GAP AFRICA PROJECTS

CONSERVATION, WILDLIFE AND VETERINARY

Course Manual 2019 - 2020

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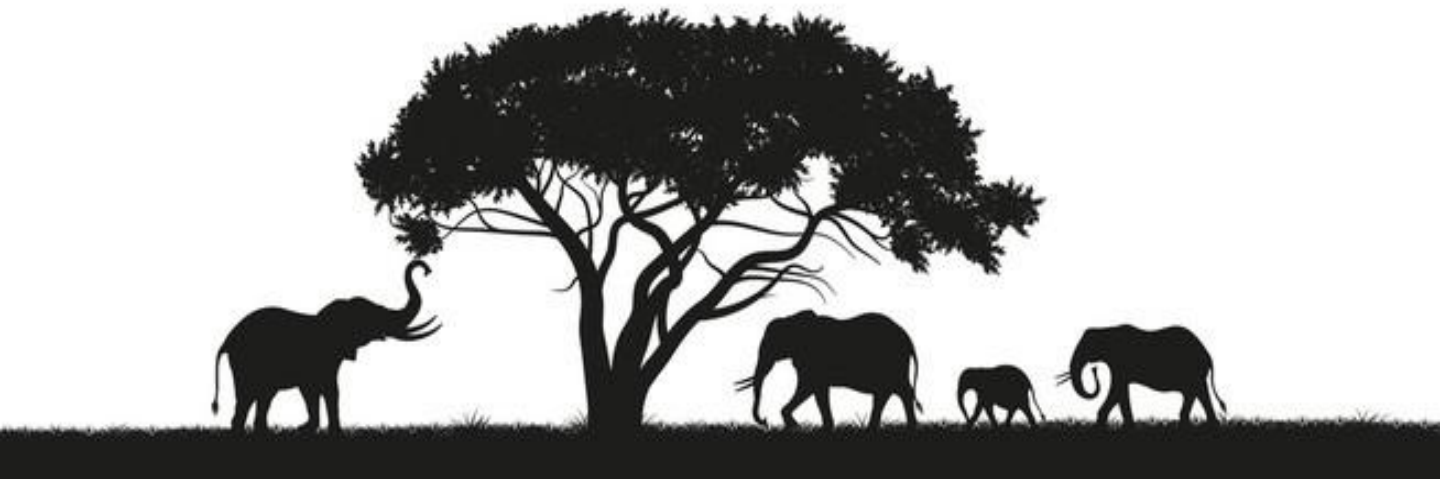

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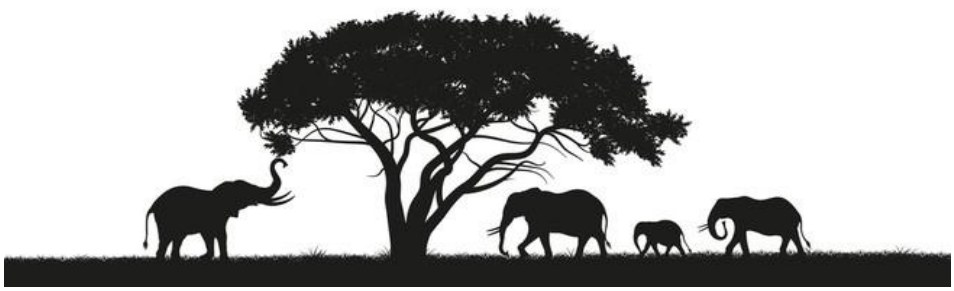


Ethical Dilemmas In South Africa and Veterinary Medicine- Part A

As you spend your time in South Africa, you will learn a lot surrounding the different points discussed here. Your views may change from your current thoughts, from both becoming more informed about these subject areas and having the experience of working in the environments where they are dilemmas part of everyday life, not just a thinking point. This page is something to do on the plane, or even before you leave home…..
Try to do this exercise as honestly as you can, because I think you will really enjoy seeing the differences! These notes are for you and you alone, so don't be afraid to write down what you are thinking even if it is that you don't have an opinion!

Below write your thoughts on hunting. What is hunting? Why do people hunt? What kind of animals get hunted? Do you agree with it?

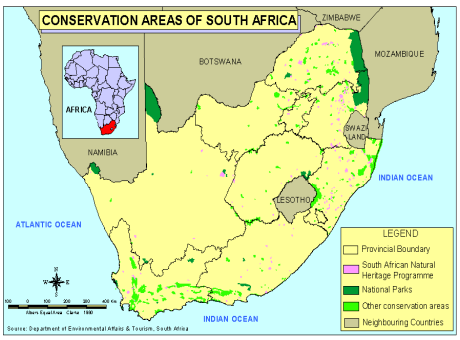
Please write below what you know about Rhino Poaching, why are they poached, how many in south Africa are killed a year? What is the solution to stopping poaching?

Did you know elephant populations are controlled with contraception? Should we be interfering with the hormones and the breeding patterns of wild animals that depend so much on social structure? What are the other options for controlling Elephant populations?

History of Conservation in South Africa

Introduction

South Africa's national protection system includes 178 protected areas, of which 18 are national parks. Ecotourism has direct and indirect benefits to the economy in terms of job creation, rural development, and the emergence of secondary industries involving local communities and remains the fifth largest earner of foreign exchange. Approximately 6.1% of South Africa's land area is currently under statutory protection. Although land claims are permitted in these areas, the land must remain in perpetuity as a national protected area, and the state has the power to block residential development and veto commercial operations which they deem detrimental to the conservation area.



Current conservation management structure in South Africa is as follows:

- National – Department of Environmental Affairs
- South African National Parks
- Provincial Authorities
- Private Reserves
- Non – Governmental Organisations

Pre-Colonial Era

South Africa has a history of conservation; traditionally people lived in harmony with nature and the philosophies of sustainability and conservation were inherent in society. As hunters and gatherers, the indigenous people of this country depended on natural resources for their survival. Prior to European colonisation access to natural resources was controlled and influenced by religious and cultural beliefs. There were superstitions against killing certain species like hyaena, hamerkop or chameleon and people were prohibited from hunting or eating their totem animals (these included eland, zebra, monkeys, squirrels or crocodiles). Scarce or valuable products like ivory, pangolin meat or leopard pelts were used by chiefs and kings only. Chiefs and tribal councils were responsible for making and enforcing the rules for resource control. Chieftaincies were powerful institutions that were respected and obeyed by local people and their authority was absolute. The combination of different types of controls regulated the use of natural resources and protected the resource base.

Colonial Era

This period saw the natural resources of the country being exploited and in 1656 Jan van Riebeeck gave instructions to regulate hunting in the Cape. The Southern Cape forests were valuable to the British Navy and from 1811 measures were introduced to conserve the forests around Plettenberg Bay. By the 1830s rapid deforestation led to increased conservation awareness and by the mid-19th century there was an active and influential conservation community in the Cape and the first game reserves in Africa were declared in the Knysna and Tsitsikamma forests in 1886.

The creation of parks resulted in communities being forcibly relocated to new areas, or losing their land. Conservation became elitist and access to parks required social privileges with game reserves being fenced off and communities losing their rights and access to resources within the reserves. Wild animals would escape from the parks into community land and damage crops and livestock and this increased feelings of resentment by local communities towards conservation authorities.

There was little or no consideration for the communities, who were seen as threats to the environment and over-grazing, over-population, cutting and burning grass, and poaching were contentious issues.

This period created distinct divisions of the land: European settlement areas, African communal areas and the beginning of the demarcation of conservation areas. The African population was forced into smaller areas of land. The notorious Land Acts of 1913 and 1936 legislated this divide, and left indigenous people with only 13% of the total land area in South Africa. Traditional authority structures were weakened and the functions of the chiefs were passed on to magistrates.

Apartheid Era

The apartheid era reinforced the division between communal managed areas and formally managed protected areas. Homelands were formed and the management of the protected areas became fragmented. Some protected areas became the responsibility of homeland governments, with each having its own legislation and management authority. Relationships between communities and government were strained due to the exclusion of communities from protected areas.

Post - Apartheid Era

Since 1994, political change in South Africa fundamentally changed the attitudes of protected area management agencies and owners. Previously, communities were excluded from playing a role in protecting the environment. Today people are becoming shareholders and new practices for protected areas are being created - allowing rural people to play a critical role. The Natives' Land Act of 1913 prohibited the establishment of new farming operations, sharecropping or cash rentals by blacks outside of so-called homelands. In 1991, after a long anti-apartheid struggle led by the African National Congress, State President F. W. de Klerk declared the repeal of several apartheid laws such as the Population Registration Act, the Group Areas and the Natives' Land Act and the Abolition of Racially Based Land Measures Act was passed. These measures ensured no one could claim, or be deprived of, any land rights on the basis of race.

Land restitution processes saw thousands of black people claiming ownership of land previously denied. Successful land claims presented new economic opportunities for the claimants who had been moved away from their land. The shift affected the approaches towards conservation and development in South Africa, which led to various people and parks type projects and other forms of community based natural resource management (CBNRM) programmes. The government is now faced with the challenge of seeing that previously disadvantaged people are supported and advised to ensure they get the benefits they deserve, whilst upholding their conservation mandates.

Land Reform and Land Claims

In 1994 the democratic Government of South Africa identified the need for land and agrarian reform as part of nation building and reconciliation. As part of land reform the restitution programme was introduced to provide redress to persons and communities dispossessed of their land rights by the apartheid Government. In 1995, victims of forced removals were afforded an opportunity to lodge land claims against the state. The initial deadline for the lodging of land claims was set for 31 December 1998. Approximately 80 000 land claims were lodged by this cut-off date. The process for the lodging of land claims was re-opened with effect from 1 July 2014 for a further period of five years, until 30 June 2019. All individuals and communities who were dispossessed of their right to land as a result of racially discriminatory laws and practices after June 1913, and who missed the initial cut-off date of 31 December 1998, now have an opportunity to lodge claims.

Since the re-opening of the process, more than 55 000 land claims had been lodged with the Commission on Restitution of Land Rights across the country by April 2015. Initially, land was bought from its owners (willing seller) by the government (willing buyer) and redistributed, in order to maintain public confidence in the land market. This system has proved to be very difficult to implement, because many owners do not actually see the land they are purchasing and are not involved in the important decisions made at the beginning of the purchase and negotiation. Restitution, where the government compensated individuals financially for being forcefully removed from land, has been very unsuccessful. There is a general agreement that land reform has been a failure and needs to be sped up with research showing that between 70% and 90% of the projects have failed, mostly as a result of lack of training and state support. The policy has now shifted to redistribution and the possibility of expropriation of land by the state without compensation.

Examples of land restitution in protected areas:

Lapalala

The privately owned Lapalala Wilderness Reserve in the UNESCO Waterberg Biosphere has played a pivotal role in breeding programmes for the critically endangered black rhino. Now, with a claim lingering over half of the 36,000 hectare Reserve, investment has been restricted and the Reserve operates on a skeleton staff. Fortunately, the owners at Lapalala understand that conservation, not just in South Africa, but the world over, must involve and no longer exclude local people. The land claim is seen as an opportunity to take this step forward and claimants and land owners have worked tirelessly to engage in Lapalala's biosphere vision whilst emphasising the potential financial benefits of cooperation and integration.

There have been successful land redistribution projects and communities have agreed that their land could be managed for conservation as long as they were actively involved in the process and when land claimants have been persuaded to convert to conservation, the benefits have been considerable.

Somkhanda

On receipt of 20,000 hectares of farmland, the Somkhanda community had three objectives: to settle; to farm; and to create a sustainable business. Four thousand hectares of land were immediately put aside for farming and housing. On the rest, fences were dropped and game introduced. With the assistance of a private commercial partner, the project yields revenue from hunting, safari tourism, and property development. There has been a high success rate with community skills development and employment. Black rhino have been reintroduced and the reserve is perfectly located to become an important member of the proposed transfrontier Peace Park between South Africa, Swaziland and Mozambique.

Makuleke

The Makuleke area was forcibly taken from the Makuleke people by the Apartheid government in 1969 and about 1500 community members were relocated to land to the south so that their original tribal areas could be integrated into the greater Kruger National Park. The land included the northern part of the Kruger National Park (the Pafuri area) and a small conservation area near the Madimbo corridor (adjacent to Zimbabwe and Mozambique). This area (now known as the Makuleke Contractual Park), situated between the Luvhunu and Limpopo Rivers, contains by far the highest combination of wild plants and animals in the Kruger National Park. At least 250 bird species have been recorded in the area, and despite comprising only 1% of the total area of the Kruger National Park the area represents 75% of the Parks animal and plant diversity. The area is also remarkable for its geological and natural heritage and as such is the site of rocks from the Permian age, abundant middle Stone Age tools, and rock art from the Stone Age.

In 1996 the Makuleke tribe submitted a land claim for 19,842 hectares. The community gained full rights to commercialise their land, however they chose not to resettle the land but to engage with the private sector to invest in tourism and did so by entering into partnerships with private investors. A contractual national park was established and greater, more sustainable, returns from eco-tourism than from farming has been realised. In terms of the contractual-park agreement, the land would continue to be administered by the Kruger National Park for a pre-determined length of time, while a Joint Management Board (with members from the Makuleke community and the South African National Parks Board) was established with final decision-making power. The Makuleke negotiated for exclusive research and tourism development rights, and a "sustainable use" clause made provision for "traditional" resource use, which included commercial and consumptive use of the region's wildlife resources.

The Makuleke community The lodges and other initiatives have generated employment. Several young men from the community were trained and employed as game rangers (anti-poaching unit). 100 persons were employed during the construction of lodges, 60 persons were employed during the construction of school classrooms and 18 community members were permanently employed. It is likely that more members of the community will be employed at the other planned lodges/camps. Anti-poaching activities in conjunction with the reintroduction of wildlife in the area resulted in a significant increase in the number of animals in the area. According to the Wilderness Trust this includes species that have been absent for many years (more than 120 years in the case of the white rhino) and is "the beginning of the restoration of the ecological integrity of the area."
The Makuleke leadership have received and utilised income from the arrangements they have entered into with private investors. Examples of items of expenditure include training; skills development and tertiary education opportunities for members of the Makuleke community (including full bursaries at the South African Wildlife College), electrification of two residential villages, construction of four school classrooms, heritage functions, feeding schemes for the poorest families, a village tourism heritage centre, hydroponic fresh produce facility and (controversially) a 4-wheel drive vehicle for the chief.

Opportunities and Challenges
Comparison of ecosystem protection levels in the terrestrial, river, wetland, estuarine, coastal and inshore, and offshore environments across South Africa show that almost 40% of all ecosystem types are not protected at all, nearly 80% of all ecosystem types (excluding coastal and estuaries) are only poorly protected and less than 20% of all ecosystem types are considered well protected.

Opportunities
- Rich biodiversity and exceptional ecosystems and habitats.
- Abundant non-renewable energy and mineral resources.
- Green growth opportunities from wildlife game farming, ecotourism, energy-efficiency measures and innovation.
- A comprehensive policy and regulatory framework for protecting the environment and managing natural resources.
- The fastest-growing renewable energy market in the G20 and the ninth-leading destination of clean energy investment.

Challenges
- One of the most energy- and carbon-intensive economies in the world.
- An over reliance on natural resources.
- Poorly regulated mining resulting in serious environmental damage.
- High pressures on limited water resources.
- Poor environmental quality and access to environmental services (sanitation, waste collection and healthy housing) affecting health, especially children.
- Increasing illegal poaching, wildlife trade and damage by invasive species.

Game Keeping and Conservation

Upon arriving in South Africa your ideas of 'the wild' and preconceptions of wildlife and game reserves will mould within your first few days on the ground in Africa and continue to change throughout your time there; as you learn more about conservation theories and how they are put into practice. One of the biggest shocks is that 'the wild' always has a fence around it; unless you travel to central Africa or east Africa where you will find African wildlife truly surviving in the wild. However, in South Africa, all the land is divided up by either private land owners or owned by the government (National parks such as Kruger).

Once upon a time all the land in Africa truly was wild and there were different ecosystems and environments all around the continent that contained different species of wildlife that suited that environment and had adapted to specific ecosytems. As time went on and civilisation took place land was claimed by communities for use as farm land and hence was cleared of wildlife. This decrease in habitat combined with increased hunting resulted in a decreasing population of certain wildlife species. But in more recent years there has been a huge movement toward turning farmed land back into wildlife reserves and restoring land to its original state with the introduction of wildlife species and breeding of populations.

The idea of conservation was born as early as 1662 when John Evelyn's research *Sylva*, presented as a paper to the Royal Society. Published as a book two years later, it was one of the most highly influential texts on forestry ever published.[2] Timber resources in England were becoming dangerously depleted at the time, and Evelyn advocated the importance of conserving the forests by managing the rate of depletion and ensuring that the cut down trees get replenished. By the mid 19th century conservation was revived, with the first practical application of scientific conservation principles to the forests of India. The conservation ethic that began to evolve included three core principles:

- That human activity damaged the environment
- That there was a civic duty to maintain the environment for future generations
- And that scientific, empirically based methods should be applied to ensure this duty was carried out

Over the next 100 years conservation efforts were started up all over the world, from India, to the artic, latin America and Africa.

This was when game reserves were truly established; a large area of land where wild animals live protected. Most game reserves are open to the public, and tourists commonly take sightseeing safaris. However, some are private and never or rarely visited. Hunting was a huge source of funding for conservation when game reserves started running and some game reserves do still allow hunting, a subject you will come to learn about in your time in South Africa. The so-called Big Five game in Africa (rhinoceros, elephant, Cape buffalo, leopard and lion) were named so because of the difficulty and danger in hunting them , however, these days they are more of a photographic target for tourists as hunting has decreased in popularity.

In a game reserve, ecosystems are protected and conservation is usually key. Indigenous wildlife in its natural habitat help in providing an environment where growth in numbers at a natural rate can occur. Some game reserves contain more than one ecosystem, sometimes even five, ranging from valley bushveld, savannah grassland and fynbos to riverine forest and acacia woodland; this provides a dramatic improvement on the types of wildlife that are present and the numerous species of birds that thrive on in these environments
So after a brief recap of the history of how we got from the wild to farming and then back to the wild! We now have wildlife populations surviving and breeding as they naturally would, but there is a fence line between them and other populations across the rest of Africa. These populations then have to be managed, those animals have to be cared for, although rarely as individuals, as a population. A game reserves main premise is to look after it's animals and conserve all species living on the land. An area of land can only support a certain number of each species and there are many factors to consider; amount of food, supply of water, area to roam, room to breed, male and female ratios. This requires lots of different job roles to focus on different areas of running the reserve, from researchers, to ecologists, veterinarians and logisitics teams.

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One of the key parts of the conservation industry in Africa is the fact that on an annual basis each reserve will have to sell and buy a portion of their wildlife/ game species. To keep numbers to an appropriate level, to maintain breeding ratios of males and females and to increase the genetic pool of the species on the reserve. This in itself has created a huge trade and market in wildlife game. Each wildlife species has a certain value and many decisions on a reserve will be made based on the value an animal may carry- this is a very interesting concept that many of us will not have been aware of before, and you will have the chance to discuss this with the team members at the reserve. An example of one of the insights you will have to the game reserve attending as a student and not just a tourist.

In order to look after the wildlife it is necessary to know a lot about them; where they are living on the reserve, what are their movement patterns, are they divided into sub populations, are they breeding successfully, what is the average age of that population (i.e. is it an ageing herd or reproducing nicely), what are they eating, are any dying un expectantly, if so what of! So much of the information we require in order to look after each species appropriately can only be gathered by research teams and people that spend time out on the reserve and record this kind of information. You will be working with the research team and be able to experience how this information is gathered and what decision on caring for each population can be made. Much of this crucial work is obviously carried out from a distance, ie not 'hands on' work, however, undoubtedly the most crucial part of looking after the mass of animals present.

There is of course a need to intervene and carry out 'hands on' work for many purposes. The main reason being to capture numbers that are overstocked or particular individuals and move them to a new home! IE the reserve sells them to a different reserve. You will learn about the various methods used to do this. Also there are occasional wildlife emergencies that require veterinary intervention such as injury, from fighting or accidental trapping. Of course as with British wildlife there is often a decision that has to be made if an animal has sustained injuries that will result in it not being able to be released into the wild again.
Another key part of 'hands on' work is for research purposes, sometimes we have to gather data in order to learn new information that leads to scientific papers being published that will help teams all over the world better look after all different wildlife species, from the honey badger to hayena!
Hopefully, this brief introduction has given you an idea of the role you will play and the experience you will be a part of. Remember to ask as many questions as you think of as you will learn so much in this new area within the field you have chosen to have your career in! Enjoy it, it will hopefully inspire you to become further involved in conservation one way or another.

Roles on a Game Reserve

There are many jobs roles and responsibilities for the people that own and work on game reserves. Here are a list of some of the job roles and different job descriptions and responsibilities, look out, one job role has been left blank! You will have the opportunity to speak with the person who fulfils this job role at Welgevonden and ask them what their job role is. There is also some space at the end for you to add in different staff members at Welgevonden, what their job role is and what they would describe as their main responsibilities on the reserve.

Welgevonden covers 34,850 hectares and is home to over 50 different mammals, including the Big Five. There are also rare and unusual species to, such as the brown hyena, pangolin, aardwolf and aardvark! So what type of skills and people do you need to work together to look after all of this!

Owner/Shareholders- All Game reserves have an owner, perhaps there are joint/multiple owners or a collection of owners that have all previously owned separate pieces of land and all taken fences down to create one large reserve. The owner may be South African National Parks or even an organisation. But ultimately someone is responsible for the ownership of the land and the reserve. Some reserves are run as businesses through a board of investors or shareholders, where the shareholders change every year, or few years. Sometimes, much like farms in the UK, the person that owns the land does not always own the animals on them and there are different agreements in place for splitting the offspring from these populations.

Operations Officer- Involved with all actions directly or indirectly that take place on the reserve, all teams will report back. The day to day running's will be controlled by the Ops team and any emergencies or crisis will be managed by them.

Reaction Officer- will manage the anti-poaching team, co ordinate the access gates and fence maintenance on the reserve as well as co-managing any joint security efforts with neighbouring reserves. This member is also responsible for the investigation of any poaching (or other criminal incidents) on the reserve and to provide evidence at court in the event of an arrest and subsequent trial.

Finance and Administration Manager- All reserves do at the end of the day have to work as a business, so it can produce profits, to continually pay its staff and pay for reserve maintenance as well as fund research and expand its species list. As with any business.. comes financial paperwork!

Ecologist- Ecologists are concerned with ecosystems as a whole, the abundance and distribution of organisms (people, plants, animals), and the relationships between organisms and their environment. They usually specialise in a particular area, such as freshwater, marine, terrestrial, fauna or flora and carry out a range of tasks relating to that area.
As an ecologist, responsibilities include:

- Conduct field surveys to collect biological information about the numbers and distribution of organisms - this may be for a database such as the National Biodiversity Network (NBN)
- Carry out taxonomy - the classification of organisms
- Cpply sampling strategies and employ a range of habitat survey techniques, such as Geographic Information Systems (GIS), Global Positioning Systems (GPS), aerial photography, records and maps
- Carry out environmental impact assessments
- Analyse and interpret data, using specialist software programs
- Work on habitat management and creation
- Write reports and issue recommendations
- Liaise with, and advise, site managers, engineers, planners and others associated with a survey
- Build relationships with stakeholders, including members of the public
- Carry out research
- Undertake teaching in schools or in field centres
- Keep up to date with new environmental policies and legislation
- Contribute ideas about changes to policy and legislation, based on ecological findings.
- Much of this work may be carried out by other teams, i.e. research may be carried out by the research team and volunteers, but ultimately the ecologist will analyse it in order to make decision about the reserve, ratios of animals etc.

Volunteer Research Programme Coordinator- manages any research and volunteers helping with the research that has to occur daily at the reserve.

Veterinarian team: Vets and Nurses- Wildlife veterinarians are licensed animal health professionals that are trained to treat a variety of wildlife species. Wildlife vets and nurses treat mammals, birds, and reptiles. They may work either in a veterinary office setting or the field. The typical routine for a wildlife vet may include sedating animals for procedures, performing exams, giving vaccinations, taking blood samples, administering fluids, performing surgeries when needed, prescribing medications, evaluating and treating wounds, taking x-rays and ultrasounds, cleaning teeth, assisting with captive breeding programs, and providing "intensive care" for very young animals abandoned by their parents.
Wildlife veterinarians can often work in conjunction with wildlife rehabilitators at a rehabilitation facility. They also must be able to interact and communicate effectively with veterinary technicians, wildlife officials, and members of the public.
Roles and Responsibilities:

- Providing veterinary advice to the management team.
- Enhancing the health and welfare of all animals on site, including swift treatment and diagnostics
- Routine darting for translocation, retagging, pregnancy diagnosing and DNA sampling.
- Liaising with the SAVC and suppliers.
- Laboratory diagnostics including microscopy, faecal examinations, PCRs and blood smears.
- Post mortems and reporting.

Operations Officer- Overall logistics and managements of daily on goings of the reserve, will manage. This includes the maintenance of roads, water supplies and structures on the reserve.

Elephant/Rhino Monitors/minders- For certain species such as those that can cause a logistical problem or those who are a target for poachers some reserves have staff members specifically dedicated to monitoring one species every day. Therefore, they often know exactly where each individual is on the reserve and will alert the managers if a certain individual has not been spotted for a couple of days, at which point the reserve may choose to locate the individual by helicopter. Having one person dedicated to watching a particular species so closely allows them to really understand the specific movement patterns and requirements of that species on that reserve, allowing them to better look after the animals.

Specific Research Project Coordinators- Many reserves will have funding for specific research projects to occur at a particular time in addition to the every day research and monitoring required on reserve, for set period of time staff member may be hired to look after and co-ordinate these specific research targets.

Workshop and Mechanical team- every reserves has vehicles and so need a nearby workshop! There is not a local ATS so it's all done on site!

Reserve Compliance Officer- As every working business has an impact on the environment, even a business trying to look after the ecosystem there is a role dedicated to ensuring that waste is managed properly, noise and light pollution is kept to minimum and overall the movements and logistics of humans living and working on a reserve is affecting the environment as little as possible. Furthermore this person is also responsible for ensuring that all rules and regulations are enforced and is responsible for investigating any complaints or breaches of rules and regulations.

Field Guide- Field guides are in essence tour guides that take clients into the field and provide guided tours in a nature reserve or national park to tourists. These tours can either be on foot, in a vehicle, on horseback or even by boat. Their role is to provide tourists with an opportunity to experience nature and to provide interesting commentary and an educational experience for their clients.

Field Ranger- Field Rangers are the anti- poaching officials on the reserve. They are responsible for ensuring the safety of all wildlife and other natural resources. Furthermore they assist the reserve compliance officer in ensuring that all rules and regulations are enforced.

Animal Capacity Models: Calculating populations

The management of a fenced game reserve is an involved and at times intricate affair. Managers of open conservation systems have, for the most part, no control of the movement patterns and behaviour of the wildlife found in these systems. Conversely it is the responsibility of managers of closed systems to manage the wildlife populations within the reserve and to mimic a natural system as far as possible. Populations need to be managed to the extent that they do not negatively impact the environment and/or overutilize the resources available to them. Predator populations must be managed so that they do not exceed a level where the overutilization of prey populations available on the reserve leads to what is termed a predator pit. A **predator pit** is created when herbivore populations have been reduced for various reasons and existing key predators, such as lions, leopards, cheetahs and hyaenas can drive those numbers even further into an abyss, prohibiting a regrowth of these populations, which in turn could lead to a predator population crash.

The maintenance of these populations within an ecologically sustainable level is known as the **Ecological Carrying Capacity (ECC)**. The ecological carrying capacity is described as the number of animals that can be sustained in a defined area without affecting the habitat quality and implies a natural balance between plants and animals and predators and prey.

