Giraffe Husbandry Manual

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CAPTIVE

1.0 Introduction

Husbandry manuals serve as a source of reference on the biology, maintenance, housing, health, behaviour, diet, breeding, restrain and transporting of animals held in captivity. They act as a major source of information for the species. They present information and experiences (both published and unpublished) together so that the knowledge of that particular species can be passed on, which in turn allows for techniques to develop rather than be reinvented. Resulting in the overall improvement in husbandry for that particular species. The goal of this Giraffe Husbandry Resource Manual is that it is used as reference tool for the zoo industry.

The giraffe is a most amazing and unusual animal it is the biggest ruminant and the tallest mammal complete with a striking coat pattern. Adult giraffe reach heights of 4m-5.5m and weigh from 550kg -1930kg. Giraffe are in the mammalian order Artiodactyla, and of the family Giraffidae, consisting of two living genera and two species (*Okapia johnstoni* and *Giraffa camelopardalis*) both are native to the African continent. Giraffe are further taxonomically divided into subspecies. There are nine recognised subspecies of giraffe, each subspecies has been identified by a particular geographical range, coat pattern and coat coloration. The home ranges of several subspecies overlap, and subspecies hybridization occurs in the wild. The exact pattern is unique to each individual as a fingerprint, the coat pattern is maintained throughout life (Kingdon 1997).
Giraffe are widespread and successful herbivores of the African savanna; giraffe browse on trees and shrubs of a variety of species but are highly selective. The height of the giraffe gives it access to a band of vegetation on which to browse that is out of reach of other browsers. Wild giraffe are non-territorial, social animals living in loose, open herds ranging in size from a few animals up to 50 individuals.
In the wild giraffe presently range, from the Eastern Transvaal to West Africa, their occurrence is patchy and discontinuous, and many are restricted to protected conservation areas. Their range continues to contract, an estimated total of 140 700 wild giraffe remain. While not threatened as a species, local populations are vulnerable in many localities. The International Union for Conservation of Nature (IUCN), conservation status of wild giraffe is lower risk - conservation dependant (East 1998).
Giraffe are displayed in zoos around the world, and there are approximately 1500 giraffe in captivity, approximately 60 are held in Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA) zoos. Eleven ARAZPA Zoos have giraffe in their collections; Adelaide Zoo, Auckland Zoo, Hamilton Zoo, Melbourne Zoological Gardens, Victoria's Open Range Zoo at Werribee, Western Plains Zoo at Dubbo, Wellington Zoological Gardens, Monarto Zoological Park, Perth's Zoological Gardens, Sydneys' Taronga Zoo in Sydney and Orana Wildlife Park. Other regional Zoos Have plans to hold giraffe in the future, including Mogo Zoo and National Zoo and Aquarium.

1.1 History in Captivity

- Captive giraffe were first recorded in roman times, Julius Caesar imported a giraffe in 46 BC, it was known as "cameleopard" because is was as big as a camel with spots like a leopard, this now makes up part of the Latin species name camelopardalis. (Dagg & Foster 1976).

- Giraffe were imported into Egypt in 2500 BC, where they no longer occurred naturally. Two translations for giraffe in Egyptian hieroglyphics are 'ser' and 'mimi' (Dagg & Foster 1976).

- In Europe, many giraffe were seen in roman times, but with the decline of the Roman Empire giraffe largely died out and were forgotten in Europe. Giraffe were reintroduced into Europe in 1215, when the sultan of Egypt gave King Fredrick II one as a gift, giraffe specimens were very rare for the next few hundred years. (Dagg & Foster 1976).

- In 1805 the first giraffe arrived in the United Kingdom, however it only survived three weeks. Soon after this giraffe were introduced more generally into Europe and became prized additions to zoological collections (Dagg & Foster 1976).

- Frances first giraffe "Zarafa", arrived in 1827 after sailing 3500 miles down the Nile river and across the Mediterranean sea to Marseilles, then finally walking 550 miles into Paris (Allin 1998).

1.1.1 History in Captivity in Australasia

Within Australasia there are two taxonomic giraffe groups Rothschild's Giraffe and subspecies hybrid giraffes, both management units are combined and managed in a single Giraffe Studbook.
The first giraffe to arrive in the Australasian region was a wild-caught male, imported to Taronga Zoo in 1926. Taronga imported several more animals from various parts of Africa in the late 1920s and early 1930s and Adelaide and Perth zoos also imported wild-caught Giraffes at this time. Many of these animals were of a known subspecies. (Jolly 2000).
Rothschild's Giraffes were not brought into the region until 1982, when a pair from Canada were imported to Orana Park, Christchurch, New Zealand these animals are descended from wild-caught specimens from Uganda, which were collected by Chipperfield's of Longleat (UK) in the 1970s (Jolly 2000).

1. 2 Popularity and Benefits of Zoo Giraffe

Giraffes are held in zoos around the world and are a popular display animal, despite being difficult and expensive to transfer, especially as adults. The species breeds well in captivity and animals generally live for more than ten years. Surplus males can be held successfully in small bachelor groups. The Australian captive giraffe population is managed in order to ensure the long-term viability and persistence of giraffe within ARAZPA zoos for education, entertainment and conservation purposes, the population is not being managed for potential reintroduction to the wild as this is logistically difficult and presently not required.

2.0 Taxonomy

2.1 Taxonomic Classification

Common name:	Giraffe
Class:	Mammalia
Order:	Artiodactyla
Family:	Giraffidae
Genus:	*Giraffa*
Species:	*camelopardalis*

Giraffe are in the mammalian order Artiodactyla (even toed ungulates), containing over 180 species which are the most diverse array of large land-dwelling mammals alive. Artiodactyla are native to all continents except Australia and Antarctica. The order Artiodactyla consists of ten families: - including pigs, camels, deer, hippopotamus, cattle, goats, sheep and antelope (Janis & Jarman 1984). Giraffe are from the family Giraffidae, consisting of two living genera (*Okapia* and *Giraffa*) and two species (*Okapia johnstoni* and *Giraffa camelopardalis*) both are native to the African continent. Giraffe are further taxonomically divided into subspecies (Pellew 1984).
The earliest known fossil giraffids were found in early Miocene about 22 million years ago in Libya. (Heintz 1975, cited in Skinner & Smithers 1990). The intermediate ancestor of the modern giraffe was *Paleotragus*, from the African Pliocene (Estes 1991). Giraffids of varied forms once ranged through Eurasia, however Africa is considered to be the original centre for evolution of the early giraffids (Heintz 1975 cited in Skinner & Smithers 1990).

2.2 Subspecies and Taxonomic Issues

Giraffe taxonomy has been much debated. Each subspecies has been identified by a particular geographical range, coat pattern and coat coloration. The home ranges of several subspecies overlap, and subspecies hybridization occurs in the wild. Formerly there are nine recognised subspecies of giraffe, (Dagg & Foster 1976 Table 1).

Considerable uncertainty surrounds the validity and geographic limits of many off the described giraffe subspecies. In the absence of geographic barriers such as mountainous country or large water bodies, many subspecies have interbred and intergrades between described subspecies has occurred (East 1998). Particularly between *G.c. rothschildi* and *G. c. reticulata* in central Kenya and between *G. c. reticulata* and *G.c. tippelskirchi* in eastern Kenya.
Prior to the 1990's nine subspecies of giraffe were formerly recognised (Dagg & Foster 1976). However (Kingdon, 1984 & 1997) grouped giraffe as four regional populations: Somali Arid, Saharan, Northern Savanna and Southern Savanna. These four populations incorporate eight of the nine subspecies; the home range of Rothschild's Giraffes falls in the overlap between the first three populations, and they are referred to as possible hybrids.
It is likely that this natural subspecies hybridization has been taking place for some time, as a recent DNA study of captive giraffe subspecies in U.S.A, (whose founders were wild caught in the 1960's) indicated that *G.c.rothschildi* are not genetically distinct from *G. c. reticulata* (Baysdorfer 2000). So giraffe taxonomy is likely to be debated for sometime into the future.

Currently in the Australasian region these are two separate taxonomic units of Giraffe: Rothschild's Giraffe - *Giraffa camelopardalis rothschildi*, and subspecies hybrid Giraffes - *Giraffa camelopardalis*. Seven of the nine Giraffe subspecies are represented in the historical listings of the Australasian Giraffe studbook. The current living population of subspecies hybrids is a mix of *G.c .rothschildi, G.c. tippelskirchi, G.c. giraffa, G.c. camelopardalis* and *G.c. reticulata*.

3.0 Natural History

3.1 General Giraffe Biology

3.1.1 Size & Shape

- The giraffes' unusual shape is accentuated by it short body length in relation to its long neck, further exaggerated by the height of their legs, the forelegs being longer than the hind.
- Giraffe have an elongated neck with a short erect, mane of dark hair. The neck of the giraffe like most mammals has seven vertebrae, though they are greatly elongated (Pellew 1984).
- The most prominent feature of the giraffe is its height, adult giraffe reach heights of 4 - 5.5m, and weights of 800 - 1930 kg for males and 550 - 1180 kg for females (Kingdon 1984).
- The body proportions of giraffe' change with age, at birth the neck is short in relation to the legs (Kingdon 1984).
- Sexual dimorphism is noted in giraffe with male giraffe being larger than females.
- Given that the giraffe is a massive animal weighing 1000+ kg from a hot climate, its body shape provides the most effective distribution of their weight against the heat. Animals in hot climates need as much surface area as possible where their body heat can be dissipated, the giraffe achieves this with its long neck and legs. (Dagg & Foster 1976).
- Giraffe have two prominent back sloping horns covered in black hair about 12 cm long, which rise from the top of their skull, and a medial horn rising from the forehead between the eyes, which is more prominent in males and varies with subspecies. (Skinner & Smithers 1990).
- A unique feature in giraffe is the capability of laying down bone material around the skull, particularly in bulls, causing them with time to be covered in bony lumps, this can increase the weight of the skull in bulls to three times that of females (Pellew 1984). These bony growths often grow on one side of the skull rather than the other indicating right or left-headedness of the particular giraffe (Dagg & Foster 1976).
- Giraffe are one of the few animals that are born with horns, although they lie flat on the head at birth, they become upright and rigid in a few days.

