Husbandry Guidelines
For

(Johns 2006)

African Lion
Panthera leo
Class: Mammalia
Felidae

Compiler: Annemarie Hillermann
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Lecturer: Graeme Phipps, Jacki Salkeld, Brad Walker

DISCLAIMER

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OCCUPATIONAL HEALTH AND SAFETY RISKS

Wildlife facilities must adhere to and abide by the policies and procedures of Occupational Health and Safety legislation. A safe and healthy environment must be provided for the animals, visitors and employees at all times within the workplace. All employees must ensure to maintain and be committed to these regulations of OHS within their workplace.

All lions are a ***DANGEROUS/ HIGH RISK*** and have the potential of fatally injuring a person. Precautions must be followed when working with lions. Consider reducing any potential risks or hazards, including;

- Exhibit design considerations – e.g. Ergonomics, Chemical, Physical and Mechanical, Behavioural, Psychological, Communications, Radiation, and Biological requirements.
- EAPA Standards must be followed for exhibit design.
- Barrier considerations – e.g. Mesh used for roofing area, moats, brick or masonry, Solid/strong metal caging, gates with locking systems, air-locks, double barriers, electric fencing, feeding dispensers/drop slots and ensuring a den area is incorporated.
- Locks used – e.g. Quick-acting cam lock, spring-loaded latch and electric shot bolt, warning systems - warning lights attached to den doors. Padlocks used for a lion enclosure are designed with a key that does not allow a person to remove the key unless the padlock is closed.
- Signage used – there must be signage within a dangerous risk animal e.g. hazard ratings, number of animals displayed and their sex, and that only authorized personnel can enter the area.
- Fire hose is readily available to the keepers, turned on at full at the main pipe, where a quick 45 degree turn will enable the water to disperse, in the case of a lion charging at a keeper.

Training of lions; Operant training and conditioning allows keepers to perform their duties more safely and decreases the level of stress in the lion.

Maintenance of keeping lions will differ in many facilities. The following need to be considered;

- The personnel involved and levels of contact – e.g. divisional supervisor, manager/supervising keeper, veterinarians, Curators, and OHS personnel.
- All keepers working with lions carry a radio/emergency device to communicate with colleagues and if entering the enclosure after hours the keepers must radio the switchboard person before entering and when leaving to ensure safe work practices.
- Two keepers, one experienced supervisor and one keeper, must work together to maintain the exhibit, while working within sight of each other at all times. The second keeper is required to double check all doors are secured and locked (all lions are secured away) before entering enclosure.
- Tasks/work procedures involved in maintaining the exhibit – Distance exams recorded daily (DE), daily record sheets, safety procedures, daily equipment checks, regular risk assessments, PPE, manual handling, mechanical use of tools, cleaning, feeding and animal care.
- Health risks - zoonoses/diseases/infections/parasites. Incident report forms must be recorded no matter how minor the injury on the animal or person when a hazard occurs.
- SOP's, safety/emergency procedures (especially escape and recapture procedures – necessary to classify the lion in the safety process "*CODE 1"*) and risk/hazard assessments used in the maintenance of keeping lions.
- Many doors are required within a lion enclosure to ensure escape is not possible; one door cannot open unless the other closed in the dens and air locks.
- Chemicals used in lion enclosures, including MSDS for those chemicals.

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Introduction

The African Lion is a highly noble and highly sociable carnivore. They have a very fascinating appearance due to their large size, colour and muscular body condition. Due to high interest in the species, research, conservation and education, is ongoing. Many documentaries have been produced based on individual research to inform the public of their conservational needs and behavioural studies. For example, *Walking with Lions, Eternal Enemies, Born Free,* and *Big Cat Diaries.* Some people dedicate their lives to investigate and understand the behavioural aspects of the lion. In Africa, many conservational programs have been developed in order to boost populations in the wild due to poachers and hunters shooting this magnificent creature simply for money and power. Although the lion is not directly vulnerable to extinction, the lion is classified as a threatened species. Currently breeding programs within the region are not in high demand. Many captive institutions acquire numbers from institutions removing them from their animal collection. Most institutions are simply maintaining numbers, however, with current generations aging there is potential for breeding this species in the future to maintain a varied genetic pool within the region.

ASMP Category

ASMP Carnivore TAG, Population Management Plan, Management Level 1a

IUCN Category

IUCN: Vulnerable Status, CITIES: II, VPC: S

EA Category

The *Panthera leo* is categorised as threatened in terms of section 56(1) of the National Environmental Management: Biodiversity Act, 2004

NZ and PNG Categories and Legislation

According to the New Zealand Legislation the *Panthera leo* is part of schedule 2 category being a threatened by trade species (subspecies Asiatic Lion is under schedule 1 category of endangered by trade species). Only with consent through CITIES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) can species in schedule 2 be traded.

(Parliamentary Counsel Office, 2008)

The *Panthera leo* is also listed in Appendix II (threatened) in Papua New Guinea legislation.

Wild Population Management

Currently no management plan, as the species is not categorised as endangered.

Species Coordinator

Holly Colahan, HOUSTON, hcolahan@houstonzoo.org

Studbook Holder

Sue Pfaff, COLUMBIA, suepfaff@riverbanks.org

Taxonomy

Nomenclature

Class Mammalia
Order Carnivora
Family Felidae
Genus *Panthera*
Species *leo*

Subspecies

Panthera leo persica (Asiatic lion) – endangered (approximately only 300 left in the wild)
Panthera leo leo/ Panthera leo berberisca (Barbary lion) – Wild population extinct and only captive populations left.
Panthera leo azandica (North East Congo lion)
Panthera leo somaliensis (Somali lion)
Panthera leo massaicus (Serengeti and Masai lion)
Panthera leo hollisteri (Congo lion)
Panthera leo bleyenberghi (Katanga/Southwest African lion)
Panthera leo roosevelti (Abyssinian lion)
Panthera leo bleyenberghi (Katanga lion)
Panthera leo krugeri (South African/Southeast African lion of which the White lion is a colour variant)
Panthera leo nubica (Ethiopian/Nubian/East African lion)
Panthera leo senegalensis (Senegal/West African lion)
Panthera leo melanochaita (Cape lion) – became extinct around 1860.
Panthera leo verneyi (Kalahari lion)

(Klappenbach, 2008) & (Harrington, 2008)

Recent Synonyms

Alternate classification –

Suborder: Feliformia
Sub-family: Pantherinae
Genus Species: *Panthera leo*
Subspecies: *Panthera leo krugeri, Panthera leo nubica, Panthera leo senegalensis* (African Lions)

Other Common Names

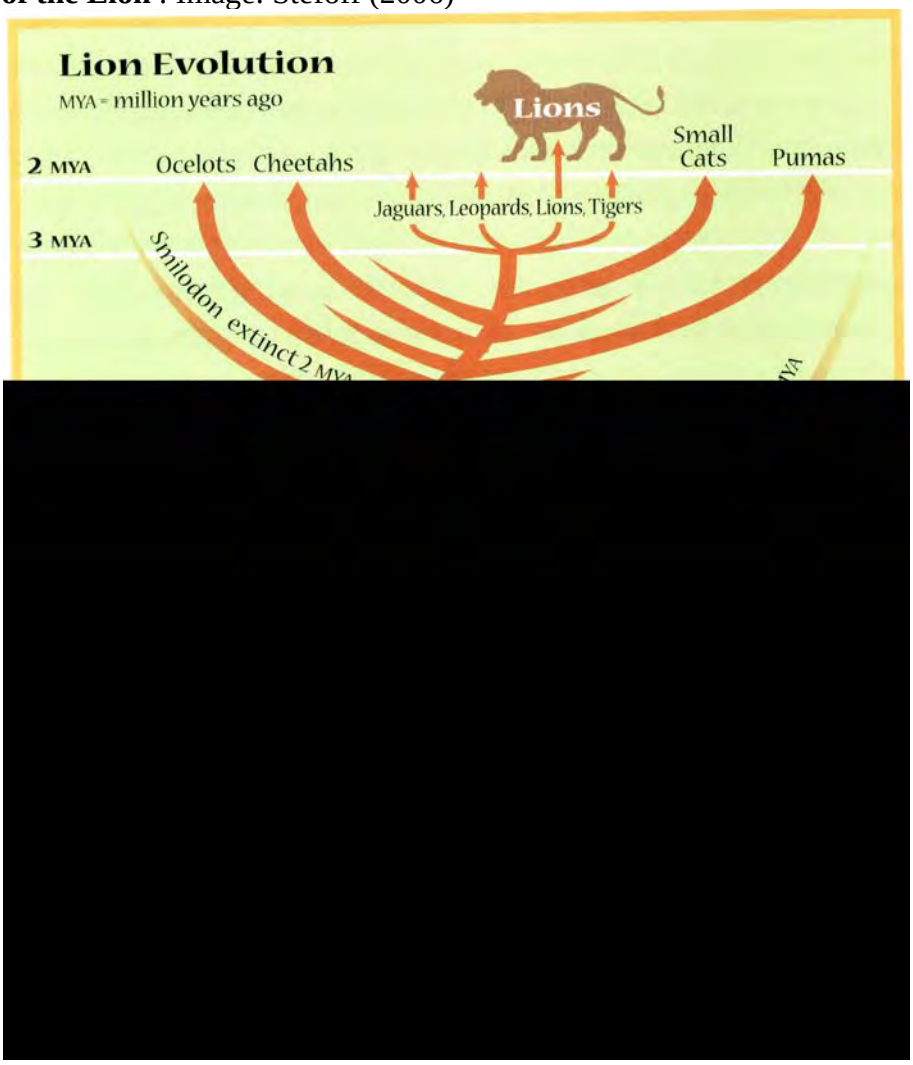
- African Black Maned Lion (for male)
- African Lioness (for female)
- Cape Lion

Natural History

History and Origin:
Lions have been known for their strength, ferocious appearance, dominating power and extraordinary locomotion for many years. However, lions were also categorised as noble or royal in their presence, hence why many people called them the 'king of the beasts.' Egyptians saw the lioness as a goddess, which they worshiped, resulting in the structure of the sphinx (a lion's body with a human head).
Sightings of a lion transposed into art through paintings, carvings, and sketches. In the Roman times, lions were used as a form of entertainment, where a person was made to fight against a lion in an arena, where only one would be able to walk out alive.
It was been as a sign of strength and power if a person hunted and successfully killed a lion many years ago. However, even in the modern times of the 21st century people are still hunting, killing, skinning and hanging the skin of the lion on display within Africa. People have even been known to pay large amounts of money to do this, as it is still not illegal within Africa to breed, hunt and kill lions for these purposes.
In ancient times, it was believed that the sound of thunder is the sound of a lion's roar. From this theory, the ancient Sumerians, Assyrians, and Babylonians believed that the symbol of an eagle with a lions head was the god of rain, storms, and fertility.
Even the Chinese employed traditional ceremonies and dances that represented the lion's impression. In more current times, lions have made a massive impact on the world. Significant figures of the lion have been transposed into movies such as the Narnia series, the Wizard of Oz, Born Free (also a novel) and the Lion King. Many documentaries and vast research on these amazing animals have been produced and gains a greater insight to the life of a lion.

Image: Steffof (2006)

Evolution of the Lion : Image: Stefoff (2006)



Interesting wild facts for keepers:

1. When new dominant males take over a pride, they kill all the young cubs, known as *infanticide*. The reason for this is that within two to three years the cubs will chase away the new dominant males and they will lose the females. Instead they kill the young cubs, so that they can have cubs of their own. A female with young cubs will not have another litter for usually two years as they are devoted to their upbringing, however, if those cubs are killed when a new male takes over they are able to have cubs again in 5 months, (Brett, 1990).

2. In the wild, it is the females' job to hunt for food and is often done in large groups, (Morgan, 2002).

3. Lions are the only family orientated Big Cat where they will stay with their pride for their whole life.

Myths (Bocknek, 2002)**:**

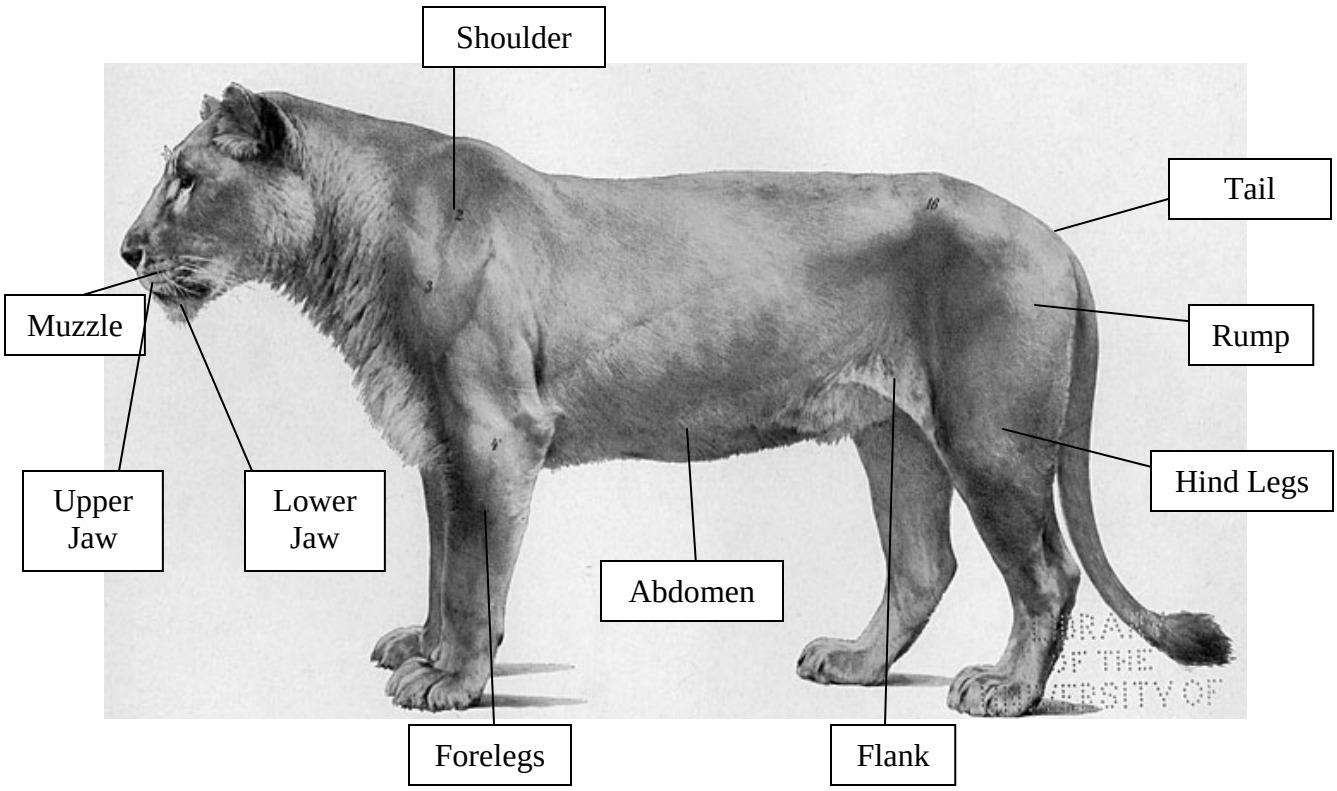
1. *Lions cannot climb trees* – Lions climb trees on a regular basis, mainly for play, resting spots, and escape from danger. They can climb as high as 7 metres from the ground.
In Africa, some tribes believe that when important people die they are reborn as lions, (Morgan, 2002).

2. *Lions hunt people for food* – Lions rarely hunt and kill people. Lions will only resort to eating people when they are old, disabled, or starving.

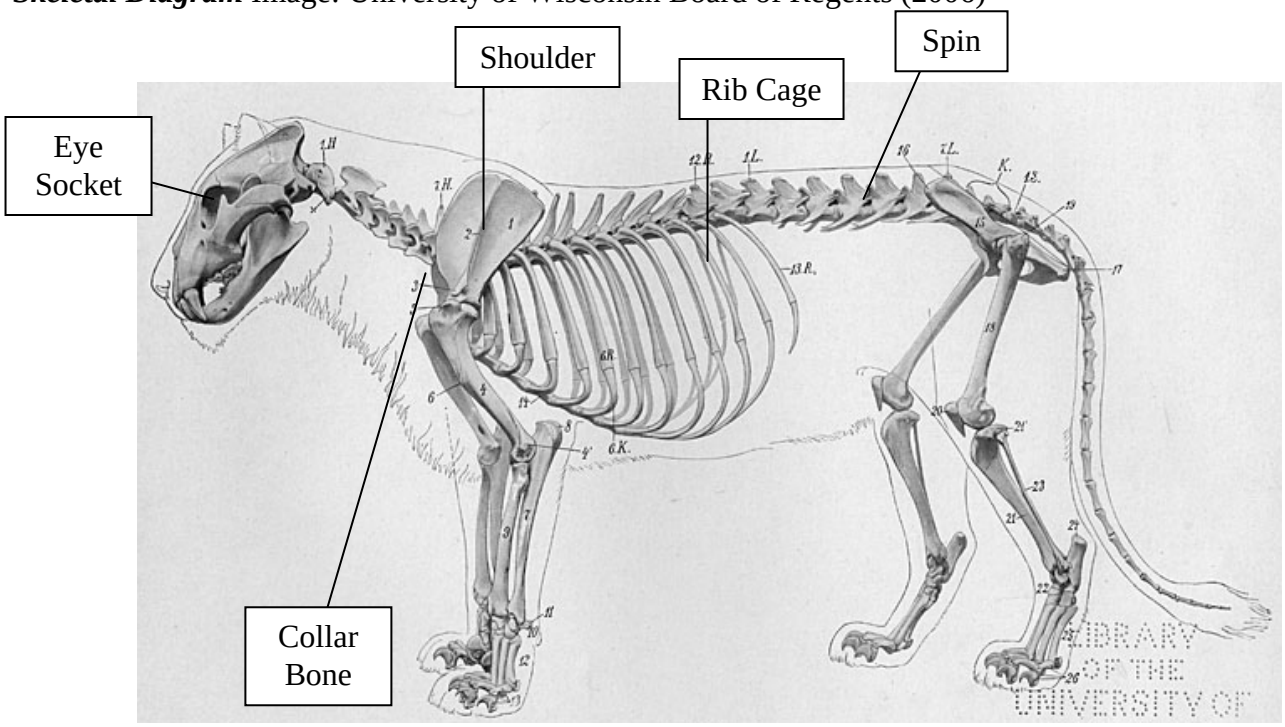
Morphometrics

Mass And Basic Body Measurements

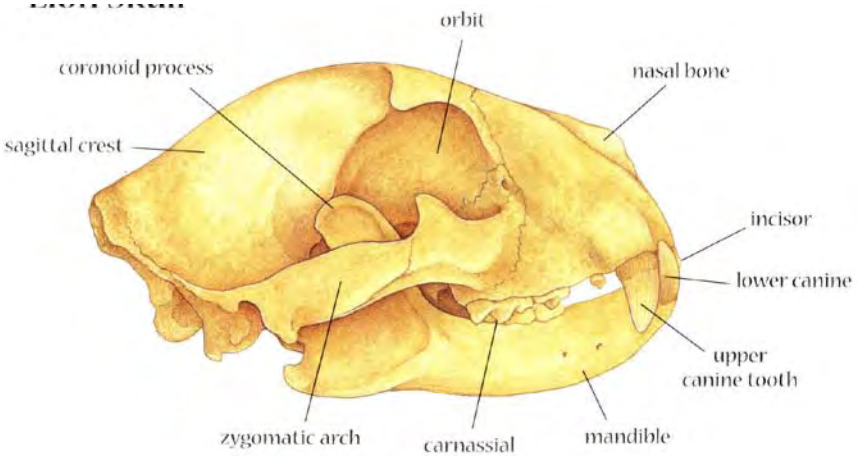
Body Diagram Image: University of Wisconsin Board of Regents (2006)

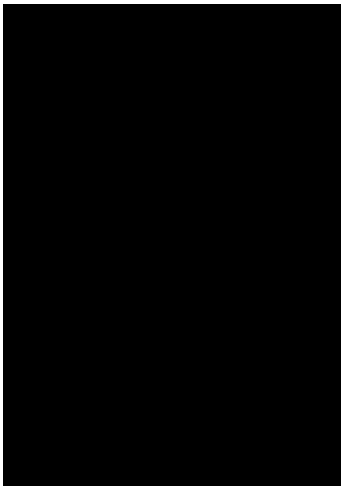


Skeletal Diagram Image: University of Wisconsin Board of Regents (2006)



Images Below: Left (Stefoff, 2006) and right (Bocknek, 2002)





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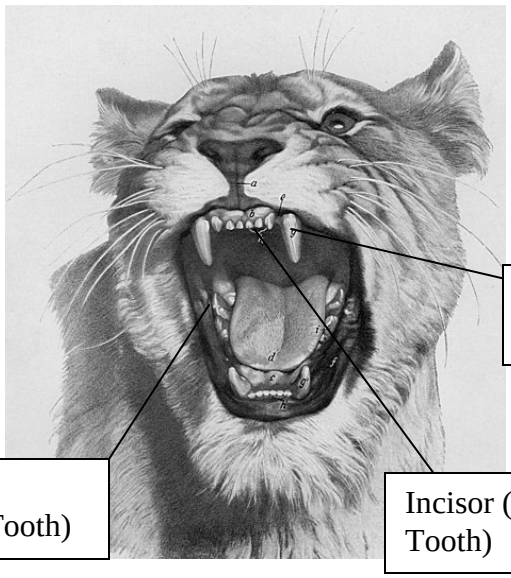
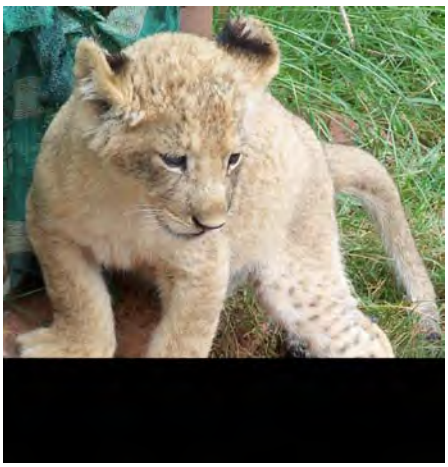


African Lion Cubs with pale brown spots
Images below: Annemarie Hillermann (2006)



Sexual Dimorphism

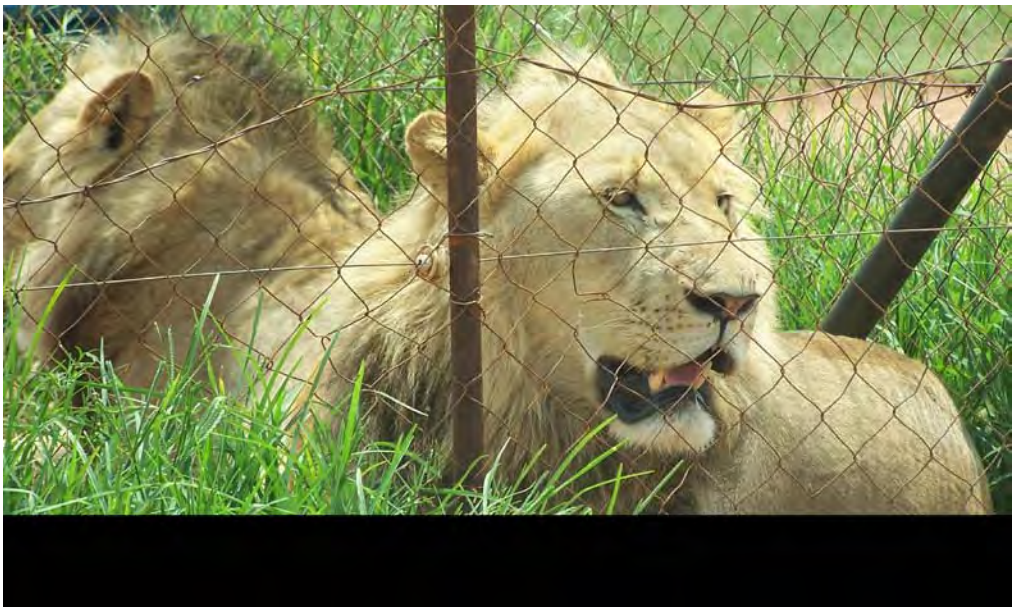
African Lions are sexually dimorphic, as males have a mane of hair framing their face, whereas females do not, (Klappenbach, 2008). Males are significantly larger than the female lion.