The aim of determining the ECC in terms of the herbivore population is to regulate the numbers and ratios of bulk feeders, mixed feeders and grazers that can be sustained in an area. In the management of wildlife there are a diverse range of factors that need to be considered when determining ecological carrying capacity. These include:

- Habitat preference
- Food preference
- Territoriality
- Inter- and intraspecific competition
- Habitat protection

The determination of an ECC is complicated by the management objectives of the game reserve and may include game viewing and tourism, trophy hunting, venison production, game farming, conservation or a combination thereof. Various options in terms of the ECC are available and these include:

- Economic carrying capacity
- Maximum harvest density
- Minimum impact density
- Maintenance density
- Tolerance density

Several techniques for assessing the ECC exist. In terms of herbivore carrying capacity determination; methodology used is based on agricultural principles as opposed to wildlife principles. For this reason, ECC determination may be considered controversial and outdated and in the determination of an ECC for game reserves it is adjusted to suit wildlife populations. The determination of an ECC is not an exact science and fluctuates between habitat types, seasons (where there is less browse or graze available in winter and therefore a lower ECC) and environmental factors such as rainfall and climate.
For the purpose of this exercise and as an introduction to the determination of an ECC we are going to be looking at the determination of a Minimum Impact Density. This method is used largely for the determination of an ECC for predator populations and the population quality under these conditions is usually either very good or optimal, as is habitat. There are different methods of determining an ECC based on the size of the property, the population of potential prey available or determining whether the prey and size of the property is sufficient based on a known predator population. In determining a predator ECC it is important to take into account the amount of potential prey available to them, their ranging behaviour and the presence of competing predators.

The African wild dog (Lycaon pictus) is an endangered species with a severely reduced population in all range states. A naturally occurring population has persisted in the Waterberg region of Limpopo Province in South Africa for many years. This population is genetically distinct from other regions within the country and had disappeared from the region for a number of years. At the beginning of 2018 a pack of 12 of these dogs re-appeared and are ranging between farms and reserves in the area. A small population has previously occurred on Welgevonden Game Reserve; unfortunately, due to their ranging behaviour and dispersal patterns they never established a permanently residing population on the reserve. For the purpose of this exercise we are going to be looking at the population of wild dogs that are in the area and the method used is based on the fact that we already know the size of the population and we are therefore going to be determining whether the prey base on Welgevonden would be sufficient to sustain this population of wild dogs for an extended period.

We are going to calculate the minimum population size of prey species required to sustain predation by a pack of 12 wild dogs over a period of one year based on established prey profiles for Welgevonden. We will also estimate the area required to sustain both the prey and wild dogs based on current densities of the individual prey species. Wild dogs generally utilise prey in proportion to abundance and feed largely on impala when it is available. They also regularly feed on waterbuck, kudu and blue wildebeest.

For the exercise below, this model will rely on several assumptions:

1. The standard unit mass for prey species is used for estimates with no differentiation between prey sex weights accounted for and uses a mean
2. That ecological carrying capacities for prey populations are constant
3. The impact of competing predators is not accounted for
4. Prey-profiles of wild dogs reintroduced into small areas would represent those observed in large areas of similar habitat
5. Consumption of additional, potentially suitable prey species is not factored into the final calculation.

The above-mentioned assumptions do not allow for localized variations in prey size or consumption by wild dogs or seasonal variation in veld conditions; but are based on generalised regional data. There will likely be localized fluctuations in prey consumption by both the wild dogs and other competing predators which can impact prey population trends beyond the scope of this example. As this is merely an introductory exercise into determining an ECC and therefore for the purposes of simplification the assumptions mentioned above are not factored in to determine the ECC. To determine a more accurate ECC the above assumptions need to be factored into calculations and would require an extrapolation of these figures for all predator species on the reserve. This exercise should shed some light on the management of a game reserve and should provide insight into proving that the management of game reserves does not merely involve the introduction (or re-introduction) of species and then leaving them to their own devices but that the management of a game reserve is in fact a scientific endeavour.

The following formula is used for determining a model on which to determine potential prey requirements for wild dogs.

$$N_{min} = \frac{4N_{prey}}{r_m}$$

N_{min} is the minimum population size required to support the predation by a pack of wild dogs of a given size over a year, N_{prey} is the number of individuals of a prey species killed per year by a pack of wild dogs and r_m is the intrinsic rate of increase of the prey population. Using the known intrinsic growth rates of the favoured prey species from research conducted in similar habitats and the estimated consumption rates of these prey species by wild dogs, the estimated required prey population of prey most commonly targeted by the wild dogs on Welgevonden to sustainably support the pack and the individual prey species over the long term are calculated below. Prey figures are based on aerial game census figures from 2017.

Prey Species	N_{prey}	R_m	N_{min}	Prey base	Prey density/km²	Required area (km²)
Impala (80 %)	277	.35	3165	828	2.3	1376
Kudu (6.6 %)	6	.23	104	346	1.3	80
Blue Wildebeest (6.6 %)	6	.22	109	1100	3.15	34
Waterbuck (6.6 %)	5	.21	95	271	.8	119

In determining the prey consumption, the most commonly targeted species based on previous research are used. 80% of the diet of the wild dogs is impala with the remaining 20% being evenly distributed between waterbuck, blue wildebeest and kudu. Incidental kills such as warthog and duiker are not taken into consideration when determining prey requirements as they make up a negligible proportion of reported kills. Furthermore, prey biomass required per day per dog is adjusted to a conservative 2.65 kg, approximating field estimates determined by research. Taking 61% of the body mass of ungulates being made up of flesh and taking an average of 55 kg for an impala we can determine that approximately 33.5 kg for an individual impala is available to the dogs for consumption. For kudu the average available weight is determined at 132 kg, for wildebeest it is 120 kg and for waterbuck it is 140 kg.

The figures for impala for the above table are determined as follows:

Nprey
Meat needed for the entire pack of wild dogs per day (2.65 x 12 = 31.8 kg)
The pack needs 0.95 impala per day (31.8 kg / 33.5 kg available)
0.95 x 365 days = 346.75 impala per year, but only 80% of diet is impala, therefore
346.75 x 80% = 277.4 (rounded down to 277) impala required per year for 12 dogs

r_m
These rates known, available and based on research
N_{min}
As per above formula
Prey base
Figures obtained from 2017 aerial census
Prey density/km²
Based on size of reserve and population of species based on 2017 aerial census
(828 / 348,5 km²)
Required area
Area required to support the number of prey animals needed to sustain the population of wild dogs in the long term
(N_{min} / prey density)
Figures for other species are determined the same way.

Assessing these figures and taking into consideration the fact that the majority of the wild dogs' prey consists of impala it should be recognized that the area available for wild dogs at Welgevonden, at current impala densities, is below the calculated minimum required area. It needs to be remembered that in determining these requirements the impact of competing predators is not taken into account.

Exercise 1.

Determine whether the population of potential prey species is sufficient to support this pack of 12 wild dogs if the utilisation of prey changes as follows:

You will need to determine the mean weight of eland (combine male and female) and work out how much is available to the dogs for consumption.

The reserve is 348.5 km^2

Prey Species	N_{prey}	R_m	N_{min}	Prey base	Prey density/km^2	Required area (km^2)
Impala (60 %)		.35		828		
Kudu (15 %)		.23		346		
Blue Wildebeest (15 %)		.22		1100		
Eland (10 %)		.2		254		

Exercise 2.

Describe in detail what the implications of your results are for the management of a resident wild dog population on Welgevonden Game Reserve. Include details on prey populations, size of the reserve, prey switching and ranging and dispersal behaviour of African wild dogs.

African Elephants and Contraception

African elephants are the largest living land mammals
Until recently there was one species of elephant in Africa - but they are now classified as either forest or bush (or savannah) elephants
Forest elephants are found in equatorial forests and have straighter trunks and rounded ears
Bush elephants are more widespread, mostly south of the Sahara in a range of habitats including savannah, swamps and deserts
Their society is guided by the oldest female - the matriarch. She determines when they eat, rest, bathe and drink

Here are two different articles on Elephant contraception, One from the BBC and one scientific journal. It should promote some critical thinking and everyone will have different opinions on ethics and management, what do you think?

-Article 1 from BBC October 2012, Martin Plaut

Birth control for elephants in South Africa is being hailed as a success, after the introduction of a contraception vaccine being trialled by researchers.

Wildlife conservationists believe it is likely to become the way to control South Africa's ever-expanding elephant population. But the plans have provoked considerable controversy. Some of the country's most eminent elephant experts are completely opposed to the contraception programme.
Elephants eat an estimated 270kg (600lbs) of food a day and can be extremely destructive while feeding, pushing over trees or breaking off branches. Unlike in many African countries, where poaching has recently been having a devastating effect on elephant numbers, in South Africa the population is estimated at about 20,000.
For the last five years, wildlife experts in the Tembe Elephant Park, which borders Mozambique, have been firing the contraceptives into the female elephants from the air.
The 300 sq km (115 sq mile) park in KwaZulu Natal province has 200 elephants in its herd - some of southern Africa's largest giant animals with magnificent tusks.
The biggest of them all is Isilo, who is about 50 years old, weighs seven tonnes, and stands 3.2m (10.5ft) tall. His tusks are about 2.5m long and weigh more than 60kg. It is a testimony to their successful conservation, but elephants can run out of vegetation and at this point they starve to death or rampage through neighbouring farms.

Pink dye
Catherine Hanekom, the district ecologist, says the new vaccine is the least disruptive way of limiting the fertility of these wild animals.

Annual boosters are required to maintain contraception
"The really nice thing about it is that it is a remote application," says Ms Hanekom, who works for Ezemvelo KZN Wildlife, a government organisation that is responsible for overseeing conservation areas and more than 57 parks in KwaZulu-Natal.
"So we will fly with the helicopter, we dart the animals from the air, the dart will fall out and that's the entire impact we have on the herd," she told the BBC.
The elephants are then marked with a pink dye to indicate they have been vaccinated, although this sometimes becomes obscured by dust. Annual boosters are required to maintain contraception. The results have been encouraging as the number of calves being born has more than halved, Ms Hanekom says. This has meant that the distressing process of hunting down and culling elephant herds has been avoided.
Tembe Elephant Park was the first public park to start using the birth control method and is one of 13 reserves in the country now using it. The Conservation Ecology Research Unit (Ceru) at the University of Pretoria says the average female elephant gives birth when 12 years old and produces 12 calves over her lifetime of about 60 years.
The South African government halted the killing of elephants in 1994, but by 2008 the numbers in the Kruger National Park had more than doubled. Known as immunocontraception, the vaccine is a non-hormonal form of birth control.

Its production and testing is being partly funded by a US non-governmental organisation, Humane Society International, and in South Africa is being supervised by the University of Pretoria's reproduction section in the department of production animal studies.
According to HSI, the porcine zona pellucida (PZP) vaccine is 90% effective and has been tested successfully on horses and deer in the US.
It works by stimulating a female elephant's immune system to produce antibodies which prevent the sperm from fertilising her egg during ovulation.
The organisation argues that this form of population control is cost effective, with each vaccination in the first year, including the use of a helicopter, amounting to about 1,200 rand ($142; £89) per elephant cow.
It is also quick.
Jaco Mattheus, from the Phinda Private Game Reserve in KwaZulu Natal which began testing the vaccine in 2004, said it was initially done at ground level, a time-consuming process.
"We then explored the opportunity to implement aerial vaccinations when the elephant congregated in more accessible areas of the reserve, as it happens at the beginning of the wet season," he told HSI in its 2012 report Free-ranging African Elephant - Immunocontraception, a new paradigm for elephant management.
"Darting from the helicopter significantly reduced the time needed to vaccinate the required animals, as well as the perceived stress on the animals. It literally only takes an hour or two now."

'Unfeasible'?
But contraception is not universally supported, with some elephant experts questioning whether it is the right approach.
Some scientists suggest the programme is not even feasible in large-scale parks like the Kruger National Park.

"Even if individual treatments were 100% effective, the costs would be likely to exceed the total management budget of the South African national parks," argued Stuart Pimm of Colombia University and Rudi J van Aarde of Ceru at the University of Pretoria.
In Kruger, the 30 years of elephant culling went hand in hand with the increasing placement of boreholes and dams.
Prof van Aarde says that the elephant numbers problem is an artificial one.
Digging water-holes that allow elephants to remain in one location even during dry seasons leads to the decimation of the vegetation and an explosion in elephant numbers.
He takes Namibia's Etosha National Park as an example - there were only 50 elephants in the park before it was fenced and 58 wells were put in place.
"Today it is home to 2,000 elephants, most of them living there throughout the year," he told the BBC.
Where there is no artificially provided water the periodic droughts provide a natural brake on elephant populations, since many calves do not survive their first four years.
The case of the Kruger National Park is also illustrative.
"In Kruger, the 30 years of elephant culling went hand in hand with the increasing placement of boreholes and dams," Prof van Aarde says. numbers grow the more water holes there are
"By the time the culling came to an end in 1994/5, there were some 280 artificial water-holes outside rest camps."
No elephant had to travel for more than 5km for water, he says.
Now the process has been reversed and over the past 10 years about half the Kruger's artificial water points have been closed.
At the same time the fences on the east of the park have been removed, allowing elephants to roam into Mozambique, and culling has ended.
Elephants responded to these changes and numbers have stabilised, says Prof van Aarde.
"As a matter of fact numbers have not changed significantly over the past five years," he says.
Clearly, there are strong opinions on the question of elephant contraception.
And what works in a small, enclosed reserve like Tembe may not necessarily be applicable for much larger nature parks like the Kruger.

-Article 2: a scientific journal from 2011

How Immunocontraception Can Contribute to Elephant Management in Small, Enclosed Reserves: Munyawana Population as a Case Study

Heleen C. Druce, Robin L. Mackey, and Rob Slotow*. Matt Hayward, Editor

Abstract

Immunocontraception has been widely used as a management tool to reduce population growth in captive as well as wild populations of various fauna. We model the use of an individual-based rotational immunocontraception plan on a wild elephant, *Loxodonta africana*, population and quantify the social and reproductive advantages of this method of implementation using adaptive management. The use of immunocontraception on an individual, rotational basis stretches the inter-calving interval for each individual female elephant to a management-determined interval, preventing exposing females to unlimited long-term immunocontraception use (which may have as yet undocumented negative effects). Such rotational immunocontraception can effectively lower population growth rates, age the population, and alter the age structure. Furthermore, such structured intervention can simulate natural process such as predation or episodic catastrophic events (e.g., drought), which regulates calf recruitment within an abnormally structured population. A rotational immunocontraception plan is a feasible and useful elephant population management tool, especially in a small, enclosed conservation area. Such approaches should be considered for other long-lived, social species in enclosed areas where the long-term consequences of consistent contraception may be unknown.Immunocontraception has been widely used as a management tool to reduce population growth in captive as well as wild populations of various fauna. We model the use of an individual-based rotational immunocontraception plan on a wild elephant, *Loxodonta africana*, population and quantify the social and reproductive advantages of this method of implementation using adaptive management. The use of immunocontraception on an individual, rotational basis stretches the inter-calving interval for each individual female elephant to a management-determined interval, preventing exposing females to unlimited long-term immunocontraception use (which may have as yet undocumented negative effects). Such rotational immunocontraception can effectively lower population growth rates, age the population, and alter the age structure. Furthermore, such structured intervention can simulate natural process such as predation or episodic catastrophic events (e.g., drought), which regulates calf recruitment within an abnormally structured population. A rotational immunocontraception plan is a feasible and useful elephant population management tool, especially in a small, enclosed conservation area. Such approaches should be considered for other long-lived, social species in enclosed areas where the long-term consequences of consistent contraception may be unknown.

Introduction

Within natural, open conservation systems, large stochastic events such as drought, fire and predation keep populations at a sustainable level by eliminating the old, weak and young [1], [2], [3], [4]. However, within modern conservation areas, especially small, enclosed reserves, natural stochastic events are altered by human management interventions [3], with more intervention required for smaller reserves [5]. Within these conservation areas, the occurrences and spread of big fires are often prevented or controlled [4], while natural droughts have limited effects on wildlife populations, as critical resources are usually never a limiting factor due to water and food provision [6], [7]. The fences prevent natural movement patterns from and into these areas, and predation events are effected and controlled within these areas, as managers determine and restrict the predator-prey ratios, and predator population structure [5], [8]. This can result in eruption of populations which leads to significant environmental problems [9], [10], which then require active management intervention [11], [12], [13], [14].

Natural processes should be simulated to achieve management objectives without a negative effect on the system [15]. However, because active management requires managers to impede the natural processes of nature [16], it can often have unforeseen consequences (e.g. killing of rhino, *Ceratotherium simum*, by elephant, *Loxodonta africana*) [17]. This is of special concern for species with complex social systems, e.g. Hamadryas baboons, *Papio hamadryas* [18], [19], Lion-tailed Macaques, *Macaca silenus* [20] and elephants [17], [21]. Thus, for management interventions to be effective and non-detrimental, a sound understanding of the natural processes is required.

Small, enclosed reserves within South Africa are experiencing eruptive elephant population growth, which is an increasing concern to conservation biologists, ecologists and wildlife managers [22], [23], [9]. In the older, larger populations, these elephants were introduced as orphans from culls in Kruger National Park [23]. These introductions have resulted in very young, fast-growing populations, with no or very low, adult senescence [11], [23]. The pressure exerted by increasing density of animals can cause environmental damage [10] and changes in biodiversity [24], [25], [26]. Therefore, overabundance and rapid growth rates may require active management [27], [28].

There are two natural processes that could control elephant population numbers. One process is natural mortality, particularly of young animals [3], [4]. During episodic catastrophic events (e.g., drought), entire cohorts of juvenile elephants can be lost [2], [3]. The second process is the regulation of female inter-calving intervals (and, less importantly, age of maturation - [11]) by environmental conditions [29]; under adverse conditions, inter-calving intervals should increase [30].

Immunocontraception has been used as a management tool around the world for numerous years to restrict rapid population growth in captive as well as wild populations of many animal species i.e. feral horses (*Equus caballus*) [31], [32], [33]; Prezewalski's horses (*Equus prezwalskii*) and banteng (*Bos javanicus*) [34]; white-tailed deer (*Odocoileus virginianus*) [35], [36]; Brandt's vole (*Microtus brandti*) [37]; Tule elk (Cervus *elaphus nanodes*) [38]; and African elephants [39], [40], [41]. Immunocontraception of African elephants has proven safe [41], [42] and effective in reducing population growth rates [41], [43], [44], [45]. Consequently, immunocontraception can be used to prevent female elephants from conceiving, or to increase the span of calving intervals of each individual female, and thereby reduce population growth. However, immunocontraception can reduce the existing population size only when it decreases the birth rate to a level that is below the mortality rate. This reduction in birth rate will subsequently age a population over the long term [46], assuming that age-specific mortality rates are constant. By preventing calving or by prolonging calving intervals, immunocontraception can be used to simulate calf mortalities from predation or prolonged bouts of adverse environmental conditions (e.g. droughts).

Immunocontraception has a minimal influence on elephant social behaviour in the medium term [41], [42], [44]. However, it has been suggested that social problems may occur in elephant populations treated with prolonged use of immunocontraception that is intended to prevent any calves being born into a population [47], [48]. Potential social problems include the lack of allomothering experience within family groups, due to prolonged absence of newborn calves, and depression amongst adult females arising from their continual oestrus cycling as an inability to conceive and give birth [48]. To overcome these potential long-term effects, females can be allowed to give birth periodically. The effects of such births on populations, and how to manage such reversal of contraception at a population level, is unknown. The rotational use of contraception can simulate natural processes within a small, enclosed population, but it remains important to monitor and study the social and behavioural effects.

This study attempted to reveal some knowledge and understanding on the rotational contraception on a species at the population level. The feasibility of implementing individual-based contraception of elephants has been demonstrated elsewhere [49]. Here we used the Munyawana elephant population as a case study to demonstrate an example of individually-based, rotational immunocontraception used to simulate the effects of natural mortality which increase inter-calving intervals. We use population models to determine potential effects of immunocontraception-based management plans on elephant population size and age structure.

Study Area

This study was conducted within the Munyawana Conservancy, KwaZulu-Natal, South Africa (27°51'30"S, 32°19'00"E). Initially, Phinda Private Game Reserve (Phinda) was established in 1991, with an area of approximately 150 km^2. During August 2004, the boundary fences between Phinda and two neighbouring reserves, Zuka and Mziki Pumalanga were removed, forming the Munyawana Conservancy (185 km^2) (see Fig. 1). During May 2006, the boundary fences were removed between Munyawana Conservancy and the neighbouring reserve, Sutton, increasing the area of the conservancy to 207 km^2 [7].

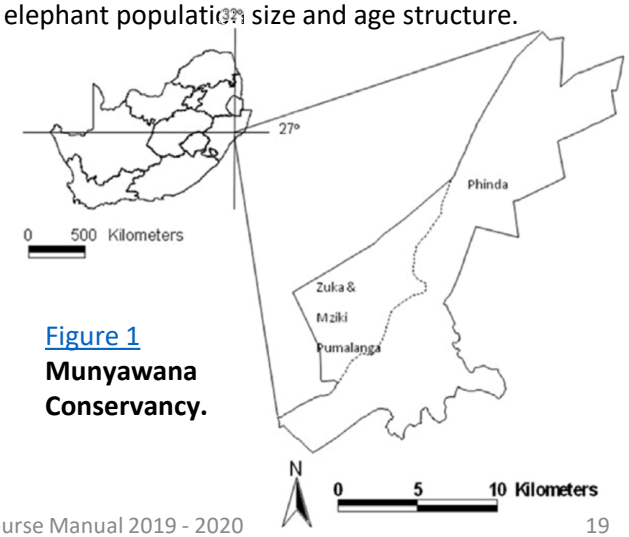

Figure 1
Munyawana Conservancy.

The vegetation types within the Munyawana Conservancy were Sand Forest ([50]; Type 3), Sweet Lowveld Bushveld ([50]; Type 20), Natal Lowveld Bushveld ([50]; Type 26), Lebombo Arid Mountain Bushveld ([50]; Type 13) and Coastal Bushveld-Grassland ([50]; Type 23). One perennial river, the Mzinene River, flows from west to east through the southern section of the conservancy, and dams were extensively distributed throughout the properties. During the rainy season, surface water was extensive; while some of these dams retain water all year round, other dams were supplied with borehole water during the dry periods, i.e. water was always available. The Munyawana Conservancy has a summer rainfall regime and temperatures range from an annual mean minimum of 10°C to an annual mean maximum of 35°C.

Munyawana Immunocontraception Management Plan

The Munyawana management team was greatly concerned about the continuous elephant population growth within the small and enclosed system. By the end of 1994, a total of 58 elephants had been introduced into Phinda from Gonarezhoa in Zimbabwe and from former Kruger culling operations [51]. Within 10 years, the Phinda elephant population almost doubled in numbers, with the average annual population growth rate since introduction equalling 9.4%. The elephant population was monitored on a daily basis from March 2003 through to July 2006 (end of data used in this study, but monitoring is still continuing in 2009). As many elephant as possible were located each day, and general location data, identities of adult individuals present and behavioural activities (in general, as well as musth, oestrus behaviours and newborn calves) were recorded. All population demographic data until July 2006 were used in the models. Monitoring of the populations within the inclusive reserve began once these areas became part of the conservancy. All individual elephants were known, as well as the family groupings.

During July 2003 the population was reduced from an estimated 107 individuals to 66 individuals through the translocation of four family groups to other private game reserves in South Africa. In July 2006, the total elephant population within the Munyawana Conservancy consisted of 98 individuals, with 20 independent bulls and seven family groups. Of this, the Phinda population comprised 88 individuals, with 19 independent bulls and five family groups. The Zuka population consisted of three young individuals and the Sutton elephant population comprised one family unit made up of seven individuals. Neither the Zuka nor the Sutton populations amalgamated into the Phinda population during this study period, and the Sutton group has subsequently (during November 2007) been translocated from the reserve.

The 2003 translocations reduced the breeding population to a more manageable size (21 sexually mature females) and during May 2004 an immunocontraception plan (ICP) was implemented. The aim of this ICP was to reduce the overall population growth rate, but not to completely prevent conception within the entire female population. The proposed ICP allowed young mothers to have their first calf before being included in the ICP. It also allowed females to calve on a rotational basis within each family group. Through this, the ICP aimed to increase the inter-calving interval of individual females within each family group, but to still allow the social needs of the family groups to be met, in that calves would still be born into the groups on a continuous and regular basis. Births would also be rotated between the females within each family group. The ICP allowed one young calf to be born into each family group at least every two to three years. A further aim of this ICP was to create a more natural population structure, with newborn births evenly spread over time. Herds derived from orphan populations tend to be synchronised in their calving as the introduced female orphans all tend to reach sexual maturity at the same time and, therefore, give birth to their calves at similar times ([23], H.C. Druce, pers. obs.). During the elephant immunocontraception darting operations, the contraceptive was administrated by methods described in detail [49]. All the immunocontraception darting procedures during 2004–2007 were done from ground, either from vehicle or on foot. Annually the same marksman administered the contraceptive remotely by means of drop-out darts fired from a Dan-Inject dart gun and thereafter darts were retrieved to ensure appropriate treatment.

Immunocontraception Model

An individual-based rotational spreadsheet model was developed to make projections of the size, growth rate and age structure of the Munyawana elephant population under a set of potential management immunocontraception intervention plans. More specifically, we examined the effect of altered inter-calving intervals versus preventing females from conceiving their first calf upon sexual maturity. To determine the robustness of our projections, we tested the sensitivity of the model projections to realistic variations in the demographic parameters (age at sexual maturity, time to conceive after release from contraception, natural calving interval).

The demographic parameters incorporated in this model were: (1) age of sexual maturity of females (age of first oestrus, with assumption of first conception), (2) calving interval (average interval between consecutive births for a mother), (3) birth sex ratio, (4) maximum age of individuals, and (5) age at menopause (see [11] for parameter details and calculated methods). Additional management parameters modelled were: (5) contraception implementation age (allowing or preventing females from conceiving their first calf upon the age of sexual maturity), and (6) conception time (the time for a cow to conceive upon being released from contraception).
The parameter values were constant for the birth sex ratio, which was 1:1 [11], [52], [53], [54], maximum age of individuals (60 years [11], [53], [54]) and the age of menopause (50 years [53], [55]). Female elephants may reach sexual maturity as late as 17 years [52], and will typically produce the first calf two years later [55], [56], [57]. However, Mackey [11], [58] calculated the average age of female sexual maturity in four small, enclosed reserves to be between 8 and 10 years. The average age of sexual maturity of the Munyawana population was previously thought to be 10 years [11], but additional data up to 2009 indicate this to be nine years. The inter-calving interval of cows is between four and five years [55], [59], [60], with estimates as high as four to nine years [61]. However, recent studies in enclosed populations in South Africa determined calving intervals at between three and four years [11], [58]. Again, newer census data up to 2009 (but before immunocontraception took effect) for Munyawana indicate average calving interval has reduced from four years [11] to three years.
Moss [59] observed that female elephants experience very short oestrus cycles of on average four days with females coming into oestrus throughout the year. Sufficient field testing has not yet been done, but estimates of the time for an elephant cow to conceive upon being released from contraception vary from 12 months [43], 12 to 18 months (D. Grobler, CatchCo Africa, pers. comm.), or may be approximately equal to the number of years an elephant cow has been subjected to vaccination [46].
The different contraception scenarios were simulated by adjusting a single parameter per scenario and keeping the rest of the parameters at the baseline value (Table 1). We assumed contraception was 100% effective in preventing conception in treated females [41], [42]. Model simulations were done for 20 years (2006 to 2026) to obtain population projections on a timescale which is of relevance to management decision making (Fig. 2).
Density dependent regulation was excluded from this simulation model because of the time-scales of the model, time-lags associated with the long generation times and 22-month gestation periods, and the young age structure of the population make changes in natural rates of senescence unlikely (As a young orphan introduced population, none of the adult elephants exceed the age of 60 within the 20 year modelled time frame). Similarly, no stochastic mortalities (drought, fire and predation) were included in the model, as the model was specifically aimed at the known Munyawana population and because, due to intensive macro-management within the small, enclosed environment, stochastic events are unlikely to impact the elephant population (artificial water sources are provided [62], fire is managed (pers. Obs.), and lion groups size kept small resulting in no lion predation of elephant [63]). The purpose of the model is to show the ability to manipulate the population, through selective interventions, to make it more natural in structure. Therefore to use individual-based rotational immunocontraception as an adaptive management tool to simulate natural mortality of young, along with natural environmental effects on female reproduction by ensuring some prolonged inter-calving intervals.