3.1.2 Coloration

- The body from the chin to the upper part of the limbs is covered in large irregularly shaped patches of colour divided from one another by a network of light colored, off-white bands. The actual colour of the patches is due to variations in hair colour, it is variable and tends to darken with age. (Skinner & Smithers 1990).
- The different subspecies of giraffe have been described in part due to the different shape and colour of the coat patches. The two most distinctly different coat patterns are that of reticulated giraffe *G.c. reticulata*, with it's latticework of thin lines separating a uniform darker colour with regular edges and the Masai giraffe *G.c. tippelskirchi* which has most irregular jaggered edged patches (refer to figures 1 and 2.).
- The exact coat pattern is unique to each individual as a fingerprint, the coat pattern is maintained throughout life though the colour may vary with season or with age (Murray 1997).
- Melanistic giraffes have been recorded, as have white or partially white individuals (Kingdon 1984).

3.1.3 Physiology

- The giraffes vascular, circulatory and respiratory systems have been investigated in detail (Dagg & Foster 1982), (Badeer 1986), (Hargens 1987, 1988), (Hicks & Badeer 1989), (Hugh-Jones *et al* 1978), (Kimani & Opole 1991), (Langman *et al* 1979 & 1982)
- The heart must pump blood 2.5m up to the brain when a giraffe is standing upright, and 2.5m down when a giraffe stops to drink. To compensate for the sudden increase in blood pressure when the head is lowered, the giraffe's circulatory system has a mechanism to prevent blood from rushing too quickly back to the heart from the brain..
- The giraffe has very elastic blood vessels and valves in the venous system of the neck. The jugular veins have valves that prevent a backflow of blood to the brain when the giraffe lowers its head, the presence of these valves in the vessels allows for sudden changes in blood pressure (Pellew 1984).
- The resting heart rate of an adult giraffe is about 60 beats per minute. The blood pressure of a calm giraffe ranges from 180/120 to 140/90 mm Hg systolic/diastolic pressure (Dagg & Foster 1982).
- The giraffe maintains alveolar ventilation by breathing about eight to ten times per minute, this is a slow respiration rate, but it servers in reducing the number of times per minute the dead space mostly in the long trachea must be filled with air. The resting tidal volume of the giraffe is around 4 litres of breath (Dagg & Foster 1982).
- The giraffe diploid chromosome number is thirty (Calle *et al* 1993).
- Adult giraffe have 32 teeth, with a dental formula : I 0/3 C 0/1 P 3/3 M 3/3. (Skinner & Smithers 1990).

3.3.2 Captive Population Trends - Australasia

- The Australasian Giraffe Studbook comprises a total of 298 (151.140.7) animals (males. females. unknown sex) Fifty-seven (29.28.0) are living within the Australasian region (as of 30th December 2002). Of the 57 living animals, 15 (9.6.0) are Rothschild's and the remaining 42 (20.22.0) are subspecies hybrids (Jolly 2000).

- Of the animals in the studbook 12.7% are wild-caught and 87.3% are captive-born, There have been 214 (110.97.7) giraffe births in this region since 1937. (Jolly 2000).

- Thirty-five (18.17.0) giraffes have been imported into the Australasian region between 1926 and 1997(Jolly 2000).

- Age-specific survivorship data indicates that 34% of Australasian Giraffes die before they are 30 days old (Jolly 2000). Age-specific survivorship is the proportion of newborn animals that survive to age class x.

- The annual rate of growth (lambda) is 1.037 for females and 1.034 for males, indicating that the numbers of both sexes are increasing slightly (lambda > 1.0 means decreasing growth rate, lambda < 1.0 means increasing growth rate) (Jolly 2000).

- In the early 1990s Australasian Species Management Plan recommendations were make to cease breeding subspecies hybrid giraffe in this region and to commence their replacement with Rothschild's Giraffes. Many of the regions zoos abided by this decision and ceased or slowed reproduction in their subspecies hybrid giraffe. The result of these efforts was that the hybrid population declined and, despite two importation's, the Rothschild's Giraffe population was unable to reproduce at a rate sufficient to meet region display demand (Jolly 2000).

- The subspecies hybrid giraffe population has been genetically improved by the incorporation of surplus male Rothschild's giraffe in recent years. (Jolly 2000).

- The ARAZPA zoos giraffe carrying capacity (total number of spaces to hold giraffe in the region) is estimated at 100 animals.

- The current regional giraffe population is estimated to have retained 88% of the gene diversity found in the original wild source population (Jolly 2000). Gene diversity is the proportion of gene diversity in the wild source population currently retained in the captive population.

- The average life expectancy (median age at death) for Australasian giraffe is 10 years for females and 8 years for males. Maximum longevity *(age at death of oldest animal in studbook) is* 28 years 2 months for females and 24 years 7 months for males (Jolly 2000).

3.3.3 Global Giraffe Populations

Table 3. Current Living giraffe Worldwide

Region	Organization	Current Living Population*	Coordinator, institution
Europe	EAZA WAZA	520	Dr. Gunther Schleussner, Studbook Keeper, Stuttgart.
North America & Canada	AZA	574	Laurie Bingaman Lackey, Studbook Keeper, ISIS. Joe Christman, Species Coordinator, Disney, Florida.
Mexico, Central and South America	AMACZOOA	43	Laurie Bingaman Lackey, Studbook Keeper, ISIS.
Australasia	ASMP	57	Lorraine Jolly Species Coordinator, VORZ.
Japan	JAZGA	193	Mizuki Karasaw, Studbook Keeper, Tama Zoo, Tokyo.
The Rest of Asia	SEAZA	107	
TOTAL		1497	

(* Data current - Jan 2003)

3.1.4 Senses

- The giraffe's eyes are situated laterally, giving giraffe a better field of vision than many mammals. Their eyes are large, and giraffe can see extremely well, they are also thought to have limited colour vision being able to distinguish red, orange, yellow, yellow-green and violet (Dagg & Foster 1976).
- Vision is particularly acute and plays an important role in maintaining herd cohesion among widely spread out individuals, it also serves as an excellent anti-predator warning system for both giraffe and other plains species they associate with (Lees 1991).
- Giraffe orient primarily by sight but their hearing and sense of smell are also acute, they have a sweet musky odor which probably carries well on the wind (Kingdon 1984)
- Giraffe are silent, but not mute. Despite possessing a well developed larynx, the giraffe is only able to utter low moans and grunts, morphological examination of the larynx and trachea indicate factors such as the thoracic expiratory flow rate and the length of trachea and laryngeal nerves are the reason for the lack of vocal power in the giraffe (Harrison 1980). The larynx is smaller than that of a horse, vocal folds and laryngeal ventricles are absent.
- The tongue of the giraffe possesses greater mechanical power than any other ungulate tongue (Dagg & Foster 1976). The free end of the tongue, is pigmented black, it has been suggested the pigmentation it to protect it from the sun. The 45 to 50cm tongue is covered in papillae and retroverted spines to help in gripping leaves.
- Browsing in giraffe is a considerable art, the leaves are pulled into the mouth by curling the long tongue around them and are held between the teeth in the lower jaw and the hard pad in the upper jaw, the leaves are stripped off the twigs with a backward pull of the head.
- Giraffe use both sight and smell to select browse plants, smell is especially important after dark. Browsing or grazing animal species evolved rumination to allow them to eat quickly in open unprotected areas and the re-chew the vegetable matter later. This process through mastication of the food, allows the micro-organisms in the rumen more opportunity the break down the food.
- Giraffe ruminate while standing, walking or sitting, the throat bulges as the food is brought up to the mouth and re-chewed (Murray 1997).

3.1 General Giraffe Biology

3.1.5 Locomotion

- The giraffe has two gaits, an ambling walk and a gallop.
- When walking the entire body weight is supported first on the left legs, then on the right legs, the neck moves in synchrony with the legs and helps the giraffe maintain balance.
- When galloping the fore feet and hind feet work together in pairs, the hind feet land outside and ahead of the forefeet.
- Giraffe can gallop at speed up to 50-60 km/h. Speed becomes difficult with increased body size because of inertia and because large muscles contract more slowly, fortunately the giraffe has little need of excessive speed (Estes 1991).
- Giraffe may doze or sleep while in a standing or lying position. Although giraffe may lay down for periods of time actual sleep only occurs for short intervals, lasting a few minutes (Murray1997).

3.2 Distribution and Habitat

Giraffe occur in a wide variety of savanna habitats ranging from scrub to woodland that provides an adequate range and supply of browsing plants. (Skinner & Smithers 1990). They do not occur in forest and are generally not associated with open plains. Rock paintings demonstrate that giraffes were once widespread in what is total desert today. The latitudinal zonation of habitats between the desert and the forest has some correspondence with the distribution of giraffe. The lightest giraffe subspecies the West African giraffe *G.c peralta*, inhabits the driest hottest and more open African habitat, where as the darker subspecies Nubian giraffe *G.c. camelopardalis* and Reticulated giraffe *G.c. reticulata* are found in the more treed habitats of North-east Africa where their coats may be better suited as camouflage (Kingdon 1984).

