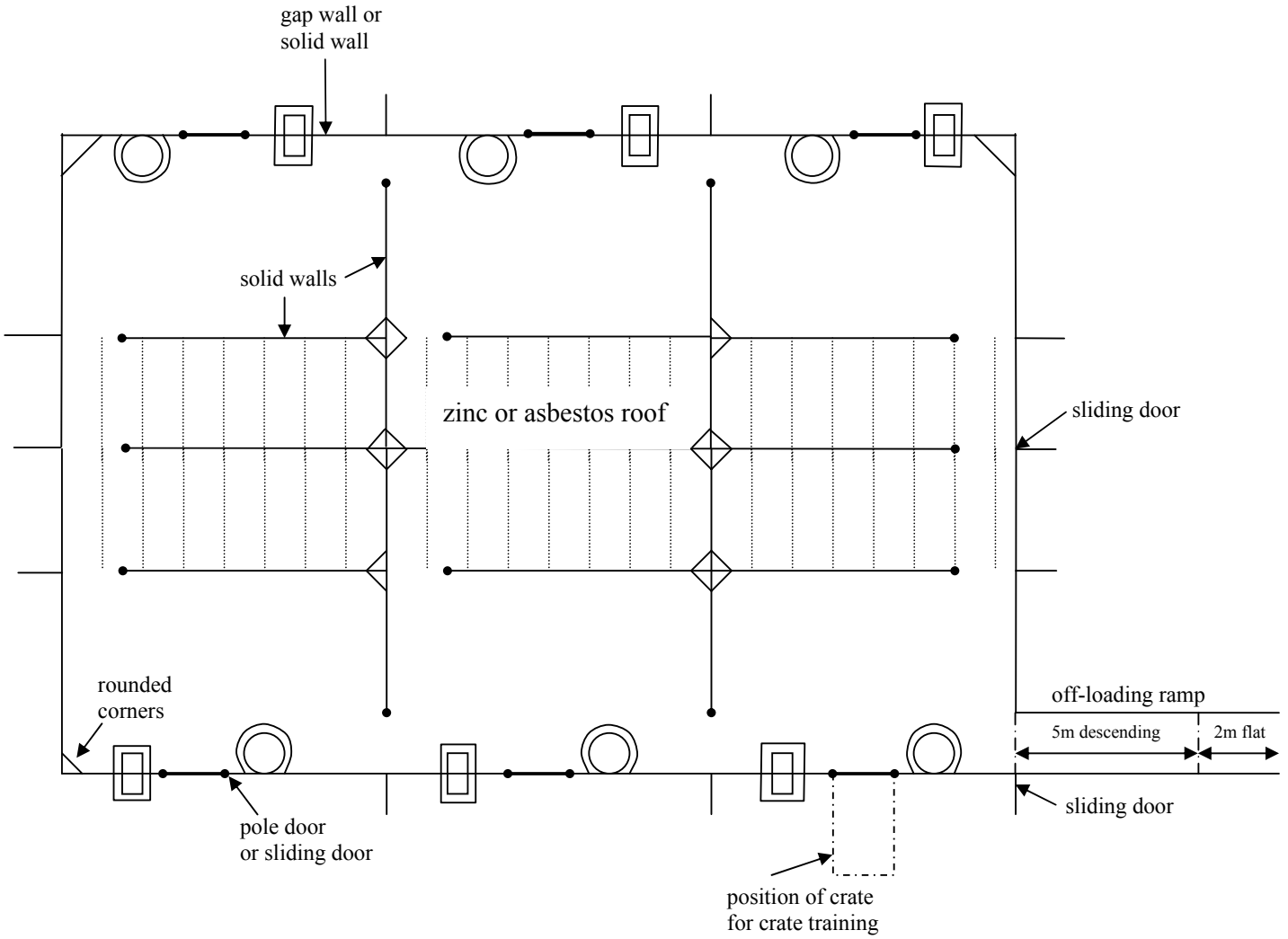

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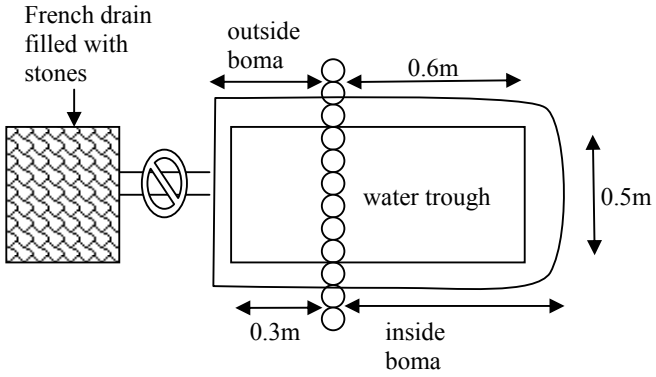
Water trough