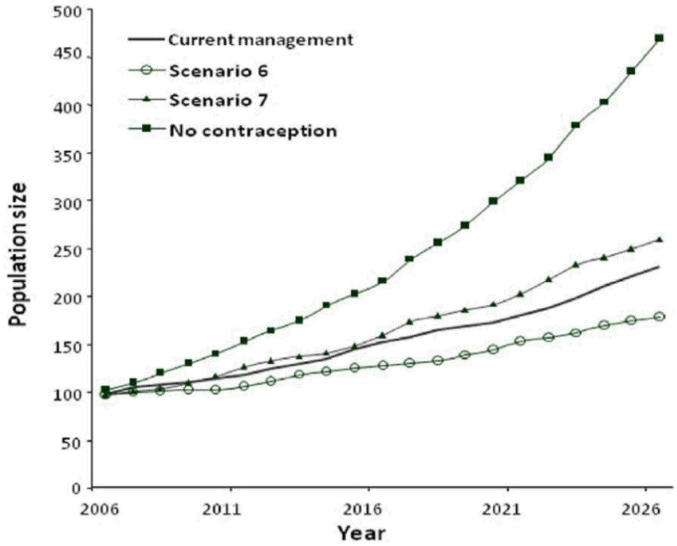

Figure 2

Projected population size for the Munyawana elephant population under different immunocontraception scenarios for a 20-year time period.

Modelled scenarios for Munyawana elephant population	Parameters				Annual growth rate (%)[v]	Population doubling time (years)[vi]	Projected population size	
	Age of sexual maturity (years)[i]	Implemen-ation age (years)[ii]	Concep-tion duration (years)[iii]	Calving interval (years)[iv]			2006 (start)	2026 (end)
Munyawana- current contraception plan	The combined Phinda & Sutton contacepted, Zuka non-treated plans				4.20	18	98	230
Munyawana- no-contraception plan	9	-	-	3	7.58	10	102[vii]	469
Scenario 1	9	10	1	8	4.16	18	98	217
Scenario 2	9	10	3	8	4.13	18	98	216
Scenario 3	8	9	2	8	4.36	17	98	228
Scenario 4	9	10	2	8	4.15	18	98	216
Scenario 5	10	11	2	8	4.03	19	98	211
Scenario 6	9	8	2	8	3.19	>20	98	178
Scenario 7	9	10	2	6	5.06	15	98	259
Scenario 8	9	10	2	10	3.48	20	98	196

Table 1

Modelled elephant population growth rate, population doubling time and population size for the contraception period 2006–2026.

The age structure of the population was determined by assigning each individual into one of five age classes (infant, juvenile, intermediate, sub-adult and adult). The adult age class was further sub-divided into smaller age categories (see breakdown in legends of Fig. 3 and Fig. 4). The absolute numbers of individuals per each age class were calculated at the end of the final year of the simulation (i.e. 2026). The age structure was calculated for the entire population as well as each family group/herd.

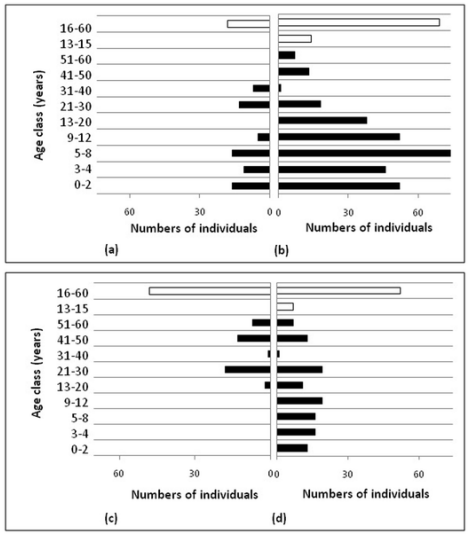

Figure 3

The projected Phinda elephant population divided into age classes represented as absolute numbers under different immunocontraception scenarios.

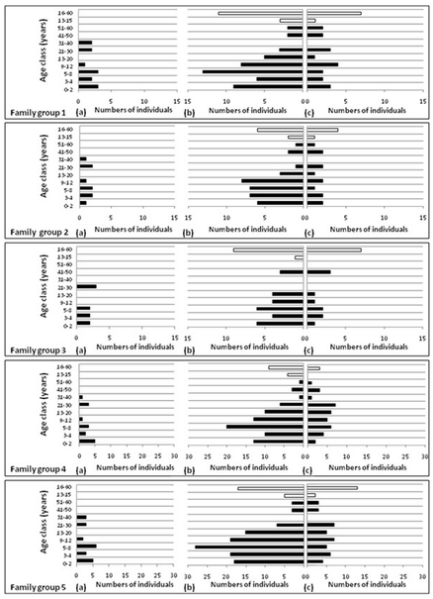

Figure 4

The projected Phinda elephant population as family groups and divided into age classes represented as absolute numbers under different immunocontraception scenarios.

Results

Changes in projected population size and growth rate were described for a 20-year span (2006–2026) of the actual contraception plan (as decided by the Munyawana management team separately for the three populations –Phinda, Zuka and Sutton), other contraception scenarios and no-contraception application. The projected effects of contraception on elephant population size showed that there was a large difference in population size over a 20-year period between a non-treated population and a treated population (Table 1, Fig. 2). Annual growth rates for the 20-year period for a non–treated population was 7.58% versus 4.2% for the Munyawana immunocontraception plan that is currently being implemented (Table 1). The slowest overall growth rate was 3.19% for the Munyawana population (Scenario 6) in which females were prevented from conceiving their first calf until 8 years after achieving sexual maturity – producing the first calf at 19 years. The highest projected value (5.06% annual growth rate) for any scenario with contraception was Scenario 7, which had a 6-year calving interval (Fig. 2).

Under the current immunocontraception plan, the Munyawana population would double after 18 years, while the same population would double within 10 years without any contraception implementation (Table 1). When the calving interval was lengthened to longer than 6 years and prevention of the first calf (such as Scenario 6 and 8) was implemented, the population doubling time was projected to be 20 years or longer.

The Zuka population, which is not under a contraception program, had the greatest overall growth rate of 8.73%. If the Zuka population continues to be left out of the contraception plan, it will double in only 6 years.

Sensitivity analyses indicate the response of the projected elephant population growth rates to changes in the demographic parameters of the model, or the robustness of model projections to change in demographic parameters. Population projections were most sensitive to changes in calving interval and the implementation age of contraception (i.e. whether a female's first calf was delayed). Changes in calving interval produced relatively large changes in population growth rate, with an increase from six to ten years resulting in a reduction of 1.58% in annual growth rate (calculated over 20 years) from 5.06% to 3.48%. Changes in implementation age of contraception from ten to eight years (i.e. if sexual maturity is at nine years of age, therefore by delaying the first born calves), produced a reduction of 0.95% in annual growth rate. The model projections were not particularly sensitive to age of sexual maturity and the length of conception time after release from contraception. Changes in age of sexual maturity produced relatively small changes in population growth rate, with an increase from eight to ten years resulting in a reduction of 0.33% in annual growth rate (from 4.36% to 4.03%). Increasing the conception time from one to three years resulted in a reduction of only 0.03% in annual growth rate (from 4.16% to 4.13%).

The model was used to project the probable changes to the age structure of the population under various contraception scenarios (Fig. 3). The initial population age structure before any immunocontraception had taken affect during 2006 was used as the baseline data (Fig. 3a) to simulate different future outcomes, where after comparisons of age structure were made between no-contraception, 100% and a rotational contraception from predicted model results at year 20 (i.e. 2026). When no-contraception was applied to the Munyawana population, the model projections indicated that the bulk of the population comprised young animals, and as the breeding population increased in size over time the recruitment of young also increased (Fig. 3b). When a continual 100% contraception rate was applied, there were no new calves added to the population and the average age of individuals in the population has increased; this ultimately had the effect of aging the population (Fig. 3c). With rotational immunocontraception application, the Munyawana population produced a limited number of calves, subsequently resulting in a more even age structure (Fig. 3d). The population age structures for 100% immunocontraception were very different from those projected for rotational contraception scenarios.

The total number of adult females (females older than 13 years of age) at the end of 2026 for the 100% contraception rate was 41 (Fig. 3c), with 77 adult females for the no-contraception application (Fig. 3b) and a total of 51 adult females for the rotational contraception application scenario (Fig. 3d). The number of adult females present within the population indicates the reproductive potential and future growth rate.

Similar projected effects were found on the age structure of individual family groups/herds and that of the overall Munyawana population under the various contraception scenarios (Fig. 4a, 4b, 4c). At the end of the 20-year modelled period under rotational contraception, the average age of individuals in the family group had increased and their growth rates had been reduced, but they still contained calves that had been born into each group over the period (Fig. 4c). A large number of independent males were contained in family group 3 as a result of a male-biased calving documented in this family group during 2006, whereas family groups 4 revealed a female calf-biased during 2006 which results in a larger amount of reproductive females at the end of the 20-year modelled period.

Discussion

Immunocontraception is a tool that can be adapted to meet different management objectives in reducing population growth [41], [49], [64]. This study showed that a rotational approach to an immunocontraception plan can be a useful tool to age a population and thereby stabilise its age structure; yield a reduced population growth and prevent irruption of young populations; allow for management of populations, family groups and individuals in relatively small reserves enclosed by fences.

The current Munyawana immunocontraception management plan approximately halved the population growth rate and doubled the population's doubling time, compared to when no-contraception was implemented. The results also provide some insight into which demographic parameters may be most important for determining rate of population growth. Mackey [11] also concluded that calving interval was more important for regulating elephant population growth than any other parameters we evaluated.

The sensitivity analyses indicated little change in population growth from variation in the other parameters, showing that the model is fairly robust. The magnitude of natural variation in demographic parameters should have little effect on model projections. Due to this projected relative insensitivity of elephant population growth to variation in demographic parameters, extremely complex immunocontraception plans may not necessarily be required. What will have the greatest effect on population growth is whether the population is treated or not; potential natural variation in demographic parameters in the short- and medium-term will lead to only minor effects on population growth. However, the population age and sex structure, as a demographic parameters are important to determine future reproductive potential, especially if management ceases future contraception treatment. The age structure will be affected by the natural old age senescence within a population and the proportion of births will be directly related to the proportion of adult females in the population at the time.

With a rotational immunocontraception plan, the population should undergo a stabilisation of the age structure. This should result when annual recruitment is reduced to the same level as senescence (the only significant source of elephant mortality in South Africa's small enclosed reserves, but see [4]). Alternatively, for a more extreme effect, a contraception rate of 100% over a long term would result in no calves being added to the population with the consequence that the population would age, due to the average age of individuals in the population increasing over time. If this rate were applied over a longer time period, it would result in a decrease in the population through senescence without births, a possible alternative to culling.

The long-term effects of immunocontraception of female reproductive health are still uncertain. Delsink [45] showed that ovulation and oestrus cycles remained the same after five years of continuous immunocontraception of female elephants. Immunocontraception is said to be reversible by some researchers [42], [43], [44], but some studies have shown that the continuous long-term use of the immunocontraception vaccine porcine zona pellucida (PZP) may cause ovarian disfunctioning [34], a slow return of fertility [65] or even the permanent loss of fertility [34]. The possibility that the long-term use of PZP might cause infertility in elephant females still needs to be tested [47], [64].

However, many of the social and behavioural concerns previously raised about prolonged, continuous and indefinite use of immunocontraception in elephants may be reduced, or eliminated, by the use of a rotational, individual-based contraception program. Concerns have been raised about the negative effects on group behaviour that could arise from immunocontraception plans that completely prevent offspring being born into a herd [40], [66]. Additional negative effects may include changes in feeding patterns and spatial use [48], the lack of allomothering (as described by [67]) affecting the learning of first-time mothers [48], and depression in mature females resulting from their inability to calve for a long period of time [48].

Because a rotational, individual based immunocontraception plan would permit all females to calve, but with prolonged inter-calving intervals, these potential negative effects of contraception should be reduced. Thus, immunocontraception following such a plan should not pose significant social or behavioural concerns and/or threats.

Managers of large reserves with a high elephant population density may question the realistic effect of immunocontraception as a management tool. Delsink [41] suggested a 'mass-darting approach' for large populations, which is a more flexible approach than the individual-based approach. When a large population of elephants is known on a herd/family group level, the rotational mass darting approach could be applied to family groups/herds within a population, whereby contraception darting can be rotated between herds at a management determined time period. The better the knowledge of an entire elephant population's demographics, the more feasible immunocontraception becomes. Further modelling and future work on testing mass application methods will need to be undertaken.

Stochastic events naturally control the population growth rate, size and age structure, while eliminating the population's old, sickly, weak and young [1], [2], [3]. Where management either controls or prevents the occurrence of normal natural stochastic events, eruptive populations arise, especially within small, enclosed conservation areas [11]. The simulation of natural events (like drought and predation) by management will have consequences on the population demographics and behaviour, which might result in problem behavioural responses as seen in elephants [17], [68], [69], predators [70] and primates [18], [19]. Therefore management requires a sound understanding of the natural processes, social demographics and behavioural requirements applied to the specific species involved. Hereafter with this understanding and essential monitoring, simulation of natural processes can be used in adaptive management plans.

Management Implications

Immunocontraception can be used as a tool to simulate natural stochastic events like drought, however a continual drought with complete calf mortality (e.g. by implementing a 100% contraception continually) is not natural. Therefore rotational immunocontraception can be used to simulate drought cycles, whereby four years of drought are simulated and thereafter four years of non-drought, which would allow cohorts of births to occur. Another approach can be to simulate predation events by using an individual-rotational immunocontraception application approach, whereby selected females are treated and prevented from conceiving, as to simulate that those calves are removed from the population. Therefore rotational, individual-based immunocontraception can be a useful, practical, effective and flexible management tool to include as part of an adaptive elephant management plan.

Ethical Approval

Ethical approval for the use of the vaccine was obtained from University of Pretoria's Animal Care and Use Committee, Project number: 36-5-251 (Project name *Non-lethal control of African elephant (Loxodonta africana): Game reserves and respective elephant populations*).

The South African Medicines Control Council issued permits and approval for the "Use of an unregistered medicine in terms of Section 21 of Act 101 of 1965". (Permit numbers SP/35/2002, SP/11/2003, SP/51/2004 and SP/166/2004) [71]. During the elephant immunocontraception darting operations, the contraceptive was administrated by approved methods, as described in [48], [45].

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Footnotes

Competing Interests: The authors have read the journal's policy and have the following conflicts: Distell (PTY) Ltd made a donation to UKZN for research on elephant conservation. This is a social responsibility donation, and is not their core business. There are no restrictions on publication from this work. This does not alter the authors' adherence to all the PLoS ONE policies on sharing data and materials.

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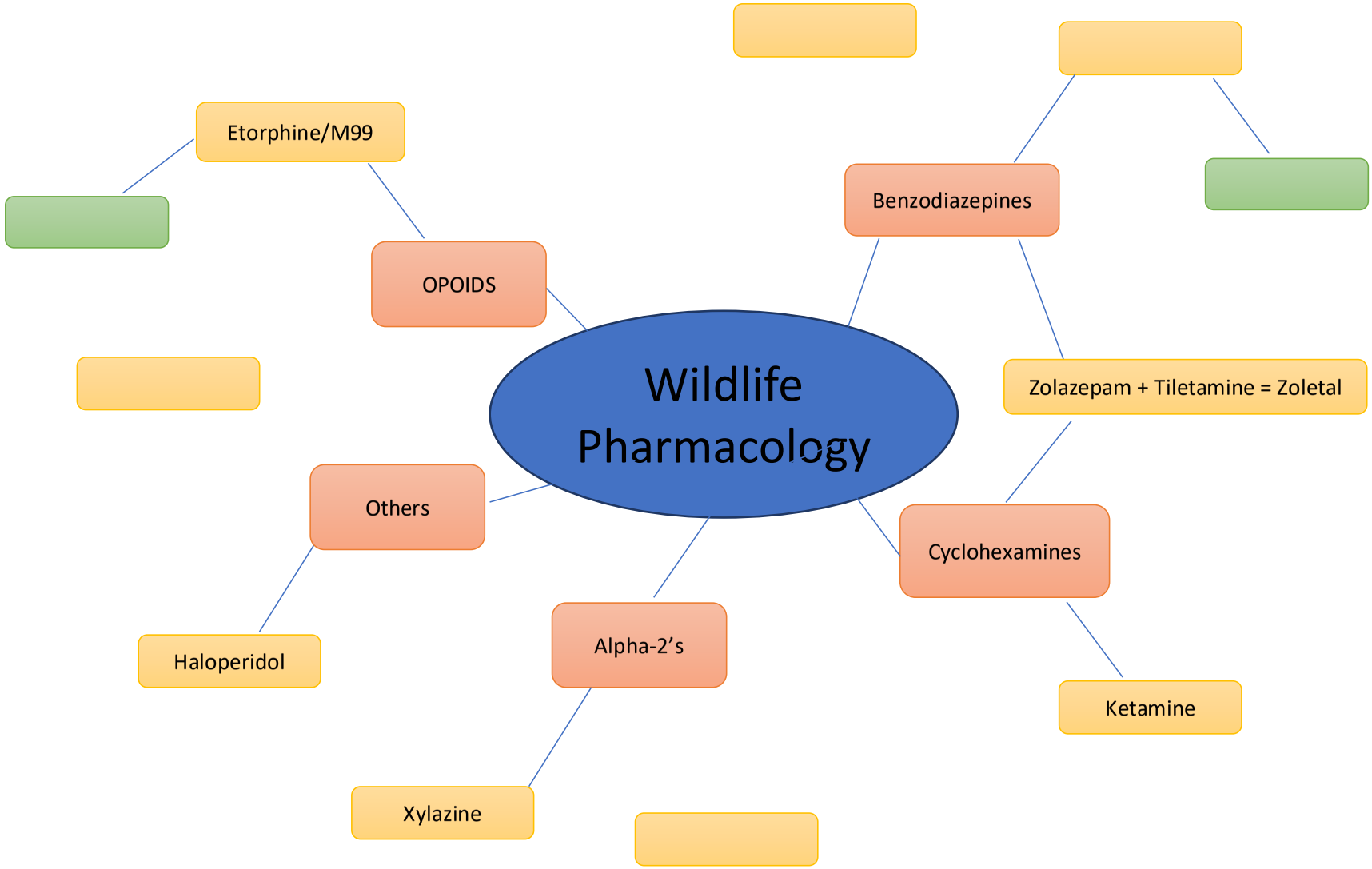
Try to complete the Wildlife Pharmacology Mind map below, you can add boxes and sections, they layout is just to start you off. You should be able to have a complete picture of the different drugs used in wildlife in South Africa after your time with the wildlife vets, and you can use this as a summary! Red boxes are for drug classes and yellow boxes are for drugs names, green boxes are for drugs that reverse others! Try to include side notes around the drug names that will help you remember when they are used. Link different boxes up and add boxes in if you need to



Game Capture

Extract from WildlifeCampus – Wildlife Management Course, Game Capture Module
Full text available at http://www.wildlifecampus.com/help/pdf/game_capture_part1.pdf

Introduction

Game capture requires both practical and scientific skills, experience and the right equipment. For these reasons, most wildlife managers make use of professional game capture teams for this purpose. Successful game capture does not only include the capture of the animals, but also the effective handling, transport and care in captivity. This facet of wildlife management has become its own specialised activity. There is however, one topic that one of the world's most experienced game capture veterinarians, Dr Ebedes, has identified as the most important and yet almost impossible to teach or convey: compassion. At all times it's crucial to remember that during game capture and translocation operations you are dealing with live, sentient, cognizant and feeling animals. At this point it is necessary to break one of the fundamental rules of scientific writing, anthropomorphism. Wild animals under capture conditions are afraid, confused, stressed, frequently aggressive and highly agitated. Treat them with compassion.

Planning a Capture Operation

The following aspects must be considered when planning a capture operation: ?? The physical condition of the animals, number of young and possible advanced pregnancy. ?? The sexes and ages of the animals. ?? The time of year, specifically relating to temperature and humidity. ?? The safest and most effective capture method for the specific type of animal. ?? The necessity of using immobilizing and tranquillising drugs. ?? The availability of vehicles and single or mass transport crates. ?? Animal health requirements such as the quarantining of animals in foot-and mouth control areas. ?? Nature conservation permits which may be required for the capture, holding and transport of animals. ?? Import and export permits between different areas and regions.

Principles for Successful Capture

Wild animals that are captured are under stress before, during and possibly even after the capture. Although game capture operations will always contain a measure of stress, the welfare of the animals involved is always of the utmost importance. The wildlife manager must therefore ensure that the method chosen also takes this into account, and that everything possible is done to minimize the stress on the captured animals. A basic principle of successful capture is to eliminate as many factors as possible that cause stress in the animal. The following should be taken into account:

The operation should be thoroughly planned beforehand.

Every person involved in the operation should be briefed in detail about their task. There should not be any unnecessary persons. Observers are by and large inexperienced in game capture and frequently hinder operations

Game capture should take place in the colder months of the year, as overheating of the animals can easily occur during capture.

The condition of animals deteriorates during winter, and the capture should therefore also not be done too late in the winter.

In warm climates it is advisable that the capture should start early morning and not stretch over the heat of the day.

Animals must never be chased over long distances or for a long period of time. This is not the way animals react in nature, and it could prove fatal. If the capture boma is far away, the animals should be given time to rest and be herded to the boma slowly.

The animals should be handled and disturbed as little as possible.

If the animals are kept in temporary captivity after the capture, steps must be taken to ensure they do not injure themselves in the bomas.

Bomas should be high enough that animals, especially antelope, cannot jump over the side. ?? Noise levels outside the bomas and crates should be kept very low.

Aggressive animals and mature bulls should be separated from each other to avoid conflict and injury.

There should be enough food and water in the bomas before the animals are brought in.

Ensure adequate protection against sun, cold and rain.

Game capture can be carried out by herding entire groups (Mass capture) or by selecting individuals and darting them from foot, a vehicle or a helicopter.

An introduction to capturing animals via Darting

Animals may be captured by being injected with immobilizing drugs. This method is used in the capture of rare and valuable herbivores on an individual basis. It requires great skill, scientific knowledge and experience to immobilize wild animals. Drugs are usually injected by firing a dart from a dartgun into the muscle of the animal, but can also be administered manually, for example when animals are caught in a net.

An important distinction needs to be made at this point:

Immobilizing drugs are used to immobilize the animal completely, with the animal losing consciousness.

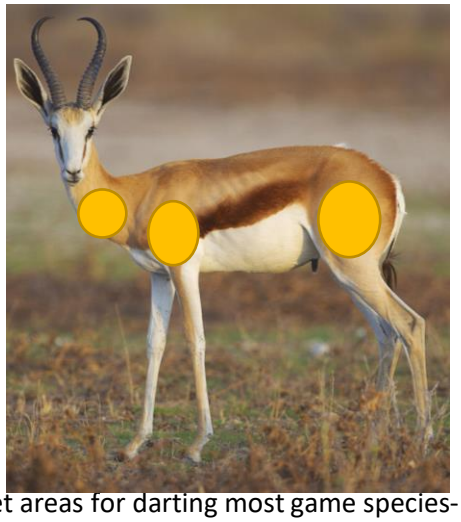
Tranquillising drugs are used to sedate the animal, while the animal is conscious of its surroundings, it remains in a relaxed state with limited movement.

In Southern Africa the drugs most commonly used are M-99/Etorphine and Fentanyl. Both of these drugs are extremely dangerous to humans and are subject to very strict control. It is advised that the choice and handling of immobilizing drugs for capture operations be left to a wildlife veterinarian with experience in this field.

The following principles are important in the darting of antelope and other herbivores:

- Selecting equipment
- The distance that the animal can be approached from
- Thickness of skin
- Approachability of the terrain
- Method of approach being ground or air will determine which strength the dartgun should be.

The right choice of dart and needle is also very important, this being influenced by the skin thickness, size of the animal and approach distance. Darting from a vehicle It is difficult to get the required approach distance from an animal on foot, so animals must usually be approached in a vehicle. Animals are often accustomed to certain vehicles, which could be an advantage. Using roads to approach the animals is more successful than driving off road, which often scares animals. Avoid driving directly at an animal or herd, as this tends to scare them off.



Ideal target areas for darting most game species- Muscle areas

Be patient in selecting the animal to be darted, and shoot only if the target area (e.g. the hindquarters) is not obscured. The dart should penetrate at a 90 degree angle, which reduces chances of the dart bouncing off. Dart sites to use are the rump, hind leg, shoulder and occasionally the neck. The aim here is to have the dart penetrate into muscle tissue only. Once the dart is in the animal, the animal should be kept within sight at all times, but should not be chased at high speed. If, however, the animal does move out of sight, wait for the appropriate time for the drug to take effect, and then start tracking the animal.

Darting from a helicopter

Making use of a helicopter for darting is often worthwhile in the capture of valuable, large or aggressive animals. An experienced helicopter pilot is of the essence. The pilot should know the habits and reactions of different game species, and be experienced in flying low and turning sharply. A strong helicopter is necessary to provide a stable platform from which to dart. Darts should be prepared in advance, with enough to spare. There should be good communication between the pilot and the ground crew. The best time to fire is when the animal and the helicopter are moving at the same speed in the same direction. Once the dart is in the animal, try and herd the animal towards the recovery vehicle. The ground crew must be notified immediately.

Signs that the drug is taking effect Some or all of the following symptoms may be seen:

- An ataxic, staggering gait.
- A high-stepping knee action
- The head held high and far back, or the animal may nibble at vegetation
- Impaired vision – the animal may collide with objects
- Loss of sense of fear of people and strange objects
- The animal reacts to noise
- The ears may droop
- Some animals stay on their feet, and others may collapse

Advantages of immobilizing through darting:

- The most effective and safest method to capture rare and valuable animals
- It is more economical than other methods when only single animals have to be caught
- Large and aggressive animals are manageable and can be loaded and transported while immobilized

Disadvantages of immobilizing through darting:

- Approach distance to dart an animal is often not adequate.
- Ruminants that collapse on their side can bloat or choke when rumen content is vomited
- If the drug is not injected into the right muscle, or the dart does not discharge properly, the animal will not be immobilized effectively. The animal could run too far and overheat or collapse from exhaustion.
- The tracking of animals in dense vegetation or rocky areas can be difficult, and animals may not be reached in time.
- Use of a helicopter can be costly.
- Animals can injure themselves if they collide with a tree or fence.
- Over dosage could be fatal if an antidote is not administered in time.

Passive capture

Passive Capture refers to the capture of animals without force. Often Bomas are set up around a central watering hole (or animals can be given supplementary feeding in particular are to draw them there for a period of time), which is closed off after the animals come to drink. Once the animals have been closed in to the boma, they are unable to wander back into the bush to forage, eliminating the need to herd the animals later. This can be a preferred method for capturing both herds and individual animals since no stress is placed on the animal at any time during the capture process. Animals are always sedated before transporting to the temporary bomas before auctions and / or relocation to other farms.

Passive Capture may be chosen where:

- Species being caught would be highly susceptible to stress injury
- Where there is a suitable mass capture boma site
- Where a helicopter/vehicles to drive the animals is unavailable/terrain and topography unsuitable.