Giraffe densities and biomass vary, but in optimal habitats, densities of up to two giraffe per km^2 (a biomass of 2000kg per km^2) is sustainable (Kingdon 1997).

Giraffe home ranges are vast ranging from 160 km^2 to 650 km^2. Giraffe spend more than half the year in smaller dry season home ranges (up to 100 km^2), but migrate further afield during the rainy season (Estes 1991).

3.3 Status and population Trends

3.3.1 Wild Giraffe

The historical distribution of giraffes has shrunk dramatically, and throughout their present range from the Eastern Transvaal to West Africa, their occurrence is patchy and discontinuous (Skinner & Smithers 1990).

Giraffe formerly occurred throughout the drier, more open savanna of sub-Saharan Africa its range has contracted markedly with the expanse of human populations, especially in western Africa (East 1989). Figure 3. displays the former range of giraffe from the Holocene period, some 7000 years ago, compared to the present range of wild giraffe (Kingdon 1997).

Giraffes are now restricted to protected conservation areas and a few sparsely populated regions. Their range continues to contract and it is estimate there are around 140 000 giraffe remaining in the wild (East 1998).

While not threatened as a species, local populations are vulnerable in many localities. The International Union for Conservation of Nature (IUCN) conservation status of wild giraffe is lower risk, conservation dependant (East 1998).

However, population trends for giraffe vary from region to region and therefore for the different races or subspecies. For example there has been a 70 % decline in giraffe population of *G.c. tippelskirchi* in the Masai Mara area of Kenya in the past 20 years due to non-migration, poaching, changes in land use and vegetation types, and increased livestock (Ottichilo et al 2000). Where as in North Tanzania, giraffe populations have recently increased due to the decrease in elephants in turn providing more browse trees (Van der Deugd & Prins 2000).

Rod East (Action Plan Coordinator, IUCN/SSC Antelope Specialist Group), coordinates an African antelope database, which includes information on wild populations of giraffe. Census figures for 1998, indicates an estimated total of 140 700 wild giraffe (all subspecies) some 46 000 animals were in protected areas as outlined in Table 2. (East 1998).

- A water source is required; this can be at ground level or raised.
- Consider the aspect of the exhibit, areas of shade and shelter from wind are required. Giraffe are particularly vulnerable to a drop in temperature accompanied by rain and strong winds, having such a large body surface area it is difficult for adult giraffe to find shelter from wind. (Clauss *et al* 1999).
- Good vehicular access is required, particularly for large trucks and cranes, for loading and unloading giraffe crates.
- The larger to area and the more varied the terrain can lead to better physical condition of giraffe due to the increased opportunity to exercise. The minimum size for a giraffe yard is 18m² (Geldenhuys 1993b).

4.2 Giraffe House Design

All captive giraffe should be provided with a house or barn in which to shelter from inclement weather. A house provides and area for giraffe to be fed, routinely move to on a daily basis for husbandry and health reasons and is an ideal site for holding, confining, quarantining, loading and unloading giraffe.

- Giraffe houses can be open plan or a series of stalls or a combination of both. Stalls that house individual giraffe overnight should measure at least 3m x 6m (Lee 1991).
- The size of giraffe house and stall combination depends on the number and herd dynamics of the giraffe group being housed. Breeding groups require a separate area either to separate the bull or to separate a cow and new calf.
- There should be adequate room in the giraffe house for all individuals to lie down and to get up easily, and to move about.
- The internal surface of the giraffe should have smooth surfaces of paneling with no protruding bolts, screws or nails.
- Giraffe raceways should be wide enough for giraffe to be able to turn around in, about 2.4 m.
- Most giraffe are housed at night and bedding, such as sawdust, straw or mulch to sleep on is provided in the house.
- The giraffe house and yard site should be both level and well drained.
- Assess the prevailing weather conditions of the site prior to positioning the house, particularly the door openings don't have giraffe house doorway facing into prevailing wind.
- Maximum effects of morning sun and winter sun should be balanced with the minimum effects of hot afternoon summer sun and cold winter wind and rain. Depending upon the location this generally means that the house should have a northerly or easterly aspect, and positioned to face north to maximize the amount of sunlight (in the Southern Hemisphere).

4.0 Housing Requirements

The size of any enclosure merely determines the potential holding capacity. Due to their large size a sufficient area of enclosure is required to hold giraffe. The major consideration in holding giraffe is how many and of what sexes and ages do you wish to hold and how many can you house at capacity. Australasian giraffe enclosures range from smaller yards and houses in metropolitan zoos (figure 4.) to large paddock areas in open range zoo situations (figure 5.).
The giraffe enclosure complex should provide arrangements for separation of one or more giraffe for a range of reasons (figure 6), such as quarantine, isolation of sick or injured giraffe, separation for calving or rearing of young, separation of bulls from cows or from other bulls or young giraffe. Areas for introductions and areas for transportation crates should also be incorporated. All captive giraffe should be provided with a house or barn in which to shelter from inclement weather. A common design of a giraffe exhibit is a day time display area, one or more smaller yards or pens with adjoining raceways and a giraffe house, in cooler climates the giraffe house is often incorporated in the public viewing area.
It is highly recommended that the giraffe facilities contain a chute or crush area where giraffe can be restrained and regularly weighted. It is generally agreed that chute or crush capabilities and training is more effective when the device it is part of the daily travel path of the giraffe (Wienker 1986). If the giraffe has to pass through the area on it way to and from the house to feed it is already accustomed to the device (figure 7.).

4.1 Exhibit Design.

Giraffe exhibits vary greatly in design, the following are some design constraints to be considered.

- The more natural the setting the greater the likelihood more natural behaviors will be displayed.
- The slope of the ground should be no steeper than 40 degrees slopes, and should be mainly firm dry ground.
- The perimeter of the enclosure will require adequate fences and boundaries. Giraffe will lean against fences to try and reach plants so they must be very sturdy.
- A range of fence materials have been used to confine giraffe: solid walls, high mesh fences, lower metal, wood or cable fencing, electric fencing, water filled or dry moats and piled rock boundaries.
- With dry moats, it is best to have and exit route in case an animal should fall in. Example dry moat dimensions: 4.5m wide, 1.5 m deep, rising from the outside wall at 60 degrees (Lee 1991).
- Any reachable trees will need to be protected or will be destroyed over time by giraffe and a accessible and surrounding plants should be non toxic.
- Raised feeding areas are required and will need a supporting structure, such as a dead tree, or wall.

4.1 Exhibit Design Con't

5.2 Record Keeping

Record keeping is an important part of animal husbandry, as it should provide a complete history of each specimen whilst it is held in captivity (Vaartjes 2000). The following are examples of animal record information.

- Identification of the individual, either by visual appearance: size coat colour and pattern, ear tag or microchip and often by house name. Each individual will be assigned an ARKS (Animal Record Keeping System) number which is an identify number for that individual whilst at a particular zoo. ARKS numbers are used to identify each individual via computer databases worldwide.
- Information on the animals origin - place of birth or capture, date of birth or capture, other relatives of the individual, transfers to other zoos, transfer permit details.
- Information each individual - sex, age, body weight and growth information, other features.
- Housing information - name of enclosure, other inhabitants, time period in this and other enclosures, seasonal housing routines.
- Information on husbandry - diet & feeding, behaviour, health, breeding and progeny.

The zoos veterinarian on a separate database MedARKS usually records detailed information on the individuals health.

5.3 Methods of Identification

Giraffe are generally identified visually, by their sex, size and coat colour and pattern. Each individual giraffe has a unique coat pattern, like a finger print, often photographic records are kept to identify giraffe. Other identification methods such as ear tags and microchips have been used in giraffe. The internationally recognised location for a microchip in a giraffe is the base of the left ear.

6.0 Diet

6.1 Wild Diet

The current distribution of wild giraffe is defined by suitable habitat in which they can obtain food. Numerous plant species of the orders Combretaceae (bush willows and terminalias) and Mimoscideae (albizias and acacias) provide the bulk of their browse (Pellew 1984). Giraffe browse on trees and shrubs of a variety of species but are highly selective, over 100 species of plants have been recorded in their diet and their choice of plants is determined by local and seasonal availability (Estes 1991).

The more obvious factors influencing giraffe's preferences are the presence of aromatic substances, the abundance and size of leaves, the shape of thorns, and the physical accessibility of a tree and its growth form (Kingdon 1984).

The height of the giraffe gives it access to a band of vegetation on which to browse that is out of reach of other browsers. At full stretch and further aided by a 45cm long tongue, giraffe are able to feed on the crowns of many smaller trees. Bulls can be up to 1m taller than cows and have a strong preference for high browsing, where as females' concentrate on regenerating trees and shrubs below 2 m high and eat a wider variety of plant species over a larger area (Estes 1991).

Food varies with the time of year, when plants are plentiful in the hot wet months the giraffe are more particular and select preferred species on which to browse, with a number of acacia species being their most preferred. Acacias leaves have a high protein content (Skinner & Smithers 1990).

Adult bulls consume some 19kg dry weight or 66kg fresh weight browse daily, cows 16kg dry, 58 kg fresh weight, in terms of proportion of body weight, cows 2.1 %, bulls 1.6% (Pellew 1984).

Giraffe select high quality foliage, although they are cud-chewing ruminants, they rely less on mastication to release nutrients than on digestive efficiency. Their stomach wall is covered in large tongue like papillae, which provides a greater surface area for absorption than any other ruminant (Kingdon 1997).

The giraffe's narrow muzzle, flexible upper lip and long prehensile tongue allow giraffe to strip leaves off branches and even select individual leaflets from between sharp thorns.