Size –

Male: 1.2m height and 2.4 - 3.3m in length
Female: 1.1 height and average 2.4m in length

Weight –

Male: average of 150 - 270 kg
Female: average of 120 - 180kg



African Lion male – the development of the mane displays that the lion is not yet full grown.
Image above: Annemarie Hillermann (2006)

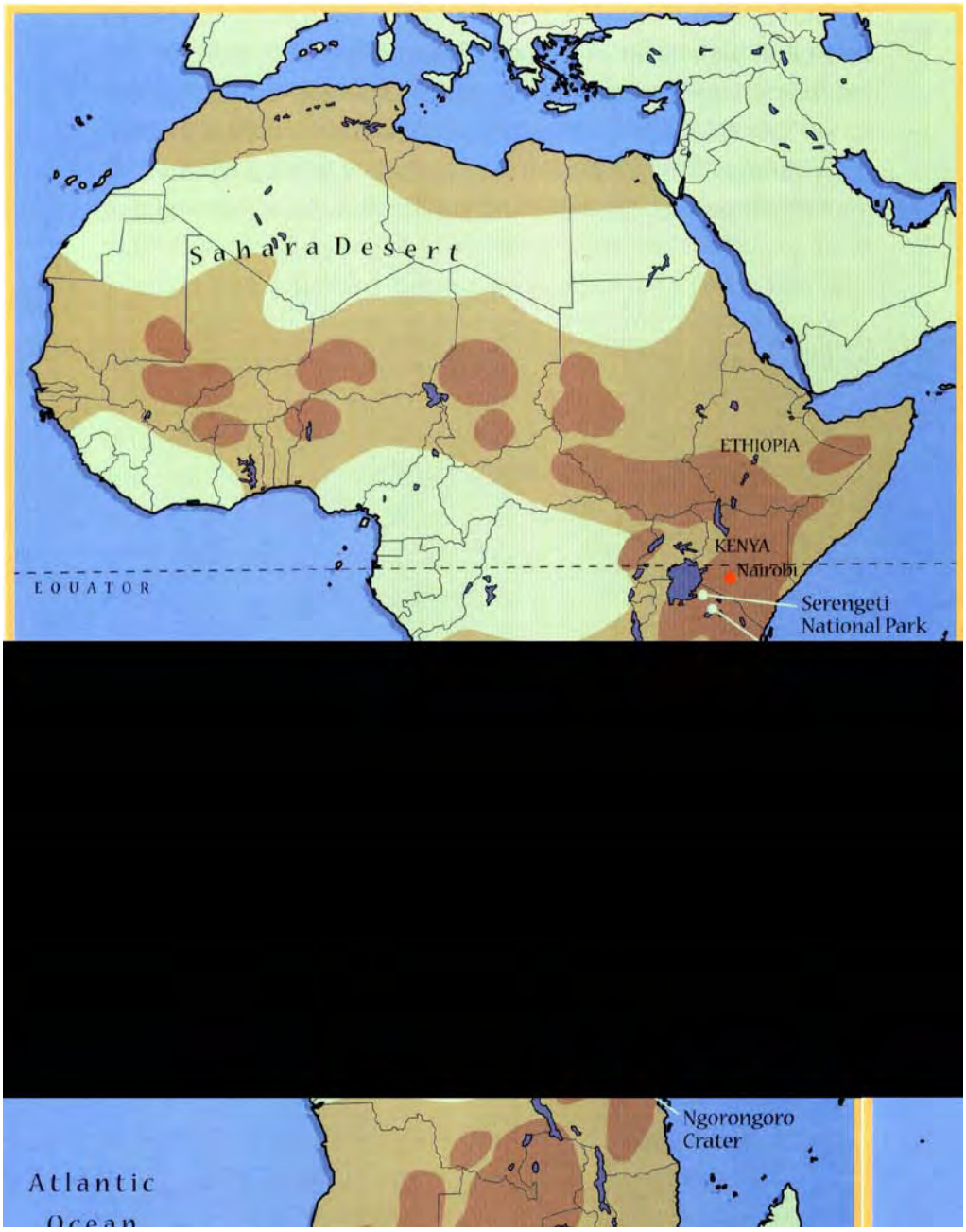
African Lioness (female lion)
Image above: Annemarie Hillermann (2006)

Distinguishing Features

The African Lion range in colour from pale tan to tawny/golden yellow to a brown; the male lion has a darker, even known as black mane, which many people believe to be more appealing to the lioness. Lions are the only big cat that has a mane. The fur on their stomach is light in colour (near white) or white. Cubs have pale spots on their body, which they eventually fade with age. A lion's mouth contains thirty powerful teeth, including four canine teeth, used to hold and kill prey, back teeth called carnassials used to slice flesh and very small teeth at the front. Lions do not have teeth to chew food; however, the tongue has rough hook-like structures to help break meat away from bones, (Bocknek, 2002).

Distribution and Habitat

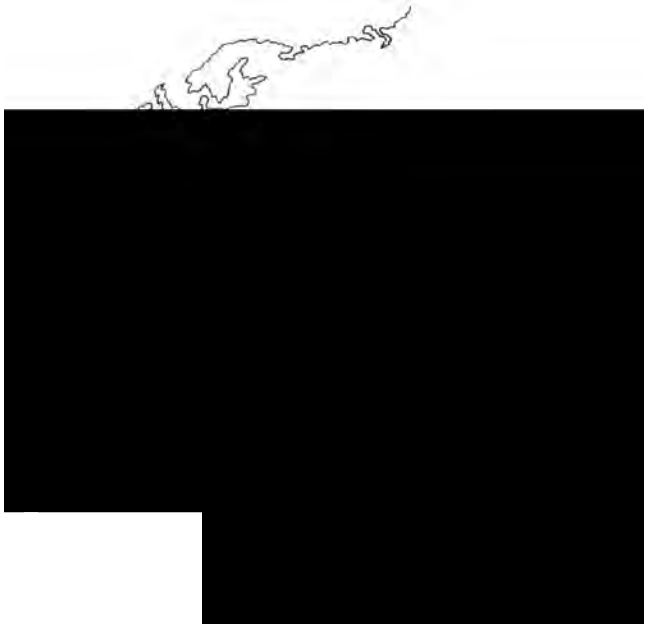
Distribution Map: Image: Stefoff (2006)



African Lion and Lioness
Image above: Harnas Wildlife Foundation (2008)

Worldwide Distribution:
Lions have a vast distribution across the world, mainly throughout Africa, Asia, and India. Lions have also previously been found, through fossilised evidence, to roam Southern Europe, Greece, China, North America and the Middle East. By the end of the last century lions had become extinct everywhere except in India and Africa.

Image:Brett (1990)



Habitat:
Wild habitat:
Lions can survive in a variety of different environments, such as grasslands and open forest areas. The area needs to have a constant supply of water, abundant food available, and suitable coverage for stalking prey.

Captive Habitat:
The Exhibited Animal Protection Act (EAPA, 1986), have developed particular standards that must be upheld for the keeping and maintenance of carnivores. To access the standards for exhibiting carnivores in New South Wales, please visit the website

below: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0015/121542/carnivore-exhibition-standard.pdf

Territory:
A lion's roar can be heard for 8km. This is used to not only communicate between members of the pride, but also to claim and identify/patrol their territory to outsiders. Lions patrol the exterior perimeters of their territory and mark their territory by urinating at significant intervals on bushes or boulders. A pride can range from approximately 20 to 400 sq km. (Stefoff, 2006)

Seasonal Variations:
Lions will remain in the same location for the most of their lives, after they have claimed their territory and pride. This poses to be very beneficial when hunting for food, as migratory animals, such as wildebeest and zebra, require passing through their territory seasonally. (Stefoff, 2006)

Enrichment Techniques: (Durrell Wildlife Conservation Trust, 1999)
Enrichment techniques should involve the following behaviours - Foraging, Play, Climbing, Locomotion on ground, Exploratory behaviour, Anti-Predator Behaviour. Exhibit enrichment includes:

1. Frozen balls of ice containing fish. (Powell, 1995)
2. Adding various scents within the enclosure. (Powell, 1995)
3. Hanging logs/branches. (Powell, 1995)
4. Bones or tails placed around enclosure.
5. Frozen blood.
6. Live prey/live insects.
7. Swinging feeder.
8. Manipulable objects – boxes, bark, hay grasses, skin from other animals.
9. Furniture.
10. Tug of war.
11. Chewing items.
12. Hammocks, trees, branches, platforms and ropes.

(please see Section 9.7 for more Enrichment techniques)

Conservation Status

According to the IUCN Status the African Lion is classified as Vulnerable.

Longevity

In the Wild

Maximum: 18 years
Average: 14 years

Females are known to live longer than male lion in the wild, as they usually stay with the family/pride.

In Captivity

Maximum: 30 years
Average: 13 years

Techniques Used to Determine Age in Adults

Bone proportions indicate the age of an African Lion. Another accurate estimation of determining an age of an African Lion is through examining their teeth. For male lions, one can estimate an age of the lion based on the development of their mane, however this cannot be 100% accurate and cannot be used for females. Other forms of ID at institutions could be taken from existing records of individuals.

Images below: Predator Conservation Trust (n.d.);

A young lion with his milk teeth

A one year old lion with his adult teeth in place, but not yet fully developed

A lion in prime condition/large adult teeth

A lion that is past its prime, and the teeth are clearly worn down.

Housing Requirements

Exhibit/Enclosure Design

Principles

- Ensure only non-toxic plants are used within the exhibit (see *Appendix A*). Try to only use native species, it becomes much easier to maintain and have access to in future. Create different arrangements of plants within the exhibit, e.g. instead of cutting herbs and placing them around the exhibit, make a hanging herb garden that can be removed and hung in keeper areas if not in use. This prevents wastage.
- Secure all furniture objects to avoid injury or death of an individual.
- Use lots of climbing structures (different textures)
- You will often see Lions sunning or lying on rock structures in Africa, utilise natural surroundings on exhibit.
- Ensure EAPA standards are being met and exceeded in basic enclosure design, e.g. size, number of individuals, behavioural habits considered, and levels of risk eliminated.
- The moat does not need to be water based; some institutions used empty/dirt moats for their exhibits. If using water ensure the levels are always kept to standard.
- Provide environmental, social and behavioural enrichment regularly.
- Rotate furniture or enrichment items regularly in order to maintain interest.
- Remove litter and keep viewing areas clean to maintain aesthetics to public.
- Create different levels for the lions, not only will it provide enrichment for them but it will look appealing to the public.
- Create a barrier from the public to the exhibit, either by placing a fence 1.5m (at least) from the moat edge or from the fence line. Design a natural appearing viewing area to enhance the experience and envelop the public into their surroundings and environment.
- Ensure freedom to run and play, provide an area for free roaming as the lions please.
- Ensure construction of Off-exhibit areas, exhibit, maintenance, servicing and keeper areas are designed to be keeper, OH&S and animal friendly (safe and ergonomic).
- Provide water, shade, shelter, and various feeding strategies.
- Ensure safe locking, double gate, air lock areas in case an animal escapes. Make sure a hose reel is kept close to exit and entry gates as a safety precaution.
- Restraint facilities, crushes anaesthetic cages should be incorporated into the housing design for capture and restraint purposes.
- Signs must be used around the exhibit public viewing areas and also in keeper access areas.
- Equipment should be easily accessible for staff.
- Perimeter electric fencing is recommended for lion enclosures.

Precautions

- Monitor tree growth along the fence line. This can become an escape risk if not maintained, either by climbing over or creating holes in the fence.
- Complete integrity checks of the exhibit daily in order to check fence line, moat levels are safe, entry of pests, or OH&S risks.

- Use natural materials only on exhibit, e.g. no ropes made of plastics.
- Ensure security of furniture, enrichment items and exhibit interiors.
- Ensure there are no dead ends or blind spots that prevents easy viewing of animal/s (lions must always be visible to keepers).
- Ensure signs are clear and straight forward.
- Ensure a secure locking system.

Holding Area Design

According to the EAPA standards (NSW Department of Primary Industries 1995):

- Denning facilities must be provided so that individuals can be denned separately.
- Dens must be water proof and maintained dry at all times.
- Animals held off-exhibit (not including short term holding yards) for periods up to 90 days (medium term holding enclosure) must be held in enclosures that have a surface area no smaller than that indicated for the species by the bracketed figure in the second column of Table 2. Animals held off exhibit for periods greater than 90 days must be held in enclosures that meet exhibit size area requirements as outlined in Table 2 below.

Image: Zoo Atlanta (1990)

The lion holding building provides for maximum visibility for both the keepers as well as the animals. A clearly marked, colour-coded numbering system facilitates animal safety issues.

(Zoo Atlanta 1990)

Western Plains Zoo Lion Dens

Image: Bailey (2004)

Image: Zoo Atlanta (1990)

Enrichment inside Dens – As lions spend up to 15 hours within the den each night and lions are nocturnal animals, it is highly important to maintain the natural behaviour and keep them active at night. Permanent scratching logs are chained vertically within dens to a wire mesh wall, scented tyres and sacks are brought in periodically, beer kegs are chained to walls as a swinging toy, a thick knotted rope through mesh wall as a tug of war game with keepers, plastic sonar tubes are hung or left free to be rolled around dens, and branches and foliage are placed into dens to promote scenting. Items are changed regularly to avoid boredom. (Noonan 1998)

Table 1: Number of Dens per Lion and Size of Den/Holding Yard at Zoos within Australia, New Zealand and Internationally

Region	< 1 den per cat	1 den per cat	> 1 den per cat	Den sizes (sq.m)	Holding Yard sizes (sq.m)
International	-	45%	55%	2-56	27
Australia	17%	23%	60%	10-81	19-560
New Zealand	-	-	100%	9-24	36-100

Researched at Taronga Zoo - (Ginman 2008)

According to Simone Keenan (pers. comm. Western Plains Zoo 2008) concrete holding yards are connected to grass yards with old boxes or small crates for lions to sleep in. Ropes, balls and other enrichment items secured to the yards fences to keep them entertained. The exhibit is also much bigger than the holding yards. (see table below for minimum size requirements).

Spatial Requirements

According to the EAPA standards (NSW Department of Primary Industries 1995):

- The shape and size of the enclosure must provide freedom to move both vertically and horizontally.

Table 2: EAPA Spacial Requirements for Lions

NAME	SURF. AREA (SQ.M)	MAX. NO. ANIMALS FOR ENCLOS. SIZE	ADDIT. AREA FOR EACH EXTRA ANIMAL IN EXHIBIT (m^2)	ADDITION. AREA FOR EACH EXTRA ANIMAL IN MEDIUM TERM HOLDING YARD (m^2)	HEIGHTABOVE WATER OF WALL ADJOIN. MOAT (M)	MOAT WIDTH (M)
Lion *Panthera leo*	300(30)	2	20	15	1.8	8

MOAT DEPTH (M)	SMOOTH FACED UNCLIM-BABLE WALL (M)	MESH FENCE HEIGHT (M)	WIRE MESH DIA. (MM)	MESH SPAC. (MM)	DEPTH OF INHANG (M)	INHANG (Degrees above horiz)
1.8	-	4.5	5	75 x 50	1.0	45

Table 3: Carnivore Biology and Exhibit Guidelines

Species	Social group	Peak Activity	Level	Mesh o/hang needed	Roof needed	Wire under substrate	Solid walls advised	Piano wire permissible	Glass front permissible	Moat	Water feature advised
Lion *Panthera leo*	G	C/N	T	Yes	-	S	-	-	Yes	-	-

Table 1 - Abbreviations used in the table are:-
Social Group - S = solitary G = group/family P = bonded pairs
Peak Activity - C = crepuscular N = nocturnal D = diurnal / = denotes a combination of active periods
Activity Level - T = terrestrial A = arboreal Aq = aquatic B = Burrows / = denotes a combination of levels
Wire Under Substrate - Pe = perimeter[1] S = sink into ground[2] E = entire floor area must be lined with subterranean wire
1 – Perimeter means the wire needs to only go across the surface of the ground at least 1m around the perimeter.
2 – Perimeter means the wire needs to only go into the ground at least 1m around the perimeter.

(NSW Department of Primary Industries 1995)

Position of Enclosures

There is not a specific position the enclosure should face. Zoo's differ in the direction they face their enclosures from Australia and Internationally. Lions have acclimatised to withstand extreme temperatures and enjoy the sun. However, must have access to shelter in hot temperatures and in rainy seasons under trees or rock ridges.

Weather Protection

The enclosure does not need to be completely closed for the African Lion. It can be semi-open, with a sheltered area, or it can be an open plan, with an in-hang shelter one metre deep and 45 degrees above horizontal surface/wall, (please see table 2 above).

Temperature Requirements

Lions do not have heating requirements and live in semi open or open enclosures. If they want to heat themselves, lions will huddle together in the pride for body heat to transfer; however, this is very rare that they cannot withstand temperatures. Some den enclosures at zoos worldwide contain under-floor heating. However, it is not necessary to have any heating within the enclosure.

Substrate

The majority of lion exhibit enclosures simply have soil, grass, rock structures (fake or real) and even concrete in particular locations. Wire needs to be placed one metre around the perimeter under the substrate for extra security. Keepers may wish to vary the substrate in various areas of the enclosure for enrichment on occasion, e.g. add sand into enclosure, form termite mounds, long grasses, and leaf matter.
Majority of holding yards/off-exhibit enclosures have concreted surfaces, a smaller portion had grass or a

combination of both. 93% of den systems had concreting flooring, some with under-floor heating. 7% used timber or tiled floors in dens. (Ginman 2008)

Nestboxes and/or Bedding Material

Lions often have benches or nest boxes with bedding or a combination of benches and hay/straw. Bedding is usually made of straw or hay, as it insulates the area and allowing a soft area for resting. Lions normally sleep in their den facilities separately where it is completely dry, sheltered and securely contained. However, if highly secure, lions do sleep in the main enclosure in some parks/sanctuaries around the world, where a large container/sheltered facility is provided with either straw or long grasses used as bedding. (Noonan 1998)

It is ideal for lions to have two dens per cat, please see table 1.

Enclosure Furnishings

According to the EAPA standards (1986):

- Sight barriers must be provided so that animals have an opportunity to remove themselves from visual contact.
- All carnivore enclosures must contain a bathing pond or container of sufficient diameter and depth to allow normal bathing behaviour. All bathing containers must have a non-slip surface with no sharp edges, filled with clean drinkable water and if container is not cleaned daily, there must be a second clean water trough.
- All enclosures and holding areas must include scratching posts, climbing structures and logs.
- There must be an area where carnivores can bask in the sun.
- There must be structures within the enclosure for carnivores to hide, climb, and escape aggressive behaviour.

Lion enclosures should contain large rocks, logs, termite mounds and long grasses in particular areas, as enrichment.
Researched behavioural enrichment furniture and materials (from Auckland Zoo) (also see *Section 9.7*) include:

- Used primate Hessian sacks or a tyre – after primates have finished with the sacks it leaves a strong scent. The sack/tyre is attached by a chain to a tree or support plank. Lions need to be observed with this added furniture as they can get teeth or claws caught in the sack on occasion and therefore, should only be an occasional enrichment technique. Their response to the sack, however, was extremely positive and promoted natural characteristics such as vocalisations, tearing, guarding, playing, stalking, and working together.
- Plastic balls – approximately 20cm in diameter and 2cm thickness with a hollow centre is thrown into the enclosure from outside. This material provides lions with continuous enrichment.
- Scratching log – a large bark log chained vertically to the branch of a tree. Not only does it provide enrichment to lions, however, it deters them from stripping the bark of the existing trees within the enclosure. It encourages clawing, biting, scratching, and chewing.
- Animal faeces – After collecting fresh faeces from other animals, including elephant, zebra and rhinoceros, it is placed around lion enclosure. Lions responded positively sniffing, tracking, rolling and even eating the faeces.
- Hiding pieces of meat and bone – Rub meat or bone on ground rocks, trees to create a scent track for lions to follow. (Noonan 1998)

General Husbandry

Hygiene and Cleaning

Majority of zoos clean and did exhibit maintenance in the morning – 68% international, 75% Australian, and 75% New Zealand zoos.

(Ginman 2008)

Cleaning and Hygiene of Housing Schedule – see *Appendix B* (Annual Cycle of Maintenance).

Cleaning agents to be used for enclosure maintenance include:

- F10 (see MSDS attached – *Appendix C*) – an effective bacterial and microbial killing disinfectant used for hard surfaces, equipment and air spaces, but harmless to both humans and animals.
- Bleach (see MSDS attached – *Appendix D*) – effective in killing bacteria and microbial bodies, however, can be corrosive and cause irritation if not diluted correctly.
- MediClean Aqua (*Appendix E*) – Cleans and disinfects waking drinking systems.
- Medidyne 35 (mainly used for agrilculture) – a disinfectant and detergent sanitiser for animal use. It is effective against various pathogens and has a colour indicator test when product becomes ineffective. Safe to use on water drinking systems.

A combination of these products may be useful, e.g. using diluted F10/Bleach for maintenance cleaning and then using the Aqua MediClean for the water troughs.

NOTE: **DO NOT** use strong scented disinfectants as it can cause discomfort and sickness is some animals, especially non domestic cats.

Record Keeping

Health Problems: *Daily records should be kept through Distance Exams (DE) and observation. If the problem is more critical, then the lion should be examined more closely by veterinary practices.*
According to Bocknek (2002), lions had in the past contracted a disease that was found to be a form of canine distemper, which caused convulsions, seizures and a painful death for lions. It had been passed on to lions from hyenas that had come into contact with dogs outside the zoos.
Parasites, such as ticks, can be an extreme problem for the lion as it is one of the common reasons for death.
Other health problems that have been detected in African Lions are:

- Gastric spiral bacteria are a common problem with the African Lions in Namibia.
- Zoonoses
- Feline Leukaemia virus
- Feline Parvovirus (wild)
- Feline Calicivirus (wild)
- Feline Herpesvirus (wild)
- Feline Coronavirus (wild)
- Feline Immunodeficiency virus, FIV (Feline HIV)
- Lymphoma
- Pneumonia
- Neutropenia

- Thrombocytopenia

Veterinary examinations with Treatments Provided: *Yearly veterinary examinations should be performed on an African Lion, however, more regular if treatment is required.*
E.g. Promoting canine distemper vaccinations for any dogs in the vicinity of a zoo or wildlife park/reserve.

Behavioural Problems and Observations: *Daily records should be kept when a behavioural problem is observed. However, positive behavioural changes should be recorded as well.*
Working procedures must be updated regularly on any physical contact or close encounters with the lions and the keeper to ensure that safety procedures are being followed and addressed. Safety classifications need to be addressed when animal management plans have changed or there were alterations to the exhibit and the behaviour of the lion has changed. Any noticeable behavioural changes occurring with enrichment activities should also be recorded.