Can you find out any other situations in which this method is chosen?

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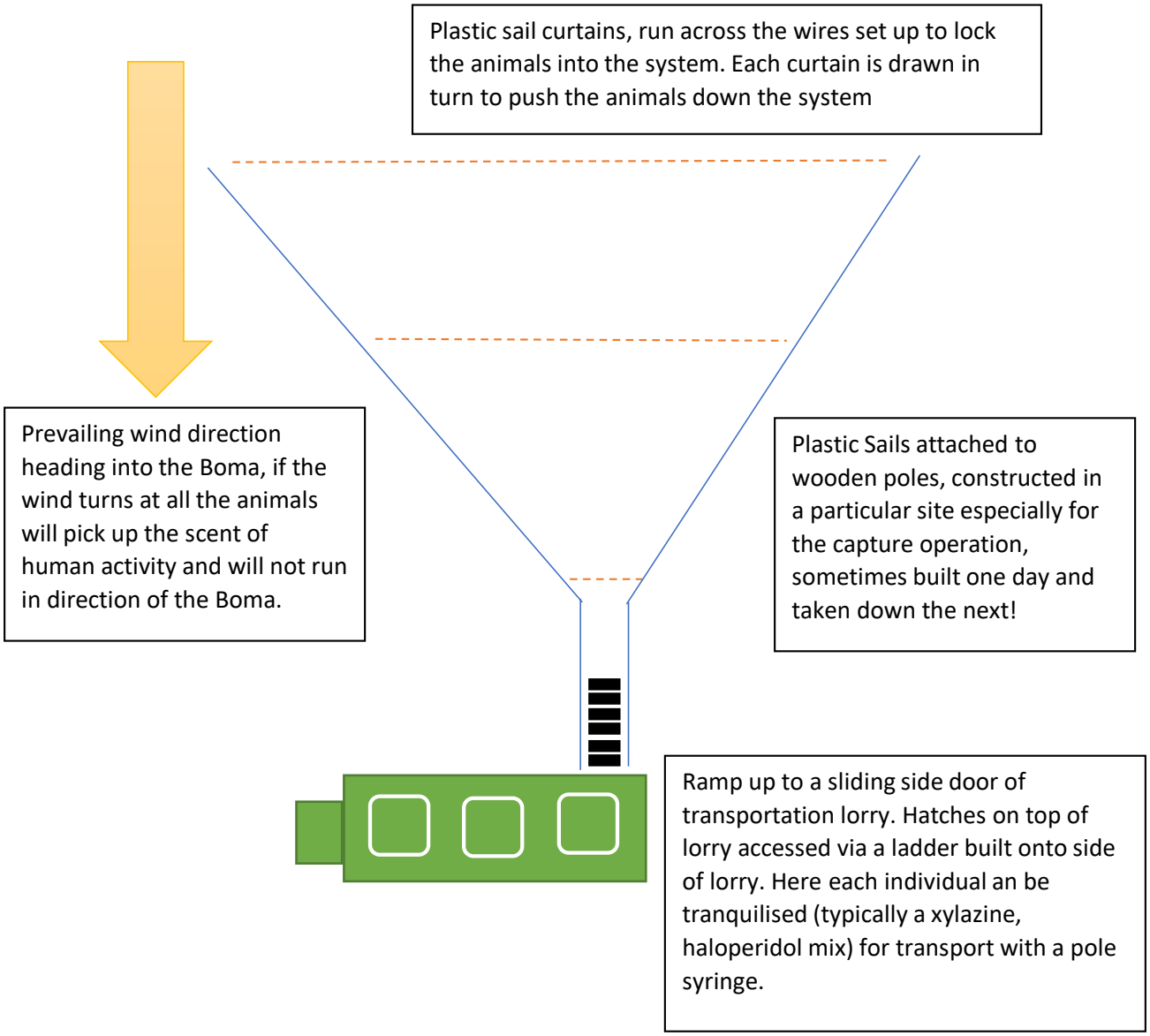
Mass Capture

Mass capturing is employed when an entire herd of animals is caught. Animals are herded to the location of the bomas with drive nets and directed through "funnels" leading to transport vehicles. Animals are sedated by administering tranquilizers individually with the use of a pole syringe.



Darting Wildlife

Darting from the ground or air is the best method of capture for certain of the larger species such as elephant, rhino and buffalo and is the method of choice for selecting individuals from a herd. However, this method may not be cost effective when attempting to capture large numbers of plains species, where 'mass capture' may be appropriate. Ground darting is cost efficient and can be very cost efficient, however, darting from a helicopter may be safer for both the animal and the operator and can be very cost effective especially when certain individuals are being selected for capture. The operator is able to constantly monitor the progress of the immobilization and can reach the animal rapidly if complications occur. In addition, the helicopter can be used to direct an animal away from water or thick bush after it has been darted so that recovery is safer and easier. Higher drug dosages can be employed to ensure rapid knock down times and reduced stress for the animal. Ground darting requires that lower drug dosages are used and may result in an animal remaining immobilized but unattended for some time while ground crew attempt to locate it. Consideration should be given to using transmitter darts and drug combinations that rapidly immobilize those species that are more prone to excitement and disperse quickly from the herd, and are difficult to find.

Glossary

Anthelmintic – Medication that kills certain types of intestinal worms; dewormer

Autoclave – Machine that uses pressurized steam to sterilize materials

Blank – Cartridge loaded with propellant and a wad but no projectile (e.g., bullet)

Caliber – Diameter of a bullet or other projectile

Cold sterilization – Immersion of an item into a liquid chemical for a given time to create a disinfected or sterile condition

Dart – Syringe that is propelled from a projector and delivers a calculated drug dosage at a distance, automatically injecting its contents on impact

Exudate – Fluid containing protein and cellular debris that has escaped from a blood vessel and been deposited in tissue

Hoof stock – Hoofed, typically herbivorous, quadruped mammal

Manometer – Instrument for measuring the pressure of gases or vapors

Muzzle (of a blowpipe or gun) – The forward discharging end

Operant conditioning – Method of training an animal so it forms an association between a behavior and a consequence

Opioid – Synthetic narcotic that has opiate-like qualities but is not derived from opium

Remote injection projector – An instrument, such as a blowpipe, rifle, shotgun, or pistol, that is used to propel a dart and deliver a calculated drug dosage

Septicemia – Presence of disease-causing microorganisms in the blood

History

Remote injection equipment has been around for thousands of years. The earliest tools, used for hunting, included arrows, spears, and poisoned darts made of wood splinters. Modified bows and blowpipes constructed out of wood or cane were used to project these weapons.[1] These primitive instruments are the basis for modern techniques that allow zoo veterinary staff to immobilize, vaccinate, or administer drugs to intractable animals that are not trained to receive injections. Remote injection techniques using a projectile syringe also facilitate the safe capture of an escaped animal that cannot be netted or properly secured without immobilization (Levens G: Personal communication, Cincinnati Zoo and Botanical Garden, Cincinnati, 2005). These methods are also used for domestic species in free-range situations, urban wildlife, and stray companion animals.[2]

Tools for Remote Injection

Blowpipes

Two kinds of blowpipes are used for immobilizing, vaccinating, or medicating animals. Lung-powered pipes are used when a small volume of drug has to be delivered to an animal confined in a small area. Compressed atmospheric air- or gas-powered pipes are used to administer larger drug volumes and have a longer projectile range.

To use a lung-powered blowpipe, the technician rapidly exhales into one end of the instrument, propelling the dart through the other end. These pipes consist of one or two aluminum tubes up to 2 m long.[3] A mouthpiece on the tube allows the operator to make a tight seal with the lips so the dart can be expelled with adequate force. Lung-powered blowpipes are the simplest remote drug delivery system and offer several advantages over other delivery systems.[4]These instruments propel lightweight darts at a low velocity, minimizing trauma to the animal on impact; therefore, they are well suited for smaller animals.[5] The lung-powered pipe is often preferred over compressed air or CO_2 projection systems because it carries a lower risk of injury, even if the animal is hit in an area that is not part of a large muscle group (Crossett V: Personal communication, Louisville Zoological Garden, Louisville, KY, 2005). However, because of their light weight and low velocity, darts from these pipes may not effectively penetrate thick hides and may be affected by environmental factors such as wind. In addition, the projectile range of a lung-powered dart is limited to less than 20 m and the darts have a maximum volume capacity of 3 ml. Frequent target practice with the blowpipe is required before adequate range and accuracy can be attained.[3,5]

Non-lung-powered blowpipes consist of a tube attached to a pistol grip. The dart is propelled from the pipe by compressed air or gas discharged from the pistol. Compressed air-powered projectors commonly use air supplied by a foot pump connected to the pistol by a hose. A manometer on the pistol or pump allows the operator to monitor pressure adjustment. Once the desired pressure is attained, the hose is disconnected from the pistol. Gas-powered blowpipes consist of a pistol grip attached to a unit containing a carbon dioxide (CO_2) cartridge and a manometer. CO_2 is pumped into the pistol reservoir by compression of a forefinger valve on the CO_2 unit,[6] and the manometer displays the amount of pressure within the pistol reservoir. The operator can adjust the pressure by compressing the trigger or the forefinger valve.

When adjusting the pressure in an air- or gas-powered blowpipe, the operator must consider how much drug is to be delivered as well as how far the dart will have to go to reach its target. Once the desired pressure is attained, the blowpipe is attached to the pistol. The longer the pipe, the greater the potential distance the dart will travel. When the trigger is pulled, the compressed air or gas within the pistol is released, expelling the dart. The trigger must be squeezed quickly, or the air or gas may not be released forcefully enough for the dart to hit its target. Air- or gas-powered blowpipes can deliver larger volumes (up to 10 ml) at longer distances (1 to 30 m) compared with lung-powered devices.[3] In addition, these systems are almost silent, which is beneficial when darting highly reactive animals. A disadvantage of the CO_2-powered system is that it may be affected by environmental temperature. Warm temperatures may increase the CO_2 pressure, extending the flight distance of the dart syringe; cold temperatures may decrease the pressure, reducing the range of the dart syringe.[5] To avoid these pitfalls, it may be helpful to shoot a few darts at a practice target to determine the pressure needed for the live dart to hit its mark. The practice darts must weigh the same as the live dart and be propelled the same distance the live dart will have to travel.

Dart Guns

Dart guns, available in rifle, shotgun, and pistol models, can safely and effectively deliver darts over a greater distance compared with blowpipe projectors.[5] These devices are also equipped with sights to help the operator aim the gun and properly place the dart. Many zoos carry all three types of dart guns, and decisions regarding which one to use are based on the animal or situation. For example, rifles are commonly used for animals in large, open areas of land, such as hoof stock exhibits (Crossett V: Personal communication, Louisville Zoological Garden, Louisville, KY, 2005). Because pistols have shorter barrels, they are often used when animals must be darted at close range. Both rifles and pistols are particularly effective in penetrating the thick skin of pachyderms, such as the rhinoceros. Any type of dart gun — rifle, shotgun, or pistol — may be used during an animal escape emergency.

Figure 12.1: Dan-Inject JM2 CO_2 dart gun

Dart guns used in the zoo setting have one of three propellants: gas generated from a .22-caliber blank cartridge (powder-charged), compressed CO_2, or compressed air supplied by a foot pump or air tank.[3] One type of powder-charged projector has a port that may be opened and closed to regulate the amount of expanded gas propelling the dart. This feature lets the operator adjust the dart range and velocity according to dart size and distance.[5] The other type does not have a velocity control, so the operator must use cartridges of different strengths to compensate for various distances. Powder-charged projectors may propel darts with volumes of up to 25 ml; however, larger volumes may reduce the potential for accurate long-range shots. These guns can safely and effectively deliver darts over distances up to 120 m.[3]

Dart guns that use CO_2 or compressed air have an effective projectile range shorter than that of powder-charged projectors. CO_2 projectors are capable of effectively delivering a dart up to 70 m, whereas compressed-air projectors have an effective range of up to 50 m.[3] These systems are usually equipped to deliver drug volumes up to 10 ml — possibly more, depending on the manufacturer. Advantages of these systems over powder-charged projectors include a lower risk of impact injury and fewer maintenance requirements. One drawback, however, is that, as with CO_2-powered blowpipes, heat and cold have a direct effect on the flight distance of darts projected by CO_2 projector systems.

Figure 12.5: Pneu-Dart X-Calibre gas-powered dart projector

Darts

Darts used to administer antibiotics, vaccines, anthelmintics, mineral and vitamin compounds, and immobilization drugs to animals consist of five basic parts: the needle, the syringe barrel, a separating plunger, the injection solution, and the tailpiece.[2] There are four major mechanisms for pushing the dart plunger forward to inject the drug solution. It is important to note that darts typically are not interchangeable between projection systems.

Plunger Mechanisms

The two simplest methods of advancing the plunger involve the expansion of a compressed substance. One type of dart uses butane gas or air that is introduced through the tail end of the dart and compressed behind the plunger; the other uses a tailpiece with a coiled spring that compresses behind the plunger when the tailpiece is screwed onto the dart. The needles that are placed on these darts have a rubber sleeve that slides over the needle port(s) before the dart is pressurized. After the drug chamber has been filled, the needle is attached and the dart is pressurized by the air, butane gas, or coil. The sleeve on the needle seals the drug solution within the dart until it is dislodged during penetration of the animal's skin. Exposure of the needle port(s) causes the gas pressure, air pressure, or compressed coil to be released, pushing the plunger forward.[7]

Another discharge mechanism is powered by the chemical reaction between a sodium bicarbonate solution and acetic acid. The impact of the dart making contact with the animal causes the acid and bicarbonate to mix, and the reaction produces enough gas to push the plunger forward. Other darts use a small explosive charge placed behind the plunger. A spring separates the charge from its firing pin until the dart reaches the target; the force of impact causes the firing pin to overcome the spring's tension and make contact with the charge. The charge detonates and produces gas that pushes the plunger forward.[7]

Comparison of Remote Injection Projectors

Projector	*Propellant*	*Distance (m)*	*Volume (ml)*	*Animal Type*
Blowpipe (lung powered)	Expulsion of breath	<20	3	Small and large; thin skinned
Blowpipe (powered)	Compressed CO_2 or air	30	10	Medium to large; thick skinned
Dart gun (pistol, rifle, shotgun)	Compressed CO_2, compressed air, or .22-caliber blank cartridge	120	25	Large; pachyderms

Because of their injection speed, darts that use an explosive charge mechanism are more likely than other dart types to cause tissue damage. Also, when using this type of dart, the operator must make sure the firing pin is inserted into the dart correctly. If the charge is not facing the right direction, the dart will discharge within the gun barrel.[7] Darts compressed with air have a slower injection time, which may allow the animal to remove the dart before all the contents has been injected.

Single-Use Darts

Single-use darts such as Pneu-Darts (Pneu-Dart, Williamsport, PA) use either an explosive charge or an acid-base reaction to expel the dart's contents. These darts combine the dart and needle in a one-piece unit. They are available in various sizes, and because the discharge mechanism is already inserted and ready to use, minimal preparation is required.[5] Also, because single-use darts are disposable, they do not require cleaning, thereby reducing the risk of accidental exposure to potent opioids (Hedberg G: Personal communication, San Francisco Zoo, San Francisco, 2005; Clark B: Personal communication, Roosevelt Park Zoo, Minot, ND, 2005) and keeping the possibility of malfunction to a minimum.[5] One disadvantage of single-use darts is cost. Disposable darts must be continually replaced; therefore, the institution's budget and frequency of remote injection should be considered when purchasing these darts.

Syringes and Tailpieces

Dart syringes are made of aluminum or plastic. Aluminum darts are more resistant to destruction by the animal being darted than are plastic darts. Tails, or stabilizers, may consist of strands of yarn or plastic fins molded from synthetic polymers.[3] The tailpiece balances and streamlines the dart as it travels through the air. It also forms a seal in the barrel of the projector so that the pressure released by the discharge mechanism has enough surface area to push against to project the dart. If the tail were absent, the released air or gas would leak around the dart.

Needles

Dart needles may be smooth or possess barbs or collars that serve to retain the dart in the animal. Darts with smooth needles will generally fall out quickly when the animal moves. Smooth needles may also bounce out of the animal if the dart is highly pressurized. Although barbs and collars prevent needles from falling or bouncing out, they may cause tissue damage on removal. However, some barbs and collars are biodegradable and dissolve on contact with tissue fluids. Needles expel their contents from the standard front opening (end port) or through a side port with the front occluded. Side ports are less likely to become plugged with tissue or skin as the needle enters the animal, but needles with end ports expel their contents more rapidly.[3]

▲ Lung-powered blowpipes with mouthpieces.

Pole Syringe

The pole syringe, also known as the jab stick or stick syringe, consists of a hypodermic syringe contained in or attached to the end of an extension pole.[5] In the basic pole syringe design, the extension pole is attached to and acts as the syringe plunger. Operation of this device requires strategic needle placement and careful manipulation of the pole. Because drug injection begins as soon as the needle meets resistance, the operator must employ a quick jab motion when inserting the needle. Adding a buffer of air within the syringe may help delay drug administration until the needle penetrates the muscle. Upon muscle penetration, steady pressure must be maintained against the animal until all the solution has been injected.[4] Pole syringes are used most often on animals confined in small cages or holding pens and provide a relatively atraumatic method for daily injections.[7] While most volumes of drug are administered easily with the basic pole syringe, volumes greater than 5 ml increase the time required to deliver the drug.[2] Newer designs include automatic pole syringes that allow larger volumes of drug to be delivered in 1 second or less.

Certain constraints are associated with the use of pole syringes. Long pole syringes may be difficult to control and may reduce accuracy. A jabbed animal may reach around and bite at the syringe, possibly ingesting it, or a quick movement by the animal may cause the needle to bend. Pole syringe needles have the potential to break off, but most devices have protective shields that enclose and support the hub. A dark-colored pole syringe is recommended because it is less likely than a lighter-colored pole to be visible to the animal.[4,7]

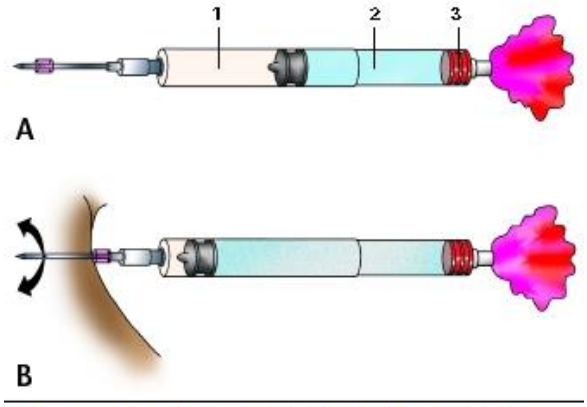
Animal Injuries

Because of the force of their impact, darts can seriously injure an animal or cause infection at the injection site. These health risks may be reduced, however, by taking some simple precautions and having a thorough understanding of the equipment being used.

▲ Blowpipe powered with attached CO_2 unit.

A dart injection site is an optimal environment for bacterial growth that will result in infection, abscess, tetanus, or septicemia if left untreated.[5] Injection-site abscesses occur most often in pigs, when debris on the surface of the animal is incorporated into the tissue with the dart (Haulena M: Personal communication, The Marine Mammal Center, Sausalito, CA, 2005). Local infection may result in any darted animal if the dart's needle or the liquid within the dart is not sterile. Darts traveling at high velocities increase the risk of tissue trauma. Misplaced shots may result in penetration of the needle shaft into bone, causing a fracture. Rapid injection of a drug by an explosive charge mechanism may cause tissue disruption, hemorrhage, and pain; if the dart needle is embedded in the marrow cavity of a long bone at the time of injection, bone-shattering hydraulic pressure may be created.[7] Primates and some carnivores may bite the dart syringe or reach around and grab it, causing the needle to break off.[4]

Selecting the proper charge, velocity, syringe/needle combination, and delivery site will reduce the risk of dart impact injuries. Ideally, the dart should strike on the downward trajectory to minimize tissue trauma.[2] Dart impact injuries can also be avoided by using power projectors only on animals weighing more than 15 kg (33 lb); darting animals only in the muscle masses of the shoulder, upper hind leg, or rump; and using a needle that is no longer than necessary.[5] If a long needle is all that is available, an additional sealing sleeve may be placed at the posterior end of the needle near the hub. In addition, understanding the capabilities and limitations of darting systems and becoming proficient in using the equipment through practice will improve accuracy and reduce impact trauma.[2]

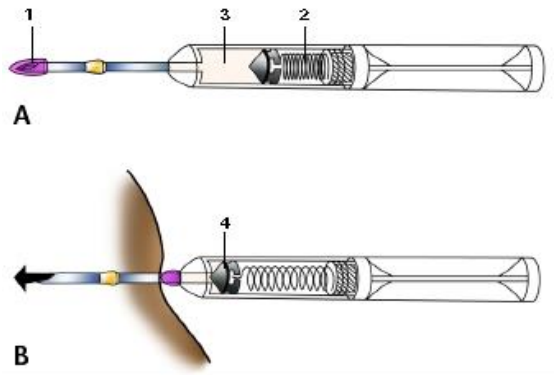


▲ Air-pressurized blow dart in flight (A) and following skin penetration (B). Note the different components: (1) drug chamber, (2) pressurization chamber, and (3) one-way valve.

Training animals through operant conditioning to receive injections by hand is a great way to avoid the pain and stress of darting for routine injections (Crossett V: Personal communication, Louisville Zoological Garden, Louisville, KY, 2005).

Preparing for Remote Delivery

Which remote delivery system to use depends on the size of the animal, the amount of drug to be administered, the distance between the animal and the projector, and personal experience.[7] Once the appropriate delivery system and projectile dart have been chosen, the equipment must be systematically assembled and checked for functionality. Ideally, the zoo veterinary staff will have a routine method for preparing equipment and will anticipate and avoid equipment failure by checking and rechecking darts and needles (Hedberg G: Personal communication, San Francisco Zoo, San Francisco, 2005).



▲ Spring-pressurized dart. (A) The dart is ready for firing, with (1) a tight-fitting cap occluding the dart's needle while (2) the coiled spring pressurizes (3) the agent. (B) Dart in the final stage of injection. The needle's cap slides backward as the needle penetrates the skin, allowing the spring to push (4) the plunger forward, injecting the agent.

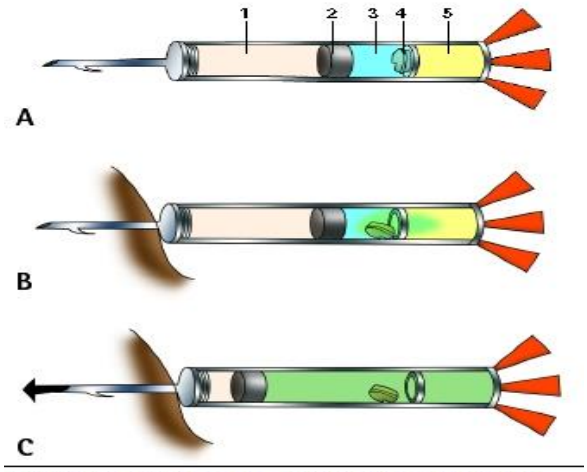
Adequate preparation for remote injection also includes training and practice. Programs such as Safe Capture International Incorporated (www.safecapture.com) offer workshops in which participants can become familiar with the latest delivery systems and techniques. Zoo internships also offer the opportunity for hands-on training under the guidance of an experienced darter. The American Association of Zoo Veterinarians often holds conferences at which manufacturers demonstrate their equipment. Firearm instruction and safety classes are another great resource for anyone who wants to learn how to use pistols, rifles, and shotguns safely. Those who rarely perform darting procedures may benefit from regular practice using paper targets, a deer decoy, or meat attached to a bale of hay (Port M: Personal communication, Tampa, FL, 2005).

Safety

General safety protocols must be observed when handling remote delivery equipment before, during, and after any darting procedure. In addition, special guidelines must be followed when a controlled drug such as carfentanil, etorphine, or diprenorphine is to be delivered.

Assembling Darts

When preparing remote delivery equipment for routine procedures such as vaccination or medication, several precautions must be taken in assembling darts. To avoid injury, pliers may be used when securing needles to dart syringes as well as during disassembly. The needle must be securely attached to the dart before pressurizing to prevent leakage or separation of the needle from the dart (Haulena M: Personal communication, The Marine Mammal Center, Sausalito, CA, 2005). Darts should be pressurized just before delivery, away from other people and animals. A 60-ml syringe case can be placed over the dart and directed away from people and animals during pressurization (Pond J: Personal communication, Lincoln Park Zoo, Chicago, IL, 2005). Dan-Inject (Fort Collins, CO) and Telinject (Agua Dulce, CA) darts come with a snug-fitting protective cover. Once the dart is pressurized, personnel in the surrounding area should be notified. A pressurized dart should be handled carefully when loaded into the projector. The muzzle of the blowpipe or gun must always be pointed in a safe direction, away from people and animals, until the actual darting takes place. A dart gun should always be treated as if it were loaded with real bullets. The safety should remain on or the gun should be uncocked until just before delivering the dart.[3] Used darts may be placed in a long container with a tight-fitting lid (Pond J: Personal communication, Lincoln Park Zoo, Chicago, IL, 2005). Because of the pressure remaining in the air chamber, reusable darts should be handled carefully when being cleaned.



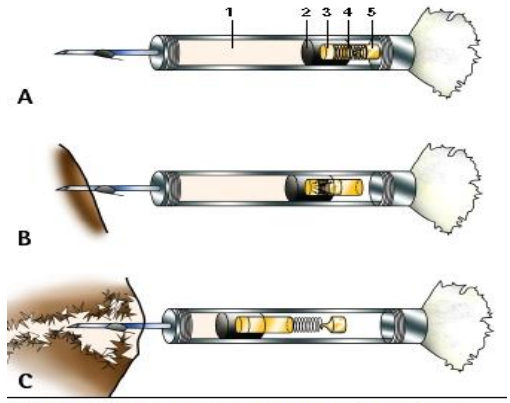
▲ Dart syringe using a soda–acid injection system; both components are in liquid form, which helps to accelerate the reaction. Note the components: (1) Drug chamber; (2) plunger; (3) saturated solution of sodium bicarbonate; (4) asymmetric weight seated in an O-ring; (5) acetic acid. (A) Dart in flight. (B) Dart on impact. When the weight falls forward, the soda and acid are able to mix. (C) Dart during the last stage of injection.

Handling Drugs

Carfentanil and etorphine are synthetic opiates with a clinical potency 10,000 times that of morphine. They are typically used for immobilizing large hoof stock. Diprenorphine is a partial antagonist used to reverse the effects of etorphine and, when administered alone, has a narcotic effect similar to that of etorphine.[8] These three agents are extremely toxic to humans. Death is most often caused by respiratory failure. Human exposure may result from accidental injection with a syringe or dart; absorption through the mucous membranes of the mouth, eyes, or nose; or direct absorption through broken skin.[3]

Agents such as carfentanil, etorphine, and diprenorphine should be handled only by trained staff, such as veterinary technicians and veterinarians. Drugs to reverse the effects of these agents should be readily available in case of accidental exposure during dart preparation and pressurization. Anyone working with these substances must wear a protective face shield, a surgical face mask, gloves, long sleeves, and long pants. All other personnel working near these agents must also wear protective clothing and gloves. When a staff member is working with a toxic substance such as carfentanil, etorphine, or diprenorphine, a second person who is capable of performing cardiopulmonary resuscitation and first aid should be standing by.

As an extra precaution when handling a dart with a potent opioid, a recycled infant incubator may be used as a loading chamber. Using the arm portholes, the operator can load the dart within the incubator and place it in a container before removing it from the incubator (Clark B: Personal communication, Roosevelt Park Zoo, Minot, ND, 2005). The container should have a tight-fitting lid clearly labeled with the name of the agent loaded in the dart. The operator may pressurize the dart using a large syringe case and should alert other staff members of the charged dart.