Giraffe may drink at intervals of three days or less when water is available, but some of their moisture needs are met by consuming green leaves and dew (Lee 1991).

Giraffe are known to lick the ground for salt and mineral deposits and osteophagia (chewing of old bones) has been observed (Langman 1978).

4.2 Giraffe House Design con't

- In places where night temperatures fall below 10°C the heating of giraffe house is recommended. Giraffe houses can be heated using, under floor heating or gas or electric radiant heaters, or forced air heating. Heaters need to be mounted out of reach of giraffe for safety.
- The height of giraffe house and particularly the doors is important, the giraffe should be able to easily move in and out without ducking its' head.
- Doors should allow for entry of machinery (front-end loader, bobcat) to maneuver transport crates, to change the bedding substrates but it may also occasionally be required to remove dead animals.
- The keeper service area must be of sufficient width to allow for wheelbarrows, ladders and bales of hay, browse branches etc.
- All electrical, gas and plumbing fittings should not be assessable to giraffe.
- Steps or ladders to access higher areas of the house to reach pulleys, lights and overhead heaters maybe required .

4.3 Substrate

Giraffe are rarely seen lying down on hard surfaces, such as cement (Murray 1997). Captive giraffe spent a much greater time standing that wild giraffe, particularly in metro zoos. To prevent the problem of overgrown hooves, a hard abrasive surface is recommended for giraffe. The surface needs to be non-slip. The following has been used: textured cement or concrete, scoria, various crushed gravels, decomposed granite, granitic sand, asphalt and loose sand spread over concrete. The abrasive surface is not required throughout the exhibit, but recommended for walkways, feed stations and areas of heavy traffic.
Inside giraffe houses, cement, and rubber mat flooring has been used, this is usually covered with some form of bedding material, such as sawdust, straw or mulch.
Excessive dust can effect giraffes eyes and can cause lung problems, earth or dirt yards or decomposed pine bark mulch can be sprayed with water to reduce the dust level (Geldenhuys 1993b).

5.0 General Husbandry

With the appropriate facilities; enclosure, yard, raceway and house, giraffe are fairly easy to manage and do not require an excessive amount of cleaning. They quickly become accustomed to daily husbandry routines, of movements in and out of various nightquarters and exhibit areas. A common husbandry routine with giraffe is to house them at night, or a least provide then with access to their house at night, this is particularly the case in winter. Giraffes should not be allowed out if the temperature is below 10°C, or when there is snow or ice, which is a real possibility in New Zealand zoos (figure 5).
Some or all of the following routine husbandry data can be collected on individuals or groups of giraffe in captivity; daily food intakes, weather conditions & temperatures, whether group housed or not, individuals heights and individuals weights.
Giraffe are more at ease when housed with one or more other giraffe. Australasian giraffe groups range from two to large breeding groups greater than ten in number.
Never overcrowd giraffe, in either a yard or house, there should be adequate room in the giraffe house for all individuals to lie down and to get up easily, and to move about. An adequate number of feeding areas should be provided for all members of the group.
Never creep up on giraffe, if they take sudden fright, they will take flight and can run into fences and injure themselves (Geldenhuys 1993c). Avoid sudden loud noises such as gunshots and firecrackers.

5.1 Hygiene and Cleaning

- Giraffe faeces needs to be racked up and removed from houses and yards on a daily basis. Giraffe urine on bedding can also be removed with the soiled bedding material.
- Dependent upon the amount and type of house bedding, it does not generally need frequent changing. Due to the volume of bedding (and cost and labor) bedding is completely replaced monthly or quarterly, this is usually done using machinery.
- Giraffe should be feed at a height of 2m - 3m above the ground, which will necessitate keeper access to hay feeders for cleaning. Old hay stalks, lucerne or pellet dust should not be allowed to accumulate in or under hayracks. Complete emptying and rotation of hayracks on a weekly basis is preferred.
- Food buckets and troughs should be washed out and scrubbed with water daily.
- A fresh clean supply of water is required at all times, water troughs should be cleaned out as required.

6.2 Captive Diet

- Exact giraffe diet formulas vary between zoos, in most cases giraffe are fed a pelleted ration, lucerne hay, browse branches and small amounts of fruit and vegetables.
- Pelleted rations are made from a variety of cereals and grains, with vitamins and minerals added. (Analysis of "Giraffe Cube" made by Ridley AgriProducts is listed in the appendix).
- Giraffe as browsers require a high protein level, pelleted rations with protein levels of 15-25 %, and lucerne hay with protein levels of 15-20%.
- The volume of food offered should be 1.5- 2% of the giraffes body weight, (eg at 2%, a 1000kg giraffe requires 20kg of food daily)(Lee 1991).
- Browse should be provided as much and often as available, being the giraffe natural diet (figure 8).
- The following plant species can be fed to giraffe as browse: acacia, eucalyptus, willow, elm, coprosma, fig, prunus, myoporum, palm and cassurina.
- Pregnant, lactating and young growing giraffe require a diet containing at least 18 % protein (Lee 1991)
- The amount of activity, which often collates with the size of the enclosure, will have a bearing on an individuals daily food requirements.
- Small amounts of fruits and vegetables are fed to giraffe; these are often used as a reward during a training session or in order to get an individual to take an oral medication.
- The following fruits and vegetables are suitable for feeding giraffe: apples, Pears, melon, carrots, lettuce, silver beet, kale, endive, beans, sweet potato.
  Care should be taken not to cut fruit or vegetables up too small, which is a choking risk.
- Do not offer giraffe the following: white potato, banana, or stone fruit

6.3 Supplements

- Mineral salt blocks should be provided for giraffe at head height.
- A source of fresh water is required, more than one source is preferable in most enclosures/ giraffe yards. Automatically filled troughs are preferred; giraffe can drink 10L at one time.
- Vitamin E, should be included in the diet, this is often added to the pelleted ration.

6.4 Presentation of Food

Giraffe food should be presented above the ground at a height of 2m to 3m, where all aged giraffe can easily feed (figure 9).
String hay feeders (as used for horses) do not generally work, giraffe have become tangled in them and have eaten the string.
There is evidence that lip and tongue movements of browsers are a functional and necessary part of feeding behaviour, and every attempt should be made to allow this behaviour to occur, in the absence of this giraffe can obsessively lick non-food items within their enclosure (Lee 1991).

7.0 Handling and Transport

7.1 Transportation Options

- Due to their size and rapid growth rate in their first year, giraffe are fairly difficult and expensive to transport between zoos. For example importation of a giraffe to Australasia from North America, transportation costs only (as no price is placed on the animal itself) in 1994 exceeded $50 000 AUD.
- Ideally Australasian giraffe are managed to minimize importations and exportations outside this region. Wherever possible giraffe transfers within regional zoos are recommended prior to the birth of the animal, so planning can commence as early a possible.
- Young giraffe, under 3m in height can be transported by air (Figure 11). Transport options for taller giraffe are by road or by sea (Figures 10 & 12) or often both.
- All giraffe being transported will require a custom built transport crate or trailer.
- Crate training and familiarization, will reduced stress on the travelling animal.
- Additional stress during transit must be kept to a minimum; this may involve avoiding excessive noise, lights, unfamiliar visitors and stable temperatures.
- Giraffe should not be transported in extremes of heat or cold, the use of crate covers and tarpaulins can help prevent cold draughts.
- Checking of respiration rate during transportation is a good indicator of stress levels, and ruminating is a good indicator of a relaxed giraffe.

8.0 Health

Preventative medicine programs are essential for keeping giraffe in captivity, as it is always easier to prevent a disease than to attempt to diagnose and treat it. Preventative medicine programs should include regular faecal collection (for identification and treatment of internal and external parasites), weighting of the animal and blood collection if possible. Animal health begins with exhibit design, knowing the species, their habits and social needs and providing for them.

Giraffe have no unique diseases, but are susceptible to most contagious diseases of domestic ruminant livestock, including clostridial diseases, leptospirosis, brucellosis, anthrax, pasteurellosis, Johne's disease and tuberculosis (Jensen 1999). If giraffe are already in poor health, changeable weather conditions may contribute to their death; giraffe are particularly vulnerable to a drop in temperature accompanied by rain and strong winds, having such a large body surface area it is difficult for adult giraffe to find shelter from wind.

Giraffe are susceptible to external parasites and internal parasites similar to other ungulates (Jensen 1999). The giraffe's long tail can switch away files from their hindquarter, but unlike most other ungulates giraffe can not scratch their heads with their hind hooves. Giraffe along with other very large ungulates such as elephants and rhinoceros do not engage in oral grooming instead use strategies such as rubbing and tolerance of oxpeckers (in the wild) (Moore *et al* 2000).

8.1 Daily health checks

Animal husbandry plays an important role in disease prevention. Close daily observations of each giraffe by keepers are essential. Keepers are often able to detect slight changes in an animal that may be the only outward signs of illness. Observations of the giraffes physical state and appearance, any changes in behaviour, and weather or not it is eating, drinking, urinating and defecating normally should be made daily. Monitoring of daily food intake and regularly weighting giraffe are good health indicators. Any health concerns should be brought to the attention of the zoos' veterinarian.

8.2 Routine Health Checks

A variety of minor medical procedures can be carried out on giraffe in a crush, these include: weighting, blood collection, injections, oral administration of drugs, microchipping, hoof work, rectal and vaginal examinations and delivery of calves. Physical restraint in a crush can be enhanced by the use of sedatives and tranquilizers (Bush et al 2002). Annual examines are recommended on conditioned giraffe, these include blood collection for haematology and biochemistry, faecal collection for flotation and culture. Preventative medicines such as; drench, clostridial vaccines and vitamin and mineral supplements can also be administered.