Reproductive Stage, Condition and Behaviour: *Daily records should be kept of reproductive stage, condition and behaviour. E.g Information on positive behaviour and abnormal behaviour, general condition of the animal (e.g. overweight or underweight, wounds, lameness, discharge etc), and courtship, ovulation and gestation information (e.g. signs of ovulation/oestrus, witnessed matings, births, rearing, weaning, weights etc) should all be significant information to record. As the cubs grow older the records can gradually be taken weekly, fortnightly, monthly and then yearly.*

Changes in Diet: *Changes in diet need to be recorded as soon as the change has been made. If it is a daily change it must be signed and recorded by the keeper. However, an African Lion will not require much of a variation in diet, except for providing multi- vitamin and mineral tablets or calcium powder added to meat. Diets may change during breeding season as an increase will be necessary when cubs are born and a gradual decrease afterwards. Other information to record about diet changes would be for age related purposes. Often captive environments will have diet change forms which will need to be passed by supervisors, veterinary officers, managers and directors.*

Movements within and between Institutions: *An ISIS record should be taken when an animal is moved within or between institutions. Necessary codes must be used to record movements, e.g. ACQ or DIS. Ensure any other necessary information or comments are recorded about the movement.*
Conditioning of a lion assists in the movement process. If a lion has been conditioned the stress levels of the animal decrease and therefore, make the situation more controllable and safe for the keeper and animal. If an individual is conditioned effectively, they may not require a tranquiliser injection (immobilisation) to be placed into a cart for transport purposes and are generally only injected when in the container to reduce stress on the animal. Safety management classifications need to be addressed and recorded when a new lion enters the exhibit.

Weights and Measurements: *An African Lion should have their weight and measurements recorded on a monthly basis at minimum. Therefore, any variations in weight can be maintained and also gives an insight into whether the animal is healthy or unhealthy (general condition) and requires specific attention or diet change.*

Methods of Identification

Injectable Microchips:
Microchips on mammals are interscapular; placed on the upper back between the shoulder blades. Other forms of identification are the colour and development of the mane in males or colour of the coat for both females and males. A keeper may be able to identify individuals through markings on the coat, such as the development of the pale brown spots for younger individuals. Markings on the face can be an identifying feature, such as the black rim around the eyes, nose and mouth, or the white markings on their stomach, under the eyes, and on the chin. These markings will vary between individuals.
According to Bocknek (2002) identifying individual lions can be done through their features, e.g.:

1. Teeth may be discoloured, missing, or chipped.
2. Ears may have slivers or chunks missing from other lion's claws damaging the ear of the lion through play, or fights over food.
3. Scars or cuts on the nose of the lion and other parts of the body.
4. Whisker spots on the lions face are similar to a humans fingerprint. They hold a distinctive individual pattern that is visible for their entire life.

Routine Data Collection

Routine facael, urine and blood analysis. All breeding information and general condition information should be continually collected and recorded.

On – going research:
Research on lions is completed for many reasons, including:-

1. Prevention of diseases – e.g. canine distemper deaths.
2. Tracking movements of lions and understanding their nature.
3. Documentaries on lions for community and public awareness.
4. Studies on enrichment techniques and the change in behaviour in captive African Lions.
5. Reproductive and breeding research.
6. Behavioural studies (ethograms).

Feeding Requirements

Diet in the Wild

Lions are known as obligate carnivores (true carnivores). In the wild, female lions need approximately 5kg of meat per day and male lions need approximately 7kg per day to survive and have the capability to eat up to 35kg (this is very rare). They prefer to prey upon medium to large sized ungulates such as wildebeest, zebra, buffalo, impala, however, also prey on baby elephant or rhino, rodents, porcupine, tortoises, hippos, crocodiles, and warthog. When there is a short supply of food, lions will feast on snakes, birds, fish, fruit, insects, or even ostrich eggs.

(Bocknek 2002) and (Brett 1990)

Lions are opportunistic and will attempt to catch any animal available at that moment in time. Lioness are the primary hunters and work as a team, each with an individual role, once a kill has been made, the lioness will roar to signal the male lions of the kill (which can be heard approximately 8km away). Lions will attempt to chase off (lions can run up to 57 km/hour) any other carnivore, especially hyenas, from their kill.

(Predator Conservation Trust n.d.)

Felids do not have the same metabolic flexibility as facultative carnivores and require high levels of animal protein, with a limited ability to conserve nitrogen when diet levels are low. Adult lions must consume at least 25% of the dry weight of the diet protein. Amino acids methoinine, taurine and arginine must be added to their captive diets as felids have difficulty synthesising these particular amino acids (deficiencies may form if neglected). Animal fats, such as polyunsaturated fatty acid and arachidonic acid, are essential and vitamin A is necessary for all felids (found in animal tissue especially in liver). However, ensure vitamin A is only provided on the occasion, as excessive amounts can lead to problems and abnormalities (limb and spinal). Feeding whole prey items can prevent deficiencies in any of these essential diet requirements. If the diet is primarily muscle meat, vitamin and mineral supplements should be provided.

(Taronga Conservation Society Australia 2009)

Image: Go2Africa Pty Ltd (2007)

Captive Diet

In Australia captive diets for the lion include:

Variety of Food	***Frequency***	***Quantity per Animal***
Kangaroo, Beef, Goat, Sheep, Emu, Horse, Deer, Chicken	One variety 5 times a week	Approximately 4.5 - 6kg (amount is usually weighed out for individual animals according to body weight and condition – check with veterinary officer)

(Roe & Cleave 2007)

Taronga Western Plains Zoo feed their lion's kangaroo, horse, beef and chicken carcass and also provide enrichment once a month with liver.

In captivity lion's expend less energy than in the wild and will therefore, require less consumption of meat. It is recommended to allow veterinary officers to assess the animal's body condition and individual requirements in order to compile accurate individual diets.

To avoid obesity in animals, the energy intake must equal the meat amount per day, for example, 5kg per day with 2 starve days = 25kg per week and 3kg per day with no starve days = 21kg. Therefore, it is not essential to include starve days in order for the lions to maintain in good condition; it is the amount of feed given per week in relation to energy usage. African Lions only have a successful capture percentage of approximately 20-30% when hunting and are rarely successful on every attempt.

(Ginman 2008)

Food quantity is changed seasonally, as energy demands vary depending on the season, for example energy demands are higher during cold seasons and lower during warm seasons. Diets also vary when breeding, as energy requirements increase when pregnant and during lactation (talk to veterinary officers to propose accurate individual increase). Diets will also vary due to old age. Therefore, decrease the diet by 500grams in seasonal variations, for example, 5kg in winter and 4.5kg in summer. A survey displayed that 87% of diets varied seasonally, daily or as needed. And only 13% of diets were not varied at all.

(Ginman 2008)

Obesity is caused by:

- Overfeeding – cat is given and taking in more energy than used per day.
- Group feeding – large carcasses are fed to reduce competition aggression and ensure everyone gets their share. However, hierarchy determines the amount of food taken in.
- Decreased activity – related to age, overall health, size of enclosure, and low levels of enrichment.
- Individuals not catered for – diets need to be designed for each individual and their specific metabolism
- Contraceptives – some lead to increased appetite or slowing of the metabolic rate.
- Lack of knowledge or experience – staff need to learn to visibly distinguish between underweight, lean, overweight, or obese cats.

(Ginman 2008)

Preparation of Meat – if required at institution

The best method to prepare the meat for lions is by humanely euthanasing the ungulate/livestock by either:
Shooting –

- Shot to the brain. Points of aim:-
    - Frontal position – aim at a point in the middle of the face just above the eye level. (Should be used for horned sheep and rams).
    - Temporal position – aim from the side of the head midway between the eye and base of ear.
    - Rear of head – aim behind the poll in the direction of the animal's muzzle.

Stunning/Captive Bolt Stunning –

- Frontal position should be used.
- Follow immediately with second method e.g. exsanguination.

Exsanguination (bleeding out) –

- Stunning must occur prior to bleeding out animal.
- A long (minimum 14cm long) sharp knife is essential.
- Making a transverse cut high up on the neck is required, ensuring the carotid arteries on both sides are severed. (Successful severance will be displayed by obvious pulsatile bleeding).
- DO NOT sever spinal cord or dislocate neck.

Please visit the Department of Primary Industries
at http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/57253/gen-001.pdf for more information on humanely euthanasing animals, which is necessary for feeding lions, (25 page document).

Storage of Food
There are large freezers and fridges which are constantly restocked. Freezer temperatures should be kept between -30 to -18 degrees Celsius and fridges should be kept between 4 to 6 degrees Celsius. When meat is transferred from freezer to fridge to defrost the meat should be fed out within 24 hours. Meat suppliers are required to only provide meat that is preservative and disease free, has not been exposed to barbiturates and carcasses have been euthanased humanely as suggested above (by shooting or stunning). A variety of whole food and carcasses are only edible to lion's once they have been defrosted in the fridge on a daily basis and are fed out once they reach room temperature. Food should be fed out randomly throughout the week. Melbourne Zoo feed out in a week items such as rats, mice, rabbits, chickens, kangaroo, beef, horse, goat, and emu. The most important aspect is to ensure that lion's have a varied diet, as they have access to a variety of animals in the wild. The food cannot be left in the wheelbarrow for longer than 2 hours otherwise it can no longer be fed to the lions. It is always a good idea to allocate one keeper to be responsible for the rotation and quality of the meat in order to not confuse the system and allow monitoring of ordering to only be done when necessary. Meat should not contain more than 10% fat as it has been known to cause vomiting in lions.

(Roe & Cleave 2007)

Supplements

Every kilogram of fresh meat that does not contain bone should be supplemented with 10g of calcium carbonate and 10g of 'Petvite' multi vitamin supplement is added to their diet. Melbourne Zoo distribute the supplements once a week or as required with a small amount of vegetable oil added to food to assist in the digestion of food and helps to prevent the compaction of fur/hair in the digestive tract, (Roe & Cleave 2007) At Harnas Wildlife Foundation in Namibia, these supplements were given to the Big Cats every second feed, every Monday, Wednesday and Thursday – 3 out of 5 times per week.

For 'Petvite' multivitamin supplement list and supplement manufacturer details see *Appendix F*.

Taronga Western Plains Zoo also use 'Petvite' only to meat that has no bones or skin as lions are able to digest the meat more readily which enables a better chance for the vitamins and minerals to enter the system.

(Pers. comm. Simone Keenan 2008)

For example, Taronga Western Plains Zoo recommends supplementing diets with 25g of calcium carbonate and 40g (2 teaspoons) of Petvite, see *Appendix F*.

Image: Yahoo!7 Pty Limited (2008)

Presentation of Food

Food is presented as whole food/carcass. It can be with or without fur, hidden under rocks, in paper bags, under wood piles, in water, or suspended from the roof or a tree. Feeding should be done at various times of the day and different locations daily, as this helps activate their natural instincts which keeps them stimulated both physically and mentally, (Roe & Cleave 2007).

According to NSW Department of Primary Industries (1995) "carnivores are to remain in an enclosure while food is being provided in the enclosure, it must be possible for the keepers to carry out this task from a position where they cannot be reached by the animal."

According to Simone Keenan (pers. comm. 2008) Taronga Western Plains Zoo present their food in a variety of ways, for example it can simply be placed in the enclosure, be hung up, hidden around the enclosure, or placed in boxes, or in other objects within the enclosure for the lions.

Food can be placed in a suspended bag, hanging food baskets, cage top feeding (small pieces of meat presented through a slightly larger gauge than the wire mesh walls), feeding poles, and food dispenser.
(Durrell Wildlife Conservation Trust 1999)

Behavioural Food Enrichment Methods (see *Section 9.7* for Food Enrichment Methods)

Example of a Weekly Recommended Diet for an adult male Lion

Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
5kg beef/ horse carcass + 300g chicken necks/roo meat	5kg kangaroo carcass + 300g chicken necks/roo meat	*Starve Day*	5kg whole chicken + 300g chicken necks/roo meat	5kg beef/horse carcass + 1Xbone +300g chicken necks/roo meat	*Starve Day* 300g chicken necks/roo meat	5kg kangaroo carcass + 300g chicken necks/roo meat
Supplements 25g calcium 40g Petvite	Supplements 25g calcium 40g Petvite *No meat needs to be defrosted*	-	Supplements 25g calcium 40g Petvite	Supplements 25g calcium 40g Petvite *No meat needs to be defrosted*	-	Supplements 25g calcium 40g Petvite

(Taronga Conservation Society Australia 2009)

NOTE: 300g of chicken necks are used during animal encounter feeds for visitors, otherwise are used for an enrichment activity feed that day (food thrown over to lions). Diets are only arranged depending on the meat available at that period time or the supplier.

According to Noonan (1998) from Auckland Zoo, the weekly diet consisted of:

Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Horse Hooves X 2 each	Whole feathered chicken X 2 each	Horse meat X 4kg each	Whole horse head X 1 each	Pelvic Beef Bones	Horse Hooves X 2 each	Horse Meat X 4kg each

Handling and Transport

NOTE: Capturing a lion is a **DANGEROUS OH&S risk**. Not only is the animal extremely powerful, it has the potential of killing a human. Humans need to beware of a lion's claws, teeth, and strength to overpower a human being. Chemicals involved in restraint can be highly dangerous and cause death if not wearing correct PPE. Follow instructions on how to handle and restraint a lion with the utmost importance for precautionary reasons.

NOTE: Although the images may display other large felids, keepers must be aware that these principles are also applied to lions.

Timing of Capture and Handling

Lions are the most active in the dawn, dusk, and night. Therefore, any handling and capture should be strategically planned for when lions are less active, for example, during the middle of the day and early afternoon, while they are resting. This also allows keepers to plan the capture in the morning and prepare all equipment, chemical agents, organise times with the veterinarian and PPE necessary. Where possible, individuals required for capture and transport, should be caught in the morning (cooler weather) where there is more staff available to assist. Other considerations include the time of arrival at the destination and the time within the crate during transport (this should be kept to a minimum).

Catching Bags

Nets can be used on small to medium sized cats, for example, a young infant cub (however, unnecessary at this age) up to a 5-7month juvenile, depending on their individual growth rate. Any cat up to 14kg can be restrained using a net and in some cases can be grasped by a snare. Any nets being used should be made of fine mesh enough to prevent the animal from poking its head or paws through the holes, to prevent injury.

Other Equipment that may be useful when handling lions

- Welder's Gloves – protects handler of chemicals used and scratching
- Snare - physical/mechanical restraint
- Carbon Dioxide fire extinguisher or hose open ready to be turned on in case of emergency to ward off lion
- Chain - physical/mechanical restraint
- Fine mesh wire net
- Squeeze cage
- Blow dart/pole syringe/powered projectiles – depending on the behaviour of the individual and type of chemical restraint required
- Proper PPE
- The injectable agent, as well as a reversal agent
- Plywood sheet, canvas sheet, or human stretcher
- Food

Capture and Restraint Techniques

Cats generally respond well to humans and handling techniques if raised from a young age and trained properly.

Infants

Cubs are easily handled by grasping the nape of the neck and become limp. They become limp because when their mother grasps this area, any slight movement of the cub could cause the mother's jaw to shut quickly in order to restrain their cub and inevitably cause an instant death of the cub. Once grasped correctly, keepers may choose to wrap the cub in a towel or canvas to eliminate scratching during the examination. If hand-raising a cub and bottle feeding, ensure that the cub is positioned into a natural position, do not cradle in arms.

(Fowler 2008)

Adult Lions

Well trained lions can be handled in a different fashion to wild or zoo cats. The keeper can use a snare or special chains to restraint and handle the individual. A chain is more useful than the snare as it can then be attached to a post and the lion can be grasped by the tail to administer a quick intramuscular injection. Squeeze cages are often used for lions, in which there are many types and styles designed for each individual and can be custom made. The body conformation of large cats, a lion should be squeezed from side to side. Adults should be baited into cages by using food. Some individuals must be immobolised before being placed into a crate. A plywood sheet, human stretcher or sheet of canvas must be used to move immobolised lion to another location.

(Fowler 2008)

FIG. 23.37. Commercial carnivore squeeze cage.

Image: Fowler (2008)

Chemical Restraint

Large carnivores can rarely be handled by physical restraint and keepers really on chemical restraint to immobolise the animals to examine, collect samples and perform therapy. Chemicals/drugs used may be selected for various reasons, such as type of sedation required, size and weight of the animal, cost, and the experience of the keeper/operator.

Keepers/operators in captive institutions should administer the chemical restraint by blow darts, pole syringe, or powered projectiles (firearms licence required). Dosages will differ for genders, free-ranging animals and captive. Drugs can usually be administered by any route and some orally. It is highly important to choose an adequate injection site, as captive lions may become obese for various reasons, and in the chase

of an obese lion it is better not to perform an intramuscular injection. The dosage will not occur correctly due to the fat storage content. Therefore, the best site for injection would be the limb muscle and scapula. According to Fowler (2008) “it is recommended to administer atropine sulfate (0.04mg/kg) subcutaneously or intramuscularly when immobolising or anesthetising a carnivore.” The drug ketamine may cause seizures in any large cat when being the only agent injected. However, when combined with other agents such as xylazine it may prevent the effects of the ketamine. If possible, it is recommended for xylazine to be injected 15 – 20 minutes earlier than the ketamine to allow the effects to take place, as ketamine has a shorter induction time. It is critical to always be aware of and monitor the danger, response/ reflexes, airway, breathing, circulation of the animal under sedation/ immobolised.

TABLE 23.9. Selected chemical restraint agents for immobilization of felids[18,23,31,36,38,43]

Agent	Dose (mg/kg), IM	Comment
Ketamine/xylazine	4.0–6.0/0.5–1.0	
Ketamine/medetomidine	2.5/0.07	
Tiletamine/zolazepam	2.0–10.0	Higher doses in cheetahs may cause apnea for 15–60 minutes; Respiratory assistance may be needed
Azaperone	0.5–0.1	Sedative dose
Medetomidine	0.05–0.1	Sedative in cheetahs[34]

Table: Fowler (2008)

Taronga Western Plains Zoo use an agent known as etorphine for larger animals, however, it is a highly dangerous drug to use, (pers.comm. Simone Keenan 2008). This agent has the potential of sending a human into cardiac arrest within 3minutes, (pers.comm. Jacki Salkeld 2008).

NOTE: When chemically restraining a lion it is essential to have the correct dosage for the weight of the individual; otherwise it is dangerous on the animal and could cause death if overdosed.

NOTE: Only veterinary officers should check the animal (check response/reflexes) and be aware of how sedated the animal is before allowing keepers to enter the enclosure, otherwise it could potentially be a fatal error if the animal is not properly sedated. It is known that lions become more aggressive when placed in certain situations. One of these situations is when the lion in under anesthesia or coming out of immobolisation. These are moments when the lion is highly dangerous and keepers must be aware of the potential risk they place themselves in if entering the enclosure during this particular time.

NOTE: drugs should only be administered if there is an antidote able to be used to reverse the effects. If in doubt of any drug being used, consult the local zoo veterinarian for assistance and further guidance.

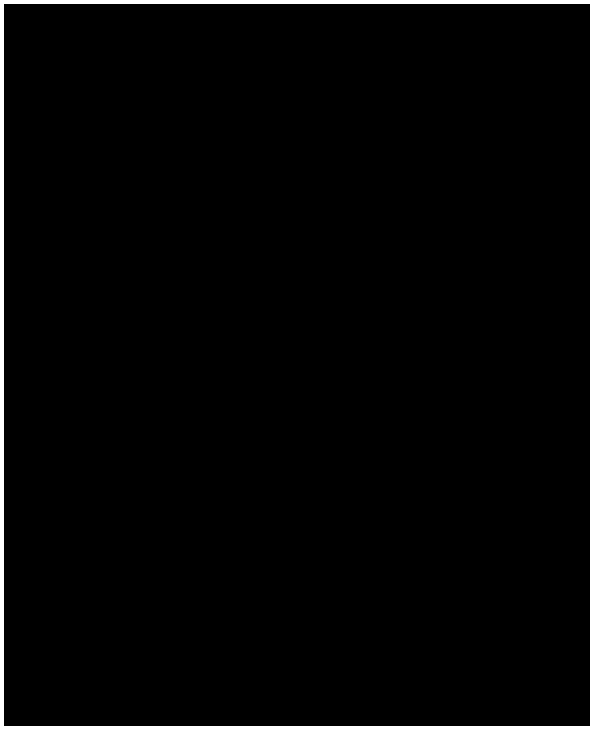
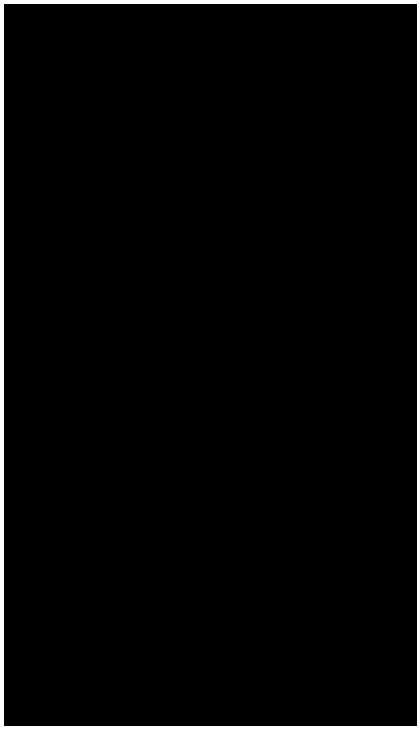
(Fowler 2008)

Keepers must take into consideration where to chemically restrain the individual in order to minimise stress on the animal and to ensure the most effective strategy is implemented. Conditioned animals could be moved into a crush or chute. Other individuals should be conducted in a holding yard. The best method would be to separate the individual from the group prior to chemically restraining e.g. all lions were in den overnight, in the morning move the individual to holding yard and allow others to go on exhibit.

The individual being sedated should be starved the night prior to the chemical restraint and ensure no food is available within the den overnight. Before the animal is the holding yard, it is important to set up the yard, place straw in areas that may have hard surfaces and ensure all risks are removed (e.g. sticks, platforms,

water troughs and rocks).

It is important to have a few staff (up to four, including Veterinarian and Veterinary Nurse) to assist in carrying the individual, especially if an adult lion.

Images: Fowler (2008)

Precautions

- Carnivore teeth are specialised for grasping and tearing prey. Their large carnivorous teeth are used almost like weapons of offense and defense.
- Muscular jaw can cause serious, if not fatal, injuries from its incredible strength.
- Paws are fitted with sharp claws that can rip and tear through most objects. Large felids have paws powerful enough that it is able to kill a person, if handled or approached incorrectly.
- The speed and agility of a lion should be highly appreciated, and keeper should be cautious of the potential of being charged.
- It is highly important to know exactly where the lion is within the enclosure, for example when working within the holding area the keeper should always know which doors are closed or open and where the lion is on the other side at all times.
- Corrective PPE must be worn during procedures– e.g. Gloves (especially is dealing with chemicals), eye protection, overalls, long sleeved shirt and a hat. A hose should be at the end of every gateway as a precautionary safety device if a lion escapes during movements.
- A two way radio must be with the keepers working with lions at all times. Where necessary have two keepers at minimum when preparing for transport and capture of a lion. One person only should move slides – while the other person double checks the first keeper's safety ensuring slides are shut.
- It may be necessary at some point to open a door partially of a carnivore cage to retrieve an object or to dart the animal, if there is no other alternative. The keepers involved must be highly cautious and use a chain or other device to prevent the door from opening further.
- Any cat will not tolerate pain being inflicted upon them.
- Cats may be able to reach out of the bars of a squeeze cage and therefore all bystanders and handlers.