View from above



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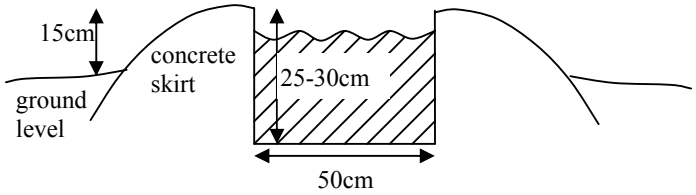

APPENDIX G

Some favoured black rhino browse

Acacia spp. (*gerrardii*, *tortilis*, *karroo*, *drapanolobuim*, *hockii*, *mellifera*)
Acalypha glabrata
Akokanthera oppositifolia
Azima tetracantha
Baphia masaiensis
Catophractes alexandri
Clausena anisata
Coddia rudis
Combretum apiculatum
Commiphora spp.
Cutanaregam spp.
Dahlbergia melanoxylon
Dichrostachys cinerea
Diplorhyncus condylocarpon
Euclea undulata, *divinoium*
Euphorbia damarana, *villosa*, *bothae*, *tetraguna*, *triangularis*
Grewia spp. (*robusta*, *flava*, *bicolor*, *flavescens*, *villosa*)
Holmskoldia tettensis
Justicia betonica
Kigelia africana
Loranthus spp
Monechma debile
Pappea capensis
Pavonia patens
Plumbago auriculata
Pterocarpus angolensis
Rhigozum obovatum, *trichotonum*
Rhus natalensis
Schotia afra
Spirostachys africana
Strychnos madagascariensis
Tagetes minuta
Viscum spp.
Ziziphus mucronata

Hand-raising of orphaned rhinoceros calves

P.S. Rogers

1 Introduction

Both the black and the white rhinoceros are extremely valuable animals, and it is essential that there should be some information available on how to raise calves that have been separated from their mothers. In the case of the black rhino, being an animal that is threatened with extinction, this information becomes even more critical. There is very little published data on the raising of rhino calves, and that which is available is sketchy and difficult to obtain. While there is still insufficient information available to make firm recommendations and predict results, it is essential that there be some review of current knowledge on this subject. Given the limitations already mentioned, I have summarized the important points into a set of general guidelines based on what information I could obtain and on personal experience in assisting with the raising five white rhino orphans. This is followed by two recent case studies that highlight some of the problems that may be associated with the difficult but rewarding task of raising rhino calves.

Rhino calves...

- Do not drink water, even if it is freely available. (It should, nevertheless, be available.) This seems to be the case while the calf is being fed milk at 10–15% of its body mass. As soon as it starts taking significant amounts of solids and the milk to body mass ratio declines, it will start taking water.

- Become stressed if they are continually exposed to strange faces.
- Do not require manual stimulation in order to urinate and defaecate.
- Become attached to their foster mothers, and adapt with great difficulty to changes in the person caring for them.
- Are unable to control their body temperature for the first six weeks of life. Rectal temperature may vary from 29,4°C (!) to 39,7°C. Body temperature appears to become more constant between six and fourteen weeks, and thereafter stabilizes at approximately 37,5°C (Trendler, pers. comm.).
- Obtain colostrum from their dams. However, there may also be transfer of antibodies before birth: there has been at least one case of a calf being raised successfully without having received colostrum or colostrum substitutes[1].
- Must be exercised regularly from an early age.
- Tend to 'flop down' and sleep after each feed.
- May occasionally develop a serous nasal discharge (runny nose), but this usually passes uneventfully.
- Have a respiratory rate of 16 to 30 breaths/minute. This increases with fever or pain, and decreases as the calf gets older.
- Become dehydrated and hypoglycaemic very quickly when they are young. Calves in this state must be warmed and given an intravenous infusion containing 5% dextrose (or Lectade® *per os* if they can still suckle).
- Are born without any teeth. Reports on tooth eruption are varied: 3 weeks (black rhino), 56 days (black rhino), 70 days (white rhino). The eruption of the teeth is usually accompanied by a rise in temperature, sore or itchy gums, and possibly even a loss of appetite and diarrhoea.
- Should be weaned at 18 months of age. They can be weaned as early as 12 months, but it is preferable to wean them later.
- Thrive on the company of other animals and humans.
- Take a variable time to start eating solids: two months (black rhino), four months (white rhino), seven months (white rhino).
- That are orphaned at five months are already eating solids well, although they still need milk. Calves that are orphaned at a young age may only take solids after 6–7 months.