8.3 Known health problems

7.1.1 Transport by Road and Sea

- The giraffe is secured into a transport crate and then loaded onto a semi-trailer truck by crane and secured.
- Due to the height of adult giraffe crates the trailer is often a low-loader, where the crate sits on a trailer lower than the tyres.
- The travel route and timing of the trip needs to be planned well in advance, a support vehicle and often a police escort should travel with the giraffe.
- Often power lines need to be raised to allow access under them.
- Giraffe travelling by container ship should always be accompanied by keeping or veterinary staff.
- Sea journeys are generally a week or longer, so ample food and other supplies are needed. Giraffe have suffered from seasickness on sea voyages (Joe Christman pers *comm.*).
- During the transport process the animals quarantine status must remain and it should not come into contact with other animals.

7.1.2 Transport by Air

- Giraffe grow extremely quickly, if they are going to be small enough to be transported by air, accurate planning to coincide weaning, quarantine and comfortable fit in the crate is required. This planning may need to commence soon after the animals birth.
- The average height of giraffe calves at birth is 1.8 - 2m and they grow at a rate of 7 - 13 cm per month in their first year (Lee 1991).
- The maximum height restriction for transportation by air is approximately 3m (but will vary with airlines), this height must include the exterior frame of the crate and a metal aircraft loading pallet), leaving and internal crate measurement of about 2.7m (Barlow 1996).
- If flying, the angle of ascent and descent of the aircraft must be a low trajectory for take off and landing a to prevent sudden pressure changes which could cause the giraffe to lose consciousness (Barlow 1996).

7.2 Transport Box Requirements

- For air transport, giraffe crates must comply with IATA Live Animal Regulations (container requirement 12 for ungulate species (IATA 1994).
- The crate must be sturdy enough not to twist or warp, but not be overly heavy for air transport.
- The crate should have a covered roof or roof frame with canvas opening cover.
- Crate design: Floor size and height are critical. The young giraffe should be able to lay down and get up again during transport. (Figure 13).
- The crate should have provisions to provide food and water, and receive medical treatment through a number of hatches.

7.3 Restraint methods

- Giraffe can be conditioned to a chute or crush to be restrained for various procedures, including injections, blood collection, hoof work (figure 14) and reproductive manipulation (figure 15).
- Chutes are ideal areas to install floor level weight bars, on which to easily and regularly weigh giraffe.
- Giraffe crushes are generally constructed using steel piping and removable plywood boards, with additional restraining bars to further restrict movement and often with nylon cargo belly straps (Lee 1991).
- The design of the restraint facility varies from a chute or moveable wall to hydraulically controlled squeeze cages.
- The key to making restraint procedures work is the design, the training and conditioning of the giraffe and the staff. Training and conditioning is widely used for many zoo species and many websites are dedicated to it (see bibliography & appendix 2).
- Individual giraffe require considerable training to accept procedures in a crush, although time consuming it is still the preferred method of restraint and considered far safer than an anesthetic.

8.5.2 Immobilization Procedure

The attending veterinarian should use the most appropriated drug combination for the situation. The usual method of administering drugs to unrestrained giraffe is remotely via dart injection. The general protocol is a staged anaesthetic protocol commencing with a premedicant of sedative followed by a combination of anaesthetic drugs and concluding by using an antagonist to reverse the anaesthetic drugs (Bush et al 2002).

Signs of sedation are usually evident including stargazing, slight ataxia, protrusion of tongue and salivation. About 15 minutes after the administration of sedatives the anaesthetic drugs can be administered. During the induction phase, the giraffe will often exhibit a prancing gait, with head raised and held slightly backwards, then totter or stumble forwards for some 10 minutes, often coming to rest leaning against a wall. Some giraffe will become recumbent themselves, but more often a rope is needed to carefully maneuver and pull the giraffe down to lateral recumbancy.

There are standard methods of handling a recumbent giraffe irrespective of the drugs used. The neck of the giraffe must be extended to insure and airway, the neck is supported with the head maintained above the rumen and nose pointed down. Supporting and positioning the neck can be aided by a long board or ladder placed under the entire length to keep it straight (figure 16). The angle of the neck should be altered every 10 -15 minutes to minimize muscle spasms and myopathy. The animal is blindfolded and earplugs are used.

Manual intubation into the trachea is fairly difficult due to the narrow gap between the molar teeth, and the mouth can only open 5-10cm, visualization is difficult without a flexible endoscope and therefore animals are often not intubated.

Monitoring a recumbent giraffe is critical to the patients' safety, particularly respiration rates and heart rates, pulse oximeters are useful. Rectal temperature is monitored since hyperthermia can be a problem and cooling down with water may be required. The depth of anesthesia can be determined by the animals' reaction to various stimuli from blood sampling, to hoof trimming to minor surgery (Bush *et al* 2002). Nonsteroidal anti-inflammatories and muscle relaxants are often administered as supportive therapy (Bush *et al* 2002).

Diet and nutritional problems have been encountered in captive giraffes, due to their selective browsing habits, captive diets need a high protein content. Clauss *et al* (2001) hypothesize that giraffe deaths linked to nutritional problems can be explained by the fact giraffe who are browsing ruminants, are not able to adapt to the physical structure of grass or lucerne hay and ingest these in comparatively lesser amounts than grazing ruminants would. Other important considerations are temperature and amount of activity, which is linked to size of enclosure. Giraffe are very susceptible to the cold and their body temperature is likely to fall when ambient air temperatures are low, in these circumstances the giraffe will have increased energy demands (Clauss *et al* 1999).

Many hoof problems have been encountered in giraffe, these are thought to be related to diet and or substrate. Giraffe with overgrown claws occur in the wild, suggesting the view that hoof problems may be a partially hereditary condition (Veasey *et al* 1996). Overgrown hooves can impair movement and lead to complications such as sprained tendons and arthritis. Most giraffe immobilizations, (80%) are to correct overgrown hooves (Benbow & Lyon 1997). Provision of suitable substrate and appropriate facilities for correction are recommended, in addition to appropriate nutrition (Lee 1991).

The region's giraffe population shows high levels of inbreeding, the populations mean inbreeding coefficient is 0.166 (note, for comparison, that the offspring resulting from a mating between full-siblings would have an inbreeding coefficient of 0.250; matings between first cousins produce offspring with inbreeding coefficients of 0.0625). Research on the U.S.A giraffe population found clear evidence that levels of inbreeding does effect survivorship (Bingaman Lackey 2000). Of the current living giraffe population, 77% are inbred, (of these 29% have an inbreeding coefficient greater than 0.250) This ratio of inbreeding has had a significant effect on survivorship resulting in a high infant mortality rate of - 34% mortality in the first 30 days. If inbreeding is not better managed and avoided within this population the 30 day and 1 year mortality rates will continue to rise (Jolly 2000).

8.5 Giraffe Immobilization

Immobilization or anesthesia of giraffe has long been considered of high risk, due to the giraffe' unique physiology and anatomy, which may cause life threatening problems during anesthesia (Bush 1993). The giraffes large size limits physical control during the critical times of induction and recovery, and limits manipulation once the animals is down and their long neck, which if not controlled acts as a lever creating a danger to the animal or the staff around it. Giraffe unlike other animals do not voluntarily become recumbent upon induction and may fall heavily causing trauma (Benbow & Lyon 1997).
The major cause of anesthetic death in giraffe is regurgitation, with subsequent inhalation of rumen contents, the posterior position of he larynx in the pharynx hampers draining of any fluid, causing rapidly fatal inhalation pneumonia (Bush 1993). Vomiting can result in increased intra-abdominal pressure occurring when the animal impacts with the ground and prolonged induction and or recovery lead to hyperthermia, myopathy and secondary trauma. Other physiological adaptations of giraffe such as; elevated systolic blood pressure, small respiratory tidal volume with large dead space and relative small cardiac output during anesthesia can all impact on immobilizations (Bush *et al* 2002). (See figures 16 17 18 & 19)

In the 1970s & 1980s Fowler & Boever (1986) stated that 25-30% of giraffe immobilized did not survive the procedure. Giraffe anesthesia has advanced over the past three decades and the immobilization mortality rate has declined to approximately 10-15% (Benbow & Lyon 1997). The main improvement to giraffe immobilizations is the development of newer and safer drugs and the development and use of physiological monitoring equipment. The size of the giraffe has a major factor in the anaesthetic success, with smaller animal having a better success rate than very large adults.

8.5.1 Planning an Immobilization

- Giraffe procedures require coordination to ensure all staff and equipment are ready, if there is a factor the can be changed to enhance the success of the procedure, it should be done, even if this results in rescheduling the procedure.
- All members of he team should be briefed and are aware of their roles.
- A minimum area of 8m x 8m is required for a giraffe immobilization.
- The site for the procedure should have smooth solid walls padded walls and sound footing, improper substrate can increase trauma from slipping during induction or recovery. Non inner spring or foam mattresses or stacked bales of hay are ideal for padding walls to prevent trauma (figure 18)
- Any posts pillars or other protruding fixtures will also require padding; feed sacks filled with straw can be attached to pillars (figure 17).
- The giraffe should be fasted for 48 to 72 hours and water removed 24 to 48 hours prior to immobilization to reduce the possibility of regurgitation.