(Fowler 2008)

FIG. 23.45. A sheet of canvas used to transport a large carnivore.

Images: Fowler (2008)

Weighing and Examination

The weight of an African lion at a healthy range should be 120 – 227kg. Weighing should be done while the animal is anesthetised on a large metal face plate or has been conditioned to enter a box with a scale as a floor.

When prolonged treatment is required, an immobolised lion should be strapped to the examination table to minimise injuries to the animal or handler if it awakens from sedation. Veins for obtaining blood samples and administer intravenous injections are both medial and lateral saphenous veins (side of leg and ankle veins), jugular, femoral (pelvic/groin region), and cephalic (upper outer arm region) veins. There is also a well developed facial and tail vein that can easily be penetrated. Other areas for injection include, intramuscular (limbs) or scapula (between shoulder blades at base of neck).The mouth of a lion can be opened for oral examination by using a speculum, for example a wooden block. The examination should include a physical health check, teeth, gums, ears, eyes, nostrils, limb movement, feeling for breaks in any bones over the body, and checking the spine.

Levels/Planes of Anesthesia

0 – no effect
1 – Mild sedation
2 – Heavy sedation
3 – Light (general anesthetic)
4 – Surgical (general anesthetic)
5 – Heavy
6 – Death
(pers. comm. Jacki Salkeld 2008)

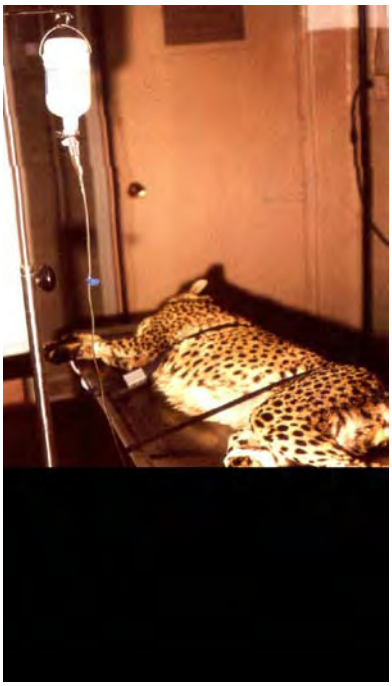


Image: Fowler (2008)

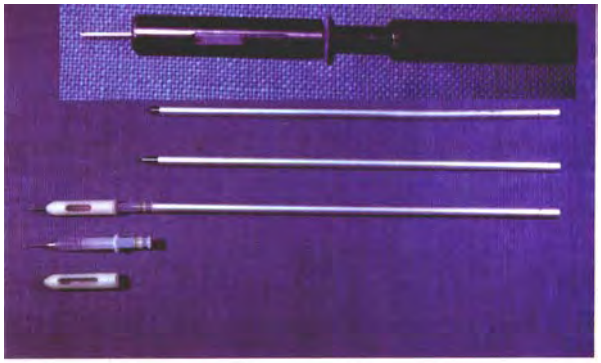


FIG. 19.3. Different types of pole or stick syringes.

Image: Fowler (2008)

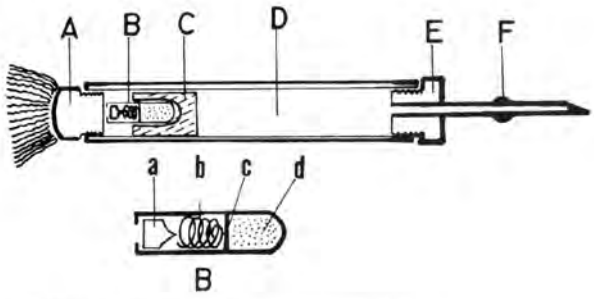


FIG. 19.14. Diagram of the mechanism of a CapChur syringe: **A.** Tailpiece. **B.** Ejection charge: (a) sharpened weight, (b) coiled spring to keep weight separated from (c) diaphragm to contain (d) charge. **C.** Plunger. **D.** Chamber for medication. **E.** Nosepiece hub. **F.** Collared needle.

Images: Fowler (2008)

Release

After all examinations and inspections are complete on the lion, the lion should be replaced back into the enclosure (if multiple species live in the enclosure place the animal in the holding yard or a den to recover) to administer the reversal agent (the veterinarian will need to inject this agent). To replace lion back to enclosure use the plywood sheet, canvas sheet, or human stretcher to transport from examination room to enclosure (if carrying for a long distance, a transport vehicle can be used). Once the veterinarian has injected the lion with the reversal agent, monitor the recovery period. If it seems to be taking longer than usual, the veterinarian will need to administer another dosage of the reversal agent. However, wait over 20 to 30 minutes before doubling reversal dosage and all responses/reflexes will need to be re-checked before entering the enclosure again to inject the second reversal agent.

If releasing from a squeeze cage or physical restraint the container can be simply attached to the new enclosure chute/transfer runway which leads into enclosure or holding yard. A shield should be used to prevent the lion from escape and guide them into the new enclosure. Always ensure that the container and new enclosure chute are fastened securely. (Fowler 2008)

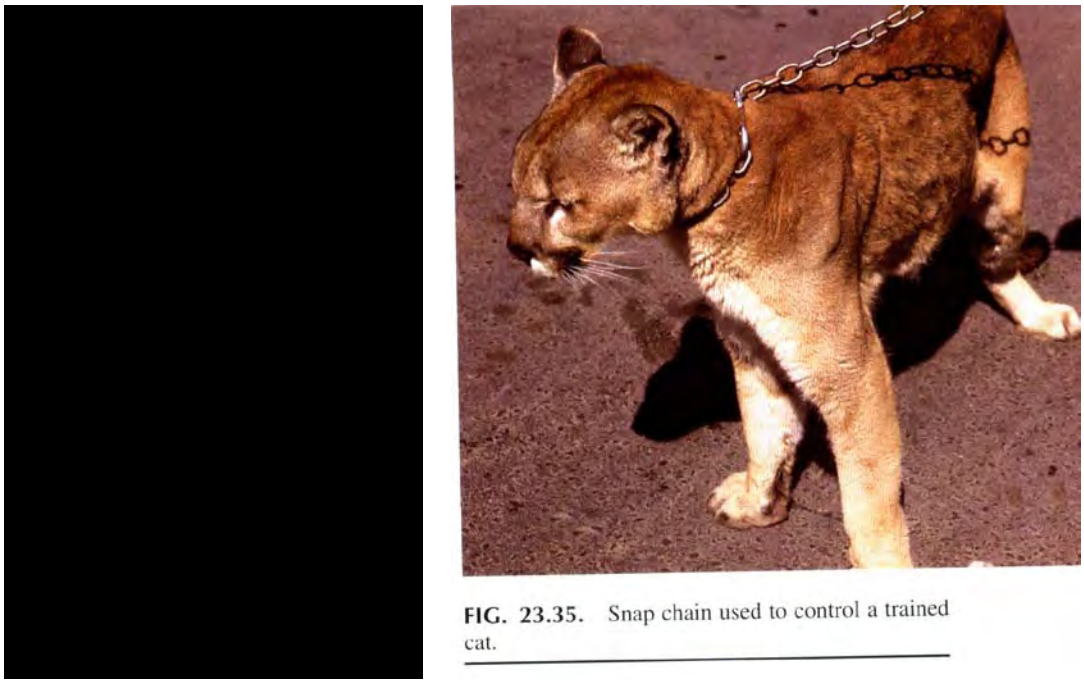


FIG. 23.35. Snap chain used to control a trained cat.

Images: Fowler (2008)

Transport Requirements

Box Design (see *Appendix G*- IATA Regulations)

Materials
Hardwood, metal, 1.3 cm minimum plywood or similar material, welded mesh, and iron bars.

Dimension
Height must allow the animal to comfortably stand upright with its head extended. The length must allow animal to lie down comfortably in the prone position. However, the animal must not be able to turn around in the box. A 10cm clearance around the animal when standing and lying is recommended.

Frame
Frame must be made of solid wood or metal bolted or screwed together. A spacer bar requirement of 2.5cm depth to the sides for air circulation needs to be taken into consideration. When weight of the container and animal exceed 60kg or the animal is highly aggressive the frame must have additional metal re-enforcing braces.

Sides
Suitable plywood or similar material must line the frame to give smooth and strong interior.

Floor
Either must be constructed in a narrow slatted form over a liquid proof tray, so that any excrements fall into the tray.

Roof
The roof must be solid with ventilation openings.

Doors
Sliding or hinged entry and exit doors must be provided; the front door must be made of steel welded mesh or strong iron bars. The animal must not be able to pass its legs between the iron bars. The front of the container must also provide a light sliding wooden shutter with either ventilation openings of 10cm or be slatted with 7cm spaces between the slats over the upper two thirds of the shutter, as this assists in reducing disturbance to the animal and to protect the handlers. Both doors are to be fastened with screws or bolts to prevent accidental opening.

Ventilation
Openings must be placed at heights that will provide air at all levels, particularly when the animal is lying down. Exterior meshed ventilation openings, with a minimum diameter of 2.5cm must be made on the sides, entry door and roof.

Spacer Bars/Handles
Provided at a depth of 2.5cm and formed from the framework of the container.

Furnishings
Feed and water containers must be fixed off the floor, to prevent soiling and positioned to the front of the container.

Labels
Various labels need to be displayed on the box before dispatch. These include, dangerous animal, live animal, the direction the container should travel in order to keep the animal upright ("This Way Up" label), the IATA animals acceptance checklist should be filled in to ensure all areas have been covered before dispatch, and any CITES documentation is provided, if required.

(IATA 1997-2007)

Furnishings

Straw could be added into the container on the floor, as long as it does not prevent the excreta from falling through to the tray. However, no furnishings are required other than feed and water containers. It is better to minimise any objects within the container to avoid injury.

(IATA 1997-2007)

Water and Food

Safe access to containers must be provided from outside box. Food intake must be reduced at least 2-3days prior to the dispatch. Only a light meal may be given prior to dispatch and food must be provided in case of emergency. Animals do not normally require feeding or watering during 24 hours following the time of dispatch. However, if they do require feeding and watering due to delay, feed once daily, preferably in the late afternoon, 1kg of meat per 20kg of live weight.

(IATA 1997-2007)

Animals per Box

Preferably only one animal should be transported per box to maximise comfort within the container. However, lions can be transported together without compartments, only if they are from the same pride,

compatible, not likely to harm each other, and cohabit normally. If more than one animal is transported in the same container the requirements above must be multiplied. The container can also be divided into compartments, by the use of partitions made by metal grills. Separate access must be provided to each container.

(IATA 1997-2007)

Timing of Transportation

This must be planned well in advance based on the patterns of the individual. Keepers will work together to plan the event of transportation and to ensure all paper work has been gathered and filled in correctly. The lion should have access to the transport container for a minimum of two weeks prior to dispatch. The best time to move a lion is during the middle of the day and early afternoon, when they are resting and immobile. This makes it easier to handle, chemically restrain animals, if necessary, and to move the animal efficiently. Lions prefer to travel in darkness or semi-darkness and therefore, the container should be covered by material that prevents light to enter, however, still allows breathing and air to move through the material. Keeping animals in darkness not only places them in safe/comfortable surroundings, but also avoids stimulus from their surroundings, as lions can become disturbed and aggressive if an outside interference or noise distresses them. If the weight of the container exceeds 60kg a forklift should be used to avoid risk of injury.

(IATA 1997-2007)

Release from Box

(please see image above)
The transport container should be positioned within the gates of the new location/enclosure the lion will inhabit (this could also be between holding yards and exhibit/quarantine area to avoid escape). All open gaps should be secured to avoid escape. The sliding door should slowly be opened without the keeper being in the enclosure itself. Allow time for the lion to orientate itself, and leave the box when it feels comfortable to enter its new surroundings. Sometimes it can take a while for the lion to leave the container, as they can become nervous in unfamiliar surroundings. Ensure the keeper monitors the lion for approximately half an hour to an hour after leaving the container. The keeper should record any significant behaviours and events, if necessary.

Image: Dollinger & Geser (2008)

Health Requirements

Daily Health Checks

Daily health checks should be done immediately upon shift in the morning, DE (distance exam) should be conducted to ensure animals are all accounted for and that the animals are in good health. Daily health checks are necessary to be conducted initially in the morning as a safety precaution to identify health issues immediately upon arrival, therefore, if an animal is ill it has been detected as soon as possible in order to be checked and treated. After DE have been completed, exhibit enclosure should be checked for safety reasons and cleaning purposes while Lions are still locked in night yards. Other checks can be completed once the African Lions have been transferred on exhibit and locked in, therefore keepers can clean night yards and determine whether any other health issues are evident. Afternoon exhibit exit exams are conducted with Lions when transferring back to night yards at the end of the day. Checks should be done every time Lions are visible.

Daily checks include:

- limbs moving well
- Feeding well
- Eyes clear
- General appearance – coat and skin
- Discharges present
- Signs of stress
- Appearance of excessive salivation
- Behaviour patterns
- Abnormalities in individual occuring
- Consistency of faecal

(Pers.comm. Mark Oriordan 2009)

Detailed Physical Examination

Physical Examination

Physical Examinations and Veterinary Checks

Common physical examinations conducted by the veterinary practitioner would include:

- Teeth/oral checks – due to carnivores doubling their life expectancy in captivity, and they rely heavily on the use of their teeth, which wear down over time, it is vital for felines to have their teeth checked regularly. Several cases of root canal operations, fixing broken teeth and general cleaning are necessary in order to live their life healthily without discomfort.
- Eyes – eyes are checked to ensure cataracts are not developing, no sign of cloudiness is present, and no discharge is visible to make sure the animal has good eye sight.
- Ears – ensure no build up of wax to enhance hearing, no discharge present,
- Nose – Clear passage ways, no discharge present, and sinus functions are normal.

- Skin – check for allergies, irritations, bruising, discolouration, dehydration, build up of fluids under skin, lumps on body, dryness, coat condition, wounds/healing process/clotting appropriately, and parasite analysis.
- Chest – scans/x-rays are conducted, in correlation with physical checks, to ensure good functions of the heart and lungs.
- Limbs/feeling exterior – full body check is required to ensure no bones have been broken, limbs are functioning properly, reflexes work normally and organs checked externally.

Chemical Restraint

Chemical Examinations and Veterinary Checks

Common chemical examinations conducted by the veterinary practitioner would include:

- Blood tests – examines the blood cells (white and red) for any weakness in immunity or signs of illness if the white blood cell count has risen.
- Biochemistry tests – examines kidney, liver, and internal organ functions, which can be tested for signs of illness and ensuring the organs function properly.
- Urine samples – examines bladder, kidney, urinary tract, and spleen for any signs of illness and general health.
- Faecal sample analysis – examines signs of stress, illness, indication of worms (endoparasites) and general wellbeing of animal.
- FIV – tested via history, clinical signs and blood tests known as ELISA (enzyme linked immunosorbent assay) which detects antibodies of the disease. It will read a false positive (feline with FIV) or false negative (feline without FIV) result. However, it should be noted that if the feline is a cub/young and the reading is positive it should be re-tested at a later date. The reason for this is that when a cub is born to a mother, infected with FIV, the cub receives antibodies from the milk produced, it does not mean that the cub has FIV, however, the cub has antibodies associated with FIV and therefore, will give a false positive reading to the test.
- FELV – This is similar to the HIV virus in humans. ELISA test can also be conducted to detect FELV and another test, IFA (immunofluorescence assay) which needs to be sent to a laboratory to test for antigens in white blood cells and platelets. (Pers.comm. Ben Briandt) & (Cat-World 2009)

Routine Treatments

Intestinal Worms (Endoparasites)

Heartworm is a main concern for felines and must be treated with prophylactic medication, e.g. ivermectin, milbememycin, and moxidectin used at standard feline doses.

Other common intestinal worms include:

- Ascariasis
- Hookworms
- Stomach Worms
- Protozoa worms
- Coccidiosis worms

- Taxoplasmosis
- Trypanosomiasis

Ectoparasites (External parasites)

Common Name	Location	Significance	Treatment
Ear Mites	External ear canal	Common in Lions	Thiabendazole and invermextin
Fleas	External ear canal	Locally common	Lufenuron, fipronil, and pyrethrins
Hippoboscid fly	In hair coat; over entire body	Local	Carbamate dust
Mange	Skin and hair coat	Rare	Amitraz and ivermectin
Ticks	Skin	Rare	Pyrethrins and fipronil

Vaccinations

All felids are to be vaccinated against feline panleucopenia, rhinotracheitis and calicivirus. Felines should be vaccinated against canine distemper and rabies using only the subunit canary pox vectored vaccine available from Merial Animal Health (see *Appendix H*).

(Fowler &Miller 2003)

Known Health Problems

Feline Immunodeficiency Virus – this is a feline version of AIDS and is a strain of lentivirus. It attacks the cells in the immune system and then leads to FAIDS (Feline Acquired Immune Deficiency Syndrome), which limits the feline's ability to fight against diseases or illnesses.

Symptoms: Weight loss, anemia, poor coat condition, gastroenteritis, diarrhoea, cancer, gingivitis, stomatitis, and chronic and recurrent infections of the eyes, skin, urinary tract, respiratory tract and other organ functions.

Transmission: Via Saliva, commonly through bite wounds on felines.

Treatment: There is no cure to FIV. However, supportive care can be given to infected felines, including regular checkups, maintaining healthy diet, parasite control, necessary supplements, immediate vet care when ill, and maintain vaccinations against disease.

Prevention: desexing all felines, separating Lions from infected individuals, and testing all breeding cats. There is a vaccine available, but is not a definite solution.

Feline Leukemia Virus – is very similar to FIV in terms of transmission, however, can also be passed through respiratory secretions, urine, faeces and milk.

Symptoms: poor appetite, weight loss, fever, apathy, enlarged lymph nodes, pale mucous membranes, gastrointestinal disorders, lymphosarcoma, secondary infections (from weakened immune system), difficulty breathing, gingivitis, and stomatitis.

Panleucopenia – Viral disease that changes components of white blood cells.

Symptoms: fever, acute onset of anorexia, depression, vomiting, and diarrhoea.
Transmission: Via contaminated furniture or fomites, e.g. bedding, nest box, platforms.
Treatments: There is a vaccine available to use within Australia to prevent transmission and contraction of disease.

Rhinotracheitis – an acute upper respiratory infection that replicates in the nasal tracts.

Symptoms: Fever, coughing, loss of appetite, runny nose, runny eyes, and sneezing attacks.
Transmission: Direct and indirect contact with infected individual.
Treatments: Oral antibiotics, eye ointments, decongestants, interferon to stop nasal discharge. Vaccinations are given to felines on a routine basis to prevent disease transmission and contraction.

Calicivirus – a respiratory disease comprising of several strains.

Symptoms: sneezing, ocular and nasal discharge, and ocular ulcers.
Transmission: can be indirect or direct contact.
Treatments: routine vaccinations are implemented at most zoo's within Australia and are generally encouraged at young ages for initial prevention and boosters are used from then after.

Canine Distemper – closely related to the human measles virus.

Sypmtoms: the main symptoms include fever, nasal discharge, depression, and loss of appetite. However, generally infected individuals will experience various affects of the virus.
Transmission: Via airborne of infected respiratory secretions.
Treatments: There is a vaccine available to prevent the disease. However, once infected it is difficult to treat. It is best to seek veterinary advice if individual is not vaccinated.

Other diseases to be aware of are Papillomarvirus, Bovine Spongiform Encephalopathy, Dermatophytosis, and Helicobacter Gastritis.

(Cat-World 2009)

Quarantine Requirements

An example of appropriate feline quarantine requirements is given below:

- All animals are to be isolated for a minimum period of thirty days at the Quaratine facitlity.
- Three faecal samples are to be collected for faecal floatation, with anthelmintic therapy as required.
- Each animal is to be anaesthetised for physical examination Blood is to be collected from all species for routine haematology, biochemistry and serum storage. Blood should be submitted for Feline Immunodeficiency Virus and feline Leukaemia virus serology. Serum should be submitted for coronavirus and toxoplasmosis serology.
- Where appropriate, all felids are to be vaccinated against feline panleucopenia, rhinotracheitis and calicivirus with an inactivated vaccine.

(Taronga Conservation Society Australia 2008)

Keepers should note that when preparing quarantine areas for African Lions it is a general requirement that felines are not kept on concrete substrate for extended periods of time. This is due to natural materials or flexible substrate (such as plastics or marine plywood) minimising the occurrence of ostheoarthritis and pad ulceration.

Behaviour

Activity

African Lions will sleep and rest up to 20hours a day and observing active lions requires persistence and pure luck. The times of most activity is late afternoon, this is when females often suckle their young followed by play and other social activities, and early and late at night, when hunting activities occur, early hours of daylight also displays some form of activity. However, lions are opportunistic and will seize any chance to catch prey at whatever time of the day it is. Lions living in dense woodland habitats with plenty of coverage will hunt during the day rather than those who live in open plains. Darkness is an advantage when hunting: on moonlit nights lions will lounge around until the moon disappears, then they become active.

(Estes 1991)

Social Behaviour

African Lions are extremely gregarious, territorial, and communal. They hold a territorial range of between 20 square kilometres to 400 square kilometres, with an average range of 200 square kilometres. Most pride groups have approximately individuals; however can have up to 40 members.

Larger groups will have individuals coming and going on their own accord, either alone or in small groups. However, a lion's presence on the territory does not mean they are a member of that pride, and on occasions "lodgers" (squatters) and nomads will enter an already claimed territory. Membership is only welcome when observation of individuals interacting is established over a significant amount of time.

Females are able to join a group if the numbers of females in that pride is lacking, however, on the contrary, if the pride is full for females, infants will have to emigrate at the age of two.

The degree of male competition in this carnivore species is unlike any other and the development of greater sexual dimorphism is the most obvious outcome in competition. The advantages of size and more extravagant mane in males has caused more muscular and conspicuous hunting abilities to become impaired. They can take up to 5 years to mature and reach puberty at 2 ½ years of age. It is when the male is 3 years old that they are forced to leave the pride because of the intolerance of other males. It is from the age of 3 onwards that males may start to challenge older males to take over the pride range, which is usually successful at this age to maturity. It is these males and the emigrated females that form groups becoming nomads and lodgers.

Within a pride, females associated much more affectionately with one another than males. This is where companionship will last a lifetime with members in the pride. According to Estes (1991), it is the "…social bonding, usually between closely related individuals that have grown up together, and particularly between mothers and daughters, is the very foundation of lion society."

It is the male littermates that generally stay together after leaving the pride and when they collide with another pride they compete for the territory as a team. Challenges as a team is much more successful then single individuals.

(Estes 1991)

Communication

Vocal communication

- Roaring - one of the most distinctive vocalisations related to lions. A roar can symbolise various activities, e.g. claim of territory (known as territorial advertising), locating pride members, intimidating rivals during aggressive encounters, strengthening social bonds (roaring in chorus) or signal of a kill being made. Typically a roar will start with a few moans, followed by a series of 4 -18 extended roars, ending with a series of grunts. A roar is audible for up to 8km when full throated. Males will begin to roar at the age of one with females beginning a few months after. Males generally dispel a deeper and louder roar than a female. Peak times for roaring include at dusk and dawn and at night.
- Grunting - often an introduction of a roar. Sometimes used by mothers at a low intensity to summon cubs. Or used as a contact call between close adults. Cubs also grunt and moan when trailing behind a moving group.
- Moaning
- Growling - graded calls that change in volume, intensity, tempo and tone of call. A growl is slurred with open mouth, and hissing.
- Snarling
- Hissing - abrupt can turn into spitting, when in sight of another strange lion. Cubs are able to hiss from 9-10 days old.
- Spitting
- Meowing - when cubs meow, it is a signal of light distress, varies from short to yippy when greeting an adult and being licked, or harsh tone/snarl when competing for a nipple. Adults also meow while snarling, the cough is short, explosive growl given during a charge.
- Purring - sound of contentment, heard during intimate interactions and when cubs suckle.
- Humming - similar to purring.
- Puffing - faint “pfff-pfff” sound with closed lips given when lions approach one another, signalling peaceful intentions.
- Woofing - an abrupt sound given by a startled lion, expresses alarm.