2 Milk substitutes

- Rhino milk is unusual in that it contains very little fat and a high proportion of lactose (see Table 1).
- Many preparations have been used as a base for a milk substitute for rhino calves: Denkavit® calf milk replacer (Flamand, pers. comm.), Elite® skimmed milk powder followed by Surromel® (Bengis, Espie, Keet, pers. comm.), Lactogen®[3,4], Melk-Vita® calf milk replacer (author), fresh skimmed mild, Nestle Rhino Milk® (Trendler, pers. comm.).
- These standard milk formulas should be modified to resemble rhino milk as closely as possible, especially with respect to fat and lactose. Melk-Vita®, Surromel®, Denkavit®, and Elite® formulas should be prepared according to the instructions and then substituted with 40 g of glucose per litre. Even though the fat content of the calf milk replacers is reasonably high, they appear to be well tolerated. A substitute based on Lactogen® has been described by Sheldrick[2].

Table 1. Percentage composition of rhinoceros milk.

Component	White rhinoceros*		Black rhinoceros**
	Sample A	Sample B	
Total solids	8,.84	8,26	8,10
Fat	0,6	Trace	Trace
Lactose	6,50	6,85	6,06
Protein	1,54	1,18	1,54
Ash	0,20	0,23	0,34
pH	-	6,4	-

* Data from Wallach, 1969 (Ref. 1). Sample A is from a cow with a five month old calf; sample B is from a cow with an eighteen month old calf.
** Data from Aschaffenberg et al., 1961 (Ref. 2). The sample was taken from a cow with a nineteen month old calf that was still suckling.

- Nestle Rhino Milk® closely resembles rhino milk, and is probably the best substitute to use. However, this milk was only developed in 1992, and may not be available to people in the field at short notice. In these cases any of the other options mentioned, suitably modified, should be adequate.
- On a milk substitute based on Melk-Vita® the dung of young rhinos is of a clay to cow pat consistency. This may be due to the relatively high fat content and brown sugar supplement. It is probably advisable to use glucose instead of sugar. As in the case of foals, rhino calves, especially young ones, may be unable to digest sucrose properly. As the intake of solids increases, the dung begins to resemble that of an adult rhino.
- Additional energy is required by the rhino calf as it gets older. This is best provided by adding a few teaspoons of cereal (e.g., Nestum®, Pronutro®) to the milk at some or all of the feeds (see the case studies below).

3 Feeding

- Milk should be fed at 10–15% of body weight. Overfeeding must be avoided as it leads to diarrhoea.
- Milk must always be fed at the same temperature, preferably body temperature.
- Rhino calves are usually presented when they have already fed from their mother, and may even be taking some solids. These calves are usually very wild and aggressive, but settle down within a day or two. It is not too difficult to get them to feed – simply put the milk in a baby bath and leave it in the pen. The calf will usually drink within a couple of hours. Unused milk must be removed before it goes off.
- Black rhino calves should be offered good quality lucerne and fresh browse; white rhino calves should be offered good quality teff with at most 10% lucerne added. Horse cubes should only be offered once the calf has adapted to its hay diet.

4 General principles

- The same person should care for and feed the calf until weaning.
- Diarrhoea must be treated by withdrawing the milk and replacing it with an electrolyte solution (e.g., Lectade®). The milk must be re-introduced gradually. Persistent or severe diarrhoea may require antibiotic therapy.