9.0 Behaviour

Giraffe are gregarious, non-territorial animals forming very loose open herds up to 50 in number. They are socially aloof, forming no lasting bonds with fellow herd members, and associating in a casual manner to individuals whose ranges overlap. All social groupings of giraffe are temporary, the only stable associations are those of female giraffes during motherhood, they are known to return to traditional calving areas to give birth and raise their calves with other female giraffe (Kingdon 1997). A giraffe herd can contain almost any possible combination of age and sexes (figure 21). Wild giraffe rarely group closely, except if browsing from a particular tree. A herd of feeding giraffe can be spread over a distance as far as one kilometer, yet they can still be in visual contact with one another. There does not seem to be any group leader or coordination in group movements (Estes 1991). Giraffe are mainly diurnal, but will move and feed after dark. The more natural the exhibit setting the greater the likelihood more natural behaviors will be displayed by the giraffe (figure22).

9.1 Habits

- In a recent study of giraffe sleep patterns, giraffe were found to sleep standing and in recumbancy, peak periods of sleep were between 20:00 and 07:00 hours, and between 12:00 and 16:00 hours, and total sleep time in a twenty-four hour period was 4.6 hours, sleep was fragmented, with most recumbent sleep episodes lasting less than 11 minutes (Tobler & Schwierin 1996).
- Wild giraffe spend about the same amount of time feeding as smaller browsers such as impala, a mean of 53.2 % for females and 43.2 % for males. As browse abundance declines the time spent feeding proportionally increases.
- Feeding is the most time consuming of giraffe activities, the main feeding periods for giraffe are early morning and late afternoon, with least browsing taking place in the middle of the day when ruminating is at its peak (Dagg & Foster 1976).
- Females take more time to select more nutritious foliage in all seasons, but spend less time ruminating (27 % vs 30 %) and walking (13 % vs 21 %) than bulls (Estes 1991).
- Daytime feeding mainly occurs in the three hours before dusk and after dawn, and most ruminating occurs in the middle or hottest part of the day.

8.5.3 Immobilization Recovery

If an antagonist drug is used to reverse the animal, the head should be supported in an elevated position with nose pointed down, two people support the head to prevent the animal from rising too quickly, before it is adequately recovered. Giraffe can be assisted to rise with the use of a rope around the giraffes shoulders, so as it attempts to stand, pulling on the rope helps the giraffe into a sternal position, once the giraffe stands the rope is dropped and the giraffe walks over it, the ideal interval from administration of the antagonist and the animal standing is 10-20 minutes (Bush *et al* 2002).

A common practice for giraffe anesthesia in Europe is to immobilize the giraffe and rope it to achieve lateral recumbancy, then to and tie the legs (right front to right hind and left front to left hind), while the head and neck is held in an elevated position. Once the legs were tied the reversal agent is administered IV and consciousness is regained. The covered head and neck are retained in a raised position and the tied legs are held firmly by the keepers, while hoof trimming or other non-surgical procedure preformed. As soon as the procedure is completed and all equipment removed from the area, the head and neck as slowly lowered to the ground and held down by at least two keepers. The leg ropes are removed and the legs massaged by hand or broom to restore circulation. The giraffe is the held laterally recumbent for 10 minutes, after which the restraining staff quietly withdraw. In most cases the giraffe sat up immediately and usually got up within two minutes (Benlow & Lyon 1997).

8.6 Quarantine Requirements

Proper quarantine of newly arrived animals is an essential part of the preventative medicine program. Ideally the new (or leaving) giraffe should be housed separately from others and serviced by staff who will not have contact with resident animals for the quarantine period. Quarantine protocols differ depending upon the animal species and the facility. For international giraffe transfers the animal will require a pre-export quarantine according to Australian Quarantine and Inspection Service (AQIS) in Australia and New Zealand Ministry of Agriculture and Forestry (MAF) in New Zealand protocols. On arrival it will then undergo a post-export quarantine.

9.5 Intraspecific Compatibility

Intraspecific interactions between giraffe individuals tend to be amicable, even between bulls, as once a bull has established his dominance he will ignore the presence of subdominant males in the vicinity. However in the captive situation some problems can arise such as over indulging in necking behaviour and misplaced sexual or homosexual behaviour as described in section 9.3 Behavioural Problems. Serious fighting between males is very rare, however situations where evenly matched males kept together, where it is difficult to keep out of each others way and in the presence of females can lead to more serious fight and is more likely to develop into habitual increased necking behaviour.
Giraffe bulls can be housed together in the absence of female giraffe in bachelor groups, lager bulls will still the will tend to assert dominance over younger or small bulls, and ample space, particularly in the nightquarters is recommended.

9.6 Interspecific Compatibility

Giraffe have been kept with a variety of other species both large and small, such as gazelles, assorted larger antelope, zebras, camels, water buffalo, deer, Rhinoceroses, ostrich, cranes, geese, and even meerkats.
The most important factor is enclosure size, species groups and individuals need to be able to avoid each other if they choose to, areas that can only be accessed by animal of a particular size are ideal The provision of the correct type and amount of food per group or individual can be difficult in mixed species exhibits.
As with all mixed species exhibits, there are pros and cons, it usually depends upon individuals of a species rather than the species itself, one zoo may display zebra with giraffe without problems, but another zoo may have a particularly territorial zebra stallion that is not compatible with their giraffe group.
At Victoria's Open Range Zoo, they had problems of giraffe aggression directed towards a white rhino, this was resolved by chemical castration of the giraffe.

9.7 Introductions and removals

All giraffe introductions should be gradual, weather it is between giraffe or giraffe and other species. Ideally individuals should familiarize them selves with each other in adjacent enclosures prior to actual introduction to ensure compatibility. (Lee 1991). Giraffe can usually be coaxed to move from area with food, particularly by offering a large branch of browse.

9.2 Reproductive Behaviour

Young bulls frequently engage in play fighting, which consists of sparring and necking (figure 20). They stand in parallel or reverse parallel stances, swinging their heads and necks in turn, and strike blows at each others flanks and shoulders, they also intertwine their necks and push each other back and forth (Calle *et al.* 1993). The part of the neck that is usually struck has 15mm thick hide. Mounting, an expression of dominance, often follows necking bouts (Murray 1997). Necking and sparring matches occur at all times of the day in all seasons regardless of the presence of females (Dagg & Foster 1976). Necking takes place only in male giraffe and is possibly used to establish a dominance hierarchy. Opponents are rarely injured, no matter how fierce the necking, and giraffes almost never kick each other, potentially a more dangerous defense used only against predators. Males begin competing for mates at around seven years of age. As male giraffe mature they become more solitary and their time is shared between feeding and monitoring the reproductive status of females within their core ranges. Male Giraffe are very hierarchical and sometimes start reacting to one another from a considerable distance away. They posture their heads and neck, submission is indicated by a lowered head and downward ears. A bull approaching another with forward stretched head with raised chin indicates dominance. (Kingdon 1984). Necking rituals select the most vigorous males without involving serious fighting, in a society with very impermanent and loose herd relationships the creation of a dominance hierarchy is most important.

Although reproduction in giraffe is typical of non-territorial ungulates (Estes 1991), the necking behaviour of giraffe bulls is not seen in other species. The fighting technique in giraffe is atypical to other ungulates, due to their body and build. The head is used to administer blows against the opponents' body and legs, opponents may face each other, but more often stand side by side, delivering wide swinging blows. The force of the blow is considerable. Bouts can consist of striking with the head interspersed with, wrapping of necks together and pushing against each other. There is a correlation between fighting technique and horn type, the force of blows administers would be lethal if the horns were longer and sharper, instead of being short and blunt.

9.3 Behavioural Problems

Stereotypic behaviors such ad pacing, head twirling and tongue playing are seen in giraffe. The stereotypic behaviour of tonguing or tongue playing is also observed in wild giraffe (Veasey *et al* 1996).

Locomotor stereotypic behaviour is more common in adult than subadult giraffe, reinforcing the view that stereotypes develop as an animal matures (Veasey *et al* 1996). In recent studies on giraffe behaviour (Veasey *et al* 1996) noted increased rumination correlated with increase enclosure size, (rumination is believed to occur when an animal is unstressed). However enclosure size and food restrictions did not increase stereotype behaviors, but factors such as social tension did.

9.3 Behavioural Problems con't

Mixed species exhibits and in turn interspecies interactions are a good source of sustainable enrichment for all species concerned (figure 22). Behaviors, which might have been classed as stereotypic in captive animals, were noted in wild individuals; suggesting captive animals are not as stress in captivity as might have previously been thought (Murray 1997).

Other behavioral problems noted in the captive situation are over indulging in necking behaviour and misplaced sexual or homosexual behaviour. In some cases young bulls that were over indulging in necking behaviour developed large swollen pectoral muscles where scar tissue had accumulated from constant blows to the chest and lower neck.

Misplaced sexual or homosexual behaviour (such as urine testing and mounting), is common in bachelor giraffe bulls which is possibly a follow on from dominance assertion, or a habitual behaviour (it is seen in retired breeding bulls as well as bulls that have never been in a breeding situation).

Increased environmental enrichment options can help in distracting individuals from problem behaviors.

9.4 Behavioural Enrichment

Animal carers are becoming increasingly aware of the importance of enrichment in the enhancement of well being for captive animals. Environmental enrichment is a concept, which describes how the environments of captive animals can be changed for the benefit of the inhabitants (Young 1998).

A range of environmental enrichment options are available for captive giraffe, the most common is the supply of hanging browse branches. Most giraffe enrichment devices involve food and employ the giraffe to use its tongue (figures 23 24 25 26 & 27). Enrichment is widely used for all species in zoos and many websites are dedicated to it (see bibliography).