Olfactory Communication

- Urine spraying - often lions will perform territorial patrols and mark objects at significant intervals by urine spraying. Although females may spray on vertical objects on the occasion, its mainly the male behaviour to spray and mark territory.
- Anal sniffing - common when greeting or meeting another lion, or when females are in heat.
- Scuffing - both females and males perform scuffing ceremonies. Raking the ground two to thirty times with the back feet, with or without urinating.
- Clawing - similar to domestic cats clawing at carpet, lions will claw at the ground.
- Urine testing
- Scent marking - lions have scent gland in their cheeks and paws. They leave scent markings by scratching or rubbing objects and trees. They can follow scent markings left by other lions and pay close attention to others’ scent markings.

Tactile Communication

- Greeting ceremony - is used as a proof of membership in the pride and indicates peaceful intentions. Two lions approach each other, often moaning softly, rub heads the sides together, with tails raised or draped over the other lions back. They often lean against one another. Females greet each other

more often than they greet their cubs and cubs will rub females often. Cubs and females will seek to rub the males within the pride, sometimes it is accepted, however, sometimes it is reserved for other male coalitions.

- Social licking and grooming - less frequently than head rubbing, however, plays a strong role in social bonding. It is between the pride who initiates a licking session, and usually the other lion will reciprocate. Cubs are often licked all over, whereas for adults its confined to the head, neck, and shoulders.
- Lying in contact - You will frequently see standing lions roll onto the one lying down, this is a form of greeting and social bond.
- Rubbing - head rubbing as a form of greeting.

Visual Communication

- Ear position, lips and tail tip accentuate expression and movements of the visual communication.

Agonistic Behaviour

Dominance/Threat Displays

- Strutting - head held high, making himself as tall as possible, with tail upright in the air curled over to his back, showing his side and walking stiffly. Generally performed by males and primarily to females. It displays dominance in the pride.
- Head-low threat - almost in a stalking position, usually accompanied with vocalisations. This is an extremely offensive posture, head low with forelegs straddled and shoulders higher than normal, starring at opponent. Tail is often trashed up and down.
- Mouth slightly open, lips in a straight line covering teeth, eyes wide and pupils small, ears twisted so that the black marks face forward.

Defensive Displays

- Ears flattened, teeth bared, head turned, eyes narrowed, crouching, lying on back, with vocalisations.

Fighting

- Slapping, grappling, biting, ganging up - usually occurs when competing for meat. Fighting usually only becomes fatal when a takeover happens.

Predatory Behaviour

Lions can reach speeds of 48-59km/hour which they can maintain for more than 100m. They need skill, patience and good judgement to capture animals with a high flight response. Experienced lions will only charge if within 30m of their prey. African lions will attempt to reach this range by stalking their prey and then running almost 88 % of the studied prides in the Serengeti region took this approach to catching prey.

Once within the catching range, lions will overpower and kill their prey without even getting injured. The prey is killed by suffocation (a bite on the throat). Small prey is brought down by a slap on the haunch, tripped, or clutched with both paws and simply dragging it down. Larger prey is brought down by entering on an oblique angle, rears and throws one paw over the shoulder of the prey, or rump, using the lion's full weight and strength pulls the prey down backwards and sideways. Once the animal is down the lion quickly lunges for its throat or nose to kill by suffocation. The grip is held until the animal stops breathing.

African Lions share their food, but reluctantly. Pride males will eat the majority of the prey and often if food is scarce, cubs will be the first to suffer. The will frequently compete for their food, slapping, growling and snarling at each other. The pride will stay and guard their kill until they have consumed as much as possible. However, their kills are often interrupted by other carnivores, such as lion nomads, hyena and vultures.
(Estes 1991)

Reproductive Behaviour

Pride tenure last no more than 2 years and have a relatively brief reproductive career, with prime years being between 5 and 9 years of age. However, larger coalitions have a longer tenure than small groups.

One of the first acts of a male, after taking over a territory, is to kill the existing cubs under the age of one or expecting to be born in the months of takeover. Older juveniles may escape but generally do not survive unless their mothers leave with them. Females may attack the males to protect their cubs and can be wounded or killed on the occasion. It is most successful when the females gang up on the infanticidal male(s). Lions are very social mammals; however, infanticide is a vital part of the male reproductive strategy.

Lioness will reproduce earlier than every two to three years at any time and only ever return back into oestrus when the cubs turn to one and a half years of age, (average interval between birth and the next oestrus is 530days). However, when they lose their litter it causes the female to re-enter oestrus and mate a few days or weeks after the event. Females can mate without falling pregnant after losing cubs on average for 134days after the takeover. In the event of a takeover and losing a litter, females engage in a much higher mating activity than usual. Estes (1991) states that;

> "other lionesses come into heat every few weeks but apparently fail to ovulate. The period of infertility may well be an adaptation that a) protects the females against the consequences of desertion by the new males, b) helps to bond the new males to the pride and reduces the likelihood of their deserting, and c) allows time for the strongest coalition around to come onto the scene and take over."

African lions have no specifc breeding season and are induced ovulators. Females have the ability to induce their oestrus and synchronise the cycle with other female members. This allows for a communal care of the cubs and deaths decrease as a result of synchronised birthing.

It is estimated that lions will copulate about 3000 times per cub born and survives the yearling stage. Males will mate with more than one female during their oestrus cycle if synchronised.

The proximity of a male and female is a general sign of a mating pair. The male follows the female very closely from behind and the pair becomes very affectionate during this period, grooming and rubbing each other. The lioness initiates the process by snarling and slaps, but later crouches down, arching the back and lowering her fore body, known as "presenting". The male will mount and once he has reach the climax will lightly bite the back of the female's neck, at this point the male will roar. The female will then turn her head and give a snarl which is a sign for him to dismount. She will then roll onto her back or side. A female lion will accept any adult male during her oestrus cycle.

Females hide their cubs in dense forestation and shrubs when they are born and up until they are 6 weeks old they will not be introduced to the pride. Cubs have the best chance of survival when females give birth at the same time and are able to suckle on any lactating female in a communal setting. It is rare that females

will abandon their young; however, in times where prey is scarce they will starve and abandon the cubs.
(Estes 1991)

Bathing

African Lions form of bathing is grooming. Grooming is mainly between females of the pride and mothers and cubs. The rough texture of the tongue works as a comb to clean fur, wipe off blood after eating, removes ticks, fleas and parasites. Other than bathing through grooming it does assist in the social bond of the pride. Lions do swim, however, is not a necessary component to bathing, as it is for other felids.

Behavioural Problems

- Aberrant appetite
- Refusal of food
- Pacing
- Overeating
- Abnormal aggressiveness
- auto mutilation
- Head tossing (weaving)

(pers. comm. Mark O'riordan 2009)

Signs of Stress

Signs of stress can be established through various observations. including:

- Consistency of faecals
- Pacing
- Displaing abnormal behaviours
- Becoming destructive

(pers. comm. Mark O'riordan 2009)

Ways to prevent stress and stimulate natural activity and behaviours is through exposing lions to behavioural and environmental enrichment strategies and becoming unpredictable in activities, e.g. feeding at different times of the day, or split feed if possible.

Behavioural Enrichment

Enrichment can vary. Classifications of enrichment include;

- Physical Enrichment
- Space
- Furniture
- Occupational devices
    - Manipulable objects
- Feeding enrichment techniques
    - Novel food items
    - Feeding enrichment devices

- Senses enrichment
    - Smell
    - Auditive
- Psychological needs enrichment
- Social environment

(Durrell Wildlife Conservation Trust 1999)

These categories can be achieved through behavioural and environmental enrichment practices:

Enrichment Methods

Behaviours such as Predatory, Grooming/Social Grooming, and Anti-Predator are found within the following enrichment suggestions. ***Please Note:*** Some may overlap into other areas and behaviour tables, however, to avoid repetition I have simply stated each enrichment once and keepers can use the enrichment for any behaviour they would like to encourage. ***Please Note:*** Food enrichment methods can also be found in Section 6 of this husbandry manual.

FORAGING BEHAVIOURS

Enrichment	***Materials and Method***	***Cautions***
Raw Eggs	Place in enclosure or night yards	
Pilchards/White bait fish	Either scatter or hide fish within the enclosure or night yards.	Pilchards/White bait fish
Stimulated prey items	This could be bags filled with scents of blood or other prey scents or even an object shaped in a prey animal. This could be provided with an engine source for movement, ensuring the animal cannot reach the item.	If the animal can reach the items, ensure they will not hold a health risk or cause illness.
Knuckle or tail bones/whole horse tails	Bones and tails can be placed throughout the enclosure according to the number of individuals.	Should be removed from enclosure if not finished during the day.
Frozen items	Items such as blood, fish, milk, and water can be frozen into usually quite large cubes.	Keepers must ensure the sanitary quality of the blood before freezing.
Live prey	If permitted, and if necessary, release the prey into the enclosure for the lions to catch.	
Live insects scattered in hay or placed in foraging tube	Live insects scattered in hay or in a forage tube.	
Hidden live prey in hollow logs	If permitted, hide prey inside a hollow log for Lions to find.	
Swinging feeder	"A piece of bamboo with the branch ends remaining, it can be attached to the cage ceiling with string or wire and then pieces of fruit can be added to it." (Durrell Wildlife Conservation Trust 1999)	Bamboo ends must be rounded in order to avoid injuries.
Activity balls	The same activity balls given to pet dogs, place treats inside the ball, and allow the lions to manipulate it in order to receive their treats.	Balls must be removed, washed and disinfected for next use after treats have been eaten.
Bamboo stem feeder	Fill a bamboo hollow with the favourite foods, seal the ends with paper. PVC tubes can also be used. Provide one tube per animal.	Be sure to round off ends if using bamboo to avoid injuries.

Hanging food baskets	Baskets made with two flower pot holders and joined at the top. Attach with rope and a pulley, so that it can easily be raised and lowered at feed times. If attempting to prevent food spillage, secure smaller food items with a fine mesh through the basket when being filled. Inside the basket activity balls can be placed to make it more difficult for the animal to get to the food.	Enclosures with groups of lions, should have more than one device. Ensure to remove the device once food has been finished.
Foraging basket	A basket of any shape filled with substrate of any item (wood shavings etc). suspend from the ground using rope.	If branches are near the device, remove them before placing the device in the enclosure to avoid ropes getting caught and causing injury to animals.
Suspended bag	Suspend a bag or net by a rope, containing food items	Lions could potentially damage the device and therefore materials must be safe to maintain the health of the animals.
Cage top feeding	Food chunks, slightly larger than the gauge of the mesh and placed on the cage in feeding times.	Food not eaten from the top of the cage should be removed after one day.
Feeding poles	Plastic box with food items inside and a hole at the base of the box. A smooth wooden template is placed at the hole and clamped to the mesh of the enclosure. Access to the box can only occur when climbing up a swinging pole, which is loosely fixed to the roof. Another type of pole is made from pickaxe handles and narrow gauge wooden brush shafts. "A large diameter brace and bit is used to drill a hole at an angle partly through the wide end of the pickaxe handle. A short section of brush shaft, four to six inches in length, is then whittled to the appropriate diameter and hammered into the hole, favoured foods can be placed on it. A strong wire hook is fixed to the narrow end of the pickaxe handle. The whole thing is then suspended from a high, strong point in the roof"(Durrell Wildlife Conservation Trust 1999)	Materials must not present any harm to the animals, and any sharp edges must be cut off or rounded off.
Goody boxes	Place a few holes in a cardboard box. Fill with leaves and food items. Place them inside the enclosure to play with and destroy. This can be left for several days.	Offer the box only when its dry and placed in a dry location to avoid fungus growth.
Hanging Hessian sacks	Hessian bags filled with hay and favourite food items should be tightened to the furniture of the enclosure. It must be able to support the weight of individuals hanging from the device.	Some animals may try to get inside bag and fall causing injury. Therefore, soft substrate should be placed underneath the device on the ground.
Blood trails	After cleaning the enclosure, using a plastic bag filled with blood, keepers can puncture a small hole in the bag to release blood and spread across the enclosure to create a scent trail for lions. This can also lead the lions to a final reward – their daily meal.	This technique must not be used too often due to health regulations and to maintain novelty the next time the enrichment is used.

Fur, hair, bones or feathers scent	Different animal skin, bones and fur are placed around enclosure.	Items must be minimised in order for lions to avoid animal distress and to maintain novelty.

PLAY

Enrichment	*Materials and Method*	*Cautions*
Manipulable objects	Mirrors, boxes, tyres, PVC tubes, phone books, scratching logs, pizza boxes, plastic balls (must be hollow, could also be filled with foods or edible enrichment items), hay or cut grass, piñata, and bark from trees.	The mirrors must be resistant to heavy blows and only be provided for a short period of time.
Brush top	Fix the brush top to the furnishings to allow lions to groom themselves, and rub against it.	If the lion begins to chew or eat the plastic brush then it should be removed immediately.
Tug of war	Rope can be attached to furniture, if able to withstand lion's strength, otherwise, it can be pulled through the enclosures for either the keepers to pull on the other side, or if lion enclosures are next to each other lions from either side are able to interact with each other through a game of tug of war.	Some gum problems may occur with rope or wire mesh tug of war games. Therefore, it should be constantly checked and monitored. The rope should not remain in enclosure all the time and activities should always be rotated to maintain interest in the rope when it is presented the next time.
Pine cones with food items placed inside	Place on the floor of the enclosure.	If there are numerous lion's within the enclosure, there needs to be an equal amount of pine cones as number of lion's. Once lion's lose interest the cones should be removed.
Unchopped or unpealed foods	Prepare shapes, sizes and colour variations	Sometimes this is not practical.
Pineapple tops	The green tops of pineapples are used with food items hidden between leaves. It is either suspended from or attached to tree branches.	Pineapple top must be washed and clean before offering and presenting.
Presence of conspecifics: important in gregarious species, the number and type, the presence can be physical, visual, auditive or sensual (odours).	Either by visual/ audiotape or presence of odours within enclosure.	It is important to allow animals to retreat from any other animal presence if they wish.

CLIMBING

Enrichment	*Materials and Methods*	*Cautions*
Trees and bushes: provides shade and shelter	Various plants and bushes are planted within the enclosure. Should choose native plants that are non toxic.	Non toxic plants only.
Trunks	Placed in different locations in the enclosure, are used for climbing, marking, exploratory, play activities.	Ensure the trunks are away from the edges of the enclosure and cannot be used for escape.

Branches	Keep leaves on branches, and allow it to resemble a tree, allows them to establish range territory and able to destroy the branch.	Ensure it is not a toxic plant and it is removed at the end of the day.
Ropes	Hanging ropes can be bridges, swings or lianas with or without knots. Increases climbing stimuli and tug of war. It also furthers a sense of equilibrium.	Note that lions could destroy the ropes very easily and only durable types should be used to ensure enrichment lasts longer. It is better using ropes made from natural fibres in case of ingestion.
Suspension Platforms	Positioned about 2 – 3 times taller than the individual.	If several lion's in enclosure a few platforms should be provided.
Hammocks	Old sacks, cloth bags or hoses interwoven are attached by chains to the furniture around the enclosure.	Sometimes difficult to clean depending on material used.
Rocks	Various sizes and shapes, placed in different locations of the enclosure: climbing and observation sites.	
Hidden food in the furnishings of the enclosure	Food should be hidden in various locations around the enclosure in order to stimulate lions to search for food. Could be hidden in trees under rocks/logs, inside log hollows, in boxes, and in tall grasses.	Lions may destroy or damage furnishings when looking for food.
Food dispenser	Use a log and cut many holes, fill the holes with favourite food items. The device can be placed on the ground or hanging in the enclosure.	If hung, ensure it is properly secured to avoid injury from the fallen log.

LOCOMOTION ON GROUND

Enrichment	***Materials and Methods***	***Cautions***
Daily feeding frequency	Split feed throughout the day on occasions instead of providing one large feed.	
Scents (see *Appendix I*)	Use various spices, herbs, essential oils, liquids, and other animal scents. Or diluted coffee.	Alcohol based products should be avoided. The amount of scent placed in the enclosure must be low to allow animals to avoid the scent if they wish

EXPLORATORY BEHAVIOURS

Enrichment	***Materials and Methods***	***Cautions***
Nest boxes	Provides shelter and a place of rest e.g. a safe house for the lions.	
Plants and grass	Encourage various substrates within the enclosure, also place long grasses in enclosure to simulate natural habitat and encourage natural hunting behaviours	
Roots	From trees, bushes, plants or grasses.	Ensure the roots are veterinary approved before giving it to felids.

Chewing Items	Wooden items, branches, and cardboard.	Any safe items for chewing are to be used.
Free spinning feeder log	"Two logs about ten inches long are drilled through the centre lengthwise and string on a steel cord across the enclosure at a height of about five feet off the floor. The logs are drilled with holes and filled with favoured foods. No access to the logs is possible from the surrounding perches. In order to reach the feeder logs , attempts to balance and walk the cord are necessary" (Durrell Wildlife Conservation Trust 1999)	The floor under the device must be softened by using soft substrate to avoid injuries if the animal falls.
Presence of other species	Presence can be physical, visual, auditive or scents.	This can only be done if the enclosure is large enough for the animals to avoid and retreat from the agonistic interaction

HIDING

Enrichment	*Materials and Methods*	*Cautions*
Large hollow logs	One or several logs are placed in the enclosure in order for animals to hide inside.	Logs must be replaced according to the use and must be large enough for the animals to not get stuck inside.
Log Piles	Logs of different sizes and shapes, placed on top of each other to create a pile. Possibly even leave space in the centre for a hiding spot/ keepers could hide food in there.	Some animals may move logs and it could injure the animal. Ensure logs are secure.

COMMUNICATION

Enrichment	*Materials and Methods*	*Cautions*
Auditive	Sounds of prey, predators, or conspecifics. Habitat sounds can be used permanently or just be enrichment.	Certain sounds, such as gun shot sounds, must be used with care as it can cause stress or make animals nervous if used too regularly.

ESCAPE

Enrichment	*Materials and Methods*	*Cautions*
Bird of prey silhouette	Made from a piece of wood and painted black in colour. Attach from one side of the enclosure by a wire to the other. Join a rope to the figure. Allow it to run from one side to the other and pull the rope attached to make the "bird" move. Enhances group behaviour.	The silhouette must only make a short appearance and then be kept in a hiding place where animals cannot see it permanently
Predator dummy	Silhouette or skins of terrestrial animals or a human hunter that could emit gun shot sounds. This releases eustress in mammals.	Only allow for a short period of time and long intervals without it (a week minimum) in order to avoid stress.

(Durrell Wildlife Conservation Trust 1999)

Introductions and Removals

Introductions
Any introductions are purely dependant on the individual. Keepers need to bear in mind the estrus cycle of females, temperament of the individual, and the sex of the individual in accordance to the number of males already in the enclosure. Gradual transition into the group needs to be done in accordance to the social behaviours as described above. Animals will be more easily accepted if exposed to the group in stages and if placed directly into the enclosure with the current pride, it could potentially be fatal. Therefore, the factors keepers need to bear in mind (written above) should be considered before exposure to the pride. Slowly, and in stages, move the individual closer to the enclosure of the pride, after initial quarantine period. This could be done by moving the individual into different holding yard enclosures gradually getting closer to the pride group. Lastly, fence line contact or interaction could be introduced to lions before allowing complete access to the pride. It should be known that females will be easier to introduce to a pride, with males being more difficult, unless in a female only pride (then the male would be easier to introduce).

Removals
As lions are pride animals, meaning they live in social family groups, it is recommended that when removing an individual from a group to simply remove them. Gradual disposition could cause stress to the animal not being able to have contact with the pride. Ensure reference to the handling and transport (section 7) of this manual is used to capture and restrain the African lion being removed.

Intraspecific Compatibility / Interspecific Compatibility

"1) Enclosures must contain no more than one species of carnivore except where the enclosure allows space sufficient to ensure the avoidance of inter-specific aggression or stress. Carnivore species that hybridise must not be kept in the same enclosure.
2) If a carnivore is being unduly stressed by the aggression/presence of another carnivore(s) in the enclosure, then it, or the other carnivore(s), must be removed from the enclosure.
3) Felids are to be housed in any one of the following ways:
a) alone (except lions) or as a female with her sub-adult offspring;
b) as a compatible pair, with or without sub-adult offspring;
c) as a single sex group (only in the case of lions and cheetahs);
d) as a juvenile group while all animals remain under breeding age; or
e) as a pride in the case of African lions."(NSW Department of Primary Industries, 1995)

Suitability to Captivity

Many institutions house African Lions, and generally do not have any problems. Ensure all procedures and government policies are followed correctly. African lions are suitable to house in captivity, especially as they are listed as Vulnerable on the IUCN Red List. Being housed in captivity could assist in behavioural research, breeding programs and education in order to maintain and prevent the species from becoming endangered.

Breeding

Image: Monette (n.d.)

Mating System

Lions are termed as being polygynandrous, this means when "two or more males have an exclusive relationship with two or more females. The numbers of males and females need not be equal, and in vertebrate species studied so far, the number of males is usually lower," (Wikipedia, 2001-2006). This can also sometimes be referred as a "group marriage." Generally there will be a resident pride, where males and females within this group will mate with one another. However, if you are not in a pride it is assumed that the individual is not mating. If there are more than one males in a pride, they often challenge each other when a female is in estrus, which can then turn into a first come first serve incident.

Notoriously, mating in lions is quick, repetitive and unsuccessful. The mating ritual involves a lot of physical rubbing (head rubbing) and presenting leading up to the actual copulation event. "Lioness will lift their hindleg with their front paw or roll onto their back and bite their hind legs," (Shelburne, 2004). Alternatively, females "present" themselves by lowering their forebody and arching their back and hind legs. The males will then select the female they want to copulate with, which is generally the first ovulating female receptive or presenting to the male.

The male will initiate mating by snarling at the female, which generally stimulates the female. Sometimes, the male will lick the back, neck and shoulders of the female until she complies. This is followed by the female assuming the presenting position and the male will then mount the female. The male will bite the female's neck and roar directly after ejaculating (*see Section 9.3* for more reproductive behaviour).

Mating will occur over about four days, each copulation session lasts for 30-70seconds with approximately 20 minute intervals. (Shelburne 2004)

Ease of Breeding

Lions are known to be prolific in reproducing and therefore, require no assistance in breeding, (Fowler & Miller, 2003). As African Lions are induced ovulators, it is recommended to not interfere with the breeding cycle and allow reproductive patterns to occur naturally. African Lions have not had breeding difficulties in the past, and do not require assistance in the reproductive cycle, as interfering could cause infant deaths within the group, due to the mother or other group members killing infants or disturbance in the cycle. Therefore, African Lions are easily bred and maintained if allowing natural breeding to occur.

(pers. comm. Michelle Campbell 2009)

The fertility rate for African Lions is quite high : 95%, once ovulation occurs, (Estes 1991).

