The innovative use of physical restraint methods such as the use of opaque plastic to create a boma (pioneered by Jan Oelofse in the 1960s) or net-gun capture – shooting a net from a helicopter – improved both individual and mass animal capture success immeasurably. Stress and mortalities were reduced further when these methods were combined with sedation and tranquilization, for example, the use of long-acting tranquillizers such as haloperidol and zuclopenthixol acetate (Clopixol-Acuphase®) in antelope and black rhino.

7.1 PLANNING A CAPTURE OPERATION

To be effective, operational planning must take place in a structured way. To start, one must have a clear objective. Priority must be given to both the safety of capture team personnel and the animals that are captured. A detailed examination of the factors that may affect the success or failure of the project must be undertaken. Plan the project on paper so that a record of the factors considered is made and may be kept for future reference. Each capture will have facets that are unique to the situation and a record of the plan adopted will be valuable in evaluating the efficacy of the work done, and indicating where improvements can be made. Being proactive and practising adaptive management will improve chances of success!

7.1.1 Objective

Ethics prescribe that those who capture animals accept the responsibility of ensuring the animals survive and that stress and trauma are kept to a minimum. (See Chapter 1: 1.7 Ethical considerations in the use of immobilizing agents for wildlife management).

The objective must be clarified as it has an overall effect on the procedure adopted.

Ask the following questions:

- What is the motivation for restraining the animal? (e.g. treatment, handling, translocation)
- What are the benefits and the risks involved?
- How will the animal be immobilized?
- What method of capture offers the greatest benefit with the least risk?
- How long will the procedure take and what factors will affect this?
- Who is the most appropriate operator qualified to accomplish the task?
- Are you qualified to accomplish the task? If not, what knowledge or skills do you need? How will you acquire them or whom could you ask for assistance?
- Has there been consideration of, and preparation/planning for possible human-related injuries?

7.2 CHEMICAL RESTRAINT

7.2.1 Factors to consider

A. The animal

Species

Consult a dosage chart to determine the dose of drug to use in the animal you intend capturing. Doses are not estimated solely on the mass of the animal but have been determined experimentally for different species and refined over time. There may be marked differences in the doses of immobilizing drugs used for different species. For example, the immobilizing dose of etorphine for an eland bull is 12–15 mg while the dose required for a white rhino bull is only 3–5 mg.
Chemical and Physical Restraint of Wild Animals

Principles of chemical and Physical restraint

It is important not to decrease the dose of the drugs used to below that recommended in a recognized dosage chart. Animals receiving a sub-optimal dose of opioids, for example, will tend to undergo a prolonged excitement phase during induction and in some cases may not go down.

Different species respond differently to the effects of drugs and to being darted. Some animals may flee immediately after darting and continue to run for long distances until the drugs slow them down and eventually immobilize them. Waterbuck, kudu and rhino often respond in this way.

Eland are well known for their tendency to undergo a prolonged excitement phase and may run some distance before the drug mixture brings them down. Due to the relatively long flight distance exhibited by eland, this species may be difficult to approach closely, and there may be a need to minimize the volume of drug used in order to place a dart accurately over such a distance. If possible, the use of a helicopter is recommended, allowing better control with this often difficult species. Physical capture using the boma method is also an option.

Giraffe are difficult animals to capture because they are heavy and clumsy and may easily injure their head or neck when going down. It is preferable to assist an experienced person in the capture of these animals to gain additional experience before attempting to capture them on your own.

Zebra often injure themselves during the induction phase, as they tend to run blindly into thorn bushes, large-stemmed trees or other obstructions. Note that carfentanil, thiofentanyl and fentanyl are not effective in zebras.

Impala are a difficult species to dart, and misses are common. They are agile and respond quickly to the noise of the dart gun. Immobilized impala tend to develop hypoxia or apnoea as a result of the effects of potent opioids. Drug combinations, which include for example medetomidine and butorphanol mixed with an opioid, are safer and more appropriate.

The dose needed to immobilize tame or habituated animals may be appreciably lower than that required for free-ranging wild animals of the same species. It is, however, not possible to estimate how much lower the effective dose will be and, to avoid administering too low a dose, it is advisable to use the ‘chart’ dosage range.