10.2 Birth

- Gestation in the giraffe is approximately 450 days, but as the estrous cycle is short at 14 days, it may be difficult to estimate the exact due date.
- As gestation progresses there is noticeable change in abdomen size and udder development.
- The teats start to enlarge about 19 days before parturition and milk production occurs about two days before (Reason 2000).
- Nearing the due date it is advisable to prepare a birthing stall with a deep bed of straw, mulch or shavings, adjacent to, but separate from the other giraffe, particularly any bulls.
- The expectant giraffe is usually kept separate each night, and should be alone as far a possible during the birth.
- Observations of the birth should be made from a distance, the area should be closed from the public and unnecessary noise should be avoided.
- As the birth nears, behavioral changes are sometimes noted, such as changes in feeding and sleeping patterns, increased water intake and decreased food intake. Some giraffe become nervous, others remain calm and unperturbed (Reason 2000).
- Fetal movement may be seen two weeks before birth.
- The duration of labor in giraffe varies, but is about 2 3/4 hours on average, labors lasting longer than 5 hours may be a cause for concern (Reason 2000).
- If there has been little or no progress in the birth an hour or so after the head appears the dam may require assistance, this may be facilitated in a crush.
- Impending parturition is indicated by fetal kicks, increased drinking, pacing and "bearing down " (where the back legs are spread slightly and the dams appears to be straining), dams may also lye down and get up again.
- Normal presentation is front feet first followed by the head and neck, positioned between the forelegs, the calf swings with the dams movement, once the shoulder emerge the calf is delivered quickly, falling to the floor and breaking the umbilical cord.
- The dam usually eats the amniotic membrane, as she licks her calf, and may or may not eat the placenta, which is usually passed within 3 hours of the birth.
- It is normal for a large amount of bloody fluid to discharge from the vulva for a few hours after the birth.
- The calf should stand and suckle within the first hour.
- The umbilicus remains attached for about two months.

10.0 Breeding

In captivity in Australasia, female Giraffes breed reliably from the ages of four to fourteen years, and have bred up to the age of 27. Male fertility peaks between the ages of 6 and 14 years, though they have continued breeding up to the age of 24.

Table 4. Reproductive parameters from studbook data

Females	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding - birth of offspring)	3 years 4 months - 27 years 5 months
Age range of peak reproduction (Age classes for which average (median) Mx value is exceeded)	4 years - 14 years
Males	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding- birth of offspring)	3 years 6 months - 24 years
Age range of peak reproduction (Age classes for which average (median) Mx value is exceeded)	6 years -14 years

10.1 Mating Systems

Giraffe will breed throughout the year, in wild giraffe there is some correlation between rainfall one-month before conception and conception (Skinner & Smithers 1990). Most females conceive for the first time in their fourth year, but males do not generally reproduce before the age of seven if housed with older bulls. When the only bull in a group captive male giraffe have proven to be precousious, with many breeding at three or four years of age the youngest bull to sire offpsring did so at age 2 years and 7 months.

Giraffes produce a single offspring (rarely twins) after a gestation period of 15 months (450 days). Three set of twins have been born in Australasia, out of 214 births, (one set at Auckland Zoo that survived and two premature sets at Western Plains Zoo, from the same dam, none of which survived) (Jolly 2000).

Giraffe cows can conceive again several months after birth, the minimum interval between births is 16 months. Lactation lasts 6 to 12 months and female giraffe continue to reproduce until around 20 years of age.

Female giraffe have reproductive tracts similar to other ruminants, ovaries are paired and symmetrical, with a bipartate uterus and symmetrical horns. The estrous cycle length is about 15 days, ovulation occurs with equal frequency from both ovaries. Oestrus lasts about one day and males giraffe detect oestrus by urine sampling. A postpartum oestrus has been observed, however a lactational anoestrus of several months is the norm (Calle *et al* 1993).

10.1 Mating Systems con't

Mature male giraffe move about herds checking females for reproductive status by urine testing. The bull sniffs the cow's vulva, stimulating her to urinate (figure 28), the bull draws urine into his mouth, with his head raised, mouth open and upper lip curled up, (figure 29) the urine is sampled in the Jacobson's organ in a typical flehemen response (Calle *et al*. 1993).

Giraffe bull dominance is a linear hierarchy expressed by the displacement of subordinates from estrous females, which frequently occurs by the mere fact of their presence. Dominant bulls are generally older and larger (Calle *et al*. 1993). Once a bull has located a cow in oestrus, he attempts to maintain a tending bond and keep rivals away. A tending bond describes the attempt of a male to monopolize mating opportunities by staying close to an estrous female and fending off all rivals, this behaviour is typical of nonterritorial, polygynous mating systems in ungulates. The male follows the female closely, moves close and displays a foreleg lift. When the female is ready to mate, she stands still, the male mounts from the rear (figure 30) by sliding his forelegs loosely onto her flanks, and stands bolt upright, with an ejaculatory thrust (Estes 1991).

The reproductive organs of the male giraffe differ little in morphology and histology than those of other ungulates. Spermatogenesis begins at 4 years of age and coincides with rapid increase in testicular weight. Mature male giraffe testes are ovoid, 10 to 14 cm long and 6 to 8 cm wide and suspended with the long axis vertical in a pendulous scrotum. Seminal vesicles, prostate gland, and bulbourethral glands are all present (Calle *et al* 1993). There is an absence of seasonal patterns in testicular testosterone levels, which is consistent with giraffe breeding throughout the year (Hall-Martin *et al* 1987).

11.1. Housing for Rearing

For the safety of both the calf being reared and the staff attending to it, it is best to be kept separated from the other giraffe initially. A stall within the giraffe house is ideal, with a deep straw bed, heating may be required depending upon the season. The calf will also need a larger area in which to exercise. At almost 2m in height at birth, keeping staff may need to elevate themselves on a step or platform in order to feed the calf at a reasonable head height.

11.2 Diet and Feeding Routines

If the giraffe calf has not suckled from its mother, it is recommended that the first feed be colostrum (ideally from the calf own mother, but rarely available), bovine colostrum available from most cattle dairies is the best alternative. (Burgess & Blyde 1991). No protein should be given before the colostrum, as this will prevent the absorption of immunoglobulins (Lee 1991)
The milk formula is offered in a 3 litre bottle with a latex teat, 20cm in length and 2.5cm in diameter (Burgess & Blyde 1991). Care should be taken to ensure the teat is secure as calves have been known to swallow them. Artificial milk replacer "Denkovit" at a dilution rate of 100g powder to 1L of water has been used to rear giraffe. " Denkovit, a calf milk replacer is similar in consumption to giraffe milk (Greed 1961) and is readily available. The water used to mix the formula is first boiled then allowed to cool to body temperature before feeding. After each feed the teat and bottle are washed with detergent, rinsed thoroughly and stored in Halamid solution, which is changed every three days.
As a general rule, a giraffe calf is expected to consume between 10-20% of it body weight over a 24hour period (Lee 1991).
Example Feeding regime - five feeds per day at four hourly intervals (between 0600to 2200hrs), from week 1 to week 5 about 6.5 litres were feed daily, from week 6 to 10 about 10 litres were fed daily, from week 10 onwards the daily volume and number of feeds was slowly reduced as the intake of solid food increased. (Burgess & Blyde 1991).

Table 5. Giraffe calf feeding regime.

Age in weeks	Number of feeds per day	Average daily volume
1 - 5 weeks	five	6.5 L
6 - 12 weeks	four	10 L
13 - 17 weeks	three	8 L
18 - 23 weeks	two	4 L
24 - 28 weeks	one	1.5 L

11.3 Weaning

Young giraffe begin browsing when a few weeks old and begin ruminating for short periods at 1 to 4 months of age (Lee 1991). From about two months of age, it is recommended that solid foods (browse, lucerne, vegetables and pelleted ration) be introduced and the amount offered be

slowly increased as the daily volume of milk formula be gradually decreased until weaning is achieved (Burgess & Bylde 1991).

11.4 Behavioural Considerations

Hand raised giraffe can be habituated to human company, in the case of two hand raised giraffe that were later moved to open range zoos (Werribee & Monarto) the individuals actively sort out humans and would regularly place their heads inside safari buses, a potentially dangerous act.

11.5 Use of Foster Species

Due to the height of infant giraffe, no other animal species would be physiologically capable of fostering a giraffe. Other lactating giraffe have been known to accept another's calf a rear it. Some lactating females will even allow other adult giraffe to suckle. However, young giraffe have benefited from the presence of companion animals in the absence of other giraffe. Dairy cows (Allin 1998), eland and camels have been successfully used as companion animals for young giraffe (at Werribee Zoo), but this can lead to the giraffe associating with the companion species in preference to other giraffe in later life.

11.6 Reintroduction Procedures

If he calf is to be reintroduced to the giraffe group it is best to house it in the same vicinity, preferable with visual and nose to nose contact with other giraffe. This can be achieved with half doors and mesh partitions. Once the calf is about three months old provided it is healthy, feeding well and growing it can be gradually introduced to other giraffe. It is best to introduce the calf for short periods to other younger giraffe first, then to adults; gradually increasing the duration spent together (Burgess & Blyde 1991). For all introductions a keeper should be present to monitor behaviors and to intervene should problems arise.

10.3 Growth and Development

- The average height of giraffe calves at birth is approximately 1.6 - 1.8m for females and 1.7 - 2m for males.
- A giraffe calf needs to be a certain height in order to reach their mother's udder to suckle.
- Young giraffe grow incredibly quickly, as much as 23cm in the first month, much of the increase is in the neck region. During their first six months giraffe calves can grow as much as 100cm, growth rates continue but slow to 2cm per month during the calf's second year (Dagg & Foster).
- Giraffe calves weight about 50 to 70 kg at birth.
- It is important that young giraffe grow quickly, as the smaller they are, the more vulnerable they are to predators (Murray 1997).
- Giraffe calves are weaned by their mothers between 8 - 18 months of age (Dagg & Foster 1976).