▲ Dart with a powder charge injection system. Note the components: (1) Drug chamber; (2) plunger; (3) explosive charge; (4) spring; (5) firing pin. (A) Dart in flight. (B) Dart impacting skin with firing pin compressing the spring and detonating the charge. (C) Dart during the last stage of injection. Note the tissue damage that is possible with this type of dart system.

After the dart has been discharged, the veterinarian or veterinary technician should release any remaining pressure in the dart, remove the dart from the animal, and wipe off and clearly mark the injection site. Only a veterinarian or veterinary technician should handle a discharged dart. The used dart should be put back in its container and secured with a lid. Protective gear should be worn when cleaning the used dart to avoid exposure to any residual drug in the syringe or on the needle parts. For extra safety, the infant incubator may also be used as an unloading chamber, especially when the dart contains a large amount of unused drug.

Cleaning, Maintenance, and Storage

To ensure reliable and consistent functioning, drug delivery equipment must be cleaned and maintained on a regular basis according to the manufacturer's recommendations and instructions. Dart guns in need of minor repairs may be taken to a local gunsmith for service. For major equipment repairs, the distributor or manufacturer may have to be consulted.[5]

Dart syringes should be disassembled and cleaned immediately after use to prolong the life of the dart (Hedberg G: Personal communication, San Francisco Zoo, San Francisco, 2005). The drug chamber of plastic darts that use gas- or air-pressure discharge mechanisms should be flushed with a mild cleaning detergent such as Alconox (White Plains, NY). The drug chamber may then be rinsed with sterile water; however, it is important to note that the air chamber should remain dry. Silicone may be applied to the inside of the drug chamber, and the plunger slid back and forth to ensure easy movement. If the syringe is cracked or the plunger does not move smoothly, the dart should be discarded. Plastic darts may be sterilized with ethylene oxide after they have completely air-dried. Aluminum darts should be completely disassembled and cleaned. Cleaning kits with dart syringe brushes are available to help remove gross debris. Aluminum parts may be autoclaved or cold sterilized; after these parts have been cleaned and dried, the inside of the dart, O-ring seals, and plunger should be lightly coated with silicone lubricant.[5] Dart syringes and parts should be stored at room temperature and are commonly kept in the pharmacy under normal temperature and humidity conditions.[9]

Needles should be flushed with water immediately after use. If cleaning is delayed, some drugs may settle out of solution and crystallize within the needle. Needles may be immersed in an ultrasonic cleaner to help break up hardened debris within the needle bore. Needles that are permanently occluded and unable to be straightened and sharpened should be discarded. Needle patency must be reestablished and confirmed before the needle is sterilized.

Tailpieces made of fabric should be clean and soft and not stiff from contamination with moisture or exudates. Special combs are available to straighten tailpieces before darting. The strands of fabric should be even and symmetric and may be trimmed for aerodynamic stability. Tailpieces may be stored in test tubes to maintain their shape.[4]

Ways to Prevent Dart Impact Injuries

- **Select the proper delivery equipment**, including projector, dart, and needle.
- **Select the proper power charge** to discharge the dart's contents.
- **Select the proper velocity** at which to deliver the dart.
- Limit the use of power projectors to **animals weighing >15 kg (33 lb).**
- Dart animals only in the **muscle masses of the shoulder, upper hind leg, or rump.**
- **Do not use needles that are longer than necessary**; if a long needle must be used, place an extra sealing sleeve near the hub of the needle.
- **Understand the capabilities and limitations** of the system being implemented.

General Guidelines for Preparing Remote Delivery Equipment

- **Test each dart** to see if it holds pressure both immediately before filling the drug chamber and after cleaning.
- **Choose the appropriate-size needle** for the species being darted.
- **Check needle patency** by passing air through the bore with a regular syringe.
- **Straighten the needle shaft if slightly bent**; discard the needle if it cannot be straightened.
- **Confirm the sharpness** of the needle point.
- **Make sure the dart plunger slides back and forth** easily.
- **Lubricate the sealing sleeve** with a small amount of antibiotic ointment so it will slide along the needle upon impact.
- When using a CO_2 pistol, **make sure there is plenty of CO_2 left in the cartridge** by checking the pressure gauge.
- **Have extra remote injection materials and supplies** on hand.

Blowpipes should be cleaned on a regular basis using a weighted tool with a piece of cotton attached to the end. After the tool is passed through the pipe several times, the pipe is lightly coated with a lubricant. Dart guns such as rifles, shotguns, and pistols require visual inspection and cleaning after each use. These projectors should not be disassembled beyond the manufacturer's recommendations. The operator must always ensure that the safety is on before he or she cleans the gun. Gun oil is commonly used to clean the exterior parts of the gun as well as the barrel; cleaning kits with brushes are also available for cleaning gun parts and barrels. While dart guns are generally stored unloaded in a dry, dust-free environment, some CO_2 dart guns should be stored charged and in the cocked position.[5] Before proceeding with cleaning, maintenance, or storage operations, the operator should always consult the equipment manufacturer's instructions.[5]

Purchasing Remote Injection Equipment

When purchasing remote injection equipment, several factors must be considered, including the size and species of animal(s) to be darted, the type and volume of drug to be administered, and the distance over which the drug will be delivered (Pond J: Personal communication, Lincoln Park Zoo, Chicago, IL, 2005). The experience of the staff members who will be using the equipment must also be considered. It is essential that dependable and reliable remote injection equipment be available to the veterinary staff and other trained personnel at all times, so cost should not be a major criterion when purchasing these systems.[5] Good-quality equipment will perform reliably for many years as long as it is handled properly and receives preventive maintenance on a regular basis.

Sometimes the zoo veterinary technician is given the task of researching the types of remote injection equipment that may best suit the zoo's needs. The zoo technician may also be responsible for restocking remote injection supplies and updating the equipment operated at the facility. The technician may set up an appointment with a darting equipment sales representative to assess the zoo's needs. The representative can inform the technician about new and improved equipment and offer guidance in selecting the tools that would be most beneficial for the zoo (Hedberg G: Personal communication, San Francisco Zoo, San Francisco, 2005). In addition, most manufacturers have Web sites that offer online catalogs of their systems and supplies; these sites are a good starting point for the zoo technician researching remote delivery systems.

General Handling Policies When Using Potent Opioid Agents

- Before the darting procedure, **notify local emergency center or emergency medical teams** of when and where the procedure will take place.
- **Have a human emergency kit, oxygen tank, and treatment protocol** available.
- **Always work in pairs.**
- **Make sure all staff members handling opioid agents are wearing protective equipment**, including long sleeves, long pants, a splash mask, a surgical face mask, and gloves.
- **Ensure that all other personnel working with the darted animal are wearing protective equipment**, such as gloves, long sleeves, and long pants.
- **Brief all staff involved in the darting procedure** on safety precautions and how the procedure is to be carried out.
- **Prepare the animal's reversal agent dose** before drawing the immobilizing drug.
- **Label all syringes** clearly.
- **Transport syringes in a tightly closed container** labeled with the agent(s) being used.
- **Cover the dart with a large syringe case when pressurizing it,** and point it in a safe direction.
- **Depressurize the dart before removing it from the animal.** Mark the dart site, and rinse it with water to remove drug residue.

Conclusion

The most important aspect of selecting, using, and maintaining a remote injection delivery system is the safety of personnel. A safety policy must be in place and strictly adhered to for every type of remote delivery system, regardless of the procedure. Following a standard protocol for preparing remote injection equipment helps ensure the smooth and successful delivery of a dart. Proper care and routine maintenance will keep remote delivery equipment in good and predictable working order.

Remote injection has become an integral part of veterinary medicine within the zoo setting and has enhanced the standard of care for exotic and wild animals housed in captivity. Technicians who are trained to perform remote injection techniques can lighten the workload of veterinarians and allow them to focus on other projects throughout the zoo. A skilled technician who is familiar and comfortable with operating darting equipment will prove to be a valuable asset in any zoologic facility.

Qualities to Look for When Purchasing Remote Injection Equipment[6]

- Safe and simple to assemble and operate
- Easy to clean, maintain, and service
- Durable and easy to transport
- Reliable, with consistently accurate performance
- Appropriately versatile for use on different species under varying environmental conditions
- Not noticeably affected by temperature, humidity, or altitude changes
- Accompanied by a valid manufacturer's warranty on parts and repair for at least 1 year

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Safe-Capture International Workshops. Visit safecapture.com to register.

Species Variation in Game Capture

Extract from WildlifeCampus – Wildlife Management Course, Game Capture Module
Full text available at http://www.wildlifecampus.com/help/pdf/game_capture_part1.pdf

This notes are designed to give you an overview, during your lectures with the Wildlife vets try and find out the different challenges that comes with anaesthetising different species and add to your notes.

Capturing Of Carnivores

Capture methods

The capture of carnivores can be done by using cage traps or camp traps that lure the animal with bait. These are best constructed and operated by professional capture teams with experience in this field. It is recommended that carnivores be tranquillised during transport, to facilitate handling and loading, and reduce stress during transport. It is imperative that an experienced person, preferably a wildlife veterinarian, take full responsibility for the immobilized animal, as any carnivore is capable of inflicting serious injury to handlers. Handling of immobilized carnivores An immobilized carnivore could collapse in an unnatural and inappropriate position, which could result in injury. The animal should be placed on its side, with its head extended. The tongue should be kept wet during immobilization. Regurgitation during immobilization is life-threatening to a carnivore. Pieces of meat that are regurgitated should be removed from the mouth as soon as possible to avoid suffocation. The immobilized animal should be turned from side to side every 20 minutes To prevent overheating the animal should be cooled down after capture and should never be left in the sun. Direct sunlight can also cause damage to the eye, and the eyes should be protected by a blindfold. An immobilized animal is still able to perceive loud noises, so every effort should be made to reduce the noise level around the animal. The vital signs – respiration rate, pulse rate, blood pressure and temperature - should be checked continually. All carnivores can be lifted by 1 – 4 persons, depending on the species and the equipment available. A good stretcher will be sufficient for loading and off-loading all the larger species, while smaller species can be lifted by hand. All carnivores should be fully immobilized when loading and off-loading. Animals should be loaded as soon as possible after capture.

Which Drugs are commonly used? And are there different combinations to choose from for different species of carnivore?

What are the common dose rates?

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Notes on Elephant Capture and Translocation

by Kathy Whittaker

On the 10th of October 2001, I was privileged to be able to watch the capture of a breeding herd of elephant for translocation. Madikwe Game Reserve has an abundance of elephant at the moment. The Parks Board is selling off elephant to new reserves that require them. Whole breeding herds are taken in one go, with a couple of bulls captured at a different time to constitute a complete breeding unit. A new reserve in the Eastern Cape required a herd, so here we were, ready to catch them and put them on the trucks for transportation. Over the previous few days, the ecologist in conjunction with Park staff had been travelling around the park looking for breeding herds of the right size, and particularly of the right temperament. A breeding herd of 6 adult females with five juveniles and one baby was identified and followed over the day. When he was happy that this was a good group to translocate, a day was set for the capture. At 6.30 the next morning we were at the appointed meeting place, waiting for the teams to arrive. The early start was necessary as the ambient temperatures were up.

to 30 ºC [86 ºF] by the middle of the day. The plan was to have the elephants waving goodbye by mid morning. These creatures had a 30 hour, 1000 km drive ahead of them! First the vet arrived. He started loading up his dart guns. He used M99 (etorphine) at an estimated dose for each elephant based on body size. Each dart that he prepared was labelled i.e. adult 1, adult 2, calf 1 etc. These darts were very interesting to see. Each dart has a propellant chamber containing acetic acid in one end and bicarbonate of soda in the other. A metal plate with an eccentric weight separates these. When the dart gun is fired, it causes the metal plate to move forward. Because the weight is unevenly distributed, it rotates slightly and allows the two chemicals to mix. Carbon Dioxide is produced which then shoots the actual dart needle with the etorphine into the animal's hide. He also made ready all his antidotes to the M99 i.e. M50/50 plus tranquillisers and other medications needed. His plan was to fly above the herd in a helicopter, with an extremely skilled pilot. The helicopter would "herd" the elephants into a reasonably open area, then he would dart them from a height of about 10 to 15 metres above each elephant. The area aimed for would be high on the buttocks, to enable ease of recovery of the dart, and prevent the elephant from lying on it while unconscious. Then arrived the vehicles – and impressive they were too! Some of these vehicles were equipped with impressive cranes and winches. The vet then took off in the helicopter, and the long train of vehicles followed down the road. Within a few short minutes, the herd had been gently encouraged to move into a fairly open area close to the road, and with some skilful low flying, the elephants had all been darted, and were gently collapsing onto the ground. Then came the action! The team split up and two at a time, rushed to each elephant. Immediately, their eyes were covered by their ears, and a stick used to keep their trunks from collapsing closed. Each elephant's pair of legs were bound together with strong strapping. One of the ecologists then took a tissue sample from the ear of each elephant for genetic studies. The dart was recovered from each elephant, as these can be reused. Each elephant was marked with a spray painted number with a corresponding number for her calf, to enable mother and calf to be loaded together. Then each elephant was hoisted with the cranes onto the flatbed recovery vehicles, to be taken off to the main loading and transport vehicles. The matriarch was fitted with a radio collar, to enable future tracking in her new home. She was too heavy to be lifted using the cranes, so was winched up onto a special trailer to be taken to the transport vehicles.

By now, the first of the elephants were being loaded into the transport vehicles, mother and calves together. You will have noticed in earlier pictures of the vehicles, that there was one large transport truck, and a smaller "crate" that could open both sides. This enabled elephants to be loaded into the transport truck at the same time as elephants loaded into the crate. Once the elephants in the loading truck were moved backwards to the front of the truck, then the loading truck reversed up to the crate, and the elephant there was encouraged to move into the loading truck. This speeded up the process immeasurably, basically being able to load two elephants at a time. Once each elephant was in the truck, the vet administered an antidote to the immobilization drug, and the doors were hastily shut. Within a few minutes, the elephant was up on her feet. Using a compartmentalized sliding door system, she was encouraged to move to the front of the truck, the sliding door was closed and the back compartment was then opened to start with the next elephant unloading. Systematically, each elephant was loaded and moved. Last to go in was the female with the smallest calf. It was so gratifying to see the baby suckling within about ten minutes of being loaded. All the elephants were hosed down in the truck, and tranquillisers administered by injection through small openings on the side of the truck. Within two and a half hours from the time the vet took off in the helicopter, the elephants were ready to undertake their journey to their new home. The speed and efficiency of this game capture team was incredible and extremely impressive.

Which Drugs are commonly used? And are there different combinations to choose from for different sizes of Elephant?
What are the common dose rates?

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Capture of Giraffe

Giraffe capture is the most nail biting, because if timings of drug delivery are not executed within a minute of the giraffe falling to the ground there is a high risk of the Giraffe sustaining injury and not recovering. The concepts of giraffe capture are interesting, as the animals physiology dictates how the entire operation proceeds.
What is it about Giraffe Physiology that makes is different to other captures?
What drugs are used? Doses?
How is the giraffe captured?
How are giraffe transported? What risks does this involve?

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Capture of Rhino

Rhino are fascinating because Black Rhino and White rhino -despite looking like fairly similar beasts, are very different to capture. They react to drugs differently and will need different doses between black and white.
What drugs are used to immobilise Rhino?
What doses are used for both white and black?
Are there any other differences that affect capture technique between white and black Rhino?
How are rhino moved from reserve to reserve?
Anything particular that reserve do when the rhino arrive to their new location to help them 'settle in'?
What is the biggest problem that we face if caring for a rhino in a Boma situation? What are the possible reasons a Rhino would have to be kept in a Boma?

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Wildlife Rehabilitation

The definition of Wildlife Rehabilitation Wildlife rehabilitation is defined as “the keeping of injured, sick or immature wildlife in captivity on a temporary basis to restore or effectively condition the wildlife so it can be successfully returned to the wild and may include medical treatment”. For rehabilitation to be deemed successful, released wildlife must be able to function successfully as wild animals. This functionality includes being able to recognize and obtain the appropriate foods, select mates of their own species and reproduce, and show the appropriate fear of potential dangers (including people, cars, cats, dogs, etc.).
In the Uk, all certified wildlife rehabilitation centres have to obide by Animal Welfare laws and regulations which provide provision for animal welfare. Animal Welfare Act (2006): These provisions relate to the animal(s) needs, namely; a) need for a suitable environment; b) need for a suitable diet; c) need to be able to exhibit normal behaviour patterns; d) need to be housed with, or apart from, other animals; e) need to be protected from pain, suffering, injury and disease.
However, in less developed and regulated parts of the world such as South Africa, and where there is an abundance of wildlife. There are many people that try to rehabilitate animals but they become domestic pets. There unfortunately is a large number of centre calling themselves rehabilitation centres but will charge members of the public to look around, often there is no intention to release any of the species back to the wild.

Is rehabilitation appropriate?
Wild animals should only be held and treated in hospitals and rescue centres where it is believed that there is a good chance that they will be successfully rehabilitated back into the wild. Where an animal is expected not to survive, or to remain permanently disabled or otherwise unfit for life in the wild, then it should be euthanased as soon as possible to avoid further suffering. Exceptions to this policy may be considered where the quality of life of the animal in a captive or semi-captive environment can be assured. The remedial treatment of wild animals should involve as little stress as possible; it should be borne in mind that contact with humans is itself distressing for most untamed wild animals. Transport and treatment should therefore seek to minimise pain and distress to conscious animals, and techniques of general tranquillisation, analgesia and anaesthesia should be applied wherever possible. Distressing sensory stimulation through noise, sight, smell or touch should be kept to a minimum.
One has to think if they would alleviate the suffering of a wild animal even when such suffering is caused naturally? And would you continue to even if your actions would create greater suffering short term?

Designing a rehabilitation plan
Once one has established that they have a wildlife species appropriate for rehabilitation it is key to design a plan of how you will, enclose, feed, give any medical attention and then release this species. It is helpful to think of the five freedoms in the animal welfare act to help write an outline of what a particular species would need.
Take a look at the following scenarios that are common place in South Africa and decided if rehabilitation is appropriate and then write a plan for the rehabilitation. You will have to do some research on the species and what they like, the research camp staff are extremely knowledgeable regarding the needs of different species, pick their brains and make some notes!

Wildlife Rehabilitation Scenarios
In each scenario think about what you need to know about that species in order to decide if it were a viable rehabilitation option. Once you have jotted down some questions, ask the staff on reserve!

A rhino calf that has been left orphaned at 2 months old

A serval cat that had its paw stuck in a trap, and now has 2 less toes

A group of 4 eland calfs, separated from their mothers during mass capture.

An injured elderly impala Bull (He is non weight bearing lame) he has injured during several fights with other males.

An 8 year old male rhino who has had his horn removed by poachers and been left alive, his facial wounds are extensive.

A Pangolin found early morning who had sustain injuries that were probably treatable but the animal was in so much shock it allowed itself to be approached by humans

An elephant, very elderly whose teeth have completely worn and the elephant is becoming increasingly emaciated and weak and struggling to keep up with the herd.

An orphaned leopard cub only 6 weeks old.

Once you have decided which animals you would choose to treat and rehabilitate please write a plan for them (assume you have all the resources you possibly could have)

- Enclosure
- Food type
- Feeding regime
- Injury treatment
- Logistics of capturing the wildlife species
- Logistics of release
- Normal behaviours that you are able to accommodate

Wildlife Veterinary Nursing

In wildlife veterinary work there is a very different range of 'routine' work than in domestic veterinary. Perhaps the most 'routine' job, is immobilising / anaesthetizing animals, either so they can be moved, or so they can have a procedure carried out. Therefore, Anesthesia is a large part of wildlife veterinary medicine, and in this was Anesthetic monitoring is essential. As a veterinary Nurse you will be familiar with the different ways you are able to monitor and manage physiological state in domestic species. However, we are now dealing with different species, logistically more challenging environments, and little monitoring equipment. However, in this scenario it is essential we use the most useful tool of all; yourself! Your eyes, ears and brain!
The wildlife vet will likely be in a vehicle or in a helicopter and you will be responsible for the animals on the ground. So it is important that you are familiar with the problems that can arise from anaesthesia in the field. Under each heading it explains how these problems could be solved or assisted by the veterinary Nurse.

Trauma (Injury)
Unfortunately, there is a high incidence of trauma when immobilising wild animals. Deaths can occur from over-exertion, neck fracture, hemorrhage, sever bruising and shock can all cause death before you have reached the animal as their instinct is to escape. Often injuries sustained may results in a decision to euthanase.
Ensure animals are grouped appropriately at transport, and tranquilized appropriately.

Respiratory Failure
Opoid drugs are used often in capture but they suppress the respiratory centre leading to sever hypoxia. Hypercapnia can lead to a spiral of reaction that result in a sudden and unexpected death. The Imidazoles also can cause hypoxia by reducing the efficacy of respiration by altering the blood flow and gas absorption in the lungs; a reduction in lung volumes of 30% can be measured in recumbent horses. Similarly this is the case in herbivores (including all antelope) mainly through :
-gut content pressing forward onto the diaphragm
-The expansion of the thorax on inspiration reducing particularly on the dependent side.
Keep animals in an upright position (you will find more than one reason for this) so that it stops ventilation prefusion mis match. Can keep a canister of supplementary 02 on hand, often used during rhino procedures.

Hyperthermia
Heat energy is a by product of metabolism and the temperature of the body is the result. Energy production is lowest when animal is at rest but can increase greatly when it is under excersise. When animals are frightened they generate a lot of heat. The body may also lose its ability to regulate its temperature under the influence of drugs. Death can occur at 43 degrees. The ambient temperature is one of the most important factors in being able to lose body heat. It is important to monitor environmental temperature and capture should not be undertaken in temperatures greater than 25 degrees.
Monitor temperature- if the animals starts to have an increase temperature can throw a bucket of cold water onto animal. Make sure if is in the shade or covered from sun.

Capture Myopathy
This describes the damage in muscle tissue when it has been over-exerted; oxygen supply to the muscle is reduced and muscle fibres cannot heal by regeneration. The two factors that play a role here are that
There is insufficient blood flow in the muscle due to increase muscle tissue pressure for longer period of time causing hypoxia.
Insufficient supply of 02 due to excessive utilization and insufficient lung capacity to meet this demand. Hyperthermia may exacerbate the problem.
Large muscle groups may be swollen or may tear, breathing is rapid and may be red brown urine due to myoglobin. Death can occur up to two months after capture, often a result of scar tissue in the myocardium. Very little you can do to treat this, key is in selecting animals that will not run a far distance.

Bloat

Large volumes are continually being produces by the rumen which normally escapes from the mouth during eructation. However, when a ruminant is anaesetised the escape of the gas can be blocked, either through the anaesethic drugs interrupting the signal to the brain or via the animals body position; lateral recumbency is not ideal, as this blocks escape of gas, sternal is the best position to be in as allows gas to escape.

If an animal is suffering from bloat, you will notice it by eye. The gas build up can get so large it block the venous return to the heart by collapsing the vena cava and so the heart fails. However, if it looks like the bloat has expanded to the level where the skin is very tight you can put a large gauge needled straight perpendicular into the stomach and release the gas.

Aspiration

When an animal does not have full control of its reflexes it may aspirate some rumen content into its lungs, causing a pneumonia.

The position of the head is essential is preventing any aspiration. If you are aware an animal has aspirated then antibiotic cover should be provided.

Stress

Stress trigger an entire cascade of hormone reactions. ACTH is secreted which will cause increased levels of corticosteroids and make changes to cell function. It moderates the immune system, gluconeogenesis and protein metabolism. Exhaustion can occur when the effects of prolonged cortisol levels take their effect, Catabolism and reduced immunity render the animal vulnerable to developing disease. Gastric ulcers often are seen. Adrenal glands show signs of exhaustion in the form of cellular degeneration.

Reduce stress as much as possible by blind folding and ear defending animals. If they are being transported not overcrowding or placing with similar sized animals. Reducing handling as much as possible. Never capture if it is too hot and do not chase the animals too fast. Keep noise to a minimum and tranquillize animals for transport where you can.

<u>Anaesthetic Monitoring</u>

Although the monitoring of anesthesia follows the same principles as in domestic species you may be unfamiliar about where to feel a femoral pulse in a lion or how fast an impala heart rate should be. You will learn about monitoring different species in the field. Which parameters are feasible to monitor and what equipment you will have to aid you. When you are working hands on in the field you will be divided into teams and each member in the team will have a different role. Try to collaborate afterward to build a full picture of what the various parameters were. ***It is also really important to always write down the TIME any anesthetic drug is given.***

Species…….	Species…….
Reason for immobilisation…….	Reason for immobilisation…….
Drugs used…….	Drugs used…….
Heart rate…….	Heart rate…….
Respiration rate…….	Respiration rate…….
Temperature……	Temperature……
Species…….	Species…….
Reason for immobilisation…….	Reason for immobilisation…….
Drugs used…….	Drugs used…….
Heart rate…….	Heart rate…….
Respiration rate…….	Respiration rate…….
Temperature……	Temperature……

Guide to Relevant Internal and External Parasites in South African Wildlife

Internal Parasites

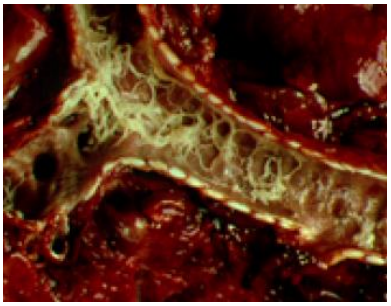
Haemonchus contortus- The Barbers Pole Worm

Haemonchus contortus, also known as the barber's pole worm, is very common parasite and one of the most pathogenic nematodes of ruminants. Adult worms attach to the stomach wall and feed on the blood. This parasite is responsible for anemia, oedema, and death of infected sheep/goats/antelope, mainly during summer in warm, humid climates.
The infection, called haemonchosis, causes large economic losses for farmers around the world, especially for those living in warmer climates. Anti-parasite drugs (Anthelminthics) are used to prevent and treat these in farmed animals, and other, worm infections, but resistance of the parasites against these chemicals is growing. Some breeds, such as the West African Dwarf goat and N'Dama cattle, are more resistant than other breeds to H. contortus (haemonchotolerance).
Morphology: The egg (oocyte) is yellowish in color. The egg is about 70–85 µm long by 44 µm wide.. The adult female is 18–30 mm long and is easily recognized by its trademark "barber pole" coloration. The red and white appearance is because H. contortus is a blood feeder, and the white ovaries can be seen coiled around the blood-filled intestine. The male adult worm is much smaller at 10–20 mm long, and displays the distinct feature of a well-developed copulatory bursa, containing an asymmetrical dorsal lobe and a Y-shaped dorsal ray.
Pathogenicity: Clinical signs are largely due to blood loss. Sudden death may be the only observation in acute infection, while other common clinical signs include pallor, anemia, oedema, ill thrift, lethargy, and depression. The accumulation of fluid in the submandibular tissue, a phenomenon commonly called "bottle jaw", may be seen. Growth and production are significantly reduced.

Teladorsagia circumcincta- The Brown Stomach Worm

Teladorsagia circumcincta (also known as *Ostertagia circumcincta*) is a species of parasitic nematodes that infect sheep and goats. The brownish worms infect the gastric glands of the stomach and lead to weight loss, decreased wool production and death.
The pathology of *T. circumcincta* infection (teladorsagiosis) is associated with the immune response to the larvae developing in the abomasal gastric glands damaging the guts ability to digest food.
Clinical Signs: Death, lethargy and collapse, weight loss, damage and inflammation of the gut resulting in diarrhoea (scouring), and lesions on the wall of the 4th stomach (abomasum) give it a 'Moroccan' leather appearance.
Brown stomach worms do not feed on blood, but damage the lining of the stomach as they mature from larvae to adult worms. Sheep or goats with heavy infections rapidly lose condition, develop profuse scours and may die. Entwined masses of worms are found on the lining of the stomach, which is thickened and red and is also covered with whitish nodules (1–2 mm in diameter). The carcass is emaciated.
Animals with fewer worms are unthrifty and daggy.