Reproductive Condition

Females

Females need to be in good health, physical appearance, and good weight range in order to reproduce successfully. If a procedure at the veterinary department is requested or planned, veterinary officers may perform an ultrasound on the uterus to check for reproductive condition. However, reproduction will be withheld if the female displays a genetic disorder or is unwell at the time of ovulation.

(pers. comm. Michelle Campbell 2009)

Males

Males indicate their level of condition through their mane. This is attributed by the age, injury, testosterone, nutrition and ambient temperature, (Shelburne, 2004). Research has shown that the males with longer, darker manes were those with higher testosterone serum and were more attractive to females. However, it was more the length of the mane that affected the females response. (Shelburne, 2004). Males also require good physical and internal health. Males hold the same genetic makeup as their fathers and other male siblings, therefore, it is necessary to maintain records of previous mating systems with other individuals within the group in order to avoid mating relatives (inbreeding), which could lead to genetic, internal or/and physical defects in the infants.

Techniques Used to Control Breeding

Keepers should allow breeding to occur naturally and is controlled within the pride on a cyclic routine of every 2-3 years. All cats have a zonal placentation. Artificial insemination, in vitro fertilisation, and embryo transfer have all been successful in breeding practices according to Fowler and Miller (2003). However, if preventing breeding and institutions do not have plans for breeding, zoo's generally resort to contraceptives. Contraception is often the simplest and least invasive form of controlling breeding. The American Zoo and Aquarium Association Contraception Advisory Group (2001, cited in Fowler & Miller, 2003) gives the following recommendations for felids.

- Ovariohysterectomy (desexing - removing ovaries and uterus of female) currently the safest method of birth control.
- Use of melengestrol acetate (MGA) implants for 2 years and then remove them for one pregnancy if possible. Do not use for more than 4 years.

- Use of other progestins such as Depo-Provera injection (%mg/kg body mass every 2 months).

CAUTIONS:

- Progestin contraceptives are associated with felid progressive uterine growth, resulting in infertility, infections, and sometimes uterine or mammary cancer. Repeated psuedopregnancy from sterile matings may result in the same side effects and this is not prevented by vasectomy of the male.
- Porcine Zona Pellucida (PZP) vaccine efficacy, safety and reversibility have not been demonstrated.
- Felids with melengestrol acetate implants should receive regular veterinary physical examinations, including palpation of the mammary chain and thoracic radiographs. ”

(Fowler & Miller 2003)

The AZA Wildlife Contraception Center (2003-2009) recommend the use of:

- GnRH Agonists - (Gonadotropin Releasing Hormone Agonists) - they are safe and reversible contraceptives. Side effects are similar to those associated with gonadectomy, especially the potential to gain weight unless diet is controlled. Types of GnRH Agonists, include;
    - Suprelorin (deslorelin) Implants (for Female or Male)
    - Lupron Depot Injection (for Female or Male)
- Ovariohysterectomy, Overietomy (Females) or Castration (Male) - safe and permanent methods.

CAUTIONS:

- “Vasectomy of males will not prevent potential adverse effect of female from prolonged, cyclic exposure to endogenous steroids associated with the obligate hormonal pseudo-pregnancy that follows copulation-induced ovulation in felids,” (Saint Louis Zoo, 2003-2009).
- Progestin contraceptives.
- PZP vaccine have only been demonstrated as safe and effective on pinnipeds and bears.

(Saint Louis Zoo 2003-2009)

Occurrence of Hybrids

The main hybrid species of Lions is the Asiatic and African Lion. A breeding programme began in India between Asiatic and African Lions, in hopes to increase the Asiatic population. However, in turn it resulted in inbreeding depression causing mental and physical defects and weakening the immune systems of the lions, which consequently debilitated the Asiatic gene pool.

Often hybrids between Barbary and other African Lion subspecies are breed in captivity.

In England, 1824, there was known to be a number of Liger (Lion X Tigress) hybrids. However, only rarely used African Lions, as it was mainly Asiatic Lions used for breeding with a Tigress.

On the contrary, they also had Tigons (Tiger X Lioness) in the early 1900’s. It was said that the mane of the males only developed at a later age and was much shorter than an actual pure bred Lion. When fertile, female Ligers or Tigons can then mate with a Lion or Tiger to create a Ti-Liger or Ti-Tigon.

Other hybrids include, Jaglion (Jaguar X Lion), which have a lions background colouring with a jaguars chocolate rosettes and the powerful build of a Jaguar. It is said that they were first born in Ontario, Canada,

with an African Lioness subspecies and a Jaguar.

There have also been records of a male Leopard being mated with a Lioness (known as a Leopan). Leopan's have also been bred in countries throughout the world in captivity, ranging from European countries to Japan, India and London. However, it was noted that wild hybrids are unlikely and would more than likely result in the leopards death. Another hybrid of Liard's (Lion X Leopardess) has also been known within captivity. Leopans can also be referred to as Spotted Lions. Young cubs display a faint spotted pattern, however, it normally disappears with age. This strain of Lion holds its marking throughout their life and these species are often found in Kenya.

There are also recessive genes in African Lions that are commonly mistaken as being a hybrid in the wild. The recessive (hidden) genes include the Black Lion and the White Lion. It is caused by a mutation of the genes and only develops when continuous inbreeding occurs. However, once that gene is dominant within that individual it may result in continuous strains of that gene in offspring (even without being inbred) if paired with another individual with this recessive gene. In fact most previous recordings or sightings of the Black Lion were a simple misunderstanding and result of poor lighting behind the cat when photographs were taken. However, there has been a record of a very dark and almost black Lion in the mid 19th century. Another record was from Scotland Zoo, reporting that the infertile male Lion had patches of pitch black skin, this occurs commonly due to somatic mosaicism (abnormal skin cells) causing pigmentation of the skin in certain areas.

The White Lion is now endangered due to poachers and game reserves allowing hunters to kill the species for money, as a symbol of power. Many programs have been developed to save the White Lion, which is a recessive gene of the African Lion commonly residing in the Timbavati region in South Africa.

(http://www.messybeast.com/genetics/hyb-lion-subspecies.htm n.d.)

Timing of Breeding

African Lions have no real breeding season as such, as they can make themselves ovulate at anytime. This is also due to scarcity or abundance of food supply in the wild, however, in captivity ovulation could be triggered by keepers by varying the diet weights. Also it must be known that females synchronise their breeding cycles with one another and therefore materials will need to be supplied enough for all female members in the enclosure.

Age at First Breeding and Last Breeding

It can take up to five years for the cubs to mature and only reach puberty at the age of two and a half years of age. Females will begin breeding at the age of four years (43 - 54 months). Males will begin breeding at five years of age. In the wild, the prime years for a Lion are between five and nine years of age and males are the fittest between five and six. After eight years, males tend to begin to lose their mane and body weight deteriorates. In captivity they begin to age at 10 -15years

(Estes 1991)

Image: Macaskill (2009)

Ability to Breed Every Year/ Ability to Breed More than Once Per Year

Breeding occurs approximately every 18 - 26 months, however, if a litter is lost, the female may be ready to mate again a few days after, (Nowak, 2005).
Generally, lioness will not breed every year. Mainly every 2-3 years lioness will produce cubs in the wild. The only variation to the breeding pattern is when the pride is in coalition and there is a male turnover. In this instance, the present young are killed by the new male's of the pride to prevent another male's blood line from continuing in "his" new pride. The male's will then mate with the females to form their blood line in the pride.
In captivity, it is unlikely to swap males and females and therefore, it is encouraged to promote breeding every 2-3 years, if written in the institutes breeding plans. It is more advantageous for lions to produce a smaller litter, as they then favour the current and future litters for the quantity and quality of young they produce.

(Shelburne 2004)

Nesting, Hollow or Other Requirements

Nesting requirements will need to be enough for all female members of the pride, in preparation for females that have synchronised their ovulation patterns. Generally, nest box with straw for bedding and comfort, usually with a rubber/plastic sheet covering the majority of the nest box for privacy, sense of security and warmth. Lions are very private about their birthing and search for thick vegetation to hide their cubs. Keepers could even use browse to help cover nest boxes even further and to provide a sense of natural environment.

Breeding Diet

The breeding diet is based on the individual's weights and body condition. However, a 40-50% weight increase of the individual is recommended during the pregnancy and therefore the diet should be calculated appropriately by veterinarians in order to achieve this healthy weight range increase during this period. The appropriate goal would be to aim for a gradual, constant and steady increase in weight during the course of the pregnancy. This in term will allow for a gradual and steady decrease, after an initial weight decrease after birthing, during the lactation period. Diet changes should be planned when female becomes pregnant in order to maintain and monitor the gestation process.

(pers. comm. Michelle Campbell 2009)

Oestrous Cycle and Gestation Period

The gestation period for lioness is generally 3.5 - 4 months (100-119days). Unlike other animals, but very common in cats, they can induce their ovulation cycle, which means they can make themselves ovulate at anytime, no specific breeding season. It is advantageous for females to sychronise oestrus, breeding, conception and birth within the pride. This allows the females and pride to take full effect and becomes highly communal.

(Shelburne 2004) & (Nowak 2005)

Litter Size

The average litter size for lions are 1-6 cubs, usually 3 or 4. Lions are very private about their birthing and seek dense vegetation to cover the litter from birth to 4-6weeks of age of the cubs' life.

Age at Weaning

Cubs are weaned from their mothers at the age of 7-9months (or 10months at the latest). However, they are still unable to fend for themselves at this age until at least 16 months, (Estes 1991).

Age of Removal from Parents

According to Estes (1991) the female infants will emigrate at the age of two. However, some females will remain within the current pride. It is said that each pride male has approximately 2.6 females. Males infants are forced to leave the pride at the age of three at the latest, mainly because of intolerance from the other males in the pride. Otherwise the males can be seen as a threat and a possibility of them attempting to take over the pride range. The emigrated females and males lead an unsteady existence, either as nomads or are seen as unwelcome lodgers which have to avoid other pride ranges.

(Estes 1991)

Image: Macaskill (2009)

Growth and Development

Cubs weigh approximately 1.2 - 2.1 kg at birth. Cubs eyes may be open at birth, however can take up to 2 weeks (generally 3-11days) to open. At birth they generally weigh approximately 1.3kg. They will follow their mother after 3 months and suckle from any lactating female in the pride. (Nowak 2005).

The cubs begin to walk at 10-15 days and run at 25-30 days. According to Estes (1991), cubs can only bite after their milk teeth erupt (21-30 days after birth), but are able to scratch immediately after birth. At approximately 4-8 weeks of age mothers will lead their cubs to kill prey. At 7 weeks they can keep up with the pride comfortably, however, still require assistance until the age of 16months for feeding and protection. Cubs and infants have the best chance of survival when the births within the pride are sychronised by the females, as they have one large group and there are no older cubs to hog the milk of their mothers. Cubs will suckle communally on any lactating female within the group and do not need to resort to their own mother. Suckling bouts last up to 1-10minutes and at 4 months cubs will suckle about 15 minutes a day.

Cubs will often be left alone for over 24 hours while mothers reside to the pride members. However, cubs are constantly hidden in dense bush or caves for protection from predators. Starvation and abandonment are likely when large prey is scarce, however, will not occur often. When cubs reach 5-7months of age, mothers will no longer slow down her pace for them, the cubs that are too weak to keep up will be left behind and abandoned. When cubs are old enough to kill for themselves, starvation only recedes at this stage. At two and a half months cubs will already begin to observe prey movements, which manipulates play enacts of stalking, ambushing, grappling, and killing motor patterns used by adults. Females will never lose their playfulness, whereas males will rarely join in after the age of three. Stalking postures are still undeveloped at the age of 7 months and sometimes spoil hunts and kills of prey because of their playful movements, trying to emulate their elders. They only begin to participate in hunting for prey at the age of 11 months. Lion cubs will remain in the maternal group for much longer than any other cat or felid species.

(Estes 1991)

Artificial Rearing

Housing

African Lion cubs should be housed in an isolated area free from other felids and adhesive weather conditions. It is suggested to use a den area or a covered holding yard that contains nest box and den facilities.

(Ginman 1999)

Temperature Requirements

African Lions can withstand diverse weather conditions and do not require specialized temperature requirements. However, for rearing purposes the cubs should be kept free of draughts and weather conditions until weaned. "Hairloss has been experienced at several Zoos and it is believed that the causes may be high environmental temperature and nutritional deficiencies" (Freeman & Hutchins, cited in Ginman 1999, 1980).

Diet and Feeding Routine

Quantity to Feed

The quantity of milk to be fed to each cub entirely depends on the interest in suckling and size of the cub. Growth and weight should be monitored and recorded closely to ensure cubs are receiving sufficient amounts of milk. This will in turn assist keepers in understanding whether there is a need to increase or decrease the milk quantity. Cubs generally continually increase in weight over the first 5-8 weeks.

Ginman (1999) recommends Biolac Kitten milk formula to be used in the artificial rearing of lions. "Using this formula, the cubs should be fed at least 5 times daily for the first week, feeding as much as the cubs will drink. The dilution rate is as follows:

- 1000 ml cool boiled water
- 170 g of Biolac Kitten formula (or 10 heaped scoops)" (Ginman 1999) (see *Appendix J*)

A good guide according to Ginman (1999) for amounts to be fed are as follows:

Body Weight	Total Volume per day
1000 g	200 ml
2000 g	400 ml
3000 g	600 ml
4000 g	800 ml
5000 g	1000 ml
6000 g	1200 ml

(Ginman 1999)

Feeding Guide

Please note: This subsection was written by Ginman (1999)

It is advised to feed the cubs between 10-20% of their body weight per day. E.g. 1 kg body weight: 10% = 100mls, 20% = 200mls. Always aim for the 20%. This daily amount is then divided into the total amount of feeds throughout the day. Weigh cubs on a daily basis and adjust accordingly. Always weigh at the same time every day prior to feeding to give an accurate and consistent weight.

Bottle/Teat Preparation and Care

Please note: This subsection was written by Ginman (1999)

After feeding, bottles and teats should be disassembled, emptied and rinsed with water

- Bottles/teats must be washed in dishwashing detergent in warm water prior to sterilising to remove the fatty deposits left by the milk.
- Use bottle brush to clean bottles and teats thoroughly. Salt can be used to remove further fatty build up on teats.
- Bottles/teats should be rinsed with clean water before placing in Milton solution
- All teats, bottles and measuring equipment should be sterilised between each feed
- Use Milton sterilising agent according to label and replace the solution every 24 hours. Correct dilution for Milton liquid is 25 mls per 2 L of water
- All bottles/teats and equipment must be thoroughly submerged in Milton solution so that no bubbles remain inside bottles etc.
- Rubber teats tend to perish in some solutions so keep a fresh supply or only soak for the minimum recommended time – 60 minutes in Milton solution.
- Bottles/teats do not need to be rinsed with water prior to use after sterilisation.

Schedule

Please note: The information in this subsection was written by Ginman (1999)

The following feeding schedule will be used for the Lion cubs:

Feeds at 4 – 6 weeks of age will be done at times below				
7 am	10 am	1.30 pm	5.30 pm	9 pm
Feeds at 6 – 8 weeks will be done at times below				
7 am	10 am	1.30 pm	4 pm	7 pm
Feeds at 8 – 10 weeks will be done at times below				
7 am	10 am	1.30 pm	5 pm	
Feeds at 10 – 12 weeks will be done at times below				
7 am	10 am	2 pm	5 pm	

Over this entire period the amount fed at each feed should continue to increase. The young should be offered as much as they will drink each feed without exceeding the recommended total volume per day/body weight (ie of up to 25%). Times, amounts fed, faeces, urine, weights, measurements and behaviour should all be recorded for each young.

Milk Preparation

Please note: This subsection was written by Ginman (1999)

- Milk formula must always be made according to the manufacturers directions.
- Cooled boiled water will be used to mix with the milk powder.
- After each feed, boiled water is to be obtained and stored in containers.
- Prior to feeding, the milk formula must be heated to approximately 38ºC and tested on the wrist to make sure that milk is not too hot.
- Heating can be done in a microwave oven or by standing the bottle/s in hot water.
- Each cub must be fed from a separate bottle/teat.
- Milk formula must be made up fresh for each feed.

Feeding Method

All cubs under 4 weeks old should be bottle fed until old enough to more solid foods. It is recommended to use a human baby bottle with a suitable teat. "A hole should be placed in the teat so as to allow a slow flow of milk to the young," (Ginman 1999). It is suggested to feed cubs in an elevated position or with their head upright. Ensure that the bottle and teat is sterile before milk is added to prevent infection and heated to body temperature before feeding. Separate bottles and teats should be used for each individual cub during feeding. Gently insert the teat into the cub's mouth and a small amount of milk should be expelled to stimulate suckling. If failing to suckle on teat and accept bottle, tube feeding should occur until they begin to suckle. However, it is recommended to pursue bottle feeding and encourage the cub to accustom itself to the teat, as tube feeding is an undesirable way of feeding.

Ensure only to mix milk powder with pre-boiled, cooled water and then warm up to correct temperature (eg. by sitting bottle in a jug of boiled water).

(Ginman 1999)

Specific Requirements

"Where possible cubs should be raised in a litter so that they can play and interact with each other. In domestic cats, the critical period of socialisation occurs between 2 – 7 weeks of age (Ginman 1999, cited in Fogle, 1991). During this period of development the cubs should be given the opportunity to encounter a range of stimuli that they will come across as adults. This will help the cubs to develop both mentally and physically so that they become well adjusted adults. Failure to expose cubs to different stimuli at this time can lead to adverse behavioural problems later in life (Fogle, cited in Ginman 1999, 1991)."

Exercise should be encouraged after the emergence stage of their development (approximately 4-6weeks onwards). Ensure cubs have complete separation/isolation from other felid species during the first few weeks as it is the most critical stage of rearing and to prevent the spread of disease, where young cubs have limited immunity from disease such as Feline Enteritis, endoparasites (e.g. roundworm or ringworm).

Vaccinations will commence at approximately 8 weeks of age.

Areas used for exercising cubs will vary in size depending on the number of cubs being housed in this space. The space must allow for cubs to freely move around and develop normal behaviours and socialisation.

Hygiene techniques should be maintained under strict instructions to prevent the transmission of disease which could potentially lead to fatality in cubs.

“If cubs kept together begin to suckle on each other, they may also develop alopecia and may need to be housed individually. A soft toy cub can be provided in place of litter mates. This also applies to lone cubs. Cubs can be kept on autoclaved straw, oaten hay or shredded paper.” Ginman (1999).

(Ginman 1999)

Data Recording

It is suggested to maintain a hand rearing data sheet for each cub during the process, used for recording daily operations such as time of feeding, amount of milk offered and amount of milk taken. Other information to record is faecal and urine samples taken. “Consistency of faeces must be recorded as diarrhea and constipation can rapidly lead to death in young cubs or be a sign of disease,” (Ginman 1999).

Weighing of cubs should occur at the same time each day, where all information should be recorded. Other important information necessary for recording includes behaviour, development, treatments and health related information. Data recorded on the hand rearing data sheet should then be recorded into the daily report system used at the institution.

(Ginman 1999)

Identification Methods

Identification methods can be done either by the pattern of the whiskers on the cub, which is like a finger print on a human, or the pale spots located on cubs up until the age of two where the markings gradually disappear or fade. Other options could include placing a mark on each cub (non-toxic substances only that are approved by the veterinarian).

When cubs reach 8 weeks of age, they will be able to have a microchip injected into their scapular region (between shoulder blades) to assist in identification.

Hygiene

Keeper’s hands and arms should be washed thoroughly and clothes clean before and after contact with the cubs to avoid transfer of disease. This is pivotal in the early stages of their development, as the cubs are highly susceptible in contracting disease from external factors (even if working with other felids at other times during the day) and could cause death.

Hygiene and Toileting

Keepers will need to stimulate the cubs (up to 6 weeks of age) to go to urinate and defecate after feeding. This is done by using a warm damp towel cloth (this rough surface helps to simulate the mother's tongue) wet wipe or cotton wool. Usually the mother would lick the region to encourage these toileting behaviours. Ginman (1999) recommends the steps below should be followed when encouraging toileting behaviours while maintaining hygienic:

- Gently but firmly rub dampened cloth/cotton wool over genitals and anus.
- Continue to stimulate until cub has urinated/defecated
- Use a separate clean cloth for each cub and change cloth once soiled
- Soiled bedding must be replaced immediately
- Soiled cloths must be rinsed and soaked in Napisan solution
- Follow Napisan manufacturer's directions when making up solution
- Napisan solution must be changed daily after each use.
- Soiled cotton wool must be placed in garbage bin
- Keeper is to wash hands with Hibiclens or another antibacterial wash/gel between toileting each cub
- Cloths soaked in Napisan must be rinsed, spin dryed and put in dryer prior to reuse.
- If cubs develop an irritation on genital region during stimulation, use cotton wool to toilet and report to veterinarians
- After each milk feed, cubs fur/mouth must be gently wiped with a clean cloth to remove any milk – a separate cloth must be used for each cub – soiled cloths must be placed in Napisan solution. This prevents matting of the fur and bacterial infections.

To provoke the cub's appetite, keepers can stimulate toileting before feeding. However, it is usually only conducted after feeding due to cub's needing to eliminate internal waste at this time.

Faecal matter will appear runny (similar to 'toothpaste' consistency), however, will begin the firm up as the cub matures and solid food is introduced into their diet. Ginman (1999) suggests faecal matter should be checked regularly for yeast infections, where a positive result is an indication of ill health or poor hygiene practices.

"Diarrhoea can cause death in young cubs if left unchecked in the first few days of life. Diarrhoea can be caused by poor quality milk or if the milk formula is too strong. Likewise constipation can be fatal and can be caused by failing to stimulate the young correctly or infrequently. The veterinarians should always be contacted if the cubs show any signs of ill health eg. diarrhoea, constipation, conjunctivitis, lethargy, coughing etc," (Ginman 1999).

Daily grooming of cubs, by the keeper, using a brush or grooming mitt will also gently massage the skin will help increase trust and a bond with the cub. Cubs can be bathed if needed, but will need to be thoroughly rinsed with warm water after the wash to remove any excess shampoo. Cubs should be towel dried and then blow dried to prevent getting ill from their damp or wet exterior.

Dens/nest boxes should be thoroughly cleaned on a daily basis to prevent the spread of disease (including hosing out area, disinfecting/bleaching and then hosing out the area of any remnants of chemicals).

(Ginman 1999)

Behavioural Considerations

Keepers need to consider whether the cubs are remaining in captivity or being released in order to drive particular behaviours. If releasing minimal contact is recommended after weaning. Hunting behaviours should be encouraged and develop a strong pride connection between members to promote wild survival and avoid lions becoming nomads. If remaining in captivity, keepers must begin to consider permanent housing considerations and encouraging natural behaviours with suitable socialisation traits. However, keepers may also want to begin the conditioning process at a young age and develop relationships and trust with this species.

Handling and Socialisation

Please note: This subsection was written by Ginman (1999)

The aim of handrearing and socialising the Lion cubs to humans is to provide ease of handling once mature. Continued contact with the cubs will be assessed as they develop. Depending on the cubs individual temperament, handling will be continued until the cubs become too boisterous for staff.