10.4 Techniques Used to Enhance or Control Breeding

10.4.1 Assisted Reproduction Techniques

Giraffe reproductive research and animal training and conditioning has enhanced the ability to perform mildly evasive procedures such as; vaginal examinations, cervical catheterization, rectal palpation, and ultrasound examination on nonsedated giraffe (Calle *et al* 1993) (figure 15, rectal ultrasound observation of ovaries in female giraffe at Taronga Zoo).
Artificial reproduction technologies offer many tools to enhance both the captive management and the long term genetic management of giraffe.
Estrus synchronization, which allows control and timing of the periovulatory period for artificial insemination or timed natural breeding, has been achieved in giraffe using oral doses of progestogen altrenogest, or injections of lutalyse or insertion of progesterone-releasing intervaginal devices (Calle *et al* 1993).
Semen collection via electro ejaculated using a domestic bull probe has been achieved on physically restrained male giraffe (Foxworth et al 1993).
Artificial reproductive technology and methodology for the synchronization of oestrus, collection and preparation of semen for artificial insemination and techniques for the introduction of semen into the uterus resulting in the live birth of a giraffe calf has been achieved in the USA (Foxworth et al 1993).
The following ARAZPA zoos have conducted assisted reproductive techniques on giraffe: Auckland Zoo, Taronga Zoo and Perth Zoo.

10.4.2 Contraception

The easiest method of contraception in giraffe is separation of the sexes. Other contraceptive methods used in ungulate species can be employed in giraffe (Porton & Hornbeck 1993). Male giraffe can be vasectomized and MGA implants and anti GnRH vaccines have been used as contraceptive methods in giraffe (Asa et al 1996). The American Zoo Association has a contraceptive advisory group who can be consulted for the latest information (AZA 2003).
The following ARAZPA zoos have uses contraceptive methods for giraffe: Victoria's Open Range Zoo, Taronga Zoo Western Plains Zoo and Wellington Zoo.

11.0 Hand Rearing of Giraffe

The decision to hand rear a giraffe calf should not be taken lightly, it is going to require a lot of work and patience lasting over six months. If a female giraffe is not going to rear her calf it is generally fairly obvious, her behaviour may range from completely ignoring the calf to being actively aggressive or fearful of it. Unfortunately these females tend to be habitual poor mothers an never rear their own calves (Colin Walbank, Pascale Benoit pers *comm.*).
In a few circumstances, giraffe mothers have been sedated to induce them to accept, or allow their calf to suckle (Fischer *et al* 1997). Any giraffe calf that stops suckling within its first four months should be bottle fed, with additional milk as it is unlikely to be able to obtain sufficient nutrients for solid food at this age (Lee 1991).
Analysis of giraffe milk indicate that the fat content ranges from 12.5% (day 10 of lactation) to 4.8% (day 150 of lactation), suggesting different requirements at different stages of development (Lee 1991).
It may be necessary to physically restrain the young giraffe for feeding for the first few days until they voluntarily accept the bottle and feed. In some cases a nasogastric tube may be required for calves that are reluctant to be restrained or are morbid. Where force-feeding is required, take care to avoid aspiration pneumonia.
It is important to ensure that the meconium (first faeces) has been passed, sometimes the meconium is retained resulting in colic symptoms, and a rectal exam and removal will alleviate the symptoms (Lee 1991).
It is important to be able to monitor the growth and development of the giraffe being reared, to compare it progress with parent reared individuals. Giraffe calves can easily be trained to walk onto scales for weighting. The following ARAZPA zoos have hand reared giraffe calves: Western Plains Zoo, Taronga Zoo, Melbourne Zoo & Perth Zoo.

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Appendix 2. Australasian Zoo Contacts

Zoo	Phone Number	Contact
Adelaide Zoo	08 8267 3255	Mark Craig mcraig@adelaidezoo.com.au
ARAZPA	02 9978 4797	Caroline Lees caroline@arazpa.org.au
Auckland Zoo	09 360 3800	Glen Holland glen.holland@aucklandcity.govt.nz
Hamilton Zoo	0 838 6720	
Melbourne Zoological Gardens	03 9285 9300	Chris Banks cbanks@zoo.org.au
Mogo Zoo	02 4474 4930	Bill Padey mogozoo@sci.net.au
Monarto Zoological Park	08 8534 4100	Colin Colquhoun mzpwildman@monartozp.com.au
National Zoo & Aquarium	02 6287 8400	Trent Russell trent@zooaquarium.com.au
Orana Wildlife Park	03 359 7109	Ian Adams info@oranawildlifepark.co.nz
Perth Zoological Gardens	08 9376 7988	Colin Hyde colin.hyde@perthzoo.wa.gov.au
Taronga Zoo	02 9969 2777	Erna Walraven ewalraven@zoo.nsw.gov.au
Victoria's Open Range Zoo	03 9731 9600	
Wellington Zoological Gardens	04 381 6750	Mauritz Basson mauritz.basson@wcc.govt.nz
Western Plains Zoo	02 6881 1400	
ASMP Giraffe Studbook Keeper	03 9731 9645	Lorraine Jolly ljolly@zoo.org.au

Appendix 3. Taronga Zoo giraffe Training Protocol

Giraffe Artificial Insemination - Conditioning Protocol

By Natalie Connors and Anthony Dorrian - Keepers African Division, Taronga Zoo. 2000

Taronga Zoo African Division staff conditioned one male and two female giraffe for assisted reproduction techniques. The giraffes are conditioned to entering, standing in and being physically confined in the crush to enable tactile conditioning. The giraffes at Taronga Zoo tolerate rectal examinations as well as vulval examinations quite well. We concentrate much of our work on rectal examinations as the ultrasounding to locate the ovaries is critical for the project. The following outline is the conditioning protocol which was followed to achieve the possible artificial insemination of female giraffe without the need for chemical restraint.

Step 1 Conditioning for semen collection should begin with familiarisation in a crush. The crush should be designed in such a way that it can be walked through as part of the daily routine.

Step 2 Once the giraffe are comfortably walking through the crush they should be re-enforced for standing and feeding in it by simply introducing a feed basket. This gives them the opportunity to leave the crush if they feel threatened. A gate can then be introduced to effectively close one end of the crush. Food can then be placed on this gate to encourage the giraffe to walk into the half closed crush. Until the giraffe are confidently walking into and remaining in the crush they should have the option of backing out and re- entering.

Step 3 Full containment in the crush should be attempted when the keepers deem it possible for short periods of time. Length of time spent contained in the crush can then be extended as the animal's stress level dictates that it is comfortable in the crush. If the animal appears stressed it should be released from the crush and encouraged to re-enter without being fully contained. This ensures that the conditioning ends on a positive note. Prior to the commencement of any tactile work the giraffe should be voluntarily entering the crush and capable of standing and feeding without showing excessive signs of stress.

Step 4 Tactile conditioning should begin with a still hand on the rump progressing to continuous strokes on the rump region, legs and underbelly. Progression of tactile conditioning will differ with individuals and should be once again predicted by the animal. If the animal is comfortable standing in the crush and feeding and shows no anxiety then progression from a still hand on the rump to gentle stroking can be attempted. We began with touching all areas around the rump and tail prior to attempting any internal work. We found that the initial touch startled the animals but they settled down quickly as long as continuous strokes were used therefore keeping a hand on their rump the whole time.

Step 5 Rectal examination should be approached by either going under the tail or moving it to one side. If possible avoid lifting the tail, it has been found to be unsettling to Taronga Zoo's females in the past. Rectal gloves and lots of lubricant are essential for this part of the conditioning. Prior to the insertion of a probe the giraffe should be conditioned to having a hand and forearm inserted into the rectum and moved around. This should be achieved as slowly as possible to avoid any undue stress on the animal. The giraffe should then be introduced to the probe. Not until the giraffe is tolerating the probe without any stimulation should electro-ejaculation be attempted.

To be very specific, rectal examination began slowly. One gloved finger with lots of lubricant, progressing to two, then three etc until a whole hand was able to be inserted. We found that the most uncomfortable time for the animals was until the hand was inserted to the wrist. The muscles contract and relax continuously at this time and we always found it best to apply constant pressure and not to go too slow. Once a hand is inserted our giraffe tend to stand relatively quietly. This is as far as the keepers, could go without the assistance of a vet. So on the days when vets were unavailable the keepers would work on doing exactly what the vets would do- that is trying to identify organs and moving a hand around internally. The vets performed several rectal examinations before bringing a specialist artificial insemination vet in to help with ultrasounding.

The vets found that the ovaries are located much closer than would probably be expected. From a lay man's perspective without all the technical jargon, once you enter the rectum head down rather than proceeding straight ahead and you will probably only need to reach as far as half way up your forearm- on the average person. The ultrasound equipment used at Taronga Zoo is an Aloka 500 unit with a 5MHz veterinary electronic linear probe (model no. UST-5811-5).

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14.0 Appendix.

14.1 Appendix 1..

14.2 Appendix 2. Australasian Zoo Contacts

14.3 Appendix 3. Taronga Zoo giraffe Training Protocol

The probe is one that is used for cattle artificial insemination and fits snuggly within the hand so provides no extra discomfort on insertion.
In Taronga Zoo steps 1 to 5 were achieved with female giraffes over a 3 month period with daily 15 minute training sessions. It is recommended that at least initially a minimum number of people are involved in the conditioning until the animal is used to the conditioning routine.