Dictyocaulus viviparous



Dictyocaulus viviparus is a bovine lungworm (a member of the Trichostrongyloidea). They are found in the trachea and larger bronchi and are responsible for parasitic bronchitis. There has been an increase in the incidence of husk in recent years; first season calves are particularly affected, although yearling and adult cattle may also succumb to the disease. Lungworm is responsible for reduced weight-gain and deaths in calves and yearlings and lowered milk-yield in dairy cows. A closely-related species is also responsible for one of the most important diseases of farmed deer. The parasite is of welfare importance if clinically affected animals are left untreated.
It can live in: Cattle, buffalo, deer and camels.
Morphology: The adults are white thread-like worms, often less than 8cm in length.
Pathogenesis: Signs include coughing and tachypnoea (depending on the number of worms) and an increased respiratory rate. In calves it can cause weight loss and even death in severe cases. In adult cattle, infection will tend to cause reduced milk yields and mild respiratory signs.
1.The penetration phase lasts one week and occurs when the larvae migrate to lungs. There are no clinical signs.
2.Then the prepatent phase lasts 1 - 3 weeks and is the development and migration of larvae leading to bronchiolitis and then eosinophilic exudate, causing the air passage to be blocked, resulting in alveolar collapse (distal to blockage). This is when clinical signs such as tachypnoea and coughing being to arise.
3.The patent phase then lasts around 4 - 8 weeks and the mature worms produce eggs during this period. Signs of bronchitis are seen due to mature worms and parasitic pneumoniais seen due to aspiration of eggs and larvae causing cellular infiltration of neutrophils, macrophages and giant cells.
4.Finally, the postpatent phase, which lasts around 8 - 12 weeks is seen and here, the majority of worms are expelled. In 25% of cases clinical signs may reappear as a result of alveolar epithelialisation, which may occur together with interstitial emphysema and pulmonary oedema, or secondary bacterial infection.
5.Reinfection syndrome may occur if immune cattle are exposed to large numbers; only then will they show clinical signs.

Ostertagia ostertagi

Morphology: *O. ostertagi*adults are slender reddish-brown worms. Adult males measure 6-8mm, adult females 8-11mm, and the eggs measure 70-86µm in length. Identification of adult medium stomach worms is based on the structure of the bursa, genital cone, and spicules in males and on the dimensions of the oesophageal valve and the configuration of the synlophe in males and females.
An important concept with this worm is that it can cause two different situations named Type 1 and Type 2 disease.

Type I Disease:
Type I disease occurs in young cattle grazing on pastures for their first time during the period of high pasture contamination. This syndrome usually occurs in the summer and fall months in the Northern hemisphere and during the winter and spring months in the Southern hemisphere.Infective larvae are ingested daily by the young stock on pasture. The pathological and clinical signs are due to the direct development of large numbers of L3 larvae to adult worms over a relatively short period of time (approximately 3 weeks) in young animals with an immune system naïve to *Ostertagia* infections. The young adult worms then break out of the gastric glands, causing substantial damage to the abomasal wall. Mild cases result in reduced growth or production and severe cases can result in fulminating disease characterized by profuse watery diarrhoea, rapid weight loss, submandibular oedema ("bottle jaw"), anemia and death
Type II Disease:
Type II disease can occur in yearlings and older cattle. It is the result of arrested L4s resuming their development to immature adults and leaving the gastric glands.This can occur weeks or months after being ingested as L3s and is a consequence of favourable environmental conditions.The larvae will then resume maturation gradually or in bursts. The clinical signs are identical to type I disease and the severity depends on the magnitude of the eruptions.In the Northern hemisphere type II disease is often seen in the early spring, and in the fall in the Southern hemisphere.
Pathology: Worms can readily be seen and identified in the abomasum, and small petechiae (blood spots) may be visible where the worms have been feeding. The most characteristic lesions of *Ostertagia* infections are multiple small, white, raised umbilicated nodules 1–2 mm in diameter. These may be discrete, but in heavy infections they tend to coalesce and give rise to a "cobblestone" or "morocco leather" appearance. Nodules are most marked in the fundus region but may cover the entire abomasal mucosa. In severe cases, edema may extend over the abomasum and into the small intestine and omentum. When examined histologically, abomasal gastric glands contain larvae in varying stages of development, which results in hyperplasia and distention of the glands, and flattening of the glandular epithelium. Affected glands lack differentiated acid-producing parietal and pepsinogen producing chief cells. Type I and type II disease is often differentiated by the presence of increased numbers of globule leucocytes, eosinophils and focal aggregates of lymphoplasmocytic cells in animals with type II disease

External parasites

Ticks
Rhipicephalus is a genus of ticks in the family Ixodidae, the hard ticks, consisting of about 74 to 75 species. Most are native to tropical Africa.
Species are difficult to distinguish from one another because most are quite similar, but at the same time, individuals of one particular species can be quite variable. Most of the characters used to identify species pertain to male and immature specimens, and "females are sometimes simply impossible to identify".
Many *Rhipicephalus* are of economic, medical, and veterinary importance because they are vectors of pathogens. They transmit the pathogens that cause the animal and human diseases East Coast fever, anaplasmosis, babesiosis, rickettsiosis, Boutonneuse fever, Lyme disease, Q fever, Rocky Mountain spotted fever, and Crimean–Congo hemorrhagic fever, and they inject a neurotoxin in their bite that leads to tick-caused paralysis.
Boophilus was once considered a separate genus, but studies in the early 2000s resulted in *Boophilus* being made a subgenus of *Rhipicephalus*.
Species familiar in the domestic environment include the brown dog tick (*R. sanguineus*).

Rhipicephalus evertsi evertsi

Rhipicephalus apendiculatus

Rhipicephalus (Boophilus) decoloratus

Amblyomma hebraeum (Bont Tick)

Amblyomma hebraeum, commonly known as the South African bont tick, is a species of hard tick that is native to southern Africa. They are sexually dimorphic.

Male Tick

Engorged Female Tick

The scutum and alloscutum of the male is dappled in various shades and colours. The female's scutum is dappled but the alloscutum is solid black. The alloscutum in both sexes is fringed by prominent festoons. The legs are swarthy or reddish, and paler at the joints.

The nymph and adult stages are vectors for Heartwater disease which affects various species of domesticated ruminants. Some wild ruminants are susceptible to the disease and suffer from clinical heartwater, but others are highly resistant. The ticks remain infective for life, but their infection rates vary according to the season and region where they occur. In South Africa 1 to 7 percent of ticks are infected at any one time.

Hyalomma spp

These are large ticks that are commonly found on the legs, udder, tail or perianal region of mammals. They are either two or three host ticks found in central Asia, southern Europe and North Africa.

Ticks of these species can identified by:
Eyes present
Long mouthparts
Ventral plates around male anus
Inornate
Banded legs

*(Hyalomma anatolicum) There are other species, this is mentioned as an example and is the species in the photo above.*Also known as: *Bont-legged tick*

There are two subspecies known, *H. anatolicum excavatum* that is found in central Europe and Asia and *H. anatolicum anatolicum* which can be found throughout the rest of the range. These ticks cause tick toxicosis in Africa which is a sweating sickness seen in pigs and ruminants. This is accompanied by a profuse moist eczema and hyperaemia of the mucous membranes. This species can also be involved in the transmission of *Theileria*, *Babesia spp.* as well as *Anaplasma marginale*

Flies
Chrysomya bezziana

Chrysomya bezziana, also known as the Old World screwworm fly or screwworm, is an obligate parasite of mammals. Obligate parasitic flies require a host to complete their development. Named to honor the Italian entomologist Mario Bezzi, this fly is widely distributed in Asia, tropical Africa, India, and Papua New Guinea. The adult can be identified as metallic green or blue with a yellow face and the larvae are smooth, lacking any obvious body processes except on the last segment.
The fly feeds on decaying organic matter, while the fly larvae feed on the living tissue of warm-blooded mammals as opposed to necrotic tissue that many other fly larvae feed on. Since the larvae can cause permanent tissue damage, *C. bezziana* has led to much public concern. Management procedures include both prevention of colonization of the fly and treatment of a current infestation. As of early 2009, little research was being conducted on the fly, as it is an unsuitable agent for maggot therapy (a medical procedure in which maggots are used to clean festering wounds) because the maggots aggressively burrow through living tissue. Recent publications of *C. bezziana* present medical case studies of the fly.
Chrysomya bezziana usually infects livestock causing myiasis. Myiasis is the infestation of tissue (living or dead) on a living mammal by fly larvae. Mammals such as sheep, dogs, cattle, pigs, and even humans can become infested. The adult female will lay her eggs on superficial wounds in live animals preferring wounds that are several days old.[4] Eggs of *C. bezziana* are commonly laid in the navel of newborn livestock species or on castration wounds in cattle. Eggs are also laid on open sores, ulcers, scratches externally or on mucous membranes throughout the body. Wounds as small as a tick bite are large enough for a female to lay her eggs.
When the eggs hatch, the larvae burrow into the animal's living tissue and feed on it. Their common name, the "screwworm", is derived from the maggots that embed themselves into the flesh of their host in a screw-like fashion. The larvae can burrow as deep as 15 centimetres (5.9 in) into the host's living tissue. As the maggots feed and cause tissue damage, the wound produces a characteristic odor, which can go unnoticed by humans. However, this wound entices female flies to the wound and encourages them to lay their eggs there as well, causing further infestation.
C. bezziana is different from other fly species because tissue infestation can occur in the absence of necrotic tissue. The *C. bezziana* maggots may cause serious and permanent tissue damage. Extremely infested wounds can lead to death if not treated. The sexually mature adult imago feeds on decomposing corpses, decaying matter, excreta, and flowers. Due to their diet, these adult flies can be a mechanical vector for pathogens.

Chrysomya albiceps

Chrysomya albiceps can reach a length of 6–9 millimetres (0.24–0.35 in). In these blow flyies thorax and abdomen are metallic blue to green. Wings are completely hyaline. Thorax bears a row of thick bristles on the meron and greater ampulla and the head shows plumose arista. The third antennal segment is dark-grayish. In males frons of the head is very narrow and the eyes are very close to each other. Frons of females have a dark brown to black color.

Adults feed on many things including decaying matter, excreta, and flowers. This insect normally reproduces within carcasses of dead animals,[5] leaving eggs inside, usually together eggs of other species. Thus, although the first larvae feed on nutrients of decomposing tissues, the second and third series of larvae become predators, feeding on larvae of different species and even practicing cannibalism. Although eggs are normally deposited in decomposing tissues, they may, however, also be found in wounds of living tissues, both in animals and in humans. The ideal heat range foregg laying is 25° to 27°o C. The durations of the larval stage may differ as a result of temperature.[4]

This species plays also a significant role as a voracious predator of other dipteran larvae during the maggot stage.[6]

At temperatures between 20 and 30 °C the life cycle of Chrysomya albiceps from egg to adult lasts about 66 days.

Lucilia cuprina-

Lucilia cuprina is a species of blow fly characterized by a metallic outer appearance and reddish eyes. They usually have a shiny green or greenish/blue abdomen with bronze/coppery reflections. Because of this, Lucilia species are known as the bronze bottle flies. Their body shape is round to oval and their length varies from 4.5–10 millimeters. They have two pairs of wings, the first pair being membranous wings and the second pair being reduced wings known as halteres which are used for flight stabilization. Adults are easy to distinguish due to bristles on the meron, in addition to the arista, the prominent hair on the terminal antennal segment being plumose, or feathery. L. cuprina are most easily identified by their strong dorsal setae and their black thoracic spiracle.

Blowfly strike, or flystrike is a serious welfare problem in the animal industry. This cutaneous myiasis or infestation not only causes severe discomfort or stress to the animal, but will also cause death when left untreated. Ewe lambs and female sheep are primarily affected and are struck predominately in the rear quadrant of the animal due to fecal staining. Due to the difficulty in controlling these flies, there are considerable losses in the sheep industry every year. Also, there is an increasing concern of the insecticidal use and the surgical procedures done to control L. cuprina, making this not only an animal welfare issue but also an economical one. The maggots of L. cuprina rapidly grow while eating the living flesh of the sheep while secreting ammonia, thus, poisoning the sheep. Sheep show signs of skin irritation by rubbing and biting the affected areas during the first few days after the eggs have been laid. This causes an inflammatory response in the sheep resulting in severe irritation and pyrexia. Once a flystrike has started other flies are attracted to the site. Although treatment is available, the delayed response time due to symptoms allows wool breakage in the affected area and fleece to be tender overall. There are many predispositions to the flystrike that make a host more favorable, including an infection with dermatophilosis and footrot, both of which can be treated and prevented. In some animals a weak resistance can develop, but this immune response is often associated with a decrease in productivity which is an undesirable trait.

Melophagus ovinus

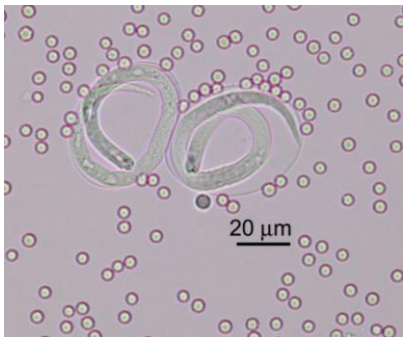
Melophagus ovinus, or the sheep ked, is a brown, hairy fly that resembles a tick. This wingless fly is about 4 to 6 mm long and has a small head; it is a fly from the family Hippoboscidae. They are blood-feeding parasites of sheep. The sheep ked feeds on the blood of its host by inserting its sharp mouthparts into capillaries beneath the skin. The legs of the sheep ked are very strong and tipped with claws. Sheep keds live their whole lives in the wool of sheep. They are most commonly found on the neck, shoulders, and underbelly of the host animal. Although they are often referred to as the "sheep tick", sheep keds spend their entire lifecycle on their hosts, which is distinguishable from the characteristics of a true tick. Additionally, sheep keds have six legs, whereas true ticks have eight legs.

In lambs, the sheep ked may cause anemia and reduce weight gain. It feeds on the blood of its host, so causes irritation to the sheep, leading it to rub, producing both loss and damage of the wool. It also makes firm, hard nodules that develops on the skin called a cockle, this will reduce the value of the hide. The ked feces also stains the sheep's wool reducing its value. They also transmit *Trypanosoma melophagium* nonpathogenic protozoan parasite of sheep. A sheep's immune response to keds reduces capillary flow to the skin. Although this response is trying to combat the ked infestation, it also results in a less abundant and lower quality fleece.

The sheep ked is capable of transmitting bluetongue virus in sheep, though little evidence suggests they are bluetongue disease vectors in nature

Some sheep have been shown to be resistant to the harmful effects of sheep keds. Resistant sheep's skin was histologically examined and showed arteriolar vasoconstriction in addition to fibrinoid degeneration of the tunica media in the lower dermis. This subepidermal region showed an increased infiltration of eosinophils and lymphocytes. The upper dermis of resistant sheep showed an increase of empty capillaries, whereas the upper dermis of susceptible sheep showed capillaries filled with red cells. The resistance of some sheep to keds was due to prolonged cutaneous arteriolar vasoconstriction. In resistant sheep, keds were unable to obtain enough blood and eventually died from starvation.

Parafilaria bovicola (Skin worm)



Also known as: Summer bleeding disease — Verminous nodules

Hosts: Intermediate host: Muscid flies and then Definitive host: Cattle and buffalos

Morpholgoy: P. bovicola are thin, white worms, ranging between 3-6cm in length.

Life Cycle: This parasite is of the superfamily Filarioidea. The life cycle of P. bovicola is indirect. The eggs hatch on the surface of the host. These eggs are ingested by the flies acting as intermediate hosts. Larvae develop and transform into infective L3. The flies then feed on the host, and the larvae are past onto the host. The larvae then enter the skin of the host, and develop into adults subcutaneously. The prepatent period of P. bovicola is 7-9 months.

NB. **What is Pre Patent Period**? This is a good term to get to know, as it is discussed a lot within parasitology. It is defined as:

The interval between infection of an individual by a parasitic organism and the first ability to detect from that host a diagnostic stage of the organism.

This is an important part of the pathogenesis of the disease and affects when we can diagnose a disease and how quickly we can treat it. The longer the PPP the harder it is to diagnose quickly and treat/control.

Glossina spp (Tse Tse Fly)

Tsetse,sometimes spelled tzetze and also known as tik-tik flies, are large biting flies that inhabit much of tropical Africa. Tsetse flies include all the species in the genus Glossina, which are placed in their own family, Glossinidae. The tsetse are obligate parasites that live by feeding on the blood of vertebrate animals. Tsetse have been extensively studied because of their role in transmitting disease. They have a prominent economic impact in sub-Saharan Africa as the biological vectors of trypanosomes, which cause human sleeping sickness and animal trypanosomiasis. Tsetse are multivoltine and long-lived, typically producing about four broods per year, and up to 31 broods over their lifespans.

Tsetse can be distinguished from other large flies by two easily observed features. Tsetse fold their wings completely when they are resting so that one wing rests directly on top of the other over their abdomens. Tsetse also have a long proboscis, which extends directly forward and is attached by a distinct bulb to the bottom of their heads.

Fossilized tsetse have been recovered from the Florissant Fossil Beds in Colorado, laid down some 34 million years ago. Twenty-three extant species of tsetse flies are known from Africa.

Tsetse were absent from much of southern and eastern Africa until colonial times. The accidental introduction of rinderpest in 1887 killed most of the cattle in these areas, and the resulting famine removed much of the human population. Thorny bush ideal for tsetse quickly grew up, and was populated by wild mammals. Tsetse and sleeping sickness soon colonised the whole region, effectively excluding farming and animal husbandry. Hunters and conservationists supposed that the empty, game-rich land was typical of primeval Africa. Large areas were turned over to reserves, first for game hunting and later for conservation. Sleeping sickness was described by conservationists as "the best game warden in Africa".

Tsetse are biological vectors of trypanosomes, meaning that in the process of feeding, they acquire and then transmit small, single-celled trypanosomes from infected vertebrate hosts to uninfected animals. Some tsetse-transmitted trypanosome species cause trypanosomiasis, an infectious disease. In humans, tsetse transmitted trypanosomiasis is called sleeping sickness.

Animal trypanosomiasis, also called nagana when it occurs in bovine cattle or horses or sura when it occurs in domestic pigs, is caused by several trypanosome species. These diseases reduce the growth rate, milk productivity, and strength of farm animals, generally leading to the eventual death of the infected animals. Certain species of cattle are called trypanotolerant because they can survive and grow even when infected with trypanosomes although they also have lower productivity rates when infected.

The course of the disease in animals is similar to the course of sleeping sickness in humans.

Trypanosoma congolense and Trypanosoma vivax are the two most important species infecting bovine cattle in sub-Saharan Africa. Trypanosoma simiae causes a virulent disease in swine.

Other forms of animal trypanosomiasis are also known from other areas of the globe, caused by different species of trypanosomes and transmitted without the intervention of the tsetse fly.

The tsetse fly vector ranges mostly in the central part of Africa.

Culicoides sp

Culicoides is a genus of biting midges in the family Ceratopogonidae. There are over 1000 species in the genus, which is divided into many subgenera. Several species are known to be vectors of various diseases and parasites which can affect animals.
Adults are small dark insects about 1–3 mm long. The antennae are long (15 segments) densely haired in the males and less hairy in females. The Thorax is hooped and carries a pair of broad mottled wings. Only the first two longitudinal veins are distinct.
Biological habits: Both males and females feed on nectar, however only the females feed on blood, which is needed for the maturation of fertilized eggs. Females typically bite at dusk or dawn often in dense swarms and usually in the vicinity of water, marshes or rotting vegetation.
Life cycle of *Culicoides*: Females lay their eggs *en masse* in a range of habitats ranging from water vegetation, slow running streams, damp soil or manure heaps. These hatch into tiny smooth white larvae with four pairs of anal gills. Pupae consist of a fused cephalothorax with slender respiratory trumpets and a segmented abdomen. Adults emerge through a straight slit after 3–7 days.
The bite of *Culicoides* is felt as a sharp prick and is often followed by irritating lumps that may disappear in a few hours or last for days.
Various *Culicoides* species have been shown to be vectors for the following viruses and conditions: *Mansonella* spp. (*M. ozzardi*, *M. perstans*, *M. streptocerca*), *Onchocerca gibsoni* and *O. cervicalis*, *Leucocytozoon*, *Plasmodium agamae*, bluetongue virus, Schmallenberg virus, African horse sickness, bovine ephemeral fever (*C. osystoma* and *C. nipponesis*), Akabane virus, Queensland itch and Epizootic Hemorrhagic Disease. A typical cycle of transmission of a virus by *Culicoides* is illustrated in the article Parasitic flies of domestic animals.

Simulium sp.

Simulium is a genus of black flies, which may transmit diseases such as onchocerciasis (river blindness). It is a large genus with several hundred species, and 41 subgenera.
The flies are pool feeders. Their saliva, which contains anticoagulants, a number of enzymes and histamine, is mixed with the blood, preventing clotting until it is ingested by the fly. These bites cause localized tissue damage, and if the number of feeding flies is sufficient, their feeding may produce a blood-loss anaemia.
The host's reaction to fly attacks may include systemic illness, allergic reactions or even death, presumably mediated by histamine. In humans, this systemic reaction is known as "black fly fever" and is characterized by headaches, fever, nausea, adenitis, generalized dermatitis, and allergic asthma.

Parasitology Record

Species of parasite:…….
Date:……..
Location:……..
Species associated with (if found on/in a host:…….
Approximate number found at site:……..

Sketch/microscopic findings
Notes:……
……
……
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……
……

Parasitology Record

Species of parasite:…….
Date:……..
Location:……..
Species associated with (if found on/in a host:…….
Approximate number found at site:……..

Sketch/microscopic findings
Notes:……
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Sketch/microscopic findings
Notes:……
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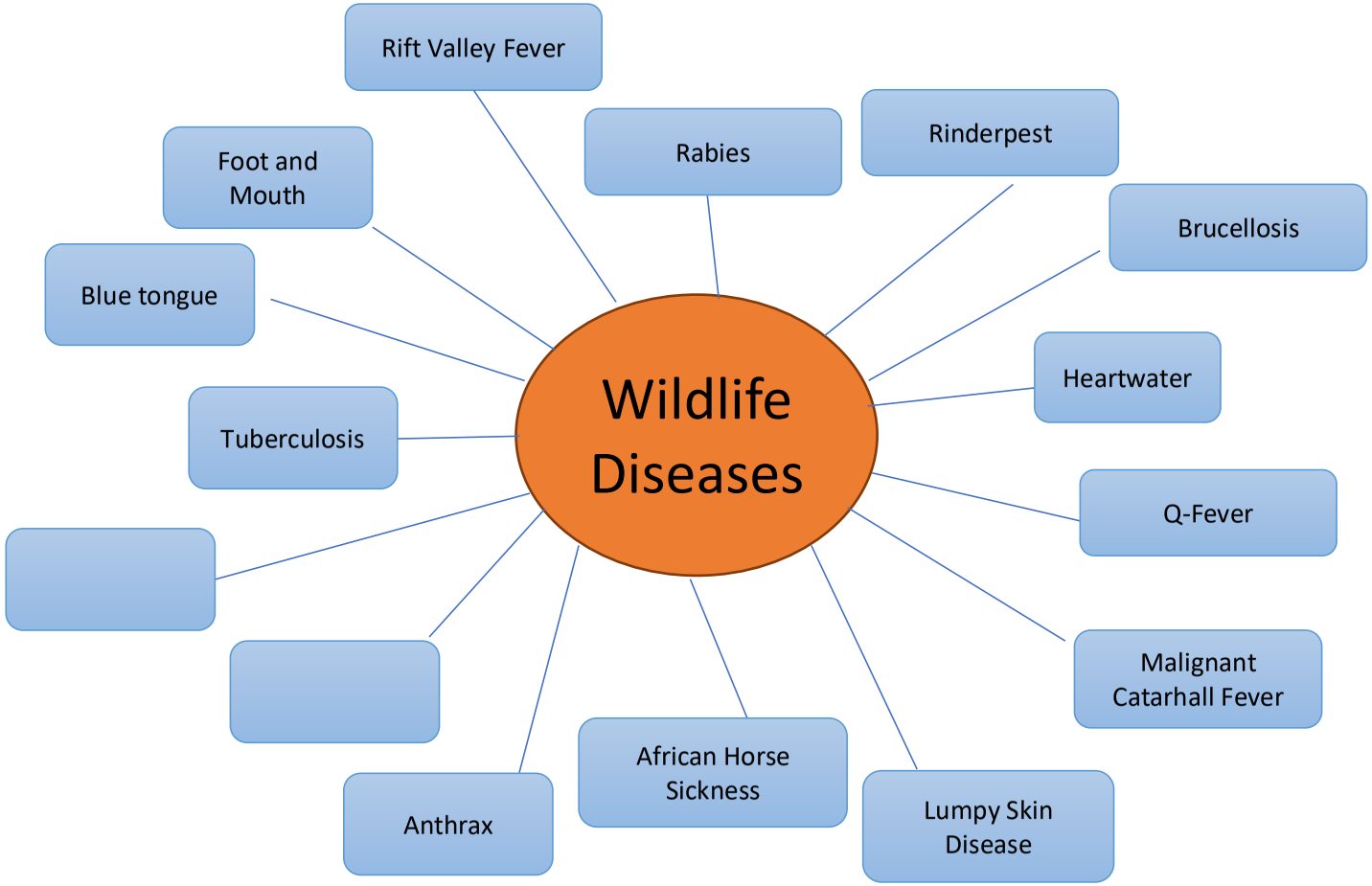
Try to complete the Wildlife Diseases Mind map below, you can add boxes and sections, they layout is just to start you off. You should be able to have a complete picture of the different disease found in wildlife in South Africa after your time with the wildlife vets, and you can use this as a summary! Link different boxes up and add boxes in if you need to 😊 Try to jot down words around the diseases that jog your memory as to which species that disease affects and any other key points that will help you remember



National Research Foundation | National Zoological Gardens of South Africa

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A Manual for Field Necropsies of Wildlife

Free ranging animals usually die naturally, are hunted or culled in the field, far from laboratory or pathology services. The information each animal can yield is critical in assuring early diagnosis of the cause of its death, prevention of spread of infectious disease to other animals and people, and in providing general baseline information on the anatomy, histology, haematology, metabolic profiles and patterns of disease in different species. Samples can be stored and made available for future research worldwide.

Necropsy procedure is standard for all mammals, apart from some differences in how to sample the gastrointestinal tract. Detailed knowledge of anatomy is not necessary to collect and store sets of tissues and organs, which may yield valuable information. We here describe a rapid procedure designed for arduous conditions and speed.This is a simple field necropsy technique, with suggested sampling protocols, designed to maximize the value of information that can be obtained from each unfortunate dead animal. Please use these references:

Munson, L. *Necropsy of Wild Animals*. Wildlife Health Center, School of Veterinary Medicine, University of California, Davis

Murnane R, Kinsel M J 2000 *Mammal field necropsy protocol*. University of Illinois Zoological Pathology Program

Woodford M H, Keet D F, Bengis R G 2000 *Post-mortem procedures for wildlife veterinarians and field biologists*. Office International des Epizooties, Care for the Wild and the Veterinary Specialist Group/Species Survival Commission of the World Conservation Union (IUCN)

OIE 2010 *Training Manual on Wildlife Diseases and Surveillance*. Office International des Epizooties website www.oie.int

1. BEFORE YOU LEAVE FOR THE FIELD:

- check you have the tools you will need:

Essential	*Optional*
Sharp knife	Forceps
Sharp scissors/garden shears	Hack saw
10% buffered formalin	Ax
Sealable plastic bags (Ziploc)	Tubes for blood
Glass slides	Swabs, sterile bottles
Disposable gloves, apron, mask, boots	Bucket, brush, soap
Paper towels	GPS
Necropsy form, pencil, pen	DMSO
String, cellotape	
Plastic ruler	
Camera	
Disinfectant	

- Get as much information as possible from people who may have seen the animal alive: including but not by any means limited to changes in behaviour, feeding, the environment of

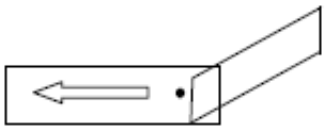
the animal, the weather, detailed information on clinical signs and any treatment received. Any recent changes in recent weather conditions that could have caused animal deaths (drought, floods, electrical storm, etc); any signs or history of struggling before death? This should not be collected for only the dead animal, but for the remaining animals including previous health issues. Ideally, you should have a template for the recording of such information.