To allow the cubs to be handled for an extended period these points must be followed at all times-

- Cubs are to be encouraged to play only with siblings
- Cubs are to be discouraged from using claws or biting keepers at any time
- Cubs are to be discouraged from jumping on keepers
- Cubs are not to be restrained or held if showing aggressive/defensive behaviour
- Keepers are not to encourage excitable behaviour in any cub
- Keepers are not to play roughly/play fight with cubs
- Keepers must not at any time handle the cubs in a harsh manner
- Keepers are not to smack cubs – to discipline cubs they can be – ignored or the keeper may use their voice as a deterrent.
- Cubs should always be rewarded for good behaviour.
- Cubs should never be rewarded for unwanted behaviour
- Consistency in handling techniques is extremely important.
- Cubs should only be handled by keepers that they feel comfortable with.

Use of Foster Species

Although there are records of foster species being used to raise African lions, according to Ginman (1999) it is not recommended to have a foster species, as "…imprinting occurs which affects future recognition of their own kind for breeding. Greater than one cub should be reared so they imprint onto each other and recognize their own species," (Ginman 1999).

Weaning

As mentioned in *Section 10 Breeding*, in the wild weaning occurs at between the age of 7 – 9 months (10months maximum). However, cubs are unable to fend for themselves until the age of 16months. If

remaining in captivity, weaning should occur naturally and in a secure environment where food is provided on a regular and routine basis, cubs should be weaned completely by 4 months of age (due to being in a controlled environment in captivity where diets are monitored carefully on a daily basis). According to Ginman (1999) the recommended weaning guideline should be as follows:

The cubs will solely be bottle fed until they are 8 weeks of age.			
Feeds at 8 – 10 weeks			
7 am	10 am	1.30 pm	5 pm

At 8 – 9 weeks of age, the cubs will be introduced to meat. Initially the cubs will be given one feed of mince meat daily at the 5 pm feed. Mince must be warmed to room temperature prior to feeding. Chicken, beef, horse and kangaroo mince will be supplemented with Petvite (vitamin/mineral supplement) as per the veterinary recommended amounts at the institution. Feeding a range of meat at this time will lead to the cubs accepting a wider range of meat as adults.

One feed of mince daily at 5 pm will continue until the cubs are 10 – 12 weeks			
Feeds at 10 – 12 weeks			
7 am	10 am	2 pm	5 pm

From 10 weeks of age, bottle feeds will only be done at 7 am and 10 am. Cubs will be fed mince as above for 2pm and 5 pm feeds.

From 12 weeks of age, the cubs will be fully weaned and will no longer receive any bottle feeds. From 12 weeks of age, the cubs will be introduced to a normal Big Cat diet (veterinary approved amounts) which contains muscle meat with fur and bones supplemented with Petvite daily. The cubs should not be given a starve day until they are mature at 2 – 3 years of age.

Initially the cubs, will receive three meat feeds daily		
Feeds at 10 – 12 weeks		
7 am	11.30 am	2.30 pm
At 16 weeks of age the feeds will be decreased to twice daily		
7 am	2.30 pm	
By 6 months of age, the feeds will be decreased to one feed daily (without a starve day)		
7 am		

Initially only small amounts of mince meat should be offered at frequent intervals for e.g. 100g offered 3 times daily. The amounts to be fed will vary according to the size of the cubs, but as a general rule the cub's abdomen should not look bloated at the completion of a meal. Overfeeding will cause diarrhoea and make the young uncomfortable. Once cubs have been introduced to meat with fur and bones, the amount to be fed will again be determined by the growth rates of the cubs.

(Ginman 1999)

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Glossary

Acclimatised – ability to adapt to various climates, altitudes, environments, and temperatures.

Agonistic – being aggressive or defensive interaction between individuals in a pride.

Anthelmintic therapy – a substance used to destroy and eliminate parasites/worms.

Antibodies – a Y shaped protein produced by B cells as a primary immune defense.

Antidote – a reversal drug or counteracting medicine.

Artificial insemination – injection of semen into the uterus by a syringe.

Ascariasis – disease or infestation caused by a parasite roundworm.

Auto mutilation – to self harm.

Barbiturates – used as a sedative or sleep inducer, which depresses the activity of the central nervous system.

Bovine Spongiform Encephalopathy – a brain disease, transmissible and affects many animals.

Calicivirus – a respiratory disease comprising of several strains.

Canine distemper – an infectious disease caused by an unidentified virus and fatal in cats. It is closely related to the human measles virus.

Carnassials - back teeth used to slice flesh.

Coccidiosis worms – microscopic parasites detected by faecal tests, however, are not actually worms and are not susceptible to de-worming treatments.

Colostrum – part of the mother milk produced in the initial stages of the birth of the young. A yellowish liquid, which contains high levels of immune properties necessary in preventing disease in the young.

Communal – in a pride, it means to share the role of caring for young. All procedures are shared within the pride, working together to achieve a goal.

Convulsions – violent and involuntary muscle contractions.

Copulate – to engage in sexual intercourse

Debilitated – impairing energy or strength on an animal.

Dermatophytosis – a fungus parasite on the skin and causing skin disease.

Dimorphism – ability to distinctly identify female and male forms in structure of the same species.

Dismount – to get off the female after copulation.

ELISA test (enzyme-linked immunoassay) – a laboratory test to detect antibodies in the blood.

Embryo transfer – the transfer of a developed embryo to or from the uterus of a surrogate mother.

Emigrated females – to leave the pride and find another pride that will accept the female and require more females.

Endogenous steroids – resulting conditions from within the organism rather than externally caused.

Facultative carnivores – (another word for meat eater) – depend on animal flesh/meat to gain nutrients.

Feline Calicivirus – a viral disease that is the cause of a respiratory infection in cats.

Feline Coronavirus – a mild disease in most cases, causes asystomatic infection and mild diarrhoea.

Feline Herpesvirus – please see Rhinotracheitis.

Feline Immunodeficiency virus, FIV (Feline HIV) - a feline version of AIDS and is a strain of lentivirus.

Feline Leukemia virus (FELV) - is very similar to FIV in terms of transmission, however, can also be passed through respiratory secretions, urine, faeces and milk.

Feline Parvovirus – a virus causing severe disease detected in the intestinal tract.

Gastric spiral bacteria – tightly coiled organisms with bipolar flagella.

Gestation – period of maternity or pregnancy.

GnRH Agonists - (Gonadotropin Releasing Hormone Agonists) – a second choice treatment used when several months of birth control pill therapy has not been effective. It is used to reduce the amount of estrogen in the body and prevent the release of eggs for ovulation.

Gonadectomy – removal of an ovary or testis.

Gregarious – being highly sociable animals; enjoying the company of others.

Haematology – medicine that deals with diseases of blood.

Helicobacter Gastritis – infection of the stomach.

IFA (immunofluorescence assay) – a diagnostic blood test.

immobilisation – to prevent the movement, activity or use of a particular limb, entire body or region of the body.

In vitro fertilisation – (IVF) joining the females egg and males sperm in a laboratory dish, in order to fertilise the egg.

Induced ovulators – the female does not ovulate any eggs (for breeding) until she has been mated with by a male.

Infanticide – killing the infants to begin their own genetic offspring.

Intramuscularly – injections in the muscle.

Lactate – to produce milk.

Locomotion – act of moving from place to place.

"Lodgers" (squatters) – an individual or pride that occupies property without consent or title/right to do so.

Longevity – life span.

Lymphoma – a tumour arising from the cellular elements of the lymph nodes.

Melengestrol acetate (MGA) – a growth stimulating additive.

Morphometrics – measurements/positioning of the body and organs.

Neutropenia – presence of abnormally small numbers of neutrophils (a cell or tissue that has no affinity for acid or dyes) in the blood.

Nomad – a wanderer that moves from place to place and has no permanent position in any pride.

Nomenclature – a system of names for a particular individual species.

Obligate carnivores - known as true carnivores (meat as the main source of nutrients), require animal tissue in order to thrive.

Oestrus – period of maximum receptivity in a female.

Opportunistic – taking advantage of any event or circumstance as much as possible.

Ovariohysterectomy (desexing) - removing ovaries and uterus of female.

Pad ulceration – sores found on the paw of the felid (commonly in between the grooves).

Palpation – examining by touch in order to determine illness or disease.

Panleucopenia – Viral disease that changes components of white blood cells.

Papillomarvirus – DNA virus.

Pneumonia – inflammation of the lungs with congestion.

Polygynandrous - when "two of more males have an exclusive relationship with two or more females.

PPE – personal protective equipment.

Progestins – a natural or synthetic substance that mimics some or all of the actions of progesterone.

Prophylactic medication – preventative drugs/protecting against disease, infection or illness.

Protozoa worms – microscopic parasites, invisible to the eye.

psuedopregnancy – false pregnancy – displaying signs of pregnancy without conception

PZP vaccine – (Porcine Zona Pellucida) – causes antibodies to prevent attachment of the sperm to the ova, injectable into the muscle of the target animal.

Recessive – an allele gene that does not produce characteristic effect in the presence of a dominant allele.

Rhinotracheitis – an acute upper respiratory infection that replicates in the nasal tracts.

Scapula – injections between the shoulder blades.

Seizures – a sudden attack.

Serology – characteristics of disease or organisms displayed by the study of blood serum.

Subcutaneously – injections under the skin.

Subunit canary pox vectored vaccine – virus based primer vaccine (booster), infects but does not cause disease.

Suffocation – to kill by restricting or preventing air flow to the blood.

Synchronise – an event occurring at the same time.

Taxonomy – technique of classification

Taxoplasmosis – a parasite commonly transmitted from cat to cat or from cat to humans via faeces or insufficiently cooked meat containing the parasite.

Thoracic radiographs – X rays of the chest and organs of the Thoracic cavity (enables visualization of beyond the chest/lungs, e.g. tissues, organs, bones. It is recommended for animals with breathing difficulties or with suspected lung or heart disease.

Thrombocytopenia – decrease in the number of blood platelets.

Trypanosomiasis – an infection or disease caused by a flagellate protozoan found in the blood or tissue of humans or vertebrates, transmitted by insects.

Vasectomy – a medical procedure where the ducts that carry sperm in the male are cut and tied off in order to stop sperm flow. A method of sterilisation in the male to stop breeding.

Zonal placentation – only particular zones/regions of the placenta have a vascular area involved in the development of the implantation of the embryo in a female.

Zoonoses – any disease with the ability to transfer from animal to humans and vice versa.

Appendices

Appendix A – (Cat World 2009)
Toxic and Non Toxic Plants for Cats

Please Note: These tables below were written by from Cat World (2009).

Toxic Plants include:

Acocanthera Aconite Alfalfa Almond (pits) Aloe Vera Alocasia Alsike Clover Amaryllis Amsinckia Angels Trumpet Angels Wings Apple (seeds) Apple Leaf Croton Apricot (Pits) Arrowgrass Arrowhead Vine Asparagus Fern Autumn Crocus Avacado (fruit and pit) Azalea	Impatiens Indian Rubber Plant Indian Tobacco Indian Turnip Inkberry Iris Iris Ivy	Quaker Bonnets
Baby's Breath Baneberry Bayonet Beargrass Beech Belladonna Bird of Paradise Bitter Cherry Bitter Nightshade Bittersweet Black-eyed Susan Black Locust Bleeding Heart Bloodroot Bluebonnet Blue Flag Blue-Green Algae Boston Ivy Bouncing Bet	Jack in the Pulpit Jamestown Weed Janet Craig Dracaena Japanese Show Lily Jatropha Java Beans Jequirity Bean Jessamine Jerusalem Cherry Jimsonweed Johnsongrass Jonquil Jungle Trumpets Juniper	Ragwort Red Clover Red Emerald Red Maple Red Princess Red-Margined Dracaena Red Sage Rhododendron Rhubarb Ribbon Plant Richweed Rosemary Pea Rubber Plant

Box Boxwood Brackenfern Brake Fern Branching Ivy Buckeyes Buddist Pine Bull Nettle Burning Bush Buttercup		
Cactus, Candelabra Caladium Caley Pea Calfkill Calla Lily Candelabra Cactus Castorbean Ceriman Chalice Vine Charming Dieffenbachia Chinaberry tree Chinese Evergreen Chinese Inkberry Christmas Plant Christmas Rose Chrysanthemum Cineria Clematis Climbing Nightshade Clover Cocklebur Common Burdock Common Privet Common Tansy Coral Plant Cordalis Cordatum Coriaria Cornflower Corn Plant Cornstalk Plant Cowslip Crabs Eye Croton Corydalis Crocus, Autumn Crown of Thorns Cuban Laurel Cuckoo Pint Cutleaf Philodendron Cycads Cyclamen Cypress Spurge	Kalanchoe Klamath Weed	Saddle Leaf Philodendron Sago Palm Satin Pothos Schefflera Scotch Broom Scouringbrush Senecio Sensitive Fern Sheep Laurel Silver Pothos Silver Queen Singletary Pea Skunk Cabbage Snake Plant Snapdragon Snowdrops Snow on the Mountain Soapwort Sorghum Spotted Dumb Cane Squirrelcorn Squirreltail Barley St. Johnswort Staggerweed Star of Bethlehem Stinging Nettle String of Pearls Striped Dracaena Sudan Grass Sweet Cherry Sweetheart Ivy Sweetpea Swiss Cheese plant

Daffodil Daphne Datura Day Lily Deadly Nightshade Death Camas Devil's Ivy Delphinium Decentrea Dieffenbachia Dog Bane Dolls Eyes Dracaena Palm Dragon Tree Duchman's Breeches Dumb Cane Dwarf Larkspur	Laburnum Lacy Tree Philodendron Lambkill Lantana Larkspur Laurel Lily Lily Spider Lily of the Valley Lima Bean Locoweed Lords and Ladies Lupine	Tangia Pea Tansy Mustard Tansy Ragwort Taro Vine Tarweed Thornapple Tiger Lily Tinsel Tree Tobacco Tolguacha Tomato Plant (green fruit, stem and leaves) Tree Philodendron Tri-leaf-wonder Trillium Tropic Snow Dieffenbachia Trumpet Vine Tulip Tung Tree
Easter Flower Easter Lily Eggplant Elaine Elderberry Elephant Ear Emerald Duke Emerald Feather English Ivy English Yew Ergot Eucalyptus Euonymus Euphorbia Evergreen Everlasting Pea	Madagascar Dragon Tree Majesty Mandrake Marble Queen Marigold Marijuana Mayapple Mescal Bean Mexican Breadfruit Mexican Poppy Milk Bush Milkweed Milo Miniature Croton Mistletoe Mock Orange Monkshood Moonseed Morning Glory Mother-in Law's Tongue Morning Glory Mountain Laurel Mushrooms	Valley Venus Flytrap Verbena Virginia Creeper
False Cactus False Hellbore Ferns Feverfew Fiddle-leaf fig Fiddleneck Florida Beauty Flag Flax	Nap-at-noon Narcissus Needlepoint Ivy Nephytis Nightshade Nutmeg	Walnuts Water Hemlock Weeping Fig West Indian Lantana White Clover White Hellebore White Sanicle White Snakeroot Wild Barley

Fleur-de-lis Fly Agaric Four O'Clock Foxglove Foxtail Barley Fruit Salad Plant		Wild Black Cherry Wild Bleeding Heart Wild Call Wisteria Wolfs Bane Wood Nettle
Geranium German Ivy Ghostweed Giant Dumb Cane Glacier Ivy Golden Chain Gold Dieffenbachia Gold Dust Dracaena Golden Chain Golden Glow Golden Pothos Gopher Purge Green Dragon Green False Hellebore Ground Ivy Groundsel	Oaks Oleander Onion Oriental Lily	Yellow Jasmine Yellow Jessamine Yellow Oleander Yellow Sage Yellow Star Thistle Yew
Hahn's Self-Branching Ivy Heartland Philodendron Hellebore Hemlock, Poison Hemlock, Water Henbane Holly Honeysuckle Horsebeans Horsebrush Horse Chestnut Horse Nettle Horse Tail Hurricane Plant Hyacinth Hydrangea	Panther Cap Mushroom Parlour Ivy Peace Lily Peach (pits and wilting leaves) Pencil Cactus Pennyroyal Peony Periwinkle Philodendron Pie Plant Pimpernel Pin Cherry Pinks Plumosa Fern Poinciana Poinsettia Poison Hemlock Poison Ivy Poison Oak Pokeweed Poppy Potato Pothos Precatory Bean Primrose Privet	

Non Toxic Plants include:

Achira Acorn summer squash African violet Airplane Plant Algarroba Aluminium Plant Alumroot American Plane Tree Anthericum Comosum Antirrhinum Multiflorum Arabian Gentian Aregelia Artillery Plant Aspidium Falcatum Aubepine Autumn Olive	Ice Plant Imbricata sword fern Irish moss Iron cross begonia Iron tree Ivy-leaf peperomia Ivy peperomia	Queencup Queens Spiderwort Queensland Arrowroot
Baby Rubber Plant Baby Tears Bachelors Buttons Ball Fern Bamboo Palm Bamboo Vine Bamboo Banana Banana Squash Barrel Cactus Beefsteak Plant Begonia Belmore Sentry Palm Big Shellbark Hickory Bitter Pecan Bitternut Hickory Black Haw Black Hawthorn Blaspheme vine Bloodleaf Plant Blooming Sally Blue Daisy Bluebottle Blushing Bromeliad Bold Sword Fern Boston Fern Bottle Palm Bottlebrush Brazilian Orchid Bride's Bonnet Bristly Greenbrier Brodiaea Pulchella Broom Hickory Bullbrier Bur Gourd	Jackson Brier Jacob's Ladder Japanese Aralia Japanese Pittosporum Japanese moss Japanese holly fern Jasmine Jewel orchid Joseph's coat Jungle geranium	Rabbits Foot Fern Rainbow Orchid Red African Violet Red Veined Prayer Plant Red Berried Greenbrier Red Hawthorne Red Palm Lily Red Edge Peperomia Reed Palm Resurrection Lily Rex Begonia Rhynchophorum Ribbon Plant Roosevelt Fern Royal Velvet Plant Rubber Plant, Baby Russian Olive

Burro's Tail Buttercup Squash Butterfly Ginger Butterfly Iris Butterfly Squash Butterfly Tulip Butterfly Orchid Button Fern		
Caeroba Calathea Insignis California Pitcher Plant Callistemon Citrinus Callistemon Bradyandrus Callistemon Viminalis Calochortus Nuttalli Calthea Lancifolia Camellia Canada Hemlock Canary Date Palm Candle Plant Candycorn Plant Canna Lily Canterbury Bell Cape Jasmine Cape Primrose Carob Tree Carob Caroba Carobinha Carolina Hemlock Carrion Flower Carrot Fern Carrot Flower Casaba Melon Cast Iron Plant Cat Ear Cat Grass Catnip Cattleya Celosia Chamaedorean Humilis Chicken Gizzard Plant Chinese Fan Palm Chinese Plumbago Chlorophytum Chlorophytum Bichetii Chocolate Soldier Plant Christmas Dagger Fern Christmas Palm Christmas Orchid Cinnamon jasmine Cinquefoil Cirrhopetalum	Kaempferis Kahali Ginger Kenilworth Ivy Kentia Palm Kenya Palm Kenya Violet Kharoub King and Queen Fern King of the Forest King Nut Kuang-yen- pa-hsieh	Saffron Spike Zebra Saint Bernards Lily Sand Lily Sand Verbena Satin Pellionia Sawbrier Scabious Scarborough Lily Scarlet Orchid Scarlet Sage Sego Lily Shagbark Hickory Shan ku'ei-lai Shellbark Hickory Shiny Leaf Smilax Shrimp Cactus Silver Nerve Plant Silver Table Fern Silver Pink Vine Silver Bell Silver Heart Silver Star Silver Berry Silver-Leaf Peperomia Silver Tree Anamiga Slender Deutzia Small Fruited Hickory Smilax Tamnoides Vas Hispida Speckled Wood Lily Spice Orchid Spider Ivy Spider Plant Spotted Laurel Squarenut Squirrels Foot Fern Star Jasmine Star Plant Star Tulip Star Window Plant Star Lily Strawberry Striped Blushing Sugar Pods Sulfur Flower Summer Hyacinth

Clearweed Cliff Brake Fern Club Moss Cockscomb Coleus Common Staghorn Fern Confederate Jasmine Coolwort Copperleaf Coral Ardisia Coral Bells Cornflower Crape Myrtle Crataegus Phaenopyrum Crataegus Creeping Charlie Creeping Gloxinia Creeping Jenny Creeping Mahonia Creeping Pilea Creeping Rubus Creeping Zinnia Crepe Myrtle Crimson Bottlebush Crimson Cup Crossandra Cucumber Cushion Moss Cushon Aloe Cyrtudeira Reptans		Swedish Ivy Sweet William Sweetheart Peperomia Sweetheart Hoya Sword Fern
Dancing Doll Orchid Donkey Tail Dwarf Date Palm	Lace Flower Vine Lace Orchid Ladies Ear Drops Lady Lou Lady Palm Lagerstroemia Indica Lance Pleumele Large Lady Palm Leather Peperomia Lemon Bottlebrush Leng-fen tu'an Leopard Orchid Leopard Lily Lesser Snapdragon Lily of the Valley Orchid Linden Lipstick Plant Little Fantasy Peperomia Little Zebra Plant Living Rock Cactus Living Stones Locust Pods Lou-lang-t'ou	Tahitian Bridal Veil Tailed Orchid Tall Feather Fern Tall Mahonia Teasel Gourd Texas Sage Thea Japonica Thimble Cactus Thorn Apple Ti Hu-Ling Tiger Orchid Toad Spotted Cactus Torch Lily Tous-Les-Mois Trailing Peperomia Tree Cactus Tree Gloxinia Tropical Moss True Cantalope Tu Fu-Ling Tulip Poplar Tulip Tree Turban Squash

	Luther	Turf Lily
Easter Daisy Easter Lily Cactus Easter Orchid Easter lily Cactus Elephant Ear Begonia Emerald Ripple Peperomia English Hawthorn Epidendrum Episcia	Madagascar Jasmine Magnolia Bush Mahonia Aquifolium Malabar Gourd Malaysian Dracaema Manila Palm Mapleleaf Begonia Maranta Marbled Fingernail Mariposa Lily Maroon Mary-Bud Measles Plant Melons Metallic Peperomia Metallic Leaf Begonia Mexican Firecracker Mexican Snowballs Mexican Rosettes Minature Maranta Minature Marble Plant Minature Fish Tail Miniature Date Palm Mistletoe Cactus Mockernut Hickory Mosaic Plant Mosiac Vase Moss Phlox Moss Agate Moss Rose Moss Campion Moss Fern Mossy Campion Mother Fern Mother of Pearl Plant Mother Spleenwort Mountain Camellia Mountain Grape Mulberry Bush Musa Paradisiaca Muscari spp. Muscari Armeniacum Muskmellon	Umbrella Plant Urbinia Agavoides Usambara Violet
Fingernail Plant Fire Weed Forster Sentry Palm Fortunes Palm Freckle Face Friendship Plant	Narrow Leafed Pleomele Natal Plum Neanthe Bella palm Neanthebella Nematanthus spp. Neoregelia Nephrolepsis Nerve Plant	Variegated Philodendron Leaf Peperomia Variegated Wax Plant Variegated Wandering Jew Variegated Oval Leaf Peperomia Variegated Laurel Velvet Plant Venus Fly Trap

	New Silver and Bronze Night Blooming Cereus	Verona Fern Verona Lace Fern Vining Peperomia Violet Slipper Gloxinia
Gerbera Gherkins Ghost Plant Ghost Leafless Orchid Giant White Inch Plant Giant Holly Fern Giant Aster Gibasis Geniculata Globe Thistle Gloxinia Gold Bloom Goldfish Plant Good Luck Palm Grape Hyacinth Grape Ivy Great Willow Herb Green Ripple Peperomia Greenbrier	Odontoglossum spp. Old World Orchid Old Man Cactus Orange Star Oregon Grape Ossifragi Vase	Waffle Plant Walking Anthericum Washington Hawthorn Water Hickory Watermelon Peperomia Watermelon Begonia Watermelon Pilea Wax Plant Wax Rosette Weeping Sergeant Hemlock Weeping Bottlebrush Weisdornbluten West Indian Gherkin Western Sword White Edged Swedish Ivy White Heart Hickory White Ginger Whitman Fern Wild Buckwheat Wild Sarsaparilla Wild Lantana Wild Strawberry Wild Hyacinth Willow Herb Windmill Palm Winter Cattleya Withered Snapdragon Woolflower
Hagbrier Haworthia Haw Hawthorn Hellfetter Hemlock Tree Hen & Chickens Fern Hickory Hindu Rope Plant Holly Fern Hollyhock Honey Locust Honey Plant Honeydew Melon Honeysuckle Fuchsia Hoya Hubbard Squash Hypocyrta	Paddys Wig Painted Lady Palm Lily Pampus Grass Panamiga Pansy Orchid Paradise Palm Parlor Plant Parlor Palm Parsley Fern Peace Begonia Peacock Plant Pearl Plant Pearly Dots Peperomia Peltifolia Peperomia Rotundifolia Peperomia Fosteri Peperomia Sandersii Peperomia Hederifolia Pepper Face	Yellow-Flowered Gourd Yellow Bloodleaf Yerba Linda

	Persian Violet Pheasant Plant Piggy Back Plant Pigmy Date Palm Pignut Hickory Pignut Pilea Microphylla Pilea Mucosa Pink Polka Dot Plant Pink Pearl Pink Starlite Pink Brocade Pirliteiro Pitaya Plantanus Occidentalis Plantanus Orientalis Platinum Peperomia Platycerium Alicicorne Plumbago Larpentiae Plush Plant Polka Dot Plant Polystichum Falcatum Pony Tail Porcelain Flower Pot Marigold Prairie Snowball Prairie Lily Prayer Plant Prickly Bottlebrush Prostrate Coleus Purple Waffle Plant Purple Baby Tears Purple Passion Vine Purpleosier Willow	Zebra Haworthia Zebra Plant Zinnia sp. Zucchini Squash

Appendix B – Annual Cycle of Maintenance

Enclosure/Holding Yards/Den(Night yards) Cleaning Frequency – Daily Tasks

Maintenance Tasks	*Checklist*
Thorough clean daily – including picking up any faecal matter, raking, remove any old bones, hosing down walls, scrub water troughs/rock structures (if applicable) and checking windows, (if applicable). – Holding yards should have particular attention when an animal is sick.	
Water changed daily with quick clean of container edges.	
Hose out den (night yard) cement (if applicable).	
Airlocks must be cleaned daily, sometimes even several times a day.	
Moat levels checked and water quality maintained.	
Integrity check of enclosure,night yards (den) and holding yards.	
Checking pest traps.	
Remove weeds/toxic plants.	
Take a faecal sample from all Lions for veterinary analysis – signs of stress, internal parasites, and oestrus levels.	
Check integrity of all electric fences, locks, slides and hydraulic systems. Grease any if necessary to ensure efficiency.	