Figure 7.2: An adult female hippo ‘immobilized’ using butorphanol-azaperone-medetomidine (BAM). The animal retains the dive reflex and once sedated can be roped and moved to dry land. This is a classic example of innovative use of drugs allowing unique methods of capture to be developed.
Limit the force and negative effects of dart impact by reducing the velocity or the mass of the dart. Powder charges come in different strengths and are usually colour-coded, so that the optimal charge for the distance can be chosen. The advantage of gas-powered dart projectors is that dart velocity can be adjusted quickly and easily. Reducing drug volume and using darts made of lighter plastic material decreases the dart’s mass and thus also its impact energy. The following examples illustrate some significant differences among common dart systems: a 3 ml aluminum Palmer Cap-Chur dart filled with water weighs ~19.6 g; darts of similar capacity, made of plastic (e.g. Aeroject) or aluminium (e.g. Pneu-Dart) weigh ~13.3 g and ~11.0 g respectively (see Chapters 11 and 12). Gas-powered systems such as Dan-Inject and Telinject use plastic darts of a smaller calibre, which are considerably lighter than the darts mentioned above. For example, a 3 ml Telinject dart filled with water weighs only ~7.9 g.

G. Dart sites

The shoulder: The muscles of the shoulder, the biceps and triceps, are among the best places for remote injection in ungulate species and present a good site for ground-darting rhino and elephant. The upper part of the shoulder should be avoided because the dart needle may become embedded in the cartilage or bone of the scapula. In slight or emaciated animals, darts may strike the spine of the scapula and result in fracture, haemorrhage or dart blockage. In thin or lightly muscled animals, the hindquarters may be a preferable site.

Withers and hump: Eland and rhino have well-developed muscles in the withers or hump, which provides a suitable darting site. When aiming from above or when darting from a helicopter, the target site may appear large, but the proximity of the head leaves little room for error and this site can be surprisingly easy to miss.

Chest: The brisket (pectoral area) can be a suitable dart site when no alternative sites are available and animals such as giraffe, buffalo and eland have been darted successfully using this approach. The chest region should only be used when the target animal refuses to shift position.

Figure 7.8a: Dart sites in some herbivores
and you are confident of the accuracy of your dart placement. Use of this dart site must be restricted to well-muscled larger animals.

**Hindquarters:** This well-muscled area is a commonly selected dart site. It is possible to dart most ungulates from any angle into the hind leg but the dart must hit perpendicular to the surface to prevent deflection and to ensure deep IM injection. The mid-lateral part of the hind leg should be avoided due to the proximity of the femur (and a large bony protuberance, notably in rhino). Placement of a dart high up on the hind leg from behind and to the side should be avoided as the bony prominences of the pelvis may deflect the dart. In certain situations, it is possible to place a dart into the muscle mass on the inside of the hind leg, but darting from directly behind the animal should be avoided due to the possibility of penetrating the soft tissue of the perineum. This is particularly important in equine species.

### H. Needle lengths and characteristics

Avoid using needles with a narrow bore. Needles with smaller diameters have thinner walls and tend to bend more easily on impact; the pressure within the dart chamber will be greater and the force of injection will be more likely to result in the dart being forced back and out of the tissue. Be aware that dart contents sprayed into the air may be dangerous to humans.

Needles that are shorter than 30 mm should be fitted with a bulb or a barb on the shaft to prevent the dart from being forced backwards and out of the animal as the drug is injected. Darts that are 60 mm in length can be used without these attachments as the length of the dart provides enough resistance to the backpressure of the ejected drug. However, these darts may fall out during the induction phase and will in all likelihood be lost. Collared needles (30–40 mm) are efficient in keeping the dart in the animal during injection but rarely hold the dart for long periods, especially in antelope. The only sure way of retaining the dart is by using a barbed needle but these needles can cause excessive soft-tissue damage as the needle moves up and down in the tissue when the animal is running.

The lengths of needles used in different species are indicated in Table 7.1. Also see Chapters 10 and 11.