- Strict hygiene must be observed with respect to both feeding and accommodation. Feeding utensils should be sterilized by boiling or in a suitable preparation (e.g., Milton's®).
- It is essential to provide adequate shelter from temperature extremes, rain, and wind.
- A mud wallow must be provided right from the start. Apart from the cooling effect, the mud seems to stop the skin cracking and also takes off old skin. It also provides protection from sun and flies.
- Attention must be paid to the need of rhino calves for company. This is essential to the survival of the calf. If sufficient attention cannot be provided, a companion (goat kid, lamb, or even another a rhino) should be obtained. The companion may also be of great help in getting the calf to take solids.

5 Colostrum

If a rhino calf has not received colostrum, there are several alternatives.

1 Give one litre of bovine colostrum – preferably within six hours of birth but definitely within the first 24 hours. Do not give more than 300 ml at a time. The efficacy of this method has not been ascertained: it does not work in foals.

2 Give one litre of rhino plasma slowly IV. A short-acting cortisone preparation (e.g., Solu Delta Cortef®) should be given at the same time to prevent anaphylactic shock. This procedure is successful in foals but has not been tried in rhinos as far as I am aware.

This option, and option 1 above, are obviously not practical in most cases.

3 Give one litre of rhino plasma orally. The problem with this alternative is that there are special cells in the wall of the gut that absorb antibodies. These cells can only absorb a limited amount of protein before they become inactive. The other proteins in the plasma therefore limit the number of antibodies (which are also proteins) that can be absorbed by the oral route. Oral administration could be combined with the IV alternative discussed above.

4 There will soon be a synthetic foal colostrum available that apparently works very well in horses. This may be useful in rhinos. An inter-species colostrum will soon be available that may also be effective.

5 Do nothing. There has been at least one case of a rhino calf being raised successfully without any colostrum or colostrum replacement, as mentioned above.

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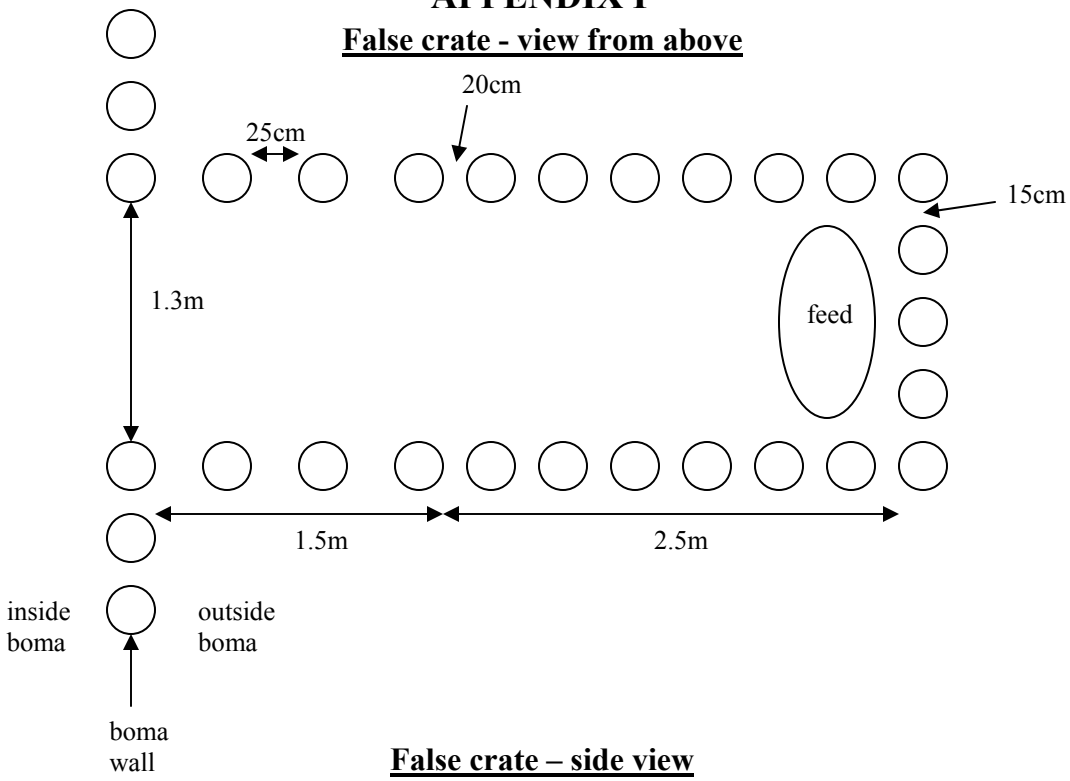
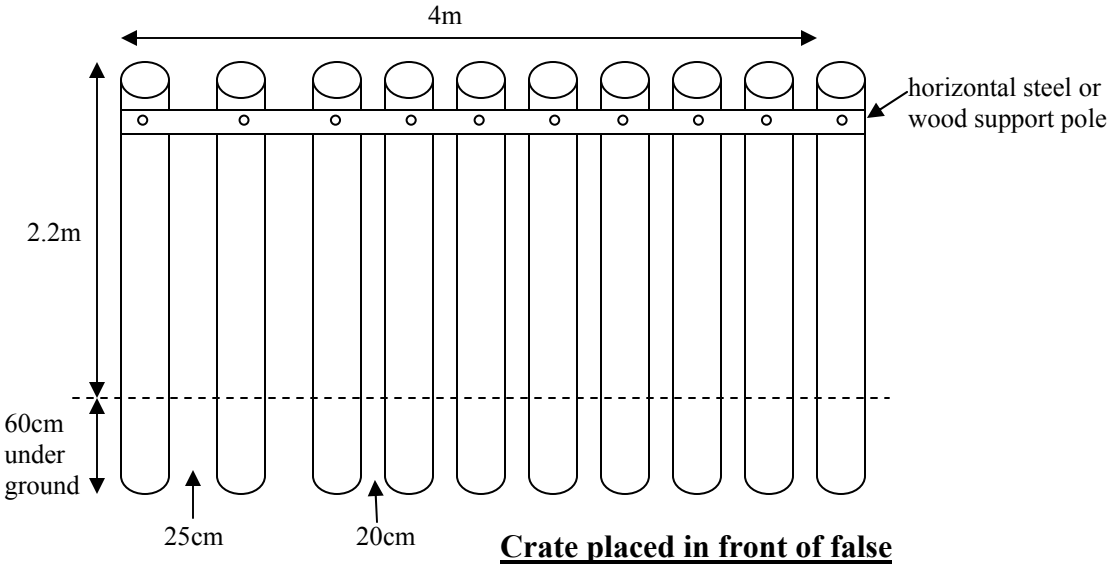
APPENDIX I