- In rare or endangered species, consider calling the Wildlife Biological Resource Centre (082 994 4 388) to have samples collected for genetic studies, as well as sperm or ova for storage.

2. **BEFORE YOU BEGIN THE EXAMINATION:**
   - All carcasses should be handled as if they were harboring potentially dangerous diseases: WEAR GLOVES. This is particularly true with carnivores and rodents. Do not eat or answer the phone while performing an examination and wash your hands well when you are finished.
   - Could this animal have a disease that is transmissible to humans, livestock or other wildlife?
     - Be particularly careful with primates, rodents and birds
     - Wet the coat/feathers with soapy disinfectant
     - If there is a history of sudden death or abortion in a ruminant and there is a possibility of Rift Valley Fever DO NOT DO A NECROPSY; CONTACT THE VET
   - If there is a history of abnormal behaviour (eg very aggressive, unusually tame), consider Rabies and consider whether you should notify a vet, take extra precautions, and make sure the person is vaccinated. If you are properly protected by vaccination, and have a mask and gloves, remove the head (see below), and cut it lengthwise down the middle. Put one half of the brain in formalin, and send the other half on ice to your veterinarian.
   - Consider if the animal could have Anthrax. If it is a carnivore, does it have a swollen head or neck? If so, make a smear from a small cut in the swollen neck (see below). In the case of other animals, does the animal have dark blood draining from the ears, eyes, nose, mouth or anus? Take a smear of blood from a small cut in the ear, and submit it as soon as possible to a veterinarian. ONLY PERFORM A NECROPSY ONCE THE VET HAS GIVEN PERMISSION.
   - Take a blood smear sample from an ear or tail vein

Slide 1

To make a blood smear, collect one TINY drop of blood with a glass slide, place it at one end of a second glass slide. Using the first slide, gently smear the blood along the length of the second slide.
Make several smears.



Slide 2

Let the smears dry, protecting them from flies, which will eat the blood off the slide. When the smears are dry, label one end of the slide (with a pencil) with the date, species, and animal ID. Wrap them in paper towel with cellotape to prevent them from breaking.

- Assess the Condition of the Environment:
  - Note recent weather conditions that could have caused animal deaths (drought, floods, electrical storm, etc)
  - Note signs of struggling before death.

- Assess the Condition of the Animal: note any bite wounds or other signs of predation. If wounds are present, look for bruising and bleeding in the tissues near the wounds, which would indicate that they occurred before the animal died. Otherwise these wound most likely were caused from the carcass being scavenged.

- If at any point during the post mortem, any obvious abnormalities are seen sample these areas, making sure to sample at the margin of the abnormality - include the abnormal region and the adjacent normal tissue so that your pathologist can orient the lesion.
  - Remember to handle tissues very gently, holding them at the edge, and cutting them with a sharp knife.
  - Make impression smears of organs by lightly touching a glass slide to the surface (air dried)

- Place them in formalin immediately. ***All tissues for formalin-fixation should be no more than 1 cm thick in any dimension and tissue:formalin ratio should be 1:10.*** **NEVER** freeze formalin fixed tissues. All tissues collected can go in the same formalin bottle. Use buffered formalin wherever possible.

3. NECROPSY PROCEDURE:

Very small animals can be fixed whole by opening the body cavities and submerging the entire animal in formalin.

The following guide is for mammals (consult the addendum for examination of birds and reptiles)

Larger animals are best placed with the right side down.

- Examine the skin for wounds and note the condition of the hair coat
- Collect samples of any *ticks* from the tail base, groin and/or ear, and a sample of the *faeces* from the rectum (*Ziploc* bags)
- Cut the skin from the chin to the tail. Remove the skin flap over the chest and abdomen as well as the right front and hind legs. During removal, sample ***skeletal muscle*** and ***skin*** for formalin fixation.
    - Check all the main muscle masses including spinal muscles for signs of capture myopathy or trauma – puncture wounds, haemorrhage, pallor, and chalky deposits.
- Sample the ***prescapular lymph node***, under the skin in front of the shoulder joint. Lymph nodes are round to oval, firmer than fat, and are white to gray.
- Dissect through the muscle of the thigh to expose the femur bone, and saw or cut transversely through the femur, and then remove a core of ***bone marrow*** for formalin fixation. If the animal is a male, also sample ***testicle*** for formalin fixation. If it is a female, sample the *mammary gland* for formalin fixation.
- Remove the wall of the abdomen carefully without puncturing any of the digestive tract.
    - Note the animal's body condition, as an indication of the duration of its illness and it's nutritional status: note the amount of fat around the heart and kidneys, and muscle development.
    - Note any abnormalities in organ placement, and the amount and appearance of fluids in the chest or abdomen.
- Sample for formalin-fixation the ***liver***, and also take a 5-10 gram sample of liver and spleen for freezing (in a *ziploc* bag).
- Then, put both ***adrenal glands*** in formalin (or full-thickness slices in large animals). They are in the fat just above both kidneys (oval, flat, yellow-orange organs, about 1\20th the size of the kidney).
    - Check the thickness of the adrenal cortex for indications of stress, which is common in recently translocated or confined animals being fed a new diet.
- Next, sample full-thickness slices of both ***kidneys***; for both formalin-fixation and also a 5-10 gram portion of one for freezing.
- If the animal is female, sample an ***ovary***, one ***uterine horn (or oviduct)*** which is the part of the uterus that divides and travels to each ovary, and sample the uterus behind/after the two uterine horns join together at the ***body of the uterus***.
- Then, find the ***urinary bladder***, which may be deep in the pelvis, and sample a small portion of this.
- Find where the esophagus enters the stomach and cut across the esophagus while holding the entry to the stomach closed to keep any food inside. Cut across the rectum while holding it closed to prevent feces from escaping. Remove the stomach and intestines from the carcass by cutting the attachments to the liver and spinal column. Leave the pancreas attached to the intestines and the spleen attached to the stomach.
- Take a sample of **spleen** in formalin.
- Sampling of the digestive system depends on the species of animal being examined.
    - Look for internal parasites, remembering that free-ranging animals often have abundant parasite loads without any associated pathology.
    - Note the content of the intestines including the amount and type of food, presence of abnormal materials such as poisonous plants.
- In all species, find and sample the blind-ended, small or large sac ***caecum***, which is at the junction of the small and large intestine. Just upstream from this, the end of the small intestine - the ***ileum*** - also needs to be sampled. In the same area of the ileum and cecum, and in the connective tissue supporting the entire intestinal tract, there are clusters of lymph nodes called ***mesenteric lymph nodes***, and these also should be sampled.
- In carnivores, rhinos and zebra, sample 3 areas of ***stomach***: just after the entry of the esophagus (the tube that enters the stomach from the chest cavity); somewhere in the body of the stomach; and just before the small intestine starts. Also take a sample of stomach contents for freezing. Next, sample the beginning of the small intestine (***duodenum***). Also at this time sample the ***pancreas***, which will be running along the duodenum, which resembles fat but is slightly more pink/red. Then, sample a portion of the middle of the small intestine anywhere along its length; this is called the ***jejunum.***

- In the carnivore, sample a portion of the end of the digestive tract, which is the part that normally contains formed faeces (***colon).***
- In the ruminant: The first structure that is easily identified is the rumen, the largest structure in the abdomen. *Do not sample this until last*, or rumen contents will obscure all other structures. Proceed as described above for all species. After locating the ***colon,*** find the tightly coiled ***spiral colon*** and section a small portion of this. The true stomach, or ***abomasum***, connects the small intestine to the rumen – take a sample of the abomasums. Finally, section at least two pieces of the wall of the ***rumen***, and collect rumen contents for freezing.
    - Examine what the animal has recently eaten - the type of food present in the stomach will give you many clues as to the nutritional status of the animal and the possibility of poisoning.
- In the rhinoceros and zebra: The largest portion occupying a majority of the abdomen is the large colon; *do not sample this until last* or its contents will obscure all other structures. Instead, proceed as described for all species. Lastly, take at least two samples from the largest structure previously described, which almost fills the abdomen (***large colon***)
- Once the intestines are sampled, the abdominal cavity organs can be removed, and the chest cavity examined. Cut through and sample the ***diaphragm***, which divides the chest from the abdomen.
- Reach into the chest and take samples from each ***lung*** on both sides of the chest. Open the trachea and note if it contains foam or fluid. Take a sample of trachea, and the **oesophagus** (food pipe) which runs next to it.
- Next remove the ***heart***, and cut a thin, transverse (cross) section in the middle of the meaty part of the heart. Save this whole portion in small animals. In large animals, removal of the heart and the contents of the front of the chest cavity (e.g. thymus) may be difficult. If so, cut off a portion of the heart, as far up as you can safely reach, and cut small portions out of the thick outer wall (***left ventricle)***, the thin outer wall (***right ventricle)***, and also the thick middle wall (***interventricular septum)***. Additionally, freeze a 5-10 gram portion of any of the meaty part of the heart.
- Finally, in front of heart, sample the ***thymus*** which is just in front of the heart and appears similar to fat but is more pink/red.
- Skin the back of the jaw and locate, just underneath the skin, ***salivary glands*** and ***lymph nodes***, which need to be sampled only on one side. The salivary glands again appear similar to fat, though are usually tan and firm. At the very beginning of the trachea, find and sample from each side, the firmly attached dark-to-light red and firm ***thyroid glands***.

- Examine the eyes, mouth and nostrils for ulcers and abnormal discharges. Remove an *eye* for histology by cutting the muscles around the eyeball.
- Cut between the lower jawbone and tongue and remove the tongue from below, taking a cross-section slice of the *tongue* for formalin. Examine the inside of the mouth, tonsils, and teeth, taking at least one *tonsil* for formalin-fixation.
- The final samples to remove are the brain and pituitary gland. First, remove the head by cutting between the head and the first neck vertebrae, and remove the skin and muscle from the back of the head forward to just behind the eyes, and including removing the ears.
- Locate the ear canals (where the ears were removed from the skull) and cut transversely (across the head) straight down through the skull and brain until the back portion of the skull falls off. In horned animals it is usually easier to turn the head upside down and cut from the bottom of the skull to the top. The brain can now be removed after cutting around the outside of the brain gently with knife or scissors to transect all the large nerves. The brain can be fixed whole in small animals, or sample a small portion from the top front (***cerebrum***), the top back (***cerebellum***), and the bottom back one-third (***brainstem***). Also freeze a 5-10 gram portion of cerebrum. You can find and sample the ***pituitary gland***, which will still be in the brain cavity on the bottom middle (in the front half of the skull). You may need to cut through the white tissue over the pituitary.

NECROPSY PROCEDURE FOR BIRDS

- Spray the bird with soapy water to wet the feathers.
  - Examine the carcass for evidence of trauma and ectoparasites.
- Place the bird on its back and open the skin from the beak to the vent.
- Disarticulate a hip joint, expose and sample for formalin the sciatic nerve
- Section the femur in 2 places, remove the section and cut it longitudinally to expose bone marrow, put both halves in formalin
- Retract the skin to expose the keelbone and breast muscles, ribs, and body wall.
- Assess the amount of body fat under the skin and in the body cavity. Assess the amount of musculature over the keel, putting a piece of muscle in formalin.
- Make a horizontal cut at the bottom edge of the keelbone extending on each side through the muscles and then remove the keelbone, cutting the muscle and bony attachments. Inspect the location and size of all organs. Note any abnormal fluids
- Examine and take samples for histology of the air sacs (thin membranes between the organs and body wall. Look for any plaques or opaque areas. Remove the heart and put the whole heart (small birds) in formalin or cut it in half first (large birds).
- Take samples from the liver for histology, bacteriology and toxicology as relevant.
- Find the spleen at the junction of the glandular and muscular stomachs. Take a sample for histology, bacteriology, molecular diagnostics as needed.
- Using scissors, open the oesophagus from the mouth, through the pouch at the base of the neck (crop), past the base of the heart, through the glandular stomach (proventriculus) and into the muscular stomach (gizzard).
- Take a sample for histology of oesophagus, crop, proventriculus and gizzard. Take material from the same organs for toxicology.
- Take the thyroid glands for histology (tiny red-brown glands at the base of the neck above the heart).
- Find the loop of intestine that empties from the gizzard and take a sample of intestine and attached pancreas (white or pale pink tissue in the loop), for histology. Open the intestinal tract at least 4 places along its length, noting the content and adding some of the contents to your sample for toxicology. Take several sections of intestine for histology and bacteriology if needed.
- Remove the liver and intestines from the body.
  - Dissect the lungs away from the body wall and take samples for histology.
    - Examine them for firmness or lumps
  - The gonads (2 testes in the male or 1 ovary in the female) are located in front of the kidneys along the backbone. The adrenal glands are located just in front of the gonads and are also attached to the body below the spine. Bluntly dissect the top part of the kidneys from the body wall, leaving the gonads and adrenals attached. Fix for histology.
  - Remove a section of skull covering the brain, and place it in formalin.

Dispose of the carcass, wash instruments, collection containers and hands, and fill in forms as for mammal necropsy.

NECROPSY PROCEDURE FOR REPTILES:

The procedure for reptiles is similar to birds. A snake is used as an example.

- Place the animal is on its back
  - Examine it for evidence of trauma.
- Open the body along the midline.
- For turtles, the bottom shell must be removed at the junction with the top shell with a saw.
  - Record the amount of body fat and condition of the musculature, as well as any abnormal fluids recorded.
- Find the thyroid(s) anterior to the heart and remove and fix them for histology.
- Beginning at the mouth, remove the trachea, heart and lungs. Open the trachea.
  - Examine the lungs for firmness or lumps.
- Open the heart. Take samples of all organs for histology.
- Remove the intestinal tract as a unit, beginning in the oral cavity. Open the esophagus, stomach and intestines along their length and take samples for histology
- Remove the liver, spleen and pancreas. Examine and sample for histology
- Remove the gonads and adrenals (along the midline in front of the gonads). In females, remove the oviduct with the ovaries. Dissect the kidneys from the body wall. Take samples for histology.
- Dispose of the carcass, wash instruments, collection containers and hands, and fill in forms as for mammal necropsy.

4. AFTER YOU HAVE COMPLETED THE NECROPSY:

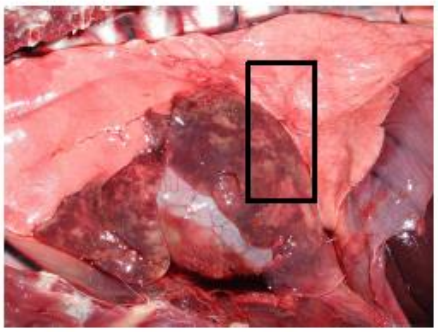
- Clean your instruments, gloves and hands. All contaminated paper or plastic materials should be either thoroughly disinfected or burnt. All blood and residual tissues should be removed from the instruments and tools with soap and water. Then the instruments should be disinfected.
- Wash, dry and label all sample containers, using a waterproof marker, with the date, animal species, animal ID (if available), geographic location and your name. For formalin-fixed tissues, a paper label with the animal identification written in pencil can be submerged in formalin with the tissues.
- Make sure all containers are adequately sealed and no leakage can occur
- Arrange for appropriate disposal of the carcass. Carcasses with anthrax or other infectious diseases should be buried (preferably covered with a disinfectant and buried at least 2 m deep to prevent scavenging). Where infectious disease is suspected, the carcass and all tissues from the carcass including blood soaked dirt should be buried or burnt.
- Complete the specimen information sheet (Appendix 1), listing all relevant history, and a description of any abnormalities you have seen. Use the following terms in your description: location, number and distribution, color, size, shape, consistency and texture. For example: "The liver contains multiple tan, firm nodules ranging from 1 to 3 cm in diameter that are distributed throughout all liver lobes. The nodules are gritty on cut surface."

5. WHEN YOU ARE BACK AT THE CENTER:

- Complete the data information sheet (WBRC, Appendix 2) and store sample and data collection Worksheet appropriately.
  - Formalin-fixed samples can be kept at cool room temperature until shipped.
- Your clothing should be thoroughly washed.

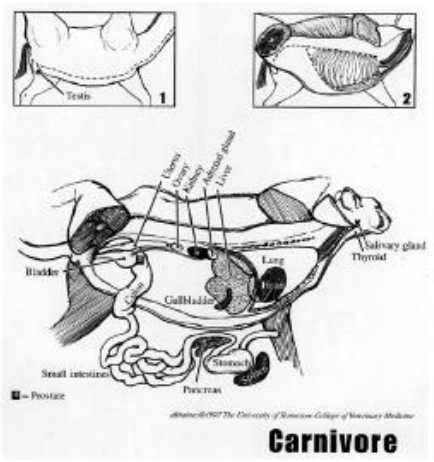
PHOTOGRAPHS:

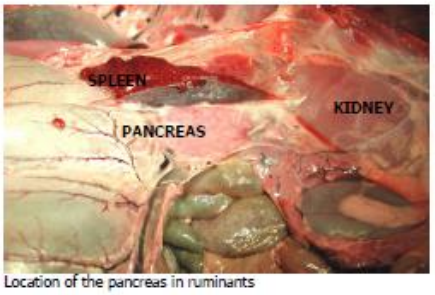
Blood smear



Make sure to sample at the margin of the abnormality – include the abnormal region and the adjacent normal tissue

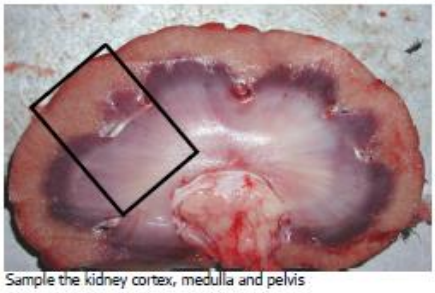
Exertional and nutritional myopathy (pale muscles, arrow)



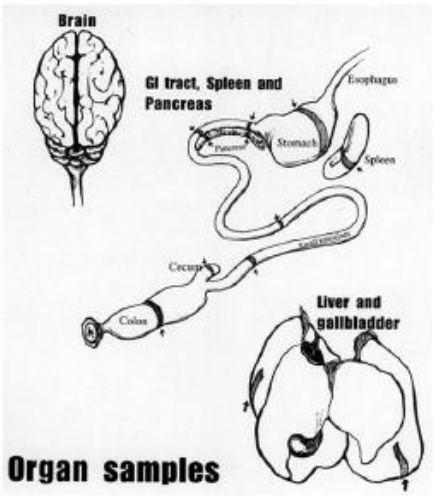


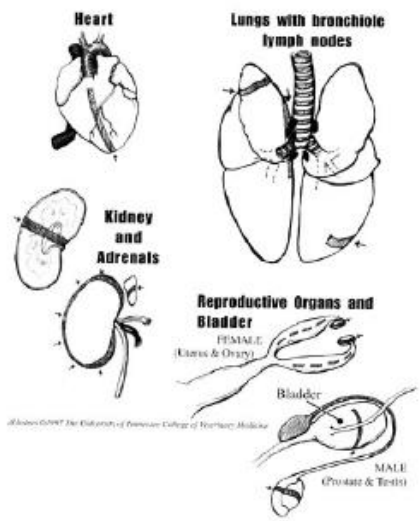
Location of the pancreas in ruminants

Location of the adrenal (may be obscured by fat deposits)



Sample the kidney cortex, medulla and pelvis



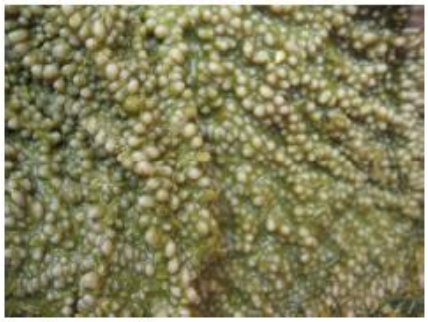


Gastric ulcers

Rumen in browser

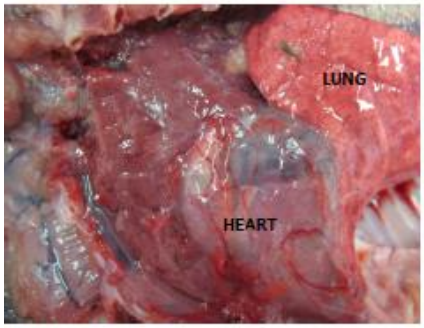
Rumen in grazer

Severe thymic atrophy (carnivore)



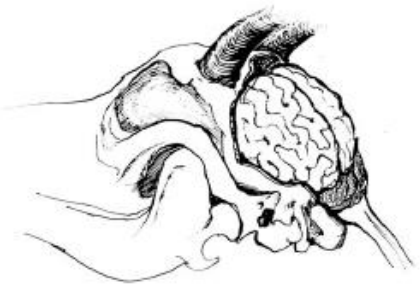
Atrophic rumen papillae

Location of thyroid (adjacent to larynx)

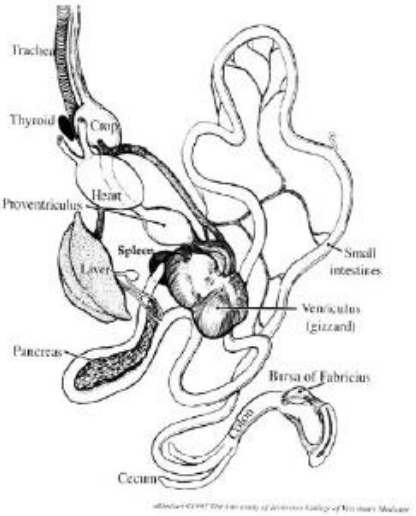


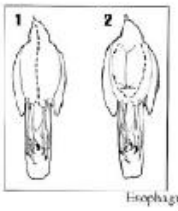
Normal thymus (Goat)

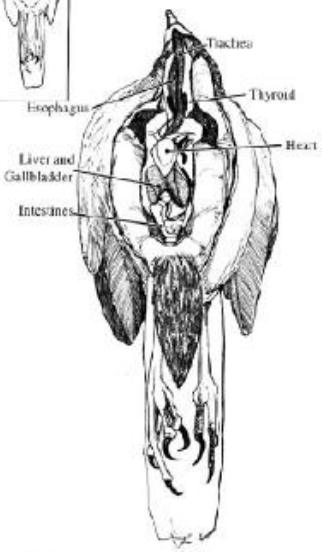
Enlarged parathyroid gland

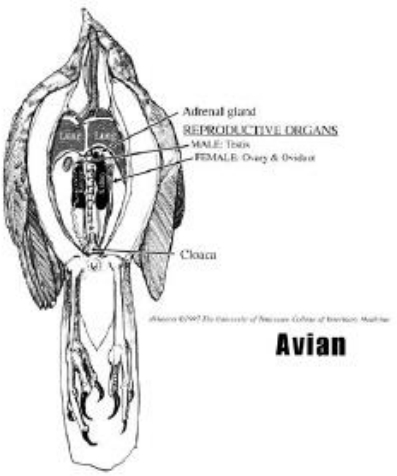


Removal of the brain

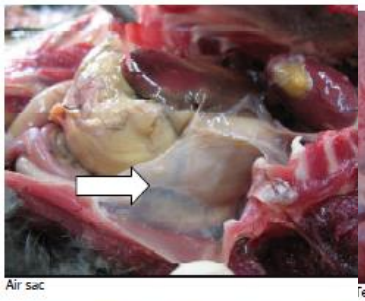




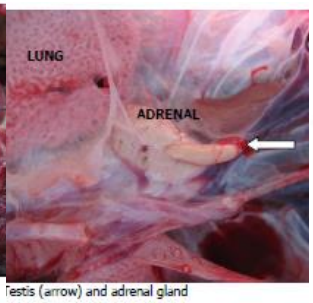




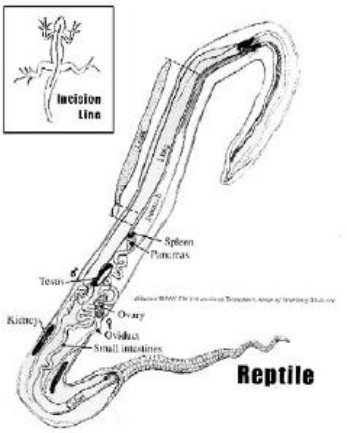
Avian



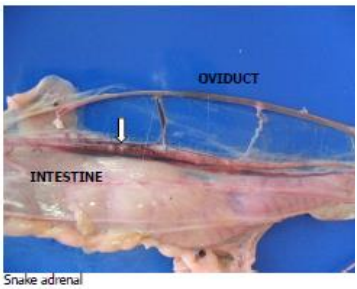
Air sac



Testis (arrow) and adrenal gland

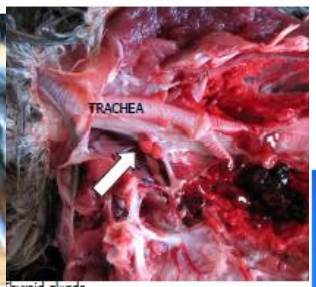


Reptile

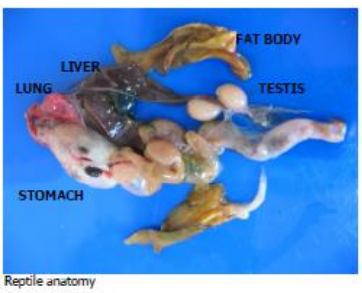


Snake adrenal

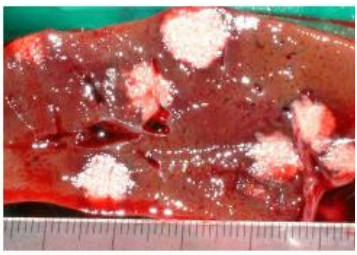
Enlarged pale spleen



Thyroid glands



Reptile anatomy



"The liver contains multiple discrete tan, firm nodules ranging from 0.5-1.5cm in diameter that are distributed throughout all liver lobes. The nodules are soft and friable on cut surface"

Ovary

Addendum 1: **PATHOLOGY REQUEST FORM** Ref no:

SUBMITTER DETAILS:

NAME:..... GPS coordinates.....

ORGANISATION:.....

POSTAL ADDRESS:.....

CONTACT DETAILS: Phone.....Fax.....

Cell phone .....Email address: .....

ANIMAL DETAILS: (include as much information as possible)

SPECIES..... ....ESTIMATED AGE..... SEX.....

ANIMAL ID:.....DATE OF DEATH.....

BODY CONDITION:.....

RELEVANT HISTORY/ANY ILLNESS NOTED PRIOR TO DEATH / SUSPECTED DIAGNOSES .....

.....

.....

.....

.....

SAMPLES SUBMITTED: .....

ABNORMALITIES NOTED DURING NECROPSY (if done: use back of sheet if necessary).....

skin .....

.....

respiratory system .....

.....

cardiovascular system.....

.....

liver.....

.....

spleen and lymph nodes .....

.....

kidney and bladder .....

.....

adrenal.....

gastrointestinal tract.....

.....

reproductive tract.....

.....

brain/spinal cord.....

bone/marrow/joints .....

thymus.....