<table>
<thead>
<tr>
<th>Species</th>
<th>Needle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant, rhino and giraffe</td>
<td>3 x 60 mm</td>
</tr>
<tr>
<td>Elephant calves, buffalo and juvenile giraffe</td>
<td>2 x 50 mm</td>
</tr>
<tr>
<td>Antelope and plains game</td>
<td>2 x 35–40 mm</td>
</tr>
<tr>
<td>Lion, leopard, cheetah and wild dog</td>
<td>1,5 x 25–35 mm</td>
</tr>
</tbody>
</table>

*Table 7.1: Recommended needle characteristics for use in different wild animals (diameter x length in mm)*

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**Figure 7.8b:** Dart sites in some carnivores
over the head and removed once improved reflexes are evident (swallowing, twitching of the ears, etc.). One person should remain with the animal until the first signs of reversal become obvious and then move away. With dangerous animals this is often not possible and blindfolds and other equipment must be removed in advance. Both operators and bystanders need to move to a safe distance and wait in their vehicles. Reversal may be sudden and ‘explosive’, which is often seen in zebra. The reversal in dangerous species such as buffalo, rhino and elephant should be observed from a position of safety. During the reversal phase, noise and disturbances must be kept to a minimum. Do not attempt to speed up the process of reversal by slapping the animal or making a noise. Ensure that once the animal has regained its feet, it can move away slowly rather than panicking, fleeing and possibly injuring itself or people in the area. If the reversal appears to be ineffective but the animal appears nevertheless to be breathing adequately, wait for a period of approximately 10–15 minutes, after which you can consider the possibility of administering additional reversal drug. In these cases it may be beneficial to give a pure opioid antagonist. Reasons for inadequate reversal include perivascular injection (outside the vein), inappropriate choice or amount of drug, or ineffective drug (expired, incorrectly stored etc.). The animal should be allowed to recover and move away at its own pace. Ensure that each animal is fully recovered before leaving the capture site or completing the operation as any delayed drug effect or renarcotization will increase the chances of injury or predation.

**Note:** Take extreme care with dangerous animals that have been reversed but have not yet fully recovered. Approaching an apparently ‘sleeping’ elephant, for example, can place you in grave danger!
7.2.2 Common causes of failures or adverse effects of chemical restraint

Successful restraint of wild animals requires knowledge of the ‘science’ but tends to be more of an ‘art’ in the field. Problems can and do occur but most are preventable. Some of the common causes are listed below.

1. Equipment failure

High-impact darts may break at the needle hub or the animal may bend or break the needle when running or falling. A syringe charge may not detonate as the dart impacts, resulting in the drug not being delivered, or the injection of the drug may be incomplete. Some large-bore needles may incise a plug of tissue when penetrating the skin and become completely or partially blocked. This may prevent discharge of the dart contents or result in the tailpiece being blown off. If a dart syringe is improperly loaded or if the tailpiece is malfunctioning or damaged, it may ‘wobble’ in its course and miss the target. Some small 1 ml darts (e.g. Pneu-Dart) may need to be fired at a slightly higher velocity than others to prevent ‘tumbling’. When darts are loaded, excess air in the drug chamber should be eliminated. Sterile water for injection may be added to completely fill the chamber, which will ensure optimal accuracy and predictability of the dart trajectory when fired.

The charge in the dart projector may be insufficient to propel the dart to its target. Commonly used powder charges may not function consistently, particularly if they have been stored in damp conditions. Carbon dioxide or compressed-air cylinders may leak, may not operate efficiently in cold conditions, or the ‘O’ ring seals in the dart projector may be faulty.

The operator must ensure that all capture equipment is in a proper state of repair, is clean and appropriately lubricated. Reusable darts and needles should be inspected for tissue plugs, thoroughly cleaned and sterilized. Equipment cleanliness and sterility must not be overlooked. Sterilize equipment using alcohol (methylated spirits) or a concentrated antibacterial solution, for example, chlorhexidine. Some apply antiseptic ointment (e.g. povidone-iodine) to the dart needle prior to loading it into the gun.

2. Darting failures

Among the most common faults resulting in capture failure include missing the target completely or hitting the animal in an inappropriate site (see Figure 7.20). Injection of drugs into fat deposits, subcutaneous tissue, or into the abdomen or chest can result in failure of effect or prolonged induction. The impact of a dart may fracture bones in smaller animals or, with sufficient impact, may penetrate a body cavity and damage vital organs, particularly when too powerful a charge or setting is used or when distances are over-estimated.

The dart must strike the animal perpendicular to the skin. A dart that hits the target at an angle may fail to discharge or may be deflected off the body. Darts fired at too high a velocity may bounce off the animal.