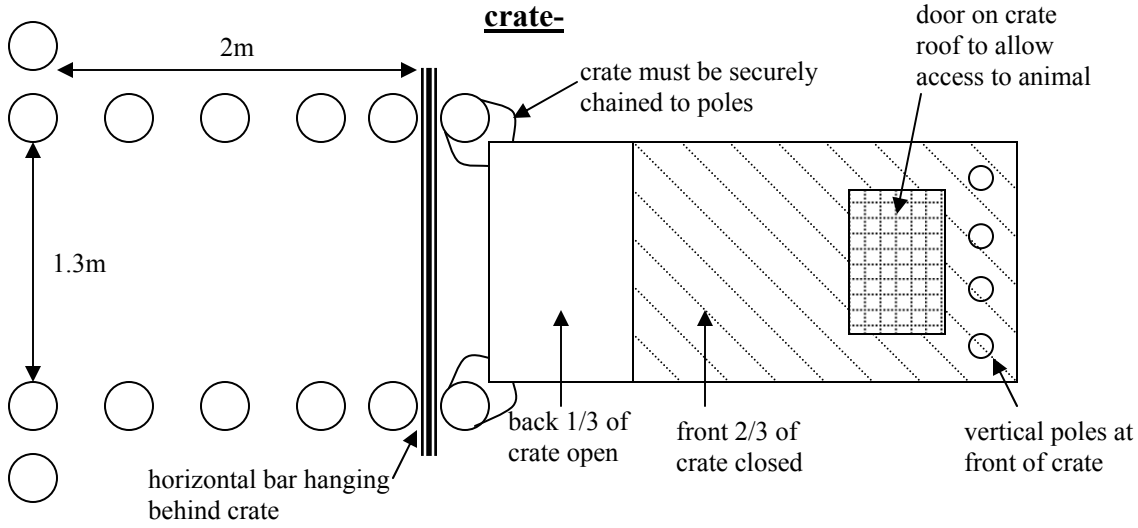
False crate - view from above



False crate – side view



Crate placed in front of false crate-



APPENDIX J

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