Enclosure/Holding Yards/Den(Night yards) Cleaning Frequency – Weekly Tasks

Maintenance Tasks	*Checklist*
Cleaning/squeegee windows, (if applicable)	
Clean and disinfecting toys and equipment/ enclosure furniture.	
Water troughs are disinfected and scrubbed.	
Depending on the tree species, logs should be changed when all bark has been shredded/ scratched off or when mould develops in wet seasons. This could be weekly or monthly.	
Stick collection.	
Nest boxes should be cleaned out of all straw/hay, disinfected and replaced with fresh straw.	
Check Cats for Fleas/other external parasites and treat if necessary.	
Disinfect night yards (den cement area) and holding yards with bleach solution. Clean walls if applicable.	
Change furniture and/or toys (rotate other furniture/toys in den and others out for cleaning - then rotate).	
Check First Aid equipment and re-fill if necessary.	

Enclosure/Holding Yards/Den(Night yards) Cleaning Frequency – Monthly Tasks

Maintenance Tasks	*Checklist*
Sand, mulch or soil (substrate) change.	
Long grasses replaced or replenished.	
Depending on the tree species, logs should be changed when all bark has been shredded/ scratched off or when mould develops in wet seasons. This could be weekly or monthly.	
Seasonal grass cutting/mowing/whippersnippering. During summer months grass should be cut every month to avoid attracting foreign species (e.g. rats/mice/snakes). Winter months the	

enclosure will only need to be done every few months, as required.	
Whenever grass cutting occurs – change furniture within enclosure e.g. large logs and rocks etc. add and remove any wanted/unwanted furniture or simply re-arrange.	

Enclosure/Holding Yards/Den(Night yards) Cleaning Frequency – Annual Tasks

Maintenance Tasks	***Checklist***
Thorough clean/scrub/disinfecting/replacing water of moats, if applicable.	
Pest control (parasites, internal and external, cockroaches and vermin, e.g. rats/mice) must be thoroughly checked and area sprayed if necessary annually. (however this should be checked daily – bait station or apparatuses may be applicable)	
Possibility of replacing any wire meshes on fences or under substrate – or immediately if OHS concern.	
Annual health veterinary examinations – vaccinations, implants (if necessary), physical examination, blood samples and general check up.	

Appendix C - (Lomb Scientific Pty Ltd 2009)

MATERIAL SAFETY DATA SHEET - F10

COMPANY DETAILS MANUFACTURER:
AUSTRALIAN DISTRIBUTOR: Health and Hygiene (Pty) Ltd
COMPANY: Chemical Essentials (Pty) Ltd P O Box 347. Sunninghill 2157,
Address: 13 Abelia Str, Doncaster East, South Africa.
Victoria 3111 Tel:+27 11 474-1668
Emergency Telephone number:+03 9841 9901 Fax: +27 11 474-1670
Fax: +03 9841 9909 e-mail: info@healthandhygiene.co.za

IDENTIFICATION

PRODUCT NAME: **F10 SUPER CONCENTRATE DISINFECTANT** UN Number: None
D G Class: None

Hazchem code: None
Poisons Schedule: 5

HAZARDOUS ACCORDING TO CRITERIA OF WORKSAFE AUSTRALIA IN THE PACK CONCENTRATE ONLY (eyes and skin irritant)
USE: Biodegradable multi purpose Disinfectant for all hard surfaces, equipment and airspaces

PHYSICAL DESCRIPTION/PROPERTIES
Appearance: Clear, colourless liquid, with a slight natural odour.
Boiling Point: 110 ^{0}C
Vapour Pressure: Not known
Specific Gravity: 1.00
Flash Point: Not flammable
Flammability Limits: Not flammable
Solubility in water: Soluble

INGREDIENTS
CAS Number Quantity (w/w)
Benzalkonium Chloride 68424-85-1 5.4%
Biguanide 27083-27-8 0.4%
Ingredients not determined to be hazardous to 100%

HEALTH HAZARD INFORMATION

HEALTH EFFECTS:
Acute
SWALLOWED: Low. Substantial ingestion may cause irritation to mouth, throat and digestive tract.
EYE: Low. Will cause irritation but not serious damage.
SKIN: Low. Concentrate may act as mild degreasant to sensitive skin.
INHALED: Low. No significant hazard.
Chronic
INHALED: Low. No significant hazard

FIRST AID

SWALLOWED: DO NOT induce vomiting. Give milk or water to drink. Seek medical advice where necessary.
EYE: Rinse eyes with water. Seek medical advice where necessary.
SKIN: Wash affected area with soap and water.
INHALED: Non-toxic. Avoid long term inhalation of neat liquid. Remove to fresh air.
FIRST AID FACILITIES: Contact a doctor or Poison Information Centre (phone 131126)
ADVICE TO DOCTOR: Treat symptomatically

PRECAUTIONS FOR USE

EXPOSURE LIMITS: No data found
Engineering controls: None required
PERSONAL PROTECTION: Not required
FLAMMABILITY: Not Flammable

SAFE HANDLING INFORMATION

Storage and Transport: Store below 30 ^{0}C in dry conditions
SPILLS AND DISPOSAL: Soak up on an inert material e.g. dry earth and dispose of in an area approved by local authority by-laws. Flush small spills with copious amounts of water
FIRE/EXPLOSION HAZARD: The product is not flammable or explosive.
OTHER INFORMATION: Ensure good industrial hygiene.
DO NOT mix with soaps or other chemicals.

CONTACT POINT: Managing Director, +03 9841 9901
Chemical Essentials Pty Ltd

KEEP OUT OF THE REACH OF CHILDREN

Issue number: 2
Issue Date: August 2004

Appendix D - Solo Pak Australia (n.d.)

Material Safety Data Sheet - Bleach

Classified as hazardous according to the criteria of Worksafe Australia

Section 01 Identification

Home

MSDS:	Rev 2 Date: 06 August 2003
Domestic Trade Name:	Bleach
Other Names:	Hypochlorite Solution, Bleach Solution, Hypo.
Manufacturers Product Code:	None Allocated
UN Number:	1791
Dangerous Goods Class:	8
HAZCHEM Code:	2X
Poison Schedule Number:	None Allocated
Use:	Bleaching Agent, Disinfectant

Section 2 Physical Description / Properties

Appearance:	Clear, green-yellow liquid having a chlorine odour. Bleach is strongly corrosive and a moderate oxidising agent.
Boiling Point or Melting Point:	110^{o}C (15% available Chlorine)
Vapour Pressure:	Not Available
Specific Gravity:	1.1
Flash Point:	Not Available
Flammability Limits:	Not Available
Solubility in Water:	Aqueous Solution

Section 3 Other Properties

pH of Concentrate:	12 (approximately)

Section 4 Ingredients

Chemical Name:	**CAS Number:**	**Proportion:**
Sodium Hypochlorite [NaOCl]	7681-52-9	10% weight / volume
Sodium Hydroxide [NaOH]	1310-73-2	0.8%
Water	-	Remainder

Section 5 Health Effects

Acute:	Corrosive and irritating if swallowed or ingested. Dangerous when in contact with the eyes.
Swallowed:	Severe internal irritation due to corrosive effect.

Eye:	Severe irritation and burns.
Skin:	Irritation and burns.
Inhaled:	Irritation of respiratory tract, resulting in coughing and breathing difficulty caused by chlorine fumes.
Chronic:	If condition persists, seek further attention.

Section 6 First Aid

Swallowed:	Wash out mouth with water and give water to drink. Do not induce vomiting.
Eye:	Irrigate immediately with water for 15 minutes and seek medical attention.
Skin:	Wash with large amounts of water. Remove affected clothing and wash underlying skin.
Inhaled:	Remove from exposure. Keep warm and at rest.

Section 6B First Aid Facilities:

Advice to Doctor:	Treat symptomatically.

Section 7 Precautions for Use

Exposure Standard:	There are no exposure limits available.
Engineering Controls:	Use in open or well ventilated areas.
Personal Protection:	Wear PVC gloves and chemical goggles. An acid resistant respirator to AS 1716 is recommended if spray mists are produced during use. It is recommended that a shirt with long sleeves and long trousers be worn. Always wash skin and clothing after using this product.
Flammabity:	Non-flamable.

Section 8 Safe Handling Information

Storage and Transport:	This product is classified as non dangerous according to the ACTDG. Store in plastic containers in a clean, dry, cool, well ventilated place away from foodstuffs, other oxidising agents and acids. Store and transport in an upright container. Containers must be carefully vented to release any pressure build-up.
Spills and Disposal:	Minimise leak and or contain spills. Collect as much of the spillage as possible. Keep pH of the remaining spilled solution above 7.0 and dilute it with large amounts of water. Avoid contact with acids. Add soda ash to the cleanup liquid to minimise release of chlorine gas during cleanup.
Fire / Explosion Hazard	This product is not flammable under the conditions of use and does not support combustion. The product is stable and will not polymerise. It is incompatible with strong acids, metals, metal salts, peroxides and other oxidising agents and with reducing agents. It decomposes on exposure to heat or light. Upon heating or upon contact with acids, this product may emit toxic

fumes, including chlorine gas which has a TLV of 1 ppm; 3 mg/m^3 – peak exposure. Source: NOHSC (under review). If the product is involved in a fire, fire fighters should wear self-contained breathing apparatus as well as PVC gloves and chemical goggles. Fire fighters should fight any fires with dry chemical, carbon dioxide, vaporising liquid or foam extinguishers or water delivered in a fine spray or fog if available.

Section 9 Other Information

Sodium hydroxide solution is chemically sensitive to:	Acids, Temperature, Metals and Aging

Section 10 Contact Point

Customer Service:	1300 307 755
Emergency Advice:	1300 307 755

Important Notes

This MSDS summarises our best knowledge of the health and safety hazard information of the product and how to safely handle and use the product in the workplace. Each user should read this MSDS and consider the information in the context of how the product will be handled and used in the workplace including in conjunction with other products.

The user should contact the Solo Pak Customer Service Department if clarification or further information is needed to make an appropriate risk assessment of the use of this material.

Appendix E - MediClean Aqua Information and Manufacturer Details (A Labpak Export Ltd Company n.d.)

MediClean Aqua is a liquid sanitising agent for the cleaning and treatment of drinking water installations. It can be used with or without animal present and can also be used to condition the drinking water

Indications

MediClean Aqua can be used on all surfaces that are resistant to oxidising products. it cleans storage tanks, pipe systems, nipples, cups,etc quickly easily and safely.With a minimum of labour cost

Benefits

Recent tests have shown the following BS1977,BS EN 1276 Quantative Suspension |Tests contact. times in minutes which reduced the bacterial numbers below the detection threshold of the test (250 cfu ml)both in the presence and absence of organic matter (1% w/v)

Precautions

Avoid prolonged contact with the skin. Do not mix with soap or detergents.

Pack Size

20 ltrs

Storage

Store in sealed containers in a well ventilated room away from direct heat or sunlight

Instructions For Use

Administer directly into the drinking lines via a dosing machine or into the header tank. Remove cap at end of the system to check for frizzing reaction that MediClean Aqua has reached every point.
Rinse all nipples and cups and allow solution to stand for 12 hours.Flush with clean water to wash and clean nipples again.
For cleaning water systems after depopulation use at the rate of 1:100 to 1:300 depending on the level of contamination
To condition the water throughout the crop, use at a rate of 1:10,000 twice a week

Properties

Stabalised Hydrogen Peroxide

Microbiological Activity

* Powerful
* Rapid acting

* Wide antimicrobial spectrum
* pH: active over a broad range

Manufacturer Details for MediClean Aqua

Head Office

Labpak Export Ltd.
47 Kenmore Road, Sale, Cheshire M33 4LG United Kingdom

Export Office

Tel: +44 (0)161 969 0398
Fax: +44 (0)161 969 0398
Export Director: Jack Bain

Website

JackBain@animalmedics.co.uk

Appendix F – (Roe & Cleave 2007)

PetVite multivitamin supplement product contents:

- Vitamin A
- Vitamin D3
- Vitamin B1
- Vitamin B2
- Vitamin B6
- Vitamin B12
- Calcium Pantothenate
- Niacin
- Folic Acid
- Choline Chloride
- Vitamin E
- Vitamin K
- Calcium
- Phosphorus
- Sodium Chloride
- Iodine
- Iron
- Cobalt
- Copper
- Magnesium
- Manganese
- Zinc

Manufacturer for Supplements for Lion Diet

Rhone Poulenc Animal Nutrition Pty Ltd
19-23 Paramount Road
West Footscray, 3012
Victoria,
Australia.

Appendix G – (IATA 1997-2007) IATA Transport Requirements

CONTAINER REQUIREMENT 72

The illustrations shown in this Container Requirement are examples only. Containers that conform to the principle of written guidelines for the species but look slightly different will still meet the IATA standards.

Applicable to:

Andean cat	Leopard species
Bear species	Lion species
Binturong	Panther species
Cheetah	Puma species
Jaguar	Tiger

Note 1: *The above species must be provided with space to lie comfortably but not turn around, except for bear species and binturong which must have space to turn around. There must be at least a 10 cm (4 in) clearance around the animal when standing in a normal position.*

Note 2: *Should a veterinary certificate be provided stating that the large cat being shipped is suitable to be transported in a container which permits it to turn around, that container may be accepted for shipment.*

See USG Exceptions in Chapter 2 and Exception SV-01 in Chapter 3.

1. CONTAINER CONSTRUCTION

(see Exception QF-01 in Chapter 3)

Materials

Hardwood, metal, 1.3 cm minimum (½ in) plywood or similar material, welded mesh, iron bars.

Principles of Design

The following principles of design must be met in addition to the General Container Requirements outlined at the beginning of this chapter.

Dimension

The height of the container must allow the animal to stand erect with its head extended and the length must permit it to lie in the prone position. The measurements will vary with the species involved.

Frame

The frame must be made from solid wood or metal bolted or screwed together. The frame must provide the spacer bar requirement of 2.5 cm (1 in) depth to the sides for air circulation. When the weight of the container plus animal exceeds 60 kg (132 lb), or the animal is very aggressive the frame must have additional metal re-enforcing braces.

Sides

Suitable plywood or similar material must line the frame to give a smooth and strong interior.

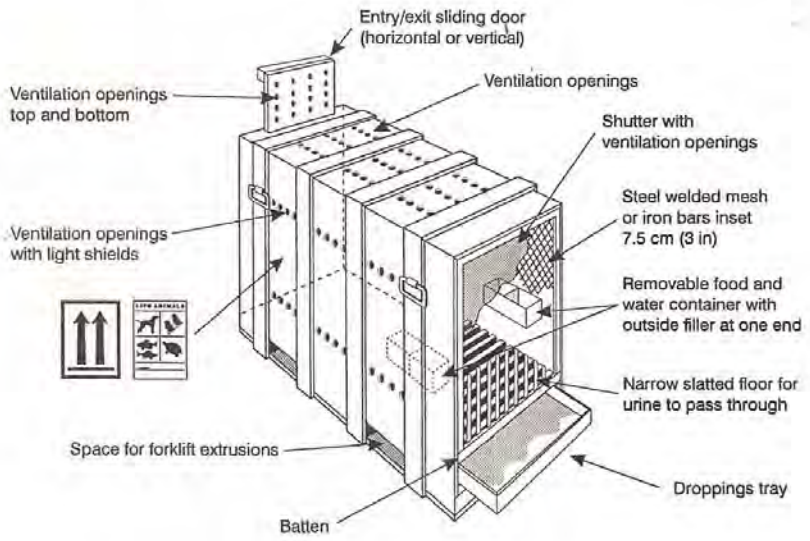
Floor

The floor must either be constructed in a narrow slatted form over a liquid proof tray in such a manner that all the excreta falls onto the tray or, if a slatted floor is not required for that species, it must be leak-proof and covered by sufficient absorbent material in order to prevent any excreta escaping.

Roof

Must be solid with ventilation openings.

EXAMPLE:



CONTAINER REQUIREMENT 72 *(cont'd)*

Doors

Sliding or hinged entry and exit doors must be provided, the front exit door must be made of steel welded mesh or strong iron bars. The iron bars must be spaced in such a way that the animal cannot pass its legs between them.

The front of the container must also be provided with a light sliding wooden shutter with either ventilation openings of 10 cm (4 in) or be slatted with 7 cm (2¾ in) spaces between the slats over the upper two thirds of the shutter, in order to reduce the disturbance to the animal and to protect the handlers.

Both doors must be fastened with screws or bolts in order to prevent accidental opening.

Ventilation

Ventilation openings must be placed at heights that will provide through ventilation at all levels, particularly when the animal is lying down in a prone position. Exterior meshed ventilation openings, with a minimum diameter of 2.5 cm (1 in), must be made on the sides, entry door and roof, as shown in the illustration.

Spacer Bars/Handles

Must be made to a depth of 2.5 cm (1 in), and formed from the framework of the container.

Feed and Water Containers

Food and water containers must be fixed off the floor, to prevent soiling, at the front of the container. Safe outside access must be provided for filling in emergency.

Special Requirements

Bears and other strong clawing animals must have the container totally lined with sheet iron or other hard metal sheeting with ventilation openings punched through to the exterior.

Forklift Extrusions

Must be provided if the total weight of the container plus animal exceeds 60 kg (132 lb).

Multiple Containers

When more than one animal is to be carried in a container, multiples of the above requirements must apply. The container can be divided into compartments by the use of partitions made of metal grills. There must be a separate access into each compartment. Compatible animals that are not likely to harm each other during shipment need not be separated by a partition.

2. PREPARATIONS BEFORE DISPATCH
(see Chapter 5)

Food intake must be reduced 2 to 3 days before shipment. A light meal may be given prior to dispatch and food must be provided in case of emergency.

These species must be kept in darkened containers to avoid stimulus from their surroundings. They have the tendency to become aggressive and belligerent if disturbed by outside interference or noise.

3. FEEDING AND WATERING GUIDE
(for emergency use only)

Animals do not normally require feeding or watering during 24 hours following the time of dispatch.

If feeding or watering is required due to an unforeseen delay, feed once daily, preferably late afternoon, 1 kg of meat per 20 kg (1 lb per 22 lb) of live weight. Polar bears will also eat fish and brown bears like fish and fruit.

4. GENERAL CARE AND LOADING
(see Chapters 5 and 10)

Animals covered by this Container Requirement prefer to travel in darkness or semi-darkness.

Appendix H - (Merial Ltd 2009)

Manufacturer Details for Merial Animal Health Australia

MERIAL AUSTRALIA PTY LTD
Locked Bag 5023
PARRAMATTA
NSW 2124
Australia
Tel: + 61 2 9893 0000
Technical Support: 1800 808 691
http://au.merial.com

Appendix I – Enrichment Scents Approved by veterinarians Taronga Conservation Society Australia (2009) in Dubbo

All Spice	Ginger Ground
African Seasoning	Garlic Powder
Arabian Seasoning	Italian Herbs
Bacon Chips	Lemon Pepper
BBQ Seasoning	Mint Flakes (or fresh mint)
BBQ Sauce	Mixed Herbs
Capue Pepper Grove	Mixed Spice
Chicken Salt	Nutmeg Ground
Chilli Ground	Onion Powder
Chinese Spice	Oregano Leaves Ground
Cumin Seed	Paprika Ground
Dill Leaf	Rosemary Leaves (fresh or Ground)
Fennel Seeds Ground (or leaf)	Sumac Ground
Fresh Chopped Chilli (very fine)	Turmeric Ground
Fresh Chopped Ginger (very fine)	Tandoori Seasoning
Fresh Chopped Garlic (very fine)	Tispi Seasoning

Other items could include: Cat Grass, freshly grown herbs and scent sprays made from these herbs or natural flower essences. (Check with Vets).

Appendix J – Biolac Kitten Formula Information and Manufacturer Details (Smith n.d.)

BIOLAC can be used on all breeds of cat.

Approximate Analysis

Protein 32%	Carbohydrates 33%
Lipid (Fat)29%	Total solids per litre 170 grams
Energy 2200kJ / 100g of powder	375kJ / 100ml of reconstituted milk

Feeding Guide

Weight grams	100	200	300	400	500	600	700	800	900	1KG
Volume MLS	15	30	45	60	75	90	105	120	135	150

Preparation:
Take 170 grams or ten heaped scoops. Mix into a paste. Add warm water. Make up to 1 litre.

Manufacturer Details for Biolac

BIOLAC
PO Box 93
BONNYRIGG NSW 2177

Phone / Fax: (02) 9823 9874

Email: **biolac@optusnet.com.au**