Veterinary Emergencies

A lovely overview written in the MSD manual by Andrew Linklater, DVM, DACVECC, Clinical Instructor, Lakeshore Veterinary Specialists, Glendale, Wisconsin:
Emergency patients present special challenges because their underlying disease processes can cause immediate, life-threatening problems that require rapid and aggressive intervention. In addition, the full extent of the animal's illness, injuries, or toxicity may not be evident for 24–48 hr or more after initial presentation. Problems can arise from an acute illness, toxicity, or injury; from a chronic illness that has decompensated; or from an unexpected complication of a concurrent illness. The status of all postoperative patients should be considered critical until life-threatening anaesthetic or surgical complications are excluded. The golden rule of emergency medicine is to treat the most life-threatening problems first.
Variables that contribute to the overall success of emergency treatment include the severity of the primary illness or injury, the amount of fluid or blood lost, age of the animal, previous health problems, the number and extent of associated conditions, time delay in instituting therapy, the volume and rate of fluid administration, and the choice of fluids (eg, crystalloid, blood components, or synthetic colloids). Therapy must be done at the right time, in the right amount, and in the right order. Therapeutic failures are generally a result of failing to act expeditiously at a crucial moment.
Emergency care often begins with the owner's initial telephone call. Instructing the owner on first aid and transport procedures can be life-saving for the animal. The clinic and staff must be in readiness, especially if more than one animal in critical condition arrives at the same time. The primary survey, or triage requires a quick and accurate assessment and decision regarding the stability of the animal. As life-threatening airway, breathing, and circulation problems are identified, immediate treatment is initiated. Once the animal has been stabilized, a more systematic and organized approach to the history and physical examination (secondary survey) and more specific diagnostic and therapeutic procedures aimed at the underlying cause can be done.

Wildlife emergencies

Dealing with a wildlife emergency presents challenges that we never have to think of in domestic veterinary medicine. Firstly, you have often never met your patient before, neither may have anyone else! So you may not have any information of history. You may not know its gender, age, underlying conditions. And as you may know if you have ever tried to body condition score a sheep with your eyes instead of your hands; it's extremely difficult to gestimate some weights and BCS from a distance, which is often what is necessary with a wildlife emergency in need of drugs. How soon the animal is found in the situation it is in, is often unknown, so you often have little clue the true extent of what is in front of you. Improvisation, is often a key skill in dealing with emergencies- you often don't have with you the ideal piece of equipment, or simply the ideal tool for the job does not exist, so you have to get creative, be resourceful and think on your feet.
As ever in veterinary medicine, you have to get your people skills in fine tune. There will often be people willing to help in emergencies but they need direction and clear instruction on how exactly they can help. Many bodies are not useful if panicking or getting caught up in the 'drama' of it all. You also may be working with people you have not worked with before and so you should be communicating all the time to achieve a good working team. Above all as in any working environment, you should take a moment to evaluate your own safety, and the safety of all others working in the situation with you. Especially in the dark, or on a reserve where there may be other dangerous animals on the ground nearby. The patient you are working with may be large and dangerous, never compromise your own safety.

Emergency Wildlife Case Studies:
During you time on the reserve you will work with many staff and different vets that have dealt with wildlife emergencies. Build a few case studies, of examples of wildlife emergencies that you have learnt about, Taking down the key facts. Here are a few questions, to prompt your 'interview' , try to think of a few more questions that you could ask, then make a few notes so you remember these exciting stories for a very long time to come!
What was the species involved?
What was the reported call that came in (sometimes the story you get on the phone is not the full picture!)
Did this species require special considerations?

What was the location of the emergency, both on a big scale (i.e. in a nearby town or a 2 hour drive or a helicopter journey away) and on small scale was it somewhere accessible (ie on a reserve, in thick undergrowth) What were the difficult parts of dealing with the situation; was it night time, was there enough light, enough hands, the correct equipment present.

Was the animal in an otherwise healthy state before the 'emergency'? Or was it elderly or poorly previously, compromising it further.

What drugs needed to be used, how did these doses change from normal i.e in an animals that has suffered an injury and is unwell, may need to use lower doses, but in an animal that has a lot of adrenaline in its system, higher doses may be needed.

From studying this case study what items would you be including in your emergency call out box if you were packing the call out truck and medicine box.

Case 1

Case 2

Case 3

Case 4

Poaching and the Rhino Crisis

Extracts From : https://www.africa-wildlife-detective.com/rhino-poaching.html
https://www.savetherhino.org/rhino_info/threats_to_rhino/poaching_for_rhino_horn

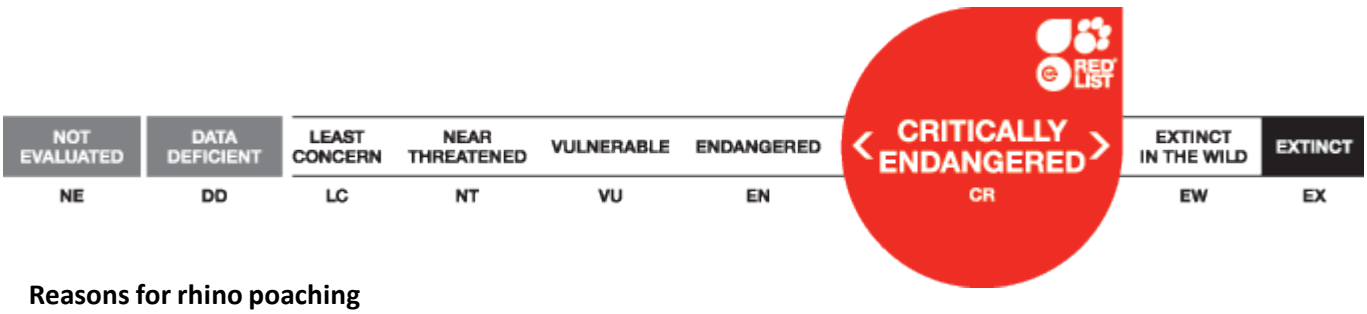
African Rhinos are really important! It's not just because they're a precious link to our planet's ancient past… rhinos also play a crucial role in their environment. White rhinos are big grazers, eating lots of vegetation, which helps shape the African landscape. Other animals benefit, and it keeps a healthy balance within the environment. Local people depend on the natural resources from these environments for food, fuel and income too. Ecotourism can be a vital sustainable source of funds for local communities. As one of Africa's wildlife 'big five', rhinos are a popular sight for tourists.By helping protect the rhino we're helping protect its environment for the benefit of both people and wildlife for generations to come.

Poaching in South Africa:

South Africa has by far the largest population of rhinos in the world and is an incredibly important country for rhino conservation. From 2007-2014 the country experienced an exponential rise in rhino poaching – a growth of over 9,000%. Most illegal activity occurs in Kruger National Park, a 19,485 km^2 of protected habitat on South Africa's north-eastern border with Mozambique. Kruger consistently suffered heavy poaching loses, and so in the last few years the government and international donors have channelled ever more funding and resources into securing the Park.

In 2016, figures show a dip in poaching in South Africa for the second year in a row, indicating that increased protection efforts are paying off. Although it is encouraging to see South Africa's poaching levels fall, the losses are still extremely high. A rise in incidents outside Kruger National Park also points to the growing sophistication of poaching gangs that are gaining a wider geographical coverage and – it would seem - expanding their operations across borders.

Rhino conservation status



Reasons for rhino poaching

Demand from China and Vietnam have elevated the price of rhino horns to new levels.
There have been reports that rhino horn has been fetching prices as high as US$50,000 per kg.
This is similar to the street price for cocaine in the UK.
This demand has obviously resulted in a big surge in the number of rhino poaching incidents.

Why are rhinos such easy targets for poachers?

Rhinos have very poor eyesight and they cannot see stationery objects even just a few meters away from them. Their poor eyesight mean they are very vulnerable against experienced poachers who are able to approach them within a few metres before opening fire.
Their hearing is however very acute and they also rely mainly on their well-developed senses of smell to warn them of approaching danger.

Who is carrying out the poaching?

At the lower end of the spectrum of poachers you find subsistence poachers.
They are usually from poor communities are driven by poverty and hunger.
Subsistence poachers are usually on foot and will shoot the rhino with random fire to the head and chest area, as well as the legs in order to immobilize the animal.
They will then remove the horns very roughly using an axe.
These poachers take high risk for comparatively little reward.
They will usually pass the horns to a syndicate member after the job is done.

At the higher end of the spectrum you will find professional poachers.
They have well-structured operations and use high technology methods which involve -

- tranquillizer guns,
- helicopters,
- veterinary drugs, and
- high caliber weapons to kill rhinos.
- Many of the poachers seem to have had military training
- Often they have had prior access to information about the farm/reserve they intend to target.

Unfortunately due to the fact that highly controlled and regulated veterinary drugs are often used in cases of rhino poaching it indicates that there is some involvement of veterinary professionals.

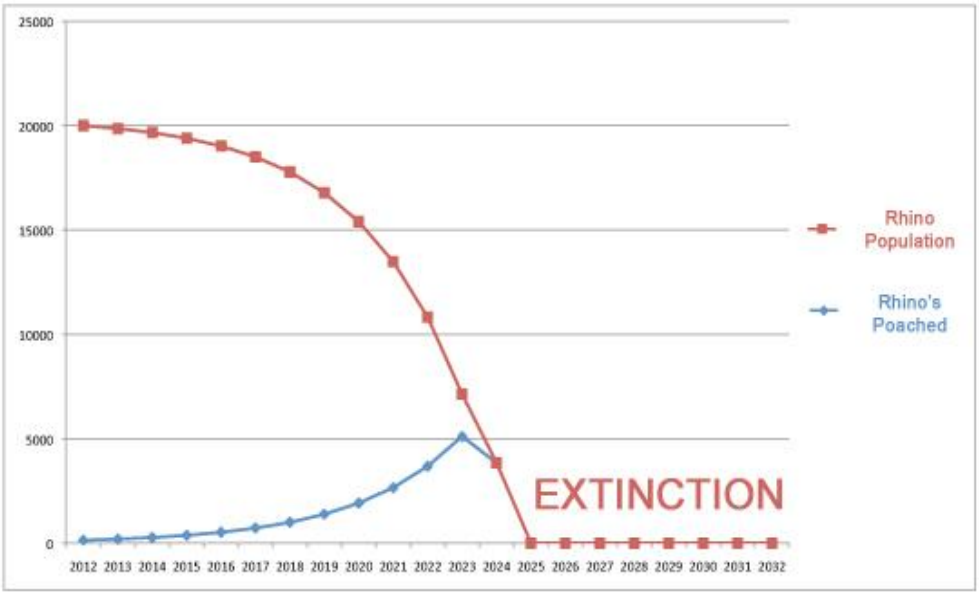
When they land the helicopter, they hack of the horns with a chainsaw. The use of a helicopter allows for easy access and quick getaways. Several media reports have indicated that the registration numbers on the tail of the aircraft get covered up or falsified during the operation. The rhino subsequently dies either from an overdose of tranquillizers or bleeds to death.

One troubling fact is that the methods being used by the syndicates often reflect those used by *wildlife capture operators* in professional rhino management operations.
The rhinos are normally darted with a dosage of lethal drugs that may result in a quick death, although some evidence shows that the animal suffered great stress before death.
If the drug dosage had been too low to kill the rhino the animal is likely to wake during the brutal removal of the horns with a chainsaw.
The severely maimed rhino will then attempt to breath through a cavity in its nasal passage between its eyes.
This rhino will have no sense of smell and if it survives will have a great battle to fight off any secondary infection.

Wildlife industry insiders part of the problem?
Increasing evidence links South Africas rhino poaching with wildlife industry insiders.
These individuals are obviously in a great position to run wildlife crime syndicates and are typically also well funded and connected within the industry.
There are also rumors that rhino poaching syndicates are penetrating the hunting industry.
The hunting industry obviously has access to guns, permits, vehicles and charter aircraft making them target for rhino poaching syndicates.
These rumors seem to have merit because of the increasing number of arrests of -
game ranchers,
safari operators and
professional hunters.

How to stop rhino poaching?
Unfortunately there is no simple and obvious solution to this problem.
There is currently numerous proposals in the pipeline and some heated debates around opinions which include the following:
Strong differences of opinion between people calling for legalized trade in rhino horn (to turn it into a commodity) and those against it.
Addressing the issue of educating the end user in Asia
To establish a database of all rhino horn DNA samples.
Etc.

When will our rhinos become extinct?



Graph credit: rhinosurvival.org

Like the graph indicates, should the current trend continue, these African animals will be poached into extinction as soon as the year 2025.
The sheer extend of the challenge and the cruelty of what we are up against is overwhelming but we must definitely not give up without a fight.

Possible Solutions to the rhino poaching Crisis:
http://www.rhinoprotect.org/news/realistic-ways-save-rhino-south-africa/

It saddens one to think that the rhino is being hunted down for the value that its horn provides to dealers from Asian countries such as Taiwan, South Korea and China, where they would use it in traditional medicines. Middle Eastern countries like Oman and Yemen use it to make all kinds of ornaments that include ceremonial daggers and other jewellery.
According to The Guardian, in August 2011 the value of the rhino horn increased by as much as £50,000 per kilo due to higher demand in Asian countries. It is absolutely criminal what all gets done to the rhino in order to get to its horn. Our heroes on the frontlines, who have thousands of kilometers to patrol, are doing all they can to safeguard our rhino from extinction. Unfortunately, they can only do so much and cannot be everywhere.
Currently, the value of the rhino horn is estimated to be close to one million US dollars. The high value placed on rhino horn makes it even harder for everyone involved to save the rhino from becoming extinct.
While 2012 has seen more arrests taking place than before, the rewards that the criminals receive for poaching rhino outweighs the poachers' fear of being thrown in jail. A lot still needs to be done to safeguard our rhino from becoming extinct. There are more ways than one to help save our rhino and preserve them for future generations. Let us take a look at some effective ways on what can be done to keep our rhinos alive.

DRASTIC TIMES CALL FOR DRASTIC MEASURES WITH REGARDS TO OUR RHINO
According to recent polls, people came up with various ways to help eliminate rhino poaching. Let us take a brief look at some of the proposals made.

Proposed ways to save the rhino from extinction include the following:

- Legalise international trade of the rhino horn. The theory is supported by the idea of farming rhinos and eventually harvesting their horns
- Safe rhino dehorning: It's been said that if done under controlled conditions, the rhino's horn could be safely removed without harming the animal. The only problem here is that it has a negative effect on the animal's behaviour and on the male rhino's ability to mate.
- Harsher prison sentences…and increased patrolling is another recommendation to serve as a deterrent to illegal poachers
- Educating people- Education around the world is another way to help dealers and poachers realise the futility in actually killing of the rhino for its horn. Then there is a need to make them realise that there is no real medicinal value that can be attached to the horn of the rhino.
- Increased funding and donations. Donations from the public will help to conserve the rhino for future generations as stricter measures can be taken to help safeguard them. Even more exciting is the introduction of a treatment known as RhinoProtect where the rhino horn is made valueless to poachers as it gets injected with color dye and poison, whereby X-ray scanners will be able to detect the horn. More information on this process will be revealed later on.
- Selling of horns from rhino who died of natural causes, or in cases where the horns broke off.
- Apparently there are over 25 tons of rhino horn available in South Africa. This process needs to be legalised to get it into motion.
- Bans on rhino horn sale. Bans being placed on using rhino horn within Asian countries like Taiwan, Korea, and Japan is certainly contributing as there is not such a high demand for horns like it used to be. Except for places like China, Thailand and Vietnam where the demand is still rising.
- Local initiatives- Raising funds through holding concerts like the Stand up concert is a useful way to ensure the survival of our rhino as it helps a lot to keep their natural habitat going. Besides poaching, forest fragmentation can also contribute to their numbers decreasing. Local awareness maintains the issue deep close to us and allows the Rhino lobbies to keep pressure on the government to find political solutions.
- Going Social- If millions of us, electors, tax payers, entrepreneurs, workers raise our voices against rhino poaching and place this dreadful issue in our first priorities we will make things change. There will be more and more initiatives, there will be more action to protect, save, prevent and finally secure the survival of our rhinos. Simply read, share, comment and be active around the rhino survival.
- Rhino horn poisoning- Positive action needs to be taken to preserve our rhino for our grandchildren and their children. RhinoProtect is a project that was initiated by Damian Vergnaud, who is the owner of Inverdoorn Game Reserve and Safari Lodge. After much discussion and consideration it was decided that it is best to poison the rhino horn, making it unpalatable for human consumption, which is the main reason for poaching taking place. The good thing about injecting color dye into the rhino horn, is that the 40 minute procedure poses no real threat to the health of the animals involved. As this procedure makes the actual horn worthless, it is a better way to ensure the survival of our rhino.

LIVE DEBATE- Hunting: Pros and Cons

For this exercise you will be split into two teams, and you will then be tasked with looking at the concept of hunting from both sides of the debate. Then you will be told which side your team is going to represent in the debate (For or Against) and have to bring your points forward for that side.
You should write down points that the other team if you had not already discussed them, so you have a full picture of both sides of the argument. The research camp staff will be on hand to answer questions you may have to help your argument!

These questions may help start you off with your discussions…….. and may prompt you to find out a little more from the reserve staff around you!

- Why do people hunt?
- Which species are hunted?
- Are you allowed to hunt any animal you like?
- Are there any laws in place to control hunting?
- What does a tourist have to do if they decide they want to hunt an animal?
- Do different animals cost different amounts?
- What is the different costs of hunting?
- Where does this money go, what is it used for?
- Is there a selection process in choosing individuals to be hunted?
- What is canned hunting?
- Is there a minimum age for hunting?
- Do you have to show any competence at weapons handling to hunt an animal?
- Could it be that some hunting is carried out ethically and some is not?
- How can this be controlled?

GROUP DISCUSSIONS

Rhino Poaching- what are the solutions?
Following your discussion with the rhino poaching staff what are some of the proposed solutions to the rhino poaching crisis?

Suggested talking points- (higher level of punishment for poachers, poisoning the horn, dehorning all rhino long term, higher levels of protection ie in a small area with armed guards)

Elephant Contraception- should we carry this out?
Having read the articles on elephant contraception with views on the pros and cons, what is the solutions. Welgevonden reserve currently use contraception with their herd. What would happen if they didn't? what would be the solution to a growing herd that the reserve cannot support?

Drug Calculation and Drip Rates

Extracts from Chemical and Physical Restraint of wild animals by Michael D Kock and Richard burrows

1kg = 1000g (grams)
1g = 1000mg (milligrams)
1mg = 1000mcg. (micrograms, sometimes displayed with a ug)
1L = 1000mls (millilitre)

In order to achieve a desirable pharmacological response to occur the correct dose of a drug must be given, and this will vary between species and also be influenced by:
Size- dose increase with size
Age- Lower than normal doses for young and old
State of Health- Usually lower (especially if liver and kidney disease)
Other drugs- Lower
A dose response curve demonstrates the changes in pharmacodynamic effect of a drug as the dose increases and decreases. Below is a quantal dose curve and is based on an all or none response. It also allows you to see the comparison between the effective and lethal doses of a drug. The most important value is the immobilisation of wildlife is the safety factor ED99- the effective dose In which 99% of the population must be increased before the LD-Dose necessary to kill1% of the population is reached.

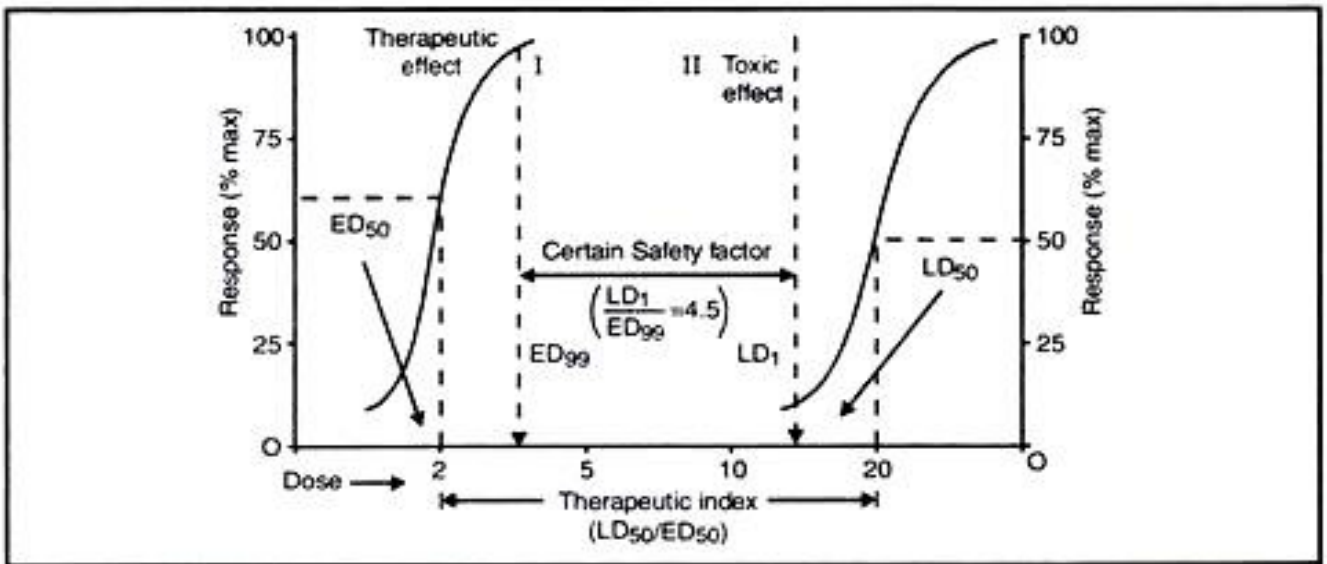


Fig. 3.6 Quantal log-dose response curves for therapeutio (I) and toxic (II) effects of a drug

Drug Stability

Most drugs are intrinsically unstable and will lose their potency over a period of time (degrade).Knowledge of degradation rates enables calculation of expiry dates for drugs and these should always be printed on the label. The most common factors influencing the rate of drug degradation are temperature, light and Ph and for this reason storage and handling are important.

Calculations

This is an extreme important aspect of drug administration and either right or wrong. Most drugs are administered on a milligram per kilogram basis and dosage calculations are divided into two parts:

- Number of milligrams of drugs to be administered to an animal
- The amount of drug product that contains this required dose

Example:

A The total number of milligrams to be delivered to an animal is 1 200mg and the concentration of the drug is 50mg/ml.
Volume of drug required = 1200 / 50 = 24 mls

B Lets consider the amount of Etorphine required to safely immobilise an adult bull elephant. The total number of milligrams required is calculated at 14mg. Etorphine is available in a concentration of 9.8mg/ml. 14/9.8= 1.42mls. This volume is placed in the syringe.
NB With the use of etorphine at 9.8mg/ml we often round off the concentration to 10mg/ml which means a volume of 1.4ml to be administered to the elephant bull.

You will see the wildlife vets calculating drug dosages in the field on the spot, as they are used to working with the numbers and are familiar with the kind of volumes they are expecting. Make sure you write down as many example calculations as you witness, so you can practice them too!

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Welgevonden Game Reserve - Large Mammal Species List

English Name	Afrikaans Name	Scientific Name
Hedgehog	Krimpvarkie	*Atelerix frontalis*
Chacma Baboon	Kaapse Bobbejaan	*Papio ursinus*
Vervet Monkey	Blouaap	*Cercopithecus pygerythus*
Lesser Bushbaby	Nagapie	*Galago moholi*
Thick-tailed Bushbaby	Bosnagaap	*Otolemur crassicudatus*
Pangolin	Ietermagog	*Manis temminckii*
Scrub Hare	Kolhaas	*Lepus saxatalis*
Jameson's Red Rock Rabbit	Jameson se Rooiklipkonyn	*Pronolagus randensis*
Tree Squirrel	Boomeekhoring	*Paraxerus cepapi*
Springhare	Springhaas	*Pedetes capensis*
Porcupine	Ystervark	*Hystrix africaeaustralis*
Bat-eared Fox	Bakoorvos	*Otocyon megalotis*
Black-backed Jackal	Rooijakkals	*Canis mesomelas*
Cape Clawless Otter	Grootooter	*Aonyx capensis*
Honey Badger	Ratel	*Mellivora capensis*
Striped Polecat	Stinkmuishond	*Ictonyx striatus*
Banded Mongoose	Gebande Muishond	*Mungos mungo*
Slender Mongoose	wartkwas Muishod	*Galerella sanguinea*
Dwarf Mongoose	Dwerg Muishond	*Helogale parvula*
White-tailed Mongoose	Witstertmuishond	*Ichneumia albicauda*
Small-spotted Genet	Kleinkolmuskejaatkat	*Genetta genetta*
Large-spotted Genet	Rooikolmuskejaatkat	*Genetta tigrina*
Civet	Afrikaanse Siwet	*Civettictis civetta*
Spotted Hyaena	Gevlektehiëna	*Crocuta crocuta*
Brown Hyaena	Bruin Hiëna /Strandjut	*Hyaena brunnea*
Aardwolf	Aardwolf	*Proteles cristatus*
African Wildcat	Vaalboskat	*Felis lybica*
Serval	Tierboskat	*Felis serval*
Caracal	Rooikat	*Felis caracal*
Cheetah	Jagluiperd	*Acinonyx jubatus*
Lion	Leeu	*Panthera leo*
Leopard	Luiperd	*Panthera pardus*
Antbear	Erdvark	*Orycteropus afer*
Elephant	Olifant	*Loxodonta africana*
Rock Dassie	Klipdassie	*Procavia capensis*
Burchell's Zebra	Botnkwagga	*Equus burchelli*
White Rhino	Witrenoster	*Ceratotherium simum*

Welgevonden Game Reserve - Large Mammal Species List – Continued…

English Name	Afrikaans Name	Scientific Name
Warthog	Vlakvark	*Phacochoerus aethiopicus*
Bushpig	Bosvark	*Potamochoerus porcus*
Hippopotamus	Seekoei	*Hippopotamus amphibious*
Giraffe	Kameelperd	*Giraffa camelopardalis*
Buffalo	Buffel	*Syncerus caffer*
Eland	Eland	*Taurotragus oryx*
Kudu	Koedoe	*Tragelaphus strepsiceros*
Nyala	Njala	*Tragelaphus angasii*
Bushbuck	Bosbok	*Tragelaphus scriptus*
Roan	Bastergemsbok	*Hippotragus equines*
Gemsbuck	Gemsbok	*Oryx gazelle*
Waterbuck	Waterbok	*Kobus ellipsiprymnus*
Mountain Reedbuck	Rooiribbok	*Redunca fulvorufola*
Common Reedbuck	Rietbok	*Redunca arundinum*
Blue Wildebeest	Blouwildebees	*Connochaetustaurinus*
Red Hartebeest	Rooihartbees	*Alcelaphus buselaphus*
Tsessebe	Tsessebe/Basterhartbees	*Damaliscus lunatus*
Impala	Rooibok	*Aepyceros melampus*
Klipspringer	Klipspringer	*Oreatragus oreotragus*
Steenbuck	Steenbok	*Raphicerus campestris*
Common Duiker	Gewone Duiker	*Sylvicapra grimmia*

Other species lists available for additional reading – please ask the reserve research team for copies:

- Welgevonden Game Reserve - Alien Plant Species List
- Welgevonden Game Reserve - Bird Species List
- Welgevonden Game Reserve - Fish Species List
- Welgevonden Game Reserve - Frog Species List
- Welgevonden Game Reserve - Grass Species List
- Welgevonden Game Reserve - Reptile Species List
- Welgevonden Game Reserve - Tree Species List

Ethical Dilemmas In South Africa and Veterinary Medicine- Part B

Something for the Plane Journey home…. Don't look back at your first notes until you have filled in this section! Below write your thoughts on hunting. What is hunting? Why do people hunt? What kind of animals get hunted? Do you agree with it?

Please write below what you know about Rhino Poaching, why are they poached, how many in south Africa are killed a year? What is the solution to stopping poaching?

Did you know elephant populations are controlled with contraception? Should we be interfering with the hormones and the breeding patterns of wild animals that depend so much on social structure? What are the other options for controlling Elephant populations?